ISD overview - High β, Long Pulse

D. Gates

NSTX Results review

9/9/02

XP's and XMP's

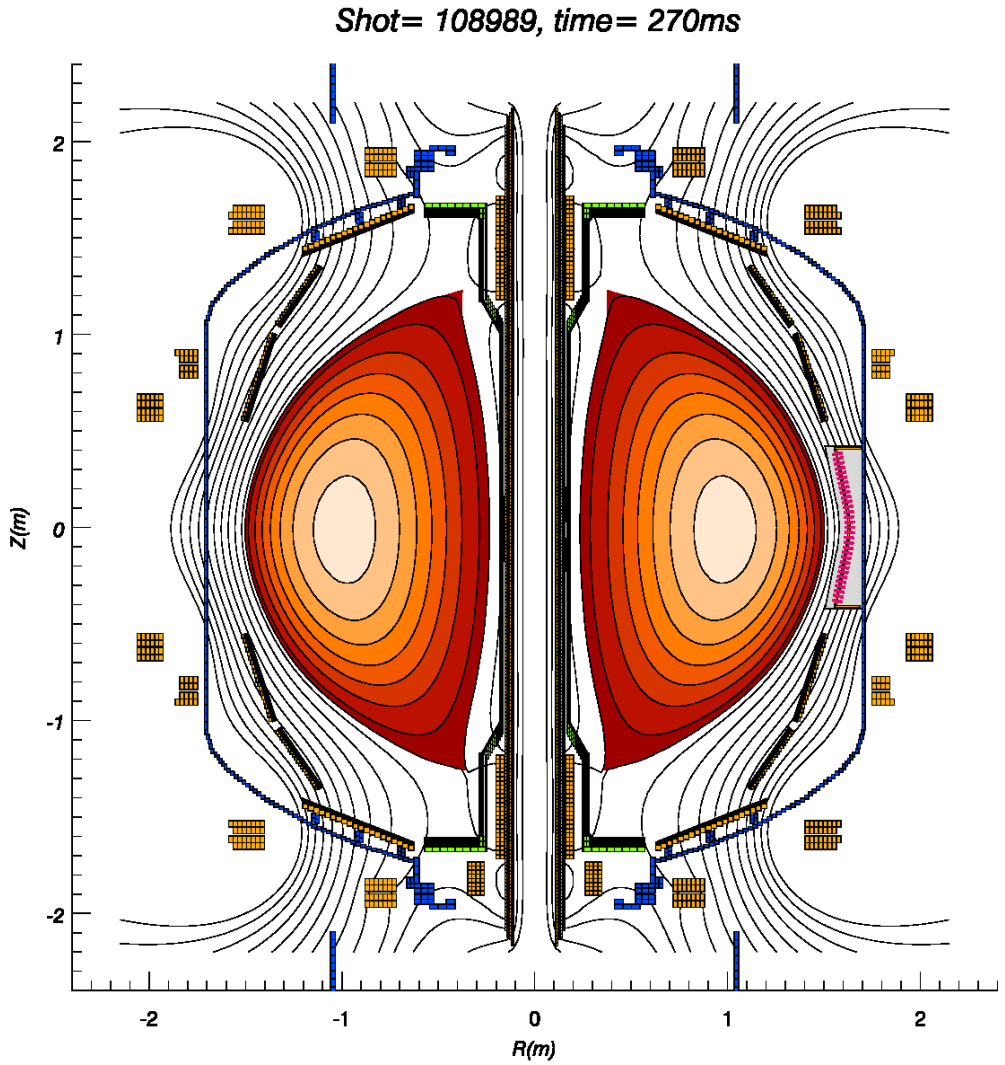
- R. Maingi - H-mode HFS/LFS fueling
- J. Menard
  - XP-222 - Early HHFW
  - XP-229 - NBI long-pulse
- F. Paoletti
  - XP 210 - Dependence of resistive wall stabilization on Equilibrium configuration
- D. Gates
  - XP 220 - High β, High $\beta\tau$, High stored energy H-mode plasmas (w/ R. Maingi)
  - XP 228 - Long pulse high current plasmas at high triangularity
- D. Gates and J. Ferron
  - XMP 24 - rtEFIT/isoflux control commissioning

Outline

- Will cover APS topics
  - High β, High βτ, High stored energy
  - Long pulse (also covered by J. Menard)
  - High β_N/l_i ~10
- rtEFIT commissioning

