

# XP 402: Long pulse DND plasma development

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At the NSTX results review

Princeton Plasma Physics Laboratory, Princeton NJ

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# Outline

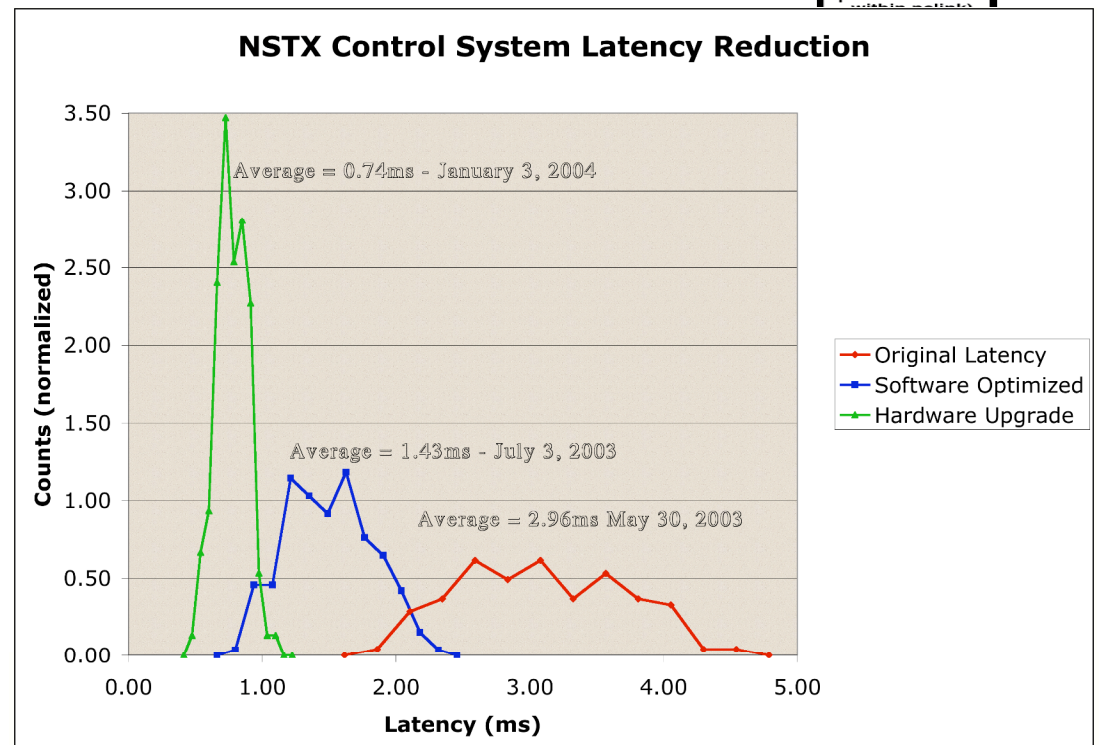
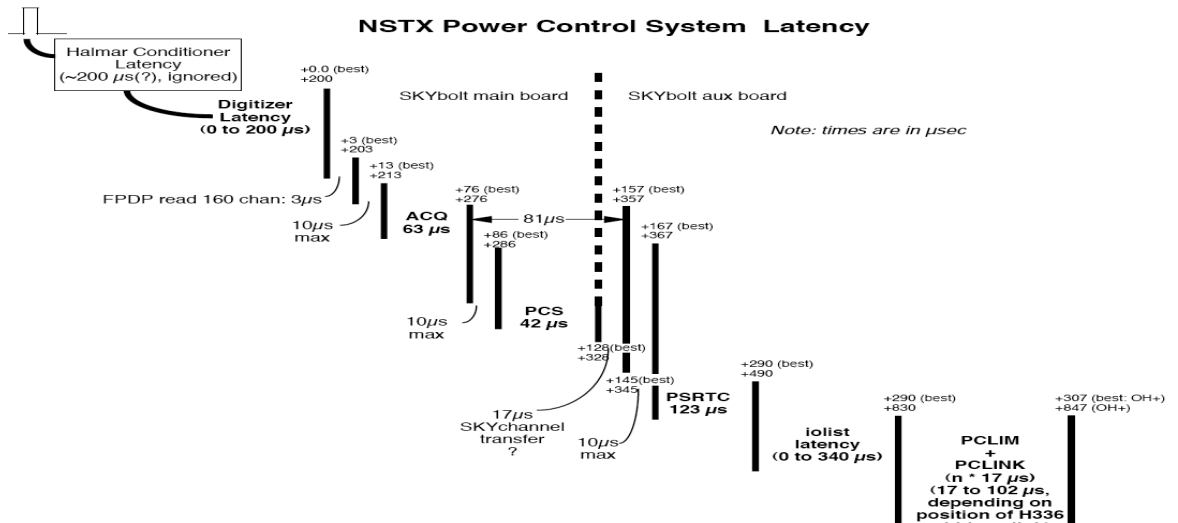
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- XP goals
- Control system improvements
- High  $\kappa$  plasma developed
- Pulse length and performance
  - Achieved 1MA, 1s pulse
- Improved operational boundaries
- Summary

