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Pedestal characteristics and MHD Stability

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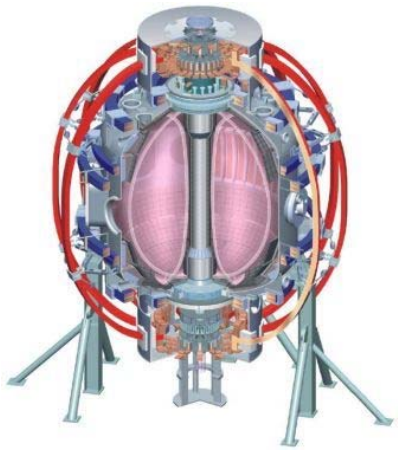
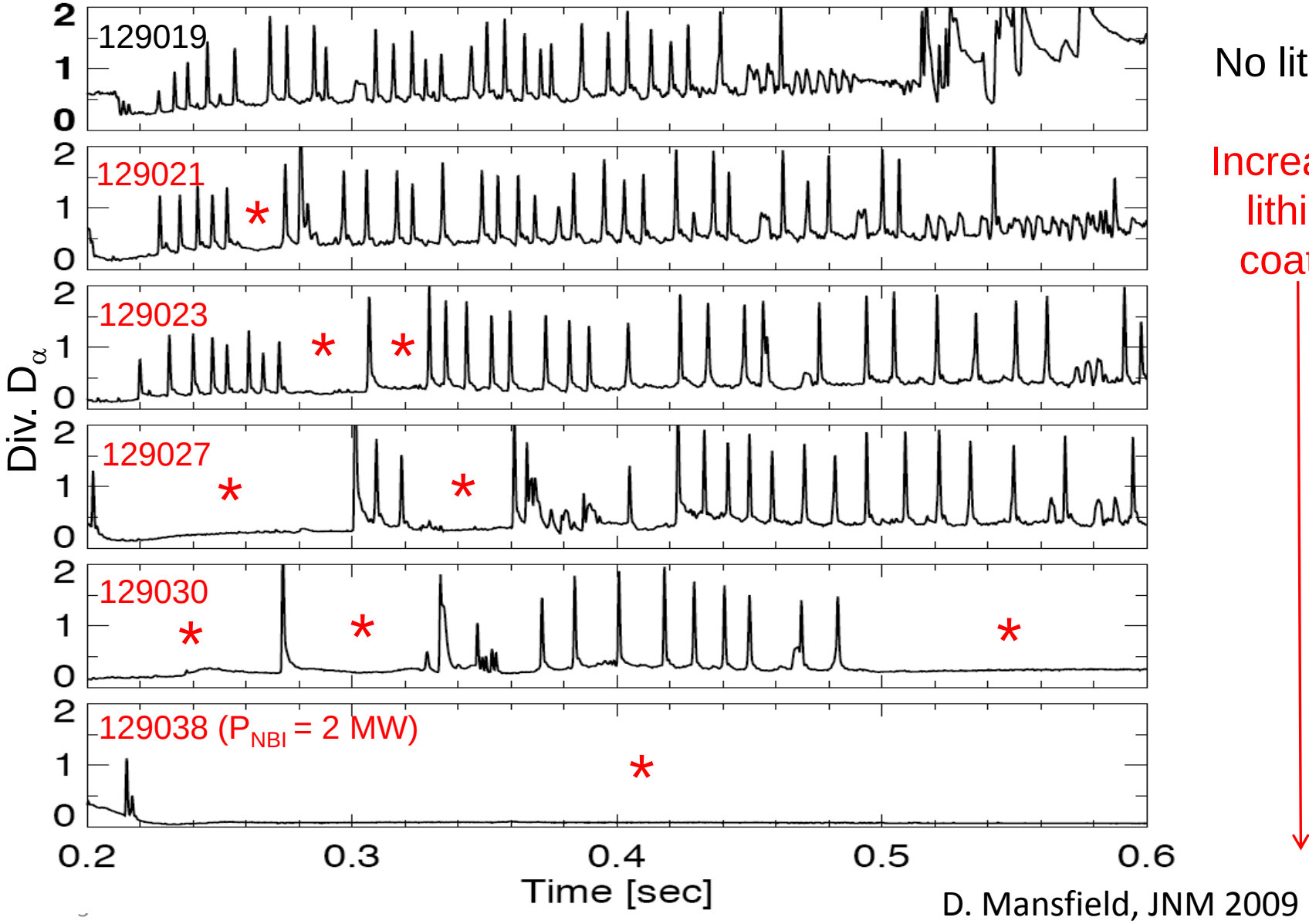


Overview

- Lithium wall coating modifies ELM behavior
- Analysis of a sequence of shots with increasing Lithium provides insight into the relationship between edge profiles and ELMs
- The location of P’_max is identified as a critical parameter

