Impurity transport in NSTX edge plasma

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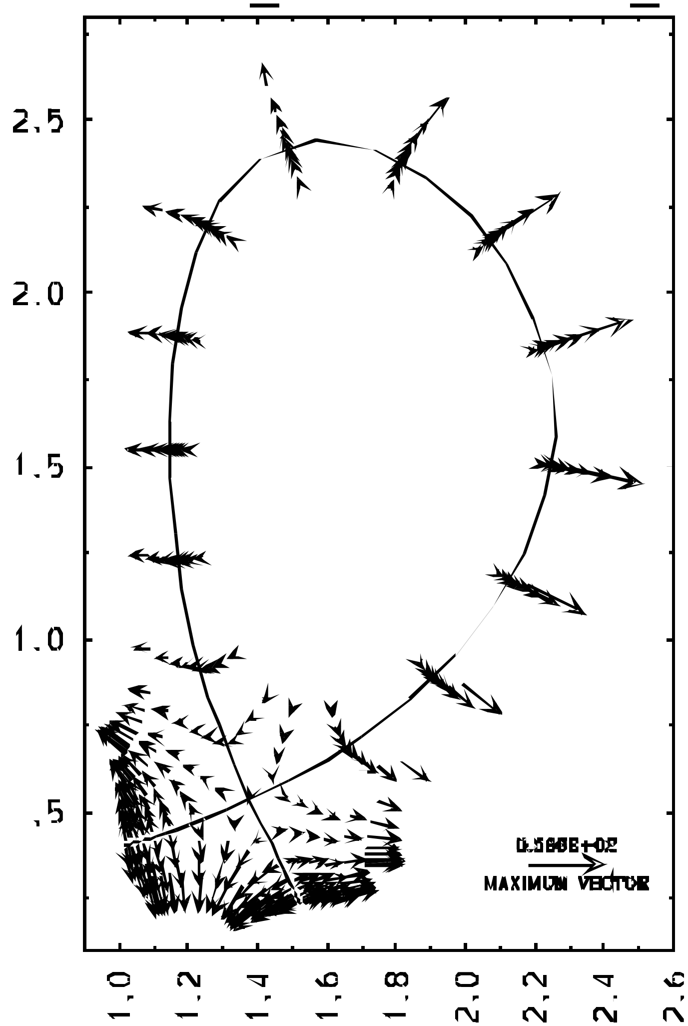
Motivation

- Hypothesis 1: Anomalous cross-field convection dominates in SOL transport. The background plasma ions and high charged impurity ions are convected toward the wall, while the lowest charged impurity states are convected toward the core plasma
- Hypothesis 2: Impurities from wall can cause significant contamination of core plasma **if** SOL impurity transport is fast and non-diffusive
- Hypothesis 3: Divertors can be a net sink for impurities

2D model for cross-field transport

Cross-field plasma flux:

_ _(ψ,_)= –D_(ψ,_) ∂n/∂r + n V_conv (ψ,_)



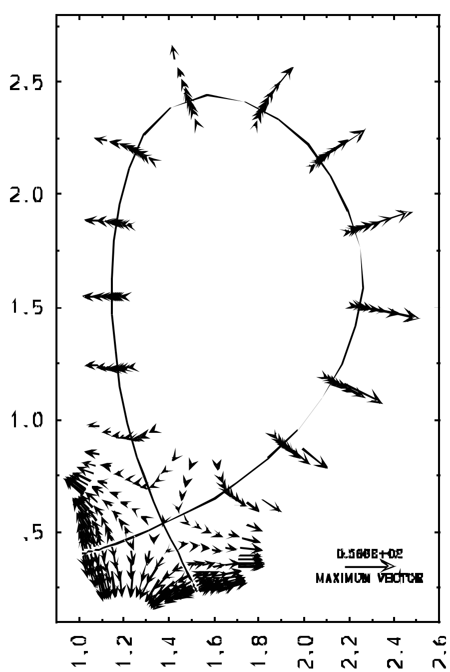
The edge physics code adjusts **D_(ψ,_)** , **_ _(ψ,_)** , **V_conv (ψ,_)** profiles to match a set of experimental data.

