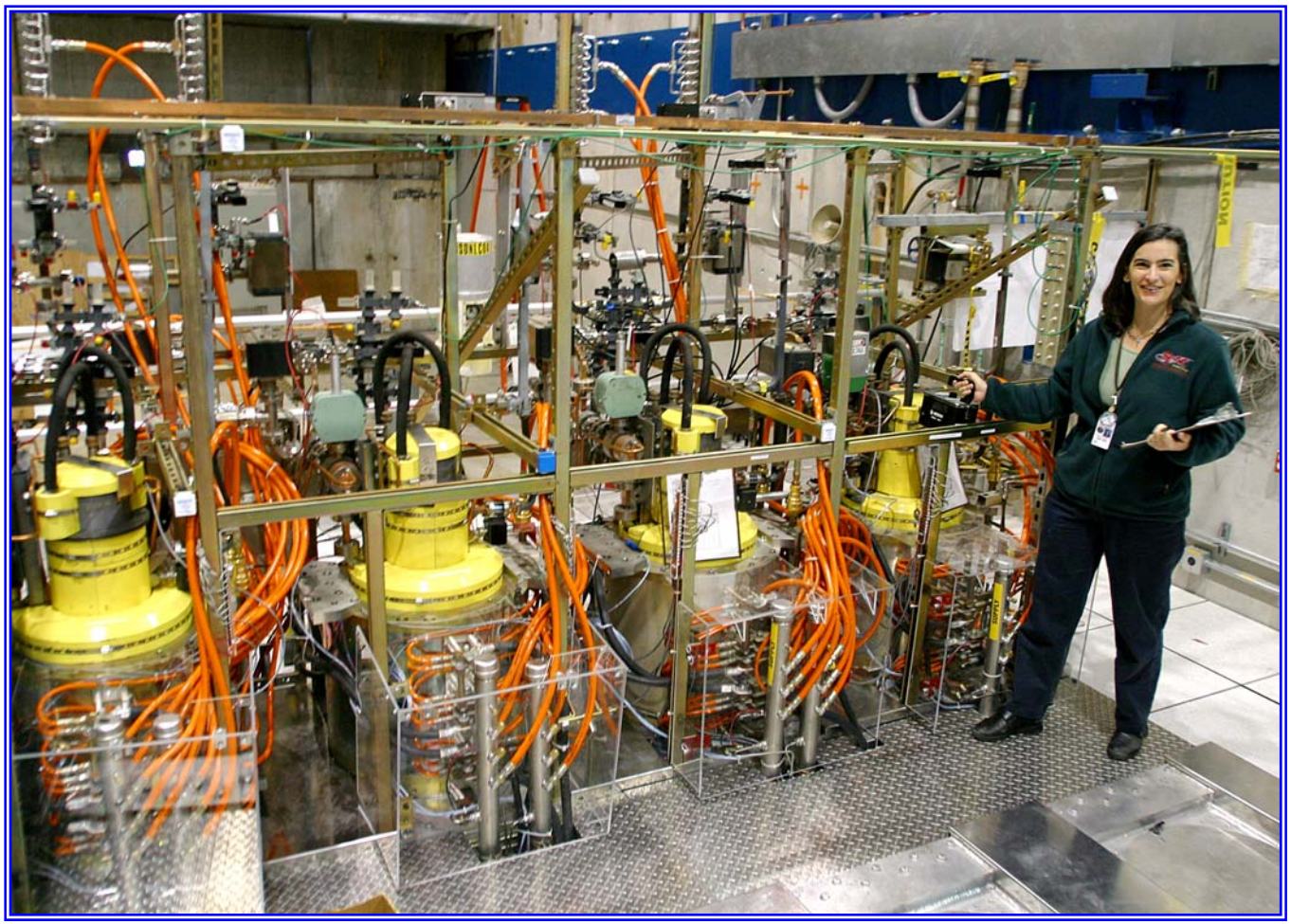
The 8-Pack Project



Four 50 MW XL4 X-band klystrons installed on the 8-Pack

The 8-Pack Project
Demonstrate an NLC power source

Two Phases:

8-Pack Phase-1 (current):

Multi-moded SLED II power compression

Produce NLC baseline power: 475 MW 400 ns.

LC TRC R1 requirement for JLC/NLC:

'Demonstration of the SLED II pulse compression system RF power and energy handling capability at the design level.'

8-Pack Phase-2 (2004):

Use the SLED II system for a Linac sub-unit test:

A full power demonstration of an RF feed to 4.8 m of high gradient structures on the NLCTA beamline.

One of the LC TRC R2 requirement for JLC/NLC:

'A linac subunit test'

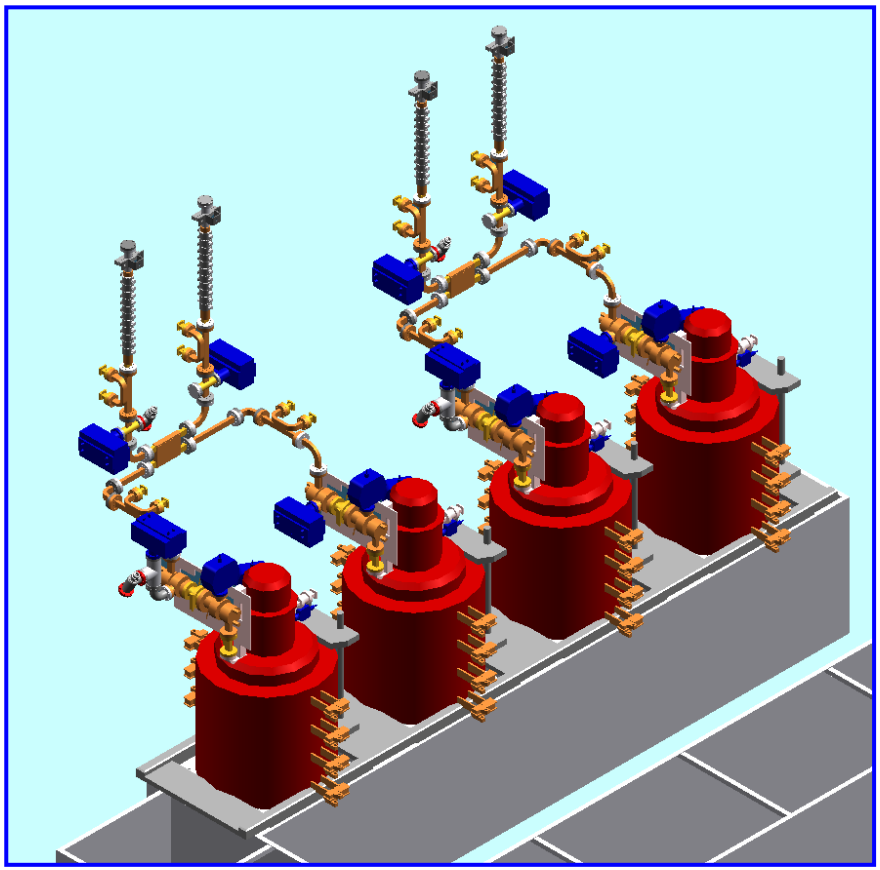
The 8-Pack Project – Phase 1

8-Pack Phase-1: Multi-moded SLED II power compression

- Assemble a system with:
  - Four XL4 klystrons to power the SLED (ea. 50 MW, 1.6 μs),
  - A solid state modulator,
  - The m-SLED II system (4x time compression, ~3.2x power).

