# Individual Antenna Calibrations in the EPN: Past, Present, and Future

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ROYAL OBSERVATORY OF BELGIUM

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# Introduction

Nov. 2006 (GPS week 1400) :
IGS switch from relative to absolute antenna calibrations

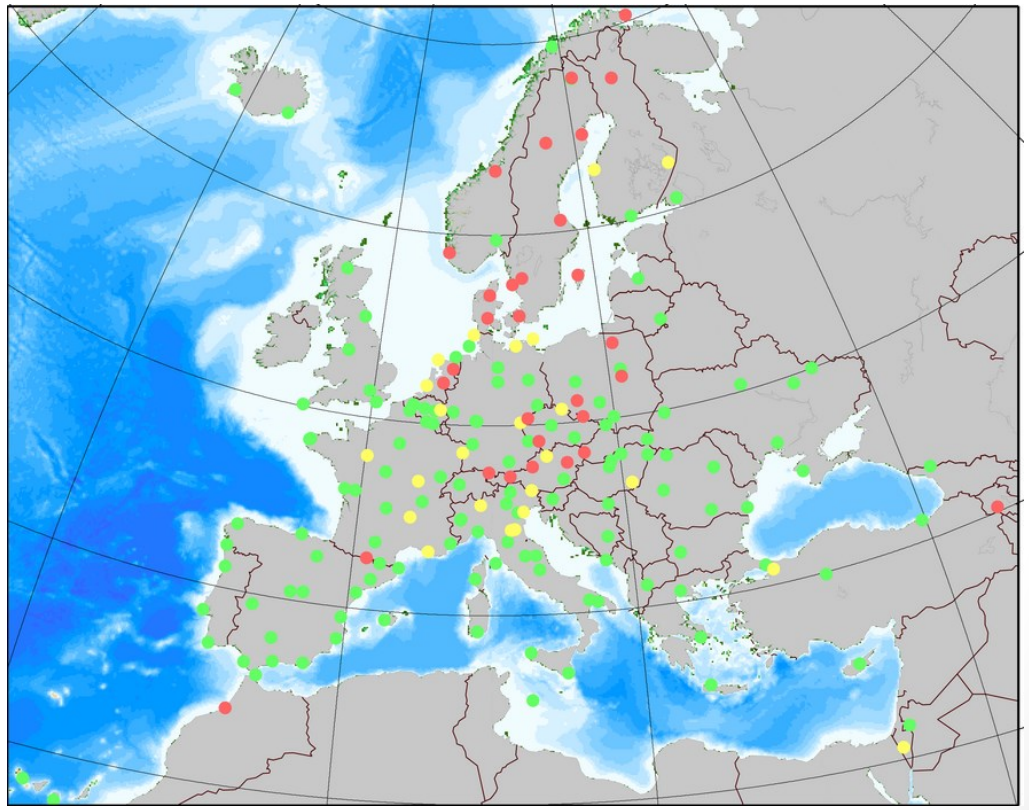
Absolute antenna calibrations used in IGS are provided by GEO++

GEO++

- IGS CB has permission to distribute type mean GEO++ calibrations for antennas/radomes belonging to IGS
- EPN CB does not have permission to freely distribute type mean GEO++ calibrations for antennas/radomes included in the EPN, but not in IGS → license fee to be paid to GEO++
- EPN CB has permission to freely distribute individual antenna calibrations from GEO++ (password protected!)

| | |
|---|---|
| Absol. from robot | 69% |
| Absol. from relative | 16% |
| No absolute | 15% |

**Nov. 2006**



# Introduction of Indiv. Antenna Calib. in EPN

EUREF TWG meeting Frankfurt, Nov. 6-7, 2006

Change of EPN guidelines

*requirement* for new stations, and antenna/radome replacements :

antenna+radome must have individual absolute calibrations or absolute antenna calibrations available from IGS CB

exceptions are allowed for

- antenna/radome combinations
  - where the effect of the radome on the APC is negligible or
  - which cannot be absolutely calibrated,
  - provided an on-site relative test/calibration is carried out
- stations that provide a clear added-value to EPN

# Introduction of Indiv. Antenna Calib. in EPN



EUREF Mail: Nov. 8, 2006

Collection of individual absolute antenna calibrations in ATX format

EPN CB

→Compilation of epnc_05.atx: indiv. calib. for 13 antennas/radomes

→Improve consistency of antenna serial number in site logs and RINEX headers

Mid-November 2006 (final EPN solutions from GPS week 1400 on):

→EPN switch to individual antenna calibrations + absolute (IGS) antenna calibrations (incl. type mean from GEO++)

