



TECHNISCHE
UNIVERSITÄT
WIEN
Vienna University of Technology

VieVS2_tie

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VieVS User Workshop
11 – 13 September, 2012
Vienna



Navigation

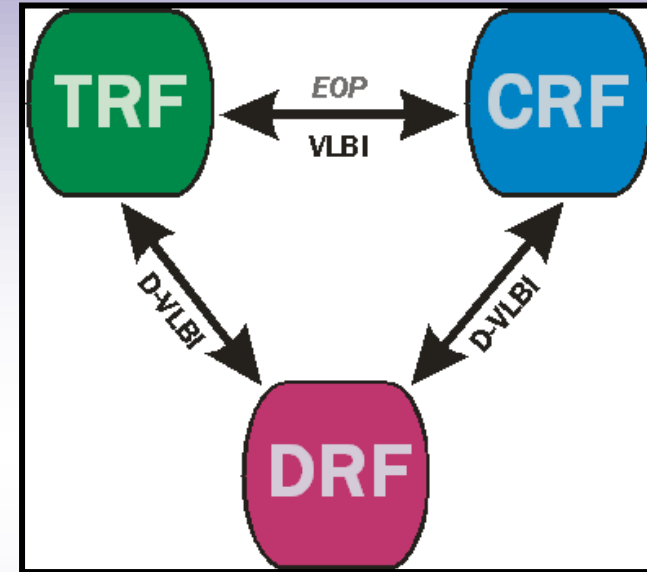
- Deep space navigation
 - Routinely done (NASA, ESA)
 - Sensitive perpendicular to line of sight
- Lunar missions
 - SELENE, Chang'e

Frame ties

- Optical \leftrightarrow radio frequencies
- Kinematic \leftrightarrow dynamic (ephemerides)

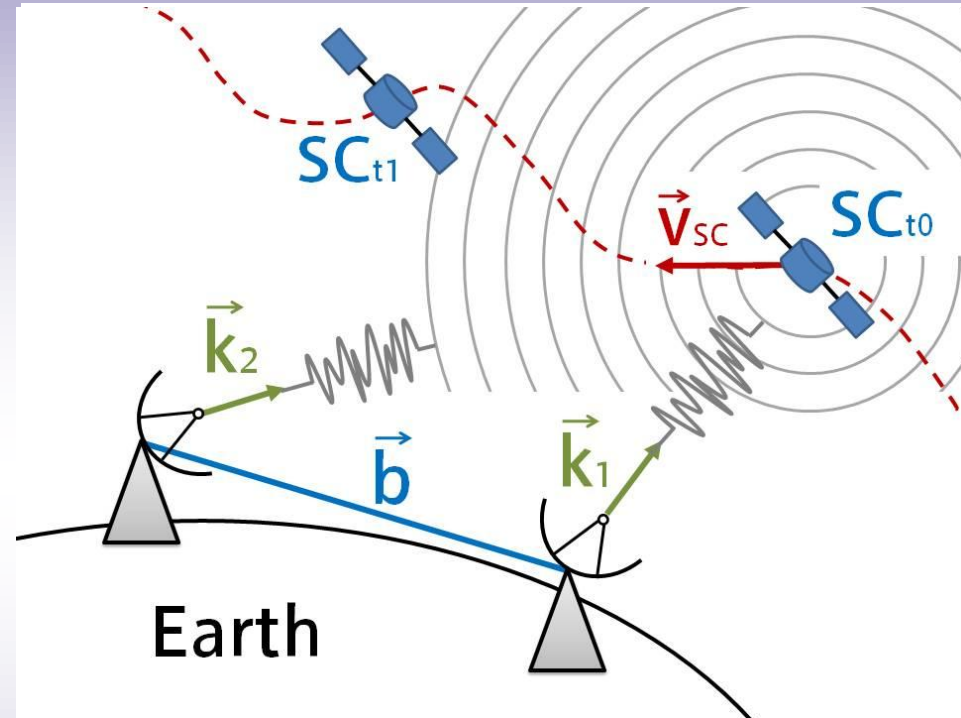
Local ties

- Co-location in space
 - GNSS, GRASP, MicroGEM,...



