The VISIBLE and INFRARED HYPERSPECTRAL IMAGING SPECTROMETER (VIRHIS): A Study for the EJSM Mission. G. Piccioni[1], G. Filacchione[1], F. Capaccioni[1], M. T. Capria[1], P. Cerroni[1], M. C. De Sanctis[1], G. Magni[1], S. Stefani[1], M. Zambelli[1], A. Adriani[2], G. Bellucci[2], A. Boccaccini[2], A. Coradini[2], D. Grassi[2], F. Nuccilli[2], E. Palomba[2], F. Tosi[2], D. Turrini[2], S. Fonti[3], F. Poulet[4], M. Berthé[4], J. P. Bibring[4], P. Eng[4], Y. Langevin[4], A. Nathues[5], D. Titov[5], E. Battistelli[6], L. Calamai[6], T. McCord[7], R. Jaumann[8], J. Helbert[8], A. Sanchez-Lavega[9], S. Debei[10], G. Arnold[11], D. Blaney[12], R. Carlson[12], P. Drossart[13], D. Reuter[14], S. Bolton[15], P. Irwin[16].
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Introduction: The VIS-IR imaging spectrometer for the EJSM mission, named VIRHIS (Visible and Infra-Red Hyperspectral Imaging Spectrometer) on the Jupiter Ganymede Orbiter (JGO), is perfectly suitable to obtain a comprehensive picture of the Jupiter system by combining information of the surfaces of the Galilean satellites, the Jupiter's atmosphere, and possibly other targets. The level of details and the extended mapping capabilities of this instrument will unveil crucial aspects of the Jovian system, including the investigation of the nature, location and abundance of chemical compounds (especially organic and non-ice constituents) on the surfaces of the Galilean satellites, the characterization of longitudinal variations like leading/trailing asymmetries and the possible association with geologic features, the characterization of the satellites' exospheres, the monitoring of peculiar aspects (Io and Europa torii, Io's volcanic activity), the study of Jupiter's atmosphere at different levels (including hot spots, aurorae and magnetic footprints) and the spectral characterization of the whole Jupiter system (including the ring system, the small inner moons, and other targets of opportunity like irregular satellites).

Instrument Concept: The VIRHIS instrument baseline for JGO is an advanced imaging spectrometer that in one compact instrument combines two spectral channels operating in the 0.4-2.2 microns and 2.0-5.2 microns ranges. It can operate both in push-broom and in scanning mode, according to the different operational phases and scenario of the mission. The instrument can collect simultaneously 480 spectra taken across the spectrometer's slit, corresponding to a 3.44° × 125 μrad FOV and allowing image reconstruction during time. To meet the scientific requirements a spectral sampling of 2.8-5.0 nm/band is assumed, respectively, for the 0.4-2.2 and 2.0-5.2 microns ranges. Two 640×480 HgCdTe sensors arrays are currently studied as focal planes for the VIS-NIR and IR spectral channels. The instrument has to be designed to survive in the harsh radiation environment as well as to be compliant with the decontamination procedures imposed by the planetary protection rules. A delta study is planned in order to make the VIRHIS concept applicable to the JEO (Jupiter Europa Orbiter) mission requirements.

Heritage: The consortium proposing the VIRHIS study has a relevant heritage in VIS-NIR imaging spectrometers guaranteed over decades on full payloads or subsystems and technical aspects including optical design, scan mirror, focal plane arrays, signal digitalization, data compression, thermo-mechanical design, internal calibration units and Jovian radiation shielding (Cassini / VIMS, Rosetta / VIRTIS, Venus-Express / VIRTIS, Dawn / VIR-MS, Mars-Express / OMEGA, BepiColombo/SIMBIO-SYS, Juno/JIRAM).

