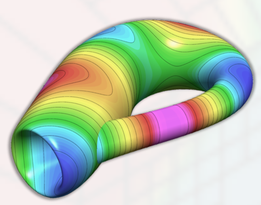
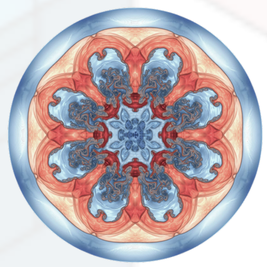
MFEM: Scalable Finite Element Methods

Modular Finite Elements

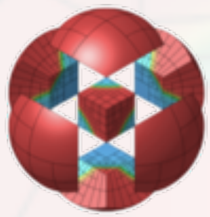
MFEM is scalable open-source C++ library for finite element research and fast application development

- ✓ *triangular, quad, tet and hex meshes (volume, surface, …)*
- ✓ *arbitrary order curvilinear mesh elements*
- ✓ *arbitrary-order H1, H(curl), H(div) and L2 elements*
- ✓ *NURBS geometries and discretizations*
- ✓ *bilinear/linear forms for many methods (Galerkin, DG, …)*
- ✓ *scalable assembly and linear solvers*
- ✓ *many example codes & miniapps*
- ✓ *integration with: xSDK, hypre, PETSc, SUNDIALS, SuperLU, …*

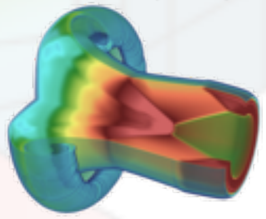
Powering next-generation multi-physics apps

MFEM: *Modular finite element methods*

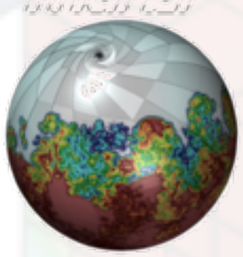


mfem.org

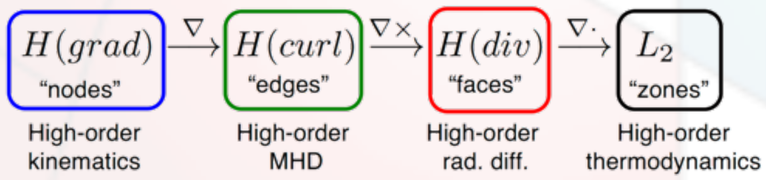
BLAST: *High-order multi-material ALE hydrodynamics*



www.llnl.gov/casc/blast

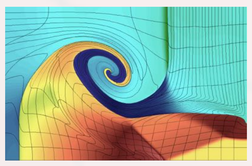


Finite elements naturally connect different physics



High-order finite elements on high-order meshes

- ✓ *increased accuracy for smooth problems*
- ✓ *sub-element modeling for problems with shocks*
- ✓ *FLOPs/bytes increase with the order*



CEED
EXASCALE DISCRETIZATIONS

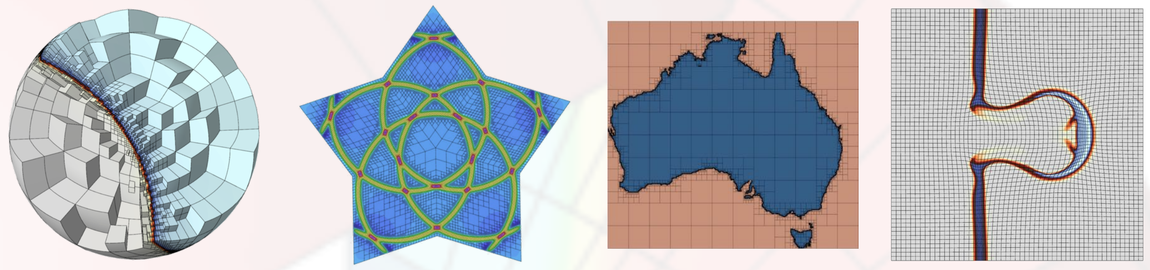
More information and downloads

- ✓ *MFEM project website: https://mfem.org*
- ✓ *BLAST website: https://computation.llnl.gov/projects/blast*
- ✓ *MFEM code repository: https://github.com/mfem*

