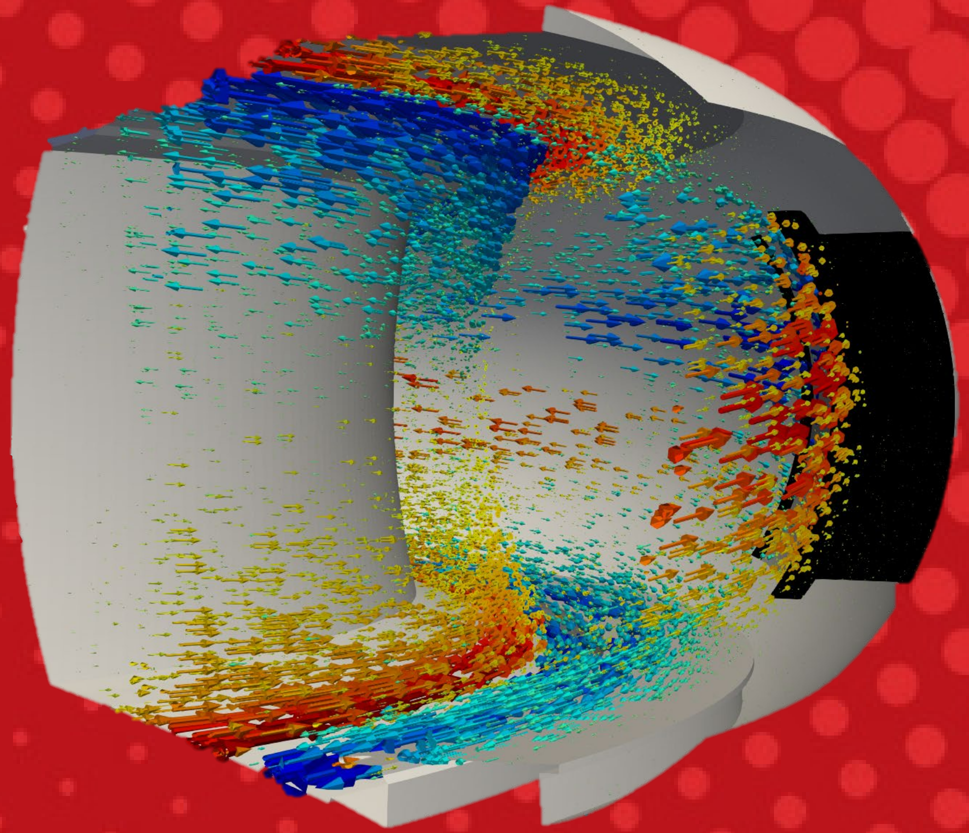


Plasma parallel velocity field in WEST from SOLEDGE

Tungsten migration modelling in WEST discharges SOL

S. Di Genova, G. Ciraolo, N. Fedorczak, A. Gallo,J. Romazanov, H. Bufferand, P. Tamain, E. Serre, S. Brezinsek

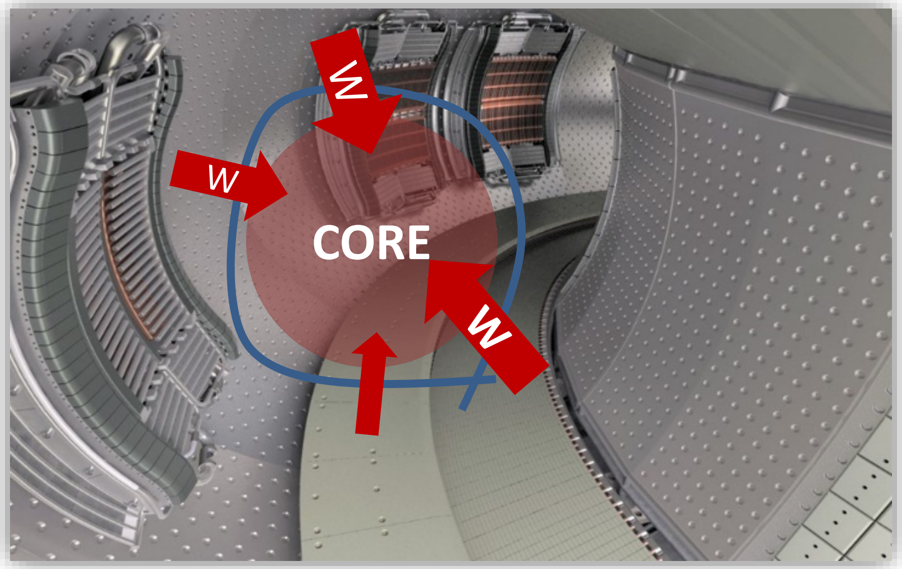
Tungsten (W) contamination in WEST

- WEST equipped with all W plasma-facing components (up to C4).
- Unmitigated radiated fraction (≥ 50% in heated scenarios).

