XP 421: Troyon scaling at high I_N

Presented by D. A. Gates

At the NSTX results review

Princeton Plasma Physics Laboratory, Princeton NJ

9/20/2004

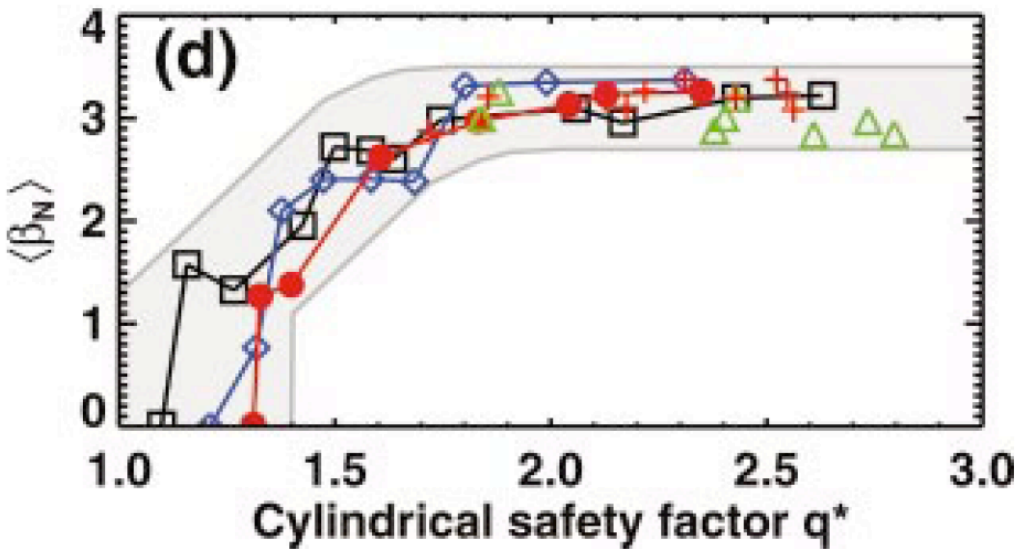
Outline

- Background theory
- High κ regime developed
- High current achieved
- Results
- Issues with determining β
- Summary

Theory predicts fall off in $<\beta_N>$ at low q^*

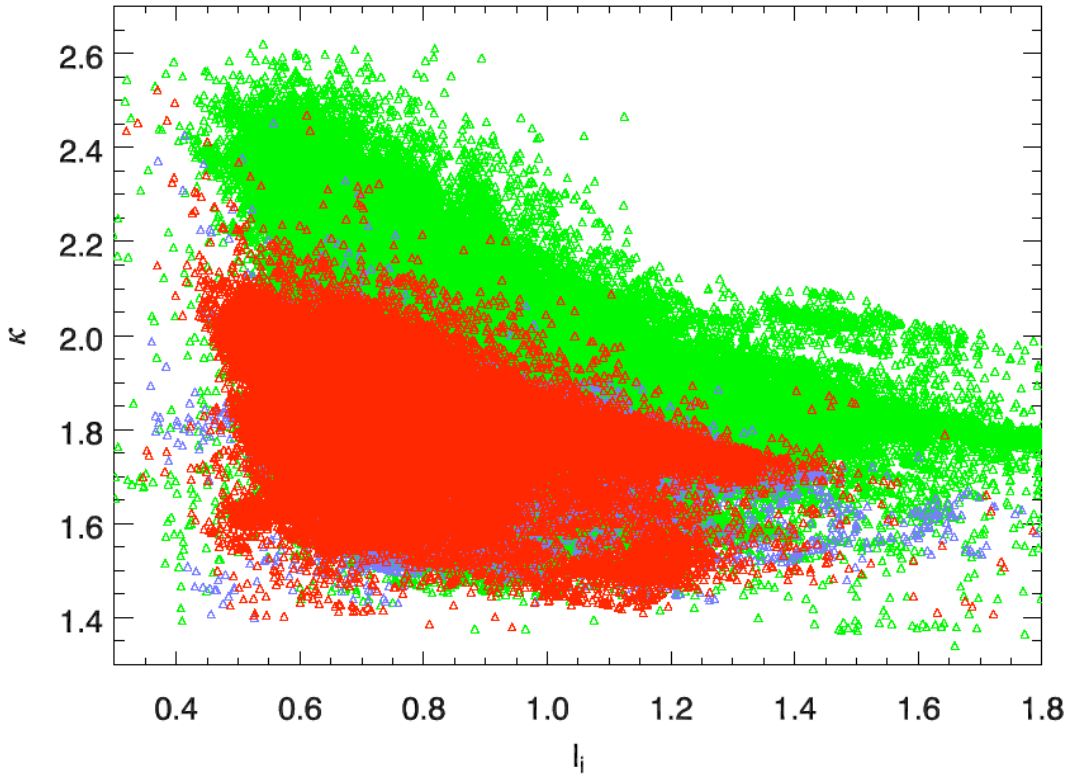
- Calculated equilibria, with optimized profiles
- Modes predicted to go from external to internal as q^* decreases
- NSTX database at low q^* quite limited (low κ, low current, very low field, low β_t, old data with poorer machine conditions)

