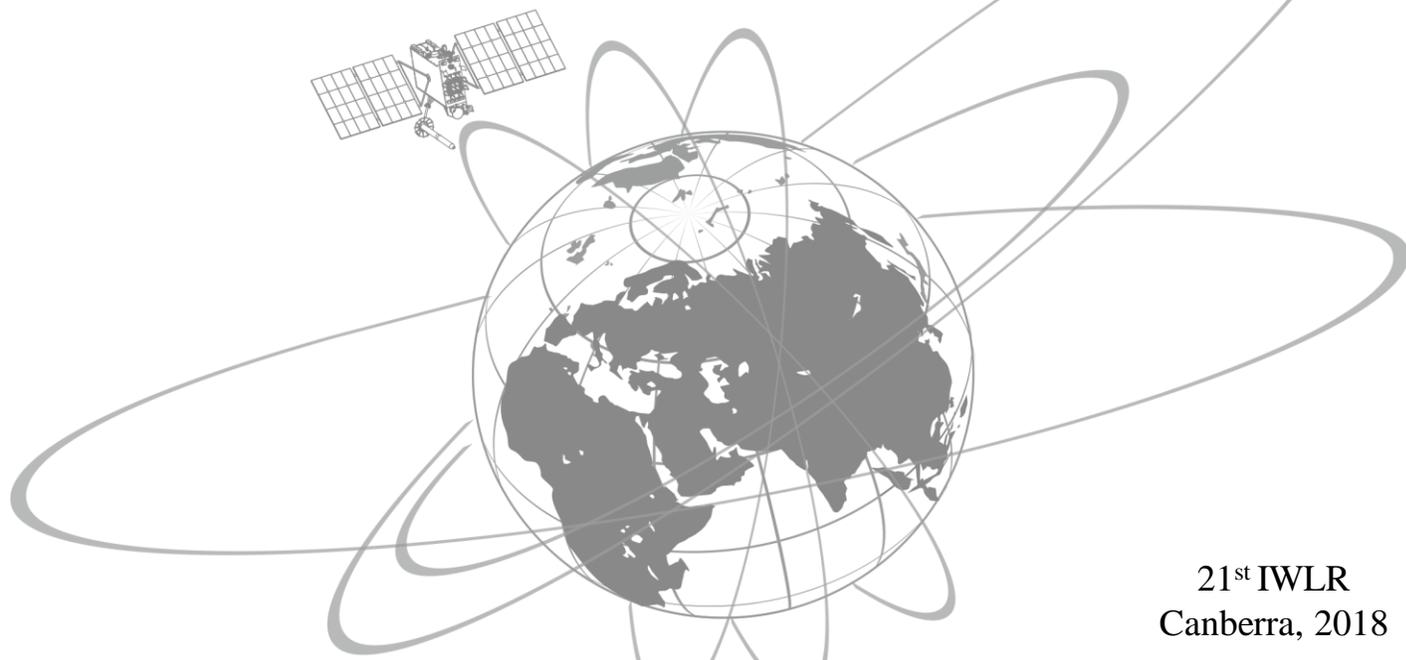




# Estimation of the laser retro-reflector array center location for GLONASS-M

V. Glotov, V. Mitrikas, A. Pafnutyev  
(FGUP TSNIIMASH)



21<sup>st</sup> IWLR  
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# General statement

**Objective:** to study ways to improve the accuracy of ephemeris support for GLONASS-M SC on the basis of joint coordinated use (co-location) of SLR and radio measurements.

