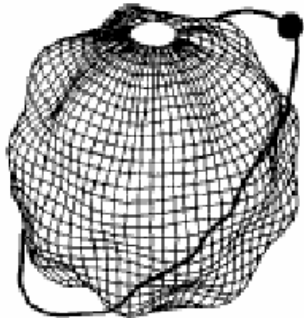


Plans for geo-VLBI in parallel to astro-VLBI observations at the VIRAC, Latvia

Ivars Shmeld, Normunds Jekabsons,
Valdis Avotins, Janis Kaminskis

Presented by Janis Kaminskis



Outline

- Introduction
- Geodetic part / Geo REF implementation
- Astro part / activities done
- Deflection of vertical or all work together
- Theory and practice cross-section
- Future developments

Location of VIRAC

VIRAC

Ventspils International
Radio Astronomy
Center



VIRAC →

*Ventspils
International
Radio
Astronomy
Centre*

More:

<http://virac.venta.lv/en/>

or <http://venta.lv/en/>

IRBENE

Typical view of
antenna,
Place in a quite
place without
radio noise

RT-32 max angular
speed around the
altitude and the
azimuth axis (2 direct-
current, 60kw
motors): **2°/sec**



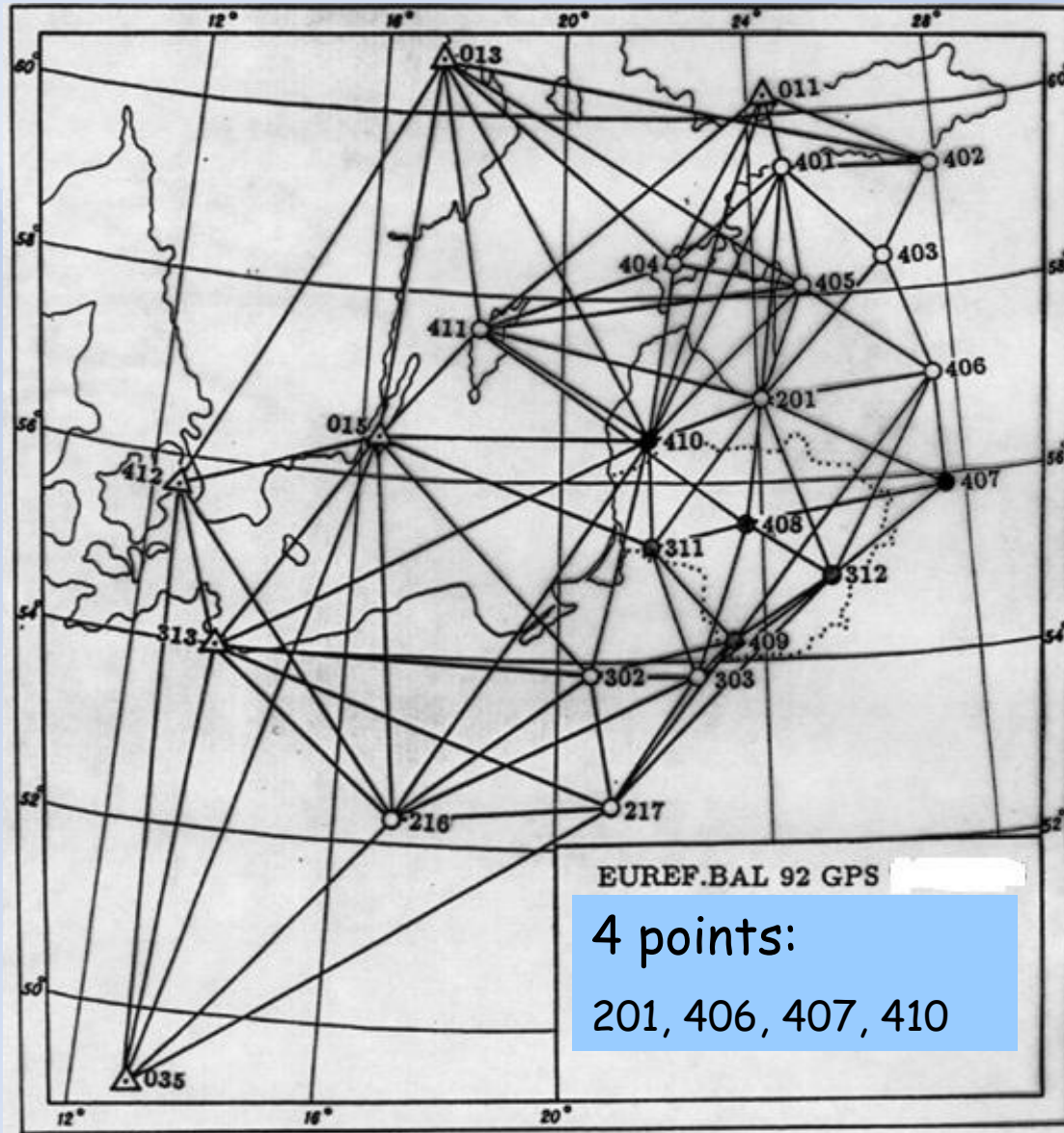
National geodetic coordinate system implementation

Latvian National Geodetic Coordinate System (LKS92)
based on common **European Terrestrial Reference System**
ETRS89

and, taking into account recommendations of International Association of Geodesy (**IAG**), was accepted by the **Resolution No. 213 of Government of Latvia in June 4, 1992.**

New resolution No. 879 of Government of Latvia in November 15, 2011 (more details on reference frames and according INSPIRE directive of EU).

