A Tau - Charm - Factory at Argonne

Workshop on the Tau - Charm - Factory
in the
Era of B - Factories

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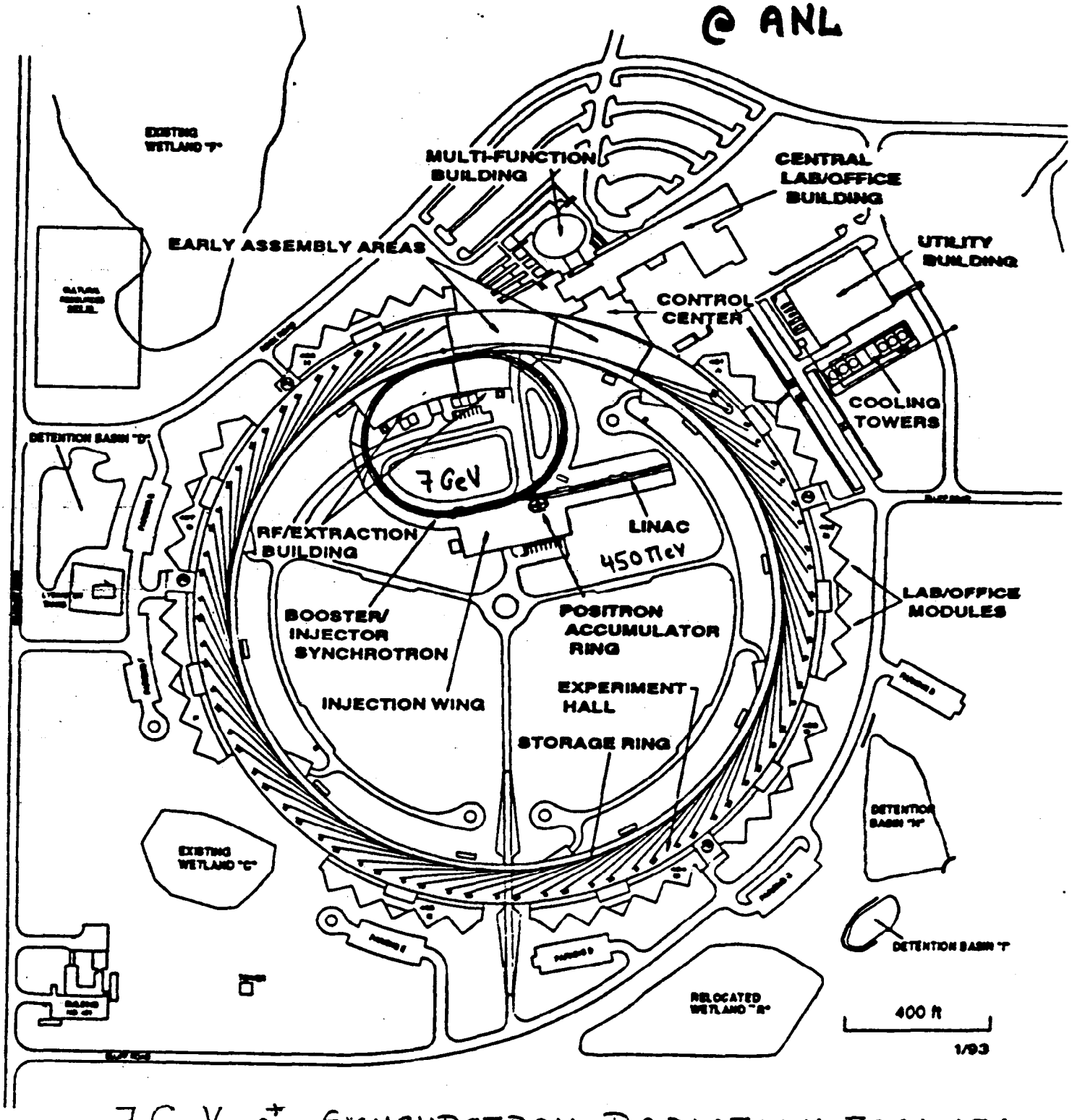
PLAN VIEW OF THE ADVANCED PHOTON SOURCE @ ANL



7 GeV e^+ SYNCHROTRON RADIATION FACILITY

OPERATIONAL 1995

Argonne High Energy Physics Division

- Involvement in experiments outside ANL: FNAL, DESY,...
- Currently NO in-house project
- Studies of different projects for the future: ATLAS, Long Baseline,...
- Tau - Charm Factory ⇒ Attractive project

