Experimental Impact Laboratory

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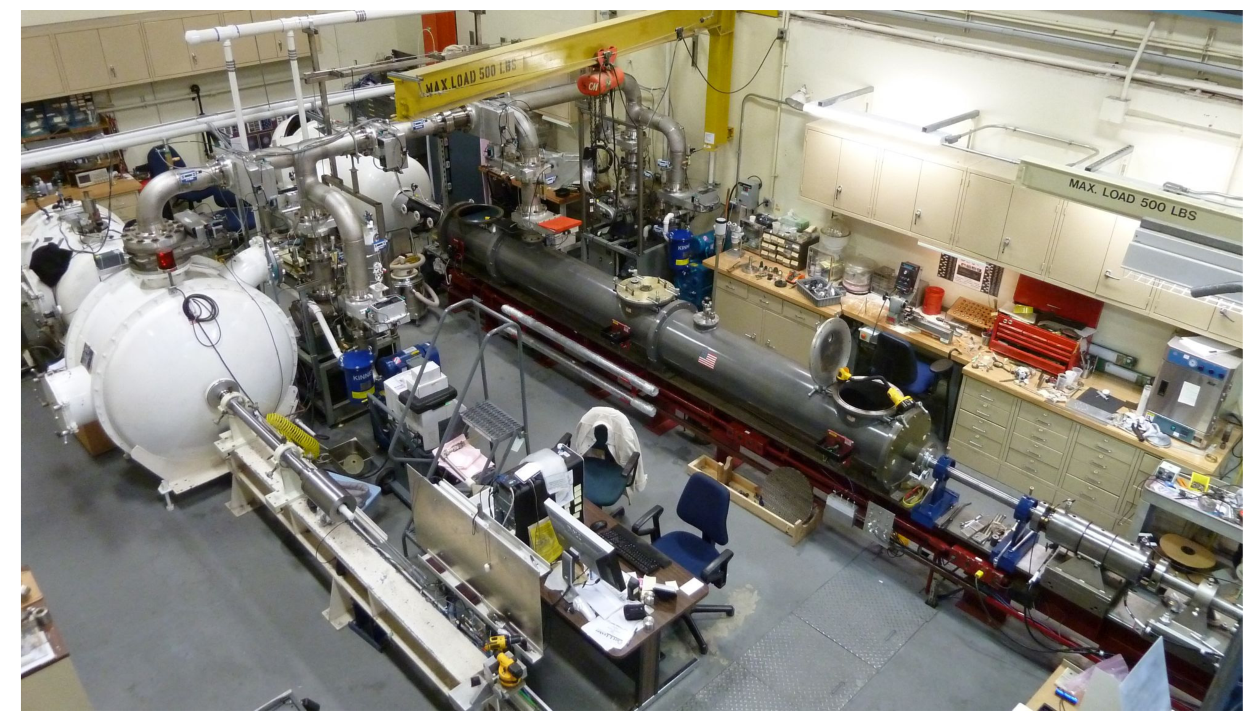
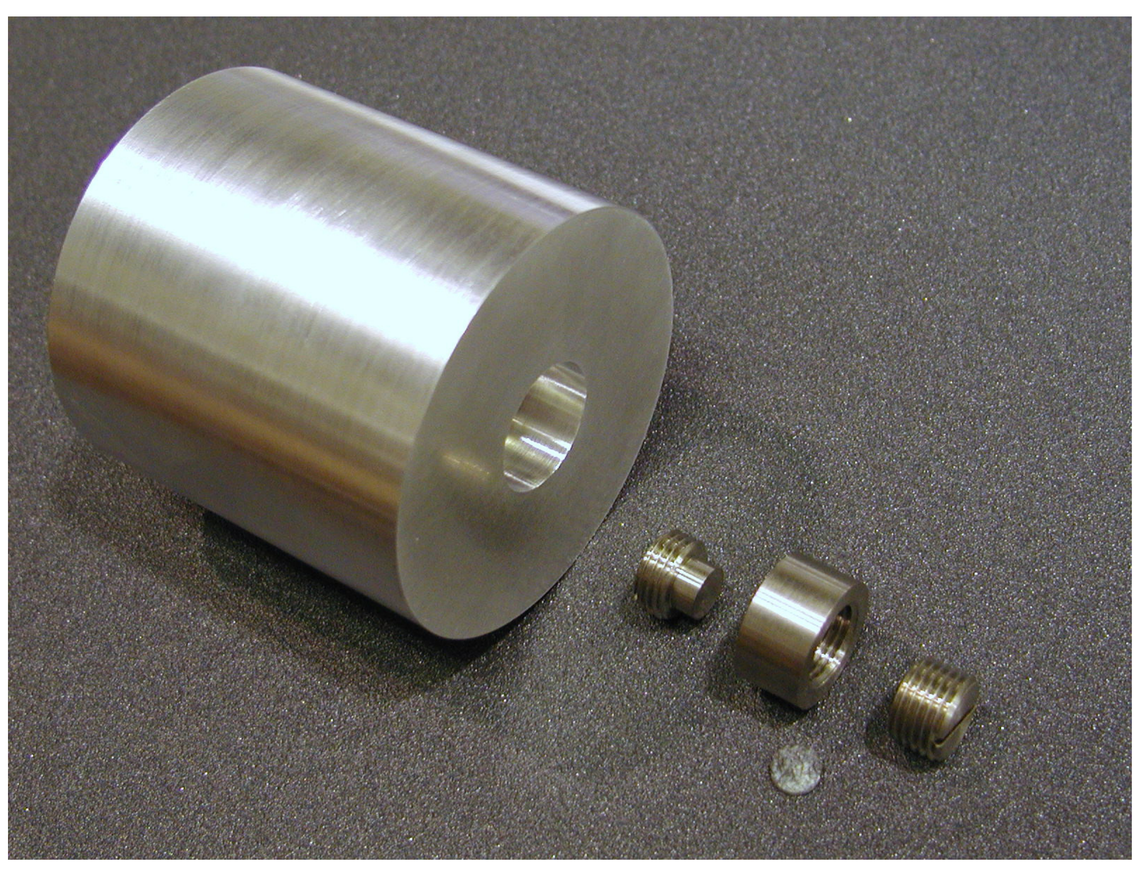
Along with a variety of support equipment (see the box in the lower right), the EIL comprises three accelerators, each of which launches its projectiles into a vacuum chamber, has its own velocity-measurement lasers and electronics, and can be configured for a wide range of experimentation.

