EUROfusion

Initial Research Phase II scenario#2 simulations with SOLEDGE2D/SOLEDGE3X-EIRENE

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Ricerca Formazione Innovazione

UNIVERSITÀ DEGLI STUDI DELLA Tuscia

JT-60SA
Advanced Superconducting Tokamak
BA-Satellite Tokamak Program

Aims of edge/SOL modelling

- Assess the heat loads on the wall and targets (check also the neutrals loads)
- Predict the onset of detachment
- Propose a seeding strategy to mitigate heat loads
- Contribute to the design studies of divertor / wall diagnostics (ENH session tomorrow)

SA-SE.CM.M.03-T003	D1- Sensitivity study of low n /current drive scenarios with C divertor, with SOLEDGE3X edge transport code, including impurity seeding impact.
	D2 - Assessment of JT-60SA Initial research phase II scenario 2 via edge modelling integrated with core conditions.

No active cooling in the Initial Research Phase - power exhaust mitigation is crucial

Requirements:
- Reliable magnetic equilibrium (including divertor legs) and wall data (chamber + subdivertor)
- Machine Data : puffing valve positions and available gases, auxiliary heating power
- Power and particle flux through the inner simulation boundary
- Reliable prediction of transport based on
  1. Experimental findings and previous simulations from C-wall JET
  2. Estimations from core and pedestal modelling
  3. Existing scalings, 2PM

Scenario #2 constraints from the SARP / PID

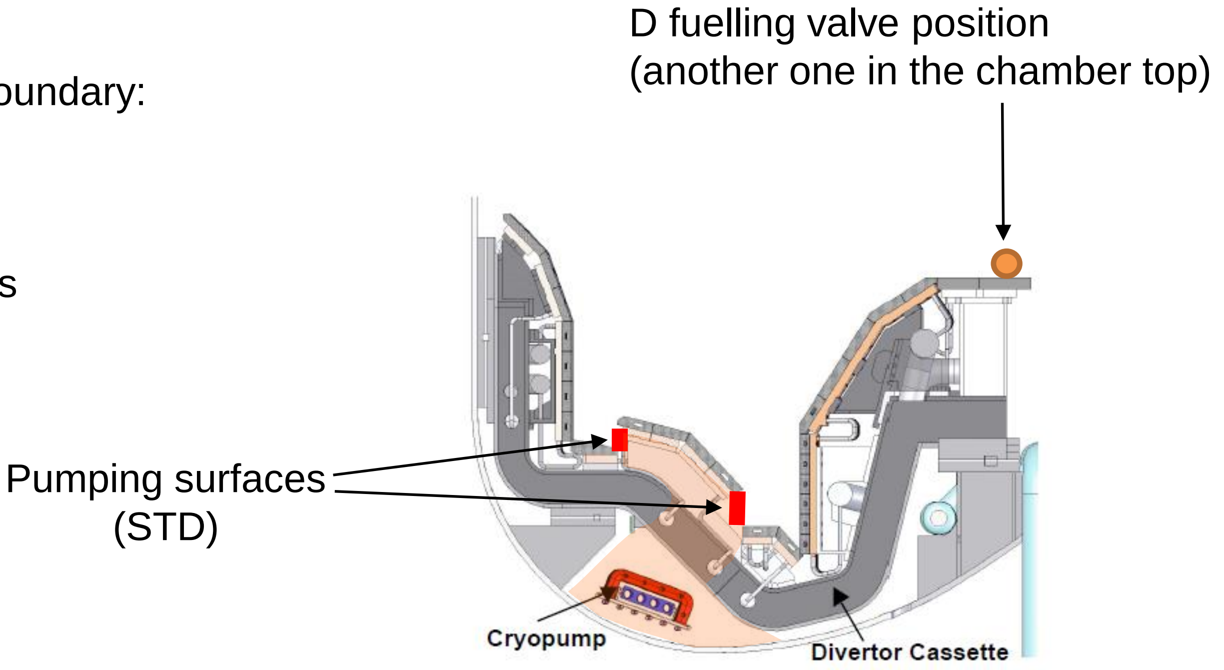
- D plasma
- Uncooled C wall
- Maximum heating power: 19/26.5/33 MW (from PID: 27 MW)
- Core average density: 5.6×10^{19} m^{-3}

