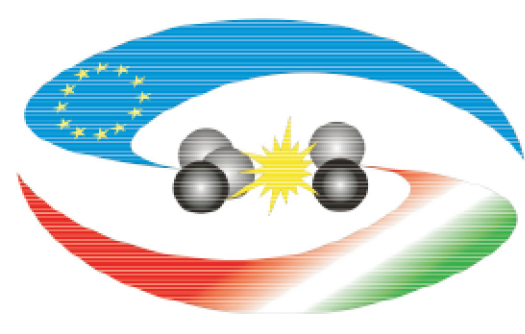
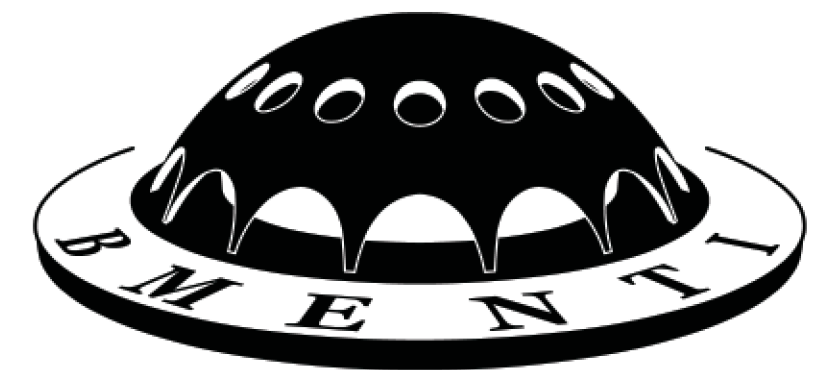




Association EURATOM/HAS

Applications of the RENATE beam emission simulation tool



CHALMERS

D. Guszejnov¹, D. Réfy¹, G. Pokol¹

1) Department of Nuclear Techniques, Budapest University of Technology and Economics, Association EURATOM, Budapest, Hungary

Collaboration: I. Pusztai², J. Schweinzer³

2) Chalmers University of Technology, EURATOM-VR Association, Göteborg, Sweden

3) IPP Garching, Association EURATOM, Garching bei München, Germany

E-mail contact of project leader: pokol@reak.bme.hu

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).

RENATE features

RENATE 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.

