Role of Outer Boundary Plasma Shape on NSTX Stability of High β Discharges

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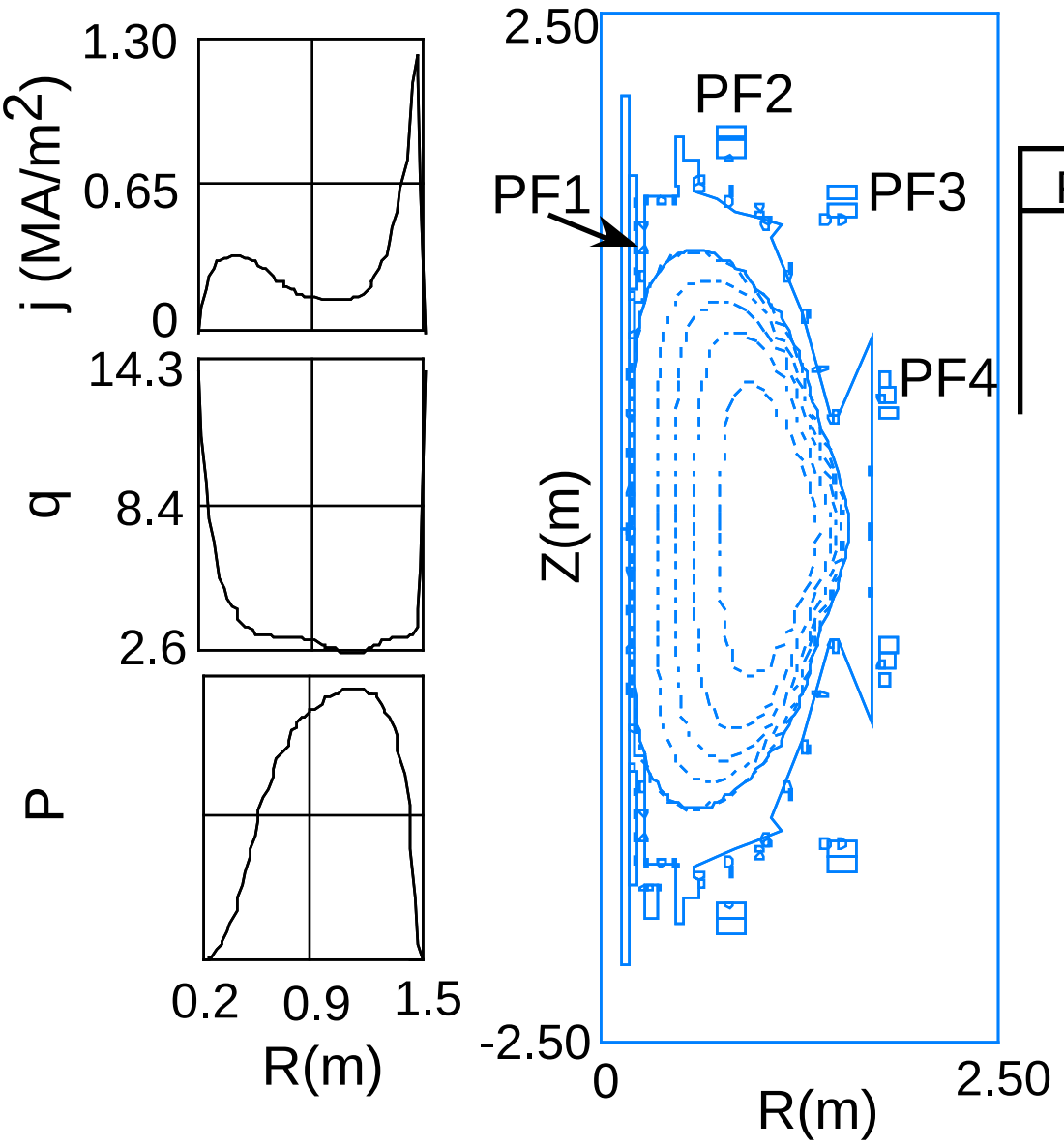
Key physics issues and implemented solutions

- NSTX PAC request: impact of outer boundary shape (stability of parametrized vs. free-boundary shapes)
  - Studied ballooning and n = 1 kink on β = 40%case ..... ✓
  - Considered alternatives to eliminate reduced β limit from non-uniform boundary curvature effect ..... ✓
    - Generated case with higher triangularity rearranging coil currents
    - Higher aspect ratio case with plasma moved 5cm inward on midplane
    - Closely matched parametrized boundary in a different coil configuration
- Study robustness of stability in targeted configurations
  - Sensitivity to changes in P' and q profiles .....
  - Quantify Effects of variations in plasma shape .....

