Characterization and Scaling of Type I ELMs on NSTX

- Motivation

  - ELM phenomena on NSTX appears different from conventional tokamaks (e.g. size scaling, perturbative penetration)

  - On conventional tokamak, ELM is mixture of n_e, T_e perturbation and relative proportion scales with collisionality

  - Effects of conductive ELMs more damaging to power handling structures

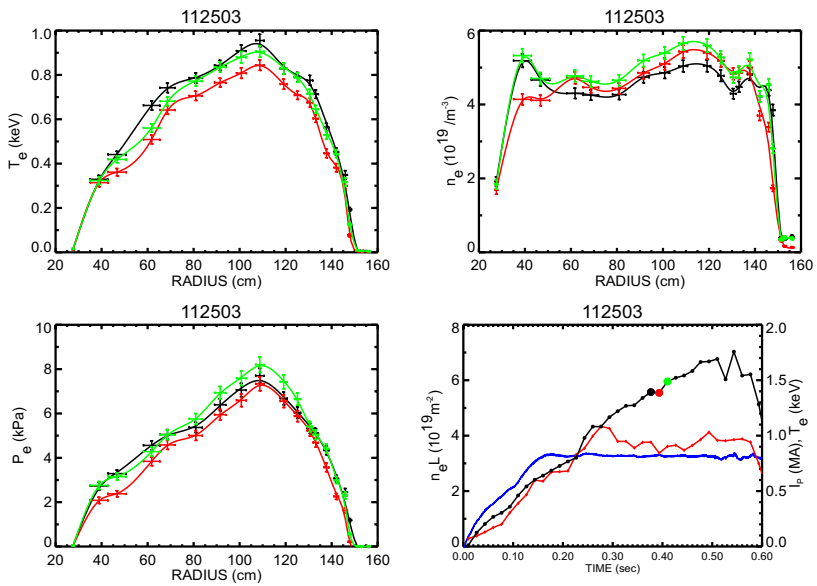
- Goals

  - Understand the scaling of conductive/convective ELM proportionality on NSTX

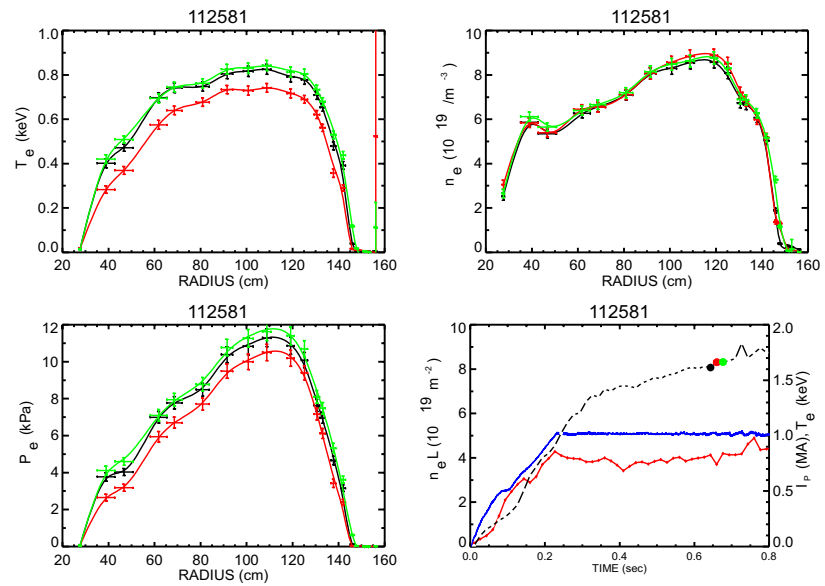
  - Investigate the dependence of the propagation and penetration of the Type I ELM perturbation

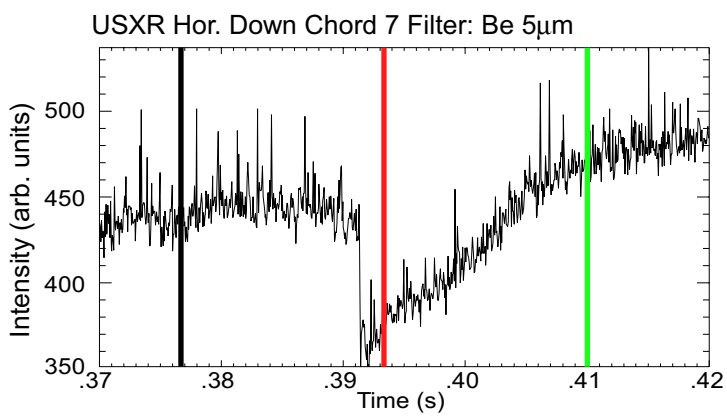
Type I ELMs Show Mixture of T_e, n_e Perturbation

