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«Precision systems and
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«Central Research
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Building»



«State Research and
Development
Institute for Air
Navigation»



«Russian
Metrological
Institute of Technical
Physics and Radio
Engineering»

«Proposals on the development of the International GNSS Monitoring and Assessment System»

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- 2. Proposals on the main development principles of the International GNSS Monitoring and Assessment System.**
- 3. Perspective technical means of GNSS monitoring and assessment in Russian Federation.**
- 4. Proposals on the ICG recommendations**

The background features a light blue gradient with a faint, semi-transparent illustration of a satellite in orbit around the Earth. The satellite is positioned in the upper right corner, with its solar panels and instruments visible. The Earth's horizon is depicted as a curved line across the middle of the frame.

Proposals on the list of parameters for monitoring within the international system.

ВНИИФТРИ

Recommendation 8A.4.1

- Determine Service Parameters to Monitor - definition and methodology to be coordinated with WG-A Compatibility sub group study
- Recommend what should be monitored by:
 - Individual GNSS monitoring/control segments
 - Shared sites of 2 or more GNSS through bilateral agreements
 - Global monitoring of Multi-GNSS parameters

Parameters of Global Navigation Satellite Systems to be monitored

List of parameters to be monitored by GNSS providers (by national monitoring/control systems)

Methodology of GNSS monitoring using national GNSS monitoring/control segments

List of parameters to be monitored by individual GNSS monitoring/control segments and/or global monitoring systems

Methodology of GNSS monitoring using national measurement means, international measurement systems and International GNSS Monitoring and Assessment System

Parameters of Global Navigation Satellite Systems to be monitored

By main user

System

Consumer

By priority

Primary: SPS
parameters

Additional

Primary parameters of Global Navigation Satellite Systems to be monitored(1)

Parameter	Means of monitoring	Type
Number of satellites Number of orbital planes Satellites distribution on the planes Reference orbit parameters	National GNSS monitoring/control segments	System
Constellation Coverage Per-slot coverage Per-slot Availability Constellation Availability	National GNSS monitoring/control segments that are additionally confirmed by International GNSS Monitoring and Assessment System	System
Operational Satellite Count	National GNSS monitoring/control segments	System
95% Global Average SIS URE (satellite) 95% Global Average SIS URE (Constellation) 99,37% Global Average SIS URE 99,14% Worst Case Single Point Average SIS URE 95% Global Average SIS URRE 95% Global Average SIS URAE 95% Global Average UTCOE	National GNSS monitoring/control segments that are additionally confirmed by International GNSS Monitoring and Assessment System	System/ Consumer

Primary parameters of Global Navigation Satellite Systems to be monitored(2)

Parameter	Means of monitoring	Type
Major Service Failure	National GNSS monitoring/control segments that are additionally confirmed by International GNSS Monitoring and Assessment System	System
SIS Continuity	National GNSS monitoring/control segments that are additionally confirmed by International GNSS Monitoring and Assessment System	System
Global PDOP Availability Worst Site PDOP Availability Global Average 95% Horizontal Positioning error Global Average 95% Vertical Positioning error Worst Site 95% Horizontal Positioning error Worst Site 95% Vertical Positioning error Global Average 95% Time transfer error Horizontal Service Availability, average location Vertical Service Availability, average location Horizontal Service Availability, average location Vertical Service Availability, average location	National GNSS monitoring/control segments that are additionally confirmed by International GNSS Monitoring and Assessment System	System/ Consumer

Additional parameters of Global Navigation Satellite Systems to be monitored

Time scale difference estimates for GNSS time scale and national time scale	System/ Consumer
Time scale difference estimates for UTC and national time scale	System/ Consumer
The difference of the frame of reference between each GNSS	System/ Consumer
Satellite orbits accuracy	System
Signal power for each satellite on the ground level	System
Differential Code Bias, Phase Center Variation(PCV) and Phase Center Offset(PCO) of satellite antenna, Inter-Frequency Bias, Inter-Signal Bias	System
Spectral and time characteristics of GNSS signal	System

The background features a light blue gradient with a faint, semi-transparent illustration of a satellite in orbit above the Earth's horizon. The satellite is positioned in the upper right quadrant, with its solar panels and antenna visible. The Earth's horizon is represented by a curved line across the middle of the image.

