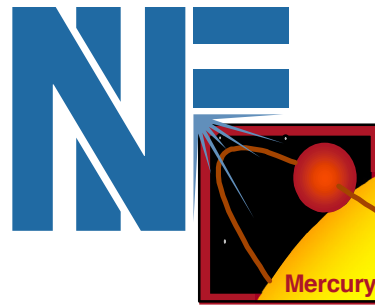


# Status of DPSSL Development

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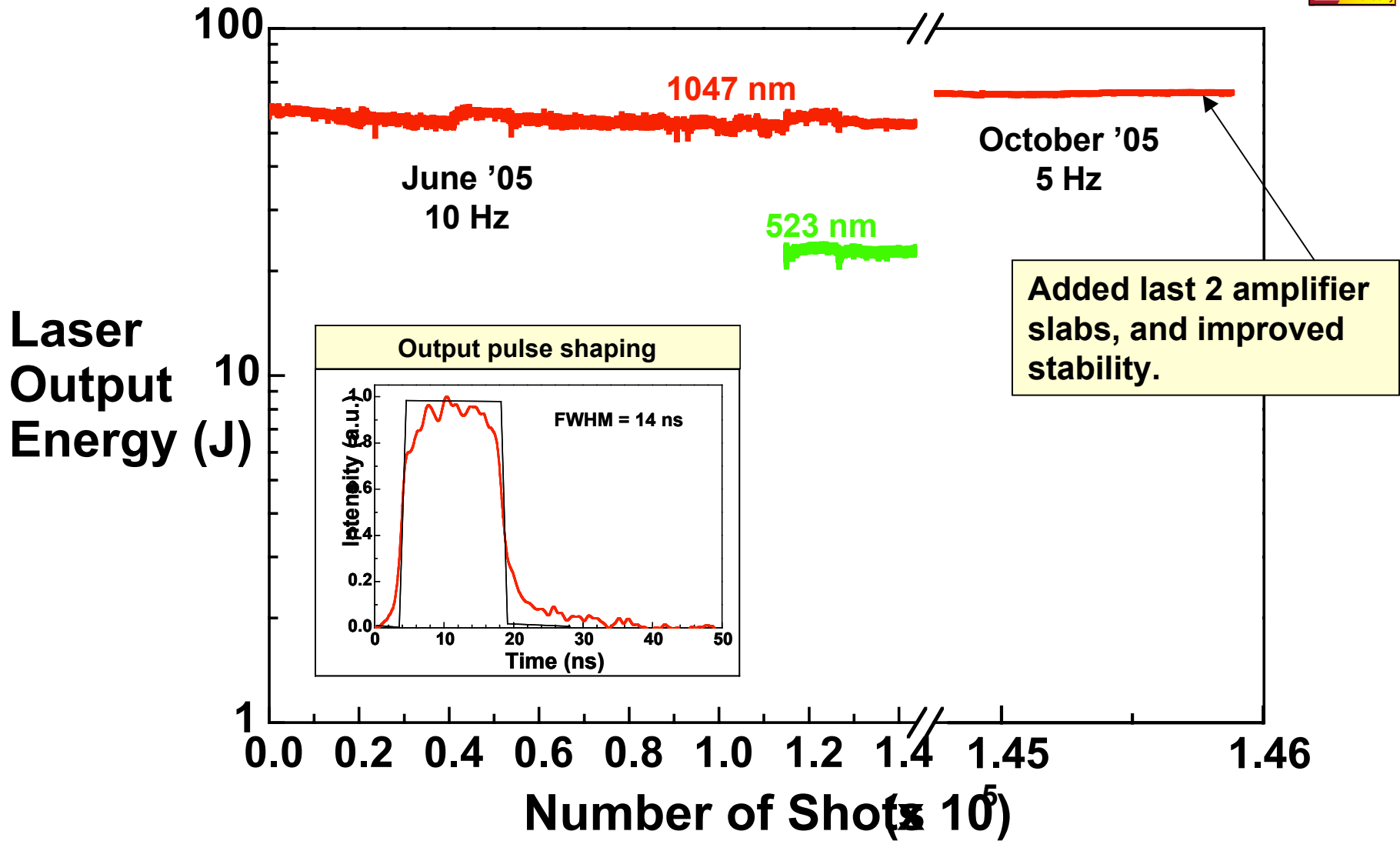
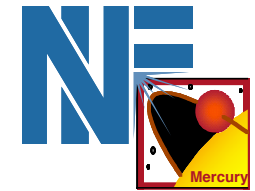
**Presented by John Caird**

**Photon Science and Applications Program  
National Ignition Facility Programs Directorate  
Lawrence Livermore National Laboratory  
Livermore, California USA 94550**

