



VIENNA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF GEODESY  
AND GEOINFORMATION

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# Scheduling of VLBI observations to satellites with VieVS

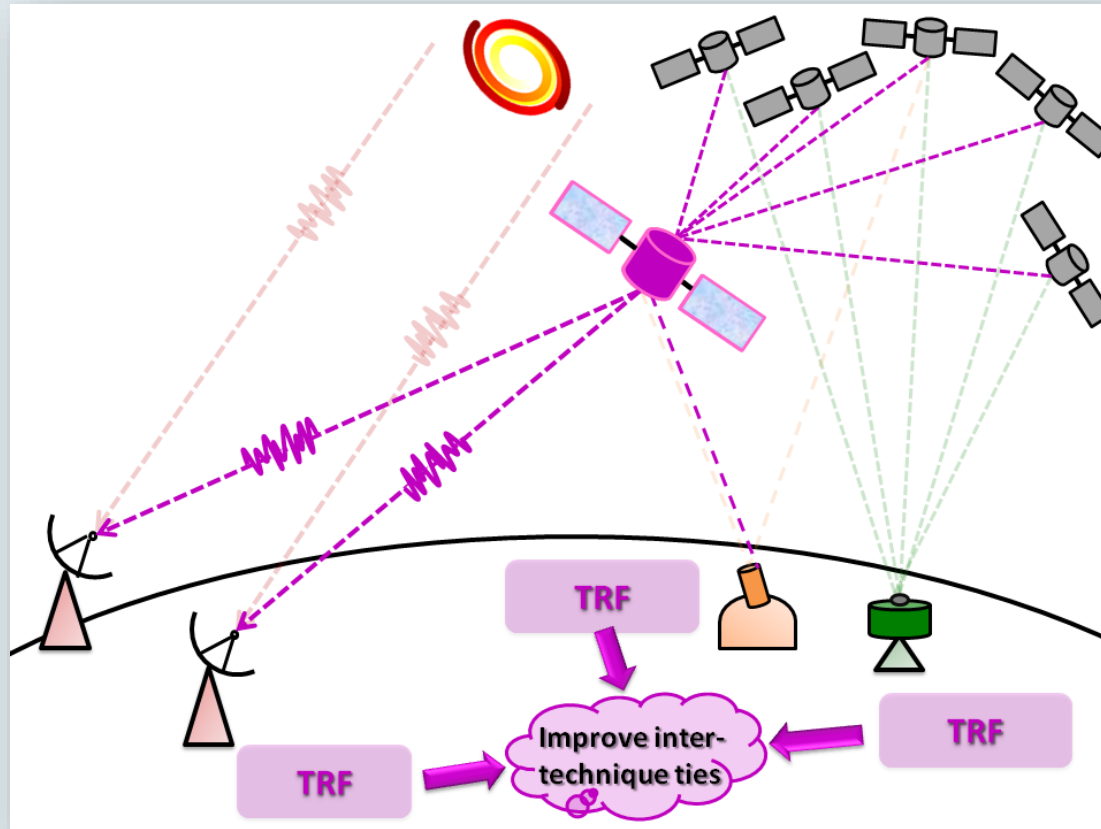
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# VLBI satellite observations

