Recent Developments in the EUREF Permanent Network (EPN) and its Central Bureau

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EPN Central Bureau
Royal Observatory of Belgium

OUTLINE

- **EPN Tracking Network**
- **New@EPN CB**
- **Historical EPN Data Centre & EPN-REPRO1**
- **Future**

EPN COMPONENTS

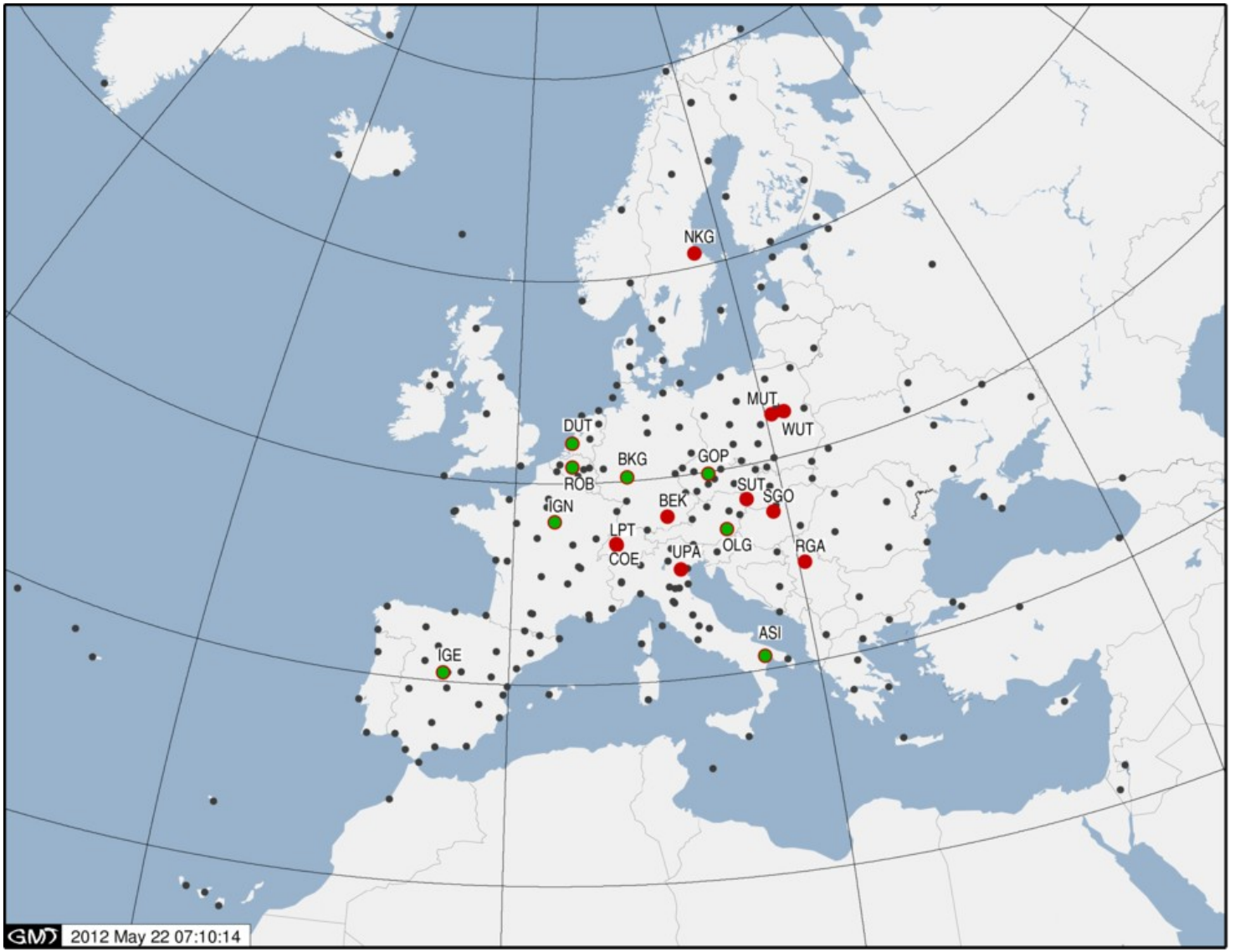
243 GNSS tracking stations

8 Data Centres

18 Analysis Centres

Special purpose data centres:

- Hourly data centre (GOP)
- High rate data centre (BKG)
- Historical data centre (ROB/EPN CB)



EPN TRACKING NETWORK

Since May 2011:

- 4 new EPN stations
- 7 stations removed from network (of which 3 stations have been replaced : BRUS, SUUR, TORA)

REMOVED EPN STATIONS

ROB

Monuments destroyed:

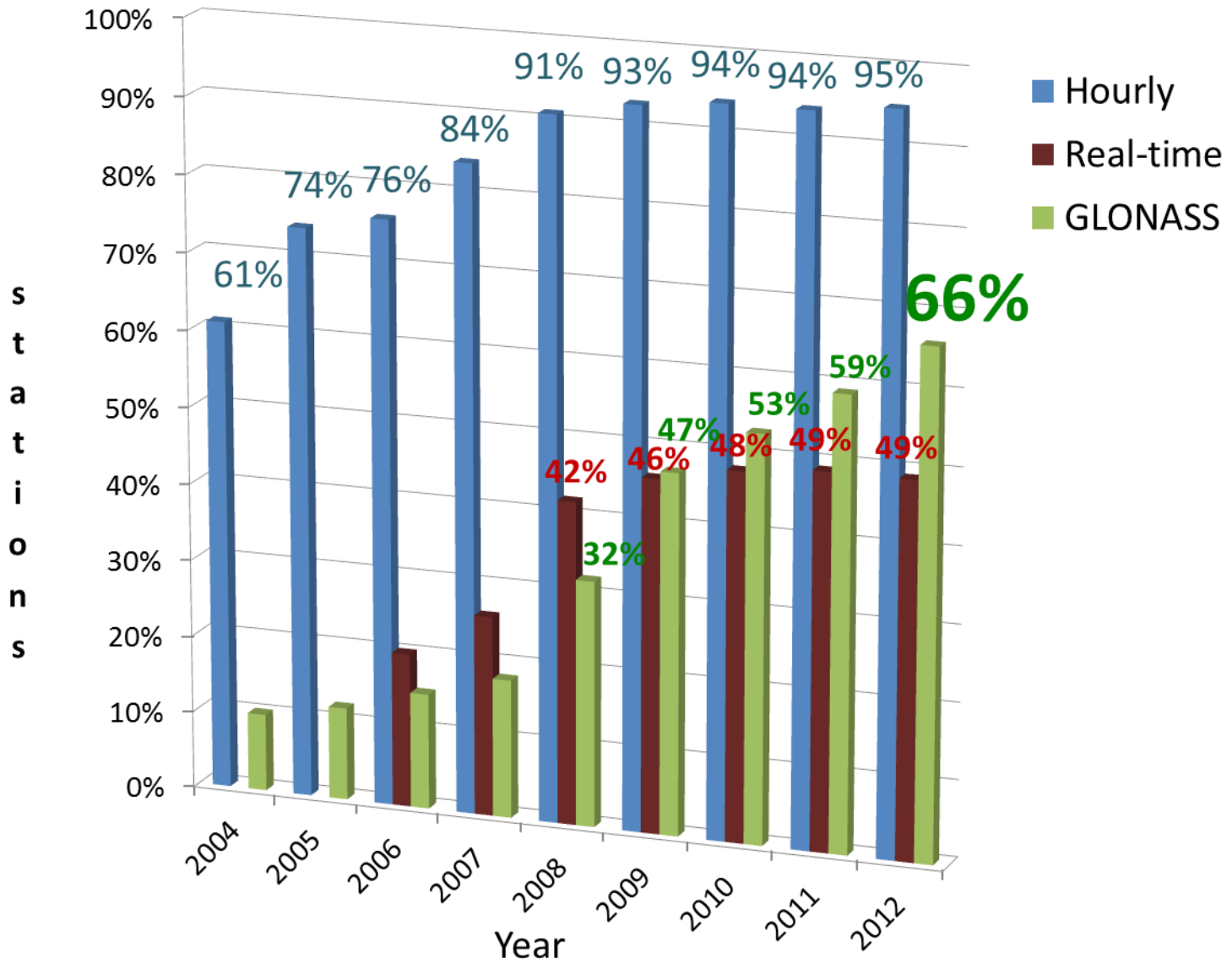
- BRUS (Belgium, 1995) → BRUX
- SUUR (Estonia, 2006) → SUR4
- TORA (Estonia, 2008) → TOR2