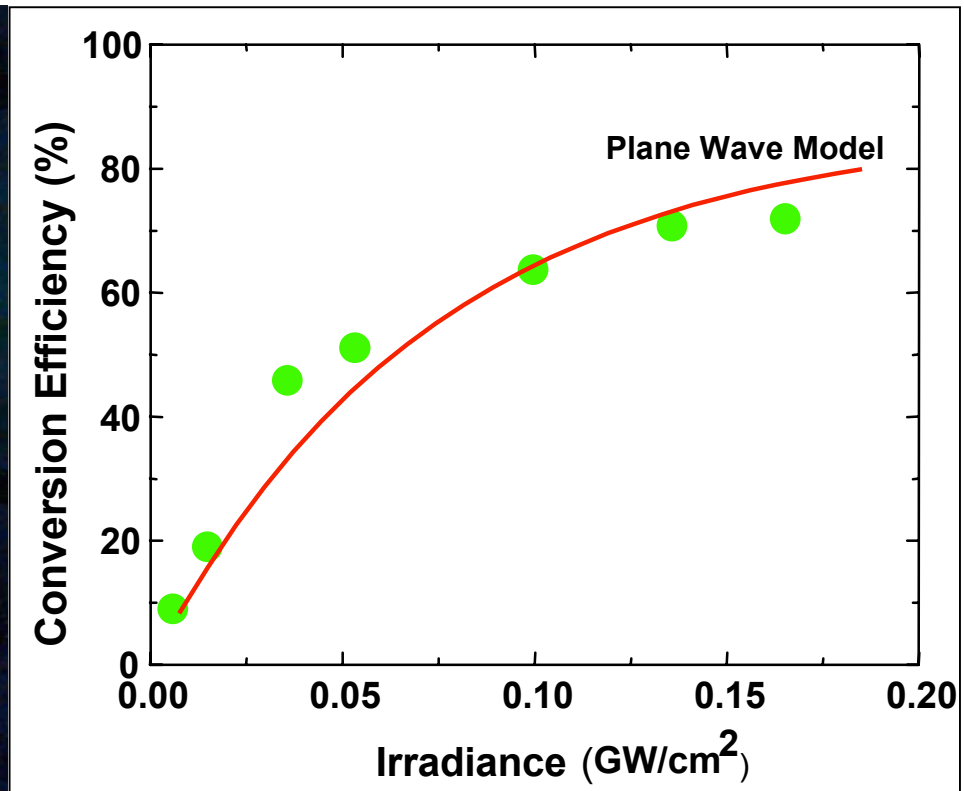
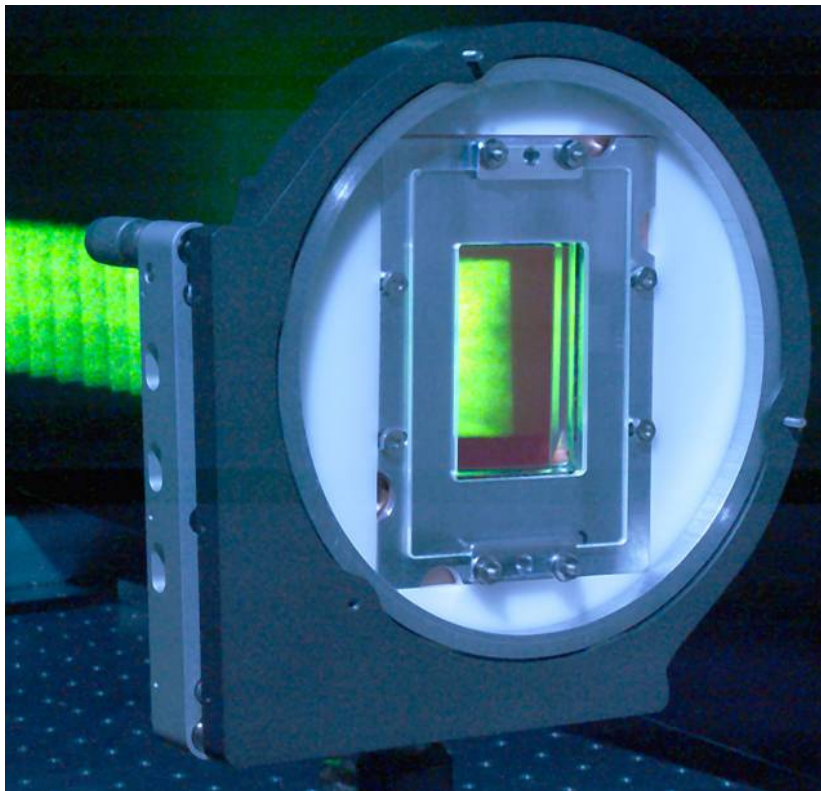
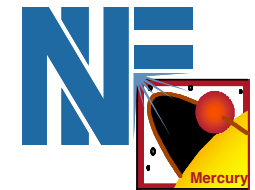
**Fusion Power Associates  
Annual Meeting and Symposium  
Fusion: Pathways to the Future**

**September 27-28, 2006**

# The Mercury laser has operated at 550 W average power (> 50% of design point)



# High average power YCOB frequency converter operated up to 73% conversion efficiency



- High efficiency frequency conversion demonstrated
- Experiment agrees with simple plane wave model

# Mercury received a third R&D 100 award for its high average power frequency converter



The screenshot shows the Lawrence Livermore National Laboratory (LLNL) website as viewed in Microsoft Internet Explorer. The browser's address bar shows the URL <http://www.llnl.gov>. The website header includes the LLNL logo, the text "University of California LAWRENCE LIVERMORE NATIONAL LABORATORY Science in the National Interest", and navigation links for "about llnl", "public affairs", "jobs", "postdocs", "library", and "visiting". There are also search boxes for "Search LLNL" and "Find People".

