THE SHOCK COMPRESSION LABORATORY AT HARVARD: A NEW FACILITY FOR PLANETARY IMPACT PROCESSES. S. T. Stewart, Harvard University (Department of Earth and Planetary Sciences, 20 Oxford St., Cambridge, MA 02138, sstewart@eps.harvard.edu).

Introduction: The Shock Compression Laboratory in the Department of Earth and Planetary Sciences at Harvard is a new facility for the study of impact and collisional phenomena. The following describes the experimental capabilities of the laboratory (Fig. 1).

Shockwave experiments. The laboratory contains a 40-mm single stage launch system, manufactured by Physics Applications Inc., capable of accelerating hundred gram projectiles to velocities between 10's m/s to over 2600 m/s and generating shock pressures over 40 GPa. High accuracy over the large range of launch velocities is achieved by using both a 10,000 psi compressed gas (He) breech (10's m/s to ~1.5 km/s) and a powder breech system (~1 km/s to >2.5 km/s).

The 40-mm smooth bore barrel (6-m length) is designed for high precision, near-muzzle, planar shockwave experiments that are required to measure shock Hugoniot states, shock and post-shock temperatures, release isentropes, and dynamic compressive and tensile strength. Shockwave profiles are measured directly with embedded gauges (e.g., PVDF piezoelectric stress gauges or electromagnetic particle velocity gauges). Tektronix 2-GHz digital oscilloscopes resolve the shock loading and unloading profiles to record dynamic strength and phase transformation features within the shock front, as well as the final shock state. The target chamber is evacuated to <100 mtorr to achieve the highest impact velocities, and the projectile velocity is measured to within ±1% by the timing of extinction between cross barrel lasers and shorting pins.

Future instrumental capabilities will include shock and post-shock temperature pyrometry and the latest generation multi-beam VALYN Velocity Interferometer System for Any Reflector (VISAR). The system will utilize a Coherent solid state laser to provide a high power (5 watts), single frequency (532 nm) source for high fidelity interferometry on low reflectivity rocks and minerals. The VISAR system is expandable to 7 beams to allow for faithful characterization of heterogeneous samples.

Impact cratering and shockwave decay experiments. The launch system also contains a 40-mm rifled barrel (4-m length), which is interchangeable with the smooth bore barrel and capable of generating launch velocities between ~100 m/s to >2.2 km/s. The primary use of the rifled barrel will be downrange impact experiments in a large enclosed range (6 m from the muzzle), where a diverse range of projectile sizes and shapes (up to about 25 mm diameter) are possible using spin separation of the sabot. In this manner, the shock pulse or impact crater from a spherical (or arbitrary shape) projectile may be studied without interference from the shock generated by an impacting sabot. Targets may be instrumented for VISAR measurements, with embedded stress gauges (to measure the amplitude of the decaying shock wave, which controls the amount of shock-damaged material, depth of phase changes, size of the transient cavity in the strength regime, and crater collapse processes in the gravity regime), or recovered for post-impact analyses.

Soft recovery experiments. The enclosed range includes a shock-absorbing soft recovery chamber (a 2.4-m deep, 0.3-m diameter steel cylinder filled with decelerating material, such as foam, and mounted on rails) to minimize post-shock damage and to control the temperature of the sample after impact. The chamber may be inserted in two locations to recover either near-muzzle planar-shock experiments or downrange spherical-shock experiments for post-impact analyses. By varying the peak shock pressure, ambient magnetic field, and shockwave shape and duration, the physical processes that govern shock-induced chemical, physical, and magnetic changes are studied under highly controlled conditions.

Low temperature facilities and experiments. The Harvard facility includes a walk-in Cold Laboratory (room temp range -40 to +20 °C, with smaller volumes controlled by liquid N down to -196 °C) for preparation and analyses of volatile materials. The 10' x 13' room contains equipment to prepare, characterize, and if necessary sinter volatile samples for shock experiments (e.g., saws, scales, grinders, press, polishing equipment, etc.). The target and soft-recovery chambers will be instrumented with automated liquid N cooling systems (and future liquid He and pre-heating capabilities) to study shockwaves in volatile materials, such as H_2O, NH_3, and CO_2.

Training and availability. One of the primary goals of the new facility is the education and training of researchers in shockwave techniques for the Earth and planetary sciences. The new laboratory is also a resource for the planetary science community. To the fullest extent possible, access will be granted to researchers from other institutions, who should contact the PI directly to discuss the availability and capabilities of the facility.

