Experimental Impact Laboratory

ILLUSTRATION CREDIT: DON DAVIS/NASA

The Astromaterials Research and Exploration Sciences Directorate (ARES / KA) at NASA's Johnson Space Center (JSC) is the home of the Experimental Impact Laboratory (EIL). The EIL includes three accelerators that permit researchers to study a wide variety of phenomena associated with the effects of high-velocity impacts into geologic materials. By studying these processes, scientists can learn about the histories and evolution of planetary bodies and the solar system as a whole.

Impact is the only process affecting every object in the solar system at a scale visible to the naked eye, and most research conducted in the EIL addresses questions involving such events. Investigations in the EIL are not limited to strictly geological processes, however, as astrobiological studies and work involving spacecraft components have been performed on occasion. The aerogel collector material flown on the Stardust spacecraft that traveled to Comet Wild-2, for instance, was tested and qualified for flight using the EIL's Light-Gas Gun.

Accelerator Area

In general, all three accelerators work essentially the same way. A high-pressure driving gas is quickly introduced into the system, pushing the projectile down the barrel and toward the target. Experiments are typically conducted under reduced atmospheric conditions (as low as 20 μtorr), but the chamber pressure and its composition can be modified to simulate that of Mars, for example, or to suit other experimental requirements.

Overhead view of the 5 mm Light-Gas Gun (right) and Flat-Plate Accelerator (white, left) in the Experimental Impact Laboratory at the Johnson Space Center.

Flat-Plate Accelerator

The Flat-Plate Accelerator (FPA) is used to shock targets to stresses as high as 700,000 atmospheres, after which they are recovered for analysis to examine the resulting effects on the target material. Target materials typically consist of geological samples such as Moon rocks, meteorites, or — more often — terrestrial rocks and simulants. The target is typically a disk about 10 mm in diameter by 1 to 2 mm thick. Unconsolidated, porous materials can also be shock-loaded via the Flat-Plate Accelerator.

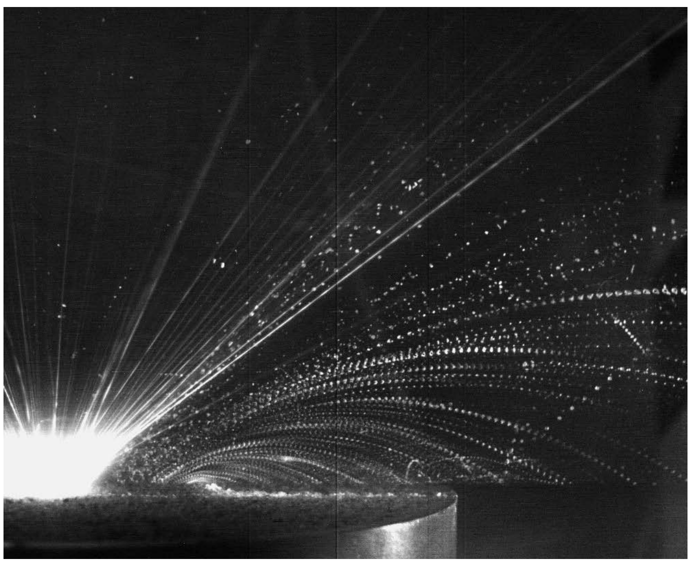
Vertical Gun

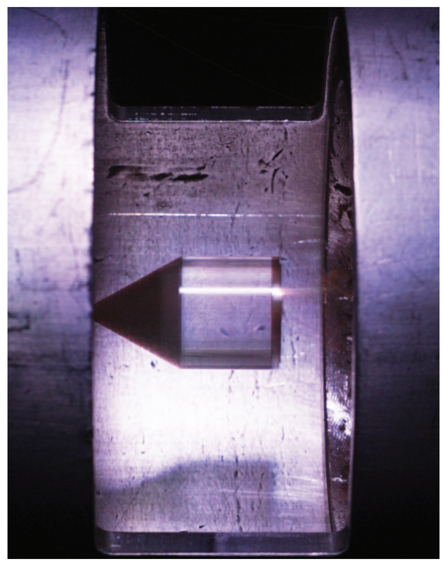
With a variety of different barrels, the Vertical Gun can launch projectiles ranging from microns across to those as large as 12 mm in diameter, with velocities approaching 3 km/s. Its impact chamber can be refrigerated, an important capability that can support experiments involving targets of H_2O ice and other cold materials. The Vertical Gun is particularly well-suited to the study of impacts into targets consisting of sand or other non-coherent materials. A laser-based ejection-velocity measurement system (EVMS) is often used in experiments conducted with the Vertical Gun (see image below, left).

