

**NASA-SSERVI and INFN Partnership “SPRINGLETS”:
Solar system Payloads of laser Retroreflectors of INFN for General reLativity,
Exploration and planeTary Science**

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SPRINGLETS is the research partnership between INFN and NASA-SSERVI, the NASA Solar System Exploration and Research Virtual Institute, centrally managed by NASA-ARC (Ames Research Center), whose activity and mission is described at:

<http://sservi.nasa.gov/nlsi-central/>, <http://sservi.nasa.gov/international/>.

INFN is the first Italian Partner of the SSERVI.

We will describe the agreement by INFN (including the SCF_Lab at INFN-LNF) and its Associate collaborators (including the ASI – Matera Laser Ranging Observatory) and SSERVI (including some NASA centers): jointly study and identify innovative laser retroreflector technologies, thermal designs, test instruments and test procedures to achieve optimized optical retroreflector performance with limited or no thermal degradation through exhaustive retroreflector characterization and/or modeling, for missions in the Solar System with laser ranging capabilities, including:

- 1) The Moon as a laser-ranged test body for General Relativity
 - Development and characterization of a next-generation passive LLR payloads based on the solid fused silica retroreflector technology, inheriting from Apollo, including a single, large CCR (Cube Corner Retroreflector), called “MoonLIGHT” a microreflector payload, called “INRRI”.
 - Studies for a Quantum Communication Earth/Moon network of optical terminals with the University of Padova, Italy.
- 2) Laser retroreflectors for Mars exploration
 - Extension of Lunar program to Mars and its satellites
 - Next generation Mars surface retroreflectors will include lightweight, passive and compact CCR array (of the INRRI type) laser-located by orbiters
 - Multiple INRRI on landers and rovers will establish an MGN and define Airy-0. INRRI will provide accurate geo-referencing of Rover exploration activity, Lidar atmospheric trace species detection; laser-communication test and diagnostics.
 - Study of PANDORA (Phobos AND DeimOs laser Retroreflector Array)
- 3) Europa/Enceladus laser Cube Corner Reflectors for Exploration/exolife up to Saturn
- 4) ILRS payload standards in Earth Orbits, as a reference for other solar system CCR payloads. This will includes support to Apollo, LAGEOS and future geodesy missions
- 5) Connecting the ITRS and ICRS
 - Connecting Earth-Moon, Mars, Europa/Encelado retroreflectors and their networks via laser communication and ranging throughout the Solar System.
- 6) Near Earth Asteroids
 - Study feasibility of laser-marking NEAs by the deployment of CCRs
- 7) Study of SCF_Lab upgrade to perform the time-of-flight laser “range correction” of CCRs in representative space conditions
- 8) Joint study for development of Cubesats for solar system exploration, including the so-called ‘LunarCubes’. Full thermal (Sun-albedo-IR) and vacuum characterization of Cubesats (and up to Microsats) is available at the SCF_Lab.
- 9) Collaborative optimization, comparison and exchange of existing laser ranging orbit reconstruction software
- 10) Implementation of an exchange program for young scientists and engineers (students, post-docs, early career professionals).