VIENNA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF GEODESY AND GEOINFORMATION

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Scheduling of VLBI observations to satellites with VieVS

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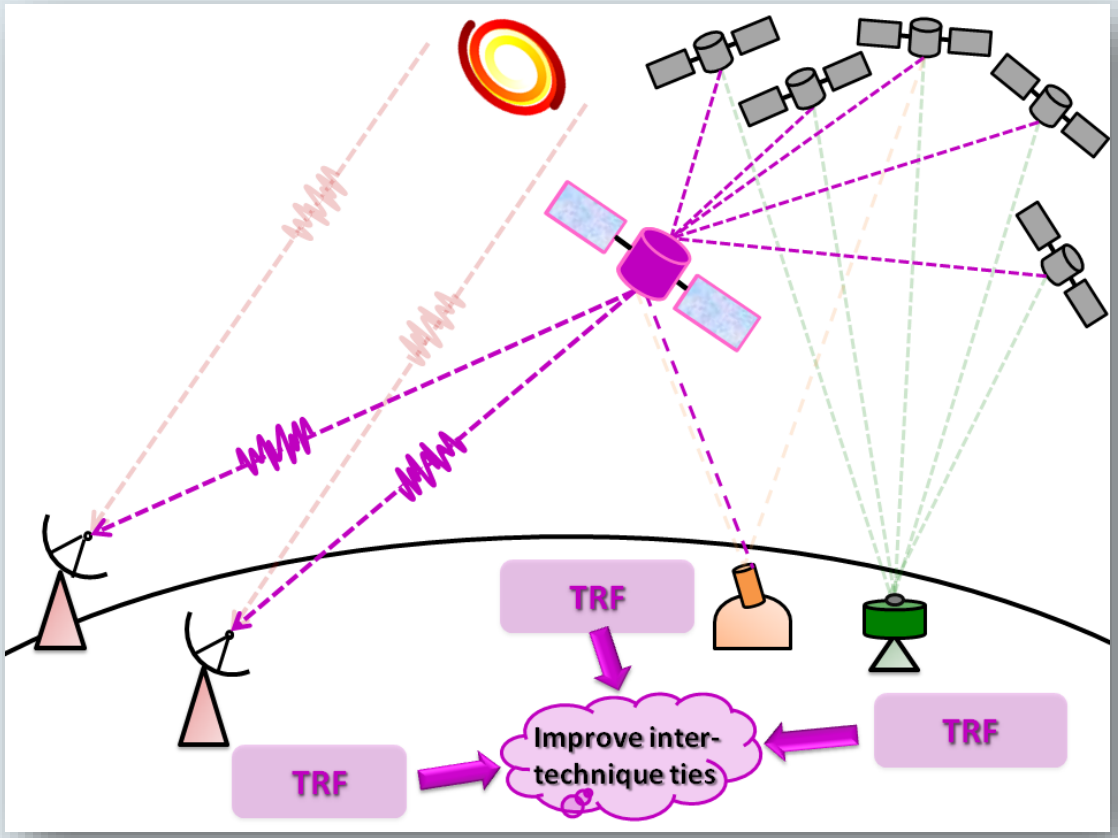
VLBI satellite observations

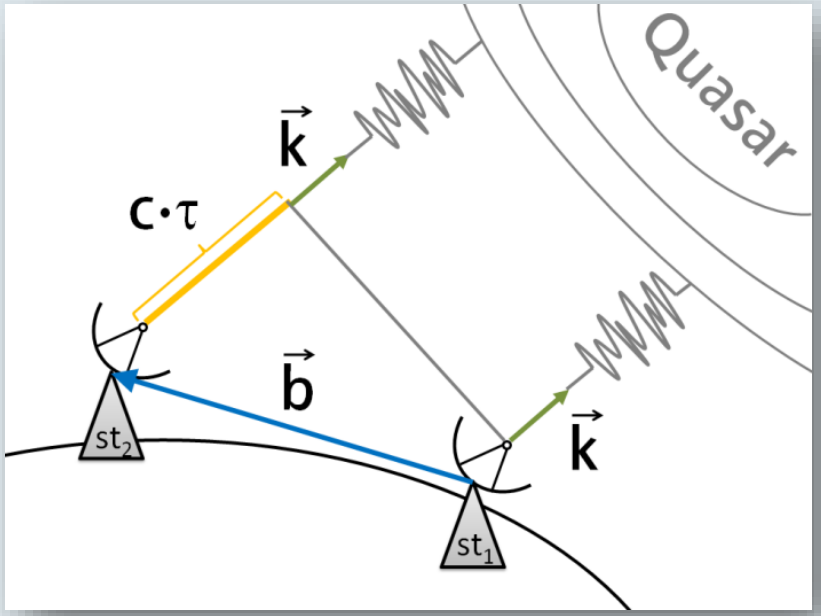
- **Motivation**
  - Establish inter-technique ties in space
  - Improved future ITRF realizations



