2nd Joint Sandia-Georgia Tech Materials Workshop @ SNL
February 10-11, 2016
SAND2016-1078C

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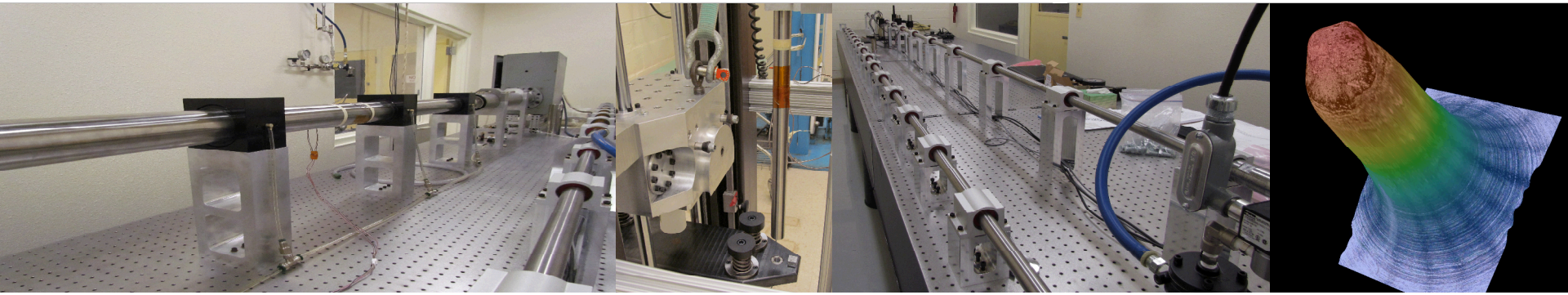
Sandia National Laboratories

SAND2016-XXXX



Material Characterization under High-Rate Deformation

Bo Song

Experimental Environment Simulation Department

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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Outline

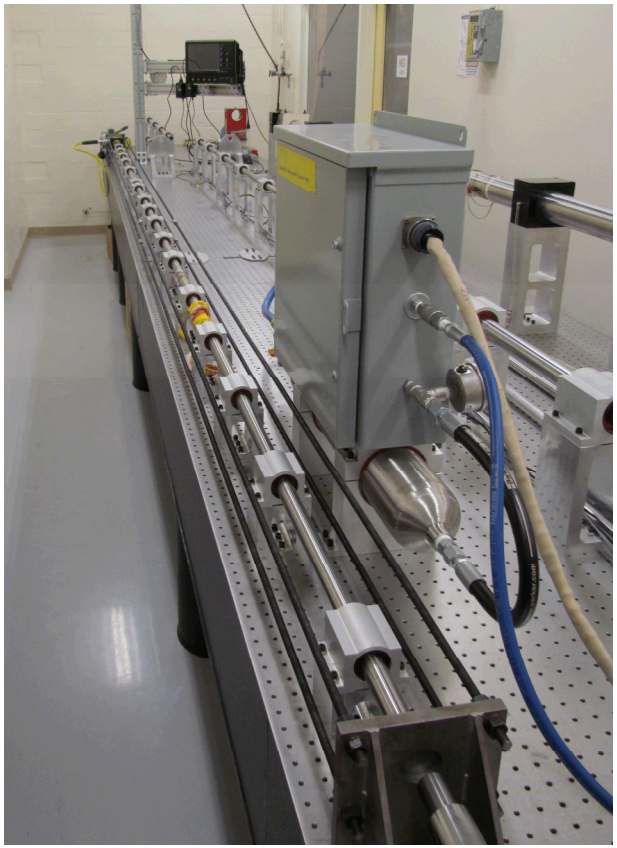
- “Who are we?”
- “What do we have?”
- “What can we do?”
- “What to expect?”

