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Theory / Experiment Comparisons over Next Five Years

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Boundary Physics Five Year Planning Meeting

Princeton, NJ
February 12, 2007

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PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. Edge Theory & Modeling Community Focused on Kinetic Edge Codes for Next ~5 Years

NSTX

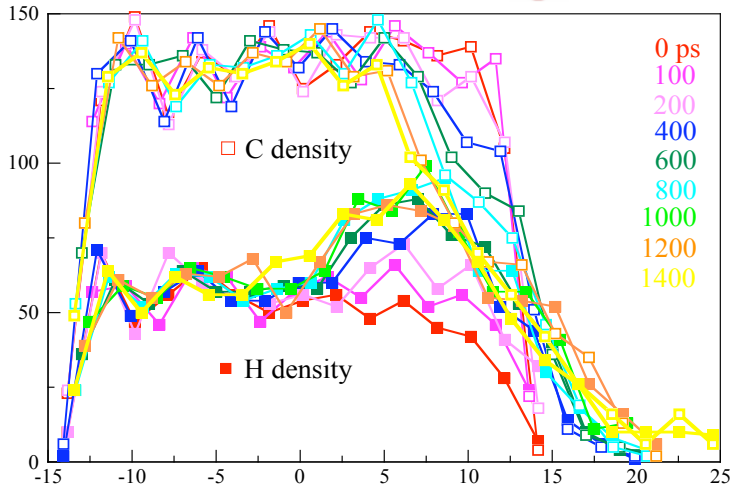
- Two code projects underway:
  1. Center for Plasma Edge Simulation - PIC (C. S. Chang, PI)
  2. Edge Simulation Laboratory - continuum (R. Cohen, PI)
  - Both L-H transition, SOL turbulence & transport, pedestal buildup, ELM stability & crash.
  - End goal: predictive capability (e.g., for ITER).
- Codes will need to validated,
  - Dedicated, well diagnosed experiments.
  - I.e., will need additional & improved diagnostics,
  - Willingness to dedicate experimental run time to validation.

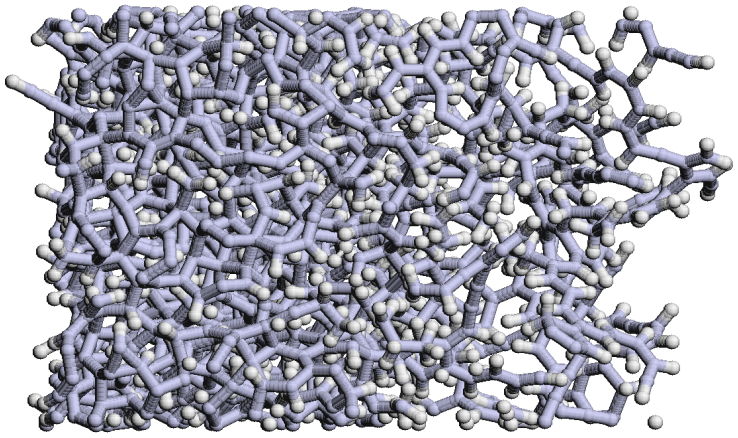
Parallel Effort in Interpretive Modeling Needed

- SOL turbulence & transport
  - Continue characterization of blobs & associated fluxes,
  - Use data to validate codes & theories ⇒ basis for predicting SOL width scaling.
- Divertor transport
  - Best tool: 2-D divertor Thomson scattering system.
    - Combined with fast camera data in divertor, can infer neutral densities.
    - Analogous to method currently proposed for midplane.
  - Complementary approach: Onion Skin Model,
    - I.e., a coupled set of two-point models.
    - Need detailed target plasma profiles, e.g., from Langmuir probes.
    - And upstream TS & probe profiles.
    - ~1 FTE required to establish & carry out modeling capability.
- Pedestal & ELM stability
  - Test peeling / ballooning model with Type I, III, and V ELMs.
  - Data on nonlinear stage of evolution?
  - Again, ties into edge kinetic code effort, including M3D & NIMROD.
  - More general: investigate 3-D physics effects.

Rapidly Improving Plasma-Material Interaction Simulations & Models Will Need to be Tested

- E.g., detailed MD simulations provide microscopic description of material evolution,
  - May provide basis for transport time scale descriptions like that being developed for B2.
- A DiMES probe capability would be useful,
- Fast IR camera also.
- But, may not be sufficient,
  - Will want to be prepared to take advantage of new PMI diagnostic techniques.





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Near Term Tasks Needed to Lay Groundwork for 5 Year Plan

- Examine feasibility of Onion Skin Modeling,
  - Do we have adequate target Langmuir probe data?
- Verify that we can get radial neutral density profile from (passive) fast D_α & D_β camera data at midplane,
  - P. Ross analysis,
  - DEGAS 2 / atomic physics inversion.
- Initial edge pedestal stability modeling with PEST or M3D.