**Multi-energy SXR to EUV imaging diagnostics for fusion experiments**

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Tomorrow's magnetic fusion experiments will address more and more complex questions concerning hot plasma transport, role of MHD phenomena, long pulse, and plasma material interface effects. Novel types of spectroscopic diagnostics and controls are needed for these experiments, capable of simultaneously covering a broad energy range with good space and time resolution, and being able to survive the harsh fusion environment for long periods of time. Our group has developed several types of multi-energy diagnostics, in which the same plasma volume is simultaneously imaged in multiple energy ranges, extending from the SXR to VUV. For the 0.1-10 keV range we developed multi-energy SXR (ME-SXR) imaging arrays, in which the plasma emission in up to six energy bands is recorded by either an image intensified 'optical SXR array', or by multiple photodiode arrays. The ME-SXR diagnostic enables for instance measuring toroidal Te and ne,Z perturbations, as illustrated by the results obtained with a tangential optical array during RWM feedback stabilization experiments on NSTX (Fig.1). For the 0.01-1 keV range (XUV-EUV) we developed transmission grating based imaging spectrometers (TGIS) having spectral resolving power up to a few%. The TGIS devices serve to constrain the modelling of the ME-SXR data and also provide tools for impurity monitoring and transport studies, as illustrated in Fig. 2 with data from a W injection experiment in NSTX. The simplicity and robustness of these diagnostics also recommends them as plasma control tools in future burning plasma experiments.

