



VDE modelling: study of wall/halo currents with M3D-C1

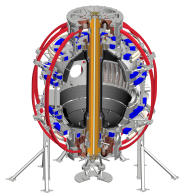
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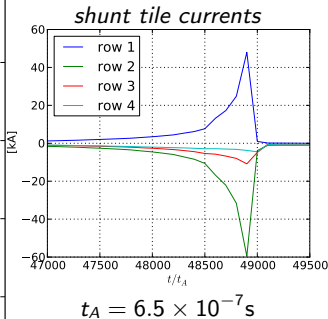
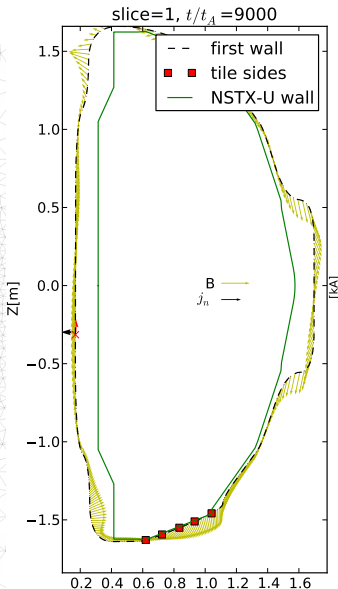
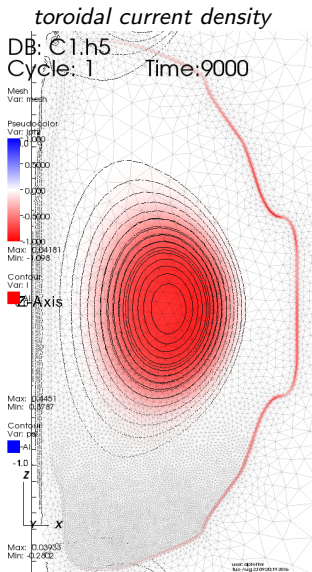
NSTX-U meeting, PPPL, September 21, 2016



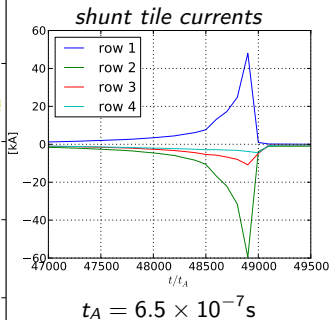
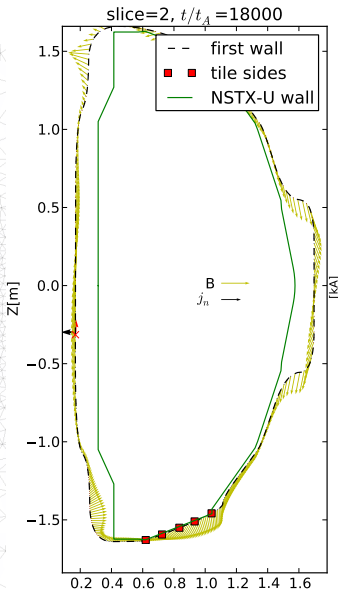
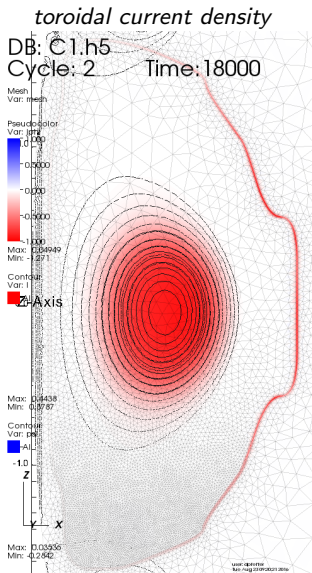
Motivation and goals

- VDEs release large currents into tokamak first wall
 - deleterious **forces** / stresses, heat loads, RE beam,...
