Completion of ITPA PEP-16: Comparison of Small ELM regimes in C-MOD, MAST, and NSTX

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Goals of PEP-16

- Identify similarities and differences between the EDA-H-mode in C-MOD, the Type V ELMy H-mode in NSTX, and small ELM regimes on MAST:
    - Does the same physics govern these regimes (and the HRS-mode on JFT-2M)?
    - Is the Type V ELMy H-mode specific to ST's?
- Establish dimensionless pedestal comparison with small ELMs between C-MOD, MAST, and NSTX
    - Match q_{95} and range in ν_{ped}^*
    - Perform a scan in β_{ped} (and ρ_{ped}^*?) to find small ELM thresholds
    - Compare structure of small ELMs with imaging diagnostics
- Expect 1/2-1 day needed for completion for NSTX part

PEP-16 Status

- C-MOD: Some data in '06, but small ELMs difficult to get
  - New experiment scheduled for 1/29/08 (tomorrow!!)
- MAST: two 1/2 sessions in May 2007
  - Mapping of existence space of small ELMs
    - 5 point power scan $1 \text{ MW} < P_{NBI} < 3 \text{ MW}$
  - More data on ELM structure and pedestal parameters
  - Failed to access regime in LSN with $\delta r_{sep} < -8$ mm
  - 2008 plan: develop LSN H-mode with lower X-point
- NSTX: three 1/2 day sessions in 2007
  - β scan in LSN ($\delta r_{sep} = -6$ mm)
    - 3 point power scan $2 \text{ MW} < P_{NBI} < 4 \text{ MW}$
  - β scan in DN ($\delta r_{sep} = -2$ mm)
    - 3 point scan $1 \text{ MW} < P_{NBI} < 3 \text{ MW}$
  - Failed to access H-mode w/$\delta r_{sep} < -8$ mm (high X-point)
  - β scan in LSN ($\delta r_{sep} = -15$ mm) at higher q_{95}
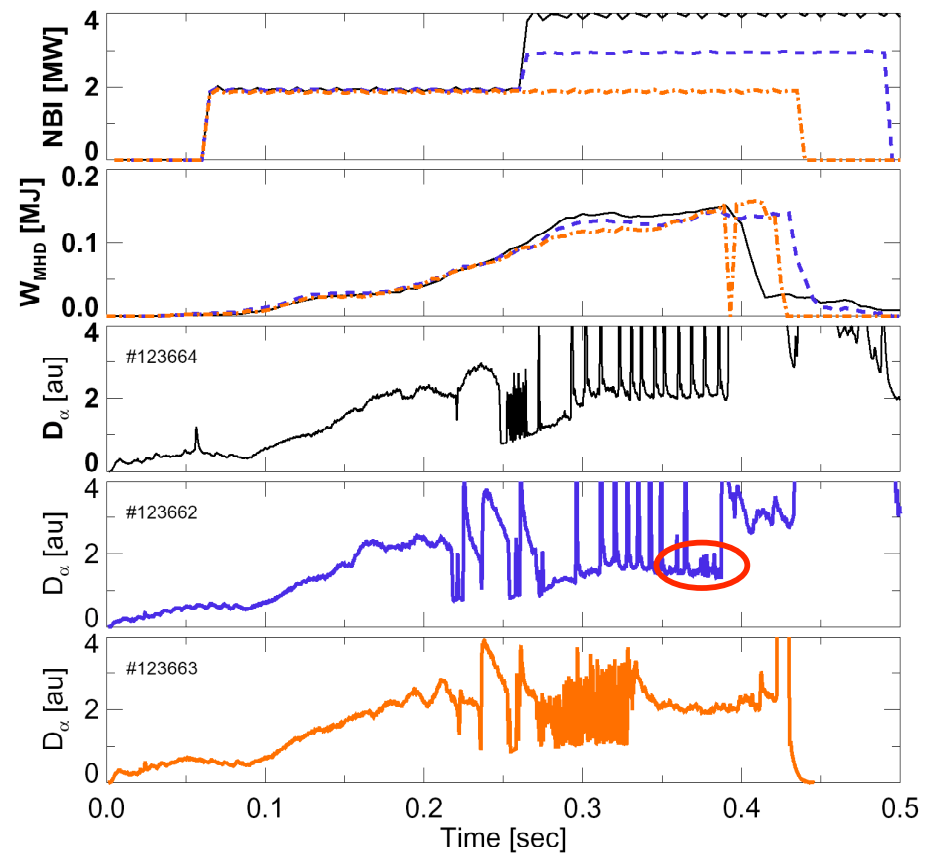 - 2008 plan: obtain β scan in LSN with as low q_{95} as possible

