Highlights of 15th HAPL Meeting, Aug 8 and 9, 2006

The 15th High Average Power Laser (HAPL) workshop was hosted by General Atomics and UCSD in San Diego, CA. The HAPL program is providing the basis for an attractive fusion power plant based on lasers and direct drive targets. The key components are developed together, closely coupling the technology, science, and final application to ensure a coherent system. Among highlights presented at the recent workshop were:

Two lasers are under development: The Electra Krypton Fluoride (KrF) electron beam pumped gas laser at NRL and the Mercury diode pumped solid state laser (DPSSL) at LLNL. The Electra group reported on a new electron emitter based on a carbon fiber array supplied by ESLI, Inc. This enabled an unprecedented continuous KrF laser run of ~ 25,000 laser shots at 2.5 Hz. The emitter was unchanged after the run. Also reported were first studies of the rep-rate laser focal profile, demonstrating recovery of the laser gas in less than 200 msec (corresponding to 5 Hz), and "first light" with the new electron beam pumped pre-amplifier (20 J/pulse). The Mercury Project staff earned its third R&D 100 award for average power frequency conversion using yttrium calcium oxyborate. Several advanced technology milestones were also reported: 73% efficient frequency conversion at 200 W, front end demonstration at 525 mJ with pulse-shaping, and adaptive optic generating a four times diffraction limited beam at 300W average power. DPSSL technology scalability was demonstrated with 65% efficient diode bars operating at 150W/bar, and the largest ($1.4 \times 6 \times 8$ cm^3) Yb:S-FAP amplifier crystal grown to date.

For target issues, the GA/Schaffer team reported successfully meeting the specifications for the foam capsule and producing the very first gastight overcoats for these capsules. They also reported room temperature operation of a fluidized bed that will be used to demonstrate mass produced smooth D_2 ice layers on the target. The University of Rochester LLE reported the first demonstration of a target with an ultra smooth DT ice layer- 0.73 microns RMS in all modes. This was done under the LLE ICF program, but is needed for inertial fusion energy. A conceptual design for an in-flight target tracking-steering system was shown at the last HAPL meeting. At this meeting the GA/UCSD team reported the first demonstration of a key component: a "glint" signal from the target was used to align and steer a simulated driver with a fast steering mirror.

NRL reported achieving intensities greater than 10^{15} W/cm^2 on the Nike laser. This will access the physics regimes of the newer direct drive targets. LLNL reported on several advanced target designs, including shock ignition (first proposed by LLE) and two-sided direct drive. Wisconsin, UNC/Chapel Hill, Sandia, and UCSD reported on experiments to study the effects of target ions on the first wall, and UCLA reported on a unified model to predict these experiments. Understanding and mitigating these effects is a key challenge . To that end, we are developing an innovative concept that uses a cusp magnetic field to divert the ions away from the wall. The ions would be absorbed in an external dump region where a number of energy-accommodation alternatives are possible without impacting the main chamber laser and target injection requirements. This was proposed by A.E. Robson. Other advantages of this approach are a smaller chamber and potentially high enough wall temperatures for efficient hydrogen production. A 1979

NRL experiment showed a cusp can stably keep the ions from a laser-produced plasma off the wall. At this meeting, Voss Scientific reported on the first simulations that accurately predict the ion trajectories in that experiment. At the end of the first day a number of other innovative options were discussed in an open session. These include: an engineered W armor to enhance He ion release and accommodate thermal stresses; allow transient armor melting; a moving solid wall; and utilizing a high heat-transfer and high-temperature capable W coated carbon fiber carpet as armor.

PLEX Corp/Wisconsin presented two final optical train concepts, one uses a Grazing Incidence Metal Mirror as a final optic, the other uses a dielectric mirror. The dielectric system is smaller and has lower neutron flux on the upstream optics. Recent ITER related experiments indicate a dielectric mirror can survive the direct neutron flux. ORNL/Penn State will expose candidate dielectric mirrors in the HFIR reactor to test this.

PPPL presented a conceptual design for a tritium recovery, processing and purification system. The design was reviewed by outsiders. LLNL presented updated economic models, which will help guide the R&D needed to maximize performance.

These results are due to the hard work of over sixty researchers from 25 institutions.
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HAPL meeting archives: http://aries.ucsd.edu/HAPL/
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