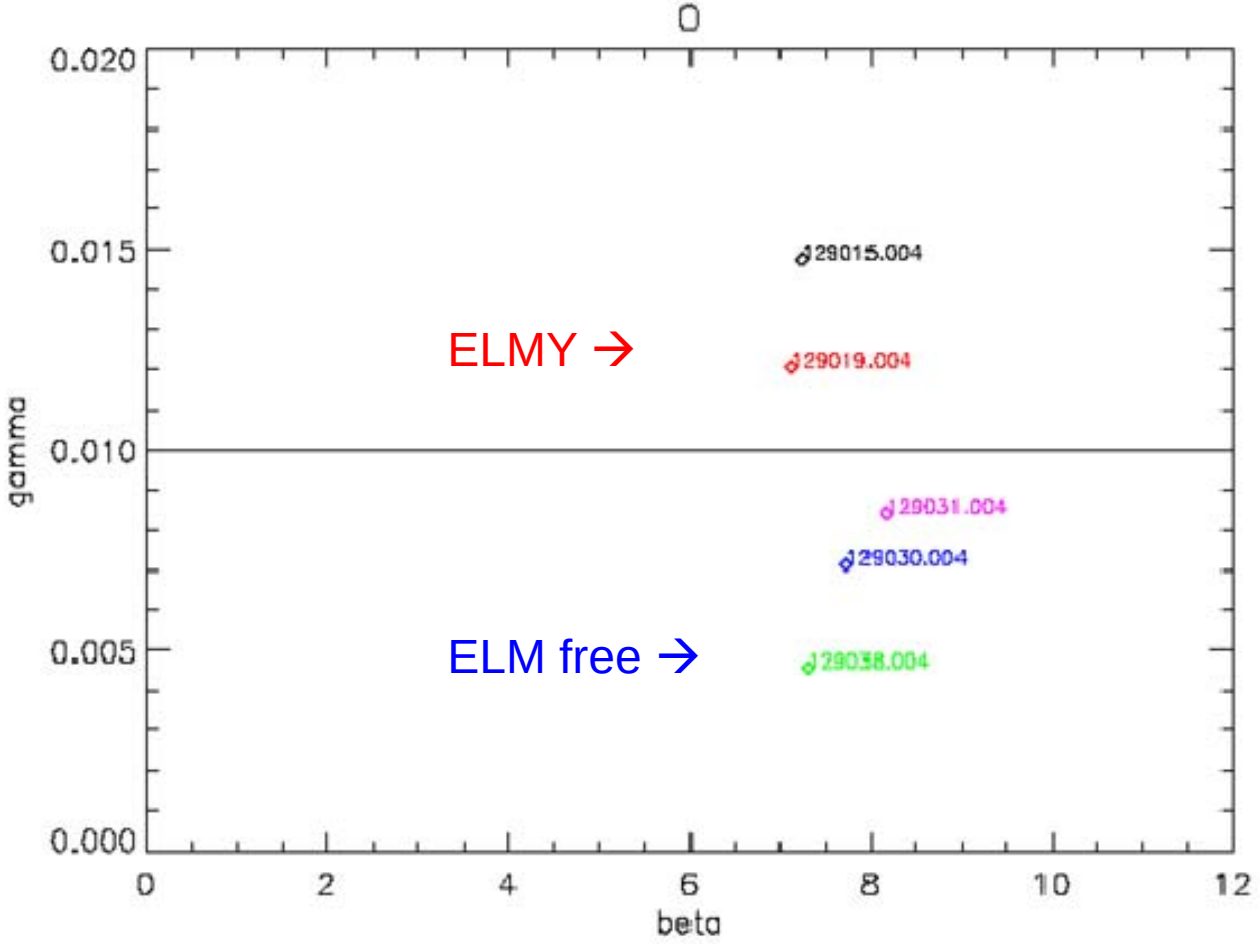
Quiescent phases (*) increase with increasing lithium coating (P_{NBI} = 4 MW)



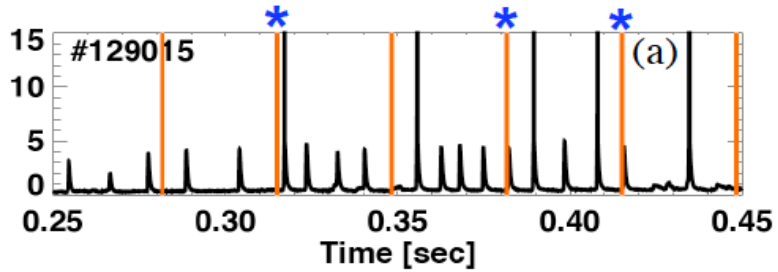
Edge stability analysis procedure

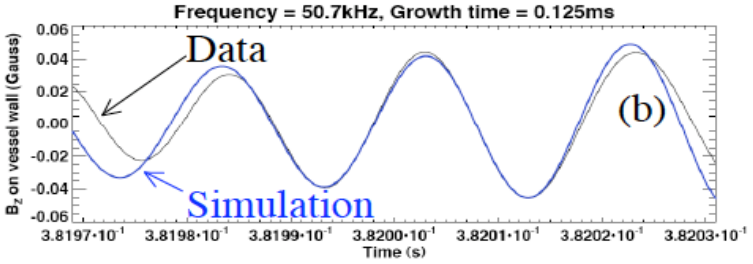
- EFIT run at Thomson profile times for ψ_N mapping
- Profile fitting of multiple time slices with standard procedures used as target for kinetic EFITs
- Free boundary kinetic EFITs run to match kinetic pressure profiles
  - Edge bootstrap current computed from Sauter neoclassical model
    - No direct measurement → biggest uncertainty
- Stability evaluated with PEST code
  - Low-n → 1 – 5 free boundary
  - n=3 is often most unstable

