Branch of Joint Stock Company «United Rocket Space Corporation» -
«INSTITUTE OF SPACE DEVICE ENGINEERING»
(Branch of JSC «URSC» - «ISDE»)

Russian geodesic class navigation equipment. Comparative tests

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Test objective

High-precision geodetic equipment is designed for:

- **execution of survey works for geodetic networks of various purposes;**
- **topographical survey and design and survey works;**
- **database support of land cadastre and monitoring of land use;**
- **relative determinations of plane coordinates and altitudes**

The test objective is to check receiver measurement accuracy as well as availability and accuracy of usable domestic software at mutual navigation determinations

General view of the equipment

Field set:

- **navigation receiver block with data storage,**
- **manual controller,**
- **geodetic antenna,**
- **AC adapter,**
- **high-capacity battery,**
- **kit packaging,**
- **radio modem,**
- **set of cables,**
- **battery charger,**
- **set of installation facilities,**
- **software.**

Receiver Specification (1)

Frequency bands - L1/L2 GLONASS/GPS

Navigation signals - L1 OF GLONASS and L1 C/A , L2C GPS

Number of parallel receiver channels - 64

Time To First Fix - not more than 1.5 min (cold start)

Frequency of coordinate updating – 1 s

Maximum time of data storage - 7 days

Coordinate systems: EP-90.02, WGS-84, SC-42, SC-95, Gauss-Kruger projection

Time of continuous work:
- from internal battery pack – up to 8 hours;
- from external high-capacity battery – up to 24 hours.

Receiver Specification (2)

Mode	Plane	Height
Static mode (up to 2 km) / Static mode (up to 100 km)	3 mm + 0,5 mm/km / 5 mm + 1,0 mm/km	5 mm + 1,0 mm/km / 8 mm + 1,5 mm/km)
RTK mode (up to 10 km)	10 mm + 1,5 mm/km	20 mm + 2 mm/km

Equipment test

Testing of equipment and its software is carried out in two stages.

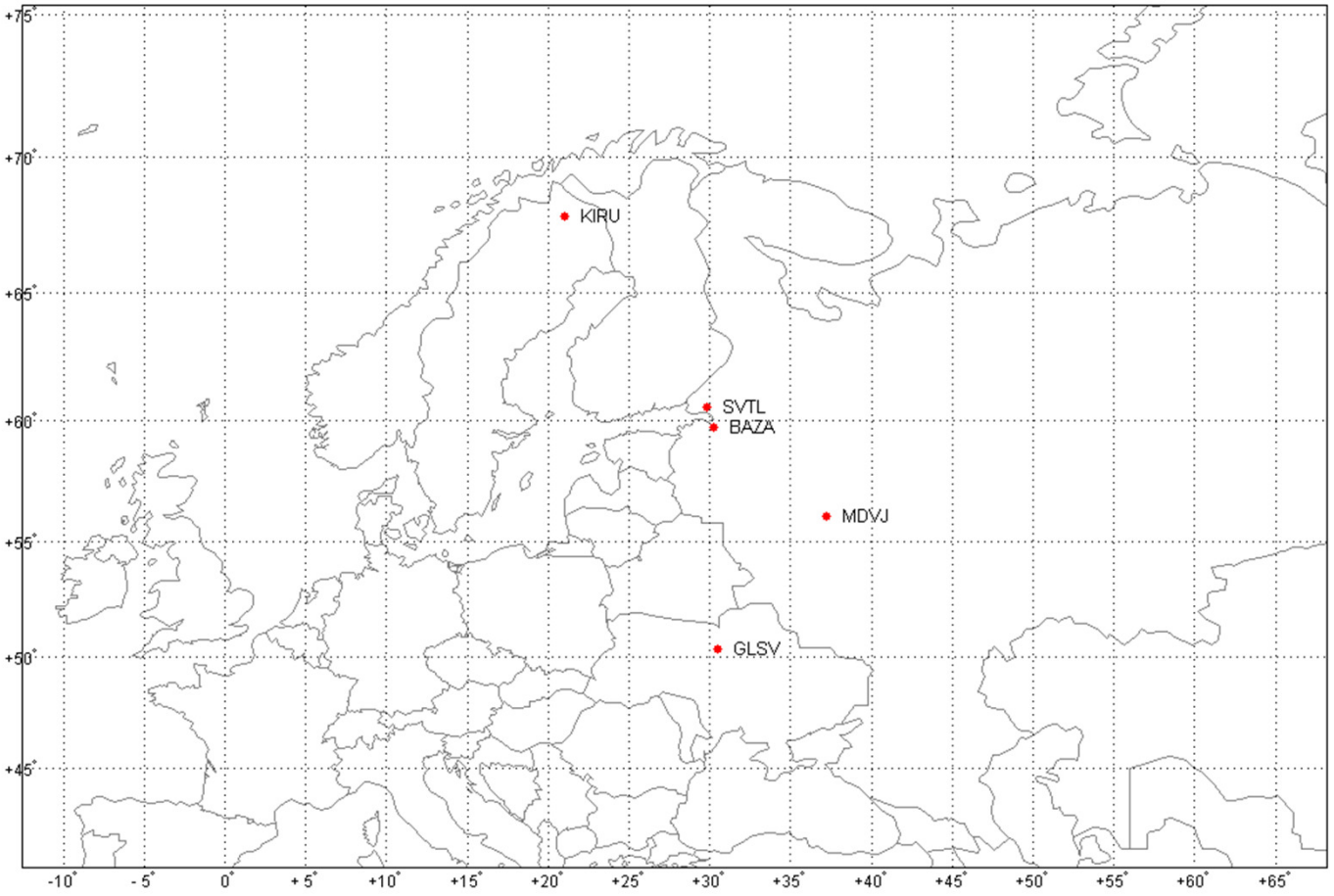
At the first stage base station measurements were performed relative to 4 IGS (MDVJ, KIRU, GLSV, SVTL) network stations to determine the coordinates of base station. Collection of measurements was produced within three days. At base station measurements were made at the sessions of 7-8 hours. In the remaining network points - at the sessions of 2-3 hours.

