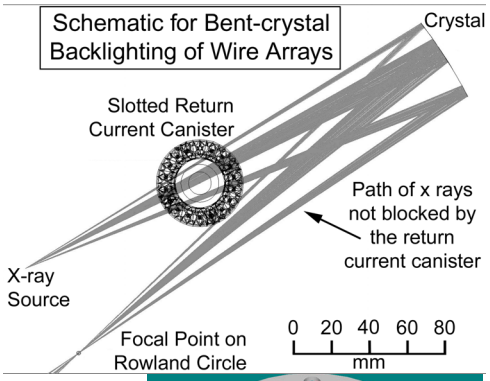
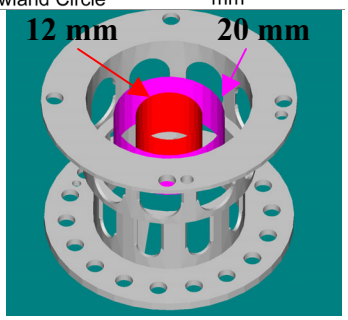
1673 News Notes: October 2002 Edition

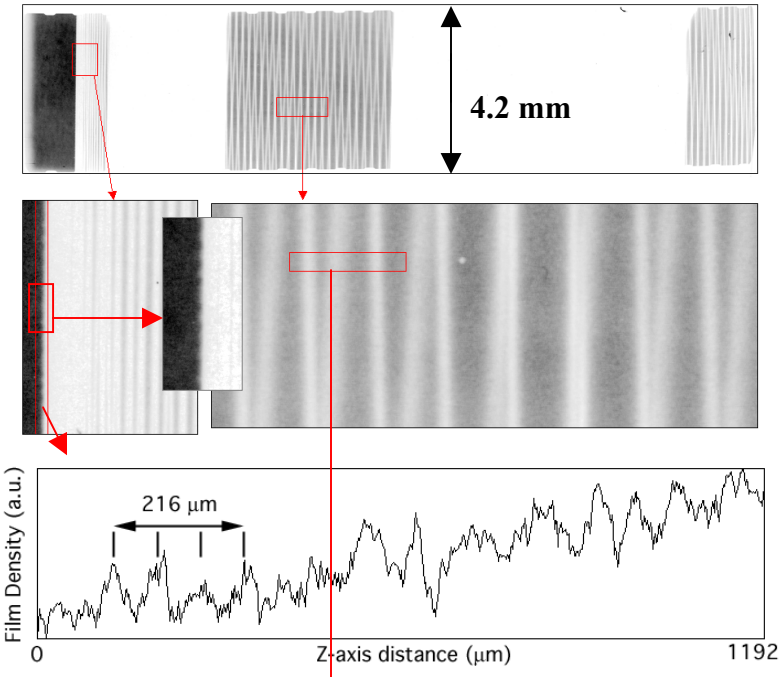


Bent crystal imaging system for wire-array backlighting

In the August News Notes the first image obtained with a new x-ray backlighting diagnostic developed by Dan Sinars (dbsinar@sandia.gov) and David Wenger was presented. This diagnostic can study the wire explosion process and the early array motion for the first time on Z. Instabilities that start at this time are thought to limit the peak radiation power produced by z pinches. Z pinches are a strong source of soft x rays, hard x-rays in the 20-100 keV photon energy range, and debris. For comparison, Z-Beamlet can produce ~1-10 J of x rays for x-ray backlighting while z pinches produce ~1,000,000 J of x rays. Thus, to obtain an image of a z pinch, it is necessary to prevent z-pinch-produced x rays and debris from reaching the detector.

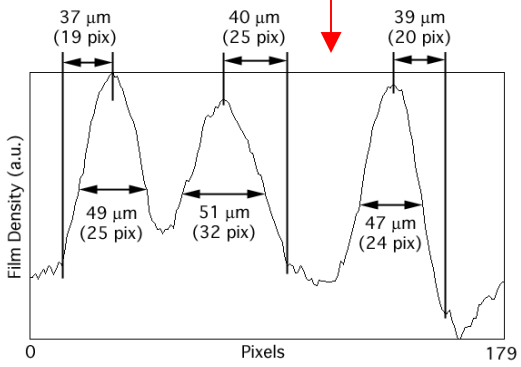


One method for doing this is to use a backlighting diagnostic based on spherically bent crystals. The crystal acts as a spherical mirror with the unique property that it only reflects a very narrow band of x rays. Photons with energies above or below that band either pass through or are absorbed in the crystal. The detector is pointed toward the crystal and has no direct line of sight to the z pinch. This allows the detector to be shielded from x rays and debris coming directly from the z pinch.



In bent-crystal backlighting, the spatial resolution does not depend on the x-ray source size. In traditional point-projection backlighting, obtaining a high spatial resolution requires a small x-ray source and a low magnification. By contrast, in crystal imaging systems the spatial resolution is very weakly dependent on the x-ray source size. A large field of view and high magnifications are possible. An x-ray backlighting diagnostic using 1.865 keV photons has been developed & fielded on Z that has a 10 μm spatial resolution, a magnification of six, and a 4x20 mm field of view.

This diagnostic was fielded during wire-array z-pinch experiments in October. In these experiments, we obtained images of a 300 wire, 20 mm diameter W wire array at about 33% of its implosion time. A sample image is shown to the left. The view of the wire array is partly blocked by the return-current can surrounding the array. The can has 9 slots spaced every 40°. The diagnostic views the wire array through three pairs of slots in the can, as shown in the upper right. The wires in the array have expanded to about 50 μm in diameter at this time from an initial size of 7.4 μm, and are at their original position. The wires are angled in the image because the top of the array is rotated 1.6 degrees counterclockwise with respect to the bottom. A tangential view of the edge of the wire array can be seen on the left side. An axial lineout along the edge of the wire array shows axial structure with a 70 μm period, which is likely from instabilities. These images will constrain and improve our simulations. A 6.18 keV backlighter using the same technique is presently under development. The higher-energy backlighter can diagnose capsule implosions and the z-pinch at stagnation on axis.



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