EUROfusion

Modelling of W erosion/redeposition in DTT 3D geometry with the ERO2.0 code

G. Alberti, M. Passoni
Politecnico di Milano

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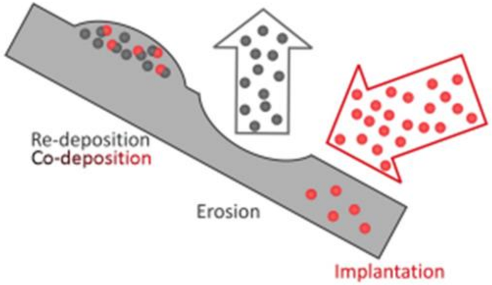
Introduction: erosion and impurity migration

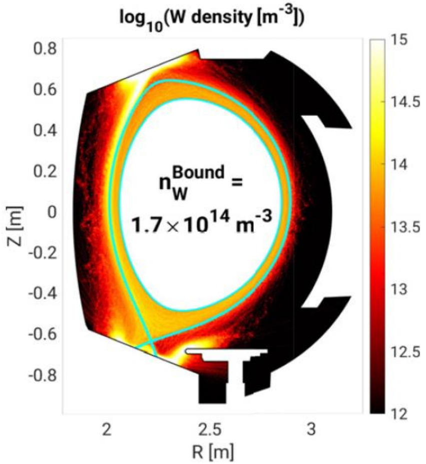
Extreme operational conditions for materials in fusion environment:

- **heat loads** up to 10-100 MW m^{-2}
- **particle fluxes** up to 10^{24} m^{-2} s^{-1}



Consequences:

- **erosion** of exposed materials, setting limit to components lifetime
- plasma dilution and cooling due to **migration** of eroded materials in core



Necessity to quantitatively measure these phenomena in a tokamak with appropriate diagnostics

→ Inputs to DTT design

S. Di Genova et al 2021 Nucl. Fusion 61 106019

Objectives of this work

Objectives

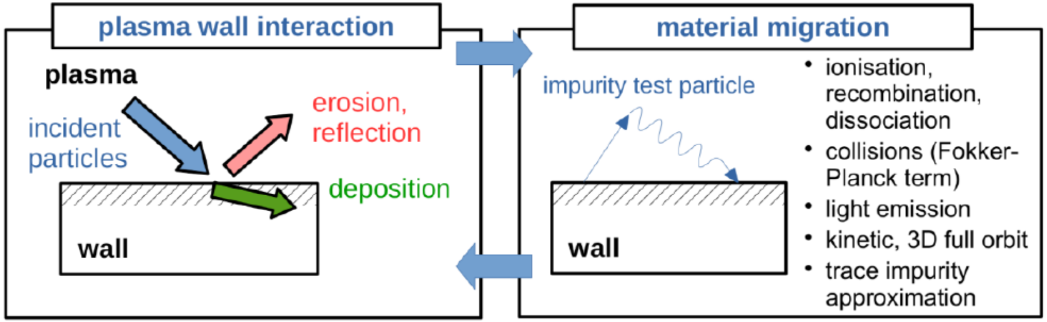
1. Evaluate distribution of **W erosion** and **redeposition** on DTT divertor and first wall, in view of assessing optimal position for erosion/deposition **diagnostics**

2. Analyze W contribution to plasma **core contamination**, estimating W flux crossing the separatrix towards the core

Plasma reference scenarios: DTT high power scenario in SN, XD, NT, detached with seeding and attached in pure D

Modelling approach: the ERO2.0 code

3D Monte-Carlo and **impurity transport** code



Input

Plasma background (n, T, velocity)
Magnetic equilibrium
Reflection/erosion yields, atomic data
3D walls geometry

Output

Erosion/deposition pattern
Core contamination
Microscale morphology evolution
…

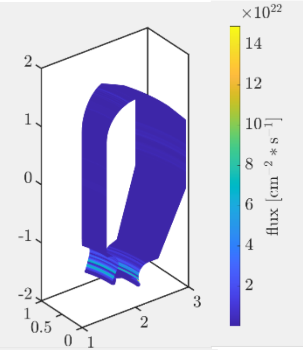
Limitations for this study:

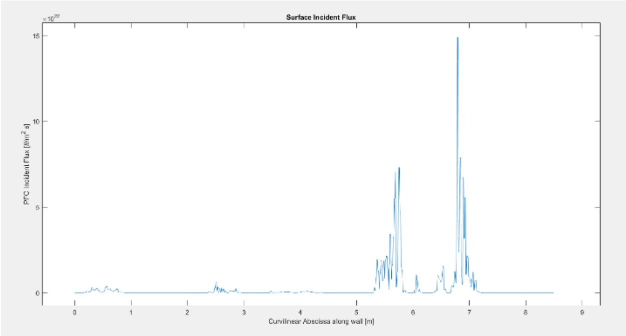
- Plasma considered as background, plasma ions not traced -> assumptions e.g. for incidence angle
- Can acquire full distributions of only one plasma species at a time -> seeding?
- Difficulties in simulating ELMs erosion, especially due to quickly variable plasma background

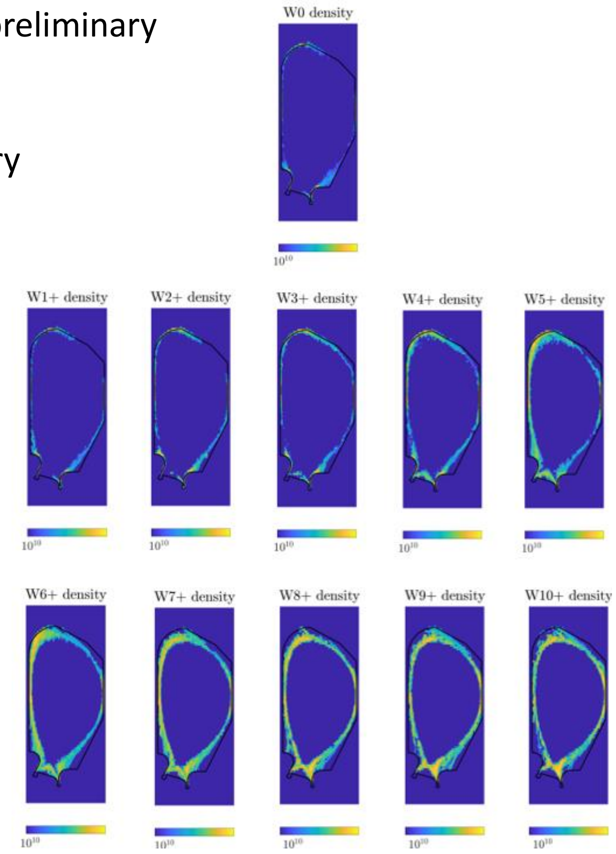
Preliminary previous results: Attached case with D^+ background

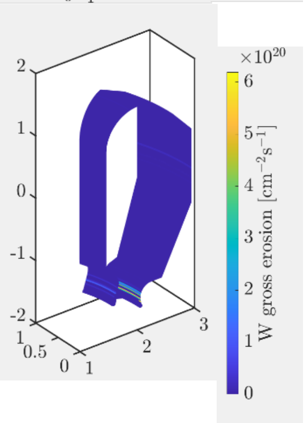
First assessment of the order of magnitude of DTT PFCs erosion, simulating a preliminary attached case:

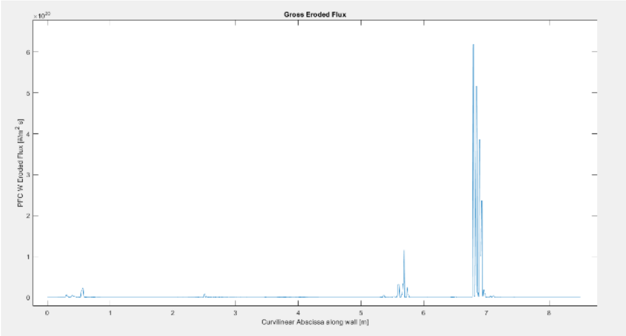
- in **divertor** configuration, to estimate divertor erosion
- in **limiter** configuration, for limiter erosion in symmetric and shaped geometry