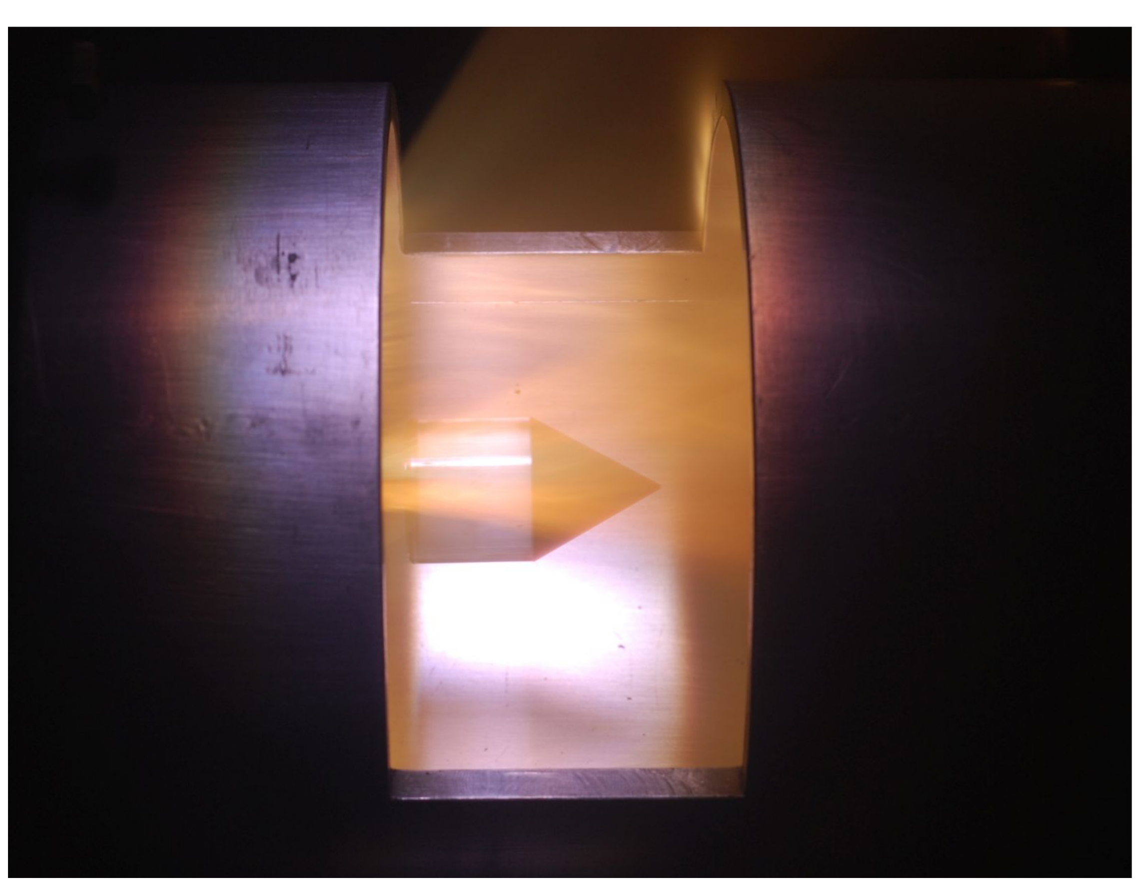


Flat-Plate Accelerator

The FPA is a horizontally mounted gun that uses gunpowder as a propellant to launch a projectile – a lexan cylinders, 25 mm in diameter, tipped with a flat, metal plate -- at a small, typically geologic sample. A shock-reverberation process raises the pressure "felt" by the impacted sample to a level much higher than that caused by the simple impact alone.



These are typical components of a target assembly, including the sample itself (the small disk). The sample is held in the three smaller parts, which get pressed into the large, cylindrical holder on the left.

