

Generation of Synthetic Radiation Patterns for Tomographic Studies in DTT Plasmas

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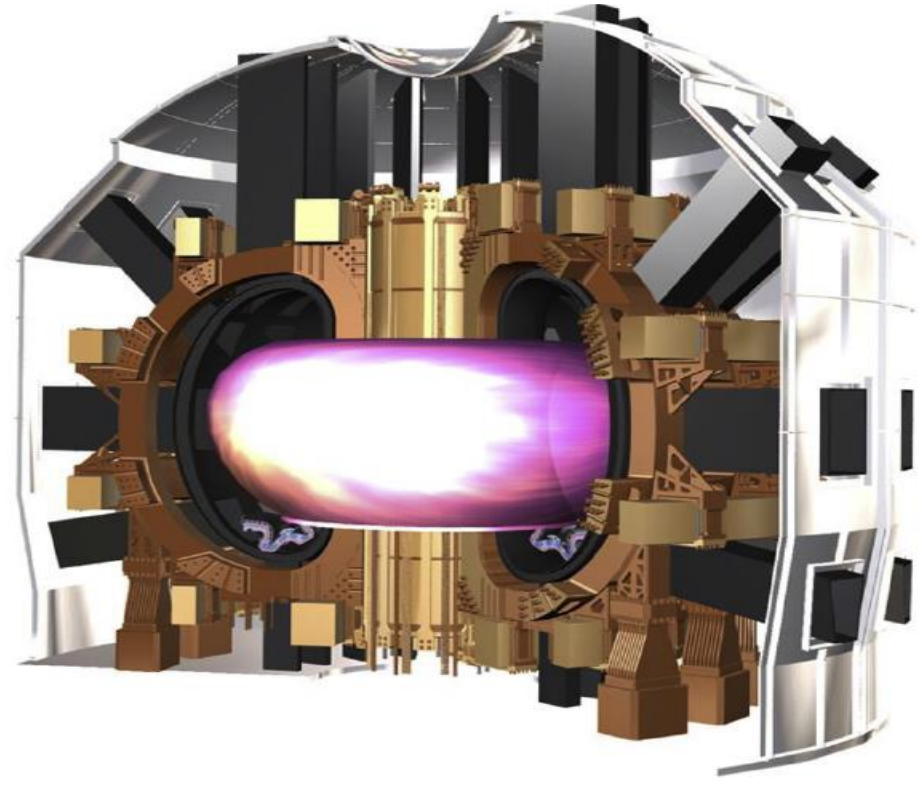
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Introduction

- The DTT (Divertor Tokamak Test) is a new tokamak that is currently under construction at the ENEA Research Centre in Frascati, Italy. Its purpose is to provide an integrated nuclear fusion environment in which to test power exhaust strategies that will be useful for next generation fusion reactors [1-3].
- The DTT bolometric layout has been defined [4], and an Expectation Maximization (EM) algorithm based on a Maximum Likelihood (ML) approach has been implemented [5].
- This study focuses on an initial test of the reduced diagnostic layout, aimed to reproduce fluctuations in emissivity maps while preserving the radial power density profiles obtained from modelling (JINTRAC [6] and ASTRA [7]).
- *Phantoms* were therefore generated from radial power density profiles obtained from simulations of a DTT single-null configuration [8].
- Poloidally symmetric and non-axisymmetric radiative patterns compatible with modelled profiles and standing as a local fluctuation of the emissivity, were considered.

