JOHNS HOPKINS
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NSTX

Study of the Relationship between Type I ELM Severity and Perturbed Electron Transport in NSTX

presented by

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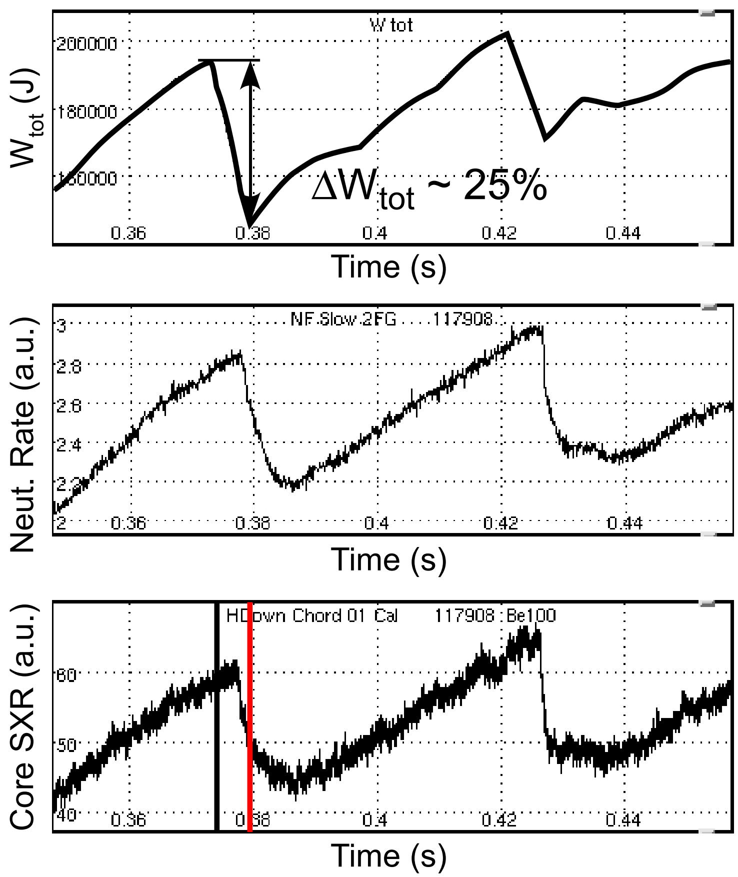
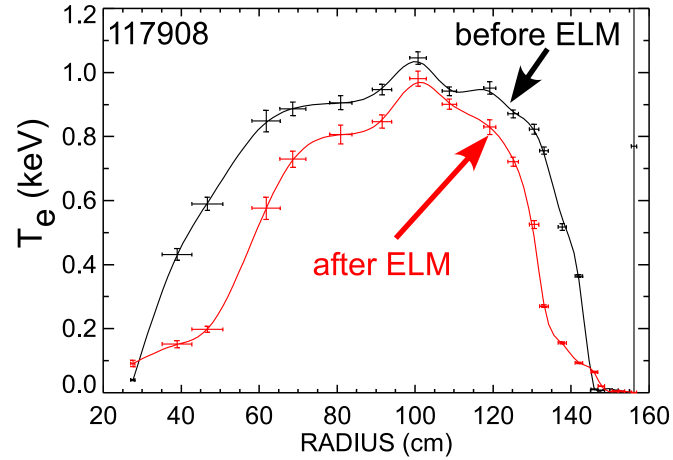
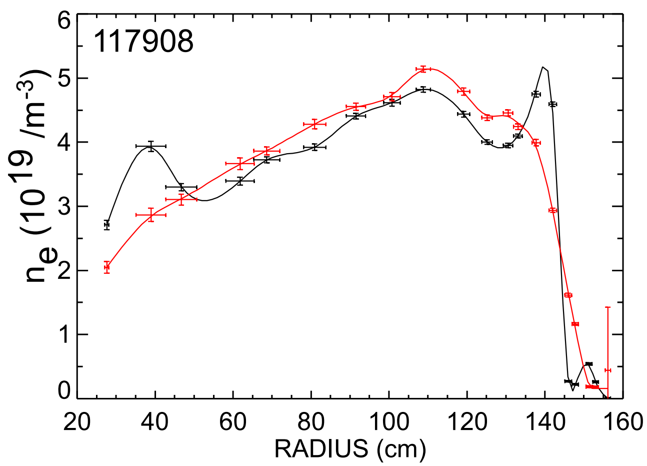
‘Giant’ Type I ELMs During High Power, LSN Plasma