- Sources are monitored with visible spectroscopy [O.Meyer et al., HTPD 2018].
  - Estimate of gross erosion only.
  - Redeposition & boundary plasma screening not measured.

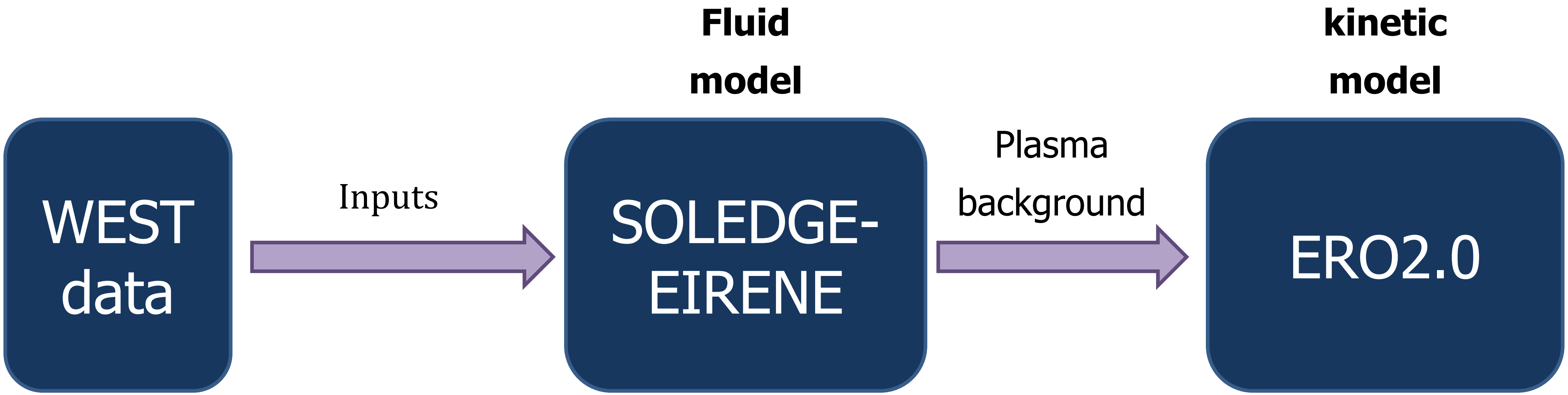
Advantages of modelling:

- Access to net erosion.
- Access to source position of W contaminating plasma
- Estimation of plasma conditions influence on W contamination



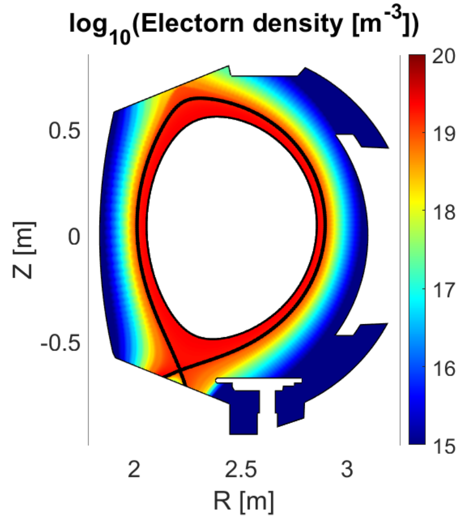
Modelling Work flow

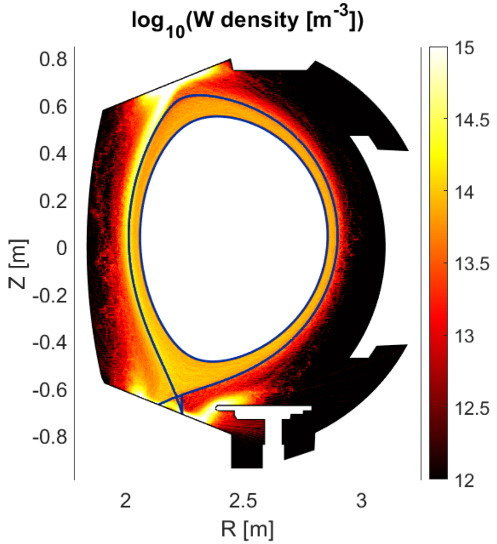
- Experimental data taken by WEST discharges.
- WEST data used as input for SOLEDGE-EIRENE.
- Outputs of the transport code used as **background** for ERO2.0.
- Output used to gain insight about PFCs role in WEST W contamination and transport mechanism in the machine.



Early test case: WEST discharge #55797

References [S. Di Genova et al., NF ,2021]





Plasma species:

pure D assumed.

Ohmic phase.

