



Real-Time applications of the International GNSS Service (IGS) Multi-GNSS Experiment (MGEX) – initial Galileo results

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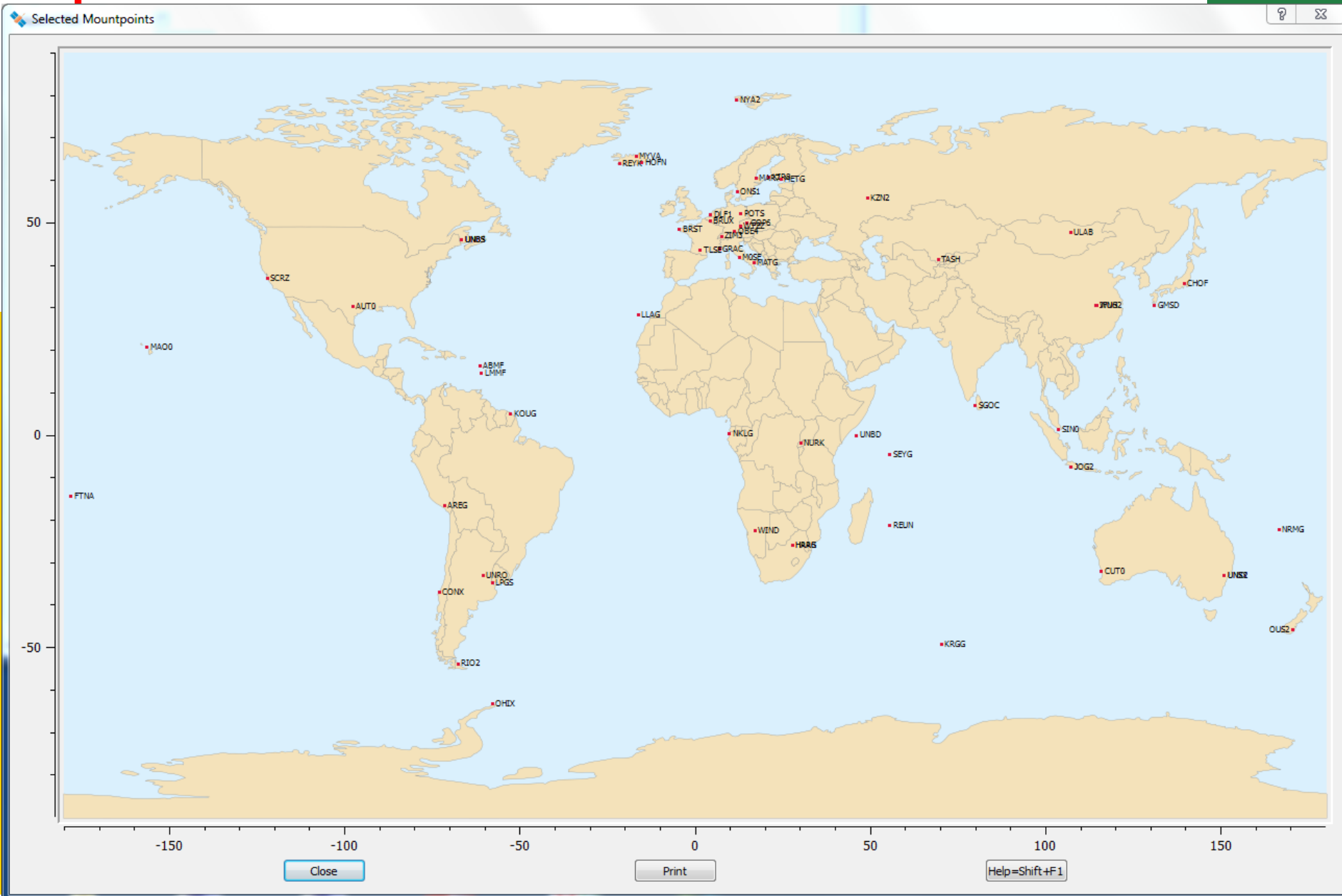
- **IGS real-time resources**
 - Real-time network of > 150 globally distributed stations
 - Using RTCM-3 stream format and Ntrip transport protocol
 - Powerful broadcast network in place on the Internet
- **Multi-GNSS Experiment**
 - Activity launched by the Multi-GNSS Working Group of the International GNSS Service
 - MGEX Call for Participation in 2011
 - Most important: GPS, GLONASS, plus ...



- **> 20 contributing agencies**
- **> 70 stations worldwide**
- **~ 10 major receiver types, ~ 7 major antenna types**
- **Tracking of GPS, GLONASS, Galileo, BeiDou, QZSS, SBAS**
- **Ntrip broadcaster at BKG for RT data**
- **Data archives at CDDIS, IGN, BKG for daily, hourly and high-rate files**
- **RTCM-3 and RINEX 3**
- **Free access**



