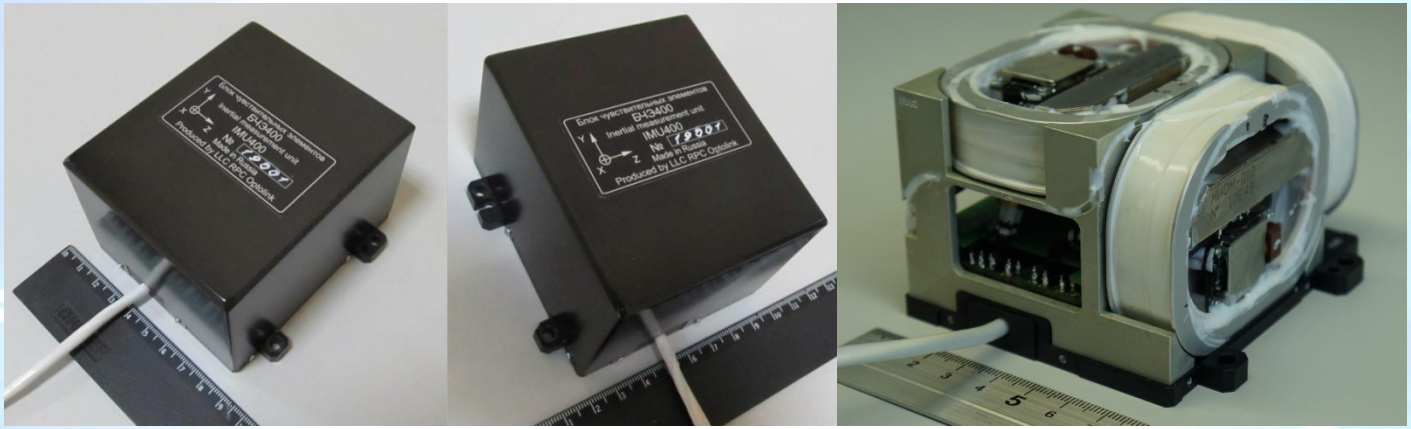
Ultra-compact navigation-grade Inertial Measurement Unit IMU400

Yu.N. Korkishko, V.A. Fedorov, V.E. Prilutskiy, V.G. Ponomarev, et. al.

OPTOLINK RPC LLC, Moscow, Russia

FIBER OPTICAL SOLUTION

Fiber Optical Solution, Riga, Latvia



Outline:

1. Optolink's production capacities & premises
2. IMU400 c-SWaP & mechanical properties
3. Sensors accuracy and specs
4. Test results - gyrocompassing & static
5. Test results – navigation
6. Conclusion

OPTOLINK

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1. Optolink's production capacities & premises

Headquarters
Moscow, Zelenograd

Development and production of **integrated optical circuits** on $LiNbO_3$, fiber-optic sensors and **inertial navigation systems**.

Arzamas branch

Production of **special optical fibers** (PM, spun, etc.) and components.

Saratov branch

Development and production of **fiber-optic gyroscopes** and sensors

Riga, Podraga 2

Riga, iela Plata 12B

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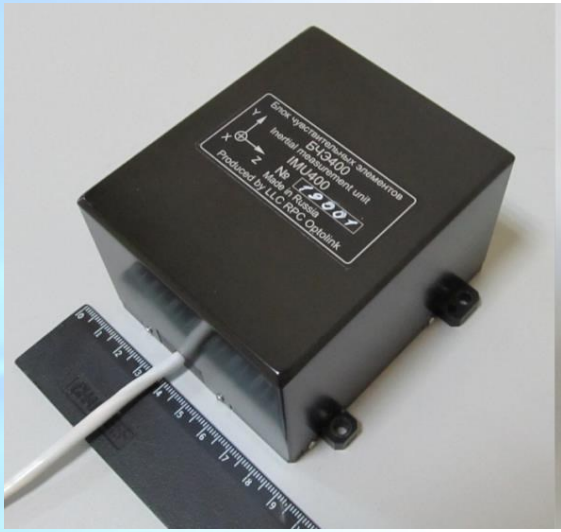
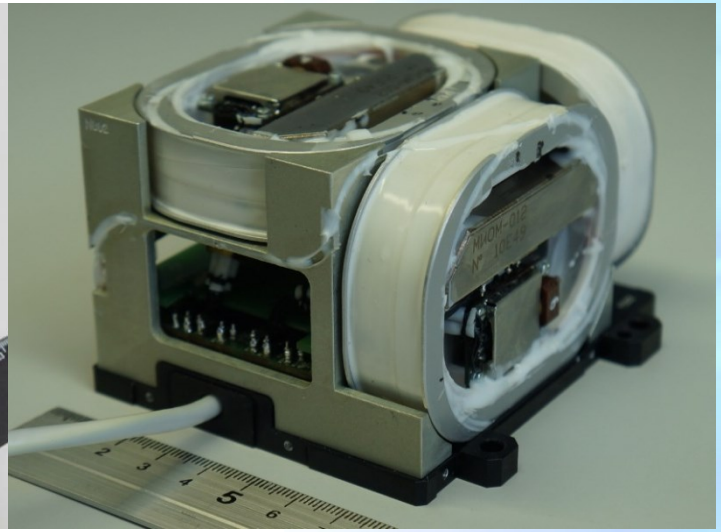
2. IMU400 c-SWaP & mechanical properties





