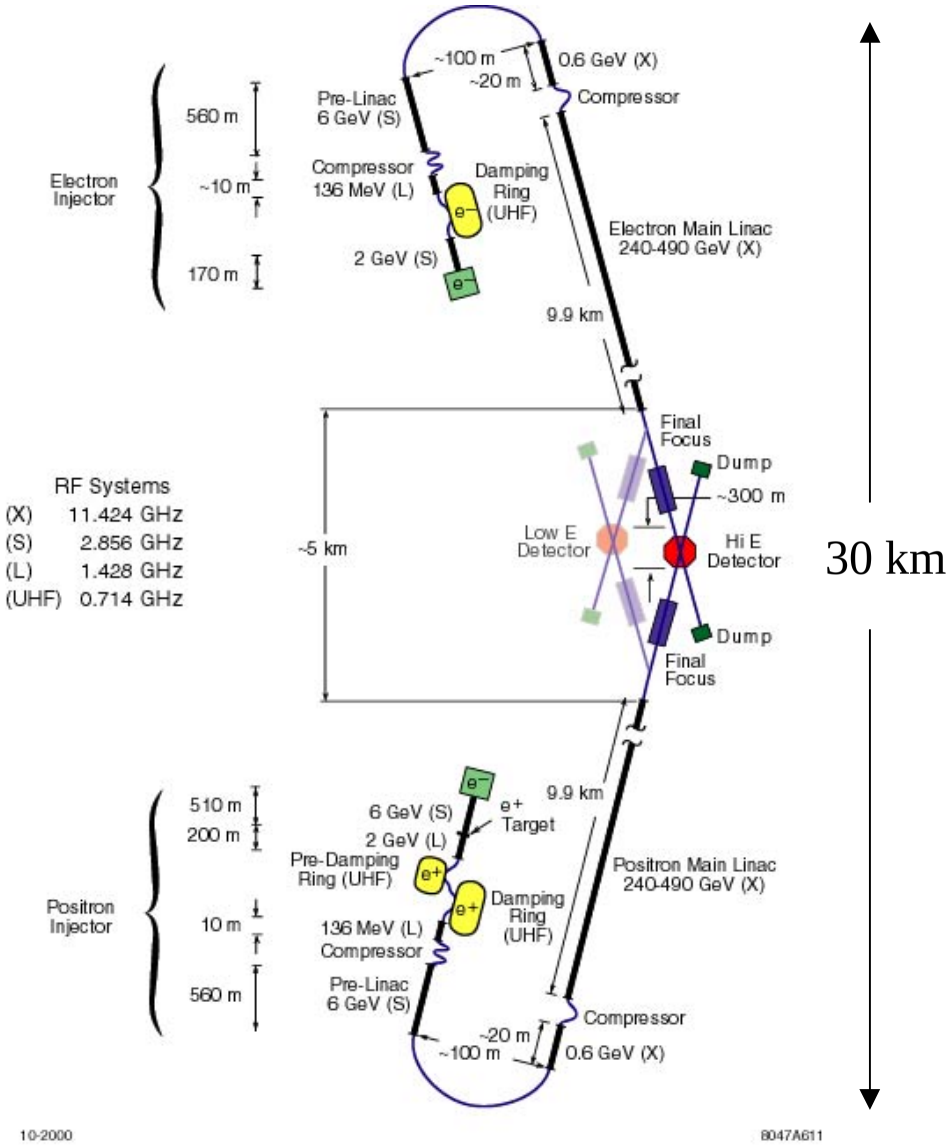
NLC e+/e- Linear Collider



Stage 1: 500 GeV cms

$L = 5x10^{33} \rightarrow 20x10^{33} \Rightarrow 500\ fb^{-1}$

Stage 2: 1 TeV cms

$L = 20x10^{33} \rightarrow 34x10^{33} \Rightarrow 1000\ fb^{-1}$

Higher Energy Upgrades:

1.5 TeV w higher gradient or length

1.5 TeV injector and beam delivery

3-5 TeV with advanced rf and upgraded injector

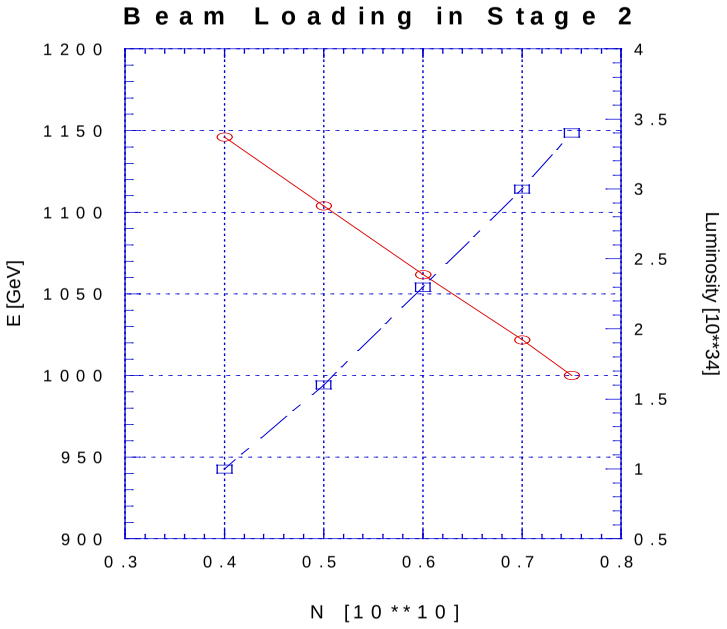
final focus sized for 3 to 5 TeV

linacs aimed at HE IR

Parameters

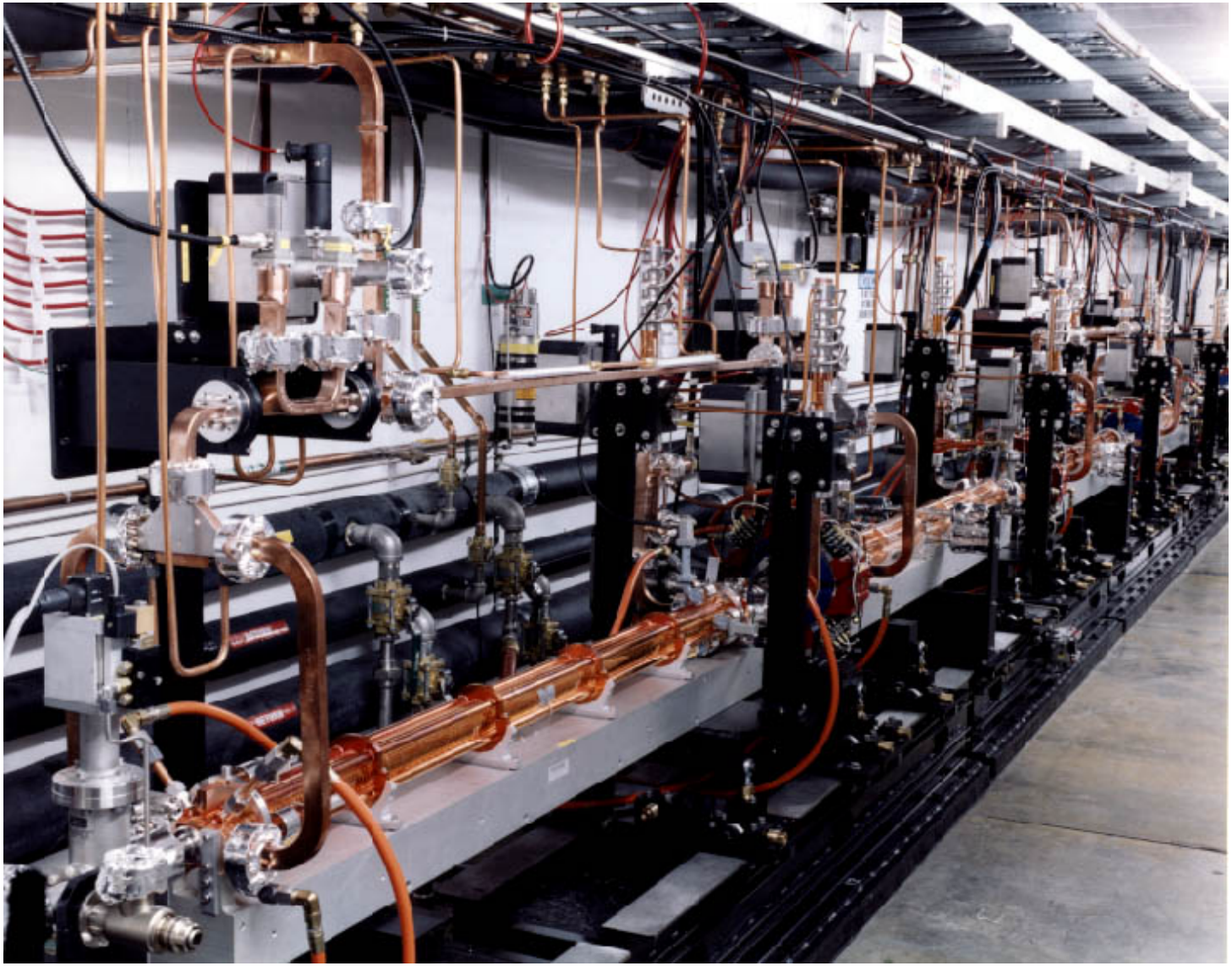
NLC Design Parameters

High E IP Parameters (3/01)	Stage 1	Stage 2
CMS Energy (GeV)	500	1000
Luminosity (10^{33})	**20**	**34**
Repetition Rate (Hz)	120	120
Bunch Charge (10^{10})	**0.75**	**0.75**
Bunches/RF Pulse	190	190
Bunch Separation (ns)	1.4	1.4
Eff. Gradient (MV/m)	**50.2**	**50.2**
Injected $\gamma\varepsilon_x$ / $\gamma\varepsilon_y$ (10^{-8})	300 / 2	300 / 2
$\gamma\varepsilon_x$ at IP (10^{-8} m-rad)	360	360
$\gamma\varepsilon_y$ at IP (10^{-8} m-rad)	**3.5**	**3.5**
β_x / β_y at IP (mm)	8 / 0.10	10 / 0.12
σ_x / σ_y at IP (nm)	**245 / 2.7**	**190 / 2.1**
σ_z at IP (um)	110	110
Υave	0.11	0.29
Pinch Enhancement	1.43	1.49
Beamstrahlung δB (%)	4.7	10.2
Photons per e+/e-	1.2	1.3
Linac Length (km)	6.3	12.8



