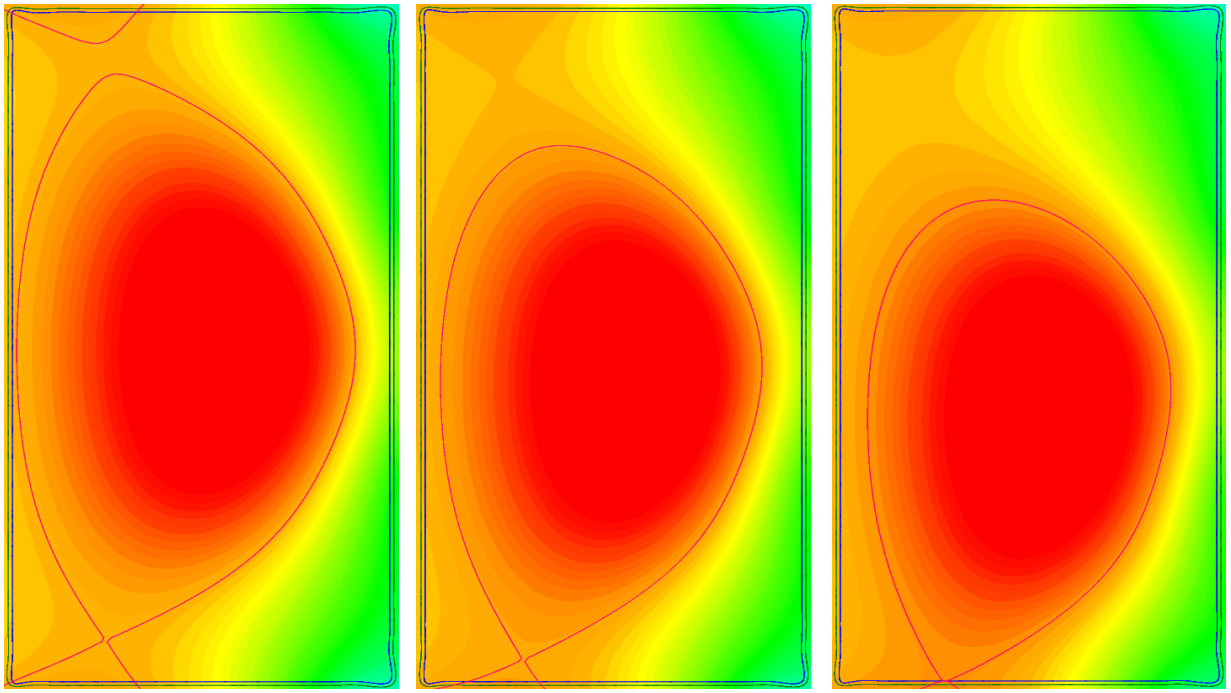


Status of M3D-C¹ VDE simulations

Isabel Krebs, S.C. Jardin, N.M. Ferraro, K. Bunkers,
F.J. Artola, C.R. Sovinec, M. Hoelzl, L.L. Lao, D. Pfefferlé

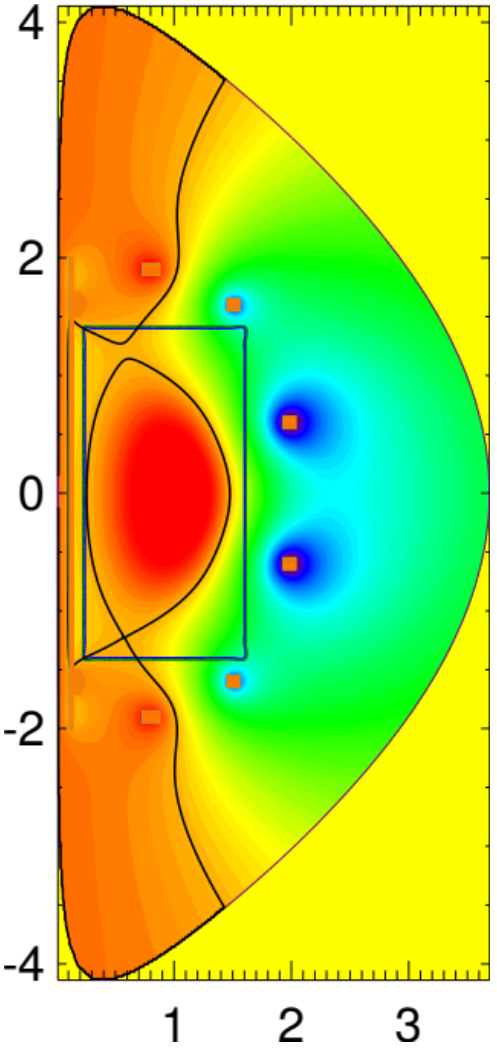
CTTS Meeting – April 22, 2018 – Auburn, AL

