SLR and GNSS co-location and delay control for the application of laser time transfer

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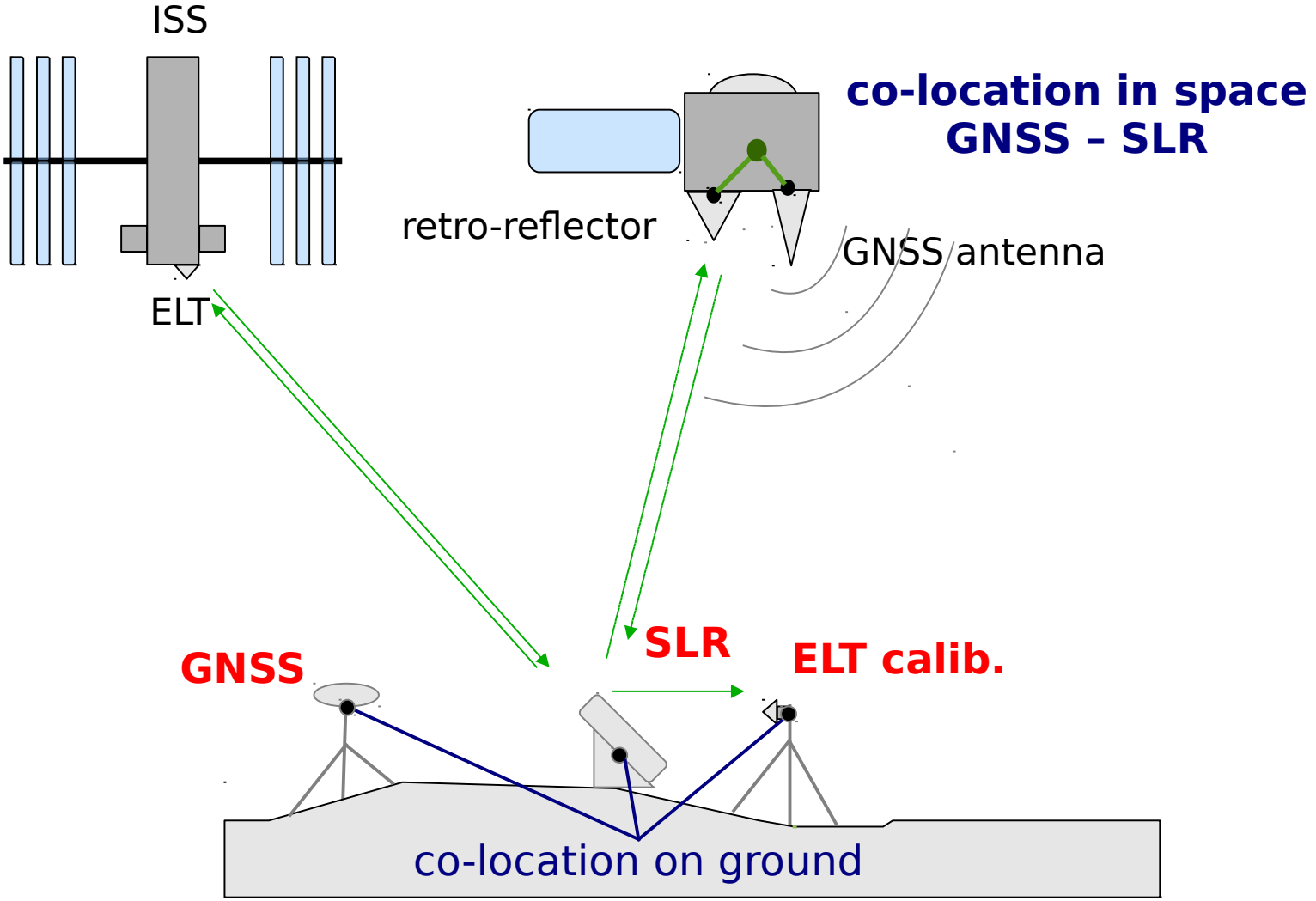
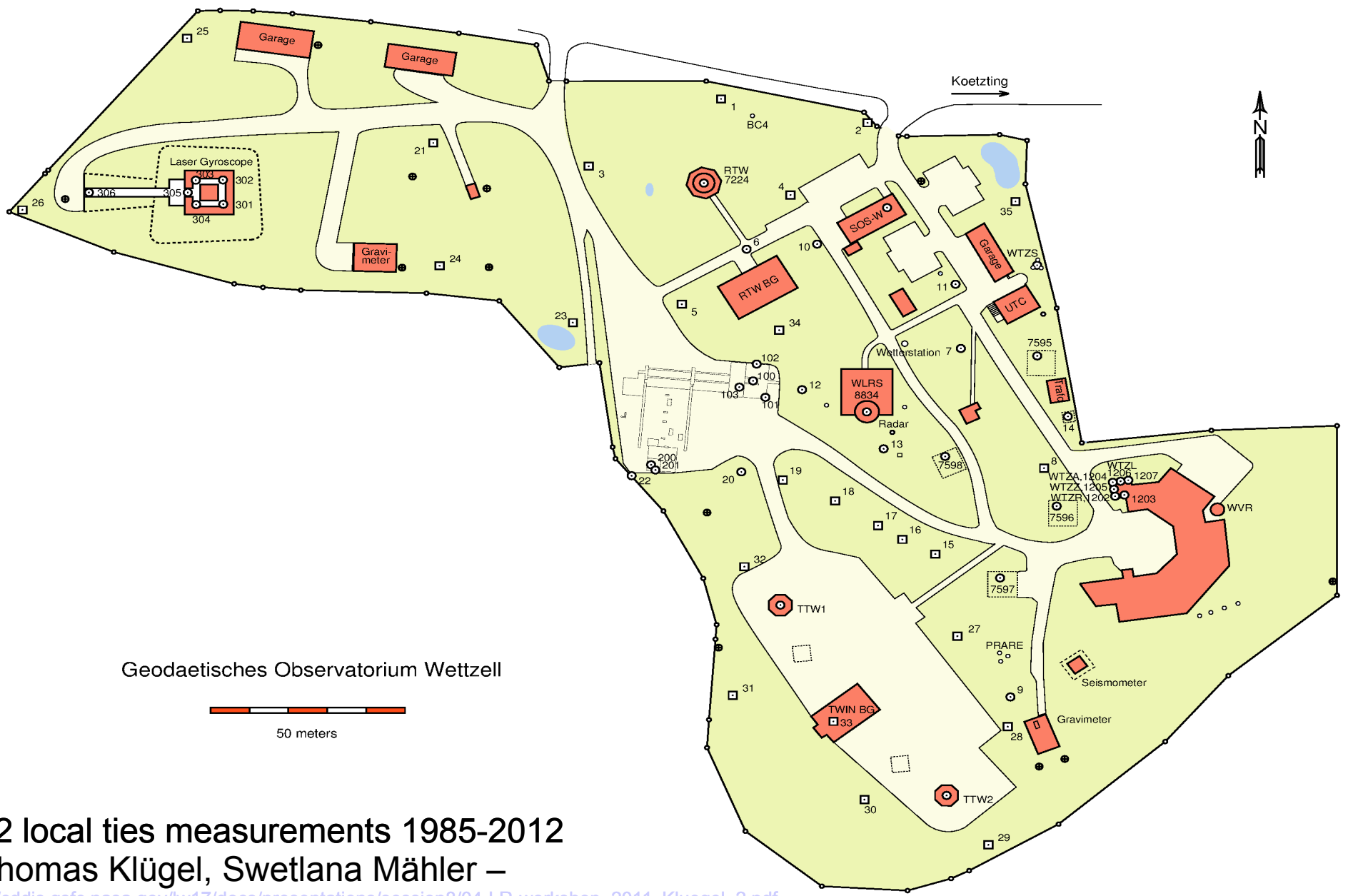
ELT and GNSS time transfer



