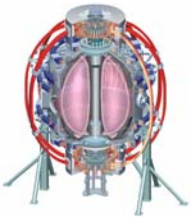
Supported by
Office of Science

R Raman, B.A. Nelson, D. Mueller[1], T.R. Jarboe, M.G. Bell[1]



University of Washington, Seattle
[1]Princeton Plasma Physics Laboratory

College W&M
Colorado Sch Mines
Columbia U
Comp-X
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton 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
JAERI
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep

# Transient CHI Startup XP725/726 Summary

NSTX Results Review
PPPL, Princeton, NJ,
23-24 July 2007

# CHI Summary

XP725 (Optimizing Transient CHI startup) – did not spend adequate time on this

XP726 (Coupling a Transient CHI target to induction from the central solenoid)

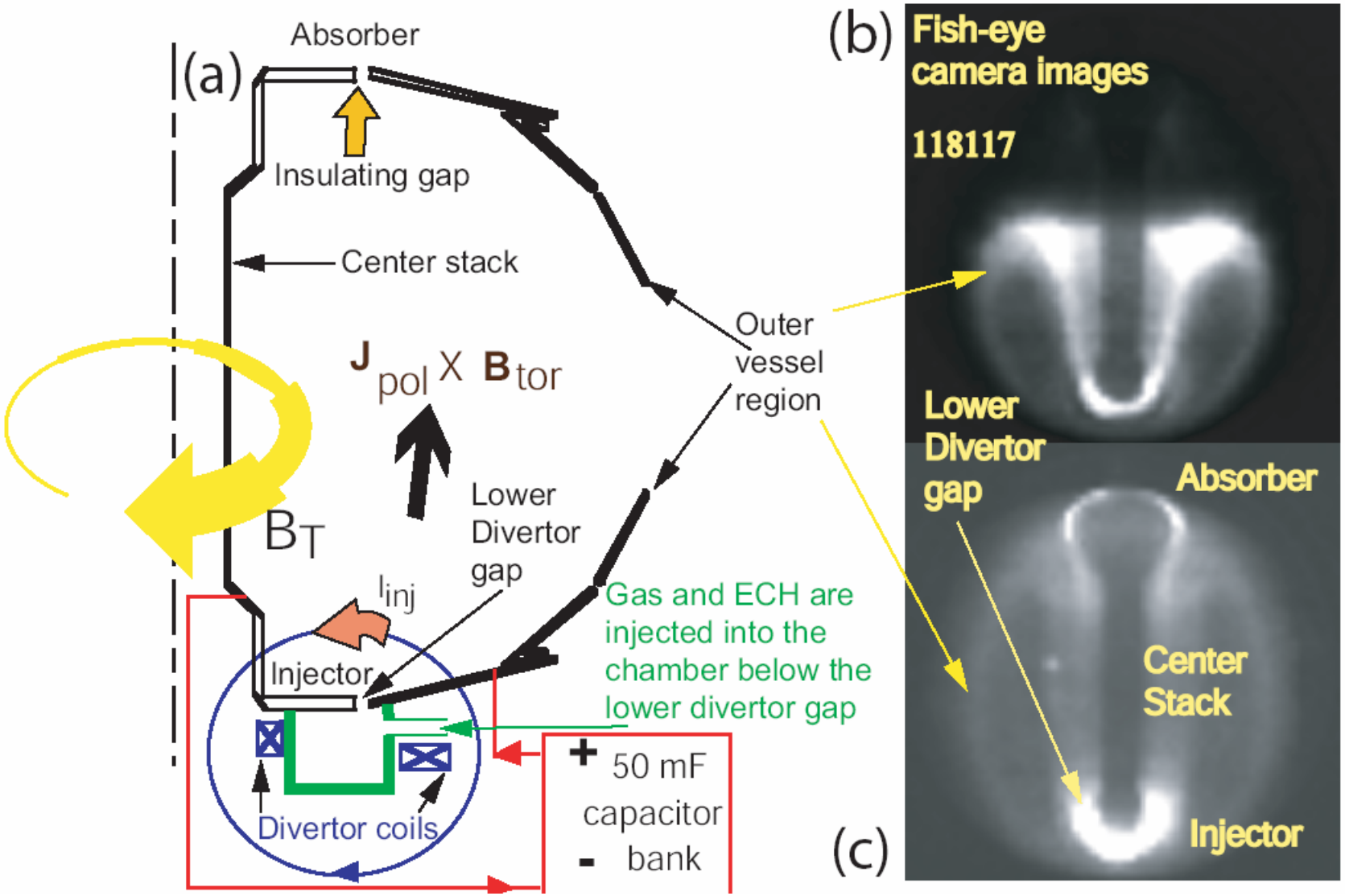
April 16: Tested New hardware installations