The main content area features a central article titled "Lab nabs seven 'Oscars of Invention'" with a large image of a glowing green laser beam. To the right, under "News Releases", there are four news items with "Read more..." links:

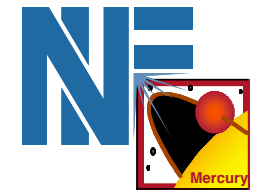
- NNSA announces new mark for world's fastest supercomputer
- Lab study pinpoints nitrate sources in Tri-Valley groundwater
- Cargo explosives screening program to be piloted at SFO
- Scientists tackle long-standing questions about plutonium
- Study shows that genetic quality of sperm deteriorates as men age

Below the main article, there are three columns of "Science & Technology Highlights", "Publications", and "Public Events".

- Science & Technology Highlights:** "Flowing freely at the nanoscale" - Highly permeable membranes made of carbon nanotubes and silicon could be used for desalination and many other applications. [Read more...](#)
- Publications:** "Science & Technology Review", "Annual Report", and "Newswire".
- Public Events:** "Explore LLNL's Discovery Center" - Exploratorium exhibits now on display. [Read more...](#)

The footer contains the UCRL-WEB-206848 | Privacy & Legal Notice, the date July 12, 2008, and logos for NNSA, LLNL, and the University of California. The text reads: "Lawrence Livermore National Laboratory 7000 East Avenue • Livermore, CA 94550" and "Operated by the University of California for the Department of Energy's National Nuclear Security Administration".

**The amplifier system is pumped by eight diode arrays producing a peak diode power of 640 kW**



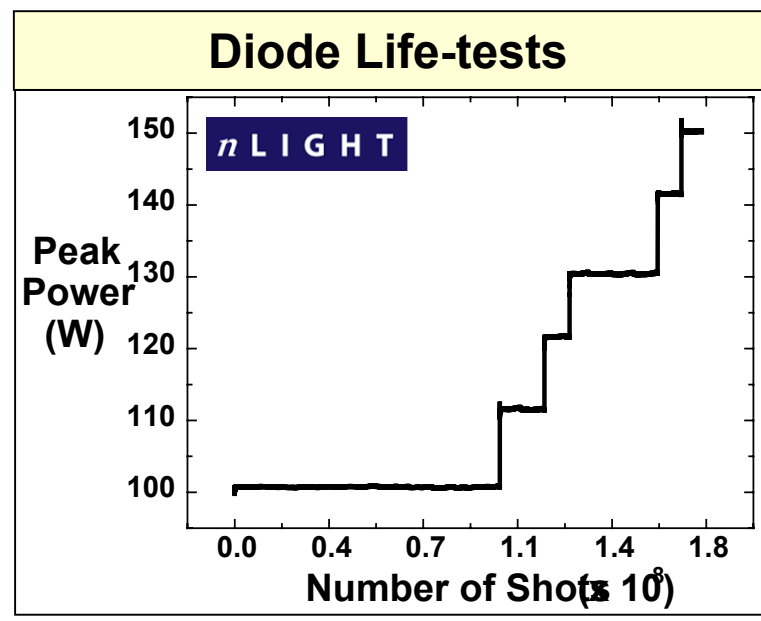
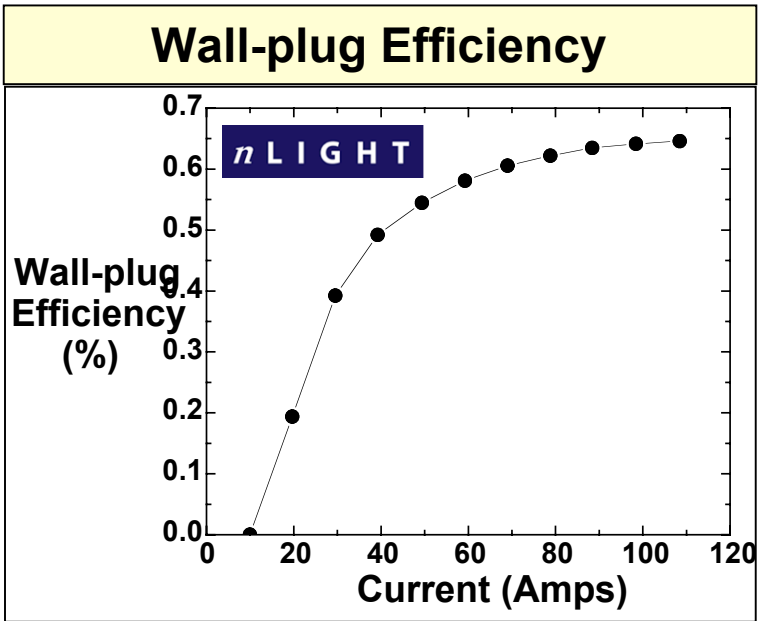
Diode tile attributes	Goal	Demonstrated Performance
Power	> 100 W/bar	120 W/bar
Reliability (shots)	> 2 x 10 <sup>8</sup> @ 100 W/bar	1.4 x 10 <sup>8</sup> @ 115 W/bar
Power droop (1 msec)	< 15 %	4.3 %
Linewidth	< 5 nm	2.3 nm
Integrated linewidth (1 msec)	< 8.5 nm	4.1 nm
Divergence	< 18 mrad x 180 mrad	15 mrad x 140 mrad
Wallplug efficiency	> 50 %	45 %

