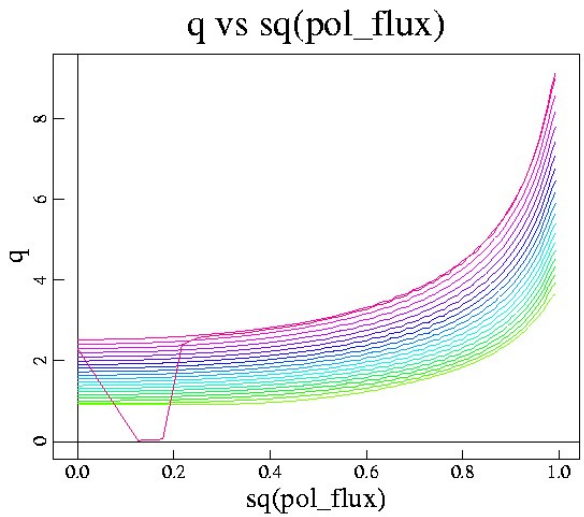
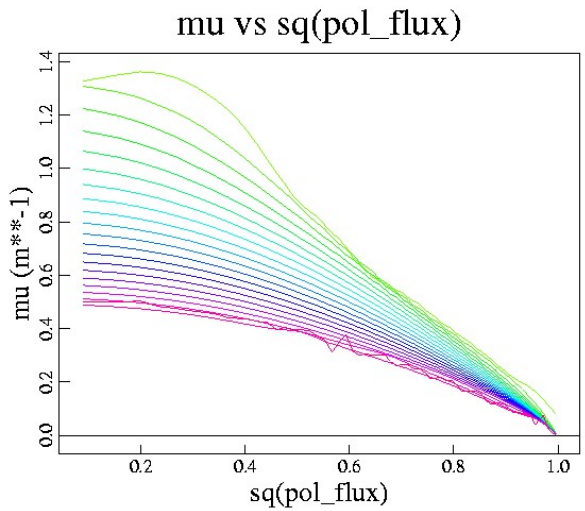
Simulations of D3D 97741

- Benchmark case suggested by Linda Sugiyama.
- First done as MHD computations, later 2-fluid.
- Equilibria are used as initial conditions (transfer_eq=T). $E_0=3.4\times10^7$ J.
- Start with g097741.01405; Scott K. also has g097741.1605.
- NIMROD multi-Fourier component runs have S=10^4, 10^5, and 10^6 with Pm=1.
- Simulations have been run with a 16x24 poly_degree=4 mesh and $0\le n\le5$.
- Number density and diffusivity profiles are flat.
- I've used continuity='fix profile' and isotropic thermal conduction with χ=1 m^2/s (η/μ_0=1.62 m^2/s at S=10^6.)
- $\tau_A=3.46\times10^{-7}$ s $v_A=2.17\times10^6$ m/s
- S=10^5 case (12,000 time-steps) was run in 29 hours on 6 processors of our Linux cluster.

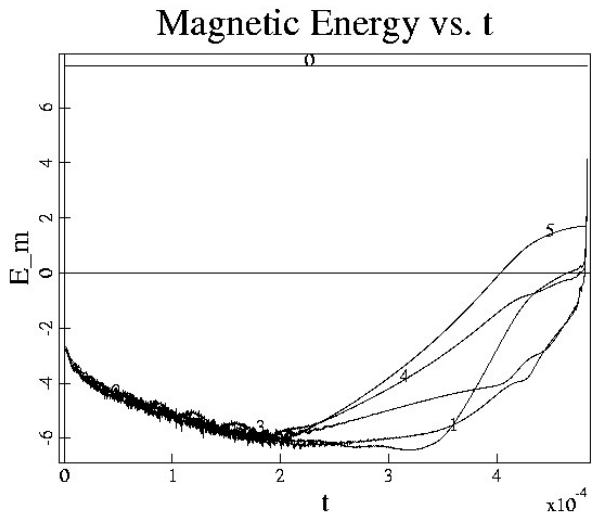
At S=10^4, there is an n=1 mode in the initial equilibrium, but the profile decays too quickly to see it in the nonlinear simulation.