„Co-Location in space “ *(Plank L, 2014)*

Framework conditions

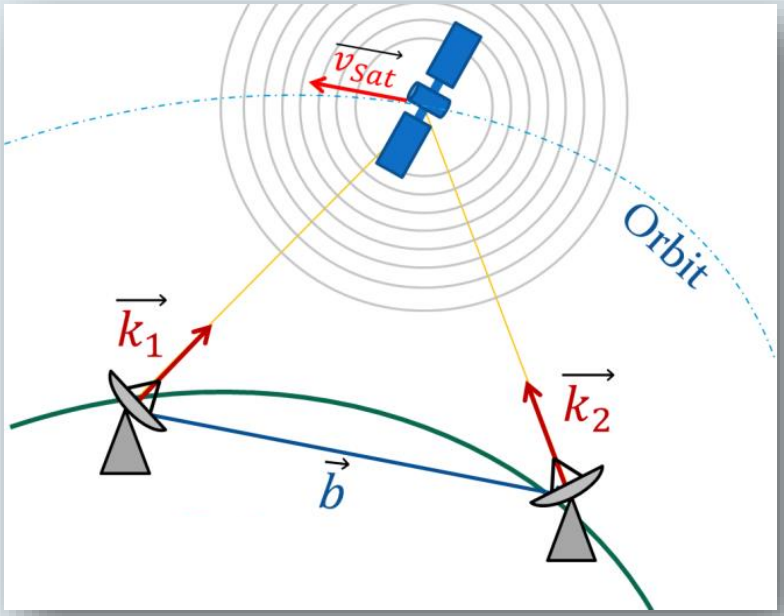
Standard VLBI



Natural radio sources (quasars)

- At an infinite distance
- Parallel view directions $\vec{k}$
- Fixed points in the sky
- S/X-band

Satellite observations



Artificial signal sources

- In the Earth's near field
- Different view directions ($\vec{k_1} \neq \vec{k_2}$)
- Moving fast
- e.g. L-band for GNSS