April 18: Produced High current CHI discharges and initial coupling studies

May 21,22: Coupled High current CHI discharges to OH

June 18: Produced Low current CHI discharges (from 2005) and Coupled to OH

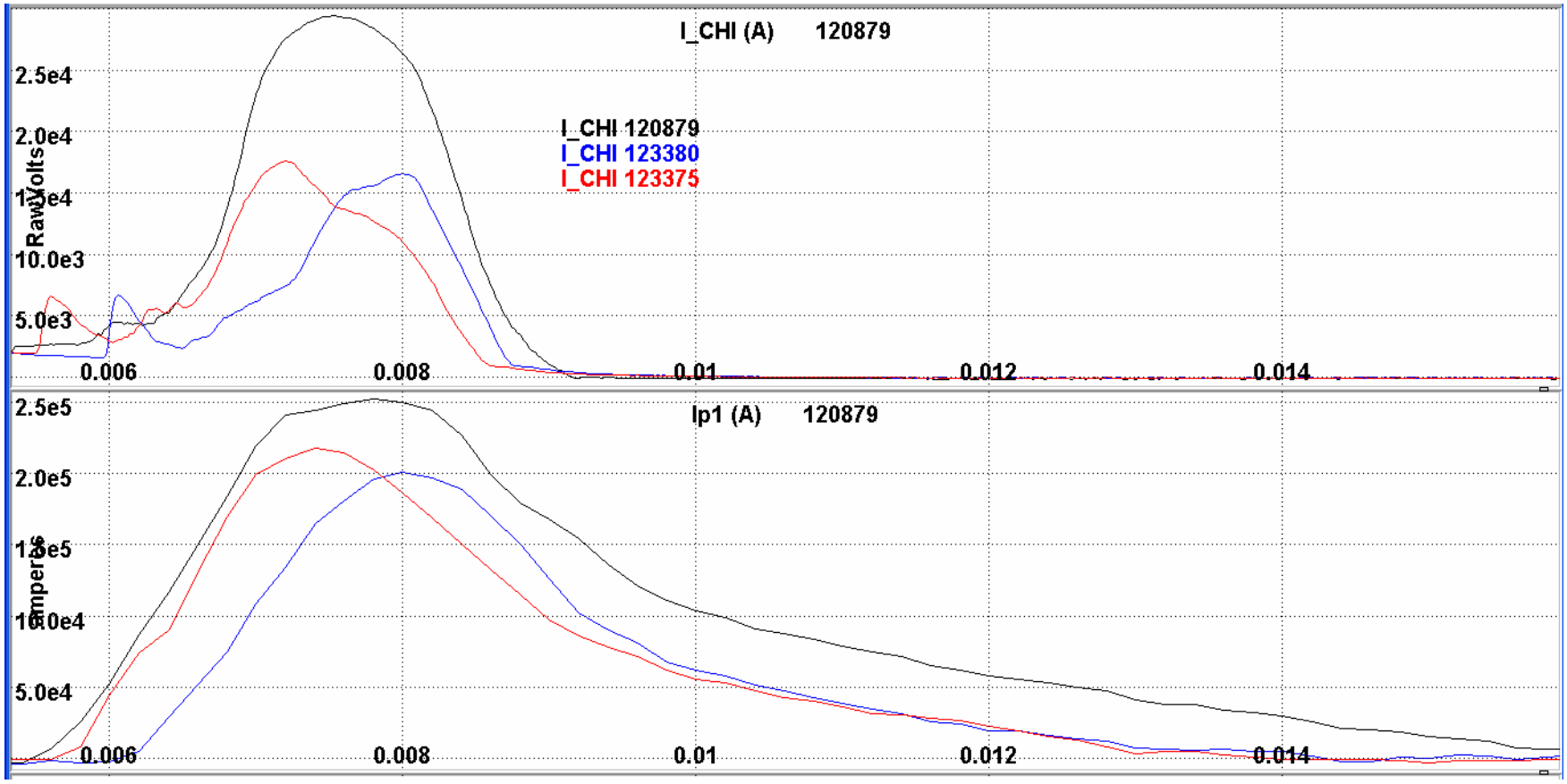
# Implementation of CHI in NSTX



# New Hardware Upgrades for 2007

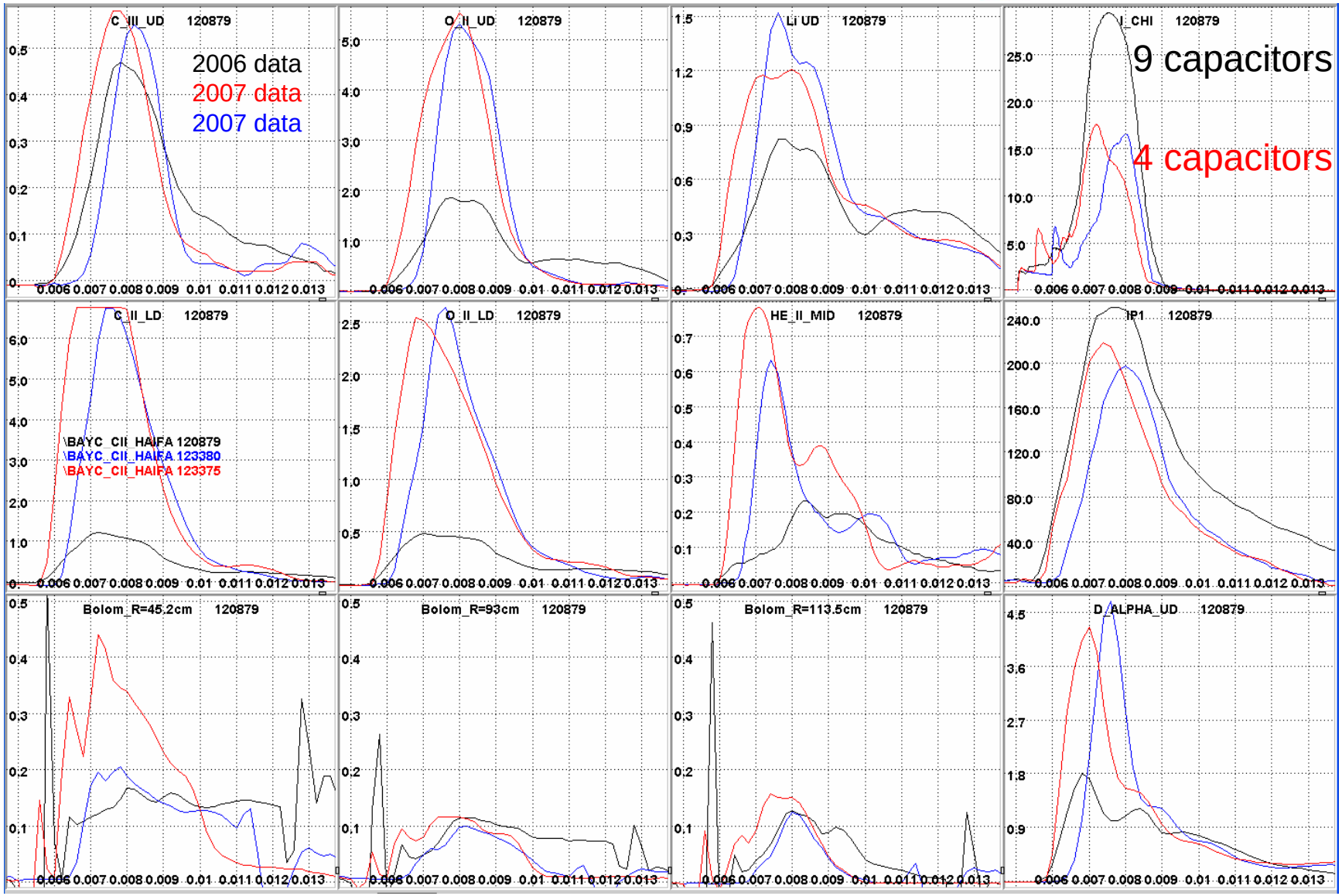

- Tested MOV current conduction
  - 4-6 capacitors (20mF)  (instead of 9 used during 2006)
  - 2-4 MOV banks (instead of 4 used during 2006)
  - About 3.5kA conduction current at 2kV capacitor charging voltage, limits voltage at injector to about 1.8kV
- Tested new Handyscope based voltage monitoring
  - Signals distorted when plasma is present
  - Restored 2006 voltage monitoring circuit
- Operated with new DC power supply
  - Allows capacitors to be charged above 1.75kV

# 4 capacitors (2007) produced nearly as much current as 9 capacitors (2006) and with less absorber arc current [April 18: Goal was to reduce absorber arc current]