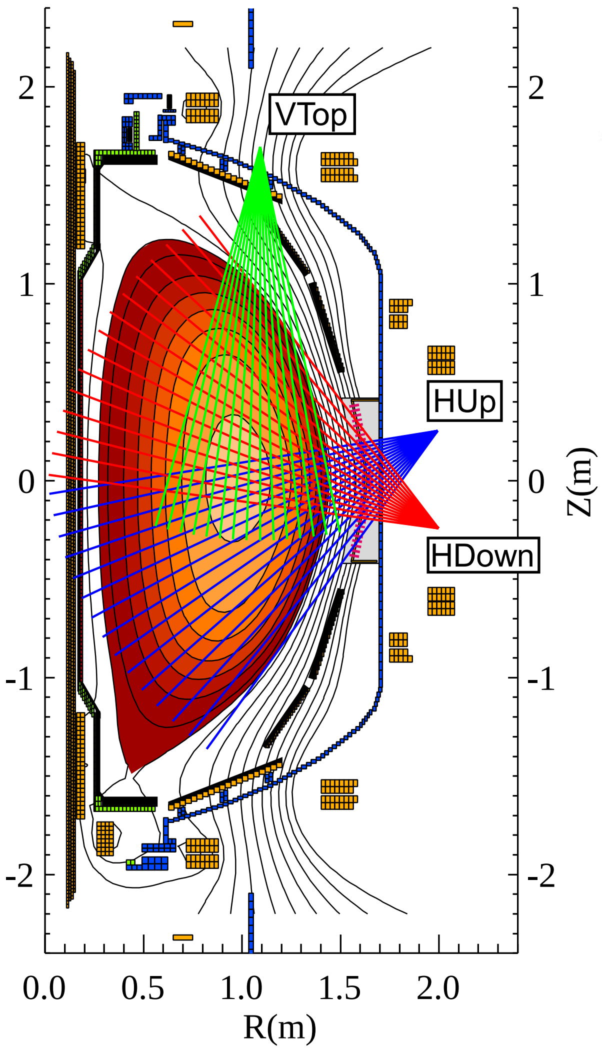




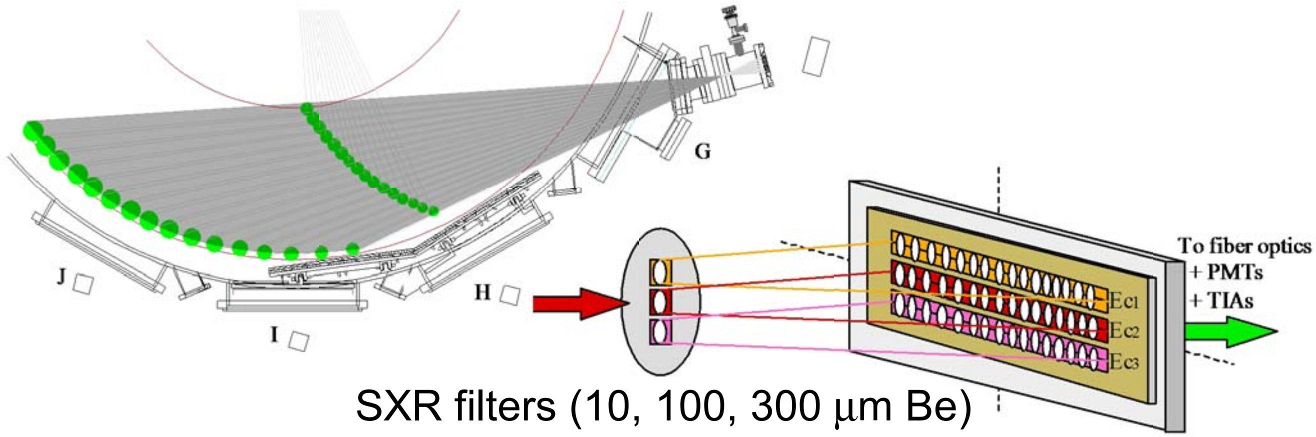
- Perturbation has large effect on W_{tot} and T_e profile
- n_e global profile relatively unchanged
- USXR tracks ELM induced T_e perturbation on few μsec timescale

