

European Laser Timing work progress

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T2L2 meeting, Wetzell, Germany, March 2014

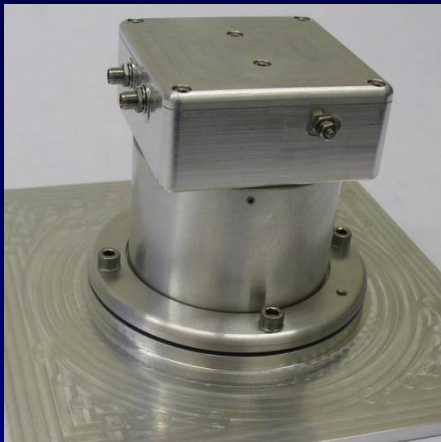
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(2) Technical University in Munich, Munich, Germany

ELT detector work progress, February 2014



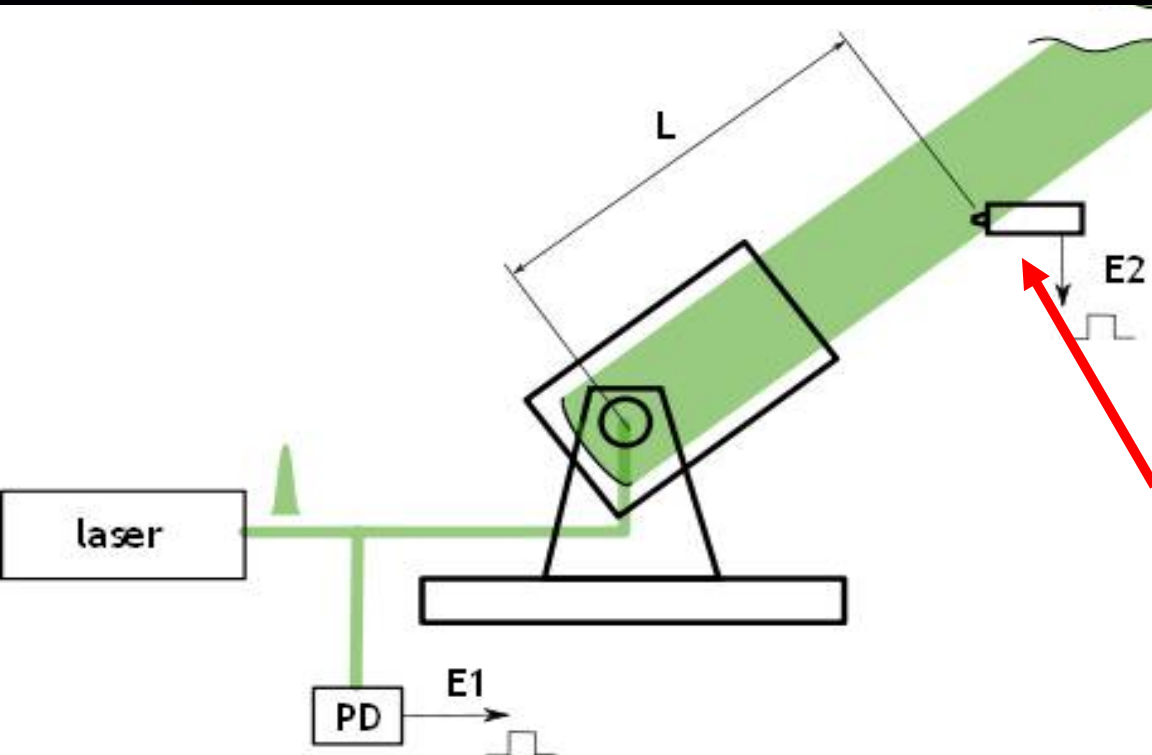
- Flying unit is manufactured
delay caused by ESA soldering qualification process
solution found
- No additional technical problems expected
- FM will be compared (detection delay) to the
ELT Calibration Device before leaving the clean room



- Progress impaired by a re-structuring of a contractor
CSRC ltd. company split into two parts
 - CSRC ltd. Clean rooms, assembly, contract..
 - KBmicro ltd. Staff, Electronics, documentation,..

