FEDERAL SPACE AGENCY

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Satellite GLONASS/GPS navigational device for the space tug "Fregat".

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Working Group B, 17 May 2011, Shanghai, China

Initial data

1. SV "Glonass-K", launch 26.02.2011 at ~ 06 h 07 m, Plesetsk

2. Regular orbit: circular, altitude h= 19100 km

3. SV "Electro-L", launch 20.01.2011 at ~ 15 h 29 m, Baikonur

4. Regular orbit: circular, geostationary, altitude h= 36000 km

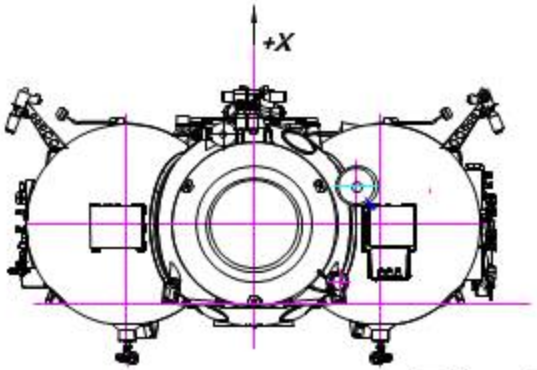
5. Continuous GLONASS navigation field up to 2000 km

6. Continuous GPS navigation field up to 3000 km

7. АСН-Ф navigation equipment operated in GLONASS/GPS continuous and discrete navigation fields

