Institut für
Technische Physik

Design and commissioning of a transportable laser ranging station STAR-C

Leif Humbert, Thomas Hasenohr, Daniel Hampf, Wolfgang Riede
Leif.humbert@dlr.de

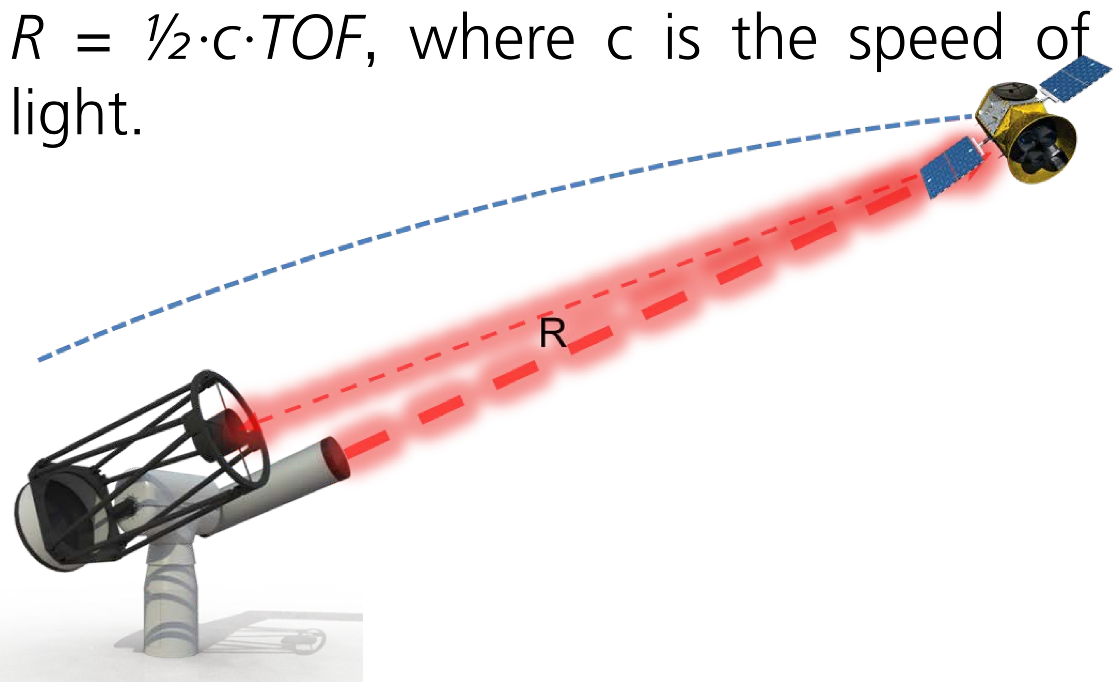
German Aerospace Center, Institute of Technical Physics, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany

Motivation

Catalogue maintenance, space surveillance as well as space traffic management are tasks which require accurate orbit prediction of orbital objects for manoeuvre planning and collision warnings for example. In addition to Radar based observations laser ranging is applicable even for uncooperative objects [1]

