IMAGING SPECTROSCOPY FOR LUNAR EXPLORATION: LUVIMS; A. Coradini¹, M.C. De Sanctis¹, F. Reininger, R. Bonsignori², G. Racca³, A. Chicarro³, ¹ IAS Reparto di Planetologia, V.le dell’Università 11, 00185 Roma, Italy; ² Officine Galileo, V. A. Einstein 35, Campi Bisenzio, 50013 Firenze, Italy; ³ ESA-ESTEC, Directorate of Scientific Programmes, Noordwijk, The Netherlands.

Among the Scientific Objectives of the Lunar Exploration in the next years, the following can be considered:

- Geochemical characterization of the lunar surface with high spatial resolution. High spatial resolution could show small scale spectroscopic heterogeneities of the surface that can be related to different chemical composition of the lunar material.
- Global mapping of the large scale structures of the Moon that allow to recognize the correlations between the morphological and geological structures on the Moon. Quantitative morphology may also help in discriminating among volcanic and impact structures, give a deeper insight into valley shaped forms such as rilles, and contribute to the understanding of buried structures such as cryptomaria.
- Identification of the spatial distribution of mineral and chemical species on the Moon. High spatial resolution added to high spectral resolution could give fundamental information on the lunar material origin and history.
- Local analysis of small scale structures of the lunar surface that will give information on the processes dominant in the lunar history: tectonism, volcanism and cratering.
- Detailed investigation of the boundary zone between different terrains. Imaging spectroscopy allows the mineralogical composition of the geologic units boundary to be determined through the analysis of the complete spectrum.
- Mineralogical analysis of different the lunar terrain: a signal to noise > 100 over the whole spectral range is needed to characterize the most important absorption features in terms of strength, band center and assymetry.
- Probe lunar stratigraphy through craters: mineralogical characterization of different layers. High resolution mineralogical mapping could enable identification of the different mineralogical composition of the ejecta blankets of craters of different ages. As these materials are probing the crust at different depths, depending on the size of the crater, and at different times, depending on the crater ages, such observation will allow a survey of the evolution of crustal material through time.

To achieve those objectives we present a new imaging spectrometer particularly designed for the lunar mission MORO (Moon ORbiting Observatory). LUVIMS (Lunar UV and Infrared Mapping Spectrometer) is characterized by high performances in terms of high spectral and high spatial resolution, being at the same time small, light weight and with low power consumption[2]. By means of LUVIMS it will be possible to identify most of the mineralogical species and to relate their distribution with the surface morphology. LUVIMS scientific objectives concerned the geochemical characterization of the Moon surface in terms of global mapping, identification of different material and their distribution, mineralogical analysis of different terrain: observations with high spatial resolution added to high spectral resolution can be the most powerful technique to have information on the lunar material origin and evolution. An imaging spectrometer, as LUVIMS, operating in the range 0.3 - 3 μm will increase the knowledge of the lunar surface. The spectrometer has been designed in order to work properly on either a tri-axis stabilized or a spinning spacecraft. In fact MORO has being studied as a candidate mission for the third cycle of Medium size missions, M3, in the framework of EAS’s Horizon 2000 scientific programme. During the assessment phase, parametric solutions have been evaluated, but it has been shown that LUVIMS can fulfill the scientific requirements in any of the proposed spacecraft configurations.
The proposed LUVIMS design is adopted from the Near Ultraviolet Visible Infrared Mapping Spectrometer (NUVIMS) concept developed in anticipation of both the MORO and Rosetta missions[2].

The LUVIMS for MORO would use a grating with a slightly higher groove density to achieve a higher spectral resolution over a narrower spectral band. Because of the shorter integration time requirement, the MORO instrument can, if necessary, use a detector with the same cut-off wavelength yet simplify the cooling system. The LUVIMS relies on a single optical channel to cover the entire spectral band to reduce mass and volume while eliminating the typical multi-instrument image alignment problems and the reliance on multi-channel beam splitters.

The optical system consists of a Shafer telescope and an Offner grating spectrometer. Both the telescope and the spectrometer rely on spherical surfaces for ease of manufacturing and alignment. The image quality is practically uniform for any angle of obliquity, and the telescope remains diffraction limited for wavelengths from the infrared to the mid-visible. The Shafer telescope maintains very good image quality over a very large FOV (up to 10 deg). LUVIMS uses a convex diffraction grating in place of the Offner secondary mirror. It is possible to realize two different groove densities on a single grating substrate to yield a high resolution dispersion for the ultra-violet/visible CCD and a low resolution dispersion for the infrared FPA. The sensor concept for the stabilized spacecraft can utilize a frame transfer CCD and a direct injection InSb or HgCdTe detector array.

The minimum performance requirement is that the SNR exceed 100 when the albedo is only 7% and the lunar temperature is 394 K; even in the highest resolution mode the performance requirement can be met across the entire spectral band for an exposure time of 60 msec. For the bright scene, 24% albedo, the SNR improves significantly and the detector is not in danger of saturating because of the rather uniform response of the instrument.

We want to stress the importance of a further exploration of the Moon: high resolution imaging spectroscopy, that allows the determination of lunar mineralogy was never performed with adequate spatial and spectral resolutions. Therefore instruments like LUVIMS that can give not only high spectral, but also high spatial resolution data, will also allow the study of the spatial distribution of the major resurfacing events that characterized the lunar surface.