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**Swiss Federal Office of Topography swisstopo**

# Multi-GNSS activities at EPN and at swisstopo

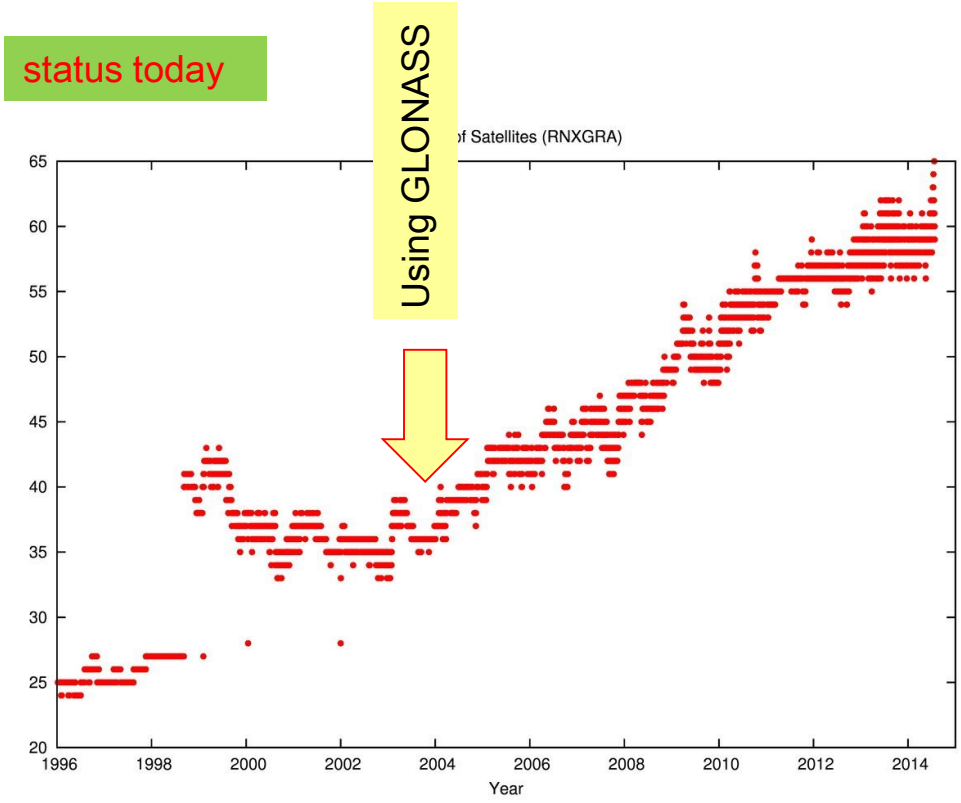
E. Brockmann, Carine Bruyninx, Alessandro Caporali, Rolf Dach, Jan Douša, Heinz Habrich, Wolfgang Sőhne, Christof Vőlksen

# Multi-GNSS development

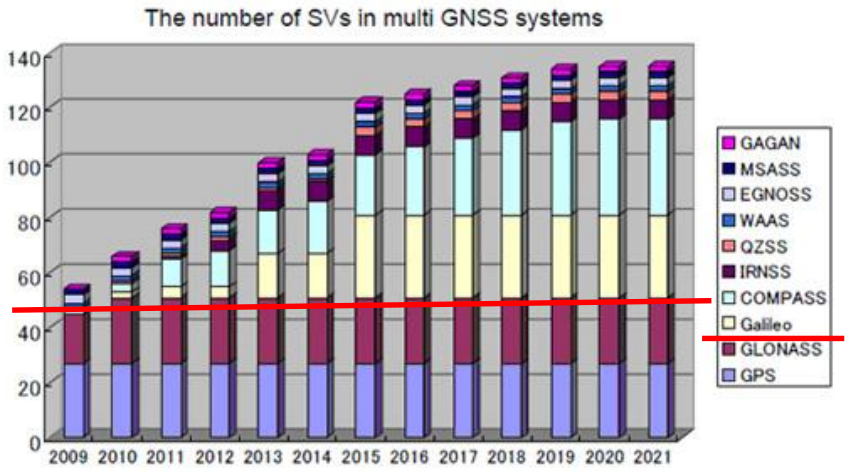
swisstopo reprocessing
# Satellites (25 -> 65)

Evolving satellite systems
GAL, BDS, QZS, …
-> 130 in 2020

status today




expected status



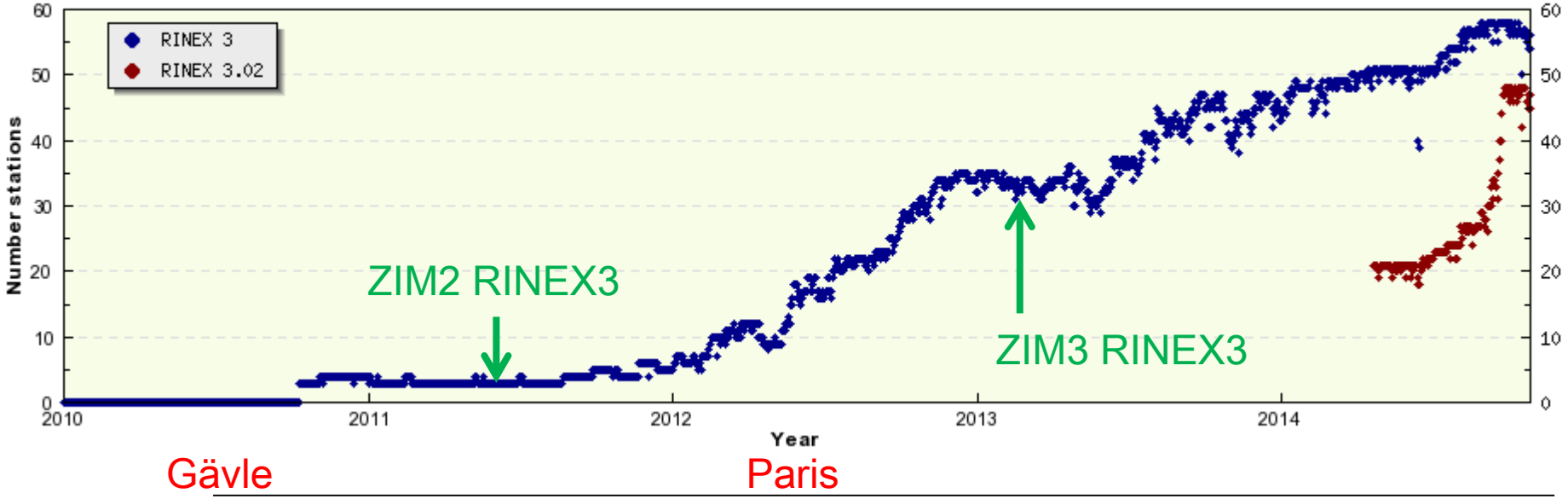

Source: cited from “Asia Oceania is the 'Showcase of the New GNSS Era' ”, presented at 5th QZSS user meeting (KOGURE, Satoshi Mr., 10th March 2010)