ACES ELT Ground Station Calibration

Request for Proposal, ESA, March 11, 2014



The ground station will be characterized by a single calibration value / station

Calibration value computed from - epoch dif. $(E2-E1)$ - geometry distance L

Calibration Device consisting of : - ELT type detector package - Epoch Timing system ET

Will be kept stable (delay) within entire ELT mission

Epoch E1 recorded using standard SLR system

Epoch E2 recorded using ELT Calibration Device (Detector & Timing device)

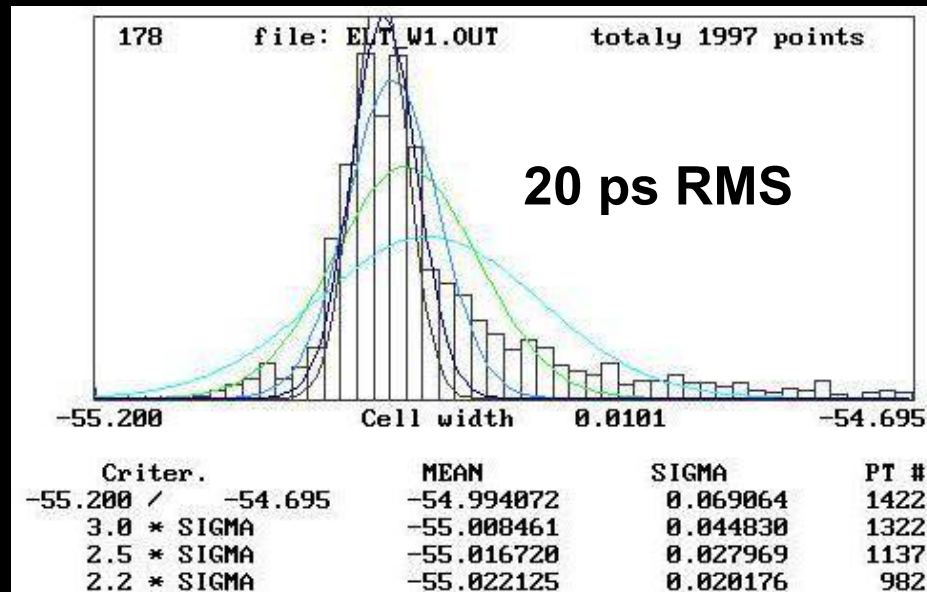
Both systems use common time & frequency

ELT Calibration Device test # 1, WLRs

Fundamental Station Wetzell, Germany, February 13-14, 2014



- ELT type detector package
std. holder with ref. point
- Event timing NPET, cabling, sw package, PC
- Installed in a dome in front of a main telescope (off axis), distance surveyed repeatedly (< +/- 1mm)



ELT Calibration Device test # 1, WLRS

Fundamental Station Wettzell, Germany, February 13-14, 2014

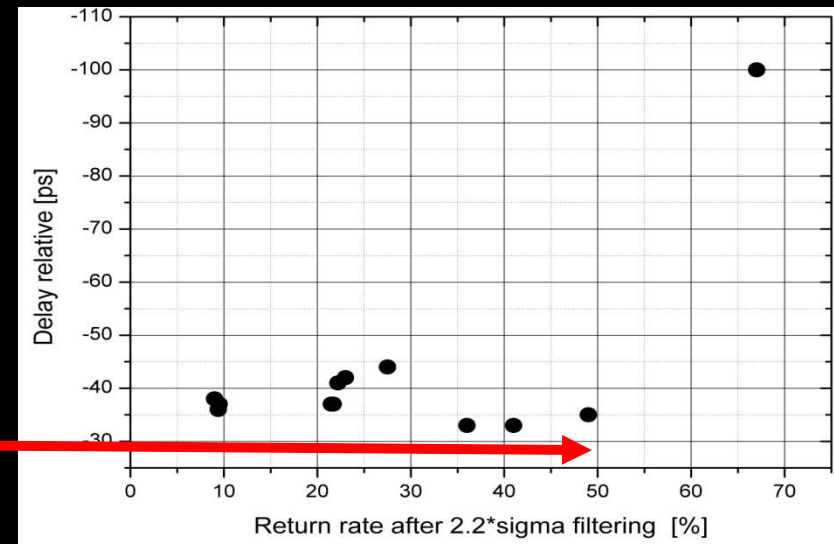
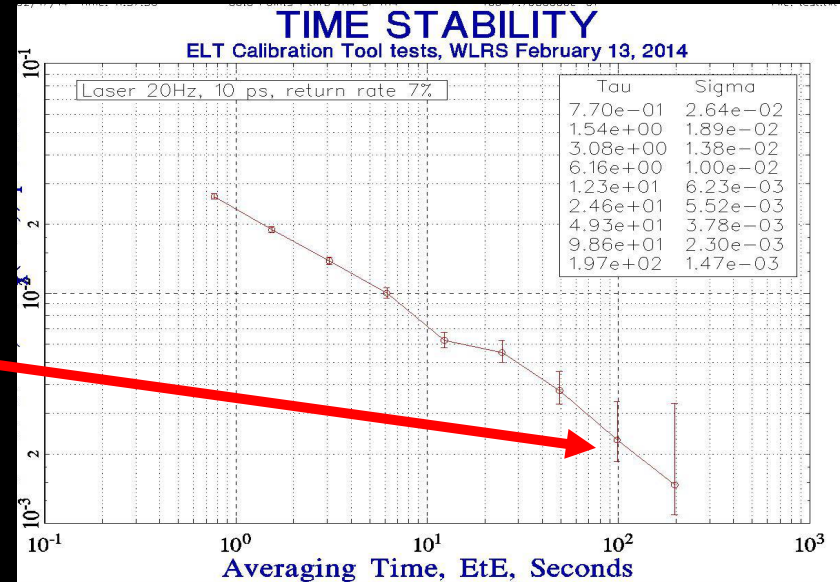
- 20 Hz, 10 ps laser FWHM, 8% rate

