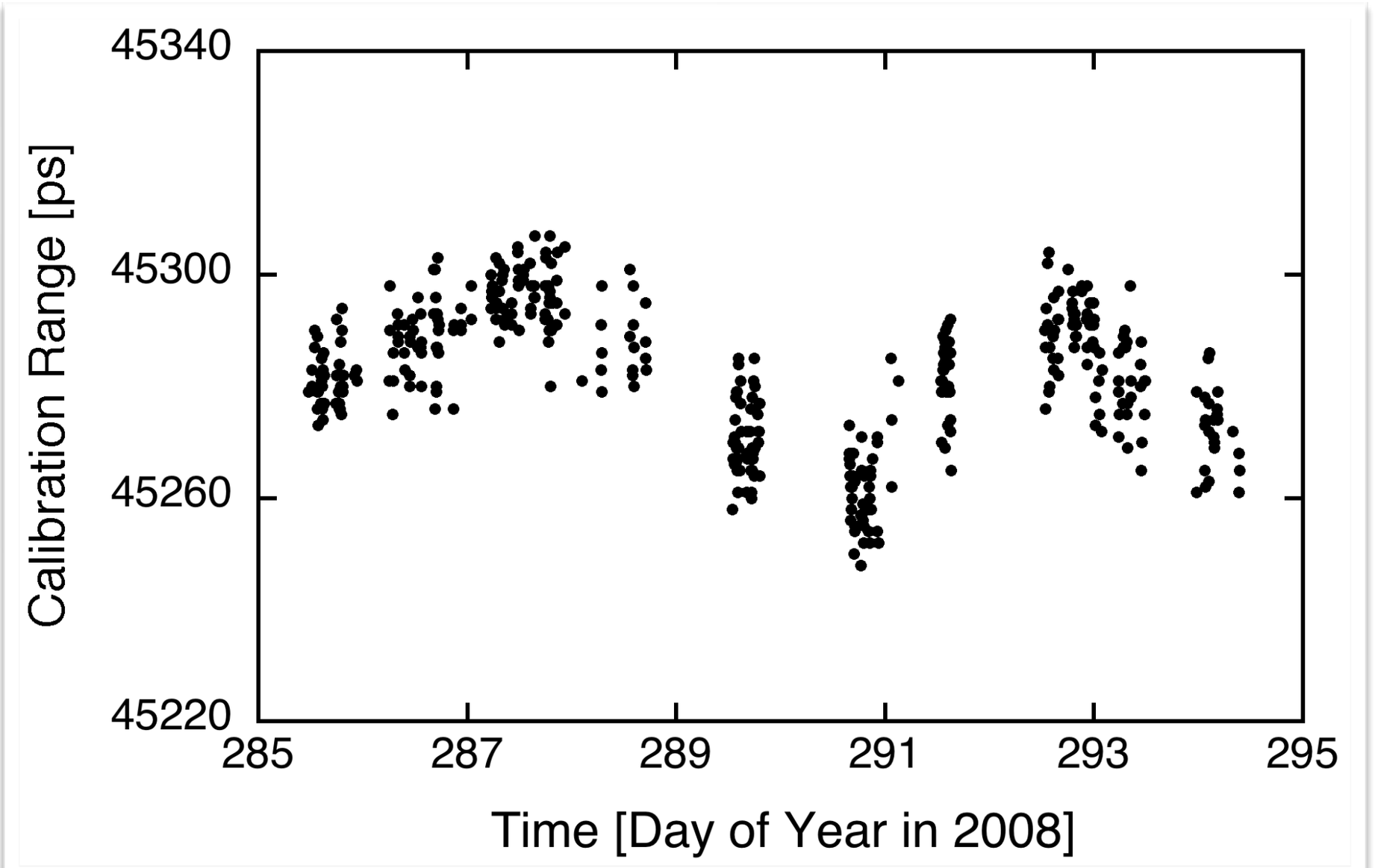
IAG: Sub-Commision 1.1.

Coordination of Space Geodetic Techniques

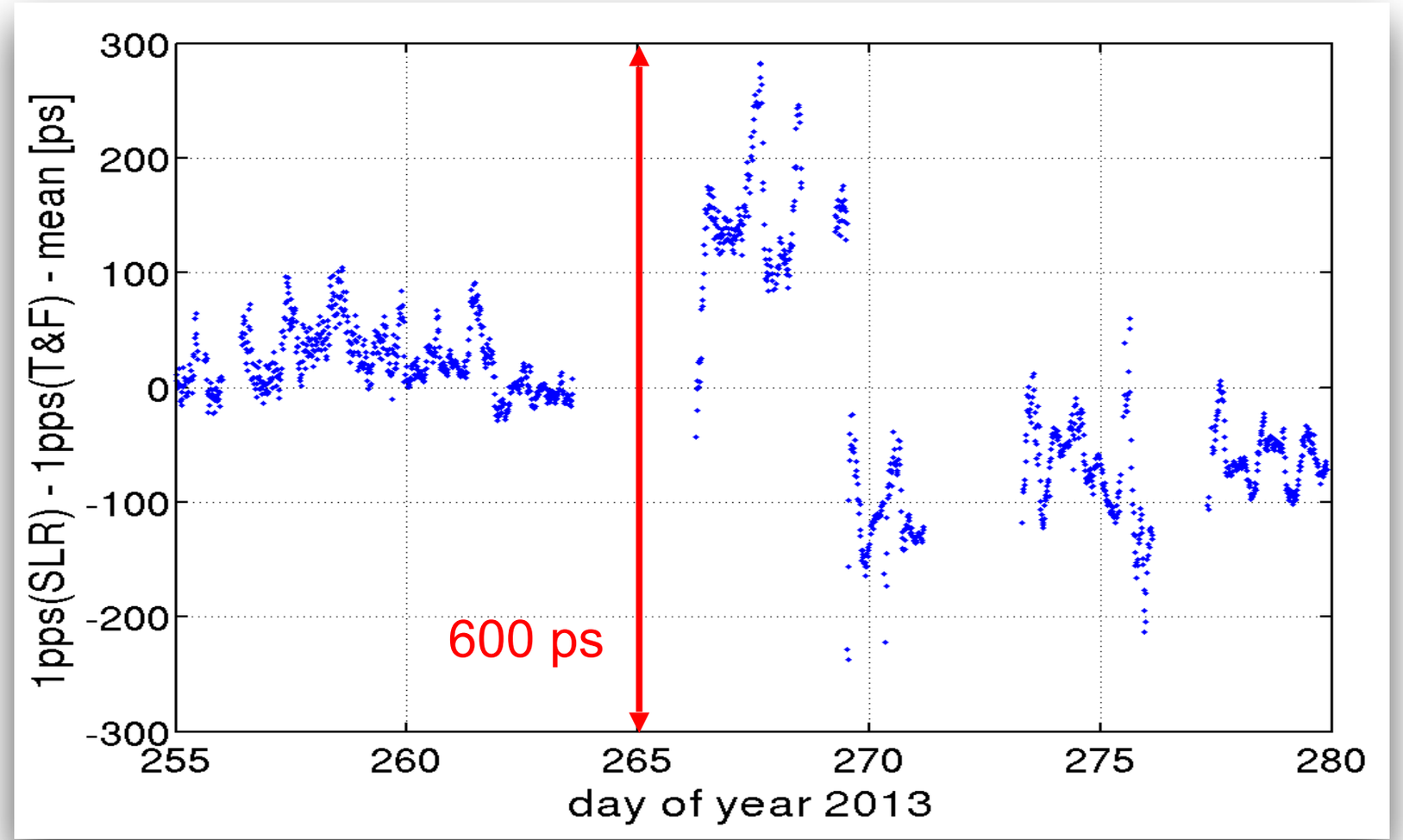
WG 1.1.1 Co-location usings Clocks and New Sensors

The establishment of accurate local ties of different space geodetic techniques at fundamental geodetic observatories poses a long-standing problem. While geometric ties can be determined at sub-millimeter-level, the relation to physical phase centers of the instruments and temporal stability of such offsets are usually known with significantly lower precision. Novel ways for inter-technique calibration at a geodetic site need to be developed using existing and new sensors and technologies, such as highly accurate time and frequency transfer, ultra-stable clocks, and co-location targets. Complementary to such development the tying of techniques shall be exploited to their limits at the analysis level e.g. to using common clock and troposphere parameters.