**Proposals on the main development principles of the International
GNSS Monitoring and Assessment System**

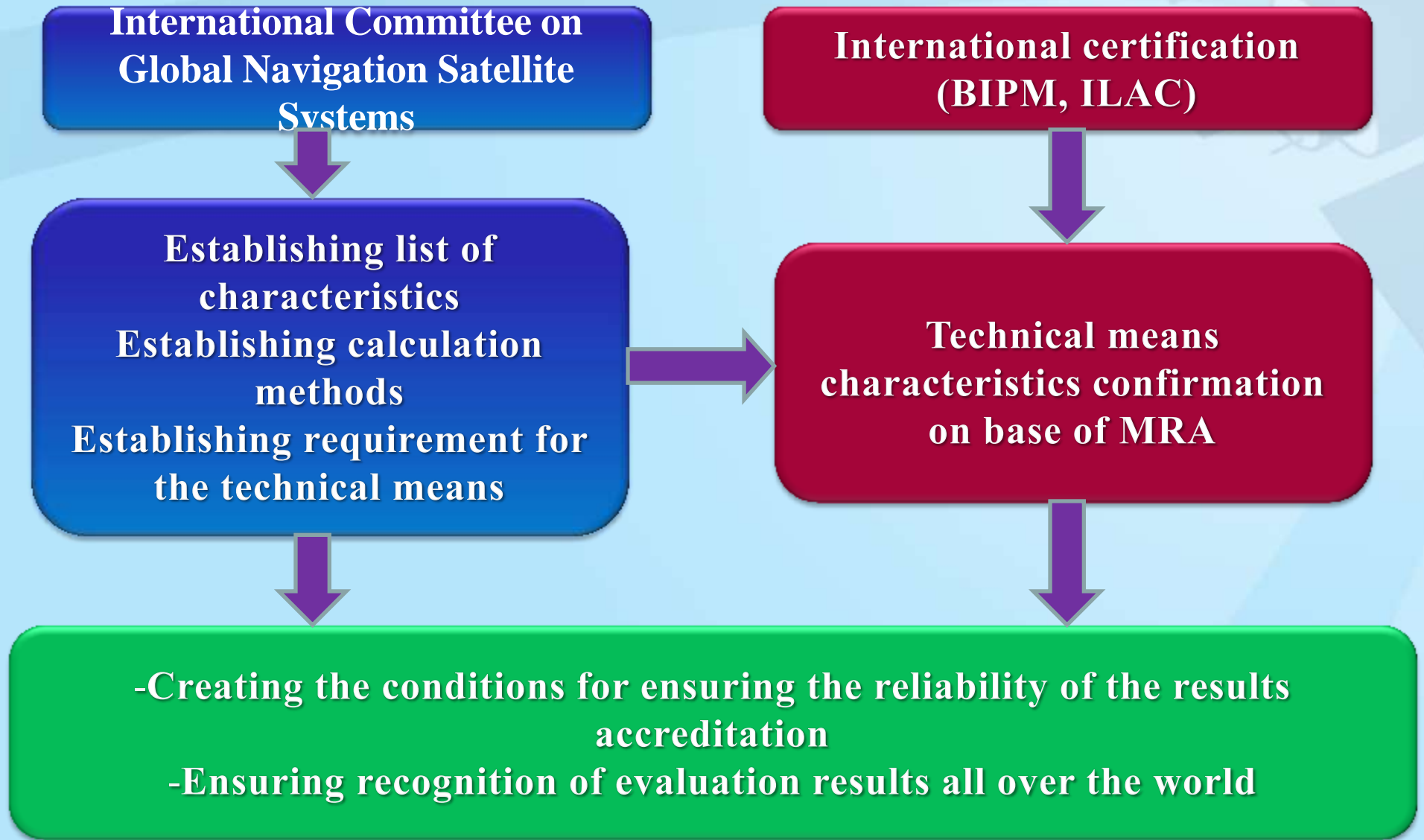
ВНИИФТРИ

Recommendation 8A.4.1

- Propose an Organizational Approach that:

- Coordinates and integrates the related activities for identifying parameters
- Avoids Duplication
- Considers the role of the current/planned IGS and
- Defines the Relationship of the proposed organization to the ICG

Proposals on the main development principles of the International GNSS Monitoring and Assessment System.



GNSS

International Committee on GNSS

Means and
results of
measurements

Means and
results of
measurements

Means and
results of
measurements

Means and
results of
measurements

Means and
results of
measurements

National
Standards of
Russia (time,
frequency,
length and
etc.)

National
Standards of
China

National
Standards of
EU