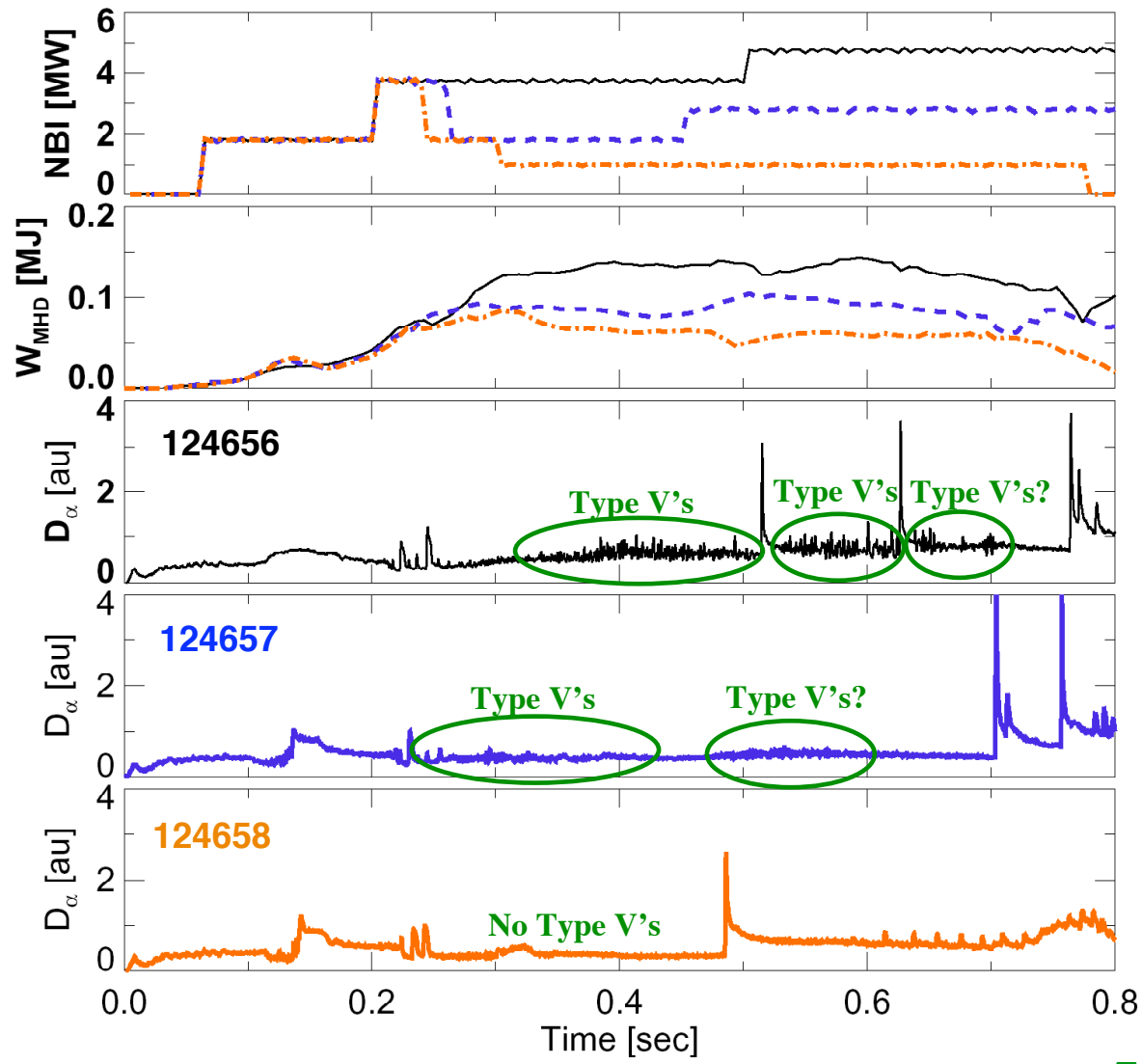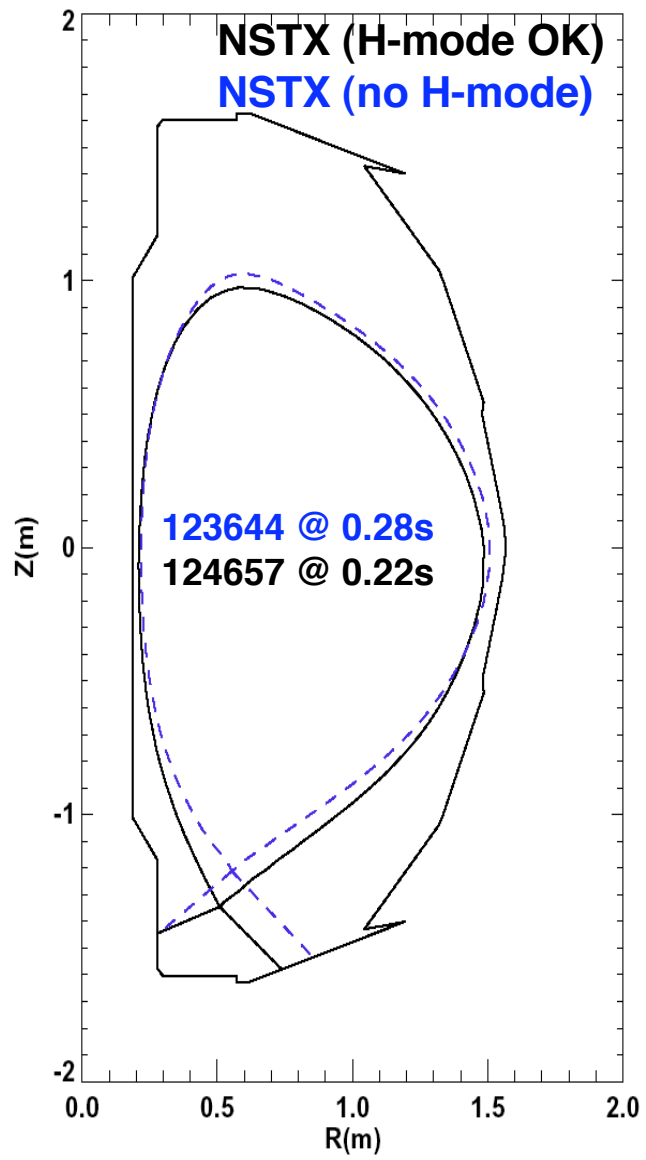# NSTX: Small ELMs observed close to DN