From J. Menard, et al., Phys. Plasmas **11** 639 (2004)



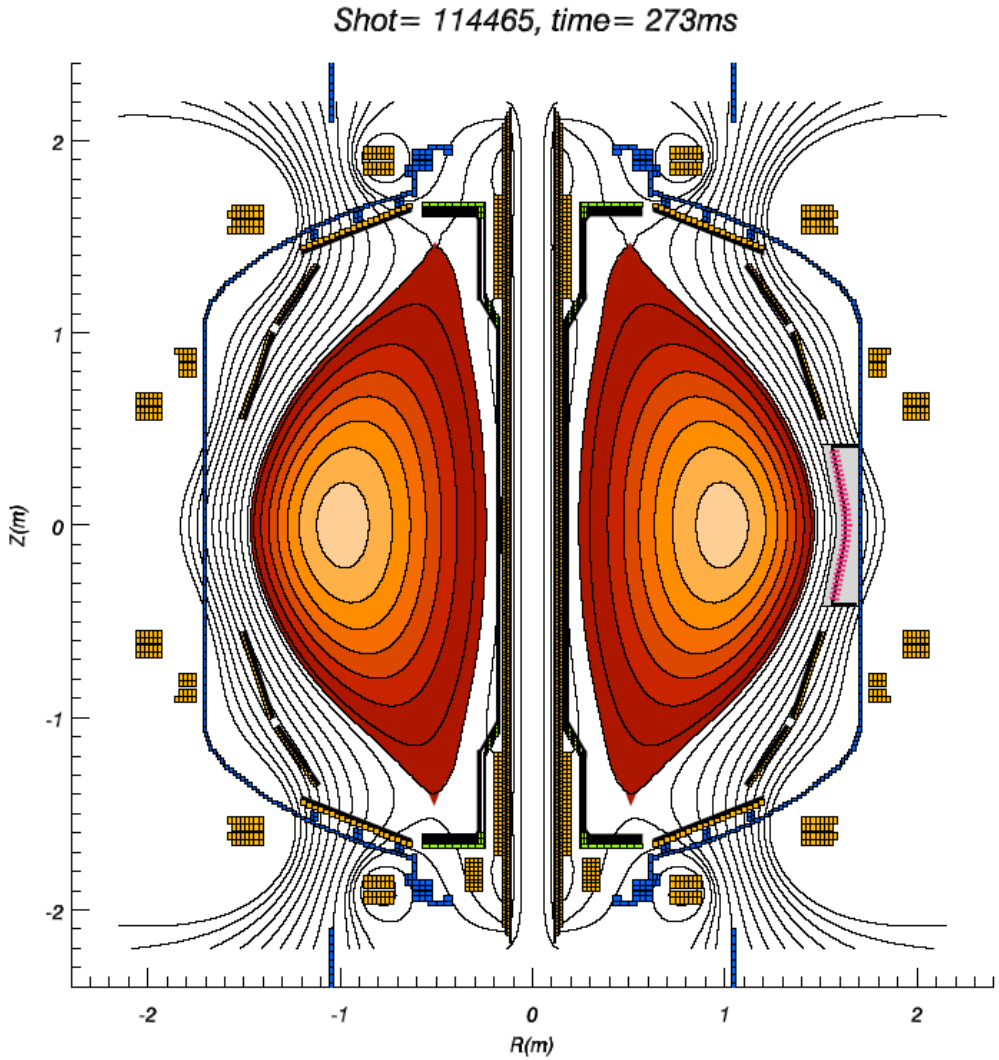
Experiment possible due to improved operating regime