Low Energy IP Parameters (8/00)	92	250	350
CMS Energy (GeV)			
Luminosity (10^{33})	**3.5**	**9.4**	**13.2**
Repetition Rate (Hz)	**120**	**120**	**120**
Bunch Charge (10^{10})	**0.75**	**0.75**	**0.75**
σ_x / σ_y at IP (nm)	**630 / 6.2**	**380 / 3.8**	**320 / 3.2**
L0 / Ltotal (%)	62	47	43
Beamstrahlung δB (%)	0.18	1.1	2
Photons per e+/e-	0.49	0.79	0.92
Polarization loss (%)	0.08	0.21	0.34

NLC Test Accelerator



X-Band RF System

NLCTA RF system (ZDR, 1996):

- Conventional PFN modulator
- 50 MW/1.5μs solenoid-focused klystrons
- SLED-II pulse compression
- DDS structures work at gradients up to 40 MV/m

→ Tested, could be used to build a 500 GeV collider

Improvements to reduce cost and improve performance:

- Solid state modulator
- 75 MW/3μs PPM-focused klystrons
- DLDS pulse compression
- RDDS structures - 70 MV/m

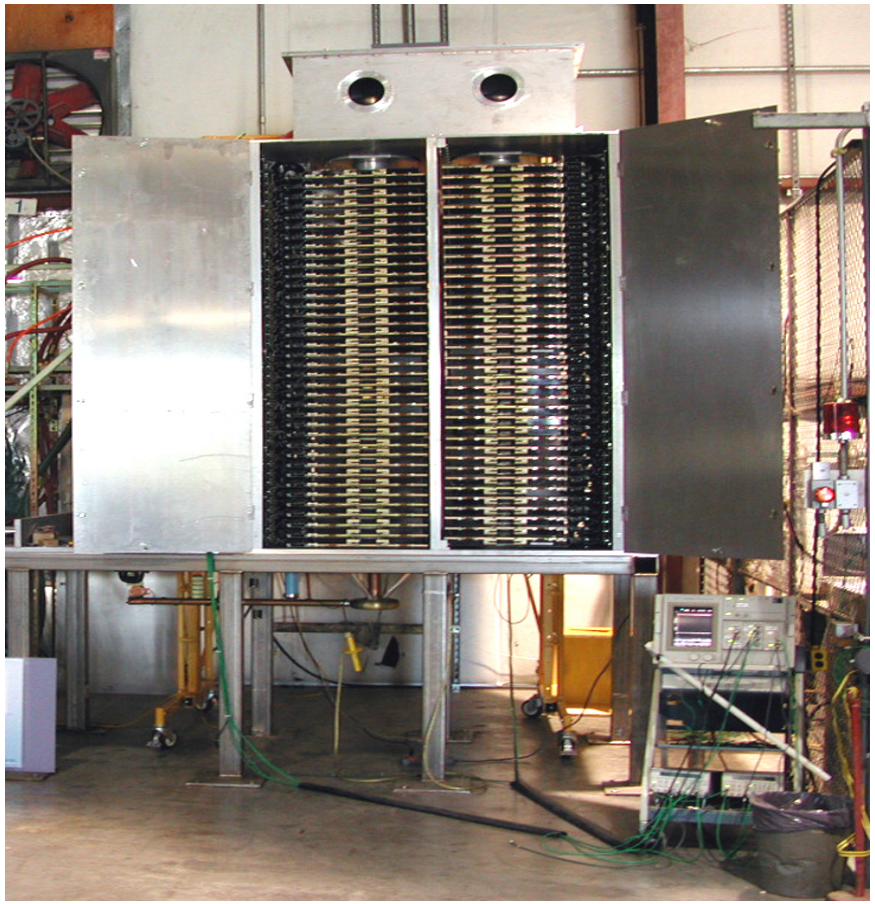
→ Aimed to optimize performance and cost at 1 TeV

Solid-State Induction Modulator R&D

SLAC-LLNL-Bechtel

10-Stack in Linac Gallery

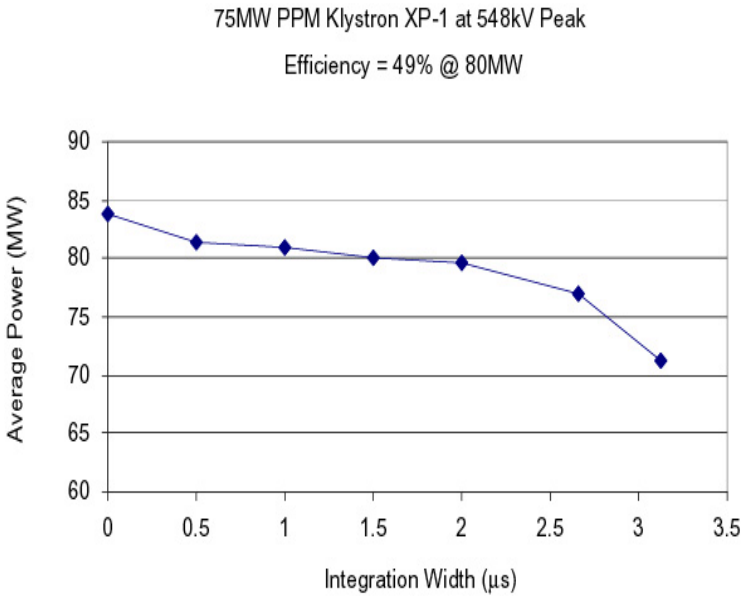
Full-scale Prototype



SLAC 75 MW Klystron Program

XP1:

Achieved Stable Performance Over 70 MW at twice the Design Pulse Length - 3 ms (Modulator Limited)



XP3: Next Generation Tube Designed for Manufacturability

- Design Essentially Complete
- Beam diode ready to test
- Klystron To Be Tested in July

Vendor Qualification: Toshiba, EEV, CPI building tubes, parts

X-Band RF Unit

Two-Mode ‘8-Pack’

Low Level RF System

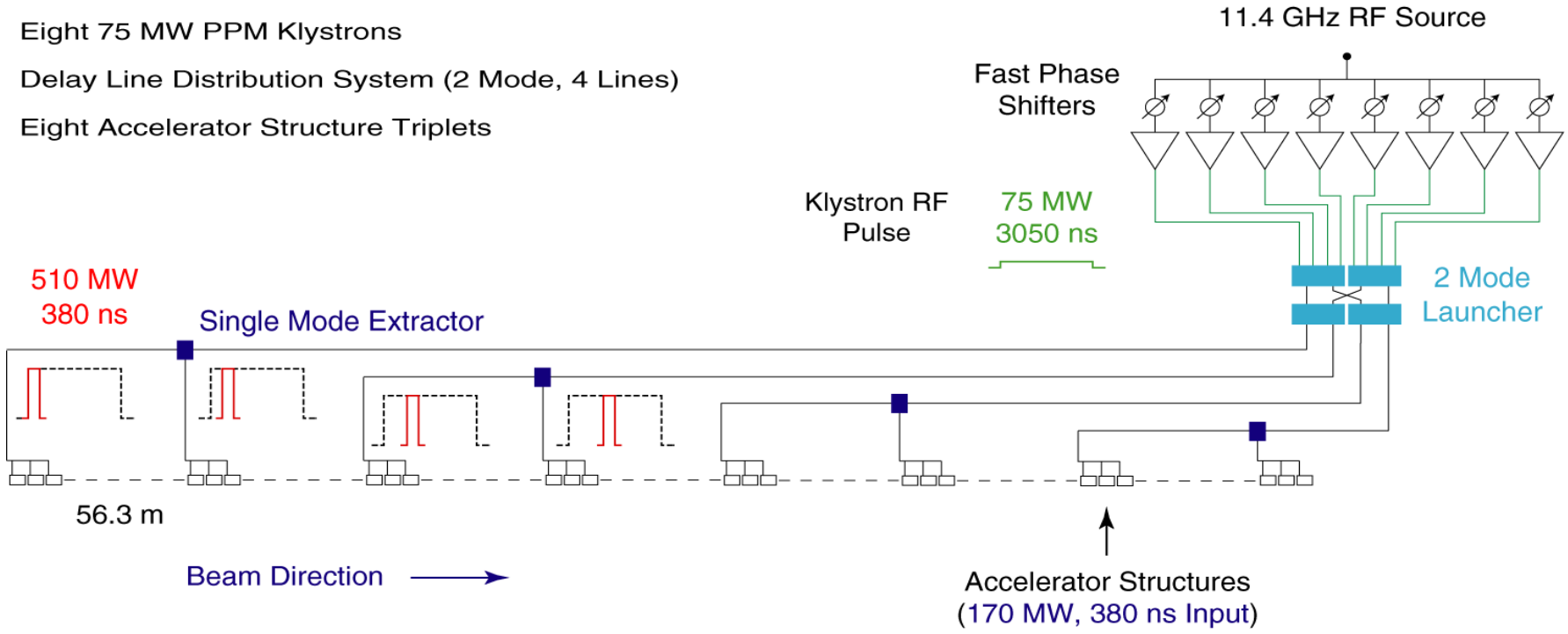
One 490 kV 3-Turn Induction Modulator (not shown)

Eight 2 KW TWT Klystron Drivers (not shown)

Eight 75 MW PPM Klystrons

Delay Line Distribution System (2 Mode, 4 Lines)

Eight Accelerator Structure Triplets



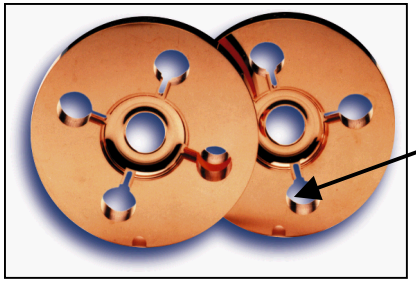
Wakefields and Accelerator Design

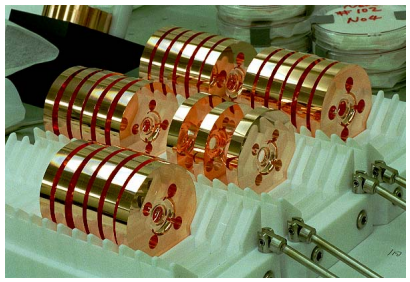
Wakefields – fields left by beam particles as they pass through the structure.