$\delta_r^{sep} \sim -0.3$ cm
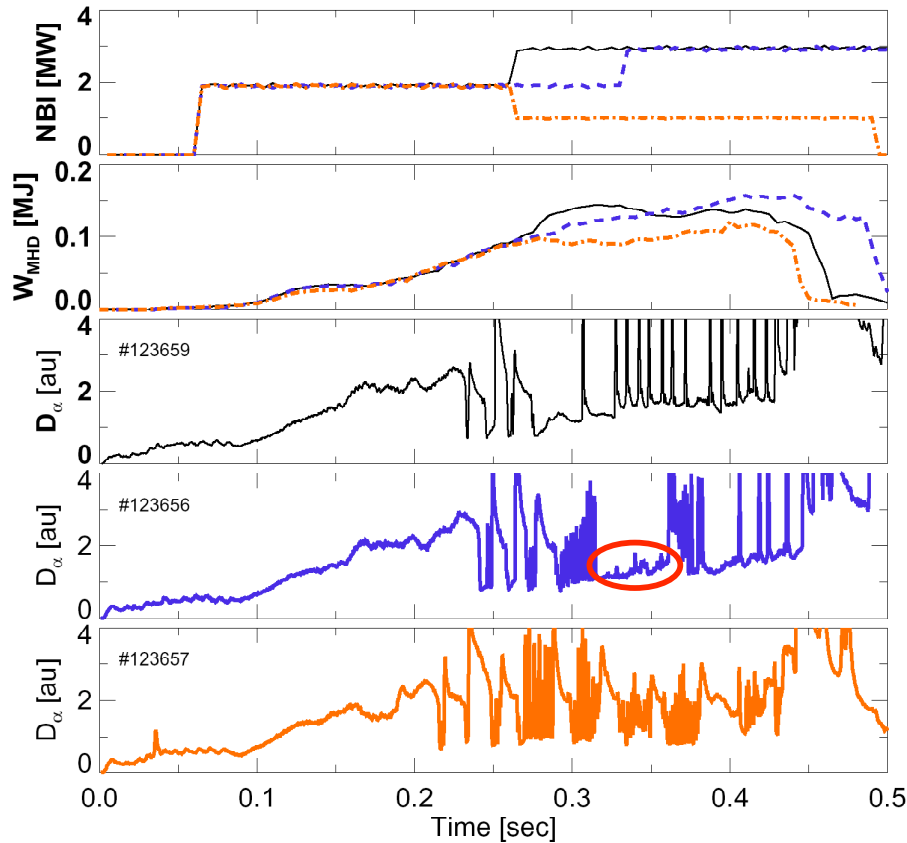
$\delta_r^{sep} \sim -0.6$ cm

- Observed between 2 MW < P_{NBI} < 3 MW.
- Probably not type-V ELMs, may be similar to MAST small ELMs in DN.

NSTX: Power scan with small ELMs in LSN with lower X-point and increased q95

NSTX (H-mode OK)
NSTX (no H-mode)

123644 @ 0.28s
124657 @ 0.22s

Z(m)

R(m)

NBI [MW]

W_{MHD} [MJ]

D_α [au]

124656

Type V's   Type V's   Type V's?

124657

Type V's   Type V's?

