NLC - The Next Linear Collider Project

The Status of the MERCURY Laser

Jeff Gronberg/LLNL

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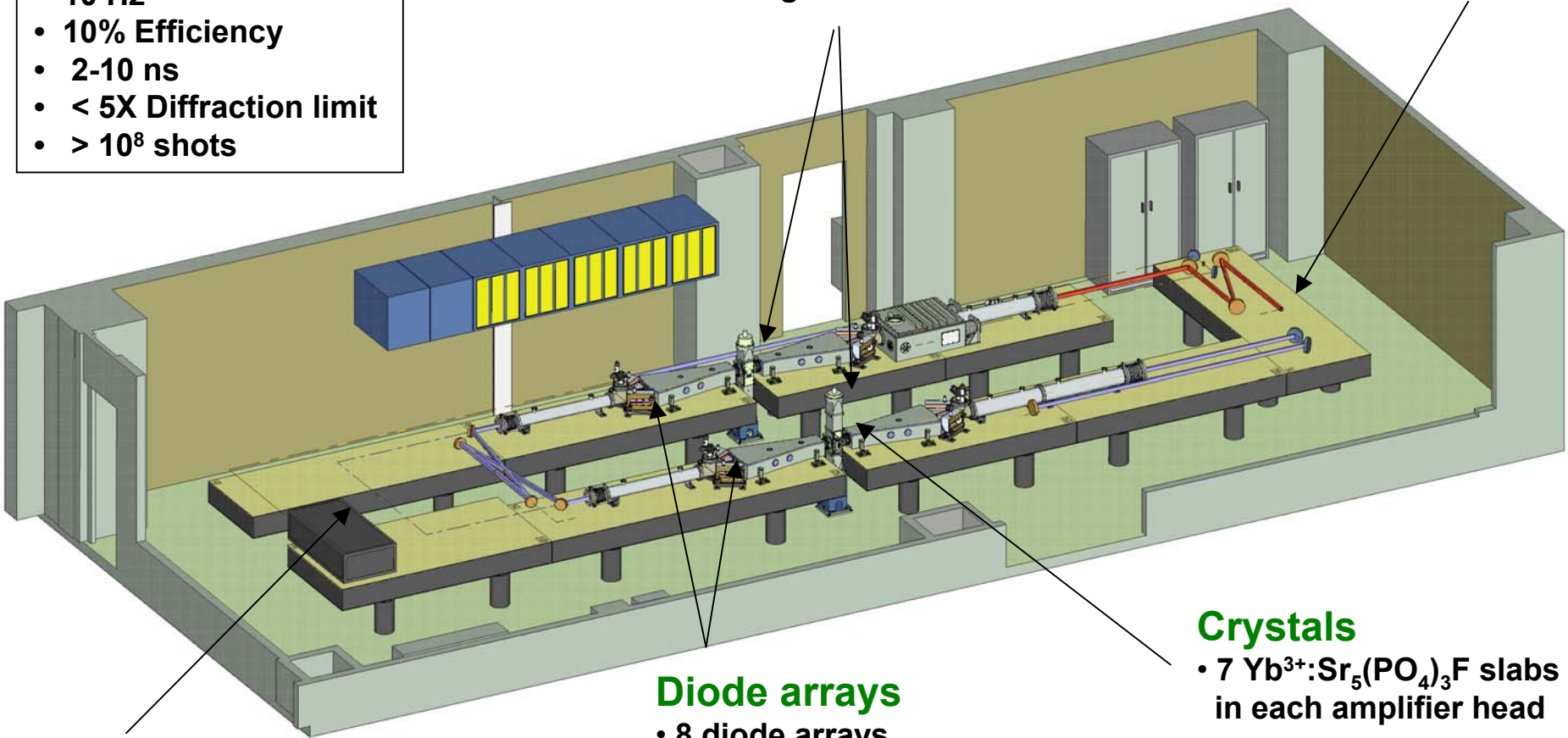
The MERCURY laser is a high-efficiency, gas cooled solid-state laser designed to produce 100J at 10Hz

