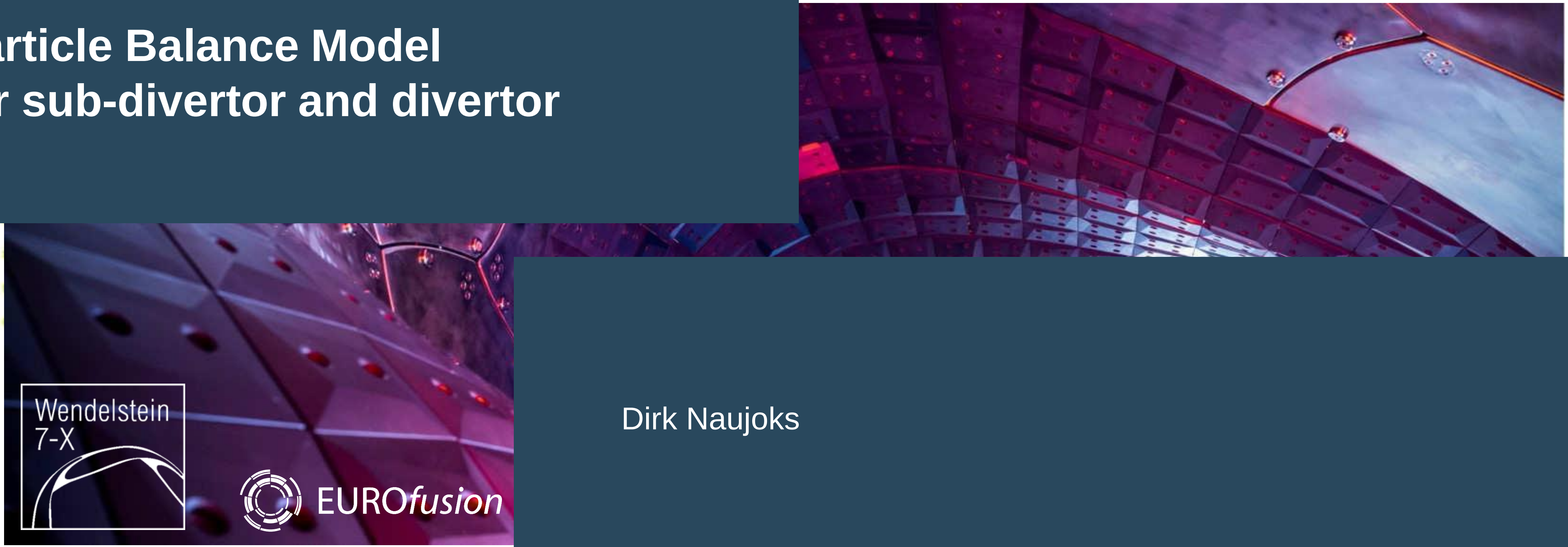
MAX-PLANCK-INSTITUT
FÜR PLASMAPHYSIK

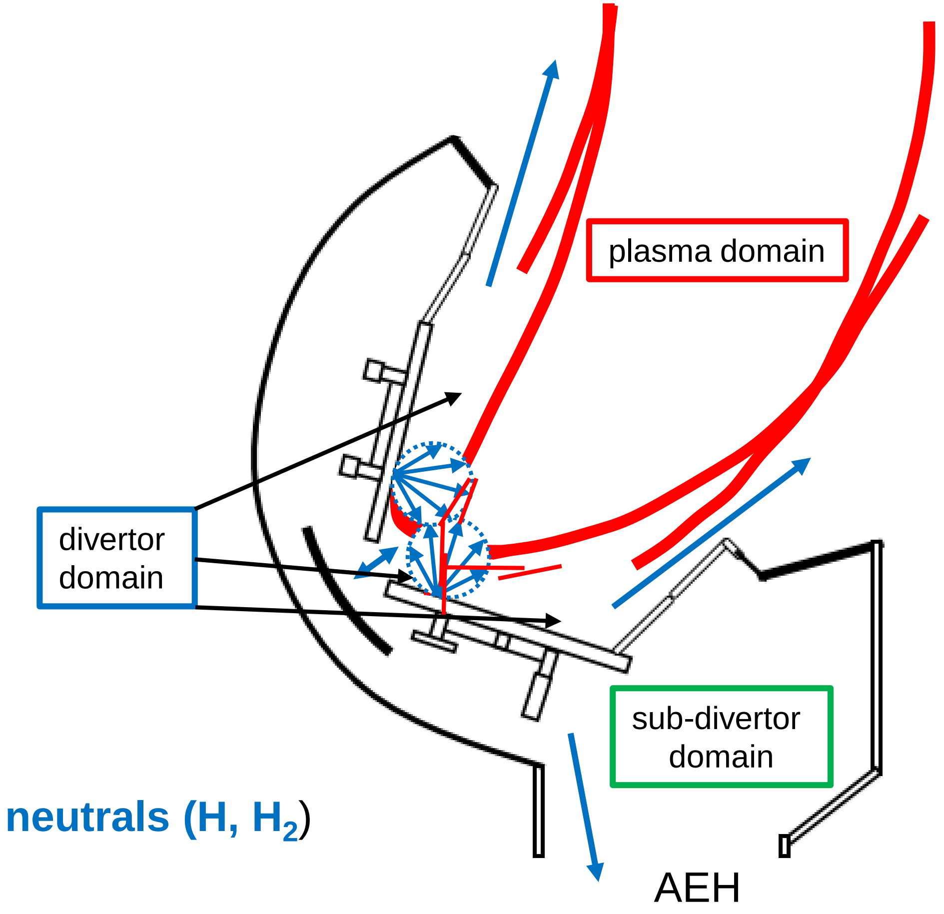
Particle Balance Model
for sub-divertor and divertor

