Perturbative electron transport experiments using 'two-color' USXR imaging and pellet injection

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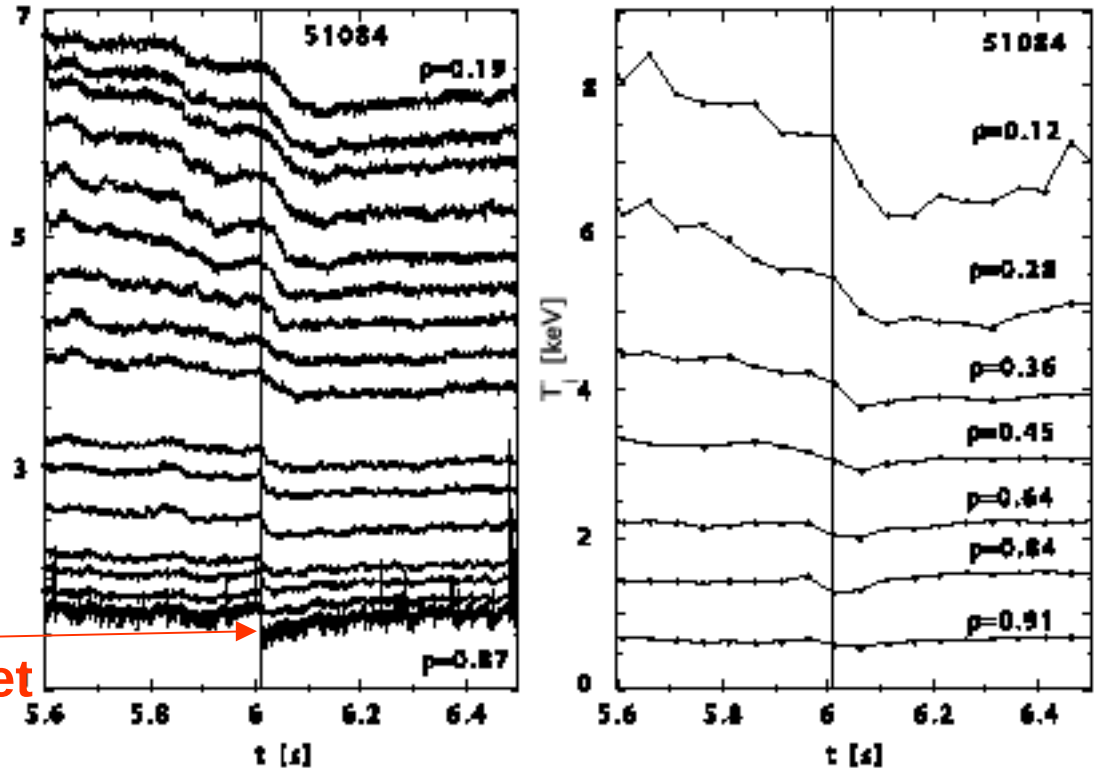
Pellet 'cold pulse' can probe χ_e^{inc}

Shallow pellet injection in JET (Mantica et al, PPCF 02)

T_e ECE (keV)

