



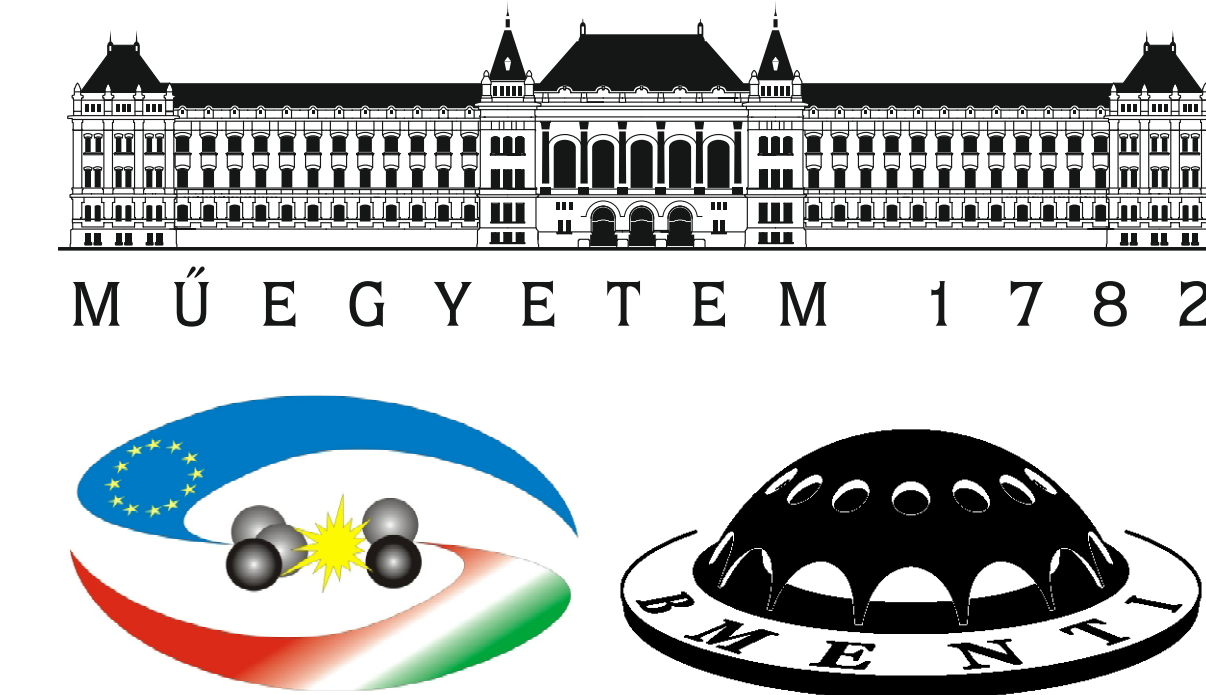
CHALMERS

Applications of the RENATE beam emission spectroscopy simulator

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Introduction, motivation

Beam Emission Spectroscopy (BES) is a diagnostic method used for density and density fluctuation measurements in fusion plasmas.

Association EURATOM-HAS has been building a large number of BES measurements around Europe.

The desire for an accurate and comprehensive simulation of the BES diagnostic, which could be used in the evaluation of BES measurement results [1, 2] and the development of new BES systems, led to the birth of RENATE (Rate Equation for Neutral Alkali-beam Technique).

