

Particle Ejection and Levitation Technology (PELT)



Lunar Launch/
Landing Site
Ejecta Mitigation

Each of the six Apollo landers touched down at unique sites on the lunar surface. Aside from the Apollo 12 landing site located 180 meters from the Surveyor III lander, plume impingement effects on ground hardware during the landings were not a problem. The planned return to the Moon requires numerous landings at the same site. Since the top few centimeters of lunar soil are loosely packed regolith, plume impingement from the lander will eject the granular material at high velocities. Figure 1 shows what the astronauts viewed from the window of the Apollo 14 lander. There was tremendous dust excavation beneath the vehicle. With high-vacuum conditions on the Moon (10^{-14} to 10^{-12} torr), motion of all particles is completely ballistic. Estimates derived from damage to Surveyor III caused by the Apollo 12 lander show that the speed of the ejected regolith particles varies from 100 m/s to 2,000 m/s. It is imperative to understand the physics of plume impingement to safely design landing sites for future Moon missions.

Aerospace scientists and engineers have examined and analyzed images from Apollo video extensively in an effort to determine the theoretical effects of rocket exhaust impingement. KSC has joined the University of Central Florida (UCF) to develop an instrument that will measure the 3-D vector of dust flow caused by plume impingement during descent of landers. The data collected from the instrument will augment the theoretical studies and analysis of the Apollo videos.

Instrumentation designs and concepts were tested in a custom-designed wind tunnel that allows a bed of granular material to be eroded. The material erosion can be measured from altitudes similar to those at which the lunar erosion first begins: up to 30 m. The wind tunnel chamber operates at atmospheric pressure; however, ρV^2 (one of the important scaling parameters) is approximately the same as those for the lander cases on the Moon. Figure 2 shows yellow quartz sand flowing in a section of the wind tunnel. Figure 3 shows 2-D flow calculations of a scene similar to that shown in Figure 2.

The instrument can also measure other lunar surface dust effects, such as dust levitated by solar charging. Though most of the effort for the current instrument has been focused toward lunar applications, the instrument is quite general and could easily be adapted to other applications such as Martian landings.



Figure 1. Example view taken during descent of Apollo lander. The dust is eroding from the lower left to the upper right.



Figure 2. Quartz sand flowing in the wind tunnel used to test the PELT instrumentation designs.

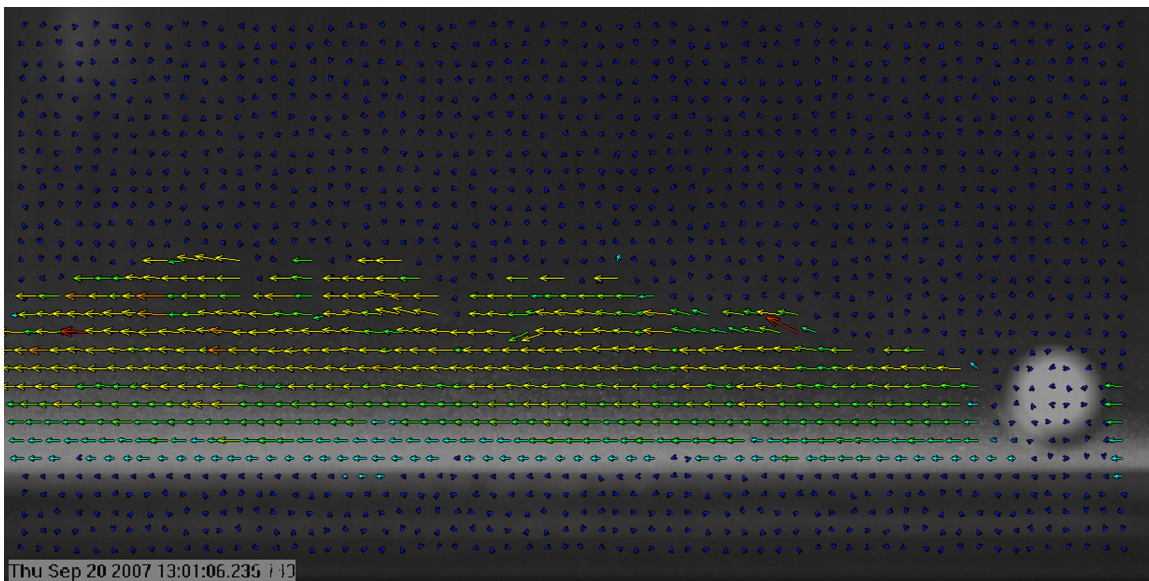


Figure 3. Example flow pattern of a scene similar to that shown in Figure 2.

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