Finnish Geodetic Institute

FGI report on geodynamics 2010-2011

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Topics

I 2010 Activity

1. **Absolute gravimetry**
   FOGN with A10 & Abs. grav with FG5
2. **Relative gravimetry & GPS**
   Supporting measurement for FOGN
3. **Superconducting gravimetry**
   Hydrological studies
4. **Long interferometrical watertube tiltmeter**
   Recordings, Baltic Sea and Arctic Sea loading?
5. **Geo-VLBI**
   IVS-T2 and *EUROPE* geoVLBI campaigns
6. **Satellite Laser Ranging system modernization**

II New structure of Dept of Geodesy and Geodynamics

III Project plans in 2011

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First order gravity net remeasurement with A10 in cooperation with FGI and Institute of Geodesy and Cartography,Warsaw

FOGN in 1963, Kiviniemi
Publ. 59, 1964

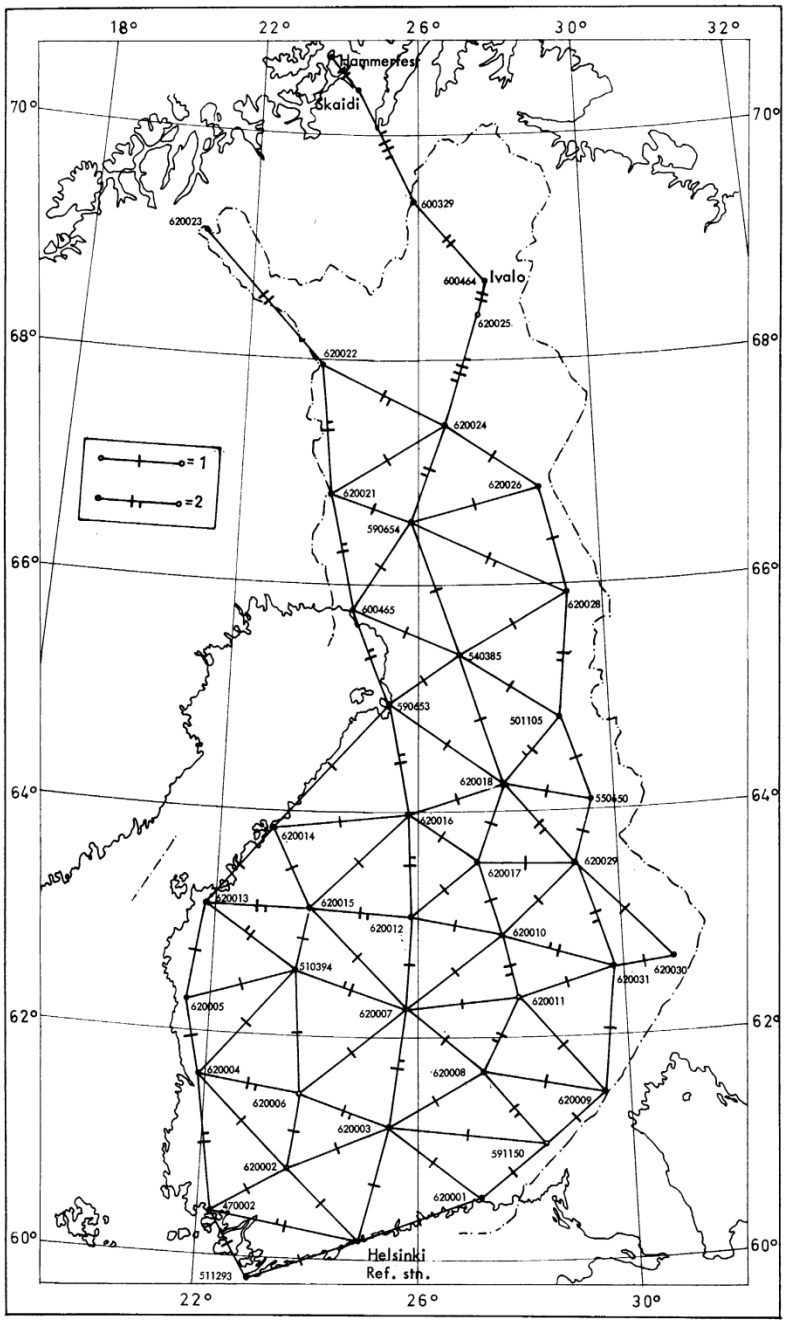


Fig. 1. The first order gravity net of Finland. 1 = double measurement, 2 = triple measurement