80×95×62 mm, 0.7 kg, 0.5 l, ≤7 W

OPTOLINK

From optical components to navigation systems

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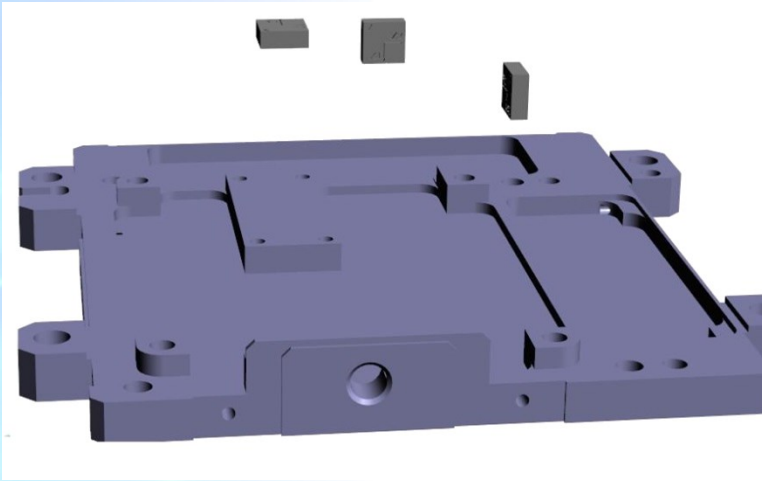

