PSI2 SciDAC — Integrating Codes to Model Plasma Surface Interactions: focus on Plasma Sheath Effects and Sputtering Near Surfaces

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**hPIC - Plasma Sheath**

- **Plasma Sheath:** establishes the link between "Edge" and "Wall"
- UCLA's full-F full-orbit plasma sheath code hPIC is used to analyze the near-surface ion kinetics
- hPIC accurately captures finite-orbit effects near to the wall, which are responsible for the generation of the magnetic presheath in oblique magnetic fields
- hPIC produces Ion Energy-Angle Distributions (IEAD) at the wall for plasma modes of multiple ion species
- IEADs are a necessary input to surface models (Fractal-TRIDYN & XOLOTL) and to the global impurity transport model (GITR)
- hPIC accepts inputs from plasma edge codes (SOLPS, XGC, etc.) and produces outputs which can be easily coupled to Material Codes

**F-TRIDYN - Ion/Matter Interaction**

- **Surface Sputtering:** the mechanism driving particle exchange between the plasma edge and wall
- F-TRIDYN is a Monte Carlo, Binary Collision Approximation code that handles atom- and ion-material interactions including reflection, implantation, damage, and sputtering
- Surface morphology is modeled in F-TRIDYN, which has a significant effect on ion-material interactions
- F-TRIDYN produces depth profiles of implanted plasma species and energy-angle distributions of reflected plasma and sputtered target species
- Accurate implantation profiles are necessary to model material evolution with Xolotl
- Sputtered target particles are the primary source of impurities tracked by GITR

**XOLOTL - Material Evolution**

- **XOLOTL:** Diffusion-Advection-Reaction model of cluster dynamics
- Xolotl solves the helium cluster evolution (cluster concentration, cluster size) and predicts quantities such as the percentage of implanted ions that is retained below the surface, fuel retention, etc.
- The code captures retention oscillations as a function of time due to bubble bursting at the surface (fig below)
- Xolotl has been coupled to F-TRIDYN through the IPS framework (trace view below)

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https://collab.cels.anl.gov/display/PSIscidac2/Plasma+Surface+Interactions+2