Other:

- CAME (Italy, 2011): equipment stolen and never replaced
- HFL2 (Austria, 2008): maintenance too expensive, no agency support
- MILO (Italy, 2005): facility closed
- RIOJ (Spain, 2005): power problem → RIO1

4 NEW EPN STATIONS

ROB

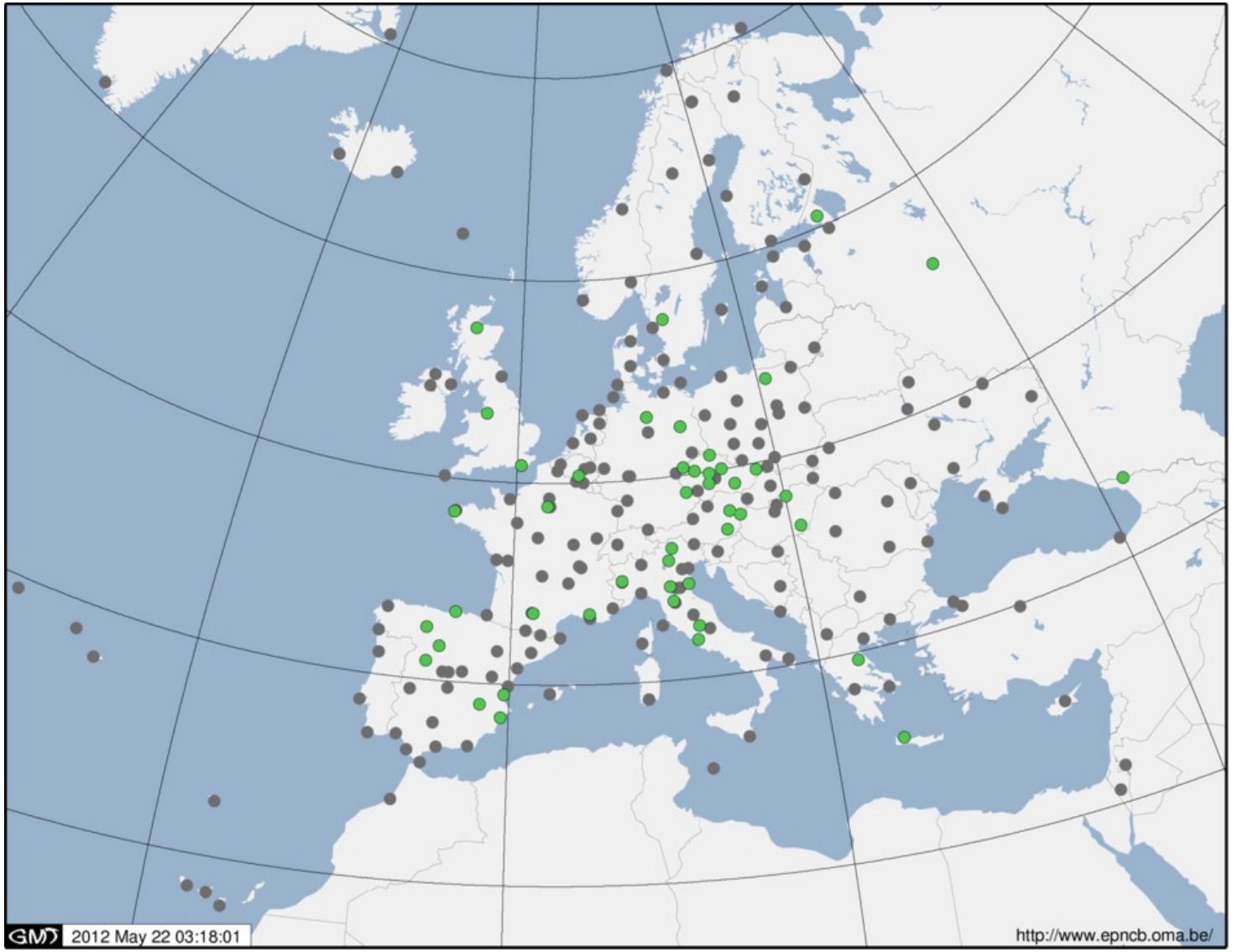


GALILEO TRACKING CAPABILITY

ROB

Receivers in EPN capable of tracking Galileo signals (46)

Status May 22, 2012



EPN ANTENNA REPLACEMENTS

ROB

23 antenna replacements (including new stations)

(14 with radome!)

GPS	GPS/GLONASS	GPS/GLONASS/GALILEO
1 ASH701945C_M	2 LEIAT504GG	1 JAVRINGANT_DM
	1 NOV702GG	1 LEIAR10
		1 LEIAR25.R3
		10 LEIAR25.R4
		1 TPSCR.G3
		5 TRM55971.00
1	3	19

