SAND2012-4595P

Exceptional service in the national interest

Sandia National Laboratories

STAR
Shock Thermodynamics Applied Research

DICE Facility

Sandia's High Pressure/High Temperature Condensed Matter Physics Gun Facilities

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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Gun platforms at Sandia

- Sandia National Laboratories is one of a few institutions in the world with a major shock-physics program
- Sandia has an institutional triad (STAR, DICE, Z) that can cover the full range (few kbars to Mbar) of material property study from
  - gas/propellant guns
  - ballistic gun (validation experiments)
  - pulsed-power driven flyers, ramp compression
- Shock Thermodynamic Applied Research (STAR) facility
  - The STAR facility is a dynamic experimental test facility that has been operating since the mid-60's
  - The facility houses a collection of five laboratory test launchers (guns)
- Dynamic Integrated Compression Experimental (DICE) facility
  - The DICE facility is a dynamic experimental test facility that has been operating since 2010
  - The facility houses a laboratory test launcher (gun) and a small pulsed-power machine (Veloce)

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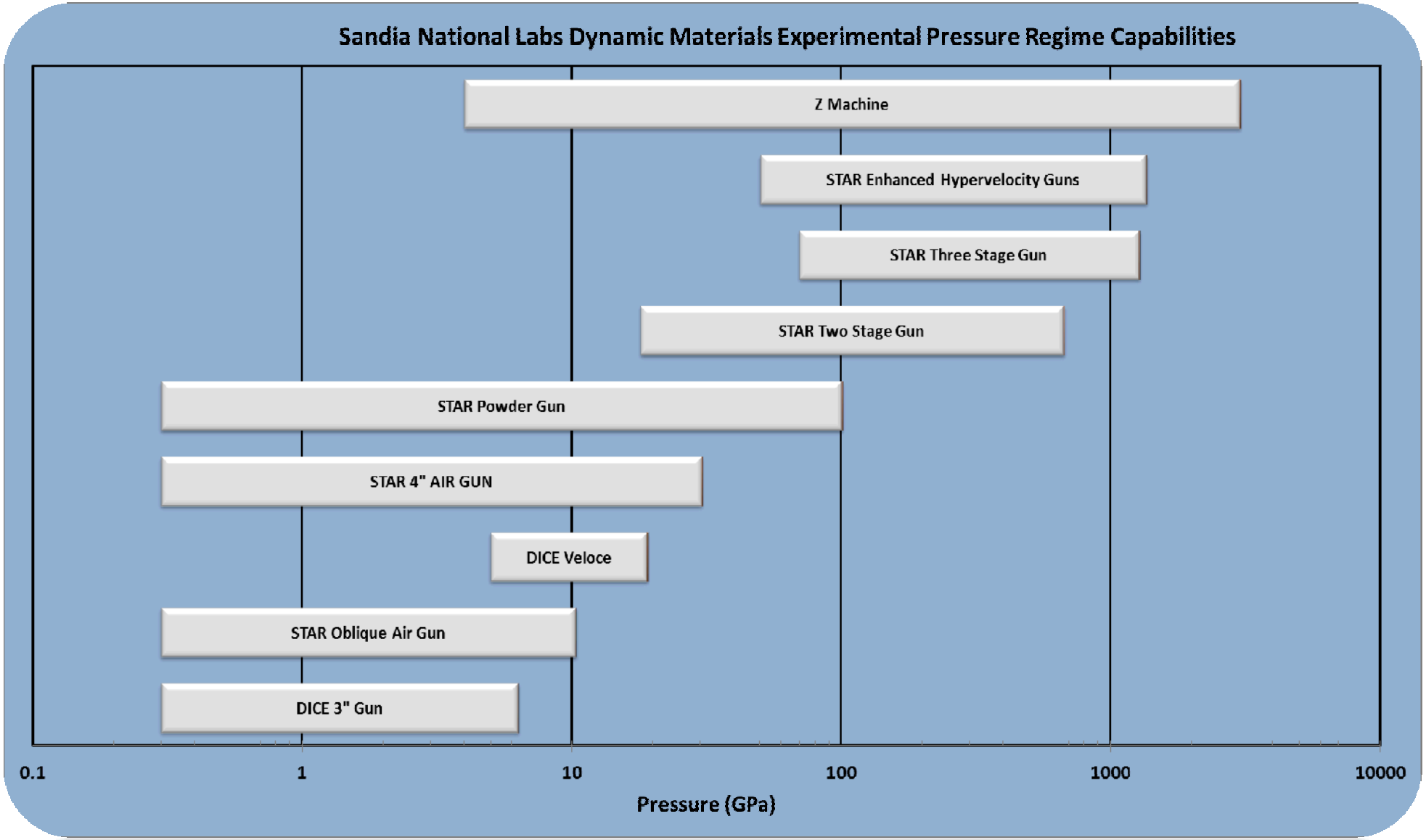
Sandia's world class experimental facilities provide a wide range of regimes that can be exploited for DM experiments