We are…

Sandia National Laboratories

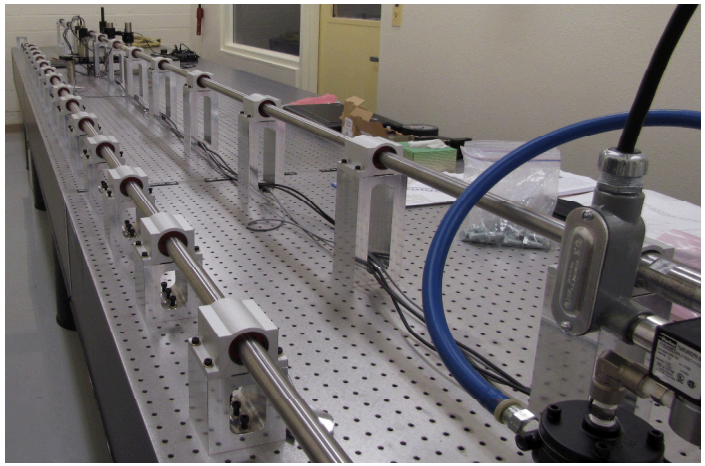
Experimental Impact Mechanics Lab. (EIML)

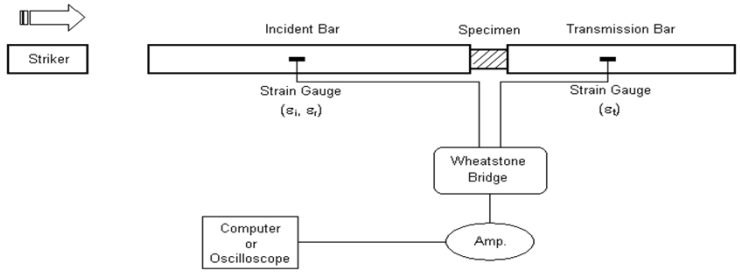
- ***Research & Development (80%)***
  - *Develop new experimental and diagnostic techniques for fundamental research on mechanical characterization under high-rate deformation*
- ***Application (20%)***
  - *Apply advanced science and technology to solve engineering problem under extreme and abnormal environments*
- ***Internal Partnership/Collaboration:***
  - *Terminal Ballistic Hopkinson Bar Lab*
  - *Structure Mechanics Lab (MTS)*
  - *Shock Mechanics Lab (Drop tables)*
  - *Mechanical Shock Facility (Gas gun, horizontal actuator)*
  - *Terminal Ballistic Lab*
  - *Geo-mechanics Lab*
  - *Modeling/simulation Group*
  - *Materials Group*

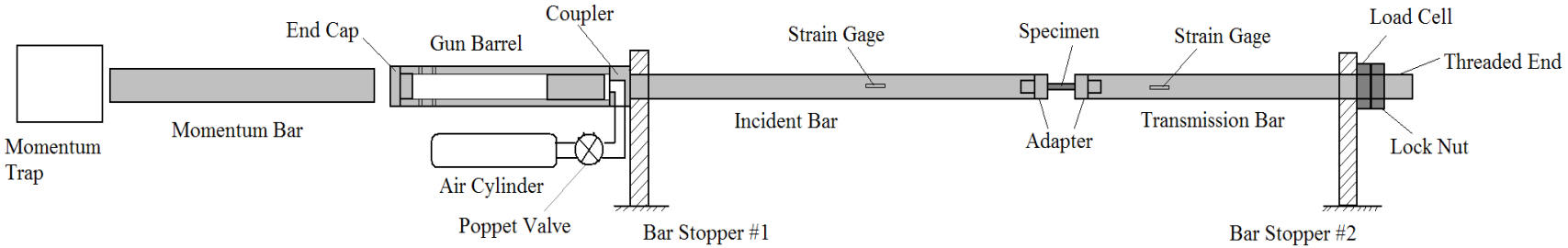


We have …

- **Split Hopkinson (Kolsky) Bars**
  - *1”-diameter split Hopkinson compression bar (Kolsky compression bar)*
  - *1”-diameter split Hopkinson tension bar (Kolsky tension bar)*