# Introduction of Indiv. Antenna Calib. in EPN

2009

- EPN CB can make publicly available the GEO++ type mean calibrations for antennas/radomes that are in EPN and not in IGS!
- If new EPN antenna/radome has no indiv. antenna calibrations
  - Check if type mean calibrations are available from IGS
    - If yes → OK
    - If not, check if type mean calibrations available from GEO++
      - If yes, contact chair of the IGS antenna WG and ask to add calibration in IGS atx file
      - If not, do not accept station in EPN

2010

- GEO++ grants permission to remove password protection from individual antenna calibrations
- Access to individual calibrations: anonymous ftp

# Maintenance of EPN Indiv. Antenna Calibration File

New release of epnc_xx.atx simultaneously with new release of igsxx.atx file :

| | GPS wk 1400 | GPS wk 1632 | GPS wk 1934 |
|---|---|---|---|
| **EPN Indiv. Calib.** | epnc_05.atx | epnc_08.atx | epnc_14.atx |

Once an epnc_xx.atx is released:

NO changes to calibrations of antenna/radomes that are used in actual EPN products →

Important that EPN CB receives individual antenna calibrations before usage of the antenna within the EPN

# Antenna Calibration Facilities

- ROBOT calibrations

**GEO++ robot system**

  - GEO++ GmbH
  - IfE, Univ. Leibniz (University of Hannover, Institute of Geodesy)
  - SenStadt BERLIN (State Survey Authorities of Berlin)
  - GeoScience Australia
  - ~~LWA, TU Dresden~~
- Chamber calibrations
  - IGG, Univ. Bonn (University of Bonn, Institute of Geodesy and Geoinformation)

Links at http://epncb.oma.be/_documentation/equipment_calibration/

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# Changes from epnc_08.atx to epnc_14.atx

## ✓ 1 removed calibration :

Calibration facility not recognized by IGS

```
TRM55971.00     TZGD 30260441    FIELD LWa         KLOP00DEU
```

## ✓ 8 additional individual calibrations :

Antenna/radome already in the routine EPN solutions when we received the calibration, or for new EPN stations.

```
JAV_RINGANT_G3T NONE 316         BONN CHAMBER      POTS00DEU
LEIAR25.R4      LEIT 10471002    GEO  ROBOT        CTAB00CZE
LEIAR25.R4      LEIT 10361017    GEO  ROBOT        CLIB00CZE
LEIAR25.R4      LEIT 10401009    GEO  ROBOT        CPAR00CZE
LEIAR25.R4      LEIT 10161007    GEO  ROBOT        CRAK00CZE
TPSCR3_GGD      CONE 2170400     GEO  ROBOT        COMO00ITA
LEIAR25.R4      LEIT 725072      GEO  ROBOT        LDB200DEU       new station
TPSCR3_GGD      CONE 2170244     GEO  ROBOT        LDB200DEU       new station
```

## ✓ 3 replaced individual calibrations :

Robot calibrations replaced by chamber calibrations for these antenna with both robot and chamber calibrations

```
LEIAR25.R3      NONE 09300021    BONN CHAMBER      DOUR00BEL
LEIAR25.R3      LEIT 10240009    BONN CHAMBER      WRLG00DEU
LEIAR25.R4      LEIT 726339      BONN CHAMBER      ISTA00TUR
```

