# Status of Coaxial Helicity Injection (CHI) Experiments in NSTX*

R. Raman[1], T.R. Jarboe[1], D. Mueller[2], M.J. Schaffer[3], R. Maqueda[4], B.A. Nelson[1], D. Gates[2], M. Bell[2], R. Bell[2], R. Ewig[1], E. Fredrickson[2], J. Hosea[2], S. Jardin[1], H. Ji[2], R. Kaita[2], S.M. Kaye[2], H. Kugel[2], L.Lao[3], B. Leblanc[2], R. Maingi[6], J. Menard[2], M. Ono[2], D. Orvis[1], F. Paoletti[5], S. Paul[2], M. Peng[6], S. Sabbagh[5], C.H. Skinner[2], J.B. Wilgen[6], S. Zweben[2]
and the NSTX Research Team

[1] *University of Washington, Seattle, WA*
[2] *Princeton Plasma Physics Laboratory, Princeton, NJ*
[3] *General Atomics, San Diego, CA*
[4] *Los Alamos National Laboratory, Los Alamos, NM*
[5] *Columbia University, New York, NY*
[6] *Oak Ridge National Laboratory, Oak Ridge, TN*

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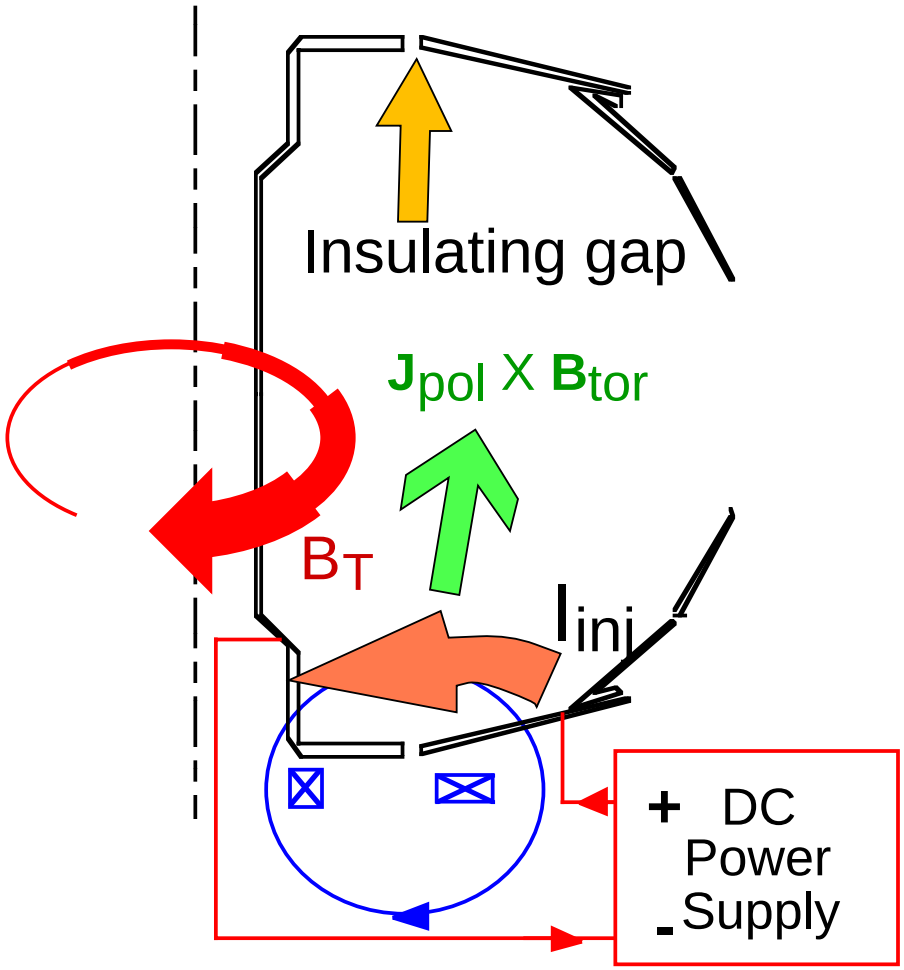
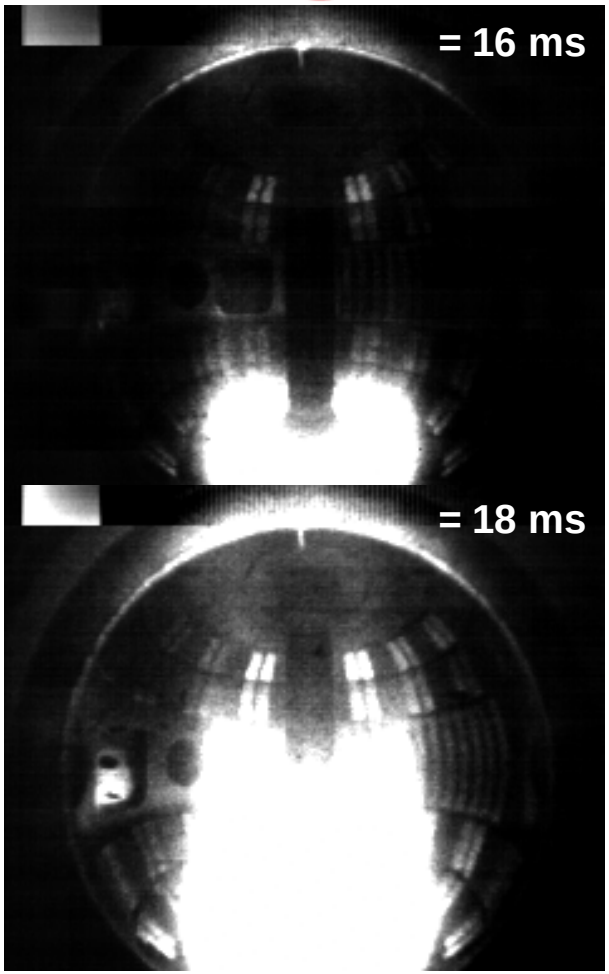
# Non inductive current initiation needed for STs