GPS L5 TRACKING CAPABILITY

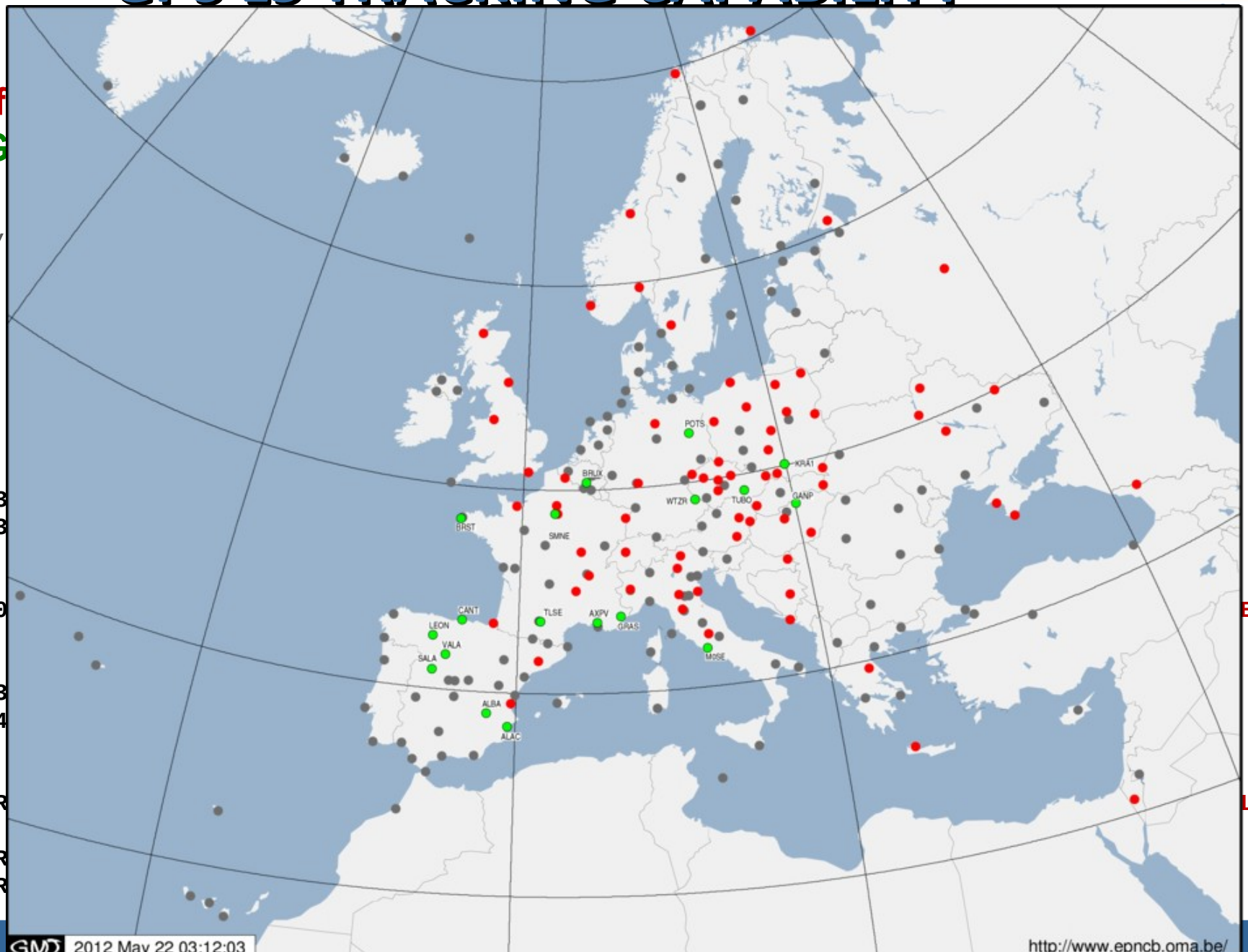
Capable of
Tracking G

Status May

JAVAD TRE_G3
JAVAD TRE_G3
LEICA GR10
LEICA GR25
LEICA GRX120

NOV OEMV3
SEPT POLARX3
SEPT POLARX4
TPS NETG3
TPS NET-G3A
TRIMBLE NETR

TRIMBLE NETR
TRIMBLE NETR



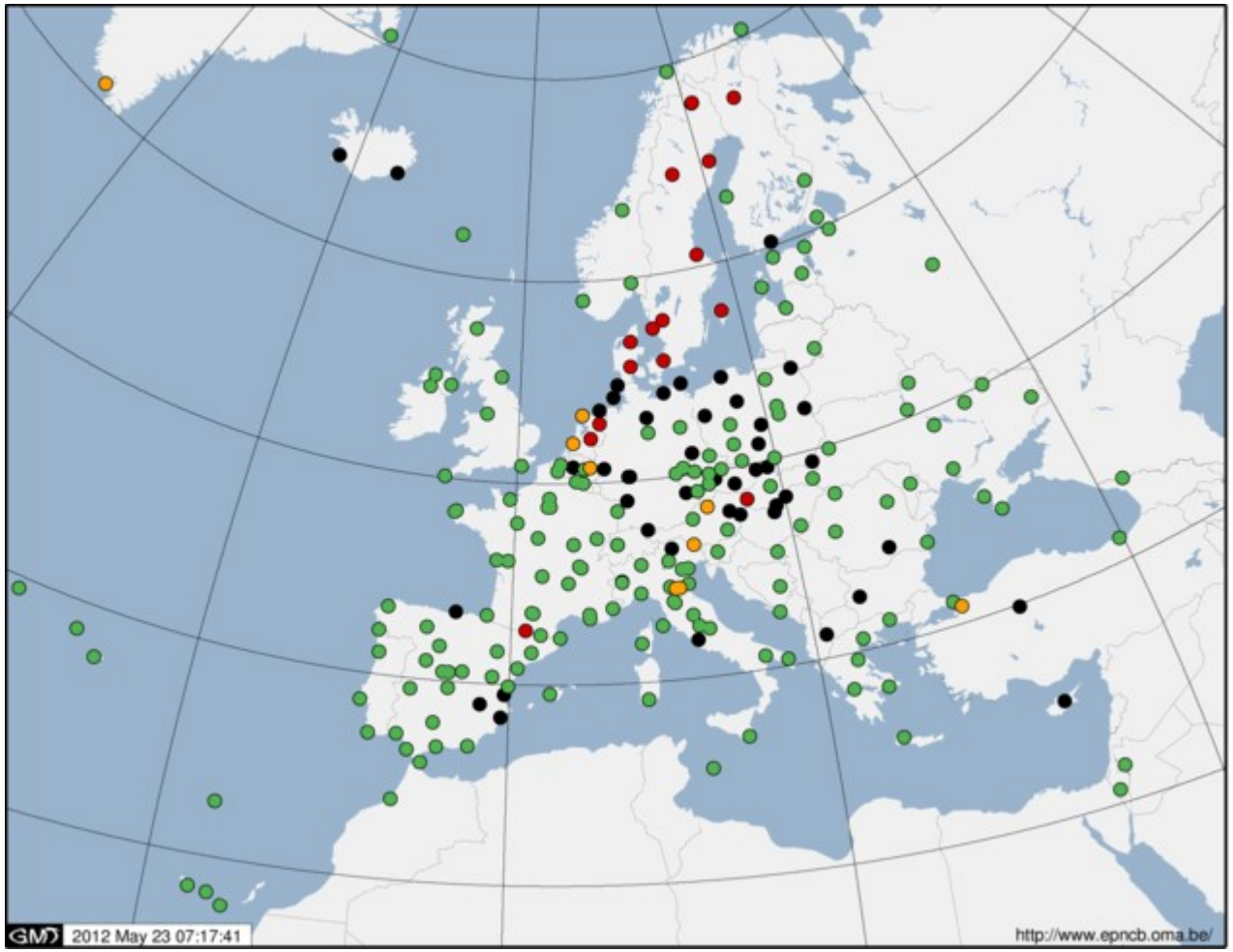
EPN ANTENNA CALIBRATIONS

Individual calibration (16%)

True absolute calibration (69%)

Converted from relative (7%)

