

## Microreflectors for Mars, Phobos/Deimos and Asteroids/Comets

**Dr. Marco Muccino**<sup>1</sup>, Dr. Simone Dell'Agnello<sup>1</sup>, Mr. Giovanni Delle Monache<sup>1</sup>, Mr. Luca Porcelli<sup>1</sup>, Mr. Lorenzo Salvatori<sup>1</sup>, Mr. Mattia Tibuzzi<sup>1</sup>, Miss Chiara Mondaini<sup>1</sup>, Dr. Giuseppe Bianco<sup>2</sup>, Daniele Dequal<sup>2</sup>, Roberto Vittori<sup>1</sup>, Dr. John Chandler<sup>3</sup>, Dr. Riccardo Marchi<sup>1</sup>, Dr. Orlando Luongo<sup>1</sup>, Mr. Luca Ioppi<sup>1</sup>, Miss Maria Tantalo<sup>1</sup>, Mr. Matteo Petrassi<sup>1</sup>, Raffaele Mugnuolo<sup>2</sup>, Mauro Maiello<sup>1</sup>, Dr. Maurizio Di Paolo Emilio<sup>1</sup>

<sup>1</sup>INFN - LNF, Frascati (RM), Italy, <sup>2</sup>ASI - CGS, Matera (MT), Italy, <sup>3</sup>Harvard-Smithsonian Center for Astrophysics, Cambridge, USA

The SCF\_Lab (Satellite/lunar laser ranging Characterization Facilities Lab) at INFN-LNF has started its activity of design, construction, qualification of microreflectors to be deployed on Mars to provide the accurate position of landers and rovers through the laser ranging (LR) technique by orbiters. The first one, INRRI (INstrument for landing-Roving laser Retroreflector Investigations), was launched in 2016 with the ESA mission ExoMars (Exobiology on Mars), deployed on the Schiaparelli lander. A second one, LaRRI (Laser Retro-Reflector for InSight), was integrated on NASA's InSight Mars Lander launched on May 5, 2018. A third one, LaRA (Laser Retroreflector Array), will be delivered to JPL for the NASA Mars 2020 Rover, and another INRRI will be delivered to ESA for deployment on the Exo-Mars 2020 Rover.

The SCF\_Lab is developing also arrays of retroreflectors, designed to be observed from laser-equipped satellites orbiting around Mars and laser tracking the orbit of Phobos and Deimos, named PANDORA (Phobos AND DeimOs Retroreflector Array).

PANDORA, INRRI, LaRRI and LaRA, can give information on the position on the center of mass of Mars for interesting tests of General Relativity (GR) at 1.5 AU in the Sun-Mars and Sun-Mars-Jupiter systems. These tests would be complementary to those achieved with Lunar Laser Ranging.

Other applications are for the minor bodies of the solar system. Laser microretroreflector arrays like COSPHERA (COMet/asteroid SPHERical Retroreflector Array) can be landed/dropped on asteroid or comet, supporting laser tracking by orbiters, laser altimetry capabilities, or lasercomm payloads that can also perform time-of-flight LR.