Institute report 2009: Chalmers
Department of Space Geodesy and Geodynamics
Onsala Space Observatory

Staff

Gunnar Elgered	(Head of Department)
Rüdiger Haas	(Senior researcher, head of GEO-group)
Jan Johansson	(Adjoint Prof., SP Borås)
Hans-Georg Scherneck	(Senior researcher)

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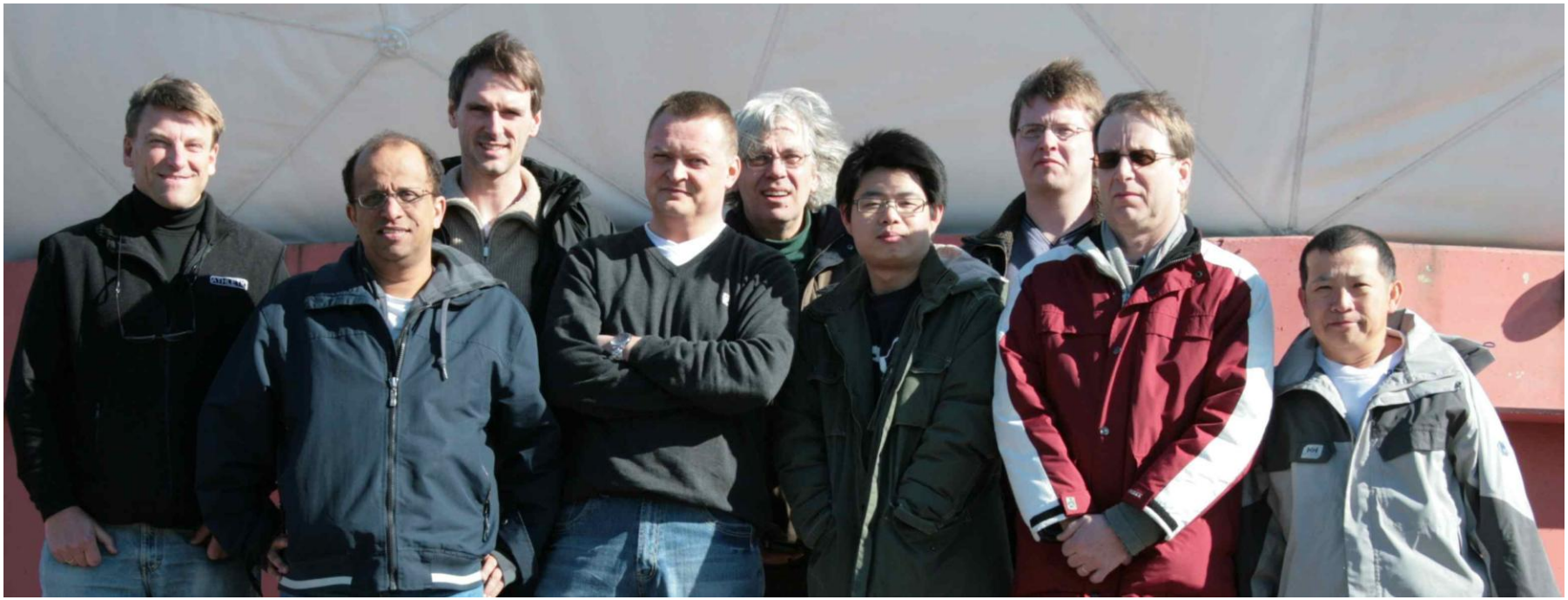
Staff



Institute report 2009: Chalmers
Department of Space Geodesy and Geodynamics
Onsala Space Observatory

Ph.D. students

Johan Löfgren

Tong Ning

Jonas P. Sundström

Susana Garcia Espada (Yebes / Complutense)

Per-Anders Olsson (industrial student, Lantmäteriet Gävle)

Surat Pramualsakdikul (Chulalongkorn U. Bangkok)

Carsten Rieck (industrial student, SP Borås)

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Department of Space Geodesy and Geodynamics
Onsala Space Observatory

- GNSS
- VLBI
- InSAR
- Gravimetry

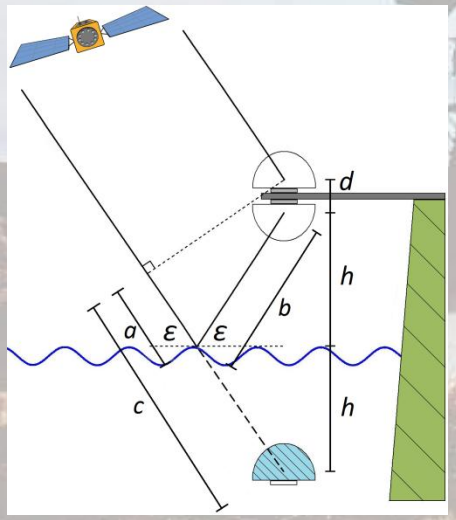
GNSS Tide Gauge

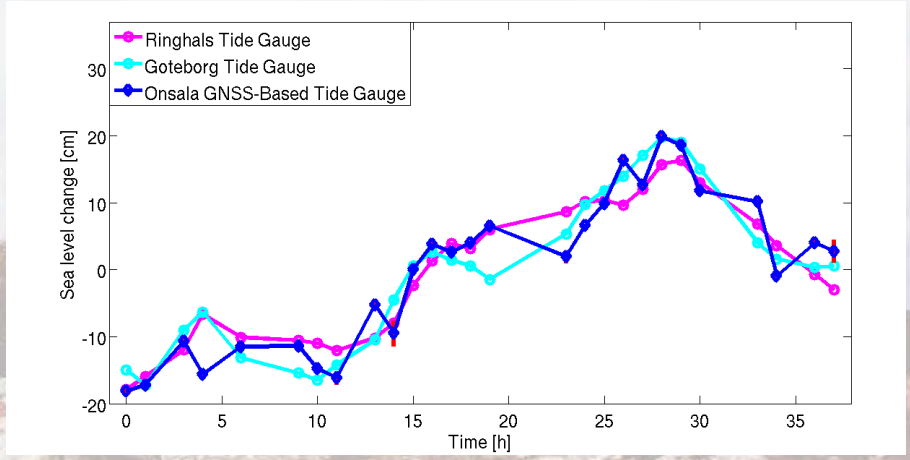
Measuring sea surface height using GNSS-signals

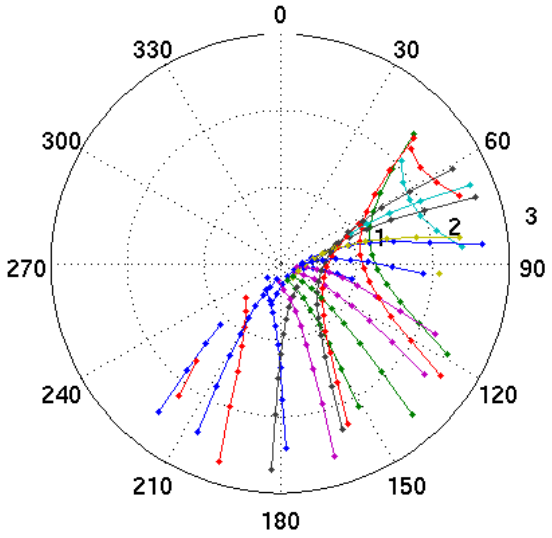
In 2008 we started a project to measure sea level and its variations using GNSS-signals. We installed two GNSS-antennas at the coast at the Onsala Space Observatory, one looking upward and another one looking downward towards the sea surface. The upward looking antenna receives the directly incoming GNSS-signals while the downwards looking antenna receives the signals that are reflected on the sea surface. The analysis of phase measurements performed with the corresponding GNSS-receivers gives results for the sea surface height and its variation.

Sea Level Monitoring
Using a GNSS-Based Tide Gauge

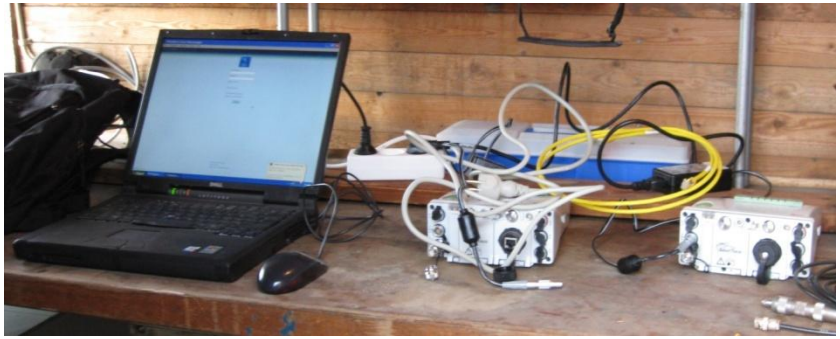
Johan Löfgren, Rüdiger Haas, Jan Johansson
Department of Radio and Space Science,
Chalmers University of Technology, Göteborg, Sweden







The surrounding to the north and west of the GNSS-based tide gauge consisted of coastline and a boathouse, while all other directions were open sea.