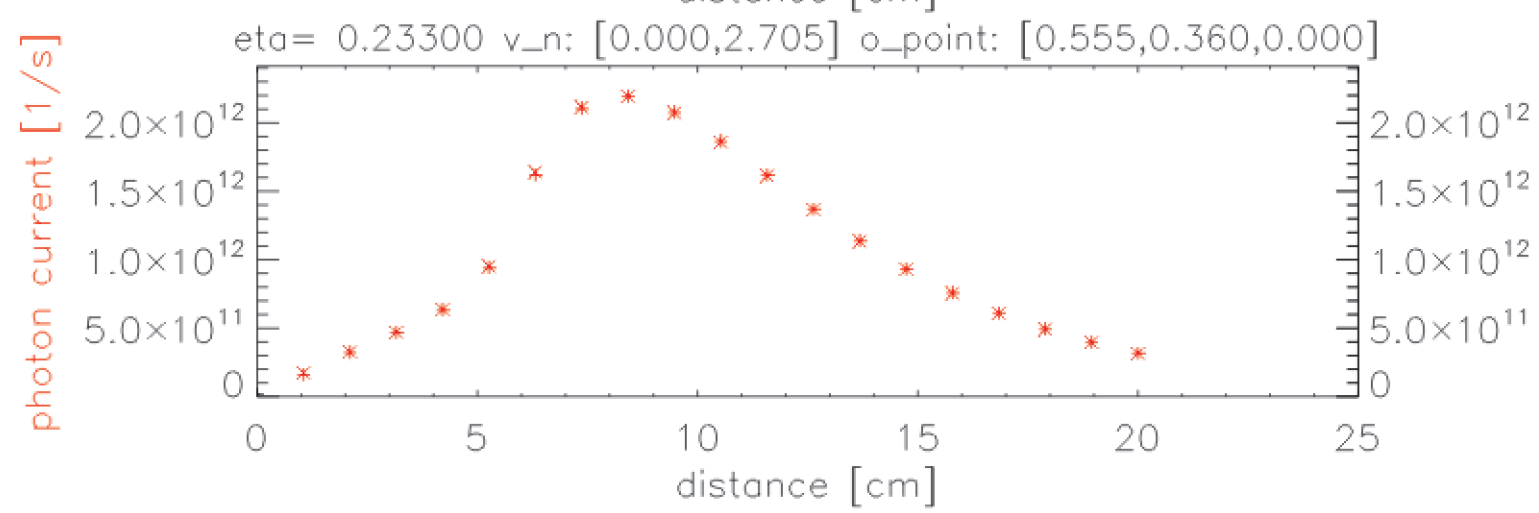
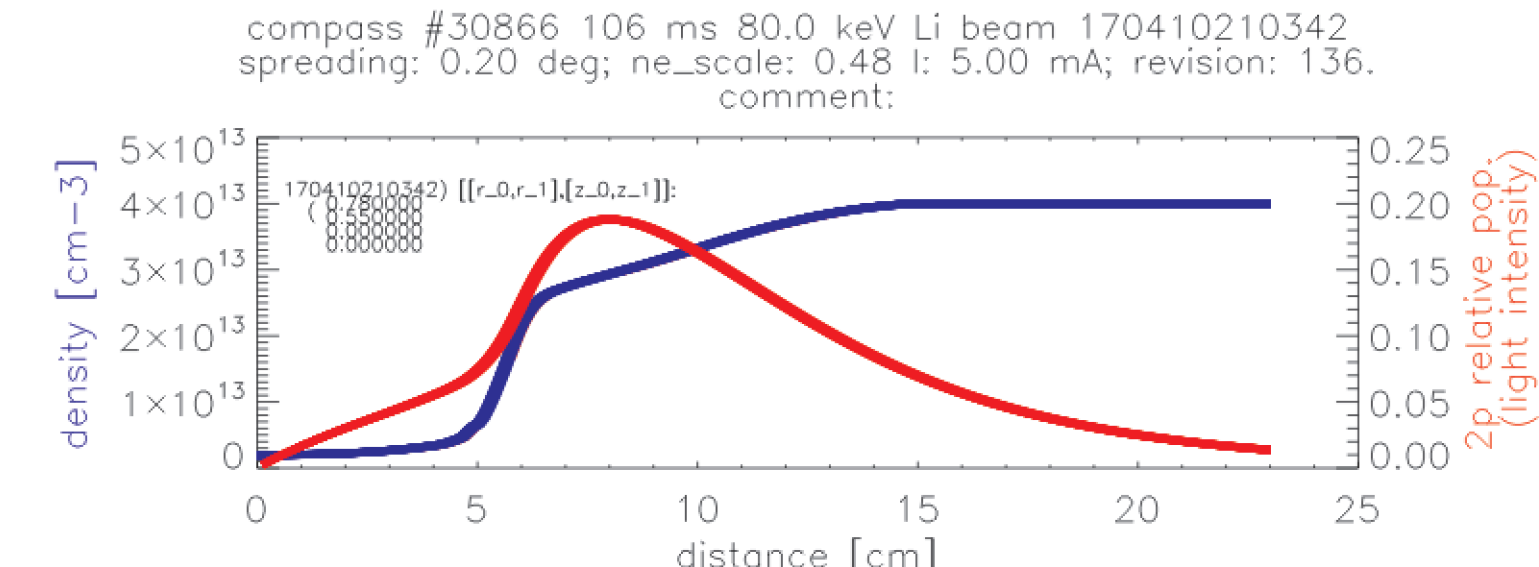
RENATE takes all the relevant atomic processes into account:

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

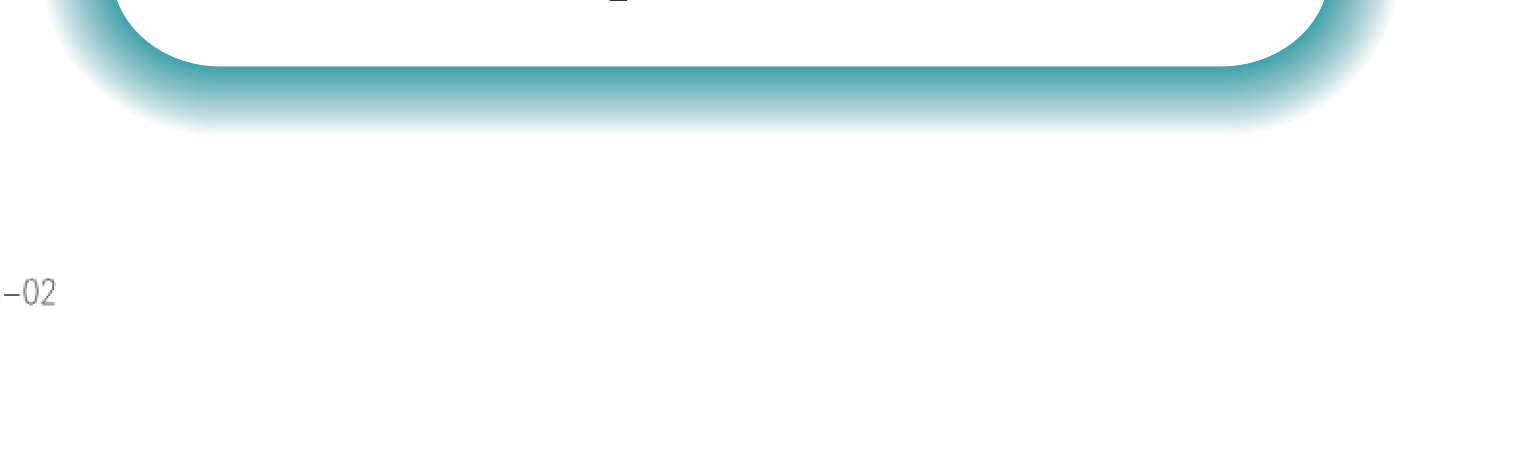
Supported beam types

Li Na H D