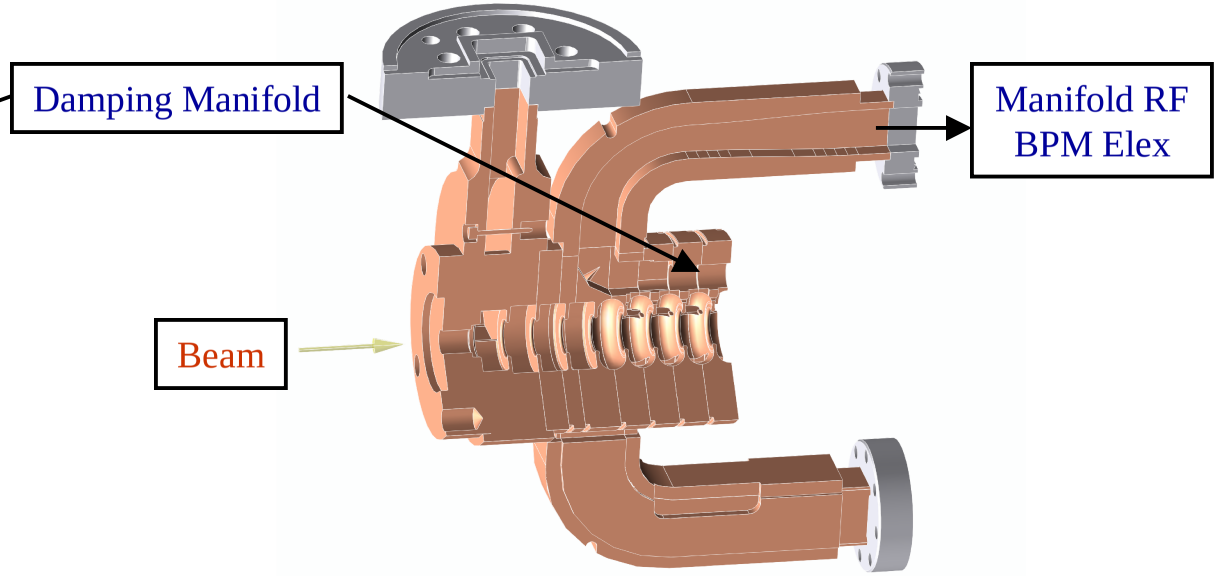
Control of transverse wakes …

- "Detune" cells by giving each different transverse dimensions.
- "Damp" transverse wakefields by coupling to damping manifold and extracting power at frequencies above 11 GHz.

Structure RF BPMs –power extracted from horizontal and vertical damping manifolds.

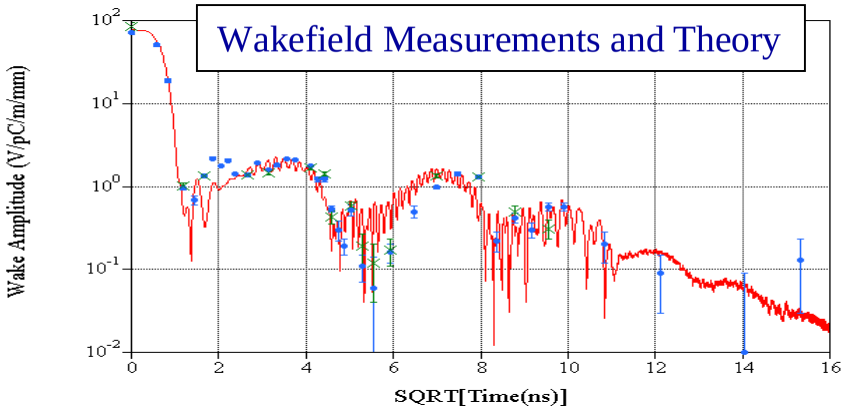


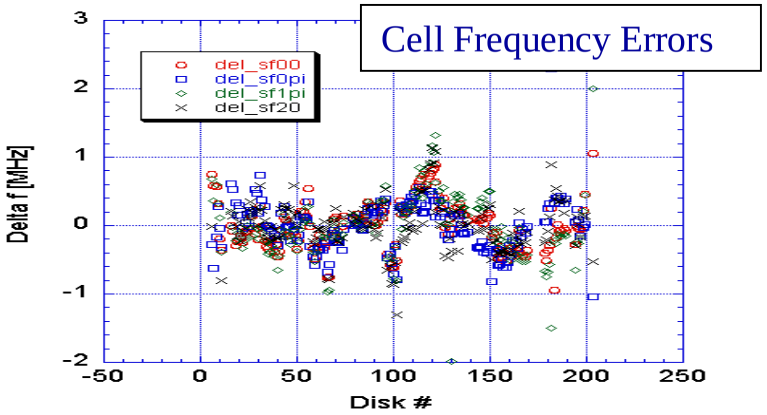




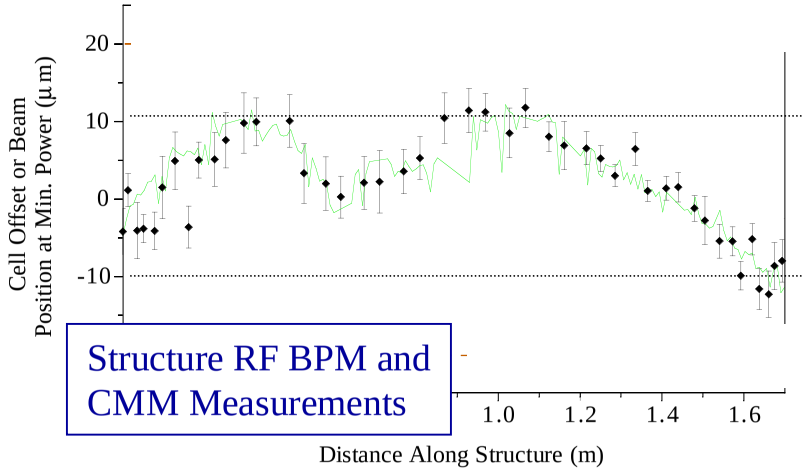
Structure Design and Manufacture

Theory accurately predicts measured wakefields in accelerator structures.