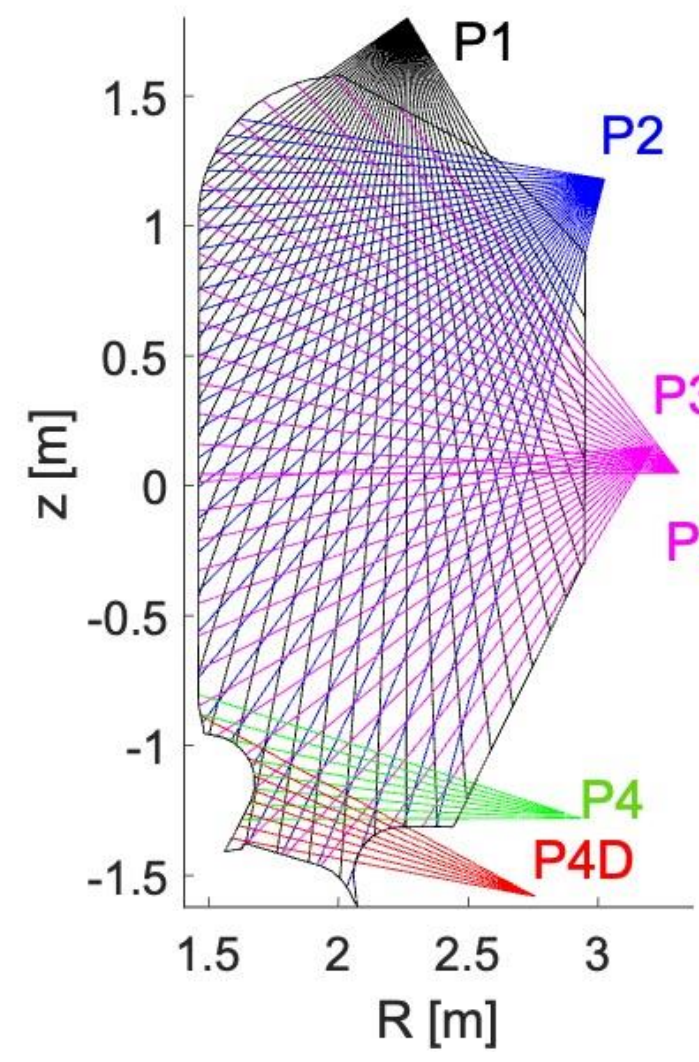
DTT (Divertor Tokamak Test)



R (m)	2.19
a (m)	0.70
V (m ³)	35
I _p (MA)	5.5
B _T (T)	6
P _{tot} (MW)	45
Pulse length (s)	100

For Single Null,
Flat-Top,
Full Power Scenario
 $T_e = 12 - 14 \text{ keV}$
 $n_e = 2.2 \cdot 10^{20} \text{ m}^{-3}$

Description

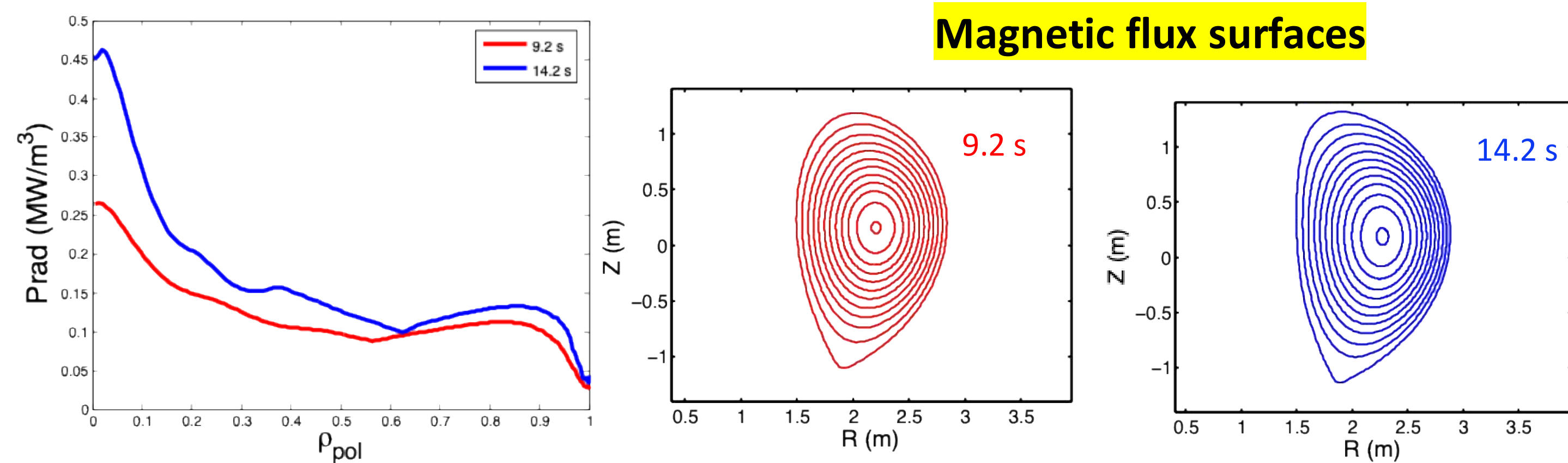


- The reduced LoS layout has currently been validated using a dedicated code for tomographic reconstruction with phantoms that have not been derived from modelling activities [3].

