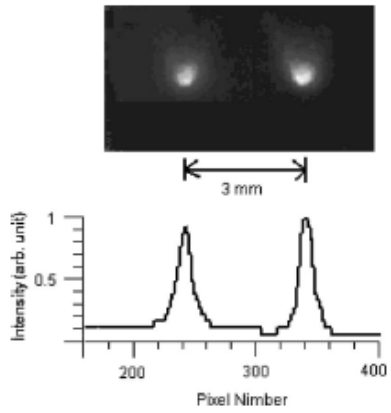
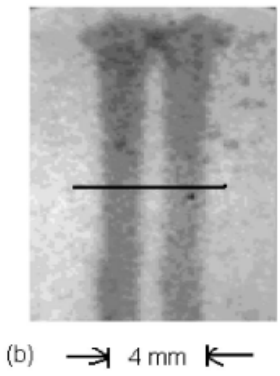
Twin point x-ray sources for radiography

Laser Plasma Laboratory has developed a novel technique of simultaneous generation of mutli-keV monochromatic twin point x-ray sources in a vacuum diode with laser plasma cathode. The diode consists of a planar aluminium slab target as the cathode and two identical point-tip anodes of titanium. The anode-cathode separation and that between the two anodes were 3 mm each. An Nd:YAG laser beam (energy ~ 2 - 40 mJ, FWHM pulse duration ~ 20 ns, repetition rate of 1 Hz) was focussed symmetrically with respect to the two anodes on the aluminium target to produce plasma. Electrons from the sheath region of the expanding laser-produced plasma were accelerated in an externally applied electric field and bombarded the anode tips to generate characteristic K-shell x-ray radiation. Approximately 10^9 photons / pulse (Ti K_α at $h\nu \approx 4.51$ keV) were generated in a pulse of 20-25 ns duration, from each source of ~ 300 μm diameter. Brightness of each source was estimated to be 4 x 10^{18} photons / cm^2-sec-sr. Single shot twin radiographs of physical objects were recorded on phosphor-coated fibre-optic-plate coupled with intensified CCD camera kept at a distance of ~ 15 cm from the twin x-ray sources. Such a source can also be attractive for single shot differential imaging by using different materials for the two anodes and for pump-probe type experiments, involving a laser as an excitation source, as the x-ray pulse can be temporally synchronized with respect to the laser pulse.



(a)

The x-ray images of the two sources.
The lineout shows their intensity profiles.



X-ray radiograph of a metal pin taken using the twin x-ray source

References :

1) Generation of multi-keV monochromatic twin x-ray point sources based on laser-driven vacuum diode,
A.Moorti, P.A.Naik, P.D. Gupta
Rev. Sci. Instrum 76, 106101, 2005