## **Publications on the subject from other authors:**

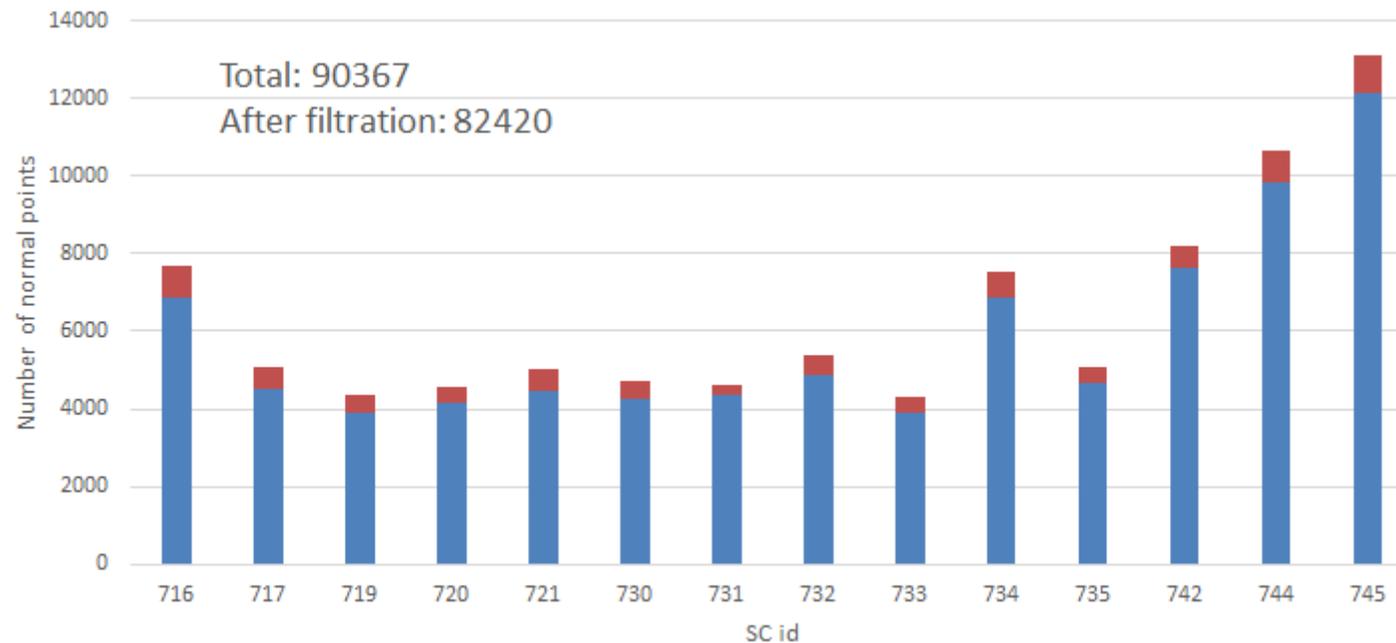
1. Thaller D, Dach R, Seitz M, Beutler G, Mareyen M, Richter B (2011):  
*Combination of GNSS and SLR observations using satellite co-locations.*
2. Thaller D, Sośnica K, Dach R, Jäggi A, Beutler G, Mareyen M, Richter B (2012a):  
*Geocenter coordinates from GNSS and combined GNSS-SLR solutions using satellite co-locations.*
3. Thaller D, Sośnica K, Dach R, Jäggi A, Baumann C (2012b):  
*The space tie between GNSS and SLR.*

## **Relevance:**

1. A massive of measurement information obtained from 2012 to 2018.
2. An increase in the accuracy of a posteriori ephemeris information for GLONASS-M SC and the consistency of different IGS analysis centers solutions.
3. Work on co-location of different measurement and observation techniques is highly important in terms of results consistency and verification.

