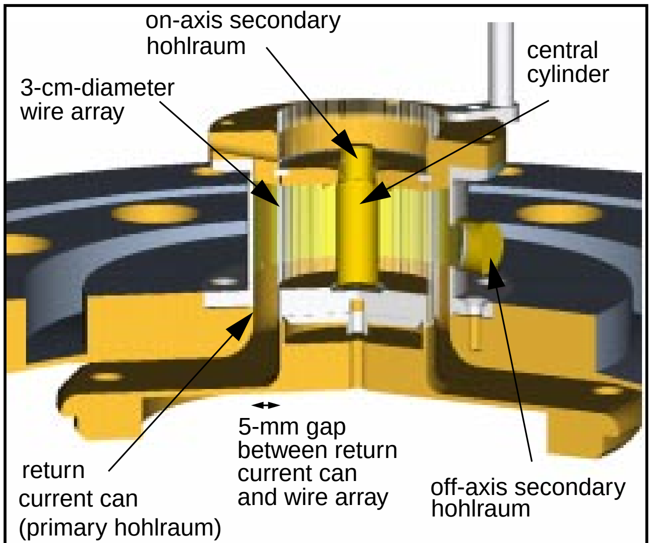
April 1997 Highlights of the Pulsed Power Inertial Confinement Fusion Program



Design of experimental hardware to characterize the x-ray flux from an imploding tungsten wire array striking a thin-walled-gold central cylinder. The radiated flux will be diagnosed via on-axis and off-axis secondary hohlraums.

This month we had our first hohlraum shots on PBFA Z. A vacuum hohlraum was placed outside the 3-centimeter-diameter wire array. The hardware for these experiments is similar to that used to evaluate the radiated energy and power scaling, except that the slotted return current can is replaced by a can that is solid (i.e., closed except for diagnostic apertures). When this solid can is coated on the inside with gold, it becomes a hohlraum. On five PBFA-Z shots we evaluated the effects of different size apertures. Experiments will begin next month to compare our predictions, from the LASNEX code, of the radiation temperature in an on-axis secondary hohlraum with that in an off-axis secondary on the same PBFA-Z shot.

Because of the large energy (~ 2 MJ) generated by the imploding z pinches, we must use long (~ 20 m) line-of-sight pipes to diagnostics located off axis or thick shielding for on-axis diagnostics. For off-axis diagnostics, the image is apertured to reduce the effect of x-ray reflection at grazing angles along the pipe and the reradiation from the portion of the return current can that is seen behind the pinch. New diagnostics are being added to characterize the z-pinch plasmas and their spectra. These include a large format time-resolved pinhole camera, which is indicating 20:1 compression of the z pinches, and a time-resolved transmission grating spectrometer, which disperses the x-ray flux onto an array of silicon photodiode detectors. Five x-ray diodes (XRDs) have been installed at the end of a new line-of-sight pipe to complement the five XRDs already in use off axis at another azimuthal position. We designed and fabricated and are testing hardware and diagnostics to compare the radiation temperature in an on-axis secondary hohlraum with that in an off-axis secondary hohlraum (see figure). New on-axis diagnostics, located ~ 2.0 m from the source, will include a six-frame, time-resolved pinhole camera, a five-channel XRD, a bolometer, and a space-resolved, time-integrated crystal spectrometer.

As part of our effort to improve the z-pinch radiation source further, on three PBFA-Z shots we reduced the gap between the return current can and the outer edge of the wire array from 5 mm to 2.5 mm. We found, as expected, that smaller gaps for the same wire diameter (3 cm) increased the energy coupled into x rays. The effect of a shorter return current can (1 cm instead of 2 cm) in increasing the radiated energy per unit length will also be evaluated.

Work is proceeding to develop the capability to simulate, in two and three dimensions in a radiative-transport, magnetohydrodynamic (MHD) code, the implosion of a z-pinch plasma and the transport of the x rays within a vacuum or foam-filled hohlraum. A 3-D, massively-parallel MHD physics package with single-group radiative transport has been added to the ALEGRA code, and a multigroup version of this arbitrary-Lagrangian-Eulerian code is being constructed. The robustness and accuracy of the code packages are being checked on problems with analytic solutions.

A uniform, preformed ion source is a key part of our strategy to obtain an intense, high-purity, low-divergence lithium beam. In the support lab, we have used a gated framing camera, filtered to observe excited lithium emission, and a two-color refraction index gradient (RING) diagnostic to characterize the ion source plasma formed by a Nd:YAG laser striking a LiAg surface. At the laser fluences that were available on PBFA X in the spring of 1996 (< 0.3 J/cm^2), the framing camera images reveal distinct nonuniformities; in contrast, the images are quite uniform at 0.9 J/cm^2. The two-color RING data indicate that the amount of ionized lithium is significantly increased at the higher fluence level in proportion to the neutral lithium. We are assembling a large Nd:YAG laser that will deliver up to 1 J/cm^2 to the SABRE anode and thereby provide a more uniform, more ionized Lithium EVaporation Ion Source (LEVIS).

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