# 23 Antenna/radomes with more than one set of Calibrations

| | | | | | | |
|---|---|---|---|---|---|---|
| AUBG00DEU | LEIAR25.R4/LEIT | 10211013 | ROBOT | (GEO) | CHAMBER | (BONN) |
| BORJ00DEU | LEIAR25.R3/LEIT | 08500021 | ROBOT | (GEO) | CHAMBER | (BONN) |
| BORJ00DEU | LEIAR25.R4/LEIT | 726363 | ROBOT | (GEO) | CHAMBER | (BONN) |
| DIEP00DEU | LEIAR25.R4/LEIT | 725268 | ROBOT | (GEO) | CHAMBER | (BONN) |
| DILL00DEU | LEIAR25.R4/LEIT | 725058 | ROBOT | (GEO) | CHAMBER | (BONN) |
| DOUR00BEL | LEIAR25.R3/NONE | 09300021 | ROBOT | (GEO) | CHAMBER | (BONN) |
| DRES00DEU | LEIAR25.R3/LEIT | 10170015 | ROBOT | (GEO) | CHAMBER | (BONN) |
| EUSK00DEU | LEIAR25.R4/LEIT | 725299 | ROBOT | (GEO) | CHAMBER | (BONN) |
| GELL00DEU | LEIAR25.R4/LEIT | 725266 | ROBOT | (GEO) | CHAMBER | (BONN) |
| GOR200DEU | LEIAR25.R4/LEIT | 725057 | ROBOT | (GEO) | CHAMBER | (BONN) |
| HEL200DEU | LEIAR25.R3/LEIT | 10020025 | ROBOT | (GEO) | CHAMBER | (BONN) |
| HELG00DEU | LEIAR25.R4/LEIT | 725559 | ROBOT | (GEO) | CHAMBER | (BONN) |
| HOE200DEU | LEIAR25.R3/LEIT | 10170026 | ROBOT | (GEO) | CHAMBER | (BONN) |
| HOE200DEU | LEIAR25.R4/LEIT | 725267 | ROBOT | (GEO) | CHAMBER | (BONN) |
| HOFJ00DEU | LEIAR25.R4/LEIT | 10211018 | ROBOT | (GEO) | CHAMBER | (BONN) |
| ISTA00TUR | LEIAR25.R4/LEIT | 726339 | ROBOT | (GEO) | CHAMBER | (BONN) |
| KARL00DEU | LEIAR25.R4/LEIT | 725092 | ROBOT | (GEO) | CHAMBER | (BONN) |
| LDB200DEU | LEIAR25.R4/LEIT | 725072 | ROBOT | (GEO) | CHAMBER | (BONN) |
| LEIJ00DEU | LEIAR25.R3/LEIT | 09390011 | ROBOT | (GEO) | CHAMBER | (BONN) |
| RANT00DEU | LEIAR25.R4/LEIT | 725552 | ROBOT | (GEO) | CHAMBER | (BONN) |
| SAS200DEU | LEIAR25.R4/LEIT | 725558 | ROBOT | (GEO) | CHAMBER | (BONN) |
| WARN00DEU | LEIAR25.R3/LEIT | 09050002 | ROBOT | (GEO) | CHAMBER | (BONN) |
| WRLG00DEU | LEIAR25.R3/LEIT | 10240009 | ROBOT | (GEO) | CHAMBER | (BONN) |

Included in epnc_14.atx

Not included in epnc_14.atx (priority given to CHAMER)

Not included in epnc_14.atx (for active EPN stations and arrived after release)

# All Available Indiv. Calibrations for EPN Stations

GPS

| G01 | G02 | G05 |
|---|---|---|
| 196 | 196 | 14 |
| 227 | 227 | 32 |

GLONASS

| R01 | R02 | R03 |
|---|---|---|
| 157 | 157 | 2 |
| 183 | 183 | 2 |

Galileo

| E01 | E05 | E06 | E07 | E08 |
|---|---|---|---|---|
| 14 | 14 | 14 | 14 | 13 |
| 32 | 32 | 32 | 32 | 31 |

IRNSS

| I05 |
|---|
| 1 |
| 1 |

BeiDou

| C01 | C06 | C07 |
|---|---|---|
| 2 | 2 | 2 |
| 2 | 2 | 2 |

QZSS

| J01 | J02 | J05 | J06 |
|---|---|---|---|
| 2 | 2 | 2 | 2 |
| 2 | 2 | 2 | 2 |

SBAS

| S01 | S05 |
|---|---|
| 2 | 2 |
| 2 | 2 |

Calibrations for Galileo frequencies

| | | |
|---|---|---|
| ASH701945C_M | NONE | (1) |
| JAVRINGANT_DM | NONE | (1) |
| JAV_RINGANT_G3T | NONE | (3) |
| LEIAR10 | NONE | (1) |
| LEIAR25.R3 | LEIT | (7) |
| LEIAR25.R3 | NONE | (1) |
| LEIAR25.R4 | LEIT | (18) |

