Fast transport in NSTX / spherical torus scrape-off-layer

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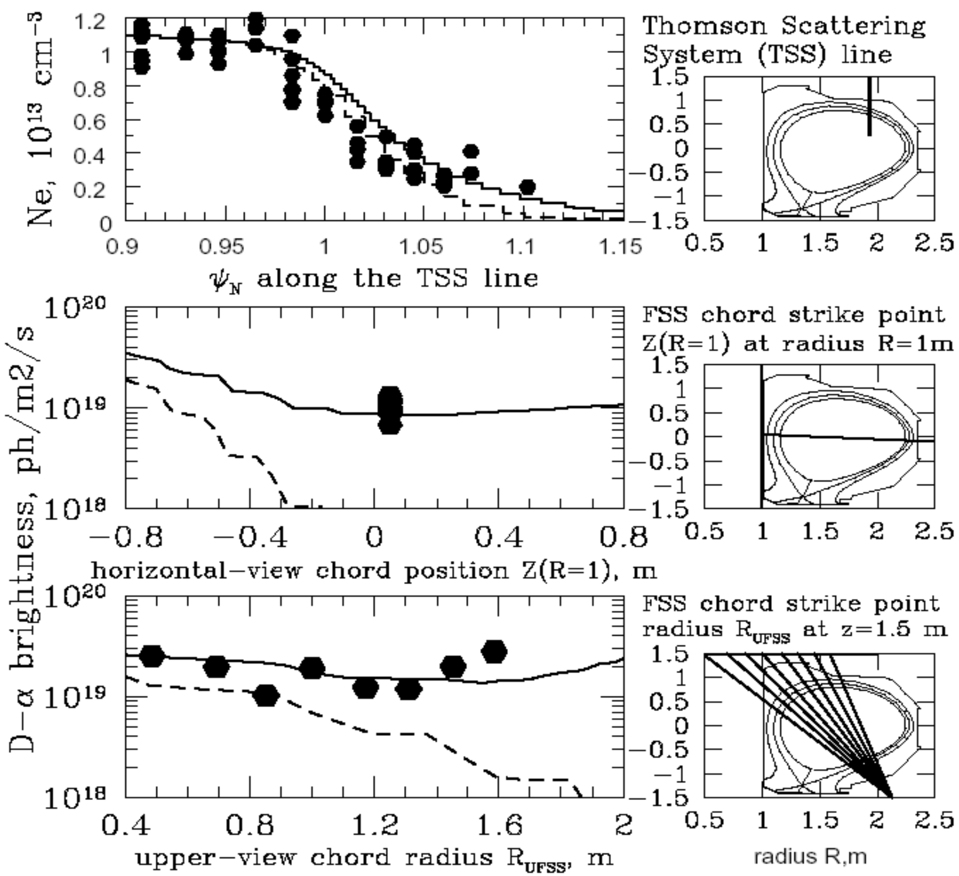
Motivation

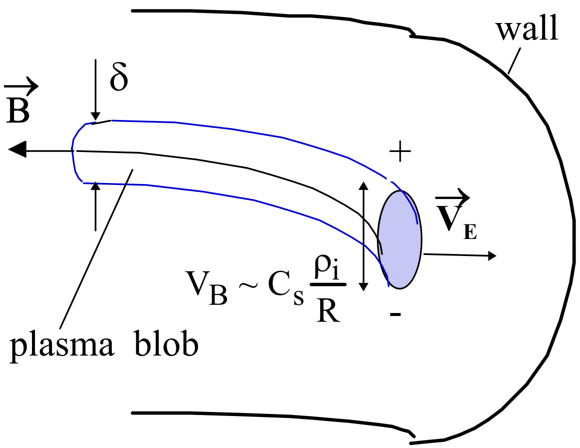
1) There are significant experimental evidence (Boedo, Antar, Zweben, Terry, LaBombard, Endler, Hidalgo,…) and some theory (Krasheninnikov, D'Ippolito, Xu) suggesting fast intermittent convective blobby transport in tokamak SOL and in linear plasma machines.
2) Macroscopic edge plasma modelling (Pigarov, Umansky, Schneider) showed that poloidally-asymmetric non-diffusive transport should be included in order to match experimental data.
3) Being low-B small-R machine, NSTX can provide unique data on edge convection valuable for cross-machine comparison.

