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ET for solenoid-free plasma startup

Roger Raman, Michael Bell

University, of Washington,
Princeton Plasma Physics Laboratory

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Milestone FY06-2 on Solenoid-free Startup and Sustainment:

"Test conditions for solenoid-free ramp-up of plasma to high pressure relative to plasma-generated magnetic field pressure. (September 2006)"-

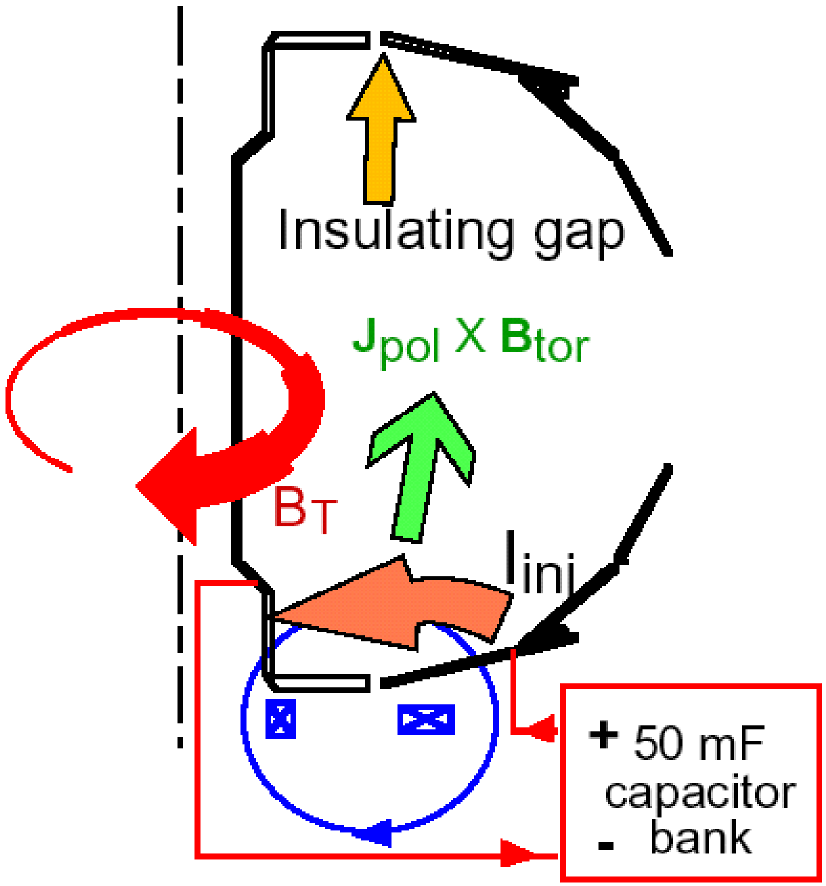
– The currents driven by the plasma pressure gradient, neutral beam injection, radiofrequency waves, and coaxial helicity injection will be combined with the intrinsic electromagnetic induction produced by the external equilibrium control coils, to increase the total plasma current beyond that achieved in the research towards Milestone FY04-4. The current will be increased without adding inductive flux from the central solenoid. High values of poloidal beta (that is, the plasma pressure divided by that of the magnetic field produced by the plasma current), substantially above 1, will be required to achieve in future experiments on NSTX an effective transition from this discharge to a fully non-inductive high-performance ST plasma, such as would be required for an ST-based CTF or power plant. In addition, CHI edge current drive will be applied to these plasmas to beneficially contribute to the edge current profile and to favorably modify edge plasma flows.