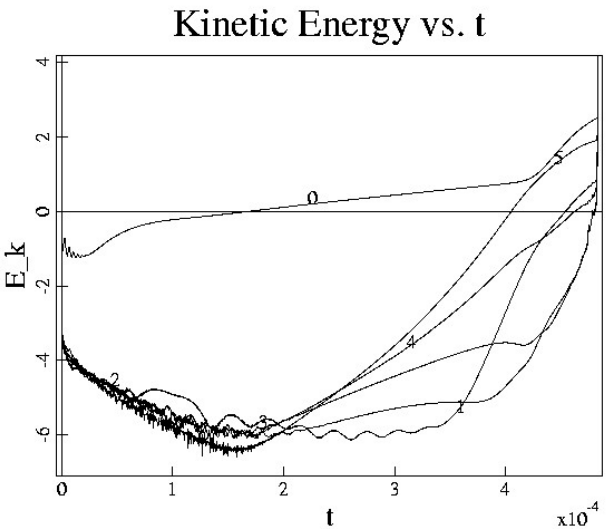
- NIMROD linear $\gamma\tau_A$=0.011, M3D linear $\gamma\tau_A$=0.0077.
- NIMROD nonlinear:



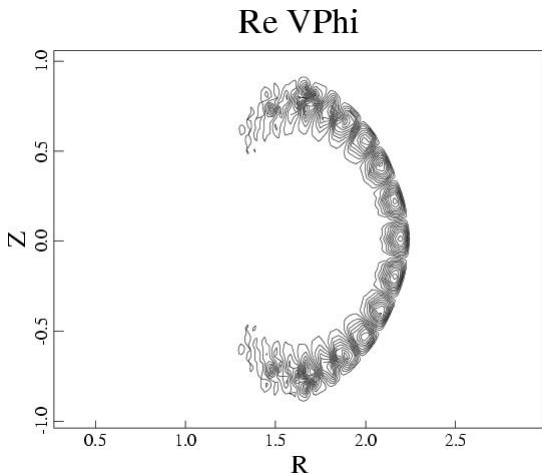


$\log_{10}(E_n/1\ J)$

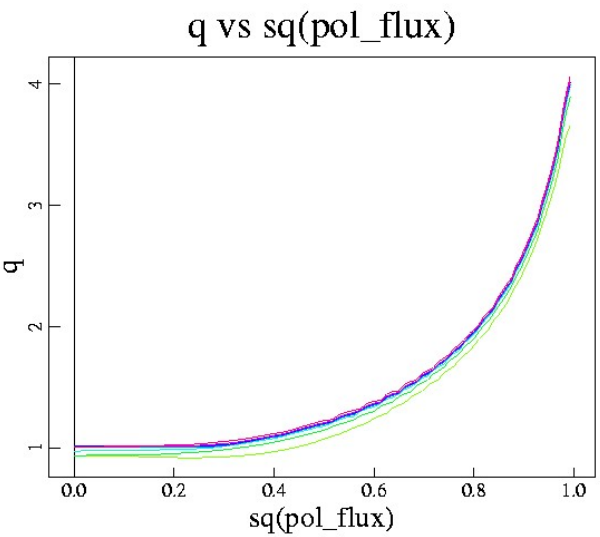


