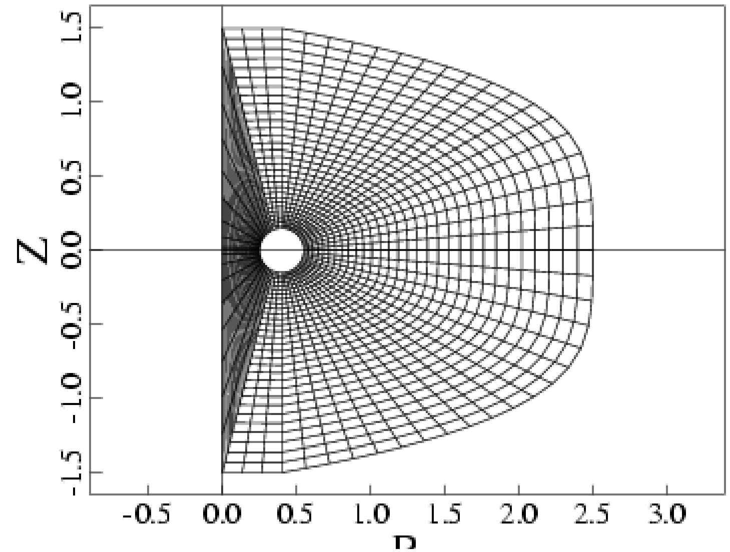
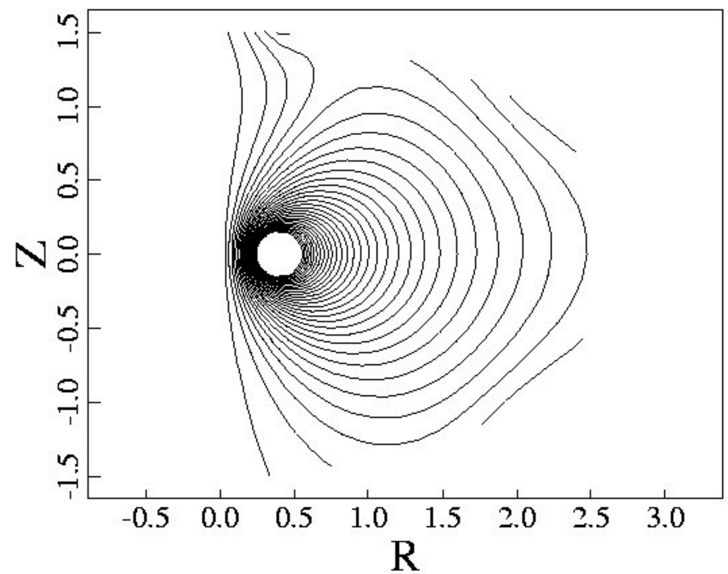
Summary of NIMROD Alternates Modeling 4/24/04

- SSPX: there are now 3 active NIMROD users in the LLNL group (B. Cohen, R. Cohen, and B. Hooper). G. Cone and C. Sovinec at UW.
- LDX: J. Kesner (MIT) is investigating MHD-driven convective cells.
- MST: J. Reynolds (UW) is modeling PPCD.
- HIT-SI: V. Izzo is investigating whether the initial hardware setup is capable of generating spheromaks.

LDX Simulation (Kesner)

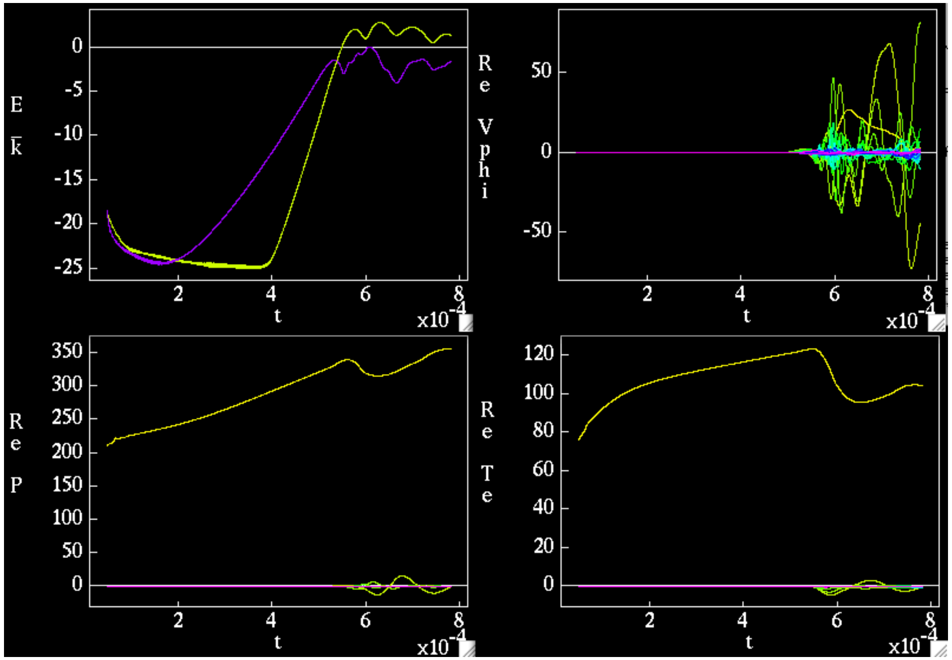
- The objective is to study convective cells in realistic geometry.
- Computational mesh wraps around the levitated coil.
- Vacuum field distribution based on external coils.
- Symmetric heating is applied outside the coil—anisotropic thermal conduction spreads energy over an annular region around the coil.