RENAME features

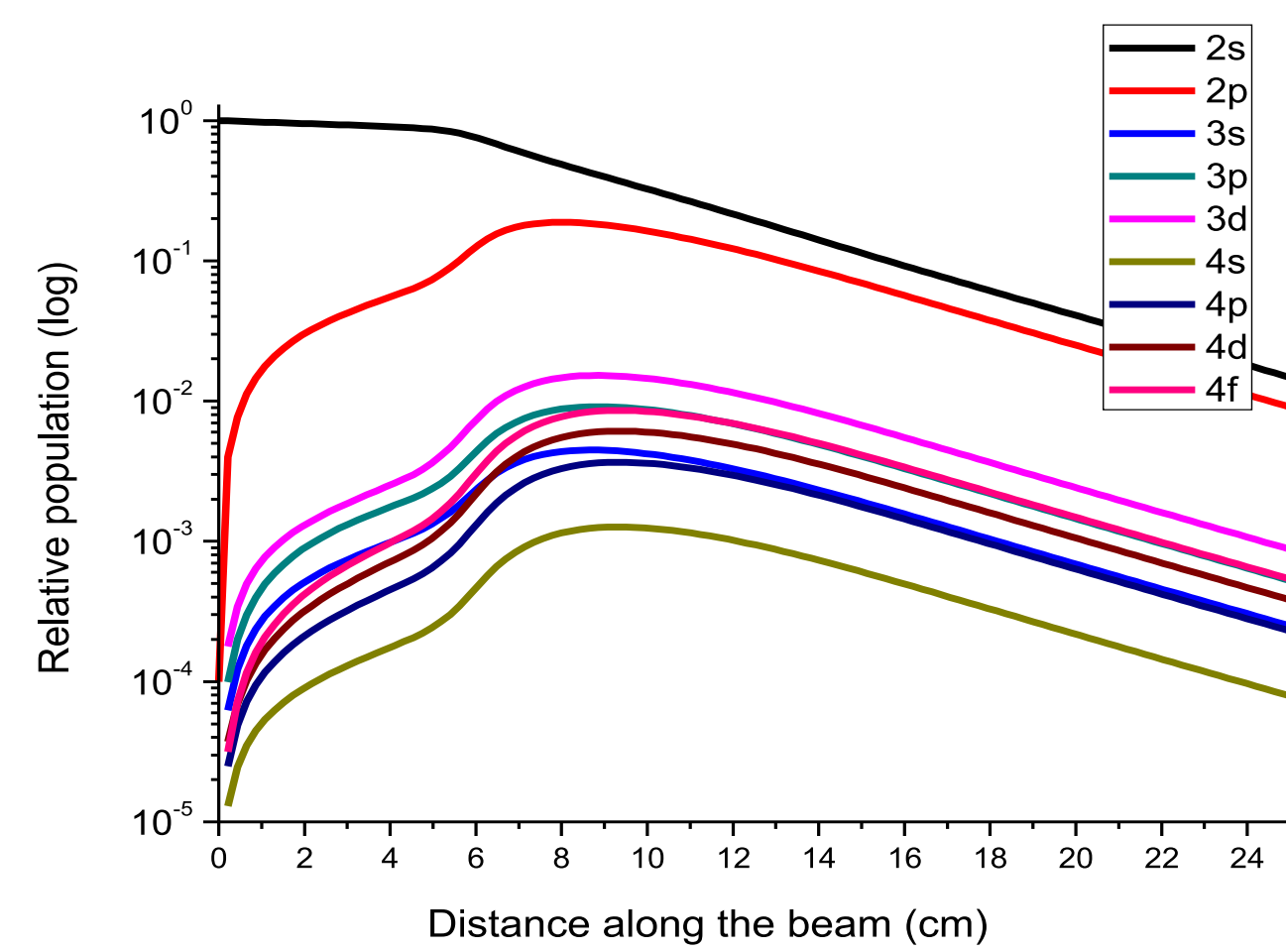
RENAME incorporates different levels of simulation of the BES diagnostic system: from the calculation of rate coefficients of atomic processes to the calculation of the photon current reaching the detector surface.

RENAME takes all the relevant atomic processes into account:

- collisional excitation/deexcitation
- collisional ionization
- charge-exchange reactions
- spontaneous deexcitement