**These eight arrays were operated in the system for > 3 x 10<sup>6</sup> shots**

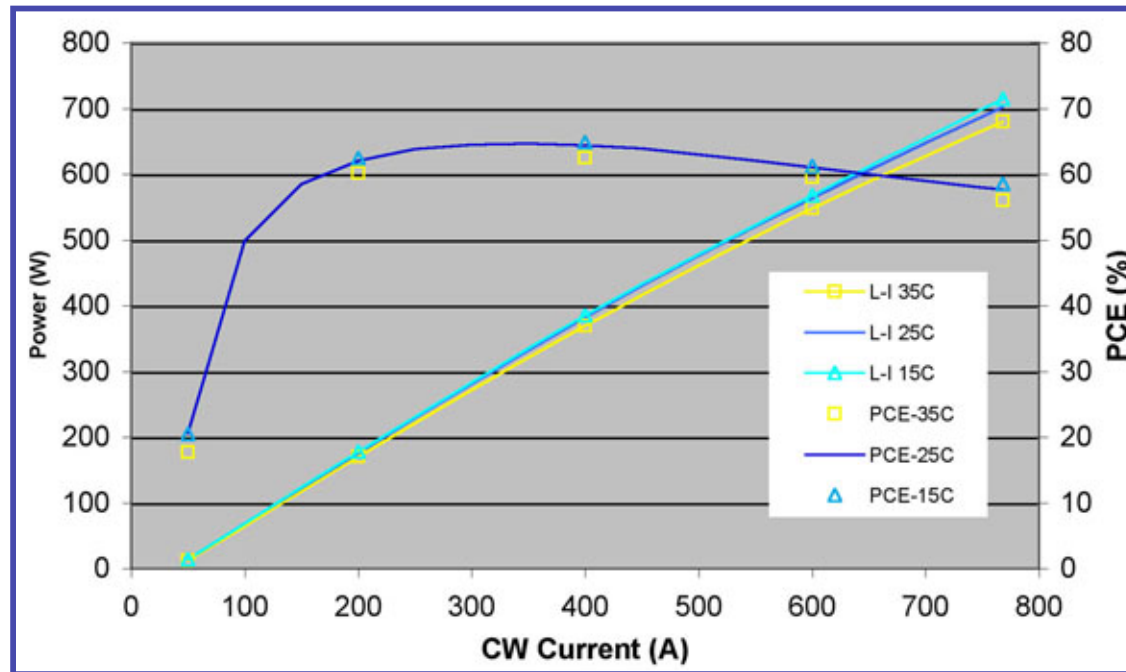
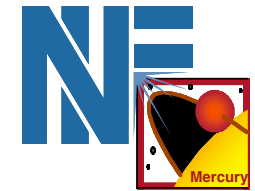
# New generation diode bars are tested at LLNL for efficiency, power, and lifetime requirements



- Initial tests of one vendor:
- nLIGHT diode material developed for the DARPA Super High Efficiency Diode Sources (SHEDS) program
  - Diode emission at 940 nm with 3 nm bandwidth