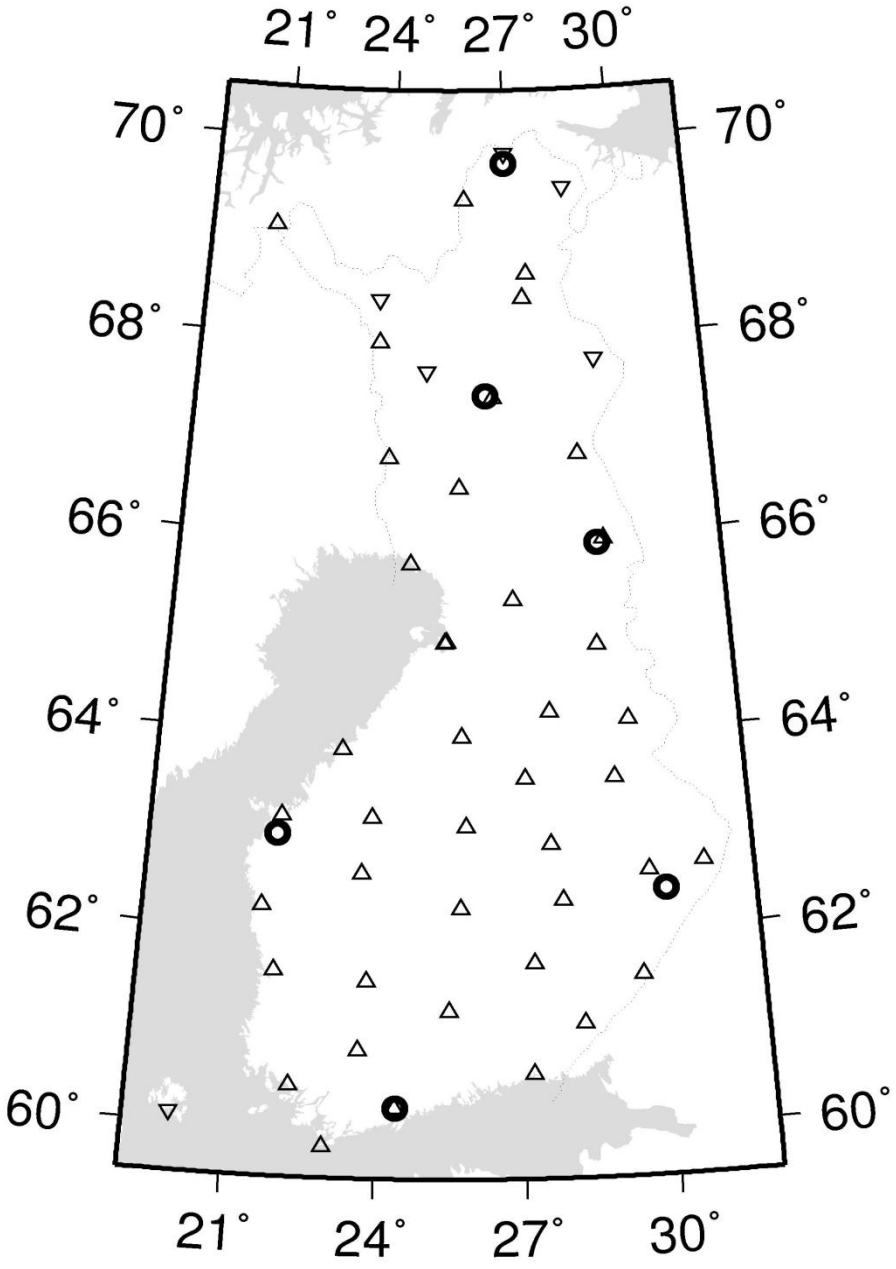
FOGN present status

- measured 1962-63 by Aimo Kiviniemi, Worden Master 227
- present zero and scale derived from a readjustment into IGSN71 by T. Honkasalo in 1971
- epoch 1963.0, mean tide system (from IGSN71)
- original estimate for accuracy of gravity differences 0.03...0.06 mgal (one-sigma)
- control measurement in 1988 by Kiviniemi
- performed in large loops, 2 x LCR-G (G-55, G-600)
- rms for discrepancies (1988-1963) of gravity differences without correction for land uplift was 0.035 mgal (JM)
- values of preserved stations were not revised in 1988