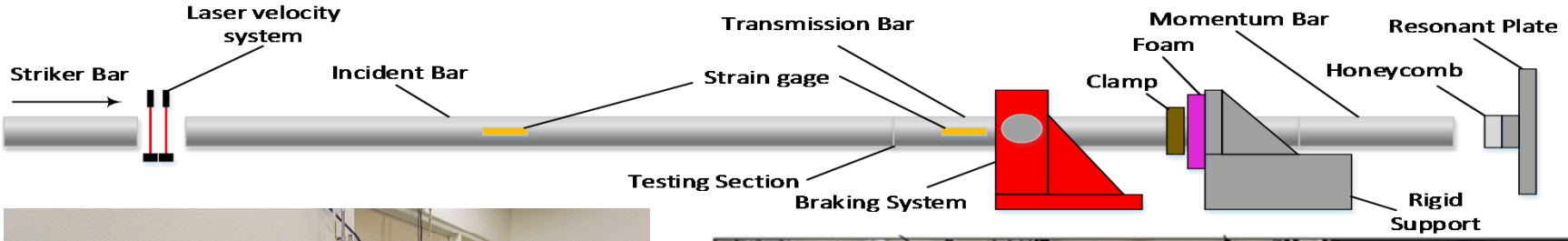


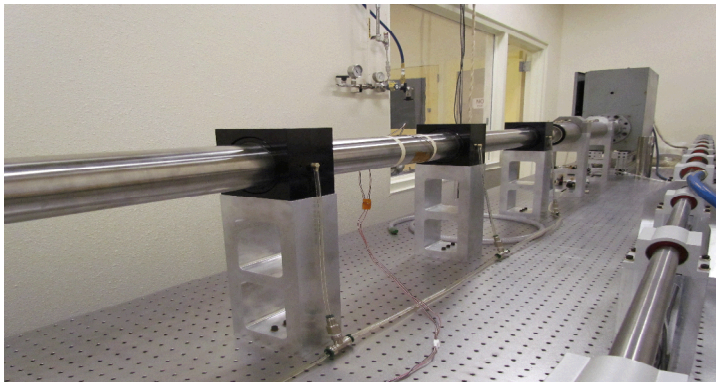


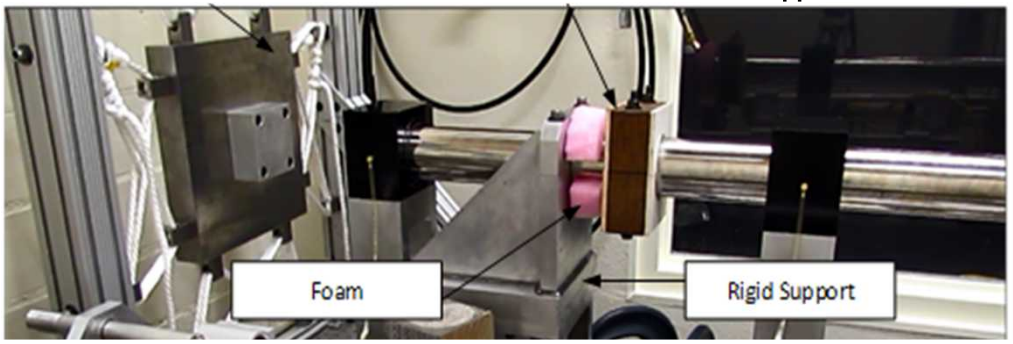


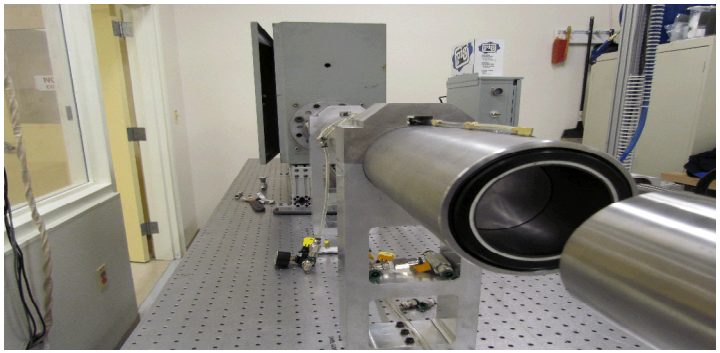
We have …

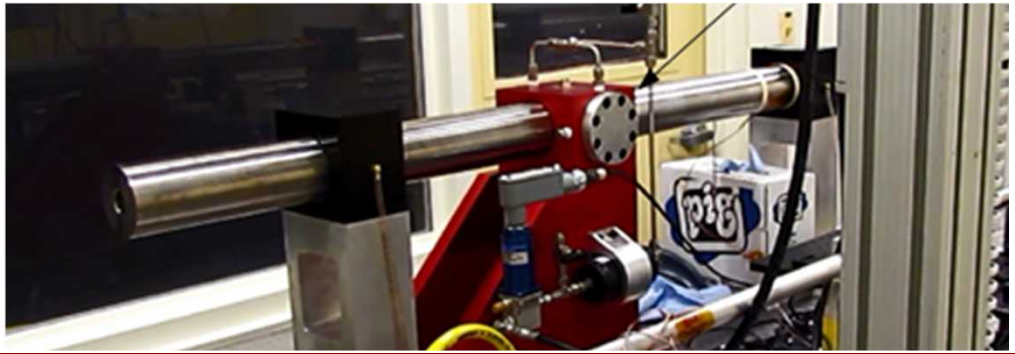
- **Split Hopkinson (Kolsky) Bars**
  - *3”-diameter split Hopkinson compression bar (Kolsky compression bar)*