National
Standards of
Japan

National
Standards of
USA

Mutual recognition of evaluation results all over the world



**Perspective technical means of GNSS monitoring and assessment in
Russian Federation**

ВНИИФТРИ



**System of control and validation for the characteristics of
GLONASS radionavigation field**

ВНИИФТРИ

GNSS Monitoring and Assessment system being developed in Russian Federation.

System of control and validation for the characteristics of GLONASS radionavigation field (SCVC)

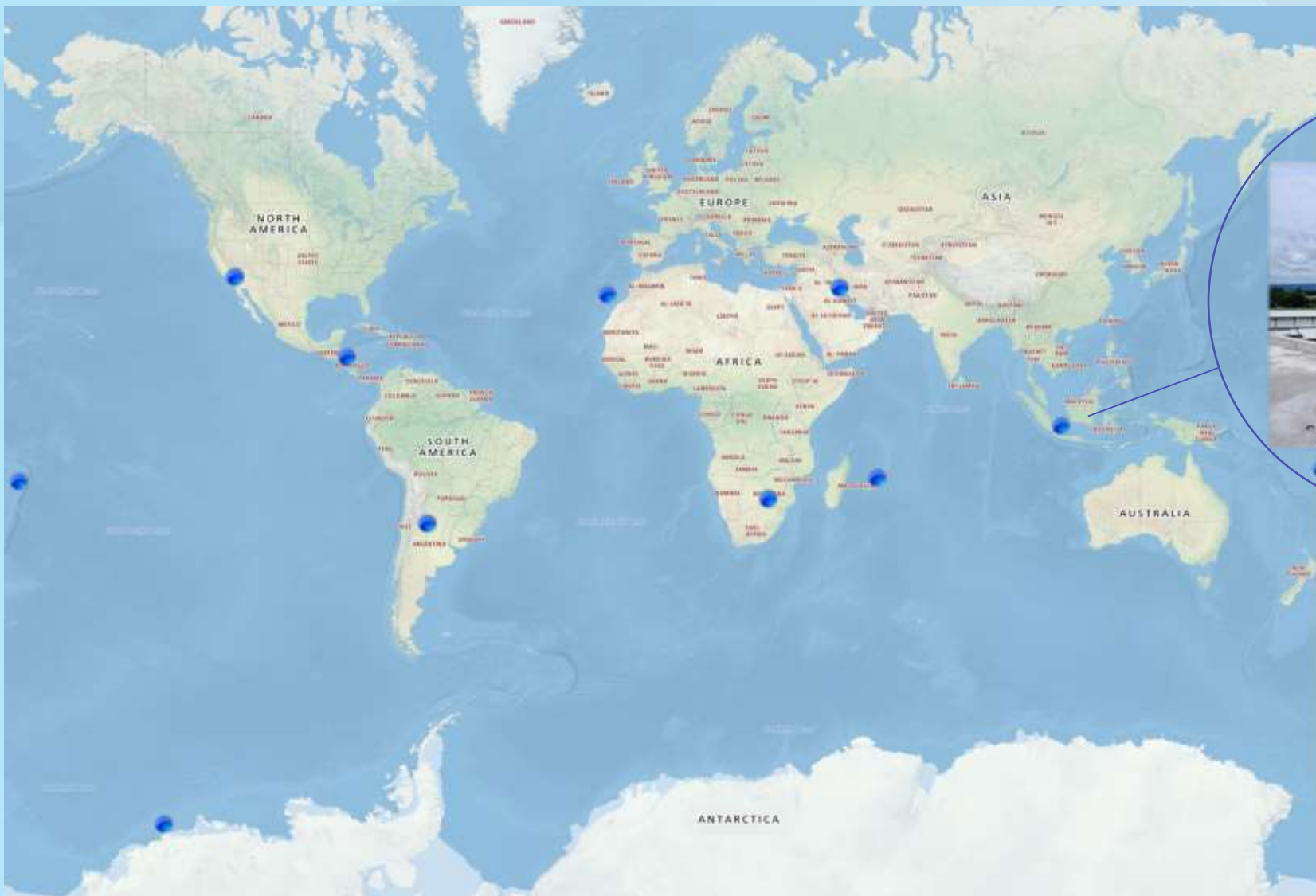
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graph TD; A[System of control and validation for the characteristics of GLONASS radionavigation field (SCVC)] --> B[SCVC Center]; A --> C[Signal's energy characteristics measurement equipment]; A --> D[Net of measurement stations];
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SCVC Center

