Achievement o the competitive level of accuracy of GLONASS navigation field based on creation of SLR, GNSS monitoring systems and VLBI collocation nodes

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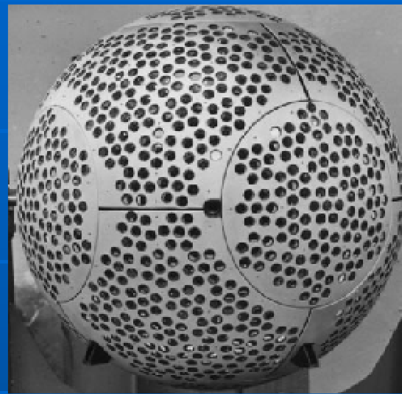
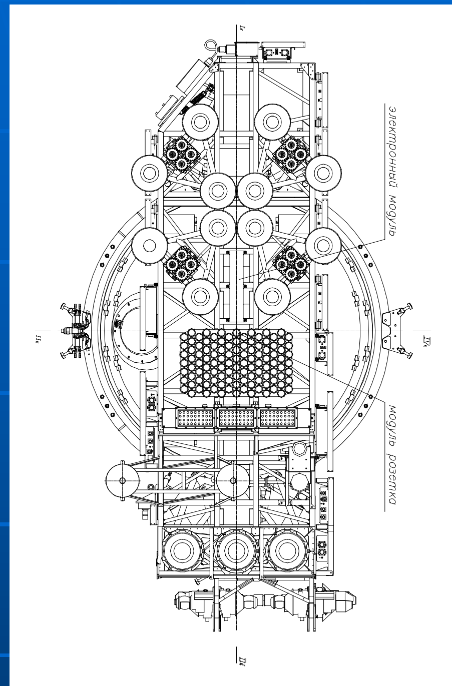
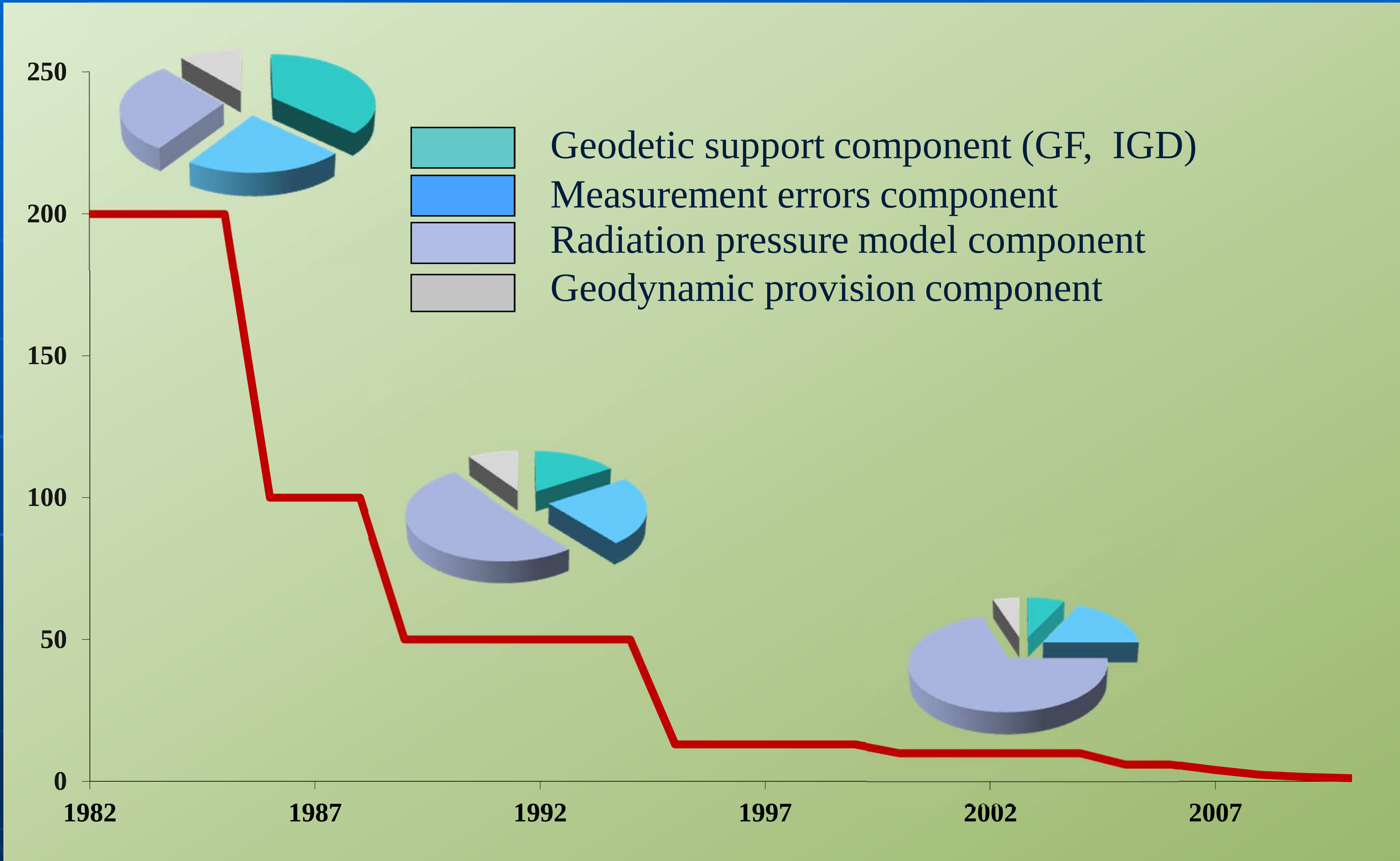
Use of SLR for development and deployment of GLONASS