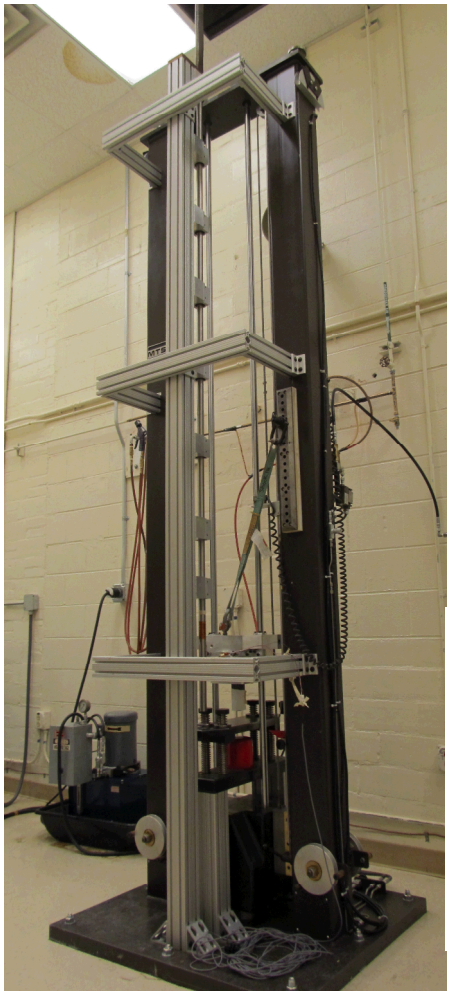


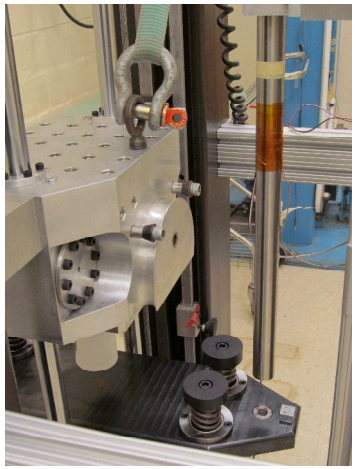


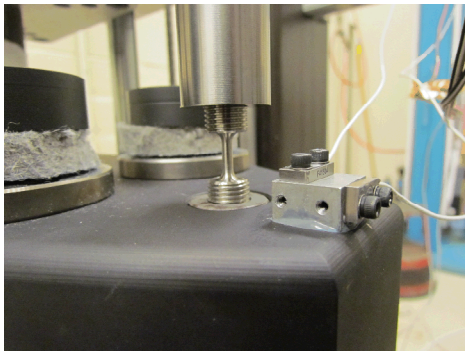


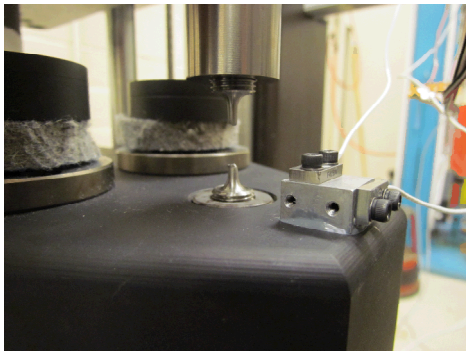
We have …

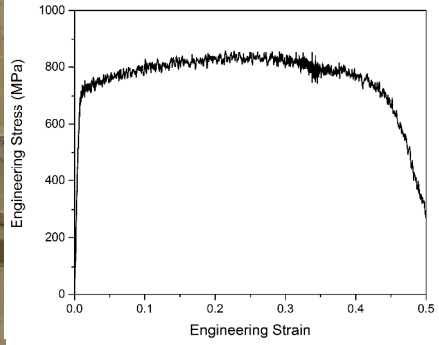
- **Split Hopkinson (Kolsky) Bars**
  - *1”-diameter “dropkinson” bar for intermediate-rate tensile testing*