Estimation of power loads for the reduced power case:

- Expected input power to SOL: 20-23 MW
- H-mode operation (P_{SOL} > 10 MW)

- SOL width < 1.5 mm

Maximum particle source at core boundary:
$S_n = 2.5\times10^{21}$ s^{-1} (NBI)
Deuterium puff range:
$\Gamma_D = [0, 1.8 \times 10^{23}]$ s^{-1}
Maximum pumping speed: 100 m^3/s



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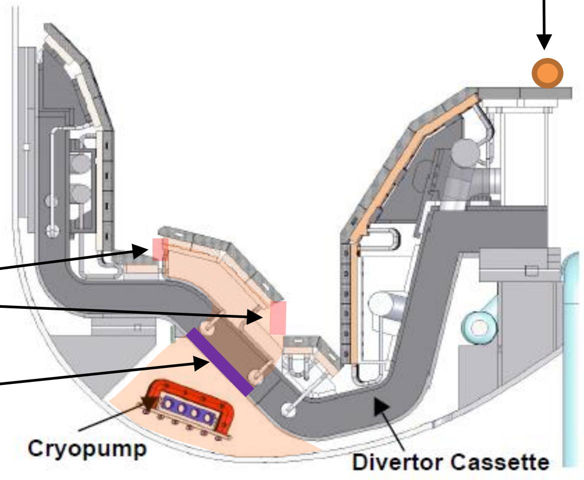
Checking possibility of using pumping speed instead of albedo on pumping surface.

D fuelling valve position
(another one in the chamber top)

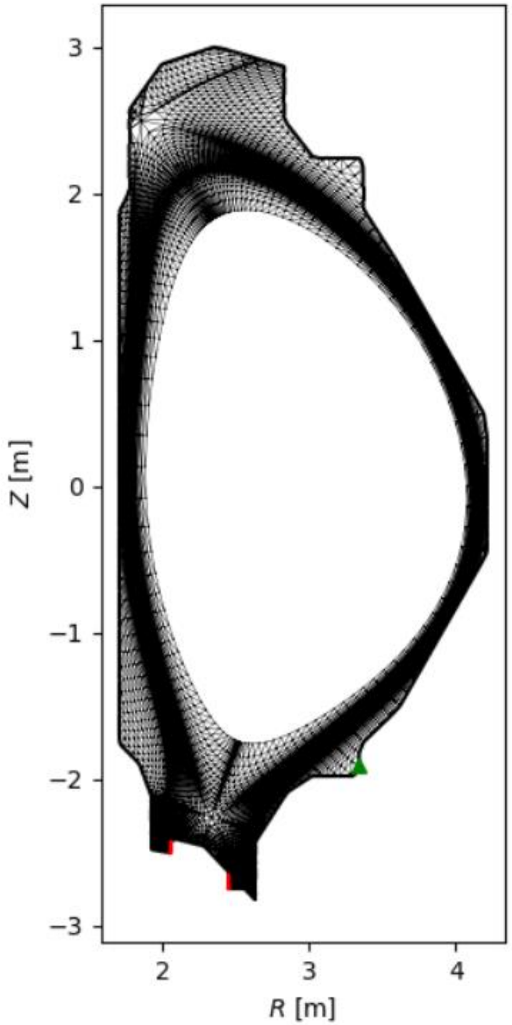
Semi-transparent surfaces

Pumping surface (SUBD)

