Report on the EPN Analysis

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Outline

- Status of Local Analysis Centres
- Status of sub-network combination
- ITRF 2005 Densification
- Short latency / high resolution products
- Points of Discussion

Status of Local Analysis Centres

ASI	MicroCosm 2005.0	Final Weekly	Rapid Daily, Hourly
BEK	Bernese 5.0		Final Daily
BKG	Bernese 5.0		Final Daily, Rapid Daily, Hourly
COE	Bernese 5.1		GLONASS
DEO	GIPSY v2.5/cov2snx		
GOP	Bernese 5.0		
IGE	Bernese 5.0		Final Daily, Rapid Daily
IGN	Bernese 5.0		
LPT	Bernese 5.0		Rapid Daily, Hourly, GLONASS
NKG	Bernese 5.0		Final Daily
OLG	Bernese 5.0		
ROB	Bernese 5.0		Rapid Daily
SGO	Bernese 5.0		Rapid Daily
SUT	Bernese 5.0		Final Daily
UPA	Bernese 5.0		Final Daily,(Rapid Daily)
WUT	Bernese 5.0		Final Daily

Note

- This slide is an acknowledgement for the 16 LACs for their continuous and reliable contribution to the EPN.
- Where all LACs submit a weekly final solution, only a view contribute to daily, hourly and GLONASS products.
- It is within the scope of this workshop to agree on an operational status for rapid products.

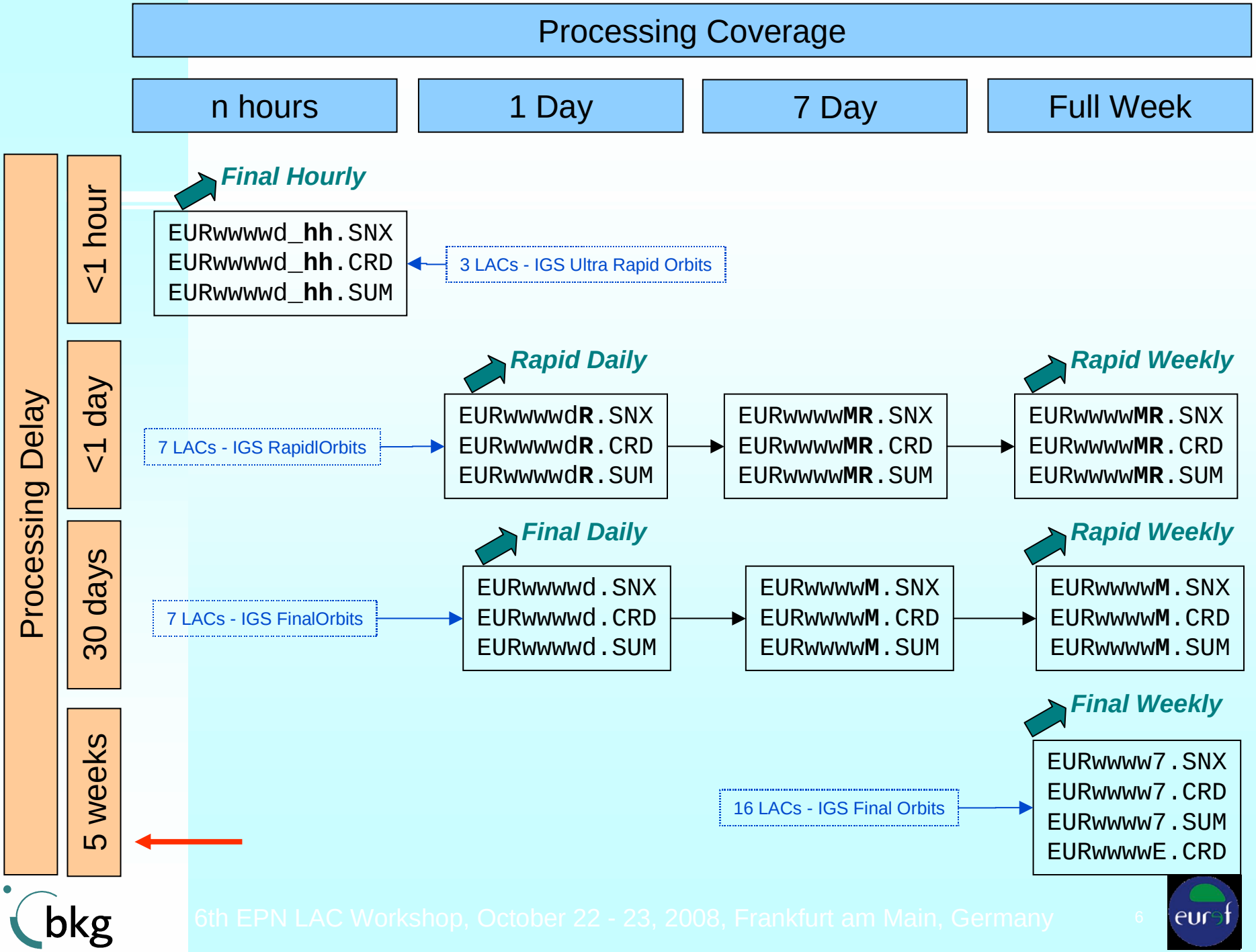
Status of Sub-Network Combination

- New: Fixed schedule for weekly combination processing

  week(i)+3 → final IGS orbit

  week(i)+5 → EPN weekly combination

  week(i)+8 → MIT T2 RNAAC
- EPN included in IGS regional network combination
  - E.g., MIT1491p.SNX available at CDDIS
- Deficiencies in conversion from SINEX to NEQ and vice versa


