Effects of Triangularity and B_{φ} on Pedestal Structure in ELMy Discharges

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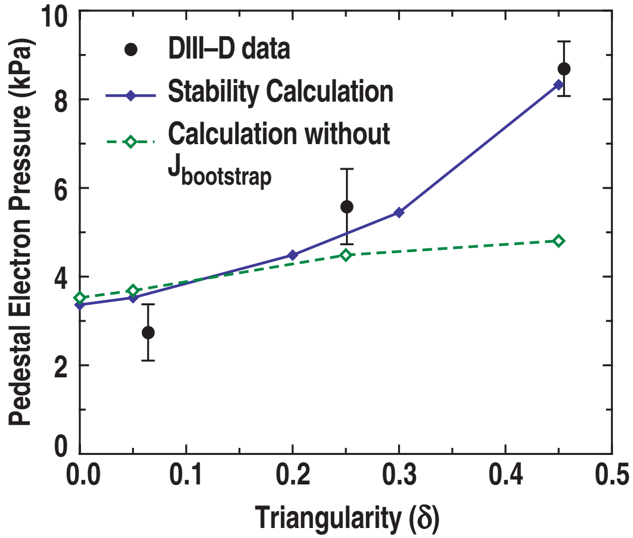
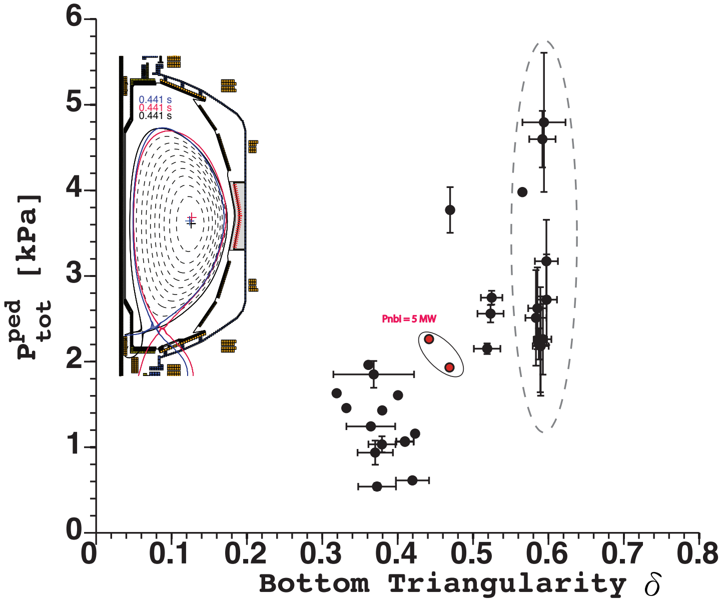
XP1112 TSG Review

Need for Further Understanding of the Pedestal Structure Evolution to Project for Future Devices through the Testing of Pedestal Models

- Higher R/a tokamaks have shown the pedestal height increases with triangularity and I_p *(not shown here)*
  - Consistent with ELITE modeling
- In NSTX, we show that the pedestal height increases with δ
  - Variability in pedestal height can be attributed to ELM frequency irregularity.
  - Pedestal width has shown large excursion consistent with scattered pedestal height.