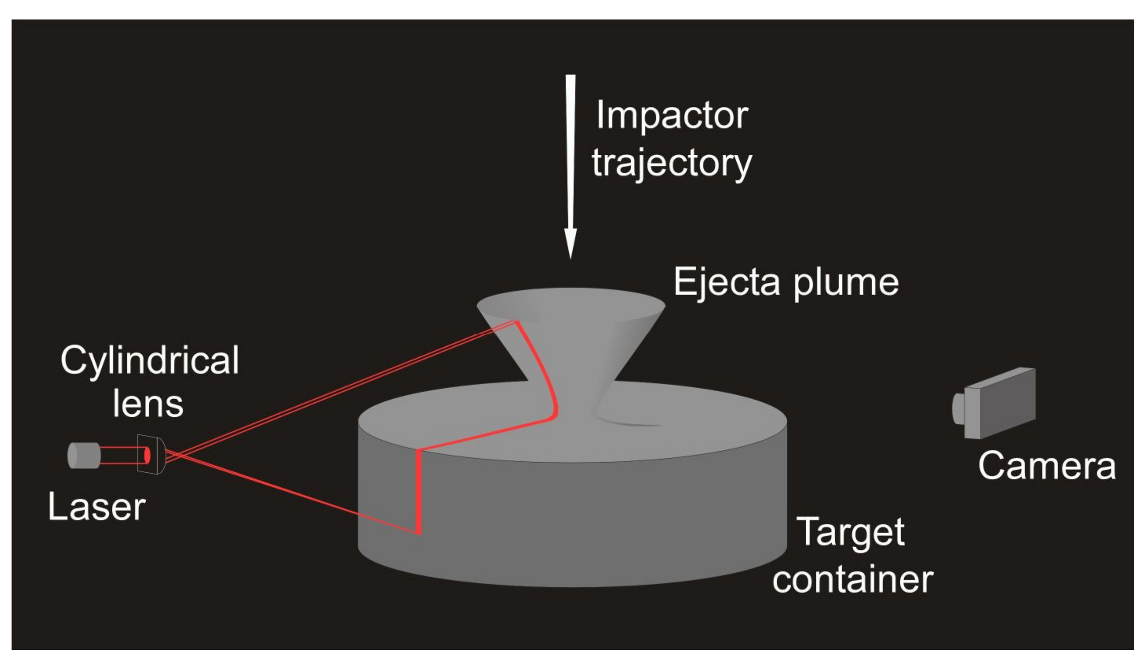


The projectile must impact the target with its front parallel, or nearly so, to the face of the target. This is determined by photographing the projectile in flight and measuring its tilt in two photographs, taken 90° from each other.

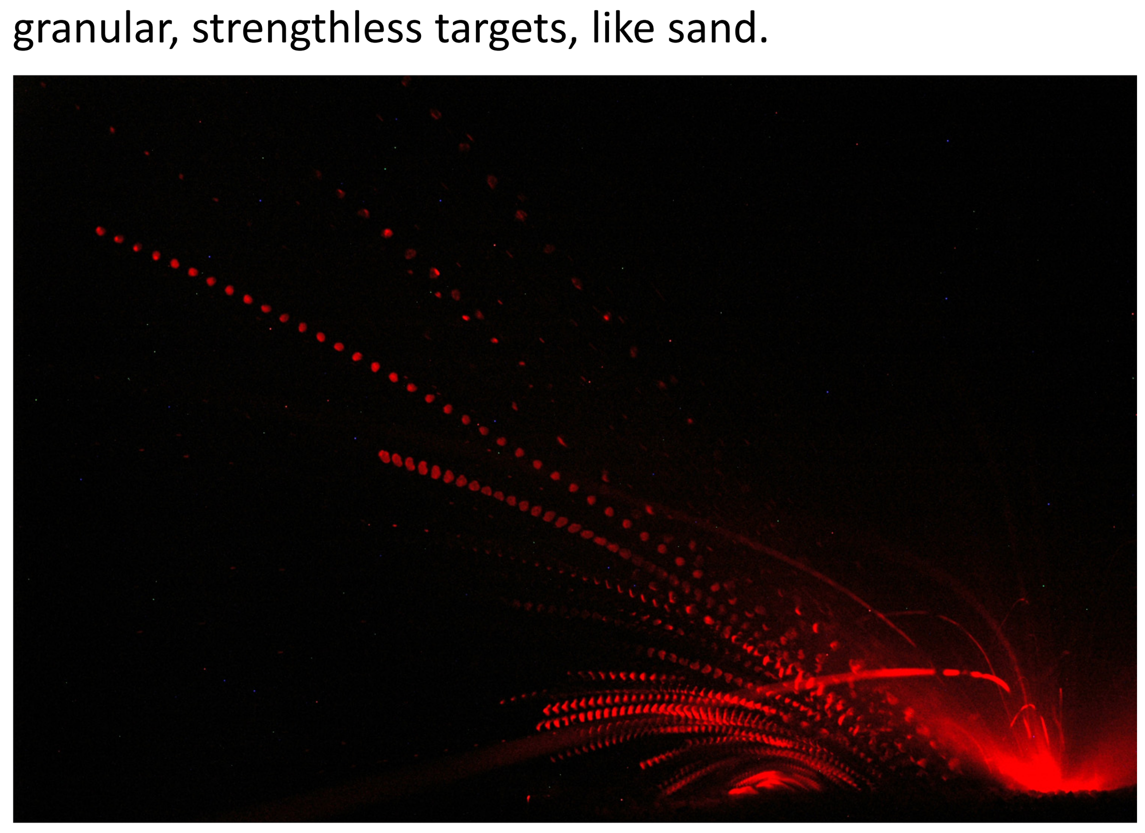
A stainless-steel target assembly after impact. The sample is still contained in the smaller sample assembly; it will be mounted in a lathe, excess metal will be machined away, and the sample recovered for a variety of possible analyses.