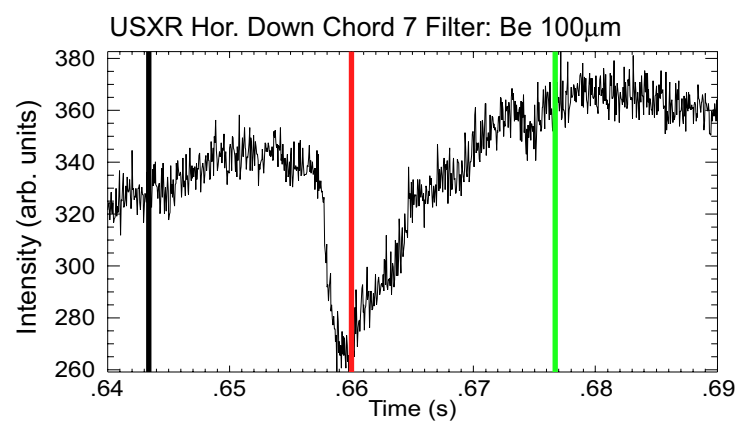
Combination T_e, n_e perturbation



Primarily T_e perturbation





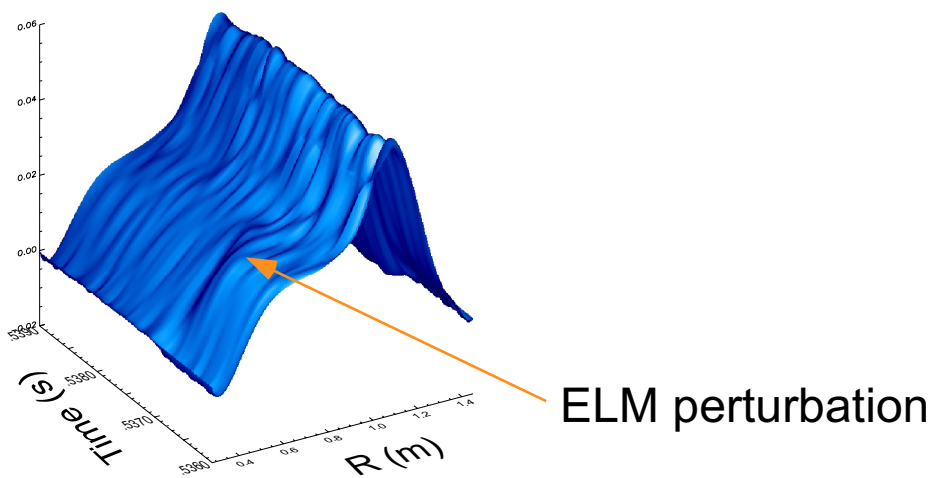


- In above cases, perturbation reaches core of plasma

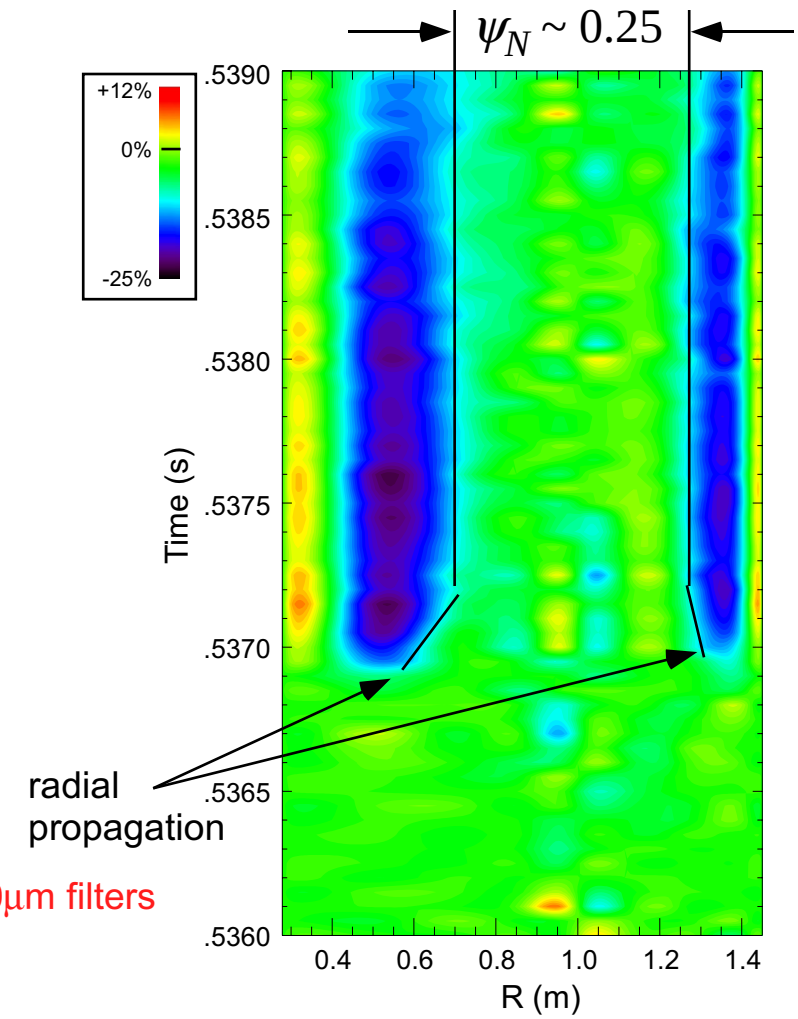
Not All Perturbations Feature Propagation to the Core

