Status of BOUT modeling of NSTX

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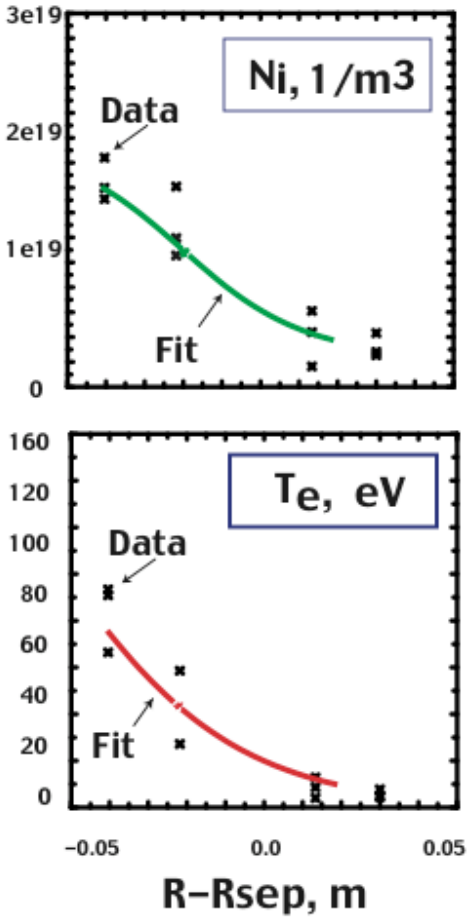
Setting a BOUT case for NSTX

- **Using a well-diagnosed NSTX shot 109033**
- **EFIT-based geometry**

  -Problem: EFIT data don't extend sufficiently far into SOL
- **Regression fit to radial profiles of T_e, N_i from Thomson data**

  -Problem: Thomson data have large scatter in the SOL

  -Problem: Fitting NSTX profiles with UEDGE is very non-trivial



NSTX case presents difficulties for BOUT due to relatively weak toroidal field

- **Large gyro-radius:** **The radial size of computational doman $\Delta X/\rho_s$ is rather small. This leads to the radial boundary conditions (in particular for the vorticity ω) strongly affecting the results.**
  Need to develop consistent boundary conditions for ω

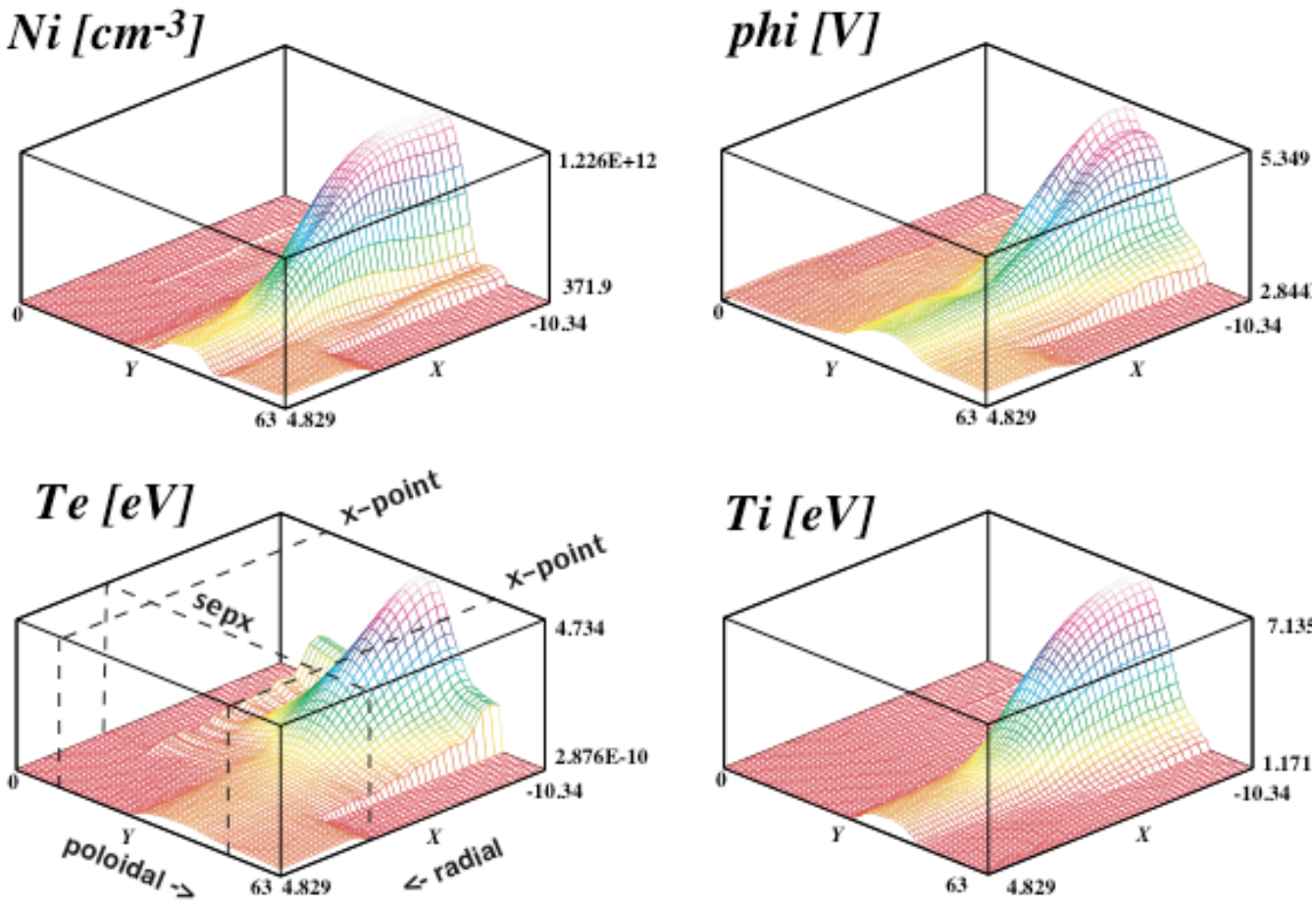
- **Small Btor/Bpol:**
  Time step is limited by electrostatic shear Alfven modes