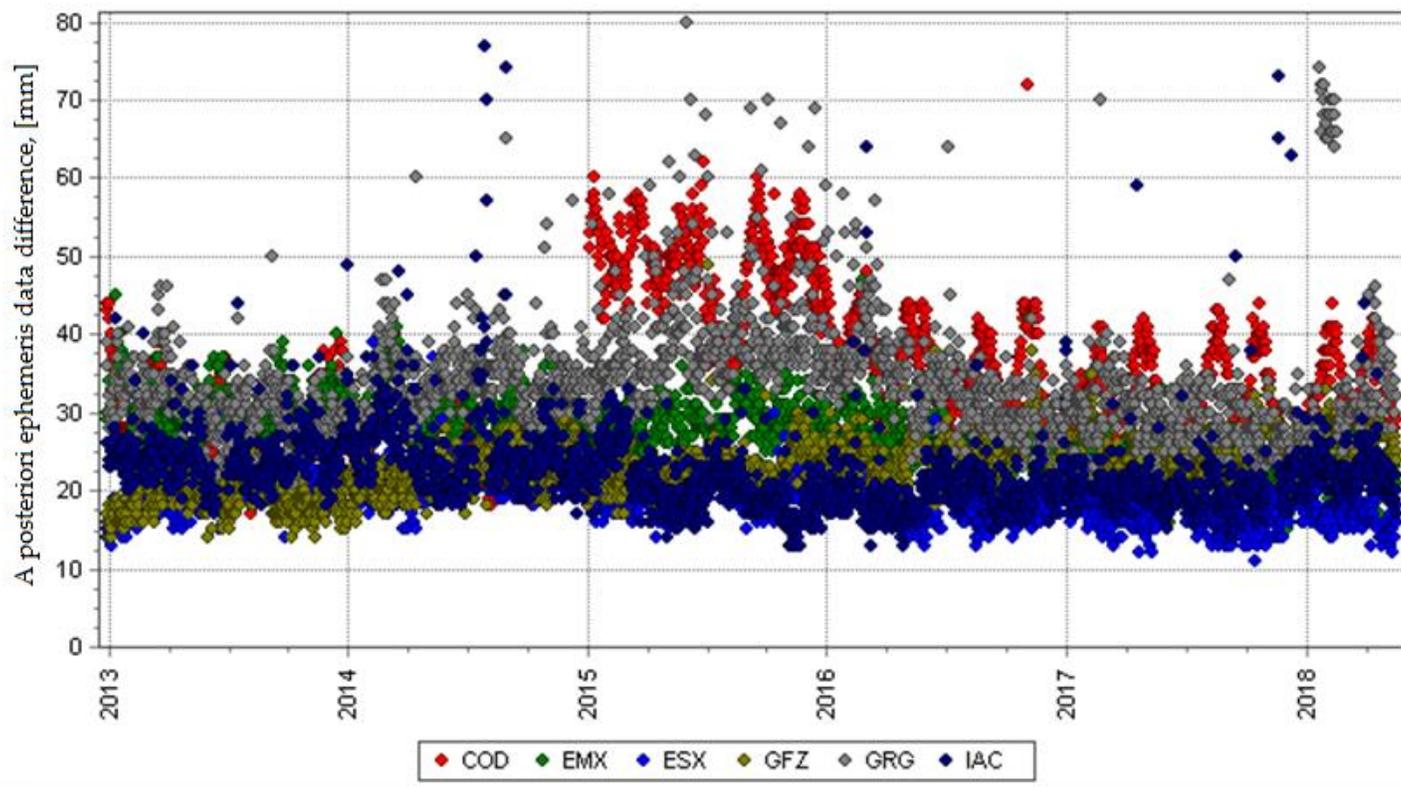
# SLR Data

1. Time period: 01.01.2012 – 01.11.2017
2. Number of ILRS stations – 37
3. Stations coordinates taken from ITRF2014 solution
4. Nominal LRA coordinates provided by the ILRS
5. Number of GLONASS-M SC: 14 SC (constantly were a part of a constellation)
6. Number of normal points total – 90367
7. Number of normal points after filtration – 82420



## GNSS Data (1/2)

1. GLONASS SC navigational antenna phase center offset from the ANTEX file recommended by the IGS.
2. To perform integrated research four sets of precise ephemerids obtained a posteriori from the phase measurements in different IGS analysis centers (IAC, ESA, CODE, IGS) were used as reference ephemeris data for GLONASS-M SC.