8. Navigation is possible than not less 4 SV are found in visibility zone

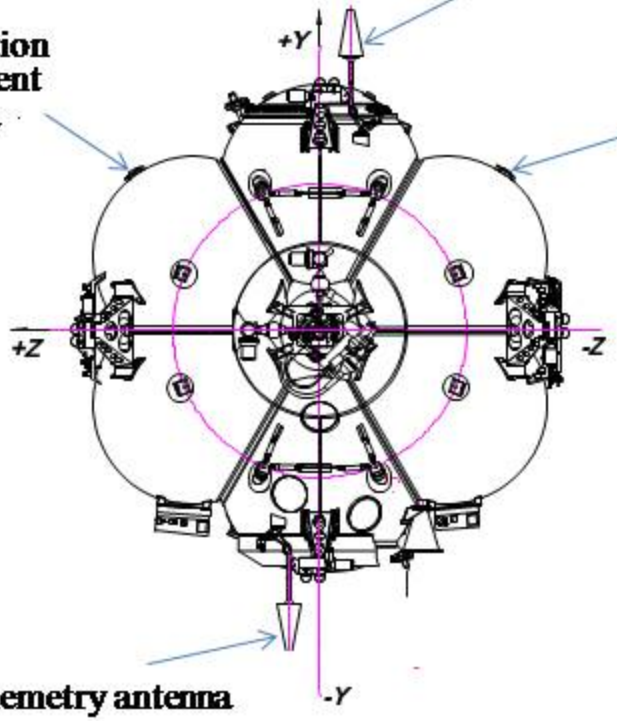
Space tug "Fregat" configuration



Telemetry antenna

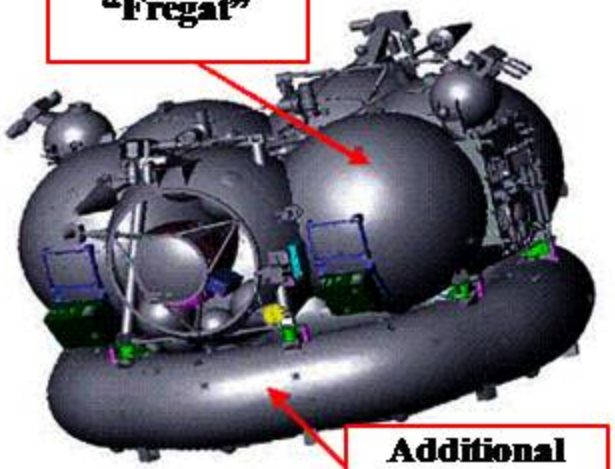
Navigation equipment antenna

Navigation equipment antenna



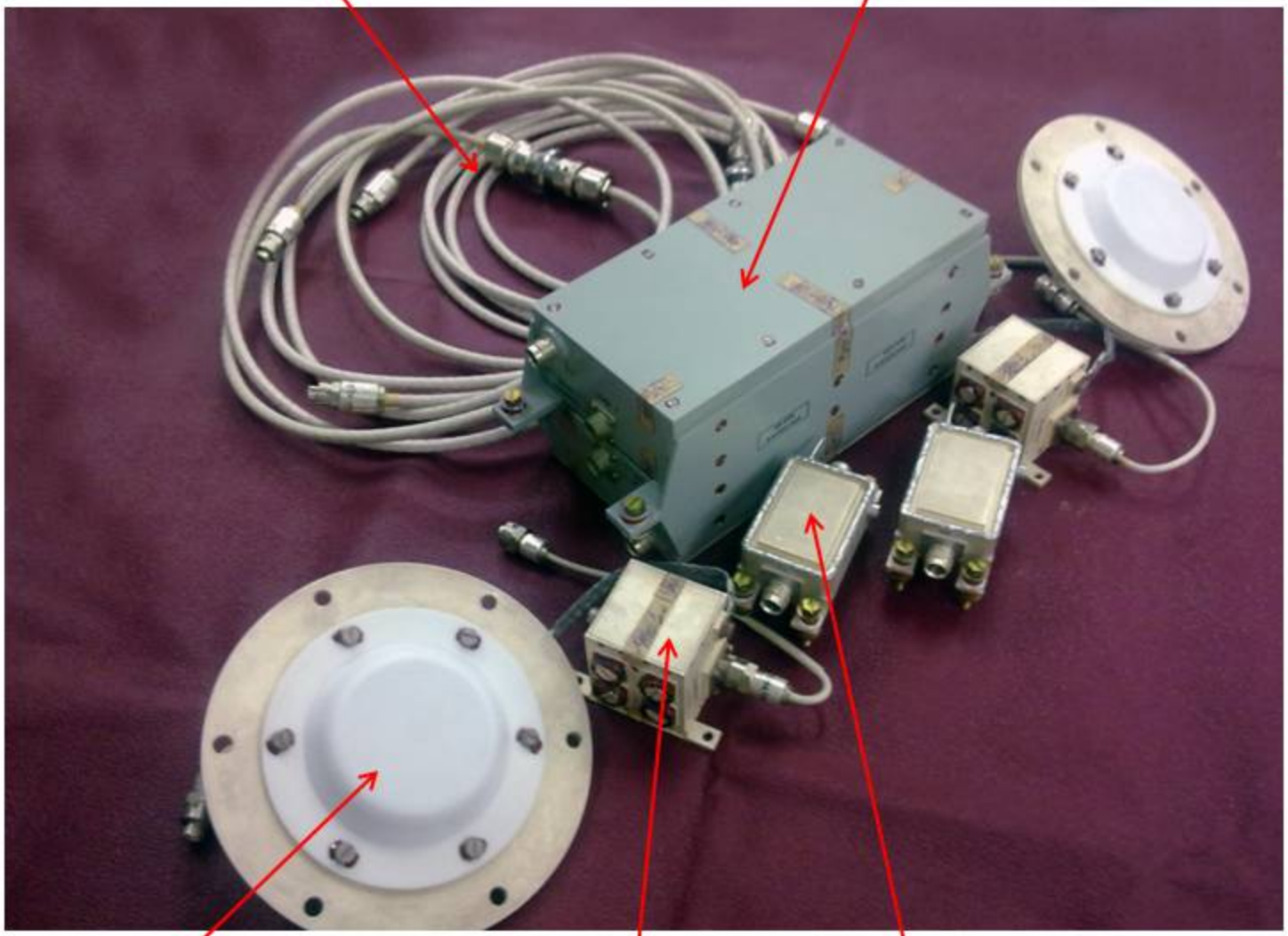
Telemetry antenna

Space tug "Fregat"