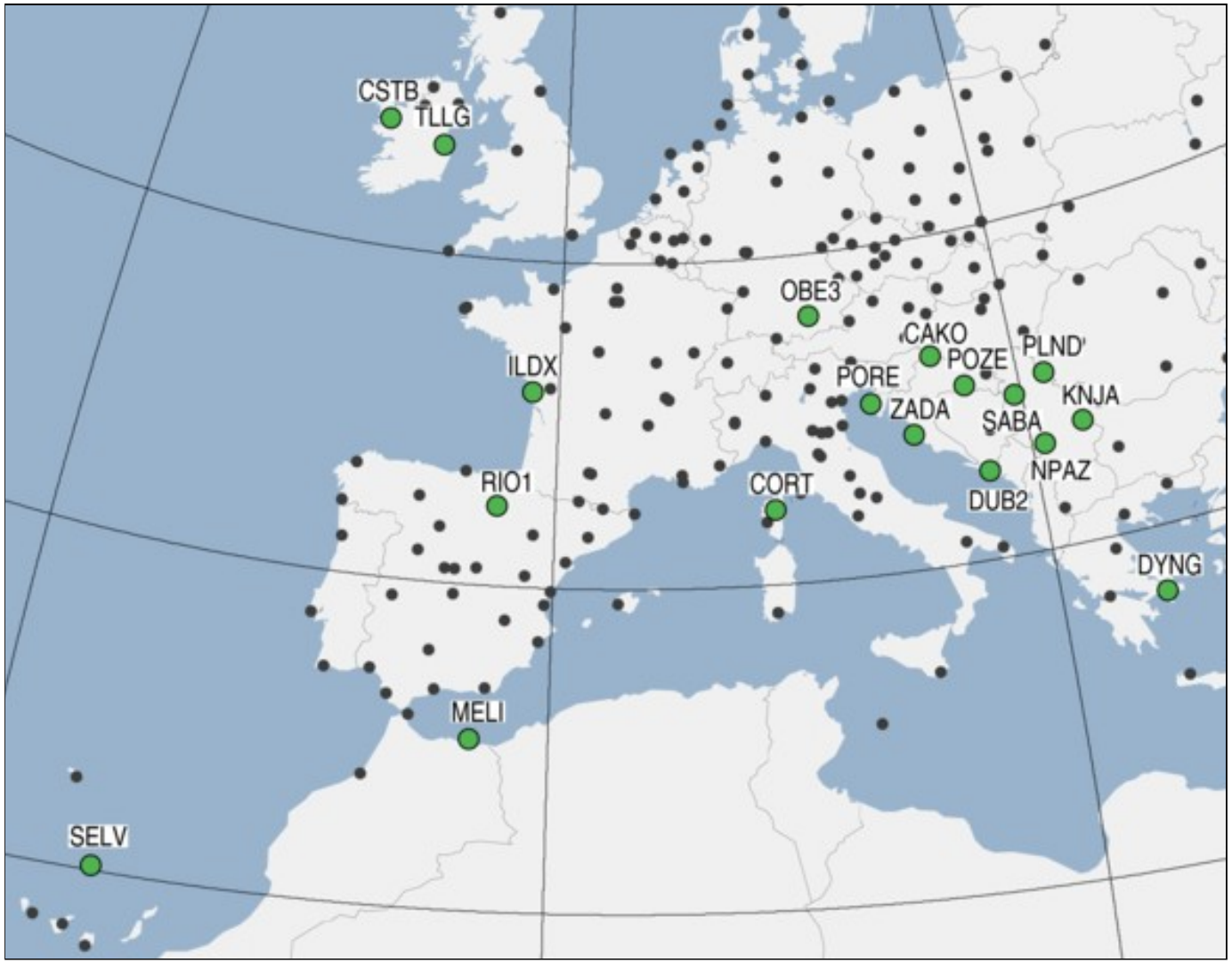
No absolute calibration (8%)



PROPOSED EPN STATIONS

- ✓ Croatia (5)
- ✓ France (2)
- ✓ Germany (1)
- ✓ Greece (1)
- ✓ Ireland (2)
- ✓ Portugal (1)
- ✓ Serbia (4)
- ✓ Spain (2)

Allready proposed last year

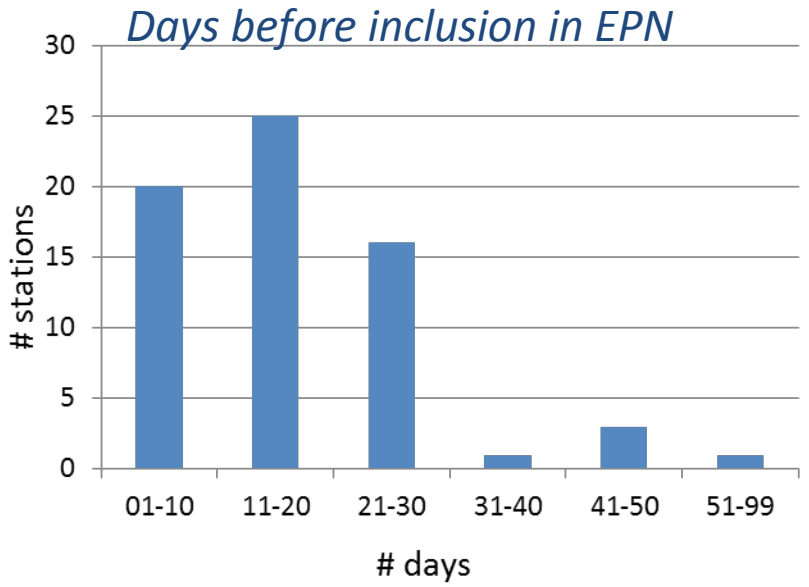


PROPOSED EPN STATIONS

ROB

Reasons for delays in integrating proposed station into the EPN:

- Communication with station manager
- Meta-data: site log, operational center form, site pictures , commitment letter
- Data availability at data centers (large latencies, format errors, data missing in one data centre)
- Data quality (data gaps → linked with data availabiity)
- Antenna/radome without absolute calibrations



Majority of proposed EPN stations is integrated into the EPN within 6 months after proposal date

PROPOSED EPN STATIONS

	Country	DQ (%)		Availability (%)					Latency			Documentation				Meta-data		Rele-vance to EPN	Data		
				Daily		Hourly			Hourly(%)												
		0°	15°	BKG	OLG	BKG	OLG	RT	BKG	OLG	RT (s)	CL	SL	SP	NC	Daily	RT		AC	DQ	
	Croatia	83	97	100	100	100	96	_	93	0	_	✔	✔	✔	✔	✔	__	R	T	✔	AS
	France	77	96	88	88	78	78	_	65	59	_	✔	✔	✔	__	✘	__	R	T	✘	IGE
	Ireland	87	96	100	100	100	98	_	95	85	_	✔	✔	✔	✘	✔	__	R	T	✔	IGE
	Croatia	92	96	100	100	100	96	_	94	0	_	✔	✔	✔	__	✔	__	R	T	✔	AS
	Greece	83	92	0	68	0	87	_	0	59	_	✘	✘	✘	__	✘	__	C	✘	✘	AS
	France	89	97	81	100	75	78	_	66	54	_	✔	✔	✔	__	✘	__	R, E, C	T	✘	IGE
	Serbia	80	96	36	0	0	0	_	0	0	_	✘	✔	✔	__	✘	__		T	✘	
	Spain	69	74	13	13	2	2	_	2	2	_	✔	✔	✔	__	✘	__	R, E	T	✔	IGE
	Serbia	83	95	64	4	0	0	_	0	0	_	✔	✔	✔	✔	✔	__	R	T	✔	OL
	Germany	72	77	96	0	100	0	_	98	0	_	✔	✔	✘	__	✔	__	R	I	✘	BE
	Serbia	79	93	89	7	0	0	_	0	0	_	✔	✔	✔	✔	✔	__	R	T	✘	BK
	Croatia	84	97	96	100	99	97	_	92	0	_	✔	✔	✔	✔	✔	__	R	T	✔	AS
	Croatia	78	91	82	86	78	78	_	75	0	_	✔	✔	✔	✔	✔	__	R	T	✔	AS
	Spain	76	78	89	93	93	92	99	93	86	0.8	✔	✔	✔	__	✔	✔	R, E	I	✔	BE
	Serbia	84	95	14	4	0	0	_	0	0	_	✔	✔	✔	✔	✔	__	R	T	✘	OL
e Island	Portugal	84	93	43	54	44	59	_	0	0	_	✔	✔	✔	__	✔	__	R	T	✘	BE
	Ireland	88	96	100	100	100	100	_	96	79	_	✔	✔	✔	✘	✔	__	R	T	✔	IGE
	Croatia	80	91	93	96	93	93	_	85	0	_	✔	✔	✔	✔	✔	__	R	T	✔	AS