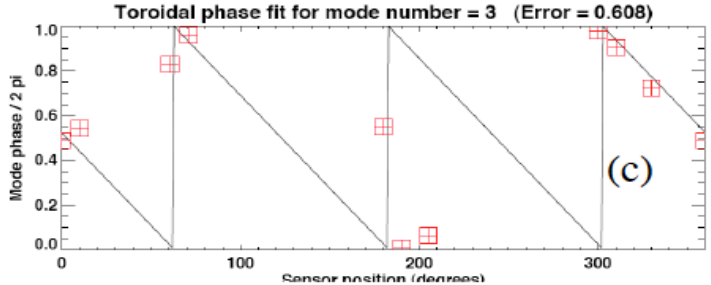
n=3 stability index is a good indicator of ELM behavior

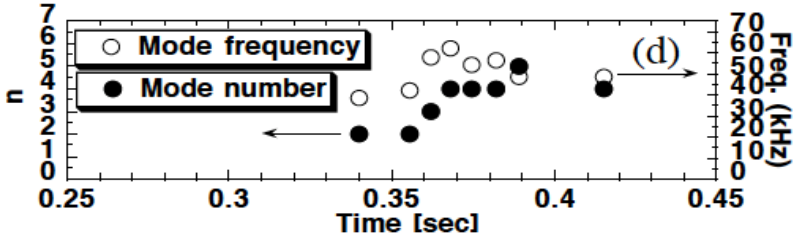


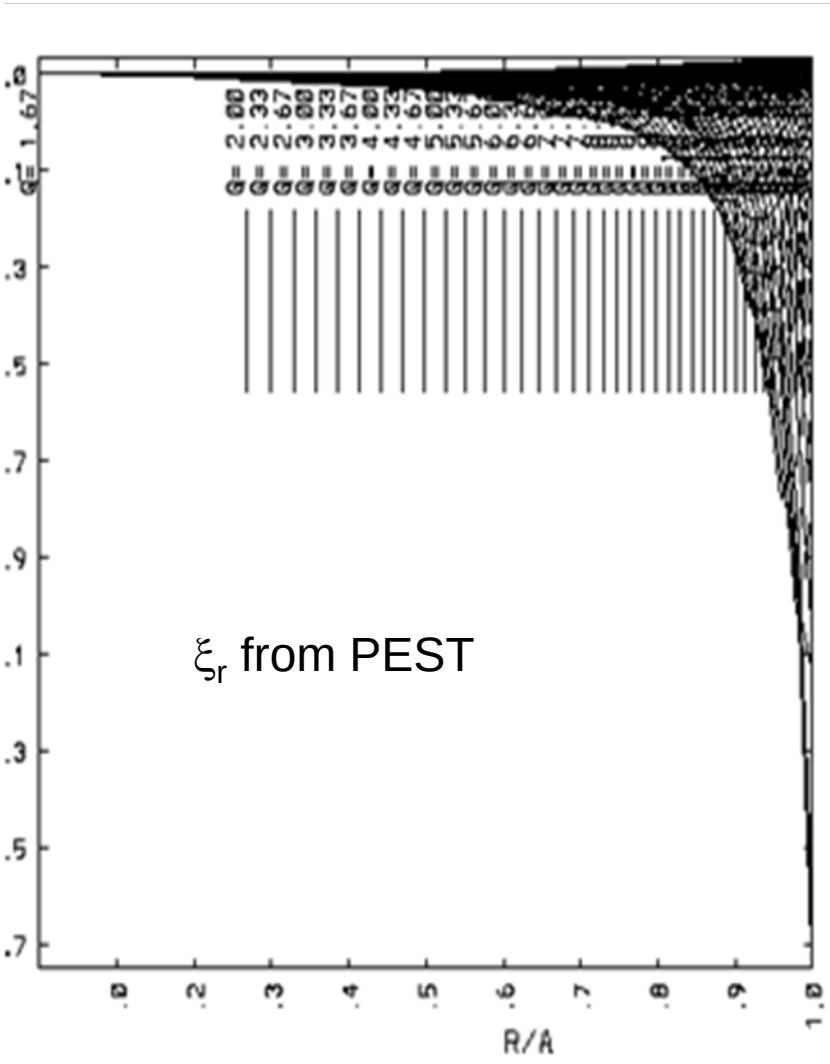
The MHD signature is consistent with an n=3 external mode



