Simulation of the boundary plasma in NSTX

M.E. Rensink, G.D. Porter, N.S. Wolf

New boundary data provides check on edge models

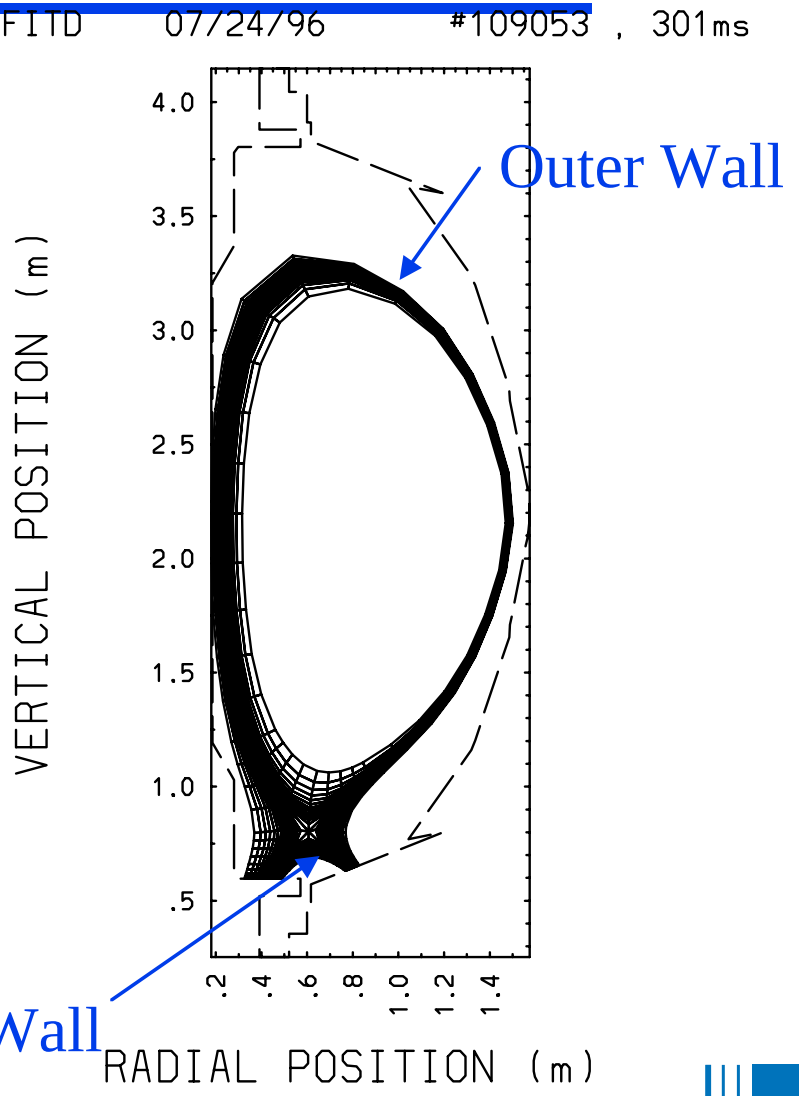
- Edge characterization experiments provide boundary data over range of conditions
- Several shots have been selected for H-mode analysis
  - Different heating power
  - Different line averaged density
  - All LSN configuration
- We've only begun the analysis, focussing on one discharge/time

Goal is to use UEDGE to help understand boundary physics

- 2-D fluid model for ions, electrons and neutrals
- Classical parallel physics, anomalous–turbulence driven–perpendicular transport
- Carbon impurity simulated with sputtering source, and parallel force balance model
- Parallel current effects included, but not effect of drifts—yet

High power H-mode discharge selected for initial simulations

- Shot is 4 MW beam heating with density increasing with time
- Equilibrium is LSN
- We use EFIT reconstruction to generate grid for UEDGE simulation