Processing Coverage
n hours
1 Day
7 Day
Full Week
Processing Delay
<1 hour
<1 day
30 days
5 weeks
Final Hourly
EURwwwwd_hh.SNX
EURwwwwd_hh.CRD
EURwwwwd_hh.SUM
3 LACs - IGS Ultra Rapid Orbits
Rapid Daily
EURwwwwdR.SNX
EURwwwwdR.CRD
EURwwwwdR.SUM
7 LACs - IGS RapidlOrbits
EURwwwwMR.SNX
EURwwwwMR.CRD
EURwwwwMR.SUM
Rapid Weekly
EURwwwwMR.SNX
EURwwwwMR.CRD
EURwwwwMR.SUM
Final Daily
EURwwwwd.SNX
EURwwwwd.CRD
EURwwwwd.SUM
7 LACs - IGS FinalOrbits
EURwwwwM.SNX
EURwwwwM.CRD
EURwwwwM.SUM
Rapid Weekly
EURwwwwM.SNX
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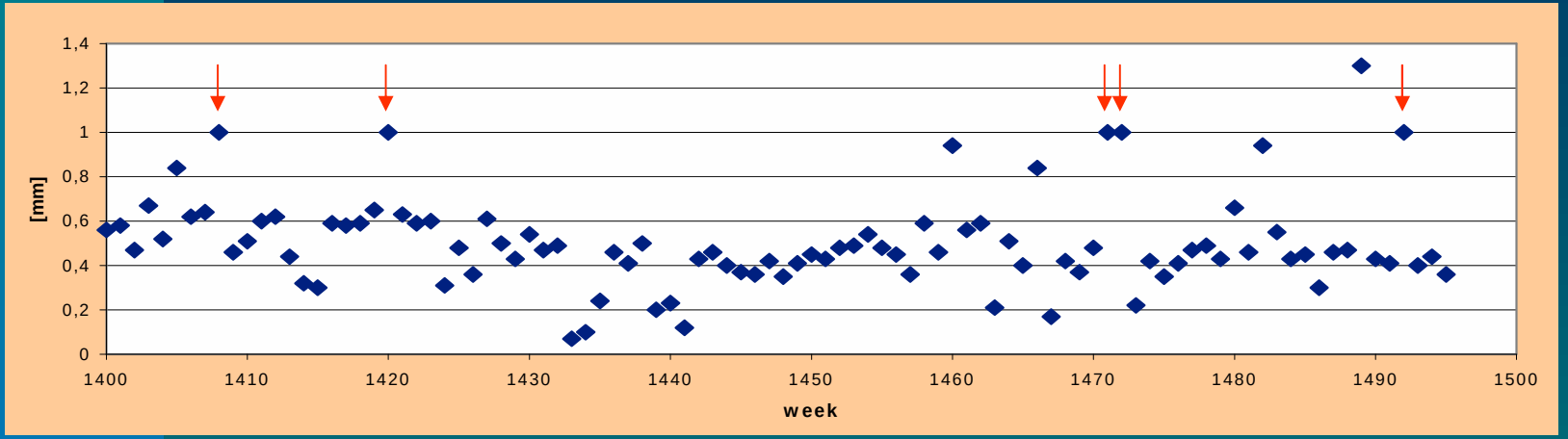
EURwwwwM.SUM
Final Weekly
EURwwww7.SNX
EURwwww7.CRD
EURwwww7.SUM
EURwwwwE.CRD
16 LACs - IGS Final Orbits

A-posteriori rms since week 1400



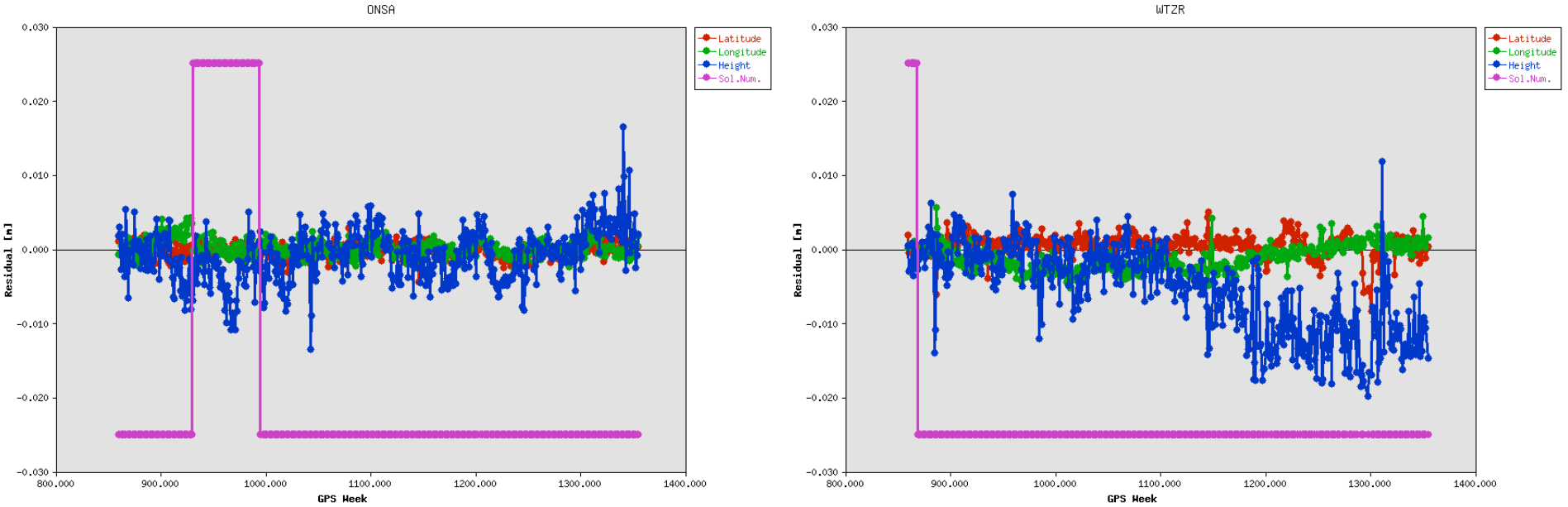

```
EUR14087.OUT: A posteriori RMS of unit weight 0.00100 m
EUR14207.OUT: A posteriori RMS of unit weight 0.00100 m
EUR14717.OUT: A posteriori RMS of unit weight 0.00100 m
EUR14727.OUT: A posteriori RMS of unit weight 0.00100 m
EUR14927.OUT: A posteriori RMS of unit weight 0.00100 m
```

- Default number due to numerical problem in SINEX to NEQ conversion?

