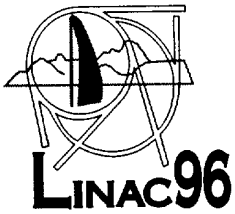
SLAC-R-627



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Compendium of Scientific Linacs

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Foreword

The International Committee supported the proposal of the Chairman of the XVIII International Linac Conference to issue a new Compendium of linear accelerators. The last one was published in 1976. The Local Organizing Committee of Linac96 decided to set up a sub-committee for this purpose.

Contrary to the catalogues of the High Energy Accelerators which compile accelerators with energies above 1 GeV, we have not defined a specific limit in energy. Microtrons and cyclotrons are not in this compendium. Also data from thousands of medical and industrial linacs has not been collected. Therefore, only scientific linacs are listed in the present compendium.

Each linac found in our research and involved in a physics context was considered. It could be used, for example, either as an injector for high energy accelerators, or in nuclear physics, material physics, free electron lasers or synchrotron light machines.

Linear accelerators are developed in three continents only : America, Asia, Europe. This geographical distribution is kept as a basis.

The compendium contains the parameters and status of scientific linacs. Most of these linacs are operational. However, many facilities under construction or design studies are also included. A special mention has been made at the end for the studies of future linear colliders.

In spite of all the care we took to compile all world linacs existing or under development, some are probably missing. The reason is either a lack of information or the fact that no answer was received from the institute.

Many thanks to all persons in the various laboratories who supplied the data about their linacs. We hope that this Compendium will be a useful tool for the Linac community.

L. Rinolfi

Committee and Contributors for the 1996 Compendium

The members of the sub-committee who produced this Compendium are the following :

J. Clendenin (SLAC)
L. Rinolfi (CERN) - Chairman
K. Takata (KEK)
D.J. Warner (CERN)

Y. Yamazaki (KEK) contributed by collecting data from Asian linacs and made useful comments.

S.L. Neboux provided great help using the WWW to obtain information about various linacs and organizing the secretariat. Last but not least, she installed and updated the Compendium on the World-Wide Web.

E. Bryant, T. Kehrer and A. Rogerson have handled the secretarial work in an efficient and enthusiastic way. The clarity of the typing and the efficiency to correct the mistakes have been appreciated. During the elaboration of the Compendium, they kept smiling and that participated to its success.

H. Haseroth, Chairman of the International Committee, proposed the compilation of a Compendium of linacs for this conference.

D. Dekkers, Chairman of the Local Organizing Committee and B. Allardyce made useful comments to finalize the catalogue.

Summary

This compendium comprises 176 scientific linacs distributed over 3 continents :

Americas	:	61
Asia	:	37
Europe	:	78

Altogether the breakdown for the types of particles is the following :

Electrons	:	111
Positrons	:	12
Protons/H^-	:	23
Ions	:	30

The lists, without technical details, are published on the World-Wide Web. The address is the following :

http://www.cern.ch/Linac96/Linacs.html

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AMERICA (North & South)

ELECTRON LINAC

Name of Linac : *Linac*
Function : *Electron Linac - Pulsed Source of Neutrons*
Institution and address : *Centro Atómico Bariloche - Bariloche - Argentina*
Person in charge : *Dr. Rolando Granada*
Name of person supplying these data : *Dr. Rolando Granada*
e-mail : *granada@cab.cnea.edu.ar*
tel. : *+54 944 45223* fax : *+54 944 45299*

HISTORY AND STATUS

Const. started : *1964* ; first beam : *1969*
Present status : *Operating*
Cost of facility :
Present linac staff : *2 man-years*
Present yearly operation time : *900* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *0.15* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Pre-Buncher*
Output : MeV; intensity : A
Pulse width, spacing : *1.2 μs, 10 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *6* m
No. sections : *1* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *(1)* ; Q : *15000*
Shunt impedance : *53-60* MΩ/m
Iris : aperture : diameter : *19.2-26.7* mm
thickness : *5.8* mm
Attenuation/section : *0.57* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *12* MW; mean : *2.6* kW

Focusing System

Type, No. of elements, and spacing :
On the injector and on the beam transport system.
None on the WG

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.025*		GeV
Accel gradient	*8.3*		MeV/m
ΔE/E (FWHM)	*5*		%
Rep. rate	*100*		Hz
Pulse length	*1.2*		μs
Beam intensity	*0.020*		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

(1) $v_g / c = 0.02 - 0.0065$

ELECTRON LINAC

Name of Linac : *LNLS* *
Function : *Storage ring injector*
Institution and address : *LNLS - CX Postal 6192, Campinas, Brazil*
Person in charge : *Lucia C. Jahnel*
Name of person supplying these data : *Lucia C. Jahnel*
e-mail : *Lucia@LNLS.ANSP.BR*
tel. : *+55 19 257 4520* fax : *+55 19 257 4632*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *12/1987*
Present status : *(1) Commissioning*
Cost of facility : *35 MUSD*
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : *40* π mm-mrad

Injector

Longitudinal matching : *Pre buncher (no buncher)*
Output : *0.08* MeV; intensity : *2* A
Pulse width, spacing : *100 ns; 66 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *20.5* m
No. sections : *4* ; lengths : *3.07* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *(2)* ; Q : *13000*
Shunt impedance : *52 - 60* MΩ/m
Iris : aperture : diameter : *26.2 - 19.2* mm
thickness : *5.8* mm
Attenuation/section : *0.57* Np
Power units, Number : *2* type : *(3) Klystron*
RF power peak : *25* MW; mean : *(4)* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids at the first acc. struc., a triplet between the second and the third acc. struc., two quadrupoles and a spectrometer at the end.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*> 0.1*	*0.10*	GeV
Accel gradient	:	*10*	*10*	MeV/m
ΔE/E (FWHM)	:		*1*	%
Rep. rate	:	*15*	*15*	Hz
Pulse length	:	*0.1*	*0.1*	μs
Beam intensity	:		*0.100*	A
Norm. emit. (1σ)	:		77×10^{-4}	π mm-mrad

OTHER RELEVANT INFORMATION

* *LNLS - Laboratório Nacional de Luz Sincrotron (100 MeV Linac)*

(1) The first two structures (50 MeV) have been in operation since 1987. During July 1995, the machine was transferred to the definitive LNLS site where the two remaining accelerating structures were installed. The first beam with energy above 100 MeV was obtained on December 22nd 1995.

(2) 0.0204 - 0.0065

(3) Divided for 2 structures.

(4) 3.8×10^{-3}

ELECTRON LINAC

Name of Linac : *IEAv * electron linac*
Function : *Neutron production and radiation dosimetry research*
Institution and address : *CTA/IEAv - Rod, Tamoios km 5.5 São José dos Campos - SP - Brasil*
Person in charge : *C.R.S. Stopa (laboratory) - C. Fuhrmann (linac)*
Name of person supplying these data : *C.R.S. Stopa*
e-mail : *stopa@ieav.cta.br*
tel. : *+55 123 413033 (ext. 278)* fax : *+55 123 414277*

HISTORY AND STATUS

Const. started : *(1) 1986* ; first beam :
Present status : *Under construction*
Cost of facility : *5 MUSD (1995)*
Present linac staff : *12 man-years*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *4* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : MeV; intensity : *2* A
Pulse width, spacing : *200 ns - 1.25 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *4* m
No. sections : *(3) 2* ; lengths : *2.0* m
Field mode : *2π/3* ; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *1.0* μs
v_g/c range : *(4)* ; Q : *19000*
Shunt impedance : *(eff) 32* MΩ/m
Iris : aperture : diameter : *44.94 - 39.40* mm
thickness : *12.00* mm
Attenuation/section : *0.23* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *60* kW

Focusing System

Type, No. of elements, and spacing :
Eight solenoids up to 30 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*0.030*	GeV
Accel gradient :		*9.0*	MeV/m
ΔE/E (FWHM) :		*15*	%
Rep. rate :		*800*	Hz
Pulse length :		*0.200*	μs
Beam intensity :		*2.0*	A
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

* *Instituto de Estudos Avançados*

(1) The linac construction was interrupted during the 90-94 period due to fund shortage.
(2) L-band prebuncher and buncher.
(3) The first accelerating structure includes a 0.57 m long bunching region.
(4) 0.0076 - 0.0047

ELECTRON LINAC

Name of Linac : *Saskatchewan Accelerator Laboratory*
Function : *Provide c.w. beams for subatomic physics research*
Institution and address : *University of Saskatchewan, 107 North Road, Saskatoon, Sask S7N 5C6 Canada*
Person in charge : *Dr Dennis M. Skopik*
Name of person supplying these data : *Dr J.J. Murphy*
e-mail : *jjm@skatter.usask.ca*
tel. : *+1 306 966 6071* fax : *+1 306 966 6058*

HISTORY AND STATUS

Const. started : *1961* ; first beam : *1965*
Present status : *Operational*
Cost of facility :
Present linac staff : *48*
Present yearly operation time : *5000* h

LINAC PARAMETERS

Electron Sources

Types : *Haimson* ; energy : *220* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : *23* π mm-mrad

Injector

Longitudinal matching :
Output : *12* MeV; intensity : *1.3* A
Pulse width, spacing : *1.5 μs, 2.8 ms*
Normalized emittance (1σ) : *0.43* π mm-mrad

Acceleration System

Total linac length : *28* m
No. sections : *6* ; lengths : *3.3 - 4.83* m
Field mode : *(1) 2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.78* μs
v_g/c range : *(2)* ; Q : *15000*
Shunt impedance : *53-60* MΩ/m
Iris : aperture : diameter : *0.75-1.0* mm
thickness : *5.8* mm
Attenuation/section : *5.7* Np
Power units, Number : *6* type : *ITT*
RF power peak : *21* MW; mean : *21* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.110-0.295*	*0.310*	GeV
Accel gradient			MeV/m
ΔE/E (FWHM)	*1*		%
Rep. rate	*180*	*360*	Hz
Pulse length	*0.36*	*2*	μs
Beam intensity	*0.016-0.060*	*0.220*	A
Norm. emit. (1σ)	*0.3*	*0.3*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) TM010
(2) 0.020 - 0 .0065

ION LINAC

Name of Linac : *ISAC* *
Function : *Accelerator of Light Radioactive Ions*
Institution and address : *TRIUMF, 4004 Wesbrook Mall, Vancouver, B.C., Canada, V6T 2A3*
Person in charge : *P.W. Schmor*
Name of person supplying these data : *G. Dutto*
e-mail : *dutto@triumf.ca*
tel. : *+1 604 222 7419* fax : *+1 604 222 1074*

HISTORY AND STATUS

Const. started : *1995* ; first beam : *2000*
Present status : *Design, prototyping*
Cost of facility : *34 MCDN*
Present linac staff :
Present yearly operat. time : *na* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3*
Types of source : *CUSP, SURFACE, ECR ...*
Species of ions : *A ≤ 30*
Range of currents : *≤ 1* μAe
Range of output energies : *2* keV/u
Pulse length : *dc* μs; rep. rate : *dc* Hz
Normalized emittance (1σ) : *0.026* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *RFQ (split ring, 4 rod) / 8* m
Output currents : *≤ 1* μAe
Output energies : *150* keV/u
Frequency : *35* MHz; peak RF power : *150* kW
Pulse length : *cw* μs; rep. rate : *cw* Hz
Normalized emittance (1σ) : *0.026* π mm-mrad

Longitudinal Matching

Type : *4 Harmonic single gap buncher*
Mod. *0.2* keV; drift *5700* mm at *11.5* MHz
0.1 keV; drift *3000* mm at *35* MHz

Accelerating System

Total linac length : *5.6* m; N°. of tanks : *5*
Tank diameters : *1* m
Number of drift-tubes : *9, 13, 15, 14, 13*
Drift-tube lengths : *25.7 - 80.0* mm
Drift-tube diam (range): *20 - 26* mm
Gap/cell length (range): *0.43 - 0.55*
Aperture diameter : *10* mm to *16* mm
RF frequency(ies) : *105* MHz
Field modes :
Eff. shunt impedance : *(1)* MΩ/m
Q : *(2)*
Filling time : μs
Equil. phases : *0°* ; accel. rate *0 - 0.24* MeV/u-m
RF rep. rate : *cw* Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : *0.08* MW; mean : *0.08* MW

Focusing System

No. elements : *5*
type : *Quad. triplet* order :
Gradients : *44* to *66* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Carbon Foil*
Charge states : *1* to *6* at *150* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :		*A ≤ 30*	
Energy :		*(3)*	MeV/u
ΔE/E (FWHM) :		*≤ 1*	%
Mean acc. rate :			MeV/u-m
Beam current :		*1*	μAe peak
Norm. emit. (1σ) :		*0.026*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *Isotope Separator and ACcelerator*

(1) (MAFIA) 350, 530, 570, 470, 390 MΩ/m
(2) (MAFIA) 10500, 14000, 19000, 22000, 23000
(3) 0.150 - 1.5 MeV/u

LINAC
- *Double Gap Spiral Resonators before IH tanks*

RFQ
- *4 rod, split ring, cw*

ELECTRON LINAC

Name of Linac : *ALS Injector*
Function : *Electron Injector for the Advanced Light Source*
Institution and address : *LBL, 1 Cyclotron Road, Berkeley, CA 94720, USA*
Person in charge : *Charles Kim*
Name of person supplying these data : *Charles Kim*
e-mail : *chkim@lbl.gov*
tel. : *+1 510 486 7218* fax : *+1 510 486 4960*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *02/1991*
Present status : *Operational*
Cost of facility : *(1) 3.75 MUSD*
Present linac staff : *NA*
Present yearly operation time : *~ 7000* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic triode* ; energy : *120* keV
Beam intensity (peak) : *1* A
Normalized emittance (1σ) : *10* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *0.5* MeV; intensity : *0.2* A
Pulse width, spacing : *(3)*
Normalized emittance (1σ) : *30* π mm-mrad

Acceleration System

Total linac length : *4* m
No. sections : *2* ; lengths : *2* m
Field mode : *2π/3* ; frequency : *2.9979* GHz
Wave type : *TW* ; filling time : *0.4* μs
v_g/c range : *0.017* ; Q : *13620*
Shunt impedance : *56.1* MΩ/m
Iris : aperture : diameter : *23.82* mm
thickness : *5.0* mm
Attenuation/section : *0.267* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *(4)* MW; mean : *0.054* kW

Focusing System

Type, No. of elements, and spacing :
7 solenoids for < 25 MeV
2 quad triplets at 25 MeV and at 50 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *4 ~ 12*
No. of particles/bunch : *2 nC / bunch*
Bunch separation : *8 ns, 1 Hz*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.050*	*0.050*	GeV
Accel gradient	:	*13*	*13*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*1*	*1*	Hz
Pulse length	:	*0.024*	*0.08*	μs
Beam intensity	:	*125*	*125*	A
Norm. emit. (1σ)	:	*40*	*40*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Actual US Dollar spent over 1987 - 1991.
(2) S Band buncher, 125 MHz Buncher, 500 MHz Buncher.
(3) 100ps FWHM, 8ns, 4~10 microbunches, 8 ns spacing.
(4) S Band buncher, section 1, section 2.

ELECTRON LINAC

Name of Linac : *RTA* *
Function : *RF Power Source Prototype for Linear Colliders*
Institution and address : *LBNL, 1 Cyclotron Road, Berkeley, CA 94720, USA*
Person in charge : *Glen Westenskow, Simon Yu*
Name of person supplying these data : *Glen Westenskow*
e-mail : *gw@llnl.gov*
tel. : *+1 510 486 6728* fax : *+1 510 486 5392*

HISTORY AND STATUS

Const. started : *1995* ; first beam : *(1) 1997*
Present status : *Under construction*
Cost of facility :
Present linac staff : *8*
Present yearly operation time : *NA* h

LINAC PARAMETERS

Electron Sources

Types : *Dispenser* ; energy : *1000* keV
Beam intensity (peak) : *1200* A
Normalized emittance (1σ) : *75* π mm-mrad

Injector *(2)*

Longitudinal matching : *Chopper*
Output : *4* MeV; intensity : *600* A
Pulse width, spacing : *0.3 μs*
Normalized emittance (1σ) : *400* π mm-mrad

Acceleration System *(3)*

Total linac length : *8* m
No. sections : *8* ; lengths : *1* m
Field mode : *TM01* ; frequency : *11.4* GHz
Wave type : *TW* ; filling time : *0.001* μs
v_g/c range : *0.26* ; Q : *(4) 8000*
Shunt impedance : *1.2* MΩ/m
Iris : aperture : diameter : *16* mm
thickness : *2.5* mm
Attenuation/section : *NA* Np
Power units, Number : *8* type : *TW & SW*
RF power peak : *(5)* MW; mean : *(6)* kW

Focusing System

Type, No. of elements, and spacing :
PPM Quadrupoles
Lattice period 20 cm
Phase advance 72 degrees

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *3000*
No. of particles/bunch : 3×10^{11}
Bunch separation : *90 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*0.004*	GeV
Accel gradient :		*0.3*	MeV/m
ΔE/E (FWHM) :		*0.3*	%
Rep. rate :		*4*	Hz
Pulse length :		*0.3*	μs
Beam intensity :		*600*	A
Norm. emit. (1σ) :		*400*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Relativistic klystron Two-beam Accelerator*

(1) Gun operation in 1997, full operation in 2002.
(2) Includes injector, chopper and compression stage.
(3) The RF parameters listed in this section are for the rf output structures used in the RTA prototype. In the main section of the prototype the induction cells hold the beam energy at about 4 MeV. RF output cavities are used to extract power from the electron beam.
(4) Wall
(5) 8 × 180 MW
(6) 8 × 0.2 kW

RTA is a linear induction accelerator.

Additional information is available at WEB site "http://rktba.lbl.gov/"

ELECTRON LINAC

Name of Linac : *100 MeV Electron-Positron Linac*
Function : *Positron production; materials science and particle research*
Institution and address : *LLNL *, Bldg. 194, L-280 Livermore CA94550 USA*
Person in charge : *Thomas E. Cowan*
Name of person supplying these data : *Thomas E. Cowan*
e-mail : *tcowan@llnl.gov*
tel. : *+1 510 422 9678* fax : *+1 510 422 0883*

HISTORY AND STATUS

Const. started : *1967* ; first beam : *1969*
Present status : *Operating*
Cost of facility : *4.6 MUSD (1969)*
Present linac staff : *3*
Present yearly operation time : *~ 500* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *105* keV
Beam intensity (peak) : *(2) 15 / 1* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *2.5* MeV; intensity : *(2) 10 / 0.8* A
Pulse width, spacing : *20ns-0.69ms/ 3μs-3.3ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *(4) 17* m
No. sections : *5* ; lengths : *2.42* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.65* μs
v_g/c range : *0.019* ; Q : *13200*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : *26 - 19* mm
thickness : *6.1* mm
Attenuation/section : *0.29 (0.12 Np/m)* Np
Power units, Number : *5* type : *Klystrons*
RF power peak : *15* MW; mean : *16.2* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids for buncher and each TW section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.11 / 0.08*	*0.165*	GeV
Accel gradient	*9.1 / 6.6*	*13.1*	MeV/m
ΔE/E (FWHM)	*2 - 5*	*< 2*	%
Rep. rate	*720 / 300*	*1440 / 300*	Hz
Pulse length	*0.020 / 2.8*	*0.1 / 3*	μs
Beam intensity	*(5) 6 / 0.7*	*(5) 10 / 0.8*	A
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

* *Lawrence Livermore National Laboratory*

(1) Thermionic (BaO in W matrix), modified Pierce geometry.

(2) The LLNL 100 MeV Linac is designed to operate in both a short and a long pulse mode depending on whether the application requires a narrow pulse width (eg. for time-of-flight applications) or high average flux. Typical applications include materials irradiation and generation of secondary positron and neutron beams. Typical short-pulse mode parameters are 1-20 ns pulse width, 10 A peak current, and variable repetition rate from single pulse up to 1440 Hz. Long pulse parameters are 1-3 μs, 0.7 A peak, and variable rep rate from single pulse to 300 Hz. Parameters are listed by short-pulse mode / long-pulse mode.

(3) S-band tapered phase velocity buncher.

(4) Measured to end of TW section # 5.

(5) Maximum beam intensity values are given for operation at 75 MeV. For 165 MeV operation design beam intensity values are 2 A / 0.1 A for short / long pulse modes.

ELECTRON LINAC

Name of Linac : *FXR - Linear Induction Linac*
Function : *Production of x-rays*
Institution and address : *LLNL, Livermore CA 94551, USA*
Person in charge : *Ray Scarpetti*
Name of person supplying these data : *Ray Scarpetti*
e-mail :
tel. : *+1 510 423 5356* fax :

HISTORY AND STATUS

Const. started : *1980* ; first beam : *1982*
Present status : *Operational*
Cost of facility : *12 MUSD (1982)*
Present linac staff : *10*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Cold Cathode* ; energy : *2500* keV
Beam intensity (peak) : *3000* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *2.5* MeV; intensity : *3000* A
Pulse width, spacing : *80 ns*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *35* m
No. sections : *14* ; lengths : *2.5* m
Field mode : ; frequency : GHz
Wave type : ; filling time : μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
Solenoid focusing

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.016*	*0.019*	GeV
Accel gradient	:	*0.65*	*0.75*	MeV/m
ΔE/E (FWHM)	:	*±3*	*±1*	%
Rep. rate	:	*0.03*	*0.1*	Hz
Pulse length	:	*0.08*	*0.08*	μs
Beam intensity	:	*2500*	*3000*	A
Norm. emit. (1σ) :				π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *ETA II*
Function : *Advanced Radiography Development*
Institution and address : *LLNL, PO Box 808, Livermore CA 94551, USA*
Person in charge : *George Caporaso*
Name of person supplying these data : *Glen Westenskow, Yu-Juian Chen*
e-mail : *gw@llnl.gov*
tel. : *+1 510 423 6936* fax : *+1 510 423 2664*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1989*
Present status : *(1)*
Cost of facility :
Present linac staff : *10*
Present yearly operation time : *NA* h

LINAC PARAMETERS

Electron Sources

Types : *Dispenser* ; energy : *1000* keV
Beam intensity (peak) : *2200* A
Normalized emittance (1σ) : *NA* π mm-mrad

Injector

Longitudinal matching : *NA*
Output : *1* MeV; intensity : *2200* A
Pulse width, spacing : *70 ns*
Normalized emittance (1σ) : *350* π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *60* ; lengths : m
Field mode : *NA* ; frequency : *NA* GHz
Wave type : *NA* ; filling time : *NA* μs
v_g/c range : *NA* ; Q : *NA*
Shunt impedance : *NA* MΩ/m
Iris : aperture : diameter : *NA* mm
thickness : *NA* mm
Attenuation/section : *NA* Np
Power units, Number : *4* type : *(2)*
RF power peak : *NA* MW; mean : *NA* kW

Focusing System

Type, No. of elements, and spacing :
82 Solenoids
23.5 cm long, 4 cm separation

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.006*		GeV
Accel gradient			MeV/m
ΔE/E (FWHM)	*2*		%
Rep. rate		*1000*	Hz
Pulse length	*0.07*		μs
Beam intensity	*2000*		A
Norm. emit. (1σ)	*350*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) Preparing for new set of experiments
(2) Magnetic Pulse Compressors

ETA II is a linear induction accelerator
- *60 induction cells*
- *6.6 cm pipe radius*

Nominal beam parameters
- *6.3 MeV plus or minus 2 % beam energy spread*
- *2 to 3 kA beam current*
- *70 ns pulse width with 30 ns flat top*
- *350 π mm-mrad for 1σ normalized emittance*
- *plus or minus 1 mm transverse sweep*

ELECTRON LINAC

Name of Linac : *AXF-0*
Function : *Injector for FEL and Laser Acceleration experiments*
Institution and address : *UC Davis Dept. of App. Science / Lawrence Livermore National Laboratory**
Person in charge : *F.V. Hartemann*
Name of person supplying these data : *Greg Le Sage*
e-mail : *lesage@wente.llnl.gov*
tel. : *+1 510 423 6776* fax : *+1 510 422 2514*

HISTORY AND STATUS

Const. started : *1994* ; first beam : *NA*
Present status : *(1)*
Cost of facility :
Present linac staff : *6*
Present yearly operation time : *NA* h

LINAC PARAMETERS

Electron Sources

Types : *Photocathode* ; energy : *NA* keV
Beam intensity (peak) : *(2)* A
Normalized emittance (1σ) : *NA* π mm-mrad

Injector

Longitudinal matching : *NA*
Output : *5* MeV; intensity : *1000* A
Pulse width, spacing : *2 μs, 0.1 s*
Normalized emittance (1σ) : *< 1* π mm-mrad

Acceleration System

Total linac length : *0.037* m
No. sections : *1* ; lengths : m
Field mode : *π* ; frequency : *8.548* GHz
Wave type : *Standing* ; filling time : *0.16* μs
v_g/c range : *NA* ; Q : *8600*
Shunt impedance : *93* MΩ/m
Iris : aperture : diameter : *6.66* mm
thickness : *6.66* mm
Attenuation/section : *NA* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *(3) 0.4* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid bucking pair

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *100*
No. of particles/bunch : *6.241×10^9 (1 nc /bunch)*
Bunch separation : *467 ps (every 4th rf cycle)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*0.005*	GeV
Accel gradient :		*135*	MeV/m
ΔE/E (FWHM) :		*0.3*	%
Rep. rate :		*10*	Hz
Pulse length :		*2*	μs
Beam intensity :			A
Norm. emit. (1σ) :		*< 1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *PO Box 808, L-402, Livermore, CA 94550, USA*
(1) Accelerator cavity hot RF testing
(2) 1 kA (1 nC / 1 psec)
*(3) 2 μs / pulse * 10 pulses / sec * 20 MW*

Drive laser based on AlGaAs semiconductor rf modelocked oscillator, locked to rf drive master oscillator. Repetition rate is fourth subharmonic of rf drive.

References

[1] "Laser ring photocathode RF linac", F.V. Hartemann, G.P. Le Sage, S. Fochs, D.B. McDermott and N.C. Luhmann Jr., Bull. APS 38, 1941 (October 1993).

[2] "Photoinjector-Driven Chirped-Pulse Free Electron Maser", G.P. Le Sage, F.V. Hartemann, H.X.C. Feng, S.N. Fochs, J.P Heritage, N.C. Luhmann Jr., M.D. Perry, and G.A. Westenskow. AGARD conference proceedings 564, High Power Microwaves, NATO Symposium, Ottowa, Canada (May 1994).

[3] "Gigahertz Repetition Rage AlGaAs / Ti: Sapphire (LiSAF) Modelocked Oscillator / Power Amplifier Laser System for Advanced Photoinjectors", P.J. Delfyett, S.N. Fochs, J.P. Heritage, G.P. Le Sage, J.D. McNally, F.V. Hartemann, N.C. Luhmann Jr., and M.D. Perry, Lasers for RF Guns Proceedings, Brookhaven National Laboratory Publication 52435, 41 (May 1994).

ELECTRON LINAC

Name of Linac : *Saturnus*
Function : *Beam Physics Studies*
Institution and address : *UCLA, Phys. Dep., 405 Hilgard Ave., LA, CA 90095-1547, USA*
Person in charge : *Claudio Pellegrini*
Name of person supplying these data : *Claudio Pellegrini*
e-mail : *pellegrini@physics.ucla.edu*
tel. : fax : *+ 1 310 206 1091*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *3 man-years*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Photoinjector* ; energy : *4000* keV
Beam intensity (peak) : *150* A
Normalized emittance (1σ) : *5* π mm-mrad

Injector

Longitudinal matching :
Output : *4* MeV; intensity : *150* A
Pulse width, spacing : *4 ps*
Normalized emittance (1σ) : *5* π mm-mrad

Acceleration System

Total linac length : *1.5* m
No. sections : *1* ; lengths : *0.4* m
Field mode : *π* ; frequency : *2.856* GHz
Wave type : *SW* ; filling time : *0.9* μs
v_g/c range : ; Q : *10000*
Shunt impedance : *50* MΩ/m
Iris : aperture : diameter : *10* mm
thickness : *10* mm
Attenuation/section : Np
Power units, Number : *1* type : *RK5*
RF power peak : *22* MW; mean : *0.200* kW

Focusing System

Type, No. of elements, and spacing :
1 Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : 6×10^9
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	*0.015*	*0.015*	GeV
Accel gradient :	*25*	*25*	MeV/m
ΔE/E (FWHM) :	*0.2*	*0.2*	%
Rep. rate :	*5*	*5*	Hz
Pulse length :	*2.5*	*2.5*	μs
Beam intensity :			A
Norm. emit. (1σ) :	*5*	*5*	π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *Naval Postgraduate School Linac*
Function : *Education and Research*
Institution and address : *Dept. of Physics, Naval Postgraduate School, Monterey, CA 93943, USA*
Person in charge : *Professor Xavier K. Maruyama*
Name of person supplying these data : *Professor Xavier K. Maruyama*
e-mail : *maruyama@physics.nps.navy.mil*
tel. : *+1 408 656 2431* fax : *+1 408 656 2834*

HISTORY AND STATUS

Const. started : *12/1966* ; first beam : *02/1967*
Present status : *Operational*
Cost of facility :
Present linac staff : *Part time*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.13* MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *3* ; lengths : *3.3* m
Field mode : ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *1* μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : *22* MW; mean : *0.1* kW

Focusing System

Type, No. of elements, and spacing :
Moveable pole tips on two deflection magnet
Quadrupole Doublet

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.1*		GeV
Accel gradient	*10*		MeV/m
ΔE/E (FWHM)	*0.3*		%
Rep. rate	*60*		Hz
Pulse length	*1*		μs
Beam intensity	3×10^{7}		A
Norm. emit. (1σ)	*300*		π mm-mrad

OTHER RELEVANT INFORMATION

Many of the parameters are equivalent to the original Stanford HEPL Mark III Accelerator.

(1) Dispenser Cathode

ELECTRON LINAC

Name of Linac : *SLAC 3-km Linac*
Function : *e^+/e^- Collider, Fixed Target, Injector for B Factory*
Institution and address : *SLAC, PO Box 4349, Stanford, CA 94309, USA*
Person in charge : *Franz-Josef Decker (Linac), Jym Clendenin (Sources)*
Name of person supplying these data : *F-J. Decker*
e-mail : *decker@slac.stanford.edu*
tel. : *+1 415 926 3606* fax : *+1 415 926 2407*

HISTORY AND STATUS

Const. started : *1962* ; first beam : *1966*
Present status : *Operating*
Cost of facility : *114 MUSD (1966)*
Present linac staff : *~ 200*
Present yearly operation time : *~ 6000* h

LINAC PARAMETERS

Electron Sources

Types : *P and T (1)* ; energy : *120* keV
Beam intensity (peak) : *(2)* A
Normalized emittance (1σ) : *(3)* π mm-mrad

Injector

Longitudinal matching : *(4)*
Output : *(5)* MeV; intensity : *(6)* A
Pulse width, spacing : *(7)*
Normalized emittance (1σ) : *100 - 200* π mm-mrad

Acceleration System

Total linac length : *3000* m
No. sections : *960* ; lengths : *3.05* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *(8)* ; filling time : *0.83* μs
v_g/c range : *(9)* ; Q : *14000-13000*
Shunt impedance : *53 - 60* MΩ/m
Iris : aperture : diameter : *26.2 - 19.1* mm
thickness : *5.84* mm
Attenuation/section : *0.57* Np
Power units, Number : *240* type : *Klystrons*
RF power peak : *(10)64* MW; mean : *27* kW

Focusing System

Type, No. of elements, and spacing :
32 quadrupoles spaced 3-m apart; 32 spaced 6-m apart; and 208 spaced 12-m apart.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *(11)*
No. of particles/bunch : *(12)*
Bunch separation : *60 ns for C; 350 ps for FT*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*(13)*	*(13)*	GeV
Accel gradient	:	*19*		MeV/m
ΔE/E (FWHM)	:	*0.25*		%
Rep. rate	:	*120*		Hz
Pulse length	:	*(7)*		μs
Beam intensity	:	*(14)*		A
Norm. emit. (1σ)	:	*(15)*		π mm-mrad

OTHER RELEVANT INFORMATION

Linac Operating modes: C= collider, FT= fixed target, I=injector for B factory.

(1) Types: Polarized (P) using a GaAs photocathode, and thermionic (T). At the end of the linac, the e^- polarization is typically 80% for C; 85% for FT. Polarized beams not required for I.

(2) Beam intensity (peak): 8×10^{10} e^-/ bunch × 2 bunches / rf-pulse for C and × 1 for I; up to 8×10^8 e^-/ bunch × 7000 bunches / rf-pulse for FT at up to 30 GeV final energy; and up to 8×10^9 e^-/ bunch × 700 for FT at up to 50 GeV. B Factory will use only 1 collider type bunch per rf pulse regardless of whether e^- or e^+.

(3) Normalized emittance (1σ): <100π mm-mrad for T; ~ 10π mm-mrad for P.

(4) Two 16th subharmonic bunchers and one 2.8 GHz buncher.

(5) Output: 1200 MeV into Damping Ring (DR) for C and I; straight into linac for FT. At 1200 MeV there are two DRs, one for damping up to 2 e^- bunches each for 1-interpulse period and a second for damping up to 2 e^+ bunches each for 2-interpulse periods. The resulting transverse emittance out of either DR can be either symmetric at ~ 16π mm-mrad each plane for round beams, or asymmetric at ~ 30(3)π mm-mrad for the x(y)-plane respectively.

(Continued on Positron Linac form.)

POSITRON LINAC

Name of Linac : *SLAC 3-km Linac*
Function : *e^+ / e^- Collider, Injector for B Factory*
Institution and address : *SLAC, PO Box 4349, Stanford, CA 94309, USA*
Person in charge : *Franz-Josef Decker (Linac), Jym Clendenin (Sources)*
Name of person supplying these data : *F-J. Decker*
e-mail : *DECKER@STANFORD.EDU*
tel. : *+1 415 926 3606* fax : *+1 415 926 2407*

HISTORY AND STATUS

Differences with respect to corresponding e^- linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*30000*	MeV
Radius (1σ)	:	*0.6*	mm
Beam intensity	:	*4×10^{10} e^-/bunch*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*W- (^{26}Re)*	
Type	:	*Trolling wheel*	
Thickness (rad.length)	:	*6*	χ
Diameter	:	*63 / 89*	mm
Mean deposited power	:	*9*	kW
Solenoidal field[a)]	:	*Flux concentrator: 5.5 T* *Tapered solenoid: 0.12 T*	
Matching device	:	*Flux concentrator*	
RF sections[a)]	:	*1 × 1.5 m 55 MV/m, then 3 × 3 m 20 MV/m*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e^- linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*(13)*	*(13)*	GeV
Accel gradient	:	*19*		MeV/m
ΔE/E (FWHM)	:	*0.25*		%
Rep. rate	:	*120*		Hz
Pulse length	:	*(7)*		μs
Yield (fin.en)	:	*0.8 - 1.2*		e^+/e^- x GeV
Beam intensity	:	*(14)*		μA peak
Norm. emit. (1σ)	:	*(15)*		π mm-mrad

OTHER RELEVANT INFORMATION

(Continued from Electron Linac form)

(5) (cont.) An e^+ bunch from the Positron Source is injected at the 200 MeV point of the injector. For C, the 2 e^- bunches and the single e^+ bunch are then co-accelerated by a single rf pulse, separated by sign of charge into the 2 Damping Rings, then 2 damped e^- bunches and a single damped e^+ bunch are reassembled in the linac and co-accelerated to high energy. (One e^- bunch is separated at the 2/3rd point (30 GeV) for positron production.)

(6) Intensity: ~ 70% of Source (note 2.)

(7) Pulse width, repetition rate: 120 ns (3 bunches) before 2/3rd point (note 5) and 60 ns (2 bunches) after with a repetition rate of 120 Hz for C; 5 ps (1 bunch) with a repetition rate up to 120 (60) Hz for I for e^-(e^+) respectively; and 200 ns to 2 μs with a repetition rate of 120 Hz for FT.

(8) Wave type: TW, constant gradient

(9) v_g / c range: 0.0204 - 0.0065

(10) RF power peak: 163 MW effective with SLED.

(11) No. of bunches/pulse: 3 (including e^+ bunch) in linac before 2/3rd point (note 5) and 2 after for C; 1 (either e^- or e^+) in linac for I; up to 7000 for FT at up to 30 GeV; up to 700 for FT at up to 50 GeV.

(12) No. of particles/bunch: ~ 70% of Source (note 2) except e^+ in linac is about 0.9 of e^- in linac.

(13) Final energy: 46.6 GeV is the normal energy of the linac for producing Z's at C. The maximum (no-load) energy is 52 GeV. For FT experiments, the linac runs between 30 and 52 GeV. For I, the energies of the extracted beams will be in the range 2.5 - 12 GeV.

(14) Beam intensity: about 4×10^{10} particles for each of the colliding bunches for C; similar intensity per bunch for I, and up to 4×10^{11} e^-/pulse for FT.

(15) Norm. emit. (1σ): For round beams for C or I, ~25π mm-mrad each plane; for flat beams for C only, 40/6 for x(y) plane.

ELECTRON LINAC

Name of Linac : *LCLS * Linac*
Function : *Linac for High Brightness X-ray FEL*
Institution and address : *SLAC/SSRL PO Box 4349, Stanford, CA 94309, USA*
Person in charge : *M. Cornacchia*
Name of person supplying these data : *V. Bharadwaj*
e-mail : *vinod@slac.stanford.edu*
tel. : *+1 415 926 4596* fax : *+1 415 926 2407*

HISTORY AND STATUS

Const. started : *1999* ; first beam : *(1) 2001*
Present status : *Design Study*
Cost of facility : *NA*
Present linac staff : *NA*
Present yearly operation time : *NA* h

LINAC PARAMETERS

Electron Sources

Types : *RF photoinjector* ; energy : *5000* keV
Beam intensity (peak) : *(2)* A
Normalized emittance (1σ) : *≤ 1* π mm-mrad

Injector

Longitudinal matching : *Not required*
Output : *70* MeV; intensity : *250* A
Pulse width, spacing : *(3) 3 ps, 8.3 ms*
Normalized emittance (1σ) : *≤ 1* π mm-mrad

Acceleration System

Total linac length : *1000* m
No. sections : *320* ; lengths : *3* m
Field mode : *2π / 3* ; frequency : *2.856* GHz
Wave type : *(4)* ; filling time : *0.83* μs
v_g/c range : *(5)* ; Q : *(6)*
Shunt impedance : *53 - 60* MΩ/m
Iris : aperture : diameter : *26.2 - 19.1* mm
thickness : *5.84* mm
Attenuation/section : *0.57* Np
Power units, Number : *80* type : *SLAC 50/45*
RF power peak : *(7)* MW; mean : *25* kW

Focusing System

Type, No. of elements, and spacing :
FODO; Under study

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1 - 10*
No. of particles/bunch : *10^{10}*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*15*	GeV
Accel gradient :		*19*	MeV/m
ΔE/E (FWHM) :		*0.1*	%
Rep. rate :		*120*	Hz
Pulse length :		*10^{-7}*	μs
Beam intensity :		*(8)*	A
Norm. emit. (1σ) :		*1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *LCLS - Linac Coherent Light Source*

(1) Estimated
(2) 1×10^{10} / bunch
(3) Bunch width, spacing
(4) TW - constant gradient
(5) 0.02 - 0.007
(6) 14000 - 13000
(7) 60 - / 130 (SLED)
(8) ~ 10^{10}

The LCLS FEL project plans to use the last 1/3 of the present SLAC linac to inject beam into an undulator to produce a high brightness 1.5 Å x-ray beam. A design study for the LCLS is presently underway. The above parameters are for single bunch operation. Multiple bunch per linac pulse are also being considered.

ELECTRON LINAC

Name of Linac : *NLCTA* *
Function : *Test Facility for Linear Collider*
Institution and address : *Stanford Linear Accelerator Center, PO Box 4349, Stanford, CA 94309, USA*
Person in charge : *Ron Ruth*
Name of person supplying these data : *Ron Ruth*
e-mail : *RRUTH@SLAC.STANFORD.EDU*
tel. : *+1 415 926 5390* fax : *+1 415 926 5368*

HISTORY AND STATUS

Const. started : *05/1992* ; first beam : *07/1996*
Present status : *Nearing Completion*
Cost of facility : *20 MUSD*
Present linac staff : *Under Construction*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *150* keV
Beam intensity (peak) : *4* A
Normalized emittance (1σ) : *6* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *90* MeV; intensity : *2* A
Pulse width, spacing : *140 ns, 88 ps*
Normalized emittance (1σ) : *30* π mm-mrad

Acceleration System

Total linac length : *(2)* m
No. sections : *6* ; lengths : *1.8* m
Field mode : *2π/3* ; frequency : *11.424* GHz
Wave type : *TW* ; filling time : *0.1* μs
v_g/c range : *0.12 - 0.03* ; Q : *6500*
Shunt impedance : *87 - 67* MΩ/m
Iris : aperture : diameter : *11.4 - 7.8* mm
thickness : *1 - 2* mm
Attenuation/section : *0.54* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *(3)* MW; mean : *0.24* kW

Focusing System

Type, No. of elements, and spacing :
Lens, 31 solenoids
32 quadrupoles
Main linac, FODO 2m spacing

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1600*
No. of particles/bunch : 4×10^8
Bunch separation : *88 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*0.63*	GeV
Accel gradient :		*50*	MeV/m
ΔE/E (FWHM) :		*0.5*	%
Rep. rate :		*10*	Hz
Pulse length :		*0.140*	μs
Beam intensity :		*0.75*	A
Norm. emit. (1σ) :		*30*	π mm-mrad

OTHER RELEVANT INFORMATION

* *NLCTA - Next Linear Collider Test Accelerator*

(1) 2 prebuncher cavities, 3 low β cells
(2) 1.8 × 6 = 10.8
(3) Klystron 50 MW - 1.5 μs with pulse compressor
90 MW - 250 ns at the section

ELECTRON LINAC

Name of Linac : *SSRL Injector Linac* *
Function : *Electron Linac for e⁻ injection to the Booster*
Institution and address : *SLAC/SSRL MS 69, PO Box 4349, Stanford, CA 94309, USA*
Person in charge : *M. Cornacchia*
Name of person supplying these data : *S. Park*
e-mail : *spark@slac.stanford.edu*
tel. : *+1 415 926 2526* fax : *+1 415 926 4100*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1990*
Present status : *Operating*
Cost of facility : *2 MUSD (1990)*
Present linac staff : *3 man-years*
Present yearly operation time : *6000* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *2900* keV
Beam intensity (peak) : *0.64* A
Normalized emittance (1σ) : *> 5* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *2.9* MeV; intensity : *0.24* A
Pulse width, spacing : *0.3-3 ps, 350 ps*
Normalized emittance (1σ) : *80* π mm-mrad

Acceleration System

Total linac length : *9* m
No. sections : *(3) 3* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *(4)* ; Q : *13000*
Shunt impedance : *53-60* MΩ/m
Iris : aperture : diameter : *19.1 - 26.2* mm
thickness : *5.84* mm
Attenuation/section : *0.57* Np
Power units, Number : *2* type : *(5) Klystron*
RF power peak : *40* MW; mean : *1* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles, two, 3m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *3*
No. of particles/bunch : 5×10^8
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.11*	*0.12*	GeV
Accel gradient	:	*12.2*		MeV/m
ΔE/E (FWHM)	:	*0.17*		%
Rep. rate	:	*10*		Hz
Pulse length	:	*2.5*	*2.5*	μs
Beam intensity	:	*(6) 0.24*		A
Norm. emit. (1σ)	:	*20*		π mm-mrad

OTHER RELEVANT INFORMATION

* *SSRL - Stanford Synchrotron Radiation Laboratory*

(1) 1.5-cell thermionic RF gun
(2) quadrupole triplet, alpha magnet, quadrupole doublet, correctors, and chopper
(3) Next to the injector, there is one additional section powered by a separate klystron, to be used as a test stand for rf gun with photo/thermionic cathode.
(4) 0.0065 - 0.0204
(5) One klystron (SLAC 5045) powers the rf gun and the first two sections. The last section and the test stand are powered by SLAC XK-5 klystrons
(6) The intensity is averaged over one RF cycle.

ELECTRON LINAC

Name of Linac : *SCA* *
Function : *Driver for Free Electron Lasers*
Institution and address : *HEPL, Stanford University, Stanford, CA 94305-4085, USA*
Person in charge : *Todd I. Smith*
Name of person supplying these data : *Todd I. Smith*
e-mail : *Todd.Smith@Stanford.edu*
tel. : *+1 415 723 1906* fax : *+1 415 725 8311*

HISTORY AND STATUS

Const. started : ~ *1968* ; first beam : ~ *1971*
Present status : *Operating*
Cost of facility : *?*
Present linac staff : *5 man-years*
Present yearly operation time : *3000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *120* keV
Beam intensity (peak) : *0.001* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *260 MHz SHB*
Output : *5* MeV; intensity : *10* A
Pulse width, spacing : *2 ps, 85.6 ns*
Normalized emittance (1σ) : *5* π mm-mrad

Acceleration System

Total linac length : *25* m
No. sections : *4* ; lengths : *6.5* m
Field mode : *π* ; frequency : *1.3* GHz
Wave type : *SW* ; filling time : *1000* μs
v_g/c range : ; Q : 2×10^6
Shunt impedance : MΩ/m
Iris : aperture : diameter : ~ *50* mm
thickness : ~ *10* mm
Attenuation/section : Np
Power units, Number : *4* type : *Klystron*
RF power peak : *0.010* MW; mean : *10* kW

Focusing System

Type, No. of elements, and spacing :
Random solenoids and quads.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *84.6 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.04*	*0.05*	GeV
Accel gradient	:	*1.5*	*2*	MeV/m
ΔE/E (FWHM)	:	*0.1*	*0.1*	%
Rep. rate	:	*20*	*20*	Hz
Pulse length	:	*10000*	*CW*	μs
Beam intensity	:	*200*	*500*	A
Norm. emit. (1σ)	:	*5*	*5*	π mm-mrad

OTHER RELEVANT INFORMATION

* *SCA - Superconducting Linear Accelerator*

This is a superconducting linac using 55 cell cavities. We are beginning an upgrade to use TESLA 9 cell cavities, operating at 10 MeV/metre. The machine energy range will remain the same, but the output current will increase to 1 mA. The peak current (in a 2 ps micropulse) will increase to 40 A. The emittance will remain at 5 π mm-mrad.

ELECTRON LINAC

Name of Linac : *SUNSHINE*
Function : *Research/educational facility, sub picosecond electron bunches*
Institution and address : *SSRL, P.O. Box 4349, Stanford, CA 94309, USA*
Person in charge : *H. Wiedemann*
Name of person supplying these data : *H. Wiedemann*
e-mail : *WIEDEMANN@slac.stanford.edu*
tel. : fax :

HISTORY AND STATUS

Const. started : *1992* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *Graduate students*
Present yearly operation time : *Daily as desired* h

LINAC PARAMETERS

Electron Sources

Types : *RF-gun* ; energy : *2600* keV
Beam intensity (peak) : *1.3* A
Normalized emittance (1σ) : *~ 10* π mm-mrad

Injector

Longitudinal matching : *None required*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *3.0* m
No. sections : *1* ; lengths : *3.0* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *(1)* ; filling time : *0.83* μs
v_g/c range : *(2)* ; Q : *14000*
Shunt impedance : *53 - 60* MΩ/m
Iris : aperture : diameter : *26.2 - 19.1* mm
thickness : *5.84* mm
Attenuation/section : *0.57* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *25* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
None required

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *~ 3000*
No. of particles/bunch : *2 - 5 × 10^8*
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.033*		GeV
Accel gradient	:	*10*		MeV/m
ΔE/E (FWHM)	:	*~ 10*		%
Rep. rate	:	*10*		Hz
Pulse length	:	*1.5*		μs
Beam intensity	:	*≤ 0.4*		A
Norm. emit. (1σ)	:	*< 1*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) TW const G
(2) 0.02 - 0.007

Facility is used to generate sub picosecond electron bunches, coherent far infrared radiation, measure sub picosecond pulses, coherent transition radiation, coherent undulator radiation, single pass FEL experiments.

References

[1] Phys. Rev. Lett. vol. 73, Aug. 1994, p. 967.

ION LINAC

Name of Linac : *Florida State University Superconducting Linac*
Function : *Heavy ion booster linac for a tandem Van de Graaff*
Institution and address : *Florida State University, Physics Dept. Tallahassee, FL 32306 USA*
Person in charge : *Prof. K. Kemper*
Name of person supplying these data : *E.G. Myers*
e-mail : *MYERS@NUCMAR.PHYSICS.FSU.EDU*
tel. : *+1 904 644 4040* fax : *+1 904 644 9848*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *03/1987*
Present status : *Operational*
Cost of facility : *2.75 USD (1984)*
Present linac staff : *1.5*
Present yearly operat. time : *3700* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3*
Types of source : *Cs Sputter, He^-, Pol. Li^-*
Species of ions : *all ions except noble gases*
Range of currents : *20* μAe
Range of output energies : *(1)* keV/u
Pulse length : *cw* μs; rep. rate : *cw* Hz
Normalized emittance (1σ) : *12* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Tandem Van de Graaff* m
Output currents : *4* μAe
Output energies : *10 000* keV/u
Frequency : *cw* MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : *1.5* π mm-mrad

Longitudinal Matching

Type : *(2)*
Mod. keV; drift mm at *48.5* MHz
keV; drift mm at *97* MHz

Accelerating System

Total linac length : *8* m; N°. of tanks : *3*
Tank diameters : *not circular* m
Number of drift-tubes : *12 cavities, 2 tubes/cavity*
Drift-tube lengths : *Atlas, high beta* mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : *25* mm to mm
RF frequency(ies) : *97* MHz
Field modes : *split loop resonator*
Eff. shunt impedance : *2×10^5* MΩ/m
Q : *(3)*
Filling time : *cw* μs
Equil. phases : *0-15* ; accel. rate *(4)* MeV/u-m
RF rep. rate : *cw* Hz; pulse : μs
Beam rate : *cw* Hz; pulse : μs
RF power peak : *cw* MW; mean : *6×10^{-4}* MW

Focusing System

No. elements : *6*
type : *superconducting solenoid* order :
Gradients : *2* to *4 Tesla* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Foils in VdG terminal and before linac*
Charge states : *-1* to *+8* at *0.33* MeV/u
Charge states : *+8* to *+12* at *2.8* MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	(5)		
Energy	*10*		MeV/u
ΔE/E (FWHM)	*0.1*		%
Mean acc. rate	*0.56*		MeV/u-m
Beam current	*(6)*		μAe peak
Norm. emit. (1σ)	*1.0*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) 120 keV
(2) Gridded pretandem & superconducting posttandem
(3) 5×10^8 loaded to 10^7 by vcx
(4) variable
(5) $^{28}Si^{8+/12+}$
(6) Beam current : 0.025 μAe

Linac consists of 12, independently phased, superconducting cavities, optimized for beta = 0.105. There is also a superconducting buncher resonator before the linac, and a superconducting rebuncher after the linac. Resonators made by Argonne National Laboratory.