Materials, Analysis, and Modeling

- Sandia's gun facilities can test nearly any type of material, solid or liquid, from explosives (PBX, Comp-B, reactive), chem/bio simulants, depleted uranium, ceramics, powders, etc..

- Sandia's gun facilities combines decades of experience in experimentation, data analysis (theoretical to practical), and modeling

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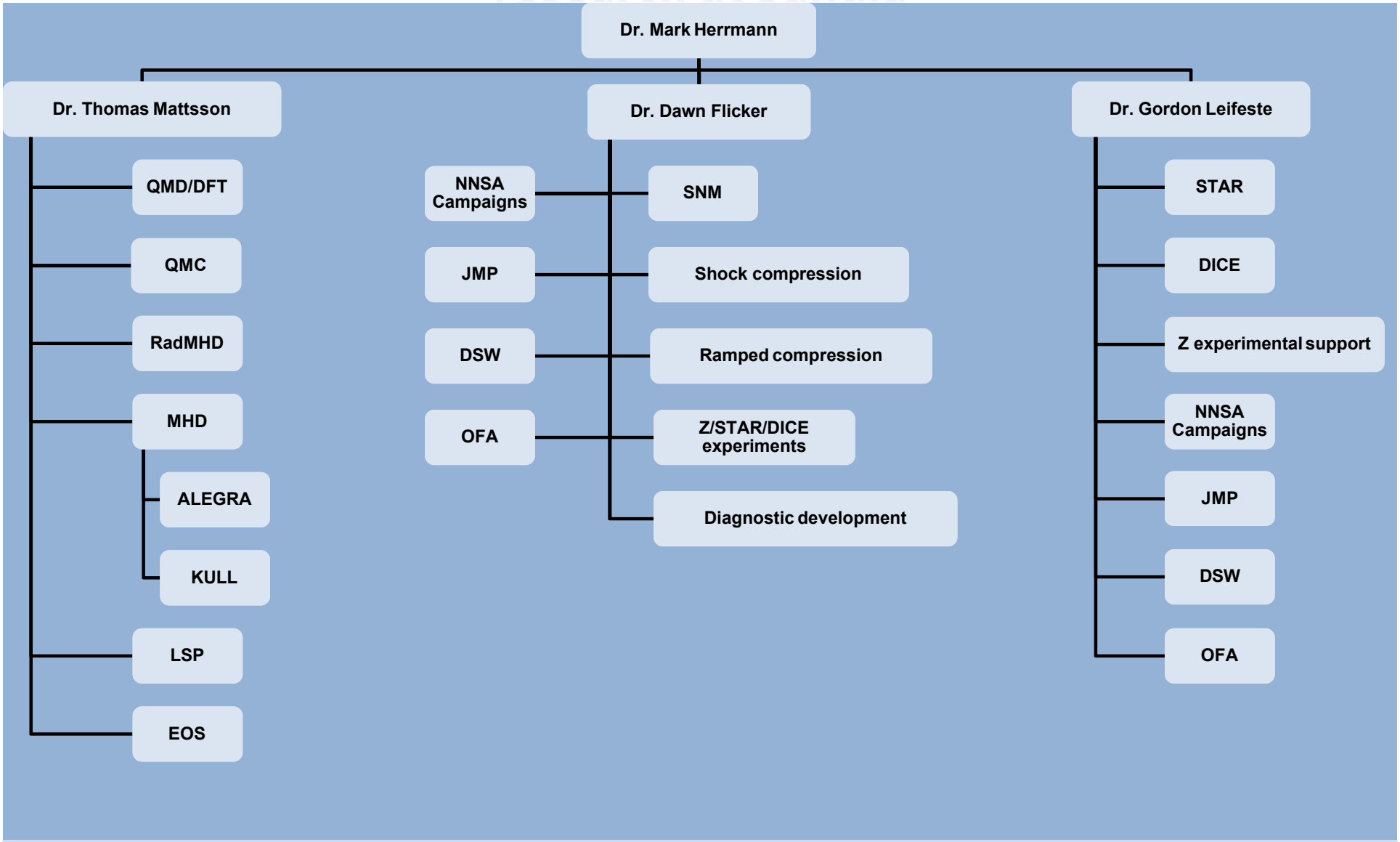
High pressure/high temperature condensed matter physics research at Sandia



