used for measurement of ovality of objects; simultaneous measurements of multiple objects; measurements of minute movements of edges, objects and gap settings between objects such as rollers etc.

Laser Micrometer Specifications

Measuring range	1.5 mm - 40 mm
Resolution	1 micron*
Accuracy	± 2 micron*
Repeatability	± 1 micron*
Display	16x2 Char Alphanumeric display
Display update selection:	1 per 2 sec, 2000 readings avg 1 per 5 sec, 5000 readings avg 1 per 12 sec, 10000 readings avg
Communication	RS-232 (9600 BAUD)
Dimensions	1000(L) x 180(W) x 180(H) mm

* The accuracy quoted is at 10000 readings averaged and at 20°C.

Development of transmission grating spectrographs

a) XUV spectrograph

A transmission grating XUV spectrograph has been set up as a diagnostic system for measurements of XUV emission spectrum of laser produced plasmas in the range of 5 Å - 150 Å. The spectrograph is based on diffraction from a free-standing transmission grating (consisting of gold microstructures) in a normal incidence geometry. The grating is mounted in a long tubular housing connected to the plasma chamber. Two different types of gratings are used: Rectangular grating of period d = 0.2 μm and aperture of 150 μm x 3000 μm, and Pinhole mounted grating of period d = 0.5 μm and 50 μm aperture. The spectrum is recorded either using an XUV soft x-ray sensitive film or a micro-channel plate (MCP) detector. To optimize spectral resolution and the radiation intensity in the detector plane, XUV spectra from carbon, aluminium and copper plasmas have been recorded for different separations between the source and the grating (L), and between the grating and the detector (D). For instance, for d = 0.2 μm grating with a separation of L = 700 mm and D = 330 mm, the plate factor and the spectral resolution in the first order are 6 Å/mm and ~2 Å respectively.

Fig.1 shows the emission spectrum of an Aluminium plasma produced at a focused intensity of 3×10^{12} W/cm^2 by 15 J, 20 ns Nd:glass laser pulses using the rectangular grating (d = 0.2 μm) and XUV sensitive UFSh-4 film. The spectrum clearly shows the central zeroth order and various prominent spectral lines in the first and higher orders symmetrically on either side. 2-D spectral imaging of the plasma is accomplished by using the pinhole transmission grating. Fig.2 shows such a spatially resolved spectrum for Aluminium plasma. Cone shaped images, emanating from different points in the direction of dispersion, correspond to the x-ray emission regions of plasma for various spectral lines. Next, an MCP detector in combination with a CCD camera-frame grabber system has also been used to facilitate on-line recording and processing of the spectrum. Optimization of this detection system is underway.

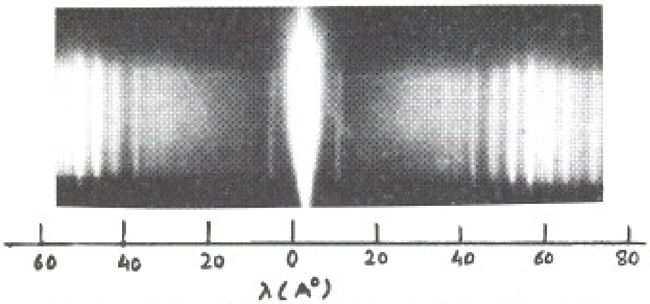


Fig. 1 XUV emission spectra of laser produced Aluminium plasma.

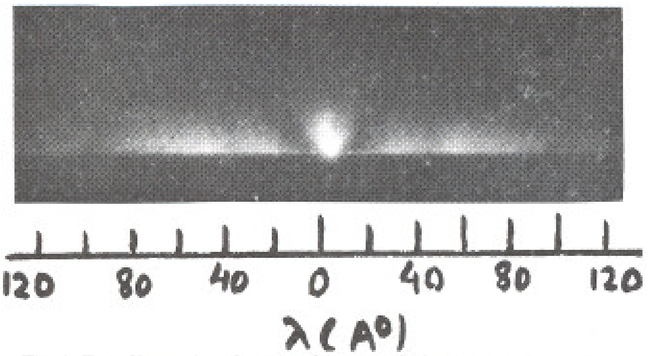


Fig. 2 Two dimensional spectral image of Aluminium plasma using pinhole transmission grating spectrograph.

b) X - ray spectrograph

An x-ray transmission grating spectrograph has been developed to record and study the x-ray spectrum emitted from laser produced plasmas. It has a free standing gold bar (~1000 lines/mm) as a grating. A phosphor screen deposited on a fibre optic plate is used as an x-ray detector. The intensity on phosphor screen is intensified using a gated image intensifier tube. This spectrograph is designed to provide inverse linear dispersion of $d\lambda / dy \sim 16$ Å/mm with spectrum resolution $\Delta\lambda \sim 6$ Å which was found to be in good agreement with the experimental measurements. All the electronic circuits for driving the image intensifier tube were also developed in CAT. The spectrometer was tested by recording the x-ray spectrum emitted from copper and gold plasma produced by irradiating a picosecond Nd:YAG laser (35 ps and 75 mJ). Fig. 3 shows the image and intensity profile of the x-ray spectrum from Cu plasma, recorded using a CCD camera and processed using the

