



Schweizerische Eidgenossenschaft
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armasuisse
Swiss Federal Office of Topography swisstopo



Multi-GNSS Working group

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



Content

- RINEX3 QC monitoring at swisstopo using updated versions of anubis and bnc (E. Brockmann)
- Anubis features (J. Dousa)
- BNC features (W. Söhne)



Tools in use at swisstopo

- G-Nut/Anubis with several improvements
 - Single frequency data are possible to plot
 - GDOP values per satellite system
 - Complete new config mechanism
 - ...
- Bnc
 - Multipath computation for all signals (instead of only MP1 and MP2)
 - Extended information in a txt file
 - ...
- Not used: recently published GFZ RINEX3 tool
- Thanks a lot for the support and iterations necessary to further improve the quality monitoring in the last months !



RINEX Monitoring

RINEX 2 (208 CH-EU stations)

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



RINEX 3 QC (31 stations)



~50 plots per day per station per RINEX version collected in a pdf-file !

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



Example: ZIM3

- Firmware version 4.85 -> 4.93
- [zim3_r3_20150319.pdf](#)
- Positive: Errors/bugs detected with QC and forwarded to Trimble removed
- Negative: Trimble's firmware change also resulted in new features in the binary T02 files -> special teqc version (Lou Estey; not yet downloadable) in use to ensure the RINEX2 data flow.



1) Beidou problem version 4.85

Bugreport June 17, 2014

Example for ZIM31650.14D:

3.02	OBSERVATION DATA	M (MIXED)	RINEX VERSION / TYPE
NetR9 4.85	Receiver Operator	14-JUN-14 00:00:00	PGM / RUN BY / DATE
ZIM3			MARKER NAME
14001M008			MARKER NUMBER
GEODETIC			MARKER TYPE
TRIMBLE NETR9	SWISSTOPO		OBSERVER / AGENCY
5229K50741	TRIMBLE NETR9	4.85	REC # / TYPE / VERS
60369	TRM59800.00	NONE	ANT # / TYPE
4331300.1495	567537.0851	4633133.5110	APPROX POSITION XYZ
0.0000	0.0000	0.0000	ANTENNA: DELTA H/E/N
G 12 C1C L1C S1C C2W L2W S2W C2X L2X S2X C5X L5X S5X			SYS / # / OBS TYPES
S 3 C1C L1C S1C			SYS / # / OBS TYPES
R 12 C1C L1C S1C C1P L1P S1P C2C L2C S2C C2P L2P S2P			SYS / # / OBS TYPES
E 12 C1X L1X S1X C5X L5X S5X C7X L7X S7X C8X L8X S8X			SYS / # / OBS TYPES
J 12 C1C L1C S1C C2X L2X S2X C5X L5X S5X C6X L6X S6X			SYS / # / OBS TYPES
C 9 C2I L2I S2I C7I L7I S7I C6I L6I S6I			SYS / # / OBS TYPES

- C2I, L2I, and S2I (3.01) should be renamed to C1I, L1I, and S1I according to 3.02 format
- Repaired in Version 4.93
- Anubis+swisstopo tool no longer need to treat the wrong format



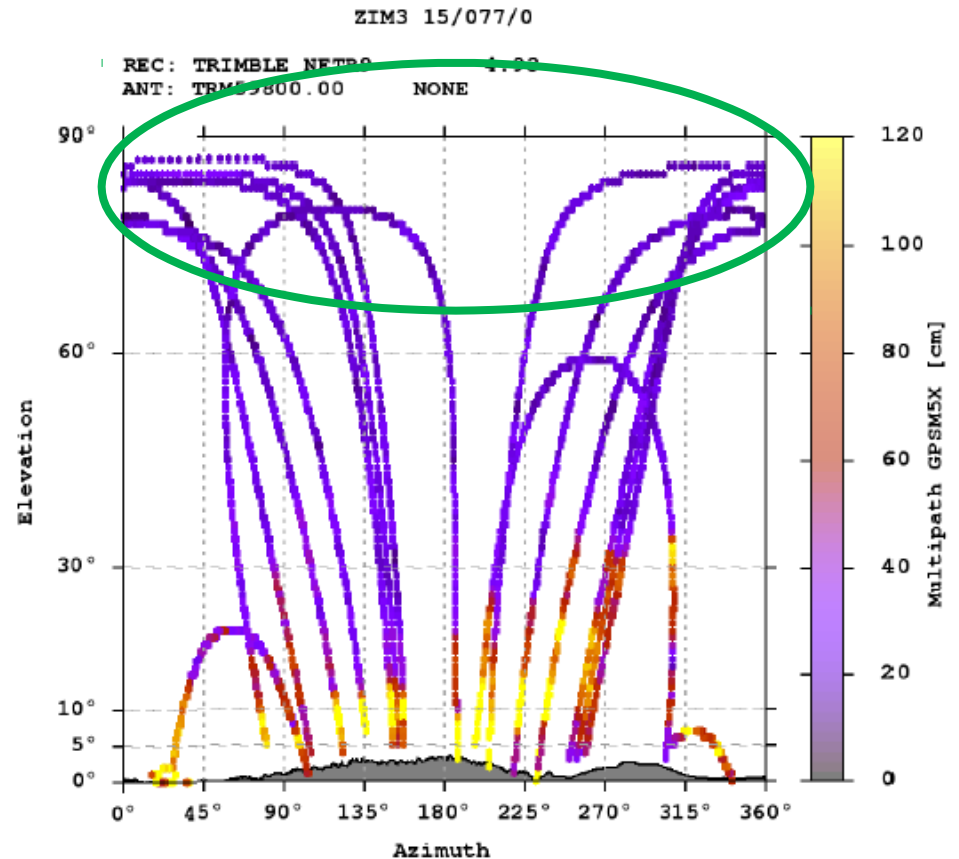
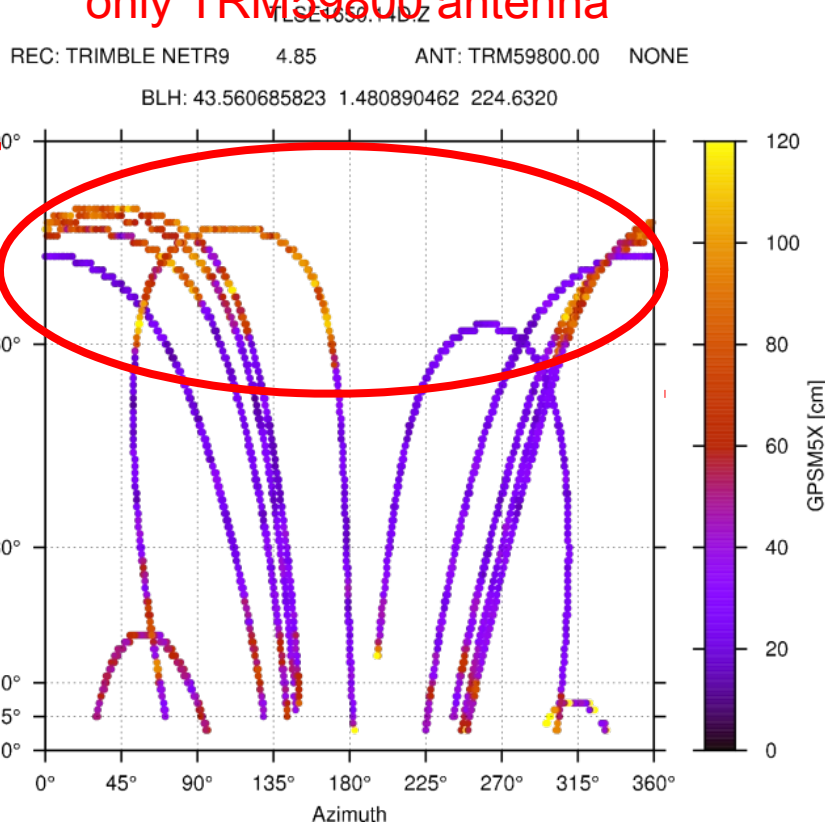
2) MP5 GPS NetR9 and TRM59800.00 antenna + Q-I (X) Tracking: Bugreport

