

# Summary of the SFPS XPs

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*College W&M  
Colorado Sch Mines  
Columbia U  
Comp-X  
General Atomics  
INEL  
Johns Hopkins U  
LANL  
LLNL  
Lodestar  
MIT  
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New York U  
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PSI  
Princeton U  
Purdue U  
SNL  
Think Tank, Inc.  
UC Davis  
UC Irvine  
UCLA  
UCSD  
U Colorado  
U Maryland  
U Rochester  
U Washington  
U Wisconsin*

*Culham Sci Ctr  
U St. Andrews  
York U  
Chubu U  
Fukui U  
Hiroshima U  
Hyogo U  
Kyoto U  
Kyushu U  
Kyushu Tokai U  
NIFS  
Niigata U  
U Tokyo  
JAEA  
Hebrew U  
Ioffe Inst  
RRC Kurchatov Inst  
TRINITY  
KBSI  
KAIST  
POSTECH  
ASIPP  
ENEA, Frascati  
CEA, Cadarache  
IPP, Jülich  
IPP, Garching  
ASCR, Czech Rep  
U Quebec*

# FY10 SFPS Run Days

## Two XPs Run

### XP1034 – Flux savings from inductive drive of a CHI started plasma

Sept. 7 - Setup and debugging hardware.

First CHI plasma at about 5:30pm (1.5 hours of run)

Sept. 8 - First full day of operation (Lost Bay F LITER at 1pm)

Sept. 9 - Ran out of Li at about 4PM

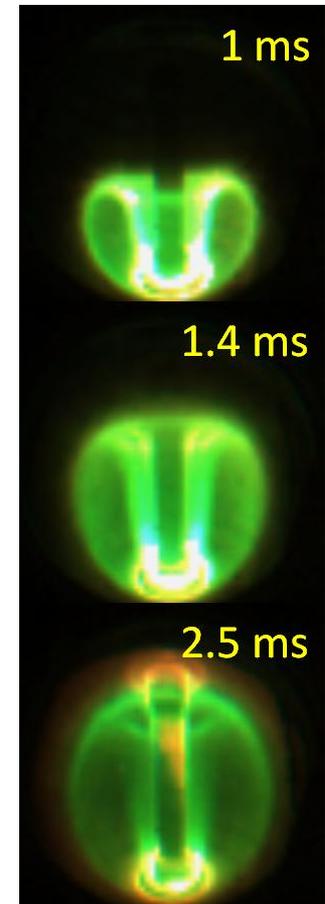
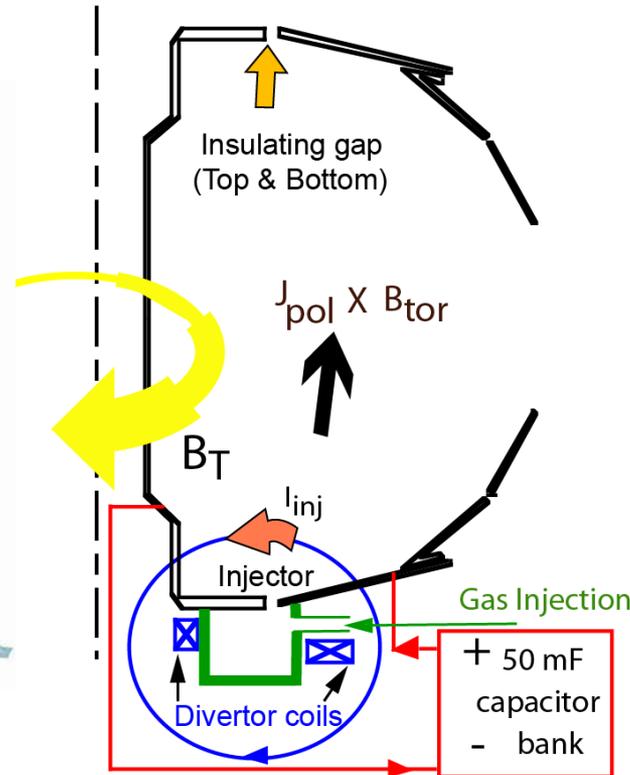
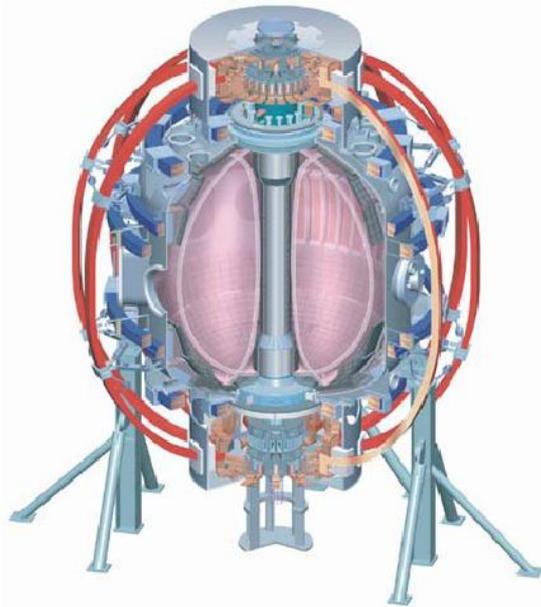
Sept. 10 - Operated without LITER