Reference

[1] E.G. Myers et al., Nucl. Instrum. and Meth. B40/41, (1989) 904.

PROTON AND/OR H- LINAC

Name of Linac : *Proton RFQ*
Function : *Neutron source for biomedical and NDE / NDA * development*
Institution and address : *Idaho State University, Dept. of Physics, ***
Person in charge : *John Knox*
Name of person supplying these data : *Frank Harmon*
e-mail : *harmon@physics.isu.edu*
tel. : *+1 208 236 2350* fax : *+1 208 236 4649*

HISTORY AND STATUS

Const. started : *08/1991* ; first beam : *10/1991*
Present status : *Operational*
Cost of facility : *USD 850 000 (1991)*
Present linac staff :
Present yearly operat. time : h

LINAC PARAMETERS

Ion Source

Type : *Duoplasmatron*
Output : *25* mA at *30* keV
Pulse length : *20 - 160* μs; rep. rate : *120* Hz
Normalized emittance (1σ) : *0.3* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 vane* ; lengths : *1.5* m
Output : *15* mA at *2000* keV
Pulse length: *20 - 160* μs; rep. rate : *120* Hz
Normalized emittance (1σ) : *0.4* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : m; No. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equilibrium phases :
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy :	*2*	*2*	MeV
Mean acc. rate :			MeV/m
ΔE/E (FWHM) :	*< 1*	*< 1*	%
Beam current :	*10 - 15*	*20*	mA peak
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

* *NDE / NDA non-destructive evaluation / non-destructive assay*

** *785 S. 8th Ave., Box 8106, Pocatello, ID 83209*

Machine is AccSys Technology PL2

ELECTRON LINAC

Name of Linac : *Advanced Photon Source Injector Linac*
Function : *e^+ and e^- injector for the APS Storage Ring*
Institution and address : *Argonne National Laboratory, Argonne, IL 60439, USA*
Person in charge : *Linac Manager, Marion M. White*
Name of person supplying these data : *Marion M. White*
e-mail : *mwhite@aps.anl.gov*
tel. : *+1 630 252 5552* fax : *+1 630 252 4732*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1993*
Present status : *Operational*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Cathode* ; energy : *110* keV
Beam intensity (peak) : *2.6* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Prebuncher / buncher*
Output : *4.5* MeV; intensity : A
Pulse width, spacing : *30 ns, 60 Hz rf rate*
Normalized emittance (1σ) : *1.2* π mm-mrad

Acceleration System

Total linac length : *(1) 50* m
No. sections : *5+9=14* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *(2)* type : *Klystrons*
RF power peak : *35* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
Solenoids, quadrupoles, triplets.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *86 microbunches per pulse*
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	*0.220*	*0.650*	GeV
Accel gradient :	*17*		MeV/m
ΔE/E (FWHM) :	*+/- 8*	*+/- 8*	%
Rep. rate :	*(3)*		Hz
Pulse length :	*0.030*		μs
Beam intensity :	*2*		A
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

(1) Standard SLAC-type accelerating structures and SLED cavities
(2) 2 + 3 = 5
(3) 48 pps @ 60 Hz

e^- linac has 5 accelerating structures and 1 SLED; 2 Klystrons
e^+ linac has 9 accelerating structures and 2 SLEDs; 3 Klystrons

POSITRON LINAC

Name of Linac : *Advanced Photon Source Injector Linac*
Function : *e^+ and e^- injector for the APS Storage Ring*
Institution and address : *Argonne National Laboratory, Argonne, IL 60439, USA*
Person in charge : *Linac Manager, Marion M. White*
Name of person supplying these data : *Marion M. White*
e-mail : *mwhite@aps.anl.gov*
tel. : *+1 630 252 5552* fax : *+1 630 252 4732*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*200 - 220*	MeV
Radius (1σ)	:	*3 - 5*	mm
Beam intensity	:	*1.7*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*Tungsten*	
Type	:	*disk*	
Thickness (rad.length)	:	*2*	χ
Diameter	:	*12*	mm
Mean deposited power	:	*0.48*	kW
Solenoidal field[a]	:	*5000 A 1.5 T*	
Matching device	:		
RF sections[a]	:	*1 SLAC-type accelerating structure 3 m long*	

[a] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.40*	*0.45*	GeV
Accel gradient	:			MeV/m
ΔE/E (FWHM)	:	*0.1 to 1.5*	*1.0*	%
Rep. rate	:	*30*	*(1)*	Hz
Pulse length	:	*0.030*	*0.030*	μs
Yield (fin.en)	:	*1-200 400*		e^+/e^- x GeV
Beam intensity	:	*12000*	*8000*	μA peak
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

(1) 48 pps @ 60 Hz. ⇒ 24 pulses at a 60 Hz rate each 0.5 s.

ELECTRON LINAC

Name of Linac : *22 MeV Chemistry*
Function : *Pulse Radiolysis - Beam diagnostics*
Institution and address : *Chemistry Division, Argonne National Laboratory, Argonne, IL 60439, USA*
Person in charge : *Charles Jonah*
Name of person supplying these data : *Charles Jonah*
e-mail : *jonah@anlchm.chm.anl.gov*
tel. : *+1 630 252 3471* fax : *+1 630 252 4993*

HISTORY AND STATUS

Const. started : *1965* ; first beam : *1968*
Present status : *Operating*
Cost of facility : *~ 750 kUSD (1968)*
Present linac staff : *(1)*
Present yearly operation time : *1300* h

LINAC PARAMETERS

Electron Sources

Types : *Hot cathode* ; energy : *135* keV
Beam intensity (peak) : *30* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *4* MeV; intensity : *20* A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : m
No. sections : *2* ; lengths : *0.845* m
Field mode : *TM01* ; frequency : *1.307* GHz
Wave type : *TW* ; filling time : *0.6* μs
v_g/c range : *0.005* ; Q : *19400*
Shunt impedance : MΩ/m
Iris : aperture : diameter : *50* mm
thickness : *12* mm
Attenuation/section : *0.228* Np
Power units, Number : type :
RF power peak : *16* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
Lots of quadrupoles

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.022*		GeV
Accel gradient	:			MeV/m
ΔE/E (FWHM)	:	*1*		%
Rep. rate	:	*1*	*800*	Hz
Pulse length	:	*5×10^{-6} - 3*		μs
Beam intensity	:	*(2)*		A
Norm. emit. (1σ)	:	*200*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 1 operator, 20% supervisor
(2) This machine was built for radiation chemistry and therefore has a wide range of pulse widths.
5 ps to 30 ps with 1000 A peak

4 ns - 40 ns, 15 A peak: transient mode
100 ns - 3 μs, 1.5 - 3 A peak: steady state mode

ELECTRON LINAC

Name of Linac : *AWA* *
Function : *Part of facility for Wakefield related R & D*
Institution and address : *Argonne National Laboratory, Argonne, IL 69439, USA*
Person in charge : *J.D. Simpson*
Name of person supplying these data : *J.D. Simpson*
e-mail : *jds@hep.anl.gov*
tel. : *+1 708 252 6587* fax : *+1 708 252 5076*

HISTORY AND STATUS

Const. started : *10/1992* ; first beam : *10/1994*
Present status : *Operational*
Cost of facility : *1.2 MUSD (1991)*
Present linac staff : *2*
Present yearly operation time : *30 %* h

LINAC PARAMETERS

Electron Sources

Types : *Photocathode* ; energy : *1700* keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2* m
No. sections : *2* ; lengths : *1* m
Field mode : *TM01* ; frequency : *1.300* GHz
Wave type : *SW* ; filling time : *5* μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : *100* mm
thickness : *10* mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *30* MW; mean : *7* kW

Focusing System

Type, No. of elements, and spacing :
Solenoidal, Spherically Aberated

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : *6×10^{11}*
Bunch separation : *1 / 30 sec*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.015*	*0.018*	GeV
Accel gradient	:	*7*	*8*	MeV/m
ΔE/E (FWHM)	:	*3 - 8*	*12*	%
Rep. rate	:	*10*	*30*	Hz
Pulse length	:	*10-50 × 10^{-6}*	*25 × 10^{-6}*	μs
Beam intensity	:	*(1)*	*(1)*	A
Norm. emit. (1σ)	:	*50 - 300*	*250*	π mm-mrad

OTHER RELEVANT INFORMATION

* *AWA - Argonne Wakefield Accelerator*

(1) 2×10^{11}/pulse operation
6×10^{11}/pulse Max.

PROTON AND/OR H- LINAC

Name of Linac : *ANL Linac**
Function : *H⁻ Injector for IPNS* **
Institution and address : *Argonne National Laboratory, Argonne, IL 60439, USA*
Person in charge : *V. Stipp*
Name of person supplying these data : *V. Stipp*
e-mail : *vstipp@anl.gov*
tel. : *+1 630 252 6604* fax : *+1 630 252 9987*

HISTORY AND STATUS

Const. started : *1959* ; first beam : *1962*
Present status : *Operational*
Cost of facility : *5 MUSD (1962)*
Present linac staff : *5*
Present yearly operat. time : *4500* h

LINAC PARAMETERS

Ion Source

Type : *H⁻ Magnetron*
Output : *50* mA at *20* keV
Pulse length : *60 - 90* μs; rep. rate : *30* Hz
Normalized emittance (1σ) : *1.8* π mm-mrad

Pre-accelerator (including RFQ)

Types : *Cockcroft-Walton* ; lengths : m
Output : *45* mA at *750* keV
Pulse length: *60 - 90* μs; rep. rate : *30* Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type : *One buncher*
Mod. *25* keV; drift *890* mm at *200.06* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *33.5* m; No. of tanks : *1*
Tank diameters : *0.95* m
Number of drift-tubes : *124*
Drift-tube lengths : *49 - 354* mm
Drift-tube diam (range): *250 - 147* mm
Gap/cell length (range): *0.22 - 0.25*
Aperture diameter : *12.7* mm to *31.75* mm
RF frequency(ies) : *200.06* MHz
Field modes : *TM010*
Eff. shunt impedance : *30* MΩ/m
Q : *80000*
Filling time : *125* μs
Equilibrium phases : *26°*
RF rep. rate : *30* Hz; pulse : *220* μs
Beam rate : *30* Hz; pulse : *60 - 90* μs
RF power peak : *3.5* MW; mean : *0.022* MW

Focusing System

No. elements : *124*
type : *DC* order : *+-+-*
Gradients : *45* to *8* T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*50*		MeV
Mean acc. rate	*1.89*		MeV/m
ΔE/E (FWHM)	*±0.25*		%
Beam current	*12*		mA peak
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

* *ANL - Argonne National Laboratory IPNS 50 MeV H⁻ Linac*
** *IPNS - Intense Pulsed Neutron Source*

ION LINAC

Name of Linac : *ATLAS* *
Function : *Heavy Ion Acceleration for basic research in Nuclear and Atomic Physics*
Institution and address : *Argonne National Laboratory, Argonne, IL 60439, USA*
Person in charge : *Dr. Jerry Nolen*
Name of person supplying these data : *R. Pardo*
e-mail : *pardo@anlphy.phy.anl.gov*
tel. : fax :

HISTORY AND STATUS

Const. started : *1977* ; first beam : *06/1978*
Present status : *Operating 7 days / week*
Cost of facility : *80 MUSD (current)*
Present linac staff : *26*
Present yearly operat. time : *> 5000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *(1)*
Species of ions : *Lithium through Uranium*
Range of currents : *0.10 - 50* μAe
Range of output energies : *33* keV/u
Pulse length : *cw* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.1 - 0.25* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *18 independent resonators 9.9* m
Output currents : *0.05 - 0* μAe
Output energies : *1300* keV/u
Frequency : *(2)* MHz; peak RF power : *(3)* kW
Pulse length : *cw* μs; rep. rate : *(4)* Hz
Normalized emittance (1σ) : *(5)* π mm-mrad

Longitudinal Matching

Type : *Harmonic buncher & sinewave 2nd buncher*
Mod. *0.5* keV; drift *23500* mm at *12.125* MHz
5 - 10 keV; drift *1500* mm at *24.25* MHz

Accelerating System

Total linac length : *24.6* m; N°. of tanks : *(6)*
Tank diameters : *Resonator 0.37* m
Number of drift-tubes : *(7)*
Drift-tube lengths : *55 / 94* mm
Drift-tube diam (range) : *25* mm
Gap/cell length (range) : *βλ / 2*
Aperture diameter : *25* mm to *25* mm
RF frequency(ies) : *97* MHz
Field modes : *βλ / 2*
Eff. shunt impedance : *≈ 3 × 10⁴* MΩ/m
Q : *≥ 10⁸*
Filling time : *cw* μs
Equil. phases : *15°* ; accel. rate *0.7* MeV/u-m
RF rep. rate : *cw* Hz; pulse : μs
Beam rate : *12.125* Hz; pulse : *(8)* μs
RF power peak : *(9)* MW; mean : MW

Focusing System

No. elements : *21*
type : *S.C. Solenoids* order :
Gradients : *3* to *8.5 T* T/m
Other : *Effective length 7 - 19 cm*

Charge Stripping (Typical)

Type(s) : *Carbon foil*
Charge states : *varies* to at *1.3* MeV/u
Charge states : *varies* to at *3-5* MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	*Li to U*		
Energy	:	*5 - 17*	*20*	MeV/u
ΔE/E (FWHM)	:	*0.04*	*0.2*	%
Mean acc. rate	:	*0.7*	*0.8*	MeV/u-m
Beam current	:	*0.05 - 0.5*	*5*	μAe peak
Norm. emit. (1σ)	:	*0.1 - 0.25*	*≈0.4*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
see above		

OTHER RELEVANT INFORMATION

* *Argonne Tandem-Linac Accelerator System*

(1) ECR scource and negative ion sputter source
(2) 48.5 / 72.75
(3) 2.7 kW cw total
(4) 12.125 MHz (microstructure)
(5) 0.4 (max.), 0.2 (typical)
(6) 7 cryostats
(7) 2 / resonator, 44 accelerating resonators
(8) 0.25×10^{-3}
(9) CW, 6 kW total

Pre-accelerators:

1. *Postive Ion Injector, ECR Ion Source on 350 kV HV platform, 18 independent resonator linac λ / 4 split coaxial.*
2. *Tandem Electrostatic Injector, Neg. Ion Sputter Source on 200 kV platform, 8.5 MV tandem accelerator.*

PROTON AND/OR H⁻ LINAC

Name of Linac: Fermilab 400 MeV H⁻ Linac
Functions: 400 MeV Injector for 8 GeV Booster Synchrotron and 66 MeV for Neutron Cancer Therapy
Institution and address: Fermi National Accelerator Laboratory, P.O. Box 500, Batavia IL, USA
Person in charge: C. W. Schmidt
E-mail, phone and fax: cschmidt@fnal.gov , 630-840-4414 , (fax)630-840-8590
WWW Linac information: http://fnnews.fnal.gov/acc_tour_linac.html or http://garlic.fnal.gov/
Data supplied by, date: L. Allen, E. McCrory, A. Moretti, M. Popovic ; March 11, 1996

HISTORY AND STATUS

0.75-116 MeV Linac

Const. started: 12/1968 ; first beam: 11/30/1970
Present status: Operational, originally 200 MeV
Cost of facility: $12.7M / 1968 currency/date

116-401 MeV Linac

Const. started: 8/1989 ; first beam: 8/28/1993
Present status: Operational
Cost of facility: $22M / 1992 currency/date
Present linac staff: 12 (5 staff, 7 techs)
Present yearly operating time: 8,000+ h

LINAC PARAMETERS

Ion Source

Type: H⁻ Magnetron source
Output: 60-100 mA at 18 keV
Pulse length: 80 μs ; rep. rate: 15 Hz

Pre-Accelerator

Type: Cockcroft-Walton (two)
Accelerating column length: 0.23 and 0.30 m
Output: 60-70 mA at 750 keV
Pulse length: 80 μs ; rep. rate: 15 Hz
1-σ normalized emittance: (out) 0.1 π mm-mrad

Low Energy Linac - 0.75-116 MeV Alvarez Linac

Longitudinal Matching

Type: one single-gap buncher
Mod.: 35 keV ; drift: 750 mm at 201.25 MHz

Accelerating System

Total length: 78 m ; no. tanks: 5 for 116 MeV
originally 144.8 m ; 9 tanks ; (200) MeV
Tank diameters: 0.94-0.84 m
No. drift tubes: 209 (277)
Drift-tube lengths: 47.4-410.0 (450) mm
Drift-tube diameter: 160 mm
Gap/cell length (range): 0.20-0.41 (0.47)
RF frequency: 201.25 MHz ; field modes: TM010
Eff. shunt impedance: 27-15 MΩ/m
Q: 50,000-60,000 ; filling time: 100 μs
Equilibrium phase: -32°
RF rep. rate: 15 Hz ; pulse: 150 (flat top) μs
Beam rate: 15 (max) Hz ; pulse: 60 μs
RF power peak: 21 MW ; mean: 0.045 MW

Focusing System

No. elements: 219 ; type: pulsed magnetic
(No. elements: 295 for 200 MeV)
Order: FD ; gradient: 70 to 7 T/m
1-σ normalized emittance: (in) 0.2 π mm-mrad

High Energy Linac - 116-401 MeV side-coupled-structure Linac

Longitudinal Matching

Type: multi-cell SCS buncher and vernier
Mod.: 1600 keV ; drift: 2675 mm at 805 MHz
Mod.: 220 keV ; drift: 1128 mm at 805 MHz

Accelerating System

Total linac length: 64 m ; no. modules: 7
Cell diameters: 269 mm ; no. cells: 448
Cell lengths: 86.3-132.3 mm
Cell bore diameter: 30 mm
RF frequency: 805 MHz ; field modes: TM01
Eff. shunt impedance: 41-56 MΩ/m
Q: 24,000-28,000 ; filling time: 6 μs
Equilibrium phase: -32°
RF rep. rate: 15 Hz ; pulse: 120 (flat top - max) μs
Beam rate: 15 (max) Hz ; pulse: 60 μs
RF power peak: 75 MW ; mean: 0.14 MW

Focusing System

No. elements: 28 ; type: pulsed magnetic
Order: FODO ; gradient: 25 T/m

LINAC PERFORMANCE

Normal operation

Energy: 0.75-116 MeV
Mean acc. rate: 1.5 MeV/m
Energy: 116-401 MeV
Mean acc. rate: 4.4 MeV/m
ΔE/E(%): 0.2 FWHM
Beam current: 50 mA peak
1-σ normalized emitttance: (out) 1.5 π mm-mrad

OTHER RELEVANT PARAMS., REFS., ETC.

The original Linac had achieved 300 mA of protons. The Linac now delivers H⁻ beams which are time shared between injection into the Booster for the high energy and accelerator physics programs, and for neutron cancer therapy.

The Linac was recently increased in energy by removing the last four tanks of the original Linac and replacing them with seven accelerating side-coupled structure modules to achieve 400 MeV in the same enclosure.

Reference publications:

1. *Particle Accelerators* 1, 93 (1970).
2. "Commissioning and First Operation of the 400 MeV Linac at Fermilab" 1994 European Part. Acc. Conf.

PROTON AND/OR H- LINAC

Name of Linac : *AccSys Technology Model PL-7 Linac*
Function : *Booster Synchrotron H⁻ Pre-injector Accelerator*
Institution and address : *Indiana Univ. Cyclotron Facility, Bloomington, IN 47408, USA*
Person in charge : *Dennis FRIESEL*
Name of person supplying these data : *Dennis FRIESEL*
e-mail : *friesel@iucf.indiana.edu*
tel. : *+1 812 855 2944* fax : *+1 812 855 6645*

HISTORY AND STATUS

Const. started : *05/1995* ; first beam : *~ 07/1996*
Present status : *Under construction*
Cost of facility : *1.2 MUSD*
Present linac staff : *85 tech staff @ IUCF*
Present yearly operat. time : *4000 (projected)* h

LINAC PARAMETERS

Ion Source

Type : *(1)*
Output : *≤ 1.0* mA at *25.0* keV
Pulse length : *≤ 400* μs; rep. rate : *1 - 5* Hz
Normalized emittance (1σ) : *0.30* π mm-mrad

Pre-accelerator (including RFQ)

Types : *RFQ* ; lengths : *2.3* m
Output : *≤ 1.0* mA at *3000* keV
Pulse length: *≤ 400* μs; rep. rate : *1 - 5* Hz
Normalized emittance (1σ) : *≤ 1.0* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *1.54* m; No. of tanks :
Tank diameters : *0.57* m
Number of drift-tubes : *22*
Drift-tube lengths : *25.4* mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : *425* MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q : *30000*
Filling time : μs
Equilibrium phases :
RF rep. rate : *1 - 5* Hz; pulse : *≤ 400* μs
Beam rate : *1 - 5* Hz; pulse : *≤ 400* μs
RF power peak : *0.360* MW; mean : *0.300* MW

Focusing System

No. elements :
type : *Quadrupole* order :
Gradients : to T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy :	*7.0*	*7.0*	MeV
Mean acc. rate :	*1.75*	*1.75*	MeV/m
ΔE/E (FWHM) :	*1.0*	*1.0*	%
Beam current :	*≤ 1.0*	*10.0*	mA peak
Norm. emit. (1σ) :	*≤ 1.0*	*≤ 1.0*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) i) Duoplasmatron H⁻;
ii) Atomic Beam Polarized H⁻

This linac is a commercially available system manufactured by AccSys. Technology Inc, Pleasanton, CA. It is a 7 MeV H⁻ linac, a model PL-7. The RFQ (3 MeV H⁻) and DTL (4 MeV H⁻) are coupled directly together to form a single 4 m long accelerator which produces 7 MeV H⁻ for injection into a 2.24 Tm Synchrotron. The linac and synchrotron are now under construction, with first beam operation scheduled for mid-1998.

References

[1] CIS, A Low Energy Injector for IUCF Cooler, IEEE 0-7083-3 (1996) 336.

ELECTRON LINAC

Name of Linac : *Notre Dame Radiation Laboratory Linac Facility*
Function : *Pulse Radiolysis for Chemical Kinetics*
Institution and address : *Notre Dame Radiation Laboratory, Notre Dame, IN 46556-0579, USA*
Person in charge : *K.-D. Asmus*
Name of person supplying these data : *John Bentley*
e-mail : *bentley.1@nd.edu*
tel. : *+1 219 631 6117* fax : *+1 219 631 8068*

HISTORY AND STATUS

Const. started : *10/1993* ; first beam : *10/1994*
Present status : *Operational*
Cost of facility : *2 MUSD (1993)*
Present linac staff : *1 man-year*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *130* keV
Beam intensity (peak) : *8* A
Normalized emittance (1σ) : π mm-mrad

Injector *(2)*

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *0.7* m
No. sections : *1* ; lengths : *0.7* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.35* μs
v_g/c range : ; Q : *13500*
Shunt impedance : *55* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *0.07* Np
Power units, Number : *1* type : *XKS Klystron*
RF power peak : *16* MW; mean : *4* kW

Focusing System

Type, No. of elements, and spacing :
Bucking coil, focus lens, eight air core focus coils in Helmholtz geometry.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *~ 7 per 2 ns pulse*
No. of particles/bunch : *~ 10^{10}*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.008*	*0.0095*	GeV
Accel gradient	*11.4*	*12.5*	MeV/m
ΔE/E (FWHM)	*2*	*2.5*	%
Rep. rate	*1*	*60*	Hz
Pulse length	*0.002*	*0.002 to 1.5*	μs
Beam intensity	*4*	*4*	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

(1) Thermionic cathode
(2) Prebuncher is integral with accelerator section

Linac was built by Titan Beta, Dublin, CA.

Beam intensity is 4 A @ 10 ns, 2 A @ 1.5 μs.

ION LINAC

Name of Linac : *Superconducting Linac*
Function : *Booster Accelerator & Decelerator for heavy ions*
Institution and address : *James R. Macdonald Lab., Kansas State Univ. Manhattan, KS, USA*
Person in charge : *Tom J. Gray*
Name of person supplying these data : *Tom J. Gray*
e-mail : *tgray@phys.KSU.edu*
tel. : *+1 913 5326782* fax : *+1 913 532 6806*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1989*
Present status : *Operational*
Cost of facility : *~ 2×10^6 USD (1987)*
Present linac staff : *7*
Present yearly operat. time : *≤ 1000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *Cs sputter & diode neg. ion*
Species of ions : *H -U*
Range of currents : *1 - 20* μAe
Range of output energies : *≤ 60* keV/u
Pulse length : *2* μs; rep. rate : *12 M* Hz
Normalized emittance (1σ) : *?* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *EN Tandem* m
Output currents : *≤ 10* μAe
Output energies : *≤ 3000* keV/u
Frequency : MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *15* m; N°. of tanks : *3*
Tank diameters : *(1) 1.5 (not full circle)* m
Number of drift-tubes : *(2)*
Drift-tube lengths : *(3)* mm
Drift-tube diam (range) : *(3)* mm
Gap/cell length (range) : *(3)*
Aperture diameter : *(3)* mm to *(3)* mm
RF frequency(ies) : *97* MHz
Field modes : *(3)*
Eff. shunt impedance : *(3)* MΩ/m
Q : *≤ 2×10^7 loaded*
Filling time : μs
Equil. phases : ; accel. rate MeV/u-m
RF rep. rate : Hz; pulse : μs
Beam rate : *12×10^6* Hz; pulse : *(4) 0.1* μs
RF power peak : *(5)* MW; mean : MW

Focusing System

No. elements : *3*
type : *Solenoid triplets* order :
Gradients : to T/m
Other :

Charge Stripping (Typical)

Type(s) : *Carbon foils - post stripping mode*
Charge states : *+1* to *bare* at *2* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :	*F^{9+}*	*Cu*	
Energy :	*5*	*3*	MeV/u
ΔE/E (FWHM) :	*0.1*	*0.1*	%
Mean acc. rate :	*2.8*	*3.0*	MeV/u-m
Beam current :	*0.1*	*~ 0.1*	μAe peak
Norm. emit. (1σ) :	*?*	*?*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
$C_2O_2Si_7Cl$	*E≤ 130 MeV*	
T_i	*depending on ion species*	

OTHER RELEVANT INFORMATION

Our Linac is superconducting like ATLAS. We used their technology. We have the Argonne Split ring Nb resonator.

(1) "bath tub" cryostats
(2) 2 per resonator - 14 resonators
(3) See Argonne National Laboratory
(4) Same as ATLAS using split ring resonators: see I. Sheppard, ANL
(5) 200×10^6

ELECTRON LINAC

Name of Linac : *CAMD**
Function : *Injector for synchrotron light source*
Institution and address : *LSU-CAMD, 6980 Jefferson Hwy., Baton Rouge, LA 70806, USA*
Person in charge : *Hans Bluem*
Name of person supplying these data : *Hans Bluem*
e-mail : *bluem@rocamd.camd.lsu.edu*
tel. : *+1 504 9257070x203* fax : *+1 504 9257078*

HISTORY AND STATUS

Const. started : ; first beam : *1991*
Present status : *Operating*
Cost of facility :
Present linac staff : *0.5 man-year*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *50* keV
Beam intensity (peak) : *0.3* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *4* MeV; intensity : A
Pulse width, spacing : *2 ns-200 ns, 100 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *14* m
No. sections : *2* ; lengths : *6* m
Field mode : *2 π/3* ; frequency : *2.9986* GHz
Wave type : *TW* ; filling time : *1.5* μs
v_g/c range : *(2)* ; Q : *13500*
Shunt impedance : MΩ/m
Iris : aperture : diameter : *26-16* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *2* type : *Klystron*
RF power peak : *35* MW; mean : *1.4* kW

Focusing System

Type, No. of elements, and spacing :
Solenoïd on buncher, triplet between sections

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.180*	*0.200*	GeV
Accel gradient	:	*14.7*	*16.3*	MeV/m
ΔE/E (FWHM)	:	*1.0*	*2.0*	%
Rep. rate	:	*10*	*10*	Hz
Pulse length	:	*0.2*	*0.2*	μs
Beam intensity	:	*25*	*70*	A
Norm. emit. (1σ)	:	*0.4*	*<1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Center for Advanced Microstructures and Devices*

(1) 500 MHz prebuncher, S-band buncher
(2) 0.0068- 0.032

Linac built by GE-MeV.

ELECTRON LINAC

Name of Linac : *Dept. of Materials and Nuclear Engineering*
Function : *Research*
Institution and address : *Univ. of Maryland, College Park, Maryland, USA*
Person in charge : *Vince Adams*
Name of person supplying these data : *Vince Adams*
e-mail : *vja@eng.umd.edu*
tel. : *1 301 405 7355* fax : *1 301 314 9467*

HISTORY AND STATUS

Const. started : *1985* ; first beam : *1985*
Present status : *Operational*
Cost of facility : *400 000 USD*
Present linac staff : *1/3 technician*
Present yearly operation time : *200* h

LINAC PARAMETERS

Electron Sources

Types : *Electron* ; energy : *1000-9000* keV
Beam intensity (peak) : *0.25* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing : *3 μs, variable*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *1.5* m
No. sections : *1* ; lengths : *1.5* m
Field mode : ; frequency : GHz
Wave type : *S* ; filling time : μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : *2.0* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.007*	*0.009*	GeV
Accel gradient			MeV/m
ΔE/E (FWHM)	*10*		%
Rep. rate	*300*		Hz
Pulse length	*3*		μs
Beam intensity			A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *MIRF* *
Function : *Physics and Dosimetry Research*
Institution and address : *NIST, Gaithersburg, MD 20899, USA*
Person in charge : *Dr. Charles E. Dick*
Name of person supplying these data : *C.E. Dick*
e-mail : *cedick@enh.nist.gov*
tel. : fax :

HISTORY AND STATUS

Const. started : *1973* ; first beam : *1974*
Present status : *Operating*
Cost of facility :
Present linac staff : *1.5 man-years*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *40* keV
Beam intensity (peak) : *<0.300* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *7-32* MeV; intensity : *0.1* A
Pulse width, spacing : *7 μs, 10 msec*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *2* ; lengths : *2.29/3.32* m
Field mode : *π/2* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *0.5* μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *25* MW; mean : *10* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.025*	*0.032*	GeV
Accel gradient	:	*6*	*6*	MeV/m
ΔE/E (FWHM)	:	*5*	*5*	%
Rep. rate	:	*100*	*100*	Hz
Pulse length	:	*7*	*7*	μs
Beam intensity	:	10^{-5}	10^{-5}	A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

* *Medical Industrial Radiation Facility*

(1) S-band Prebuncher and Buncher

This machine was originally built as a therapy machine for use at Yale New Haven hospital. In 1992 it was dismantled and setup at NIST as a Medical and Industrial Radiation Facility.

ELECTRON LINAC

Name of Linac : *MIT Linac* *
Function : *Research*
Institution and address : *PO Box 846, Middleton, MA 01949, USA*
Person in charge : *Prof. Stanley Kowalski*
Name of person supplying these data : *Prof. Stanley Kowalski*
e-mail : *sk@mitlns.mit.edu*
tel. : *+1 617 253 9200* fax :

HISTORY AND STATUS

Const. started : *1967* ; first beam : *1971*
Present status : *Operating*
Cost of facility : *6 MUSD (1967)*
Present linac staff : *83 FTE (1)*
Present yearly operation time : *4000* h

LINAC PARAMETERS

Electron Sources

Types : *(2)* ; energy : *370* keV
Beam intensity (peak) : *0.04* A
Normalized emittance (1σ) : *10* π mm-mrad

Injector

Longitudinal matching : *120°*
Output : *20* MeV; intensity : *0.04* A
Pulse width, spacing : *16 μs, 1-6 ms*
Normalized emittance (1σ) : *10* π mm-mrad

Acceleration System

Total linac length : *150* m
No. sections : *22* ; lengths : *(3)* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *1.27* μs
v_g/c range : *(4)* ; Q : *13750*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : *24 - 29* mm
thickness : *5.84* mm
Attenuation/section : *0.825* Np
Power units, Number : *12* type : *Klystrons*
RF power peak : *5* MW; mean : *100* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids over first four sections; six quad doublets spaced 17 & 34 m in remainder of linac

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *46000*
No. of particles/bunch : 9×10^6
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*(5) 0.1 - 1.0*	*1.06*	GeV
Accel gradient	:	*3*	*9*	MeV/m
ΔE/E (FWHM)	:	*0.3*	*0.3*	%
Rep. rate	:	*600*	*1000*	Hz
Pulse length	:	*16*	*16*	μs
Beam intensity	:	*0.004*	*0.04*	A
Norm. emit. (1σ)	:	*10*	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

* *MIT-Bates Linac - Massachussets Institute of Technology-Bates Linear Accelerator Centre*

(1) Full Time Equivalent
(2) Thermionic & polarized sources
(3) 4 sections at 3.7 m and 18 sections at 7.35 m
(4) 0.0389 - 0.0093
(5) Energies above 0.5 GeV achieved using a recirculator to send the beam through the linac a second time.

ION LINAC

Name of Linac : *MIT / FAA AccSys DL-1*
Function : *Neutron radiography, fast neutron analysis*
Institution and address : *Massachusetts Institute of Technology, Cambridge MA, USA*
Person in charge : *Richard Lanza*
Name of person supplying these data : *Richard Lanza*
e-mail : *lanza@mit.edu*
tel. : *+1 617 253 2399* fax : *+1 617 253 2343*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1989*
Present status : *Running*
Cost of facility : *USD 400 000 (1989)*
Present linac staff : *3*
Present yearly operat. time : *1000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *Duoplasmatron*
Species of ions : D^+
Range of currents : *(peak) 8000* μAe
Range of output energies : *25* keV/u
Pulse length : *≤ 100* μs; rep. rate : *≤ 640* Hz
Normalized emittance (1σ) : *0.15* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *0.7* m
Output currents : *(peak) 6000* μAe
Output energies : *900* keV/u
Frequency : *425* MHz; peak RF power : *60* kW
Pulse length : *≤ 100* μs; rep. rate : *≤ 640* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : m; N°. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range) : mm
Gap/cell length (range) :
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equil. phases : ; accel. rate MeV/u-m
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other :

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	:		
Energy	:		MeV/u
ΔE/E (FWHM)	:		%
Mean acc. rate	:		MeV/u-m
Beam current	:		μAe peak
Norm. emit. (1σ)	:		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

Manufactured by: *AccSys Technology*
Pleasanton, CA

ION LINAC

Name of Linac : *Sandia Tandem Booster*
Function : *Heavy Ion Post Accelerator*
Institution and address : *Sandia National Labs, PO Box 5800, ABQ, NM 87185 USA*
Person in charge : *Harald Schone*
Name of person supplying these data : *Harald Schone*
e-mail : *hschon@somnet.sandia.gov*
tel. : *+1 505 844 2598* fax : *+1 505 844 7775*

HISTORY AND STATUS

Const. started : *1/1994* ; first beam : *10/1995*
Present status : *Development*
Cost of facility : *1.6 MUSD (1995)*
Present linac staff : *1/2 man-year*
Present yearly operat. time : *400* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3*
Types of source : *(1)*
Species of ions : *most elements Au*
Range of currents : *0.1 - 10* μAe
Range of output energies : *0.3 - 60* keV/u
Pulse length : *DC* μs; rep. rate : *DC* Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *EN-TANDEM* *20* m
Output currents : *10* μAe
Output energies : *50 - 12 × 10^3* keV/u
Frequency : *DC* MHz; peak RF power : *n.a.* kW
Pulse length : *n.a.* μs; rep. rate : *n.a.* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Longitudinal Matching

Type : *none*
Mod. *n.a.* keV; drift *n.a.* mm at *n.a.* MHz
n.a. keV; drift *n.a.* mm at *n.a.* MHz

Accelerating System

Total linac length : *6.2* m; N°. of tanks : *2*
Tank diameters : *0.5* m
Number of drift-tubes : *n.a.*
Drift-tube lengths : *n.a* mm
Drift-tube diam (range) : *n.a.* mm
Gap/cell length (range) : *- 16 mm - 45 mm*
Aperture diameter : *1.5* mm to mm
RF frequency(ies) : *425* MHz
Field modes : *TE210*
Eff. shunt impedance : *2* MΩ/m
Q : *7000*
Filling time : *10* μs
Equil. phases : ; accel. rate *0.276* MeV/u-m
RF rep. rate : *1-1000* Hz; pulse : *10-110* μs
Beam rate : *1-1000* Hz; pulse : *10-110* μs
RF power peak : *0.76* MW; mean : *8×10^{-3}* MW

Focusing System

No. elements : *7*
type : *dc doublet triplet* order : -
Gradients : *2* to *3.5* T/m
Other :

Charge Stripping (Typical)

Type(s) : *carbon foil*
Charge states : *7+* to *28+* at *0.25* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	*Au^{28+}*		
Energy	:	*1.91*		MeV/u
ΔE/E (FWHM)	:	*0.4*		%
Mean acc. rate	:	*8×10^{-3}*		MeV/u-m
Beam current	:		*3×10^{-5}*	μAe peak
Norm. emit. (1σ)	:	*0.2*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) Li-exch., Sputter, Duo-plasmatron

ELECTRON LINAC

Name of Linac : *PHERMEX**
Function : *Flash Radiography - Intense e⁻ beam Study*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *Scott A. Watson*
Name of person supplying these data : *Scott A. Watson*
e-mail : *scottw@lanl.gov*
tel. : *+1 505 665 6233* fax : *+1 505 665 4396*

HISTORY AND STATUS

Const. started : *1957* ; first beam : *1963*
Present status : *Operational*
Cost of facility : *~ 5 MUSD (year)*
Present linac staff : *6*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types *Thermionic cathode* ; energy : *500* keV
Beam intensity (peak) : *20* A
Normalized emittance (1σ) : *500* π mm-mrad

Injector

Longitudinal matching :
Output : *0.5* MeV; intensity : *1000* A
Pulse width, spacing : *200 ns, 10 s*
Normalized emittance (1σ) : *500* π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *3* ; lengths : *2.6* m
Field mode : ; frequency : *0.05* GHz
Wave type : ; filling time : *1000* μs
v_g/c range : *Beta = 1* ; Q : *100000*
Shunt impedance : MΩ/m
Iris : aperture : diameter : *150* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *8* type :
RF power peak : *5* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
9 Solenoïds

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *10*
No. of particles/bunch : *~ 10^{15}*
Bunch separation : *20 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.03*		GeV
Accel gradient	:	*5.0*	*6.5*	MeV/m
ΔE/E (FWHM)	:	*50*	*80*	%
Rep. rate	:	*0.1*	*1*	Hz
Pulse length	:	*0.2*	*0.2*	μs
Beam intensity	:	*(1)*		A
Norm. emit. (1σ)	:	*500*	*500*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Pulsed High Energy Machine Emitting X Rays*

(1) 1000 A e⁻ beam at 30 MeV focused to a 3 mm spot size.

ELECTRON LINAC

Name of Linac : *AFEL* *
Function : *Electron Accelerator and FEL*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *R. Sheffield*
Name of person supplying these data : *R. Sheffield*
e-mail : *Sheff@lanl.gov*
tel. : *+1 505 667 1237* fax : *+1 505 667 8207*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1992*
Present status : *Operating*
Cost of facility : *6 MUSD (1992)*
Present linac staff : *2*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Photocathode* ; energy : *0.0004* keV
Beam intensity (peak) : *200* A
Normalized emittance (1σ) : *0.5* π mm-mrad

Injector

Longitudinal matching : *none*
Output : *1.5* MeV; intensity : *200* A
Pulse width, spacing : *5-20 ps, 10 ns*
Normalized emittance (1σ) : *(1)* π mm-mrad

Acceleration System

Total linac length : *1.2* m
No. sections : *1* ; lengths : *1.2* m
Field mode : *π/2* ; frequency : *1.3* GHz
Wave type : *SW* ; filling time : *2* μs
v_g/c range : ; Q : *8000*
Shunt impedance : *45* MΩ/m
Iris : aperture : diameter : *24* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *50* kW

Focusing System

Type, No. of elements, and spacing :
One solenoid around first several cells of accelerator

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *2000*
No. of particles/bunch : *6 - 40 × 10^9*
Bunch separation : *10 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.017*	*0.02*	GeV
Accel gradient	:	*19*	*22*	MeV/m
ΔE/E (FWHM)	:	*0.3*	*0.3*	%
Rep. rate	:	*1*	*60*	Hz
Pulse length	:	*20*	*20*	μs
Beam intensity	:			A
Norm. emit. (1σ)	:	*2*	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Advanced Free-Electron Laser*

(1) For 1 nC

References

[1] Sheffield, R.V. et al., (1992) Nucl. Inst. and Methods in Phys. Res. A318, 282 - 289.

[2] Nguyen, D.C. et al., (1995) Nucl. Inst. and Methods in Phys. Res. A 358, 27 - 30.

ELECTRON LINAC

Name of Linac : *DARHT* *
Function : **
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge :
Name of person supplying these data : *Michael J. Burns*
e-mail : *burns_michael_j@lanl.gov*
tel. : *+1 505 667 5069* fax : *+1 505 667 8316*

HISTORY AND STATUS

Const. started : *05/1994* ; first beam : *01/1999*
Present status : *(1)*
Cost of facility : *(2)*
Present linac staff : *N/A*
Present yearly operation time : *N/A* h

LINAC PARAMETERS

Electron Sources

Types : *(3)* ; energy : *N/A* keV
Beam intensity (peak) : *(4)* A
Normalized emittance (1σ) : *(5)* π mm-mrad

Injector

Longitudinal matching : *N/A*
Output : *3.75* MeV; intensity : *4000* A
Pulse width, spacing : *(6)*
Normalized emittance (1σ) : *(5)* π mm-mrad

Acceleration System *(7)*

Total linac length : *33.5* m
No. sections : *8* ; lengths : *3.65* m
Field mode : *N/A* ; frequency : *N/A* GHz
Wave type : *N/A* ; filling time : *(8) 5* μs
v_g/c range : *N/A* ; Q : *< 5*
Shunt impedance : *(9) ~ 0.001* MΩ/m
Iris : aperture : diameter : *none* mm
thickness : *N/A* mm
Attenuation/section : *N/A* Np
Power units, Number : *32* type : *(10)*
RF power peak : *N/A* MW; mean : *N/A* kW

Focusing System

Type, No. of elements, and spacing :
(11)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *see notes*
No. of particles/bunch : *1.5×10^{15} (4kA, 60 ns)*
Bunch separation : *see notes*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*0.02*	GeV
Accel gradient :		*0.5*	MeV/m
ΔE/E (FWHM) :		*< 1rms*	%
Rep. rate :		*see below*	Hz
Pulse length :		*0.06*	μs
Beam intensity :		*4000*	A
Norm. emit. (1σ) :		*(6)*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Dual-Axis Radiographic Hydrodynamic Test facility*

** *Two high-current electron beam accelerators to generate bremsstrahlung x-ray pulses for flash (-60 ns) radiography of very dense (areal mass - 100's g/sq.cm) objects moving very quickly (object velocities of many mm/microsecond)*

(1) Construction resumed after 15-month suspension
(2) 106 MUSD (1st accel. all facilities)
187 MUSD (full, 2-machine facility)
(3) cold-cathode field emitter or ArF eximer-laser driven photocathode
(4) ~ 60-65 A/sq. cm
(5) Normalized 4 × rms 700-1000 π mm-mrad (Lapostolle)
(6) 60 ns flat-top, single square-wave pulse
(7) Linear Induction Accelerator
(8) Pulsed power charging time
(9) (peak ~800MHz)
(10) Water Blumlein PFLs
(11) quadrufilar-wound, square-hollow Cu tube solenoids with iron homogonizer rings at injector anode, within 64 accelerating cells, and within HEBT. Peak field about 2.8 kG, 5.5 kG, iron-clad final focus solenoid for ~ 1.2 mm (2 rms) beam diameter on bremsstrahlung conversion target

DARHT will consist of two LIAs oriented perpendicular to each other to generate either two simultaneous radiographs containing 3D information or two time-sequenced radiographs.

The first machine (operational in 1999) will generate a single pulse. The second machine (operational in 2001) may generate 4 or more pulses at 2-5 MHz rep. rate.

ELECTRON LINAC

Name of Linac : *DARHT ITS* *
Function : *Engineering prototype for DARHT* **
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge :
Name of person supplying these data : *Michael J. Burns*
e-mail : *burns_michael_j@lanl.gov*
tel. : *+1 505 667 5069* fax : *+1 505 667 8316*

HISTORY AND STATUS

Const. started : *11/1990* ; first beam : *05/1991*
Present status : *(1) Operational*
Cost of facility : *(2) 10 MUSD*
Present linac staff : *~ 8*
Present yearly operation time : *~ 1000* h

LINAC PARAMETERS

Electron Sources

Types : *(3)* ; energy : *N/A* keV
Beam intensity (peak) : *(4)* A
Normalized emittance (1σ) : *(5)* π mm-mrad

Injector

Longitudinal matching : *N/A*
Output : *3.75* MeV; intensity : *4000* A
Pulse width, spacing : *(6)*
Normalized emittance (1σ) : *(5)* π mm-mrad

Acceleration System *(7)*

Total linac length : *3.65* m
No. sections : *1* ; lengths : *3.65* m
Field mode : *N/A* ; frequency : *N/A* GHz
Wave type : *N/A* ; filling time : *5* μs
v_g/c range : *N/A* ; Q : *< 5*
Shunt impedance : *(9) ~ 0.001* MΩ/m
Iris : aperture : diameter : *none* mm
thickness : *N/A* mm
Attenuation/section : *N/A* Np
Power units, Number : *4* type : *(10)*
RF power peak : *N/A* MW; mean : *N/A* kW

Focusing System

Type, No. of elements, and spacing :
(11)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : *1.5×10^{15} (4 kA, 60 ns)*
Bunch separation : *single pulse*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.0055*	*0.006*	GeV
Accel gradient	:	*0.5*	*0.5*	MeV/m
ΔE/E (FWHM)	:	*(12)*	*(12)*	%
Rep. rate	:	*single shot*	*single shot*	Hz
Pulse length	:	*0.062*	*0.06*	μs
Beam intensity	:	*3000-4000*	*3000*	A
Norm. emit. (1σ)	:	*(5)*	*(5)*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Integrated Test Strand*
** *Dual-Axis Radiographic Hydrodynamic Test Facility*

(1) See comment on original
(2) include 3.5 MUSD building
(3) cold-cathode field emitter or ArF eximer-laser driven photocathode
(4) ~ 60-65 A/cm²
(5) Normalized 4 × rms 700-1000 πmm-mrad (Lapostolle)
(6) 60 ns flattop, single square-wave pulse
(7) Linear Induction Accelerator
(8) Pulsed power charging time
(9) (peak ~ 800 MHz)
(10) Water Blumlein PFLs
(11) quadrufilar-wound, square-hollow Cu tube solenoids with iron homogonizer rings at injector anode, within 8 accelerating cells, and within HEBT. Peak field about 1.2 kGauss.
(12) 0.05 % (rms) Operation
< 1 % (rms) Design

ELECTRON LINAC

Name of Linac : *Subpicosecond High-Brightness Accelerator Facility*
Function : *Short bunch compression / plasma interaction experiments*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *B. Carlsten*
Name of person supplying these data : *B. Carlsten*
e-mail : *bcarlsten@lanl.gov*
tel. : *+1 505 667 5657* fax : *+1 505 667 8207*

HISTORY AND STATUS

Const. started : *10/1994* ; first beam : *04/1995*
Present status : *Operating*
Cost of facility : *0.5 MUSD (1995)*
Present linac staff : *1 man-year*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Photoinjector* ; energy : keV
Beam intensity (peak) : *1000* A
Normalized emittance (1σ) : *5* π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *0.5* m
No. sections : *1* ; lengths : *0.5* m
Field mode : *π/2* ; frequency : *1.3* GHz
Wave type : *SW* ; filling time : *2* μs
v_g/c range : ; Q : *10000*
Shunt impedance : *~ 20* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *5* MW; mean : *0.050* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles 8 (all electromagnets)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *10 - 20*
No. of particles/bunch : *~ 10^{11}*
Bunch separation : *9 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.008*		GeV
Accel gradient	:	*20*		MeV/m
ΔE/E (FWHM)	:	*1*		%
Rep. rate	:	*1*		Hz
Pulse length	:	*10*		μs
Beam intensity	:	*(1) 1000*		A
Norm. emit. (1σ)	:	*5*		π mm-mrad

OTHER RELEVANT INFORMATION

Uses a chicane to compress an initial 10 - 20 ps bunch to ~ 1 ps.

(1) peak

PROTON AND/OR H- LINAC

Name of Linac : *LEDA**
Function : *Technology*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *J. David Schneider*
Name of person supplying these data : *J. David Schneider*
e-mail : *jdschneider@lanl.gov*
tel. : *+1 505 667 5454* fax : *+1 505 667 4344*

HISTORY AND STATUS

Const. started : *04/01/1996* ; first beam :
Present status : *Design & construction*
Cost of facility : *165 MUSD*
Present linac staff : *65*
Present yearly operat. time : *0 (except injector)* h

LINAC PARAMETERS

Ion Source

Type : *Microwave (2.45 GHz)*
Output : *130* mA at *75* keV
Pulse length : *CW* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Pre-accelerator (including RFQ)

Types : *RFQ* ; lengths : *8.0* m
Output : *100* mA at *6700* keV
Pulse length: *CW* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Longitudinal Matching

Type : *Integrated into structures*
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *23* m; No. of tanks : *4*
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range): *2 or 3*
Aperture diameter : mm to mm
RF frequency(ies) : *350 & 700* MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : *20* μs
Equilibrium phases :
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : *6.0* MW; mean : *6.0* MW

Focusing System

No. elements :
type : *Electro Quads* order :
Gradients : to T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	:	*20*	MeV
Mean acc. rate	:	*1.0*	MeV/m
ΔE/E (FWHM)	:		%
Beam current	:	*100*	mA peak
Norm. emit. (1σ)	:	*0.2*	π mm-mrad

OTHER RELEVANT INFORMATION

* *LEDA - Low Energy Demonstration Accelerator*

Use of new coupled-cavity drift-tube linac structures.

Approximately 20 MeV output energy.