GNSS seismometry

- **GNSS-measurements of simulated seismic events**

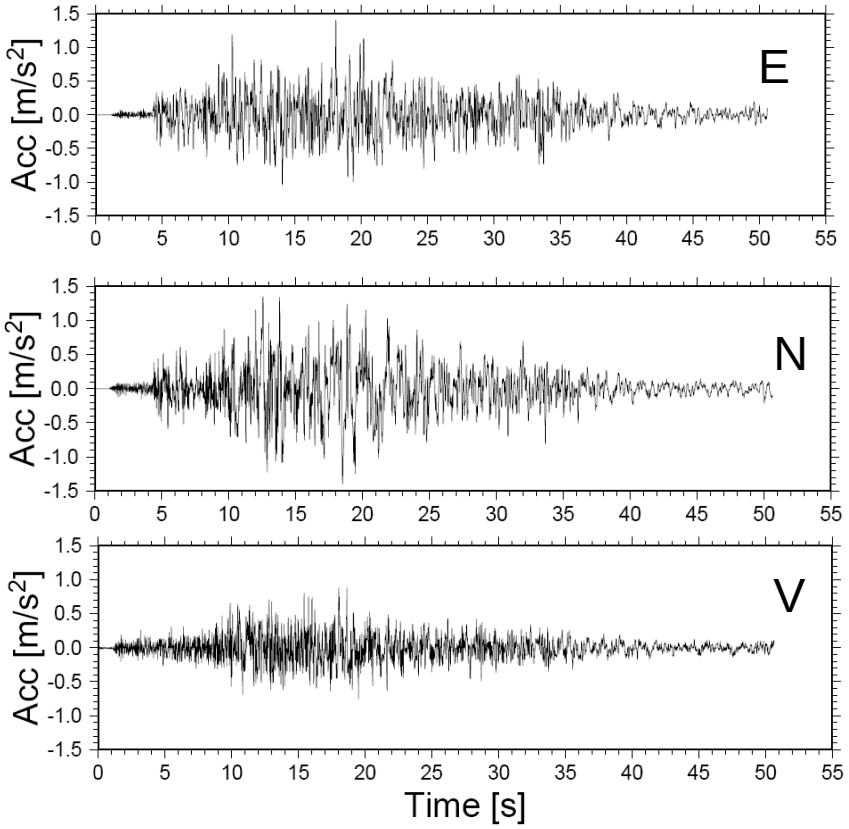
  Starting in 2008 we performed several hundred simulations of seismic events with an industrial robot. A GNSS antenna was mounted on top of the robot, and its movements were measured with a high-rate GNSS receiver.

High-Rate GNSS Techniques for the Detection of Large Seismic Displacements

T. Ning, J.M. Johansson, H.-G. Scherneck, P.O.J. Jarlemark, and R. Emardson

Proceedings of the *IEEE International Geoscience and Remote Sensing Symposium (IGRASS)*, pp. 359–362, 13–17 July, Cape Town, South Africa, 2009

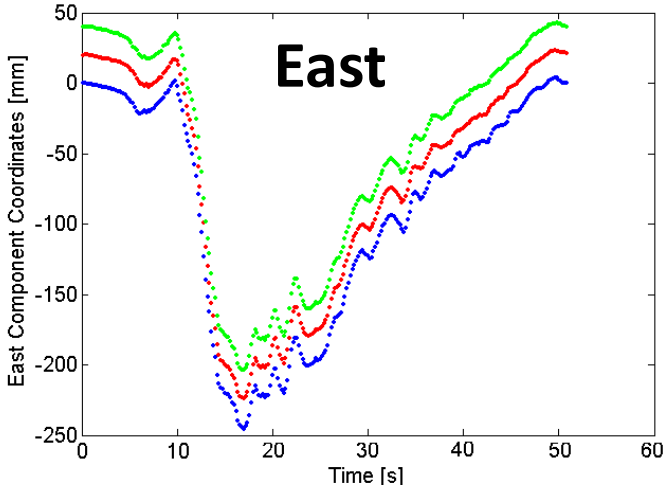
Acceleration (seism. observations)

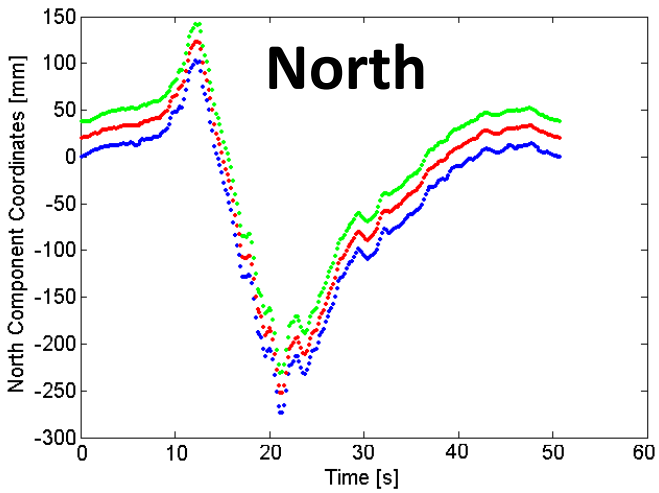


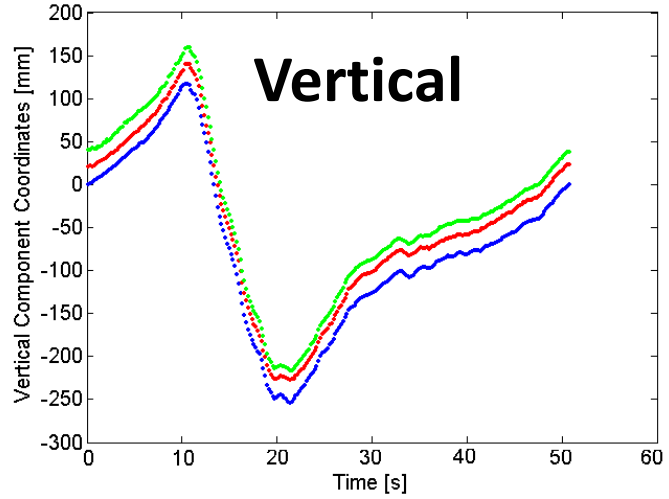
Simulate Michoacán (Mexico) earthquake Sep 19, 1985, M_w=8.0

Parameter	Michoacán	empirical
Subsurface rupture length	180 km	200 km
Rupture area	9000 km^2	10 000 km^2
Displacement	~6.5 m	0.8 … 3 m

Comparsions between the commanded robot coordinates (blue data) and the estimated coordinates obtained from the GPS data







The plotted GPS curves are offset +20 and +40 mm for the Short and long baseline processing to increase visibility.

GNSS Data Processing

Use GPS L1 carrier phase observations as fundamental measurements

Short baseline processing (400 m)

- **Identical Atmospheric delays (ionospheric, netural) are cancelled out by single differences of the carrier phase measurements from two receivers observing the same satellite.**
- **Fixed ambiguity.**
- **Unkown parameters estimated by the Kalman filter:**