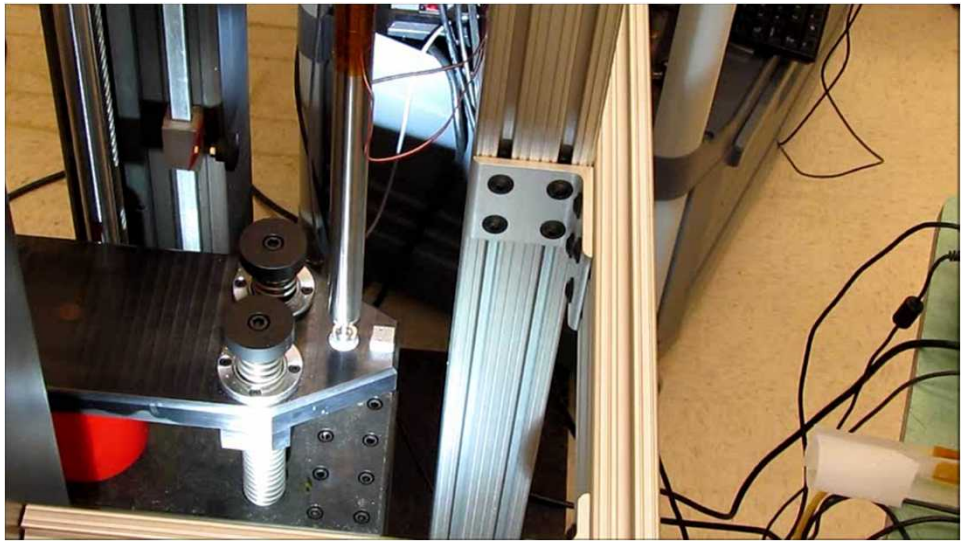












We have …

- Instrument/Equipment
  - *Teledyne LeCroy 4-channel high-speed digital oscilloscope*
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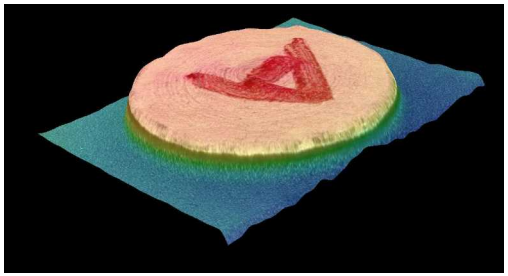
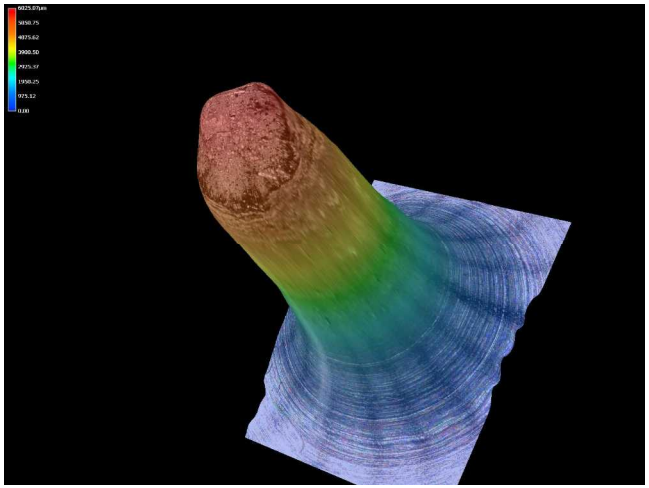
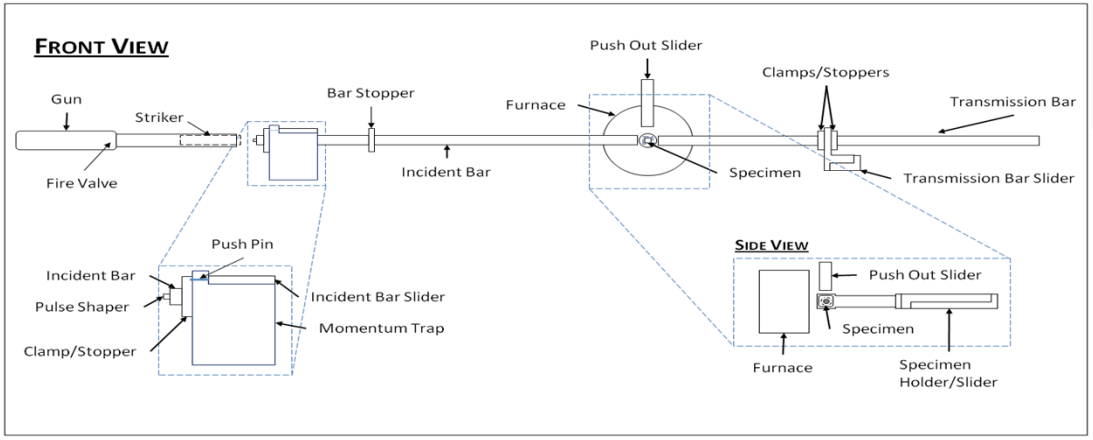
  - *Keyence VHX-5000 digital microscope (20X-5000X)*
  - *Vishay 4-channel signal conditioner*