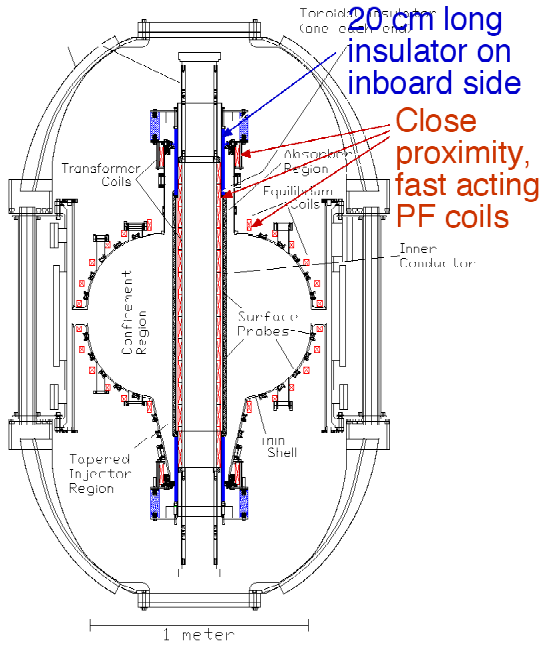

- Demonstrate non-inductive creation of target plasma
- Sustain target plasma by providing edge current drive
- Reduce poloidal flux swing of transformer