 - imperative to understand dynamics to improve mitigation and avoidance
- in NTSX-U, halo/wall currents are measured via a dozen shunt tiles
 - signal at (only) 2 poloidal angles \times 4 toroidal angles along divertor plate
 - quantify halo currents, non-axisymmetric component, rotation
 - large database collected and analysed [Myers, 2016]
- Support from theory / numerical simulation
 - M3D-C1 (FEM and **implicit**) + resistive wall capabilities
 - development, validation and prediction
 - simulation of the entire VDE (drifting + wall touching phase)
 - 2D/3D nonlinear MHD evolution + linear study along the way
 - realistic drift \sim 30ms and quench \sim 5ms times
 - flexible wall geometry and thickness (2D)
 - virtual diagnostic for wall currents and forces

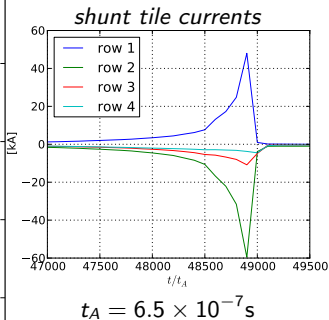
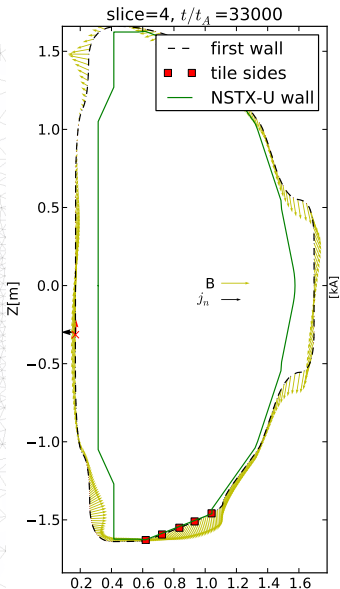
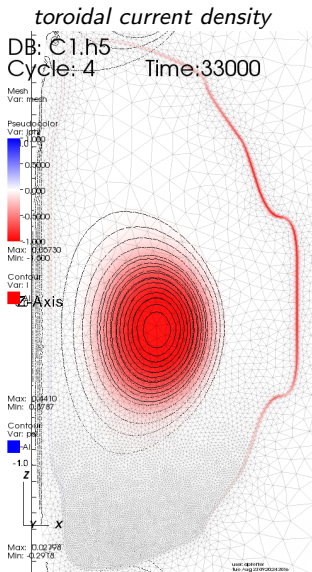
M3D-C1 nonlinear simulations of NSTX #132859



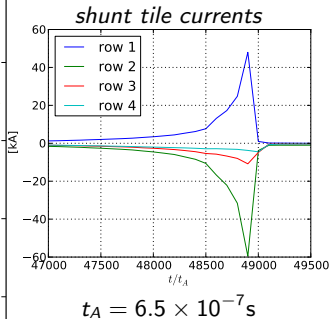
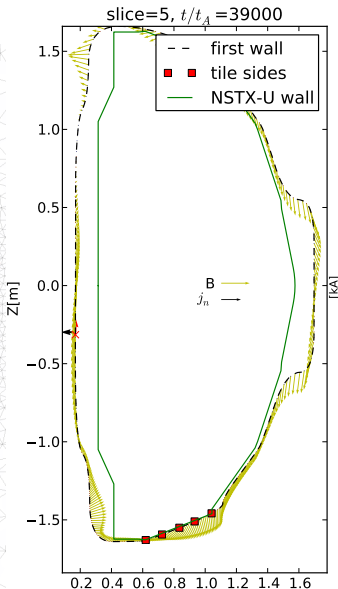
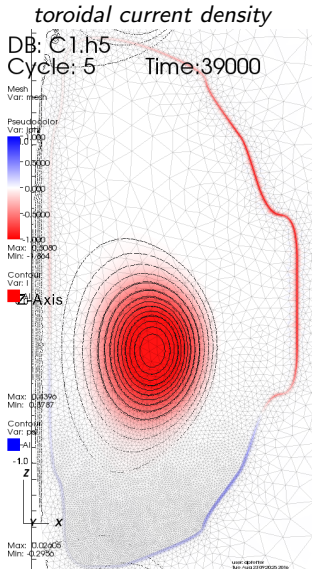
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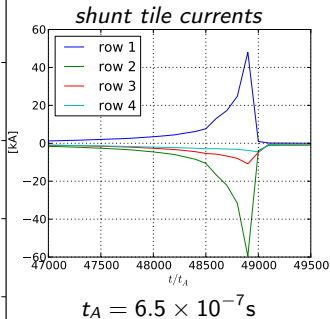
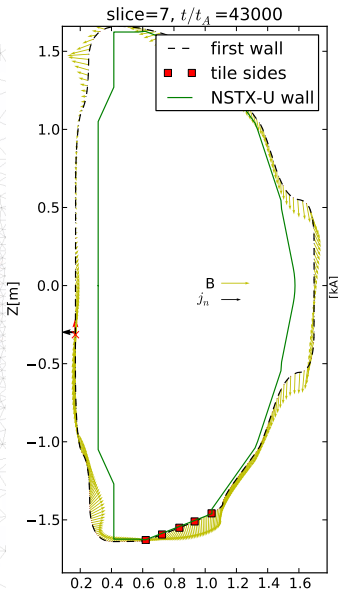
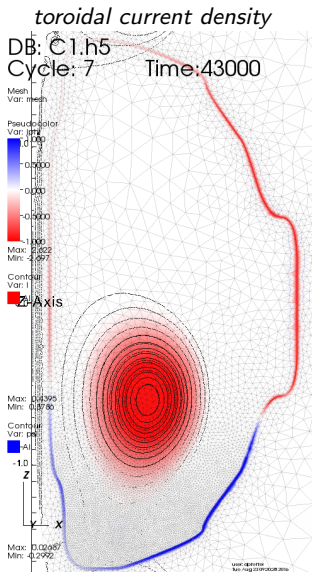
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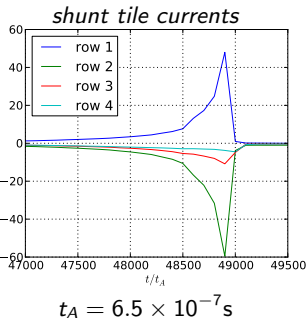
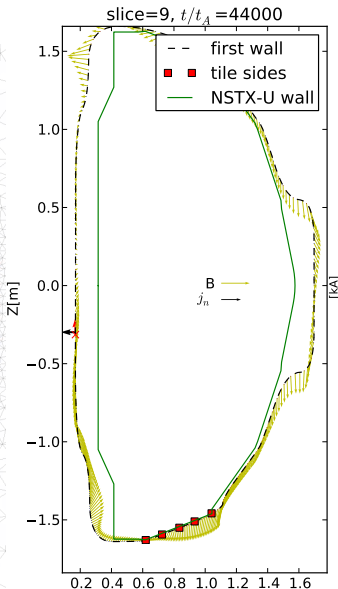
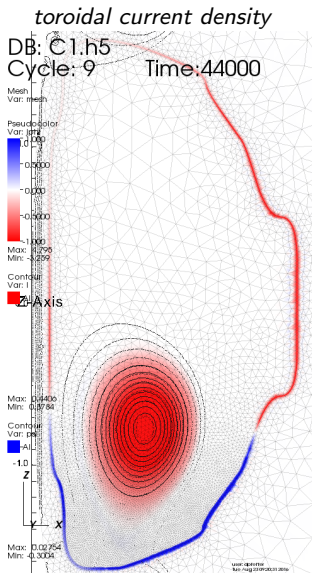
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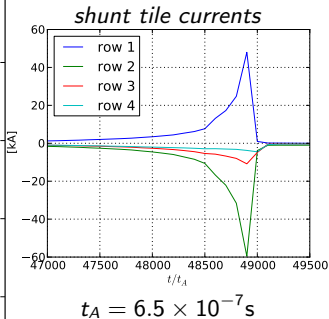
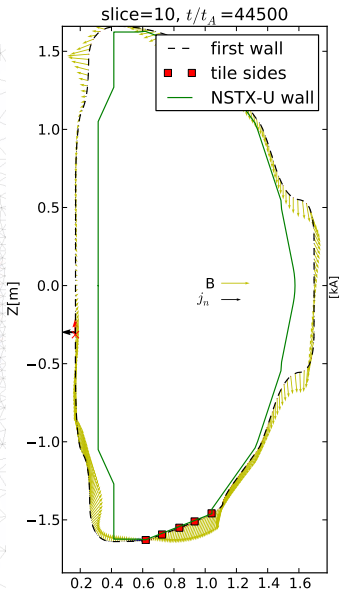
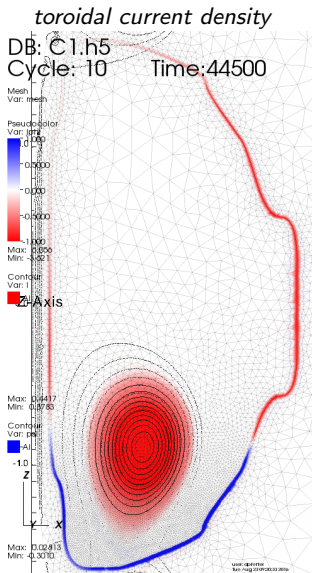
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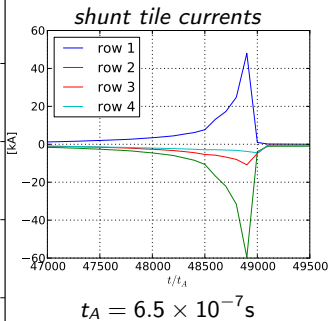
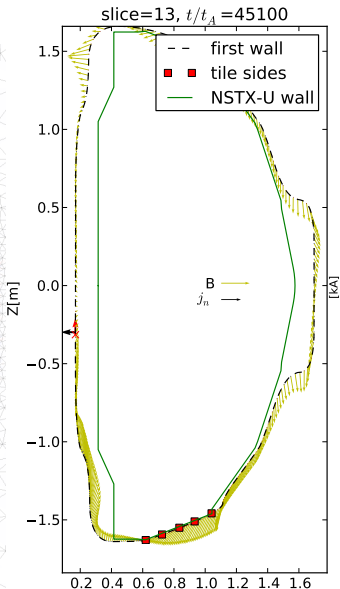
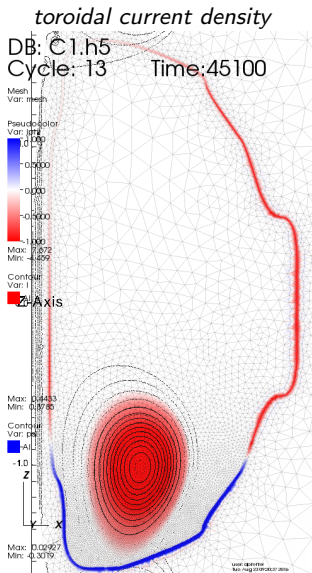
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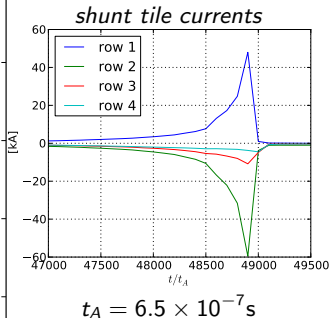
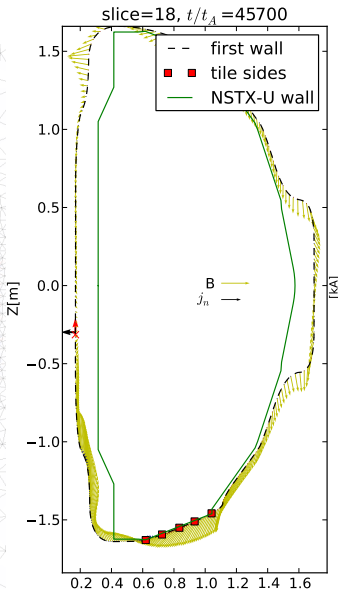
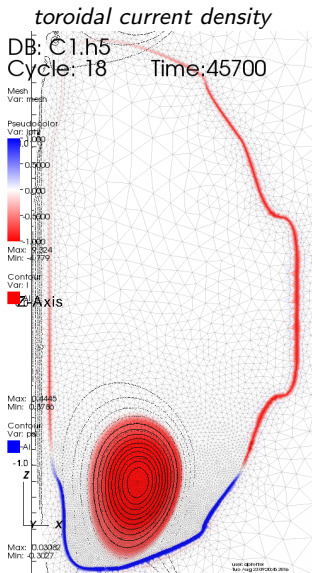
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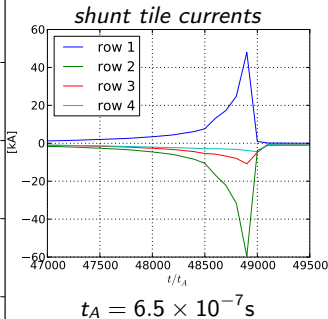
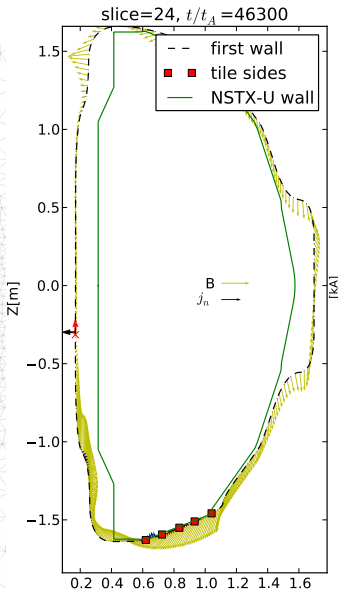
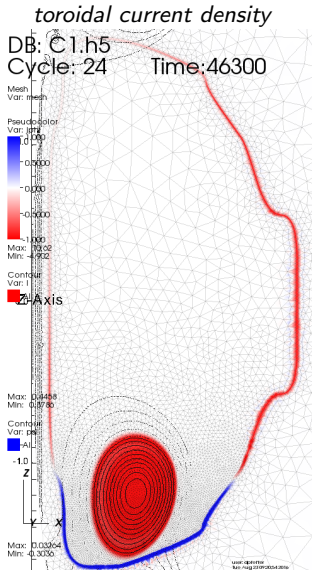
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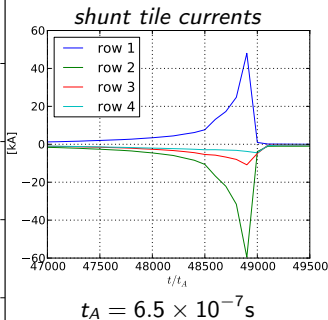
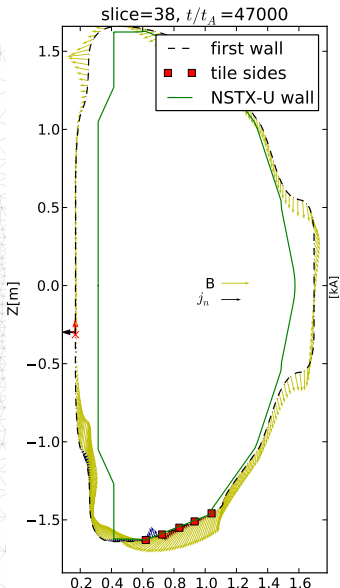
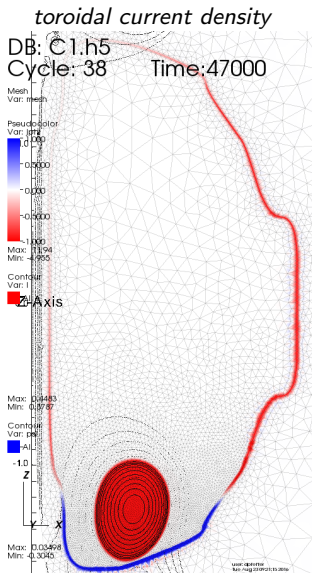
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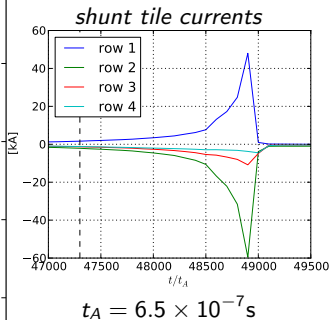
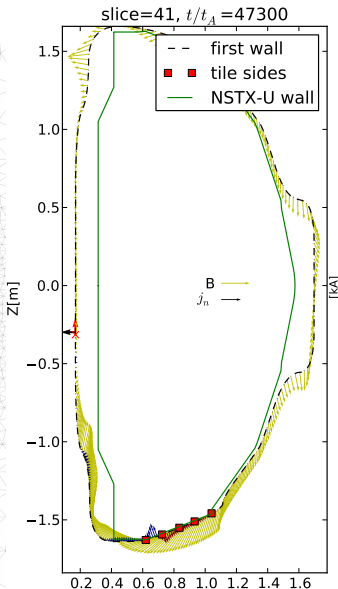
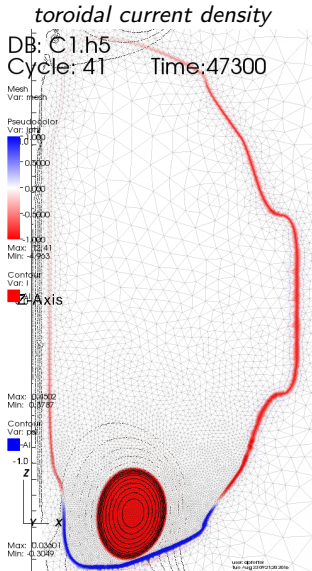
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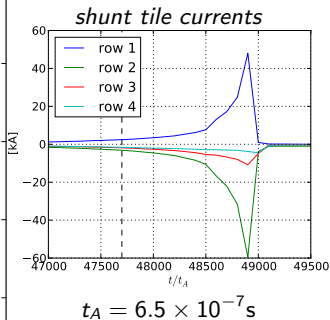
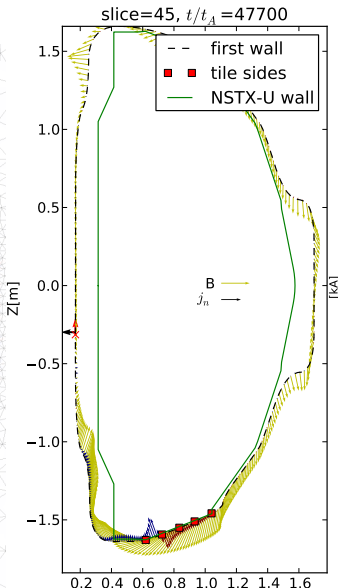
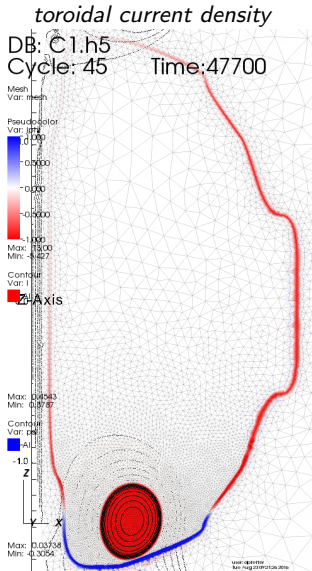
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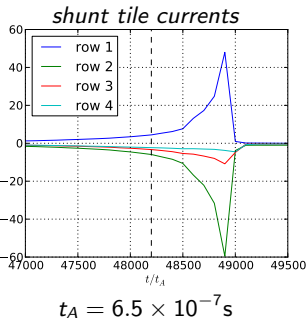
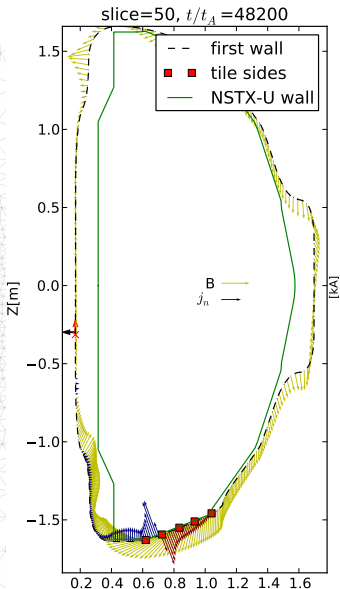
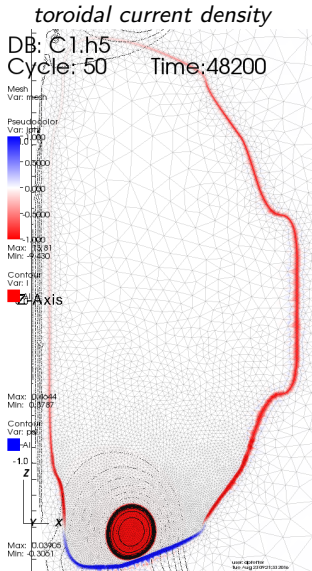
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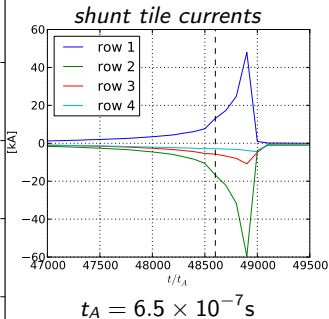
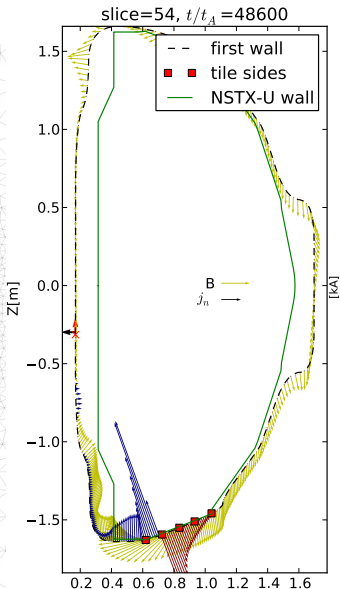
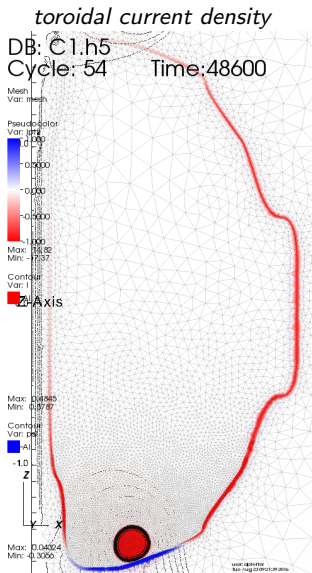