- The goal is to co-locate ELT and GNSS through time transfer and to build the solid infrastructure for ELT calibration
- ELT calibration – spacial case of local tie interconnecting distant measurement with delay

Ground Survey at Geodetic Observatory Wettzell

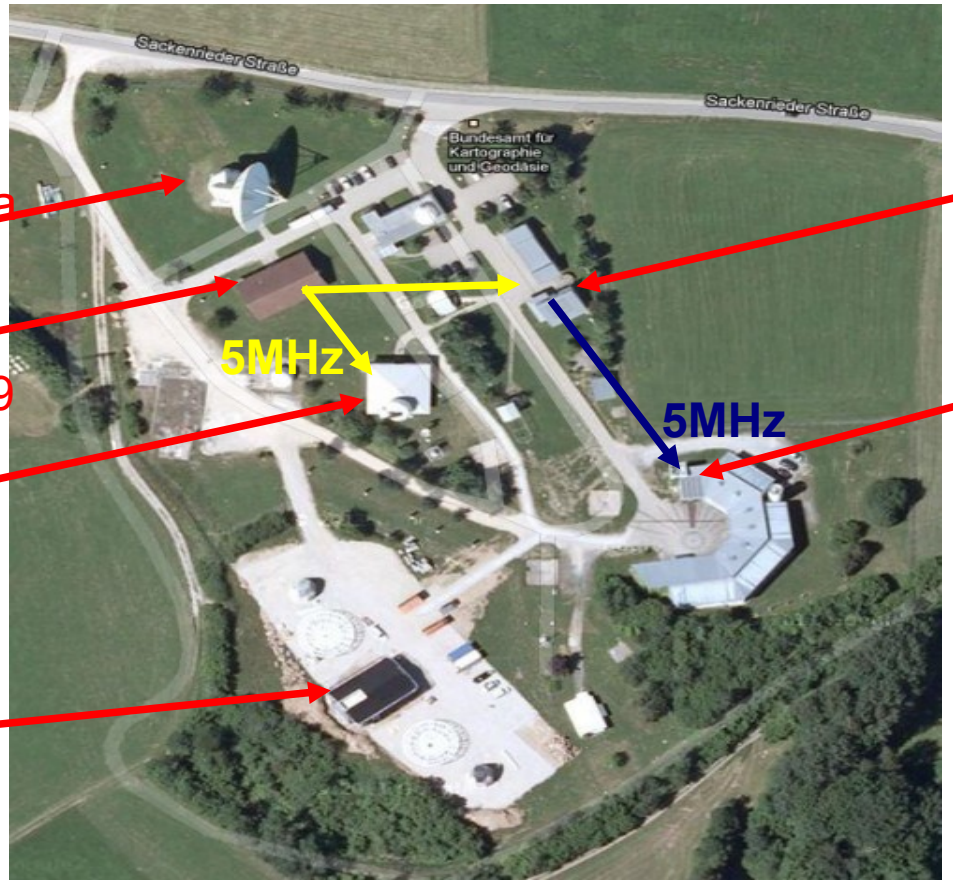


- 12 local ties measurements 1985-2012
- Thomas Klügel, Swetlana Mähler –
http://cddis.gsfc.nasa.gov/lw17/docs/presentations/session8/04-LR-workshop_2011_Kluegel_2.pdf

Local Ground Survey Network in Wettzell

- 12 local ties survey 1985-2012
- The space technique reference points show no significant displacements
- Good repeatability, also when using different instruments small systematic errors
- The TWIN was added to local ties network (2012), automatic Local Ties Survey was tested (M. Lösler, et al. 2013)
- Stable markers show displacements not exceeding 2-3 mm in 27 years
- The precision of the local ties in Wettzell are in the order of 1-2 mm

Stable Time and Frequency Standard for all Space Techniques at Wettzell



VLBI antenna

H-Maser
EFOS 1,18,39

SLR

H-Maser
EFOS 61

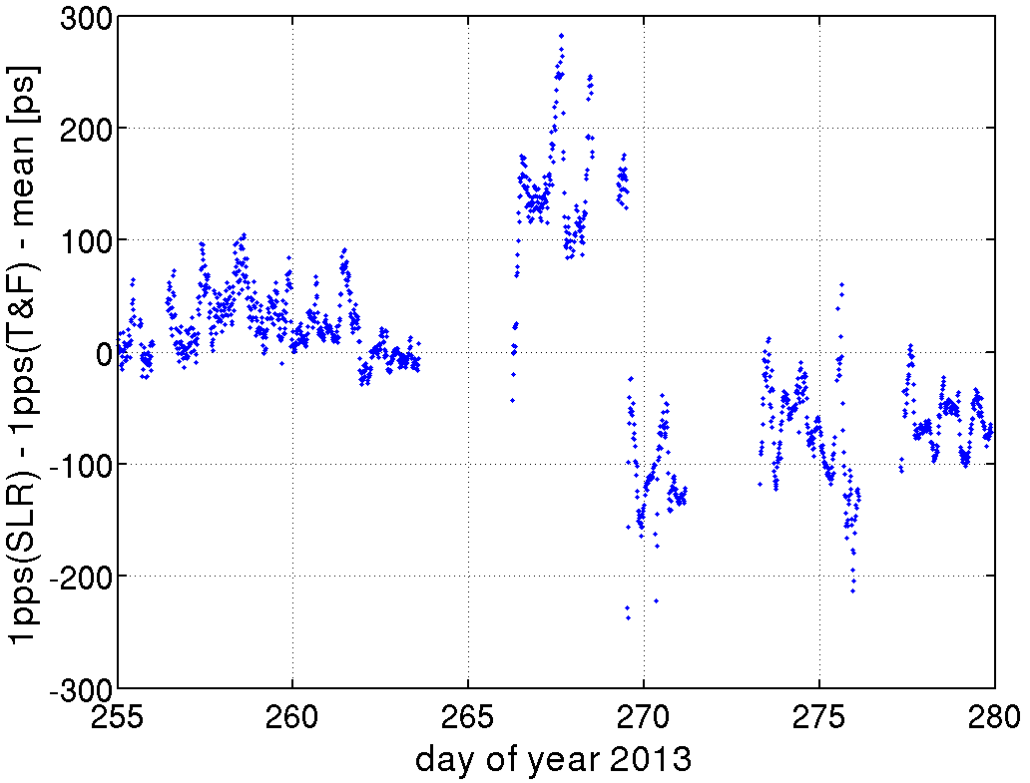
5xCs
HP1732 - UTC(IFAG)
WTZS – PolarX2

GNSS laboratory
WTZA – Ashtech Z12T

- 4x H Maser clocks, SLR and VLBI are running from EFOS 18
- 5x Cs clocks, HP1732 – UTC(IFAG) reference point
- **No GNSS for time transfer connected to SLR clock**