Observation: Variable Delays at the level of ≈ 2 cm

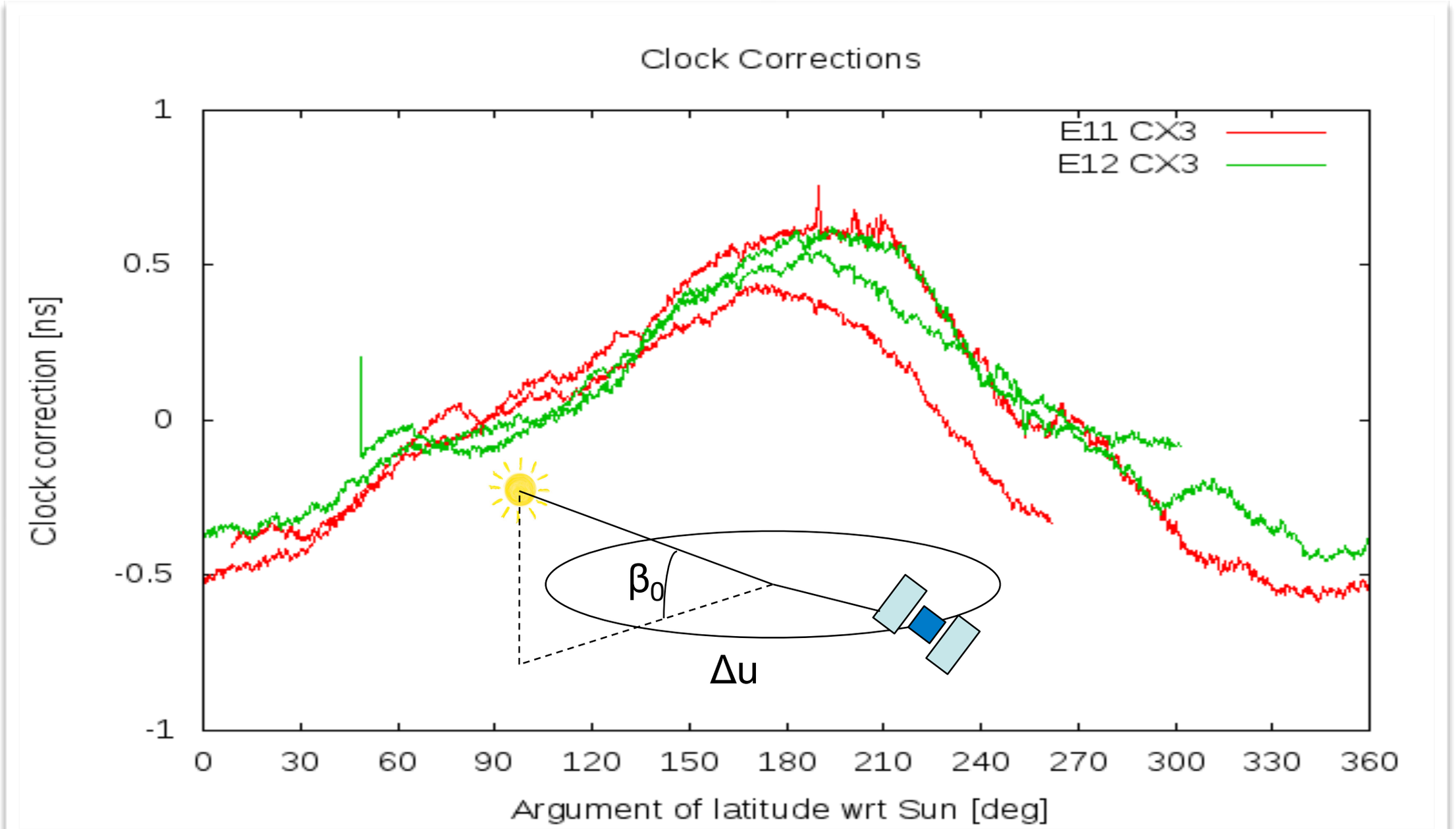


The distribution of the broadband PPS time signal shows variability at the level of several hundred ps.



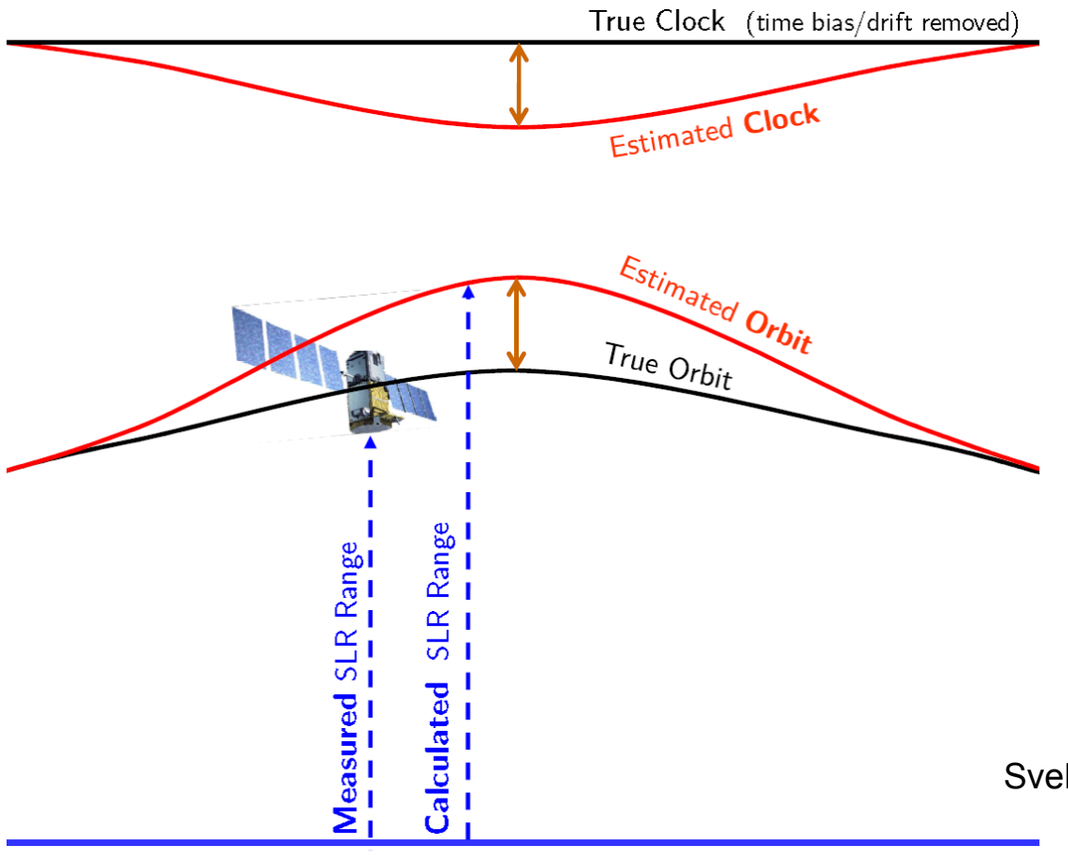
... over a longer period: $\Delta t \leq 5$ ns