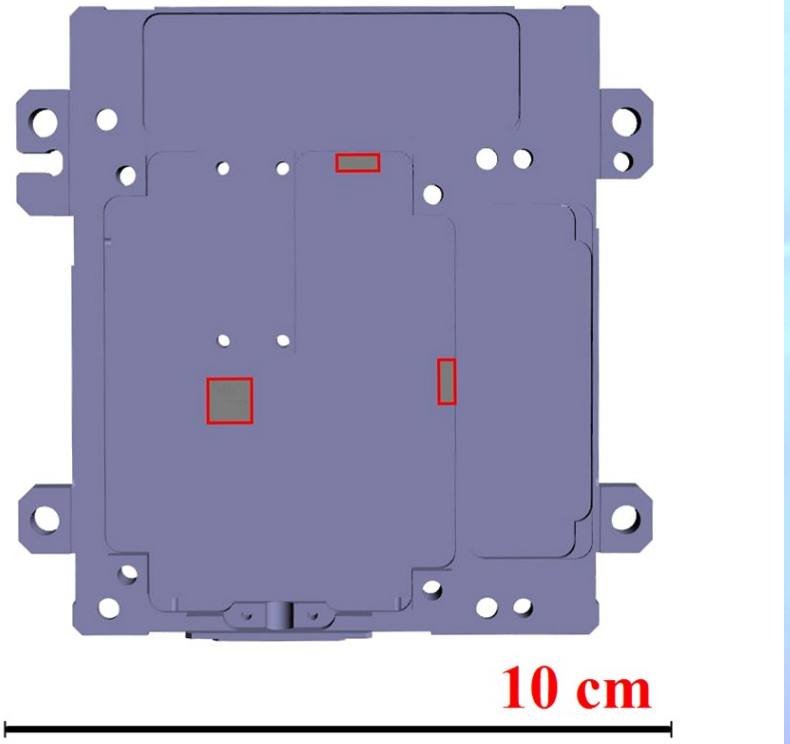

Spatial displacement of 3 physical MEMS-accelerometer triads inside the IMU400

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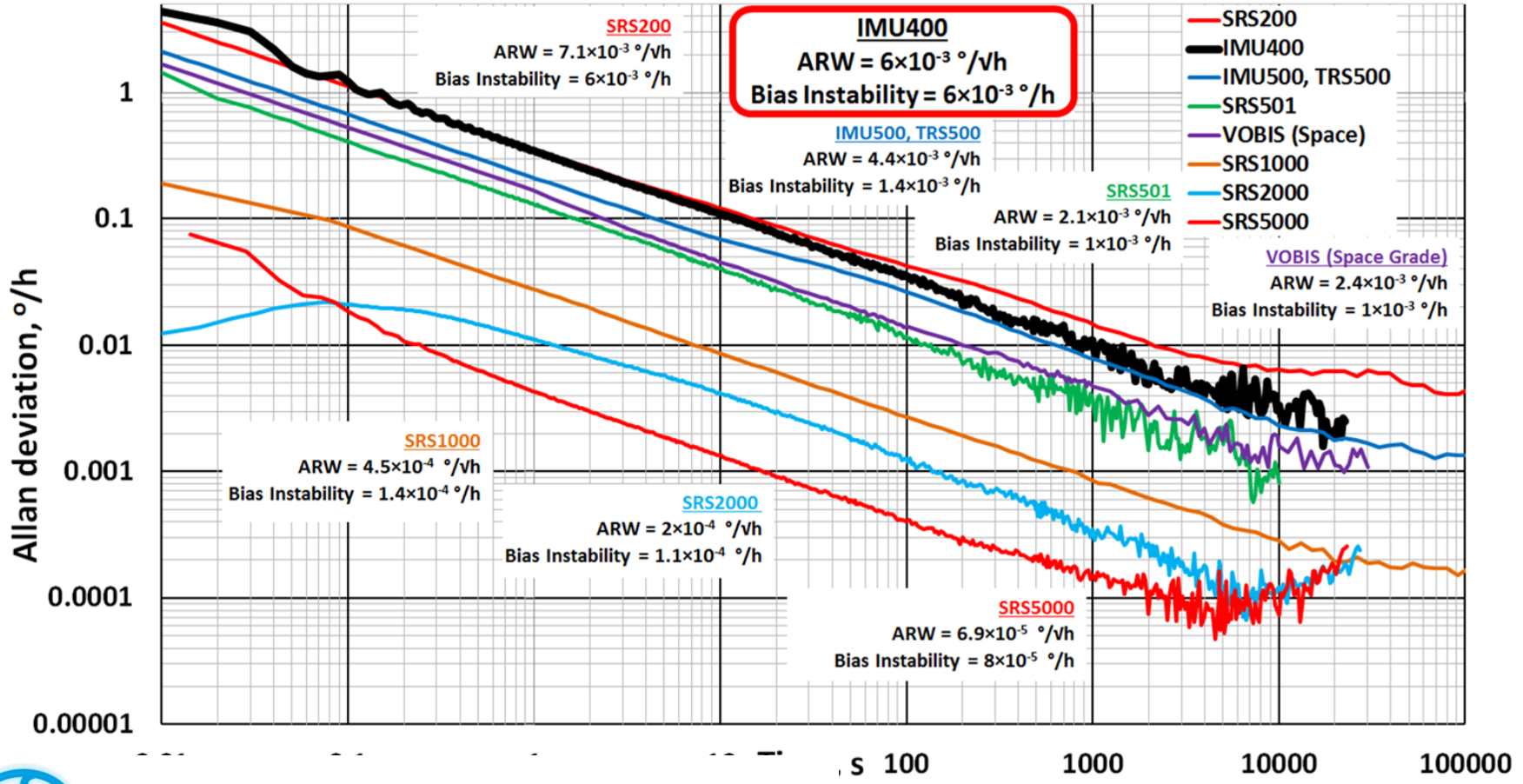
3. Sensors accuracy and specs



ıce plot in Optolink's FOG family

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3. Sensors accuracy and specs