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Single stage, smooth bore, compressed light gas gun

- 100 mm bore diameter
- 900-9000 gm projectile mass
- 0.01 – 1000 m/s projectile velocity
- 30 GPa (300 kbar) impact pressure

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Single stage, smooth bore, powder gun

- Propellant driven
- 89 mm bore diameter
- 900-9000 gm projectile mass
- 400 – 2200 m/s projectile velocity
- 100 GPa (1Mbar) impact pressure

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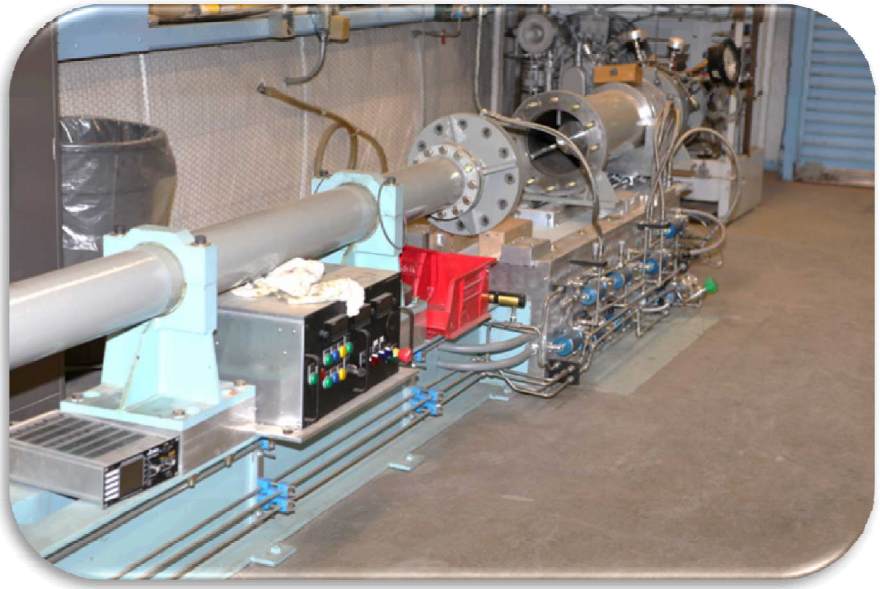
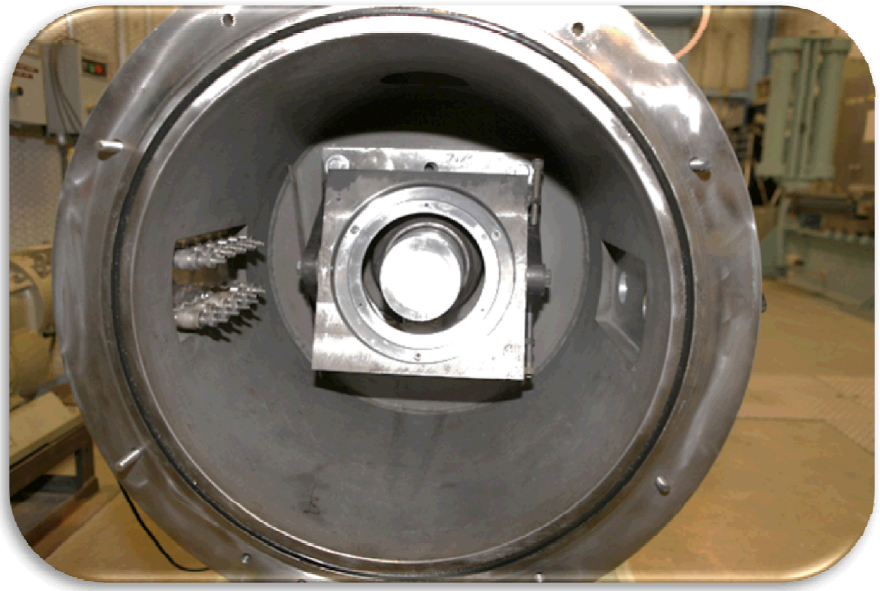
Single stage, keyed-bore compressed light gas gun (aka oblique gun)