# Co-axial electrodes inject helicity in to the ST vessel, reconnection processes convert open flux to closed surfaces



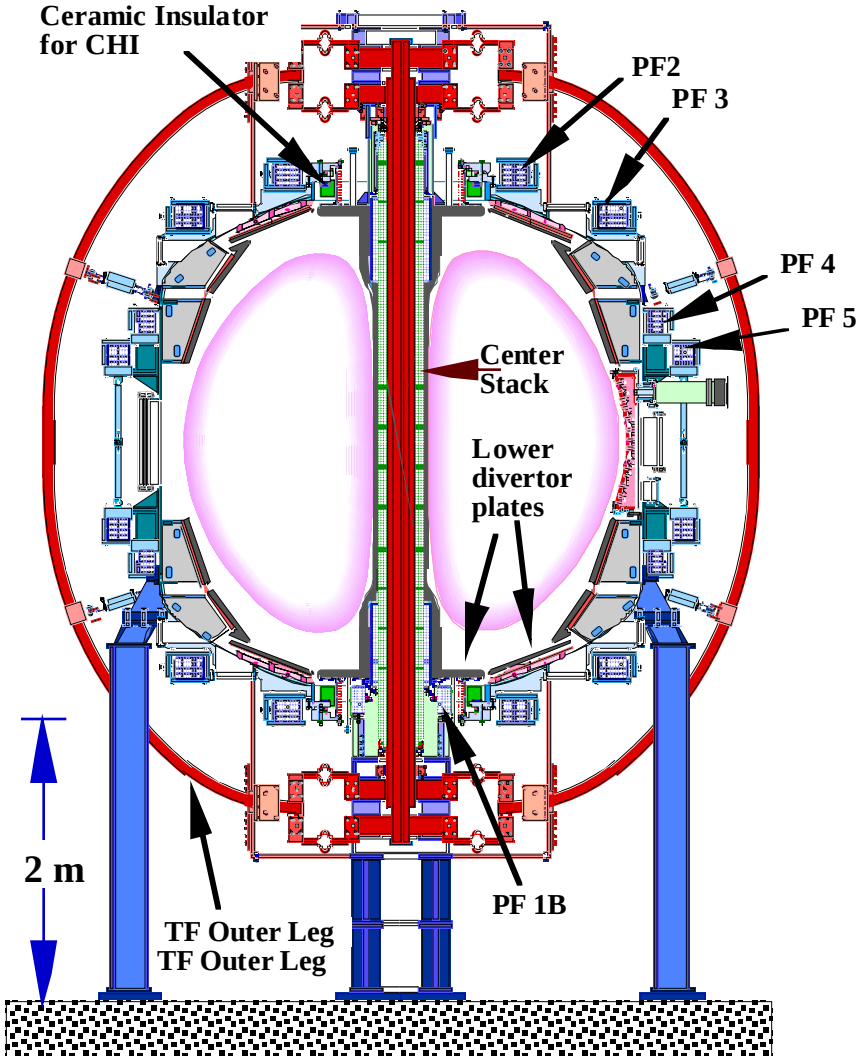



