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HIGH RESOLUTION SOFT X-RAY SPECTROMETER WITH 5-PICOSECOND TIME-RESOLUTION FOR LASER-PRODUCED PLASMA DIAGNOSTICS

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HIGH RESOLUTION SOFT X-RAY SPECTROMETER WITH 5-PICOSECOND TIME-RESOLUTION FOR LASER-PRODUCED PLASMA DIAGNOSTICS

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A 5-picosecond time-resolution spectrometer, that permits simultaneous measurement of emission in the soft X-ray and extreme UV domain, has been developed for laser-produced plasma diagnostics. The instrument is basically a modified version of a high-resolution, interferometrically adjusted 2 m grating Schwob-Fraenkel spectrometer operating at extreme grazing incidence (1° - 2½°), which is coupled to a new ultrafast C 850 X electronic streak camera, with 60 μm spatial resolution. In the present version the spectrometer main body materializing the Rowland cylinder is made of two parts, the second part which supports the photographic plates (or the Al coated reference plate) being removed, in order to allow the motion of the camera. The camera can be moved on tracks concentric to the Rowland circle. It is equipped with a flat Au photocathode operating in reflection configuration and accurately adjusted to be tangent at its center to the Rowland cylinder. An accurate mounting accepting interferometrically pre-adjusted grating holders enables fast grating interchange without any further optical adjustment. The total wavelength coverage of the instrument is 20-140 Å, 40-280 Å or 80-560 Å with 2400 gr/mm, 1200 gr/mm or 600 gr/mm grating, respectively. When equipped with the medium dispersion grating, the spectral resolution FWHM is better than 0.1 Å and the spectral coverage on the photocathode slit varies from 4 Å at the short wavelength limit to 11 Å at the long wavelength side.

Résumé :

Nous décrivons la réalisation d'un nouveau spectrographe XUV à résolution temporelle dont les performances esperées sont une résolution spectrale de 0.1 Å et temporelle de 3 ps . Cet instrument est constitué d'un spectromètre Schwob-Fraenkel modifié, couplé à une nouvelle caméra électronique à balayage de fente ultra-rapide.

Abstract :

A new XUV spectrometer designed to have a time-resolution of 3 ps and a spectral resolution of 0.1 Å is described. It is basically a modified version of a Schwob-Fraenkel spectrometer, which is coupled to a new ultrafast electronic streak camera.

Introduction

Study of laser plasmas leading to a possible population inversion in the range 30 - 300 Å has nowadays fostered worldwide efforts . First appreciable results obtained at L.L.N..L.[1] , at Princeton University[2] or in P. Jaeglé team[3] have shown the utmost utility of time resolving the possible lasing line and the parent lines.

Time resolution can provide a better signal to noise ratio as the emission of the later plasma is not recorded, and in the case of large wavelengths, as it reduces the amount of diffuse light reaching the recording device. Furthermore the "lasing line" emission duration is frequently much shorter than the X-ray emission of the hot plasma, and ,if it is possible, a detailed temporal measurement will provide valuable informations on the mechanisms building and quenching the population inversion, and more generally, on the ionization dynamics.

Various time-resolved instruments[4-6] have been developed in the VUV spectral region, each offering different trade-offs in spectral and temporal resolution. Our goal is to improve these both factors by achieving a continuous 3 ps time resolution (not snap-shots) and a 0.1 Å spectral resolution which have already been obtained independently in our laboratories.

For this purpose we have built a time-resolved XUV spectrometer by modifying a Schwob-Fraenkel 2 meter grazing incidence spectrometer in order to record the soft X-ray spectrum on our new P851X bilamellar streak camera. X-ray collection is achieved through use of a toroidal mirror derived from the P. Jaeglé's system design.

In this poster we present the apparatus, which is presently under final stage of construction, and some results obtained with this type of spectrometer on photographic plates and on a 2 dimension, light intensified CCD recording device.

The spectrometer :

The spectrometer built at the Hebrew University of Jerusalem is basically a modified version of high-resolution, interferometrically adjusted 2 meter grating Schwob-Fraenkel spectrometer[7] operating at extreme grazing incidence (1° - 2°30'). In the present version the spectrometer main body materializing the Rowland cylinder is made of two parts : the second part which supports the photographic plates (or the Al coated reference plate) can be removed, in order to allow the motion of the camera. The camera can be moved on an accurately machined curved way concentric to the Rowland circle. The camera is equipped with a flat Au coated photocathode operating in reflection and accurately adjusted to be tangent at its center to the Rowland cylinder. A high precision mounting accepting interferometrically pre-adjusted grating holders permits fast grating interchange without any further optical adjustment. The total wavelength coverage on the photocathode slit is 20-140 Å, 40-280 Å, or 80-560 Å with 2400 gr/mm, 1200 gr/mm, or 600 gr/mm grating, respectively. When equipped with the medium dispersion grating, the spectral resolution FWHM is better than 0.1 Å and the simultaneous coverage on the photocathode slit varies from 4 Å at the short wavelength limit to 11 Å at the long wavelength limit.

