Improving the Local Ties of a Fundamental Station by a Multi-Technique Ground Target

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2015 ILRS Technical Workshop

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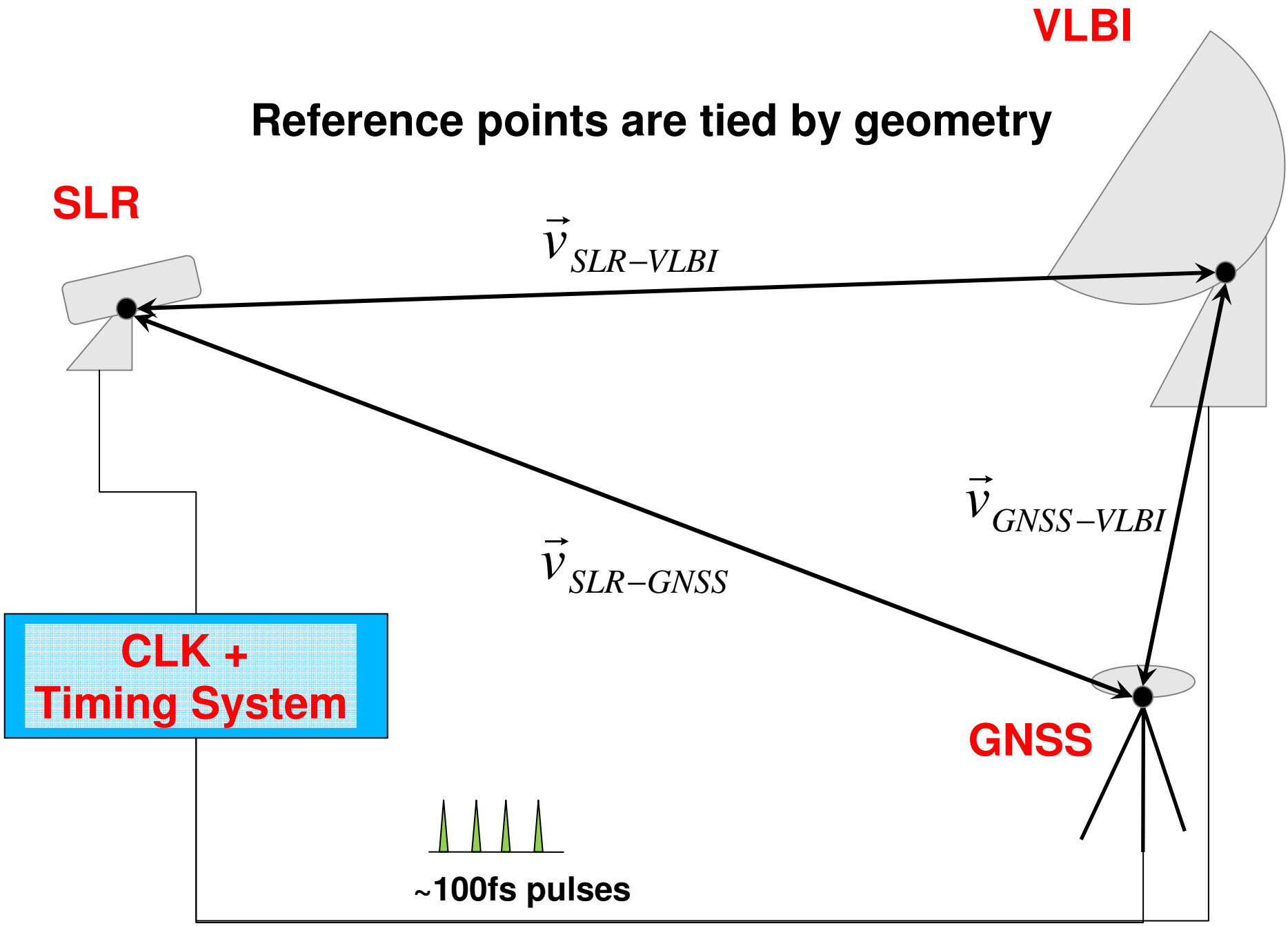
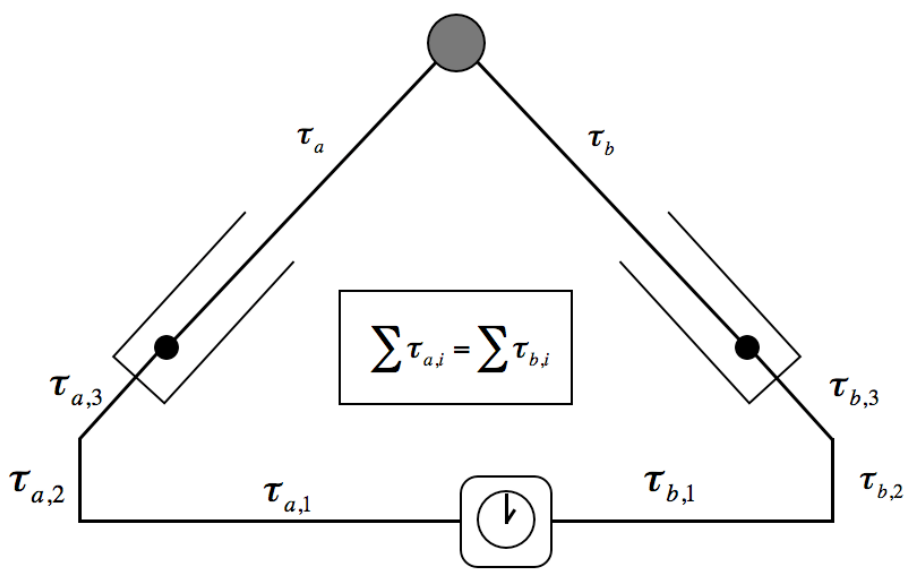
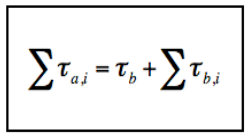
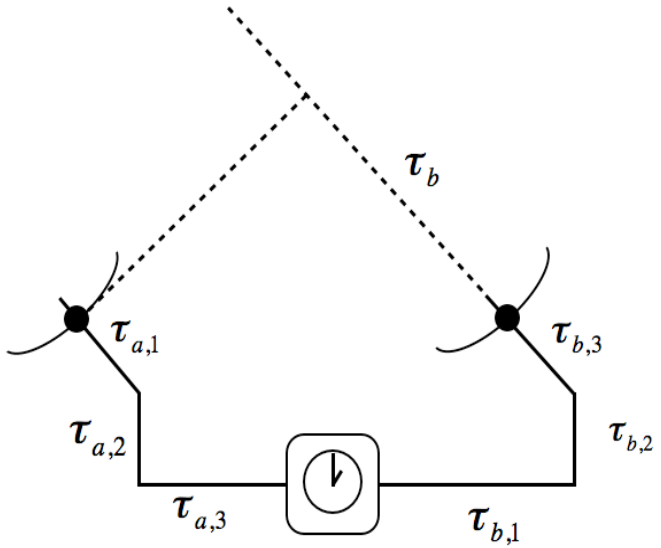
Motivation