ITRF2005 Densification
- *Scope* -

- Network densification of ITRF2005 for Europe
- Observation interval to be conform with the ITRF2005 data → weeks 860 to 1355 has been combined
- Definition of discontinuities conform with ITRF2005 → For non-ITRF2005 sites of EPN discontinuities according to EPN Time Series Project
- Resulting coordinates and velocities will be compared
- Combination of solutions on NEQ level needs to be discussed

Coordinate Time Series Residuals
- Example -



Comparison of 3 Solutions

- ITF-Solution:
  - ITRF2005 solution as available from ftp://itrf.ensg.ign.fr/pub/itrf/itrf2005/ITRF2005_IGS-TRF.SNX.gz
  - Built with CATREF software
- AC-Solution:
  - Multi-year solution for EPN weekly combined SINEX files, calculated by the EPN AC
  - Built with Bernese GPS Software v5.0
- TSP-Solution:
  - Multi-year solution for EPN-weekly combined SINEX files, calculated within the EPN Time Series Project
  - Built with CATREF software

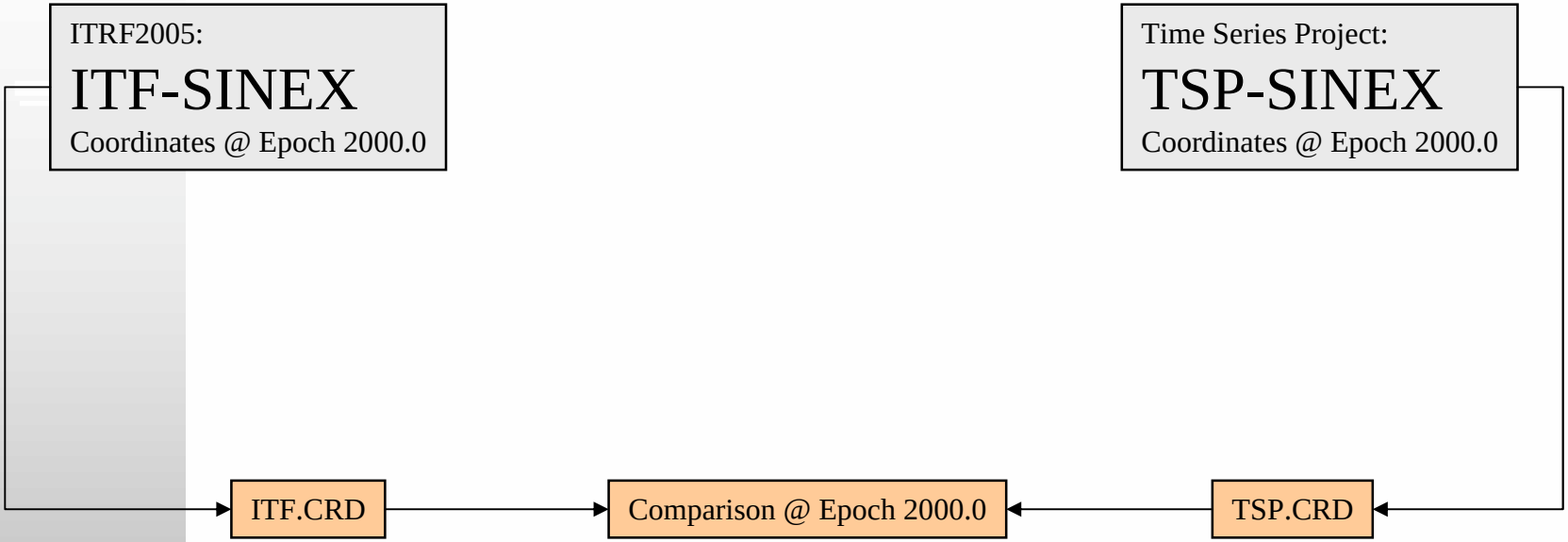
Comparison Concept (1/2)

- Difficulty of different formats for station discontinuities:
  - CATREF uses „SINEX style“ format
  - Bernese software uses the so-called STA-file
  - No software to convert between the two formats available
- Comparison concept considers SINEX format
  - Station coordinate and velocity files converted from SINEX files of each available solution with the Bernese software
  - New solution numbers for stations are added in the resulting coordinate and velocity file automatically as soon as it occurs in the SINEX file.
  - Thus **harmonized coordinates and velocities** w.r.t. discontinuities have been prepared.

Comparison Concept (2/2)

- Different solution epoch of coordinates and velocities in SINEX
  - Bernese: 1996.5 (first observation epoch)
  - CATREF: 2000.0 (~ mean epoch selected)
  - Extrapolation of coordinates to common epoch before comparison