Overview

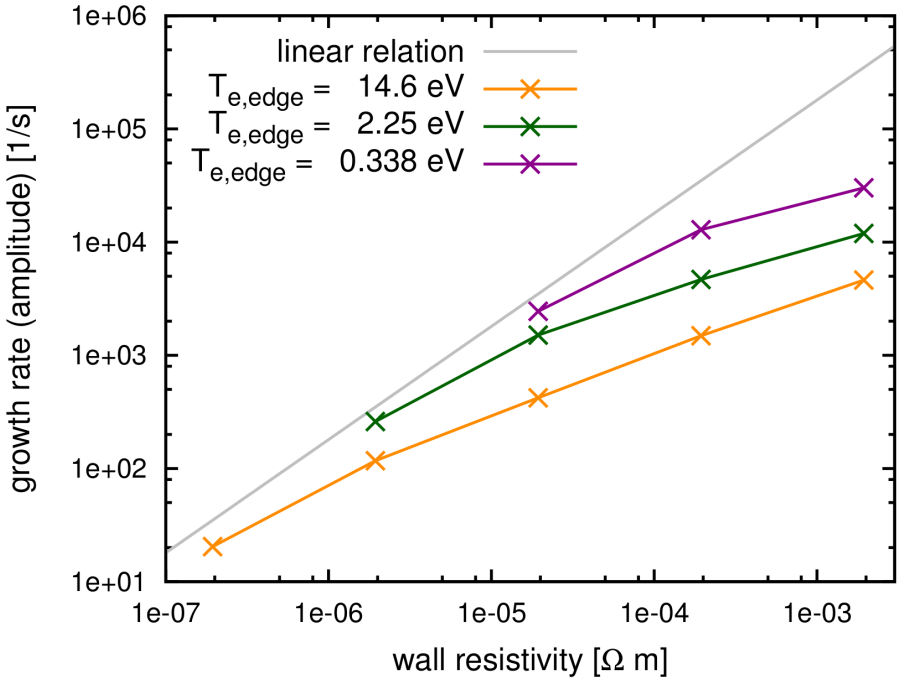
- VDE benchmark between M3D-C[1] & NIMROD
- JOREK joined VDE benchmark
- Validation of VDE results against DIII-D experimental measurements
- ITER VDE benchmark with CarMaONL

CTTS VDE benchmark

- equilibrium based on NSTX VDE discharge #139536
- rectangular resistive wall
- goal:
  - Linear, 2D & 3D nonlinear benchmark
  - Compare VDE evolution & forces on vessel wall



Linear parameter scan



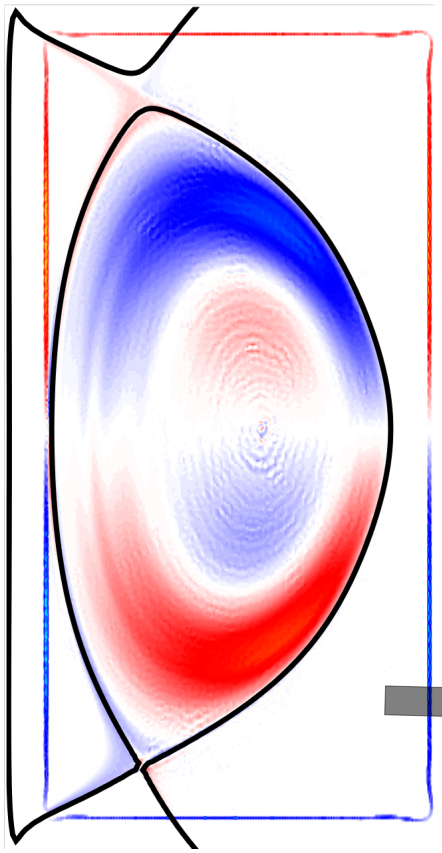
- wall resistivity < open field line region resistivity:

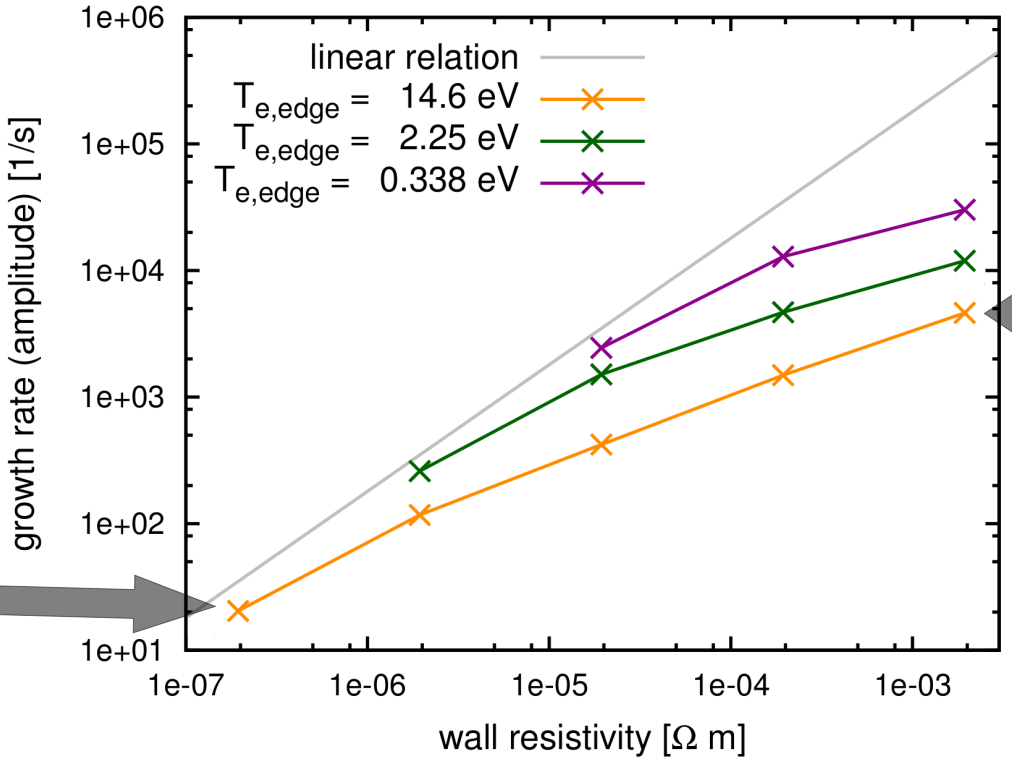
  VDE growth rate ~ wall resistivity

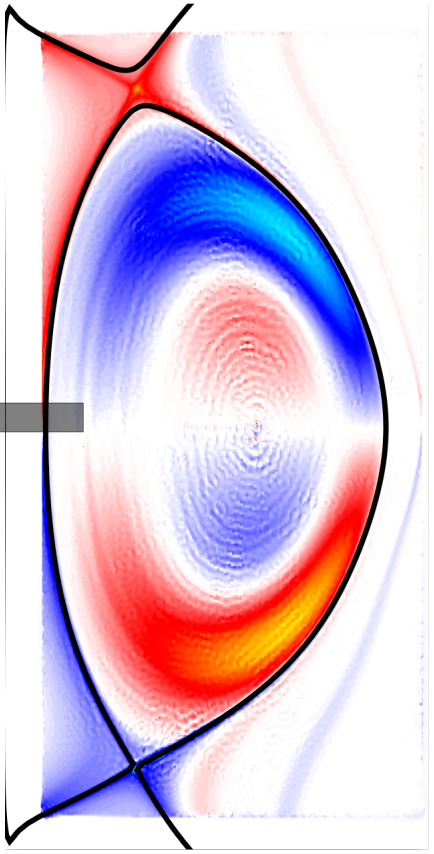
- wall resistivity comparable to open field line region resistivity:

  edge plasma currents slow down VDE

Linear parameter scan







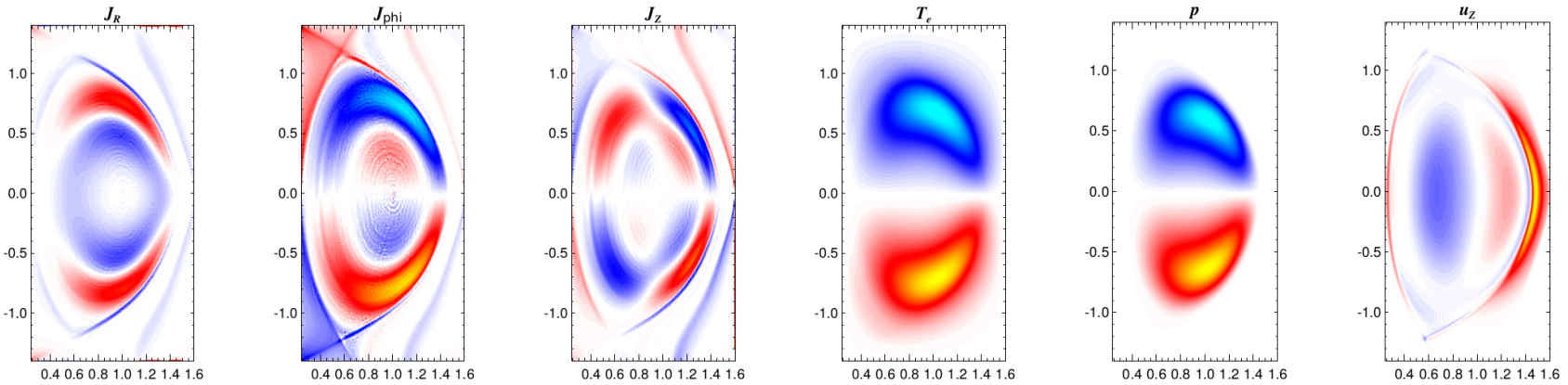
toroidal current density perturbation

toroidal current density perturbation

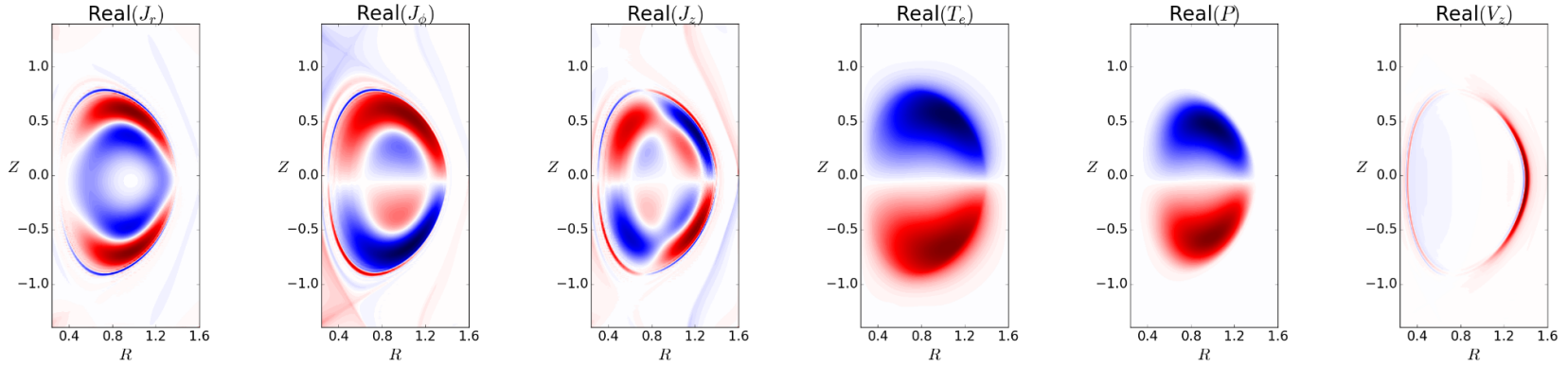
Status linear benchmark

- eigenfunctions are similar

M3D-C[1]