VLBI
Reference points are tied by geometry
SLR
$\vec{v}_{SLR-VLBI}$
$\vec{v}_{GNSS-VLBI}$
$\vec{v}_{SLR-GNSS}$
CLK +
Timing System
GNSS
~100fs pulses

Common Clock for Space Geodetic Techniques

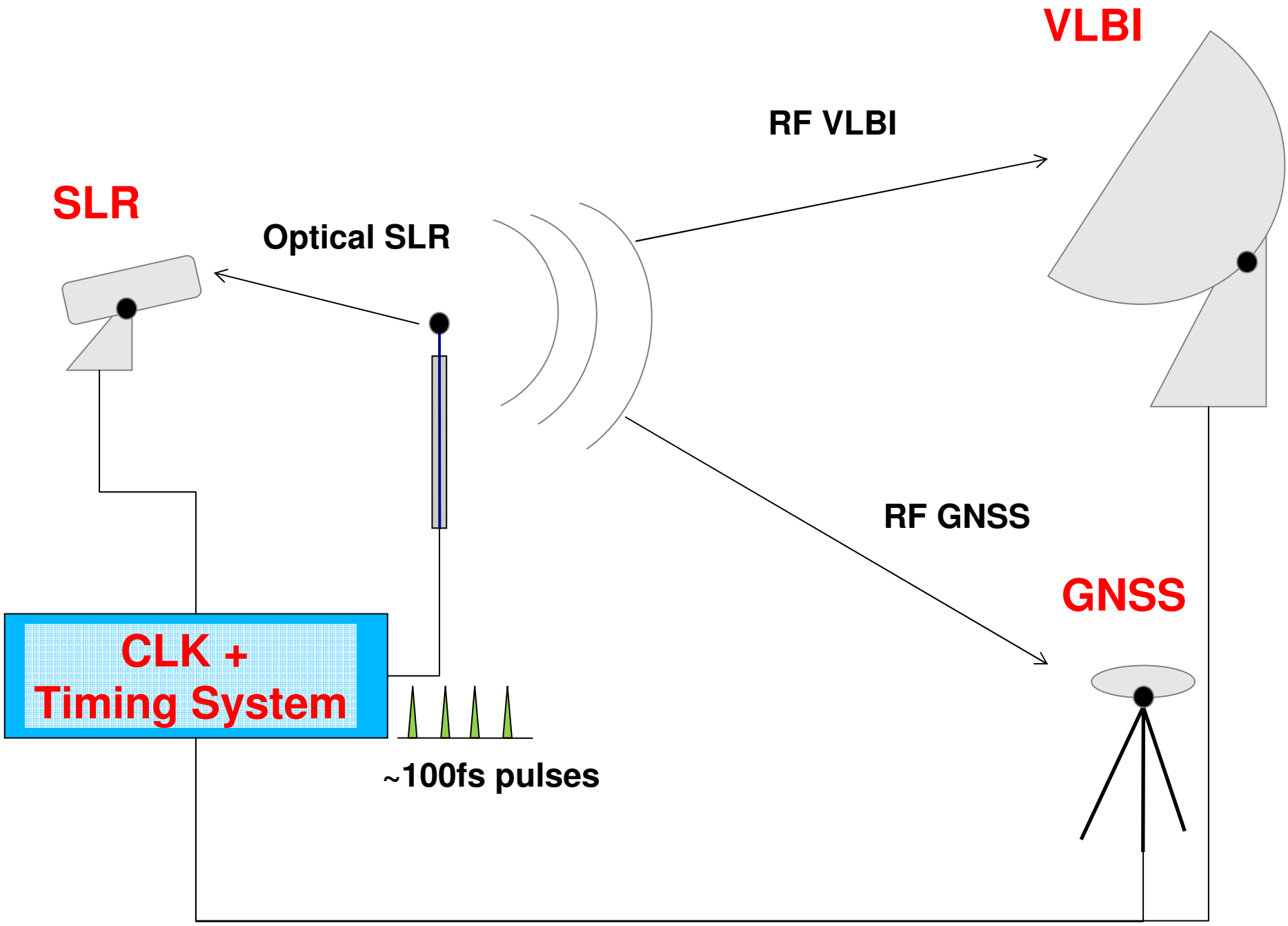




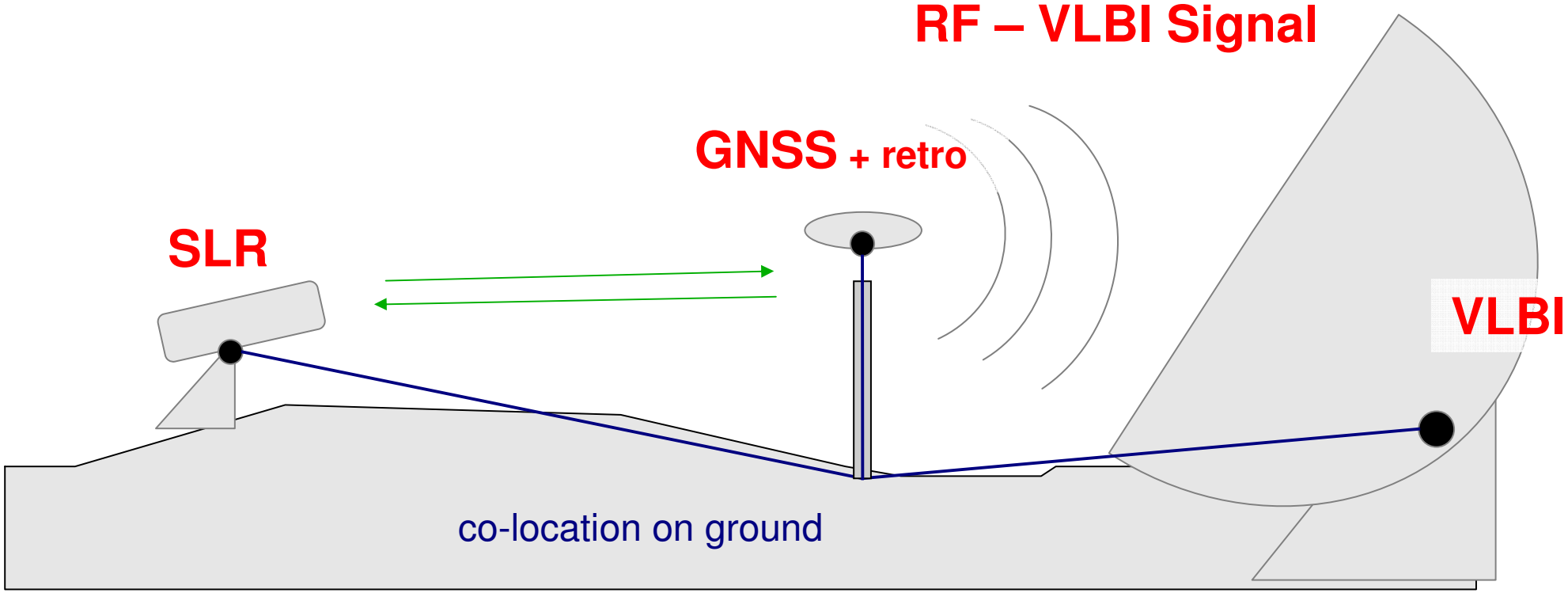


Using two or more measurement systems of the same technique with a common clock provides equal delays in the time regime if all systematic biases are correctly established. The illustration shows the case for SLR on the left and VLBI on the right side.