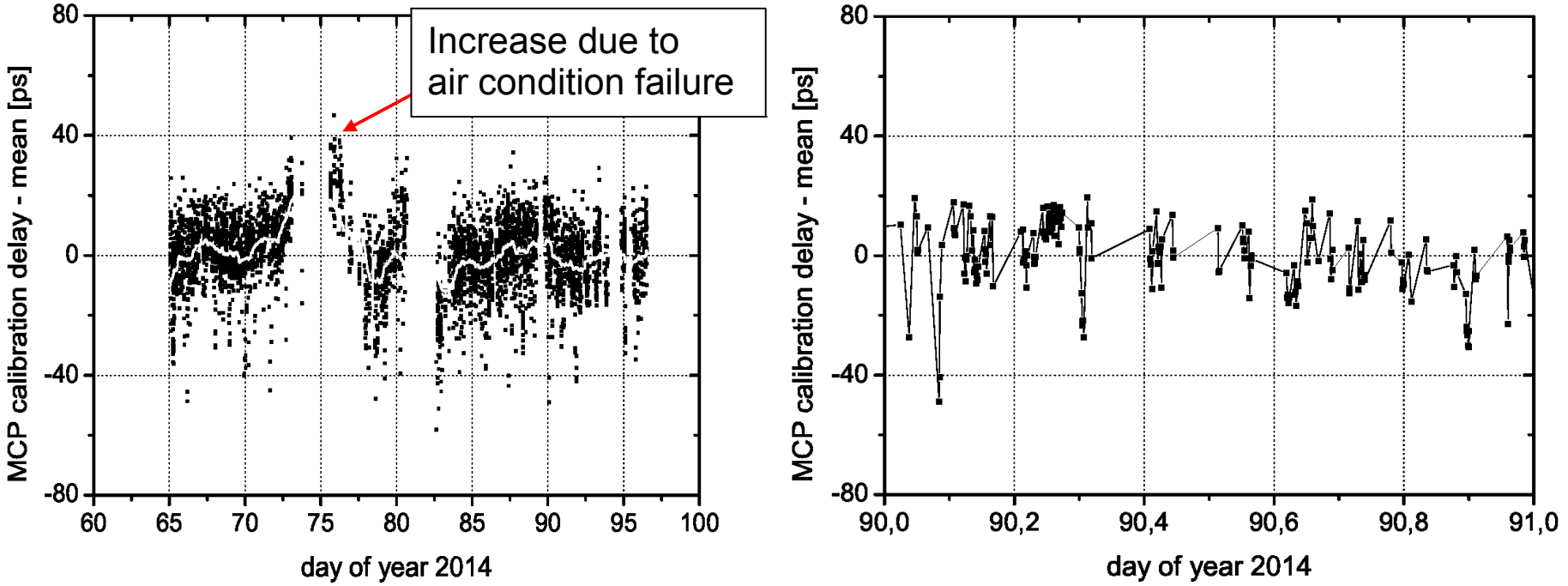
TWTT GNSS WTZS ↔ SLR

same clock, different passes



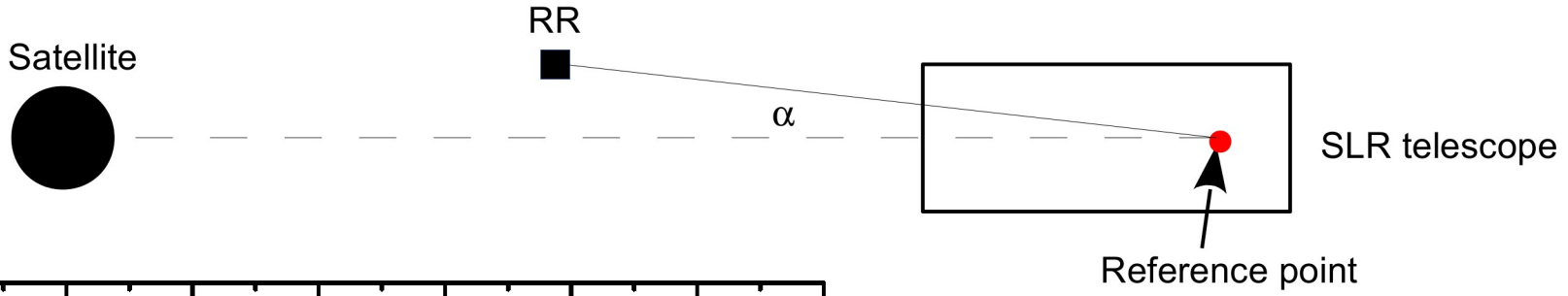
- Implementing TWTT method to support T2L2 and ELT time transfers
- Comparing T2L2, ELT and GNSS time transfer
- Without proper measurement of delay GNSS ↔ SLR, the comparison GNSS/Laser can not be evaluated!
- **We have finalized plans for new hardware for time and frequency distribution with delay stability better 10 ps**