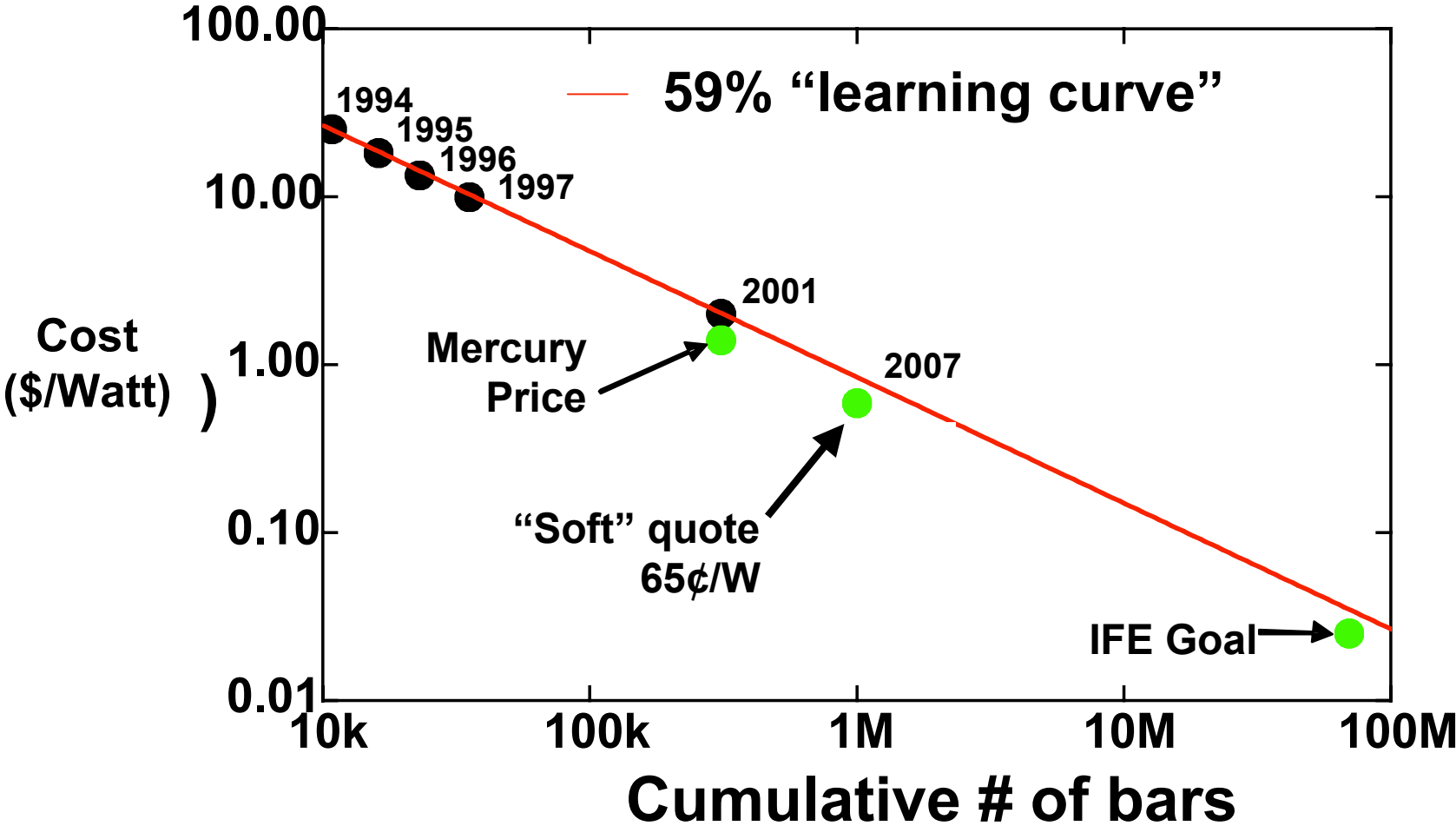


# Newport's Spectra-Physics Lasers Division set new diode power record with ProLite® laser bar



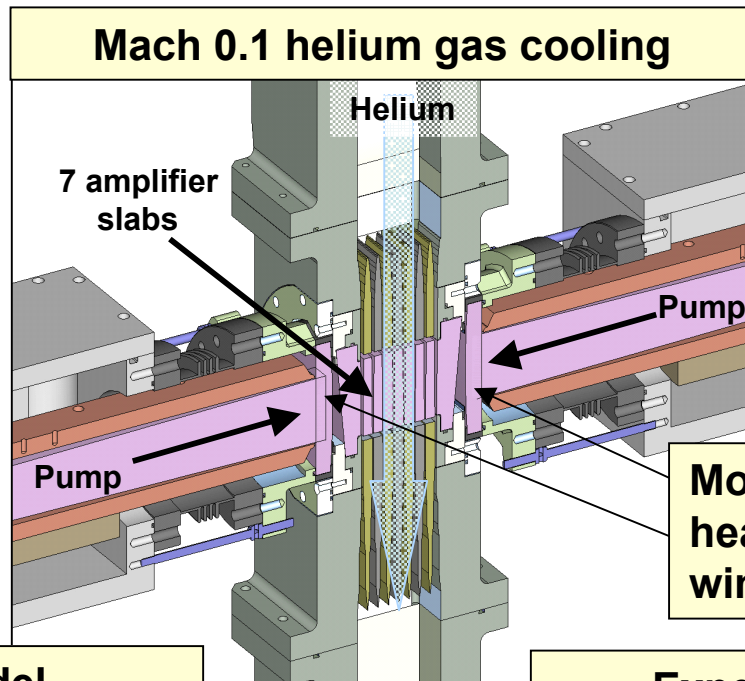
- 714 Watts (W) of continuous operation @ 940 nm
- Newest epitaxial design, state-of-the-art growth process, and industry-leading device engineering.
- 5 tiles give 80 kW versus 36 tiles on current arrays
- Significant \$/Watt cost reduction anticipated
- Details @ <http://www.newport.com/>