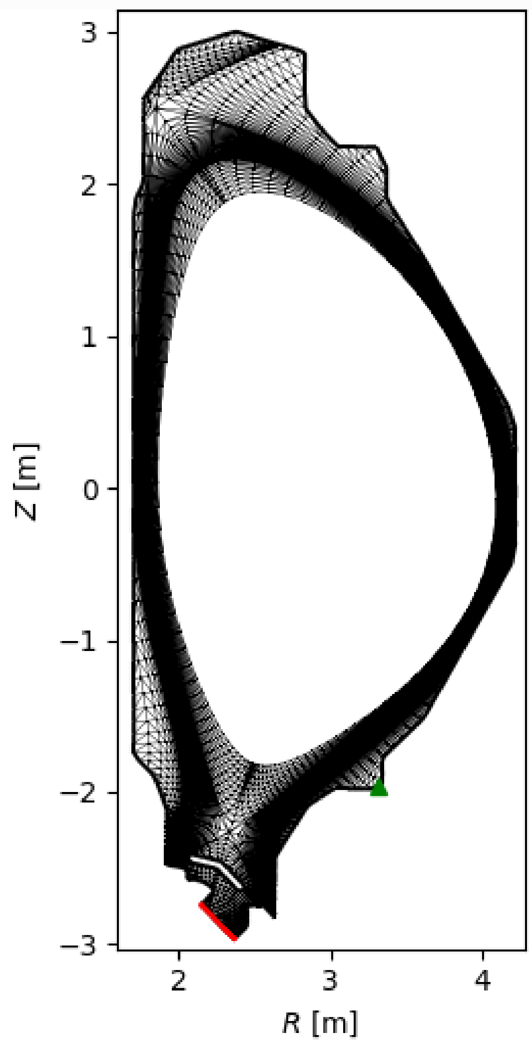


The grid

STD: „real” wall
+ pumping at gaps



SUBD: the same,
but with subdivertor



The grid incorporates the secondary X-point and the volume at the top of the chamber.

Adjusted the details of the wall.

Equilibrium from the IDM repository.

Gas puff position according to documentation in SARP.

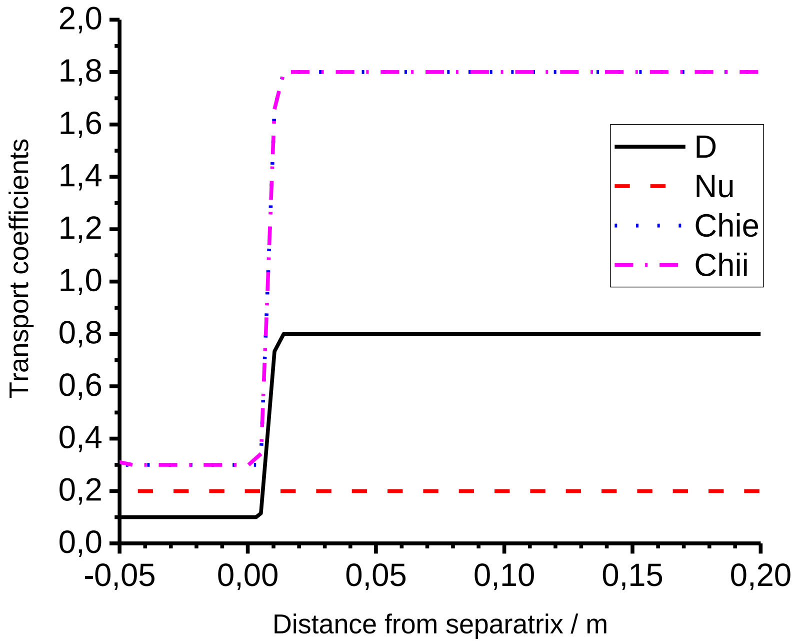
Modeling parameters

Auxiliary input power scan: [15, 17.5, 20. 22.5, 25] MW (50/50 electrons/ions)

Particle sources: S_{core}= 1.0×10^{21}/s, Γ_D = 1.0×10^{21} s^{-1}, pump albedo 0.95

Electron density at the seaparatrix should be ~ 2×10^{19} m^{-3}

Transport coefficient profiles (for the H-mode)



