

National Aeronautics and Space Administration



Southern Impact Testing Alliance

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

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USAF/AEDC*

www.nasa.gov

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 SITA

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

The Ballistic Impact Range is an outdoor range used to accommodate full-scale targets and small arms test firing.

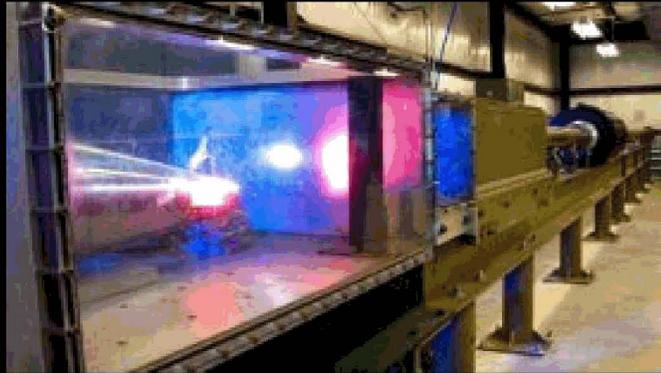


Small Ballistic Gun (SBG)

- 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



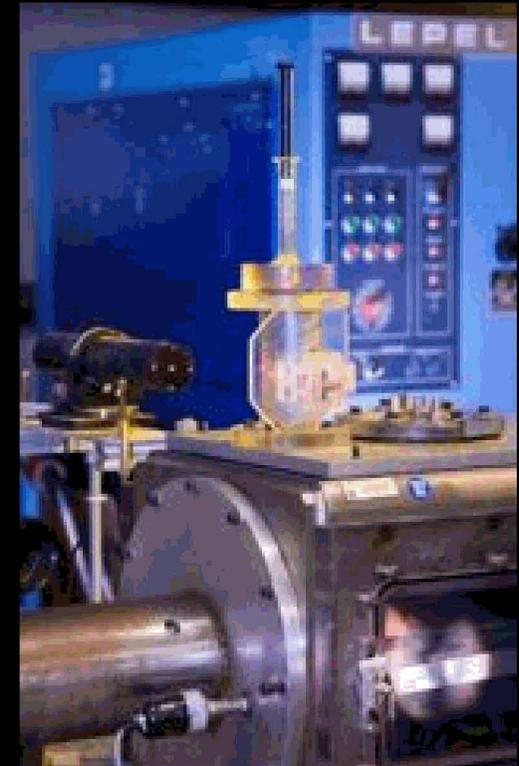
Single/Multi-Particle Gun

- 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 capabilities for rain, hail, sand, and dust impacts. Applications previously tested include radome, IR window, rotor blade materials.