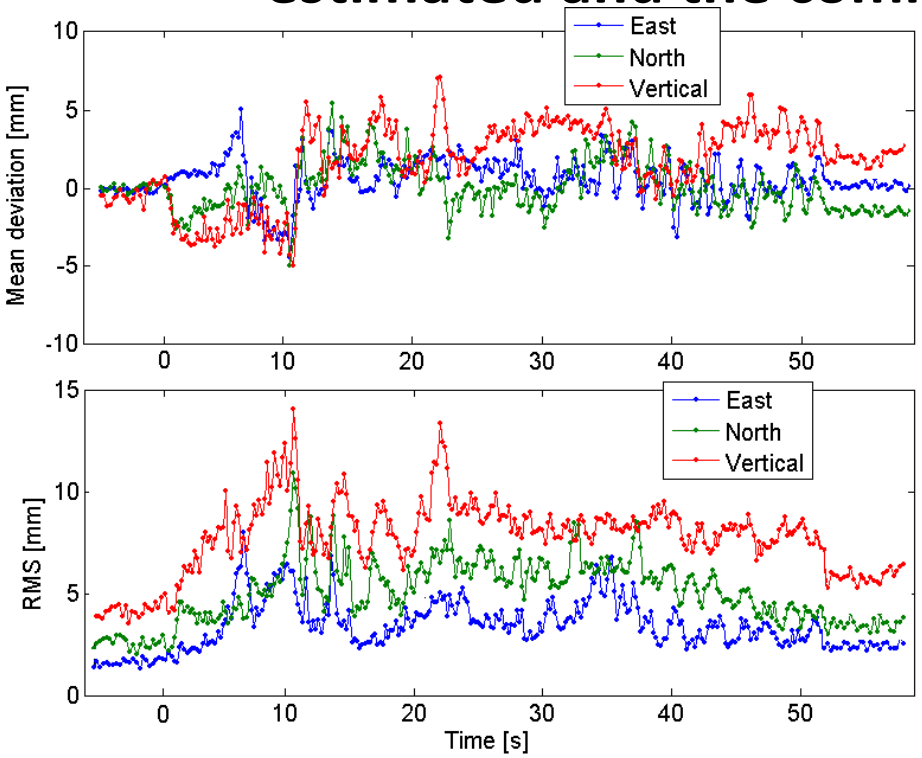
[E(t); N(t); V(t); Tr(t)]

Long baseline processing (60 km)

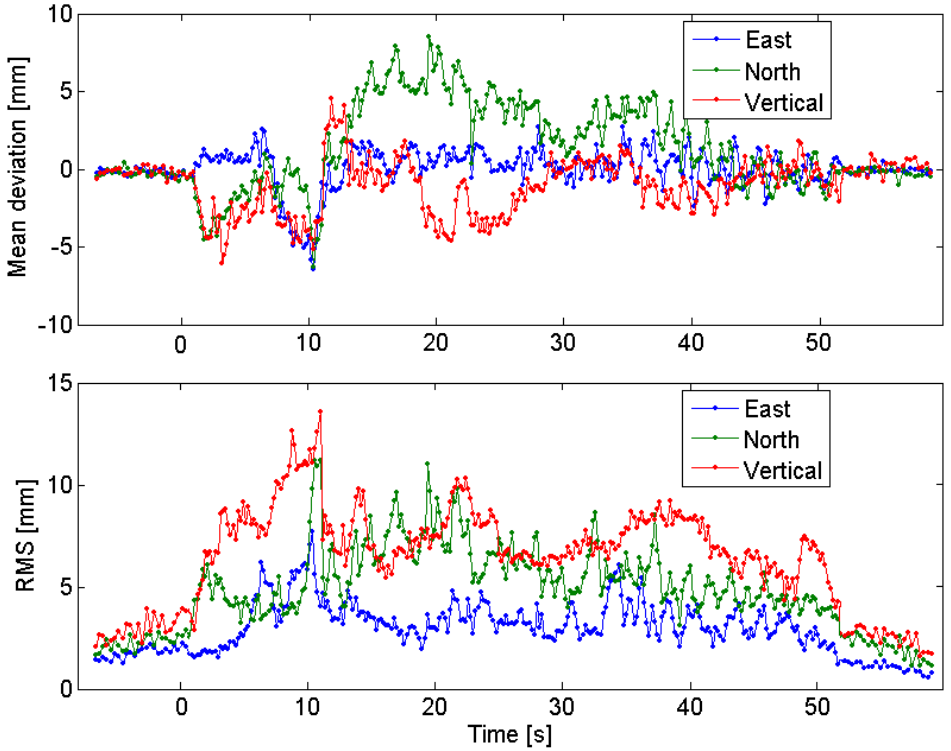
- **Estimate a linear trend (k) and offset (m) in each cycle (51 s) of the combination of all variations for each satellite.**
- **Unkown parameters estimated by the Kalman filter:**

[E(t); N(t); V(t); Tr(t); k1;k2;...k_n; m1;m2;...;m_n]

The mean deviations and the RMS differences between the estimated and the commanded robot coordinates



Short baseline processing



Long baseline processing

Mean RMS differences 3.5 mm (east), 5.6 mm (north), and 8.1 mm (vertical). Both methods give similar (within 0.5 mm) results.

VLBI

- **Simulations of atmospheric propagation delays using turbulence models**

  We contribute to the development of VLBI2010, the next generation geodetic Very Long Baseline Interferometry (VLBI) system, with simulations of atmospheric propagation delays. These simulations are based on turbulence models and aim at producing realistic delays that can be used to systematically study different VLBI2010 designs. The parameters C_n that describe atmospheric turbulence are derived from high-resolution radiosonde profiles.

Turbulence simulations

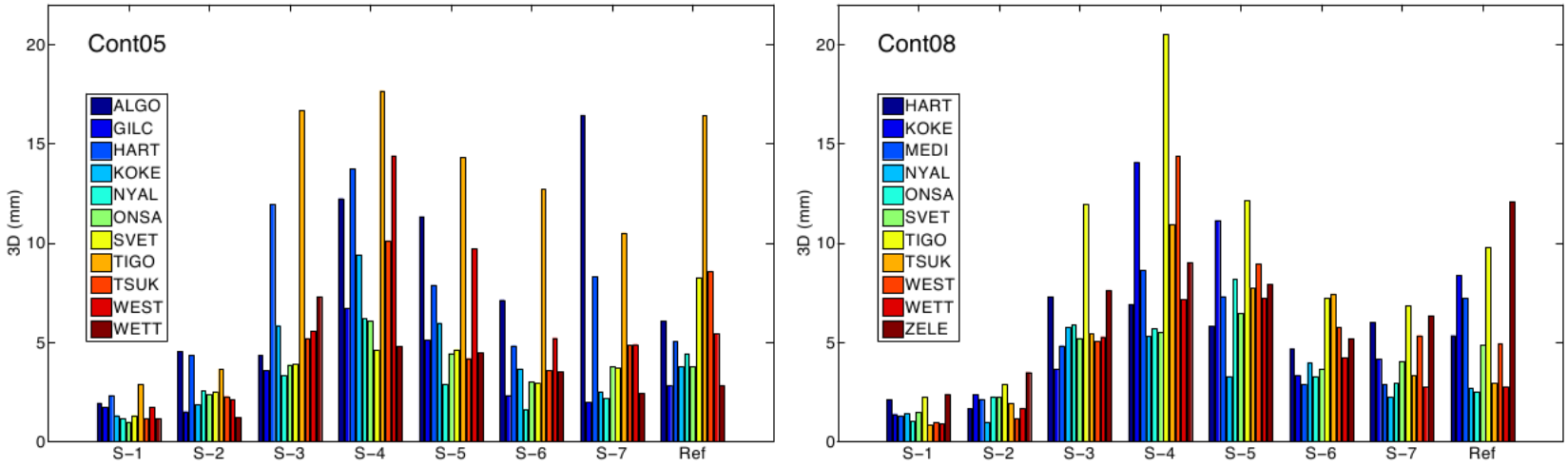


Figure 1. Repeatabilities of the three dimensional station positions grouped according to analysis (simulations S-1 to S-7 and reference solution Ref) for CONT05 (left) and CONT08 (right). The participating stations are shown with colored bars. Be aware that the color codes are different for CONT05 and CONT08.

Climate trends of H_2Ov

Table 2. RMS differences in the ZWD inferred from GPS, VLBI and radiosonde data acquired during the time period Nov. 1996–Nov. 2006.

Compared synchronized data Method 1 – Method 2	Number of data points	Mean ZWD[1] (mm)	RMS (mm)	Bias[2] (mm)
VLBI (NMF) – GPS	2737	91.3	7.5	−1.1
VLBI (VMF1) – GPS	2737	91.3	7.5	−0.5
VLBI (NMF) – radiosonde	511	86.2	11.4	−0.1
VLBI (VMF1) – radiosonde	511	86.2	11.3	+0.5
GPS – radiosonde	7914	84.6	10.2	+1.7
GPS – radiosonde (VLBI periods only)	479	85.6	10.7	+2.8

[1] The mean value is that of Method 2
[2] Method 1 – Method 2

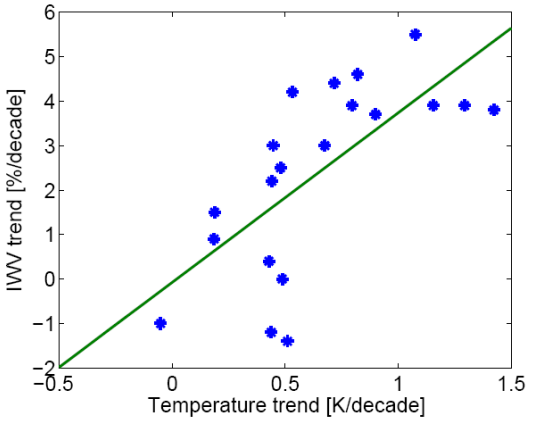


Figure 3. The relation of estimated IWV trends from GPS sites in the Swedish GPS network vs. the corresponding trends in the ground temperature at nearby sites.

