DEMO-FNS project

- Edge and divertor plasma by SOLPS4.3 code
- Core plasma by ASTRA code with IPB(1,2) scaling law
- Neutral beam by NUBEAM code
- Neon and Helium impurity by STRAHL code

SOLPS4.3 result scaling laws

For boundary conditions
- $n_{\text{sep}} = 3.20 \times 10^{-2} \times \mu^{0.122} \times P_{\text{pel}}^{0.357} \times C_{\text{Ne}}^{0.204}$
- $T_{\text{e, sep}} = 6.98 \times 10^{-1} \times \mu^{-0.064} \times P_{\text{pel}}^{0.304} \times C_{\text{Ne}}^{0.204}$
- $T_{\text{He, sep}} = 2.33 \times 10^{-2} \times \mu^{0.075} \times P_{\text{pel}}^{0.333} \times C_{\text{He}}^{0.200}$
- $\Gamma_{\text{D, sep}} = 9.33 \times 10^{-2} \times \mu^{0.580} \times P_{\text{pel}}^{0.082} \times C_{\text{He}}^{-0.912}$

For divertor condition
- $\mu = 3.93 \times 10^{-1} \times \mu^{0.242} \times P_{\text{pel}}^{0.513}$

For power peak load to divertor targets
- $q_{\text{pl}} = 5.47 \times 10^{-1} \times \mu^{0.401} \times P_{\text{pel}}^{0.674} \times C_{\text{Ne}}^{-0.367}$

For helium balance boundary conditions
- $n_{\text{He, sep}} = 7.72 \times 10^{-2} \times \mu^{-0.668} \times P_{\text{pel}}^{0.162} \times C_{\text{He}}^{2.266} \times P_{\text{pump}}^{0.50} \times C_{\text{He}}^{-0.39}$
- $\Gamma_{\text{He, sep}} = 1.66 \times 10^{-4} \times \mu^{-0.756} \times P_{\text{pel}}^{0.269} \times C_{\text{He}}^{-2.549} \times P_{\text{pump}}^{0.50} \times C_{\text{He}}^{-0.39}$

Contribution to the helium source from recycling is 5-7 times larger than that from the fusion reactions. Therefore, the He level in the core must be sensitive to the pumping conditions, although we did not vary $C_{\text{He, pump}}$ in the present study.

Diffusion coefficient for core to be taken from experiment

Values are within the range of the experimental data from DIII-D, JET and MAST.

$D_{\text{He}} = 0.2 \pm 0.3$ ratio selected for DEMO-FNS modelling is consistent with data from these devices.