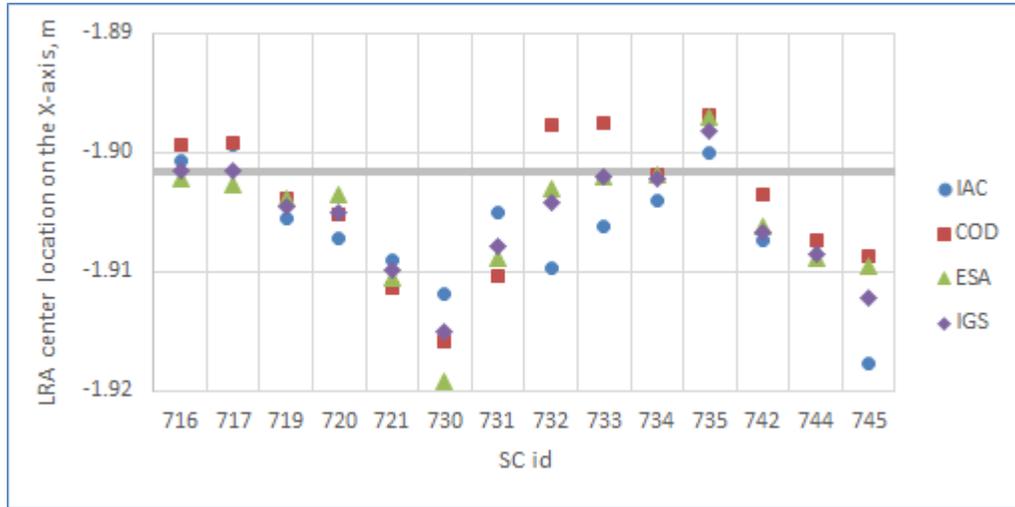
# GNSS Data (2/2)

GLONASS SC antenna phase center location (ANTEX)

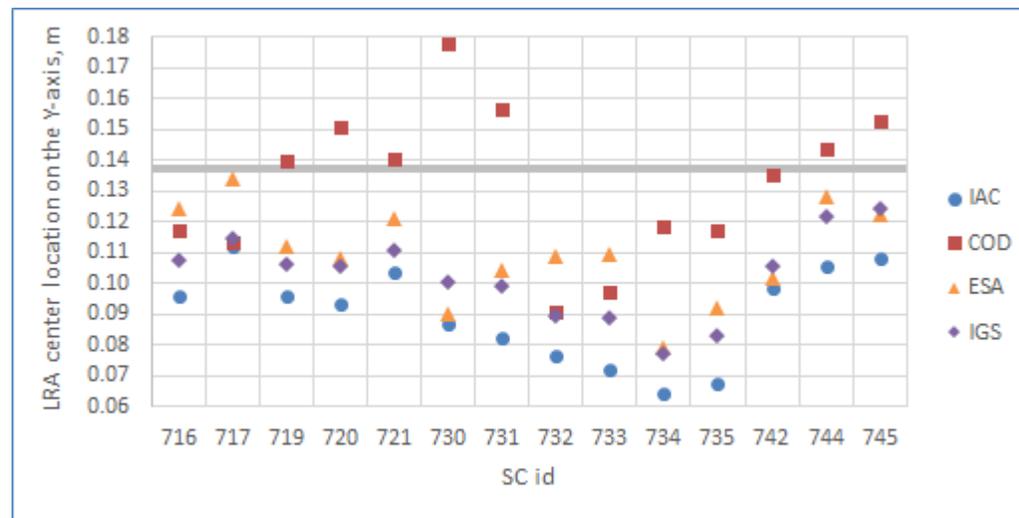
SC (PRN)	Antenna phase center location, mm		
	X Axis	Y Axis	Z Axis
GLONASS-716 (R15)	-545.00	0.00	2451.20
GLONASS-717 (R10)			2315.70
GLONASS-719 (R20)			2408.50
GLONASS-720 (R19)			2443.80
GLONASS-721 (R13)			2375.10
GLONASS-730 (R01)			2306.90
GLONASS-731 (R22)			2347.00
GLONASS-732 (R23)			2261.90
GLONASS-733 (R06)			2411.40
GLONASS-734 (R05)			2421.10
GLONASS-735 (R24)			2461.20
GLONASS-742 (R04)			2333.60
GLONASS-744 (R03)			2517.20
GLONASS-745 (R07)			2600.10

