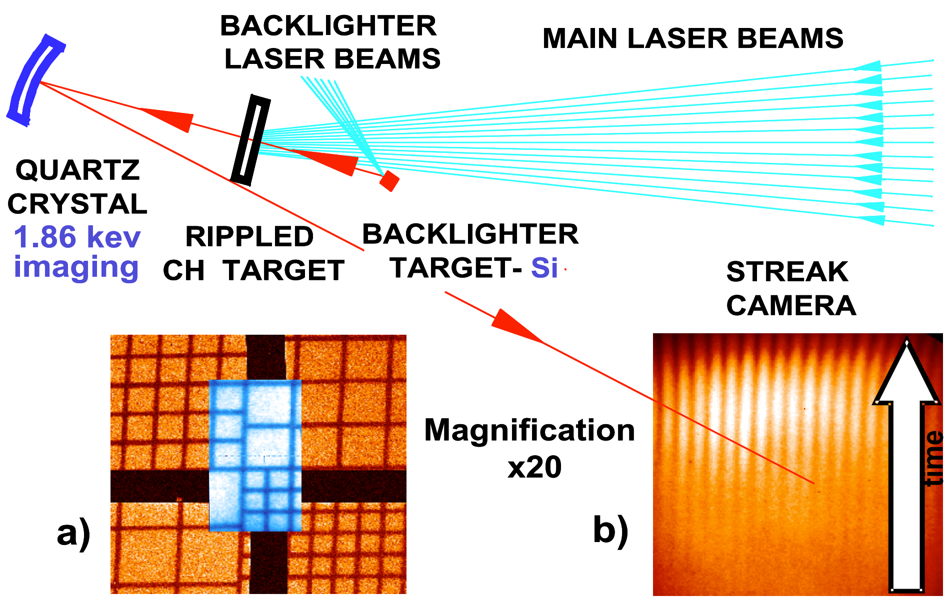
NRL LASER FUSION PROGRAM
September-October 2000
Bimonthly Highlights

Streak camera coupled with the high resolution x-ray crystal imager

The diagnostic setup shown on a figure is a modification of the Nike monochromatic x-ray imaging system based on the Bragg reflection from spherically curved crystals. An addition of a streak camera to this system makes it possible to analyze continuous time behavior of mass variation, which is necessary to reveal the non-monotonic evolution of the processes under study. The energy of 12 Nike beams, ~500 J, is delivered to a silicon backlighter target, producing x-rays that backlight the main target for about 5 ns. The spherically curved quartz crystal selects the resonance line of the He-like Si (1.86 keV) and projects a monochromatic image of the target on the slit of an x-ray streak camera. We use a quartz crystal with the cut 1011 and radius of curvature 200 mm. With magnification of 20 the crystal-to-detector distance is about 2 m. We are able to position the target image on the entrance slit of the streak camera with an accuracy that corresponds to 30 µm on the target. This setup provides spatial resolution in one relevant direction, e.g. along the wave vector of the ripple on the target surface, producing the streak record like that shown in figure (b).



General scheme of the experiment. (a) Test images of a 150-to-400 lpi composite mesh obtained on x-ray film (quadrants) and on an open photocathode of the streak camera (insert in the middle). (b) An actual streak record showing the Rayleigh-Taylor growth of areal mass variation (40 µm thick, rippled CH target with 0.25 µm initial peak-to-valley amplitude). Peaks and valleys are more pronounced at late time.

The spatial resolution of the x-ray optical system was tested with the help of x-ray film as a detector and was found to be of order 6-7 µm. High throughput of the x-ray optical system allows us to magnify the images by a factor of 20 to compensate for the modest resolution of the streak camera. Despite the high magnification of the system, the overall spatial resolution is still limited by the streak camera and was estimated by test pictures of the composite mesh (see Fig.a). The MTF of the entire diagnostic system was obtained by imaging a knife-edge target and verified by imaging an undriven target with predetermined amplitude. The MTF at λ =30µm and 45 µm is 0.4 and 0.7, respectively. With 1.86 keV probing energy we were able to study 40 µm to 90 µm thick CH targets either flat or rippled with perturbation wavelength λ = 30 µm or 45 µm. The streak records were taken with time resolution of 170 ps. This is sufficient for the 0.5 ns characteristic times of interest. The large field of view (500 µm) combined with the large flat top (400 µm) of the laser focal spot gives us more ripples available for Fourier transform analysis, thus ensuring confidence in determining the dominant mode s amplitude.

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