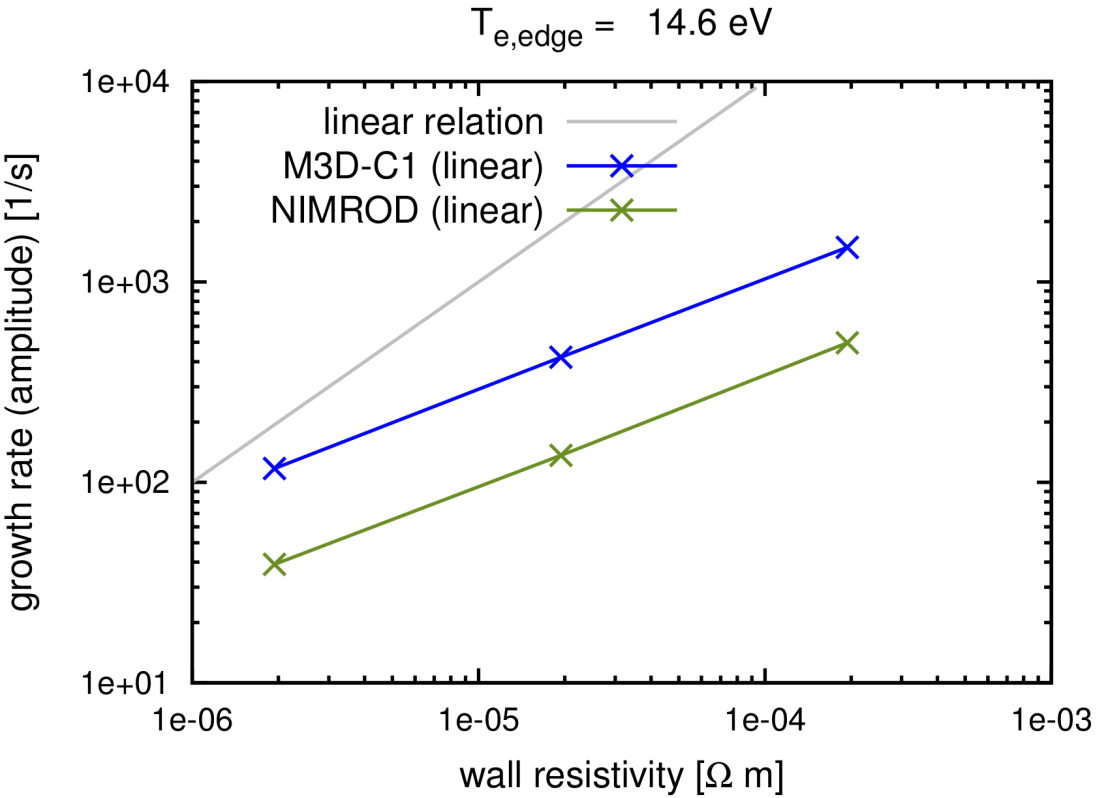


NIMROD



Status linear benchmark

- growth rates differ by factor 3
  - exactly the same equilibrium?
  - ideal domain boundary
  - linear vs. 2D nonlinear



Status JOREK benchmark

- contacts: Matthias Hoelzl (IPP Garching) & Javier Artola (PhD student)
- start with linear phase of 2D nonlinear simulations (linear n=0 not possible)

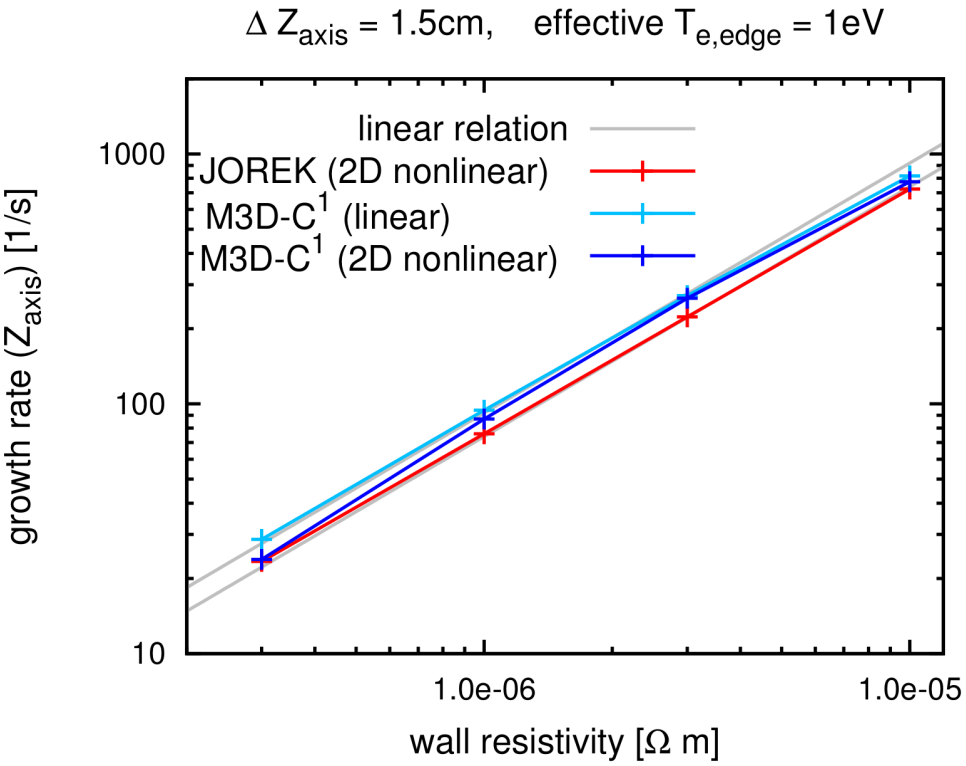
- differences:
  - JOREK uses reduced MHD model for VDE calculations
  - no ideal wall BCs at domain boundary
  - only normal velocity component vanishes at resistive wall