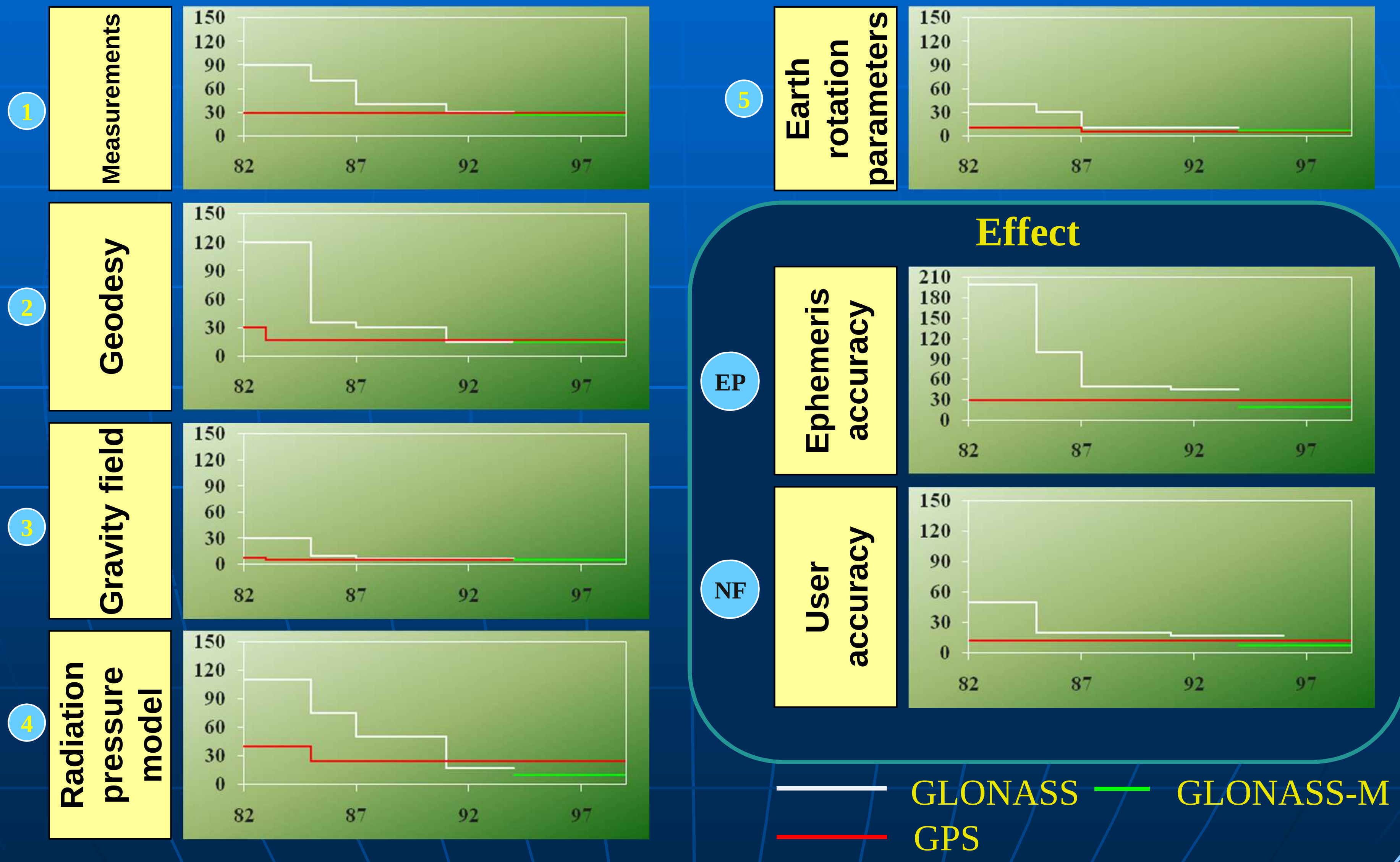


- accuracy improvement of radio systems
- on-board and ground equipment calibration
- development of motion and measurement models of passive satellite “Etalon”, models of one-way SLR measurements
- development and refinement of parameters of models of GLONASS radiation pressure
- refinement of relative reference of measurement stations