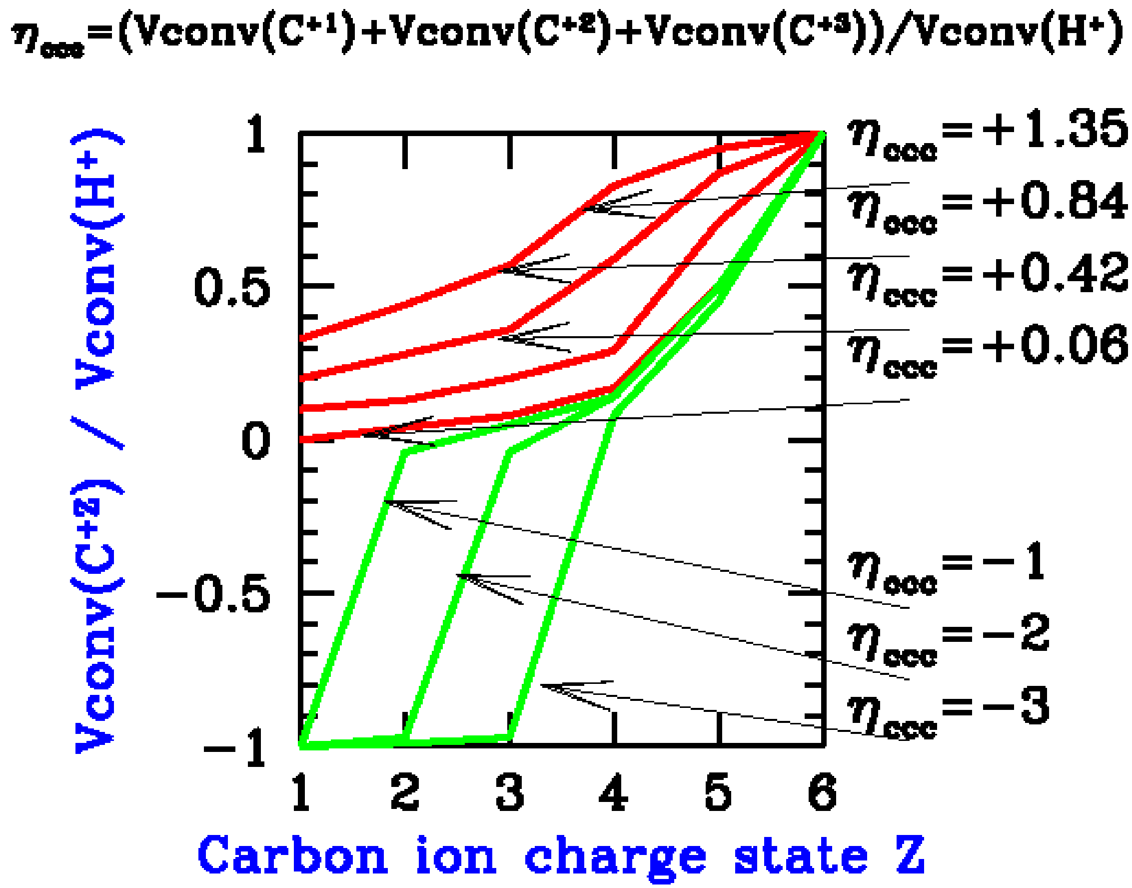
Results may be very uncertain, if there is no idea about the nature of cross-field transport.

But if any framework is known, the code can even provide automatic best fit to experimental data

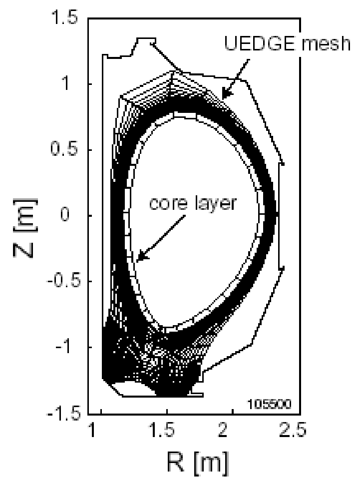
Model for anomalous convection of impurity ions

