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

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

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**hPIC - Plasma Sheath**

- Plasma Sheath: establishes the link between "Edge" and "Wall".
- UUC's full-F full-orbit plasma sheath code hPIC is used to analyze the near-surface ion kinetics.
- hPIC accurately captures finite-orbits 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.

** GITR - Impurity Transport**

- **ITER Geometry for GITR Simulation**
- **ITER Outer Diverter Target (Graded W Melt)**
- **XOLOTL - Material Evolution**

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**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 atomic-scale 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.

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**FTRIDYN Simulations of Tungsten Self-Sputtering and Applications to Coupling Plasma and Material Codes**

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**XOLOTL**

- **XOLOTL - Material Evolution**
- Diffusion/Adsorption Reaction model of cluster dynamics.
- Model simulates 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://github.com/ORNL-Fusion/xolotl