# Impact of Individual GNSS Antenna Calibration Used in the EPN on Positioning

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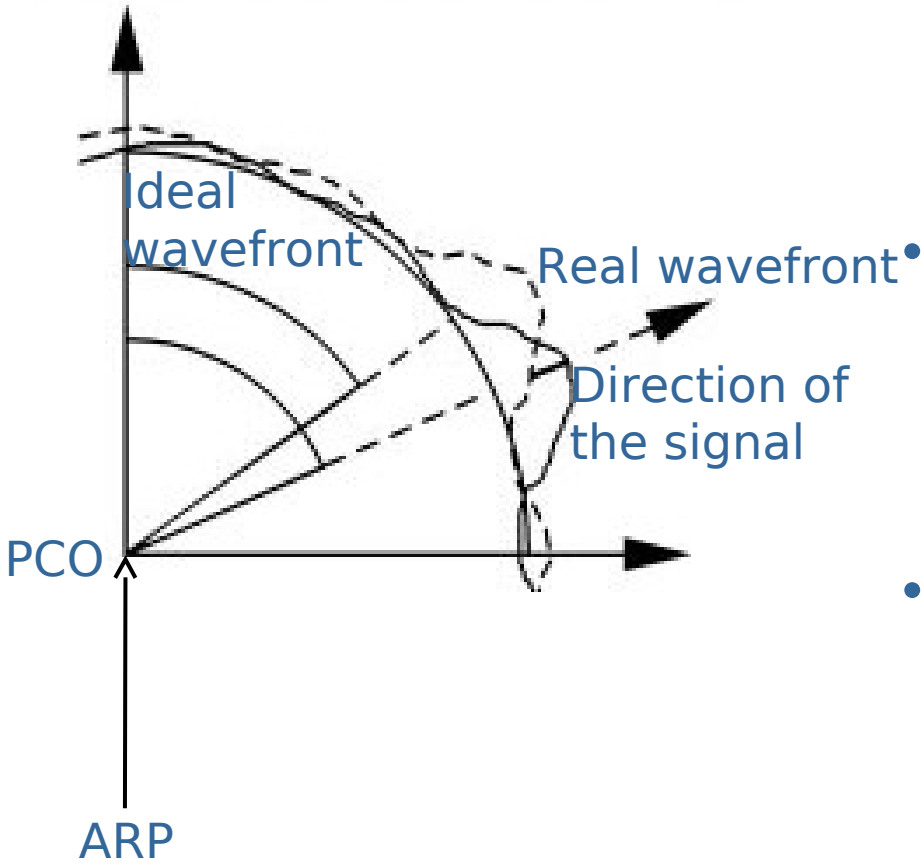
# Outline

- Individual antenna calibration methods
- Methodology
  - Precise Point Positioning
  - Data sets
- Impact on geodetic positioning
  - Comparison between individual and igs08.atx calibrations
  - Comparison between different individual calibrations
- Summary and conclusions

# Phase Center Variation

- The position of a station refers to the Antenna Reference Point (ARP)




- The distance measured refers to the phase center of the antenna
- Phase center offset (PCO): difference between the ARP and the phase center of the antenna
- Phase center variation (PCV): deviation of the phase center with respect to an ideal wavefront
- PCV is elevation and azimuth dependent

# Individual calibration methods

- Robot calibrations

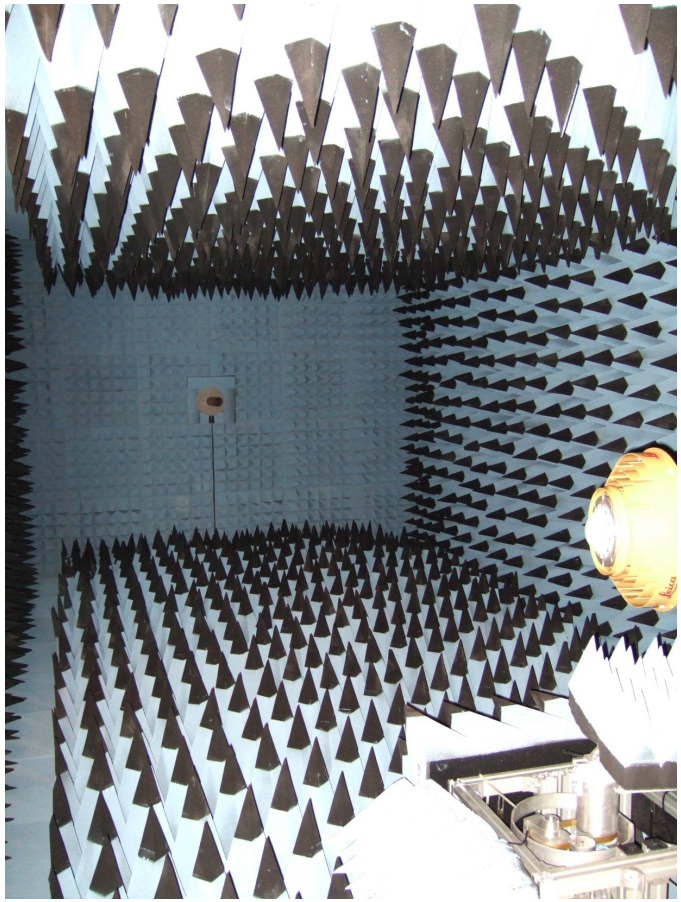
- Carried outdoor
- Use real GNSS signals
- Signal treated with a GNSS receiver
- Multipath mitigated by the movement of the robot
- Used by the IGS to generate type mean calibrations

➡ Geo++

Also Ife, SendStadt Berlin

# Individual calibration methods

- Anechoic chamber calibrations



- Anechoic supposed to reduce reflections
- Use generated sine wave
- Vector Network Analyzer
- Multipath mitigated by the chamber