$$Vconv(\psi_n,\theta, z) = V^{BP}conv(\psi_n,\theta)\ \ \Phi_z(z)$$

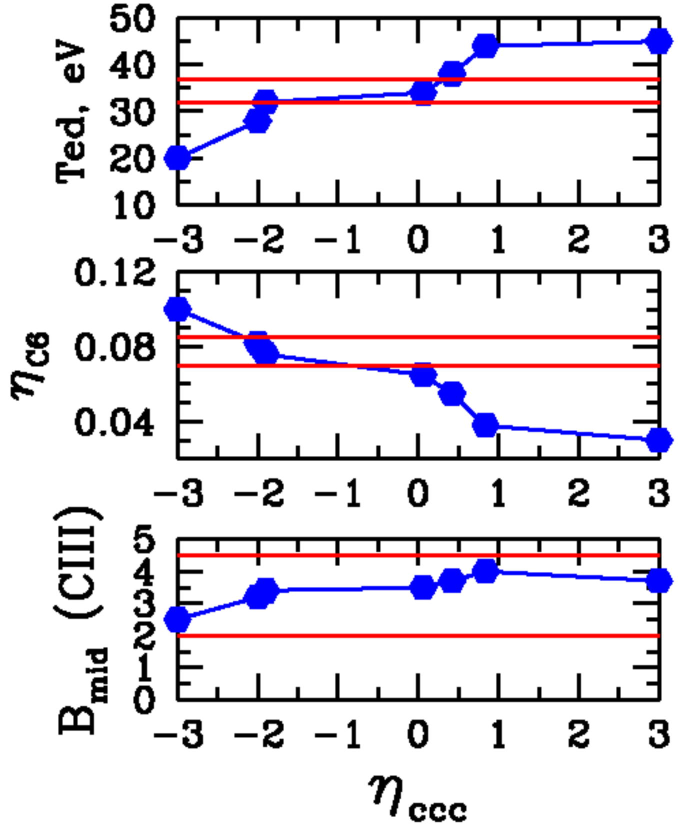




Direction of impurity ion anomalous convection has strong impact on DIII-D edge plasma



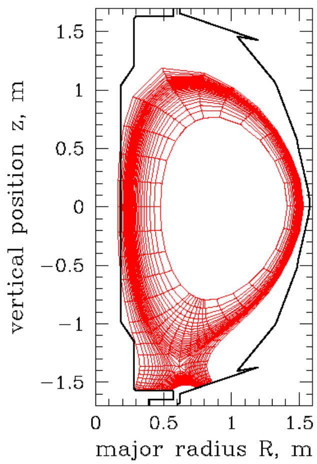
DIII-D 105500



The weaker the carbon atom penetration through SOL, the stronger should be the inward impurity ion convection of lowest charge states to match core impurity level

The more ion charge states are re-directed inward, the closer the divertor to detachment.

NSTX experimental data can be modelled using the same cross-field transport model