Black: included in epnc_14.atx

Red: available from EPN CB

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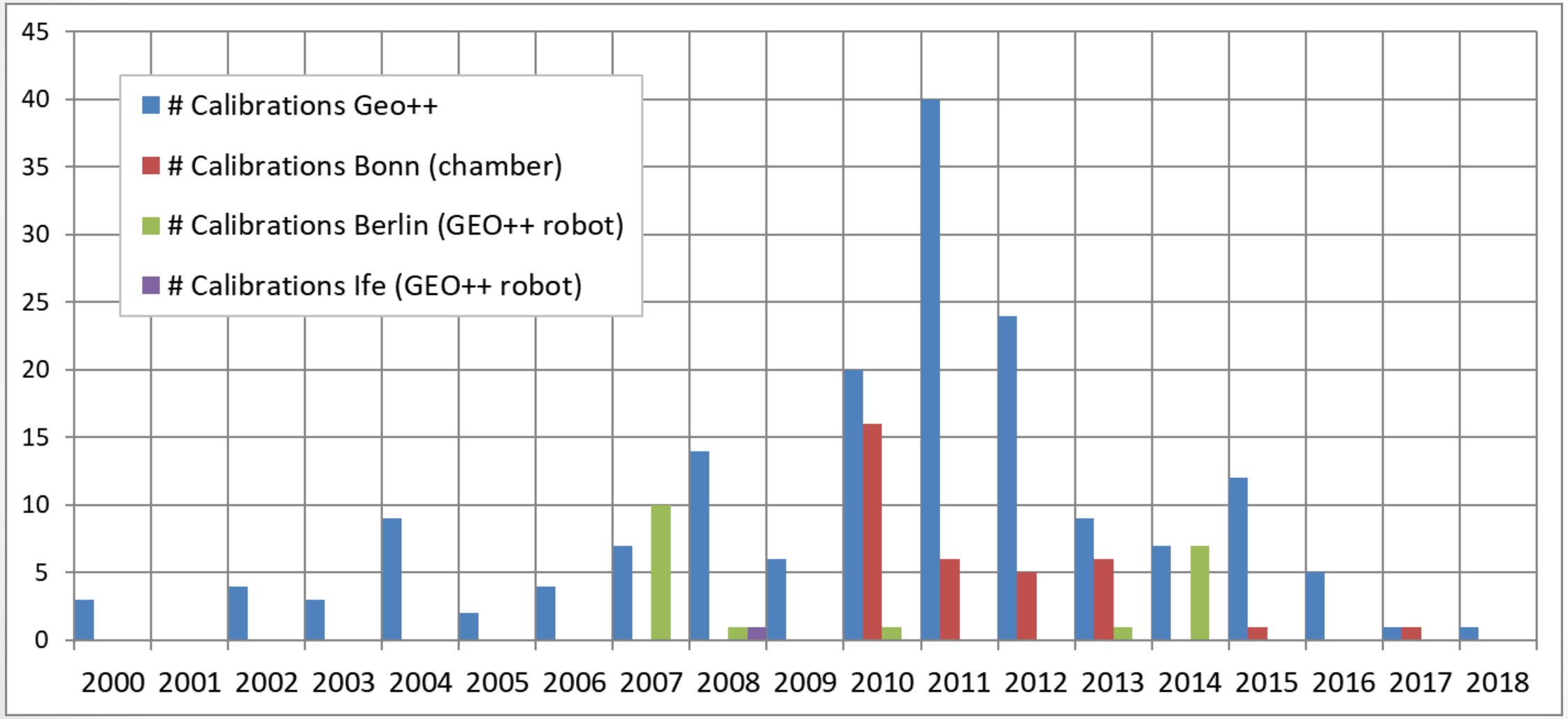
# Calibration Dates



# Stop using Individual Antenna Calibrations?

Yes, stop!

- No inconsistencies with IGS anymore
- Individual antenna calibrations are not perfect: ~mm calibration error
- After antenna installation, the antenna environment changes the phase center again

No, do not stop!

- Switching to type mean calibrations cannot be done just now. Will give jumps in position time series
- Keeping individual antenna calibrations avoids jumps in position time series upon new release calibration file
- IGS type mean calibrations are not necessary representative for all antennas/radomes of one type
- More multi-GNSS calibrations when using individual antenna calibrations (but not enough)

# Improve consistency with IGS?

- Use IGS type mean calibrations by default. Only use individual antenna calibrations if no IGS type mean available.
  - Problem when IGS adds new type mean calibrations for an antenna/radome for which EPN uses individual antenna calibrations
- Use always IGS type mean calibrations for IGS reference stations in EPN

# Improve multi-GNSS calibrations?

- Accept only individual calibration which contain calibrations for all frequencies tracked by the station.

# Conclusion

Usage (or not) of individual calibrations remains a hot-topic.

But … most downloaded antenna calibration files from EPN CB in April 2018

| ATX file | # Downloads | |
|---|---|---|
| [redacted] | | |
| epn_08.atx/epncb_08.atx | 18 408 | *Not updated anymore since Jan 2017* |
| [redacted] | | *Not updated anymore since April 2011* |

# Thank you

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# Where to Find all this Info on EPN CB?

**EPN stations:**

ftp://epncb.eu/ftp/station/general/indiv_calibrations/ 222 indiv. antenna calibrations

ROBOT: 20 Senstadt BERLIN + 1 Univ Leibniz Hannover, IfE + 171 GEO++

CHAMBER: 35 Bonn

LEIAR25-LEIT-20006-GEO-20081103-ADAR.atx

ANTENNA_NAME-RADOME_NAME-ANTENNA SERIAL NUMBER (last 5 digits)

-CALIBRATION FACILITY-CALIBRATION DATE-STATION NAME (4CHAR)

ftp://epncb.eu/ftp/station/general/ epnc_xx.atx and epn_xx.atx

**EPN densification stations:**

ftp://epncb.eu/station/densification/indiv_calibrations 12 indiv. antenna calibrations

ROBOT: 11 GEO++

CHAMBER: 1 Bonn