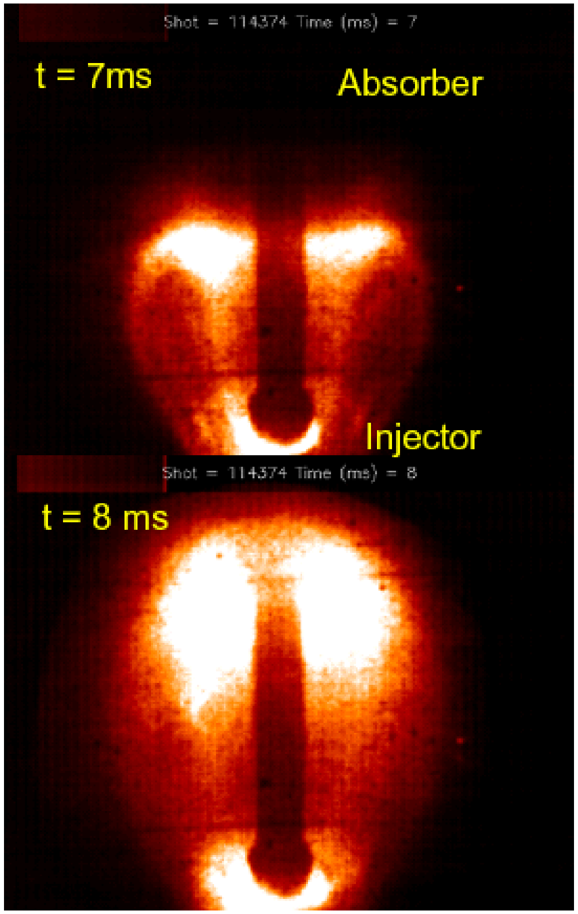
Research areas in solenoid-free plasma startup