Multicolor SXR Diagnostic for Fast T_e Measurements

Poloidal USXR Array



Multicolor Tangential Optical Soft X-ray Array



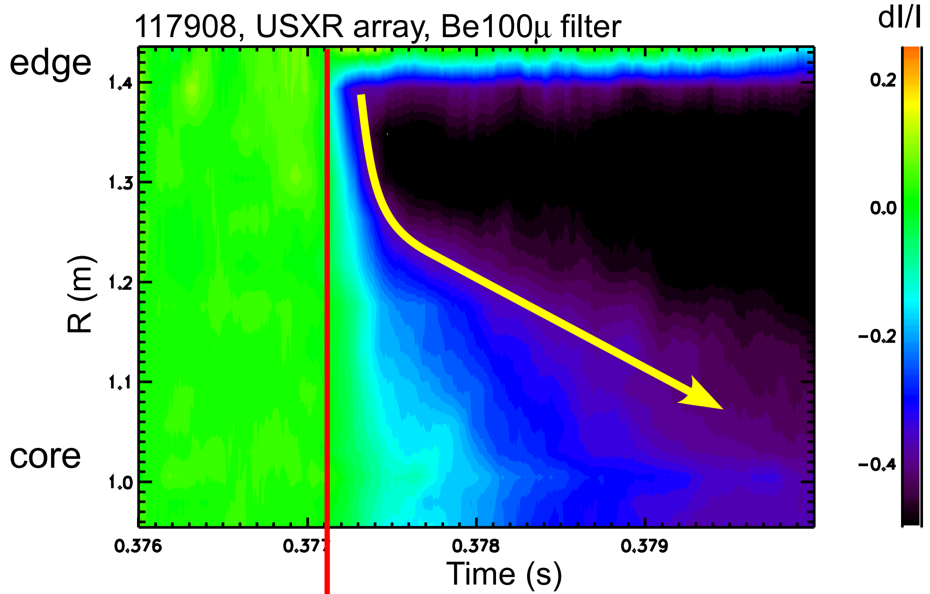
SXR filters (10, 100, 300 μm Be)

$Energy_{cutoff}$ (0.6, 1.6, 2.4 keV)

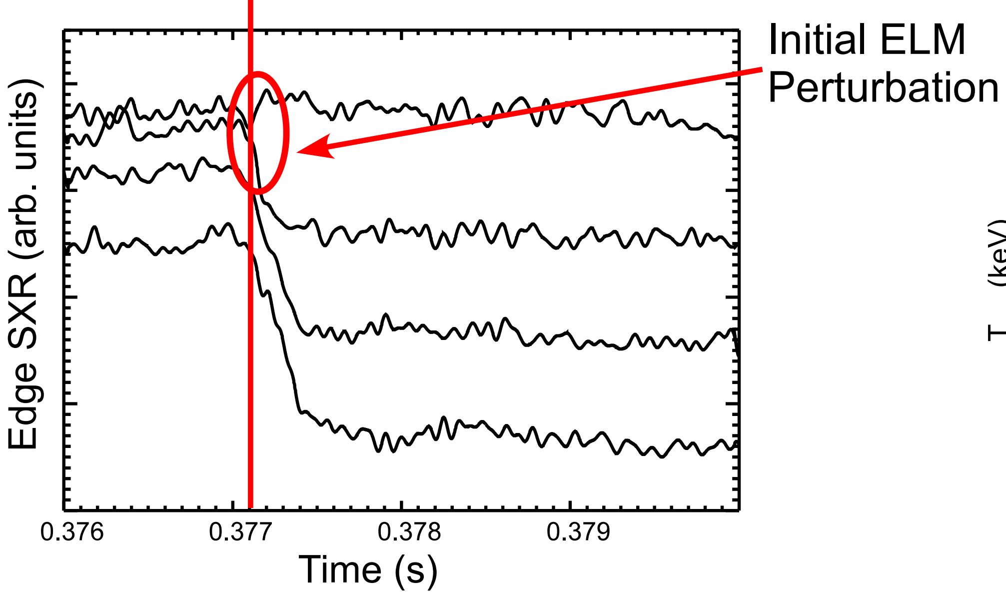
- “Multicolor” filter set simultaneously samples same plasma volume
- Time propagation of normalized Thomson profiles extracts fast T_e information from SXR
- Poloidal system improves edge spatial coverage