# EUREF Multi-GNSS WG

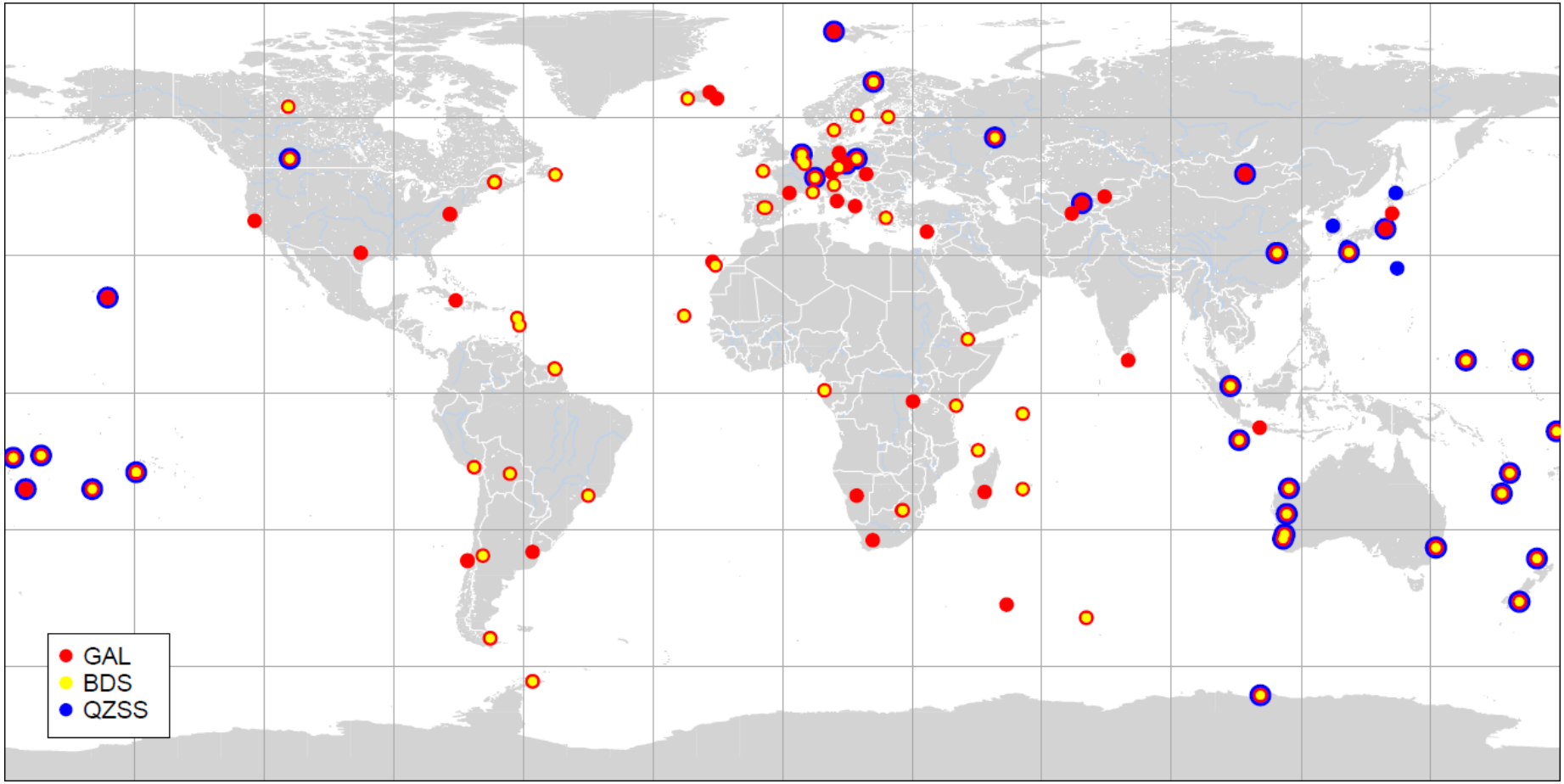
- Working group initialized at Gaevle Symposium 2010
- Action plan defined at Paris Symposium 2012
  - GPS -> GLO
    since 2014 almost all AC switched from BSW50 to BSW52 and use GLO in the data processing (exception SUT, ASI-GIPSY)
  - Encouraging station managers to submit RINEX3 data
  - Cooperation with IGS MGEX project
  - In progress: Prepare necessary steps towards integration in the routine data flow and product generation

# Development of RINEX3 files in EPN

- Actual status: 58 stations delivering RINEX3
  - 13 stations 3.01 (10 Leica, 3 Javad)
  - 45 stations 3.02
- ~15 additional IGS-MGEX stations in Europe



# The IGS MGEX Network: ~120 stations



# GNSS signals

current analysis standard

| | | | | |
|---|---|---|---|---|
| GPS | **L1** 1575.42 MHz | | **L2** 1227.60 MHz | **L5** 1176.45 MHz |
| GLONASS | **L1** 1598-1605 MHz | | **L2** 1243-1249 MHz | **L3** 1202.025 MHz |
| Galileo | **E1** 1575.42 MHz | **E6** 1278.75 MHz | **E5 AltBOC** **E5b** 1207.14 MHz | **E5a** 1176.45 MHz |
| BeiDou | **B1** 1561.10 MHz | **B3** 1268.52 MHz | **B2** 1207.14 MHz | |
| QZSS | **L1** 1575.42 MHz | **LEX** 1278.75 MHz | **L2** 1227.60 MHz | **L5** 1176.45 MHz |
| IRNSS | **S** 2492.028 MHz | | | **L5** 1176.45 MHz |

# RINEX3 obs Types: ZIM2 – ZIM3

GPS/ GLO

**Tracking**

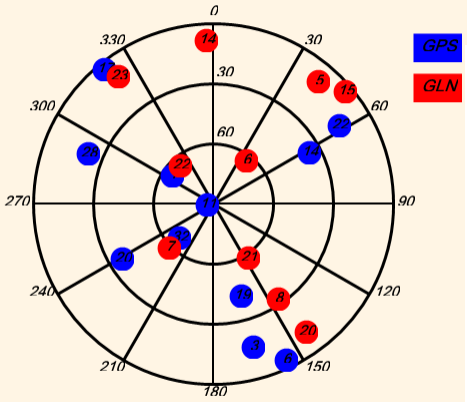
Elevation Mask 0 °

Everest™ Enable

Clock Steering Enable

| Type | Signal | Enable | Options |
|---|---|---|---|
| GPS | L1 - CA | ☑ | |
| GPS | L2 - Legacy | ☑ | |
| GPS | L2 - CS | ☐ | |
| GPS | L5 | ☑ | I + Q |
| SBAS | L1 - C/A | ☐ | |
| SBAS | L5 | ☐ | |
| GLONASS | L1 - C/A | ☑ | |
| GLONASS | L1 - P | ☑ | |
| GLONASS | L2 - C/A(M) | ☐ | |
| GLONASS | L2 - P | ☑ | |