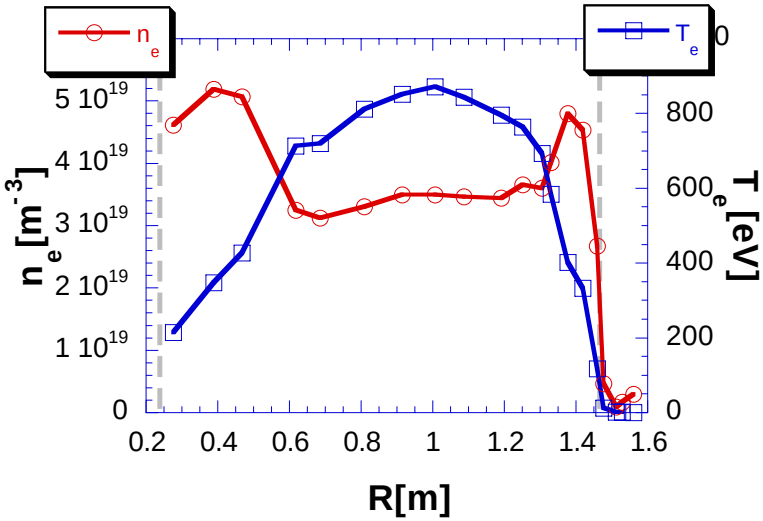


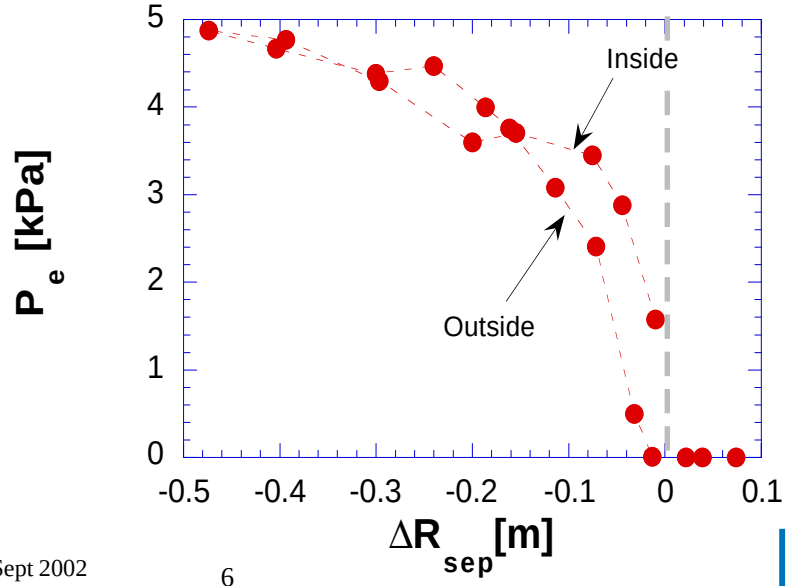
UEDGE assumptions for NSTX simulations

- 100% of ions striking divertors recycle as neutrals
- λ_n at PF and outer wall is 2 cm
- λ_g at 90% flux surface is $\sqrt{\lambda_i \cdot \lambda_{CX}}$
- Ion flux to walls recycles as neutrals
- No neutral pumping on PF wall
- 5% of neutrals to outer wall are pumped
- Transport diffusivities are spatially constant

Profile data suggests EFIT separatrix location is off

- Separatrix location at outer midplane is at low gradient portion of profile
- Electron pressure is different on inside and outside
- Power balance is achieved when separatrix is just outside position of peak T_e gradient

