**_ALADDIN_: EXPLORATION AND SAMPLE RETURN FROM THE MOONS OF MARS.** C. Pieters[1], A. Cheng[2], B. Clark[3], S. Murchie[2], J. Mustard[1], J. Papike[7], M. Zolensky[5] [1]Brown Univ., Providence, RI 02912; [2]Johns Hopkins Univ. Applied Physics Lab., Laurel, MD; [3]Lockeed Martin Astronautics, Denver, CO; [4]Univ. New Mexico, Albuquerque, NM, [5]NASA Johnson Space Center, Houston, TX

**Mission Overview:** Aladdin is a remote sensing and sample return mission focused on the two small moons of Mars, Phobos and Deimos. Understanding the moons of Mars will help us to understand the early history of Mars itself. Aladdin's primary objective is to acquire well-documented, representative samples from both moons and return them to Earth for detailed analyses. Samples arrive at Earth within three years of launch. Aladdin addresses several of NASA's highest priority science objectives: the origin and evolution of the Martian system (one of two silicate planets with satellites) and the composition and nature of small bodies (the building blocks of the solar system).

The Aladdin mission has been selected as a finalist in both the 1997 and 1999 Discovery competitions based on the high quality of science it would accomplish. The equivalent of Aladdin's Phase A development has been successfully completed, yielding a high degree of technical maturity.

Aladdin uses an innovative flyby sample acquisition method, described in detail in [1], which has been validated experimentally and does not require soft landing or anchoring. An initial phasing orbit at Mars reduces mission propulsion requirements, enabling Aladdin to use proven, low-risk chemical propulsion with good mass margin. This phasing orbit is followed by a five month elliptical mission during which there are redundant opportunities for acquisition of samples and characterization of their geologic context using remote sensing.

The Aladdin mission is a partnership between Brown University, the Johns Hopkins University Applied Physics Laboratory, Lockheed Martin Astronautics, and NASA Johnson Space Center.

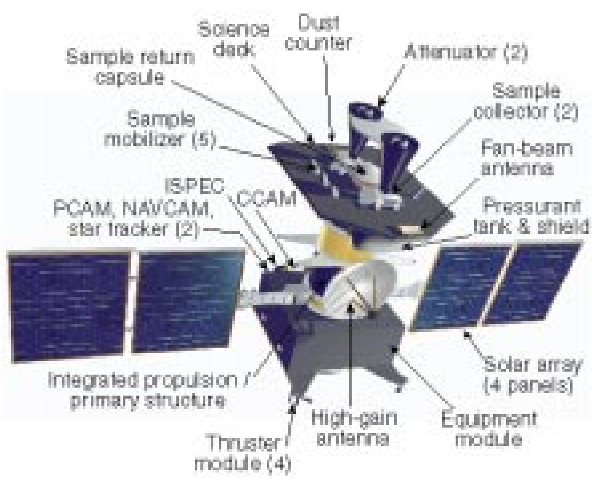


**Fig. 1.** The Aladdin spacecraft.

**Science Background:** How (and when) did Mars develop a system of satellites? How are the Martian satellites related to Mars itself? Are they indicative of common processes in the evolution of silicate planets or are they the products of special circumstances? On the one hand, Phobos and Deimos are postulated to be related to primitive outer solar system objects [2, 3]. The geology of each satellite is distinctive and complex [4, 5]. Both satellites have low densities and optical properties resembling primitive asteroids, and they may be the remnants of bodies that delivered organics, water, and other volatiles to the inner solar system. Such primitive bodies are not well represented in meteorite collections, but the proximity of Phobos and Deimos to Mars make them far more accessible with low-cost spacecraft. On the other hand, the two satellites exhibit spectra with a continuum that is similar to that of the Moon and Mercury [5]. This suggests their surface properties might be explained by a space-weathered silicate assemblage resembling bulk material of the terrestrial planets, having a common origin with or derived from Mars.

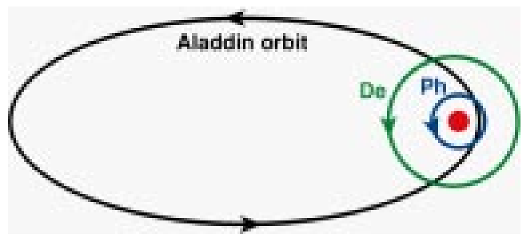


**Fig 2.** Aladdin's orbit at Mars has repeated encounters with Phobos and Deimos.

Resolving the origins and histories of the two satellites provides insight into early Martian history, but it requires detailed analysis of the mineralogy and chemistry of regolith samples that can only be performed using the advanced analytical capabilities of Earth-based facilities. These measurements will determine whether either moon co-accreted with Mars, is a captured more primitive asteroid or extinct comet, or is derived from Martian basin ejecta. With current analytical technology and expanding experience with IDPs, the amount of sample required to achieve these science objectives can be as small as 3 µg [6]. Aladdin is of course designed to collect far more than this requirement, orders of magnitude more material than the cumulative amount of IDPs analyzed to date. The availability of Aladdin samples in terrestrial laboratories would be a priceless resource for the planetary community, since it would enable questions not yet even conceived to be addressed using techniques not yet developed.