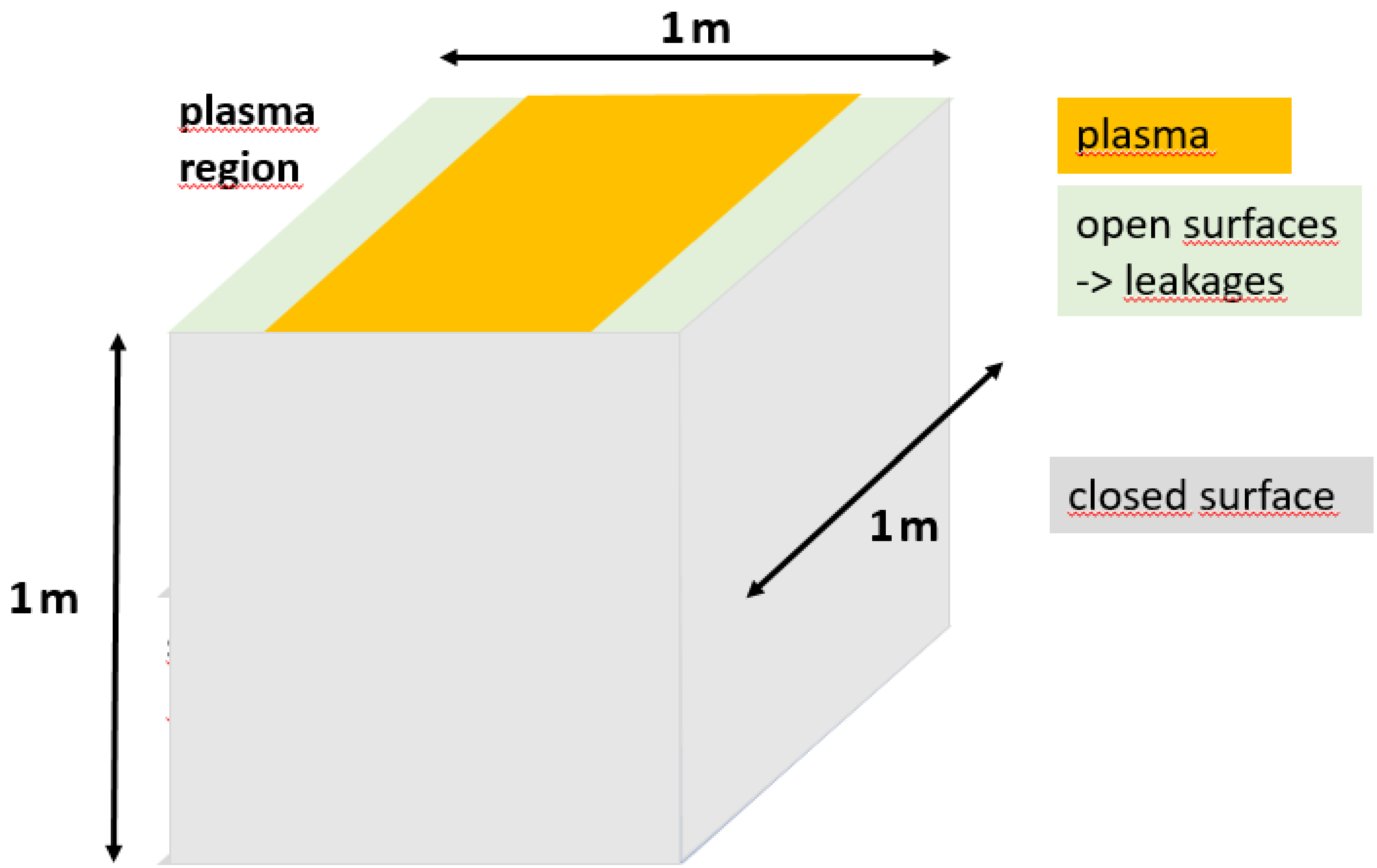


Dirk Naujoks

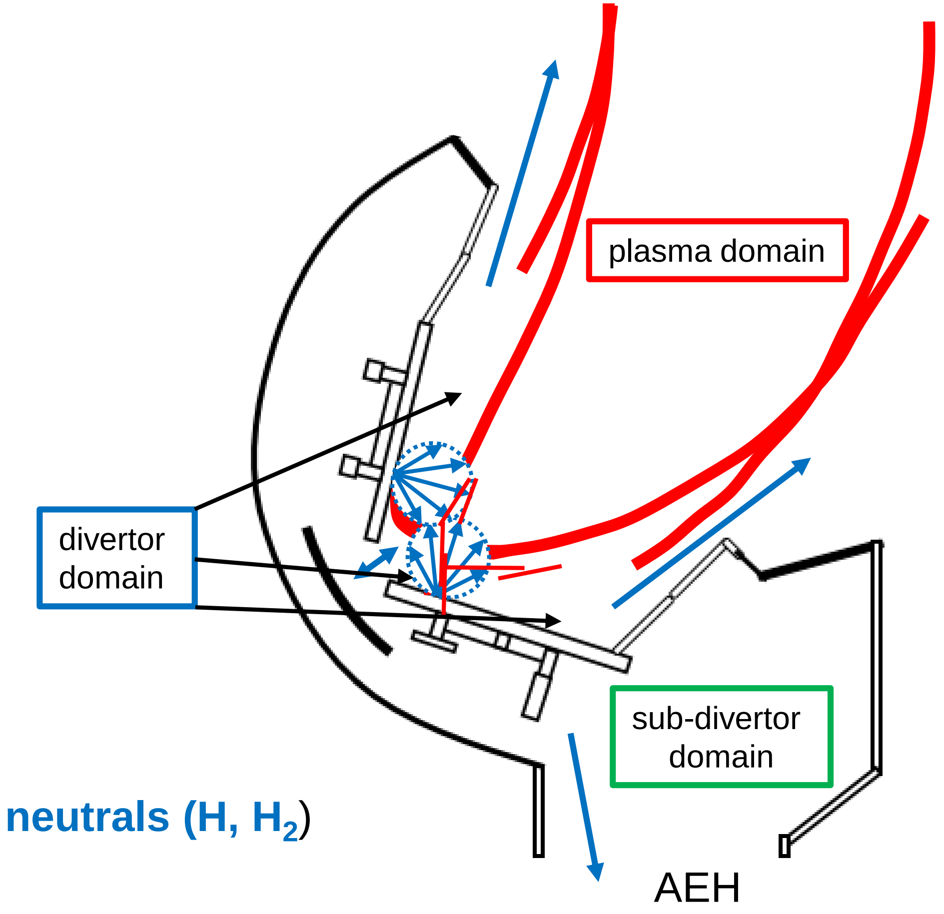
This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