➢ Produce NLC baseline power: 475 MW 400 ns (@ loads)
1 RF sys. fault / 10^7 pulses

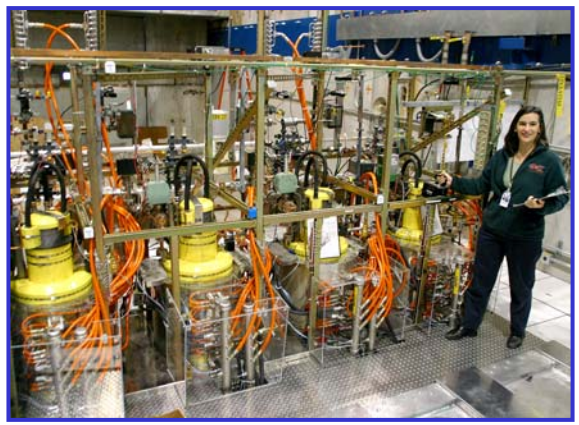
Current klystron layout for Modulator & LLRF commissioning



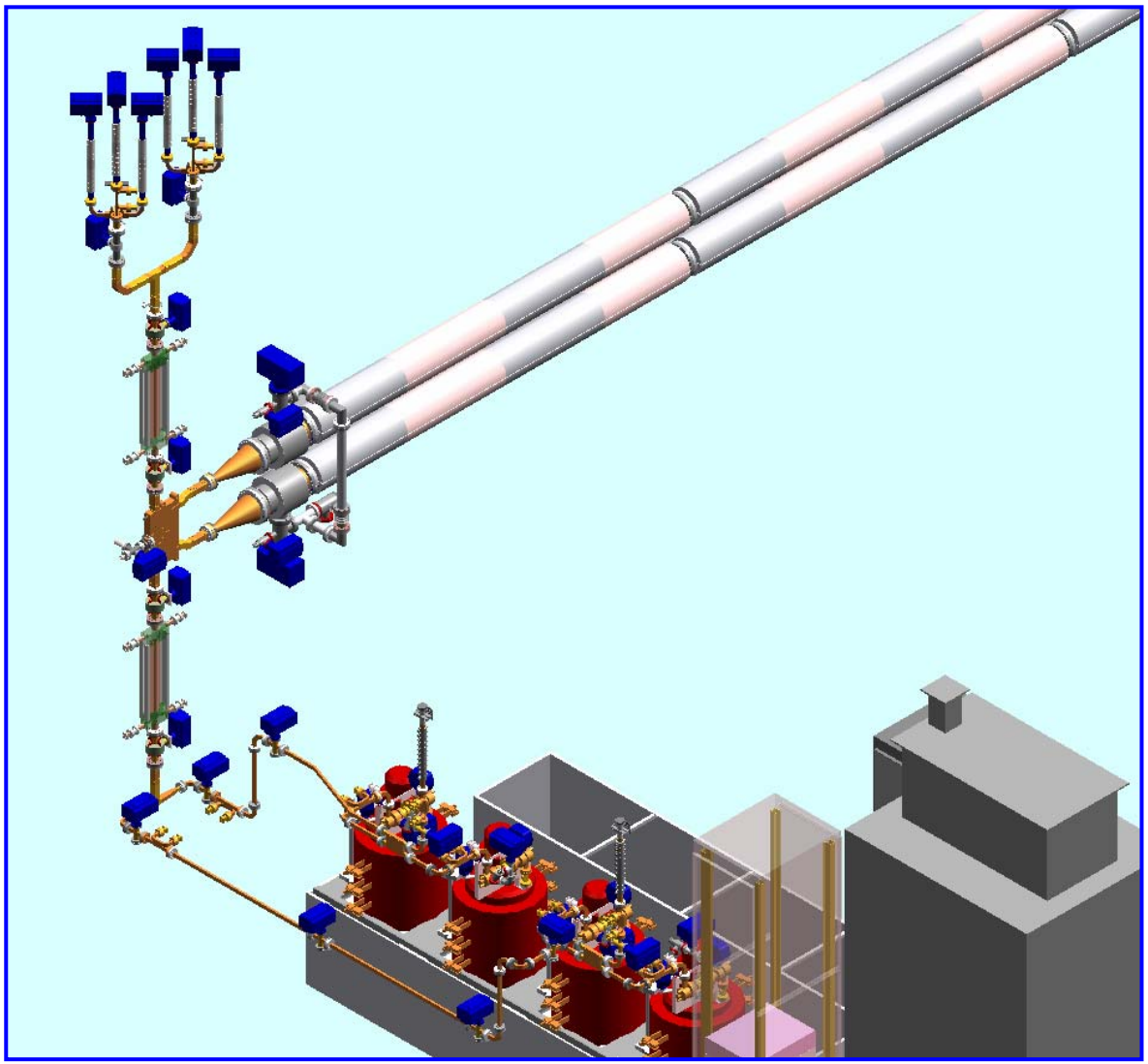
Four 50 MW klystrons on modulator; HV checkout, RF checkout, ongoing.

Sufficient power for Phase 1 & 2

The modulator and LLRF systems will be exercised while the SLED system is being installed.



Phase 1 Summer '03
m-SLED 'Straight-up' layout



Allows SLED commissioning and full power operation.