Performance	IMU400
Gyro	
Angular rate range, °/s	±550
Bias drift at constant temperature (1σ, 100s-averaging), °/h	0.1
Bias drift (1σ, 100s-averaging) in operational temperature range, °/h	0.7 (*0.3)
Angle random walk, °/ √h	0.01
Scale factor error, ppm	500 (*200)
Bandwidth, Hz	> 1000

Accelerometers	
Range, g	±10
Bias drift at constant temperature, mg	1
Bias drift in operational temperature range, mg	1.0 (*0.4)
Scale factor error, ppm	500 (*300)
Noise power density, mg/ √Hz	0.08
Bandwidth, Hz	> 300
Physical Characteristics	
Misalignment, °	0.08 (*0.015)
Output sample rate, Hz	up to 2000
Power supply, V / Consumption, W	5 / 7
Digital output interface	RS-422
Operational temperature range, °C	-40 ~ +60
Dimensions, mm	80 × 95 × 62
Weight, kg	0.7

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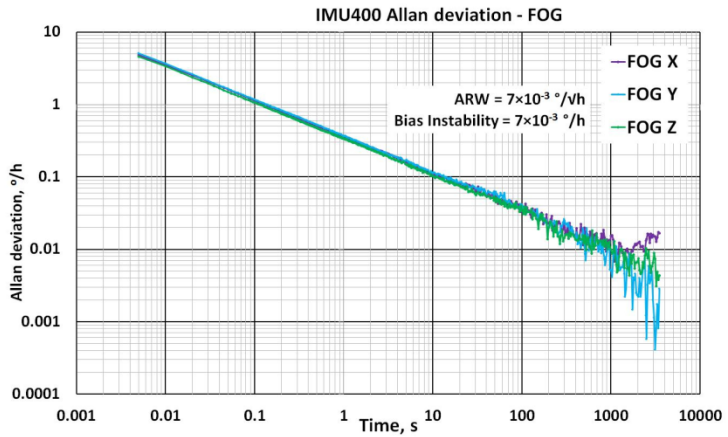
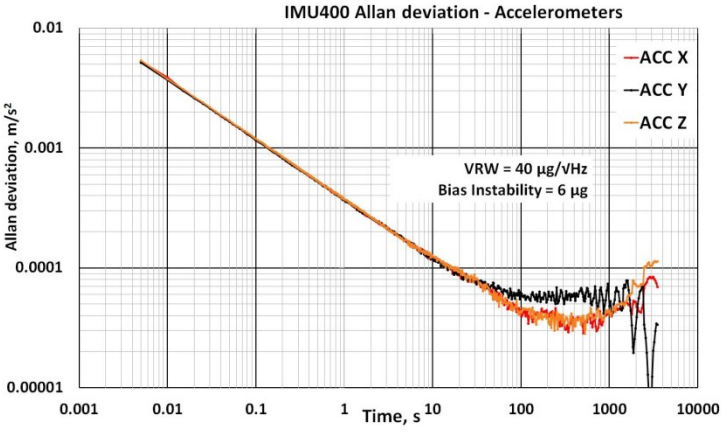
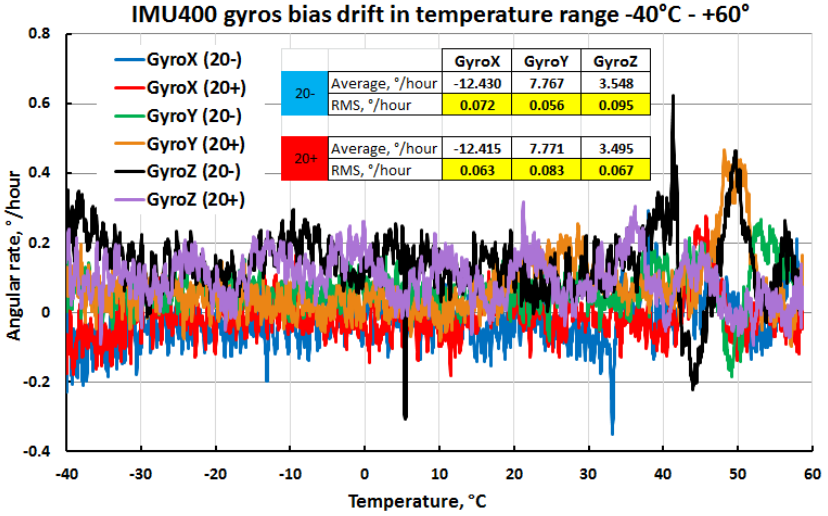
3. Sensors accuracy and specs

