# Demonstration on how to process Galileo data with Bernese GNSS Software, version 5.2

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IGS Tutorial on the Bernese GNSS Software
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# Content

- Preparing General Files
- Obtaining MGEX products
- Running the Processing Example (RNX2SNX)
- Demonstration using CODE's MGEX products
- Additional Information

# Preparing General Files

# What has to be changed?

- Receiver Information File (RECEIVER.)
  indicate Galileo capability for each receiver
- Satellite Information File (SATELLITE.I14)
  → ftp://ftp.aiub.unibe.ch/BSWUSER52/GEN/SATELLITE.I14
- Update Phase Center Variation file (PCV)
  → ftp://ftp.aiub.unibe.ch/BSWUSER52/GEN/I14.ATX
- PCV file containing Galileo patterns for satellites and receiver antennas *(taken from GPS)!*
- Define RINEX 3 data selection in OBS.SEL
  → ftp://ftp.aiub.unibe.ch/BSWUSER52/GEN/OBS_GAL.SEL

# Receiver Information File

The files contains the information on the supported GNSS for each receiver: add Galileo where applicable

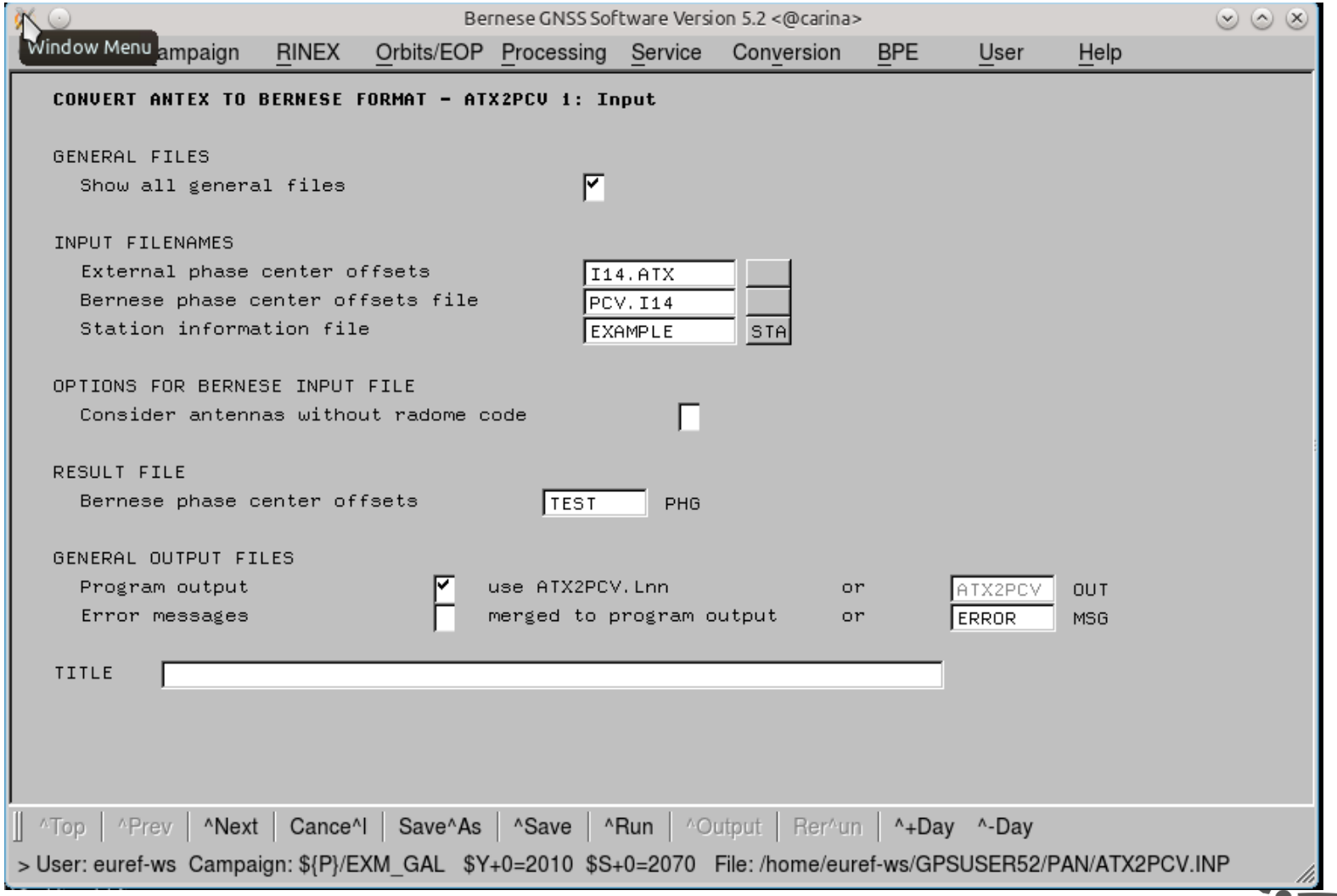
**→$X/GEN/RECEIVER.**

```
RECEIVER INFORMATION FILE, BERNESE GNSS SOFTWARE 5.2
------------------------------------------------------------------------------

RECEIVER TYPE         #FREQ  CODE  FREQ  WAVE.F.  SYST
********************   *     **    L*:     *     ****

DEFAULT                 2     C1    L1:     1     GRE
                              P2    L2:     1

TRIMBLE NETR8           2     C1    L1:     1     GR
                              P2    L2:     1

TRIMBLE NETR9           2     C1    L1:     1     GRE
                              P2    L2:     1

TRIMBLE NETRS           2     C1    L1:     1     G
                              P2    L2:     1
```

