Coaxial Helicity Injection for the generation of non-inductive current in NSTX

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ICC 2000
Lawrence Berkeley National Laboratory

Presentation Outline

- Motivation for CHI
- CHI on NSTX
- Experimental results
- Summary and plans

Motivation for CHI on NSTX

- ST designs can be simplified by removing solenoid
  - Demonstrate non-inductive creation of seed plasma
  - Sustain seed plasma using non-inductive methods
- Edge current drive during sustained phase
- Save V.s for Ohmic plasmas

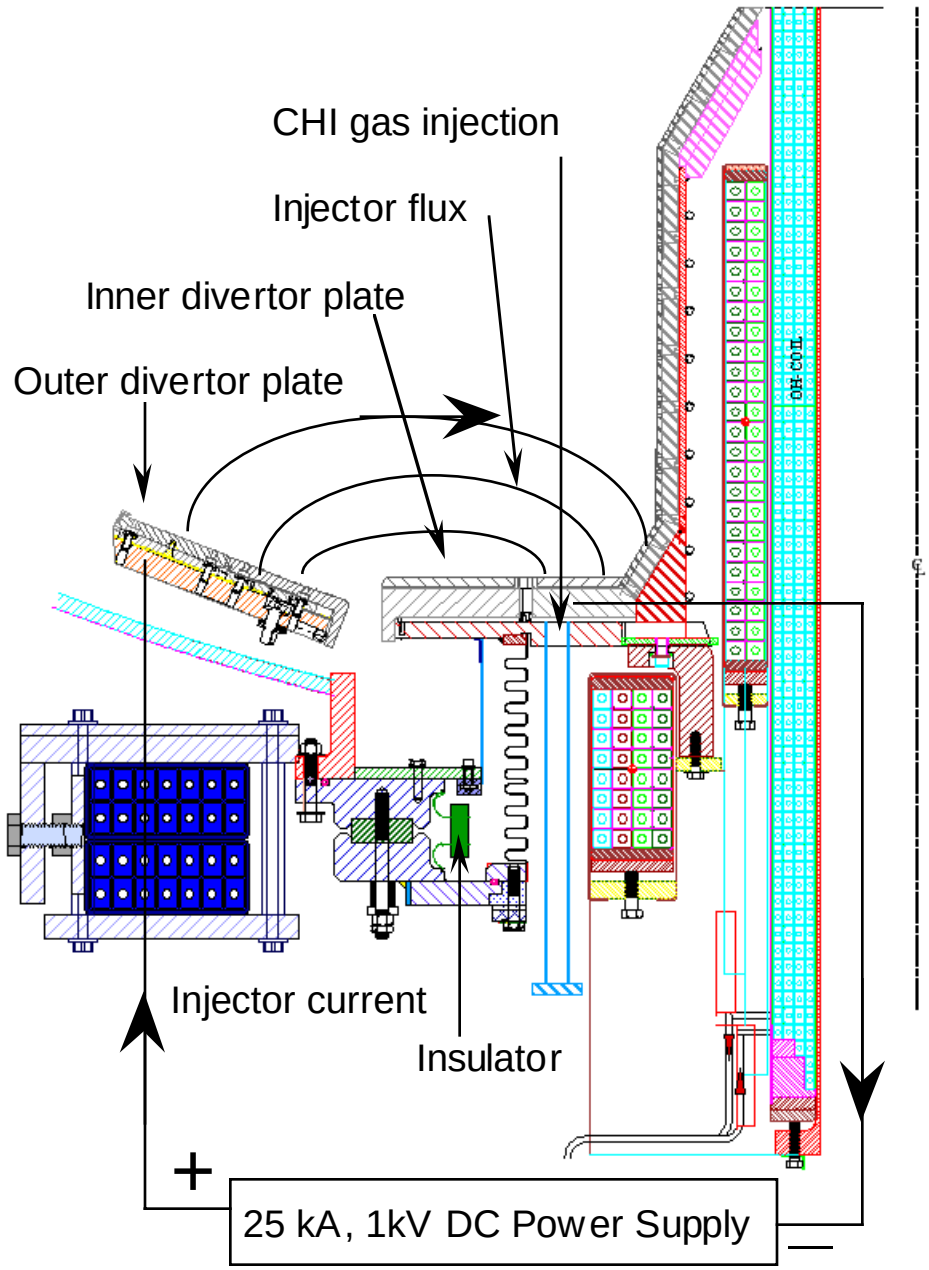
CHI Terminology

- Injector: Lower divertor plate region
- Absorber: Upper divertor plate region
- Injector current: Current supplied by PS (excluding absorber arc)
- Toroidal current: Closed flux current + open flux current

CHI Requirements for ST

- Injector region where voltage can be applied along poloidal flux penetrating two insulated electrodes in the presence of a toroidal field.

