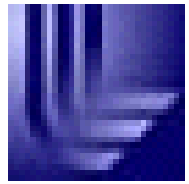
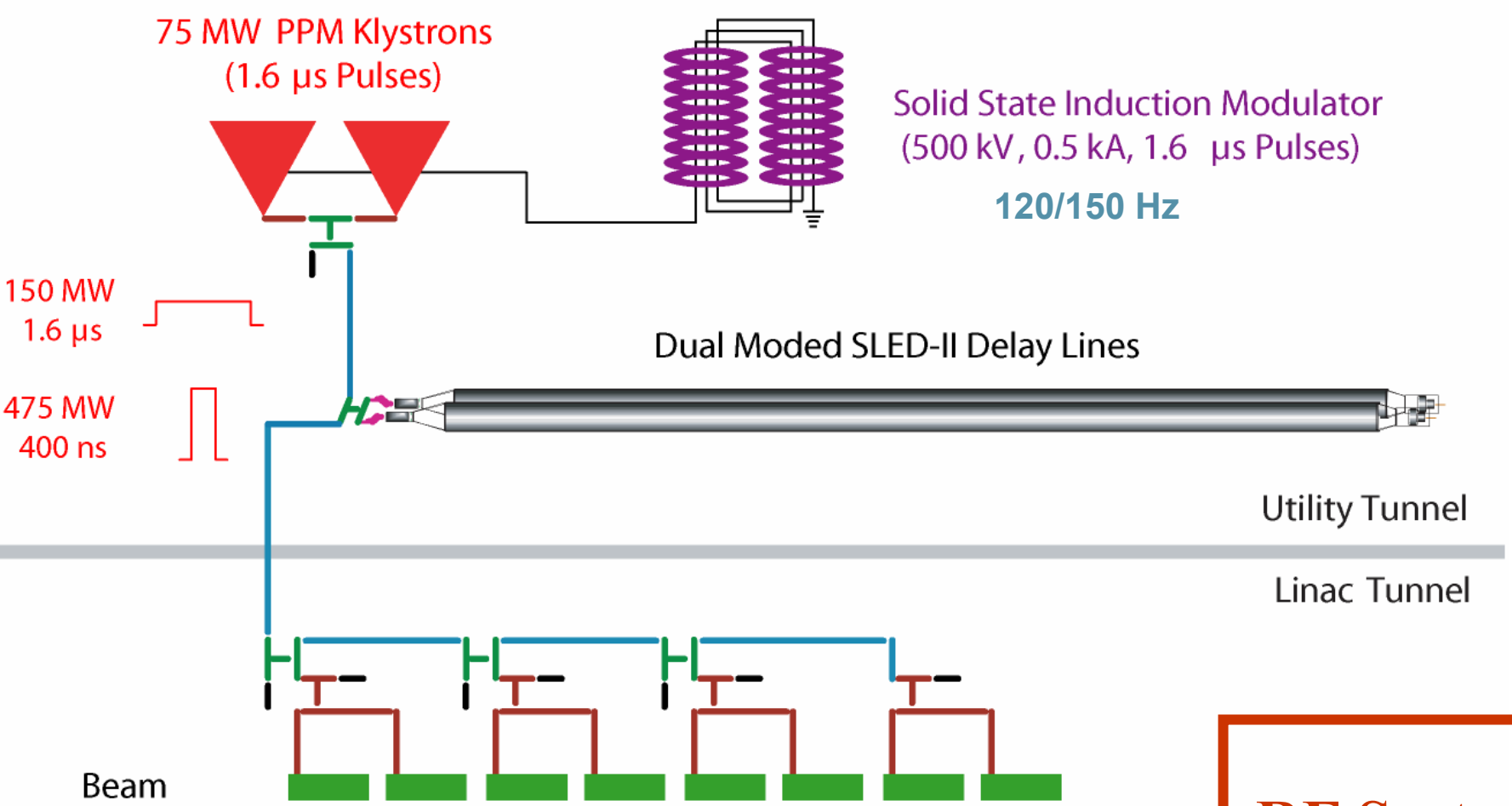


The Normal-Conducting Linear Collider preparation - *status and plans*

07.01.2004

Marc Ross



Eight Accelerator Structures (0.6 m, 65 MV/m Unloaded, 52 MV/m Loaded)

RF System: Copper Accelerator

- *Design:* KEK, Fermilab and SLAC
- *Production:* KEK, Fermilab, LLNL and SLAC
- *High Power Test:* KEK and SLAC

X-band test facilities

GLCTF at KEK

2003

1 test position /w full power @100Hz

(3 in 2004)

beam in 2005

2 x 50 MW pk klystrons

KEK Tristan Assembly Hall

NLCTA at SLAC

1996

4 test positions /w full power @60 Hz

(8 in 2004)

