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PROBA-3 MISSION - IMPLEMENTATION OF PRECISE FORMATION CONTROL OF TWO SMALL
SPACECRAFT TO OBSERVE THE SUN AS NO SINGLE SPACECRAFT IS ABLE TO DO

Abstract

After Solar Orbiter, ESA's next mission observing the Sun will be Proba-3. Involving not only one spacecraft but two: the pair of satellites making up Proba-3 will fly in formation to cast an artificial solar eclipse, opening up the clearest view yet of the Sun's faint atmosphere – probing the mysteries of its million degree heat and magnetic eruptions.

The study of the Sun inner corona down to 1.1 solar radius can only be performed by creating in space an artificial eclipse with a distance between a Coronagraph instrument and an occulting disk much bigger than the size of any spacecraft that could fit within a launcher.

Proba-3 will achieve these enhanced scientific observations by controlling two small satellites (1.5 m cubes in the 200-300kg range) as a 150 m long 'large virtually rigid structure' by maintaining millimetre and arc-second relative precision. In effect the paired satellites will fly as a giant virtual satellite creating an 'externally occulted' coronagraph, in which a satellite imager is shielded from the glaring sunlight by an occulting disk on the other satellite, forming an artificial eclipse.

Proba-3 is at full speed in the assembly, integration and verification phase, with the aim of launching in two years' time. The paper describes the overall Proba-3 mission concept and detailed design, and specifically addresses the various challenges and solutions reached to be able to link the two spacecraft to act as a single one, including the implementation of different novel metrologies (such as inter-satellite links, relative position coarse and fine sensors) and formation flying control schemes.

Proba-3 forms part of the ESA's GSTP program, as a new element of the Proba series of technology demonstration missions. Additionally, Proba-3 science activities are supported by a Science Team, and the Proba-3 Mission is supported by the ESA Science Programme as an opportunity mission, to complement the science data provided by the large ESA solar physics missions. Proba-3, as the world's first precise formation flying mission, demonstrates how small satellites can be used to implement novel space mission architectures unachievable by single larger and costlier spacecraft, being capable of achieving relevant scientific goals within a tight programmatic context.