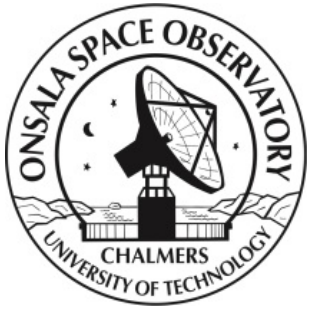
Observation of GLONASS satellites with VLBI



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Outline

- Motivation
- Observations
- Modelling and correlation
- Preliminary analysis
- Conclusions and outlook

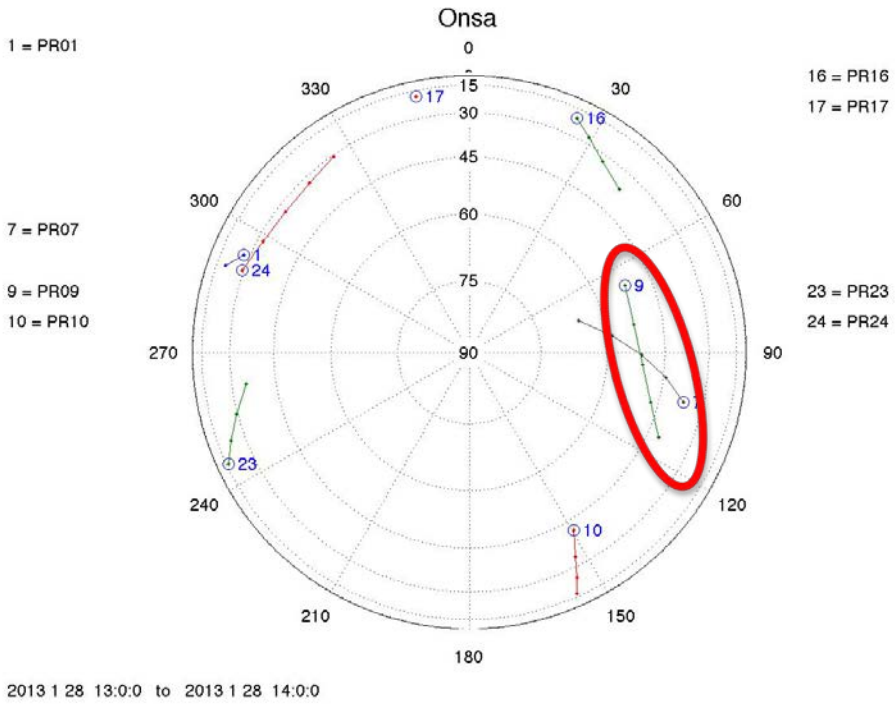
Motivation

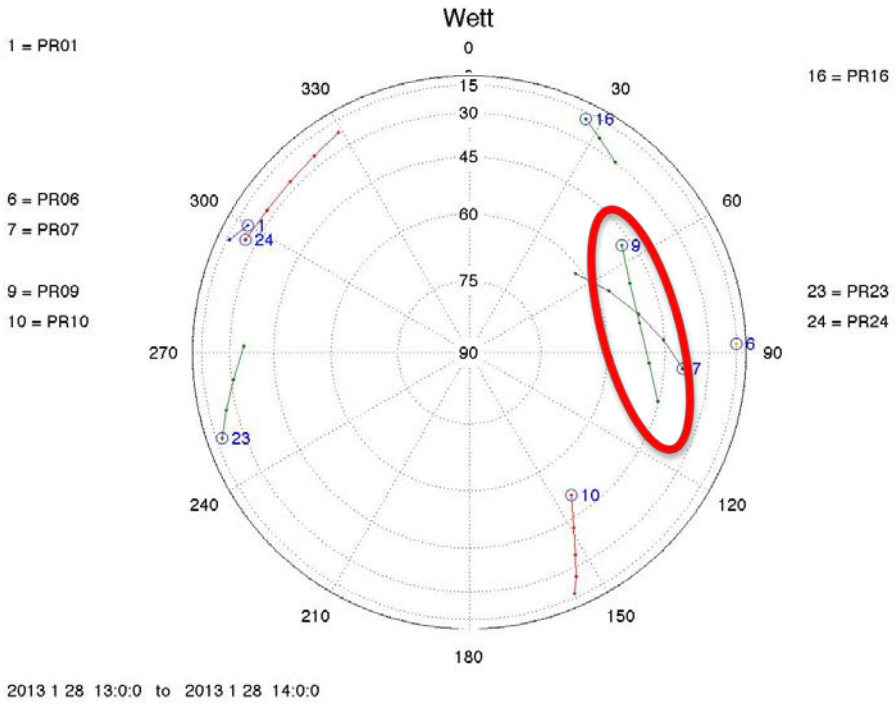
- Question: Can GNSS-VLBI be used to improve the combination of reference frames (?)
- Several previous tests during the last 5 years, mainly Onsala-Medicina, (e.g. Tornatore *et al.*, ESA workshop proc., 2010; Tornatore *et al.,* IAG proc., 2014)
- Using L-band systems at EVN-stations
- To test the new L-band system at Wettzell
- To test different different software correlators and apriori delay models
- To get an impression on achievable observation accuracy

Observations

- GLONASS-experiments in 2013 and 2014
  - G130128 – 2013.01.28 Onsala-Wettzell
  - G140116, G140121 – 2014.01.16/21 Onsala-Wettzell
- Onsala 25 m telescope, L-band system
- Wettzell 20 m with L-band system via S-band horn
- G130128: 1 GLONASS satellite observed (PR09, Norad # 37139) for 45 min (9 scans à 4 min)
  - 4 IF channels of 8 MHz centered at 1.58687 MHz
  - JIVE prepared the vex-file, 15 s stop-and-go
- G140116/21: 8 GLONASS satellites observed (PR01,PR02, PR08, PR11, PR12, PR17, PR23, PR24), for in total 4 h
  - Vex-file prepared with VieVs-sched, 15 s stop-and-go

