Dependence of Resistive Wall Stabilization on Equilibrium Configuration

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Investigate dependence of resistive wall stabilization on MHD equilibria at high β

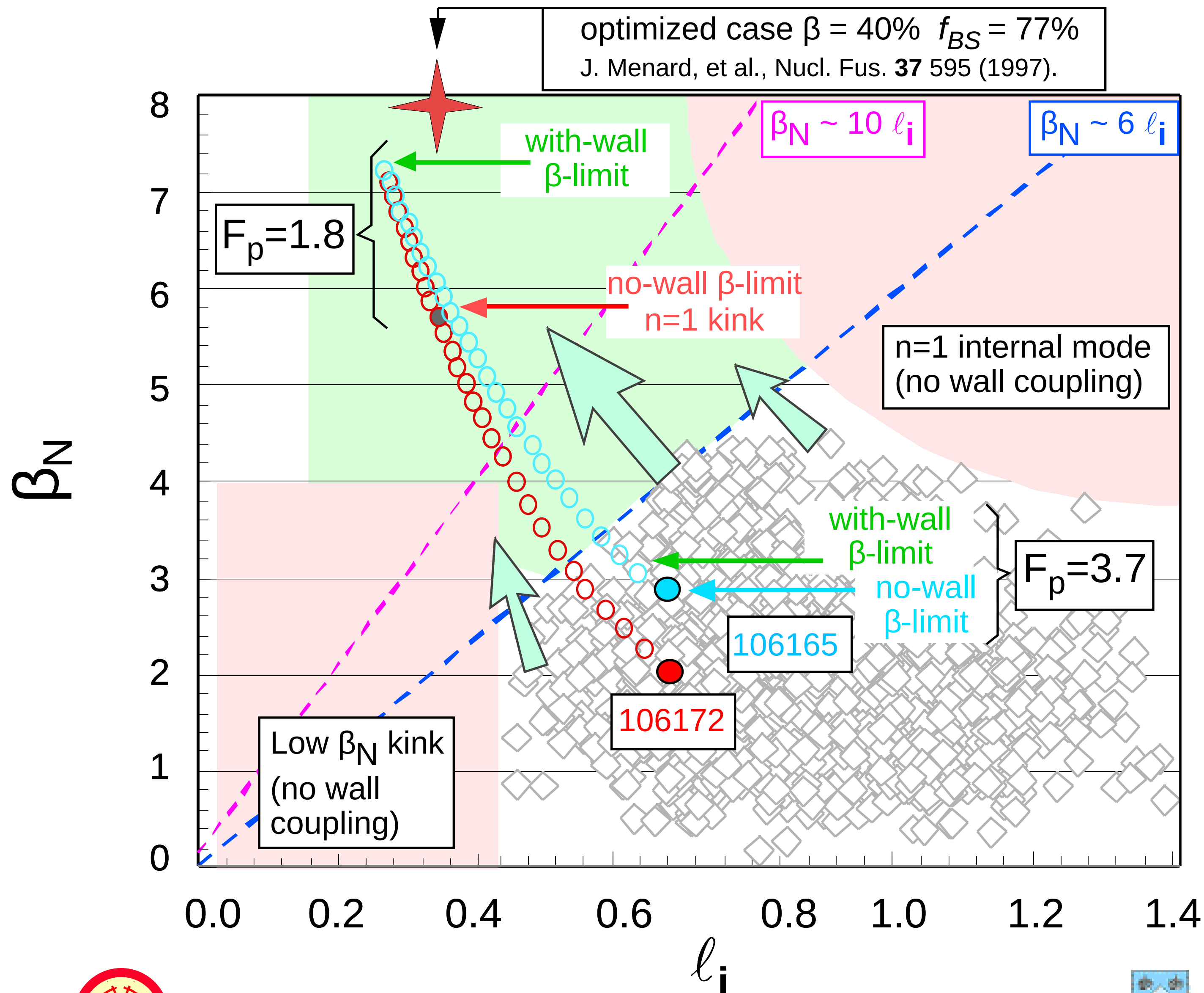
MOTIVATION

- Experimentally explore equilibrium trajectories providing access to elevated β_N and low ℓ_i through resistive wall stabilization
- Determine dependence of no-wall and with-wall β_N-limits on equilibrium configuration