Geo Ref implementation in 1992



EUREF BAL'92 GPS Network (Class "C")

Base for updates and implementation

NKG 2003 campaign (Class "B")

Resolutions

of the EUREF Symposium in Riga, 14 – 17 June 2006

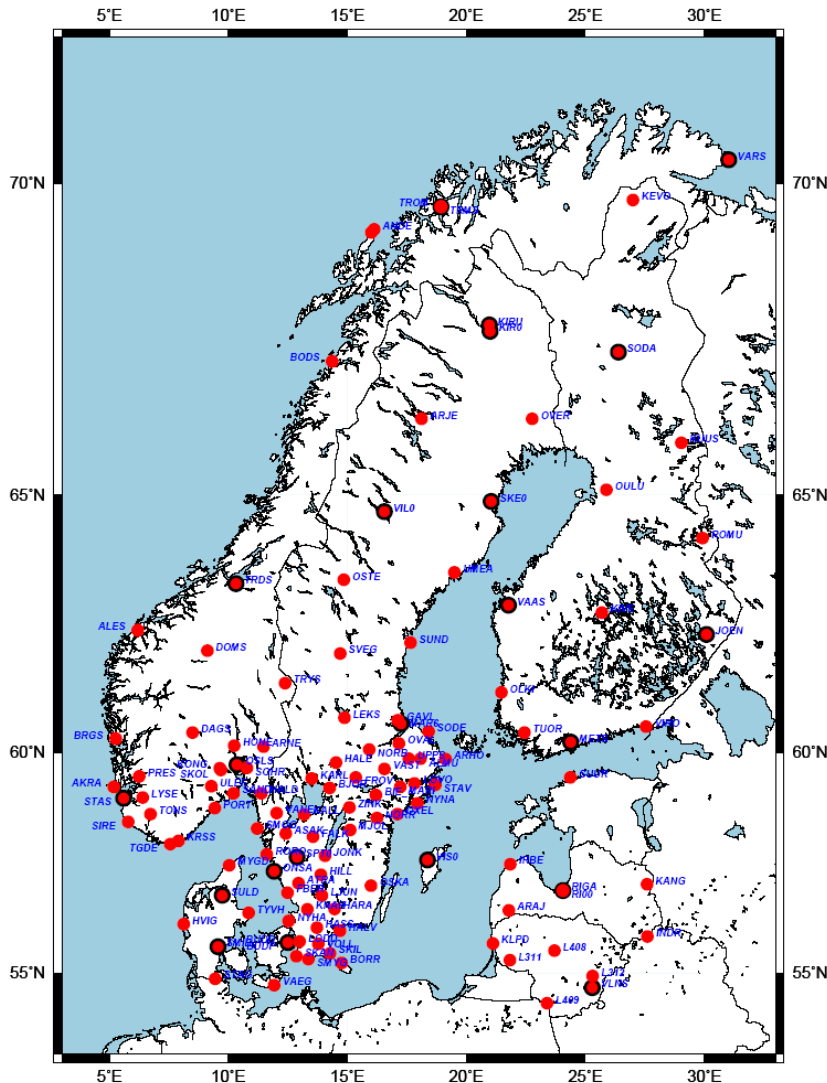
Resolution no. 1

The IAG Reference Frame Sub-commission for Europe (EUREF)

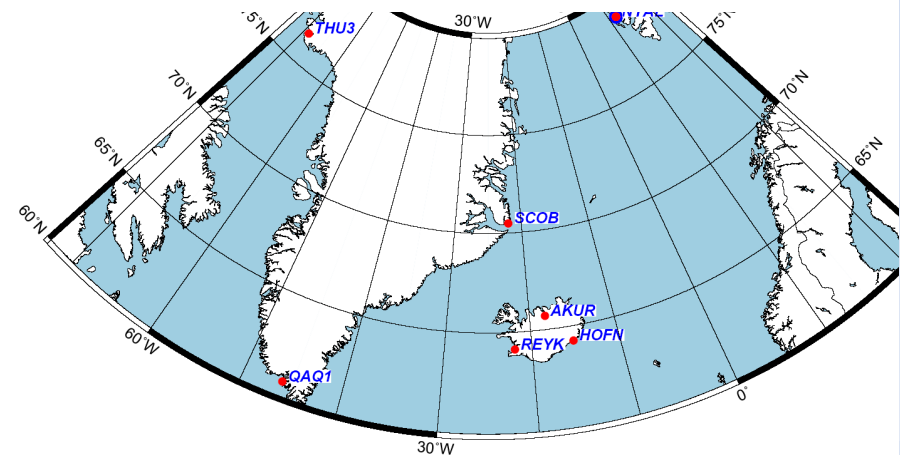
recognising that

- in October 1993 the EUREF-BG-93 campaign in Bulgaria was observed and was reprocessed in 2005,
 - in August-September-October 2004 the EUREF-BG-2004 campaign was observed,
 - in September-October 2003 the EUREF-NKG-2003 in Scandinavia and the Baltic countries was observed, including points in Latvia and Lithuania, and
- all the results were submitted to the EUREF technical working group, where they were accepted as Class B standard (about 1 cm at the epoch of observation)

endorses the subset of points submitted to the EUREF Technical Working Group as extensions to the current realisation of ETRS89



6 points in Latvia



Development and cooperation / for VLBI



RT – 32 → D=32m

At the beginning

VIRAC has been founded in **1994** on base of former military site, contained two **parabolic antennas** with diameter **32 and 16 meters**

Possible use in geo-VLBI

Activities carried out within LFDVN

International cooperation:

Low Frequency VLBI Network (LFDVN)

INTAS 960183; head of project: Igor Molotov, Russia

Start of the project: 1996

Main goal: to involve the radio telescopes of former Soviet Union in the international VLBI activity

VLBI experiments at LFDVN are carried out using various combinations of radio telescopes of **Russia, Ukraine, China, Italy, Latvia** on different scientific tasks.

