



**Space Experiment**  
**«Laser Communication System»**  
**on the International Space Station 2011 – 2013**

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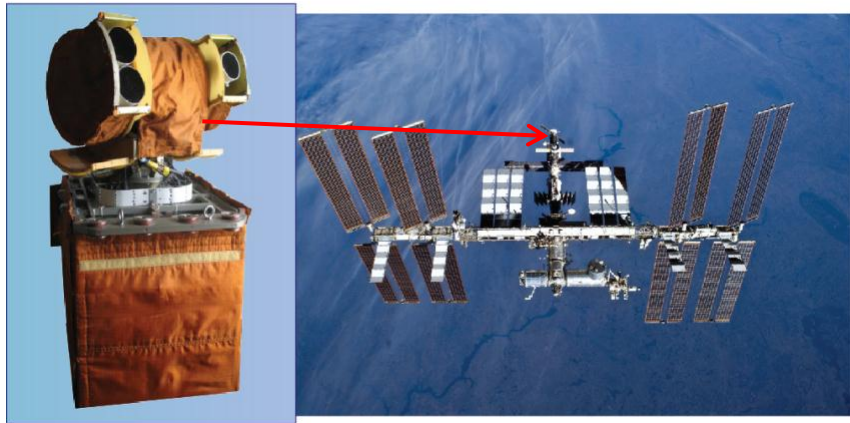


# Goals

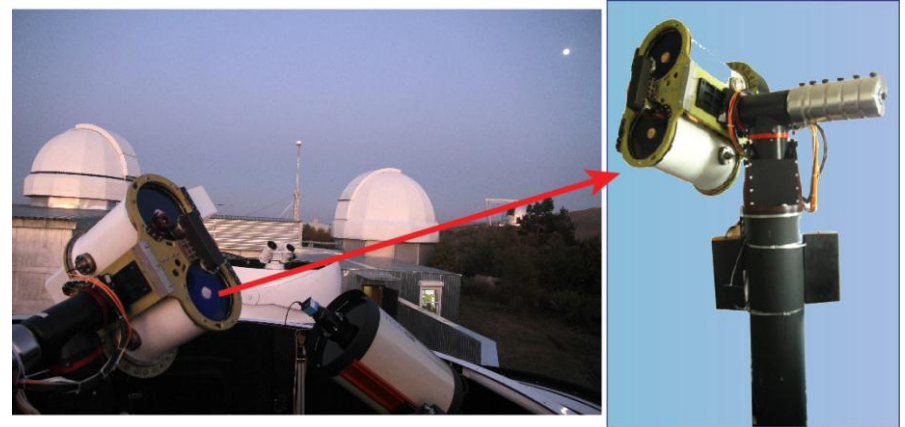
- 1. Refinement of the main technological and design solutions in the conditions of a space flight on the Russian segment of the ISS.**
- 2. Refinement of technology for transmission and reception of large volumes of information using laser communication link.**
- 3. Study of operation feasibility and conditions of laser communication links “S/C – ground station” in different atmospheric conditions.**



# Accommodation of the equipment



**On-board Laser Communication (OBLCT)  
Terminal is installed on the Russian  
segment of the International Space Station  
(RS ISS)**



**Ground laser terminal (GLT) is placed at the optical  
observations station “Arkhyz” (Northern Caucasus) –  
a branch of Open Joint-stock Company «Research-  
and-Production Corporation «Precision Systems and  
Instruments»**



# Main operational parameters

Module	Parameter	OBLC	GLT
<b>Beacons</b>	Wavelength, nm	808	780
	Quantity	4	12
	Power of one channel, W	0.5; 1	1
	Modulation	continuous	32 kHz
	Divergence	4°	12'
<b>Transmitters</b>	Wavelength, nm	1550	850
	Quantity	1	7
	Power of one channel, W	3; 6	1
	Modulation NRZ (PRS), Mbit/s	3; 125; 622	3
	Ethernet, Manchester-II, Mbit/s	125	3
	Divergence	2 arc minutes (1/e <sup>2</sup> )	4 arc minutes
	Synch error	-	10 ns
<b>Direction Finders</b>	Filed of view	Wide field: 2.6 °	Wide field: 3°
		Search and acquisition: 51.5'	Tracking: 12'
		Tracking: 4.3'	-
<b>Receiving channel</b>	Diameter, mm	80	250
	Photo receiver type	APD	APD
<b>Pointing system</b>	Type	2-axis	4-axis
	Tracking errors	0.3-0.5 arc seconds	1.0-1.5 arc seconds
	<b>PRS – pseudo random sequence</b>		