Vertical Gun

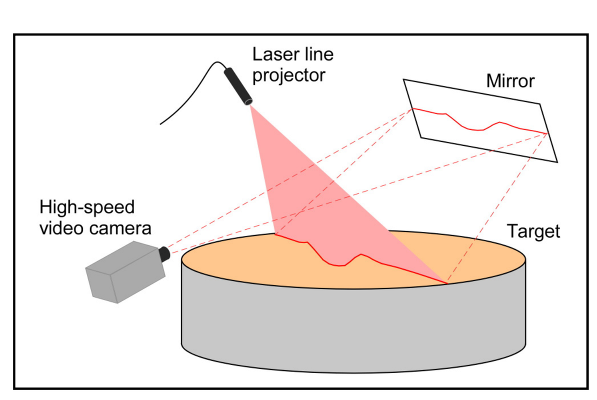
The vertical gun uses gunpowder in standard rifle shells as a propellant to launch projectiles as large as .30 caliber at a wide variety of targets. Because its projectiles travel straight down (hence its name), targets can range from strengthless materials, like sand, to solid rock, which can be used to simulate asteroids. The impact chamber of the vertical gun can be refrigerated, permitting the use of ice as a target material.



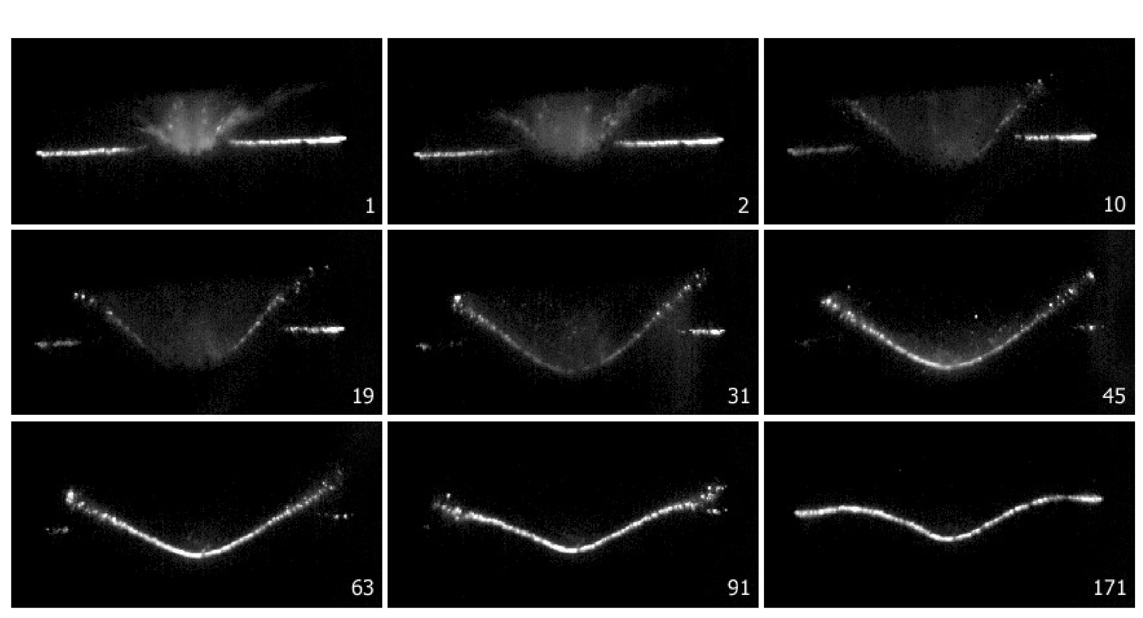
A capability afforded by the vertical gun is the measurement of ejection velocities from craters formed in granular, strengthless targets, like sand.