PROTON AND/OR H⁻ LINAC

Name of Linac "Los Alamos Neutron Science Center" (LANSCE) Linac
Function(s) High intensity proton beams and H⁻ for Proton Strorage Ring
Institution and address Los Alamos National Laboratory, Los Alamos, NM 87545
Person in charge Stanley O. Schriber
Name, e-mail, telephone and fax no. of person supplying these data
Frank E. Merrill fmerrill@lanl.gov 505-665-1396 505-665-0046 date 5/1/96
Earl W. Hoffman earl@lanl.gov 505-667-7816 505-665-8604 date 5/1/96

HISTORY AND STATUS

Const. started...2/68...first beam.....6/72...(dates)
Present status.....Operational.....
Cost of facility..US.$57M(1968)...currency/date
Present linac staff....100.....(incl. beam delivery)
Present yearly operat. time.....3600...h

LINAC PARAMENTERS

H⁻ Ion Source

Type..H⁻ Converter type surface Plasma Source
Output.....17...mA at.....80...keV
Pulse length.....825...μs; rep. rate.....120...Hz

H⁻ Pre-accelerator (including RFQ)

Type.....CW.....; length.....m
Output.....17...mA at.....750...keV
1-σ normalized emit. .....0.2...πmm-mrad

H⁻Longitudinal Matching

Type.....2 Bunchers.....
Mod. ...3...keV; drift...4714..mm..at...201..MHz
...16...keV; drift...1795..mm..at...201..MHz

H⁺ Ion Source

Type.....duo-Plasmatron.....
Output....30...mA....at.....30...keV
Pulse length...825..μs; rep. rate.....120...Hz

H⁺Pre-accelerator (including RFQ)

Type.....CW.....; length.....m
Output.....30..mA at.....750...keV
1-σ normalized emit.....0.03...πmm-mrad

H⁺ Longitudinal Matching

Type....2 Bunchers.....
Mod. ...5 keV; drift 5853 mm at 201.25 MHz
...16 keV; drift 1795 mm at 201.25 MHz

DTL Focusing System

No. Elements...135...type....Quad....order.....FODO.....
Gradients.....74.0...to.....5.0...T/m

SCL Focusing System

No. Elements...104...type....Quad....order.....FDO.....
Gradients.....20.0...to....30.0...T/m

LINAC PERFORMANCE

	Normal Operation	*Max, or Design*	
Energy	800	800	MeV
Mean Acc. rate	1.0	1.0	MeV/m
ΔE/E (%)	0.1	0.1	FWHM
H^+ Beam current	17 mA		mA peak
H^+ 1-σ norm emit.	0.3		π mm-mrad
H^- Beam current	11 mA		mA peak
H^- 1-σ norm emit.	0.3		π mm-mrad

	DTL	SCL
Total linac length (m)	62	731
No. tanks	4	104
Tank diameters (m)	0.9	0.26
No. drift-tubes/cells	165	4960
Drift-tube lengths (mm)	48-373	n/a
Drift-tube dias (mm)	160-180	n/a
Gap/cell length	0.16-0.4	n/a
Aperture dias. (mm)	15 to 30.0	31.8 to 44.5
RF frequencies (MHz)	201.25	805
Field modes	TM010	TM010
Eff. shunt imps. (MΩm)	50-70	25-38
Q	$60\text{-}75\times10^3$	$18\text{-}25\times10^3$
Filling time (μs)	150	15
Equil. phases	26°	31°- 42°
RF rep. rate (Hz)	120	120
RF pulse (μs)	1035	985
Beam rate (Hz)	120	120
Beam pulse (μs)	825	825
RF power peak (MW)	3.0	1.25
RF mean power (MW)	0.26	0.09

OTHER RELEVANT PARAMS., REFS. ETC.

R. E. O. Ericson, V. W. Hughes and D. E. Nagle, *The Meson Factories,* (University of California Press, Los Angeles, 1991).

M. Stanley Livingston, "LAMPF A Nuclear Research Facility," LA-6878-MS, September 1977.

M. Stanley Livingston, "Origins and History of the Los Alamos Meson Physics Facility," LA-5000.

PROTON AND/OR H- LINAC

Name of Linac : *PL-2 RFQ*
Function : *Proton, Deuteron acceleration*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *Richard Morgado*
Name of person supplying these data : *Charlene Cappiello*
e-mail : *ccappiello@lanl.gov*
tel. : *+1 505 667 7728* fax : *+1 505 665 3457*

HISTORY AND STATUS

Const. started : ; first beam : *1994*
Present status : *(1)*
Cost of facility : *USD 750 000 (1994)*
Present linac staff : *None*
Present yearly operat. time : *200* h

LINAC PARAMETERS

Ion Source

Type : *Duoplasmatron*
Output : *> 30* mA at *30* keV
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : *< 50* π mm-mrad

Pre-accelerator (including RFQ)

Types : *RFQ* ; lengths : *1.92* m
Output : *0.5* mA at *1750* keV
Pulse length: *5 - 50* μs; rep. rate : *(2)* Hz
Normalized emittance (1σ) : *< 50* π mm-mrad

Longitudinal Matching *NA*

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System *NA*

Total linac length : m; No. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equilibrium phases :
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*1.75*		MeV
Mean acc. rate			MeV/m
ΔE/E (FWHM)	*2.790*		%
Beam current	*25*		mA peak
Norm. emit. (1σ)	*< 50*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) Currently on loan to Oak Ridge National Laboratory, located at Western Kentucky University.

(2) 150 - 1500

Also capable of deuteron acceleration. Coupled with a beryllium target, it produces neutrons.

PROTON AND/OR H- LINAC

Name of Linac : *CRITS RFQ* *
Function : *Test CW RFQ Operations*
Institution and address : *AOT Division, LANL *, Los Alamos, NM 87545, USA*
Person in charge : *J. David Schneider*
Name of person supplying these data : *Joseph Sherman*
e-mail : *jsherman@lanl.gov*
tel. : *+1 505 667 3511* fax : *+1 505 665 2509*

HISTORY AND STATUS

Const. started : *06/1993* ; first beam :
Present status : *Awaiting funding*
Cost of facility :
Present linac staff :
Present yearly operat. time : h

LINAC PARAMETERS

Ion Source

Type : *Microwave proton source*
Output : *90* mA at *50* keV
Pulse length : *DC* μs; rep. rate : Hz
Normalized emittance (1σ) : *(1) 0.13* π mm-mrad

Pre-accelerator (including RFQ)

Types : *RFQ* ; lengths : *1.47* m
Output : *75* mA at *(2) 1250* keV
Pulse length: *CW* μs; rep. rate : Hz
Normalized emittance (1σ) : *(2) 0.50* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : m; No. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equilibrium phases :
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	:	*1.25*	MeV
Mean acc. rate	:	*0.82*	MeV/m
ΔE/E (FWHM)	:	*5*	%
Beam current	:	*55*	mA peak
Norm. emit. (1σ)	:	*0.4*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Radiofrequency quadrupole*
** *Los Alamos National Laboratory*

(1) Estimated
(2) Design

Linac completed at Chalk River Laboratories, Ontario, Canada.

ELECTRON LINAC

Name of Linac : *CESR Linac*
Function : *Electron filling of CESR Storage Ring*
Institution and address : *Cornell University, Wilson Laboratory, Ithaca, NY 14853*
Person in charge : *Roy Cutler (of Linac)*
Name of person supplying these data : *Roy Cutler*
e-mail : *RIC@LNS62.LNS.CORNELL.EDU*
tel. : *+1 607 255 4882* fax : *+1 607 255 8061*

HISTORY AND STATUS

Const. started : *1965* ; first beam : *(1)*
Present status : *Operating*
Cost of facility : *1.9 MUSD (1966)*
Present linac staff : *~ 1 man-year*
Present yearly operation time : *6000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *150* keV
Beam intensity (peak) : *(2)* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *0.15* MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *45* m
No. sections : *8* ; lengths : *3×3m;* m
Field mode : *2π/3* ; frequency : *2856* GHz
Wave type : *TW* ; filling time : *(4)* μs
v_g/c range : *(5)* ; Q : *(5)*
Shunt impedance : *(5)* MΩ/m
Iris : aperture : diameter : *(5)* mm
thickness : *(5)* mm
Attenuation/section : *(5)* Np
Power units, Number : *8* type : *Klystron*
RF power peak : *21* MW; mean : *6* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid coils for injector and section 1.
Quad doublets or triplets between other sections.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *7 - 21*
No. of particles/bunch : 2×10^9
Bunch separation : *14 - 220 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.34*	*0.35*	GeV
Accel gradient	:	*10*	*10*	MeV/m
ΔE/E (FWHM)	:	*0.25*		%
Rep. rate	:	*60*		Hz
Pulse length	:	*(6)*		μs
Beam intensity	:			A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

All eight sections used to accelerate electrons for CESR filling. For positrons, W target is inserted after section 4 (150 MeV). Positrons accelerated by sections 5 - 8 to 200 MeV. 7 - 21 μ bunch / pulse for either electron or positron operation.

(1) 1966 electrons, 1976 positrons
(2) 5×10^{10} (pos.), 3×10^9 (elec.)
(3) Two 214 MHz subharmonic Bunchers
(4) 0.55 - 0.82 μs
(5) Linac consists of 4 different types of sections - all constant gradient (average 10 MeV/m).
Section 1 - SLAC type
Sections 2 - 8 and energy compressor - Varian
(6) RF pulse length 2.2 μs on the flat-top

POSITRON LINAC

Name of Linac	:	*CESR Linac*
Function	:	*Electron Filling of CESR Storage Ring*
Institution and address	:	*Cornell University, Wilson Laboratory, Ithaca, NY 14853, USA*
Person in charge	:	*Roy Cutler*
Name of person supplying these data	:	*Roy Cutler*
		e-mail : *RIC@LNS62.LNS.CORNELL.EDU*
		tel. : *+1 607 255 4882* fax : *+1 607 255 8061*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*150*	MeV
Radius (1σ)	:	*2 - 3*	mm
Beam intensity	:	*(1)*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*W*	
Type	:	*Stationary*	
Thickness (rad.length)	:	*2*	X
Diameter	:	*20*	mm
Mean deposited power	:	*0.3*	kW
Solenoidal field[a)]	:	*0.24 T, 10 m long, DC*	
Matching device	:	*λ/4 0.95 T Pulsed Solenoid*	
RF sections[a)]	:	*(2)*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.2*		GeV
Accel gradient	:	*10*		MeV/m
ΔE/E (FWHM)	:	*1*		%
Rep. rate	:	*60*		Hz
Pulse length	:	*(3) 2.2*		μs
Yield (fin.en)	:	*1.3×10^{-2}*		e^+/e^- x GeV
Beam intensity	:	*(4)*		μA peak
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

(1) 3×10^{10} Electrons / microbunch
(2) 4 x 5 m + 1 x 5 m energy compressor
(3) RF pulse length on the flat-top
(4) 6×10^7 e^+ / microbunch

7 - 21 microbunch / pulse
Energy compression at output to reduce energy spread by ~ 10 X. Consists of an achromatic bend and 5 m long linac section operated at ~ 5 MeV (peak).

ION LINAC

Name of Linac : *Stony Brook Superconducting Heavy-Ion Linac*
Function : *Heavy-Ion Accelerator for Basic Research in Nuclear & Atomic Physics*
Institution and address : *University of Stony Brook, Stony Brook, NY 11794-3800 USA*
Person in charge : *Prof. Gene D. Sprouse*
Name of person supplying these data : *John W. Noé*
e-mail : *John.noe@sunysb.edu*
tel. : *+1 516 632 8156* fax : *+1 516 632 8573*

HISTORY AND STATUS

Const. started : *1980* ; first beam : *1983*
Present status : *Full-time Operation*
Cost of facility : *4 MUSD (1982)*
Present linac staff : *About 5 (FTE)*
Present yearly operat. time : *About 4000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *Negative-ion sputter*
Species of ions : *Protons to Bismuth*
Range of currents : *0.1 - 10* μAe
Range of output energies : *(1) 200 - 400* keV/u
Pulse length : *cw* μs; rep. rate : Hz
Normalized emittance (1σ) : *5 - 10* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *FN tandem Van de Graaff / 14* m
Output currents : *≤ 10* μAe
Output energies : keV/u
Frequency : *cw* MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : *~ 1.0* π mm-mrad

Longitudinal Matching

Type : *(2)*
Mod. *500* keV; drift *8000* mm at *150* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *16* m; N°. of tanks : *(3)*
Tank diameters : m
Number of drift-tubes : *Resonators = 16 + 24*
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : *19* mm to mm
RF frequency(ies) : *150.4* MHz
Field modes : *βλ / 2*
Eff. shunt impedance : MΩ/m
Q : *~ 10^8*
Filling time : μs
Equil. phases : *- 15°* ; accel. rate MeV/u-m
RF rep. rate : *cw* Hz; pulse : μs
Beam rate : *cw* Hz; pulse : μs
RF power peak : *(4)* MW; mean : MW

Focusing System

No. elements : *12*
type : *(5)* order :
Gradients : to T/m
Other :

Charge Stripping (Typical)

Type(s) : *5 μg/cm² carbon after tandem*
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	*Li6 - Zr90*		
Energy	*≤ 12*		MeV/u
ΔE/E (FWHM)	*0.1*		%
Mean acc. rate	*~ 0.4*		MeV/u-m
Beam current	*0.01 - 1.0*	*(6) 3*	μAe peak
Norm. emit. (1σ)	*~ 0.5*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
Protons	*1 - 20 MeV*	*Tandem only*
Gold	*50 - 100 MeV*	*without linac*

OTHER RELEVANT INFORMATION

(1) Unit = keV
(2) Double-drift harmonic buncher & s/c resonator
(3) Cryostats = 12
(4) cw = 7 kW total
(5) Room temperature quadrupole doublet
(6) μAe cw

Linac has 16 superconducting QUARTER-WAVE RESONATORS with β opt = 0.07 c and 24 s/c split-loop resonators with β opt = 0.10 c. Energy gain per resonator is approx. 500 keV per unit charge. Superconductor is lead-tin on copper.

References

[1] J.W. Noé, Rev. Sci. Instr. 57, 757 (May 1986)

ELECTRON LINAC

Name of Linac : *Gaerttner*
Function : *Electron LINAC for Various Research Experiments (1)*
Institution and address : *Rensselaer Polytechnic Institute, Tibbits Ave., Troy, NY 12180, USA*
Person in charge : *Dr Robert C. Block, Director*
Name of person supplying these data : *Peter J. Brand*
e-mail : *brandp@rpi.edu*
tel. : *+1 518 276 6406* fax : *+1 518 276 4007*

HISTORY AND STATUS

Const. started : *1958* ; first beam : *1960*
Present status : *Operating*
Cost of facility :
Present linac staff : *4 man-years*
Present yearly operation time : *700* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *75* keV
Beam intensity (peak) : *0 - 40* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *20.1* m
No. sections : *8* ; lengths : *1* m
Field mode : *π/4* ; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *1.25* μs
v_g/c range : ; Q :
Shunt impedance : *12.0* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *0.36* Np
Power units, Number : *8* type : *Klystron*
RF power peak : *10* MW; mean : *15* kW

Focusing System

Type, No. of elements, and spacing :
Axial magnetic field incorporated in accelerator section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*(2)*	*0.090*	GeV
Accel gradient	*7.5*	*11*	MeV/m
ΔE/E (FWHM)	*10*	*10*	%
Rep. rate	*(3)*	*720*	Hz
Pulse length	*0.015 - 5*	*5*	μs
Beam intensity	*≤ 3*		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

(1) Neutron cross-section, isotope generation, electronic testing, gemstone coloration and other research needs, as required.

(2) Two extraction ports are available. One provides energy from 5 to 25 MeV, the second from 25 to > 60 MeV.

(3) Single to 720

ELECTRON LINAC

Name of Linac : *NSLS* *
Function : *Electron Injector for NSLS Booster Synchrotron*
Institution and address : *Brookhaven National Laboratory, Upton, NY 11973-5000,USA*
Person in charge : *Eric Blum*
Name of person supplying these data : *Eric Blum*
e-mail : *BLUM@BNLLS1.BNL.GOV*
tel. : *+1 516 344 2438* fax : *+1 516 244 3029*

HISTORY AND STATUS

Const. started : *1978* ; first beam : *1980*
Present status : *Operating*
Cost of facility : *Unknown*
Present linac staff : *2*
Present yearly operation time : *7100* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *~1* A
Normalized emittance (1σ) : *~100* π mm-mrad

Injector

Longitudinal matching : *S-Band Prebuncher*
Output : *0.2* MeV; intensity : A
Pulse width, spacing : *2.5 μsec, 1.2 sec*
Normalized emittance (1σ) : *~100* π mm-mrad

Acceleration System

Total linac length : *9.5* m
No. sections : *3* ; lengths : *4.5, 3, 3* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *1.2, 0.8* μs
v_g/c range : ; Q : *13000*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *3* type : *Klystrons*
RF power peak : *21* MW; mean : *0.044* kW

Focusing System

Type, No. of elements, and spacing :
None

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *7*
No. of particles/bunch : 3×10^{10}
Bunch separation : *95 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.12*	*0.12*	GeV
Accel gradient	:	*12.6*	*12.6*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*0.83*	*2*	Hz
Pulse length	:	*2.5*	*2.5*	μs
Beam intensity	:			A
Norm. emit. (1σ)	:	*1*	*1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *National Synchrotron Light Source injector Linac*

The linac was built from a Varian buncher section that was originally installed at Cornell University and two SLAC sections.

ELECTRON LINAC

Name of Linac : *ATF* *
Function : *Users's Facility for Accelerator and Beam Physics*
Institution and address : *Brookhaven National Laboratory, Upton, NY 11973-5000, USA*
Person in charge : *Ilan Ben-Zvi*
Name of person supplying these data : *Ilan Ben-Zvi*
e-mail : *ILAN@BNL.GOV*
tel. : *+1 516 3445143* fax : *+1 516 3443029*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1991*
Present status : *Operating*
Cost of facility : *5 MUSD (1993)*
Present linac staff : *8 man-years*
Present yearly operation time : *1100 (1995)* h

LINAC PARAMETERS

Electron Sources

Types : *Photoinjector* ; energy : *4500* keV
Beam intensity (peak) : *100* A
Normalized emittance (1σ) : *2* π mm-mrad

Injector

Longitudinal matching : *Injector ≡ Source*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *6* m
No. sections : *2* ; lengths : *3.05* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *(1)* ; Q : *13000*
Shunt impedance : *52* MΩ/m
Iris : aperture : diameter : *19.2* mm
thickness : *5.842* mm
Attenuation/section : *0.57* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *25* MW; mean : *0.25* kW

Focusing System

Type, No. of elements, and spacing :
1 Solenoid following photoinjector. Nothing in linac.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *Variable 1-200*
No. of particles/bunch : *Variable up to* 3×10^9
Bunch separation : *12.5 ns or 25 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.05*	*0.07*	GeV
Accel gradient	:	*8*	*11*	MeV/m
ΔE/E (FWHM)	:	*0.5*	*0.2*	%
Rep. rate	:	*1-3*	*6*	Hz
Pulse length	:	*2.5*	*4*	μs
Beam intensity	:	*100*	*300*	A
Norm. emit. (1σ)	:	*2*	*1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Accelerator Test Facility*

(1) 0.0204 - 0.0065

The ATF has 3 beam lines and 15 User Experiments approved by a peer review committee.

High power (multi GW) laser beams, synchronized with the e⁻ beam are provided.

More information is on the World Wide Web from http://www.BNL.GOV. Select the Accelerator Test Facility link.

PROTON AND/OR H- LINAC

Name of Linac : *Brookhaven 200 MeV H⁻ Linac*
Function : *H⁻ injector for the AGS Booster*
Institution and address : *Brookhaven National Laboratory, Upton, NY 11973-5000, USA*
Person in charge : *D.I. Lowenstein / T. Roser*
Name of person supplying these data : *J. Alessi*
e-mail : *ALESSI@BNL.GOV*
tel. : *+1 516 344 7563* fax : *+1 516 344 5011*

HISTORY AND STATUS

Const. started : *04/1967* ; first beam : *11/1970*
Present status : *Operational*
Cost of facility : *22.4 MUSD (1970)*
Present linac staff : *9*
Present yearly operat. time : *4000* h

LINAC PARAMETERS

Ion Source

Type : *Magnetron H⁻*
Output : *80 - 100* mA at *35* keV
Pulse length : *500* μs; rep. rate : *7.5* Hz
Normalized emittance (1σ) : *0.37* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4-vane RFQ* ; lengths : *1.6* m
Output : *65* mA at *750* keV
Pulse length: *500* μs; rep. rate : *7.5* Hz
Normalized emittance (1σ) : *0.4* π mm-mrad

Longitudinal Matching

Type : *Three buncher (5.9 m transport)*
Mod. *(1)* keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *144.* m; No. of tanks : *9*
Tank diameters : *0.94 - 0.84* m
Number of drift-tubes : *277*
Drift-tube lengths : *47 - 446* mm
Drift-tube diam (range): *180 - 160* mm
Gap/cell length (range): *0.20 - 0.47*
Aperture diameter : *20* mm to *40* mm
RF frequency(ies) : *201.25* MHz
Field modes : *TM010*
Eff. shunt impedance : *50.15* MΩ/m
Q : *53000 - 40000*
Filling time : *< 100μs* μs
Equilibrium phases : *-32°*
RF rep. rate : *7.5* Hz; pulse : *600* μs
Beam rate : *7.5* Hz; pulse : *300* μs
RF power peak : *30.0* MW; mean : *0.14* MW

Focusing System

No. elements : *286*
type : *Pulsed* order : *FODO*
Gradients : *80* to *7* T/m
Other : *Pulsed flat-top ~ 650 μs*

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Energy	*200*	MeV
Mean acc. rate	*1.45*	MeV/m
ΔE/E (FWHM)	*± 0.2*	%
Beam current	*35 - 40*	mA peak
Norm. emit. (1σ)	*1.9*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Mod. 28 keV; drift : 2986 mm at 201.25 MHz
Mod. 12 keV; drift : 1454 mm at 201.25 MHz
Mod. 24 keV; drift : 729 mm at 201.25 MHz

Original machine described in Part. Accel. 9 (1979), 1-156.

Converted to H⁻ acceleration in 1982.

Converted from Cockcroft-Walton to RFQ in 1989.

AGS Booster accepts approx. 4 pulses/3 sec; all remaining pulses go to Brookhaven Linac Isotope Producer (BLIP).

Beam Pulse width will be increased to 500μs during 1996 running period.

ELECTRON LINAC

Name of Linac : *Duke Linac*
Function : *Storage Ring Injection, Beam Transport Experiments, Free-Electron*
Institution and address : *Duke University, PO Box 90305, Durham, NC 27708-0319, USA*
Person in charge : *Patrick O'Shea*
Name of person supplying these data : *Patrick O'Shea*
e-mail : *oshea@fel.duke.edu*
tel. : *+1 919 660 2652* fax : *+1 919 660 2671*

HISTORY AND STATUS

Const. started : *(1)* ; first beam : *10/1994*
Present status : *Operational*
Cost of facility : *(1)*
Present linac staff :
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *(2)* ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *44* m
No. sections : *11* ; lengths : *3.05* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.8* μs
v_g/c range : *(3)* ; Q : *13000*
Shunt impedance : *58* MΩ/m
Iris : aperture : diameter : *26.22 - 19.23* mm
thickness : *5.84* mm
Attenuation/section : *0.57* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *32* MW; mean : *0.32* kW

Focusing System

Type, No. of elements, and spacing :
Quad doublets spaced every 4 accelerator sections

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *100 - 3000*
No. of particles/bunch : 10^8 - 10^9
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*(4) 0.280*	*(4) 0.295*	GeV
Accel gradient	:	*6.4*	*6.7*	MeV/m
ΔE/E (FWHM)	:	*0.1*	*0.1*	%
Rep. rate	:	*2*	*5*	Hz
Pulse length	:	*0.03*	*1*	μs
Beam intensity	:	*0.04*	*0.2*	A
Norm. emit. (1σ)	:		*10*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) The linac began its life as the MkIII linac at Stanford University in the early 1960s. The accelerator sections are from some of the early production runs of the SLAC constant gradient structures. New rf, vacuum and magnet systems were added at Duke. Therefore, a construction cost is difficult to estimate. Installation of the linac at Duke began in 1993.

(2) The electron source/injector is a single-cell rf thermionic gun with α-magnet for longitudinal matching. The cathode material is LaB_6. The gun operates at a nominal energy of 1 MeV.

(3) 0.0204 - 0.0065

(4) The linac sits in a 150m long tunnel, and will be extended to reach 1.2 GeV. An upgrade to 500 MeV is currently underway. A description of the linac can be found in a paper by P.G. O'Shea et al., to appear in the Proceedings of the 1995 IEEE Particle Accelerator Conference, Dallas, May 1995.

ELECTRON LINAC

Name of Linac : *MKIII FEL Linac-Driver*
Function : *Driver for mid-infrared MKIII FEL*
Institution and address : *Duke University, FEL Lab., PO Box 90305, Durham, NC 27708-0319, USA*
Person in charge : *Prof. John M.J. Madey, Director*
Name of person supplying these data : *John M.J. Madey*
e-mail :
tel. : *+1 919 660 2643* fax : *+1 919 660 2671*

HISTORY AND STATUS

Const. started : *1982* ; first beam : *1984*
Present status : *Operational*
Cost of facility : *(1) 250 KUSD*
Present linac staff : *4*
Present yearly operation time : *2500* h

LINAC PARAMETERS

Electron Sources

Types : *Microwave Gun* ; energy : *860* keV
Beam intensity (peak) : *0.6* A
Normalized emittance (1σ) : *2 × 8* π mm-mrad

Injector *(2)*

Longitudinal matching : *(3)*
Output : MeV; intensity : *(4) 40* A
Pulse width, spacing :
Normalized emittance (1σ) : *2 × 8* π mm-mrad

Acceleration System *(5)*

Total linac length : m
No. sections : *1* ; lengths : *3* m
Field mode : ; frequency : GHz
Wave type : ; filling time : μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *30* MW; mean : *9* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupole, triplet at input to linac, doublet pair to match into FEL

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 2×10^4
No. of particles/bunch : 5×10^8
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.043*	*0.045*	GeV
Accel gradient	:	*14*		MeV/m
ΔE/E (FWHM)	:	*0.3*		%
Rep. rate	:	*30*		Hz
Pulse length	:	*8*		μs
Beam intensity	:	*0.25*		A
Norm. emit. (1σ)	:	*(6)*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) Linac only
(2) Integrated microwave thermionic gun
(3) α-magnet momentum analyzer/bunch compressor
(4) Peak
(5) Acceleration system = SLAC-type
(6) Vertical : 2
Horizontal : 8

ELECTRON LINAC

Name of Linac : *ORELA**
Function : *Electron Linac for Production of Neutrons and Slow Positrons*
Institution and address : *Oak Ridge National Lab, Bldg. 6010, MS-6354, Oak Ridge, TN 37831, USA*
Person in charge : *D.C. Larson*
Name of person supplying these data : *T.A. Lewis*
e-mail : *lewista@ornl.gov*
tel. : *+1 423 574 4594* fax : *+1 423 576 8746*

HISTORY AND STATUS

Const. started : *1966* ; first beam : *1969*
Present status : *Operating*
Cost of facility : *4.8 MUSD (1969)*
Present linac staff : *2*
Present yearly operation time : *1600* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *150* keV
Beam intensity (peak) : *60* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *16.4* m
No. sections : *4* ; lengths : *4.1* m
Field mode : *2π/3* ; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *1.85* μs
v_g/c range : *0.007* ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : *Variable* mm
thickness : mm
Attenuation/section : *0.41* Np
Power units, Number : *4* type : *Klystron*
RF power peak : *24* MW; mean : *65* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid over LINAC length.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.140*	*0.178*	GeV
Accel gradient	*10*	*10*	MeV/m
ΔE/E (FWHM)			%
Rep. rate	*to 1000*	*to 1000*	Hz
Pulse length	*0.002-0.05*	*0.002-0.05*	μs
Beam intensity	*15*	*25*	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* *Oak Ridge Electron Linear Accelerator*

(1) Buncher part of first section

Linac used to produce intense, pulsed bunches of neutrons at repetition rates from 15-1000 Hz. Burst widths from 4-30 ns. Flight tube lengths from 8-200 m. Intensity 10^{14} n/sec. Has attached an intense pulsed source of slow positrons.

Home Page : http://www.phy.ornl.gov/orela/orela.html

ELECTRON LINAC

Name of Linac : *CEBAF* *
Function : *Electron Linac for Nuclear Physics*
Institution and address : *CEBAF, Newport News, VA 23606, USA*
Person in charge : *A . Hutton, Director of Operations*
Name of person supplying these data : *J. Bisognano*
e-mail : *bisognano@cebaf.gov*
tel. : *+1 804 249 7521* fax : *+1 804 249 5024*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1994*
Present status : *Operating*
Cost of facility : *600 MUSD*
Present linac staff : *approx. 500*
Present yearly operation time : *5000* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *100* keV
Beam intensity (peak) : *< 0.01* A
Normalized emittance (1σ) : *0.19* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *45* MeV; intensity : *0.200* A
Pulse width, spacing : *CW*
Normalized emittance (1σ) : *0.25* π mm-mrad

Acceleration System

Total linac length : *(3)* m
No. sections : ; lengths : m
Field mode : *π* ; frequency : *1.497* GHz
Wave type : *SW* ; filling time : μs
v_g/c range : ; Q : *(4)*
Shunt impedance : *480.0* MΩ/m
Iris : aperture : diameter : *70* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *320* type : *Klystrons*
RF power peak : MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
FODO in 2 antiparallel 400 MeV linacs;
9 recirculation arcs for 5 pass acceleration.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *CW*
No. of particles/bunch : *< 1.25×10^6*
Bunch separation : *667 ps or 2 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*4*	*4*	GeV
Accel gradient	*5*	*5*	MeV/m
ΔE/E (FWHM)	*10^{-4}*	*$0.5\ 10^{-4}$*	%
Rep. rate	*na*	*na*	Hz
Pulse length	*na*	*na*	μs
Beam intensity	*50×10^{-6}*	*200×10^{-6}*	A
Norm. emit. (1σ)	*1*	*1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *CEBAF - Continuous Electron Beam Accelerator Facility superconducting recirculating linac*

(1) Thermionic or photoemission
(2) Room temperature chopper & buncher 18 superconducting cavities
(3) 320 0.5m active length, 5-cell superconducting cavities in 40 8-cavity cryomodules
(4) 6.6×10^9 loaded (2.4×10^9 from cavity walls)

ELECTRON LINAC

Name of Linac : *Boeing Linac*
Function : *FEL Driver**
Institution and address : *FEL Program, Boeing D&SG, PO Box 3999 M/S 2T-50, Seattle, WA 98124, USA*
Person in charge : *John L. Adamski*
Name of person supplying these data : *A.M Vetter*
e-mail : *vetamx00@ccmail.ca.boeing.com*
tel. : *+1 206 544 5922* fax :

HISTORY AND STATUS

Const. started : *03/1996* ; first beam : *03/1997*
Present status : *Under construction*
Cost of facility :
Present linac staff : *10*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *NA* keV
Beam intensity (peak) : *(2) 0.10* A
Normalized emittance (1σ) : *7 @ 3.6 nC* π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *20* MeV; intensity : *(2) 0.10* A
Pulse width, spacing : *800 μs, 33.3 ms*
Normalized emittance (1σ) : *7* π mm-mrad

Acceleration System

Total linac length : *(4) 20* m
No. sections : *6* ; lengths : *1.5* m
Field mode : *3π/4* ; frequency : *1.3* GHz
Wave type : *(5)* ; filling time : *5* μs
v_g/c range : *0.003* ; Q : *20000*
Shunt impedance : *(6) 16.6* MΩ/m
Iris : aperture : diameter : *55* mm
thickness : *14.5* mm
Attenuation/section : *2.6 dB (power)* Np
Power units, Number : *4* type : *Klystron*
RF power peak : *10* MW; mean : *60* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupole triplets between section pairs

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *3.6 nC*
Bunch separation : *36.9 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*0.100*	GeV
Accel gradient :		*6.7*	MeV/m
ΔE/E (FWHM) :		*0.5*	%
Rep. rate :		*30*	Hz
Pulse length :		*200*	μs
Beam intensity :		*0.10*	A
Norm. emit. (1σ) :		*10*	π mm-mrad

OTHER RELEVANT INFORMATION

* *FEL - Free Electron Laser*

(1) RF photocathode ($K_2Cs\ Sb$)
(2) During RF macropulse.
(3) Injector is 20 MeV linac described on separate sheet, interfaced to main linac by a 1.3 GHz linac section and chicane buncher to compress 60 ps bunch to 7 ps.
(4) Excluding injector described on separate sheet.
(5) TW const. Z
(6) $R = V_a^2/2P_c$

References

[1] J.L. Adamski, et al., "A Kilowatt Class Visible Free Electron Laser Facility," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.

[2] D. Dowell and A. Vetter, "Magnetic Pulse Compression using a Third Harmonic RF Linearizer," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.

ELECTRON LINAC

Name of Linac : *Boeing Linac*
Function : *FEL Driver Injector**
Institution and address : *FEL Program, Boeing D&SG, PO Box 3999 M/S 2T-50, Seattle, WA 98124, USA*
Person in charge : *John L. Adamski*
Name of person supplying these data : *A.M. Vetter*
e-mail : *vetamx00@ccmail.ca.boeing.com*
tel. : *+1 206 544 5922* fax :

HISTORY AND STATUS

Const. started : *06/1994* ; first beam : *06/1995*
Present status : *Operational*
Cost of facility :
Present linac staff : *10*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *NA* keV
Beam intensity (peak) : *(2) 0.25* A
Normalized emittance (1σ) : *7 @ 3.6 nC* π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *2* MeV; intensity : *(2) 0.25* A
Pulse width, spacing : *800 μs, 33.3 ms*
Normalized emittance (1σ) : *7* π mm-mrad

Acceleration System

Total linac length : *8.5* m
No. sections : *4* ; lengths : *(4)* m
Field mode : *π* ; frequency : *0.433* GHz
Wave type : *SW* ; filling time : *5* μs
v_g/c range : ; Q : *27000*
Shunt impedance : *(5) 13* MΩ/m
Iris : aperture : diameter : *50* mm
thickness : *166* mm
Attenuation/section : *NA* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *4* MW; mean : *(6) 100* kW

Focusing System

Type, No. of elements, and spacing :
Axial field coils between cavities

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *3.6 nC*
Bunch separation : *36.9 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.02*	*0.025*	GeV
Accel gradient	:	*3*	*3*	MeV/m
ΔE/E (FWHM)	:		*1*	%
Rep. rate	:	*30*	*30*	Hz
Pulse length	:	*800*	*8300*	μs
Beam intensity	:	*0.1*	*0.23*	A
Norm. emit. (1σ)	:	*9*	*7*	π mm-mrad

OTHER RELEVANT INFORMATION

* *FEL - Free Electron Laser*

(1) RF photocathode ($K_2Cs\ Sb$)
(2) During RF macropulse.
(3) Photocathode is in side wall of a 433 MHz single cell cavity with 3 cm gap; following is a second single cell cavity with a 4.5 cm gap.
(4) 2 sections of 1 m, 2 sections of 1.7 m.
(5) $R = V_a^2/2P_c$
(6) Quantity given is for operation as injector for 100 MeV linac. RF duty factor up to 25% is possible.

References

[1] T.D. Hayward et al., "A High Duty Factor Electron Linac for FEL," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.

[2] J.L. Adamski, et al., "A Kilowatt Class Visible Free Electron Laser Facility," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.

ION LINAC

Name of Linac : *University of Washington Superconducting Booster*
Function : *Post-accelerator for heavy ions*
Institution and address : *Nuclear Physics Lab, Box 354290, Univ of Washington, Seattle WA 98195 USA*
Person in charge : *Derek W. Storm*
Name of person supplying these data : *D.W. Storm*
e-mail : *storm@npl.washington.edu*
tel. : *+1 206 543 4085* fax : *+1 206 685 4634*

HISTORY AND STATUS

Const. started : *11/1983* ; first beam : *10/1987*
Present status : *Operational*
Cost of facility : *9.6 MUSD (1985)*
Present linac staff : *7 people, 3 FTE (1)*
Present yearly operat. time : *3000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3 (all negative)*
Types of source : *(2)*
Species of ions : *any mass up to 64*
Range of currents : *1 - 20* μAe
Range of output energies : *5 - 35* keV/u
Pulse length : *CW* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.15* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *FN tandem van de Graaff* m
Output currents : *1 - 10* μAe
Output energies : *16000 - 1500* keV/u
Frequency : *12.5* MHz; peak RF power : kW
Pulse length : *CW* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.4 - 3* π mm-mrad

Longitudinal Matching

Type : *Single superconducting resonator*
Mod. *< 500* keV; drift *4m* mm at *162.5* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *18* m; N°. of tanks : *12*
Tank diameters : m
Number of drift-tubes : *(3)*
Drift-tube lengths : mm
Drift-tube diam (range) : mm
Gap/cell length (range) :
Aperture diameter : *20* mm to mm
RF frequency(ies) : *150* MHz
Field modes : *TEM (λ/4)*
Eff. shunt impedance : 2×10^5 MΩ/m
Q : $5 \times 10^7 - 2 \times 10^8$
Filling time : μs
Equil. phases : *- 20°* ; accel. rate MeV/u-m
RF rep. rate : *CW* Hz; pulse : μs
Beam rate : *CW* Hz; pulse : μs
RF power peak : *< 500W* MW; mean : *< 500W* MW

Focusing System

No. elements : *13*
type : *dc doublets* order :
Gradients : *47* to T/m
Other :

Charge Stripping (Typical)

Type(s) : *c foil following FN tandem injector*
Charge states : to *19* at *> 1.5* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	*A ≤ 64*		
Energy	:	*5 - 15*		MeV/u
ΔE/E (FWHM)	:	*0.1*		%
Mean acc. rate	:			MeV/u-m
Beam current	:	*0.01 -- 1*		μAe peak
Norm. emit. (1σ)	:			π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) Full Time Equivalent
(2) Sputter, DEIS, Duoplasmatron w/exchange
(3) No drift-tubes, number of resonators: 24; 12

24 Superconducting quarter wave resonators of 0.18m diameter, optimum velocity 0.1 c.
Lead plated copper construction.
Independently phased.
Accelerating fields 3.0 MV/m in resonators.

References

[1] Project described in D.W. Storm et al., IEEE Trans. Nucl. Sci. NS-32 (1985) 3262.

ASIA

ELECTRON LINAC

Name of Linac : *Beijing Electron-Positron Linac*
Function : *Injector of Beijing Electron-Positron Collider*
Institution and address : *Institute of High Energy Physics, P.O. Box 918, Beijing, China*
Person in charge : *Wang, Jin*
Name of person supplying these data : *J. Wang*
e-mail : *wangj@bepc2.ihep.ac.cn*
tel. : *+86 10 6821 3344 ext.2268* fax : *+86 10 6821 3374*

HISTORY AND STATUS

Const. started : *10/1984* ; first beam : *11/1987*
Present status : *Operating*
Cost of facility : *12 MUSD (1984)*
Present linac staff : *45 man-years*
Present yearly operation time : *6000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *6* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : MeV; intensity : A
Pulse width, spacing : *2.5 ns, 80 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *202* m
No. sections : *56* ; lengths : *3.05* m
Field mode : *2/3π* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *0.012* ; Q : *11000*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : *26 ~ 20* mm
thickness : *5* mm
Attenuation/section : *0.57* Np
Power units, Number : *16* type : *Klystron*
RF power peak : *25* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Triple Q 14 sets
Steering 9 sets
Solenoid 9 m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *7*
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*1.3*	*1.8*	GeV
Accel gradient	:	*10*	*10*	MeV/m
ΔE/E (FWHM)	:	*0.8*		%
Rep. rate	:	*12.5*	*25*	Hz
Pulse length	:	*3.0*	*3.0*	μs
Beam intensity	:	*0.6*	*2.4*	A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

(1) S-band pre-buncher and buncher

POSITRON LINAC

Name of Linac : *Beijing Electron / Positron Linac*
Function : *Injector of Beijing Electron - Positron Collider*
Institution and address : *Institute of High Energy Physics, P.O. Box 918, Beijing, China*
Person in charge : *WANG, Jin*
Name of person supplying these data : *J. Wang*
e-mail : *wangj@BEPC2.IHEP.AC.CN*
tel. : *+86 10 6821 3344* * fax : *+86 10 6821 3374*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*150*	MeV
Radius (1σ)	:		mm
Beam intensity	:	*2.4*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*Tungsten*	
Type	:		
Thickness (rad.length)	:	*(1)*	χ
Diameter	:	*10*	mm
Mean deposited power	:		kW
Solenoidal field[a)]	:	*0.35 T 9 m long*	
Matching device	:	*(2)*	
RF sections[a)]	:		

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*1.3*	*1.6*	GeV
Accel gradient	:	*10*	*10*	MeV/m
ΔE/E (FWHM)	:	*1*		%
Rep. rate	:	*12.5*	*25*	Hz
Pulse length	:	*3*	*3*	μs
Yield (fin.en)	:	*0.025*		e^+/e^- x GeV
Beam intensity	:	*3000*	*9000*	μA peak
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

* *Ext. 2268*

(1) 5 mm
(2) Taped solenoid :
2.7 T max. ; 0.35 T min. ; 12 cm long

ELECTRON LINAC

Name of Linac : *Beijing FEL Facility Linac*
Function : *FEL-driver*
Institution and address : *Institute of High Energy Physics, P.O. Box 918, Beijing, China*
Person in charge : *Jialin Xie*
Name of person supplying these data : *Jialin Xie*
e-mail : *XIEJL@BEPC3.IHEP.AC.CN*
tel. : fax : *+86 10 8213374*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1991*
Present status : *Operating*
Cost of facility : *1 MRMB (1990)*
Present linac staff : *6*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *RF-gun* ; energy : *1200* keV
Beam intensity (peak) : *0.200* A
Normalized emittance (1σ) : *20* π mm-mrad

Injector

Longitudinal matching :
Output : *1.2* MeV; intensity : *0.200* A
Pulse width, spacing : *4.5 μs , 100 ms*
Normalized emittance (1σ) : *20* π mm-mrad

Acceleration System

Total linac length : *3.05* m
No. sections : *1* ; lengths : *3.05* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *(1)* ; Q : *(2)*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : *26.231/19.243* mm
thickness : *5.844* mm
Attenuation/section : *0.57* Np
Power units, Number : *1* type : *XK-5*
RF power peak : *20* MW; mean : *10* kW

Focusing System

Type, No. of elements, and spacing :
No

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *12852*
No. of particles/bunch : 9.7×10^8
Bunch separation : *350 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.03*		GeV
Accel gradient	:	*10*		MeV/m
ΔE/E (FWHM)	:	*1*		%
Rep. rate	:	*10*		Hz
Pulse length	:	*4.5*		μs
Beam intensity	:	*0.200*		A
Norm. emit. (1σ)	:	*30*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 0.0208/0.007
(2) 13800/13900

PROTON AND/OR H- LINAC

Name of Linac : *Beijing 35 MeV Proton Linac*
Function : *Proton Beam Application*
Institution and address : *Institute of High Energy Physics, P.O. Box 918, Beijing, China*
Person in charge : *S.H. Wang*
Name of person supplying these data : *Z.H. Luo*
e-mail : *luozh@bepc3.ihep.ac.cn*
tel. : fax : *+86 10 8213374*

HISTORY AND STATUS

Const. started : *1982* ; first beam : *08/1985*
Present status : *Operating*
Cost of facility : *4 MUSD (1982)*
Present linac staff : *40*
Present yearly operat. time : *~4000* h

LINAC PARAMETERS

Ion Source

Type : *Duoplasmatron*
Output : *250* mA at *750* keV
Pulse length : *150* μs; rep. rate : *12.5* Hz
Normalized emittance (1σ) : *3.0* π mm-mrad

Pre-accelerator (including RFQ)

Types : *Cockcroft-Walton* ; lengths : m
Output : *180* mA at *750* keV
Pulse length: *150* μs; rep. rate : *12.5* Hz
Normalized emittance (1σ) : *3.0* π mm-mrad

Longitudinal Matching

Type : *Double Bunchers*
Mod. *55* keV; drift *950* mm at *201.25* MHz
25 keV; drift *800* mm at *402.5* MHz

Accelerating System

Total linac length : *21.8* m; No. of tanks : *1*
Tank diameters : *0.94 ~ 0.90* m
Number of drift-tubes : *105*
Drift-tube lengths : *48 ~ 274* mm
Drift-tube diam (range): *180 ~ 160* mm
Gap/cell length (range): *0.21 ~ 0.31*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *201.25* MHz
Field modes : *TM 010*
Eff. shunt impedance : *30 ~ 55* MΩ/m
Q : *45000*
Filling time : *150* μs
Equilibrium phases : *-40°~ -25°*
RF rep. rate : *12.5* Hz; pulse : *450* μs
Beam rate : *12.5* Hz; pulse : *150* μs
RF power peak : *5.0* MW; mean : *0.03* MW

Focusing System

No. elements : *105*
type : *Pulsed* order : *FODO*
Gradients : *92* to *20* T/m
Other : *Pulsed flat top ≈ 250 μs*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy :	*35.5*	*35.5*	MeV
Mean acc. rate :	*1.59*	*1.59*	MeV/m
ΔE/E (FWHM) :	*± 0.6*	*± 0.8*	%
Beam current :	*40*	*60*	mA peak
Norm. emit. (1σ) :	*6*	*8*	π mm-mrad

OTHER RELEVANT INFORMATION

- *Post coupled Alvarez Structure*
- *Used for Nuclear Physics Experiment, Radio-isotope production and Neutron Therapy for Cancer.*
- *Original one was 10 MeV proton Linac, constructed during 1978 - 1982, then up-graded to 35 MeV.*

ELECTRON LINAC

Name of Linac : *HIL* *
Function : *Electron Injector Linac for HLS* **
Institution and address : *USTC NSRL, Hefei, Anhui 230026 P.R. China*
Person in charge : *Xiaofeng Shen*
Name of person supplying these data : *Sai Dong*
e-mail : *sdong@mail.nsrl.ustc.edu.cn*
tel. : *+86 551 3602011* fax : *+86 551 5561078*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1987*
Present status : *Operating*
Cost of facility : *7.6 MYuan (1987)*
Present linac staff : *14 man-years*
Present yearly operation time : *5500* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *0.5* A
Normalized emittance (1σ) : *21* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *26* MeV; intensity : *> 0.1* A
Pulse width, spacing : *1 μs, 20 ms*
Normalized emittance (1σ) : *1.8* π mm-mrad

Acceleration System

Total linac length : *35.128* m
No. sections : *8* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *0.012* ; Q : *13500*
Shunt impedance : *57.6* MΩ/m
Iris : aperture : diameter : *21.977* mm
thickness : *5.0* mm
Attenuation/section : *0.54* Np
Power units, Number : *4* type : *Klystrons*
RF power peak : *15* MW; mean : *1.875* kW

Focusing System

Type, No. of elements, and spacing :
2 magnetic lenses at between the gun and the buncher; solenoids up to 10 MeV; 3 quadrupole lenses pair between sections to 200 MeV.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *2856*
No. of particles/bunch : 3.1×10^{11}
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.20*	*0.225*	GeV
Accel gradient	:	*12*		MeV/m
ΔE/E (FWHM)	:	*1.0*	*0.8*	%
Rep. rate	:	*50*	*300*	Hz
Pulse length	:	*1.0*	*0.2 - 1.0*	μs
Beam intensity	:	*0.07*	*0.05*	A
Norm. emit. (1σ)	:		*0.45*	π mm-mrad

OTHER RELEVANT INFORMATION

* *HIL - HLS Injector Linac*
** *HLS - Hefei Light Source*

(1) S-band pre-buncher, buncher and pre-accelerator

References

[1] Yuan Ji Pei, An injector 200 MeV electron LINAC for HESYRL storage ring, R.S.I. Vol. 60, No. 7, 1701 (1991).

[2] Yuan Ji Pei, "The Design of a 200 MeV linear Accelerator", Proceedings of '80 National Conference on Particle Accelerators, 1984, 10.

[3] De-Fa Wang, Yuanji Pei, Duohui He, "The 200 MeV LINAC at HESYRL", Proc. of International Conference on Linac Accelerator, 1986, SLAC.

ELECTRON LINAC

Name of Linac : *FELI**
Function : *Electron Linac for Free Electron Laser*
Institution and address : *FELI, 2-9-5 Tsudayamata, Hirakata, Osaka, Japan*
Person in charge : *Takio Tomimasu*
Name of person supplying these data : *T. Tomimasu*
e-mail :
tel. : *+81 720 96 0414* fax : *+81 720 96 0421*

HISTORY AND STATUS

Const. started : *1994* ; first beam : *1994*
Present status : *Operating*
Cost of facility : 9×10^8 *JPY*
Present linac staff : *4 man-years*
Present yearly operation time : *1600* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *120* keV
Beam intensity (peak) : *2.3* A
Normalized emittance (1σ) : *5* π mm-mrad

Injector

Longitudinal matching :
Output : *6* MeV; intensity : *(1) 60* A
Pulse width, spacing : *10 ps, 44.8 ns*
Normalized emittance (1σ) : *12* π mm-mrad

Acceleration System

Total linac length : *46* m
No. sections : *7* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.5* μs
v_g/c range : *(2)* ; Q : *13500*
Shunt impedance : *53 - 57* MΩ/m
Iris : aperture : diameter : *26 - 20* mm
thickness : *5.0* mm
Attenuation/section : *0.4 - 0.7* Np
Power units, Number : *2* type : *Klystrons*
RF power peak : *50* MW; mean : *1.2* kW

Focusing System

Type, No. of elements, and spacing :
5 Solenoids up to 6 MeV
A doublet at every 4 m up to 165 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *535*
No. of particles/bunch : 4×10^9 *electron/bunch*
Bunch separation : *No*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.165*	*0.165*	GeV
Accel gradient	:	*7.6*	*7.6*	MeV/m
ΔE/E (FWHM)	:	*0.9*	*0.5*	%
Rep. rate	:	*10*	*10*	Hz
Pulse length	:	*24*	*24*	μs
Beam intensity	:	*60*	*80*	A
Norm. emit. (1σ)	:	*26*	*30*	π mm-mrad

OTHER RELEVANT INFORMATION

* *FELI - Free Electron Laser Research Institute*

(1) 0.6 nC/10 ps = 60 A
(2) 0.01 ~ 0.02

References

[1] T. Tomimasu et al., Nucl. Instr. Meth. A358 (1995) ABSli

[2] T. Tomimasu, IEEE Trans. N5-28, No.3 (1981) 3523

[3] T. Tomimasu et al., IEEE Proc. Pac '95 (Dallas, May 1-5) 257

[4] T. Tomimasu et al., Nucl. Instr. Meth. A375 (1996) 626

[5] T. Tomimasu et al., First lasings at 0.28 ~ 0.63 μA using a S-band linac with a thermionic gun. Submitted to Nucl. Instr. Meth. (June 1996).