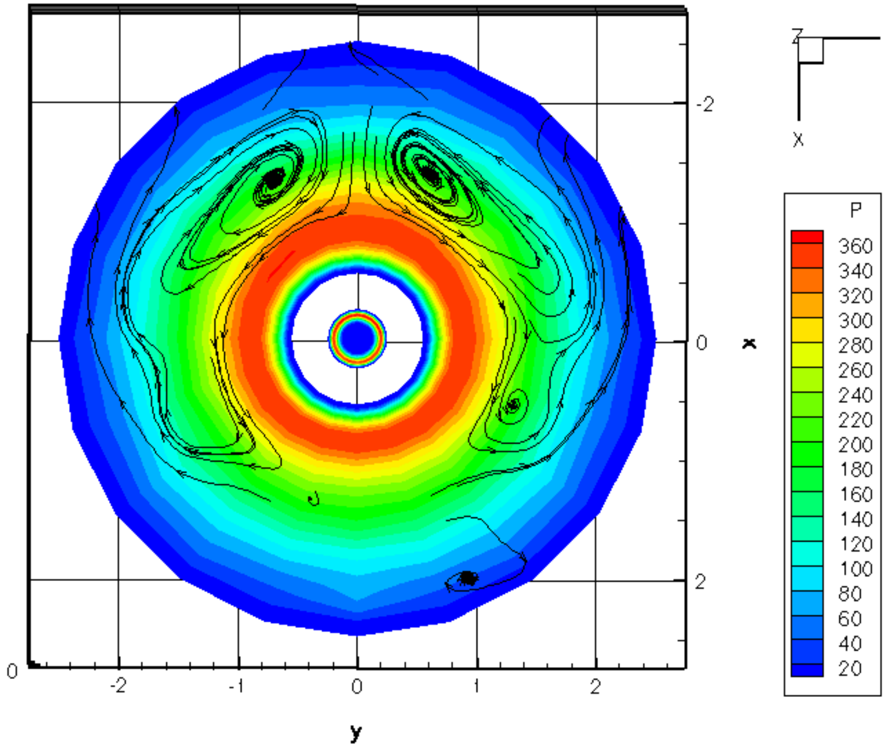




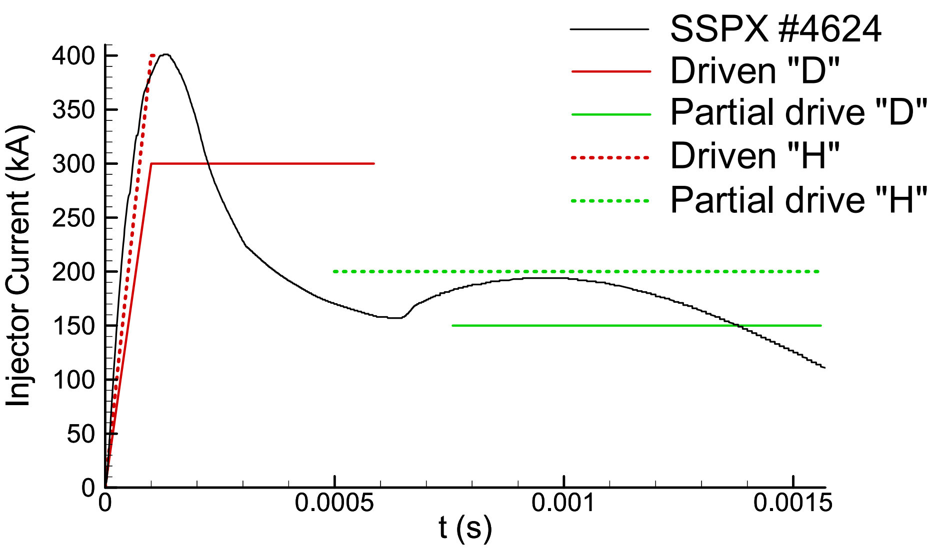
LDX Simulation (Kesner)

- n=21 grows first, but n=1 catches up and leads to a β collapse.
- Convective cells form after heating is increased at t=0.6 ms.
- Newest simulation is using bicubic elements for better resolution of thermal conduction anisotropy.

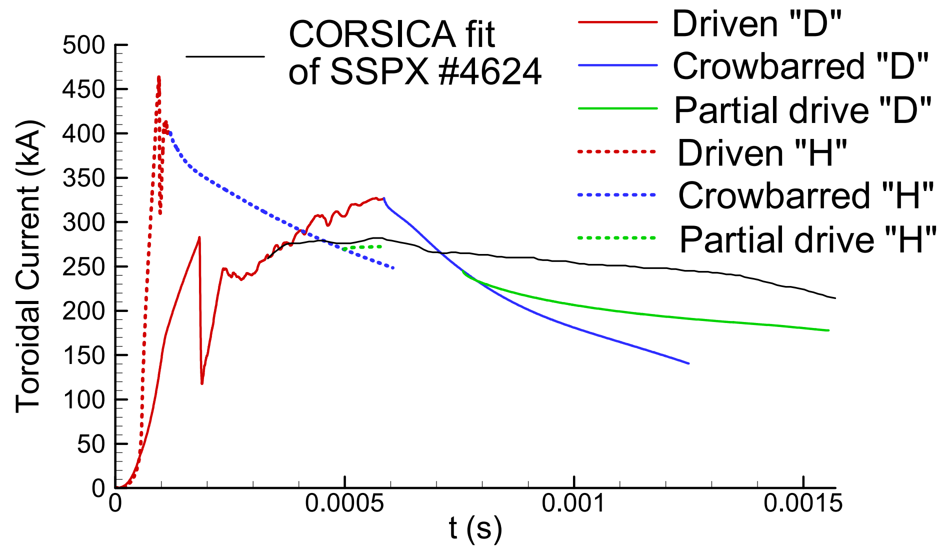




SSPX Simulations Model Specific Discharges



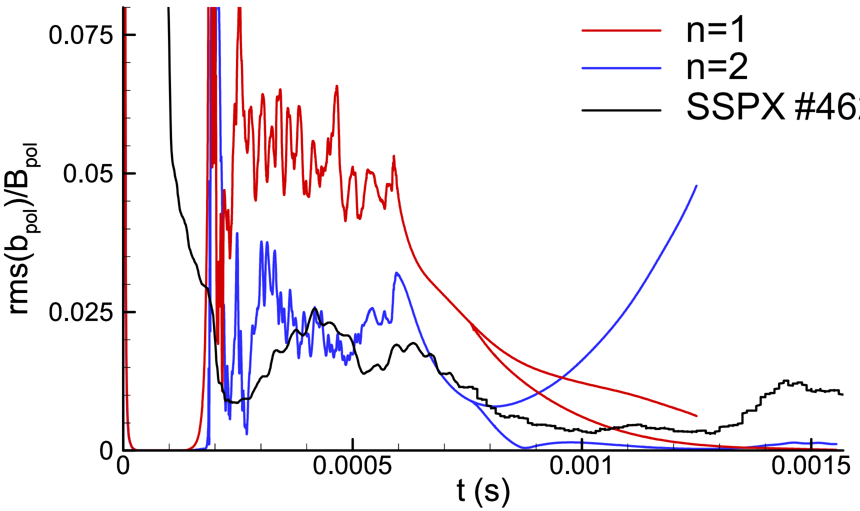
A strongly driven phase is followed by decay and then a second, partial drive. [SSPX Data courtesy of H. S. McLean.]