**Satellites - Skyplot**




2013-02-22T07:25:34Z (UTC)

MULTI-GNSS

**Tracking**

Elevation Mask 0 °

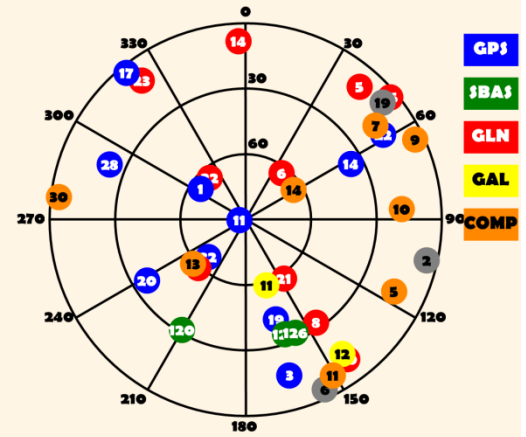
Everest™ Enable

Clock Steering Enable

| Type | Signal | Enable | Options |
|---|---|---|---|
| GPS | L1 - CA | ☑ | |
| GPS | L2 - Legacy | ☑ | L2 - CS and Legacy |
| GPS | L2 - CS | ☑ | CM + CL |
| GPS | L5 | ☑ | I + Q |
| SBAS | L1 - C/A | ☑ | |
| SBAS | L5 | ☑ | |
| GLONASS | L1 - C/A | ☑ | |
| GLONASS | L1 - P | ☑ | |
| GLONASS | L2 - C/A(M) | ☑ | |
| GLONASS | L2 - P | ☑ | L2 - C/A(M) and P |
| GLONASS | L3 | ☑ | Data + Pilot |
| GALILEO | E1 | ☑ | |
| GALILEO | E5 - A | ☑ | |
| GALILEO | E5 - B | ☑ | |
| GALILEO | E5 - AltBOC | ☑ | |
| COMPASS | B1 | ☑ | |
| COMPASS | B2 | ☑ | |
| COMPASS | B3 | ☑ | |
| QZSS | L1 - CA | ☑ | |
| QZSS | L1 - SAIF | ☑ | |
| QZSS | L2 - C | ☑ | |
| QZSS | L5 | ☑ | |
| QZSS | LEX | ☑ | |

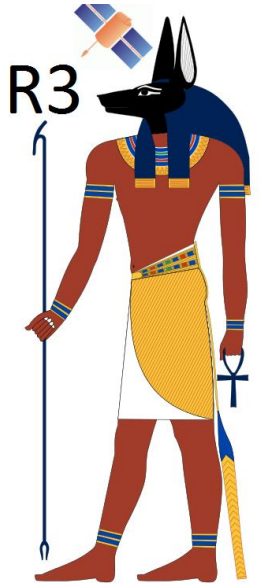
OK Cancel

**Satellites - Skyplot**




2013-02-22T07:25:12Z (UTC)

# RINEX3 QC tools in use




- G-Nut/Anubis [1.3.2] ($Rev: 990 $ )
- BNC [2.12] checkout version 6635
- Thanks a lot for the support and iterations necessary to make the quality monitoring operational !

BKG + GOPE

# Daily RINEX Monitoring

RINEX 2 (208 CH-EU stations)

Google swisstopo Rinex Monitoring

http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/anubis_monitor_r2.html


sortable tables

| ANTENNA |
|---|
| AOAD/M_B |
| AOAD/M_T |
| AOAD/M_T |
| AOAD/M_T |
| AOAD/M_T |
| AOAD/M_T |
| ASH700936A_M |
| ASH700936A_M |
| ASH700936A_M |
| ASH700936A_M |
| ASH700936C_M |
| ASH700936C_M |
| ASH700936D_M |