High β plasma with optimized profiles

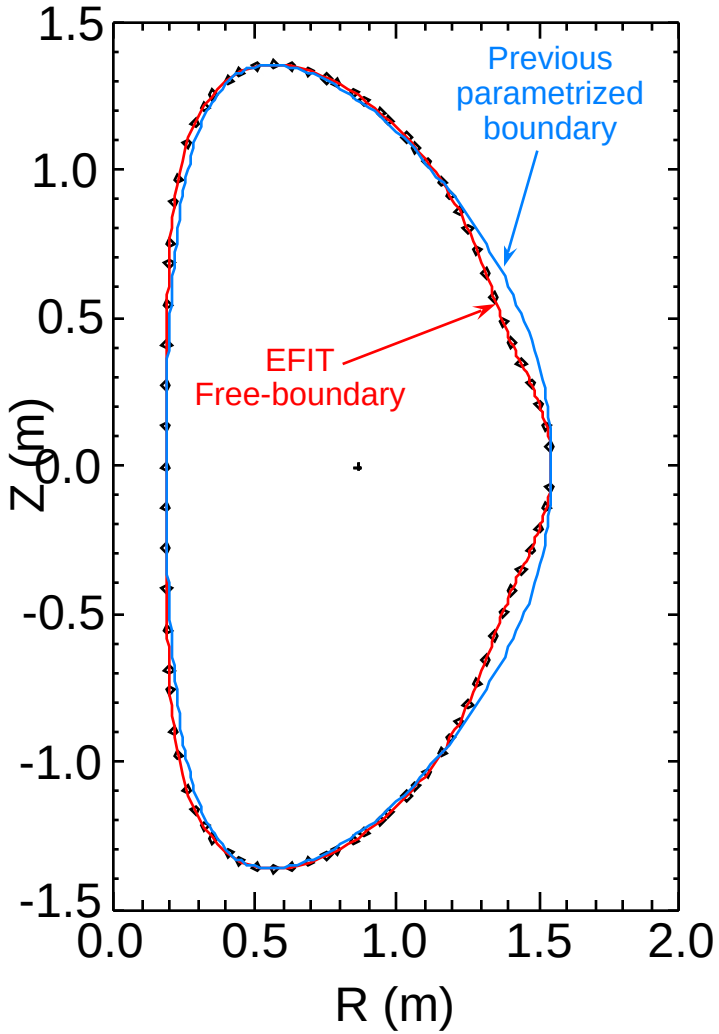


PF	currents
1	-0.4 kA
2	0.04 kA
3	-5.7 kA
4	-8.7 kA

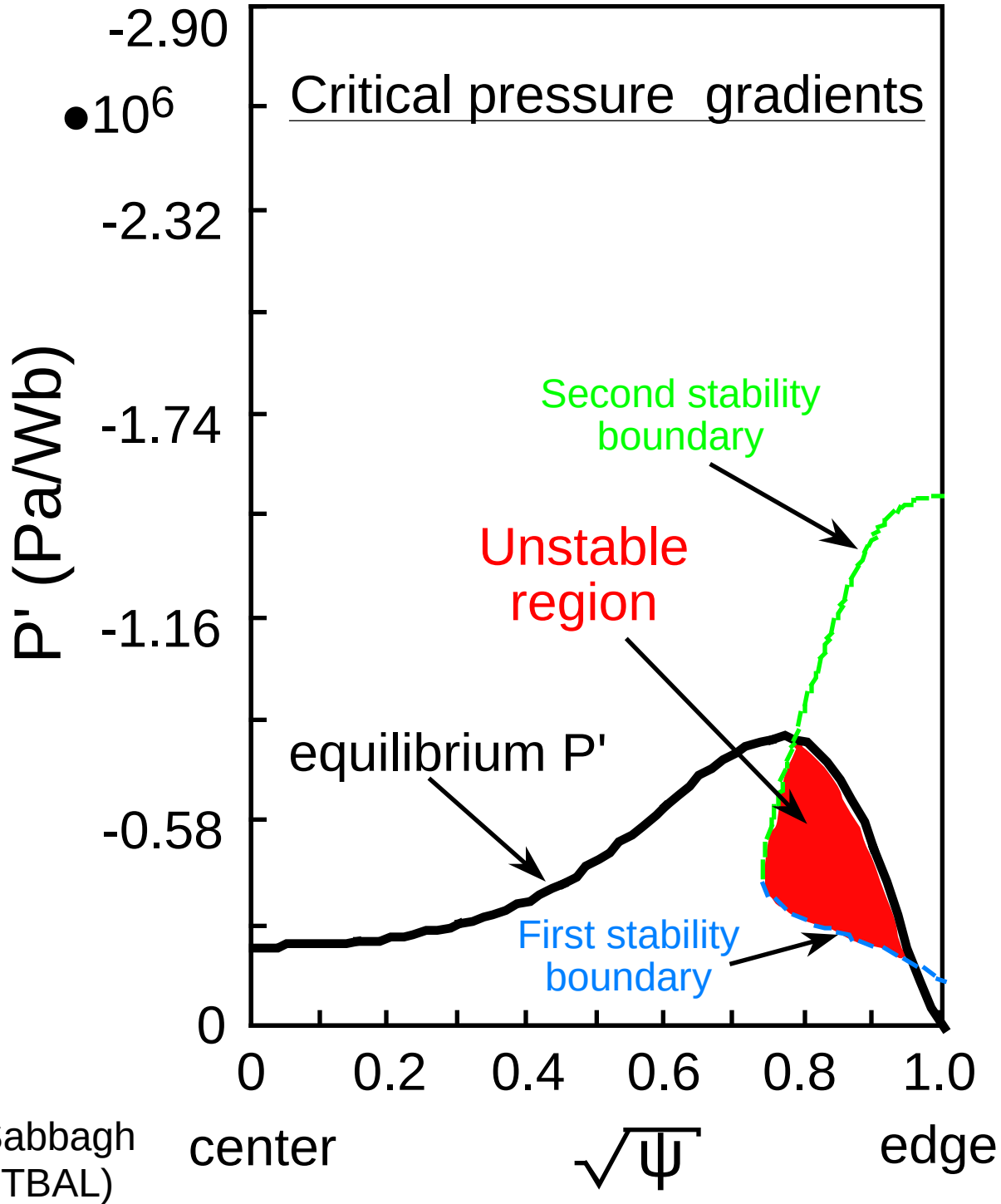
- Used P'(ψ), FF'(ψ) optimized profiles previously used in JSOLVER

Strong dimple alters stability

- EFIT boundary generated by existing coil set (free-boundary minimizing ΣI_{coil}^2)
- Previous JSOLVER boundary imposed in a parametrized form
- n = 1 ideal kink stabilized with conducting wall at b/a = 1.2
- Ballooning β limit reduced from 40% to 33%

