Beam emission spectroscopy (BES) is an active plasma diagnostic employed for the study of plasma density and density fluctuations, caused by various plasma transport phenomena and turbulent processes [1]. The Rate Equation for Neutral Alkali beam TExchnique (RENATE) simulation code models various BES diagnostic systems, simulating BES signals from the emission of an arbitrary 3D neutral beam using a collisional radiative model and integrating the emission based on a 3D model of the observation system [2].

Based on past efforts [3], a method was developed for the study of plasma turbulence using Fluctuation Response Matrices (FRM), created by the RENATE simulation code for arbitrary observation geometries. Generation of the FRM occurs by registering the variation in detected photon current at each detector, caused by the introduction of plasma density perturbations along the beam. Assuming linearity between light fluctuation and density perturbations, it is possible to reconstruct the spatial structure of the density perturbation from the detected beam emission. Applicability of the FRM was studied for the reconstruction of density fluctuations with regard to perturbation size, amplitude and signal-to-noise ratio. The impact of spatial resolution was determined as well, accounting for atomic physics processes dependent on beam energy and species; magnetic field orientation to the lines of sight within the beam geometry and sensitive detector volume size.

Studies on the FRM based density perturbation reconstruction were performed using models of the LiBES and DBES diagnostic systems of the EAST tokamak.

References