The "MINERalogy Venture Analyser" MINERVA

a Compact, Low-Weight Payload for in Situ Sensing of Lunar Rocks with Integrated Optical Spectroscopic Techniques

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Payload "MINERVA"

MINERVA is a payload concept resulting from a technological study for the development of an integrated payload for the In Situ Sensing of the Moon with optical spectroscopy techniques.

The MINERVA payload employs several optical spectroscopy methods for the in-situ and ex-situ compositional determination and mineralogical characterisation of lunar rocks:

- ***Laser Induced Plasma Spectroscopy (LIPS)***, for the determination of elemental composition (major and minor elements, trace elements);
- ***Raman spectroscopy,*** for the determination of molecular bonds (mineralogical species, amorphous/crystalline solid; presence of hydrates or ice);
- ***Fluorescence spectroscopy,*** for the qualitative characterisation of rocks and the determination of trace elements.
- ***Reflectance spectroscopy*** in the VIS-NIR.

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"MINERVA" architecture

MINERVA carries out these measurements on the same sample at a ***microscopic scale*** and it is conceived to be deployed on a landing platform (lander or rover). It is composed of:

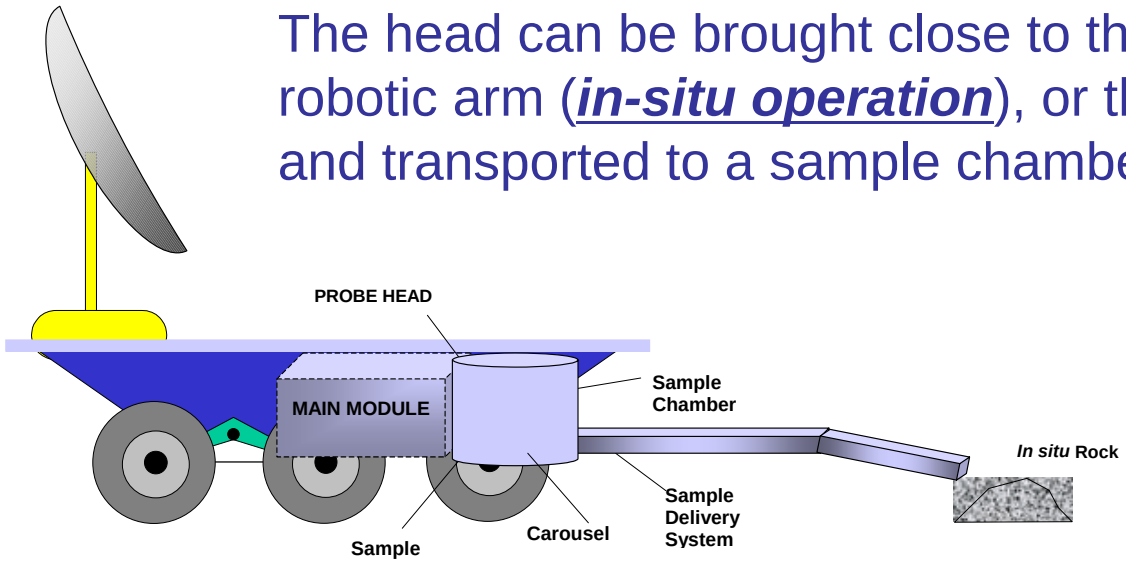
- ***a main module****, on board the platform, containing the laser sources for Raman and fluorescence spectroscopy, the pump laser for LIPS excitation laser, three spectrometers, and the ancillary systems;*
- ***a probe head****, integrating the excitation laser for the LIPS spectroscopy, the collecting optics, and a coaxial micro-imager.*

The probe head and the main module are connected by ***optical fibers*** for the transport of the excitation/emission radiation to/from the sample.