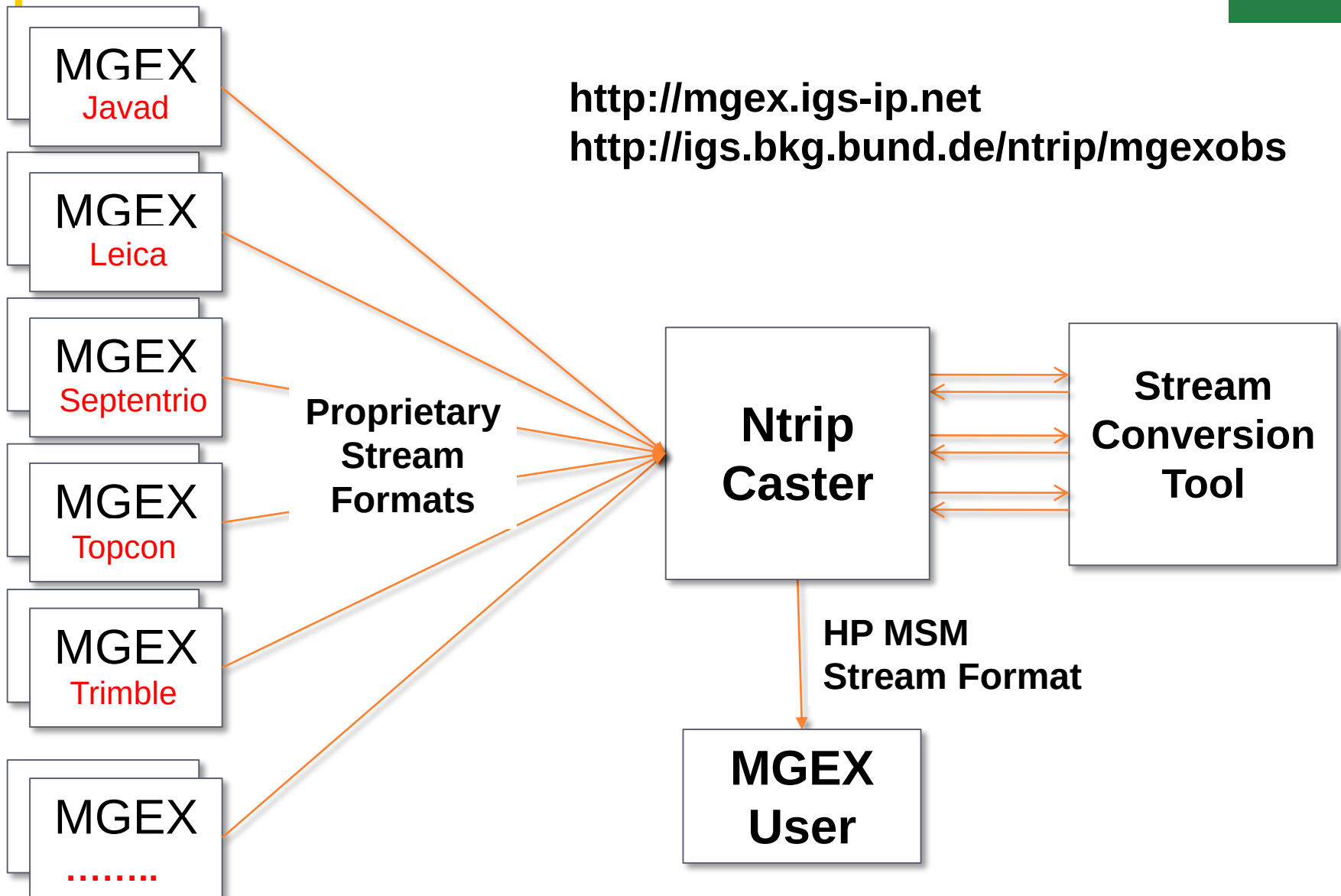
IGS MGEX RT data availability map





MGEX real-time data flow

<http://mgex.igs-ip.net>
<http://igs.bkg.bund.de/ntrip/mgexobs>





Monitoring MGEX real-time data availability

The screenshot shows a web browser window with the address bar displaying <http://mgex.igs-ip.net/home>. The browser has several tabs open, including "EUREF Permanent GNSS Netw...", "iGoogle", and "MGEX.IGS-IP Ntrip Broadca...". The main content of the page is titled "Welcome to the MGEX.IGS-IP Ntrip Broadcaster". Below the title, it states the protocol is NTRIP 2.0 and provides information about the server's location and operation. A list of links is provided for more information, including a source table, M-GEX home page, real-time observations, and real-time FAQ. A paragraph describes the BKG Ntrip Client (BNC) and its functionality. Another paragraph mentions that most observation streams are protected and require authorization through an online user registration. A final paragraph provides contact information for the BKG. At the bottom, there is a disclaimer stating that the BKG is responsible for operating the MGEX.IGS-IP Broadcaster and disclaims any liability.

Protocol: *NTRIP 2.0*
This server is mgex.igs-ip.net, running on Port 80 and 2101 (*http*) and on Port 443 (*https*), operated by [BKG](#) in support of the IGS Multi-GNSS Experiment (M-GEX).

Details about GNSS observation streams on the MGEX.IGS-IP Ntrip Broadcaster are available through

- Source [Table](#).
- M-GEX [Home Page](#).
- M-GEX [Real-time Observations](#).
- M-GEX [Real-time FAQ](#).

For receiving GNSS observation streams via NTRIP in real-time you may use the BKG Ntrip Client ([BNC](#)). This is a multi-stream Ntrip Client program designed to run on a PC or Laptop. It retrieves data from any NTRIP supporting Broadcaster. The program handles the HTTP communication and can transfer received GNSS data to a Serial or IP port to feed your application.

Most of the observation streams on the MGEX.IGS-IP Ntrip Broadcaster are protected. Authorization is provided through an online user [Registration](#).

For more information visit

- [Products IGS-IP.Net](#) for the Real-Time IGS products
- [RTIGS](#) for the Real-Time IGS Working Group
- [NTRIP](#) for the real-time GNSS data dissemination technique
- A list of [other](#) Ntrip Broadcaster implementations

Or contact igs-ip@bkg.bund.de.

The BKG is responsible today for operating the MGEX.IGS-IP Broadcaster. It disclaims any liability and responsibility to any person or entity with respect to any loss or damage caused, or alleged to be caused, directly or indirectly by the use and application of the NTRIP technology.

Monitoring MGEX real-time data availability

MONITORING

USERS

GROUPS

RETRIEVE DATA

PUSH DATA

MAP

SOURCETABLES

CONFIGURATION

LOAD CONFIGURATION

USER-STREAM HANDLING

ERROR-LOG

CASTER: MGEX.IGS-IP.NET

PRIMARY

VERBOSE

MONITORING

ad in: 0 day(s) 00:01:36

All

Offline

Online

Warning

109

23

86

0

ABMF ₂	ABMF ₇	BRST ₂	BRST ₇	BRUX ₁	BRUX ₇	CONX ₁	CONX ₇	CUT ₀₀	CUT ₀₇
DLF ₁₀	DLF ₁₇	DYNG ₂	DYNG ₇	FTNA ₁	FTNA ₇	GAP ₁₀	GAP ₁₇	GMSD ₀	GMSD ₇
GOP ₆₀	GOP ₆₇	GRAC ₂	GRAC ₇	HARB ₂	HARB ₇	KIR ₈₀	KIR ₈₇	KOUG ₂	KOUG ₇
KRG ₂	KRG ₇	KZN ₁₀	KZN ₁₇	LMMF ₂	LMMF ₇	LPG ₅₇	LPG _{5R}	MoSE ₀	MoSE ₇
MAR ₇₀	MAR ₇₇	MATG ₀	MATG ₇	METG ₂	METG ₇	MYVA ₀	MYVA ₇	NAN ₇₀	NAN ₇₁
NAN ₇₂	NAN ₇₃	NAN ₇₄	NAN ₇₅	NAN ₇₆	NAN ₇₇	NKLG ₂	NKLG ₇	NRMG ₂	NRMG ₇
NURK ₇	NURKR	NYA ₂₇	NYA _{2R}	OBE ₄₇	OBE _{4R}	OHIX ₀	OHIX ₇	ONS ₁₀	ONS ₁₇
OUS ₂₇	OUS _{2R}	POTS ₇	POTS _R	RA _{3Mo}	RA _{3Mo}	REUN ₁	REUN ₇	RIO ₂₇	RIO _{2R}
SCRZ ₀	SCRZ ₇	SEYG ₂	SEYG ₇	SGOC ₇	SGOCR	TASH ₇	TASHR	TLSE ₂	TLSE ₇
ULAB ₇	ULABR	UNB ₃₀	UNB ₃₇	UNBS ₀	UNBS ₇	UNSX ₇	UNX ₁₀	UNX ₁₇	WIND ₇
WINDR	WTZ ₁₀	WTZ ₁₇	WTZ ₃₀	WTZ ₃₇	WTZZ ₀	WTZZ ₇	WUH ₁₇	WUH _{1R}	

AlberdingCaster-Interface :::

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info@alberding.eu :::

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- **Radio Technical Commission for Maritime Services Special Committee 104 „on Differential Global Navigation Satellite Systems (DGNSS)**
- **RTCM Multiple Signal Messages (MSM)**
 - 1071-1077: GPS
 - 1081-1087: GLONASS
 - 1091-1097: Galileo
 - 1101-1107: SBAS
 - 1111-1117: QZSS
 - 1121-1127: BeiDou
- **1xx7 High-Precision MSM providing full GNSS pseudo-ranges, carrier phases, Doppler and signal strength used at MGEX caster**



- **Since February 2013 GPS, GLO, GAL MSM confirmed**
- **BDS, QZSS, SBAS postponed**
- **Navigation messages 1019, 1020 for GPS+GLO and now 1045 for Galileo**
- **Navigation message 1046 for Galileo under discussion**



- **Open Source Real-time GNSS Tool, Linux, Solaris, Window, MAC**
- **Feeding GNSS Engine**
- **RINEX**
 - **Conversion from MSM streams**
 - **Editing and Concatenation**
 - **RINEX Quality Check**
 - **Multipath analysis sky plots**
 - **Signal-to-Noise sky plots**
 - **Satellite availability plots**
 - **Satellite elevation plots**
- **Galileo capability**



BNC2.9 – signal analysis for Galileo

BKG Ntrip Client (BNC) Version 2.9

File Help

Network General RINEX Observations RINEX Ephemeris **RINEX Editing & QC** Broadcast Corrections Feed Engine Serial Output

RINEX file editing, concatenation and quality check.

