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Study of Single Null divertor in DTT with Nitrogen, Neon and Argon seeding

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ABSTRACT

- Power exhaust study and assessment of divertor conditions in DTT.
- Standard Single Null scenario as reference point for the advanced magnetic divertor configurations.
- Three different impurity injections (N, Ne, Ar) to define operational windows
- SOLPS-ITER and SOLEDGE2D-EIRENE as SOL modeling tool

DTT FEATURES

- Bridge the gaps between present machines and the plasma conditions in DEMO
- Test and find the best divertor magnetic configurations
- Test liquid metal divertor
- Demonstrate the fully integrated scenario (plasma performance and technological limits)

	DTT	DEMO
R [m]	2.11	9
R/a	3.3	3.1
I_p [MA]	5.5	18
B_T [T]	6	5.9
n_e/n_G	0.42	1.1
P_{SEP}/R [MW/m]	17	17

SIMULATION SETUP AND CONSTRAINTS

MAIN INPUTS

- Reference density scenario, i.e. $n_{e,sep} = 5\times10^{19}$ m^{-3}.
- Input power P_{in} = 36 MW, corresponding to P_{aux} = 45 MW.
- Diffusion coefficients D= 0.35 m²/s and Χ = 0.15 m²/s to get λ_q = 3 mm.

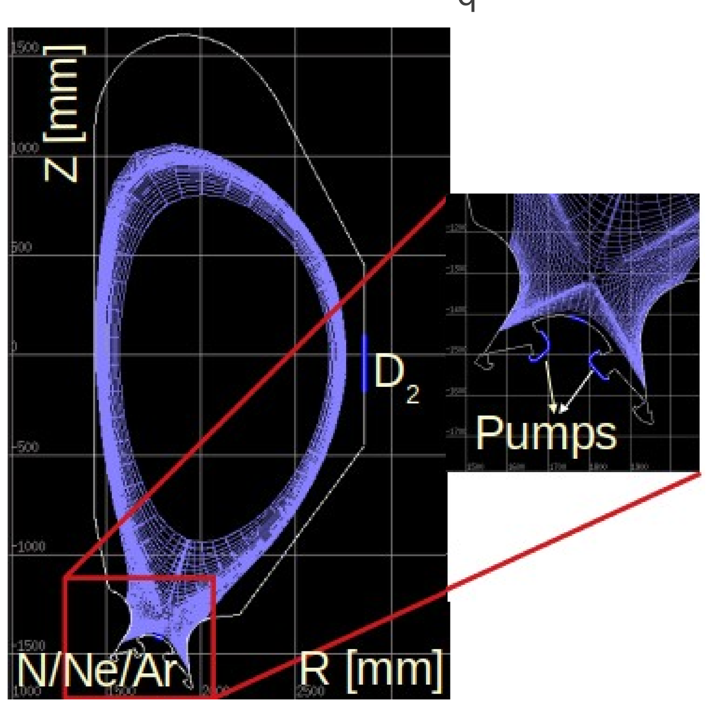
CONTRAINTS

To define the operational windows two main constraints are imposed related to the technological limits of the materials:

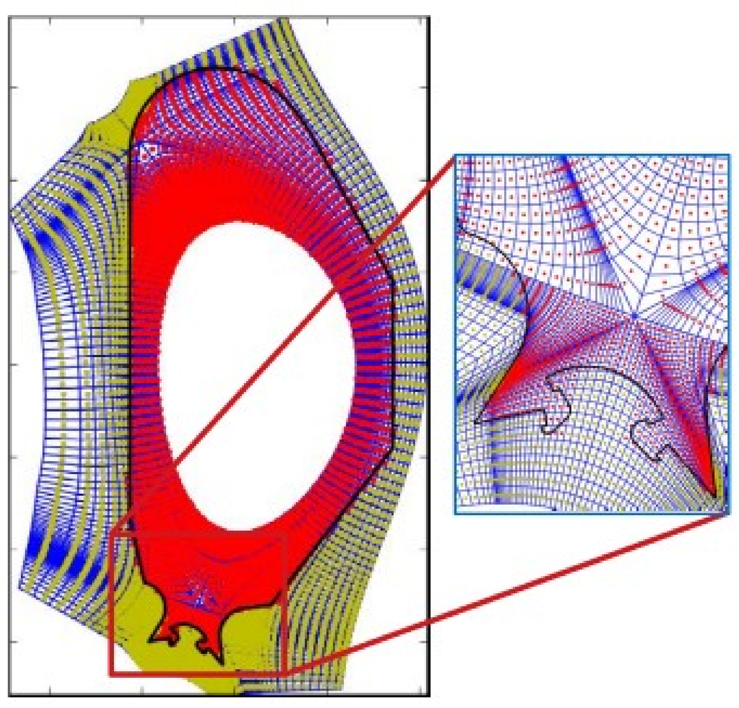
- $P_{max,targ}$ = 10 MW/m²
- $T_{e,targ}$ < 5 eV.

