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

Boundary Group XP Proposal for 2006 run

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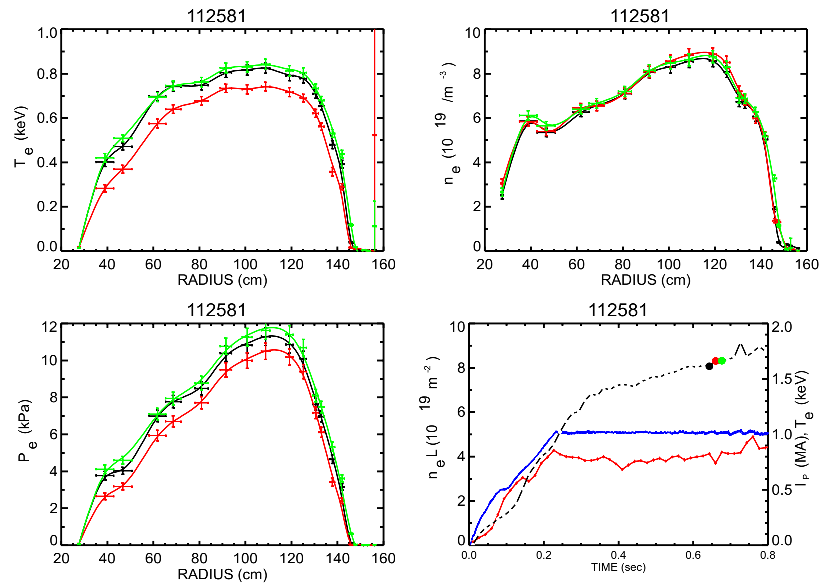
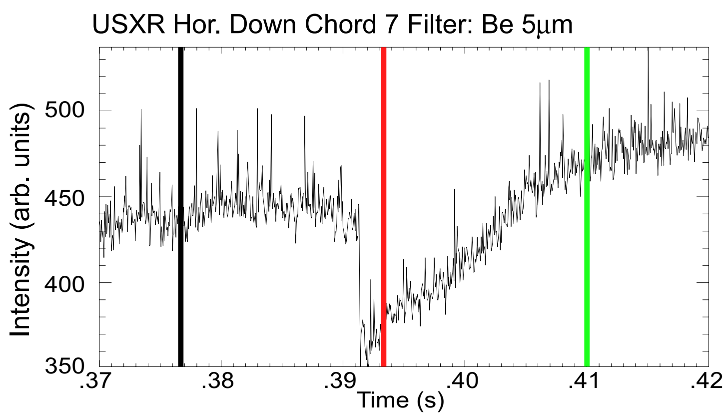
Experimental Observations/Motivations

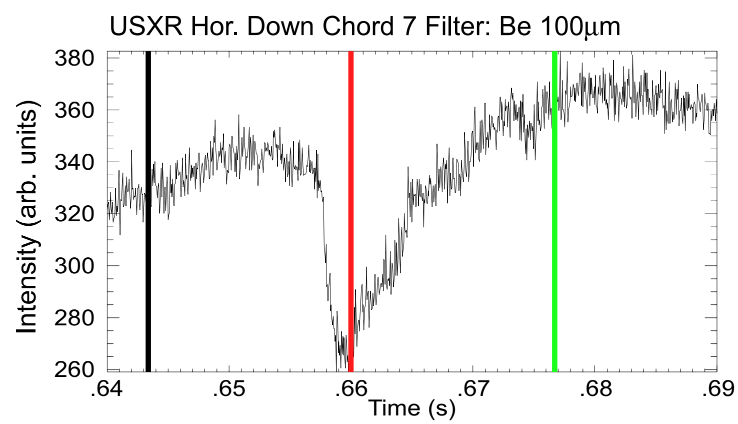
- **Motivation**
  - ELM phenomena on NSTX appears different from conventional tokamaks (e.g. ΔW_{tot}, perturbative penetration)
  - On NSTX, Type I ELM can perturb T_e profile with cold pulse reaching core on fast (~100's μs) time scales
  - Similar T_e perturbations observed with Li pellet injection into H-mode discharges
  - New long pulse regime (DND, high δ, 6MW) has small Type I ELMs and small pellet response
  - Perturbation heat flux XP612 indicated dependence of ELM/pellet response to current profile
- **Goals**
  - Use beam heating/timing to modify current profile (seen in XP612)
  - Scan profile to investigate dependence of ELM severity on current profile
  - Inject C pellets between/after ELM period to compare perturbations
  - Use pellets to check transport in LSN "modified" ELM regimes