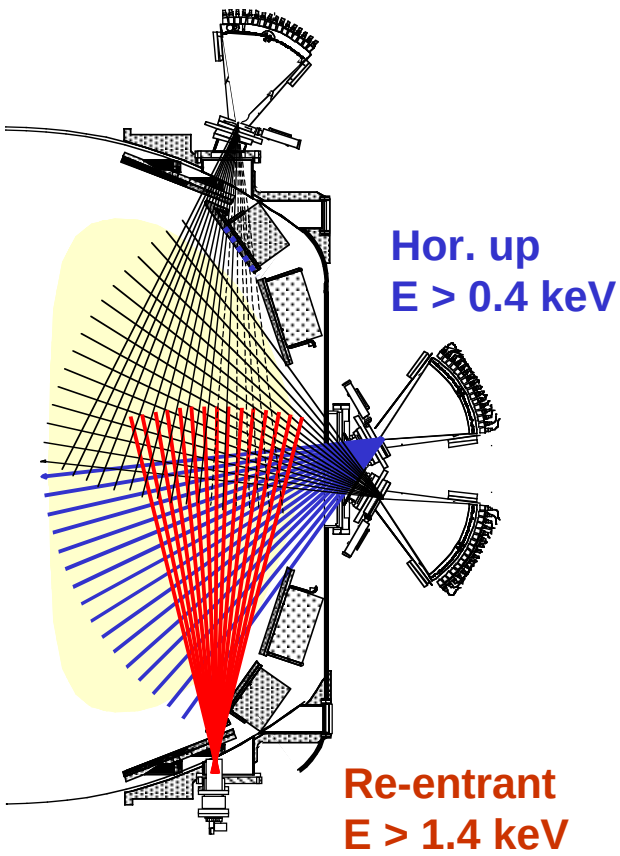


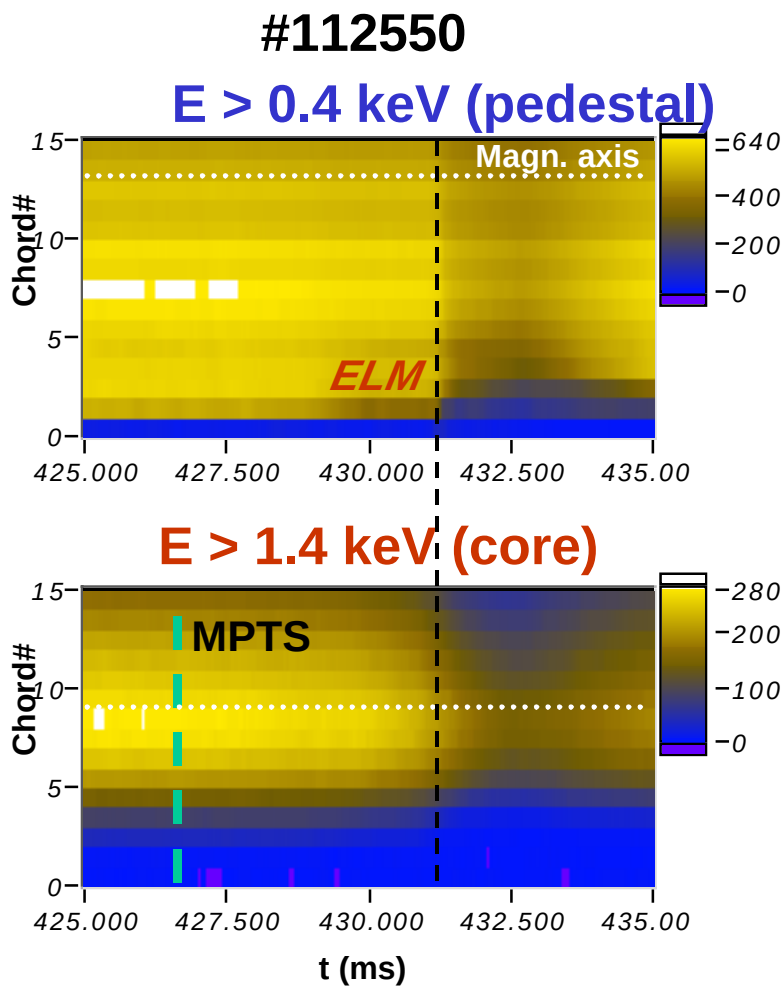
T_i CHERS (keV)

d≈ 3 mm,
80 m/s D pellet

- Powerful test of 'criticality' of electron transport from edge to core (extensive TFTR experience)
- In conjunction with turbulence measurements and nonlinear modeling could help understand transport origins in NSTX
- 'Two-color' USXR imaging *in lieu* of ECE

