Laboratory testbed for the calibration and the validation of the Shadow Position Sensor subsystem of the PROBA3 ESA mission

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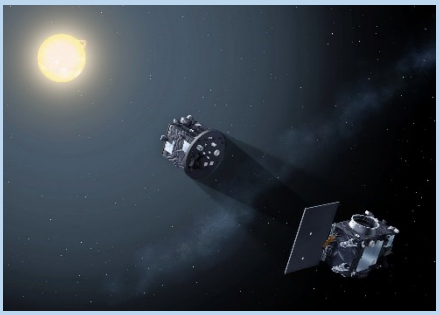
PROBA3 mission

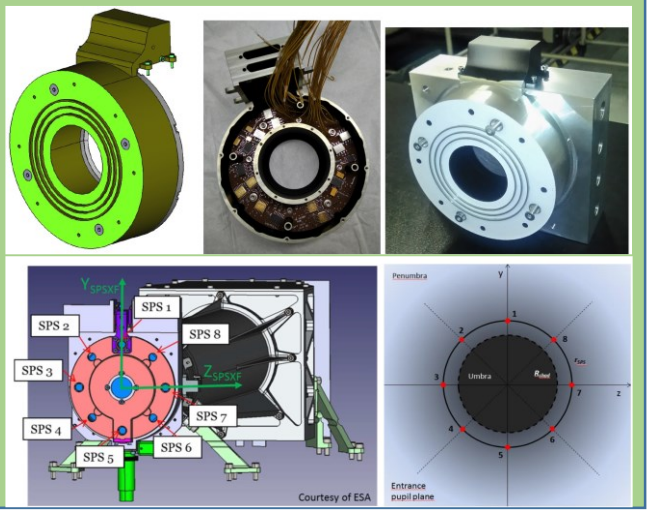
PROBA-3 is an ESA mission aimed at verifying and validating different metrology concepts to realize and maintain **formation flying (F^2)** of two separate and independent spacecraft. with respect to the Sun, with accuracy down to micron level.



The FF validation tool is the realization of a diluted giant Coronagraph, named ASPIICS, with the telescope (CI) on one satellite and the external occulter (EO) on the other one, at the Inter Satellite Distance **ISD = 144.3m.** ASPIICS will perform high spatial and temporal resolution imaging of the Solar Corona in the visible waveband from $1.08R_{sun}$ to about $3R_{sun}$. PROBA3 will be flown in a high elliptic orbit (HEO) with the perigee at 600K and the apogee at $6 \cdot 10^4$ Km. The FF will be realized and maintained over 6hrs across the apogee,. During all the other orbital phases the F^2 will be maintained on a safety geometry by means of GPS and RFL control.

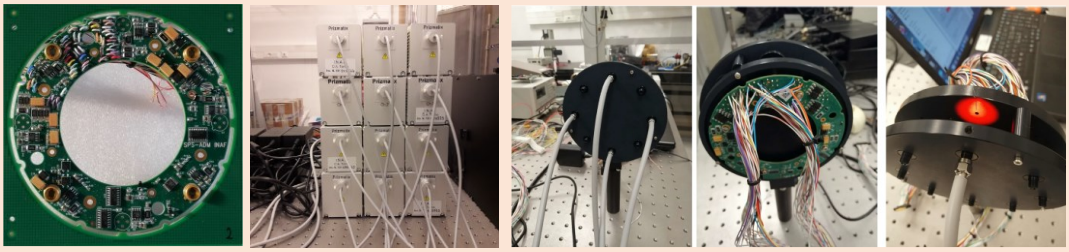
Shadow Position Sensor (SPS) metrology system

The SPS consists of a mechanical flange mounted in front of the ASPIICS telescope boom, hosting an electronic board where a set of 8 silicon multipliers (SiPMs), positioned along a circumference concentric with the telescope pupil, monitor the symmetry of the penumbra projected by the external occulter. Each diode receives the Sun irradiance through a pinholes properly positioned and dimensioned to optimize the readouts. A dedicated metrology ***algorithm*** embedded in the OBSW elaborates the digitized SPS response to calculate the lateral and the longitudinal positioning of the FF

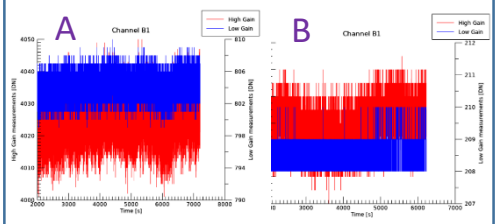


SPS on-ground calibration and testbed

The objective of the on-ground calibration of the SPS is to completely characterize the radiometric and spectral behavior of the 8 sensors in order to provide the metrology algorithm with the required coefficients needed to manage in the proper way the SPS response. An Advanced Demonstration Model (ADM) of the SPS PCB, fully equivalent to the Flight Model (FM), a part of the use COT components, was manufactured with two different aluminum-made flanges mounted one in front to the other and rigidly fixed. One flange with same mounting interfaces as the FM one, to install ADM; the second flange with SMA fiber connectors to bring light from a calibrated source and to uniformly illuminate the 8 pinholes of the first flange and the underlying SPS diodes.



Time stability test results

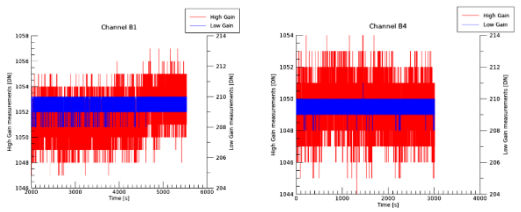


A HG = HG=4026±6.5 DN; LG=804DN; HG/LG=5.006

B HG=1045±1.4 DN; LG=209 DN; HG/LG=5.03

C HG = 102±0.1 DN; LG = 19 DN; HG/LG = 5.37

Radiometric test results



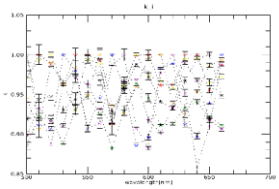
HG = 1052 DN; LG = 209 DN
HG/LG = 5.03; ki = 0.982

HG = 1172 DN; LG = 234 DN
HG/LG = 5.001; ki = 0.881

HG = 1024 DN; LG = 204 DN
HG/LG = 5.03; ki = 1.009;

HG = 1049 DN; LG = 209 DN
HG/LG = 5.01; ki = 0.985

Spectral characterization results



Time stability: SPS outputs variation at constant irradiance, for about 2 hrs at Low, Medium, High input flux regime.

Radiometric test: SPS responsivity (DNs for each channel per unit of input irradiance) → $\mathbf{k_i}$ factors to "equalize" the SPS response.

Spectral characterization: $\mathbf{k_i}$ factors variation within the SPS operative waveband.