Action: Analyze Set Edit Options

Input files (full path): /BRUX1090.13O ... Obs /BRDC1090.13P ... Nav

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

bnc.log Log

Directory for plots: ./

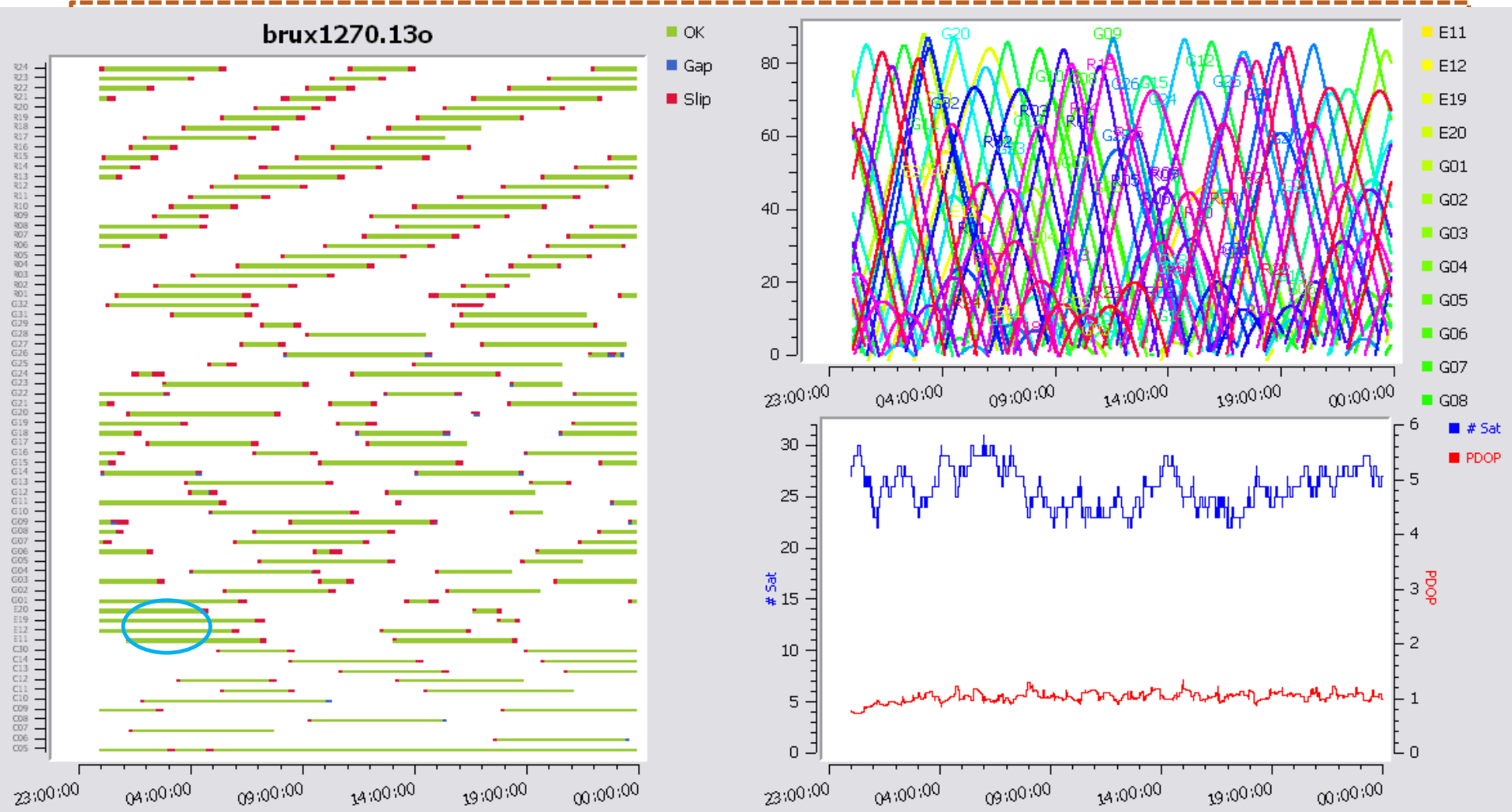
Sky Plots for: Galileo

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

Log Throughput Latency PPP Plot