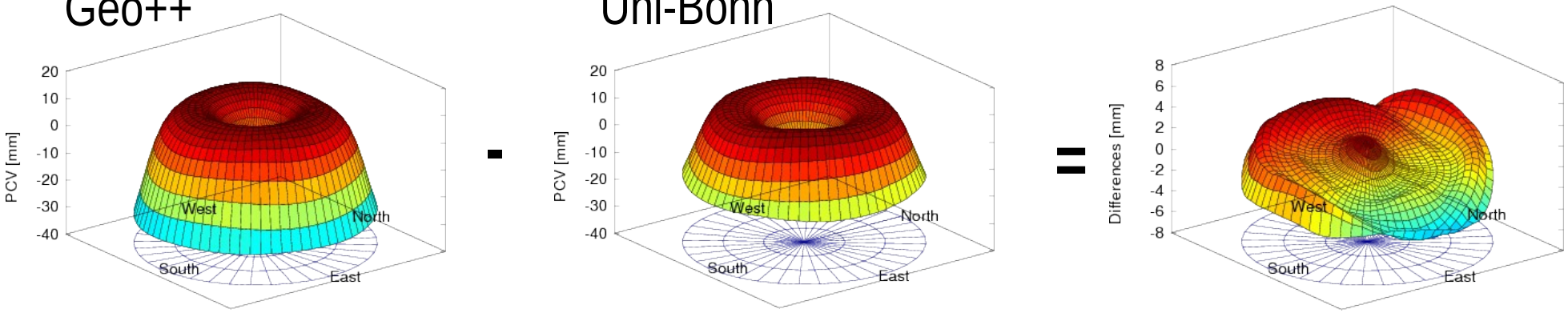
➡ at IfE Bonn

# Differences of calibration

- Differences between Geo++ and Uni-Bonn calibration for the same antenna on $L_3$

TRM59800.00 NONE 54099 installed in RTBT

Geo++ - Uni-Bonn = 



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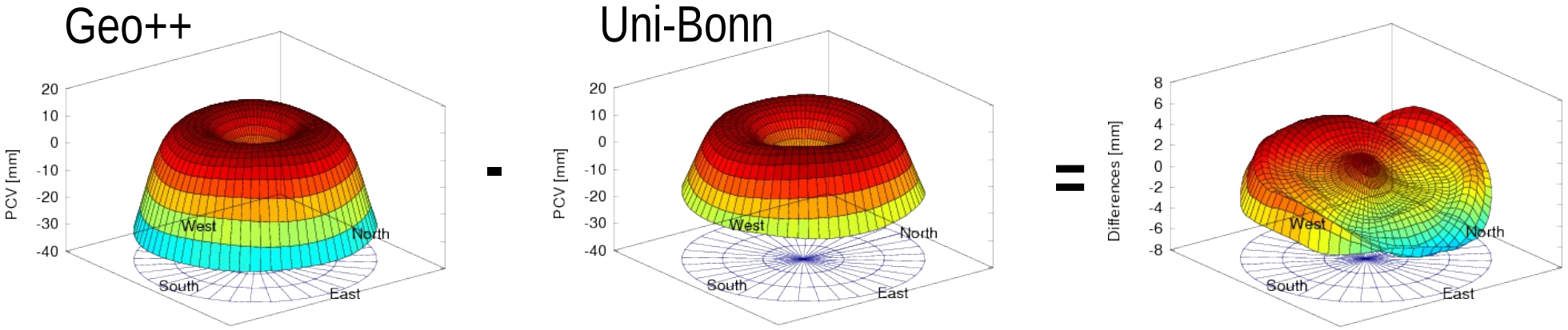
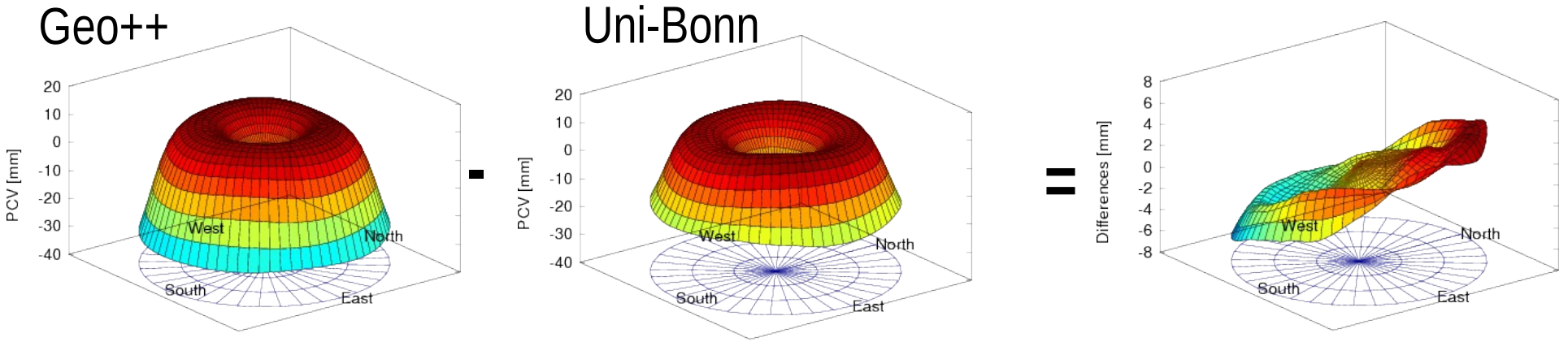
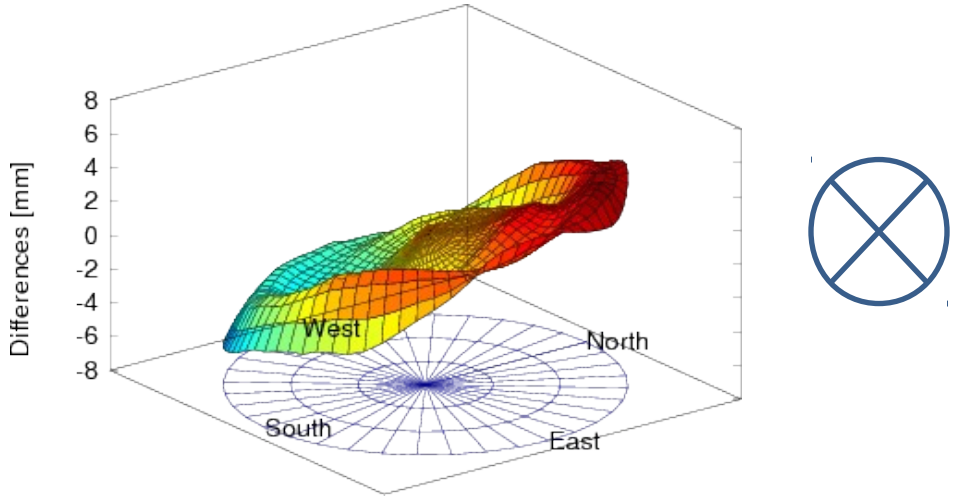


