Applications of Unstructured Mesh Technologies

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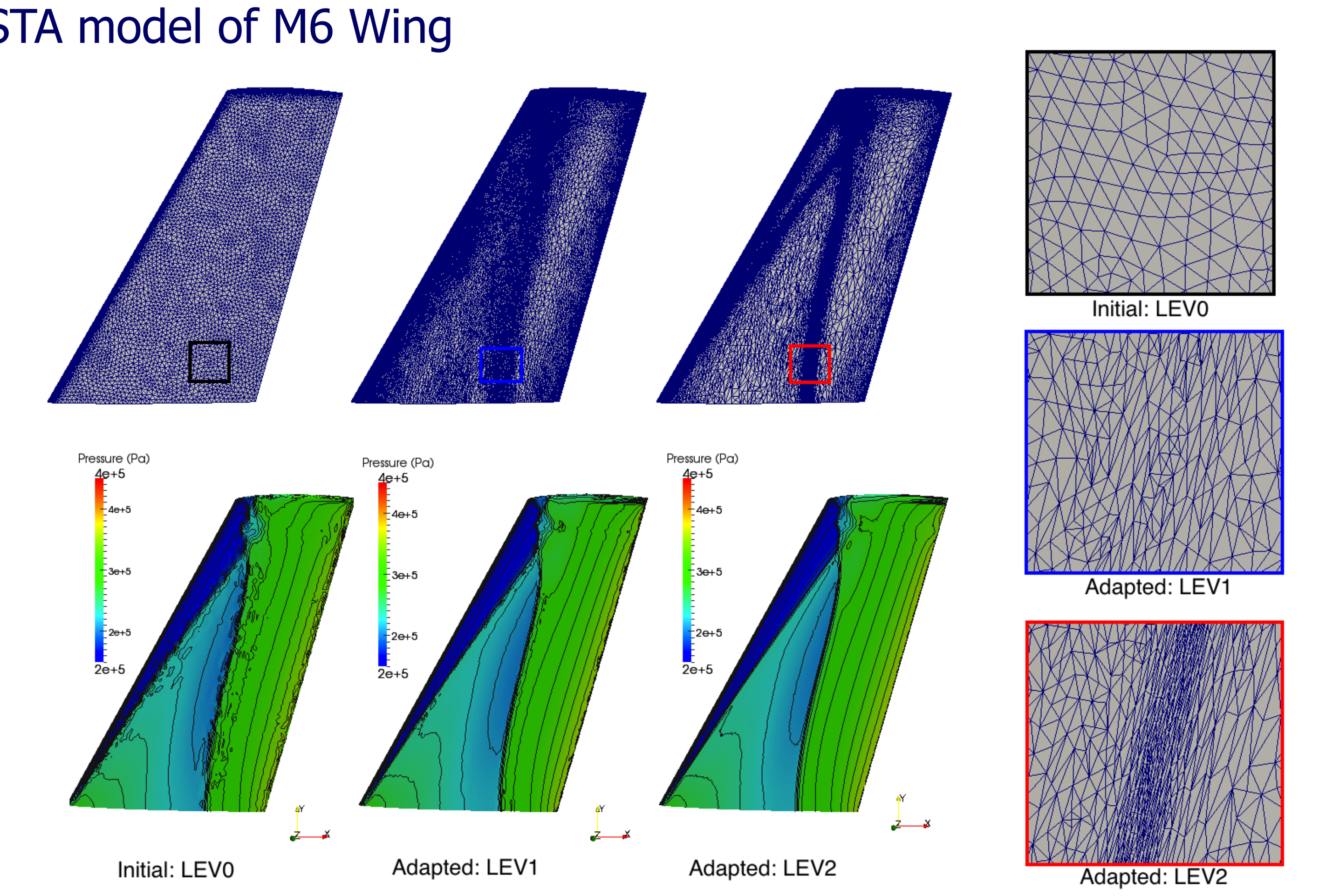
FASTMath unstructured mesh technologies are simplifying the development of parallel applications in a variety of application areas, allowing scientists to concentrate on the scientific discovery

