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Creating a Blast-Induced Shock Environment

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ESRF External Review Board, 7/15/21

NEW MEXICO TECH
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LDRD LABORATORY DIRECTED RESEARCH & DEVELOPMENT

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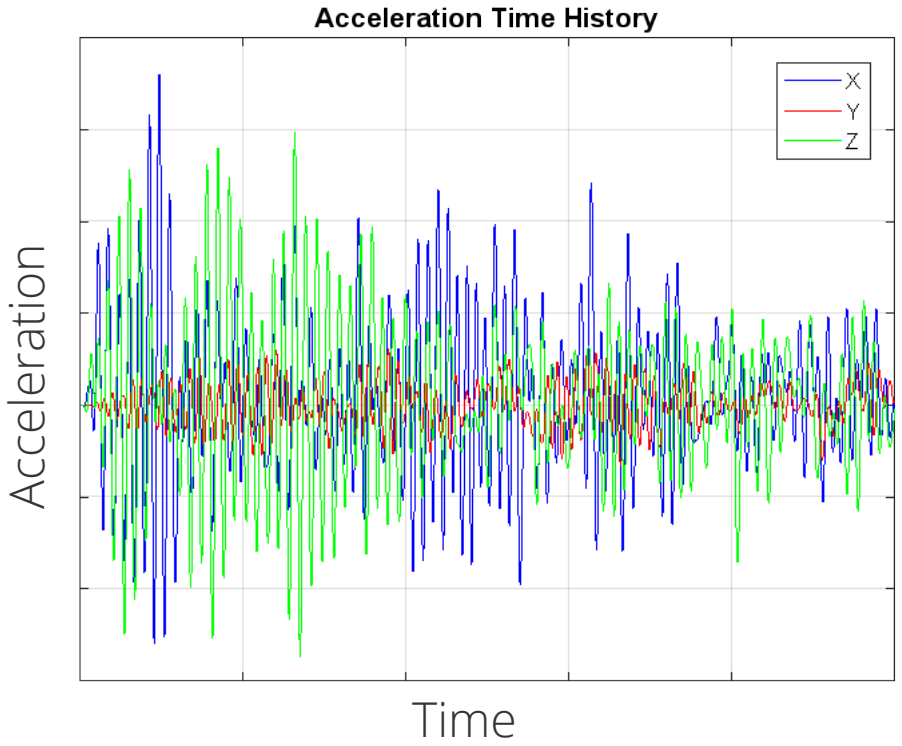
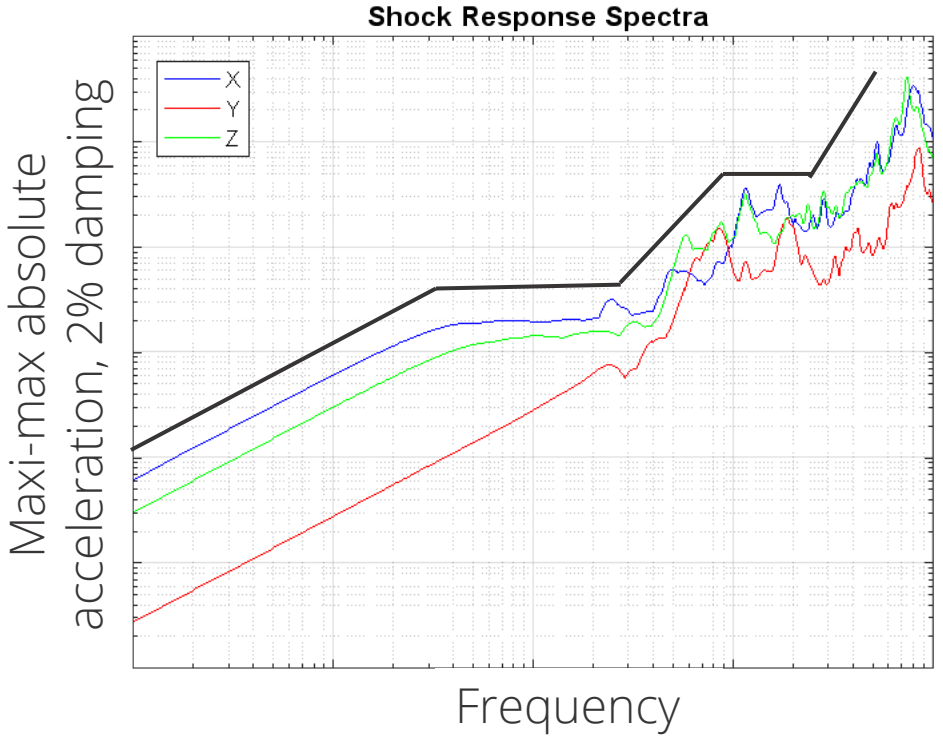
Our goal is to use explosives to create representative environments