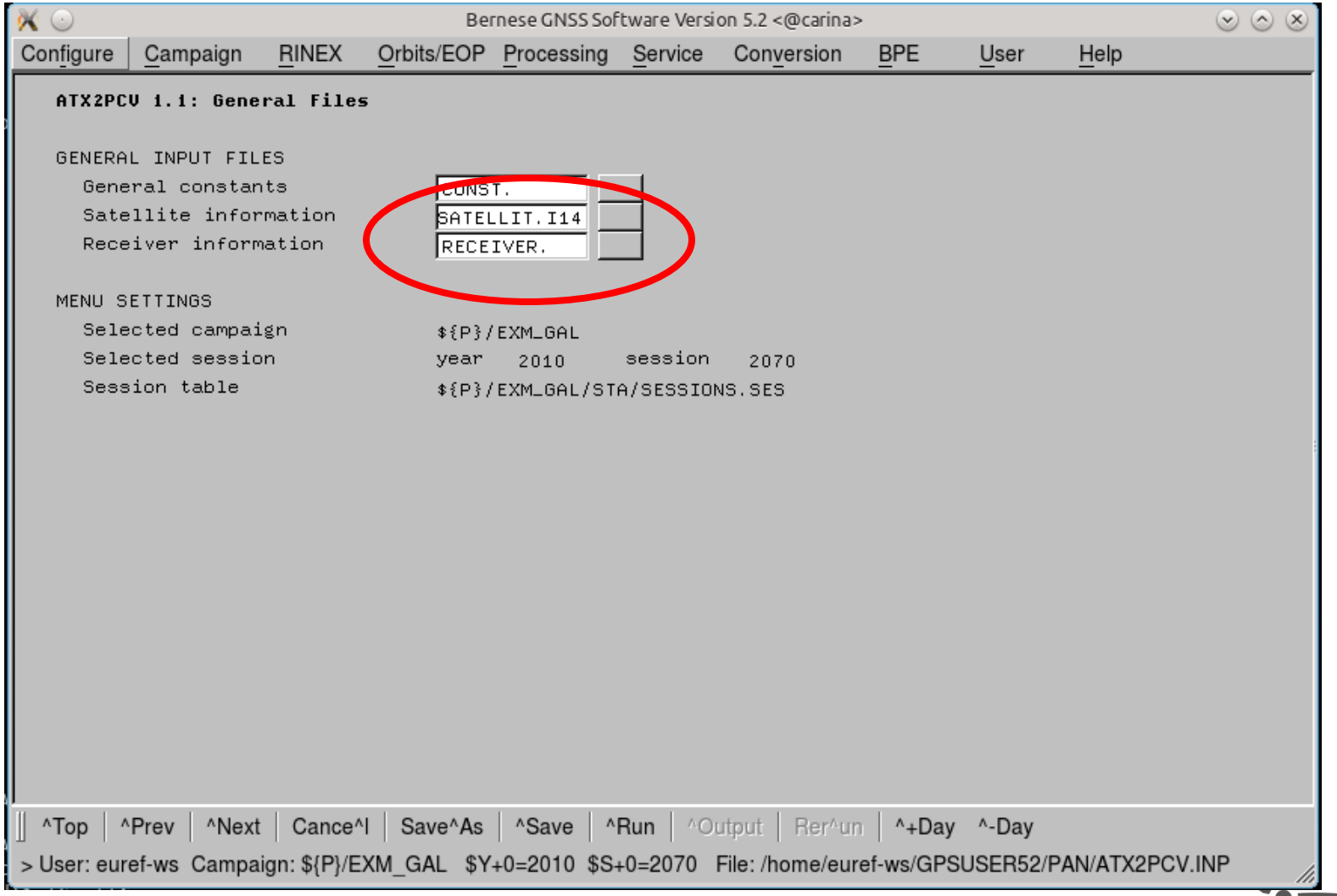
# PCV Update

- Update PCV using I14.ATX
  (including Galileo, download from BSW ftp server )
- ATX2PCV: Adapt setting considering Galileo satellite and receiver patterns
  - Satellite pattern available from IGS ANTEX file
  - Receiver patterns usually GPS / GLONASS only
    → use GPS pattern to substitute Galileo patterns
    (suboptimal, better than zero patterns)
- Apply ATX2PCV also for individual calibrated patterns
- Copy updated PCV file (to $X/GEN)

