Gerhardt: NSTX Capabilities May Enable Interesting Experiment/Simulation Comparison for Disruption Physics

- Halo Currents:
  - Ever expanding array of halo current diagnostics in NSTX
  - Presently focusing on increased coverage with “instrumented tiles”…resistor under the tile.
    - Increased lower divertor coverage in 2010
    - More in upper divertor in 2011…can we actually measure the halo width?
  - ITER task agreement to benchmark TSC halo current model against NSTX and AUG data presently underway.
    - NSTX modeling by R. Sayer and S. Jardin.

- Thermal quenches and beta-collapses.
  - NSTX plasmas suffer from both traditional pre-disruption thermal quench and large beta-collapses due to RMWs, LMs, VDEs,…
  - Both lead to near total energy loss (and presumably divertor/FW heat loading).
  - Combined ORNL fast IR camera capability and JHU USXR measurements should allow experimental studies of collapse dynamics, in core and divertor.
  - Can we created a simplified disruption scheme where it is possible to make comparisons to a nonlinear MHD code?
    - Themal quench following a triggered VDE (q_{edge}=? at time of collapse?)
    - Beta collapse following a LM?
    - What are the best points of simulation/experiment comparison? Central stored energy collapse time, divertor heat flux?
    - Do the details of the initial MHD mode impact the characteristics of the final disruption (both experiment and simulation)?

R. Maingi: ELM physics

- Small ELM as resistive MHD:
  - Naturally occurring small ELM regimes may be the most promising for future devices, provided the ELM physics can be understood. Here one could use M3D to compare with characteristics of naturally occurring small ELM regimes, particularly if some part of the operational window has a transition to giant ELMs (e.g. Type V ELMs)
- Giant ELM physics:
  - giant ELMs may uniformly consist of a large edge perturbation, followed by relaxation of gradients due to proximity of critical gradients (e.g. Tritz's paper on 2 time scale giant ELMs, with longer time scale related to cold pulse). The largest ELMs define the PFC lifetime in devices, so understanding these is important. Compare M3D simulations with data from giant ELM discharges, and try to understand why triangularity helps to recover normal ELMs.

- Triggered ELM comparisons with M3D, trying to understand important underlying instability mechanisms. Pretty self-evident. Looking at sub-threshold fields and plasma response would be very interesting

Menard: Kinetic extensions applied to ELM and EF

- Kinetic MHD effects recently shown to be important for RWM
  - Bounce, transit, precession, E×B motion all matter for determining mode damping and therefore marginal stability
    - Fast ions also important – expect this to be discussed by Sabbagh
- Idea: Extend PEST/MISK analysis to NSTX ELMs
  - There are questions about the validity of the $\omega^*_i/2$ correction added to ideal growth rate to compute stability (ala ELITE)
  - Can we use MISK for low-n NSTX ELMs to incorporate the non-ideal effects more self-consistently?
- Idea: Extend PEST/MISK analysis to islands/locked modes
  - Mode natural frequency is supposedly determined by diamagnetic rather than E×B frequency in ohmic plasmas.
  - This frequency difference from lab (i.e. error field) frame likely responsible for plasma self-shielding of error fields
  - Use M3D to investigate impact of diamagnetic flow on locking thresholds?
    - Extend error-field/locked-modework already done by Breslau and Park
- Note: Some in community still use PEST-3 – how do we support this?
  - Should we do more?

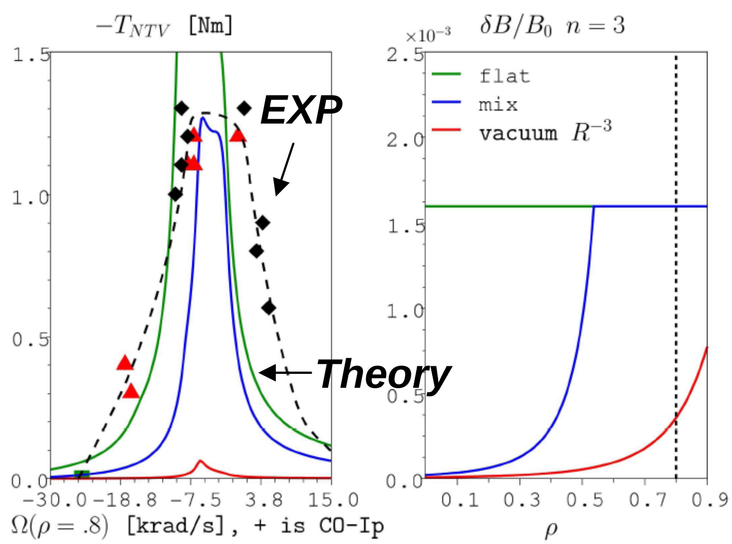
J-K Park: Numerical simulation of 3D neoclassical transport (NTV transport) is necessary