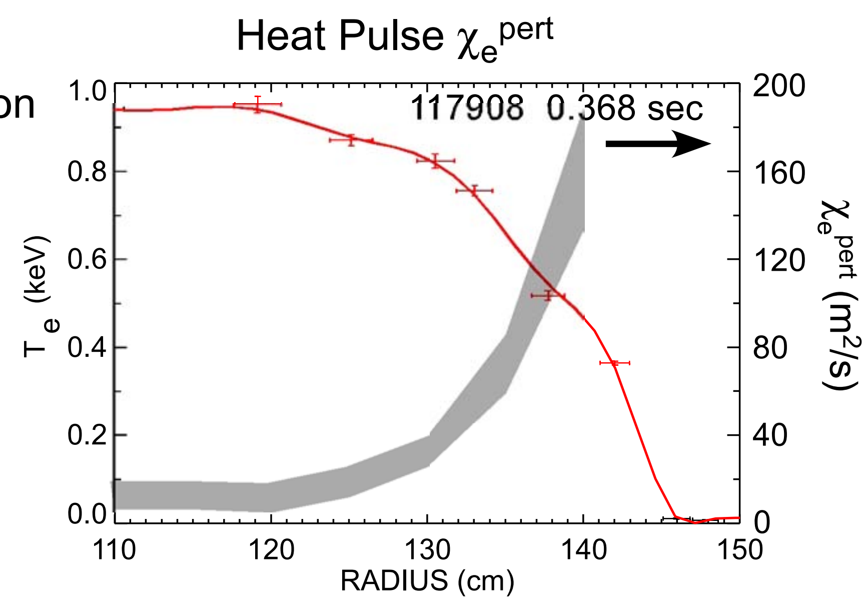
SXR Data Indicates Rapid Cold Pulse Propagation

Relative change of SXR signal

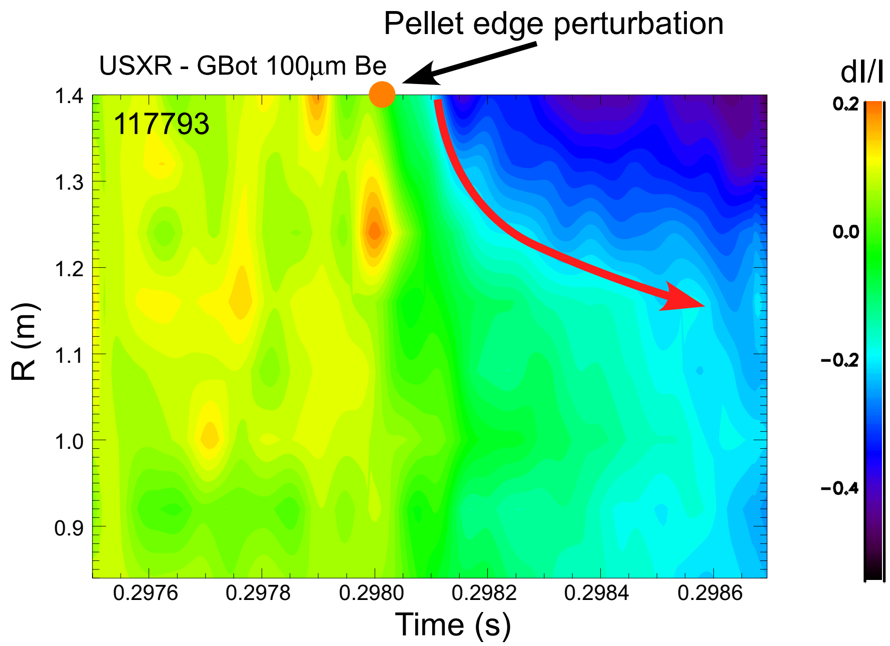


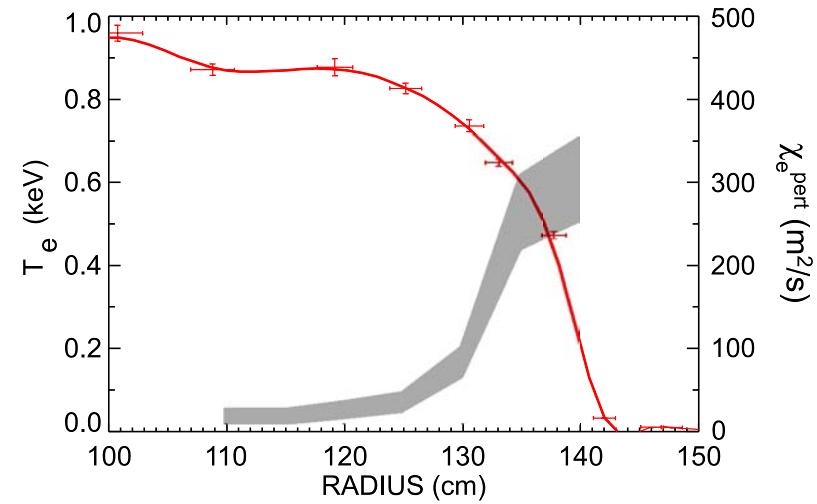
- T_e crash propagates from edge to core (~1m in 2ms)
- Propagation indicates two regions of perturbed transport
- Sawtooth heat pulse model estimates perturbed χ_e (Callen, Nucl. Fus. **19**, 1979)