Goals 2 amps:
- 100 J
- 10 Hz
- 10% Efficiency
- 2-10 ns
- < 5X Diffraction limit
- > 10^8 shots

Gas-cooled amplifier heads
- Helium gas flow at 0.1 Mach

Output



Crystals
- 7 $Yb^{3+}:Sr_5(PO_4)_3F$ slabs in each amplifier head

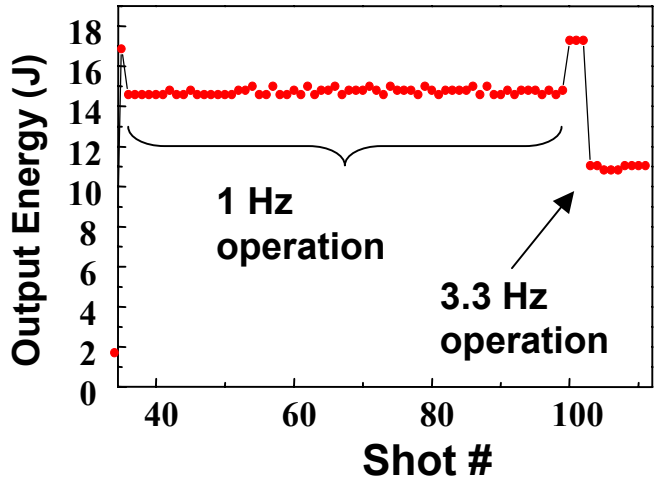
Diode arrays
- 8 diode arrays
- 6624 diodes total (900 nm)
- 730 kW peak power (110W/bar)

Front-end
- 300 mJ

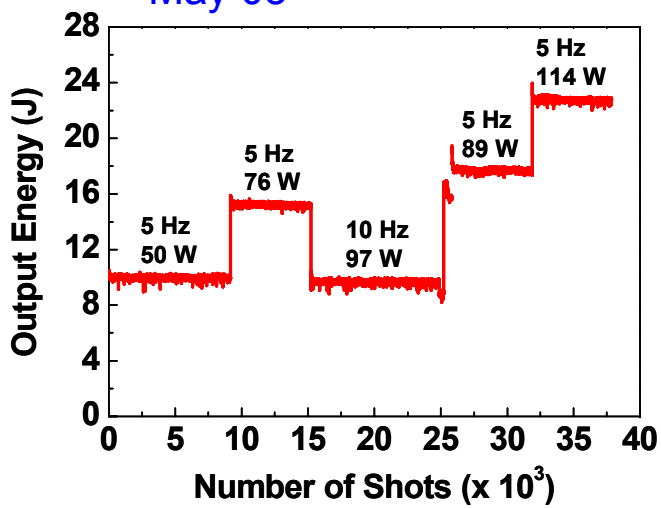
At the time of Jeju tests with a single amplifier head had begun

- At Jeju
  - Single head operation was begun
- In summer of 03 single head testing was completed
  - Redesign of amplifier crystal coating to reduce damage
  - All crystals refabricated
  - Other system improvements made
- January 04, full system installed
  - First light in the full system

