

Overview of the RENATE beam emission spectroscopy simulation package

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One of the main diagnostic tools for measuring electron density profiles and the characteristics of long wavelength turbulent fluctuations in fusion plasmas is Beam Emission Spectroscopy (BES) [1]. To facilitate the design of new systems along with the evaluation of measured data the RENATE (Rate Equations for Neutral Alkali-Beam Technique) simulation code was developed. As its name suggests, it was originally intended for the modeling of alkali beams (lithium and sodium), but support for the more common H and D beams was also added.

RENAME is a modular BES simulation code written in IDL language, capable of simulating all key levels of a BES system. It possesses two different atomic physics kernels, allowing the calculation of the beam evolution either by directly solving the rate equations [2], or by employing a quasi-steady approximation [3]; both of these utilize the latest atomic physics data. Unlike most beam evolution codes, RENATE is developed to model the three-dimensional features of the measurement in detail, including the inner structure of the beam and the optical setup, thus allowing the modeling of complete BES systems, in particular heating beam measurements.

RENAME also has a set of tools aimed at simulating and designing fluctuation measurements: visualization of the spatial resolution and calculation of the fluctuation response matrix.

The results of the rate equation solver module of RENATE has been benchmarked for hydrogenic beam species and lithium. Meanwhile validation of the code is in progress by detailed comparisons to a heating beam BES measurement at the KSTAR tokamak. In the future RENATE is to be tested against other experimental results and is to be upgraded by including wavelength dependent effects (e.g. motional Stark-effect).

[1] D. M. Thomas, G. R. McKee et al., *FST*, **53**, 488-527, 2008.

[2] B. Scwheer, *FST*, **53**, 425-432, 2008.

[3] H. Anderson, M. G. von Hellermann, et al., *PPCF*, **42**, 781, 2009.