

# Real Time Geomonitoring with Low-cost L1 GPS

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Landslide in Ticino Switzerland on 14.05.2012  
(@ Andrey Eroshin)

## Motivation

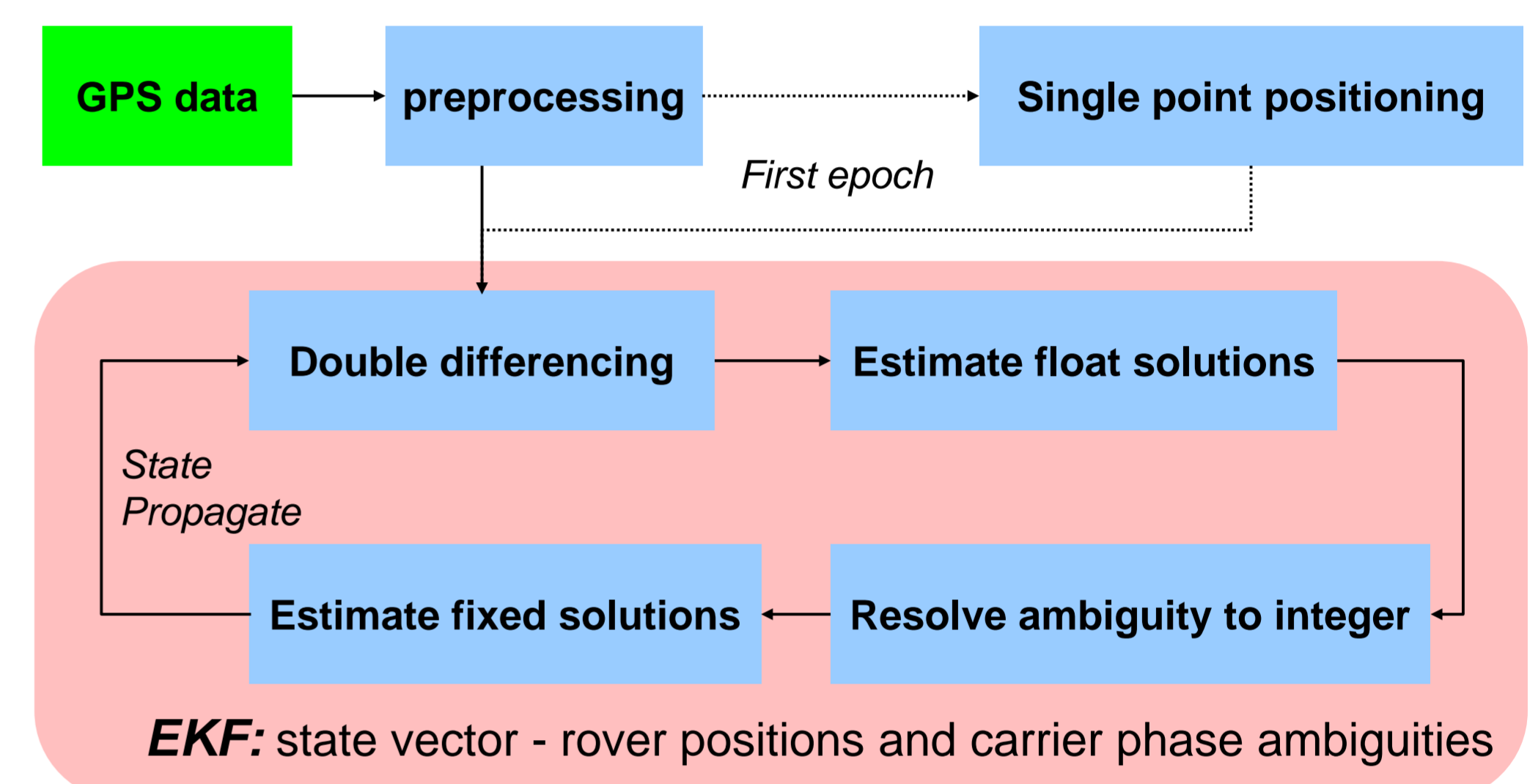
- Increasing disasters caused by mass movement are happening world-widely: in 2012, 115 archived landslides with 192 death toll; in 2013 (till 22, April), 117 archived landslides with more than 306 dead, according to archived landslide news by U.S. Geological Survey.
- Six percent of Switzerland is prone to slope instability (Lateltin et al., 2005).
- There is a strong demand for low-cost/cost-effective Geomonitoring system in hostile areas.