- Confinement region in which the CHI produced plasma can be maintained in equilibrium using PF coils.



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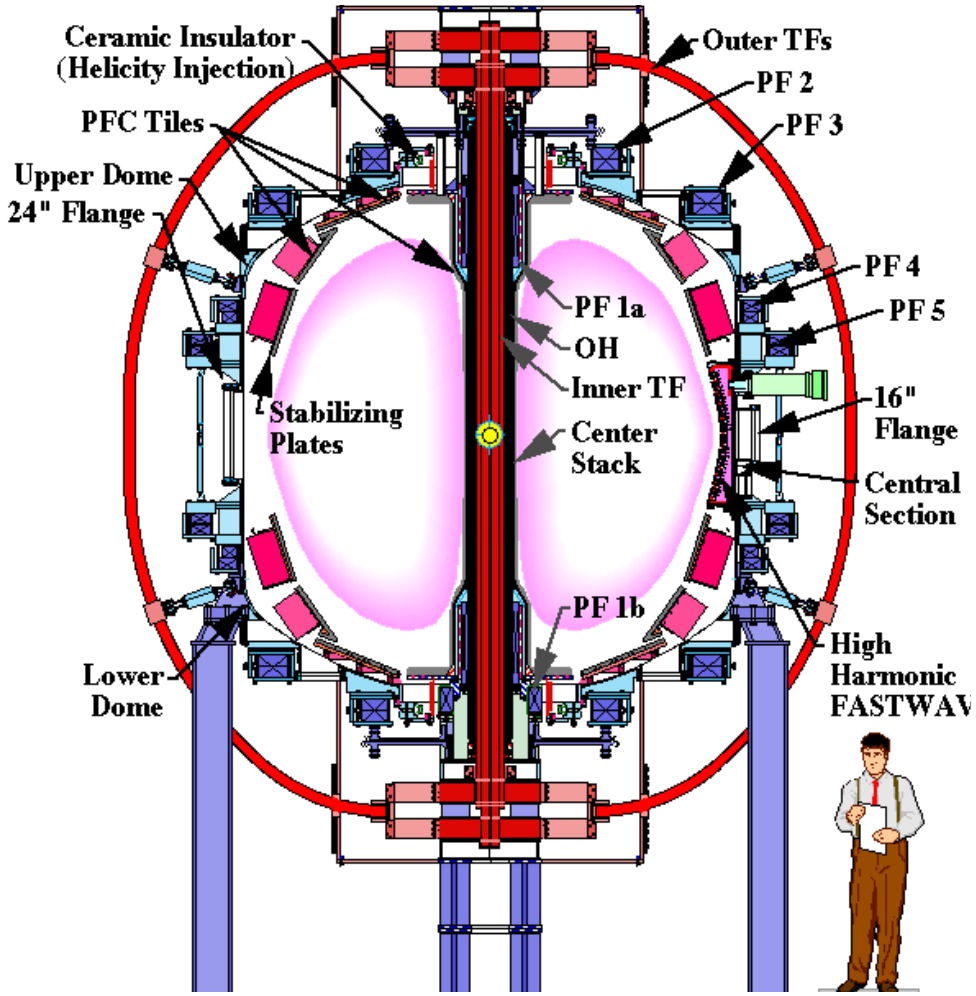
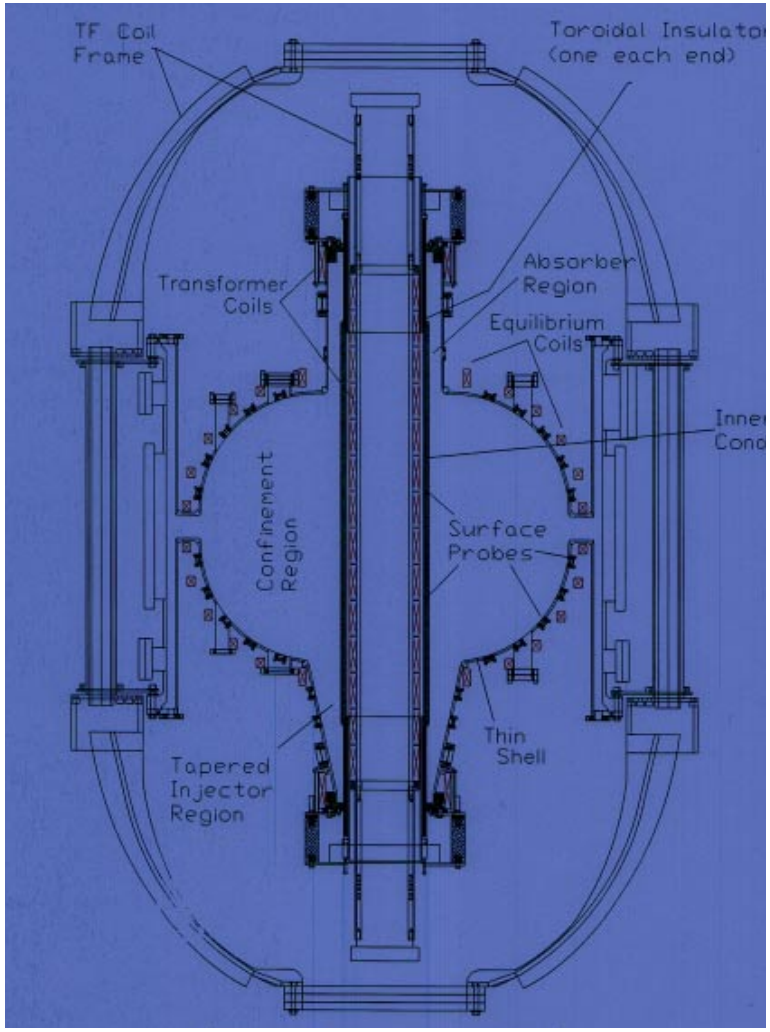
CHI on HIT and NSTX