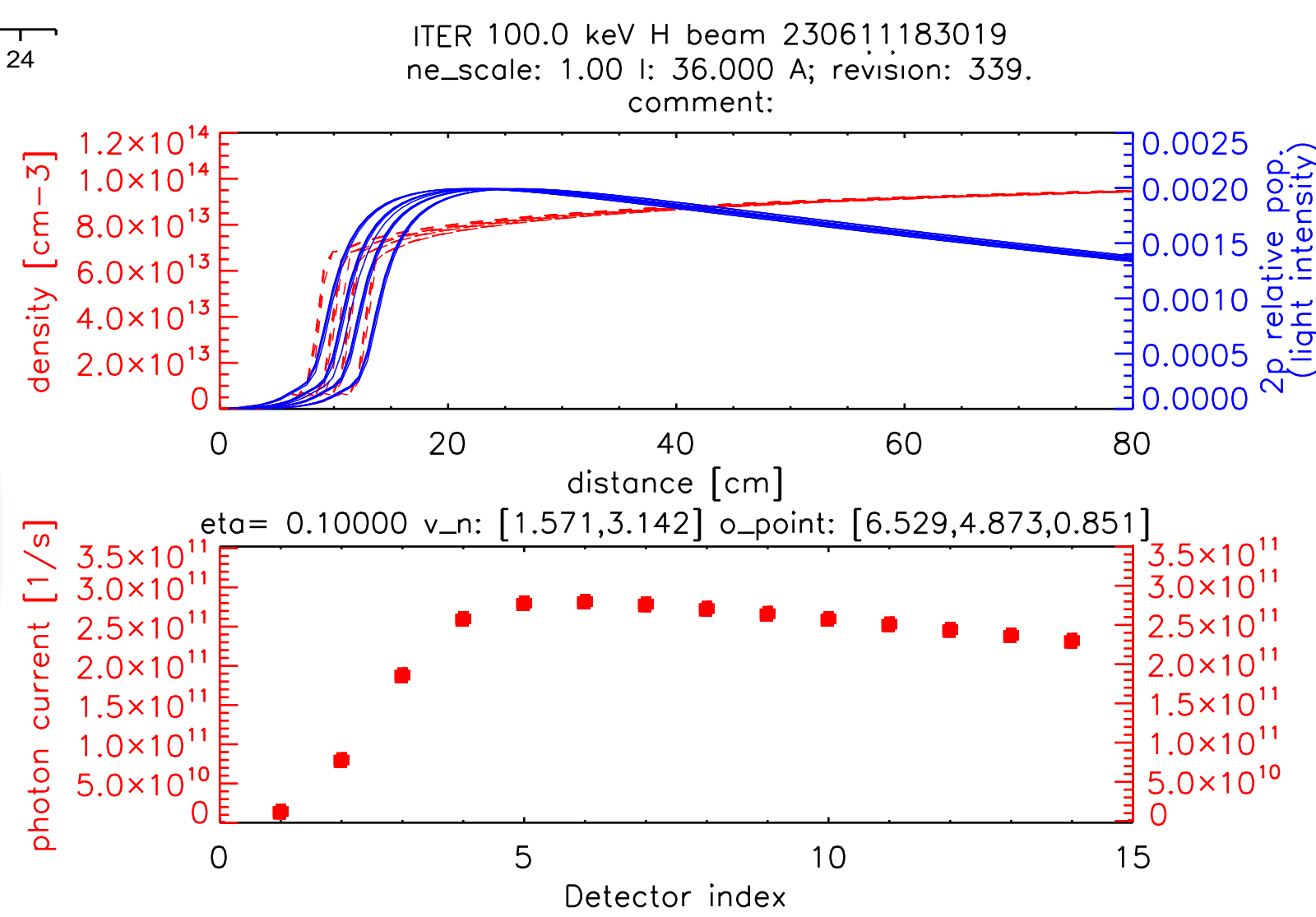
Supported beam types

Li Na H D

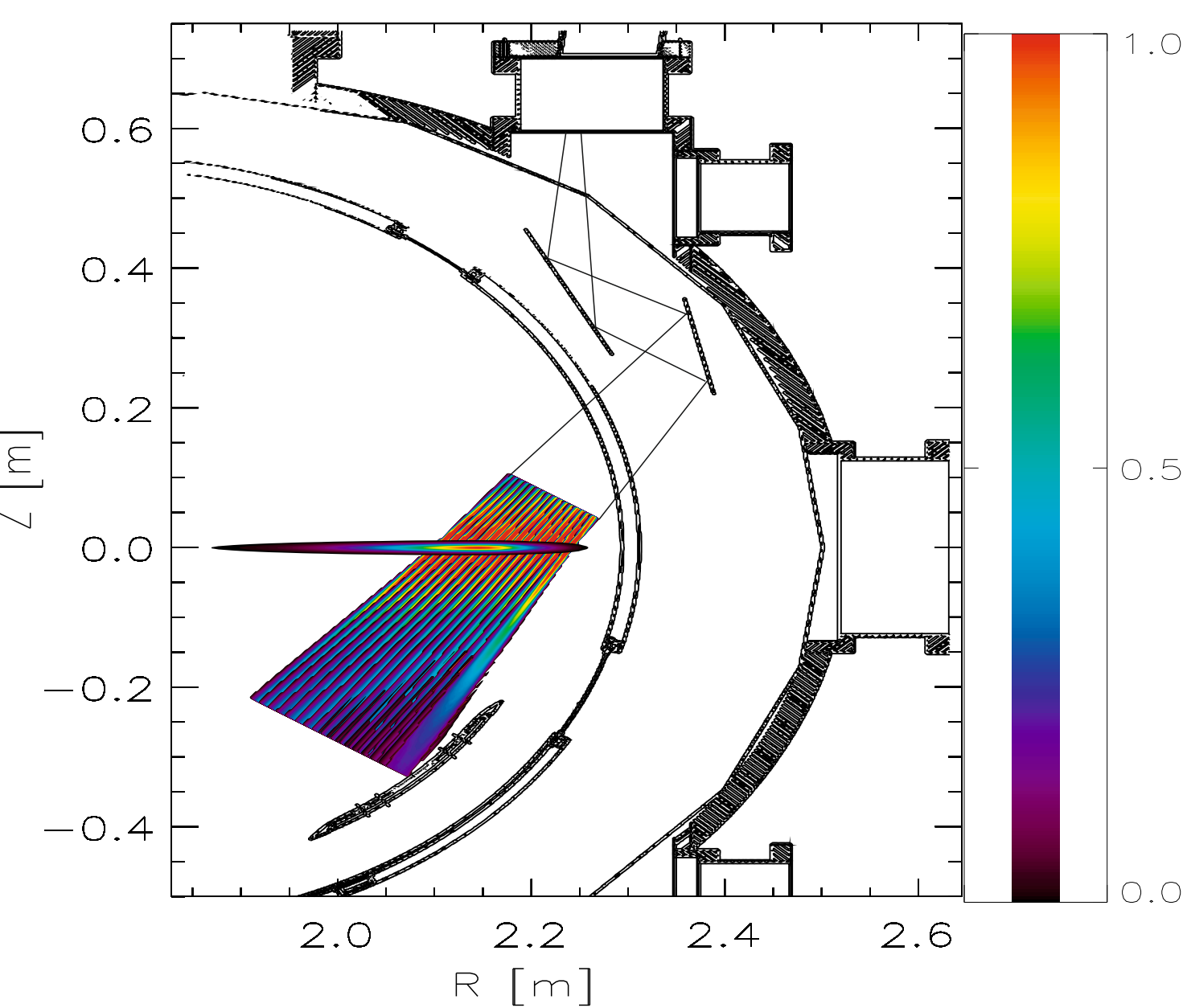


Calculates relative population of atomic levels along the beam (light profile)