pdf with all plots

# Daily RINEX 3 QC (31 stations)

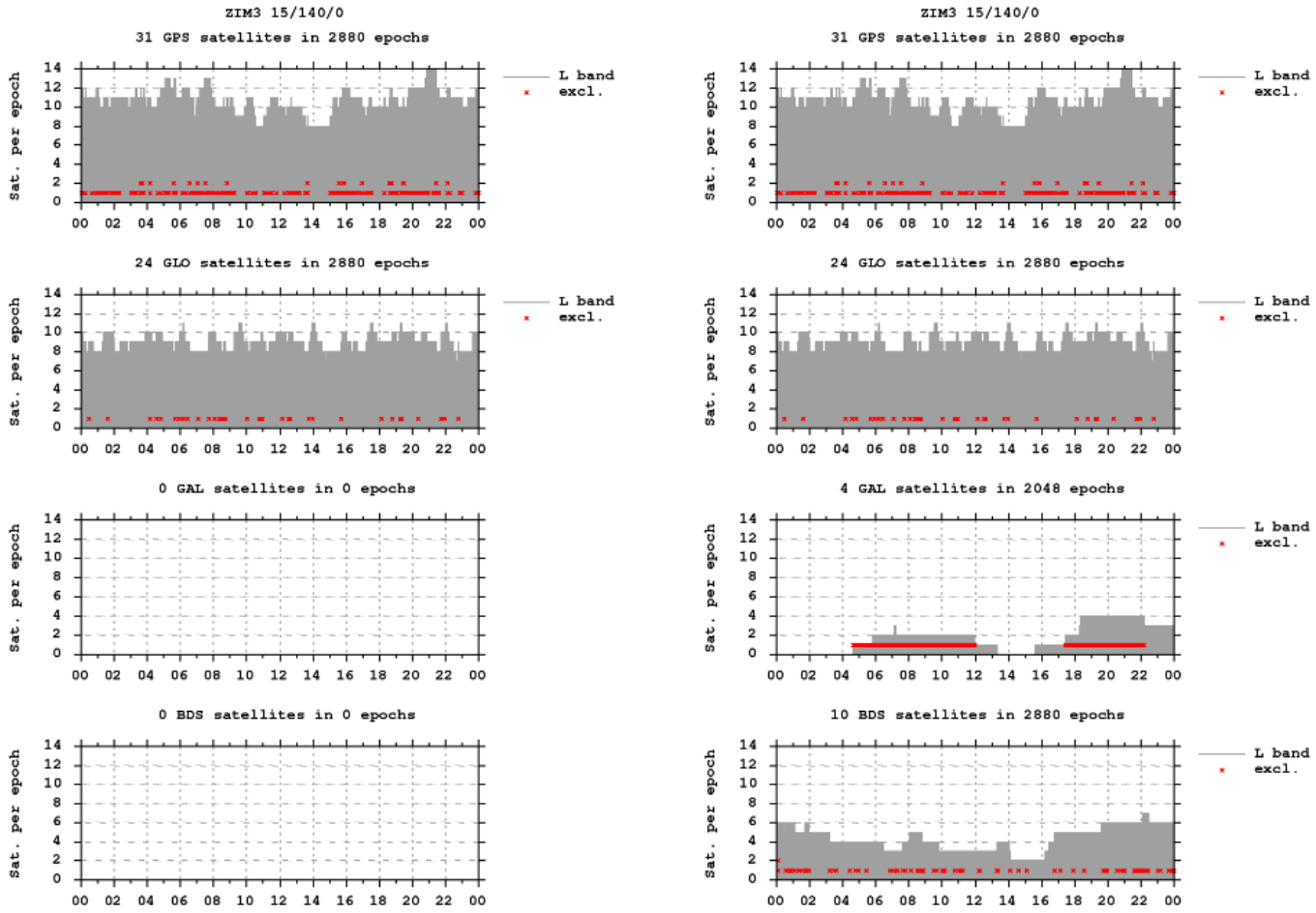

| MARKER | RECEIVER | | ANTENNA | | Vers | In | Epo | G | R | E | C | PDF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AJAC 10077M005 | LEICA GR25 | 3.11 | TRM57971.00 | NONE | 3.02 | 30 | 2880 | 30 | 24 | 6 | 8 | ajac_r3.pdf |
| AUTN 10080M001 | LEICA GR25 | 3.11 | TRM57971.00 | NONE | 3.02 | 30 | 2880 | 30 | 24 | 6 | 8 | autn_r3.pdf |

http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/anubis_monitor_r3.html

http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/qsumzim3.html

# Cross-checking R2 / R3 monitoring

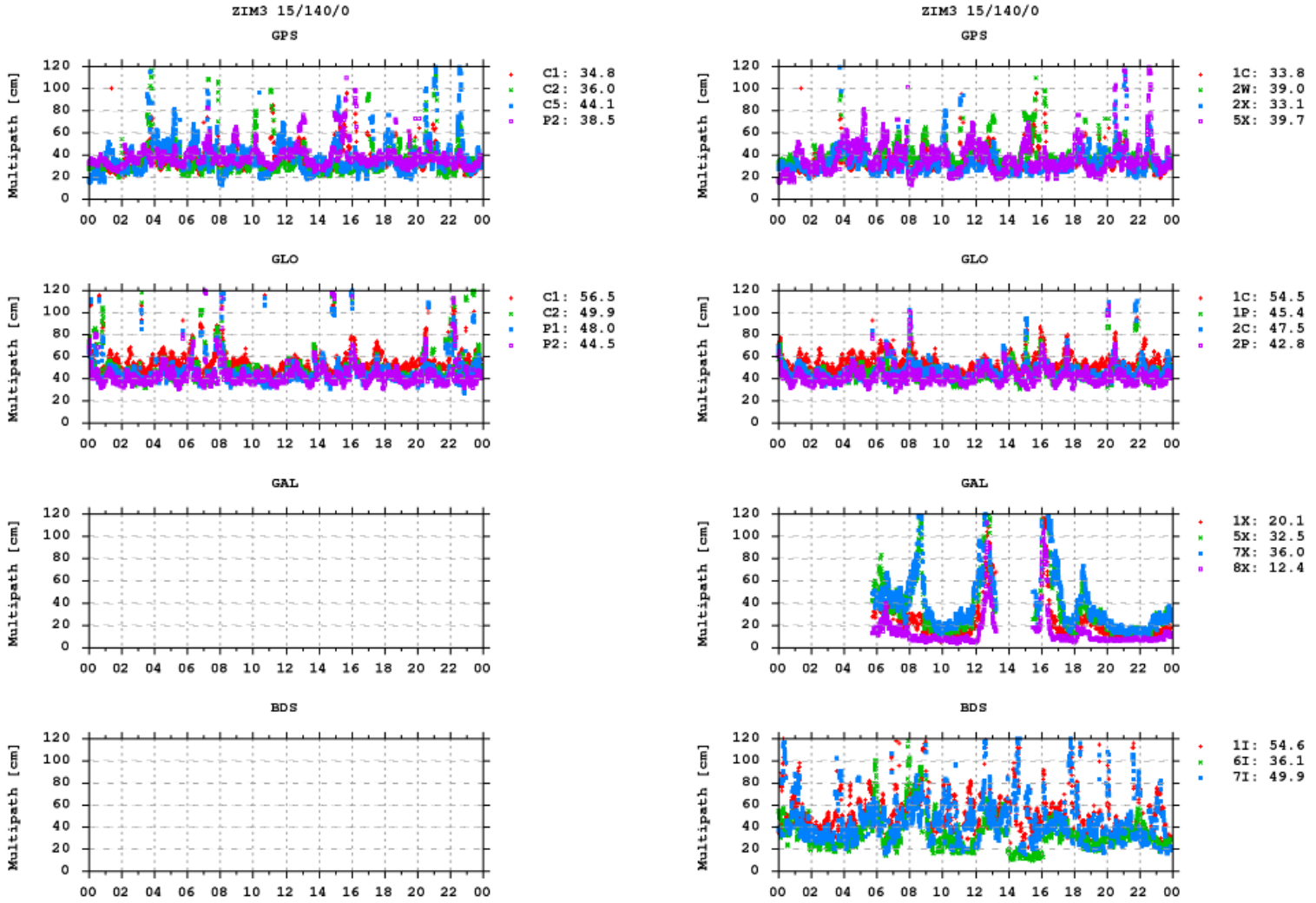
## Number of observations (RINEX 2/3) last day