ELECTRON LINAC

Name of Linac : *ISIR S-Band Linac*
Function : *Scientific Research*
Institution and address : *ISIR, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567, Japan*
Person in charge : *Seiichi Tagawa*
Name of person supplying these data : *S. Okuda*
e-mail : *s-okuda@sanken.osaka-u.ac.jp*
tel. : fax :

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1989*
Present status : *Operational*
Cost of facility :
Present linac staff : *3*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *100* keV
Beam intensity (peak) : *0.65* A
Normalized emittance (1σ) : *50* π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *3* ; lengths : *3* m
Field mode : *2/3 π* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.68* μs
v_g/c range : *0.0147* ; Q : *12600*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *0.459* Np
Power units, Number : type :
RF power peak : *35* MW; mean : *12* kW

Focusing System

Type, No. of elements, and spacing :
Triplet Q magnet - 4

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *4300*
No. of particles/bunch : 1.4×10^9
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.10*	*0.15*	GeV
Accel gradient	:	*19.3*	*20*	MeV/m
ΔE/E (FWHM)	:	*2*		%
Rep. rate	:	*60*		Hz
Pulse length	:	*1.5*		μs
Beam intensity	:	*0.65*		A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *ISIR L-Band Linac*
Function : *Scientific Research*
Institution and address : *ISIR, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567, Japan*
Person in charge : *Seiichi Tagawa*
Name of person supplying these data : *S. Okuda*
e-mail : *S-okuda@sanken.osaka-u.ac.jp*
tel. : fax :

HISTORY AND STATUS

Const. started : *1975* ; first beam : *1978*
Present status : *Operational*
Cost of facility :
Present linac staff : *4*
Present yearly operation time : *2300* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *110* keV
Beam intensity (peak) : *30* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *3* m
No. sections : *1* ; lengths : *3* m
Field mode : *2/3 π* ; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *1.96* μs
v_g/c range : *0.0075* ; Q : *19000*
Shunt impedance : *40* MΩ/m
Iris : aperture : diameter : *36 - 43* mm
thickness : *13* mm
Attenuation/section : *0.2832* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *20* MW; mean : *50* kW

Focusing System

Type, No. of elements, and spacing :
Triplet Q Magnet - 4

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : 4.2×10^{11}
Bunch separation : *9.2 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.03*	*0.038*	GeV
Accel gradient	:	*10*	*13*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*120*	*720*	Hz
Pulse length	:	*0.020*	*0.020*	μs
Beam intensity	:	*(1)*		A
Norm. emit. (1σ)	:	*400*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 67 nC bunch

ION LINAC

Name of Linac : *HIMAC Injector*
Function : *Injector for HIMAC*
Institution and address : *NIRS, 4-9-1 Anagawa, Inage-ku, Chiba 263, Japan*
Person in charge : *S. Yamada*
Name of person supplying these data : *S. Yamada*
e-mail : *yamada_s@nirs.go.jp*
tel. : *+81 43 256 0122* fax : *+81 43 251 1840*

HISTORY AND STATUS

Const. started : *03/1987* ; first beam : *03/1993*
Present status : *Operational*
Cost of facility : *3 BJPY (1987)*
Present linac staff : *13*
Present yearly operat. time : *4000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *16 GHz ECR & PIG*
Species of ions : *He to Ar*
Range of currents : *100 to 1000* μAe
Range of output energies : *8* keV/u
Pulse length : *3000* μs; rep. rate : *3* Hz
Normalized emittance (1σ) : *0.6* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *4 vane RFQ, 7.3* m
Output currents : *60 to 600* μAe
Output energies : *800* keV/u
Frequency : *100* MHz; peak RF power : *260* kW
Pulse length : *700* μs; rep. rate : *3* Hz
Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *23.9* m; N°. of tanks : *3*
Tank diameters : *2.20 / 2.18 / 2.16* m
Number of drift-tubes : *107*
Drift-tube lengths : *98.5 - 257.3* mm
Drift-tube diam (range) : *160* mm
Gap/cell length (range) : *0.21 - 0.26*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *100* MHz
Field modes : *TM010*
Eff. shunt impedance : *25 - 36* MΩ/m
Q : *96 000 / 99 200 / 100 800*
Filling time : *250* μs
Equil. phases : *(1)* ; accel. rate *0.22* MeV/u-m
RF rep. rate : *3* Hz; pulse : *1,200* μs
Beam rate : *3* Hz; pulse : *500* μs
RF power peak : *(2)* MW; mean : *0.0043* MW

Focusing System

No. elements : *55*
type : *pulsed* order : *FODO*
Gradients : *60* to *24* T/m
Other :

Charge Stripping (Typical)

Type(s) : *C foil*
Charge states : *Ar6+* to *18+* at *6* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :	*C*	*Ar*	
Energy :	*6.0*	*6.0*	MeV/u
ΔE/E (FWHM) :	*±0.2*	*±0.2*	%
Mean acc. rate :	*0.22*	*0.22*	MeV/u-m
Beam current :	*250*	*200*	μAe peak
Norm. emit. (1σ) :			π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
Ne	*6.0*	
Si	*6.0*	

OTHER RELEVANT INFORMATION

(1) -30°, -25°
(2) 1.2 (max)

ELECTRON LINAC

Name of Linac : *SPring - 8 Linac*
Function : *Injector for SPring - 8*
Institution and address : *SPring - 8, Kamigori, Hyogo, 678-12 Japan*
Person in charge : *Hideaki YOKOMIZO*
Name of person supplying these data : *Hideaki YOKOMIZO*
e-mail : *yokomizo@haru01.spring8.or.jp*
tel. : *+81 7915 8 0885* fax : *+81 7915 8 0850*

HISTORY AND STATUS

Const. started : *1991* ; first beam : *(1)*
Present status : *Under construction*
Cost of facility : *5 BJPY (1996)*
Present linac staff : *12*
Present yearly operation time : *5500 (plan)* h

LINAC PARAMETERS

Electron Sources *(2)*

Types : *Triode* ; energy : *200* keV
Beam intensity (peak) : *20* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *9* MeV; intensity : *0.1 - 100* A
Pulse width, spacing : *1 ns - 1 μs, 16.6 ms*
Normalized emittance (1σ) : *50* π mm-mrad

Acceleration System

Total linac length : *140* m
No. sections : *26* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.6* μs
v_g/c range : *0.016* ; Q : *13500*
Shunt impedance : *52* MΩ/m
Iris : aperture : diameter : *20 - 26* mm
thickness : *5* mm
Attenuation/section : *0.4* Np
Power units, Number : *14* type : *Klystron*
RF power peak : *80* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 9 MeV and triplets up to final energy

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*1.15*	GeV
Accel gradient :		*17*	MeV/m
ΔE/E (FWHM) :		*1*	%
Rep. rate :		*60*	Hz
Pulse length :		*1*	μs
Beam intensity :		*0.100*	A
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

(1) 1996 (Expected)
(2) The electron gun has three modes of pulse length : 1ns, 10 - 40 ns and 1 - 2 μs.
(3) S-band pre-buncher and buncher

References

[1] H. Yoshikawa et al., Proc. of 1996 Int. Linac Conf., to be published.

POSITRON LINAC

Name of Linac : *SPring-8 Linac*
Function : *Injector for SPring-8*
Institution and address : *SPring-8, Kamigori, Hyogo, 678-12, Japan*
Person in charge : *Hideaki Yokomizo*
Name of person supplying these data : *Hideaki Yokomizo*
e-mail : *yokomizo@haru01.spring8.or.jp*
tel. : *+81 7915 8 08855* fax : *+81 7915 8 0850*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*250*	MeV
Radius (1σ)	:	*< 1.0*	mm
Beam intensity	:	*10*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*90% W 10% Cu*	
Type	:	*Stationary*	
Thickness (rad.length)	:	*2.0*	χ
Diameter	:	*10*	mm
Mean deposited power	:	*1.0*	kW
Solenoidal field[a)]	:	*0.4 T over 2.5 m; DC*	
Matching device	:	*2 T pulsed solenoid*	
RF sections[a)]	:	*19 × 3 m*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:		*0.9*	GeV
Accel gradient	:		*17*	MeV/m
ΔE/E (FWHM)	:		*1.0*	%
Rep. rate	:		*8*	Hz
Pulse length	:		*0.040*	μs
Yield (fin.en)	:		*1.2*	e^+/e^- x GeV
Beam intensity	:		*30000*	μA peak
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

In order to avoid ion trapping in the storage ring, SPring-8 Linac is able to provide positron beam. In the electron mode, the tungsten target is pulled out from the beam line.

The pulsed solenoid coil has adjustable mechanism for tilting and parallel movement to search the best position to have maximum positron yield.

ELECTRON LINAC

Name of Linac :
Function : *Electron Injector Linac for NIJI-III and FEL*
Institution and address : *Sumitomo Electric**
Person in charge : *Dr. H. Takada*
Name of person supplying these data : *K. Emura*
e-mail : *emura@okk.sumiden.co.jp*
tel. : *+81 7915 8 0659* fax : *+81 7915 8 0670*

HISTORY AND STATUS

Const. started : *1993* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *2 man-years*
Present yearly operation time : *800* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *200* keV
Beam intensity (peak) : *5* A
Normalized emittance (1σ) : *7* π mm-mrad

Injector

Longitudinal matching : *S-band, SHPB / PB / B*
Output : *4* MeV; intensity : *2* A
Pulse width, spacing : *10 ps, 2.1 ns*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *2* ; lengths : *3* m
Field mode : *2π / 3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.6* μs
v_g/c range : ; Q : *13500*
Shunt impedance : *50* MΩ/m
Iris : aperture : diameter : *20* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *2* type : *Klystron*
RF power peak : *45* MW; mean : *6* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 4 MeV.
2 Triplets

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.10*	*0.12*	GeV
Accel gradient	*18*	*22*	MeV/m
ΔE/E (FWHM)	*1.0*	*1.0*	%
Rep. rate	*2*	*2*	Hz
Pulse length	*1 and 10*	*1 and 10*	μs
Beam intensity			A
Norm. emit. (1σ)	*60*	*60*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Harima Science Garden City, Kamigori, Hyogo, 678-12 Japan*

References

[1] K. Emura, K. Tsumori, M. Moriguchi and H. Takada, "Development of a Compact Linear Accelerator for SR Injection", Sumitomo Electric Technical Review, No. 39 (1995).

ELECTRON LINAC

Name of Linac : *45 MeV Electron Linear Accelerator Laboratory*
Function : *Electron Linac for the study of atomic science and nuclear engineering*
Institution and address : *Hokkaido Univ., N-13 W-8, Kita-ku, Sapporo 060, Japan*
Person in charge : *T. Enoto*
Name of person supplying these data : *T. Enoto*
e-mail : *tem@hune.hokudai.ac.jp*
tel. : *+81 11 706 7128* fax : *+81 11 706 7128*

HISTORY AND STATUS

Const. started : *1971* ; first beam : *1974*
Present status : *Operating*
Cost of facility : *250 MJPY (1971)*
Present linac staff : *3 men*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *2.0* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *S-band buncher*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *23* m
No. sections : *3* ; lengths : *2* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.56* μs
v_g/c range : *0.00783* ; Q : *12200*
Shunt impedance : *60* MΩ/m
Iris : aperture : diameter : *19.0 - 20.0* mm
thickness : mm
Attenuation/section : *0.628* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *5* MW; mean : *3* kW

Focusing System

Type, No. of elements, and spacing :
Q-magnet, 10 section
steering magnet, 4 section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *30-10000*
No. of particles/bunch : 1.5×10^{11} - 4.4×10^{8}
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.045*	*0.045*	GeV
Accel gradient	:	*7.5*	*7.5*	MeV/m
ΔE/E (FWHM)	:	*15*	*15*	%
Rep. rate	:	*100*	*200*	Hz
Pulse length	:	*0.01 - 3*	*0.01 - 3*	μs
Beam intensity	:	*1.5*	*2*	A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *PNC Linac*
Function : *Electron Linac for Transmutation*
Institution and address : *PNC-OEC * 4002 Oarai-machi, Ibaraki-ken 311-13, Japan*
Person in charge : *Takashi Emoto*
Name of person supplying these data : *Takashi Emoto*
e-mail : *emoto@oec.pnc.go.jp*
tel. : *+81 29 267 4141 ext.3130* fax : *+81 29 266 3868*

HISTORY AND STATUS

Const. started : *1994* ; first beam : *1996*
Present status : *Under the commissioning*
Cost of facility : *5000 MJPY*
Present linac staff : *17 man-years*
Present yearly operation time : *NA* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *200* keV
Beam intensity (peak) : *0.400* A
Normalized emittance (1σ) : *NA* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *2.0* MeV; intensity : *0.100* A
Pulse width, spacing : *4 ms, 16 ms*
Normalized emittance (1σ) : *NA* π mm-mrad

Acceleration System

Total linac length : *18* m
No. sections : *8* ; lengths : *1.2* m
Field mode : *2π/3* ; frequency : *(2)* GHz
Wave type : *TW* ; filling time : *(3) 13* μs
v_g/c range : *(4)* ; Q : *(5)*
Shunt impedance : *16.2 - 39.1* MΩ/m
Iris : aperture : diameter : *24.5 - 32.4* mm
thickness : *12* mm
Attenuation/section : *0.04076 - 0.06082* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *1.2* MW; mean : *(6) 240* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 3.5MeV; a doublet at 3.5MeV and between sections to 10 MeV; a triplet at 10 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.01*	*NA*	GeV
Accel gradient	:	*1.0 - 1.4*	*NA*	MeV/m
ΔE/E (FWHM)	:	*0.2*	*NA*	%
Rep. rate	:	*0 - 50*	*NA*	Hz
Pulse length	:	*10 - 4000*	*NA*	μs
Beam intensity	:	*0.100*	*NA*	A
Norm. emit. (1σ)	:	*N/A*	*NA*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Power Reactor & Nuclear Fuel Development Co. Oarai Engineering Centre*

(1) L-band pre-buncher and buncher
(2) 1.249135
(3) Resonant Ring filling time
(4) 0.011-0.025
(5) 20130-15392
(6) 1.2MW klystron only

ELECTRON LINAC

Name of Linac : *KURRI*-LINAC*
Function : **
Institution and address : *KURRI, Kumatori-cho, Sennan-gun, Osaka, 590-04, Japan*
Person in charge : *Y. Fujita*
Name of person supplying these data : *K. Takami*
e-mail : *takami@rri.kyoto-u.ac.jp*
tel. : *+81 724 52 0901 ext. 2278* fax : *+81 724 53 0488*

HISTORY AND STATUS

Const. started : *1965* ; first beam : *1967*
Present status : *Operating*
Cost of facility : *1.1 MUSD (1965)*
Present linac staff : *3*
Present yearly operation time : *1900* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *85* keV
Beam intensity (peak) : *~ 20* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *L-band pre-buncher*
Output : MeV; intensity : A
Pulse width, spacing : *10 ns ~ 4 μs, 2 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *5* m
No. sections : *2* ; lengths : *2 & 2.5* m
Field mode : *2π/3* ; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *2* μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *2* type : *Klystrons*
RF power peak : *20* MW; mean : *30* kW

Focusing System

Type, No. of elements, and spacing :
Not installed

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *13 - 5200*
No. of particles/bunch : *~ 2.5 × 10^{10}*
Bunch separation : *770 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.030*	*0.046*	GeV
Accel gradient	:	*6.7*	*10*	MeV/m
ΔE/E (FWHM)	:	*10*	*3*	%
Rep. rate	:	*360*	*480*	Hz
Pulse length	:	*0.01 ~ 4*	*0.01 ~ 4*	μs
Beam intensity	:	*6*		A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

* *KURRI - Kyoto University Research Reactor Institute*
** *Neutron source, X-ray source, light source, electron irradiation, γ-ray irradiation, positron production*

ELECTRON LINAC

Name of Linac : *Tohoku 300 MeV Electron Linac*
Function : *Electron Linac for nuclear physics and other applications*
Institution and address : *Lab. of Nucl. Sci. Tohoku Univ., Sendai 982, Japan*
Person in charge : *M. Oyamada*
Name of person supplying these data : *M. Oyamada*
e-mail : *oyamada@thkln1.lns.tohoku.ac.jp*
tel. : *+81 22 743 3423* fax : *+81 22 743 3401*

HISTORY AND STATUS

Const. started : *1963* ; first beam : *1967*
Present status : *Operating*
Cost of facility : *500 MJPY (1963)*
Present linac staff : *8 man-years*
Present yearly operation time : *4000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *2.0* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *0.4* MeV; intensity : *1.0* A
Pulse width, spacing : *4μs, 3.3ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *52* m
No. sections : *8+12* ; lengths : *1.05, 2.1* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.4, 0.8* μs
v_g/c range : *0.0088* ; Q : *14000*
Shunt impedance : *54* MΩ/m
Iris : aperture : diameter : *20.9* mm
thickness : *5.842* mm
Attenuation/section : *0.275, 0.55* Np
Power units, Number : *2+3* type : *Klystron*
RF power peak : *25* MW; mean : *30* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids, 20 sets, each acc. structure
quadrupole doublets, 3 pairs, 8m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.25*	*0.3*	GeV
Accel gradient	*7.8*	*9.4*	MeV/m
ΔE/E (FWHM)	*1.5*	*1.0*	%
Rep. rate	*300*	*300*	Hz
Pulse length	*3*	*3*	μs
Beam intensity	*0.1*	*0.1*	A
Norm. emit. (1σ)	*60*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) S-band pre-buncher and buncher

References

[1] Performance of an Energy Compressing System for the Tohoku 300-MeV linac. M. Sugawara et al.; Nucl. Instr. & Meth. 153, 343-346 (1978).

[2] SSTR - The 150 MeV pulse stretcher of Tohoku University. T. Tamae et al.; Nucl. Instr. & Meth. A264, 173-185 (1988).

[3] The Tohoku University Stretcher-Booster Ring. M. Oyamada et al.; Proc. the 10th Symp. on Acc. Sci. and Tech. Hitachinaka, Japan, 463-465 (1995).

ELECTRON LINAC

Name of Linac : *INS-ES * 15 MeV Linac*
Function : *Electron Injector Linac for INS-ES*
Institution and address : *INS **, University of Tokyo, Midoricho, Tanashi, Tokyo 188, Japan*
Person in charge : *M. Muto*
Name of person supplying these data : *M. Muto*
e-mail : *muto@ins.u-tokyo.ac.jp*
tel. : *+81 424 69 9552* fax : *+81 424 62 0775*

HISTORY AND STATUS

Const. started : *1972* ; first beam : *1974*
Present status : *Operating*
Cost of facility :
Present linac staff :
Present yearly operation time : *~ 3000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *0.5* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2.1* m
No. sections : *7* ; lengths : m
Field mode : *2π / 3* ; frequency : *2.758* GHz
Wave type : *TW* ; filling time : *0.54* μs
v_g/c range : *(1)* ; Q : *11700*
Shunt impedance : *64* MΩ/m
Iris : aperture : diameter : *29.795 ~ 19.893* mm
thickness : *5.0* mm
Attenuation/section : *0.44* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *6* MW; mean : *0.52* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 15 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.015*	*0.015*	GeV
Accel gradient	:	*7.5*		MeV/m
ΔE/E (FWHM)	:	*~ 5*		%
Rep. rate	:	*21.5*	*21.5*	Hz
Pulse length	:	*1.2*		μs
Beam intensity	:	*0.150*		A
Norm. emit. (1σ)	:	*~ 30*		π mm-mrad

OTHER RELEVANT INFORMATION

* *INS 1.3 GeV Electron Synchrotron*
** *Institute for Nuclear Study*

(1) 0.008 - 0.0309

References

[1] "The Construction of 15 MeV Linear Accelerator as Injector for INS Electron Synchrotron", T. Katayama et al., INS-Report 240 (1975).

ION LINAC

Name of Linac :
Function : *ISOL * post accelerator*
Institution and address : *Institute for Nuclear Study***
Person in charge : *S. Arai*
Name of person supplying these data : *S. Arai*
e-mail : *arai@ins.u-tokyo.ac.jp*
tel. : *+81 424 69 9558* fax : *+81 424 62 0775*

HISTORY AND STATUS

Const. started : *04/1992* ; first beam : *03/1996*
Present status : *Tuning*
Cost of facility : *520 MJPY over 5 years*
Present linac staff : *8 man-years*
Present yearly operat. time : h

LINAC PARAMETERS

Ion Sources

No. of sources : *4*
Types of source : *(1)*
Species of ions : *Ions up to Ni^{2+} Z/A - 1/30*
Range of currents : *(2)* μAe
Range of output energies : *2* keV/u
Pulse length : *Variable* μs; rep. rate : *10 ~ 1000* Hz
Normalized emittance (1σ) : *(3)* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Split coaxial RFQ (8.6)* m
Output currents : *(2)* μAe
Output energies : *170* keV/u
Frequency : *25.5* MHz; peak RF power : *(4)* kW
Pulse length : *(5)* μs; rep. rate : *1 ~ 999* Hz
Normalized emittance (1σ) : *(3)* π mm-mrad

Longitudinal Matching

Type : *6-Gap Double Coaxial λ/4 cavity*
Mod. *200* keV; drift *3760* mm at *25.5* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *5.6* m; N°. of tanks : *4*
Tank diameters : *1.49, 1.34* m
Number of drift-tubes : *7 ~ 10 + 2 (1/2)*
Drift-tube lengths : *29 ~ 53* mm
Drift-tube diam (range) : *38 ~ 52* mm
Gap/cell length (range) : *0.5*
Aperture diameter : *20* mm to *32* mm
RF frequency(ies) : *51* MHz
Field modes : *TE110 like (IH)*
Eff. shunt impedance : *218 ~ 289* MΩ/m
Q : *10681 ~ 18490*
Filling time : *33 ~ 58* μs
Equil. phases : *-25°* ; accel. rate *0.15* MeV/u-m
RF rep. rate : *1 ~ 999* Hz; pulse : *(5)* μs
Beam rate : *1 ~ 999* Hz; pulse : *(5)* μs
RF power peak : *(6)* MW; mean : *(6) cw* MW

Focusing System

No. elements : *9*
type : *DC* order : *Triplet*
Gradients : *38* to *45* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Carbon foil (10μg /cm²)*
Charge states : *Ni^{2+}* to *Ni^{9+}* at *0.17* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:			
Energy	:	*1.05*	*1.05*	MeV/u
ΔE/E (FWHM)	:		*0.5 ~ 2*	%
Mean acc. rate	:	*0.15*	*0.15*	MeV/u-m
Beam current	:		*(7)*	μAe peak
Norm. emit. (1σ)	:		*0.1*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *ISOL - Isotope Separator On-Line*
** *University of Tokyo, Midari-cho, Tanashi-shi, Tokyo 188, Japan*

(1) ECR, SURFACE IONIZ., FEBIAD for unstable nuclei
ECR for stable nuclei
(2) < 10^{10} pps for unstable nuclei
200 μA for $^{14}N^{+}$
(3) 0.03 ~ 0.1 for unstable nuclei
0.1 for stable nuclei
(4) max 250 kW
(5) 50 ~ 3000
(6) 0.015 ~ 0.039 (max)
(7) 6000 for Z/A - 1/30

ELECTRON LINAC

Name of Linac : *SCARLET* *
Function : *Superconducting RF Linac Driver for FEL*
Institution and address : *Tokai Research Establishment, JAERI* **
Person in charge : *Eisuke J. Minehara*
Name of person supplying these data : *E.J. Minehara*
e-mail : *minehara@felwu0.tokai.jaeri.go.jp*
tel. : *+81 29 282 5464* fax : *+81 29 270 5923*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *12/1993*
Present status : *Operating*
Cost of facility : *13.5 MUSD (1995)*
Present linac staff : *5 man-years*
Present yearly operation time : *(1)* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *250* keV
Beam intensity (peak) : *0.1 - 0.2* A
Normalized emittance (1σ) : *20* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *2* MeV; intensity : *10 - 20* A
Pulse width, spacing : *1 ms, 100 ms*
Normalized emittance (1σ) : *> 20* π mm-mrad

Acceleration System

Total linac length : *25* m
No. sections : *2* ; lengths : *1.5* m
Field mode : *π* ; frequency : *0.4998* GHz
Wave type : *SW* ; filling time : *500-1000* μs
v_g/c range : *0.7 - 0.9* ; Q : 2×10^9
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *2* type : *MMIC*
RF power peak : *0.050* MW; mean : *1.5* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.015*	*0.023*	GeV
Accel gradient	:	*6.5*	*> 7*	MeV/m
ΔE/E (FWHM)	:	*< 0.8*	*0.75*	%
Rep. rate	:	*10*	*10*	Hz
Pulse length	:	*50 - 400*	*1000*	μs
Beam intensity	:	*3.5 - 7*	*14 (10)*	A
Norm. emit. (1σ)	:	*> 20*	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

* *SCARLET - Super Conducting Accelerator for Research of Light Emission at Tokai*

** *Japan Atomic Energy Research Institute , 2 - 4 Shirakata-Shirane, Tokai, Naka, Ibaraki 319-11 Japan*

(1) About 2000 hrs on beam, 8400 hrs of refrigerator on duty.

(2) A pair of 0.3 m single cell 500 MHz preaccelerator 83.3 MHz 1/6th SubHarmonic Buncher

PROTON AND/OR H- LINAC

Name of Linac : *JAERI 2 MeV RFQ*
Function : *Beam Test*
Institution and address : *JAERI, Tokai-mura, Naka-gun, Ibaraki-ken, 319-11, Japan*
Person in charge : *Motoharu Mizumoto*
Name of person supplying these data : *Motoharu Mizumoto*
e-mail : *mizumoto@linac.tokai.jaeri.go.jp*
tel. : *+81 29 282 6451* fax : *+81 29 282 5663*

HISTORY AND STATUS

Const. started : *03/1992* ; first beam : *02/1994*
Present status : *Operating*
Cost of facility :
Present linac staff : *11*
Present yearly operat. time : h

LINAC PARAMETERS

Ion Source

Type : *Multi-cusp*
Output : *140* mA at *100* keV
Pulse length : *100* μs; rep. rate : *100* Hz
Normalized emittance (1σ) : *0.08* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 vane* ; lengths : *335* m
Output : *70* mA at *2000* keV
Pulse length: *700* μs; rep. rate : *100* Hz
Normalized emittance (1σ) : *0.7* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : m; No. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equilibrium phases :
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	:	*2*	MeV
Mean acc. rate	:	*0.6*	MeV/m
ΔE/E (FWHM)	:	*< 5*	%
Beam current	:	*70*	mA peak
Norm. emit. (1σ)	:	*0.7*	π mm-mrad

OTHER RELEVANT INFORMATION

RFQ only.

ION LINAC

Name of Linac : *JAERI Tandem-Booster*
Function : *Independently-phased Heavy-ion Booster Linac*
Institution and address : *JAERI Tokai, Naka, Ibaraki Japan 319-11*
Person in charge : *Y. Yoshida*
Name of person supplying these data : *S. Takeuchi*
e-mail : *takeuchi@tdm.alph1.tokai.jaeri.go.jp*
tel. : fax : *+81292826321*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *11/1993*
Present status : *Operational*
Cost of facility : *2 BJPY*
Present linac staff : *5*
Present yearly operat. time : *1000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *5*
Types of source : *SNICS, HPIG, Duopla*
Species of ions : *H^1 to Bi^1*
Range of currents : *10* μAe
Range of output energies : *200/A (mass)* keV/u
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *tandem acc.* m
Output currents : *0.5* μAe
Output energies : *(2) 17000 (1+Q) / A* keV/u
Frequency : MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : *1* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *20* m; N°. of tanks : *10*
Tank diameters : *1.3* m
Number of drift-tubes : *(1)*
Drift-tube lengths : *70* mm
Drift-tube diam (range) : *90* mm
Gap/cell length (range) : *40/150*
Aperture diameter : *26* mm to mm
RF frequency(ies) : *129.8* MHz
Field modes : *CW*
Eff. shunt impedance : MΩ/m
Q : *0.5 - 1 × 10^9*
Filling time : μs
Equil. phases : ; accel. rate MeV/u-m
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : *0.002* MW

Focusing System

No. elements : *9*
type : *doublet* order :
Gradients : *0* to *25* T/m
Other : *placed outside the tanks*

Charge Stripping (Typical)

Type(s) : *C foil*
Charge states : *12* to *28* at *1.6* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	*C to Au*	*C to Au*	
Energy	:	*(3) 25Q/A*	*(3) 30Q/A*	MeV/u
ΔE/E (FWHM)	:	*approx. 0.2*	*0.01-0.2*	%
Mean acc. rate	:			MeV/u-m
Beam current	:	*0.01-0.1*		μAe peak
Norm. emit. (1σ)	:			π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) 40 (Quarter Wave Resonators)
(2) Q: charge state, typically 12
(3) Q: 12 - 28

ELECTRON LINAC

Name of Linac : *Subpicosecond Twin Linac*
Function : *Picosecond Time-resolved Measurement for Radiation Physics and Chemistry*
Institution and address : *NERL *, University of Tokyo, Tokai, Ibaraki, Japan*
Person in charge : *Mitsuru Uesaka*
Name of person supplying these data : *Mitsuru Uesaka*
e-mail : *uesaka@utnl.gen.u-tokyo.ac.jp*
tel. : *+81 29 287 8421* fax : *+81 29 287 8488*

HISTORY AND STATUS

Const. started : *1975* ; first beam : *1977*
Present status : *Operating*
Cost of facility : *5 MUSD*
Present linac staff : *4 persons*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *90* keV
Beam intensity (peak) : *10* A
Normalized emittance (1σ) : *100* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : *100* π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *2* ; lengths : *2* m
Field mode : *2/3π* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.6* μs
v_g/c range : *0.0085* ; Q : *1931*
Shunt impedance : *56* MΩ/m
Iris : aperture : diameter : *20* mm
thickness : *4* mm
Attenuation/section : *0.39* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *7* MW; mean : *1.8* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1 - 14300*
No. of particles/bunch : *≤ 3 nC*
Bunch separation : *350 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design
Final energy	:	*(2)*	GeV
Accel gradient	:	*10*	MeV/m
ΔE/E (FWHM)	:	*0.3*	%
Rep. rate	:	*50*	Hz
Pulse length	:	*(3)*	μs
Beam intensity	:	*≤ 1000*	A
Norm. emit. (1σ)	:	*100*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Nuclear Engineering Research Laboratory*

(1) 476 MHz SHB, 2.856 GHz Prebuncher
(2) 0.028, 0.018, 0.035
(3) 700 fs to 5 μs

ION LINAC

Name of Linac : *TIT-IH-2-Linac*
Function : *Booster Linac of Heavy Ion Accelerator*
Institution and address : *RLNR, Tokyo Institute of Technology, Tokyo, Japan*
Person in charge : *Director of RLNR*
Name of person supplying these data : *T. Hattori*
e-mail : *thattori@nr.titech.ac.jp*
tel. : *+81 3 5734 3055* fax : *+81 3 5734 2959*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1987*
Present status : *Operational*
Cost of facility : *0.5 MUSD (1984)*
Present linac staff : *1 man-year*
Present yearly operat. time : *100* h

LINAC PARAMETERS

Ion Sources

No. of sources :
Types of source :
Species of ions :
Range of currents : μAe
Range of output energies : keV/u
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *TIT-IH-Linac* *7* m
Output currents : *0.1* μAe
Output energies : *2.4* keV/u
Frequency : *48* MHz; peak RF power : *80* kW
Pulse length : μs; rep. rate : *DC* Hz
Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *3* m; N°. of tanks : *1*
Tank diameters : *0.76* m
Number of drift-tubes : *21+2 (1/2)*
Drift-tube lengths : *56.0 ~ 66.6* mm
Drift-tube diam (range) : *60* mm
Gap/cell length (range) : *1/2*
Aperture diameter : *30* mm to mm
RF frequency(ies) : *96* MHz
Field modes : *TE111*
Eff. shunt impedance : *132* MΩ/m
Q :
Filling time : *DC* μs
Equil. phases : *0* ; accel. rate *1.33* MeV/u-m
RF rep. rate : *DC* Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : *(1)* MW; mean : *0.001* MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other : *No*

Charge Stripping (Typical)

Type(s) : *Carbon foil*
Charge states : C^{3+} to C^{6+} at *2.4* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	*P*	*Cl*	
Energy	:	*3.4*	*3.4*	MeV/u
ΔE/E (FWHM)	:	*5*	*5*	%
Mean acc. rate	:	*0.36*	*1.33*	MeV/u-m
Beam current	:	*0.03*	*0.1*	μAe peak
Norm. emit. (1σ)	:	*0.6*	*0.6*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
P	*3.4 MeV/u*	
O^{6+}	*3.0 MeV/u*	*at 10 kW*

OTHER RELEVANT INFORMATION

(1) 10 kW (50 kW)

ION LINAC

Name of Linac : *TIT-IH-Linac*
Function : *Main Linac of Heavy Ion Accelerator*
Institution and address : *RLNR, Tokyo Institute of Technology, Tokyo, Japan*
Person in charge : *Director of RLNR*
Name of person supplying these data : *T. Hattori*
e-mail : *thattori@nr.titech.ac.jp*
tel. : *+81 3 5734 3055* fax : *+81 + 5734 2959*

HISTORY AND STATUS

Const. started : *1983* ; first beam : *10/1984*
Present status : *Operational*
Cost of facility : *3.5 MUSD (1983)*
Present linac staff : *1 man-year*
Present yearly operat. time : *200* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *PIG and SNICS-II*
Species of ions : *He ~ Cl* $\varepsilon \geq 1/4$
Range of currents : *30* μAe
Range of output energies : *20* keV/u
Pulse length : *DC* μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *5SDH-2* m
Output currents : *10* μAe
Output energies : *240* keV/u
Frequency : *DC* MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *7* m; N°. of tanks : *1*
Tank diameters : *1.4* m
Number of drift-tubes : *43+2 (1/2)*
Drift-tube lengths : *43.5 ~ 134.2* mm
Drift-tube diam (range) : *50/100* mm
Gap/cell length (range) : *1/3*
Aperture diameter : *23* mm to *1.0* mm
RF frequency(ies) : *47* MHz
Field modes : *TE111*
Eff. shunt impedance : *179* MΩ/m
Q : *21500*
Filling time : *DC* μs
Equil. phases : *-30* ; accel. rate *1.23* MeV/u-m
RF rep. rate : *DC* Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : *0.08* MW; mean : *0.08* MW

Focusing System

No. elements : *DC*
type : *QM* order : *FODO*
Gradients : *20* to *50* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Carbon foil*
Charge states : Cl^{4+} to Cl^{9+} at *0.24* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :	*Cl*	*Cl*	
Energy :	*2.4*	*2.4*	MeV/u
ΔE/E (FWHM) :	*0.5*	*0.5*	%
Mean acc. rate :	*1.23*	*1.23*	MeV/u-m
Beam current :	*0.1*	*0.1*	μAe peak
Norm. emit. (1σ) :	*0.6*	*0.6*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
P	*2.4 MeV/u*	*PIG*
Cl	*2.4 MeV/u*	*SNICS-II*

OTHER RELEVANT INFORMATION

ION LINAC

Name of Linac : *Deuteron IH Linac*
Function : *Radio-Isotope Production for PET*
Institution and address : *RLNR, Tokyo Institute of Technology, Tokyo, Japan*
Person in charge : *T. Hattori*
Name of person supplying these data : *T. Hattori*
e-mail : *thattori@nr.titech.ac.jp*
tel. : *+81 3 5734 3055* fax : *+81 3 5734 2959*

HISTORY AND STATUS

Const. started : *1993* ; first beam : *06/1996*
Present status : *Operational*
Cost of facility : *0.1 MUSD*
Present linac staff : *1 man-year*
Present yearly operat. time : *100* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *Compact ECR*
Species of ions : *P, d*
Range of currents : *100* μAe
Range of output energies : *100* keV/u
Pulse length : *DC* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.6* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *HVPS (0.5)* m
Output currents : *100* μAe
Output energies : *100* keV/u
Frequency : *DC* MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *1.9* m; N°. of tanks : *1*
Tank diameters : *0.56 - 0.64 - 0. 7* m
Number of drift-tubes : *28+2 (1/2)*
Drift-tube lengths : *13.1 ~ 21.1* mm
Drift-tube diam (range) : *30 - 60* mm
Gap/cell length (range) : *~ 0.5*
Aperture diameter : *24* mm to *44* mm
RF frequency(ies) : *103* MHz
Field modes : *TE111*
Eff. shunt impedance : *420* MΩ/m
Q : *16000*
Filling time : *DC* μs
Equil. phases : ; accel. rate *1.7* MeV/u-m
RF rep. rate : *DC* Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : *DC* MW; mean : *0.012* MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other : *APF (-90° ~ +15°)*

Charge Stripping (Typical)

Type(s) : *No*
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :	*P*	*D*	
Energy :	*1.7*	*1.7*	MeV/u
ΔE/E (FWHM) :			%
Mean acc. rate :			MeV/u-m
Beam current :	*1*	*1000*	μAe peak
Norm. emit. (1σ) :	*0.6*	*0.6*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
P	*1.7 MeV/u*	
D	*1.7 MeV/u*	

OTHER RELEVANT INFORMATION

ION LINAC

Name of Linac : *TIT-RFQ*
Function : *Heavy Ion Linac for plasma experiment*
Institution and address : *RLNR Tokyo, Institute of Technology, Tokyo, Japan*
Person in charge : *T. Hattori*
Name of person supplying these data : *T. Hattori*
e-mail : *thattori@nr.titech.ac.jp*
tel. : *+81 3 5734 3055* fax : *+81 3 5734 2959*

HISTORY AND STATUS

Const. started : *1992* ; first beam : *11/1993*
Present status : *Operational*
Cost of facility : *0.75 MUSD (1992)*
Present linac staff : *1 man-year*
Present yearly operat. time : *600* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *ECR*
Species of ions : *(1)*
Range of currents : *1600 (7000)* μAe
Range of output energies : *0.22* keV/u
Pulse length : *DC* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.5* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *HVPS (0.2)* m
Output currents : μAe
Output energies : keV/u
Frequency : MHz; peak RF power : kW
Pulse length : μs; rep. rate : *DC* Hz
Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *4.4* m; N°. of tanks :
Tank diameters : *725* m
Number of drift-tubes : *242*
Drift-tube lengths : *413* mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : *0.8* mm to *1.0* mm
RF frequency(ies) : *81* MHz
Field modes : *TE210*
Eff. shunt impedance : *28* MΩ/m
Q : *12000*
Filling time : *150* μs
Equil. phases : *(2)* ; accel. rate *0.78* MeV/u-m
RF rep. rate : *30* Hz; pulse : *3000* μs
Beam rate : *30* Hz; pulse : *3000* μs
RF power peak : *0.115* MW; mean : *0.012* MW

Focusing System

No. elements : *242*
type : *FD* order :
Gradients : to T/m
Other : *RFQ*

Charge Stripping (Typical)

Type(s) : *No*
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	*He*	*Xe^{10+}*	
Energy	:	*0.22*	*0.22*	MeV/u
ΔE/E (FWHM)	:	*0.5*	*0.5*	%
Mean acc. rate	:	*0.3*	*0.78*	MeV/u-m
Beam current	:	*1.6*	*6.8*	μAe peak
Norm. emit. (1σ)	:	*0.5*	*0.5*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
$He \sim Xe^{10+}$, Pb^{3+}	*0.22 MeV/u*	*ECR IS*

OTHER RELEVANT INFORMATION

(1) He^{+}, $^{16}O^{+}$, Xe^{10+} $\varepsilon \geq 1/16$
(2) -90, -30, -20

ELECTRON LINAC

Name of Linac : *KEK PF * 2.5 GeV Linac*
Function : *Injector Linac for 2.5 GeV PF Storage Ring and AR ***
Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken, 305, Japan*
Person in charge : *Kazuo Nakahara*
Name of person supplying these data : *H. Kobayashi*
e-mail : *hitoshik@kekvax.kek.jp*
tel. : *0298 64 5585* fax : *0298 64 2801*

HISTORY AND STATUS

Const. started : *1978* ; first beam : *1982*
Present status : *Operating*
Cost of facility : *7000 MJPY (1982)*
Present linac staff : *29*
Present yearly operation time : *5300* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *200* keV
Beam intensity (peak) : *>10* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *43* MeV; intensity : *10* A
Pulse width, spacing : *10 ns, 40 ms*
Normalized emittance (1σ) : *70* π mm-mrad

Acceleration System

Total linac length : *415* m
No. sections : *160* ; lengths : *1.9* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.45~0.56* μs
v_g/c range : *(1)* ; Q : *> 13000*
Shunt impedance : *55.4 - 60.3* MΩ/m
Iris : aperture : diameter : *24 - 19.5* mm
thickness : *5* mm
Attenuation/section : *0.23 - 0.55* Np
Power units, Number : *40* type : *Klystron*
RF power peak : *30* MW; mean : *5.3* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupole triplets, 28 triplets
~ 10 m interval in the first fifth part
~ 20 m interval in the remainder of accelerator

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*2.5*	*3.0*	GeV
Accel gradient	:	*8*	*20*	MeV/m
ΔE/E (FWHM)	:	*0.4*		%
Rep. rate	:	*25*	*50*	Hz
Pulse length	:	*0.001*	*1*	μs
Beam intensity	:	*0.4*	*10*	A
Norm. emit. (1σ)	:	*180*		π mm-mrad

OTHER RELEVANT INFORMATION

* *PF - Photon Factory*
** *AR - Accumulator Ring*

(1) 0.019 -0.0083

The linac is being upgraded from 2.5 GeV to 8 GeV.

References

[1] J. Tanaka, Nucl. Instr. Meth. 177 (1980) 101.

POSITRON LINAC

Name of Linac : *KEK PF 2.5 GeV Linac*
Function : *Positron Injector Linac for 2.5 GeV PF Storage Ring and AR*
Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken, 305, Japan*
Person in charge : *Kazuo Nakahara*
Name of person supplying these data : *H. Kobayashi*
e-mail : *hitoshik@kekvax.kek.jp*
tel. : *+81 0298 64 5585* fax : *+81 0298 64 2801*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*250*	MeV
Radius (1σ)	:	*~1*	mm
Beam intensity	:	*10*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*Ta*	
Type	:	*Stationary*	
Thickness (rad.length)	:	*2.0*	χ
Diameter	:	*20*	mm
Mean deposited power	:	*2*	kW
Solenoidal field[a)]	:	*(1) QWT*	
Matching device	:		
RF sections[a)]	:		

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*2.5*	*3*	GeV
Accel gradient	:	*8*	*20*	MeV/m
ΔE/E (FWHM)	:	*0.44*		%
Rep. rate	:	*25*	*50*	Hz
Pulse length	:	*0.001*	*0.04*	μs
Yield (fin.en)	:	*1.8×10^{-2}*	*1.8×10^{-2}*	e^+/e^- x GeV
Beam intensity	:	*32000*	*50000*	μA peak
Norm. emit. (1σ)	:	*2000*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) QWT - Quarter Wave Transformer
2 T pulsed solenoid (50 mm)
0.4 T DC solenoid (8 m)

References

[1] A. Enomoto et al., Nucl. Instr. Meth. A281 (1989)1.

ELECTRON LINAC

Name of Linac : *ATF * Linac*
Function : *Injector Linac for the ATF Damping Ring*
Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken 305, Japan*
Person in charge : *S. Takeda, H. Hayano, T. Naito & M. Akemoto*
Name of person supplying these data : *S. Takeda*
e-mail : *takeda@kekvax.kek.jp*
tel. : *+81 298 64 5304* fax : *+81 298 64 4403*

HISTORY AND STATUS

Const. started : *1993* ; first beam : *1995*
Present status : *Operating*
Cost of facility :
Present linac staff : *3 man-years*
Present yearly operation time : *(1)* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *(2)* keV
Beam intensity (peak) : *(3)* A
Normalized emittance (1σ) : *< 100* π mm-mrad

Injector

Longitudinal matching : *(4)*
Output : *80* MeV; intensity : *< 3* A
Pulse width, spacing : *54 ns, 20 or > 40 ms*
Normalized emittance (1σ) : *< 100* π mm-mrad

Acceleration System

Total linac length : *(5)* *88* m
No. sections : *(6) 16+2* ; lengths : *3.0* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *(7)* ; Q : *13000*
Shunt impedance : *60* MΩ/m
Iris : aperture : diameter : *(8) 25.3 - 18.4* mm
thickness : *5.0* mm
Attenuation/section : *0.54* Np
Power units, Number : *(9)* type : *(9)*
RF power peak : *(10)* MW; mean : *(10)* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 80 MeV, Matching section at 80 MeV, Triplet from 0.08 to 0.28 GeV, Doublets from 0.28 to 0.6 GeV, Singlets from 0.6 to 1.54 GeV.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *(11) 20*
No. of particles/bunch : *$< 3 \times 10^{10}$*
Bunch separation : *2.8 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*1.54*	*2.0*	GeV
Accel gradient	:	*33*	*40*	MeV/m
ΔE/E (FWHM)	:	*1.0*	*1.0*	%
Rep. rate	:	*25*	*50*	Hz
Pulse length	:	*0.054*	*0.054*	μs
Beam intensity	:	*(12) < 1.8*	*(12) < 2*	A
Norm. emit. (1σ)	:	*< 100*	*< 100*	π mm-mrad

OTHER RELEVANT INFORMATION

* *ATF - Accelerator Test Facility*

(1) 900 h / 17 week (Beam op.)
(2) 150 keV (Max 240 keV)
(3) < 4 A (instant current), 1 ns FWHM, 20 beam pulses, 2.8 ns separation.
(4) Two 357 MHz SHB + S-band TW Buncher + 3 m long accelerating structure.
(5) 18 m for injector and 70 m accelerator.
(6) 16 structures at 2.856 GHz are installed for the accelerating section. 2.856 + 4.327 MHz structure and 2.856 - 4.327 MHz structure are installed for the multi-bunch Energy Compensation System (ECS).
(7) 0.0204 - 0.0065
(8) Linac consists of three types of constant gradient structures with different apertures (25.251-18.376), (25.269-18.414) and (25.287 - 18.453)
(9) 8 Klystrons equipped with SLED and 2 Klystrons for ECS. Two Klystrons without SLED are for ±Δf ECS.
(10) Peak: 80 MW (400 MW from SLED)
Mean: 18 kW at 50 Hz rep. rate
(11) Bunch by bunch instrumentations are installed for the position, profile, intensity, bunch shape, energy and emittance of each bunch.
(12) Instantaneous beam current of multi-bunch beam.

PROTON AND/OR H- LINAC

Name of Linac : *KEK 40 MeV Linac*
Function : *Injector for 12 GeV Proton Synchrotron*
Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken 305, Japan*
Person in charge : *Isao Yamane*
Name of person supplying these data : *Eiichi Takasaki*
e-mail : *eiichi@kekvax.kek.jp*
tel. : fax : *+81 298 64 3182*

HISTORY AND STATUS

Const. started : *04/1971* ; first beam : *08/1974*
Present status : *Operational*
Cost of facility :
Present linac staff : *3 - 4*
Present yearly operat. time : *~ 5000 (1995)* h

LINAC PARAMETERS

Ion Source

Type : *Cusp H⁻ Ion Source*
Output : *25* mA at *370* keV
Pulse length : *200* μs; rep. rate : *20* Hz
Normalized emittance (1σ) : *1.4* π mm-mrad

Pre-accelerator (including RFQ)

Types : *Cockcroft-Walton* ; lengths : m
Output : *25* mA at *750* keV
Pulse length: *80* μs; rep. rate : *20* Hz
Normalized emittance (1σ) : *1.4* π mm-mrad

Longitudinal Matching

Type : *One buncher system with 2 gaps*
Mod. *16* keV; drift *944.2* mm at *201.07* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *(1)* m; No. of tanks : *2*
Tank diameters : *0.94 / 0.90* m
Number of drift-tubes : *90 / 36*
Drift-tube lengths : *23.29 to 287.90* mm
Drift-tube diam (range): *180 / 160* mm
Gap/cell length (range): *0.21 to 0.317*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *201.069* MHz
Field modes : *TM 010*
Eff. shunt impedance : *53 / 46* MΩ/m
Q : *65000*
Filling time : *100* μs
Equilibrium phases : *-30°*
RF rep. rate : *20* Hz; pulse : *275* μs
Beam rate : *20* Hz; pulse : *80* μs
RF power peak : *(2)* MW; mean : *0.0165* MW

Focusing System

No. elements : *(3)*
type : *(4)* order : *FODO*
Gradients : *110* to *22* T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Energy	*40.3*	MeV
Mean acc. rate	*1.42*	MeV/m
ΔE/E (FWHM)	*± 0.4*	%
Beam current	*18*	mA peak
Norm. emit. (1σ)	*1.2*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) 28.4 m (15.5 / 12.9)
(2) 3 MW (1.5 × 2)
(3) 90 / 36
(4) pulsed/permanent Q-mags.

- *There are two pre-accelerators (CW - type) for the high intensity H⁻ beams and the polarized beams (H⁻ / D⁻).*
- *The upgrade from 20 MeV to 40 MeV was completed in 1985. The second tank has a post coupled Alvarez structure and all quadrupole magnets are fabricated with permanent magnets.*
- *The single gap re-entrant cavity is used as a debuncher system.*
- *The velocity monitors are installed after each tank and are used for controlling phases and amplitudes of the RF fields.*

PROTON AND/OR H- LINAC

Name of Linac : *KEK 5 MeV H⁻ Linac Test Stand*
Function : *Accelerator Study for JHP*
Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken 305, Japan*
Person in charge : *Y. Yamazaki*
Name of person supplying these data : *Y. Yamazaki*
e-mail : *yoshishi@kekvax.kek.jp*
tel. : *+81 298 64 5202* fax : *+81 298 64 3182*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1994*
Present status : *Partly operational*
Cost of facility : *700 MJPY (1995)*
Present linac staff : *6*
Present yearly operat. time : h

LINAC PARAMETERS

Ion Source

Type : *Volume-production Type H⁻ Ion Source*
Output : *16* mA at *50* keV
Pulse length : *350* μs; rep. rate : *50* Hz
Normalized emittance (1σ) : *0.13* π mm-mrad

Pre-accelerator (including RFQ)

Types : *(1) 4 vane RFQ* ; lengths : *2.7* m
Output : *(2) 13.2* mA at *3000* keV
Pulse length: *(3) 200* μs; rep. rate : *(4) 20* Hz
Normalized emittance (1σ) : *0.15* π mm-mrad

Longitudinal Matching

Type : *One buncher system*
Mod. *115* keV; drift *784* mm at *432* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *1.17* m; No. of tanks : *1*
Tank diameters : *0.44* m
Number of drift-tubes : *17*
Drift-tube lengths : *43 to 54* mm
Drift-tube diam (range): *80* mm
Gap/cell length (range): *0.24 to 0.26*
Aperture diameter : *10* mm to mm
RF frequency(ies) : *432* MHz
Field modes : *TM010*
Eff. shunt impedance : *62* MΩ/m
Q : *44000*
Filling time : *16* μs
Equilibrium phases : *-30°*
RF rep. rate : *50* Hz; pulse : *600* μs
Beam rate : Hz; pulse : μs
RF power peak : *0.095* MW; mean : *0.003* MW

Focusing System

No. elements : *19*
type : *(5) PQM* order : *FODO*
Gradients : *175* to *168* T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy :	*3*	*5.4*	MeV
Mean acc. rate :		*2.1*	MeV/m
ΔE/E (FWHM) :			%
Beam current :	*6*	*20*	mA peak
Norm. emit. (1σ) :		*0.3*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) With PISL's 432 MHz.
(2) The H⁻ beam test with LEBT.
(3) High power test up to 600 μs.
(4) High power test up to 50 Hz.
(5) Permanent quadrupole magnet.
a) One quarter structure of the 10 MeV drift-tube linac. Post-coupled structure.
b) The full beam test will be done in 1997.