Additional tank

Navigation equipment



Main characteristic

Signals: GLONASS/GPS

Frequency band: L1

Number of channels: 12

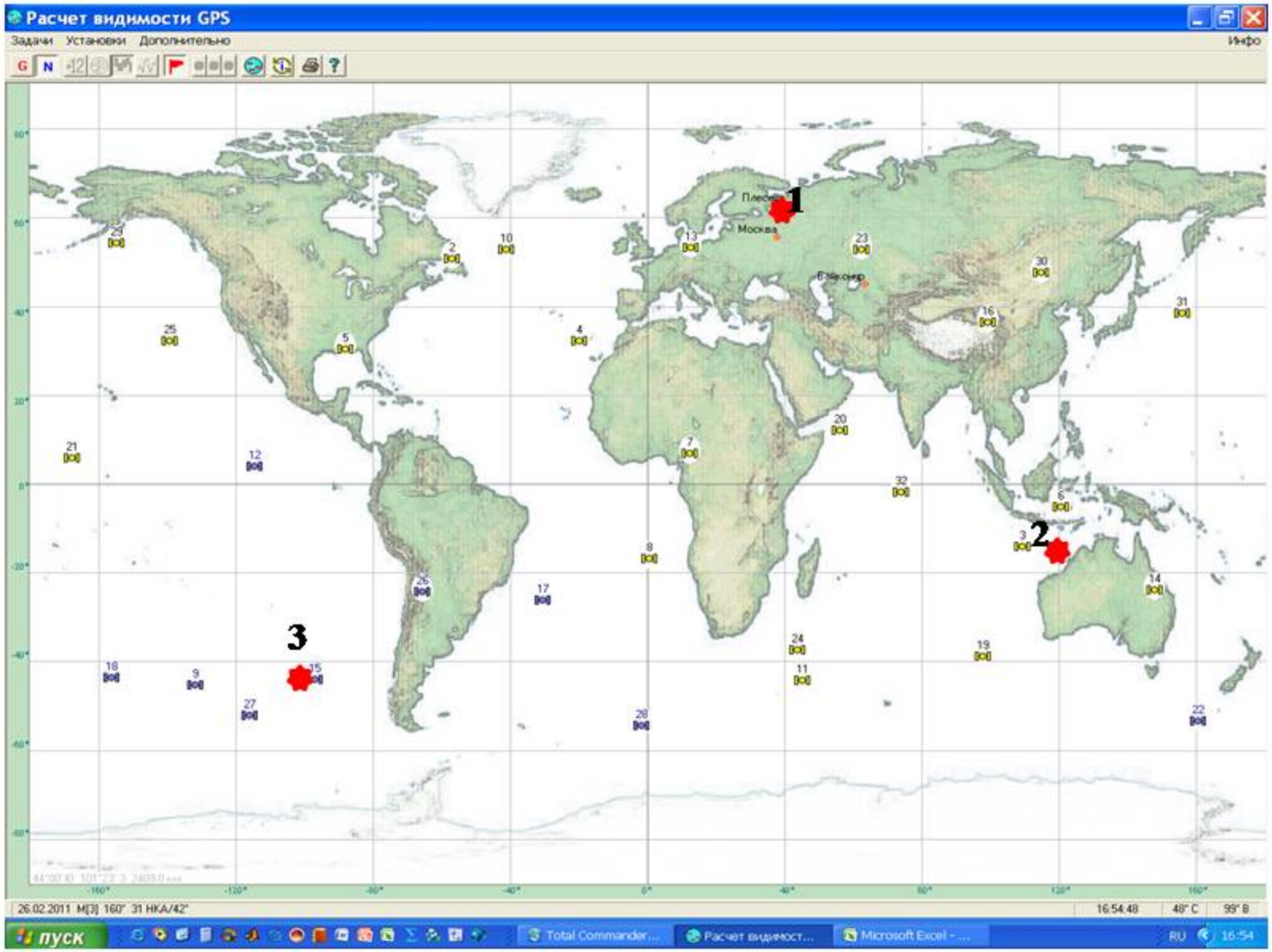
Mass (2 modules): 5 kg

Power consumption (2 modules): 17 W

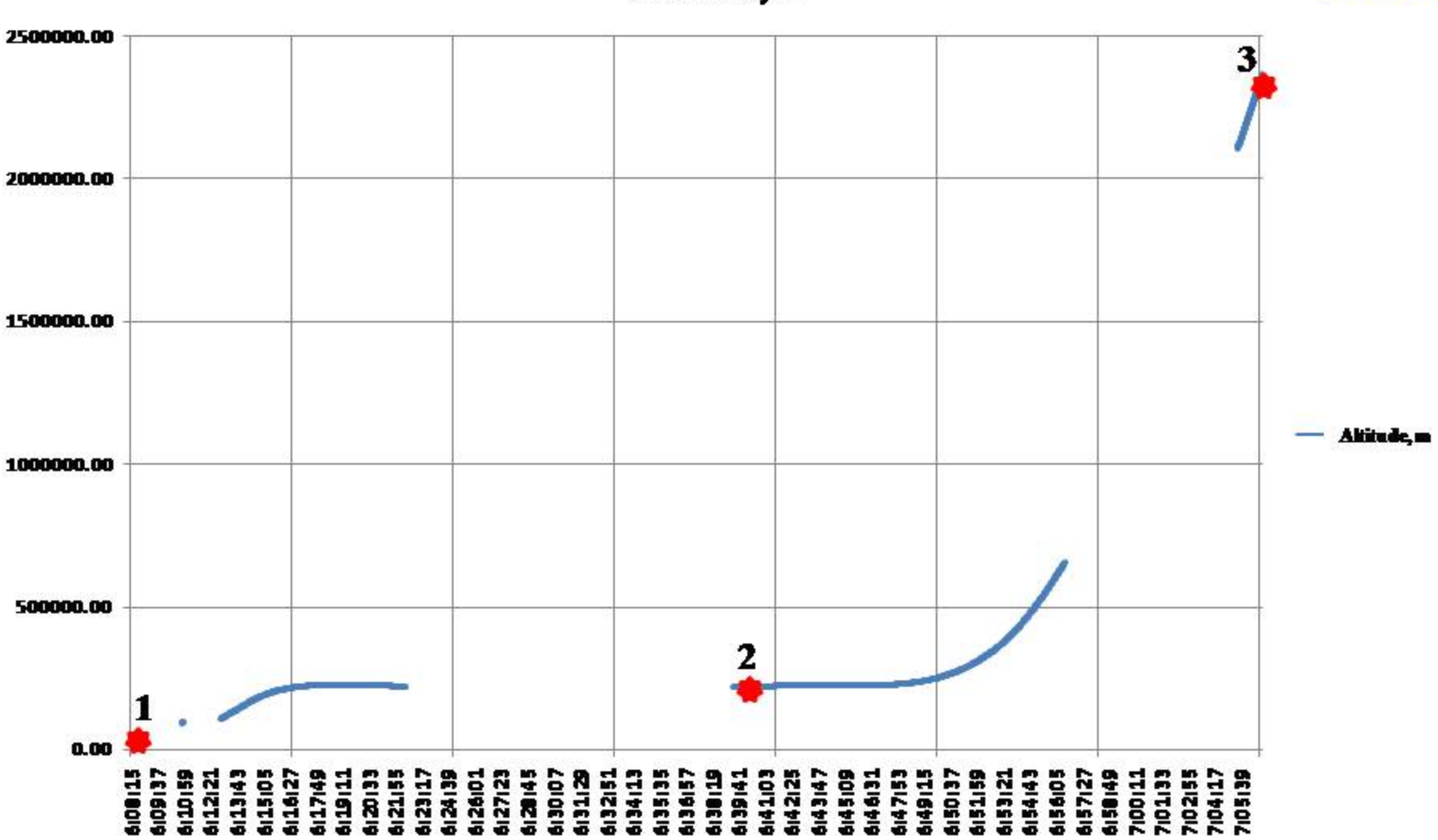
Output data:
coordinate vector,
velocity vector,
raw measurements,
ephemerides,
clock parameters,
telemetry parameters

Navigation accuracy
coordinates $3\sigma \leq 20$ m
velocity $3\sigma \leq 6$ sm/s

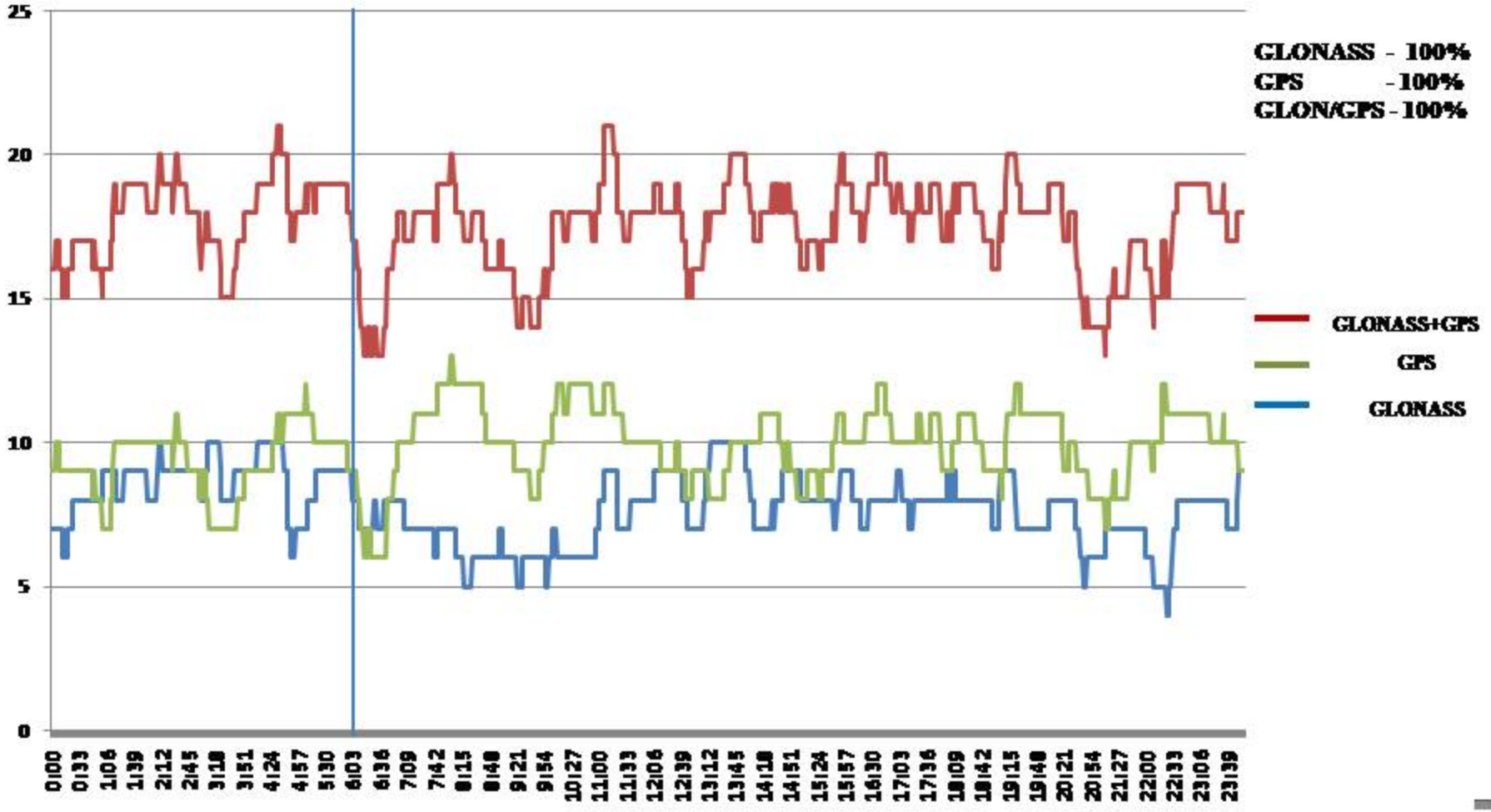
SV «Glonass-K» launch (1)



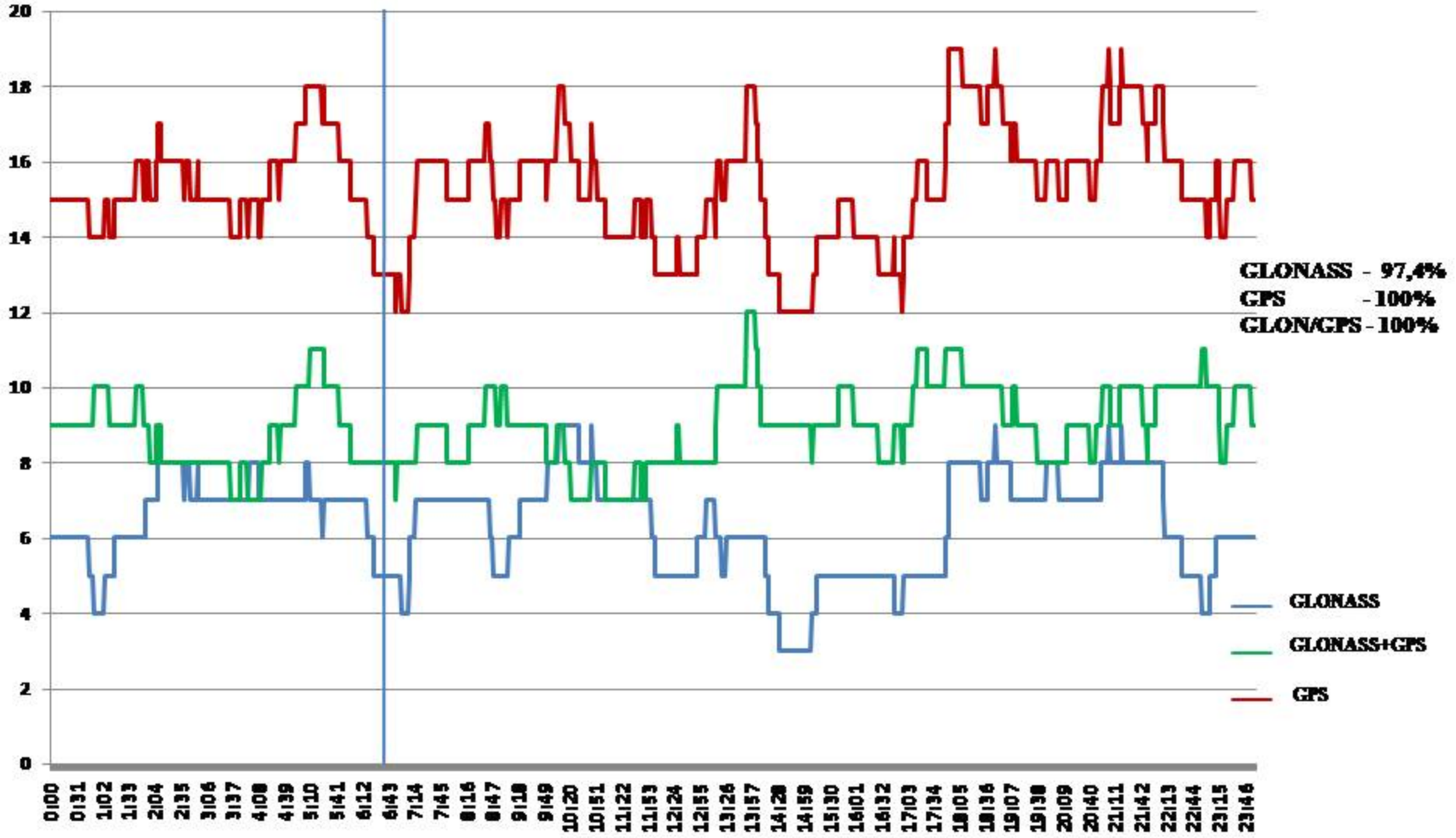
SV «Glonass-K» launch (2)



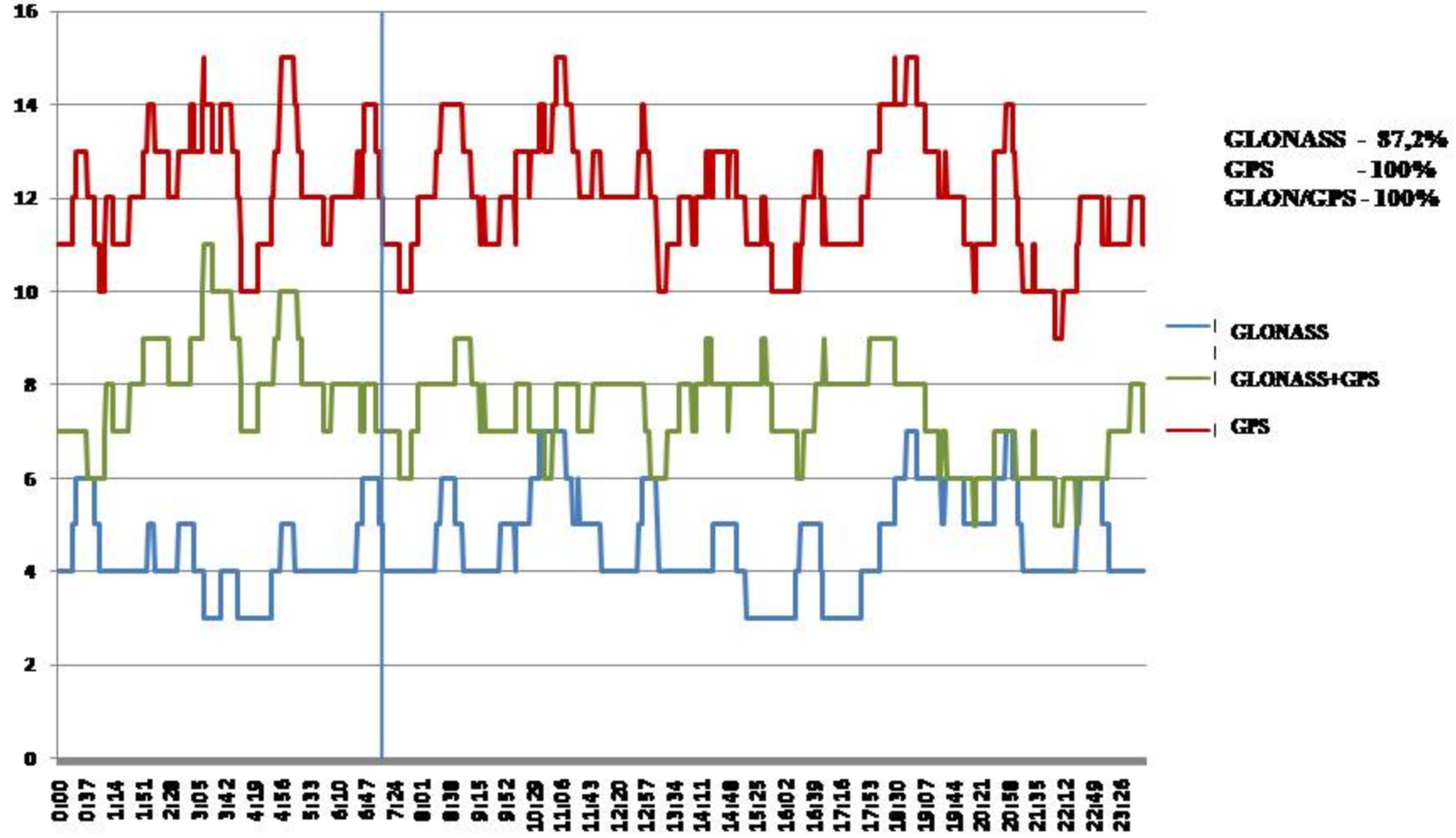
SV «Glonass-K» launch, GLONASS/GPS SVs visibility at ground surface (point 1)



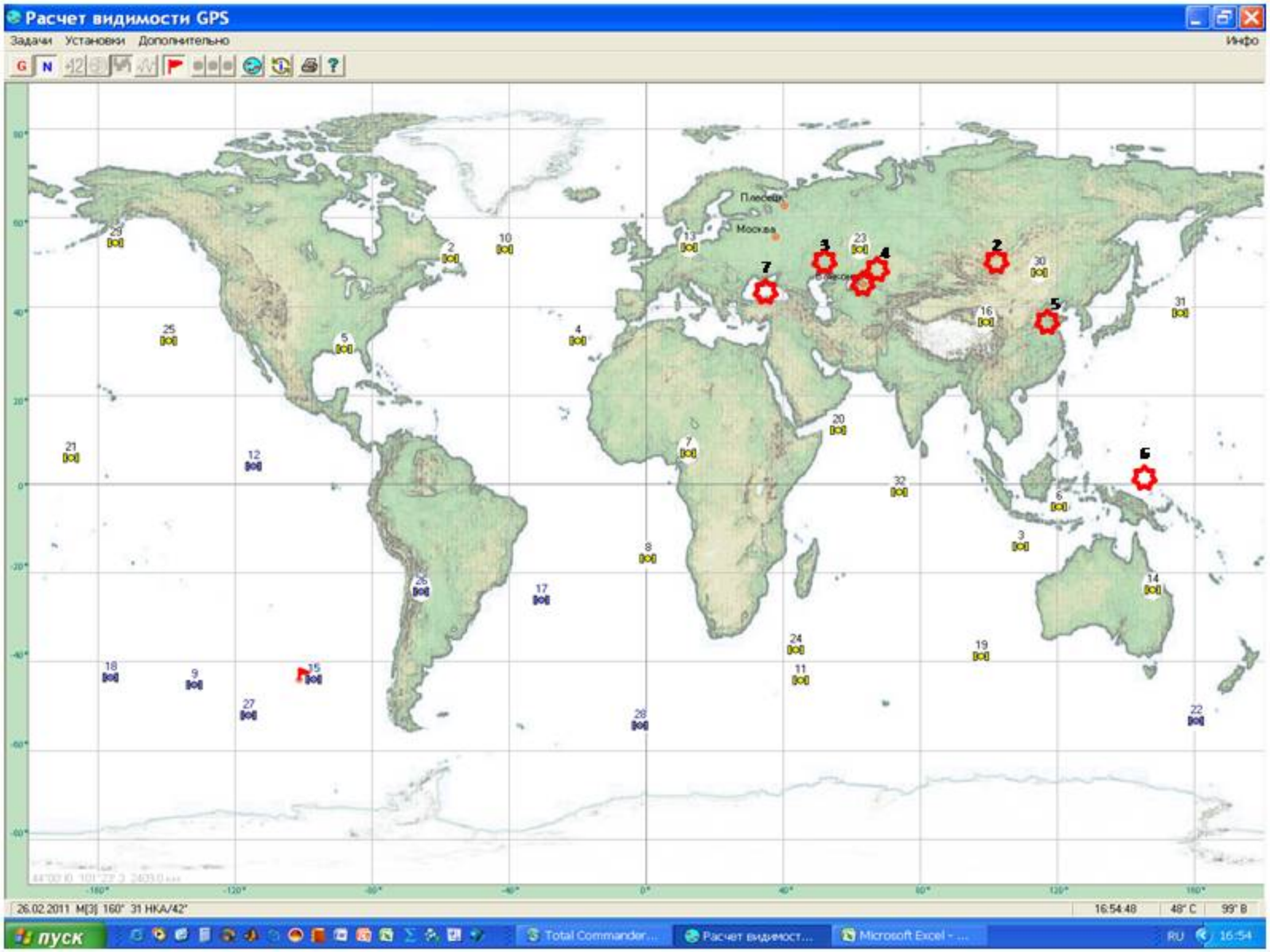
SV «Glonass-K» launch, GLONASS/GPS SVs visibility at altitude 215 km (point 2)



