Southern Impact Testing Alliance

One-Stop Shop Combined Capabilities Impact Testing for Space, Department of Defense or Private Industry

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Southern Impact Testing Alliance
SITA

Efforts to form this Alliance began in 2008 to showcase the impact testing capabilities within the southern United States.

SITA Partners Include:

- Arnold Engineering Development Center Hypervelocity Range Facility
- Auburn University’s Space Research Institute
- Marshall Space Flight Center Impact Testing Facility
- University Alabama Huntsville Aerophysics Research Center
Southern Impact Testing Alliance
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Advantages for the customer:

- Impact testing customers can utilize SITA partner capabilities to provide supporting data during all program phases-materials/component/flight hardware design, development, and qualification.

- This approach would allow programs to reduce risk by providing low cost testing during early development to flush out possible problems before moving on to larger scale/higher cost testing.

- Various SITA partners would participate in impact testing depending on program phase-materials characterization, component/subsystem characterization, full-scale system testing for qualification.

- SITA partners would collaborate with the customer to develop an integrated test approach during early program phases.

- Modeling and analysis validation can start with small-scale testing to ensure a level of confidence for the next step large or full-scale conclusive test shots.
Marshall Space Flight Center
Impact Testing Facility

- MSFC ITF serves as an important installation for space and missile related materials science research
- ITF was established and began its research in spacecraft debris shielding in the early 1960’s and played a major role in the International Space Station debris shield development
- As a result of return to flight testing after the loss of STS-107 (Columbia) MSFC ITF realized the need to expand their capabilities beyond meteoroid and space debris impact testing. MSFC partnered with the Department of Defense and academic institutions as collaborative efforts to gain and share knowledge that would benefit the Space Agency as well as the DoD.

**MSFC ITF current capabilities:**
- Hypervelocity Impact Testing
- Ballistic Impact Testing
- Environmental Impact Testing
Hypervelocity Impact Range

Micro-light Gas Gun (MLGG)
- Bore size up to 4 mm (0.16 in) diameter
- Velocity Range: 0.3 – 7.5 km/s
- Target chamber approx 1.3 m (4 ft) dia. x 1.6 m (5 ft) long
- Shot Frequency: 5-7 per day or more depending on shot configuration

Light Gas Gun (LGG)
- Bore size up to approx 2 cm (0.8 in) diameter
- Velocity Range: 2.5 - 7.5 km/s
- Target chamber approx 3 m (10 ft) dia. x 6 m (20 ft) long
- Shot Frequency: 2-3 per day

Projectile types for both guns include but are not limited to spheres and cylinders of materials such as aluminum, borosilicate glass, polymers, and ceramics.
Ballistic Impact Range

Large Ballistic Gun (LBG)
- 7.5 cm diameter barrel or custom-made barrel to accommodate a range of projectiles up to 15 cm diameter
- Velocities up to Mach 2

Small Ballistic Gun (SBG)
- Used for hail, and launch and ascent debris simulation
- Projectiles up to 3 cm (1.2 inch) diameter
- Velocities up to Mach 2

This range is used for laboratory ballistic evaluation of items from ball ammunition (up to 50 caliber AP) to 30 mm high explosive incendiary (HEI) rounds, vehicle launch and ascent debris impacts, and ice impacts on radomes and other structures.
Environmental Impact Range

**Single/Multi-Particle Gun**
- Velocities from 500 – 2000 m/s (1640-6562 ft/s)
- Simulating dust, sand, and rain particles from 5 mm down to 10 microns

**Exploding Wire Gun**
- Velocities up to 7 km/s
- Particle sizes: 0.4 - 4.0 mm

**Rain Gun**
- Velocities up to 1430 m/s (4700 ft/s)
- Water drops from 1 - 5 mm dia.
- 30, 45, 60, and 90 degree impacts available, others possible
- Specimen sizes up to 20 mm dia.

ITF test systems provide capabiities for rain, hail, sand, and dust impacts. Applications previously tested include radome, IR window, rotor blade materials.
AEDC RANGE COMPLEX INCLUDING RANGE G AND RANGE I
RANGE G TRACK AND RECOVERY TUBE SYSTEM

Two-Stage Light-Gas Gun (Powder/Hydrogen)
Track Guidance System
Recovery Tube
Launcher Blast Tank Range Tank Recovery Tube
1,900 ft
MODEL / WATER DROPLET IMPACT SEQUENCE (TWO IMPACTS)

Model Velocity: 2,460 m/sec  Range Pressure: 354 torr

1.2-mm-diam Water Droplets
EROSIVE FIELDS TESTING IN THE RANGE G 900 FOOT RANGE TANK SYSTEM
The UAH Aerophysics Research Center began operations in 1991 on Redstone Arsenal, AL following the donation to UAH by GM Delco of three two-stage light gas guns.