- Plasma startup by CHI
- Edge current drive by CHI
- Steady-state CHI

- Outer PF and RF startup

Implementation of Transient CHI

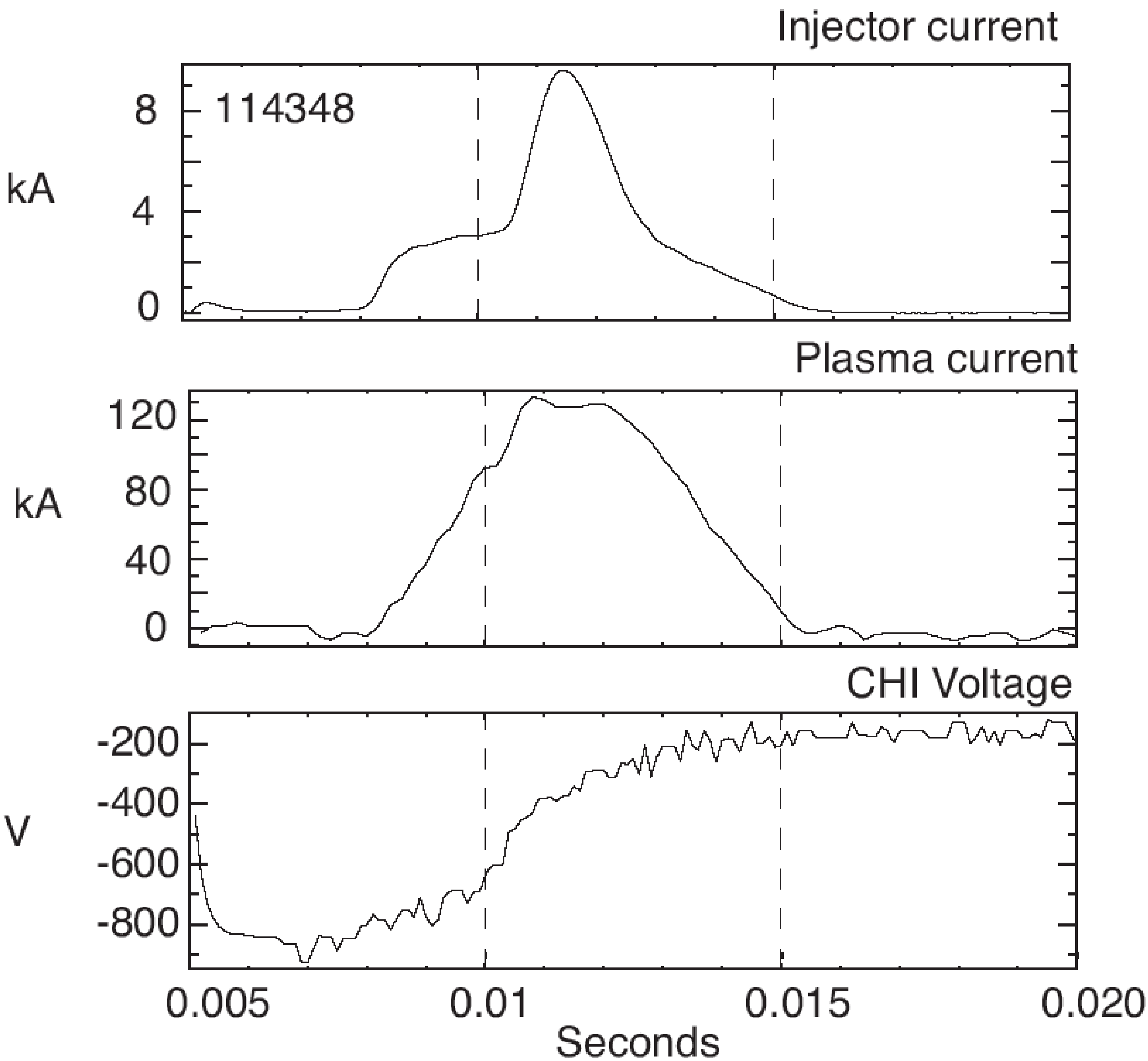


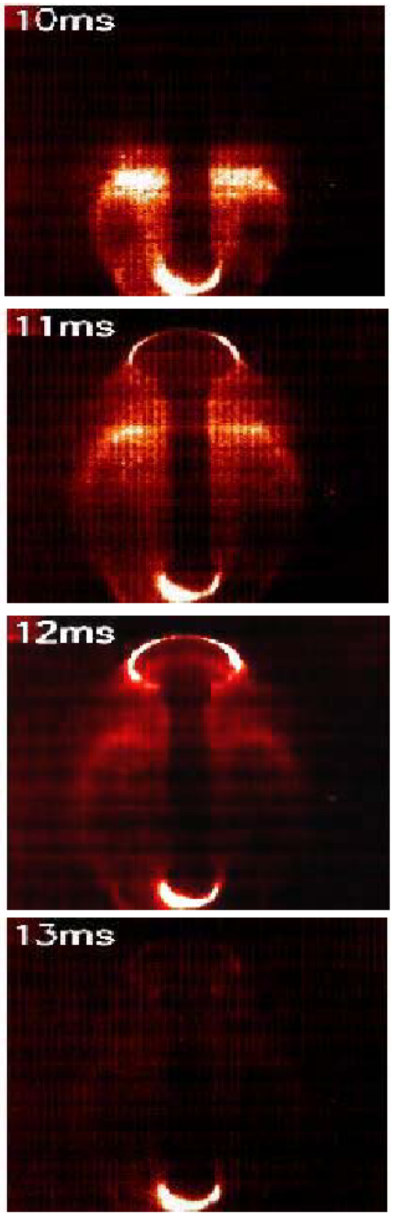


Expect axisymmetric reconnection at the injector to result in formation of closed flux surfaces

Fast camera: C. Bush (ORNL)