- 100 mm bore diameter
- 500-5000 gm projectile mass
- 50-350 m/s projectile velocity
- 10 GPa (100 kbar) impact pressure

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Two stage, smooth bore, light gas gun

- Propellant driven
- 20, 30, 67 mm bore diameter
- 15-60 gm projectile mass
- 800 – 7500 m/s projectile velocity
- 650 GPa (6.5 Mbar) impact pressure
- Three stage/HVL/EHVL=Two stage gun + fixtures

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Terminal Ballistic Facility

- Propellant driven
- Two stage, smooth bore, light gas gun
- 6-30 m bore diameter
- 1-60 gm projectile mass
- 800-7500 m/sec projectile velocity
- 650 GPa (6.5 Mbar) impact pressure

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Ballistic Studies at the STAR Facility

- Utilizes two-stage light gas gun and range for investigations into material fragmentation, spacecraft studies, and code validations on scaled targets
- Validation experiments can be performed with virtually any geometric shape impactor
- Impacts up to 19 km/s for space applications: micrometeoroid, space junk, etc..
- Sandia is the only institution that incorporates low-pressure target chambers for hypervelocity impacts exceeding 10 km/s
- Radiography, Photography, Interferometry

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STAR also has a multiple array of small caliber arms

- Conventional velocities are used to study
  - Construct penetration
  - Body armor resistance
  - Code validation