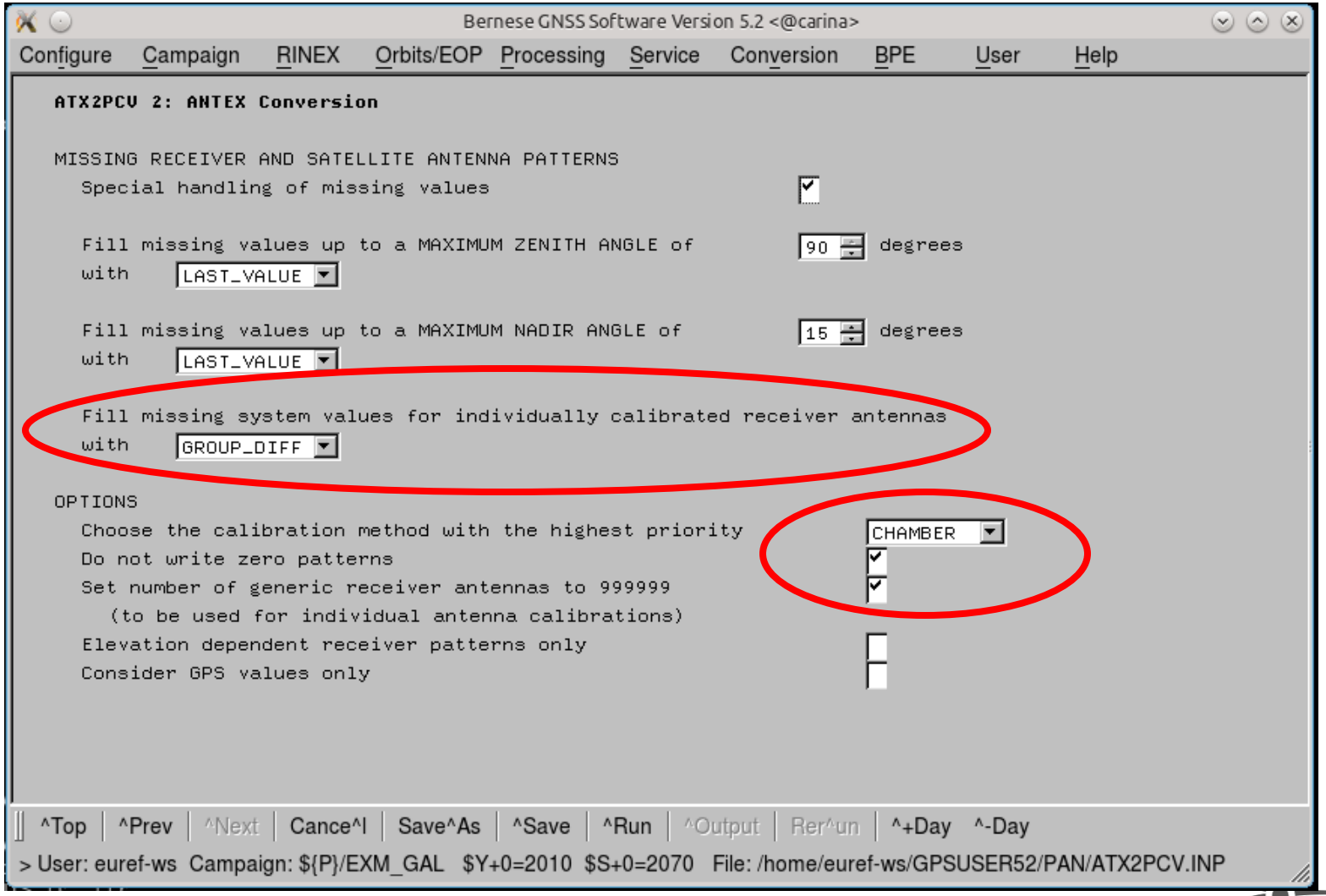
# ATX2PCV


Bernese GNSS Software Version 5.2 <@carina>
Window Menu
ampaign RINEX Orbits/EOP Processing Service Conversion BPE User Help
CONVERT ANTEX TO BERNESE FORMAT - ATX2PCV 1: Input
GENERAL FILES
Show all general files
INPUT FILENAMES
External phase center offsets
I14.ATX
Bernese phase center offsets file
PCV.I14
Station information file
EXAMPLE
STA
OPTIONS FOR BERNESE INPUT FILE
Consider antennas without radome code
RESULT FILE
Bernese phase center offsets
TEST
PHG
GENERAL OUTPUT FILES
Program output
use ATX2PCV.Lnn
or
ATX2PCV
OUT
Error messages
merged to program output
or
ERROR
MSG
TITLE
^Top ^Prev ^Next Cance^l Save^As ^Save ^Run ^Output Rer^un ^+Day ^-Day
> User: euref-ws Campaign: ${P}/EXM_GAL $Y+0=2010 $S+0=2070 File: /home/euref-ws/GPSUSER52/PAN/ATX2PCV.INP

# ATX2PCV


Bernese GNSS Software Version 5.2 <@carina>
Configure Campaign RINEX Orbits/EOP Processing Service Conversion BPE User Help
ATX2PCV 1.1: General Files
GENERAL INPUT FILES
General constants
CONST.
Satellite information
SATELLIT.I14
Receiver information
RECEIVER.
MENU SETTINGS
Selected campaign
${P}/EXM_GAL
Selected session
year 2010 session 2070
Session table
${P}/EXM_GAL/STA/SESSIONS.SES
^Top ^Prev ^Next Cance^l Save^As ^Save ^Run ^Output Rer^un ^+Day ^-Day
> User: euref-ws Campaign: ${P}/EXM_GAL $Y+0=2010 $S+0=2070 File: /home/euref-ws/GPSUSER52/PAN/ATX2PCV.INP

# ATX2PCV


Bernese GNSS Software Version 5.2 <@carina>
Configure Campaign RINEX Orbits/EOP Processing Service Conversion BPE User Help
ATX2PCV 2: ANTEX Conversion
MISSING RECEIVER AND SATELLITE ANTENNA PATTERNS
Special handling of missing values
Fill missing values up to a MAXIMUM ZENITH ANGLE of 90 degrees
with LAST_VALUE
Fill missing values up to a MAXIMUM NADIR ANGLE of 15 degrees
with LAST_VALUE
Fill missing system values for individually calibrated receiver antennas
with GROUP_DIFF
OPTIONS
Choose the calibration method with the highest priority CHAMBER
Do not write zero patterns
Set number of generic receiver antennas to 999999
(to be used for individual antenna calibrations)
Elevation dependent receiver patterns only
Consider GPS values only
^Top ^Prev ^Next Cance^l Save^As ^Save ^Run ^Output Rer^un ^+Day ^-Day
> User: euref-ws Campaign: ${P}/EXM_GAL $Y+0=2010 $S+0=2070 File: /home/euref-ws/GPSUSER52/PAN/ATX2PCV.INP

