A Proposal for Startup of NSTX without using the OH coils

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NSTX Research Forum

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Outline

- Motivation
- Calibration of TSC on NSTX (including CHI)
- Method #1…plasma OH
- Method #2…S-1 revisited
- Method #3…Outboard Layering
- Summary and Future Work

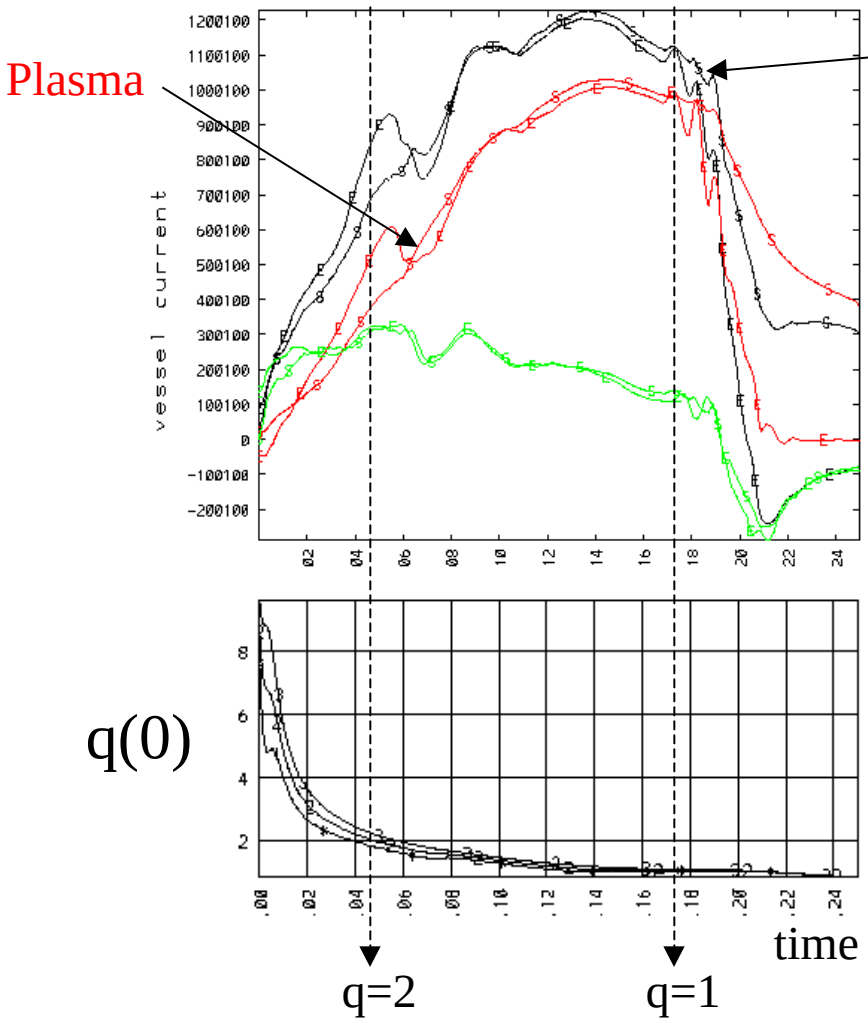
Motivation

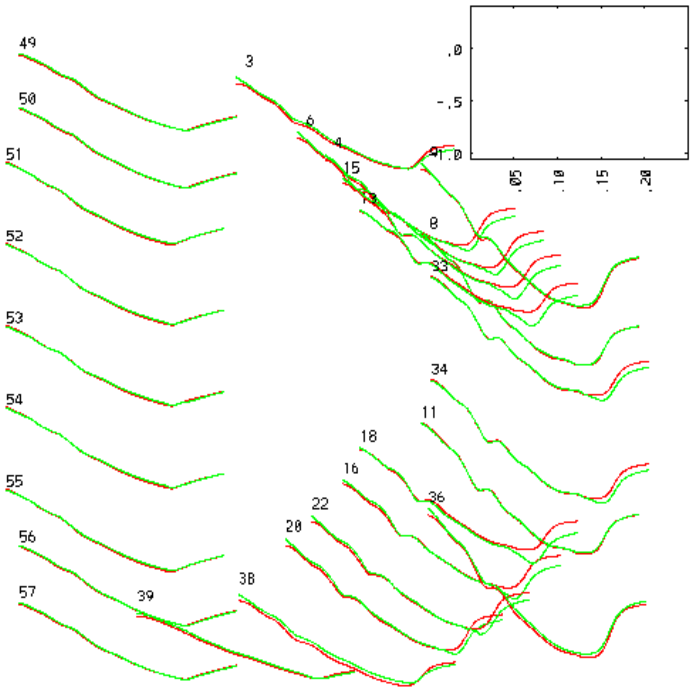
- If NSTX could demonstrate ST startup without using the OH coil, it would greatly increase the perceived attractiveness of the ST as a fusion concept