Type I ELMs Show Global T_e Perturbation

Primarily T_e perturbation

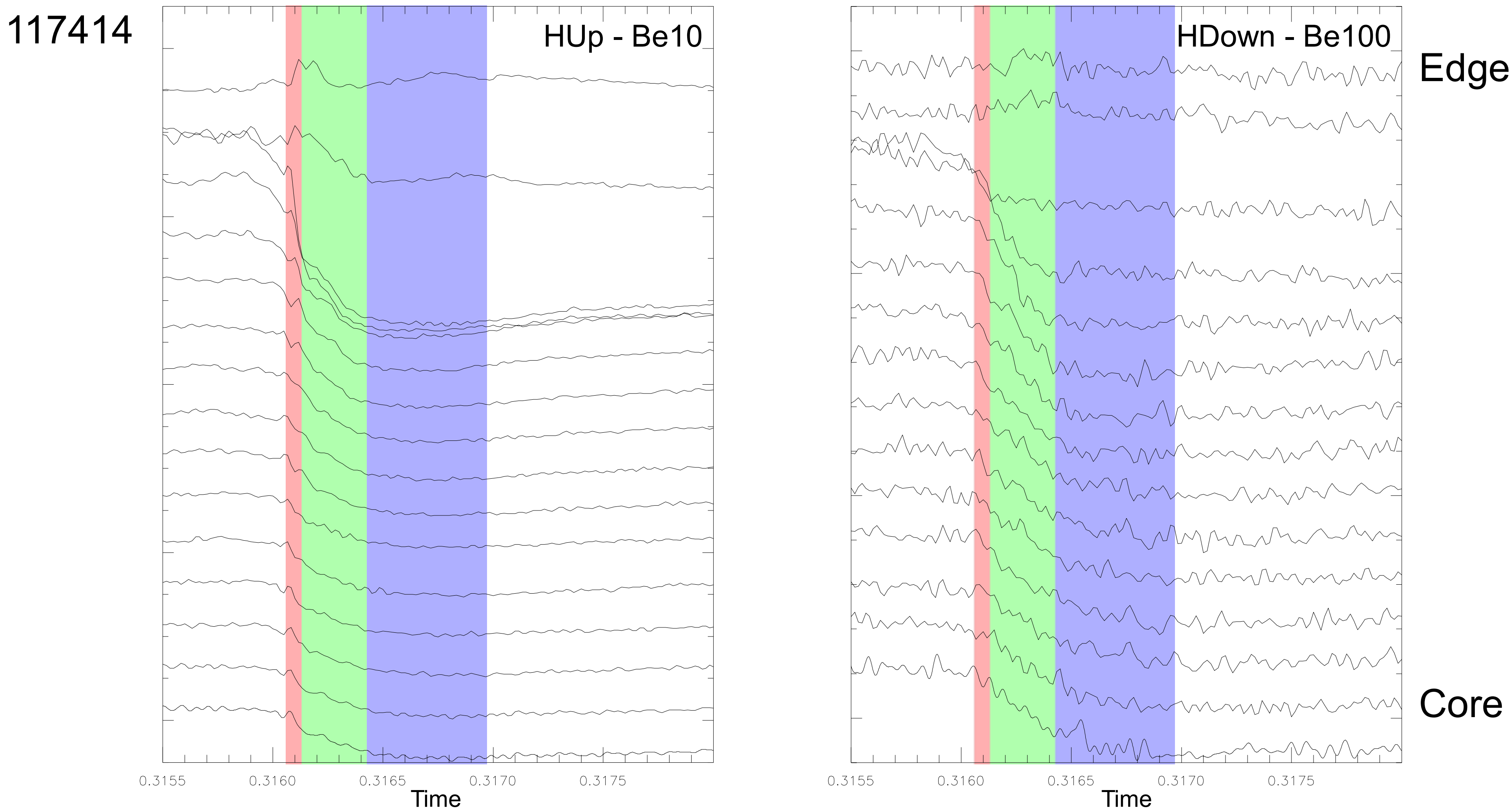






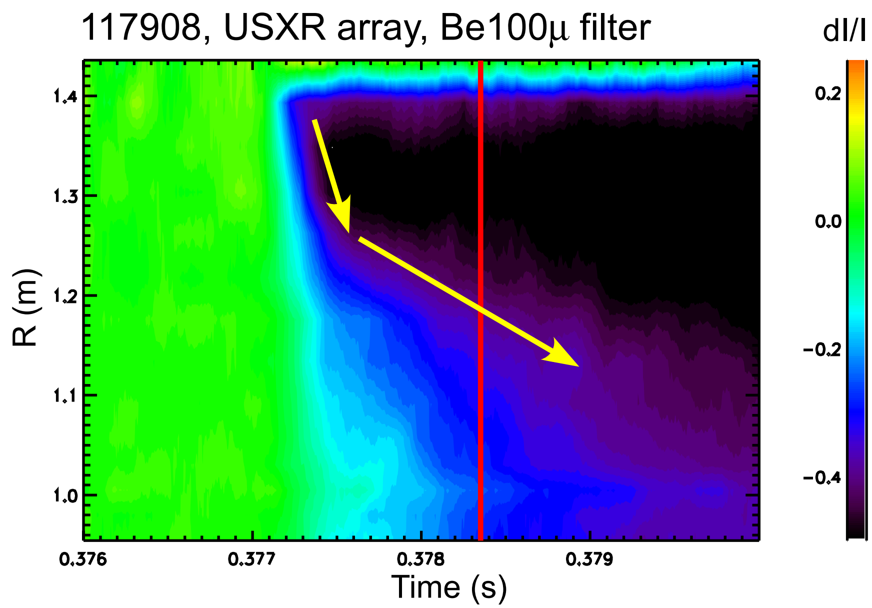
- In above case, perturbation reaches core of plasma

ELM Perturbation Evolves on Different Timescales



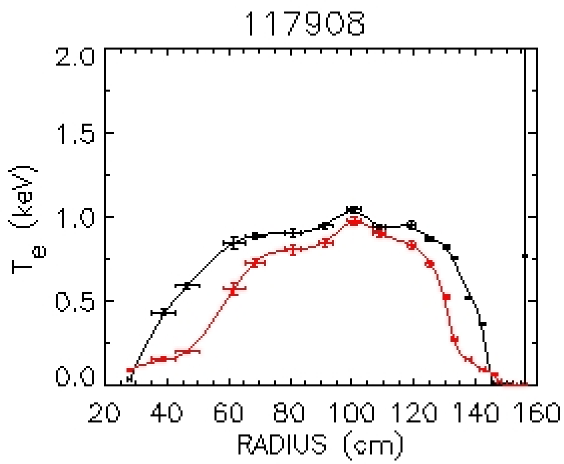
Fast edge crash	~50µs
Cold pulse propagation	~few 100µs
Te profile evolution	~0.5-3ms