## Goal

- To get precise, reliable and real time 3 dimensional positions of study targets with low-cost GPS sensors
- To make not only monitoring but also early warning of mass movements through low-cost GPS networks possible

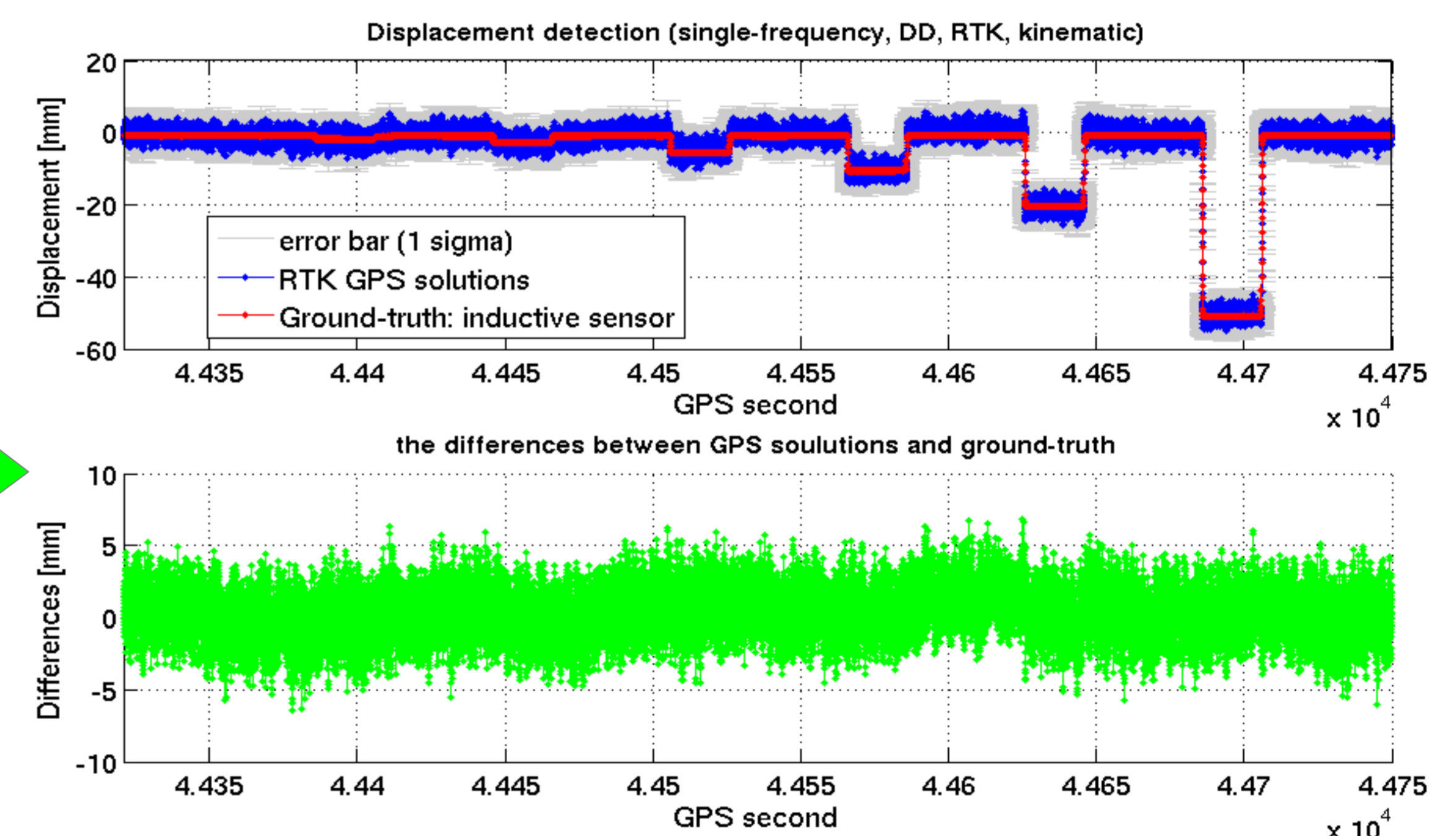
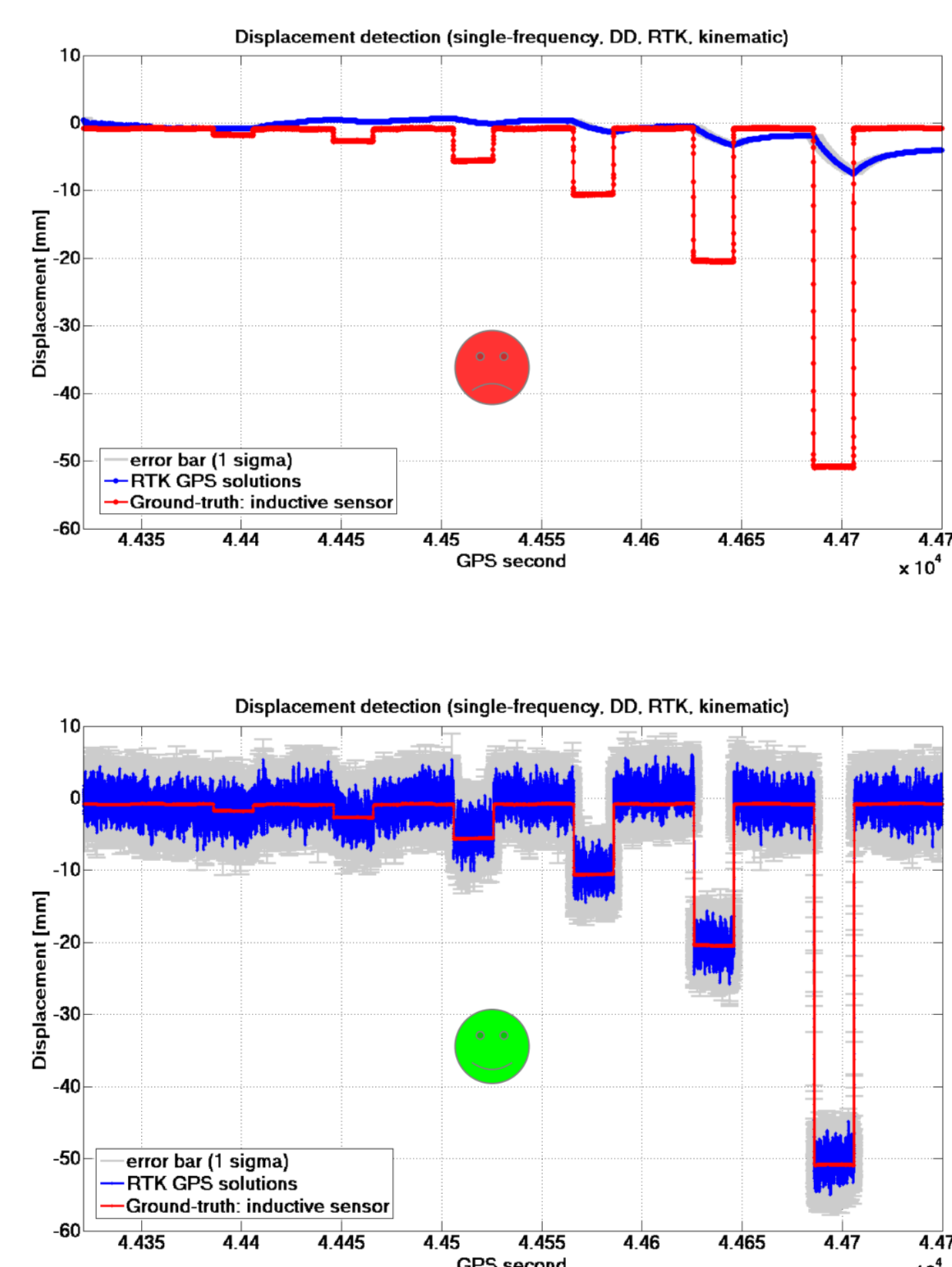
## Methodology