In 1999, 2000, 2007, 2008 the **RT-32 of VIRAC** took part in VLBI-observations, carried out on LFDVN.

Example of common activities



VLBI Radar Cooperation of LFNV



Example of common activities

Interesting LFVN experiment was realized **on 30 of June of 2010** by **Institute of radioastronomy** of Italy.

The irradiation of space debris objects was implemented by power transmitter of **Evpatoria locator on RT-70** (Ukraine) (F=5 GHz);

Reception was performed by **RT-32 (Medicina, Italy)**, **RT-32 (Irbene, Latvia)** in bandwidth 500 kHz.

The data processing is carried out simultaneously in **Medicina and Nizhnij Novgorod**.

IRBENE involved in EVN activities



EVN radio telescope



NREN partner



Correlation facility



Storage facility*

*also at all telescopes



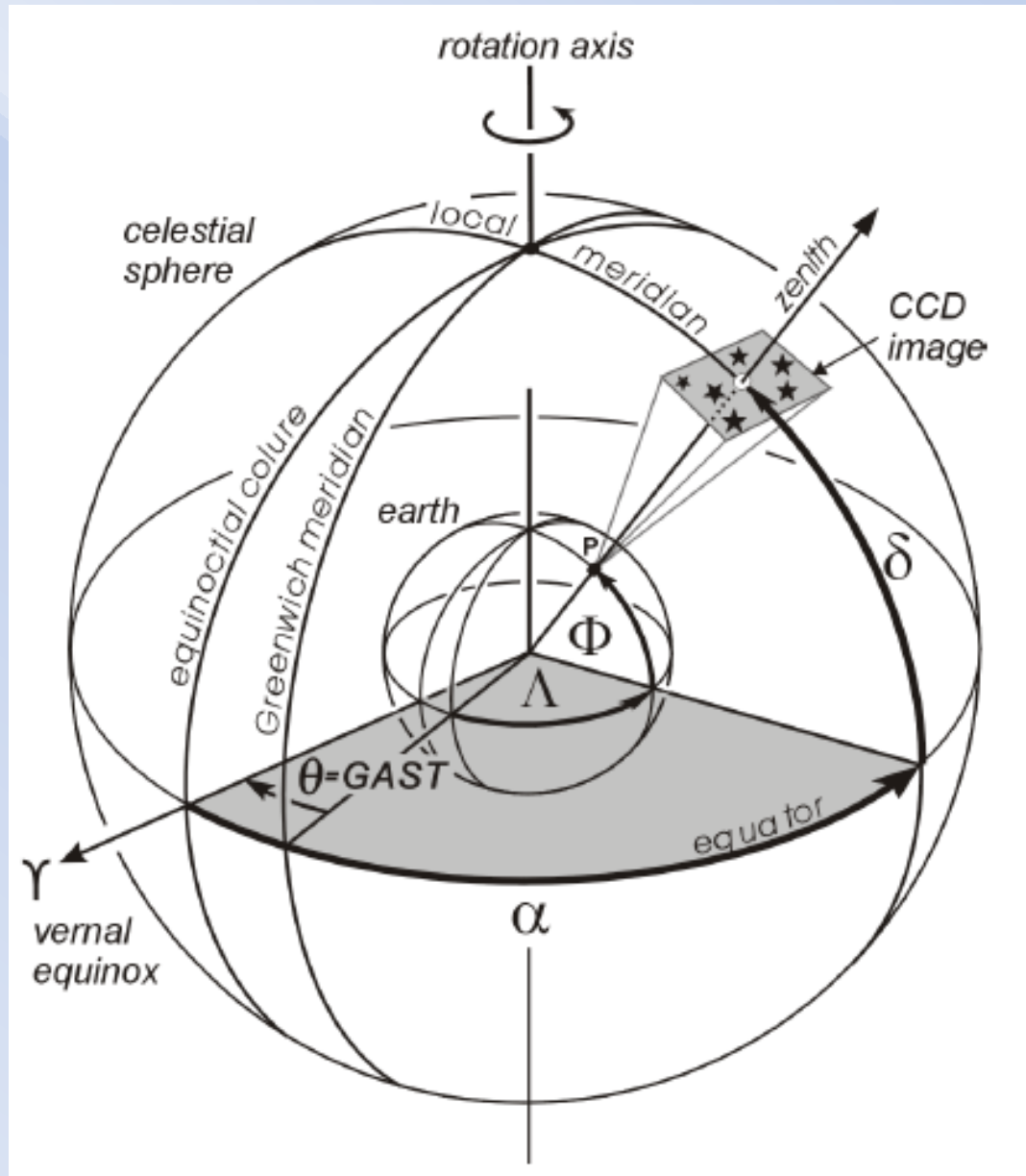
VIRAC participates in NEXPReS project

The screenshot displays the VLBI Workflow Manager interface. At the top, the title bar includes 'File', 'Edit', 'Scenario', 'View', and 'Help' menus. Below the title bar is a toolbar with icons for file operations and a play button. The main header area features the 'EXPReS' logo on the left and the text 'VLBI WORKFLOW MANAGER' in the center. To the right of the header are four small images of radio telescopes. Below the header is a 'Workflow Information' panel on the left and a main workspace on the right. The 'Workflow Information' panel shows the following details:

- Workflow Name:** F08L1
- Workflow Description:** Irbene, Torun, Medicina, Cambridge
- Created By:** (field is empty)
- Edit** button

The main workspace displays a workflow diagram for the 'Europe' region. The diagram shows four radio telescope icons at the top, labeled 'Irbene', 'Medicina', 'Torun', and 'Cambridge'. Arrows point from 'Irbene' and 'Medicina' to a server icon labeled '[Cn] VeA correlator'. Arrows point from 'Medicina', 'Torun', and 'Cambridge' to another server icon labeled '[Cn] JIVE correlator'. Finally, arrows from both correlator servers point to a server icon at the bottom labeled '[TN] JIVE File Server'.