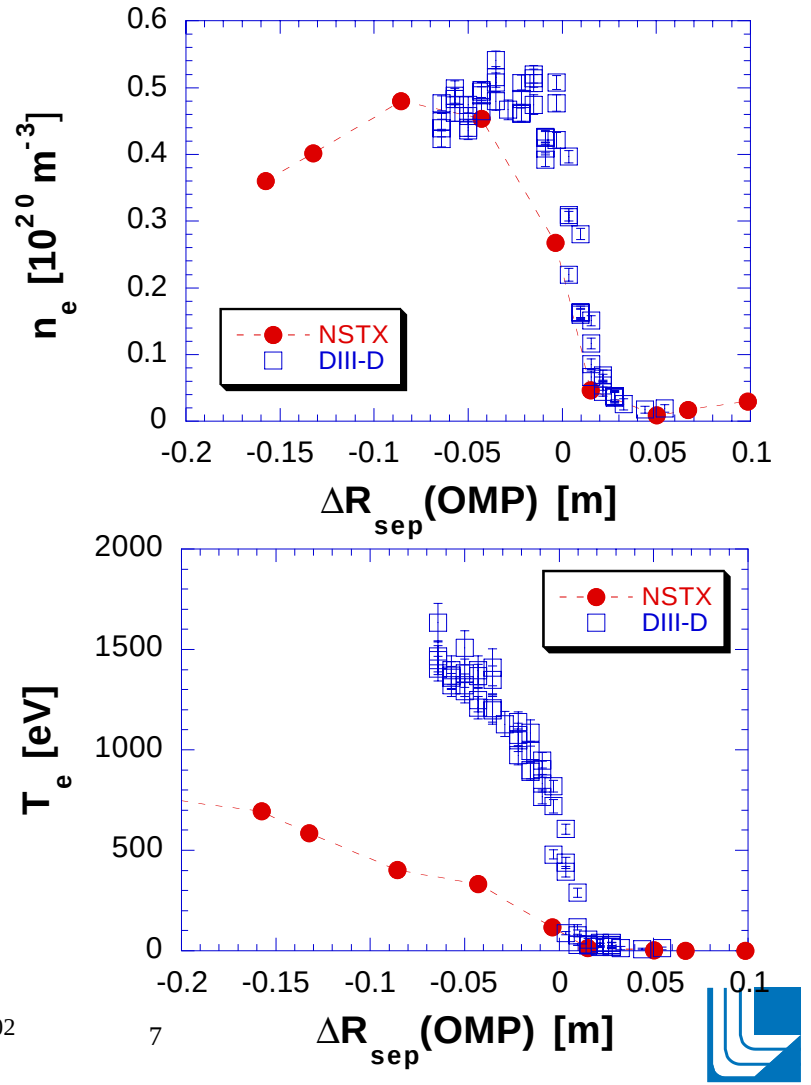




NSTX density profile similar to DIII-D H-mode profile

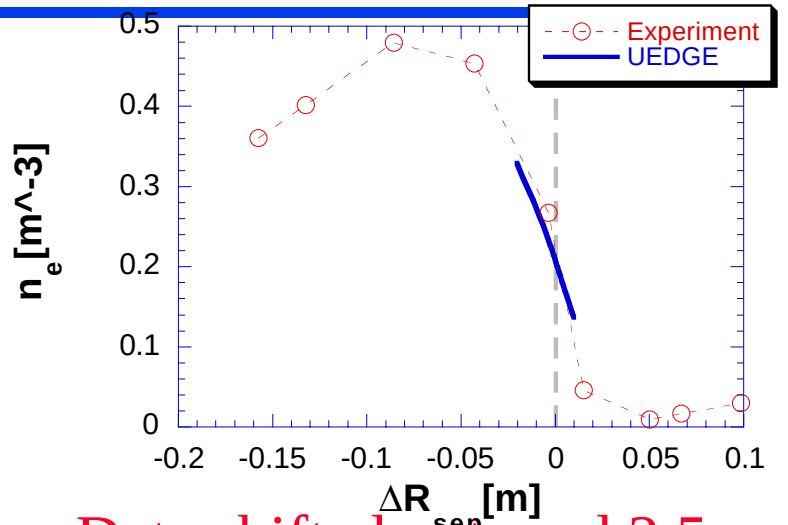
- Density profile similar when plotted vs ΔR_{sep}
- Top of density pedestal lies at Ψ_N=0.95 on DIII-D, <0.90 on NSTX
- Suggests neutrals penetrate much deeper in flux space
- Boundary simulations must cover broader flux range in NSTX

NSTX data shifted outward 2.5 cm

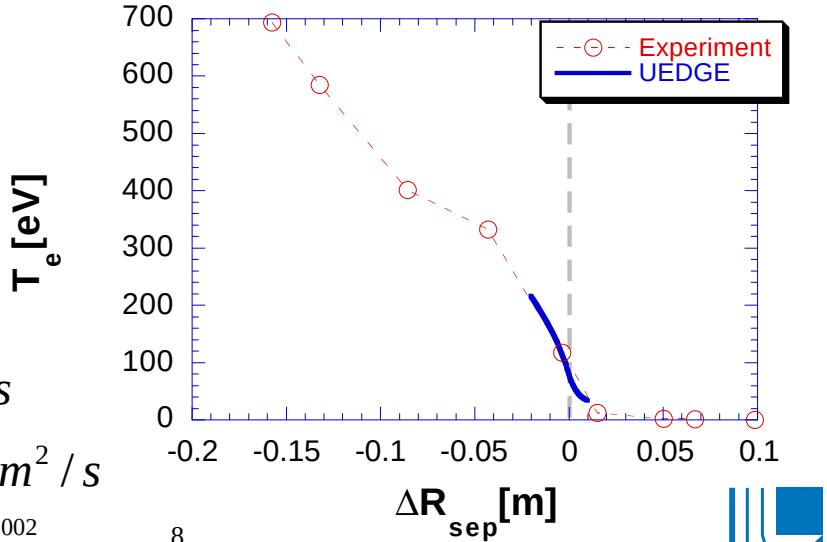


Initial simulation consistent with upstream profiles

- Power across 90% flux surface is 4.2 MW
- D^+ density on 90% surface is specified
- Z_{eff}=1.4 on closed lines (calculated)
- D and χ are about 10 times that expected for H-mode in DIII-D