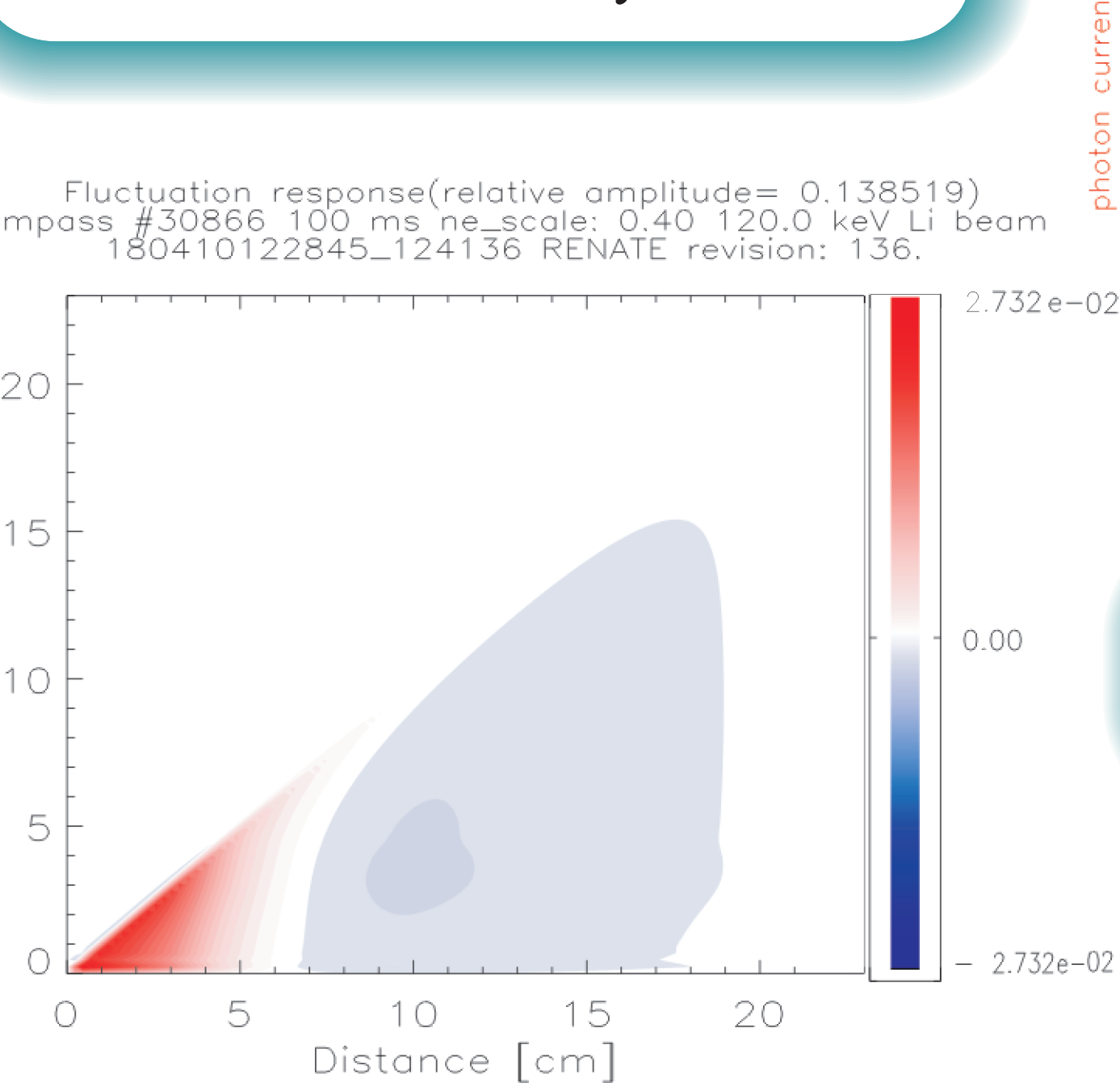
Calculates relative population of atomic levels along the beam (light profile)