Status JOREK benchmark

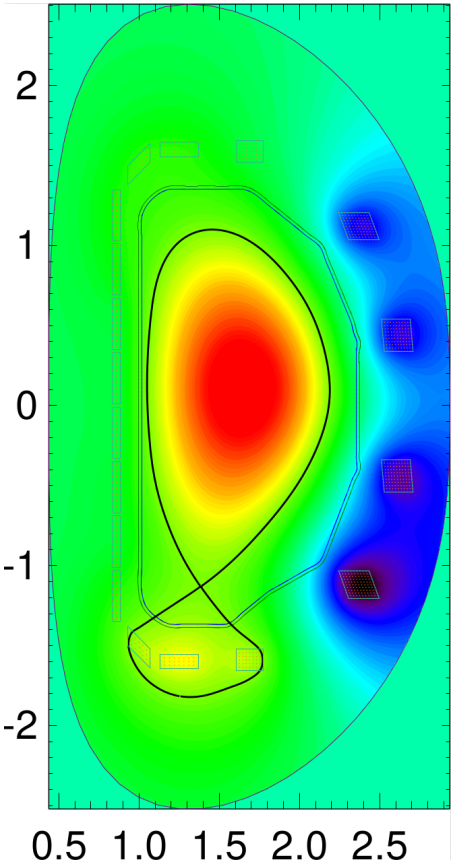
- low diffusion coefficients
- negative temperature offset in resistivity calculation to avoid influence of currents in open field line region:

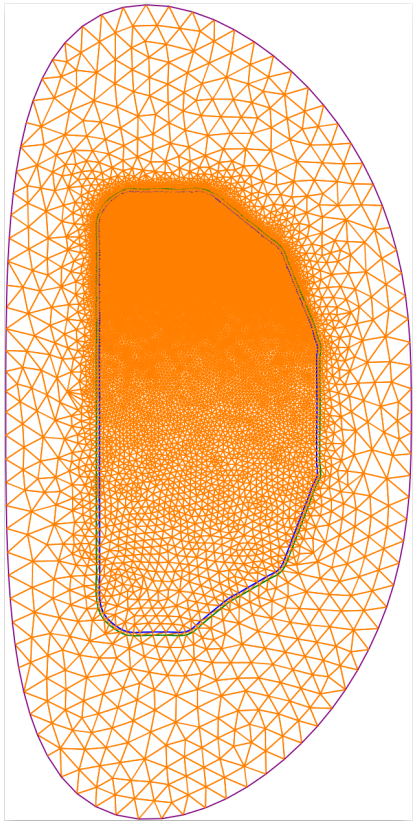
  $\eta = \eta_{Spitzer}(T_e - T_{off})$

  => growth rate ~ wall resistivity
- maximal deviation of growth rates: 20%
- linear M3D-C¹: restart from 2D