Gallileo IOV satellites: Clock correction vs.angle



Clock and measured delay τ (orbit) are highly correlated for the 1-way techniques

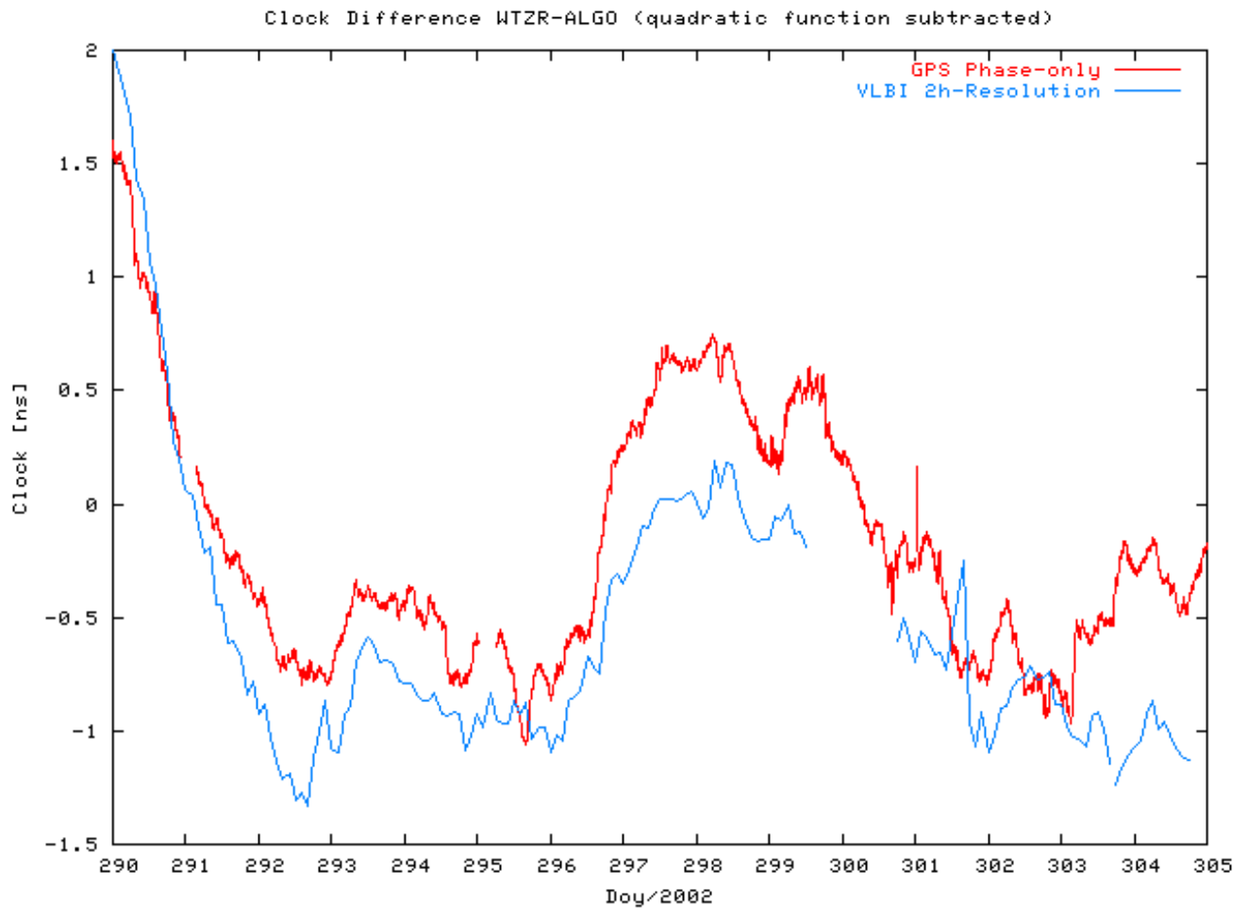
+ variable and unrecognized system delays are causing biases



Svehla et al. 2013

Consequence: Degradation of geodetic product quality

Closure measurements are powerful tools



Observation: Clocks accumulate all sorts of systematics (Delays) of the various techniques.

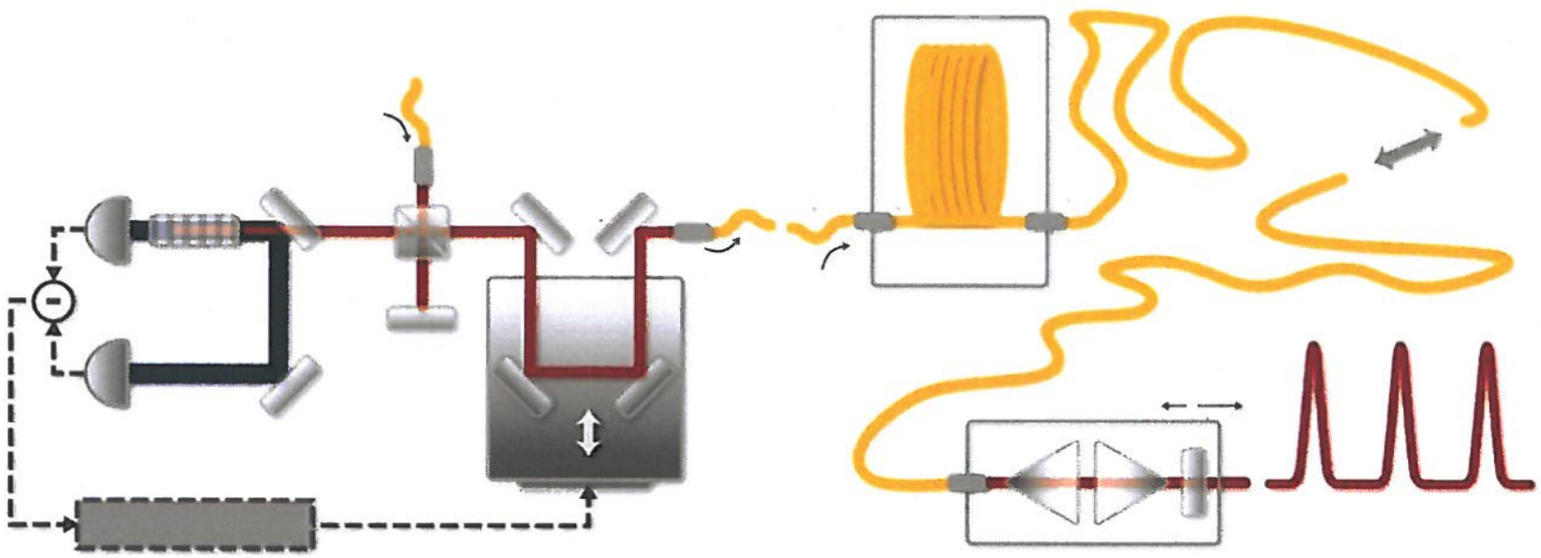
Therefore clock parameters are showing technique specific delays. This applies for inter- and intra- technique comparisons.