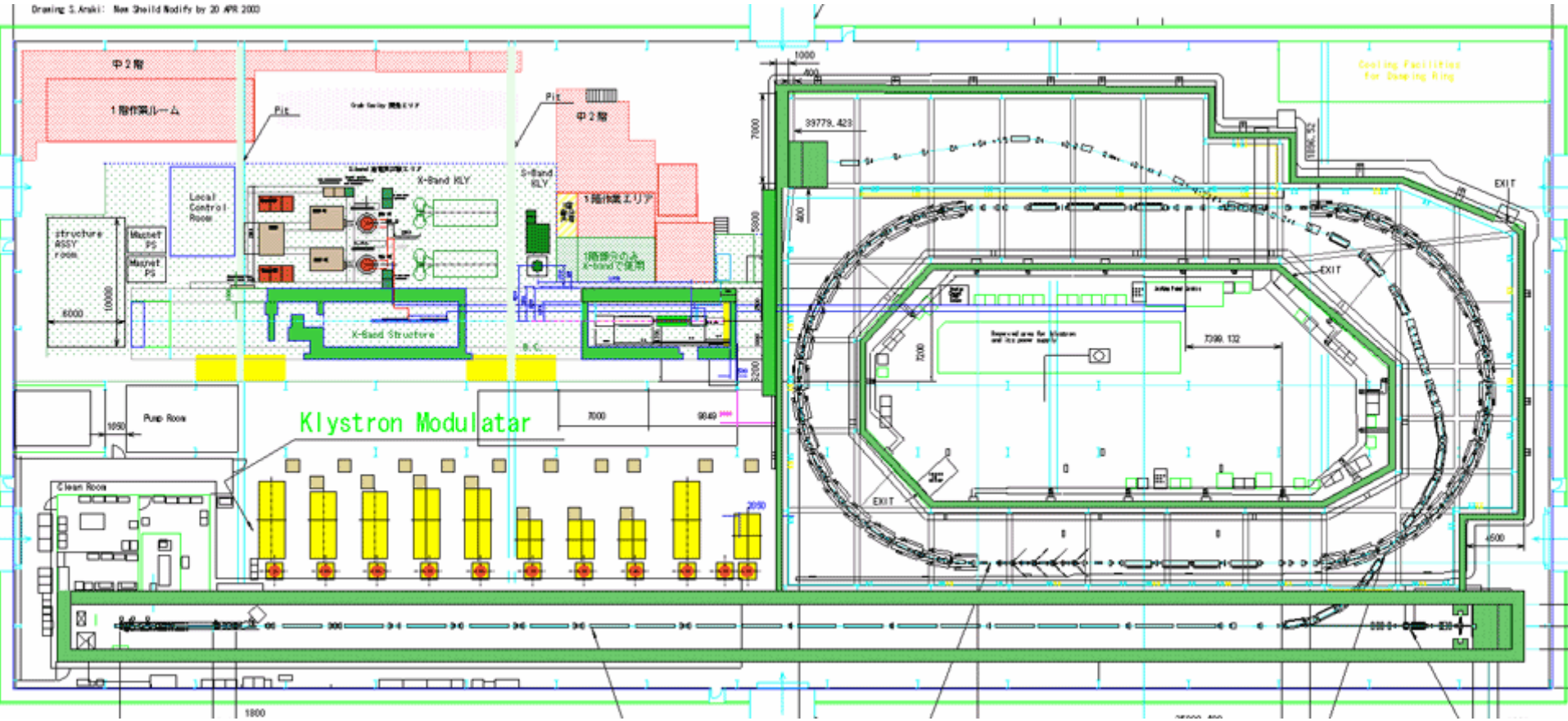
170 ns beam

9 x 50 MW pk klystrons

SLAC End Station B


GLCTF at KEK in April 2003

高エネルギー加速研究機構



The Accelerator Test Facility at KEK

1.3 GeV Damping Ring and S-band linac
100 MW X-band structure testing
1998 →

The world's largest LC test facility

World's lowest emittance beam:

ε_y = *4 pm-rad*
below X-band LC req's

Tevatron 1984: " Make and test magnets *(structures)* as fast as possible"

A. V. Tollestrup

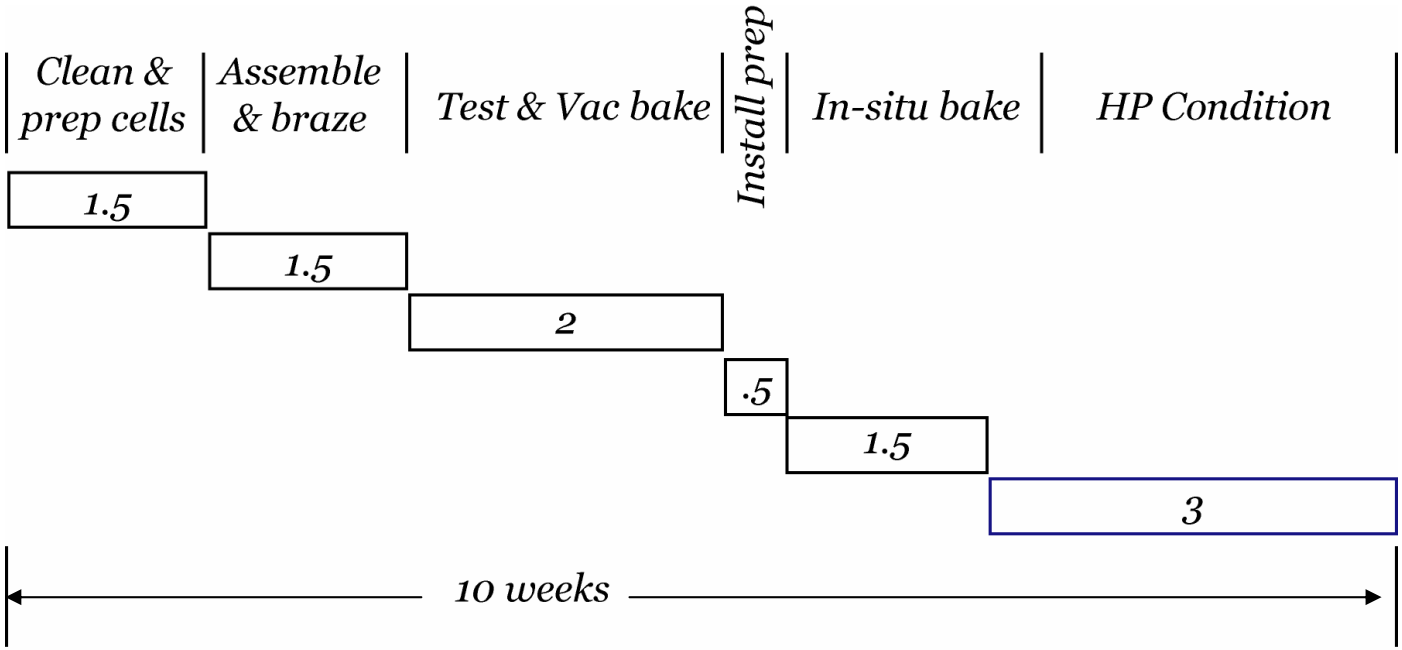
X-band structure production

- Structure RD: *three – fold focus*
  - *Electrical design*
    - coupler, power flow and gradient
  - *Materials / fabrication process*
    - particulates, surface, grain size and chemistry
  - *Test and understand*; validate with beam
    - diagnostics, post-mortem and analysis

- 2003 structure production rate:
  - 16/year
  - (almost) fully featured
  - 2x higher in 2004 -- *Fermilab*

RD Goal:
Fully featured structure (slots...)
Maximum efficiency
Sustainable gradient
'breakdown rate'

Structure Testing & Processing



from machined cells to high gradient in 10 weeks – *FNAL, SLAC & KEK*

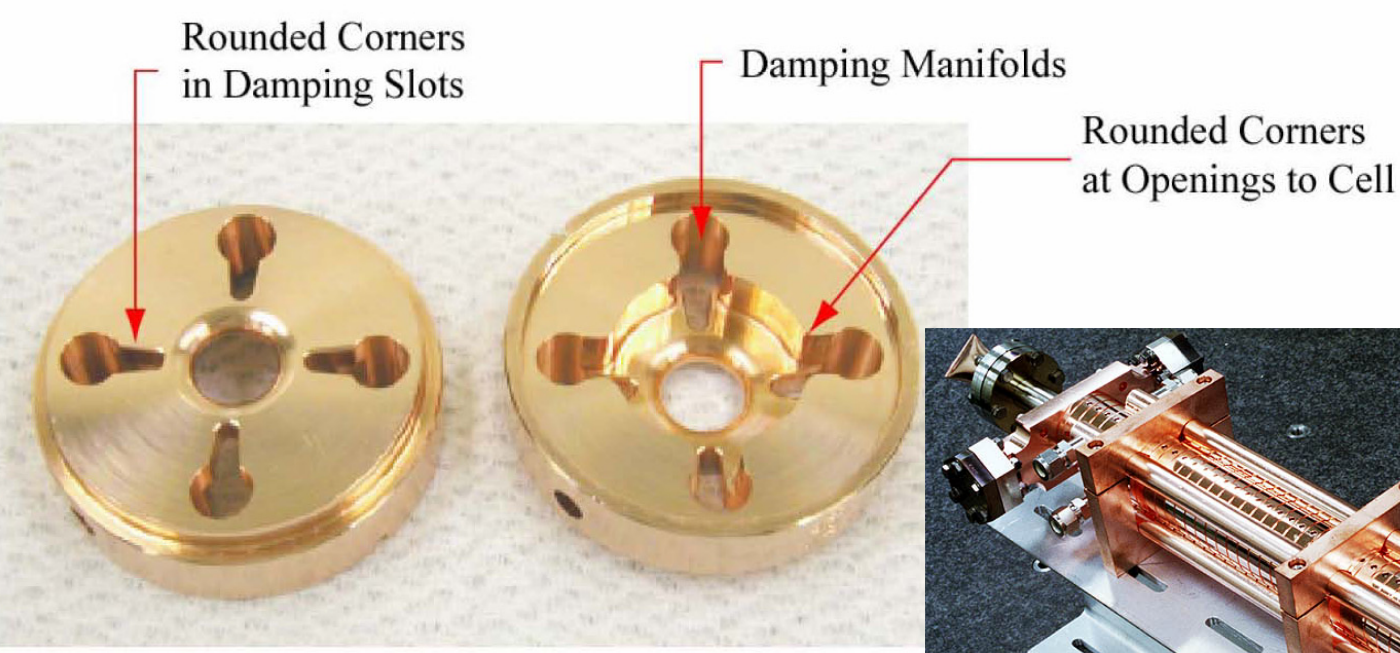
NLCTA/GLCTF operate ~ 4000 hours / year

Production rate:

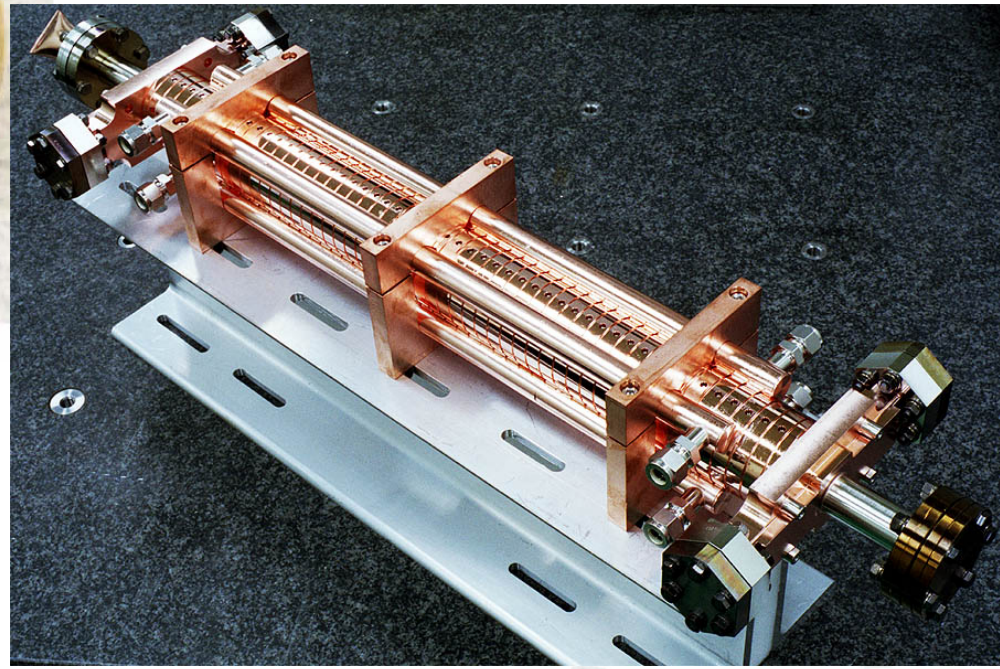
~ 16 x 0.6m/year

=10 m / year

= 650 MeV/year

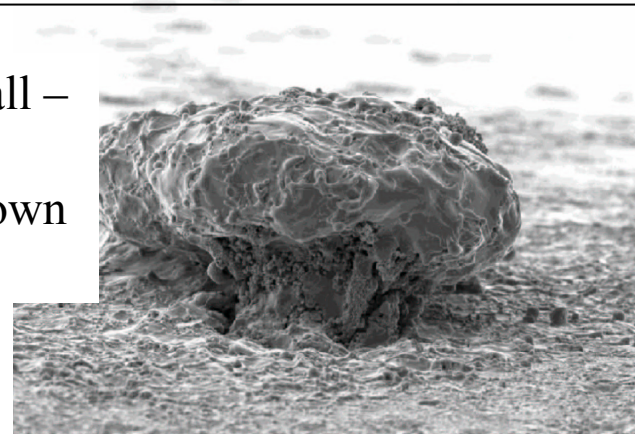


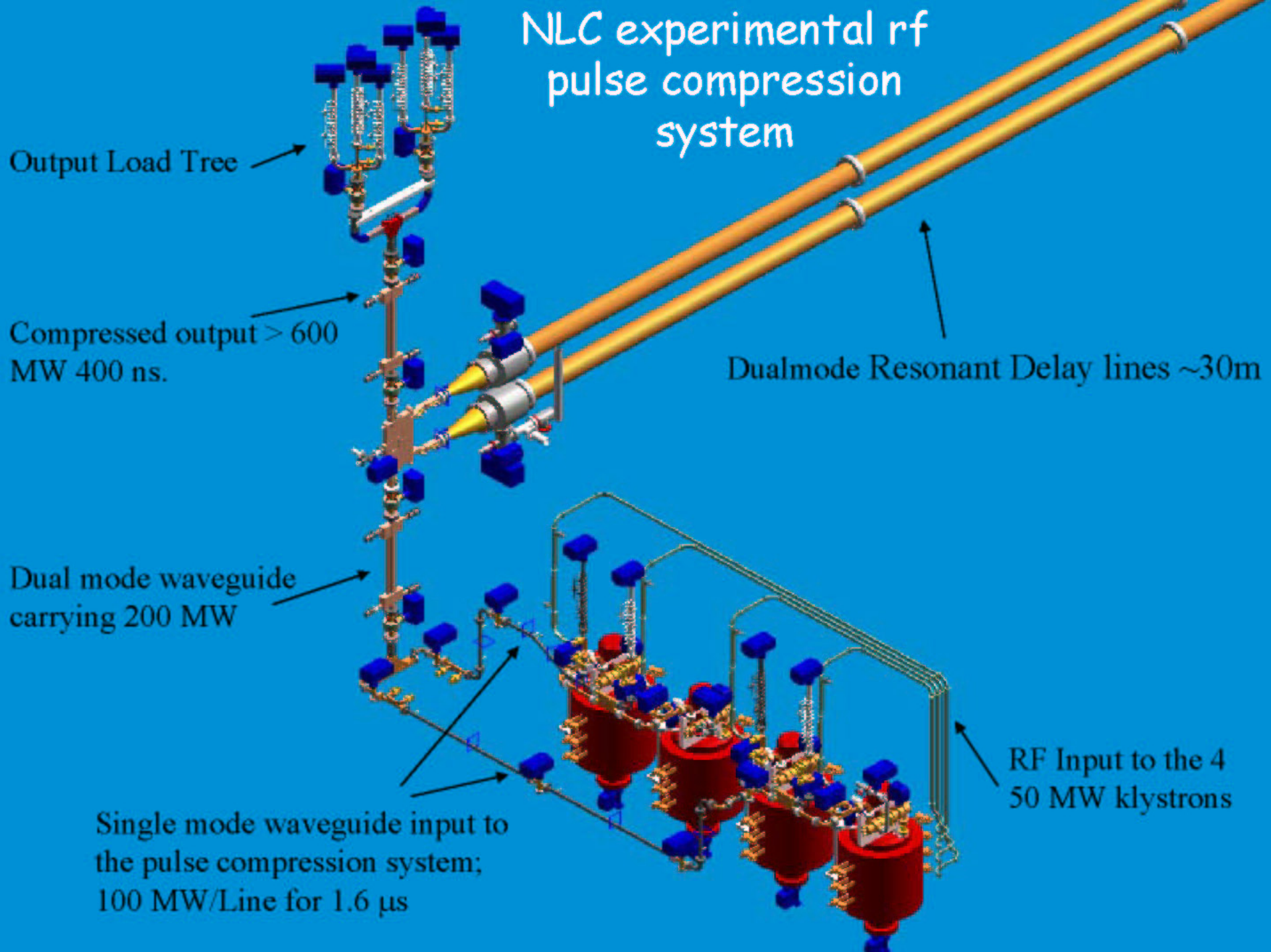
Structure fabrication includes:



- good copper
- high quality commercial machining
- light chemical etch
- in-house brazing, diffusion bonding
- vacuum fire or hydrogen fire
  - increases grain size
- in-situ bake
- nominal clean room process

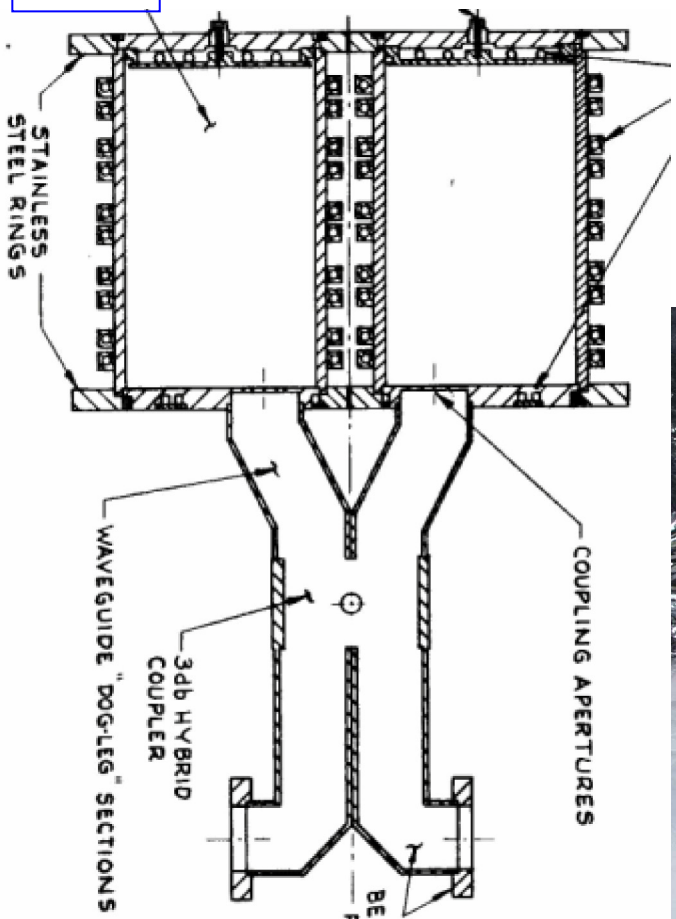
SS inclusion in cell wall – covered with and surrounded by breakdown 'craters' →



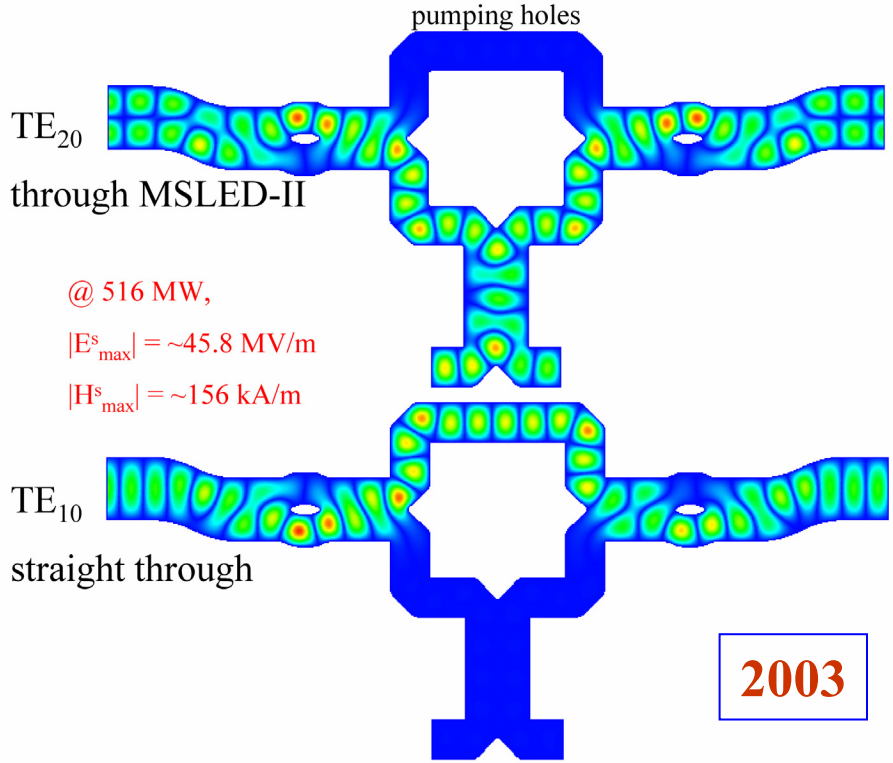

NLC experimental rf pulse compression system
Output Load Tree
Compressed output > 600 MW 400 ns.
Dual mode waveguide carrying 200 MW
Single mode waveguide input to the pulse compression system; 100 MW/Line for 1.6 μs
Dualmode Resonant Delay lines ~30m
RF Input to the 4 50 MW klystrons

