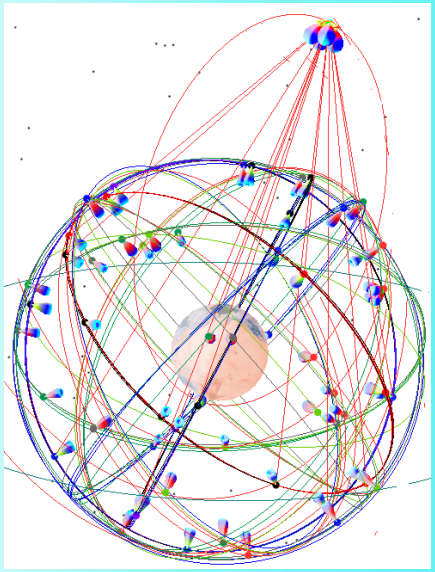
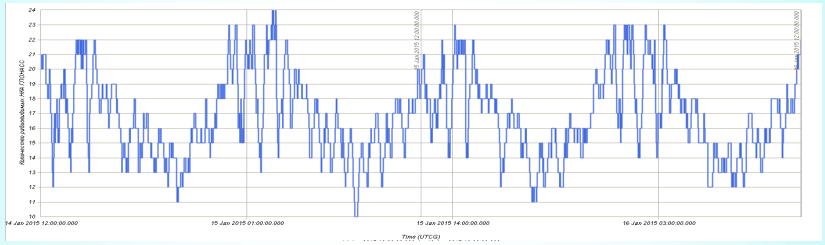
Space users navigation equipment: development , classification and unification principles

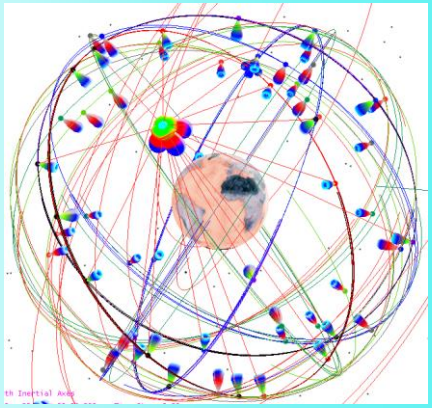
Dmitry Marareskul
JSC “Information Satellite System - Reshetnev Company”
Russia, Krasnoyarsk region, Zheleznogorsk,

Features of onboard navigation systems for high-orbit satellites

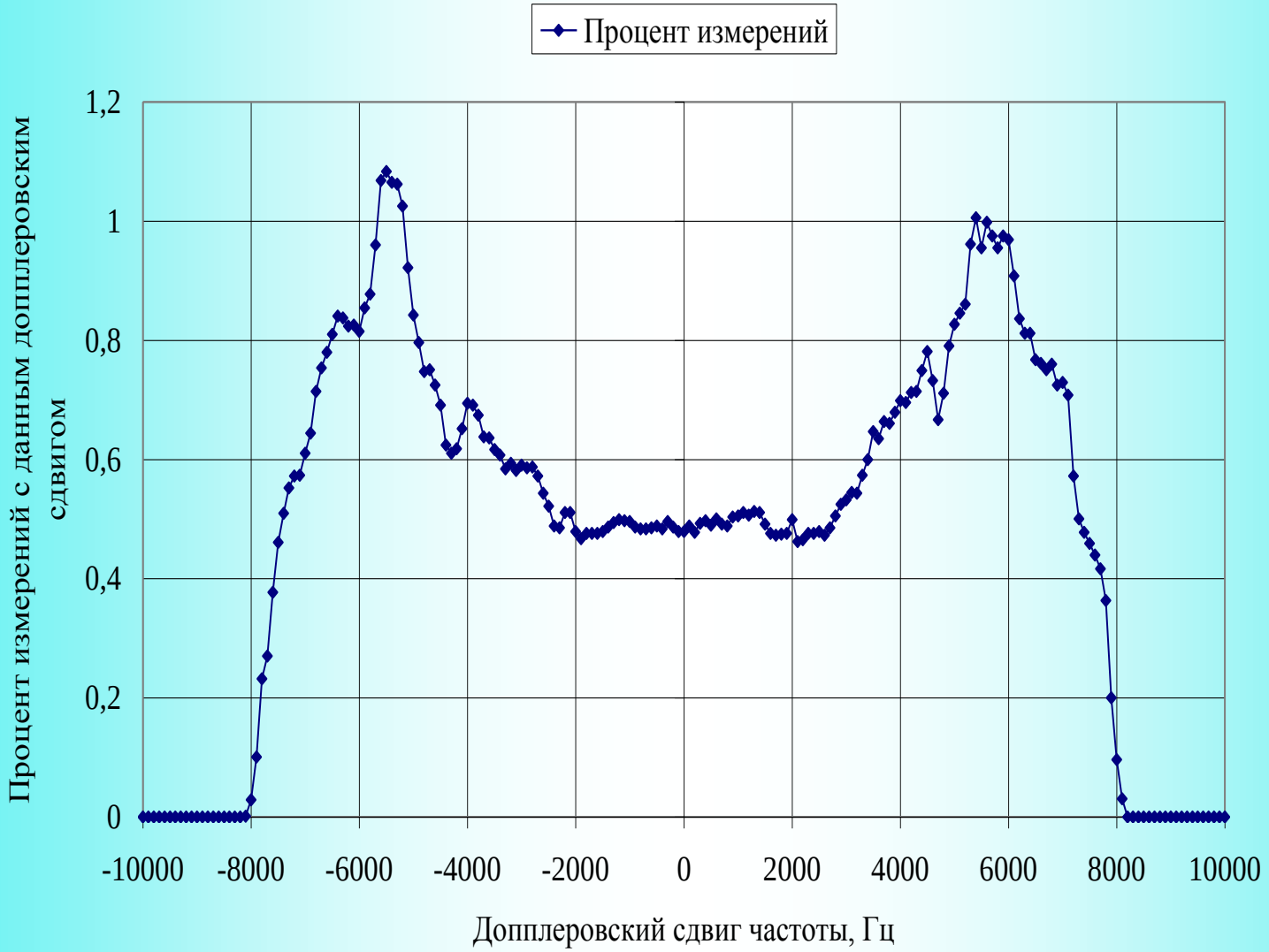
- The use of special antenna systems
- Special sensitive receivers for receiving weak signals
- Special algorithms for receiving and processing signals
- A greater range of changes of signal power and Doppler shift
- Special positioning and timing algorithms