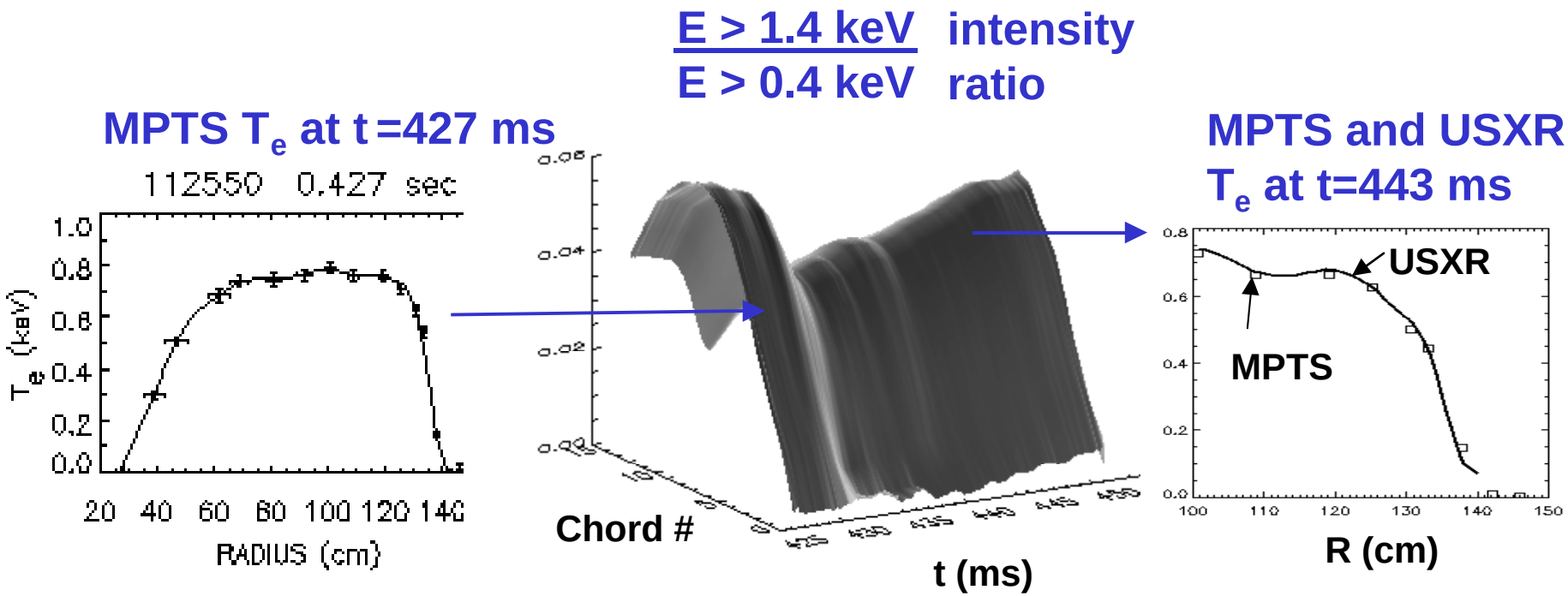
Two-color USXR 'sees' fast T_e perturbation at Type-I ELM





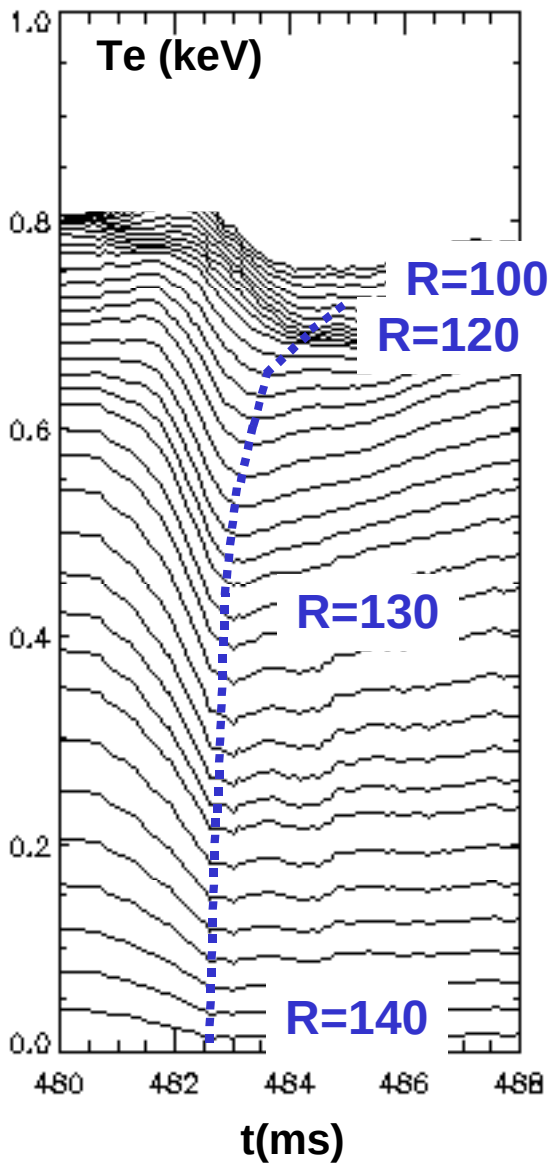
- Low energy profile shows rapid pedestal crash
- High energy profile suggests fast 'cold pulse' propagation in the core
- No reconnection in the core (transport and not MHD effect)

