Spatial resolution modelling of various beam emission spectroscopy experiments

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Beam emission spectroscopy is diagnostic of magnetically confined plasmas, routinely used on numerous experimental devices. The principle of the measurement can be summarized as an accelerated atomic beam – either heating or diagnostic beam – penetrates the plasma where the beam atoms collide with the plasma particles, which interaction – among others - excites the valence electrons of the beam atoms. The de-excitation of these electrons results in a characteristic photon emission, which intensity distribution and fluctuation can be detected through a complex optical system. The main purpose of the BES is to determine the electron density profile, and to characterize e.g. plasma turbulence, zonal flows, ELMs.

One of the main parameters of a BES system is the spatial resolution, namely the radial and the poloidal resolution which defines a lower limit for the detectable fluctuation wave number, and affects the density profile reconstruction as well, thus his parameter is essential in case of a BES system.

The comprehensive simulation of the beam, the magnetic, the machine and the observation geometry, and the modelling of the observation are needed in order to obtain the spatial resolution of such system. The RENATE beam emission simulator is a tool for BES system modelling, and fulfils the above mentioned conditions: the programme calculates the beam evolution for given magnetic, plasma and beam parameters, as well as the detected photon flux on each individual detector segments. The spatial resolution can be obtained from the so called fluctuation response calculation, which evaluates the response of the photon flux for each detector caused by an infinitesimal arbitrary density perturbation. These responses are then projected along the magnetic field lines and summed up on a poloidal plain, where dimension of the positive fluctuation response distribution is considered as the spatial resolution.

The results of these calculations are to be presented for proposed experiments and for existing experiments, those are to be compared with measurements as well.