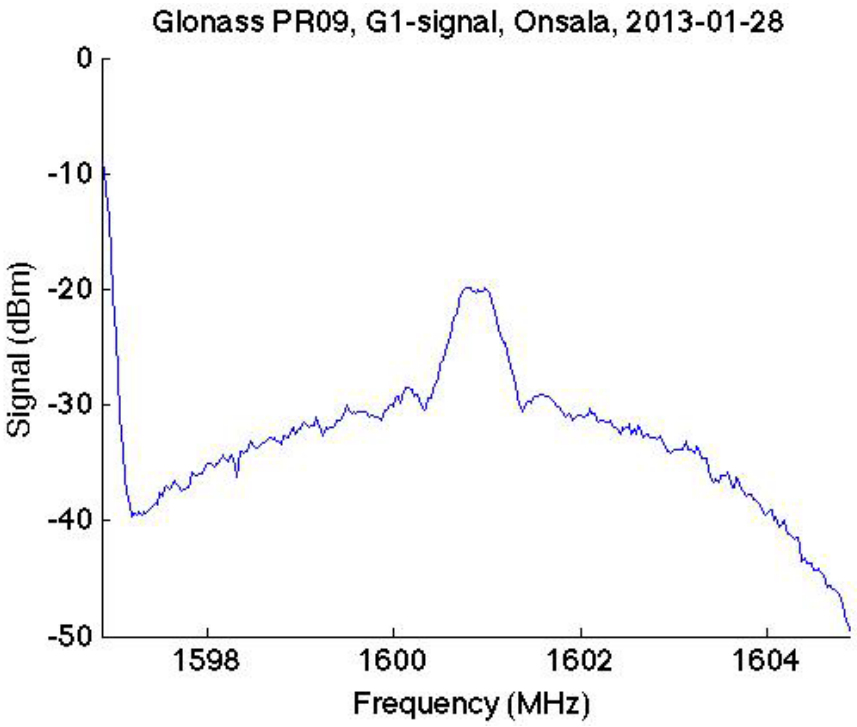
Example: observations G130128





PR09

Observations G130128

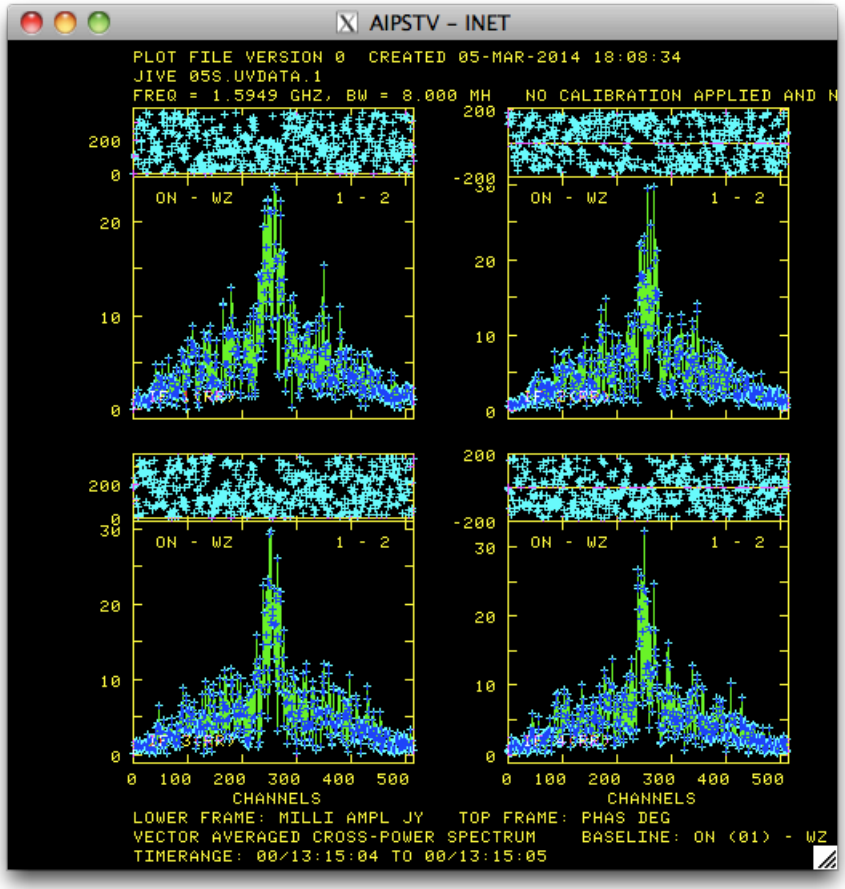


Strong satellite signal:
=> additional RF-attenuation 30 dB necessary

Modelling and correlation

- Three different apriori delay models
  - D-model: Dmitry Duev (Duev *et al.*, A&A, 2012)
  - R-model: Rüdiger Haas
  - L-model: Lucia Plank
- Correlation with
  - SFCX at Jive (D-model), 0.5 and 1 sec integration
  - DiFX at Onsala (D-, R- and L-model), 0.25 s integr.
- Post-processing with AIPS/Fringe at Onsala

AIPS/Fringe processing on SCFX data



SFCX data before fringing.