# Diode costs are following a 59% learning curve similar to other semiconductor manufacturing

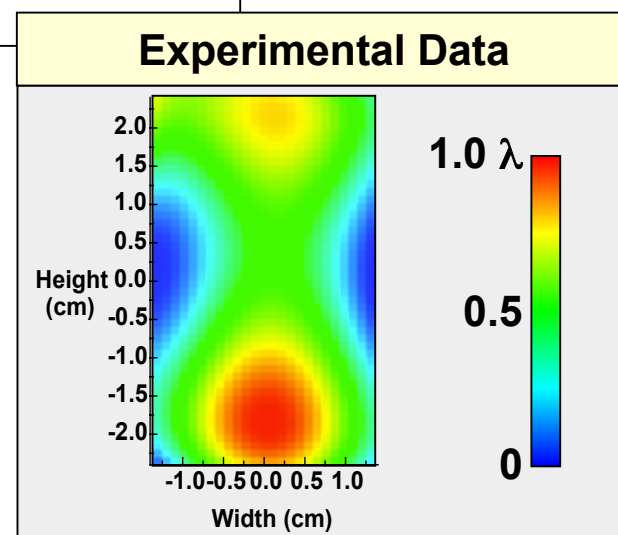
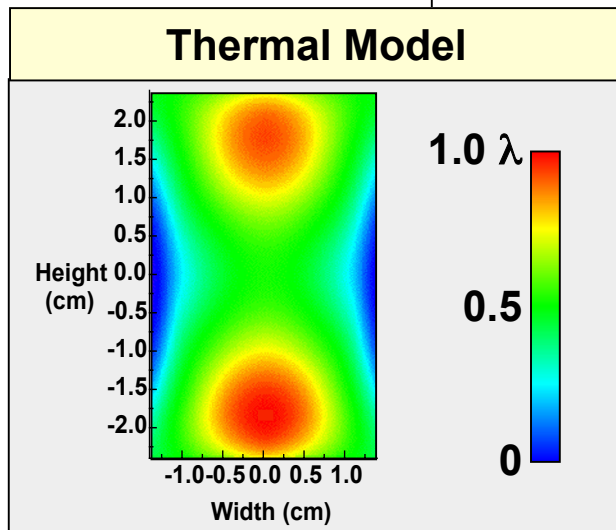




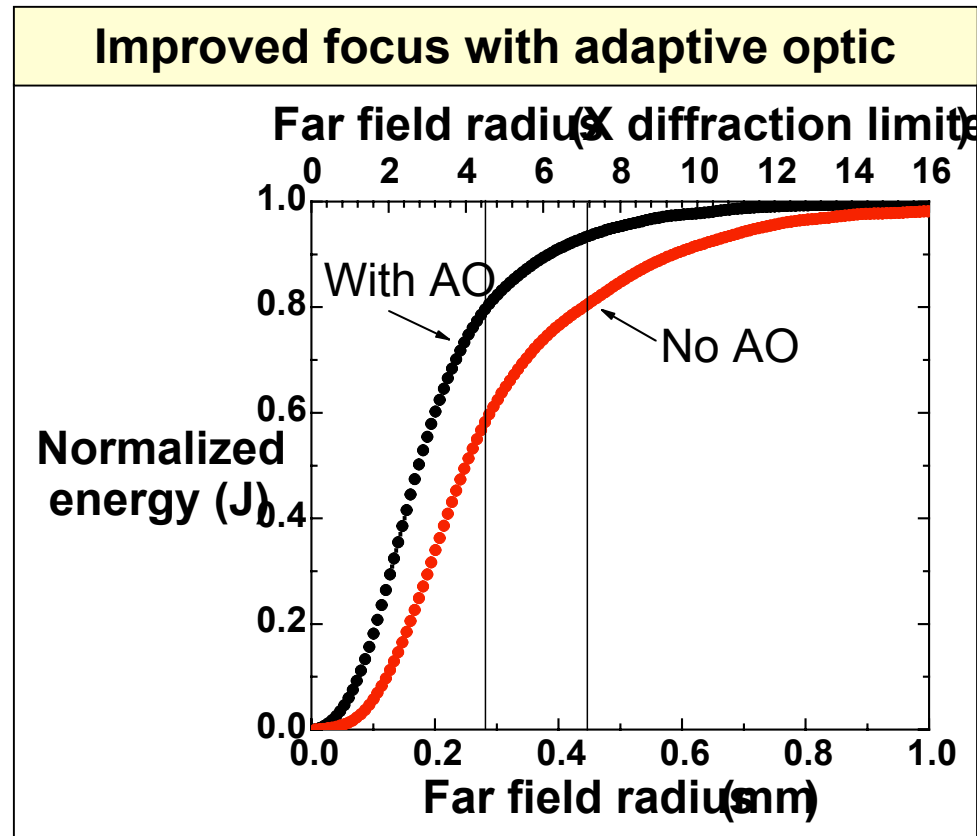
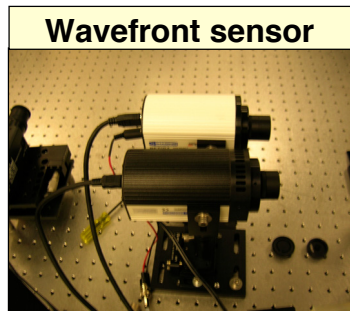
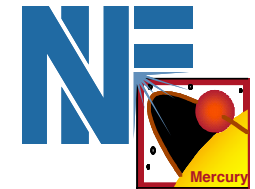
# The thermal wavefront was benchmarked against a complete thermal model of the amplifier head



