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APPLICATIONS OF THE POLOIDAL ULTRASOFT X-RAY SYSTEM ON NSTX

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A 50 chord poloidal ultrasoft X-ray (USXR) imaging system has been developed and implemented on NSTX by the Johns Hopkins Plasma Spectroscopy Group. The use of large area, low capacitance absolute AXUV diodes enables high sensitivity, uniform spectral response from 0.1 to 10 keV and bandwidth of a few hundred kHz. The low energy capability of the system is needed for imaging the colder plasmas produced in non-inductive start-up experiments.

The main function of the system is imaging the MHD activity in the plasma core and periphery. In NSTX this turns out to be a more challenging task than in conventional tokamaks. First, the main NSTX operational regimes have $q_0 > 1$, being characterized by persistent, but low amplitude (a few percent) m/n > 1 MHD activity. In addition, the strong NSTX toroidicity couples the core and peripheral modes, creating complex spatial structures locked in frequency and phase.

Furthermore, the USXR profiles measured in H-mode discharges are persistently hollow. Modeling the impurity (mostly C) distribution associated with these profiles shows strong peaking of the C density in the peripheral region and unusually low (≤ 0.5 %) central C content. In conjunction with ‘ears’ in the peripheral electron density (most probably created by the C accumulation) and core electron temperatures of only 1-1.5 keV, this makes for faint core USXR emission and very strong peripheral emission. This combination ‘hides’ in effect the weak core MHD signature.

Another application of the USXR system is the study of impurity transport. Perturbative transport experiments were performed by puffing small amounts of neon into neutral beam heated discharges and measuring its radial penetration with the USXR arrays and high-resolution spectrometers. The injected Ne ions typically form a hollow shell, which essentially stagnates at mid-radius for the whole duration of the MHD quiescent plasma. Modeling the Ne evolution with an impurity transport code coupled with an atomic physics package gives a diffusion coefficient in the neoclassical range inside r/a < 0.6, consistent with the low ion thermal loss assessed in NSTX, as well as with the linear gyrokinetic microstability analysis.

Ongoing and proposed upgrades and applications of the NSTX USXR system will be also discussed.