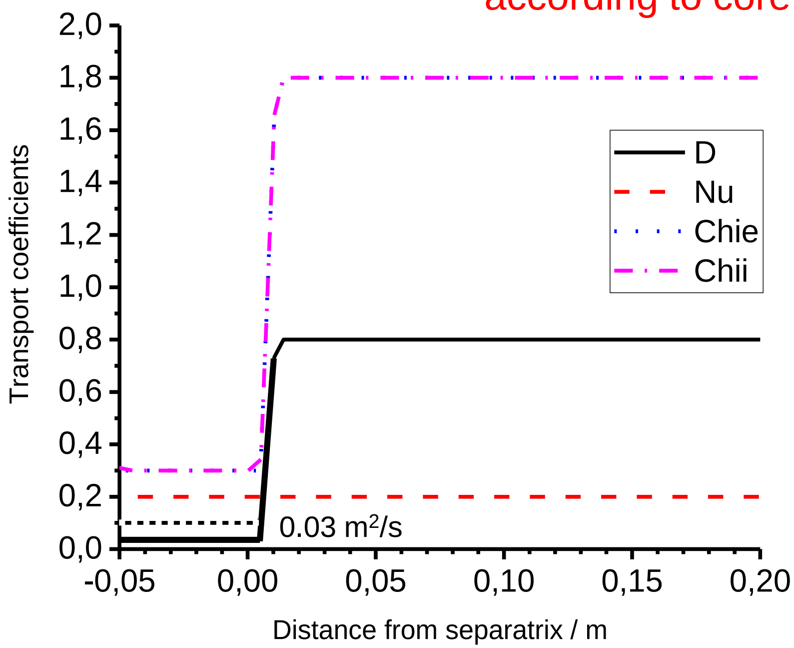
Modeling parameters

Auxiliary input power scan: [15, 17.5, 20. 22.5, 25, 27.5, 30] MW (40/60 electrons/ions)

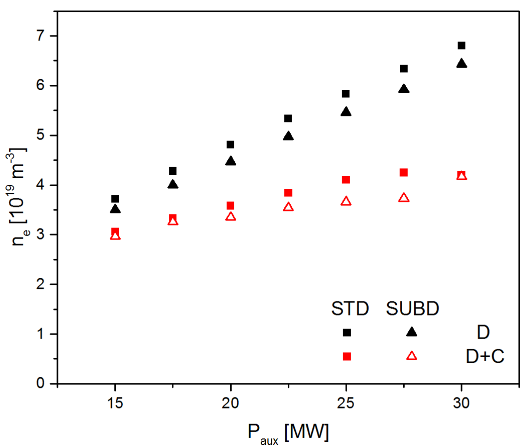
Particle sources: S_{core}= 1.0×10^{21}/s, Γ_D = 1.0×10^{21} s^{-1}, pump albedo 0.95/pumping speed 100m^3/s

Electron density at the seaparatrix should be ~ 2×10^{19} m^{-3} [impossible to achieve without adjustment of Γ_D, which is already relatively low]

Transport coefficient profiles (for the H-mode) – modified D in the barrier for more narrow SOL, according to core modelling, compatible with the previous COREDIV modelling



Fun fact



Status of work

Published in
EPS proceedings*

$D^{barrier}$=0.1	D	D+C	D+C+Ar
STD	OK	OK	running
SUBD	OK	OK	running

$D^{barrier}$=0.03	D	D+C	D+C+Ar
STD	OK	-	-
SUBD	OK	running	running

Each cell represents a series of cases within power range [15, 30]

** K. Galazka et al. "SOL modelling of the JT-60SA tokamak initial operational scenario using SOLEDGE3X-EIRENE code" (contributed poster)*

Publication plan

EPS conference:

- K. Galazka et al. "SOL modelling of the JT-60SA tokamak initial operational scenario using SOLEDGE3X-EIRENE code" (contributed poster)

AAPPS-DPP2022 conference:

- K. Galazka et al. "Particle transport and heat loads in JT-60SA studied by SOLEDGE-EIRENE" (invited talk)