Primary Function is conducting experimental research on hypersonic flight and hypervelocity impact.

Programs supported range from basic research through prototype development. While the government laboratory community is the principal customer, student/faculty research, SBIR projects and contractor IR&D efforts are also performed.
University of Alabama in Huntsville –
108 MM Pump Tube Light Gas Gun

45’ Long x 4.25” Diameter Pump Tube
25’ Long Interchangeable Launch Tubes
Launch Tube Diameters from 0.75” to 1.2”
6’ Diameter x 14’ Long Impact Chamber
Launch Mass’s up to ~ 130 g.
Launch Energy’s up to ~ 1 MJ.
University of Alabama in Huntsville – 
133 MM Pump Tube Light Gas Gun

- 60' Long x 5.25” Diameter Pump Tube
- 50’ Long Interchangeable Launch Tubes
- Launch Tube Diameters from 1.15” to 1.4”
- 8’ Diameter x 22’ Long Impact Chamber
- Launch Mass’s up to ~ 300 g.
- Launch Energy’s up to ~ 1 MJ.
University of Alabama in Huntsville –
254 MM Pump Tube Light Gas Gun

125’ Long x 10” Diameter Pump Tube
75’ Long Interchangeable Launch Tubes
Launch Tube Diameters from 2.2” to 6.0”
10’ Diameter x 41’ Long Impact Chamber
Launch Mass’s up to ~ 12 kg.
Launch Energy’s up to ~ 25 MJ.
Projectiles

<table>
<thead>
<tr>
<th>Projectile Type</th>
<th>Velocity [km/sec]</th>
<th>Mass [grams]</th>
</tr>
</thead>
<tbody>
<tr>
<td>254 mm LGG</td>
<td>2S4</td>
<td>133</td>
</tr>
<tr>
<td>133 mm LGG</td>
<td>LOG</td>
<td>8</td>
</tr>
<tr>
<td>108 mm LGG</td>
<td>LM</td>
<td>5</td>
</tr>
</tbody>
</table>

Equivalent MACH # at Sea Level

Projectile Mass [grams]

1 Megajoule
10 Megajoules
20 Megajoules

Projectile Kinetic Energy Curves
Auburn University Space Research Institute

- **Arc Driven Plasma Drag Gun**
  - Accelerates 5 to 50 particles per test (10-150 μm diameter)
  - Velocity 5 to 12 km/s
  - Individual particle size, velocity and location identified.
  - Micrographs and measurements
  - Minimal gun debris, clean targets

- **Cryogenic & Elevated Temperature**
  - Liquid Helium Cooling
  - Infrared Heating
  - Target Temp: 24 to 450K