# Key Test Results (1/4)

LRA center offset on the X-axis (gray – nominal value)

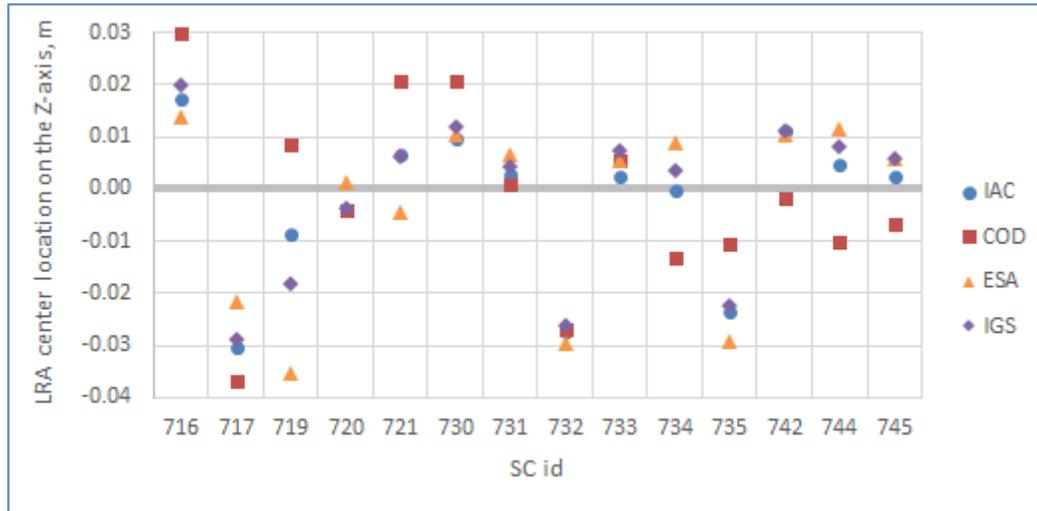


LRA center offset on the Y-axis (gray – nominal value)



## Key Test Results (2/4)

LRA center offset on the Z-axis (gray – nominal value)