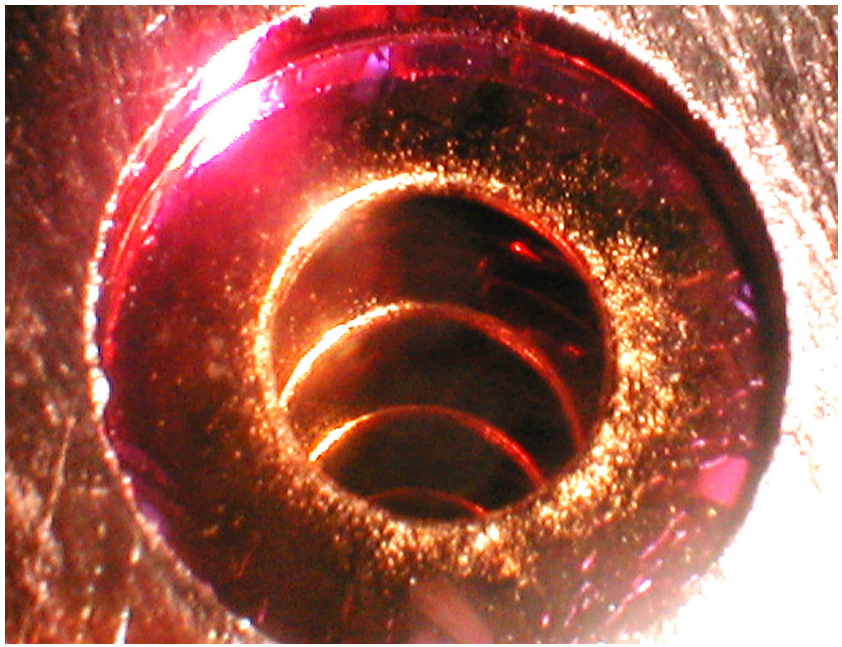
Cell frequency errors of 0.5 MHz (tol 3 MHz).

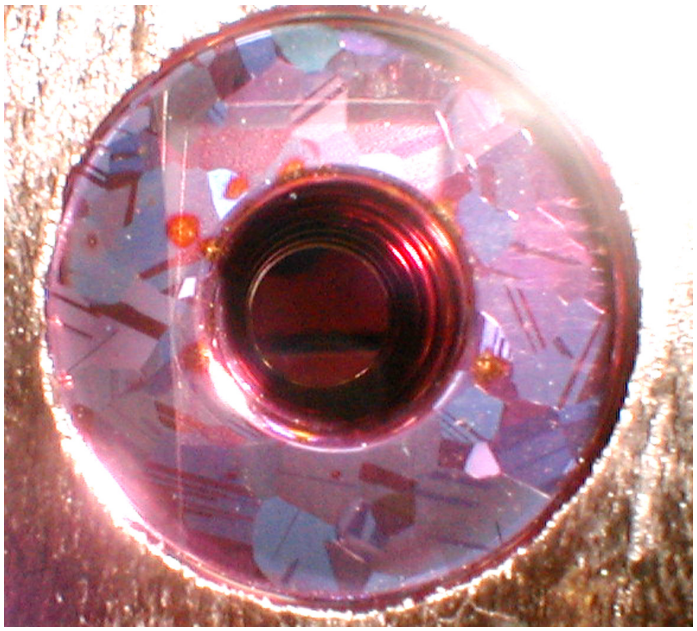


Structure RF BPM precision of 1µm (tol 10).

High Gradient Damage

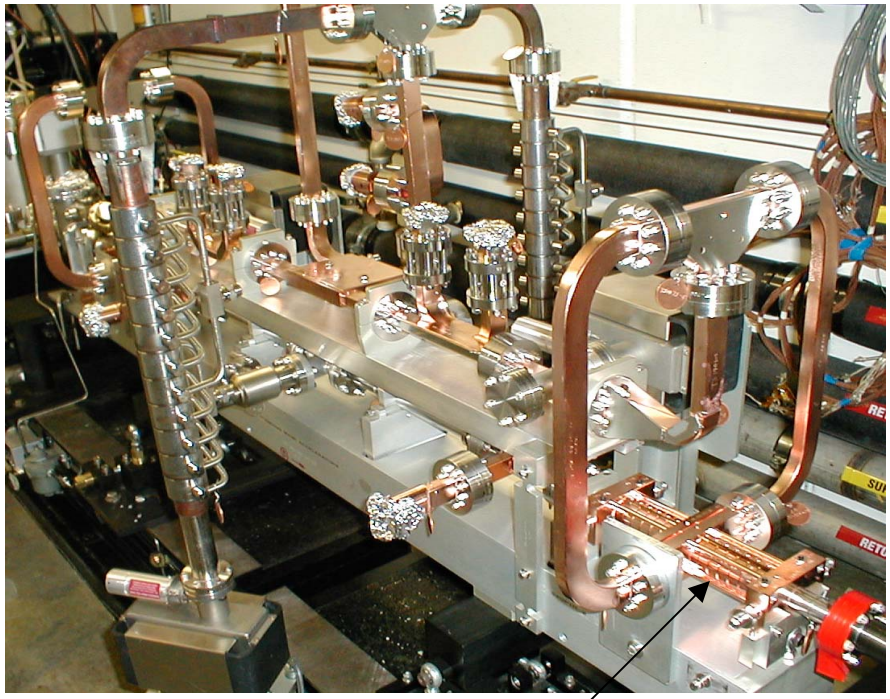
- Damage (pitting) around irises is observed in the front of the structure (1000 hours @ ~ 50 MV/m)
- The downstream part is undamaged (same surface field!)