Re-measurement of the FOGN

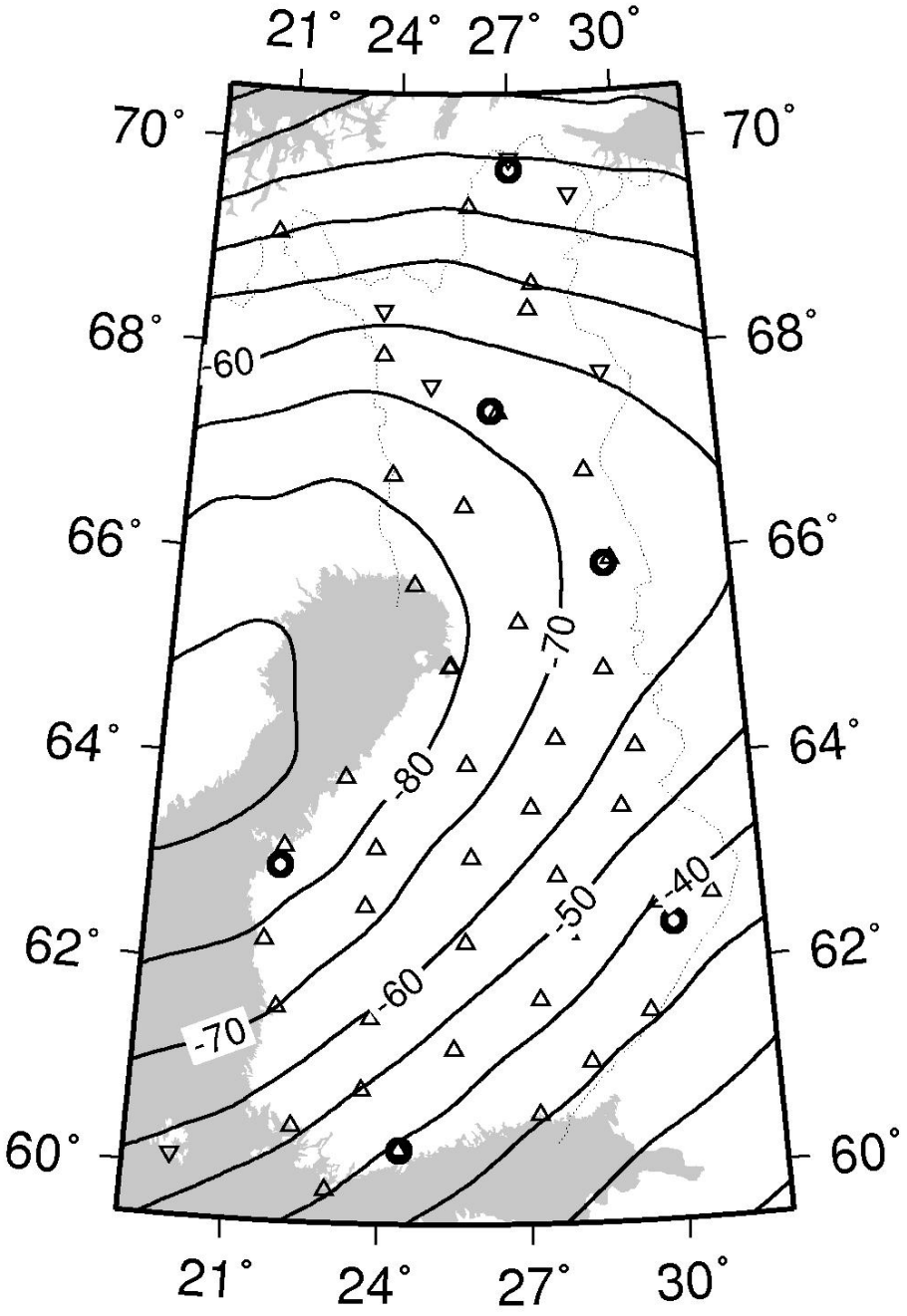
- Future uses of the FOGN shall be the same as the old uses: reference for gravity survey
- in other words, no geodynamical task added
- old stations retained and remeasured 2009-2010 with A10
- co-operation with IGiK Warsaw
- A10-0020 of IGiK operated by Marcin Sekowski
- 19 FOGN sites occupied in 2009 and 32 sites in 2010
- Supporting measurements started in 2010, will be completed in 2011

A10-20 at FOGN station 620003 (Asikkala)