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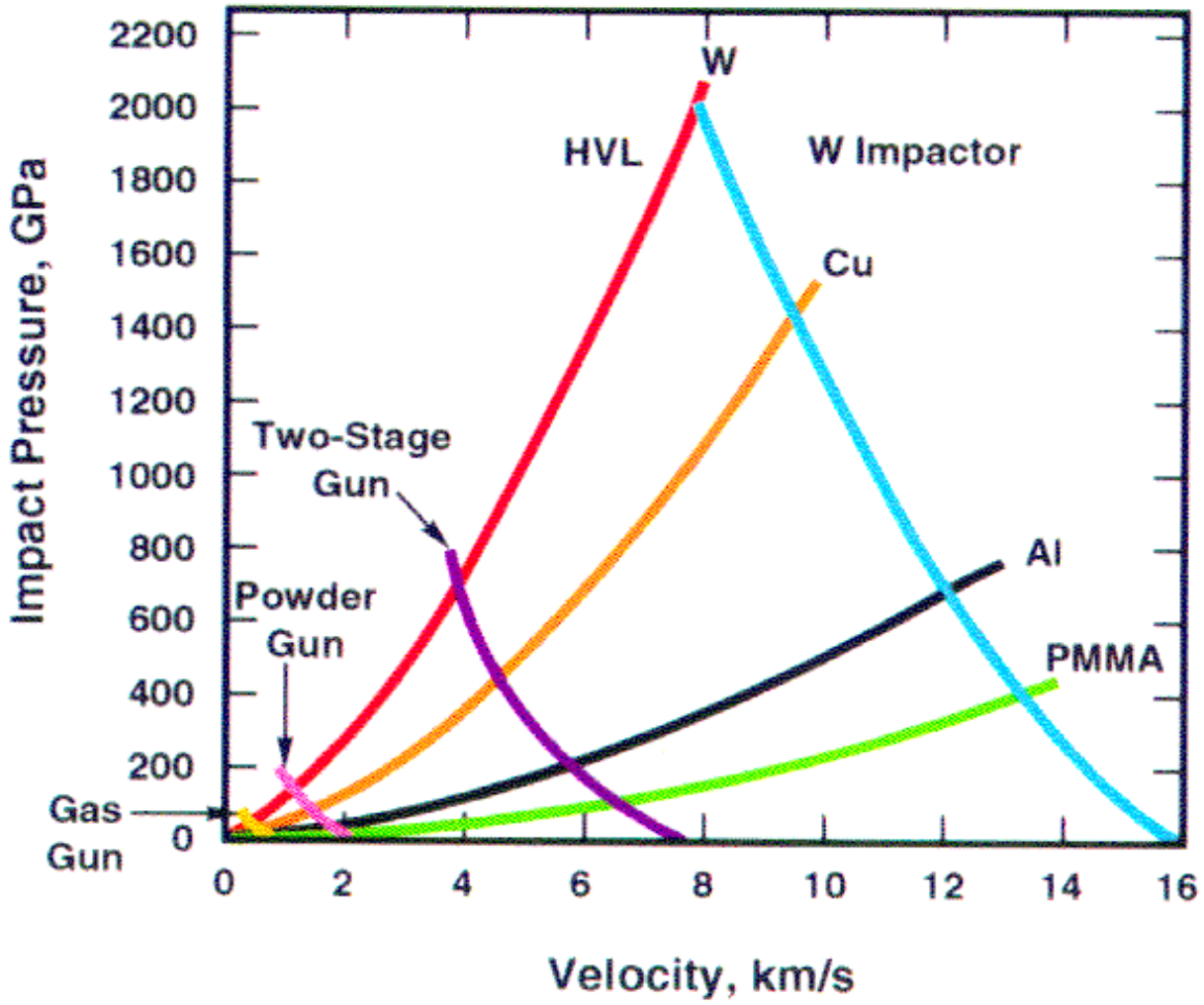
Capabilities of the STAR Facility



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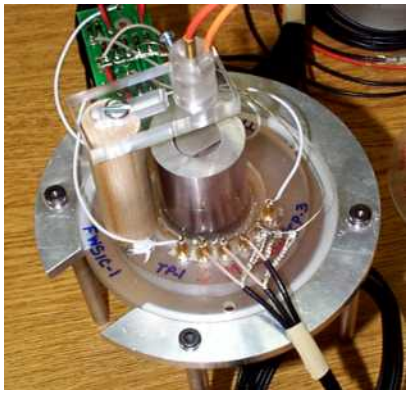
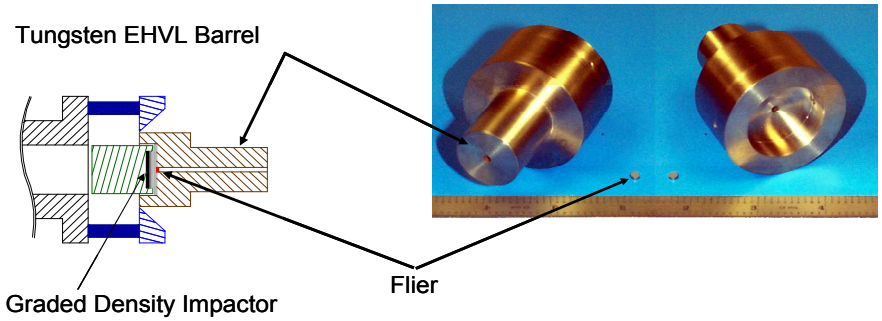
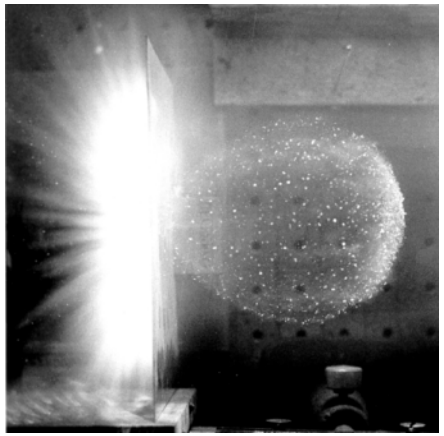
Capabilities, Tools, Diagnostics, and Advancements at STAR