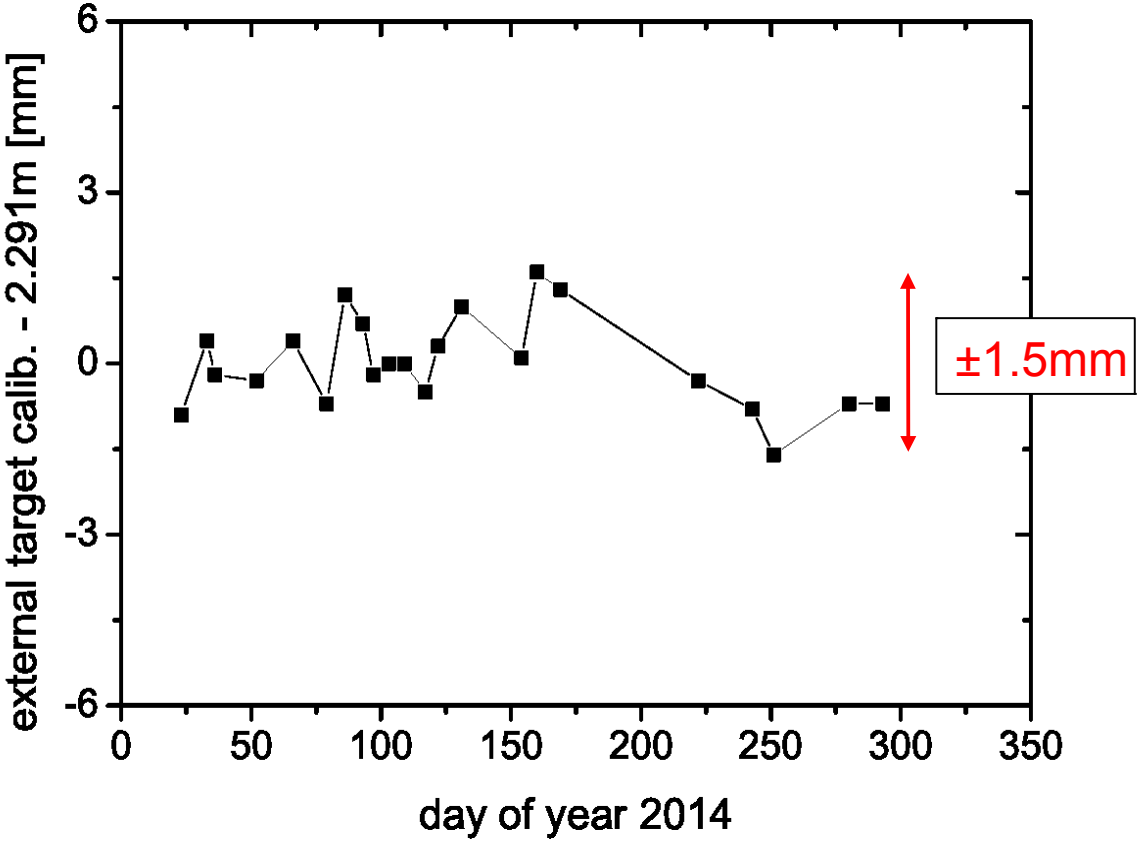
WLRS ET Time Setting and Internal Calibration