Light-Gas Gun

The 5-mm, two-stage Light-Gas Gun is the largest and most complex accelerator in the EIL. Because it uses both gunpowder and gaseous hydrogen at extremely high pressures to accelerate the projectile, it is also the most time-consuming accelerator to prepare and fire.

The Light-Gas Gun is capable of accelerating projectiles smaller than 5 mm in diameter to velocities as high as 8 km/s, although velocities between 6 and 7 km/s are much more common. The large ("free-flight") distance between the muzzle of the launch tube and the target means that this is a very "clean" launcher, in that little, if any, noticeable material impacts the target other than the intended impactor(s). Very small projectiles (as small as 1 µm) have been launched successfully in the Light-Gas Gun using a "shotgunning" technique.

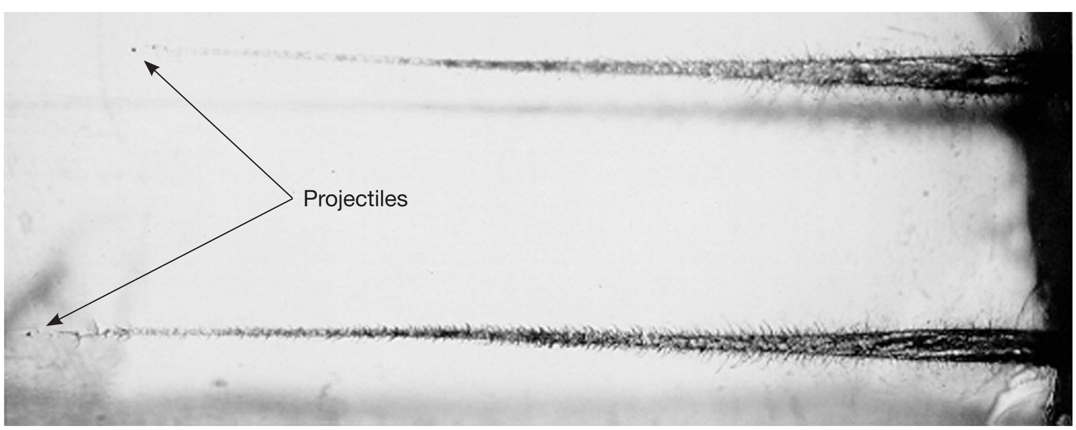




Left: EVMS photograph of ejecta from the impact of a 4.76 mm aluminum sphere into coarse sand at 1.26 km/s. Each parabolic track is defined by multiple images of individual sand grains as they were illuminated by a strobing laser.

Right: FPA projectile carrying a stainless steel flyer plate, traveling at 1.0 km/s, microseconds before impacting the target.

Two 10 µm, glass spheres launched by the Light-Gas Gun after they were captured in a block of aerogel. The two long, carrot-shaped tracks are typical of such impacts which, in this case, occurred at 6.1 km/s. This example is from a series of experiments that were used to flight-qualify the aerogel that was used on the Stardust Mission to the Comet Wild-2 that returned particles from that comet.



National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

www.nasa.gov

FS-2012-03-013-JSC

For more information visit
http://ares.jsc.nasa.gov/ares/kr_laboratories/EIL.cfm
or contact Dr. Mark J. Cintala (*mark.j.cintala@nasa.gov*)
or Thomas H. See (*thomas.h.see@nasa.gov*).