# Observation Selection File (for RINEX 3)

## Observation Selection Files is used by RNXSMT to select the observation types ($X/GEN/OBS_GAL.SEL)

```
GNSS observation selection for Bernese GNSS Software Version 5.2     21-Aug-2012
-------------------------------------------------------------------------------

Format version:  1.00

Receiver type         S/S  O/F  RINEX observation codes and their priority
**********************  ***  ***  *** *** *** *** *** *** *** *** *** *** *** ***

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

# Obtaining MGEX products

# Obtain GNSS orbits and clocks (MGEX)

- Create local repository for MGEX products
  (e.g.: ~/GPSDATA/DATAPOOL/COM)
- Choose product to be used
  (e.g. MGEX products from CODE, same schedule as IGS Final)
- Alternative products
  (http://mgex.igs.org/IGS_MGEX_Products.html)
  - E.g. GZF (rapid products)

# Obtain GNSS orbits and clocks (MGEX)

- Adapt downloader to obtain CODE MGEX products:
  - Location:
    ftp://ftp.aiub.unibe.ch/CODE_MGEX/CODE/yyyy/
- Orbits:
  - COMWWWWD.EPH (SP3 files)
  - COMWWWWD.ERP
- Clock
  - COMWWWWD.CLK
- Bias
  - COMWWWWD.DCB
  - COMWWWWD.BIA

# Adjust RNX2SNX.PCF

# RNX2SNX.PCF

## Adapt Options:

```
...
V_A      A priori information                    APR
V_B      Orbit/ERP, DCB, CLK information         COD
V_RNXDIR Directory with the RINEX files          RINEX
V_RX3DIR Directory with the RINEX files
V_OBSINF RINEX 3 observation type selection      OBS.SEL
V_RESULT Directory … for the RNX2SNX results     RNX2SNX
V_SATSYS Select the GNSS (GPS, GPS/GLO)          GPS/GLO
V_GNSSAR GNSS … used for amb. resolution         ALL
...
```

# RNX2SNX.PCF

## Adapt Options:

```
...
V_A      A priori information                    APR
V_B      Orbit/ERP, DCB, CLK information         COM
V_RNXDIR Directory with the RINEX files          RINEX
V_RX3DIR Directory with the RINEX files          RINEX3
V_OBSINF RINEX 3 observation typ selection       OBS_GAL.SEL
V_RESULT Directory … for the RNX2SNX results     R2S_GAL
V_SATSYS Select the GNSS (GPS, GPS/GLO)          ALL
V_GNSSAR GNSS … used for amb. resolution         ALL
...
```

# Ambiguity resolution

```
File         Length      Before      After     Res  Sys  Max/RMS L1
              (km)     #Amb (mm)  #Amb (mm)  (%)       (L1 Cycles)
 ------------------------------------------------------------------
 Tot:  10   691.611    558  0.1    219  0.2  60.8 G     0.180  0.081  #AR_WL
 Tot:  10   691.611    617  1.3    313  1.3  49.3 G     0.143  0.058  #AR_NL


 File         Length      Before      After     Res  Sys  Max/RMS L5     Max/RMS L3
               km)     #Amb (mm)  #Amb (mm)  (%)       (L5 Cycles)    (L3 Cycles)
 ------------------------------------------------------------------------------------
 Tot:  10   691.611    626  1.4    564  1.4   9.9 G     0.422  0.135  0.098  0.034  #AR_QIF
 Tot:   8   717.291    890  1.4    436  1.5  51.0  R    0.478  0.117  0.100  0.033  #AR_QIF
 Tot:   4   657.525    180  1.6    112  1.6  37.8   E   0.169  0.039  0.094  0.025  #AR_QIF
 Tot:  10   691.611   1696  1.4   1112  1.4  34.4 GRE   0.478  0.113  0.100  0.033  #AR_QIF