http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/qsumzim3.html

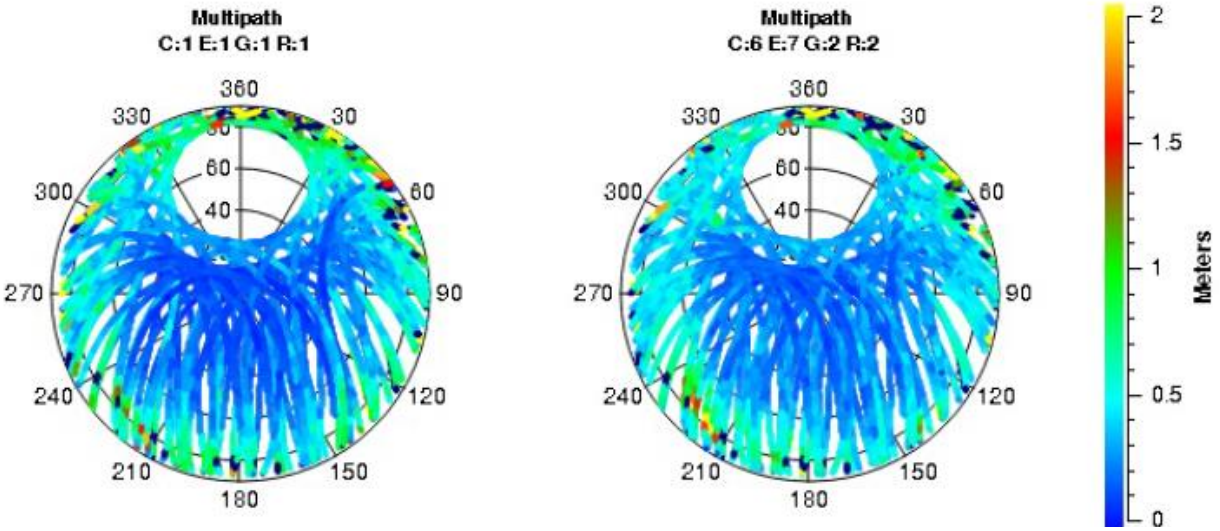
# Cross-checking R2 / R3 monitoring

## Multipath of observations (RINEX 2/3) last day

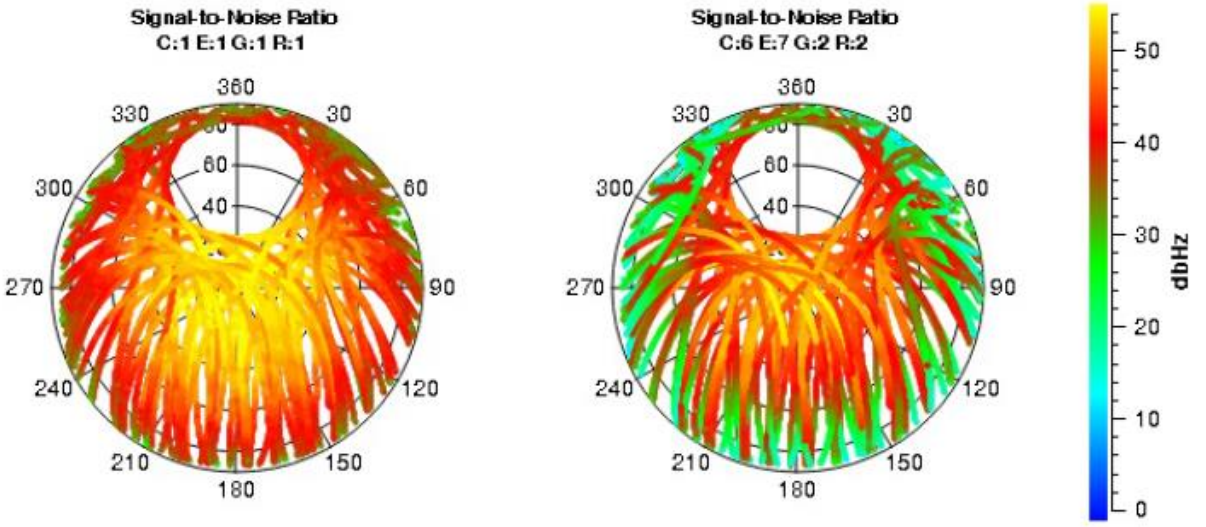


# BNC plots

Multipath



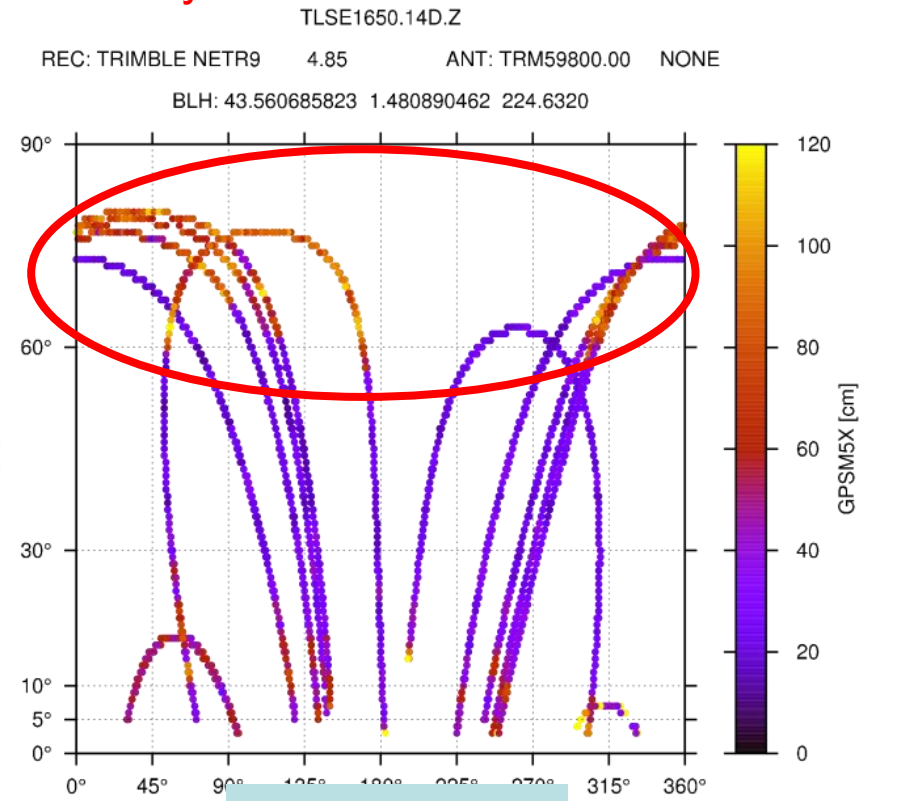

Signal-to-Noise

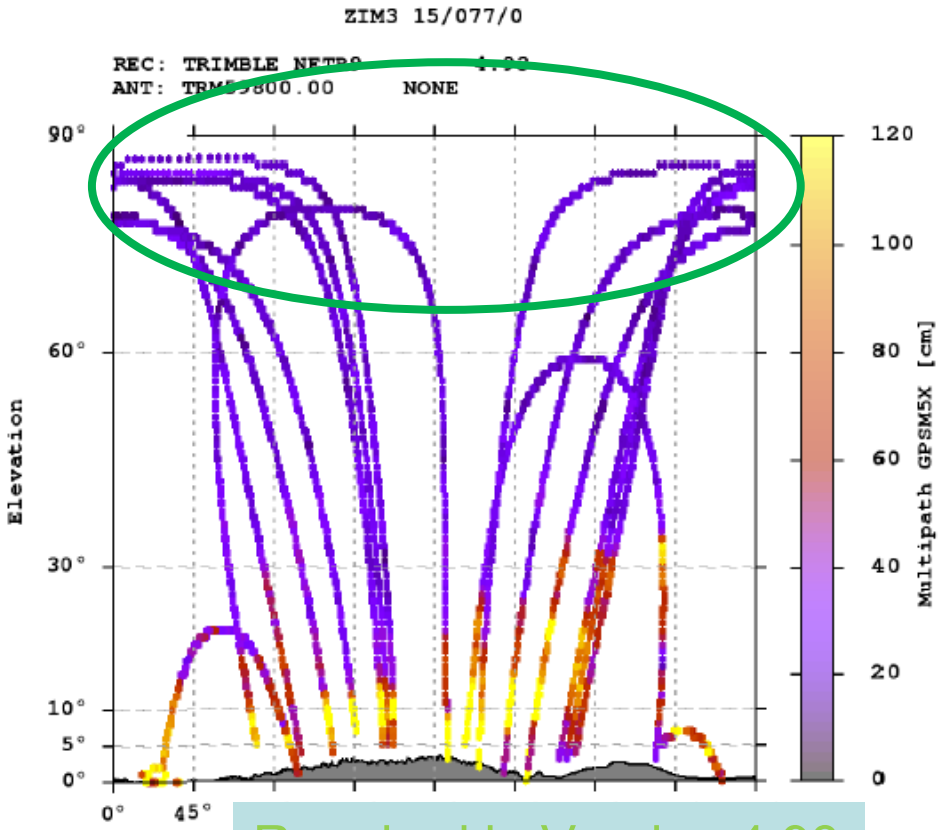


# MP5 GPS NetR9 and TRM59800.00 antenna + Q-I (X) Tracking

Ok for cephyr antenna

hight noise on high elevations
only TRM59800 antenna