- CHI startup still needs to be demonstrated for large configurations with long timescales
  - May not be feasible in NSTX

- Bootstrap overdrive + RF current drive is predicted to require high toroidal fields and long times
  - May not be feasible in NSTX

Shot 101522--comparison of TSC results <u>using measured coil currents</u> with data



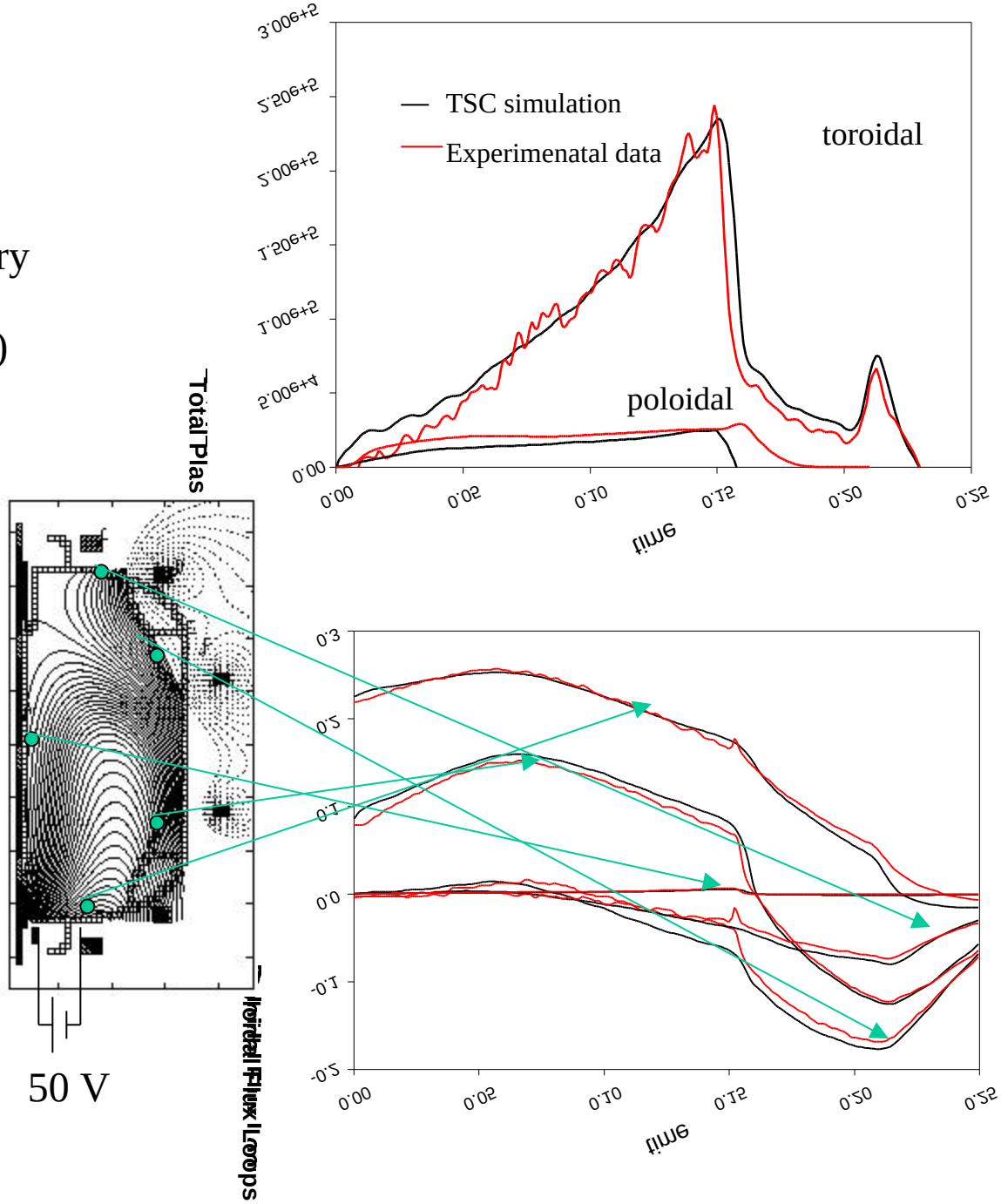


Comparison of flux loop values:
green…TSC simulation
red….Experiment