[about 2-1/4 days with LITER,

### XP1009 – Heating of a low plasma current target using HHFW

July 17 – ½ - day [summarized within the wave particle group]

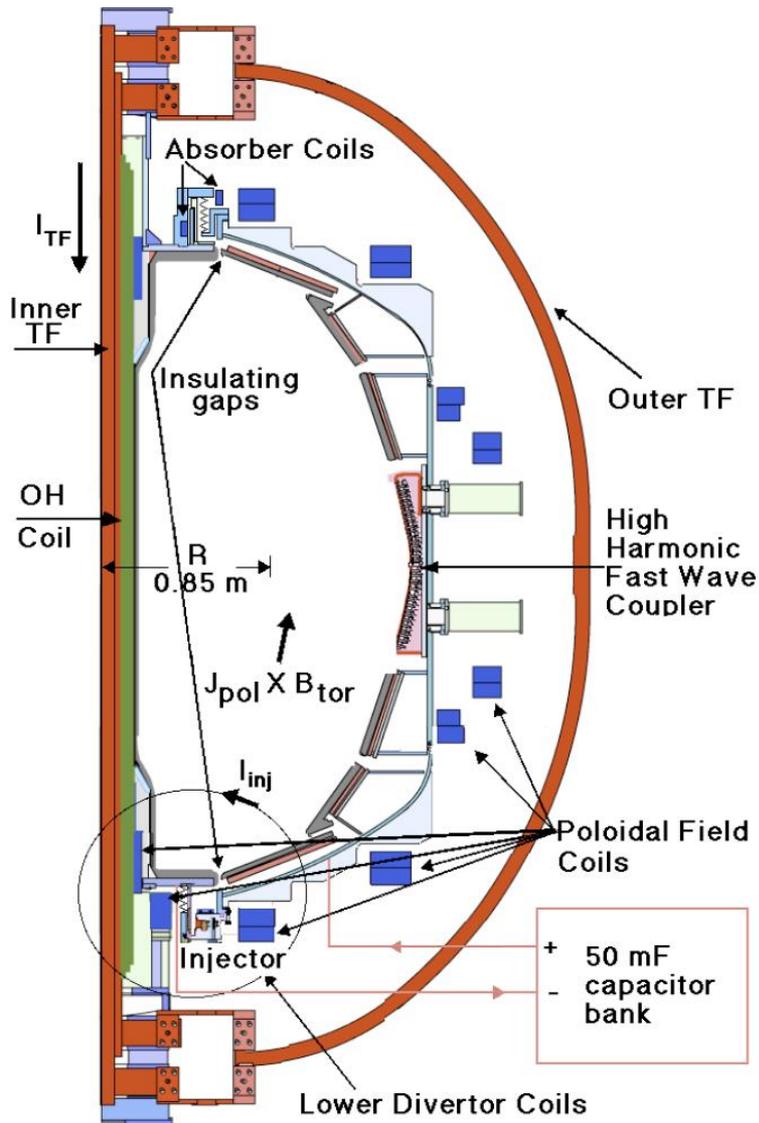
# Transient CHI: Axisymmetric Reconnection Leads to Formation of Closed Flux Surfaces



- Demonstration of closed flux current generation (2006)
  - Aided by gas injection from below divertor plate region
- Demonstration of coupling to induction (2008)
  - Aided by staged capacitor bank capability

CHI for an ST: T.R. Jarboe, Fusion Technology, 15 (1989) 7  
 Transient CHI: R. Raman, T.R. Jarboe, B.A. Nelson, et al.,  
 PRL 90, (2003) 075005-1

# Flux Savings on NSTX Now Realized After Low-Z Impurity Reduction



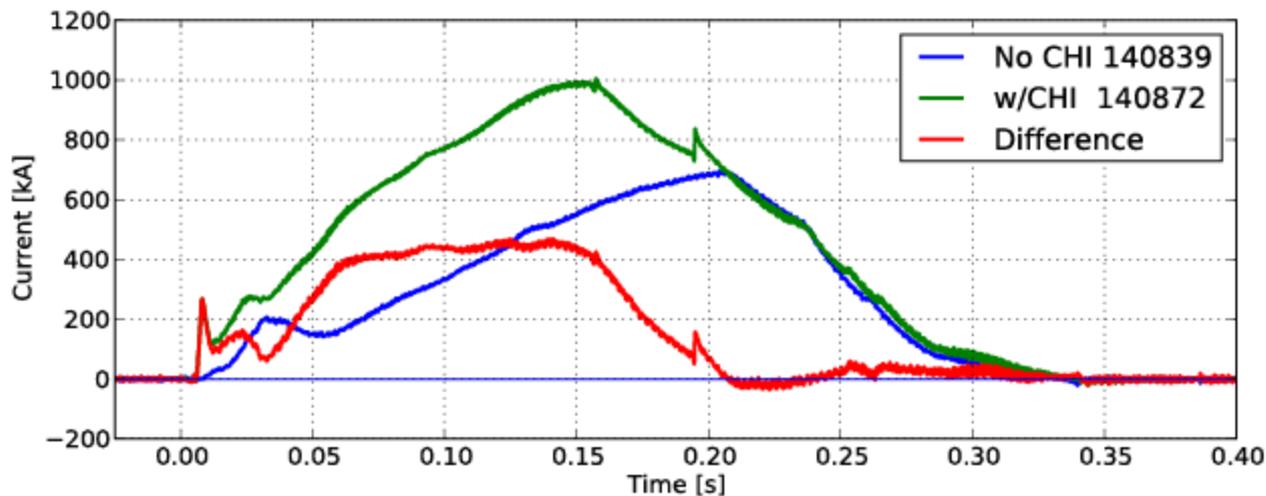
Long-pulse (400ms) CHI discharges in a 'stuffed-injector' current mode used to ablate Low-Z impurities from lower divertor