124658

No Type V's

Time [sec]

NSTX shot plan (1/2 day)

- Reproduce 124657: previous H-mode at high q95 (3 shots)

- Increase I_p by 0.1 MA increments while making sure that H-mode access is maintained for target q95=5.5 (5 shots)

- Decision point: if time permits, drop B_t by 0.05 T to get lower q95 (2 shots)

- Perform 5 point NBI scan in 3 shots to determine ELM stability threshold, as in 124656-58 (5 shots)

- Report results of ELM structure comparison and edge stability analysis at IAEA 2008
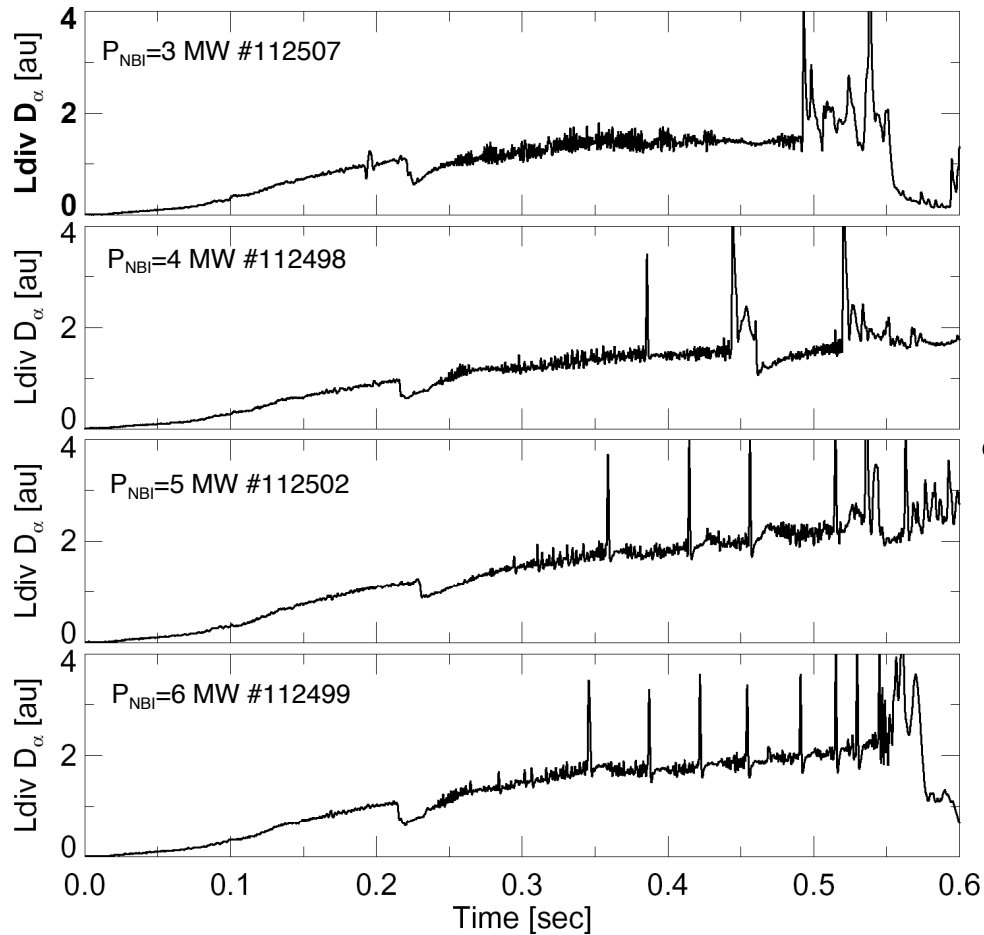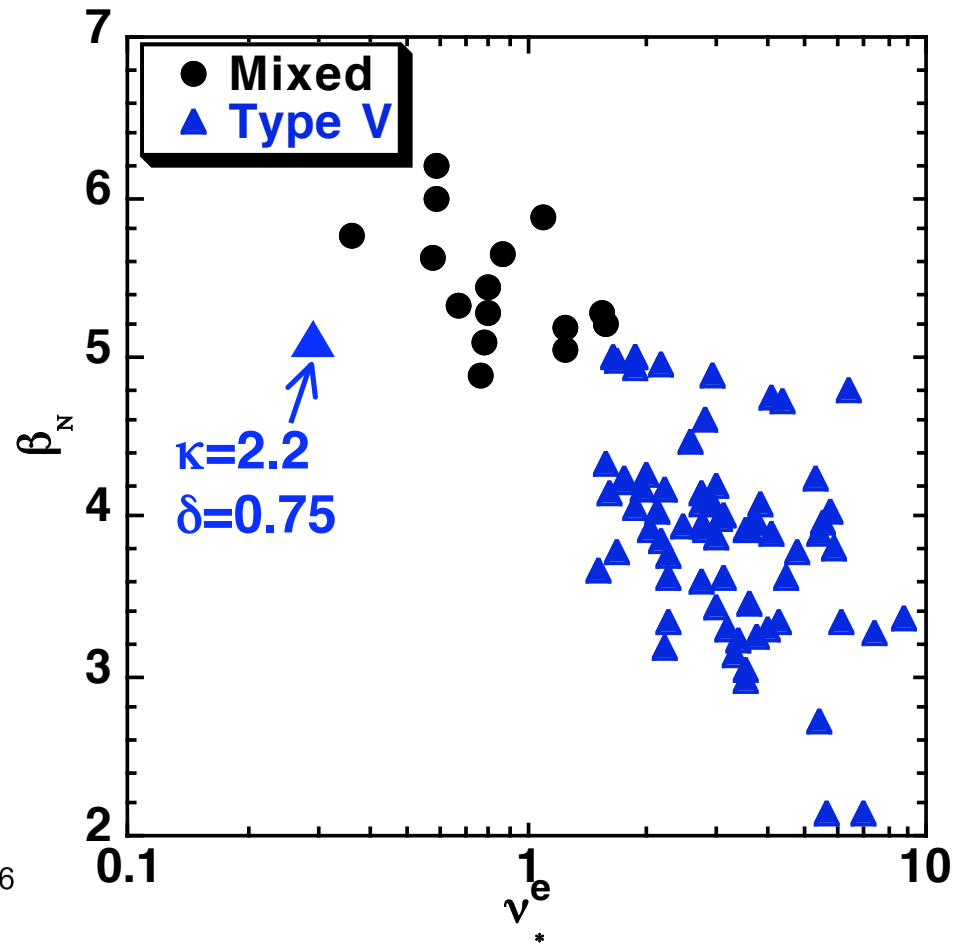
Note: requires src. C at 1 MW power level