SLED hybrids: 1973-2003

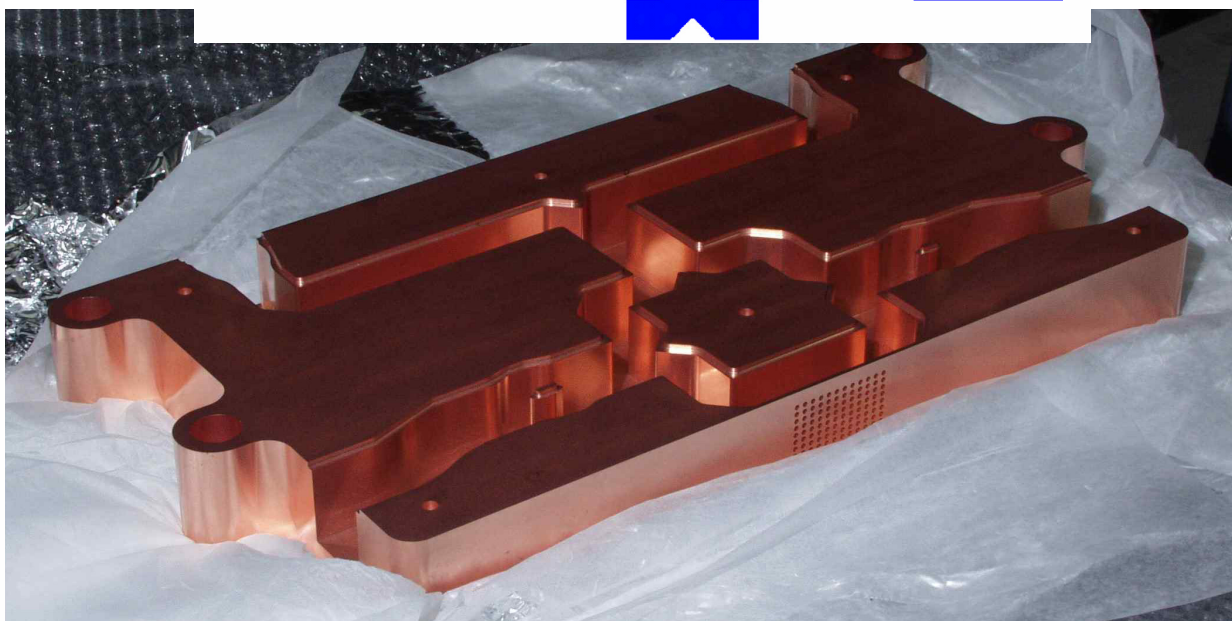
1973

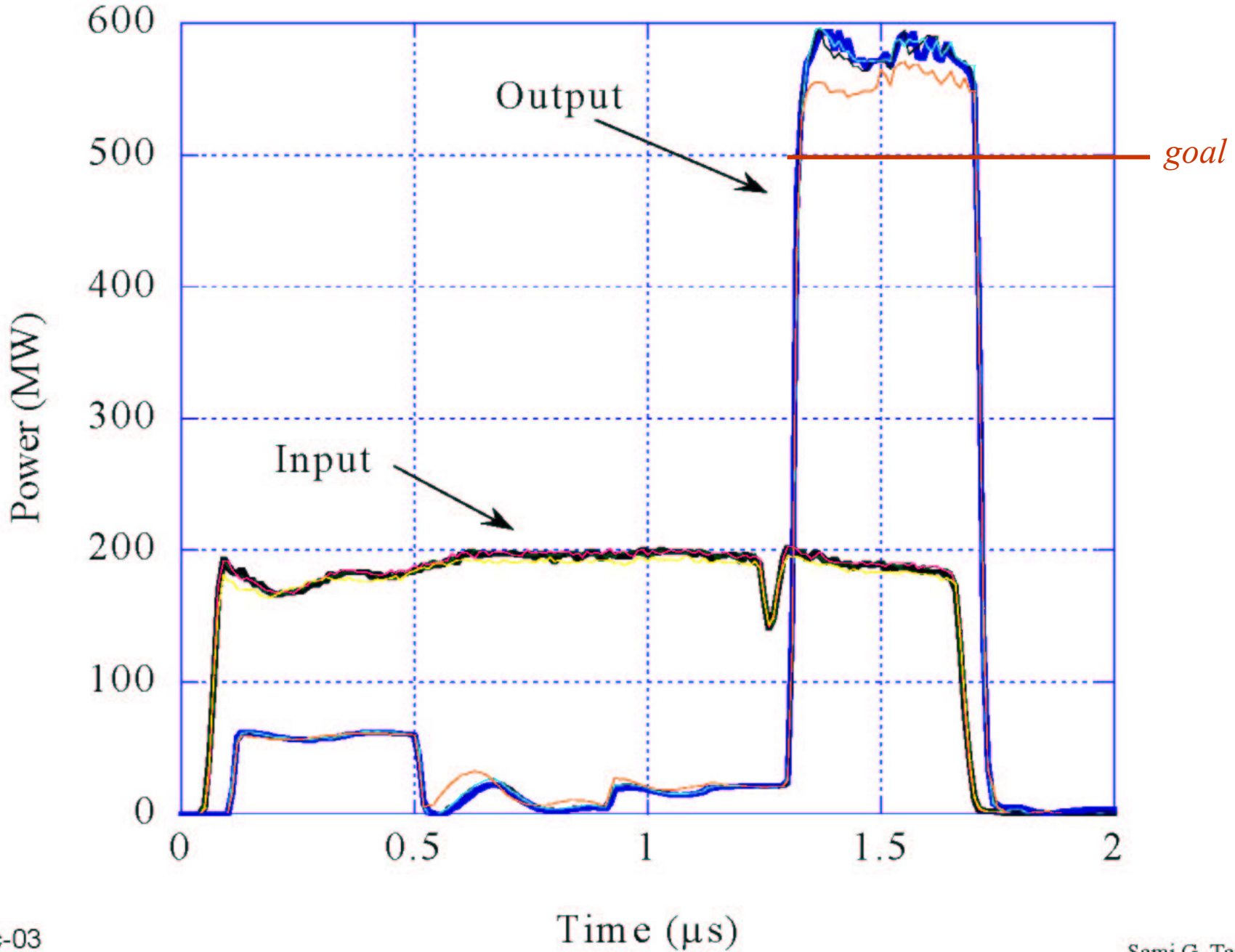


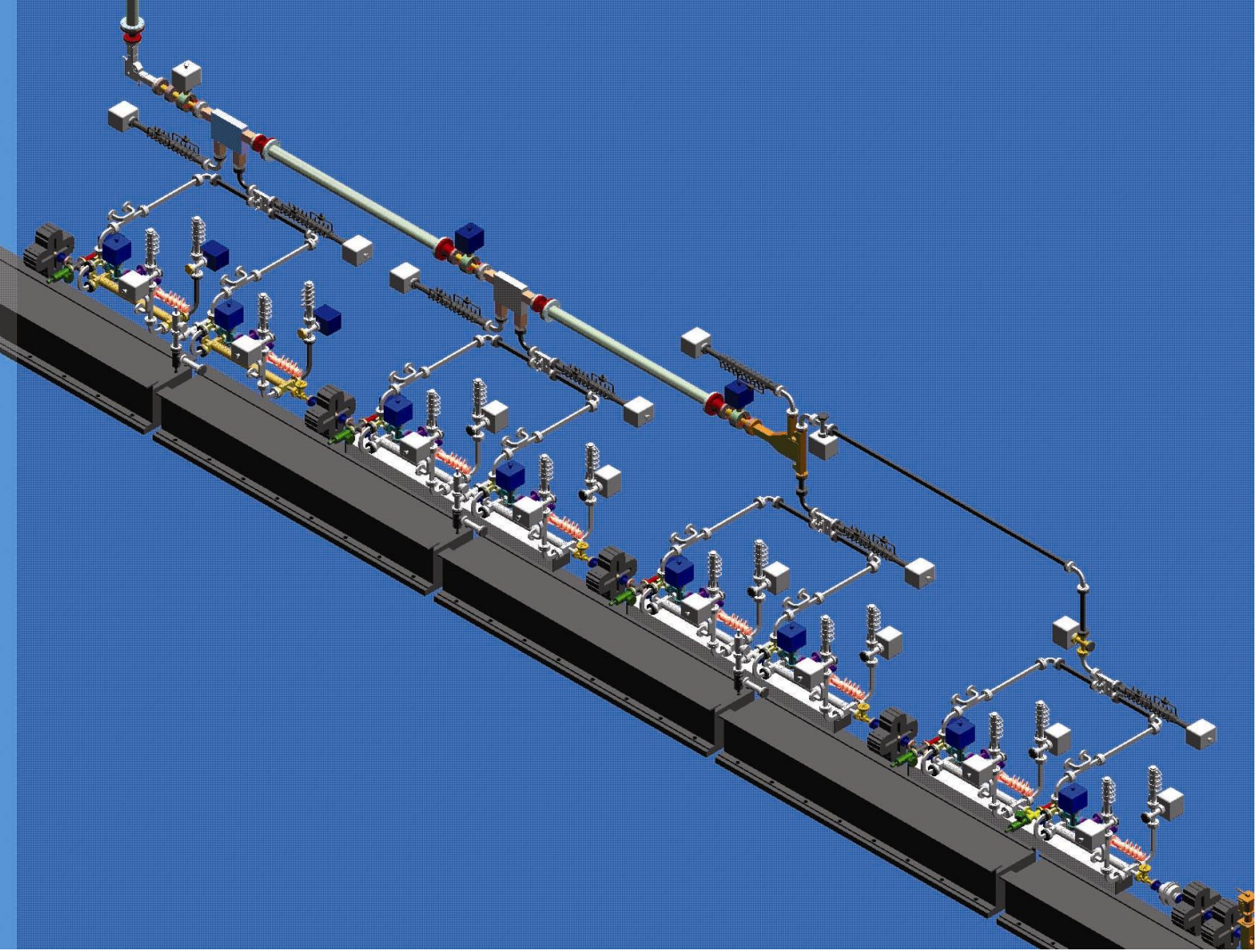
Sled Head Simulations



2003




600
500
400
300
200
100
0
Power (MW)
Output
goal
Input
0
0.5
1
1.5
2
Time (μs)