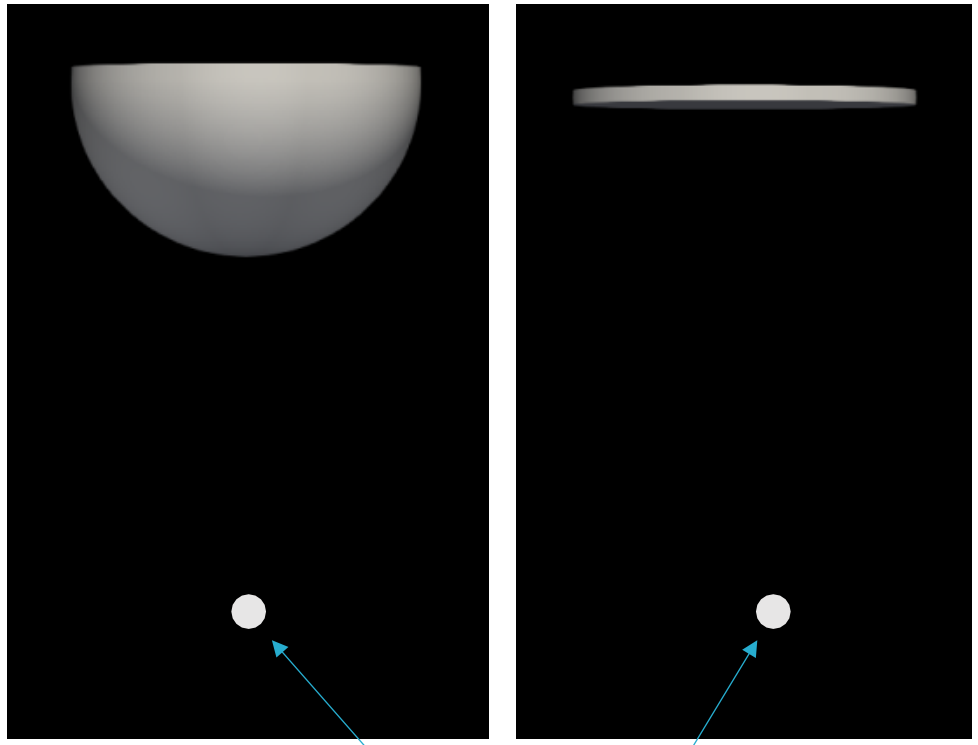
- An **environment** is characterized by acceleration vs. time input on a test article
- Environments created in lab using different machines
  - resonant plate, shaker table, drop shock machine
- To be representative, the lab input is specified based on the shock response spectrum (SRS) and “envelopes” the SRS curves





Fundamental blast-induced shock environment study

- Scientific question: **How does the structural vibration response depend on blast loading?**
- "Simple" lab-scale configuration of explosive and structure
  - Plate and hemisphere geometries
- Joint testing and mod/sim effort
  - Experiments performed at New Mexico Tech (through Campus Executive Program)
  - High fidelity simulations on Sandia HPCs
- Even lab-scale study is not addressed in literature to the best of our knowledge