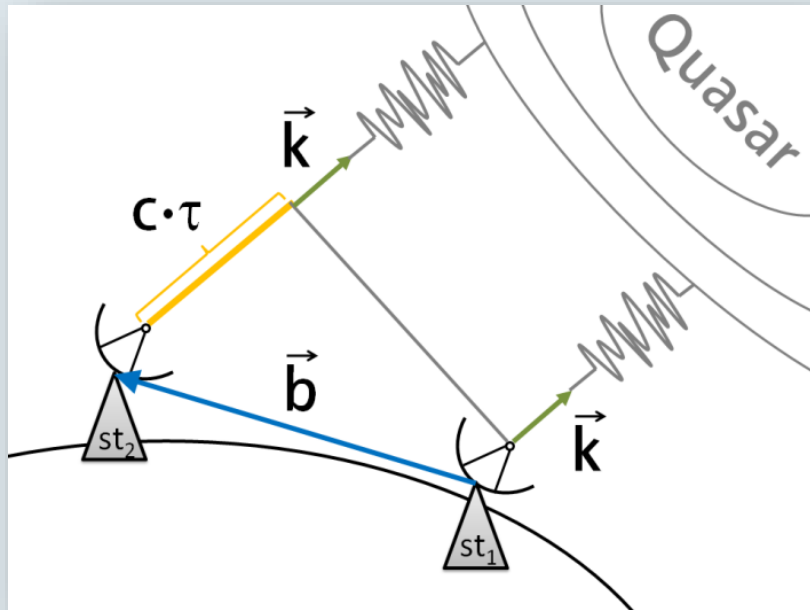
- **Motivation**

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



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

## Standard VLBI

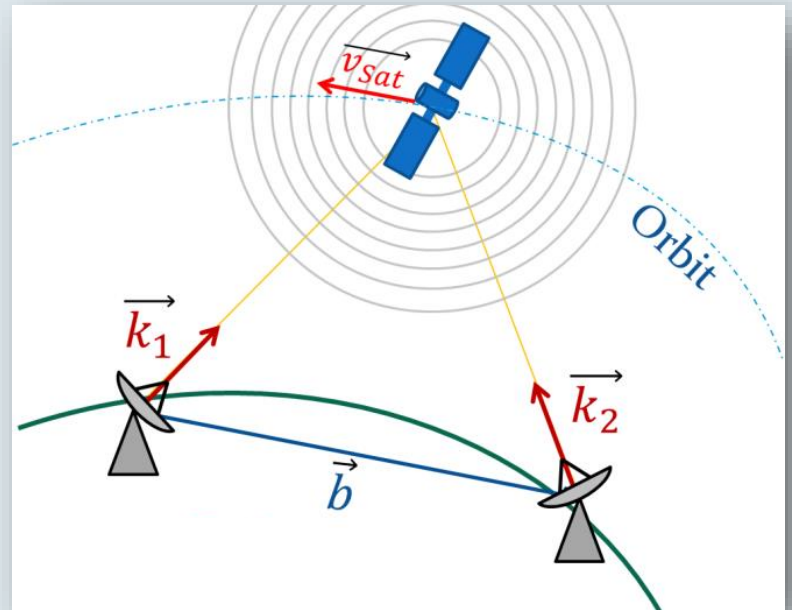


### Natural radio sources (quasars)

- 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

- 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*).

**Station network**

Available	Selected	Predefined
GBT_VLBA	ONSA85	INT1.mat
NRAO20	WETTZELL	IVSR1.mat
NYALES20		IVSR4.mat
OHIGGINS		VLBI2010.mat
ONSA85		
ORION_5M		
OV-VLBA		
OVR0_130		
PARKES		
PENTCTON		
PTZMMN		

**Satellite scheduling**

Select local TLE file: glonass\_sup.tle  
Update TLE files from WWW

Available	Selected
COSMOS 2425 (716)	COSMOS 2432 (719)
COSMOS 2426 (717)	COSMOS 2433 (720)
COSMOS 2424 (715)	COSMOS 2457 (733)
COSMOS 2433 (720)	
COSMOS 2432 (719)	
COSMOS 2434 (721)	
COSMOS 2456 (730)	
COSMOS 2457 (733)	
COSMOS 2458 (734)	
COSMOS 2459 (731)	
COSMOS 2464 (736)	
COSMOS 2470 (742)	
COSMOS 2476 (744)	
COSMOS 2477 (745)	
COSMOS 2475 (743)	
COSMOS 2485 (747)	

**Parameters**

Sundist [°] 4 [deg]  
Cut-off el [°] 5 [deg]  
Source flux 0.25 [Jy]

**Time options**

Start time / end time: 13 : 00 : 00

**Strategy**

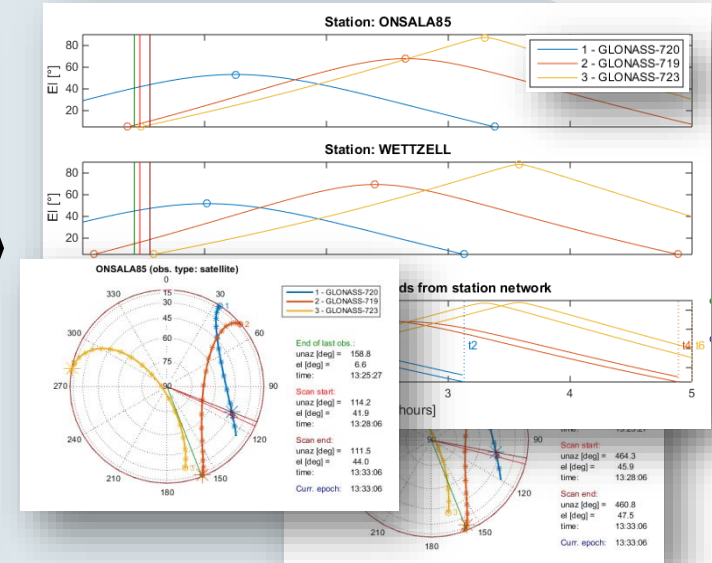
- Source-based strategy (Number of sources observed simultaneously: 2 (1/2/4))
- Station-based strategy (Distribute observations over sources)
- Satellite observations**
- manually

**settings**

- disp sky coverage
- multi-Sched
- Open scheduler interface
- open sched analyser
- write log files