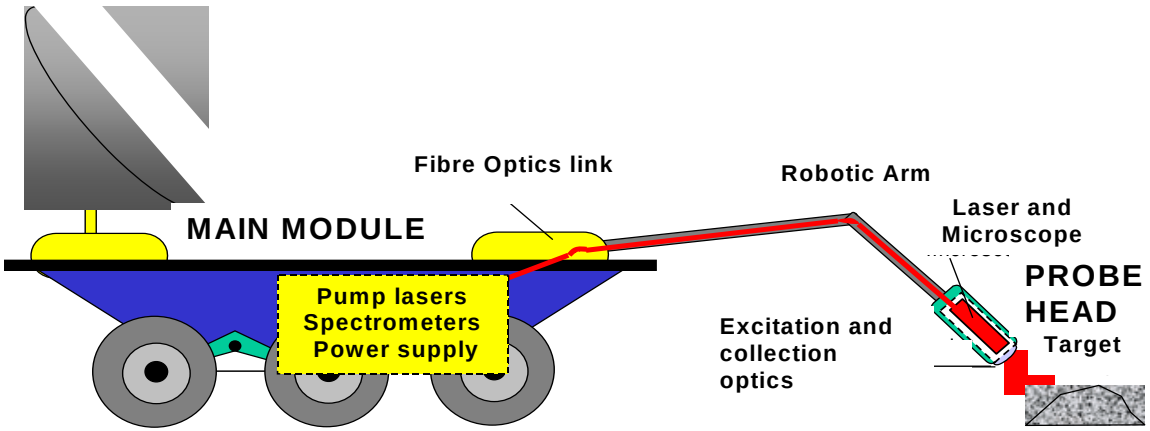
The ***overall mass*** is around **4.5 kg**, the **volume** is around **4.5 dm^3**, and the **peak power consumption** is about **4.5 W.**

“MINERVA” configurations

The head can be brought close to the target by means of a robotic arm (***in-situ operation***), or the sample can be collected and transported to a sample chamber (***ex-situ operation***).

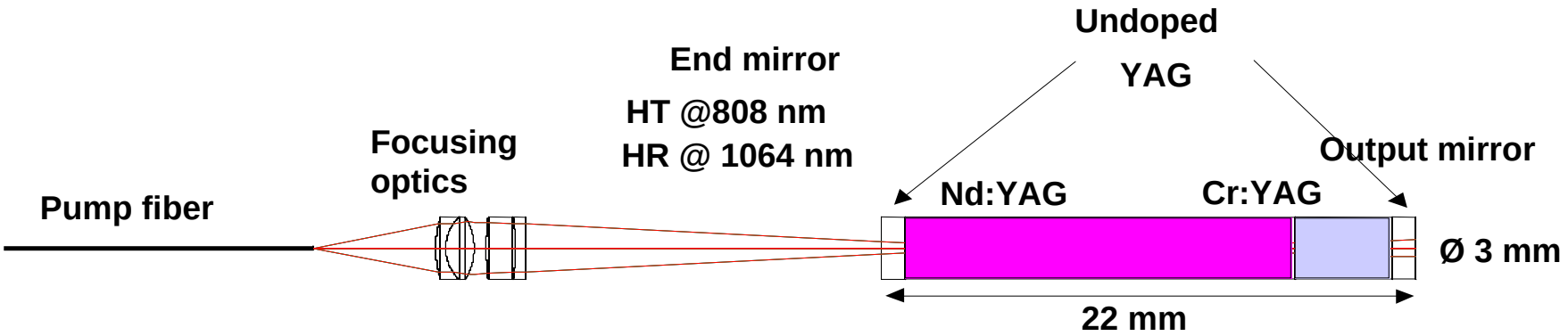


Ex situ configuration



In situ configuration

MINERVA in situ, ex situ: laser for LIPS



For the LIPS excitation, we designed a monolithic Nd:YAG microlaser, passively Q-switched. It is pumped through an optical fiber by a quasi-CW semiconductor laser. The laser cavity has a monolithic structure, with the laser crystal, the undoped YAG caps and the passive Q-switch crystal (Cr:YAG) joined by diffusion bonding. The mirrors are directly coated on the end faces.

By design, the laser delivers 1.5 mJ pulses with a duration of 1.2 ns, at low repetition rate, with an optical-to-optical efficiency of about 10%.