Validation against DIII-D data

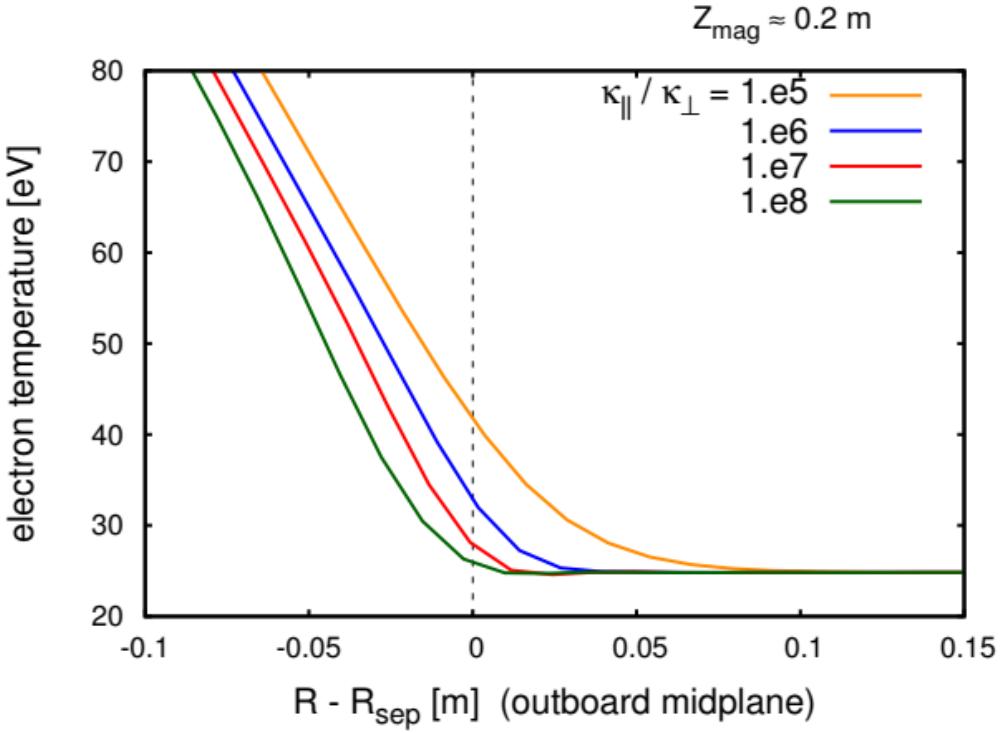


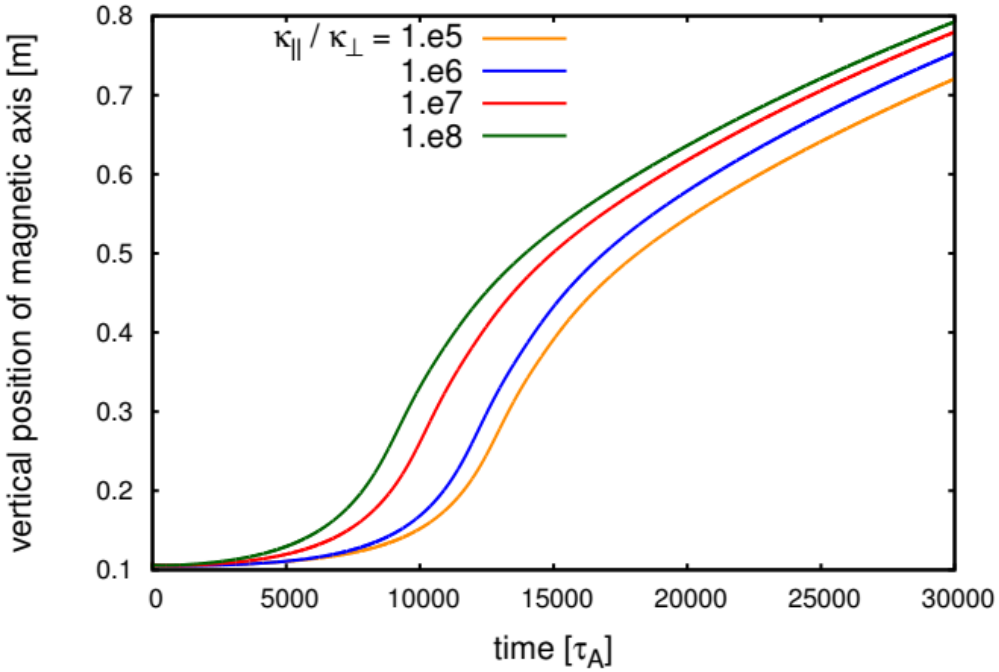


- based on DIII-D VDE discharge #88806 (“killer pellet”)
- simplified model of DIII-D first wall & vacuum vessel