EPN MANAGEMENT

EUREF Technical Working Group → General policies

EPN Coordination Group → propose EPN policy to the EUREF TWG + control general EPN activities + generation of EPN products

- Network Coordinator + EPN Central Bureau — C. Bruyninx
  → Day-to-day EPN management
- Data Flow Coordinator — G. Stangl
- Analysis Coordinator — H. Habrich
- Troposphere Coordinator — W. Söhne
- Chair Real-time Analysis project — W. Söhne
- Chair Reprocessing project — C. Völksen
- Reference Frame Coordinator NEW — A. Kenyeres
  - ✓ Regularly updated long-term EPN positions & velocities, residual position time series
  - ✓ List of EPN Class A stations
  - ✓ Densification of the long-term positions & velocities of the EPN

OUTLINE

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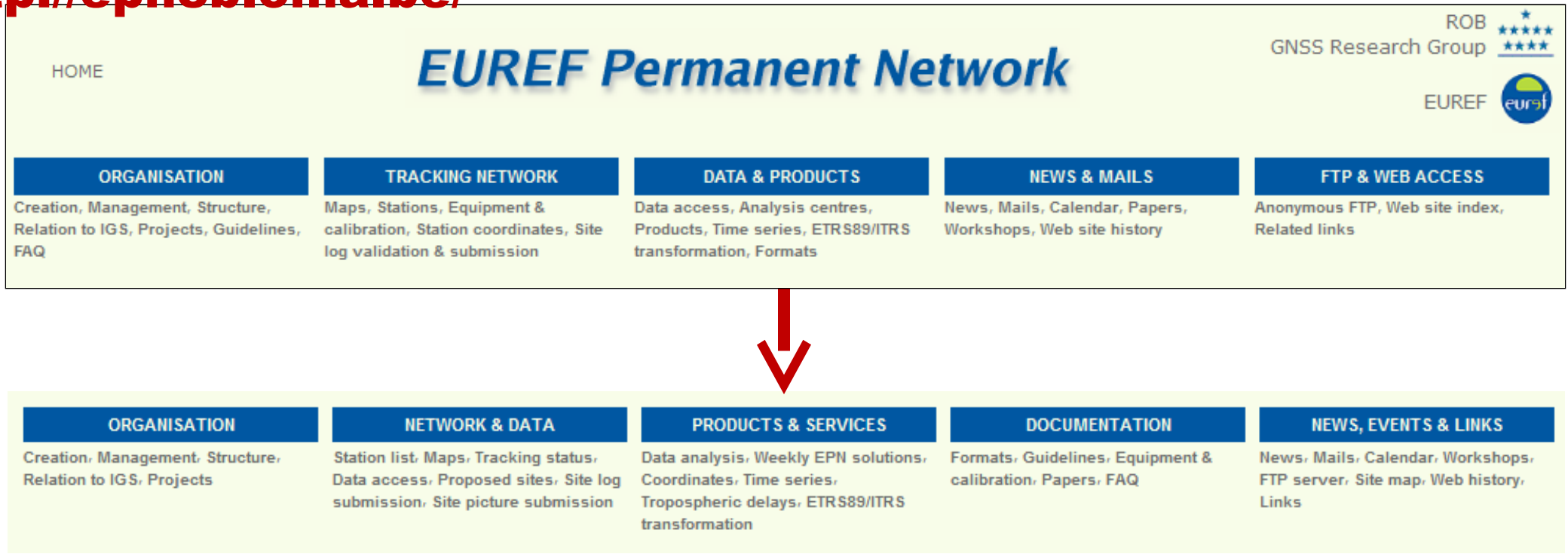
- Historical EPN Data Centre & EPN-REPRO1
- Future

CHANGE OF MENU OF EPN CENTRAL BUREAU

ROB

http://epncb.oma.be/

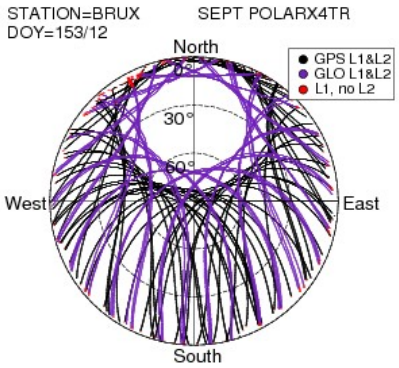


- Previous menu structure historically based in menu of IGS CB
- No web pages lost, but some links will require updating
  - Access to most visited web pages directly from menu

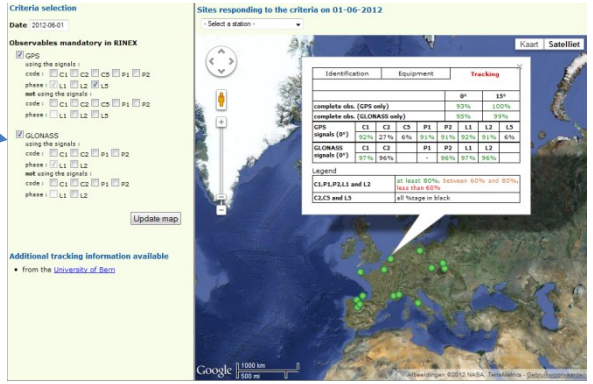
EPN CB - NEW QUALITY CHECK SOFTWARE

QualCheck

- Skyplots of satellite tracking
- Ratio observed/predicted number of observations



- Suited for specific use at EPN CB (skyplots, MySql, web pages)
- EPN guidelines → less run-time options
- Evolution following the modernization of the EPN tracking network
- Tracking statistics/signals



EPN CB - NEW QUALITY CHECK SOFTWARE

Criteria selection

Date 2012-06-01

Observables mandatory in RINEX

☑ GPS
using the signals :
code : ☐ C1 ☐ C2 ☐ C5 ☐ P1 ☐ P2
phase : ☑ L1 ☐ L2 ☑ L5
not using the signals :
code : ☐ C1 ☐ C2 ☐ C5 ☐ P1 ☐ P2
phase : ☐ L1 ☐ L2 ☐ L5

☑ GLONASS
using the signals :
code : ☐ C1 ☐ C2 ☐ P1 ☐ P2
phase : ☑ L1 ☐ L2
not using the signals :
code : ☐ C1 ☐ C2 ☐ P1 ☐ P2
phase : ☐ L1 ☐ L2

