PlanetVac: Sample Acquisition and Delivery System for Instruments and Sample Return

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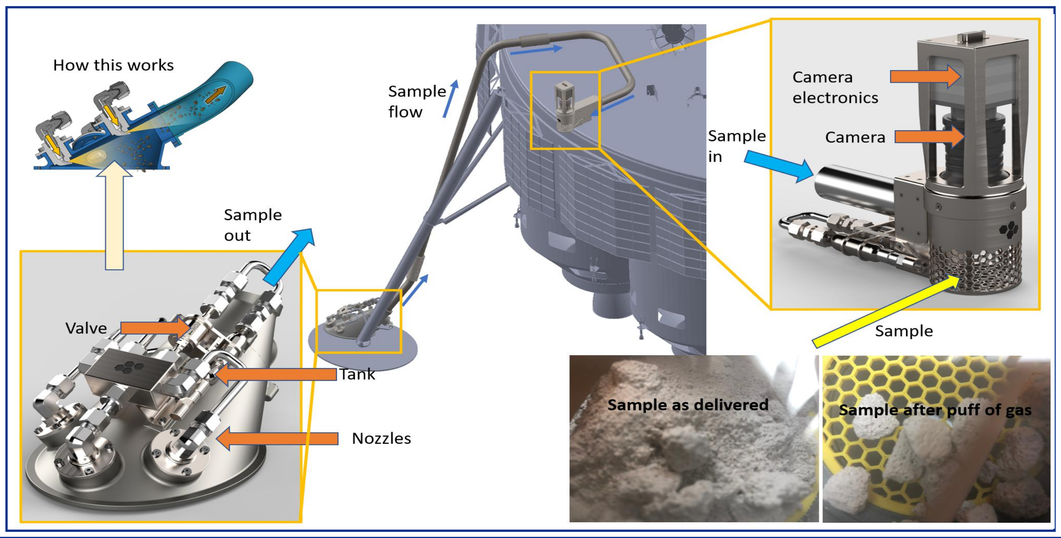
Exploration Technology



Introduction

PlanetVac is a revolutionary technology for acquiring and transferring regolith from the lunar surface to instruments (for in situ analysis) or sample returned container (for sample return missions). PlanetVac uses robust and dust tolerant pneumatic approach, similar to traditional pneumatic based powder delivery technologies used on earth. The main difference is the sources of gas: PlanetVac uses a standalone gas canister to provide working fluid.

As illustrated by numerous surface missions (Viking, Mars Phoenix, MSL Curiosity, Venera, Luna etc.) sample acquisition and delivery is one of the most difficult aspects of the mission. In fact, several missions (e.g. Venera) did not meet their scientific goals because of sample delivery system failure, while other missions (e.g. Phoenix) had not utilized the entire instrument suite because of difficulty in sample delivery. The technology has been demonstrated on reduced gravity flights at lunar gravity and vacuum. The technology has been demonstrated in delivering samples (fines as well as rocklets) to various instrument cups [3]. The technology has also been demonstrated on actual lander: Masten Xombie during tests in Mojave, CA.

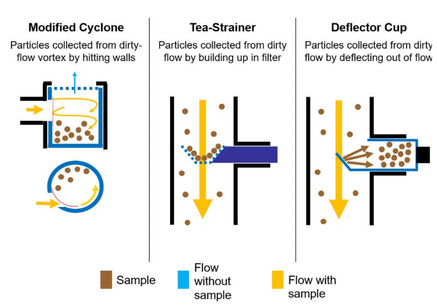
System Overview

- **PlanetVac spacecraft accommodation:** PlanetVac, in the base scenario, is attached to a footpad (or footpads if more than one PlanetVac is used) of a lander and is connected to instruments or sample return containers via a pneumatic transfer hose. Hence the exact location of the instruments and sample container is irrelevant since the transfer hose can be routed around other systems. The sample is acquired within seconds, with virtually no power. The only command is a signal to open gas valve connected to a tank.
- **CLPS:** For CLPS, PlanetVac will deliver lunar regolith and demonstrate sieving of the lunar regolith in the sample return container (Figure 1). The regolith will be split into fines and rocklets. Sample delivery verification will be done with a camera.

Sample Capture

The main advantage of the pneumatic transfer is that the point of acquisition and point of delivery can be anywhere on the spacecraft. Unlike scoops deployed by robotic arms, that are constrained by kinematic position of the arm, and placement of instruments, pneumatic transfer lines can be routed around potential obstacles. As such, sample acquisition hardware can be placed where it's best for sample acquisition, and instruments can be placed in the best location for performing analysis.

There are other advantages of using pneumatics in sample transfer. For example, heating of sample is minimized or can even be prevented altogether. When using compressed gas, the sample temperature will more likely go down as opposed to up, since gas temperature will drop as it is released from a pressurized gas tank. However, since gas has very low thermal inertia and transfer happens very fast (seconds), thermal transfer via convection is virtually null.