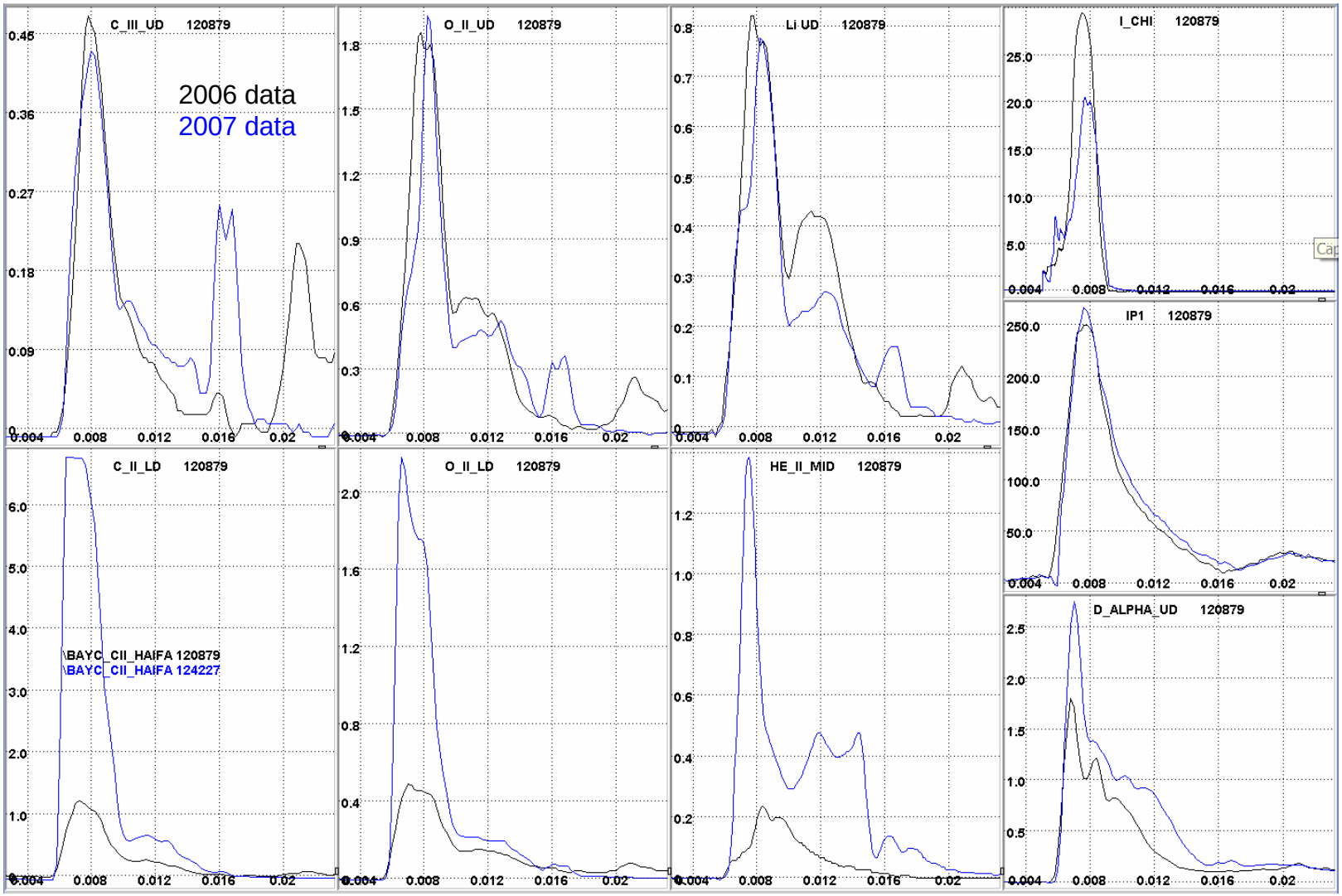



- 120879 (2006), 123380, 123375 (2007)
- Faster current decay for 2007 data attributed to poor wall conditions

# Although absorber current was reduced, Carbon, Oxygen and He line intensities increased considerably [Commissioning Li evaporator introduced water into NSTX vessel, CHI was first Expt. After commissioning]

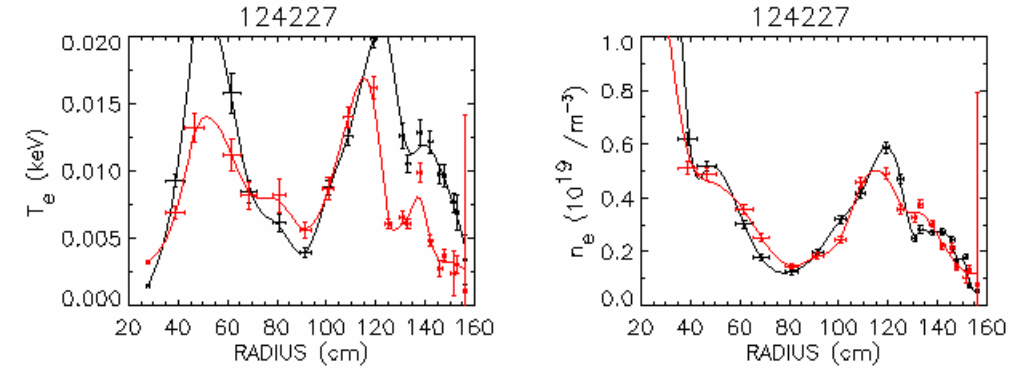


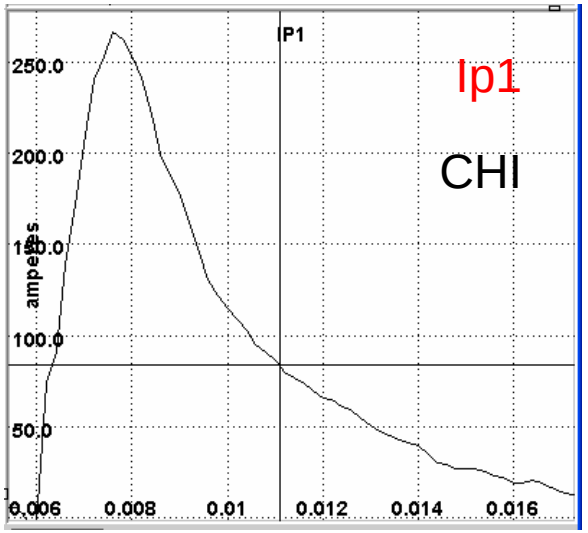
# May 21-22: Reproduce High Current discharge after boronization
# [Li evaporator now in routine use was not used for 113 shots prior to CHI]
# Spectroscopically only lower divertor signals are high



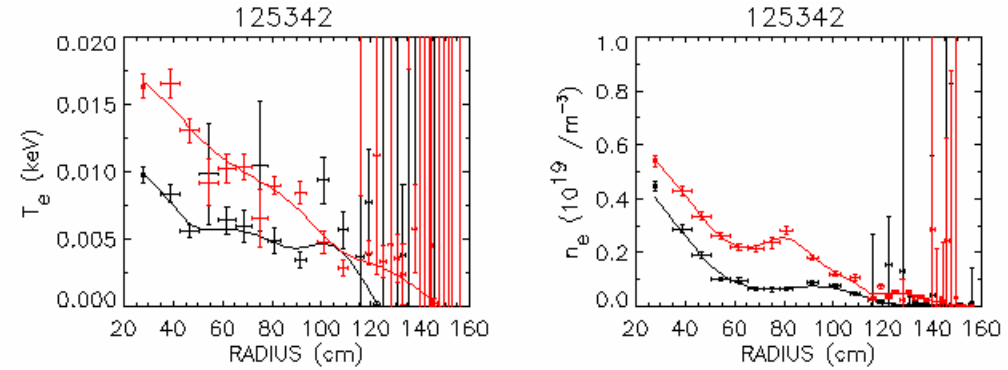
# Measured Electron temperatures at 9 and 11ms for CHI discharge 124227 and for an inductive discharge during IP ramp up when Ip is 50kA

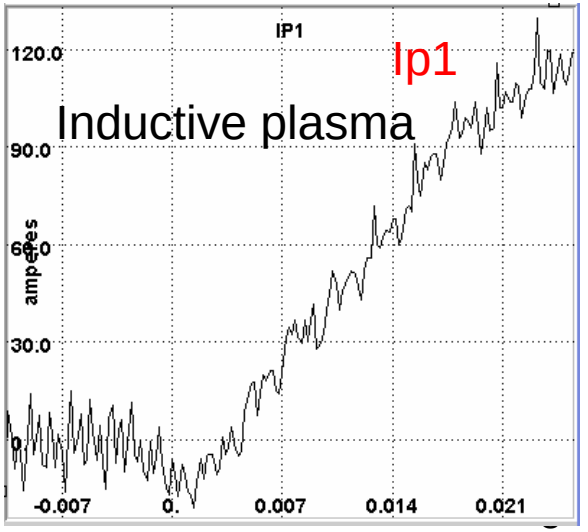
## CHI discharge (9 and 11ms)