- 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



Target shape developed

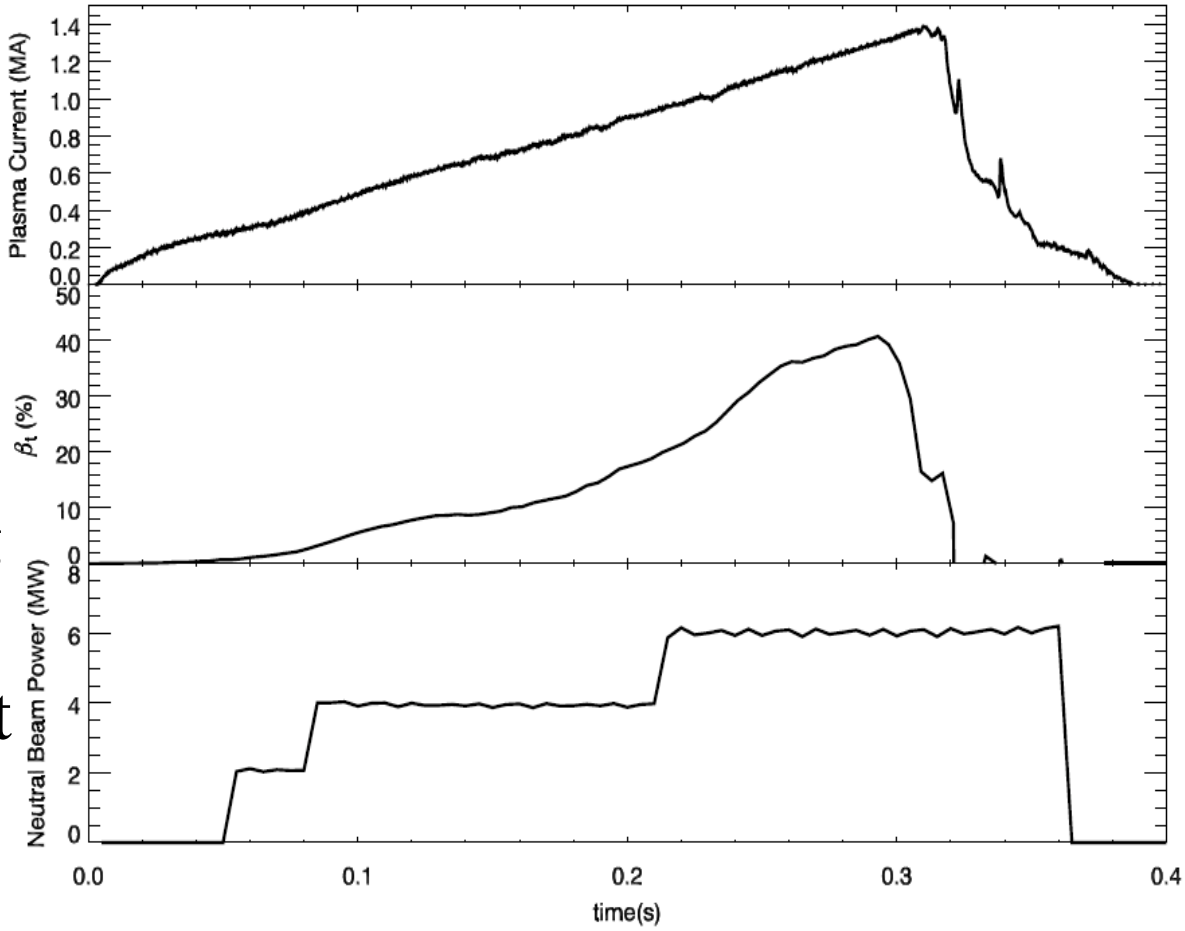
- Initial attempts with rtEFIT failed due to poor control at high κ
  - *vertical control in rtEFIT has since been improved, but still lags ~5% in κ*
- X-point control balance would benefit from rtEFIT
- H-mode access an issue with DND and current ramp