While still having insufficient temporal resolution,
VLBI demonstrates its potential to verify long-term atmospheric H_2Ov trends

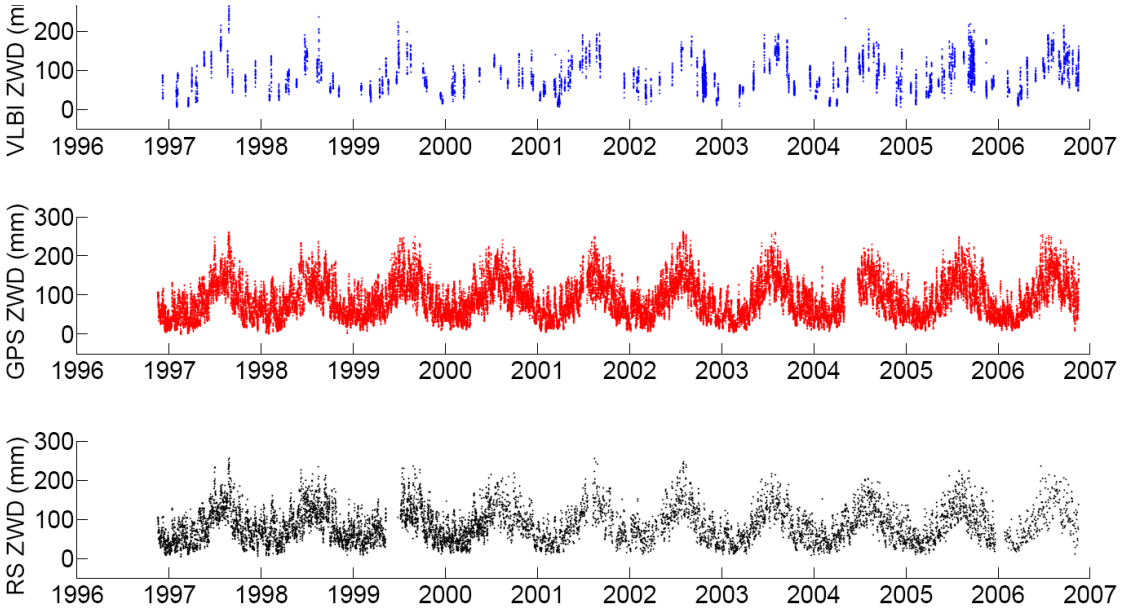
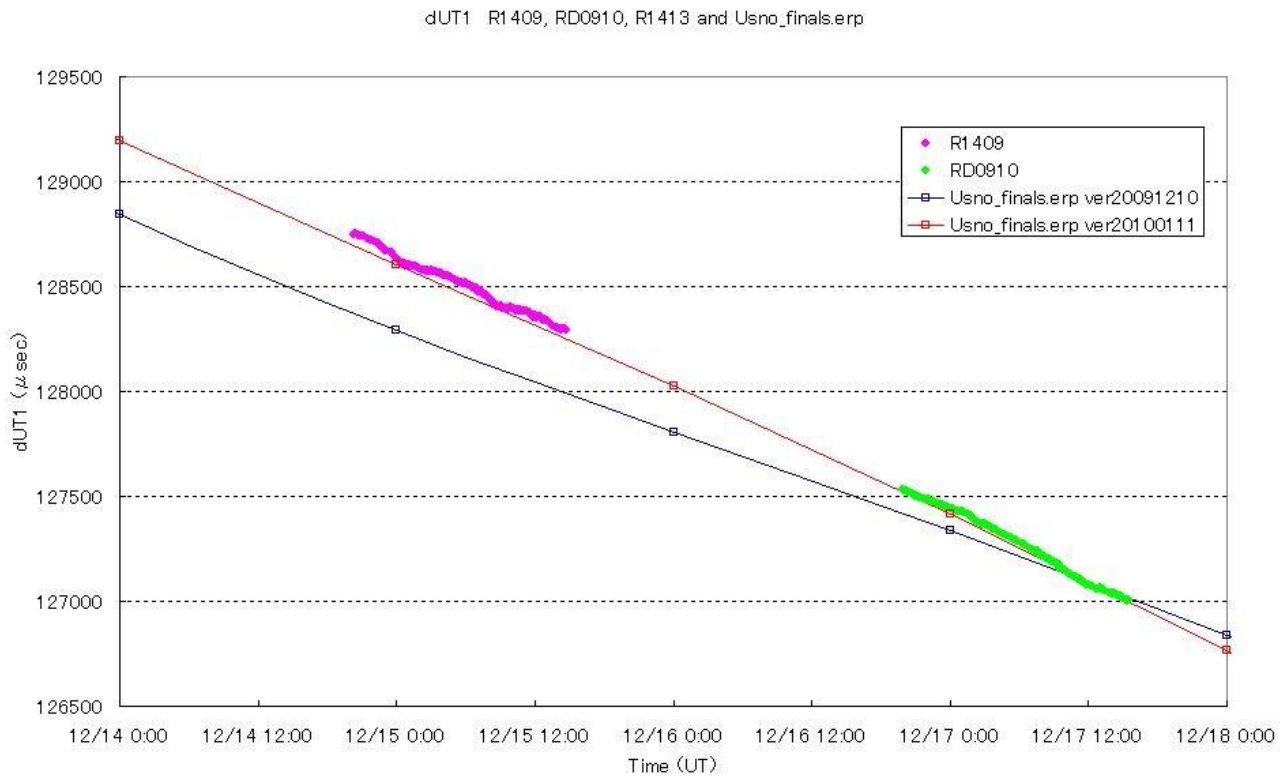


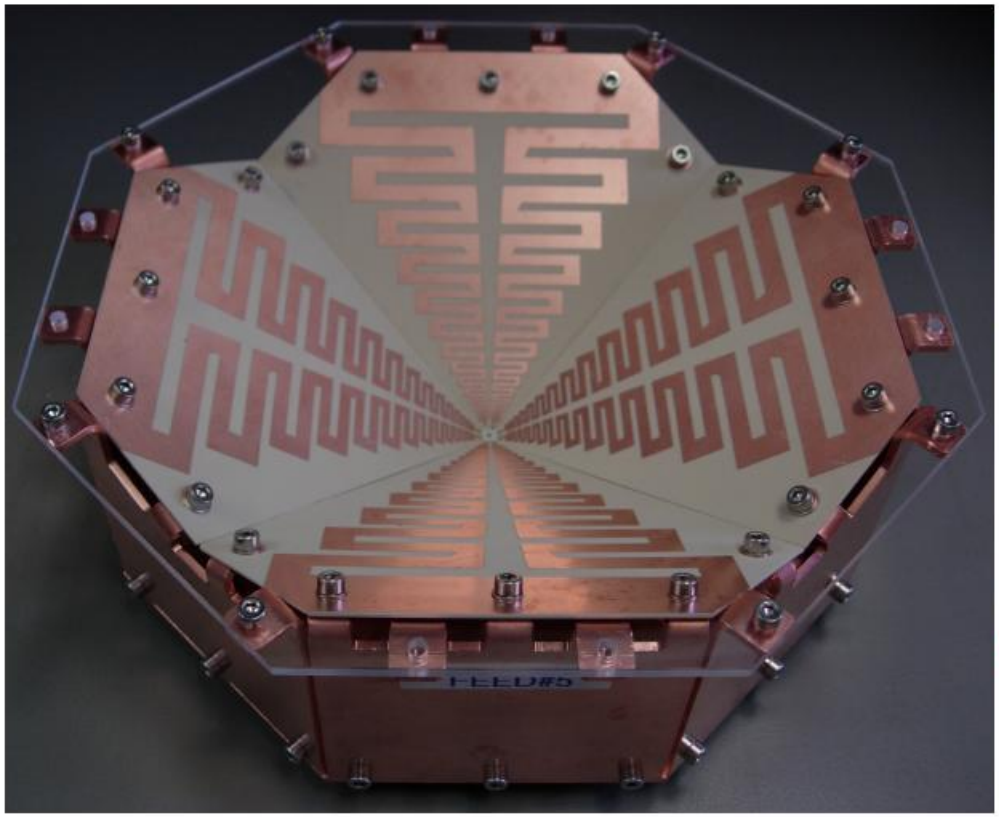
Figure 4. Time series of the equivalent zenith wet delay (ZWD) estimated from VLBI data (top), GPS data (middle), and radiosonde data (bottom).