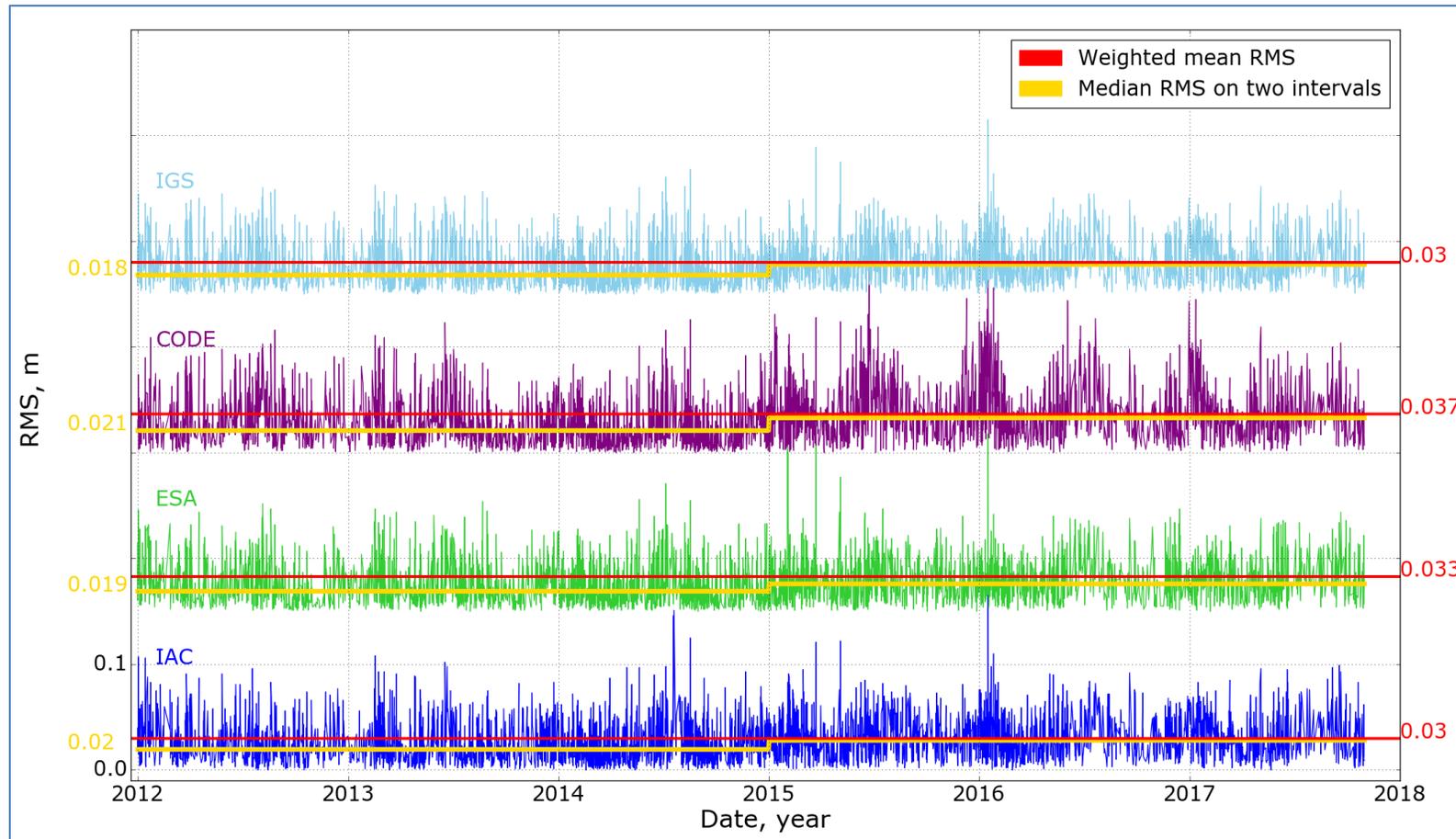


Mean LRA center offset for 14 SC for each analysis center with respect to the nominal position

Axis	Nominal value, m	$\Delta$ LRA IAC, mm	$\Delta$ LRA CODE, mm	$\Delta$ LRA ESA, mm	$\Delta$ LRA IGS, mm
X	-1.9016	-4.9	-2.6	-4.1	-4.1
Y	0.1370	-46.7	-4.7	-27.2	-34.4
Z	0.0000	-2.6	-1.7	-3.3	-1.4

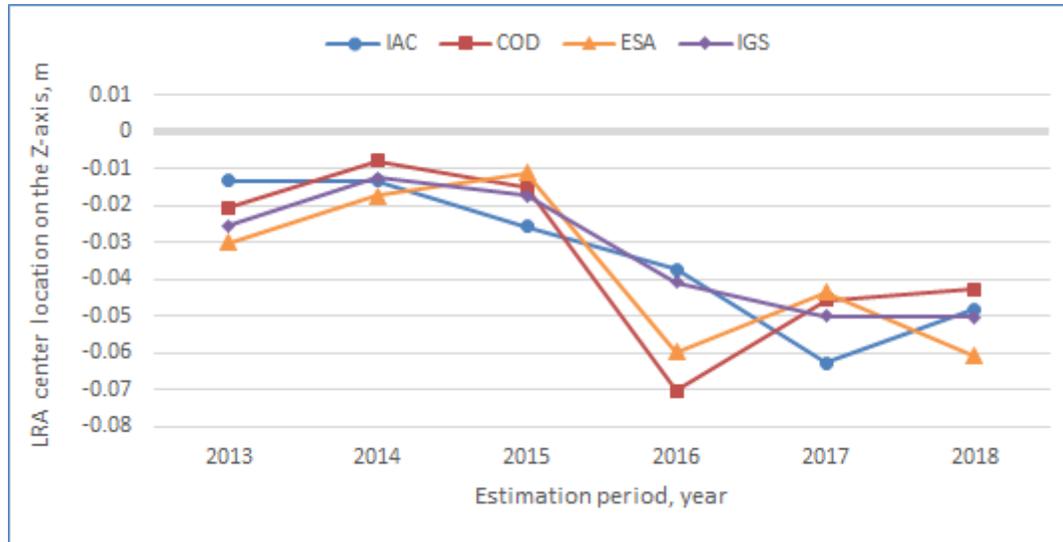
# Key Test Results (3/4)

