FY09, FY10, FY11

PPPL Theory MHD Studies (non-stellarator)

M3D Code Development and Applications

- Improve vacuum code interface to handle ITER double wall and axisymmetric terms (MC)
- Continue sawtooth studies to better understand period and trigger dependencies on transport quantities.
    - Include flow and two-fluid physics (JB)
- Extend sawtooth studies to include energetic particle component (SWIM). (JB)
- Simulate Zakharov model of kink-unstable plasma in contact with resistive wall (JB)
    - Extend error field and RMP studies to include rotation effects. Clarify when island shielding (amplification) will happen. (JB)
- Implement chaotic coordinate technique for calculating heat conduction in stochastic fields during sawtooth cycle.
    - Possible collaboration with Japanese and inclusion in HINT (SH)

M3D-C^1 Code Development

- Carry out extensive 3D linear tests benchmarking: (SJ)
    - Free-boundary capability for different “vacuum” models
    - Dependence of growth rates on flow and 2-fluid terms.
- Improve and automate the grid-packing and rezoning features to increase efficiency (SJ)
- Implementation of non-rectangular domain boundary.(SJ)
- Implement resistive wall boundary condition for study of resistive wall modes (MC)
- Begin fully 3D non-linear studies using PETSc GMRES with Block-Jacobi pre-conditioner using SuperLU_dist.
    - Initial applications is to benchmark with M3D (SJ, JB)

SWIM Project

- Add additional components as needed to the Integrated Plasma Simulation system (IPS)   (NUBEAM, NOVA-K)
    - perform detailed modeling of LHCD current ramp on CMOD, including stability evaluation,
    - model CMOD sawtooth modification experiments,
    - Realistic ITER discharges.
- Develop and calibrate improved reduced “Porcelli-like” sawtooth model using NOVA-K module in IPS
- Parallelize the TSC/TGLF transport advance
- Simulation and analysis of sawtooth in the presence of energetic particle population
- Realistic simulation of ECH stabilization of NTM

Adaptive Mesh Refinement MHD Project

- Validate AMR pellet code using DIII-D data (RS)
- Develop free-boundary version of AMR code and apply to ELM simulations (RS)
- Basic studies of plasmoid formation in high-Lundquist number magnetic reconnection (RS)
- Basic studies of interfacing new implicit methods to AMR code to enable studies of resistive modes in tokamaks.(RS)

Resistive Wall Mode Theory. (SS, SJ)

- Develop a high-accuracy eigenvalue code in collaboration with Jeff Freidberg (MIT) that solves the ideal MHD equations together with arbitrary flow, and with a resistive wall, and
    - obtains the equations in a standard form: $A \bullet X = \lambda B \bullet X$.
    - Emphasis is on resolving the continuum damping

Neoclassical Tearing Mode

- Applying helical symmetry (2D) version of PIES code to compute saturated island size for NTM.
    - Comparison with TFTR data. (DR, DM, AR, EF)
    - Possible extension to 3D PIES

Linear (Ideal MHD) Stability Studies

- Modeling experimental discharges: stability analysis, mode identification, and comparison of synthetic diagnostics (SRX, ECE, MSE) with experimental data. (JM)
    - NSTX(Maingi, Canik, Sontag and Delgado),
    - LTX(Majeski,..),
    - DIII-D (Okabayashi),
    - JET (Gryaznevich, Hender, Howell)
- Collaborate with Efremov Institute on disruption kink mode simulation with electro-magnetic model of the ITER wall (LZ)

Equilibrium reconstruction and ASTRA-ESC code system (LZ)

- Perform calibration of magnetic diagnostics on LTX in the double wall environment
- Incorporate the theory of variances into equilibrium reconstruction technique
- Combine the ESC reconstruction routines with ASTRA transport simulations for future Real Time Forecast of ITER discharges
- Simulate the LiWall Fusion plasma regimes for NSTX, ITER, 3 step ST program

Stability of a special case of separatrix limited plasmas with finite current density at the edge (LZ)

- Develop the integral equation solver for the mentioned case
- Make comparison of results with the KINX and other codes
- Determine stability limits for LiWall Fusion plasma regimes

Dependence of local magnetic reconnection layer width on global geometrical parameters (JB)

- Using magnetic reconnection code developed for Breslau thesis
- Working with MRX (Ji) and student (Jacobson)