**Signal's energy
characteristics
measurement equipment**

**Net of
measurement
stations**

Broad use of measurement results from the open measurement stations is planned (IGS and etc.)



ВНИИФТРИ

The background features a stylized satellite in the upper right corner, emitting a beam of light towards a globe. The globe is rendered with light blue and white curved bands, suggesting latitude and longitude. The overall color palette is light blue and white.

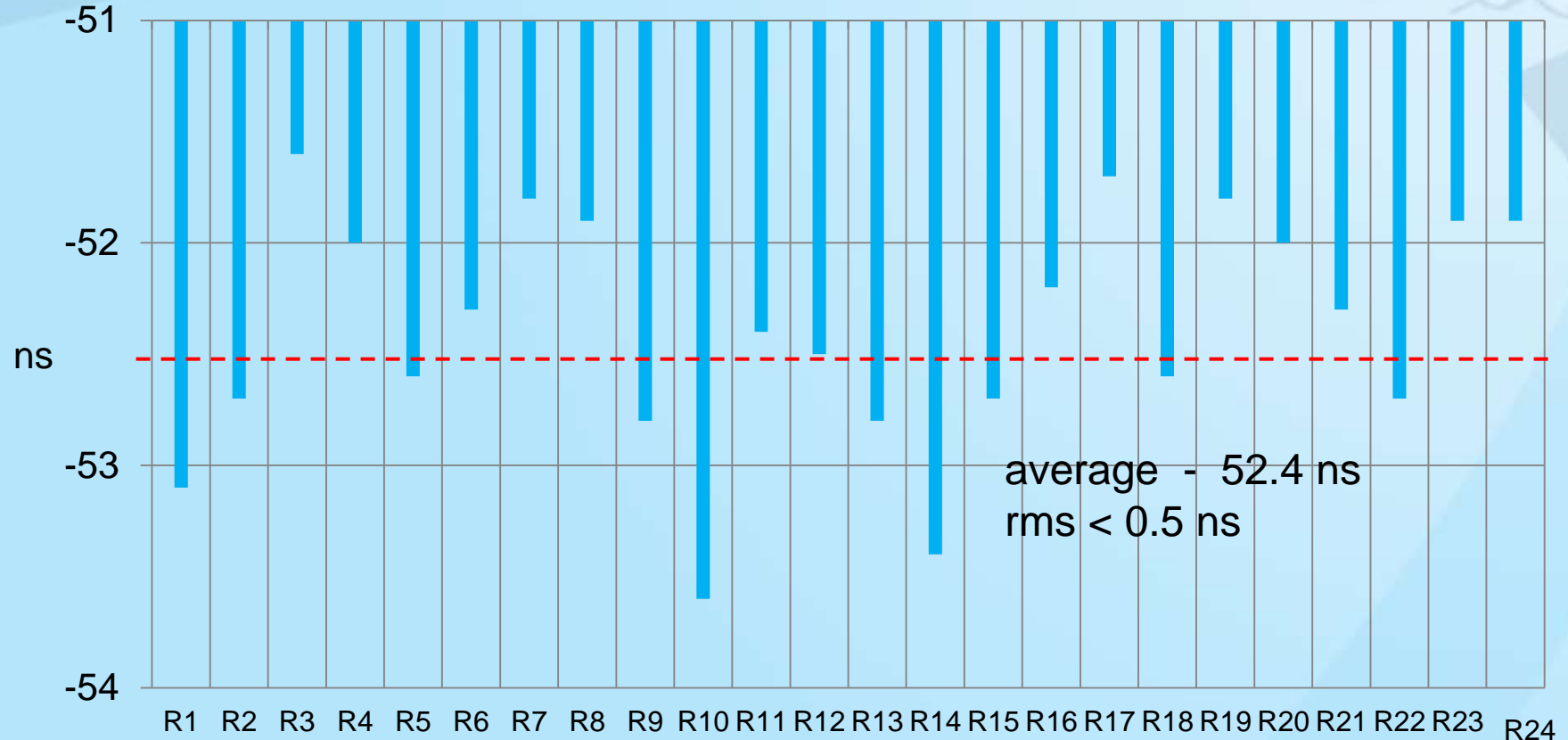
Means of GLONASS metrological assurance

ВНИИФТРИ

Time scale difference monitoring

Results of absolute calibration GLONASS/GPS receivers

REF IN - GLONASS L1 C



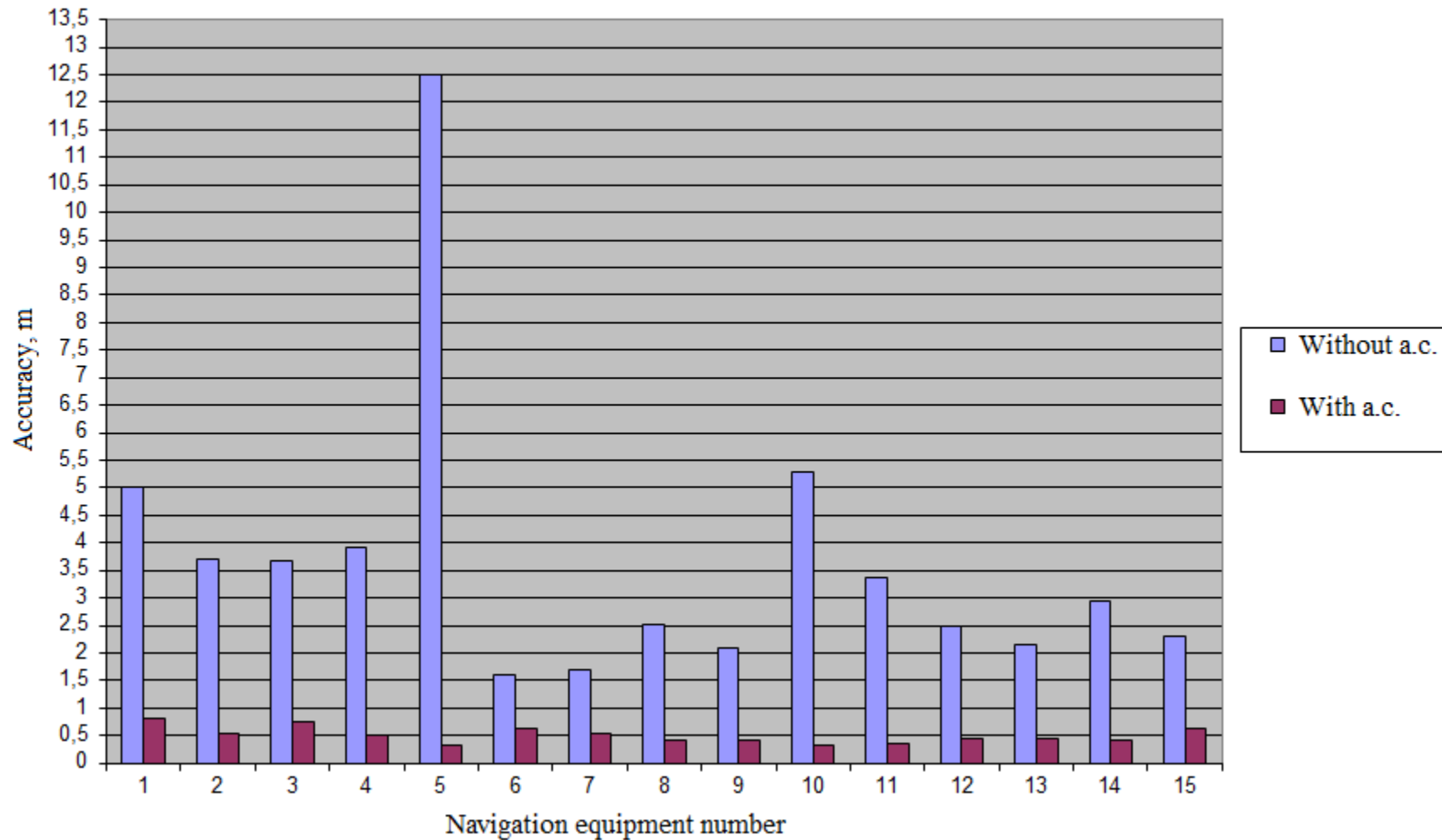
Results of absolute calibration GLONASS/GPS receivers