File         Length      Before      After     Res  Sys  Max/RMS L1
              (km)     #Amb (mm)  #Amb (mm)  (%)       (L1 Cycles)
 ------------------------------------------------------------------
 Tot:   2     0.010    216  1.2     38  1.3  82.4 G     0.053  0.010  #AR_L12
 Tot:   1     0.002    110  1.2     22  1.2  80.0  R    0.027  0.009  #AR_L12
 Tot:   1     0.002     48  1.2      0  1.2 100.0   E   0.021  0.006  #AR_L12
 Tot:   2     0.010    374  1.2     60  1.3  84.0 GRE   0.053  0.009  #AR_L12
```

# Comparison with IGS14

## Solution: GPS only

| NUM | NAME | FLG | RESIDUALS IN MILLIMETERS | | | |
|---|---|---|---|---|---|---|
| 75 | GANP 11515M001 | I W | 2.70 | 0.12 | -17.45 | |
| 92 | HERT 13212M010 | I W | 0.55 | -0.81 | 7.39 | |
| 107 | JOZ2 12204M002 | P A | -17.92 | 7.93 | 8.04 | M |
| 122 | LAMA 12209M001 | P A | -21.96 | 8.46 | 17.68 | M |
| 136 | MATE 12734M008 | I W | 6.00 | -3.43 | 2.10 | |
| 176 | ONSA 10402M004 | I W | -0.90 | 0.98 | 11.99 | |
| 192 | PTBB 14234M001 | P A | -17.36 | 8.34 | 9.34 | M |
| 236 | TLSE 10003M009 | I W | -1.02 | -1.73 | -6.38 | |
| 262 | WSRT 13506M005 | I W | -3.34 | -1.15 | 4.59 | |
| 263 | WTZR 14201M010 | I W | -0.60 | 1.12 | -8.35 | |
| 264 | WTZZ 14201M014 | P A | -2.15 | 1.73 | -3.94 | M |
| 276 | ZIM2 14001M008 | I W | -2.60 | 1.67 | 1.37 | |
| 278 | ZIMM 14001M004 | I W | -0.81 | 3.22 | 4.73 | |

PARAMETERS:

| | | | | | |
|---|---|---|---|---|---|
| TRANSLATION IN | N | : | 0.00 | +- 1.88 | MM |
| TRANSLATION IN | E | : | 0.00 | +- 1.88 | MM |
| TRANSLATION IN | U | : | -0.00 | +- 1.88 | MM |

# Comparison with IGS14

## Solution: GPS/GLO

| NUM | NAME | FLG | RESIDUALS IN MILLIMETERS | | | |
|---|---|---|---|---|---|---|
| 75 | GANP 11515M001 | I W | 2.15 | -0.50 | -20.95 | |
| 92 | HERT 13212M010 | I W | 0.60 | -0.38 | 8.14 | |
| 107 | JOZ2 12204M002 | P A | -18.14 | 7.60 | 7.70 | M |
| 122 | LAMA 12209M001 | P A | -22.58 | 8.48 | 17.11 | M |
| 136 | MATE 12734M008 | I W | 5.74 | -3.85 | 2.83 | |
| 176 | ONSA 10402M004 | I W | -0.57 | 1.28 | 11.22 | |
| 192 | PTBB 14234M001 | P A | -17.34 | 8.41 | 8.95 | M |
| 236 | TLSE 10003M009 | I W | -1.07 | -0.96 | -2.91 | |
| 262 | WSRT 13506M005 | I W | -3.42 | -1.09 | 3.45 | |
| 263 | WTZR 14201M010 | I W | -0.65 | 0.82 | -7.06 | |
| 264 | WTZZ 14201M014 | P A | -1.92 | 2.29 | -3.69 | M |
| 276 | ZIM2 14001M008 | I W | -1.88 | 1.39 | 0.55 | |
| 278 | ZIMM 14001M004 | I W | -0.89 | 3.30 | 4.73 | |