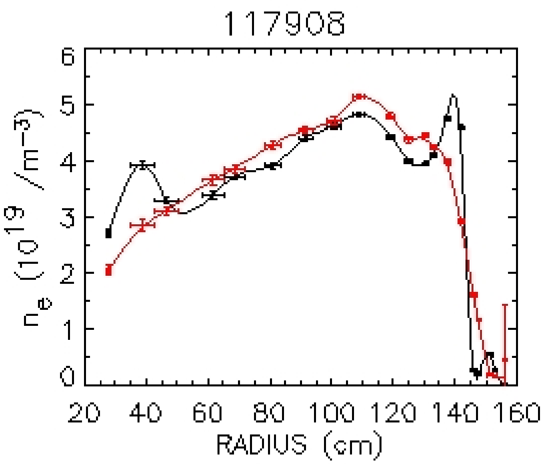
LSN Exhibits “Giant” Type I ELM Crashes

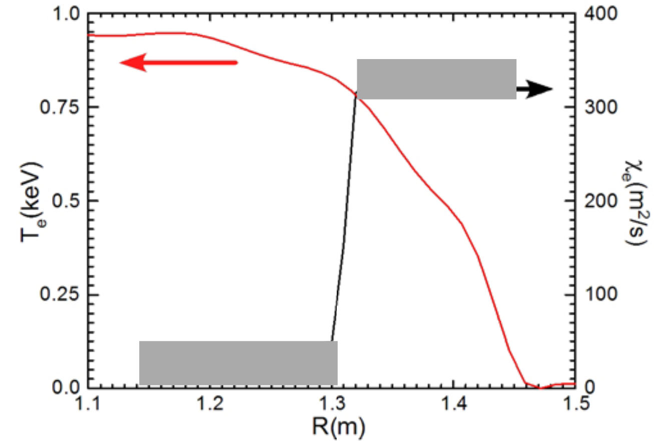


T_e crash propagates from edge to core, n_e globally unperturbed

Difference in propagation speed corresponds to differences in perturbed electron heat transport