# Control latency reduction

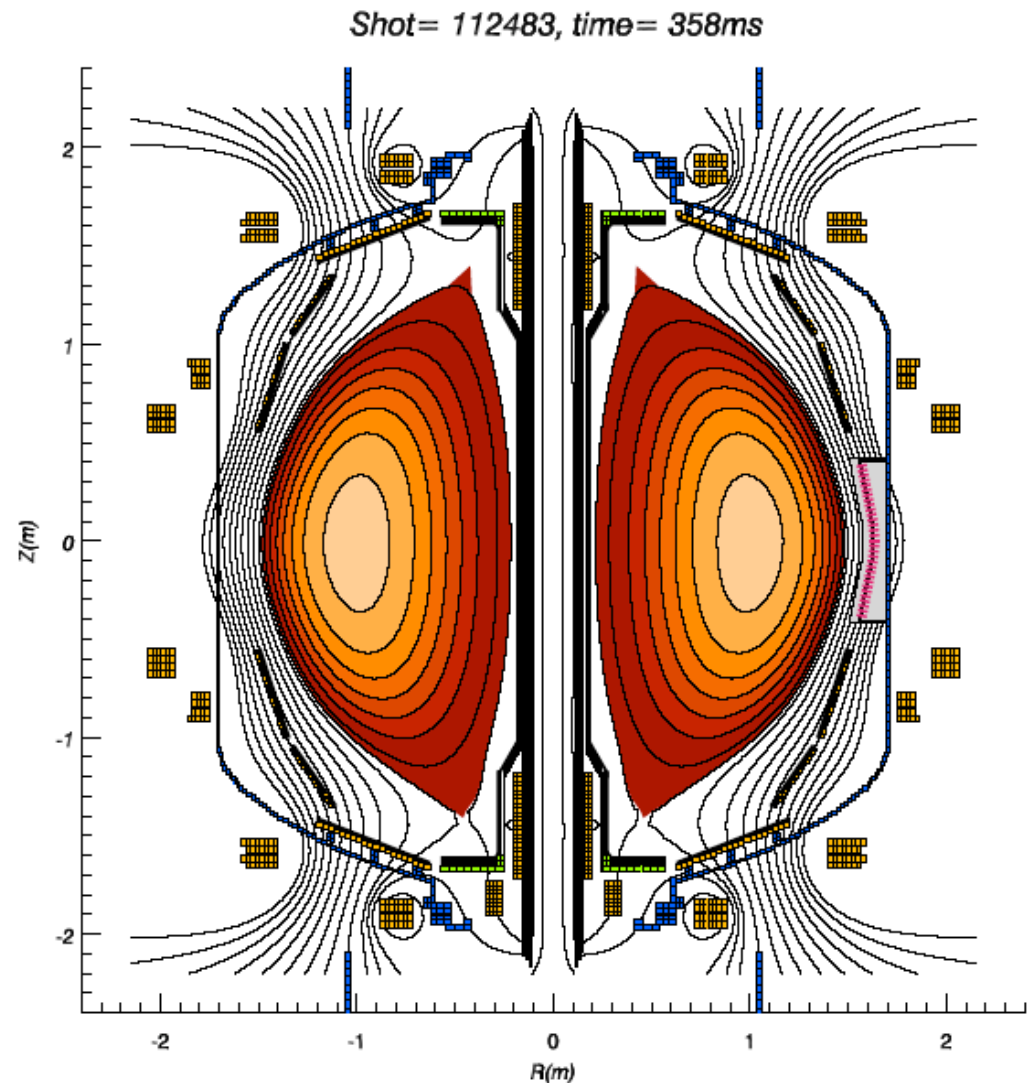
- Identified system latency as primary source of vertical stabilization limits
- Systematically identified latencies and removed them
- Latency now  $\sim 1/4$  value in 2003
- Also added analog vertical voltage difference measurement