Data shifted outward 2.5 cm

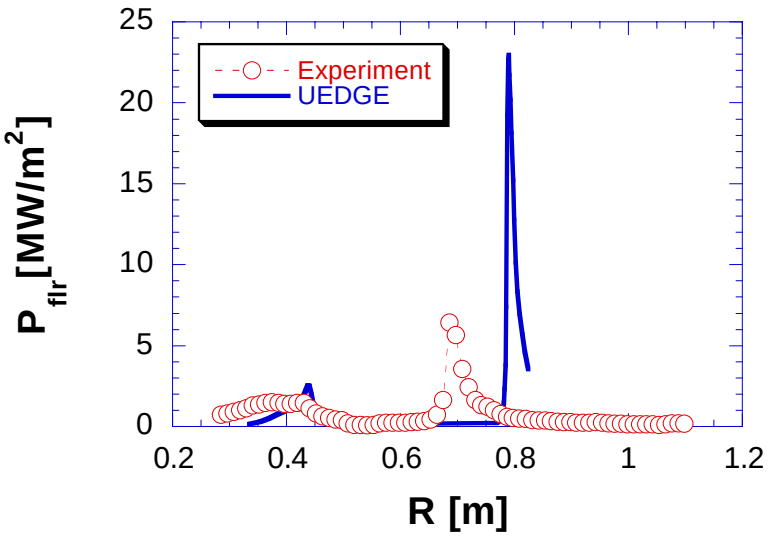


$$D_\perp = 1.0 m^2/s$$

$$\chi_i = \chi_e = 3.0 m^2/s$$

Divertor heating power is too large in simulation

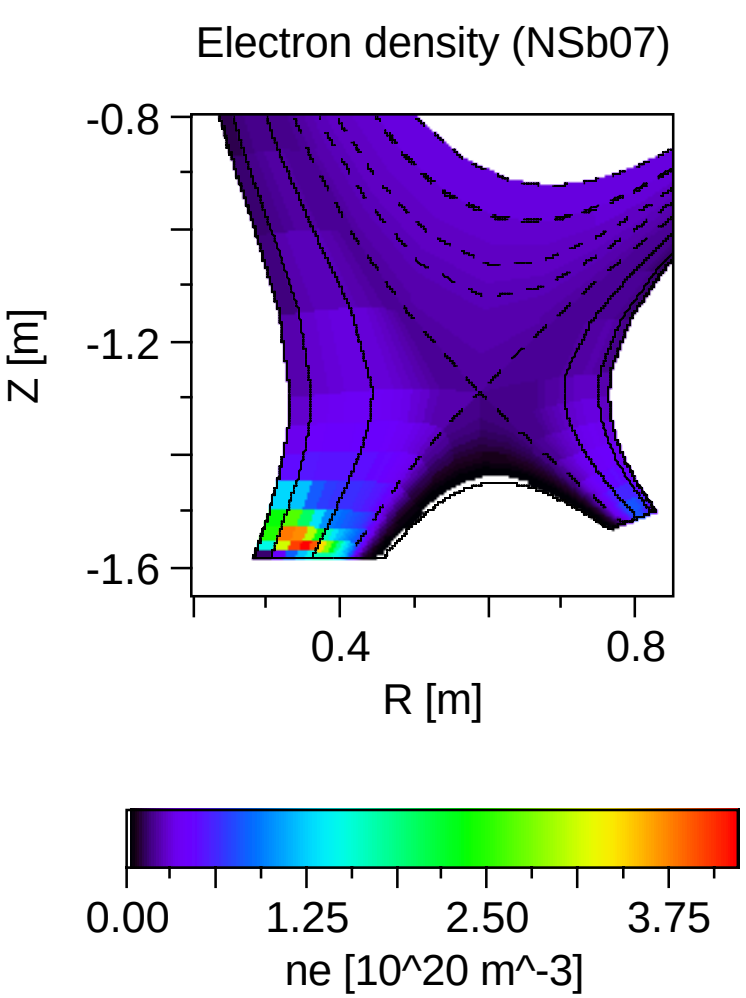
- Only 0.6 MW radiated (0.41 MW in carbon, 0.19 in deuterium)
- Peak at strike point determined from EFIT
- Experiment peaks ~10 cm on PF side of strike point
- Same effect seen in DIII-D if j(separatrix)=0 in EFIT

