Proposal for Vertical Stability and Control Study at High Elongation

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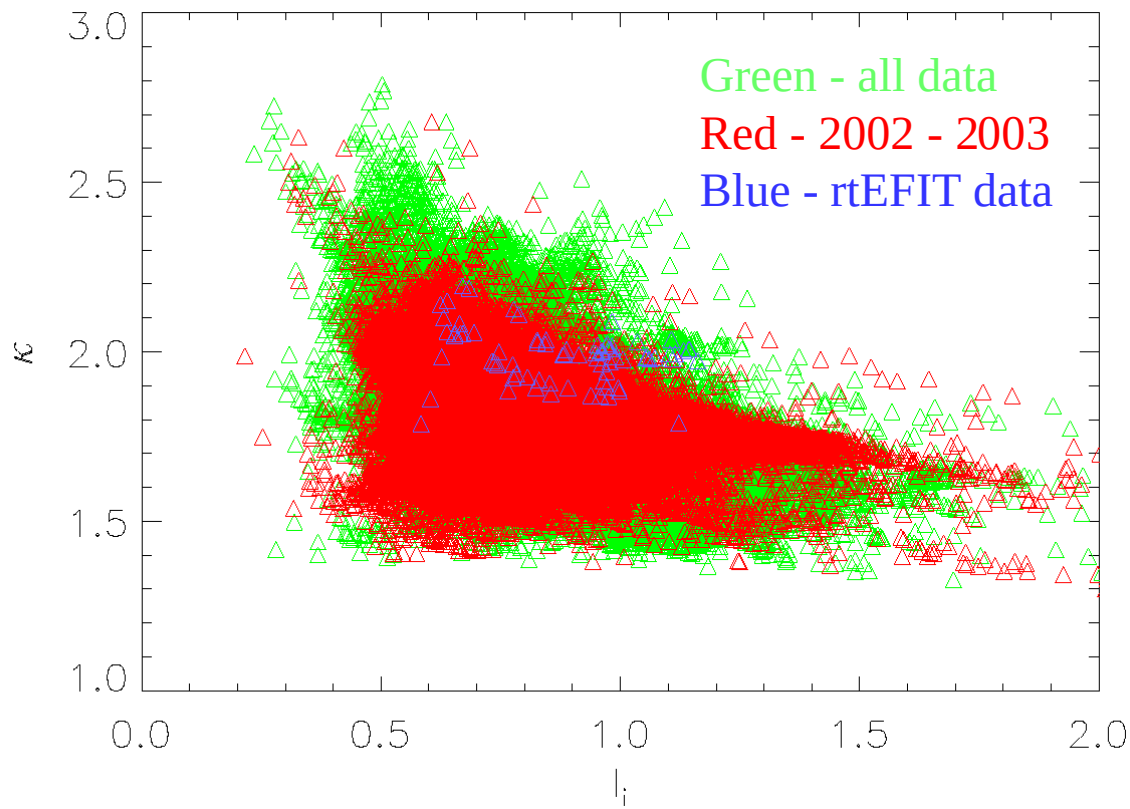
Background

- Stable operation at higher vertical elongation enables higher β, higher performance
- Reduction in PF control latencies in 2003 (Gates) enables stable operation at higher $\kappa>2.4$
- NSTX/DIII-D collaboration + TSC analyses will produce optimized vertical control algorithms for NSTX PCS
- Experimental goals: demonstrate and explore controllability at high κ, study nature of VDE in NSTX