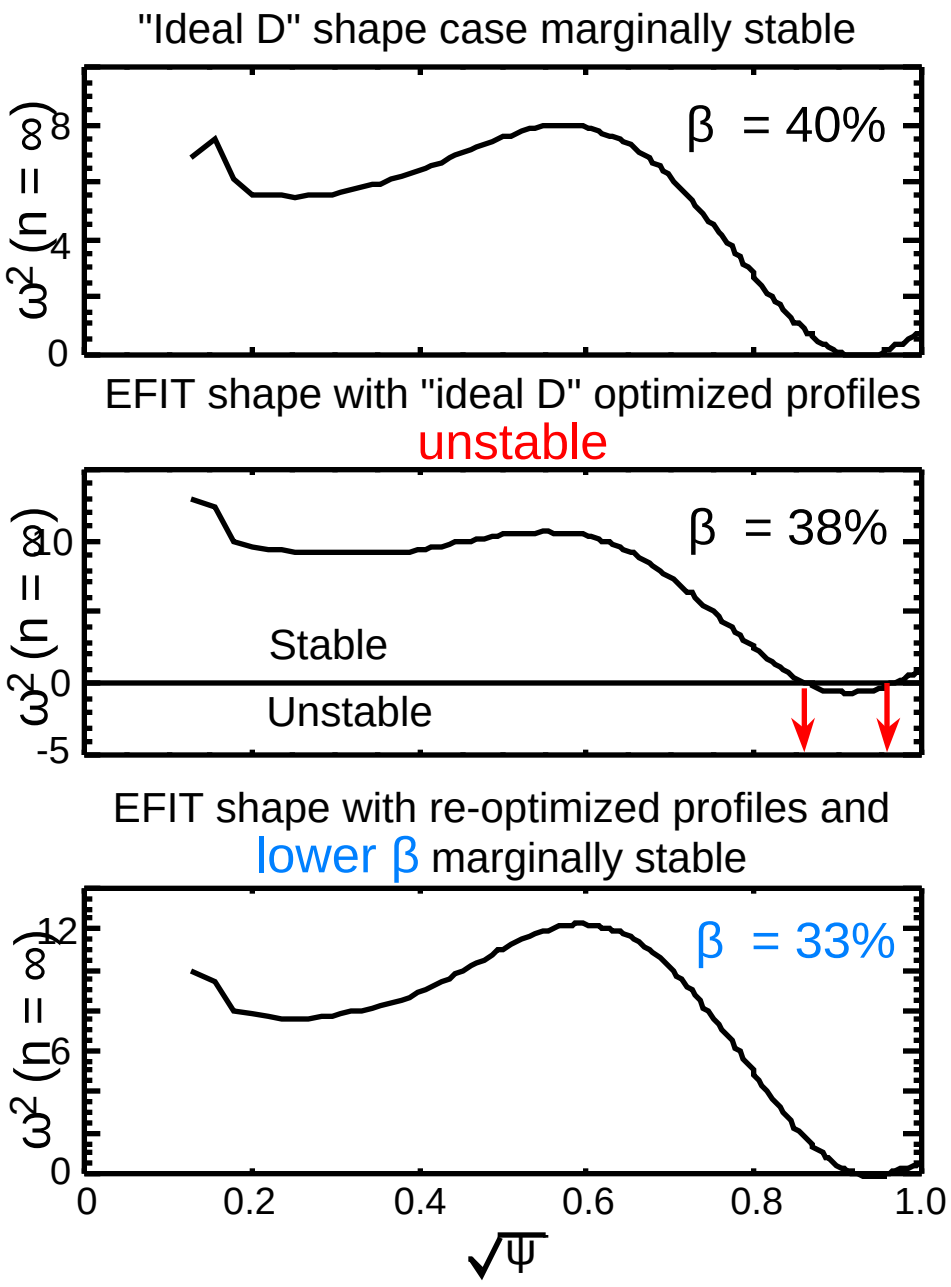


EFIT free-boundary case with 40% β shows edge ballooning instability



S. Sabbagh
(STBAL)

β limit reduced by non-uniform boundary curvature



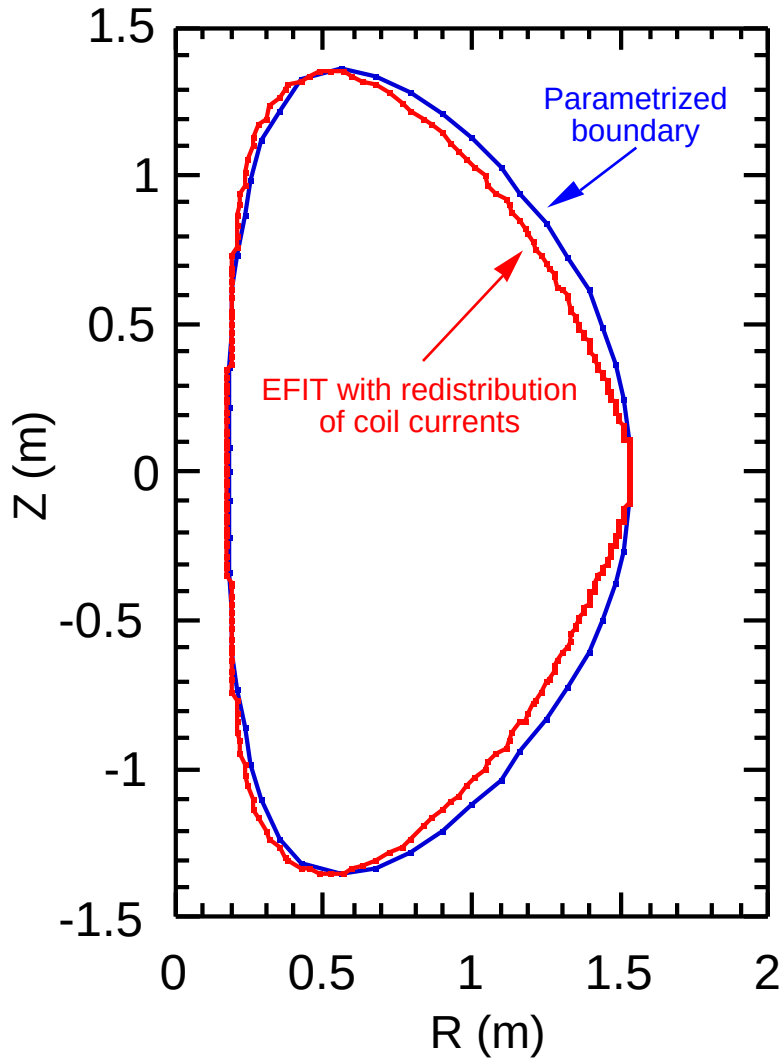
J. Menard (BALLOON)