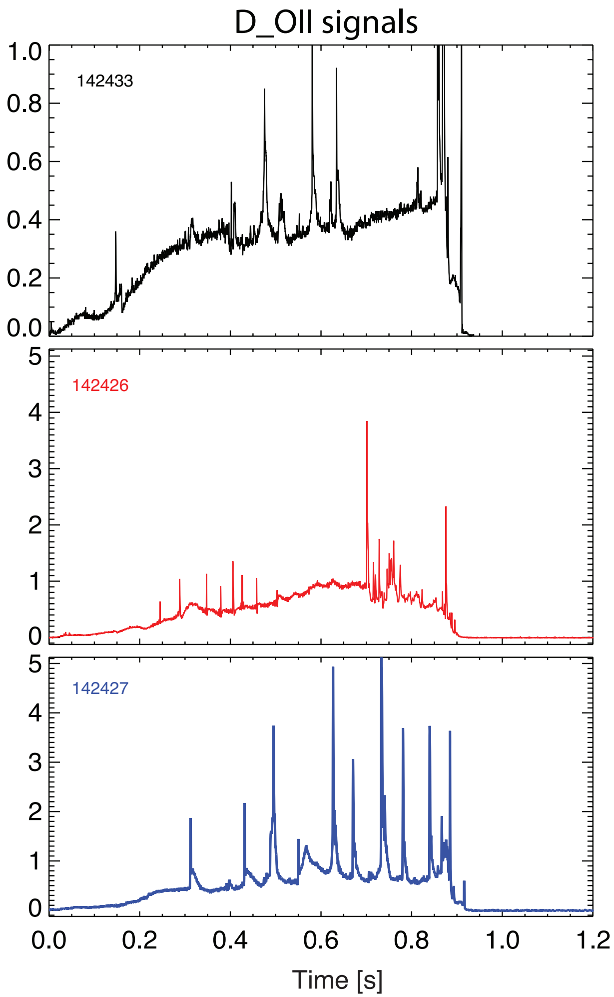


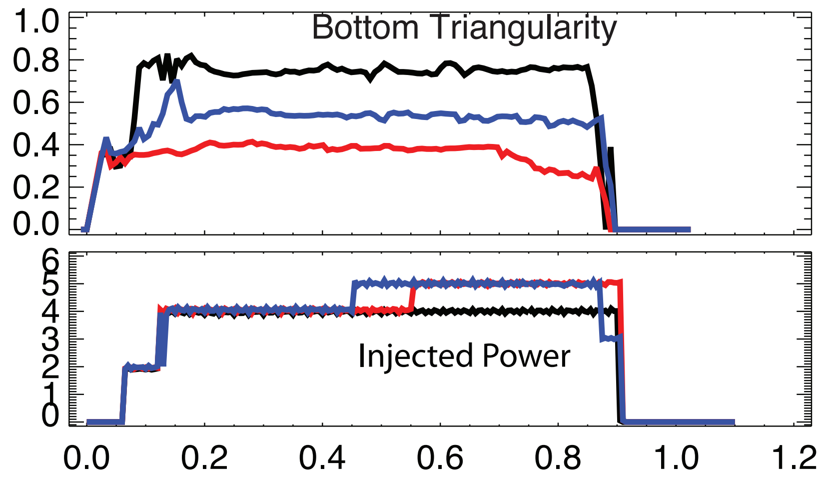


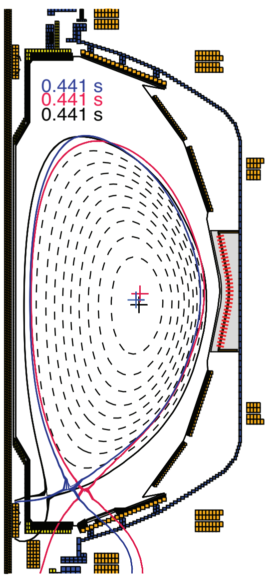
Goal: Complete XP1074 scan of the bottom triangularity δ and quantify their effects on the pedestal width

- This XP targets FY 2011 Joint Research Milestone on the pedestal structure
- Complete systematic scan of the bottom triangularity at fixed X-point height to quantify the dependence of the triangularity on the pedestal structure with additional MPTS channels.
- Obtain a "clean" B_φ scaling of the pedestal structure
- Questions this XP might address:
  - How does the pedestal width depend on the bottom triangularity?
  - Is the pedestal buildup during an ELM cycle depending on the shaping?
  - Which of the two knobs (bottom or average triangularity) has the dominant effect on the pedestal structure? (if time permits)
  - Can we determine the range of values in triangularity enabling to transition from the peeling to peeling-ballooning dominated drive in the stability curve?
  - What are the fluctuation characteristics during an ELM cycle for high and low triangularity?
  - Quantify the scaling of the pedestal structure with B_φ and project to NSTX-U
  - Supplement the NSTX pedestal database for modelers.

Example of Target Discharges



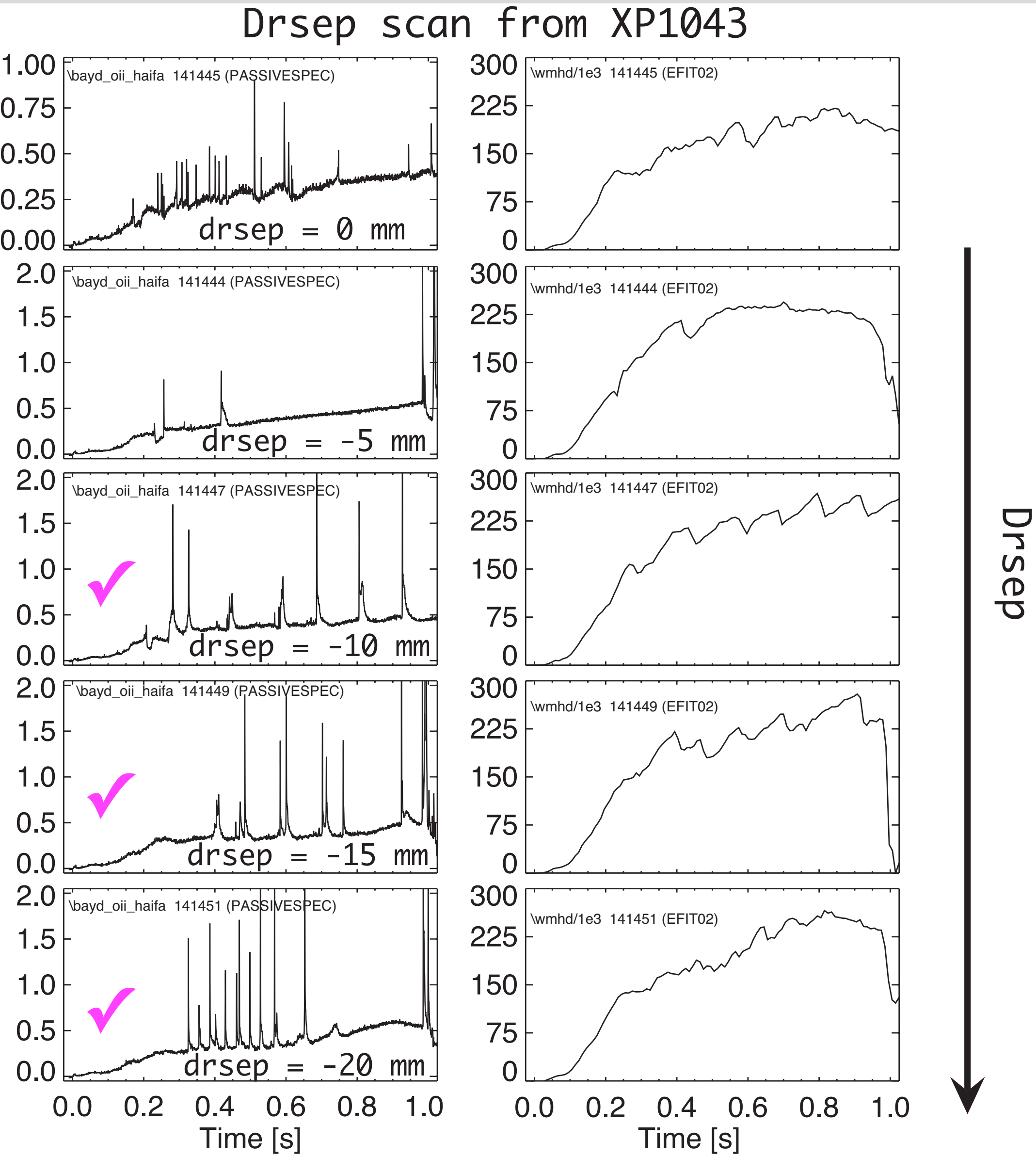




Drsep = - 5 mm

Irregularity of ELM frequency makes the ELM syncing approximate

Drsep is a reliable knob to achieve constant ELM frequency during the discharge



- Scan was performed at 900 kA
- Lithium deposited > 100 mg
- ELM-free to ELMy regime
- Target drsep > -5 mm to generate ELMy discharges

2 Session-Run Plan (in order of priority)

- Session 1: Effect of δ on pedestal structure
  1. Aim: Improve ELM reproducibility during the discharge
  2. Reload 142433 discharge at high triangularity (0.7- 0.8) [4 shots]
     - Ip = 0.8MA, Bt = 4.5kG
     - Biased down: drsep = -5 mm
     - Keep top triangularity between 0.3 and 0.5
     - Include the X-point height and strike point controls
     - Lithium @ 50 mg
       - Vary drsep to [-10 ; -15; -20] mm to insure reproducibility of the ELM frequency
  3. Reload 142427 discharge (0.3- 0.4) [4 shots]
     - Keep the same top triangularity as above
       - Vary drsep to [-10 ; -15; -20] mm to insure reproducibility of the ELM frequency
  4. Reload 142426 (0.5 - 0.6) [4 shots]
       - Vary drsep to [-10 ; -15; -20] mm to insure reproducibility of the ELM frequency
  5. **Decision point:**
     - If ELM frequencies are not reproducible enough !
     - Increase Lithium to 150 mg
     - Increase Drsep to -20 mm to obtain ELM frequency < 100 Hz and step from(2) - (4) ([12 shots])
  6. If time permits (??), vary the top and bottom triangularity independently keeping the average triangularity constant at 0.8-1
     - Set bottom triangularity at minimum achieved earlier (0.3-0.4) and top triangularity at 0.5-0.6 ([5 shots])