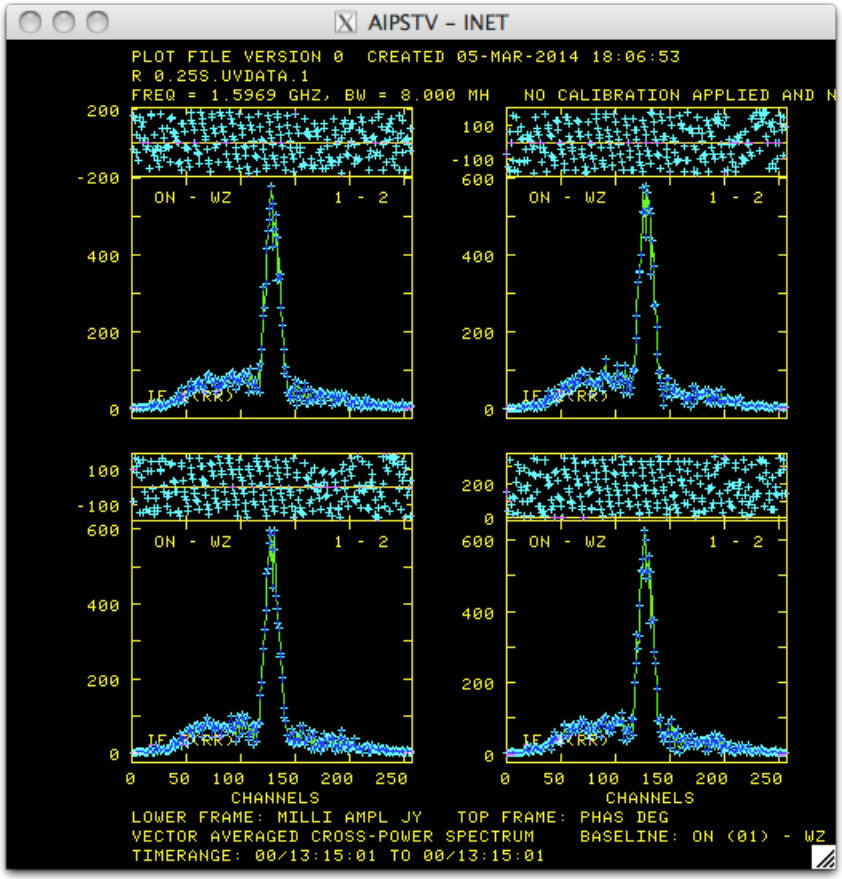
SFCX data:

Some problems with
Fringe fitting
Relatively low amplitudes
Noisy phases

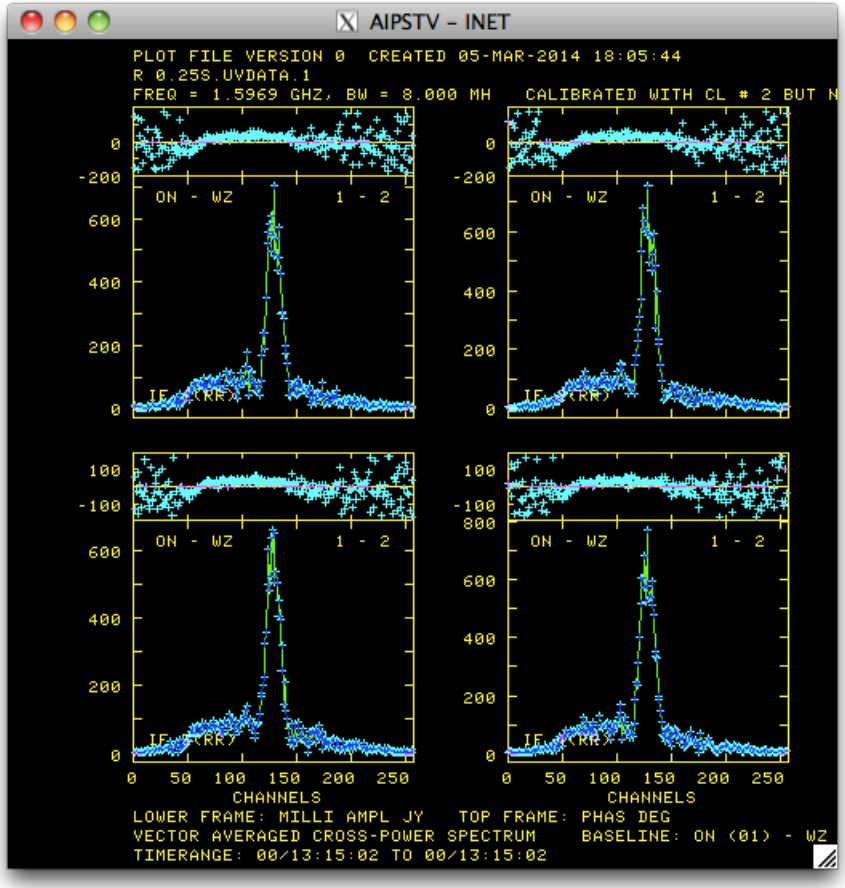
Strange delay rate results …

➔ No success ☹

AIPS/Fringe processing on DiFX data

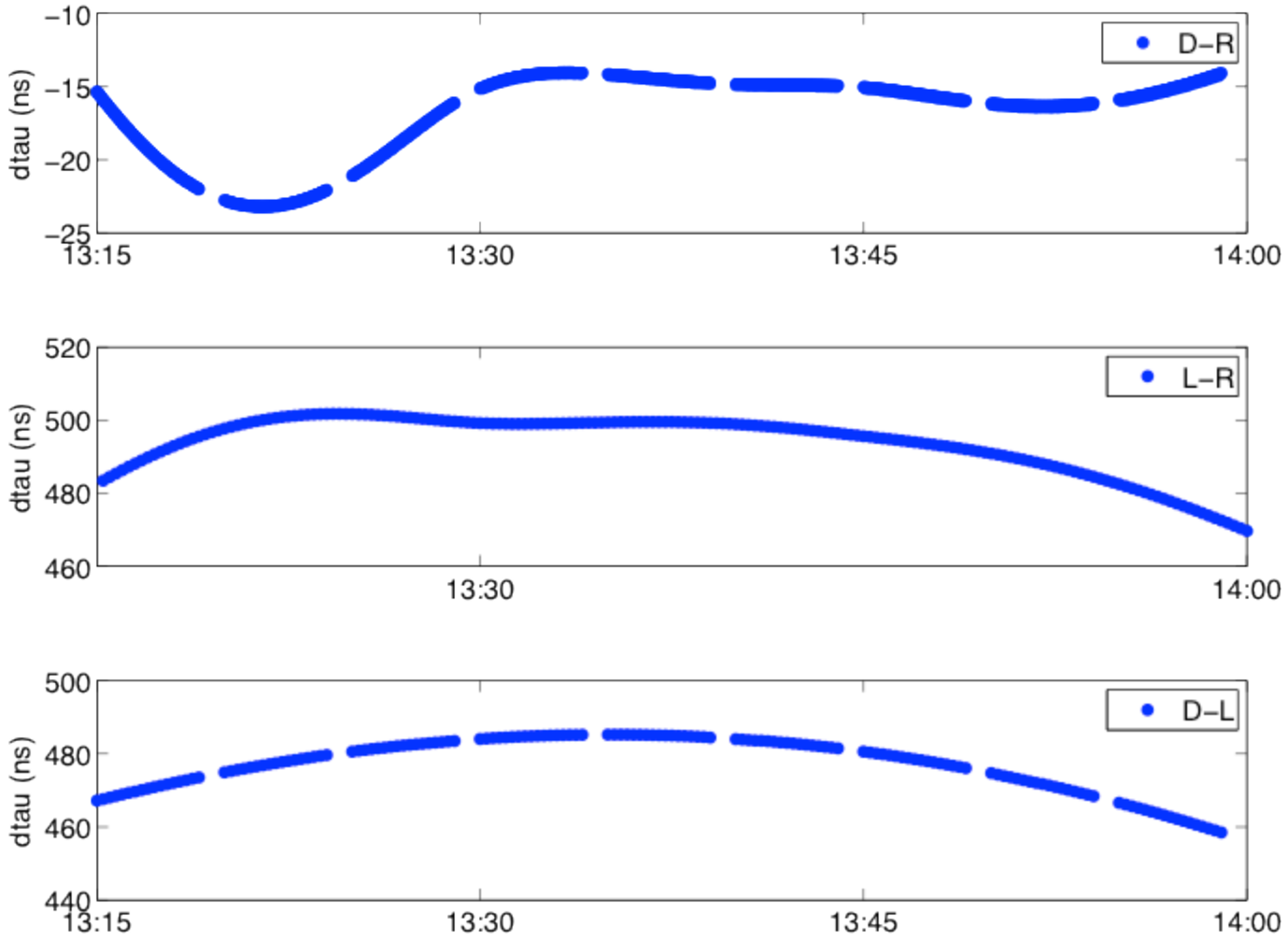


DiFX data before fringing.