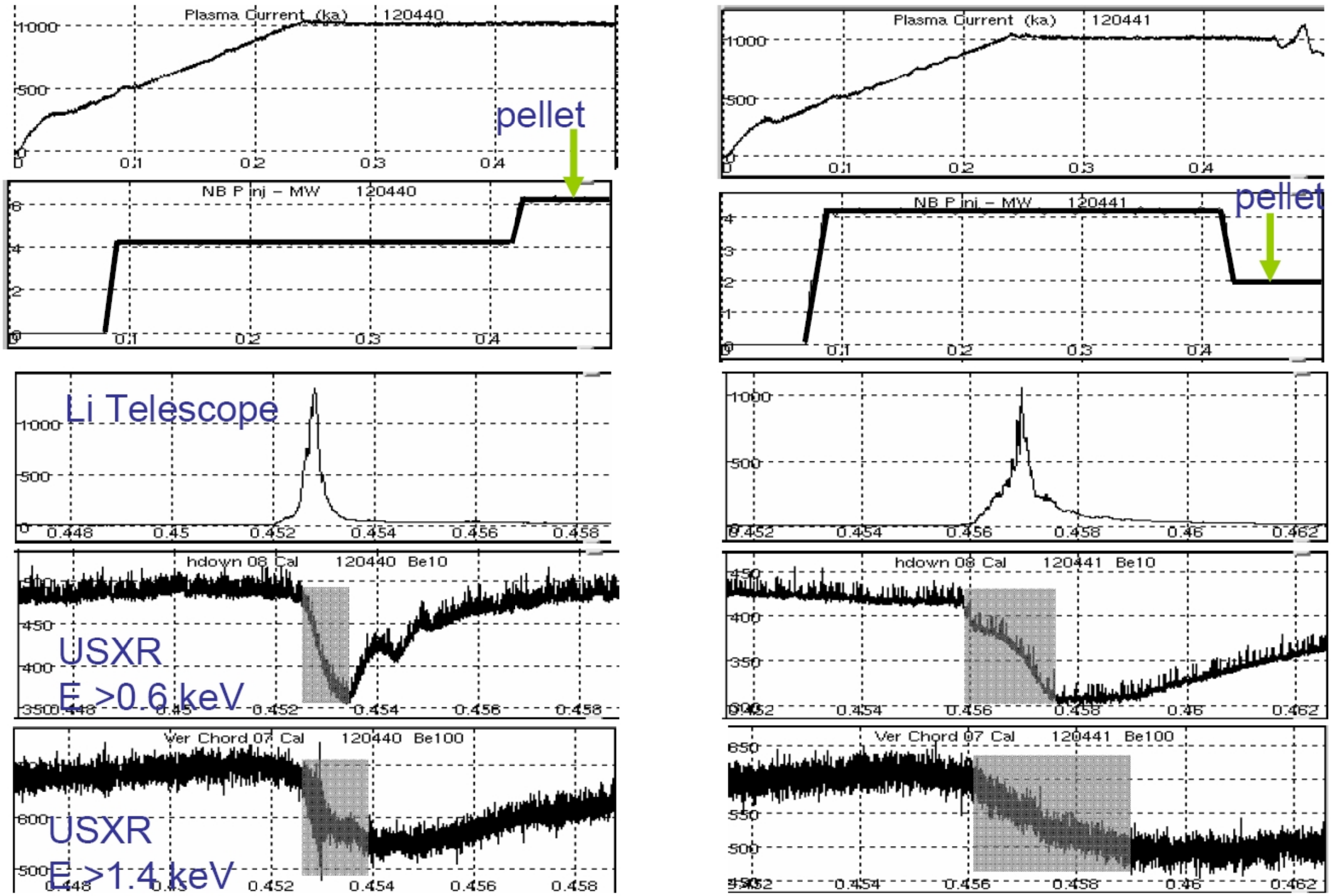






Lower beam power or changing to DND configuration reduces ELM severity

XP612 Changed Beam Power/Timing



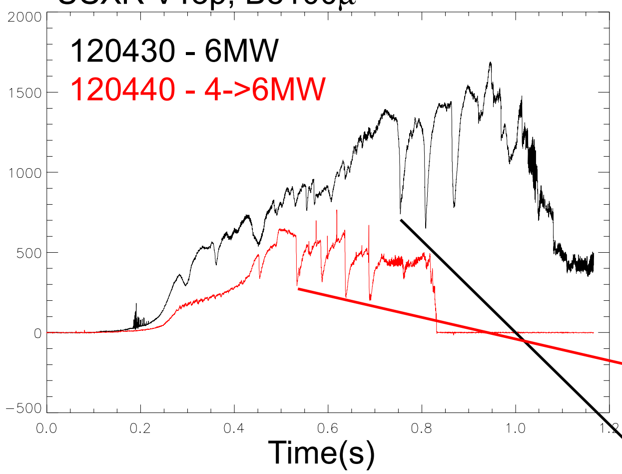
Perturbation propagation velocity showed dependence on plasma heat flux

Beam power/timing scan also indicated perturbation affected by current profile