S3XE simulation
By H. Yang

ERO2.0 Input parameters:

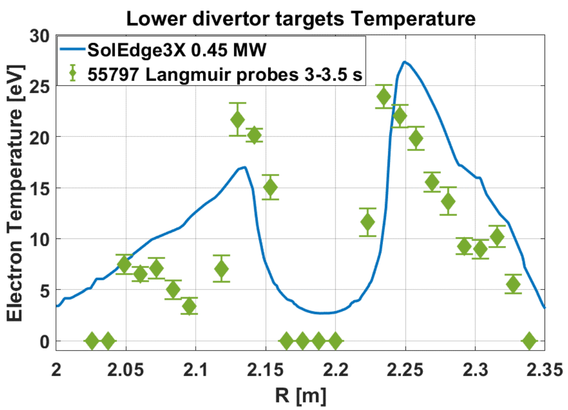
$$D_{\perp}^{an} = 0.3 \text{ m}^2/s$$

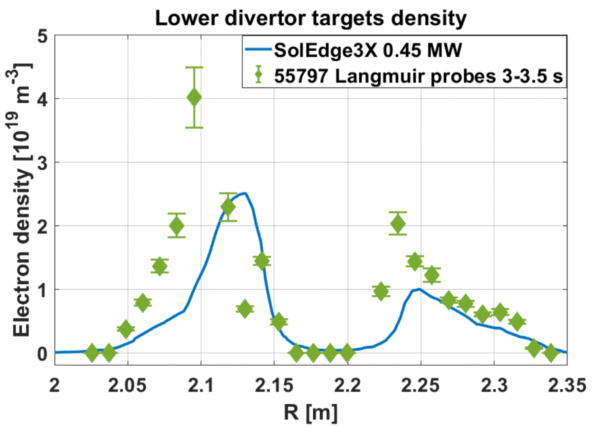
Impurities:

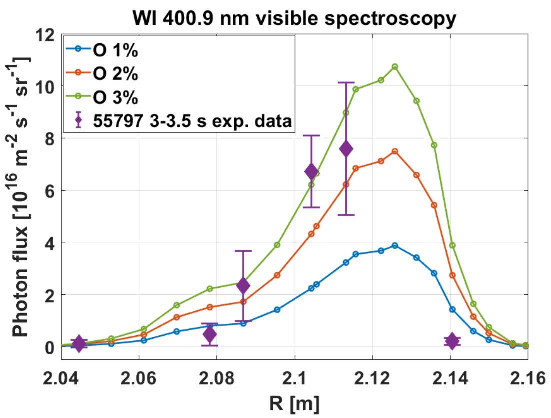
Homogeneous oxygen

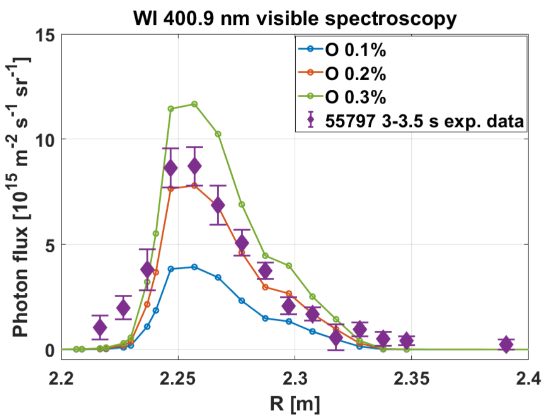
Ionisation states: from 1+ to 3+

We manage to reproduce divertor signal with synthetic Spectroscopy







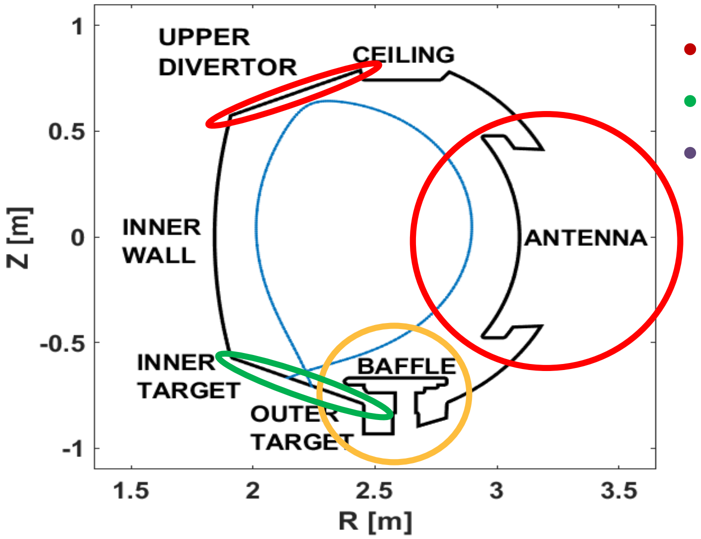


Screening is very different between PFCs

We compute a parameter linked just to transport:

Penetration factor

$$\tau_W = \frac{N_{in}}{\phi_{wall}} = \frac{\text{Number of W ions in separatrix}}{\text{Eroded partcles rate}}$$

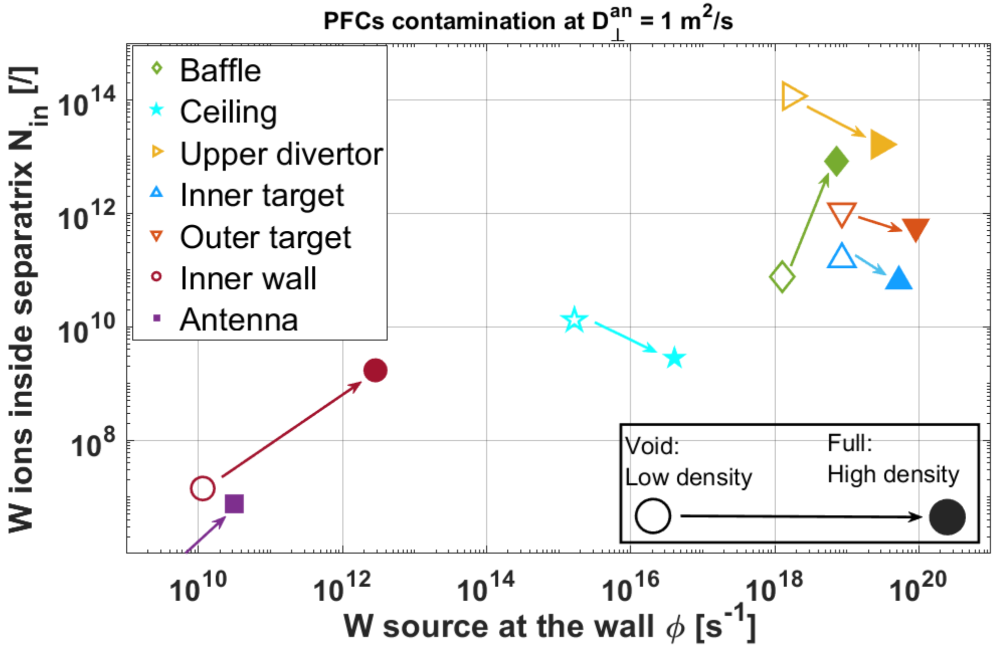


- Weakly screened
- Strongly screened
- Variable with plasma conditions

- Lower divertor is very screened.
- main chamber PFCs are low screened.

PFC	D=0.3 m²/s	D=1 m²/s
Antenna	2.3×10^{-5}	2.3×10^{-4}
Upper divertor	3.5×10^{-7}	5.7×10^{-7}
Baffle	2.8×10^{-9}	1.1×10^{-6}
Outer target	$\sim 10^{-12}$	6.8×10^{-9}
Inner target	$\sim 10^{-12}$	1.2×10^{-9}

Ratio between contamination N_{in} and source ϕ_{wall} For different PFCs In high density case



Background with modified upper X-point height

References [A. Gallo et al., NF ,2020][G. Ciraolo et al, NF,2021]