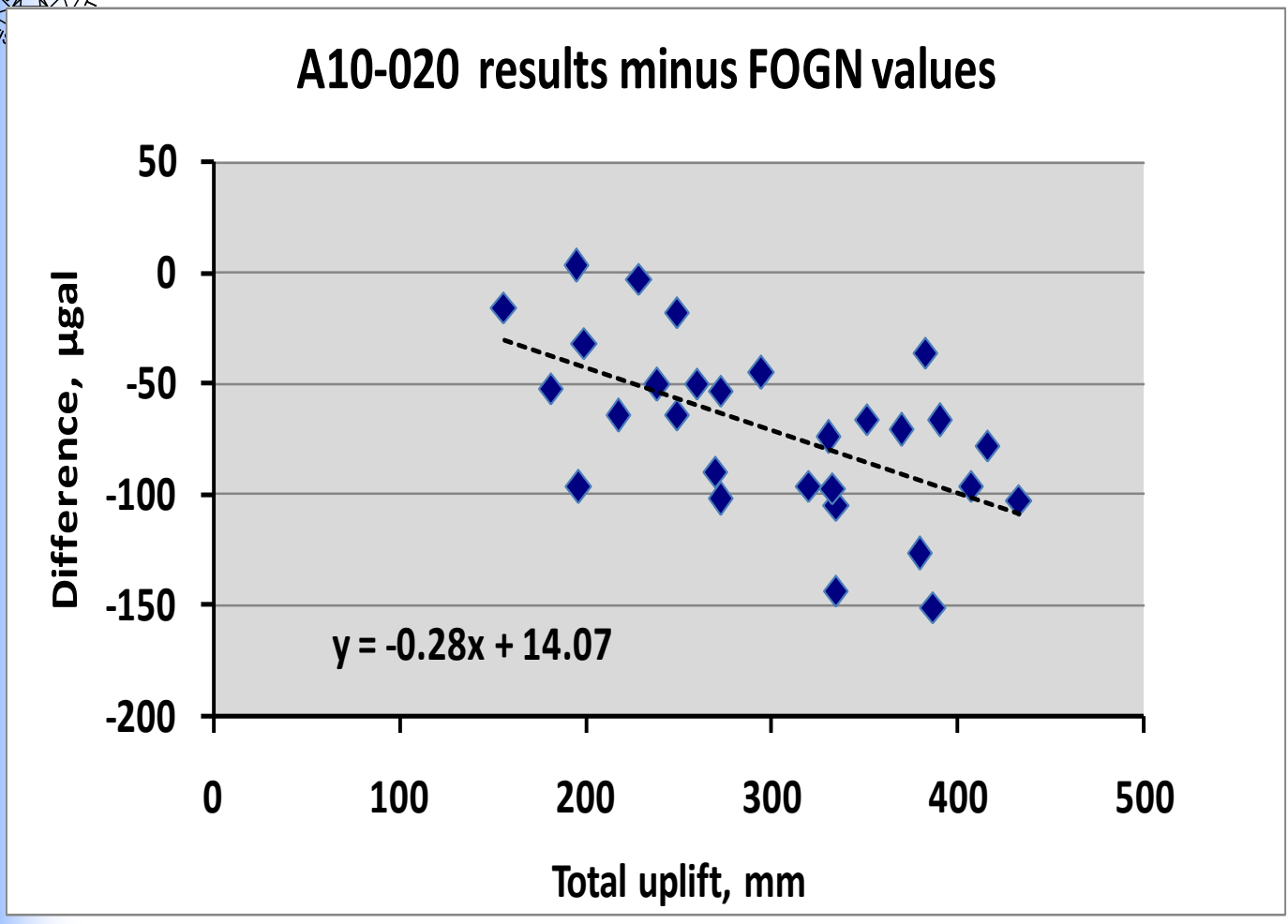


Final network of new FOGN
51 sites measured with A10
Circles:
Control sites with FG5 results

(Mäkinen, NKG GA, Sundvolden, 2010)



Isolines (unit µgal) show expected gravity change 1963–2010 due to PGR , (Mäkinen, NKG GA, Sundvolden, 2010)



A10-020 minus FOGN (when corrected to zero-tide)
vs. total uplift 1963.0 → 2010.0 in mm
estimated from NKG2005LU_ABS
Slope -0.28 µgal/mm is too steep! Should be about –0.15 µgal/mm

(Mäkinen, NKG GA, Sundvolden, 2010)

Supporting geodetic and gravimetry measurements

- separate 2-person expedition, will be completed in 2011
- **3-level gradients for A10 computation**, for users, and for connecting
  - Worden in 1962-63 at about 0.5 m height (tripod)
  - LCR-G in 1988 at about 0.16 m height (plate)
  - A10-020 in 2009-2010 at 0.681 m
- **relative ties when FOGN and A10 stations are not same**
- **levelling** to BM with better than 1 cm accuracy
- 3-D coordinates from **VRS-GPS** in combination with **tachymeter**
- plan was to make terrestrial laser scan of sites but scanner was busy elsewhere most of 2010