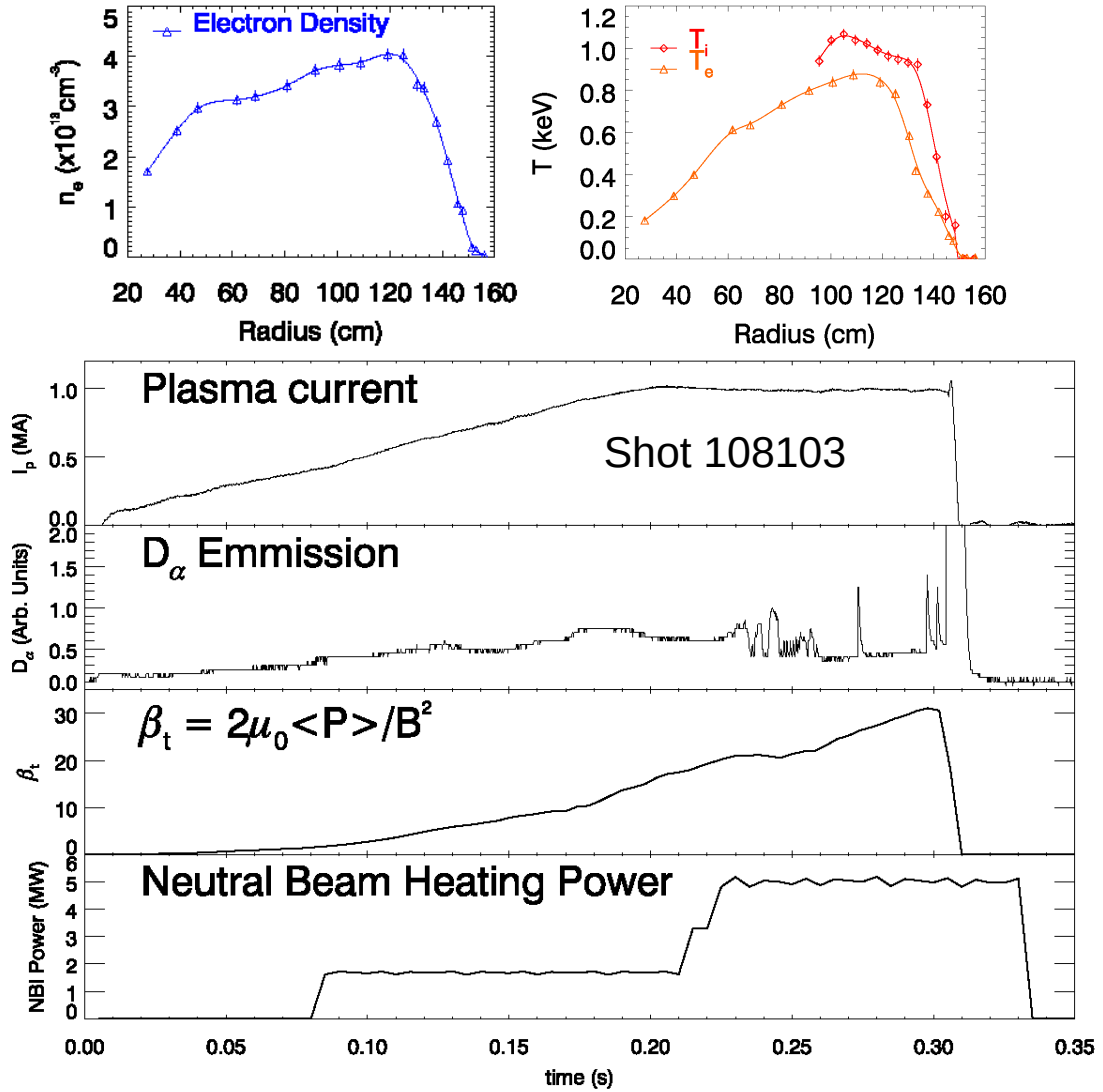
Strong shaping key to high β

- High triangularity and elongation raises edge q for fixed current, toroidal field
  - *Effect stronger at low A*
  - $A \sim 1.4$
  - $\kappa \sim 2.0$
  - $\delta \sim 0.8$
- Can reach higher I/aB
- Also allows more rapid I_p ramp