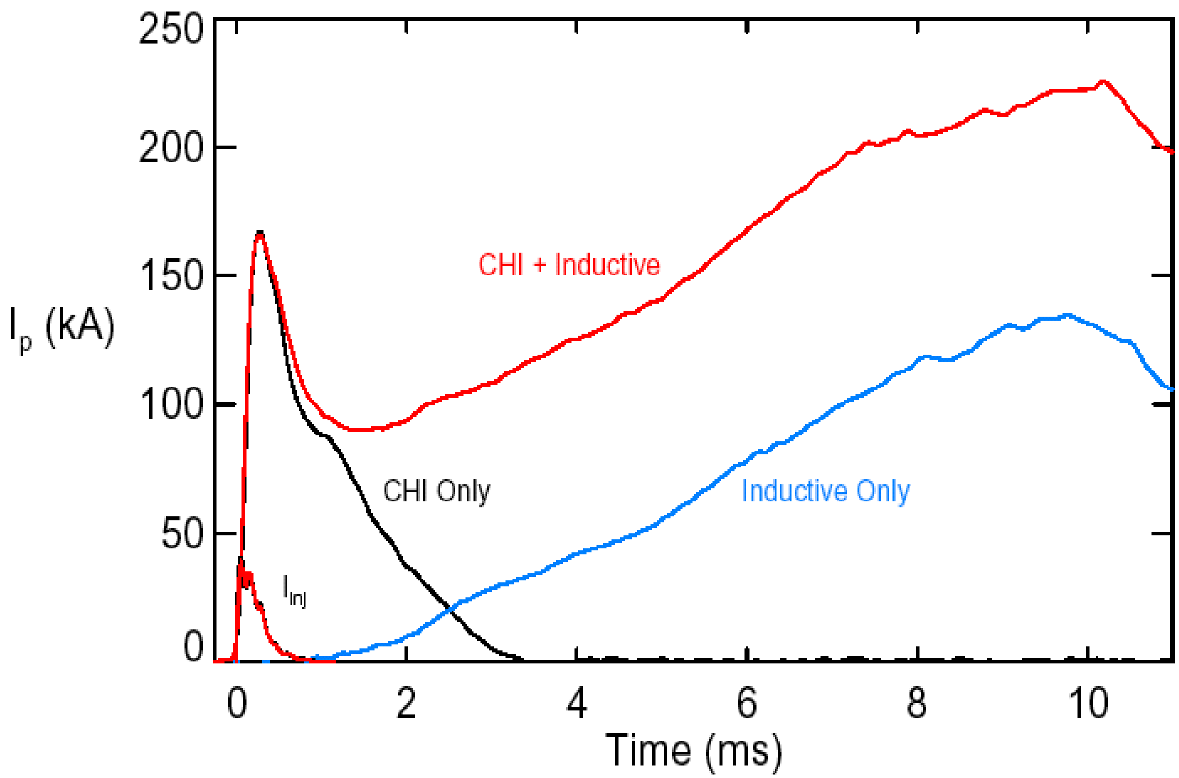
Initial transient CHI discharge in NSTX



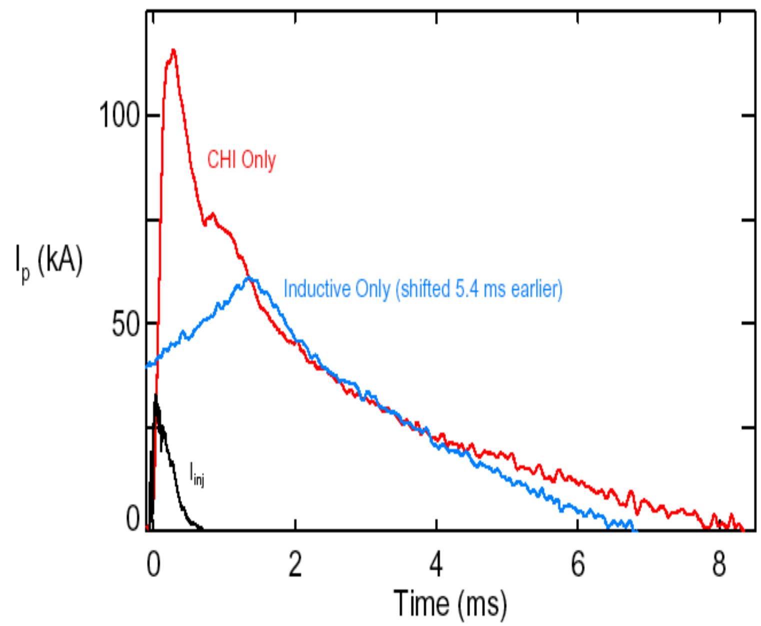


Current persistence not yet observed

A CHI startup plasma has sufficient quality to be ramped up by induction. The startup discharge was produced with CHI followed by relaxation on HIT-II.

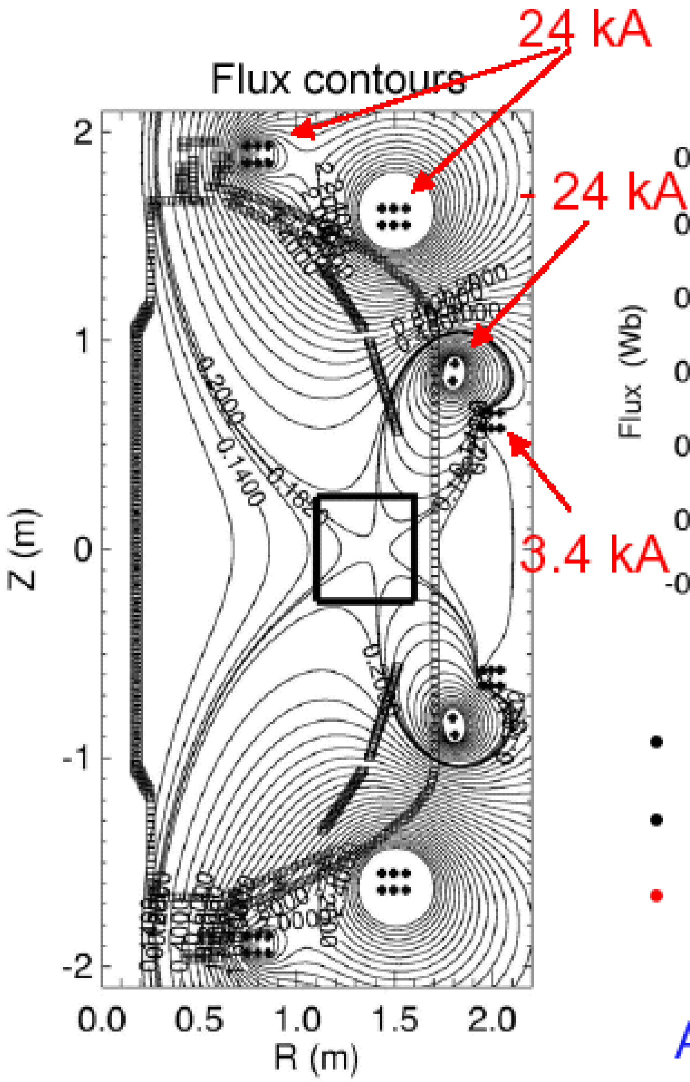


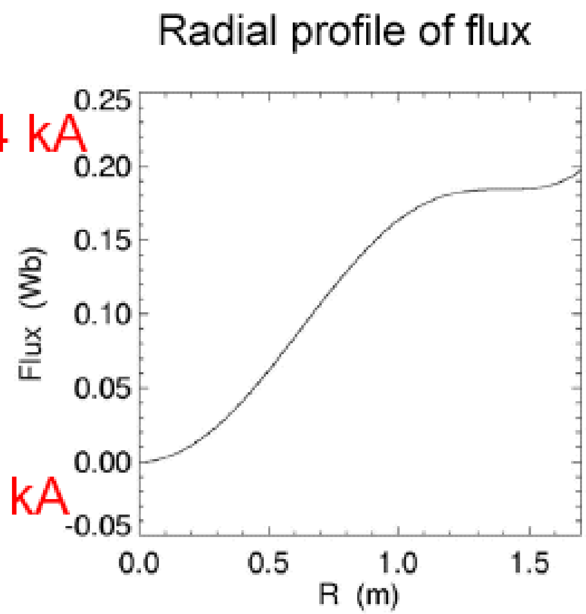
Both discharges (CHI + induction and induction-only) have identical loop voltage programming

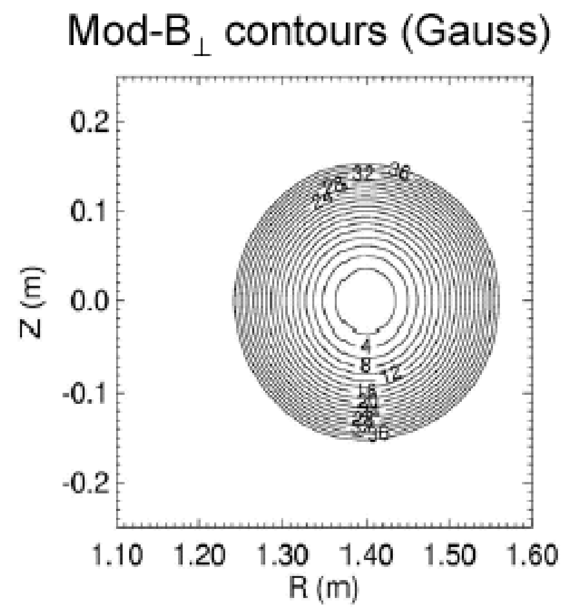


The CHI discharge has the same current decay time as the inductively produced discharge