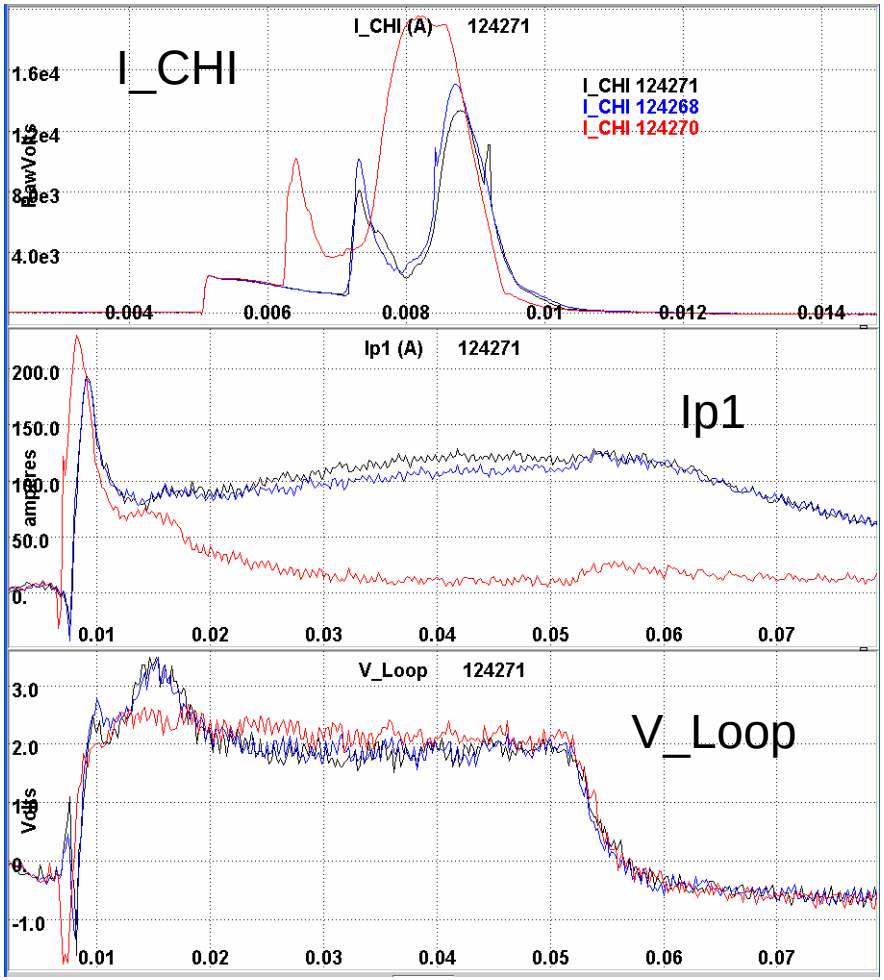

## Inductive Discharge (7 and 10 ms)

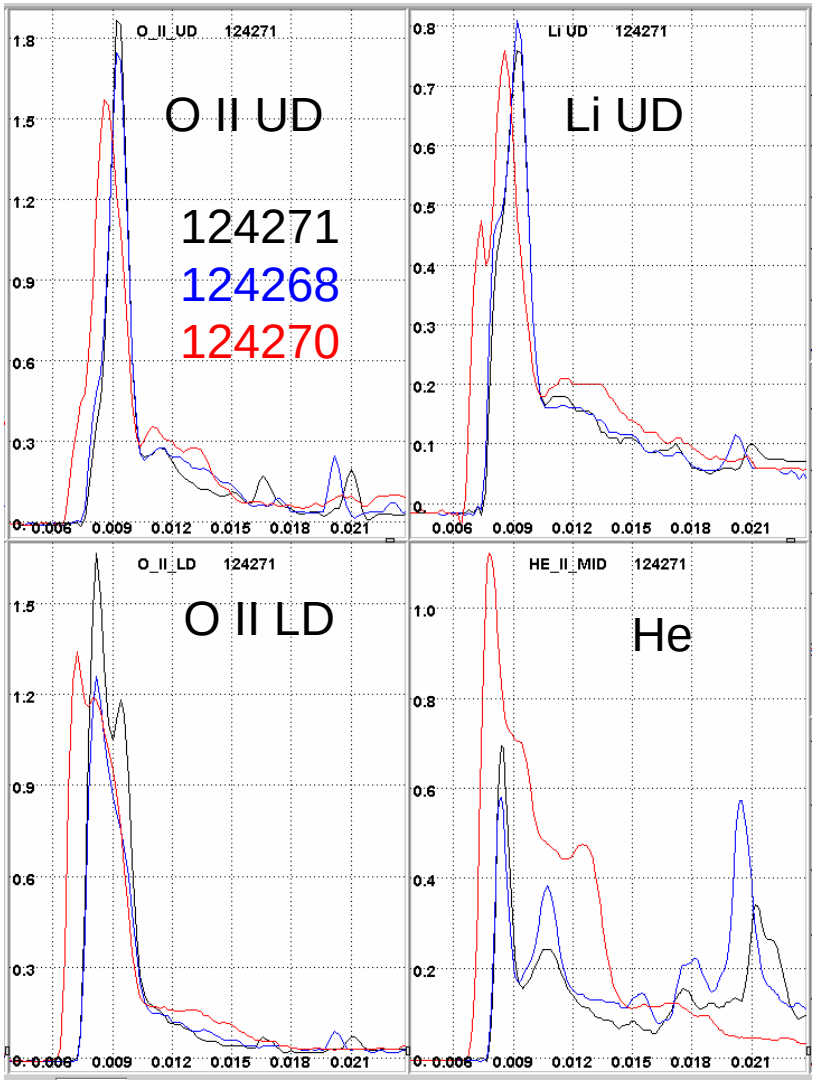


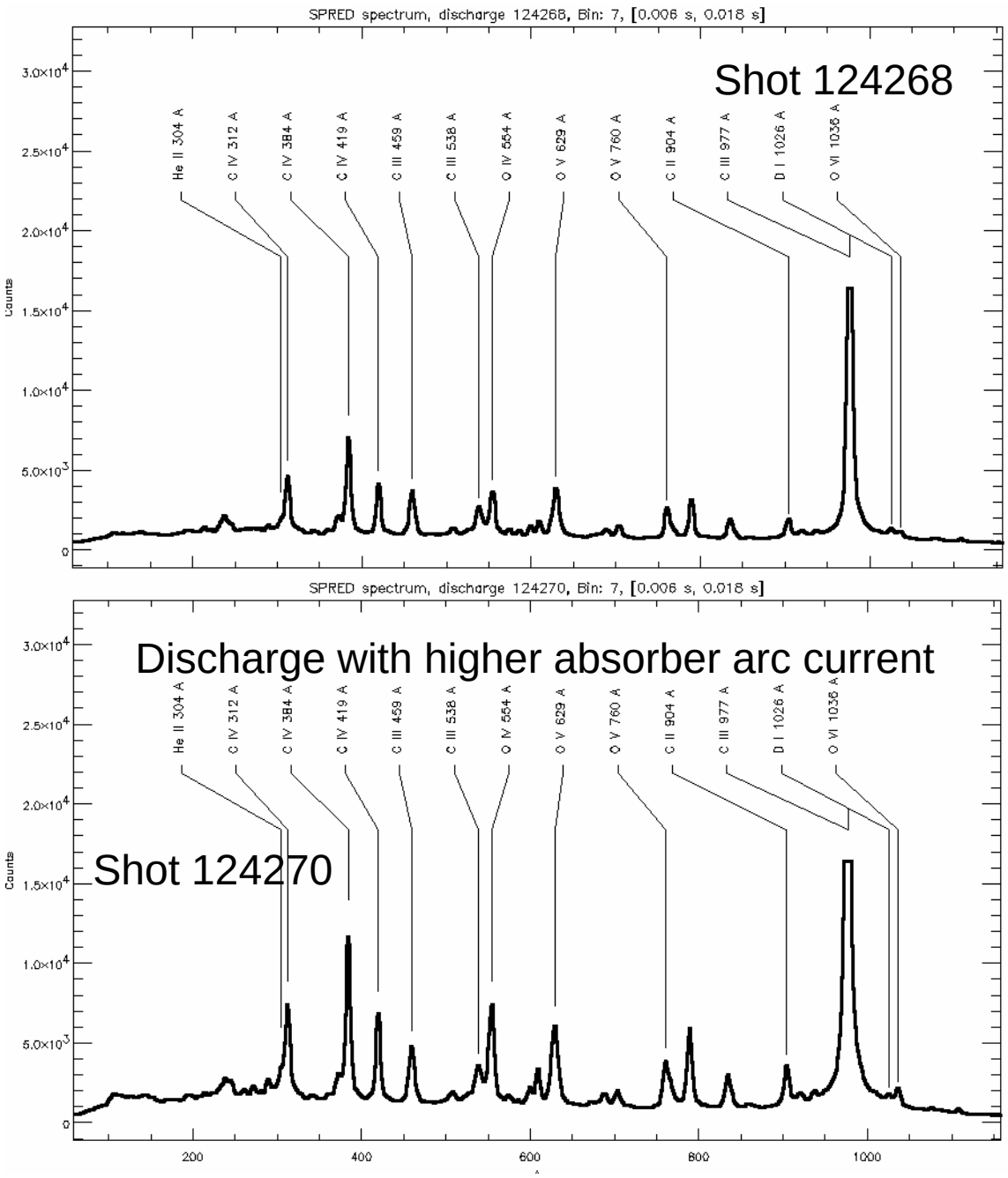
# Measured Electron temperatures at 9 and 11ms for CHI discharge 124227 and for an inductive discharge during IP ramp up when Ip is 50kA