# NSTX builds on progress made on HIT device

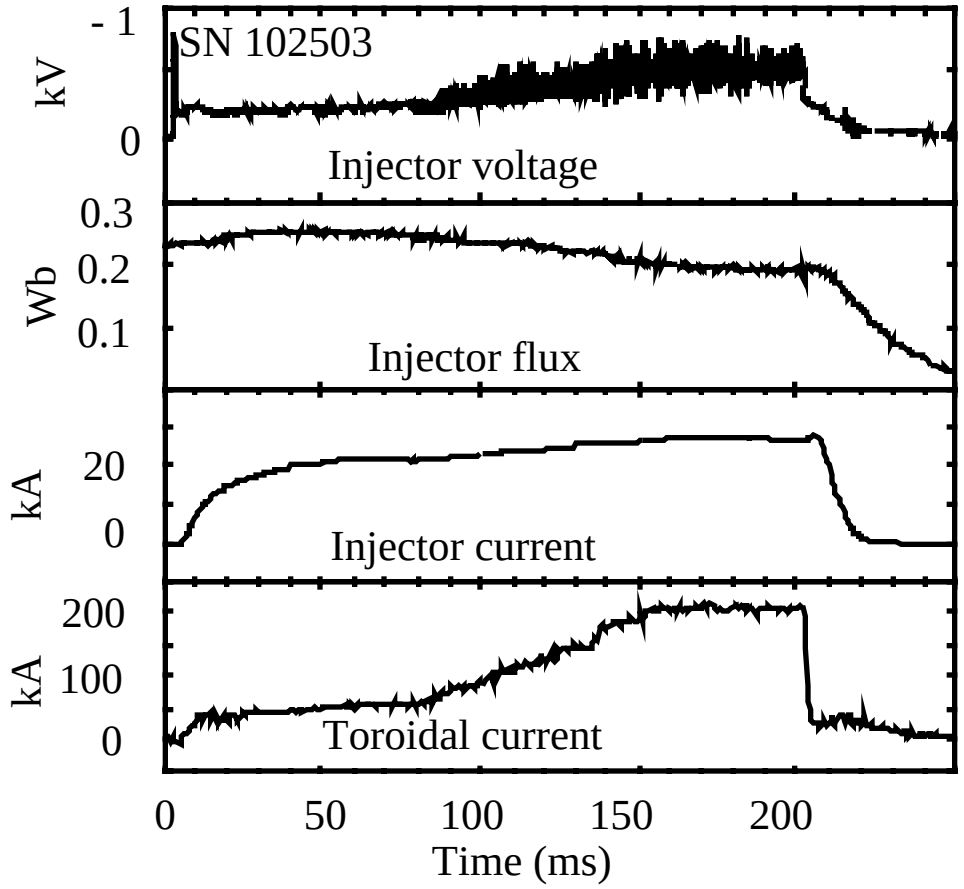


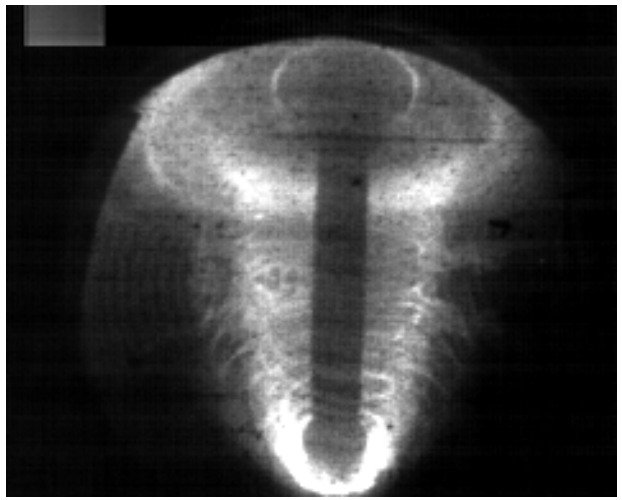

x 30 volume →

NSTX pulse length much longer (x 20)