- ρ_{pol} flux coordinate
- ψ normalized psi

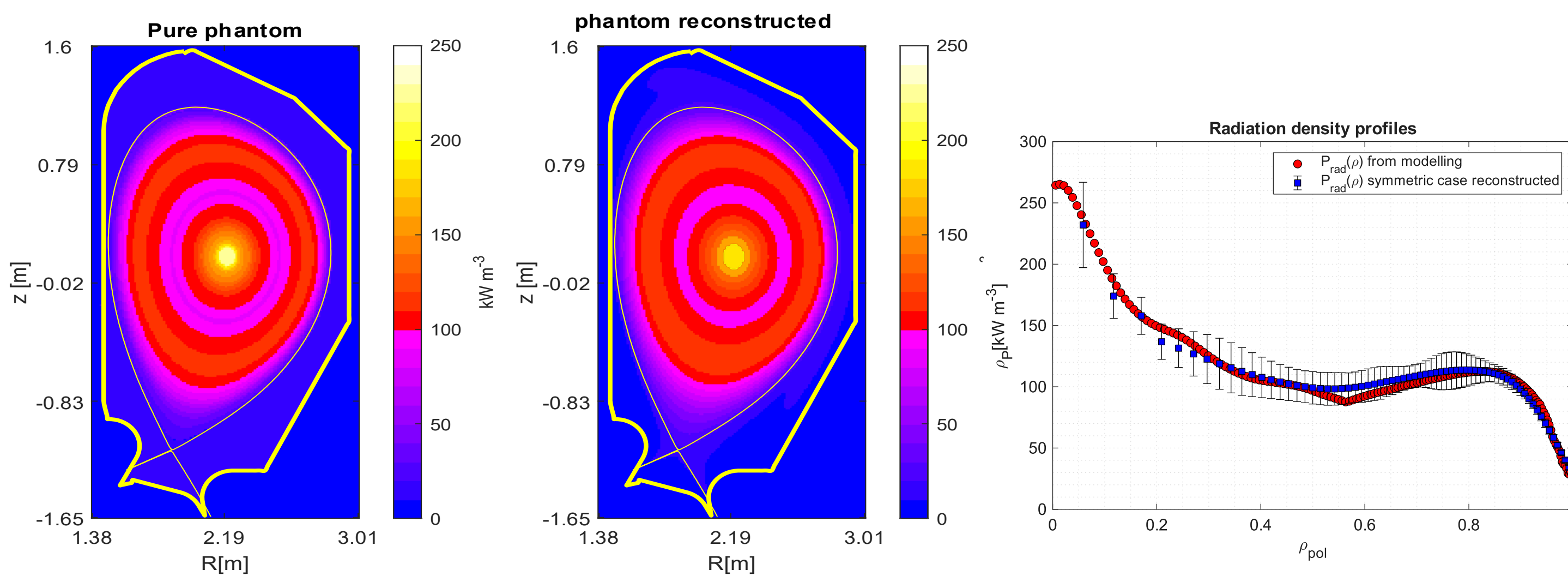
$$\rho_{pol} = \sqrt{\frac{\psi - \psi_0}{\psi_a - \psi_0}}$$

The Single Null scenario has been considered.



Radiation density evolution from the **ramp-up (red at 9.2s)** to the **flat-top one (blue at 14.2s)** phase.