# Target shape developed



- Plasma shape control using old control system
  - Used offline equilibrium code to predict required coil currents
- Able to control inner gap by reducing outer squareness
- $\delta$  limited to  $< 0.6$

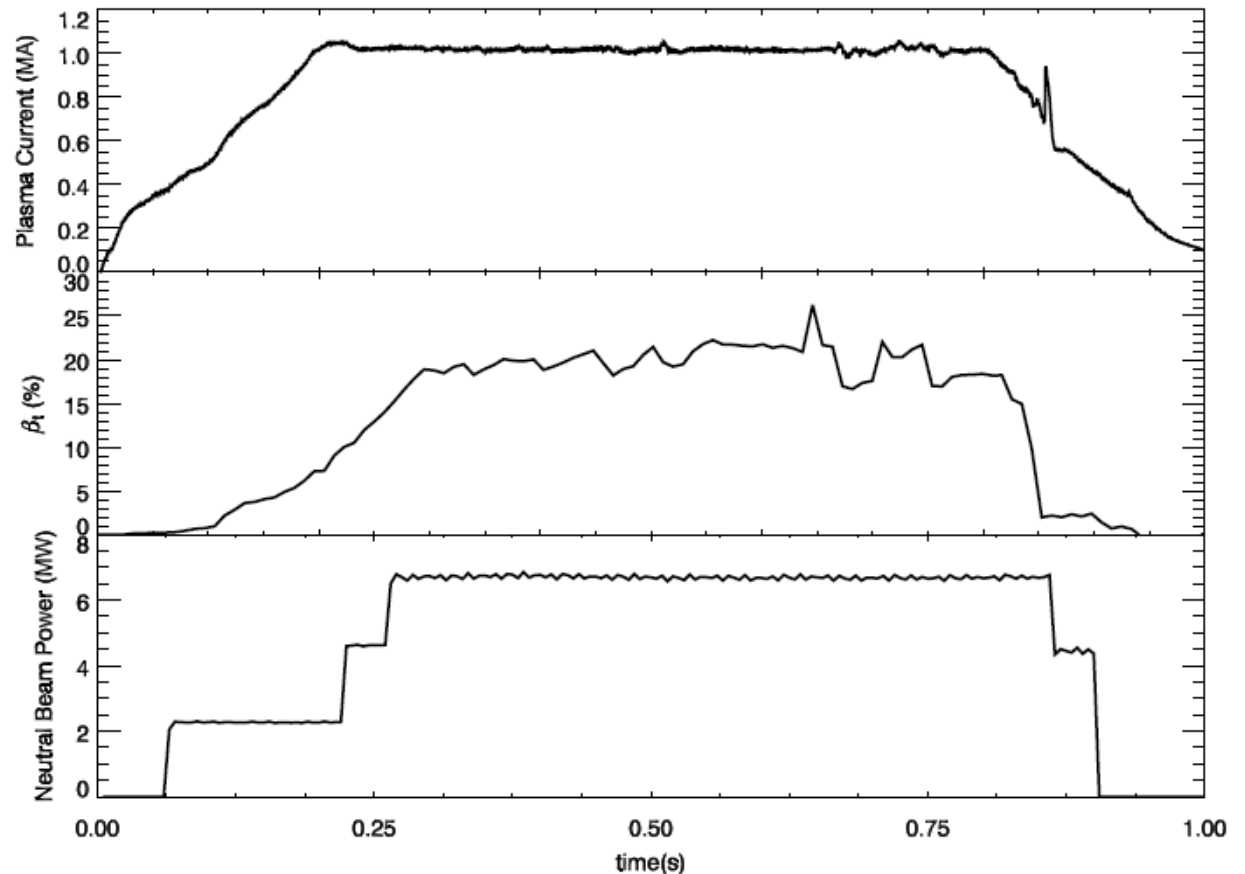


