The BepiColombo SERENA/ELENA unit development: a new technique to detect sputtered neutral atoms escaping from Mercury surface

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ELENA (Emitted Low-Energy Neutral Atoms) is one of the four units of the SERENA experiment for the ESA cornerstone BepiColombo mission to Mercury. It is primarily devoted to understanding of Ion Sputtering processes and emission from planetary surfaces, particle back-scattering and Charge Exchange via neutral atoms detections in the energy range ~20 eV - 5 keV.

ELENA instrument is a Time-of-Flight system based on a peculiar Start section: an oscillating shutter (operated at frequencies up to a 100 kHz by an ultrasonic piezo-actuator) composed by mechanical grating (two self-standing silicon nitride (Si3N4) membranes, patterned with arrays of long and narrow openings). This shutter allows to identify the start time of the particles entering in the Time-of-Flight chamber with a good capability to reject UV photons. The Stop section at the end of the pattern is a 1-dimensional array composed by MCPs detector with discrete anodes corresponding to a Field of View of 4,5°x76°. This system allows having the determination of velocity and direction of the incoming particles.

In this paper the crucial part of the instrument will be shown: the main ELENA electronics (shutter position encoder; piezo controller; multi-channel front-end integrated circuits (ASIC); FPGA sequencer); the nano-structure membranes manufacturing; the shuttering system; the optical propriety of the membranes; the instrument performances (photons and particles test).