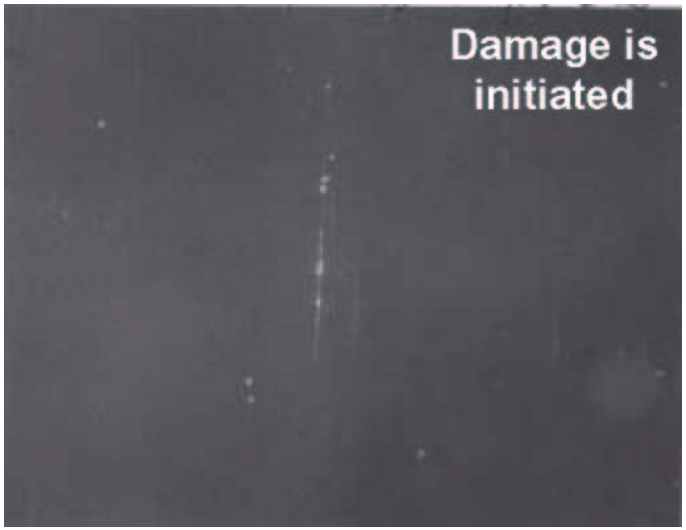
August 02, Jeju

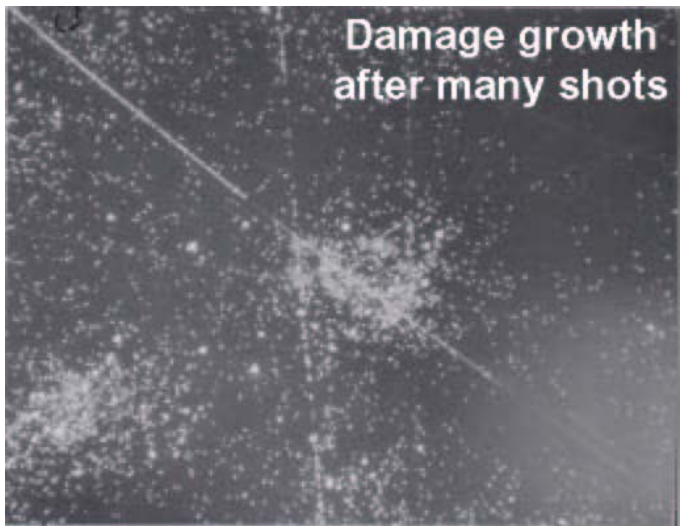


May 03

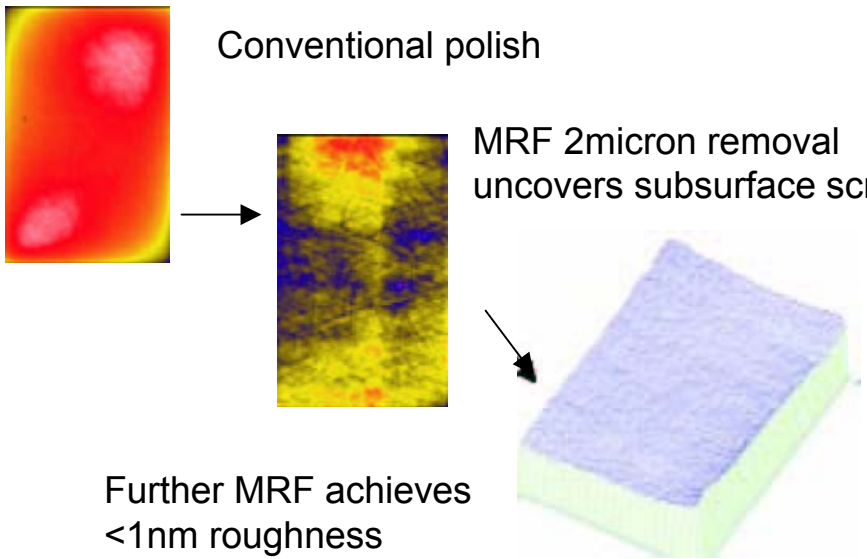


Crystals need better than standard polishing for damage resistance



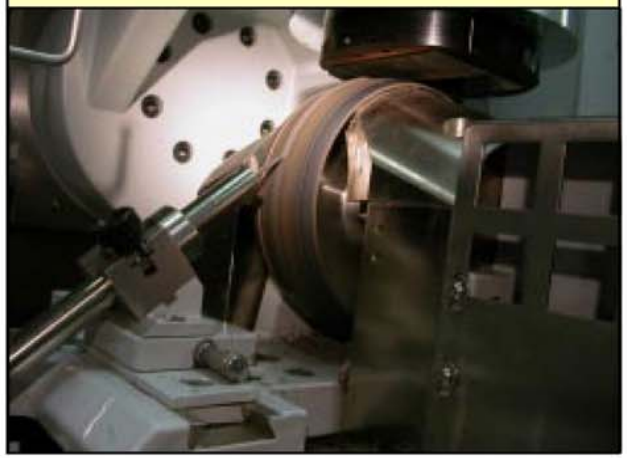


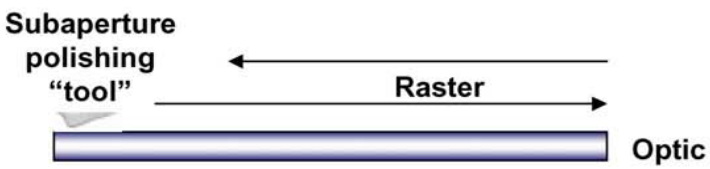
- High damage threshold coatings require high quality surfaces
  - Damage in the crystal transfers to the coating and is the site of damage formation
  - Magneto-rheological finishing (MRF) removes sub surface damage



The Magnetorheological Finishing (MRF) machine at LLNL is being used to improve the wavefront of Yb:S-FAP slabs