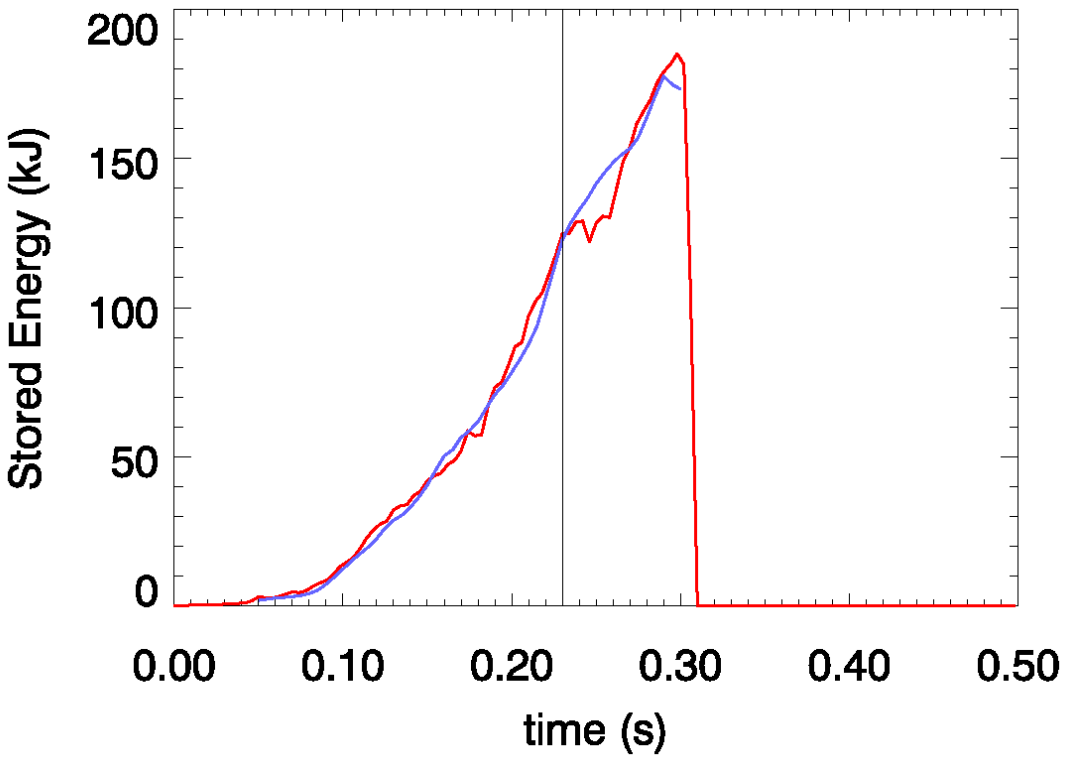
β_t = 34% achieved on NSTX

- β_t ($=2\mu_0<P>/B_t^2$) of 34% achieved in high triangularity double null H-mode discharge
- $\beta_N \sim 6.3$
- $l_i \sim 0.8$
- I_p = 1MA
- B_t = 0.3T
- P_{NBI} = 5MW