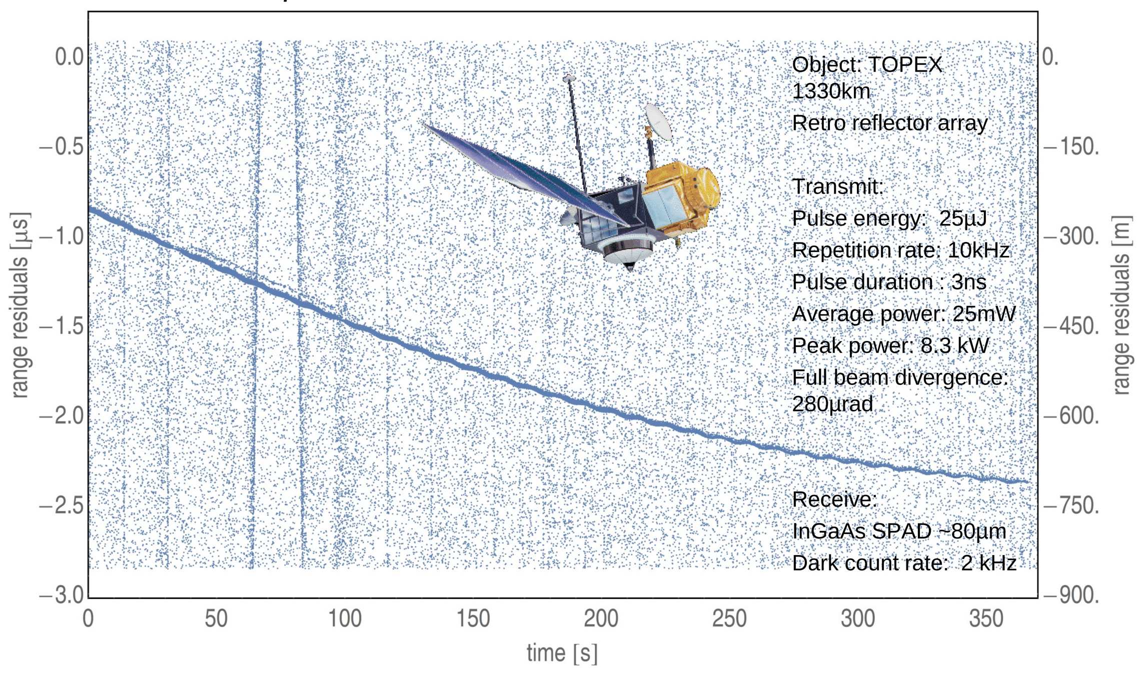
Laser Ranging

In the simplest form the slant range to an object is given by the time of flight (TOF) of a laser pulse to an object by $R = ½·c·TOF$, where c is the speed of light.



Basic principle of laser ranging. Emitted pulses are reflected by an object and returning photons are collected with a telescope.

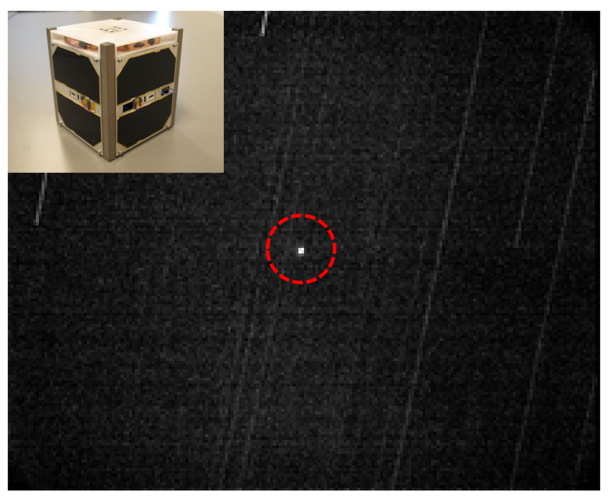
Since the total loss (two way) is on the order of 10^{-19} the number of detected photons per pulse, is typically less than 1. Thus for verifying the slant range *R* one calculates the temporal residual of a predicted TOF_{pred} and a measured TOF_{meas}, *which is simply given by:* $t_{res} = TOF_{pred} - TOF_{meas} - t_{cal}$.



The actual slant range R occurs where the residuals are statistically enhanced.

Tracking and laser ranging

Orbit predictions based on TLE data contained in the NORAD catalogue are too inaccurate for blind laser tracking of an object. However, such a prediction is often sufficient to capture the objects' visual solar reflection in the field of view (FOV) with a wide field telescope. A tracking algorithm continuously corrects the initial prediction and keeps the object at a specific position within the FOV.



Closed loop tracking of a cubesat.

During the closed loop tracking one aims a ranging laser at the object and takes the TOF measurements.

Transportable laser ranging station

At the Institute of Technical Physics/ German Aerospace Center a transportable laser ranging station, Surveillance, Tracking and Ranging Container (STAR-C) is currently under construction.