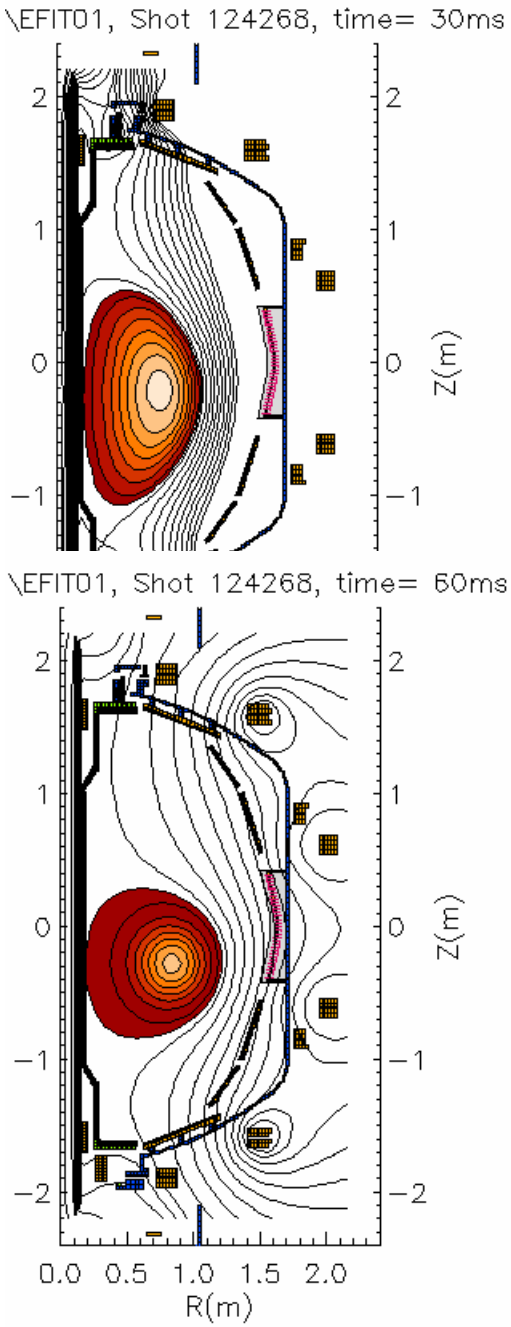
Discharge with higher absorber arc current does not couple to OH



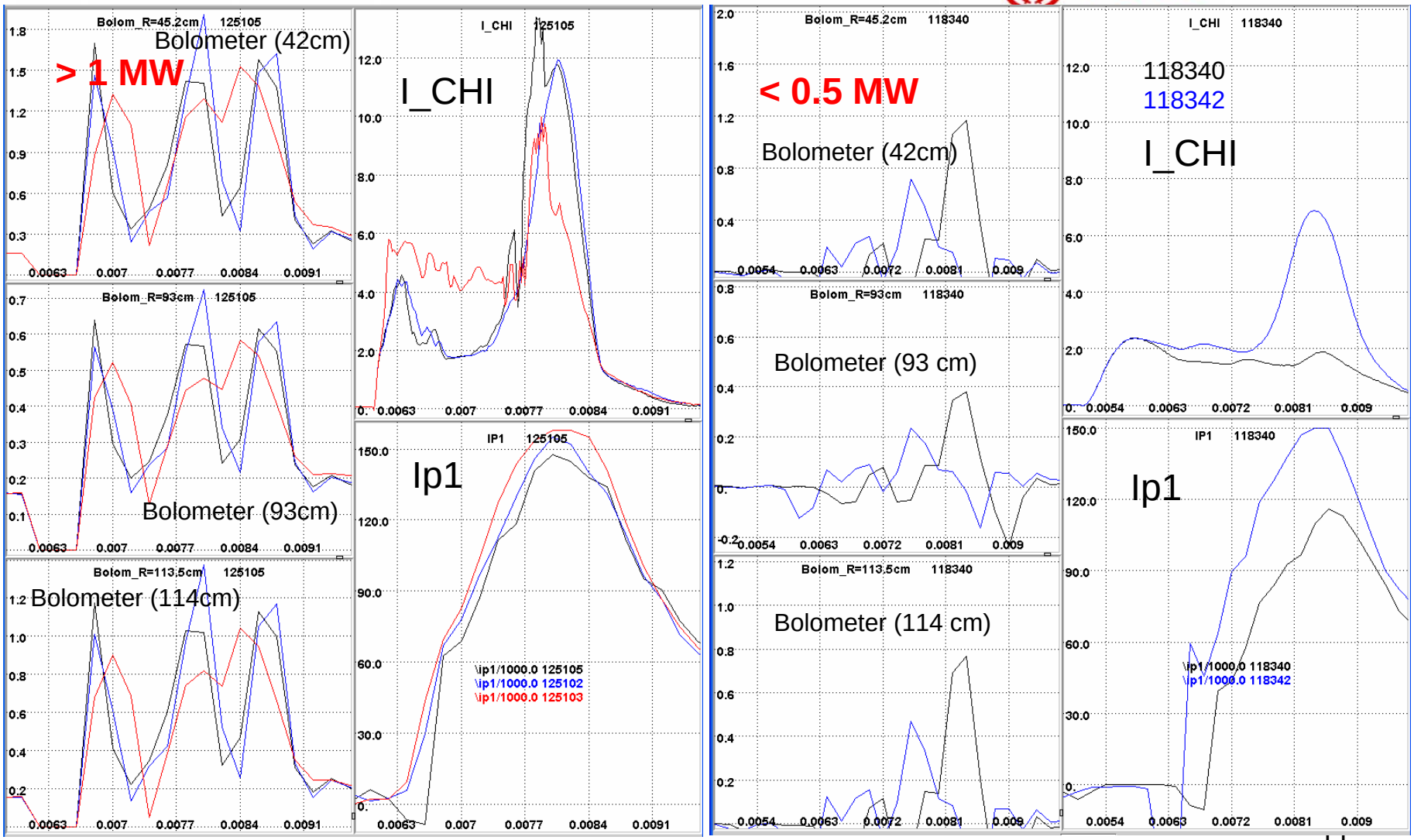



# SPRED spectrum: Discharge with higher absorber arc current has more line radiation



June 18: Goal was to reproduce absorber arc-free higher Te discharges from 2005
However these have much higher radiated power and lower Te than 2005 discharges
[Extensive Li deposition 2 days before CHI using recently commissioned second Li evaporator]

