NSTX

Particle Transport Studies in NSTX for 2009-2013

R. Maingi
Oak Ridge National Laboratory

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OAK RIDGE NATIONAL LABORATORY

Deuterium and Impurity Particle Transport Studies

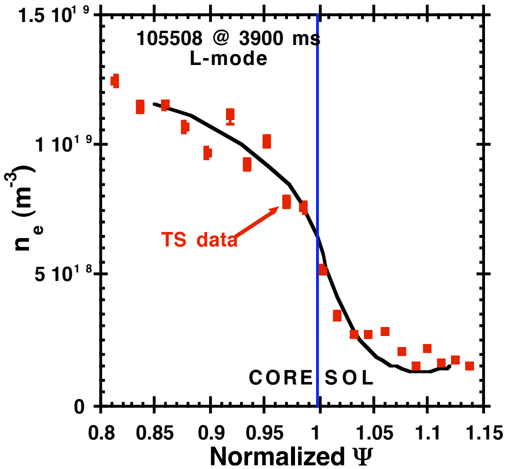
- Motivation - particle transport less well understood than energy transport (e.g. GLF23 models the energy transport more accurately than the particle transport)
- Core deuteron particle transport (r/a < 0.8-0.9) can be assessed with TRANSP, but edge particle transport requires knowledge of the 2-D/3-D fueling/recycling source terms
  - ➢ The fueling source can be assessed with combined edge plasma (e.g. b2, UEDGE) and neutral gas (e.g. DEGAS-2, EIRENE) calculations, allowing D's and χ's to be extracted
- Impurity transport, particularly Helium, can be assessed with appropriate CHERs system (He-II n=4-3 transition@468.6 nm)

B2.5 / DEGAS simulation of D3D shot 105508@3.9 sec provide good match to experimental data

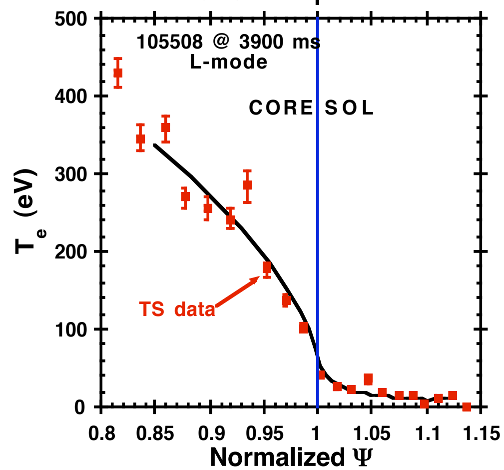
- **B2.5 equilibrium 2** matches the experiment relatively well:
  - Total radiated power = 0.51 MW
  - Power crossing separatrix = 0.81 MW
  - Core particle efflux = 519 amps (B2.5)
  - Core fueling rate = 519 amps (DEGAS)
  - NBI fueling rate = 9 amps
  - Average core particle confinement time = 0.12 s
  - Integrated particle flux *inner divertor 2475 amps, outer divertor 2508 amps*
  - Required radiation multiplier = 2.4
- Unity divertor recycling ($R_{div\text{-}in} = R_{div\text{-}out} = 1.0$ > saturated targets) with pumping walls matched to midplane D_α also agrees well with measured divertor data for **B2.5 equilibrium 2**.
- **B2.5 equilibrium 1** (with $R_{in} = 0.925$ and $R_{out} = 0.99$) tests the effects of low recycling

Plasma Simulation Matches Background DIII-D plasma data at the outer midplane and X-point region