MILESTONES AND PHYSICS GOALS

- Achieve values of the stability parameter $\beta_N / \ell_i \geq 10$ and operate 50% above the present max β_N-limit
- Characterize plasma transition para to diamagnetic (high β_p; drop I_p)
- Measure rotation damping rate and critical rotation frequency in presence of resistive wall mode at high β_N where wall/no-wall β_N-limit gap is large

Study dependence of β-limits on MHD equilibria



Pressure peaking factor

$$F_p = \frac{p(0)}{\langle p \rangle}$$

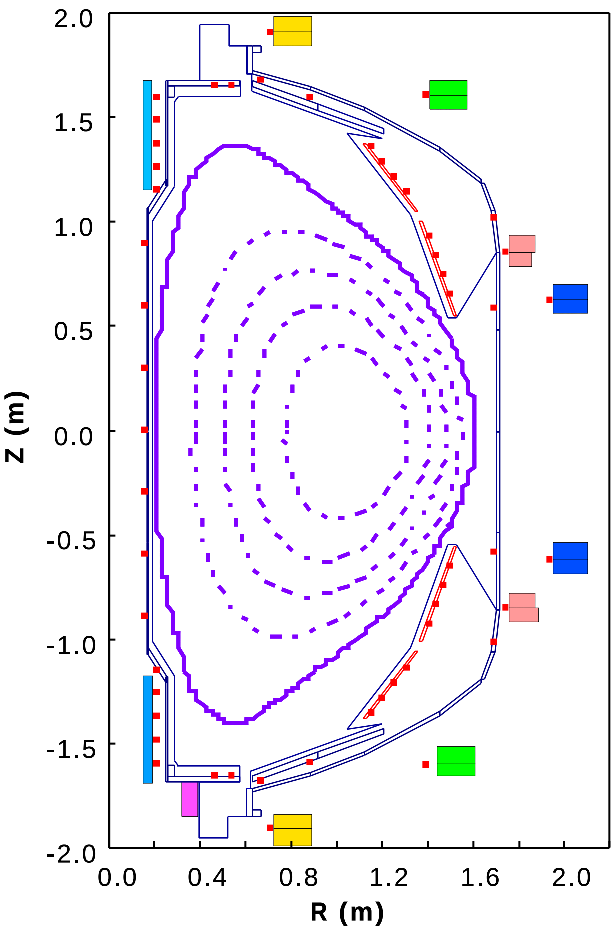
Strategies for experimental study of wall stabilization dependence on equilibrium

- Start from mid-ℓ_i ~ 0.7 plasmas at low β_N ~ 2.0 (L-mode F_p ~ 3.7)
- Increase β_N while transitioning to H-mode
  - Can run at B_T ~ 0.45 T - attempt operation at B_T ~ 0.35 T
- Vary F_p (H-mode P profiles ➔ F_p ~ 2.1 - 2.6)
- Start also from low and high ℓ_i to determine mode coupling to the wall
- Decrease ℓ_i through NBI step down and/or plasma expansion
  - At high-β_N , enhanced bootstrap current will naturally tend to reduce ℓ_i
  - Explore alternative ways to reduce ℓ_i through HHFW application
- Run in reduced error field to avoid, as much as possible, error field mode amplification (➔ use upper SN configuration)

