

# **The Status and Implementation of the ECGN. Draft plan for the implementation of the 2<sup>nd</sup> stage.**

Markku Poutanen and the ECGN Working Group  
<First draft May 20, 2009>

## **1. Background**

The European Combined Geodetic Network (ECGN) is a European Network for the integration of time series of spatial/geometric observations with GNSS technique, and physical quantities with gravity field related observations and parameters including precise levelling, tide gauge records, gravity observations, and earth and ocean tides. Moreover, a large variety of supplementary information (meteorological parameters, surrounding information of the stations, e.g. eccentricities and ground water level) are also needed.

The objectives of ECGN as an integrated European Reference System for Spatial Reference and Gravity are the maintenance of the terrestrial reference system with long-term stability for Europe. In order to ensure the long-time stability of the terrestrial reference systems with an accuracy of  $10^{-9}$  in the global and continental scale, the interactions between different time dependent influences of the system Earth to the terrestrial reference systems and the related observations have to be considered in the evaluation models. This implies the in-situ combination of geometric positioning with physical height and other Earth gravity parameters in better than 1 cm accuracy level and the modelling of influences of time depended parameters of the solid Earth of the Earth gravity field, the atmosphere, the oceans, and the hydrosphere for different applications of positioning.

Further the ECGN should contribute to the European gravity field modelling, the modelling of gravity field components to validate the satellite gravity missions CHAMP, GRACE and GOCE, and to present a platform for further geo-components (GMES, GEOSS, GGOS). The ECGN is considered as a European contribution to Global Geodetic Observation System (GGOS) of the IAG, and both have very similar visions and goals. As stated in the GGOS reference document, GGOS is the unifying umbrella for the IAG Services, which integrates the observing systems for changes in the Earth's shape, gravity field, and rotation and ensures internal consistency. It links the geodetic services into the global Earth observation systems and provides a consistent service to the users. In particular, GGOS aims to ensure that the geodetic products and tools respond to the increasingly more demanding user requirements.

At the business meeting of the IGGC (International Gravity and Geoid Commission) at the Gravity and Geoid 2002 Symposium in Thessaloniki the ECGN project as a cross-commission project was approved. The primary concern of the project consists in connecting the height component with the gravity determination while allowing for measuring data that are acquired in the European coastal regions and above adjacent seas.

The first call for participation in the ECGN in 2003 was directed to the implementation of the ECGN stations. The paper of the 1st call for Participation was sent out to about 150 potential institutions and organisations in Europe as starting point for the ECGN project. As response of the 1st Call more than 20 European countries sent proposals. About 70 stations were proposed to participate in the ECGN, later the number was reduced to about 50 as the other ones turned out to be not suitable.

At ECGN Working Group Meetings at EUREF Symposium 2003 in Toledo and September 4-5, 2003 in Frankfurt/Main an agreement about the criteria to evaluate the proposals of the 1st call was founded and the individual proposals were discussed. A validation of the proposed stations were done. As result the a station list with status in four criteria

- core (criteria for ECGN are fulfilled and there are additionally some special conditions like fundamental station/observatory and/or measurements of SG)
- ok (criteria are fulfilled at present or will fulfilled in the future)
- candidate (few of the criteria are not fulfilled (e.g. perm GPS not yet realised))
- proposed (some more criteria are at present and perhaps will not be fulfilled in the future)

was evaluated. These stations include the standard GNSS observation techniques, gravity (super-conducting gravimeter and/or absolute gravimeter), levelling connections to nodal points of the European levelling network (UELN) and meteorological parameters. As a result of the evaluation a total of 7 stations have core status, 36 are OK, 5 are candidate and 14 proposed (out of 62 stations, status of 2007-07-02).