#54067

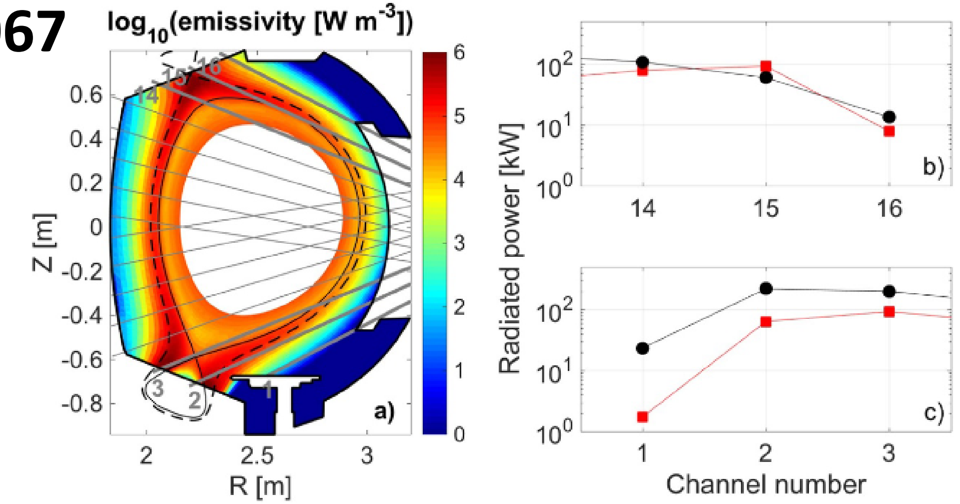
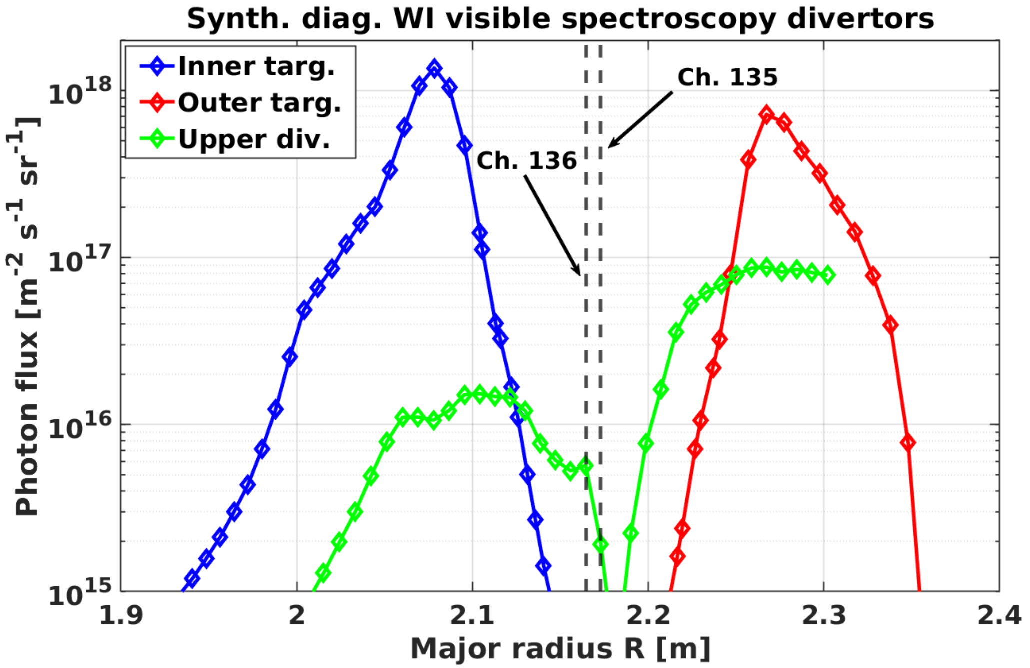
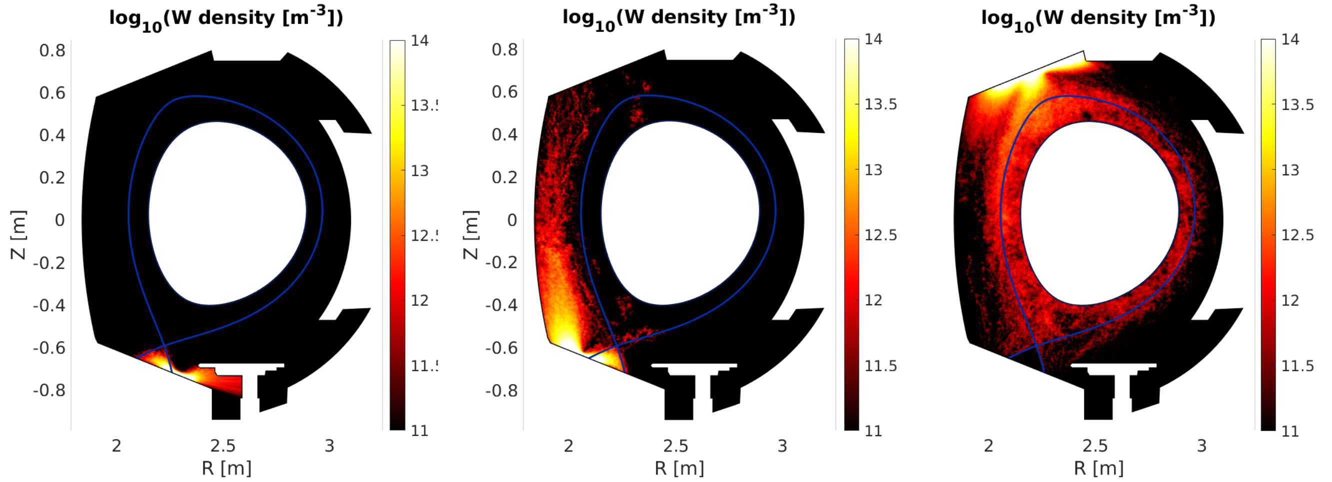


Figure 6. (*a*) Poloidal map of emissivity calculated by SolEdge2D-EIRENE with bolometry channels (gray lines); (*b*) power radiated along channels 14 to 16 and (*c*) along channels 1 to 3 from bolometers (black dots) and calculated by SolEdge2D-EIRENE (red squares).