Astronomical and geodetic coordinates

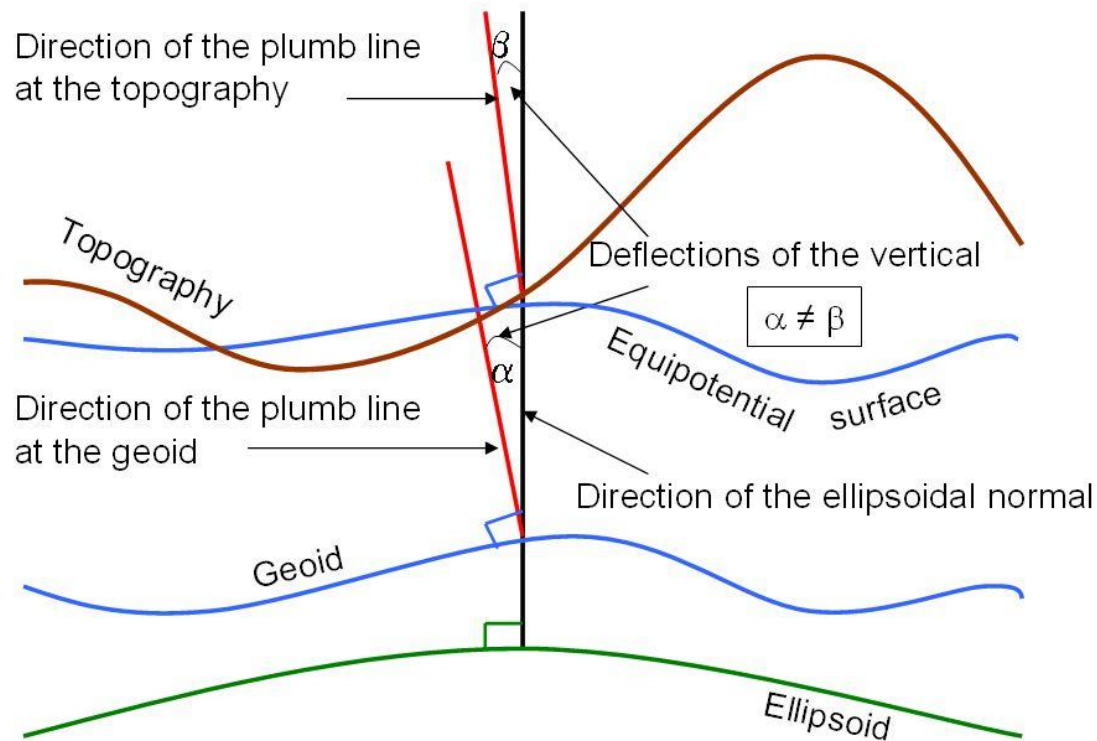


Or like deflection from computations

Deflection of the vertical

$$\text{North-South Component: } \xi = \Phi - \phi$$

$$\text{East-west Component: } \eta = (\Lambda - \lambda) \cos(\phi)$$



Computations with GRAVSOF

```
C:\Users\Janisk\Desktop\GEOID_~1\GEOID_O.EXE

*****
*
*   GEOID - GRAUSOFT geoid interpolation and transformation   *
*
*   vers. MAR95 (c) RF, Kort- og Matrikelstyrelsen, Denmark *
*****

Enter task: 1 = interpolate geoid heights
            2 = ellipsoidal to orthometric heights using geoid
            3 = orthometric heights to ellipsoidal - - -
            4 = geoid heights in different datum ...
            5 = deflections of the vertical ...

-> 5

--- deflections of the vertical wanted, unit: arcsec ---
Enter binary geoid file name: CR=\geoide\geoid94a.bin
-> geoid94a.BIN

Geoid grid limits and spacing in degrees:
    55.00000    59.00000    20.00000    30.00000    0.02500    0.05000
Do you wish to input data points from a file? (Y/N or CR=N)
-> N

Enter file name for output: (CR=geoid.out)
-> deflection_vertical.out

Type of input: 1 = lat, lon (degrees)
               2 = lat, lon (deg,min,sec)
               3 = X, Y, Z (meter)
               4 = N, E (UTM, meter)

-> 1

- output coordinates are geographic degrees -
Enter: rfi, rla (x=exit)
-> 57.553  21.855

      1  57.55300000  21.85500000    2.961    0.268
Enter: rfi, rla (x=exit)
-> _
```


Deflection of vertical to the gravity field

$$\xi = -\frac{dN}{ds_\varphi} = -\frac{1}{R} \frac{\partial N}{\partial \varphi'}$$