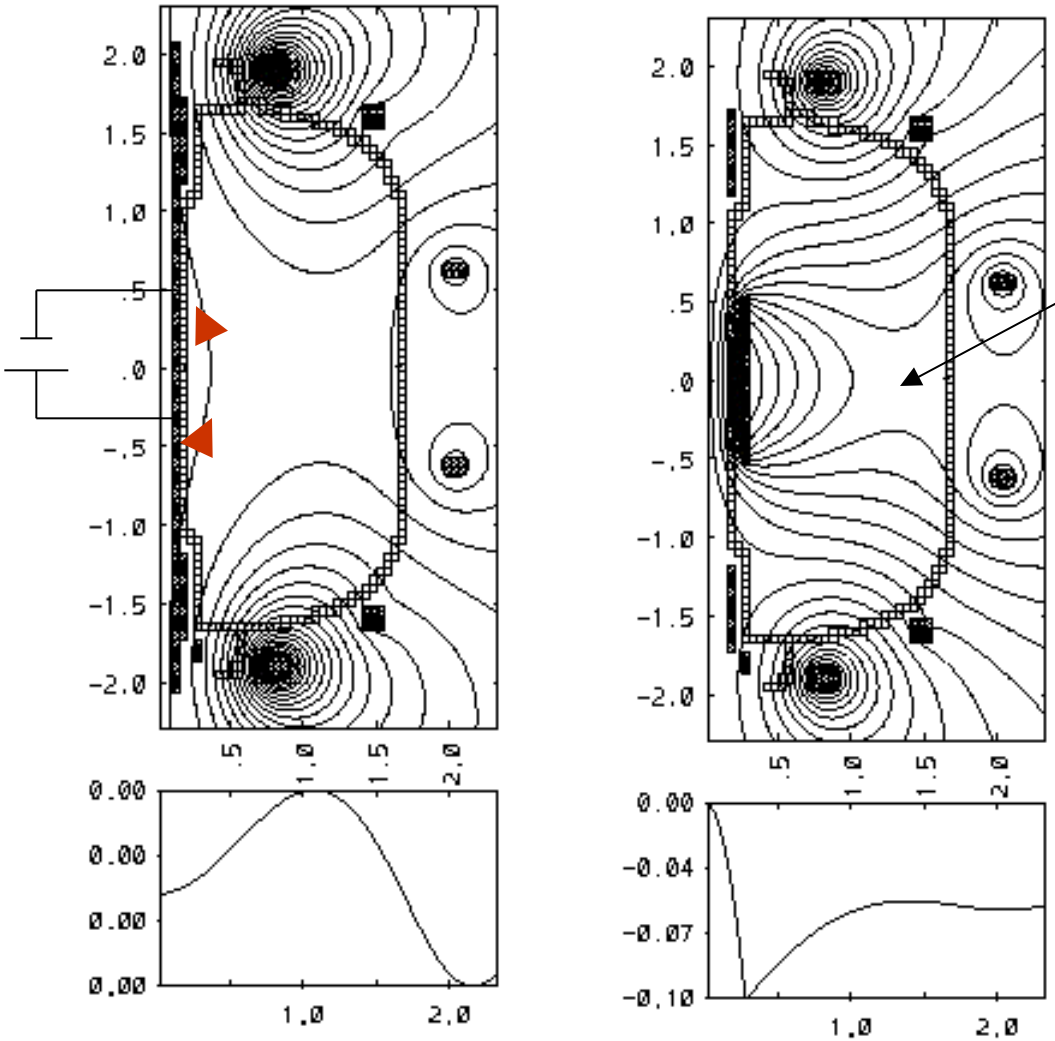
Add slide

TSC simulation of SN 102578

- Plasma resistivity given as a function of flux and time to try and match data: $\eta(\psi,t)$
- (varies between 4 and 15 ev)
- Calculation uses actual experimental coil current values
- Constant voltage of 50V applied between vessel gap
- TSC then evolves system in time by solving 2D MHD equations using realistic geometry and boundary conditions.
- Better fit is possible with more effort

