IMPROVEMENT OF GLONASS ACCURACY WITH MORE STABLE ON-BOARD CLOCKS

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ISS – Reshetnev Company

12th Meeting of the International Committee on GNSS

December 4, 2017 Kyoto, Japan
Glonass-M #52
Launch date: 22.09.2017

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

6 more Glonass-M SCs are being stored at ISS-Reshetnev.
Global Average Availability 100%

PDOP Map
5° elevation mask


https://www.glonass-iac.ru/GLONASS/MomentaryAvailability.php
Daily Averaged SISRE, m

https://www.glonass-iac.ru/GLONASS/technical_characteristics.php
EXISTING GROUND CONTROL SEGMENT

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

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

Passive H-maser

Passive H-maser
Light version

Optically pumped
Cs atomic clock

Expected daily clock instability in flight: better than $1 \times 10^{-14}$
# CLOCK DEVELOPMENT FOR FUTURE GLONASS-K2 SPACECRAFTS

## Baseline

<table>
<thead>
<tr>
<th>13L</th>
<th>14L</th>
<th>24L</th>
<th>25L</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Satellite" /></td>
<td><img src="image2.png" alt="Satellite" /></td>
<td><img src="image3.png" alt="Satellite" /></td>
<td><img src="image4.png" alt="Satellite" /></td>
</tr>
</tbody>
</table>

- **Baseline**
  - 2 classical Cs clocks
  - 2 classical Rb clocks

## Flight Experiment

- **1 Passive Hydrogen Maser**
  - In-orbit qualification

- **1 Passive Hydrogen Maser (light version)**
  - For in-orbit qualification

- **1 optically pumped Cs atomic clock**
  - For in-orbit qualification

- **1 optically pumped Cs atomic clock**
  - For in-orbit qualification

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*To be refined based on the results of flight tests*
Thank you!

Eremenko Natalia, ISS-Reshetnev

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