Goal: It would be desirable to operate a "**Common** (super) **Clock**" for all techniques within an observatory and link the instrumentation with a

"super-conductor for time" and

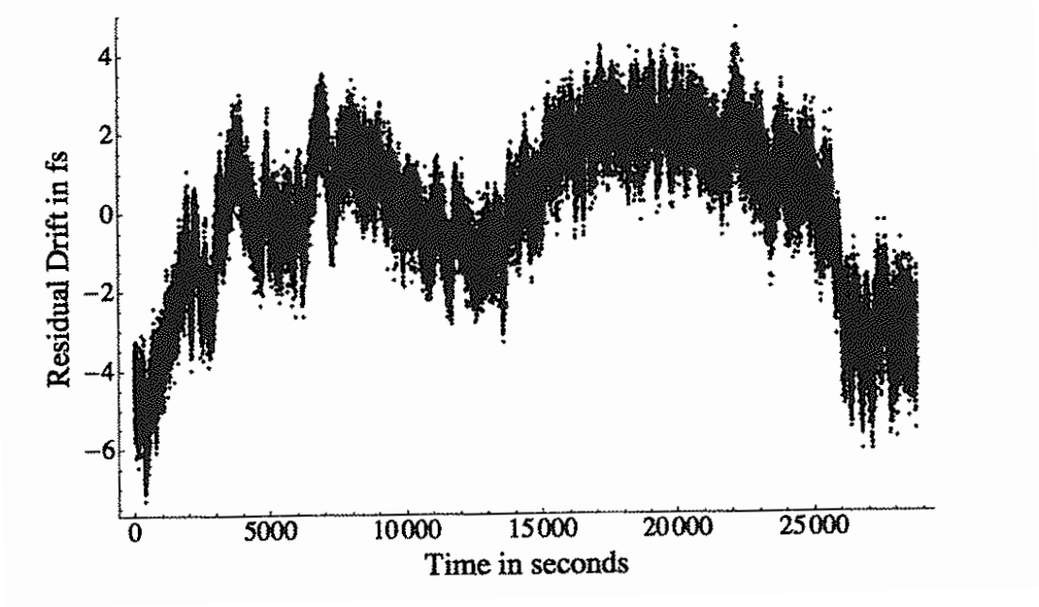
tie all techniques to a single point regardless of their nature

Two- Way Timing Techniques (local)



- 2-Way compensation technique only possible in the optical domain
- required broadband signal available from fs-pulse lasers only
- Expected uncertainty < 100 fs: ≈ 5 orders of magnitude gain over current situation
- Consequences for Local Survey: 1 mm = 3 ps

