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## **IMPROVEMENT OF GLONASS ACCURACY WITH MORE STABLE ON-BOARD CLOCKS**

***Eremenko Natalia, ISS-Reshetnev***

***ISS – Reshetnev Company***





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## RECENT LAUNCH: GLONASS-M #52



**Glonass-M #52**

**Launch date: 22.09.2017**

**Operation: 16.10.2017.**



<b>Mass</b>	<b>1415 kg</b>
<b>EPS Power</b>	<b>1400 W</b>
<b>ADCS</b>	<b>Three-axes, active</b>
<b>Lifetime</b>	<b>7 years</b>
<b>Orbit type</b>	<b>MEO circular, inclined</b>
<b>Orbit height</b>	<b>19100 km</b>
<b>Clocks</b>	<b>3 Caesium clocks (<math>1 \times 10^{-13}</math>)</b>
<b>FDMA signals</b>	<b>L1OF, L1SF, L2OF, L2SF</b>

**6 more Glonass-M SCs are being stored at ISS-Reshetnev.**

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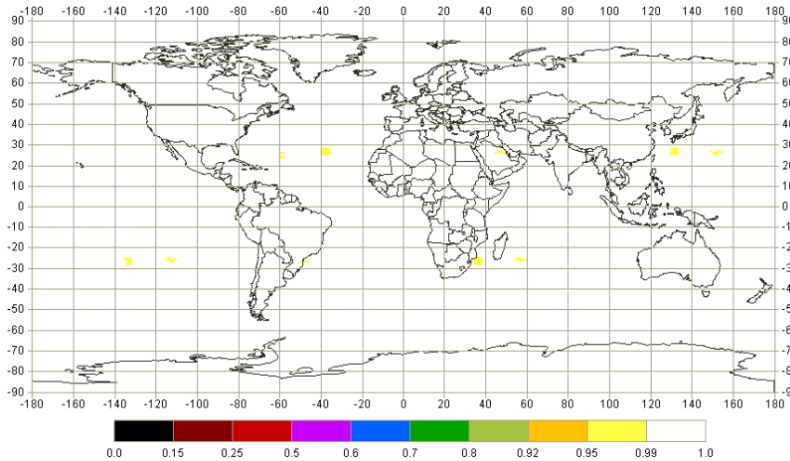
# GLONASS AVAILABILITY



РОСКОСМОС



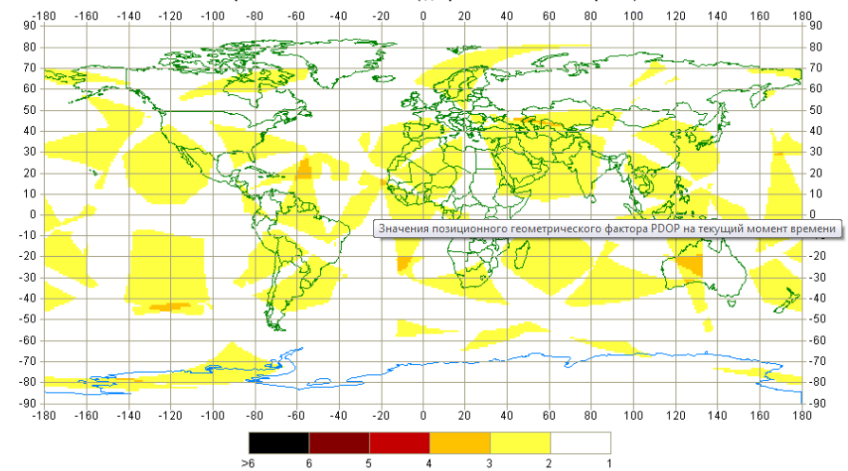
Global Average Availability 100%



Интегральная доступность глобально: 100.0%  
Интегральная доступность по России: 100.0%