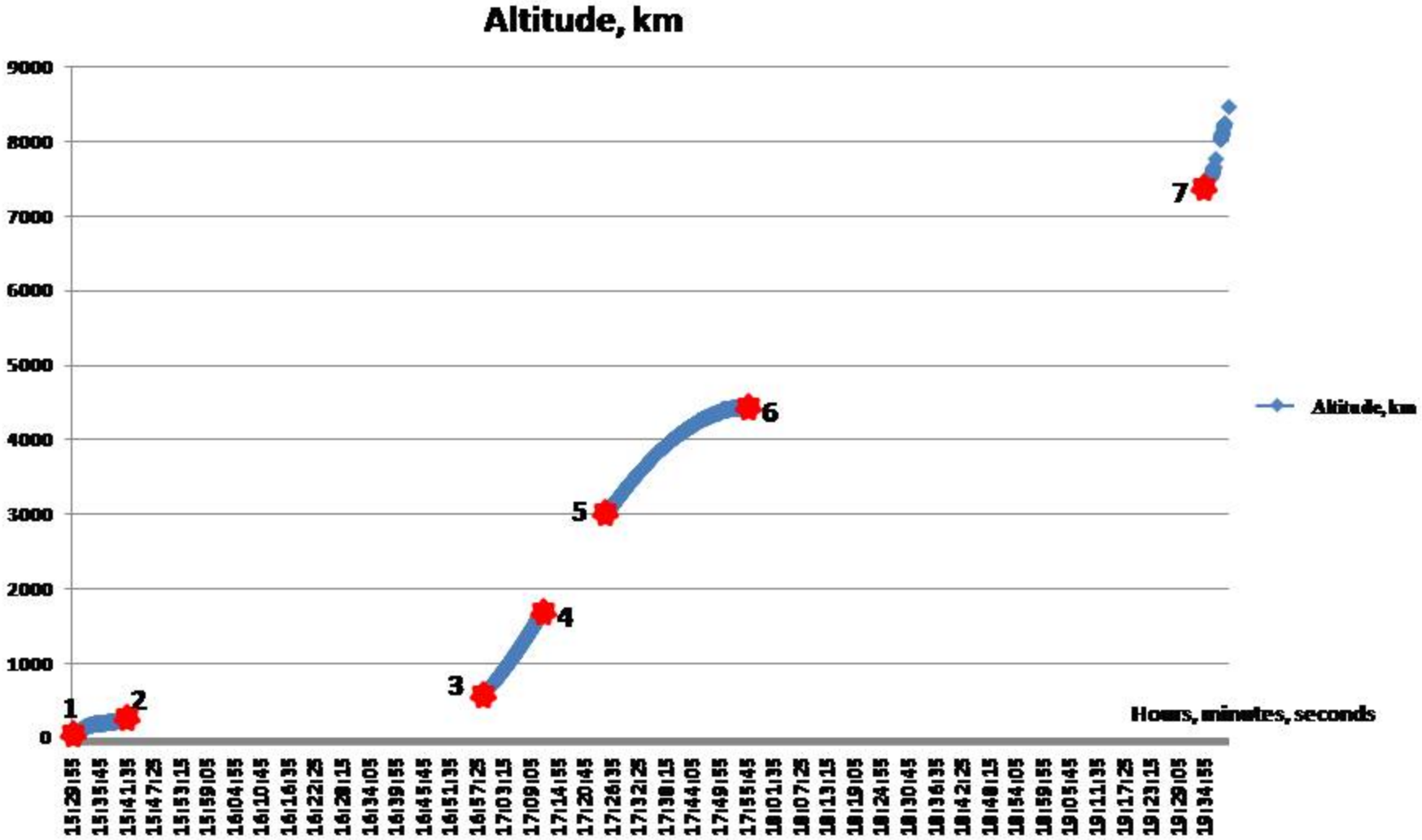
SV «Glonass-K» launch, GLONASS/GPS SVs visibility at altitude 2409 km (point 3)



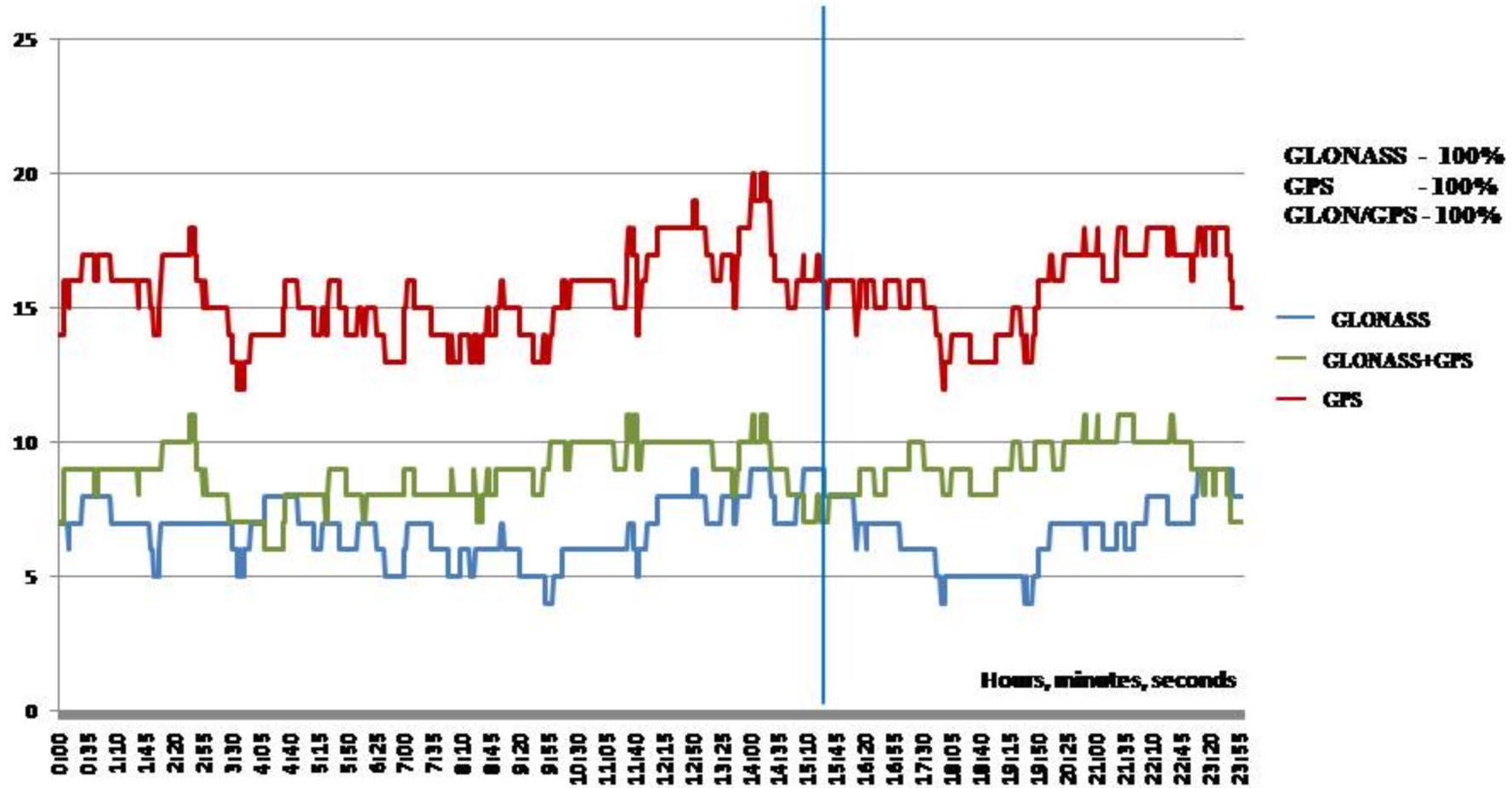
SV «Electro-L» launch (1)