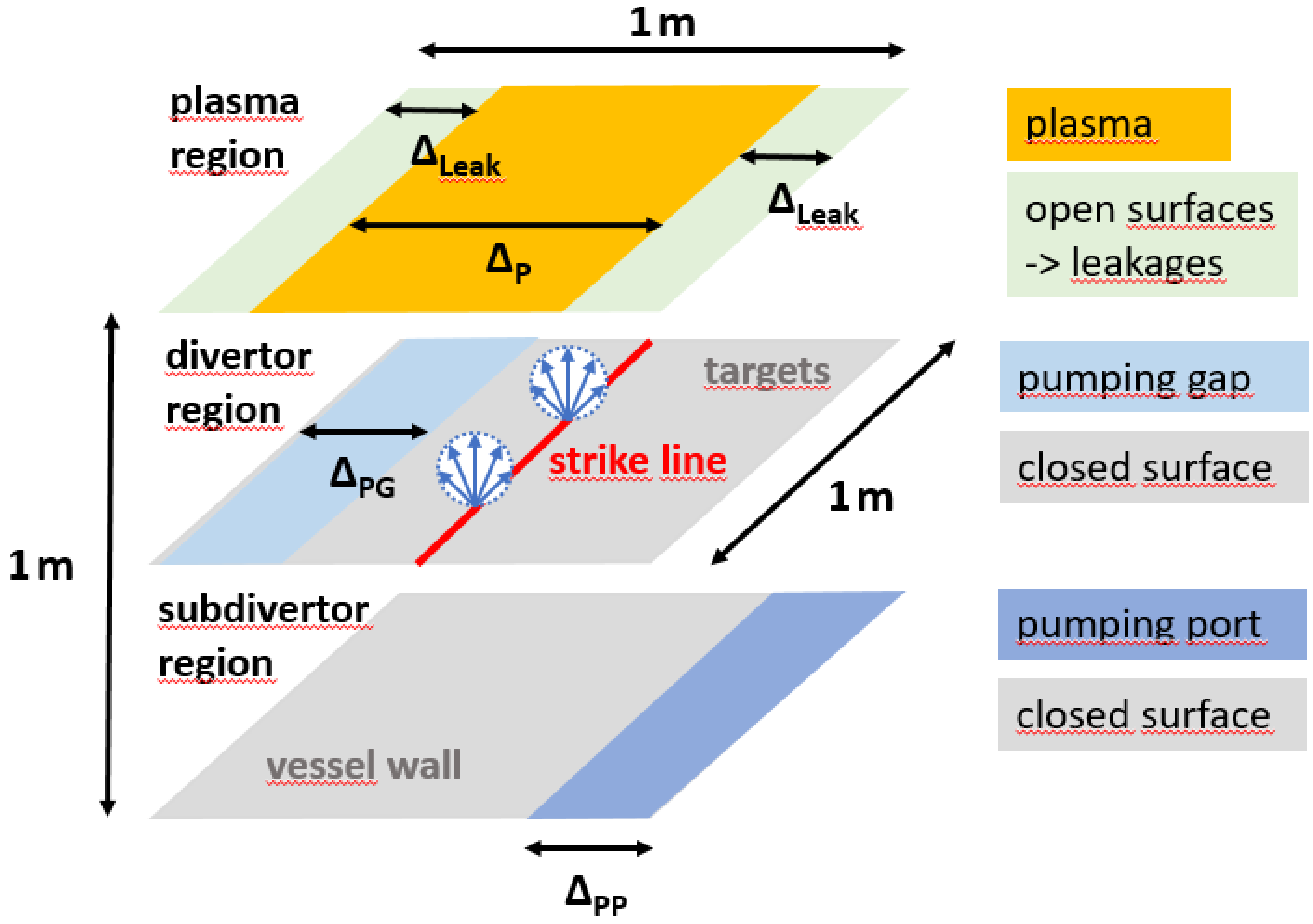
Particle balance subdivertor/divertor





Particle balance