Contribution ID: **8** Type: **Soft X-ray Detector Workshop**

Multi-energy SXR detector to study fusion plasmas

Tuesday, 13 January 2026 15:15 (20 minutes)

A DECTRIS PILATUS3 100K detector is being used to sample the SXR emission from magnetically-confined fusion plasmas at different energies. The detector is equipped with a pixelated silicon sensor and it features single counting and CMOS readout ASICs. Lower energy thresholds at pixel level were calibrated via a custom procedure by exposing the detector to a series of fluorescence targets and scanning the detector characteristic responsivity ("S-curve") across the 64 possible energy threshold values for each pixel; this novel capability is explored by fine-tuning the voltage of a 6-bit digital-analog converter after the charge-sensitive amplifier for each of the ˜100k pixels. Thanks to this pixel-level calibration, the lower energy threshold of each pixel can be set independently in the range 2-20 keV, allowing the measurement of the x-ray emission with spatial, temporal and energy resolution simultaneously. Through meticulous selection of the lower energy thresholds it is possible to separate signal from line emission from the continuum, in order to simultaneously investigate multiple plasma properties. The energy-resolved measurements in a spectral region dominated by strong tungsten lines are used to infer impurity concentrations. The variation of emissivity with photon energy in a spectral region free from line radiation is utilized to infer plasma electron temperature, plasma centroid position, and radiated power density.

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Session Classification: Tender X-rays

Track Classification: Soft X-ray Detectors: Tender X-rays