High current achieved at 3kGauss

- $I_N = I_p/aB \sim 7$ *(MA/[m•T])*
- $I_p/I_{rod} \sim 1.1$
- β_t need uncertain within ~ 10%
  - No CHERS yet (low core Z_{eff}, big ears)
- MSE available but not yet analyzed

Shot 114465, 1.4MA, Itf = 35.5kA

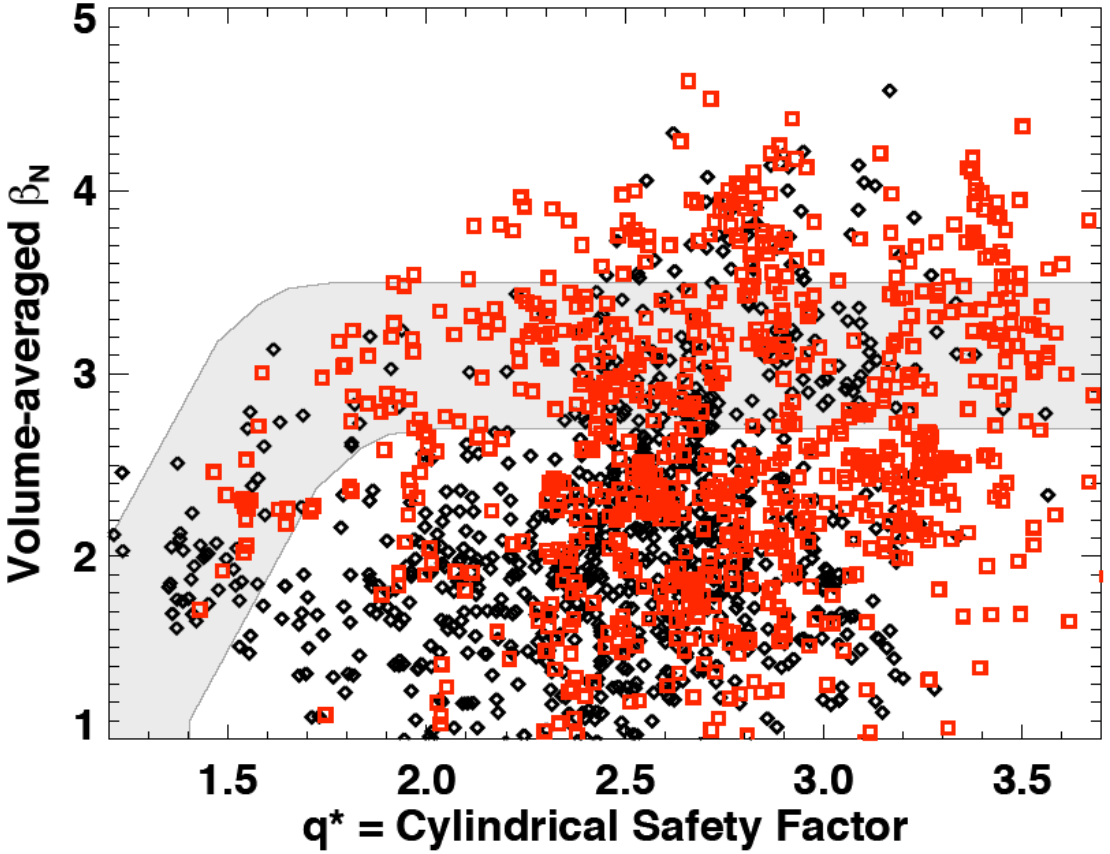


Data consistent with ideal MHD

- Data at low q^* does not appear to show the benefit of wall stabilization
- Low q^* from previous years at low I_N
- Some low q^* shots show external modes

Red - 2004 data