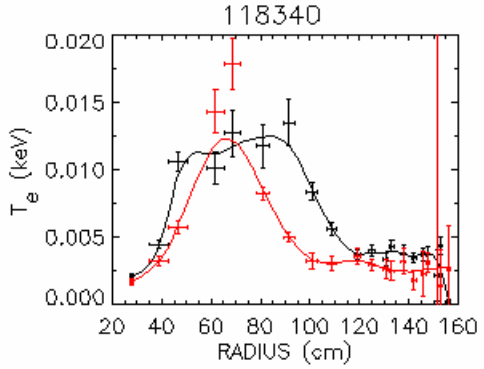


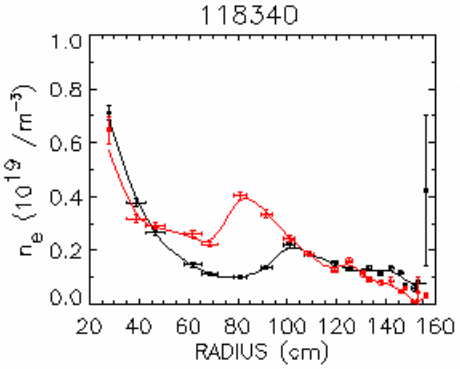

2007 data

2005 data

# June 18 discharges:
# (1) Have tendency to start in High-injector current mode
# (2) Have lower Te compared to 2005 discharge
# 2005 discharges produced at end of run under very good wall conditions