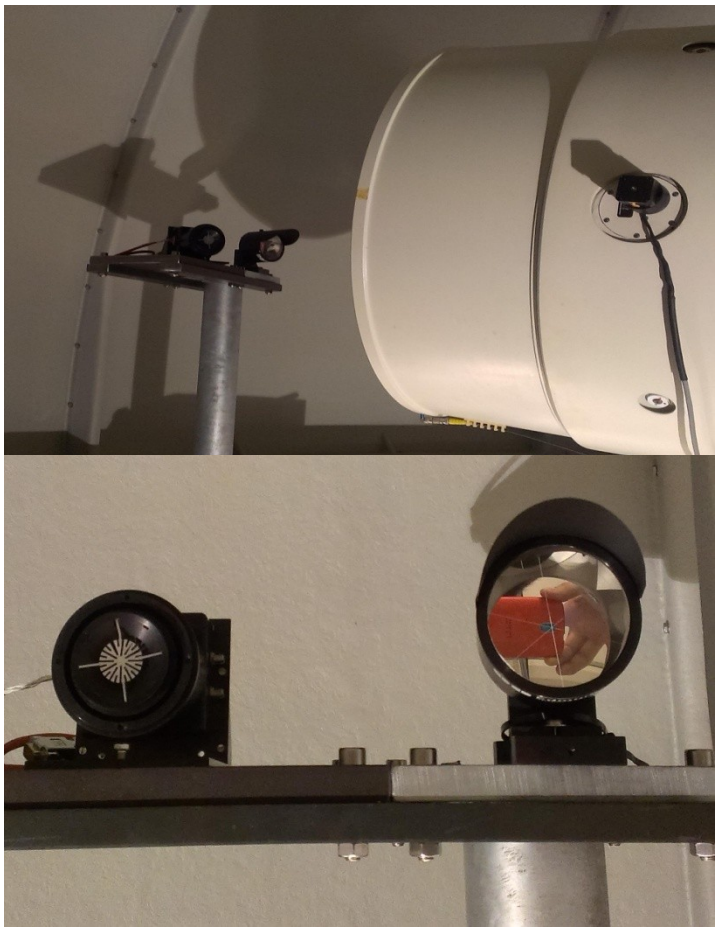


- The SLR is calibrated trough internal calibration process, with each laser shot there is one calibration measurement
- Long time calibration reflects good stability
- Short time stability is affected by wrong time setting of Event Timer HW and SW problem
- The improper time setting is not allowing to do time transfer with SLR
- **We have finalized the plans for upgrading ET to be compatible with time transfer applications**