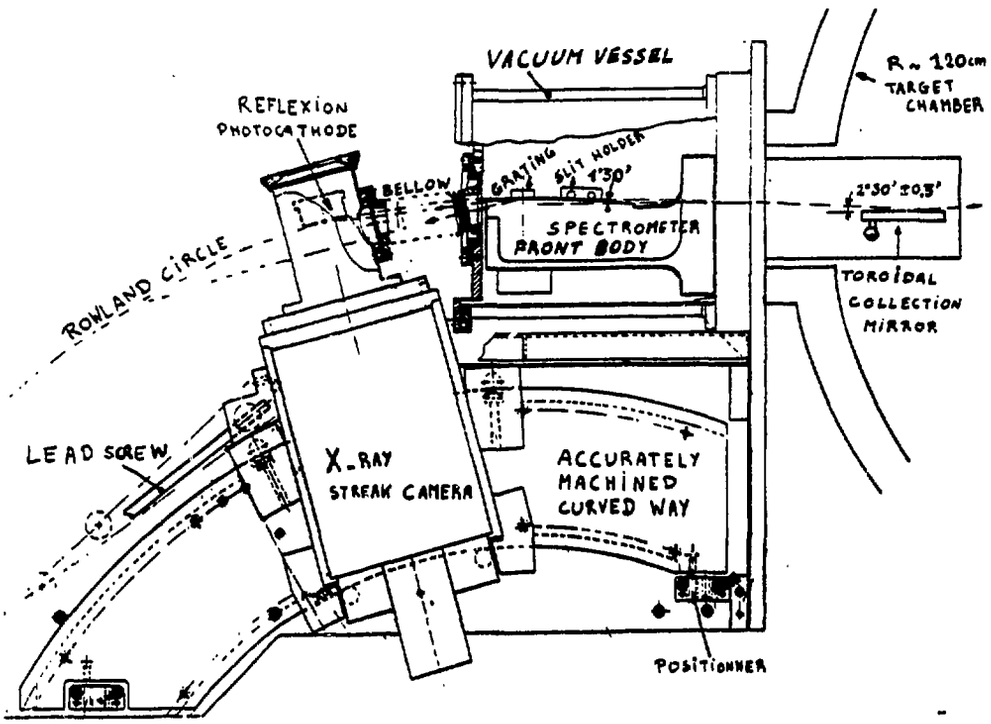

Fig. 1 : Schematic of the instrument

The streak camera :

The camera is built around the new P851X tube., derived from the RTC P750X tube already presented elsewhere[8] , in which focussing and sweaping are achieved by use of a bilamellar electrostatic lens.

The expected performances are listed below :

usable slit length (in spectral dispersion direction)	10 mm
screen dimensions	15 x 10 mm^2
magnifying ratio	1.5
spot width (on the screen)	40 µm
spatial resolution on photocathode (with RTC XX1410 intensifier)	25 l. pairs/mm
time resolution	2-3 ps

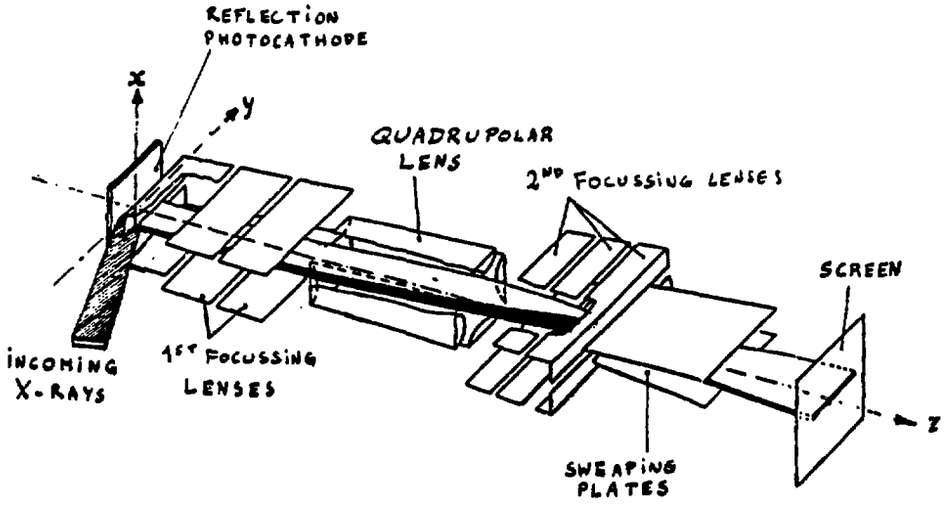

figure 2 : Disposition of elements in P851X tube

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