



The Hypervelocity Free-Flight Facilities at NASA Ames Research Center

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Hypervelocity Free-Flight Facilities

Ames Research Center

General Description:

The HFFF Complex consists of two active ballistic ranges; the Aerodynamic Facility (HFFAF) and the Gun Development Facility (HFFGDF). These are NASA's only aeroballistic ranges.

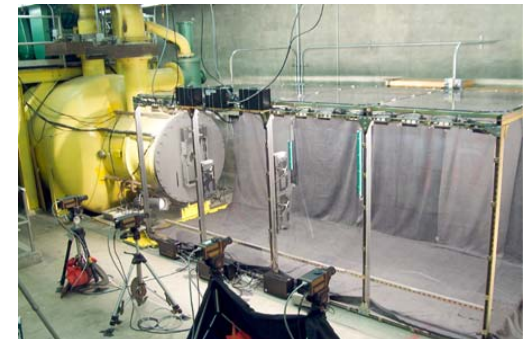
The HFFAF is the only aeroballistic range the nation currently capable of testing in gases other than air and at sub-atmospheric pressures. It is used primarily to study the aerodynamics, aerothermodynamics and gas-dynamics associated with hypervelocity flight (such as incurred during atmospheric entry). A broad range of model velocities are attainable with its arsenal of powder guns and light-gas guns. Data derived from observations of model flight include: aerodynamic parameters (i.e. lift, drag & pitching moment coefficients, dynamic stability criterion, etc.), flow-field characteristics (shock structures, spectral emission details of shock layers & wakes), model ablation behavior, and surface temperature distributions (heat transfer rates, transition locations). There are sixteen, orthogonal, shadow-graph imaging stations (with 12" and 15" diameter windows) spaced every 5 ft along the test section.

The HFFGDF is a very useful compliment to the HFFAF. In it's current configuration it utilizes an atmospheric test section which has virtually unobstructed, orthogonal views and allows for high lifting/swerving models. Models are detected using photodiode light screens, and data is captured using 8 (or more), orthogonally positioned, visible ICCD cameras which take multiple exposures (typically 10 to 16 for each camera). This yields high-fidelity recordings of model trajectories. In an alternate configuration, the atmospheric test section can be replaced with a flight tube and impact chamber to enable light-gas gun development studies and hypervelocity impact testing.

**Hypervelocity Free-Flight
Aerodynamic Facility**
Aero & Aerothermodynamics



**Hypervelocity Free-Flight Gun
Development Facility**
Aerodynamics





Hypervelocity Free-Flight Aerodynamic Facility

Ames Research Center

OPERATOR: Space Technology Division,
Thermo-Physics Facilities Branch

STATUS: Operational (since 1964)

LOCATION: N-237

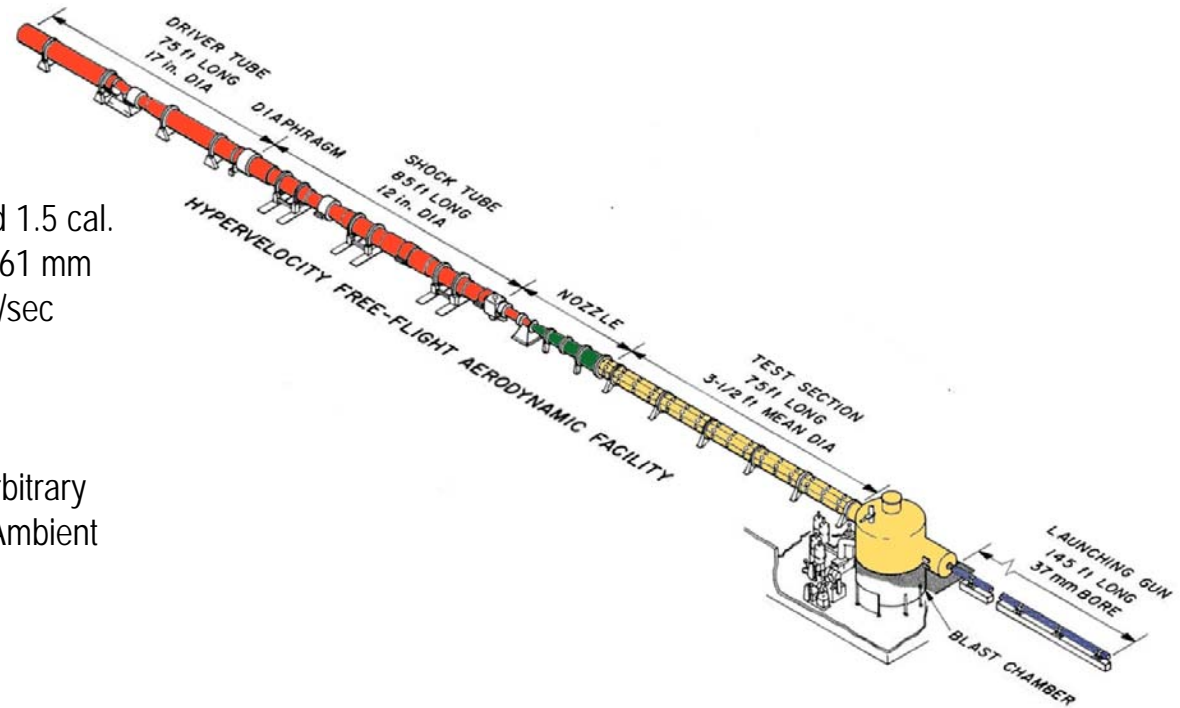
PERFORMANCE SUMMARY:

Light-gas Guns	.28, .50, 1.0 and 1.5 cal.
Powder Guns	20, 25, 44 and 61 mm
Velocity	700 to 26,000 ft/sec
Max. Reynolds Number	2×10^6 1/ft
Model Acceleration	1.5×10^6 g
Model Mass	5 to 100 gm
Test Gas	Air, N ₂ , CO ₂ , arbitrary
Pressure/Temperature	0.03 - 760 torr/Ambient
Sabot Separation	Aerodynamic

TEST SECTION DIMENSIONS:

Length	75 ft. (22.8 m)
Diameter	3.5 ft. (1.1 m)

PREVIOUS SUPPORT: Apollo, PAET, Viking, Pioneer Venus, Galileo, AOTV/AFE, NASP, ISS, RLV/X-33, MSL, NGLT, ISP, RTF, CEV, FAP.





Hypervelocity Free-Flight Aerodynamic Facility

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HFFAF Data Gathering Systems:

Trajectory & Aerodynamic Coefficients-

Type: Focused shadowgraph (film-based)

Light Source: Spark gap (capacitive discharge)

Shuttering: Kerr cell, 40 ns exposure (electro-optical)

Detection: Photomultiplier-tube/halogen light sheet

Aeroballistic Models



Shadowgraph Image



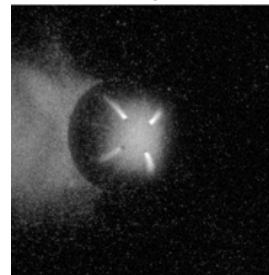
Aerothermodynamics-

Thermal Imaging: Distributed Visible ICCD & IR cameras

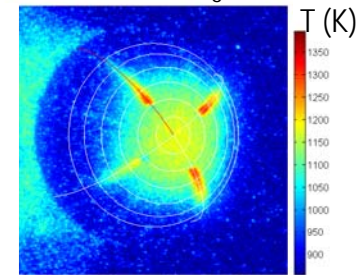
Subsystem: Helium plumes (to eliminate gas cap radiation)

Primary Data: Surface temperature profiles, from which one can infer heat transfer rates & transition locations

0.5 μ s Image of Model



Thermal Image





Hypervelocity Free-Flight Gun Development Facility

Ames Research Center

OPERATOR: Space Technology Division,
Thermo-Physics Facilities Branch

STATUS: Operational (reactivated 2004)

LOCATION: N-237

PERFORMANCE SUMMARY:

Powder Guns	20, 25, 44 and 61 mm
Air Guns	25 mm
Velocity	300 to 6,000 ft/sec
Model Mass	5 to 200 gm
Test Gas	Air
Pressure/Temperature	Ambient
Sabot Separation	Aerodynamic or muzzle blast

TEST SECTION DIMENSIONS:

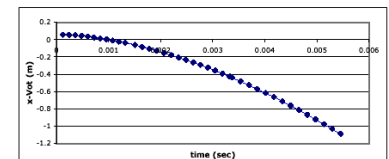
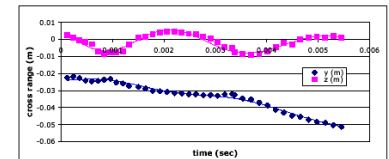
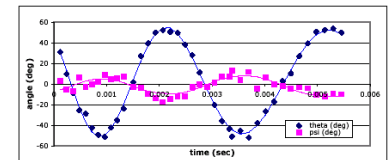
Length, ft	16
Height x width, ft	6.5 x 6.5

CAPABILITIES: 6-DOF trajectory data and static and dynamic aero coefficients, for high-lift, high-drag, large-amplitude, and rapidly-oscillating projectiles.

PREVIOUS SSPO SUPPORT: Shuttle External Tank insulating-foam aerodynamics to validate CFD for Return to Flight.

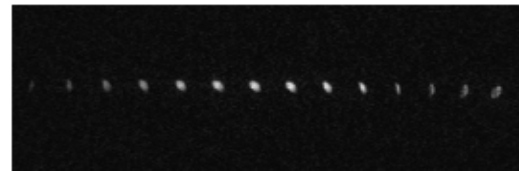


Processed Trajectory Data

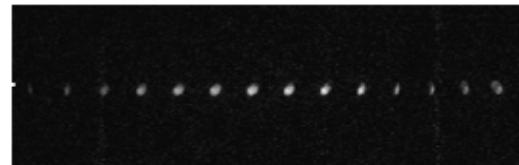


Orthogonal set of images (HFFGDF)

Top View



Side View





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HFFF Flight Simulation Capability:

