CT Fueling for NSTX Fy 04-08 steady-state operation needs

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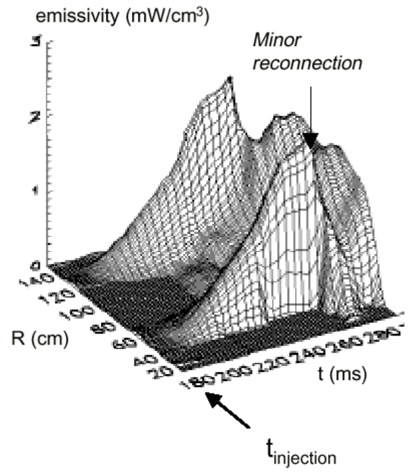
Motivation

• On NSTX, injection of neon resulted in a sharp build-up of neon at the edge with little or no penetration into the core [1], implying the possible presence of an edge barrier to neutrals.

[1] D. Stutman, APS 2001 and NSTX 2001 Research Review presentations.

He-, H-like Ne lines (USXR)



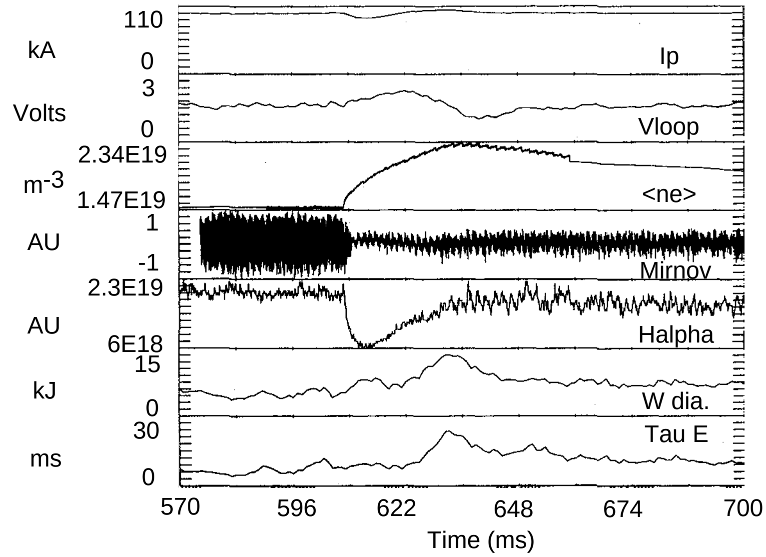
• Fueling present NSTX (transient plasmas) is a challenge (very difficult to obtain and alter the density as would be desirable by the XP).

• Fuelling future NSTX (steady-state plasmas), with profiles optimized to maximize bootstrap current will be even more challenging (localized, very flexible fueling system needed – 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.

The CT Fueling proposal has two primary goals.

1. Reliable initiation of H-modes and large surface area limited H-modes.



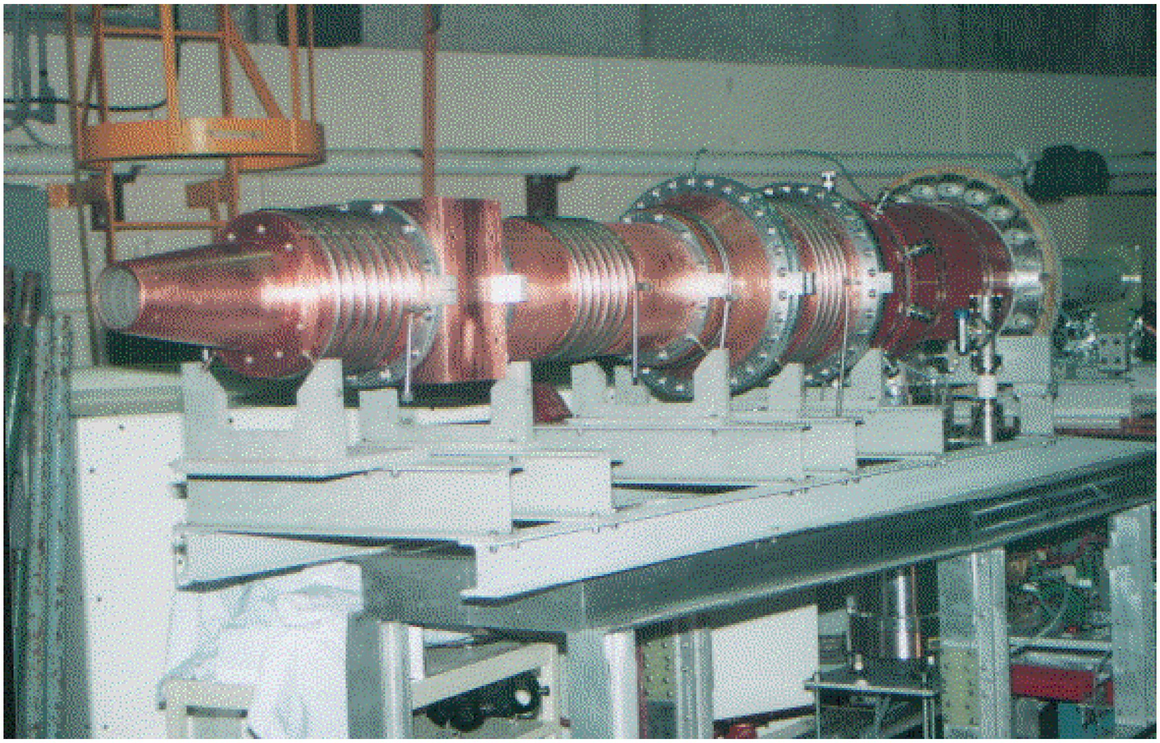
Low velocity CT injection into a limiter ohmic discharge on TdeV can cause a rapid reduction in the Mirnov coil fluctuation amplitude and a reduction in the H_{α} signal. This is possibly due to a rapid steepening of the edge density gradient [3]. Similar features are seen on limiter discharges on STOR-M [4].