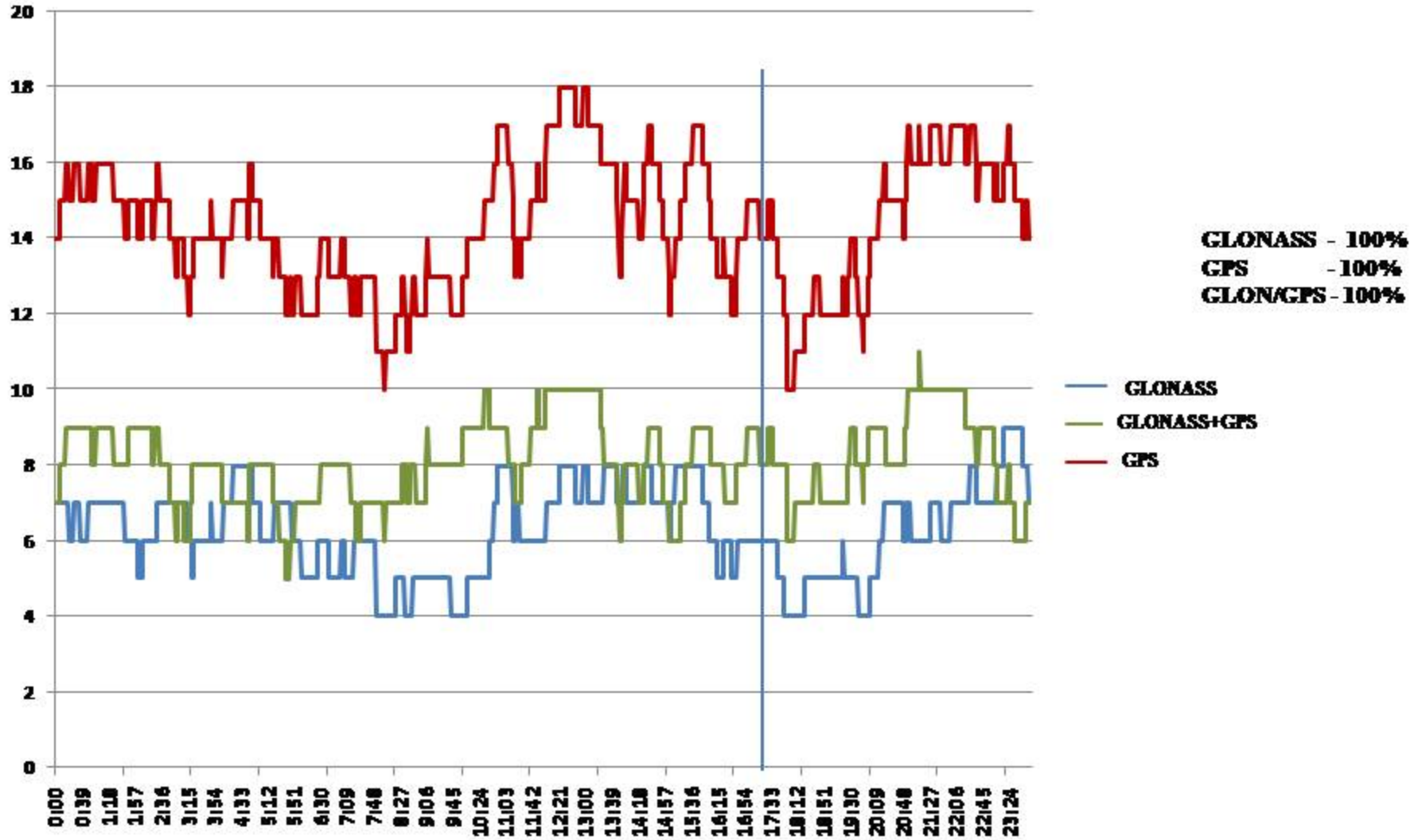
SV «Electro-L» launch (2)



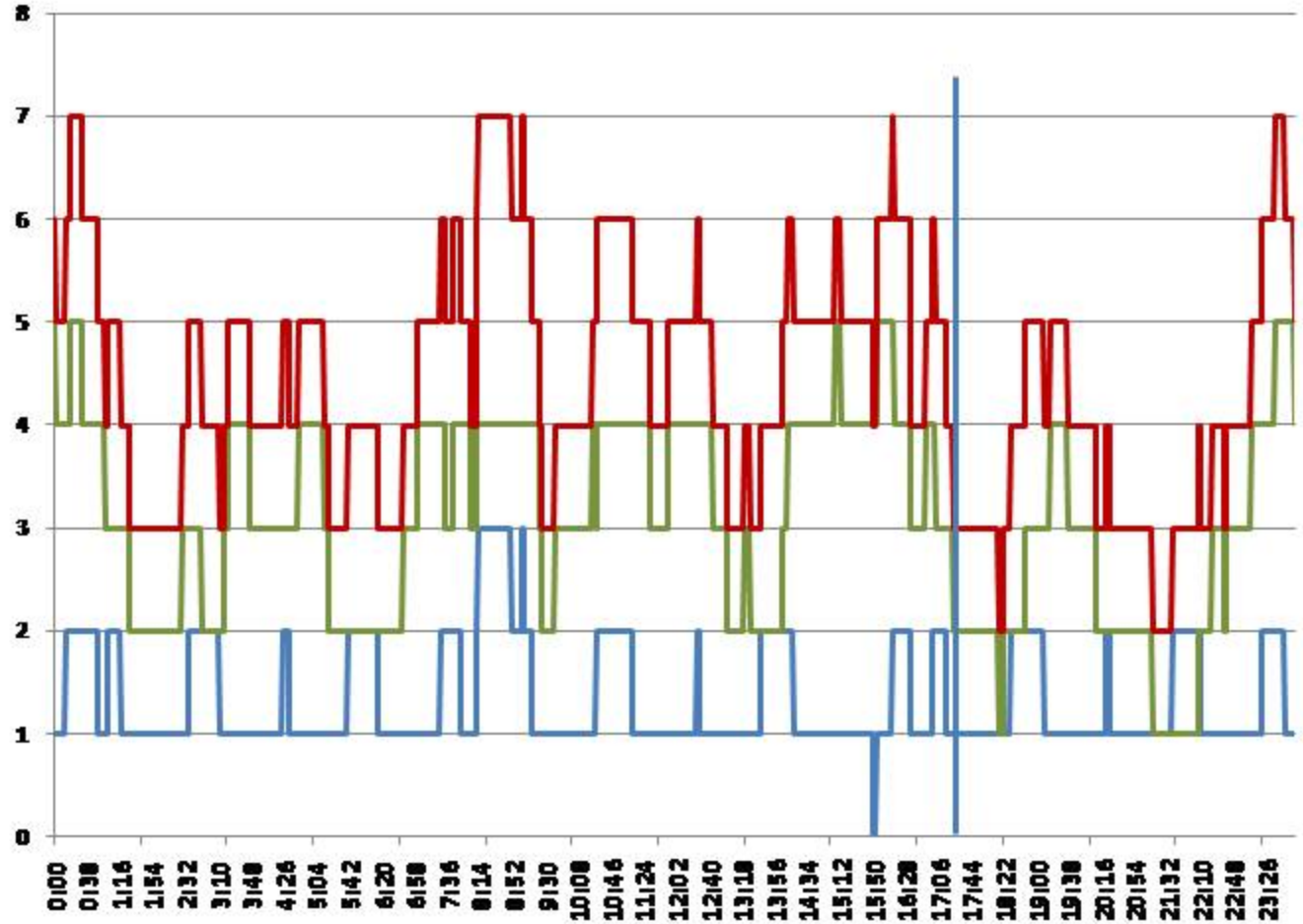
SV «Electro-L» launch, GLONASS/GPS SVs visibility at ground surface (point 1)



