



Understanding the 3D island divertor with a simplified model



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Investigating the 3D island divertor with a simplified model

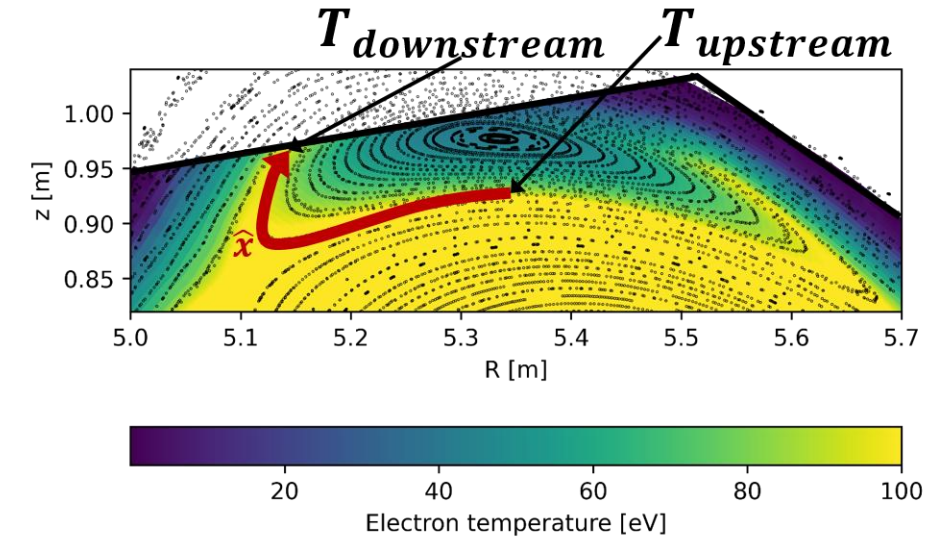
0D model relating **upstream** and **downstream** quantities:

- Energy: $\Theta \frac{d}{dx} \left(-\kappa_{e,i} T_{e,i}^{5/2} \Theta \frac{dT_{e,i}}{dx} \right) + \frac{d}{dx} \left(-\chi_{e,i} n \frac{dT_{e,i}}{dx} \right) = 0$
- Pressure: $\Theta \frac{d}{dx} \left(n v_{i\parallel}^2 + \frac{p}{m_i} \right) = S_{mom}$
- Boundary: $q_{\parallel} = \gamma n_d c_{sd} T_d$ **binormal $\perp$ transport**

Integration and extension gives:

- $T_u^{7/2} = T_d^{7/2} + \frac{7(1-f_{conv})q_{\parallel}L_C}{2\kappa_e} - \frac{7\chi(n_u+n_d)}{4\kappa_e\Theta^2} (T_u - T_d)$ f_{conv} : convected power fraction
- $p_u = \frac{2p_d}{1-f_{mom}}$ f_{mom} : a general momentum losses parametrization
- $q_{\parallel} = \frac{\gamma n_d c_{sd} T_d}{1-f_{cool}}$ f_{cool} : a target-localized dissipated power fraction