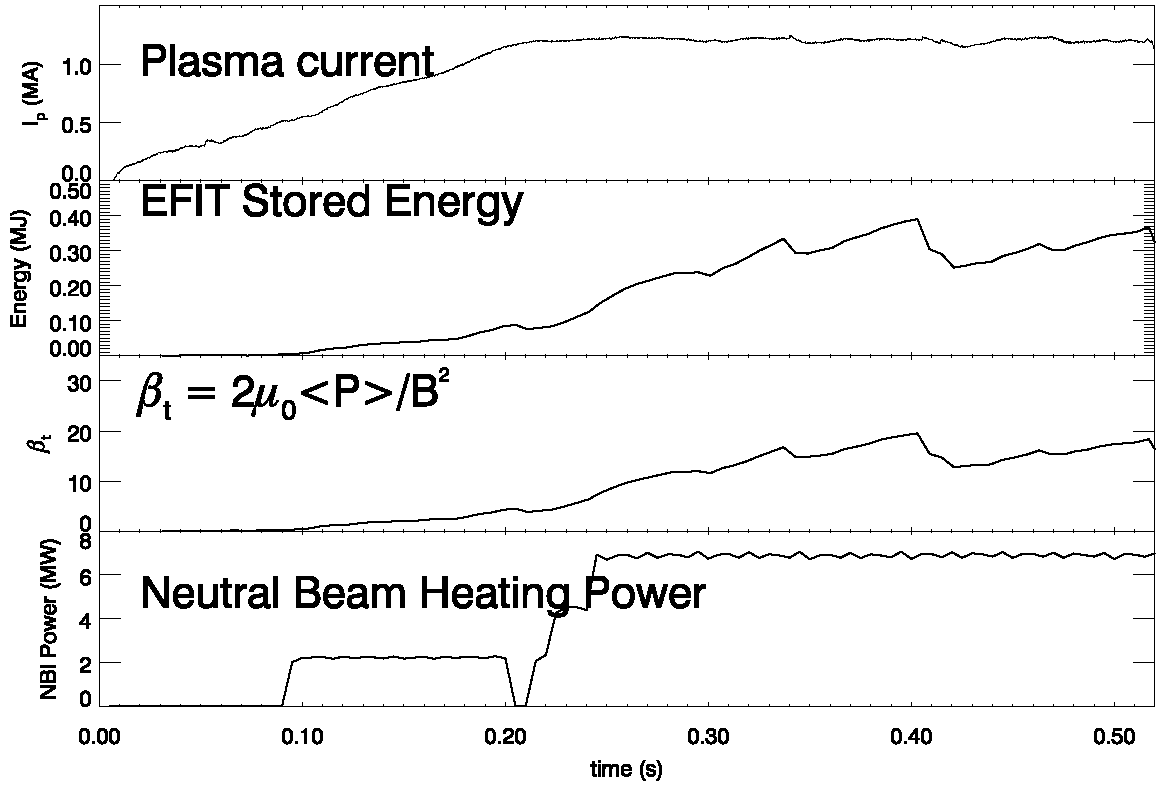
Early TRANSP results promising

- Stored energy in good agreement using measured n_e, T_e, T_i
- Ion temperature still preliminary
  - Stored energy not sensitive to details of T_i profile