June 17, 2014

Repaired in Version 4.93

Ok for cephyr antenna

high noise on high elevations
only TRM59800 antenna

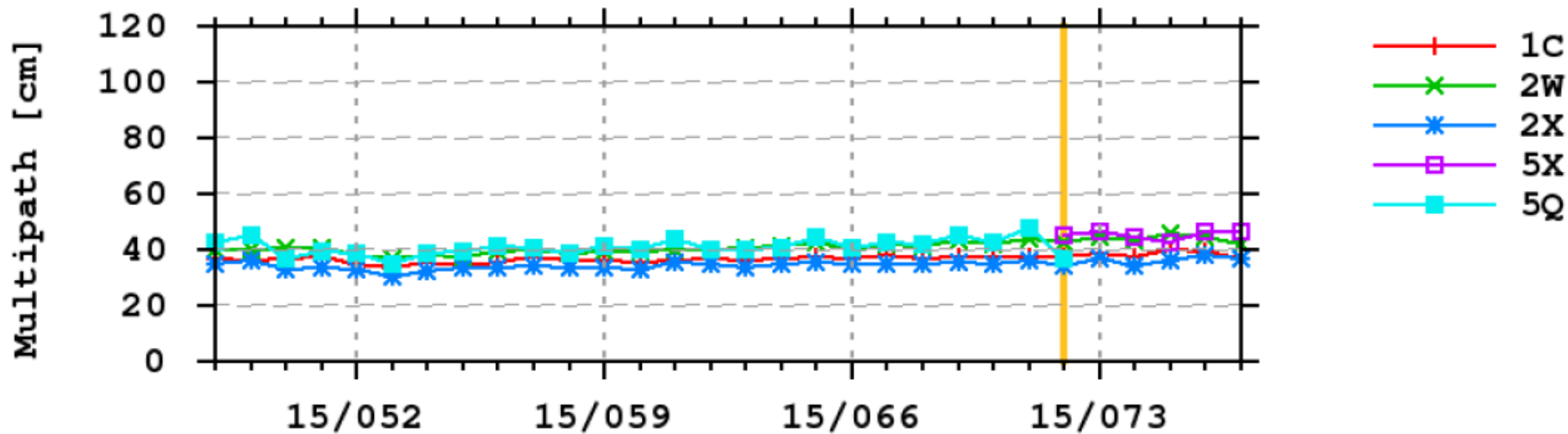




NetR9 V4.93: without increased MP L5 Q -> Q+I (X) tracking

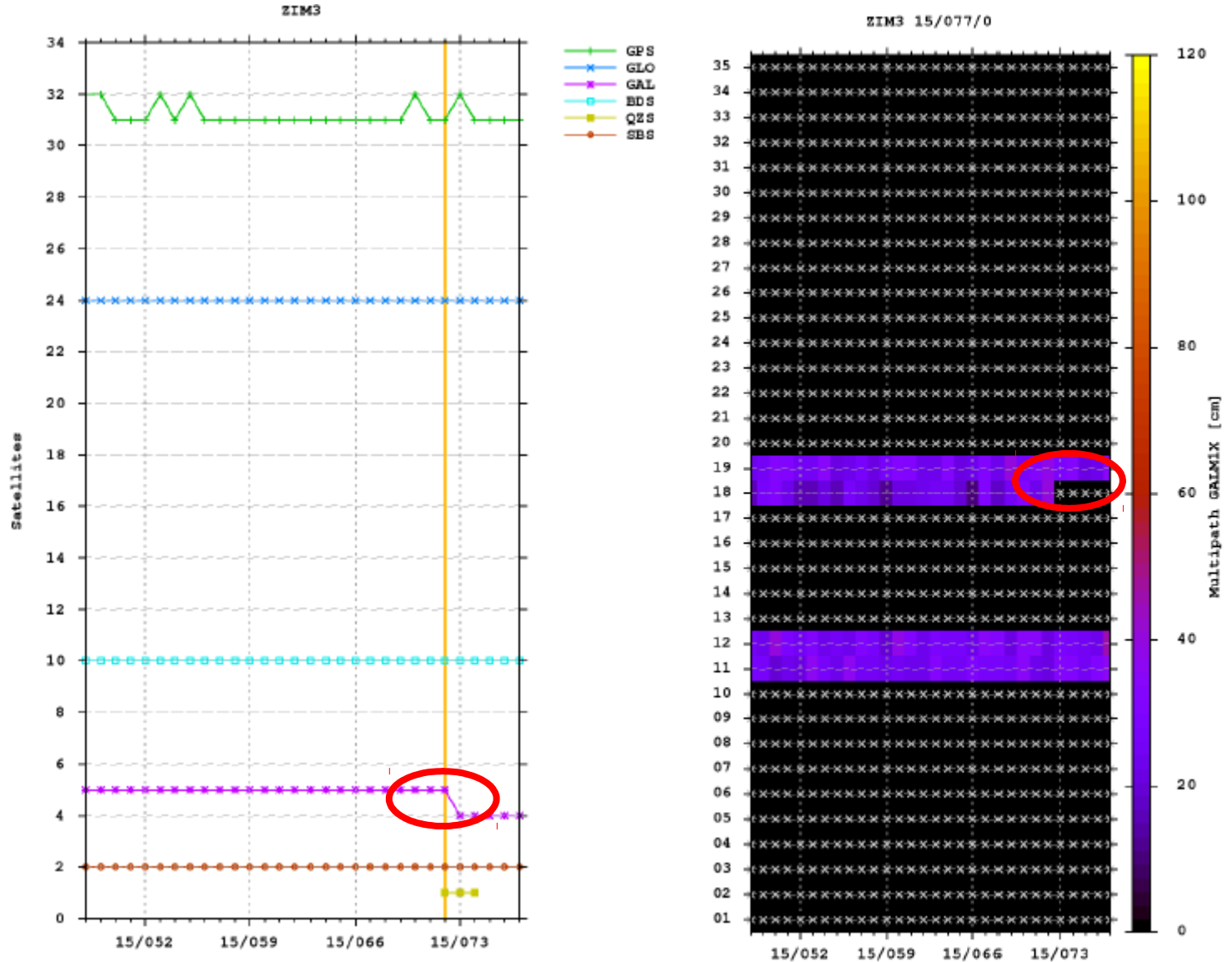
ZIM3

GPS

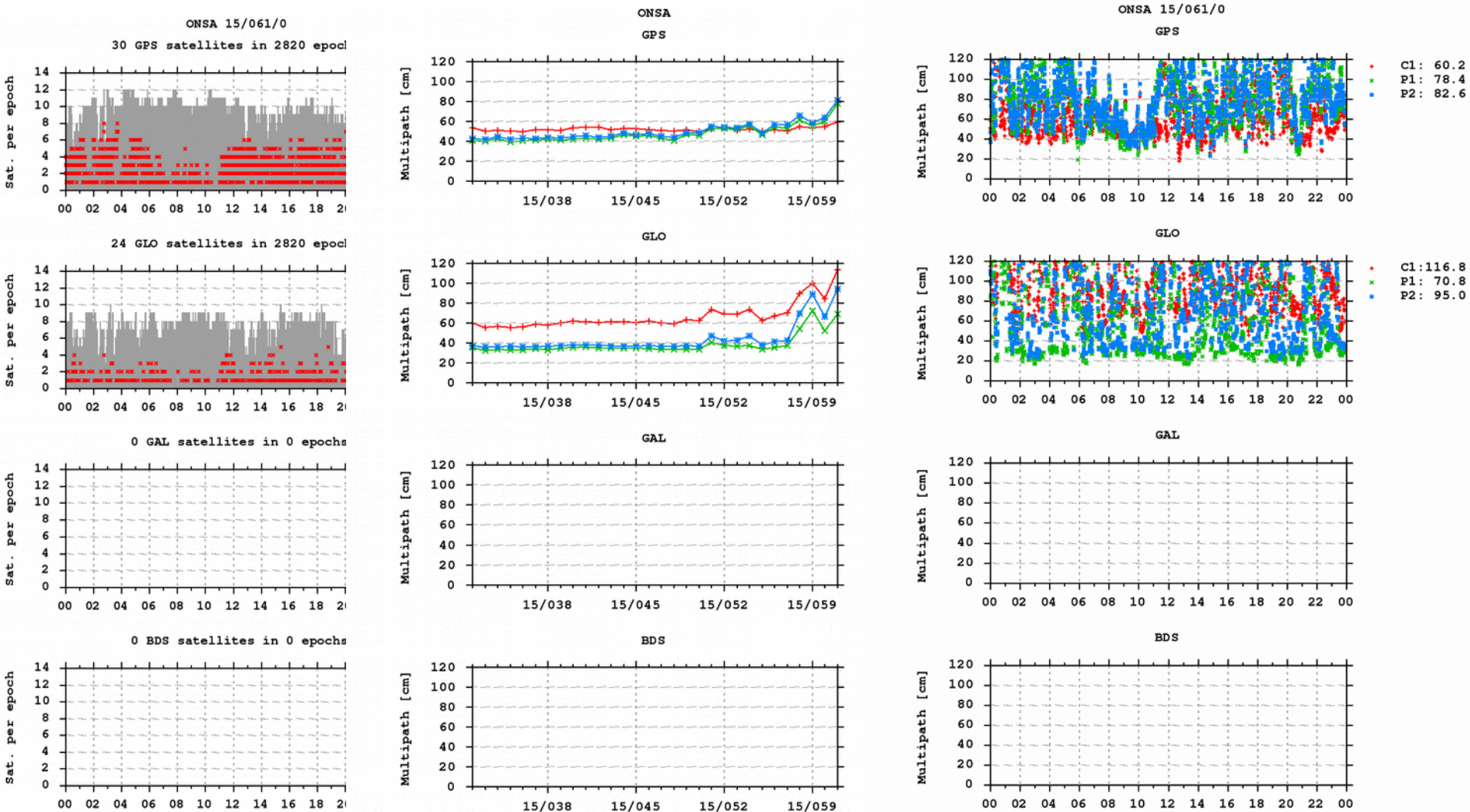


Friday, March 13 2015: Version 4.93

Version 4.93 – no E18 tracking



Example performance problems ONSA



Short news for Anubis QC Tool

Release 1.3

Jan Douša, Pavel Václavovic

Geodetic Observatory Pecný, RIGTC, Czech Republic

EUREF TWG Meeting

March 23-24, 2015, Warsaw, Poland

History and recent releases

- **2015-03-18 - Released Anubis 1.3.2** - actual official release after minor bug fixing described in: [RELEASE NOTES](#)
- **2015-01-28 - Released Anubis 1.3** - complete multi-GNSS capability: all-constellations/-bands/-signal pre-processing & selection, advanced statistics, support of merged navigation messages etc.
- **2014-08-13 - Released Anubis 1.2** - navigation messages for all GNSS constellations, GPS, GLONASS, Galileo, BeiDou standard positioning
- **2014-04-29 - Released Anubis 1.1** - qualitative QC for GPS&GLO, Bancroft positioning, boost-independent version, RINEX3.02 support
- **2013-08-16 - Released Anubis 1.0** - multi-path detection for all constellations, signals and frequencies
- **2013-03-10 - Released Anubis 0.9** - beta version

→ *roughly half a year between major releases with new functionalities*

→ *continuous debugging and providing minor releases in the meantime*

Important news

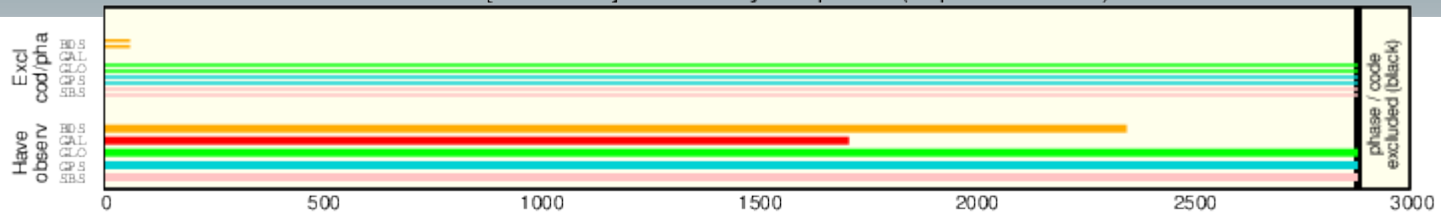
- New multi-frequency cascade cycle-slip detection and recovery
 - all GNSS constellations and all signals
 - for all bands if 2/3/4/5 frequencies available
- New observation handling and signal bands & attributes selection