Multiyear Solution Validation

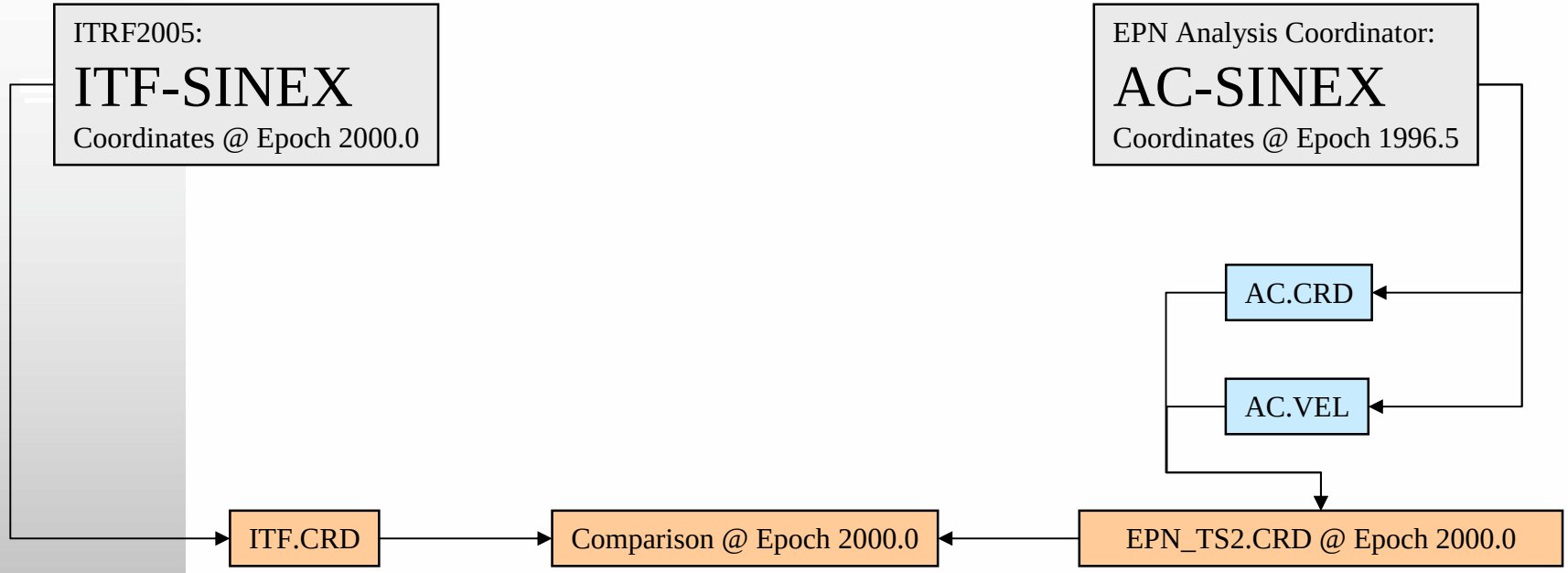


Helmert Transformation ITF – TSP @ Epoch 2000.0

```
NUMBER OF PARAMETERS  :     3
NUMBER OF COORDINATES :   375
RMS OF TRANSFORMATION :     3.6 MM

PARAMETERS:
TRANSLATION IN  X     :           0.7     +-  0.3    MM
TRANSLATION IN  Y     :          -0.5     +-  0.3    MM
TRANSLATION IN  Z     :           0.7     +-  0.3    MM

NUMBER OF ITERATIONS  :     2
ACCEPTED STATIONS     :   125
REJECTED STATIONS     :     5

LIST OF REJECTED STATIONS (10 mm horizontal, 20 mm vertical criterion)
STATION                          RESIDUALS (MILLIMETERS)
                                   N         E         U
QAQ1 43007M001A                 -0.7       5.0      44.6 (observation mismatch)
SFER 13402M004                  -1.7     -11.0       4.5 (observation mismatch)
REDU 13102M001                  -2.1       2.8      23.2 (observation mismatch)
OBET 14208M004                  -3.3       2.1      26.8 (observation mismatch)
QAQ1 43007M001                  -1.8       5.2      54.7 (observation mismatch)
```

- Observation mismatch: Formal observation interval different for TSP and ITF
  → corrected comparison pending
- Note: More inconsistencies of solution numbers possible (not visible here), but out of scope of this comparison.

Multiyear Solution Validation



Helmert Transformation ITF – AC @ Epoch 2000.0

NUMBER OF PARAMETERS : 3
NUMBER OF COORDINATES : 360
RMS OF TRANSFORMATION : 4.2 MM

PARAMETERS:

TRANSLATION IN X	:	**1.0**	+- 0.4	MM
TRANSLATION IN Y	:	**-0.8**	+- 0.4	MM
TRANSLATION IN Z	:	**1.9** ←	+- 0.4	MM

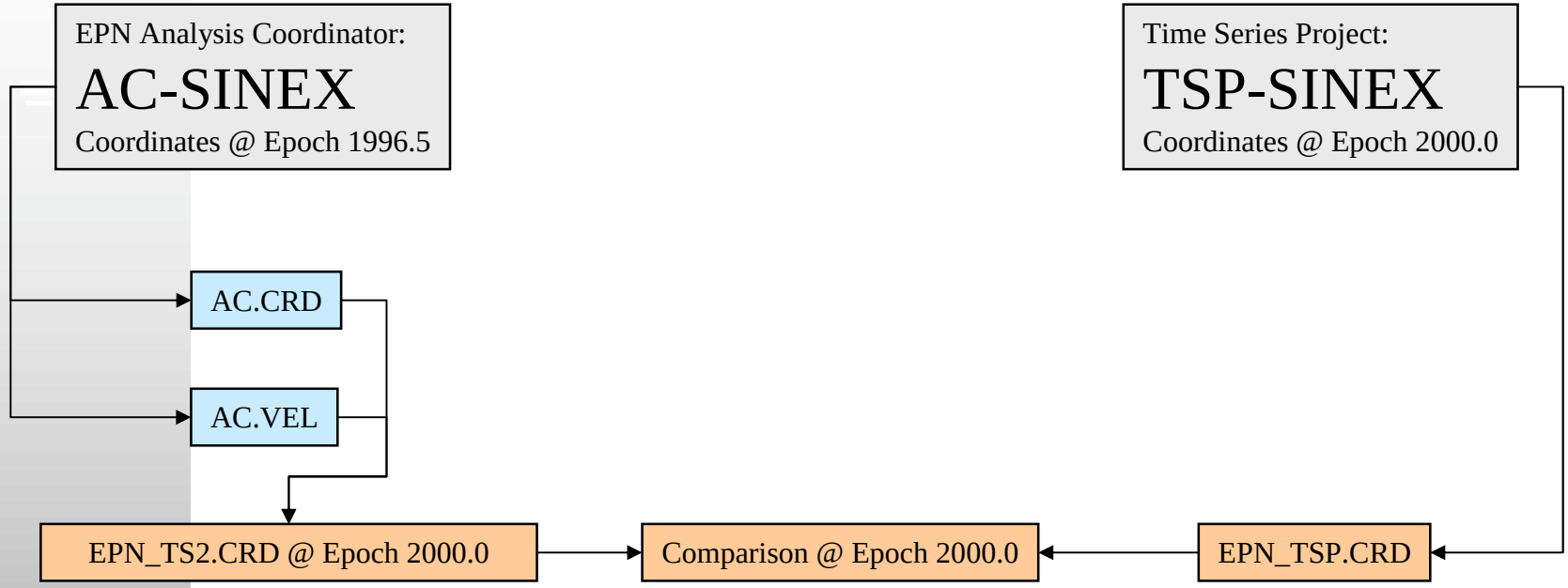
NUMBER OF ITERATIONS : 2

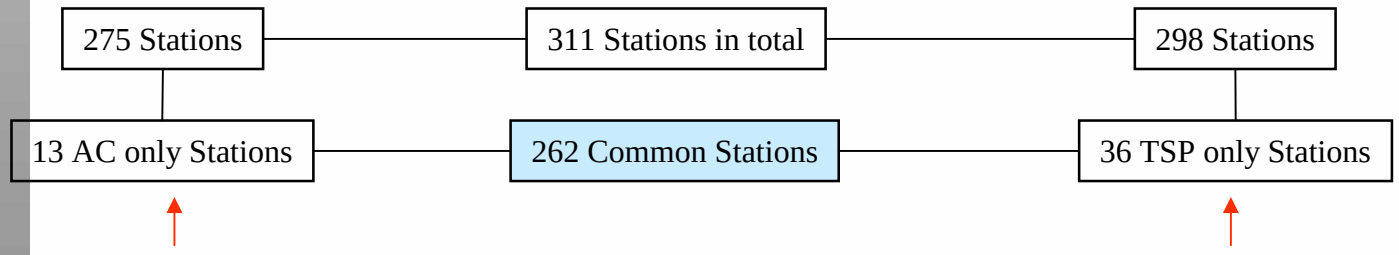
ACCEPTED STATIONS : **120**
REJECTED STATIONS : **6**

LIST OF REJECTED STATIONS (10 mm horizontal, 20 mm vertical criterion)

STATION	RESIDUALS (MILLIMETERS) N	E	U
KELY 43005M001	-3.5	-1.1	54.7
THU1 43001M001	-0.4	-5.7	-22.1
SFER 13402M004B	-3.4	11.3	-2.6
REDU 13102M001	3.4	-2.1	-20.7
OBET 14208M004	1.7	-0.3	-33.7
TRO1 10302M006	2.0	12.3	1.6

Multiyear Solution Validation





Helmert Transformation AC – TSP @ Epoch 2000.0

```
NUMBER OF PARAMETERS  :     3
NUMBER OF COORDINATES :   747
RMS OF TRANSFORMATION :     3.5 MM

PARAMETERS:
TRANSLATION IN  X     :           1.6     +-  0.2    MM
TRANSLATION IN  Y     :          -0.7     +-  0.2    MM
TRANSLATION IN  Z     :           2.1 <--- +-  0.2    MM

NUMBER OF ITERATIONS  :     2
ACCEPTED STATIONS     :   249
REJECTED STATIONS     :    13  <---
```

LIST OF REJECTED STATIONS (10 mm horizontal, 20 mm vertical criterion)

STATION	RESIDUALS (MILLIMETERS) N	E	U	
QAQ1 43007M001A	-3.0	-1.5	44.9	(observation mismatch in TSP)
THU3 43001M002	-0.7	-2.0	27.8	(observation mismatch in TSP)
QAQ1 43007M001	-5.9	-4.1	65.0	(correlated with solution A?)
NEWL 13273M103	0.4	-1.6	27.0	(observation mismatch in TSP)
BUTE 11209M001	-0.7	-7.5	-27.6	(observation mismatch in TSP)
COBA 13453M001	-50.9	30.2	-299.1	(observation mismatch in TSP)
KHAR 12314M001	-2.5	18.4	-69.7	(observation mismatch in TSP)
BOLG 12771M001	-14.2	15.6	101.4	(observation mismatch in TSP)
ENTZ 10014M002	-12.0	1.0	-6.4	(short interval of 25 weeks only)
PUYV 10065M001	7.8	6.6	-28.2	(short interval of 25 weeks only)
VFCH 10046M001	10.5	4.0	-7.0	(short interval of 25 weeks only)
HOE2 14284M002	7.6	3.5	-36.6	(short interval of 21 weeks only)
LINZ 11033S001	-18.4	12.3	38.0	(solution mismatch)→ now edited

Helmert Transformation AC – TSP @ Epoch **2010.0**

```
NUMBER OF PARAMETERS  :     3
NUMBER OF COORDINATES :   609
RMS OF TRANSFORMATION :     4.6 MM


PARAMETERS:

TRANSLATION IN  X     :           6.6     +-  0.3    MM
TRANSLATION IN  Y     :          -2.8     +-  0.3    MM
TRANSLATION IN  Z     :         -16.0     +-  0.3    MM


NUMBER OF ITERATIONS  :     2


ACCEPTED STATIONS     :   203
REJECTED STATIONS     :    59 (10 mm horizontal, 20 mm vertical criterion)
```

- 59 rejected stations acceptable?
- Extrapolation of coordinates is on open issue
- Aspect of „classification“: „Class A“ (1 cm for all epochs) fulfilled?