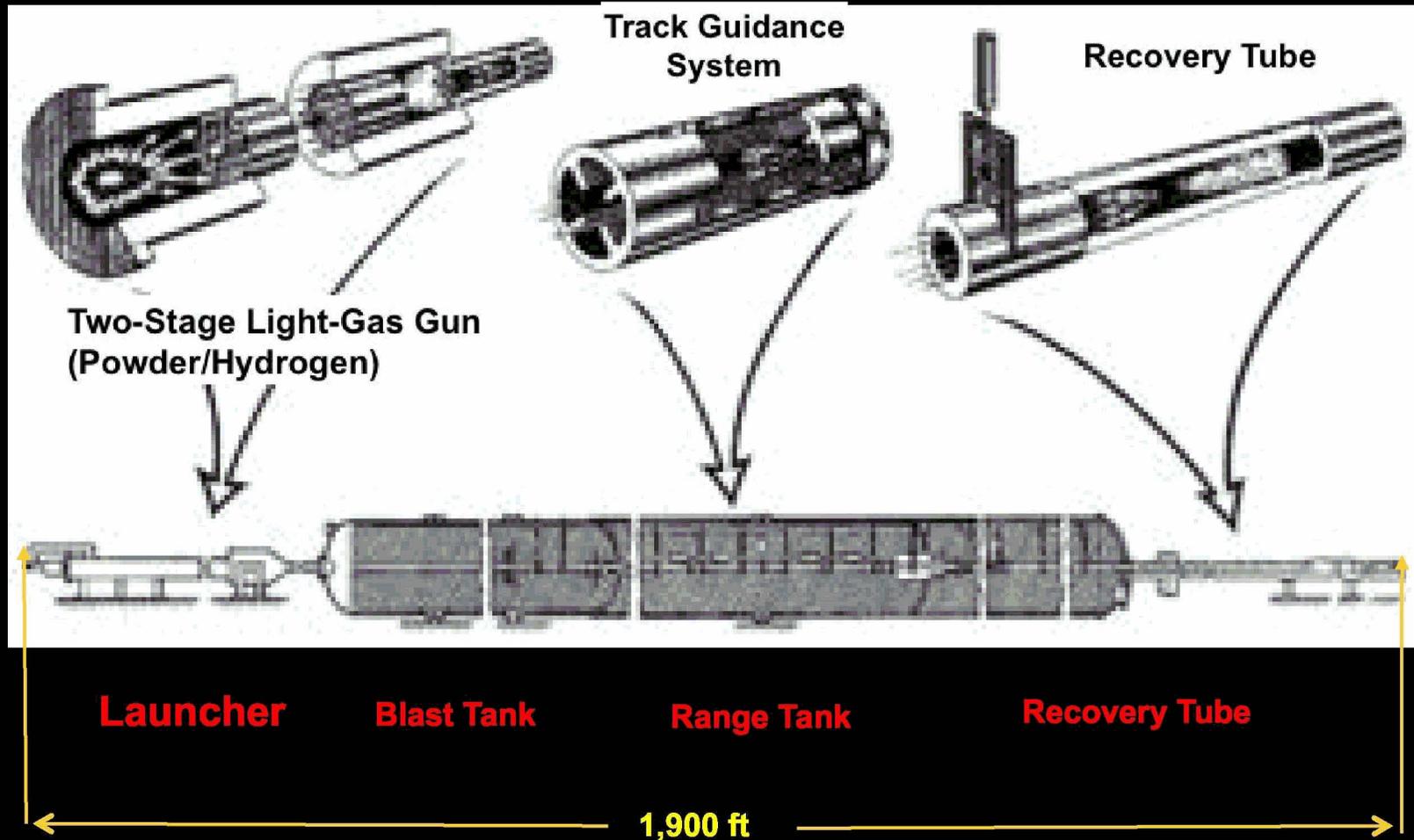


AEDC RANGE COMPLEX INCLUDING RANGE G AND RANGE I



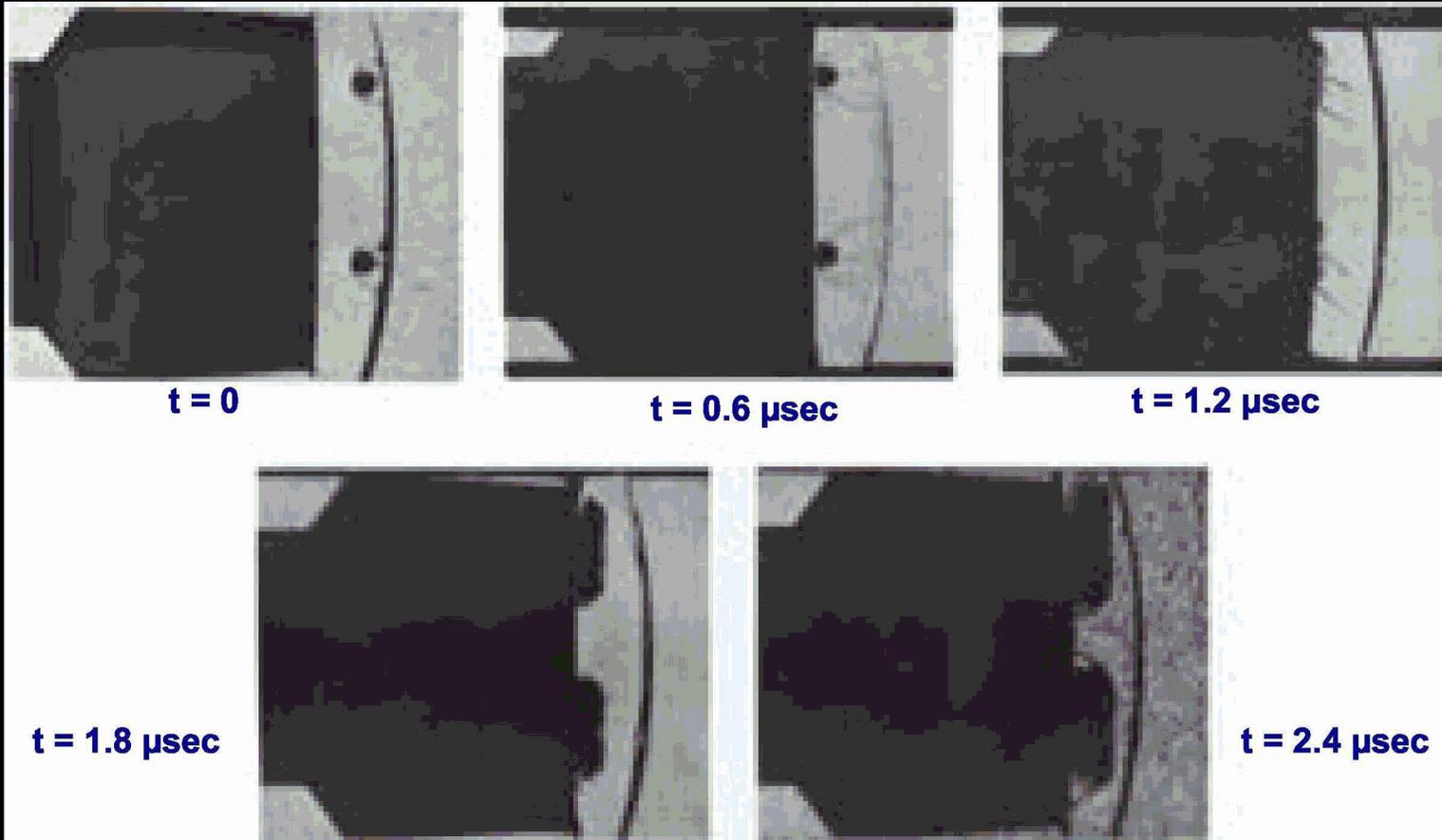


RANGE G TRACK AND RECOVERY TUBE SYSTEM





MODEL / WATER DROPLET IMPACT SEQUENCE (TWO IMPACTS)