- photos, sketches, dimensions, control distances

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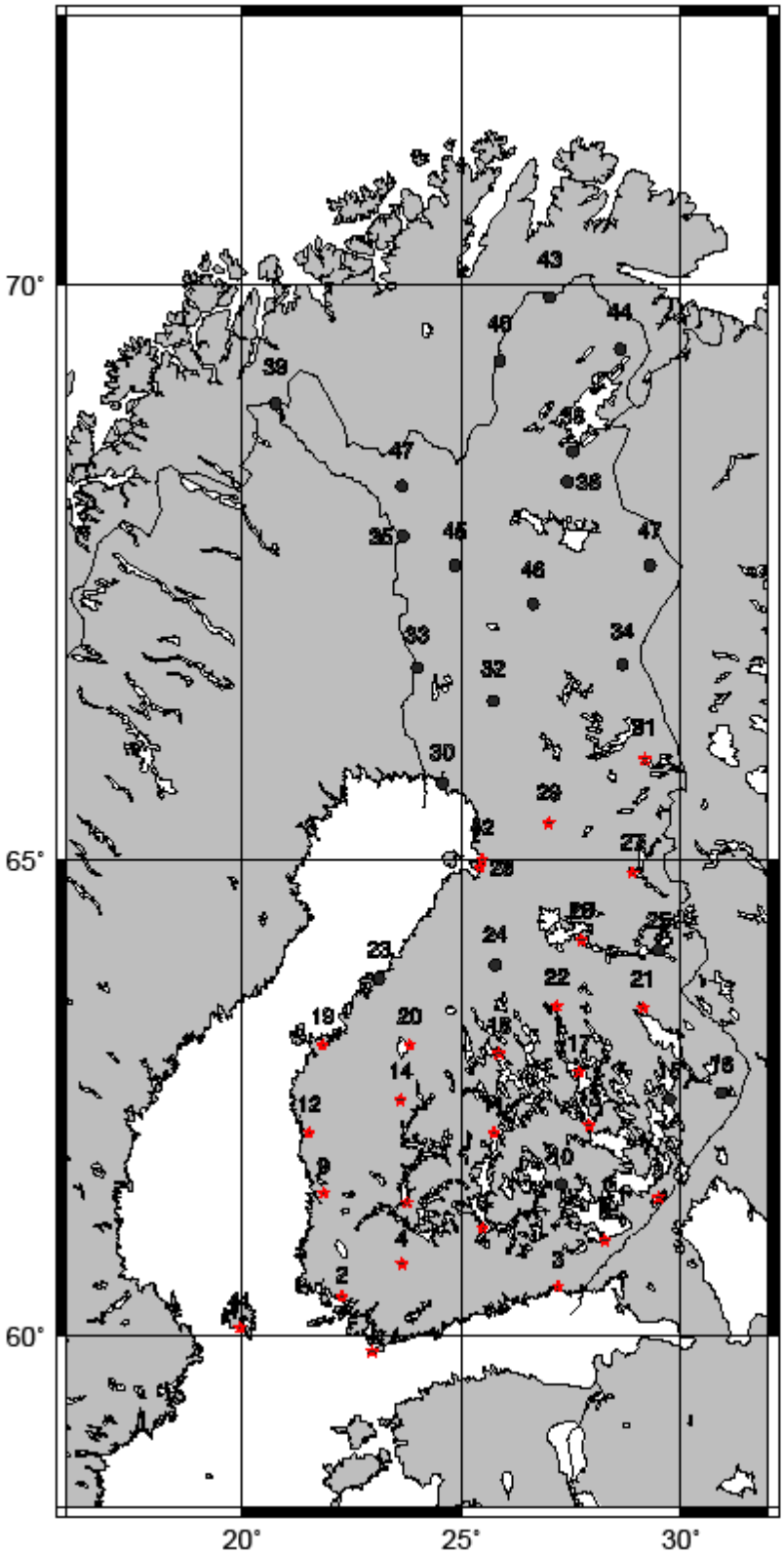

1 Hanko
2 Turku
3 Hamina
4 Forssa
5 Lauritsala
6 Asikkala
7 Tampere
8 Parikkala
9 Noormarkku
10 Mikkeli
11 Jyväskylä
12 Lapväärtti
13 Varkaus
14 Alavus
15 Joensuu
16 Ilomantsi
17 Kuopio
18 Viitasaari
19 Koivulahti
20 Vimpeli
21 Nurmes
22 Iisalmi
23 Kokkola
24 Kärsämäki
25 Kuhmo
26 Kajaani
27 Ämmänsaari
28 Oulunsalo
29 Kurenalus
30 Kemi
31 Kuusamo
32 Rovaniemi
33 Pello
34 Salla
35 Muonio
36 Laanila
37 Hetta
38 Ivalo Ch.
39 Kilpisjärvi
40 Karigasniemi
41 Maarianhamina
42 Oulu A.p.
43 Utsjoki
44 Näätämö
45 Kittilä
46 Sodankylä
47 Tulppio

Papers of FOGN measurements

Mäkinen J., Sękowski M., Kryński J., Ruotsalainen H., (2010a): *Gravity change in Finland fromcomparison of new measurements using the outdoor absolute gravimeter A10 with legacy relative measurements – first results, Geophysical Research Abstracts Vol. 12,* ***EGU2010****-12932, EGU* General Assembly 2010, 2–7 May 2010, Vienna, Austria, Abstract.

Mäkinen J., Sękowski M., Kryński J., Ruotsalainen H., (2010b): *Updating the Finnish first order gravity network using the outdoor absolute gravimeter A10, IAG* ***Symposium on Terrestrial*** **Gravimetry: Static and Mobile Measurements (TG-SMM2010)**, 22–25 June 2010, Saint
Petersburg, Russia, Abstract.

Manuscript of measurements submitted to Polish **Geoinformation Issues**, October 21, 2010 by Mäkinen, Krynski and Secowski

Absolute gravity with FG5 in 2010

- Metsähovi_AB, Vaasa AA&AB, Joensuu, Kuusamo, Sodankylä and Kevo remeasured Aug-Sep. 2010 by HR & Co
- Results obtained expected
- J. Näränen in FG5 training school in Micro-g Solutions in Colorado USA 9/2010

SG-TT20, Metsähovi

Virtanen H., et al.

Photo: H. Virtanen

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Present goals of SG study

Research work with SG T020 has been concentrated on **hydrological studies.**

Test field around laboratory (within distance 100m-150m) consist of **13 groundwater tubes**,

5 tubes for radiometric measurements, 54 soil moisture sensors and soil resistivity field with 441 probes.

A key question is the separation of the attraction of near-field water storage from the loading effect of the regional water storage, as the two are strongly correlated and the size of the former depends on very local hydrogeology around the SG.