An example of a picture taken during the impact of a 3.2 mm (1/8") glass sphere into a coarse sand at 2.45 km/s.



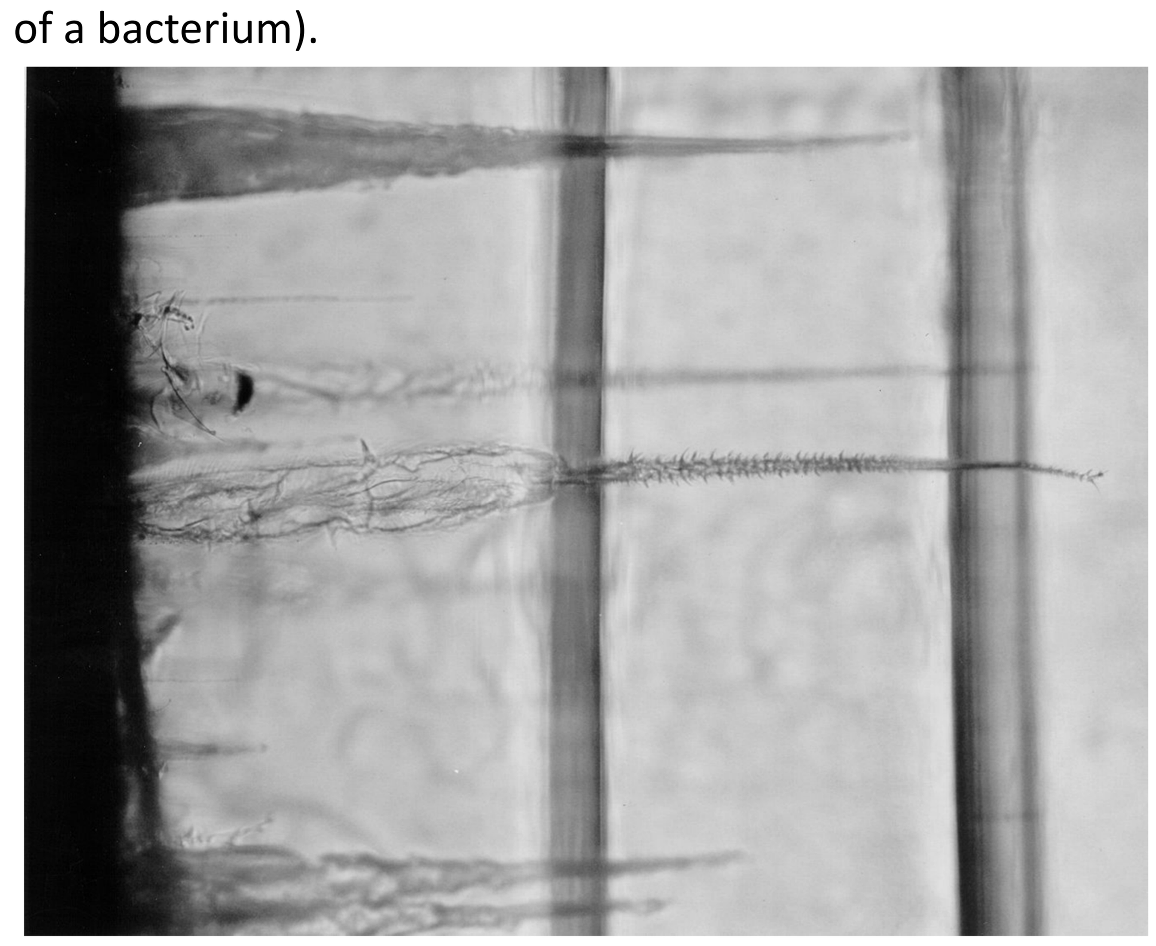
A similar system can be used to observe the growth of the crater below the surface as it happens.