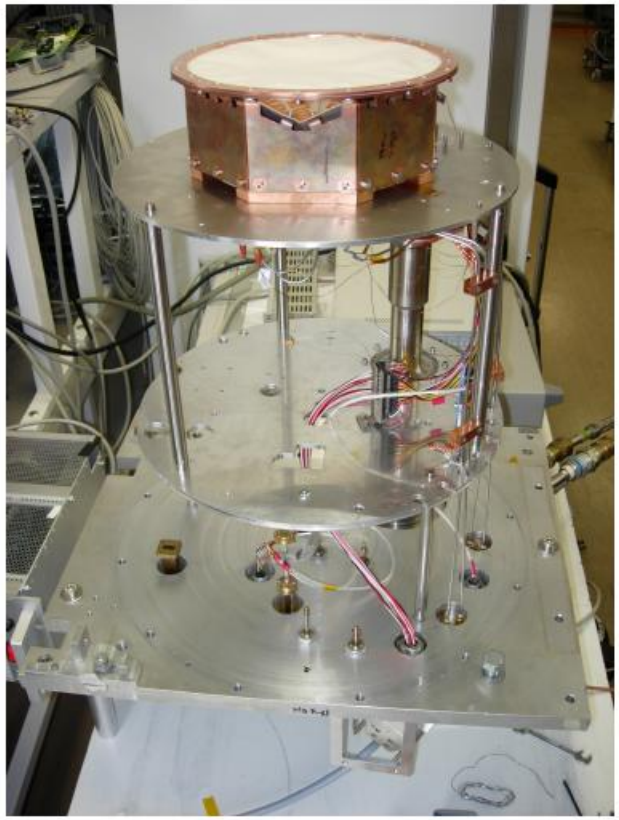
VLBI technical development

- Ultra-rapid earth orientation
  - Real-time VLBI correlation (Tsukuba)



Prototype Eleven-Feed for VLBI 2010



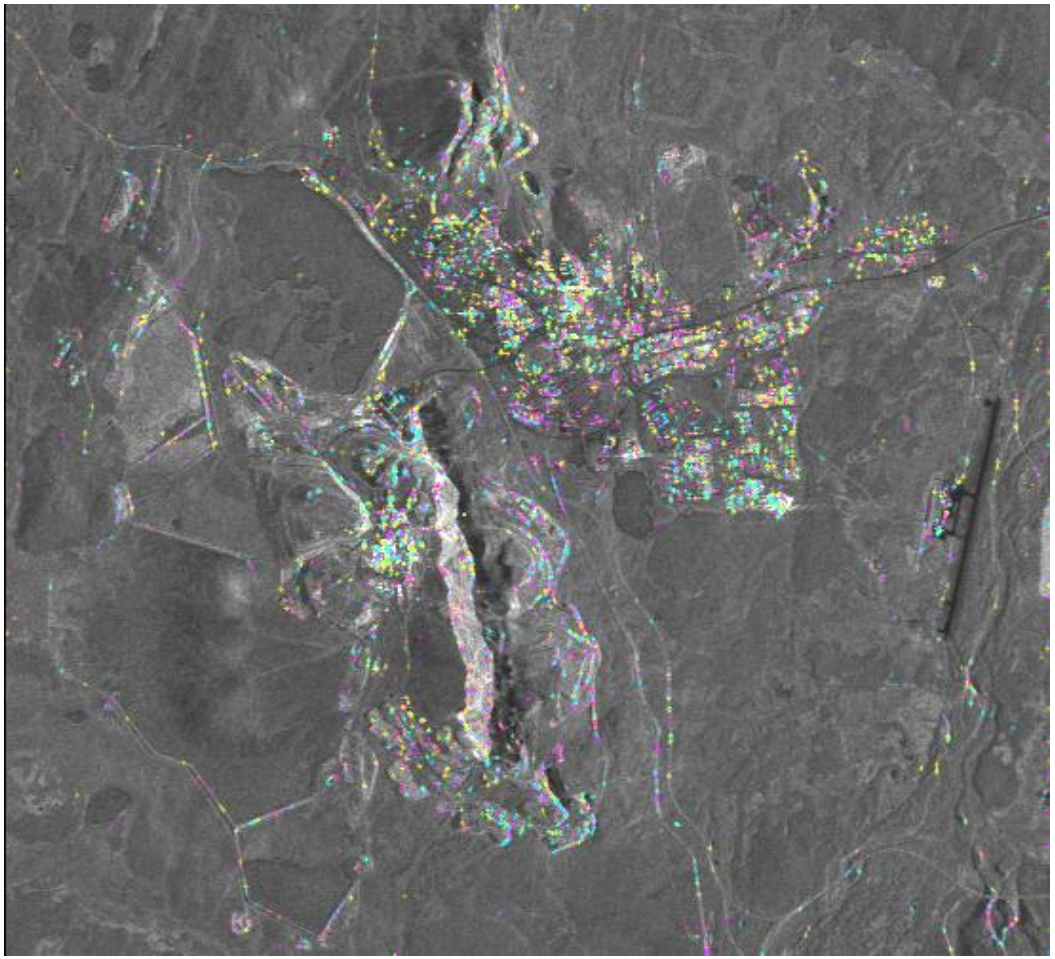


OSO colaboration with Chalmers Dept. Micro-electronics and Nanoscience, Chalmers Antenna Group, and Hartebeesthook R.O.; additional partners MIT and Haystack.
20 K operating temperature, 29 K noise temperature, 2-13 GHz band.

Time and Frequency lab

- 2 H2 Masers
- Several GPS timing receivers
- Acquired a Cs Clock in 2009

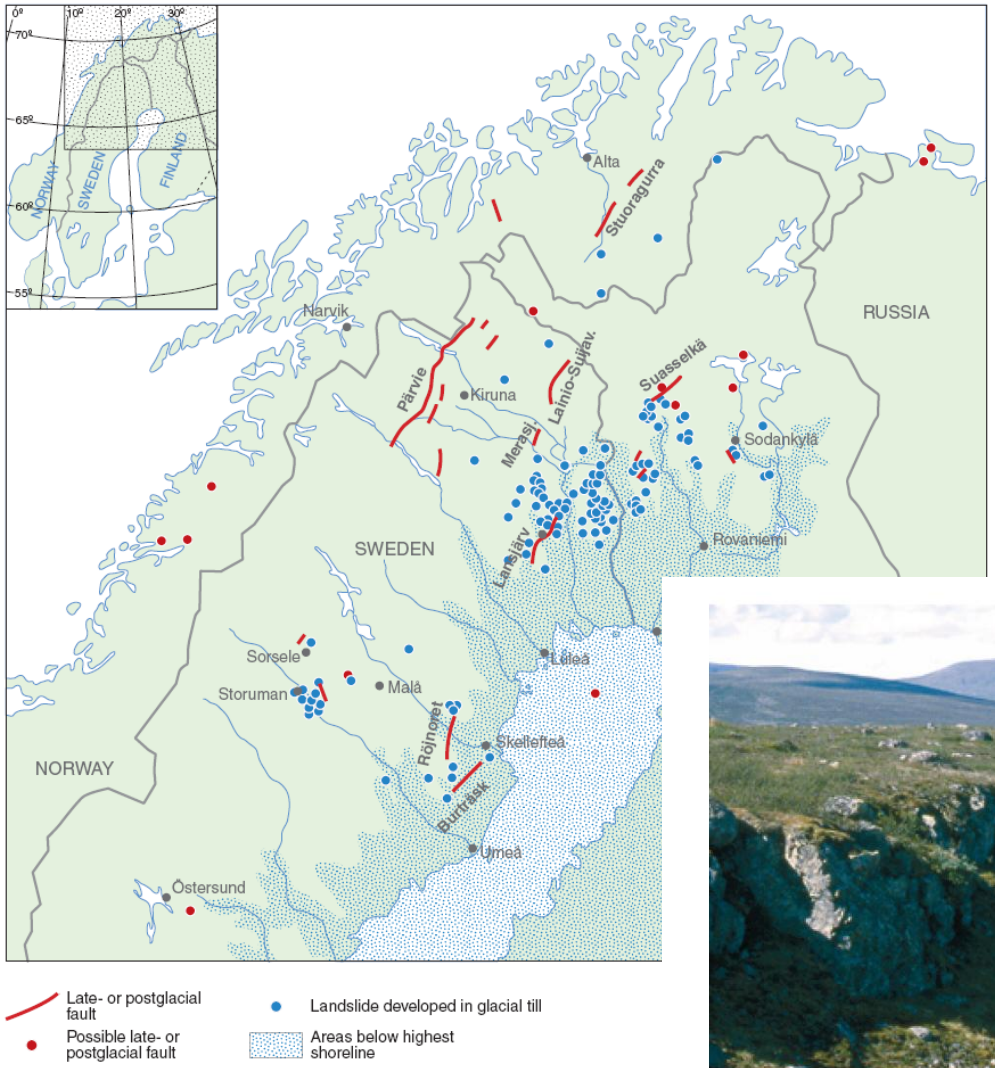
Interferometric SAR Permanent Point-Targets