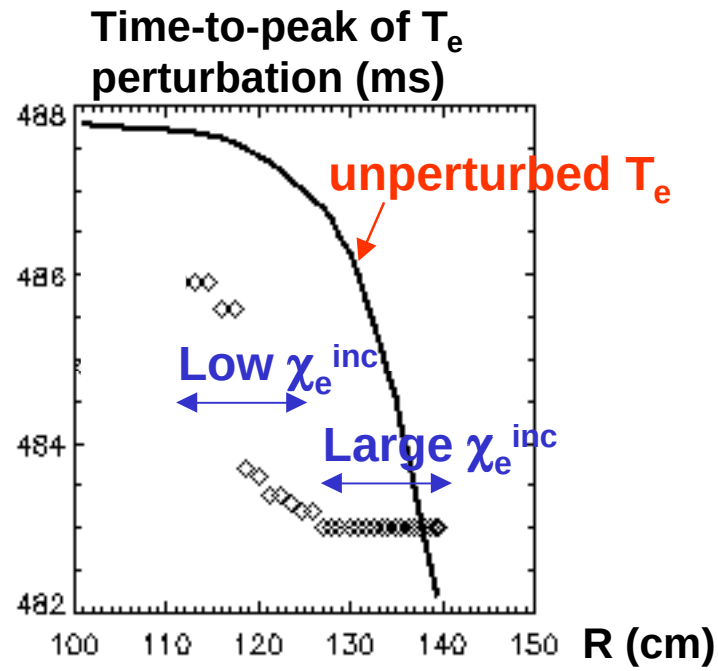
MPTS T_e profile 'propagated' by two-color modeling



- High / low energy USXR ratio T_e sensitive, N_e x N_z factors out
- Need however to correctly model the USXR spectrum
- C, O and B with coronal radiative coefficients and EFIT mapping
- Small N_e x N_z perturbation at ELM (K. Tritz, Results Review)
- Good agreement between USXR 'prediction' and next MPTS T_e profile

Very large difference between χ_e^{inc} and χ_e^{PB} in NSTX ?

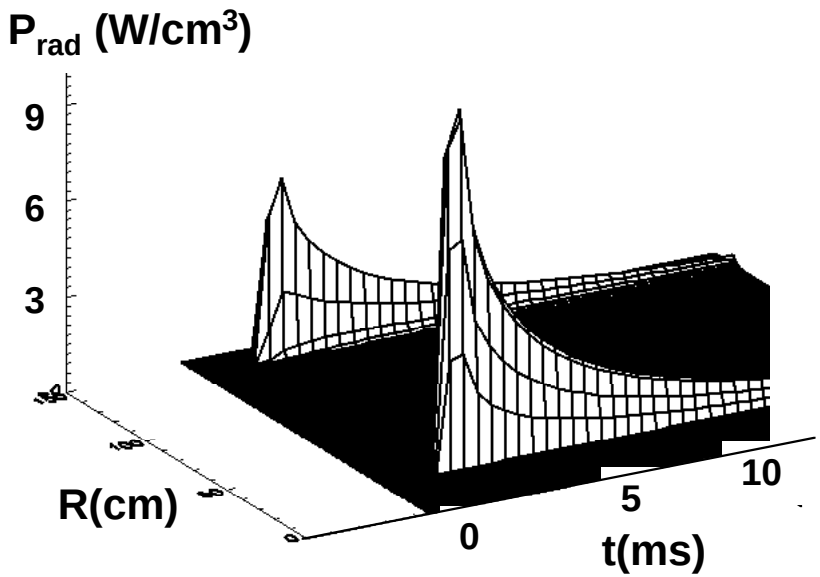




- Initial modeling suggests very fast propagation in region of large ∇T_e and slow propagation where ∇Te is low
- Are we *far above* a critical gradient ? 'Ballistic' effects ?
- Proposed XP would use *controlled* T_e perturbation instead of random ELMs

Graphite pellet could be used for edge T_e perturbation

1 mg C at the separatrix (H-mode)



- Power radiated by C pellet sized at present capability of NSTX injector (few mg) could make fast (≈ ms) edge T_e perturbation
- C would not alter the USXR spectrum (JHU imaging TG spectrometer)
- CHERS could possibly be used for T_i, N_z perturbation (likely slower)
- Supersonic Gas Injector could also be tried (CH_4, N_2, Ne)

Proposed experiment

- **Establish C injection capability in separate XMP (1/2 day)**
- **Perturbative electron (ion, particle) transport measurements in discharges with different T_e and q-profiles (1 day):**
  - **H-mode vs. L-mode**
  - **Flat-q vs. reversed-q (L-mode and H-mode if achieved)**
  - **I_p scaling (hints that electron transport improves), P_{beam} scaling (fast degradation ?), β scaling**
- **Diagnostics:**
  - **multi-color USXR**
  - **multi-chordal Transmission Grating spectrometer (JHU)**
  - **MSE**
  - **CHERS, MPTS**
- **'Cold pulse' analysis (E. Fredrickson), GYRO and GS2 analysis**
- **Experience important for upcoming runs, when dedicated *multi-color Optical USXR arrays* (talk by L. Delgado) and *high-k turbulence measurements* will be available**