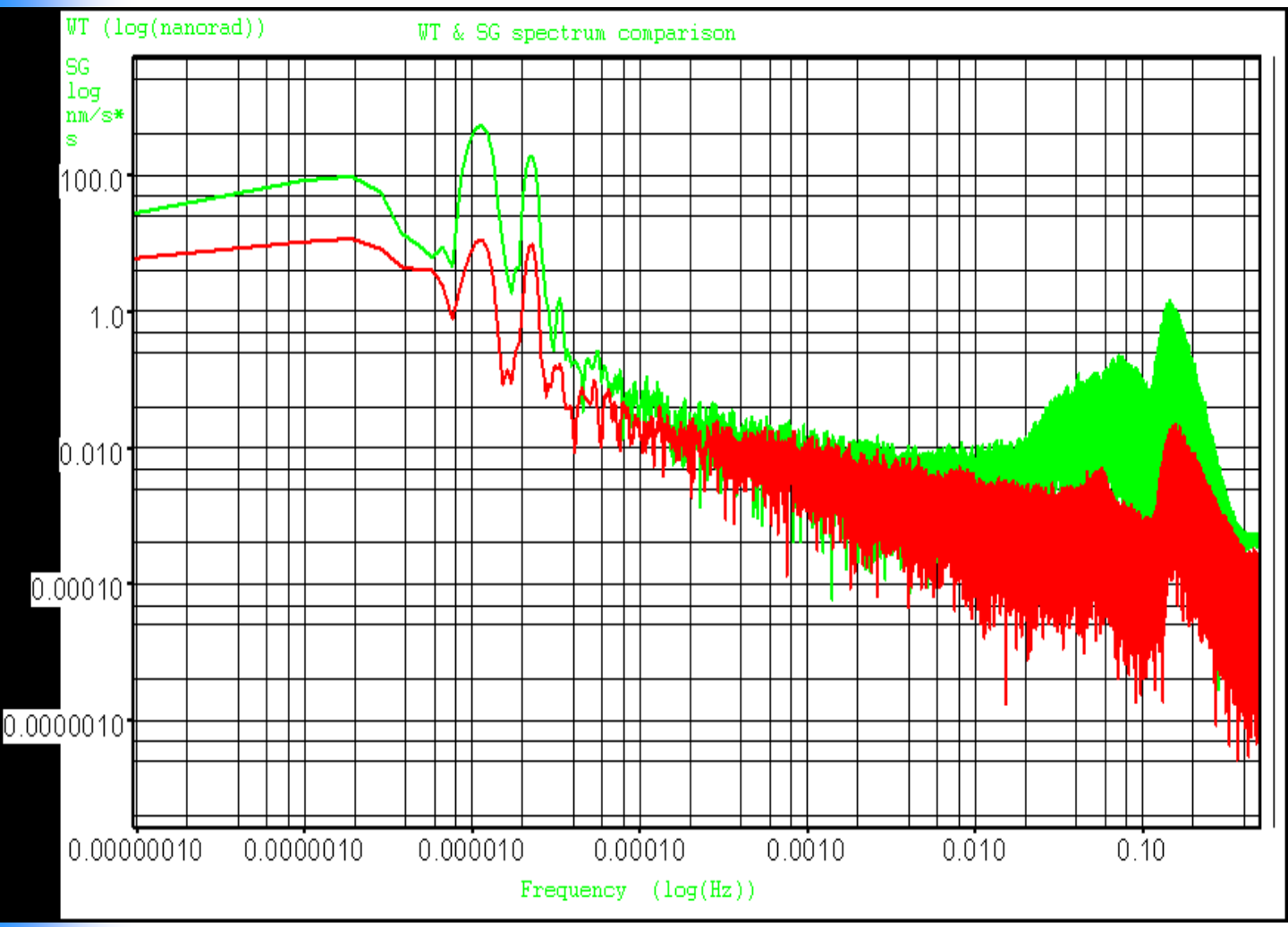
Modeling the local hydrology would allow us to use the SG to check regional hydrology from GRACE.

The ambition of hydrological studies, using T020 is to verify and develop gravity and hydrological models in the spatial scales from regional (Finland) to continental (European).

Interferometrical water tube tiltmeter, Lohja

- NSWT recording continued, GGP filters tested and tidal tilt analyse carried out with old and new data
- **Baltic Sea** loading studies continued
- **Microseismic storms** –and its spectral response together with SG in Metsähovi studied
- Free oscillations after big earthquakes (**Chilean earthquake under study)**

NSWT/SG spectra from microseismic storm 26.1.- 2.1.2010



Red - NSWT-spectrum

Green SG GWR-TT20 spectrum

Geodetic- **VLBI**

FGI: Saaranen, Arsov, Zybko

Aalto Univ., Metsähovi Radio Observatory: Molera, Mujunen,Ritakari, Wagner,Oinaskallio, Uunila

