Tin LMD modeling

2022 kick-off meeting

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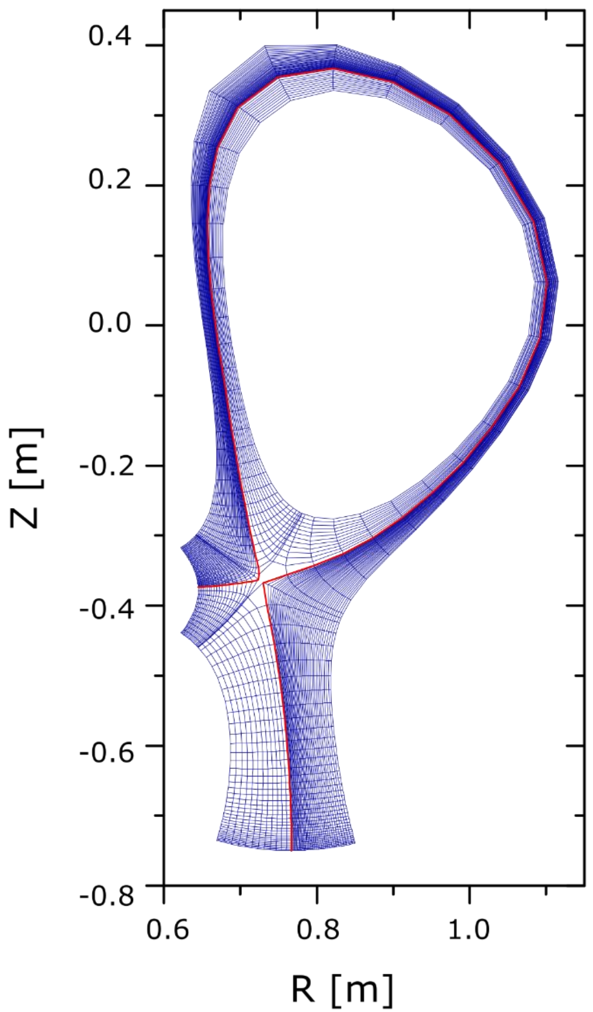
Outline

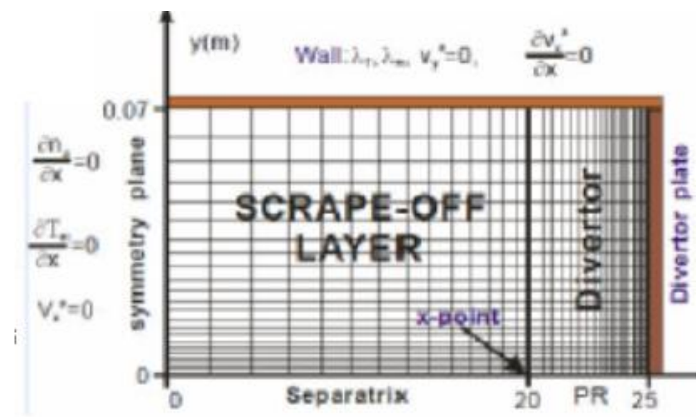
- Joint COREDIV – TECXY modeling
- Tin divertor with Ar seeding
- Tin source model
- Plans for 2022 – model extensions

TECXY and COREDIV

TECXY – SOL modelling



COREDIV 1D core + slab SOL model



COREDIV uses a slab geometry and although both codes solve the same equations and have the same set of SOL parameters like for instance cross field diffusion $D_{\perp}$, they do not provide the same answers for the same parameters values.