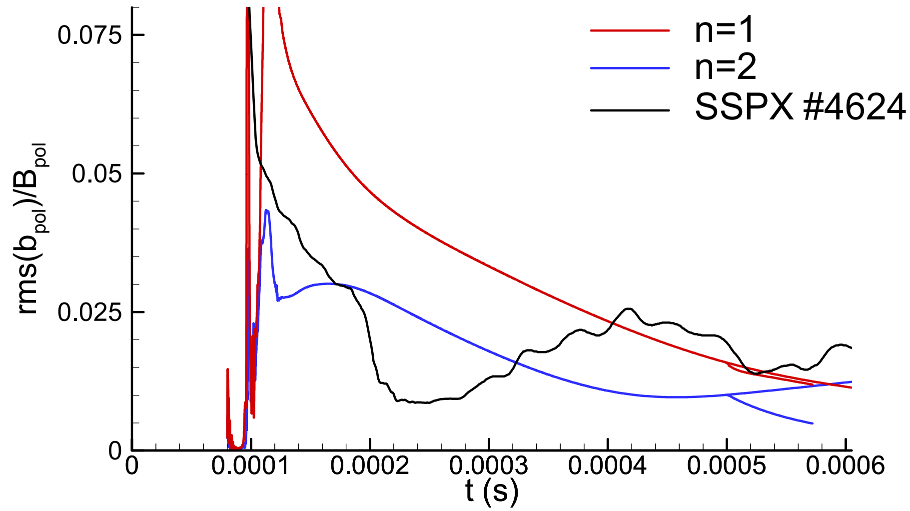
I_{tor} resulting from the series of NIMROD simulations is compared with I_{tor} from CORSICA equilibrium fits of SSPX data.

- The rate of decay of toroidal current in the simulation is similar to that found by the CORSICA fits [Hooper, *et al.*, NF **39**, 863 (1999)] during the partial drive stage.

<u>Both simulation and experiment show a quiescent phase when partial drive is applied after a brief period of decay.</u>



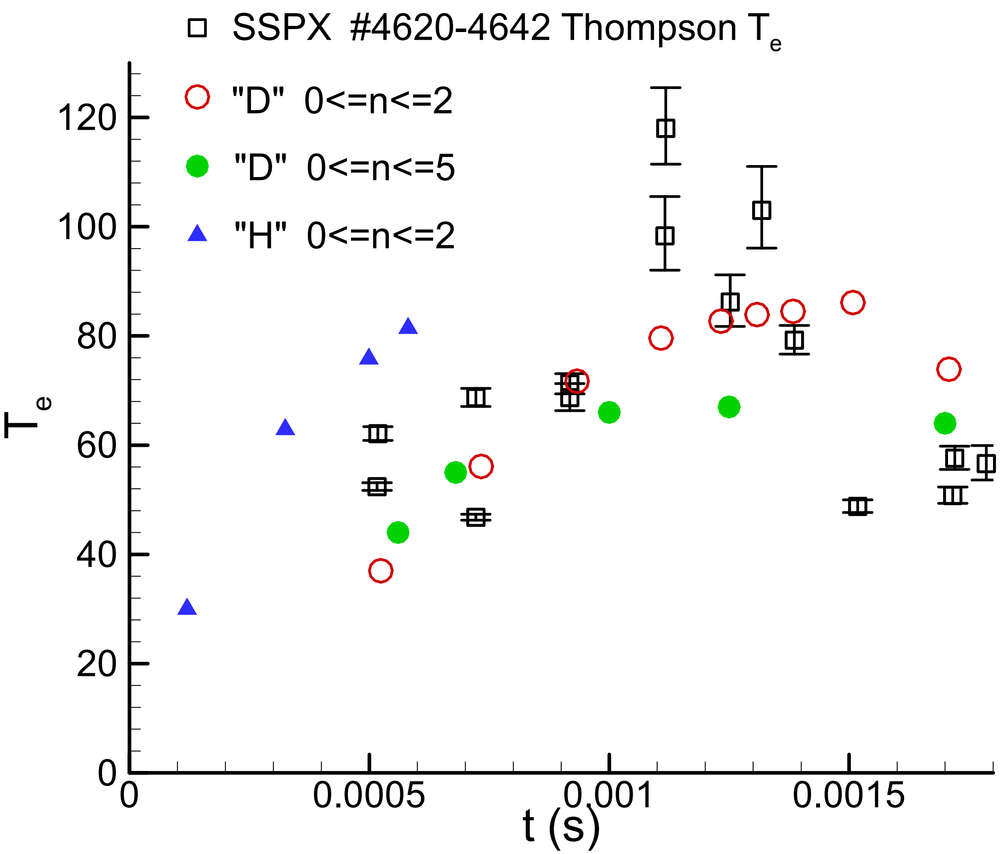
Relative poloidal magnetic field fluctuations at the outboard mid-plane position. Simulation results for continuing free decay are also shown ("Deuterium" simulation and SSPX probe).