Backup

Small ELMs appear in wide β and ν* space in NSTX

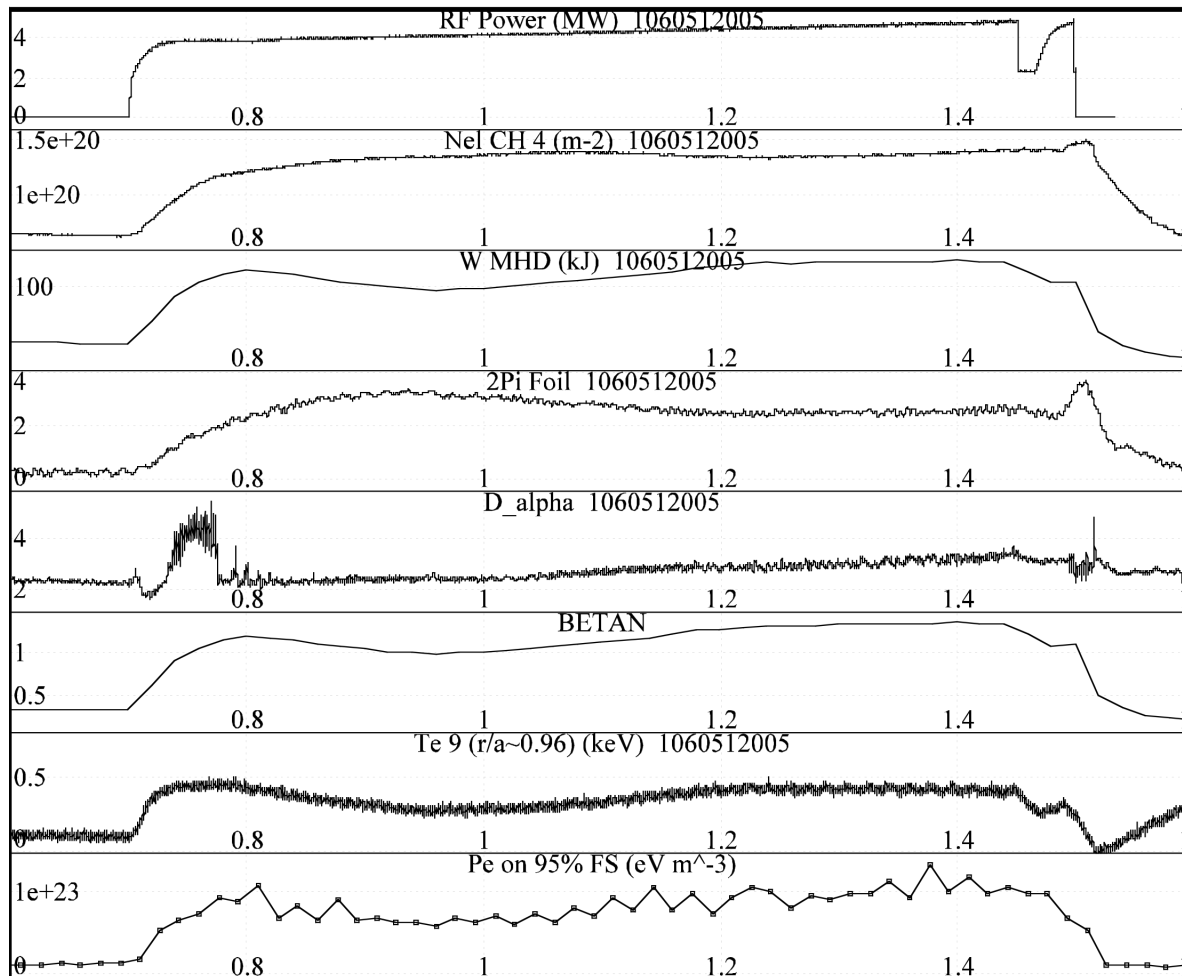- Mixed between larger ELMs at highest β

P_NBI=3 MW #112507

P_NBI=4 MW #112498

P_NBI=5 MW #112502

P_NBI=6 MW #112499

Maingi, JNM 2007

Mixed
Type V

κ=2.2
δ=0.75

Maingi, PoP 2006

Difficult to reproduce small ELM regime in C-MOD in '06

NSTX

- 4.7 MW RF
- $\beta_N \sim 1.3$
- $P_{e,ped} \sim 19$ kPa
- Good H-mode
- No evident ELMs, why?

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MAST summary

- Lower power threshold hard to determine
  - Small ELMs mixed in between type-III ELMs
- Small ELMs disappear at high power and low collisionality $\nu^* < 1.5$ and high β_{ped}^{LFS}