An outside plasma startup scenario that uses PF 4



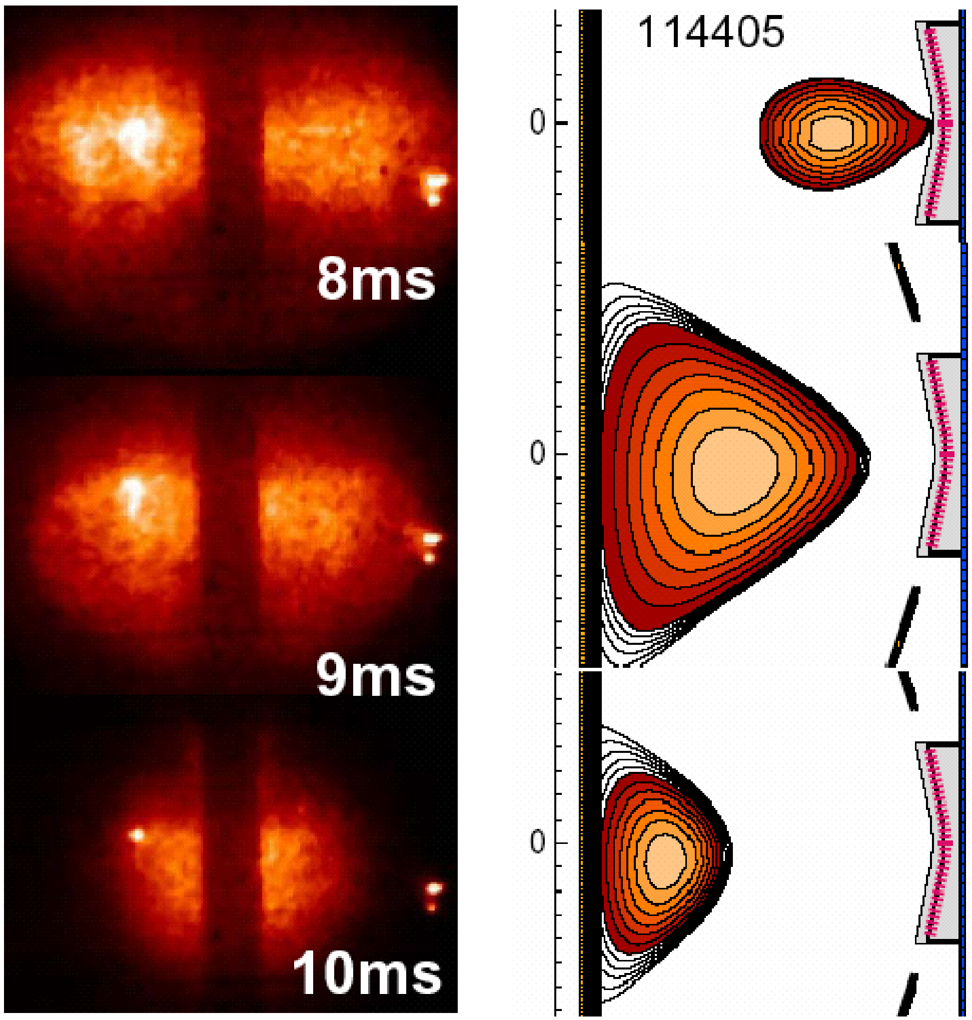




- ~0.15 Vs available on NSTX
- NSTX obtained 1 MA with ~ 0.3 V-S OH
- Suggest possibility of up to ~ 500 kA in NSTX

Analysis by W. Choe: Null-B code

Plasma images and EFIT show plasma is born on inboard side and has a radial inward trajectory



- LRDFIT code used for reconstructions
  - $I_{Vessel} \approx 10 \times I_P$
- Careful control of B_Z after breakdown helped raise I_P from 10kA to 20kA
- More B_Z evolution optimization possible

J. Menard et al. (PPPL)

Agenda - Wed. September 22 in B252: Time: 1pm to 5:30pm

Time	Speaker	Title
1-1:10	Introduction	
1:10-1:25	J. Menard	Increased plasma current using PF-only startup
1:25-1:40	V. Soukhanovskii	Supersonic gas jet fueling of the non-inductive plasma start-up phase
1:40-1:55	R. Raman	Transient CHI Startup
1:55-2:10	Break	
2:10-2:25	D. Mueller	Edge current drive
2:25-2:40	A. Redd	Low-TF Steady-State CHI Discharges in NSTX: Toroidal Current and Poloidal Flux Buildup By Magnetic Relaxation
2:40-2:55	X. Tang	CHI simulations with CHIP
2:55-3:10	C. Sovenic	CHI simulations with NIMROD
3:10-3:25	M. Ono	Outer PF startup
3:25-5:00	Group	Discussion
5:00-5:30	Group Leaders	Prepare summary