Multi-Technique Ground Target



Multi-Technique Ground Target



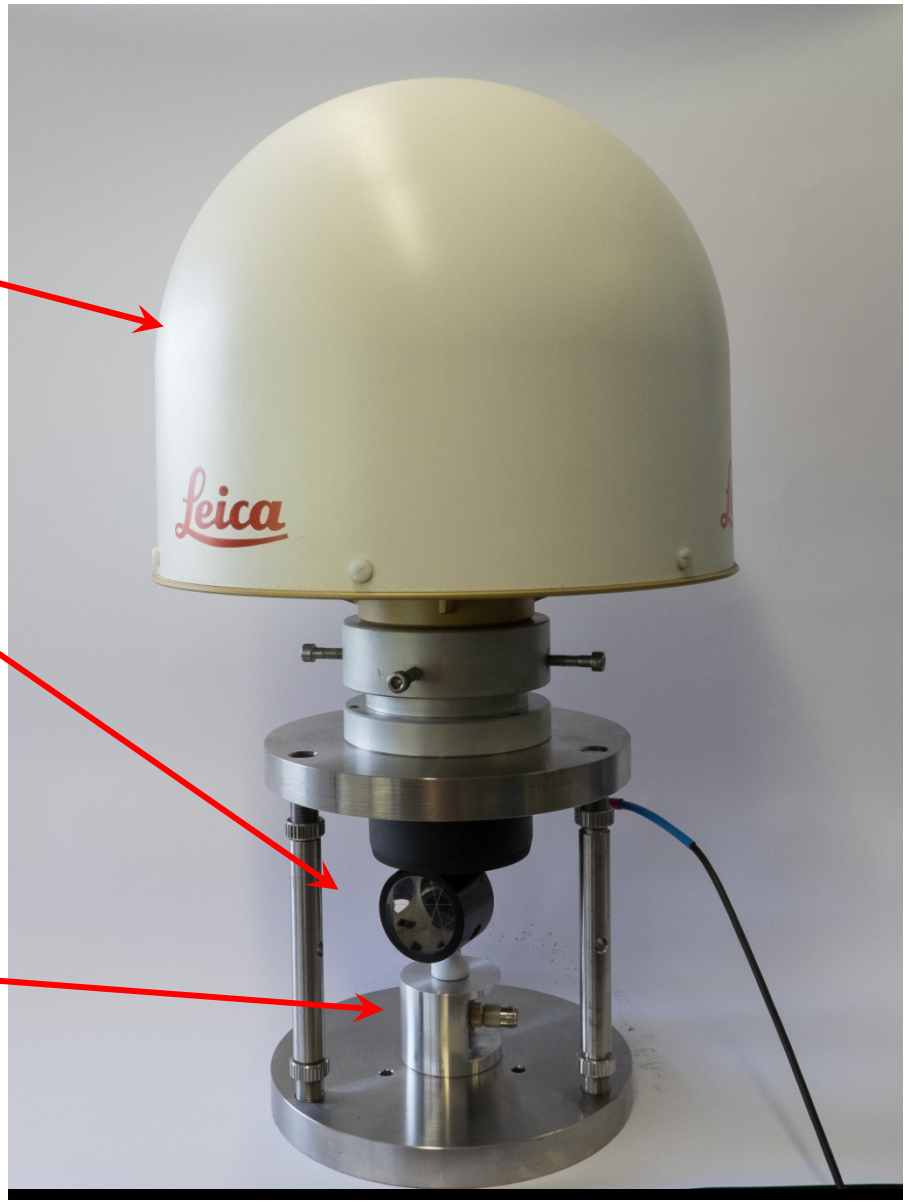
Multi-Technique Ground Target must be visible from WLRS, SOS-W, RTW, TWIN1 and TWIN2 => Not Trivial!

Multi-Technique Ground Target Construction

GNSS Antenna

SLR Reflector mounted on rotating table

VLBI Radio-source



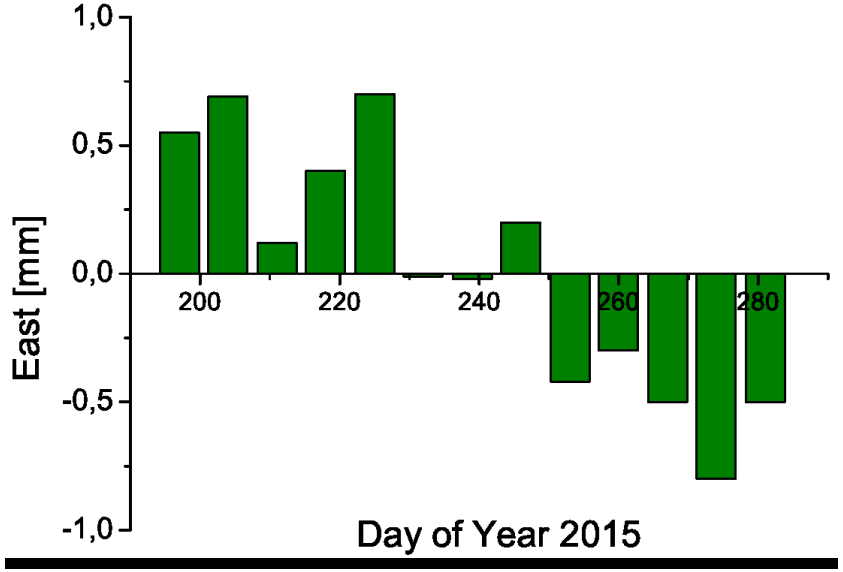
Multi-Technique Ground Target Construction

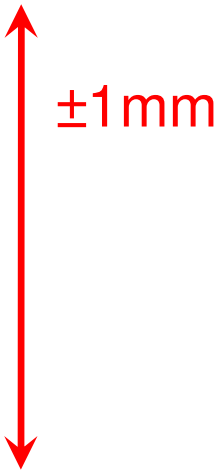
2014 27.3.2015 15.4.2015 20.4.2015 13.5.2015