  Collider: Expertise available from the ANL Advanced Photon Source

  Detector: Expertise in the HEP Division

SLAC - 419

II τCF WORKSHOP

Comparison of Measurements and Sensitivities in τ Physics

	Measurement	1993 Cornell (Dallas)	τcF 1993	SLAC BF 1993
General Properties	m_τ	± 0.3 MeV	± 0.1 MeV	?
	τ_τ	±1.0%	-	±0.3%
	m_{ν_τ}	<32.6 MeV CL=95%	<1 MeV CL=95%	< 5.5 MeV CL=95%
	ρ	± 3.9%	± 0.02%	±O(0.1)%
	τ Polarization	± 10%	-	-
	d_τ	-	$< 1 \times 10^{-17}$ecm	?
	Universality	O(0.5)%	0.1%	0.5%
Branching Ratios	$e\nu\nu$	± 0.8%	± 0.1%	± 0.5%
	$\mu\nu\nu$	± 0.9%	± 0.1%	± 0.5%
	$\pi\nu$	± 2.2%	± 0.1%	± 0.5%
	$K\nu$	± 10%	± 0.8%	?
	$\rho\nu$	± 1.3%	?	?
	$3\pi\nu$	± 2.4%	?	?
	$\pi 2\pi^0\nu$	± 3.6%	?	?
	$5\pi\nu$	± 16%	?	?
	$5\pi\pi^0\nu$	± 43%	?	?
Rare Decays	$\pi\pi^0\eta\nu$	$< 1.1 \times 10^{-2}$ CL=95%	$< 10^{-7}$	$< 10^{-6}$
	$e\gamma$	$< 1.7 \times 10^{-4}$ CL=90%	$< 10^{-7}$	$< 10^{-6}$
	$\mu\gamma$	$< 4.2 \times 10^{-6}$ CL=90%	$< 10^{-7}$	$< 10^{-6}$
	3μ	$< 1.7 \times 10^{-5}$ CL=90%	$< 2 \times 10^{-8}$ CL=90%	$< 5 \times 10^{-7}$ CL=90%
	$\pi\eta\nu$	$< 0.9 \times 10^{-2}$ CL=95%	$\sim 1 \times 10^{-5}$	$< 5 \times 10^{-5}$ CL=95%

BETTER by

~ × 10 ~ × 5

Topics in Charm and Charmonium Physics

- **CKM Matrix Elements** — V_{cd}/V_{cs} to $\sim 1\%$

  SEMILEPTONIC D^0 DECAYS

- **Weak Decay Constants** — f_D, f_{D_s} to 2%

  PURELY LEPTONIC D DECAYS

- **New Physics** — Sensitivity to BR's $O(10^{-8})$

  RARE DECAYS

- **D - $\overline{D}$ Mixing** — $r_D < 2.0 \times 10^{-5}$ in 1 year
  No confusion with DCSD

  SEMI-LEPTONIC DECAYS
  HADRONIC DECAYS

- **CP Violation** — Reach $\sim 1\%$ in 1 year

  $D^{*0}\overline{D^0}$ EVENTS
  $J/\psi'' \rightarrow$ (SEMILEPTONIC)(CP EIGENSTATE)
  $J/\psi'' \rightarrow$ (CP EIGENSTATE)(CP EIGENSTATE)

- **Absolute Branching Ratios**

  D MESONS: O(1%)
  D_s, Λ_c, Ξ_c, ... O(5%)

- **Charmonium** — O(3) more statistics

  SPECTROSCOPY
  ELECTROMAGNETIC COUPLINGS
  GLUONIUM SEARCH

Design of the Collider

- Collaboration with APS accelerator physicists
- Based in part on CERN/Spanish design
- Optimization of the lattice
- Vacuum chamber design
- Preliminary list of parameters
- The ideal injector system
- Cost estimate:

  Not complete yet

  Expected to be similar to CERN design
- Written document(s) in preparation
- CDR

  Approximately 2 years

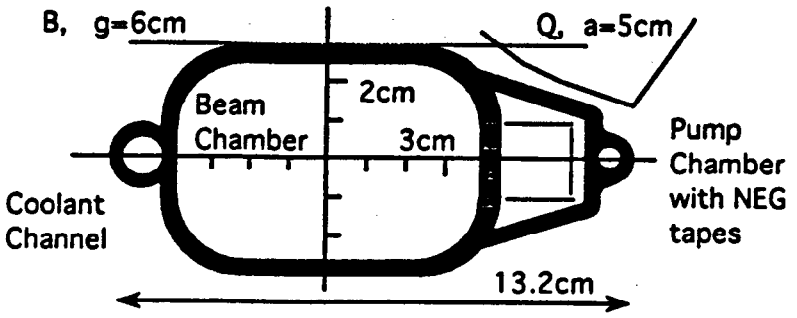
  5 - 10 people

Optimization of Lattice

- Monochromatic and Standard High Luminosity options were compared.
- The monochromatic option, along with a standard FODO arc, produced comparable luminosity, for a given tune shift with less modification of the arc lattice.
- We adopted the monochromatic mode as the primary option, with $\beta_x = 0.01$ m, $\beta_y = 0.037$ m, $D_y = 0.5$ m and $\varepsilon_x = 247$ nm @ 1.5 GeV.
- This leads to large charge/bunch.

  $I = 0.95$ A, $N = 2 \cdot 10^{11}$ /b, $\xi_x \sim \xi_y \sim 0.25$
- Higher currents require minimal impedance. Assume superconducting Cornell type cavities which should dominate the impedance of the ring.