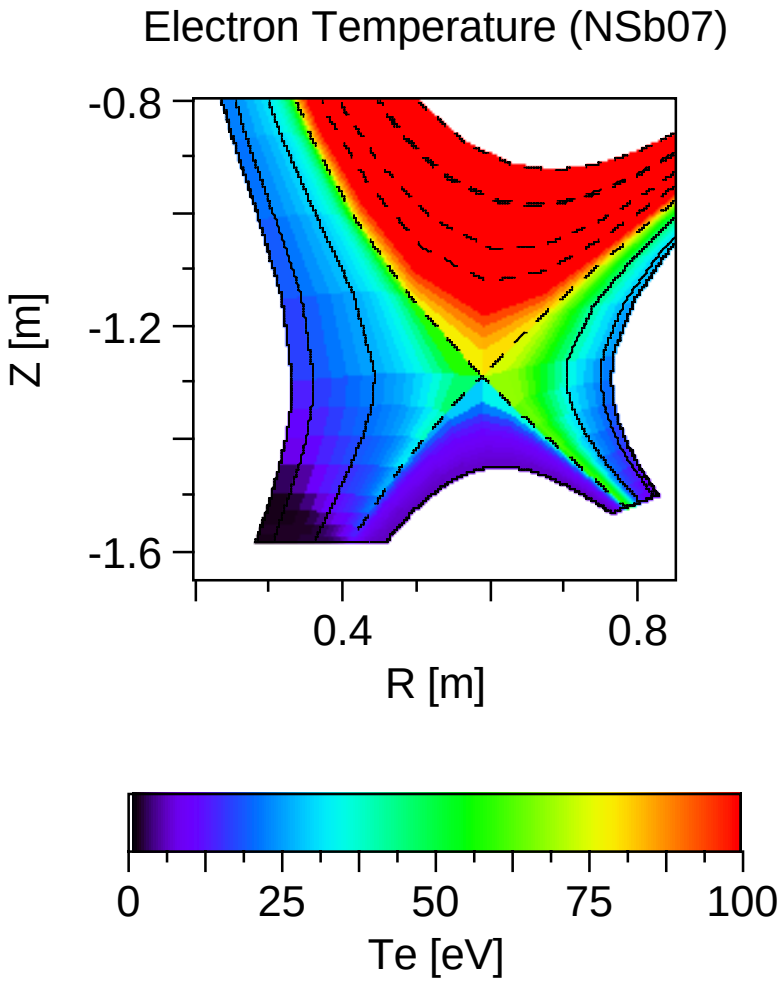


$$D_{\perp} = 1.0 m^2 / s$$

$$\chi_i = \chi_e = 3.0 m^2 / s$$

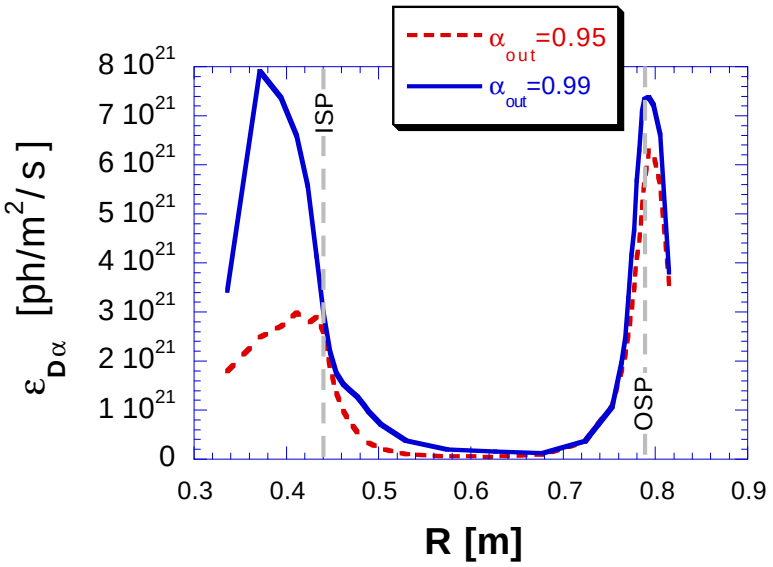
Inner divertor low temperature, but not detached





Reduced outer wall pumping increases D_α emission

- Neutral albedo increased from 95% to 99%
- Total radiation increased to 0.9 MW
- Peak divertor heating power dropped only 10%
- Suggests less power is flowing across 90% flux surface



Summary

- We have a good start on analysis of recent boundary characterization experiments
- Separatrix position calculated by EFIT seems inconsistent with edge data
- H-mode transport coefficients appear about 10 times DIII-D
- Simulated impurity content is lower than experiment