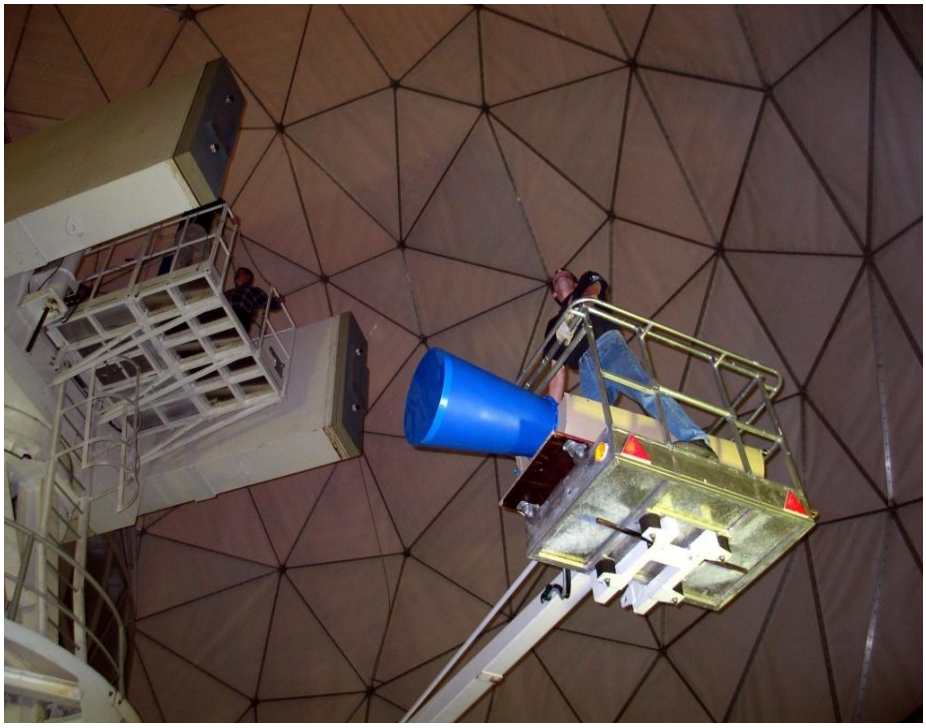


Photo. M. Poutanen

Participation in *IVS-T2* and *EUROPE* geoVLBI campaigns coordinated by International VLBI Service. During 2010 participated in 7 geoVLBI sessions (VS, NZ). In 2010 started to analyze VLBI sessions with **VieVS software** (Vienna University of Technology) . The *EUROPE* and *IVS-T2* sessions of 2002–2009 years have been analyzed by Nataliya Zubko for the study of the **difference** of crustal movements obtained with ***EUROPE* and *IVS-T2* networks.**