Save runp Save + Run

**Graphics & Visibility information**

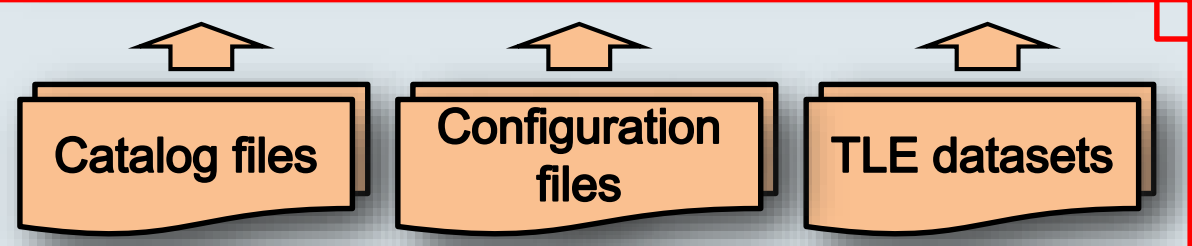


**Observation time & duration parameter**

**User-interface**

**Input data**

**Generation of VEX files**



```
##### 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
```

- **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

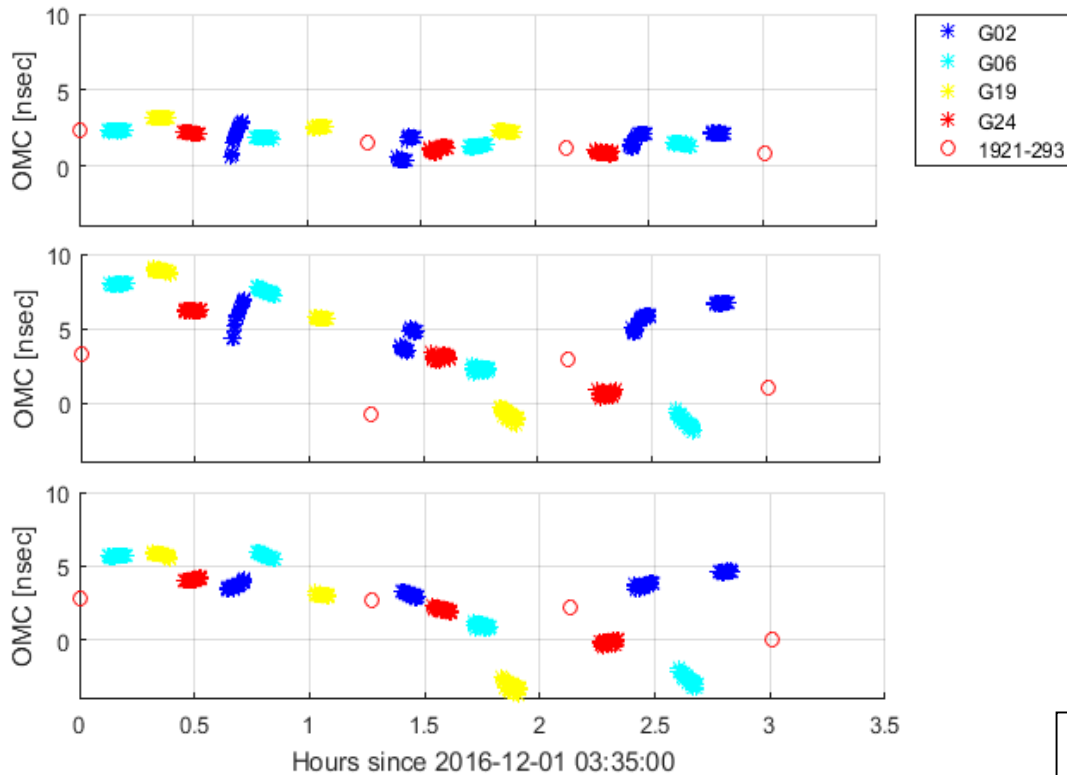
## 2. Automatic mode (NEW!!)

- 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

## 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



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

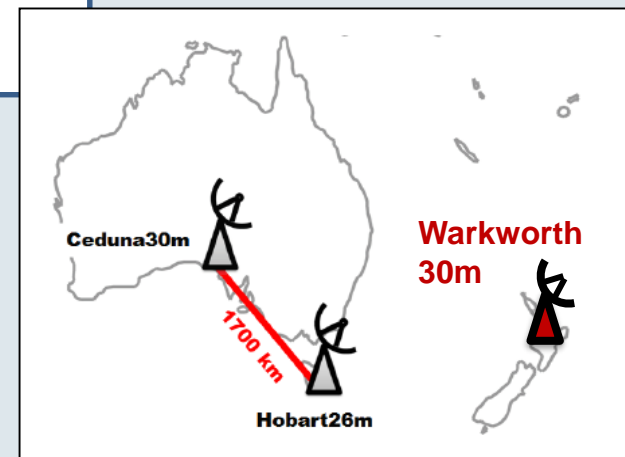
**Cd-Wa: ~ 10 ns**

**Ho-Wa: ~ 10 ns**

**Delay residuals** (observed minus computed) of session g336 (Dec 1 2016).

## Main Challenges

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





# Questions?

## Contact:

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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.