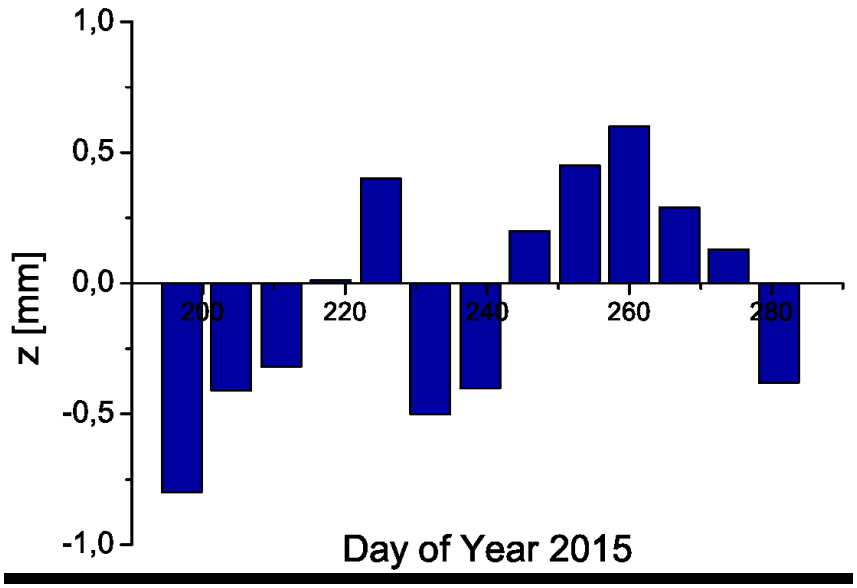
Multi-Technique Ground Target

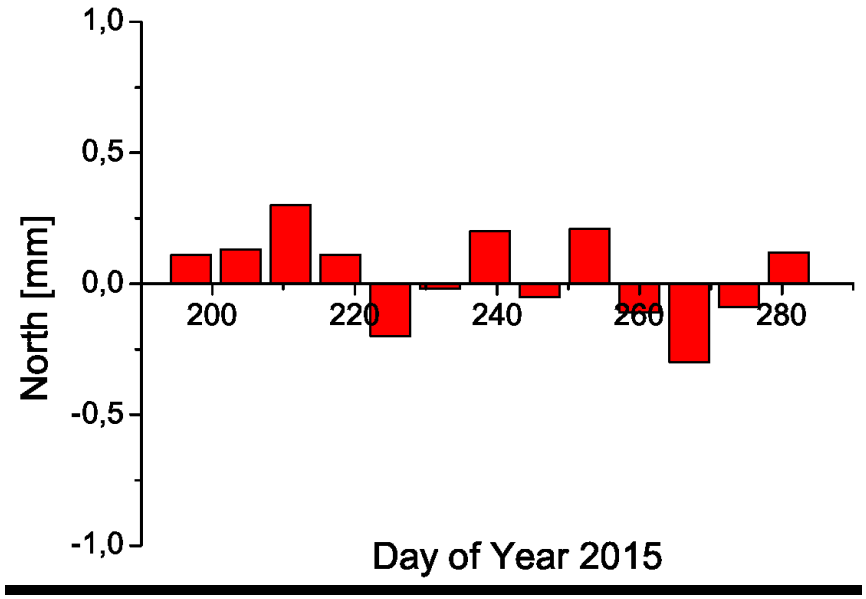
Multi-Technique Ground Target

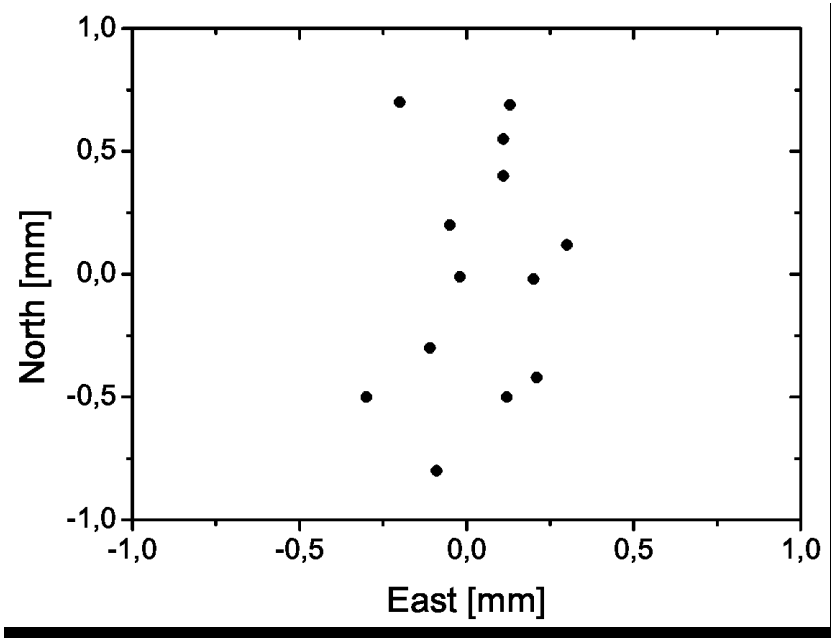
GPS Week Solution; first 13 weeks



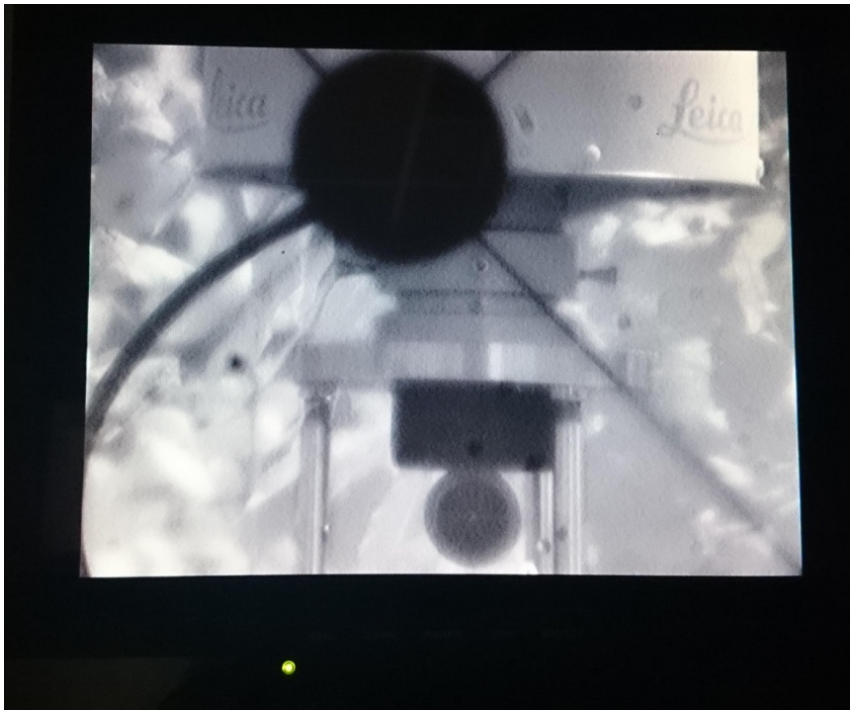








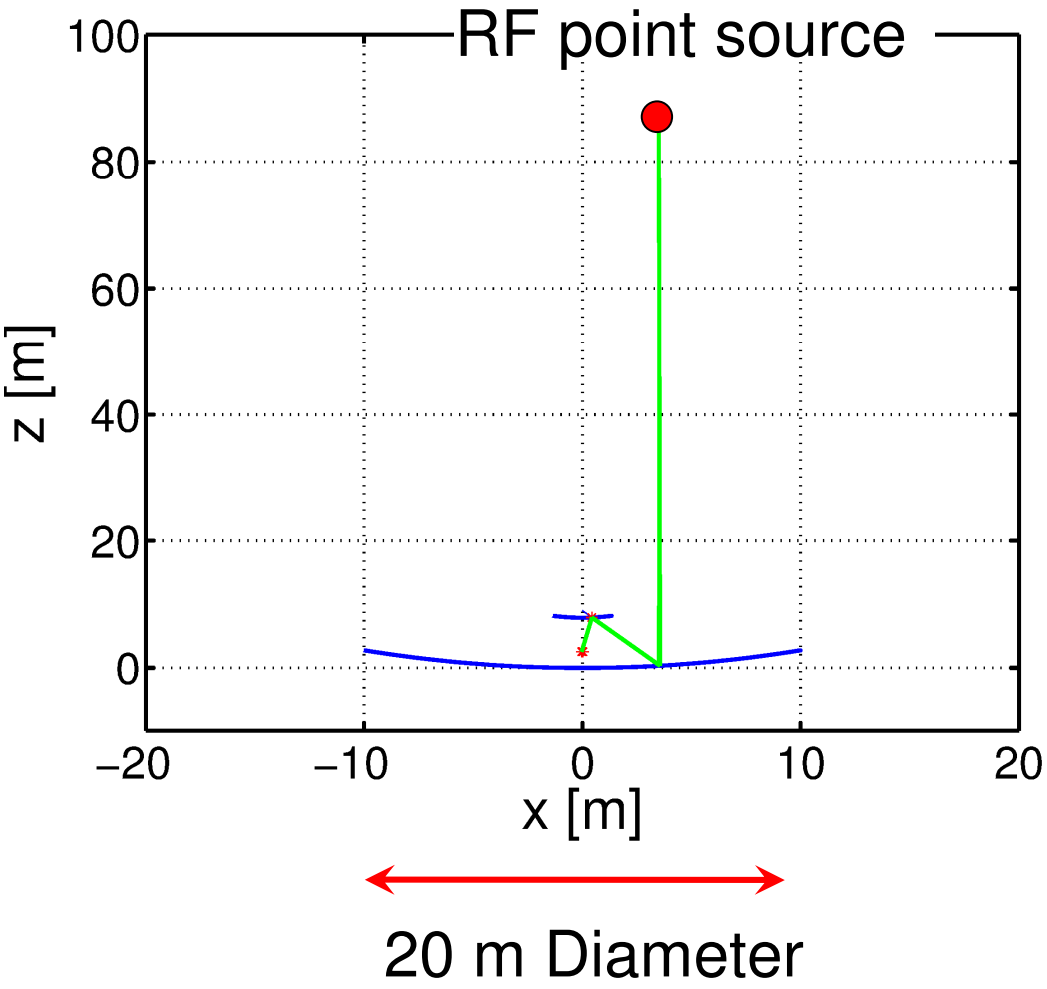
Multi-Technique Ground Target
WLRS and SOS-W Measurements



Common Geodetic Target
Through WLRS

- WLRS – Monostatic mount
  - We are modifiing WLRS laser to eye safe mode
  - Already tested, including in to automatic calibration
- SOS-W - Bistatic mount
  - Need to use Tx telescope for receiving signal