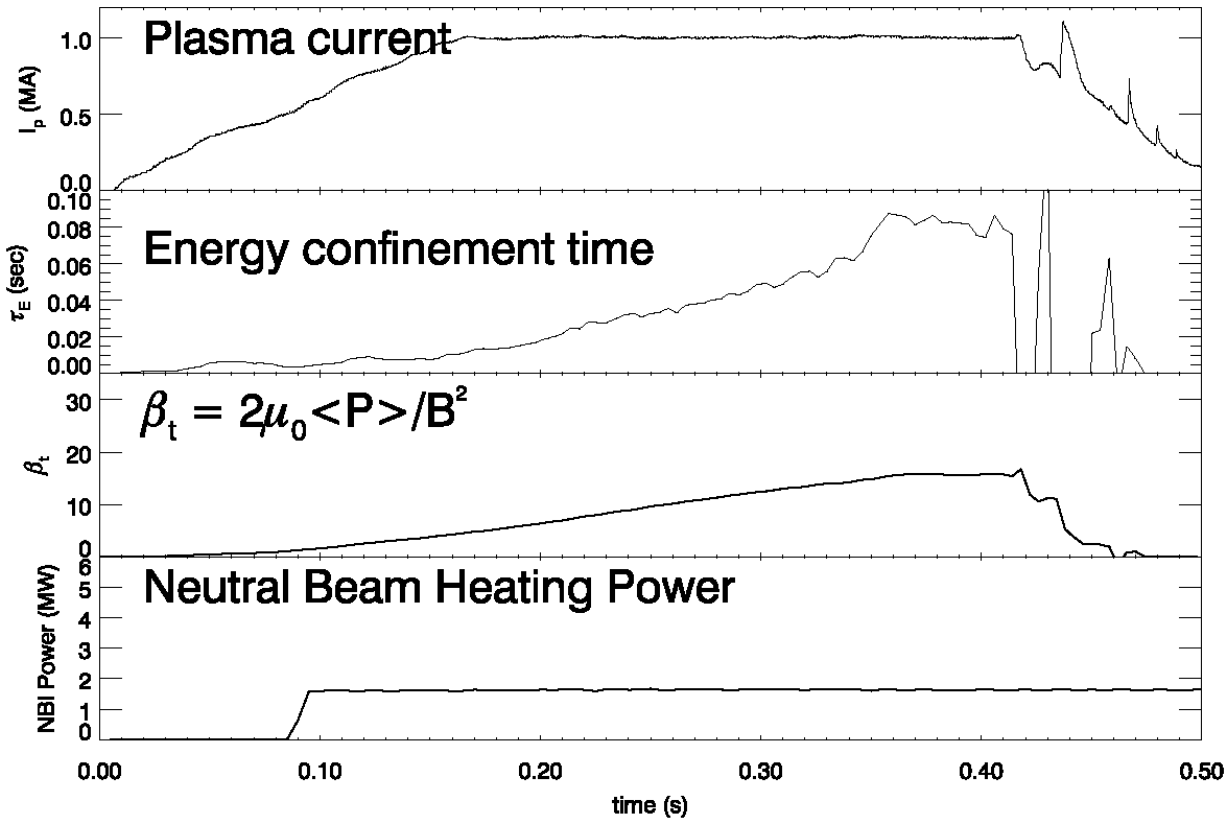
High stored energy

- Reached 20% beta at 5.5kGauss
- 7MW injected power
- Loop voltage low

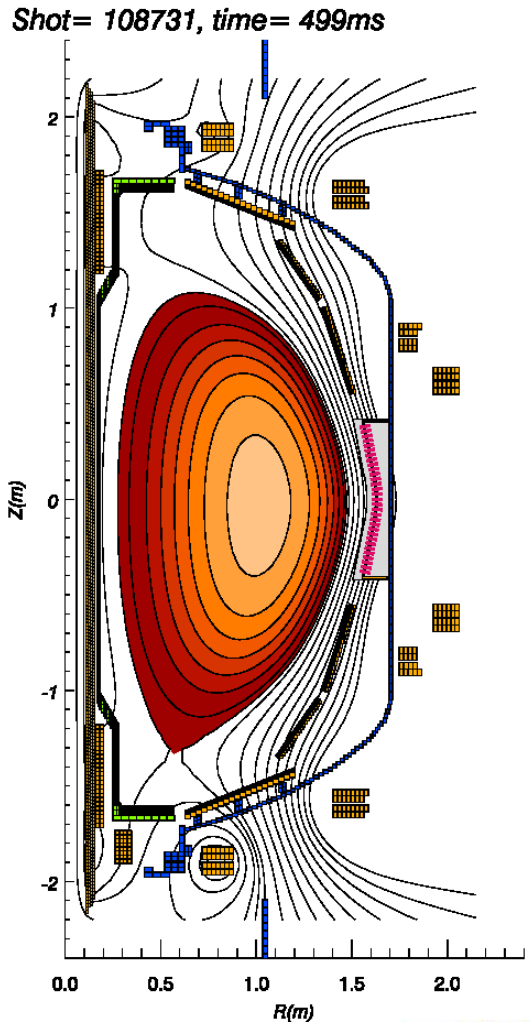


High $\beta\tau_E$

