XP 1157
Increasing the CHI start-up current magnitude in NSTX

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Background

- Higher levels of CHI-started currents reduce central solenoid flux requirements to ramp to a given current level.
- In recent years we have focused on coupling CHI-started currents to induction for a demonstration of central solenoid flux savings. This was adequately demonstrated during FY2010.
- CHI-only discharges on NSTX were actively studied during 2005 and 2006. In 2010 less than 2 hours were devoted to these experiments, yet the potential for generating 400 kA of startup current was seen.
- The higher startup currents were achieved by increasing the injector flux, which require higher levels of injector current.
- Eventually at sufficiently high levels of injector current the low-Z impurity influx may limit the useful amount of injected poloidal flux. These limits have not yet been established for NSTX.
- For 2011/12, improvements to the CHI capacitor bank circuit are expected to enable improved programming of the capacitor bank voltages to reduce absorber arcs, which is what limited the performance of the near-400 kA CHI-only discharge during 2010.
- All discharges will use the full TF capability of 0.55 T so as to minimize the injector current, maximize current multiplication, and reduce the influx of low-Z impurities.

Experimental Run Plan

- Start with 12 mg/min Li evaporation rate for 8.5 min. Ensure that there is no NBI gas injection pulse just before the CHI discharge.
- Restore a reference CHI-only discharge from XP1034 (142163). Reproduce using a total of 4 capacitors.
  - Parameters: V_CHI = 1700 V. Thomson time = 9 and 13 ms. CHI start time = 6 ms. Cap bank dwell time = 3 ms. Branch-5 plenum pressure = 1700 Torr.
  - Use the same coil programming as in 142163, including those for the PFAB1 and 2 coils.
  - After successfully running this shot with no absorber arc, reduce the Branch-5 plenum pressure to 1600 and then to 1500 Torr.
  - Other small adjustments to the voltage and to the PF1AL, PF3L and PF2L coils may be needed. The fast camera images and spectroscopic data will be used to assist with these changes, as we have routinely made during the past CHI runs.
  - Repeat with NBI gas pulse

Increase Injector Flux in 10% Increments

- Increase the flat-top current magnitude in PF1B by 10%
  - Switch to banks 1 and 2 charged to 1700 V, triggered at 6 and 6.5 ms, with 3ms dwell time. The magnitude and length of the current pulse in PFAB1 needs to be adjusted to reduce absorber arcs.
  - Adjust the PF2L to allow the plasma to be pushed into the vessel and to allow it to detach. Small changes to PF3L and PF1AL may also be needed.
  - After successful current generation, continue to increase the PF1B current in 10% steps until the full coil current limit is reached or until the cap bank is no longer able to inject the poloidal flux or until the injector current becomes too high so that a large increase in lower divertor low-Z impurities places a limit on the useful injected flux. The original reference shot used 7.2 kA in PF1B. The maximum limit is 10 kA.
  - All three capacitor banks may be needed. Under this scenario, bank No. 1 should be charged to the maximum voltage of about 1.7 kV. Banks 2 and 3 could be charged to a lower voltage . Variations to these voltage changes will be experimentally determined based on fast camera images, extent of plasma growth and the detachment of the plasma from the injector.
  - Note that small changes to the Branch-5 gas pressure may be needed. The goal is to operate at as low as pressure that allows reliable breakdown.
  - Eventually Li evaporation rates may need to be increased.

Establish Control Parameters

- After a current limit is reached on the PF1B coil, further increases to the injector flux will be possible by delaying the start of the ramp-down of the PF1B coil current.
  - Start with 1 ms delays in the start of current ramp down and optimize at these condition.

- For discharges that have now attained 350 kA (FY11) and 400 kA (FY12), with longer current decay times
  - Repeat the final discharges without the NBI gas injection to assess the benefits of not injecting the NBI gas pulse.
  - Determine, gas programming, capacitor bank voltage programming, capacitor bank dwell time, Li deposition level, PFAB1 and 2 programming. PF2L, 3L, 1AL programming and those in PF5, 3U and 2U.