- Injector and absorber regions different
- NSTX volume 30 x HIT-II
- NSTX used high current DC power supplies vs. capacitors on HIT
- ECH Pi on NSTX vs. electron gun and 6kV capacitor on HIT

NSTX and HIT-II machine layout





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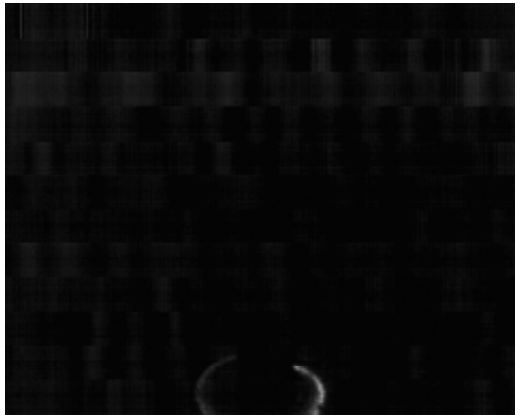
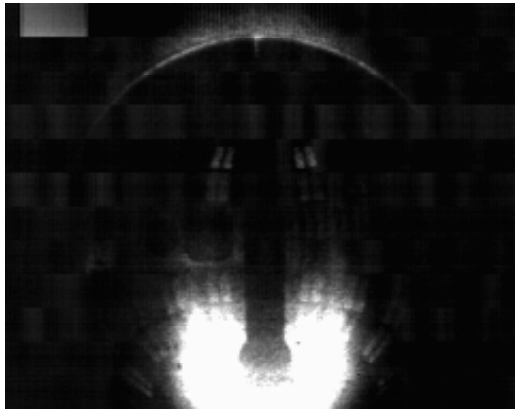
CHI discharge evolution (R. Maqueda, LANL)