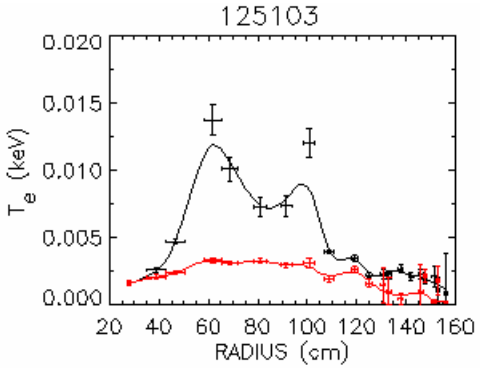
(2005 data): Te at 13 and **15ms**

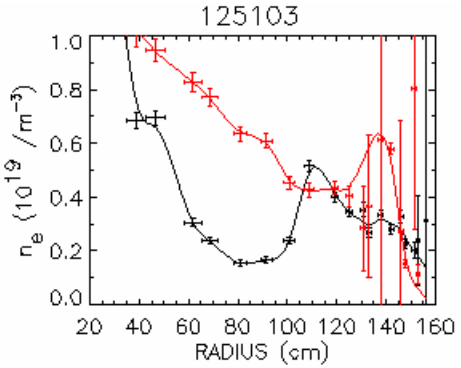


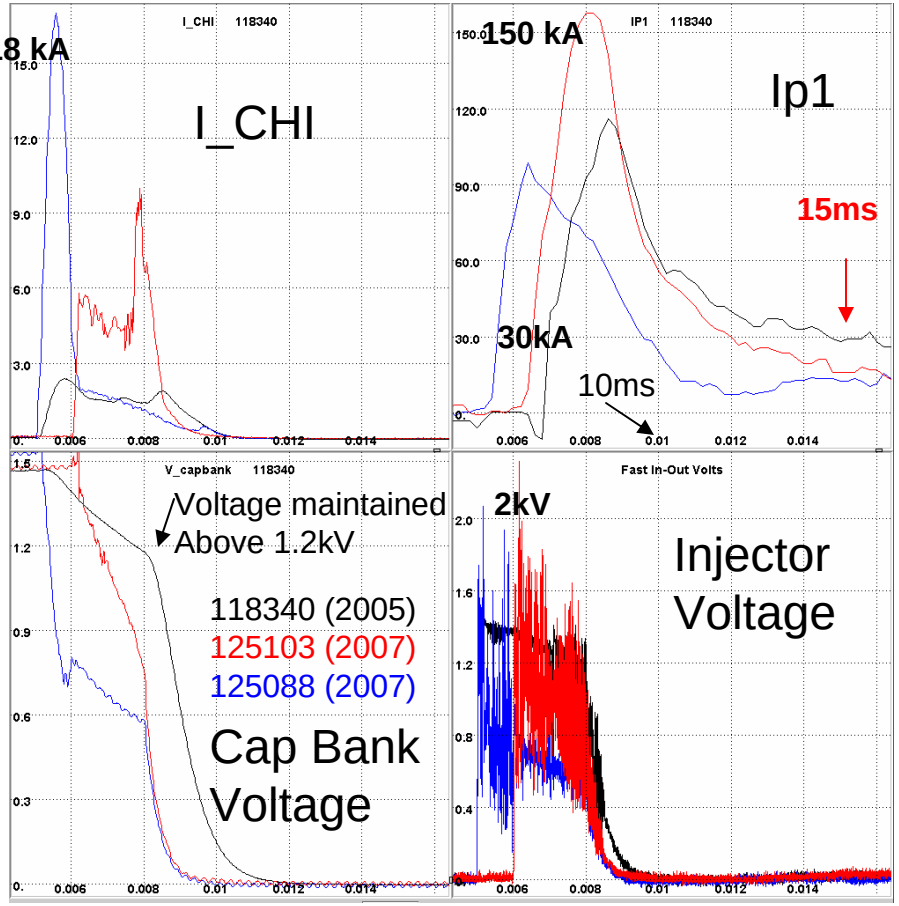




(2007 data) 125103 at 10 and 12ms

**1.5 kV**

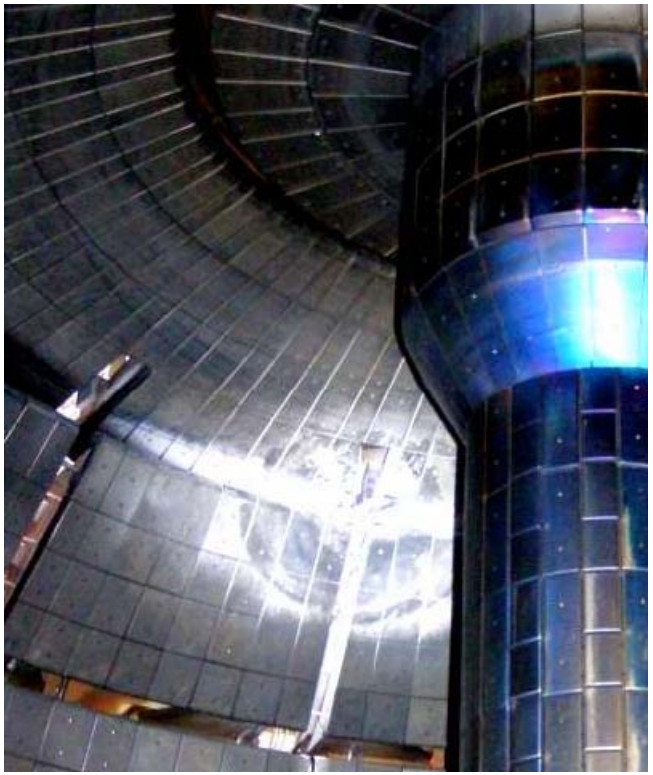


# Vessel inspection after FY07 Run shows localized large Li / (Li oxides?) deposition on the lower divertor plates

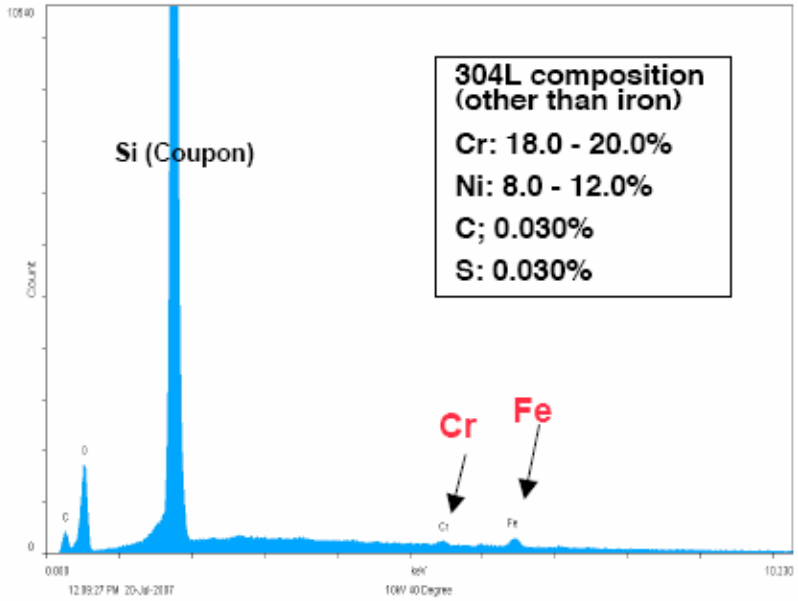
# Li deposited as thick flakes in upper vessel region could be responsible for the observed dust during 2007 CHI discharges



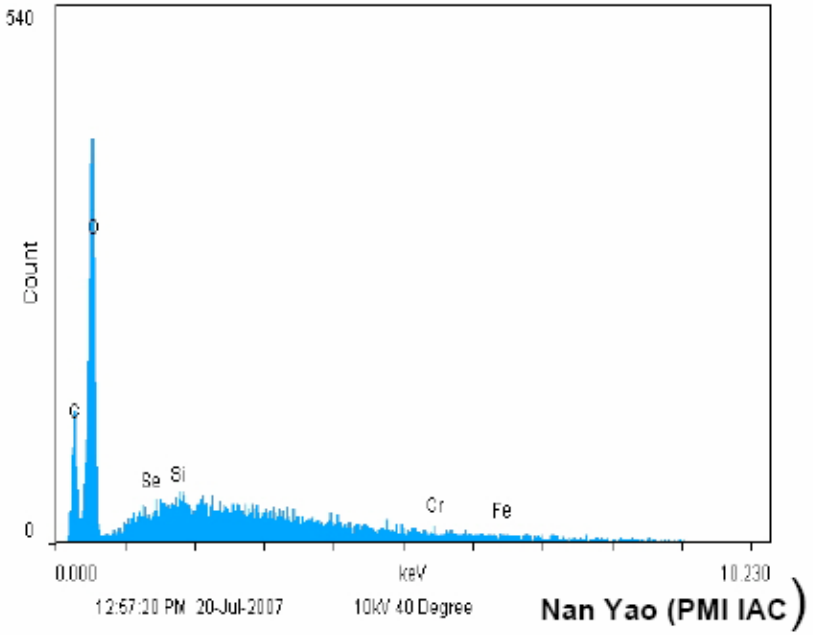
# • Bay I-J Midplane Coupon Exhibits Fe and Cr Deposition
# • Thick Flake Sample at LITER Output Shows No Metals

NSTX

• The K-Xray spectrum of the Bay I-J Midplane Silicon Coupon exhibited C, O, Si (coupon) and small amounts of Cr and Fe. No Ti Ni, or Mo were observed.



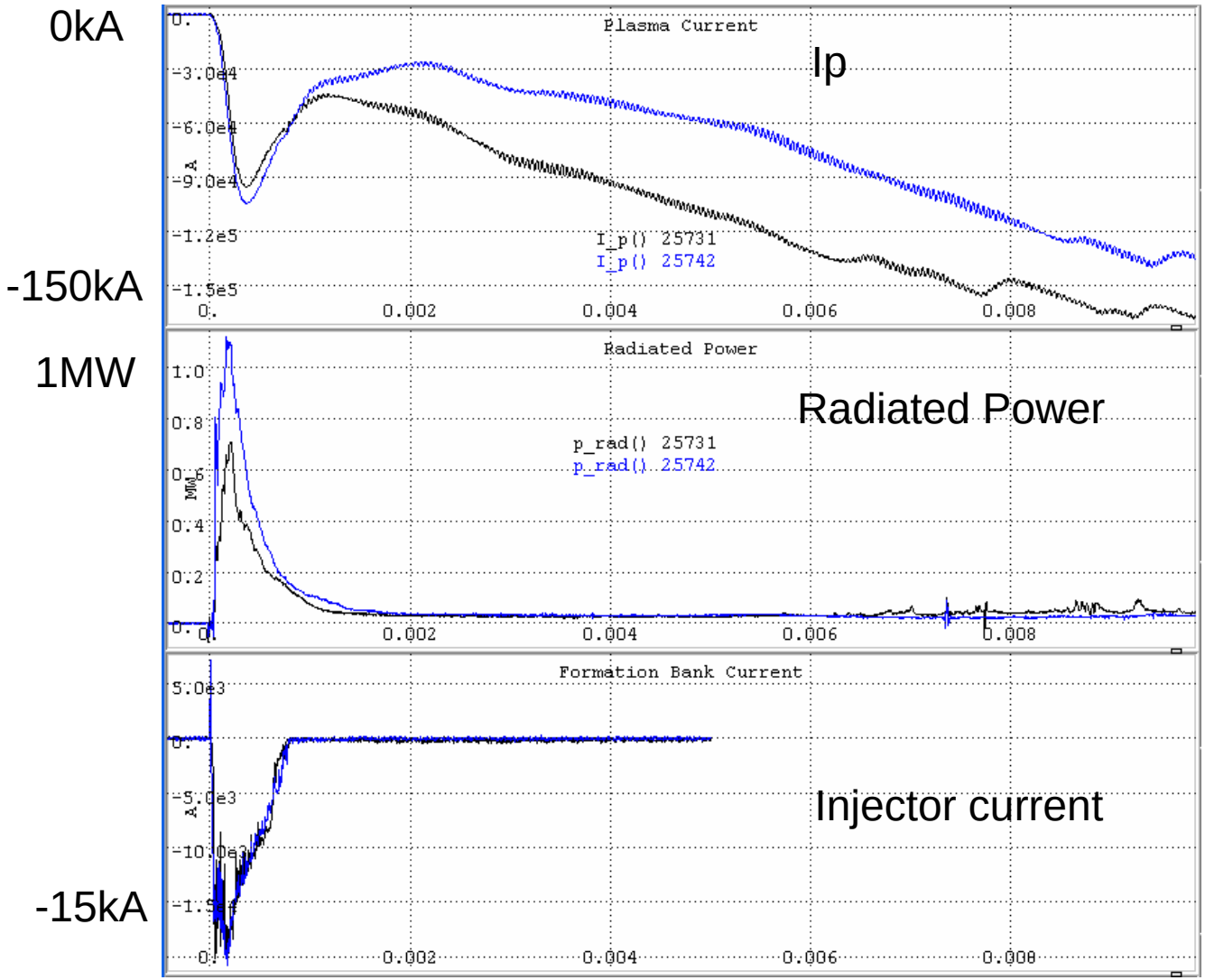

• Bay F Upper Divertor thick flake obtained from the local lithium HeGDC buildup near the output of LITER exhibited only C, O, and no Si (coupon) and no Cr, Fe, or other metals.