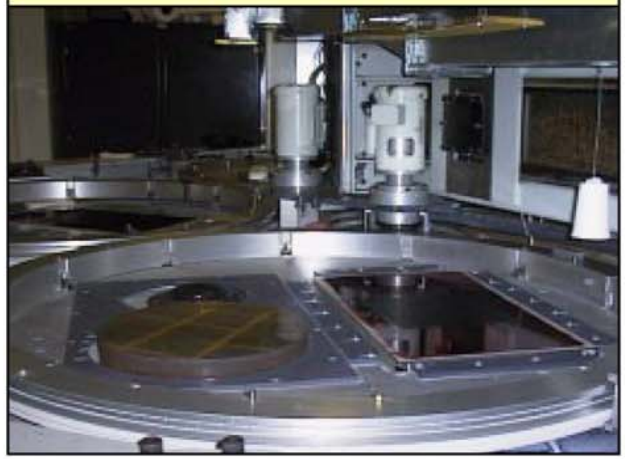
Deterministic finishing

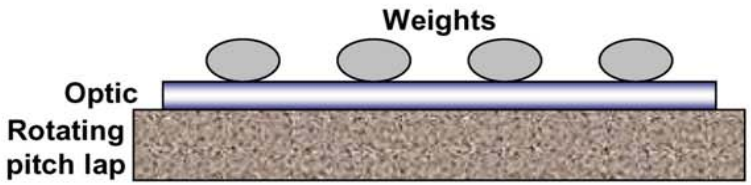


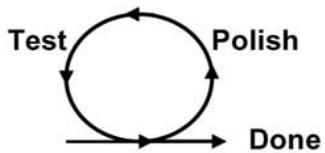


Test → Polish → Test → Done

Conventional polishing

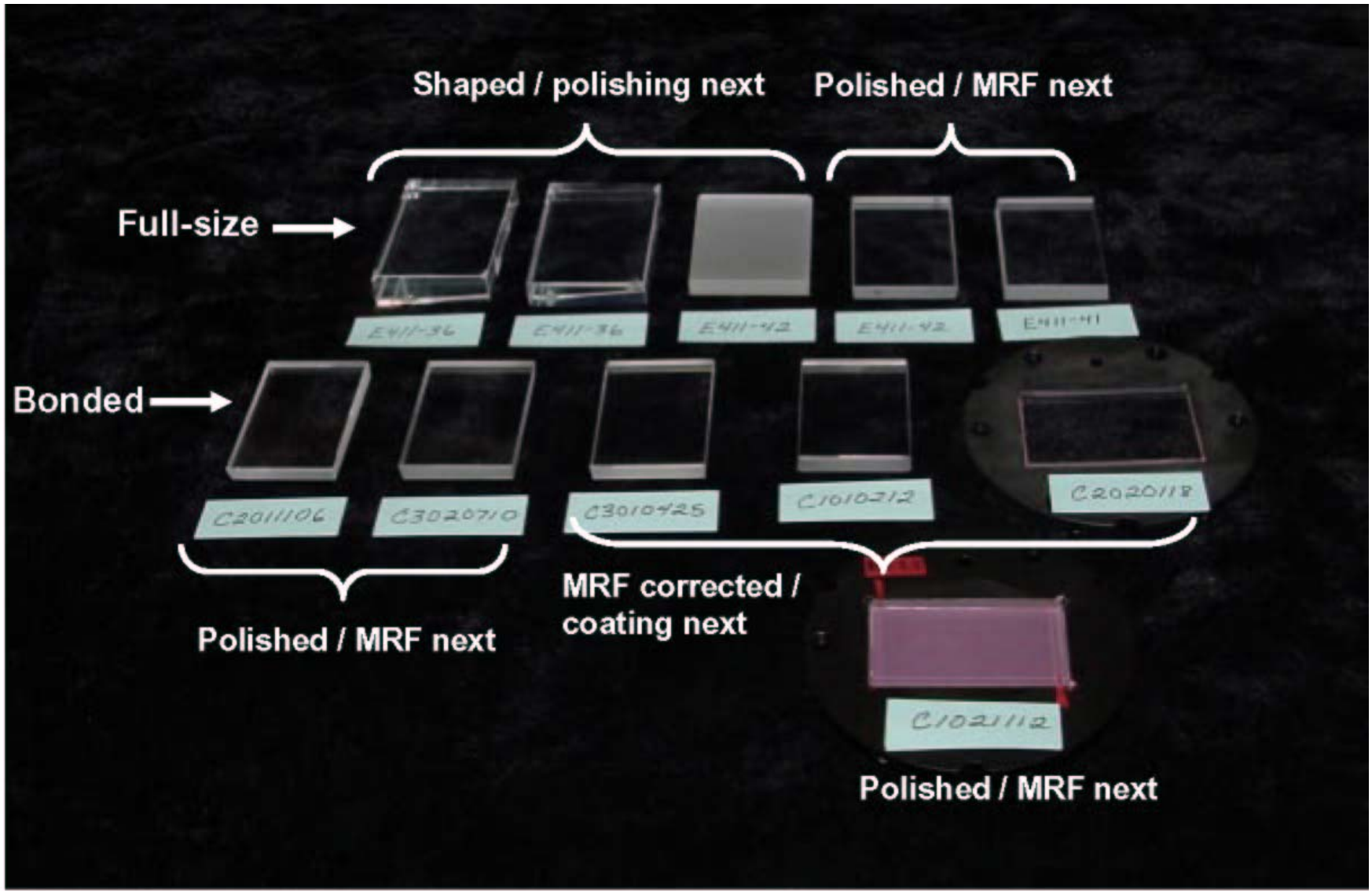






The removal function is held constant during polishing and material removal is controlled by varying the residence time over the optical surface

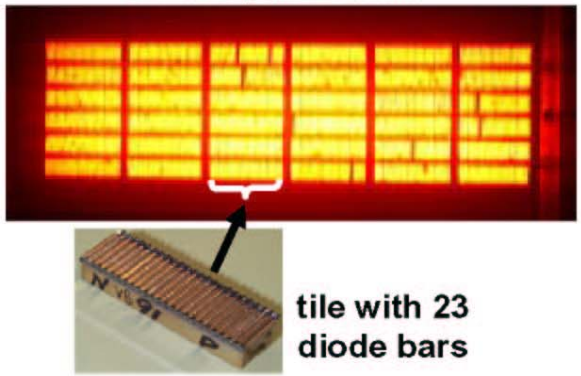
Reprocessing all amplifier crystals has led to some delay