PARAMETERS:

| | | | | | |
|---|---|---|---|---|---|
| TRANSLATION IN | N | : | -0.00 | +- 1.95 | MM |
| TRANSLATION IN | E | : | -0.00 | +- 1.95 | MM |
| TRANSLATION IN | U | : | -0.00 | +- 1.95 | MM |

# Comparison with IGS14

## Solution: GPS/GLO/GAL

| NUM | NAME | FLG | RESIDUALS IN MILLIMETERS | | | |
|---|---|---|---|---|---|---|
| 75 | GANP 11515M001 | I W | 1.66 | -0.15 | -18.77 | |
| 92 | HERT 13212M010 | I W | 0.71 | -0.36 | 8.44 | |
| 107 | JOZ2 12204M002 | P A | -18.07 | 7.44 | 8.66 | M |
| 122 | LAMA 12209M001 | P A | -22.73 | 8.32 | 17.35 | M |
| 136 | MATE 12734M008 | I W | 5.41 | -4.00 | 2.03 | |
| 176 | ONSA 10402M004 | I W | -0.67 | 1.24 | 12.17 | |
| 192 | PTBB 14234M001 | P A | -17.34 | 8.47 | 9.11 | M |
| 236 | TLSE 10003M009 | I W | -1.26 | -1.90 | -4.58 | |
| 262 | WSRT 13506M005 | I W | -3.36 | -1.07 | 4.31 | |
| 263 | WTZR 14201M010 | I W | -0.26 | 1.16 | -9.17 | |
| 264 | WTZZ 14201M014 | P A | -1.44 | 2.96 | -6.45 | M |
| 276 | ZIM2 14001M008 | I W | -1.60 | 1.58 | 0.93 | |
| 278 | ZIMM 14001M004 | I W | -0.62 | 3.50 | 4.64 | |

PARAMETERS:

| | | | | |
|---|---|---|---|---|
| TRANSLATION IN | N | : | -0.00 +- 1.94 | MM |
| TRANSLATION IN | E | : | -0.00 +- 1.94 | MM |
| TRANSLATION IN | U | : | -0.00 +- 1.94 | MM |

# GNSS Inter-System Translation Bias (GTRA)

## Helmert: NO GTRA (GRE)<-> GTRA (GAL)

| NUM | NAME | FLG | RESIDUALS IN MILLIMETERS | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| 75 | GANP 11515M001 | W W | -0.25 | -0.20 | -1.64 | |
| 92 | HERT 13212M010 | W W | -0.00 | -0.13 | 0.07 | |
| 107 | JOZ2 12204M002 | A A | 0.03 | 0.09 | 0.03 | |
| 122 | LAMA 12209M001 | A A | 0.08 | 0.09 | 0.01 | |
| 136 | MATE 12734M008 | W W | -0.10 | 0.04 | 0.52 | |
| 176 | ONSA 10402M004 | W W | 0.13 | -0.03 | -0.01 | |
| 192 | PTBB 14234M001 | A A | 0.04 | -0.03 | 0.07 | |
| 236 | TLSE 10003M009 | W W | 0.26 | 0.34 | -0.46 | |
| 262 | WSRT 13506M005 | W W | 0.02 | -0.08 | 0.05 | |
| 263 | WTZR 14201M010 | W W | -0.00 | 0.12 | 0.86 | |
| 264 | WTZZ 14201M014 | A A | -0.04 | -0.24 | 1.47 | |
| 276 | ZIM2 14001M008 | W W | -0.11 | -0.00 | -1.03 | |
| 278 | ZIMM 14001M004 | W W | -0.04 | -0.01 | 0.07 | |
| | | | | | | |
| | RMS / COMPONENT | | 0.12 | 0.15 | 0.77 | |
| | MEAN | | 0.00 | -0.00 | 0.00 | |
| | MIN | | -0.25 | -0.24 | -1.64 | |
| | MAX | | 0.26 | 0.34 | 1.47 | |

RMS OF TRANSFORMATION : 0.49 MM

# GNSS Inter-System Translation Bias (GTRA)

## Helmert: NO GTRA (GRE) <-> GTRA (GAL)