Model updates include heating of the fused silica windows and lenses

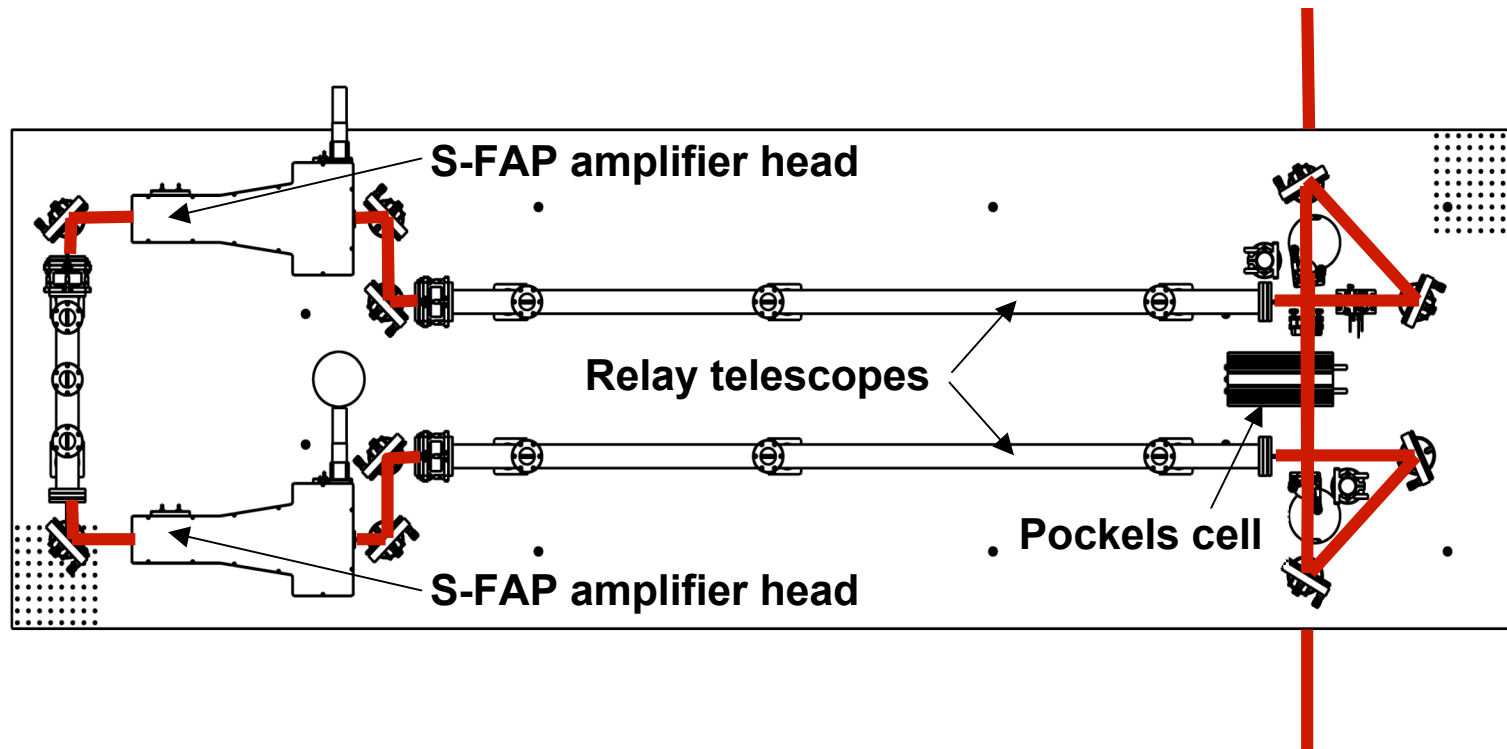
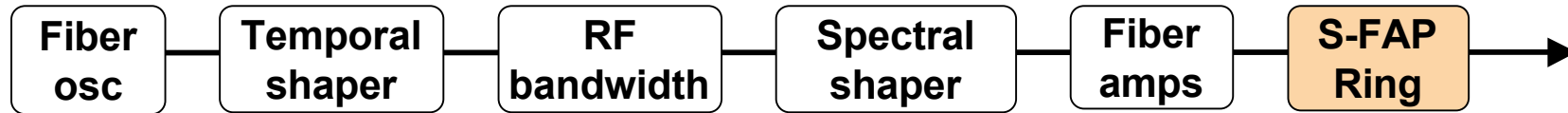
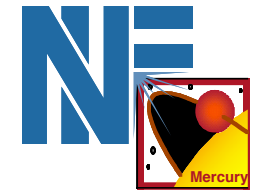


# Adaptive optic system has high resolution sensor and bimorph mirror to improve beam quality

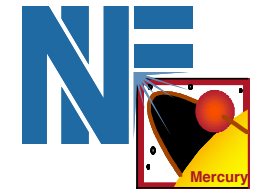


The adaptive optic (AO) system is now fully operational and has been used for system operations at up to 300 W.