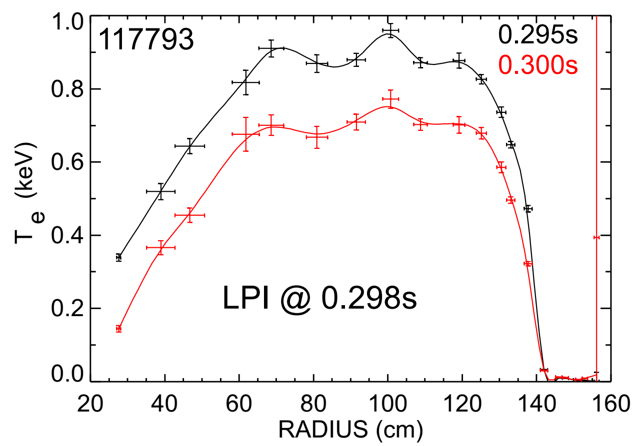


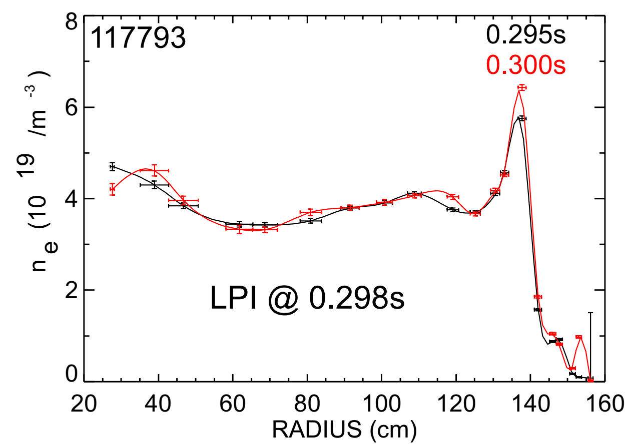


Lithium Pellet Perturbation Similar to Type I ELM



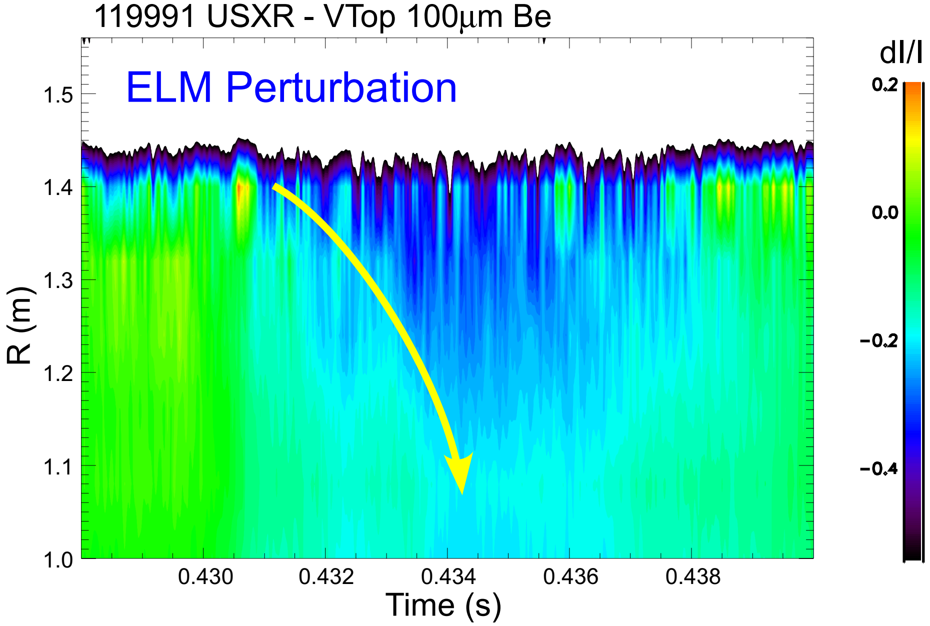


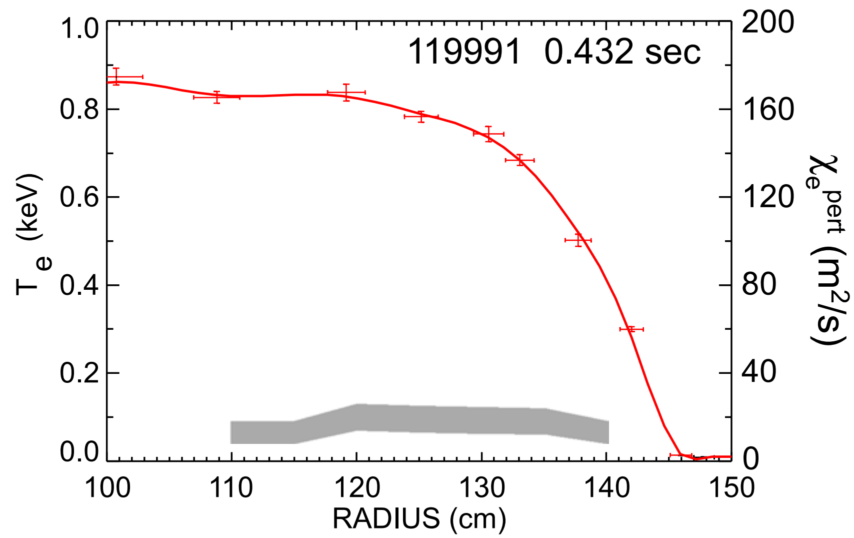


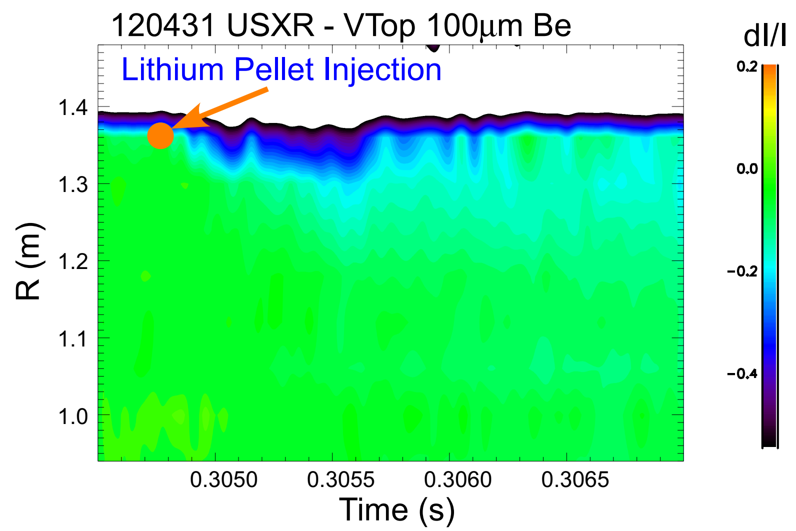