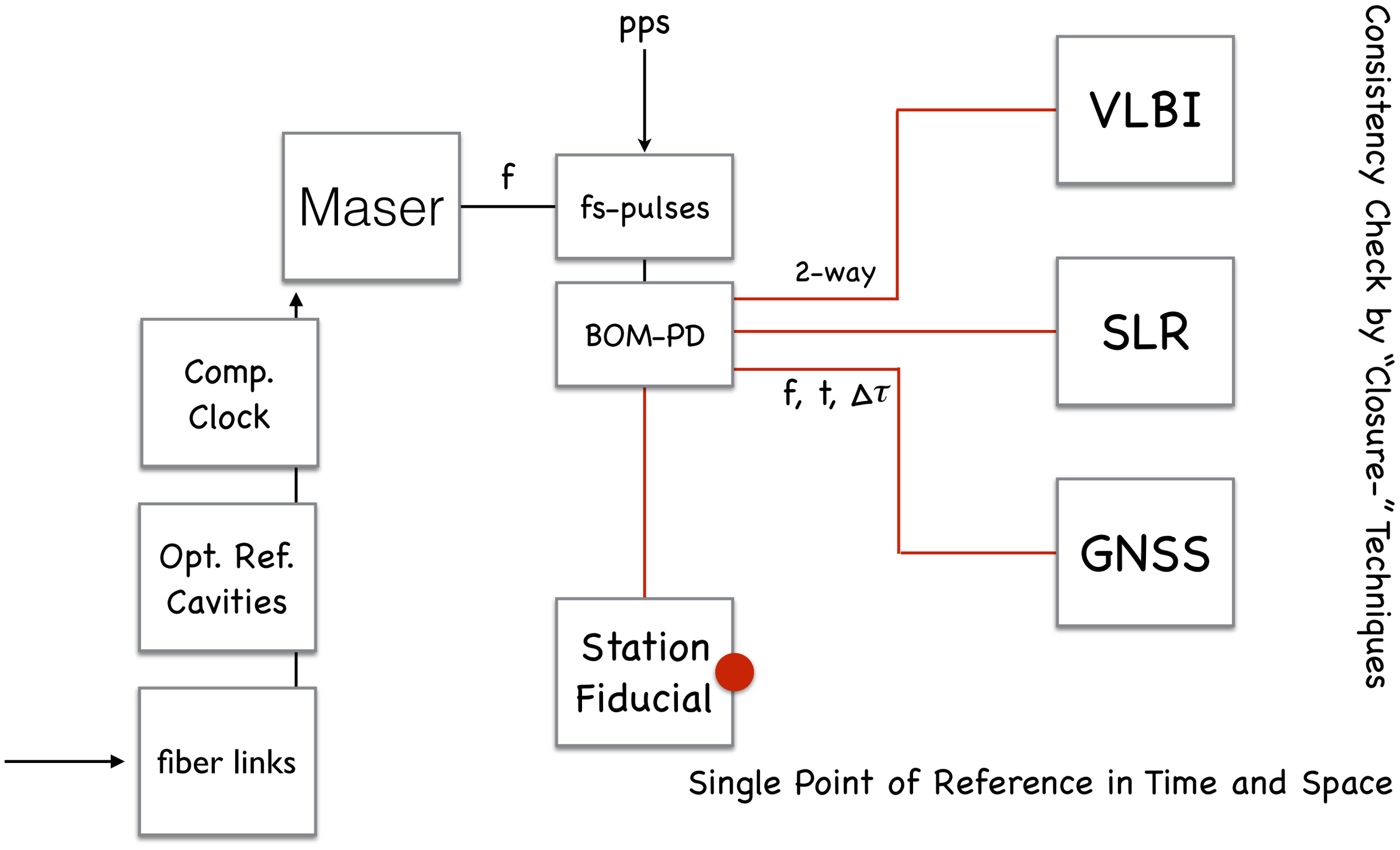
Example: FEL in Trieste



lossless distribution

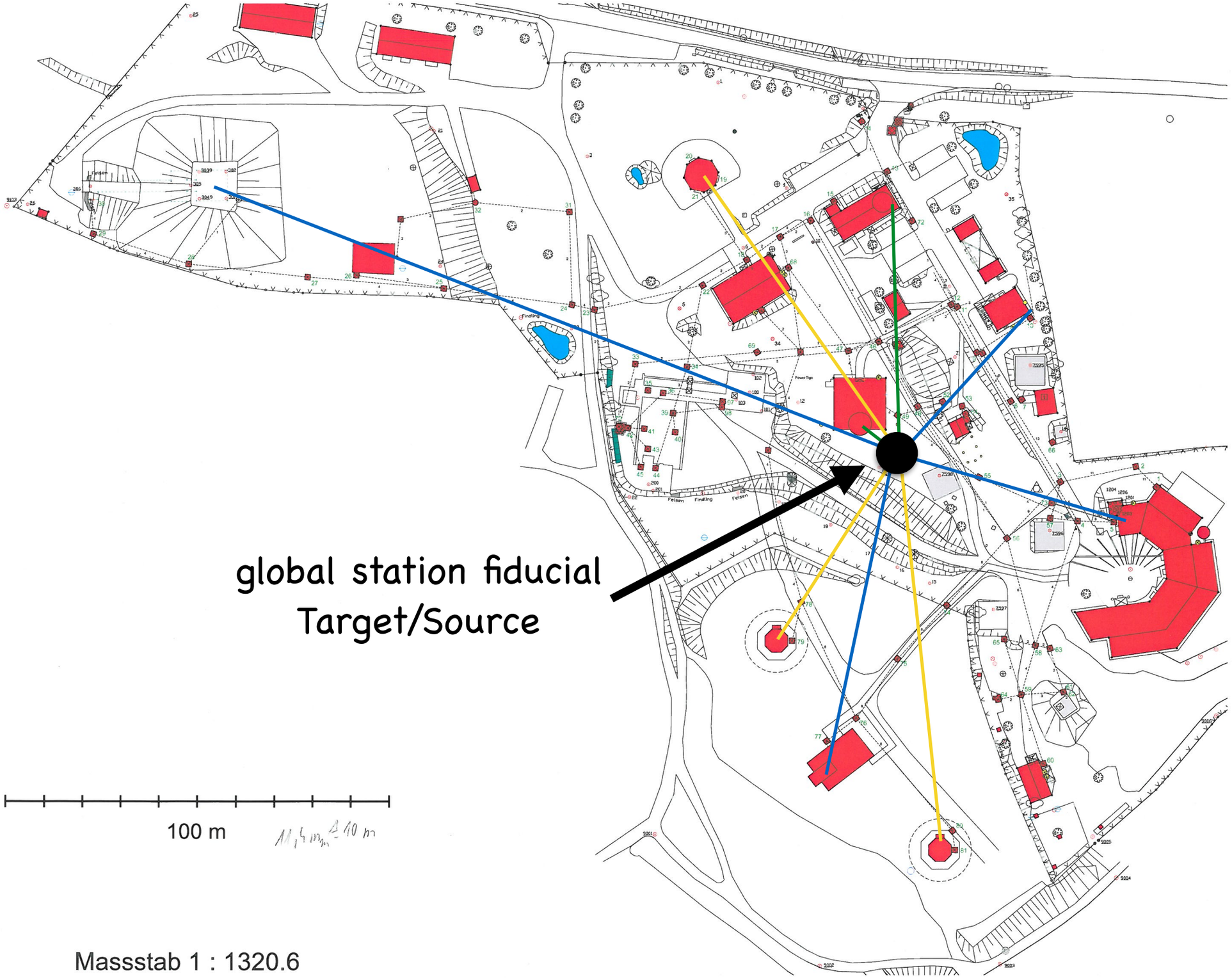
Interpolator

Geodetic Techniques



Consistency Check by "Closure-" Techniques

Single Point of Reference in Time and Space

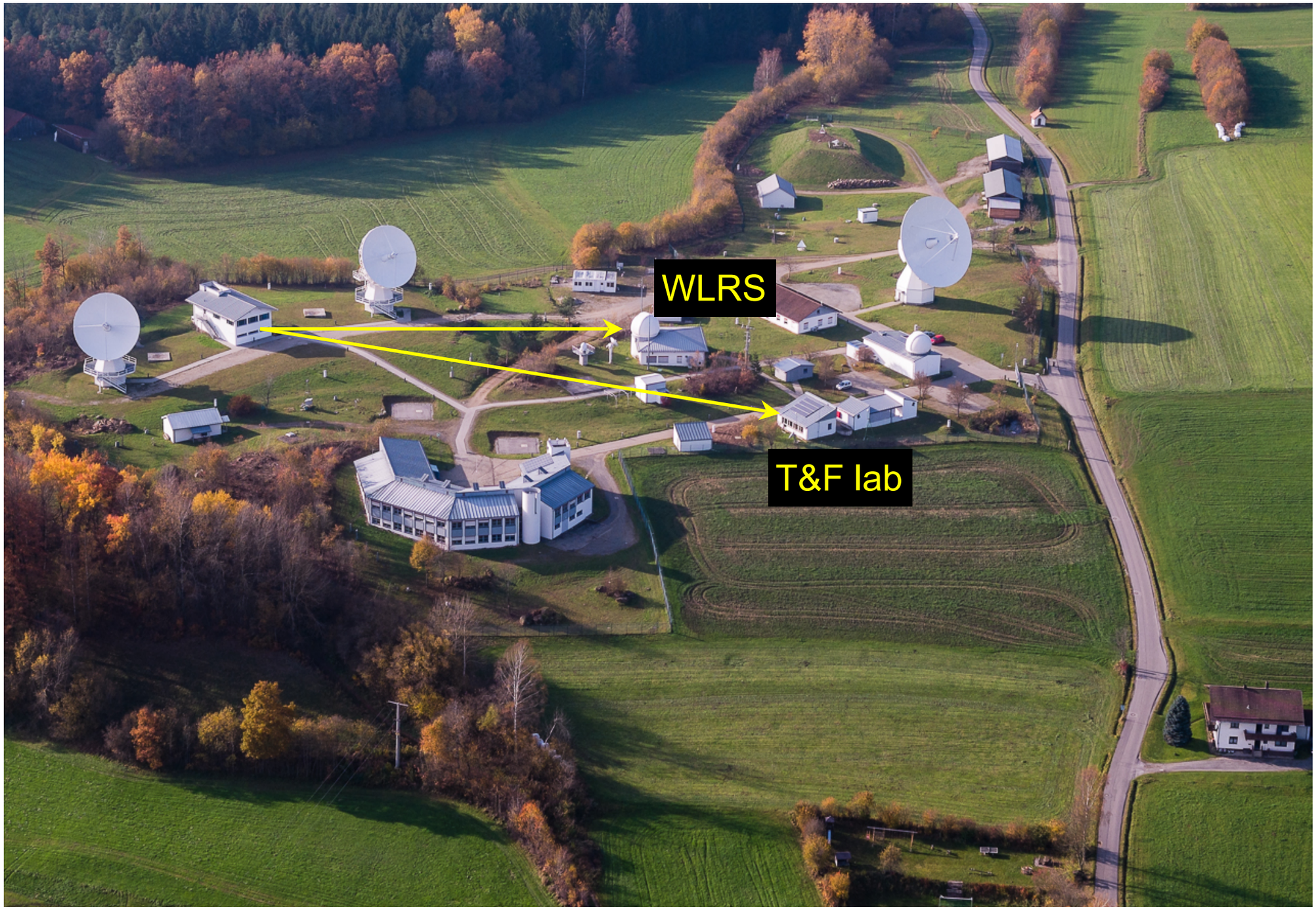