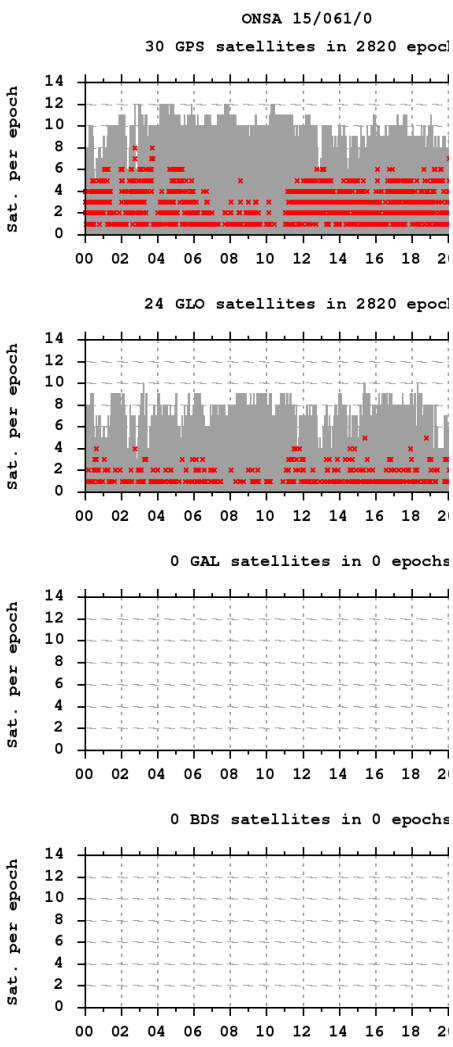



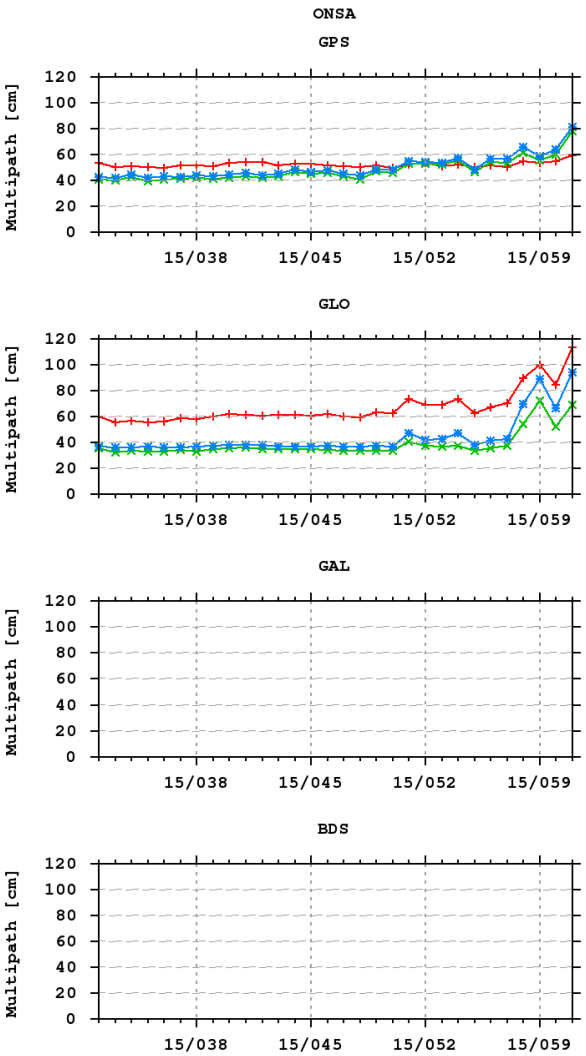

Version 4.85
June 2014

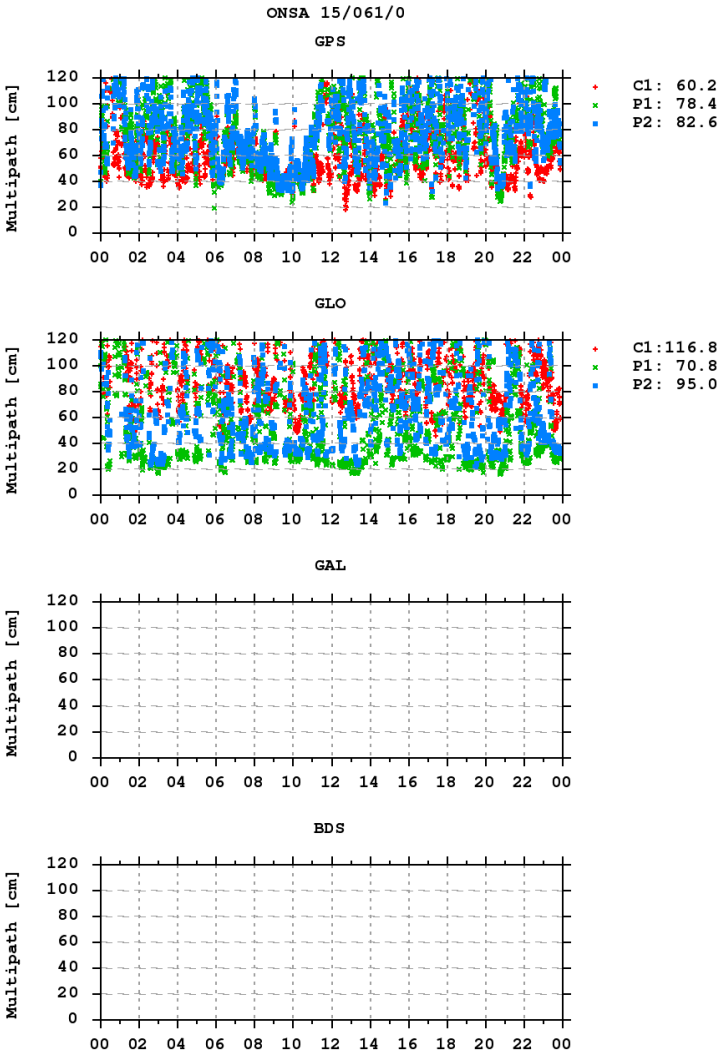
N and at swisstopo
ography swisstopo

Repaired in Version 4.93
March 2015

# Example performance problems ONSA

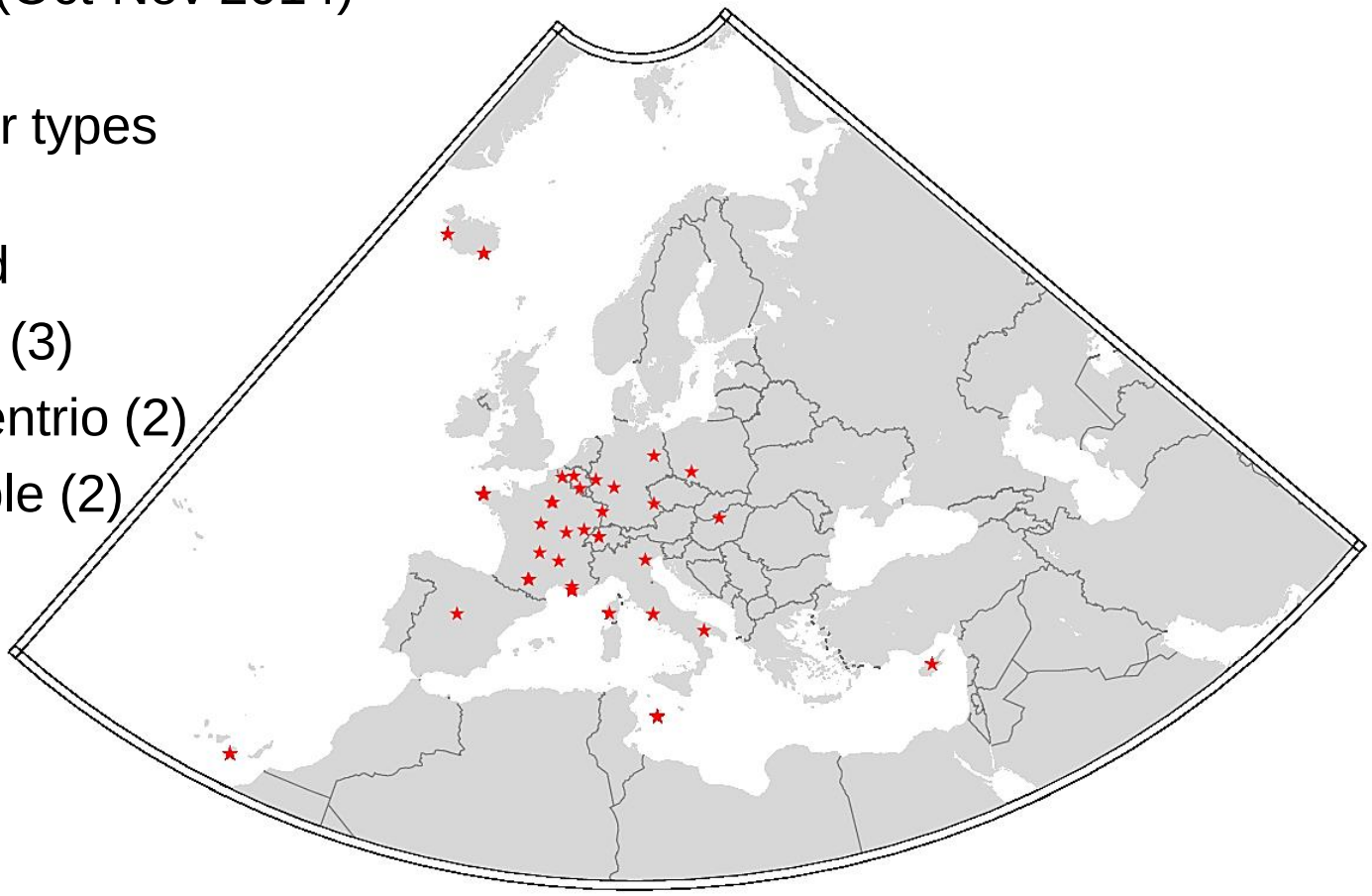


# First Galileo data analysis: data set

- 36 stations with RINEX 3; incl. ZIM2, ZIM3, ZIMJ
- 6 weeks (Oct-Nov 2014)
- 8 receiver types
  - Javad
  - Leica (3)
  - Septentrio (2)
  - Trimble (2)



# First Galileo data analysis: BSW52 + BSW53

- Assignment of the observation to 2 frequencies
  G=GPS, R=GLONASS, E=Galileo

```
S/S  O/F  RINEX observation codes and their priority
***  ***  *** *** *** *** *** *** *** *** *** *** *** ***

G    L1   L1C L1P L1W
G    L2   L2W L2P L2L L2S L2X L2C L2D
G    C1   C1C C1P C1W
G    C2   C2W C2P C2L C2S C2X C2C C2D
R    L1   L1C L1P
R    L2   L2P L2C
R    C1   C1C C1P
R    C2   C2P C2C
E    L1   L1C L1X
E    L2   L5Q L5I L5X
E    C1   C1C C1X
E    C2   C5Q C5I C5X
```

