COMPASS
INSTITUTE OF PLASMA PHYSICS ASCR

DEMO divertor modelling via BIT-1(3)

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MINISTRY OF EDUCATION,
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Motivation

The **scaling** used for the classical sheath model

$$h << \lambda_D \sim \sqrt{n_e} << \rho_i \sim \sqrt{T_i m_i} / B << L \sim T^2 / n_e$$

$$J_i = enC_s \sin(\theta), \quad C_s = \sqrt{\frac{T_e + T_i}{m_i}},$$

$$Q_{div} = \gamma J_i T_e, \quad \gamma \sim 10$$

J_TD_Ne_50.inp.d

What happens when this scaling is not valid?

Main area of interest – divertor sheath: highest particle and power loads, strong erosion ets

Modelling of divertor plasmas

Different densities, with and without neutrals and molecules.

Number of simulated cells: 3-10x10^5

N_{sim} ~N_{real}

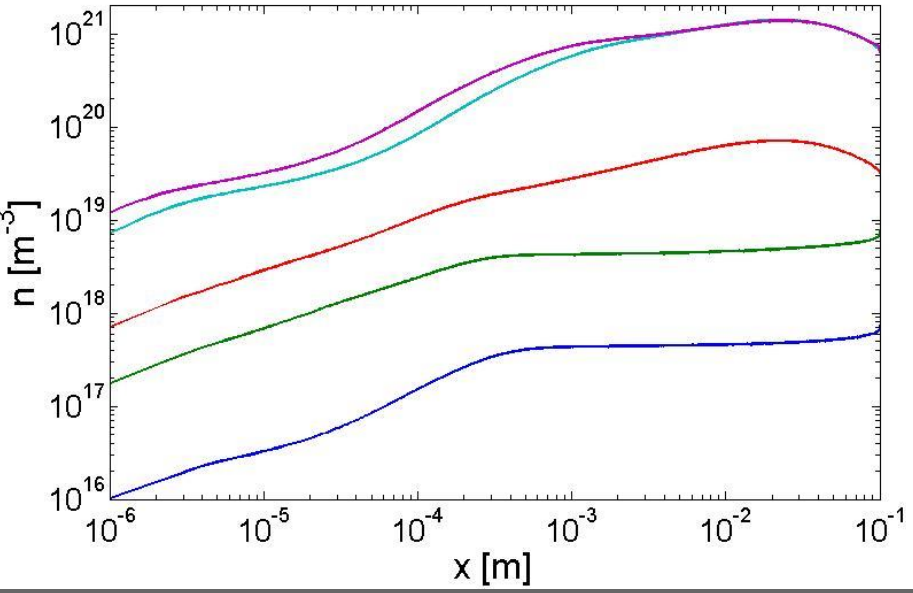
„Very high“ density = ITER relevant

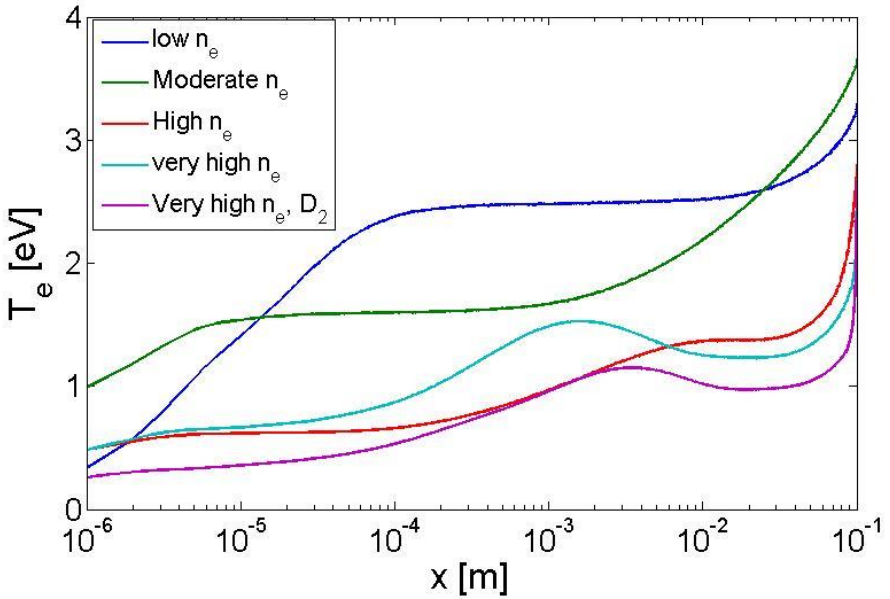
Estimation for DEMO

$$\frac{n_{div}^{DEMO}}{n_{div}^{ITER}} \sim \left(\frac{\nu^{DEMO}}{\nu^{ITER}}\right)^2 \left(\frac{1-f_{rad}^{ITER}}{1-f_{rad}^{DEMO}}\right)^2 \approx 10,$$

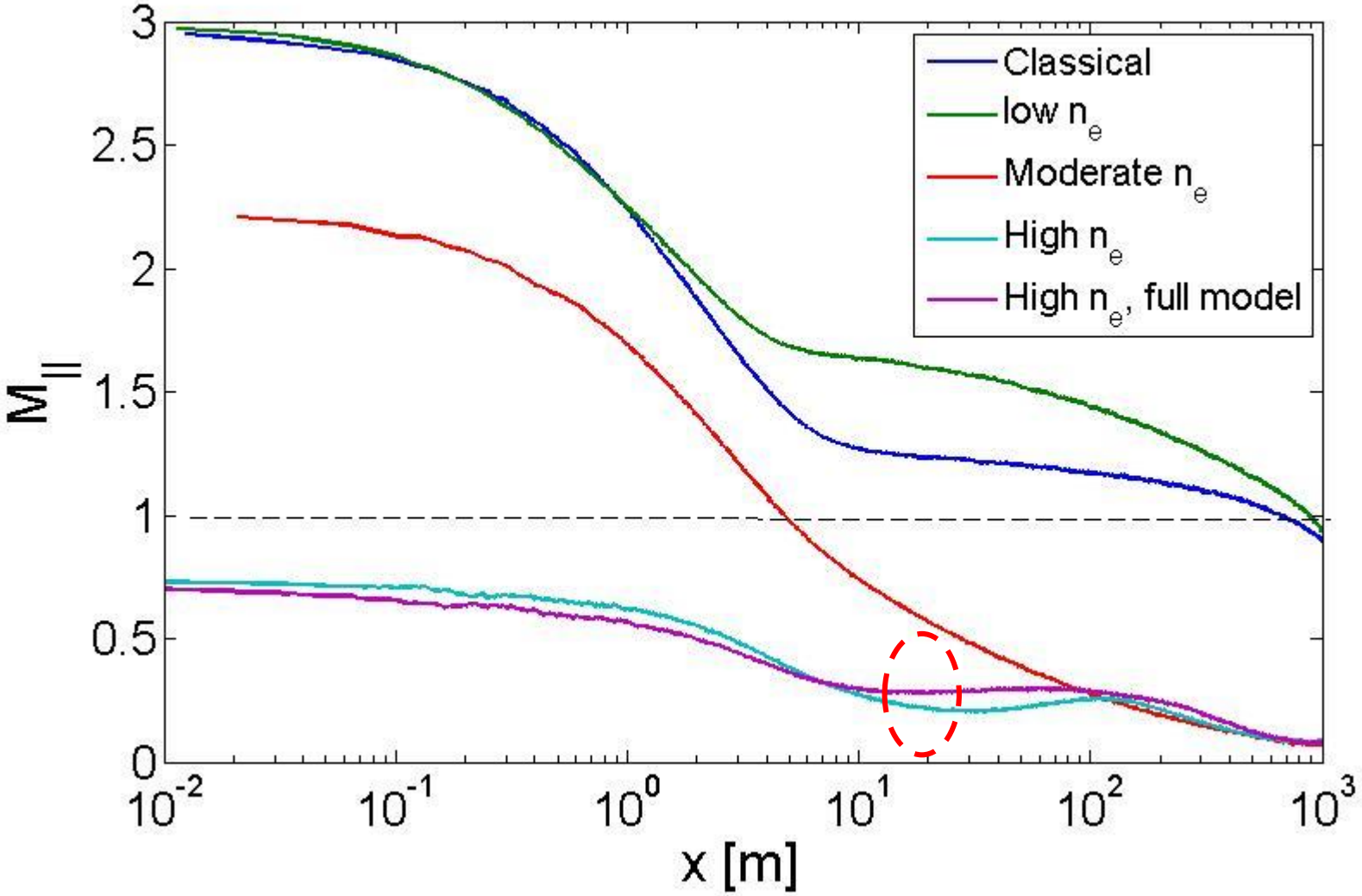
$$\frac{1-f_{rad}^{ITER}}{1-f_{rad}^{DEMO}} \approx \frac{1-f_{rad}^{DEMO} R^{ITER}/R^{DEMO}}{1-f_{rad}^{DEMO}} \approx 2.2$$