Multi-Technique Ground Target
VLBI Measurements

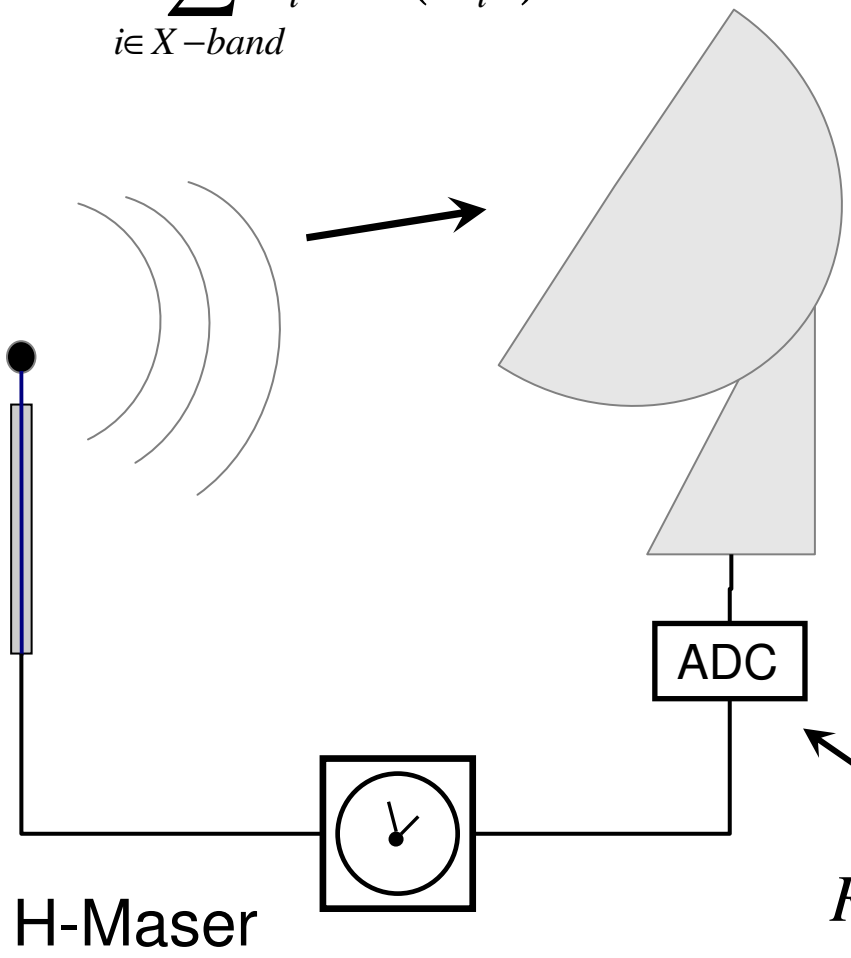


- 20m RTW – simple geometry model
- No phase dependency of feed => feed was modeled as a plain
- The spatial distortion ~15 ps

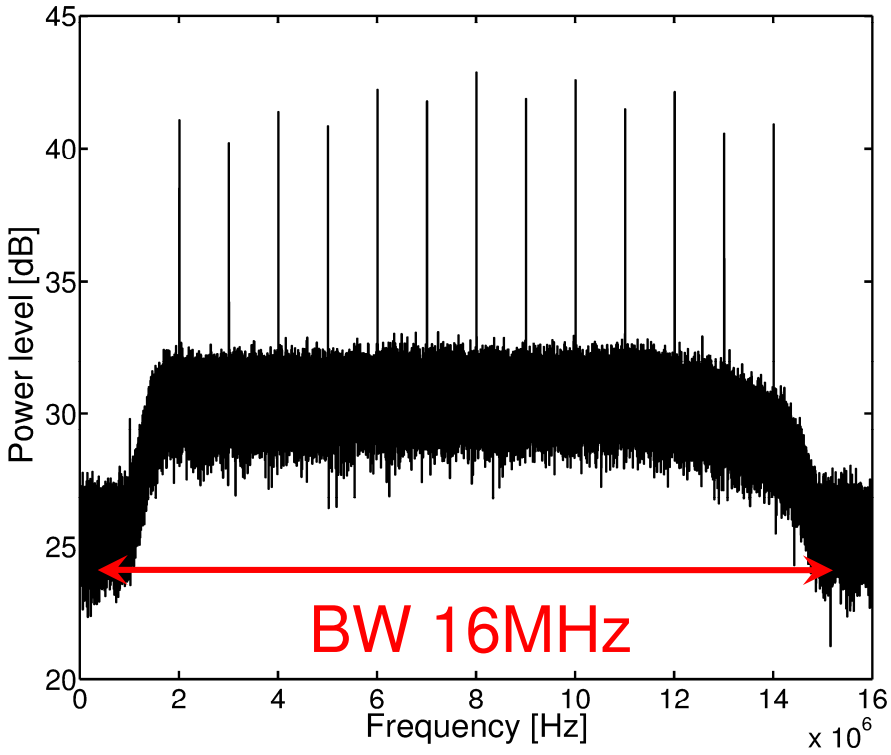
Multi-Technique Ground Target
VLBI Measurements