Minimum Constraint *versus* Heavily Contraint AC @ Epoch 2000.0

```
NUMBER OF PARAMETERS  :     3
NUMBER OF COORDINATES :   825
RMS OF TRANSFORMATION :     1.5 MM

PARAMETERS:
TRANSLATION IN  X     :          -4.7     +-  0.1    MM
TRANSLATION IN  Y     :          -0.7     +-  0.1    MM
TRANSLATION IN  Z     :           9.0     +-  0.1    MM

NUMBER OF ITERATIONS  :     2
NO OUTLIER DETECTED


TRANSFORMATION IN EQUATORIAL SYSTEM (X, Y, Z):
RESIDUALS IN LOCAL SYSTEM (NORTH, EAST, UP)
-------------------------------------------------------------------------
| NUM |      NAME         | FLG |     RESIDUALS IN MILLIMETERS    |    |
-------------------------------------------------------------------------
|     | RMS / COMPONENT   |     |        9.3       1.4       4.6 |    |
-------------------------------------------------------------------------

NUMBER OF PARAMETERS  :     0
NUMBER OF COORDINATES :   825
RMS OF TRANSFORMATION :     6.0 MM
```

- Alignment to ITRF2005 by usage of minimum constraint conditions under investigation.

ITRF2005 Densification
- Summary -

- General consistency between ITF, TSP and AC solution on the 1-2 mm level
- Remaining inconsistency in site selection (station inclusion) and solution numbers (discontinuities) must be resolved
- Extrapolation of coordinates needs to be discussed
- „Misalignment“ from minimum constraint conditions will be investigated
- Comparison of velocities is pending
- Combination of 2 or 3 solutions needs to be discussed

EPN Rapid Analysis Products
- Update -

- Scope:
  - Short latency of solutions
  - High resolution coordinates
  - Monitoring
- Outcome:
  - Hourly, rapid daily and daily coordinate solutions

Hourly Combination – Daily report

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Hourly Summary for day 14721