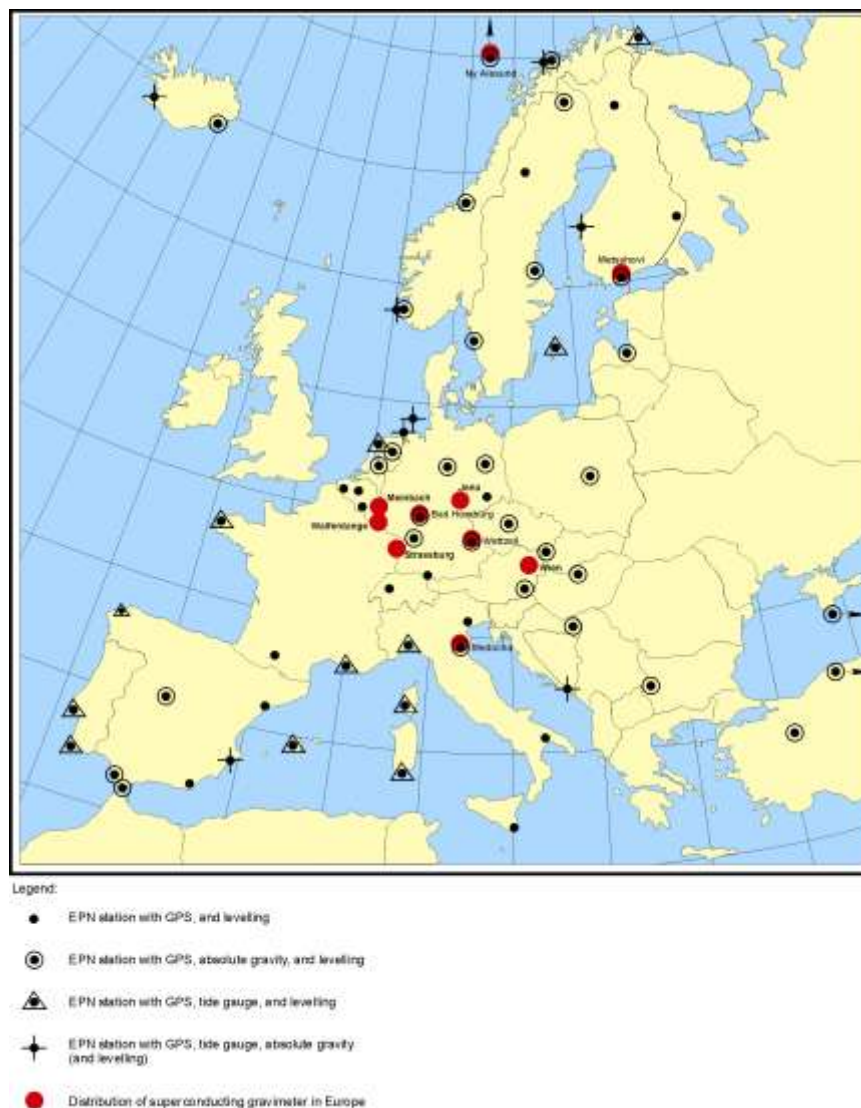


Figure 1. ECGN candidate stations after 1st call.

## 2. Current status

In Table 1 there is a summary of techniques proposed in ECGN. VLBI, SLR and Doris are not considered in the ECGN. GNSS is the only technique related to the geometry, all others are related to gravity. Practically all components already exist, and data are collected and archived in a well defined way. In the following we give a short summary of status.