- Pellets used to probe χ_e^{pert} with controlled, small edge perturbation
- Plasma energy loss appears related to perturbed electron transport

High-δ DND Plasmas Show Reduced ELM Severity







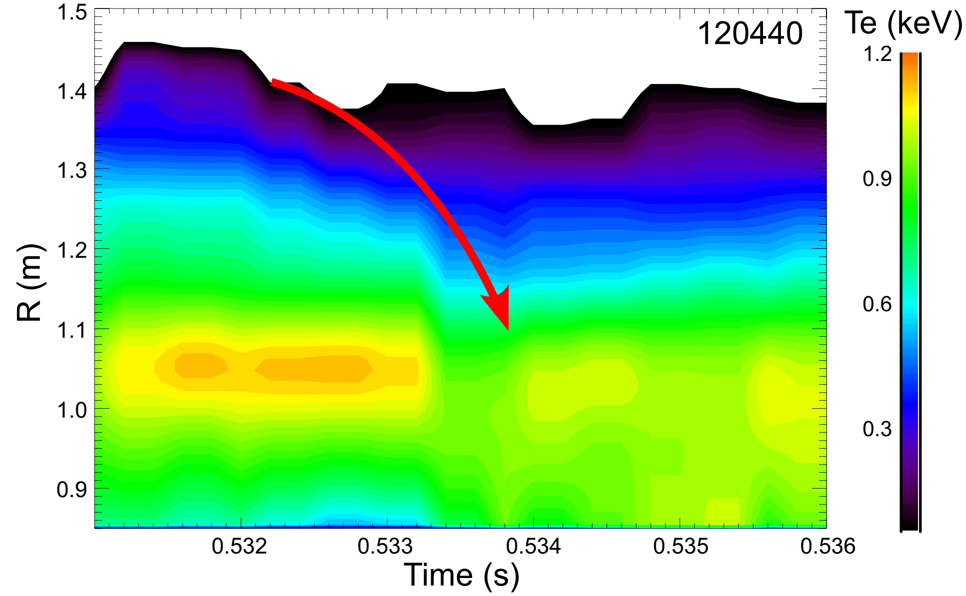
- ΔW_{tot} ~3-5%
- No fast edge propagation
- χ_e^{pert} ~10's m²/s across T_e profile