▶ Differential VLBI (D-VLBI)

- ▶ Quasar – spacecraft (SC)
 - ▶ Deep space navigation
 - ▶ DSN, Δ DOR
 - ▶ NASA, ESA
- ▶ SC – SC
 - ▶ multi-frequency method
 - ▶ same beam method
 - ▶ e.g. SELENE (JAXA)



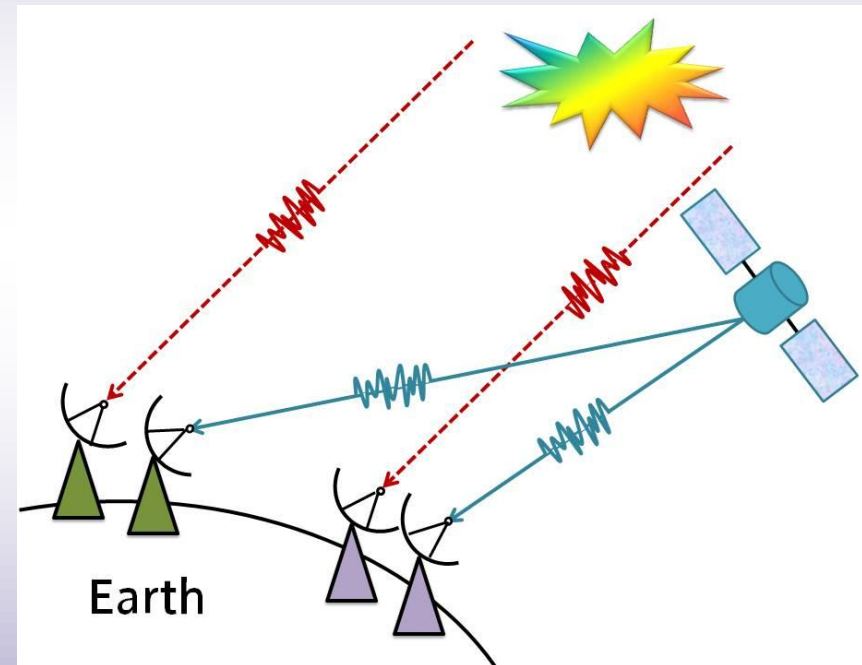
▶ Satellite VLBI

- ▶ Chang'e-1
- ▶ Tracking of GNSS satellites
- ▶ Tracking of other satellites

- ▶ Technical realization is strongly mission-dependent.
 - ▶ Differential vs. Single
 - ▶ Signal structure
 - ▶ Phase vs. Group delay
 - ▶ Receiving system

But:

- ▶ Promising recent & future missions
 - ▶ Better accuracy, small antennas,...
- ▶ Technical development
 - ▶ VLBI transmitters as payload
 - ▶ twin-telescopes offer new observing modes
- ▶ Strong request for inter-technique ties
 - ▶ Co-location in space
 - ▶ GRASP, GNSS, Micro-GEM,...



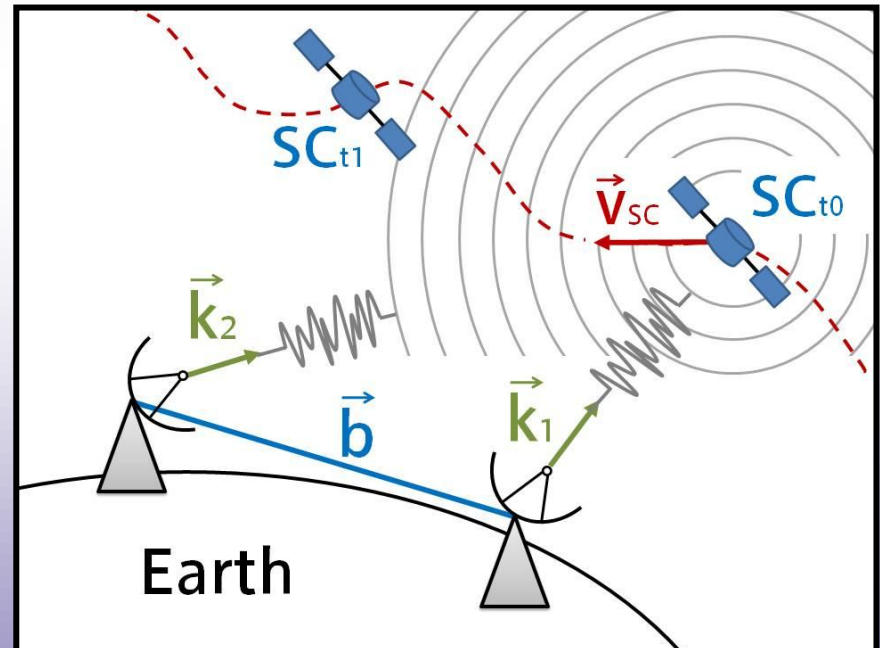
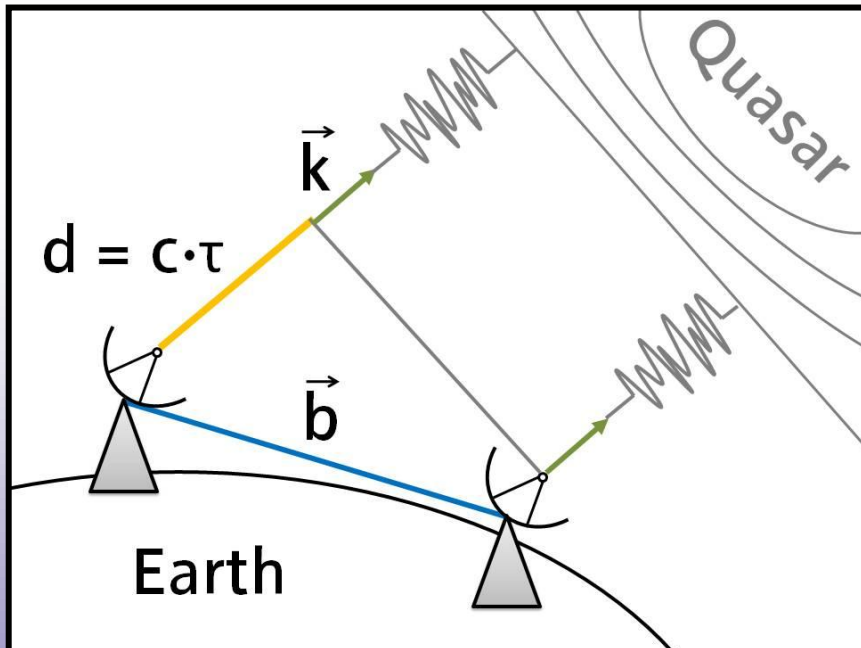
Possible observing mode with 2 twin telescopes

GEODETIC VLBI

- plane wave front
- stable sources

SPACECRAFT VLBI

- curved wave front
- fast moving sources
- time of emission t_0



1

Same beam differential VLBI data from Selene *provided by NAOJ Mizusawa*

Results: e.g. Plank et al. IVS GM 2012

VERIFICATION

2

VieVS2_tie

Vienna VLBI Software 2.0

File Parameters Estimation Global solution Simulation Scheduling Run Plotting Help

Run options

Scheduling

Run vie_sched

Simulation

Run vie_sim

VieVS

one subdirectory (recommended)

different subdirectories

vie_init -> vie_mod -> vie_ism ->

vie_glob ->

Run vie_init
 Run vie_mod
 Run vie_ism_sim
 Run vie_ism

VieVS2tie

Run_VieVS2tie
 include Q

Global solution

Path to LEVEL2 data

LEVEL2 subdirectory

Output directory for vie_glob Run vie_glob

- Modified version of VieVS2_0
- Scheduling-simulation-processing

Scheduling:





- ▶ sp3-files or time series
- ▶ Station list
- ▶ Primarily designed for 1 satellite „seen“ by several stations

Simulation:

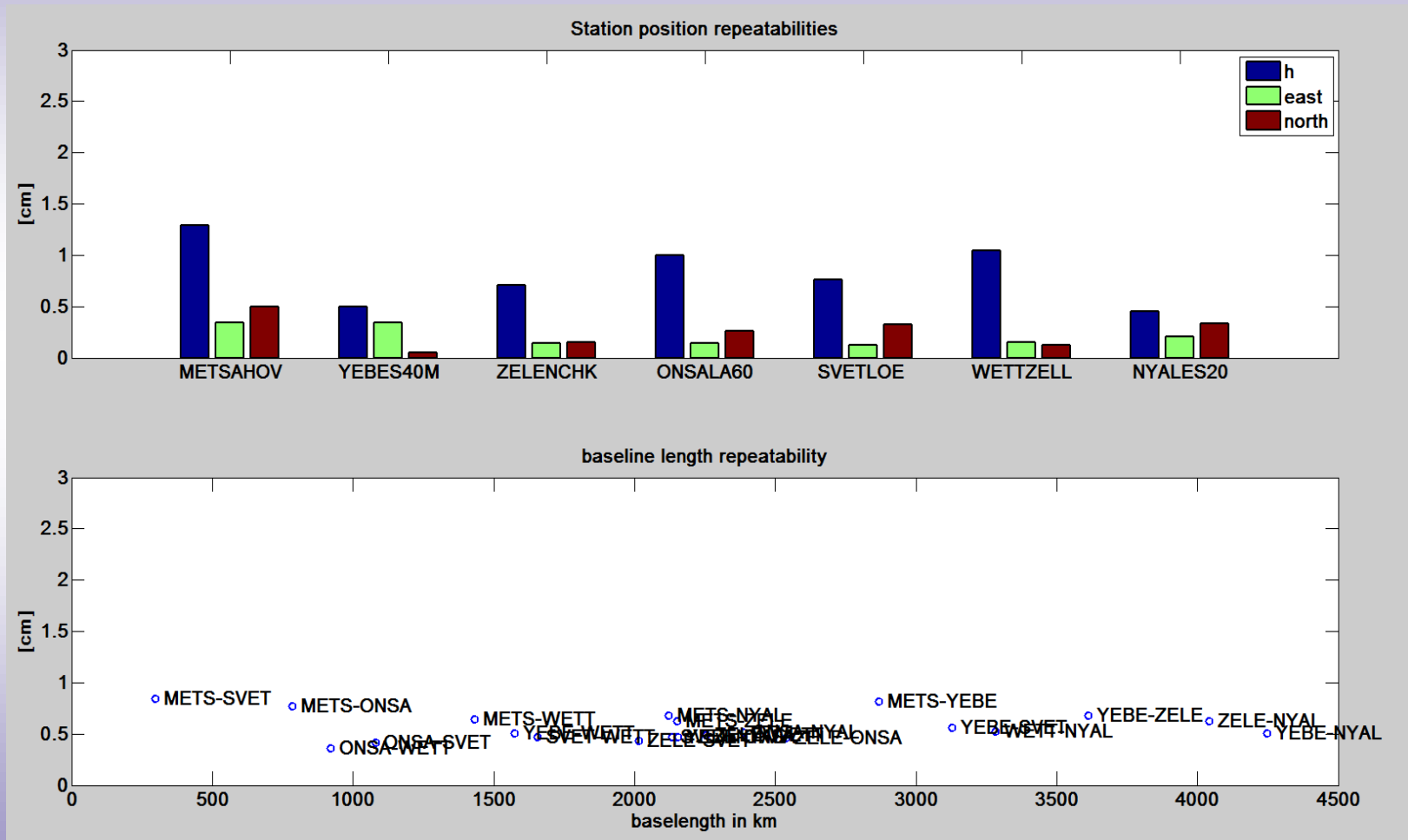
- ▶ Normal vie_sim (clock, turbulence, noise)
- ▶ Short-track (no ngs-files) for faster processing
 - ▶ Scan.obs.com → scan.obs.com(1:n)
 - ▶ Only run vie_lsm_tie n-times

New data format

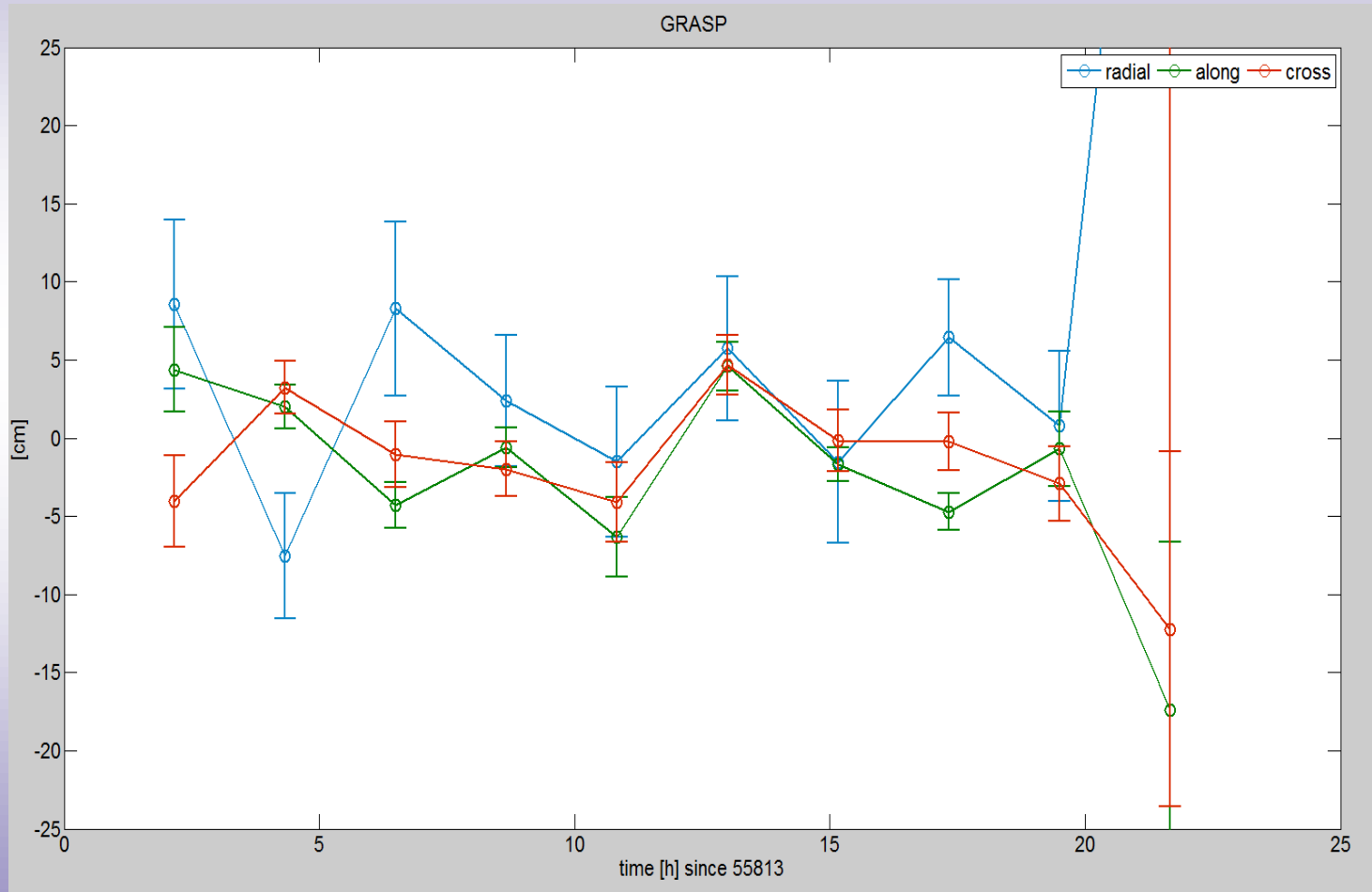
```
2011 9 9 2 9 18.00 ONSALA60 SVETLOE 1846+322 qq -0.001804647737173
2011 9 9 2 9 18.00 ONSALA60 WETTZELL 1846+322 qq -0.001864982615788
2011 9 9 2 9 18.00 ONSALA60 YEBES40M 1846+322 qq -0.000044401838132
2011 9 9 2 9 18.00 SVETLOE WETTZELL 1846+322 qq -0.000060334352203
2011 9 9 2 9 18.00 SVETLOE YEBES40M 1846+322 qq 0.001760246770377
2011 9 9 2 9 18.00 WETTZELL YEBES40M 1846+322 qq 0.001820581134111
2011 9 9 2 20 0.00 METSAHOV SVETLOE GRASP sc -0.000722196597655
2011 9 9 2 20 0.00 METSAHOV ZELENCHK GRASP sc -0.006072045752198
2011 9 9 2 20 0.00 SVETLOE ZELENCHK GRASP sc -0.005349845417472
2011 9 9 2 30 0.00 METSAHOV NYALES20 GRASP sc 0.003273026486254
2011 9 9 2 30 0.00 METSAHOV ONSALA60 GRASP sc 0.001776754825856
2011 9 9 2 30 0.00 METSAHOV SVETLOE GRASP sc -0.000467079793519
2011 9 9 2 30 0.00 METSAHOV WETTZELL GRASP sc 0.003178800478522
```

-  Orbit handling
-  Delay model for sources at finite distance
-  Adapted partial derivatives
-  Modified vie_lsm (estimation of source position, xyz resp. LoS - along Track - X track)

 GRASP_2000, sc-q, simulated



 GRASP_2000, sc-q, simulated; orbit error



- We successfully used VieVS to model delays of space VLBI applications; we implemented
 - Selene same beam data processing
 - Chang'e-1 VLBI tracking data processing
 - Glonass GNSS observations
- VieVS2_tie enables investigations for satellite-VLBI from **scheduling** and **simulations** to **dedicated analysis**.