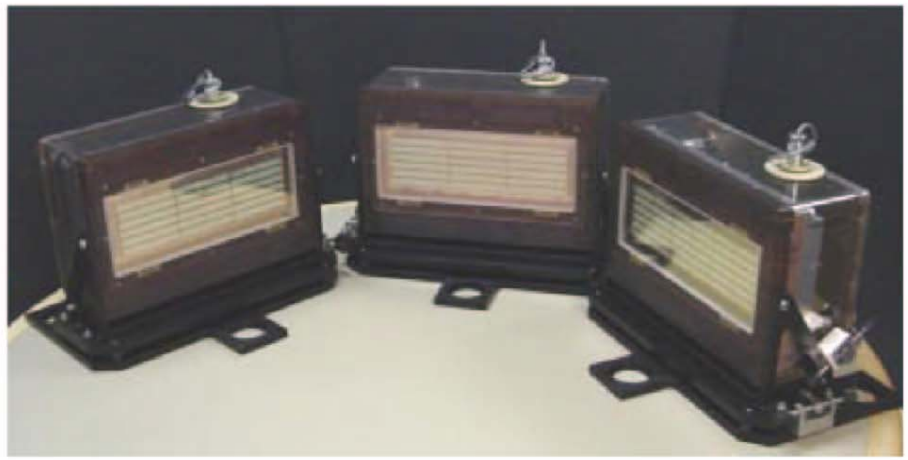
We have fabricated and qualified 80 kW diode arrays for a total of 320 kW of peak diode power

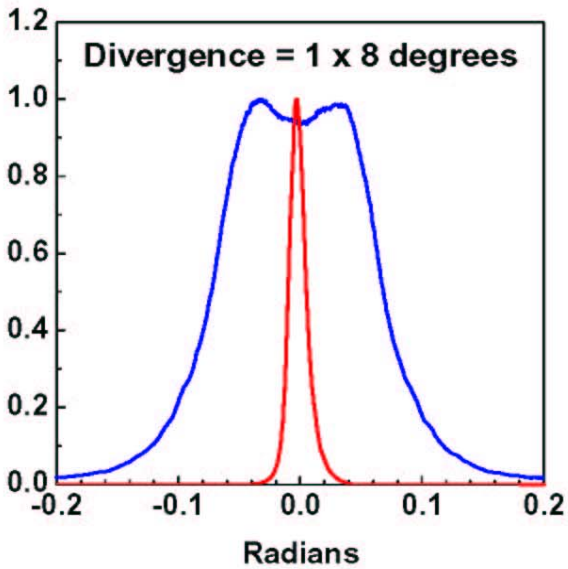
Operated at:

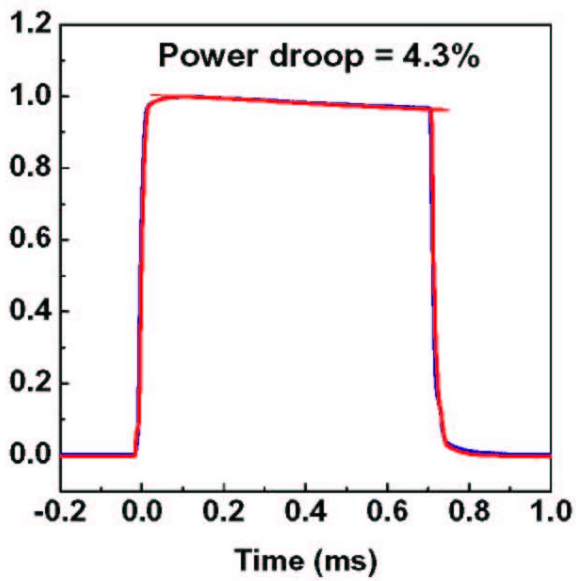
- 120 W/bar at 10 Hz
- 900 ms pulsewidth