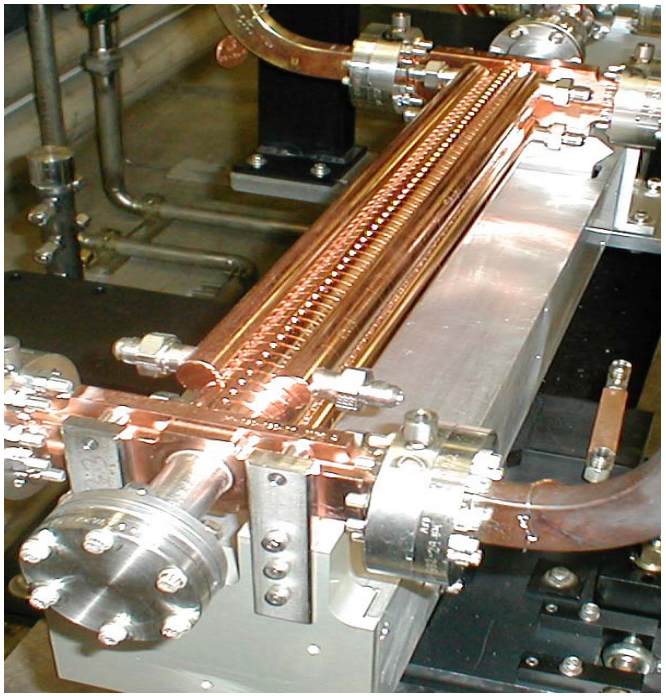
C. Adolphsen

High Gradient Run 3 – Now Running in NLCTA



S20PI

New 20 cm standing wave pair.



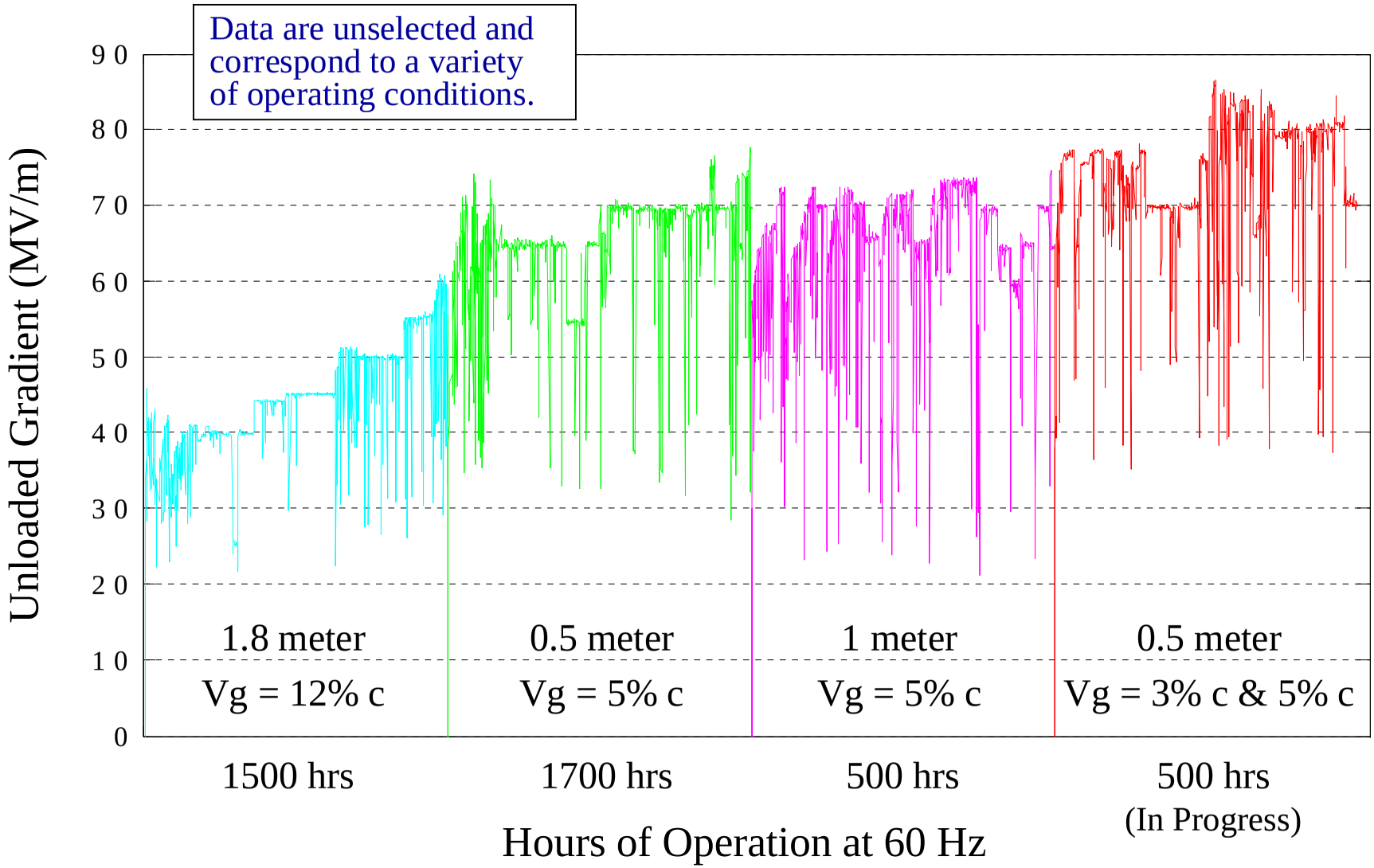
T53VG5N and T53VG3N

New 53 cm test structures.