WLRS External Target Calibration

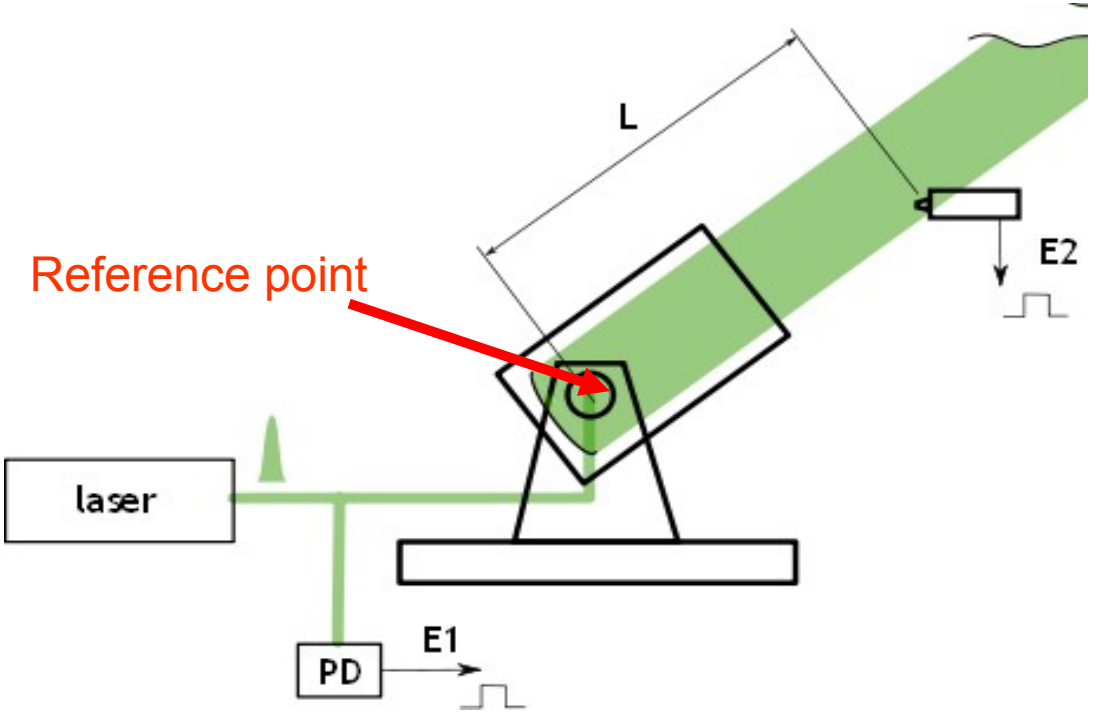


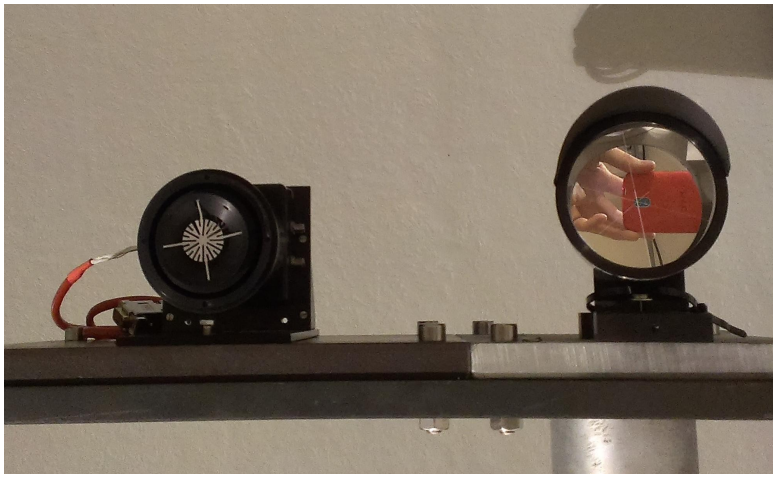


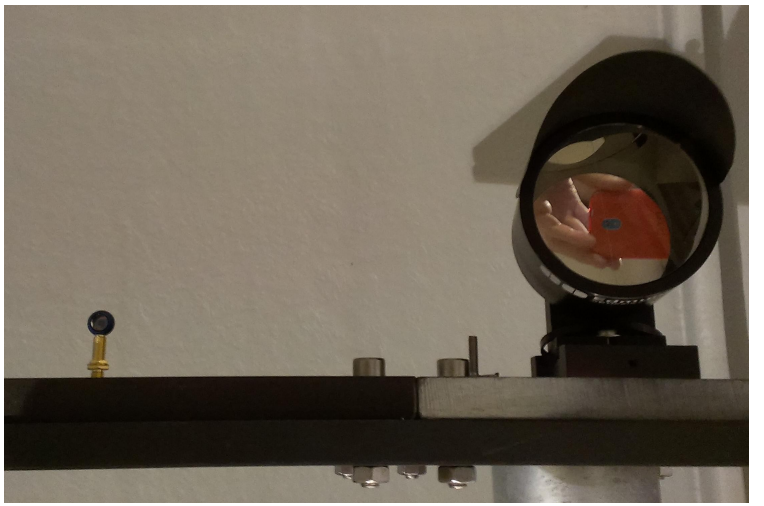