Breakdown of accuracy problem during development of GLONASS time and frequency provision

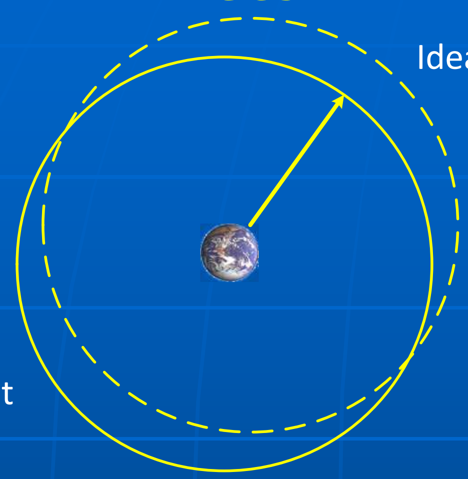


Influence of SLR in the initial phase of GLONASS deployment



Influence of geodetic support on ETP GLONASS

Regional placement of GLONASS GCS



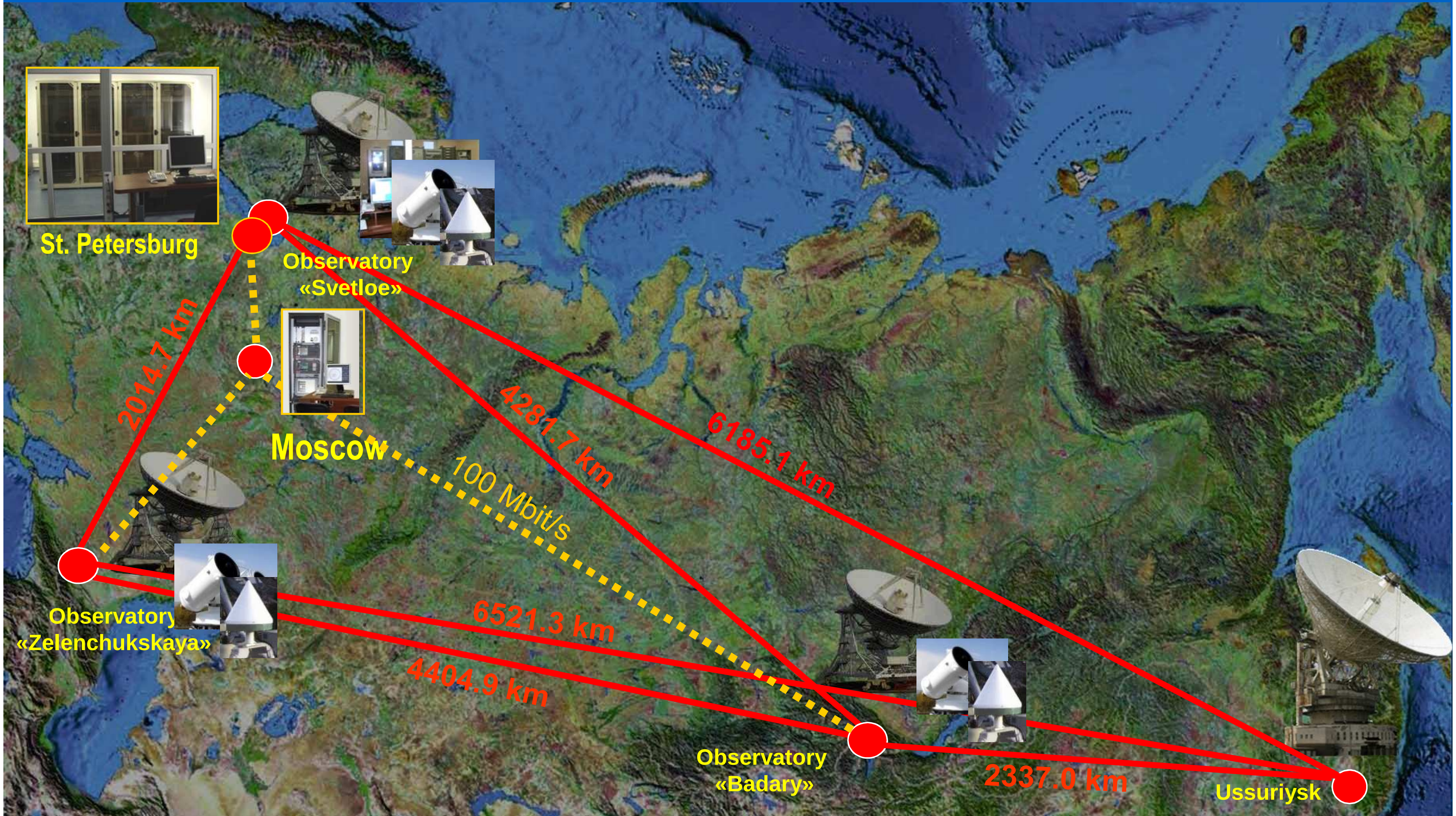
Shift along Z axis at the pericentre of GLONASS near-circular orbit over Russian territory leads to fixation of the determined orbit below optimal one, rise of apogee part of the orbit and error in calculation of eccentricity.