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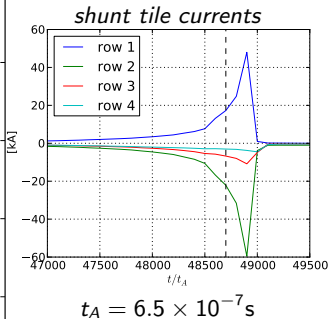
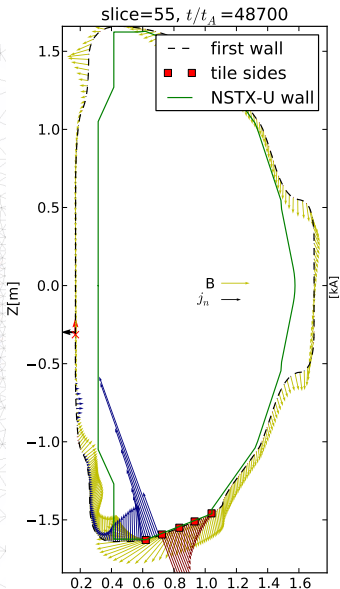
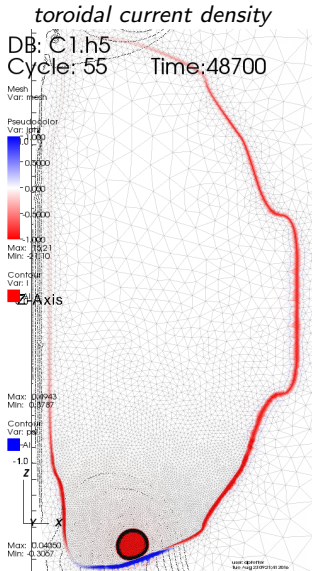
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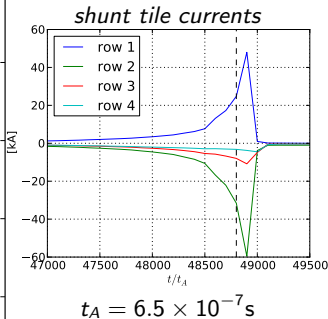
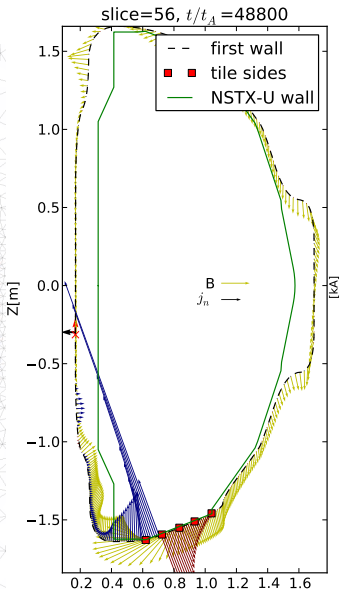
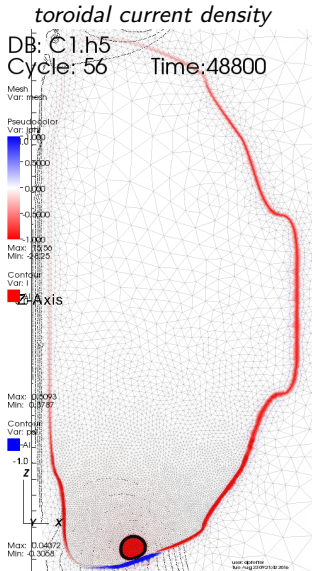
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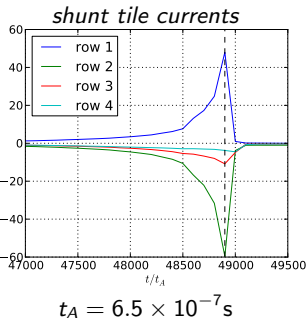
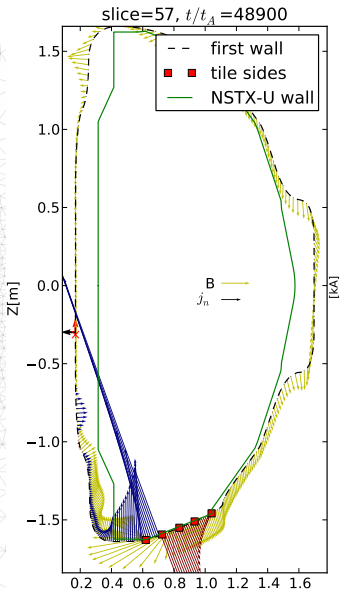
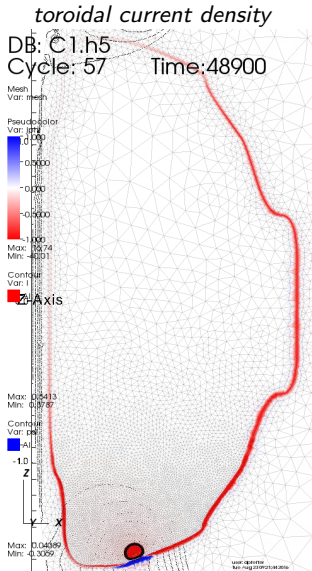
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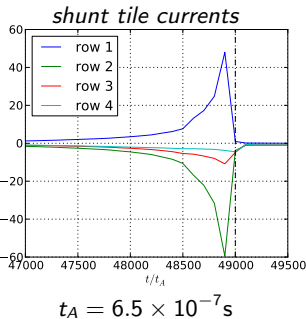
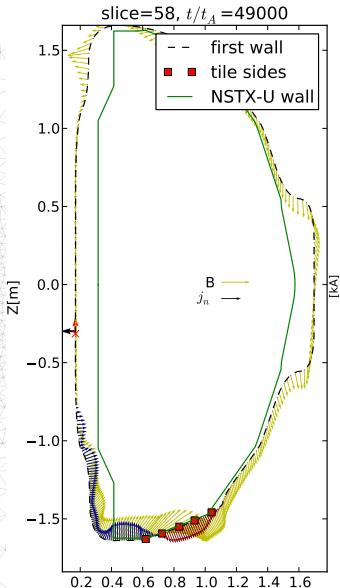
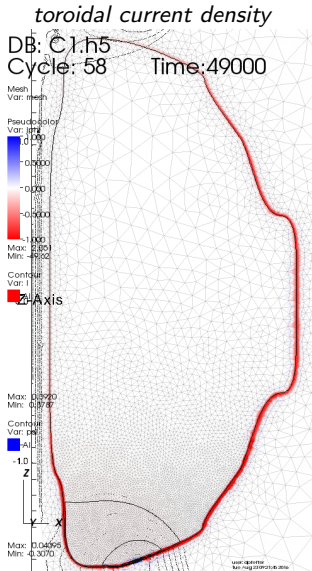