global station fiducial
Target/Source

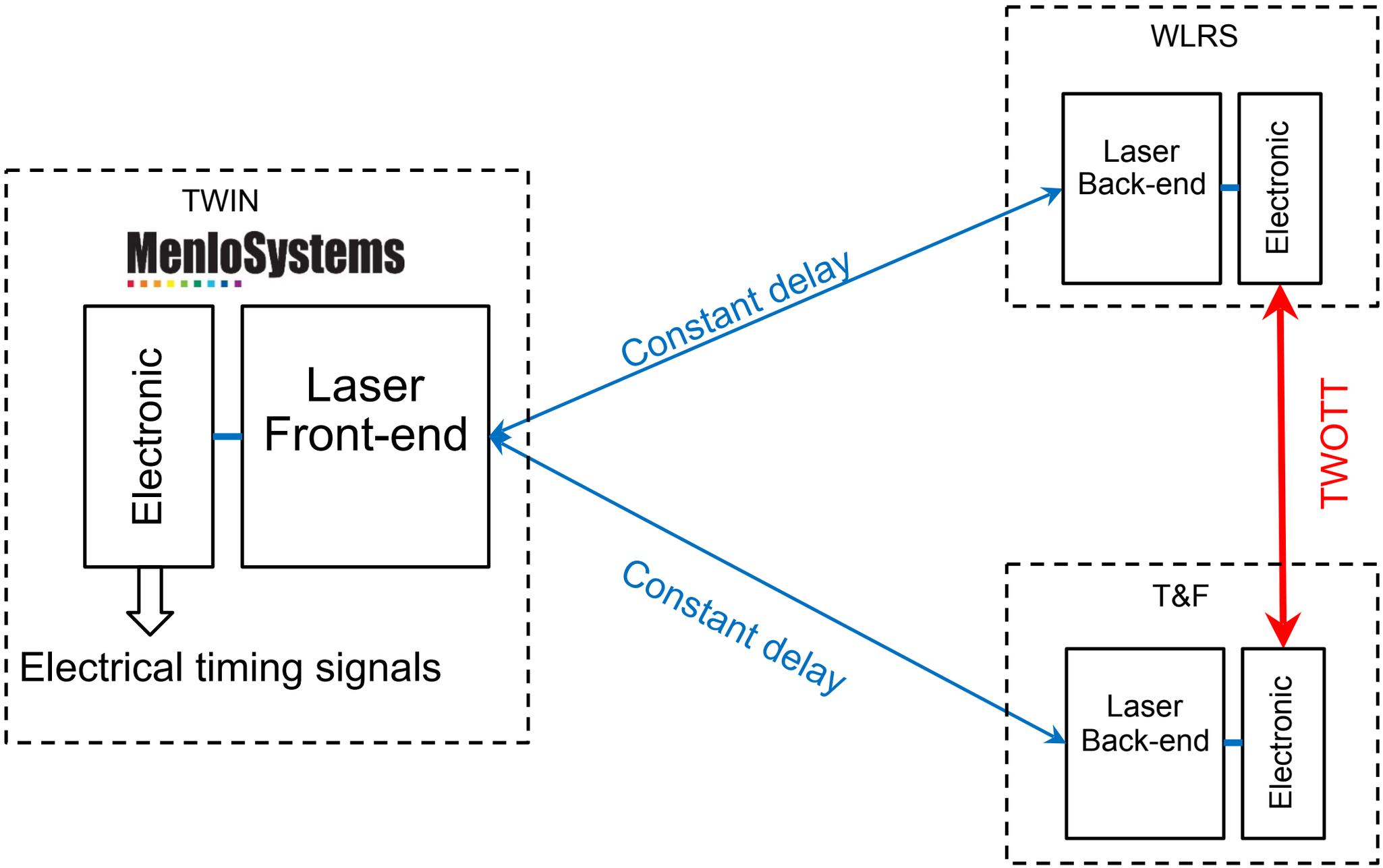
100 m

Massstab 1 : 1320.6

ELT (Time Transfer via ACES)



Common Clock for Space Geodetic Techniques



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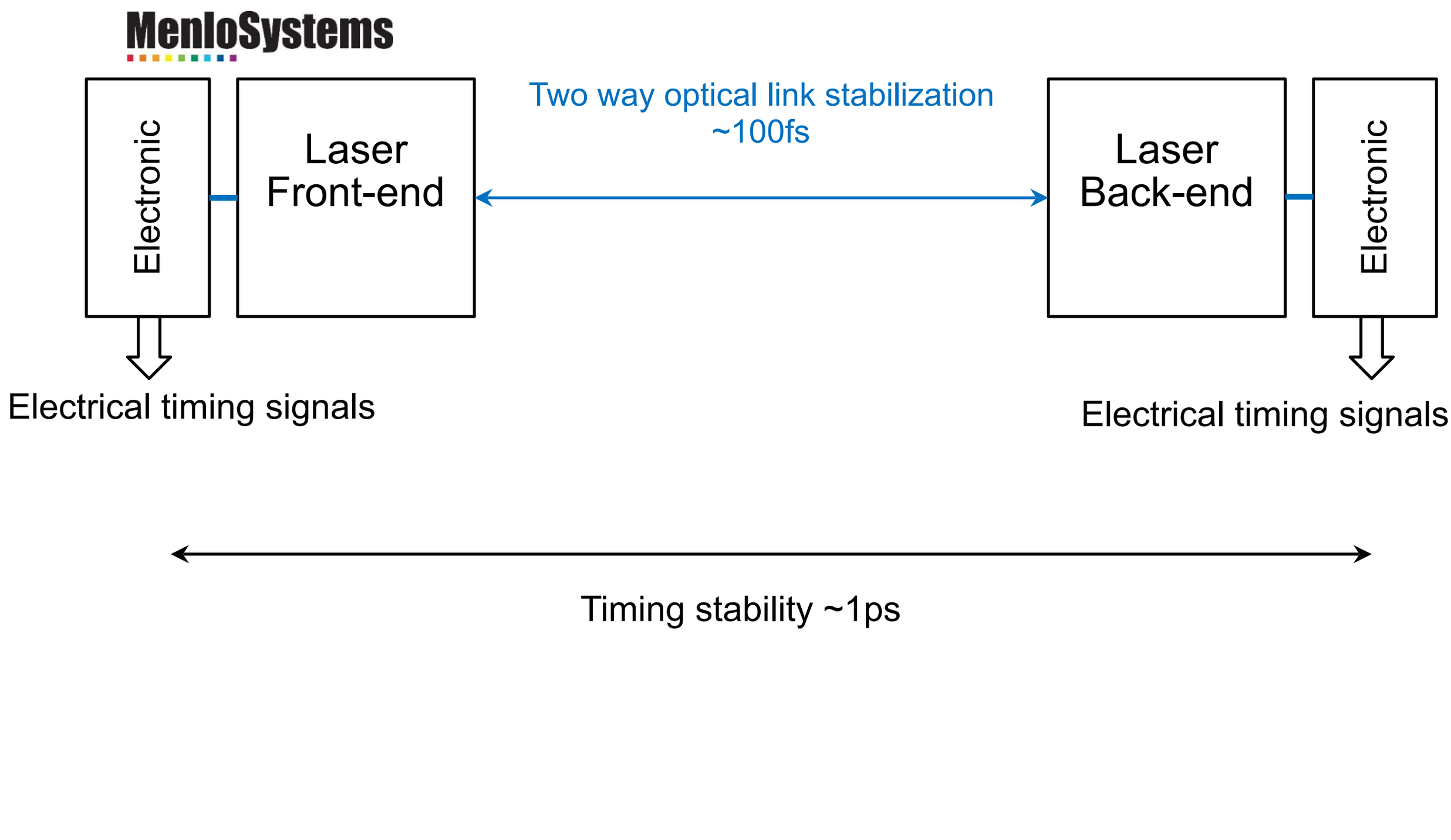
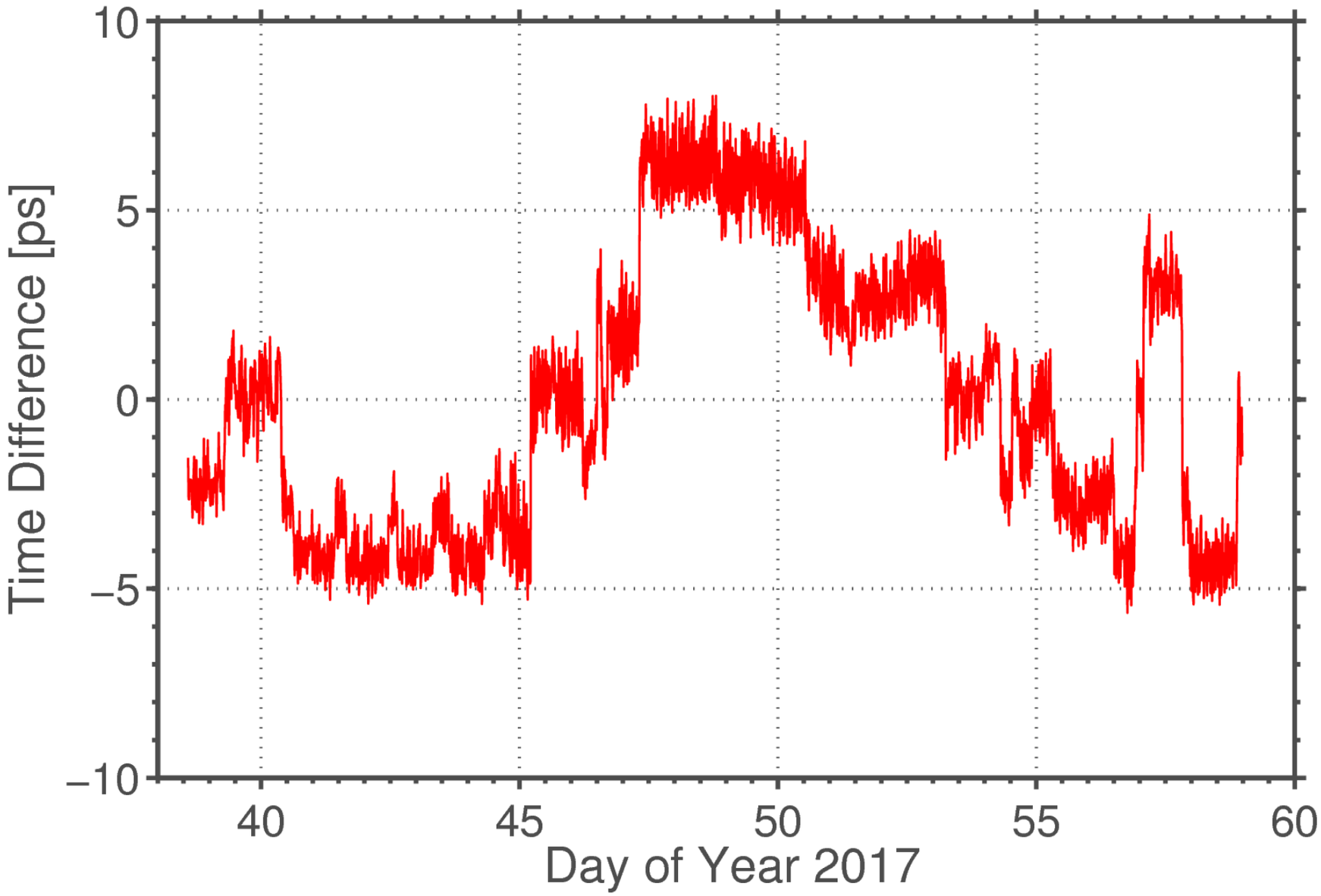