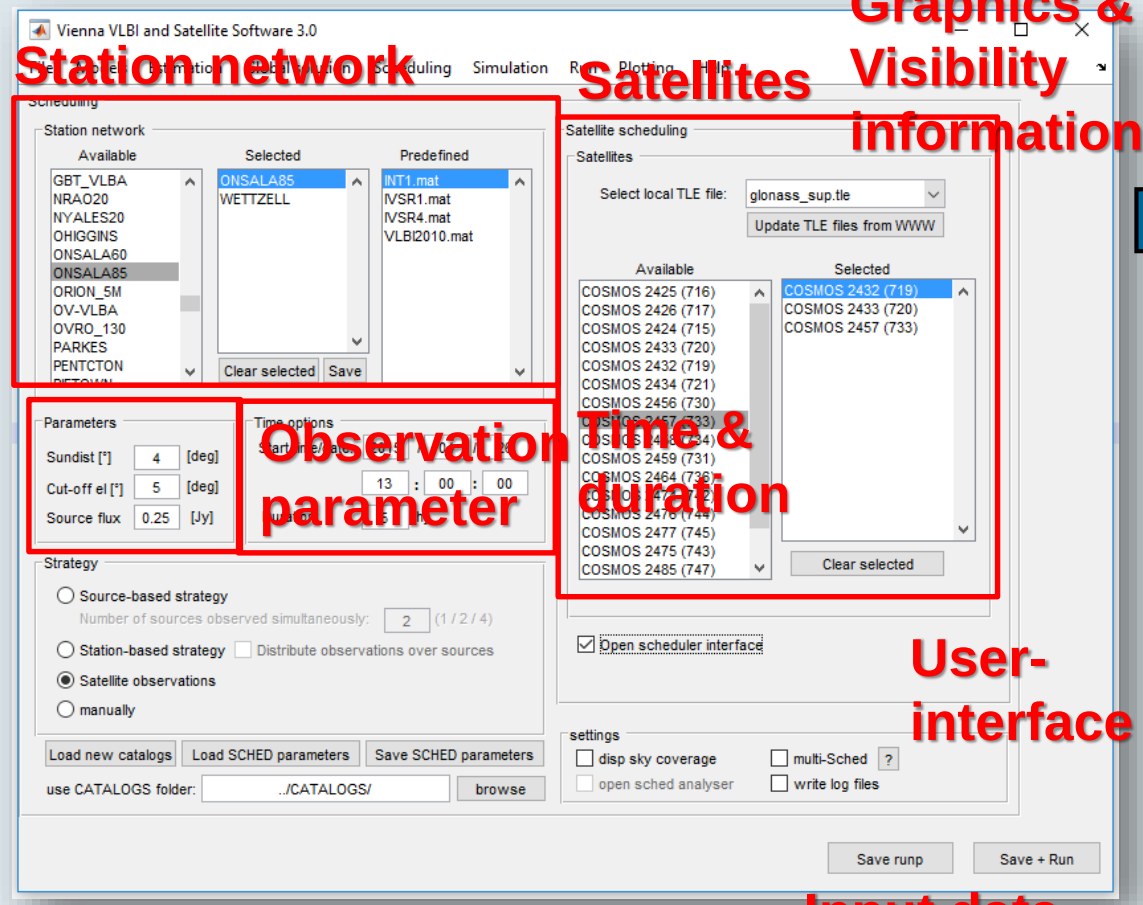
VLBI satellite observations

- Suitable observation plans („**Schedules**“) are required
  - Defining the time sequence of a VLBI experiment
  - Generated by dedicated VLBI scheduling software
    - SKED (*Gipson J, 2012*)
    - VIE_SCHED (*Sun J, 2014*)

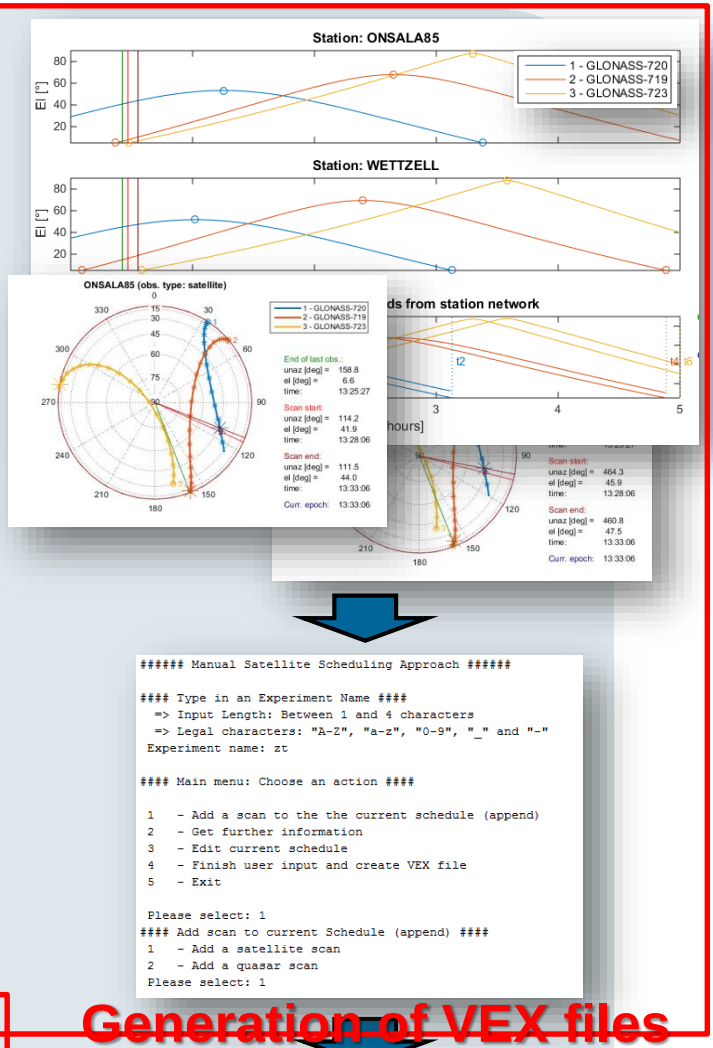
➔ **Problem:** Available scheduling programs for geodetic VLBI did not support satellites as radio sources routinely.