SV «Electro-L» launch, GLONASS/GPS SVs visibility at altitude 1666 km (point 4)

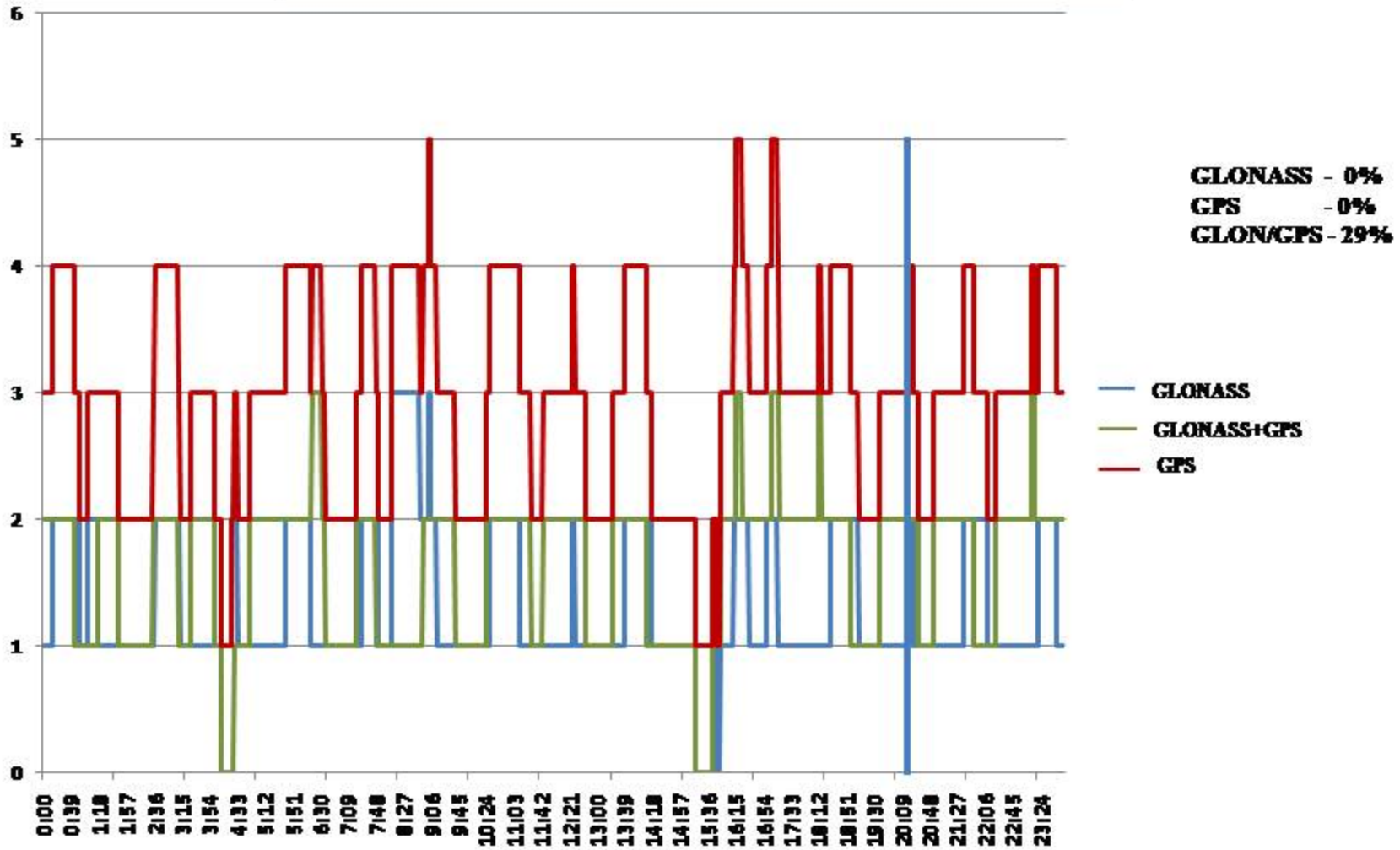


SV «Electro-L» launch, GLONASS/GPS SVs visibility at altitude 4400 km (point 6)



GLONASS - 0%
GPS - 36%
GLON/GPS - 75%

SV «Electro-L» launch, GLONASS/GPS SVs visibility at altitude 7000 km (point 7)



Summary

1. The use of navigation equipment in the control systems of space vehicles, launch vehicles, space tugs improves the accuracy and reliability of their navigation.

2. Mainly two versions of navigation equipment are applied:
   - direct use of the navigation equipment;
   - periodic adjustment of inertial facilities with navigation equipment.

3. Reliable and precise navigation of space objects using one GNSS is only possible in the presence of a continuous navigation field (GLONASS $h \leq 2000$ km, GPS $h \leq 3000$ km)

4. For reliable operation of navigation equipment in GNSS discrete fields it is advisable to use more than two GNSS.

5. I propose to include the next question in the work plan of the Group "B".
   Navigation of space objects in discrete navigational fields:
   - benefits of multiple GNSS use,
   - probability of navigation definitions,
   - accuracy of navigation,
   - special features of navigation equipment design.