- High n filaments rotate co-current, not all of them detach.
  - Larger ELMs: all filaments detach, medium n.
- The characteristics seem different from type-V ELMs.
- Failed to access H-mode with $\delta r_{sep} < -8$ mm with $\kappa < 1.7$ with $P_{NBI} < 3.4$ MW.
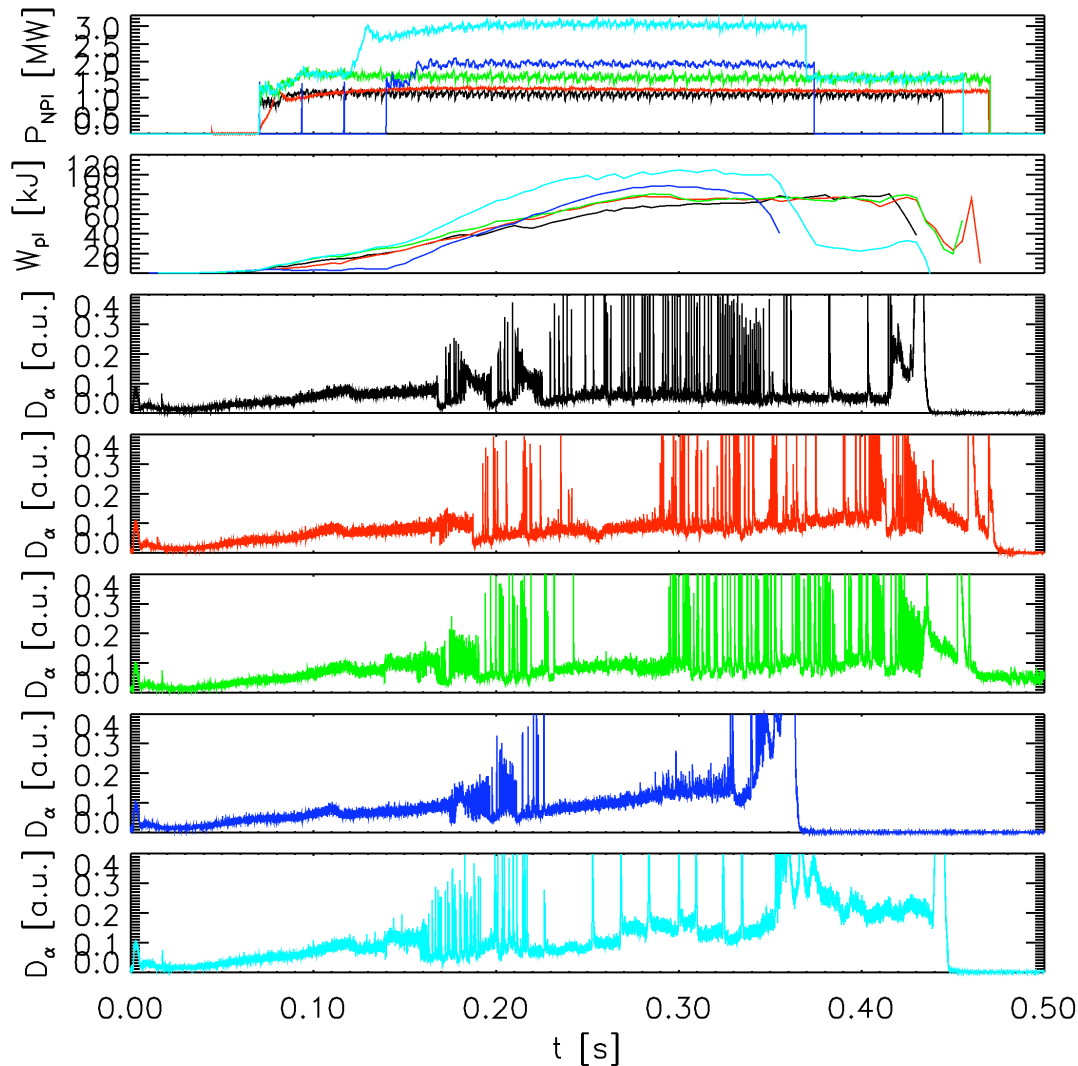
- Even with P_{NBI}=1 MW small ELMs are present.
  - Mixed with threshold Type III ELMs
- With P_{NBI} = 3.2 MW small ELMs appear only during early H-mode.
- Pressure pedestal seems to be narrow compared to ELM free phases (PEP-9).
  - Width ~ 1.5%-2.5% of ψ_N (half of the width seen in PEP-9)
  - Higher pressure gradient.