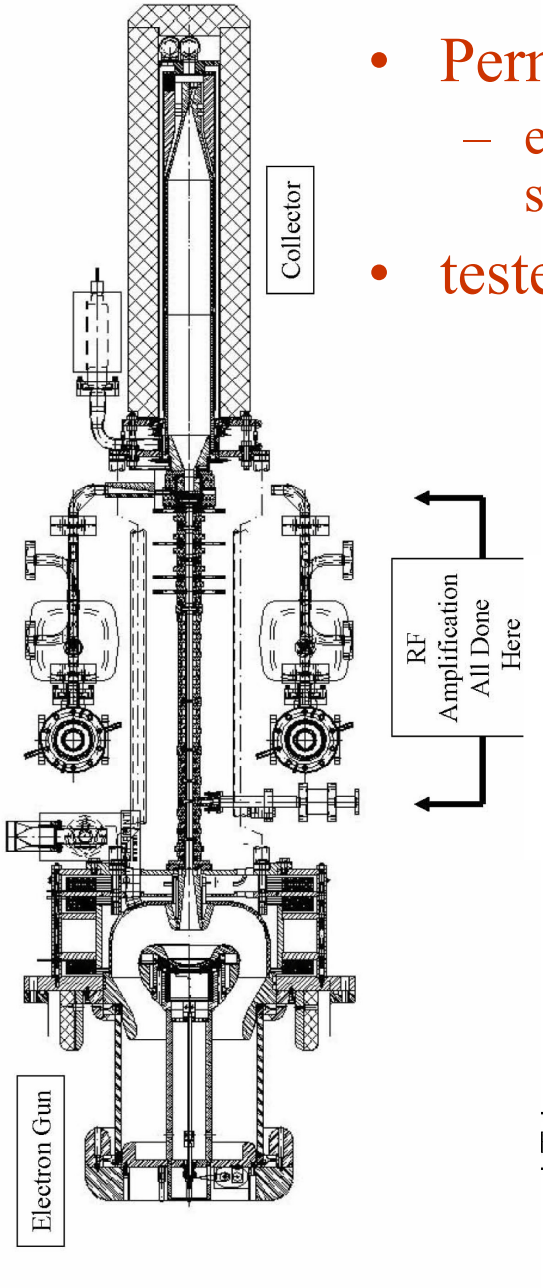


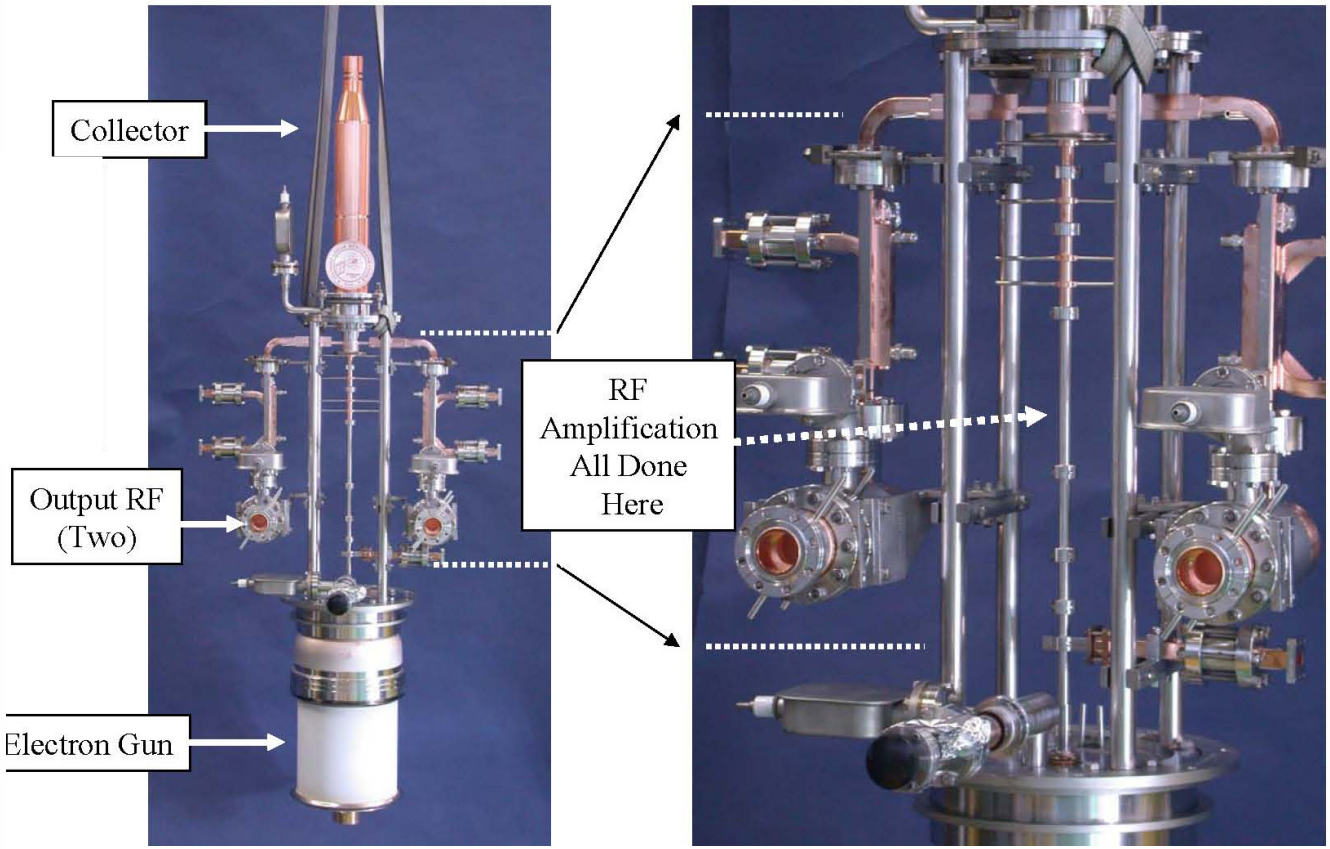
Connect SLED 2 to NLCTA March 2004

- Connect the output of the new SLED 2 system to the structure testing stations in NLCTA
  - Doubles the number of testing stations
- complete NLC/GLC RF system