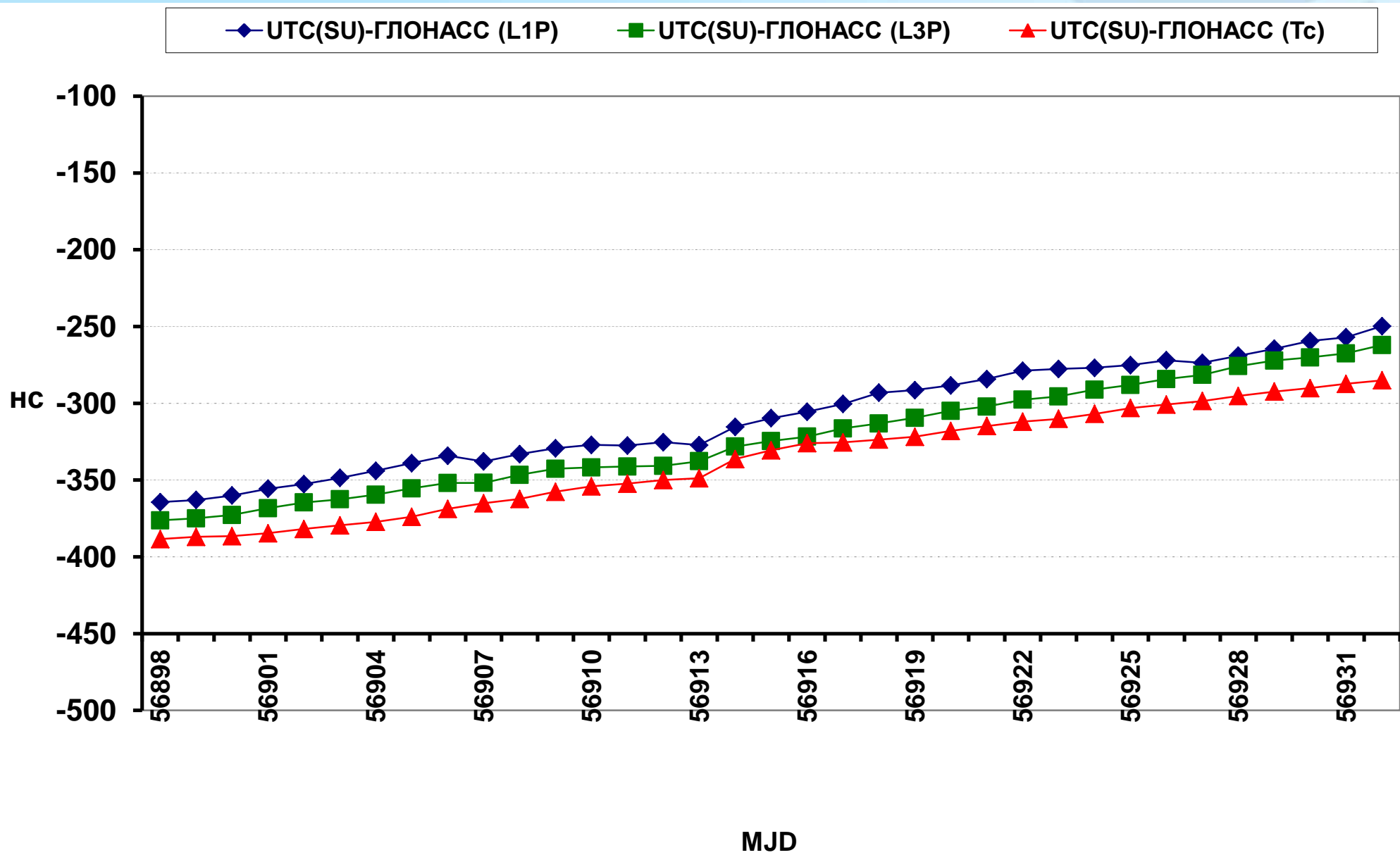
Results of the antenna receiver calibration

Antenna	L1, ns	L2, ns
Javad MarAnt+ SN: MA2994	11.4	15.2
Leica AR25 SN: 09330030	20.3	18.4
GPS-703-GGG SN: NEG 13160014	18.6	17.2

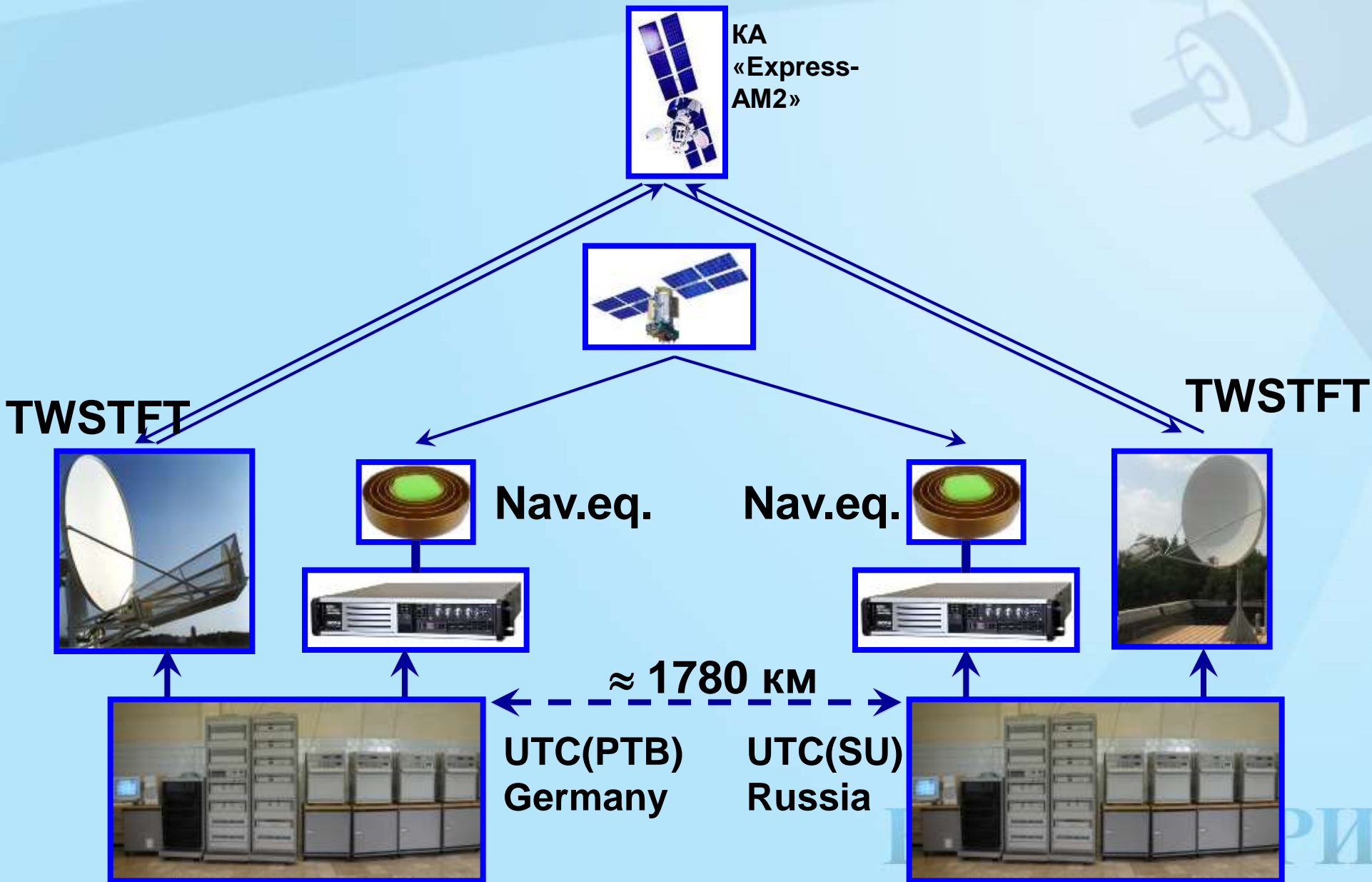
Uncertainty of antenna receiver calibration no more than 0.5 ns