  - *Custom made laser displacement measurement system*
  - *1200°C electrical furnace*
  - *MTI 15kW induction heater*
  - *Instron environmental chamber (-100 - 350°C)*
  - *Buehler diamond saw*
  - *Thermocouple welder*
  - *Kirana ultra-high speed digital camera (5M frames per second)*
  - *NI acquisition and control system*

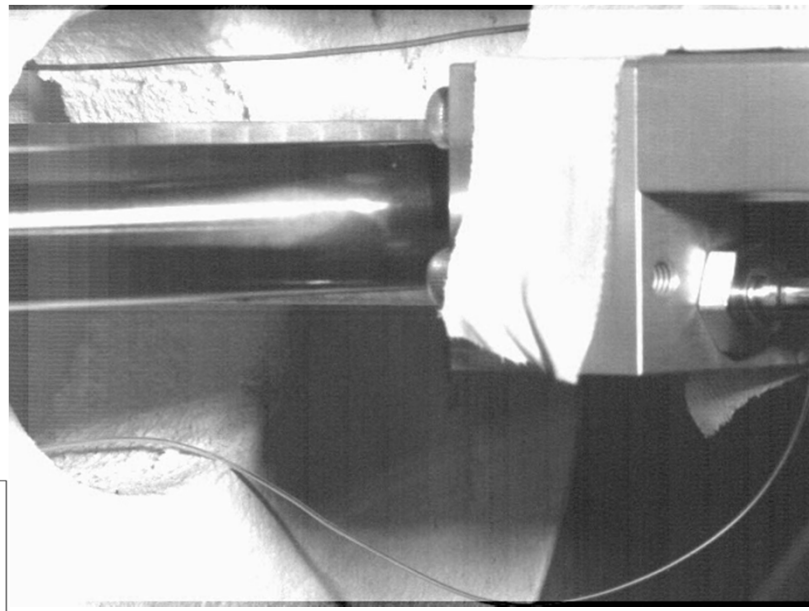




What Can We (EIML) Do?