$t = 0$

$t = 0.6 \mu\text{sec}$

$t = 1.2 \mu\text{sec}$

$t = 1.8 \mu\text{sec}$

$t = 2.4 \mu\text{sec}$

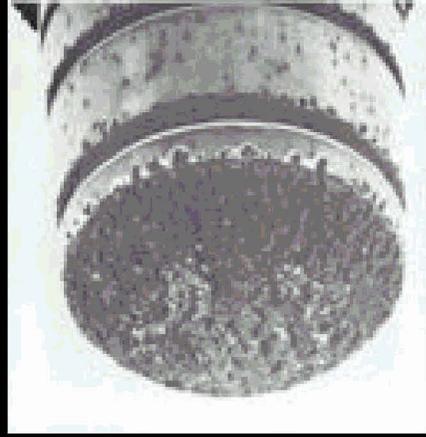
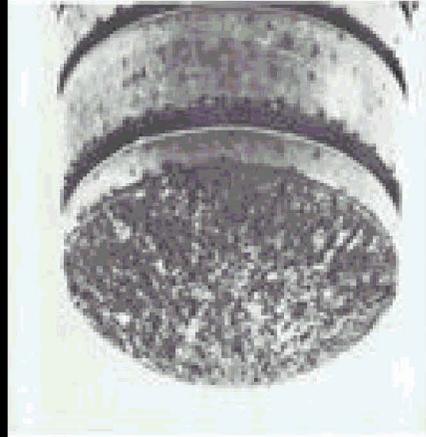
Model Velocity: 2,460 m/sec

