Versatile multi-energy hard x-ray camera to study confined and unconfined anisotropic characteristics of fast-electron dynamics

T. Barbui[1], L. F. Delgado-Aparicio[1], Y. Savoye-Peysson[2], B. Stratton[1], R. Dumont[2], K.W. Hill[1], N.A. Pablant[1] and the WEST team[2]

[1] *Princeton Plasma Physics Laboratory, Princeton, NJ 08540, USA*
[2] *CEA, IRFM, 13108 Saint-Paul-lez-Durance, France*

Corresponding Author Email: tbarbui@pppl.gov

A powerful and flexible hard x-ray camera has been recently installed and tested on the WEST tokamak (CEA, France) in a collaboration with the Princeton Plasma Physics Laboratory. The diagnostic is a pinhole camera fielded with a 2D pixel detector equipped with a 1mm thick CdTe sensor. The novelty of this diagnostic technique is the detector capability of adjusting the threshold energy at pixel level. This innovation provides great flexibility in the energy configuration (e.g. pixel arrangements in rows, columns or meta-pixel configurations) allowing simultaneous space, energy and time resolved x-ray measurements. The novel camera has been used to measure the core Lower Hybrid Current Drive (LHCD) radiation from non-Maxwellian electrons, and recently also the thick-target emission of tungsten in the divertor region produced by fast electron losses interacting with the target, observing new anisotropic characteristics of the hard x-ray radiation. A new method has been developed to infer the mean energy of fast electron losses through the measure of the thick-target emission. The method is based on comparing the measured radiation with modeled tungsten spectra produced by a Monte Carlo code which simulates the interaction between a beam of electrons and a solid target. The results show that fast electron losses during LHCD discharges at WEST have a mean energy of 90-140 keV and represent only 2% of the total heat flux at the target. Additionally, anisotropic hard x-ray emission has been detected for the first time at the WEST core and edge plasma, and with opposite toroidal intensity trends. This counterintuitive observation is well explained by the forward-peak emission characteristics of two distinctive populations of fast-electrons: co-current fast-electrons in the core and counter-current fast-electron losses at the inner strike point. Data will be presented from the most recent WEST campaign.

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