XGC0-DEGAS2 Edge & SOL Transport Studies

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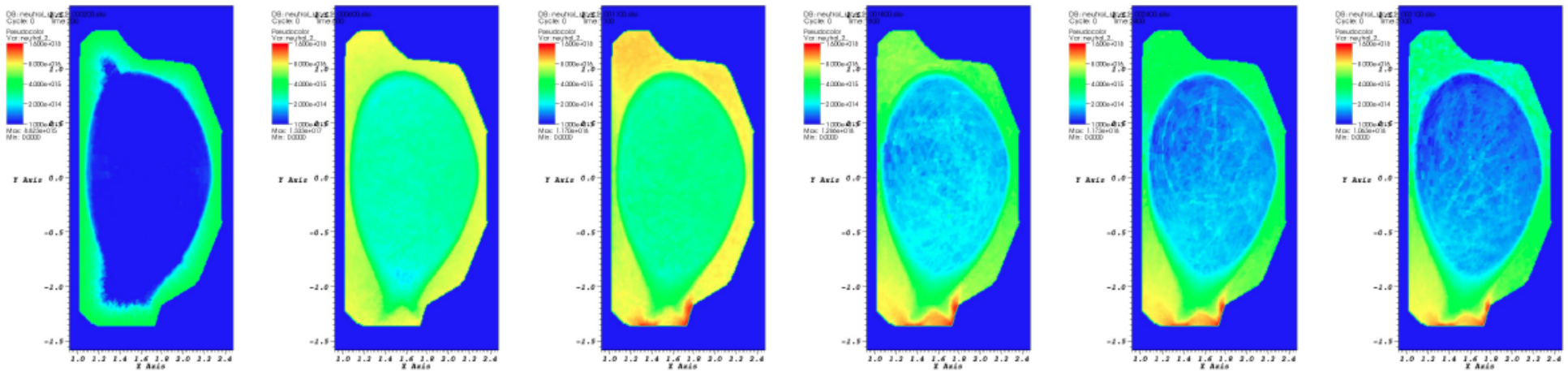
PRINCETON
PLASMA PHYSICS
LABORATORY

Coupled XGC0 Neoclassical Particle & DEGAS2 Monte Carlo Neutral Transport Codes Provide Kinetic Treatment of Recycling, Edge & SOL Plasma

- XGC0: neoclassical plasma density, temperature, rotation, electrostatic potential transport in separatrix geometry.
  - Neoclassical, Lagrangian particle motion, momentum & energy conserving collisions.
  - Neutrals, impurities (fixed charge state), specified anomalous transport.
  - Highlights:
    - Narrowing of SOL heat flux width due to NC effects (2010 JRT),
    - More accurate bootstrap current calculations,
    - Self-consistent RMP penetration & pedestal response calculations,
    - NC explanation for low Li concentration in NSTX core.
- XGC0-DEGAS2:
  - Characterized cold ions from recycling ⇒ “natural fueling” pinch.
  - New: consistent evolution of recycling, neutral & plasma profiles as pedestal builds up.



Impurity Transport & Radiation in XGC0-DEGAS2 Edge NC Transport Code

- Capabilities supporting NSTX-U:
  - Improved understanding of impurity generation & transport,
  - Consistent calculation of impurity radiated power and source rates due to sputtering & evaporation.
- Code Development:
  - Incorporate transport of all impurity charge states & associated radiation into XGC0,
    - Rates will come from ADAS.
  - Add impurity sputtering sources to DEGAS2,
    - Use empirical & theoretical rates for sputtering, evaporation.
- Limitations:
  - Material state & PMI input, via either empirical or simplified models.
  - Effects of turbulence described by anomalous diffusion.
- For validation:
  - Camera coverage of all PFCs & 2-D tomography ⇒ quantify impurity (& D) emission,
  - 2-D plasma parameters in SOL & divertor ⇒ compute from emission impurity (& D) sources.
  - Surface probe data ⇒ characterize incident fluxes.

SOL & Divertor Transport in XGC0 Edge NC Transport Code

- Capabilities supporting NSTX-U:
  - Next step towards first principles edge, SOL, & divertor simulation capability.
  - Physics content comparable to fluid plasma models UEDGE, B2, but fully kinetic.
  - Improved simulation of heat loads & divertor flow patterns.
  - Kinetic characterization for PMI studies, probe physics.
- Code Development
  - Near term: 2-D varying electrostatic potential in SOL with $\|$electric field = electron pressure gradient.
  - Longer term: verify against UEDGE, B2.
- Validation: similar to above,
  - But, can utilize any additional data for constraining unknowns,
  - E.g., neutral density, MAPP probe,