Range Pressure: 354 torr

1.2-mm-diam Water Droplets

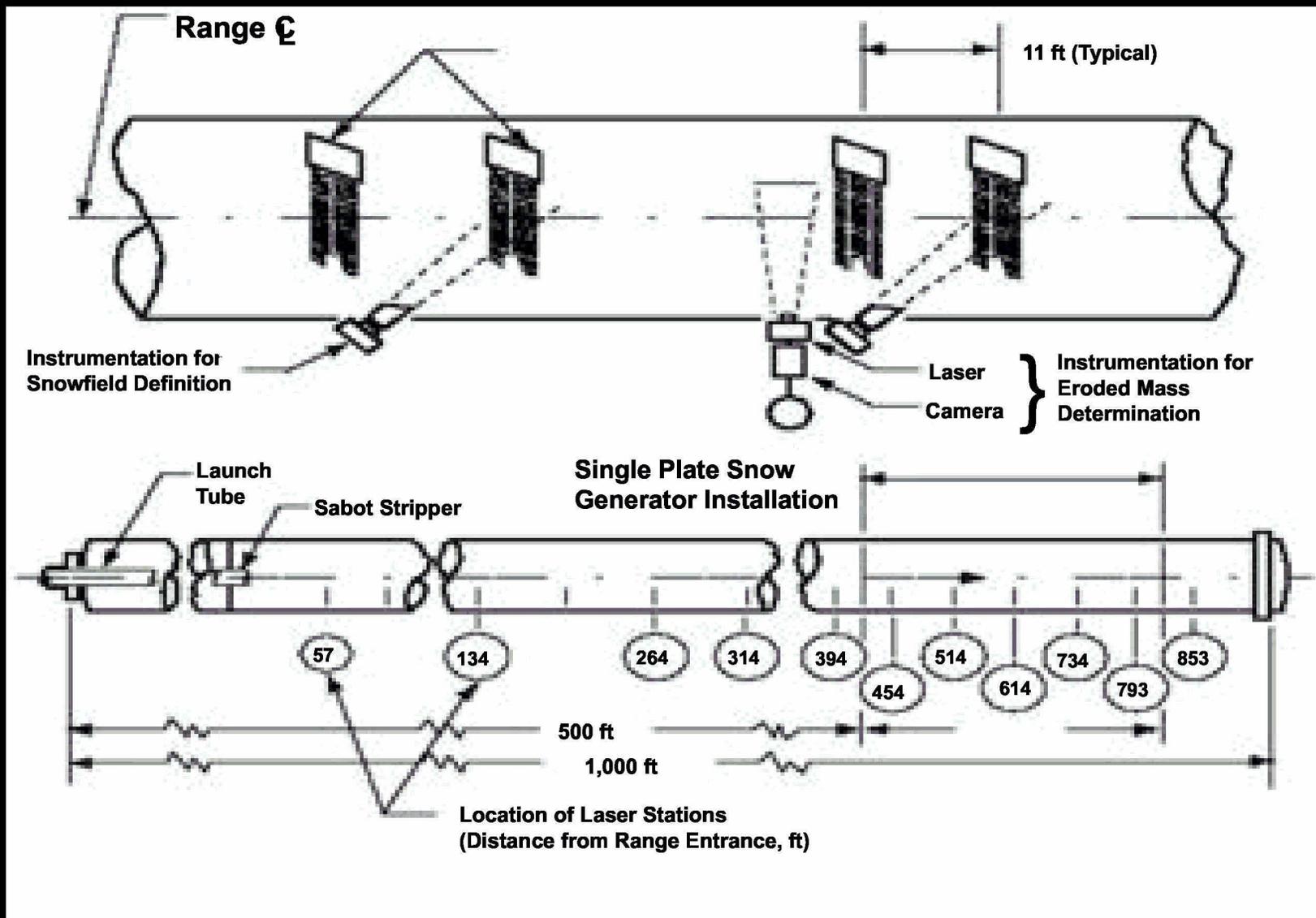


EROSIVE FIELDS TESTING IN THE RANGE G 900 FOOT RANGE TANK SYSTEM





SNOWFIELD GENERATOR INSTALLATION IN AEDC RANGE G



University of Alabama in Huntsville – Aerophysics Research Center



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.