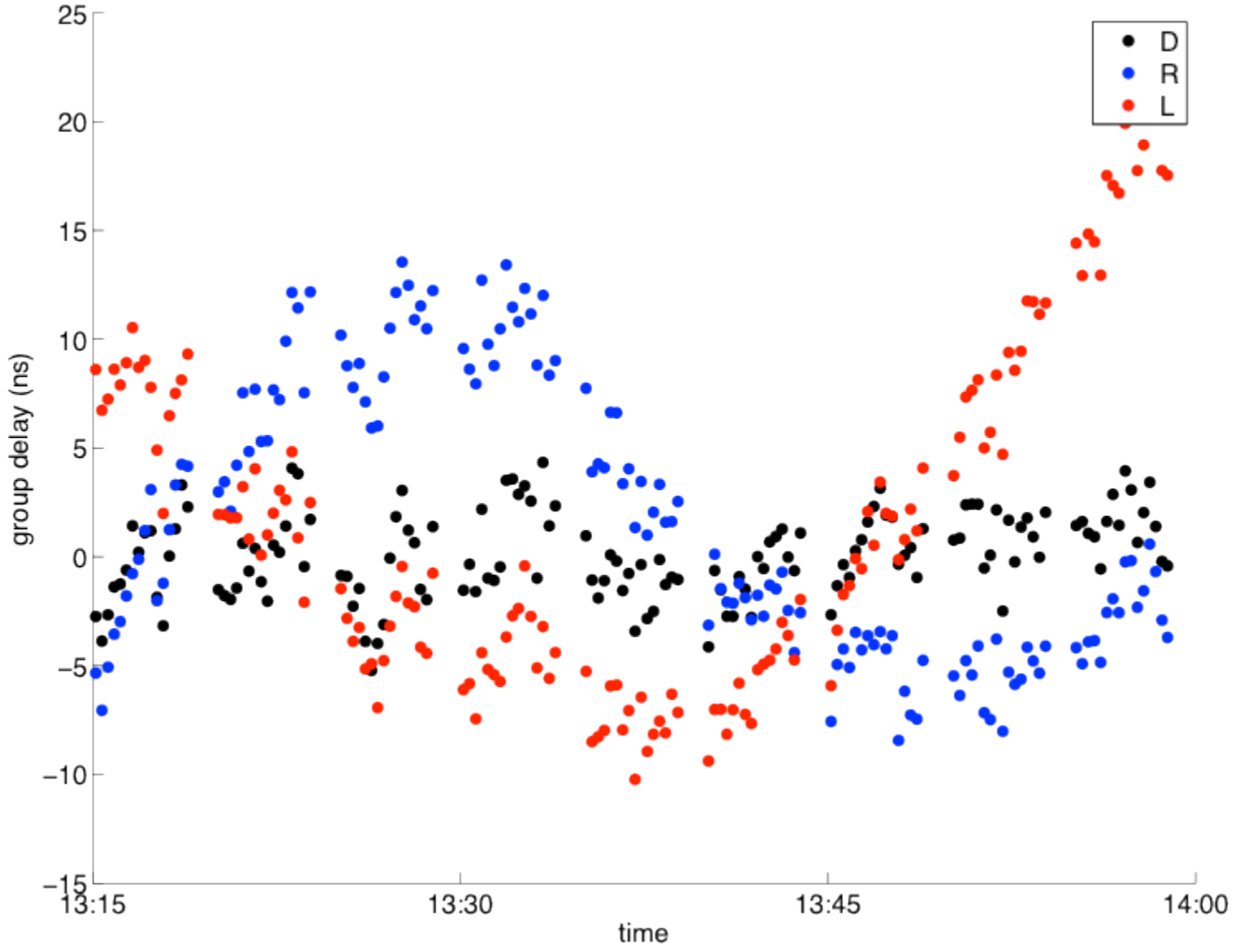


DiFX data after fringing.