[3] R. Raman, et al., "CT Fueling of TdeV," *Proc. 24th EPS*, Berchtesgaden, 9 - 13 June EAC Vol. **21A** 293 (1997).
[4] C. Xiao et al., " CT injection experiments on STOR-M," *Proc. 17th IAEA*, Yokohama, Japan, October (1998).

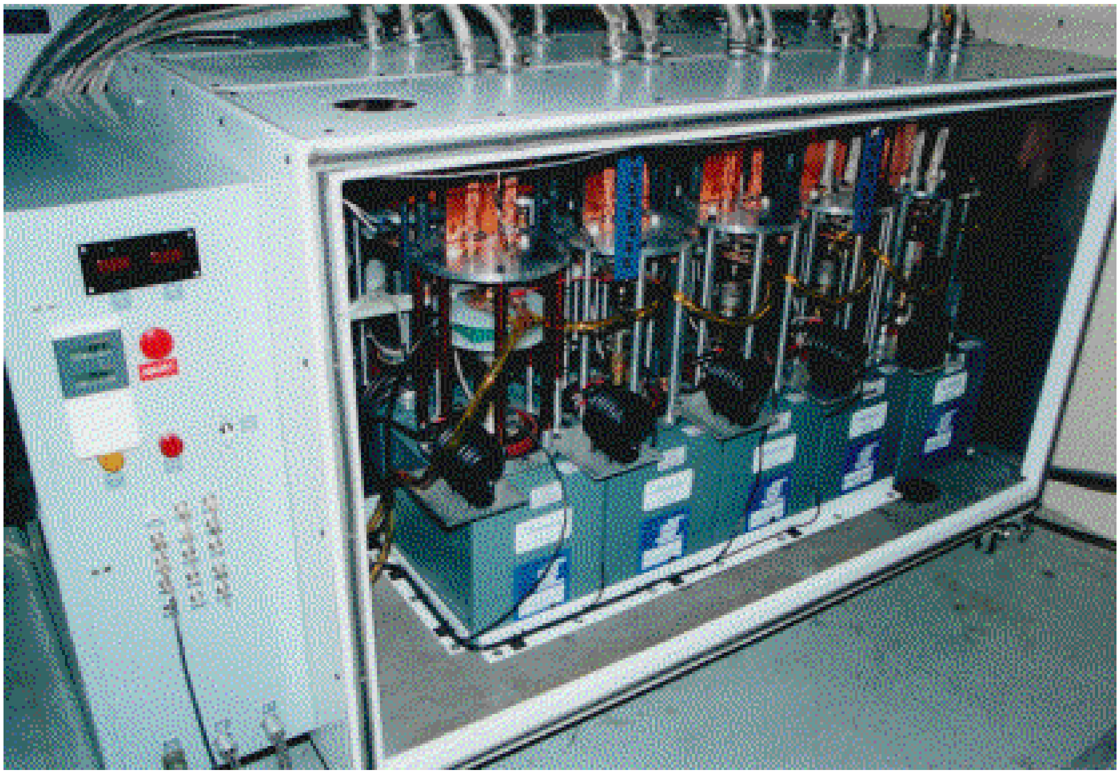
2. Develop localized core fueling tool to meet NSTX Steady State mission objectives.

Advanced Tokamak (AT) scenarios are essential for the viability of the ST concept. *Under this 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.* Reactor relevant fueling systems have not demonstrated successful fueling of sustained AT type discharges. CT fueling has the potential to meet this need, but this technology is largely undeveloped.

The CT Fueler



The CTF-2 injector is about 3meters in length. The injector compression and acceleration sections are fabricated from oxygen free copper and all plasma-facing components are coated with state-of-the-art vacuum plasma spray of dense tungsten to minimize electrode erosion.



The 50kJ / 10kV formation power supply

Summary

- Excellent density profile control 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).

- Other benefits include transport studies using isotope doped CTs.