Adaptive Mesh Refinement

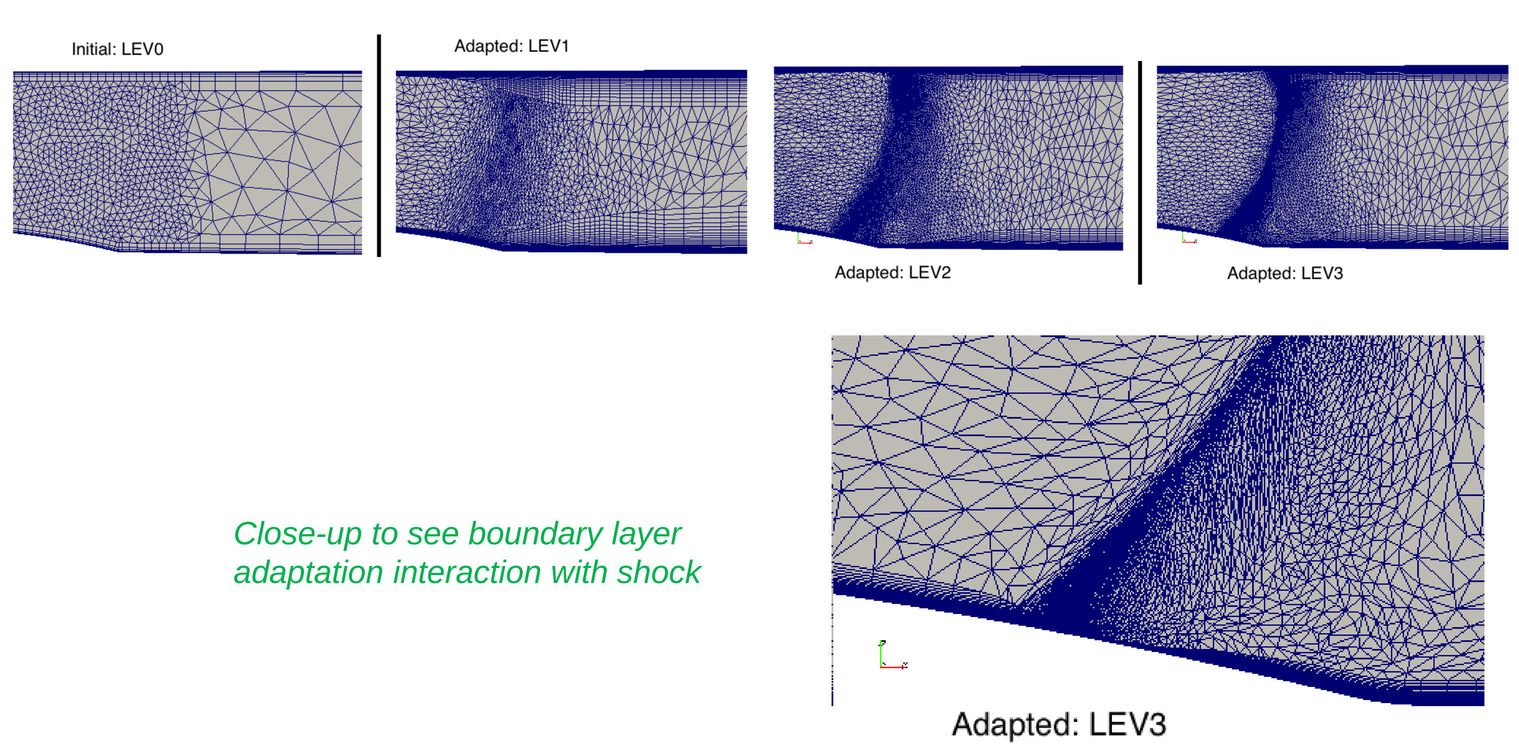
PHASTA model of M6 Wing



Boundary Layer Adaptation

- Boundary layer separation from wall affects model
  - If separated, wall shear stress computed using finite differences
  - If not, turbulent and shear stress computed using Spalding's Law
- Also need to control mesh when shock interacts with BL