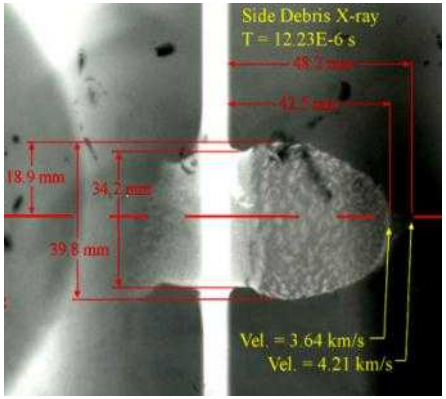


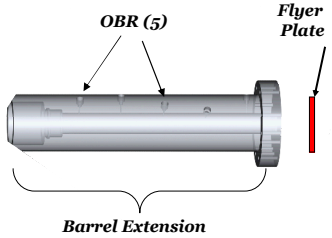
Electrical Diagnostics

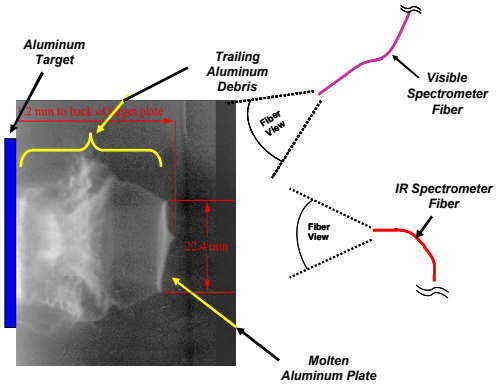


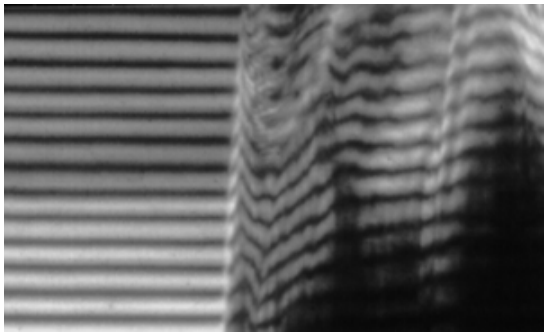
High speed Photography



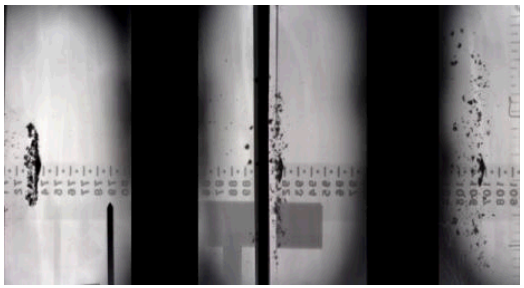






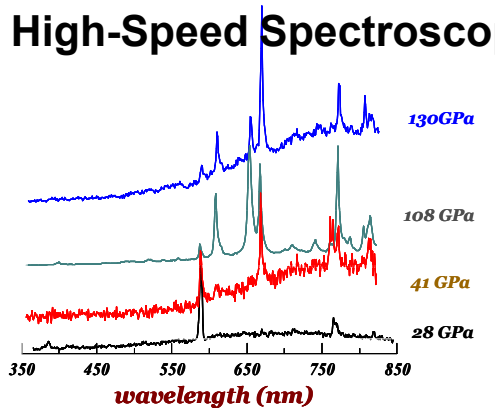


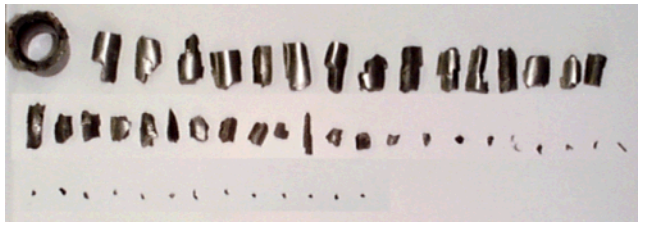
Line VISAR Interferometry



Radiography

High-Speed Spectroscopy





Fragmentation