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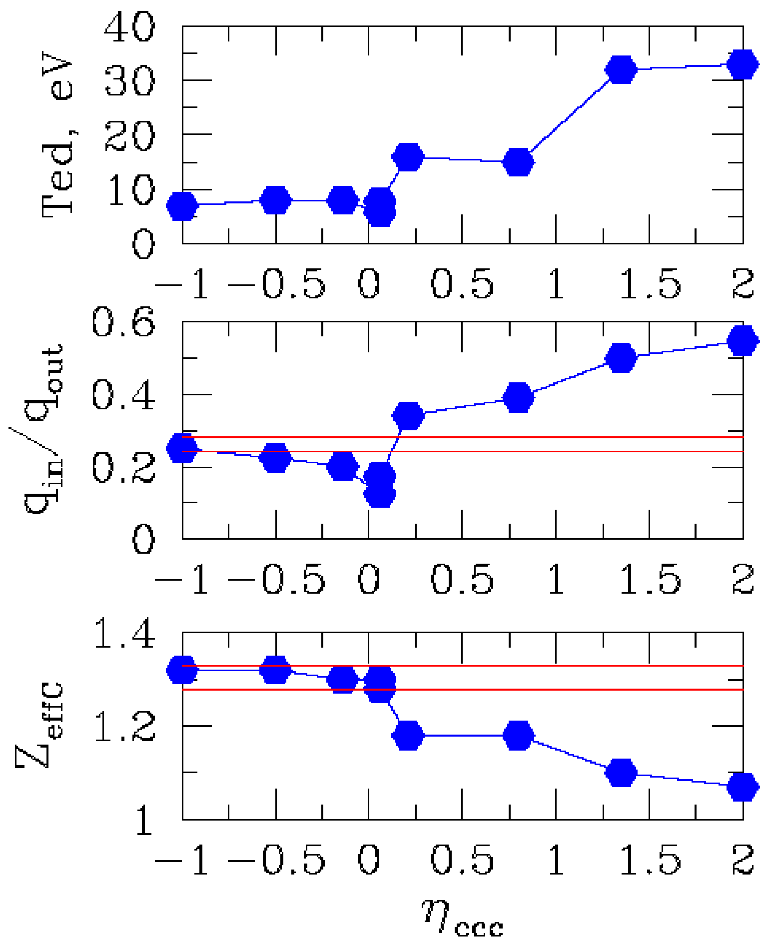
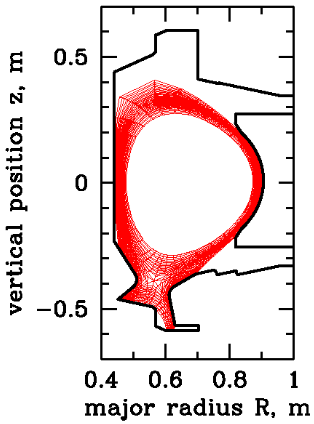
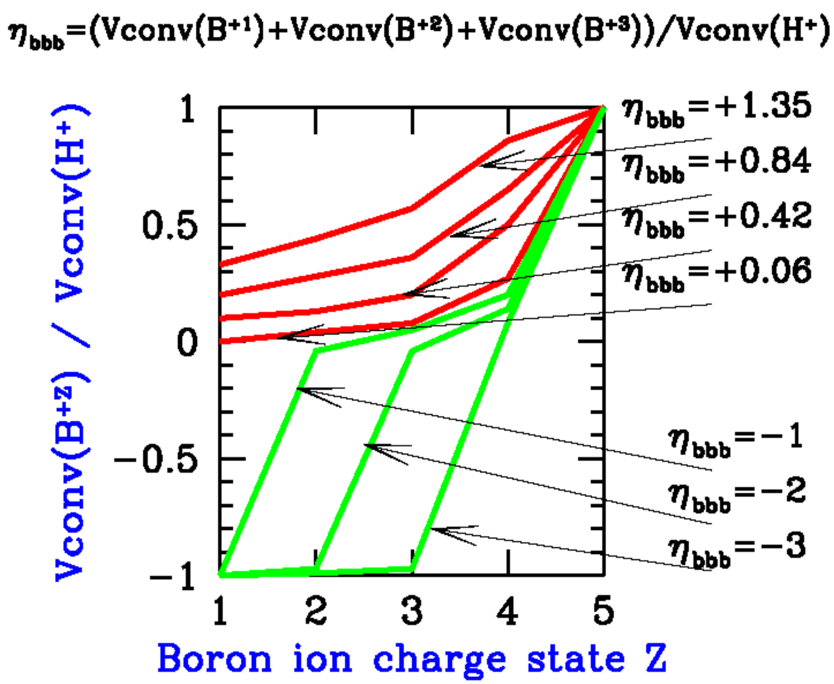
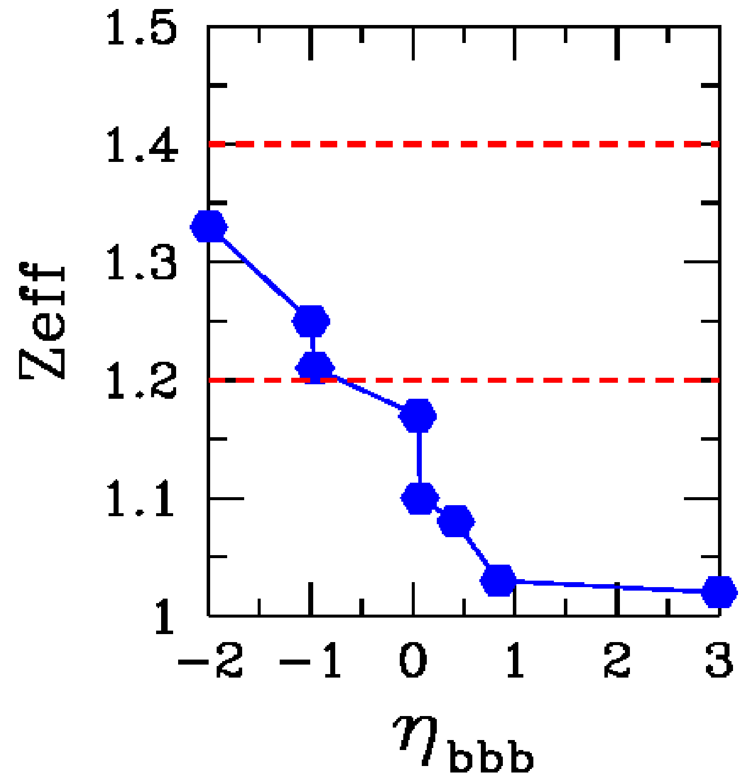
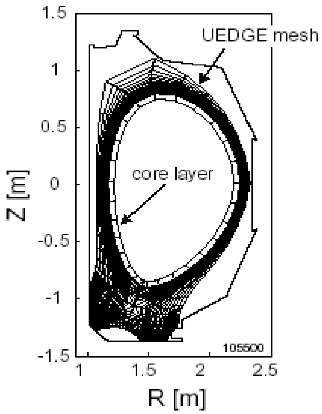