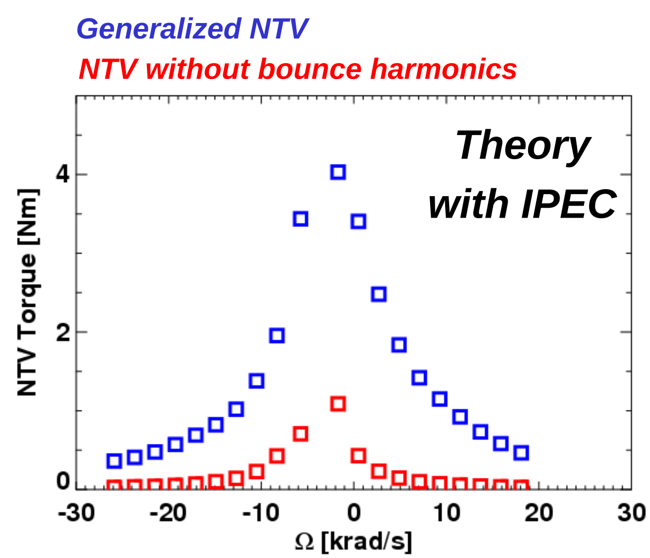
- Magnetic braking (Sabbagh,Park) - toroidal momentum transport by 3D field - in tokamaks is still empirical?
- Theoretical prediction (Shaing,Mynick,Boozer,Park,Cole) is already complicated and must be tested by numerical simulation?

$$\tau_\varphi \cong C\left[\delta B\right]^2 p \frac{\nu(\omega_E - \omega_0)}{(\ell\omega_\ell - n\omega_E - n\omega_B)^2 + \nu^2}$$

- Present ORBIT (White) can be used to test Maxwellian particles? With realistic radial variations of given energy and field?
- Other codes such as FORTEC-3D (Satake,Wexing) is necessary?

DIII-D n=3 braking





A. Boozer: MHD THEORY OF IMPORTANCE TO NSTX

- Analysis of error fields, RWM's, and ELM control require perturbed plasma equilibria. The central topics are

- Toroidal torque due neoclassical (NC) transport:
  - Prediction of even small torques requires better calculations.
  - Strong torques shield perturbations; requires change in IPEC.

- Opening of magnetic islands:
  - An island broader than ρ_s locks plasma.
  - Island shielding implies torque, but $\vec{\nabla} \times \vec{B} = \mu_0 \vec{j}$ limits torque.

- Both topics could be addressed with known techniques. Making ELM control predictable will place special demands on the theory of these two topics.

Breslau/Jardin: NSTX core saturated 1/1+2/1 mode

- Common in NSTX as q_{min} → 1.1-1.3 + weak reversed shear?
  - Menard kink/interchange NF 2005/PRL 2006, Gerhardt NTM NF 2009
- Submitting a theoretical/modeling IAEA paper on the onset of the saturated m=1 mode with m=2 islands in NSTX, and implications for Advanced Tokamak operation in ITER.
  - Have linear stability analysis of Shot 124379 and find a mode similar to the experimentally observed mode.
  - Looking at the nonlinear saturation of the mode, and how it depends on initial conditions, etc.
  - Starting a TSC simulation of that shot, and will include NUBEAM modeling of the fast ions.   This is something that we promised for the SWIM work scope, and this paper will provide additional motivation.
  - Have at least one JSOLVER equilibrium for NOVA-K
    - What do we know about the experimentally observed EP modes for shot?