ELECTRON LINAC

Name of Linac : *TELL**
Function : *Electron Linac as injector for 3 storage rings and generation of slow positron*
Institution and address : *Quantum Radiation Division, Electrotechnical Laboratory, ***
Person in charge : *Tomohisa Mikado*
Name of person supplying these data : *Tetsuo Yamazaki*
e-mail : *tyamazak@etl.go.jp*
tel. : *+81 298 54 5541* fax : *+81 298 58 5683*

HISTORY AND STATUS

Const. started : *1980* ; first beam : *12/1980*
Present status : *Operating*
Cost of facility : *(1) 900 MJPY (1980)*
Present linac staff : *(2) 10 man-years*
Present yearly operation time : *1800* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *(3) 2* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(4)*
Output : *5* MeV; intensity : *0.200* A
Pulse width, spacing : *(5)*
Normalized emittance (1σ) : *7(horiz)6(vert)* π mm-mrad

Acceleration System

Total linac length : *76* m
No. sections : *4* ; lengths : *2.16;* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *(6) 0.4* μs
v_g/c range : *0.013-0.02* ; Q :
Shunt impedance : *57-51* MΩ/m
Iris : aperture : diameter : *(7) 27-23* mm
thickness : *5* mm
Attenuation/section : *(8)* Np
Power units, Number : *8* type : *Klystron*
RF power peak : *25* MW; mean : *25* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids and Q doublet at the injector, 12 quadrupole doublets, a quadrupole triplet between Acc. 8 and 9.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.31*	*0.5*	GeV
Accel gradient	:	*5.5*	*9*	MeV/m
ΔE/E (FWHM)	:	*1.5 - 3*	*1.5*	%
Rep. rate	:	*0.1 - 100*	*0.1 - 250*	Hz
Pulse length	:			μs
Beam intensity	:	*0.250*		A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

* *Tsukuba Electrotechnical Laboratory Linac*
** *1-1-4 Umezono, Tsukuba-shi, Ibaraki, 305, Japan*

(1) Including the beam-transporting system and excluding the cost of building
(2) Those people operate, maintain and do their own scientific research.
(3) With pulse width of 4 μs : 0.002 A
With pulse width of 1 ns : 1 A
(4) 2 S-band prebuncher and a buncher
(5) Long pulse mode: pulse width : 500 - 400 ns
spacing : 10 - 5000 ms
Short pulse mode: pulse width : 1 ns
spacing : 500
(This mode is used for single bunch injection into storage ring)
(6) 0.4 μs for 2 m sections
0.6 - 0.7 μs for 3 m sections
(7) Constant-gradient type. The diameter depends on the type of acc. tube.
(8) Depends on the type of acc. tube.
0.28 Np (2m section), 0.44-0.51 Np (3m section)

Slow-positron beam is generated usually with beam energy of 60-75 MeV in the low-energy experimental room.

600 MeV storage ring NIJI-II for SR processing is usually filled with electron energy of 150 MeV.

800 MeV storage ring TERAS for SR research is usually filled with electron energy of 310 MeV.

500 MeV storage ring NIJI-IV dedicated to free-electron lasers is filled with electron energy of 310 - 340 MeV.

ELECTRON LINAC

Name of Linac : *ICR 100 MeV Electron Linac*
Function : *Electron Linac for KSR injection*
Institution and address : *ICR, Kyoto University, Gokano-sho, Uji-city, Kyoto 611, Japan*
Person in charge : *M. Inoue*
Name of person supplying these data : *A. Noda*
e-mail : *noda@kyticr.kuicr.kyoto-u.ac.jp*
tel. : *+81 774 32 5806* fax : *+81 774 33 5509*

HISTORY AND STATUS

Const. started : *10/1994* ; first beam : *10/1995*
Present status : *Operating*
Cost of facility :
Present linac staff : *5 man-years*
Present yearly operation time : *300 (1995)* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *100* keV
Beam intensity (peak) : *0.12* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Prebuncher, Buncher*
Output : *5* MeV; intensity : *0.1* A
Pulse width, spacing : *1 μs, 50 ms*
Normalized emittance (1σ) : *100* π mm-mrad

Acceleration System

Total linac length : *10.5* m
No. sections : *3* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2.857* GHz
Wave type : *TW* ; filling time : *0.58* μs
v_g/c range : *0.0172* ; Q : *13500*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : *26.8 - 23.48* mm
thickness : *5.84* mm
Attenuation/section : *0.383* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *21* MW; mean : *1* kW

Focusing System

Type, No. of elements, and spacing :
FD.
FD Lattice, 5 elements, 3.5m spacing

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.1*		GeV
Accel gradient	:	*12*		MeV/m
ΔE/E (FWHM)	:			%
Rep. rate	:	*20 (max)*		Hz
Pulse length	:	*1*		μs
Beam intensity	:	*0.100*		A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

(1) Pierce type thermal gun

The duty factor is 2×10^3 %

PROTON AND/OR H- LINAC

Name of Linac : *ICR 7MeV Proton Linac*
Function : *Proton Linac for Accelerator Development and Material Irradiation*
Institution and address : *ICR, Kyoto University, Gokano-sho, Uji-city, Kyoto 611, Japan*
Person in charge : *M. Inoue*
Name of person supplying these data : *A. Noda*
e-mail : *noda@kyticr.kuicr.kyoto-u.ac.jp*
tel. : *+81 774 32 5806* fax : *+81 774 32 5509*

HISTORY AND STATUS

Const. started : *04/1986* ; first beam : *01/1992*
Present status : *Operating*
Cost of facility : *300 MYEN (1986)*
Present linac staff : *5 man-years*
Present yearly operat. time : *1500 (1995)* h

LINAC PARAMETERS

Ion Source

Type : *Multi-cusp Field Type*
Output : *10* mA at *50* keV
Pulse length : *500* μs; rep. rate : *max 180* Hz
Normalized emittance (1σ) : *1* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 vane RFQ* ; lengths : *2.195* m
Output : *1.2* mA at *2000* keV
Pulse length: *50* μs; rep. rate : *max 180* Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type : *(1)*
Mod. *190* keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *(2)* m; No. of tanks : *1*
Tank diameters : *0.451* m
Number of drift-tubes : *28*
Drift-tube lengths : *38.8 - 65.3* mm
Drift-tube diam (range): *55* mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : *433* MHz
Field modes : *TM010*
Eff. shunt impedance : *100* MΩ/m
Q : *(3) 40000*
Filling time : *10* μs
Equilibrium phases :
RF rep. rate : *max 180* Hz; pulse : *60* μs
Beam rate : *max 180* Hz; pulse : *50* μs
RF power peak : *0.33* MW; mean : *0.003* MW

Focusing System

No. elements : *29*
type : *PMQ (NdFeB)* order : *FODO*
Gradients : *175* to T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*7*		MeV
Mean acc. rate	*1.7*		MeV/m
ΔE/E (FWHM)	*±3*		%
Beam current	*0.6*		mA peak
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

(1) Longitudinal Matching Type : Single rebuncher with double gap resonator between RFQ and DTL.
(2) 1.868
(3) Unloaded

ION LINAC

Name of Linac : *RILAC* *
Function : *Basic Research, Injector for the Ring Cyclotron*
Institution and address : *The Institute of Physical and Chemical Research (RIKEN)***
Person in charge : *Y. Miyazawa*
Name of person supplying these data : *A. Goto*
e-mail : *goto@ringps.riken.go.jp*
tel. : *+81 48 462 1111* fax : *+81 48 461 5301*

HISTORY AND STATUS

Const. started : *1974* ; first beam : *1981*
Present status : *Operational*
Cost of facility : *(1) 10 MUSD*
Present linac staff : *10*
Present yearly operat. time : *4000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *ECR source (Neomafios)*
Species of ions : *(2) Heavy Ions*
Range of currents : μAe
Range of output energies : *(3)* keV/u
Pulse length : μs; rep. rate : *CW* Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Cockcroft-Walton* m
Output currents : 10×10^3 μAe
Output energies : *(4)* keV/u
Frequency : *CW* MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *30* m; N°. of tanks : *6*
Tank diameters : $3^{(L)} \times 2^{(D)} \times 3.5^{(H)}$ m
Number of drift-tubes : *87*
Drift-tube lengths : *18 ~ 220* mm
Drift-tube diam (range): *100 ~ 160* mm
Gap/cell length (range): *(40 ~ 90) / (60 ~ 310)*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *17 ~ 40* MHz
Field modes : *λ / 4 coaxial / Wideröe*
Eff. shunt impedance : *20 ~ 100* MΩ/m
Q : *18500 ~ 12000*
Filling time : μs
Equil. phases : ; accel. rate MeV/u-m
RF rep. rate : Hz; pulse : *CW* μs
Beam rate : Hz; pulse : *CW* μs
RF power peak : MW; mean : *2.0* MW

Focusing System

No. elements : *36*
type : *Quadupole magnet* order :
Gradients : *10* to *60* T/m
Other :

Charge Stripping (Typical)

Type(s) : *C - Foil Stripper*
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :	*He ~ Bi*		
Energy :	*(5)*		MeV/u
ΔE/E (FWHM) :		*0.5*	%
Mean acc. rate :			MeV/u-m
Beam current :			μAe peak
Norm. emit. (1σ) :			π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *Riken Linear Accelerator*
** *Wako-shi, Saitama, 351-01, Japan*

(1) Machine only
(2) 52 species ever accelerated
(3) 16 MV
(4) 0.5 MV
(5) 3 MeV/u for m/q < 5

References

[1] M. Odera et al., N.I.M. 227, 187 (1984)

ELECTRON LINAC

Name of Linac : *PLS 2-GeV Linac*
Function : *Injector to Pohang Light Source*
Institution and address : *Pohang Accelerator Laboratory, Pohang 790-784, Korea*
Person in charge : *Won Namkung*
Name of person supplying these data : *Won Namkung*
e-mail : *namkung@vision.postech.ac.kr*
tel. : *+82 562 279 1006* fax : *+82 562 279 1099*

HISTORY AND STATUS

Const. started : *4/1/1991* ; first beam : *5/10/1994*
Present status : *Normal Operation*
Cost of facility : *(1)*
Present linac staff : *34*
Present yearly operation time : *5000* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic Gun* ; energy : *80* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : *10* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *(3) 0.27* MeV; intensity : A
Pulse width, spacing : *1 ns, 100 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *150* m
No. sections : *(4) 42* ; lengths : *3.072* m
Field mode : *TM01* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μs
v_g/c range : *(5)* ; Q : *13000*
Shunt impedance : *53 ~ 60* MΩ/m
Iris : aperture : diameter : *19.093 ~ 26.220* mm
thickness : *5.842* mm
Attenuation/section : *1.751* Np
Power units, Number : *11* type : *(6) Klystron*
RF power peak : *80* MW; mean : *(7) 3.2* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles
#1, #2, #3, #4, #5, #6 : φ 44 mm
#1:8m, #2, #3:16m, #4, #5, #6:27m

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*2*	*2.34*	GeV
Accel gradient	:	*15.5*	*20*	MeV/m
ΔE/E (FWHM)	:	*0.3*	*0.3*	%
Rep. rate	:	*10*	*60*	Hz
Pulse length	:	10^{-3}	*0.04*	μs
Beam intensity	:	*2*	*2*	A
Norm. emit. (1σ)	:	*0.32*	*0.075*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) 16 BKRW (20 MUSD), (1994)
(2) S-band prebuncher and buncher
(3) Estimated by PARMELA
(4) Accelerating section: HEM11 suppressor included
(5) 0.0204 ~ 0.0065
(6) Toshiba E-3712
10 detunable pulse compressors used
200 MW modulator using SCR gate control
(7) 4 μs pulse with 10 Hz operation

3 beam exits: 100 MeV, 1 GeV, 2 GeV

References

[1] W. Namkung, et al., "Commissioning of PLS 2-GeV Electron Linac", Proc. 1994 EPAC, p742 (1994), and references therein.

[2] I. Ko, et al., "Control System of PLS 2-GeV Electron Linac", Proc. 1995 IEEE Real-Time Computer Applications, p 271 (1995), and references therein.

ELECTRON LINAC

Name of Linac : *SRRC* *
Function : *Preinjector linac for SRRC 1.3 GeV Booster Synchrotron*
Institution and address : *No 1 R&D Road VI Hsinchu Science-Based Industrial Park, Hsinchu 300, Taiwan*
Person in charge : *Tzong-Shyan Ueng (Linac) Prof. Y.C. Liu (Director)*
Name of person supplying these data : *Tzong-Shyan Ueng*
e-mail : *UENG@SRRC01.SRRC.GOV.TW*
tel. : *+886 35 780281 ext. 6315* fax : *+886 35 783892*

HISTORY AND STATUS

Const. started : *1991* ; first beam : *1992*
Present status : *Operating*
Cost of facility : *1 MUSD*
Present linac staff : *5 man-years*
Present yearly operation time : *4500* h

LINAC PARAMETERS

Electron Sources

Types *Dispenser cathode* ; energy : *150* keV
Beam intensity (peak) : *< 2.5* A
Normalized emittance (1σ) : *< 40* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *NA* MeV; intensity : *NA* A
Pulse width, spacing : *NA*
Normalized emittance (1σ) : *NA* π mm-mrad

Acceleration System

Total linac length : *3.08* m
No. sections : *1* ; lengths : *3.08* m
Field mode : *2π/3* ; frequency : *2.9979* GHz
Wave type : *TW* ; filling time : *0.78* μs
v_g/c range : *0.012* ; Q : *13025*
Shunt impedance : *NA* MΩ/m
Iris : aperture : diameter : *NA* mm
thickness : *NA* mm
Attenuation/section : *0.564* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *30* MW; mean : *0.9* kW

Focusing System

Type, No. of elements, and spacing :
Along the beam centerline: lens 1, drift space steering, lens 2, chopper bras, lens 3, waveguide steering, solenoids 1, 2, 3 and 4.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.05*	*0.05*	GeV
Accel gradient	*16.8*	*16.8*	MeV/m
ΔE/E (FWHM)	*0.4*	*0.4*	%
Rep. rate	*10*	*10*	Hz
Pulse length	*0.2 - 2*	*0.2 - 2*	μs
Beam intensity	*0.024*	*0.024*	A
Norm. emit. (1σ)	*100*	*100*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Synchrotron Radiation Research Centre*

(1) Dual cavity 3GHz chopper/prebuncher

References

[1] See Instruction Manual HRC - 780 50 MeV Linac for SRRC preinjector

EUROPE

ELECTRON LINAC

Name of Linac : *ELECTRONICA U-006*
Function : *Applied Researches*
Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
Person in charge : *Kh. Harutyunyan*
Name of person supplying these data : *Kh. Harutyunyan*
e-mail :
tel. : *+7 8852 3742 340083* fax : *(3742) 350030 /151695*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1990*
Present status : *Operational*
Cost of facility : *300 kUSD*
Present linac staff : *3*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *30* keV
Beam intensity (peak) : *1.5* A
Normalized emittance (1σ) : *1* π mm-mrad

Injector

Longitudinal matching :
Output : *10* MeV; intensity : *0.75* A
Pulse width, spacing : *5μs, 1 - 200 Hz*
Normalized emittance (1σ) : *80* π mm-mrad

Acceleration System

Total linac length : *4.5* m
No. sections : *1* ; lengths : *2.2* m
Field mode : *π/2* ; frequency : *1890* GHz
Wave type : *TM01* ; filling time : *0.2* μs
v_g/c range : *0.03* ; Q : *≥ 8000*
Shunt impedance : *25* MΩ/m
Iris : aperture : diameter :
thickness : mm
Attenuation/section : *4* Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *10* MW; mean : *1 - 10* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units, placed along section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *9500*
No. of particles/bunch : 2.5×10^9
Bunch separation : *16cm bunch length ≤ 53 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*10*	*10*	GeV
Accel gradient	:	*4.5*	*4.5*	MeV/m
ΔE/E (FWHM)	:	*5*	*5*	%
Rep. rate	:	*1 - 200*	*1 - 200*	Hz
Pulse length	:	*5*	*5*	μs
Beam intensity	:	*0.00075*	*0.00075 (1)*	A
Norm. emit. (1σ)	:	*80*	*80*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Mean

ELECTRON LINAC

Name of Linac : *High Current Injector for YerPhI Synchrotron*
Function :
Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
Person in charge : *V. Nikogossian*
Name of person supplying these data : *G. Oksuzian*
e-mail : *Oksuzian@vx1.yerphi.am*
tel. : *+7 8852 3742 344066* fax : *(3742) 350030 /151695*

HISTORY AND STATUS

Const. started : ; first beam :
Present status : *(1) Installation and Tuning*
Cost of facility : *8 MUSD*
Present linac staff : *9*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *150* keV
Beam intensity (peak) : *5 - 10* A
Normalized emittance (1σ) : *0.7* π mm-mrad

Injector

Longitudinal matching :
Output : *20* MeV; intensity : *1.2* A
Pulse width, spacing : *(2)*
Normalized emittance (1σ) : *1.2* π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *2* ; lengths : *2 × 2* m
Field mode : *π/2* ; frequency : *2.856* GHz
Wave type : *TM01* ; filling time : *5 - 10* μs
v_g/c range : *0.03* ; Q : *≥ 8000*
Shunt impedance : *~ 50* MΩ/m
Iris : aperture : diameter : *29* mm
thickness : *4* mm
Attenuation/section : *7* Np
Power units, Number : *(3)* type : *Klystron*
RF power peak : *20* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units, placed in the injector section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *28000*
No. of particles/bunch : 1×10^9
Bunch separation : *(4)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.020*	*0.120*	GeV
Accel gradient	*5*	*5*	MeV/m
ΔE/E (FWHM)	*1.5*	*1.5*	%
Rep. rate	*50 - 100*	*50 - 100*	Hz
Pulse length	*5 - 10*	*5 - 10*	μs
Beam intensity	*(5) 0.001*	*0.001*	A
Norm. emit. (1σ)	*0.8*	*0.8*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) High-current electron source
(2) (5-10) μs, (50-100) Hz
(3) 2 (18)
(4) 10.5 cm, bunch length ≤ 35 ps
(5) Mean current

ELECTRON LINAC

Name of Linac : *Injector for YerPhI Synchrotron*
Function : *Generation 75 MeV electrons*
Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
Person in charge : *V. Nikogossian*
Name of person supplying these data : *G. Oksuzian*
e-mail : *Oksuzian@vx1.yerphi.am*
tel. : *+7 8852 3742 344066* fax : *(3742) 350030/151695*

HISTORY AND STATUS

Const. started : *1961* ; first beam : *1965*
Present status : *Operational*
Cost of facility : *4 MUSD*
Present linac staff : *6*
Present yearly operation time : *6000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *50 + 80* keV
Beam intensity (peak) : *0.5* A
Normalized emittance (1σ) : *0.7* π mm-mrad

Injector

Longitudinal matching :
Output : *15 + 75* MeV; intensity : *0.2* A
Pulse width, spacing : *1 μs, 50 Hz*
Normalized emittance (1σ) : *1* π mm-mrad

Acceleration System

Total linac length : *25* m
No. sections : *4* ; lengths : *4.5 × 4* m
Field mode : *π/2* ; frequency : *2.7973* GHz
Wave type : *TM01* ; filling time : *~ 0.4* μs
v_g/c range : *~ 0.03* ; Q : *≥ 8000*
Shunt impedance : *~ 50* MΩ/m
Iris : aperture : diameter : *29* mm
thickness : *4* mm
Attenuation/section : *7* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *20* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units placed in the injector section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *2800*
No. of particles/bunch : 5×10^7
Bunch separation : *(1)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.075*	*0.050*	GeV
Accel gradient	*4.5*	*4.2*	MeV/m
ΔE/E (FWHM)	*2.0*	*2.5*	%
Rep. rate	*50*	*50*	Hz
Pulse length	*0.5 - 1*	*0.5 - 1*	μs
Beam intensity	*0.000010*	*0.000010*	A
Norm. emit. (1σ)	*0.9*	*0.9*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) 10.7 cm, bunch length ≤ 35 ps

ELECTRON LINAC

Name of Linac : *LAE-8 Electronics*
Function : *Irradiation of materials and radiation technology*
Institution and address : *Yerevan Physics Institute, 375036, Yerevan, Armenia*
Person in charge : *A. Oganessian*
Name of person supplying these data : *G.N. Yeritsian*
e-mail : *Yeritsian@vxc.yerphi.am*
tel. : *+7 8852 3742 350030* fax :

HISTORY AND STATUS

Const. started : *1986* ; first beam : *1986*
Present status : *Irradiation source*
Cost of facility : *430000 RUR (1986)*
Present linac staff : *3 persons*
Present yearly operation time : *800* h

LINAC PARAMETERS

Electron Sources

Types : *Oxide* ; energy : *40* keV
Beam intensity (peak) : *5* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.05* MeV; intensity : *5* A
Pulse width, spacing : *1 - 5 μs*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2* m
No. sections : *1* ; lengths : *2* m
Field mode : ; frequency : *1.86* GHz
Wave type : *TW* ; filling time : *5* μs
v_g/c range : ; Q : *1000*
Shunt impedance : *2* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *18* MW; mean : *18* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.008*	*0.008*	GeV
Accel gradient	:	*4*	*4*	MeV/m
ΔE/E (FWHM)	:	*20 - 25*	*15 - 25*	%
Rep. rate	:	*150 - 250*	*150 - 250*	Hz
Pulse length	:	*4*	*4*	μs
Beam intensity	:	2×10^{-5}	4×10^{-5} *(1)*	A
Norm. emit. (1σ)	:	*20*	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Mean current

ELECTRON LINAC

Name of Linac : *ELECTRONICA U-003*
Function : *Applied Researches*
Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
Person in charge : *Kh. Harutyunyan*
Name of person supplying these data : *Kh. Harutyunyan*
e-mail :
tel. : *+7 8852 3742 340083* fax : *(3742) 350030 /151695*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1989*
Present status : *Operational*
Cost of facility : *200 kUSD*
Present linac staff : *3*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *30* keV
Beam intensity (peak) : *1.5* A
Normalized emittance (1σ) : *1* π mm-mrad

Injector

Longitudinal matching :
Output : *5* MeV; intensity : *0.75* A
Pulse width, spacing : *5 μs, 1 - 200 Hz*
Normalized emittance (1σ) : *80* π mm-mrad

Acceleration System

Total linac length : *4* m
No. sections : *1* ; lengths : *2* m
Field mode : *π/2* ; frequency : *1.890* GHz
Wave type : *TM01* ; filling time : *0.2* μs
v_g/c range : *0.03* ; Q : *≥ 8000*
Shunt impedance : *25* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *4* Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *10* MW; mean : *1 - 10* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units placed along section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *9500*
No. of particles/bunch : 2.5×10^9
Bunch separation : *16cm, bunch length ≤ 53ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.005*	*0.005*	GeV
Accel gradient	*2.5*	*2.5*	MeV/m
ΔE/E (FWHM)	*5*	*5*	%
Rep. rate	*1 - 200*	*1 - 200*	Hz
Pulse length	*5*	*5*	μs
Beam intensity	*0.00075*	*0.00075 (1)*	A
Norm. emit. (1σ)	*80*	*80*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Mean

ELECTRON LINAC

Name of Linac : *LAE-4 Electronics*
Function : *Irradiation of materials and sterilization*
Institution and address : *Yerevan Physics Institute, 375036, Yerevan, Armenia*
Person in charge : *A. Oganessian*
Name of person supplying these data : *G.N. Yeritsian*
e-mail : *Yeritsian@vxc.yerphi.am*
tel. : *+7 8852 3742 350030* fax :

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1984*
Present status : *Irradiation Source*
Cost of facility : *160000 RUR (1984)*
Present linac staff : *3 persons*
Present yearly operation time : *800* h

LINAC PARAMETERS

Electron Sources

Types : *Oxide cathode* ; energy : *30* keV
Beam intensity (peak) : *5* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.05* MeV; intensity : *3* A
Pulse width, spacing : *1 - 4 μs*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2* m
No. sections : *1* ; lengths : *2* m
Field mode : ; frequency : *1.86* GHz
Wave type : *Mobile* ; filling time : *5* μs
v_g/c range : ; Q : *1000*
Shunt impedance : *2* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *18* MW; mean : *18* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.004*	*0.004*	GeV
Accel gradient	:	*2*	*2*	MeV/m
ΔE/E (FWHM)	:	*20 - 25*	*15 - 20*	%
Rep. rate	:	*150 - 250*	*150 - 250*	Hz
Pulse length	:	*4*	*4*	μs
Beam intensity	:	0.4×10^{-3}	*0.8* ×	A
Norm. emit. (1σ)	:	*15*	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Mean current

ELECTRON LINAC

Name of Linac : *GELINA*
Function : *Electron Linac for neutron and radiation physics*
Institution and address : *European Commission JRC IRMM, Retieseweg B-2440 Geel, Belgium*
Person in charge : *J-M. Salomé*
Name of person supplying these data : *J-M. Salomé*
e-mail :
tel. : *+32 14 57 15 03* fax : *+32 14 59 19 80*

HISTORY AND STATUS

Const. started : *1963* ; first beam : *1965*
Present status : *Operational*
Cost of facility : *5 MECU*
Present linac staff : *10*
Present yearly operation time : *3 - 4000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *20* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *S-band buncher*
Output : *20* MeV; intensity : *15* A
Pulse width, spacing : *10 ns - 2 μs*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *15* m
No. sections : *2* ; lengths : *2 × 6* m
Field mode : *2π/3* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *1.07* μs
v_g/c range : *(1)* ; Q : *15000*
Shunt impedance : *64* MΩ/m
Iris : aperture : diameter : *26 - 18* mm
thickness : mm
Attenuation/section : *5.8 db* Np
Power units, Number : *1* type : *(2)*
RF power peak : *30* MW; mean : *30* kW

Focusing System

Type, No. of elements, and spacing :
Per section, 6 solenoids 1m long, 0.18T

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.15*	*0.2*	GeV
Accel gradient	:		*16*	MeV/m
ΔE/E (FWHM)	:	*(3)*		%
Rep. rate	:	*800*		Hz
Pulse length	:	*0.010 to*	*2*	μs
Beam intensity	:	*10*	*12*	A
Norm. emit. (1σ)	:	*≈5*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 0.03 à 0.011
(2) F 2042 Klystron
(3) Depends on pulse length.

A compressing magnet is installed at the end of the linac.

Pulses of 11A, 11ns are injected in the magnet and compressed to ≈1ns, ≈100 A, average energy ≈100 MeV.

ELECTRON LINAC

Name of Linac : *Gent University Electron Linac*
Function : *Electron Linac for Interdisciplinary Research*
Institution and address : *Subatomic and Radiation Physics, Proeftuinstraat 86, B-9000 Gent, Belgium*
Person in charge : *W. Mondelaers*
Name of person supplying these data : *W. Mondelaers*
e-mail : *Wim.Mondelaers@Rug.Ac.Be*
tel. : *+32 9 264 65 33* fax : *+32 9 264 66 99*

HISTORY AND STATUS

Const. started : *1981* ; first beam : *1984*
Present status : *Operating*
Cost of facility : *85 MBF (1984)*
Present linac staff : *4 man-years*
Present yearly operation time : *5000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *40.0* keV
Beam intensity (peak) : *0.25* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *1.75* MeV; intensity : *0.150* A
Pulse width, spacing : *10 μs, 500 μs*
Normalized emittance (1σ) : *180* π mm-mrad

Acceleration System

Total linac length : *7* m
No. sections : *1* ; lengths : *4.5* m
Field mode : *2π/3* ; frequency : *2.9985* GHz
Wave type : *TW* ; filling time : *1* μs
v_g/c range : *0.008 -* ; Q : *15000*
Shunt impedance : *65* MΩ/m
Iris : aperture : diameter : *25 - 18* mm
thickness : *5.0* mm
Attenuation/section : *7* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *4* MW; mean : *60* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids
A triplet at 1.75 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 3.10^4
No. of particles/bunch : 2.10^8
Bunch separation : *300 psec*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.010*	*0.015*	GeV
Accel gradient	*2*	*3*	MeV/m
ΔE/E (FWHM)	*1*	*1*	%
Rep. rate	*2000*	*5000*	Hz
Pulse length	*10*	*14*	μs
Beam intensity	*0.100*	*0.100*	A
Norm. emit. (1σ)	*200*	*200*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) S-band prebuncher and buncher

References

[1] "The Gent University 15 MeV high-current linear electron accelerator facility" W. Mondelaers et al. Nucl. Instr. & Meth. A368 (1996) 278.

ELECTRON LINAC

Name of Linac : *PIVAIR* *
Function : *Prototype Induction Accelerator for AIRIX* **
Institution and address : *CEA/CESTA BP2, 33114 Le Barp, France*
Person in charge : *P. Anthouard*
Name of person supplying these data : *J. De Mascureau*
e-mail :
tel. : *+33 56 68 46 98* fax : *+33 57 71 54 40*

HISTORY AND STATUS

Const. started : *1994* ; first beam : *1994*
Present status : *In development*
Cost of facility : *(1) 40 MFRF (1994)*
Present linac staff : *6 man-years*
Present yearly operation time : *1600* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *4000* keV
Beam intensity (peak) : *3500* A
Normalized emittance (1σ) : *800* π mm-mrad

Injector

Longitudinal matching :
Output : *4* MeV; intensity : *3500* A
Pulse width, spacing : *80 ns FWHM*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : m
No. sections : ; lengths : m
Field mode : ; frequency : GHz
Wave type : ; filling time : µs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
16 solenoïds, 1 per induction cell.

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.006*	*0.008*	GeV
Accel gradient	:	*0.5*	*0.5*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*SINGLE*	*SHOT*	Hz
Pulse length	:	*(2) 0.080*	*0.080*	µs
Beam intensity	:	*3500*	*3500*	A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

* *Prototype d'Installation pour Valider l'Accélérateur à Induction de Radiographie*

** *Accélérateur à Induction de Radiographie pour Imagerie X. (AIRIX is a new high resolution X-Ray Flash Radiography facility.)*

(1) The cost only includes the injector, 16 cells and 8 high voltage generators.

(2) FWHM

- *The injector is a single shot pulsed diode electron generator. The electron source is a ø 76mm Velvet cathode.*
- *This linac uses the induction technology. Magnetic cores are Ni-Zn ferrites. Cells are powered by 250kV high voltage generators.*
- *The normal operation is 6MeV final energy at present status with 8 induction cells. By the end of 1996 it will reach 8MeV with 16 induction cells.*
- *The emittance value is RMS normalized.*
- *The energy spread is measured over the flat-top duration of the electron pulse.*

ELECTRON LINAC

Name of Linac : *LELIA* *
Function : *Free Electron Laser - Intense Electron Source*
Institution and address : *CEA-CESTA BP2, 33114 Le Barp, France*
Person in charge : *L. Voisin*
Name of person supplying these data : *J. Gardelle*
e-mail :
tel. : *+33 56 68 46 96* fax : *+33 57 71 54 40*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1992*
Present status : *Operational*
Cost of facility : *20 MFRF (1990)*
Present linac staff : *3 man-years*
Present yearly operation time : *1600* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *1000* keV
Beam intensity (peak) : *1000* A
Normalized emittance (1σ) : *410* π mm-mrad

Injector

Longitudinal matching :
Output : *1* MeV; intensity : *1000* A
Pulse width, spacing : *80 ns FWHM*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : m
No. sections : ; lengths : m
Field mode : ; frequency : GHz
Wave type : ; filling time : µs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
17 solenoïds, 1 per induction cell

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.0022*	*0.003*	GeV
Accel gradient	:	*0.275*	*0.375*	MeV/m
ΔE/E (FWHM)	:			%
Rep. rate		*SINGLE SHOT*	*0.1*	Hz
Pulse length	:	*(1) 0.08*	*0.08*	µs
Beam intensity	:	*1000*	*1000*	A
Norm. emit. (1σ) :				π mm-mrad

OTHER RELEVANT INFORMATION

* *Laser à Electrons Libres on Induction Accelerator*

(1) FWHM

- *This linac uses the technology of induction to create the accelerating field.*
- *The cost only corresponds to the Accelerator and its power supply (the magnetic compressor).*
- *Energy spread*

ΔE/E (%)	*Δt(ns)*
10	*50*
2	*20*
1	*10*

- *The given emittance value is the RMS normalized one.*

ELECTRON LINAC

Name of Linac : *ELSA*
Function : *FEL and e-beam applications*
Institution and address : *C.E.A. - 91680 Bruyeres-le-Chatel, France*
Person in charge : *Serge Joly*
Name of person supplying these data : *Serge Joly*
e-mail : *joly@bruyeres.cea.fr*
tel. : *+33 1 69 26 47 27* fax : *+33 1 69 26 70 24*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *11/1991*
Present status : *Operating*
Cost of facility :
Present linac staff : *5*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Photo-injector*
Output : *2* MeV; intensity : A
Pulse width, spacing : *20-60 ps*
Normalized emittance (1σ) : *2* π mm-mrad

Acceleration System

Total linac length : *4.5* m
No. sections : *3* ; lengths : *1.04* m
Field mode : *π* ; frequency : *0.433* GHz
Wave type : *SW* ; filling time : μs
v_g/c range : ; Q : *3000*
Shunt impedance : *11.25* MΩ/m
Iris : aperture : diameter : *60* mm
thickness : *26* mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *6* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *30-10800*
No. of particles/bunch : 3.10^{10}
Bunch separation : *13.8 ns - 5 μs*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.016*	*0.020*	GeV
Accel gradient	*5.3*	*7*	MeV/m
ΔE/E (FWHM)	*0.1*	*0.1*	%
Rep. rate	*1*	*20*	Hz
Pulse length	*100*	*150*	μs
Beam intensity	*(1) 100*	*(1) 500*	A
Norm. emit. (1σ)	*2*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) Beam Intensity (peak)

ELECTRON LINAC

Name of Linac : *ESRF Preinjector*
Function : *Electron linac*
Institution and address : *ESRF, Ave des Martyrs, BP 220 - F 38043 Grenoble, France*
Person in charge : *Jean Paul PERRINE*
Name of person supplying these data : *JP Perrine*
e-mail :
tel. : *+33 76 88 24 14* fax : *+33 76 88 20 54*

HISTORY AND STATUS

Const. started : *02/1988* ; first beam : *06/1991*
Present status : *Operating*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *< 0.05* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Buncher*
Output : *4* MeV; intensity : *0.03* A
Pulse width, spacing : *1.2 μs/2 ns 100 ms/1 s*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *2* ; lengths : *6* m
Field mode : *2π / 3* ; frequency : *2.9988* GHz
Wave type : *TW* ; filling time : *1.8* μs
v_g/c range : *(1)* ; Q : *15000*
Shunt impedance : *74* MΩ/m
Iris : aperture : diameter : *25 - 18* mm
thickness : *5* mm
Attenuation/section : *8.30* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *35* MW; mean : *14* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 4 MeV (Around bunchers)
(2)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.160*	*0.200*	GeV
Accel gradient	:	*13*	*16*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*10 / 1*	*10 / 1*	Hz
Pulse length	:	*1.22 / 0.002*	*1.2 / 0.002*	μs
Beam intensity	:	*0.02*	*2.5*	A
Norm. emit. (1σ)	:	*< 100*	*< 100*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) 0.0075 - 0.022
(2) Focusing triplets:
- *one after the buncher*
- *one between the 2 accelerating sections*
- *solenoids around each section*

These data are values in standard operation. Initially, the gun and the buncher were designed to roduce high current (> 2.5 A) allowing the optional production of e+. As this option has been completely abandoned, the linac is running as a low current electron injector.

Gun's running mode

- *Long pulse : 1.2 μs 25 mA*
- *Long pulse modulated by the 352 MHz of the ring. In this case, the gun emits current only during the positive part of the sinewave of 352 MHz.*
- *Short pulse : 2 ns pulse lengths from 1 to 4 pulses each 100 ms.*

ELECTRON LINAC

Name of Linac : *Orsay Linac*
Function : *Electron Linacs for Physics Experiments* *
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 01405 ORSAY France*
Person in charge : *L. Melard*
Name of person supplying these data : *M-A. Tordeux*
e-mail : *Tordeux@LALCLS.IN2P3.FR*
tel. : *+33 1 64 46 81 80* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Const. started : *1965* ; first beam : *1968*
Present status : *Operating*
Cost of facility :
Present linac staff : *26 man-years*
Present yearly operation time : *150* h

LINAC PARAMETERS

Electron Sources

Types : *(1) Diode* ; energy : *100* keV
Beam intensity (peak) : *0.1* A
Normalized emittance (1σ) : π mm-mrad

Injector *(1)*

Longitudinal matching : *(2)*
Output : *20* MeV; intensity : *0.07* A
Pulse width, spacing : *(1) 20 ns, 40 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *290* m
No. sections : *38* ; lengths : *6* m
Field mode : *π/2* ; frequency : *2.9986* GHz
Wave type : *TW* ; filling time : *1* µs
v_g/c range : *0.011 -* ; Q : *(3)*
Shunt impedance : *11 - 16* MΩ/m
Iris : aperture : diameter : *30 - 18* mm
thickness : *3* mm
Attenuation/section : *0.54 - 0.92* Np
Power units, Number : *38* type : *Klystron*
RF power peak : *(4)* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*1.1*	*2.3*	GeV
Accel gradient	*10*	*11/13*	MeV/m
ΔE/E (FWHM)			%
Rep. rate	*25*	*50*	Hz
Pulse length	*0.02*	*1.5*	µs
Beam intensity	*70*	*100*	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* *The same linac, used as Super-ACO e^+ Injector, is also used in experimental halls with e^-*

(1) Pulse width up to 1500 ns
(2) Deflecting plates and S-band Buncher
(3) 10000 to 11800
(4) 20 - 25

ELECTRON LINAC

Name of Linac : *Orsay Linac*
Function : *Electron Linac for e^+ Production*
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 01405 Orsay, France*
Person in charge : *L. Melard*
Name of person supplying these data : *M-A. Tordeux*
e-mail : *Tordeux@LALCLS.IN2P3.FR*
tel. : *+33 1 64 46 81 80* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Const. started : *1965* ; first beam : *1968*
Present status : *Operating*
Cost of facility :
Present linac staff : *26 man-years*
Present yearly operation time : *760* h

LINAC PARAMETERS

Electron Sources *(1)*

Types : *Diode* ; energy : *100* keV
Beam intensity (peak) : *3* A
Normalized emittance (1σ) : π mm-mrad

Injector *(1)*

Longitudinal matching : *(2)*
Output : *20* MeV; intensity : *1.4* A
Pulse width, spacing : *20 ns, 40 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *130* m
No. sections : *17* ; lengths : *6* m
Field mode : *π/2* ; frequency : *2.9986* GHz
Wave type : *TW* ; filling time : *1* μs
v_g/c range : *0.011 -* ; Q : *(3)*
Shunt impedance : *10 - 18.3* MΩ/m
Iris : aperture : diameter : *30 - 18* mm
thickness : *3* mm
Attenuation/section : *0.54 - 0.92* Np
Power units, Number : *17* type : *(4)*
RF power peak : *25* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
(5)

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*1*	*1*	GeV
Accel gradient	:	*10*	*13*	MeV/m
ΔE/E (FWHM)	:			%
Rep. rate	:	*25*	*50*	Hz
Pulse length	:	*0.005/0.020*	*id*	μs
Beam intensity	:	*2.5/3.5*	*id*	A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

(1) A second injector "NIL" provides short pulses which are bent at 16 MeV to the main Linac through an achromatic transport line. It allows "single bunch" injection into Super-ACO.

Electron Source

Type : *Triode;* Energy : *100 keV;* Beam Intensity : *7 A*

Injector

Long. matching : *S-band Prebuncher and Buncher*
Output k.e.: *16 MeV ;* Intensity : *3.5 A*
Pulse width, spacing : *5 ns, 40 ms*

(2) Deflecting plates and S-band Buncher
(3) 10000 to 11800
(4) Klystron / F2040E
(5) Solenoids upto 20 MeV, a triplet at 80 MeV, doublet at 200 MeV / 440 MeV / 680 MeV, a triplet before target

References

[1] "NIL, the New Injector of the Orsay Linac". M-A. Tordeux et al., EPAC 94 p. 170

POSITRON LINAC

Name of Linac	:	*Orsay Linac*
Function	:	*Positron Injector for Storage Rings (Super-ACO and DCI)*
Institution and address	:	*LURE, Centre Universitaire, Bât. 209 D, 91405 Orsay, France*
Person in charge	:	*L. Melard*
Name of person supplying these data	:	*M-A. Tordeux, A. Pichot*
		e-mail : *Tordeux@LALCLS.IN2P3.FR*
		tel. : *+33 1 64 46 81 80* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right. (1)

Primary Beam (e^-) at Conversion Target

Energy	:	*1000*	MeV
Radius (1σ)	:		mm
Beam intensity	:	*1 or 3*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*96% W 2% Cu 2% Ni*	
Type	:	*Removable*	
Thickness (rad.length)	:	*7*	χ
Diameter	:		mm
Mean deposited power	:	*0.5 / 0.4*	kW
Solenoidal field[a]	:	*1600 G over 6 × 6 m; DC*	
Matching device	:	*(2) Adiabatic lens*	
RF sections[a]	:	*23 × 6 m with Klystron 2043*	

[a] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right. (3)

LINAC PERFORMANCE *(4)*

		Normal Operation	Max, or Design	
Final energy	:	*0.8 / 1.1*	*1.4*	GeV
Accel gradient	:	*8 / 10*	*10*	MeV/m
ΔE/E (FWHM)	:	*1.4 / 1*		%
Rep. rate	:	*25*	*50*	Hz
Pulse length	:	*0.005 /0.020*		μs
Yield (fin.en)	:	*0.7 / 0.45*		e^+/e^- x GeV
Beam intensity	:	*21000 /4500*		μA peak
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

(1) Two primary beams are available. See Electron Linac for narrative description

(2) 1.25 T peak field

(3) After the DC solenoid on the first 6 sections, 6 triplets between sections and 2 doublets.

(4) Two types of operation are provided: injection of short bunches (5 ns) for single bunch mode, and long bunches (20 ns) for multibunch operation in the storage ring Super-ACO (800MeV), and injection of long bunches (20 ns) in the storage ring DCI (1.1 GeV).

References

[1] R. Chehab et al. "An adiabatic matching device for the Orsay Linear Positron Accelerator", PAC83, Santa Fe, 1983.

ELECTRON LINAC

Name of Linac : *EPLUS* *
Function : *Electron Linac for e^+ production (for SOLEIL ** SR Ring)*
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 91405 Orsay, France*
Person in charge : *R. Chaput*
Name of person supplying these data : *R. Chaput*
e-mail : *chaput@lure.u-psud.fr*
tel. : *+33 1 64 46 81 58* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Const. started : ; first beam :
Present status : *Project*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *15* MeV; intensity : *1* A
Pulse width, spacing : *(2)*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *~ 24* m
No. sections : *3* ; lengths : *6* m
Field mode : *2π/3* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *1.5* μs
v_g/c range : ; Q : *13500*
Shunt impedance : *72 - 60* MΩ/m
Iris : aperture : diameter : *26.8 - 16* mm
thickness : *3* mm
Attenuation/section : *0.83* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *45* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid then triplet of quadrupoles

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		*0.34*	GeV
Accel gradient :		*18*	MeV/m
ΔE/E (FWHM) :		*10*	%
Rep. rate :		*10*	Hz
Pulse length :		*0.005 or0.3*	μs
Beam intensity :		*0.7*	A
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

* *Electron Positron Linac Ulterior for SOLEIL*
** *SOLEIL - Source optimisée de Lumiére d'Energie Intermédiare de Lure*

(1) S-band prebuncher and buncher
(2) 5 ns or 300 ns at 10 Hz

References

[1] "Linac Injector for SOLEIL", R.. Chaput, M.A. Tordeux, EPAC '96.

POSITRON LINAC

Name of Linac : *EPLUS* *
Function : *Positron Injector for SOLEIL ** (SR Ring)*
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 01405 Orsay, France*
Person in charge : *R. Chaput*
Name of person supplying these data : *R. Chaput*
e-mail : *chaput@lure.u-pusd.fr*
tel. : *+33 1 64 46 81 58* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*340*	MeV
Radius (1σ)	:		mm
Beam intensity	:	*0.7*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*W in Cu Matrix*	
Type	:	*Removable*	
Thickness (rad.length)	:	*2.0*	χ
Diameter	:		mm
Mean deposited power	:	*0.14*	kW
Solenoidal field[a)]	:	*0.4 T over 6.1 m DC*	
Matching device	:	*λ/4 1.8 T pulsed Solenoid*	
RF sections[a)]	:	*(1) 4 × 6 m*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:		*0.35*	GeV
Accel gradient	:		*15*	MeV/m
ΔE/E (FWHM)	:		*3*	%
Rep. rate	:		*10*	Hz
Pulse length	:		*(2)*	μs
Yield (fin.en)	:		*2%*	e^+/e^- x GeV
Beam intensity	:		*2000*	μA peak
Norm. emit. (1σ)	:		*1500*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Electron Positron Linac Ulterior for SOLEIL*
** *SOLEIL - Source Optimisée de Lumière d'Energie Intermédiare de Lure*

(1) The first and second sections have some wider iris aperture (30.4 - 24 mm) and smaller efficiency 13.9 MV / (MW)$^{1/2}$. The 3rd and 4th are General Electric standard sections.
(2) 0.005 or 0.3

ELECTRON LINAC

Name of Linac : *ELIOS* *
Function : *Electron Injector Linac for SOLEIL** (SR Ring)*
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 91405 Orsay, France*
Person in charge : *R. Chaput*
Name of person supplying these data : *R. Chaput*
e-mail : *chaput@lure.u-psud.fr*
tel. : *+33 1 64 46 81 58* fax : *+33 1 69 853997*

HISTORY AND STATUS

Const. started : ; first beam : *2002*
Present status : *Project*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *0.250* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *15* MeV; intensity : *0.110* A
Pulse width, spacing : *(1)*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *~ 10* m
No. sections : *(2) 1* ; lengths : *6* m
Field mode : *2π/3* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *1.5* μs
v_g/c range : *(3)* ; Q : *13500*
Shunt impedance : *72 - 60* MΩ/m
Iris : aperture : diameter : *26.8 - 16* mm
thickness : *3* mm
Attenuation/section : *0.83* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *35* MW; mean : *1.5* kW

Focusing System

Type, No. of elements, and spacing :
Two lens, between gun and prebuncher, solenoid on buncher and quadrupoles before and after section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy		*0.10*	GeV
Accel gradient		*14*	MeV/m
ΔE/E (FWHM)		*1*	%
Rep. rate		*10*	Hz
Pulse length		*(4)*	μs
Beam intensity		*0.011*	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* *ELIOS - Electron Linac Injector of SOLEIL*
** *SOLEIL - Source Optimisée de Lumiére d'Energie Intermédiare de Lure*

(1) 5 ns or 300 ns, 100 ms
(2) General Electric, standard accelerating structure, 6m long.
Efficiency 18.5 MV/√MW
(3) 0.035 - 0.0067
(4) 0.005 or0.3

Electron production at 100 MeV for the booster (2.15 GeV) of the ring.

Two operating modes:
- *3 pulses of 5 ns, 120 ns apart at 10 Hz. Total charge 1 nC*
- *30 pulses of 5 ns at 100 MHz and 10 Hz. Total charge 3.3 nC*

ELECTRON LINAC

Name of Linac : *CLIO* *
Function : *Electron and Linac for Infrared FEL*
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 91405 ORSAY, France*
Person in charge : *R. Chaput*
Name of person supplying these data : *R. Chaput*
e-mail : *chaput@lure.u-psud.fr*
tel. : *+33 1 64 46 81 58* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1991*
Present status : *Operating*
Cost of facility : *25 MFRF (1987)*
Present linac staff : *5 man-years*
Present yearly operation time : *2400* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *1.2* A
Normalized emittance (1σ) : *15* π mm-mrad

Injector

Longitudinal matching : *(1) S-band buncher*
Output : *5* MeV; intensity : *0.7* A
Pulse width, spacing : *12 μs, 20 ms*
Normalized emittance (1σ) : *150* π mm-mrad

Acceleration System

Total linac length : *18* m
No. sections : *1* ; lengths : *4.5* m
Field mode : *2π/3* ; frequency : *2998.6* GHz
Wave type : *TW* ; filling time : *1.35* μs
v_g/c range : *(2)* ; Q : *14000*
Shunt impedance : *63 - 74* MΩ/m
Iris : aperture : diameter : *24 - 18* mm
thickness : *5.0* mm
Attenuation/section : *0.844* Np
Power units, Number : *1* type : *(3) Klystron*
RF power peak : *(4)* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Air-coils and solenoid up to 5 MeV, two lens, and solenoid on the section. Transport: 9 quadrupoles 3 bending magnets

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *400 - 3000*
No. of particles/bunch : 4×10^9
Bunch separation : *(5) 32 ns or 16, 8, 4*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.050*	*0.07*	GeV
Accel gradient	:	*12.6*		MeV/m
ΔE/E (FWHM)	:	*< 0.75*	*0.25*	%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	*12*	*12*	μs
Beam intensity	:	*55*	*20*	A
Norm. emit. (1σ)	:	*150*	*200*	π mm-mrad

OTHER RELEVANT INFORMATION

* *CLIO - Centre Laser Infra-rouge Orsay*

(1) Sub-harmonic prebuncher (500 MHz) and S-band buncher.
(2) 0.0067-0.02
(3) Klystron TH 2130 V great HF pulse width ~ 20 μs with 20 MW.
(4) 20. For a 19 μs pulse
(5) Wide range of bunch separation able to fill the optical cavity by 1, 2, 4, 8 light pulses.