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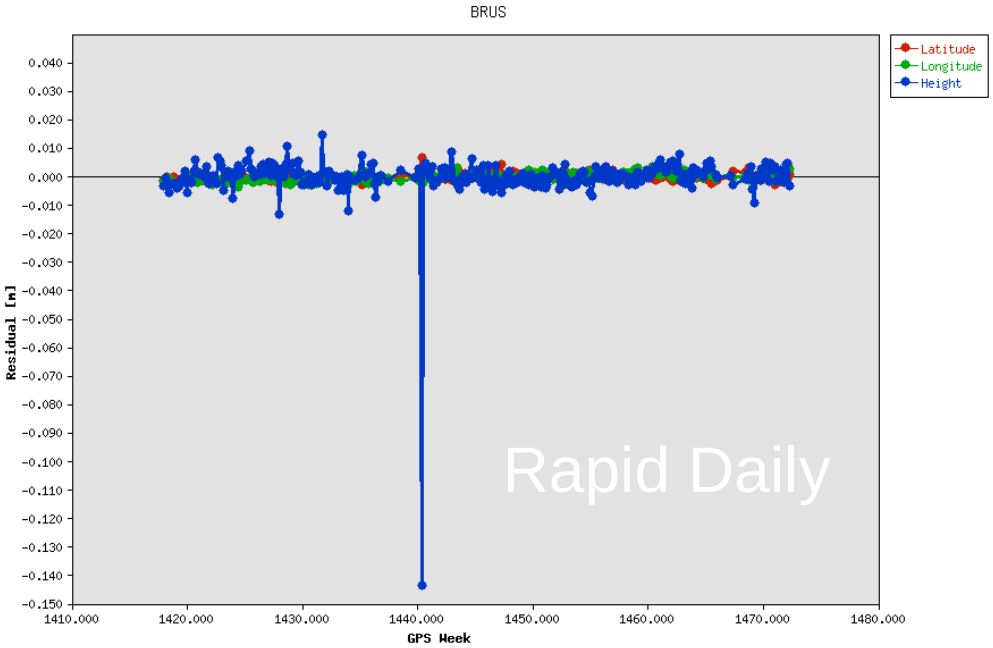
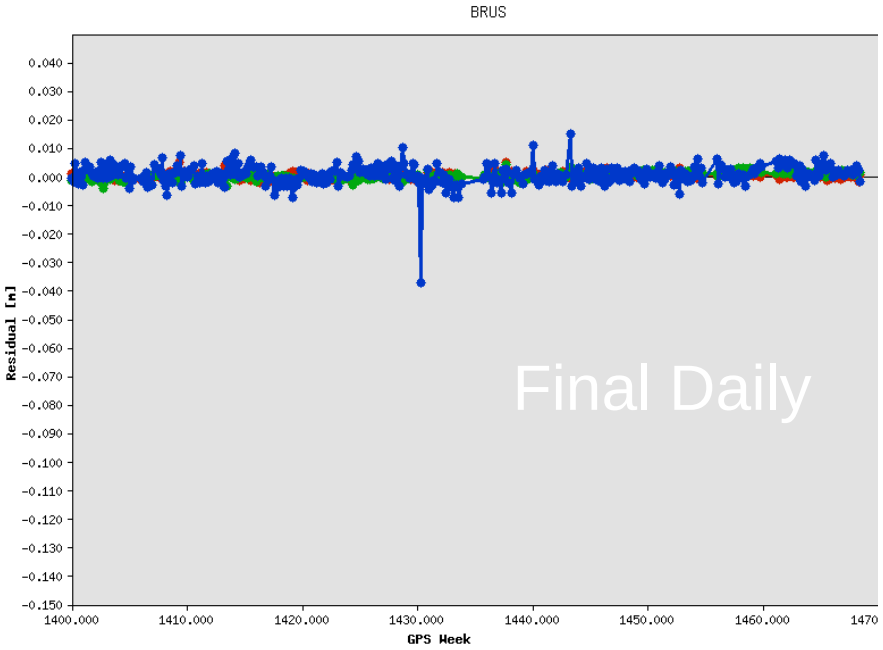
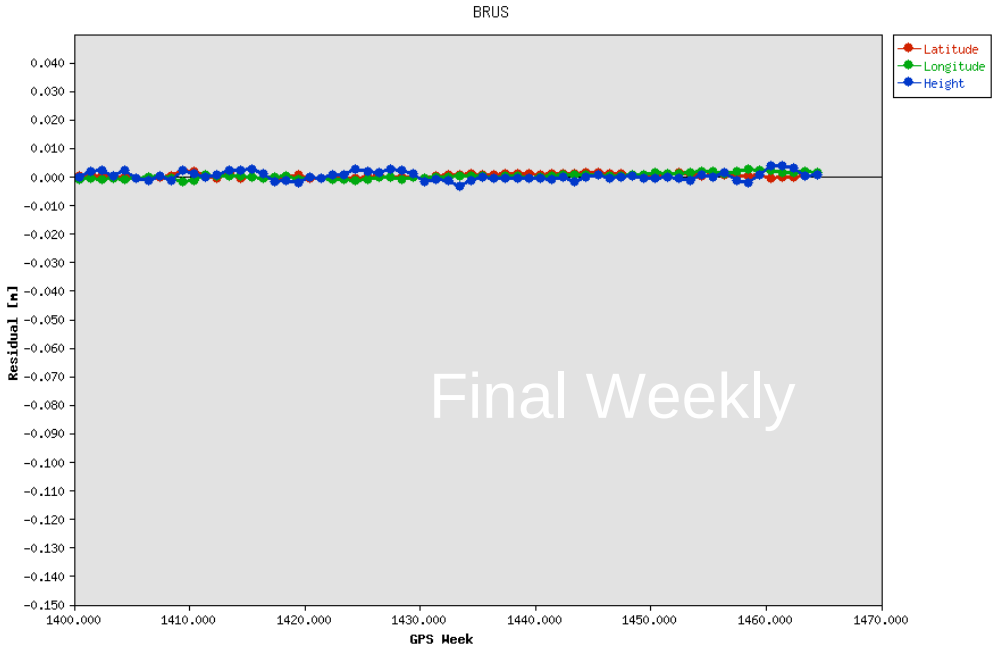
Hour	#Sol.	#Sta.	Repeatability (mm) N	E	U	Local Analysis Centres RMS Helmert Transformation (mm)		
00	3	120	3.92	4.33	15.03	ASI(0.14)	BKG(6.66)	LPT(2.34)
01	3	118	3.63	5.03	9.47	ASI(0.18)	BKG(4.48)	LPT(2.35)
02	3	120	4.30	7.09	9.65	ASI(0.22)	BKG(5.04)	LPT(3.02)
03	3	118	2.93	4.92	7.94	ASI(0.15)	BKG(3.86)	LPT(1.53)
04	3	121	5.86	6.91	14.63	ASI(0.21)	BKG(6.90)	LPT(2.74)
05	3	124	4.46	9.01	10.22	ASI(0.91)	BKG(6.01)	LPT(2.53)
06	3	122	11.23	31.07	14.74	ASI(0.18)	BKG(15.04)	LPT(2.91)
07	3	121	3.64	8.85	7.62	ASI(0.18)	BKG(4.85)	LPT(2.89)
08	3	116	2.48	4.34	6.26	ASI(0.15)	BKG(2.87)	LPT(2.68)
09	3	121	15.54	31.43	12.71	ASI(1.09)	BKG(15.89)	LPT(2.60)
10	3	109	1.89	3.93	5.68	ASI(1.95)	BKG(2.56)	LPT(0.58)
11	3	121	2.72	3.94	7.02	ASI(1.14)	BKG(3.41)	LPT(2.16)
12	3	120	2.67	4.76	6.51	ASI(1.13)	BKG(3.46)	LPT(1.96)
13	3	121	4.89	9.06	8.53	ASI(1.30)	BKG(6.18)	LPT(1.92)
14	3	118	6.22	11.64	9.97	ASI(0.12)	BKG(6.76)	LPT(2.06)
15	3	121	3.67	4.07	7.54	ASI(0.87)	BKG(3.67)	LPT(2.10)
16	3	120	3.27	3.84	7.87	ASI(0.14)	BKG(3.74)	LPT(2.20)
17	3	118	3.68	3.74	9.77	ASI(1.09)	BKG(4.48)	LPT(2.04)
18	3	122	4.59	4.53	9.33	ASI(1.33)	BKG(4.68)	LPT(2.25)
19	3	121	3.75	4.34	7.27	ASI(0.11)	BKG(3.77)	LPT(2.26)
20	3	119	10.55	10.74	6.96	ASI(0.13)	BKG(6.95)	LPT(2.45)
21	3	118	10.10	4.93	13.50	ASI(0.12)	BKG(7.11)	LPT(2.27)
22	3	119	6.29	5.80	14.11	ASI(0.13)	BKG(6.89)	LPT(2.12)
23	3	121	4.00	5.17	7.65	ASI(0.13)	BKG(4.06)	LPT(2.23)