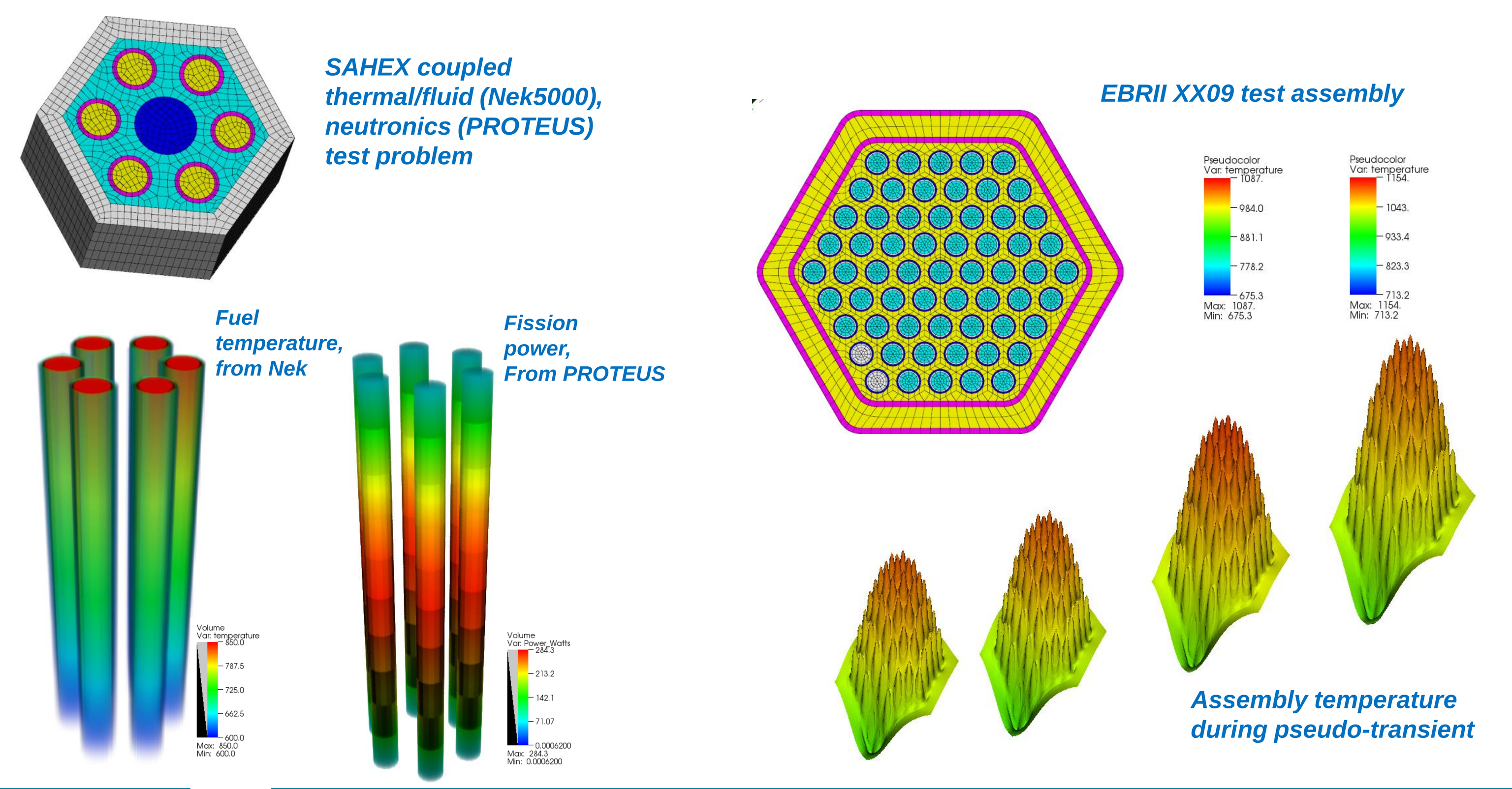
Evolution of adapted meshes



Close-up to see boundary layer adaptation interaction with shock

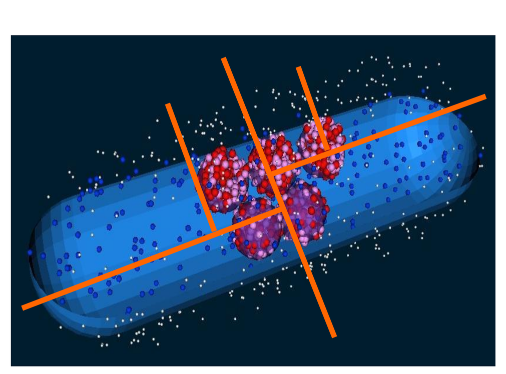
Parallel MultiPhysics Reactor Simulation

- Plug-and-play with existing physics modules requires conservative solution transfer between disparate meshes
- Physics modules communicate and possibly share mesh/solution with data backplane layer in MOAB
- Solution transfer must support different mesh types (tri/tet, quad/hex) and discretizations (FE, FV, SE)