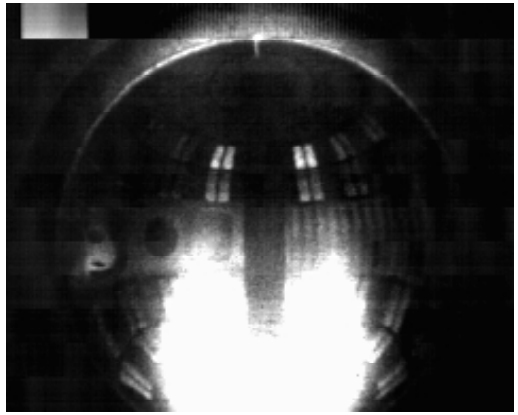
14ms



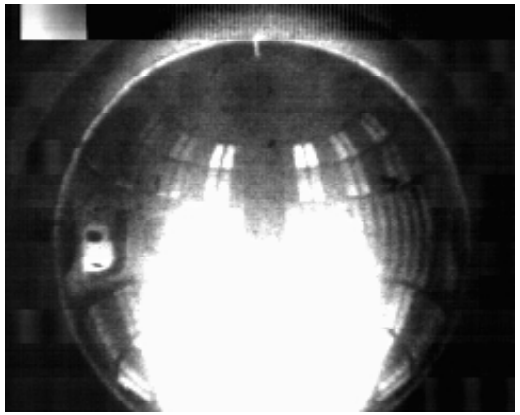
15ms



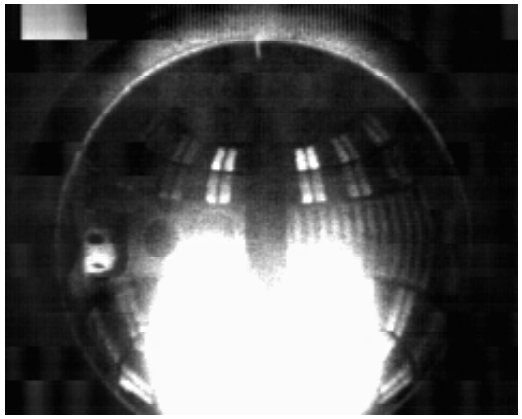
16ms



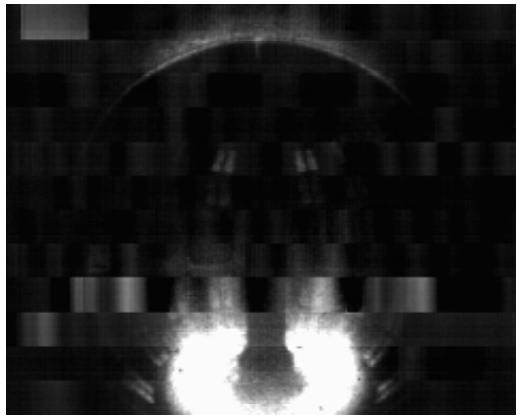
22ms



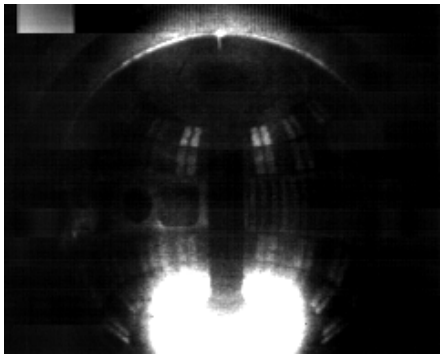
44ms



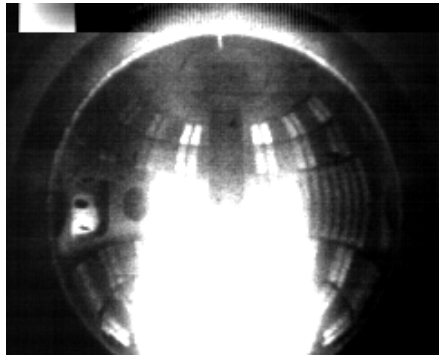
53ms



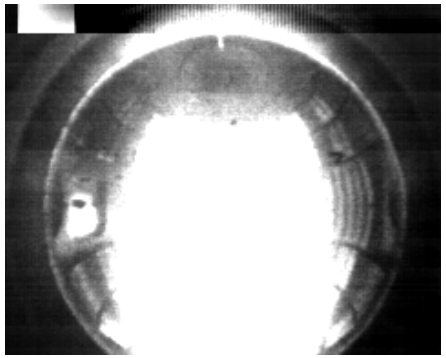
Current multiplication



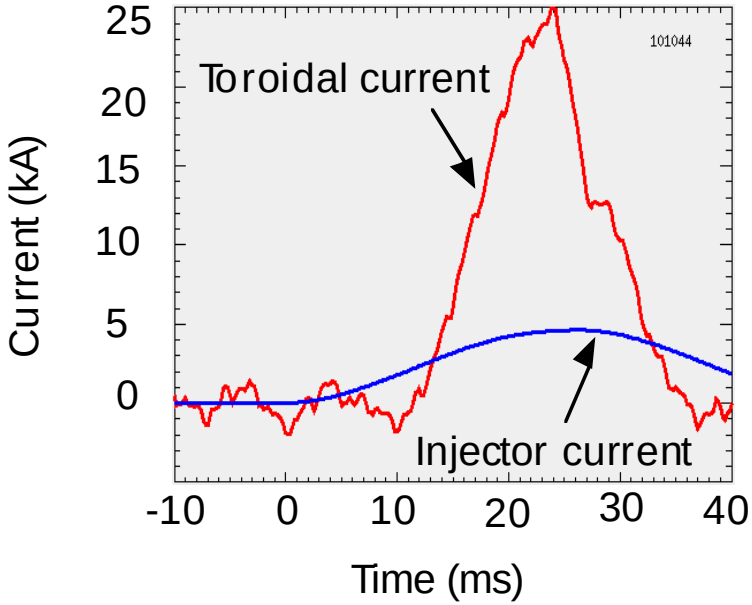
16ms



18ms

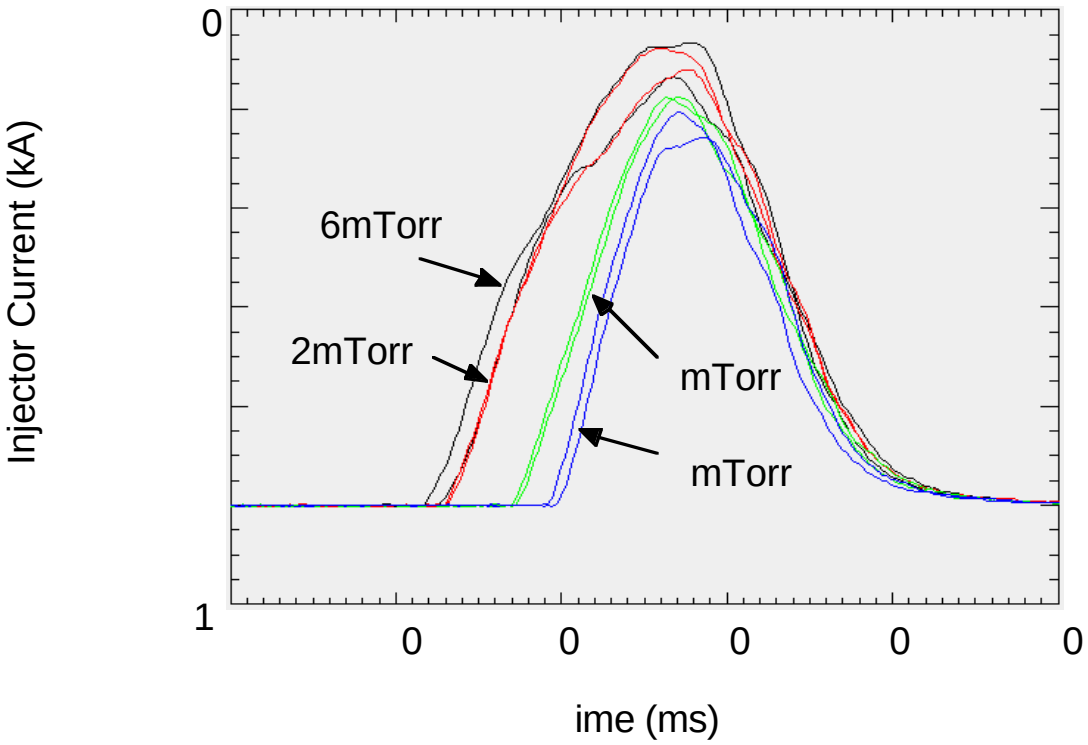


20ms



- CHI systems successfully introduced on NSTX
- First measurement of CHI produced current on NSTX
- Current multiplication of 4 achieved