Position determination of the base station was executed by domestic and Bernese software packages.

At the second stage the relative coordinate error estimate is performed for local area network station situated near the base station

Determination of local area network station coordinates was executed by two software packages: domestic and Trimble Business Center .

Location of base and IGS network stations



Errors of base station position determination

Date	ΔX(m)	ΔY(m)	ΔZ(m)
2014.05.15	-0.0009	0.0028	0.0021
2014.05.16	0.0013	0.0008	0.0021
2014.05.17	0.0062	0.0004	0.0055
2014.05.18	-0.0058	-0.0011	-0.006
2014.05.19	-0.0010	-0.0025	-0.0033
σ (m)	0.0013	0.0019	0.0044

RMS measurement errors of base station coordinate are defined using two different software packages.

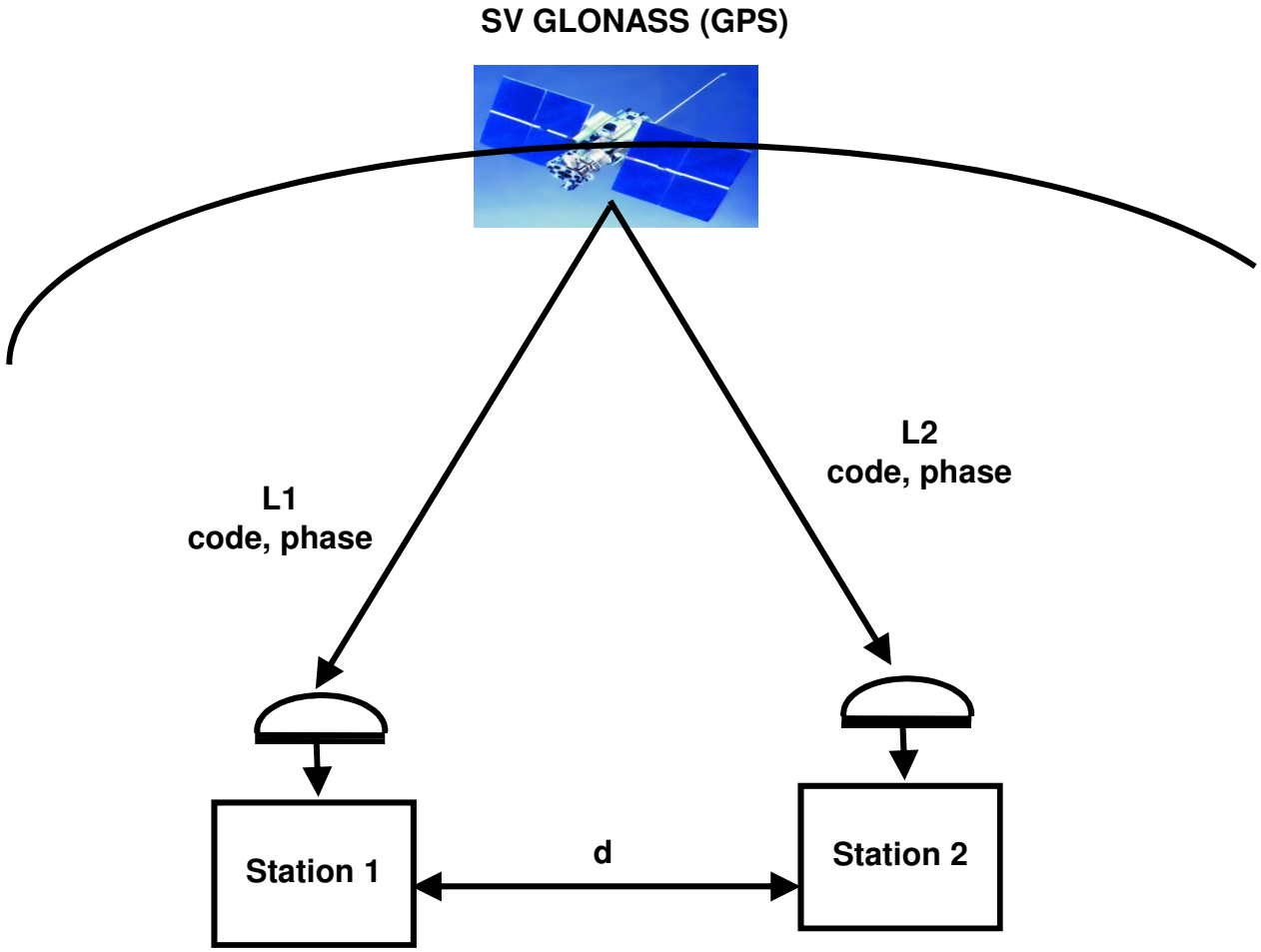
RMS errors are practically coincided and equal:

σ(X) = 0,13 (0.13) cm, σ(Y) = 0,19 (0.17) cm, σ(Z) = 0,44 (0.38) cm.

Coordinate error estimate for local area network station. Differences between two solutions

Network Stations	ΔX (м)	ΔY (м)	ΔZ (м)	L (км)
Kabo	0.002	-0.004	0.012	5.4
Leni	-0.001	-0.005	-0.008	0.8
Mixa	-0.002	0.013	0.0047	8.1
Skac	-0.001	0.005	0.001	4.0