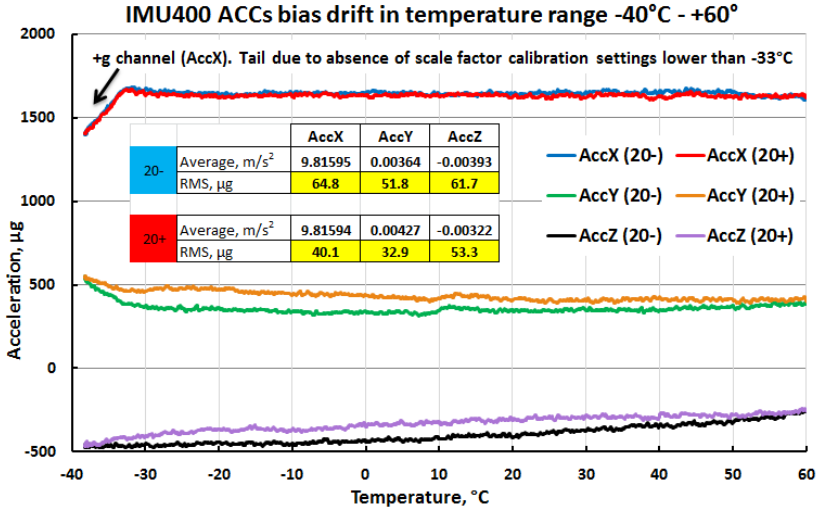




IMU400 FOG and ACC channels Allan variance plot



		GyroX	GyroY	GyroZ
20-	Average, °/hour	-12.430	7.767	3.548
	RMS, °/hour	0.072	0.056	0.095
20+	Average, °/hour	-12.415	7.771	3.495
	RMS, °/hour	0.063	0.083	0.067



		AccX	AccY	AccZ
20-	Average, m/s²	9.81595	0.00364	-0.00393
	RMS, µg	64.8	51.8	61.7
20+	Average, m/s²	9.81594	0.00427	-0.00322
	RMS, µg	40.1	32.9	53.3

IMU400 Gyroscopes & Accelerometers bias stability plots in temperature range

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4. Test results - gyrocompassing

Heading °	1	2	3	4	5	6	Average for	Dispersion for	RMS for Heading, °
0	0.195	0.034	0.380	0.002	0.098	0.279	0.1647	0.0452	**0.212**
90	90.339	90.513	90.541	90.276	90.051	90.398	90.3531	0.1514	**0.389**
180	179.857	179.605	179.770	179.926	179.778	179.731	179.7779	0.0594	**0.244**
270	269.555	269.798	269.531	269.476	269.569	269.804	269.6221	0.1597	**0.400**
0	0.011	-0.192	-0.278	-0.023	0.145	0.115	-0.0226	0.0211	**0.145**

	Bias, °/hour		
	X	Y	Z
test1	0.028	0.054	-0.019
test2	0.036	0.040	0.008

At 56° N Lat.

Total disp.	Total RMS
0.0979	**0.313**

	Cardinal direction					
	0°	90°	180°	270°	0°	Average
RMS (Mean-shifted), °	0.147	0.179	0.110	0.142	0.153	**0.146**