# Long pulse DND 1MA, 1s



Shot 112483, DND H-mode

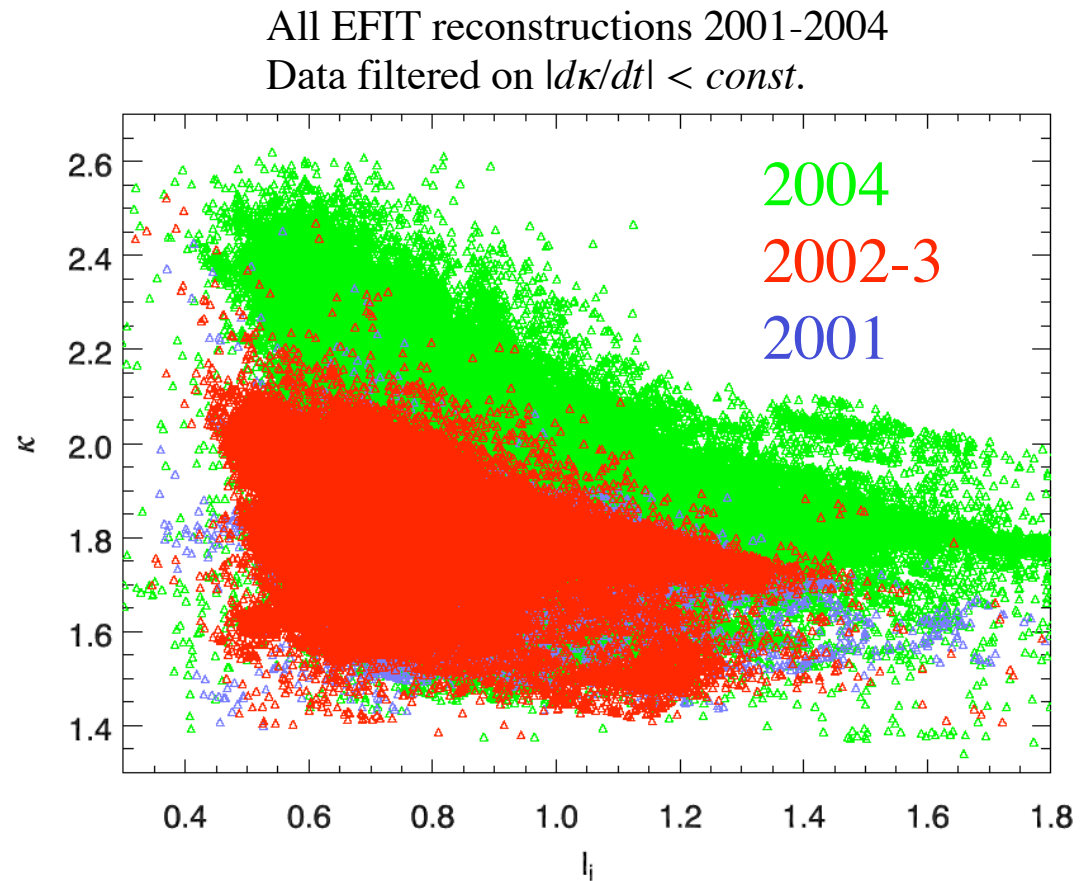
- $\sim 20\%$   $\beta$  for  
 $\sim 16\tau_E$
- $\kappa \sim 2.3$
- H89P  $\sim 2.1$
- No early H-mode
  - Would likely benefit from early H-mode onset