Comparison of Time: T&F - WLRS

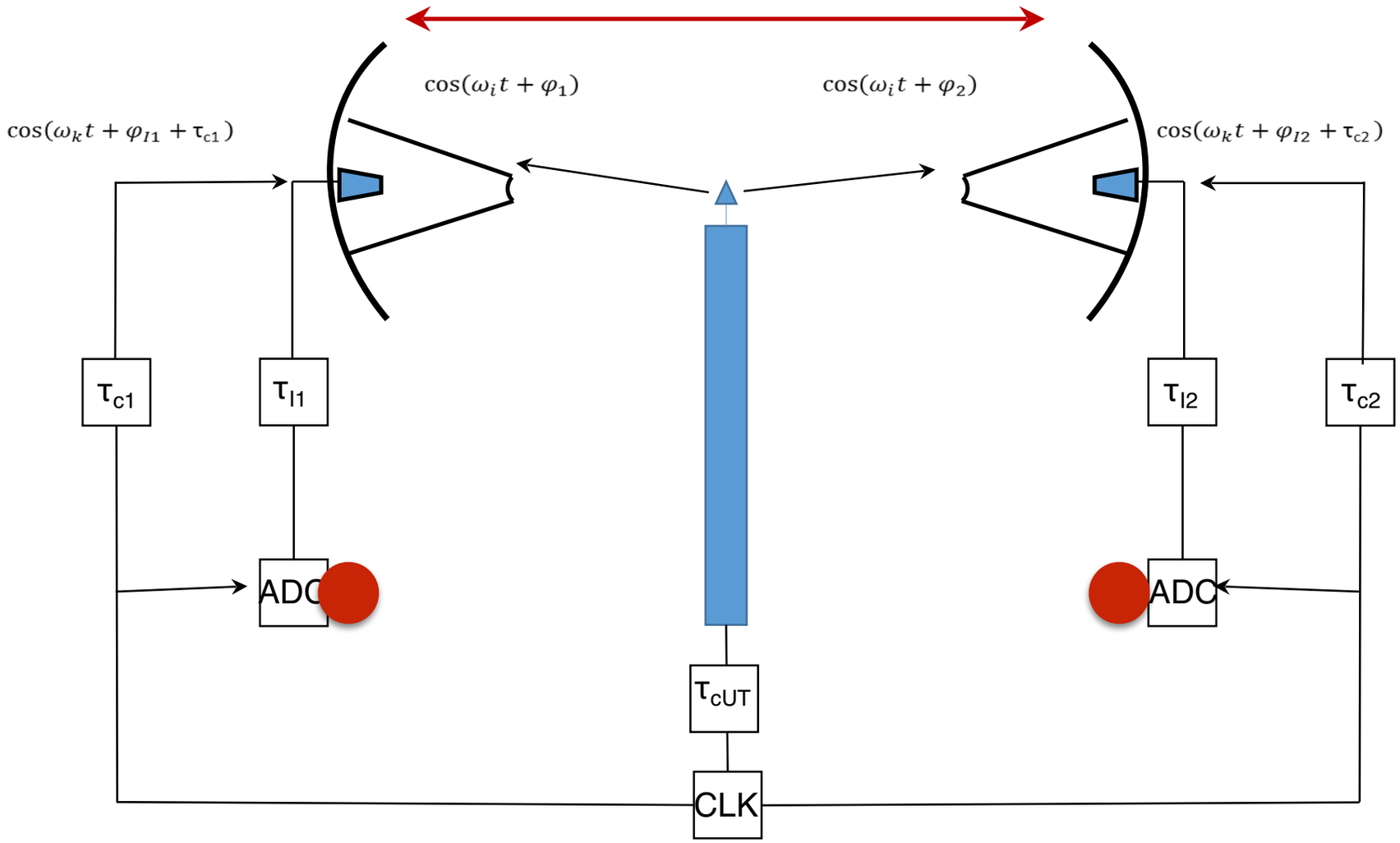


Scatter higher because of undue temperature variation in the time laboratory. Origin of jumps still unclear (Candidates: Plugs)

Universal Target VLBI Concept

$\Delta\varphi = \varphi_1 - \varphi_2 = const.$
When τ_{cUC} = const. ⇒
$\varphi_1 and\ \varphi_2 = const.$

$\Delta\tau_g = \tau_{g1} - \tau_{g2} = const.$
$\Delta\tau_g = \frac{d\varphi_1}{d\omega} - \frac{d\varphi_1}{d\omega} = const.$
When τ_{cUC} = const. ⇒
$\tau_{g1}\ and\ \tau_{g2} = const.$