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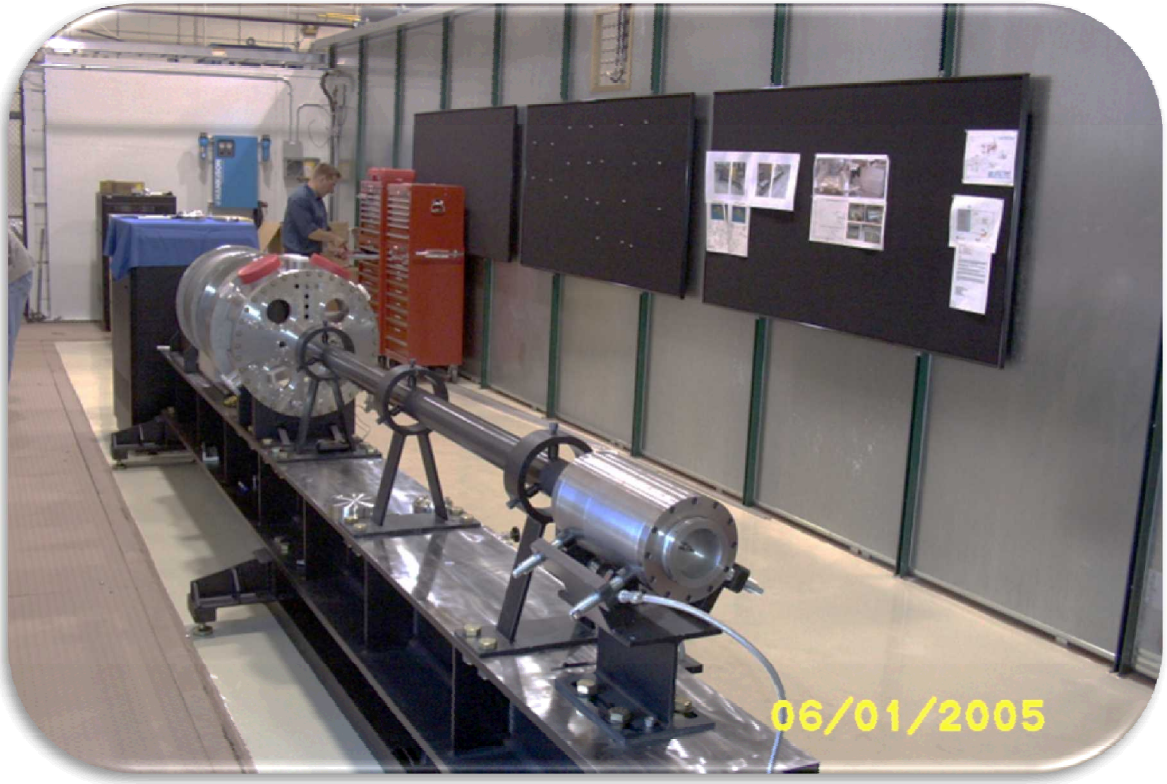
DICE gun



- 76mm Bore
- 240-540 gm projectile mass
- 80-450 meters/second velocity
- 0.3-6 GPA (60kbar)
- VISAR, Line ORVIS, X-Ray diffraction

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DICE target fabrication area

- Class 1000 clean room
- High Precision weight/mass measurements
- Nikon video precision measurement systems

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