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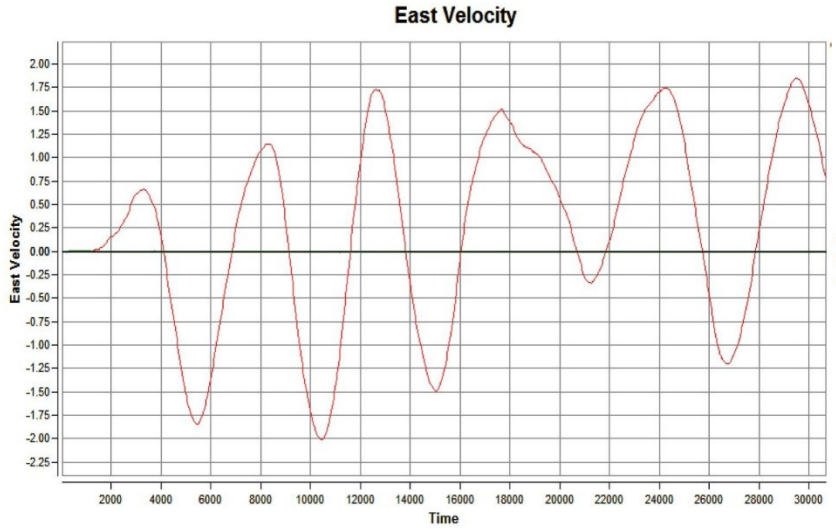
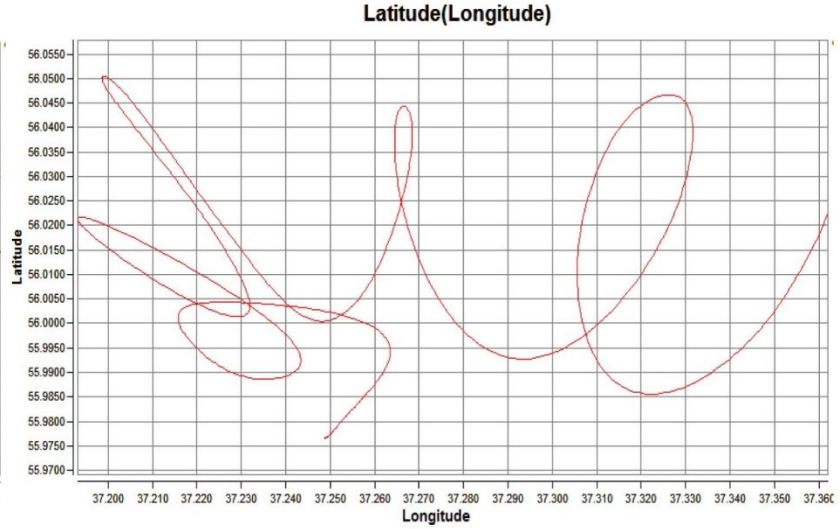
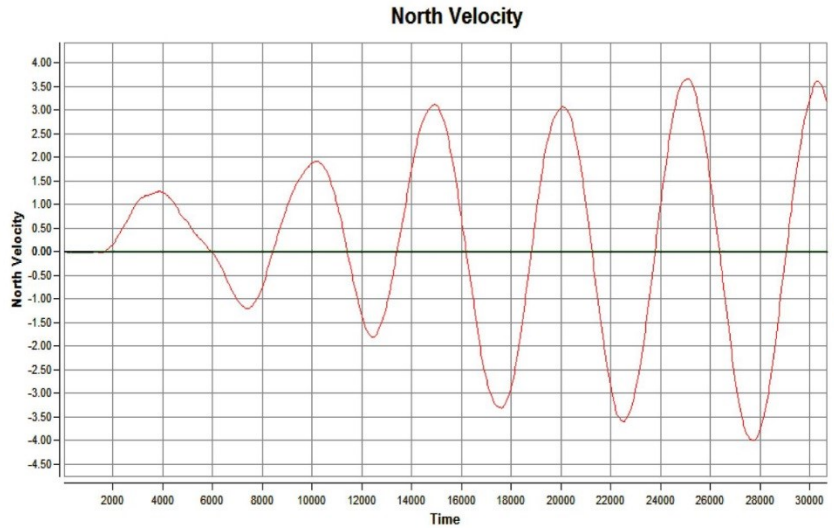
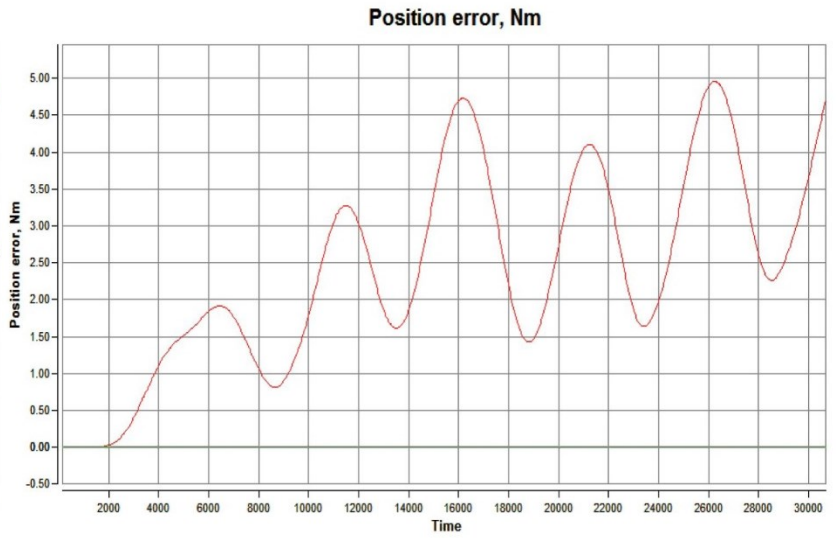
4. Test results – static – 5Nm at 8h