# Steady-state 200kA toroidal current generation demonstrated (FY 00 milestone)



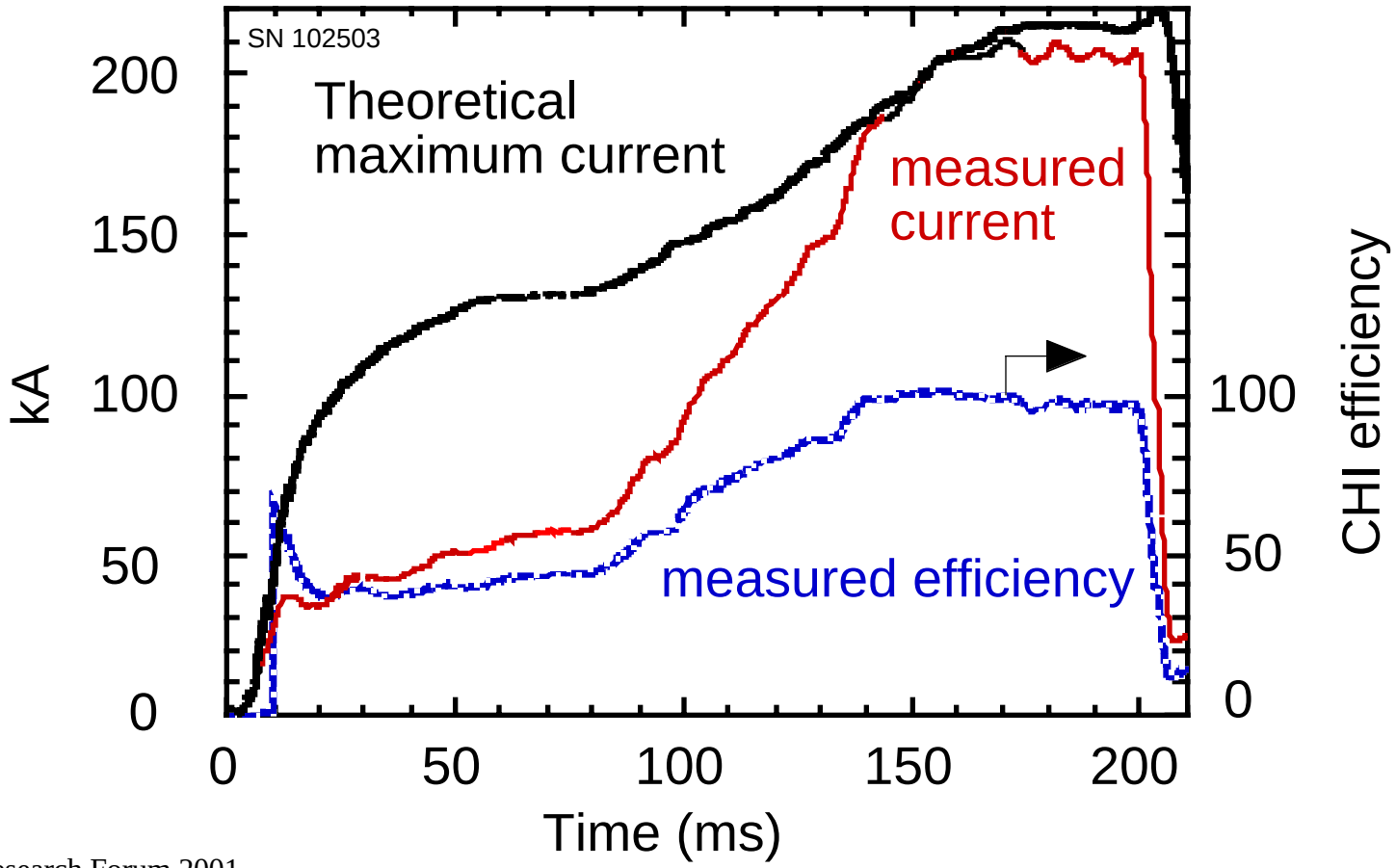
ast camera image

- Start with high injector flux
- Reduce injector flux
- Increase injector voltage

260kA obtained with 26kA injector current in 170ms pulse

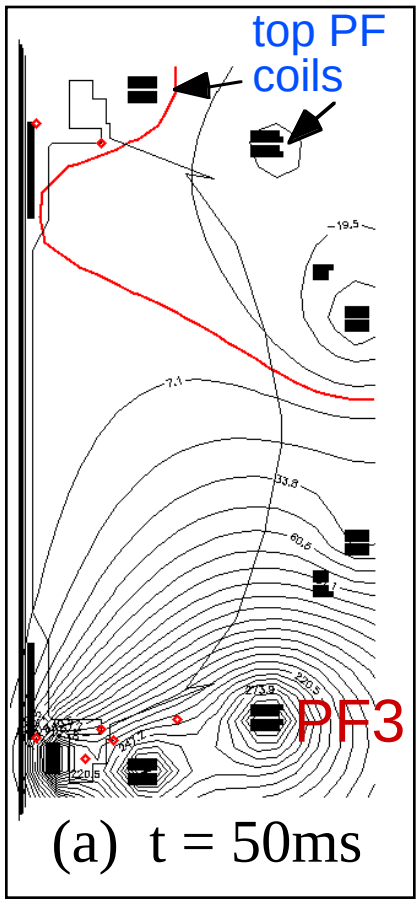
# Measured $I_{toroidal}$ approached theoretical maximum

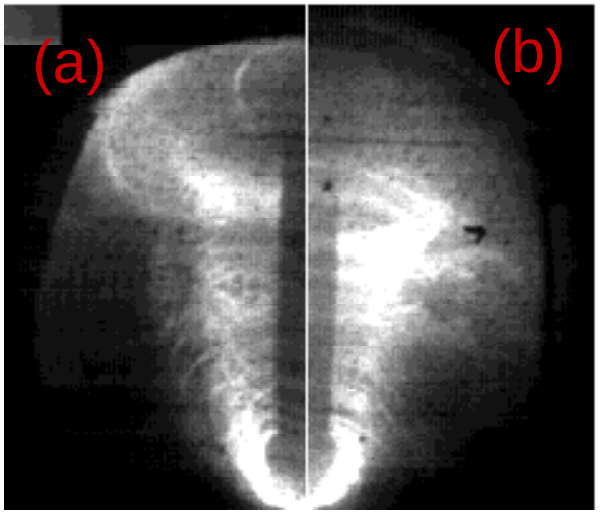
The maximum current is calculated as $(\Psi_{toroidal}/\Psi_{inj})*I_{inj}$ and is a measure of the amount of injector flux that couples to the ST