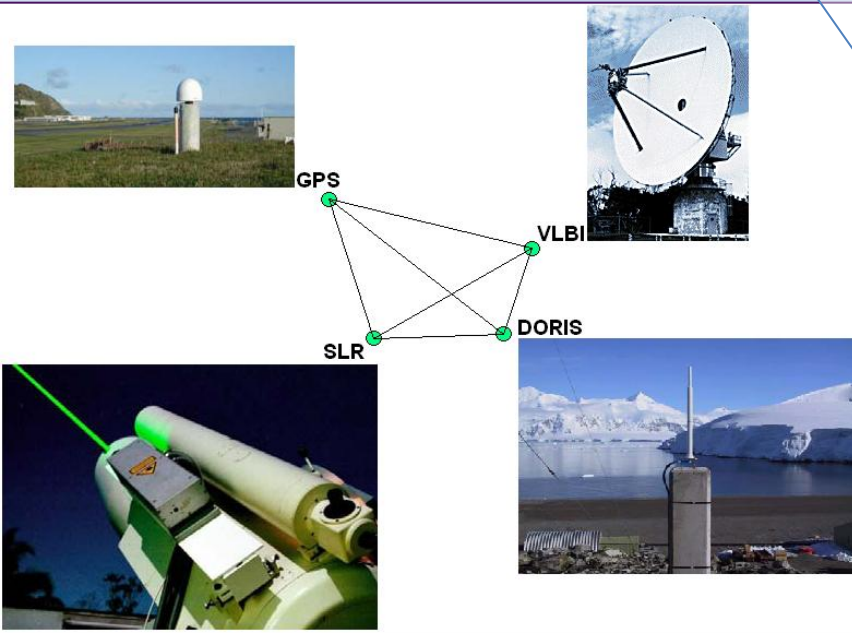
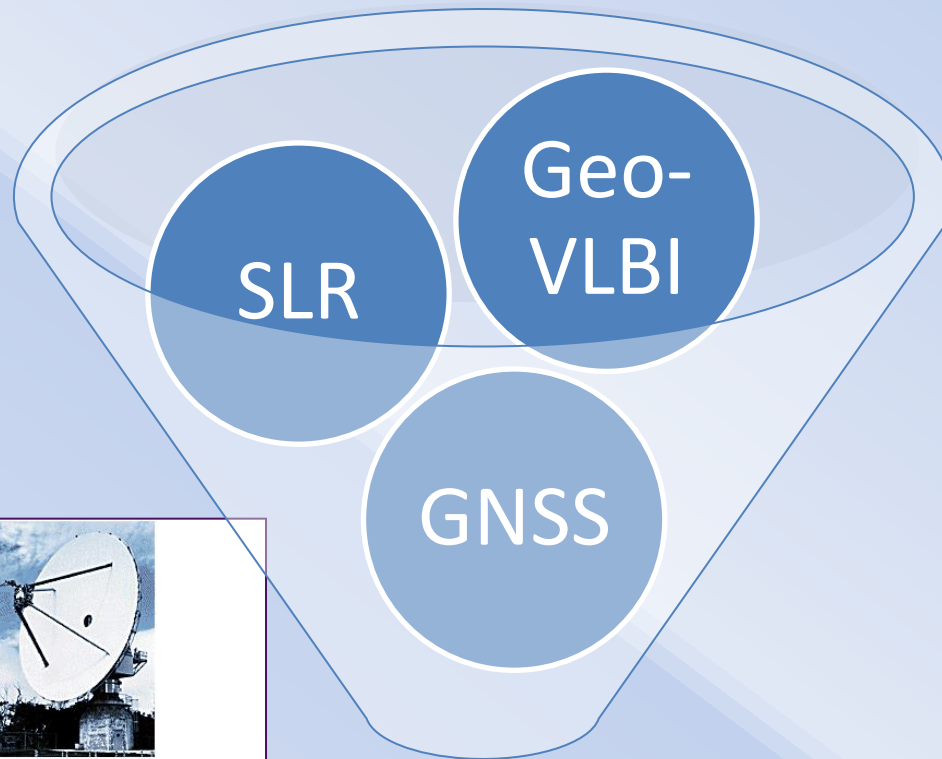
$$\eta = -\frac{dN}{ds_\lambda} = -\frac{1}{R \cos \varphi} \frac{\partial N}{\partial \lambda'}$$

Could be a way to connect 2 of fundamental pillars →
geometry and gravity

Results from GRAFSOFT at IRBENE and around

No	LATITUDE	LONGITUDE	DEFLECTIONS IN ARCSEC		
1	57.55300000	21.85500000	2.961	0.268	VLBI IRBENE
2	57.65300000	21.85500000	2.070	0.616	TO NORTH
3	57.45300000	21.85500000	3.131	-0.397	TO SOUTH
4	57.55300000	21.95500000	3.131	0.293	TO EAST
5	57.55300000	21.75500000	2.538	-0.053	TO WEST