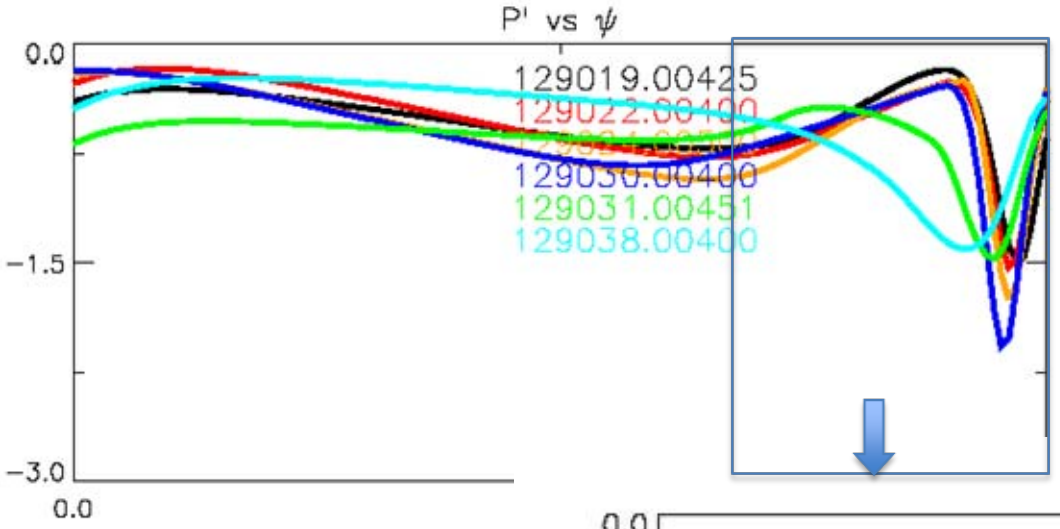




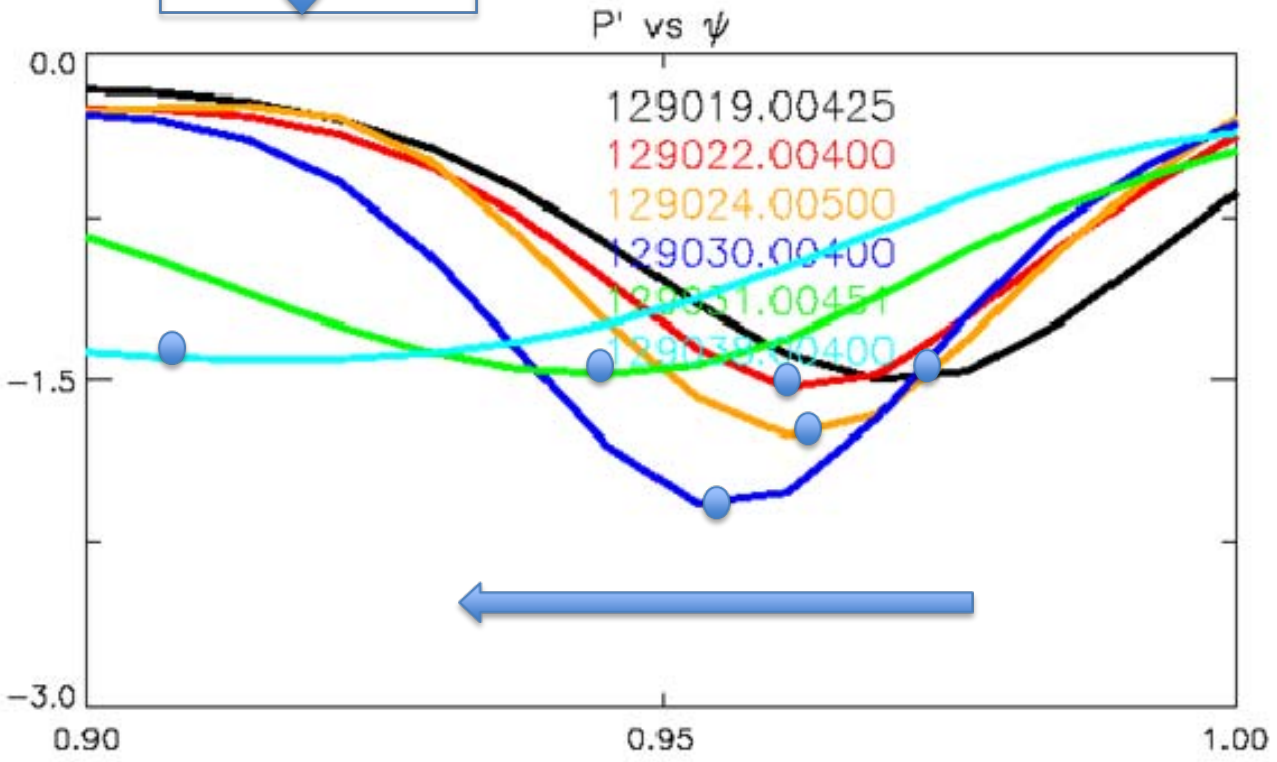


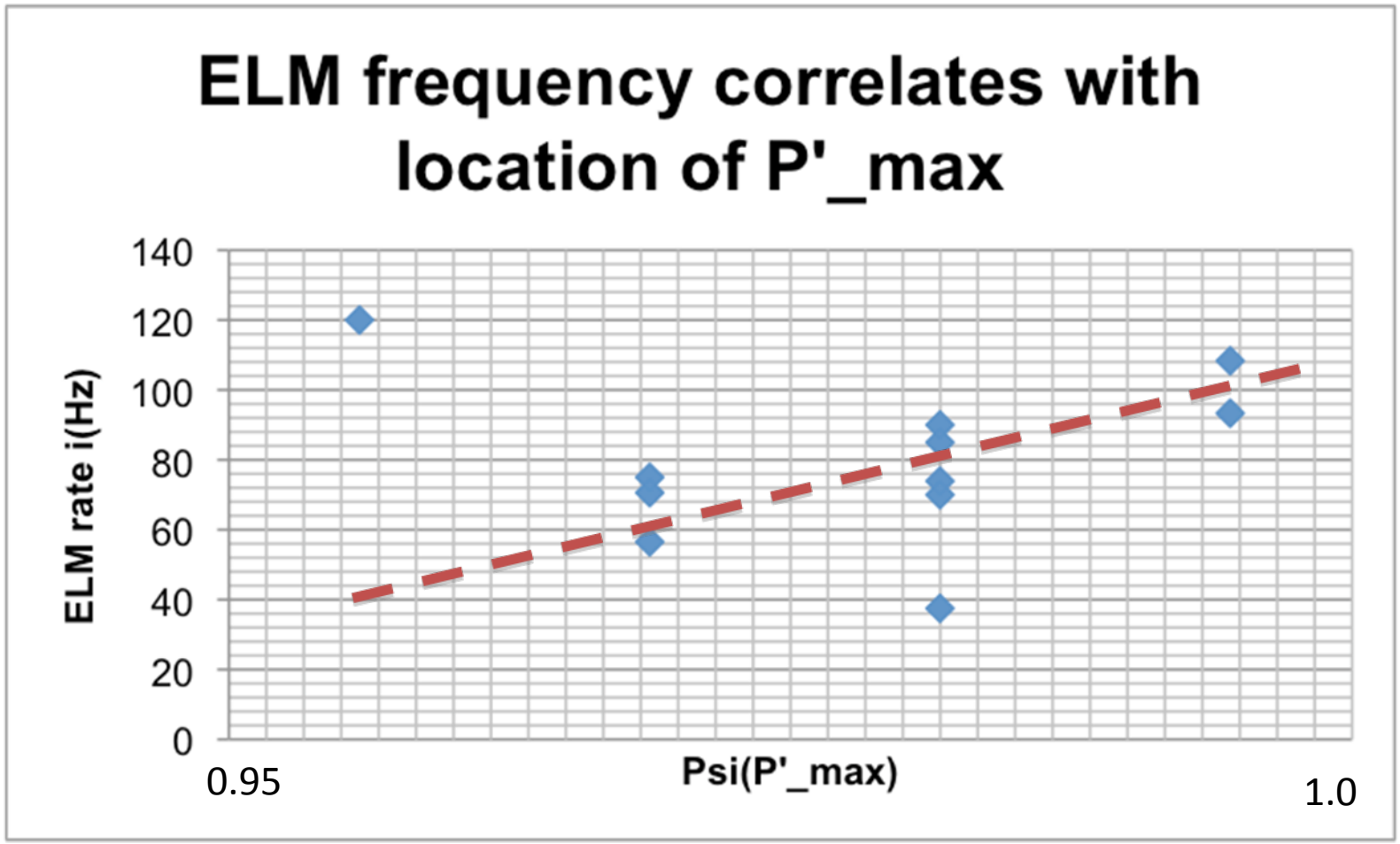


P’ profiles



Note the systematic inward shift of the location of p’_max