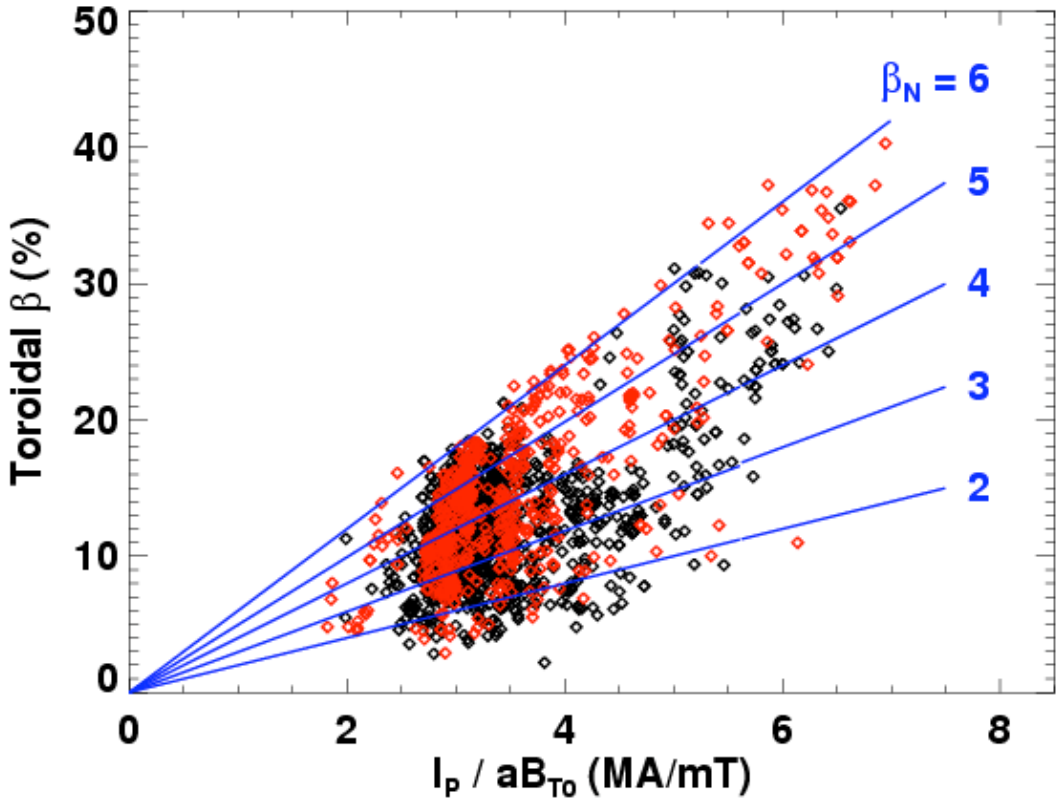
Black - previous years



$$q^* = 2\pi a^2 B_\phi ((1+\kappa^2)/2)^{1/2}/(\mu_0 R I_p)$$

Low q^* points now at high I_N

- No TF ramp down
- Many more high β data points
- Things should improve substantially with upgraded PF1A coils



Summary

- Data was obtained at low q^* with high I_N
  - Enabled by higher κ
- Data seems consistent with ideal MHD predictions - detailed mode analysis to follow
- Issues determining β require further effort
  - CHERS at low Z_{eff} and EFIT w/MSE