References

[1] LAL/RT-89/04, February 1989 . Rapport d'étude du projet de laser à électrons libres CLIO. J.C. Bourdon et al.

[2] 14th International FEL Conf., August 1992. Operation of the CLIO Accelerator. R. Chaput et al.

[3] 17th International FEL Conf, August 1995. Activities of the CLIO Infrared Facility. JM. Ortéga et al.

ELECTRON LINAC

Name of Linac : *NEPAL**
Function : *Experimental High Gradient Accelerators*
Institution and address : *LAL, Bât. 200, Campus d'Orsay, 91405 Orsay, France*
Person in charge : *G. Bienvenu*
Name of person supplying these data : *G. Bienvenu*
e-mail : *BIENVENU@LALCLS.IN2P3.FR*
tel. : fax :

HISTORY AND STATUS

Const. started : *1986* ; first beam : *02/1988*
Present status : *Stand-by*
Cost of facility : *3 MFRF*
Present linac staff : *1/2 man-year*
Present yearly operation time : *150* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *4* MeV; intensity : *10* A
Pulse width, spacing : *0.2-3 μs, 10-40 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : m
No. sections : *1* ; lengths : *0.5* m
Field mode : *2 π/3* ; frequency : *3* GHz
Wave type : *TW* ; filling time : *0.3* μs
v_g/c range : *6.4 10^-3* ; Q : *14600*
Shunt impedance : *74.2* MΩ/m
Iris : aperture : diameter : *18* mm
thickness : *5* mm
Attenuation/section : *0.2* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *(2)* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.003*	*0.1*	GeV
Accel gradient	:		*80*	MeV/m
ΔE/E (FWHM)	:			%
Rep. rate	:	*6.25*	*25*	Hz
Pulse length	:	*0.2*	*3*	μs
Beam intensity	:	*0*	*40*	A
Norm. emit. (1σ)	:	*(for 3 A)*	*42*	π mm-mrad

OTHER RELEVANT INFORMATION

* *NEPAL - Nouvelle Expérience de Physique des Accélérateurs Linéaires.*

(1) S-band pre-buncher and buncher
(2) 35/260 (LIPS)

There is another RF cavity of 1 m long (and 0.6 μs filling time) instead of 0.5 m (and 0.3 μs filling time), with the same characteristics given under "Acceleration System".

A third cavity of 1.3 m has the following characteristics:

Field mode : 4π/3 ; Frequency : 3 GHz
Wave Type : TW/BW ; Filling Time : 0.2 s
v/c range : 6.4 10^-3 ; Q : 11100
Shunt Impendance : 75-0
Iris: aperture: diameter : 12 mm
thickness : 3 mm
Atten./section : 0.17 Np
Power units, No.: 1 Type : Klystron
RF power peak: (2) MW; mean: 20 kW

ELECTRON LINAC

Name of Linac : *CANDELA* *
Function : *Photo-injector R & D for linear colliders*
Institution and address : *LAL - Université d'Orsay - Bât. 200 - F 91405*
Person in charge : *Chris Travier*
Name of person supplying these data : *Chris Travier*
e-mail : *travier@lalcls.in2p3.fr*
tel. : *+33 1 64 46 83 68* fax : *+33 1 69 07 14 99*

HISTORY AND STATUS

Const. started : *1991* ; first beam : *09/1993*
Present status : *Operating*
Cost of facility : *6 MFRF (1995)*
Present linac staff : *3 man-years*
Present yearly operation time : *300* h

LINAC PARAMETERS

Electron Sources *(1)*
Types : *(2)* ; energy : *0* keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector *(1)*
Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System
Total linac length : *0.085* m
No. sections : *1* ; lengths : *0.085* m
Field mode : *π* ; frequency : *2.9985* GHz
Wave type : *SW* ; filling time : *0.6* μs
v_g/c range : ; Q : *10000*
Shunt impedance : *65* MΩ/m
Iris : aperture : diameter : *10* mm
thickness : *16* mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *3.5* MW; mean : *0.25* kW

Focusing System
Type, No. of elements, and spacing :
1 solenoid at gun exit
max field 2400 Gauss

Beam Pulse Structure (if applicable)
No. of bunches/pulse : *1*
No. of particles/bunch : $< 1.25 \times 10^{10}$
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.0025*	*0.0035*	GeV
Accel gradient	:	*70*	*106*	MeV/m
ΔE/E (FWHM)	:			%
Rep. rate	:	*12.5*	*12.5*	Hz
Pulse length	:	$< 50 \times 10^{-6}$	$< 50 \times 10^{-6}$	μs
Beam intensity	:	*< 40*	*1000*	A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

* *CANon..DEclenché par LAser*

(1) CANDELA is an RF gun and thus the electron source (photocathode) is directly located at the beginning of acceleration system.
(2) Dispenser Cathode.

Characteristics of laser system used to illuminate the photocathode.

Type : Ti: sapphire
useful wavelength : 266 nm
Energy maximum : 200 μJ
Bunch length : 0.5 - 15 ps
Repetition rate : 12.5 Hz

ELECTRON LINAC

Name of Linac : *MACSE**
Function : *Study of superconducting RF accelerator techniques*
Institution and address : *CEA DSM/DAPNIA, CEA/Saclay, 91191 Gif-sur-Yvette, France*
Person in charge : *Jean Gastebois*
Name of person supplying these data : *Marcel Jablonka*
e-mail : *JABLONKA@hep.saclay.cea.fr*
tel. : *+33 (1)69087323* fax : *+33 (1)69087408*

HISTORY AND STATUS

Const. started : *02/1989* ; first beam : *01/1991*
Present status : *Operated for experiments*
Cost of facility : *50 MFRF (1989)*
Present linac staff : *6*
Present yearly operation time : *300* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *0.003* A
Normalized emittance (1σ) : *0.5* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *2* MeV; intensity : *0.0005* A
Pulse width, spacing : *DC*
Normalized emittance (1σ) : *1* π mm-mrad

Acceleration System

Total linac length : *12* m
No. sections : *(2) 5* ; lengths : *0.5* m
Field mode : *π* ; frequency : *1.497* GHz
Wave type : *SW* ; filling time : μs
v_g/c range : ; Q : *(3) 1.10^7*
Shunt impedance : MΩ/m
Iris : aperture : diameter : *70* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *(5)* type : *Klystron*
RF power peak : *(6)* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
Solenoïdal lenses at 2 MeV
Triplets at 20 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *DC*
No. of particles/bunch : *4×10^5*
Bunch separation : *668 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.015*	*0.025*	GeV
Accel gradient	:	*7*	*10*	MeV/m
ΔE/E (FWHM)	:	*0.1*	*0.1*	%
Rep. rate	:	*DC*	*DC*	Hz
Pulse length	:			μs
Beam intensity	:	*10^{-4}*	*10^{-4}*	A
Norm. emit. (1σ)	:	*1*	*1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Module Accelerateur à Cavité Supraconductrice pour Electrons (Electron Accelerator Module using Super-conducting Cavities)*

(1) 60° chopper, NC pre-buncher 0.84c 5 cell SC cavity
(2) Superconducting 5 cell cavities.
(4) loaded
(5) TH2466
(6) 5×10^{-3}

References

[1] First description in proceedings of 1990 Linear Acc. Conf. p.141.

[2] Detailed description in report DAPNIA/SEA 92-09, Juin 1992.

ELECTRON LINAC

Name of Linac : *Linac*
Function : *Science of First Electrons for Pulse Radiography*
Institution and address : *Hahn-Meitner Institut, 14109 Berlin, Germany*
Person in charge : *Dr. E. Janata*
Name of person supplying these data : *Dr. E. Janata*
e-mail : *janata@hmi.de*
tel. : *+49 30 806 22853* fax : *+49 30 806 22434*

HISTORY AND STATUS

Const. started : *1968* ; first beam : *1969*
Present status : *Operational*
Cost of facility :
Present linac staff :
Present yearly operation time : *Low* h

LINAC PARAMETERS

Electron Sources

Types : *Cathode* ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.08* MeV; intensity : A
Pulse width, spacing : *2 ns - 2 μs , 20 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *~ 5* m
No. sections : *1* ; lengths : *~ 2* m
Field mode : ; frequency : *1.3* GHz
Wave type : ; filling time : μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : *10* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *min. 3*
No. of particles/bunch :
Bunch separation : *~ 0.8 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.015*		GeV
Accel gradient			MeV/m
ΔE/E (FWHM)			%
Rep. rate	*50*		Hz
Pulse length	*2 ns - 2 μs*		μs
Beam intensity	*6*		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

ION LINAC

Name of Linac : *RQ13*
Function : *Ion Injector for Separated Sector Cyclotron*
Institution and address : *Hahn-Meitner Institut, 14109 Berlin, Germany*
Person in charge : *H. Homeyer*
Name of person supplying these data : *A. Schempp*
e-mail : *A.Schempp@em.uni-frankfurt.de*
tel. : *+49 69 79822802* fax : *+49 69 79828510*

HISTORY AND STATUS

Const. started : *01/1994* ; first beam : *1997*
Present status : *Construction*
Cost of facility : *2 MDEM*
Present linac staff : *2*
Present yearly operat. time : h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *14 GHz ECR*
Species of ions : *1/5 > z/A > 1/8*
Range of currents : *50* μAe
Range of output energies : *15 to 30* keV/u
Pulse length : *cw* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.22* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *4 rod RFQ* m
Output currents : *25* μAe
Output energies : *90 to 360* keV/u
Frequency : *(1)* MHz; peak RF power : *20* kW
Pulse length : *cw* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.22* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : m; N°. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equil. phases : ; accel. rate MeV/u-m
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other :

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	:		
Energy	:		MeV/u
ΔE/E (FWHM)	:		%
Mean acc. rate	:		MeV/u-m
Beam current	:		μAe peak
Norm. emit. (1σ)	:		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) 85 to 120 MHz

ELECTRON LINAC

Name of Linac : *Linac 1* *
Function : *Electron Injector for Synchrotron*
Institution and address : *Bonn University, Physics Inst., Nussallee 12, D-53115 Bonn*
Person in charge : *D. Husmann*
Name of person supplying these data : *D. Husmann*
e-mail : *Husmann@AXPIB.PHYSIK.UNI-BONN.DE*
tel. : *+49 228 73 3617* fax : *+49 228 73 3620*

HISTORY AND STATUS

Const. started : *1964* ; first beam : *1966*
Present status : *Operating*
Cost of facility : *1.2 MDM (1964)*
Present linac staff : *(1) ELSA Staff*
Present yearly operation time : *5500* h

LINAC PARAMETERS

Electron Sources

Types : *(2) Diode* ; energy : *120* keV
Beam intensity (peak) : *1.5* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(3) S-band prebuncher*
Output : *0.12* MeV; intensity : *0.8* A
Pulse width, spacing : *1.5 μs , 20 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *3.20* m
No. sections : *1* ; lengths : *2.40* m
Field mode : *2π/3* ; frequency : *2.9986* GHz
Wave type : *TW* ; filling time : *0.5* μs
v_g/c range : ; Q : *10000*
Shunt impedance : *50* MΩ/m
Iris : aperture : diameter : *20* mm
thickness : *0.6* mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
1 solenoid in front of section
3 solenoids covering section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE *(4)*

	Normal Operation	Max, or Design	
Final energy	*0.02*	*0.02*	GeV
Accel gradient	*8.3*	*8.3*	MeV/m
ΔE/E (FWHM)	*10*	*10*	%
Rep. rate	*50*	*50*	Hz
Pulse length	*1*	*1*	μs
Beam intensity	*0.3*	*0.8*	A
Norm. emit. (1σ)	*80*	*80*	π mm-mrad

OTHER RELEVANT INFORMATION

* *VARIAN V-7720*

(1) ELSA - Electron Stretcher Accelerator
(2) A second source is used to provide polarized electron beams. It is a source based on a Ga As photocathode.
(3) The buncher is integrated in the section.
(4) Data are given for operation with thermionic gun only.

ELECTRON LINAC

Name of Linac : *Linac 2* *
Function : *Electron Injector for Synchrotron*
Institution and address : *Bonn University, Physics Inst., Nussallee 12, D-53115 Bonn*
Person in charge : *D. Husmann*
Name of person supplying these data : *D. Husmann*
e-mail : *Husmann@AXPIB.PHYSIK.UNI-BONN.DE*
tel. : *+49 228 73 3617* fax : *+49 228 73 3620*

HISTORY AND STATUS

Const. started : *(1) 1992* ; first beam : *1995*
Present status : *Operating*
Cost of facility : *NA*
Present linac staff : *(2) ELSA Staff*
Present yearly operation time : *(3)* h

LINAC PARAMETERS

Electron Sources

Types : *(4) Triode* ; energy : *50* keV
Beam intensity (peak) : *1* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(5)*
Output : MeV; intensity : A
Pulse width, spacing : *1 μs, 20 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *5.00* m
No. sections : *1* ; lengths : *3.00* m
Field mode : *π/2* ; frequency : *2.9985* GHz
Wave type : *TW* ; filling time : *0.5* μs
v_g/c range : ; Q : *12000*
Shunt impedance : *50* MΩ/m
Iris : aperture : diameter : *2.85 - 1.95* mm
thickness : *0.3* mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids covering section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE *(6)*

	Normal Operation	Max, or Design	
Final energy :		*0.030*	GeV
Accel gradient :		*10*	MeV/m
ΔE/E (FWHM) :			%
Rep. rate :	*50*	*50*	Hz
Pulse length :	*1*	*1*	μs
Beam intensity :		*0.6*	A
Norm. emit. (1σ) :		*120*	π mm-mrad

OTHER RELEVANT INFORMATION

* *(1 Section of former Mainz Linac "Muell")*

(1) Linac has been constructed using parts of the former Mainz Linac "MUELL"
(2) ELSA - Electron Stretcher Accelerator
(3) No routine operation
(4) A second source is used to provide polarized electron beams with a Ga As photocathode
(5) S-band prebuncher and buncher
(6) Normal operation data are not yet well known.

ION LINAC

Name of Linac : *GSI Heavy Ion Linac Wideröe (Linac I)*
Function : *Heavy Ion Injector for UNILAC Postaccelerator*
Institution and address : *GSI, 64220 Darmstadt, PO 11 05 52, Germany*
Person in charge : *J. Klabunde*
Name of person supplying these data : *J. Klabunde*
e-mail : *j.klabunde@GSI.de*
tel. : *+49 6159 712344* fax : *+49 6159 712987*

HISTORY AND STATUS

Const. started : *1972* ; first beam : *1975*
Present status : *Operational*
Cost of facility : *8 MDEM (1972)*
Present linac staff : *6 / 2 = 3 man-years*
Present yearly operat. time : *6000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *PIG, CHORDIS, MEVVA*
Species of ions : *All ions up to uranium*
Range of currents : *500* μAe
Range of output energies : *0.5 - 1.0* keV/u
Pulse length : *5000* μs; rep. rate : *50* Hz
Normalized emittance (1σ) : *0.5* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *320 kV DC Preaccelerator* m
Output currents : *500* μAe
Output energies : *11.7* keV/u
Frequency : MHz; peak RF power : kW
Pulse length : *5000* μs; rep. rate : *50* Hz
Normalized emittance (1σ) : *0.5* π mm-mrad

Longitudinal Matching

Type : *2-gap double drift buncher*
Mod. *4* keV; drift *1000* mm at *27* MHz
4 keV; drift *1500* mm at *27* MHz

Accelerating System

Total linac length : *26* m; N°. of tanks : *4*
Tank diameters : *1.2* m
Number of drift-tubes : *35, 35, 29, 25*
Drift-tube lengths : *10 - 290* mm
Drift-tube diam (range) : *34 - 40* mm
Gap/cell length (range) : *0.33 - 0.65*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *27.1* MHz
Field modes : *Coaxial βλ / 2 Structure*
Eff. shunt impedance : *45.4, 50.6, 46, 34.7* MΩ/m
Q : *4400, 5100, 7200, 7000*
Filling time : *100* μs
Equil. phases : *- 30°* ; accel. rate *0.054* MeV/u-m
RF rep. rate : *50* Hz; pulse : *5500* μs
Beam rate : *50* Hz; pulse : *5000* μs
RF power peak : *1.0* MW; mean : *0.28* MW

Focusing System

No. elements : *60*
type : *Singlet* order : *FFDD*
Gradients : *30* to *100* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Gas*
Charge states : *23* to *31* at *1.4* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation *(1)*	Max, or Design	
Species :	*All ions*	U^{10+}	
Energy :	*1.4*	*1.4*	MeV/u
ΔE/E (FWHM) :	*1*	*1*	%
Mean acc. rate :	*0.054*	*0.054*	MeV/u-m
Beam current :	*3000*	*70*	μAe peak
Norm. emit. (1σ) :	*0.5*	*0.5*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) All ions with q/m ≥ 0.04 can be acclerated, parameters given for U^{10+}.

ION LINAC

Name of Linac : *GSI Heavy Ion Linac HLI (Linac II)*
Function : *Heavy Ion Injector for UNILAC Postaccelerator*
Institution and address : *GSI, 64220 Darmstadt, PO 11 05 52, Germany*
Person in charge : *J. Klabunde*
Name of person supplying these data : *J. Klabunde*
e-mail : *j.klabunde@gsi.de*
tel. : *+49 6159 712344* fax : *+49 6159 712987*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1991*
Present status : *Operational*
Cost of facility : *6 MDEM (1990)*
Present linac staff : *4 / 2 = 2 man-years*
Present yearly operat. time : *6000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *14 GHz ECR*
Species of ions : *All ions up to uranium*
Range of currents : *6* μAe
Range of output energies : *2.5* keV/u
Pulse length : *CW* μs; rep. rate : *CW* Hz
Normalized emittance (1σ) : *0.5* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *4-rod RFQ/3* m
Output currents : *6* μAe
Output energies : *300* keV/u
Frequency : *108.4* MHz; peak RF power : *130* kW
Pulse length : *- 5000* μs; rep. rate : *100* Hz
Normalized emittance (1σ) : *0.5* π mm-mrad

Longitudinal Matching

Type : *λ / 4 - 4 gap resonator*
Mod. *160* keV; drift *500* mm at *108.4* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *3.3* m; N°. of tanks : *1*
Tank diameters : *0.6* m
Number of drift-tubes : *43*
Drift-tube lengths : *19 - 58, 369.9, 374.7* mm
Drift-tube diam (range): *24 - 27* mm
Gap/cell length (range): *0.2 - 0.5*
Aperture diameter : *18* mm to *20* mm
RF frequency(ies) : *108.4* MHz
Field modes : *TE111 (1)*
Eff. shunt impedance : *300* MΩ/m
Q : *20000*
Filling time : *< 100* μs
Equil. phases : *0, - 30°*; accel. rate *0.33* MeV/u-m
RF rep. rate : *100* Hz; pulse : *5500* μs
Beam rate : *100* Hz; pulse : *5000* μs
RF power peak : *0.11* MW; mean : *0.6* MW

Focusing System

No. elements : *2*
type : *Triplet* order : *FDF*
Gradients : *50* to *70* T/m
Other :

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation *(2)*	Max, or Design	
Species	:	*All ions*	U^{28+}	
Energy	:	*1.4*	*1.4*	MeV/u
ΔE/E (FWHM)	:	*1.0*	*1.0*	%
Mean acc. rate	:	*0.33*	*0.33*	MeV/u-m
Beam current	:	*- 1000*	*6*	μAe peak
Norm. emit. (1σ)	:	*0.5*	*0.5*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) (IH βλ/2 operation)
(2) All ions with q/m ≥ 0.11 can be acclerated, parameters given for U^{28+}.

References

[1] Linac described in Linac Conf. Proc. 1988, 1990, 1992.

ION LINAC

Name of Linac : *GSI Heavy Ion Postaccelerator (Linac III)*
Function : *Synchrotron Injector, Physics Experiments*
Institution and address : *GSI, 64220 Darmstadt, PO 11 05 52, Germany*
Person in charge : *J. Klabunde*
Name of person supplying these data : *J. Klabunde*
e-mail : *j.klabunde@gsi.de*
tel. : *+49 6159 712344* fax : *+49 6159 712987*

HISTORY AND STATUS

Const. started : *1972* ; first beam : *1975*
Present status : *Operational*
Cost of facility : *12 MDEM (1972)*
Present linac staff : *6 / 2 = 3 man-years*
Present yearly operat. time : *6000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *see GSI Linac I, II*
Types of source :
Species of ions :
Range of currents : μAe
Range of output energies : keV/u
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *see GSI Linac I, II* m
Output currents : μAe
Output energies : keV/u
Frequency : MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *70* m; N°. of tanks : *5*
Tank diameters : *2.0* m
Number of drift-tubes : *62, 24, 20, 36, 31*
Drift-tube lengths : *114 - 230* mm
Drift-tube diam (range): *200* mm
Gap/cell length (range): *0.25*
Aperture diameter : *30* mm to *35* mm
RF frequency(ies) : *108.4* MHz
Field modes : *TM010*
Eff. shunt impedance : *50, 55, 57, 58, 60* MΩ/m
Q : *(1)*
Filling time : *5000* μs
Equil. phases : *30; 25*; accel. rate *0.2* MeV/u-m
RF rep. rate : *50* Hz; pulse : *5500* μs
Beam rate : *50* Hz; pulse : *5000* μs
RF power peak : *5.0* MW; mean : *1.4* MW

Focusing System

No. elements : *173*
type : *Singlet* order : *FFDD*
Gradients : *20* to *40* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Carbon foil*
Charge states : *71* to *75* at *11.4* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation *(2)*	Max, or Design	
Species	*All ions*	U^{28+}	
Energy	*(3) 1.4 - 15*	*1.4 - 15*	MeV/u
ΔE/E (FWHM)	*0.5*	*0.5*	%
Mean acc. rate	*0.2*	*0.2*	MeV/u-m
Beam current	*3000*	*5 - 30*	μAe peak
Norm. emit. (1σ)	*0.5*	*0.5*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) 112, 108, 107, 105, 104 × 10^3
(2) The linac has the capability to accelerate on a pulse-to-pulse basis beams of differing ion species to individual energies.
(3) Energy variation between 1.4 and 15 MeV/u by additional 15 single gap cavities.

ELECTRON LINAC

Name of Linac : *S-DALINAC*
Function : *Nuclear and Radiation Physics, FEL Driver*
Institution and address : *Institut für Kernphysik, TH Darmstadt, Germany*
Person in charge : *A. Richter*
Name of person supplying these data : *H-D. Gräf*
e-mail : *Graef@linac.ikp.physik.th-darmstadt.de*
tel. : *+49 6151 163323* fax : *+49 6151 164321*

HISTORY AND STATUS

Const. started : *1983* ; first beam : *1987*
Present status : *Operating*
Cost of facility : *20 MDEM*
Present linac staff : *6*
Present yearly operation time : *2500* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic Gun* ; energy : *250* keV
Beam intensity (peak) : *≤ 0.03* A
Normalized emittance (1σ) : *≤ 2* π mm-mrad

Injector

Longitudinal matching : *Chopper + Prebuncher*
Output : *10* MeV; intensity : *≤ 0.00006* A
Pulse width, spacing : *CW*
Normalized emittance (1σ) : *≤ 2* π mm-mrad

Acceleration System

Total linac length : *17* m
No. sections : *8* ; lengths : *8 × 1* m
Field mode : *π* ; frequency : *3* GHz
Wave type : *TM 010* ; filling time : *1590* μs
v_g/c range : *Stan.wave* ; Q : $1 \cdot 10^9$
Shunt impedance : 1.25×10^6 MΩ/m
Iris : aperture : diameter : *35* mm
thickness : *6.4* mm
Attenuation/section : *Standing wave* Np
Power units, Number : *12* type : *Klystron*
RF power peak : *(1)* MW; mean : *0.5* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles, 4, 3.8 m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *CW*
No. of particles/bunch : 1.25×10^5
Bunch separation : *333 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.03 - 0.12*	*0.130*	GeV
Accel gradient	*≤ 7*	*10*	MeV/m
ΔE/E (FWHM)	*0.05*		%
Rep. rate	*CW*		Hz
Pulse length	*NA*		μs
Beam intensity	$\leq 60 \times 10^{-6}$		A
Norm. emit. (1σ)	*≤ 2*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 5×10^{-4}

Superconducting recirculating electron linac.

Superconducting cavities:
2 cells, β = 0.85
5 cells, β = 1.00
10 × 20 cells, β = 1.00

Two recirculations (three passes through linac).

ELECTRON LINAC

Name of Linac : *DELTA Injector Linac*
Function : *Electron Injector Linac for 1.5 GeV Synchrotron Radiation Light Source DELTA*
Institution and address : *Universtiy of Dortmund, D-44221 Dortmund, Germany*
Person in charge : *Th. Weis*
Name of person supplying these data : *Th. Weis*
e-mail : *weis@marvin.physik.uni-dortmund.de*
tel. : *+49 231 755 5370* fax : *+49 231 755 5383*

HISTORY AND STATUS

Const. started : *(1) 1992* ; first beam : *1994*
Present status : *Operating*
Cost of facility : *NA*
Present linac staff : *1 man-year*
Present yearly operation time : *1100* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *50* keV
Beam intensity (peak) : A
Normalized emittance (1σ) : *< 80* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *3.8* MeV; intensity : *1* A
Pulse width, spacing : *2-20 ns, 10 -100 ms*
Normalized emittance (1σ) : *< 200* π mm-mrad

Acceleration System

Total linac length : *12* m
No. sections : *2* ; lengths : *4.2* m
Field mode : *2π/3* ; frequency : *2.9986* GHz
Wave type : *TW* ; filling time : *0.7* μs
v_g/c range : *(3)* ; Q : *10000*
Shunt impedance : *42* MΩ/m
Iris : aperture : diameter : *30 - 20* mm
thickness : *Not known* mm
Attenuation/section : *0.62* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *20* MW; mean : *1 -10* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 3.8 MeV; a triplet at 3.8 MeV and a triplet between sections at 40 - 50 MeV.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *6 - 60*
No. of particles/bunch : 1.2×10^9
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.07*	*0.1*	GeV
Accel gradient	:	*8.33*	*11.9*	MeV/m
ΔE/E (FWHM)	:	*10*	*10*	%
Rep. rate	:	*10*	*100*	Hz
Pulse length	:	*0.002*	*0.020*	μs
Beam intensity	:	*0.6*	*0.6*	A
Norm. emit. (1σ)	:	*140*	*140*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Linac has been constructed using old system parts of the Mainz university 400 MeV electron linac (first operation 1966, shut down 1989).

Mainz components:
- *2 linac sections (age 20 years)*
- *20 MW klystrons, pilot klystron*
- *substantial part of the modulators*
- *gun body and prebuncher*

New installed components:
- *3.8 MeV buncher*
- *gun*
- *complete focusing system*
- *monitoring*
- *rf-network*

(2) S-band prebuncher and buncher
(3) 0.011-0.036

References

[1] DELTA, a Status Report, DELTA Group, University of Dortmund.

[2] G. Blokesch, J. Friedl, A. Jankowiak, C. Piel, T. Weis, K. Wille and DELTA Group, The Injector Linac of the DELTA-Facility, Proc. 1996 European Particle Accelerator Conference, Sitges.

ELECTRON LINAC

Name of Linac : *Linac 2*
Function : *Electron Injector for PIA (DORIS, HERA)*
Institution and address : *DESY, Notkestr. 85, 22603 Hamburg, Germany*
Person in charge : *D. Trines*
Name of person supplying these data : *M. Nagl*
e-mail :
tel. : *+49 40 8998 3796* fax : *+49 40 8998 4364*

HISTORY AND STATUS

Const. started : *1966* ; first beam : *01/1971*
Present status : *Operating*
Cost of facility :
Present linac staff : *6*
Present yearly operation time : *6700 (1995)* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *150* keV
Beam intensity (peak) : *4.0* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : MeV; intensity : A
Pulse width, spacing : *20 ns; 20 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *70* m
No. sections : *(2) 6* ; lengths : *5.2* m
Field mode : *2π/3* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *0.74* μs
v_g/c range : *(3)* ; Q : *14000*
Shunt impedance : *51.5* MΩ/m
Iris : aperture : diameter : *29.5 - 22.5* mm
thickness : *5.56* mm
Attenuation/section : *0.50* Np
Power units, Number : *(2) 6* type : *(4) Klystrons*
RF power peak : *25* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
0.08 T solenoids on the first 3 sections; quadrupoles on the last 5 sections

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.45*	*0.90*	GeV
Accel gradient	:	*14.4*	*17.7*	MeV/m
ΔE/E (FWHM)	:	*0.27*		%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	*0.020*		μs
Beam intensity	:	*0.030-0.060*		A
Norm. emit. (1σ)	:	*60*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) S-band prebuncher and buncher
(2) See Positron Linac for e^+ operation.
(3) 0.012-0.0043
(4) 11 klystrons are equipped with RF pulse compression.

POSITRON LINAC

Name of Linac	:	*Linac 2*
Function	:	*Positron Injector for PIA (DORIS, HERA)*
Institution and address	:	*DESY, Notkestr, 85, 22603, Hamburg, Germany*
Person in charge	:	*D. Trines*
Name of person supplying these data	:	*M. Nagl*
		e-mail :
		tel. : *+49 40 8998 3796* fax : *+49 40 8998 4364*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*400*	MeV
Radius (1σ)	:	*0.3*	mm
Beam intensity	:	*1.5*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*Tungsten*	
Type	:	*Stationary*	
Thickness (rad.length)	:	*2.0*	χ
Diameter	:	*10*	mm
Mean deposited power	:	*2*	kW
Solenoidal field[a)]	:	*0.4 T DC over 2 RF sections (10.4 m)*	
Matching device	:	*λ/4; 1.8 T pulsed solenoid*	
RF sections[a)]	:	*6 (7) × 5.2 m*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.45*	*0.55*	GeV
Accel gradient	:	*14.4*	*17.7*	MeV/m
ΔE/E (FWHM)	:	*1.0*	*1.0*	%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	*0.060*	*0.1*	μs
Yield (fin.en)	:	*0.025*	*0.03*	e^+/e^- x GeV
Beam intensity	:	*10000*	*15000*	μA peak
Norm. emit. (1σ)	:	*3000*		π mm-mrad

OTHER RELEVANT INFORMATION

The electrons are accelerated in five accelerator sections, which are powered by five klystrons. Each klystron is equipped with RF pulse compression.

The electron beam is focused by a quadrupole doublet onto the target.

Behind the converter, comprising the target and the small 1.8 T positron lens, there are two RF sections with 0.4 T solenoids, followed by a matching quadrupole doublet and 5 RF sections equipped with 25 quadrupoles in a FODO channel lattice. Six of these seven klystrons are equipped with RF pulse compression.

ELECTRON LINAC

Name of Linac : *TTF* *
Function : *Test Facility for a Superconducting Linear Collider*
Institution and address : *DESY, Notkestr. 85, 22603 Hamburg, Germany*
Person in charge : *Bernard Aune*
Name of person supplying these data : *Hans Weise*
e-mail : *Weise@desy.de*
tel. : *+49 40 8998 3950* fax : *+49 40 8998 3094*

HISTORY AND STATUS

Const. started : *1995* ; first beam :
Present status : *Under construction*
Cost of facility : *44 MDEM (1995)*
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *(2)* keV
Beam intensity (peak) : *(3) 0.010* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(4)*
Output : *10 (20)* MeV; intensity : *(3) 0.008* A
Pulse width, spacing : *see beam pulse structure*
Normalized emittance (1σ) : *(5) < 5* π mm-mrad

Acceleration System

Total linac length : *50* m
No. sections : *3 × 8* ; lengths : *1.0* m
Field mode : *π* ; frequency : *1.3* GHz
Wave type : *Standing* ; filling time : *≈500* μs
v_g/c range : *1* ; Q : *3×10^9*
Shunt impedance : *0.001* MΩ/m
Iris : aperture : diameter : *78* mm
thickness : *(6)* mm
Attenuation/section : Np
Power units, Number : *2* type : *Klystron*
RF power peak : *(7)* MW; mean : *(8)* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids at 250 keV, 2 triplets at 10 MeV (matching section), quadrupole doublets every 12.2m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *216×800 (1×800)*
No. of particles/bunch : *2.3×10^8 (5×10^{10})*
Bunch separation : *1/216 μs (1 μs)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy		*0.4 - 0.6*	GeV
Accel gradient		*15 - 25*	MeV/m
ΔE/E (FWHM)		*0.1*	%
Rep. rate		*10*	Hz
Pulse length		*800*	μs
Beam intensity		*(3) 0.008*	A
Norm. emit. (1σ)		*<5*	π mm-mrad

OTHER RELEVANT INFORMATION

* *TESLA Test Facility Linac*

(1) Two different injectors are under construction; Injector I (Triode) will be used for commissioning, Injector II (RF Gun) for cavity studies.
(2) Triode gun: 250 keV
RF gun : 3500 keV
(3) Average current for the 800 μs long macro pulse.
(4) Injector I : 216 MHz Buncher
Injector II : magnetic bunch compressor
(5) For the RF gun, E = 20 π mm.mrad
(6) Special shape
(7) 24 × 0.2
(8) peak × 0.8/100

ELECTRON LINAC

Name of Linac : *SBTF* *
Function : *Linear Collider Test Facility*
Institution and address : *DESY, Notkestr. 85, 22603 Hamburg, Germany*
Person in charge : *Norbert Holtkamp*
Name of person supplying these data : *Norbert Holtkamp*
e-mail : *MPYHOL@mint2.desy.de*
tel. : fax :

HISTORY AND STATUS

Const. started : *1992* ; first beam : *1995*
Present status : *Under construction*
Cost of facility : *10 MUSD*
Present linac staff : *~ 10 man-years*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *6* A
Normalized emittance (1σ) : *5* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *6* MeV; intensity : *(2)* A
Pulse width, spacing : *2 μs, 16 ns, 50 Hz*
Normalized emittance (1σ) : *~ 500* π mm-mrad

Acceleration System

Total linac length : *30* m
No. sections : *4* ; lengths : *6* m
Field mode : *2π/3* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *0.8* μs
v_g/c range : *4.1 - 1.4* ; Q : *13800*
Shunt impedance : *~ 55* MΩ/m
Iris : aperture : diameter : *27 - 13* mm
thickness : *5* mm
Attenuation/section : *0.55* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *150* MW; mean : *25* kW

Focusing System

Type, No. of elements, and spacing :
Triplets, solenoids

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *74 / 125 / 250*
No. of particles/bunch : $\geq 5 \times 10^{10}$
Bunch separation : *8 / 16 / 24 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.400*	*0.45*	GeV
Accel gradient	:	*17*	*22*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	*2*	*2*	μs
Beam intensity	:	*0.300*	*0.400*	A
Norm. emit. (1σ)	:	*500*	*400*	π mm-mrad

OTHER RELEVANT INFORMATION

* *SBTF - S - Band Test Facility*

(1) S-band, 500 MHz & 125 MHz buncher
(2) 1 kA peak, 300 mA average

PROTON AND/OR H- LINAC

Name of Linac : *Linac 3*
Function : *Proton Injector for DESY Accelerator Complex*
Institution and address : *DESY, Notkestr. 85, 22603 Hamburg, Germany*
Person in charge : *D. Trines*
Name of person supplying these data: *M. Nagl*
e-mail :
tel. : *+49 40 8998 3796* fax : *+49 40 8998 4364*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *11/1988*
Present status : *Operating*
Cost of facility :
Present linac staff : *4*
Present yearly operat. time : *6900 (1995)* h

LINAC PARAMETERS

Ion Source

Type : *H^- magnetron ion source*
Output : *60* mA at *18* keV
Pulse length : *75* μs; rep. rate : *6* Hz
Normalized emittance (1σ) : *0.6* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 rod RFQ* ; lengths : *1.2* m
Output : *20* mA at *750* keV
Pulse length: *30* μs; rep. rate : *0.25 (1)* Hz
Normalized emittance (1σ) : *0.8* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System *(2)*

Total linac length : *33.6* m; No. of tanks : *3*
Tank diameters : *0.94; 0.90; 0.86* m
Number of drift-tubes : *(3)*
Drift-tube lengths : *(4)* mm
Drift-tube diam (range): *180; 160; 160* mm
Gap/cell length (range): *22-31%; 20-29%; 26-31%*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *202.56* MHz
Field modes : *TM010*
Eff. shunt impedance : *36* MΩ/m
Q : *60000*
Filling time : *(5)* μs
Equilibrium phases : *-35° to -25°; -25°; -25°*
RF rep. rate : *0.25 (1)* Hz; pulse : *250* μs
Beam rate : *0.25 (1)* Hz; pulse : *30* μs
RF power peak : *3.6* MW; mean : *0.0002* MW

Focusing System

No. elements : *131*
type : *Pulsed* order : *FODO*
Gradients : *100* to *20* T/m
Other : *Pulsed flat-top (100 μs)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy :	*50*	*50*	MeV
Mean acc. rate :	*1.48*	*1.48*	MeV/m
ΔE/E (FWHM) :	*0.28*	*0.28*	%
Beam current :	*12*	*20*	mA peak
Norm. emit. (1σ) :	*1.0*	*2.0*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Maximum 1 Hz
(2) Post coupled Alvarez linac structure.
(3) 51+2/2; 43+2/2; 31+2/2
(4) 48-147; 177-258; 274-316
(5) Determined by feedback; < 100 μs

ION LINAC

Name of Linac : *Heidelberg Postaccelerator*
Function : *Heavy Ion Booster for Tandem-Accelerator Nuclear and Atomic Physics*
Institution and address : *Max-Planck-Institut für Kernphysik, POBox 103980, D69029 Heidelberg*
Person in charge : *Roland Repnow*
Name of person supplying these data : *Roland Repnow*
e-mail : *REP@HERING.MPI-HD.MPG.DE*
tel. : *+49 6221 516 277* fax : *+49 6221 516234*

HISTORY AND STATUS

Const. started : *1974* ; first beam : *1979*
Present status : *Operating*
Cost of facility : *10 MDEM (1980)*
Present linac staff : *6 persons*
Present yearly operat. time : *1500-2500* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *(1)*
Species of ions : *all ions from p to U*
Range of currents : *0.1 - 200* µAe
Range of output energies : *190* keV/u
Pulse length : *DC/200* µs; rep. rate : *55* Hz
Normalized emittance (1σ) : *1.5* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *(2) 25* m
Output currents : *0.1 - 10.0* µAe
Output energies : *1000 - 24000* keV/u
Frequency : *0* MHz; peak RF power : *na* kW
Pulse length : *(3)* µs; rep. rate : *55* Hz
Normalized emittance (1σ) : *1.5* π mm-mrad

Longitudinal Matching

Type : *a) Harmonic buncher b) Spiral resonator (4)*
Mod. *a) 1.2* keV; drift *5000* mm at *13.56* MHz
b)300 keV; drift *3200* mm at *108.48* MHz

Accelerating System

Total linac length : *16* m; N°. of tanks : *40*
Tank diameters : *0.35-0.5* m
Number of drift-tubes : *48*
Drift-tube lengths : *35 - 146* mm
Drift-tube diam (range): *32* mm
Gap/cell length (range): *180 - 215*
Aperture diameter : *20* mm to mm
RF frequency(ies) : *108.48* MHz
Field modes : *na*
Eff. shunt impedance : *30* MΩ/m
Q : *3500*
Filling time : *na* µs
Equil. phases : *-20°* ; accel. rate *0.5* MeV/u-m
RF rep. rate : *55* Hz; pulse : *2000* µs
Beam rate : *55* Hz; pulse : *2000* µs
RF power peak : *3.6* MW; mean : *0.9* MW

Focusing System

No. elements : *10*
type : *Quad. Dupl.* order : *FD*
Gradients : *8* to *30* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Gas / Foil*
Charge states : *-1* to *6 12* at *0.1* MeV/u
Charge states : *6 12* to *15 30* at *1* MeV/u

LINAC PERFORMANCE

	Normal Operation *(5)*	Max, or Design *(6)*	
Species :	^{12}C	^{120}SN	
Energy :	*11 / 15*	*5.5*	MeV/u
ΔE/E (FWHM) :	*0.04*	*0.1*	%
Mean acc. rate :	*0.25 / 0.5*	*0.12/0.25*	MeV/u-m
Beam current :	*1.0*	*0.080*	µAe peak
Norm. emit. (1σ) :	*2.0*	*2.0*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range *(7)*	Other info.
32 S	*8 /13 MeV/u*	*(25% DF)*
58 Ni	*5.3 / 10 MeV/u*	*(25% DF)*
197 Au	*3.6 MeV/u*	*(25% DF)*

OTHER RELEVANT INFORMATION

(1) CE x Duopl., Cs-Sputter-Source (neg)
(2) 12MV Electrostatic Tandem
(3) 200 - 2000 µs
(4) c) rf-chopper 13.56 MHz 150 kV
(5) light ions : cw / pulsed
(6) heavy ions : cw / pulsed
(7) cw / pulsed

Beams can be further accelerated by TSR-storage ring in synchrotron acceleration mode.
Second linac-injector for high particle currents under construction.

References

[1] IEEE Trans. Nucl. Sci. Vol. NS-28, No. 2, April 1981 p. 1441: Heavy Ion Acceleration at the Heidelberg Tandem Postaccelerator Combination, B. Huck, H. Ingwersen, E. Jaeschke, B. Kolb, R. Repnow. Th. Walcher.

ION LINAC

Name of Linac : *Heidelberg High Current Injector*
Function : *Heavy Ion High Current Injector, Nuclear and Atomic Physics*
Institution and address : *Max-Planck-Institut für Kernphysik, PO Box 103980, D 69029 Heidelberg*
Person in charge : *Robert von Hahn*
Name of person supplying these data : *Robert von Hahn*
e-mail : *vonhahn@zoohey.mpi-hd.mpg.de*
tel. : *+49 6221 516 396* fax : *+49 6221 516 234*

HISTORY AND STATUS

Const. started : *1991* ; first beam :
Present status : *Under construction*
Cost of facility : *5 MDEM*
Present linac staff : *5*
Present yearly operat. time : h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *(1)*
Species of ions : *(1) Be, Li / all ions from p to U*
Range of currents : *(1) 4000 / 10-400* μAe
Range of output energies : *4* keV/u
Pulse length : *2000* μs; rep. rate : *ca 60* Hz
Normalized emittance (1σ) : *na* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *2 RFQ resonators, 3m each* m
Output currents : *T=90 % calculated* μAe
Output energies : *480* keV/u
Frequency : *(2)* MHz; peak RF power : *80* kW
Pulse length : *4000* μs; rep. rate : *60* Hz
Normalized emittance (1σ) : *na* π mm-mrad

Longitudinal Matching

Type : *Spiral Resonator*
Mod. *200* keV; drift *1500* mm at *108.48* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *10* m; N°. of tanks : *8*
Tank diameters : *0.5* m
Number of drift-tubes : *48*
Drift-tube lengths : *36 - 59* mm
Drift-tube diam (range) : *32* mm
Gap/cell length (range) : *51 - 78*
Aperture diameter : *20* mm to mm
RF frequency(ies) : *108.48* MHz
Field modes : *na*
Eff. shunt impedance : *100* MΩ/m
Q : *5500*
Filling time : *na* μs
Equil. phases : *-20°* ; accel. rate *0.18* MeV/u-m
RF rep. rate : *60* Hz; pulse : *4000* μs
Beam rate : *60* Hz; pulse : *4000* μs
RF power peak : *0.72* MW; mean : *0.18* MW

Focusing System

No. elements : *4*
type : *quad.dupl.* order : *FD*
Gradients : *8* to *30* T/m
Other :

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	:	*p to U*	
Energy	:	*2*	MeV/u
ΔE/E (FWHM)	:	*0.5*	%
Mean acc. rate	:	*0.2*	MeV/u-m
Beam current	:	*10 - 4000*	μAe peak
Norm. emit. (1σ)	:	*na*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) 1st phase: CHORDIS / 2nd phase: ECR
(2) 108.48 MHz

Beams can be further accelerated by the postaccelerator and the storage ring in synchrotron mode.

ELECTRON LINAC

Name of Linac : *MAMI * - ILAC*
Function : *Injector to the CW-RTM-Cascade MAMI*
Institution and address : *Institut für Kernphysik, D-55099 Mainz, Germany*
Person in charge : *Dr. K.H. Kaiser*
Name of person supplying these data : *Dr. H. Euteneuer*
e-mail : *EUT@vkpmza.kph.uni-mainz.de*
tel. : *+49 6131 39 5869* fax : *+49 6131 39 2964*

HISTORY AND STATUS

Const. started : *1986* ; first beam : *1988*
Present status : *Operating*
Cost of facility : *~ 0.8 MDEM (1988)*
Present linac staff : *(1)*
Present yearly operation time : *5000 to 7000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *0.0015* A
Normalized emittance (1σ) : *0.15* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *0.1* MeV; intensity : *2.10^{-4}* A
Pulse width, spacing : *9 ps, 408 ps*
Normalized emittance (1σ) : *0.15* π mm-mrad

Acceleration System

Total linac length : *(3) 9* m
No. sections : *(4) 3* ; lengths : *(5)* m
Field mode : *π/2(bip.)* ; frequency : *2.4495* GHz
Wave type : *SW* ; filling time : *NA* µs
v_g/c range : *(6)* ; Q : *(7)*
Shunt impedance : *(8) 77* MΩ/m
Iris : aperture : diameter : *12.4* mm
thickness : *2.9* mm
Attenuation/section : *NA* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *NA* MW; mean : *35* kW

Focusing System

Type, No. of elements, and spacing :
6 double solenoids, 1 at gun, 2 at chopper and 1 at each accelerating section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *2.5×10^5*
Bunch separation : *408 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.00353*	-	GeV
Accel gradient	:	*(9) 0.72*	*average*	MeV/m
ΔE/E (FWHM)	:	*0.1*	-	%
Rep. rate	:	*NA*	-	Hz
Pulse length	:	*NA*	-	µs
Beam intensity	:	*(10)*	*2.10^{-4}*	A
Norm. emit. (1σ)	:	*≤0.4*	*1*	π mm-mrad

OTHER RELEVANT INFORMATION

* *MAMI - Mainz Microtron. This Linac is the injector for MAMI (Mainz Microtron), a cascade of 3 race-track microtrons.*

(1) 13 staff, 17 student-operators
(2) 2.45 GHz double-chopper & prebuncher
(3) 2.63 m (injector) + 6.35 m
(4) The ILAC consists of
- graded-β-section (0.1 - 0.55 MeV);
- β = 0.918/0.966-section (0.55 - 1.99 MeV);
- β = 0.987-section (1.99 - 3.53 MeV).
(5) 0.78 / 2.03 / 2.11
(6) 5.1 to 3.5%
(7) 16500 (unloaded)
(8) for high β
(9) average
(10) 10^{-15}-1.5×10^{-4}

References

[1] A detailed description of gun, chopper, the linac and its diagnostics is given in Proc. of EPAC '88, Rome; p.997 and 1149 respectively.

[2] The setup and the operating experience of the MAMI-facility are given in : Proc. Linac'88, Cebaf Report-89-001, p. 247 and Proc. EPAC'94, London, p. 506.

ION LINAC

Name of Linac : *SchweIN : IH type*
Function : *Heavy ion postaccelerator*
Institution and address : *Beschleunigerlabor der LMU und TUM; D-85747 Garching, Germany*
Person in charge : *Eckehart Nolte*
Name of person supplying these data : *Eckehart Nolte*
e-mail : *nolte@physik.tu-muenchen.de*
tel. : *+49 89 289 12554* fax : *+49 89 289 14280*

HISTORY AND STATUS

Const. started : *1971* ; first beam : *1976*
Present status : *Operating*
Cost of facility : *2 MDEM*
Present linac staff : *1 operator*
Present yearly operat. time : *1440* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *CS sputter source*
Species of ions : *(1)*
Range of currents : *1* μAe
Range of output energies : *4300 - 6400* keV/u
Pulse length : μs; rep. rate : *d.c.* Hz
Normalized emittance (1σ) : *(2) 80* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *MP Tandem, 24* m
Output currents : *1* μAe
Output energies : *≈ 2400* keV/u
Frequency : MHz; peak RF power : *dc* kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : *3* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *8* m; N°. of tanks : *2*
Tank diameters : *1; 0.5* m
Number of drift-tubes : *50*
Drift-tube lengths : *≈ 100; ≈ 50* mm
Drift-tube diam (range) : *8000* mm
Gap/cell length (range) : *0.5*
Aperture diameter : *30* mm to *20* mm
RF frequency(ies) : *78; 156* MHz
Field modes : *TE111; IH*
Eff. shunt impedance : *150; 170* MΩ/m
Q : *30000; 20000*
Filling time : *d.c.* μs
Equil. phases : *(3)* ; accel. rate *0.5* MeV/u-m
RF rep. rate : *d.c.* Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : *90* MW; mean : *90* MW

Focusing System

No. elements : *3 outside tanks*
type : *QD* order :
Gradients : to *30* T/m
Other :

Charge Stripping (Typical)

Type(s) : *Ni*
Charge states : *11* to *22* at *2.4* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :	*Ni*		
Energy :	*6*		MeV/u
ΔE/E (FWHM) :	*1*		%
Mean acc. rate :	*0.5*		MeV/u-m
Beam current :	*1*		μAe peak
Norm. emit. (1σ) :	*3*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) S^-, Cl^-, Ca^-, T^-, MnO^-, Fe^-, Ni^-, Ge^-
(2) After preaccelerator (170 kV)
(3) + 5 to - 10°
(4) 3 (outside tanks)

First IH structure in operation.
First postaccelerator after Tandem accelerator.

