3.3b Zimmerwald Laser Observations to Determine Attitude States of Space Debris

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The currently proposed space debris remediation measures include active removal of large objects and “just in time” collision avoidance by deviating the objects using, e.g., ground-based lasers. Both techniques require precise knowledge of the attitude state and state changes of the target objects. In the former case, to devise methods to grapple the target by a tug spacecraft, in the latter, to precisely propagate the orbits of potential collision partners as disturbing forces like air drag and solar radiation pressure depend on the attitude of the objects.

SLR observations of space debris targets equipped with retroreflectors is a promising technique to accurately and reliably determine rotation or tumbling rates and the orientations of the actual rotation axis of objects, as well as their temporal changes.

This information is crucial for the Active Debris Removal Missions. Furthermore this technique can be used to validate other attitude determination methods and techniques which can be applied in combination with SLR or in cases when retro-reflectors are not visible or not even installed on the target (non-cooperative objects). An example of such a method is the acquisition and processing of optical light curves.

The 1-meter telescope ZIMLAT of the Astronomical Institute of the University of Bern has been used to collect SLR ranges and light curves of LEO and MEO objects. We will present the observation techniques, SLR and partially light curves, and the data reduction methods. Eventually first results of attitude determination for ENVISAT satellite will be provided.

Optical observations can be also used in combination with SLR ranges measurements in order to improve the targets orbits. Improved ephemerides (cpf) will increase the tracking efficiency for space debris targets and allow stations with no visual tracking aids to acquire targets which they could otherwise not track based on the originally poor predictions. The improved orbits also lead to better and more accurate results when determining attitude states from SLR measurements. AIUB is currently developing techniques to fuse astrometric positions (angles) and SLR range measurements in order to achieve these goals.