subdivertor/divertor





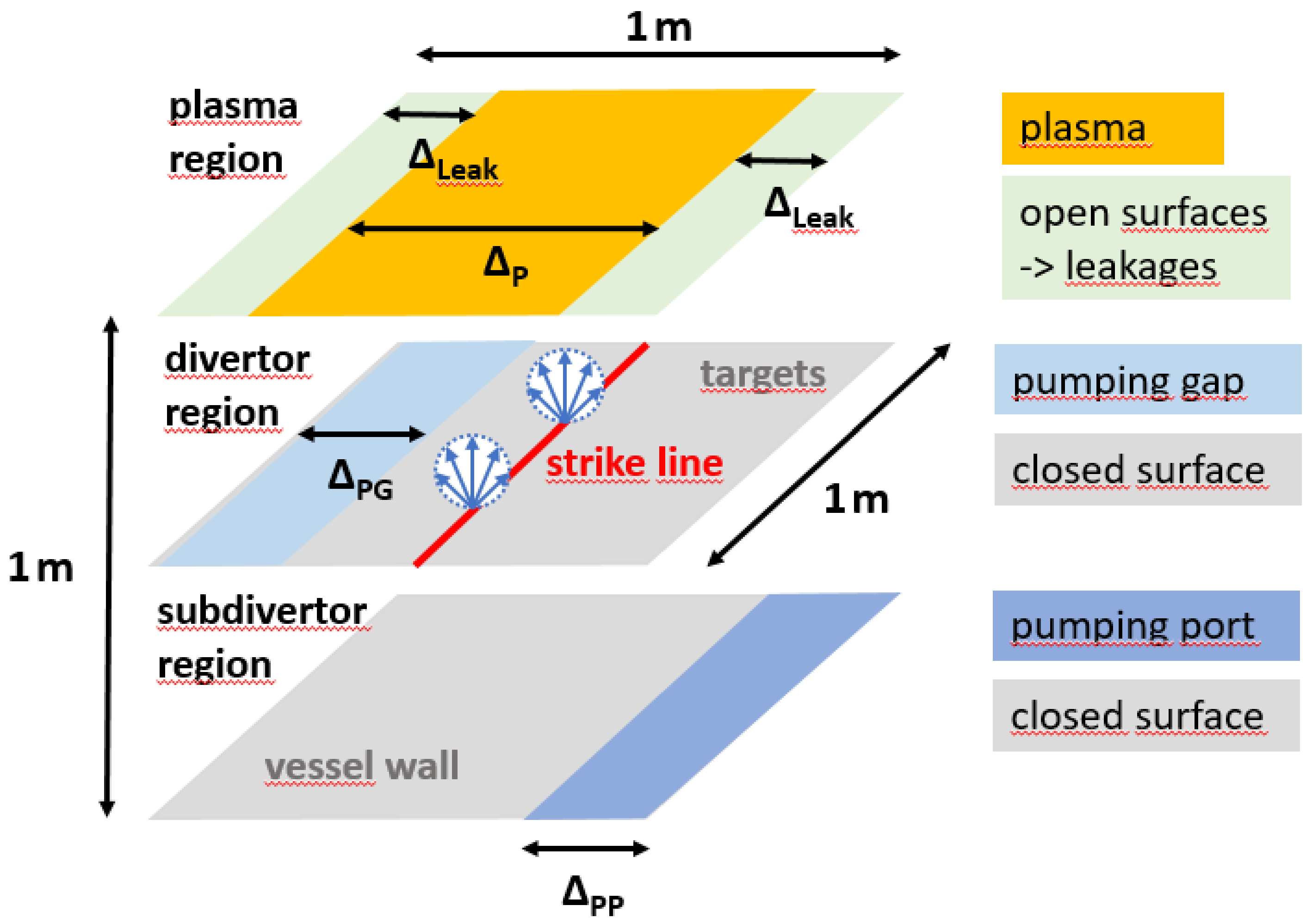
Particle balance subdivertor/divertor - parameters