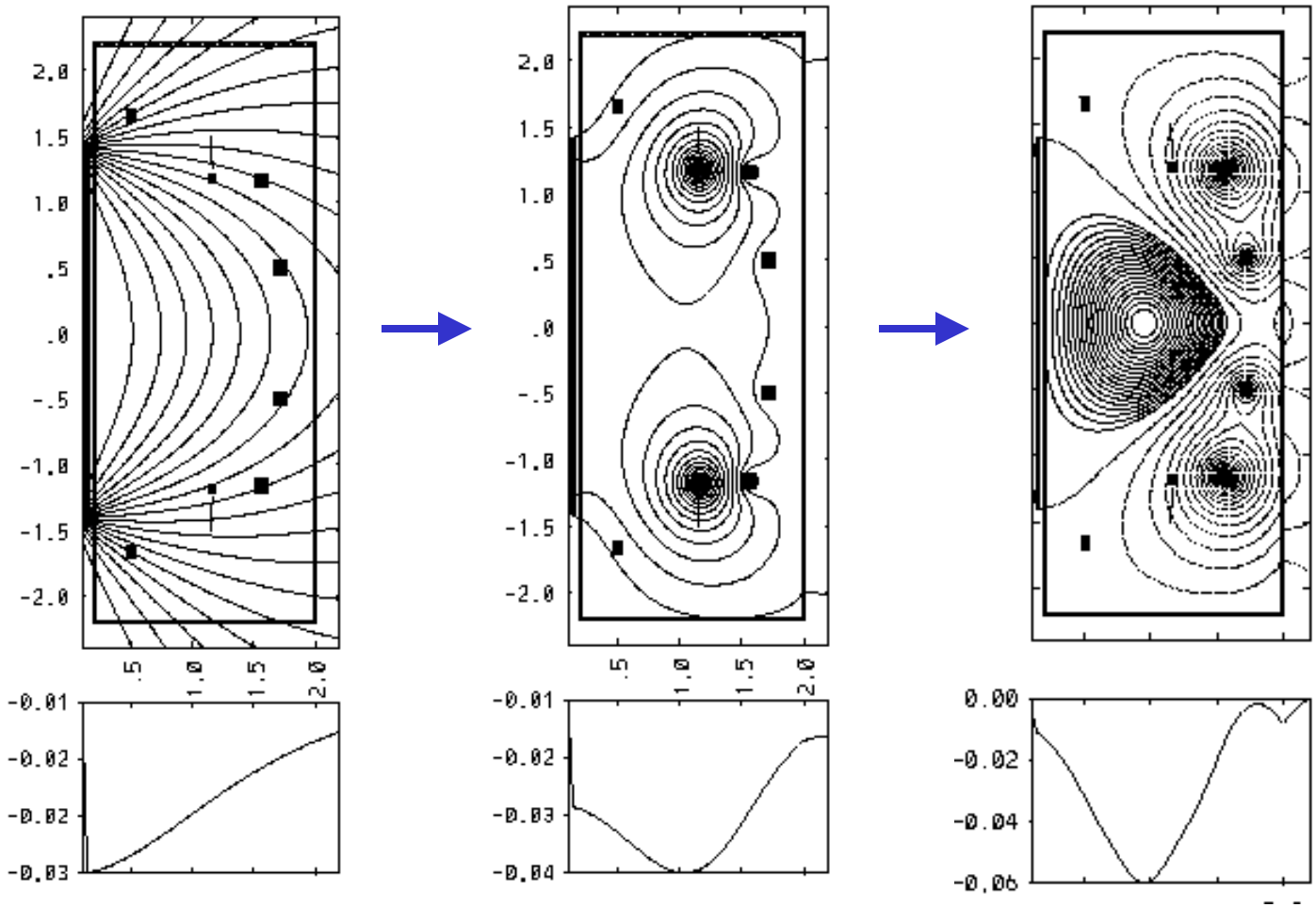


- Method #1…plasma OH

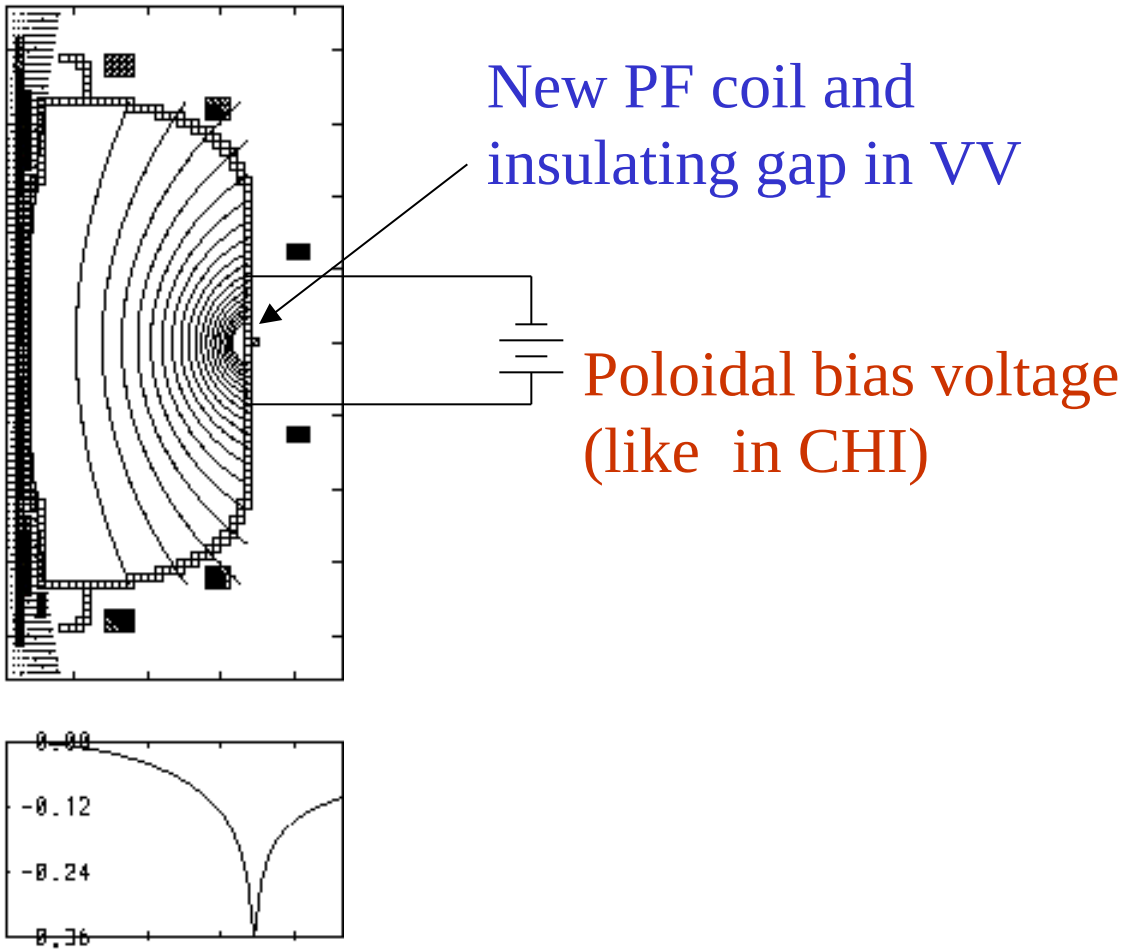


Plasma forms in field null region here when plasma OH discharge is suddenly stopped