C-Mod experimental data can be modelled using the same cross-field transport model



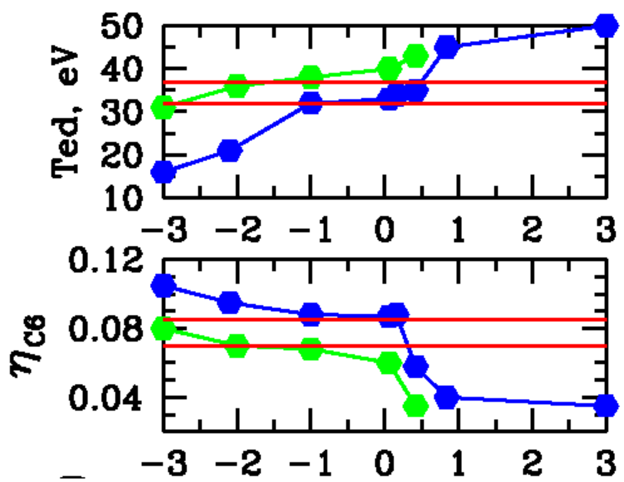






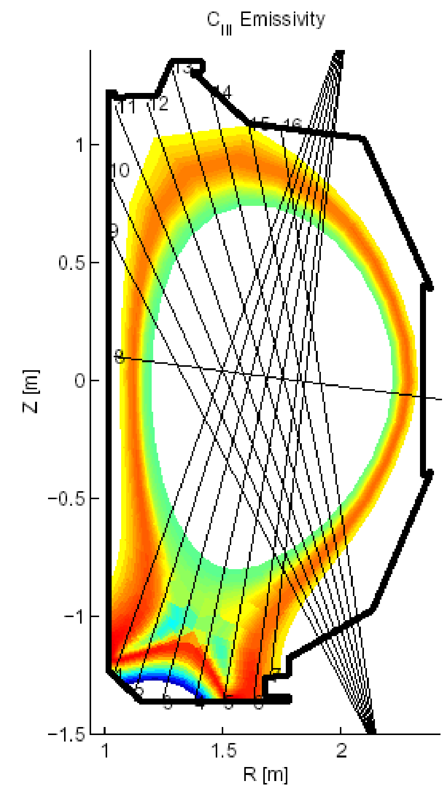
Chamber wall is important source of impurities causing significant core plasma contamination

DIII-D 105500



Concentration of impurities almost linearly increases with sputtering yield at wall.

Impurities from wall can cause significant contamination of core plasma **if** SOL impurity transport is fast and non-diffusive



Important parameters to be measured for intrinsic impurities transport study and comparison with UEDGE

- Temporal evolution of radial profiles of carbon ions (C+6 and C+2) in the core and SOL
- Poloidal asymmetry of C+2 emission
- Impurity gas pressure

- Methane puff at mid-plane to study the strength of recycling source on wall

Extrinsic impurity gas puff in L-mode plasma

- Puff different impurity gases (recycling and non-recycling) into the divertor. Content of impurities in puffing gas can be variable.
- Study divertor impurity shielding by comparing the rate of increase of impurity emission in the divertor and core regions
- Puff impurities at mid-plane, ideas are certain.
- Study radial profiles and poloidal asymmetries of impurity ions as well as impurity gas pressures at different locations.