Table 1. Techniques considered to the ECGN

| Technique                   | Objective  | Accuracy                             | Component(s)   |
|-----------------------------|--|--------------------------------------|--|
| GNSS                        | Point positioning relative to a satellite system   | E: 1-2 cm <sup>*)</sup><br>C: 1-2 mm | Surface displacement<br>Reference frame                        |
| Levelling                   | Height differences of points relative to the geoid | < 1 mm/km <sup>1/2</sup>             | Surface displacement<br>Reference frame                        |
| Tide gauges                 | Height of points relative to sea level             | E: 10 cm<br>C: 1 cm                  | Surface displacement<br>Reference frame                        |
| Absolute gravimeters        | Absolute gravimetric accelerations                 | 2-3 µGal                             | Surface displacement; Earth rotation, Gravity; Reference frame |
| Superconducting gravimeters | Relative gravimetric accelerations                 | 0.1 µGal<br>(< 1 nGal periods)       | Surface displacement; Earth rotation, Gravity; Reference frame |
| Spring gravimeters          | Relative gravimetric accelerations                 | 2-3 µGal                             | Gravity<br>Reference frame                                     |
| VLBI                        | Point positioning relative to space                | 0.001 ppb<br>0.1 mas                 | Surface displacement; Earth rotation; Reference frame          |
| SLR                         | Point positioning relative to many satellites      | < 1 cm (range)<br>1-2 cm             | Surface displacement; Earth rotation; Reference frame          |
| DORIS                       | Point positioning relative to satellites           | 1-5 cm                               | Surface displacement<br>Reference frame                        |

<sup>\*)</sup> *E means episodic and C continuous measurements*

### Status of GNSS

All ECGN stations should be included to the European Permanent GPS network (EPN, <http://www.epncb.oma.be/>). Therefore the stations have to fulfill the requirements of EPN. Standards for becoming a GNSS EPN Station are given on the EPN web page. EPN up and running and it is fully organized. There exist operational and analyzing centers, as well as data base which is easy to access. There is a connection to the GGOS via IGS and IERS.

In the viewpoint of the ECGN no further action is needed. This component is ready and operational and it produces data and results for global and regional use.

### Status of levelling network

All ECGN stations should be connected to the United European Levelling Network - UELN (see <http://crs.bkg.bund.de/evrs>). The rules for connection the ECGN station to UELN are

described in the guideline and the corresponding measurements data should be registered in the ECGN Levelling Form.

UELN levelling network exists, as well as ECGN Standards for Levelling Connection of the ECGN Station and ECGN Levelling Form. In the viewpoint of the ECGN no further action is needed.

### **Status of gravity measurements**

There exists ECGN Standards for Absolute Gravity measurements, and standards for SG observations (Global Geodynamic Project GGP). For the absolute gravity measurements an own data base should be established. Currently, there is a data base and archive for AG measurements in BKG (<http://agrav.bkg.bund.de/agrav-meta/index.html>), but a lot of data are missing there. A similar situation is for relative gravimetry and in general, data are not freely available. For superconducting gravimetry a common data base exists via the GGP.

### **Status of Tide gauge measurements**

For Tide Gauge measurement the data of Permanent Sea Level Observing System - PSMSL and the project European Sea Level Service - ESEAS should be used. There exists the ECGN Standards for Tide Gauge measurements. Contrary to the other techniques, many tide gauges are maintained and owned by non-geodetic organizations. This implies either lack of full control over physical existence of the stations or some restrictions to the data access.

### **Status of VLBI, SLR and DORIS**

These techniques are not considered as an active part of the ECGN. All these stations are included in the respective IAG services. If needed, data access and results are obtained via the services.

### **Co-located sites, local ties and metadata**

A crucial aspect is the co-location of different techniques. The observation of different techniques should be in a close range according to the conditions of the ECGN station. Each type of observation has its own reference and local ties between the instrument and a local reference network should be obtained in a mm-accuracy. The accuracy should be consistent and reliably controlled over long time periods. Currently, local ties are not fulfilling all requirements, and a development must be done in the future to reach the goal.

In general the ECGN should collect the information about the data. The metadata base is an essential part of the project. There exists the ECGN metadata form and the local ties are also a part of the form. However, data base is not complete and a lot of effort is needed to get all necessary information; some of data (e.g. some local ties, meteo data, ...) even do not exist.