 - priorities for each GNSS and for each frequency band
- New web mini docu + New extraction and plotting tool
 - Initial end-user QC visualization and support
- New information
 - histograms of sampling rates + auto estimate of sampling rate
 - improved counting expected vs. available observations (with/wout NAV)
 - estimated satellites crossing horizon for theoretical check of low-elevation data
 - histograms of observations at predefined elevation bins
- Merging and saving(!) navigation messages in RINEX 3.02 file
 - GPS, GLONASS, Galileo, BeiDou, SBAS, QZSS
- Provided precompiled binaries along with the source code (GPL v3)
 - Linux static 32bit & 64bit
 - In near future considering Windows, BDS, OS2 (not officially supported yet)

Refined implementations & testing

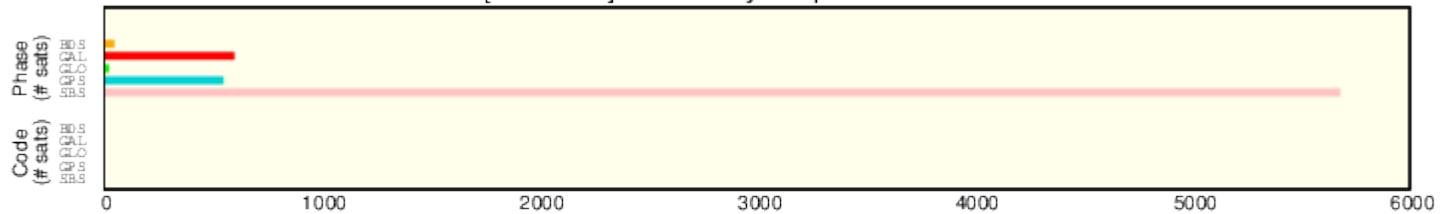
- Various internal improvements
 - refined observation container structure
 - initial use of smart pointers (testing support of c++11 standards)
 - data decoding filtering (site/satellite specific, period, signals, ..)
 - Improved handling large clock drifts, GDOP for individual GNSSs
 - data decoding/checking/changing (Beidou B1/B2 in RINEX 3.01 vs. 3.02)
 - etc.
 - G-Nut/Anubis 1.3 extensive testing:
 - RINEX 3.xx tested on all EURv3 sites (2012-2014)
 - RINEX 3.xx tested on all IGS/M-GEX sites (2013-2014)
 - RINEX 2.xx tested on all EUREF Permanent Network sites (1996-2014)
 - RINEX 2.xx & 3.xx AGNES & EUREF testing at Swisstopo
- ➔ **thanks for a very constructive feedback provided by S.Lutz & E.Brockmann**

QC visualization - Summary 1

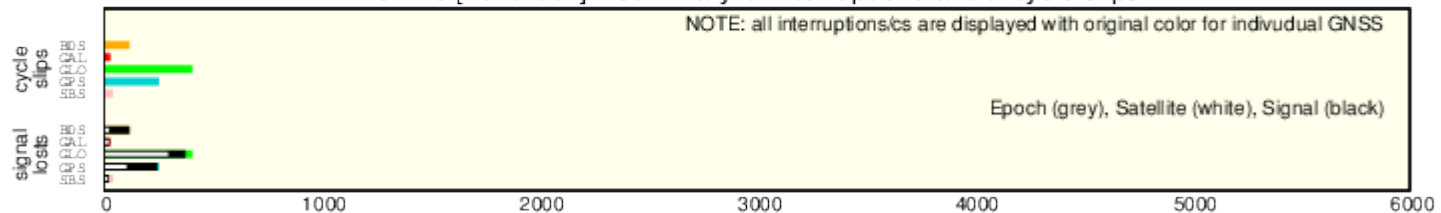
UNB3 [2015:001] - Summary: # epochs (expected: 3000)



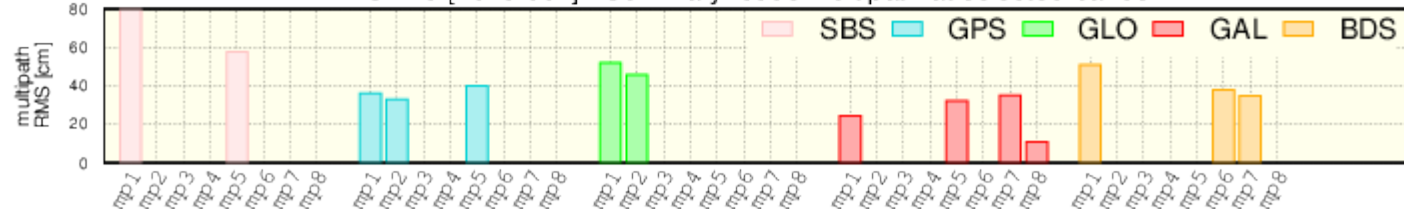
UNB3 [2015:001] - Summary: # epoch-satellites excluded