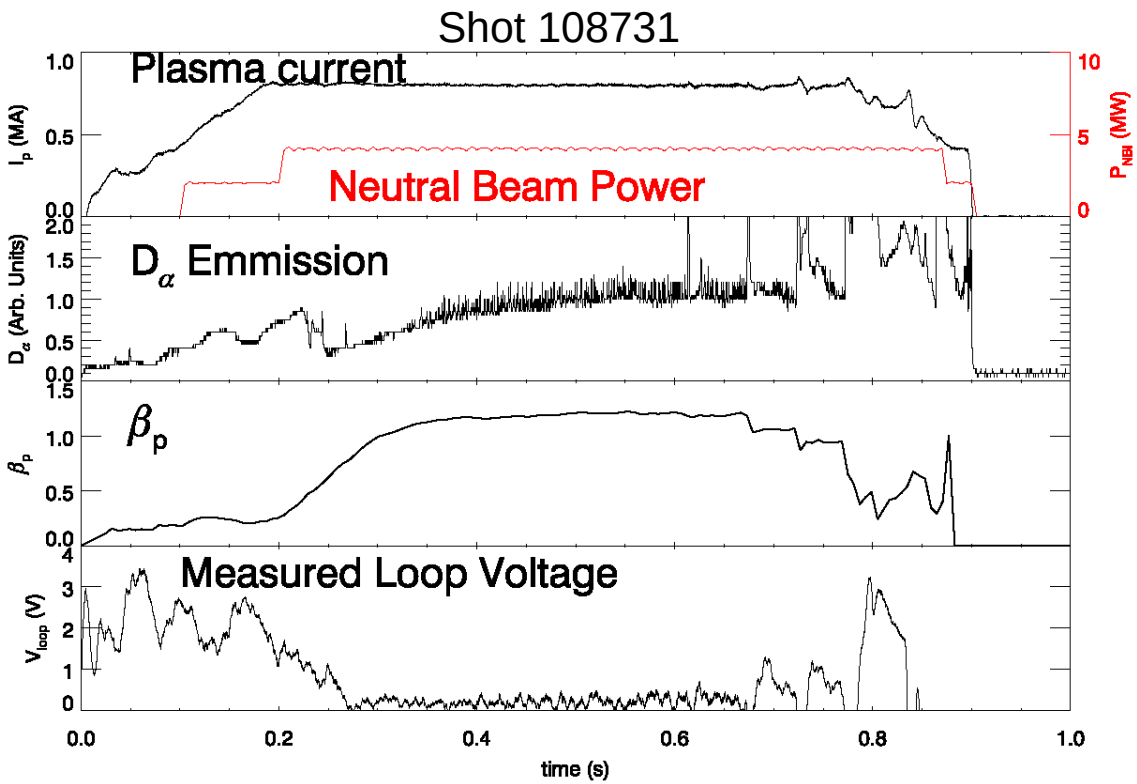
- Highest product achieved in high δ DND H-mode plasmas
- MHD causes flattop - limits confinement
- As in most long pulse discharges on NSTX confinement improves with time (rotation?)