<https://www.glonass-iac.ru/GLONASS/CumulativeAvailability.php>

PDOP Map  
5° elevation mask



<https://www.glonass-iac.ru/GLONASS/MomentaryAvailability.php>

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РОСКОСМОС

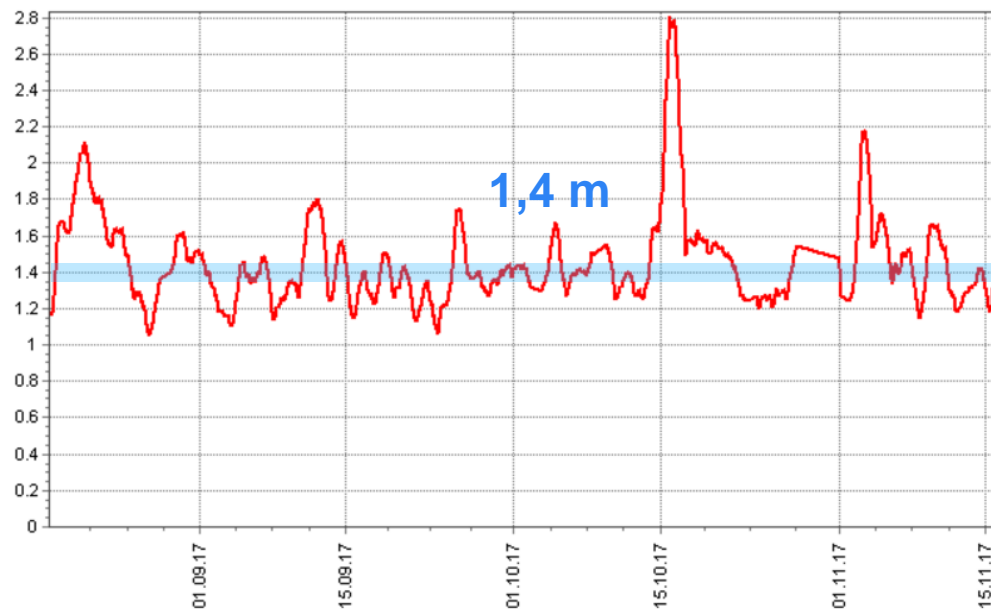


# GLONASS PERFORMANCES



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Daily Averaged SISRE, m



[https://www.glonass-iac.ru/GLONASS/technical\\_characteristics.php](https://www.glonass-iac.ru/GLONASS/technical_characteristics.php)

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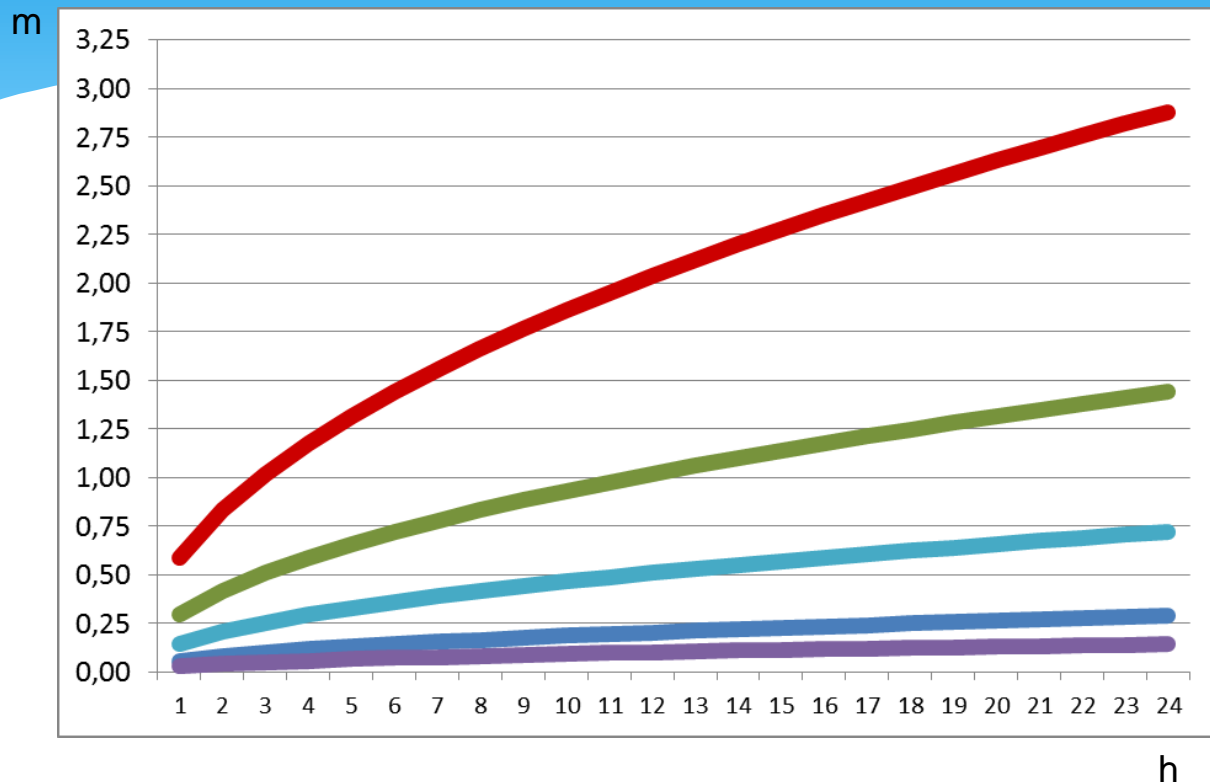
# EXISTING GROUND CONTROL SEGMENT





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## SIS RANGE ERRORS (CLOCK ERROR PREDICTIONS) (M) DUE TO CLOCK INSTABILITY