Factor	Maximum errors of daily forecast, m			
	L	R	N	ERC
Geopotential errors (EGM-96 – PZ-90 GLONASS)	6.0	0.8	0.7	1.2
Reference to Earth COG Δz = -1.2 m	1.5	0.6	1.8	0.7
Errors of relative reference of GCS stations $\Delta x=\Delta y=\Delta z=1$ m	3.0	0.7	3.9	1.0
Earth difference from solid body (dynamic effects)	1.3	0.2	0.1	0.3
Total influence of above listed factors	7.8	1.6	4.9	2.1

	Δx	Δy	Δz	ω_x	ω_y	ω_z	$m*10^6$
	м			mas			
GOST	-1,1	-0,3	-0,9	~0	~0	-200	0,12
IGEX-98	~0	~0	-1,6	~0	~0	-300	~0

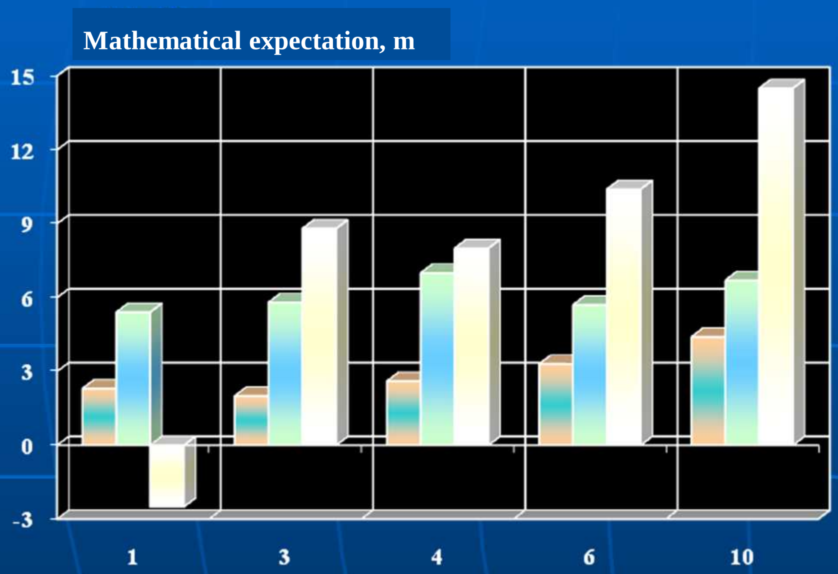
Conclusion: contribution of errors of initial geodetic data to ephemeris error is significant.

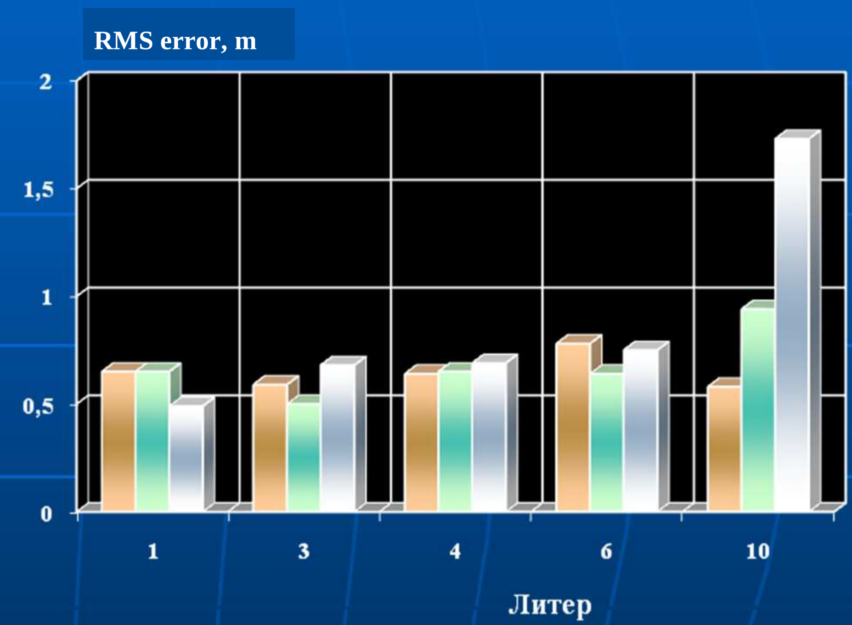
Creation of allocation nodes SLR, GMS and VLBI



