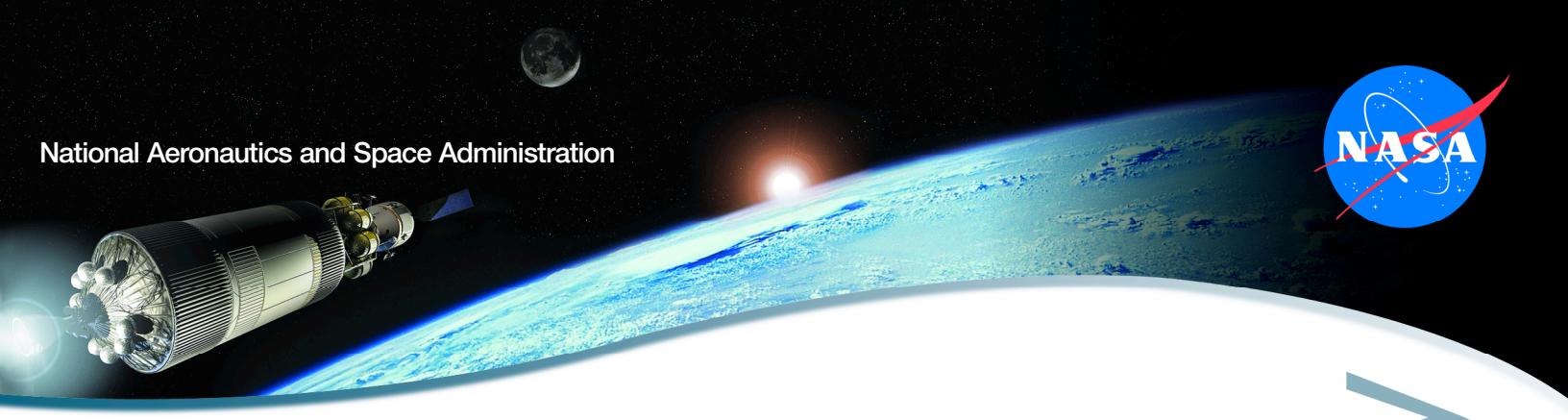


Particle Image Velocimeter

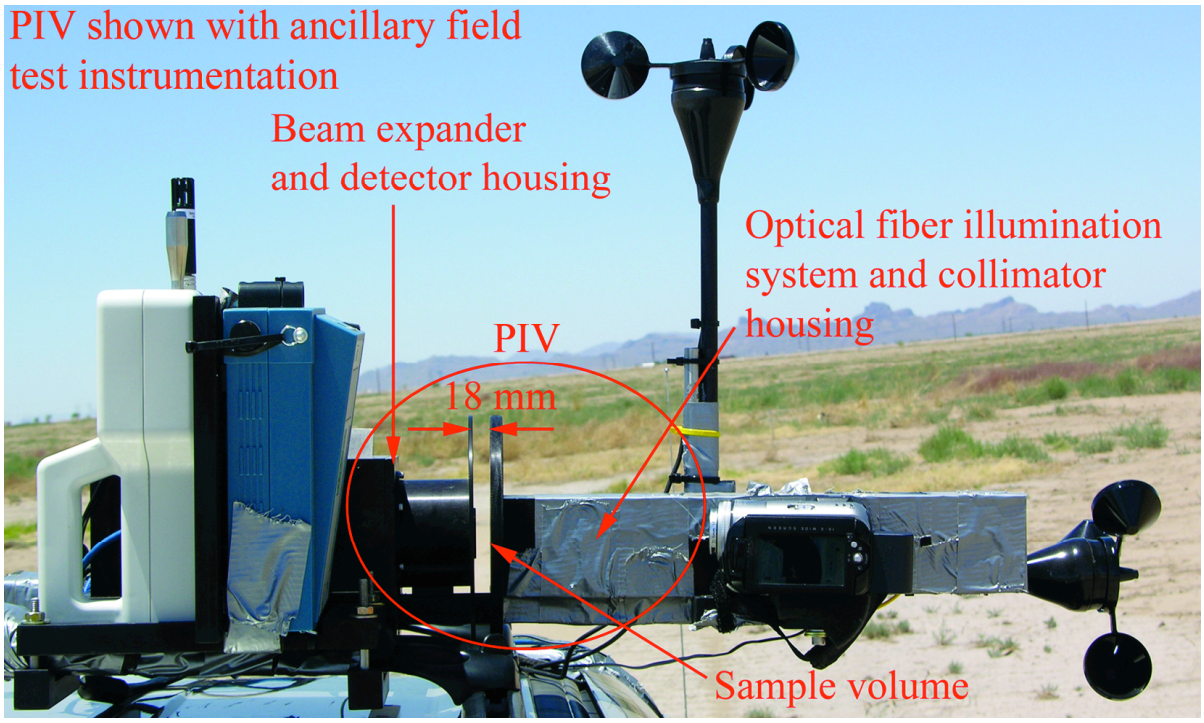
Measuring Dust Concentrations on the Moon

About the Technology

To understand the ambient dust environment on the Moon and ultimately design hardware to protect the human explorers who may go there, NASA needs an instrument that measures dust particle sizes, concentrations, and velocities. Although sensors exist to gather these types of measurements in terrestrial applications, they will not work in the Moon's low-pressure atmosphere because they typically create pressure differentials to direct particle-laden airflows into a sensor chamber.