75MW Klystron X band power source

- Toshiba/KEK & SLAC
- Permanent magnet focusing
  - efficiency improved 2x without solenoid
- tested successfully summer '03





X-band RF summary

- Power converter: *tested at full voltage,*
  - reduced repetition rate
- Source: *2 successful tubes* with ~ 100 hours
- Distribution: *operated successfully well above goal*
  - now steadily accumulating operations 'hours'
- Structure: *~ fully slotted structures*
  - → breakdown rates at full unloaded gradient ~ 2 x above goal

Interlaboratory Collaboration for R&D Towards TeV-scale Electron-Positron Linear Colliders

International Linear Collider Technical Review Committee

ILC-TRC

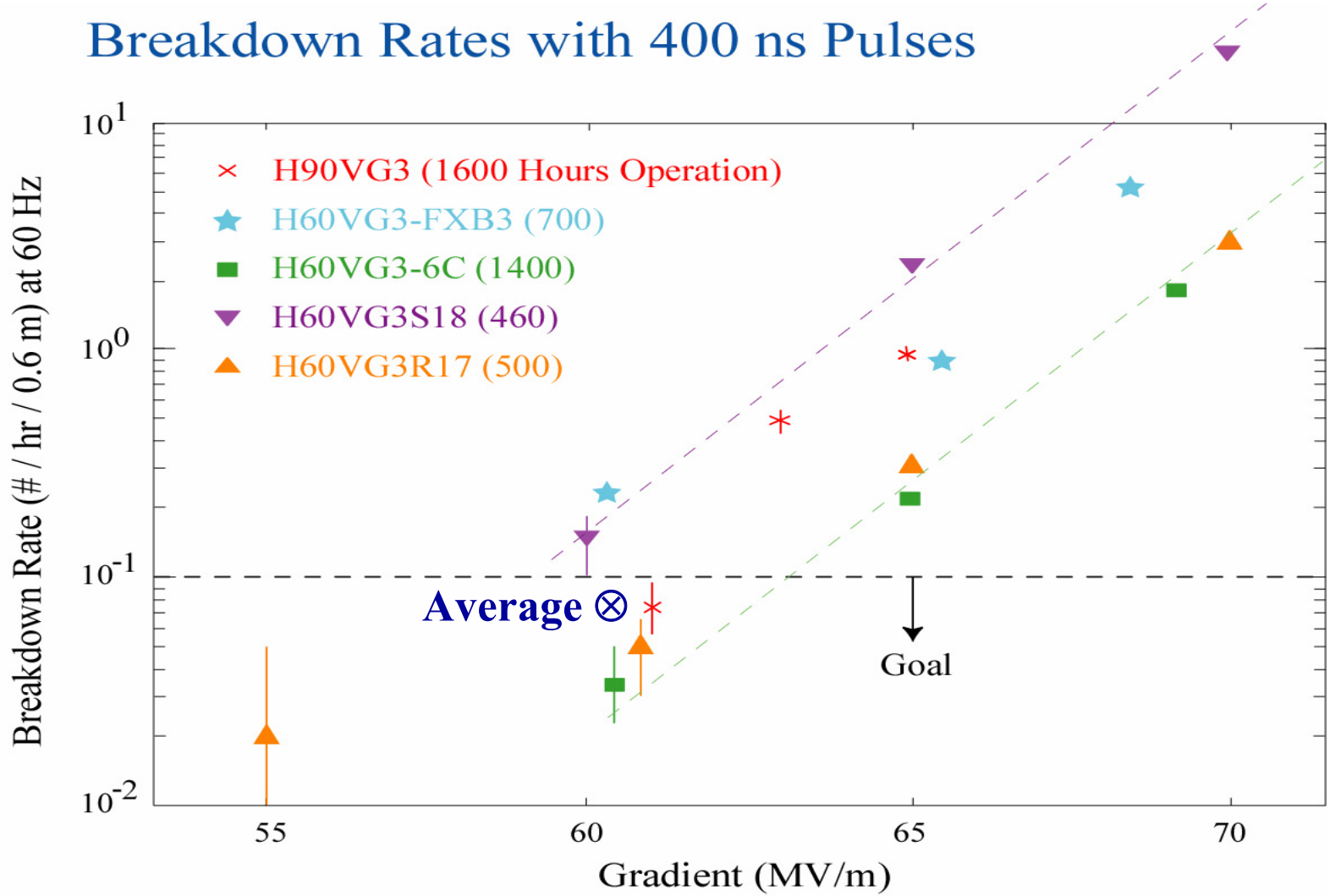
GLC(X)/NLC Level I R&D Requirements (R1)

Done

- "Demonstration of SLED-II pulse compression system at design power level."

- "Test of complete accelerator structure at design gradient with detuning and damping, including study of breakdown and dark current."

High Gradient Performance



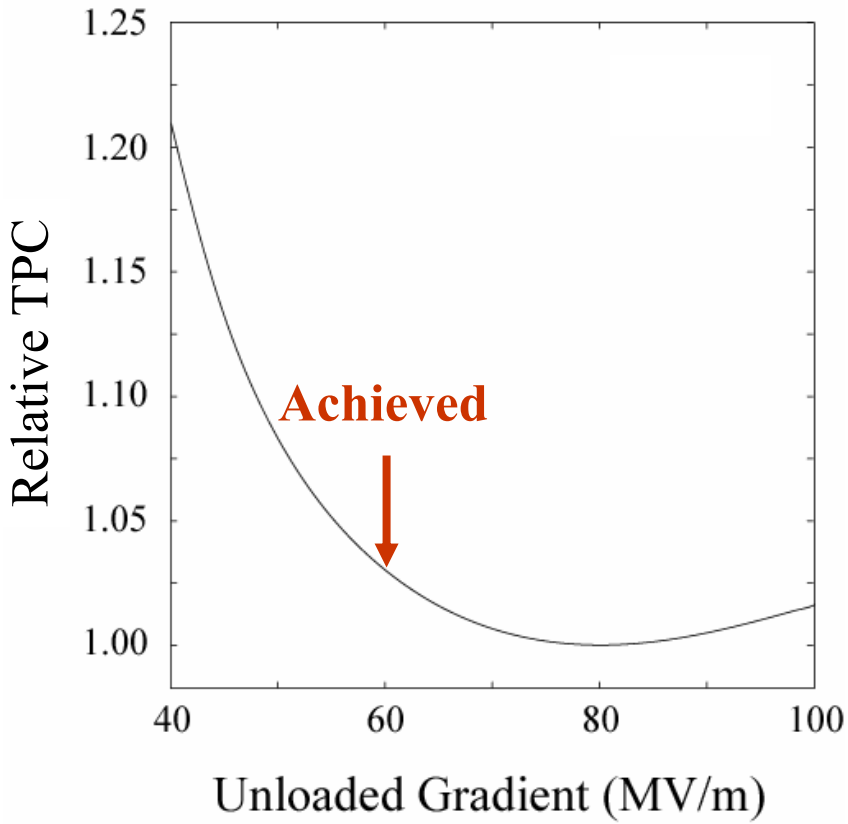
Cost Versus Gradient

Cost of the linac is a balance between cost of the power sources (which increases with gradient), and cost of accelerator length (which decreases with gradient).