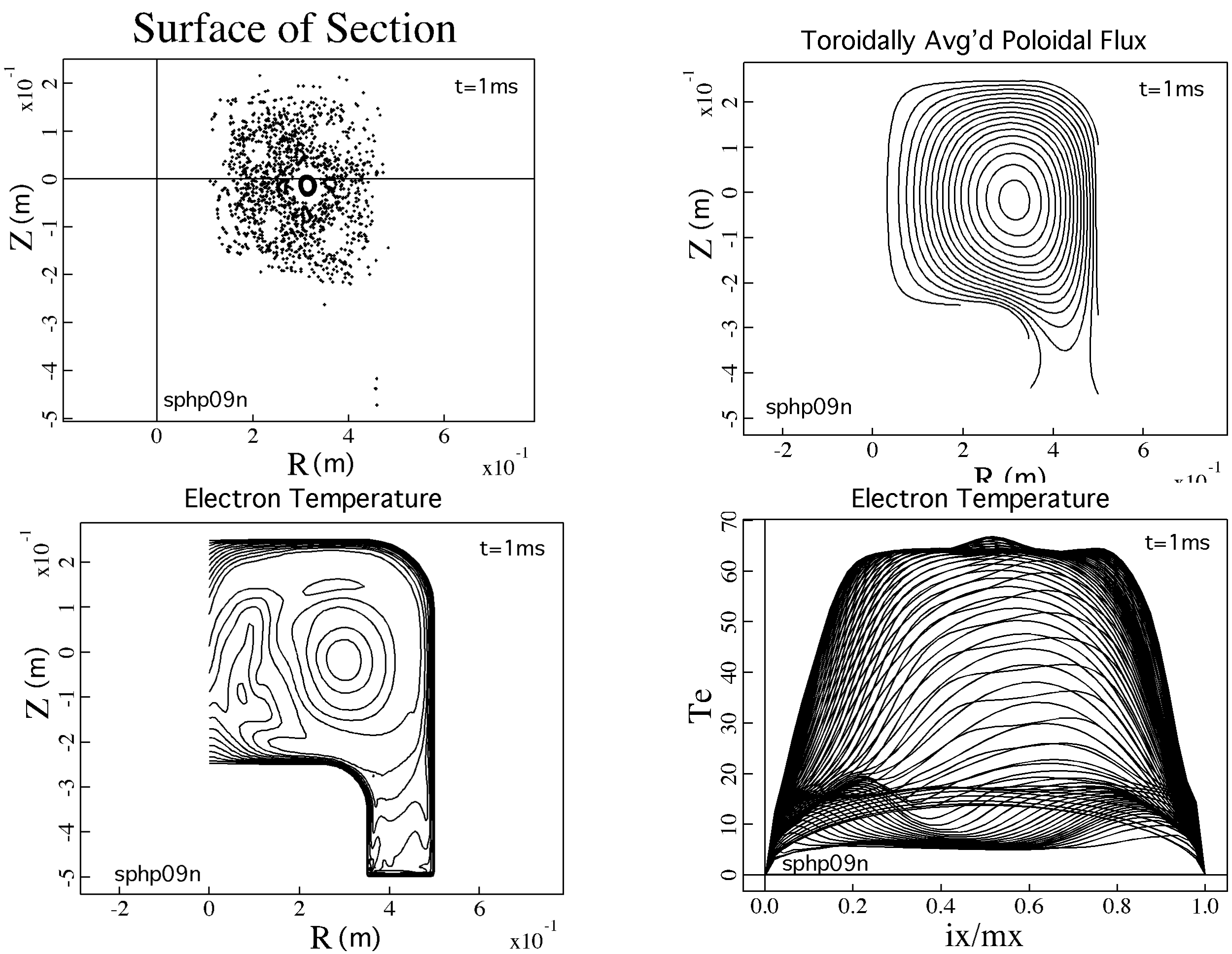
Relative poloidal magnetic field fluctuations at the outboard mid-plane position. ("Hydrogen" simulation and SSPX probe).