SOLPS-ITER and SOLEDGE2D-EIRENE MODELING

- Same locations of the D and impurity injections and of the pumps
- EIRENE for neutral description
- Different albedo: α = 0.94 in SOLPS-ITER and α = 0.82 in SOLEDGE2D-EIRENE
- 8 points within a λ_q



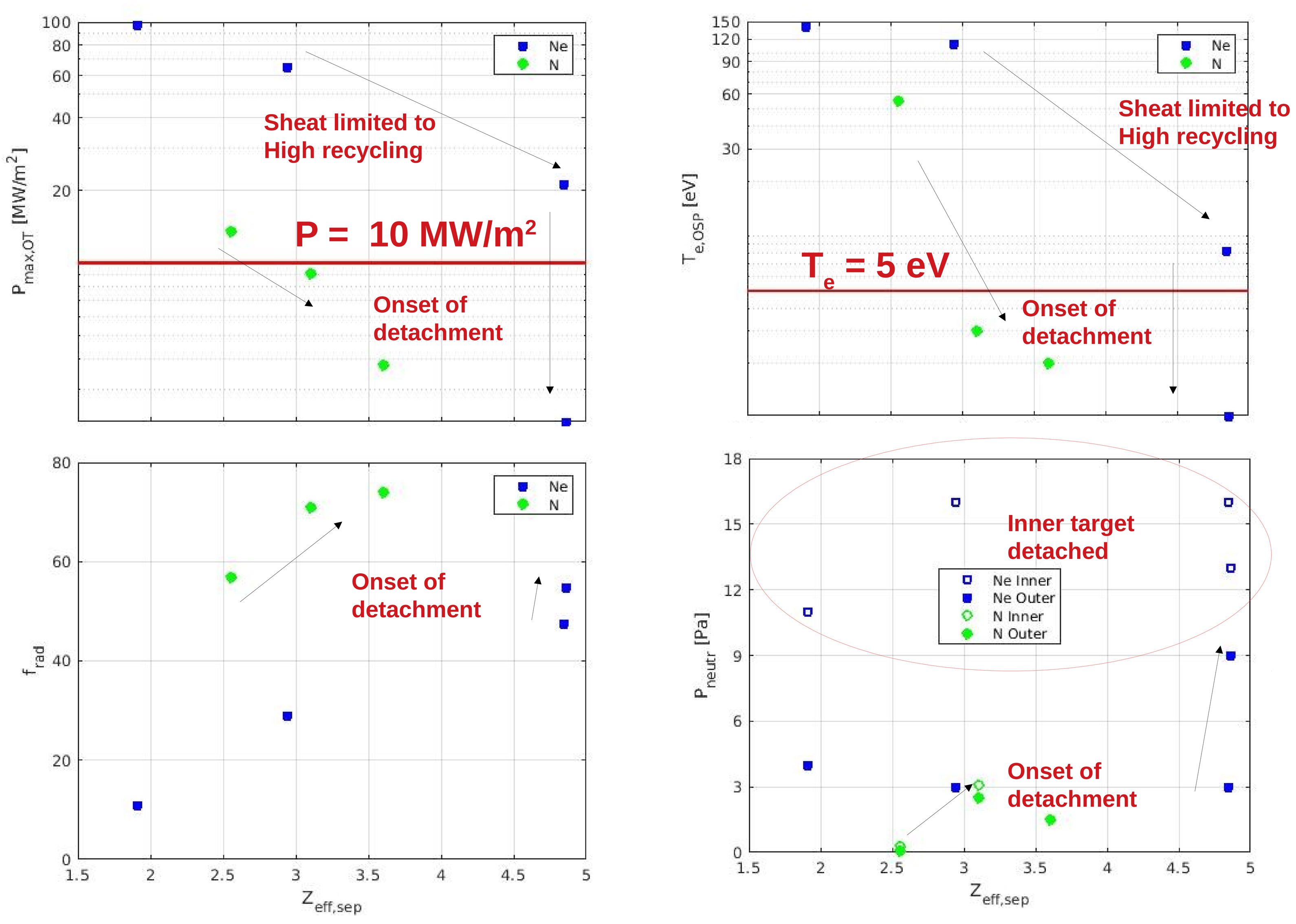
SOLPS-ITER mesh



SOLEDGE2D-EIRENE mesh

RESULTS

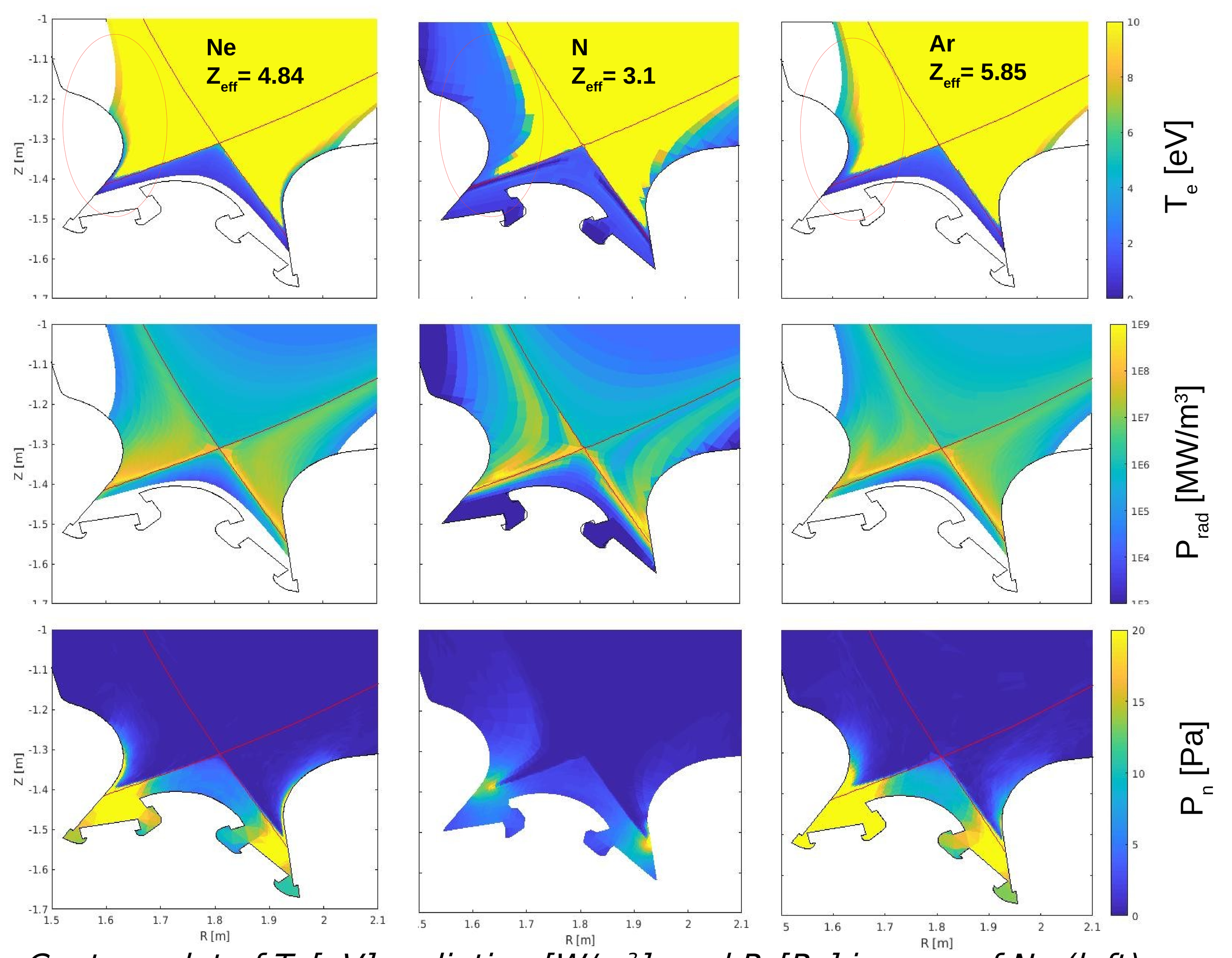
ASSESSMENT OF OPERATIONAL WINDOWS



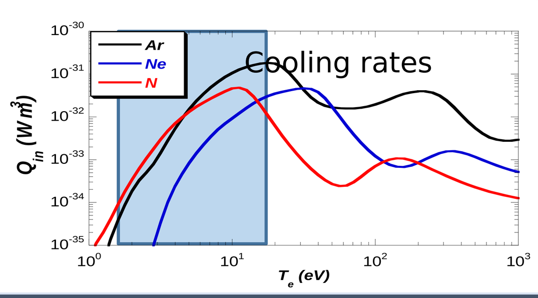
Divertor plasma parameters ($P_{max,OT}$, $T_{e,OSP}$, f_{rad}, P_n) as a function of upstream Z_{eff} for Ne and N impurities.

- f_{rad} ~ 50 % is necessary to start the detachment and to stay below the prescribed technological limits.
- The onset of detachment is reached with a neutral pressure of P_n ~ 10 Pa with Ne while P_n ~ 2 Pa with N.
- Inner divertor is completely detached throughout the scan.

DIVERTOR CONDITIONS



Contour plot of T_e [eV], radiation [W/m³] and P_n [Pa] in case of Ne (left), N (middle) Ar (right) at the onset of detachment.



- *Ar and N favour the detachment in the inner target due to peak at low T_e*
- *Ne is more effective at the outer*
- *divertor T_e*

CONCLUSIONS

- The simulations show that at least 50% of P_{in} must be radiated to reach the onset of detachment.
- In this condition the imposed constraints are satisfied

N is the best radiator in terms of plasma contamination probably related to the low temperature at inner target: $Z_{eff,N}$ = 3,1, $Z_{eff,Ne}$ = 4.8, $Z_{eff,Ar}$ = 5.8. Further investigations are needed.

- Ar and N favour the detachment of Inner target