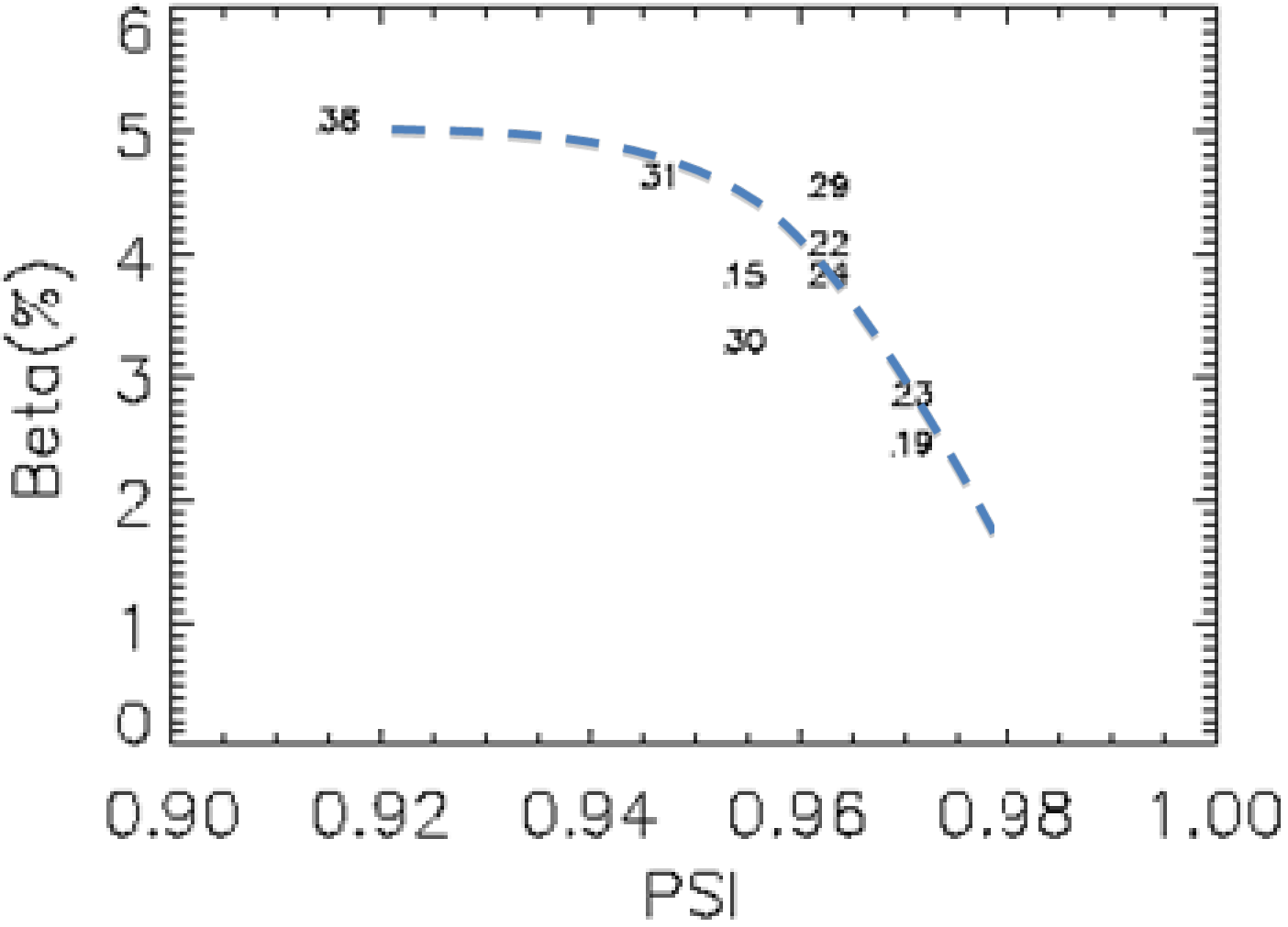



ELM frequency correlates with location of P'_max
ELM rate i(Hz)
140
120
100
80
60
40
20
0
0.95
Psi(P'_max)
1.0

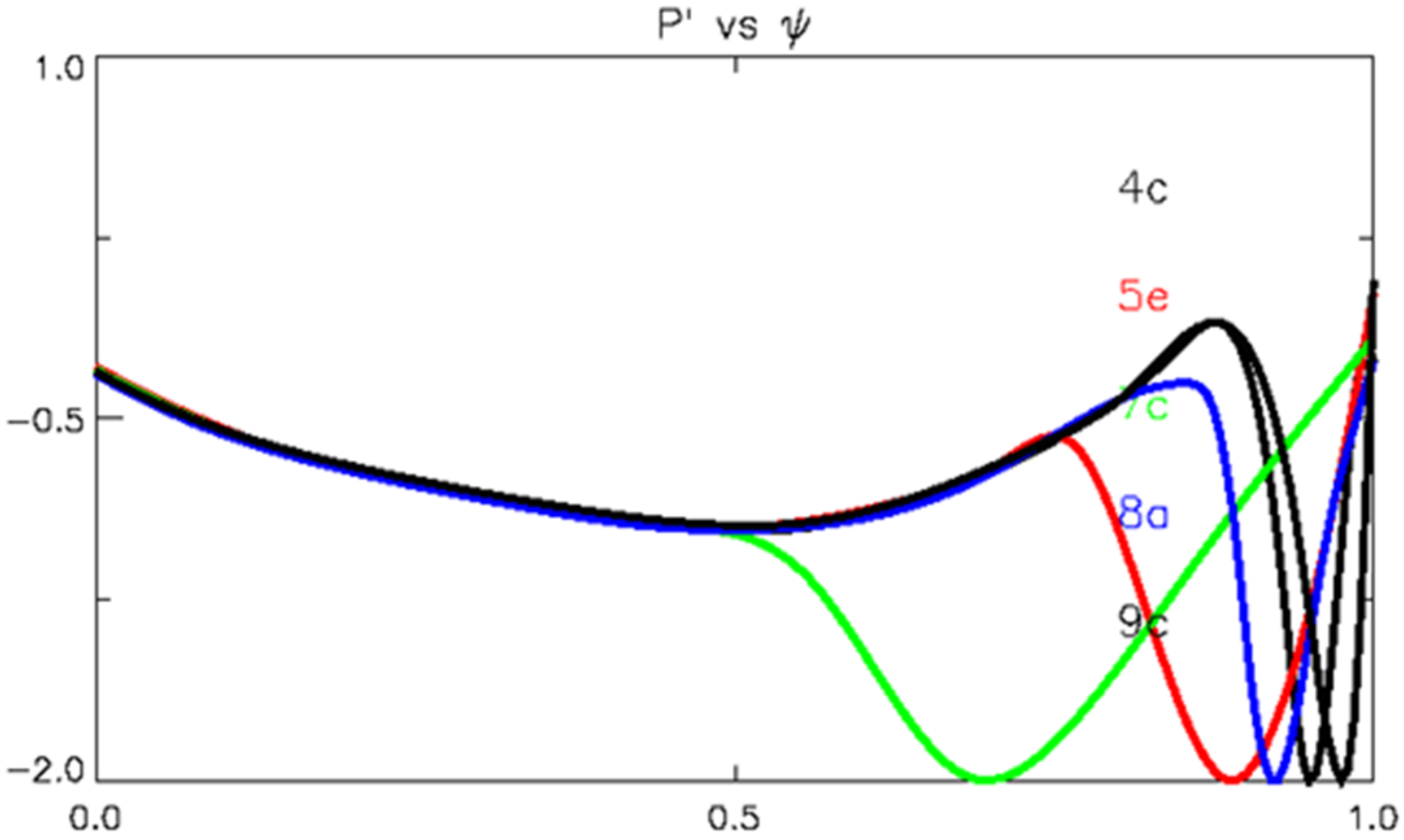
Simulation

- Determine beta limits for experimental shots
  - Start from kinetic EFIT equilibrium
  - Scale P and P’ to vary beta
  - PEST stability analysis
- Theoretical modeling
  - Vary pressure and current profiles
  - Determine beta limits