### **3. Proposal for the next step implementation plan**

The ECGN working group is to be updated. A query has been sent to the original members of the working group, with a few replies, several without a reply, and one deny. The current status is as follows (TWG members considered as *ex officio*):

|                         |  |
|-------------------------|--|
| Markku Poutanen (chair) | <i>ex officio</i>                              |
| Martine Amalvict        | no reply                                       |
| Carine Bruyninx         | <i>ex officio</i>                              |
| Olivier Francis         | no reply                                       |
| Jaakko Mäkinen          | <i>ex officio</i>                              |
| Johannes Ihde           | <i>ex officio</i>                              |
| Ambrus Kenyeres         | <i>ex officio</i>                              |
| Steve Shipman           | OK   |
| Jaroslav Simek          | OK   |
| Herbert Wilmes          | no reply                                       |
| Trevor Baker            | retired, proposed Simon Williams (unconfirmed) |

#### **Proposals:**

*Item 1. The proposed WG members as above; assuming positive reply from all (done)*

*Item 2. The first task of the WG is to consider the objectives, tasks and guidelines of the ECGN and prepare necessary updates (t.b.d. before the autumn 09 TWG)*

*Item 3. Based on the updated guidelines, prepare a query to the stations mentioned in the list (appendix) to update their status (t.b.d. before the autumn 09 TWG) and to submit a query for additional candidates for an ECGN station*

*Item 4. Inventory of data and metadata banks (t.b.d. a status summary before the autumn 09 TWG)*

*Item 5. Renewal of metadata bases (t.b.d. 2009, based on output from items 2-4)*

Further activities will include

- organizational aspects, i.e. how the tasks will be organized or shared;
- status of ECGN and its connections to GGOS and other regional GOSs (e.g. NGOS);
- resources and funding needed for tasks;
- how to maintain the activity in the future;
- research related to the ECGN; e.g. detailed analysis of the different observation types, differences between the applied techniques, correction models to be used in a combined analysis;

All comments and proposals are greatly welcome.

Markku

# Appendix. ECGS Stations based on the 1<sup>st</sup> call (Status 2007-07-02)

## ECGN Stations

Status: 2007-07-02

# Countries: 21, # Stations: 74

| Country | Site Name                             | Station Code (GPS) | GPS Status (EPN) | absolute gravity measurement  | Super conducting gravimeter (SG) | Levelling    | Tide Gauge       | EUVN point (close to ECGN point) | SLR                  | VLBI                 | Materology | other Technologies  | Comment            | Status |
|---------|---------------------------------------|--------------------|------------------|---|----------------------------------|--------------|------------------|----------------------------------|----------------------|----------------------|------------|---|--------------------|--------|
| AT      | Graz                                  | GRAZ               | EPN              | 1998-2004   |                                  | 1            | no               | GRAZ                             | permanent since 1982 |                      | yes        |   |                    | ok     |
| AT      | Innsbruck / Hafelekar                 | HFLK               | EPN              | 2003, 2004  | no                               | not possible | no               | no                               | no                   | no                   |            |   |                    | ok     |
| AT      | Bregenz, Pfänder, Moos                | PFAN               | EPN              | 1988 Bregenz, 2004, 2005  | no                               | 1            | no               | PFAN                             | no                   | no                   |            |   |                    | ok     |