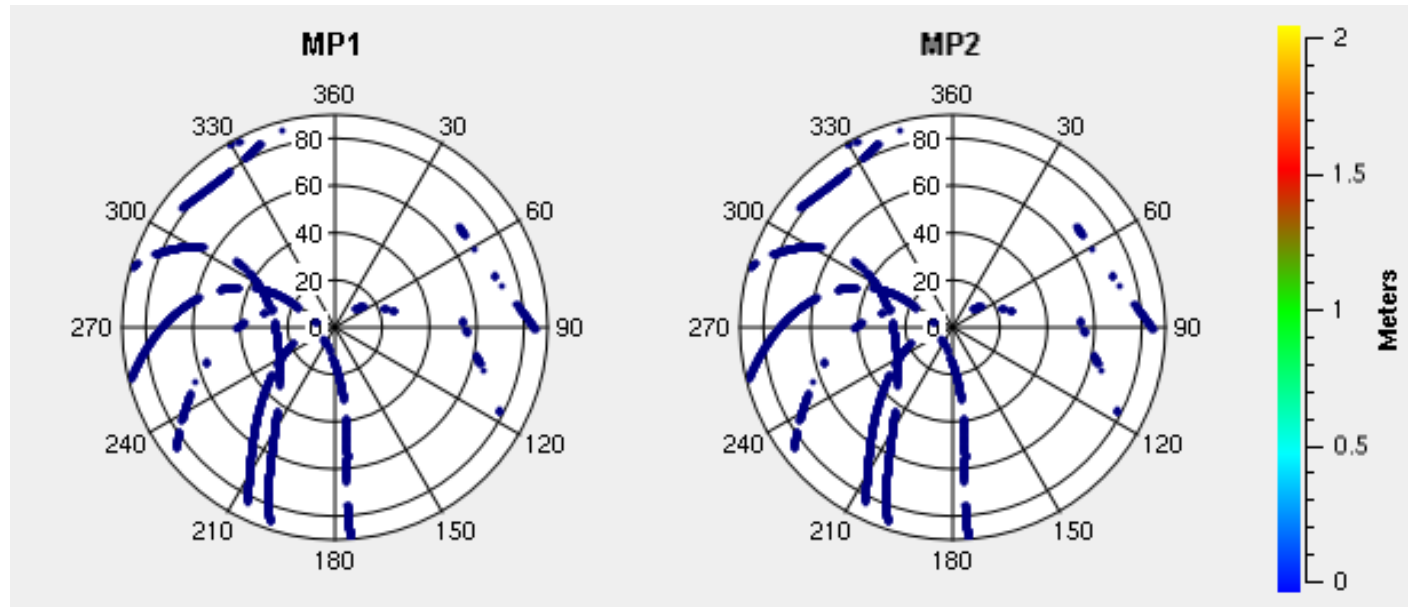


BNC2.9 – signal analysis for Galileo



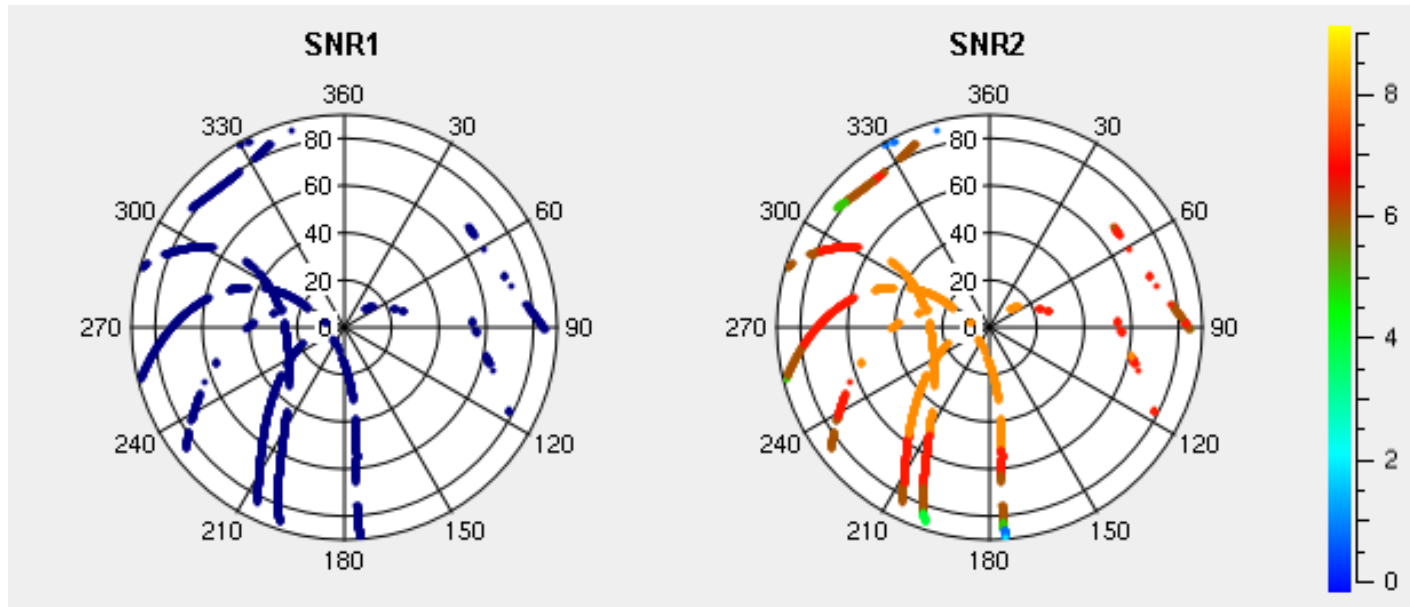


BNC2.9 – signal analysis for Galileo



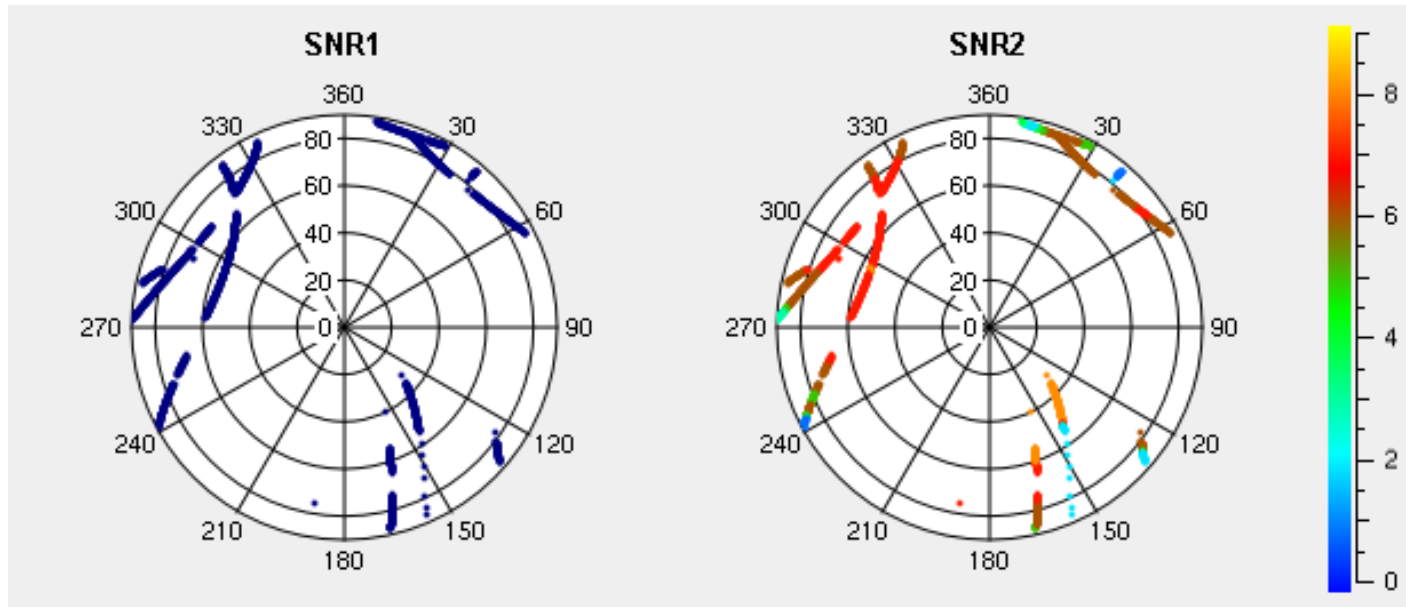


BNC2.9 – signal analysis for Galileo



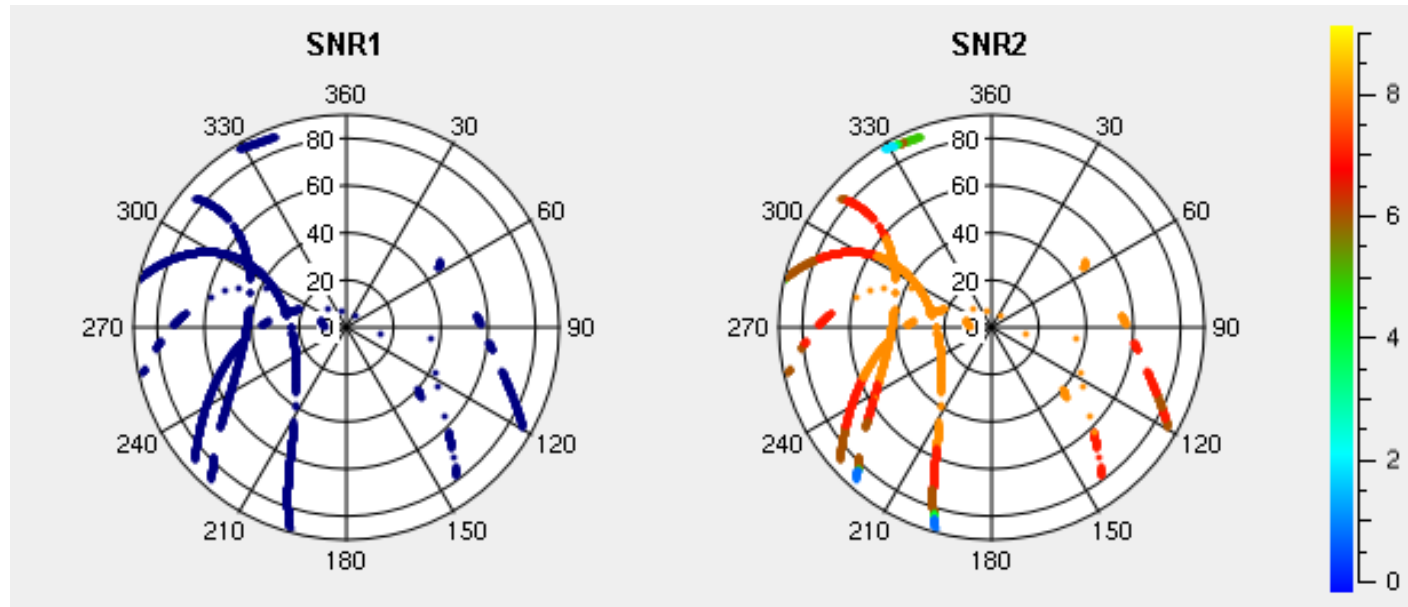


BNC2.9 – signal analysis for Galileo