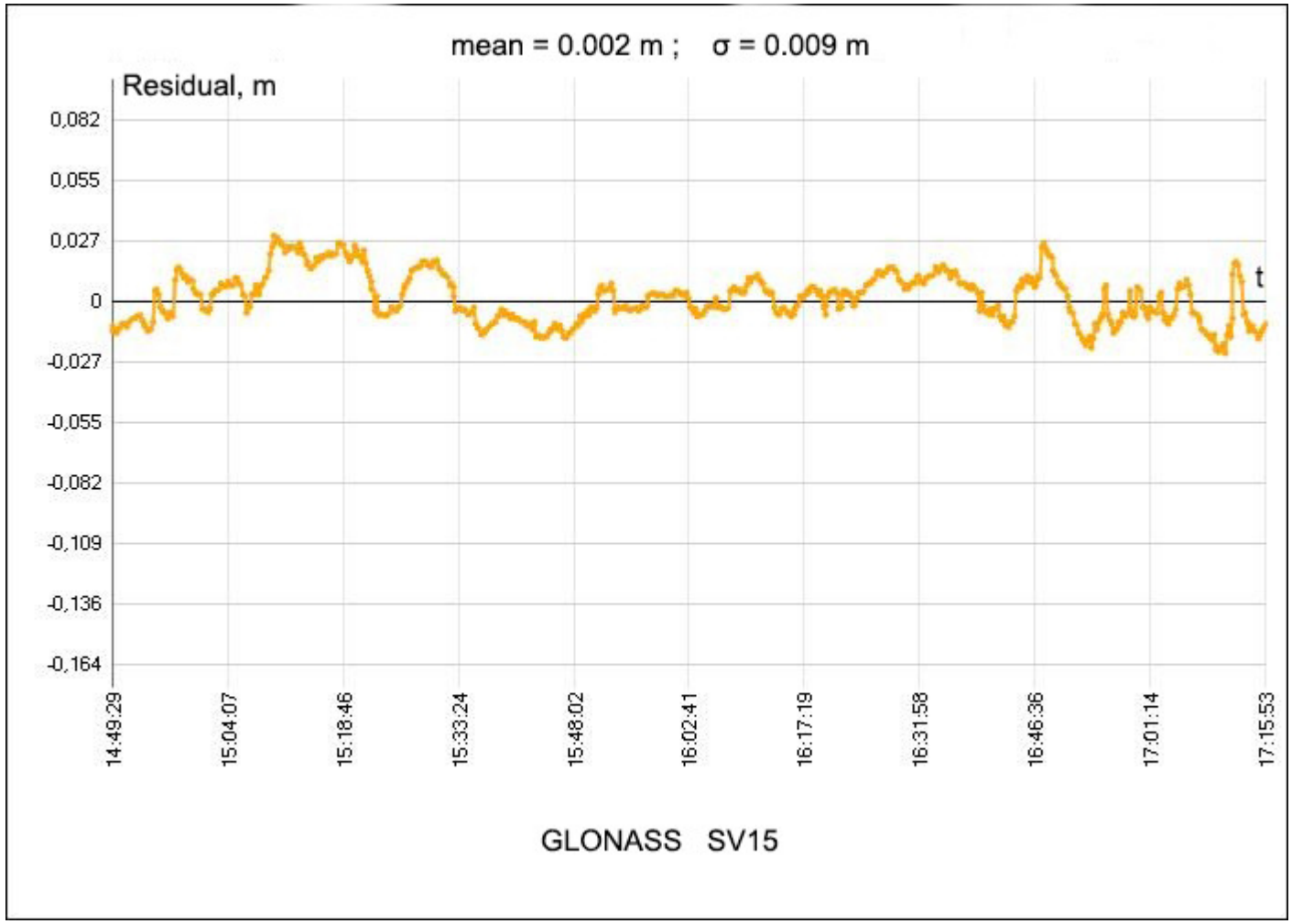
Diagram of residual determination



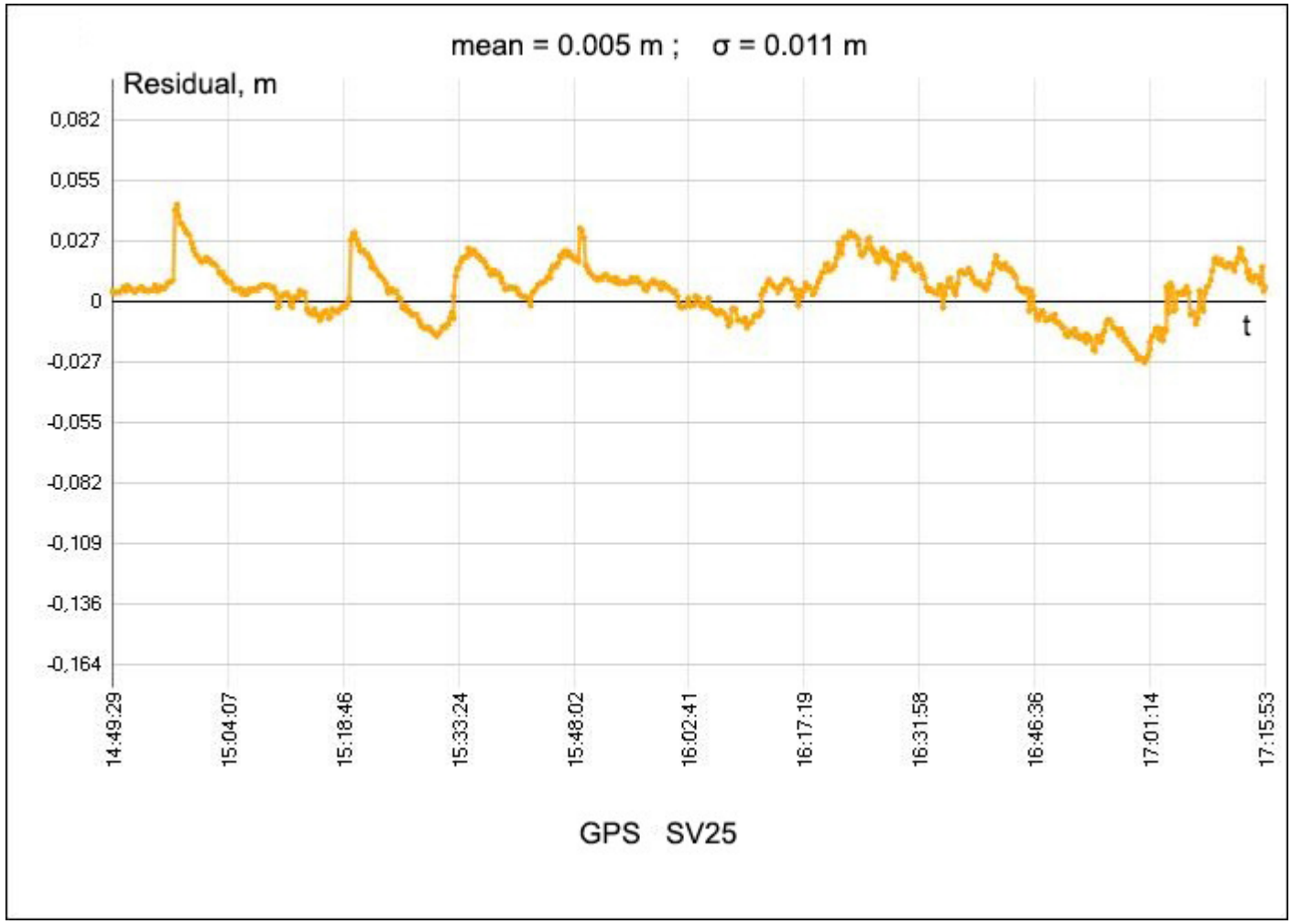
$$\Delta 1(L) = L1_m - L1_{cal} ; \qquad \Delta 2(L) = L2_m - L2_{cal}$$

$$\Delta\Delta(L) = \Delta 1(L) - \Delta 2(L) = L1_m - L1_{cal} - (L2_m - L2_{cal})$$

Residuals, SV GLONASS



Residuals, SV GPS



Summary

1. Fluctuating measurement error comprises σ ≈ 1 cm both to SV GLONASS and to SV GPS, that complies with geodetic requirements .

2. Coordinate determination errors of base station about IGS network stations obtained with the help of domestic and Bernese software are practically equal: σ(X) = 0,13 (0,13) cm, σ(Y) = 0,19 (0,17) cm, σ(Z) = 0,44 (0,38) cm.

3. Local station network coordinate estimations about base station obtained with the help of domestic and Trimble Business Center software differ by no more than 1,3 cm.

4. Domestic software is equivalent to similar foreign software packages for geodetic problems.

Thank you for the attention