XP 1159
Confinement Assessment of CHI Started Discharges Coupled to Induction

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Background

- Recent experiments on NSTX have focused of savings of inductive flux after coupling CHI started discharges to induction
- The coupled discharges have ramped to 1MA, saving inductive flux
- These discharges have exhibited useful properties needed for advanced scenario operations (low internal plasma inductance and density), but the confinement properties of these coupled discharges has not been adequately studied
- In this XP we will study two discharges
  - 350kA discharge heated by HHFW
  - 700kA discharge heated by NBI

Run Plan

- First reproduce the discharge from FY10 to assess vessel conditions to be able to support higher injector current (and higher Ip) discharges
- Reload a good shot from XP1158 or 1157
- Ramp this to 1MA using the PF coil programming used during FY10 & make some adjustments
  - Reduce inductive ramp-rate (if possible)
  - Start gap control at 20ms
  - Readjust absorber PF coil currents
  - Readjust low field side and CS gas injection
  - Readjust PF5 to account for new higher IP level (PF4 use a possibility)

Generate a 350kA Ip flat-top current

- After reliable current ramps to 1MA is achieved, limit the current ramp to 350kA by using feedback control on the plasma current.
  - Turn off the neutral beam pulses and produce a reference discharge.
  - Using the RF waveform developed in XP1160 apply a 100-200ms RF pulse during the current flat-top to assess the benefits to electron temperature and current drive as noted by the reduction to the loop voltage to maintain the current at the 350kA level.
  - Move the RF waveform earlier in time.
  - When reproducible plasmas have been obtained apply a 20 ms beam blip near the end of the current pulse to obtain MSE measurements.
  - Repeat by changing the RF strap phasing and compare the confinement properties of these discharges to those produced in XP1060.

Generate a 700kA Ip flat-top current

- Restore NBI pulses as before and obtain a reference discharge at 700kA, with RF pulse from XP1058
  - Produce a lower diverted configuration, if it does not already exist due to CHI start-up
  - Now vary the NBI timing and voltage. Use NBI at 60keV, 75keV and 90keV and inject the three sources starting t=20, 40, 60 ms (for TRANSP analysis). For the 60 and 75 keV cases, run some shots with SRC A at 90keV to obtain MSE data. Compare to no NBI cases.
  - If one of the discharges at the higher beam power has not already transitioned into an H-mode readjust the CS gas pulse to attain H-mode

Reduce Impurity From Absorber (with moderate Absorber Arcing)

- Final optimization (FY2012)
  - Run a suitable case that shows the best CS flux savings
  - Restore a discharge that produced the highest CHI started current (XP1157) without moderate absorber arcing and inductively ramp it using the method previously developed.
  - Run a suitable inductive only plasma (double null, produced during FY11/FY12) and inject Li from the Li dropper to coat the upper divertor region.
  - After one to three such discharges, repeat the high-current CHI discharge to assess the benefits due to reduced impurity injection from the upper divertor.
  - Repeat with the Li evaporation rates on the lower divertor plates increased to 200mg and then to 300mg/shot.

Analysis

- The magnetic analysis codes LRDFIT and EFIT will be used to analyze the plasma equilibrium.
- A major part of this XP is to run TRANSP/TSC codes to understand neutral beam coupling efficiencies and to project to NSTX-U
- The benefits of RF coupling will be studied using RF coupling codes.
- MSE measurements of q-profile will be made of representative shots.
- Data from the MPTS and other kinetic diagnostics will be used to supplement the magnetic data for the assessment of confinement properties for CHI started discharges.
- A major objective of this study is to determine CHI capability and requirements for the NSTX-U.