- Session 2: B_φ scaling of the pedestal structure (supplement width scaling of XP1044 data)
  - Keep the best achieved configuration in session 1 to perform the scan
  - Reload 139047 (Ip = 1MA) (or best configuration achieved in session 1 at high triangularity) and vary B_φ
    - 0.35 T [4 shots]
    - 0.45 T [4 shots]
    - 0.55 T [4 shots]

1-day run **24 (41) discharges**

Diagnostic Requirements and Analysis

- Need
  - MPTS with newly implemented edge channels
  - CHERS
  - Filterscope
  - EFIT
- Desired
  - MSE
  - GPI
  - USXR (edge channels)
  - Reflectometry
  - Tangential SXR Edge channels
- Analysis
  - Profiles analysis using Osborne tools
  - ELITE, PEST, TRANSP

Backup

Pedestal Structure Analysis on NSTX is consistent with Higher aspect ratio tokamaks. Impact of Shape Moments on Pedestal ?

- XP 1044: Experiments of pedestal structure scaling have been performed to show: *A. Diallo, submitted to NF (2011)*
  - Pedestal height increases quadratically with plasma current
  - Pedestal width (Δ) scales with the poloidal β at the top of pedestal: $\Delta = 0.17\sqrt{\beta}$ consistent with MAST results.
  - no clear scaling of the pedestal height with B_φ
    - limited data set
  - pedestal height does not ALWAYS saturate before the ELM crash
  - what is the effect of plasma shaping on the pedestal structure?
- The effect of plasma shaping role in setting the pedestal width and height has yet to be quantified.
  - XP1074 confirms the increase of pedestal density and temperature with triangularity
    - The width, however, has large errorbars which we hope to reduce with the addition of the new MPTS channels