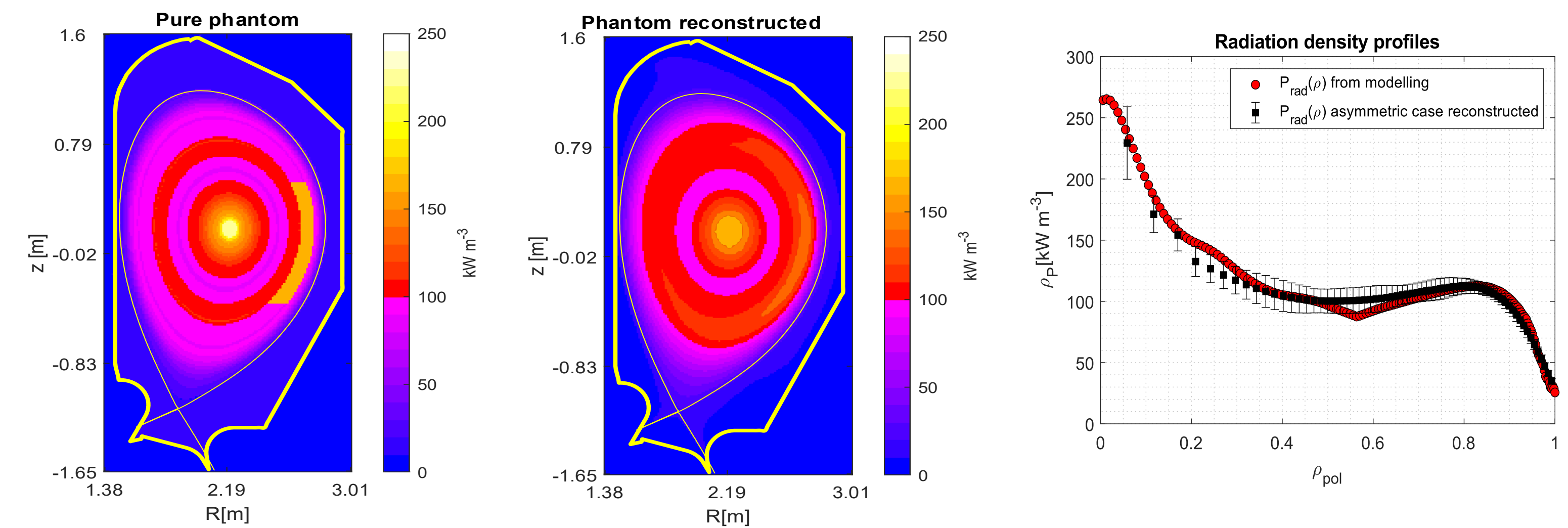
Poloidally symmetric radiation emissivity for the SN full power scenario (@ 9.2 s)



References

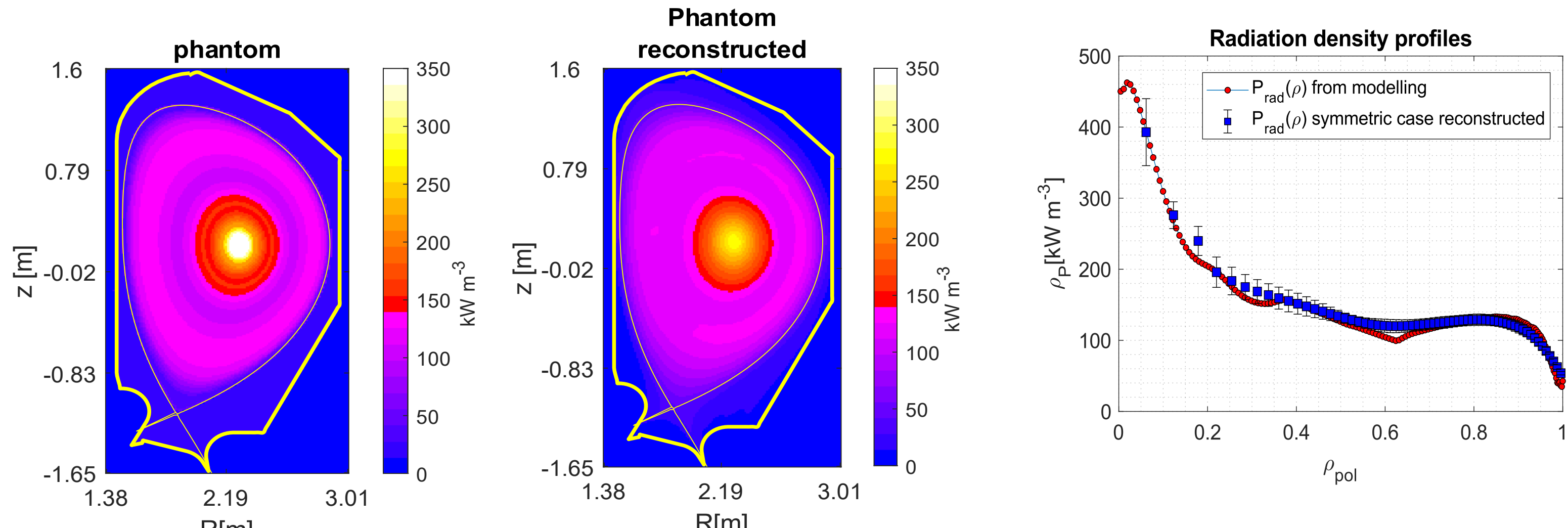
- [1] G.M. Polli et al., 2022) MELECON 2022 - IEEE Mediterranean Electrotechnical Conference, Proceedings, pp. 477 - 482, doi: 10.1109/MELECON53508.2022.9843123
- [2] F. Crisanti et al., 2024 Nucl. Fusion 64 106040
- [3] G. Giruzzi et al., 2026 Nucl. Fusion 66 116017
- [4] G.M. Apruzzese et al., Proceedings P5.043 EPS 2024
- [5] E. Peluso et al., FED 215 (2025)
- [6] Casiraghi et al., Plasma Phys. Control. Fusion 65 (2023) 035017
- [7] N. Bonanomi et al., 2025 Nucl. Fusion 65 016005
- [8] G.M. Apruzzese et al., Proceedings of the 52th EPS Conferenze 2026