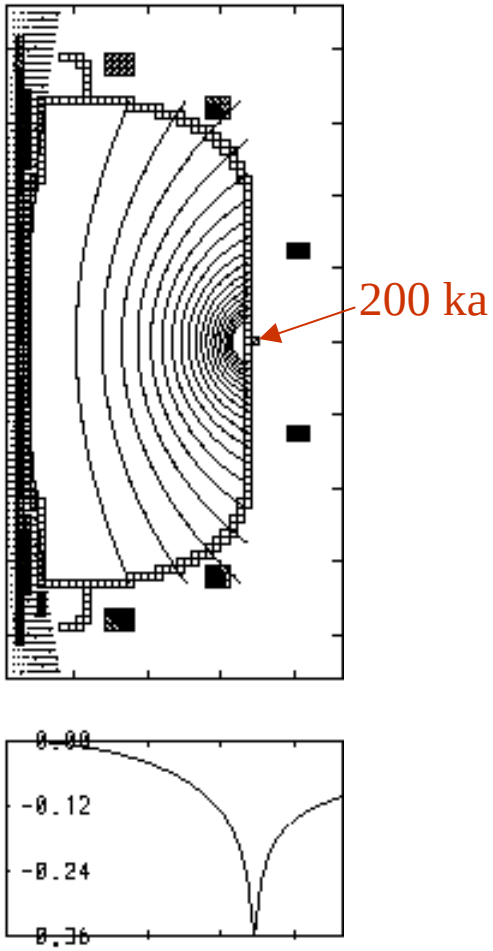
Method #2…S-1 revisited (like MAST)