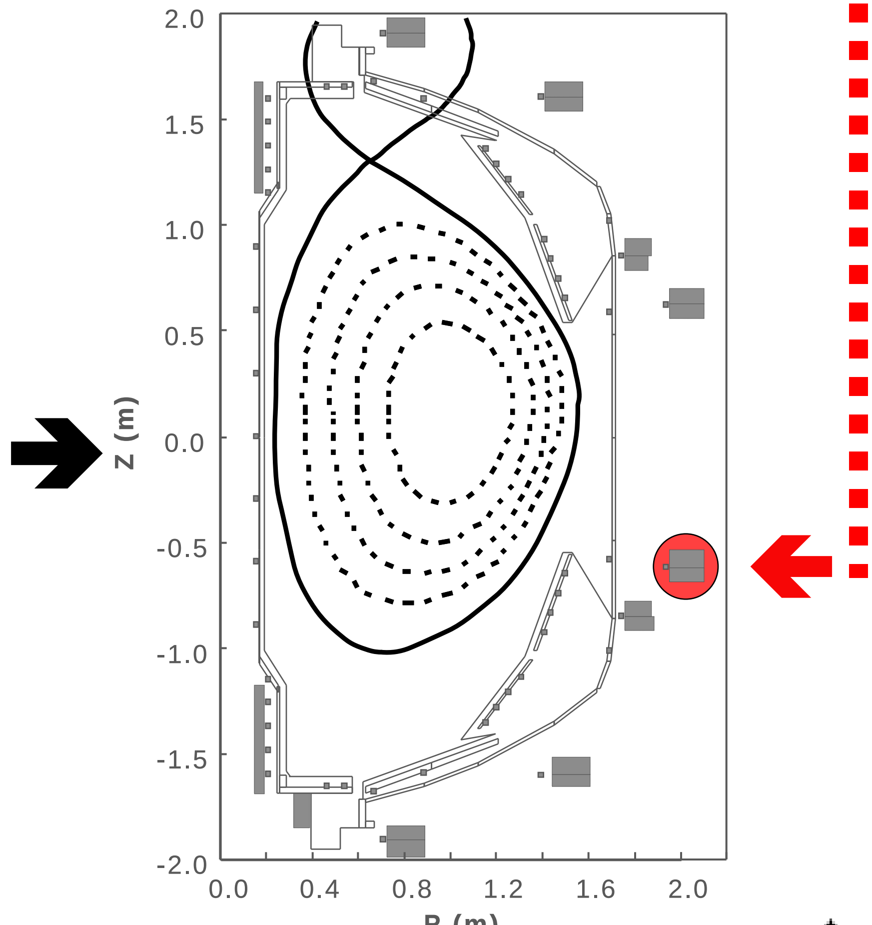
Use Upper-SN plasmas to minimize error field effects

Starting point:
Shot # 106172; t = 178 ms

- R = 0.87 m
- a = 0.68 m
- $\kappa = 2.0$
- $\delta = 0.51$
- A = 1.27
- I_p = 0.94 MA
- B_T = 0.34 T
- β_t = 8.0%
- β_N = 2.0
- β_p = 0.28
- F_p = 3.7
- ℓ_i = 0.65



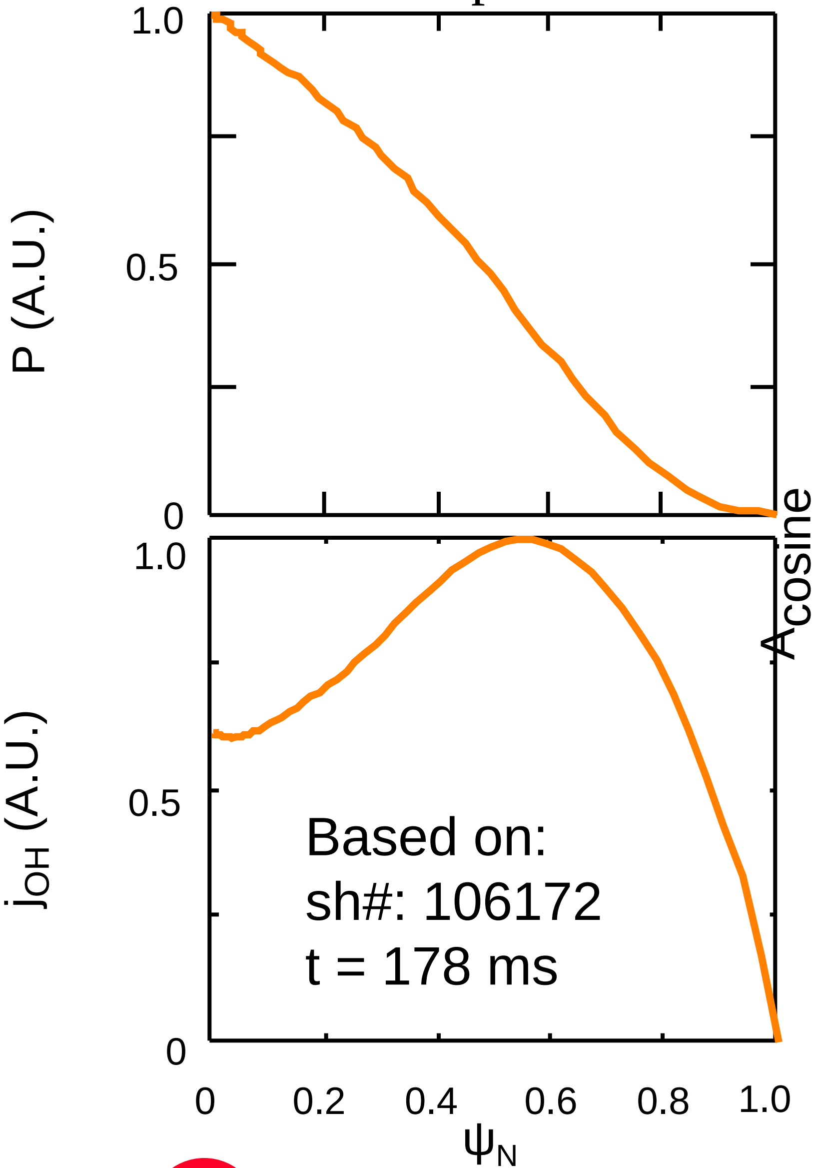
- Error field major component is in lower PF5 coil