$$\frac{\nu^{DEMO}}{\nu^{ITER}} \approx \frac{R^{DEMO}}{R^{ITER}} \approx 1.45, \qquad f_{rad}^{DEMO} \sim 0.8$$

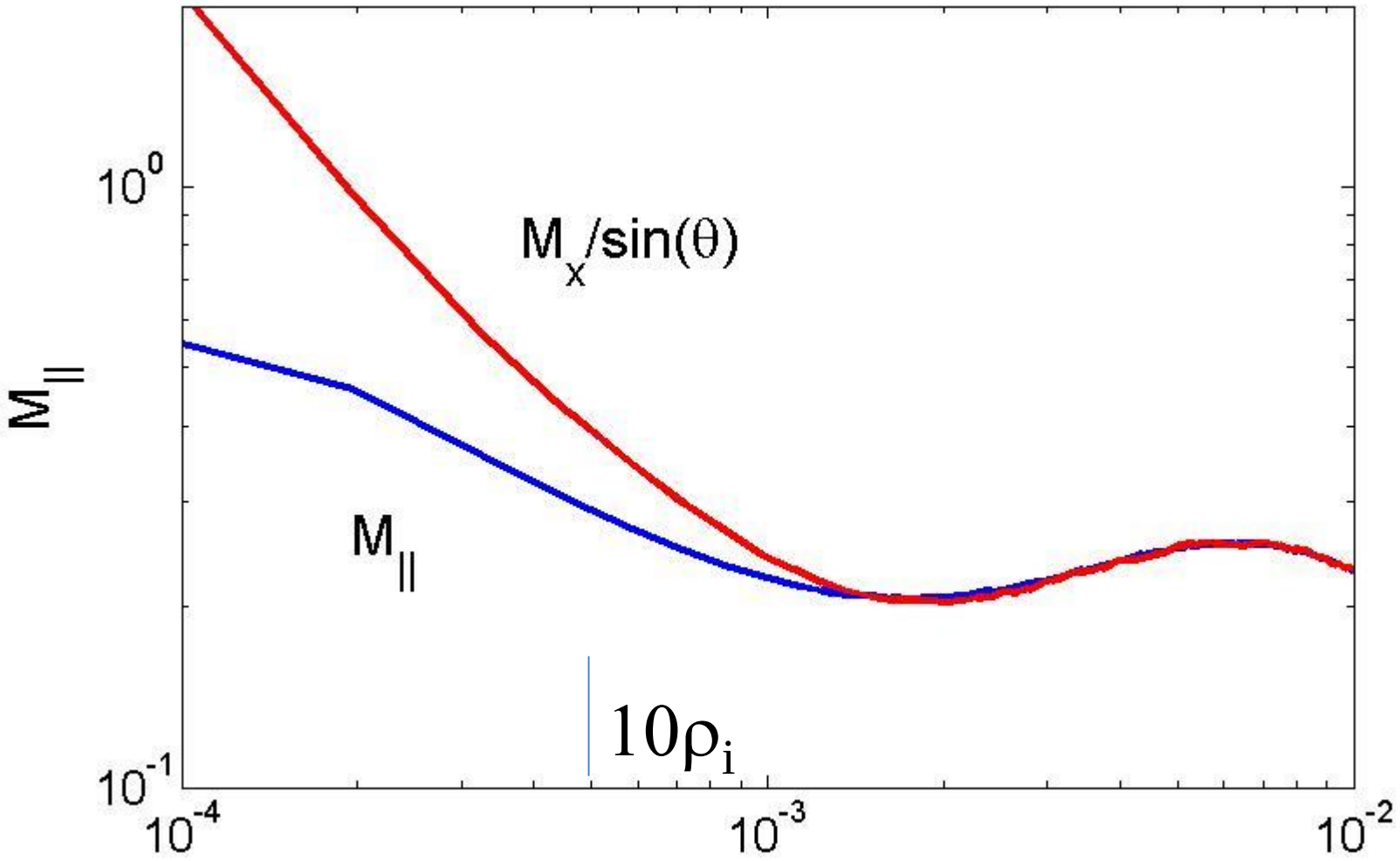