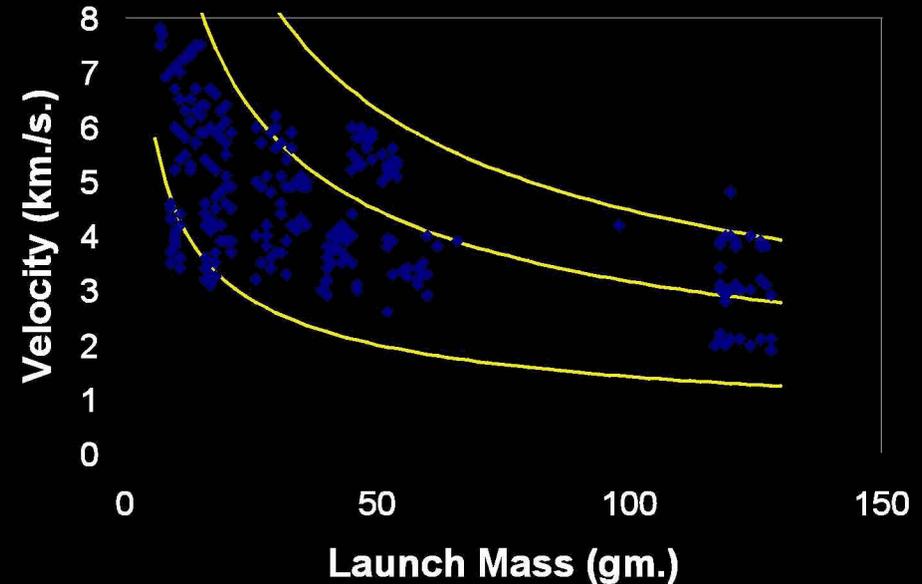
Primary Function is conducting experimental research on hypersonic flight and hypervelocity impact.

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.



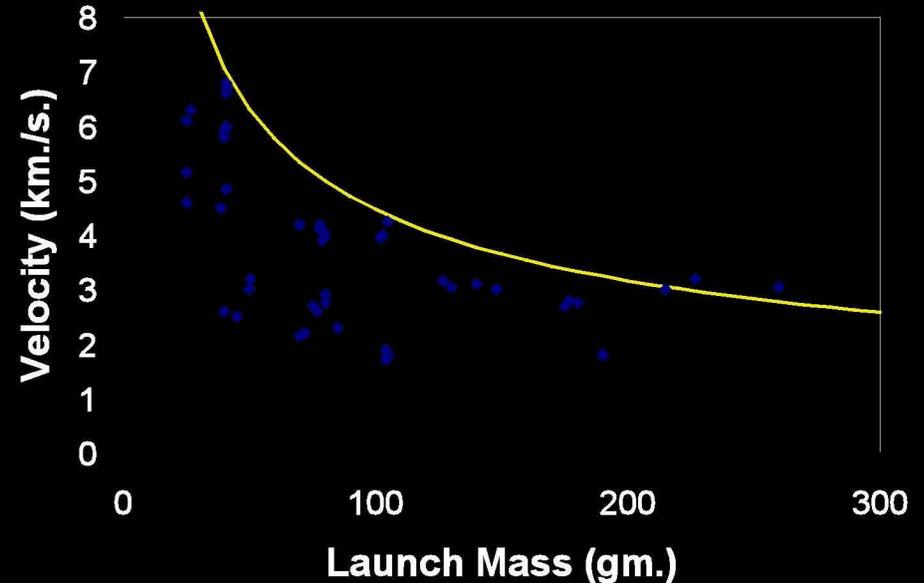
University of Alabama in Huntsville – 108 MM Pump Tube Light Gas Gun



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.