Deuterium Glow Discharge cleaning employed to chemically sputter and reduce oxygen levels

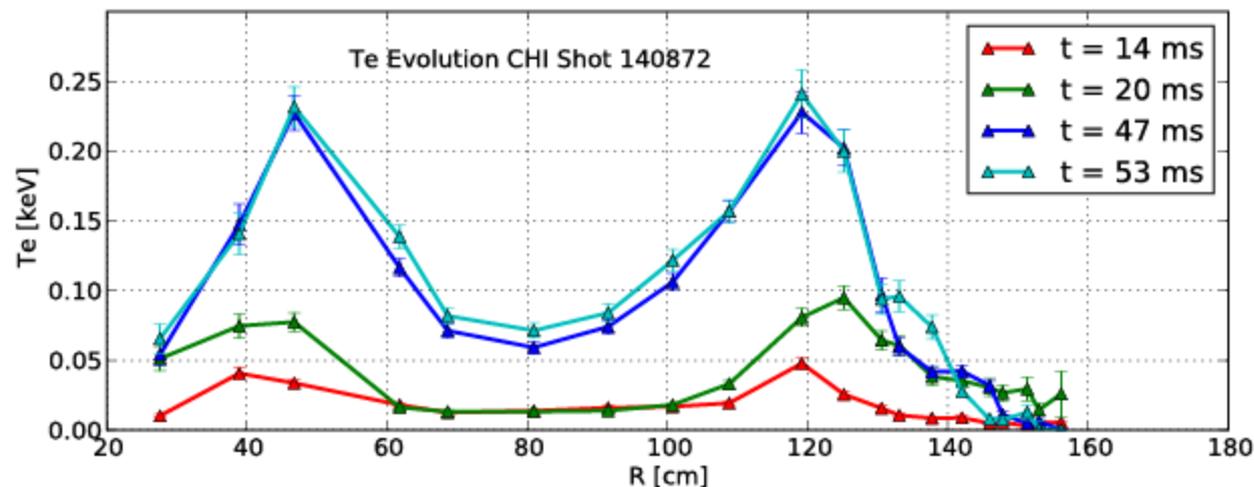
A buffer field was provided using new PF coils located in the upper divertor region (Absorber region) to reduce interaction of CHI discharge with un-conditioned upper divertor plates

Lithium evaporation on lower divertor plates improved discharge performance

# NSTX has Demonstrated a Viable Solenoid-Free Plasma Startup Method for the ST



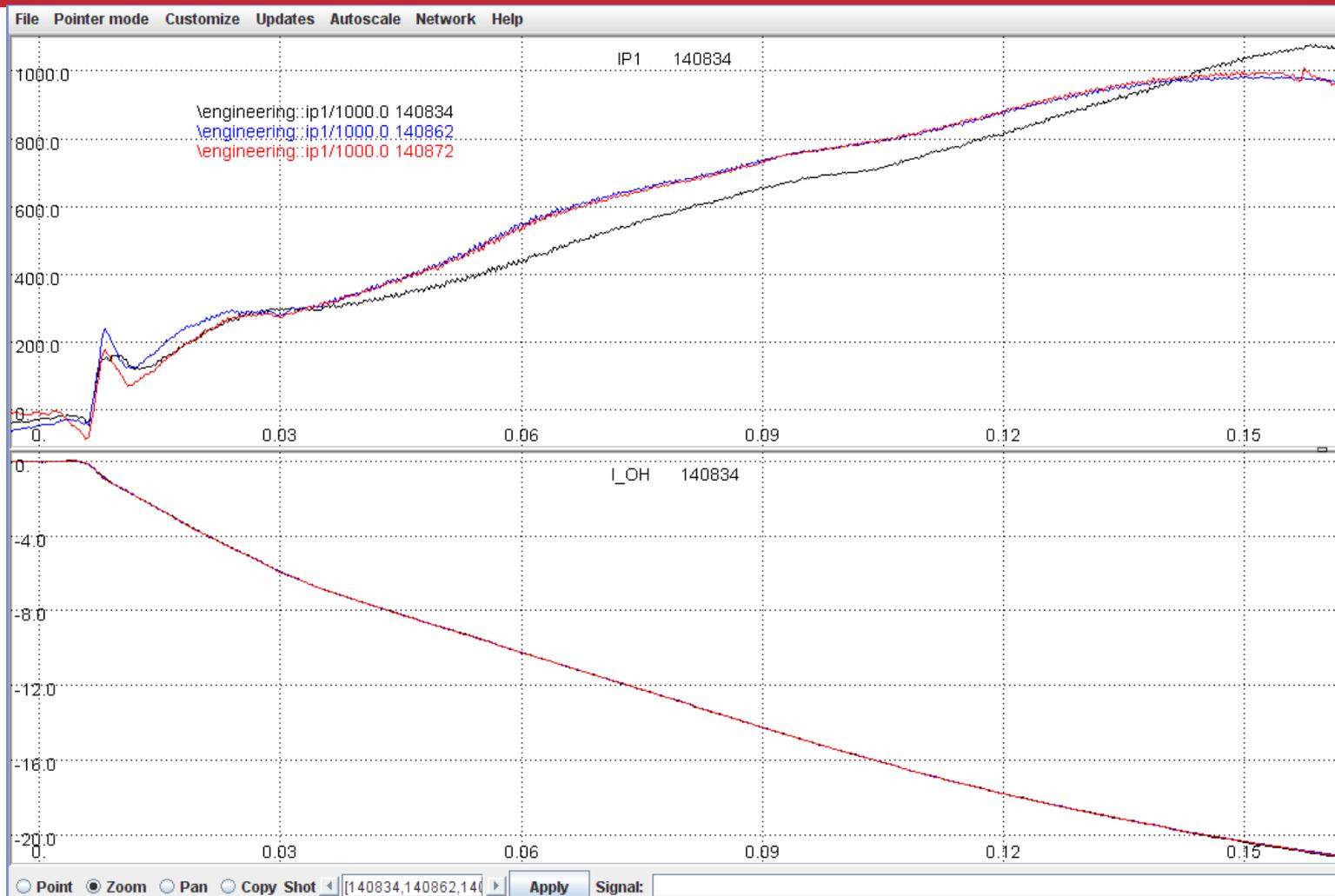
1) Ramped up to 1MA after startup and used 20kA change in current in OH coil