Collocation of SLR and GMS for calibration of radio systems

Problem: signal path delays of GMS due to frequency division of GLONASS navigation signals





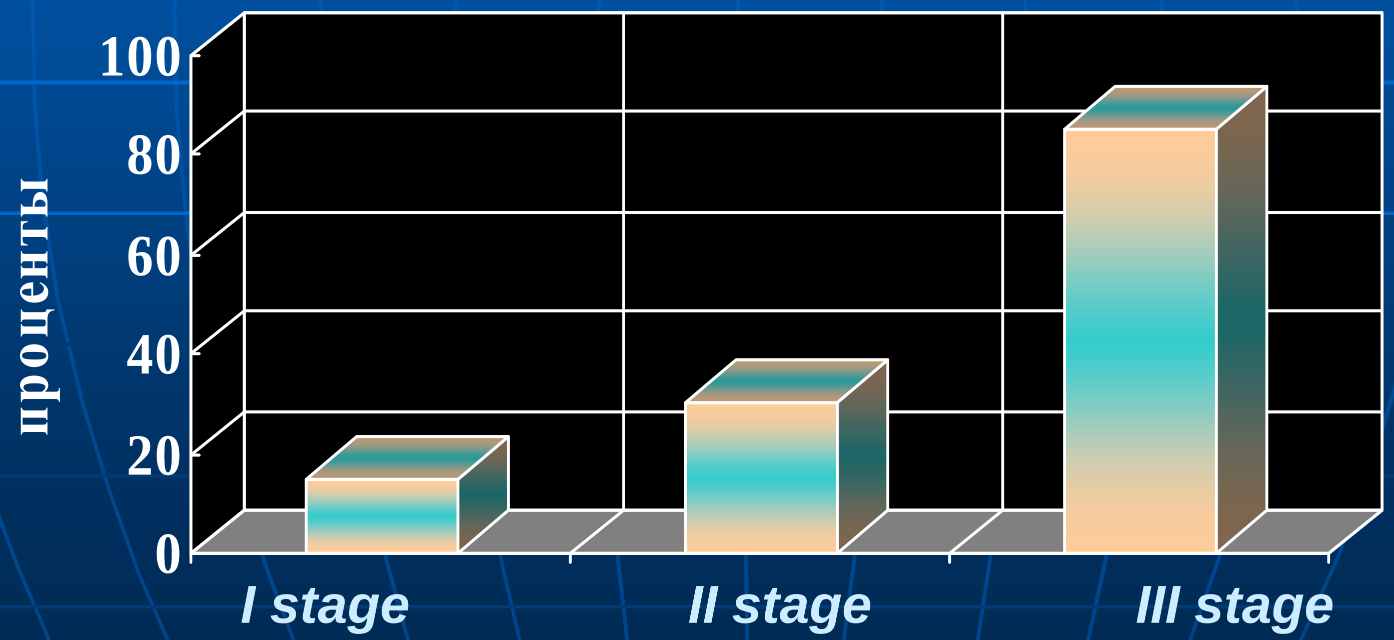
- Moscow   - Krasnoyarsk   - Komsomolsk-On-Amur

Result: calibration accuracy of one-way measurement systems is ensured at decimeter level – For GMS this error is less than 0.5 m (RMS)

Collocation of GMS and SLR for verification of PZ-90.02 and evaluation of contribution in ETP GLONASS