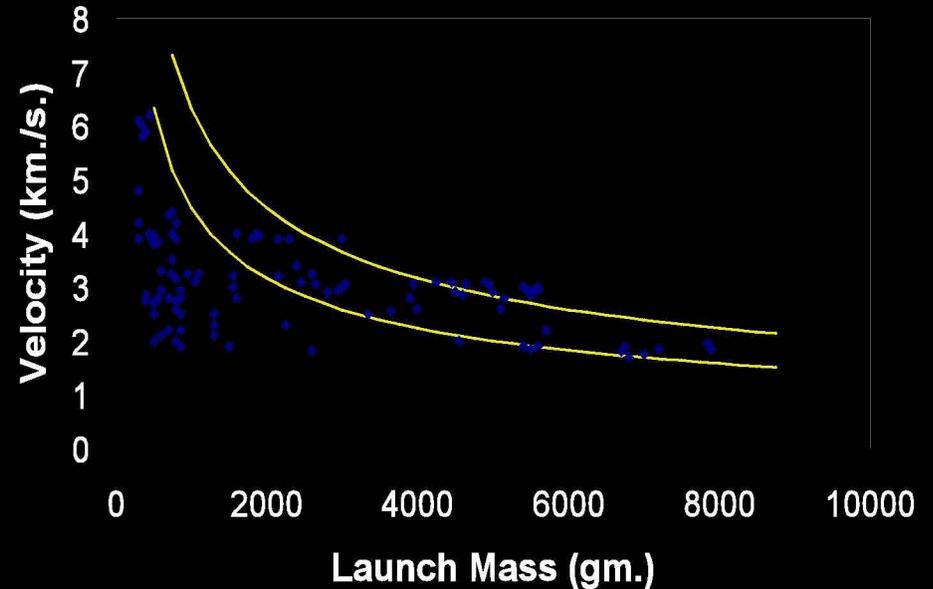
University of Alabama in Huntsville – 133 MM Pump Tube Light Gas Gun



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.



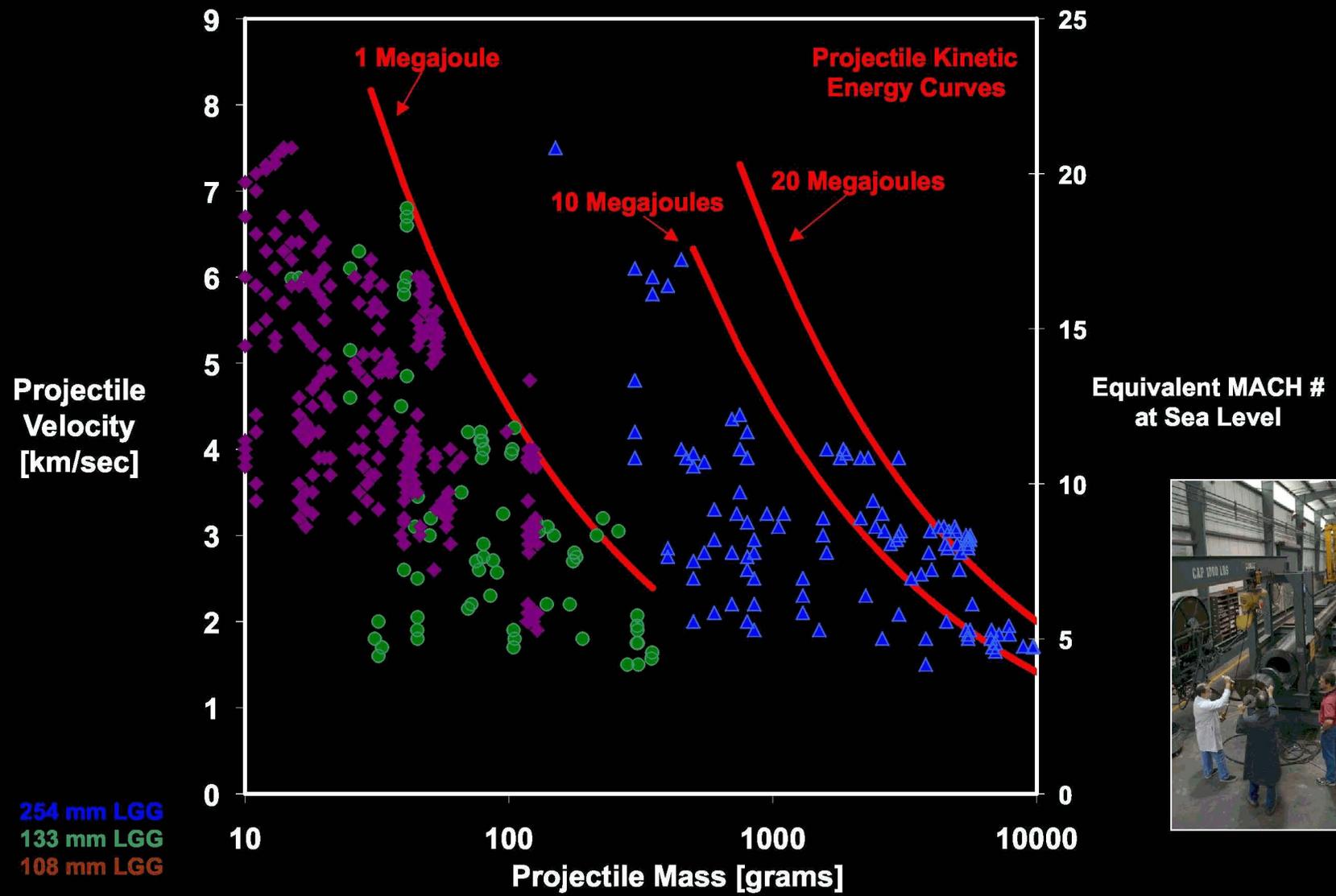
University of Alabama in Huntsville – 254 MM Pump Tube Light Gas Gun



