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Development of a new Planetary SCD-based X-Ray Fluorescence Spectrometer Package for in-situ Analysis

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We propose an X-Ray Fluorescence Instrument Package (XRF-X and XRF-ISM) in order to measure the composition of rock-surface materials from orbiter, lander, and rover-based systems directly and quantitatively. It is suited for all future missions to the Moon, but also to the Galilean Satellites or any other solid-surface solar system body without an atmosphere.

Collected data will be used for constructing detailed geochemical maps of the target body's surface composition. The typical spectral range is 1 - 10 keV (1.2 - 0.12 nm) with no sharp limits, achieving a spectral resolution of 160 eV at 6 keV. At these conditions, elemental abundances of lighter elements (atomic no. 11-32, K-Lines) and heavier elements (atomic no. 33-80, L-lines) will be observable. This will allow for mapping concentrations of the main mineral- (and therefore rock-) forming elements of surface materials, in particular Na, Mg, Al, Si, K, Ca, Ti, Mn, and Fe. The spatial resolution (GSD) is 10 km/px at an orbit altitude of 50 km.

The package consists of two subsystems: (1) the main instrument targeting at a body's surface (XRF-X), and (2) a zenith-pointing solar monitor which incorporates calibration targets for taking account of solar X-Rays and particles (XRF-ISM). Both instruments make use of Energy-Dispersive X-Ray Fluorescence (EDX) with solar X-Ray excitation to probe materials over arbitrary distances.

By monitoring incident Solar X-Ray and potential particle flux through synchronous measurement of a calibration target, XRF-X measurements can be obtained even over long distances, e.g. from a lunar orbiter. A scalable and modular design allows for instrument adaptions to desired resolution, to weight and power-consumption constraints and to expected sun emission intensities. The design will also allow adaption for employment on different observation platforms.

In the current laboratory setup, both experiments are developed using large-area swept charge devices (SCD) to allow for high X-Ray returns. The X-Ray spectra are acquired by single photon counting with nearly 100% quantum efficiency and on-board histograming (MCA). As of today, the laboratory components have passed TRL 4 and 5; TRL 6 is expected no later than end of 2014. Development is funded by the German Aerospace Agency under grant 50 JR 1303.