References

[1] E. Nolte et al. NIM 158 (1979) 311

[2] E. Nolte et al. NIM 201 (1982) 281

[3] U. Ratzinger et al. NIM A263 (1988) 261

ELECTRON LINAC

Name of Linac : DAΦNE - LINAC
Function : *Electron Injector Linac per* DAΦNE *and for the* DAΦNE *BTF**
Institution and address : *INFN LNF via E.Fermi 40 CP 13 00044 Frascati Italy*
Person in charge : *F. Sannibale*
Name of person supplying these data : *F. Sannibale*
e-mail : *SANNIBALE@LNF.INFN.IT*
tel. : *+39 6 94032213* fax : *+39 6 94032256*

HISTORY AND STATUS

Const. started : *1992* ; first beam : *1995*
Present status : *Operating*
Cost of facility : *12 MUSD (1992)*
Present linac staff : *10 man-years*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *120* keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *S-band PB and Buncher*
Output : *3* MeV; intensity : *7* A
Pulse width, spacing : *10 ns, 20 ms*
Normalized emittance (1σ) : *< 300* π mm-mrad

Acceleration System

Total linac length : *62* m
No. sections : *(1) 15* ; lengths : *3* m
Field mode : *2π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.820* μs
v_g/c range : *(2)* ; Q : *13400*
Shunt impedance : *53 - 60* MΩ/m
Iris : aperture : diameter : *26.2 - 19.1* mm
thickness : *5.842* mm
Attenuation/section : *0.57* Np
Power units, Number : *4* type : *(3) Klystron*
RF power peak : *45* MW; mean : *100* kW

Focusing System

Type, No. of elements, and spacing :
(4)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *28*
No. of particles/bunch : *$1 - 3 \times 10^{8}$*
Bunch separation : *12.5 ps*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.510*	*0.8*	GeV
Accel gradient	:	*18*	*25*	MeV/m
ΔE/E (FWHM)	:	*1.0*	*1.0*	%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	*0.010*	*0.010*	μs
Beam intensity	:	*150*	*150*	A
Norm. emit. (1σ)	:	*< 300*	*< 300*	π mm-mrad

OTHER RELEVANT INFORMATION

* *BTF - Beam Test Facility. It is a branch line designed to work also in single electron mode.*

(1) SLAC type sections
(2) 0.0204 - 0.0065
(3) Equipped with RF pulse compression (SLED)
(4) Helmotz coils up to 55 MeV, FODO 2 m step up to 250 MeV (Positron converter position), solenoids around two accelerating sections downstream the positron converter, FODO tapered step (0.5 - 2m) up to the LINAC end 800 MeV.

The first section downstream the positron converter has an operating gradient of 25 MeV/m

POSITRON LINAC

Name of Linac : DAΦNE - LINAC
Function : *Positron Injector Linac per* DAΦNE *and for the* DAΦNE *BTF* *
Institution and address : *INFN LNF via E. Fermi 40 CP 13 00044 Frascati Italy*
Person in charge : *F. Sannibale*
Name of person supplying these data : *F. Sannibale*
e-mail : *sannibale@lnf.infn.it*
tel. : *+39 6 94032213* fax : *+39 6 94032256*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right. (1)

Primary Beam (e^-) at Conversion Target

Energy	:	MeV
Radius (1σ)	:	mm
Beam intensity	:	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*Tungsten with ~25% Rhenium*	
Type	:	*Removable*	
Thickness (rad.length)	:		χ
Diameter	:	*8 mm*	mm
Mean deposited power	:	*~ 150 W*	kW
Solenoidal field[a)]	:	*(2)*	
Matching device	:	*(3) 5 T Flux Concentrator*	
RF sections[a)]	:	*(4) 10 × 3 m*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.510*	*0.550*	GeV
Accel gradient	:	*18*	*25*	MeV/m
ΔE/E (FWHM)	:	*2.0*	*2.0*	%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	*0.010*	*0.010*	μs
Yield (fin.en)	:			e^+/e^- x GeV
Beam intensity	:	*0.036*	*0.036*	μA peak
Norm. emit. (1σ)	:	*< 3000*	*< 3000*	π mm-mrad

OTHER RELEVANT INFORMATION

* *BTF: Beam Test Facility. It is a branch line designed to work also in single electron mode.*

(1) Const. started : 1992
Present status : Starting commissioning
Cost of facility : 12 MUSD (1992)
Present linac staff : 10 man-years
Present yearly operation time : 0 h

(2) 1.2 T tapered field DC solenoid, 0.5 T DC solenoid over 7 m

(3) SLAC type.

(4) The first section downstream the positron converter has an operating gradient of 25 MeV / m. This section will work in a decelerating mode in order to increase the positron capture.

Between the second and the third accelerating section downstream the positron converter there is a magnetic separator where the electron beam is stopped.

ION LINAC

Name of Linac : *ALPI* *
Function : *Heavy Ion Linac*
Institution and address : *INFN - LNL via Romea 4-35020 Legnaro Italy*
Person in charge : *G. Fortuna*
Name of person supplying these data : *G. Fortuna*
e-mail : *fortuna@lnl.infn.it*
tel. : *+39 49 829 2442* fax : *+39 49 64 19 25*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *05/1994*
Present status : *Operational*
Cost of facility : *30 GITL*
Present linac staff : *10 man-years*
Present yearly operat. time : *2000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *Sputtering source*
Species of ions : *Stable isotopes 28 ≤ A ≤ 100*
Range of currents : *Up to 3 + 5* μAe
Range of output energies : *2 + 7* keV/u
Pulse length : *dc* μs; rep. rate : Hz
Normalized emittance (1σ) : *0.2(estimated)* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *16 MV XTU - Tandem* m
Output currents : *Up to 1* μAe
Output energies : *Up to 7000* keV/u
Frequency : *dc* MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : *0.5(estimated)* π mm-mrad

Longitudinal Matching

Type : *(1) 5-10 MHz DD Buncher, n°2 choppers*
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *(2)* m; N°. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range) : mm
Gap/cell length (range) :
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equil. phases : ; accel. rate MeV/u-m
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements : *29*
type : *Singlets-Triplets* order : *FDF*
Gradients : to *12* T/m
Other : *8 dipoles 3.2 T·m*

Charge Stripping (Typical)

Type(s) : *c foils 5 + 10 μg/cm²*
Charge states : *14* to *30* at *0.8-7* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	$^{28}S_I/Z_I$ ^{90}	$^{28}S_I/U$ ^{238}	
Energy	:	*20/10*	*20/6*	MeV/u
ΔE/E (FWHM)	:	*0.5*	*0.1*	%
Mean acc. rate	:			MeV/u-m
Beam current	:	*5 pnA*	*30 pnA*	μAe peak
Norm. emit. (1σ)	:	*0.5% (est.)*	*0.5*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *Acceleratore Lineare Per Ioni Superconducting Linac*

(1) n°2 ScQWRS Bunchers

(2) **Accelerating System**

Number and type of resonators : 52, QWR
RF frequency : 80 160 MHz ; Field mode : TEM
Q: 10^8÷10^9; Stored Energy : 64 -110 mJ/(MV/m)²
E_{peak}/E_{acc} : 4.5 + 5; Hp/Eq : 100 Gauss/MV/m
Active length : 18cm ; β opt : 0.11, 0.14, 0.055
TTF (β opt) : 0.92; Number of gaps: 2
Operating RF power per resonator at 4.5 K : 7 W
Average accelerating field : 2.5 - 5 MV/m
Phasing : all resonators independently phased
Number and type of cryostats : 13, vertical
Cryogenic plants : 1300 W at 4.5 K, 3900 W at 80K. Duty cycle : CW

Notes: we use three types of resonators namely, lead plated, Nb sheets, Nb sputtered based cavities

ELECTRON LINAC

Name of Linac : *ELETTRA 100 MeV*
Function : *Electron preinjector for ELETTRA Injector Linac, electron linac for FERMI*
Institution and address : *SINCROTRONE Trieste - Padriciano 99 34012 Trieste, Italy*
Person in charge : *G. D'Auria*
Name of person supplying these data : *C. Rossi* *G. D'Auria*
e-mail : *Carlo.Rossi@Elettra.Trieste.it* *Gerardo.Dauria@Elettra.Trieste.it*
tel. : *+39 40 375 8654,* fax : *+39 40 375 8565*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1991*
Present status : *Operating*
Cost of facility :
Present linac staff : *7 man-years*
Present yearly operation time : *4000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *4* MeV; intensity : *(2)* A
Pulse width, spacing : *(3)*
Normalized emittance (1σ) : *< 200* π mm-mrad

Acceleration System

Total linac length : *10.9* m
No. sections : *2* ; lengths : *3.2* m
Field mode : *2π/3* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *0.900* μs
v_g/c range : *(4)* ; Q : *14770*
Shunt impedance : *> 60* MΩ/m
Iris : aperture : diameter : *22.4 - 16.04* mm
thickness : mm
Attenuation/section : *0.6* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *(5)* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 4 MeV, a triplet at each section output, solenoids on the two accelerating sections.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *(2) 1 / 5+150 / 208+312*
No. of particles/bunch : *1.188 / 0.165 / 0.938* 10^9
Bunch separation : *(2)100 ms/2 ns/32+48 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.100*	*0.100*	GeV
Accel gradient	*15*	*15*	MeV/m
ΔE/E (FWHM)	*(6) ± 0.5*	*±0.5*	%
Rep. rate	*10*	*10*	Hz
Pulse length	*0.03 + 0.1*	*0.01 + 0.3*	μs
Beam intensity	*0.010*	*0.010*	A
Norm. emit. (1σ)	*< 200*	*< 200*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) Long. matching : 500 MHz Chopper and Pre-buncher, S band Prebuncher and Buncher

(2) The 100 MeV Trieste Linac can be operated in three different beam modes:
i) single bunch mode: one intense burst of electrons every 100ms (0.2nC in less that 1ns, 20 A peak);
ii) multibunch mode: a variable time length pulse from 10 to 300 ns which is normally used for injecting into ELETTRA (10mA at 300 ns);
the energy of the injection modes is kept at 100 MeV and the RF power requirements are 42MW 3 μs.
iii) FEL mode: a train of 2 ns electron pulses at a frequency variable from 20.8 to 31.2 MHz in a macropulse of 10 μs length at 10 Hz repetition rate. In the FEL mode the energy range is variable from 30 to 75 MeV, with a RF pulse up to 10 μs, 22.5 MW.

(3) 2ns/10+300ns/10μs, 100ms

(4) 0.0068 - 0.0196

(5) 22.5/45 (2)

(6) ± 0.6% measured in FEL mode at 30 MeV beam energy.

ELECTRON LINAC

Name of Linac : *ELETTRA INJECTOR LINAC* *
Function : *Electron injector for ELETTRA*
Institution and address : *SINCROTRONE Trieste - Padriciano 34012 Trieste, Italy*
Person in charge : *G. D'Auria*
Name of person supplying these data : *C. Rossi* *G. D'Auria*
e-mail : *Carlo.Rossi@Elettra.Trieste.it* *Gerardo.Dauria@Elettra.Trieste.it*
tel. : *+39 40 375 8654* fax : *+39 40 375 8565*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *7 man-years*
Present yearly operation time : *4000* h

LINAC PARAMETERS

Electron Sources

Types : ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *67* m
No. sections : *7* ; lengths : *6.15* m
Field mode : *3π/4* ; frequency : *2.998* GHz
Wave type : *BTW* ; filling time : *0.760* μs
v_g/c range : *0.026* ; Q : *11600*
Shunt impedance : *> 71* MΩ/m
Iris : aperture : diameter : *10* mm
thickness : *9.5 ÷ 10* mm
Attenuation/section : *0.61* Np
Power units, Number : *7* type : *(1) Klystron*
RF power peak : *45* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Same as ELETTRA 100 MeV up to 100 MeV, then solenoids on section 1 and triplets at the end of each section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *5 ÷ 75*
No. of particles/bunch : *$0.25\ 10^9$*
Bunch separation : *2 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*1.0*	*1.2*	GeV
Accel gradient	*25*	*27*	MeV/m
ΔE/E (FWHM)	*± 0.5*	*± 0.5*	%
Rep. rate	*10*	*10*	Hz
Pulse length	*0.03 ÷ 0.1*	*0.01 ÷ 0.15*	μs
Beam intensity	*0.020*	*0.020*	A
Norm. emit. (1σ)		*< 200*	π mm-mrad

OTHER RELEVANT INFORMATION

* *The ELETTRA Injector Linac is fed by the ELETTRA 100 MeV. A small bending magnet, located between the ELETTRA 100 MeV and the ELETTRA Injector Linac, allows to transfer the low energy beam to the FEL experimental hall.*
The operation modes of Injector Linac are the single bunch mode and the multibunch mode (see ELETTRA 100 MeV for more details).

(1) Equipped with RF pulse compression.

ELECTRON LINAC

Name of Linac : *MEA**
Function : *Electron Injector Linac for AmPS*
Institution and address : *NIKHEF, Kruislaan 409, 1098 SJ Amsterdam, Netherlands*
Person in charge : *L.H. Kuyer*
Name of person supplying these data : *F.B. Kroes*
e-mail : *Frans@nikhefk.nikhef.nl*
tel. : *+31 20 5922055* fax : *+31 20 5922165*

HISTORY AND STATUS

Const. started : *1975* ; first beam : *1978*
Present status : *Operating*
Cost of facility : *30 MFL (1975)*
Present linac staff : *15 man-years*
Present yearly operation time : *5500* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *400* keV
Beam intensity (peak) : *0.300* A
Normalized emittance (1σ) : *8* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *6* MeV; intensity : *0.060* A
Pulse width, spacing : *3.5 μs, 4 ms*
Normalized emittance (1σ) : *16* π mm-mrad

Acceleration System

Total linac length : *200* m
No. sections : *23* ; lengths : *7.35* m
Field mode : *2 π/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *1.3* μs
v_g/c range : *(2)* ; Q : *13750*
Shunt impedance : *56.5 - 48* MΩ/m
Iris : aperture : diameter : *32 - 17* mm
thickness : *5.84* mm
Attenuation/section : *0.825* Np
Power units, Number : *13* type : *Klystron*
RF power peak : *10* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Solenoïds up to 100 MeV
Quadruplet/2 sections up to 750 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.7*	*0.8*	GeV
Accel gradient	:	*5*	*7*	MeV/m
ΔE/E (FWHM)	:	*(3) <0.1*	*(3) <0.1*	%
Rep. rate	:	*150*	*250*	Hz
Pulse length	:	*2*	*3.5*	μs
Beam intensity	:	*0.040*	*0.060*	A
Norm. emit. (1σ)	:	*25*		π mm-mrad

OTHER RELEVANT INFORMATION

* *Medium Energy Electron Accelerator*

(1) S-band chopper, pre-buncher and buncher
(2) 0.0093 - 0.0389
(3) Energy Spectrum Compressor

Around 1990 the 500 MeV high duty factor (1%) electron linac MEA was upgraded to a 700 MeV low duty (0.1%) factor injector linac for AmPS (Amsterdam Pulse Stretcher).

References

[1] "High Duty Factor Electron Linear Accelerators"; J.Haimson, Lapostolle & Septier, Linear Accelerators, 1970. North Holland publishing Comp. Amsterdam.
[2] "Modification of MEA Modulator-klystron units enabling short pulse injection into a Pulse Stretcher Ring"; F.B. Kroes, E. Heine, IEEE Proc. of the Part. Acc.Conf., Chicago, March 20-23, 1989.
[3] "An Energy Compressor System (ECS) for AmPS"; J.G. Noomen, R.Maas, IEEE Proc. of the Part.Acc.Conf., Chicago, March 20-23, 1989.
[4] "Improvement of the 400 keV Linac Electron Source", F.B. Kroes et al., Proc. of the 3rd European Part. Acc. Conf., Berlin, March 24-28, 1992.

ELECTRON LINAC

Name of Linac : *FELIX* *
Function : *FEL-driver*
Institution and address : *FOM-"RYNHUIZEN", Edisonbaan 14, 3439 MN Nieuwegein, Netherlands*
Person in charge : *Dr. A. F. G. van der Meer*
Name of person supplying these data : *Dr. A. F. G. van der Meer*
e-mail : *meer@rijnh.nl*
tel. : *+31 306096999* fax : *+31 306031204*

HISTORY AND STATUS

Const. started : *06/1990* ; first beam : *05/1991*
Present status : *Operational*
Cost of facility : *8 MNLG (1990)*
Present linac staff : *3 man-years*
Present yearly operation time : *3000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *0.2* A
Normalized emittance (1σ) : *15* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *4.5* MeV; intensity : *0.2* A
Pulse width, spacing : *10 μs, 100 ms*
Normalized emittance (1σ) : *25* π mm-mrad

Acceleration System

Total linac length : *15* m
No. sections : *2* ; lengths : *3.15* m
Field mode : *2π/3* ; frequency : *2.9985* GHz
Wave type : *TW* ; filling time : *0.6* μs
v_g/c range : *0.01-0.02* ; Q : *12000*
Shunt impedance : *57* MΩ/m
Iris : aperture : diameter : *18-23* mm
thickness : mm
Attenuation/section : *0.41* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *4* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to end of 1st linac (25 MeV), triplet, solenoid around 2nd linac.

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch : 10^9
Bunch separation : *1 ns or 40 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.012-0.050*	*0.015-0.045*	GeV
Accel gradient	*10*	*10*	MeV/m
ΔE/E (FWHM)	*0.3-0.6*	*0.6*	%
Rep. rate	*5*	*10*	Hz
Pulse length	*9*	*20*	μs
Beam intensity	*0.17*	*0.2*	A
Norm. emit. (1σ)	*30*	*25*	π mm-mrad

OTHER RELEVANT INFORMATION

* *FELIX - Free Electron Laser for Infrared Experiments*

(1) 1 GHz pre-buncher, S-band buncher

References

[1] "A Low-Energy-Spread RF Accelerator for a Far-Infrared Free-Electron Laser", C.A.J. van der Geer et al., NIM A 334 (1993) 607-616.

ELECTRON LINAC

Name of Linac : *TEUFEL* *
Function : *Driver for Free-Electron-Laser* **
Institution and address : *University of Twente: Drienerlolaan 5; 7522 NB Enschede; the Netherlands*
Person in charge : *G.J. Ernst, J.W.J. Verschuur*
Name of person supplying these data : *J.W.J. Verschuur*
e-mail : *J.W.J.Verschuur@tn.utwente.nl*
tel. : *+31 53 489 3971* fax : *+31 53 489 1102*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *2 man-years*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *(1) RF gun* ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *0.65* m
No. sections : *1* ; lengths : *0.65* m
Field mode : *π/2* ; frequency : *1.3* GHz
Wave type : *SW* ; filling time : *4* μs
v_g/c range : ; Q : *16885*
Shunt impedance : *47.0* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
1 solenoid at position of cathode and first 2.5 cells with bucking coil to zero field at cathode

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *< 1200*
No. of particles/bunch : $< 4.4 \times 10^{10}$
Bunch separation : *12.31 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.006*	*0.007*	GeV
Accel gradient	:	*10 - 30*		MeV/m
ΔE/E (FWHM)	:	*0.5*		%
Rep. rate	:	*< 10*		Hz
Pulse length	:			μs
Beam intensity	:	*(2)*	*(2)*	A
Norm. emit. (1σ)	:	*5*		π mm-mrad

OTHER RELEVANT INFORMATION

* *Twente Eindhoven Urenco Free Electron Laser*
** *Injector for 25 MeV racetrack microtron*

(1) Photocathode
(2) 5 nC / bunch with a maximum of 7 nC / bunch

ELECTRON LINAC

Name of Linac : *S-20**
Function : *Research in Accelerator Technology, Testing of Accelerating structures*
Institution and address : *SINS **, 05-400 Otwock-Swierk, Poland*
Person in charge : *W. Maciszewski*
Name of person supplying these data : *W. Maciszewski*
e-mail : *sinsp10@cx1.cyf.gov.pl*
tel. : *+ 48 2 779 8632* fax : *+ 48 2 779 3481*

HISTORY AND STATUS

Const. started : *1995* ; first beam : *1996*
Present status : *under construction*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *30* keV
Beam intensity (peak) : *0.200* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2.50* m
No. sections : *1* ; lengths : *2.20* m
Field mode : *2π/3* ; frequency : *2.995* GHz
Wave type : *TW* ; filling time : *0.9* μs
v_g/c range : ; Q :
Shunt impedance : *18* MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *5* MW; mean : *3.5* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.022*		GeV
Accel gradient	*10*		MeV/m
ΔE/E (FWHM)			%
Rep. rate	*100*		Hz
Pulse length	*7*		μs
Beam intensity			A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* *Laboratory set-up*
** *SINS - Soltan Institute for Nuclear Studies*

More detailed data will be given after running up.

ION LINAC

Name of Linac : *LU-20 **
Function : *Ion Injector for Nuclotron*
Institution and address : *JINR LHE. 141980 Dubna, Moscow Region, Russia*
Person in charge : *V.A. Monchinsky*
Name of person supplying these data : *A.I. Govorov*
e-mail : *edik@sunhe.JINR.Dubna.SU.*
tel. : fax : *+7 7096 2165889*

HISTORY AND STATUS

Const. started : *02/1966* ; first beam : *11/1973*
Present status : *Operational*
Cost of facility : *15 MUSD (1995)*
Present linac staff : *10 man-years*
Present yearly operat. time : *2000 (1995)* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *LIS, EBIS*
Species of ions : *Ions up to Kr^{29+} Z/A > 1/3*
Range of currents : *(1)* μAe
Range of output energies : *3* keV/u
Pulse length : *5 - 150* μs; rep. rate : *0.2* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Accelerating tube 2.2* m
Output currents : *(2)* μAe
Output energies : *150* keV/u
Frequency : MHz; peak RF power : kW
Pulse length : *600* μs; rep. rate : *0.2* Hz
Normalized emittance (1σ) : *0.3* π mm-mrad

Longitudinal Matching

Type : *1 gap buncher*
Mod. *50* keV; drift *800* mm at *145* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *14.38* m; N°. of tanks : *1*
Tank diameters : *1.4* m
Number of drift-tubes : *57 + 2 (1/2)*
Drift-tube lengths : *56 - 316* mm
Drift-tube diam (range) : *133.5 to 110* mm
Gap/cell length (range) : *0.25; g/2 βλ*
Aperture diameter : *17* mm to *25* mm
RF frequency(ies) : *145* MHz
Field modes : *TM010*
Eff. shunt impedance : *16* MΩ/m
Q : *40000*
Filling time : *< 150* μs
Equil. phases : *-10°-25°*accel. rate *0.34* MeV/u-m
RF rep. rate : *0.5* Hz; pulse : *500* μs
Beam rate : *0.2* Hz; pulse : *5 - 400* μs
RF power peak : *5.0* MW; mean : *0.0005* MW

Focusing System

No. elements : *58*
type : *DC* order : *FODO*
Gradients : *65* to *9* T/m
Other :

Charge Stripping (Typical)

Type(s) : *C foil*
Charge states : *equil.* to *charge* at *5.0* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max. or Design	
Species :	*(3)*	*(4)*	
Energy :	*5.0*		MeV/u
ΔE/E (FWHM) :	*+ 0.25*		%
Mean acc. rate :	*0.34*		MeV/u-m
Beam current :	*(3)*	*(4)*	μAe peak
Norm. emit. (1σ) :	*3.5*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
p	*20 MeV*	*duoplas.*
d, α	*5 MeV/u*	*duoplas.*

OTHER RELEVANT INFORMATION

* *LHE JINR Ion Linac (LU-20)*

(1) for LIS : 200×10^3 μAe
for EBIS : 10 μAe

(2) for LIS : 40×10^3 μAe
for EBIS : 5 μAe

(3) for LIS : Species C^{4+}, Mg^{10+}
Beam Current 3×10^3

(4) for EBIS : Species Kr^{29+}
Beam Current 2

ELECTRON LINAC

Name of Linac : *RTM * Injector*
Function : *Nuclear Physics and Applied Research*
Institution and address : *Institute of Nuclear Physics, Moscow State University, 119899 Moscow, Russia*
Person in charge : *B.S. Ishkhanov*
Name of person supplying these data : *V.I. Shvedunov*
e-mail : *shved@cdfe.npi.msu.su*
tel. : *+7 095 939 2451* fax : *+7 095 939 0896*

HISTORY AND STATUS

Const. started : *1986* ; first beam : *1991*
Present status : *Operating*
Cost of facility : *3 MRUR (1991)*
Present linac staff : *5 persons*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic, DC* ; energy : *100* keV
Beam intensity (peak) : *0.016* A
Normalized emittance (1σ) : *2* π mm-mrad

Injector

Longitudinal matching : *Chopper-buncher*
Output : *0.1* MeV; intensity : $\leq 10^{-3}$ A
Pulse width, spacing : *17 ps, 408 ps*
Normalized emittance (1σ) : *2* π mm-mrad

Acceleration System

Total linac length : *7* m
No. sections : *6* ; lengths : *1* m
Field mode : *π/2* ; frequency : *2.45* GHz
Wave type : *SW* ; filling time : μs
v_g/c range : ; Q : *(1)*
Shunt impedance : *76* MΩ/m
Iris : aperture : diameter : *10* mm
thickness : *4* mm
Attenuation/section : Np
Power units, Number : *6* type : *Klystron*
RF power peak : MW; mean : *22* kW

Focusing System

Type, No. of elements, and spacing :
Solenoidal and quadrupole lenses

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *Continuous wave*
No. of particles/bunch : $\leq 2.5 \times 10^6$
Bunch separation : *408 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*(2) 0.0067*	*0.0115*	GeV
Accel gradient	*1.1*	*1.1*	MeV/m
ΔE/E (FWHM)	*0.3*	*0.5*	%
Rep. rate	2.45×10^9	2.45×10^9	Hz
Pulse length	*CW*	*CW*	μs
Beam intensity	$\leq 10^{-3}$	$\geq 2.5 \times 10^{-3}$	A
Norm. emit. (1σ)	*4*	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

* *RTM - Race Track Microtron*

Linac was built as injector to CW-RTM.

(1) 14500 unloaded
(2) Plans exist to increase beam energy to 11.5 MeV by beam acceleration in opposite direction, and to increase beam current to 2.5 mA by injection from high current 1.2 MeV booster Linac.

References

[1] Electron gun is described in:
B.S. Ishkhanov et al., Prib. Tekh. Exp. 3 (1987) 24

[2] Chopper-buncher system in:
A.S. Alimov et al., NIM A278 (1989) 379

[3] The whole linac description is in:
A.S. Alimov et al., NIM A326 (1993) 391

PROTON AND/OR H- LINAC

Name of Linac : *MMFL* *
Function : *Nuclear physics, Isotope production*
Institution and address : *INR, 117312 Moscow 60th Anniversary pr. 7A, Russia*
Person in charge : *S.K. Esin*
Name of person supplying these data: *P.N. Ostroumov*
e-mail : *OSTROUMOV@AL20.INR.TROITSK.RU*
tel. : fax : *+7 095 135 22 68*

HISTORY AND STATUS

Const. started : *1977* ; first beam : *1990*
Present status : *Operational*
Cost of facility : *130 MRUR (1989)*
Present linac staff : *170*
Present yearly operat. time : *3000* h

LINAC PARAMETERS

Ion Source

Type : *H^+ Duoplasmatron, H^- Dudnikov - type*
Output : *250H^+, 100 H^-* mA at *40H^+, 20H^-* keV
Pulse length : *100* μs; rep. rate : *100* Hz
Normalized emittance (1σ) : *0.5* π mm-mrad

Pre-accelerator (including RFQ)

Types : *Accelerating tube* ; lengths : *1.3* m
Output : *(1)* mA at *750* keV
Pulse length: *100* μs; rep. rate : *100* Hz
Normalized emittance (1σ) : *0.7* π mm-mrad

Longitudinal Matching

Type : *2 bunching cavities*
Mod. *12.5* keV; drift *1270* mm at *198.2* MHz
50.0 keV; drift *500* mm at *198.2* MHz

Accelerating System

Total linac length : *430* m; No. of tanks : *33*
Tank diameters : *1.05-0.89 0.46 - 0.40* m
Number of drift-tubes : *186 + 10 × 0.5*
Drift-tube lengths : *47.8 - 390.5* mm
Drift-tube diam (range): *150* mm
Gap/cell length (range): *0.242 - 0.3976*
Aperture diameter : *15 - 28* mm to *38* mm
RF frequency(ies) : *198.2 991.0* MHz
Field modes : *TM010 TM020*
Eff. shunt impedance : *33-20 22-40* MΩ/m
Q *64000-50000 17000-29000*
Filling time : *100 10* μs
Equilibrium phases : *37-26 33*
RF rep. rate : Hz; pulse : μs
Beam rate : *100* Hz; pulse : *80* μs
RF power peak : *110.0* MW; mean : *1.2* MW

Focusing System

No. elements : *434*
type : *Quadrupoles* order : *FODO/FDO*
Gradients : *60* to *20* T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy :	*423*	*600*	MeV
Mean acc. rate :	*1.4*	*1.4*	MeV/m
ΔE/E (FWHM) :	*0.9*	*0.8*	%
Beam current :	*20.0*	*50.0*	mA peak
Norm. emit. (1σ) :	*0.8*	*1.5*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Moscow Meson Factory Linac*

(1) 90H^+, 20H^-

Part I - post coupled Alvarez linac structure.
Part II - disc and washer linac structure.

Proton stretcher - compressor ring is under construction (Energy - 600 MeV, circulating current - 11 A, orbit circumference - 106.7 m, duty factor - max 98 %, min 10^{-3} %, rep. rate 100 Hz).

References

[1] V.D.Burlakov et.al, Proc. of the 1984 Linac Conf. Seeheim, Germany, p 9-13.

PROTON AND/OR H- LINAC

Name of Linac : *ISTRA-36* *
Function : *Driver for Subcritical Test Facility; Production of Radionuclides*
Institution and address : *Inst. for Theoretical and Experimental Physics, 117259, Moscow, Russia*
Person in charge : *A. Kozodaev*
Name of person supplying these data : *A. Kozodaev*
e-mail : *kozodaev@rØ2vax.itep.ru*
tel. : *+7 095 123 0292* fax : *+7 095 123 6584*

HISTORY AND STATUS

Const. started : *1982* ; first beam : *19/09/1989*
Present status : *Assembled*
Cost of facility : *2 MUSD (1992)*
Present linac staff : *6*
Present yearly operat. time : h

LINAC PARAMETERS

Ion Source

Type : *Cold cathode duoplasmatron*
Output : *300 - 400* mA at *82* keV
Pulse length : *5-150* μs; rep. rate : *0.5-25* Hz
Normalized emittance (1σ) : *0.5* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4-vane RFQ* ; lengths : *4.6* m
Output : *150* mA at *3000* keV
Pulse length: *5-150* μs; rep. rate : *0.5-25* Hz
Normalized emittance (1σ) : *0.8* π mm-mrad

Longitudinal Matching

Type : *It is not necessary*
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *16* m; No. of tanks : *2*
Tank diameters : *0.65; 0.63* m
Number of drift-tubes : *33 + 2 (1/2); 54 + 2 (1/2)*
Drift-tube lengths : *68-100; 123-193* mm
Drift-tube diam (range): *100; 85* mm
Gap/cell length (range): *0.18-0.25; 0.18-0.29*
Aperture diameter : *18* mm to *18* mm
RF frequency(ies) : *297* MHz
Field modes : *TM010*
Eff. shunt impedance : *28; 38* MΩ/m
Q : *35000; 36000*
Filling time : μs
Equilibrium phases : *-50° to -37°; -37° to -30°*
RF rep. rate : *0.5 - 25* Hz; pulse : *230* μs
Beam rate : *0.5 - 25* Hz; pulse : *5 - 150* μs
RF power peak : *7.3* MW; mean : MW

Focusing System

No. elements : *91*
type : *Quadrupole* order : *FODO*
Gradients : *60* to *23.6* T/m
Other : *$SmCo_5$ quadrupoles*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Energy	:	*36*		MeV
Mean acc. rate	:	*2*		MeV/m
ΔE/E (FWHM)	:	*1.2*		%
Beam current	:	*150*	*200*	mA peak
Norm. emit. (1σ)	:	*1.5*		π mm-mrad

OTHER RELEVANT INFORMATION

* *ISTRA-36 (ITEP Proton Linac)*

RFQ RF frequency 148. 5 MHz

Drift-tubes are open to vacuum

Ion channel will be between DTL tanks

RFQ and tank No.1 (DTL-10MeV) have launched at 150mA, 5μs, 1 Hz

References

[1] Description of the ISTRA-36 see in Proc. of 1990 Linac Conf., p.776 and Proc. of 1994 Linac Conf., p.128.

ION LINAC

Name of Linac : *I-2* *
Function : *Injector of 10 GeV PS*
Institution and address : *Inst. for Theoretical and Experimental Physics, 117259, Moscow, Russia*
Person in charge : *N.V. Lazarev*
Name of person supplying these data : *N.V. Lazarev*
e-mail : *Skachkov_v@cl.itep.ru*
tel. : fax : *+7 95 123 6584*

HISTORY AND STATUS

Const. started : *1962* ; first beam : *1966*
Present status : *Injector of 10 GeV PS*
Cost of facility : *4 MUSD*
Present linac staff : *8 for shifts + 6 for service*
Present yearly operat. time : *5500* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *Cold cathode duoplasmatron*
Species of ions : *p*
Range of currents : *2×10^6* μAe
Range of output energies : *15* keV/u
Pulse length : *20 - 25* μs; rep. rate : *2* Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *750 kV acc. column 2.3* m
Output currents : *1.2×10^6* μAe
Output energies : *703* keV/u
Frequency : MHz; peak RF power : kW
Pulse length : *20 - 25* μs; rep. rate : *2* Hz
Normalized emittance (1σ) : *8* π mm-mrad

Longitudinal Matching

Type : *One-gap buncher*
Mod. *30* keV; drift *850* mm at *148.5* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *6 +* m; N°. of tanks : *2*
Tank diameters : *1.37* m
Number of drift-tubes : *1/2+18+1/2 1/2+33+1/2*
Drift-tube lengths : *137 - 313, 190 -314* mm
Drift-tube diam (range) : *190 - 150, 150* mm
Gap/cell length (range) : *0.2 - 0.3; 0.16 - 0.3*
Aperture diameter : *20* mm to *25* mm
RF frequency(ies) : *148.5* MHz
Field modes : *E010*
Eff. shunt impedance : *22* MΩ/m
Q : *65000 - 70000*
Filling time : *150* μs
Equil. phases : *37°* ; accel. rate *1.35* MeV/u-m
RF rep. rate : *2* Hz; pulse : *300* μs
Beam rate : *2* Hz; pulse : *15 - 20* μs
RF power peak : *1.0+2.0* MW; mean : *0.002* MW

Focusing System

No. elements : *37 + 68*
type : *dc* order : *FOD, FOFDOD*
Gradients : *55* to *18* T/m
Other : *Each drift tube contains 2 lenses of opp. signs*

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Species	:	*p*		
Energy	:	*24.6*	*24.6*	MeV/u
ΔE/E (FWHM)	:	*1.0*	*0.8*	%
Mean acc. rate	:	*1.3*	*1.3*	MeV/u-m
Beam current	:	*0.18-0.2×10^6*	*0.23×10^6*	μAe peak
Norm. emit. (1σ)	:	*10*	*8*	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
He_4^{2+}	*24.6 MeV/n*	

OTHER RELEVANT INFORMATION

* *I-2 (Injector the 2nd)*

(1) Cold cathode duoplasmatron ion source with pulse exhaust valve.
(2) Used 750 kV pulse (1ms) transformer.
(3) Acc. period is $2\beta\lambda$ in the 1st cavity and $\beta\lambda$ in the 2nd cavity.

References

[1] "Pribory i Technika Eksperimenta" N5, p. 9-70, 1967

[2] Proc. of the 6th Int. Conf. on High Energy Accelerators, 1967 p. A_1- A_3, A_{30}- A_{31}

ION LINAC

Name of Linac : *ITEP* *
Function : *Prototype of Driver for Heavy Ion Fusion*
Institution and address : *Inst. for Theoretical and Experimental Physics, 117259, Moscow, Russia*
Person in charge : *Kulevoy T.V.*
Name of person supplying these data : *Kulevoy T.V.*
e-mail : *Kulevoj@mvax3.itep.ru*
tel. : fax : *+7 125 65 84*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1986*
Present status : *Operational*
Cost of facility :
Present linac staff : *4 man-years*
Present yearly operat. time : *500 (1995)* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *MEVVA*
Species of ions : Cu^{+}, Mo^{3+}, Ta^{3+}, W^{3+}, U^{4+}
Range of currents : *Up to 100000* μAe
Range of output energies : *1.3* keV/u
Pulse length : *400* μs; rep. rate : *1* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *RFQ, 12* m
Output currents : *15000* μAe
Output energies : *36* keV/u
Frequency : *6.19* MHz; peak RF power : *3000* kW
Pulse length : *600* μs; rep. rate : *0.25* Hz
Normalized emittance (1σ) : *0.3* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : m; N°. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range) : mm
Gap/cell length (range) :
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equil. phases : ; accel. rate MeV/u-m
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other :

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :	*(1)*		
Energy :	*0.036*		MeV/u
ΔE/E (FWHM) :	*4*		%
Mean acc. rate :	*0.003*		MeV/u-m
Beam current :	*<15 000*		μAe peak
Norm. emit. (1σ) :	*0.3*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *ITEP Heavy Ion Linac (TIPr-1)*

(1) Any metal ions with mass-to-charge rate about 60.

ELECTRON LINAC

Name of Linac : *Linac-60 RRC (FAKEL)*
Function : *Electron and neutron source for physical research*
Institution and address : *RRC Kurchatov Institute 123182 Moscow Russia*
Person in charge : *V.V. Petrenko*
Name of person supplying these data : *V.V. Kalachnikov*
e-mail : *kalach@fakel.ssspi.msk.ru*
tel. : *+7 095 196 77 42* fax : *+7 095 196 59 73*

HISTORY AND STATUS

Const. started : *1963* ; first beam : *12/1973*
Present status : *Operating*
Cost of facility : *10 MRUR (1973)*
Present linac staff : *22 man-years*
Present yearly operation time : *3200* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *100* keV
Beam intensity (peak) : *3* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Inflector and buncher (2m)*
Output : *4* MeV; intensity : *1.5* A
Pulse width, spacing : *1-5 μs*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *5* ; lengths : *2* m
Field mode : *2π/3* ; frequency : *1.818* GHz
Wave type : *TW* ; filling time : *0.3* μs
v_g/c range : *0.03 - 0.01* ; Q :
Shunt impedance : *50 - 40* MΩ/m
Iris : aperture : diameter : *47 - 33* mm
thickness : *6* mm
Attenuation/section : *0.13* Np
Power units, Number : *6* type : *Klystron*
RF power peak : *30* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid up to 4 MeV, 3 doublets after 1, 3 and 5 sections

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.054*	*0.060*	GeV
Accel gradient	:	*5*	*6*	MeV/m
ΔE/E (FWHM)	:	*8*	*6*	%
Rep. rate	:	*150*	*150*	Hz
Pulse length	:	*4.2*	*5.5*	μs
Beam intensity	:	*0.8*	*1*	A
Norm. emit. (1σ)	:			π mm-mrad

OTHER RELEVANT INFORMATION

In particular, one of targets (breeding target) is used with neutron multiplication coefficient of 5. The target can operate with electron beam up to 100 kW. The target is equipped with path lengths with length of several metres.

ELECTRON LINAC

Name of Linac : *VEPP-5 Pre-injector*
Function : *Pre-injector*
Institution and address : *Budker INP *, Novosibirsk 630090, Russia*
Person in charge : *A.V. Novokhatski*
Name of person supplying these data : *P.V. Logatchev*
e-mail : *logatchov@inp.nsk.su*
tel. : *+7 3832 359583* fax : *+7 3832 352163*

HISTORY AND STATUS

Const. started : *1988* ; first beam :
Present status : *Under construction*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic gun* ; energy : *200* keV
Beam intensity (peak) : *10* A
Normalized emittance (1σ) : *100* π mm-mrad

Injector

Longitudinal matching :
Output : *510* MeV; intensity : *1000* A
Pulse width, spacing : *20 ps, 20 ms*
Normalized emittance (1σ) : *15* π mm-mrad

Acceleration System

Total linac length : *70* m
No. sections : *14* ; lengths : *3* m
Field mode : *TM01* ; frequency : *2.856* GHz
Wave type : *(1) TW* ; filling time : *0.5* μs
v_g/c range : *0.02* ; Q : 1.3×10^4
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : *25.9 : 83.8* mm
thickness : *6* mm
Attenuation/section : *(2)* Np
Power units, Number : *4* type : *5045 Klystron*
RF power peak : *63* MW; mean : *45* kW

Focusing System

Type, No. of elements, and spacing :
2 solenoids
FODO 31 el., spacing 1700 mm

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : 10^{11}
Bunch separation : *20 ms*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.510*	*0.510*	GeV
Accel gradient	:	*18*	*18*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	2×10^{-5}	2×10^{-5}	μs
Beam intensity	:	*1000*	*1000*	A
Norm. emit. (1σ)	:		*15*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Institute for Nuclear Physics*

(1) $2\pi/3$
(2) $0.11\ Np/m$

POSITRON LINAC

Name of Linac : *VEPP-5 pre-injector*
Function : *Pre-injector*
Institution and address : *Budker INP *, Novosibirsk 630090, Russia*
Person in charge : *A.V. Novokhatski*
Name of person supplying these data : *P.V. Logatchev*
e-mail : *logatchov@inp.nsk.su*
tel. : *+7 3832 359583* fax : *+7 3832 352163*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*300*	MeV
Radius (1σ)	:	*0.5*	mm
Beam intensity	:	*1000*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*Tungsten (W)*	
Type	:	*Solid*	
Thickness (rad.length)	:	*2.5*	χ
Diameter	:	*3*	mm
Mean deposited power	:	*0.016*	kW
Solenoidal field[a)]	:	*0.5*	
Matching device	:	*AD*	
RF sections[a)]	:	*25 MeV/m*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.510*	*0.510*	GeV
Accel gradient	:	*18*	*18*	MeV/m
ΔE/E (FWHM)	:	*3*	*3*	%
Rep. rate	:	*50*	*50*	Hz
Pulse length	:	2×10^{-5}	2×10^{-5}	μs
Yield (fin.en)	:	*0.05*	*0.05*	e^+/e^- x GeV
Beam intensity	:	*5 x 10 7*	*5 x 10 7*	μA peak
Norm. emit. (1σ)	:	*(1)*	*(1)*	π mm-mrad

OTHER RELEVANT INFORMATION

(1) 25 π mm-mrad

PROTON AND/OR H- LINAC

Name of Linac : *I-100*
Function : *Fixed target*
Institution and address : *IHEP, 142284, Protvino, Moscow Region, Russia*
Person in charge : *V.A. Teplyakov*
Name of person supplying these data : *Maltsev A.P.*
e-mail : *zherebtsov@vx.olu.decnet.ihep.su*
tel. : fax : *+95 230 23 37*

HISTORY AND STATUS

Const. started : *1961* ; first beam : *11/1966*
Present status : *Operational*
Cost of facility :
Present linac staff : *8 man-years*
Present yearly operat. time : *1000 (1994)* h

LINAC PARAMETERS

Ion Source

Type : *Plasma accelerator*
Output : *300* mA at *700* keV
Pulse length : *300* μs; rep. rate : *1* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Pre-accelerator (including RFQ)

Types : *Pulse transf.* ; lengths : *2.2* m
Output : *300* mA at *700* keV
Pulse length: *300* μs; rep. rate : *1* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Longitudinal Matching

Type : *One buncher system*
Mod. *25.4* keV; drift *995* mm at *148.5* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *80* m; No. of tanks : *3*
Tank diameters : *1.32; 1.22; 1.08* m
Number of drift-tubes : *(1)*
Drift-tube lengths : *(2)* mm
Drift-tube diam (range): *232 - 100* mm
Gap/cell length (range): *0.185 - 0.277*
Aperture diameter : *20* mm to *40* mm
RF frequency(ies) : *148.5* MHz
Field modes : *E010*
Eff. shunt impedance : *25 - 15* MΩ/m
Q : *72000; 50000; 36000*
Filling time : *< 100* μs
Equilibrium phases : *-37° to 50°*
RF rep. rate : *1* Hz; pulse : *400* μs
Beam rate : *1* Hz; pulse : *100* μs
RF power peak : *10* MW; mean : *0.004* MW

Focusing System

No. elements : *163*
type : *Pulsed* order : *FODO*
Gradients : *60* to *4* T/m
Other : *Pulsed flat top (250 μs)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*38;74;103*		MeV
Mean acc. rate	*1.25*		MeV/m
ΔE/E (FWHM)	*0.45*		%
Beam current	*≤ 100*		mA peak
Norm. emit. (1σ)	*2*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 93+2 (1/2); 41+2 (1/2); 26+2 (1/2)
(2) 62 - 413; 456 - 537; 586 - 624

Alvarez linac structure.

Proton injector for IHEP Acclerator complex in 1967-1983.

PROTON AND/OR H- LINAC

Name of Linac : *URAL-30*
Function : *Proton Injector for IHEP Accelerator Complex*
Institution and address : *IHEP, 142284, Protvino, Moscow region, Russia*
Person in charge : *V.A. Teplyakov*
Name of person supplying these data : *A.P. Maltsev*
e-mail : *ZKEREBTSOV@VX.OLU.DECNET.IHEP.SU*
tel. : fax : *+7 095 230 23 37*

HISTORY AND STATUS

Const. started : *07/1973* ; first beam : *11/1983*
Present status : *Operational*
Cost of facility :
Present linac staff : *7 man-years*
Present yearly operat. time : *1080 (1995)* h

LINAC PARAMETERS

Ion Source

Type : *Plasma accelerator*
Output : *200-250* mA at *100* keV
Pulse length : *5-10* μs; rep. rate : *16.6* Hz
Normalized emittance (1σ) : *0.1 - 0.15* π mm-mrad

Pre-accelerator (including RFQ)

Types : *2H RFQ* ; lengths : *4.1* m
Output : *100* mA at *1980* keV
Pulse length: *5-10* μs; rep. rate : *16.6* Hz
Normalized emittance (1σ) : *0.8* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *21.3* m; No. of tanks : *2*
Tank diameters : *0.42 ; 0.42* m
Number of drift-tubes : *65 ; 57*
Drift-tube lengths : *9.7 - 97.5 ; 50.8 - 89.6* mm
Drift-tube diam (range): *34.4 ; 37.4* mm
Gap/cell length (range):
Aperture diameter : *19* mm to *22* mm
RF frequency(ies) : *148.5* MHz
Field modes : *Longitudinal magnetic field*
Eff. shunt impedance : *120 - 10* MΩ/m
Q : *15000*
Filling time : *< 30* μs
Equilibrium phases : *-30° ; -30°*
RF rep. rate : *16.6* Hz; pulse : *5-10* μs
Beam rate : *16.6* Hz; pulse : *5-10* μs
RF power peak : *10* MW; mean : *0.004* MW

Focusing System

No. elements : *122*
type : *RFQ* order : *FFDD*
Gradients : *337 kV/cm²* to T/m
Other : *Space-periodic RFQ focusing system*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*30*		MeV
Mean acc. rate	*1.3*		MeV/m
ΔE/E (FWHM)	*± 0.35*		%
Beam current	*50 - 70*	*100*	mA peak
Norm. emit. (1σ)	*2.5*		π mm-mrad

OTHER RELEVANT INFORMATION

Space-periodic radio-frequency quadrupole focusing system.

H^- resonator; RFQ : $2H^-$ resonator.

Linac parameters described at EPAC 1988.

ELECTRON LINAC

Name of Linac : *Electron Linear Accelerator LU-50*
Function : *
Institution and address : *Russian Federal Nuclear Center* **
Person in charge : *Yu.A. Khokhlov*
Name of person supplying these data : *N.V. Zavyalov*
e-mail : *zavyalov@expd.rfnc.nnov.su*
tel. : *+7 83 130 17072* fax : *+7 83 130 58269*

HISTORY AND STATUS

Const. started : *1976* ; first beam : *1981*
Present status : *Operating*
Cost of facility : *3 MUSD (1996)*
Present linac staff : *6 man-years*
Present yearly operation time : *1500* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *50* keV
Beam intensity (peak) : *0.0024* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *29* m
No. sections : *1-2* ; lengths : *3.795* m
Field mode : *2π/3* ; frequency : *1.818* GHz
Wave type : *TW* ; filling time : *0.9* μs
v_g/c range : *0.013* ; Q : *(1) 12000*
Shunt impedance : *80* MΩ/m
Iris : aperture : diameter : *38.082 - 33.00* mm
thickness : *5* mm
Attenuation/section : *0.32* Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *30* MW; mean : *100* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	*0.065*	*0.075*	GeV
Accel gradient :	*8.6*	*10*	MeV/m
ΔE/E (FWHM) :	*20*	*20*	%
Rep. rate :	*2400*	*2400*	Hz
Pulse length :	*0.01*	*0.01*	μs
Beam intensity :	*0.00024*	*0.00024*	A
Norm. emit. (1σ) :	*6.5*	*6.5*	π mm-mrad

OTHER RELEVANT INFORMATION

* *Electron Linac for neutron spectrometry with time-of-flight method in an energy range from few hundreds keV to few tens MeV.*

** *All Russia Scientific Research Institute of Experimental Physics (RFNC-VNIIEF), 607190 Sarov (Arzamas-16), Nizhnii Novgorod Region, Russia.*

(1) Maximum value

At the present time the linac Lu-50 is widely used for investigation of nuclear reactions which are induced by fast neutrons.

References

[1] *Yu.A. Khokhlov, N.V. Zavyalov, I.A. Ivanin et al., "Linear accelerator of All-Union Scientific Research Institute of Experimental Physics for neutron spectrometry". Nuclear Data for Science Technology. Proceedings of an International Conference, held at the Forschungszentrum Jülich, Fed. Rep. of Germany, 13-17 May 1991, p.487-489.*

[2] *Report on Linac96 "Electron Linear Accelerators of RFNC-VNIIEF", N.V. Zavyalov and etc.*

ELECTRON LINAC

Name of Linac : *Electron Linear Accelerator LU-10-20*
Function : *Electron Linac for support and development of new radiation technologies*
Institution and address : *Russian Federal Nuclear Center* *
Person in charge : *N.V. Zavyalov*
Name of person supplying these data : *N.V. Zavyalov*
e-mail : *zavyalov@expd.rfnc.nnov.su*
tel. : *+7 83 130 17072* fax : *+7 83 130 58269*

HISTORY AND STATUS

Const. started : *1992* ; first beam : *1994*
Present status : *Operating*
Cost of facility : *750 000 USD (1996)*
Present linac staff : *4 man-years*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *40* keV
Beam intensity (peak) : *0.005* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *3* m
No. sections : *1* ; lengths : *1.65* m
Field mode : *2π/3* ; frequency : *1.818* GHz
Wave type : *TW* ; filling time : *0.54* μs
v_g/c range : *(1)* ; Q : *(2) 12000*
Shunt impedance : *6 - 58.3* MΩ/m
Iris : aperture : diameter : *27.53 - 47.5* mm
thickness : *6.23* mm
Attenuation/section : Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *6* MW; mean : *22* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.008*	*0.009*	GeV
Accel gradient	:	*7*	*8*	MeV/m
ΔE/E (FWHM)	:	*10*	*10*	%
Rep. rate	:	*1000*	*1000*	Hz
Pulse length	:	*0.002-0.005*	*0.004*	μs
Beam intensity	:	*1.5*	*0.0015*	A
Norm. emit. (1σ)	:	*10*	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

* *All Russia Scientific Research Institute of Experimental Physics (RFNC-VNIIEF), 607190 Sarov (Arzamas-16), Nizhnii Novgorod Region, Russia*

(1) 0.0065 - 0.027
(2) Maximum value

At the present time the linac Lu-50 is widely used for investigation of nuclear reactions which are induced by fast neutrons.