Non-inductive current ~60% in high β_p discharges

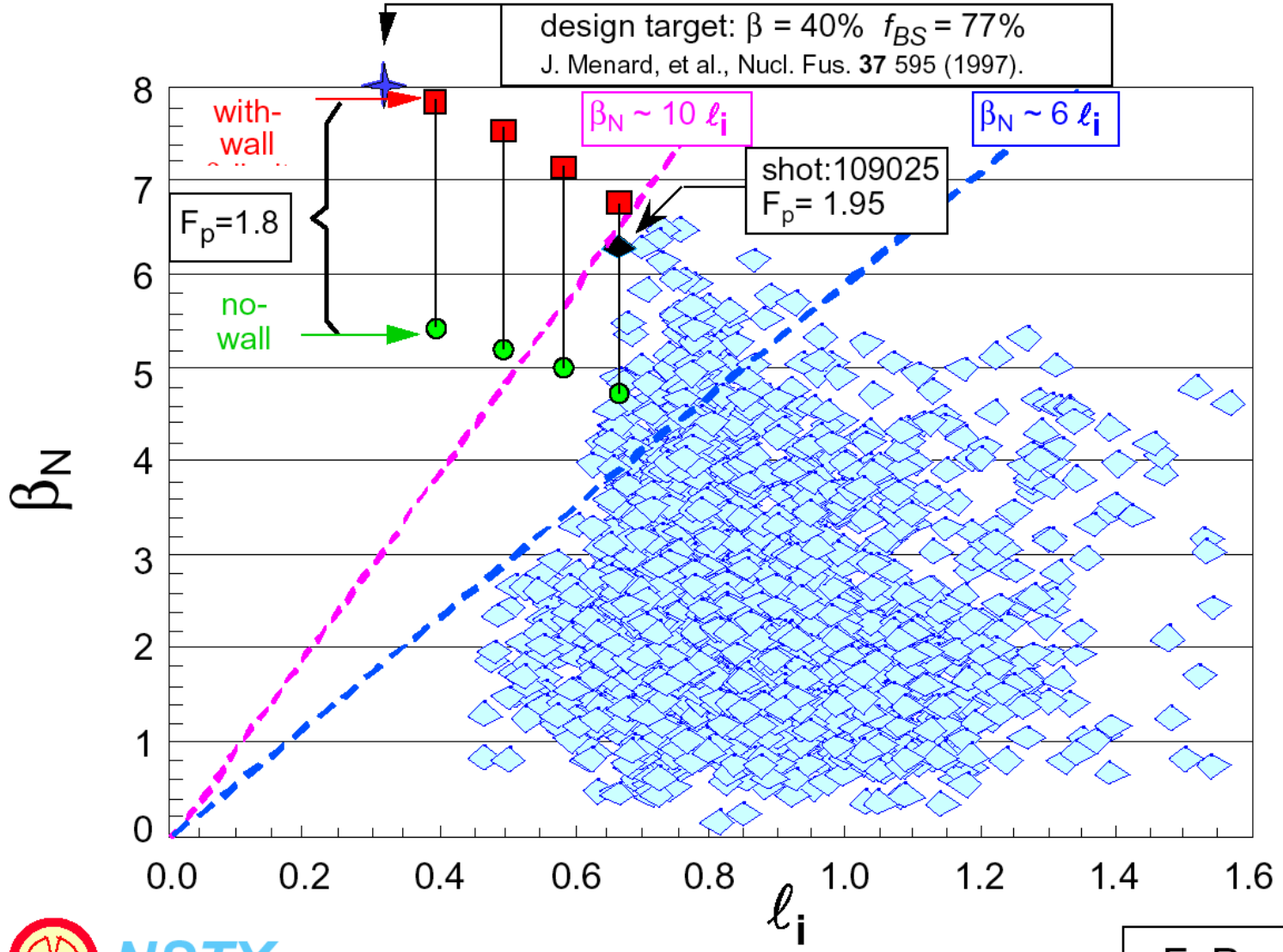


- Bootstrap current crucial to the ST concept
- Loop voltage < 200mV for > 0.4s
- Single null offers easier H-mode access



J. Menard

Access to high-β high bootstrap fraction target exists

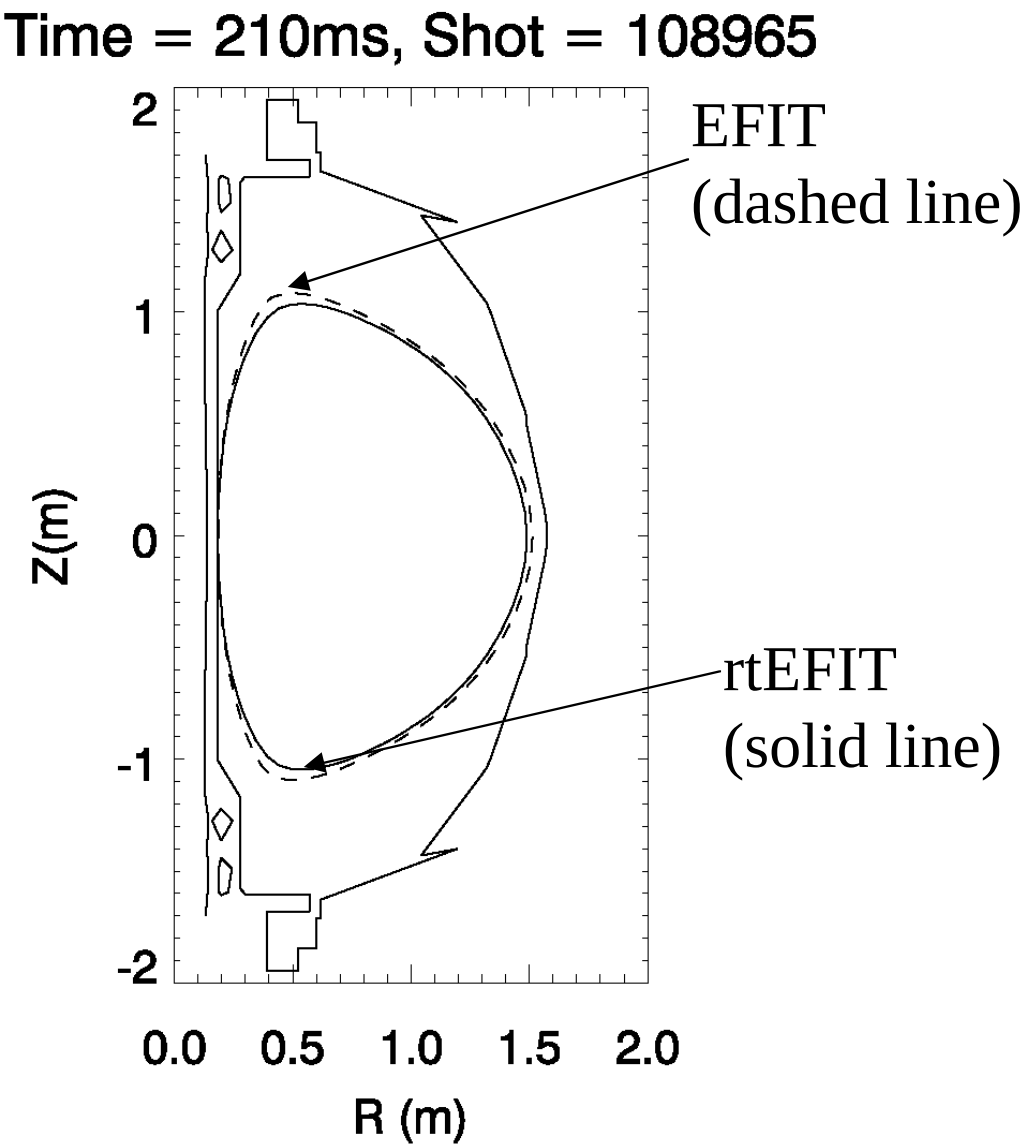


rtEFIT development

- rtEFIT/isoflux control demonstrated
- ~ 5 plasma shots with control enabled
- rtEFIT (slowloop) reconstructions every 20ms
  - Optimization has reduced this to ~12ms
- Small errors in boundary due to bad fiber optic units