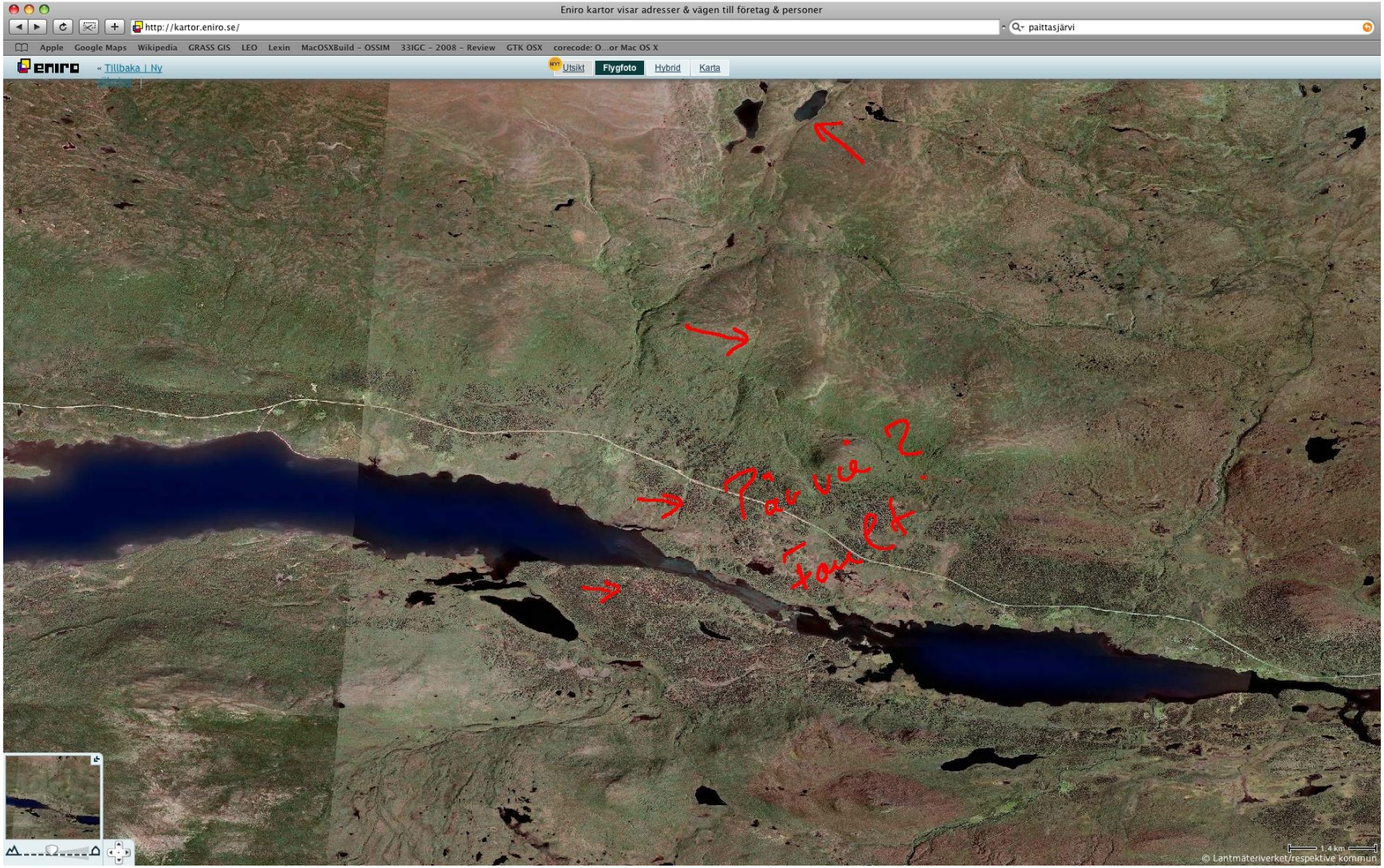
Kiruna

Kiruna and Pärvie Postglacial Fault

- ERS1-ERS2 Single-Look Complex
  - 25 pairs to one master image, 1994-2005
- LMV's DEM model



Lagerbäck & Sundh, 2008.
SGU Res. Pap. C836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GRASS GIS
LEO
Lexin
MacOSXBuild – OSSIM
33IGC – 2008 – Review
GTK OSX
corecode: O...or Mac OS X
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« Tillbaka | Ny
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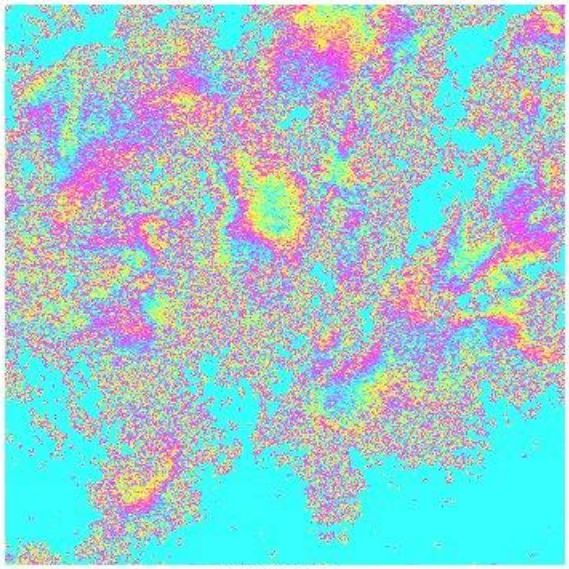
Karta
Parvie 2
Tjoulek
1.4 km
© Lantmäteriverket/respektive kommun

Displacement



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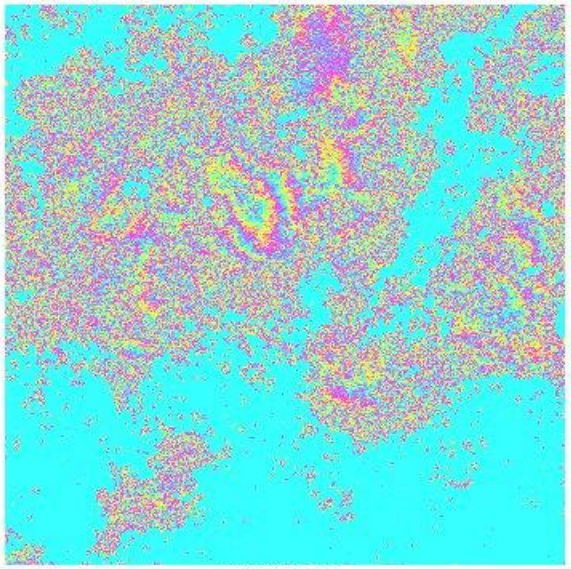

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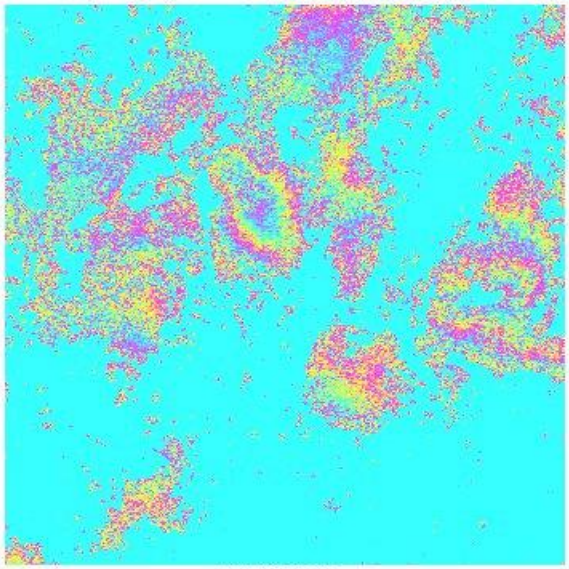