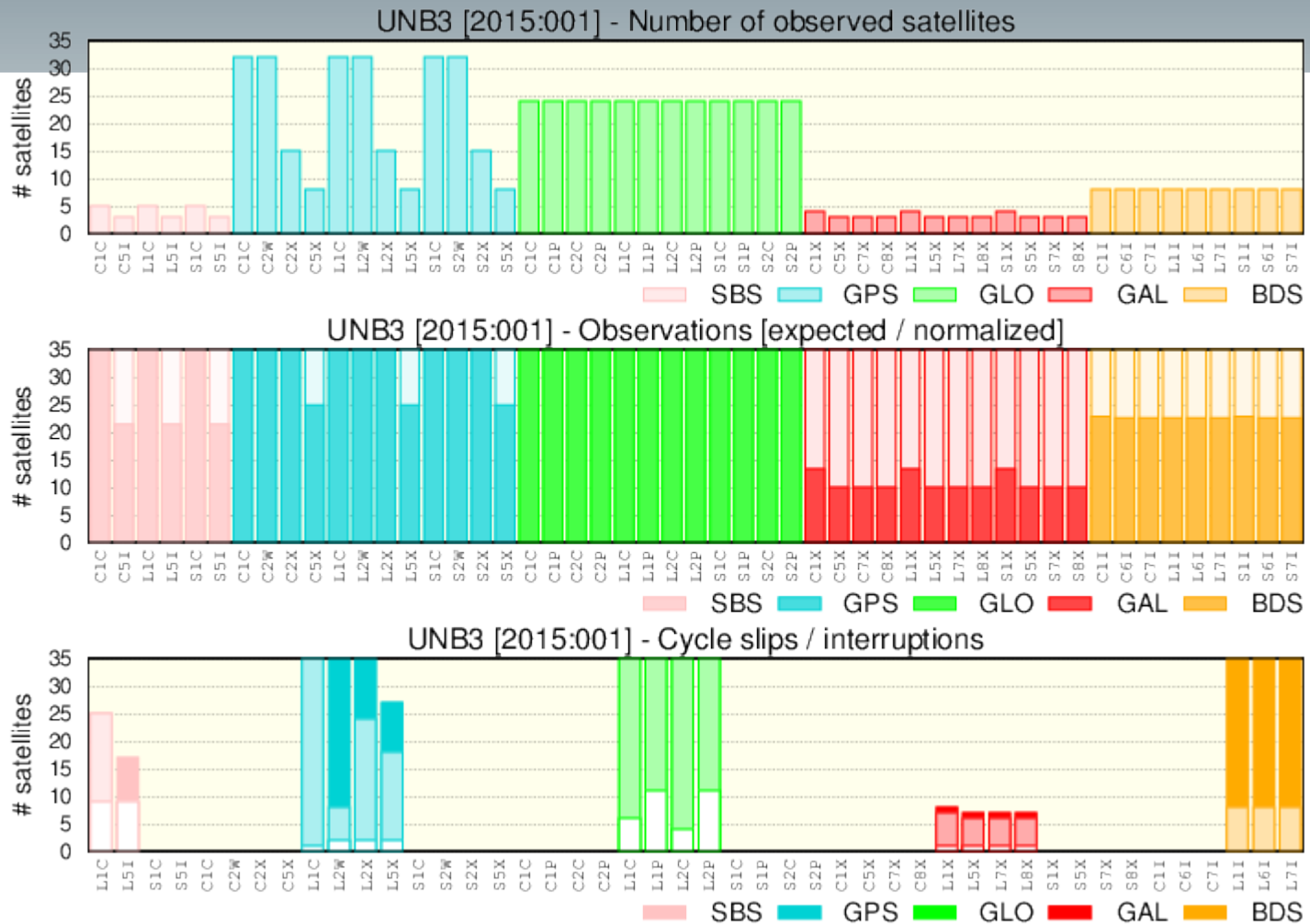
UNB3 [2015:001] - Summary: # interruptions and # cycle-slips



UNB3 [2015:001] - Summary: code multipath at selected bands

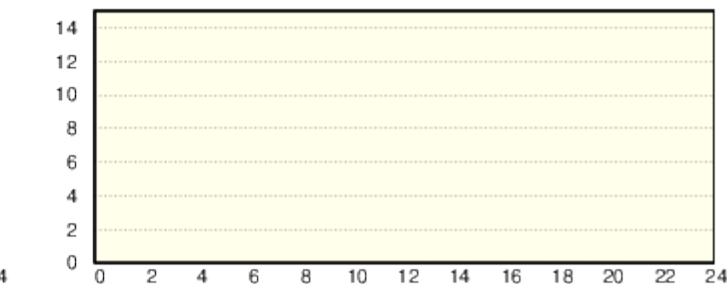
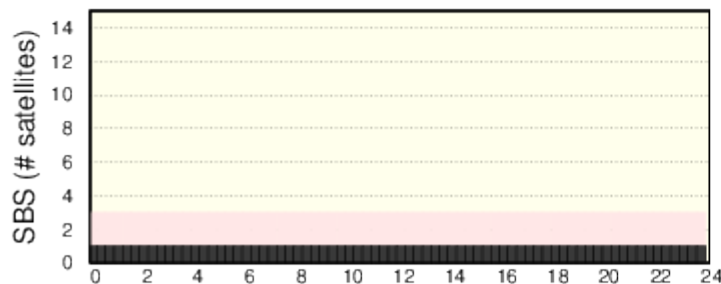
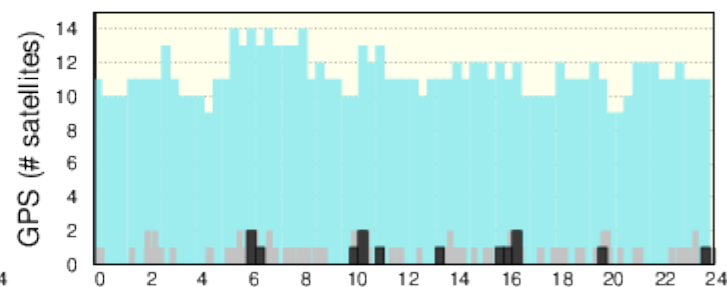
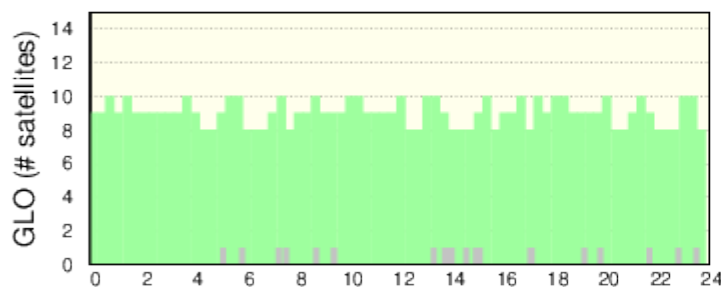
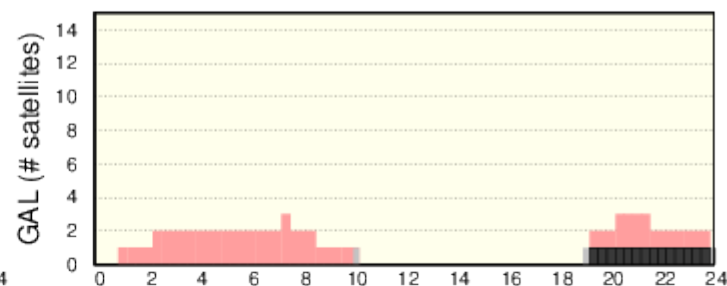
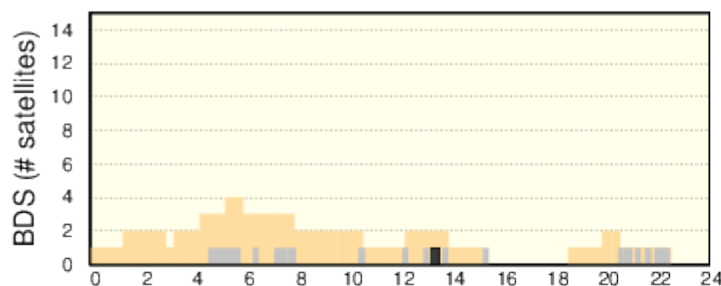