SOL width & heat diffusion

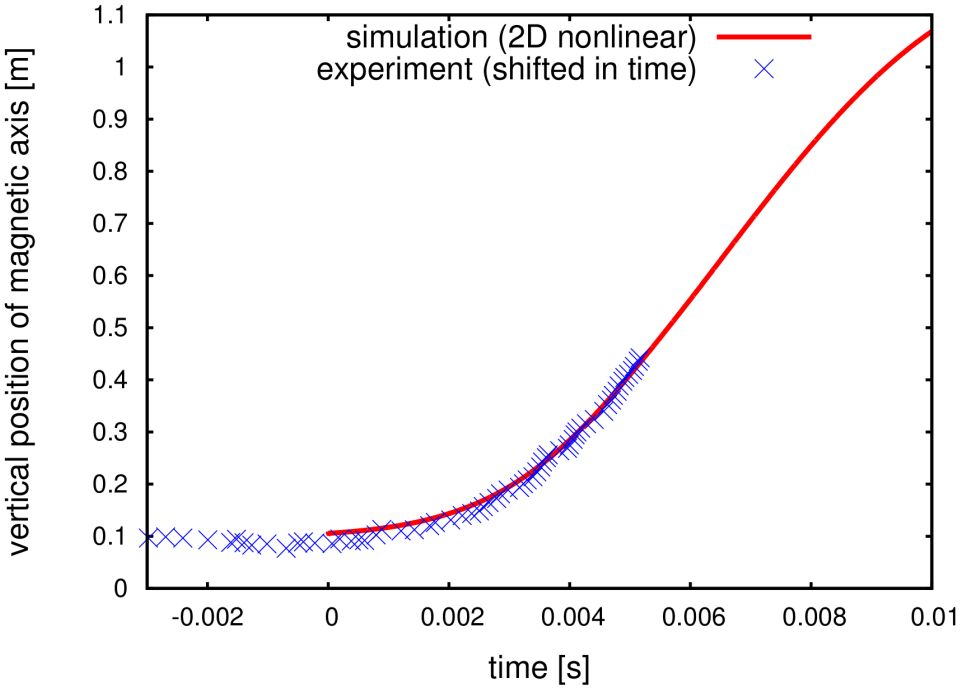
- scrape-off layer width can be self-consistently changed via heat diffusion anisotropy





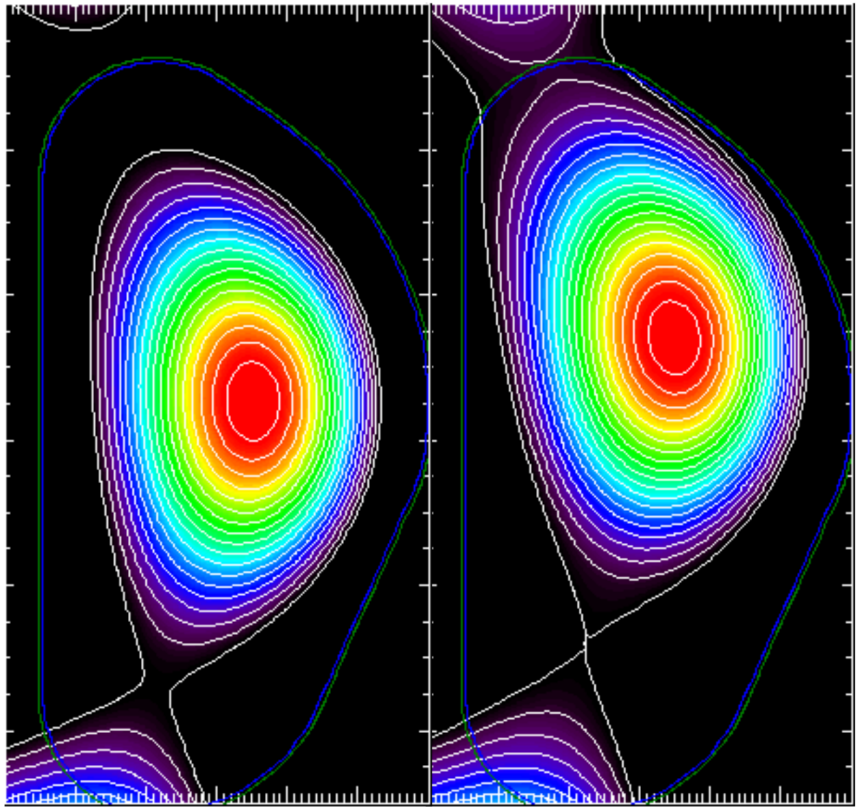
Preparation of 3D nonlinear simulation

- axisymmetric nonlinear test simulations
- mimic thermal quench by increasing heat diffusion
- wall resistivity chosen to match experimental VDE evolution (5.25e-6 Ωm, wall width = 2cm)
- negative temperature offset (effective T_{edge} = 1.24 eV)



ITER benchmark

- planned: benchmark with CarMaONL code based on ITER baseline case using simplified 2D wall model
- initial 2D nonlinear test simulation with increased wall resistivity



Summary

- Benchmark and validation activities to provide a basis for predictive capabilities
- Progress in benchmark of linear VDE growth rates between M3D-C[1], NIMROD & JOREK
- Influence of temperature in open field line region (& SOL width) on VDE growth
- Lessons learned regarding technical issues (domain boundary, linear restart,...)

Domain boundary size