Method #3 …Outboard Layering

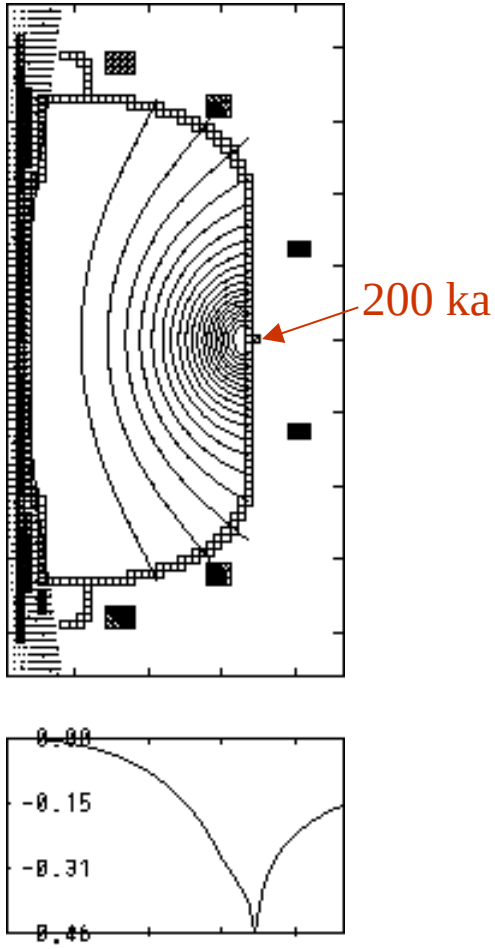


$I_P = 0$



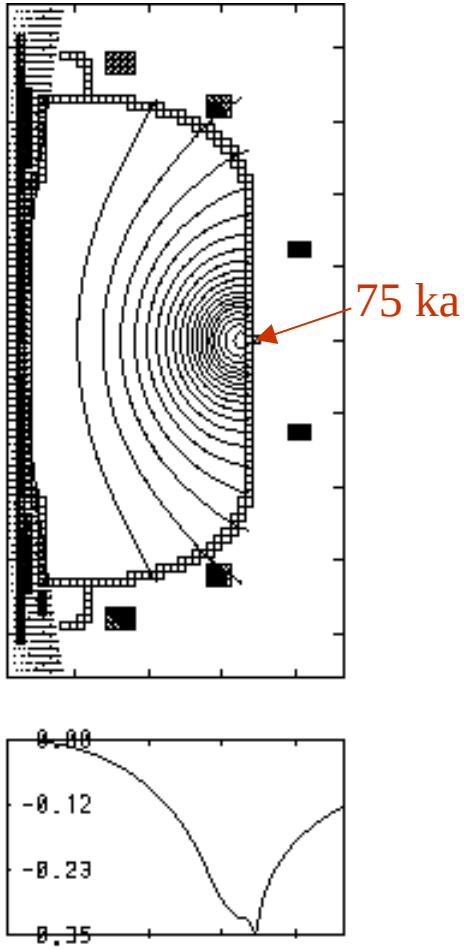
t = 0

$I_P = 158$ kA



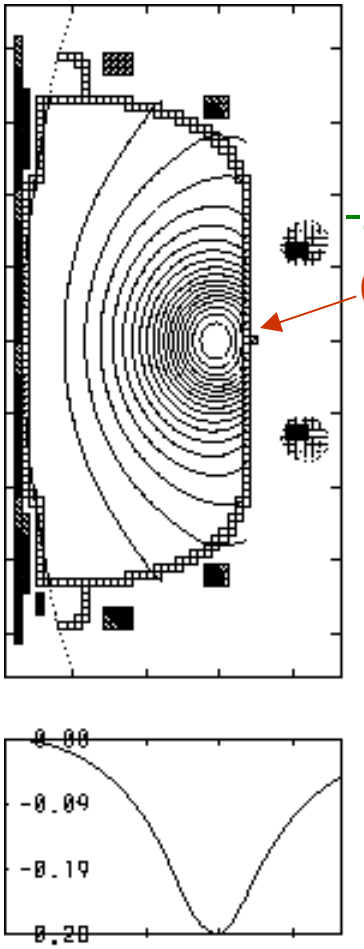
t = 58 ms

$I_P = 288$ kA



t = 78 ms

I_P = 491 kA

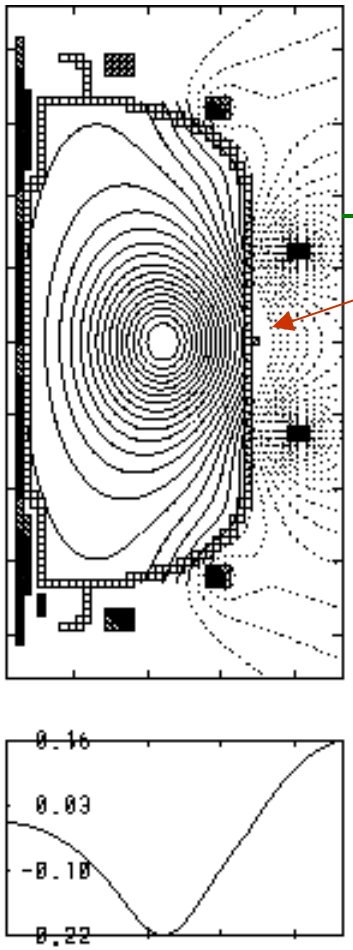


-220kA

0 ka

t = 102 ms

I_P = 1091 kA

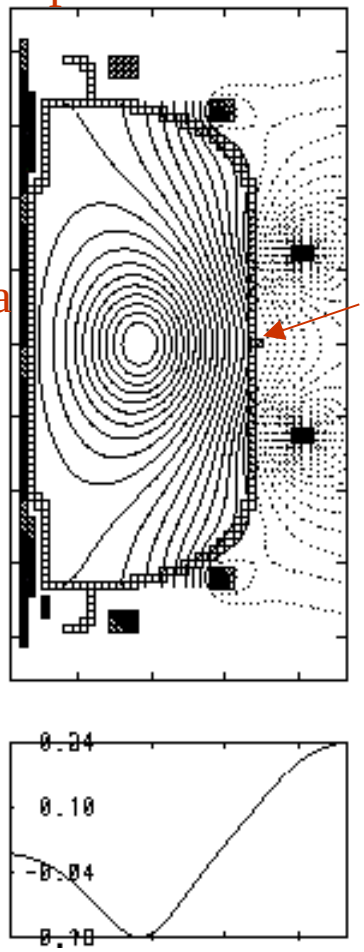


-600kA

-140 ka

t = 147 ms

I_P = 1268 kA



-600kA

-150 ka

t = 183 ms

Summary and Future Directions

- The “baseline” methods of bootstrap overdrive and CHI startup may not be feasible in NSTX
- OH plasma method needs to be evaluated with TSC. May not be able to get high enough initial current in “plasma OH”
- S-1 (or MAST) method will work. Needs simulations to optimize. Would require new internal coils.
- Outboard layering method holds much promise. Needs much more simulation work to understand tradeoffs, optimal structure for electrodes, voltage requirements, etc.