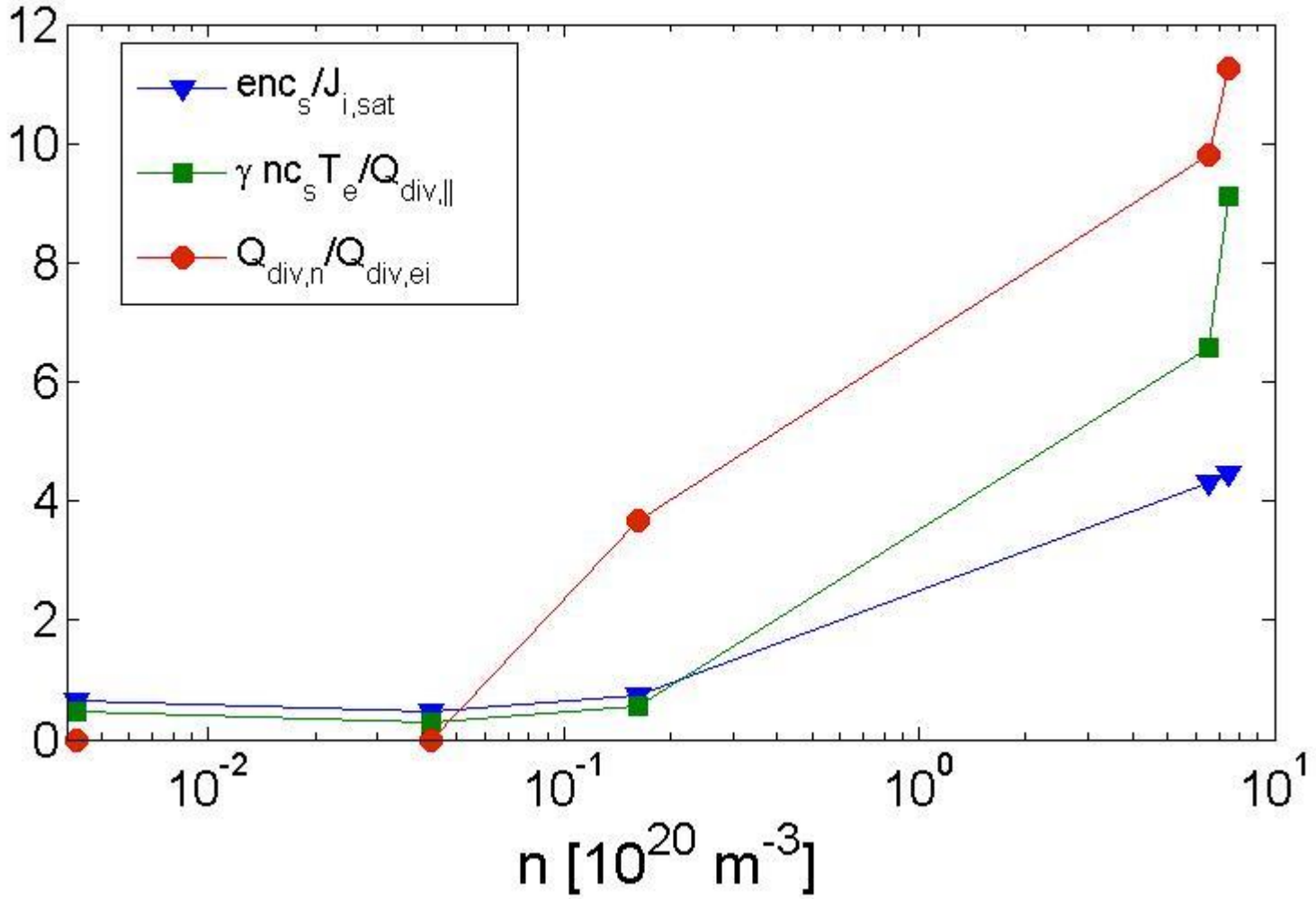
Mach number


Classical
low n_e
Moderate n_e
High n_e
High n_e, full model
M_||
x [m]
3
2.5
2
1.5
1
0.5
0
10^-2
10^-1
10^0
10^1
10^2
10^3