Small change in current as pressure is lowered



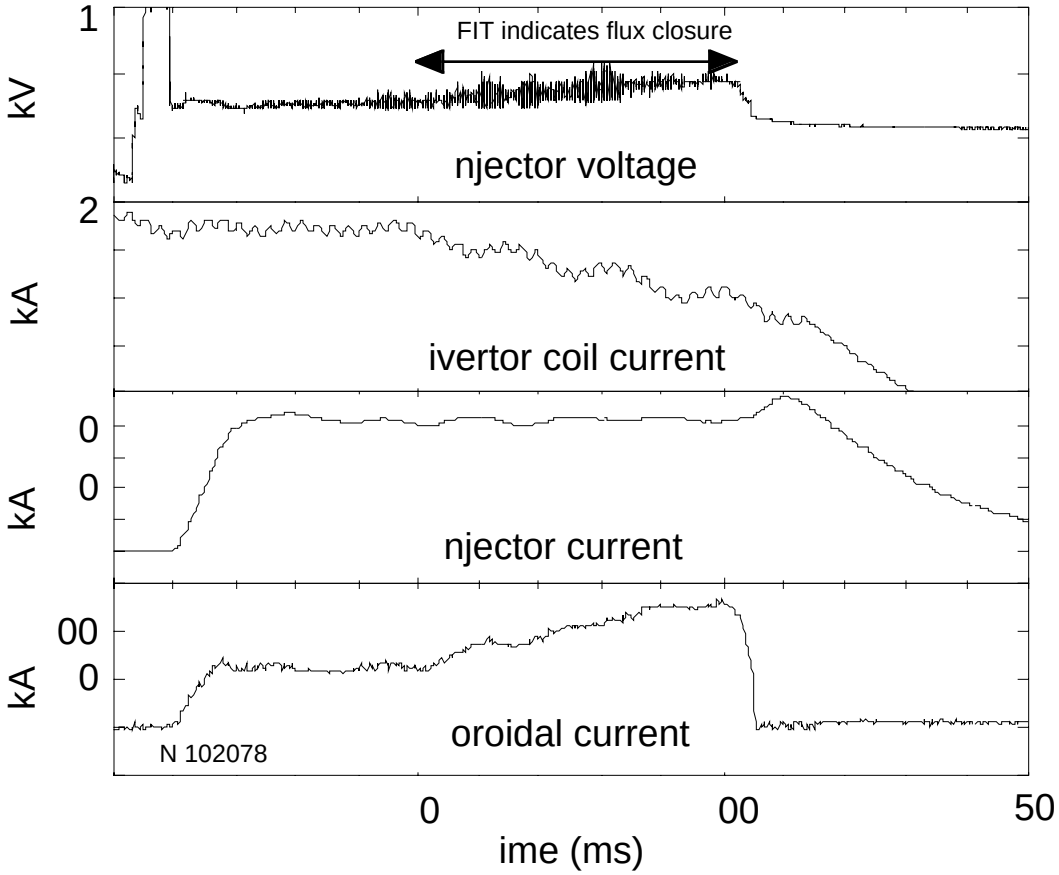
Fast gas puff system injects gas in the injector region

4mTorr pressure compatible with divertor operation

Further improvements possible

No ECH (→delay @ low pressure)