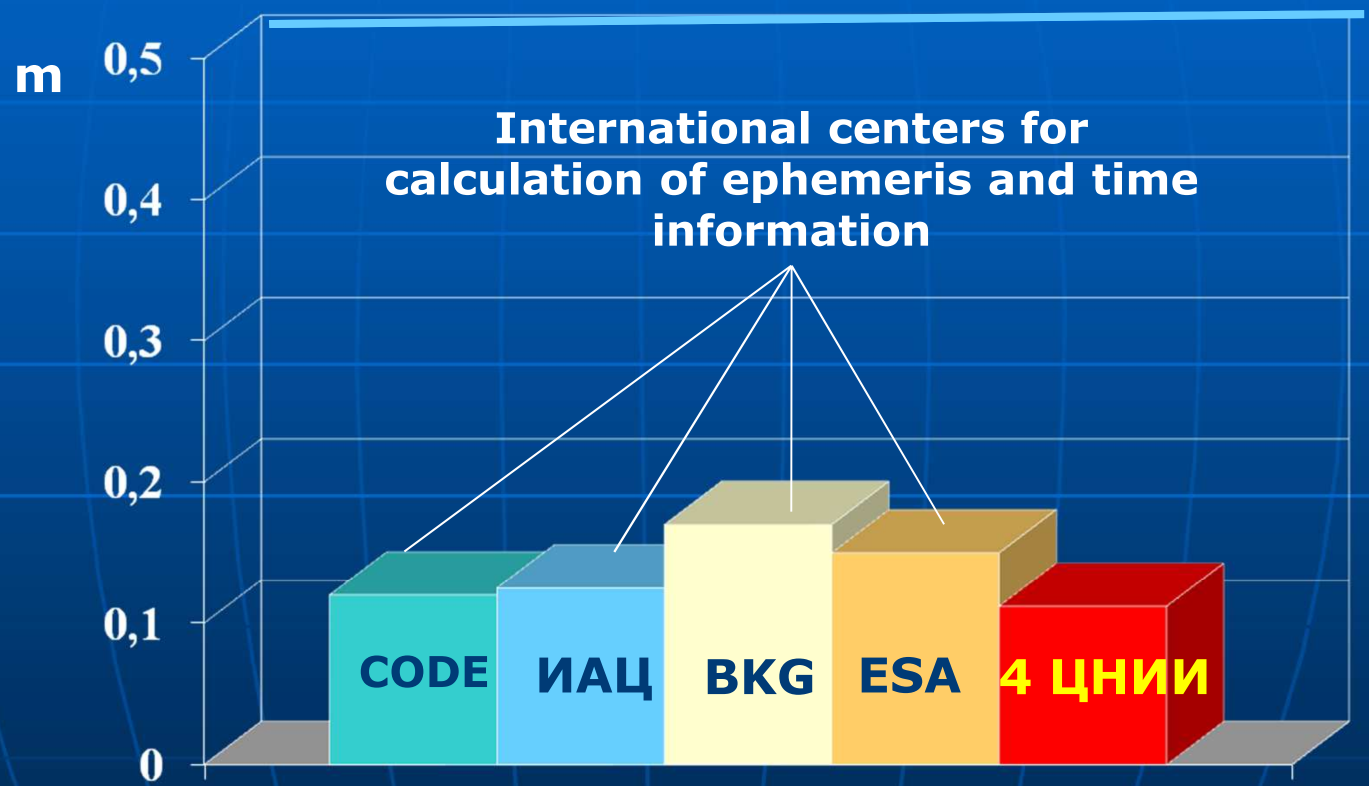
Problem: shift of coordinate system PZ-90.02 relative to Earth center of gravity

Evaluation of FGCS PZ-90.02 implementation errors contribution to the accuracy of navigation definitions



Collocation of GMS and SLR for accuracy improvement of GLONASS posterior ETP

Contribution of posterior ETP in the equivalent range error

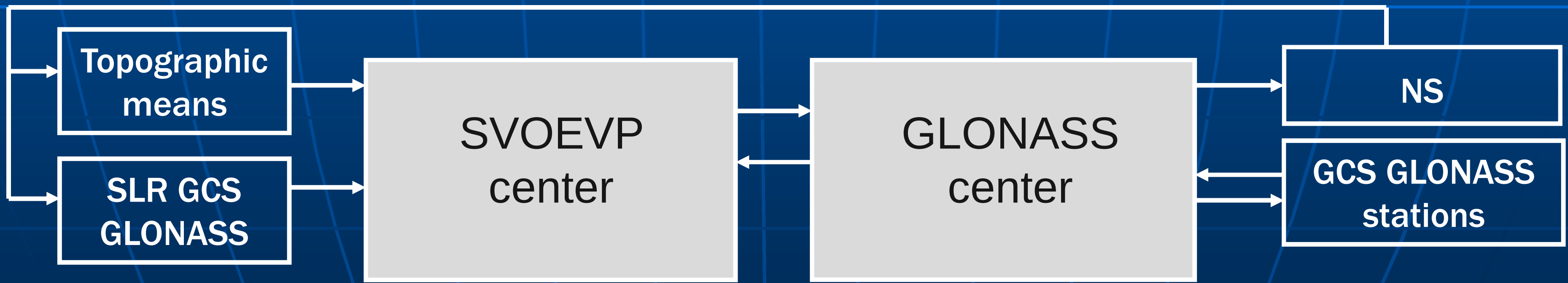


Higher than world level accuracy of the posterior ETI is ensured

SLR and GMS collocation for refinement of geodetic stations network and check of transfer of FGCS by GLONASS navigation field

GLONASS stations

Structural schematics of information exchange



First time in Russia there was created a System for check of accuracy of transfer of initial reference frame by GLONASS navigation field.