Calculates the density fluctuation response matrix



Calculates photon current detected by the observation system

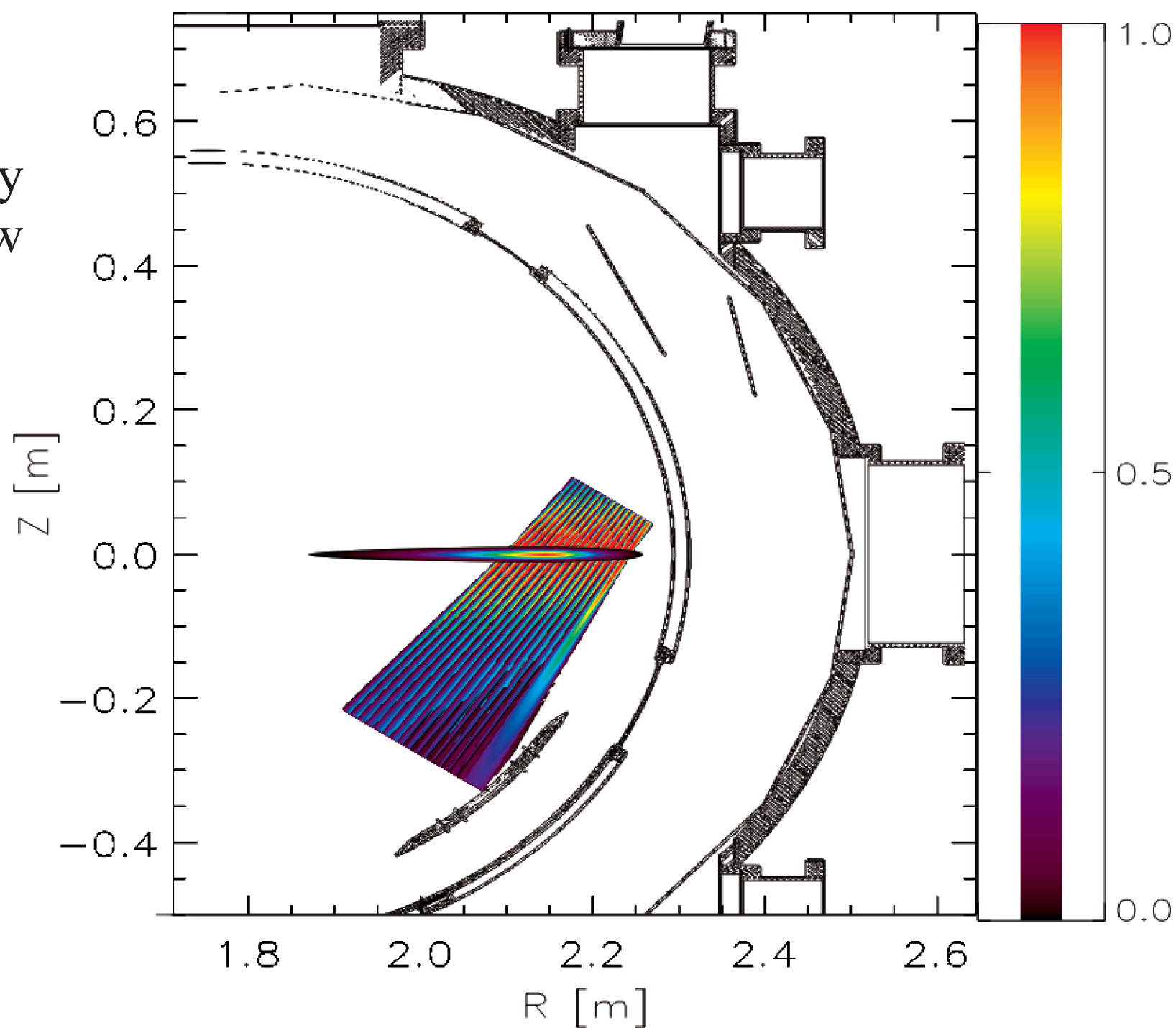


Application to TEXTOR

The desire for greater simulation accuracy of TEXTOR BES diagnostics led to the development of a new optical module of RENATE that replaces the older camera obscura model with a newer one, which takes the real observation system into account through a transmission matrix, calculated with Geometric Image Analysis from ZeMax.

The probabilistic electron density reconstruction method on TEXTOR is now based on this simulation [3].