Long pulse discharge



Start with high Injector flux

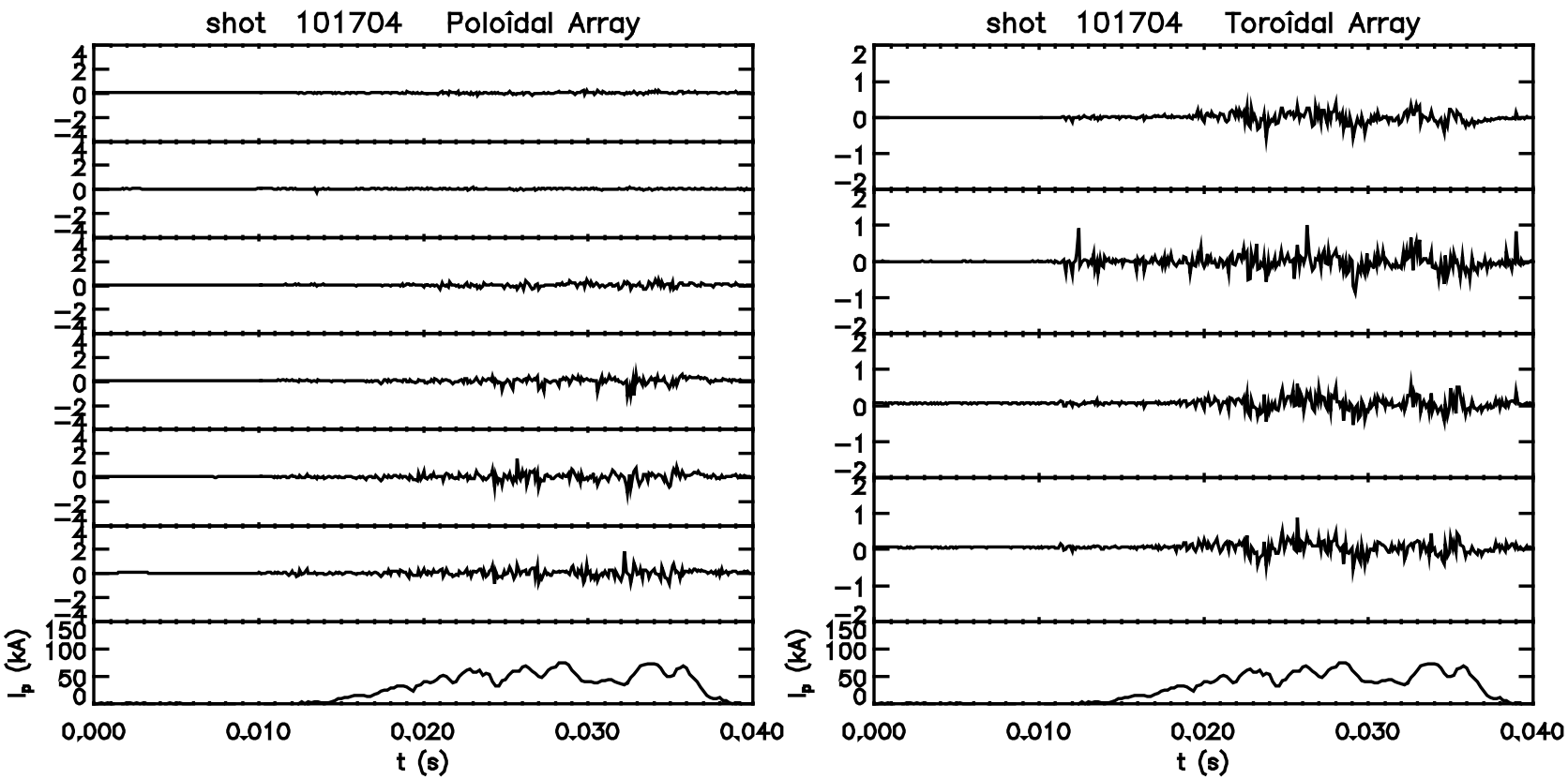
Reduce Injector flux

Increase Injector voltage

Vessel pressure ~ 3mTorr

MHD analysis (H. Ji, PPPL)
MHD fluctuations localized in lower half of vessel but toroidally uniform