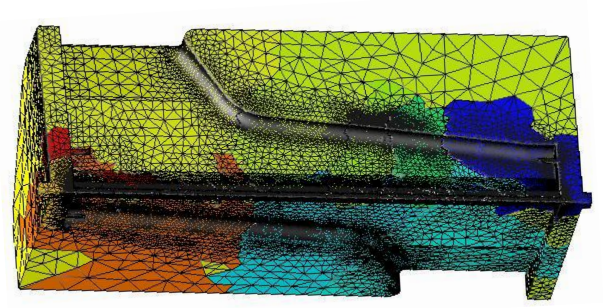


Zoltan Applications

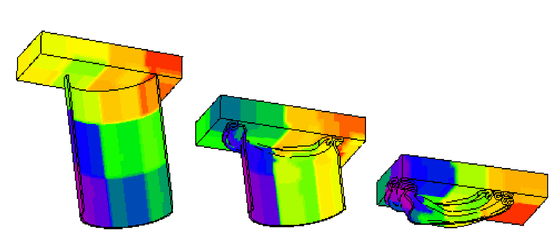
Partitioning and load balancing often comes with application-specific constraints or balancing metrics:
- Balance and locality for static partitioning (left)
- Load balancing with minimal migration for AMR (right)



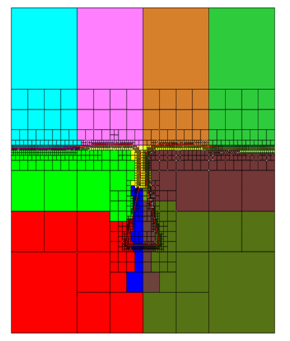
Balancing and maintaining locality of particles in cell simulations in ChemCell (S. Plimpton, SNL)



Rebalancing workloads during AMR to maintain scalability of PHASTA simulations (M. Shephard, RPI)