• This result is consist with the deposition of typical plasma impurities on the Midplane Coupon and no metal output from LITER.

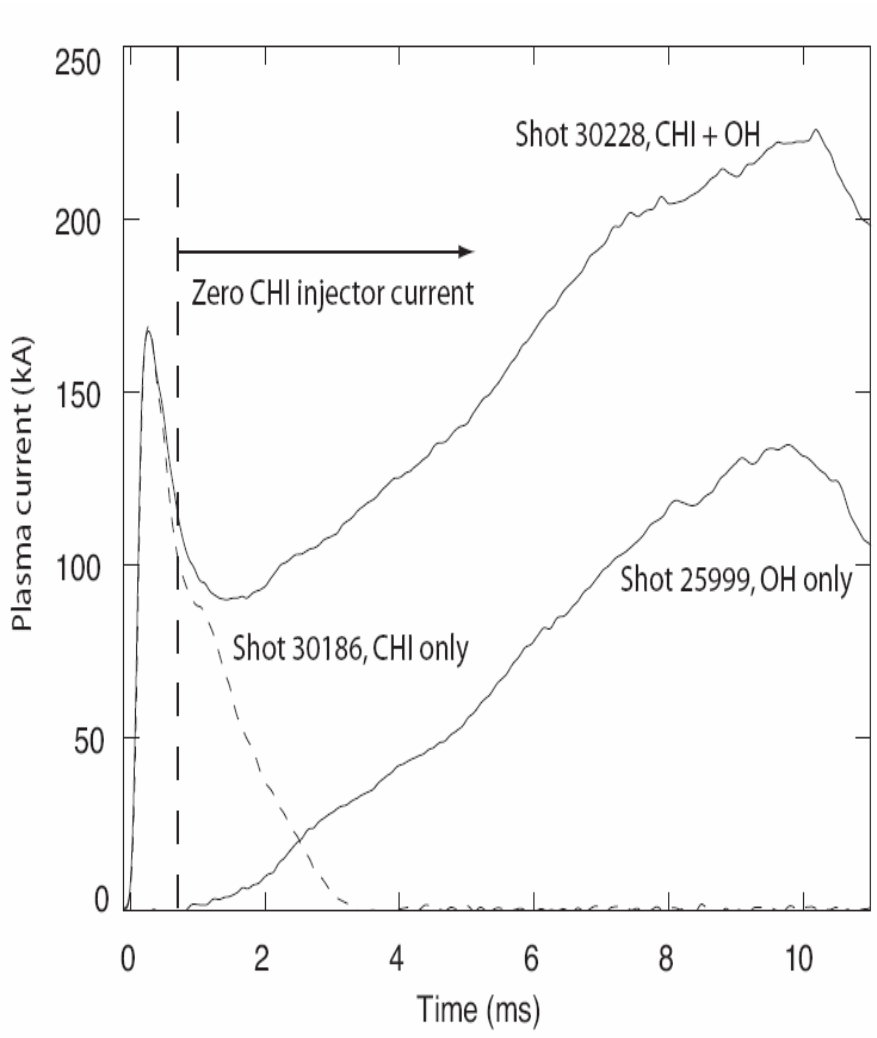
***From: H.W. Kugel presentation, 2007 NSTX Results Review***

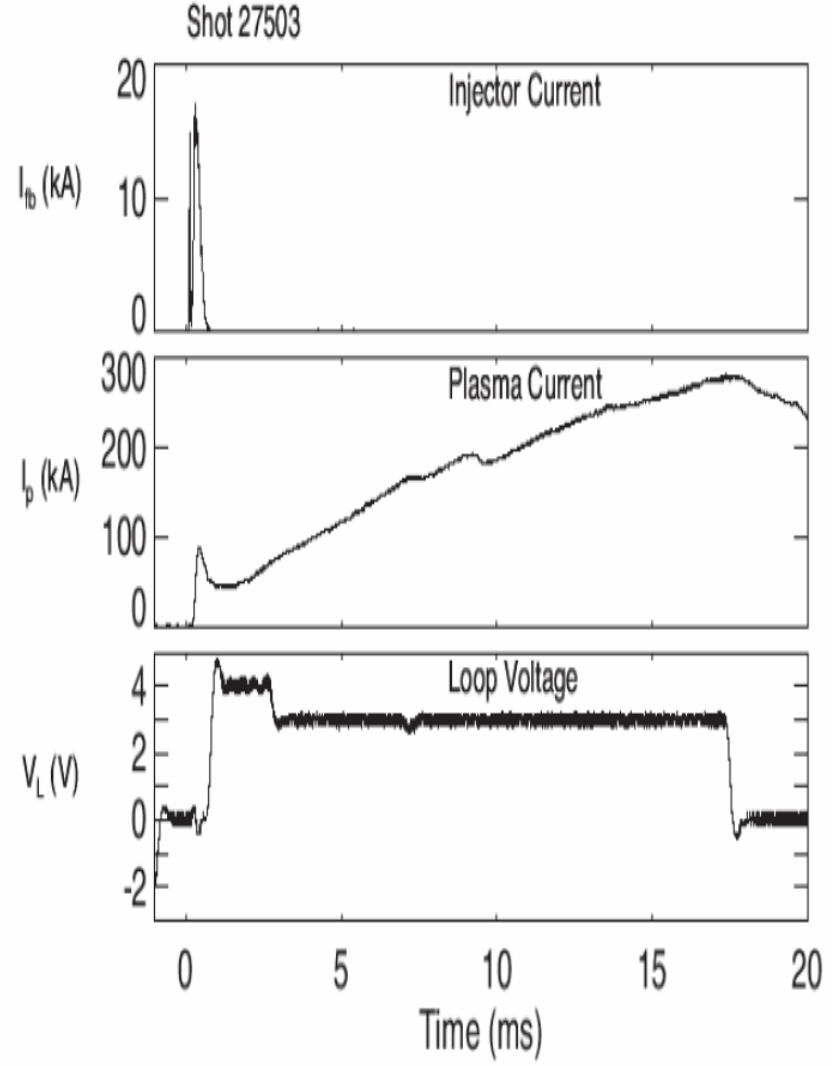
# On HIT-II discharges with higher levels of radiated power have poorer coupling to induction




Direction of Ip in HIT-II is negative

# On HIT-II discharges under good wall conditions out-perform inductive–only discharges



# Conclusions

- CHI start-up plasma originates from lower divertor region
- Arc discharge on lower divertor plates will ionize divertor plate components, including hydroxides of Li
- CHI startup uses very low energy (only 7 to 20kJ), so particularly sensitive to wall conditions
  - Electrode wall conditions are particularly important for CHI (from HIT-II)
- Ensuring electrode material is composed of only good quality graphite will reduce additional energy losses from Oxygen (Re: 2005 results)
- Pure Li is good, but oxides and hydroxides of Li are bad

- In HIT-II, discharges under poor wall conditions do not couple to induction
- In HIT-II, discharges under good wall conditions out-perform inductive-only discharges, producing nearly 300kA using only 52mWb of central solenoid flux
- NSTX has produced record levels of non-inductive closed flux current using CHI

- Present observations on NSTX are that CHI started discharges couple to induction.
  - Similar observations on HIT-II indicate that some improvements to wall and electrode conditions should improve coupling
  - Te and ne for a low current inductive discharge similar to CHI plasma
- To improve coupling & current ramp-up, electrodes need to be properly conditioned prior to CHI startup, absorber arcs to be reduced some more