The 8-Pack Project

An overview of the status and schedule for the project.
High power SLED operations in March 2003
New Phase 2 goal: SLED to power RF feed to 5.4m of structures.
8-PACK Project People

Project Manager: David Schultz
Assistant Project Managers: Joe Frisch, Ray Larsen, John Cornuelle, Clay Corvin
Project Physicist: Chris Adolphsen
Project Engineer: Dennis Atkinson
Project System Engineering: Bobby McKee
Area Manager: Kathleen Ratcliffe
NLCTA Interface: Marc Ross, Keith Jobe
Safety Liaison: Keith Jobe
Conventional Facilities: Javier Sevilla, Fred Asiri, Juanito Buhain
Klystrons: John Cornuelle, Chris Pearson, Saul Gold, Zane Wilson
Modulators: Richard Cassel – SLAC, Ed Cook – LLNL, Craig Brooksby – Bechtel
High Power RF: Jose Chan, Carl Rago, Sami Tantawi, Chris Nantista
LLRF: Steve Smith, Elias Andrikopoulos, Andrew Young
Controls & DAQ: Ron Chestnut, Janice Nelson
Vacuum Controls: Tom Porter, Earl Hamner
Cable Plant: Ponciano Rodriguez, Les Johnson
PPS Systems: Patrick Bong
Special Instrumentation: Joe Frisch, Doug McCormick
High Gradient Structures: Harry Carter – FNAL
The 8-Pack Project - redefined

LC TRC R1 requirement for JLC/NLC (500 GeV c.m.) :
“Demonstration of SLED II pulse compression system at design power level.”

- **Phase-1**: Multi-moded m-SLED II power compression
  - Assemble a system with:
    - Four XL4 klystrons to power the SLED (ea. 50MW, 1.6µs)
    - A solid state modulator (formerly of the ‘4-dog’ tests)
    - The multi-moded SLED system (4x compression)
  - Produce (new) NLC baseline power: 500 MW 400 ns (@ loads)

- **Phase-2**: Use SLED for a full power demonstration of an RF feed to 5.4m of high gradient structures on the NLCTA beamline.
  - Split the high power to 3 x 3 x 60 cm high gradient RF structures
  - Include high power test area for future high power component testing.
  - Power the m-SLED II system with two PPM klystrons as available
### NLC/JLC SLED-II Baseline Demonstration Schedule (FNAL, KEK, LBNL, LLNL, and SLAC)

<table>
<thead>
<tr>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept</td>
<td>Oct</td>
<td>Nov</td>
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<td></td>
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</tbody>
</table>

#### Permanent Magnet Klystrons
- Test PPM3
- Test PPM2R
- Test PPM4
- Test XP3-2
- Test XP3-3
- Test XP4-1
- Test XP4-2

#### Solid-State Modulator
Operation with XL-4 Solenoid Klystrons ➔ PPM/XP Installation and Operation

#### SLED-II System
- Microwave Tests ➔ Demonstration of Baseline ➔ Demonstration of Power Generation*
- High-Gradient structures with wakefield detuning and damping.

#### Accelerator Structures
- NLC/JLC Structure Development ➔ Test NLC/JLC-Ready Structures***

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* SLED-II Baseline Output Power: 500 MW pulse of 400 ns duration.
** Split SLED-II output power into three feeds terminated in loads.
*** High-Gradient structures with wakefield detuning and damping.
Phase 1 October ‘02 klystron layout for Modulator & LLRF commissioning

Currently 2 klystrons on modulator, HV checkout, RF checkout, then install and connect the other two klystrons.

Allows modulator and LLRF systems to be exercised while SLED system is being installed Nov. – Feb.

RF on: 11/25 (1st two tubes)
1/6 four tubes
Phase 1 March ‘03 m-SLED
‘Straight-up’ layout

Allows SLED commissioning and full power operation.

Milestone:
600 MW, 400ns at the load tree
March 2003

Baseline:
500 MW, 400ns

MAC Review, November 6, 2002
8-Pack Status
The view from End Station B.

The modulator, TWTs, klystron power supplies, and klystrons

Electronics racks

Two XL4 klystrons

MAC Review, November 6, 2002
8-Pack Status
The view from End Station B.

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

**Infrastructure:**
98% complete, with utilities sized for the phase 2 upgrade. Supports for ‘Straight-up’ loads to be installed next week.

**LLRF system:**
System for SLED control is being fabricated. Some parts are installed. Complete commissioning 12/2. Near term – use a kluged system to get underway.

**Control system:**
Backbone system complete (PLC, CAMAC, VME, Ethernet) PLC control of modulator is being commissioned. Software commissioning of LLRF controls needs hardware.
8-Pack Status

Modulator:
The ‘4-Dog’ modulator is operational on the 8-pack. It has delivered enough power for four XL4 klystrons.

A current limiting feedback circuit, installed to protect the IGBTs, causes some cards to overheat, limiting the rep rate at full power. This will be remedied by adjusting the feedback, and adding drivers if necessary.