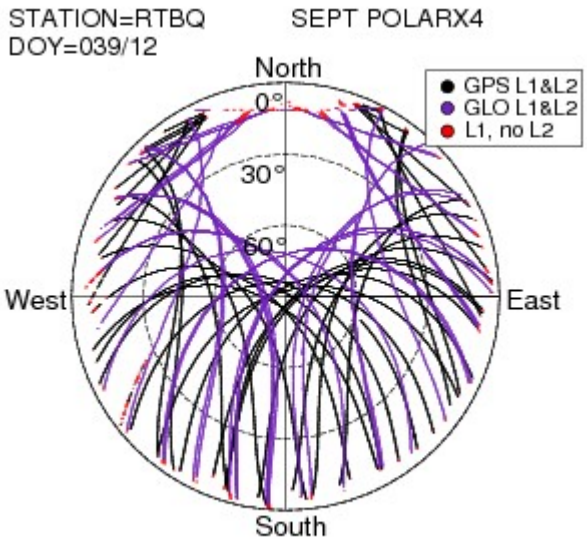

TRM59800.00 NONE 54144 installed in RTBQ



# How to estimate the impact on positioning

- The impact on positioning is not direct:
  - PCO+PCV will affect each satellite differently at each epoch



# Methodology : PPP

A similar approach was followed as the one used by Rebischung et al., 2011:

- Two separate PPP: identical processing options (satellite antenna calibrations, orbits and clocks, etc…), except for the receiver antenna calibration model.
- Receiver antenna calibration model: igs08.atx and individual calibrations.
- Position offset caused by the changed of receiver antenna calibration model: difference between the daily positions obtained by the different PPP

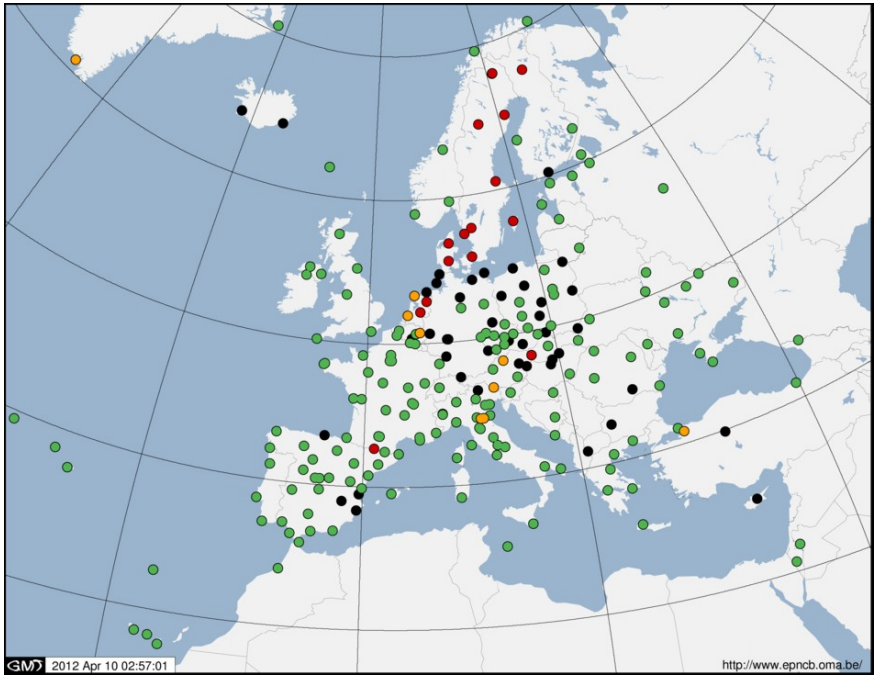
- Final position offset of a station obtained by taking the mean of the daily estimates over the considered data set of that station

# Methodology : Data sets

- Two data sets are analyzed here
  - The EPN stations with individual calibration
    - from the beginning (2003 for the first individual calibration in the EPN) to April 2011.
    - compared to the type calibrations from igs08.atx.
  - The six antennas installed at ROB
    - Each of those antenna have been individually calibrated by both GEO++ and Uni-Bonn.
    - comparing the two calibrations for each antenna.

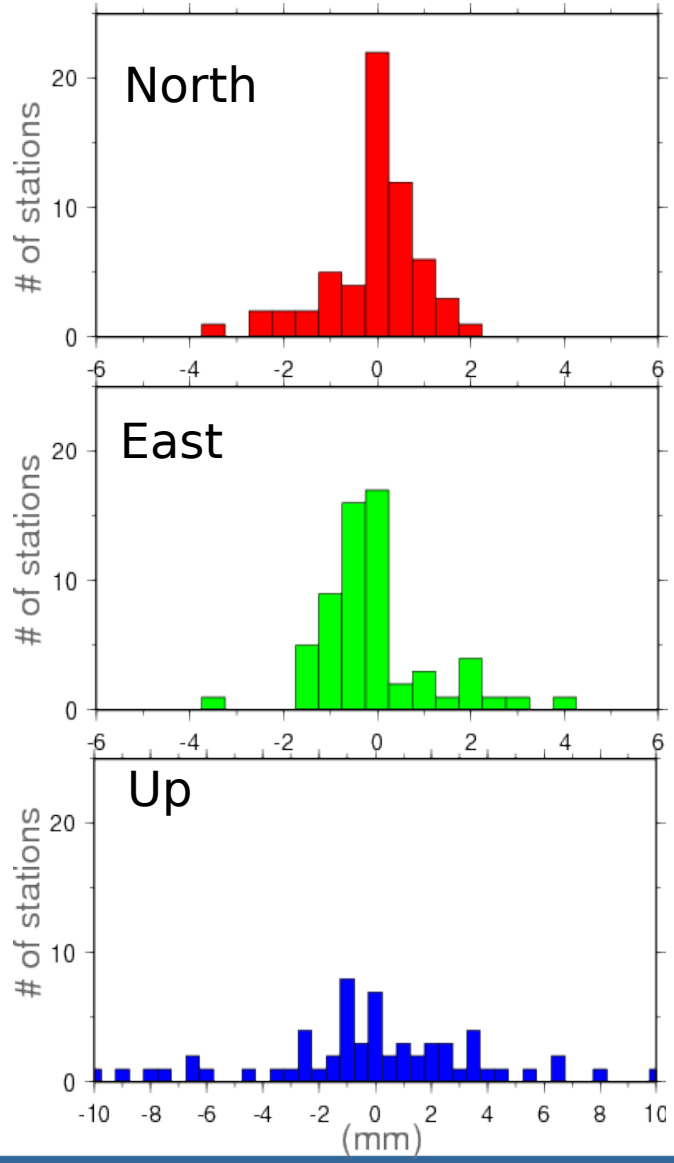
# Impact on Geodetic Positioning
## Individual vs igs08.atx type calibrations

- The first set of data :
  - EPN stations with individual calibration: from 2003 to April 2011. They are compared to the type calibrations from igs08.atx.