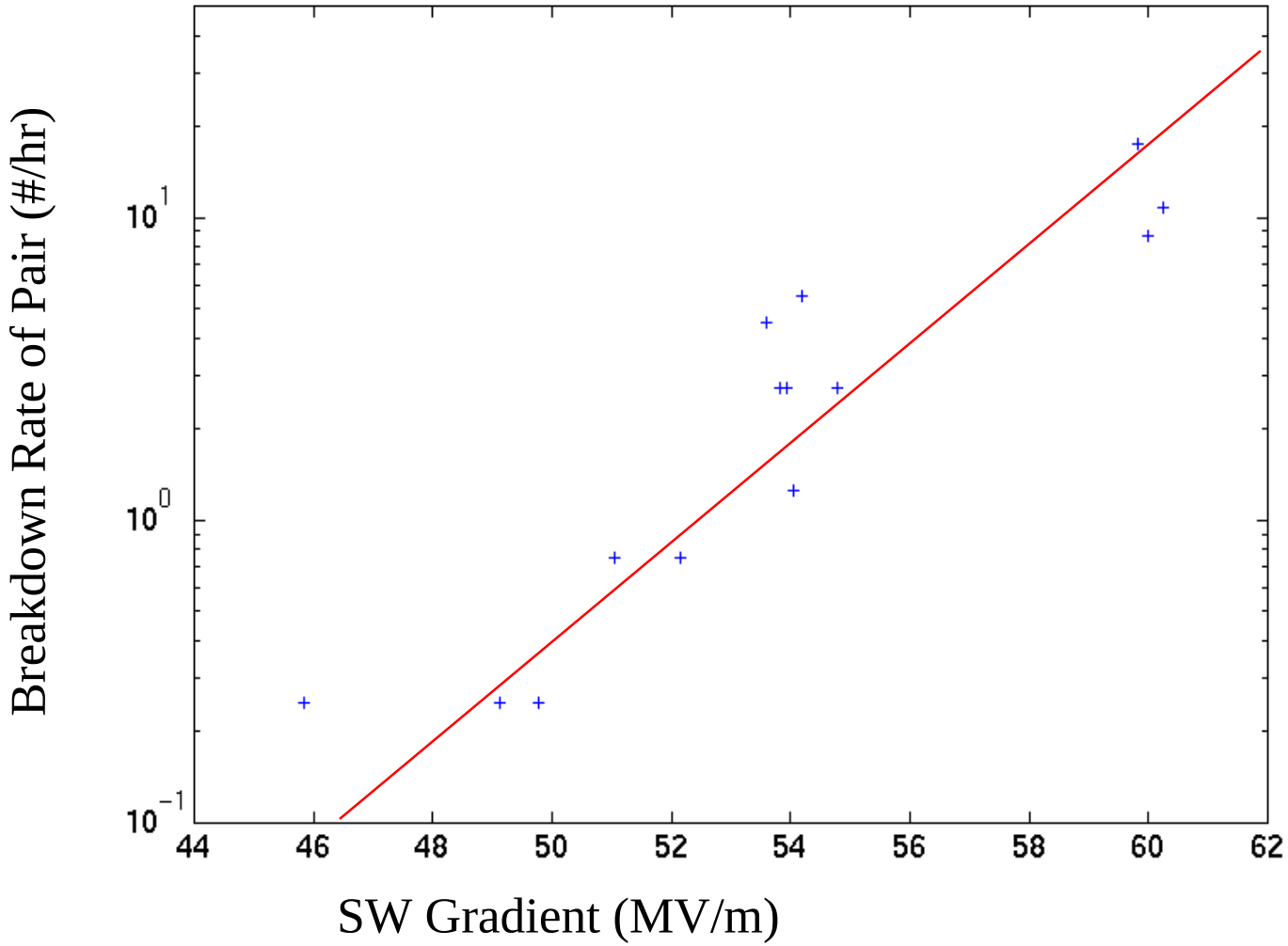
v_g from 5% to 3.3% c

and v_g from 3.3% to 1.6% c

Operational History of Test Structures



First Standing Wave Structure Performance



NLC Status and Plans

- Integrated System test of prototype components with beam in NLCTA in 1997 (Eacc = 40 MV/m)
- Verified HOM damping and detuning.
- Accelerator structures for higher gradients (55 MV/m loaded, 70 MV/m unloaded) under test now.
- Early 2002: High gradient test of 0.9m structure with low vg, continue standing wave tests.
- Early 2003: System test for high power pulse compression system components, klystrons, new modulator.
- Early 2004: Integrated system test with 8-pack RF station, modulator, klystrons, pulse compression and 12 structures.