Calculates photon current detected by the observation system



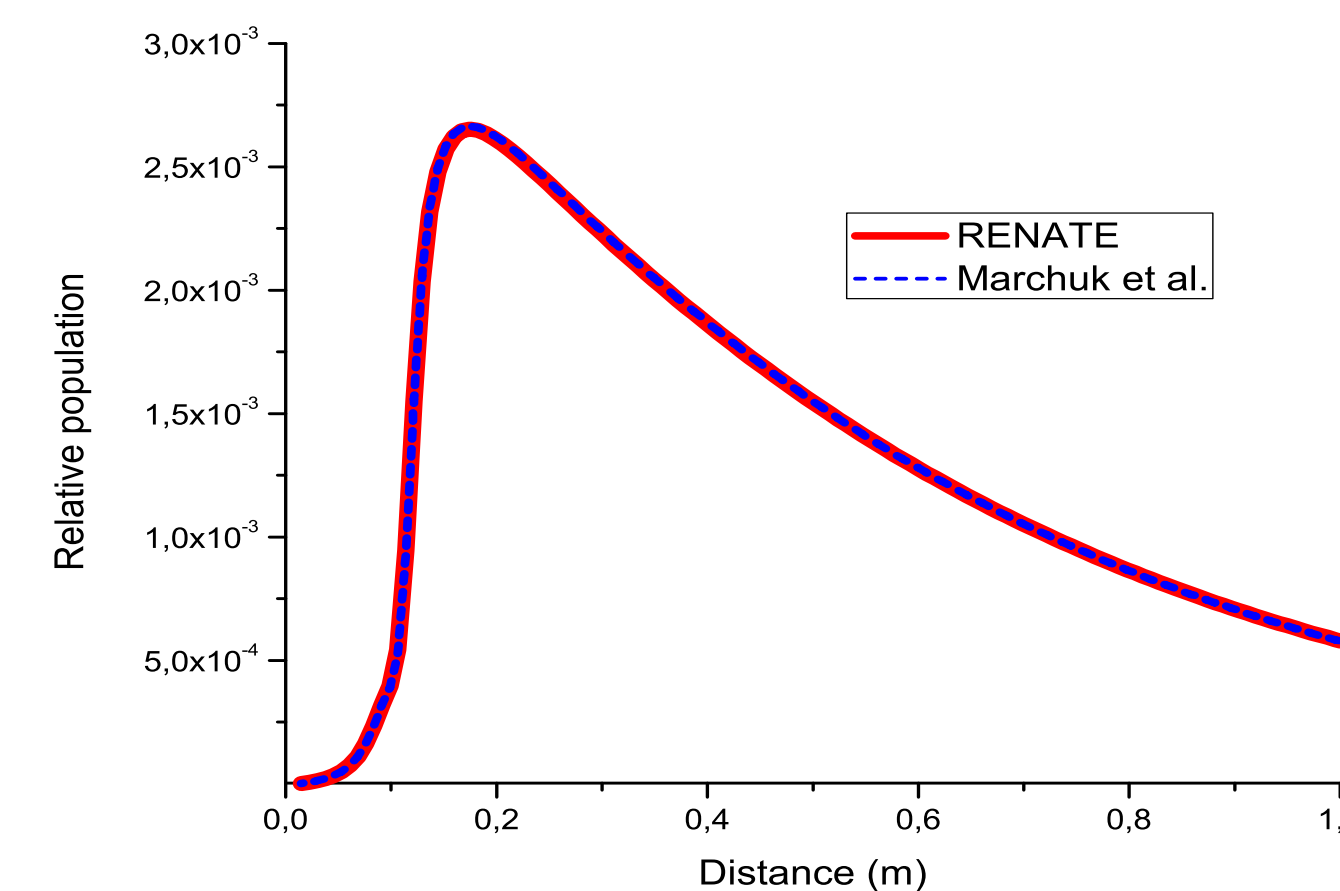
Optical transfer matrix for accurate observation system modeling