Coil currents redistribution brings β limit to 37%

- EFIT boundary generated weighting the current in the PF4 coil (δ = 0.59)

PF	most dimple	new case
1	-0.40 kA	0.62 kA
2	0.04 kA	2.39 kA
3	-5.70 kA	-7.79 kA
4	-8.70 kA	-8.03 kA

- Ballooning β limit reduced from 40% to 37%

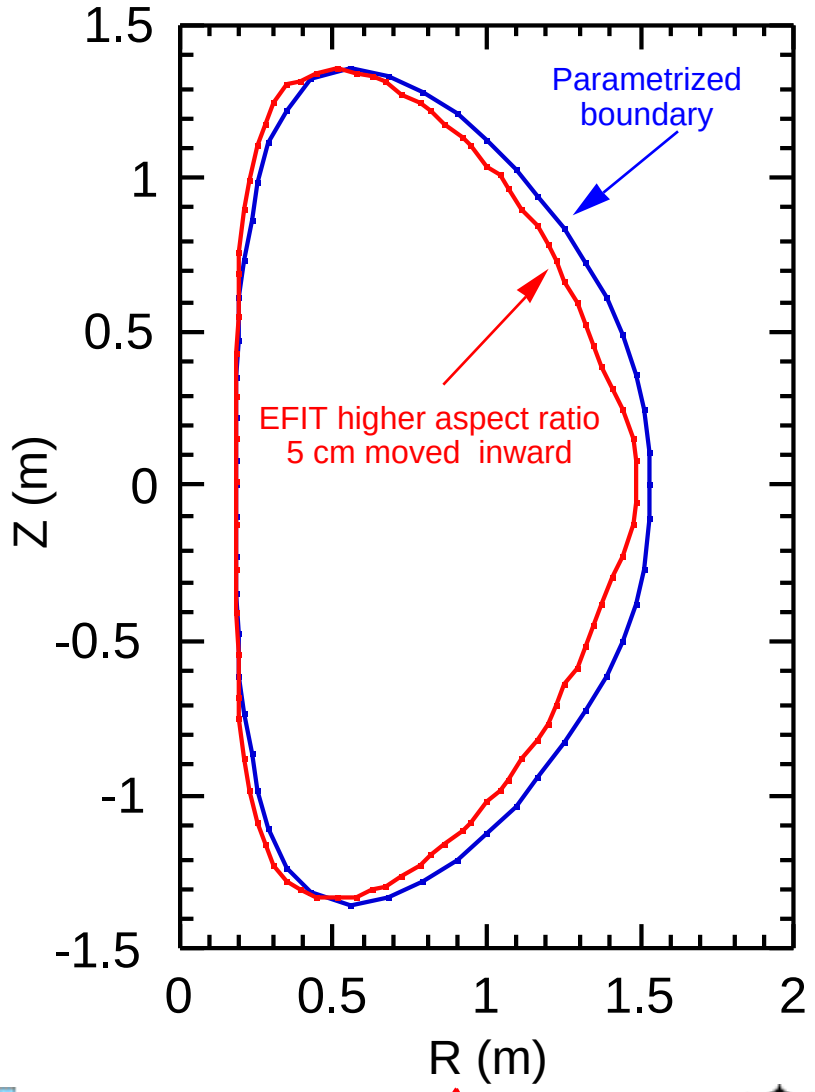


Moving plasma 5 cm inward increases β limit to 41%

- EFIT boundary generated moving plasma 5 cm inward on midplane: $R(z=0) = 1.483$ m ($\delta = 0.55$)