Update map

Additional tracking information available

- from the University of Bern

Sites responding to the criteria on 01-06-2012

- Select a station -

Kaart | Satelliet

Identification	Equipment	Tracking

	0°	15°
complete obs. (GPS only)	93%	100%
complete obs. (GLONASS only)	95%	99%

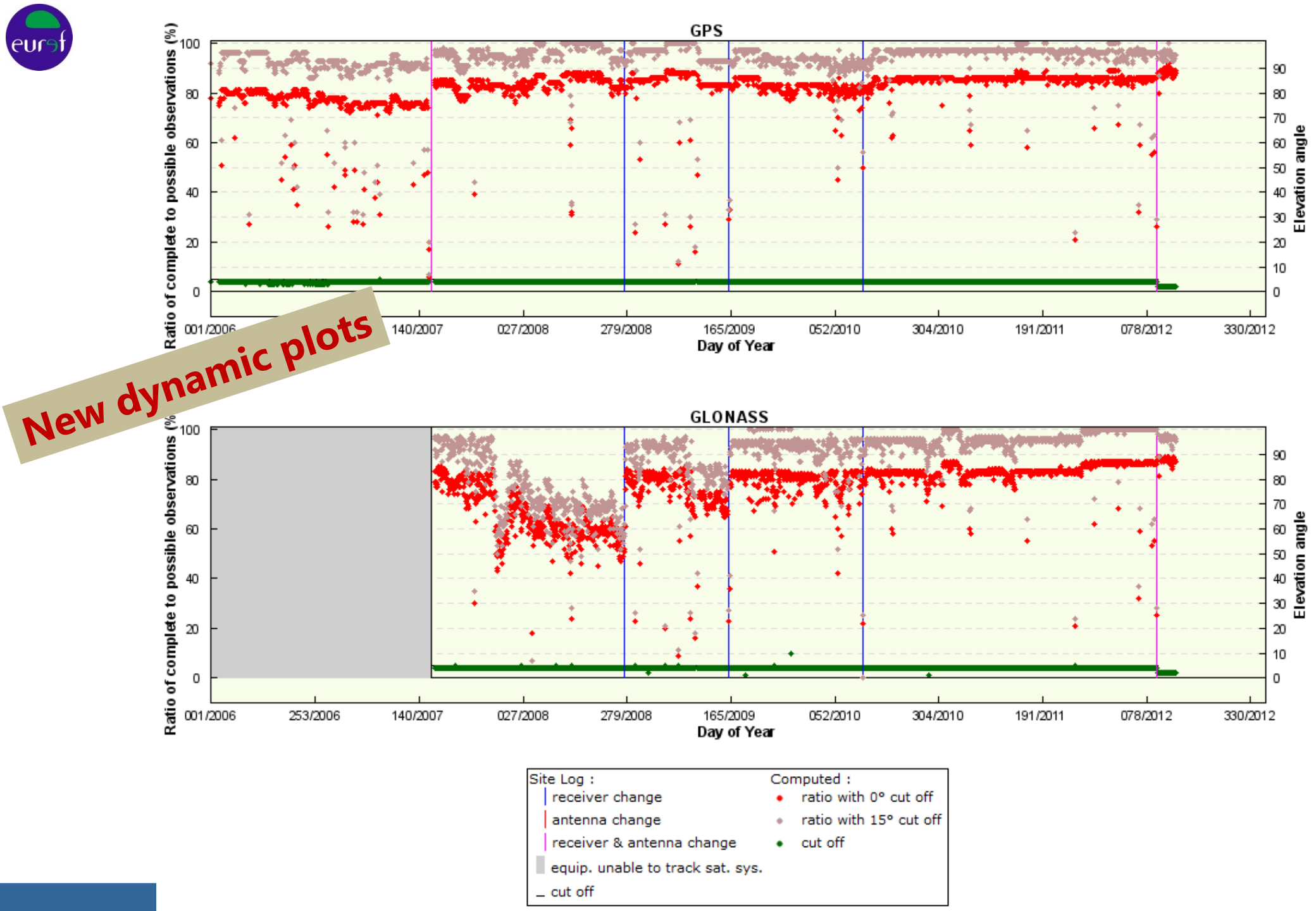
GPS signals (0°)	C1	C2	C5	P1	P2	L1	L2	L5
	92%	27%	6%	91%	91%	92%	91%	6%

GLONASS signals (0°)	C1	C2		P1	P2	L1	L2	
	97%	96%		-	96%	97%	96%	

Legend

C1,P1,P2,L1 and L2	at least 80%, between 60% and 80%, less than 60%
C2,C5 and L5	all %tage in black

Google 1000 km 500 mi



New dynamic plots

EPN CB - NEW QUALITY CHECK SOFTWARE

- Differences between QualCheck and TEQC

Qualcheck	TEQC
Daily RINEX = 24h	Daily RINEX = 24 h – time of first obs.
All satellites considered	Unhealthy and satellites not present in the observations are not considered
Only observations at 30s are considered	All observations are considered
Outputs for skyplots	Outputs for mp1, mp2 and cycle slips
Only for data quality check	Data quality check but other features

→ lower % of complete obs. with QualCheck vs. TEQC when

- Incomplete RINEX obs. file
- (Unhealthy) satellites missing in RINEX obs. file

EPN CB - NEW QUALITY CHECK SOFTWARE

- QualCheck: routine + historical (in progress) EPN data
  - Validation, comparison with TEQC
- Results on EPN CB

- Future developments :
  - Computation of RMS of code multipath for each frequency
  - Number of cycle slips
  - Integration of additional signals

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EPN HISTORICAL DATA CENTER

ROB

Routine access to daily EPN data:

- Regional data centers: BKG & OLG
- Local data centers: ASI, DUT, IGE, IGN, ROB

In addition:

Historical data center at EPN CB/ROB:

Goal: Support to EPN reprocessing activities

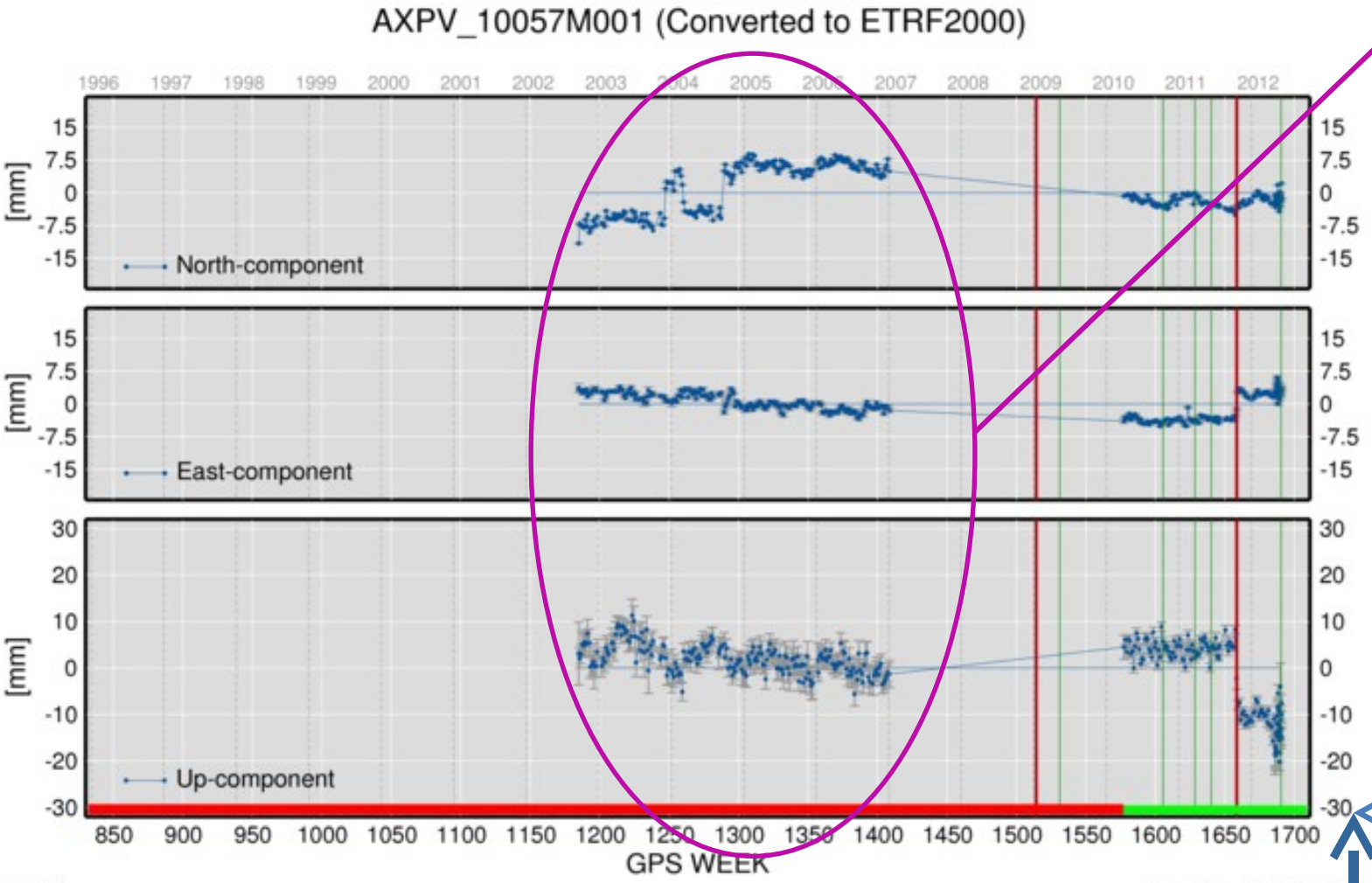
- Largest available RINEX data files (BKG, OLG)
- Historical data from EPN stations, even before inclusion in EPN
- RINEX header info corrected following site log (no info in log, no data)