- **Dynamic Characterization of Materials**
  - *Dynamic stress-strain response of materials in compression or tension (shear coming soon)*
  - *Dynamic failure and fracture of materials*
  - *Pre-compression or tension load capability*
  - *Interrupted test capability*
  - *Strain-rate range: ~100 – 10,000 s^{-1}*
  - *Temperature range: -100 – 1200°C*
  - *Stress state: uniaxial stress; triaxial stress (in compression only)*
  - *Materials covered: ceramics, alloys, composites, glasses, polymers, foams, biological tissues, concretes, sands, soil, etc*

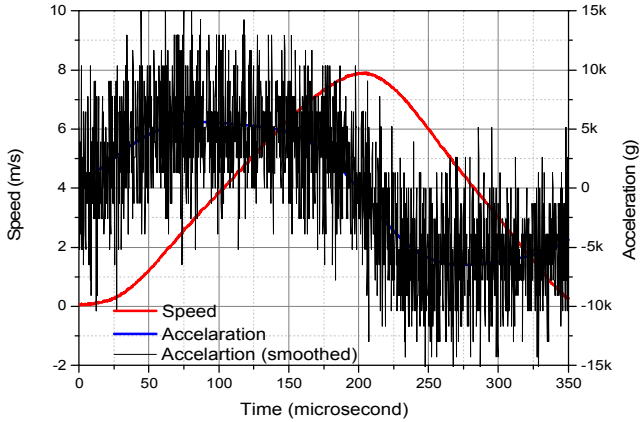


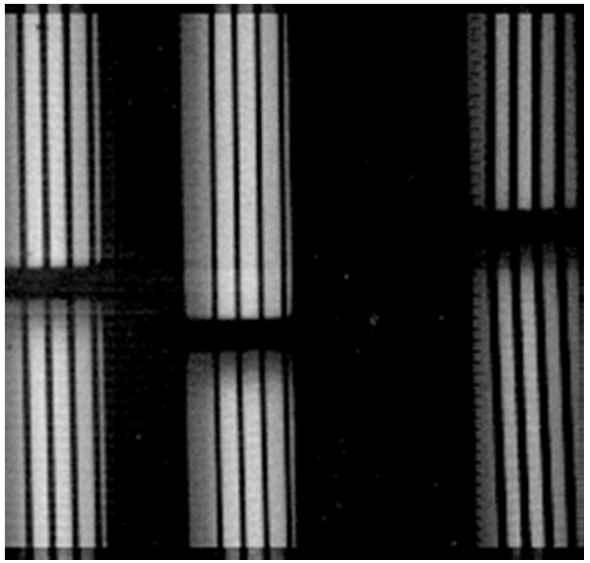


Example: dynamic high-temperature compression tests of 304L stainless steel for recrystallization investigation

What Can We (EIML) Do?

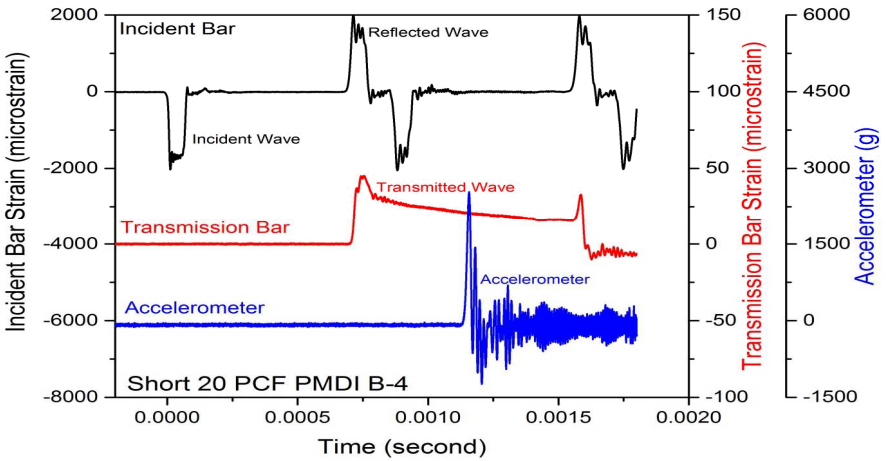
- **Dynamic Characterization of Components/Small Structures**
  - *Dynamic structural testing with preload capability (compression or tension)*
  - *Wave propagation/interaction*
  - *Shock mitigation*
  - *Dynamic interface problem*
  - *Component/device functionality/survivability in abnormal mechanical environments*
    - *High-g, high-frequency impact and vibration*
  - *Impact Sensor characterization*