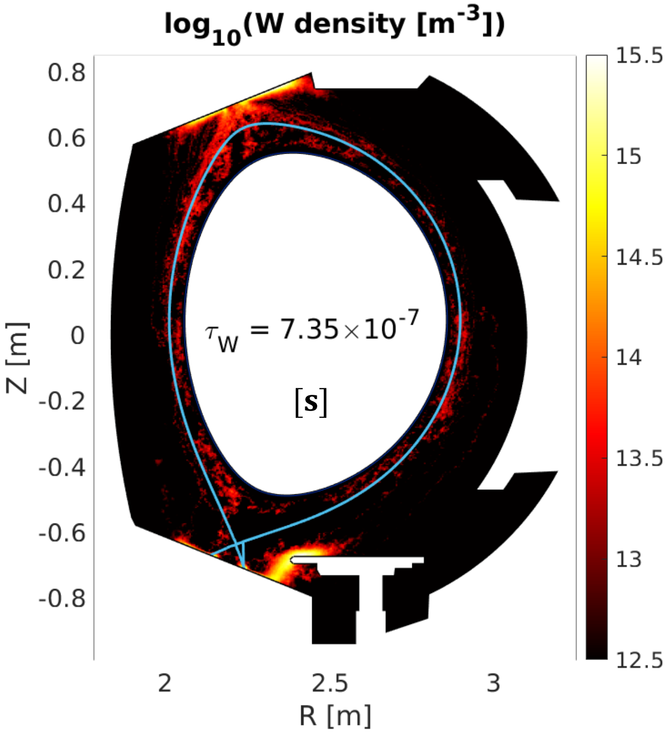




Lower Vs upper divertor signals compatible with what is seen in experiments.
Upper divertor screening still very low.

Improving W migration description

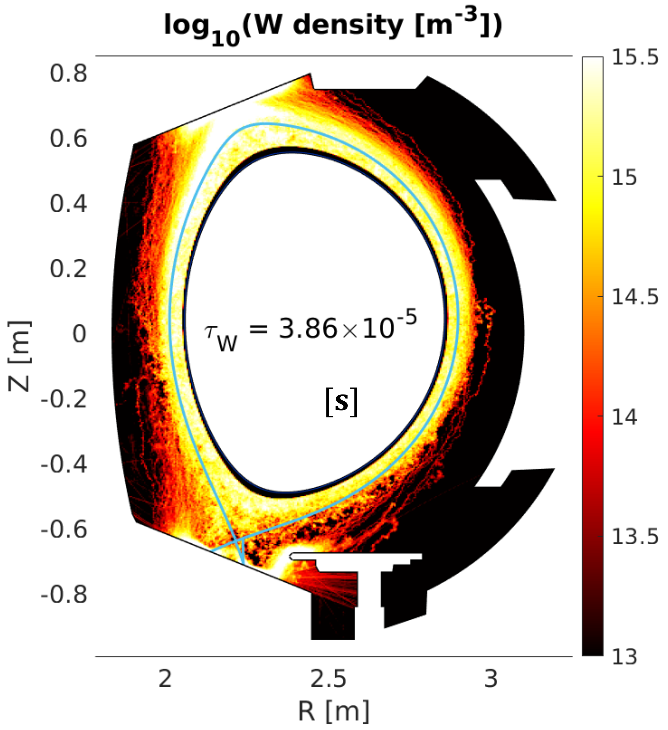
2021 simulations → **2022 simulations**



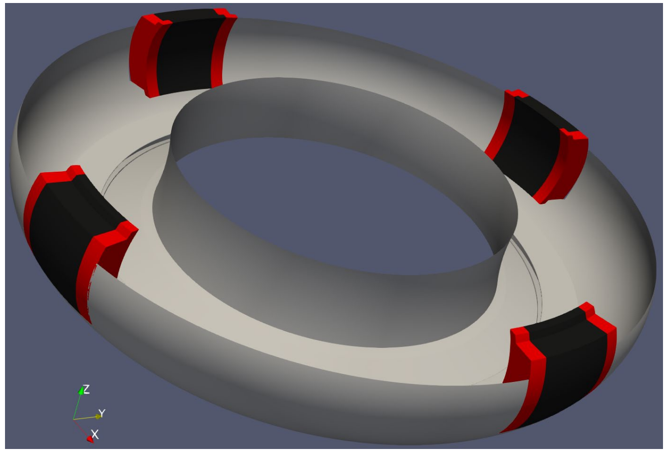
Model physical features	
CODE UPDATE Collisional forces	friction forces F_0, thermal forces $F_{\nabla T}$
CODE UPDATE Sheath physics	Electron density with Boltzmann factor: $n_e = n_0 \exp\left(-\frac{\phi}{k_B T_e}\right)$
Plasma impurities	Uniform 3% Oxygen mixture from O^{1+} to O^{8+}