- ELM severity reduced when perturbed electron transport is reduced

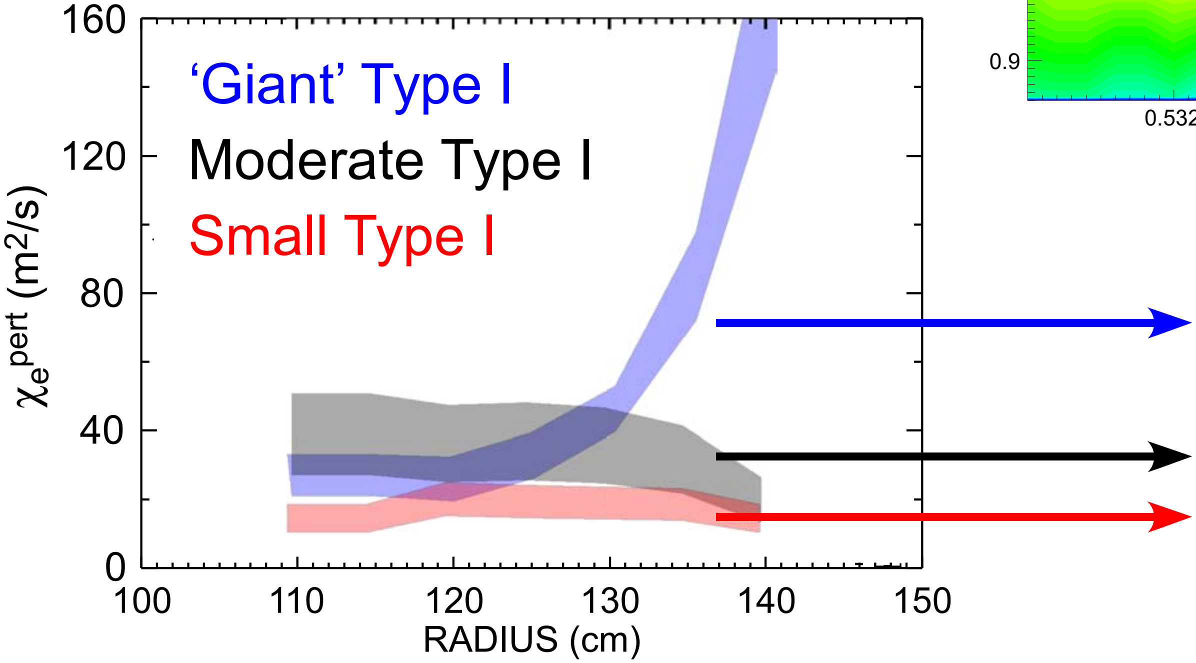
Furthermore, χ_e^{pert} and ELM Severity Change with NB Power

- P_{NB}, q-profile scan used to vary χ_e^{pert} (see poster by D. Stutman)