# Experiment possible due to improved operating regime



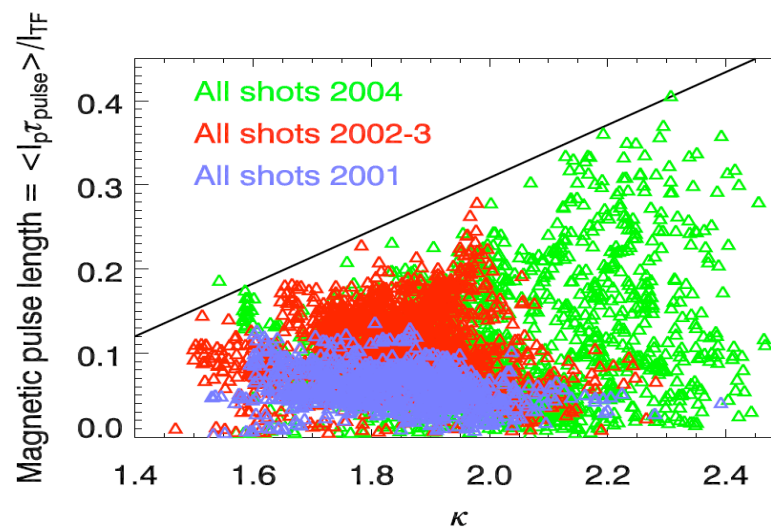
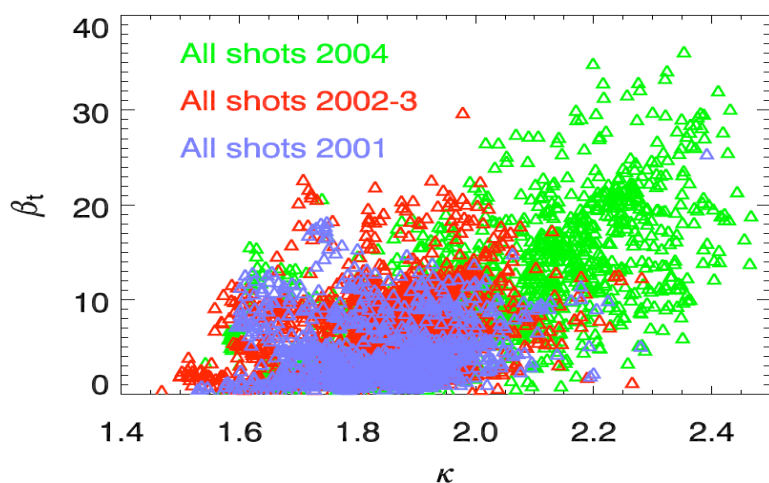
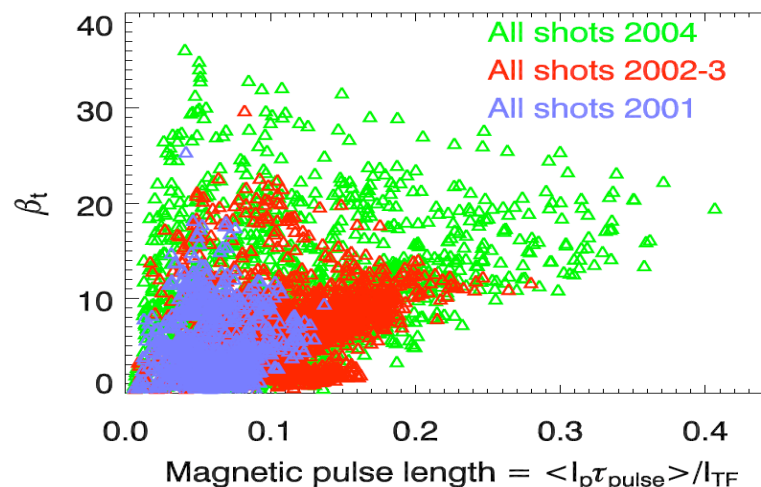
- System latency reduced by 1/3
- Major system upgrade
  - New i/o cards
  - New Sky computer
  - New power supply link
  - New operating system
  - Extensive software optimization
- Wider range of I/aB by increasing the breadth of the NSTX operating regime



# Operating regime broadened substantially



- Simultaneous doubling of  $\beta_t$  (pulse averaged) and 50 % increase in normalized pulse length
- Increase correlates strongly with high  $\kappa$



# Summary

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- Control system latency reduced (x1/4) - impressive effort by control team
  - R. Marsala, T. Gibney, D. Mastrovito, G. Rossi
- Latency reduction has increased  $\kappa \sim 20\text{-}30\%$
- 1MA, 1s plasma produced
- Increased  $\kappa \Rightarrow$  increased pulse length (x1.5) and  $\beta$  (x2) simultaneously for long pulse discharges