Seminar

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Institute for Plasma Research

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Title: Multi-anode X-ray Source for Calibration of ITER – X-ray Crystal Spectrometers

Speaker: Dr. Gaurav Shukla
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Date: 9th March 2023 (Thursday)

Time: 11:00 AM

Venue: Join the meeting online: https://meet.google.com/cta-sbyu-crg

Abstract

Calibrated light sources are routinely used in spectroscopic diagnostics for spectrometer calibration, and characterization of components (optics, detector, filter, etc.). Commercially, light sources are available for UV-visible spectroscopy in a wide range to choose from any specific application. However, such sources in the soft X-ray energy range remain a challenge. Commercially available monochromatic X-ray tubes are widely used for medical imaging, non-destructive testing, and other applications. For calibration of X-ray crystal spectrometers, a large area, high flux, and uniform source generating constant photon flux still is a topic of research and development. Taking into account the broad wavelength band (1 – 100Å) operation of ITER X-ray crystal spectrometers to be delivered by India, the design of a multi-anode (10) X-ray source based on tungsten filament is carried out. An assessment of various types of filament material and shapes gave the insight to use a hair-pin type filament to enhance thermionic electron emission. The anode materials are selected so that the characteristics line emission is closer to the ITER plasma impurity line emission in the X-ray range. The source chamber is designed to have multiple emission ports to enable simultaneous measurement of the X-ray beam going into the spectrometer/component under calibration testing.

To characterize the X-rays generated and monitor the source performance, a photodiode-based detector system will be installed on one of the ports. The photodiode detectors will measure characteristic line emission, and photon flux distribution both spatially and temporally. For this purpose, as a prototype, a Si-PIN detector is developed using a low-cost photodiode having a small area ($2mm^2$). A preamplifier together with an integrator is made in-house for the amplification and integration of small photocurrent signals in the range of nA to μA, which are produced by the photons in the depletion layer. The performance of the photodiode detector is measured using radio sources and X-ray generators available in the lab. The development of electronics for large-area Si-PIN photodiodes ($100mm^2$) has started and it will be characterized for measurement on the multi-anode X-ray source.

In this presentation, we will report on the design of the Multi-Anode X-ray source and the development of a photodiode-based X-ray detection system.