Transfer accuracy of PZ-90.02 by GLONASS system was confirmed at the level 10-15 cm

Use of one-way SLR for check of target characteristics

One-way SLR (high-accuracy check of time and frequency parameters of GNS GLONASS)

Ground channel of one-way and two-way SLR

- two-way range measurement to S/C with accuracy 0.015 m;
- registration of pulse start time in GLONASS central time scale with the error of 0.2 ns;
- pulse repetition rate – not less than 300 Hz;
- pulse length – not greater than 0.2 ns a wavelength 0.532 μm;
- information exchange with on-board one-way SLR equipment.

Onboard equipment of one-way and two-way SLR

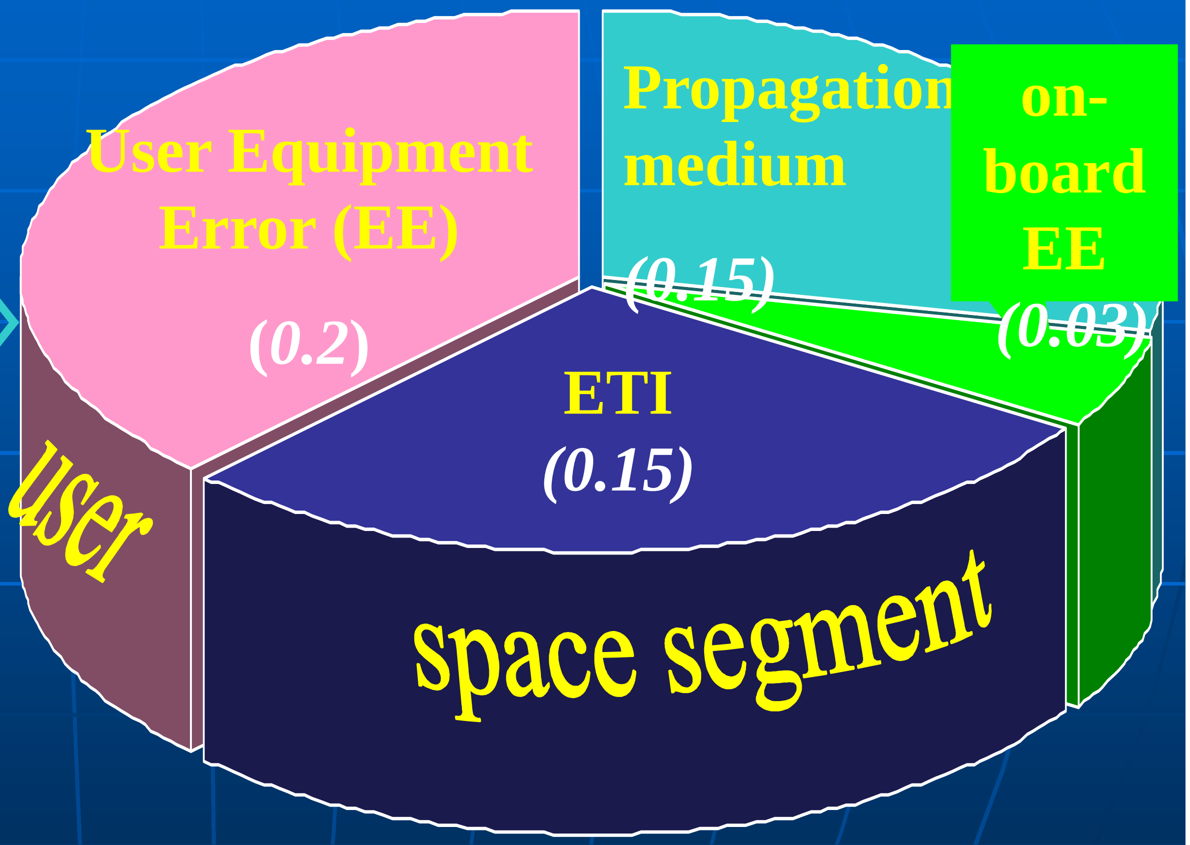
- one-way range measurement to S/C with accuracy 0.015 m;
- registration of pulse arrival time in the onboard time scale with the error of 0.2 ns;
- provision for information exchange with GLONASS onboard systems for transfer pulse arrival times to the GCS for further processing