Combinations for development or future / together different techniques

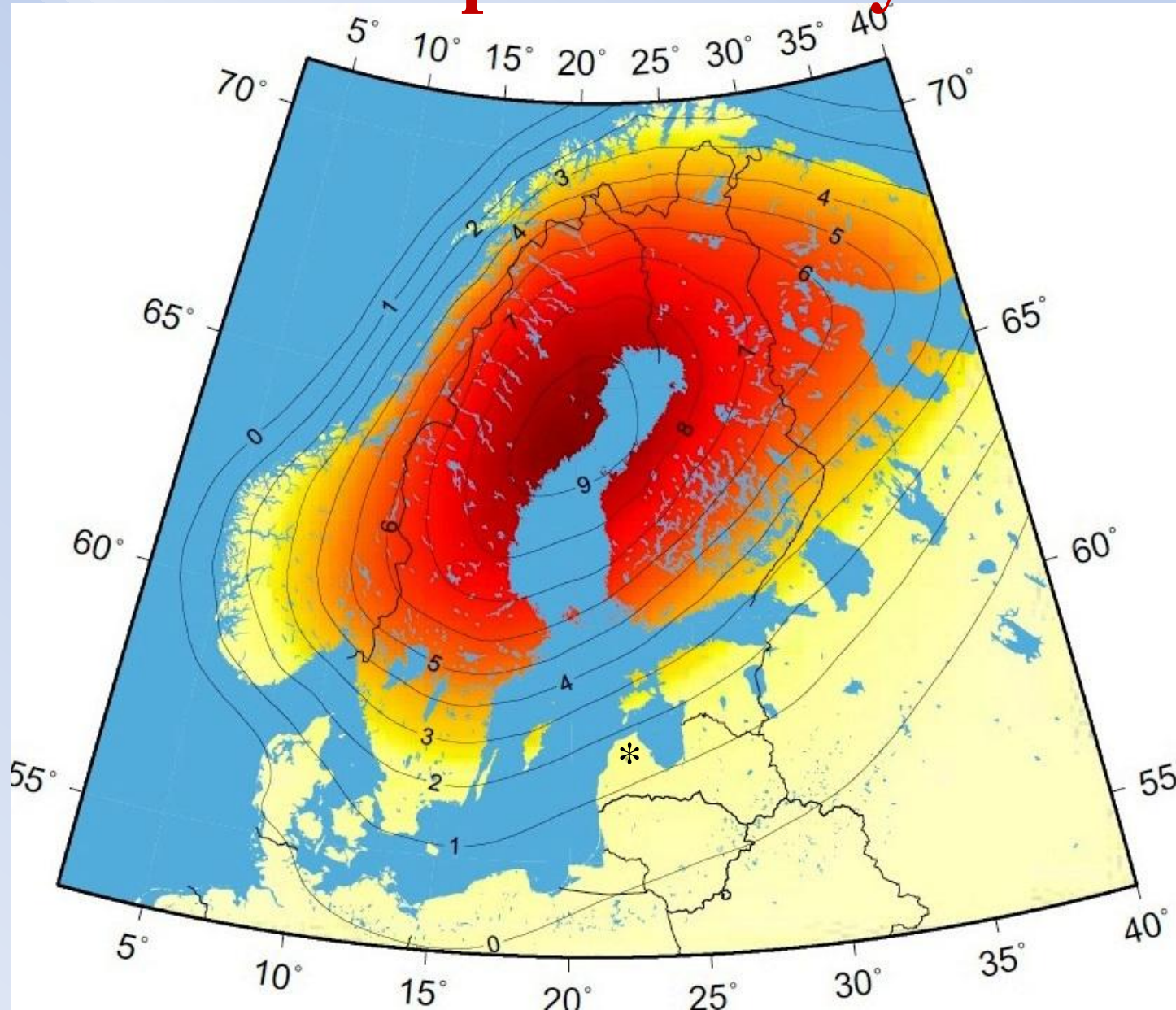


Achievements in accuracy

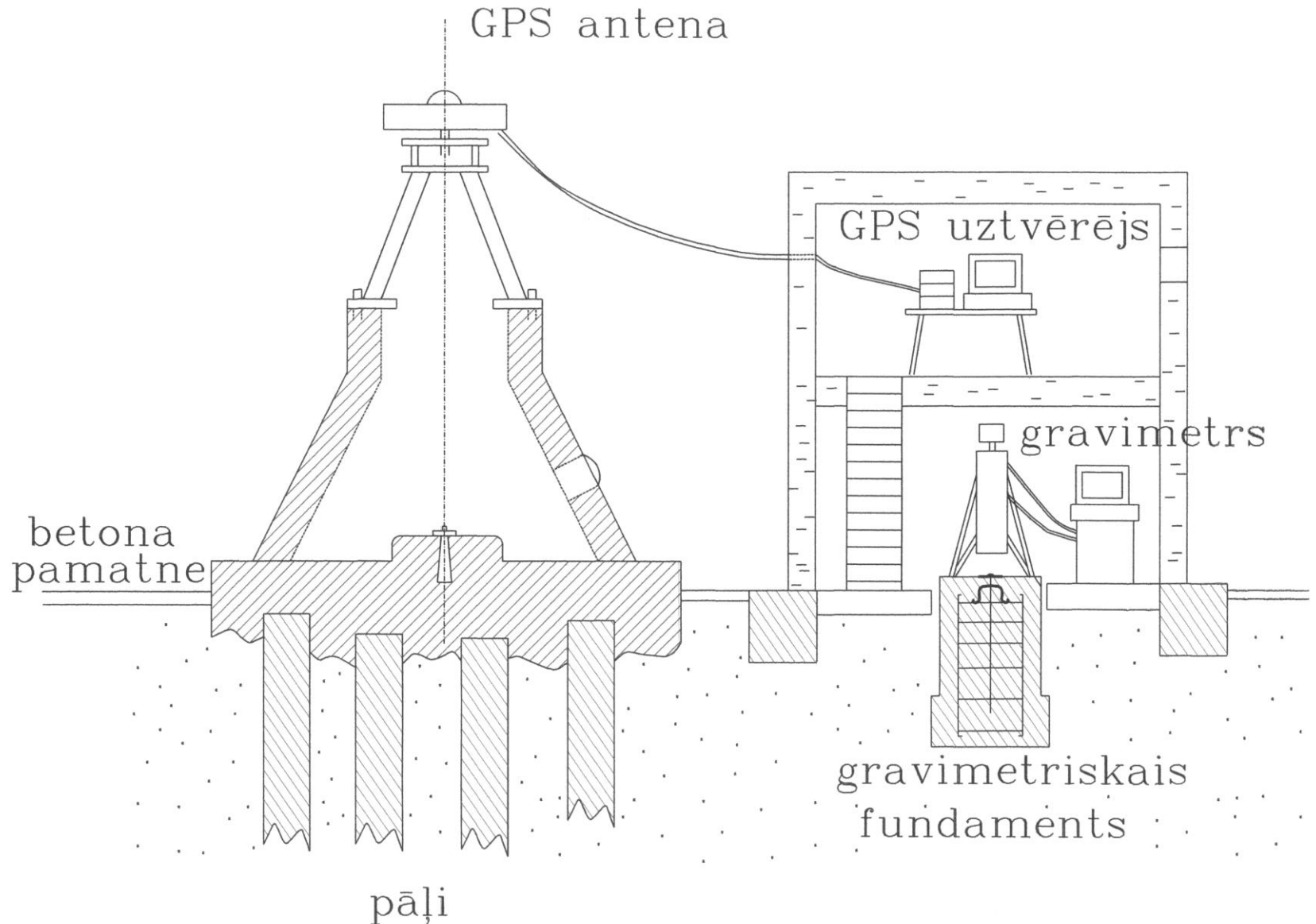
Mobile SLR unit of Latvia University, Institute of Geodesy and Geoinformation