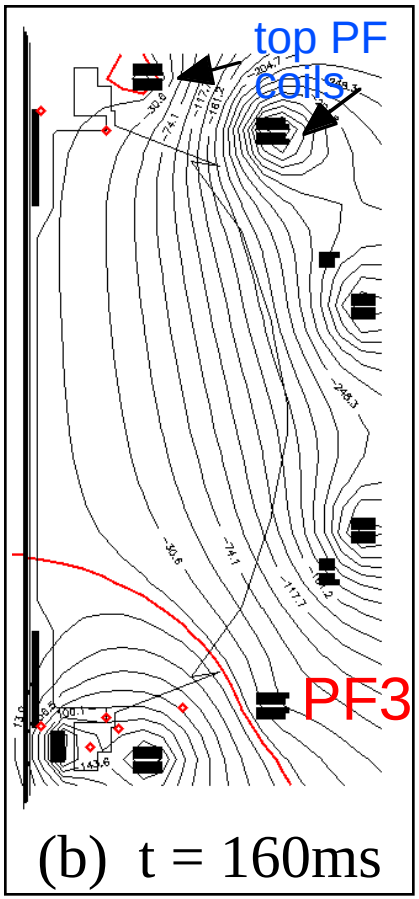
# Generation of configurations to increase flux closure

High current configuration ⟶ Preferred configuration




- Reverse current in PF3
- Increase current in top PF coils
- Increase vertical field