➔ **Idea:** Development of a **satellite scheduling module** for the Vienna VLBI Software (VieVS; *Böhm et al., 2012*).

Workflow



GUI of the VieVS satellite scheduling module

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###### Manual Satellite Scheduling Approach ######

#### Type in an Experiment Name ####
  => Input Length: Between 1 and 4 characters
  => Legal characters: "A-Z", "a-z", "0-9", "_" and "-"
 Experiment name: zt

#### Main menu: Choose an action ####

 1   - Add a scan to the the current schedule (append)
 2   - Get further information
 3   - Edit current schedule
 4   - Finish user input and create VEX file
 5   - Exit

 Please select: 1
#### Add scan to current Schedule (append) ####
 1   - Add a satellite scan
 2   - Add a quasar scan
 Please select: 1
```

Generation of VEX files

Catalog files

Configuration files

TLE datasets

VEX files

Scheduling modes

- **Combination of quasar- and satellite-scans** in one schedule

1. **Manual mode**
   - Manual source selection
   - Schedule is assembled scan by scan
   - Automatic calculation of scan starts/end
   - Good for short test sessions

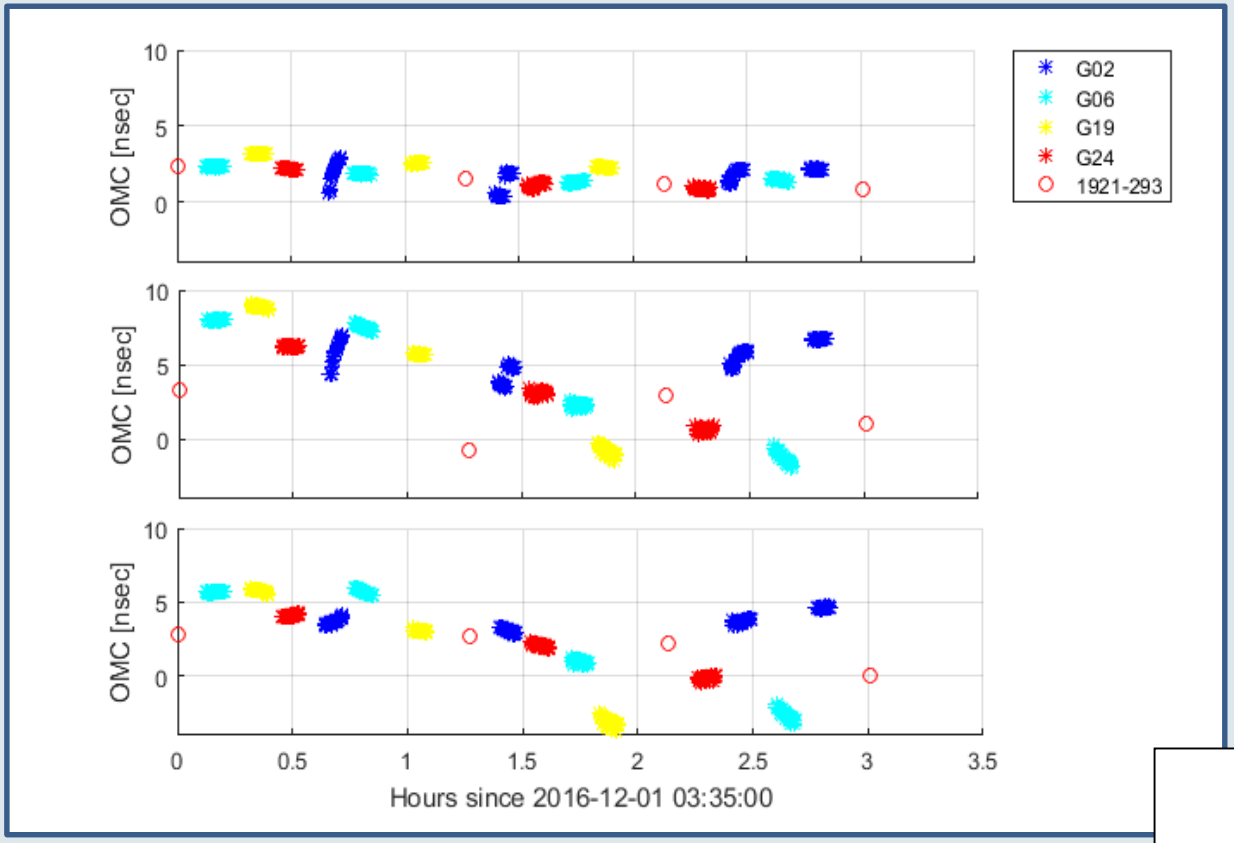
2. **Automatic mode** (NEW!!)
   - Station-based scheduling approach with sky coverage optimization at each site
   - Suitable for longer sessions and the integration of satellite scans in a geodetic schedule