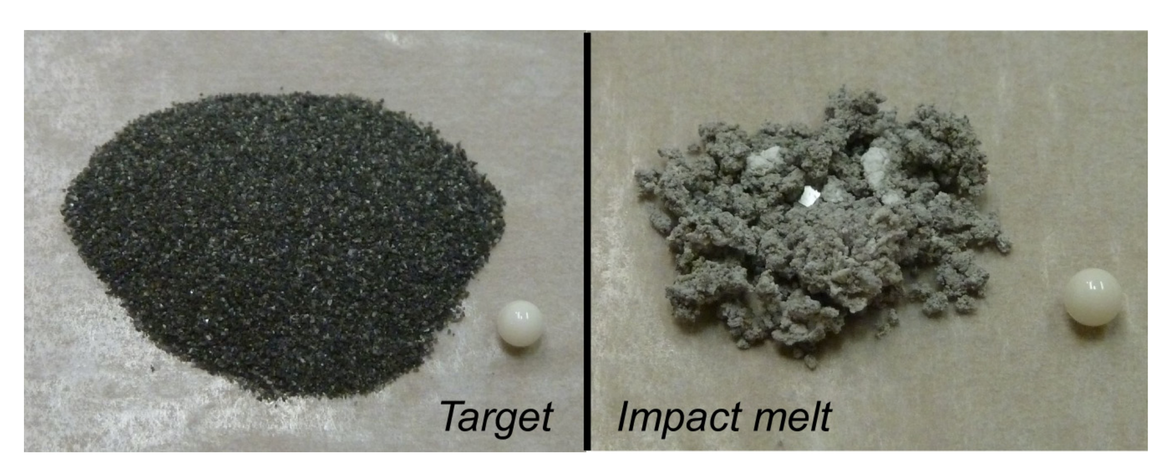
Sequence of high-speed video frames documenting the growth of an impact crater in the laboratory. Numbers indicate milliseconds after impact.

Light-Gas Gun

The LGG uses gunpowder to compress hydrogen gas to extremely high pressures. When that pressure exceeds the strength of a rupture disk, the disk breaks in a controlled way and the hot hydrogen escapes through the hole, pushing the projectile ahead of it. Launch speeds can approach 8 km/s. Projectiles can range from 5.56-mm (about 0.22") down to 1 µm in diameter (roughly the size of a bacterium).



Glass spheres 50 µm across (about as wide as a human hair) made these tracks in a three-layer aerogel target when they impacted at 6 km/s. Remnants of one of the particles can be seen at the end of the track in the center of the right edge. Experiments like this were performed during development and testing of the Stardust aerogel, which ultimately captured cometary dust.



The LGG is capable of duplicating impact conditions in the asteroid belt. As an example, this powdered gabbro (a dark, igneous rock often polished and used for kitchen counters) was impacted with a ceramic sphere (shown for scale) at 5.5 km/s, fast enough to melt a large fraction of the rock. Such impact melts could be important components of asteroid soils.

EIL operations are very intensive and varied, with each set of experiments having its own, often unique, set of requirements. Support for these projects must be equally flexible, so the EIL includes a machine shop, controlling and sequencing computers, analytical electronics, and a walk-in freezer for cold target preparation and post-shot analyses. Analytical work in support of operations is conducted with scales and analytical balances, a Chatillon force-measurement stand, a 3D laser scanner, and an optical binocular microscope.