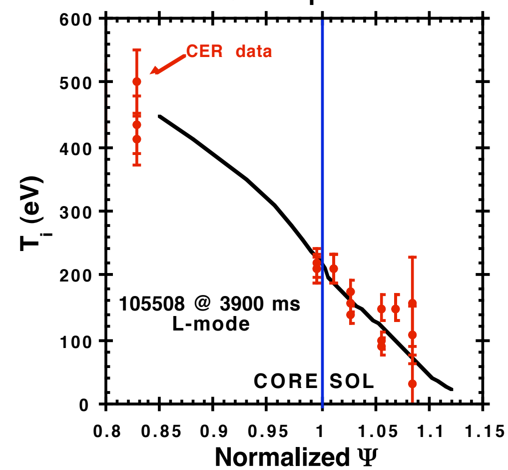
Electron density



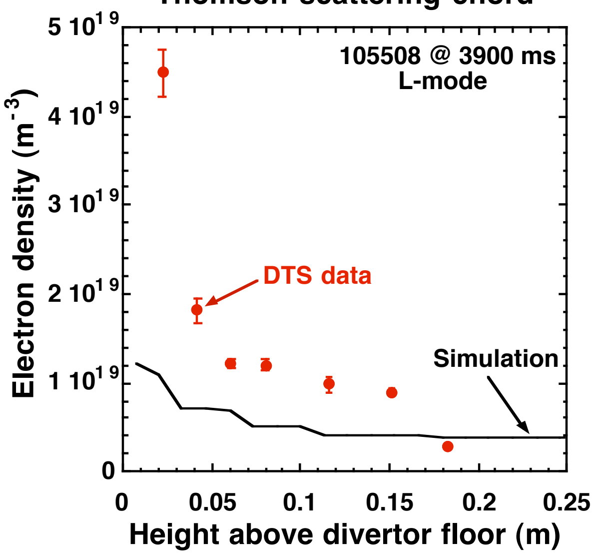
Electron temperature



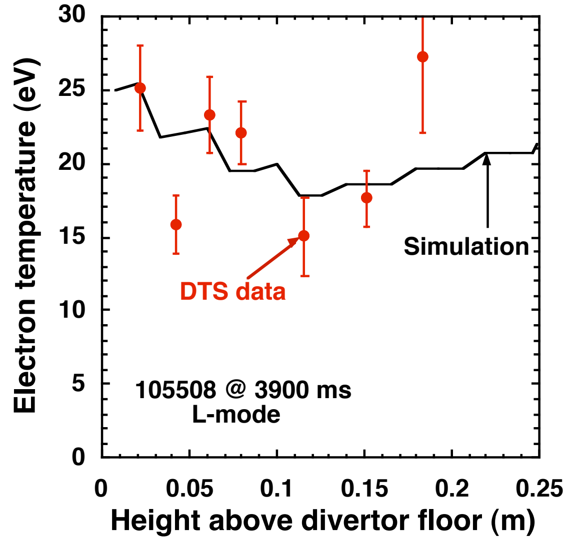
D^+ ion temperature



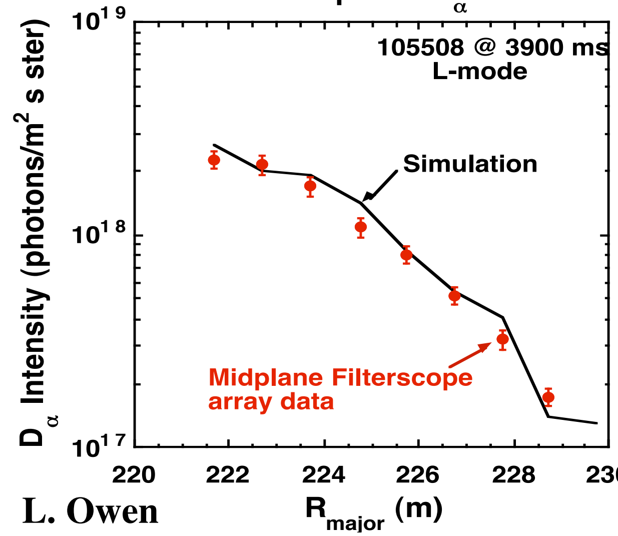
Electron density along the divertor Thomson scattering chord



