Model Order Reduction

S&T Campaign: Computational Sciences
Predictive Simulation Sciences

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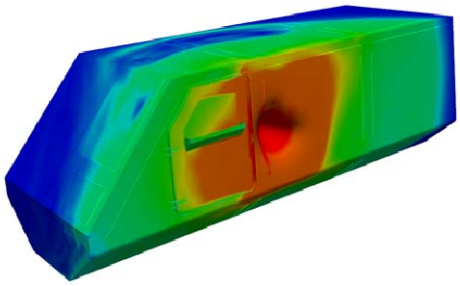
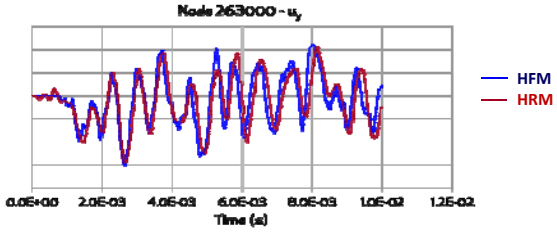
Research Objective

- Develop nonlinear Model Order Reduction (MOR) methods that are applicable to a range of models, particularly Underbody Blast, to enable parametric studies in a reasonable amount of time.
- Accelerate the meaningful interpretation of large amounts of data generated by High Fidelity Models (HFM) minimizing the burdens associated with "big-data".



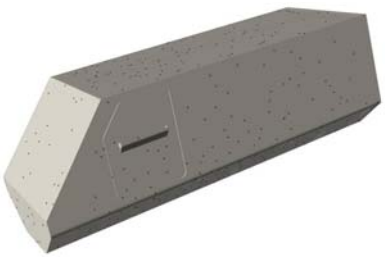
Underbody Blast High Fidelity Model with 476,749 Elements



Comparison of HFM and HRM. 23,000 X speedup.

Challenges

- Nonlinear models present all sorts of difficulties such as shock waves, large deformations, fractures, etc. Capturing these effects in a stable and accurate Reduced Order Model (ROM) is challenging.
- Nonlinear ROM operation count scales with the large HFM dimension. A second level approximation, hyper-reduction, is needed to reduce this dependency.



Hyper-Reduced Model (HRM) performed on 1,177 Elements.

ARL Facilities and Capabilities Available to Support Collaborative Research

- Blast Protection of Platforms and Personnel Institute
- Software development expertise
- Numerical analysis expertise
- Open Campus
- ARL Distributed Shared Resource Center
  - Unclassified: 3.7 PFLOPS
  - Classified: Combined 780 TFLOPS

101,184 cores, 3.7 PFLOPS, 400 TB Memory and 4 PB disk.

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Expertise in Model Order Reduction
- Expertise in CFD and CSM
- High Performance Computing (High Fidelity Models)
- Computational Science
- Mathematics
  - Numerical Analysis
  - Linear Algebra
  - PDEs & ODEs

Multidiscipline effort required to put it all together.