# New front end Multi-Pass Ring Amplifier (MPRA) uses two diode-pumped SFAP crystal amplifiers



# Advanced front end has temporal, spectral, and spatial sculpting capability for pulse injection



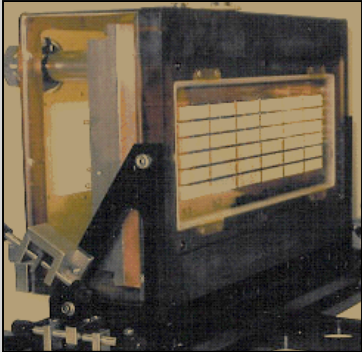
Laser Performance		Goal	Status
Energy	Energy (mJ)	500	525
	Stability (%)	< 1	1.5
	Signal to noise (ASE)	10 <sup>4</sup> :1	10 <sup>6</sup> :1
Spatial	Beam quality - Focusability (times diffraction limited)	< 1.5	~5
	RMS Uniformity (%)	< 10	~10
Temporal	Shaping contrast	> 20:1	150:1
	Intensity fluctuations (%)	< 5	2.2
	Jitter (ps)	< 250	260
Spectral	Amplitude shaping	> 100:1	300:1
	Phase shaping	> 100:1	300:1
	Stability (GHz)	< 3	0.08
	Bandwidth (GHz)	333	240

# Summary: Mercury component development is making rapid progress



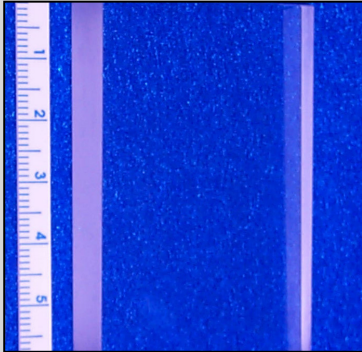
**Diode pump arrays**

- Commercialized package
- New High Eff / High power

A photograph of a diode pump array assembly. It consists of a black metal frame with a grid of small, rectangular components (likely diodes) mounted on a central panel. The assembly is shown in a laboratory setting.

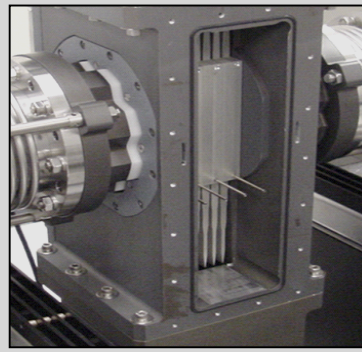
**Solid-state amplifier**

- Improved quality
- 12 cm diameter growth

A photograph of a solid-state amplifier. It shows a blue, textured surface with a vertical strip of purple material. A ruler is visible on the left side, indicating the size of the component.

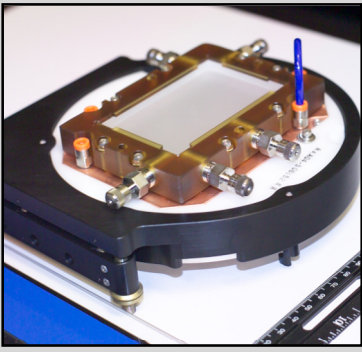
**Helium gas cooling**

- Low thermal wavefront
- 4 hours operation (10 Hz)

A photograph of a helium gas cooling system. It shows a complex, metallic assembly with various pipes, valves, and a central chamber. The system is mounted on a base and appears to be part of a larger experimental setup.

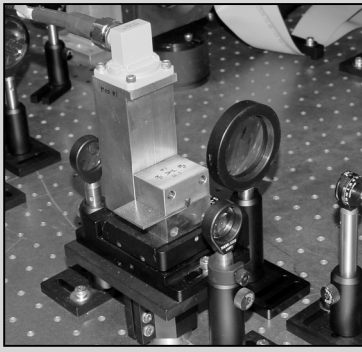
**Frequency Converter**

- 6 x 8 cm<sup>2</sup> YCOB slabs
- Scalable cooling design

A photograph of a frequency converter. It shows a circular, metallic assembly with a central white slab (likely a YCOB slab) and various electrical connections. The assembly is mounted on a black base.

**Broadband Front End**

- Fiber based design
- 525 mJ demonstrated

A photograph of a broadband front end. It shows a complex, metallic assembly with various optical components, including lenses and mirrors, mounted on a base. The assembly is shown in a laboratory setting.

**Adaptive Optic**

- High resolution sensor
- 41 act. bi-Morph mirror

A photograph of an adaptive optic. It shows a circular, black assembly with a central lens or mirror. The assembly is mounted on a yellow base.