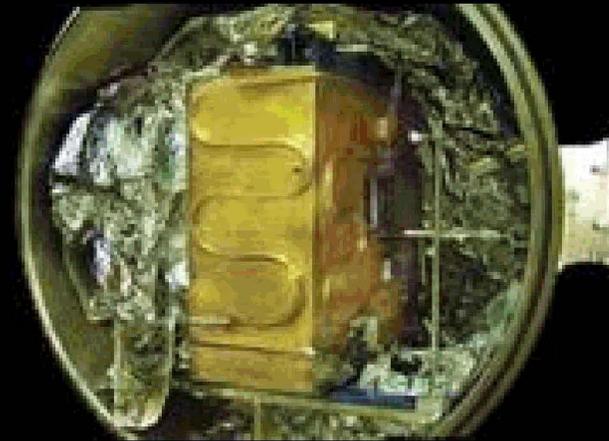
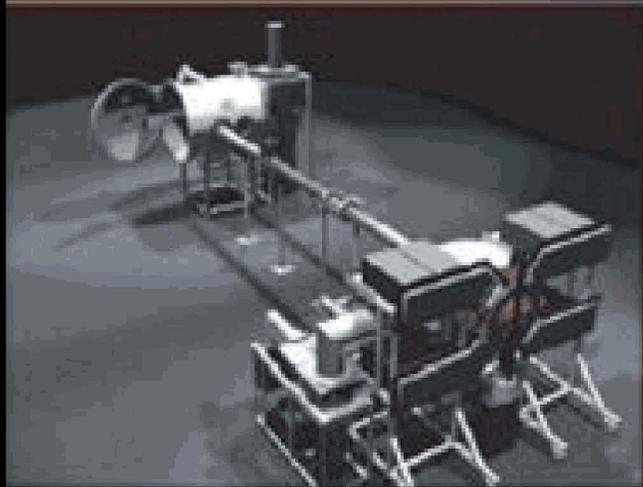
125' Long x 10" Diameter Pump Tube
75' Long Interchangeable Launch Tubes
Launch Tube Diameters from 2.2" to 6.0"
10' Diameter x 41' Long Impact Chamber
Launch Mass's up to ~ 12 kg.
Launch Energy's up to ~ 25 MJ.