**Sample Collection.** Aladdin derives its name from its "flying carpet" sample collector, a flexible fiber maze trap. As described in [1] the spacecraft flies through a plume of debris released by small artificial impactors targeted at specific geologic formations on the satellites (two for Phobos, two for Deimos, plus a spare). Regolith particles from the surface are preserved during capture by the exposed carpet collector since both impact and collection velocities are relatively low (~1 km/s). Segments of the carpet are reeled into a sample return capsule (SRC) after each "launch and catch" event, retaining and protecting samples and allowing them to be analyzed separately when returned to Earth. Onboard particle detectors confirm successful interception of each regolith sample. The Aladdin payload dedicated to sample collection includes 5 sample projectile launchers, sample collectors on a spooled carpet, the SRC, and the dust detector.

**Remote Sensing:** A coordinated series of remote sensing observations obtained before, during, and after sample acquisition place the sample sites in geologic context, and allow inference of global properties from detailed sample analyses. Aladdin's high resolution color imager (CCAM) and visible / near-infrared (0.45-3.6 µm) imaging spectrometer (ISPEC) are used to characterize the moons' surfaces and map geologic units and compositional variations. A specialized monochromatic camera records and locates the artificial impact plumes of regolith (PCAM). A panchromatic navigation camera (NAVCAM) provides optical navigation images for precision targeting.

Radio science experiments will provide significant improvements in the mass estimates, and hence derived density measurements, of both Phobos and Deimos. Knowledge of the densities of these two bodies is expected to be determined to within <10%.

In addition, Aladdin's ISPEC imaging spectrometer is capable of acquiring unique compositional measurements of the Martian surface, with no additional spacecraft or payload capability requirements. The spectral range and resolution of ISPEC are sufficient to discriminate features due to iron-bearing rock forming minerals (crystal field transitions), ferric oxides, and OH-bearing alteration minerals (overtones of vibrational absorptions). The wavelength range includes the regions where fundamental vibrational absorptions of carbonates occur near 3.5 µm. Coupled with these capabilities are a projected SNR that exceeds 200:1 in the visible, 800:1 in the SWIR, and 100:1 near 3 µm. ISPEC design thus provides an excellent opportunity for imaging spectrometer observations of Mars capable of mapping minerals indicative of aqueous environments. A 6000 km periapse orbit allows data to be acquired for Mars with a swath width of ~150 km at 600 m/pixel from equatorial regions to ±50° latitude. Extensive regions of high scientific priority will be mapped at high spatial resolution under high-sun lighting conditions. Aladdin data would provide exceptionally valuable information on Mars' mineralogy that is complementary to, but independent and distinctly different from, data obtained by the Mars Surveyor Program at longer wavelengths.

Table 1. Payload (Sample collection; Remote Sensing)

| Instrument | Function |
|---|---|
| Sample Mobilizer | 5 projectile launchers; create plumes of regolith sample from targeted areas on the satellites |
| Sample Collectors | 5 independent carpet segments plus interconnecting leader; collects mobilized regolith. |
| SRC | Returns samples to Earth |
| Dust Counter | Detects >1 ng particles; confirms interception of sample |
| ISPEC Imaging Spectrometer | 230 channels, 0.4 - 3.6 µm; characterizes and map mineralogy including Fe and hydrated species, organics |
| CCAM | characterize moons' geology |
| NAVCAM | High resolution panchromatic camera; optical navigation, morphology |
| PCAM | Wide-angle camera; images mobilized regolith plume |

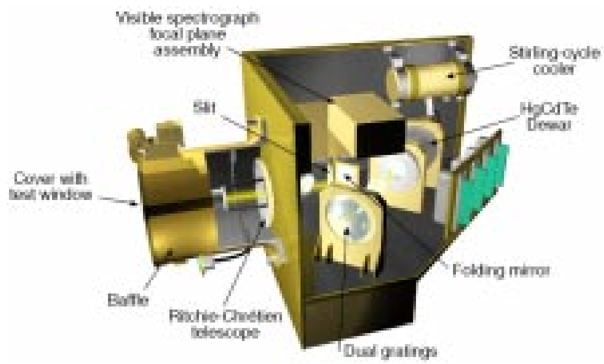


**Fig 3**. ISPEC, Aladdin's visible to near-infrared imaging spectrometer.

**References**: [1] Cheng et al. (2000) Concepts and Approaches for Mars Exploration, LPI. [2] Burns J. (1992) in *Mars* (Kieffer et al), 1283. [3] Bell J et al., (1993) in *Resoures of Near-Earth Space*, U AZ, 887. [4] Thomas P. et al. (1992) in *Mars* (Kieffer et al.) 1257. [5] Murchie S. and Erard S (1996) *Icarus*, 123, 63. [6] Zolensky et al. (1998) LPS29, 1716; Zolensky et al., (2000) *MAPS* 35, 9-29.