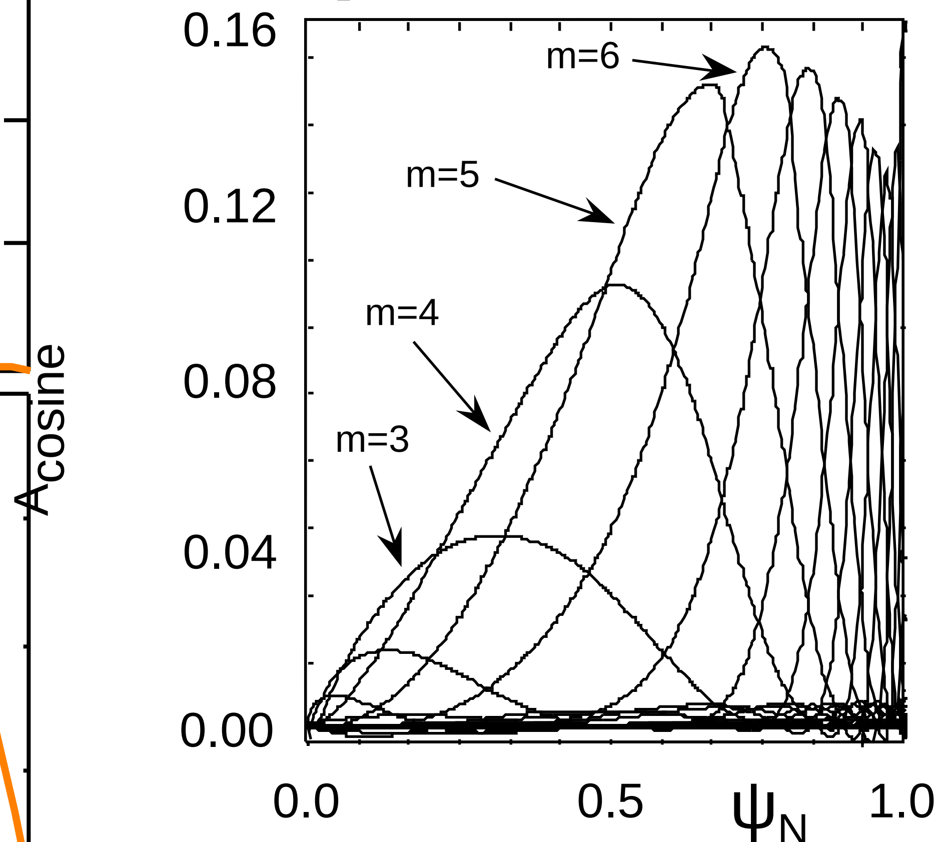
Required and Desired Diagnostics

- Required
  - Flux loops and integrated poloidal Mirnov coil data
  - CHERS toroidal rotation measurement
  - Locked mode detector measurements
  - Thomson scattering
  - Diamagnetic loop
  - USXR
- Desired
  - Second toroidal position USXR array
  - Toroidal Mirnov array
  - Measurements of currents in passive conducting structures
  - Mirnov coils measuring radial field perturbation
  - Fast camera

At ℓ_i and F_p of target case no-wall limit at $\beta_N = 5.7$;