- Double-differenced GPS carrier phase processing with short baselines to reduce distance dependent GPS signal errors (such as troposphere and ionosphere delays) as well as orbits and clock errors
- Real time processing of GPS data by EKF (Extended Kalman Filter)
- Modeling and correcting remaining errors (e.g., multipath) in the calculated GPS positions
- Solution validation procedure to select trustable RTK solutions for motion detection



## Feasibility study

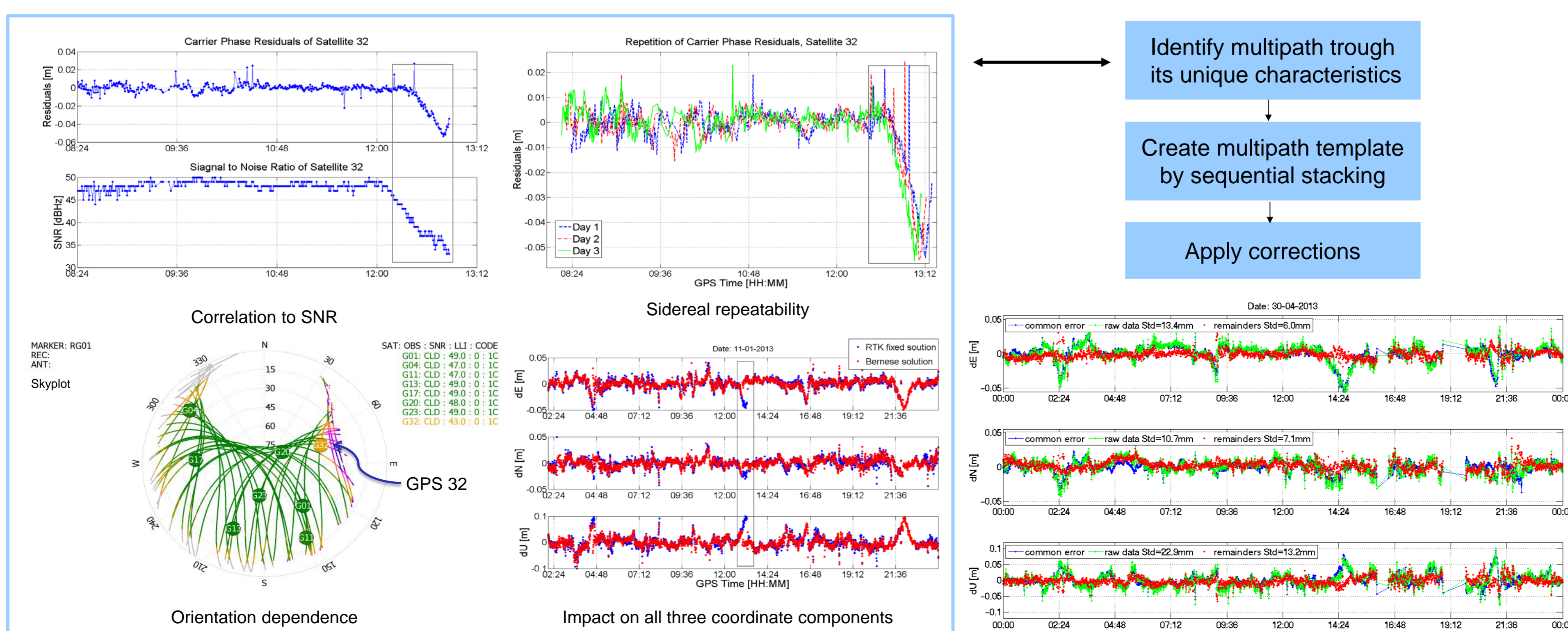
- Movements generated by shake table
- GPS data measured under ideal conditions
- Benchmarking system- inductive sensor
- Test of two different algorithms