| AT      | Pernitz / Trafelberg                  | TRFB               | EPN              | 2003, 2004  | since 2005                       | 2            | no               | no                               | no                   | no                   | yes        | seismometer   | UELN               | ok     |
| BG      | Rozhen                                | [ROZH]             | perm             | planned   |                                  |              | no               | no                               |                      |                      |            |   |                    | p      |
| BG      | Sofia                                 | SOFI               | EPN              | 1998, 2001 form UNIGRAC Station PLANA -9 km                               |                                  | 2            | no               | BG03                             |                      |                      |            |   | eccentricity, UELN | ok     |
| BG      | Varna                                 | [VARN]             | perm (p)         | UNIGRACE Station  |                                  | 2            | yes              | BG04                             |                      |                      |            |   |                    | p      |
| CH      | Zimmerwald                            | ZIMM               | EPN              | 1997, 2004, time series planned   |                                  | 1            | no               | ZIMM                             | permanent            |                      | yes        | Earth tide gravimeter, astro measurements (zenith camera), astronomic project COSSP - link to astron. reference system), meas. of high-frequency gravity variations |                    | core   |
| CZ      | Ondrejov, Pecný, Geodetic Observatory | GOPE               | EPN              | time series since 1978, now own FG5                                       | since 2007                       | 1            | no               | GOPE                             |                      |                      | yes        | relative gravity measurements, tidal gravity variations   |                    | core   |
| DE      | Bad Homburg                           | BADH               | EPN              | time series   | since 1983                       | 2            | no               | no                               |                      |                      | no         |   | UELN               | ok     |
| DE      | Helgoland Island                      | HELG               | EPN              | 1997, 2001, 2003, 2008  | no                               | 2 Island     | yes (since 1924) | no                               | no                   | no                   | yes        |   |                    | ok     |
| DE      | Moxa                                  | MOX2               | perm             | 2000-12, 2002-12, 2003-05, 2004-02 and 06, 2005-03 and 11, 2006-05 and 11 | yes                              | 1            | no               | no                               | no                   | no                   | yes        |   | EPN                | ok     |
| DE      | Sassnitz                              | SASS               | EPN              | May 2003  | planned                          | 1            | yes (since 1882) | no                               | no                   | no                   | yes        |   |                    | ok     |
| DE      | Wetzell                               | WTZR               | EPN              | twice a year  | yes                              | 1            | no               | WTZR                             | permanent since 1988 | permanent since 1983 | yes        |   |                    | core   |