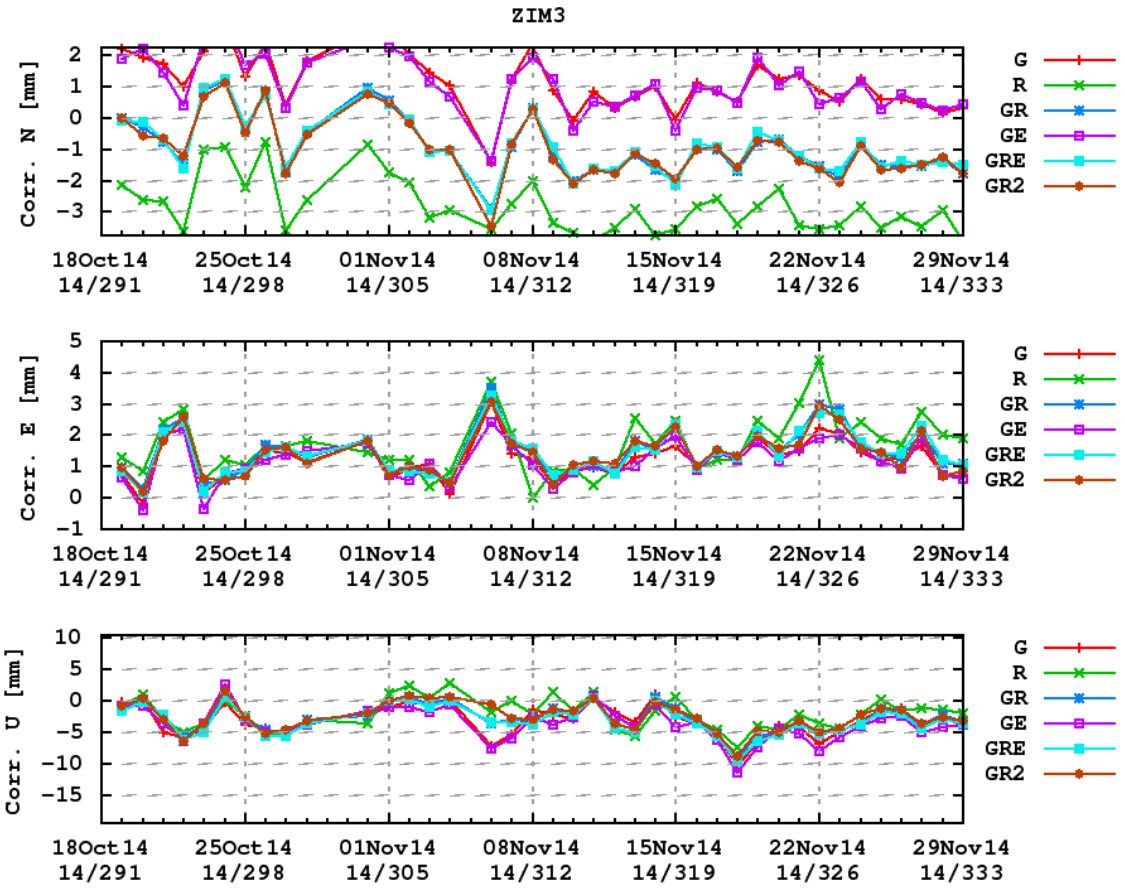
# First Galileo data analysis: results

- Coordinate differences (w.r.t. apriori model)

North

East

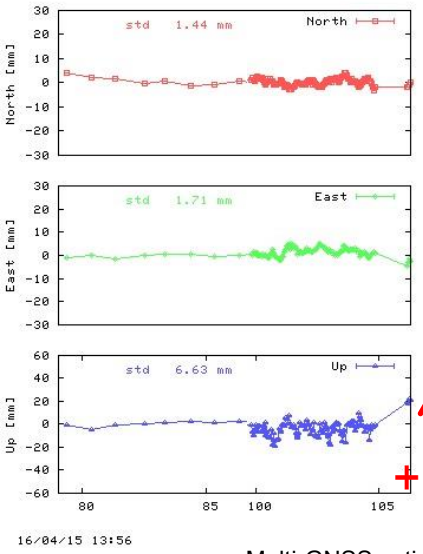
Up



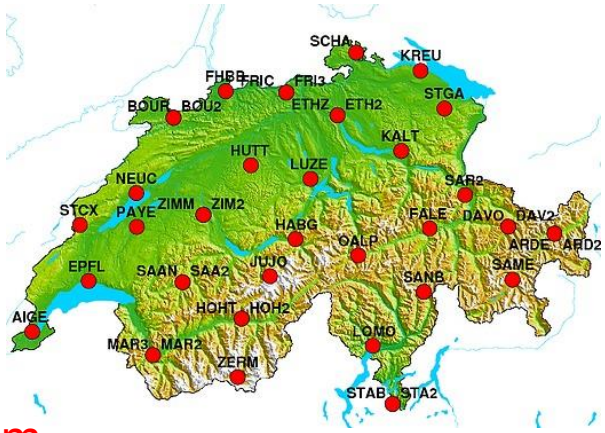
# Multi-GNSS at Swiss permanent stations

- Feb-May 2015: **all 41 Swiss stations are enhanced from GPS/GLO receivers to Multi-GNSS** (+ 15 chokering antennas: causing jumps of ~ 2 cm despite individual antenna PCVs)

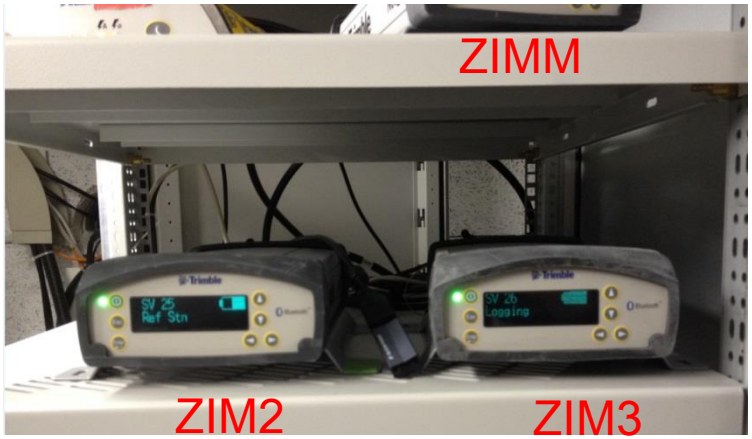
PAYE




+ ~2 cm




ZIMJ (Javad)



# Thanks for your attention