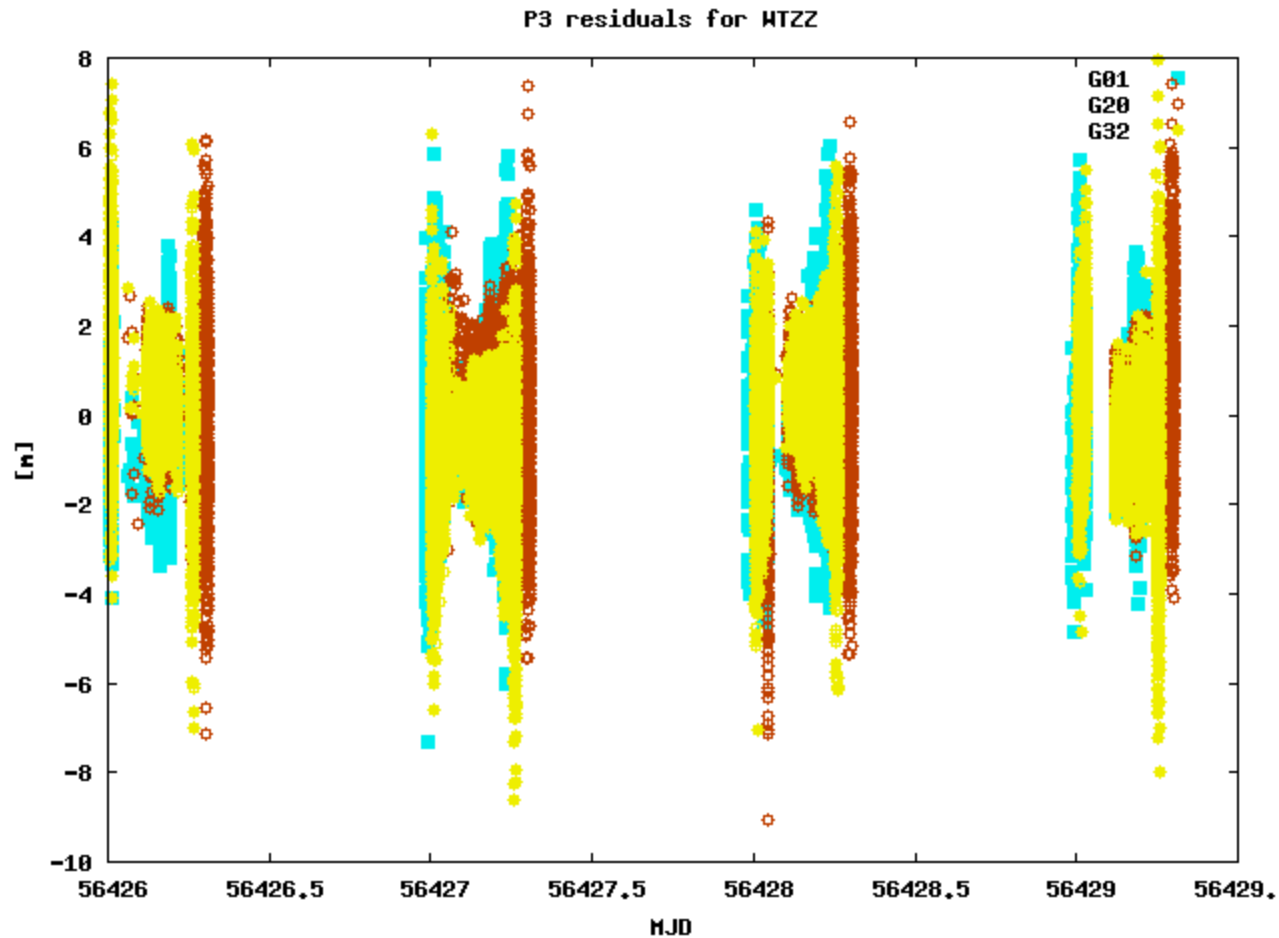


BNC2.9 – signal analysis for Galileo



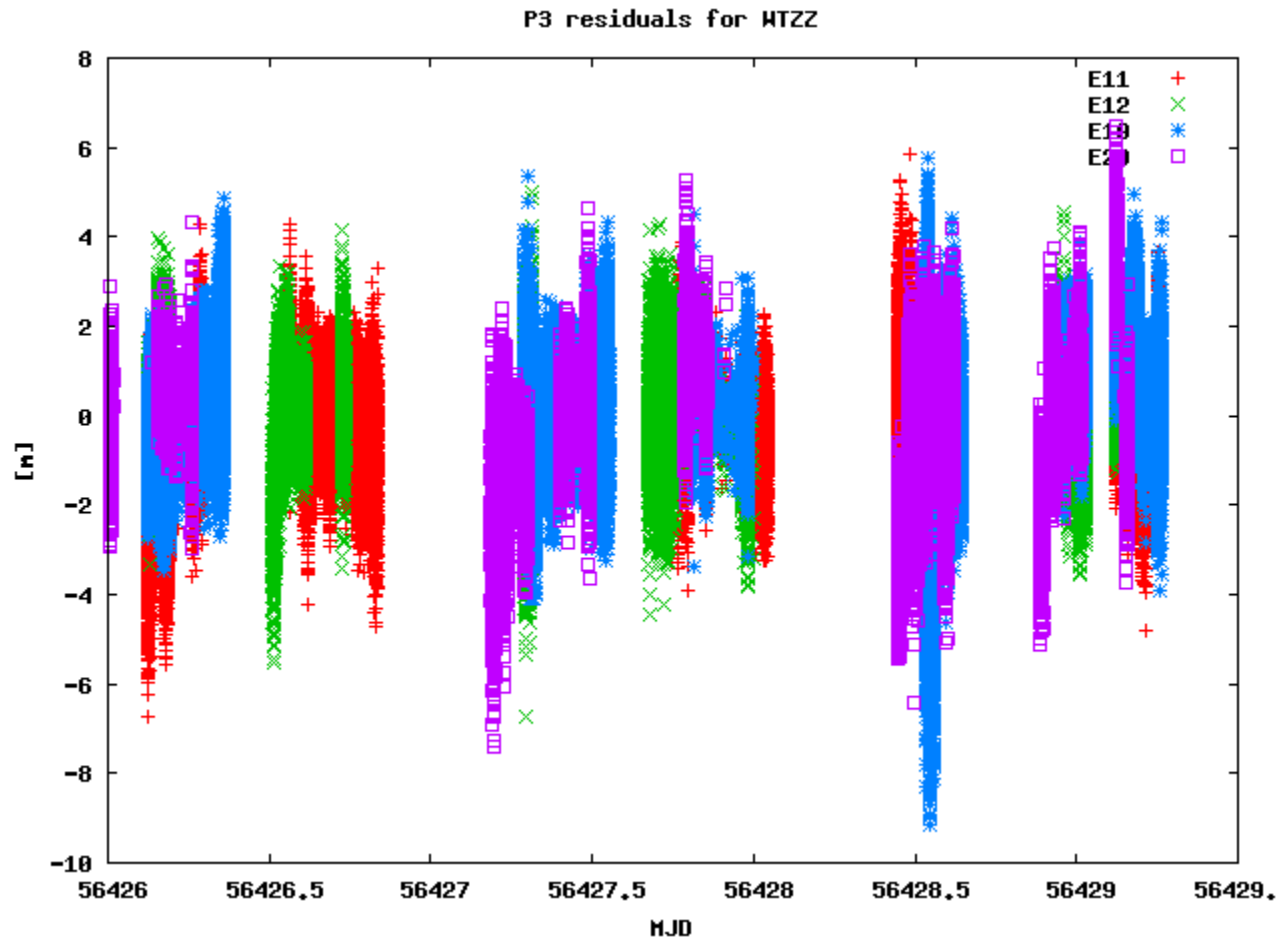


Example: P3 residuals (SPP) - GPS



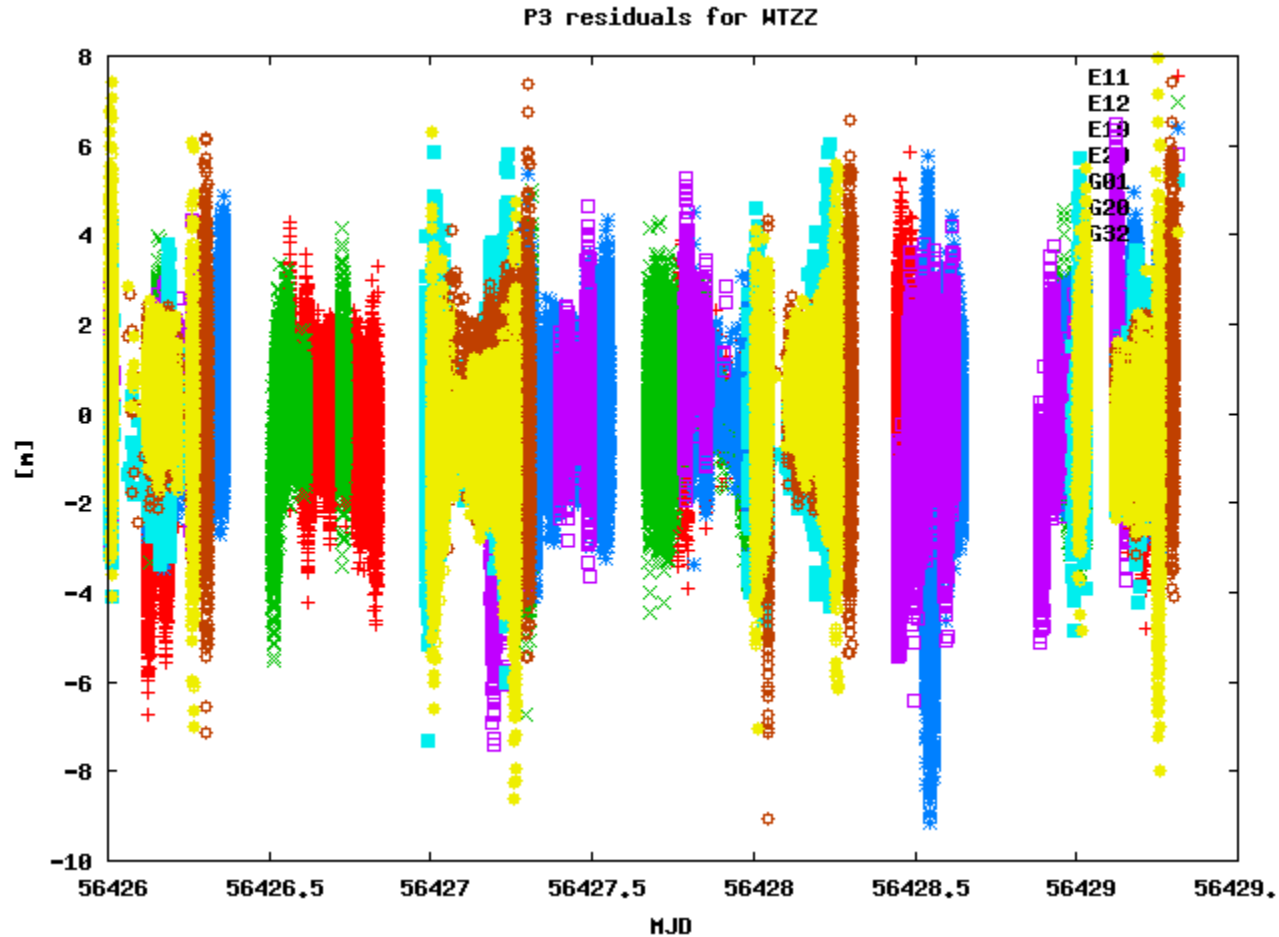


Example: P3 residuals (SPP) - Galileo



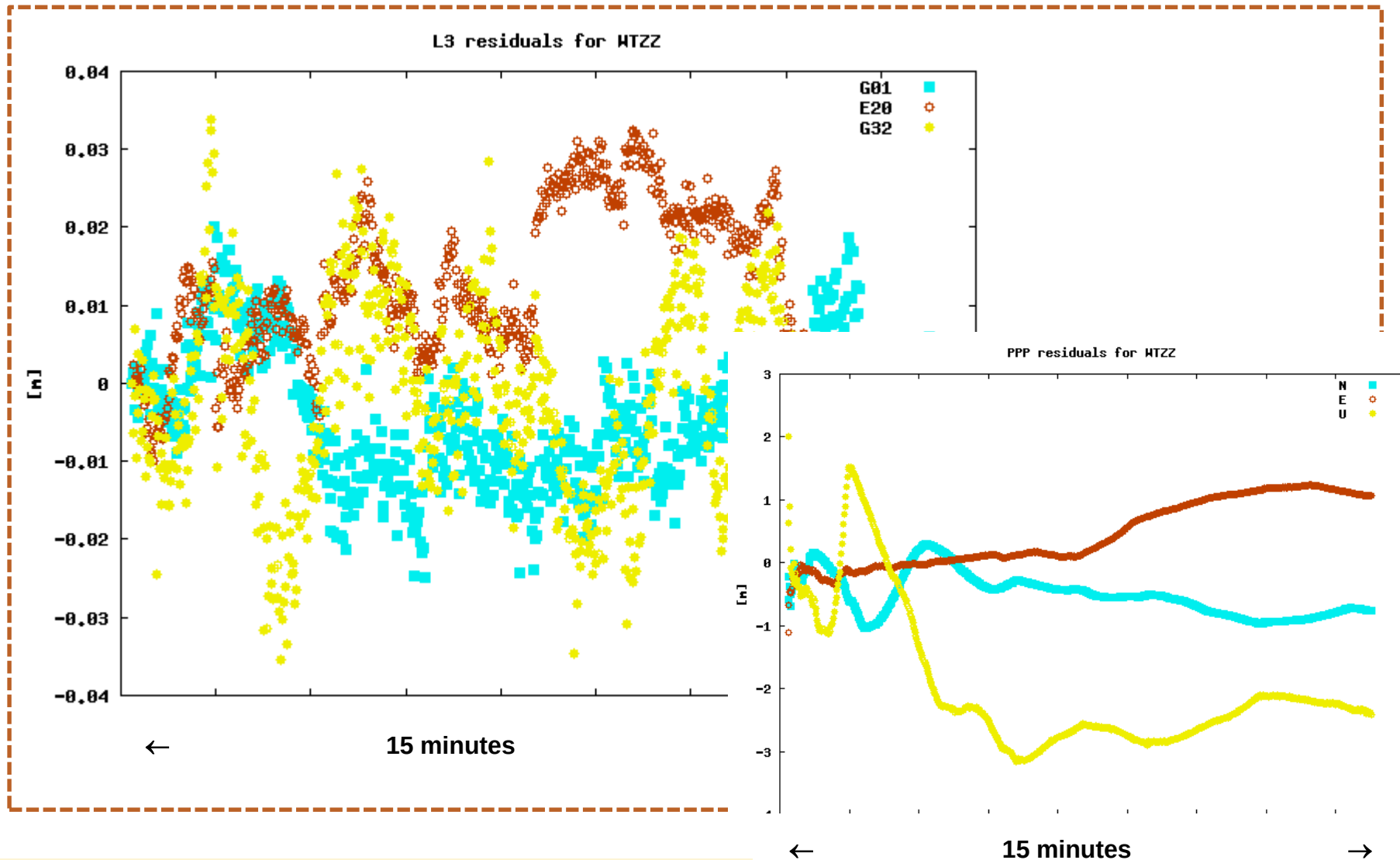


Example: P3 residuals (SPP) – GPS+GAL