Short demonstration

Scenario:

- **Station network:** WETTZELL, ONSALA85
- **Date/time:** 2017-09-14, 12:00 – 14:00 UT
- **Scans:** 1.) Quasar (calibrator)
  2.) GPS satellite (10 min track)
  3.) Quasar (calibrator)

GPS observations with Cd-Ho-Wa

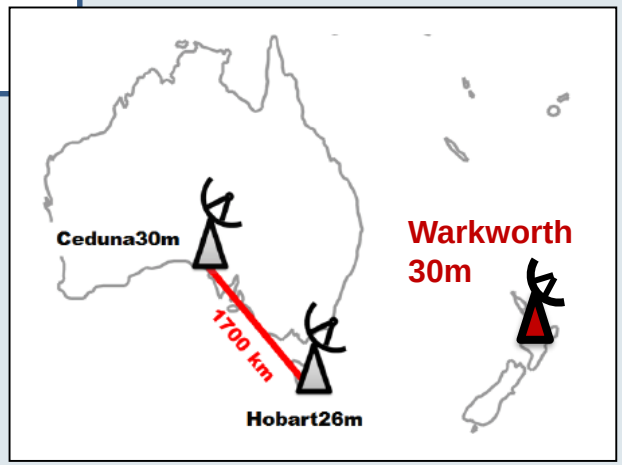


Delay residuals (observed minus compurted) of sessgion g336 (Dec 1 2016).

Cd-Ho: ~ 3 ns
(with AGC fixed)

Cd-Wa: ~ 10 ns

Ho-Wa: ~ 10 ns



Main Challenges

- Large & slow antennas for astronomy
- L-band receiver equipment not ideal

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Questions?

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References:

Böhm J et al. (2012), The New Vienna VLBI Software, Proceedings of the 2009 IAG Symposium, Buenos Aires, Argentina, 31 August 2009 - 4 September 2009, Series: International Association of Geodesy Symposia, Vol. 136, Kenyon S, Pacino MC, and Marti U (eds.), ISBN 978-3-642-20337-4, pp. 1007-1012.

Gipson J (2012), SKED – VLBI Scheduling Software, program manual, NASA Goddard Space Flight Center

Hellerschmied et al. (2014), Observing satellites with VLBI radio telescopes – practical realization at Wettzell, 8th IVS General Meeting, Shanghai, March 2014.

Plank L (2014), Precise station positions from VLBI observations to satellites: a simulation study, J Geod, 88: 659–673.