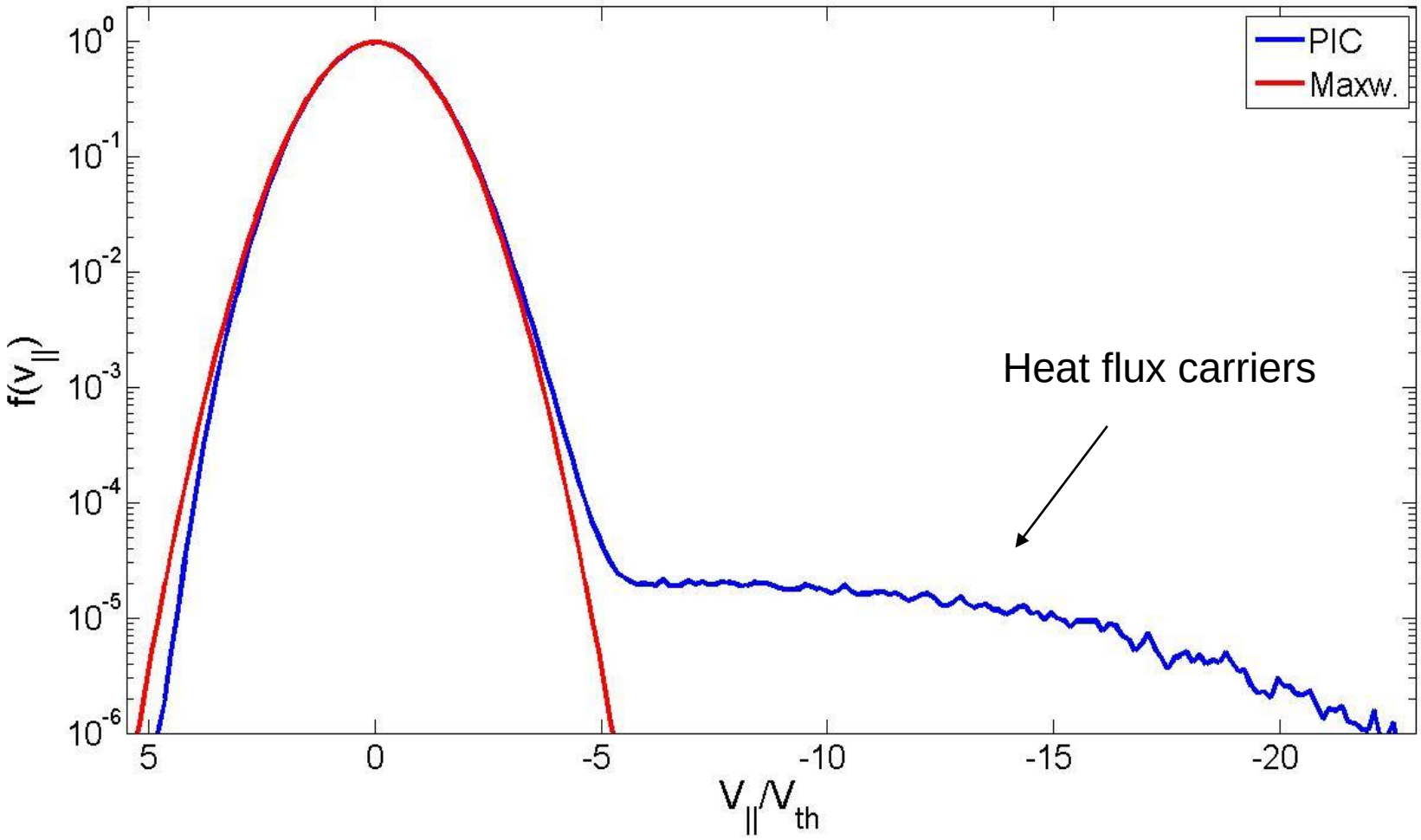
De-magnetization of plasma



Introduction



Electron VDF at the JET ID



BIT1 output (complete)

Next steps

- Complete modelling of DEMO-relevant divertor sheath ($n_e \sim 10^{22}$)

  Implementation of Ar, photon-plasma interaction?

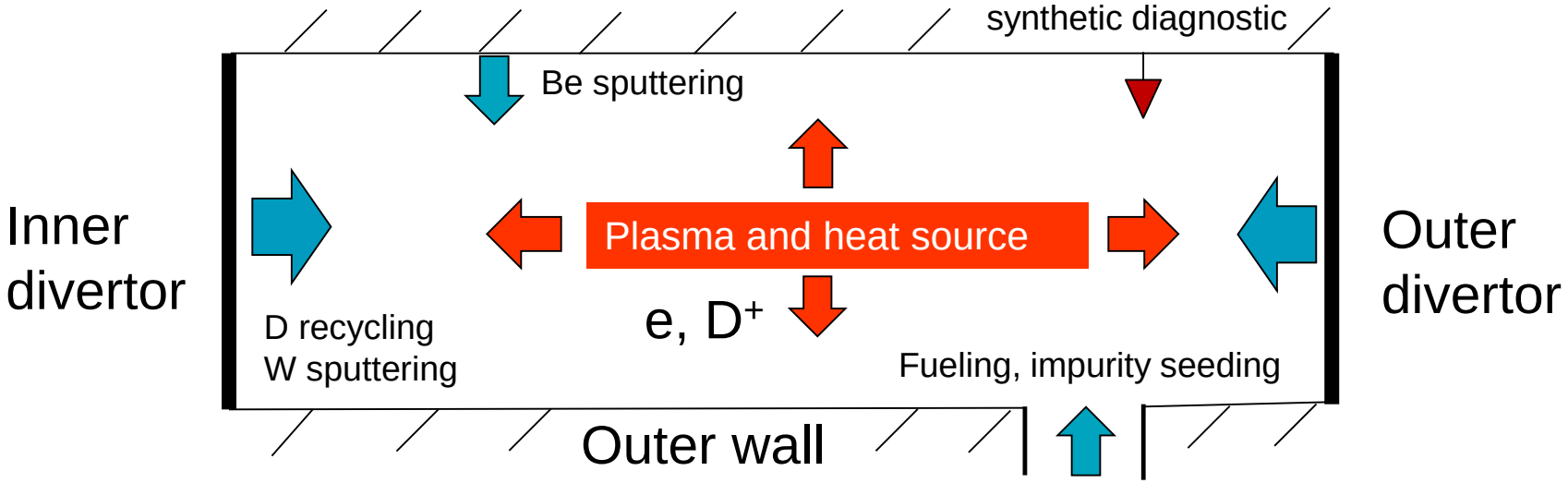
- Start multi-dimensional sheath modelling (BIT3)

- Other “requests” from TSVV-7 team?

Most of the activity will be performed In collaboration with J. Kovačič

Main tools to be used: BIT1 (3)

Massively parallel (scaling >$4x10^3$), nonlinear interaction between plasma, neutral and impurity particles, linear PSI (all together ~1000 processes)



Output of codes: all possible plasma profiles; energy, velocity and angular distribution functions at any positions and PFC; radiation spectrum and intensity.

Contributions to

TSVV-3, 4, 7

Synthetic diagnostic: plasma probes, spectroscopy