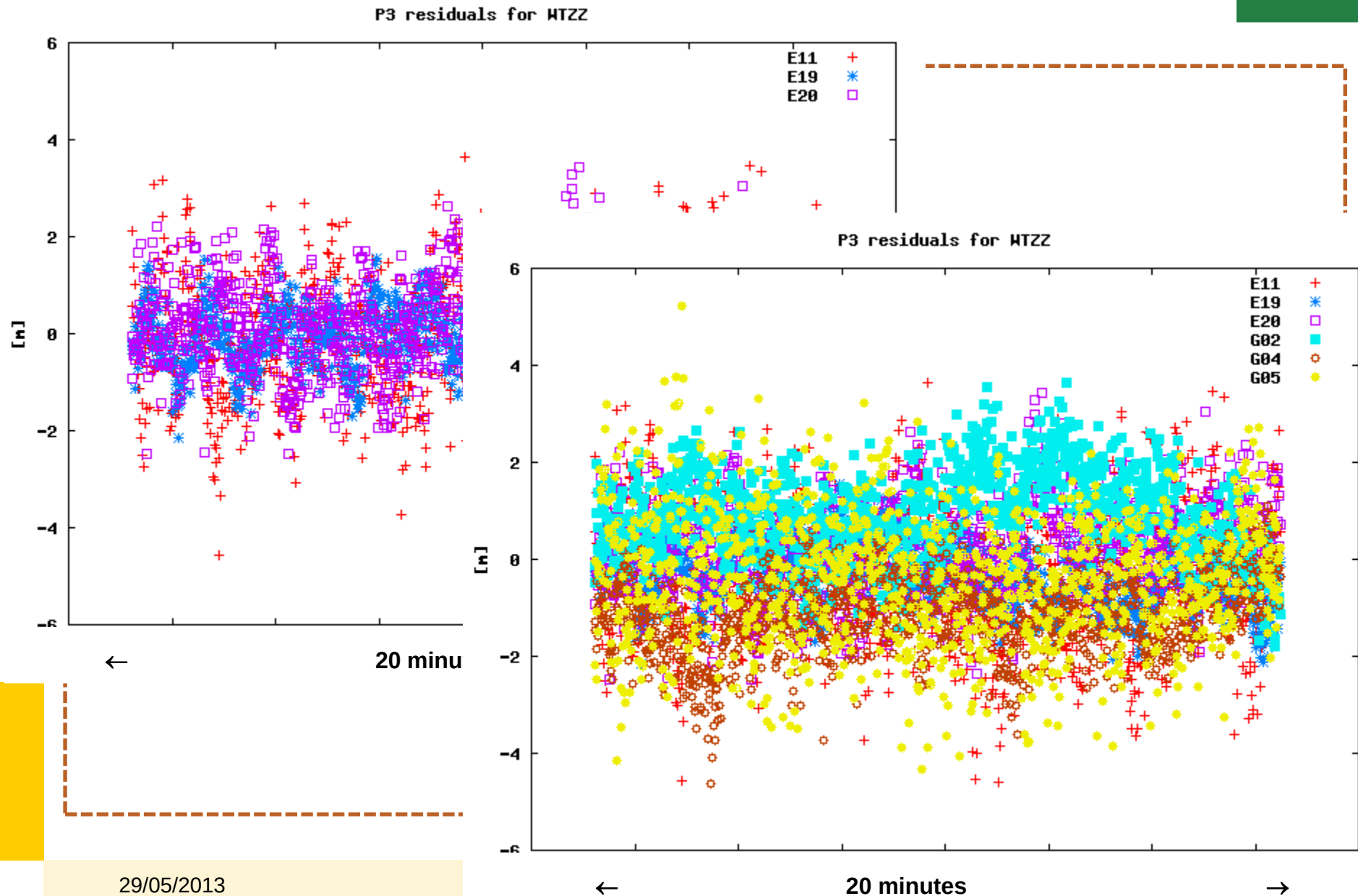


Example: L3 residuals (SPP) – GPS+GAL





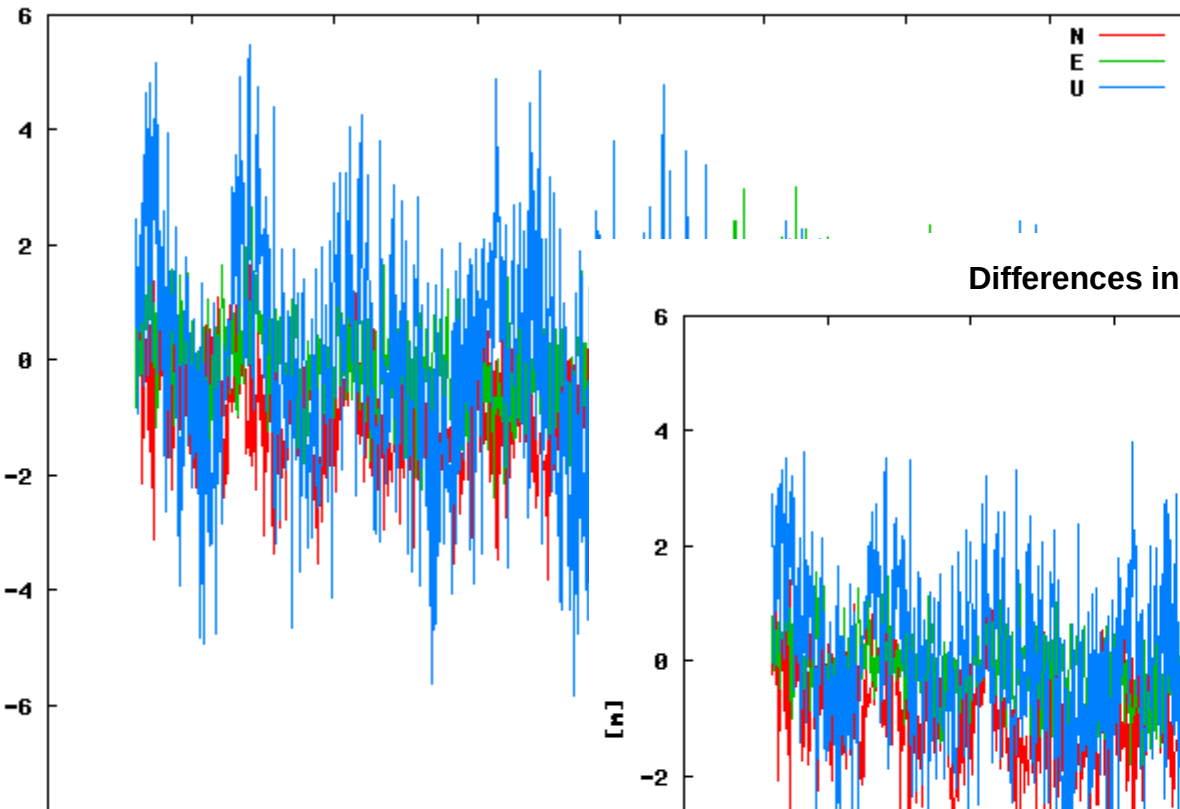
Example: SPP – GPS+GAL vs. GPS-only





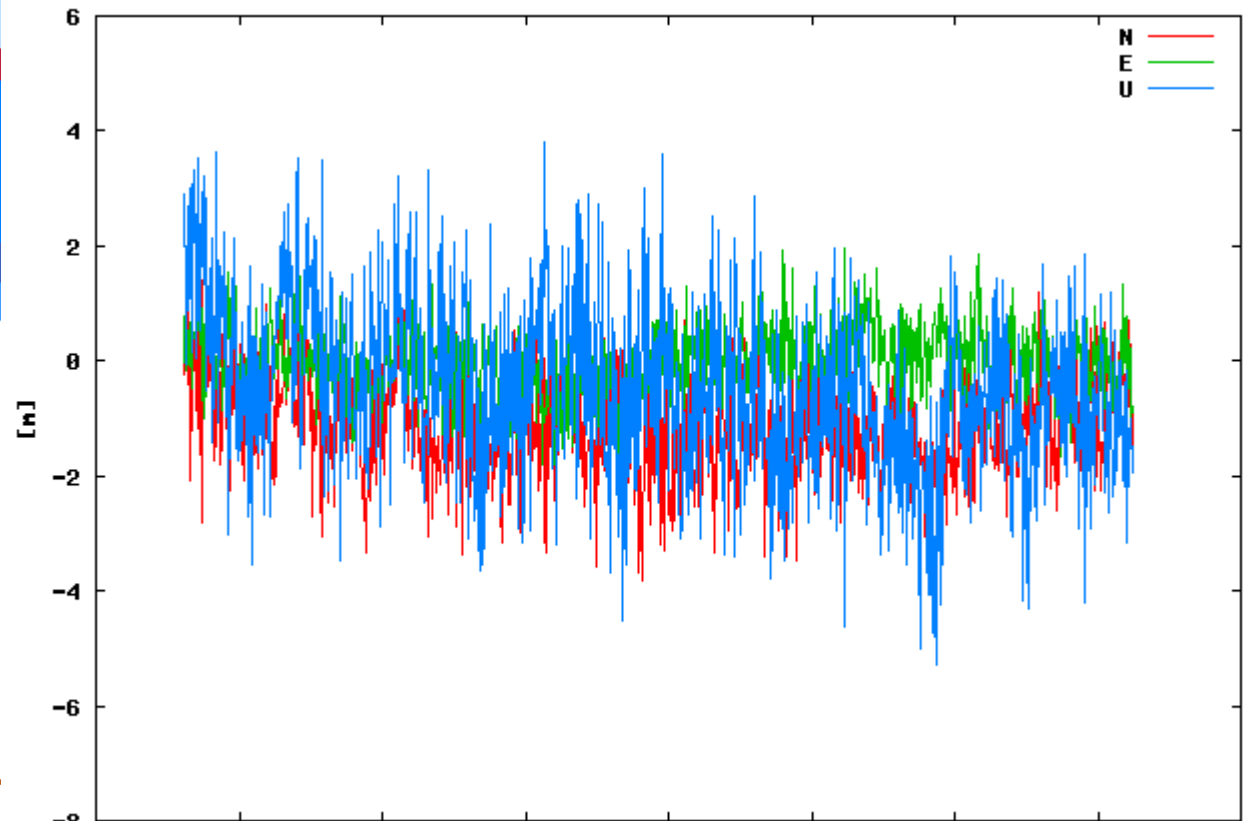
Example: SPP – GPS+GAL vs. GPS-only

Differences in North/East/Up with GPS-only



10 GPS + 3 GAL over 20 minutes

Differences in North/East/Up with GPS+GAL