Milestone:

475 MW, 400ns at the load tree

June 2003

Test capability:

540 MW, 400ns

The 8-Pack Project

Phase 1&2 baseline goals

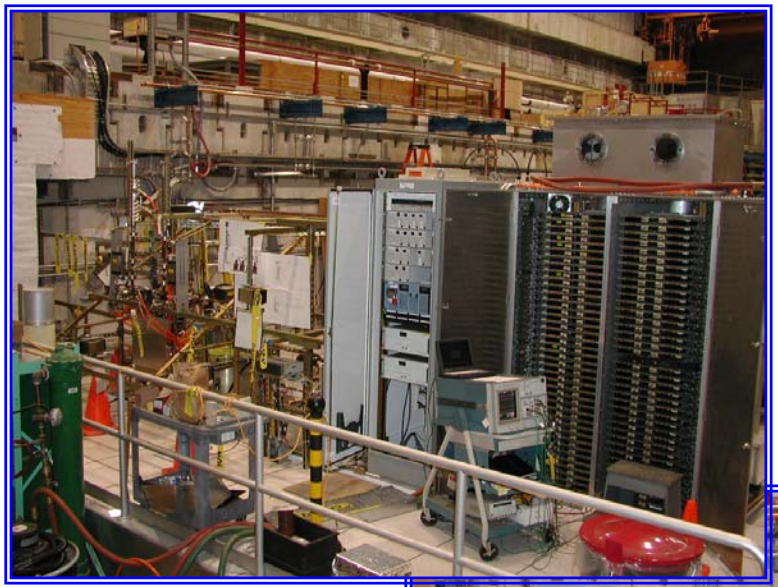
	NLC Baseline		Phase 1		Phase 2	
Klystrons @ power	2 @ 75 MW		4 @ 50 MW		4 @ 50 MW	
Pulse length	1.6 μs		1.6 μs		1.6 μs	
Klys. - SLED power transfer efficiency	95%		90%	(1)	90%	(1)
SLED power multiplier	3.3		3.0 - 3.2	(2)	3.0 - 3.2	(2)
Power at SLED output	475 MW		540 - 576 MW		540 - 576 MW	
Pulse length	400 ns		400 ns		400 ns	
SLED - structure power transfer efficiency	95%		n/a		90%	(1)
Power at structures - total	450 MW				486 - 518 MW	
Structure gradient	65 MV/m				66 - 68 MV/m	(3)

Notes:

1) Phase 1 power handling inefficiency is due to liberal use of WR90
2) Phase 1 SLED power multiplier low due to potential mode conversion inefficiency
3) Eight 60 cm. structures

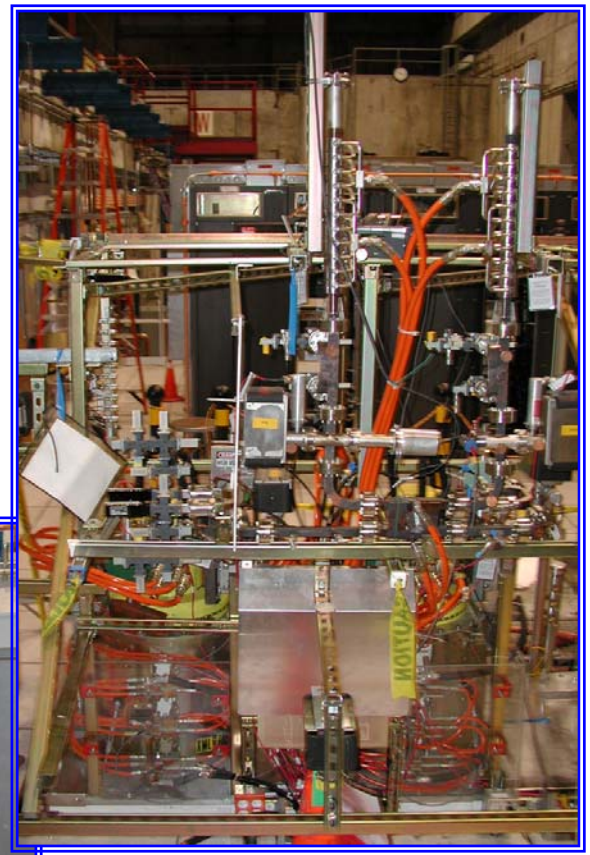
8-Pack Phase 1 Status

The view from End Station B.



The modulator, TWTs, klystron power supplies, and klystrons

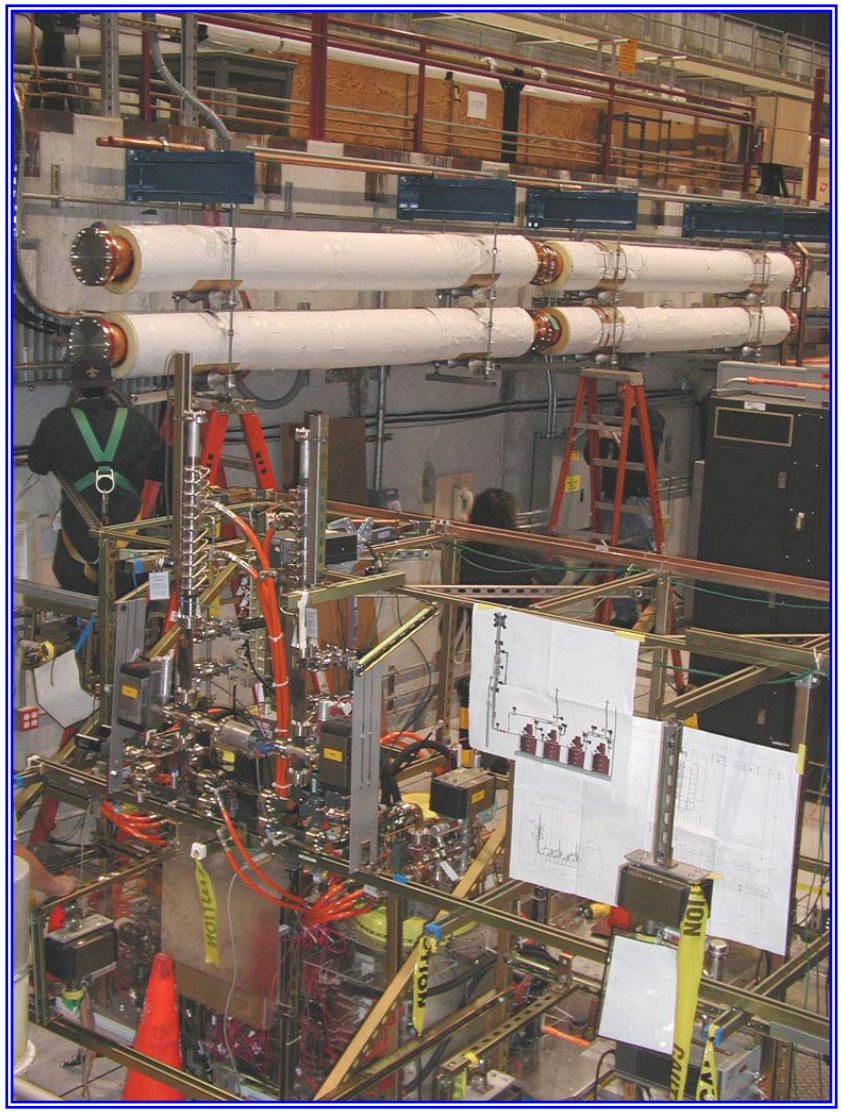
Electronics racks



XL4 klystrons

8-Pack Phase 1 Status

The view from End Station B.