QC visualization - Summary 2



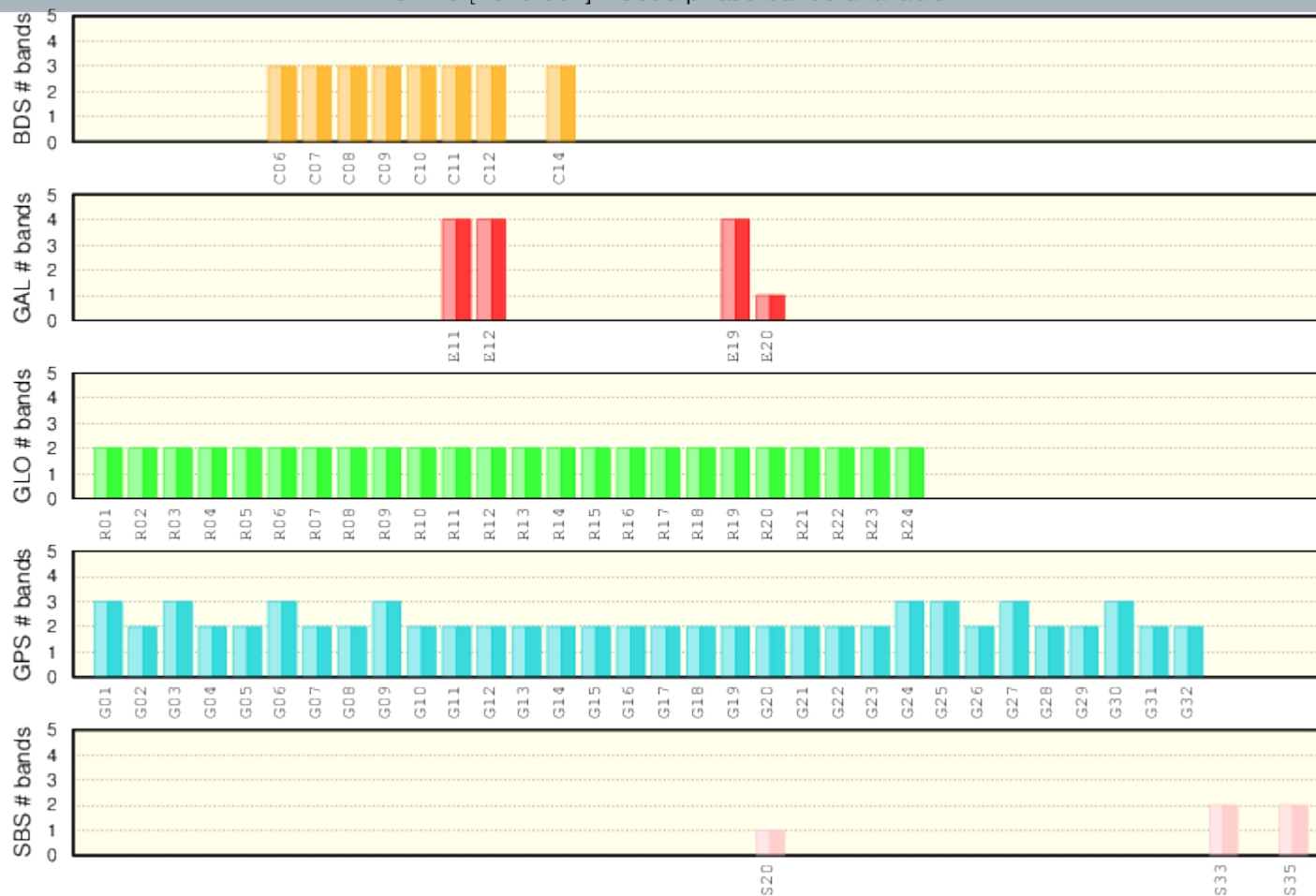
QC visualization – Frequency bands 1

UNB3 [2015:001] - Number of satellites available (single- vs. multi-band)

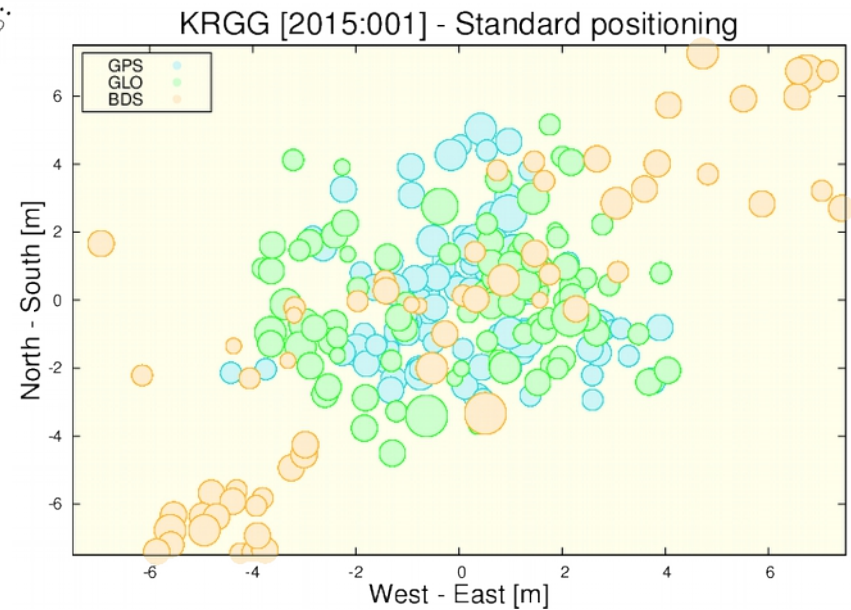
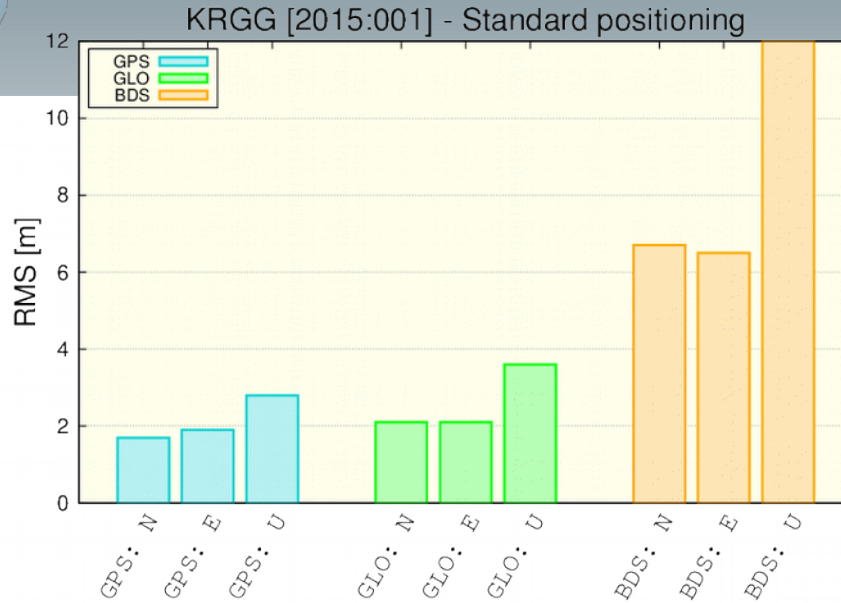