PF	most dimple	new case
1	-0.40 kA	0.35 kA
2	0.04 kA	2.19 kA
3	-5.70 kA	-7.53 kA
4	-8.70 kA	-8.50 kA

- Increased ballooning β limit from 40% to 41%

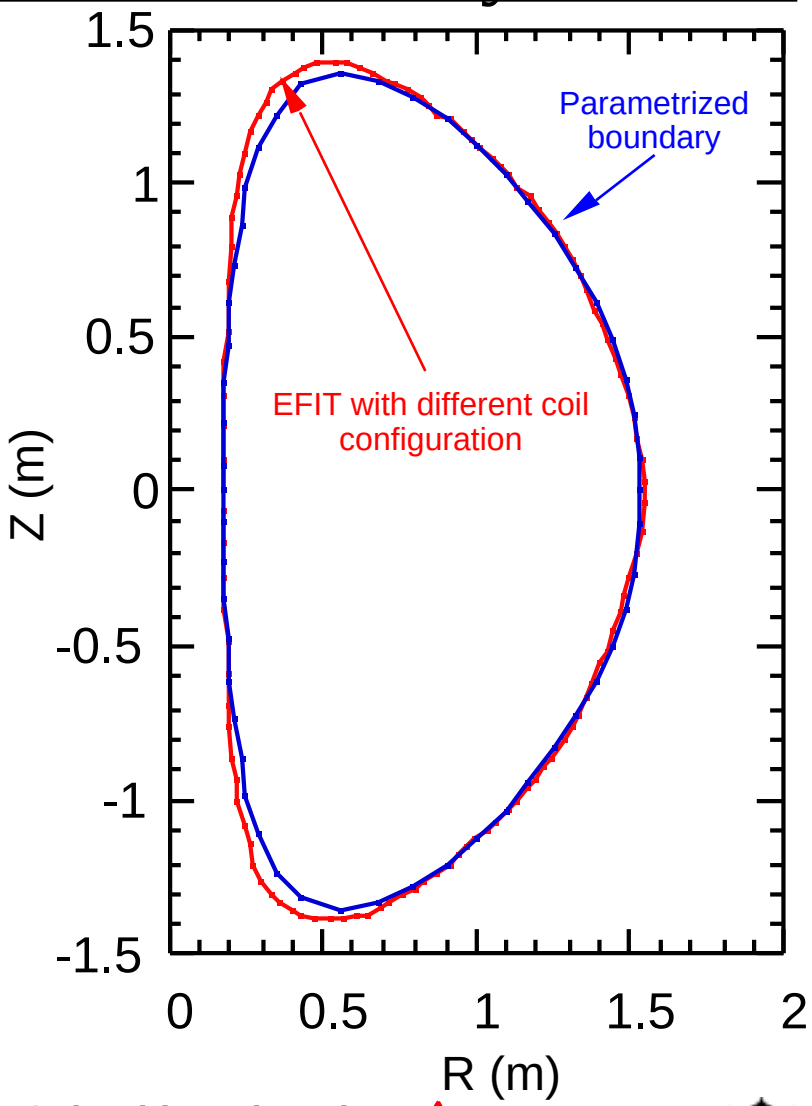


Moving PF4 outward allows better boundary match

- EFIT boundary generated moving the PF4 coils 20.9 cm outward ($\delta = 0.54$)
- Parametrized boundary much closely matched

PF	most dimple	new case
1	-0.40 kA	0.41 kA
2	0.04 kA	1.64 kA
3	-5.70 kA	-6.80 kA
4	-8.70 kA	-8.96 kA

- Ballooning β limit found at 39%



Progressive dimple suppression requires less change in P' to reach β limit