DND has Different ELM Characteristics

Is ELM perturbation/propagation related to current profile?

USXR VTop, Be100µ

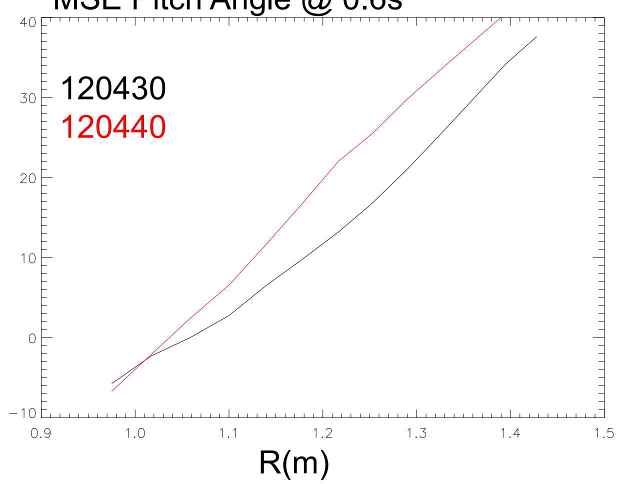


In 6MW case, perturbations occur latter with shallower penetration

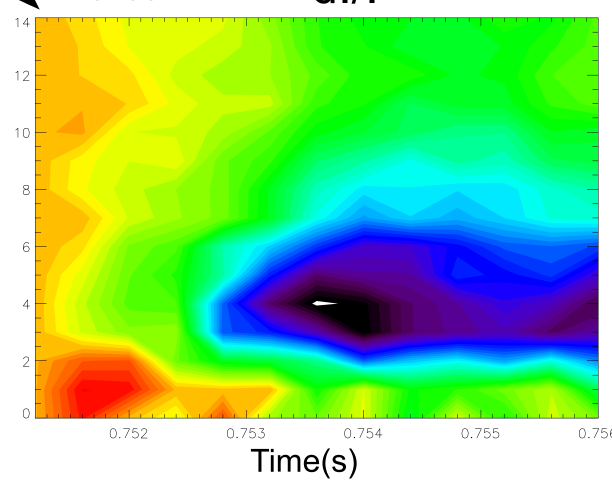
Staged beam heating “freezes” different current profile?