- black: antenna/radome pairs with absolute individual calibrations (15.98%)
- green: antenna/radome pairs with true absolute type calibrations (69.26%)
- orange: antenna/radome pairs with absolute calibrations converted from relative values (6.56%)
- red: antenna/radome pairs without absolute calibrations. In this case, the radome is neglected and the

# Impact on Geodetic Positioning
## Individual vs igs08.atx type calibrations




- Position jumps for the 53 station/antenna+radome pairs individually calibrated
- Horizontal:
  - Distribution around 0 mm
  - Values up to 4 mm
- Vertical:
  - No clear distribution
  - Great differences up to 10 mm

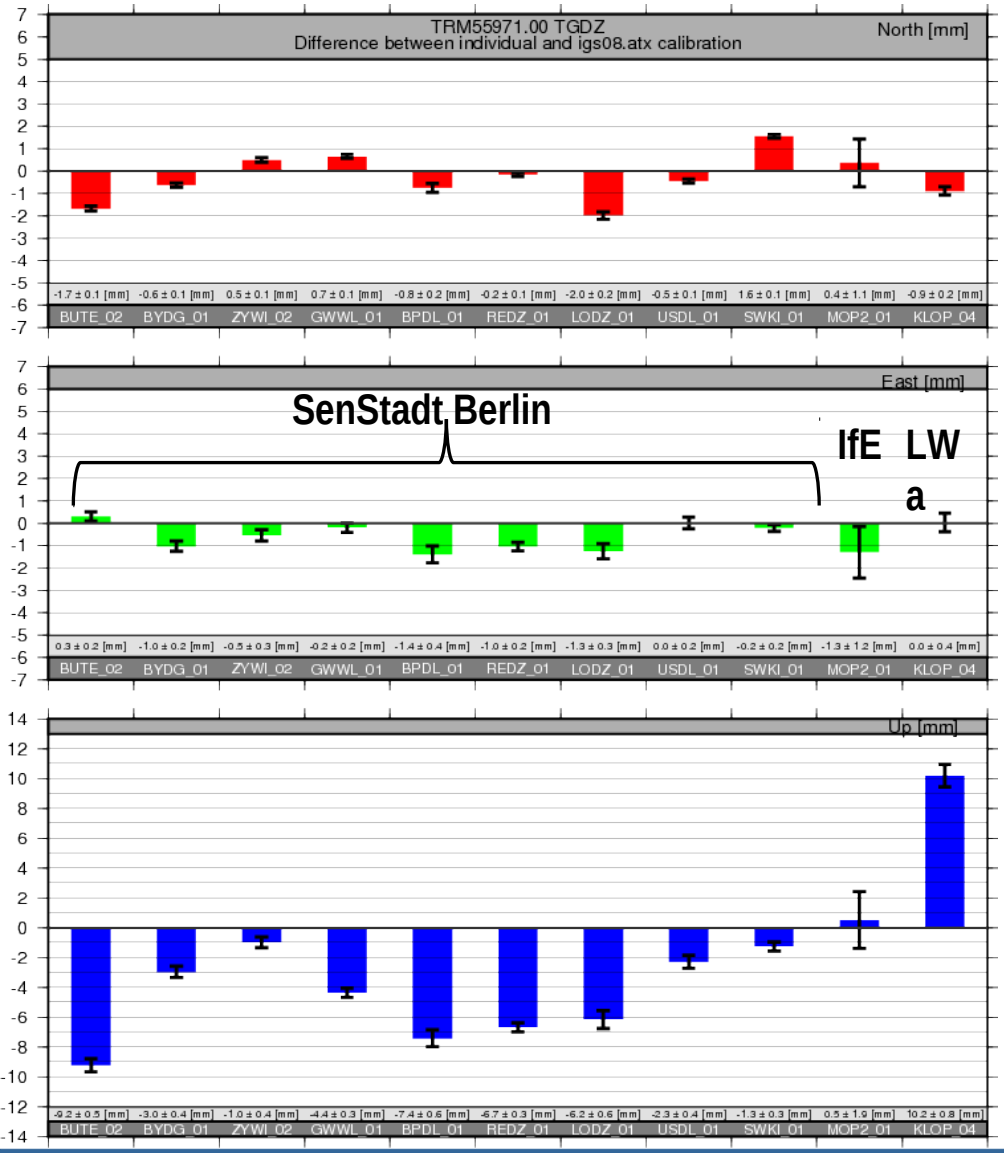
# Impact on Geodetic Positioning
## Individual vs igs08.atx type calibrations

- Some position biases equal to 0:
  - Type mean based on 1 individual calibration

- A particular model of antenna, the TRM55971.00 TZGD, is present in 11 stations and with individual calibration

⇨ What are the differences between each individual calibration and the type calibration ?