- Although conditions are not sustained, partial drive forces fluctuations to smaller amplitude, postpones the emergence of $n>1$ modes.
- The more realistic current waveform in the "Hydrogen" case drives the plasma harder but only for $t<0.12$ ms

Observed and computed temperatures increase to their maximum values during the quiescent phase.



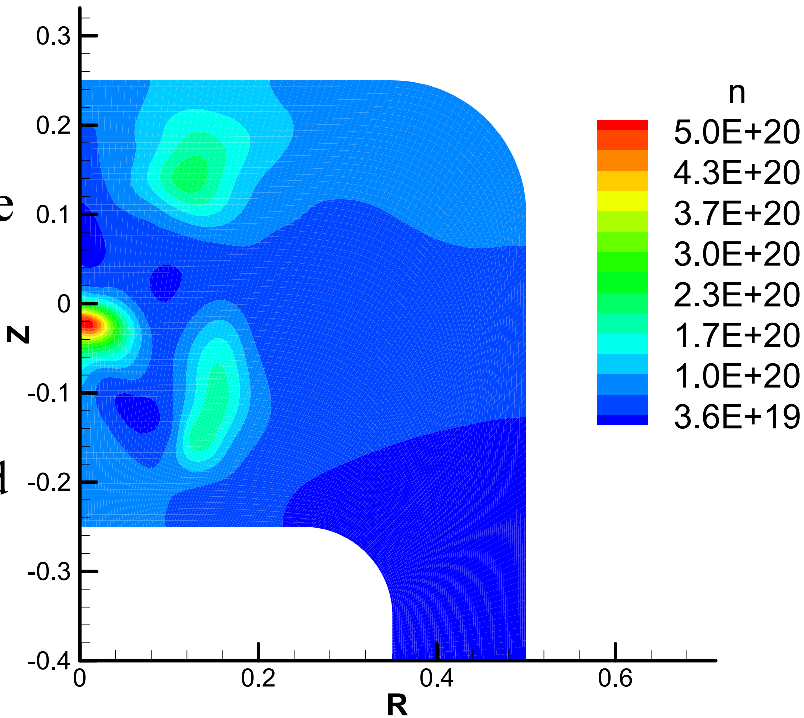
Here, temperatures also increase with the help of the transient, but an m=4, n=5 mode limits core confinement, resulting in a lower maximum temperature.



To date, n=5 activity has not been detected in SSPX. (Safety factor profiles agree with CORSICA fits of SSPX; absence is possibly 2-fluid effect??)