Stored energy similar after ~0.5s

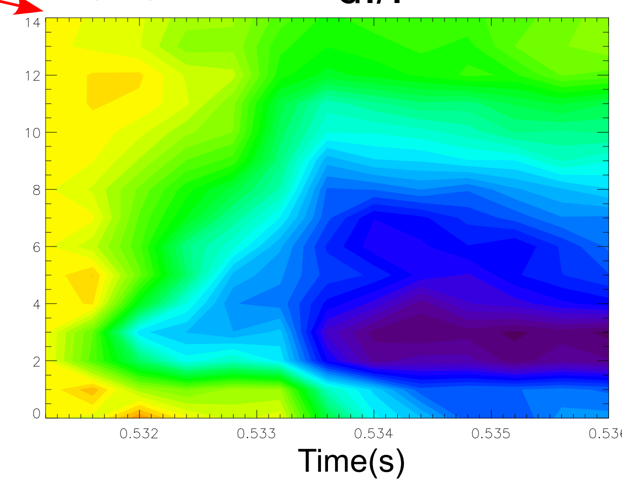
MSE Pitch Angle @ 0.6s



tOSXR - Be100µ
120430 - 6MW dI/I



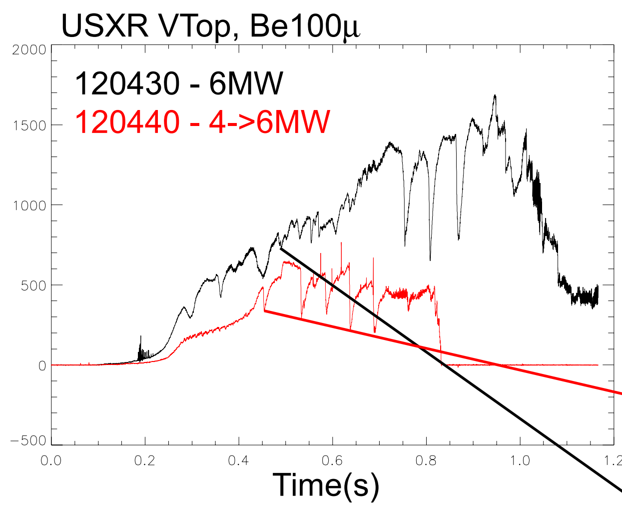
tOSXR - Be100µ
120440 - 4->6MW dI/I



Be300µ shows even more difference

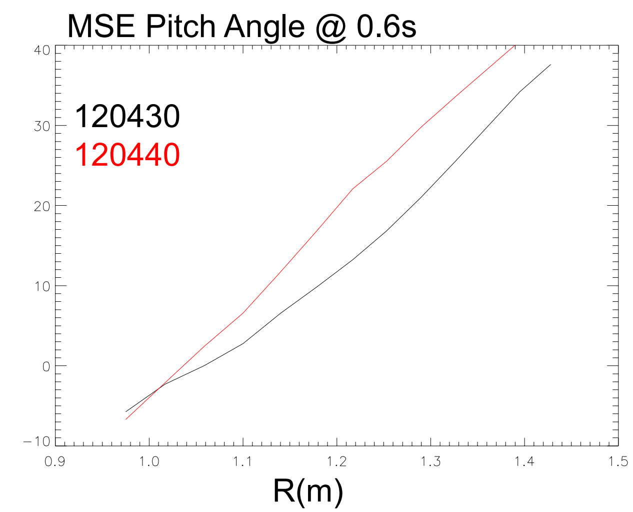
DND has Different Pellet Characteristics