Electron temperature along the divertor Thomson scattering chord



Midplane D_α



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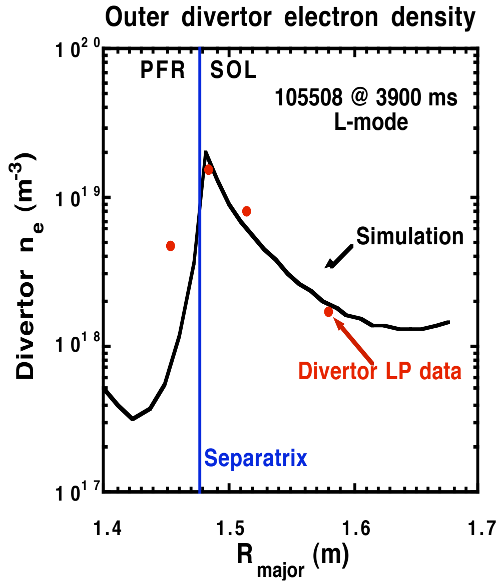
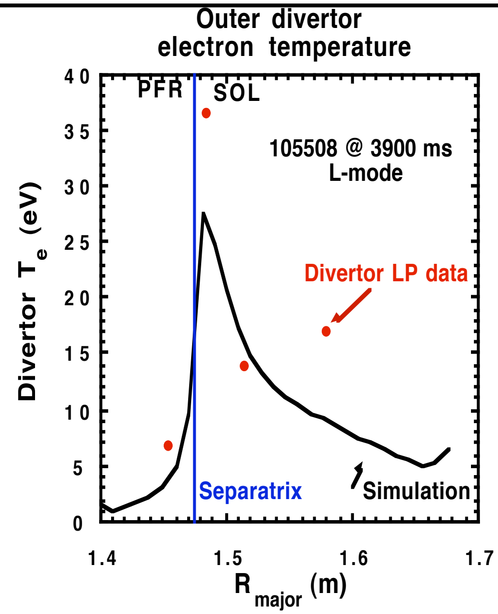
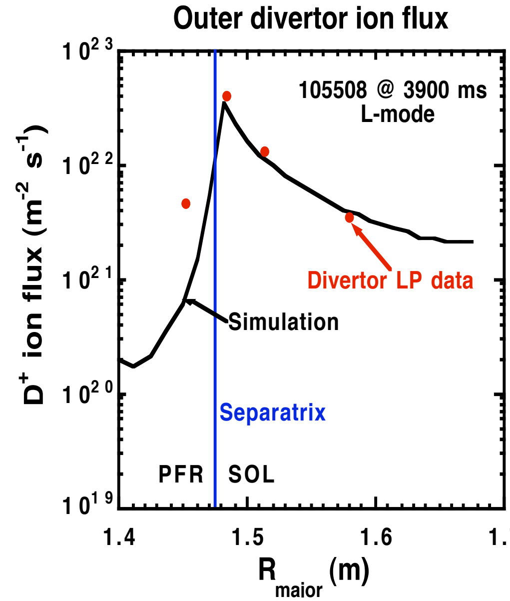
Plasma Simulation Matches Background DIII-D plasma data at the outer divertor target