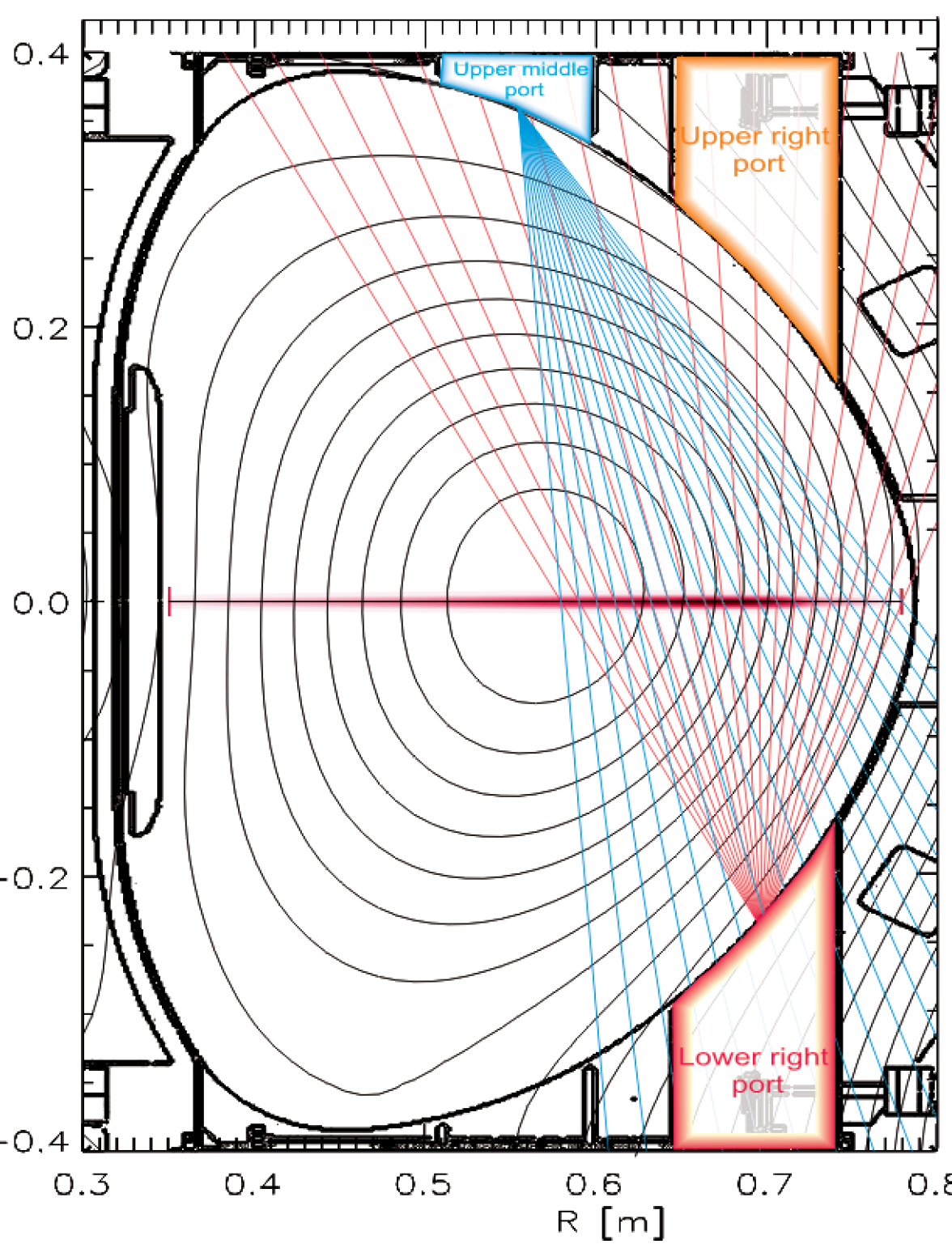
Poloidal cut of the transmission matrix and the normalized light profile