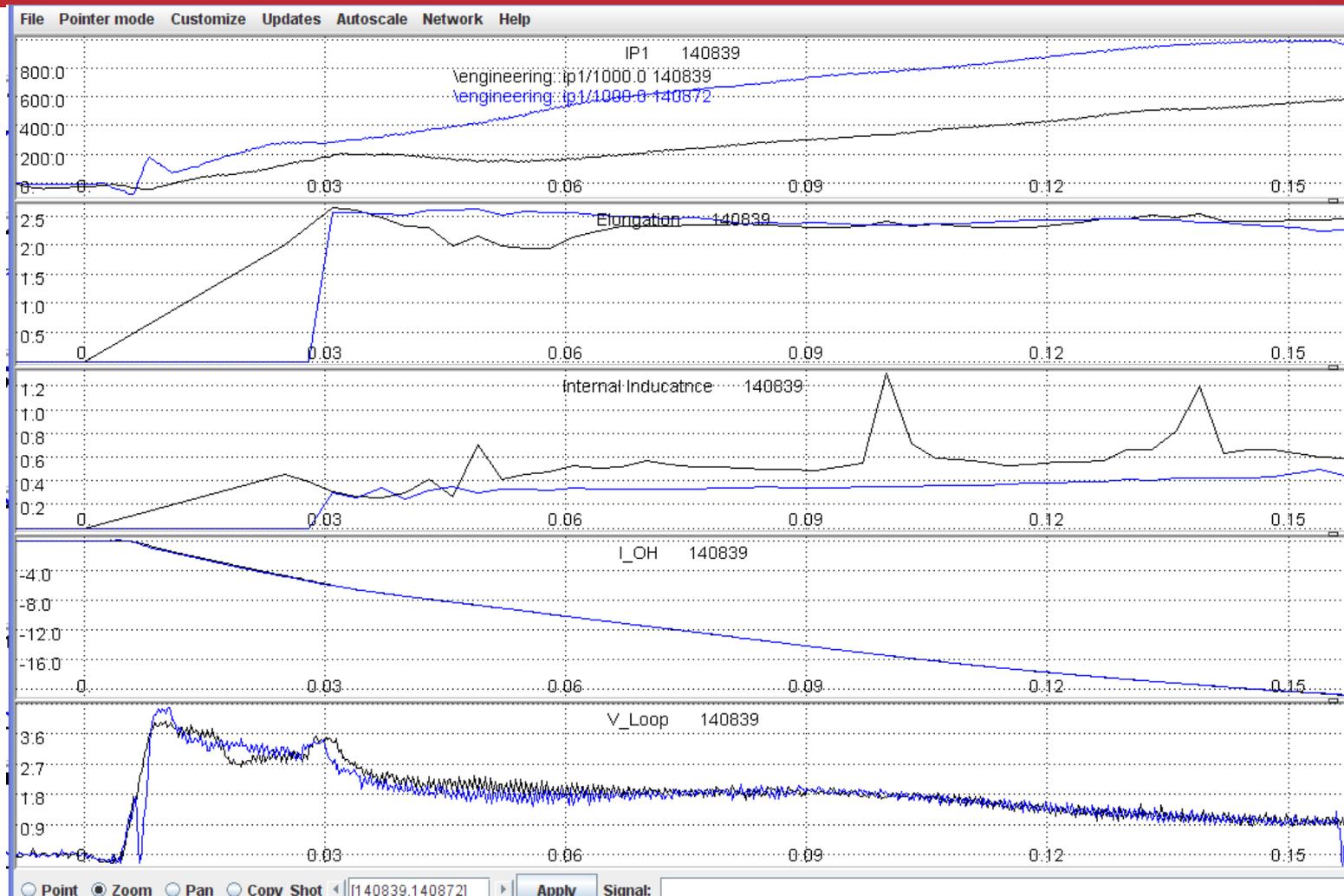
2) Hollow electron profile maintained during current ramp