SN 101704



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Distinct features for low and high current phases (H. Ji)

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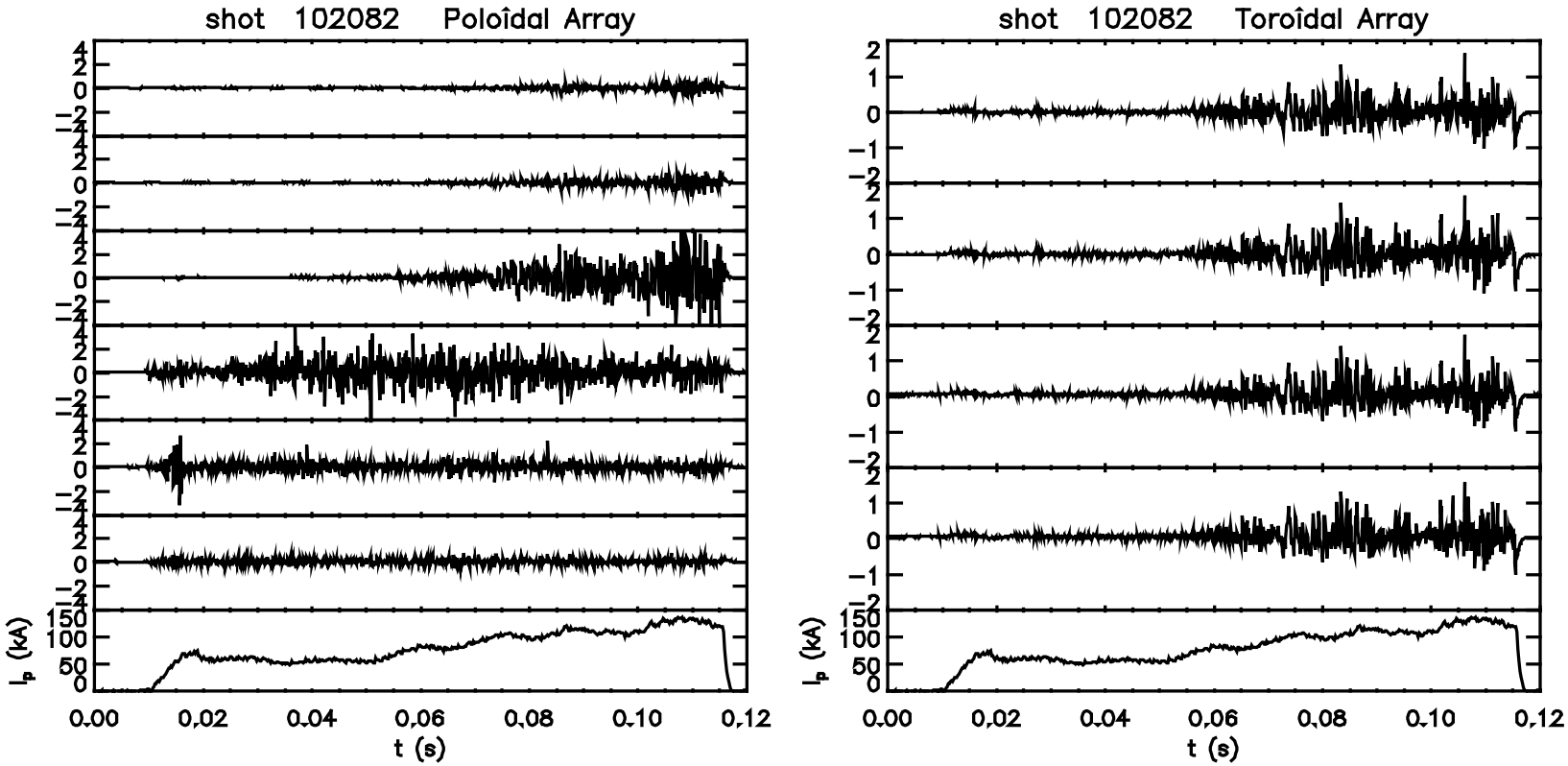
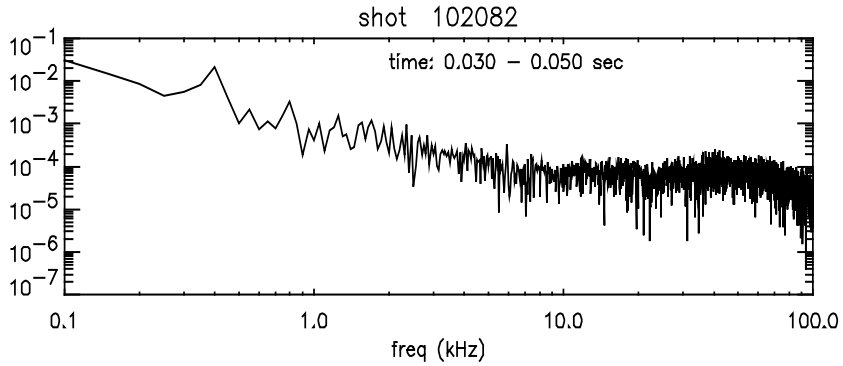