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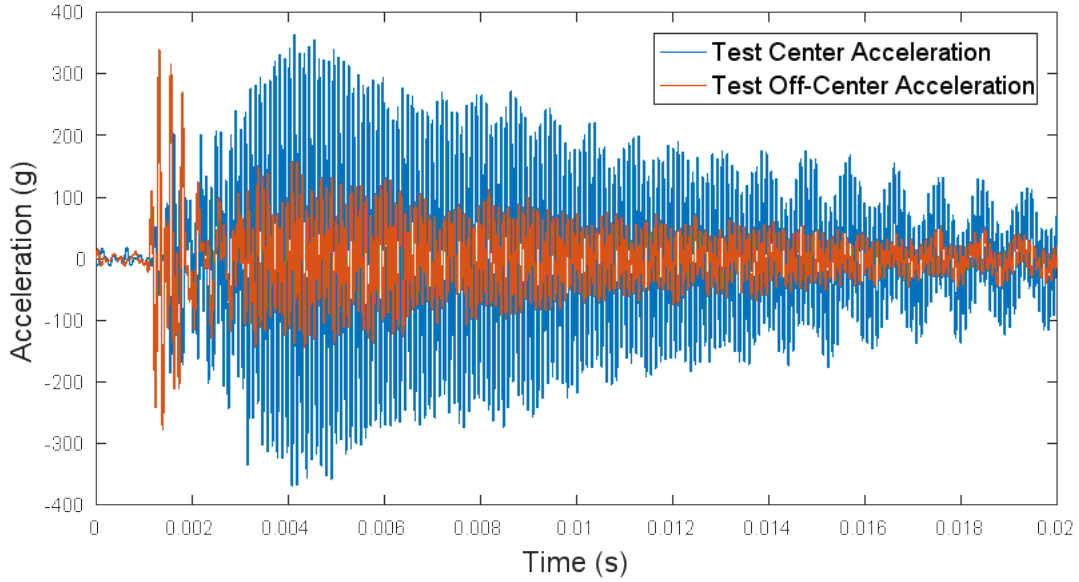
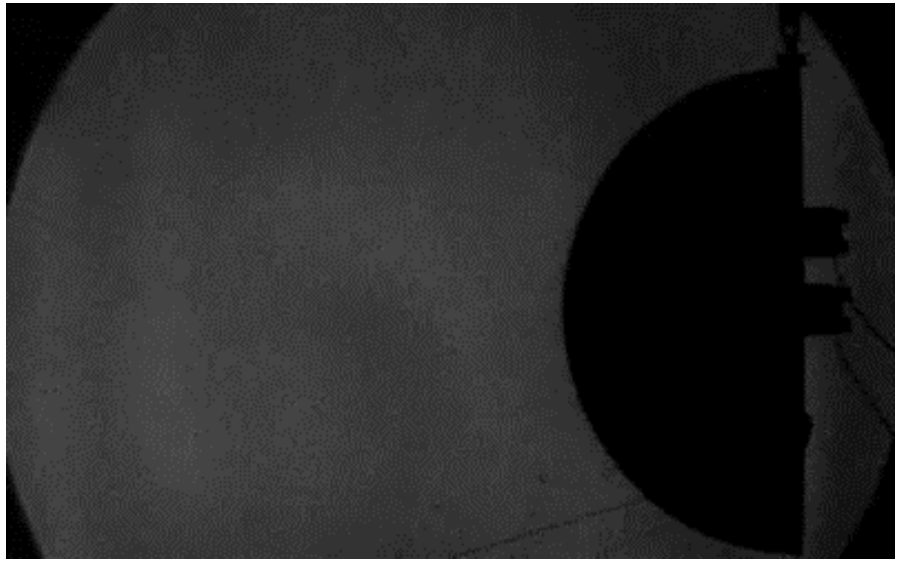
First test series conducted at NM Tech