SLED line tubes being test-fitted into position. 11/4/02

SLED tubes to begin installation 4/14

8-Pack Phase 1 Status

Infrastructure:

Complete, with utilities sized for the phase 2 upgrade.

Supports for components being installed now.

Control system:

Backbone system complete (PLC, CAMAC, VME, Ethernet)

PLC control of modulator is commissioned.

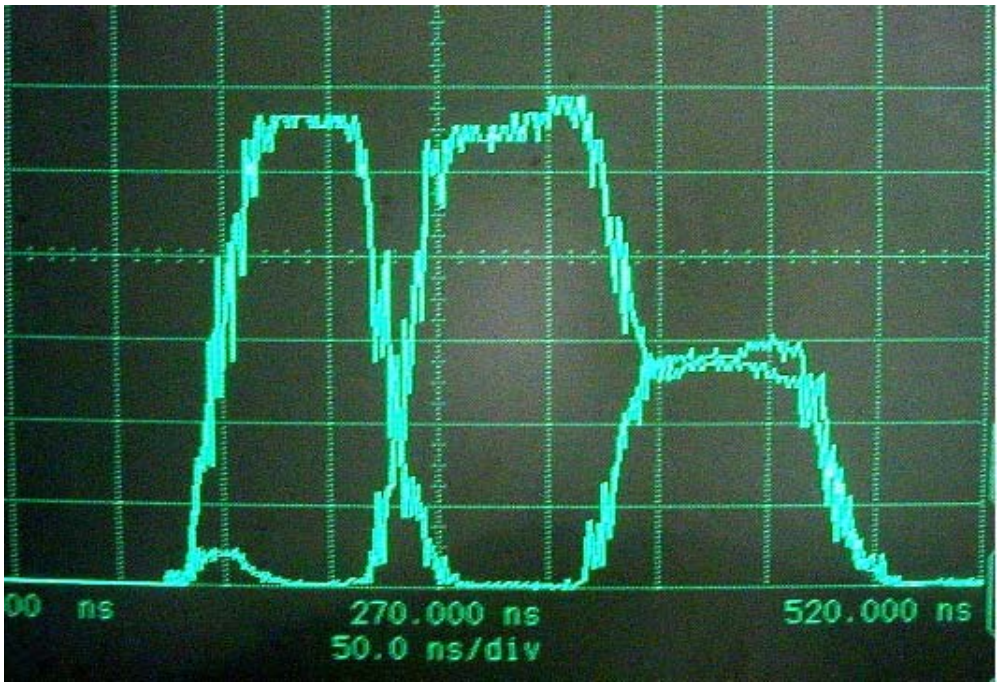
Software commissioning of LLRF controls needs hardware.

8-Pack Phase 1 Status:

LLRF:

The system for LLRF control is in and being commissioned.

The system for LLRF monitoring is being commissioned as installed.



Power from 2 klystrons combined and sent to alternate loads on the hybrid.

~80-100 MW combined

50 ns/div.

Both pairs of klystrons have been so tested.

From Steve Smith

Complete commissioning 4/03.

8-Pack Phase 1 Status

Modulator:

Solid state modulator.

76 boards with an IGBTs

Driving a three turn secondary

Improved efficiency and lifetime over thyratron / PFN systems

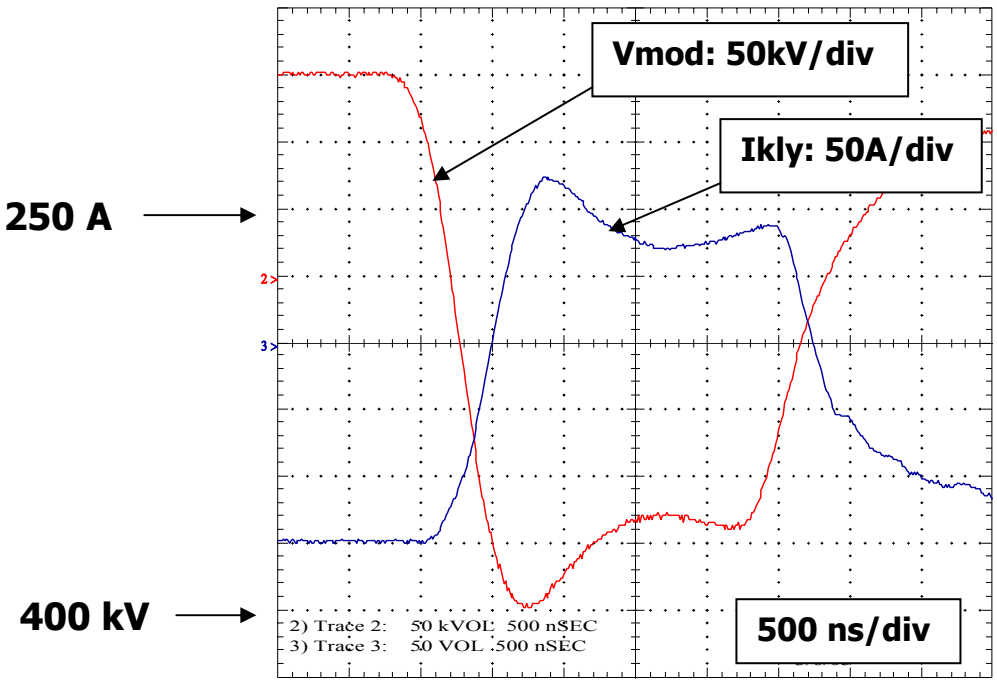
8-Pack Phase 1 Status

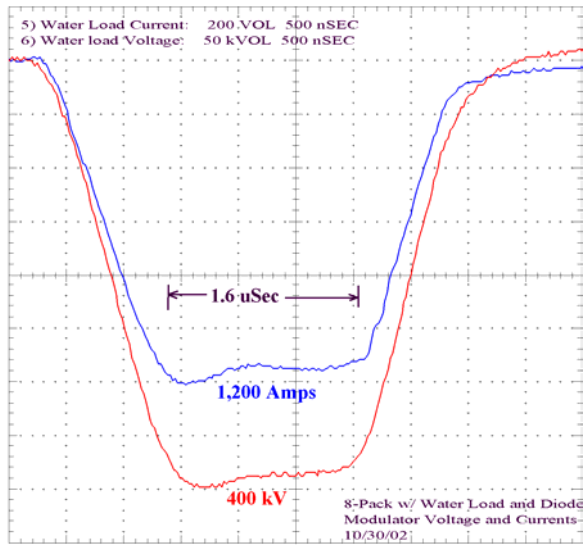
Modulator:

The modulator is operational on the 8-pack.