QC visualization – Frequency bands 2

UNB3 [2015:001] - Code/phase bands available

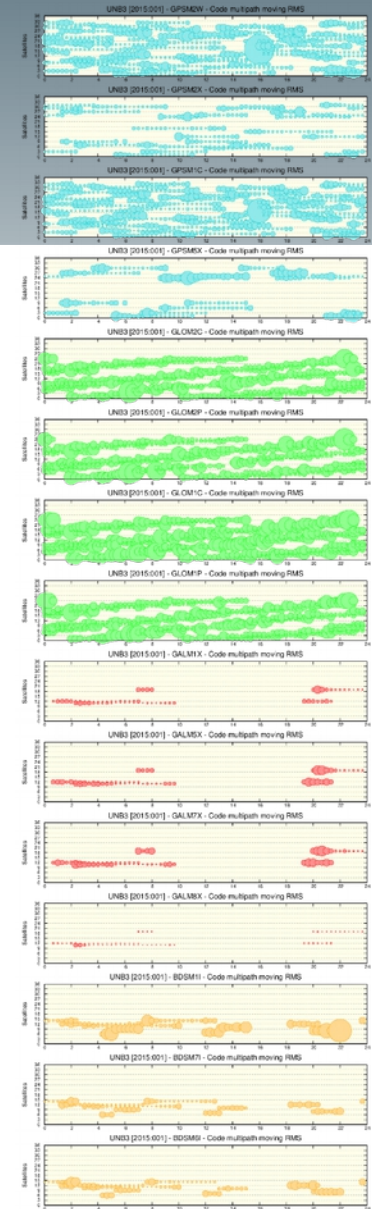
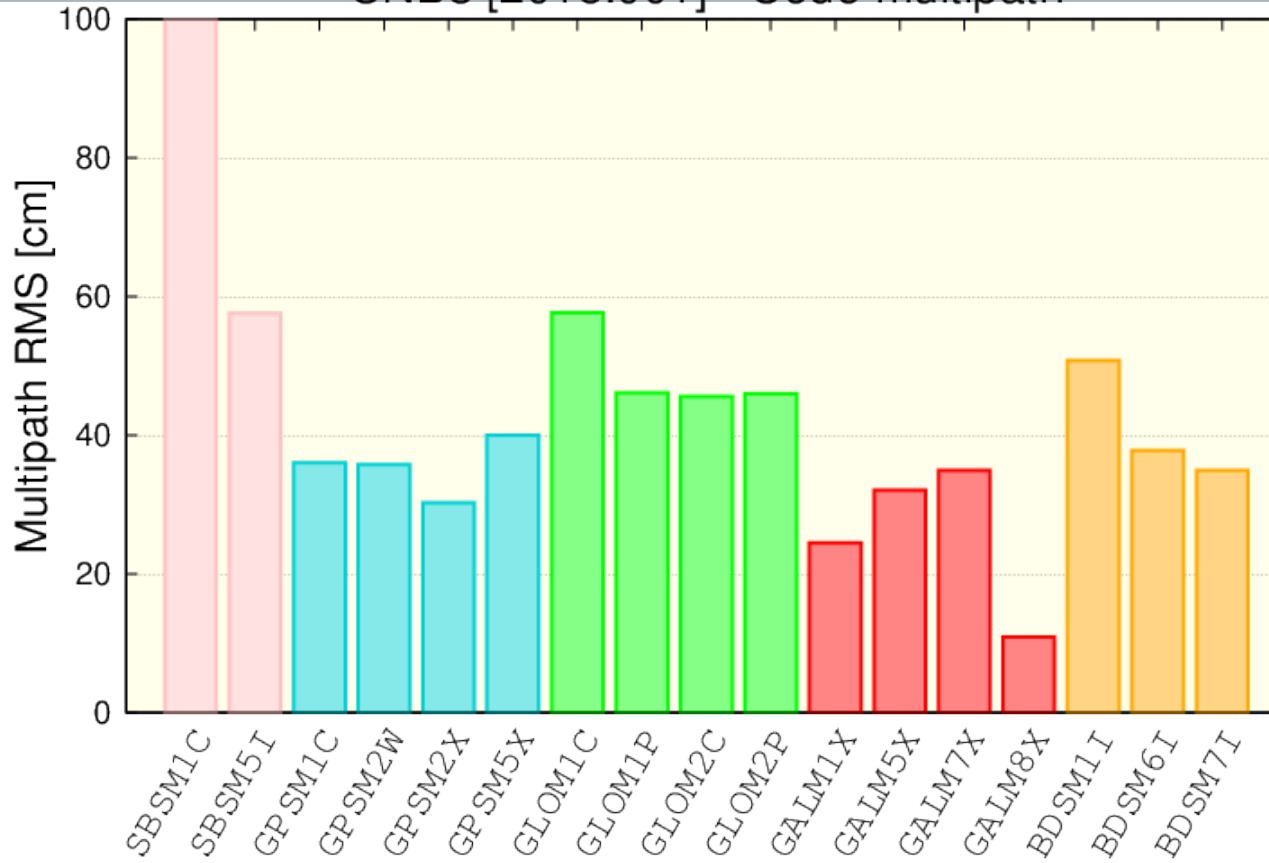


QC visualization – Std. Positioning



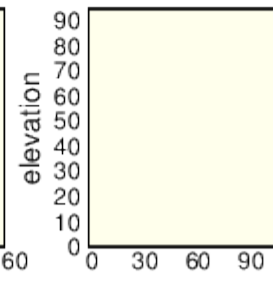
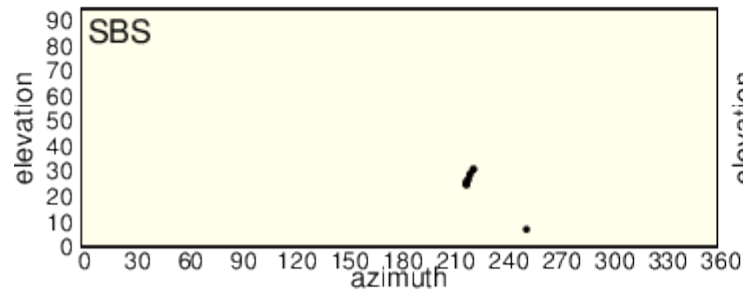
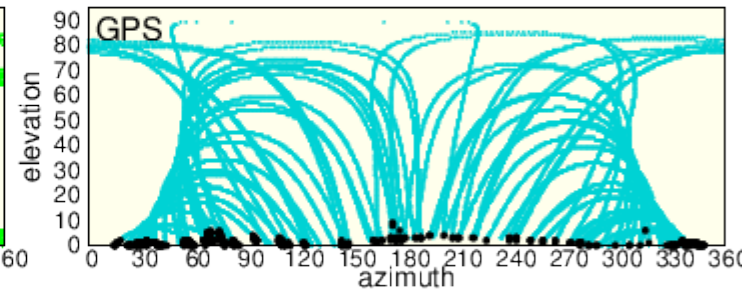
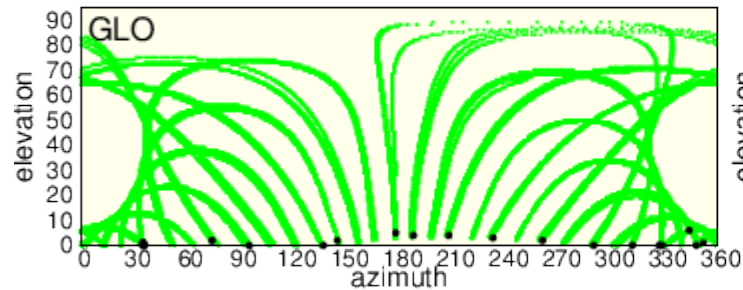
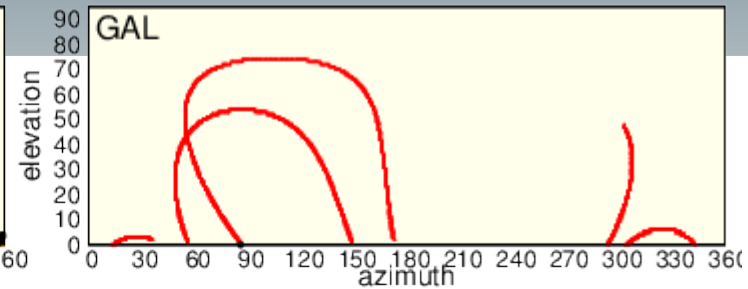
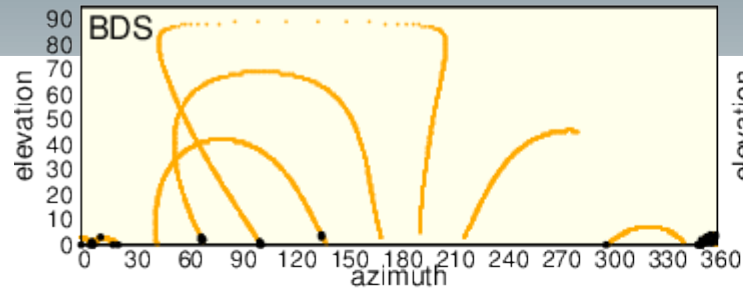
QC visualization – Multipath

UNB3 [2015:001] - Code multipath

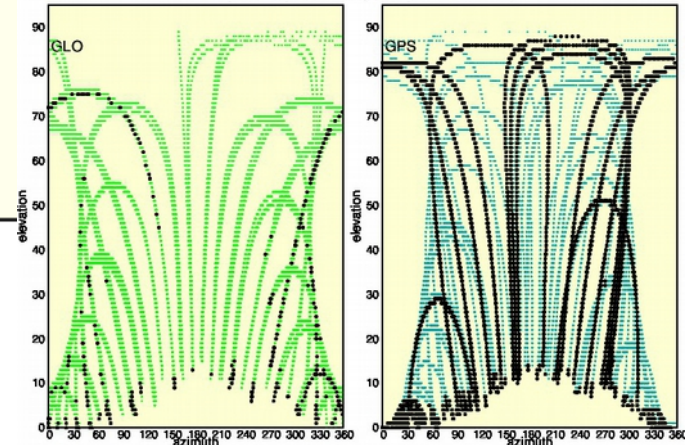


QC visualization – Skyplot + Unusable

UNB3 [2015:001] - Satellite sky track (azimuth/elevation)



MOP2 [2015:048] - Satellite sky track (azimuth/elevation)





BNC Quality Checking

Federal Agency for Cartography and Geodesy



- **BNC 2.12**
 - **Completely new PPP module implemented**
 - **Galileo processing**
 - **BeiDou ephemeris decoding**
 - **Full Rx2 <-> Rx3 conversion**
 - **SINEX TRO output**
 - **Quality control feature for Rx3**