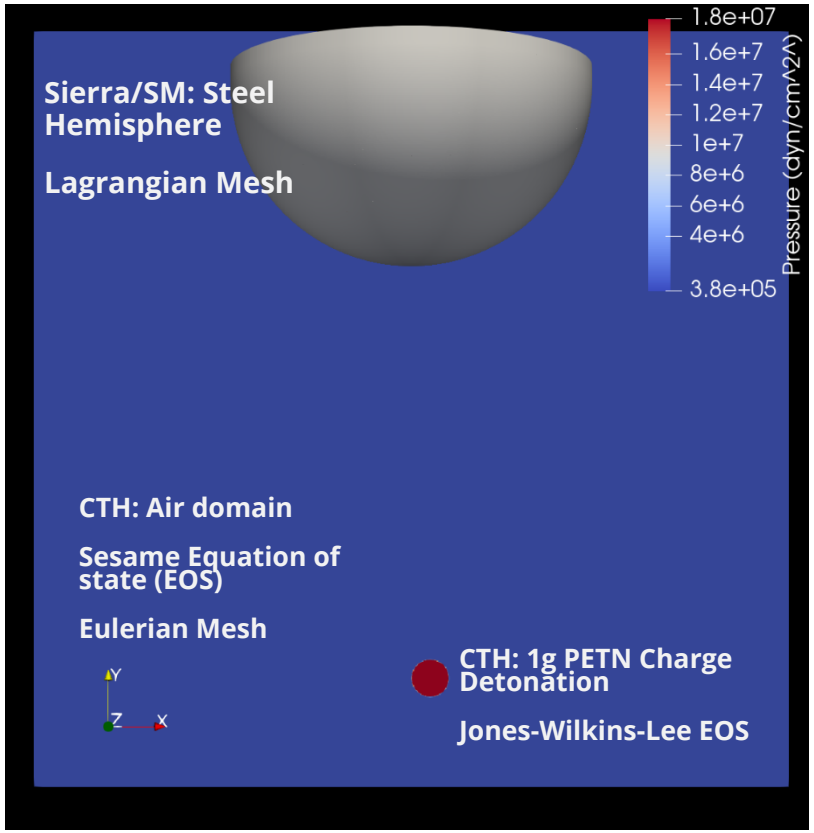
Teaming & Communication

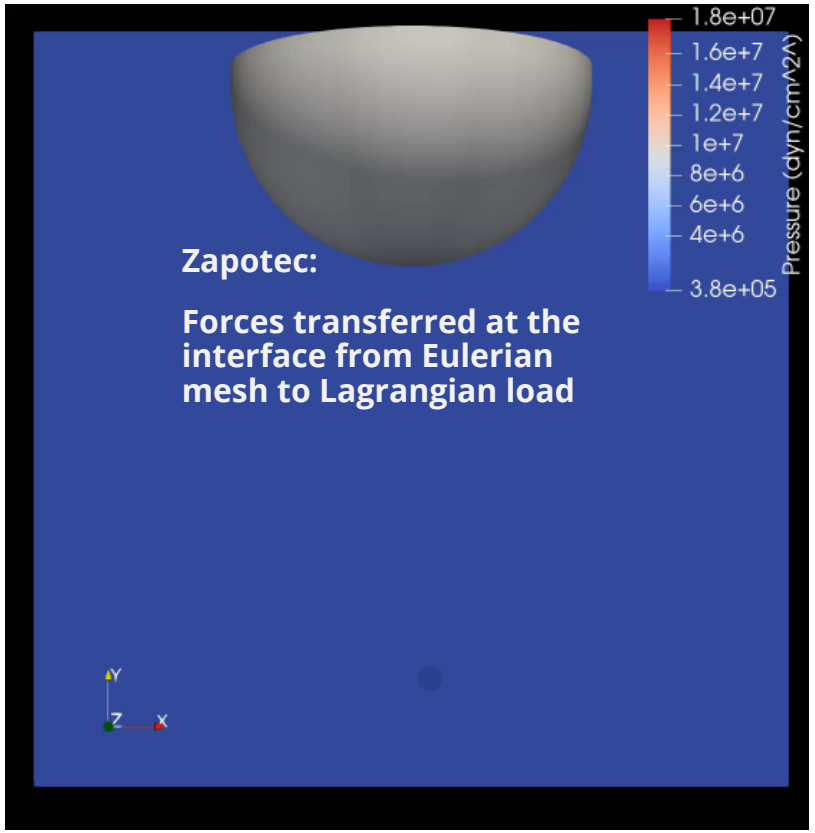
- Experiment Configuration
  - 1 g spherical PETN charge
  - 2 circular plate shots, 2 hemisphere shots
- Diagnostics:
  - Ultra-high speed video with Schlieren imaging, 1 million frames/sec
  - Accelerometers to measure transient response, 10 kHz sample rate