Residuals RMS error of laser measurements for the 732 GLONASS-M SC

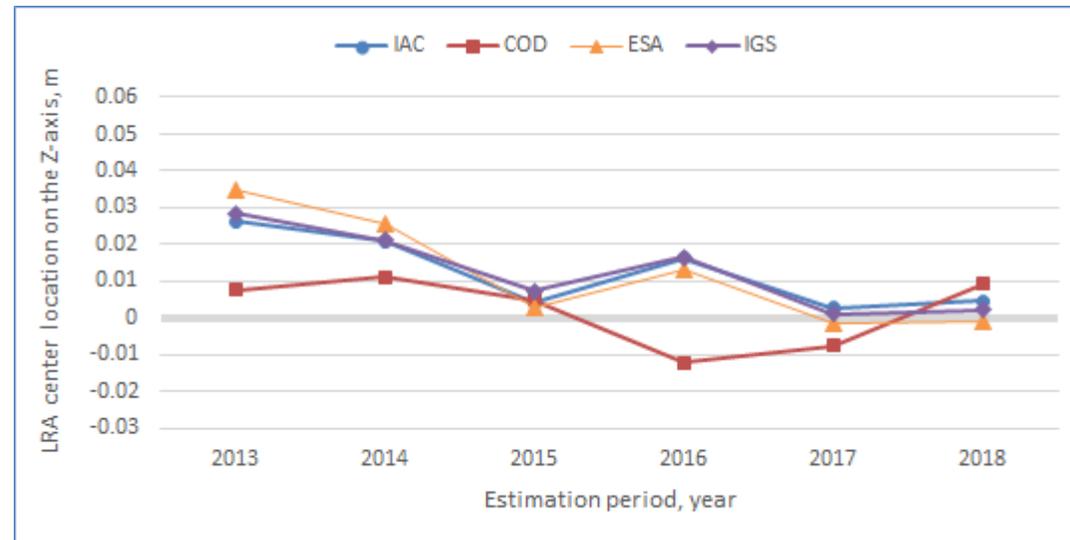


# Key Test Results (4/4)

LRA offset changes over time for the 732 GLONASS-M SC



LRA offset changes over time for the 742 GLONASS-M SC



## Conclusion

- An estimation with the Residuals RMS Error of SLR measurements about 3 cm.
- Relative position of the LRA and GNSS antenna phase center for each GLONASS-M SC is unique.
- Maximum difference between estimated values of the LRA center coordinates for two SC reaches 6.7 cm.
- With improved source data filtering mechanism, it may be possible to increase the accuracy and obtain individual values of the LRA center coordinates.
- The studies can be continued in monitoring mode using the most accurate measurements from the ILRS network obtained upon careful filtering of the source measurement data.



Thank you  
for your attention!

**FGUP TSNIIMASH**, Russia, Moscow Region,  
141070, Korolyov, 4 Pionerskya Street  
Tel./Fax: +7 (495) 513 41 39  
E-mail: [ianc@glonass-iac.ru](mailto:ianc@glonass-iac.ru)  
Website: [www.glonass-iac.ru](http://www.glonass-iac.ru), [www.tsniimash.ru](http://www.tsniimash.ru)