Backup slides

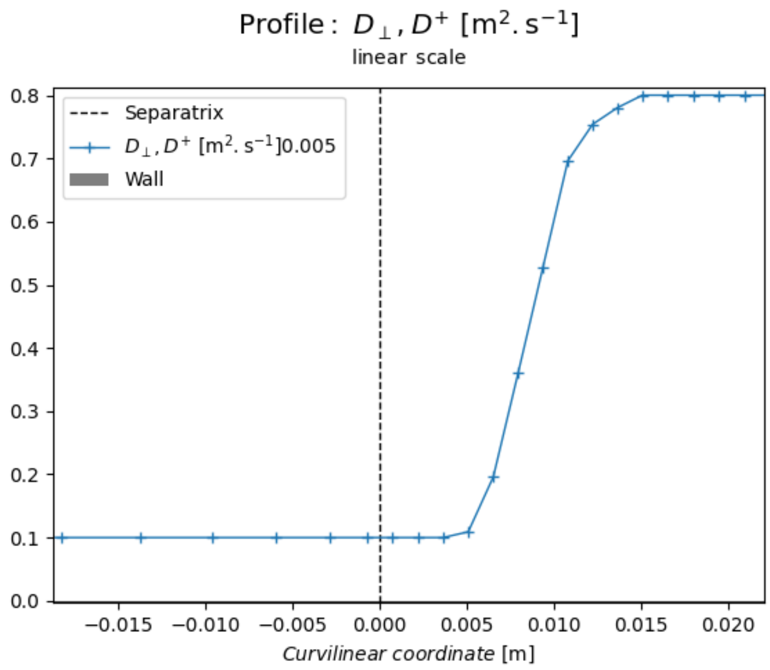
Other parameters – for discussion

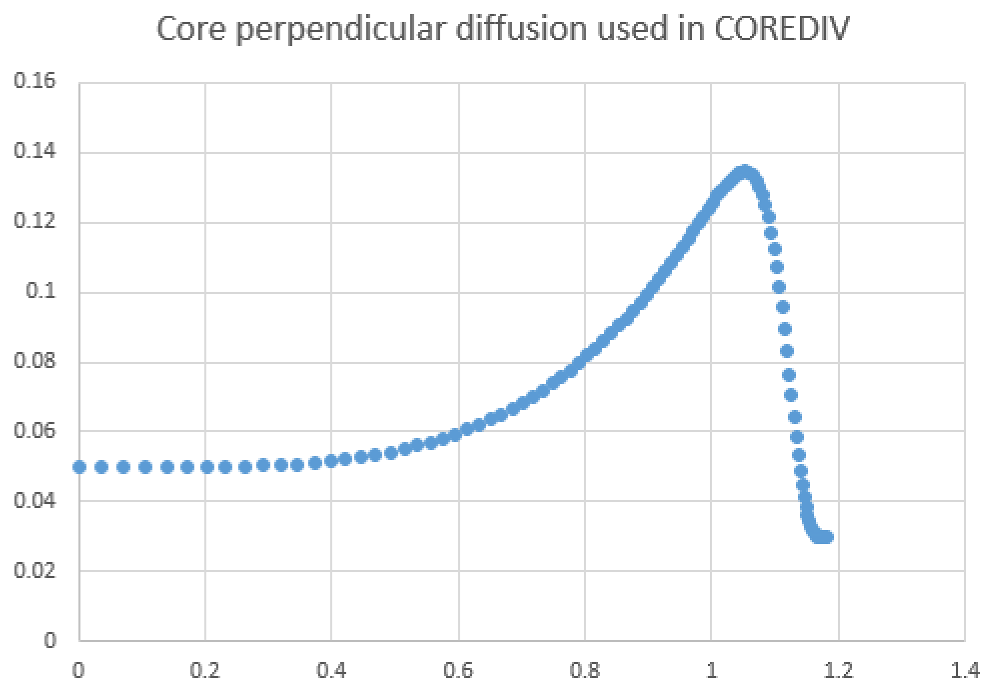
	D	C	Ar
Recycling: R	1.0	0.0-0.1	1.0
Pumping:	0.95	0.0-0.1	0.78

Pumping speed?
Input power sharing between e and i?
Magnetic configuration – now: corner-corner

Details of diffusion profile – comparision

Auxiliary input power scan: [15, 17.5, 20. 22.5, 25] MW (50/50 electrons/ions)
Particle sources: S_{core}= 2.5×10^{21}/s, Γ_D = 1.0×10^{21} s^{-1}, pump albedo 0.95
Electron density at the seaparatrix should be ~ 2×10^{19} m^{-3}





S_{core}=1.e21 approx.
R_C = 0.0 approx.
P_{NBI} = 10n + (10+10)p MW

Detail of diffusion profile