- **Oil Free Pumping**
  - suited for optical samples where post test characterization is desired.
<table>
<thead>
<tr>
<th>Gun Type</th>
<th>Velocity Range</th>
<th>Projectile Mass</th>
<th>Launch Energy</th>
<th>Target Chamber</th>
<th>Launch Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compatibility Range</strong></td>
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<tr>
<td><strong>Hypervelocity Range</strong></td>
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</tr>
<tr>
<td>Micro Light Gas gun two-stage</td>
<td>2.5 - 7.5 km/s</td>
<td>2-19 mm (1/8&quot;-3/4&quot;)</td>
<td>up to 3 m dia.</td>
<td>4 ft dia. X 5 ft length</td>
<td>photo diode</td>
</tr>
<tr>
<td>Large two-stage light gas gun</td>
<td>2.0 - 7.5 km/s</td>
<td>0.2 - 1.0 mm</td>
<td>up to 1 m dia.</td>
<td>10 ft dia X 20 ft length</td>
<td>photo diode</td>
</tr>
<tr>
<td><strong>Outdoor Range</strong></td>
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<tr>
<td>Large Ballistic Gun</td>
<td>up to 3000 ft/s</td>
<td>3 - 8 inch</td>
<td>open-air range</td>
<td>open-air range</td>
<td>high speed video</td>
</tr>
<tr>
<td>Small Ballistic Gun</td>
<td>up to 3000 ft/s</td>
<td>0.5 - 1.0 inch</td>
<td>open-air range</td>
<td>open-air range</td>
<td>high speed video</td>
</tr>
<tr>
<td>Range is also rated</td>
<td>small arms</td>
<td>ball rounds to 10&quot;</td>
<td>full-scale hardware</td>
<td>open-air range</td>
<td>high speed video</td>
</tr>
<tr>
<td><strong>Environment Impact Range</strong></td>
<td></td>
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<tr>
<td>Hydrometeor (Rain) Gun</td>
<td>up to 4200 ft/s</td>
<td>1-5mm rain drop</td>
<td>&lt;20 mm</td>
<td></td>
<td>high speed video</td>
</tr>
<tr>
<td>Single or Multi-particle Gun</td>
<td>up to 6000 ft/s</td>
<td>0.01mm</td>
<td>12 X 12&quot; inch</td>
<td>18 X 24 X 36 inches</td>
<td>high speed video</td>
</tr>
<tr>
<td>Exploding Wire Gun</td>
<td>50 km/s</td>
<td>0.4mm</td>
<td>open-air range</td>
<td>open-air range</td>
<td>high speed video</td>
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<tr>
<td><strong>University of Alabama Huntsville (UAH) Aerodynamics Research Center</strong></td>
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<tr>
<td><strong>Hypervelocity Range</strong></td>
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</tr>
<tr>
<td>108 mm two-stage light gas gun</td>
<td>1 - 7.5 km/s</td>
<td>up to 130 grams</td>
<td>up to 1 MJ</td>
<td>6&quot; dia. X 14&quot; long</td>
<td>25&quot; long, 75-12&quot; dia.</td>
</tr>
<tr>
<td>133 mm two-stage light gas gun</td>
<td>1 - 7.5 km/s</td>
<td>up to 300 grams</td>
<td>up to 1 MJ</td>
<td>7.9&quot; dia. X 22&quot; long</td>
<td>59&quot; long, 115-14&quot; dia.</td>
</tr>
<tr>
<td>254 mm two-stage light gas gun</td>
<td>1 - 7.5 km/s</td>
<td>up to 8000 grams</td>
<td>up to 25 MJ</td>
<td>10&quot; dia. X 41&quot; long</td>
<td>75&quot; long, 22-60&quot; dia.</td>
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<tr>
<td><strong>Arnold Engineering Development Center (AEDC) Hypervelocity Range Facility</strong></td>
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<tr>
<td><strong>Hypervelocity Range</strong></td>
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<tr>
<td>355 mm two-stage light gas gun</td>
<td>1.5 - 7.5 km/s</td>
<td>up to 20,000 grams</td>
<td>up to 96 MJ</td>
<td>10&quot; dia X 940&quot; long</td>
<td>125-190&quot; long, 272-321&quot; dia.</td>
</tr>
<tr>
<td>203 mm two-stage light gas gun</td>
<td>1.5 - 6.5 km/s</td>
<td>up to 1,000 grams</td>
<td>up to 21 MJ</td>
<td>10&quot; dia X 33&quot; long</td>
<td>98&quot; long, 207&quot; dia.</td>
</tr>
<tr>
<td>38,76,77 mm two-stage light gas gun</td>
<td>1.5 - 8.5 km/s</td>
<td>2.0 - 6.0 grams</td>
<td>up to 1 MJ</td>
<td>6&quot; dia X 15&quot; long</td>
<td>12, 14, 36&quot; long, 3, 5, 8, 75&quot; dia.</td>
</tr>
<tr>
<td>Compressed air launcher</td>
<td>98 - 1200 ft/sec</td>
<td>4.535 grams</td>
<td>N/A</td>
<td>Open</td>
<td>33&quot; long, 6&quot; dia.</td>
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<tr>
<td><strong>Erosive Field Characteristics</strong></td>
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<tr>
<td>Dust</td>
<td>800 ft</td>
<td>200.325, 650 microns</td>
<td>&lt; 2.0 gm/m³</td>
<td>2.0 gm/m³</td>
<td></td>
</tr>
<tr>
<td>Rain</td>
<td>800 ft</td>
<td>1.0 - 2.0 mm</td>
<td></td>
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</tr>
<tr>
<td>Snow (Cirrus, Dendritic)</td>
<td>800 ft</td>
<td>0.2 - 3mm</td>
<td>&lt; 1.0 gm/m³</td>
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<tr>
<td><strong>Auburn University Space Research Institute</strong></td>
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<td><strong>Hypervelocity Range</strong></td>
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<tr>
<td>Plasma Drag Gun</td>
<td>5 - 12 km/sec</td>
<td>10-150 um diameter</td>
<td>5 to 50 particles/test</td>
<td>3.9' X 6.6'</td>
<td>24 - 450K</td>
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<tr>
<td><strong>Temperatures</strong></td>
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