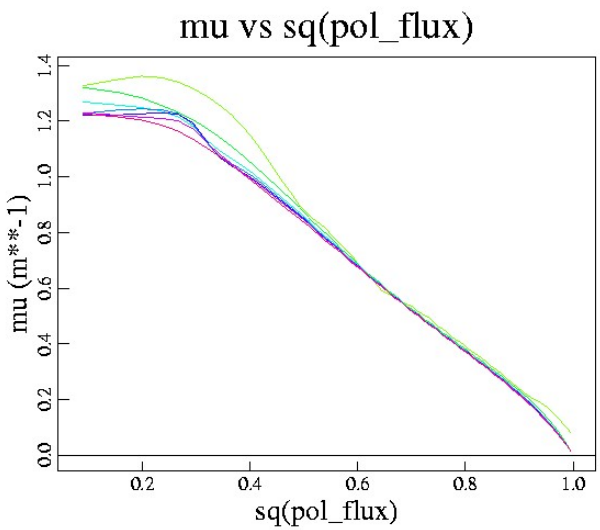


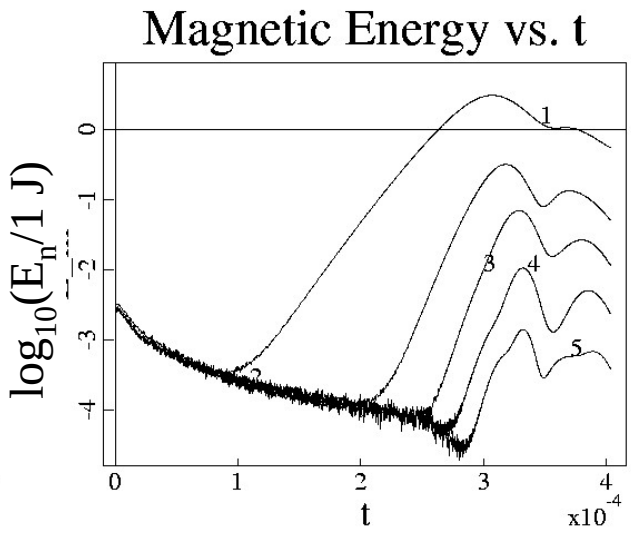
V_ϕ from n=5

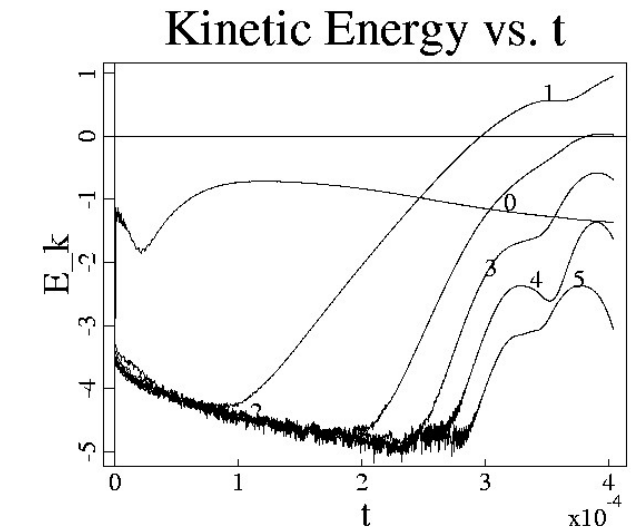


At S=10^5, the n=1 mode saturates and force $q(0)$ to 1 before the decay of central current density.