COREDIV – TECXY modeling

Common settings

Divertor model settings
d_W=5mm
d_{Sn}=1mm
T_0=200C
$\alpha_{inc} = 0$

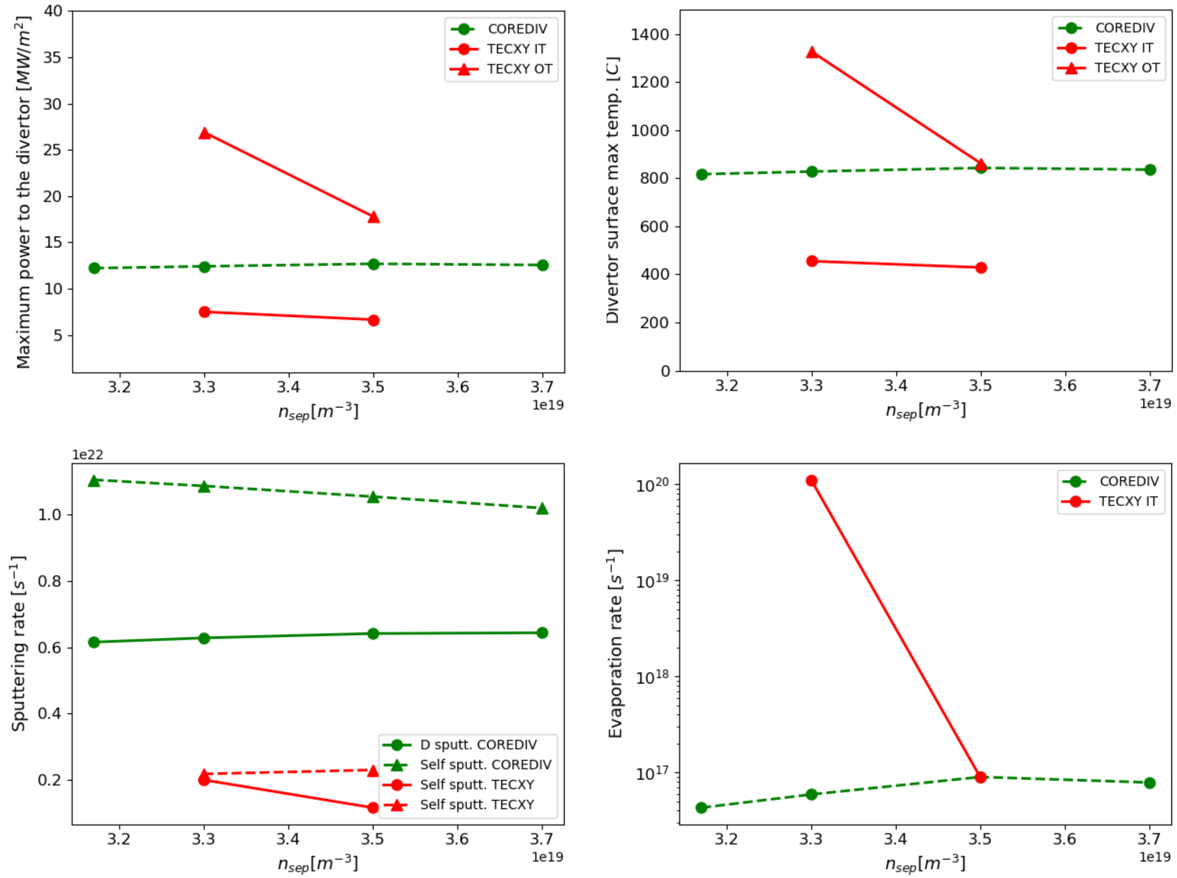
Transport settings

$$D_\perp = 0.42 \frac{m^2}{s}$$

$$\chi_e = 0.18 \frac{m^2}{s}$$

$$\chi_i = 0.18 \frac{m^2}{s}$$

Dependence on n_{sep}



At $n_{sep} = 3.5 \times 10^{19} m^{-3}$ COREDIV and TECXY OT divertor surface temperature overlap.
Sputtering rate predicted by COREDIV is of order of magnitude higher than TECXY prediction