Block diagram: In Fig. 1 is shown the block diagram of the instrument's concept which conisists of three units: 1) Optical Head (OH), housing the telescope, scanning mirror, spectrometer, focal planes, internal calibration unit, thermal control (passive radiator and coldfingers); 2) Proximity Electronics Module (PEM), necessary to drive the focal planes acquisitions and digitize the signals; 3) Main Electronics (ME) shall include a power distribution unit, a command and

process control unit and data compressors.

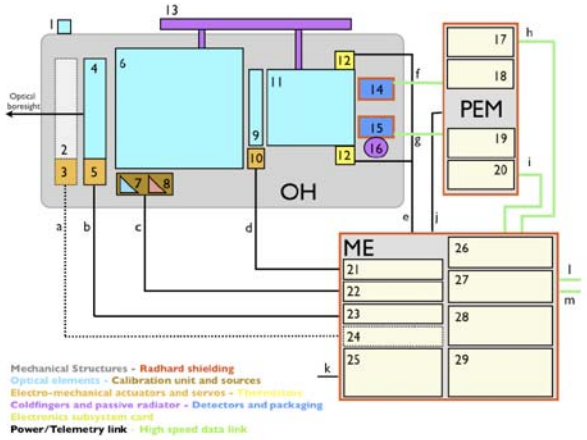

Figure 1: VIRHIS concept block diagram. The instrument consists of three units: Optical Head (OH), Proximity Electronics Module (PEM) and Main Electronics (ME). Instrument subsystems legend: 1. Alignment reference cubic mirror; 2. Optical head cover (Optional); 3. Cover mechanism (Optional); 4. Scan mirror; 5. Scan mirror mechanism; 6. Telescope; 7. Internal calibration unit, VIS-NIR reference source; 8. Internal calibration unit, IR source; 9. Slit with motorized shutter; 10. Shutter mechanism; 11. Spectrometer; 12. Heaters (for annealing and surviving); 13. Passive radiator, coupled to the OH structure; 14. VIS-NIR FPA, with radhard shield; 15. IR FPA, with radhard shield; 16. IR FPA coldfinger (S/C provided); 17. High speed I/O interface for data downlink to ME, VIS-NIR channel; 18. FPGA controller, VIS-NIR channel; 19. FPGA controller, IR channel; 20. High speed I/O interface for data downlink to ME, IR channel; 21. Shutter mechanism controller card; 22. Internal calibration unit controller card; 23. Scan mirror mechanism controller card; 24. Cover mechanism controller card (Optional); 25. Power supply; 26. High speed I/O interface for data downlink from PEM, VIS-NIR and IR channels; 27. High speed I/O interface for data downlink to S/C bus, VIS-NIR and IR channels; 28. Data compressor; 29. DPU, including mass memory. Instrument links legend: a. Cover mechanism to ME, power and telemetry; b. Scan mirror mechanism to ME, power and telemetry; c. Internal calibration unit to ME, power; d. Shutter mechanism to ME, power and telemetry; e. Heaters to ME and S/C bus, power and temperature readings; f. VIS-NIR FPA to PEM, high speed analog datalink; g. IR FPA to PEM, high speed analog datalink; h. PEM to ME, high speed digital datalink for VIS-NIR channel; i. PEM to ME, high speed digital datalink for IR channel; j. ME to PEM, power line; k. S/C bus to ME, power line; l. ME to S/C bus, high speed digital datalink for VIS-NIR channel; m. ME to S/C bus, high speed digital datalink for IR channel. Colors codes are indicated in the legend for each subsystem and link.

VIRHIS Study Timeline: by the end of the ESA study (July-August 2010) the VIRHIS team will present the results that will define with a sufficient level of detail the characteristics, interfaces, resources and expected performances of the instrument. During the study, the team will address in particular the following issues:

- Thermal model;
- Radiometric model;
- Optical layout architecture;
- VIS-NIR FPA and proximity electronics;
- IR FPA and proximity electronics;
- Main Electronics;
- Internal calibration unit scheme;
- Radiation hardness and criticality;
- Planetary protection impacts.