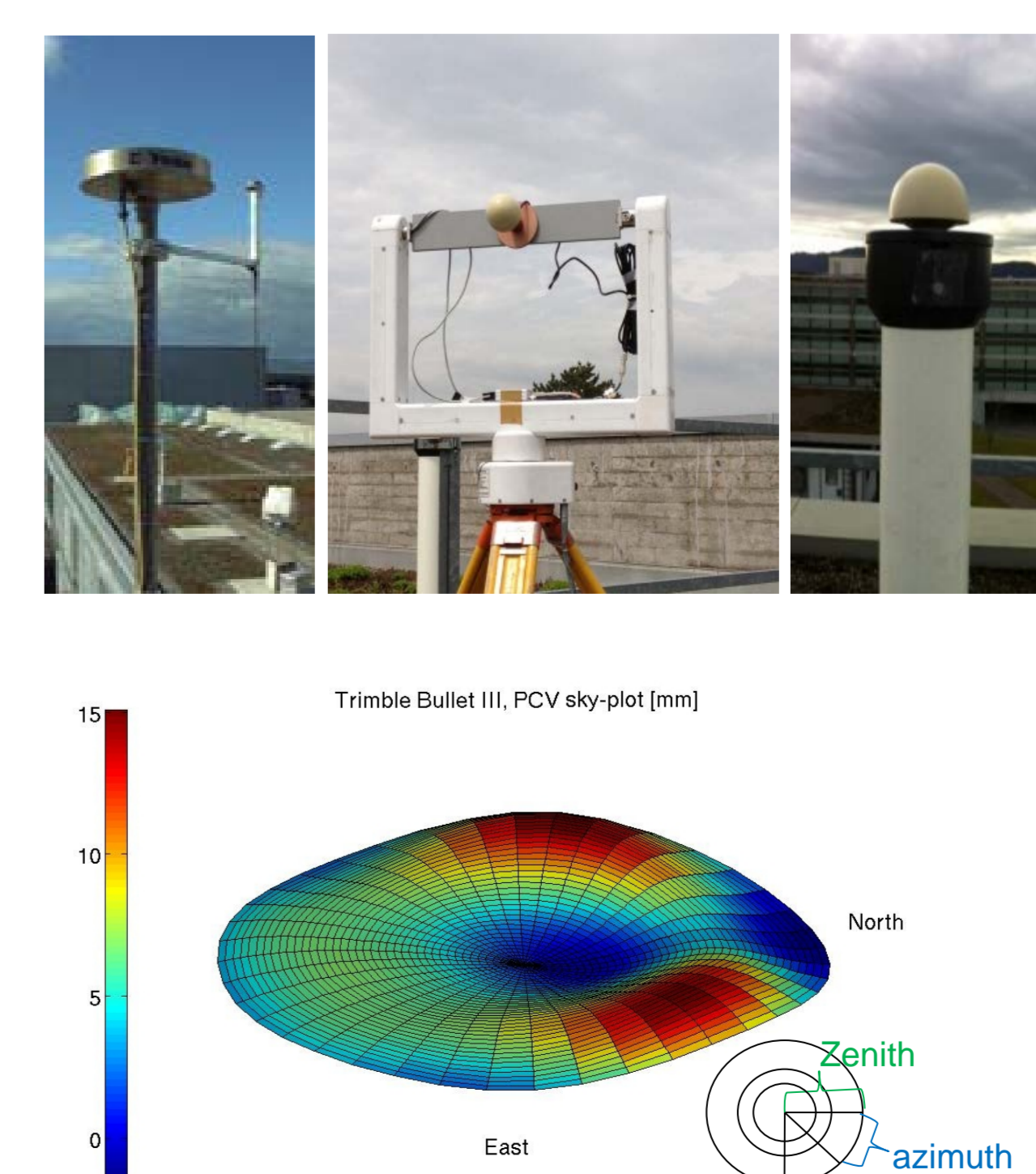
## Main challenges & Solution

- To reduce multipath effect, the major factor limiting the accuracy of RTK positions
- To estimate low-cost GPS antenna pattern - PCO (Phase Center Offset) and PCV (Phase Center Variation)
- To know which is trustable and can be used for motion detection