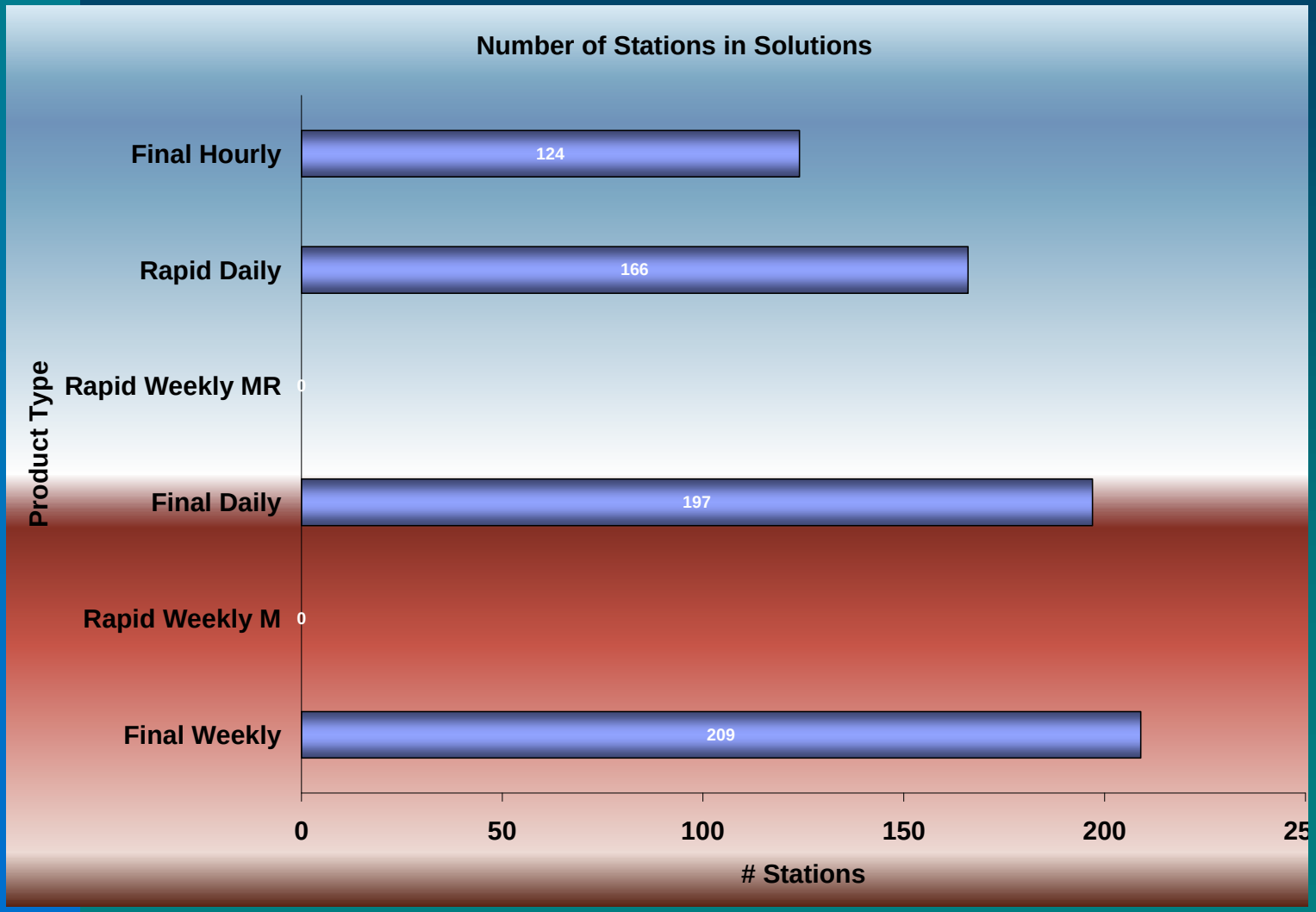
BRUS Time Series

- daily/weekly vs. combined (NEQ stacking)





Station Counting since week 1400



EPN Rapid Analysis - *Next Steps*

- Extension to all EPN sites
  - Call for participation to existing LACs and others?
  - Management task of EPN-CB?
- Product announcement and feedback from users
  - Ask for resolution at next EUREF Symposiuim?
- Discussion of monitoring objective
  - Improvement of outlier handling
  - Harmonisation of hourly analysis specifications
  - Establishment of „alert system“ ?

Points of Discussion
- Evaluation of Real-Time Strategies -

- Motivation:
  - EUREF-IP Project provides real-time observations
  - EPN LACs should initiate real-time analysis strategies
- Actions:
  - General agreement on real-time analysis within LACs
    - Is real-time analysis within the scope of this workshop?
  - Discussion of strategic plan
    - Identification of real-time products
    - Identification of real-time analysis centres

Points of Discussion
- EPN Upgrade to GNSS -

- Motivation:
  - EPN Tracking network holds GPS/GLONASS observations
  - First Galileo test satellite launched
  - Software for processing of GNSS data available, some LACs already include GLONASS data
- Action:
  - Promote to include all GLONASS observations of EPN tracking network in LAC processing
  - Ask for resolution at next EUREF symposium?

Points of Discussion
- EPN Re-processing (1/3)-

- Motivation:

  LAC workshop 2003, Graz

  – Improvement of EPN time series

  – EPN will follow IGS activities

- Action:

  LAC workshop 2006, Padua

  – Weight, until IGS has done a reprocessing and new orbits are available !

  – Get opinions from LACs

Points of Discussion
- EPN Re-processing (2/3)-

- Progress of IGS Reprocessing
  - 8 participating ACs
  - 4 combination centres (2 SINEX, 1 orbits, 1 clocks)
  - Definition of essential elements of analysis procedures finished
  - Definition of file naming and archiving conventions finished
  - 3 month test period (1st quarter of 2000) finished
  - Reprocessing and combination for 2007 finished (SINEX available at CDDIS)

Points of Discussion
- EPN Re-processing (3/3)-

EPN Reprocessing:

- No further need to wait for IGS
- Need for agreement on reprocessing procedure
  - Contributing ACs?
  - Suggested schedule?

Thank you!