Solid-State Modulator Performance talk, R. Cassel
8-Pack Status

**Klystrons:**
Two XL4 klystrons are installed and being connected to the modulator. Two more are just completing tests and are ready to be moved to ESB. These four klystrons are sufficient to perform all Phase 1 and 2 testing.

Two XP3 PPM klystrons being produced – on test 1/03 & 6/03
With known and suspected faults from the first 2 XP3s corrected

A PPM2 klystron from KEK/Toshiba is to be tested at SLAC – due this month – on test 2/03

A XP4 PPM klystron under development – on test 8/03

Two PPM klystrons can be mounted on the 8-pack stand and;
run alternately with the XL4 klystrons,
attach to the SLED system when appropriate,
be used for the phase 2 demonstration.

Klystron Development talk, G. Caryotakis

MAC Review, November 6, 2002
8-Pack Status

High power RF system:

All parts in hand for the “October” configuration
allowing for commissioning of LLRF, modulator and klystrons.

‘Straight-up’ configuration components are in fabrication.
Using assembly, cleaning and handling procedures borrowed from the experience gained in the high power structure program.

The design of critical components have been cold tested
Have validated the design of planar components (with lower pulsed heating, fields)
will continue to cold test parts as they come out of fabrication

The design of circular-rectangular mode converter has been 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 shown to work.

Pulse Handling Design and Tests talk, S. Tantawi
8-Pack Status

High power RF system:

Cross potent part

2nd set of SLED tapers

SLED pump tee

MAC Review, November 6, 2002
8-Pack Status

**High power RF system:** Multimoded coupler parts

MAC Review, November 6, 2002
Project schedule overview
Phase 1

2 klystrons, RF power to loads 11/25
4 klystrons, RF commissioning 1/6/03 (“October ‘02” layout)
Pump down SLEDII lines (alone) 12/16,
bake over the Xmas break
High power RF components installed 2/28
“Straight-up” configuration RF commissioning 3/6/03
600 MW 400 ns milestone 3/11/03
8-Pack Phase 2
Baseline demonstration

“Demonstration of SLED II pulse compression system at design power level.”

Plan:

Power three strongbacks of three 60 cm. structures each.
   For budgetary, workload and logistical reasons this spreads into FY04.

**FY03**
   Send power through a 1-3 power splitter on the NLCTA roof, to loads.
   Demonstrate full baseline power handling: 500 MW 400ns.
   Minimal interruption to NLCTA high gradient structure R&D.

**FY04**
   Deliver power to three sets of structures, 5.4 m total, on the NLCTA linac.
   Integrate >1000 hours of operational experience with the system.

   Power the SLED system with the four SLAC XL4 klystrons.
   Replace the XL4 tubes with PPM klystrons as available.
Phase 2 8-Pack Layout

Schematic of the power handling to the beamline

All other power handling components are copies of those used in Phase 1.
8-Pack Status Phase 2

FNAL RF structures:
- FXB002 for High gradient testing arriving this month
- FXB004 - 012 for installation onto the NLCTA beamline
  Scheduled to arrive at SLAC, 1st set March 2003, 2nd set July 2003
  (schedule dependant on funding)

Girder / Strongback layout:

FNAL Structure Fabrication talk, H. Carter

3 FNAL FXB structures
Project schedule overview
Phase 2

Begin system design Nov. ‘02
Phase 2 system design review Jan. ‘03
Fabrication Jan. – May ‘03
System installation June – July ‘03
500MW split 1-3 on the roof Sept. ’03

FNAL strongbacks arrive at NLCTA
   April ‘03, July ‘03, Oct. ‘03
Tunnel system installation period June – Dec. ‘03
   (working around the structure test program)
Commission / Process strongbacks sequentially
65 MeV/m milestone Feb. 2004

MAC Review, November 6, 2002
8-pack in FY04

RF Structures:
- Finish installation of 5.4 m of high-gradient (combination of detuned-only and damped-and-detuned) structures on the NLCTA linac.
- Finish installation of power feeds to these structures.
- Integrate >2000 hours of high-power, high-gradient operation.

PPM klystrons:
- Gain operational experience, integrate 10,000 hrs with PPM klystrons.

