Laser ranging on space debris with the MéO station

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Since the beginning of the space conquest, there are fifty years ago, different objects like fuel tank or booster rocket are left in orbit. With time and also due to different colliding, the population of debris has increased. The density of these objects is now at such a level that companies involved in spatial business are worried for future missions. In this context, we have established a collaboration with ASTRIUM to prove the ability to perform laser ranging on space debris but also to validate the dimensioning of a laser station dedicated to active tracking on orbital debris.

With a telescope of 1.54m in diameter, MéO is fundamentally well suited to track the moon and high altitude satellites. But to obtain laser echoes on non-cooperative object, some technical developments have been done to increase the energy by pulse and to minimize the noise of the detection (thanks to the huge uncertainty of the initial position of the debris):

1) a laser Continuum DLS has been integrated. It produces optical pulses at 532 nm with a repetition rate of 10Hz, pulse width of 5 ns and 2 Joules per pulse.
2) A SAP500 low noise photo-detection has been characterized and implemented. It is used in Geiger mode with a Quantum efficiency measured around 40 %. The noise measured is around 55 events/µs at 20 °C and the global field of view is 28 arcsec.

The repeatability error of the whole system is 5 ns which corresponds to a resolution of 1 meter for the distance measurement. But in fact, the resolution of the measurement is governed by the depth of the debris.

Two difficulties have been added. There is no prediction in the CPF format for space debris like for current satellites. We had to use Two Lines Element (TLE) predictions computed from RADAR observations. And in fact, the precision of the TLE predictions is around 10 km. This problem was overcomed with the use of a camera and the ability to see the debris when it is illuminated by the sun. Due to the use of a very powerfull laser and to ensure the safety of the airspace, observations have been scheduled in collaboration with the French Civil aviation and also restricted during the night above 45° in elevation.

The first laser echoes have been obtained the 20th march 2012 on SL14. Then, during a campaign of 3 days, ten non-cooperative objects were detected at distance between 847 km and 1800 km.

The system is installed permanently and it can be quickly operational. After the success of this collaboration, we think that laser ranging on space debris could be a complementary technique together with RADAR observations. Laser ranging permits to dramatically reduce the amount of time that would be necessary with passive observations to obtain metric orbits. This precision level is very important to manage active spacecraft and so to avoid collisions.