

# PUMIPic Parallel Unstructured Mesh Infrastructure for Particle-in-Cell

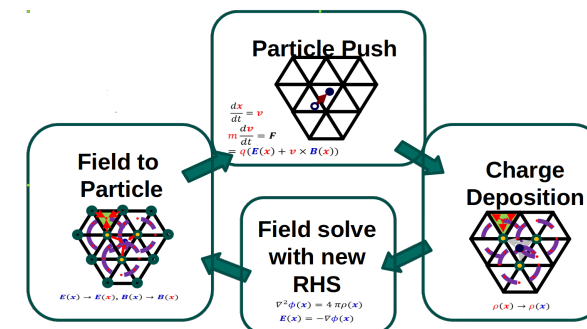
Parallel management of unstructured meshes with particles.  
Framework for GPU accelerated particle-in-cell applications using unstructured meshes.

## Core functionality

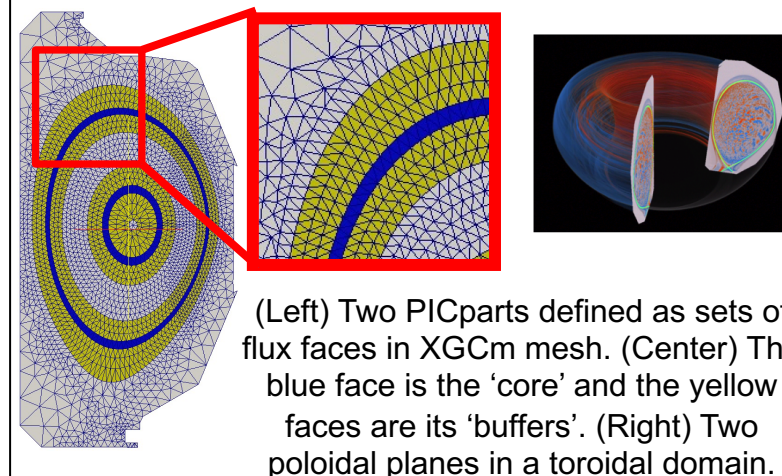
- Unstructured mesh-based approach
  - Particles accessed through mesh
  - Particle search through mesh adjacencies
  - Effective coupling to PDE solvers
  - Partitioning using bounding flux surfaces, graph, or geometric methods
  - PICpart: owned elements (defined by partition) + copied elements from topologically or spatially neighboring processes
  - Stored on GPU using Omega\_h library: [github.com/SNLComputation/omega\\_h](https://github.com/SNLComputation/omega_h)
- Particles
  - Supports multiple species each with distinct combinations of 'Plain Old Data' per particle
  - Group particles by the mesh element that they are spatially located within
  - Multiple choices for particle storage using abstraction layer: Sell-C-Sigma [Kreutzer 2014], COPA Cabana, and CSR.
- Parallel kernel launch function abstracts underlying particle and mesh storage

## Applications Supported

- GITRm: impurity transport
- XGCm: core+edge fusion plasma physics
- Weak scaling on up to 24,000 GPUs of Summit with 1.15 trillion particles running push, particle-to-mesh, and mesh-to-particle operations with an XGCm tokamak mesh and domain decomposition



Stages of a PIC application supported by PUMIPic



**Source Code:** [github.com/SCOREC/pumi-pic](https://github.com/SCOREC/pumi-pic)  
**Paper:** [scorec.rpi.edu/REPORTS/2020-2.pdf](https://scorec.rpi.edu/REPORTS/2020-2.pdf)