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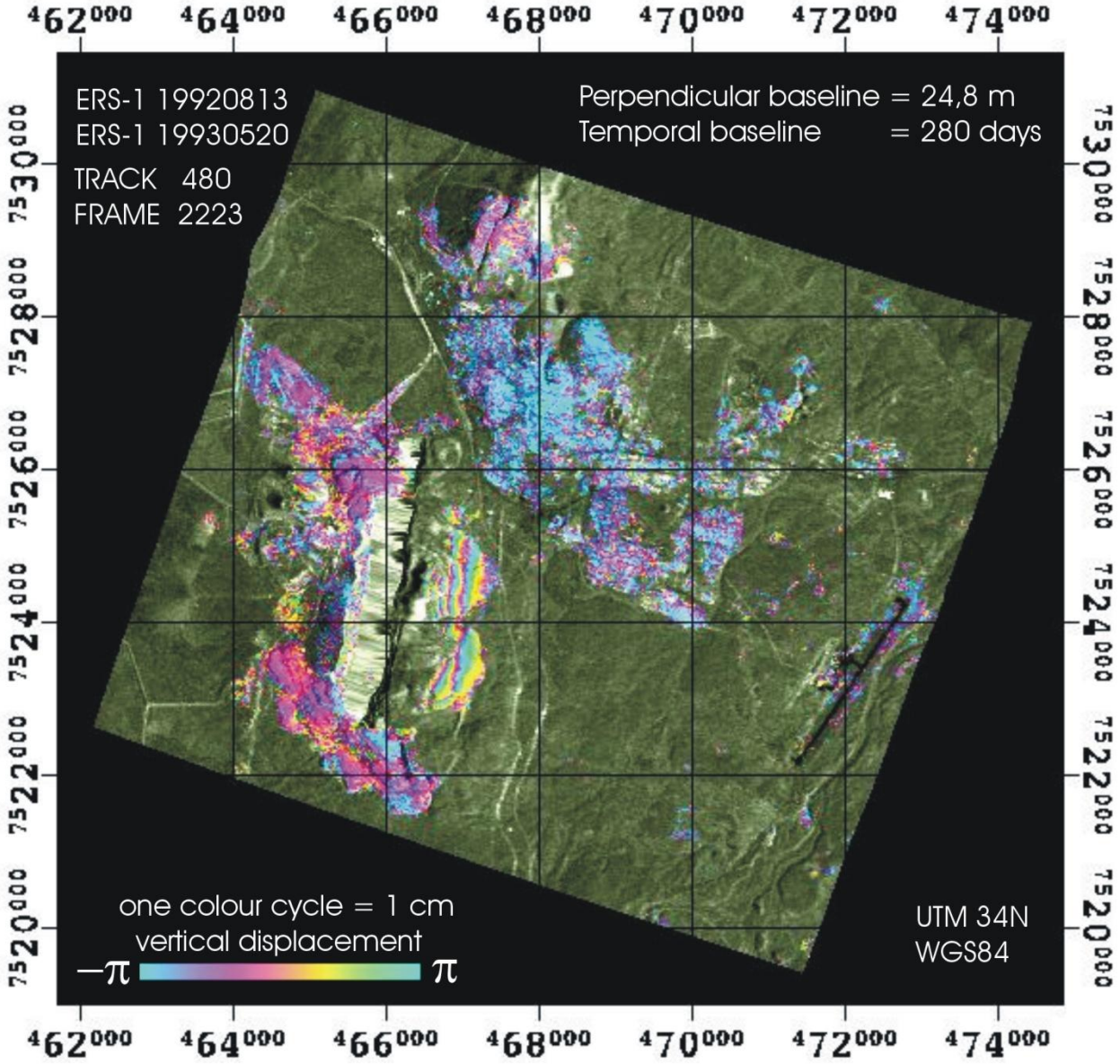
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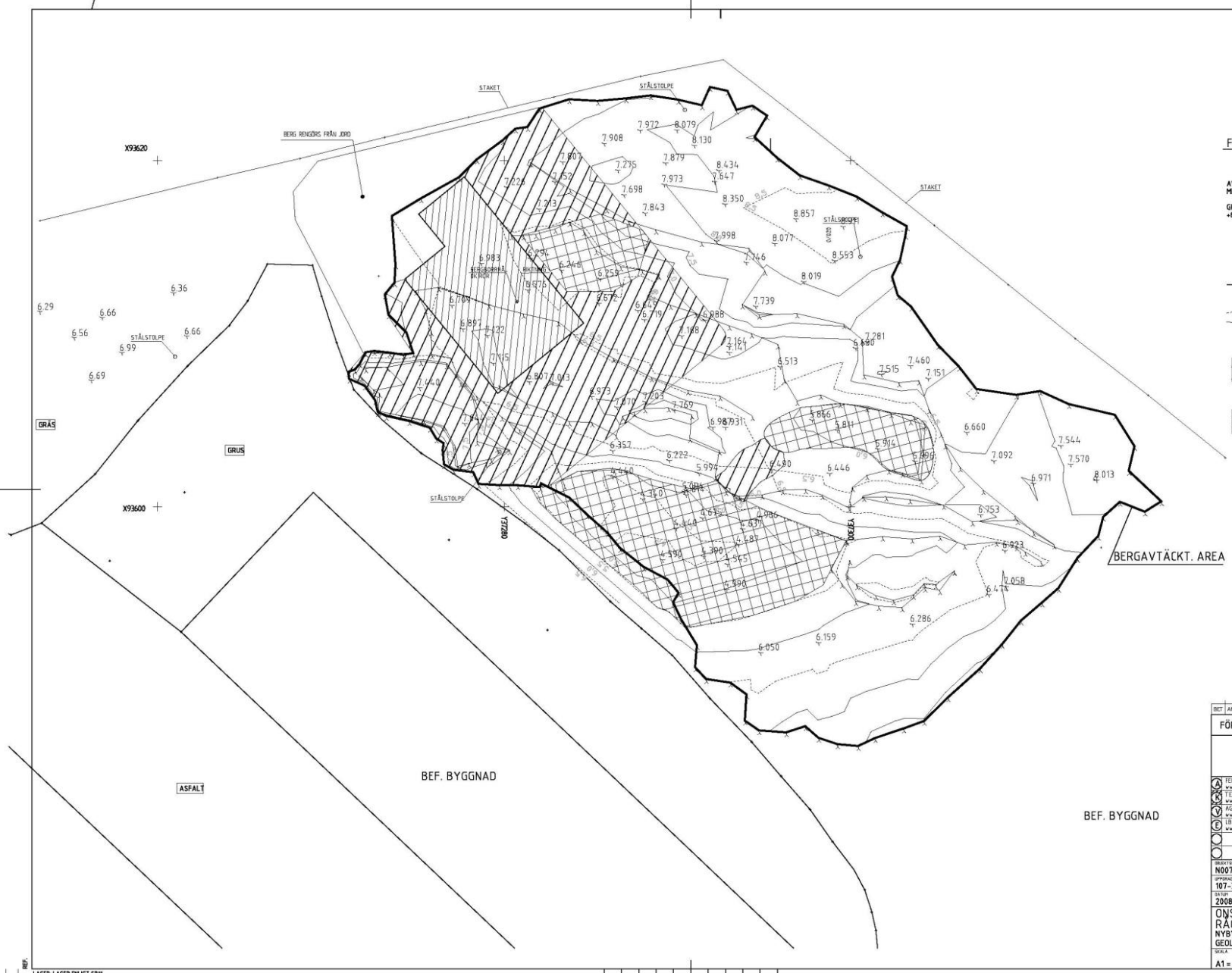
7520000
ERS-1 19920813
ERS-1 19930520
TRACK 480
FRAME 2223
Perpendicular baseline = 24,8 m
Temporal baseline = 280 days
one colour cycle = 1 cm
vertical displacement
−π
π
UTM 34N
WGS84

Gravimeter station

- SCG monument in passive-climate inner cabin
- 2 AG monuments: 2100 x 1200 + 1000 x 1200 mm
  - mechanically decoupled
  - Air draft protected
  - 1.5 m high, concrete blocks
  - No steel inforcements used
  - On bedrock
  - Rock surface honed to ascertain drainage of surface water into a controlled well
- Climatised (0.5 C), no windows
  - Heat insulating apron 3 m wide
  - Heat produced in the cabin will warm the rock surface by means of air circulation



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		FÖRFRÅGNINGSUNDERLAG 2008-06-18		