<u>input parameters:</u>

Γ_{H2} [molec./s], T_{H2} = 300 K
Δ_{Leak} [m]
$\Delta_{Leak}/\Delta_P = \Delta_{Leak}/(1-2\Delta_{Leak})$, A_{Leak} [m^2]
Δ_{PG} [m], A_{PG} [m^2]
Δ_{PP} [m],
L_{BOX} [m] = 1 m
A_{strike} = 0.1 m
$V_{sub} = L_{BOX} L_{BOX} (L_{BOX}/2)$
$V_{div} = L_{BOX} L_{BOX} (L_{BOX}/2)$

<u>output parameters:</u>

p_{sub} and p_{div}



Particle balance subdivertor/divertor – steady state condition

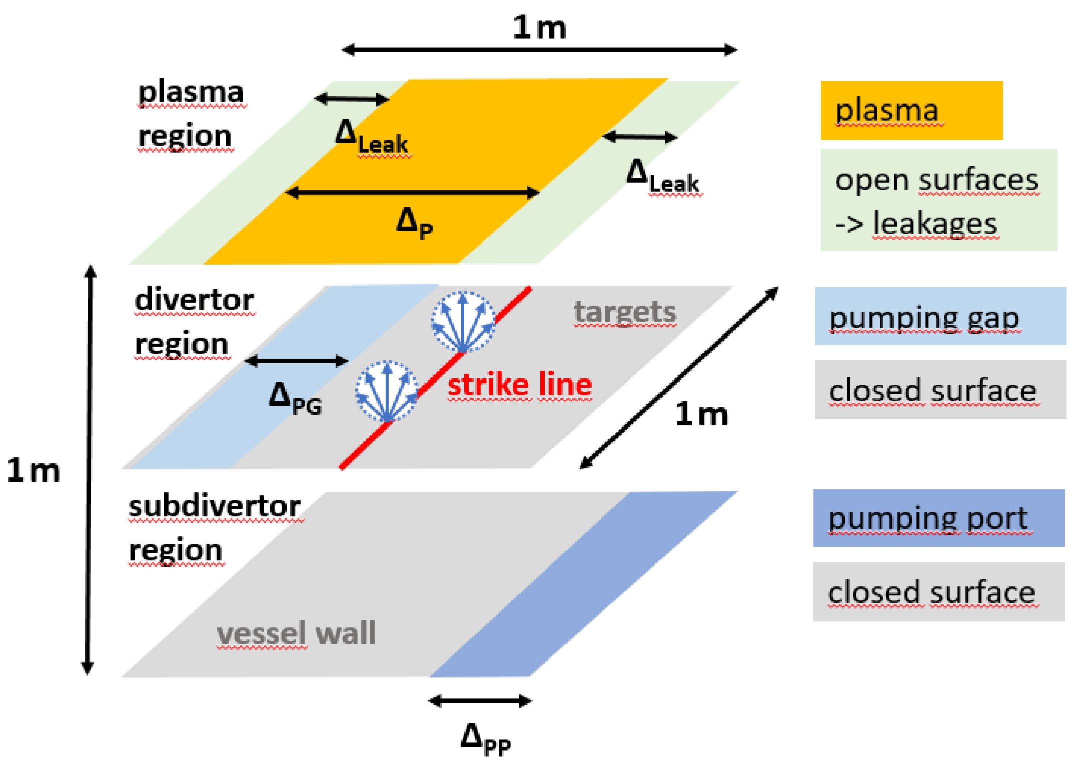
$$\frac{\mathrm{d}p_{sub}}{\mathrm{d}t} = -p_{sub}\frac{S_{eff}}{V_{sub}} - \frac{C_{con}(p_{sub}-p_{div})}{V_{sub}} = 0$$