- External target mean = 2.291m
- Local ties measurement = 2.294m
- => System delay offset change 3mm

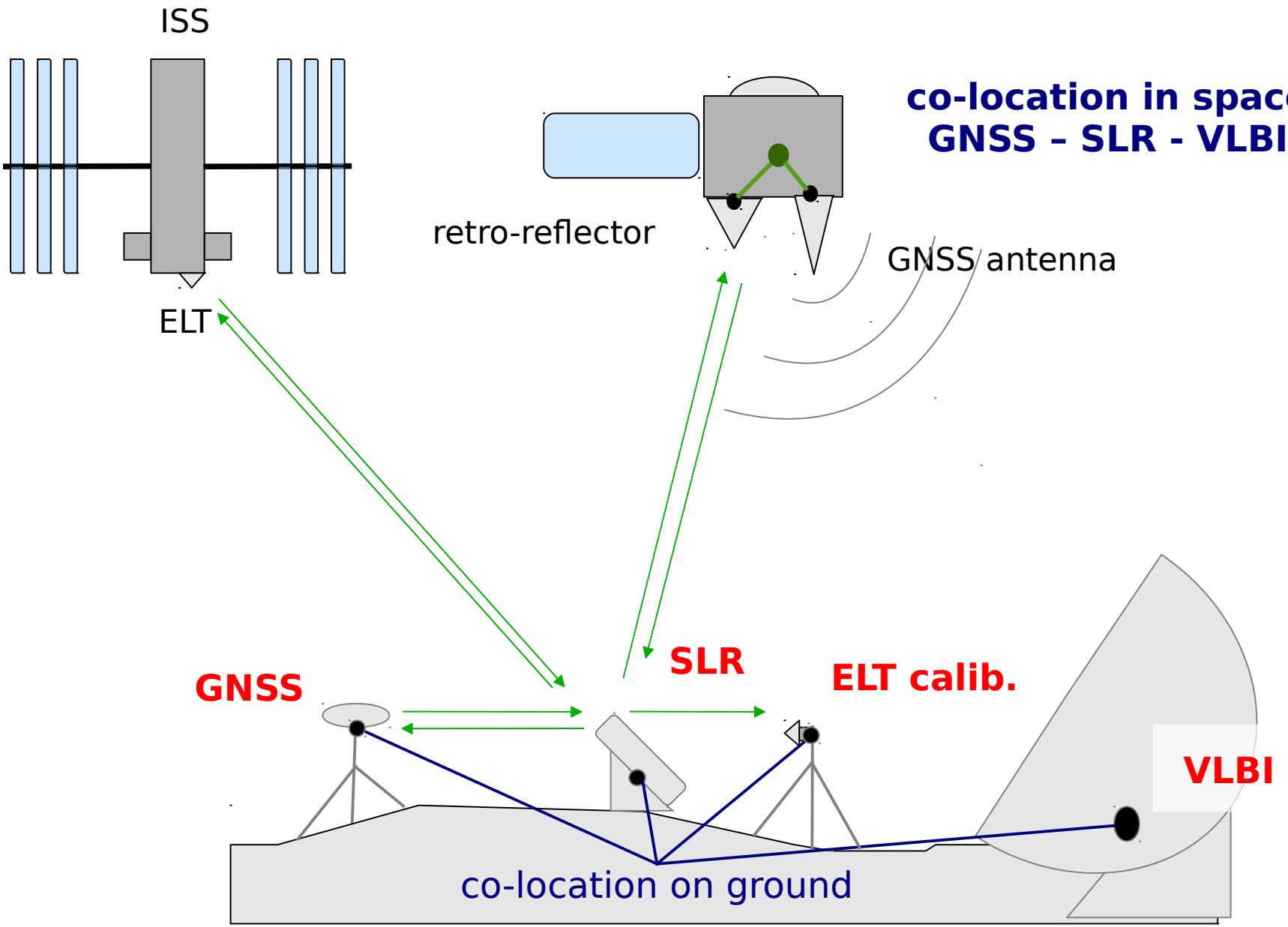
Estimating ELT Reference Point at SLR Station