Discharges with early high electron temperature ramp-up to higher current

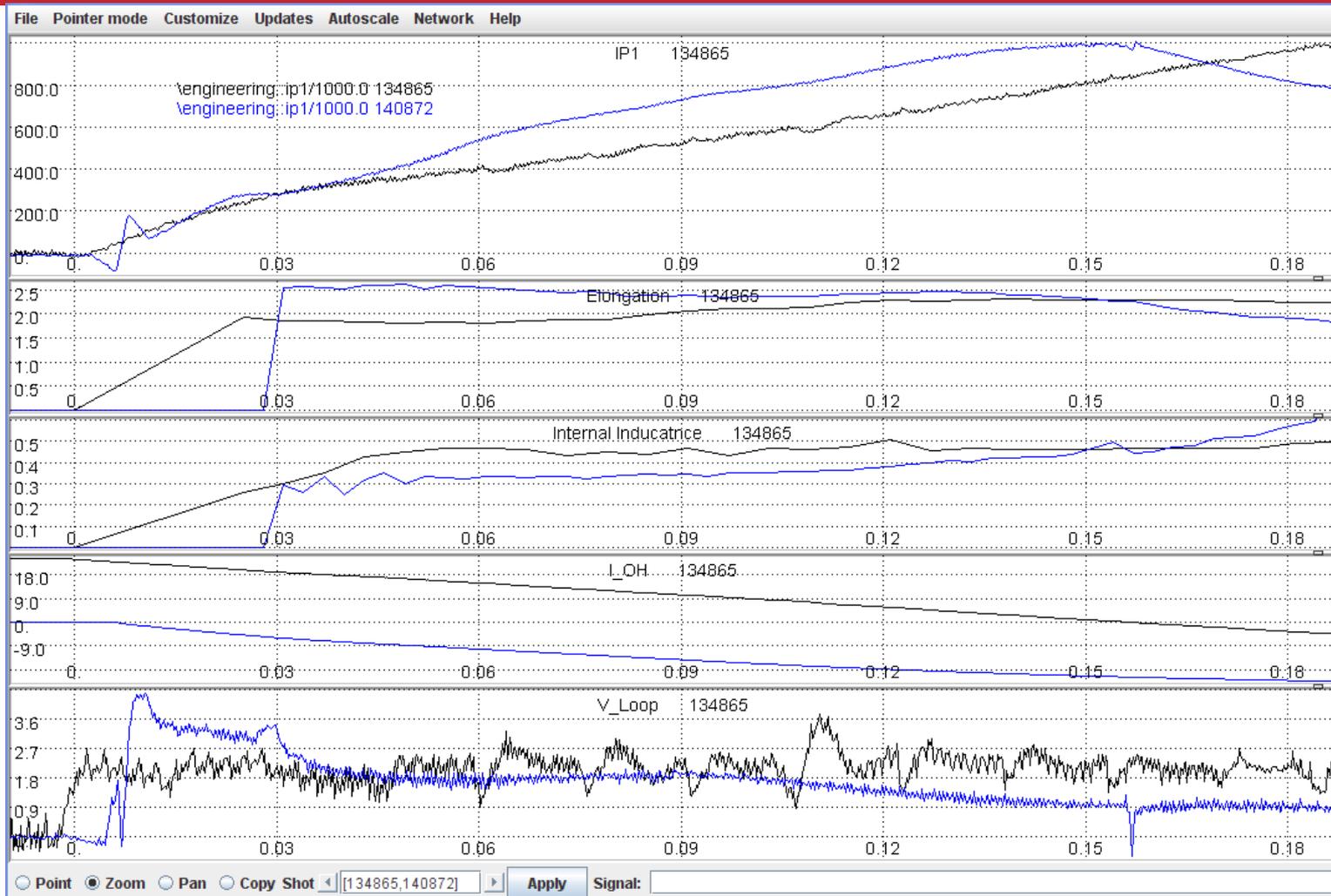
# Several Very Reproducible Discharges Obtained (all ramping to high current)