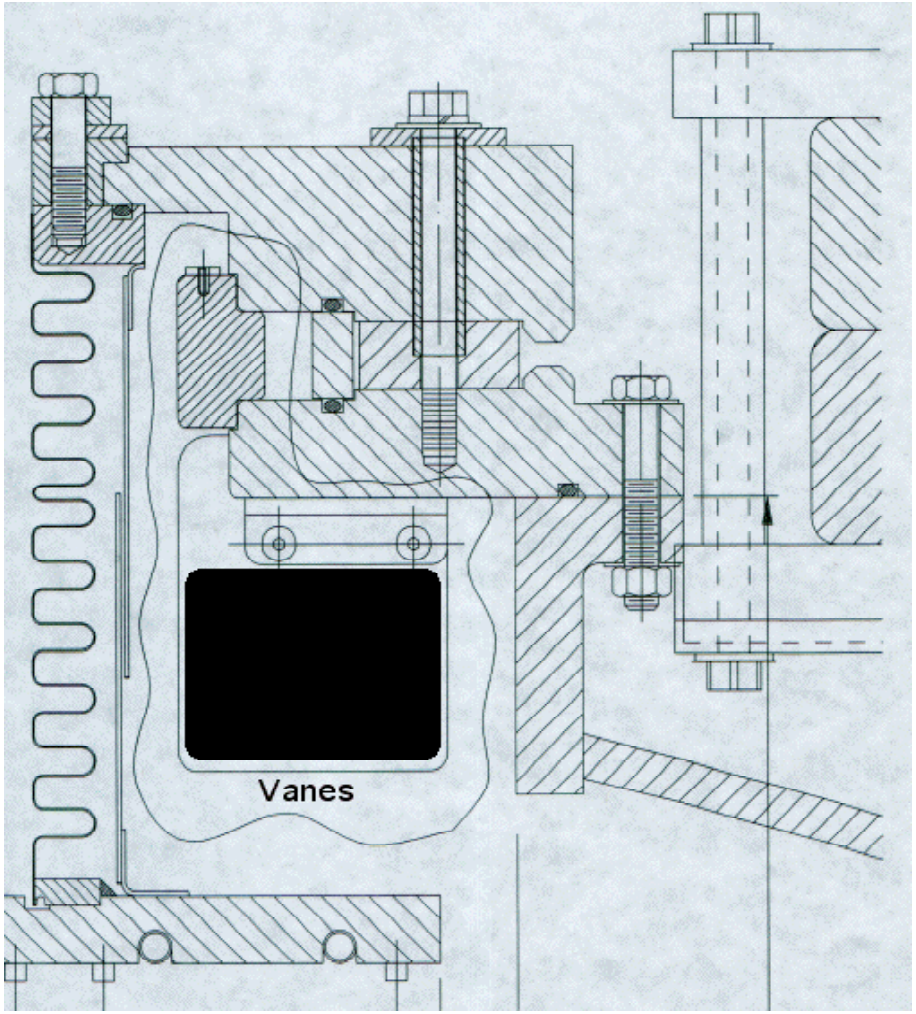


# Recent Hardware improvements to suppress absorber acs

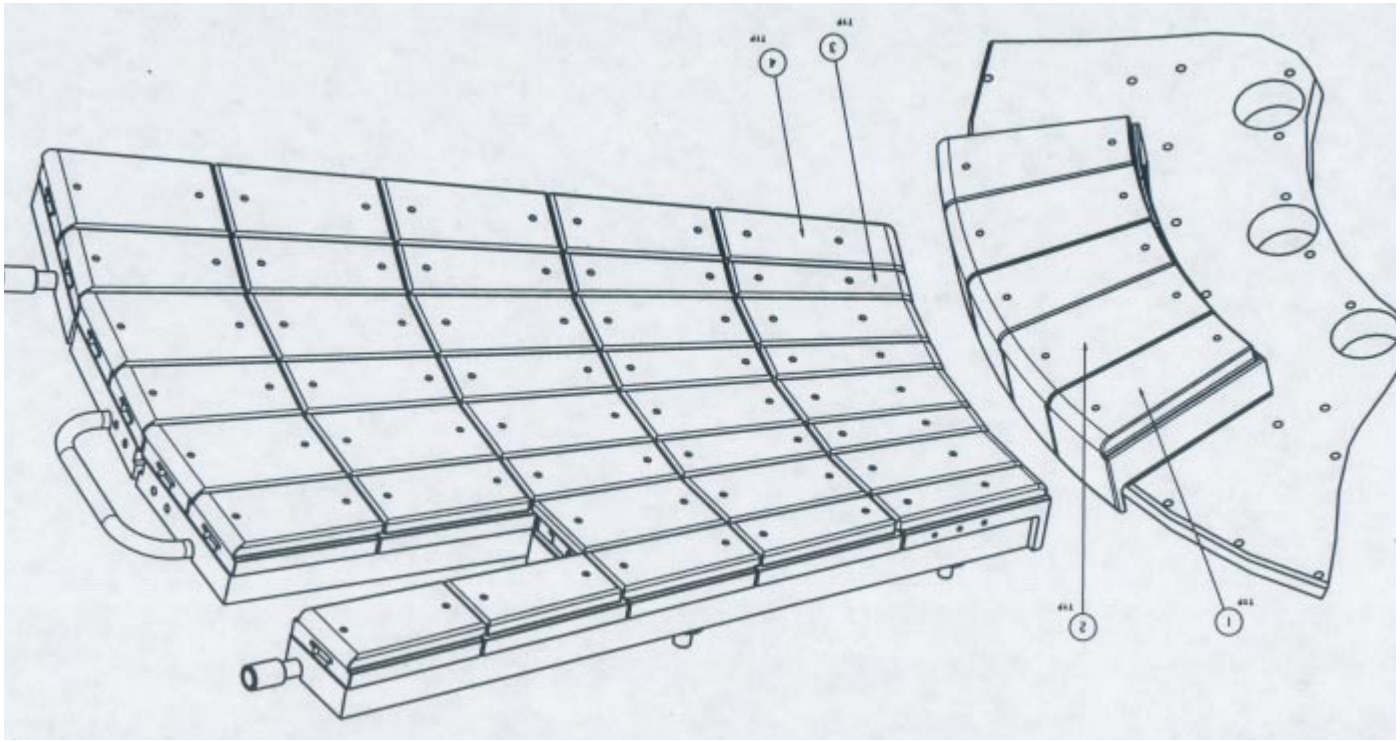
Many shots ended in absorber arcs

- Freewheeling diode across inductor (C. Neumeyer and others)
- Divertor tile extension (M. Williams and others)
- Installed Boron Nitride Vanes (M.Schaffer, D. Mueller)
- Redesigned absorber shield (D.Gates and others)