# Impact on Geodetic Positioning
## Individual vs igs08.atx type calibrations




- The type calibration is the mean of GEO++ calibration of 8 antennas
- All the individual calibration not done by the same institute
- The north component shows differences up to 2 mm with respect to the type calibration
- The up component shows large differences up to 10 mm with respect to the type calibration

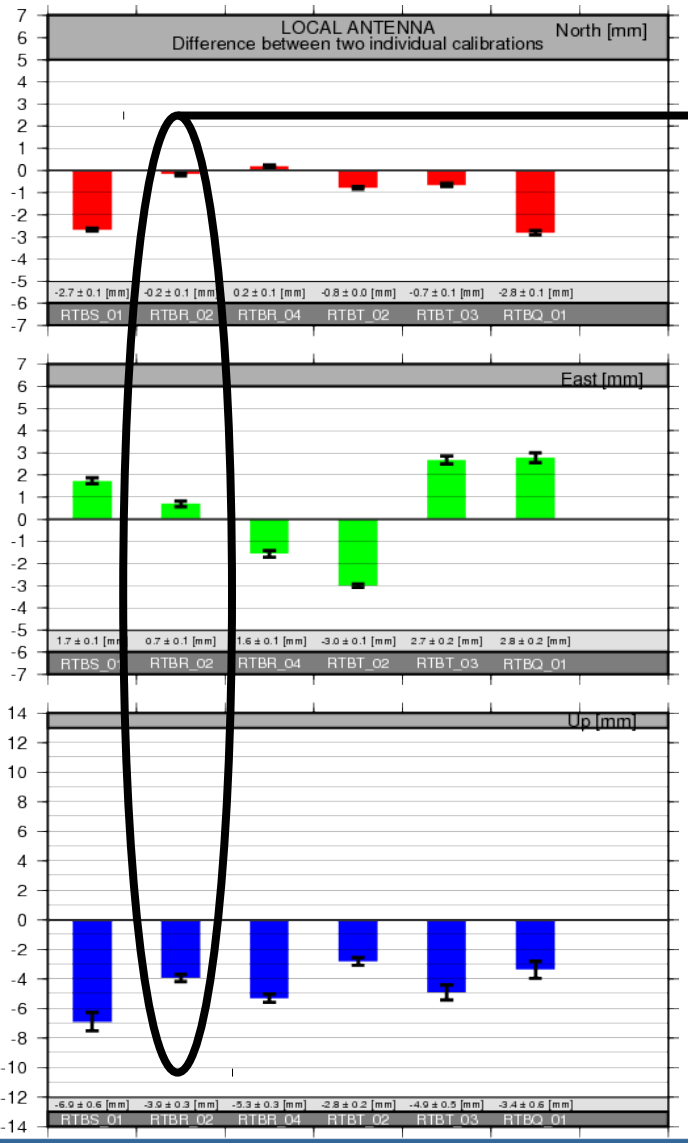
# Impact on Geodetic Positioning
## Geo++ vs Uni-Bonn

- The second set of data :
  - The six antennas installed at ROB. Each of those antenna have been individually calibrated by both GEO++ and Uni-Bonn. The impact of the calibration method on the positioning is investigated by comparing the two calibrations for each antenna.

- What is the impact of the calibration method on the positioning ?

# Impact on Geodetic Positioning

## Geo++ vs Uni-Bonn



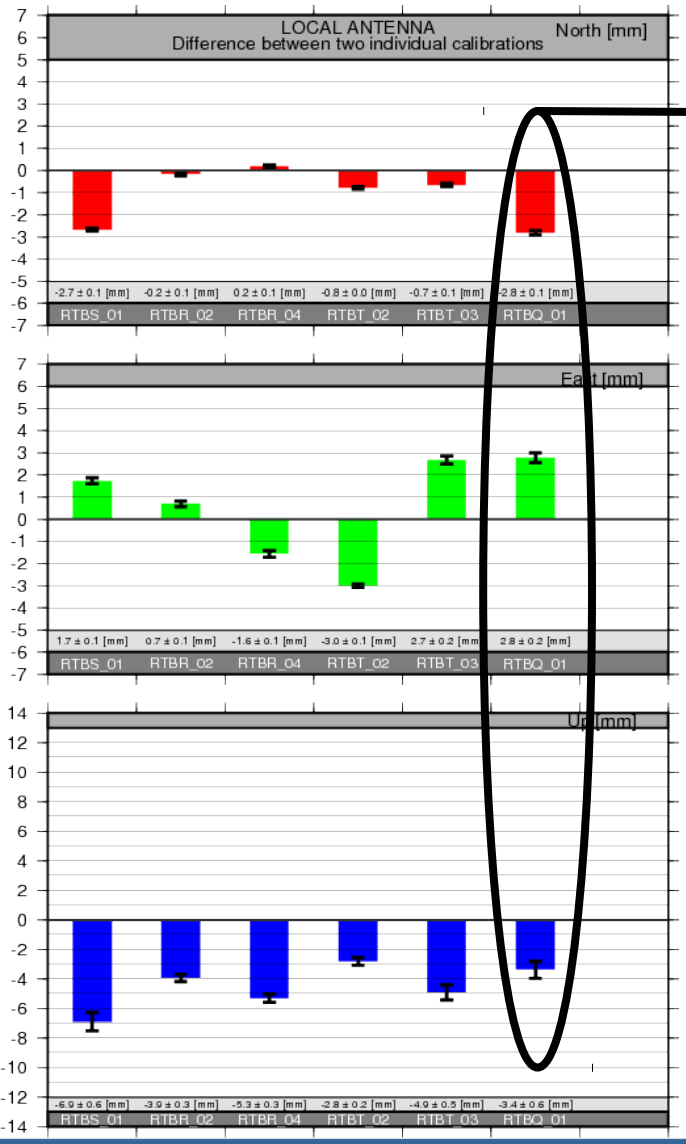

- One LEIATR25.R3 NONE antenna
- All the other antennas are TRM59800.00 NONE antennas.

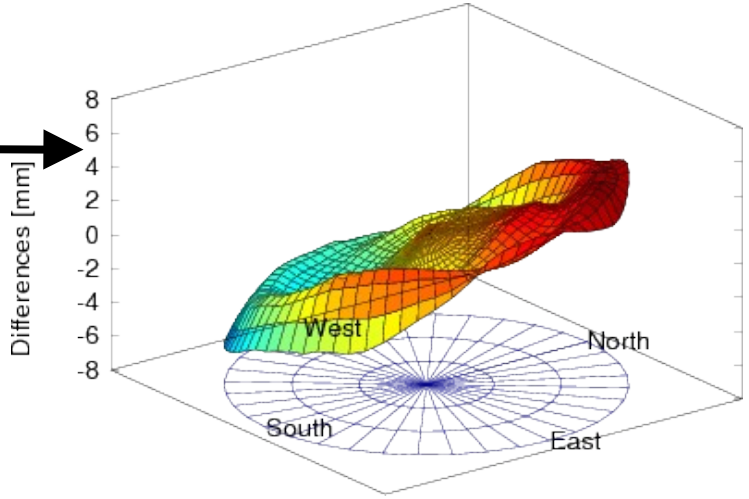
- No systematic effect on the horizontal component. But significant effect