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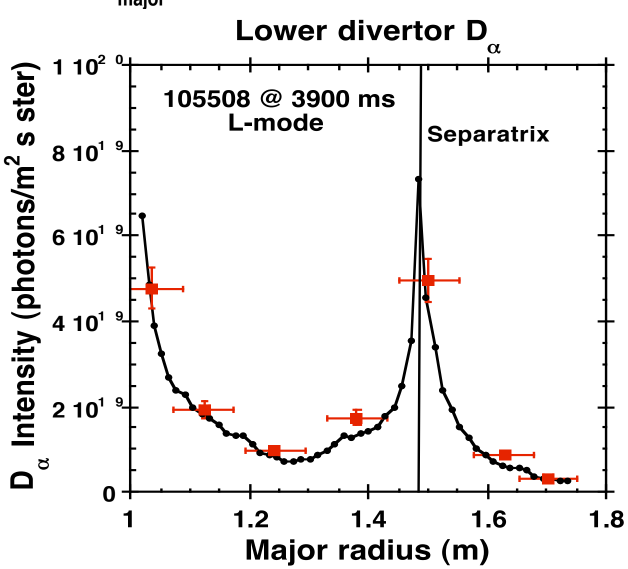
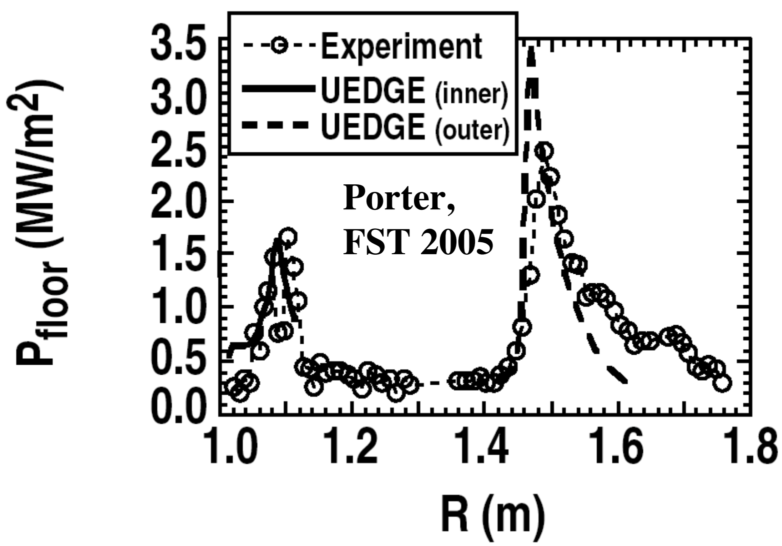
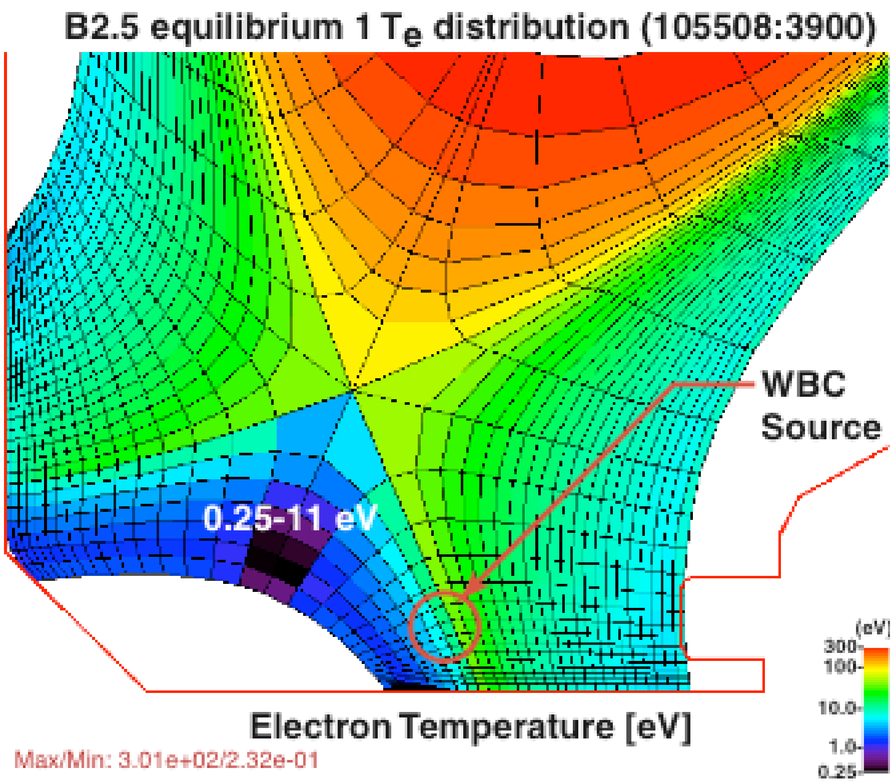
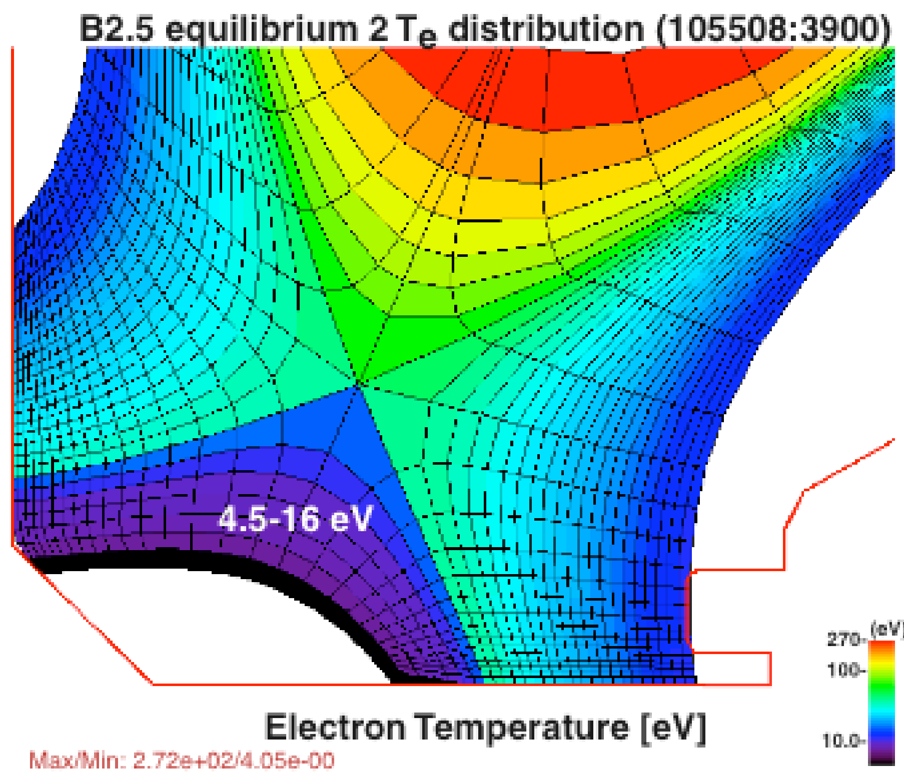