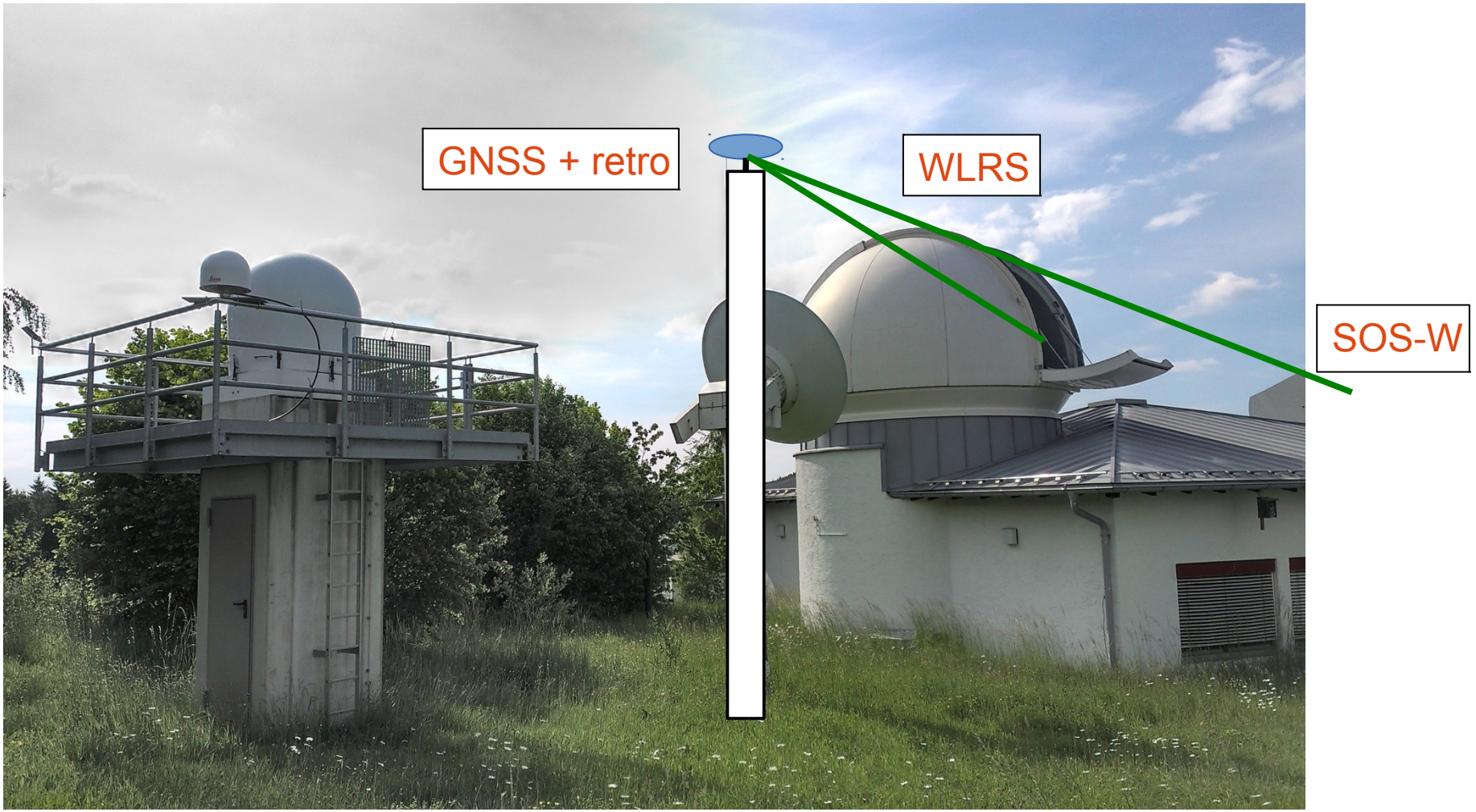




GNSS Satellites Observations and ELT



WLRS External Target on GNSS



- We are building new GNSS time co-located station with capability using the station as an external target for WLRS and SOS-W

Universal Geodetic Ground Target

Summary

- We are continuously working on improving local ties between instruments at Wettzell observatory
- In past we have developed and implemented TWTT measurement technique to co-locate GNSS and SLR time transfer, and we are building up new GNSS station time co-located to SLR
- Besides ELT calibration campaign and establishing new external target we are building up new universal external target

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