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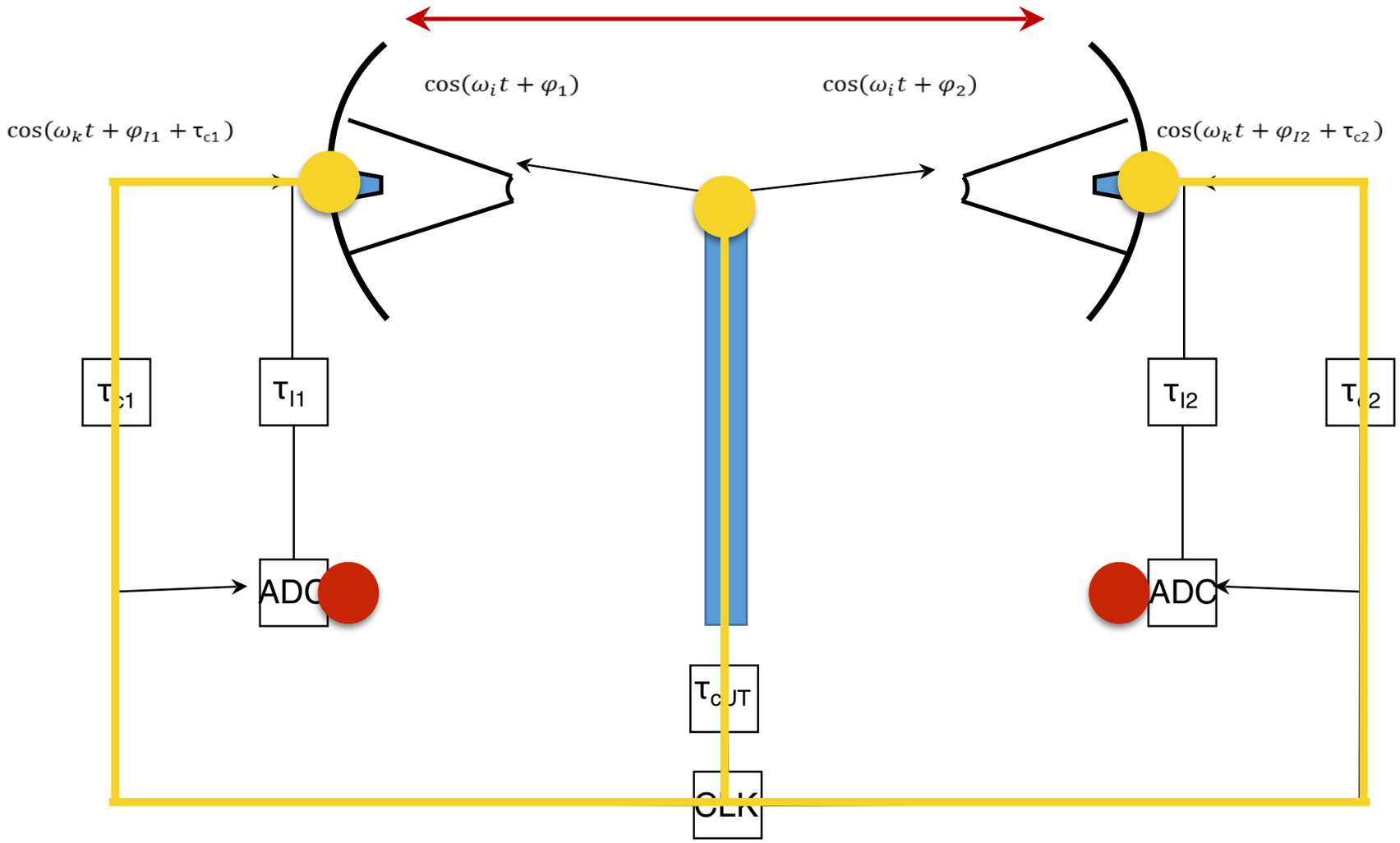
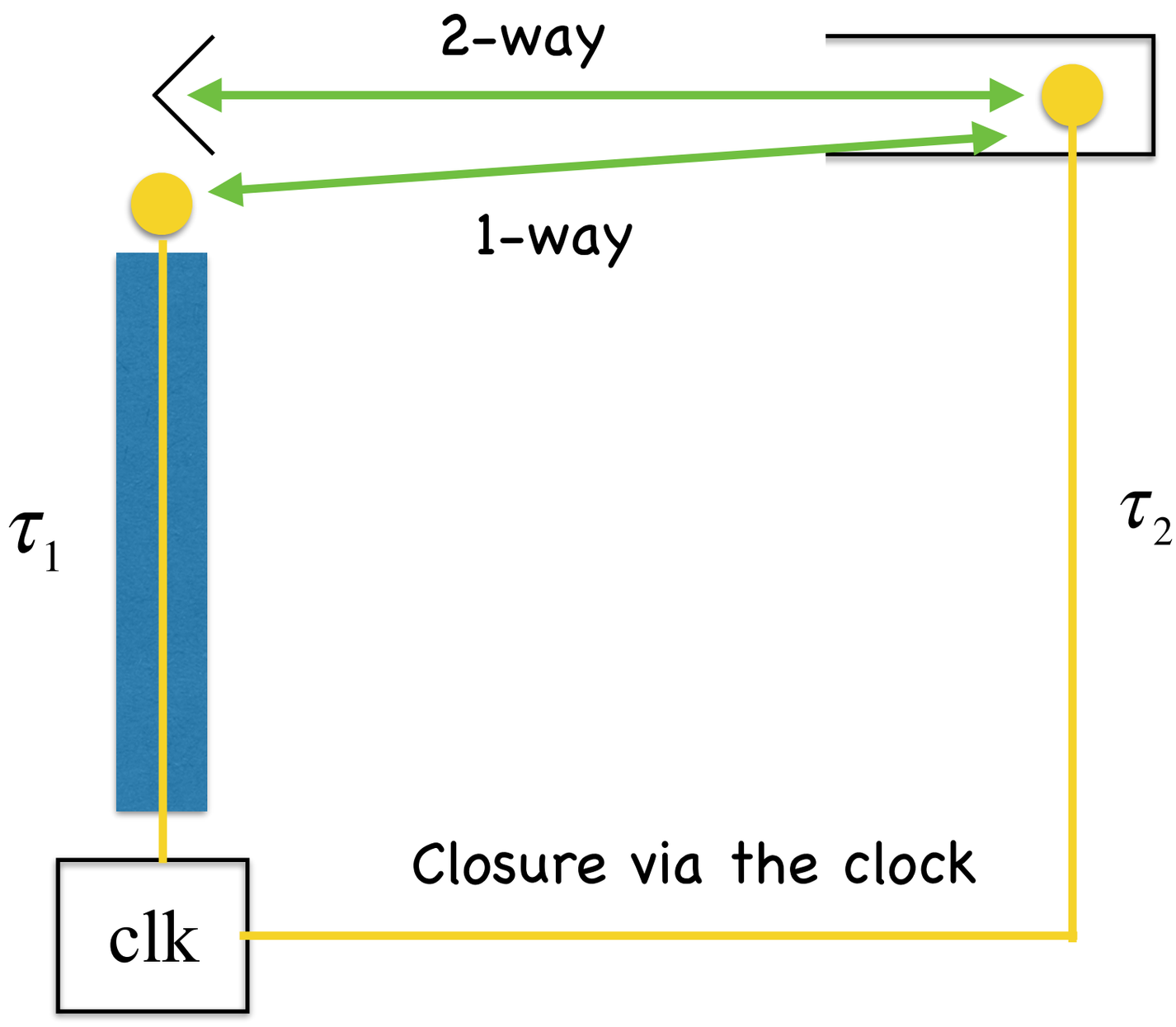


Closure via the clock


2-way
1-way
τ_1
τ_2
clk
Closure via the clock