Tin divertor with Ar seeding

COREDIV modelling

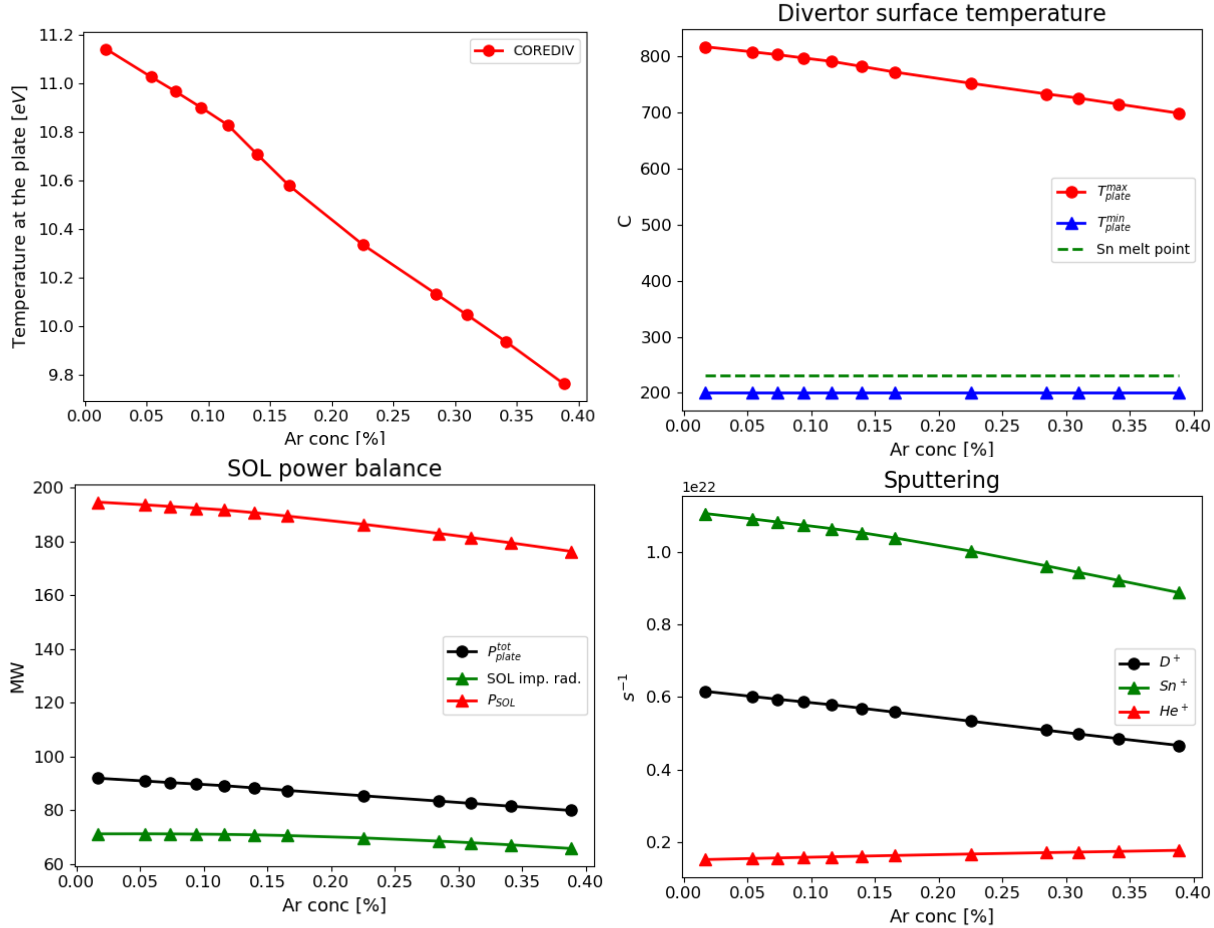
Divertor model settings
d_W=1.5mm
d_{Sn}=2mm
T_0=130C
$\alpha_{inc} = 45^o$

Transport settings

$$D_\perp = 0.42\frac{m^2}{s}$$

$$\chi_e = 0.18\frac{m^2}{s}$$

$$\chi_i = 0.18\frac{m^2}{s}$$



Transport typical for real SOL geometry models (TECXY, SOLPS) is too small for slab geometry. Too narrow SOL in the X point and divertor region limits impurity radiation and tin concentration stays at high level.