- TDEV 2.3 ps @ 100 s averaging

- 100 s series simulating ISS path in all other measurement

- Resulting in ~ 160 raw readings / path
= > ~ 140 valid data points

- Dynamical range 0.. 50 % (!!!)
within +/- 6 ps half p-p
(good for SLR tracking..)



ELT Calibration Device test # 1, WLRS

February 13-14, 2014

Geometry – independent survey

Two different scales

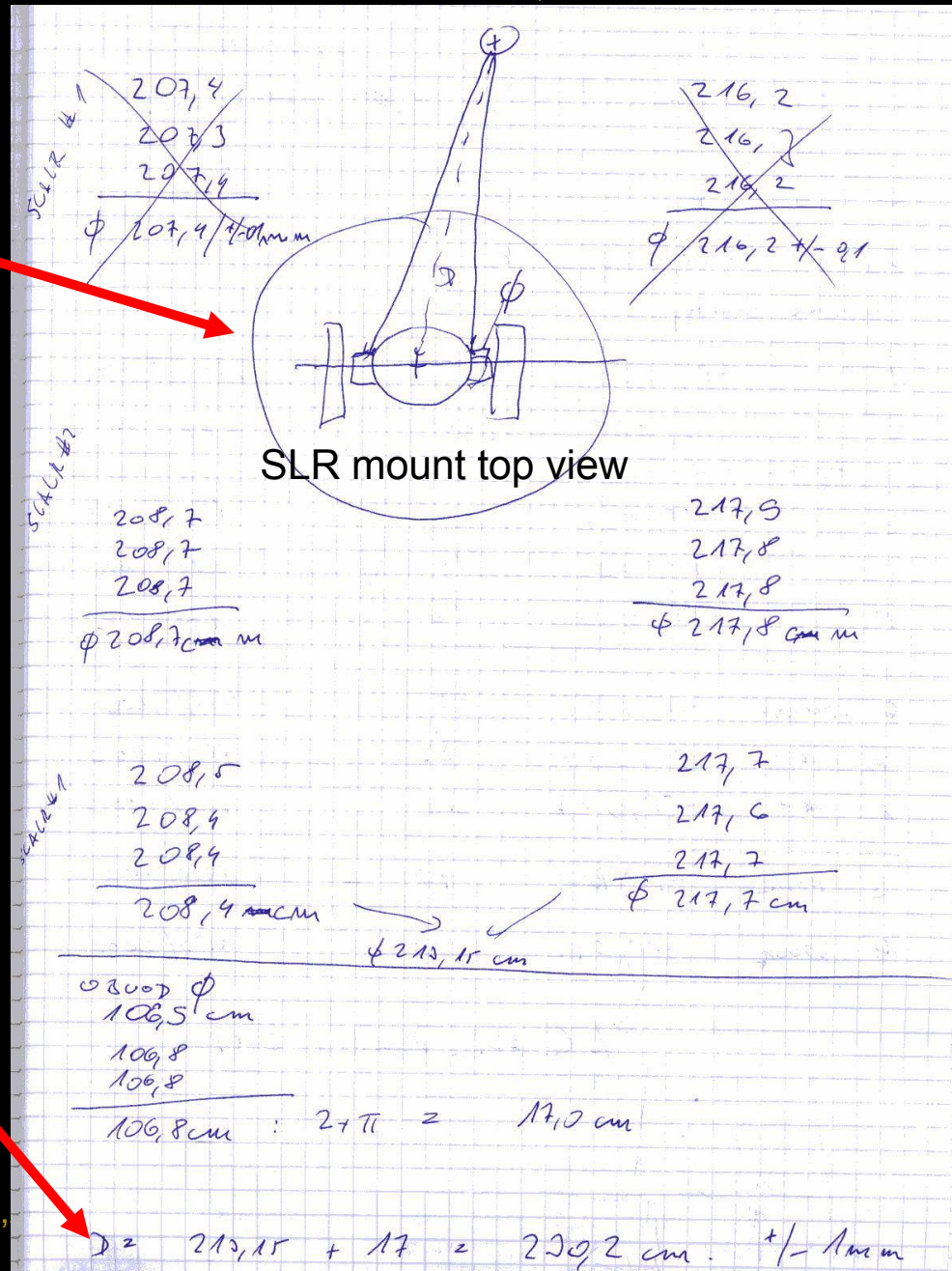
Two independent surveyors

Three series each

ELT detector versus WLRS reference points

$D = 2302 \pm 1 \text{ mm}$

Comparison to Wettzell survey
TBD



I. Prochazka et al.,

ELT Calibration Device test # 1, WLRS RESULTS SUMMARY

The resulting distance
=> one way propagation delay

$$\underline{D = 2302 \pm 1 \text{ mm}}$$
$$\underline{DT = 7673 \pm 3 \text{ ps}}$$