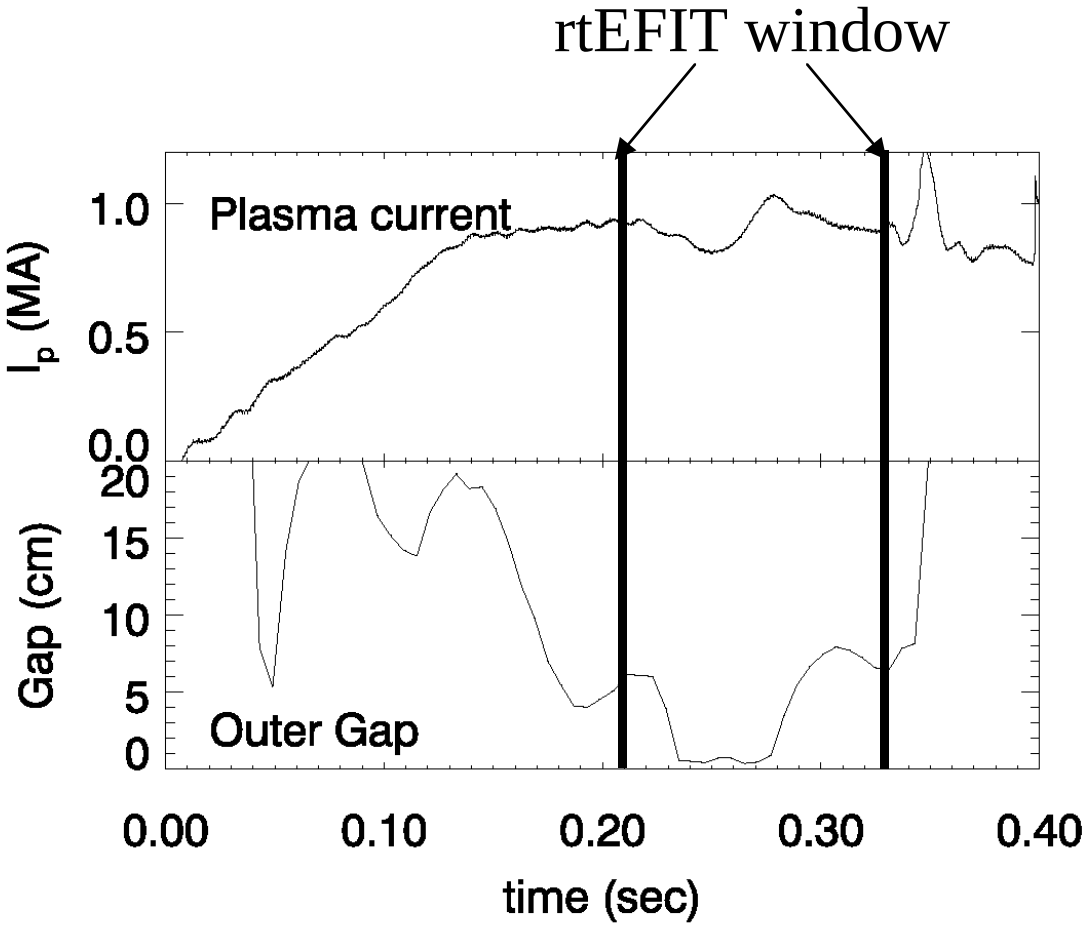
rtEFIT reconstructions accurate

- Use same vessel model as offline EFIT
- Errors due to bad real time data channels
  - 4 adjacent Mirnovs (worst case)



Control using rtEFIT/isoflux

- Outward motion due to initial boundary error
- Plasma comes back under control!
- Further optimization required :-)



Summary

- XP's in the ISD ET was very successful at incorporating physics learned from other ET's and utilizing this information to optimize operational scenarios
- There is a lot more to come