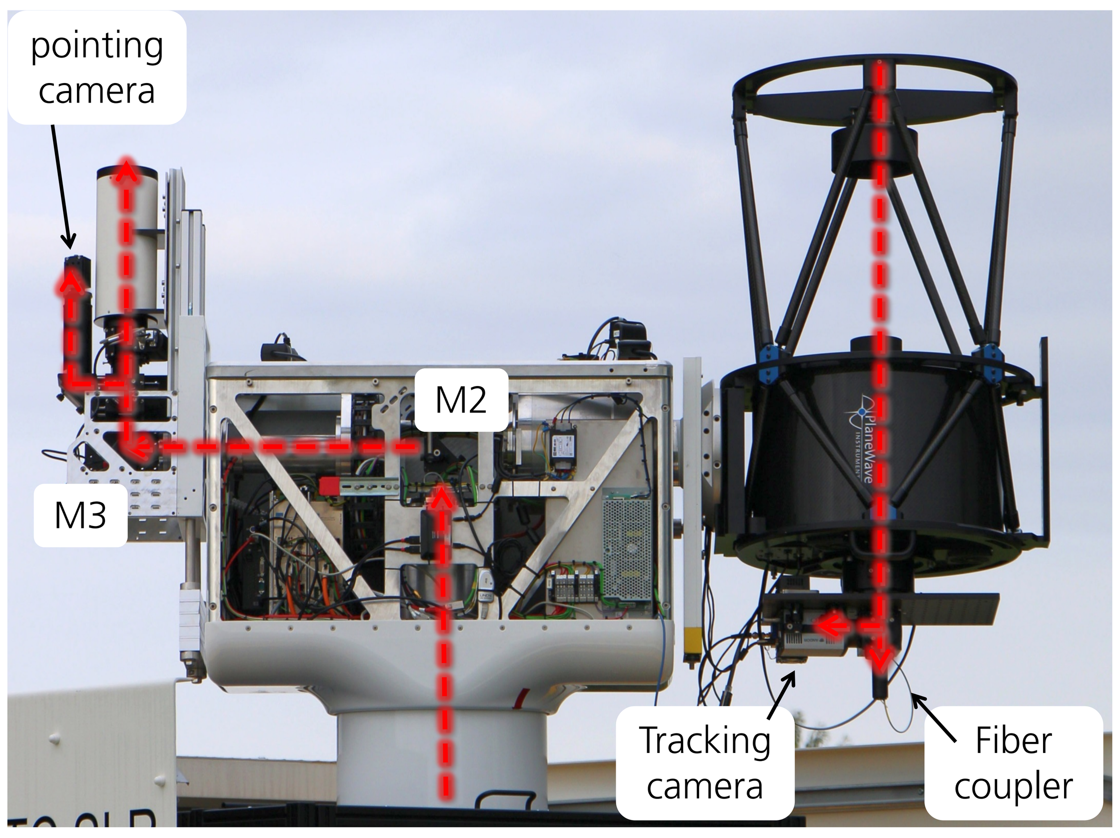
STAR-C: A platform raises a bi-static set-up of a wide field telescope and a laser transmitter above the roof of the container.

Transmit channel

Starting from a pulsed infrared laser source, a coude´ train guides the laser light through the axes of an alt-azimuth mount with high resolution encoders to the transmitter telescope. A fraction of the light is sampled with a beam sampler and focused on a camera in order to monitor the pointing of the laser.

Receive channel

A wide field telescope (Planewave CDK17) collects both the visual light for tracking and infrared light for ranging. Both parts are separated on a cold mirror, where the infrared light transmits through the cold mirror and the visual reflects of the cold mirror.



Beam paths of the transmit and receive channels: A set of mirrors guide the ranging laser through the axes of the mount. The last mirror M3 controls the pointing of the laser. A wide field telescope collects the light for tracking and ranging.

[1] Georg Kirchner, Franz Koidl, Fabian Friederich, Ivo Buske, Uwe Völker, Wolfgang Riede, Laser measurements to space debris from Graz SLR station, Advances in Space Research, Volume 51, Issue 1, 2013, Pages 21-24, ISSN 0273-1177

Knowledge for Tomorrow

Wissen für Morgen

DLR
**Deutsches Zentrum
für Luft- und Raumfahrt**
German Aerospace Center