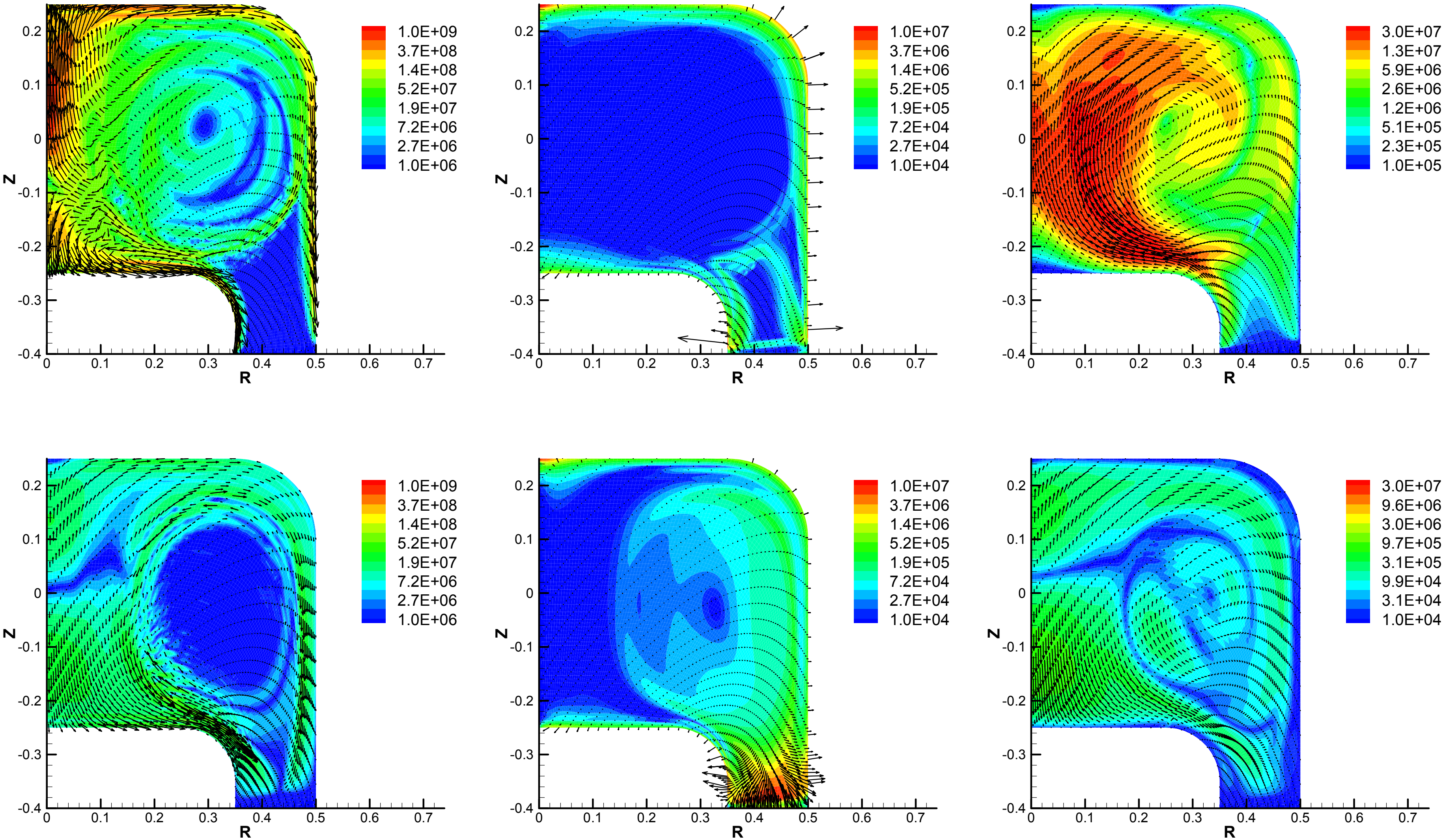
The impact of continuity evolution is being investigated.

- Heat flux diagnostics show that convection is large and may affect confinement.
- The evolving number density is used in the flow velocity and temperature equations of the "Hydrogen" simulations.
  - *D* has to be large ($\tau_n \leq \tau_E$ -observed).
  - Driven stage is quite violent.
  - Particle transport is one of the least understood aspects of SSPX, according to experimentalists.
- To prevent negative values, *D* is locally enhanced to $\Delta x^2/\Delta t$ where $<n>$ is less than $0.03n_0$, and amplitudes of nonsymmetric Fourier components are limited.
- Preliminary comparisons do not indicate strong sensitivity to *n*-evolution modeling.



Number density in the ϕ=0 plane at t=0.1 ms of the "Hydrogen" simulation.

Thermal transport changes character from driven to decaying conditions (0.12 ms top row and 0.5 ms bottom row in "H" case).



conductive $\langle q_{\parallel} \mathbf{B}_{pol} \rangle$ conductive $\langle \mathbf{q}_{\perp pol} \rangle$ convective $\langle 2nT\mathbf{V}_{pol} \rangle$

Note the different exponential scales for the magnitudes of the three heat vectors.