SLR renovation, Metsähovi

Arsov, Näränen, Raja-halli

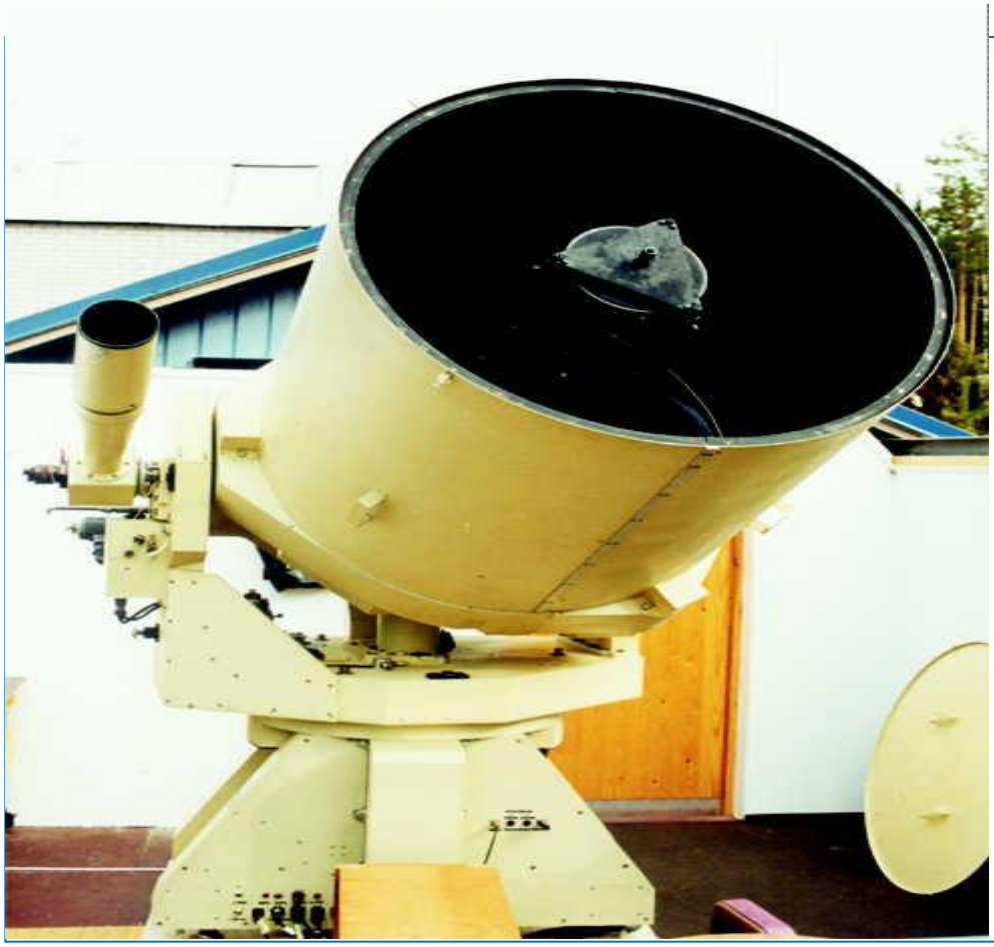


Photo: M.Poutanen

Renovation work continues

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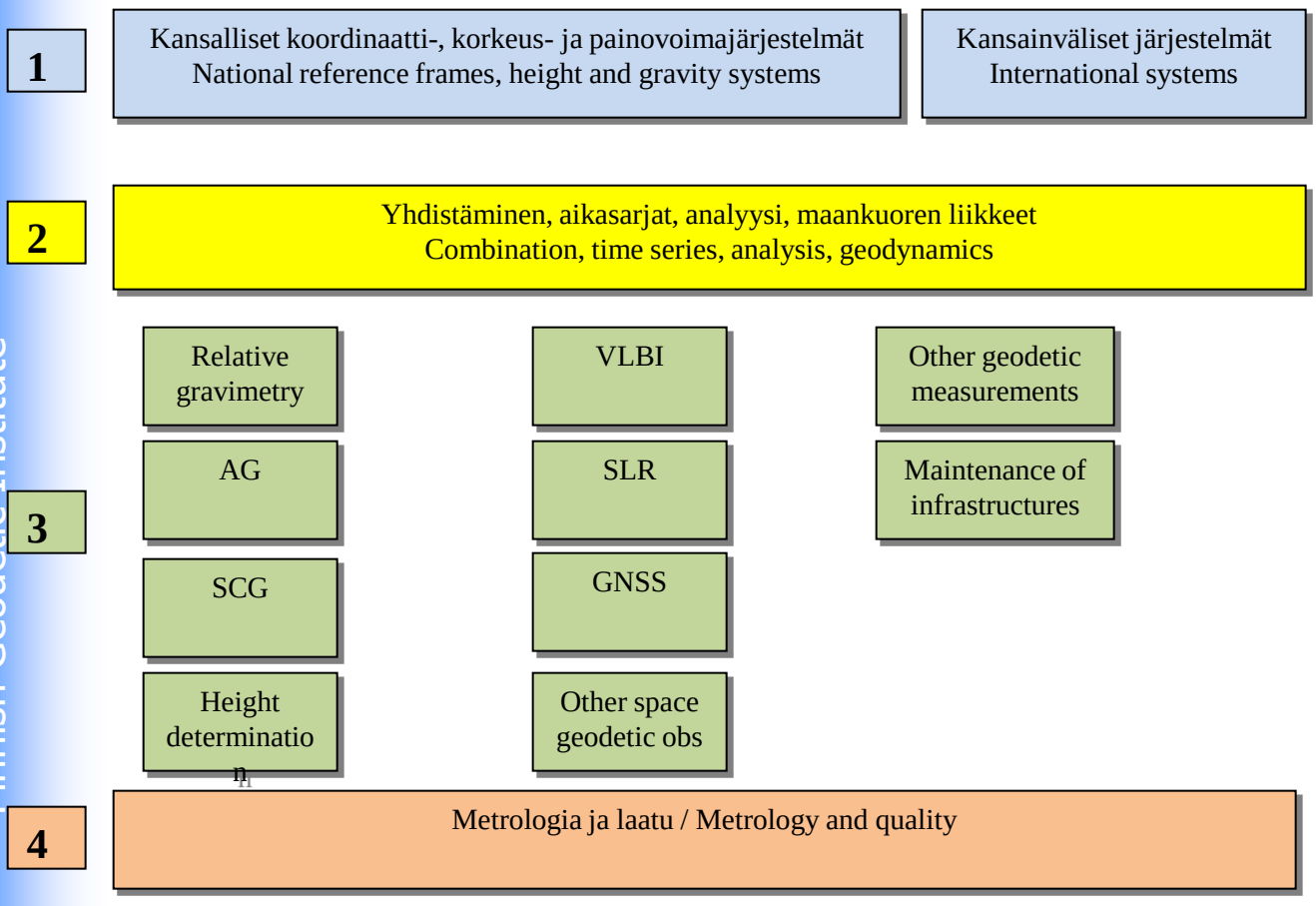
Osaston yleinen rakenne ja tehtävät / General structure and tasks of the Department



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Geodynamics in 2011

- **ABS GRAV**
- FG5 measurements in Finnish stations Aug.
- FG5 comparison LMV 3/2011 in Metsähovi, Moscow, ST. Petersburg, Luxembourg comparisons
- FG5 measurements in Antarctica at the end of year

FOGN relative gravimetry measurements

measurements continue in May – June in Northern Finland and field works are tried to be finalized before July.