IRBENE located in Fenno-Scandinavian uplift territory



IRBENE



IRBENE



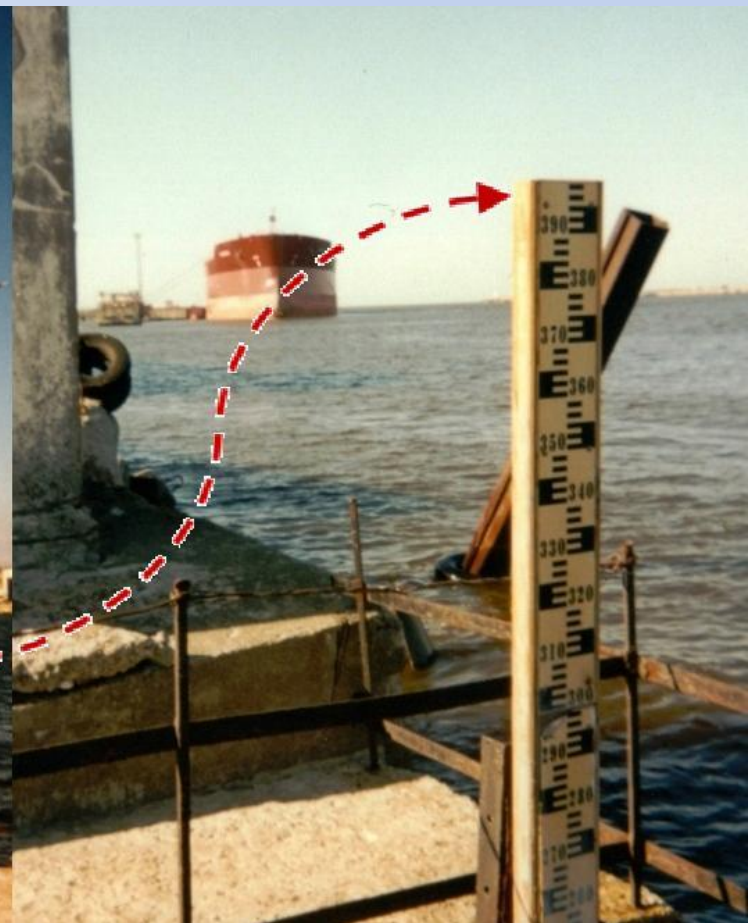
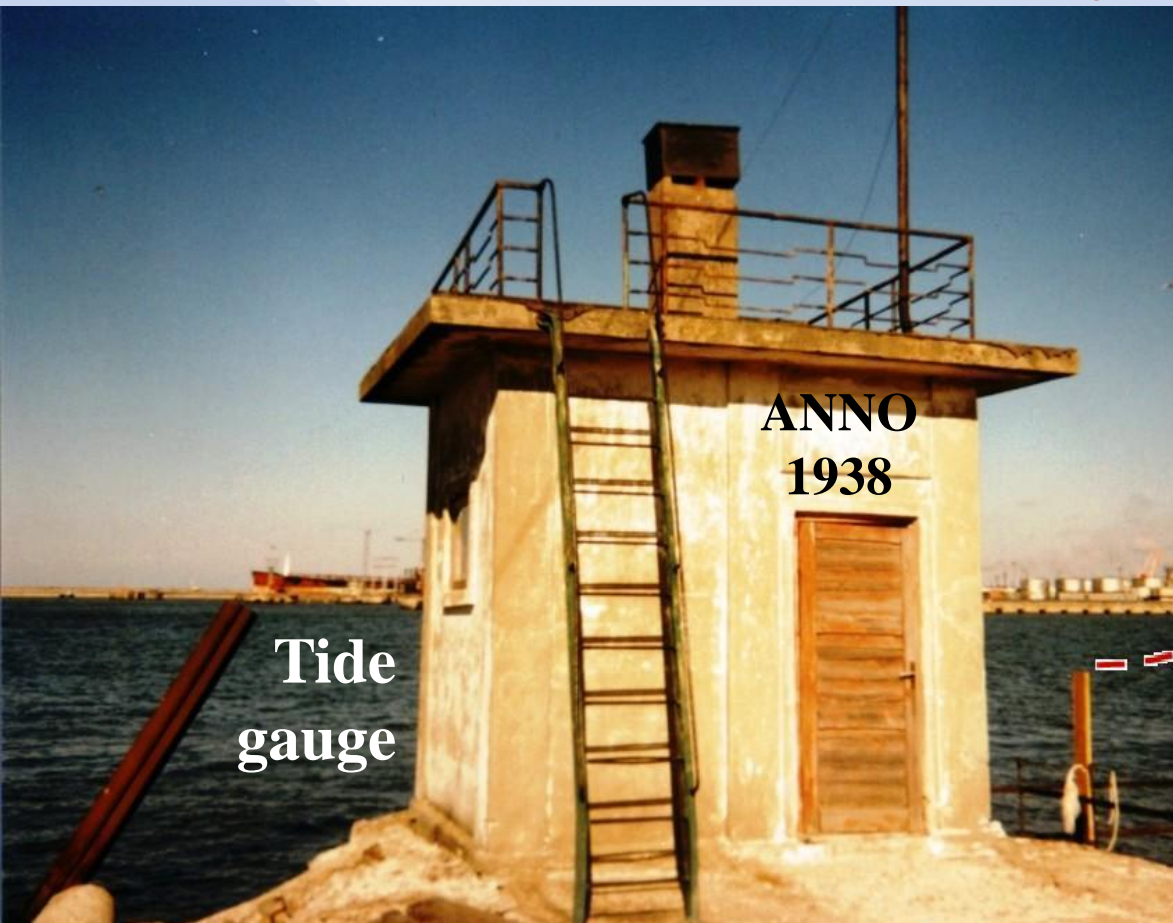
GNSS pillar

