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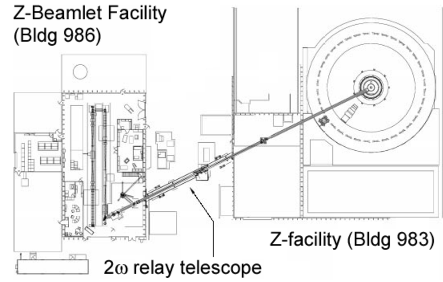

Z-Beamlet Facility wins R&D 100 Award

R&D magazine will announce in its May issue that the Z-Beamlet (ZBL) facility won the "2002 Renovated Lab of the Year Special Mention Award." This award highlights the successful transfer of the Beamlet laser, formerly at Lawrence Livermore National Laboratory in CA, to Sandia. As part of this project, Bldg. 986 was transformed from a dusty storage warehouse to a class 100,000 cleanroom laser facility with a vacuum line-of-sight into the Z-machine in the neighboring building. The disassembly, transfer, and upgrades to the laser components, as well as the refurbishment of Bldg. 986, were completed in only 3 years for $12.9 million. John Porter, the manager of 1673, is proud of this award, noting that it is indicative of the high quality of work put in by the ZBL team.

Petawatt upgrade for Z-Beamlet

The Z-Beamlet facility (www.z-beamlet.sandia.gov) is capable of generating 2 trillion watts (2 TW) of 527 nm light (green) in a pulse as short as 0.25 billionths of a second (0.25 ns). By contrast, all of the electrical generators in the world together produce about 4 TW of continuous power. ZBL can deliver several thousand joules of energy in these pulses. As discussed in the March 2002 News Notes, this energy can be used to generate x rays to image experiments on the Sandia Z-machine. Though experiments on the Z-machine typically occur once per day, the ZBL laser can fire 3-4 times a day. To take advantage of this, a small test chamber has been constructed in Bldg. 986 for independent tests using only the ZBL laser.

Presently there is a nationwide effort to develop "petawatt" lasers (1 PW = 1000 TW) at several locations across the country. The goal of this effort is to develop high-power lasers to support the nation's nuclear weapons complex, as well as the training and education of the next generation of scientists and engineers at selected universities. Thus, petawatt-class laser facilities have been proposed for construction at Sandia, the Laboratory for Laser Energetics in Rochester, Lawrence Livermore National Laboratories (LLNL), the Univ. of Texas-Austin, and the Univ. of Nevada-Reno. Facilities in Europe and Japan are also building petawatts. LLNL recently deactivated a prototype petawatt laser that demonstrated the concept.

Sandia's Z-Beamlet laser is a natural candidate for these upgrades because it is coupled to the world's most powerful x-ray source, the Z-machine, capable of producing >200 TW of x rays. By the time a petawatt upgrade would be complete (2006), the Z-machine will be upgraded to a more powerful version called ZR, designed to produce about 350 TW of x rays. There are two principal applications for a petawatt laser on ZR: high-energy radiography of ZR experiments, and "fast ignition." In traditional ICF approaches, x rays are used to uniformly compress and heat a target capsule to very high densities and temperatures until fusion reactions begin to occur and the capsule "ignites." Driving capsules to these conditions requires an x-ray source more advanced than any presently operational facilities. It has been proposed, however, that an energetic petawatt laser beam could be used to heat a compressed capsule to make it ignite, much like a spark plug ignites fuel in a combustion engine. In this case the power and symmetry requirements on the main compression facility would be relaxed, making such a facility cheaper and less complex. A petawatt laser coupled with the ZR facility would allow fast ignitor experiments at a facility capable of generating high-quality, compressed capsule implosions.

To increase the power (energy per unit time) generated by ZBL to the petawatt range, the same energy will be compressed into a shorter pulse. The minimum pulse duration will initially decrease from 0.25 ns to 0.0004 ns (0.4 ps). This will be done using chirped-pulsed amplification (CPA). A laser pulse has several different spectral components moving together in phase. The CPA hardware spreads the spectral components out in time, so that each component passes through the system and is amplified independently from the others. Thus, each spectral component can be amplified up to the damage threshold of the amplifiers. After amplification, the CPA hardware recombines the components into a single, coherent pulse using diffraction gratings. The gratings are a critical part of the upgrade because at high powers they are easily damaged.

The full upgrade from a 2 TW facility to a PW facility will occur in three stages. At the end of the first stage (2003), the laser will be capable of generating 0.1 PW pulses (40 J in 0.4 ps). The second stage will be capable of 0.5 PW pulses (200 J in 0.4 ps). When the petawatt upgrade is complete (2006), the laser will generate a ≥1000 J, 5-ps pulse suitable for fast ignitor experiments. The coupling to the ZR facility will be complete by 2007. To prevent the upgrade from interfering with ZBL operations on Z or ZR, a developmental beamline in Bldg. 986 will be dedicated for petawatt development. This will also allow us to continue doing additional experiments in the ZBL test chamber as the upgrade progresses.

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