

# NIMROD simulations of some Innovative Confinement Concepts

Charlson C. Kim

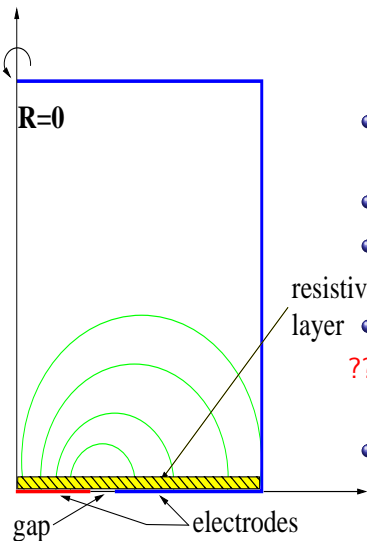
Plasma Science and Innovation Center  
University of Washington, Seattle

PSI-Center Meeting 2010  
University of Washington  
August 17, 2010

# Outline

- 1 Bellan Box simulations
  - coplanar flux injection
- 2 LDX simulations
  - LDX simulations
- 3 RFP simulations
  - FLR stabilization
  - edge modes
- 4 Misc.
  - Misc.

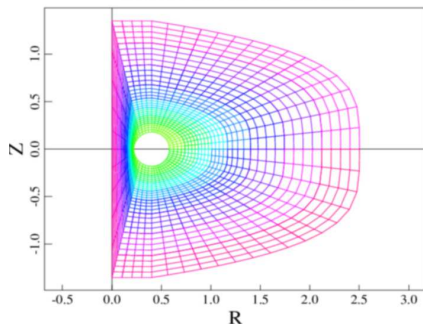
# Coplanar Flux Injection Simulation



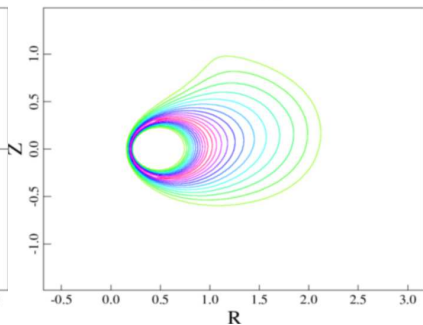
- simulation mimics geometry of Bellan vacuum vessel
- modest success with coplanar current injection
- thin highly resistive layer across bottom  $10^5$  larger than background resistivity
- exploit Ampere's law  $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I$
- ?? add curl-free surface  $E_R = \eta J_R - V_Z \times B_\phi$  (and  $V_Z$ ) to better control  $J_{pol}$
- **simulations lay fallow**

# LDX simulations

## Finite Element Mesh



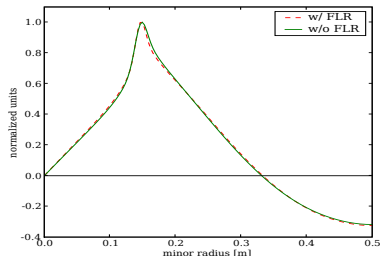
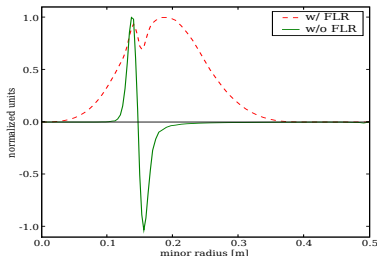
## Re Tion



- levitated superconducting cryo-donut generates dipole field  
1.2MA with divertor coil on top 100's kA
- add heat source to "grow" axisymmetric equilibrium
- add modes to "grown" equilibrium
- high  $n$  calculations run by J. Kesner (MIT)
- no contact since pre-Sherwood - may be worth visit

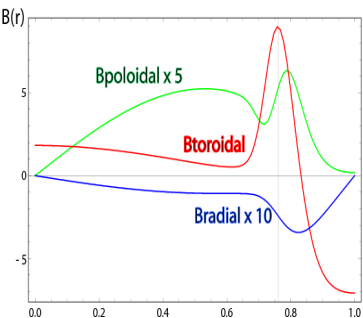
# FLR Stabilization of Tearing Modes in a RFP

- alpha model equilibrium  $\nabla \times \mathbf{B} = \lambda \mathbf{B}$   $\lambda = \lambda_0 \left[ 1 - \left( \frac{r}{a} \right)^{\alpha_0} \right]$
- cylinder  $a = .5\text{m}$ ,  $B_0 = .3\text{T}$ ,  $\lambda_0 = 3.5$ ,  $\alpha_0 = 3$ ,  $S = 10^4$
- stabilization with increasing  $\mathbf{v}_\perp$  (agreement Svidzinski 2003)
- velocity eigenmode altered (left), magnetic eigenmode unaltered (right)



# $m = 0$ Edge Tearing Mode in RFP's

plot provided by V. Mirnov



- $m = 0$  tearing mode seen in experiment
  - nonlinearly driven by high  $m$  tearing modes
  - spontaneously unstable in high confinement shots

- use  $\lambda \propto \left[ \exp \left( \frac{r^\alpha - d^\alpha}{w^\alpha} \right) + 1 \right]^{-1}$

- stable to high  $m$ , unstable to  $m = 0$
- toroidal eigenmodes compare well with experiment
- study interaction of edge modes with core
- energetic particles

# Misc.

- while in Colorado also visit A. Light - CU Boulder
  - discuss NIMROD simulations of CU-FRC
  - interested in tilt dynamics of merging spheromaks
  - interested in optimal center rod geometry
- NERSC future computing needs workshop
  - most likely hybrid GPU based machine
  - many “hidden” computing resources
    - workflow software
    - hidden free queues on clouds
  - should initiate a NIMPSI project directory
  - look into proto-FSP workflow tools