MAST: No small ELMs at low ν^* and high β_{ped}
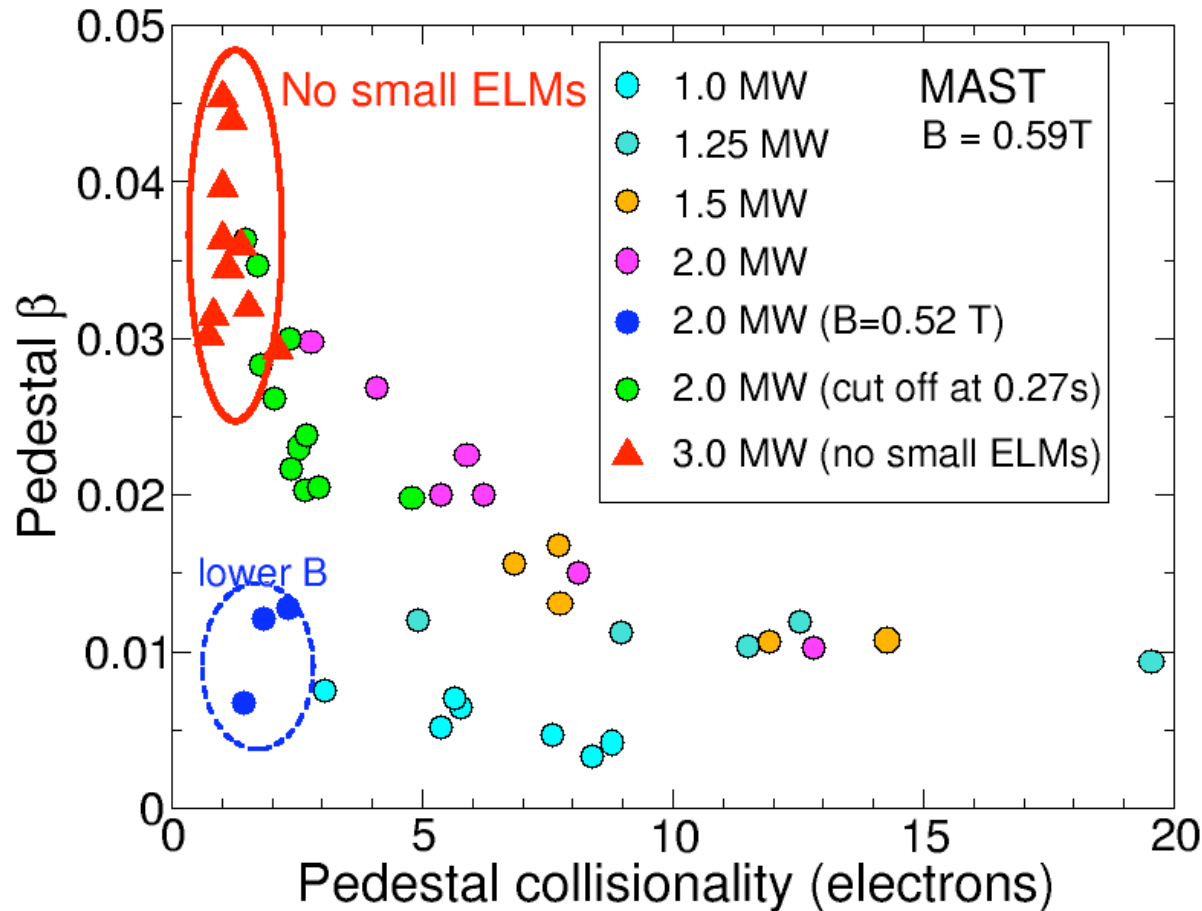
- Small ELMs exist over a wide range in ν^* and β_{ped}.
- At low power they are mixed with type-III ELMs