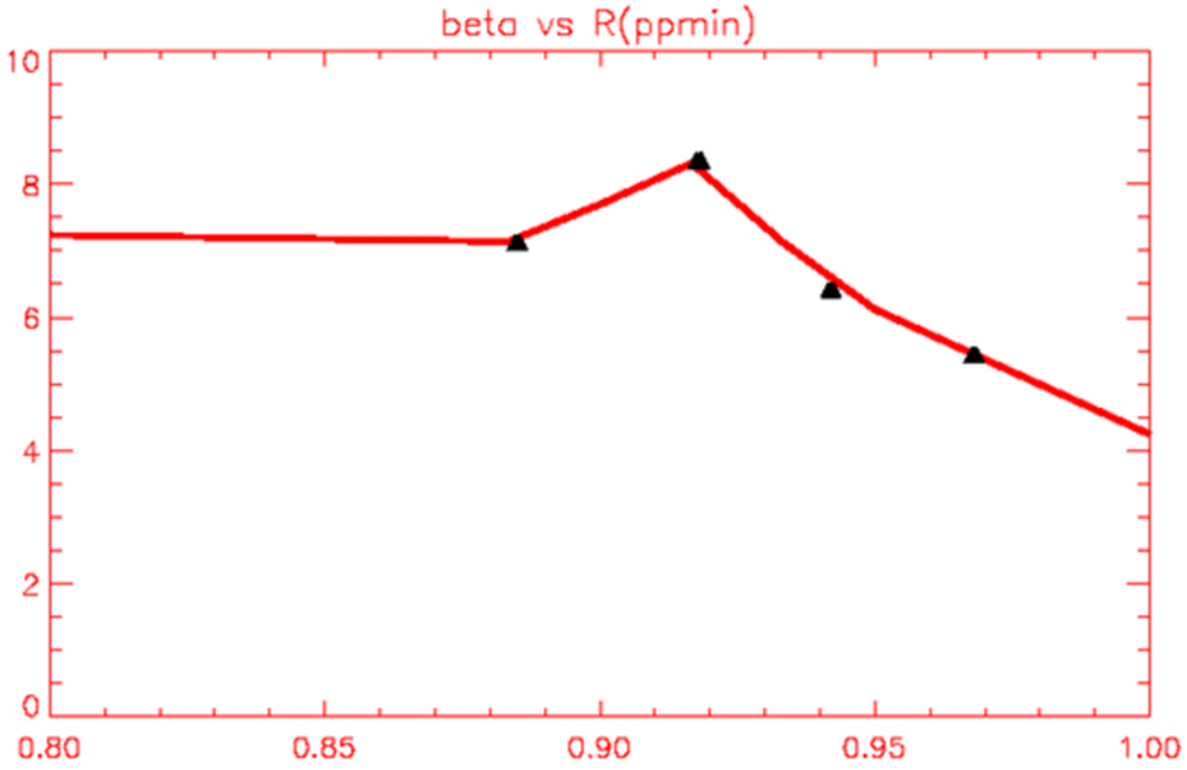
Location of p'_{max} correlates well with Beta-limits (γ=0)



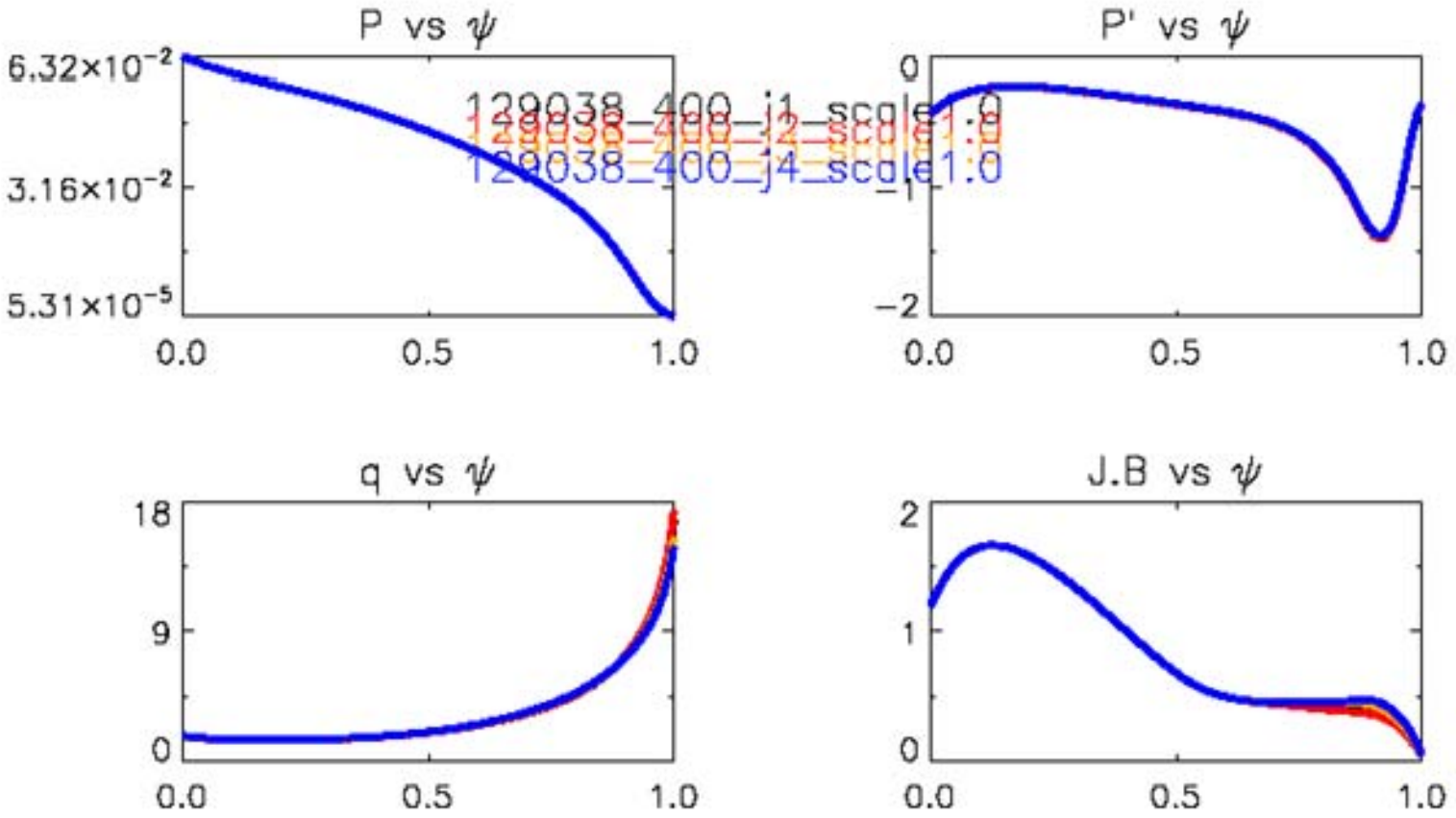
Vary the location of max p’