$$C_{con} = \tfrac{1}{4}A_{PG}\,\overline{v} = \tfrac{1}{4}A_{PG}\sqrt{8k_BT_{H_2}/(\pi m_{H_2})}$$

$$\frac{\mathrm{d}p_{div}}{\mathrm{d}t} = \frac{\frac{\mathrm{d}N_{H_2}}{\mathrm{d}t}\cdot k_BT_{H_2}}{V_{div}} - \frac{q_{pV}^{Leak}}{V_{div}} - \frac{C_{con}(p_{div}-p_{sub})}{V_{div}} = 0$$

$$\mathrm{d}N_{H_2}/\mathrm{d}t = \Gamma_{pl}/2$$

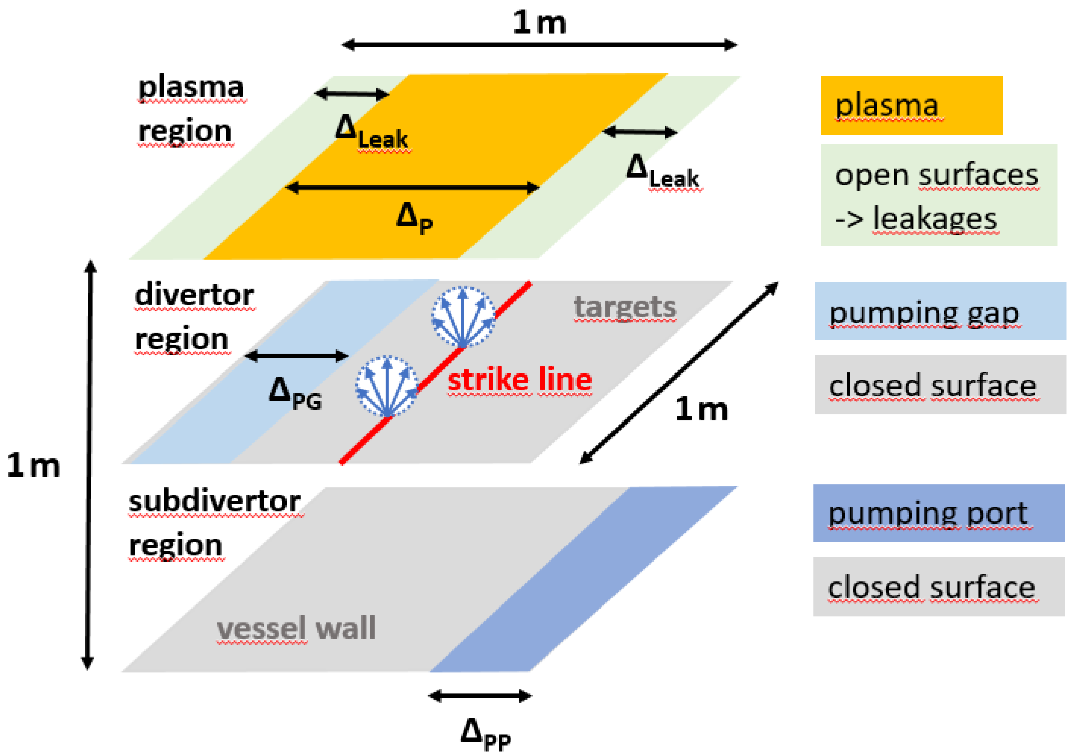
$$q_{pV}^{Leak} = A_{leak}\,p_{div}\,\sqrt{k_BT_{H_2}/(2\,\pi\,m_{H_2})}$$



Particle balance subdivertor/divertor – results

$$p_{sub} = p_{div} \frac{C_{con}}{C_{con} + S_{eff}}$$

$$p_{div} = \frac{\Gamma_{pl} \sqrt{\pi \, m_{H_2} k_B T_{H_2}/2}}{A_{leak} + A_{PG} \, S_{eff} / \left(A_{PG} \sqrt{\frac{k_B T_{H_2}}{2\pi m_{H_2}}} + S_{eff} \right)}$$