Penetration factor increases up to a factor 50

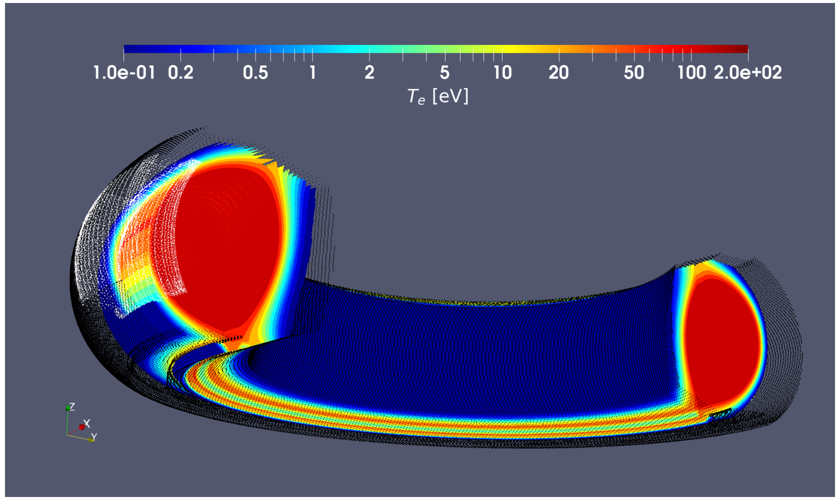
W density closer to values expected from experiments