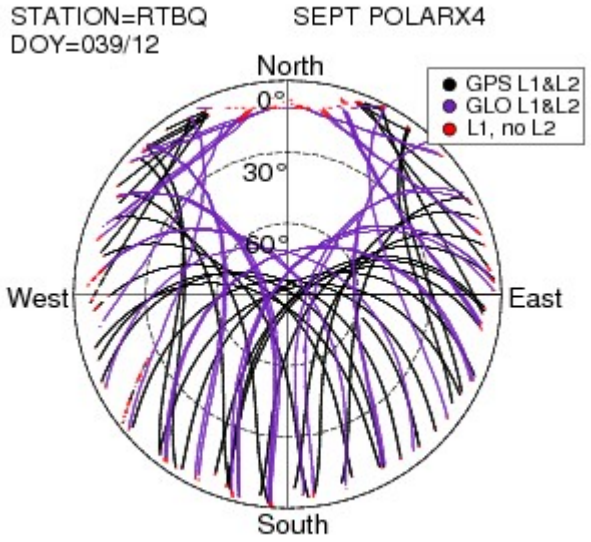
- Values up to -7 mm. Too few values to evocate a trend

# Impact on Geodetic Positioning

## Geo++ vs Uni-Bonn

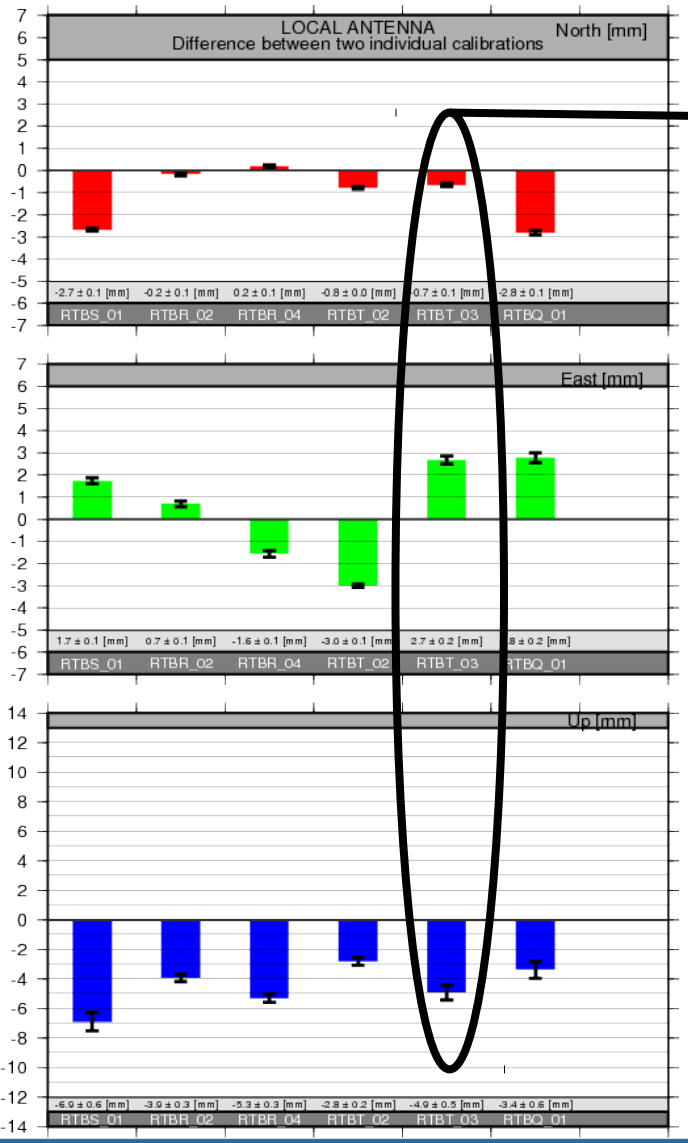


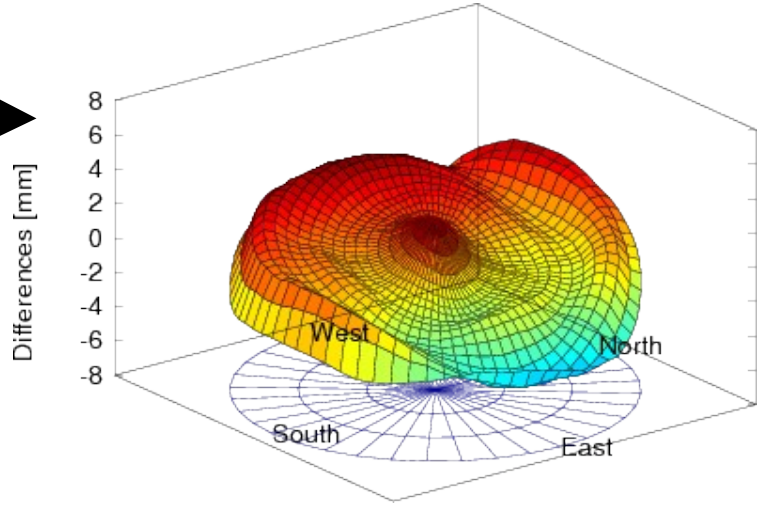



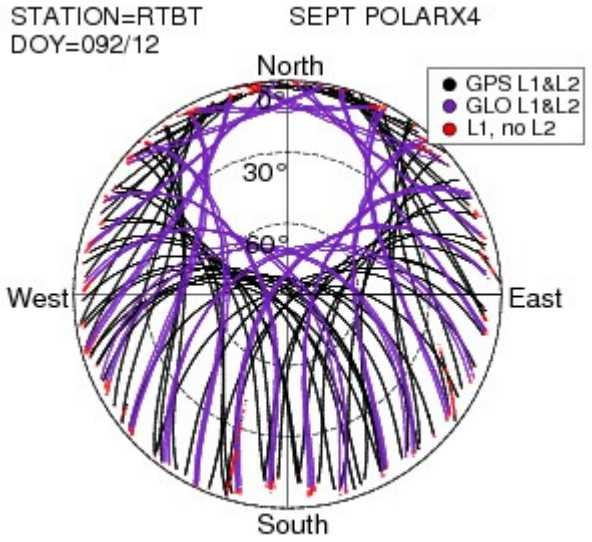



# Impact on Geodetic Positioning

## Geo++ vs Uni-Bonn



# Summary

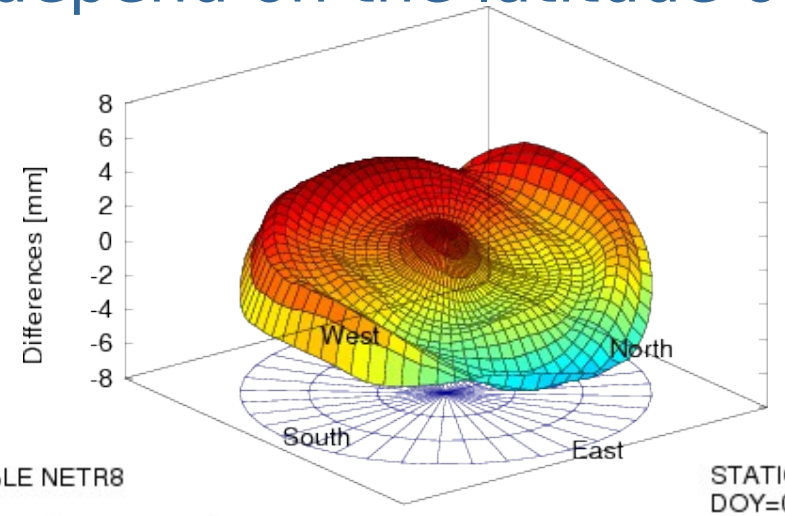
- Comparisons between station positions computed with individual and igs08.atx receiver antenna calibrations show that (results for Europe):
  - The position offset can reach 4 mm in horizontal component and 10 mm in the vertical component.
  - The position offsets have a greater impact on the vertical component.