Vertical Stability Experience

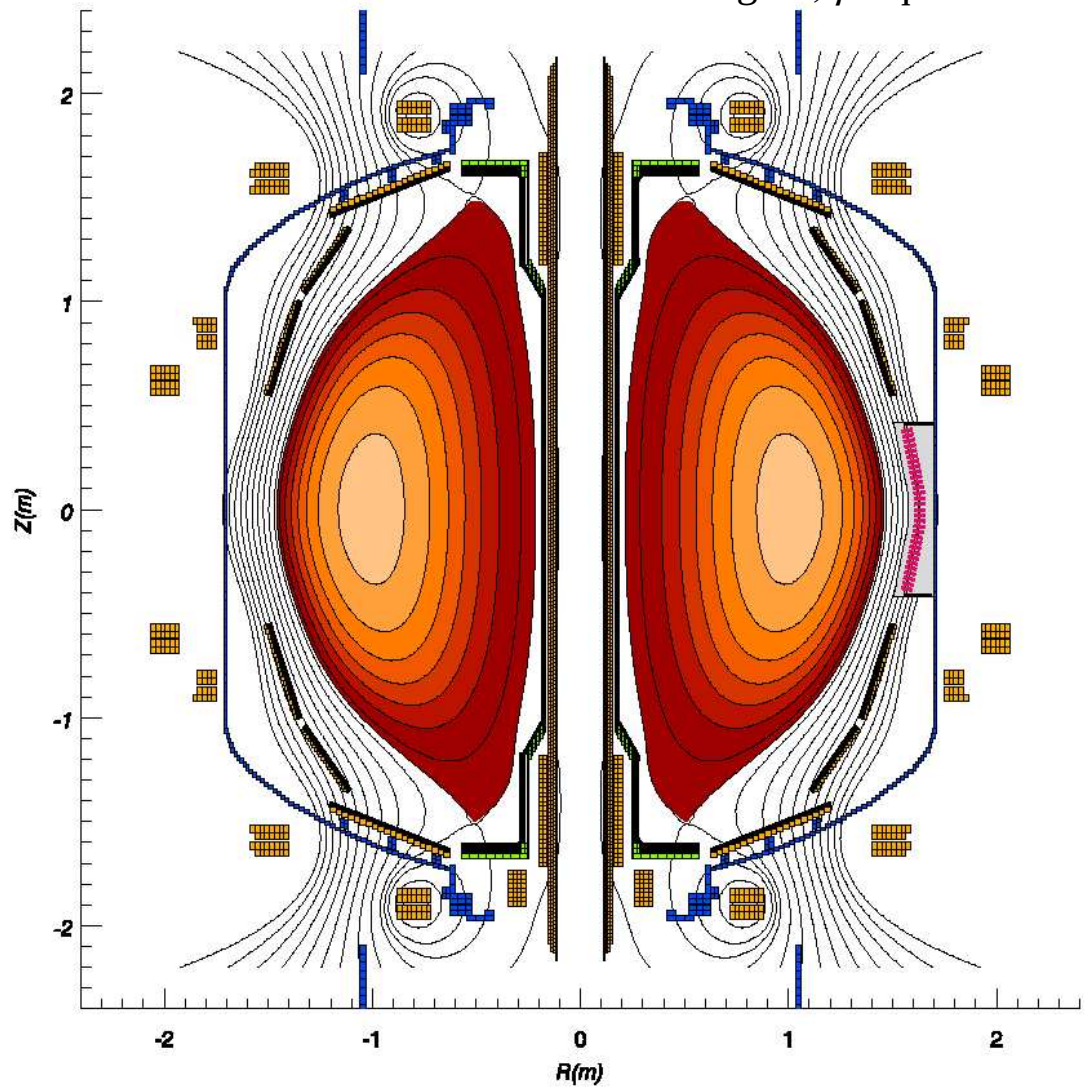
- NSTX has already established wide operating window with elongated plasmas
- Need to extend to higher κ to enable achievement of f_{bs} goals (high β_p)
- Recent effort to understand sources of control system delay have reduced the measured system latency from 4.3ms to ~1.1ms
- Further hardware upgrades should reduce maximum delay to <0.5ms (estimate)



Improved Vertical Control Supports Broader High Performance Goals

- Demonstrate high κ operation with moderate δ
- Demonstrate high f_{bs} operation
- Maintain plasma boundary shape at high β and high κ

Simulated high κ, β equilibrium



Proposal for Experiment to Study Vertical Stability and Controllability

- Implement and test several new vertical control algorithms in new low-latency PCS/control loop
- Evolve κ in discharges to specified values (nominally range from 2.0→2.4), hold and demonstrate stable control for > 10 growth times (ie ~50-200 ms for range of cases)
- Apply vertical position step commands to excite closed loop mode
- Switch to DoNothing/FreezeCommand phase to trigger VDEs in selected cases
- Vary control algorithms to test predicted unstable control onset (time permitting)

Results Expected from Vertical Stability and Controllability Experiment

- Experimental optimization and commissioning of new vertical control algorithms enabling high κ operation
- Detailed validation of fundamental axisymmetric response models
- Assessment of mode rigidity, resistive plasma effects
- VDE physics and effects data