IRBENE



**Absolute
gravity
station**

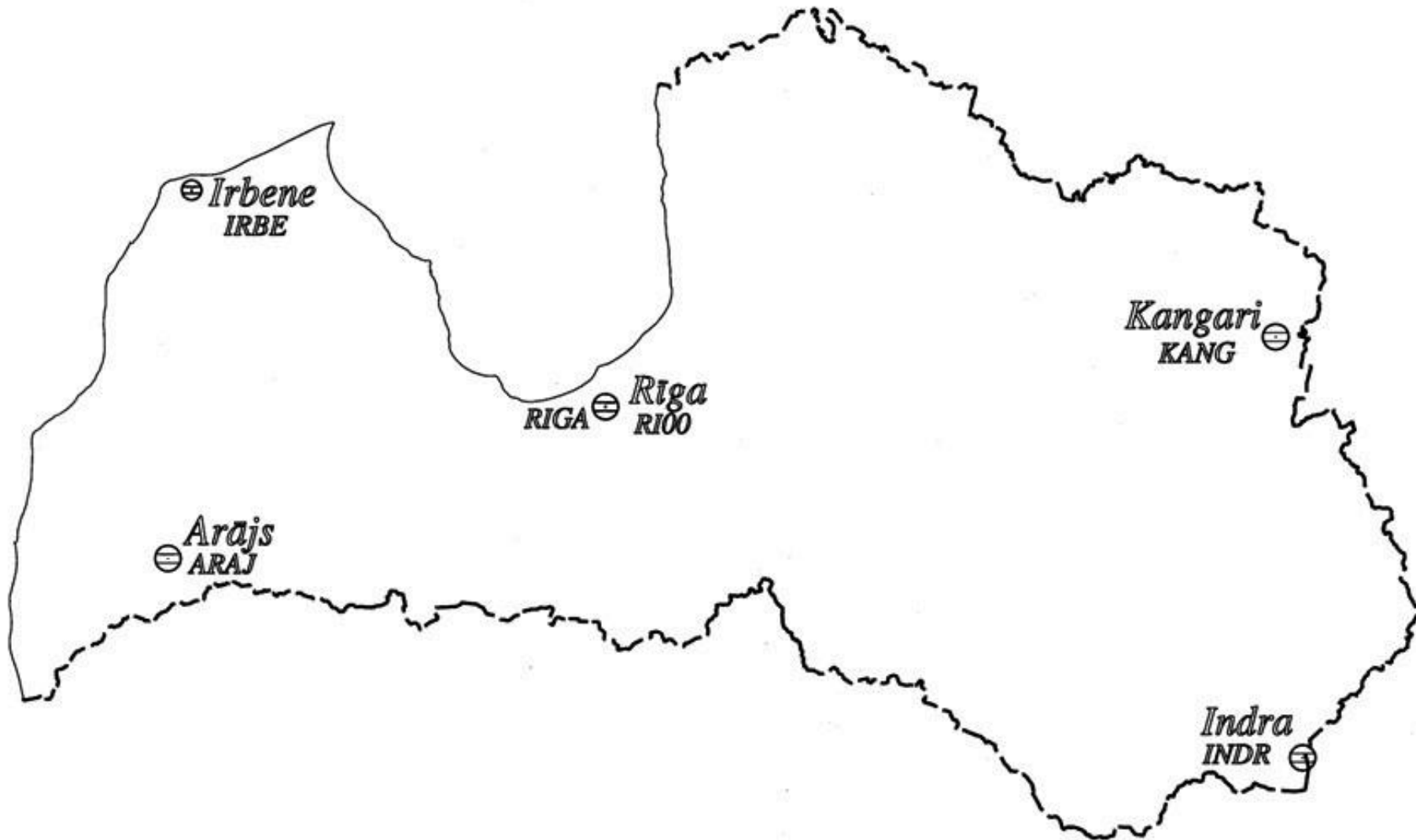
IRBENE located near Baltic Sea, water level always recorded



Ventspils = LV03, observed during campaigns BSL 1997 & EUVN'97

REFERENCE NETWORK

ETRF 1989 realization since EUREF 2006 in Riga



The current works with perspective of VIRAC in the field of VLBI are carried out on the next directions:

- Investigation of space debris objects by the method of radar-VLBI;
- Studies of the structure of the solar-wind plasma and Earth ionosphere;
- Researches of spatio-temporal structure of solar bursts;
- Participation in NEXPREs project.

Plans in future :

Investigations, active work in VLBI, participation in global projects works of VIRAC have been aimed on including of radiotelescope **RT-32 and RT-16** in international radio astronomy researches as a site of **VLBI-network**.

To become also fundamental geodetic station and to be a special place for astronomy and geodesy. Contribute to stable reference frames.



THANK YOU FOR ATTENTION !

Questions ?

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