Power distribution:
- Test advanced high power RF components to validate upgrades and/or replacement systems for SLED II
- End -
### 8-Pack Schedule – near term

**Near-term 8-pack Phase 1 schedule**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Week beginning</th>
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</thead>
<tbody>
<tr>
<td>1. LLRF installed</td>
<td>10/14</td>
</tr>
<tr>
<td>2. Check-out LLRF</td>
<td>10/21</td>
</tr>
<tr>
<td>3. RF control checkout</td>
<td>10/28</td>
</tr>
<tr>
<td>4. Modulator testing into H2O</td>
<td>11/4</td>
</tr>
<tr>
<td>5. Connect Modulator to klys</td>
<td>11/11</td>
</tr>
<tr>
<td>6. PLC/EPICS checkout</td>
<td>11/18</td>
</tr>
<tr>
<td>7. HV test 2 XL4s</td>
<td>11/25</td>
</tr>
<tr>
<td>8. RF test 2 XL4s</td>
<td>12/2</td>
</tr>
<tr>
<td>9. Install klystron XL4-12 in slot 8</td>
<td>12/9</td>
</tr>
<tr>
<td>10. Inst. klystron XL4-6 in slot 7</td>
<td>12/16</td>
</tr>
<tr>
<td>11. Setup klystrons</td>
<td>12/23</td>
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<tr>
<td>12. Adjust delay Modulator drivers</td>
<td>12/30</td>
</tr>
<tr>
<td>13. Connect Modulator to klys</td>
<td>1/6</td>
</tr>
<tr>
<td>14. HV tests</td>
<td>1/13</td>
</tr>
<tr>
<td>15. RF system final assembly</td>
<td>1/20</td>
</tr>
<tr>
<td>16. RF system bake</td>
<td>1/27</td>
</tr>
<tr>
<td>17. RF commissioning</td>
<td>2/3</td>
</tr>
<tr>
<td>18. Stairway moved</td>
<td>2/10</td>
</tr>
<tr>
<td>19. SLED supports installed</td>
<td>2/17</td>
</tr>
<tr>
<td>20. SLED support electrical work</td>
<td>2/24</td>
</tr>
<tr>
<td>21. SLED support plumbing work</td>
<td>3/3</td>
</tr>
<tr>
<td>22. SLED tapers cold test</td>
<td>3/10</td>
</tr>
<tr>
<td>23. SLED tapers clean</td>
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<tr>
<td>24. SLED short ready</td>
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<tr>
<td>25. SLED installation</td>
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<tr>
<td>26. SLED bakeout</td>
<td></td>
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<tr>
<td>27. CP assy. hanger installed</td>
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<td>28. Cross potentiometer ready</td>
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<td>29. Combiner ready</td>
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<td>30. MIM couplers ready</td>
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<td>31. Splitter ready</td>
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<td>32. Quadruplet ready</td>
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<tr>
<td>33. Loads ready</td>
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<tr>
<td>34. Install &quot;Straight up&quot; system</td>
<td></td>
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<tr>
<td>35. 600MW 400ns milestone</td>
<td></td>
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</table>

**Dated:** 11/5/02
### 8-Pack Schedule – FY03

8-pack Phase 1 schedule for FY03 dated: 11/5/02

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/25</td>
<td>Run RF in 4 XL4 Klystrons</td>
</tr>
<tr>
<td>12/9</td>
<td>Connect to SLED</td>
</tr>
<tr>
<td>12/16</td>
<td>Bake</td>
</tr>
<tr>
<td>1/20</td>
<td>Run RF through SLED</td>
</tr>
<tr>
<td>1/6</td>
<td>600MW, 400 ns milestone</td>
</tr>
<tr>
<td>2/3</td>
<td>RF Feed Design components</td>
</tr>
<tr>
<td>2/17</td>
<td>Fabricate components</td>
</tr>
<tr>
<td>3/1</td>
<td>Install high power components</td>
</tr>
<tr>
<td>3/3</td>
<td>High power tests</td>
</tr>
<tr>
<td>3/31</td>
<td>3x170MW, 400 ns milestone</td>
</tr>
<tr>
<td>4/14</td>
<td>on the roof</td>
</tr>
<tr>
<td>4/28</td>
<td>in the housing</td>
</tr>
<tr>
<td>5/12</td>
<td>Fabricate parts</td>
</tr>
<tr>
<td>5/26</td>
<td>Install in tunnel</td>
</tr>
<tr>
<td>6/9</td>
<td>Install to Structures</td>
</tr>
<tr>
<td>6/23</td>
<td>FNAL Girder delivery</td>
</tr>
<tr>
<td>7/7</td>
<td>Girder installation</td>
</tr>
<tr>
<td>7/21</td>
<td>Power to Girder(s)</td>
</tr>
<tr>
<td>8/4</td>
<td>NLCTA structure tests</td>
</tr>
<tr>
<td>8/18</td>
<td><strong>NLCTA</strong> structure tests</td>
</tr>
<tr>
<td>9/1</td>
<td>Girder delivery</td>
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<tr>
<td>9/15</td>
<td>Girder delivery</td>
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<tr>
<td>9/29</td>
<td>Girder delivery</td>
</tr>
<tr>
<td>10/13</td>
<td>Girder delivery</td>
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</tbody>
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MAC Review, November 6, 2002
With tapers, to be incorporated into a monolithic block

C. Nantista 8/02

MAC Review, November 6, 2002
DLDS layout

• Demonstrate DLDS pulse compression to attain NLC power specs.
  - 500 MW, 396 ns
    (@ girder)