# Discharge with CHI start-up has low inductance from early on in the discharge phase

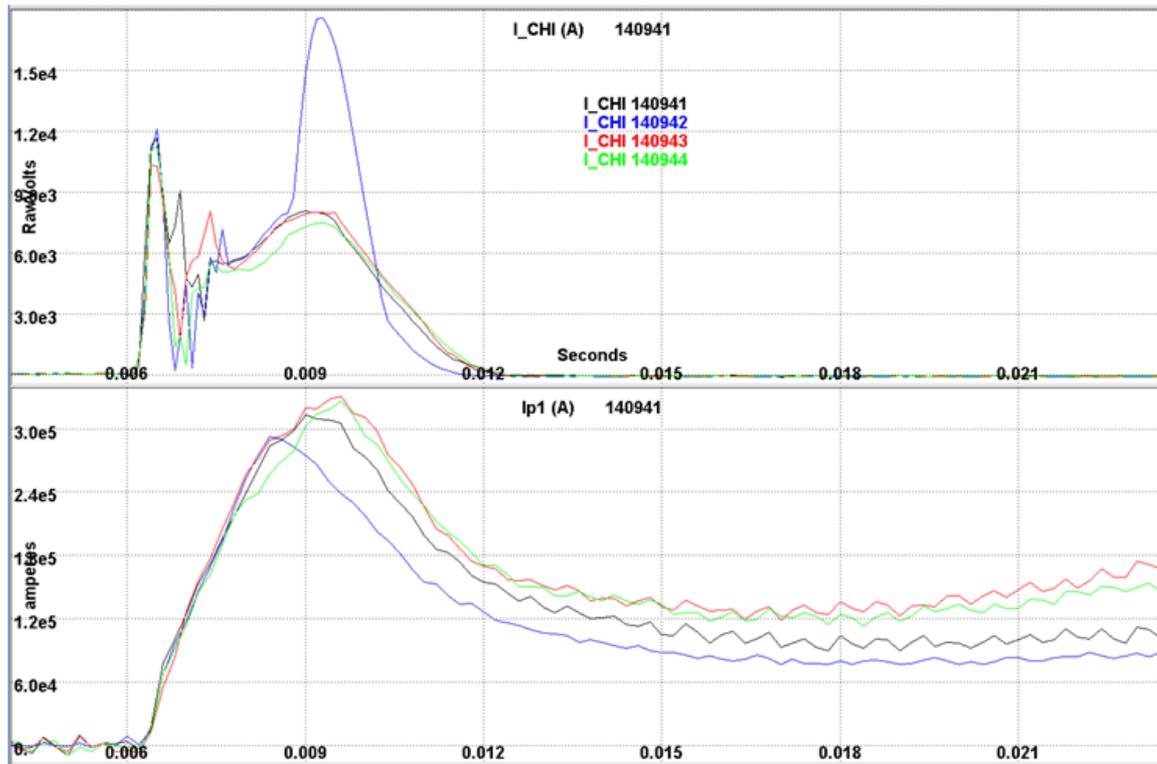


# CHI start-up uses 20kA of OH, OH-only uses 28kA to get to 1MA (40% less flux). 40% flux generates ~360kA



L-mode, 1 NBI source for both discharges

# Produces start-up discharges using 5 caps without absorber arcs



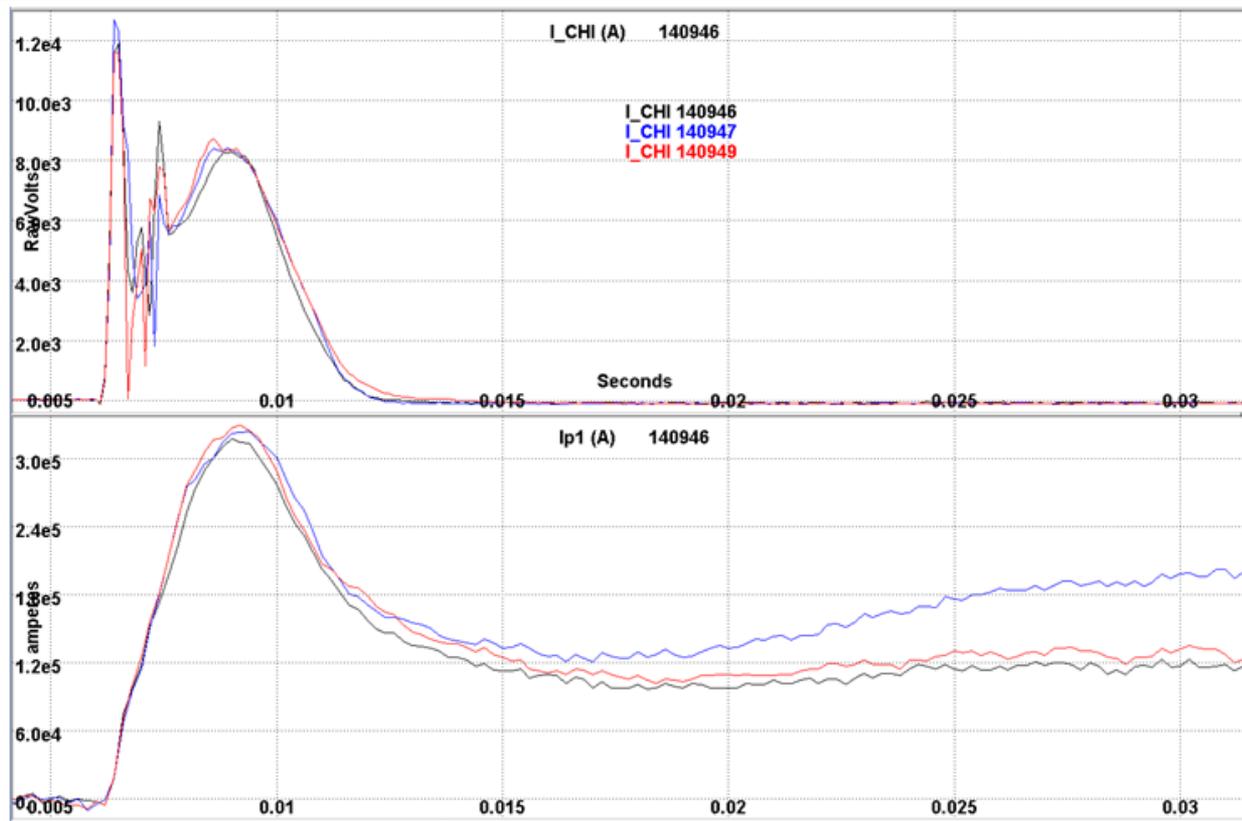
140941: 5 caps, 120mg from Li dropper, Bay I