Benchmarking

RENAME calculates rate coefficients using cross sections from the IAEA ALADDIN and the Open ADAS databases with corrections from [3].

The rate equation solver of RENATE has been benchmarked against the simulation code introduced in [4].

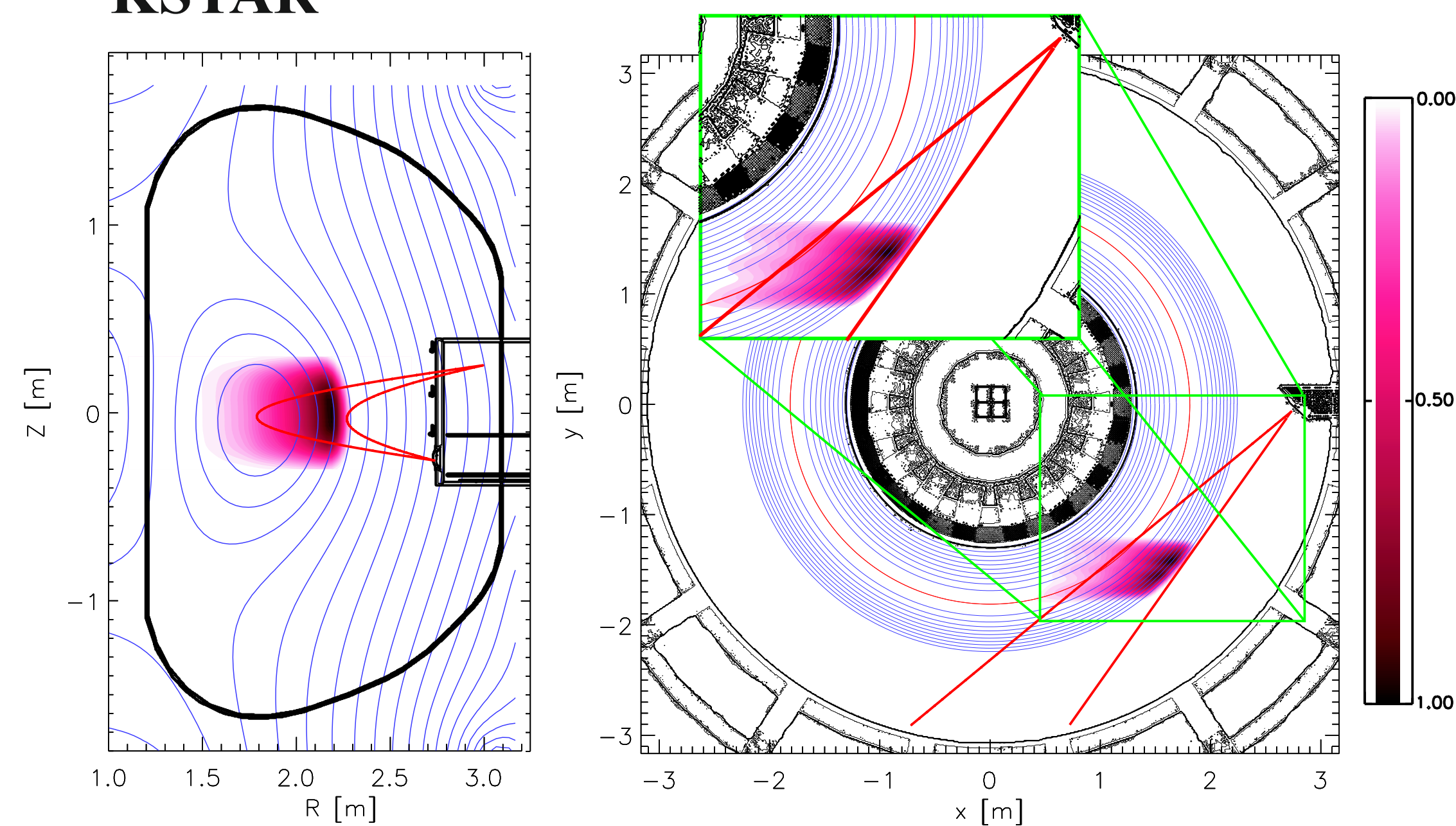


Applications

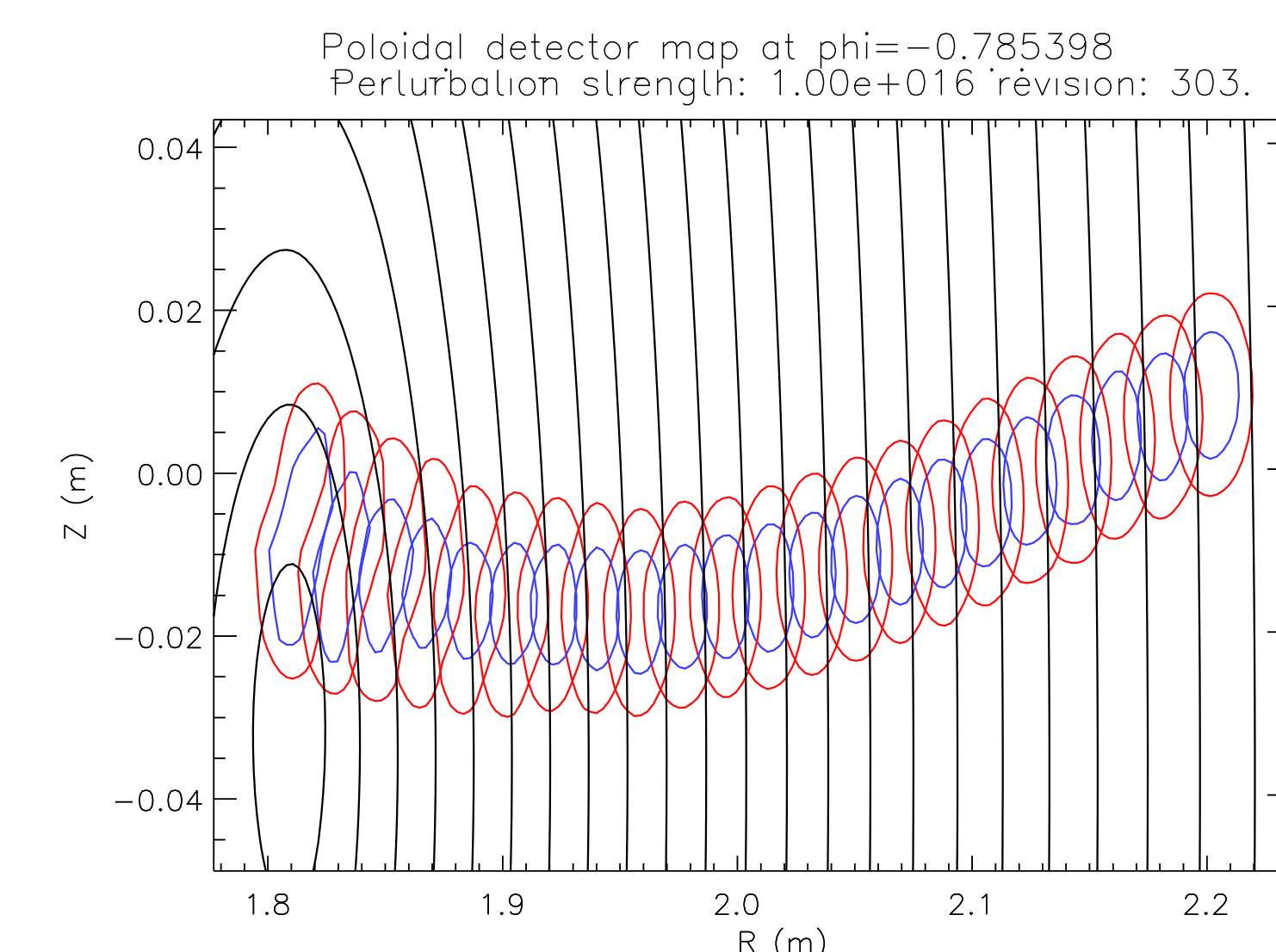
RENAME is already being actively used in the development of BES systems for ITER and KSTAR [5].