- ELM erodes "bump" at inboard of plasma
  - Perturbation reaches $\psi_N \sim 0.25$ (0.7m inboard, 1.27m outboard)
  - Radial propagation ~few 100μs
  - Preliminary hints that ELM size/ propagation boundary related to I_p

Reconstructed midplane intensity



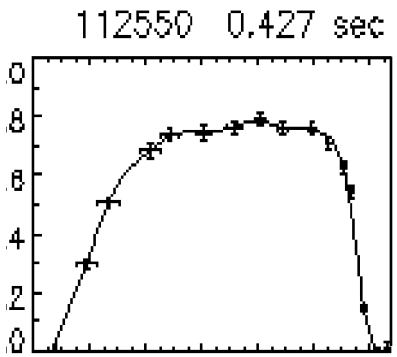
Relative midplane intensity change



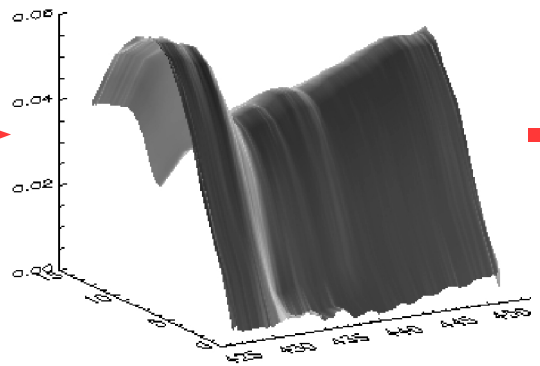
Tomographic reconstruction of shot 112581 @ .536s, Be 100μm filters

Multi-color SXR Imaging Separates Δn_e, ΔT_e

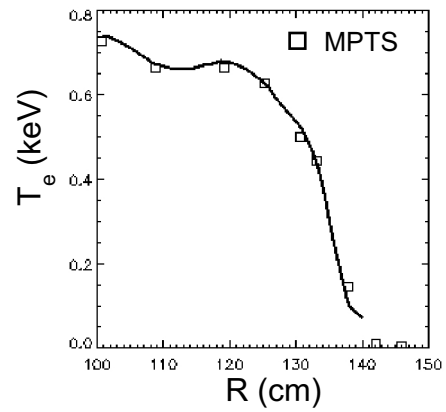
MPTS $T_e(R)$ @ .427s



$\frac{E > 1.4keV}{E > 0.4keV}$ intensity ratio



Post-ELM MPTS Comparison



- Use Be 100μm/Be 5μm ratios to propagate MPTS T_e profile
  - Use pre-ELM MPTS to fit model parameters (e.g., $n_e(R)$, $n_z(R)$, $T_e(R,t=t_0)$)
  - High / low energy USXR ratio T_e sensitive, n_e x n_z factors out
  - USXR spectrum modeled with C, O, and B coronal radiative coefficients and EFIT mapping
  - Good agreement between USXR 'prediction' and subsequent MPTS T_e profile

Experimental Proposal

- Use 'typical' high performance H-mode plasma which exhibits desired Type I ELM phenomena
- Scan plasma current, TF, NBI power (if headroom exists)
  - Investigate I_p scan at fixed TF and fixed q
  - Density scan occurs naturally throughout shot
  - Repeat shots for statistics and to change USXR filters between tomographic and multi-color configuration
- Diagnostics
  - USXR (multi-color/tomographic)
  - Transmission grating spectrometer (if available)
  - MPTS (preferably with spatial resolution upgrade)
  - CHERS (preferably with time resolution upgrade)
  - Fast divertor camera (measure relative inboard/outboard arrival time)
  - MSE (edge channels if available)
- Analysis
  - Multi-color/tomographic imaging of ELM perturbation and propagation
  - If diagnostic coverage permits, stability analysis and comparison of eigenmodes to radial structure of perturbation