On C-Mod and DIII-D the fast convection has important effect on SOL profiles: it frequently leads to far-SOL density shoulders and to main chamber recycling regimes



UEDGE simulations with anomalous radial convection allows us successfully match experimental data which could not be matched otherwise.

Intermittent (blob) transport theory is under development. Convective transport is predicted to be strong for NSTX



Simple estimate for characteristic blob velocity and size (Krasheninnikov etal, EPS2002):

$$V_b < (V_b)_{max} \sim C_s \left\{ \left(\frac{\rho_i}{R}\right)^2 \frac{1}{\pi q} \right\}^{1/5} \sim 2000 \ \ m/s$$

$$V_b > (V_b)_{min} \sim C_s \left\{ \left(\frac{\rho_i}{R}\right)^2 \frac{1}{\pi q} \right\}^{1/3} \sim 150 \ \ m/s$$

$$\delta > \delta_{min} \sim C_s \left\{ (\pi q)^2 R \rho_i^4 \right\}^{1/5} \sim 0.5 \text{ cm}$$

If blob generation frequency varies slowly with plasma parameters, one possible scaling for convective velocity is

$\mathbf{V_{conv} \sim Ti^{9/10} \ B^{-4/5} \ R^{1/5} \ \Phi(N)}$

Convective transport is expected to be high on NSTX. For similar L-mode discharges: **V_{conv}(NSTX) ≈ 2 V_{conv}(DIII-D)**

UEDGE simulation of fast convective transport in NSTX scrape-off layer and cross-machine comparison

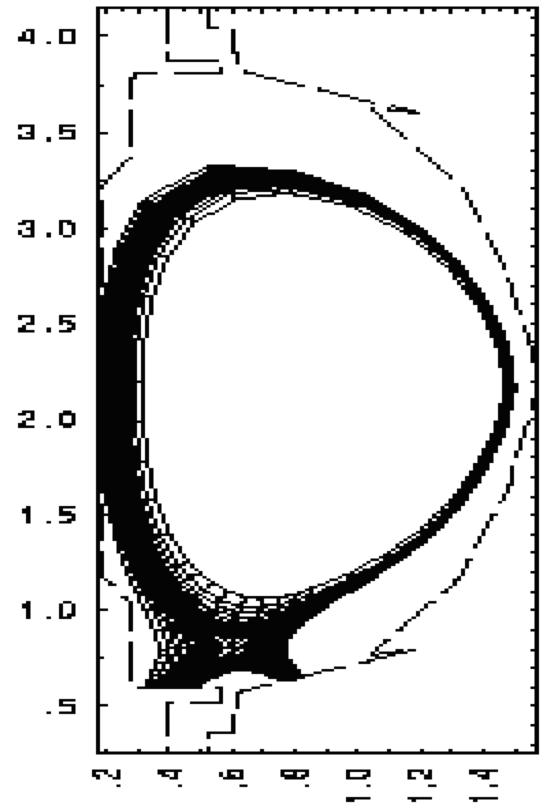
We have modeled with UEDGE the Simple-As-Possible-Plasma experiments on **DIII-D** that deal with maximum diagnostics, lowest-power, L-mode shots (Pigarov,PSI2002).

Recently, a series of L-mode OH discharges on **Alcator C-Mod** was successfully simulated with UEDGE including fast anomalous convection.

By analogy, Simple-As-Possible-Plasma experiment on **NSTX**, that is a series of L-mode (or OH) shots representing plasma density scan will be very useful for comprehensive non-diffusive transport analysis.

Possible experiments aimed at the detailed study of SOL transport

*** Variation of magnetic equilibrium to study in/out transport asymmetries, plasma profiles during outer gap scan, intermittency and convection scaling with B and R, and main chamber recycling.



Major transport occurs on outboard side. Most of outer SOL is already in the shadow of inner wall. If SOL transport is fast enough, then inner wall has probably no effect on outer SOL profiles. Push plasma as deep as possible towards inner wall by reducing major and/or minor radius.

*** "Bypass" experiments with controlled leakage from the divertor (by modifying the existing passive stabilizing plates?).

These experiments can be modeled with UEDGE.