University of Alabama in Huntsville – Overall Mass/Velocity Test Capability



Auburn University Space Research Institute



- **Arc Driven Plasma Drag Gun**

- Accelerates 5 to 50 particles per test (10-150 μ m 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.

SITA Capabilities Summary Page

Southern Impact Testing Alliance					
Marshall Space Flight Center Impact Testing Facility					
Gun	Velocity Range	Projectile	Target size	Target Chamber	Velocity measurement
Hypervelocity Range					
Micro light gas gun two-stage (ballistic mode)	2.5 - 7.5 km/s 2000-4500 ft/s	2-19 mm (1/8"-3/4") 1-4 mm spheres	up to 3 m dia. 2 X 2 inch @ 90°	4 ft dia. X 5 ft length open to room	photo diode high speed video
Large two-stage light gas gun	2.0 - 7.5 km/s	0.2 - 1.0 mm	up to 1 m dia.	10 ft dia X 20 ft length	photo diode
Outdoor Range					
Large Ballistic Gun	up to 3000 ft/s	3 - 8 inch	open-air range	open-air range	high speed video
Small Ballistic Gun	up to 3000 ft/s	0.5 - 1.0 inch	open-air range	open-air range	high speed video
Range is also rated	small arms	ball rounds to HEI	full-scale hardware	open-air range	high speed video
Environment Impact Range					
Hydrometeor (Rain) Gun	up to 4200 ft/s	1-5mm rain drop	<20 mm		high speed video
Single or Multi-particle Gun	up to 6000 ft/s	≥0.01mm	≈ 12 X12 inch	18 X 24 X 36 inches	high speed video
Exploding Wire Gun	≤10 km/s	≥0.4mm	open air range	open-air range	high speed video
University of Alabama Huntsville (UAH) Aerophysics Research Center					
Hypervelocity Range (Pump Tube Diameter)	Velocity Range	Projectile mass	Launch Energy	Target Chamber	Launch Tube
108 mm two-stage light gas gun	1 - 7.5 km/s	up to 130 grams	up to 1 MJ	6' dia. X 14' long	25' long, .75-1.2" dia.
133 mm two-stage light gas gun	1 - 7.5 km/s	up to 300 grams	up to 1 MJ	7.9' dia. X 22' long	50' long, 1.15-1.4" dia.
254 mm two-stage light gas gun	1 - 7.5 km/s	up to 8000 grams	up 25 MJ	10' dia. X 41' long	75' long, 2.2-6.0" dia.
Arnold Engineering Development Center (AEDC) Hypervelocity Range Facility					
Hypervelocity Range (Pump Tube Diameter)	Velocity Range	Projectile mass	Launch Energy	Target Chamber	Launch Tube
355 mm two-stage light gas gun	1.5 - 7.5 km/sec	up to 20,000 grams	up to 96 MJ	10' dia X 940' long	125-190' long, .272, .331, .666" dia.
203 mm two-stage light gas gun	1.5 - 6.5 km/sec	up to 1,000 grams	up to 21 MJ	10' dia X 33' long	98' long, .207" dia.
38,76.77 mm two-stage light gas gun	1.5 - 8.5 km/sec	2.0 - 6.0 grams	up to 1 MJ	6' dia X 15' long	12, 14, 36" long, .3, .5, .6, .75" dia.
Compressed air launcher	98 - 1200 ft/sec	4,535 grams	N/A	Open	33' long, .6' dia.
Erosive Field Characteristics	Field Length	Projectile Diameter	Concentration		
Dust	800 ft	200,325, 650 microns	< 2.0 gm/m ³		
Rain	800 ft	1.0 - 2.0 mm			
Snow (Cirrus, Dendritic)	800 ft	0.2 - 3mm	< 1.0 gm/m ³		
Auburn University Space Research Institute					
Hypervelocity Range	Velocity Range	Projectile size	Projectile quantity	Target Chamber	Temperatures
Plasma Drag Gun	5 - 12 km/sec	10-150 um diameter	5 to 50 particles/test	3.9' X 6.6'	24 - 450K

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