Accuracy with and without calibration

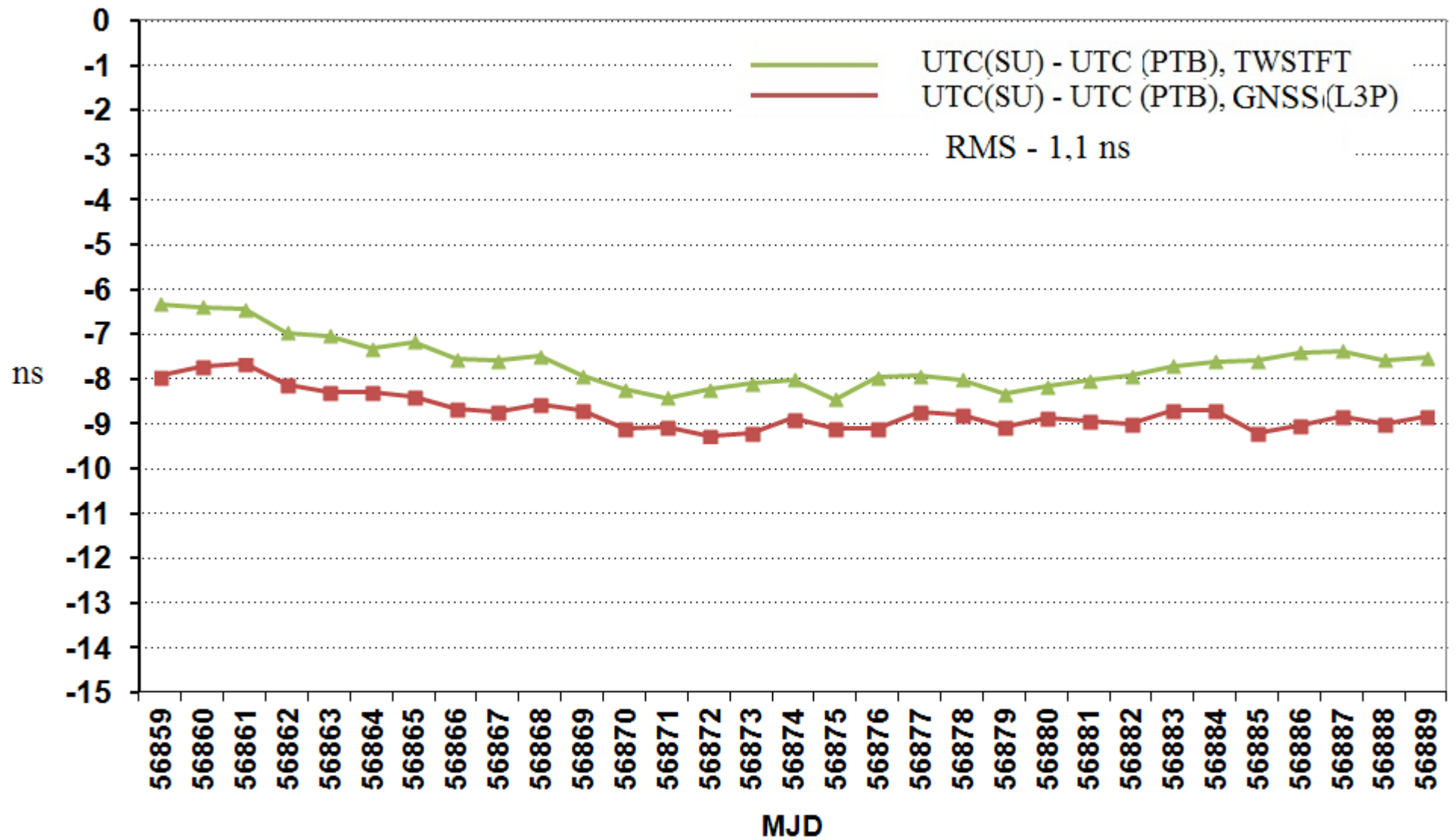




Experiment on UTC(SU) and UTC(PTB) time scale comparison



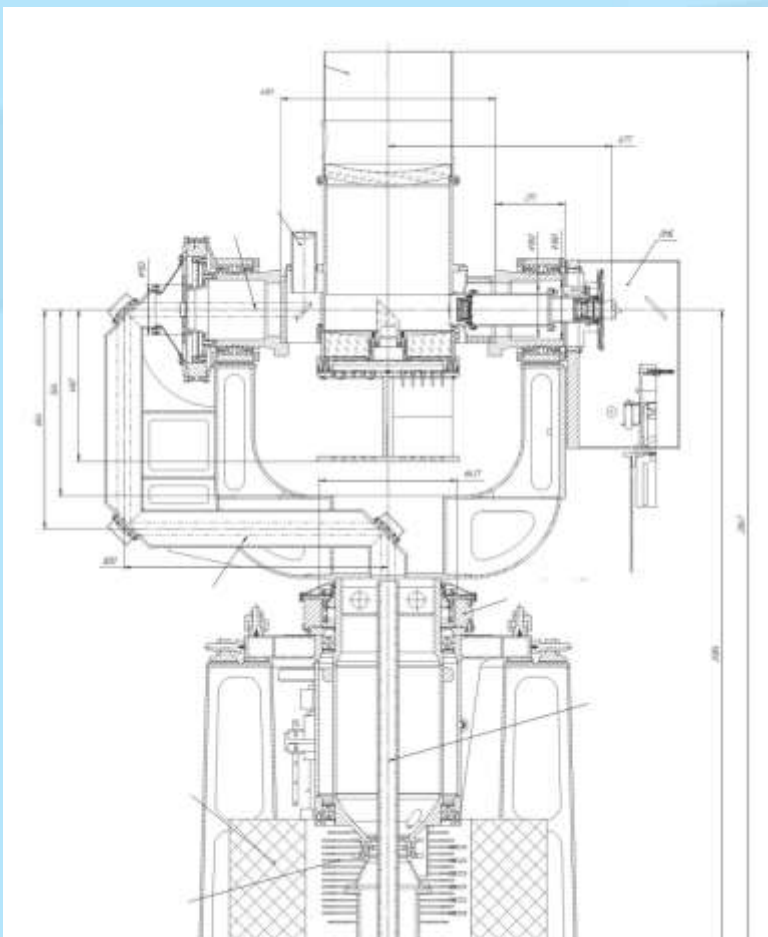
Results of UTC(SU) and UTC(PTB) time scale comparison





Spectral and time characteristics of GNSS signal measurement

L1 (1602 MHz), L2 (1246 MHz), L3 (1202 MHz) GLONASS;
GPS L1 (1575 MHz), GPS L2 (1227 MHz), GPS L5 (1176 MHz), GALILEO L1 (1575 MHz), GALILEO E5a (1176 MHz), GALILEO E5b (1207 MHz)