The B2.5 T_e distributions in the private flux region are very sensitive to target recycling

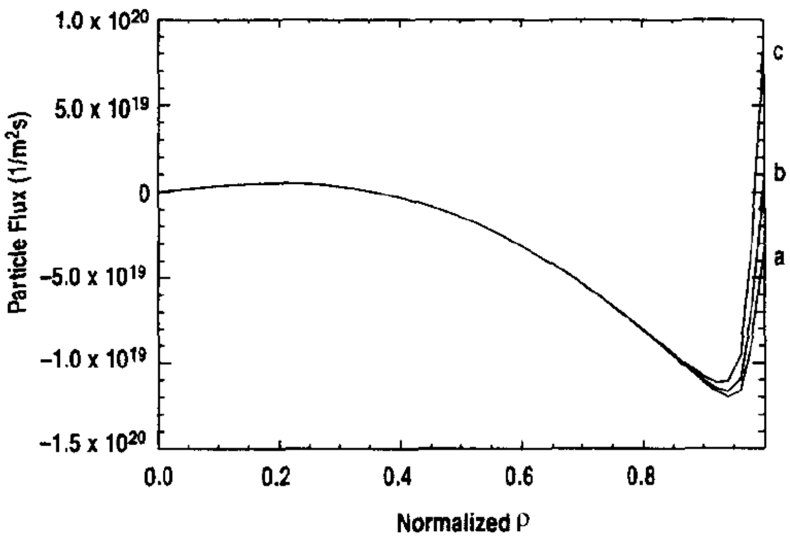


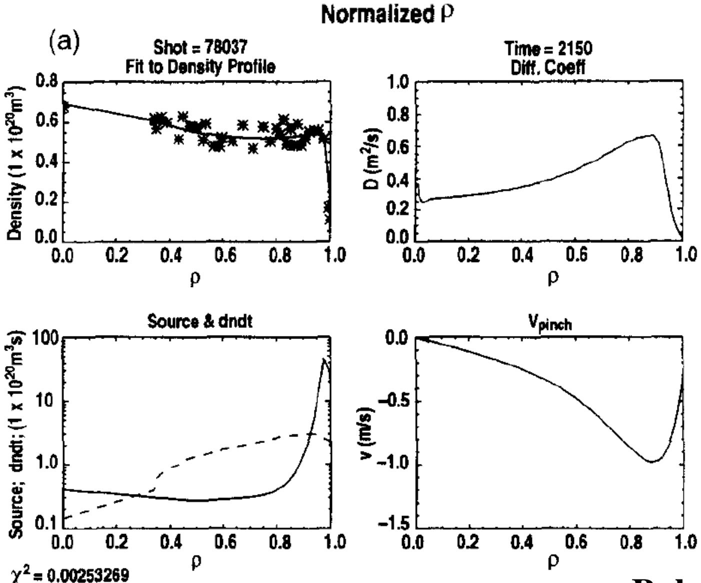
R_{div-in}=0.925 & $R_{div-out}$ = 0.99

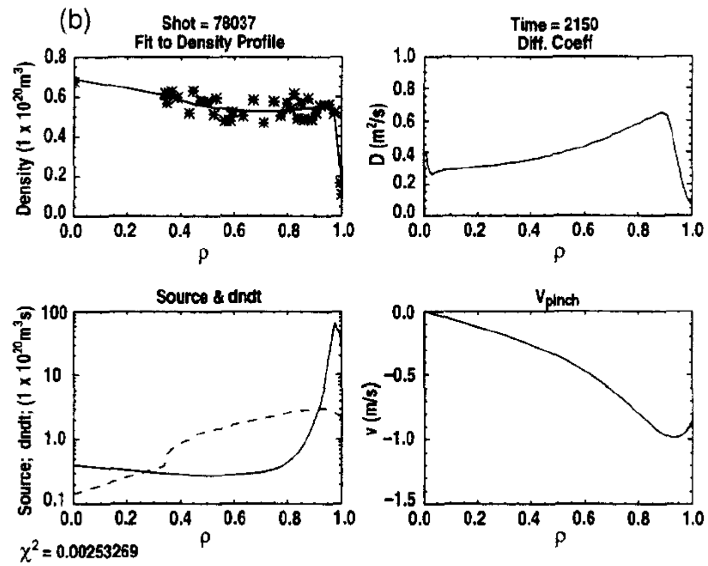


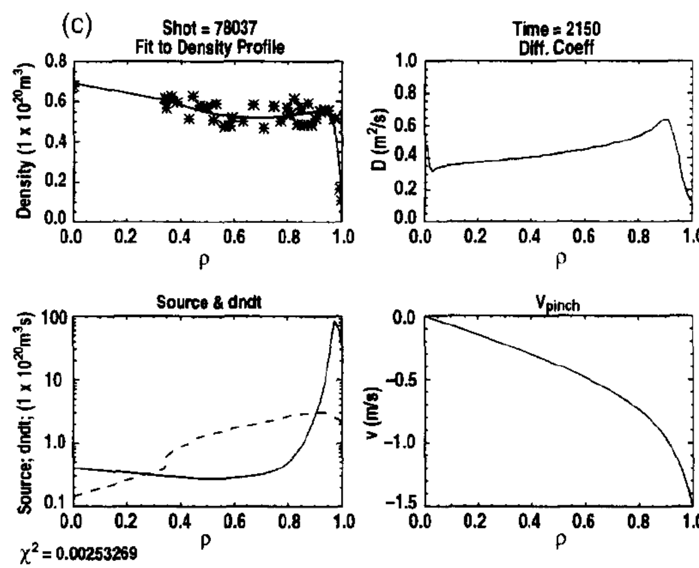
R_{div-in}= $R_{div-out}$ =1.0
D_α matched at midplane

Edge particle flux varies strongly with edge source









Baker, JNM 1997

Most Required Diagnostic Data Available Now for Deuterium Edge Particle Transport Studies

- Midplane n_e, T_e, T_i, n_c- Thomson, CHERs, Edge Rotation Diagnostic, Scanning probe
- Wall and Divertor D_α profiles (${D_\beta}$ or D_γ help to determine if ionizing or recombining spectrum)
- Divertor heat flux for divertor heat flow regime
- Diagnostic enhancements needed, but studies are manpower limited!
  - ➢ Higher spatial resolution n_e, T_e from divertor probes
  - ➢ Midplane D_α radial profile from cameras
  - ➢ Divertor n_e, T_e above the target would help

➢ What is role of SOL flows in core fueling?

Helium and Impurity Transport Can be investigated in NSTX for development of integrated scenarios

- Modified CHERs system could be used for n_{He} (ρ, t)
- Helium transport in the core could be assessed without concern for the edge recycling source
- Edge helium transport could be assessed as edge deuteron transport with 2-D modeling, if desired
- Diagnostic enhancements needed
  - ➢ Helium recycling profiles - filter purchases for CCD cameras

Synakowski, PRL 1995