M3D plans for NCSX simulations

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External kinks and ELMs

- **We have studied fixed boundary nonlinear ballooning modes in NCSX**
  - **Found that high n ballooning limit underestimates the critical beta because hign n modes are stabilized by gyroviscosity (H. Strauss, L.E. Sugiyama, G. Y. Fu, W. Park, J. Breslau, N. F. 44, 1008 (2004))**
- **NCSX may be unstable to external kinks (toroidal mode number n ~ 5)**

- **We have been studying ELMs in tokamaks (H. Strauss, L. Sugiyama, C.S. Chang, G.Y. Park, S. Ku, W. Park, J. Breslau, S. Jardin, "ELM Simulations with M3D," 21st IAEA Fusion Energy Conference, Chengdu, China, TH/P8-6 (2006))**
  - **ELMs are peeling (kink) / ballooning modes**
  - **"vacuum" is modeled as low temperature, low density plasma**
  - **Low temperature: 3D Spitzer like resistivity model**
  - **Low density: upwind numerical method to deal with advection of steep edge density gradient**

- **We would like to apply these techniques to external kinks (low n) and ELMs (moderate n ~ 10) in NCSX.**

M3D – improved resolution

- **Can perform full torus simulations**
  - **Previously simulated 1/3 torus in NCSX**
  - **Computers are now faster**
  - **Can include n = 1, 2 modes**

- **M3D has used a low order finite element discretization**
  - **We are developing high order spectral elements**
  - **could improve accuracy and convergence**