BKG Ntrip Client (BNC) Version 2.12

File Help

neris RINEX Editing & QC SP3 Comparison Broadcast Corrections Feed Engine Serial Output Outages Miscellaneous PPP (1) PPP (2) PPP (3)

Precise Point Positioning - Options

GPS LCs P3&L3 Sigma C1 10.0 Sigma L1 0.007

GLONASS LCs P3&L3 Max Res C1 30.0 Max Res L1 0.04

Galileo LCs no Ele Wgt Code ☒ Ele Wgt Phase ☒

Wait for corrections 12 sec Min # of Obs 4 Min Elevation 7 deg

Seeding (seconds)

Streams:	resource loader / mountpoint	decoder	lat	long	nmea	ntrip	bytes
1	products.igs-ip.net:2101/CLK11	RTCM_3.0	50.08967	8.66458	no	2	0 byte(s)
2	products.igs-ip.net:2101/RTCM3EPH	RTCM_3.0	50.08967	8.66458	no	2	0 byte(s)
3	www.euref-ip.net:2101/GANP0	RTCM_3.0	49.03	20.32	no	2	0 byte(s)

Log Throughput Latency PPP Plot

Add Stream Delete Stream Map Start Stop Help ?=Shift+F1



BKG Ntrip Client (BNC) Version 2.12

File Help

Network General RINEX Observations RINEX Ephemeris RINEX Editing & QC SP3 Comparison Broadcast Corrections Feed Engine Serial Output Outages Miscellaneous PPP (1) PPP (2)

RINEX file editing, concatenation and quality check.

Action: Edit/Concatenate Set Edit Options

Input files (full path): aten/mao00010.15o Obs: aten/brdm0010.15p

Output files (full path): Obs:

Logfile: /Results/mao00010G.log Summary only ☒

Plots for signals: G:1C&2X

Directory for plots: coder/BNC213A/Results

Streams: resource loader / mountpoint decoder lat long

Log Throughput Latency PPP Plot

Add Stream Delete Stream Map Start Stop Help ?=Shift+F1

RINEX Editing Options

RNX Version: 3 Sampling: 30 sec

Start: 1967-11-02 00:00:00 End: 2099-01-01 00:00:00

Run By: V2 Priority: CWPX_?

Use Obs. Types:

Comment(s):

Old New

Marker Name: TLSE1

Antenna Name:

Receiver Name:

Help=Shift+F1 OK / Save Cancel



BKG Ntrip Client (BNC) Version 2.12

File Help

Network General RINEX Observations RINEX Ephemeris RINEX Editing & QC SP3 Comparison Broadcast Corrections Feed Engine Serial Output Outages Miscellaneous PPP (1) PPP (2)

RINEX file editing, concatenation and quality check.

Action:

Input files (full path): ... Obs: ... Nav:

Output files (full path): Obs: Nav:

Logfile: Summary only ☒

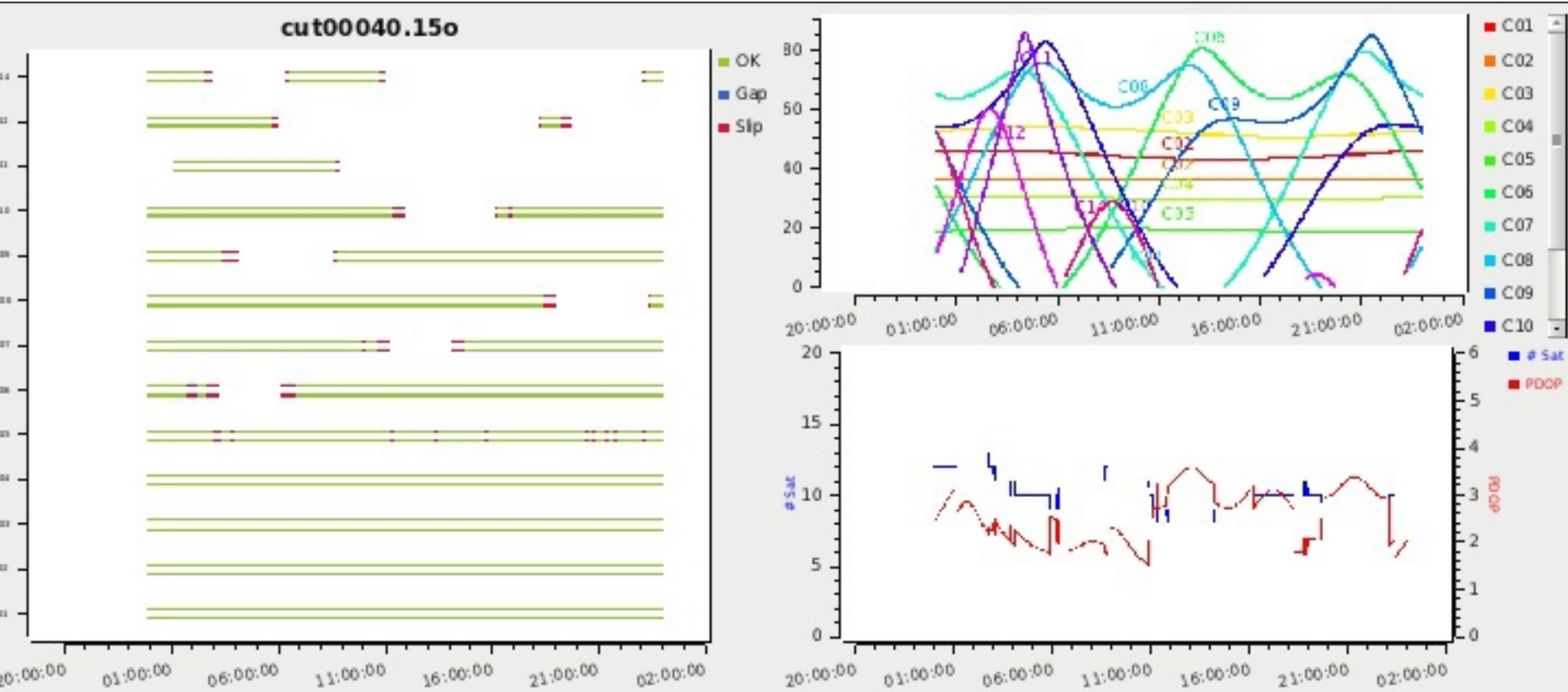
Plots for signals:

Directory for plots:

Streams: resource loader / mountpoint decoder lat long nmea ntrip bytes

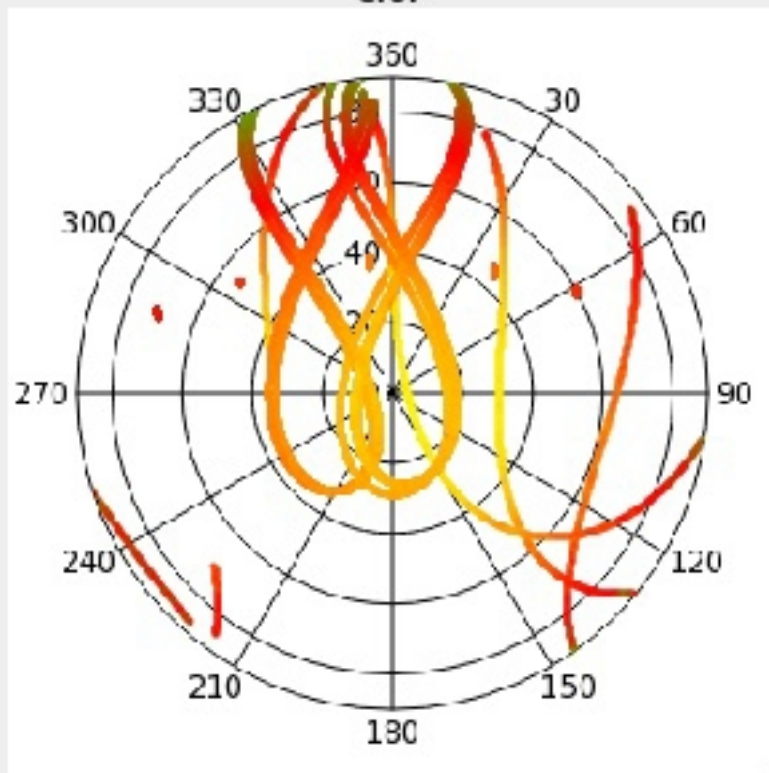
Log Throughput Latency PPP Plot

Add Stream Delete Stream Map Start Stop Help ?=Shift+F1

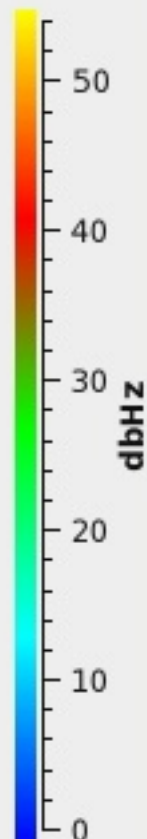
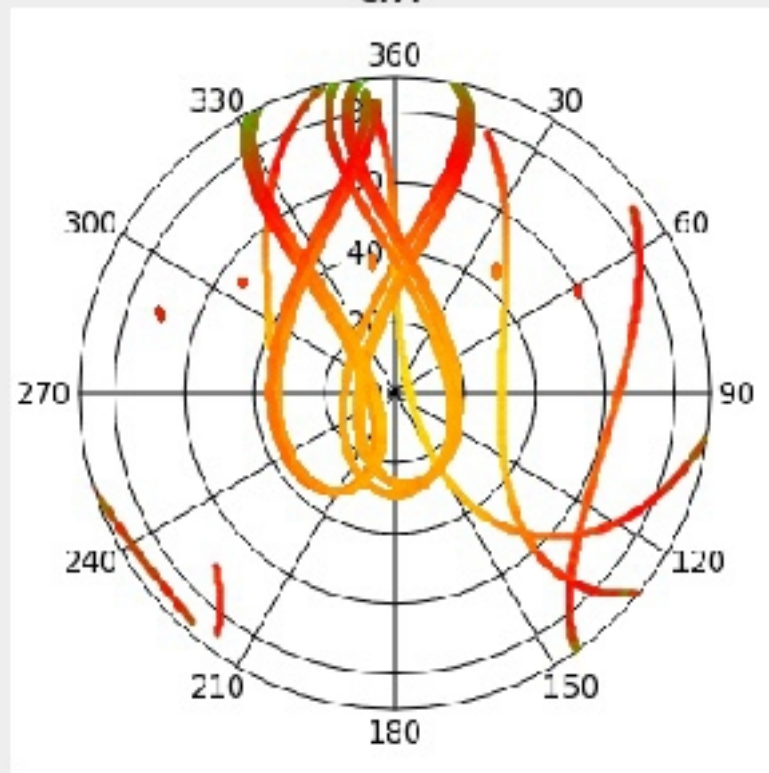


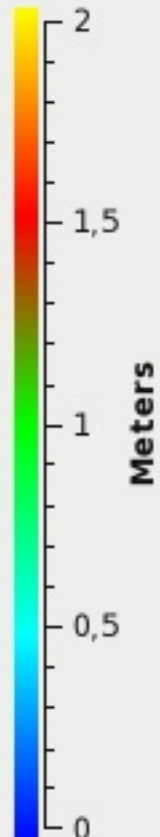
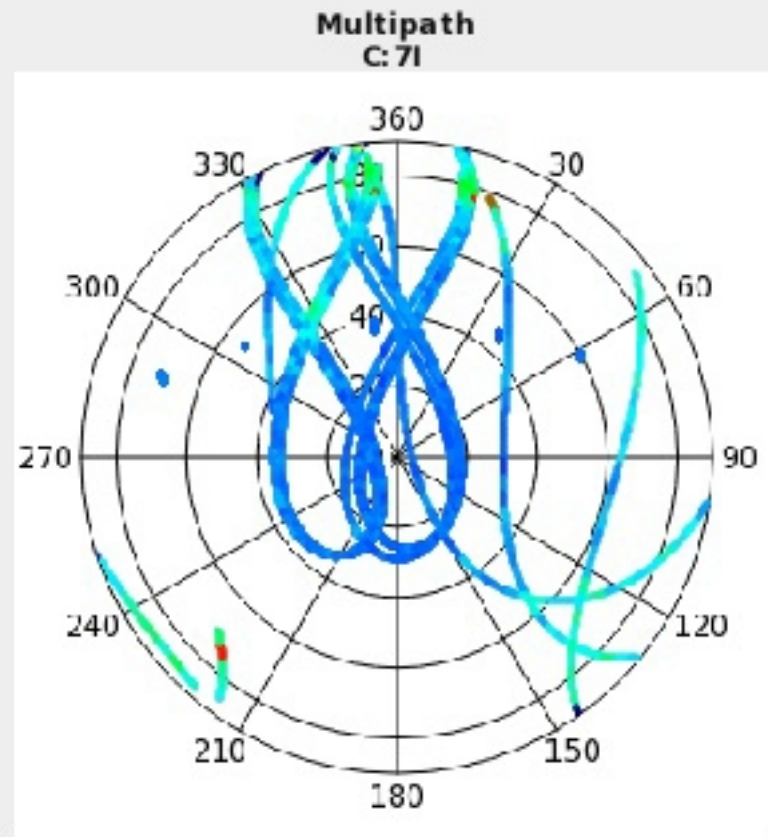
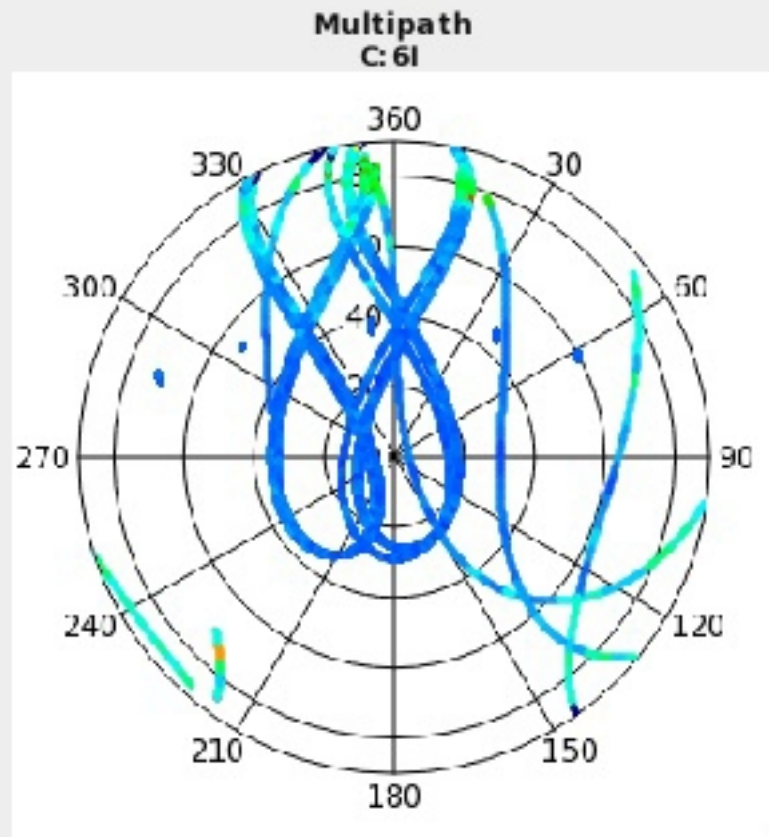


**Signal-to-Noise Ratio
C:61**



**Signal-to-Noise Ratio
C:71**







```
soehne@
Datei Bearbeiten Ansicht Suchen Terminal Hilfe
QC Format Version : 1.0

Navigation File(s): brdm0120.15p
Ephemeris       : 6118 OK  2 BAD
  Bad Ephemeris : brdm0120.15p S29 2015 01 12 22 25 04
  Bad Ephemeris : brdm0120.15p R02 2015 01 12 23 30 00

Observation File : cut00120.15o
RINEX Version    : 3.02
Marker Name     : CUT0
Marker Number    : 59945M001
Receiver        : TRIMBLE NETR9
Antenna         : TRM59800.00 SCIS
Position XYZ    : -2364337.2971 4870285.5843 -3360809.8188
Antenna dH/dE/dN : 0.0000 0.0000 0.0000
Start Time      : 2015-01-12 00.00.00.0
End Time        : 2015-01-12 23.59.30.0
Interval        : 30
Navigation Systems: 1 C

C: Satellites: 13
C: Signals : 3 1I 6I 7I

C: 1I: Observations : 29488
C: 1I: Slips (file+found): 131 + 2
C: 1I: Gaps : 12
C: 1I: Mean SNR : 42.2
C: 1I: Mean Multipath : 0.39

C: 6I: Observations : 29456
C: 6I: Slips (file+found): 142 + 2
C: 6I: Gaps : 32
C: 6I: Mean SNR : 44.8
C: 6I: Mean Multipath : 0.25

C: 7I: Observations : 29456
C: 7I: Slips (file+found): 142 + 2
C: 7I: Gaps : 32
C: 7I: Mean SNR : 44.3
C: 7I: Mean Multipath : 0.28
```