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|---------|-----------------------------------|--------------------|-------------------------------|------------------------------|----------------------------------|---------------------------|------------|----------------------------------|-----------|----------------------------------|-----------|----------------------------|--|---|
| DK      |                                   |                    |                               |                              |                                  | 1-UELN 2-national network |            |                                  |           |                                  |           |                            | comment and necessary supplementary arrangements | code<br>ok<br>c = candidate<br>p = proposed<br>a = preliminary<br>submitted |
| DK      | Smidstrup, Vejle                  | SMID               | EPN                           | planned                      |                                  | 1                         | no         | no                               |           |                                  |           |                            | AG   | ok  |
| DK      | Suldrup                           | SULD               | EPN                           | planned                      |                                  | 1                         | no         | no                               |           |                                  |           |                            | AG   | ok  |
| DK      | Qaqortoq, Julianehaab (Greenland) | QAQ1               | EPN                           | planned                      |                                  |                           | yes        | no                               |           |                                  | yes       |                            | AG   | ok  |
| EE      |                                   |                    |                               |                              |                                  |                           |            |                                  |           |                                  |           |                            |  |   |
| EE      | Suurnä                            | [SUUR]             | perm (communication problems) | 1966 + planned               |                                  | 1                         |            | EE02                             |           |                                  |           |                            | EPN  | ok  |
| ES      |                                   |                    |                               |                              |                                  |                           |            |                                  |           |                                  |           |                            |  |   |
| ES      | A Coruna                          | ACOR               | EPN                           | in study                     |                                  | 1                         | yes        | ES05                             |           |                                  |           |                            | AG   | c   |
| ES      | Albacete                          | ALBA               | perm                          | in study                     |                                  |                           | no         | no                               |           |                                  |           |                            |  | p   |
| ES      | Alicante                          | ALAC               | EPN                           | 1996, planned for 2003       |                                  | 1                         | yes        | ES01                             |           |                                  |           |                            |  | ok  |
| ES      | Almeria                           | ALME               | EPN                           | planned for 2003             |                                  | 1                         | yes        | ES02                             |           |                                  |           |                            | AG   | ok  |
| ES      | Caceres                           | CACE               | EPN                           | in study                     |                                  |                           | no         | no                               |           |                                  |           |                            |  | p   |
| ES      | Ceuta                             | CEUT               | EPN                           | 1994, 1998                   |                                  |                           | yes        | no                               |           |                                  |           |                            | UELN   | ok  |
| ES      | Huelva                            | HUEL               | perm                          | in study                     |                                  | Island                    | yes        | no                               |           |                                  |           |                            |  | p   |
|         | La Palma / Roque de los Muchachos |                    |                               |                              |                                  |                           |            |                                  |           |                                  |           |                            |  |   |
| ES      | Observatory                       | LPAL               | EPN                           |                              |                                  |                           | no         | no                               |           |                                  |           |                            |  | p   |
| ES      | La Rioja                          | RIOJ               | perm                          | 2002                         |                                  |                           | no         | no                               |           |                                  |           |                            | EPN, UELN  | c   |
| ES      | Malaga                            | MALA               | perm                          | 2002                         |                                  |                           | yes        | no                               |           |                                  |           |                            | EPN, UELN  | c   |
| ES      | Palma de Mallorca                 | MALL               | EPN                           | in study                     |                                  | 2<br>Island               | yes        | ES08                             |           |                                  |           |                            | AG, UELN   | c   |
| ES      | Santander                         | CANT               | EPN                           | planned for 2003             |                                  | 1                         | yes        | ES08                             |           |                                  |           |                            | AG   | ok  |
| ES      | Sonseca                           | SONS               | perm                          | 2002                         |                                  |                           | no         | no                               |           |                                  |           | seismograph                | EPN, UELN  | c   |
| ES      | Valencia                          | VALE               | EPN                           | 2002                         |                                  |                           | yes        | no                               |           |                                  |           |                            | UELN   | ok  |
| ES      | Vigo                              | VIGO               | perm                          | in study                     |                                  |                           | yes        | no                               |           |                                  |           |                            |  | p   |
| ES      | Yebes                             | YEBE               | EPN                           | planned for 2003             |                                  |                           | no         | no                               |           | permanent                        |           | radioastronomy             | AG, UELN   | ok  |
| FI      |                                   |                    |                               |                              |                                  |                           |            |                                  |           |                                  |           |                            |  |   |
| FI      | Degeby                            | [DEGE]             | perm                          |                              |                                  | 1                         | yes        | FI01                             |           |                                  |           |                            | EPN, AG  | ok  |
| FI      | Jornai                            | JOEN               | EPN                           | 1969                         |                                  | 1                         | no         | JOEN                             |           |                                  |           |                            |  | ok  |
| FI      | Kikkonummi / Metsähovi            | METS               | EPN                           | time series                  | yes                              | 1                         | yes        | METS                             | permanent | mobile (1969), permanent in 2003 |           | DORIS (permanent), GLONASS |  | core  |
| FI      | Sodankylä                         | SODA               | EPN                           | 1976, 1980, 1982, 1998       |                                  | 1                         | no         | SODA                             |           |                                  |           |                            |  | ok  |
| FI      | Vaasa                             | VAAS               | EPN                           | 1965, 1999                   |                                  | 1                         | yes        | VAAS                             |           |                                  |           |                            |  | ok  |