```
 ------------------------------------------------------------------------
 |     | RMS / COMPONENT  |     |       0.12      0.15      0.77 |   |
 |     | MEAN             |     |       0.00     -0.00      0.00 |   |
 |     | MIN              |     |      -0.25     -0.24     -1.64 |   |
 |     | MAX              |     |       0.26      0.34      1.47 |   |
 ------------------------------------------------------------------------

RMS OF TRANSFORMATION :    0.49 MM

 PARAMETERS:

 TRANSLATION IN  X     :           0.49     +-  1.59    MM
 TRANSLATION IN  Y     :           0.28     +-  1.85    MM
 TRANSLATION IN  Z     :           1.36     +-  1.54    MM
 ROTATION AROUND X-AXIS:     0  0  0.000002 +-  0.000054 "
 ROTATION AROUND Y-AXIS:  -  0  0  0.000016 +-  0.000058 "
 ROTATION AROUND Z-AXIS:     0  0  0.000009 +-  0.000050 "
 SCALE FACTOR          :         -0.00019  +-  0.00020 MM/KM
```

# Additional Information

- Bernese Example Campaign including Galileo
  - Latest version of the Bernese 5.2 Tutorial: http://www.bernese.unibe.ch/docs/TUTORIAL.pdf

- Tutorial contains additional examples:
  - Section 7.5: Using RINEX 3 Data
  - Section 7.6: Processing Galileo Observations
  - Contains data for 1. Aug. 2017