Investigation of Plasma Disruptions during Current Rampdown

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Motivation

- NSTX plasmas often disrupted when the plasma current was rapidly ramped down at the end of the nominal discharge.
- No systematic study has been done to determine by what mechanism the thermal quench occurs in these discharges, and how best to avoid them.
- We propose to carry out a series of shots with varying current ramp-down rates on otherwise identical discharges to determine experimentally what the critical ramp-down rate is for disruption-free plasma termination.
- These experiments will be supported by both transport and MHD modeling and the results will be compared with both linear and nonlinear stability codes.
- The goals are to both obtain a better understanding of what causes a thermal quench and to provide guidance for obtaining disruption-free operation during current ramp-down.

Experimental Procedure

1) Use the morning fiducials to ramp the plasma current down to zero at different ramp rates. On each day a different ramp-rate will be used. After a sufficient set of data has been collected and analyzed, there may be some dedicated time, if needed (2 - 4 hours) to collect the missing data, or to do a dedicated scan on the same day as part of a controlled sequence of shots.

2) Maintain the discharge in full iso-flux control (i.e., do not transition to the shutdown phase)

3) For some of the faster current ramp-rates, the plasma will disrupt. Establish this critical current ramp-rate limit for the fiducial discharges.

4) Starting from near the critical current ramp-rate limit, for the fiducial, implement other small changes to the discharge to extend the critical current ramp rate to a faster valve. The initial changes will be:
   - Starting from 100ms before the the start of the current ramp time, modulate the NBI power down over time, and re-establish the new critical current ramp rate at which the plasma disrupts.

Theoretical and Modeling Support

We will apply modeling tools to these discharges including TRANSP discharge modeling, linear MHD analysis using PEST-II and M3D-C1, and nonlinear MHD analysis using M3D-C1.

Goals will be to compare linear mode structure with experimental results, and to further understanding how and when linearly unstable modes grow to lead to a thermal quench.

Estimated Run Time:

20 Good fiducials (Piggyback operation)

6 to 12 dedicated discharges (2 to 4 hours)