  - For the same antenna model, the position offsets induced by different individual calibrations with respect to igs08.atx calibrations can reach 2 mm in the horizontal component and 10 mm in the vertical component.

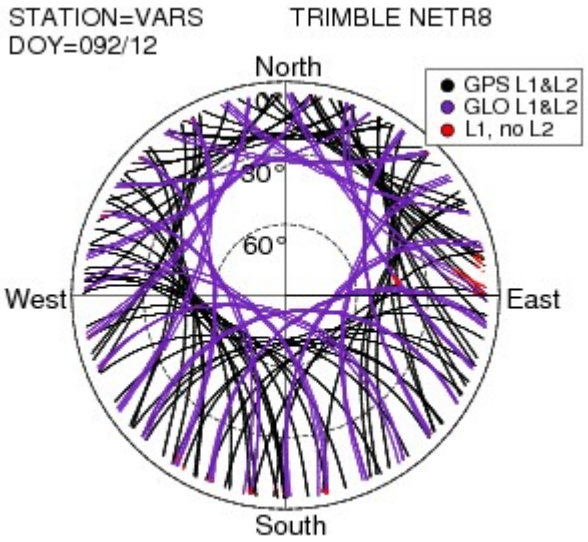
# Summary

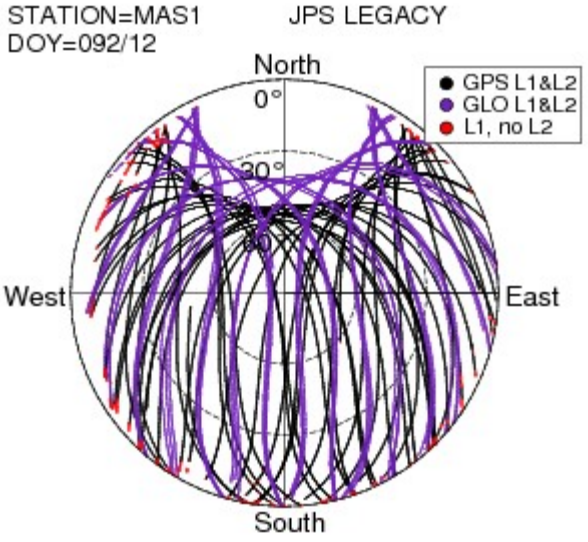
- Individual receiver antenna calibrations from Geo++ and UniBonn show that (results for 6 antennas in Brussels):
  - The position offsets can reach 3 mm in the horizontal component and 7 mm in the vertical component.
  - Position offsets induced by different calibration methods can be larger than those induced by the difference between an individual and type calibrations.

# Conclusion

- This effect will depend on the latitude of the station:

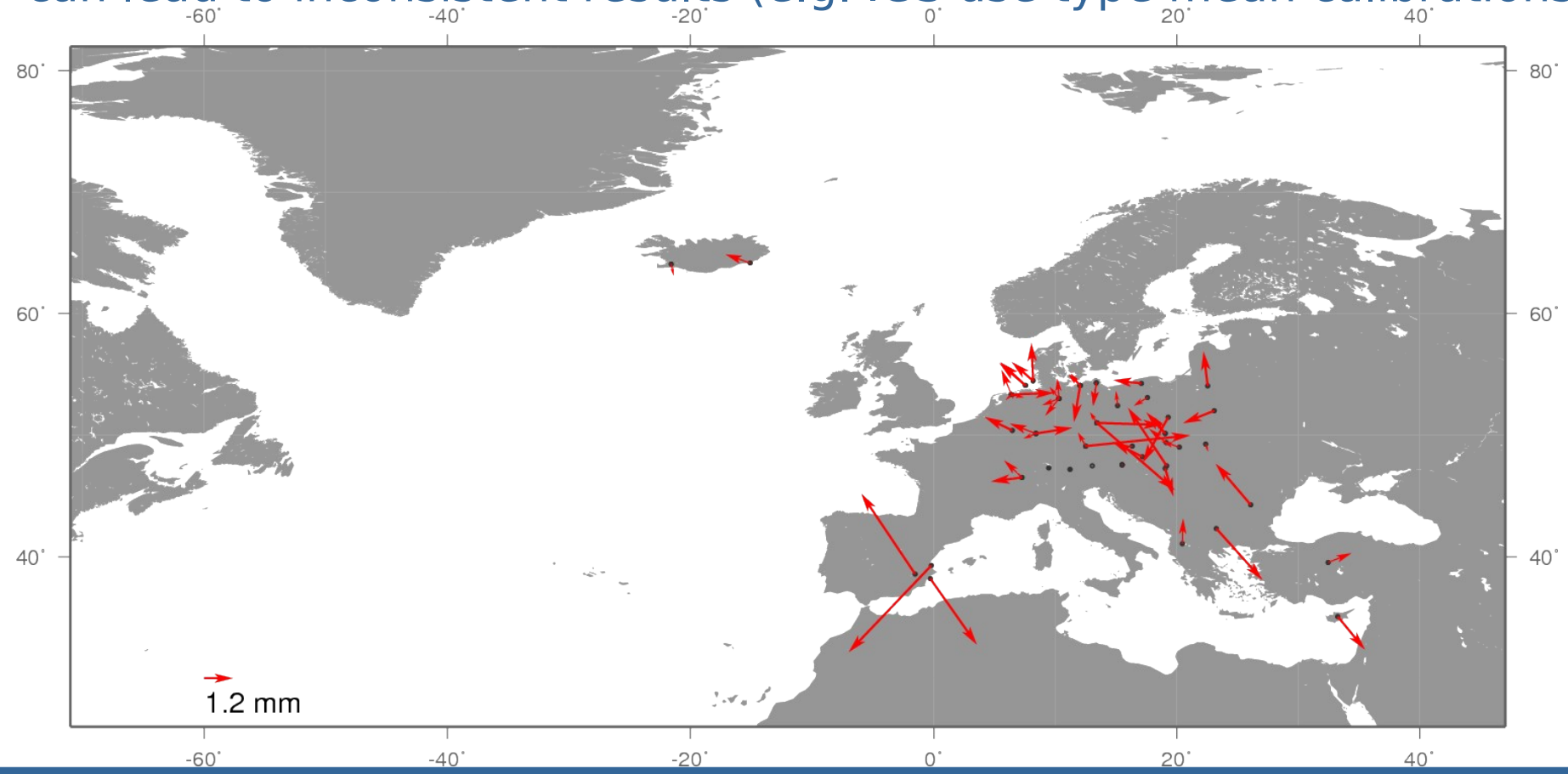


# Conclusion

- Use of individual calibrations for positioning applications:
  - physically more relevant than type mean calibrations
  - can lead to inconsistent results (e.g. IGS use type mean calibrations)



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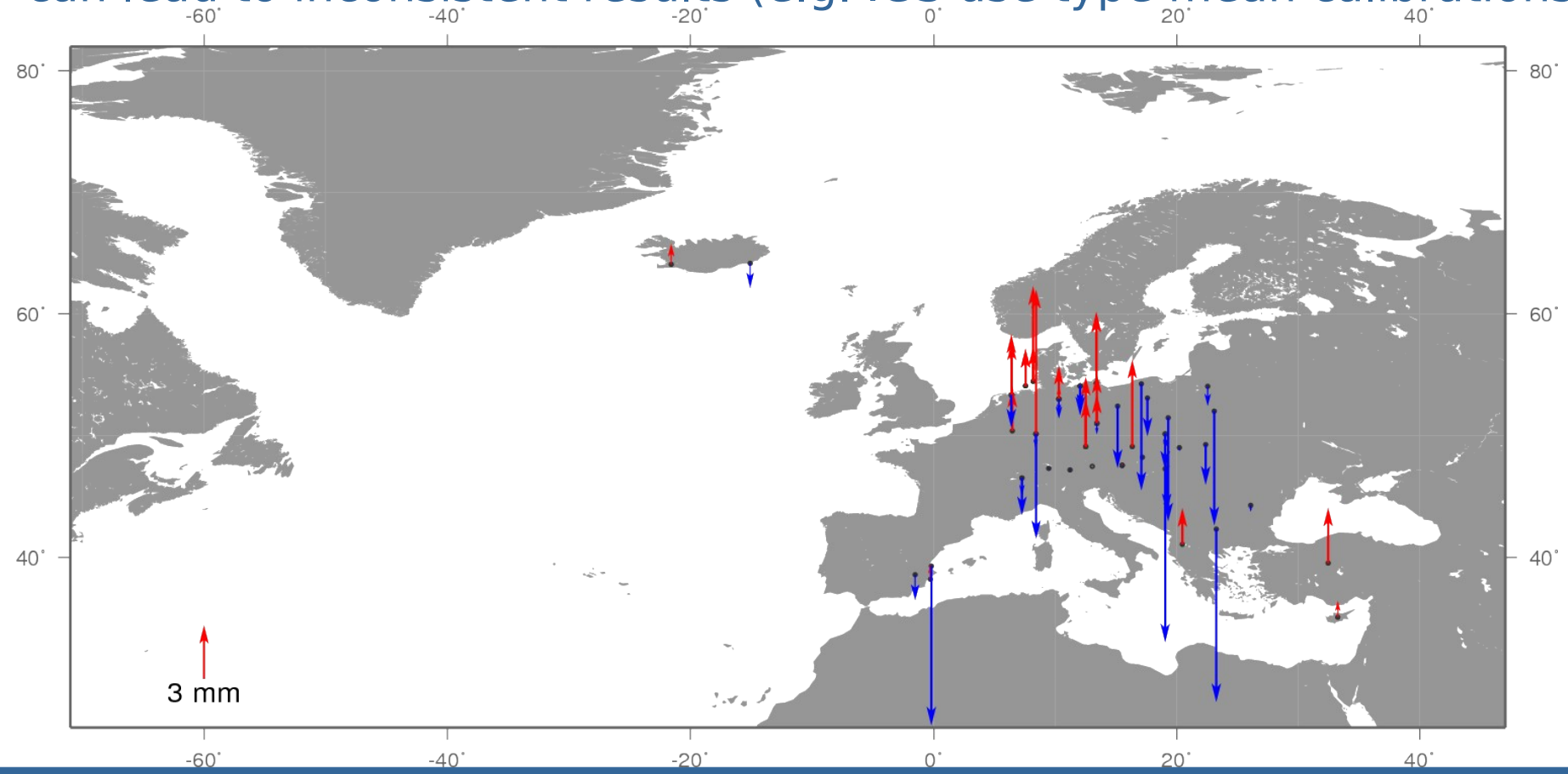

# Conclusion

- Difference between individual and type mean calibrations
  - Nothing on the accuracy on positioning
  - No clue of an improvement of the repeatability so far

- But
  - No jumps in the timeseries when the type mean calibration are updated

⇨ Individual calibrations ensure continuity in the timeseries