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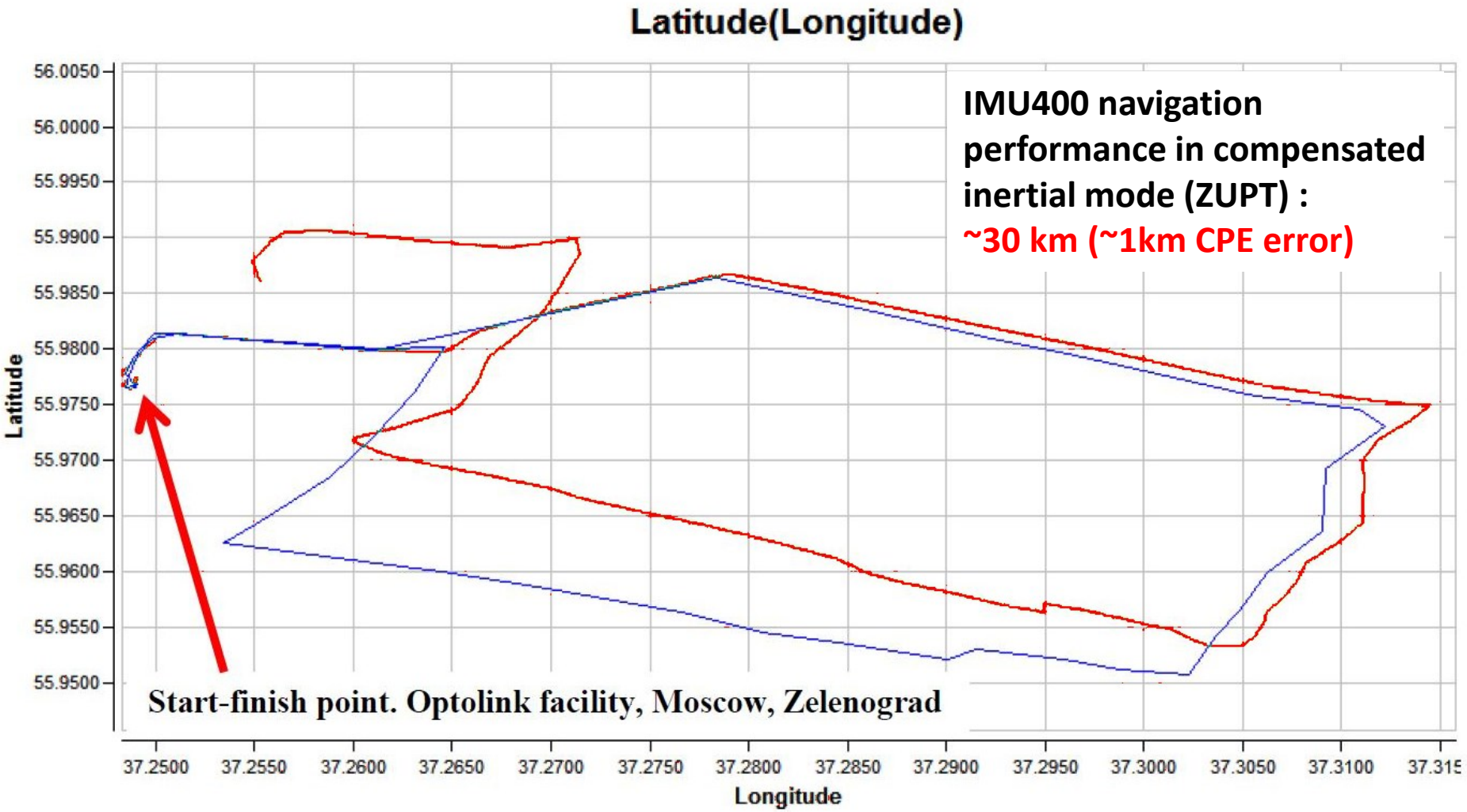
5. Test results - navigation