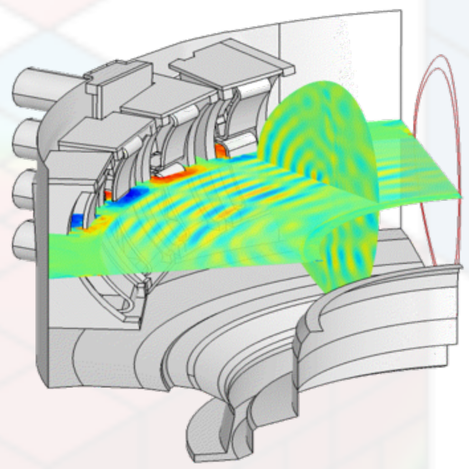
Recent Developments

Unstructured AMR and mesh relaxation at library level

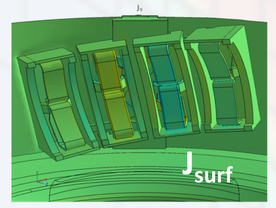
- ✓ *conforming local refinement on simplex meshes*
- ✓ ***non-conforming refinement for quad/hex meshes***
- ✓ *h-refinement with fixed p*
- ✓ *various mesh quality metrics + TMOP mesh optimization methods*

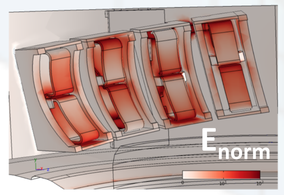


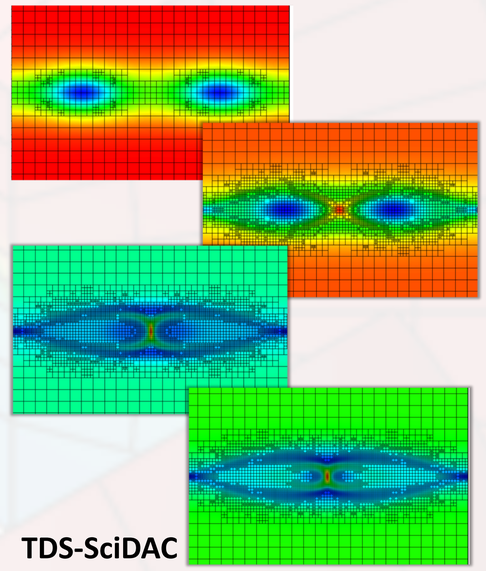
SciDAC Applications



RF-SciDAC



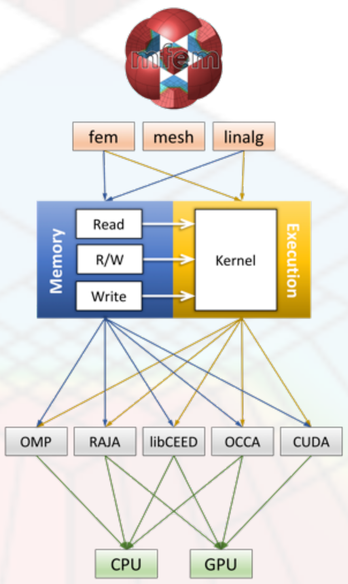


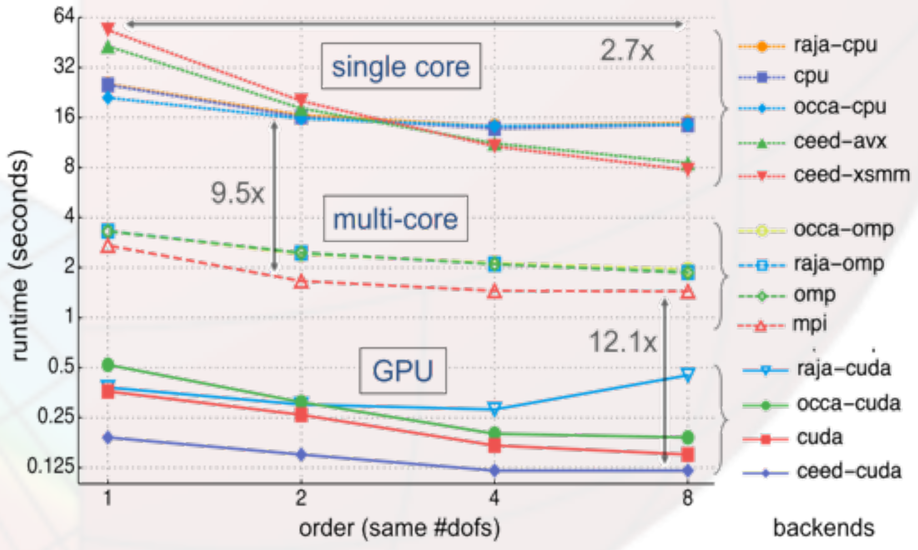


TDS-SciDAC

GPU acceleration

- ✓ *MFEM-4.0 adds GPU support in many linear algebra +FEM operations*
- ✓ *Kernels can be specified via loop-body capture, or raw CUDA, OCCA*
- ✓ *Backends are runtime selectable, can be mixed*
- ✓ *Coming soon: support for AMD GPUs/HIP*





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