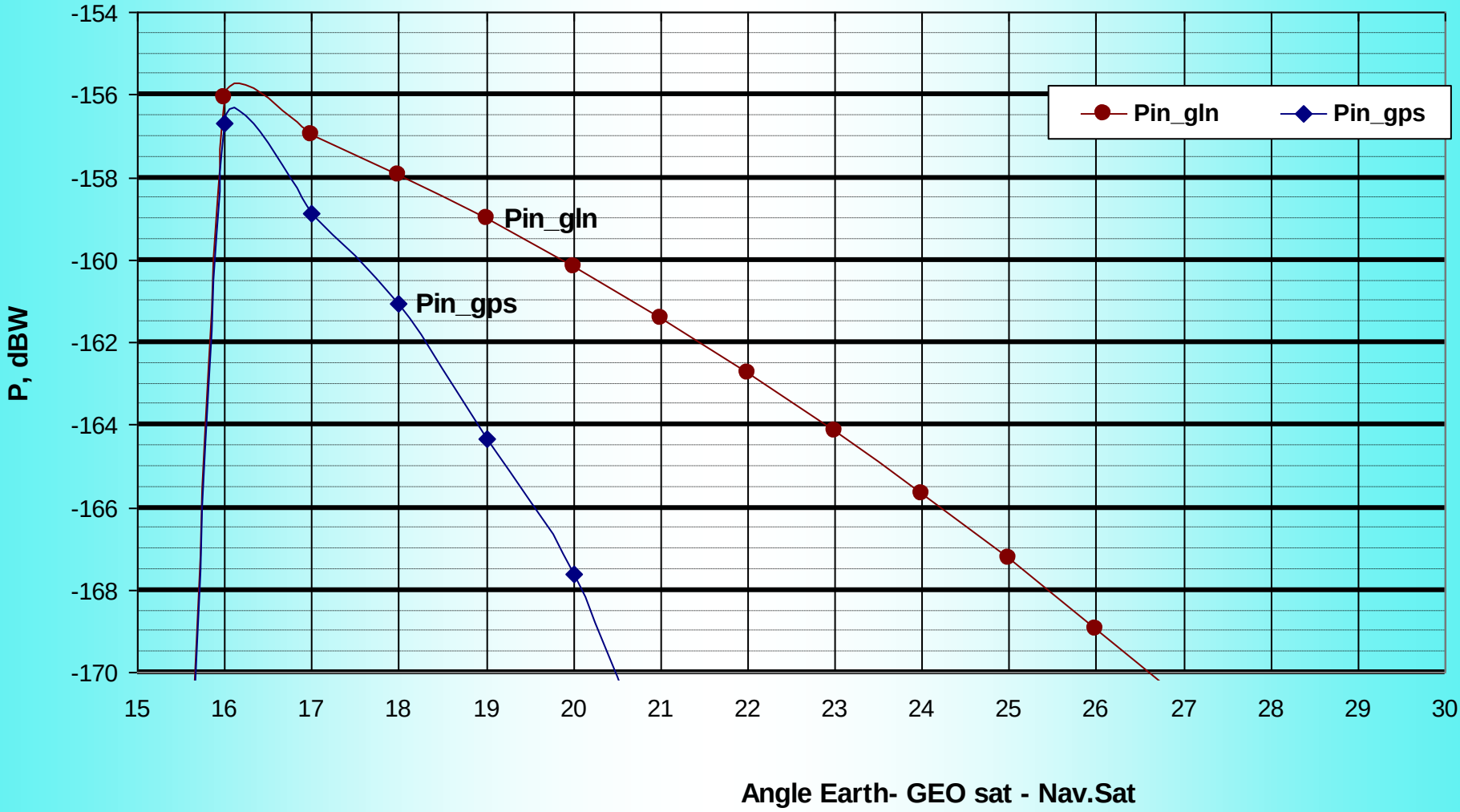




The distribution of Doppler frequency shift GEO receiver GLONASS and GPS signals



GLONASS and GPS power of signal on input of GEO onboard receiver with a single 15 dB receiving antenna 15 dB



Categories and the system of classification of equipment for space onboard GNSS navigation

By the application stage:

- Stage of the launch rocket and launch into the reference orbit
- The transition stage on the target orbit
- The operation phase to the target orbit

By the terms of orbit type :

- LEO (h= 200....10,000 km)
- Medium orbit (h= 10000..21000 km)
- HEO (Molniya, Tundra, QZSS…)
- GEO

By the terms of the satellite attitude :

- Earth fixed attitude mode
- Velocity fixed attitude mode
- Mission pointed attitude mode
- Free not controlled attitude mode

Categories and the system of classification of equipment for space onboard GNSS navigation

By the purpose on board the satellite :

- Unit for the decision of tasks of the satellite platform
- Unit for coordinate and time maintenance of the payload

By the combination of goal function:

- For determination of the satellite orbital parameters and curren position
- For providing a reference time signals of stable frequency
- For determination of the attitude angles o
- For determination of the high precision relative position from the reference or base satellite
- For special and scientific tasks

Categories and the system of classification of equipment for space onboard GNSS navigation

By the class of required positioning and timing precision:

Low precision	- position error 500..1500 m	time error 1ms
Medium precision	- position error 100..500 m,	time error 0,5..1mks
Precision	- position error 10..100 m,	time error 100..500 ns
High precision (relative)	- position error 0.01..1 m,	time error 1..10 ns

By sensitivity :

- Standard sensitivity -161... -163 dBW
- High sensitivity -164…-175 dBW
- Very high sensitivity -175…-185 dBW

By the duration of the mission :