It has delivered enough power for four XL4 klystrons.

IGBT problems solved.



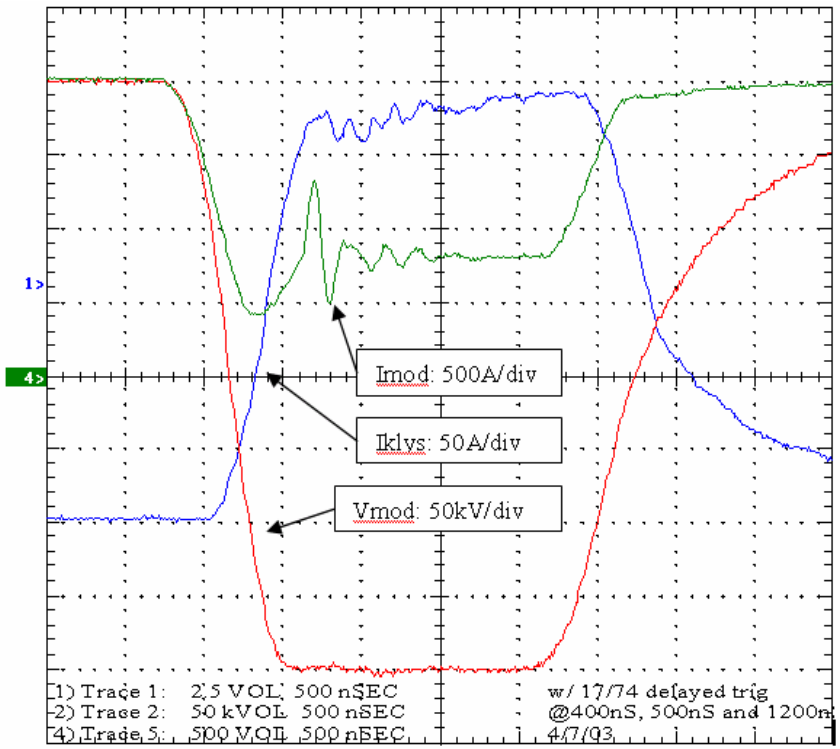


Modulator test pulse into a water load

8-Pack Phase 1 Status

Modulator:

The voltage pulse is made flat by delaying the turn-on of some of the driver cards.



M. Nguyen

Flatness for 4 XL4s at 400 kV
1.6 μs, ± 0.7% 4/7/03

Currently:

Flattening the RF power pulse at full voltage.

19 boards delayed to flatten overshoot.

Runs at 30 Hz, additional boards to be modified for 60 Hz operation.

8-Pack Phase 1 Status:

Klystrons:

Four XL4 klystrons are installed and connected to the modulator.

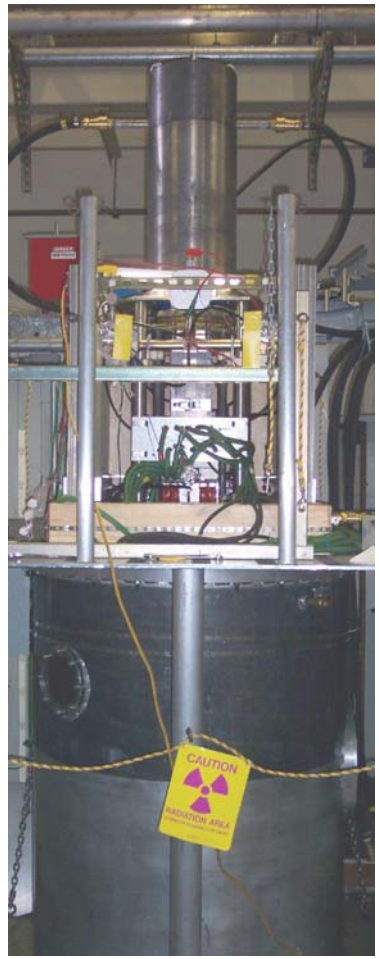
All have been run, each delivering ~50MW at 400 kV.

These are sufficient to perform all high power tests, for 8-Pack phases 1 & 2.

KEK/Toshiba klystron PPM2, which achieved 70 MW @ 1.5 μs at KEK, is now under test at SLAC.

Activity at one RF window has limited power to 75 MW @ 100 ns, now processing to full pulse length.

KEK/Toshiba klystron PPM4 is to be shipped to SLAC mid-May



KEK PPM2 under test at SLAC

One of the LC TRC R2 requirement for JLC/NLC:

'A full test of a PPM klystron at 120 or 150 Hz.'

8-Pack Phase 1 Status:

Klystrons:

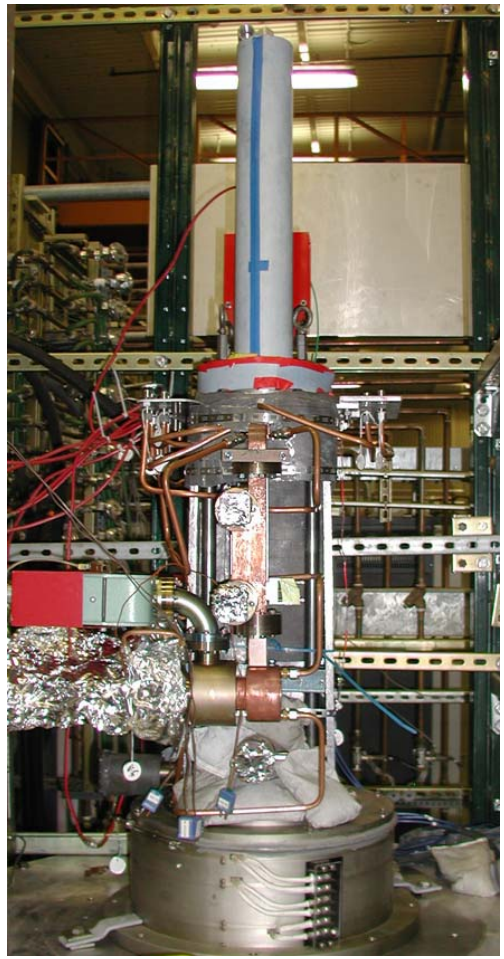
SLAC PPM klystron, XP3-3, is being tested.
- Eliminate transverse magnetic fields.
- Re-defeat 11.7 GHz oscillation.