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|---------|----------------------------------|--------------------|------------------|---------------------------------|---------------------------------|-----------|------------|----------------------------------|---------------------------|-------------------|-----------|--|--------------|--------|
| FR      | Brest                            | BRST               | EPN              | 1998, 1999, 2001, 2003          |                                 | 1         | yes        | FR04                             |                           | mobile            | in study  |  |              | ok     |
| FR      | Strasbourg STJB                  | STJB               | perm             | time series, 1997 - ongoing     | yes                             |           | no         | no                               |                           |                   |           | water table gauge 1987-ongoing, relative grav. measurements, seismometer         | EPN, UEIN    | core   |
| FR      | Wieschnouch, Vogese Mountains    | WELS               | perm             | time series, 1997 - ongoing     |                                 |           | no         | no                               |                           |                   |           |  | EPN, UEIN    | ok     |
| IS      | Hofn                             | HOFN               | EPN              | 1997, 1998                      |                                 | no        |            | HOFN                             |                           | mobile (1992)     |           | PRAIRE (permanent)   |              | p      |
| IS      | Reykjavik                        | REYK               | EPN              | 1988, 1997                      |                                 | no        | yes        | REYK                             |                           |                   |           | DORIS (permanent)  |              | p      |
| IT      | Bologna                          | BOLG               | EPN              | Jan 2002, Jan 2003, Aug 2003    |                                 |           | no         |                                  |                           |                   | yes       | INSAR-data   | UEIN         | ok     |
| IT      | Medicina (University of Bologna) | MSEL               | EPN              | time series since 1996          | yes                             |           | no         | MEDI                             |                           | yes               | yes       | axis bi-axial tiltmeters, INSAR-data, geological surveys, water level variations | UEIN         | (core) |
| LT      | Vilnius                          | VLNS               | EPN              | 1994, 2002, Exz. GPS-Grav -8 km |                                 | 1         | no         | LT02                             |                           |                   |           |  | eccentricity | ok     |
| LV      | Liberec                          | LIBE               | perm             |                                 |                                 | 1         |            | LV04                             |                           |                   |           | radioastronomy   | EPN, AG      | ok     |
| LV      | Riga                             | RIGA               | EPN              | 1996, 1998, 2004                |                                 | 1         | yes        | RIGA                             | permanent                 | yes               |           |  |              | ok     |
| MD      | Balti                            | BALT               | no               |                                 |                                 |           | no         | no                               |                           |                   |           |  |              | p      |
| MD      | Chisinau                         | CHIS               | no               |                                 |                                 |           | no         | no                               |                           |                   |           |  |              | p      |
| MD      | Comrat                           | COMR               | no               |                                 |                                 |           | no         | no                               |                           |                   |           |  |              | p      |
| NL      | Urniden                          | UMIJ               | perm (p)         |                                 |                                 | 2         | yes        | TERS                             |                           |                   |           |  |              |        |
| NL      | West-Terschelling                | TERS               | EPN              |                                 |                                 | 1         | yes        |                                  |                           |                   |           |  | EPN, UEIN    | ok     |
| NL      | Westerbork                       | WVRT               | EPN              | yes                             | planned                         | 1         | no         | WVRT                             | infra-structure available | yes               | yes       | Earth tide gravimeter  |              | ok     |
| NO      | Bodø                             | BODO               | perm             |                                 |                                 |           |            |                                  |                           |                   |           |  |              | p      |
| NO      | Ny-Alesund NYA1 (EPN) / NYAL     | NYA1 / NYAL        | EPN              | 1998, 2000, 2001, time series   | yes                             |           | yes        | NYAL                             | yes                       | permanent         |           | DORIS, PRAIRE  | UEIN         | core   |
| NO      | Stavanger STAS (EPN) / STAV      | STAS / STAV        | EPN              | 1991, 1993, 1996                |                                 | 1         | yes        | NO02                             |                           |                   |           |  |              | ok     |
| NO      | Tromsø TRO1                      | TRO1               | EPN              | 1992, 1993, 1996, 1998          |                                 |           | yes        | TROM                             | mobile                    | mobile (Aug 1997) |           | SATREF   | UEIN         | ok     |
| NO      | Trondheim TRDS (EPN) / TRON      | TRDS / TRON        | EPN              | 1996, 1998                      |                                 |           | yes        | no                               |                           | mobile            |           |  | UEIN         | ok     |



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|---------|-----------|--|------------------|------------------------------|----------------------------------|------------------------------|------------|----------------------------------|-----|--------|------------|--------------------|--|--|
|         |           | [.] code not available, temporary defined code | (p) = planned    |                              |                                  | 1=UELN<br>2=national network |            |                                  |     |        |            |                    | comment and necessary supplements/arrangements | core ok<br>c = candidate<br>p = proposed<br>a = preliminary admitted |
| NO      | Trysil    | [TRY S]  | perm             | 1991, 1993, 1998, 2001, 2003 |                                  |                              | no         | no                               |     | mobile |            |                    | UELN, EPN                                      | ok   |
| NO      | Vardoe    | VAR S  | EPN              |                              |                                  | 1                            | yes        | NO12                             |     |        |            |                    |  | p  |