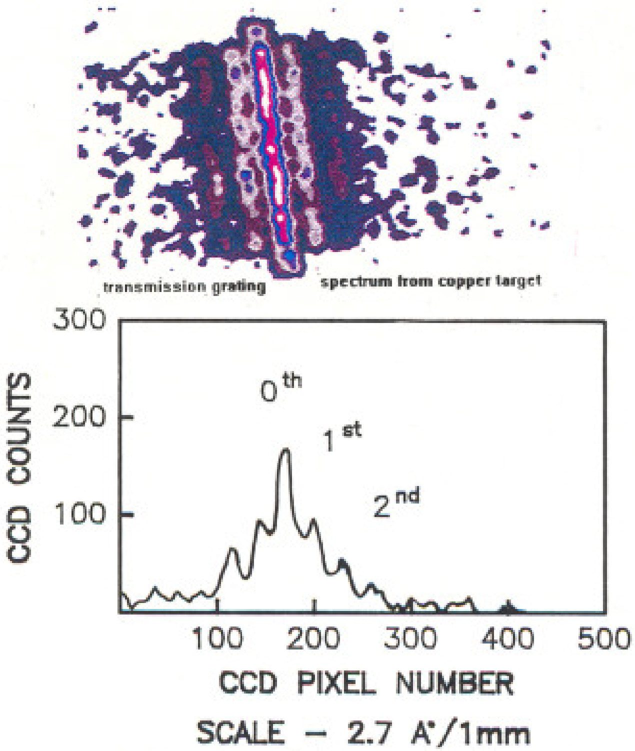


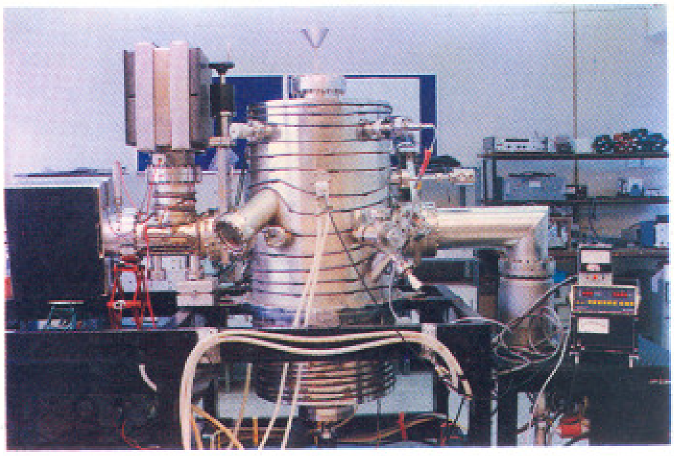
Fig. 3 Image and intensity profile of x-ray spectrum from copper plasma.

PROMISE Software. The spectrum shows clearly 1st and 2nd orders on both sides of the 0th order.

ACCELERATOR PROGRAMME

Commissioning of booster synchrotron

An accelerated current of 9 mA at 450 MeV energy has now been achieved in the booster synchrotron. This increase in current from 1.8 mA (CAT Newsletter, July - December, 1995) was achieved by optimisation of RF parameters and steering of the beam orbit. The beam is steered in both horizontal and vertical planes using six horizontal steering magnets located on the six dipole magnets and five vertical steering magnets, installed separately. Now these steering magnets were operated in ramp mode. The RF parameters were optimised by detuning of cavity frequency with respect to revolution frequency and ramping of the RF voltage linearly from 1.5 kV (at injection energy) to 5 kV (at peak energy). Lower voltage at the injection energy reduces the losses due to synchrotron oscillations. Whereas at higher energy, high voltage is required to compensate for the synchrotron radiation losses. Earlier a constant voltage was applied throughout the ramping. Besides this, injection magnet parameters and other magnet parameters were further optimised. Beam extraction trials will start very soon.



Setup for electron beam deposition for X-ray multilayer mirrors

Electron beam deposition system for x-ray multilayer mirrors

Optical elements with multilayer coatings for XUV optics have wide application in many fields including synchrotron radiation instrumentation, plasma diagnostics, soft x-ray spectrometers and x-ray astronomy. These elements consist of stacks of thin film which are composed of materials with alternate high and low scattering power, and have periodicity in the range of 10 to 100 Å. These can be operated at higher angles of incidence. For developing such films an electron beam (e-b) evaporation system has been developed. In this, three e-b evaporation sources have been incorporated in an ultra high vacuum deposition chamber. This is evacuated by a turbomolecular pump and two sputter ion pumps. The film thickness and deposition rate is monitored using two quartz crystal monitors and a quadrupole mass analyzer. A substrate holder which can be cooled to liquid nitrogen temperature is also installed. A movable masking system has been mounted just below the substrate to deposit several kind of multilayers without venting the system.

Radiological safety in Indus-1 building

With the increase in beam current and energy during commissioning stage of booster synchrotron, radiation fields inside booster synchrotron hall have increased significantly. In view of the potential radiation hazards (Bremsstrahlung X-rays and neutrons) in Indus-1 building during operation of microtron and booster synchrotron, several steps have been taken for ensuring radiological safety of working personnel. The Indus-1 building has been divided into three zones based on their hazard potential:

(1) Normal areas, such as the entry lobby, main corridor etc. where persons have free access.

(2) Restricted entry areas (synchrotron radiation source hall, microtron control room) where monitoring