The second unit, XP3-4, is in design.
- Convert to an integral polepiece design.
- Re-optimize cavity tuning for max. RF power.

XP3-4 on test 7/03

PPM klystron XP4 is finishing design.
- More robust design.
- Larger gun ceramic for lower gradients.
- Integral polepiece design as XP3-4.

XP4-1 on test 11/03
XP4-2 on test 3/04



XP3-3 under test at SLAC

8-Pack Phase 1 Status

High power RF system:

The design of the planar components has been validated through cold testing.

We will continue to cold test parts as they come out of fabrication.

The design of the 'Circular-rectangular mode converter' has been cold tested and tuned.

A point of concern as there are 8 of these units in the 'Straight-up' configuration.

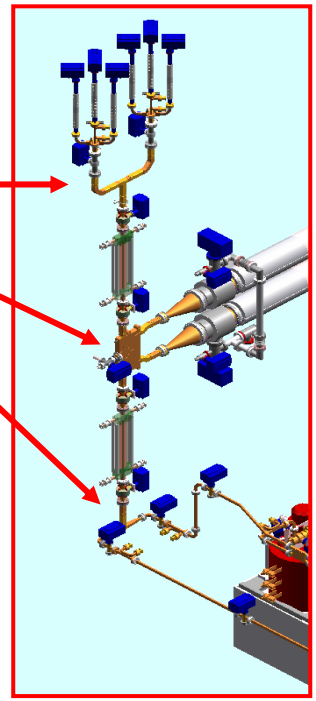
The 'step' tapers for the SLED lines have been cold tested and shown to work.

Unwanted TE01-TE02 mode conversion seen in a test of a short SLED line could lead to ~5% degradation in SLED power multiplication (3.3 $\rightarrow$ 3.2 or 3.0)

8-Pack Phase 1 Status:

High power RF system:

All 'Straight-up' configuration components are in fabrication (or ready).



Critical Items:

The Combiner, the Cross Potent, Splitter

– all parts machined, in the 1st brazing cycle

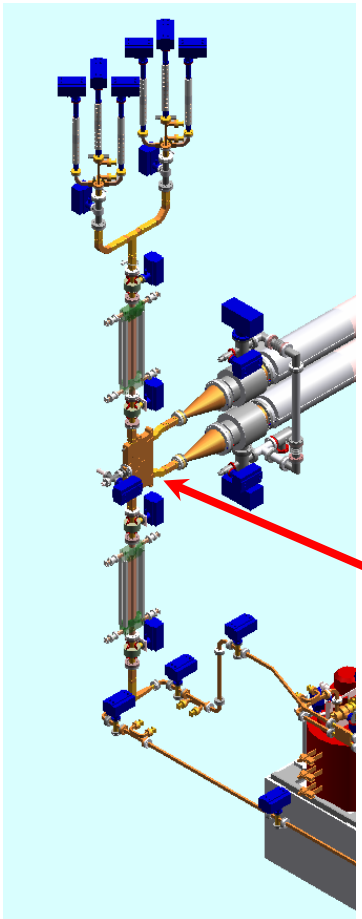
All these require:

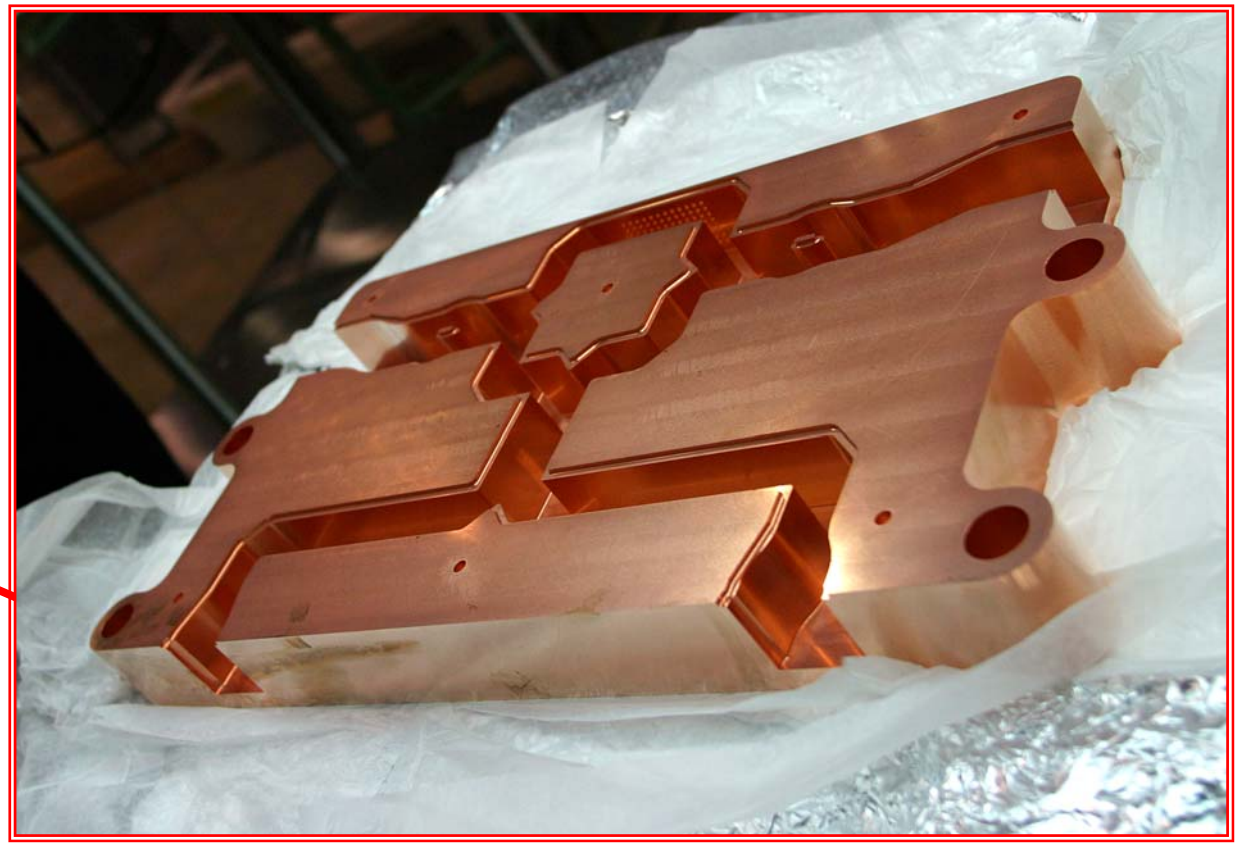
parts machined
sub-assembly braze
post-braze machining
further sub-assembly braze
post-braze machining
final assembly braze (with circular-to-rectangular converters)