06:44:58

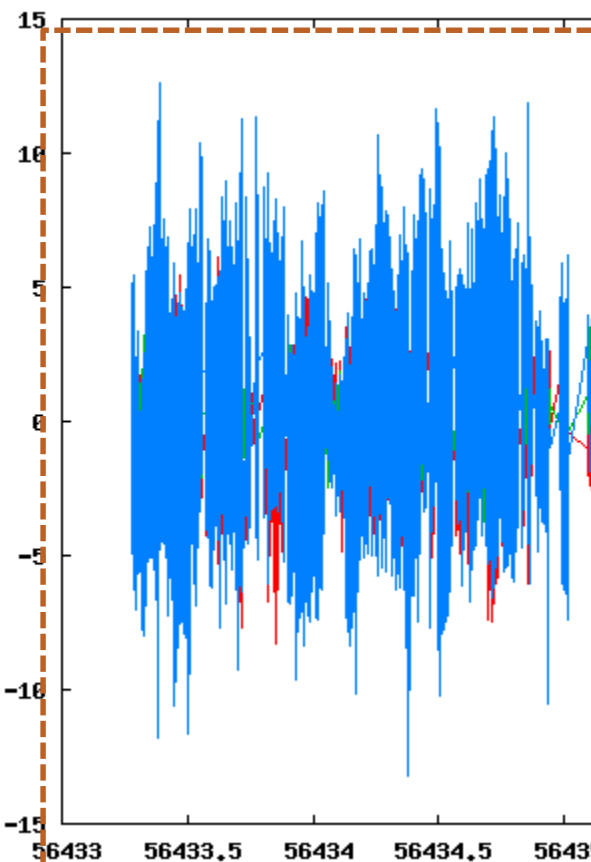
06:44:58

07:04:03



Example: SPP – GPS+GAL vs. GPS-only

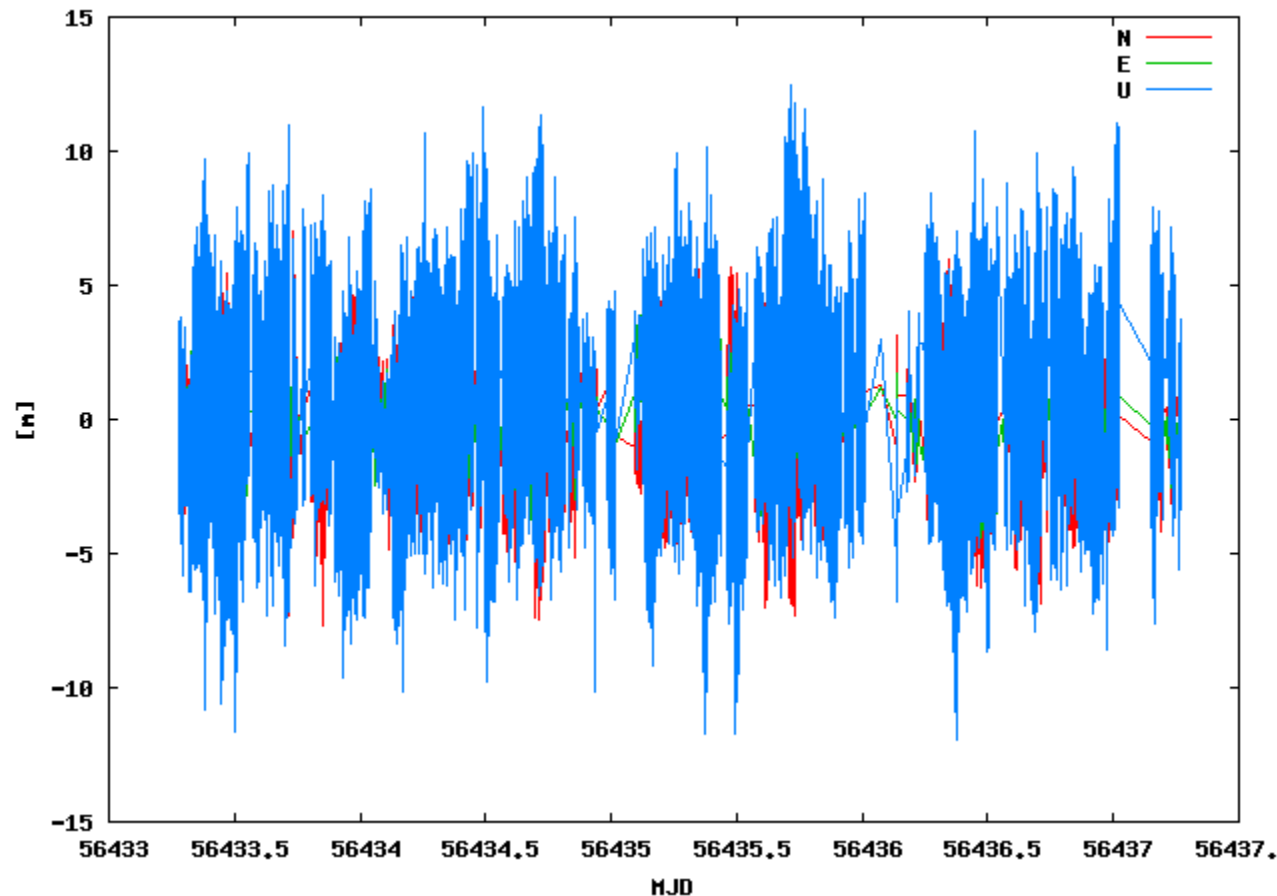
Coordinate differences GPS only



N
E
U

10 GPS + 3 GAL over 4 days

Coordinate differences GPS+GAL





- **IGS MGEX real-time data (GPS+GLO+GAL/BDS/QZSS/SBAS) available on a global and regional level**
- **Format for orbit & clock corrections for Galileo as part of RTCM State Space Representation under development**
- **Real-time formats will allow provision of Galileo (and BeiDou and more?) corrections soon**
- **More station manager are encouraged to provide multi-GNSS data in RTCM-3 and RINEX 3**