$$\omega = \sqrt{\frac{M}{m}}\,\Omega_{ci}\,\frac{k_{\parallel}}{k_{\perp}} \qquad 1/q$$

- **Leads to extremely small time step!** $\Delta t \sim O(1e\text{-}3/\Omega_{ci})$

BOUT results from not fully saturated run

Turbulent activity peaks near core boundary. An artifact of □ boundary condition?

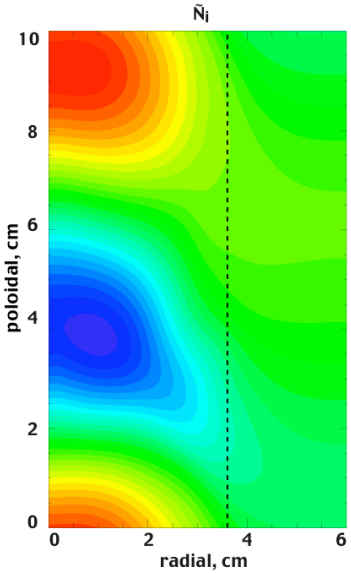


BOUT results from not fully saturated run

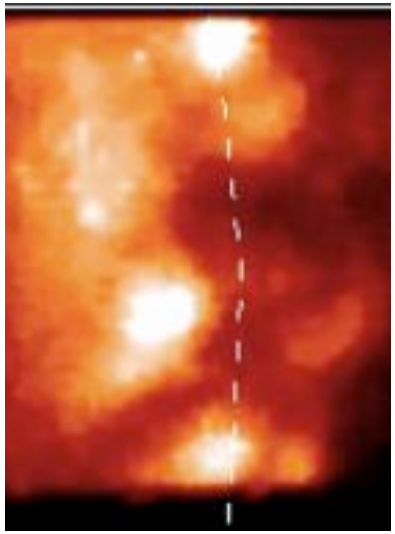
BOUT fluctuations from NSTX case appear to have reasonable spatial and temporal scales

- $\tilde{N}_i$ at the level ~10%
- $\tilde{T}_{ei}$ at the level a few eV
- $\tilde{\phi}$ at the level ~10 V
- Spatial scale ~ 2 cm
- Frequency f ~ 1e5 s^{-1}

BOUT



SZ data



Summary/Conclusions

- **Modeling of NSTX presents a challenge for BOUT, due to the relatively weak B-field**
- **The time step is extremely small, limited by high-frequency electrostatic shear-Alfven modes**
- **Large ρ_* leads to difficulties in the potential solver through the radial boundary conditions for ϕ**
- **Nevertheless, we have obtained some preliminary results with BOUT for NSTX**
- **With collecting a longer time history we will attempt quantitative comparison with the experimental data**