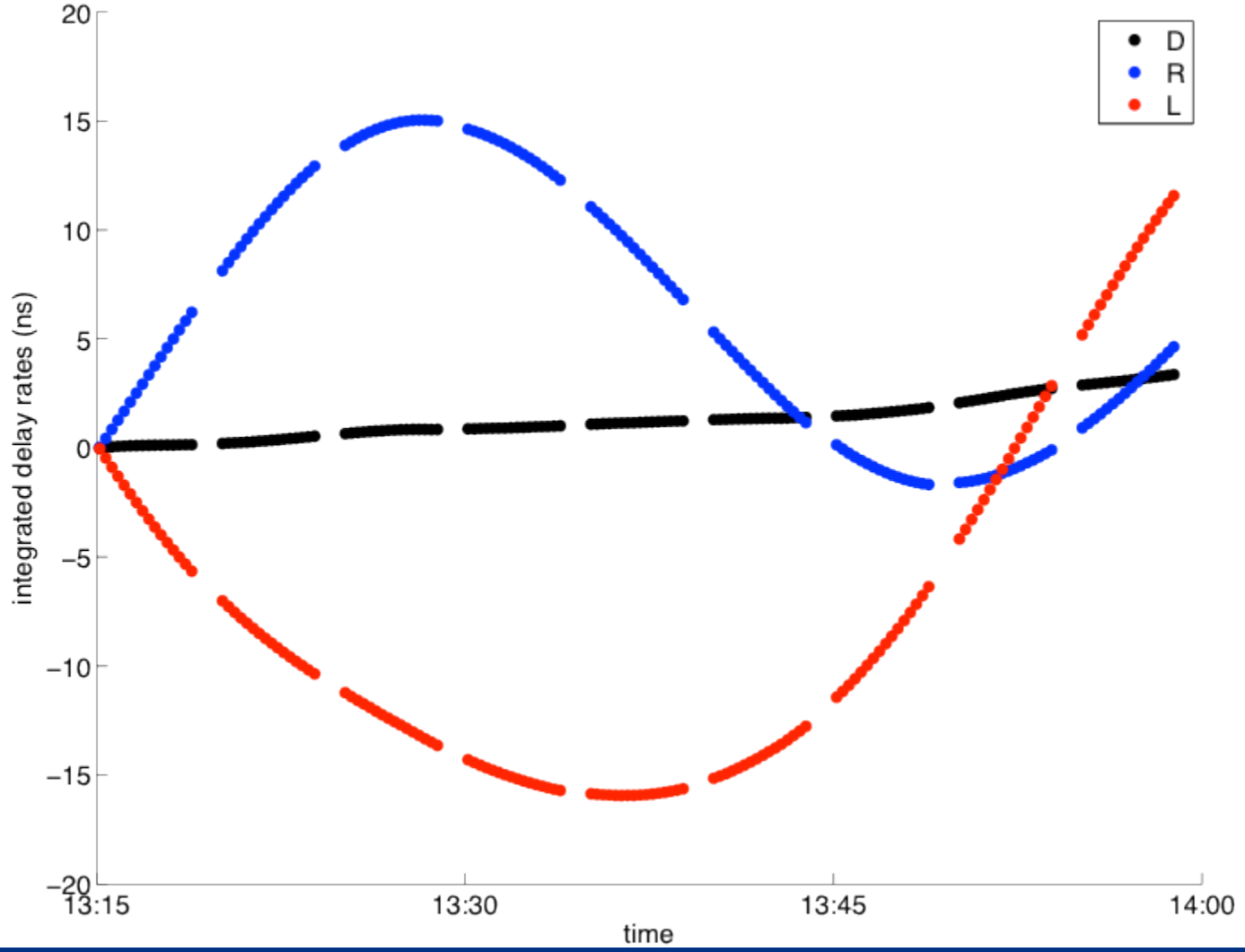
Apriori delay model differences



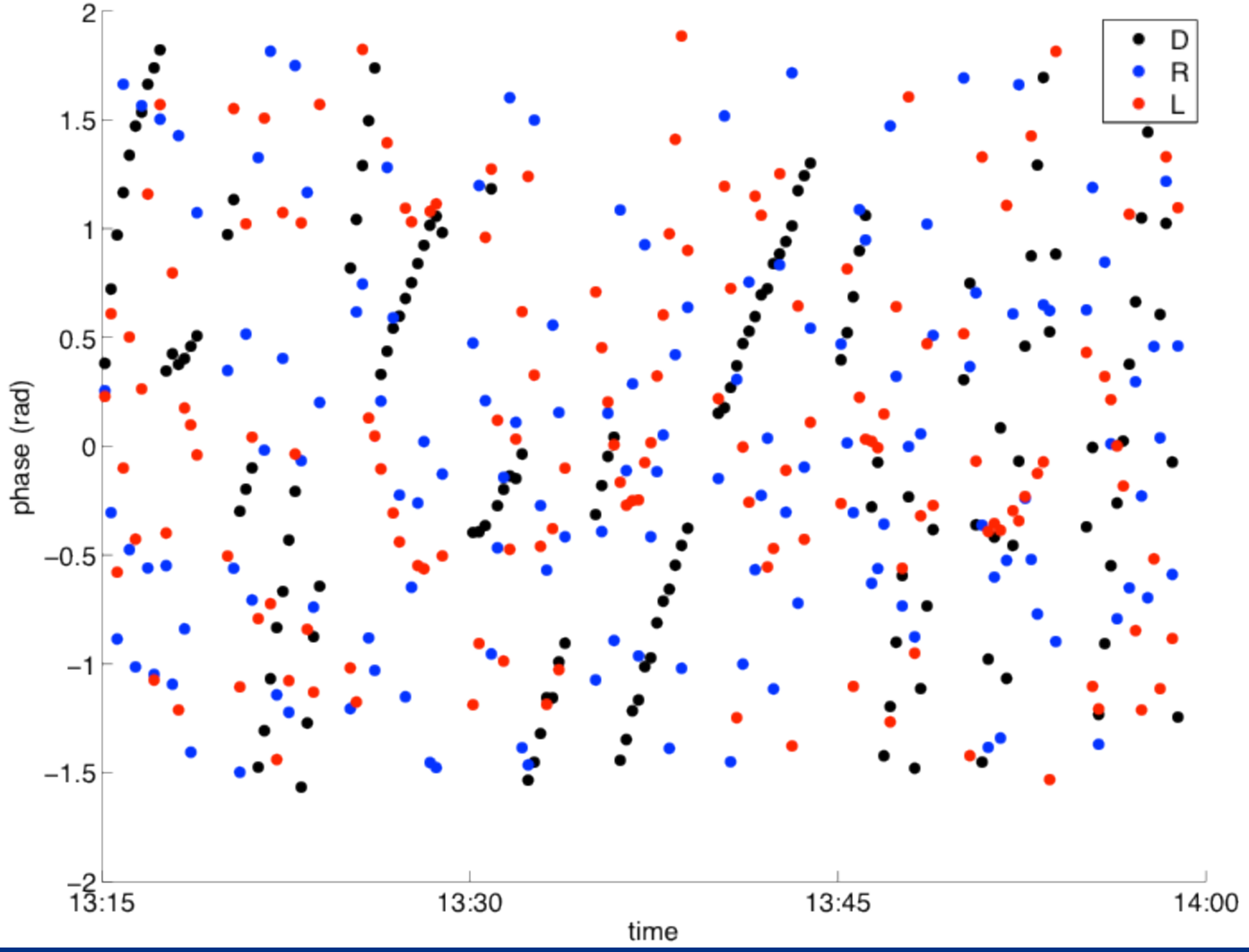
Group delays from AIPS/Fringe



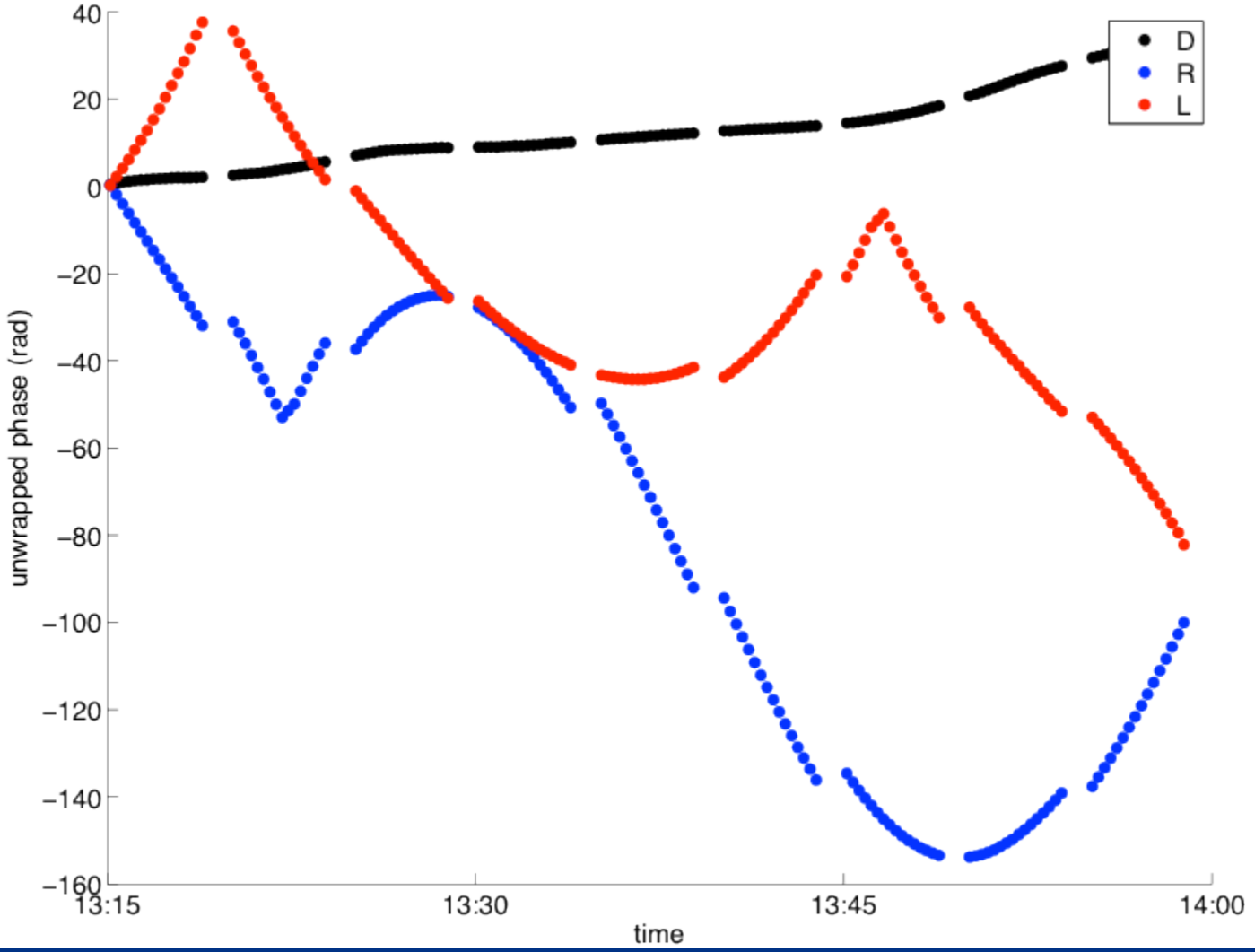
Integrated delay rates from AIPS/fringe



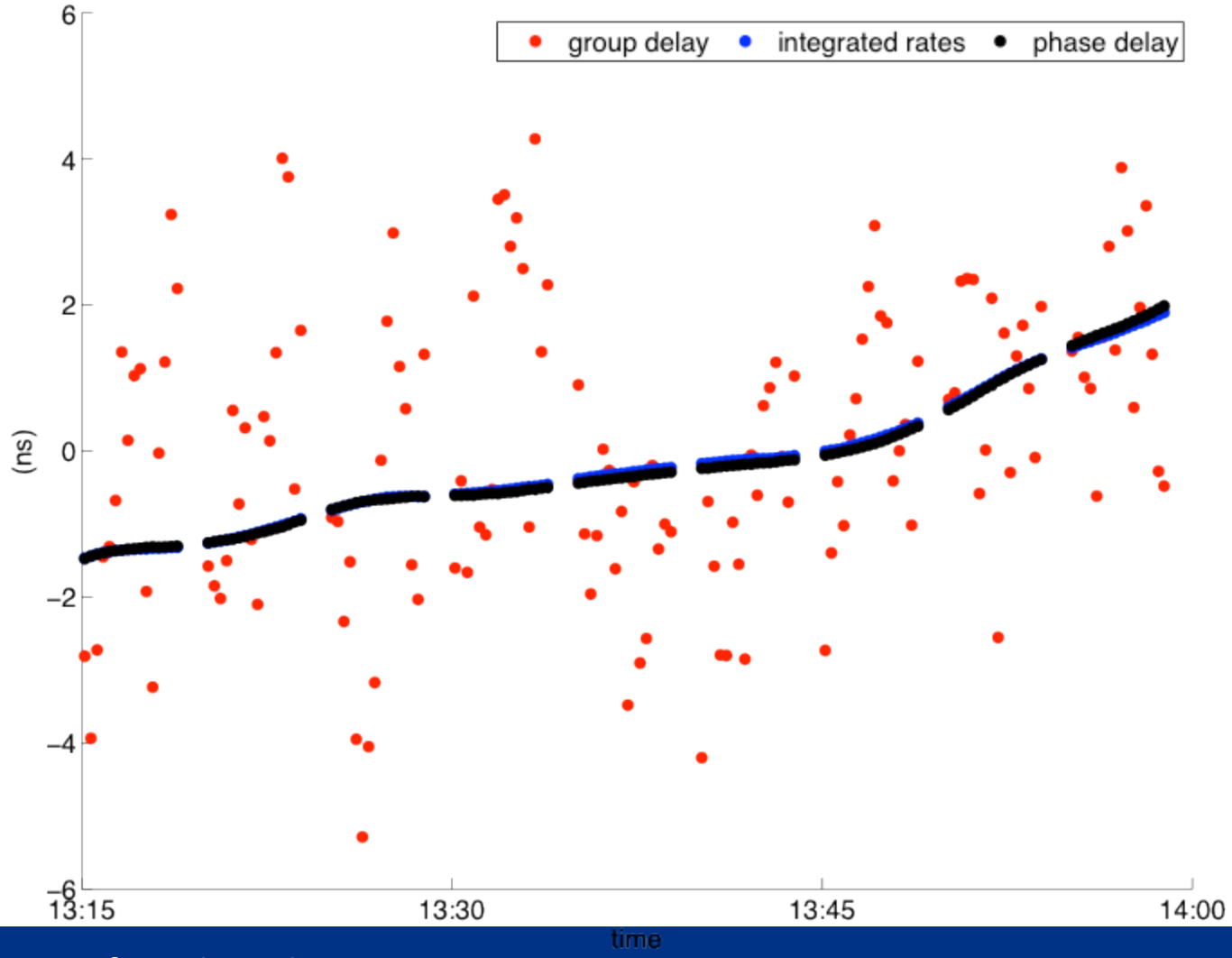
Phases from AIPS/fringe



”unwrapped” phases



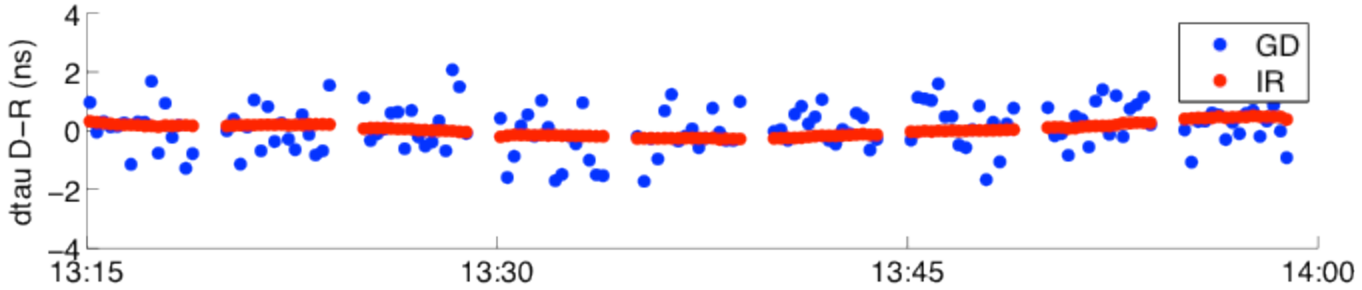
Group delay, integrated delay rate, phase delay



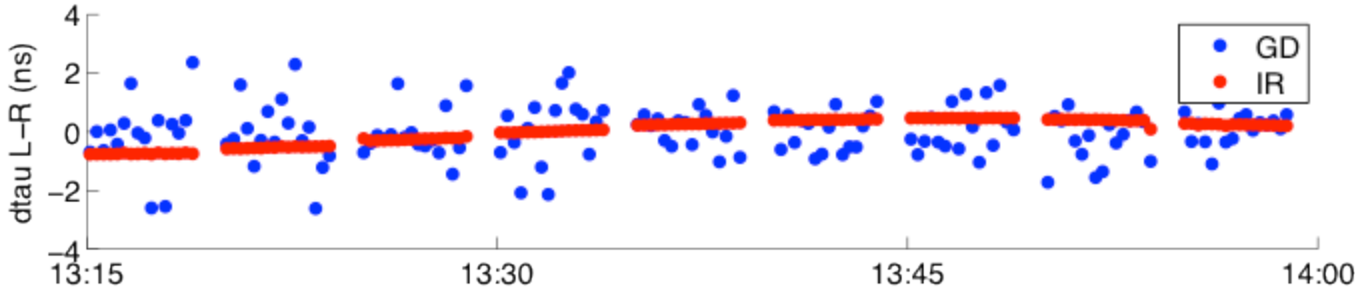