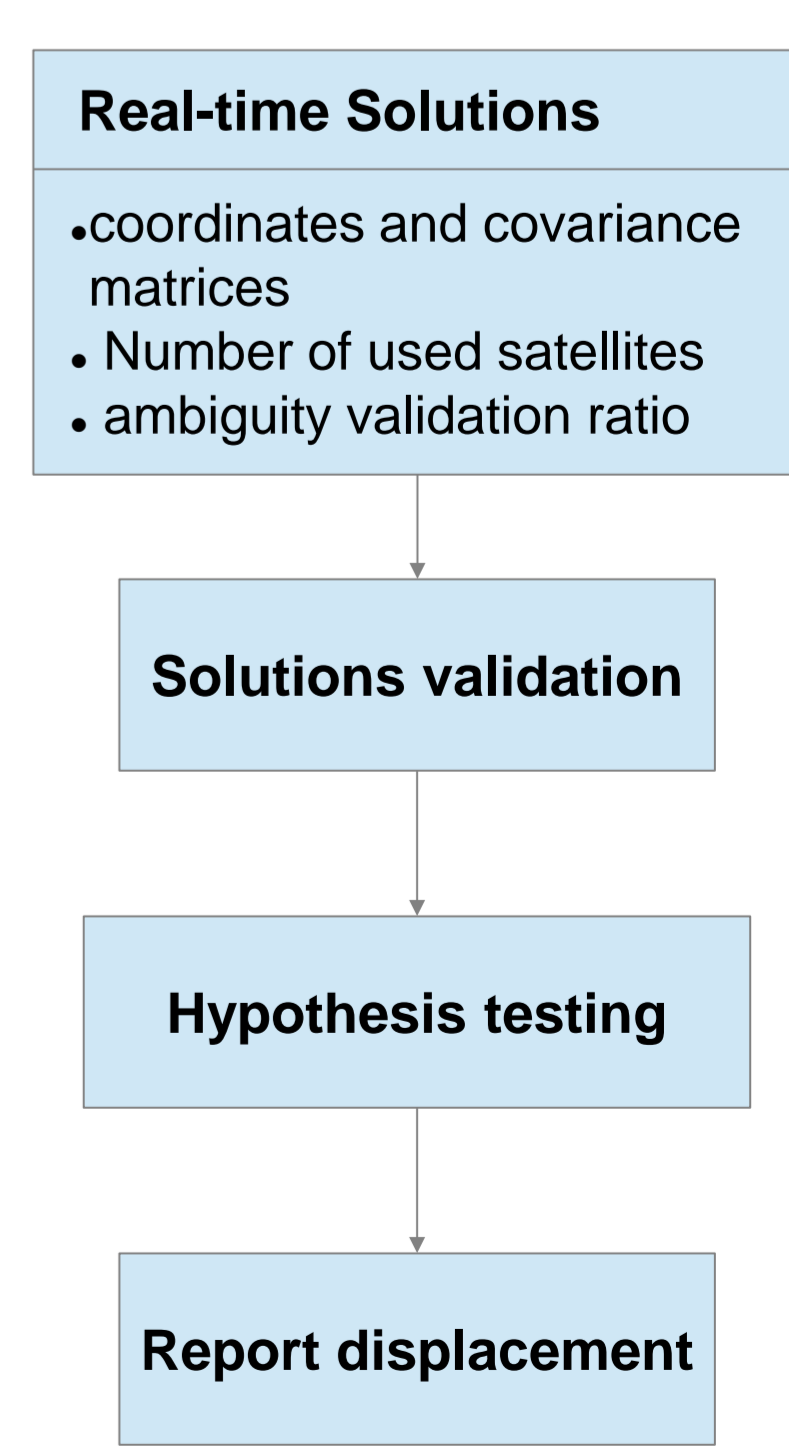
### Multipath modeling and mitigation



### Antenna pattern estimation



### Solution validation



## Acknowledgments

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## References

Olivier Lateltin, Christoph Haemmig, Hugo Raetzo, Christophe Bonnard, 2005, Landslide risk management in Switzerland, Springer-Verlag 2005, DOI 10.1007/s10346-005-0018-8