RENAME can determine the expected photon currents (and thus the SNR) and the spatial resolution for each detector segment.

KSTAR

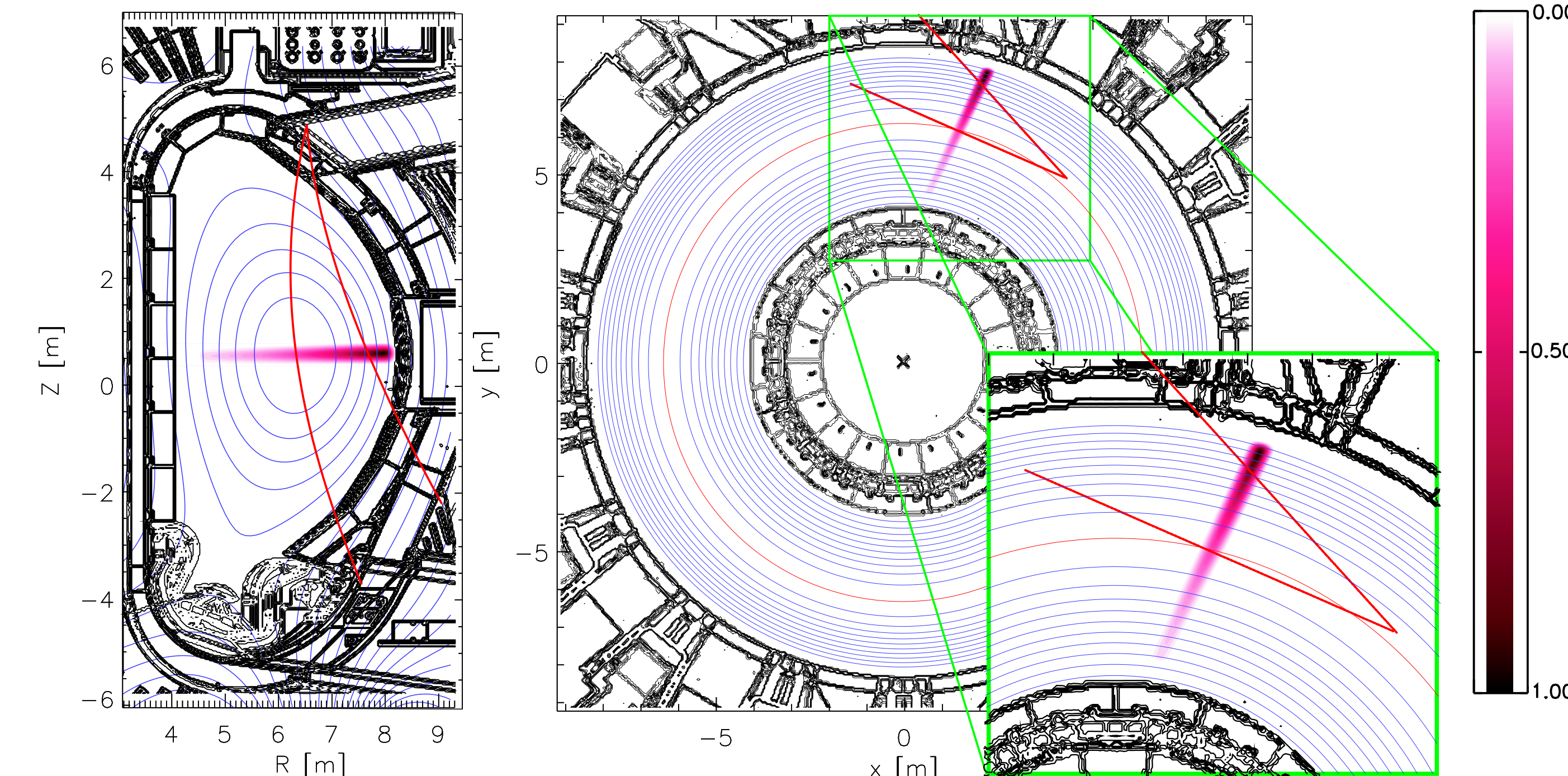


Poloidal and toroidal projections of the simulated KSTAR configuration



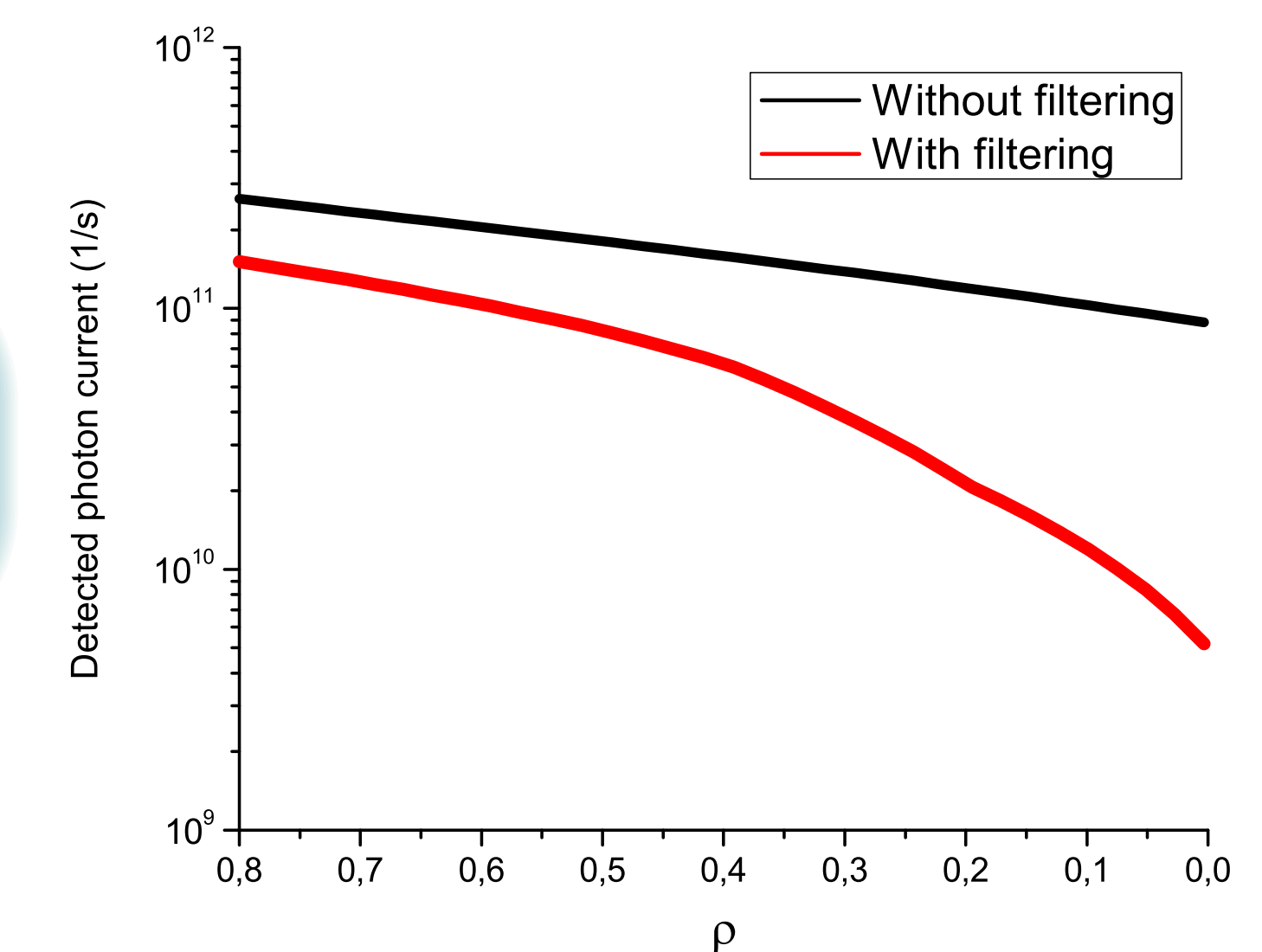
Observed area of each detector in a given poloidal plane for KSTAR. Gives the poloidal and radial resolution of the system.

ITER



Poloidal and toroidal projections of the simulated ITER configuration

Detected photon currents in the simulated ITER configuration



Future development

Due to its modular structure, new modules can easily be added to RENATE. The RENATE development team is currently planning to expand its functionality with the following:

Validation

Full validation of all RENATE modules against experimental data.
In progress, to be finished by 2012.

Wavelength dependency

New optical module that takes the wavelength dependent effects of optical transmittance into account.

References

- [1] I. Pusztai, et al.; *ECA* **31F** 2.137 (2007)
- [2] I. Pusztai, et al.; *Rev Sci Instrum.* **80**, 083502 (2009)
- [3] E. Delabie, et al.; *PPCF* **52** 125008 (2010)
- [4] O. Marschuk, et al.; *Rev Sci Instrum.* **79** 10F532 (2008)
- [5] D. Guszejnov, KSTAR BES Workshop, Budapest (2011)