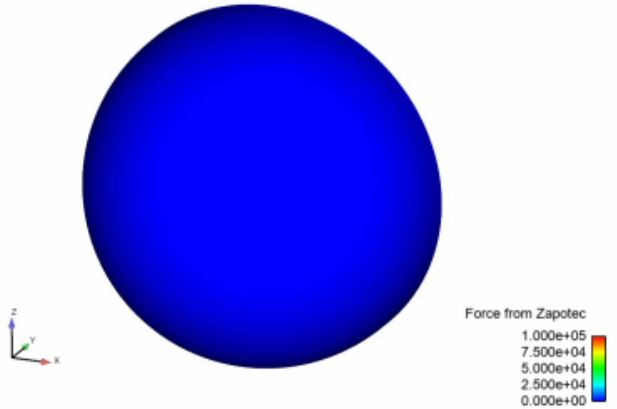




Mod/Sim "Infrastructure" Established

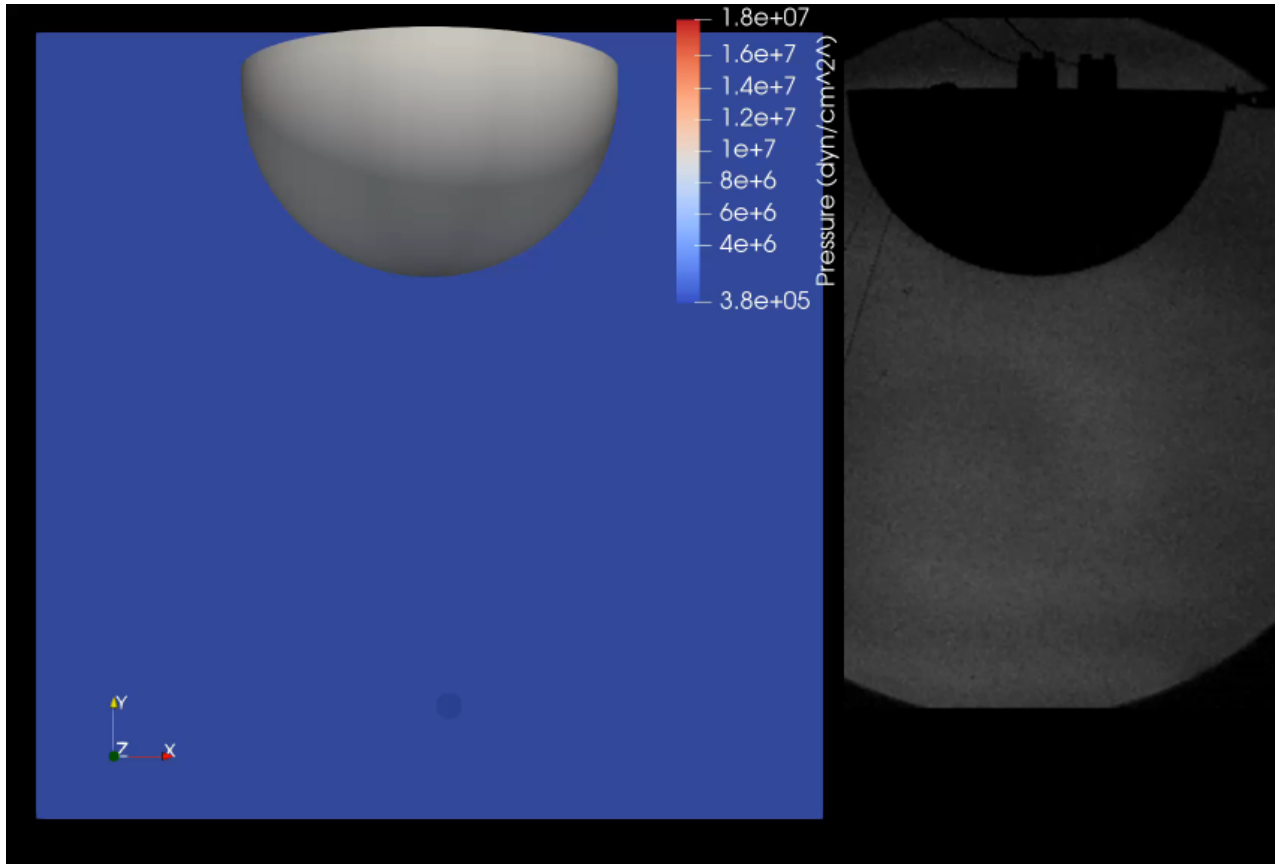


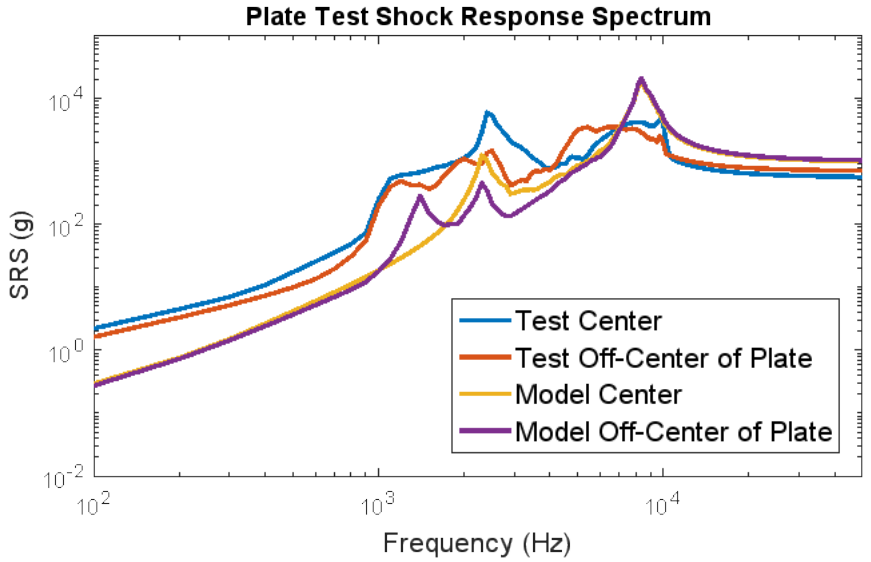


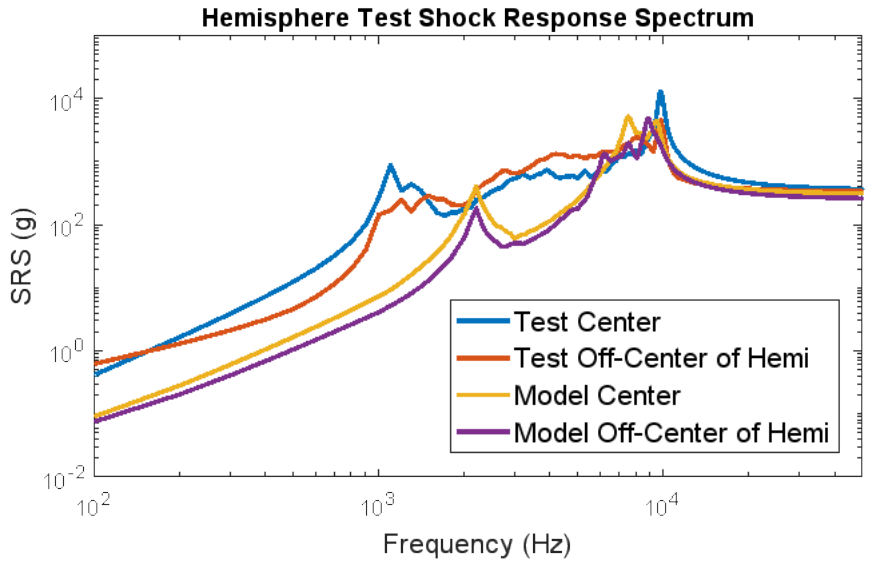


- **First known use of Zapotec results coupled to Sierra/SD**
  - Zapotec couples hydrocode CTH (detonation + shock propagation) with solid mechanics code Sierra/SM (structural loads)
  - Time dependent loading is passed onto Sierra/SD for vibration response

Modeling results agree with experiments







<10% difference in time of arrival

Resonant modes accurately captured in SRS

Summary and Future Directions

- Demonstration of **successful integration of mod/sim with experiments** in studying blast-induced shock environments
- Predictive models allow us to design and tune explosive-structure configurations to create representative environments
- External nature of blast loading facilitates creation of combined environments for advanced characterization
- Future work: Further probe variables such as standoff location or dampening materials during second test series and/or additional mod/sim runs