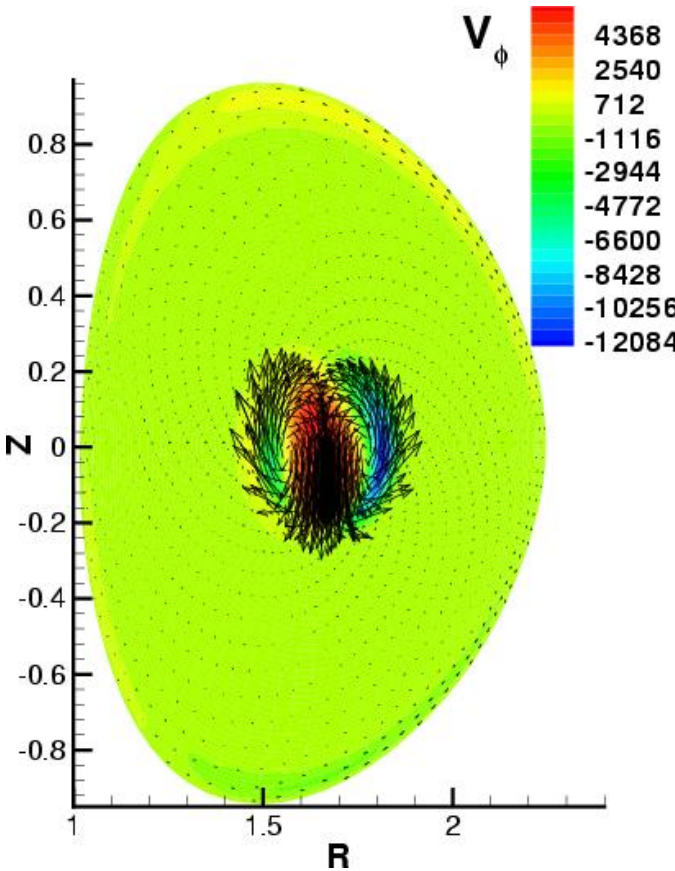




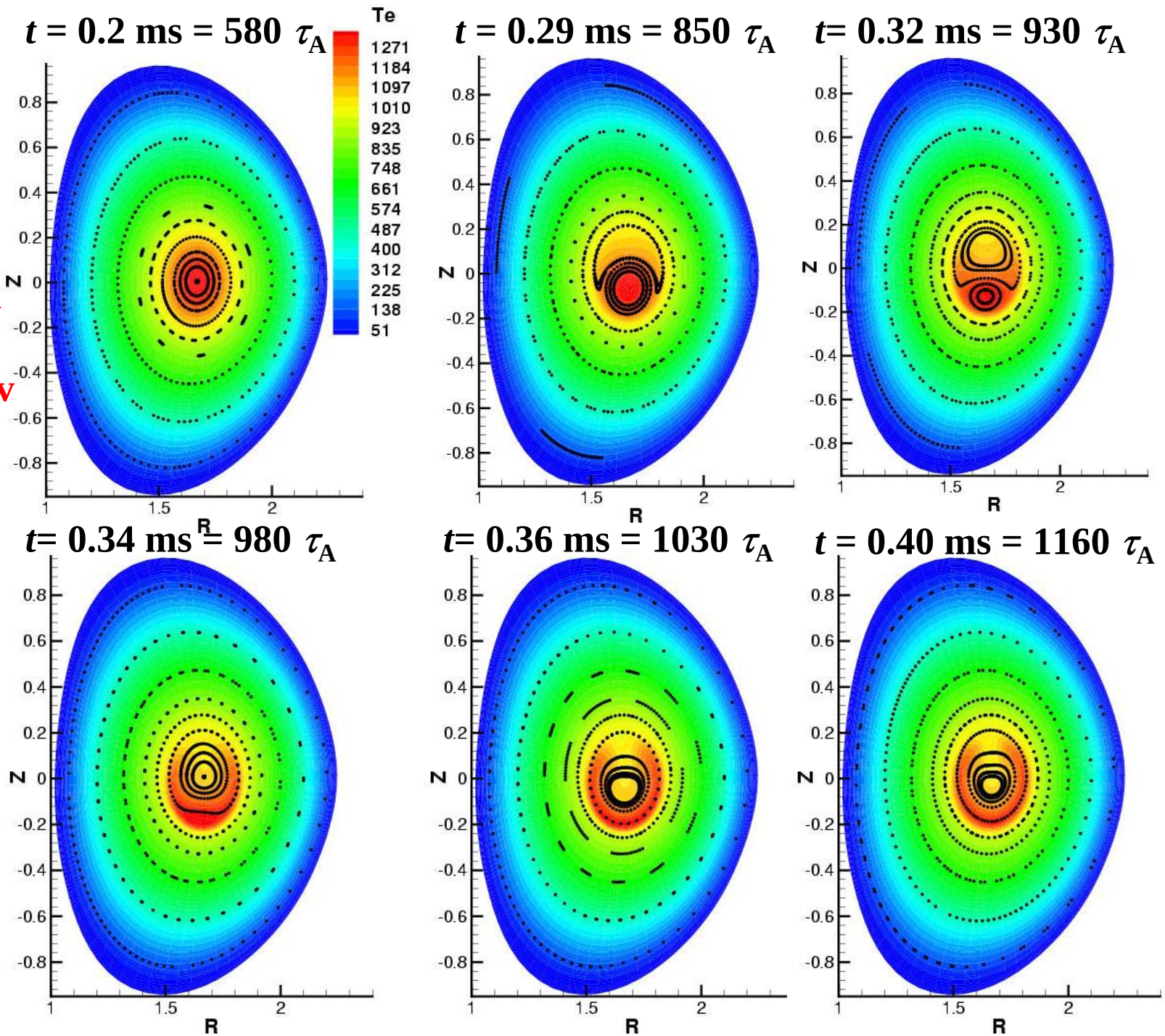




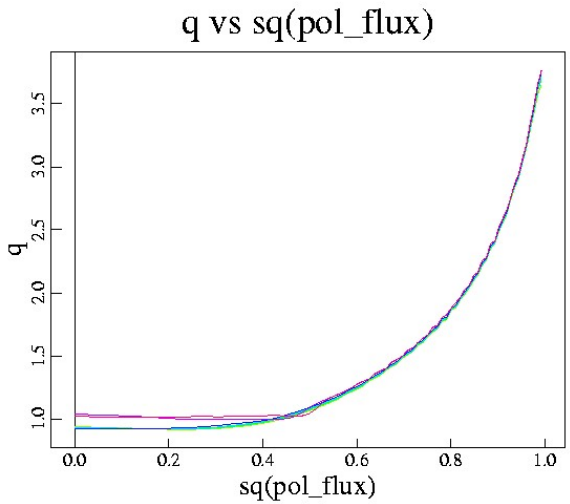
V at ϕ=0, 930 τ_A

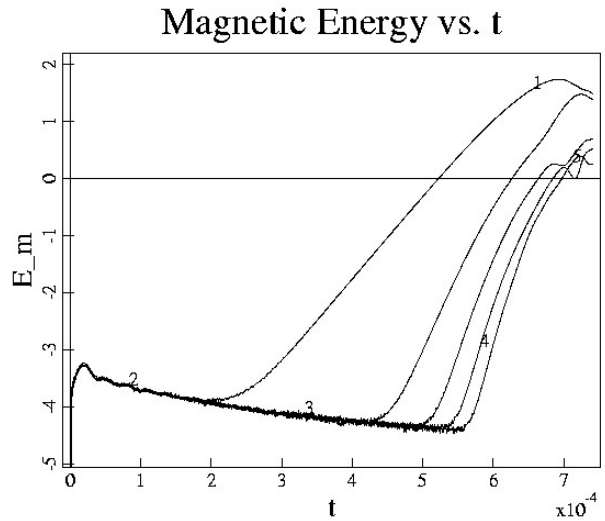


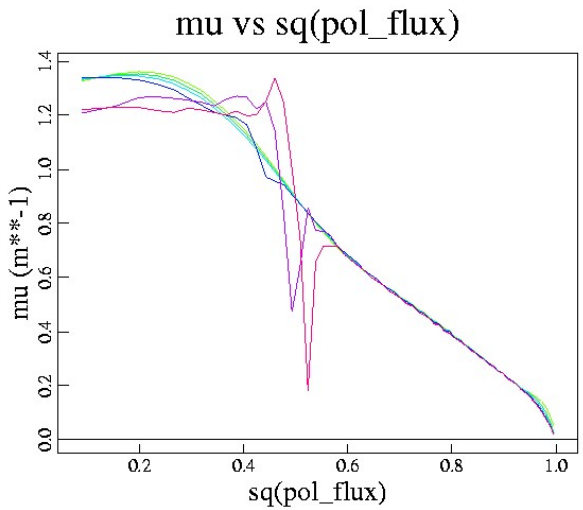
S=10^5 simulation shows Kadomtsev recon-nection.

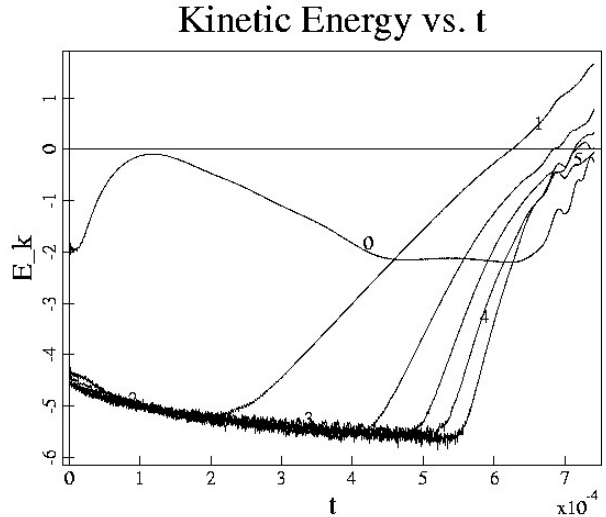


So far, the $S=10^6$ simulation behaves similarly to the $S=10^5$, but the q=1 extends farther from the magnetic axis (in poloidal flux), and the n=1 mode gains more energy before saturating.









This simulation will need more spatial resolution, but I'm pleasantly surprised that it runs as far as it does with a 16×24 p=4 mesh.

Status

- MHD simulations are now running well.
- Initial MHD comparisons with M3D are reasonable
    - n=1 growth rates and n=0 kinetic energy generated by equilibrium errors
- NIMROD 2-fluid n=0 computation with the old Hall advance dies within 10s of Alfven times.
    - We'll try again with the new algorithms.