New SLR system

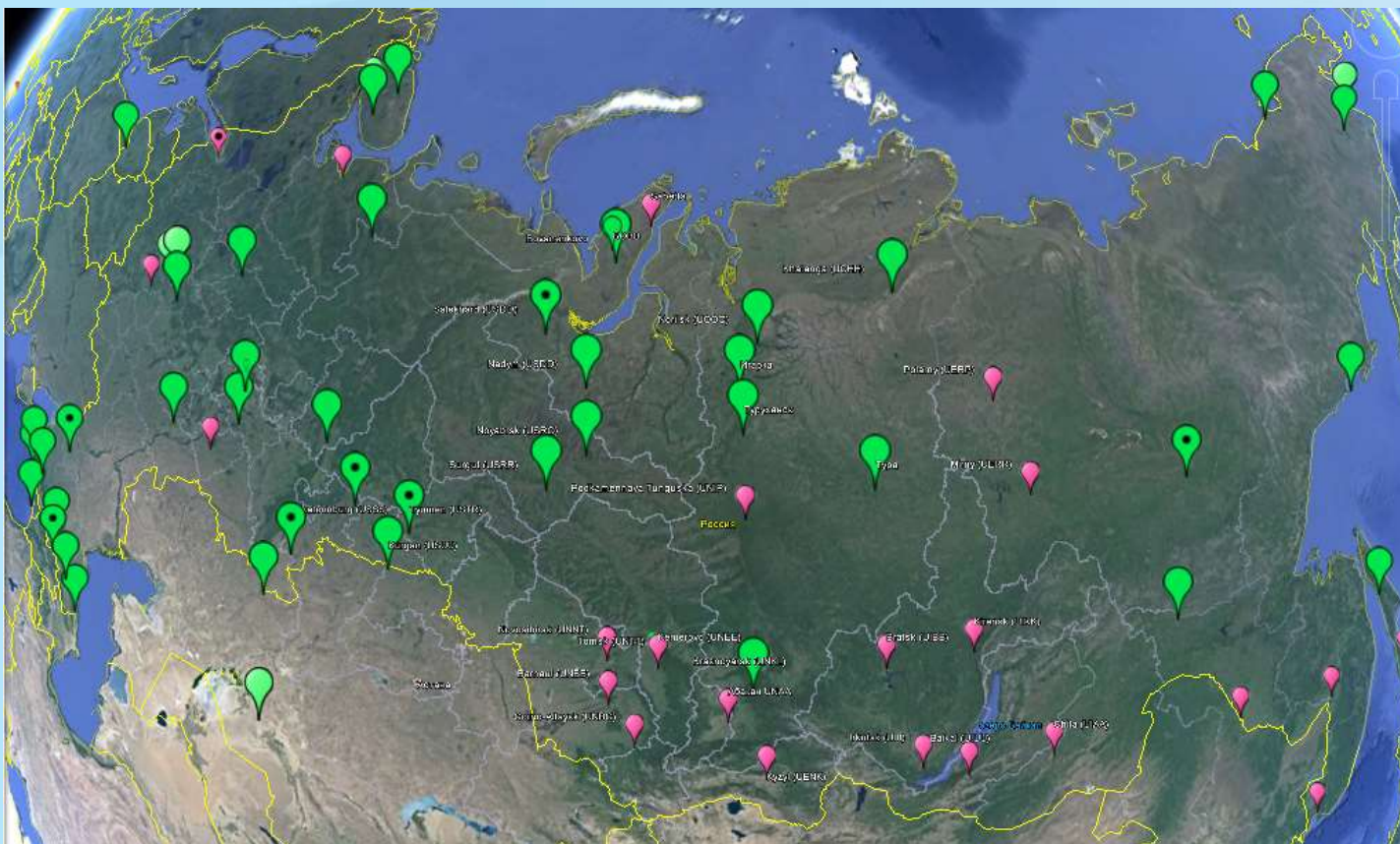
Accuracy of no more than 1 mm for the averaging period of 300 s

ВНИИФТРИ

The background features a light blue color scheme with a stylized satellite in the upper right corner and a globe-like shape in the center. The satellite is depicted with various components, including a cylindrical body and a protruding antenna. The globe is represented by a curved, shaded band across the middle of the frame.