STATENS FASTIGHETSVERK

A	FERRUM ARKITEKTER AB www.ferrumarkitekter.se	Tel 031-7014850 Fax 031-7014850
B	TELLSTEDT I GÖTEBORG AB www.tellstedt.se	Tel 031-7297300 Fax 031-3358109
C	AGERA VVS-DESIGN AB www.agera-vvs.se	Tel 031-7754300 Fax 031-7754329
D	LB ELKONSULT AB www.lb-elkonsult.se	Tel 031-275980 Fax 031-874084

PROJEKTNUMMER N907029	PROJEKTNAMN	
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DATUM 2008-05-	ANSVARIG B.TELLSTEDT	

ONSALA RYMDOBSERVATORIUM
RÅO 1:11, KUNGSBACKA
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GEOLOGISKPLAN,

SKALA	NUMMER	BET
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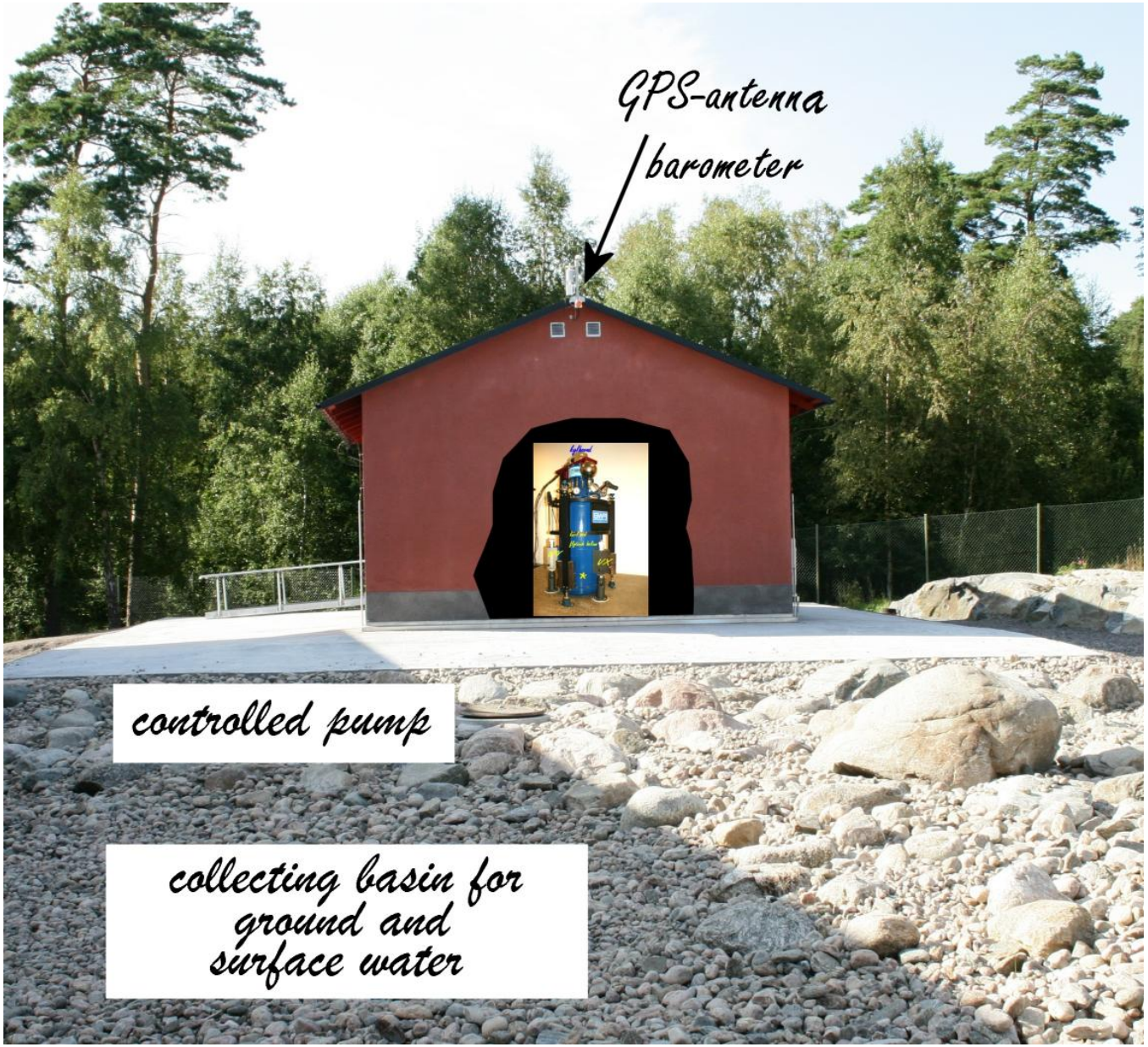
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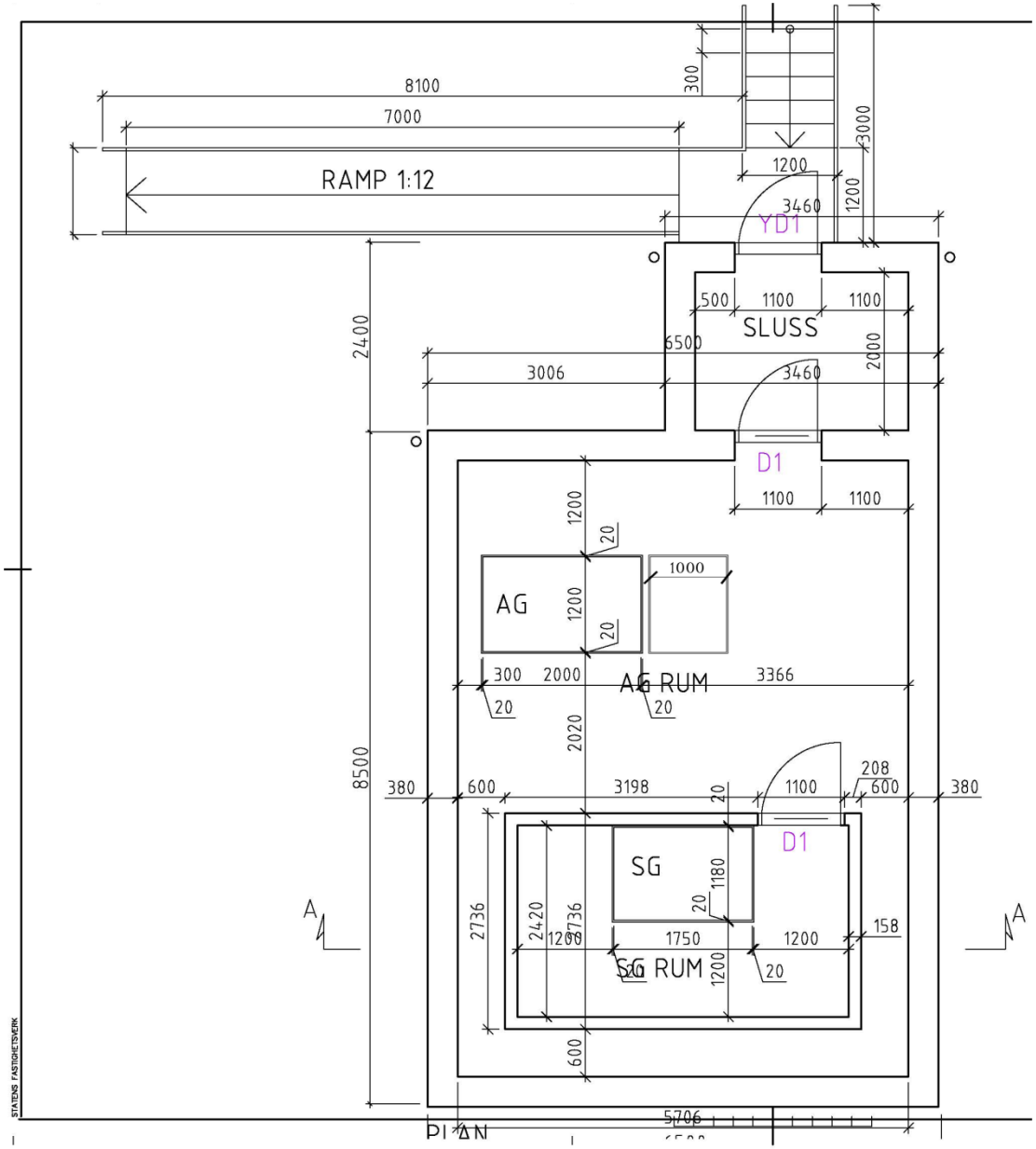
surface water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STATENS FASTIGHETSVERK


GWR


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INSTRUMENTS, INC

Publications 2009

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