Some Ideas for the Boundary Program

UC San Diego

- Many of the Reactor/ITER critical issues are edge-related:
  - ELMs and ELM control
  - Turbulence and Intermittency > Transport
  - Heat and particle loads to PFCs in-between ELMs (mostly intermittency)
  - Carbon transport >> Tritium retention
  - L-H transition details
  - Pedestal formation
  - Momentum transport

Lots of Progress Made Lately. But…….

UC San Diego

- ELM theory and measurements
- RMP ELM suppression. High collison. mitigation, etc.
- ELM-mediated particle and energy transport to SOL/walls
- Intermittent transport characterization and understanding
- Pedestal understanding improving
- Turbulence modeling greatly improved
- 3D boundary modeling emerging
- BUT:
  - Further understanding of the boundary is lacking
  - Some critical unknowns, edge physics needs new/more diagnostics

Unknowns Point to Possible Directions

UC San Diego

- Mass and Energy Transport is still poorly understood. Codes can NOT reproduce measurements, fully, everywhere.
- Among unknowns are: *Poloidal asymmetries in radial turbulent transport. Parallel flow generation by anomalous momentum transport or poloidal asymmetries. 3D structure of field (and errors) on heat/particle transport (heat footprint on divertor floor <> homoclinic tangles)*
- Also, *momentum transport in edge, off-diagonal transport terms (Reynolds Stress), zonal flows in L-H transition.*
- These lead to the rest >> impurity transport, tritium retention, etc.
- Unknown quantities are: Neutral density, Ion temperature, flow velocities, etc.
- New diagnostics needed to reduce code free parameters and uncover the physics. (Nn, Ti, Vflow, etc)
- Diagnostic coverage needs improvement (extend toroidally and poloidally, upper divertor ,etc)

What can be a focus for NSTX Boundary?

UC San Diego

- What basic physics needs understanding/measuring?
  - ***Tackle turbulent radial transport asymmetries***
    - ***Techniques exist, extend diagnostic spatial coverage***
  - ***Measure poloidal/toroidal flows and ExB flows***
    - ***Dito***
  - ***Measure Nn and Ti in the edge/SOL***
    - ***Need to develop somewhat***
  - ***Momentum transport?***

- These should do for vastly improved 2D understanding >> Compare to 2D fluid codes. Compare to new, improved turbulence codes. Improve pedestal understanding.

- Further understanding requires toroidally extended diagnostic coverage >> compare to emerging 3D codes, ELM rotation, etc.

Active Heat Deposition Control

UC San Diego

- One focus could be on heat flux to divertor
  - Add coil sets and fast power supplies to take advantage of homoclinic tangle divertor footprint
    - Sweep tangles across floor to spread heat flux
  - Add divertor diagnostics (X-point probe)
    - Instrumented tiles with dense probes and thermocouples
- Add divertor channel/leg to improve detachment
- If Lithium does not perform as expected, add a cryo pump