References

[1] Report on Linac96 "Electron Linear Accelerators of RFNC-VNIIEF", N.V. Zavyalov and etc.

ELECTRON LINAC

Name of Linac :
Function : *Electron Injector Linac for Synchrotron Radiation Source*
Institution and address : *Laboratori del Sincrotrò de Barcelona,* *
Person in charge :
Name of person supplying these data : *M. Pont*
e-mail : *mpont@ifae.es*
tel. : *+34 3 581 2832* fax : *+34 3 581 7302*

HISTORY AND STATUS

Const. started : ; first beam :
Present status :
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : m
No. sections : ; lengths : m
Field mode : ; frequency : GHz
Wave type : ; filling time : μs
v_g/c range : ; Q :
Shunt impedance : MΩ/m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : MW; mean : kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :			GeV
Accel gradient :			MeV/m
ΔE/E (FWHM) :			%
Rep. rate :			Hz
Pulse length :			μs
Beam intensity :			A
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

* *Vila Universitària G-002, 06193 Bellaterra, Spain*

We are in the design stage of the future Synchrotron Radiation Source in Barcelona (Spain), but right now we cannot produce specific data on the Linac that will be used at LSB.

ELECTRON LINAC

Name of Linac : *LIL* *
Function : *Electron Injector Linac for LEP* **
Institution and address : *CERN, 1211 Geneva 23, Switzerland*
Person in charge : *L. Rinolfi*
Name of person supplying these data : *J:P: Potier*
e-mail : *POTIER@cernvm.cern.ch*
tel. : *+41 22 767 2584* fax : *+41 22 767 8510*

HISTORY AND STATUS

Const. started : *1982* ; first beam : *1986*
Present status : *Operating*
Cost of facility : *32.5 MSF (1987)*
Present linac staff : *9 man-years*
Present yearly operation time : *5800* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *< 0.3* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *4* MeV; intensity : *0.150* A
Pulse width, spacing : *10 ns, 10 ms*
Normalized emittance (1σ) : *< 200* π mm-mrad

Acceleration System

Total linac length : *101* m
No. sections : *16* ; lengths : *4.5* m
Field mode : *2π/3* ; frequency : *2.9986* GHz
Wave type : *TW* ; filling time : *1.2* μs
v_g/c range : *(2)* ; Q : *14900*
Shunt impedance : *63-74* MΩ/m
Iris : aperture : diameter : *(3) 25.0-18.0* mm
thickness : *5.0* mm
Attenuation/section : *0.844* Np
Power units, Number : *4* type : *(4) Klystrons*
RF power peak : *35* MW; mean : *19* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 4 MeV; a triplet at 4 MeV and between sections to 200 MeV; a quadruplet at 200 MeV. FODO from 200 MeV to 500 MeV.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *30*
No. of particles/bunch : 2×10^8
Bunch separation : *330 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	*0.5*	*0.75*	GeV
Accel gradient :	*9.2*	*12.0*	MeV/m
ΔE/E (FWHM) :	*1.0*	*1.0*	%
Rep. rate :	*100*	*100*	Hz
Pulse length :	*0.01*	*0.01*	μs
Beam intensity :	*0.060*	*0.060*	A
Norm. emit. (1σ) :	*80*	*<< 600*	π mm-mrad

OTHER RELEVANT INFORMATION

* *LIL - LEP Injector Linac*
** *LEP - Large Electron Positron Collider*

(1) S-band pre-buncher and buncher
(2) 0.0075 - 0.022
(3) 1-2% larger in the 2nd - 4th sections
(4) 2 equipped with RF pulse compression (LIPS)

Lepton production for the Electron-Positron Accumulator (EPA) at 500 MeV uses 2 linacs in series. For e^-, LIL runs at low charge. After passing through a 2mm hole in the e^+/e^- converter target (at 200 MeV) the e^- beam is accelerated another 300 MeV by 8 of the 12 sections.
For e^+, LIL provides a high intensity 200 MeV e^- beam at the converter target with 4 sections. Then 12 sections accelerate the positrons, captured at 4 MeV, to 500 MeV.

References

[1] "LEP Injector Linacs", J.H.B. Madsen, CERN/PS 89-56

[2] "Parameters of the LEP Injector Linacs", D. Blechschmidt, D. Warner, CERN/PS 88-07

[3] " A new front-end for the LEP Injector Linac", J.C. Godot, L. Rinolfi, A. Pisent, H. Braun, IEEE 1991 PAC (San Francisco) and CERN/PS 91-19 (LP)

POSITRON LINAC

Name of Linac : *LIL**
Function : *Positron Injector Linac for LEP***
Institution and address : *CERN, 1211 Geneva 23, Switzerland*
Person in charge : *L. Rinolfi*
Name of person supplying these data : *J.P. Potier*
e-mail : *potier@cernvm.cern.ch*
tel. : *+41 22 767 2584* fax : *+41 22 767 8510*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	*200*	MeV
Radius (1σ)	:	*0.4*	mm
Beam intensity	:	*1.4*	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	*W in Cu matrix*	
Type	:	*Stationary*	
Thickness (rad.length)	:	*2.0*	χ
Diameter	:	*5*	mm
Mean deposited power	:	*0.6*	kW
Solenoidal field[a)]	:	*0.36 T over 9 m ; DC field*	
Matching device	:	*(1)*	
RF sections[a)]	:	*(2)*	

[a)] key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right. (3)

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.5*	*0.65*	GeV
Accel gradient	:	*9.2*	*12.0*	MeV/m
ΔE/E (FWHM)	:	*1.0*	*1.0*	%
Rep. rate	:	*100*	*100*	Hz
Pulse length	:	*0.025*	*0.025*	μs
Yield (fin.en)	:	*(4)*	*3.0×10^{-2}*	e^+/e^- x GeV
Beam intensity	:	*5000*	*11000*	μA peak
Norm. emit. (1σ)	:	*2800*	*2300*	π mm-mrad

OTHER RELEVANT INFORMATION

* *LIL - LEP Injector Linac*
** *LEP - Large Electron Positron Collider*

(1) Quarter Wave Transformer; λ /4, 0.85 T pulsed solenoïd
(2) Decelerating mode at the capture. Gradient : 9.5 MV/m
(3) 12 sections powered by 4 klystrons, 2 of which are equipped with RF pulse compression.

Two solenoïds, 0.36 T, on the first 2 accelerator sections, 1 quadrupole doublet, 4 independent matching quadrupoles, followed by a 32-quadrupole FODO lattice.

(4) 2.5×10^{-2}. The yield is given within an energy spread of ± 1%.

References

[1] "New Optics of the LEP Injector Linac for e^+ Production". C. Bourat, H. Braun, L. Rinolfi, EPAC94 (London) and CERN/PS 94-18 (LP).

ELECTRON LINAC

Name of Linac : *CTF* *
Function : *Test facility for a linear collider (CLIC **)*
Institution and address : *CERN, 1211 Geneva 23, Switzerland*
Person in charge : *J. Madsen*
Name of person supplying these data : *L. Rinolfi*
e-mail : *rinolfi@ps.msm.cern.ch*
tel. : *+41 22 767 20 07* fax : *+41 22 767 85 10*

HISTORY AND STATUS

Const. started : *07/1989* ; first beam : *12/1990*
Present status : *(1)*
Cost of facility :
Present linac staff : *4*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *RF gun* ; energy : *4500* keV
Beam intensity (peak) : *100* A
Normalized emittance (1σ) : *20* π mm-mrad

Injector

Longitudinal matching : *No*
Output : *50* MeV; intensity : *100* A
Pulse width, spacing : *10 ps, 100 ms*
Normalized emittance (1σ) : *20* π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *(2) 2* ; lengths : *0.28* m
Field mode : *2π/3* ; frequency : *30* GHz
Wave type : *TW* ; filling time : *0.011* μs
v_g/c range : *0.082* ; Q : *4220*
Shunt impedance : *110* MΩ/m
Iris : aperture : diameter : *4* mm
thickness : *0.5* mm
Attenuation/section : *0.25* Np
Power units, Number : *(3) 1* type : *RF sections*
RF power peak : *80* MW; mean : *(4)* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid at 4 MeV.
Doublet structure between 45 MeV and the end of linac.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *(5) 1 - 2*
No. of particles/bunch : 8×10^9
Bunch separation : *0.33 - 10 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.095*	*0.320 (2)*	GeV
Accel gradient	:	*80*	*80*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*10*	*10*	Hz
Pulse length	:	10×10^{-6}	10×10^{-6}	μs
Beam intensity	:	*100*	*100*	A
Norm. emit. (1σ)	:	*20*	*20*	π mm-mrad

OTHER RELEVANT INFORMATION

* *CLIC Test Facility*
** *CLIC - Compact Linear Collider*

(1) CTF1 ran from 1990 until 1995
CTF2 will start in July 1996
(2) It is foreseen to install later on 10 more 30 GHz sections in order to achieve 320 MeV
(3) The power units consist of one RF decelerating structure where a drive beam (high charge, short pulses) generates the 30 GHz. This structure feeds 2 accelerating structures.
(4) 9.6×10^{-3}
(5) Figures are given for the Main beam. For the drive beam, they will be:
Nb of bunches/pulse : 48
Nb of particles/bunch : 1.3×10^{11}
Bunch separation : 333 ps

Reference

[1] "CTF2 Design Report", The CLIC Study Group, CLIC Note 304 - CERN PS 96-14 (LP).

PROTON AND/OR H- LINAC

Name of Linac : *CERN 50 MeV Proton Linac (Linac 2)*
Function : *Proton Injector for CERN Accelerator Complex*
Institution and address : *CERN, 1211 Geneva 23, Switzerland*
Person in charge : *H. Haseroth*
Name of person supplying these data : *C.E. Hill*
e-mail : *CEH@PS.MSM.CERN.CH*
tel. : *+41 22 7673659* fax : *+41 22 7679145*

HISTORY AND STATUS

Const. started : *11/1973* ; first beam : *09/1978*
Present status : *Operational*
Cost of facility : *23 MCHF (1978)*
Present linac staff : *16/2 = 8 man-years*
Present yearly operat. time : *6700 (1995)* h

LINAC PARAMETERS

Ion Source

Type : *Duoplasmatron with polarized expansion cup*
Output : *250-300* mA at *92* keV
Pulse length : *20-150* μs; rep. rate : *1 (max* Hz
Normalized emittance (1σ) : *0.8* π mm-mrad

Pre-accelerator (including RFQ)

Types : *(1) 4 vane RFQ* ; lengths : *1.8* m
Output : *165* mA at *750* keV
Pulse length: *500* μs; rep. rate : *1 (max* Hz
Normalized emittance (1σ) : *1.2* π mm-mrad

Longitudinal Matching

Type : *Two buncher system*
Mod. *150* keV; drift *285* mm at *202.56* MHz
120 keV; drift *146* mm at *202.56* MHz

Accelerating System *(2)*

Total linac length : *33.6* m; No. of tanks : *3*
Tank diameters : *0.94; 0.90; 0.86* m
Number of drift-tubes : *(3)*
Drift-tube lengths : *(4)* mm
Drift-tube diam (range): *180; 160; 160* mm
Gap/cell length (range): *(5)*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *202.56* MHz
Field modes : *TM010*
Eff. shunt impedance : *36* MΩ/m
Q : *60000*
Filling time : *(6)* μs
Equilibrium phases : *-25° to -35°; -25°; -25°*
RF rep. rate : *1 (max 2)* Hz; pulse : *500* μs
Beam rate : *1 (max 2)* Hz; pulse : *20-150* μs
RF power peak : *10* MW; mean : *0.002* MW

Focusing System

No. elements : *131*
type : *pulsed* order : *FODO*
Gradients : *100* to *20* T/m
Other : *Pulsed flat top (≈ 200 μs)*

LINAC PERFORMANCE *(7)*

	Normal Operation	Max, or Design *(8)*	
Energy	*50*		MeV
Mean acc. rate	*1.48*		MeV/m
ΔE/E (FWHM)	*± 0.25*		%
Beam current	*150*	*180*	mA peak
Norm. emit. (1σ)	*5*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) Converted from Cockroft-Walton injector to RFQ in 1993.
(2) Post coupled Alvarez Linac structure.
(3) 51+2(1/2); 43+2(1/2); 31+2(1/2)
(4) 48-147; 177-258; 274-316
(5) 0.22-0.31;0.2-0.29;0.26-0.31
(6) determined by feedback < 100 μs
(7) Beam length modulated at source according to beam user. Users are SPS fixed target physics, Antiproton production, Test beams, ISOLDE, LEAR..
(8) Maximum performance obtained in tests for LHC beams.

References

[1] Original machine described at Linac Conference 1979 (Montauk) and PAC 1979.
RFQ modifications described at Linac 1994 (Tsukuba).

PROTON AND/OR H- LINAC

Name of Linac : *PL2 RFQ Linac*
Function : *Calibration of L3 E.M. Calorimeter*
Institution and address : *CERN, 1211 Geneva 23, Switzerland*
Person in charge : *H. Newman*
Name of person supplying these data : *H. Newman*
e-mail : *newman@vxcern.cern.ch*
tel. : *+41 22 767 6366* fax : *+41 22 767 8530*

HISTORY AND STATUS

Const. started : *05/1989* ; first beam : *(1)*
Present status : *Operating*
Cost of facility : *USD 940 000*
Present linac staff : *3 (part-time)*
Present yearly operat. time : *≈240* h

LINAC PARAMETERS

Ion Source

Type : *Multi-cusp, RF driven, H⁻ volume*
Output : *12* mA at *29* keV
Pulse length : *50* μs; rep. rate : *60 (2)* Hz
Normalized emittance (1σ) : *~0.3 (3)* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 vane* ; lengths : *1.626* m
Output : *7* mA at *1850* keV
Pulse length: *5* μs; rep. rate : *(2) 60* Hz
Normalized emittance (1σ) : *(3) 0.4* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : m; No. of tanks :
Tank diameters : m
Number of drift-tubes :
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : mm to mm
RF frequency(ies) : MHz
Field modes :
Eff. shunt impedance : MΩ/m
Q :
Filling time : μs
Equilibrium phases :
RF rep. rate : Hz; pulse : μs
Beam rate : Hz; pulse : μs
RF power peak : MW; mean : MW

Focusing System

No. elements : *4 quads*
type : *Electromagnets* order : *FDFD*
Gradients : *0* to *20.5* T/m
Other : *2 bends for horizontal and vertical steering*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*1.85*		MeV
Mean acc. rate	*1.14*		MeV/m
ΔE/E (FWHM)	*(3) 1*		%
Beam current	*7*		mA peak
Norm. emit. (1σ)	*(3) 0.4*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) First proton beam at factory; 08/1990
First H⁻ beam at factory: 08/1991;
First normal operation in L3 at CERN: 11/1992

(2) Maximum repetition rate 150 Hz, normally run at about 60 Hz, rate limited by L3 DAQ.

(3) Estimated value

Mfg: AccSys Technology Inc.
Pleasanton CA 94566
USA

ION LINAC

Name of Linac : *CERN Heavy Ion Linac (Linac 3)*
Function : *(Heavy) Ion Injector for CERN Accelerator Complex*
Institution and address : *CERN, 1211 Geneva 23, Switzerland*
Person in charge : *H. Haseroth*
Name of person supplying these data : *C.E.Hill*
e-mail : *CEH@PS.MSM.CERN.CH*
tel. : *+41 22 767 3659* fax : *+41 22 767 9145*

HISTORY AND STATUS

Const. started : *06/1991* ; first beam : *06/1994*
Present status : *Operational*
Cost of facility : *15 MCHF (1994)*
Present linac staff : *16/2 = 8 man-years*
Present yearly operat. time : *2500 (1995)* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *14 GHz ECR (afterglow mode)*
Species of ions : *Lead 27+*
Range of currents : *120* μAe
Range of output energies : *2.5* keV/u
Pulse length : *100-1500* μs; rep. rate : *10 /5* Hz
Normalized emittance (1σ) : *0.28* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *4 rod RFQ, 2.66* m
Output currents : *80* μAe
Output energies : *250* keV/u
Frequency : *101.3* MHz; peak RF power : *200* kW
Pulse length : *1000* μs; rep. rate : *1 (max 10)* Hz
Normalized emittance (1σ) : *0,4* π mm-mrad

Longitudinal Matching

Type : *4 gap buncher*
Mod. *100* keV; drift *530* mm at *101.3* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *8.1* m; N°. of tanks : *3*
Tank diameters : *Not circular section* m
Number of drift-tubes : *41; 28; 30*
Drift-tube lengths : *18 - 72 (triplet 430)* mm
Drift-tube diam (range) : *28 to 32* mm
Gap/cell length (range) : *0.29 to 0.54; g/0.5 βλ*
Aperture diameter : *18* mm to *22* mm
RF frequency(ies) : *101.28, 202.56, 202.56*MHz
Field modes : *TE110 (IH βλ/2 operation)*
Eff. shunt impedance : *270; 250; 285* MΩ/m
Q : *21200; 12500; 1440*
Filling time : *(1)* μs
Equil. phases : *0 - 30°*; accel. rate *0.52* MeV/u-m
RF rep. rate : *1 (max 10)* Hz; pulse : *1000* μs
Beam rate : *1 - 10 max* Hz; pulse : *(2)* μs
RF power peak : *1.1* MW; mean : *0.55 /11* MW

Focusing System

No. elements : *4 x 3*
type : *DC triplet* order : *FDF*
Gradients : *69* to *56.5* T/m
Other : *2 triplets in tank 1, 2 between tanks*

Charge Stripping (Typical)

Type(s) : *C foil (≈ 100 μg cm^{-2})*
Charge states : *27+* to *(3)* at *4.2* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	*Lead 53+*	*Lead 55+*	
Energy	*4.2*		MeV/u
ΔE/E (FWHM)	*0.5 - 0.6*		%
Mean acc. rate	*0.52*		MeV/u-m
Beam current	*25*		μAe peak
Norm. emit. (1σ)	*0.95*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) determined by feedback; <10
(2) 40, 600, 1000 max
(3) (52+) 53+ (55+)

Constructed by international collaboration between CERN, France, Germany, Italy, India, Czech Republic, Sweden and Switzerland.

Parameters given for 208Pb, ions with q/m > 0.12 can also be accelerated provided source extraction for 2.5 keV/u is between 13 and 25 kV. Linac was designed for Pb25+.

Beams length modulated at source. Users are SPS ion physics, test beams and LEAR.

References

[1] Project described in "CERN Heavy-Ion Facility Design Report", CERN 93-01 (1993).

ELECTRON LINAC

Name of Linac : *LUE 2000**
Function : *Electron Linac for Fixed Target Experiments*
Institution and address : *NSC-KPTI "Accelerator" R&D&P Est., 310108 Kharkov, Ukraine*
Person in charge : *A. Dovbnya*
Name of person supplying these data : *Y. Tur*
e-mail : *tur@nik.kharkov.ua*
tel. : *+380 57 235 6533* fax : *+380 57 235 3731*

HISTORY AND STATUS

Const. started : *1958* ; first beam : *1964*
Present status : *Since 1992 - idle*
Cost of facility : *NA*
Present linac staff : *112 man-years*
Present yearly operation time : *4000 (1991)* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *80* keV
Beam intensity (peak) : *3* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *20* MeV; intensity : *1* A
Pulse width, spacing : *2.0 μs; 10 - 80 ms*
Normalized emittance (1σ) : *<200* π mm-mrad

Acceleration System

Total linac length : *240* m
No. sections : *49* ; lengths : *4.3* m
Field mode : *π/2* ; frequency : *2.797* GHz
Wave type : *TW* ; filling time : *0.4* μs
v_g/c range : *0.04* ; Q : *10000*
Shunt impedance : *43* MΩ/m
Iris : aperture : diameter : *30.0* mm
thickness : *4.0* mm
Attenuation/section : *0.3375* Np
Power units, Number : *50* type : *Klystron*
RF power peak : *20* MW; mean : *2.6* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 20 MeV, triplets at 20 MeV and between sections up to 300 MeV; 5 quadruplets at 0.4, 0.8, 1.2, 1.6, 2.0 GeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	*1.8*	*2.0*	GeV
Accel gradient :	*8.4*	*10*	MeV/m
ΔE/E (FWHM) :	*0.3*	*0.1*	%
Rep. rate :	*50*	*100*	Hz
Pulse length :	*2.5*	*2.5*	μs
Beam intensity :	*0.0005*	*0.001*	A
Norm. emit. (1σ) :	*480*	*200*	π mm-mrad

OTHER RELEVANT INFORMATION

* *LUE 2000 (2 GeV Kharkov Linac)*

(1) S-band pre-buncher, buncher

Ten new quasi-constant gradient accelerating stuctures (4 subsections) have been designed, constructed and installed in acceleration system [1].

Characteristics are following :
Filling time : 0.94 μs; v_g/c : 0.015; Q : 11000
Shunt impedance : 56 MΩ/m
Iris diameter : 25-19 mm
Attenuation/section : 0.952 Np

With the new 40 MW klystron [2] :
Normal gradient : 14 MeV/m
Max gradient : 20 MeV/m

References

[1] "Development of Components for Multisection Electron Accelerators" - Proceedings of the Workshop on JINR C-tau Factory, Dubna, 1992, pp. 365-374.

[2] "Development of Linear Electron Accelerators for Basic Scientific Researches and Advancement of Technologies in Ukraine" - Ukrainian Physical Journal, vol. 40 (1995), No. 9, pp. 909-912, (in Ukrainian).

ELECTRON LINAC

Name of Linac : *LUE 60* *
Function : *Electron Injector Linac for 600 MeV SRS*
Institution and address : *NSC-KPTI "Accelerator" R&D&P Est., 310108 Kharkov, Ukraine*
Person in charge : *Y. Tur*
Name of person supplying these data : *Y. Tur*
e-mail : *tur@nik.kharkov.ua*
tel. : *+380 57 235 6533* fax : *+380 57 235 3731*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1990*
Present status : *Since 1992 - idle*
Cost of facility : *1 MUSD (1990)*
Present linac staff : *11 man-years*
Present yearly operation time : *400 (1991)* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *750* keV
Beam intensity (peak) : *0.540* A
Normalized emittance (1σ) : *15* π mm-mrad

Injector

Longitudinal matching : *RF-Gun with α-magnet*
Output : *0.75* MeV; intensity : *0.107* A
Pulse width, spacing : *(2)*
Normalized emittance (1σ) : *20* π mm-mrad

Acceleration System

Total linac length : *4* m
No. sections : *1* ; lengths : *3.3* m
Field mode : *π/2* ; frequency : *2.797* GHz
Wave type : *TW* ; filling time : *1.24* μs
v_g/c range : *0.009* ; Q : *12000*
Shunt impedance : *53* MΩ/m
Iris : aperture : diameter : *21.8 - 16.6* mm
thickness : *4.0* mm
Attenuation/section : *1.171* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *26* MW; mean : *1.7* kW

Focusing System

Type, No. of elements, and spacing :
Two lenses between RF gun, α-magnet and accelerating section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.06*	*0.06*	GeV
Accel gradient	:	*(3) 18.2*	*18.2*	MeV/m
ΔE/E (FWHM)	:	*<2*	*1*	%
Rep. rate	:	*12.5*	*25*	Hz
Pulse length	:	*0.1*	*1.2*	μs
Beam intensity	:	*0.1*	*0.107*	A
Norm. emit. (1σ)	:	*<150*	*<150*	π mm-mrad

OTHER RELEVANT INFORMATION

* *LUE 60 (60 MeV Kharkov Linac)*

(1) 1-cell thermionic RF gun
(2) 0.03-1.2 μs; 80-1000 ms
(3) Quasi-constant gradient accelerating structures (3 subsections)

References

[1] "Compact 60 MeV Accelerator with Precise Beam Parameters" - Proceedings of the Workshop on JINR c-tau Factory,Dubna, 1992, pp. 350-364.

[2] "Development of Linear Electron Accelerators for Basic Scientific Researches and Advancement of Technologies in Ukraine" - Ukrainian Physical Journal, vol. 40 (1995), No. 9, pp. 909-912, (in Ukrainian)

ELECTRON LINAC

Name of Linac : *LUE 40**
Function : *Electron Linac for Fixed Target Experiments*
Institution and address : *NSC-KPTI "Accelerator" R&D&P Est., 310108 Kharkov, Ukraine*
Person in charge : *A. Zykov*
Name of person supplying these data : *Y. Tur*
e-mail : *tur@nik.kharkov.ua*
tel. : *+380 57 235 6533* fax : *+380 57 235 3731*

HISTORY AND STATUS

Const. started : *1958* ; first beam : *1964*
Present status : *Since 1992 - idle*
Cost of facility : *NA*
Present linac staff : *10 man-years*
Present yearly operation time : *1500 (1991)* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *80* keV
Beam intensity (peak) : *4* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *19 - 8* MeV; intensity : *0.05 - 1* A
Pulse width, spacing : *10 μs; 20 - 80 ms*
Normalized emittance (1σ) : *200* π mm-mrad

Acceleration System

Total linac length : *8.5* m
No. sections : *1* ; lengths : *4.3* m
Field mode : *π/2* ; frequency : *2.797* GHz
Wave type : *TW* ; filling time : *0.38* μs
v_g/c range : *0.04* ; Q : *10000*
Shunt impedance : *43* MΩ/m
Iris : aperture : diameter : *30.0* mm
thickness : *4.0* mm
Attenuation/section : *0.3375* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *10* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
2 axial symmetric lenses between gun and injector, solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.02*	*0.04*	GeV
Accel gradient	*2.9*	*5.8*	MeV/m
ΔE/E (FWHM)	*3*	*3*	%
Rep. rate	*50*	*100*	Hz
Pulse length	*10*	*10*	μs
Beam intensity	*0.8*	*1.0*	A
Norm. emit. (1σ)	-	*200*	π mm-mrad

OTHER RELEVANT INFORMATION

* *LUE 40 (40 MeV Kharkov Linac)*

(1) Pre-buncher; TW buncher 3 m

References

[1] Described in "Atomnaya energya" 1979, v.46, No. 3, pp. 336 - 340 (in Russian).

ELECTRON LINAC

Name of Linac : *LIC* *
Function : *Multipurpose scientific experimental facility*
Institution and address : *NSC - KPTI "Accelerator" R&D&P Est., 310108 Kharkov, Ukraine*
Person in charge : *V.A. Kushnir*
Name of person supplying these data : *V.A. Kushnir*
e-mail : *kushnir@nik.kharkov.ua*
tel. : *+380 57 235 6286* fax : *+380 57 235 3731*

HISTORY AND STATUS

Const. started : *1991* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *3 man-years*
Present yearly operation time : *(1995) 1000* h

LINAC PARAMETERS

Electron Sources

Types : *RF-gun* ; energy : *700 - 1100* keV
Beam intensity (peak) : *1.7* A
Normalized emittance (1σ) : *12* π mm-mrad

Injector

Longitudinal matching : *RF-gun*
Output : *0.7 - 1.1* MeV; intensity : *1.5* A
Pulse width, spacing : *2 μs, 160 - 1000 ms*
Normalized emittance (1σ) : *12* π mm-mrad

Acceleration System

Total linac length : *4.0* m
No. sections : *1* ; lengths : *2.3* m
Field mode : *4π/3* ; frequency : *2.797* GHz
Wave type : *TW* ; filling time : *0.9* μs
v_g/c range : *0.01* ; Q : *13000*
Shunt impedance : *12* MΩ/m
Iris : aperture : diameter : *50* mm
thickness : *50* mm
Attenuation/section : *0.6* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *22* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
One axial. symmetric lens between RF-gun and section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	*0.015*	*0.02*	GeV
Accel gradient	*6.5*	*8.7*	MeV/m
ΔE/E (FWHM)	*3*	*< 8*	%
Rep. rate	*1 - 6.25*	*6.25*	Hz
Pulse length	*0.3 - 1.5*	*2.5*	μs
Beam intensity	*1.0*	*1.3*	A
Norm. emit. (1σ)	*14*	*< 20*	π mm-mrad

OTHER RELEVANT INFORMATION

* *(Laser Injector Complex)*

a) *Microsecond pulses*
This facility produces pulses in the microsecond range

b) *Nanosecond pulses*
It can be used also in the nanosecond range.

Pulse width	*: 7 ns*
Spacing	*: 320 - 1000 ms*
Final Energy	*: 0.018 GeV*
Acc. gradient	*: 7.8 MeV/m*
ΔE/E (%)	*: 2*
Beam intensity	*: 1.5 A*
Beam Pulse Structure:	
No. of bunches/pulse	*: 20*
No. of particles/bunch	*: 3×10^9*
Bunch separation	*: 358.2 ps*

References

[1] Project described in "Proceeding of the 13 Conference on Charge Particles Accelerators, Dubna, 1992" (in Russian). Present-day status described in report that submitted to EPAC '96.

PROTON AND/OR H- LINAC

Name of Linac : *KMTA* *
Function : *Nuclear and Irradiation Physics*
Institution and address : *NNC KFTI Academicheskaja str.1, 310108 Kharkov, Ukraine*
Person in charge : *Ye.V. Gussev*
Name of person supplying these data : *N.A. Khizhnyak*
e-mail : *kfti@rocket.kharcov.ua*
tel. : *+38 057 235 6414* fax : *+38 057 235 3564*

HISTORY AND STATUS

Const. started : *1985* ; first beam :
Present status : *Under construction*
Cost of facility : *2.5 MUSD*
Present linac staff :
Present yearly operat. time : h

LINAC PARAMETERS

Ion Source

Type : *Duoplasmotron*
Output : *500* mA at *150* keV
Pulse length : *1000* μs; rep. rate : *1 - 20* Hz
Normalized emittance (1σ) : *2* π mm-mrad

Pre-accelerator (including RFQ)

Types : *Pulse transformer* ; lengths : m
Output : *500* mA at *150* keV
Pulse length: *1000* μs; rep. rate : *1 - 20* Hz
Normalized emittance (1σ) : *2* π mm-mrad

Longitudinal Matching

Type : *H_{11} cavity: 152.5 MHz: 6.0 kV/cm: 26 - gaps*
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *10.9* m; No. of tanks : *3*
Tank diameters : *0.4* m
Number of drift-tubes : *22: 24: 22*
Drift-tube lengths : *9 - 180* mm
Drift-tube diam (range): *10.26 - 200.0* mm
Gap/cell length (range): *0.39 - 0.67*
Aperture diameter : *12.5* mm to *100.0* mm
RF frequency(ies) : *152.5* MHz
Field modes : *H_{11N}*
Eff. shunt impedance : *45.0: 52.5: 50.3* MΩ/m
Q : *5000: 7200: 9500*
Filling time : *20.0 - 30.0* μs
Equilibrium phases : *-90° ÷ +50°*
RF rep. rate : *1 - 20* Hz; pulse : *1000* μs
Beam rate : *1 - 20* Hz; pulse : *1000* μs
RF power peak : *7.56* MW; mean : *0.15* MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other : *Modify Alternating-phase Focusing (MAPF)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*(1) 22.5*		MeV
Mean acc. rate	*2.0*		MeV/m
ΔE/E (FWHM)	*± 1.5*		%
Beam current	*50.0*	*100.0*	mA peak
Norm. emit. (1σ)	*4*		π mm-mrad

OTHER RELEVANT INFORMATION

* *Kharkov Material Test Accelerator*

(1) The first turn

It is built:

- *RF frequency system to 35.0 MW peak power, 0.8 MW - mean;*
- *injector;*
- *water cooling system;*
  and other.

ION LINAC

Name of Linac : *Kharkov Heavy Ion Linac* *
Function : *Heavy Ion Accelerator*
Institution and address : *NNC KFTI Academicheskaja str.1, 310108 Kharkov, Ukraine*
Person in charge : *B.I. Rudvak*
Name of person supplying these data : *V.A. Bomko*
e-mail : *kfti@rocket.kharkov.ua*
tel. : *+38 057 235 3564* fax : *+38 057 235 3564*

HISTORY AND STATUS

Const. started : *1955* ; first beam : *1958*
Present status : *Operational*
Cost of facility :
Present linac staff : *20 man-years*
Present yearly operat. time : *1500 (1994)* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *Duoplasmatron and MEVVA*
Species of ions : *Argon 3+, Titanium 3+*
Range of currents : *2500* μAe
Range of output energies : *3* keV/u
Pulse length : *300* μs; rep. rate : *2-5* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Pulse Transformer KG-800* m
Output currents : *500* μAe
Output energies : *33* keV/u
Frequency : MHz; peak RF power : kW
Pulse length : *500* μs; rep. rate : *10* Hz
Normalized emittance (1σ) : *0.3* π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *15.4* m; N°. of tanks : *2*
Tank diameters : *(1)* m
Number of drift-tubes : *47; 40*
Drift-tube lengths : *14 to 72; 72 to 210* mm
Drift-tube diam (range): *56 to 129; 72 to 210* mm
Gap/cell length (range): *0.5; g/0.25βλ*
Aperture diameter : *24* mm to *30* mm
RF frequency(ies) : *47.2; 47.2* MHz
Field modes :*TE110 (1H βλ/2 operation)*
Eff. shunt impedance : *150; 50* MΩ/m
Q : *14000: 15000*
Filling time : *10: 10* μs
Equil. phases : *-20°-30°*accel. rate *(2)* MeV/u-m
RF rep. rate : *2-5* Hz; pulse : *500* μs
Beam rate : *2-5* Hz; pulse : *500* μs
RF power peak : *0.4: 2.3* MW; mean : *(3)* MW

Focusing System

No. elements : *20*
type : *Quadrupole* order : *FODO*
Gradients : to *30* T/m
Other :

Charge Stripping (Typical)

Type(s) : *C foil*
Charge states : *3+* to *12+* at *1* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	: *Argon 12+*		
Energy	: *8.5*		MeV/u
ΔE/E (FWHM)	: *0.5*		%
Mean acc. rate	: *0.658*		MeV/u-m
Beam current	: *2*		μAe peak
Norm. emit. (1σ)	: *1*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
Nitrogen,	*8.5 MeV/u*	
Aluminium	*8.5 MeV/u*	

OTHER RELEVANT INFORMATION

* *Kharkov Heavy Ion Linac (Multi Charged Ion Linac MILAC)*

(1) 0.9 × 1.16 (not circular); 1.5 m
(2) 0.235; 0.658 MeV/u-m
(3) 7×10^{-4} ; 4×10^{-3} *MW*

ION LINAC

Name of Linac : *MLUD-3*
Function : *Neutron generator*
Institution and address : *NNC KFTI Academicheskaja str.1, 310108 Kharkov, Ukraine*
Person in charge : *N.G. Shulika*
Name of person supplying these data : *N.A. Khizhnyak*
e-mail : *kfti@rocket.kharkov.ua*
tel. : *+38 057 235 6414* fax : *+38 057 235 3564*

HISTORY AND STATUS

Const. started : *1972* ; first beam : *1975*
Present status : *Operational*
Cost of facility : *300000 USD*
Present linac staff : *2 man-year*
Present yearly operat. time : h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
Types of source : *Duoplasmotron*
Species of ions : *Deuteron 1+*
Range of currents : *300×10^3* μAe
Range of output energies : *75* keV/u
Pulse length : *250* μs; rep. rate : *1.10* Hz
Normalized emittance (1σ) : *10* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : m
Output currents : μAe
Output energies : keV/u
Frequency : MHz; peak RF power : kW
Pulse length : μs; rep. rate : Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type :
Mod. keV; drift mm at MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *1.2* m; N°. of tanks : *1*
Tank diameters : *0.5* m
Number of drift-tubes : *16*
Drift-tube lengths : *7 to 135* mm
Drift-tube diam (range) : *20 to 120* mm
Gap/cell length (range) : *0.33 to 0.75*
Aperture diameter : *9* mm to *40* mm
RF frequency(ies) : *97.8* MHz
Field modes : TE_{11N}
Eff. shunt impedance : *35* MΩ/m
Q : *5000*
Filling time : *20* μs
Equil. phases : *(1)* ; accel. rate *1.65* MeV/u-m
RF rep. rate : *1-10* Hz; pulse : *300* μs
Beam rate : *1-10* Hz; pulse : *250* μs
RF power peak : *0.6* MW; mean : *0.01-0.15* MW

Focusing System

No. elements :
type : order :
Gradients : to T/m
Other : *Modified Alternating-phase Focusing (MAPF)*

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	: *Deuteron 1+*		
Energy	: *1.65*		MeV/u
ΔE/E (FWHM)	: *+2.5*		%
Mean acc. rate	: *1.4*		MeV/u-m
Beam current	: *65×10^3*		μAe peak
Norm. emit. (1σ)	: *4*		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
Proton	*1.65 MeV*	*~40 mA peak*
H_3^+	*3.3 MeV*	*~75 mA peak*

OTHER RELEVANT INFORMATION

* *Small-size deuterium Linac (MLUD-3)*

(1) -90° ÷ +50°

PROTON AND/OR H- LINAC

Name of Linac : *ISIS Injector*
Function : *Injector for Synchrotron of Pulsed Spallation Neutron Source*
Institution and address : *Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 0QX*
Person in charge : *I.S.K. Gardner (ISIS), CW Planner (Linac)*
Name of person supplying these data : *C.W. Planner*
e-mail : *cwp45@isise.pl.ac.uk*
tel. : *+44 1235 445434* fax : *+44 1235 445720*

HISTORY AND STATUS

Const. started : *(1)* ; first beam : *01/1983*
Present status : *Operational*
Cost of facility : *(2)*
Present linac staff : *6*
Present yearly operat. time : *5000* h

LINAC PARAMETERS

Ion Source

Type : *H⁻ Penning*
Output : *35* mA at *18* keV
Pulse length : *300* μs; rep. rate : *50* Hz
Normalized emittance (1σ) : π mm-mrad

Pre-accelerator (including RFQ)

Types : *Cockcroft-Walton* ; lengths : m
Output : *35* mA at *665* keV
Pulse length: μs; rep. rate : *DC* Hz
Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type : *Buncher coaxial resonator - double gap*
Mod. *23* keV; drift *800* mm at *202.5* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *43* m; No. of tanks : *4*
Tank diameters : *0.94, 0.927, 0.828,* m
Number of drift-tubes : *(3)*
Drift-tube lengths : *45 - 340* mm
Drift-tube diam (range): *180 - 160* mm
Gap/cell length (range): *0.21 - 0.37*
Aperture diameter : *20* mm to *38* mm
RF frequency(ies) : *202.5* MHz
Field modes : *E (010)*
Eff. shunt impedance : MΩ/m
Q : *40000 - 60000*
Filling time : *125* μs
Equilibrium phases : *- 30 °*
RF rep. rate : *50* Hz; pulse : *700* μs
Beam rate : *50* Hz; pulse : *500* μs
RF power peak : *7.0* MW; mean : *0.24* MW

Focusing System

No. elements : *152*
type : *(4)* order : *FFDD*
Gradients : *40* to *4.6* T/m
Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	*70.4*		MeV
Mean acc. rate	*1.7*		MeV/m
ΔE/E (FWHM)	*(5) ± 0.26*		%
Beam current	*25*		mA peak
Norm. emit. (1σ)	*10 (99%)*		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 1977 - Conversion to H⁻

(2) Originally built as a low duty cycle proton linac, 1973-76, at construction cost of £1.8 M.
Converted to high duty cycle, H⁻ linac at cost (capital) of £0.9 M.
Tanks 2 & 3 originally formed part of an earlier 50 MeV proton linac that operated 1960-69.

(3) 55+2 × 1/2, 40+2 × 1/2, 26+2 × 1/2, 23+2 × 1/2

(4) Pulsed ANDC

(5) Design after Debuncher

ELECTRON LINAC

Name of Linac : *SRS* *
Function : *Electron Injector for SRS Booster*
Institution and address : *CLRC, Daresbury Laboratory, Warrington, WA4 4AD, UK*
Person in charge : *D M Dykes*
Name of person supplying these data : *D M Dykes*
e-mail : *d.m.dykes@dl.ac.uk*
tel. : *+44 1925 603142* fax : *+44 1925 603192*

HISTORY AND STATUS

Const. started : *1976* ; first beam : *1978*
Present status : *Operational*
Cost of facility : *284 MGBP (1978)*
Present linac staff : *4 part time*
Present yearly operation time : *< 500* h

LINAC PARAMETERS

Electron Sources

Types : *(1) Triode* ; energy : *80* keV
Beam intensity (peak) : *> 0.350* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Integral S-band buncher*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2* m
No. sections : *1* ; lengths : *2* m
Field mode : *2π/3* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *< 1* μs
v_g/c range : *0.16 - 0.1* ; Q : *17600*
Shunt impedance : *56 - 64* MΩ/m
Iris : aperture : diameter : *23.36 - 20.0* mm
thickness : *5.95* mm
Attenuation/section : *0.236* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *6* MW; mean : *1.2* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids: 2 for source and
2 distributed for accelerator

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *500*
No. of particles/bunch : 2.5×10^{10}
Bunch separation : *2 ns*

LINAC PERFORMANCE

		Normal Operation	Max, or Design	
Final energy	:	*0.012*	*0.015*	GeV
Accel gradient	:	*6*	*7.5*	MeV/m
ΔE/E (FWHM)	:	*1*	*1*	%
Rep. rate	:	*10*	*10*	Hz
Pulse length	:	*1*	*2*	μs
Beam intensity	:	*0.020*	*0.030*	A
Norm. emit. (1σ)	:	-	*10*	π mm-mrad

OTHER RELEVANT INFORMATION

* *SRS - Synchrotron Radiation Source*

(1) Electron source uses an Eimac planar triode, 8755, fitted to the gun assembly. The anode is broken off, cathode/grid assembly is then reconditioned.

The source is modulated via the grid at 500 MHz.

LINEAR COLLIDERS

Linear Collider Studies

Within the framework of an international collaboration, different approaches for Linear Colliders in the TeV range are under study. It is worth mentioning the main laboratories who contribute to this research, in the 1996 compendium of linacs.

An "International Linear Collider Technical Review Committee Report" was published by G. Loew (SLAC) in December 1995.

At EPAC96, J.P. Delahaye (CERN) presented a review on "Design Issues of TeV Linear Colliders".

The two following tables were presented at the Linac96 Conference by G. Loew. They show an updating of the parameters and they provide the reader with an overview of e^-/e^+ linear colliders under consideration at 500 GeV.

Table 1

Linear Colliders: Overall and Final Focus Parameters -- 500 GeV (c.m.)

	TESLA		SBLC		JLC(S)		JLC(C)		JLC(X)		NLC		VLEPP		CLIC	
	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96
Initial energy (c.of .m.) (GeV)	500		500		500		500		500		500		500		500	
RF frequency of main linac (GHz)	1.3		3		2.8		5.7	4.2	11.4		11.4		14		30	
Nominal Luminosity (10^{33} cm^{-1} s^{-1})†	2.6		2.2		5.2		7.3		5.1		5.3	3.9	12.3		0.7-3.4	3.9
Actual luminosity (10^{33} cm^{-1} s^{-1})†	6.1	6.0	3.75	5.0	4.3		6.1	9.1	5.2		7.1	5.5	9.3		1.07-4.8	7.5
Linac repetition rate (Hz)	10	5	50		50		100		150		180		300		2530-1210	280
No. of particles/bunch at IP (10^{10})	5.15	3.63	2.9	1.1	1.44		1.0	1.1	.63		.65	.75	20		.8	
No. of bunches/pulse	800	1130	125	333	50		72		85		90		1		1-10	50
Bunch separation (nsec)	1000	708	16.0	6	5.6		2.8		1.4		1.4		–		.67	1
Beam power/beam (MW)	16.5	8.2	7.26	7.25	1.3		2.9	3.2	3.2		4.2	4.8	2.4		.8-3.9	4.47
Damping ring energy (GeV)	4.0		3.15		2.0		2.0		2.0		2.0		3.0		2.15	
Unloaded/loaded gradient (MV/m)††	25/25		21/17		31/--		40/32	40/29.3	73/58		50/37	50/35	100/91		80/78	100/95
Total two-linac length (km)	29	32	33	32	22.1		18.8	20.2	10.4		15.6	17.6	7		8.8	7.4
Total beam delivery length (km)	3		3		3.6		3.6		3.6		4.4	10.4	3		2.4	
$\gamma\varepsilon_x/\gamma\varepsilon_y$(m-rad x 10^{-6})	20/1	14/.25	10/.5		3.3/.05		3.3/.05		3.3/.05		5/.05	4/.09	20/.08		3/.15	4.9/.08
β_x^*/β_y^*(mm)	25/2	25/.7	22/.8	11/.45	10/.1		10/.1	15/.2	10/.1		10/.1	10/.15	100/.1		10/.18	10/.13
σ_x^*/σ_y^* (nm) before pinch	1000/64	845/19	670/28	335/15	260/3.0		260/3.0	318/4	260/3.0		320/3.2	285/6.8	2000/4		247/7.4	315/3
σ_z^* (μm)	1000	700	500	300	120		120	200	90		100	125	750		200	100
Crossing Angle at IP (mrad)	0		3	2.5	6.4		6.0	8	6.1		20		6		1	20
Disruptions D_x/D_y	.56/8.7	.28/17	.36/8.5	.32/7.1	.29/25		.20/18	.23/17	.096/8.3		.07/7.3		.4/215		.29/9.8	.21/9.9
H_D	2.3		1.8		1.6		1.4	1.82	1.4		1.34	1.4	2.0		1.42	1.25
Upsilon sub-zero	.02		.037		.20		.14		.12		.089	.09	.059		.07	
Upsilon effective	.03		.042		.22		.144	.079	.12		.090		.074		.075	.084
δ_B (%)	3.3	2.9	3.2	3.1	12.7		6.5	3.9	3.5		2.4	3.2	13.3		3.6	3.5
n_γ (no. of γ's per e)	2.7		1.9		2.2		1.5	1.4	.94		.8	1.0	5.0		1.35	1.38
N_{pairs} (p_T^{min}=20 MeV/c,Θ_{min}=0.15)	19.0		8.8		31.6		10.3		2.9		2.0		1700		3.0	
$N_{hadrons}$/crossing	.17		.10		.98		.23		.05		.03		45.9		.05	
N_{jets}x10^{-2} (p_T^{min}=3.2 GeV/c)	.16		.14		3.4		.66		.14		.08		56.4		.10	

† For the sake of uniformity, the nominal luminosity is simply defined as $N^2/4\pi\,\sigma_x^*\,\sigma_y^*$ times the number of crossings per second, and in all cases assumes head-on collisions, no hour-glass effect and no pinch. The actual luminosity incorporates all these effects, including crossing angle where applicable. NLC calculations assume crab-crossing.

†† The main linac loaded gradient includes the effect of single-bunch (all modes) and multibunch beam loading, assuming that the bunches ride on crest. Beam loading is based on bunch charges in the linacs, which are slightly higher than at the IP.

Table 2

Pre-linacs, Damping Rings and Main Linac Parameters -- 500 GeV (c.m.)

	TESLA		SBLC		JLC(S)		JLC(C)		JLC(X)		NLC		VLEPP		CLIC	
	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96	TRC 12/95	Updated 7/96
Pre-linacs																
First stage $e^{\pm}$ energy (GeV)	4		3.15		1.98		1.98		1.98		2		3		2.15	
Second stage $e^{\pm}$ energy (GeV	-		-		-		20		10-20		10		-		9	
Beam energy to make e^{+} (GeV)	250		250		10		10		10		3-6		150		2.15	
Damping Rings																
e^{+} pre-damping ring energy (GeV)	-		-		1.98		1.98		1.98		2		-		2.15	
$e^{\pm}$ damping ring energy (GeV)	4		3.15		1.98		1.98		1.98		2		3		2.15	
Ring circumference (m)	20,000		650		222		321		277		223		160		283	
Damping times (ms) (τ_x/τ_y)	20/20		3.8/3.8		6.1/8		3.5/4.3		4.0/5.2		4.1/4.6		1.8/2.9		10.5/10.5	
Number of bunches per ring	800	1130	125	333	100		288		340		360		3		48x10	48x50
Bunch length (mm)	10		3.6		4.8		5		5		4.1		9.8		1.8	
Extr. beam emittance, ($\gamma\varepsilon_x/\gamma\varepsilon_y$, 10^{-6})	20/1	14/.25	10/.5	5/2.5	3.3/.05		3.3/.05		3.3/.05		2.5/.03	3.6/.04	45.5/.45		2.5/.04	
Main Linacs																
RF frequency (GHz)	1.3		3		2.8		5.7		11.4		11.4		14		30	
Unloaded/loaded gradient (MV/m)[††]	25/25		21/17		31/-		40/32		73/58		50/37	50/35	100/91		80/78	100/
Active two-linac length (km)	20	22	30.2		19.8		15.7	15.1	8.7		14.2	16.3	5.8		6.3	5.3
Total two-linac length (km)	29	32	33	32	22.1		18.8		10.4		15.6	17.6	7		8.8	7.4
Total number of klystrons	604		2517		2560		43561	4184	3320		3936	4528	1400		2	10
Total number of modulators	604		2517		2560		2178	2092	3320		1970	2264	140		NA	
Klystron peak power (MW)	8		150		135		48	50.3	135		50		150		NA	153000
Klystron repetition rate (Hz)	10	5	50		50		100		150		180		300		2530/1210	220
Klystron pulse length (μsec)	1315		2.8		4.5		2.4		.5		1.2		.5		.0116/.00176	.072
Pulse compression ratio	-		-		3.75		5		2		5		4.55	3.2	-	
Pulse compression gain	-		-		~2		3.5	3.35	1.96		3.83	3.6	3.2		-	
RF pulse length at linac (μsec)	1315		2.8		1.2		.480		.23		.24		.11		.0116/.00176	.072
Number of sections	19328		5034		5120		8712	8368	6640		7872	9056	5600		22466	11200
Section length (m)	1.04		6		3.6		1.8		1.31		1.8		1		.280	.44
a/λ (range if applicable)	.15		.16/.11		.14/.1		.16/.12	.17/.12	.20/.14		.22/.15		.14		.2	
Total AC power to make rf (MW)	164	88	139	140	118		139	153	114		103	121	57		100	77
Wall plug → beam efficiency (%)	20	19	10.7	10.4	3.0		4.6	4.2	5.6		8.2	7.9	8.4		1.6/7.8	11.6

[††] The main linac loaded gradient includes the effect of single-bunch (all modes) and multibunch beam loading, assuming that the bunches ride on crest. Beam loading is based on bunch charges in the linacs, which are slightly higher than at the IP.