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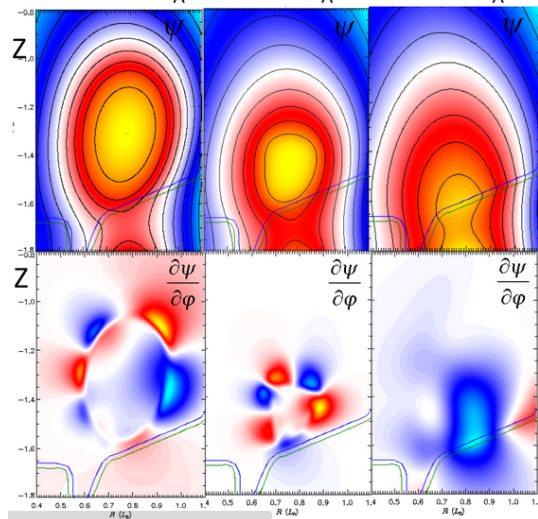


Preliminary 3D nonlinear runs

$t = 7825 \tau_A$ $t = 7912 \tau_A$ $t = 7962 \tau_A$

Switching 2D \rightarrow 3D as plasma approaches wall

- First successful 3D simulation (~ 300 CPU kH on NERSC):
 - fast VDE, high wall resistivity
 - low 3D activity (stable), low halo resistivity (temperature too high)
- simulations in progress (APS)
 - anisotropic mesh
 - higher wall conductivity \Rightarrow more realistic timescales
 - prescription of halo resistivity (higher) \Rightarrow stronger 3D MHD
 - diagnose helical currents, halo rotation



Ongoing work and future plans

- Simulations, numerics
 - more 2D runs: finer time traces during quench, scans in wall resistivity, halo temperature function, heat conductivity, loop voltage,...
 - as many 3D runs as possible: convergence with toroidal planes, timing of 2D to 3D switching, smoothing/damping of numerical instabilities,...
- Analysis, interpretation and comparison with experimental data
 - repeat modelling based on recent NSTX frozen VDE shot
 - sequence of events (z_{mag} , total currents, q-profile) + linear study
 - halo currents, wall forces, mode rotation, torque, TPF,...
 - virtual diagnostics for shunt tiles + magnetic probes
 - ⇒ pattern and positioning optimisation
- Extensions and additional effects
 - CHI gap (enforce zero poloidal wall currents)
 - non-uniform / non-axisymmetric wall resistivity

Bibliography I

C. Myers, PPPL (2016).