Fitted Multicolor T_e profile



Comparison of ELM severity



ΔW_{tot} ~ 25%

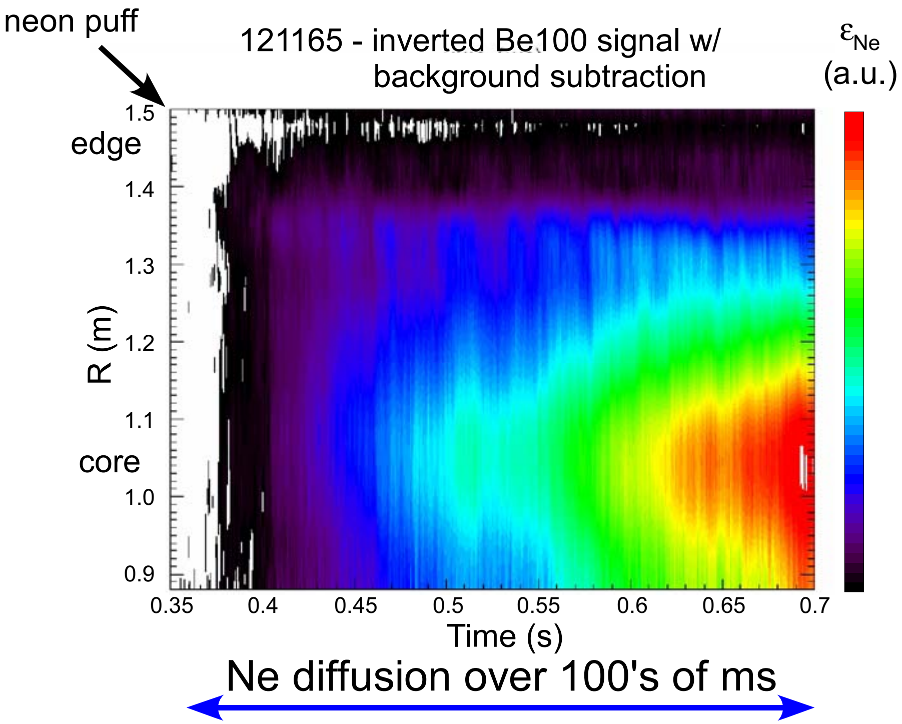
ΔW_{tot} ~ 10%

ΔW_{tot} ~ 4%

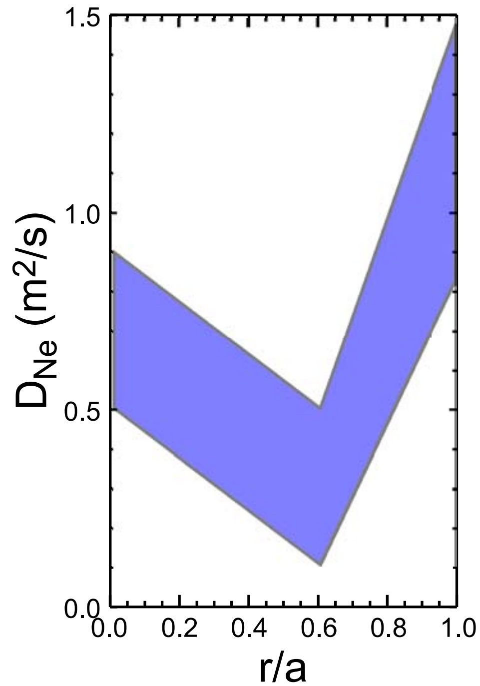
- ELM severity scales proportionally with perturbed electron transport

Perturbed Impurity Diffusion Much Slower Than χ_e^{pert}

SXR Neon Emissivity



MIST Simulation of Neon Diffusion



- D_{Ne} in the neoclassical range (see poster from L. Delgado)
- $\chi_e^{pert} >> D_{Ne}$ suggests suppression of low-k turbulence
- Energy loss possibly related to high-k and/or magnetic transport

Summary

- “Multicolor” USXR technique enables investigation of perturbed transport with good spatial and temporal resolution

- Type I ELM severity appears related to perturbed electron thermal transport:

  i) ‘Giant’ Type I ELMs have strong χ_e^{pert} at r/a > 0.5

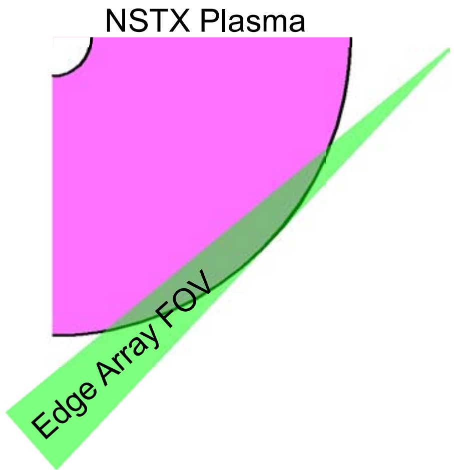
  ii) Pellet injection has the same perturbative effect in the same plasmas

  ii) χ_e^{pert} and ELM severity seem to directly correlate

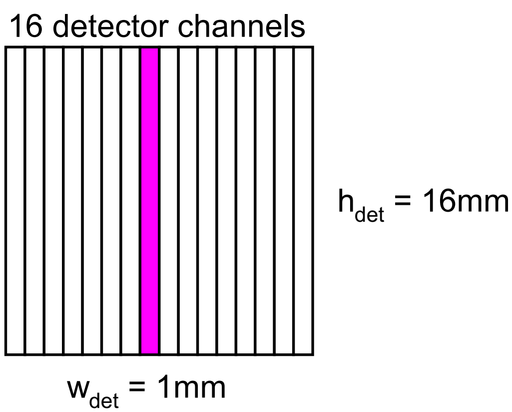
- $D_{Ne} << \chi_e^{pert}$ suggests high-k or magnetic turbulence may be involved

- High resolution, multicolor edge array planned to improve spatial resolution in the pedestal

Multicolor Edge Array for High Resolution Edge T_e



- Edge array designed for tangential view of plasma edge ~135-150cm
- Pixels are narrow for high radial spatial resolution and tall for increased throughput
- Spatial resolution ~1cm desired to resolve edge gradients



- Field curvature can "smear" radial resolution ~δR if 3-D response not evaluated