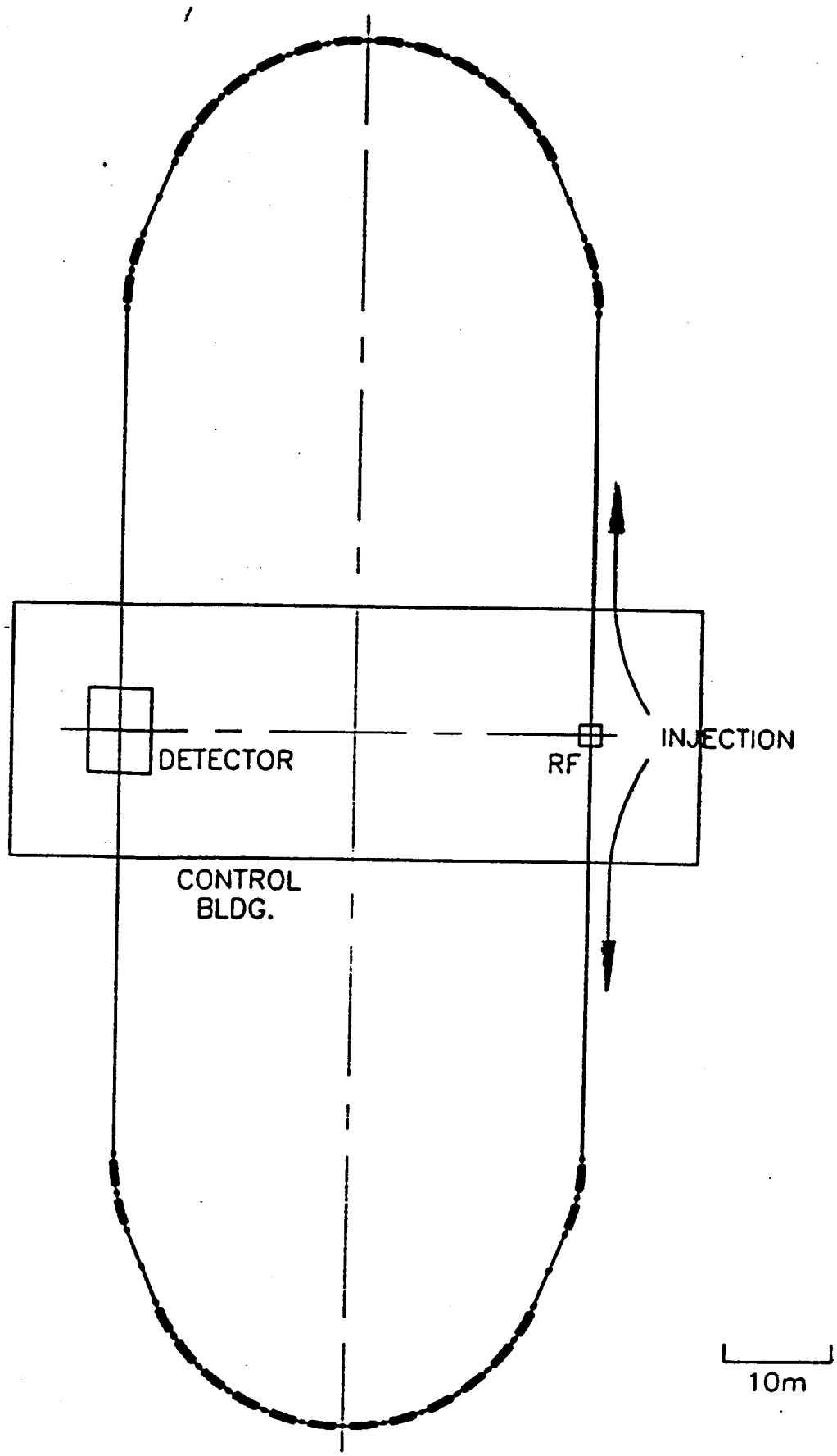
Vacuum Chamber



- Cost has driven the design.
- Vacuum chambers in arcs would be extruded Copper (or Aluminum).
- Pumping would be with non-evaporable getter (NEG) strips.
- Slots would be machined in extrusions, or cut using EDM.
- Chamber sections would be bent like the APS vacuum chamber.

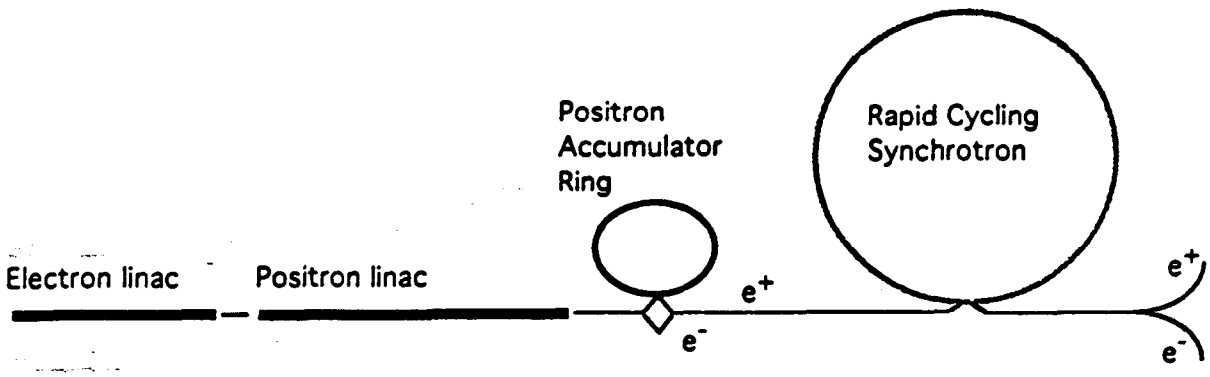
Initial Parameters

General		
Center of mass energy	3.0 - 5.0	GeV
Luminosity	10^{33}	/s /cm^2
Current	0.96	A /beam
Electrons (positrons)	$2 \cdot 10^{11}$	/bunch
Approximate circumference	360	m
Bend radius	11.71	m
Bunch spacing	~10	m
Natural emittance, ε_x, ε_y	247 / 5	nm
Bunch length	0.01	m
Momentum compaction	0.094	
Interaction Point		
β_x^*, β_y^*	0.010 / 0.037	m
Disperson, D_y^*	0.5	m
Beam beam tune shifts. ξ_x, ξ_y	0.025 / 0.026	
RF System		
RF frequency	~500	MHz
Required RF voltage	3.	MV
Radiated power	280	kW /beam
Cavities	1	/ring


DETECTOR
RF
INJECTION
CONTROL
BLDG.
10m

Injector Options

- An ideal high current injector would consist of
  - ~200 MeV electron linac
  - 450 MeV positron linac
  - Positron accumulator ring
  - Rapid cycling synchrotron



- The choice between reversing the synchrotron or building extra lines has been studied. Reversing seems cheaper.

- We have also studied the option without the positron accumulator ring and lower energy linacs.

General Considerations

- Strong support and interest within ANL HEP & APS divisions
- Interest by ANL management

  HEP community support?
- Proposal for Laboratory Directed R & D Funds submitted
- Recently, cancellation of ANL Integral Fast Reactor program

  Effect on new proposals at ANL?

Conclusions

- In our view: Physics motivation for a τcF is strong

  Despite B - factories, LEP

- ANL preliminary design of the collider almost complete

- Next steps:

  Initiation of detector studies

  Conceptual design report of collider

- Go ahead dependent:

  HEP community interest

  Support by ANL management

  DOE