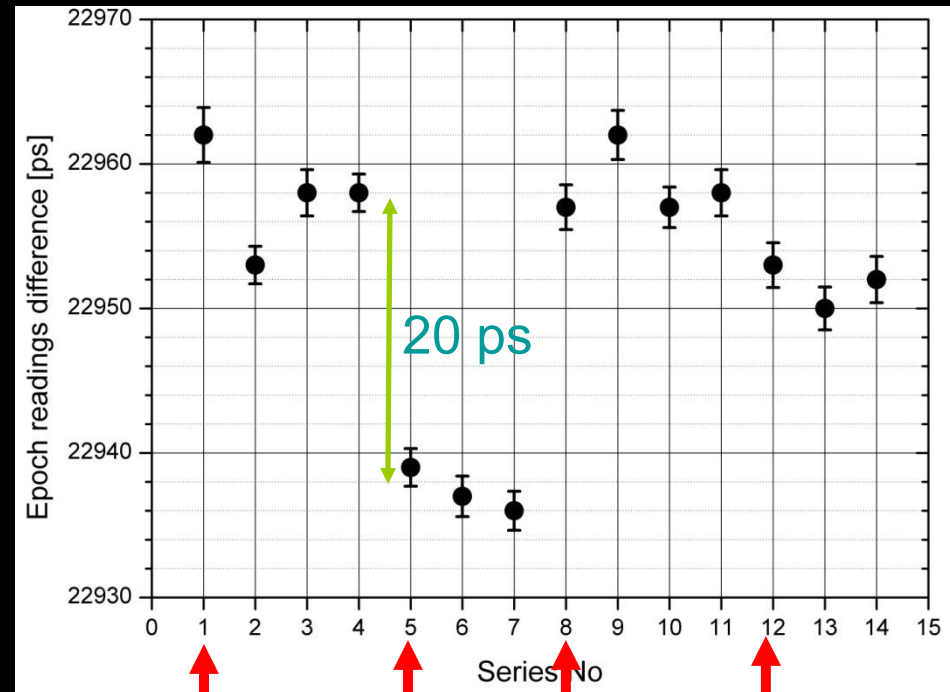
Statistical spread between groups 1-2 ps without re-sync. effects

group to group jumps
3 to 20 ps p-p due to "1pps" cable
delay variations / mechanical

Overall mean epochs difference
22 952 +/- 13 ps half p - p

+/- 13 ps is a worst case estimate
+/- 6 ps is a typical value

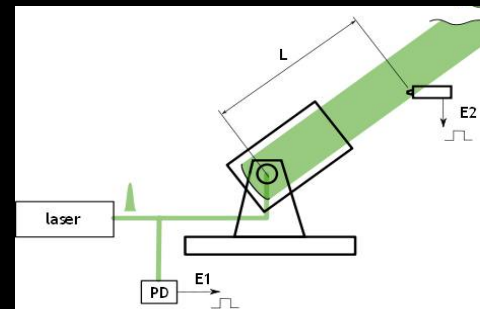
ELT calibration value
DT = 15 279 ps +/- 13 ps half p - p



re-sync

CONCLUSION - ELT status march 2014

- ELT detector FM being completed (exp. End 2014)
- ELT Ground Station Calibration RFP response delivered to ESA
start expected mid 2014
- The ELT FM delay calibration FM ↔ Calibration Device
expected CSRC Kromeriz, fall 2014
- SLR Calibration missions WLRS 1st demo February 2014
systematics =< 13 ps demonstrated
Graz tests expected July 2014
- EU 3 x SLR calibrations pre-launch calibrations 2015
mission run calibrations 2016 - ?



ACES IWG meeting Neuchatel, March 13, 2014

- Problem ACES Hydrogen maser out of specs
- no way to improve the design (schedule & budget)
- frequency stability $\sim 4 * 10^{-14}$
- - drift $\sim X * 10^{-14} / K$
- - drift $\sim X * 10^{-14} / \text{orbit (magnetic)}$
- Solution proposed temperature and mag.field sensors built in
- drifts measured and sw models implemented
- Problem ELT
- no information about phase /delay/ changes
- IP was asking repeatedly for data & info – no response
- (Timing will be seriously influenced by phase drifts !)
- Obviously the ACES community is not aware of this problem.
- What next ? !