Assumes: i) toroidal symmetry ii) equivalence of parallel and binormal transport



EMC3-Eirene simulations of a simplified geometry

EMC3-Eirene: 3D fluid plasma (without drifts) with kinetic neutrals

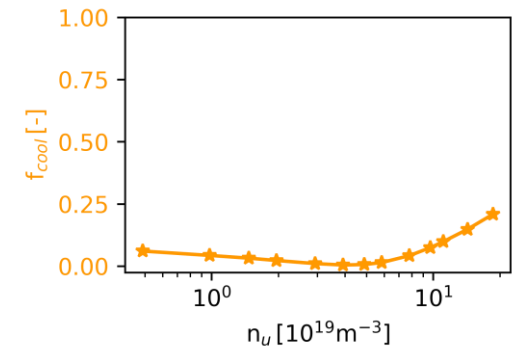
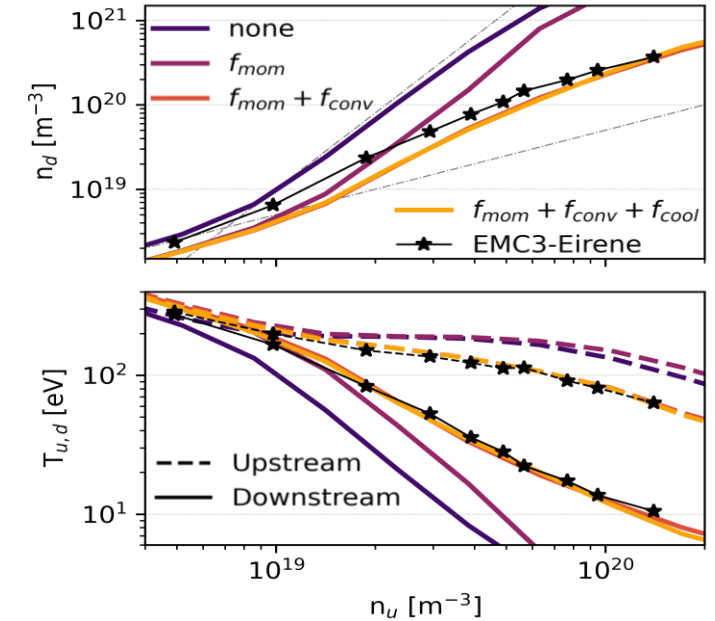
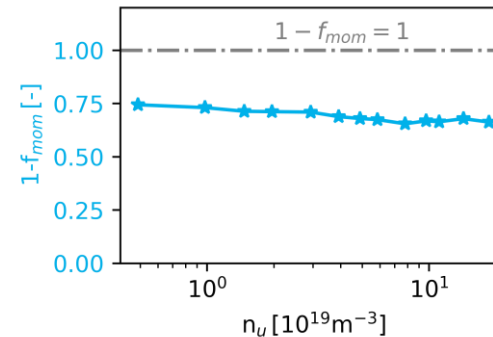
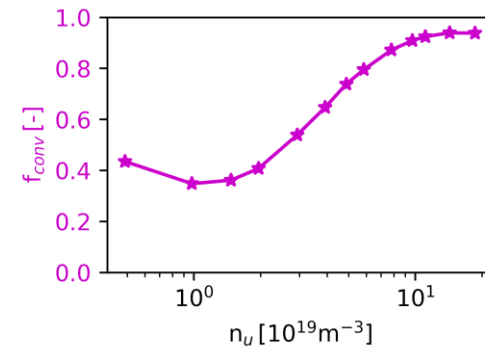
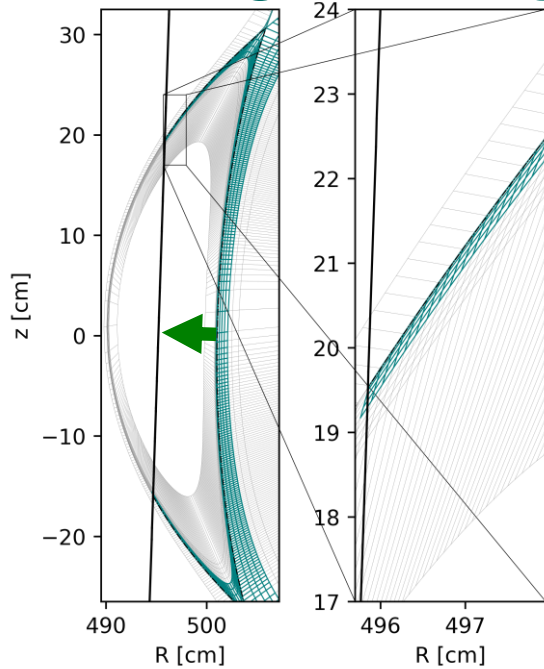
Power **C**arrying **L**ayer geometry:

suppresses **flux-surface** $\perp$ **transport**

Quantitative STPM-EMC3 match $\rightarrow$

Given parametrization from the simulations:

PCL geometry



Investigating 3D effects

I. Target-induced abrupt parallel profile variations:

Toroidally discontinuous target $\rightarrow$ localized particle sources

II. Perpendicular transport into TSR

Field line in the vicinity of TSR

TSR transport scan, depletion strength

III. Steps in shortest connection length to target

Target discontinuity leads to steps in **poloidal profiles**:

Challenges interpretation of W7-X measurements