$$RF = \sum_{i \in X-band} A_i \cos(\omega_i t)$$

VLBI

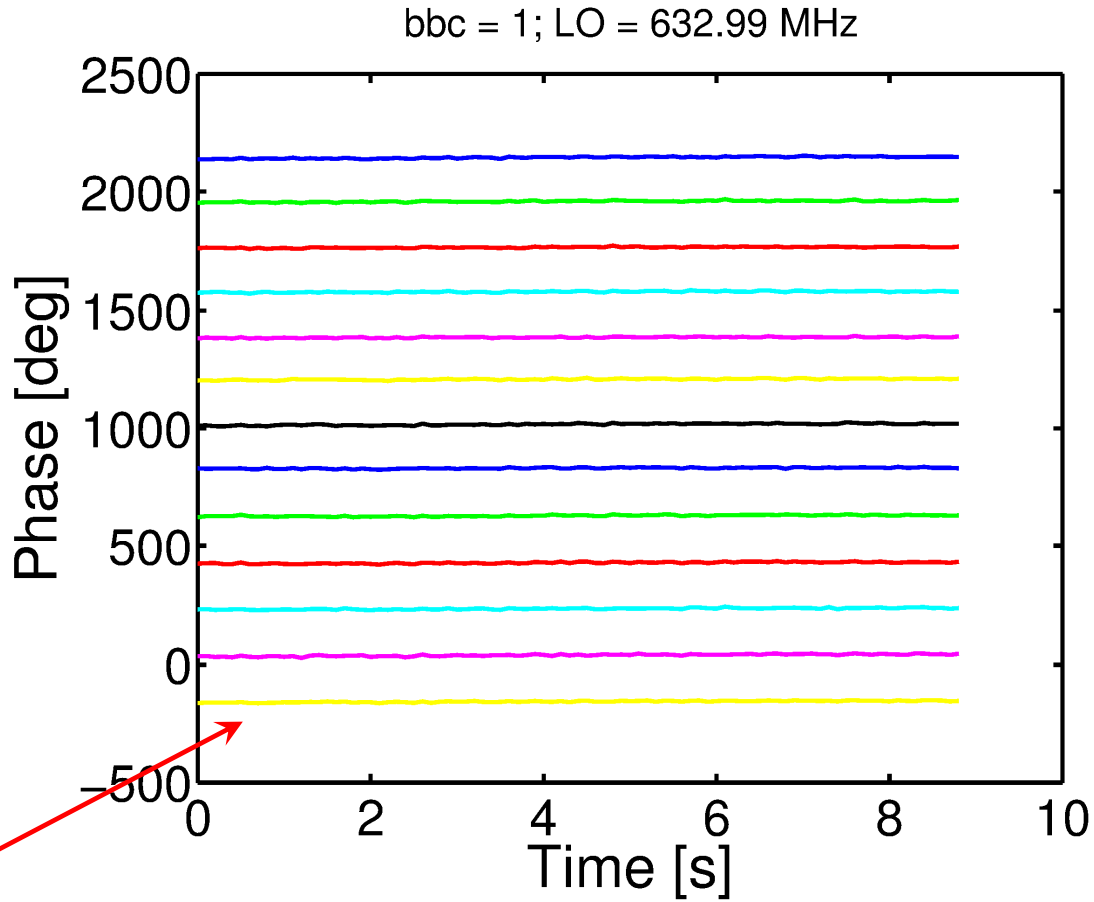


UT rf sigmal; bbc = 1; LO = 132.99 MHz



$$RF_{ADC} = \sum_{i \in X-band} A_i \cos(\omega_i t + \varphi_i)$$

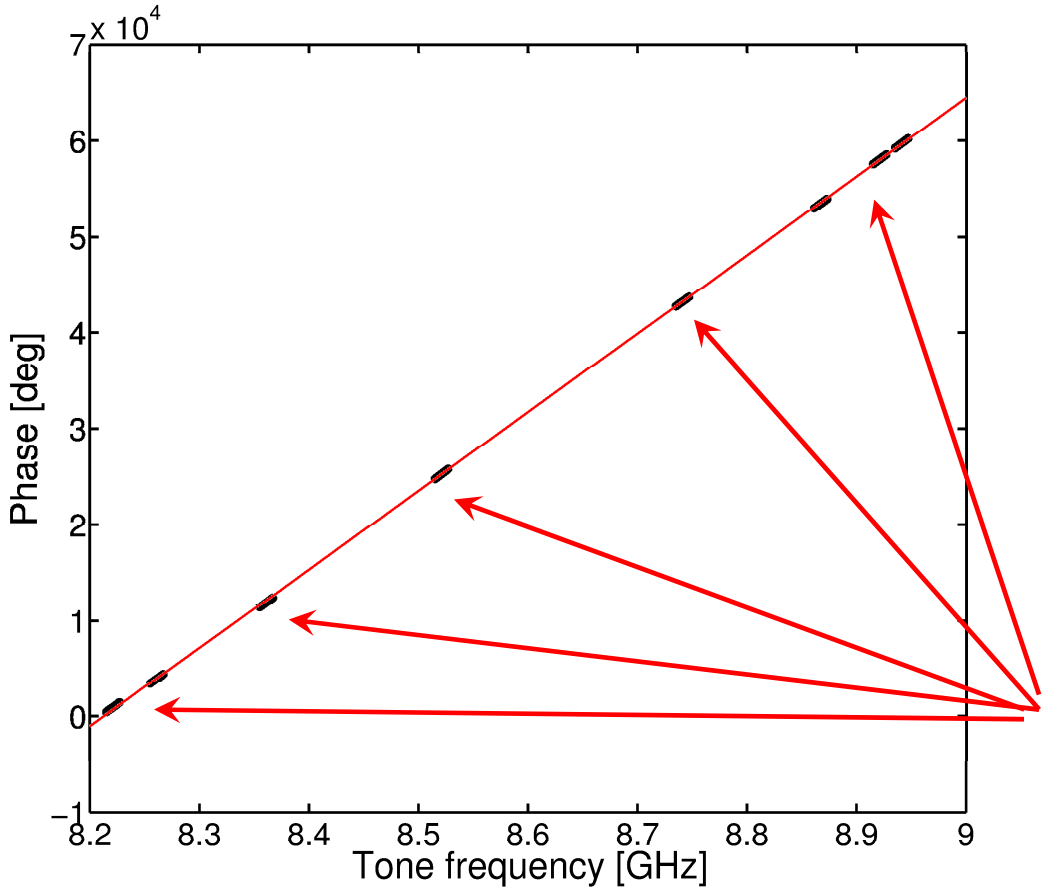
Multi-Technique Ground Target
VLBI Measurements



13 tones from Multi-Technique Ground Target

- Tones from universal target rms ~ 2° for integration time 100ms
- Single band group delay estimation = 228.4 ns; rms = 1.16 ns

Multi-Technique Ground Target
VLBI Measurements



Spanned X-band
720 MHz

- Group delay estimation = 227.498 ns
- Representing free space propagation + delay inside cables

Summary

- We are continuously working on improving local ties between instruments at Wettzell observatory

FOR1503