The Goddard Space Flight Center has developed and field-tested a proof-of-concept dust-flux instrument – the Large-Depth of Field Particle Image Velocimeter (PIV) – that can detect airborne particles as small as 8 microns with signal-to-noise ratios of 13 or better. And with flight-like hardware, the instrument is expected to detect particles down to 2 microns in size. Ultimately, its developers hope to configure the prototype as an astronaut-deployable, surface experiment to monitor the dust environment on the Moon. The technology could also be used as an airlock dust monitor to assess the efficacy of dust mitigation and airlock "dust flush" operations.

See reverse side



Using Goddard Internal Research and Development funding, principal investigators carried out a field campaign in Arizona to demonstrate the Particle Image Velocimeter (PIV), an instrument that measures dust particle sizes, concentrations, and velocities using a unique optical architecture. The instrument would be ideal for obtaining similar measurements of lunar dust.

goddard technology

PIV

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Benefits of the Technology: At-A-Glance

- Measures dust particle sizes, concentrations, and velocities without relying on particle capture. No other instrument concept provides all three measurements.
- Demonstrated during a field campaign in Arizona, during which its developers answered most questions about the basic physics of its unique optical architecture.
- Further improvements expected in the area of autonomous instrument algorithms to extract particle data of interest and produce manageable data files for downlink.

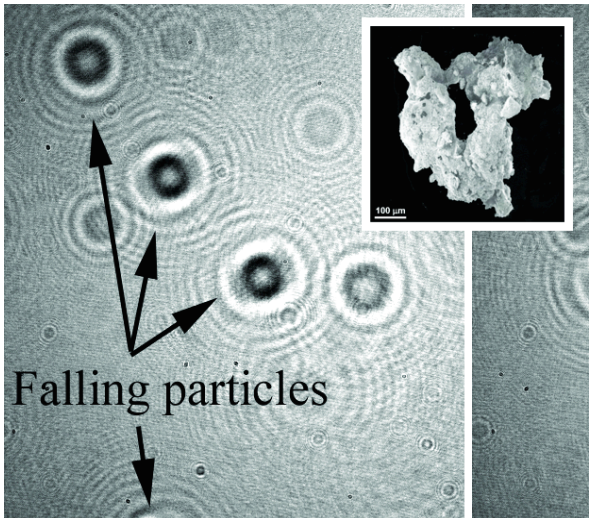
Significance of the Technology

NASA has long identified lunar dust as a serious challenge that must be overcome before establishing permanent human outposts on the Moon. The Moon's ultra-small dust particles are highly electrostatic due to the fact that the Moon is charged positively on the day-side by way of photoemission and strongly negative on the night-side due to plasma currents. As a result, the dust levitates in all directions and at various speeds, adhering to everything with which it comes into contact. Before developing specific technologies to mitigate the problem, however, NASA first must understand the nature of the dust phenomenon.

As a consequence, several Centers have identified dust characterization as an important area. In fact, Goddard's PIV instrument technology is directly competing with a Glenn Research Center technology that operates differently, but gathers the same types of measurements. The Goddard instrument, however, offers an important advantage. It also measures small particle velocity, which is unique to the PIV technology.

Technology Origins

Goddard technologists demonstrated the original proof-of-concept instrument in FY 2006. In FY 2007, they advanced the technology and used Goddard Internal Research and Development (IRAD) funding to carry out a field campaign in Arizona, answering most of the questions regarding the basic physics of the instrument's unique optical architecture. During that demonstration, the instrument team acquired 14 sets of data from naturally occurring dust events and showed that it could detect particles as small as 8 microns.



During the field campaign, the PIV instrument took these images showing that it could detect and image dust particles as small as 8 microns. Dust particles on the Moon (inset) also are ultra-small. They also are sharply barbed.

Looking Ahead

To obtain images needed to determine particle count, shape, size, and velocity, the instrument generates about 4 gigabytes of data for every 3-1/2 minutes of operation. It is highly unlikely that a planetary lander would be able to downlink such large data sets. With current IRAD funding, instrument developers are concentrating on creating an algorithm that can autonomously identify, measure, and track the dust particle signals measured by the PIV. The aim is to significantly reduce the amount of data that the spacecraft instrument would downlink. Efforts also are continuing to further mature the dust technology so that it wins a flight opportunity on a future lunar or Mars lander.

Contact:

Brent.J.Bos@nasa.gov

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