CT Fueling of NSTX
(Milestones and time schedules for Integration and Control)

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Motivation

• Fueling present NSTX (transient plasmas) is a challenge (very difficult to obtain and alter the density as would be desirable by the XP).

• Fuelling future NSTX (steady-state plasmas), with profiles optimized to maximize bootstrap current will be even more challenging (localized, very flexible fueling system needed – this does not exist!).

• Excellent density profile control will become the control mechanism of choice for a burning plasma reactor and for devices relying on Advanced Tokamak type scenarios.

Primary objective (during Fy 04-08): Develop localized core fueling tool to meet NSTX Steady State mission objectives.

- Advanced Tokamak type scenarios are essential for the viability of the ST concept.

"Under AT mode of operation, the fueling system must deposit small quantities of fuel at the desired location, but more frequently without significantly altering the optimized density profile."

CT Fueling of NSTX (milestones and time schedules)

T_start (0) T_start +1yr T_start +2yrs T_start +3yrs T_start +4yrs (Time in years)

- Assemble & recommission injector
- Interface CTF-II control system to NSTX control system

- Interface CTF-II to NSTX
- Large surface area limited H-mode or Improved confinement mode
- Ohmic H-mode
- Controlled ELM trigger during ELM-free H-mode phase for density control
- Locked mode avoidance (prompt density input, induce rotation after +4yrs)

- Localized core fueling
- Demonstrate ability to alter CT mass and fuel deposition location
- Transport studies using isotope doped CTs
- Initial estimates of power supply for rep-rate requirements
- Build small prototype high rep-rate power supply module

- Improve assessment of CT mass and velocity requirements for rep-rate operation
- Design and fabricate rep-rate power supply
- Modify PCS for density profile feedback control capability (i.e. capability to alter CT mass and velocity on each CT pulse)

Hardware related or paper studies
Plasma enhancement
MHD
Transport
CT physics

- Demonstrate density profile control
- Initiate studies on CT momentum input for plasma rotation studies

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Summary

- Excellent density profile control (in addition to other optimized conditions) will enable STs to reach their highest potential.

- Fueling a plasma during steady-state operation is far more difficult than fueling a transient plasma discharge. No reactor relevant fueling system has demonstrated this capability. Yet, NSTX plans for steady-state pulses with high beta and high bootstrap current during Fy 04-08.

- The CT injection concept has the potential to arbitrarily alter the CT mass and the fuel deposition location on each pulse as required by the control system (exactly what is needed for fueling AT discharges)

- The CT is also a source of momentum input, and so has the potential to sustain transport barriers (in a rector the α power is isotropic, so reactors will lose the benefit of directed NBI power).

- Approximately a 1-year lead-time is needed from the time the CT crates are opened, to when it can be interfaced to NSTX.