Sample Capture Options

History of PlanetVac

2002 Pneumatic Sampler Concept for RASC-AL

Pneumatic Scoop Concept

Pneumatic Mining Rover in Vacuum Chamber (Zacny et al., 2008a)

Reduced Gravity Tests of Pneumatic Sampler in Vacuum Chamber

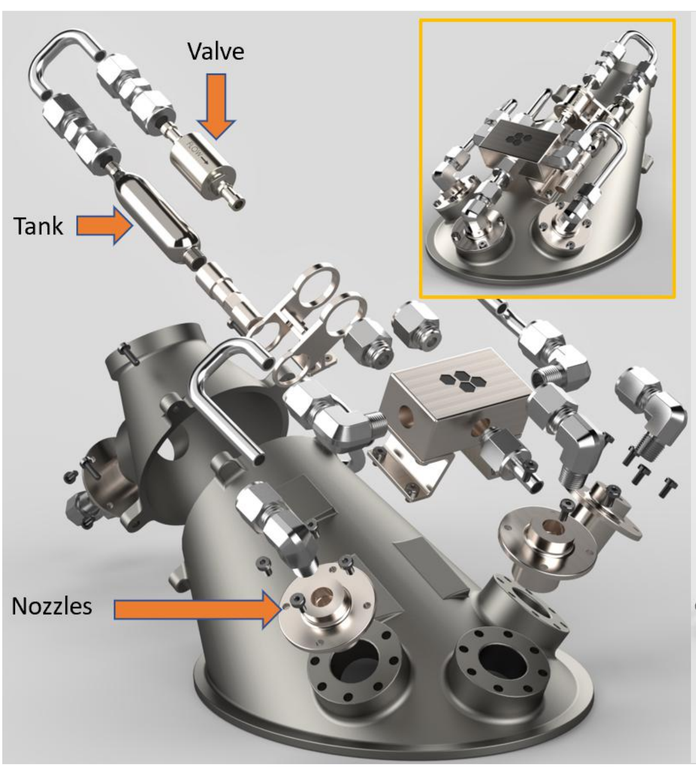
MarsVac Concept

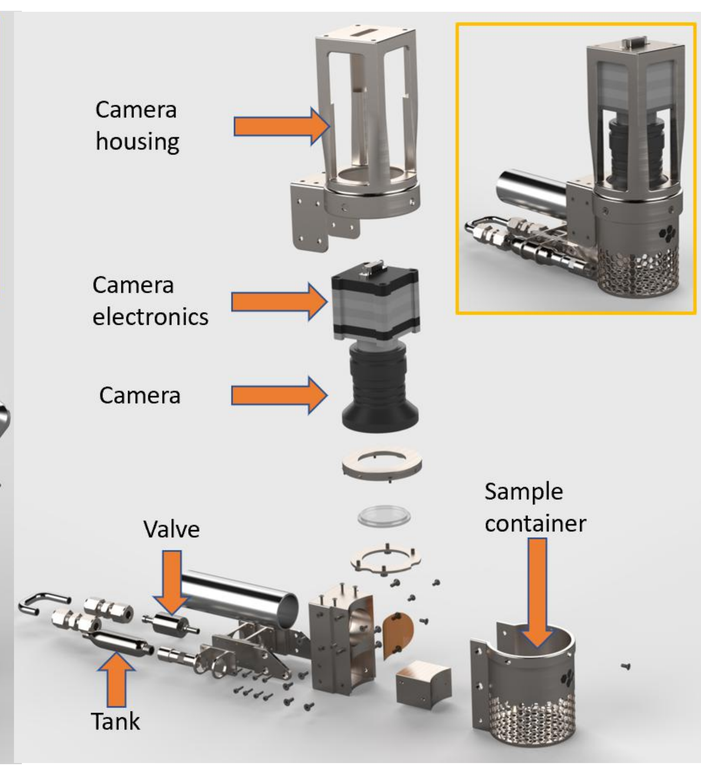
PlanetVac Vacuum Chamber Tests

screenPneumatic Sample Transfer for Carbothermal Reactor

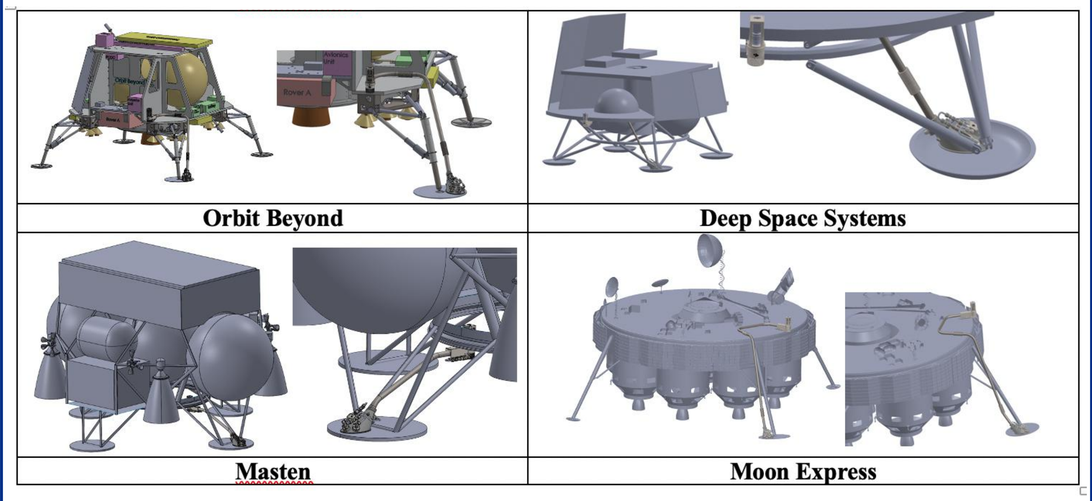
PlanetVac on Masten Lander

Pneumatic Sample Acquisition System for NF CAESAR mission





Details of PlanetVac on the CLPS Landers



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