Error (RMS) of check of frequency and time parameters 0.05 ns

Budget of errors of navigation definition using GNS GLONASS signals

Navigation definition error requirements

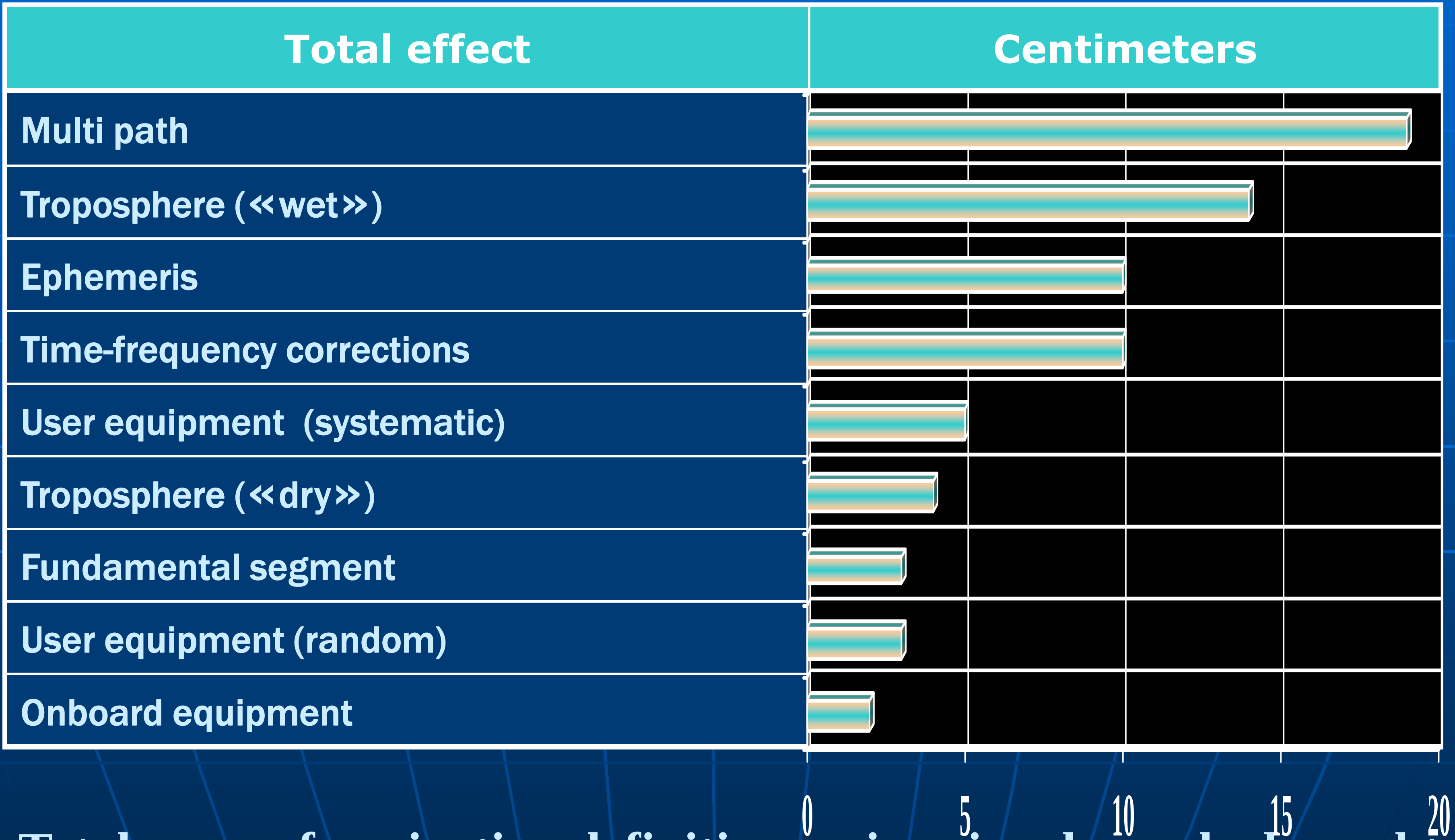
30 cm



Problems

- ✓*GMS global network*
- ✓*TC OBCS - 1·10^{-15}*
- ✓*reduction of un-modeled accelerations*
- ✓*phase ambiguity resolution in real time*
- ✓*calibration of onboard and ground equipment*

GNS GLONASS navigation definition error components contribution



Total error of navigation definitions using signals can be brought down to ~30 cm by 2020.

CONCLUSIONS

Perspectives of GLONASS development require refinement of SLR, GMS and VLBI collocation nodes to:

1 Create SLR with sub-millimeter accuracy for one-way and two-way measurements, and development of ground stations network.

2 Development of S/C “BLITS” with millimeter-level target error for refinement of the geocenter position determination and relative reference of measurement stations.

3 Development of GMS-SLR and VLBI-GMS-SLR collocation nodes to achieve target characteristics of a new Federal Target Program GLONASS at the new level of accuracy.

4 Include water vapor radiometers in the collocation nodes.

Thank you for your attention