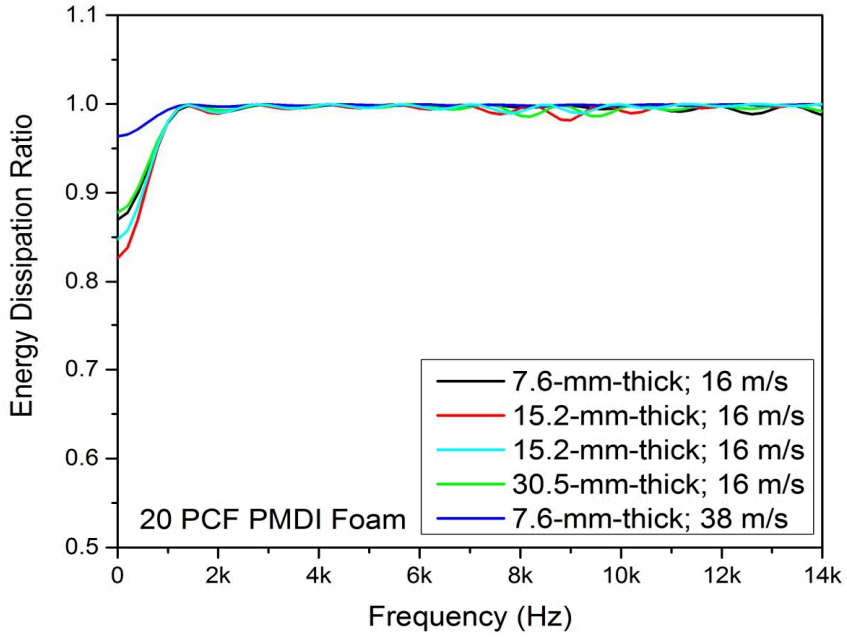


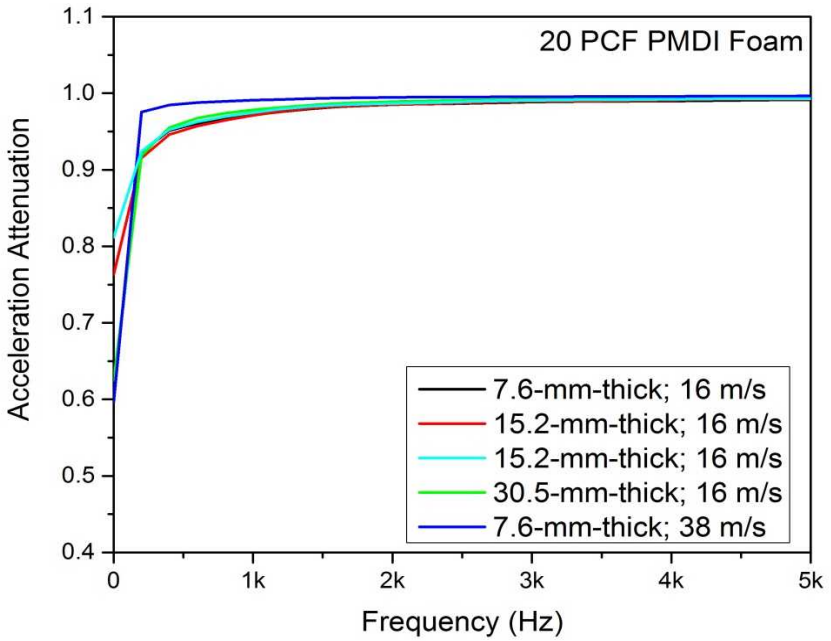


What Can We (EIML) Do?

- **Rate-dependent Model Validation**
  - *Abnormal mechanical environments (high rate, high frequency, high temperature, etc)*
- **Direct experimental solution to engineering problems**







What to Expect?

- **Mission**
  - *Develop advanced experimental and diagnostic techniques for scientific discovery*
  - *Provide high-fidelity experimental data for model development and validation under extreme and abnormal environments*
  - *Specially designed experiments to directly solve engineering problems*
- **Path Forward**
  - *Internal and external collaboration/partnership*
  - *Integrating experiments and numerical simulations*

We are highly motivated and looking forward to any kind of external collaboration/partnership, particularly with universities, on fundamental research and applications

EIML POC (Lead/Principal Investigator)

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