Poloidally asymmetric radiation emissivity for the SN full power scenario (@ 9.2 s)

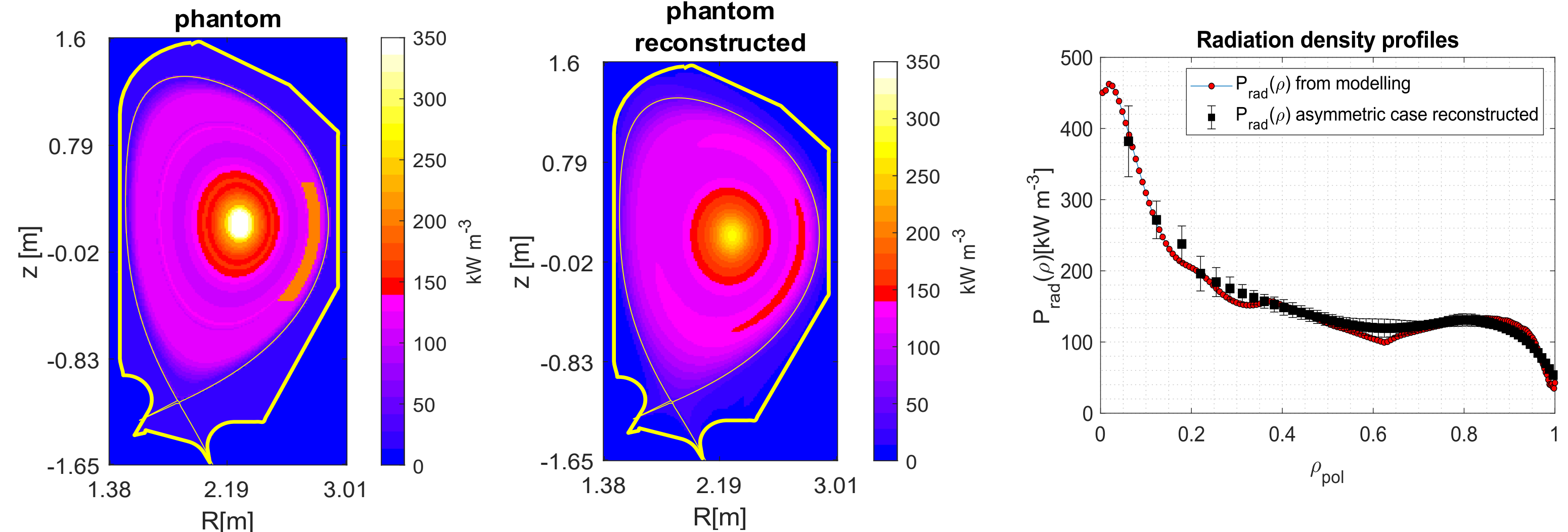


The emissivity profile outside the perturbed region has been consistently modified in order to maintain the radial consistency of the initial power distribution.

Poloidally symmetric radiation emissivity for the SN full power scenario (@14.2s)



Poloidally asymmetric radiation emissivity for the SN full power scenario (@14.2s)



Good agreement between synthetic (red) and reconstructed (blue/black) 1D radiation profiles for both poloidally symmetric and asymmetric cases.

- The reported profile stands for the average one obtained from a set of noised phantoms. The uncertainties correspond to the estimated standard deviation.

Conclusions

- ❖ Taking into account the radiation density profiles predicted by ASTRA for the single null, full-power scenario currently envisaged by DTT, compatible poloidally symmetric and asymmetric tomographic reconstructions have been obtained.
- ❖ These results confirm the reliability of the methodology for providing an initial description of emissivities in the form of modelled quantities.

Future works

- ❖ While the current work focuses on the predicted measurements within the last closed surface for SN scenarios at full power, for ramp-up and flat-top phases, other scenarios at not-full power will be taken into account.
- ❖ At the same time, further emissivity patterns, including the divertor region, will be investigated.