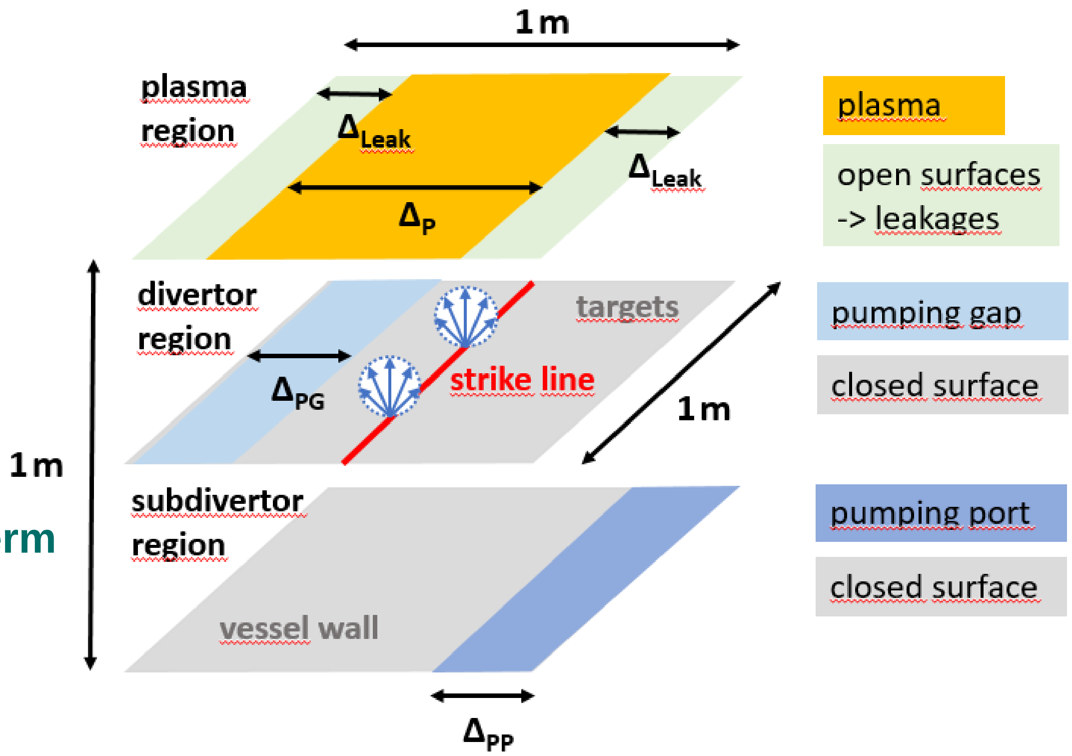
Particle balance subdivertor/divertor – dependences

$$p_{sub} = p_{div} \frac{C_{con}}{C_{con} + S_{eff}}$$

$C_{con} >> S_{eff}$

$$p_{div} = \frac{\Gamma_{pl} \sqrt{\pi\, m_{H_2} k_B T_{H_2}/2}}{A_{leak} + \left(A_{PG}\, S_{eff} / \left(A_{PG} \sqrt{\frac{k_B T_{H_2}}{2\pi m_{H_2}}} + S_{eff} \right) \right)}$$

first term is usally 100 times larger than the second term



Ne=3.000000e+19[m^3], Te=Ti=3.000000e+01[eV], angle=5.235988e-02[rad], cs=7.578555e+04[m/s]
A_PG=1.420000e-01[m^2], A_Leak=7.100000e-01[m^2], A_strike=1.000000e-01[m^2]
C_con=6.331751e+01[m^3/s], S_eff=3.000000e+00 [m^3/s]
psub=7.435151e-04[mbar], pdiv=7.787430e-04[mbar]

pdiv in case of no leakage=8.685257e-02[mbar]