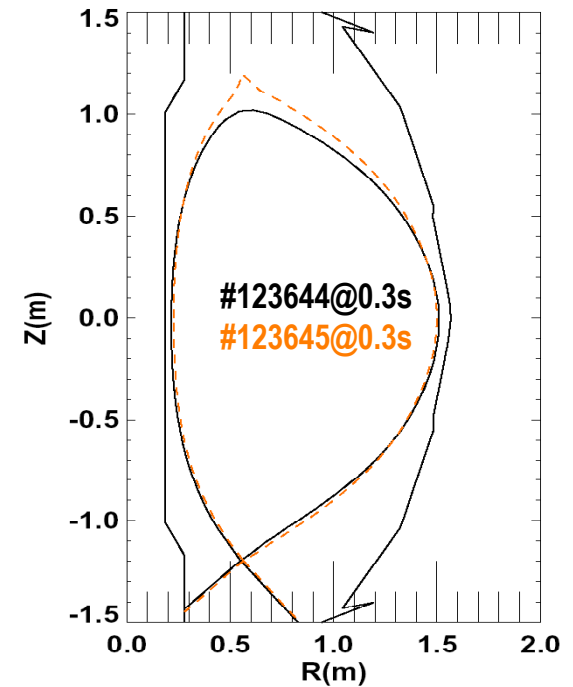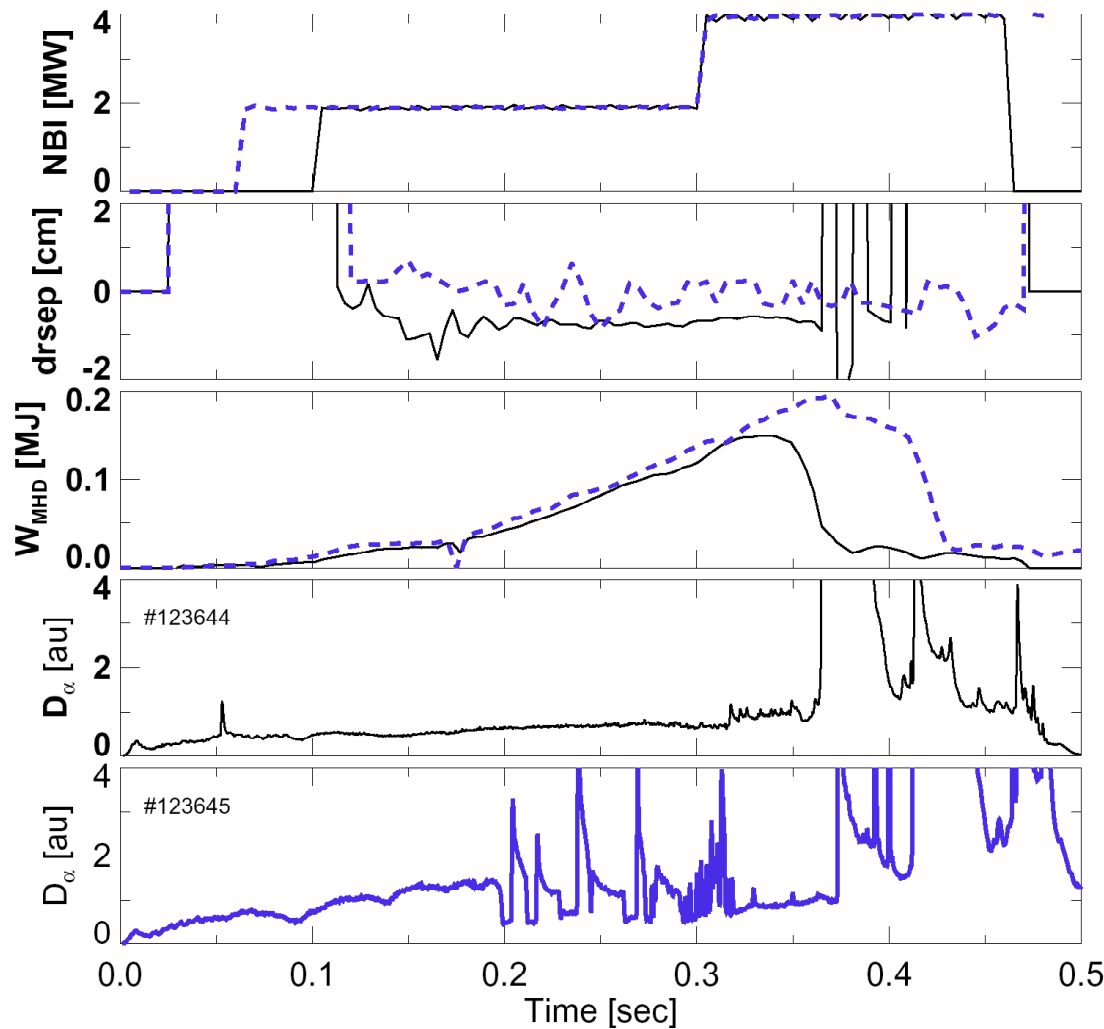
- No H-mode access at $\kappa \leq 1.7$ with with $\delta r_{sep} = -15$ mm.
  - Max $P_{NBI} = 6$ MW.
- No problems at $\kappa \geq 1.9$