The launch system was successfully tested in October 2003. More information is available at http://www.fas.harvard.edu/~planets/shocklab.html.

Acknowledgements. This facility is partially funded by the NASA Planetary Major Equipment Program.

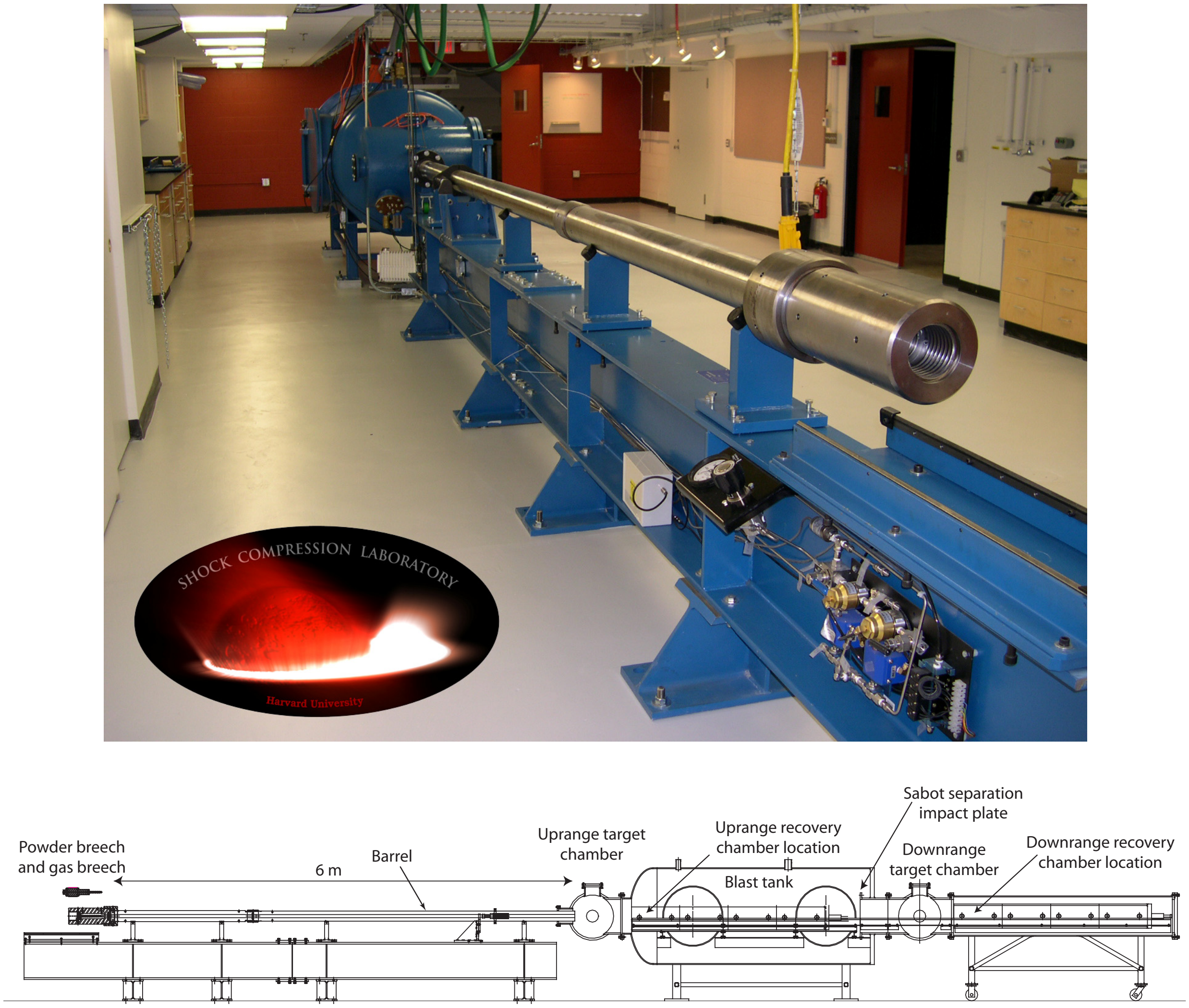

Fig. 1. Top: 40-mm launch system, shown with smooth bore barrel and powder breech. Bottom: Schematic of 40-mm launch system configurations.