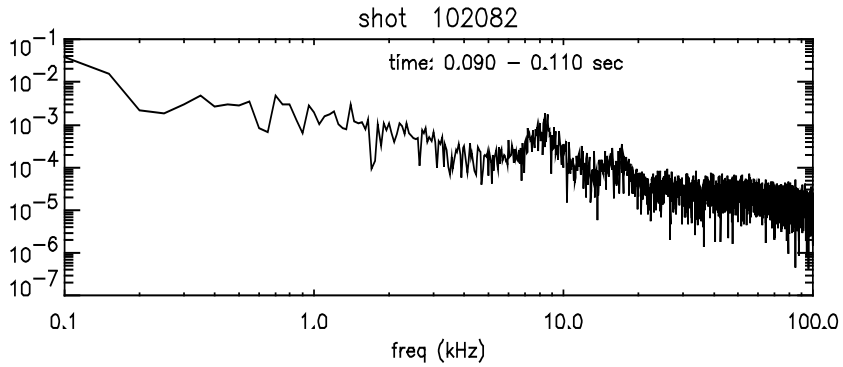
- Current < 50kA: MHD activity is localized in outer bottom
- Current >100kA: MHD activity more uniform except for outboard

Low frequency (9kHz) coherent mode only during high current phase (H. Ji)

NSTX

- Mode only in outer Mirnov's





Near term objectives

- Extend CHI produced toroidal current to 200kA
- Improve vertical position control
- Extend discharges to vessel pressure < 0.5mTorr
- Improve flux closure at higher current
- Initiate experiments on "Ohmic + CHI"

Summary

- Obtained 20kA injector current for ~ 500V applied
- Obtained 130kA toroidal current
- Obtained current multiplication up to 10
- Produced stable high current, long pulse (130ms) discharges
- Demonstrated discharges at 1mTorr
- No fundamental difficulty in applying CHI to a large plasma device

Future Objectives

- Use NBI for heating and current drive
- Increase toroidal current to 500kA
- Optimize "Ohmic + CHI" and produce CHI target for Ohmic