DiFX with D-model aprioris

Total delay differences

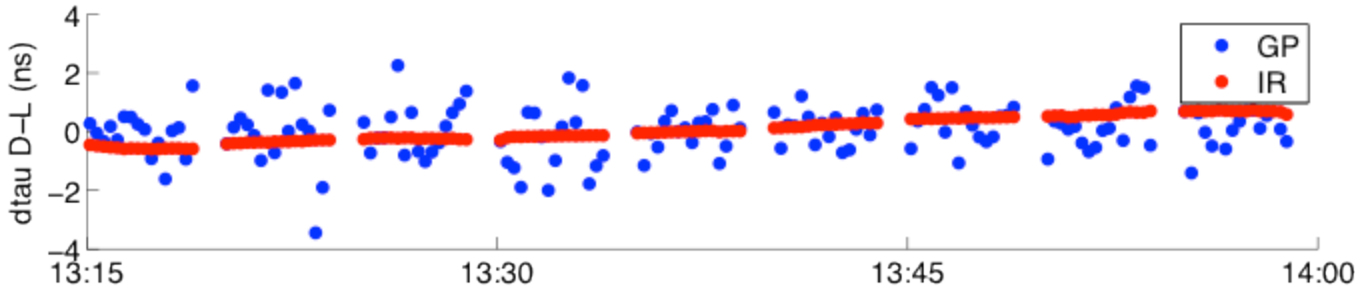
D vs. R



L vs. R



D vs. L



RMS GD:
0.8 – 0.9 ns

RMS IR:
0.2 – 0.4 ns

Conclusions and outlook

- Verified that the Wettzell L-band system works fine
- Successful fringes On-Wz with SFCX and DiFX
- Post-correlation analysis failed for SFCX data
- DiFX correlation tested successfully with three different apriori delay models
- Phase delay determination possible with AIPS
- Total delay values agree with rms 0.8–0.9 ns for group delays and 0.2–0.4 ns for phase delays (via integrated delay rates)

Conclusions and outlook

- Observation and analysis of further test experiments is planned for 2014/2015
- Use of DiFX and fourfit
- Include more L-band stations and observe several GLONASS satellites
- Parallel observations with SLR at Wettzell
- Dedicated L/S/X-experiment

  Wettzell (20 m L/S/X) – Onsala (25m L + 20 m S/X)