GNSS monitoring center for civil aviation of the Russian Federation

ВНИИФТРИ

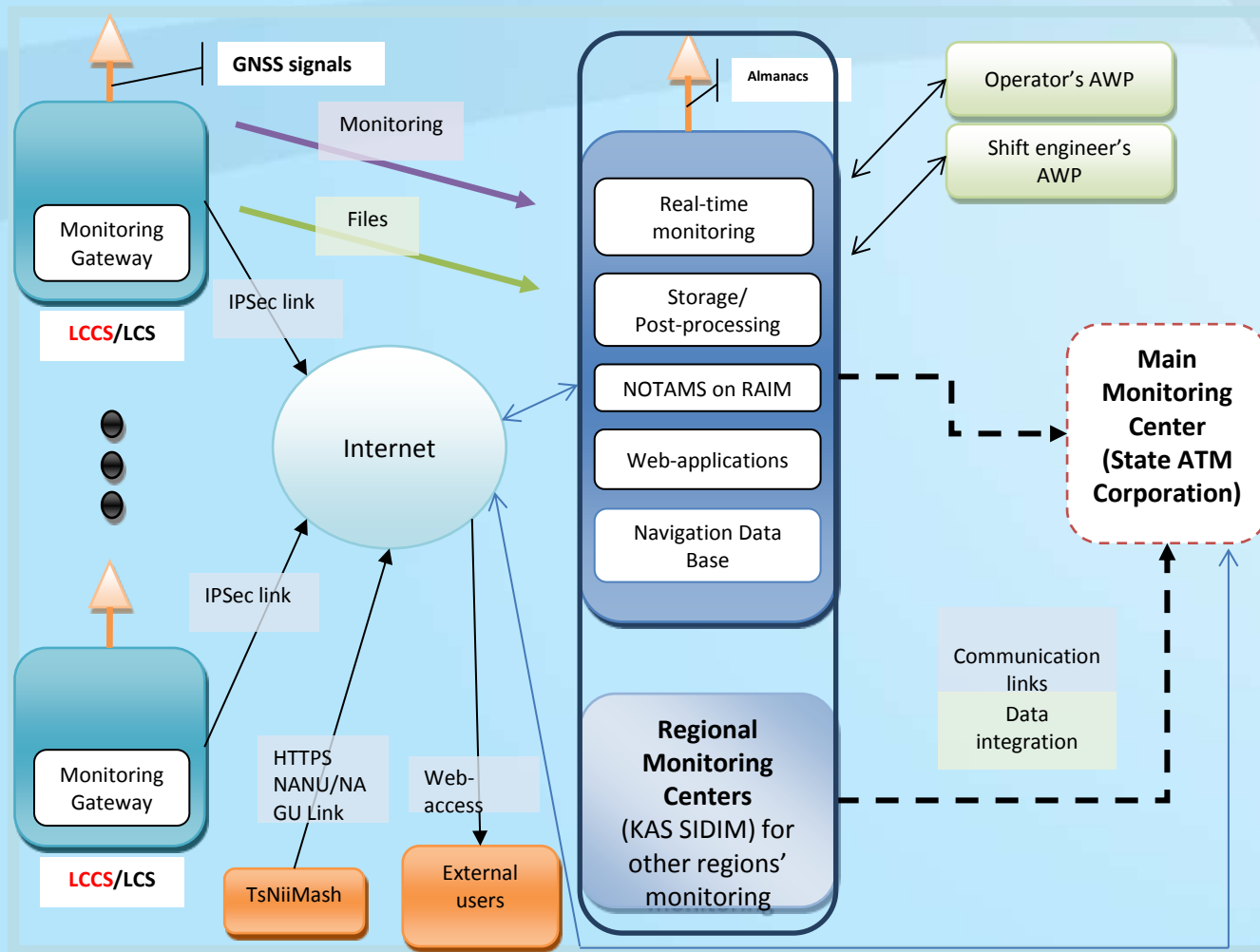


The verified stations are marked in green

The main source for monitoring information on the GNSS status is the network of local multi-system (GPS/GLONASS) control and correction stations GBAS LCCS-A-2000 developed in the RF. These stations provide ICAO CAT I landings defining differential corrections for aircraft coordinates and passing them on board aircraft (AC) in their area of responsibility



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Proposals on the ICG recommendations

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Recommendation:

Among current GNSS monitoring activities, each has its own service/analysis center with different information service:

Those centers may be associated under the ICG's umbrella

Information about each center may be available on the ICG portal

Both existing and perspective system's centers may provide raw data, products and information service of GNSS OS monitoring with free access, free of charge

To archive the goal of international recognition of monitoring and assessment results, this centers must use the unified list of characteristics to be monitored and their unified definitions; unified calculation methods; for the technical means of monitoring must be assured the international recognition of their accuracy and other characteristics on base of national standards.

Recommendation of ICG WG-A Action:

WG-A recommends that existing monitoring [service] centers for GNSS open services establish a link to a new ICG portal designed by the IGMA Task Force.

This portal will allow GNSS users worldwide to easily find GNSS monitoring information and products by just looking for the ICG webpage.

Eventually, open service monitoring and analysis centers linked to the ICG portal will use an ICG-recommended list of open service parameters to be monitored that are defined and calculated using accepted techniques and procedures based on a consensus among GNSS service providers.



Thank you for your attention!

ВНИИФТРИ