TECXY+COREDIV modeling scheme

TECXY

$\lambda_q \rightarrow D_\perp, \chi_{e,i} \rightarrow fluxes, radiation$

P_{SOL}

COREDIV

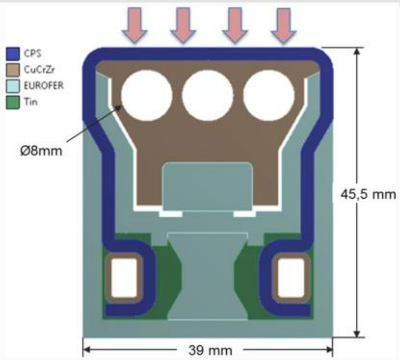
$D_\perp, \chi_{e,i}$

Impurity source from divertor

Impurity transport to the core

Modelling is ongoing

Tin source model development in 2022



Rocella et al., JoFE 2020

Divertor model settings
d_W=1.5mm
d_{Sn}=2mm
T_0=130C
$\alpha_{inc} = 45$

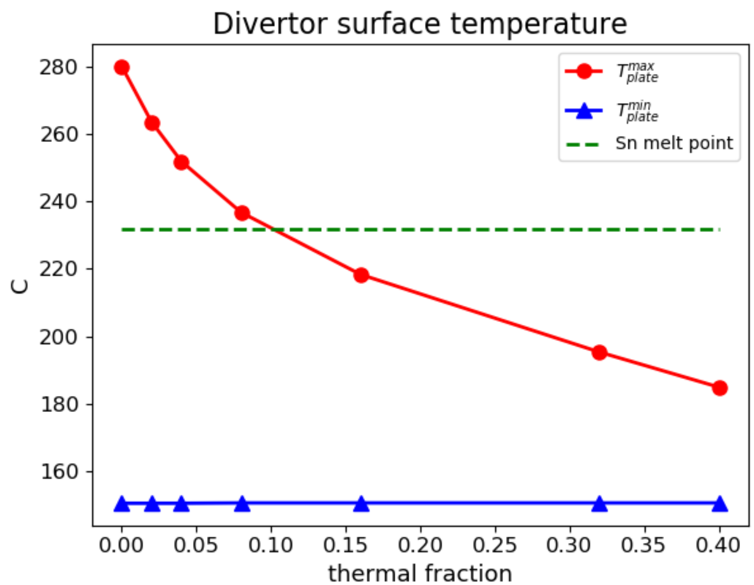
Transport settings

$$D_{\perp} = 0.5\frac{m^2}{s}$$

$$\chi_e = 1.0\frac{m^2}{s}$$

$$\chi_i = 0.5\frac{m^2}{s}$$

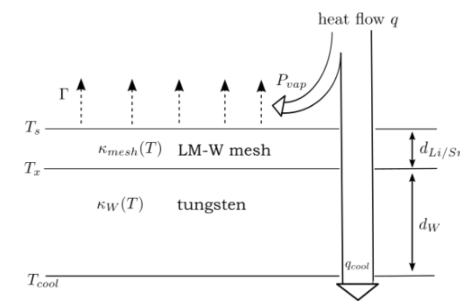
COREDIV modeling – no Ar seeding, higher wrt TECXY cross field transport



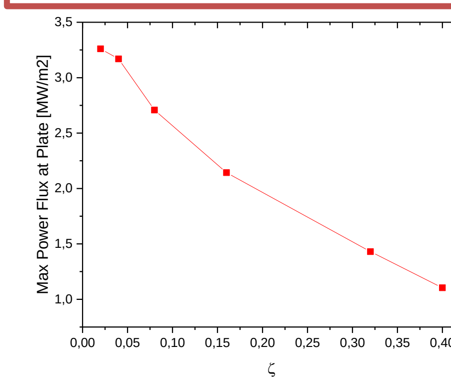
sputtering yield $Y = Y_{col} + \zeta Y_{th}$

ζ – thermal fraction

Including thermal sputtering by light ions (D+, He+) further decreases surface temprature.



Simple divertor model used in COREDIV and TECXY does not include additional heating preventing tin resolidification. MODEL UPGRADE NEEDED!



Max Power load drops from 3.3MW/m^2 to 1MW/m^2 below CHF 20-30MW/m2

Summary

- Observed max heat flux 1-5MW/m^2 in steady state conditions.
- Modelling of tin LMD for divertor design parameters requires new upgrades to the model and joint TECXY and COREDIV modeling.

Plans for 2022

- Development of divertor model to include low surface temperatures → crucial when using tin thermal sputtering component + design settings
- Continue joint TECXY and COREDIV modeling of tin divertor design.
- Depending on the results: including CHF in the divertor model, useful when modeling larger heat fluxes