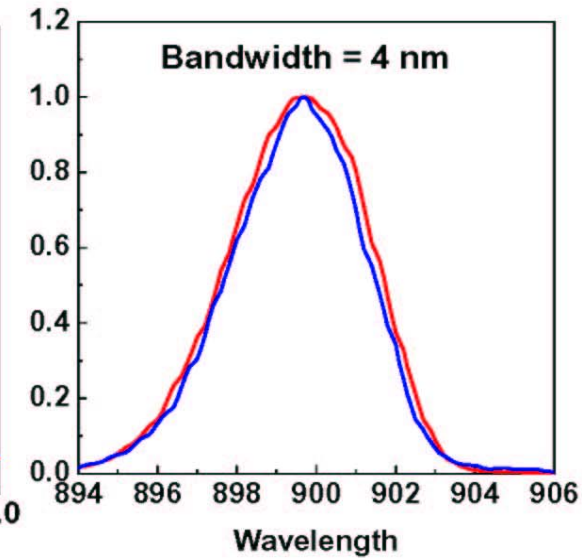


tile with 23 diode bars

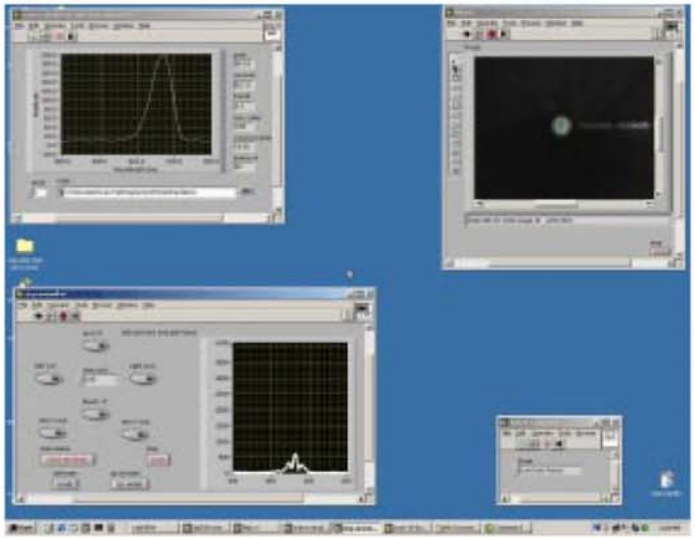




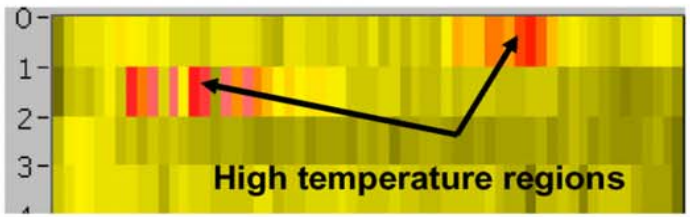




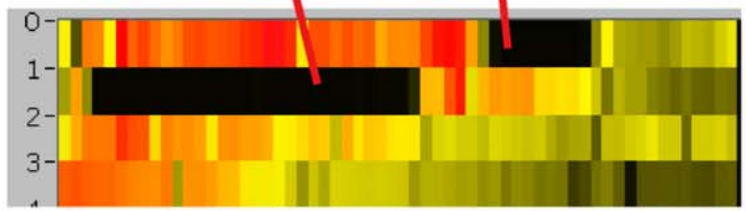
An experimental set-up has been built to observe anomalous, high temperatures that are precursors to diode failures



- Two “hot” regions identified
- Strong correlation between hot spots and eventual failures



Temperature (before burn-in)



Power (after burn-in)

We anticipate the temperature field scan technology will be a useful diagnostic for eliminating weak diode bars and improving process-control

Many improvements made in preparation for the two-head running

- Improved processing of crystals
  - Higher damage threshold for coatings
  - Better wavefront control, higher extraction efficiency
- Automated monitoring of diode bars
- Pockels cell to prevent spontaneous amplification
- Improved coatings on beamline optics
- Wavefront corrector plates installed in the amplifier heads

- Industrialization, several vendors are looking at
  - Growing Yb:S-FAP crystals, cutting, bonding
  - Producing diode bars

First light is in the system
Full power running this summer