Short mission	- 10min...1000 hours
Mission average duration	- 1 to 3 years
The mission's long duration	- 7, 10, 15 years

Categories and the system of classification of equipment for space onboard GNSS navigation

Classification by type of used signals and band :

	L1	L2	L3/ L5
Glonass Glonass-K Glonass-K2	L1OF L1OCd, L1OCp	L2OF L2OCp	L3OCd L3OCp
GPS	C/A, L1C	C/A ,	
Galileo	E1	E6	E5
BeiDou	B1, L1C	B3	B2
WASS,SBAS, SDKM, QZSS	C/A,		

Categories and the system of classification of equipment for space onboard GNSS navigation

By the number and type of used antenna systems:

- One non-directional antenna
- One directional antenna
- Two antennas
- Multi antennas system with independent antenna (3..6)
- Phased antenna array system with multi beam and angle direction guidance

By communication interface:

- MIL-STD-1553b
- Space Wire (ECSS-E-50-I2C)
- RS 485
- CAN

By voltage power supply:

5 V, 12 V, 27 V, 100 V

The unification principles

A wide range of missions and different requirements causes the creation of one unified onboard navigation equipment is technically inappropriate.

It is advisable to allocate at least the following classes of equipment:

- Standard navigation equipment for positioning: performed optional for the satellites in LEO, GEO and HEO
- Onboard navigational equipment for positioning and timing performed optional for the satellites in LEO, GEO and HEO
- Special equipment for launch vehicles and upper stages and busters
- Special precision equipment for LEO satellites
- Special precision equipment for satellites in GEO and HEO
- Special navigation equipment for undirected satellites
- Special navigation equipment for positioning and attitude determination

Thank You for attention

Marareskul Dmitry
Head of the onboard satellite navigation R&D sector

JSC “Information Satellite System - Reshetnev Company”
RF, 662972, Zheleznogorsk, Krasnoyarsk region,Lenin str.,52.
tel: +7-(3919)-764-246
dimar@iss-reshetnev.ru
www.iss-reshetnev.ru