Application to COMPASS

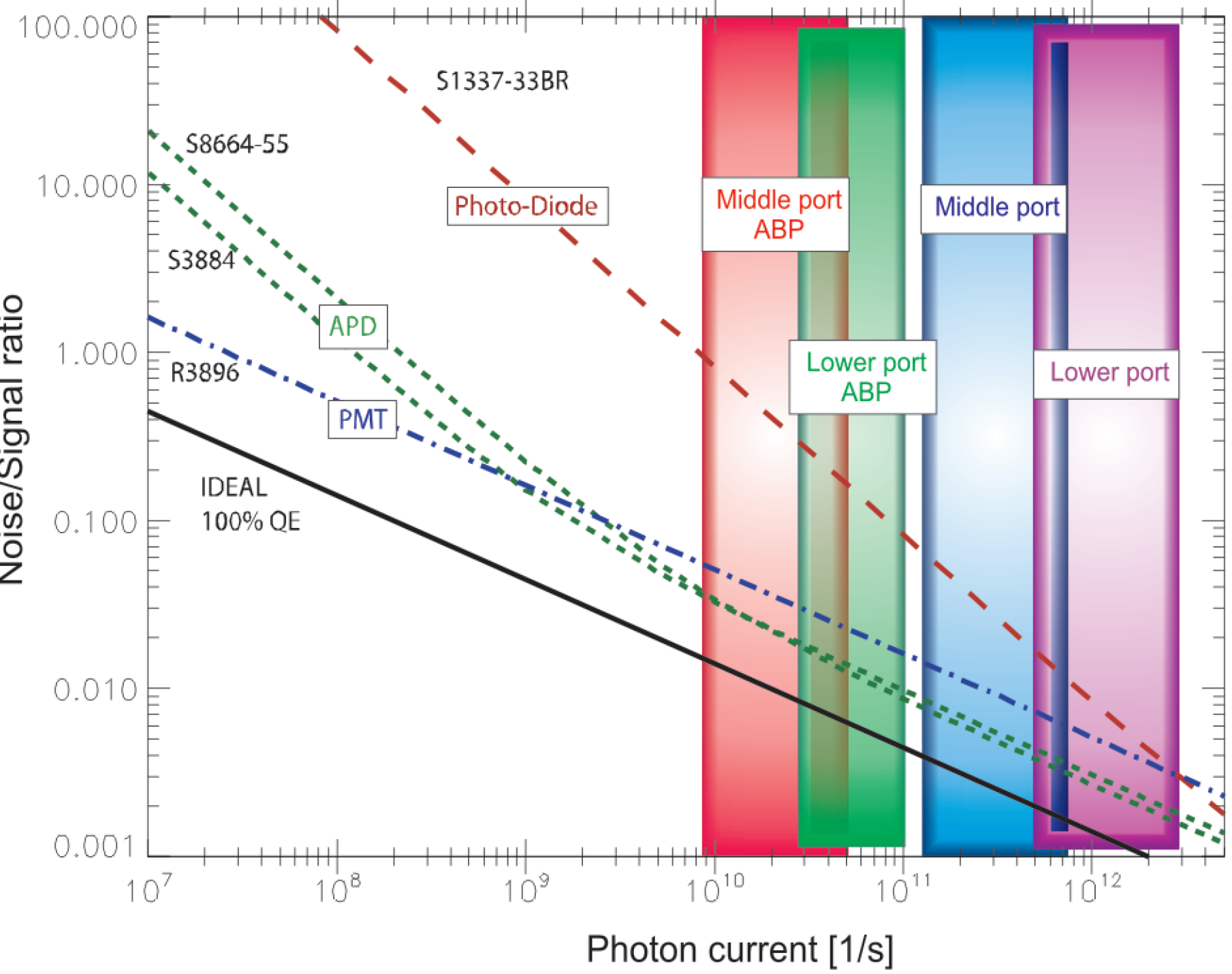
In 2009 the COMPASS tokamak was moved from Culham to Prague, where it is being upgraded [3]. In the course of this upgrade a new BES diagnostic system is being installed into COMPASS, whose development was significantly supported by RENATE simulations.

Determination of optimal observation range and number of APD detector channels based on simulated light profiles



Selecting detector type for fluctuation measurements with ideal signal to noise ratio [5]

Comparing possible installation configurations and selecting the ideal one



Conclusions

The RENATE is a simulation tool that is capable of simulating all the relevant processes of the beam emission spectroscopy. By contributing to the upgrade of COMPASS, it has already proved to be a valuable asset in the development of new BES diagnostic systems.

Future development

In order to eliminate the existing limitations of RENATE, thus creating a universal simulator for BES diagnostic systems, the RENATE developer team is planning to upgrade RENATE with a number of new modules.

Validation

Full validation of all RENATE modules against experimental data.
In progress, to be finished by 2011.

Geometry generalization (3D)

RENATE will be able to simulate the BES diagnostics of tokamaks of any geometry (e.g. JET, ITER).
by 2011.

Wavelength dependency

New optical module that takes the wavelength dependent effects of optical transmittance into account.
by 2012.

References

- [1] I. Pusztai, et al.; *ECA* **31F** 2.137 (2007)
- [2] I. Pusztai, et al.; *Rev Sci Instrum.* **80**, 083502 (2009)
- [3] S. Kalvin, et al.; *ECA* **33E** P5.211 (2009)
- [4] R. Panek, et al.; *CJP* **56** B125 (2006)
- [5] D. Dunai, et al.; *RSI* submitted

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