Antenna contamination: 3D wall model

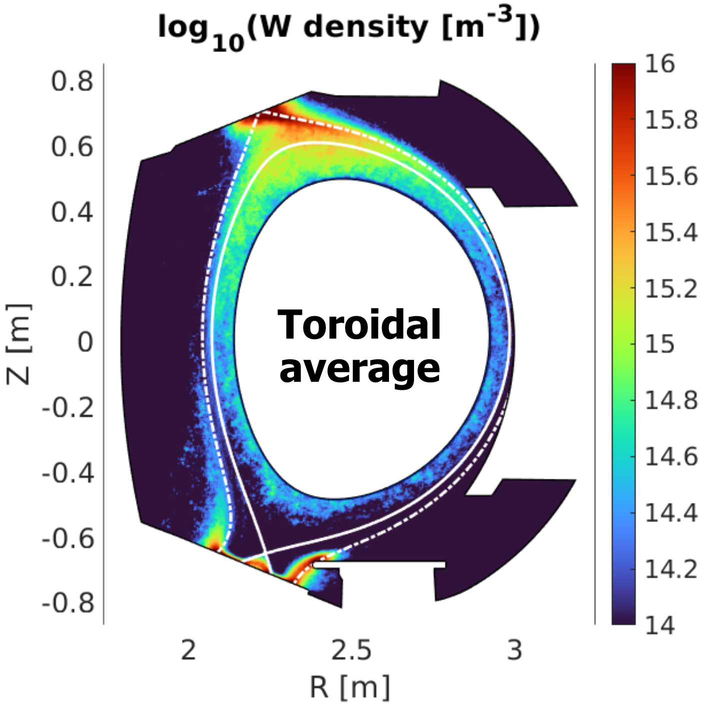


New 3D asymmetric wall model:
Radial Outer Gap: 1.5 cm

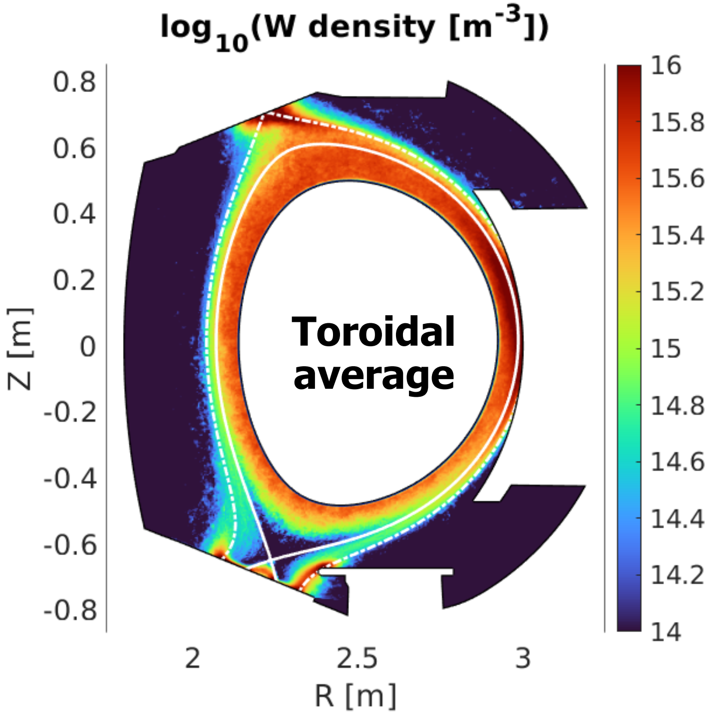


SOLEDGE background plasma

Without Antenna erosion



With Antenna erosion



Results in this configuration	Antenna protections	Other PFCs
Erosion rate Q [# s^{-1}]	3.27×10^{19}	2.54×10^{20}
Contribution core W content N_W [#]	9.00×10^{16}	9.95×10^{15}
	90% of contamination	85% of erosion

Conclusions/ Take-home messages

- SOLEDGE-EIRENE and ERO2.0 can be used as tools to make interpretative modelling of W contamination and screening.
- Divertor W visible signal was reproduced in modelling
- Screening seems to be very different between PFCs
- Modelling hypotheses updated to reach realistic levels of contamination

Ongoing Projects: plasma backgrounds

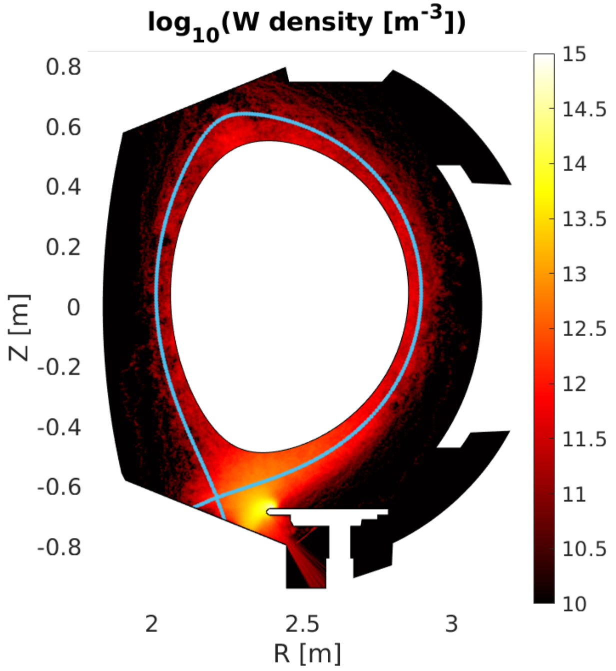
- Modelling WEST Helium discharges
- Modelling X-point radiator configuration
- 3D modelling of WEST scanning distances between separatrix and plasma

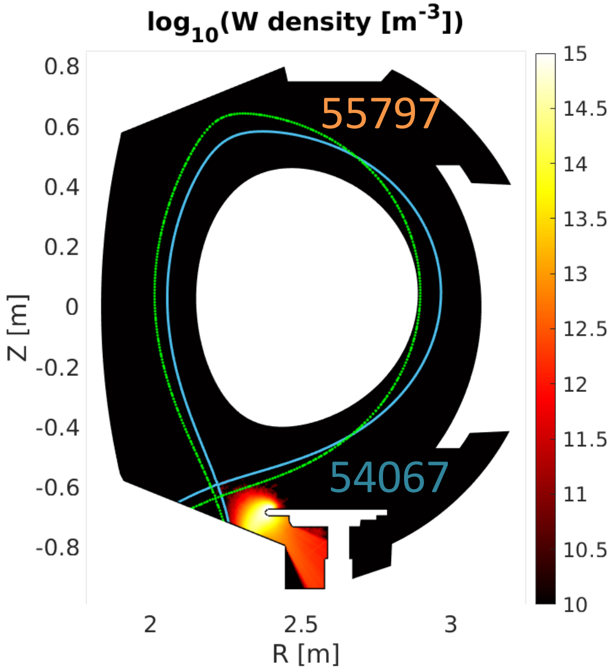
Future Projects: W migration

- Upper divertor erosion analyses from next campaign will be compared to modelling
- Scanning gap between antenna and separatrix and study a possible correlation on W contamination
- Study W erosion in long pulses

BACKUP SLIDES

Baffle contamination: two different magnetic configurations





#55797: low X-point

Simulation power 2.5 MW

Separatrix density: 2.1e19 m-3

Penetration factor τ_W: 1e-6 s

#54067: high X-point

Simulation power 3 MW

Separatrix density: 2.5e19 m-3

Penetration factor τ_W : 1e-11 s

ERO2.0 Input parameters:

$D_{\perp}^{an} = 1\,\mathrm{m}^2/s$

Future simulations to investigate X-point height influence on W contamination