**Alkali Beam Emission Spectroscopy for absolute electron density radial profile measurements for NSTX**

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Alkali beam emission spectroscopy (ABES) is a well-established diagnostic technique for absolute electron-density profile measurements [1]. This diagnostic technique was successfully applied to the measurement of the absolute ne radial profile on numerous devices including ASDEX Upgrade, JET, and W7-X. Fulfillment of the scientific objectives (1. and 2.) of the NSTX-U (National Spherical Torus Experiment Upgrade) 5-year plan [2] requires fast scrape-off layer (SOL) and edge electron density profile measurements which cannot be provided by the currently available diagnostics.

Our study shows that high temporal and spatial resolution absolute electron density profile measurements would be feasible on the NSTX-U tokamak by means of alkali beam emission spectroscopy. We propose a Sodium beam setup with 1 mA ion equivalent beam current, 2.5 cm beam diameter and 60 keV beam energy. This beam setup perturbs the plasma negligibly with approximately 100 W deposited heat and 1016 m-3 Na impurity in the SOL. The proposed observation geometry consists of 32 by 2 radial by poloidal pixels each covering approximately a 5 mm x 20 mm (radial × poloidal) area. The combined beam-observation geometry provides high estimated photon current (≈ 7 · 1010 s-1) and high estimated signal-to-noise ratio (130 at the pedestal and 20 in the far-SOL for 500 kHz analogue bandwidth). Our simulations show that the combined smearing of the atomic physics and the misalignment of the magnetic field to the line of sight gives an overall estimated radial resolution of 12 mm in the far-SOL, 10.5 mm at the separatrix and 7.5 mm in the pedestal.

[1] S. Zoletnik et al: “Advanced neutral alkali beam diagnostics for applications in fusion research (invited),” Rev. Sci. Instrum. **89**, 10D107 (2018),

[2] NSTX-U 5year plan FY2021-FY2025, <https://sites.google.com/a/pppl.gov/nstx-u/program/5-year-plan-fy21-25>,