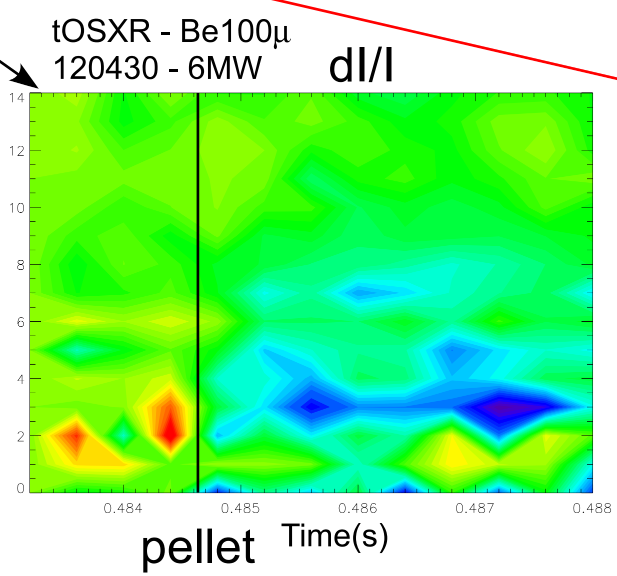
~0.5mg Li pellet injected into same discharges

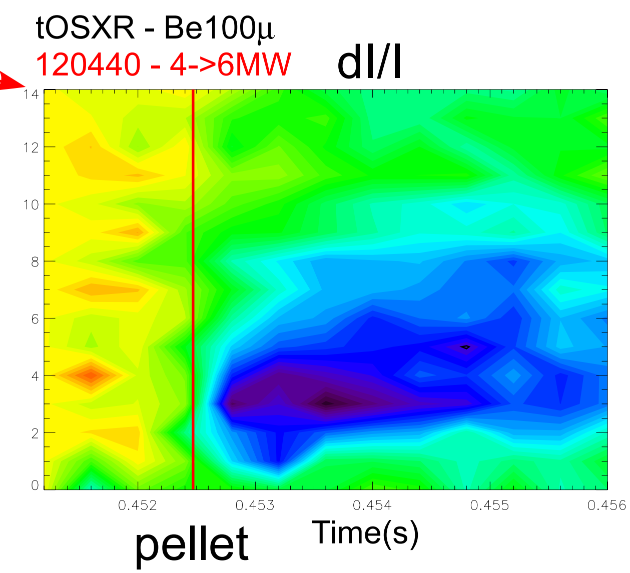


In 6MW case, pellet causes negligible Te perturbation

Staged heating results in larger pellet perturbation







Experimental Proposal

- Use long pulse high power DND H-mode plasma which exhibits desired Type I ELM phenomena (120430)
  - Add C pellets between/after ELM period for comparison of perturbation
- Scan Beam C timing at fixed TF/Ip to change current profile
  - Scan beams with lower Ip/higher TF for additional data at higher q
  - Touch base with pellets into LSN large and “modified” ELM regime (119083)
- Diagnostics
  - USXR (multi-color)
  - MPTS
  - CHERS
  - Fast cameras for ELM imaging
  - MSE
  - Fast T_i (NPA in fast ion mode)
  - High-k scattering
- Analysis
  - Multi-color analysis of ELM perturbation and cold pulse propagation
  - Fast EFIT/LRDFIT w/MSE for boundary geometry and current profile
  - TRANSP calculations of equilibrium electron confinement, electron transport
  - If diagnostic coverage permits, stability analysis and computation of eigenmode depths to isolate MHD effects, investigate internal stability

LSN Shot Matrix

Base shot: 119083, LSN, NB 4MW, Ip ~0.8MA, BT 4.5kG

- C pellet will be injected after few ELM periods ~0.5-0.6s

NB power	BT	# shots	comments
5.5MW	4.5kG	2	frequent Type I ELMs (117410)
4MW	4.5kG	1	fewer “giant” ELM case (119083)
3MW	4.5kG	1	no large ELM activity (112507w/no mod.)
6MW	4.5kG	1	DND conversion, small ELMs (117432)
		1	contingengy

Total: 6

Current Scan Shot Matrix

Base shot: 120430, DND, NB 4MW ➛ 6MW, Ip ~1MA, BT 4.5kG

- C pellet will be injected after few ELM periods ~0.6-0.8s

NB C @	BT	# shots	comments
0.15s	4.5kG	2	start beam timing scan
0.55s	4.5kG	1	
0.35s	4.5kG	1	
0.25s	4.5kG	1	
0.45s	4.5kG	1	

repeat scan (full or partial) at 0.8MA Ip, 5.0kG TF

Total: 6 + 3-5 (15-17)

with remaining time, fill in fine scan beam timing (0.2,0.3,0.4,0.5)

Total: 4 + 4 (23-25)