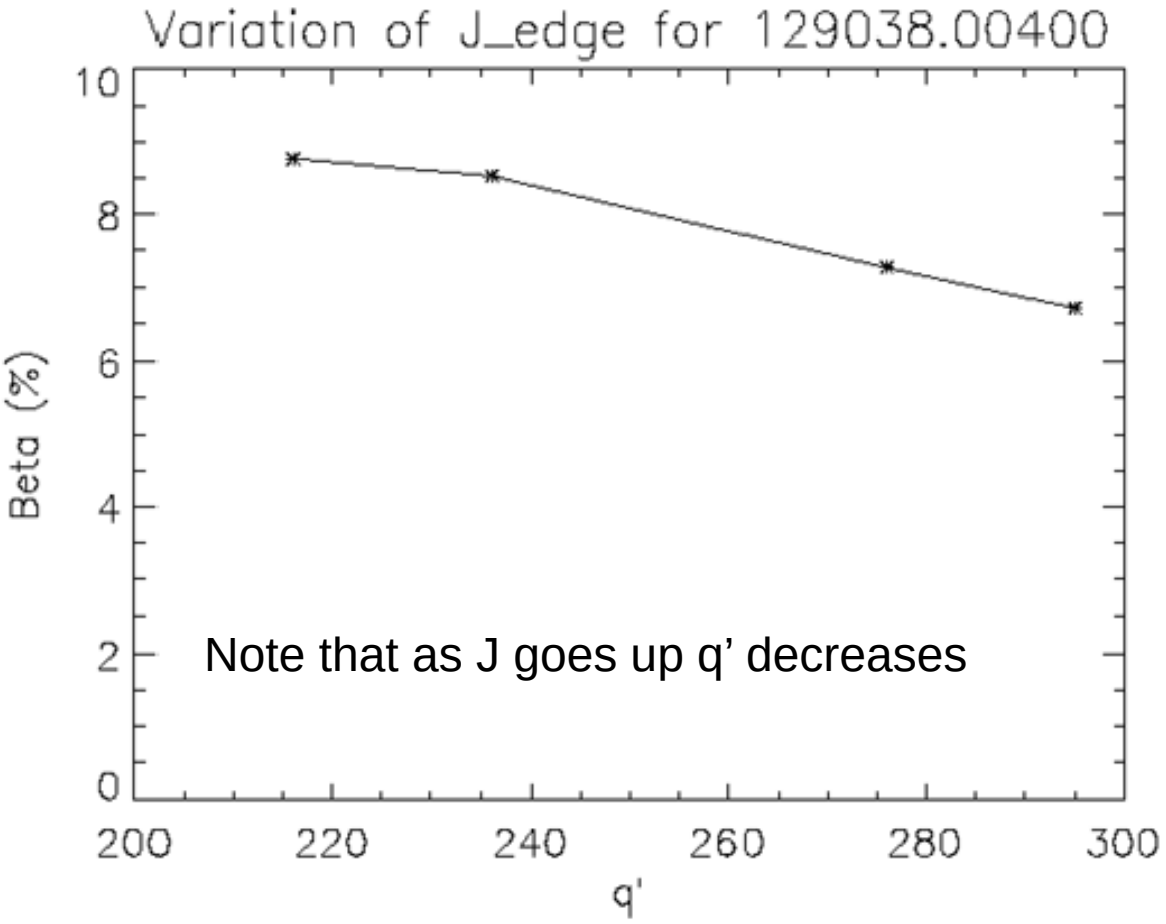
The beta threshold for the n=3 kink/ballooning mode shows a sharp increase as r/a decreases from 1 to 0.9



Vary the current profile



Beta threshold shows a modest change



Summary

- NSTX has the capability of varying the pressure profile near the edge and changing the ELM frequency
- Stability analysis shows that these variations are consistent with the stability of n=3
- Analysis of experimental data and model profiles is providing insight on the correlation between the pedestal structure and ELMs

Suggestions for experiments

- Shift the location of P’_max inwards to stabilize ELMs or outwards to trigger them
- Ramp the current profile, up and down to stabilize or trigger ELMs
- Varying the plasma shape varies the shear and provides yet another knob

Bootstrap current is dominant in ELMing discharges