# Vanes (M. Schaffer, GA and D. Mueller, PPPL)



# Divertor tile extension (M. Williams, PPPL)



# Hardware improvements being studied

- PF1A Bipolar for improved absorber field nulling
- TF voltage arc detector
- Fast neutral pressure gauges
  - New field nulling coils for absorber
  - Insulator on inboard side (as on HIT-II)
  - Long insulating cylinder for injector

# Summary


- CHI produced 260kA toroidal current
- Obtained CHI injector current multiplication of 10 at 26kA
- Produced non inductive, long pulse (200ms) discharges
- Sustained discharges at 1mTorr vessel neutral pressures. NSTX ohmic discharges operated at similar vessel neutral pressures.

- There is no fundamental difficulty in applying CHI electrical systems to a large plasma device.

# FY 01 Plans


- Establish flux closure
- Test OH induction on a high current CHI discharge
- Test CHI edge current on an OH discharge

- EFIT with open field line currents in private flux region
- Reduce absorber arcs
- Initiate feedback control tests

# Status of diagnostics


**Fully functioning diagnostics**

- Fast Camera (Ricky Maqueda, LANL)
- Bolometer profiles (Steve Paul, PPPL) -need other diagnostics for comparison of results
- Thomson temperature and density (B. Leblanc, R. Bell, PPPL)
- Spectroscopy (C.H. Skinner, PPPL, R. Maingi, ORNL) -systematic studies to begin in FY 01
- Mirnov coils (J. Menard, PPPL)

**Under development**

- 2mm Interferometer (R. Kaita, PPPL)
- Edge probing studies (H. Ji, S. Zweben, PPPL, J. Boedo, UCSD) - partial probe design and implementation underway.
- MSE (F. Levinton, Nova Photonics) -will become essential in FY 02
- Far-InfraRed Interferometer (N. Luhmann, B. Deng, UCSD)

# Status of analysis

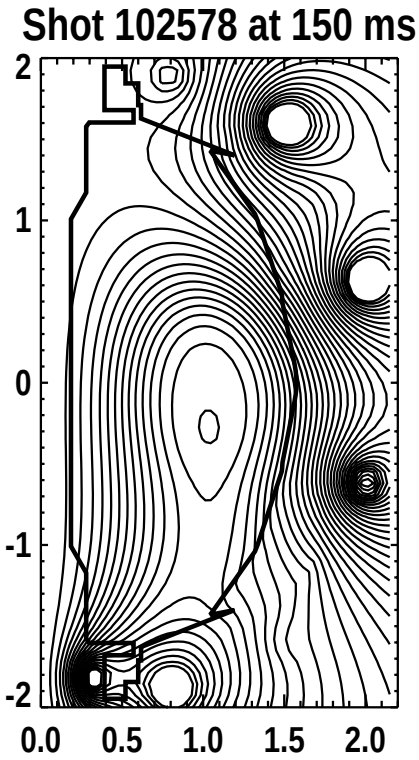
MFIT (Mike Schaffer, GA) - useful during operation

EFIT (Lang Lao, Mike Schaffer, GA and S. Sabbagh, F. Paoletti, Columbia Univ.) - - Simulations possible, work in progress to include more current on open field lines and private flux region. Essential for flux closure assessment.

TSC Simulations (Steve Jardin, PPPL) - Simulations possible, work in progress pending creation of CHI discharges that show good flux closure from EFIT.

MHD mode analysis (H. Ji, E. Fredrickson, PPPL and B.A. Nelson, Univ. of Washington) - Need higher current CHI plasmas with increased elongation.

# EFIT Runs With Thick SOL Current in CHI Discharges




- EFIT CHI results in CY 2000:
  - EFIT can be run with force-free current in a thick SOL (halo).
    - E.g. out to 2nd X-point in this example.
  - EFIT gets good fits to magnetic data, but the equilibrium is still far from converged when closed flux is small.
  - Under these uncertain circumstances, EFIT sometimes returns fits with small closed flux regions.