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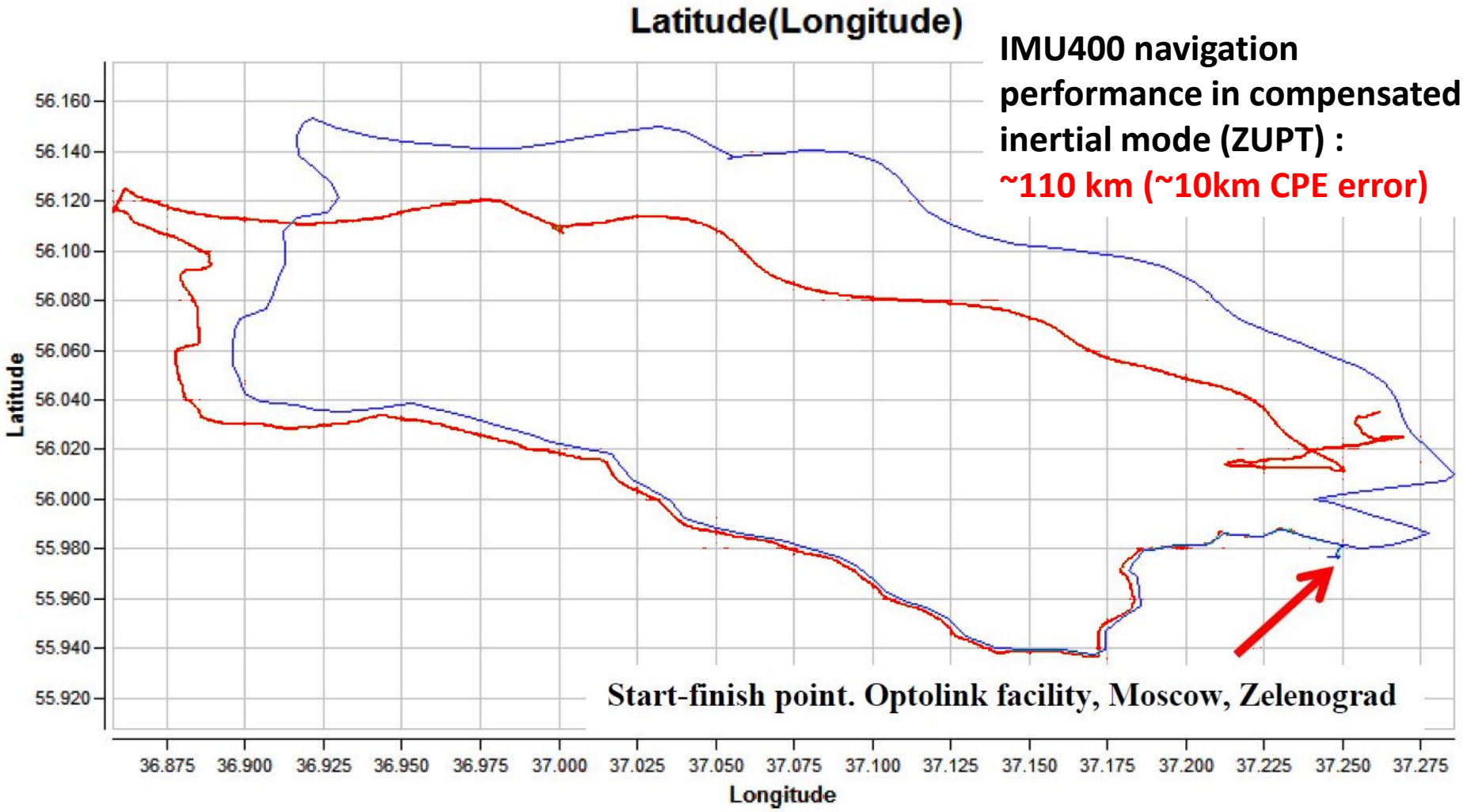
5. Test results - navigation



IMU400 navigation performance in compensated inertial mode (ZUPT) :

~110 km (~10km CPE error)

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6. Conclusion

Demonstrated performance allows to assess IMU400 as navigation or near-navigation grade IMU with unique combination of performance / cost / SWaP characteristics.

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