Circular-to-rectangular converters (8) –parts have been machined,

8-Pack Phase 1 Status

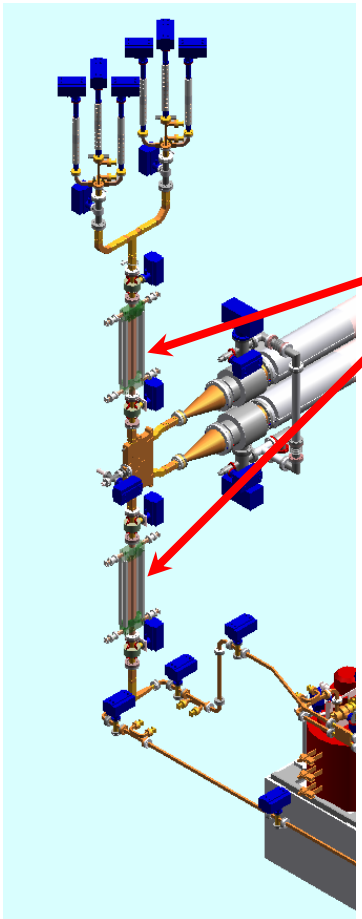
High power RF system: Cross Potent body

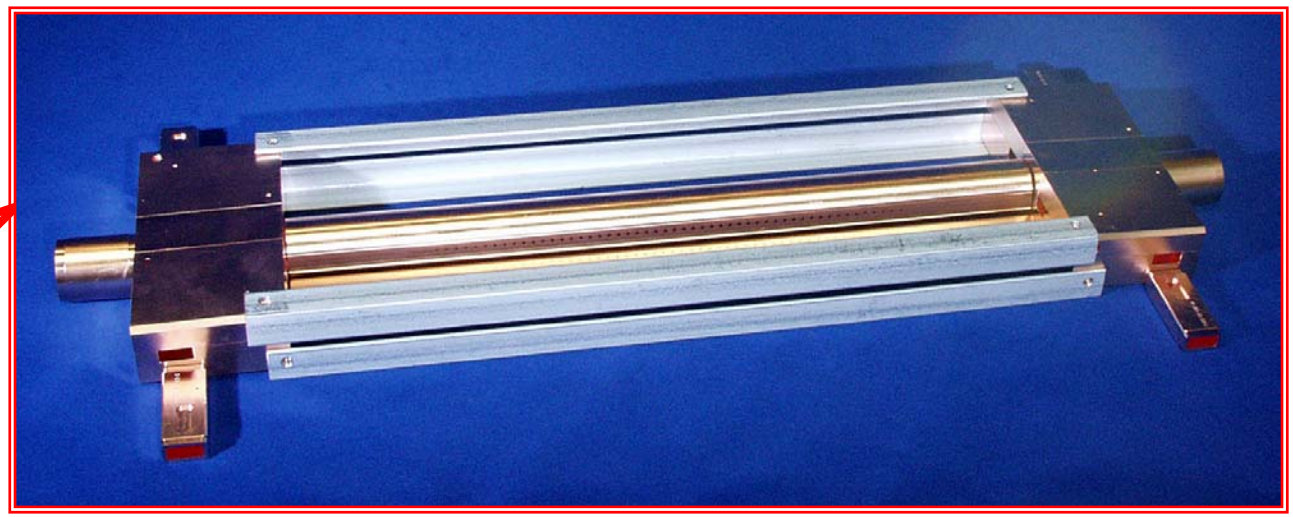


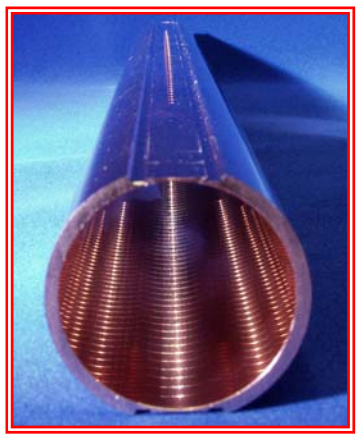


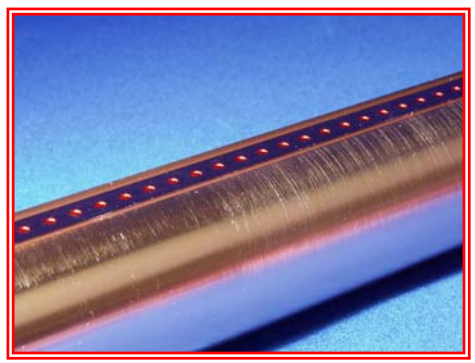
8-Pack Phase 1 Status

High power RF system: Multimoded coupler

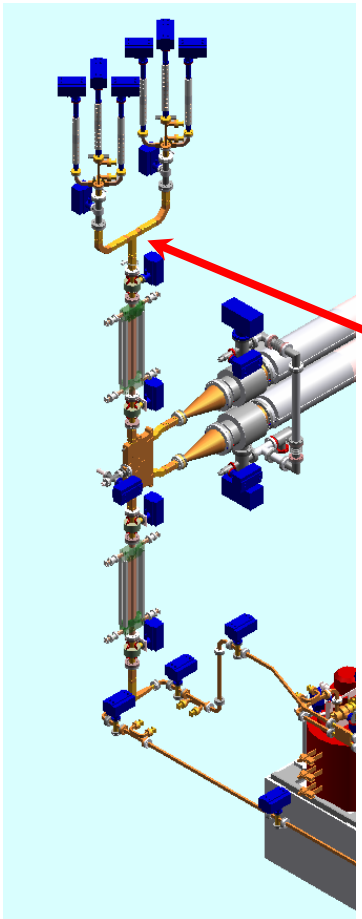




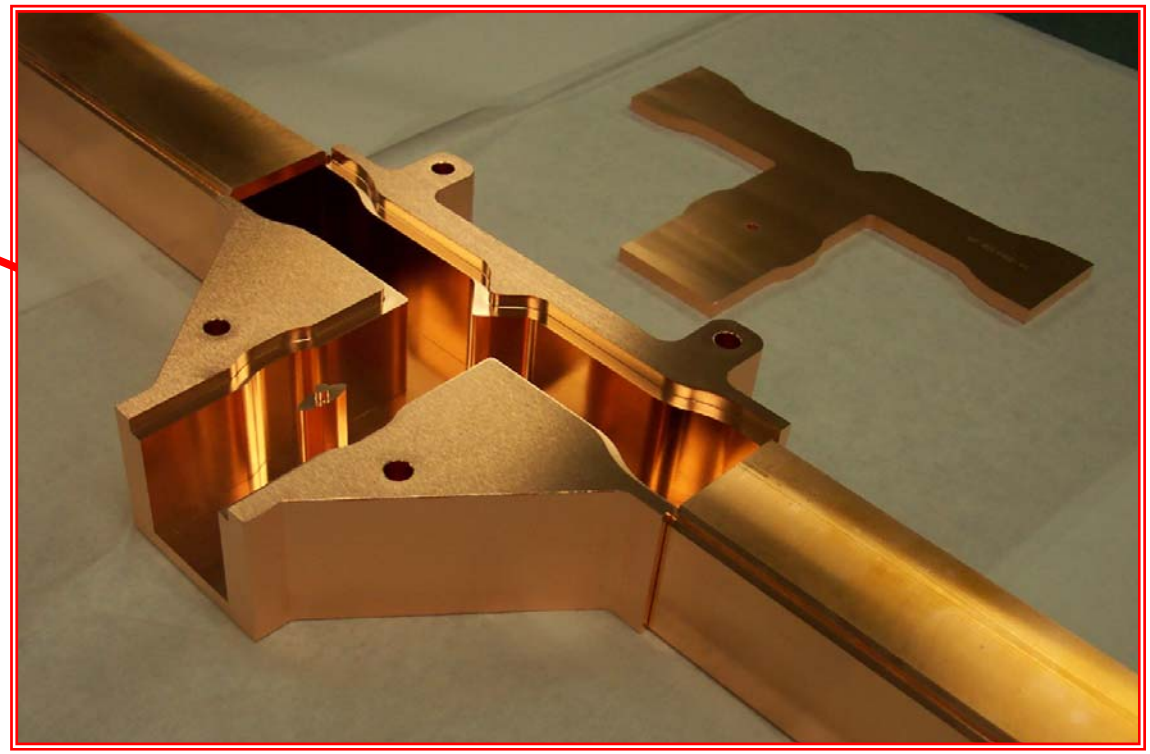




8-Pack Phase 1 Status



High power RF system: Combiner parts, machined at LBL, ready for brazing



Project schedule overview
Phase 1

4 klystrons, RF commissioning 4/03 (current configuration)

High power RF components installed 6/03

"Straight-up" configuration RF commissioning 6/03

475 MW 400 ns milestone 7/03

The 8-Pack Project – Phase 2

One of the LC TRC R2 requirement for JLC/NLC:

'A Linac subunit test'

8-Pack Phase-2:

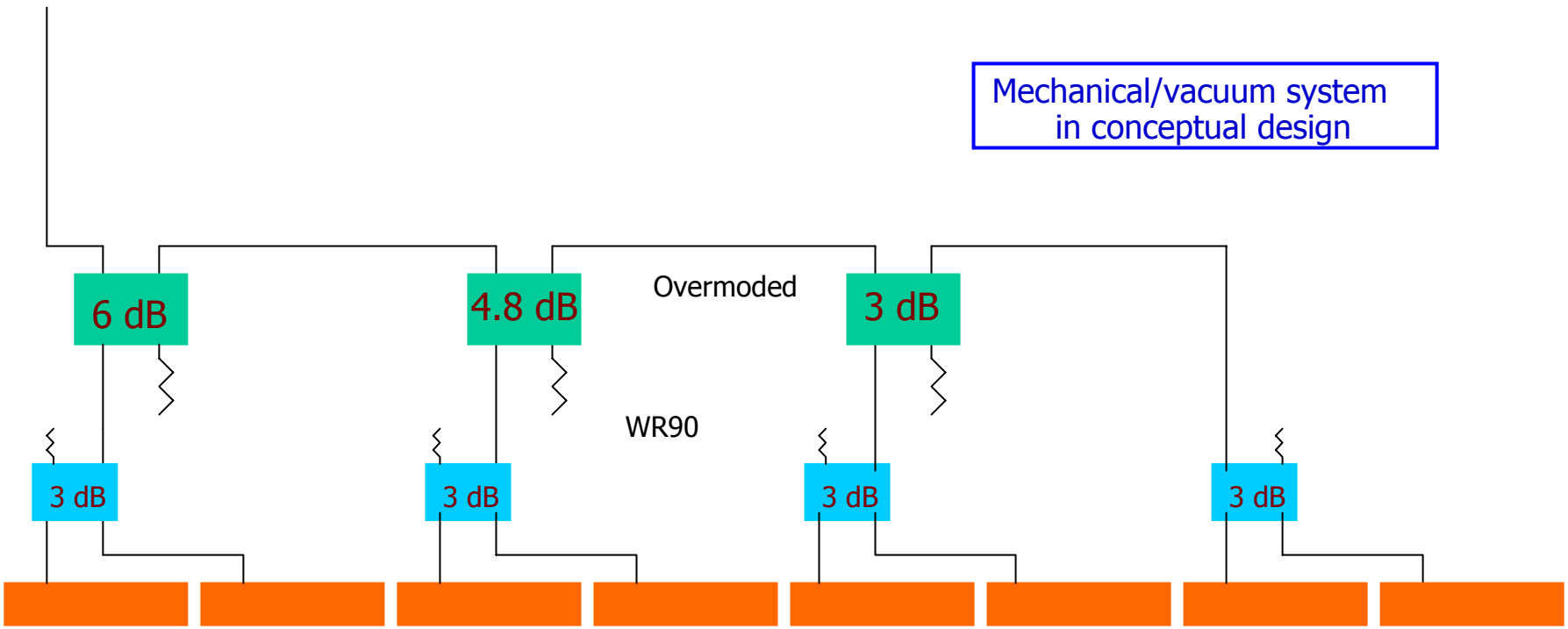
Use the SLED II system for a full power demonstration of an RF feed to 4.8 m of high gradient structures on the NLCTA beamline.

- Install eight 60 cm long high gradient RF structures
- Transmit the high power from the SLED II system to the beamline.
- Split the high power to the high gradient RF structures
- Gain experience with a JLC/NLC RF feed at full power and full rep. rate

Phase 2 8-Pack Layout

Schematic of the power handling to the beamline

Power handling components are copies of those used in Phase 1, or morphed from them.



Phase 2 schedule overview

Begin system design; underway

Fabrication Jun.– Nov '03

System installation Oct.– Nov. '03

(working around the structure test program)

Commission / Process structures in sets

65 MeV/m milestone Feb. 2004

Integrate >2000 hours of high-power, high-gradient operation.

(see the talk by C. Adolphsen)