Minimum occurs when these are equal, and is rather shallow. The linac is about half the total cost of the collider.

Collider optimized at 60 MV/m would be 10% longer, and cost 3% more than with the present design at 65 MV/m.

→ **We can deliver the particle physics with what we have achieved today!**



'USLCSG'

- The Accelerator Subcommittee of the US Linear Collider Steering Group (USLCSG) has been charged with the preparation of options for the *siting* of an international linear collider in the US.
- The 'Accelerator Subcommittee has produced a written evaluation of cold/warm 0.5 (upgrade to 1) TeV cm with:
  - cost - availability -risk - *site studies*
  - ....

publication soon...

- The evaluation has allowed the opportunity to refine our understanding of what is ready / what is not (*risk*)

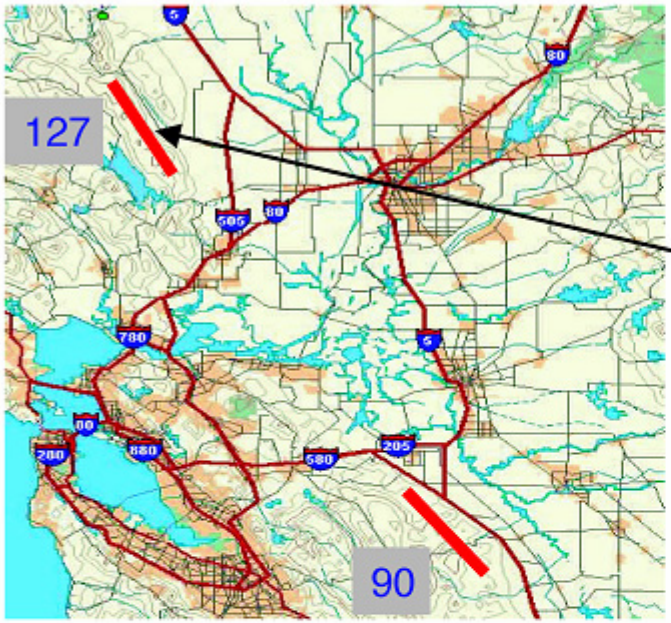
Himel's talk...

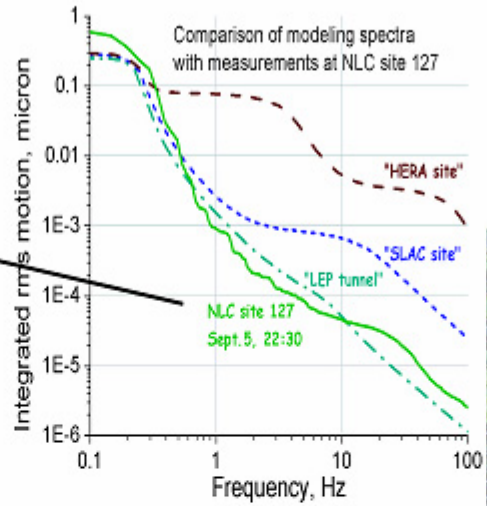
- → NC Linear Collider design is ready (E and $\mathcal{L}$) and has been critically tested ←

beam physics/ instrumentation, power/ uwave engineering, civil/ mechanical

U.S. Linear Collider Site Studies

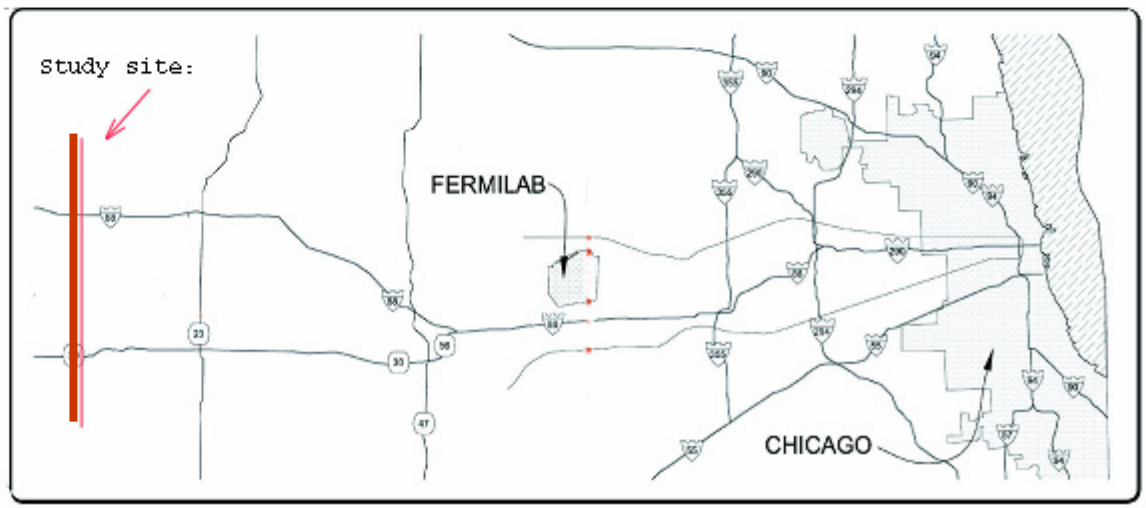
Civil Engineering





California

Illinois

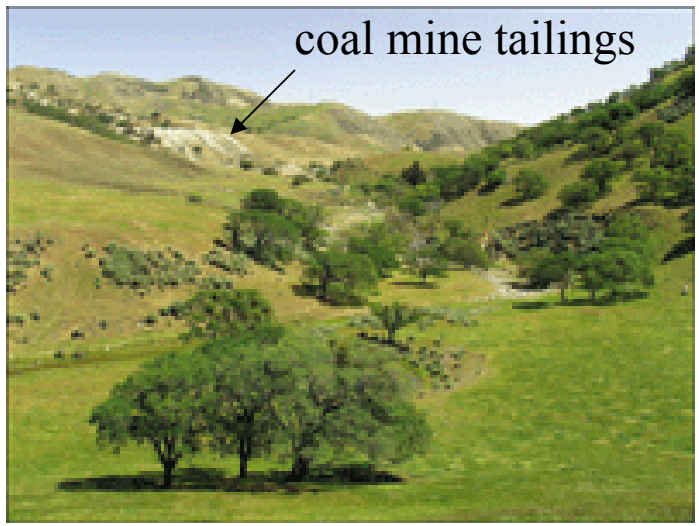


Sample sites studied in Illinois and California
Development of site criteria...

USLCSG Site study *'90'*

Central Valley near Livermore Nat'l Lab

→ very near 19th century coal mining town of TESLA, CA (1850-1920)



(2001)

(1898)

HEP must aggressively attack *Controls/Instrumentation* issues

- System challenges are clearly greater for HEP machines
- Look at the shift SLAC.DESY.KEK accelerator groups away from HEP toward nuclear/synchrotron radiation/FEL physics and technology
  - very active growth field
- Many accelerator designers have *no intrinsic connection* with HEP

Comment:

- Stong, proven, international collaboration (esp. high energy physicists) is an extremely valuable (*political and practical*) asset
  - *urgent*: work to strengthen accelerator development collaboration across the spectrum of RD effort in parallel with the development of design team

Conclusions

Next few months are pivotal for the X band technology demonstration

- present status encouraging
- collaboration KEK-SLAC-Fermilab has good vitality