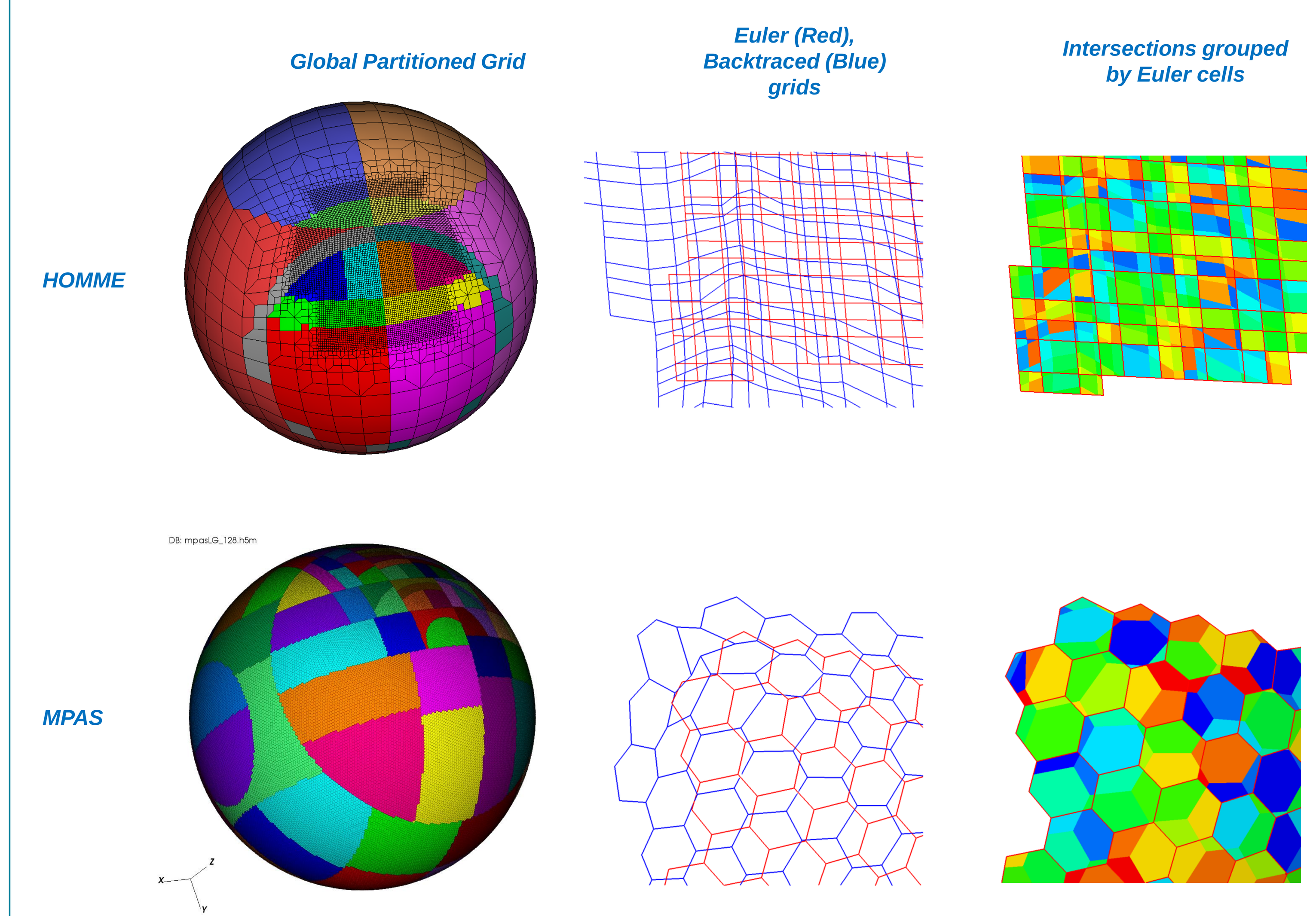
Maintaining geometric locality of surfaces for contact detection in SIERRA/ACME (K. Brown, SNL)



Redistributing work as AMR tracks chemical vapor deposition surfaces In CHISELS. (L. Musson, SNL)

Tracer Transport for Atmospheric Modeling

Conservative Semi-Lagrangian (CSLAM) tracer transport on arbitrary parallel meshes for CAM (SE, FV, MPAS, …)
- Current codes perform backtrace for every chemical species
- Current implementations also distinct for different grid types
- MOAB-based implementation works with arbitrary grid types
- Supports CAM-FV, HOMME, MPAS grid types; GCRM coming soon



Other Applications

- XOLOTL (plasma-surface interactions)*
- XGC1 (plasma modeling)*
- Aces4bgc (bio geo-chemical transport)*
- ACE3P (accelerator modeling)*
- ParNCL (climate data analysis)
- AthenaVMS (fluid/structure interaction)
- FUN3D (high-speed viscous flows)
- DAG-MCNP (monte carlo neutron transport)

* - represented by talk or poster at this meeting

More Information: http://www.fastmath-scidac.org or contact Tim Tautges, tautges@mcs.anl.gov, 608-354-1459

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