*On-board Clock  
daily instability*

$1 \times 10^{-13}$

$5 \times 10^{-14}$

$2,5 \times 10^{-14}$

$1 \times 10^{-14}$

$5 \times 10^{-15}$

***With On-Board Clock stability equal or better  $1 \times 10^{-14}$   
the 12-hour prediction error is negligible.***

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# CLOCK DEVELOPMENT FOR FUTURE GLONASS-K2 SPACECRAFTS



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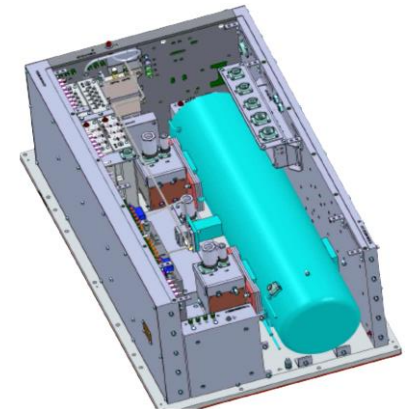
Passive H-maser



Passive H-maser  
Light version



Optically pumped  
Cs atomic clock



Expected daily clock instability in flight: better than  $1 \times 10^{-14}$

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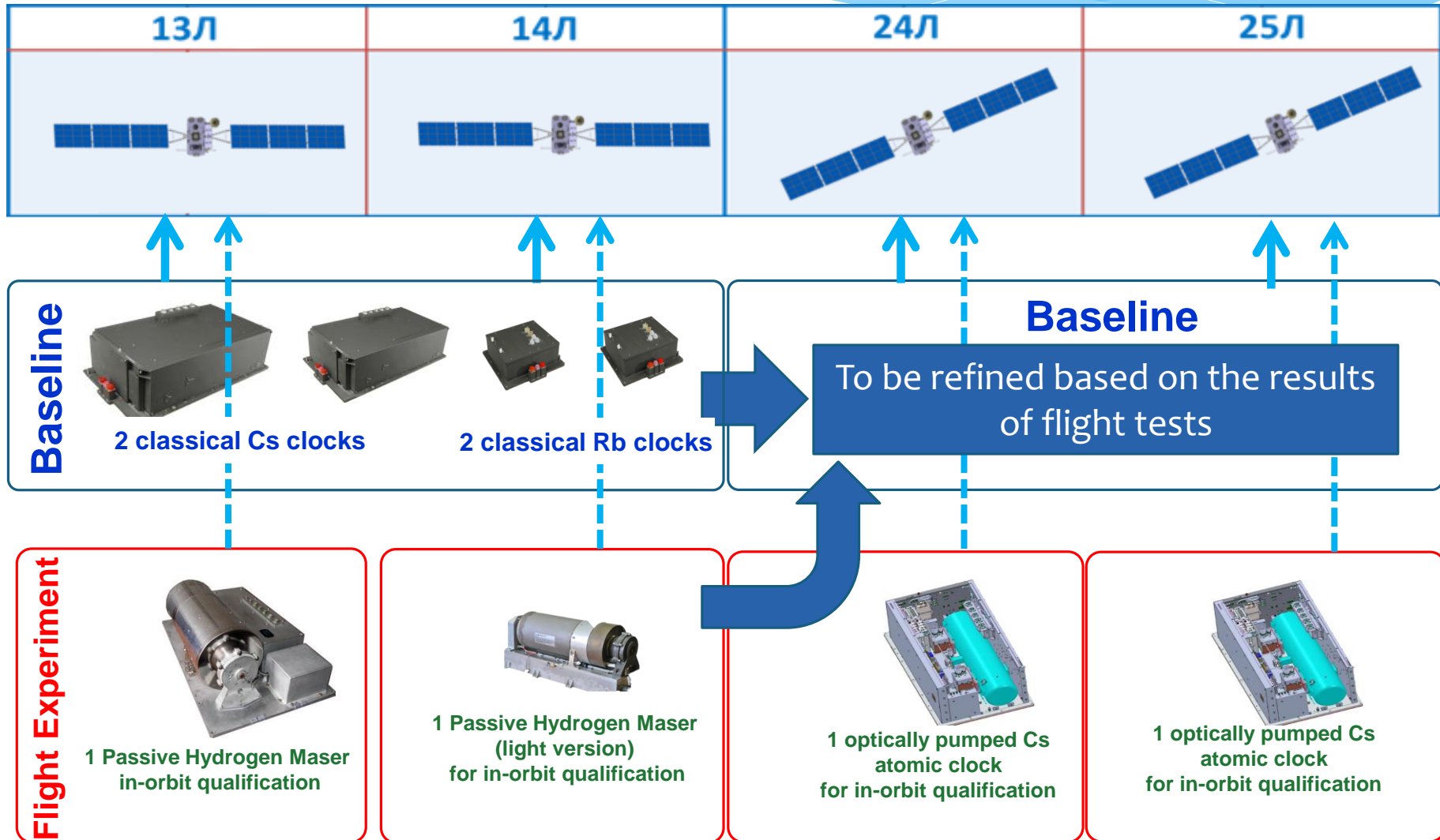


# CLOCK DEVELOPMENT FOR FUTURE GLONASS-K2 SPACECRAFTS



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***Thank you !***

*Eremenko Natalia, ISS-Reshetnev*

**JSC “M.F. Reshetnev “INFORMATION SATELLITE SYSTEMS”**