$F_p \sim 1.8$; $\ell_i \sim 0.34$



PEST1

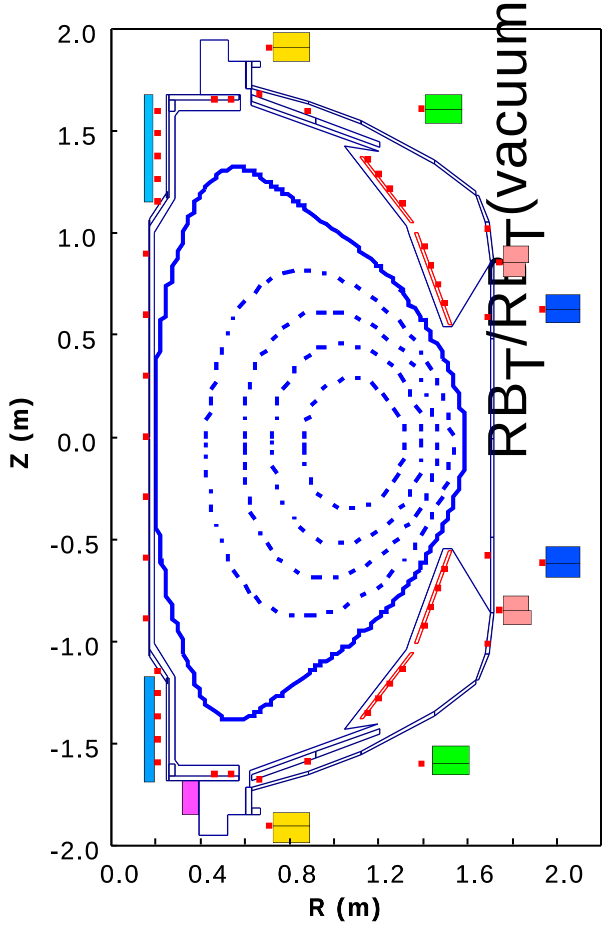
- Global n=1 kink structure
- Wider window for wall stabilization with r_{wall} =1.25 a

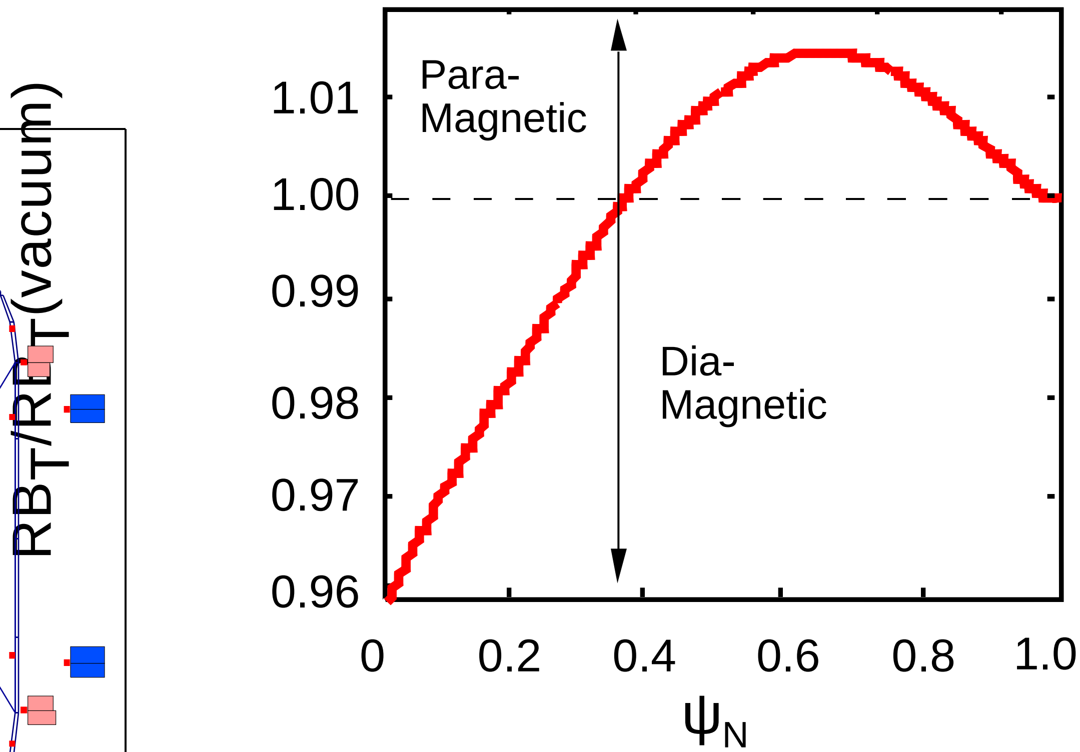
At high β_N ~ 5.7 plasma transitions to diamagnetic

Based on:
sh#: 106172; t = 178 ms

R = 0.87 m
a = 0.68 m
κ = 1.95
δ = 0.43
A = 1.27
I_p = 0.94 MA
B_T = 0.34 T
β_t = 24.0%
β_N = 5.7
β_p = 0.74

F_p = 1.8
ℓ_i = 0.34





Plasma center becomes diamagnetic