→ Delay of few months compared to operational data centers

ftp://ftp.epncb.oma.be/pub/obs/

POSITIONS EXTRACTED FROM WEEKLY EPN SNX

ROB

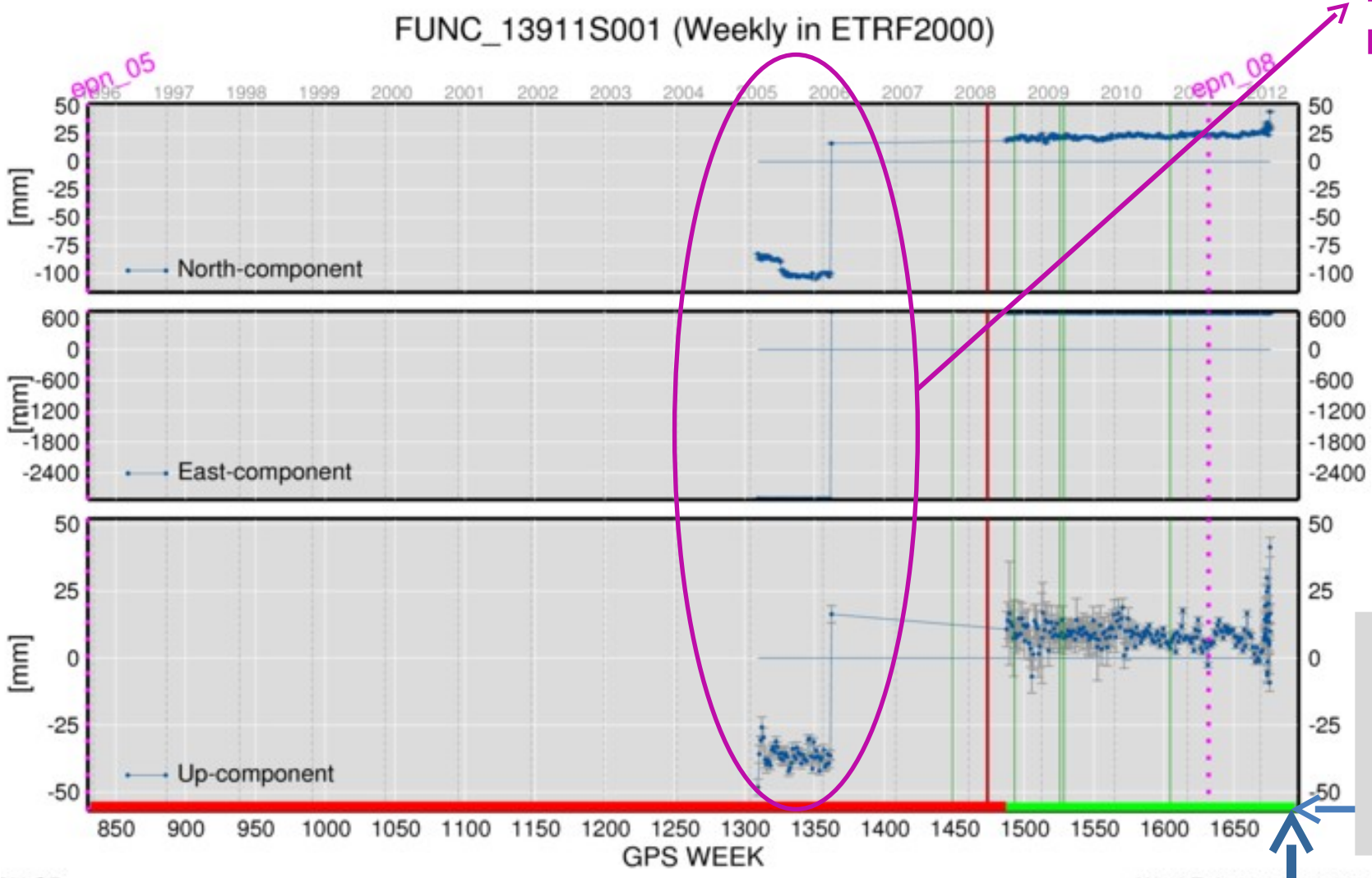


EPN reprocessing

Inclusion in EPN:
Not included
Included

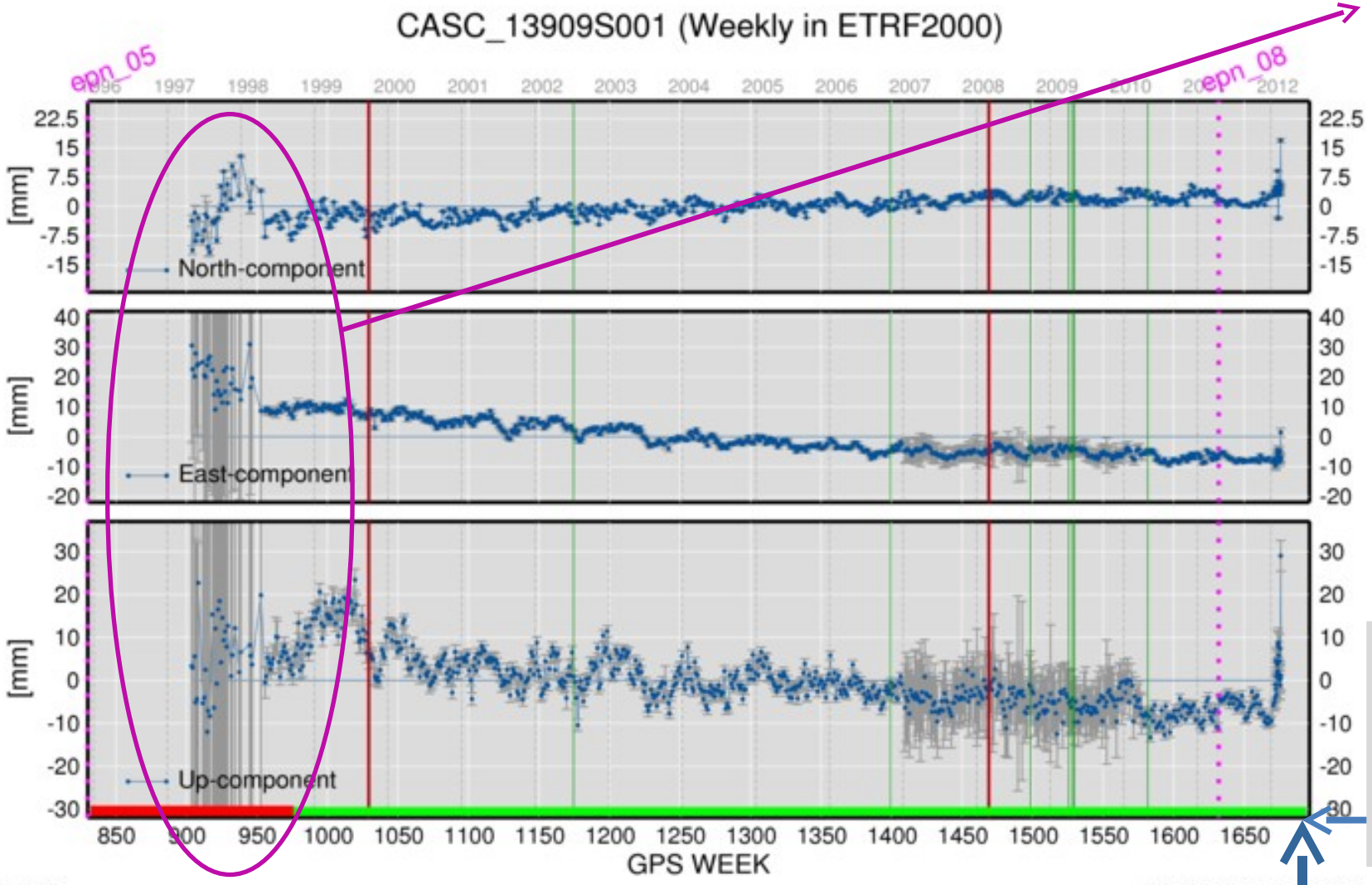
POSITIONS EXTRACTED FROM WEEKLY EPN SNX

ROB



POSITIONS EXTRACTED FROM WEEKLY EPN SNX

ROB



EPN reprocessing

Inclusion in EPN:
Not included
Included

EPN-REPRO1 WEEKLY SOLUTIONS

ROB

EPN-REPRO1 weekly SNX solutions have been generated taking LAC solutions "as is":

- No outlier rejection
- No elimination of non-EPN or pre-EPN stations
- No elimination of data not documented by site log

Full outlier rejection :

- Done by *EPN Reference Frame Coordinator*
- During the combination when generating long-term EPN solution, *Kenyeres, Session 3*

re-EPN data: some good, some bad

nown tracking problems for EPN stations → to be removed

LESSONS FOR FUTURE REPROCESSING

PN LAC should RINEX data from historical data base

nder condition that historical data base separates the “good” from the “bad” !

mplement the info from EPN-REPRO1 (inventory available) in EPN

historical data base to
- take advantage of valuable pre-EPN data
- flag “bad data”

→EPN CB will contact station managers to find agreement on station

OUTLINE

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THE FUTURE …

Today:

244 EPN stations, 66% GPS+GLONASS, 46 Galileo-capable

Future:

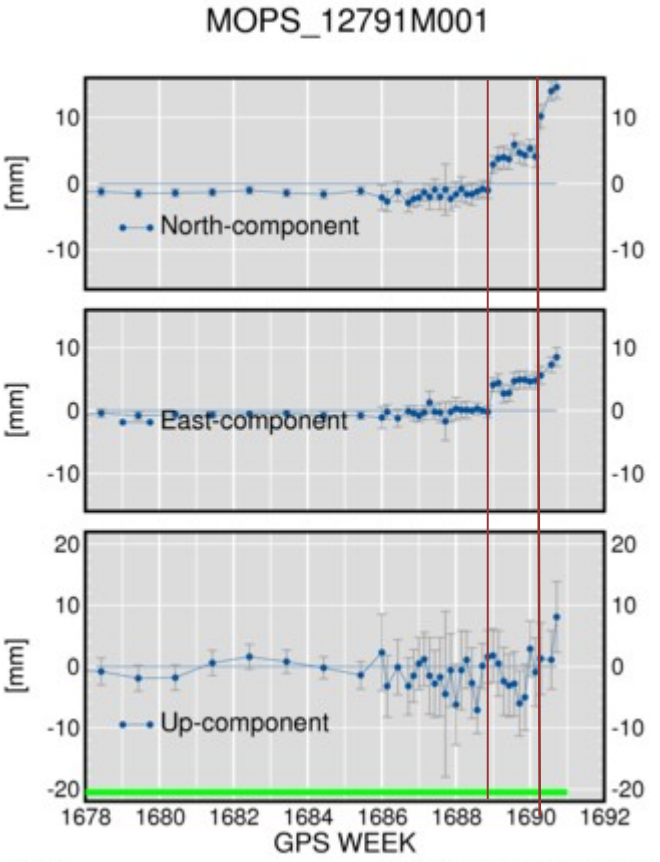
- Continuation of restructuring of EPN CB web site
- Integration of all EPN-REPRO1 results in EPN CB web site + new IGS08 densification
- Further development of obs. data quality checks + integration in EPN CB + Alarms
- New formats, new signals, …

EARTHQUAKES IN NORTHEASTERN ITALY

ROB

EPN station: MOPS

EPN rapid time series



Earthquakes May 19-20, 2012

DOY 2012/141 (May 20) → MOPS: Δ N=5mm ; Δ E=5mm,

Earthquakes May 29, 2012

DOY 2012/150 (May 29)→ MOPS: ΔN=6mm

Presentation by Caporali & Ostini, Session 3!

ROB

Questions?

Part of the EPN CB is funded by the Solar-Terrestrial Centre of Excellence