140942: 5 caps, another 85 mg from Li dropper, Bay I

140943: 5 caps, another 85 mg from Li dropper, Bay C

140944: 5 caps, 120mg from Li dropper from Bay I + 85 mg from bay C

# Produces start-up discharges using 7 caps without absorber arcs

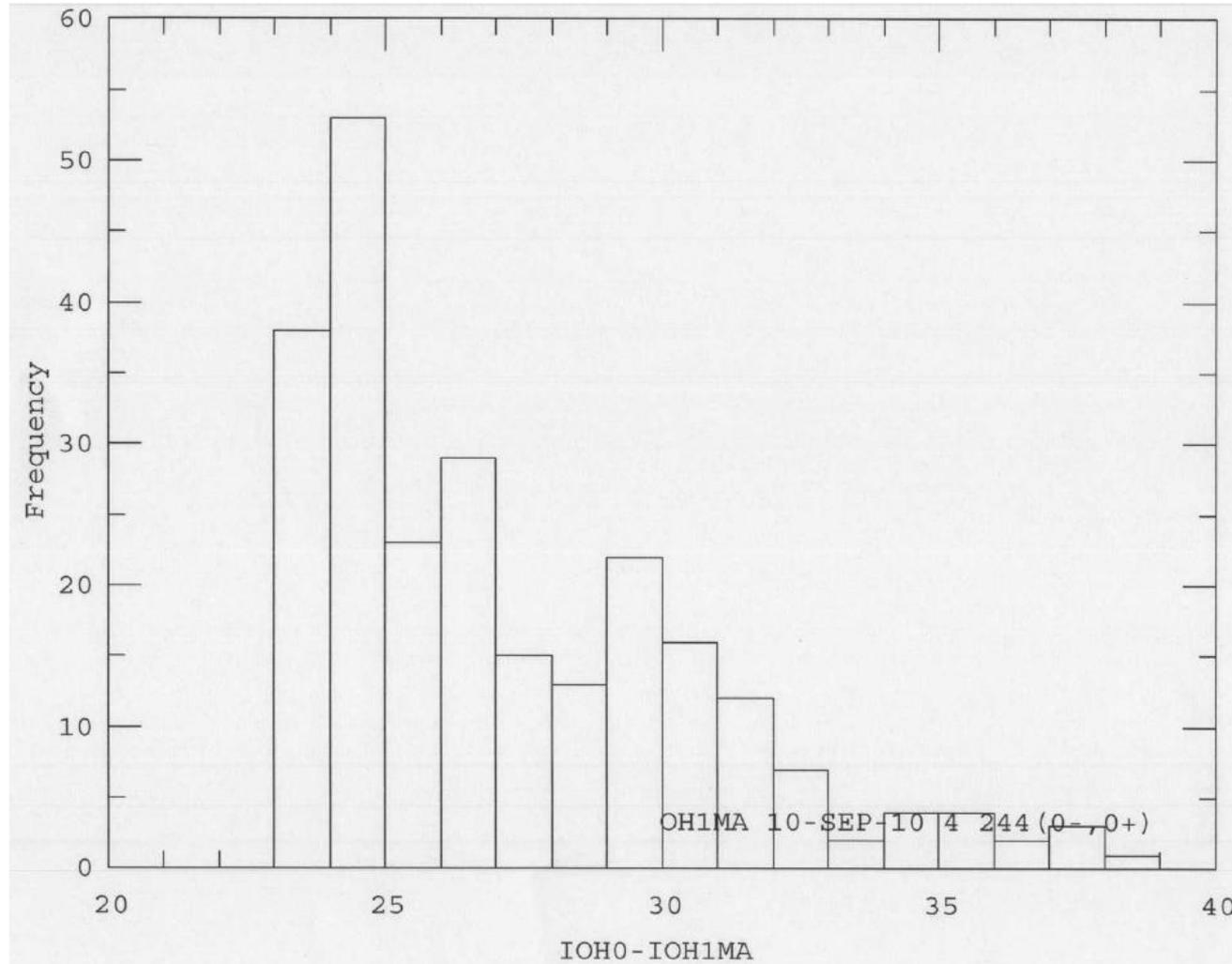


140946: 5 caps, 120mg from Li dropper, Bay I + 85mg from Bay C

140947: 7 caps, 800 mg from Li dropper, Bay I +C

140949: 7 caps, No additional Li deposition

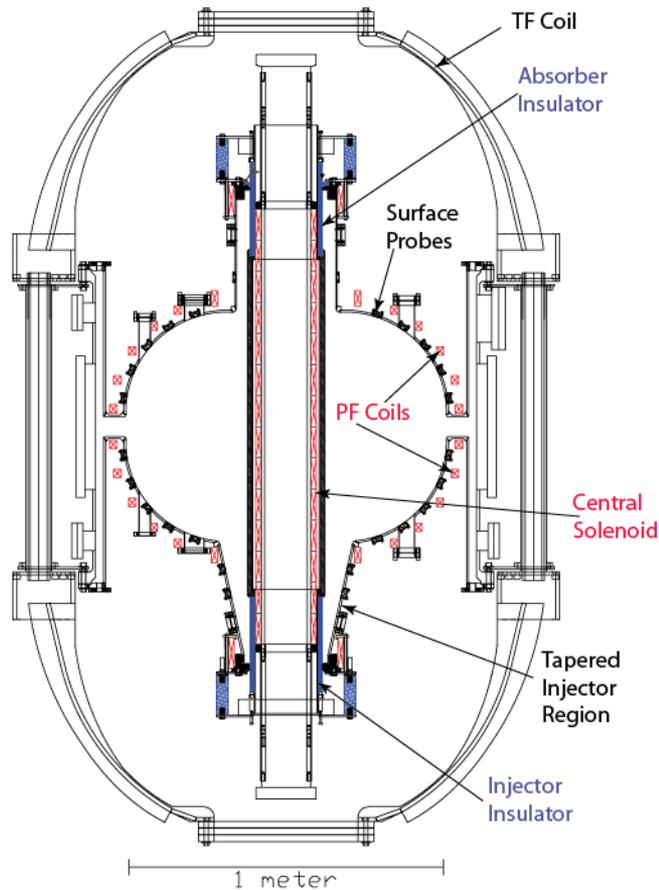
# Inductive plasma in NSTX data base [compiled by M. Bell] shows 23kA or higher current change in CS to ramp to 1MA (H-modes using more than 1 NBI source)



# Very Productive FY10 CHI Run

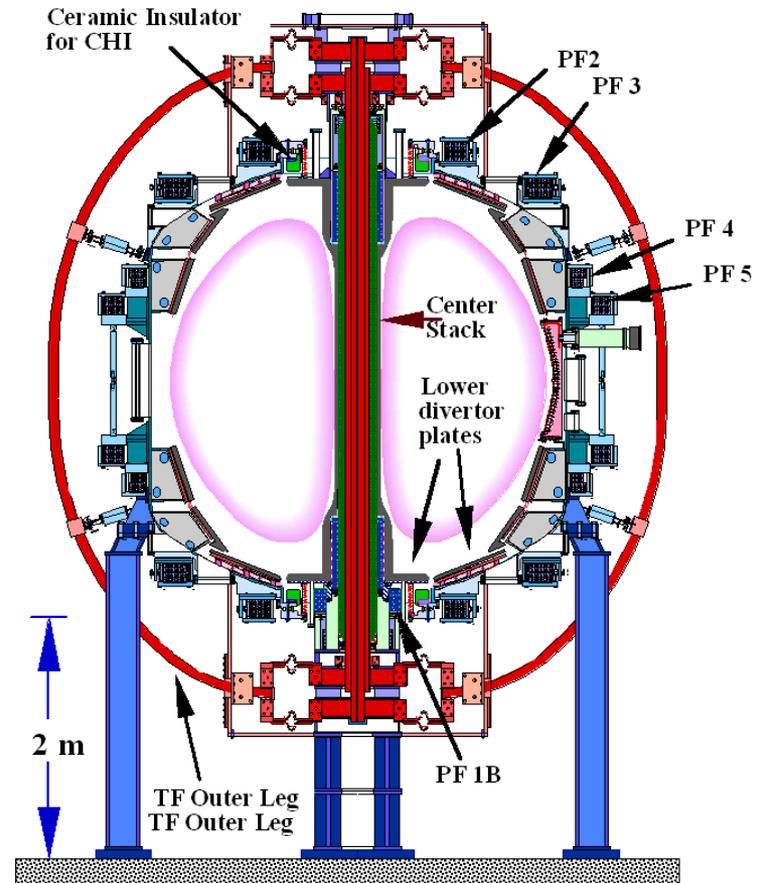
- Improved overall discharge evolution to ramp to 1MA using less inductive flux that has ever been done on NSTX
- Compared to CHI started discharges, Inductive L-mode discharges in NSTX require ~40% more inductive flux to ramp to 1MA.
- 40% inductive flux typically generates 360kA of current in NSTX
- Now produced CHI start-up discharges using 5 and 7 capacitors without absorber arcs
  - These are now ready to be coupled to induction
  - Will further improve the early discharge phase
  - Will increase NBI power input and add it earlier in time to heat the early phase of the CHI plasma

# NSTX Plasma is ~30 x Plasma Volume of HIT-II



## Concept exploration device HIT-II

- Built for developing CHI
- Many Close fitting fast acting PF coils
- 4 kV CHI capacitor bank



## Proof-of-Principle NSTX device

- Built with conventional tokamak components
- Few PF coils
- 1.7 kV CHI capacitor bank