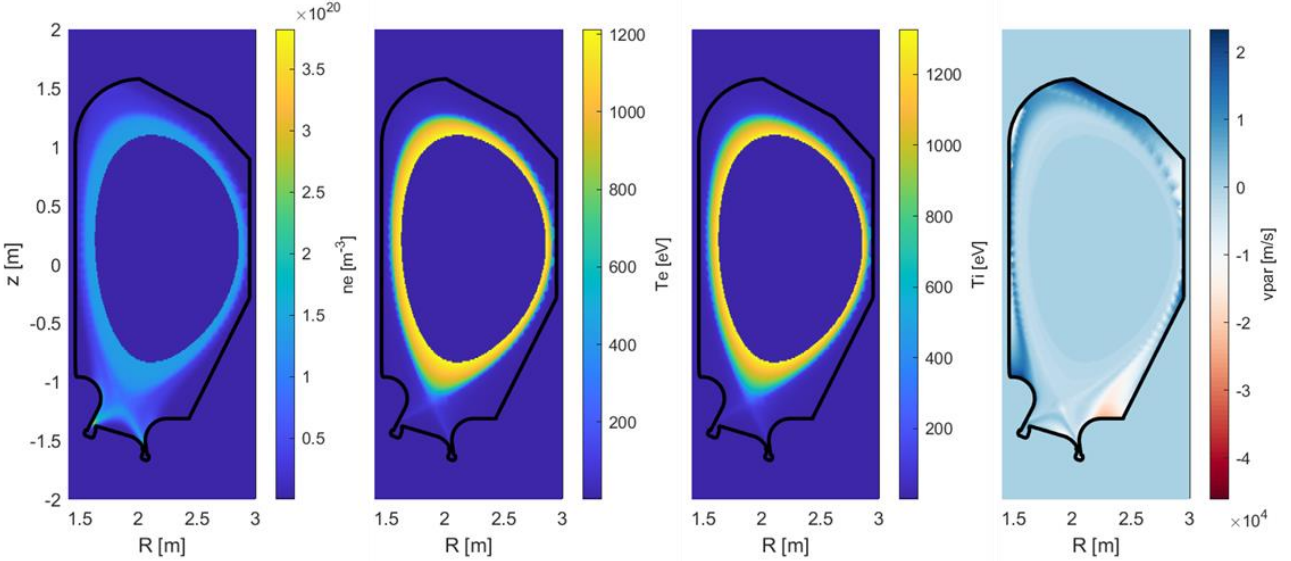


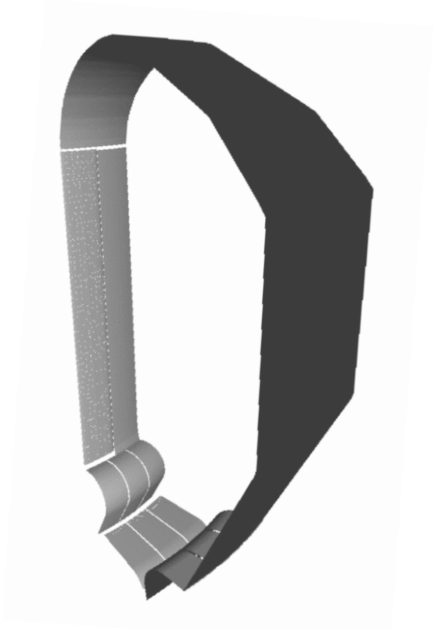


Work and images by F. Cani

ERO2.0 inputs

- Plasma background from previous SOLEDGE simulations
- 3D toroidally symmetric geometry -> wall shaping may be considered at later stage
- SDTrimSP database for sputtering/reflection yields





SOLEDGE background produced by P. Innocente
Images: courtesy of F. Cani

ERO2.0 limitations for predictive studies

Limitations		Strategy
Incidence angle of plasma species, not traced by ERO (sheath deflection)	➡	Parametric scan on incidence angle, indications from PIC simulations
Seeding impurities in plasma background, full distribution of > 1 species not acquirable by ERO	➡	Use variable M_{eff} and Z_{eff} in plasma to overcome constant distribution assumption
Erosion estimation during **ELMs**	➡	Not directly simulated, scan on W concentration in inter-ELM phase to partially account for ELMs effect

Workplan

1. **Attached pure D-plasma** in **SN** configuration, symmetric 3D wall, no CX neutrals erosion
    a. Investigate effect of ion incidence angle assumption for plasma
    b. Investigate effect of W impurities presence in inter-ELM phase due to ELMs

2. Refine obtained results considering:
    a. Erosion due to **CX neutrals**
    b. Possibility to consider **wall shaping** and **shadowing**

3. Estimate **W crossing the separatrix** coming from different parts of the wall

4. Select cases of interest to compare obtained results with **XD**, **NT** and in **detached** with seeding conditions

Thank you for your attention!

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