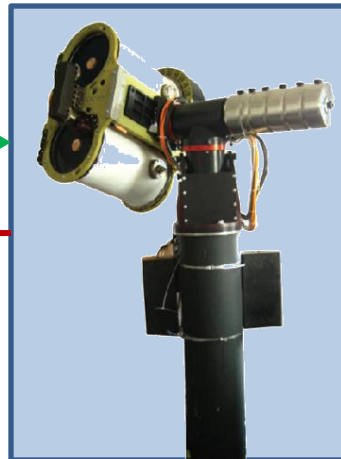


# Operating modes

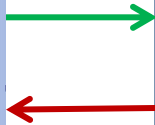
Pointing system		Information system
Direction Finders	Scanning modes	Transmitter operation modes
Search – acquisition direction finder (square) Tracking – tracking direction finder (square)	«Big Scanning» 5,8°×16°  Small scanning 4°×4°	PRS - 3 Mbit/s
Search – acquisition direction finder (square) Tracking – tracking direction finder (square) Search and tracking – search and acquisition direction finder (CCD)	«Big Scanning» 5,8°×16°  No scanning	PRS -125 Mbit/s Ethernet – 125 Mbit/s
Search – acquisition direction finder (square) Tracking – tracking direction finder (square)	«Big Scanning» 5,8°×16°  No scanning	PRS - 622 Mbit/s



On-board Laser Communication Terminal (OBLCT)



Ground Laser Terminal (GLT)



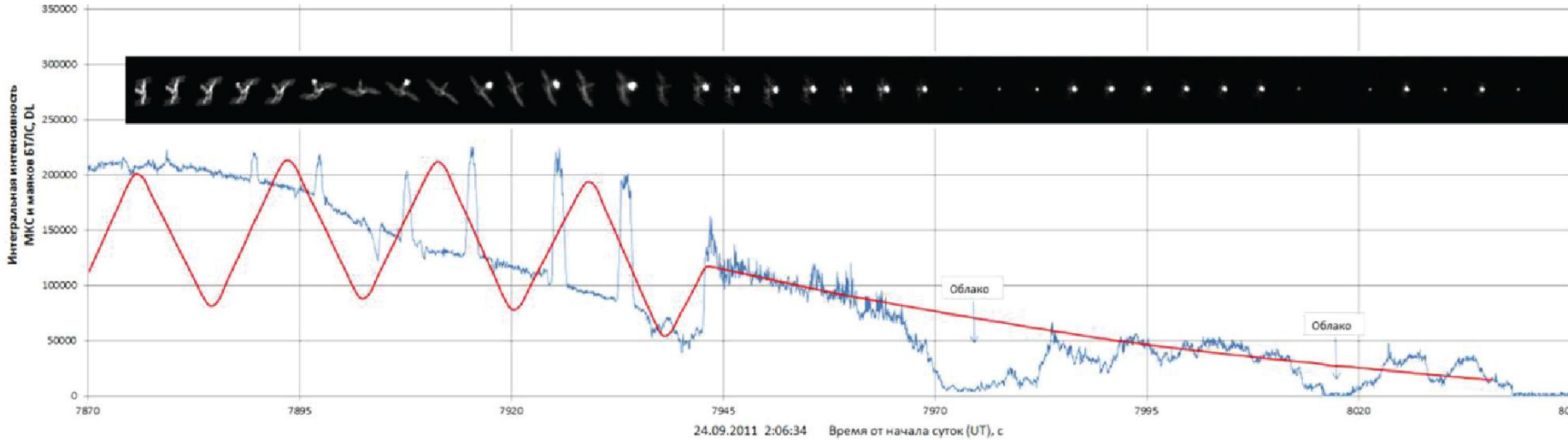
In clear weather and with use of a CCD direction finder for OBLCT targeting, communication session duration is about 240 s. Maximum volume of data that can be potentially transmitted from the ISS to GLT over 240 s with data error rate BER <math>10^{-7}</math> is:

- PRS-3 ..... 366 Mbytes
- PRS-125..... 3.5 Gbytes
- Goal Info-125 .....1.75 Gbytes



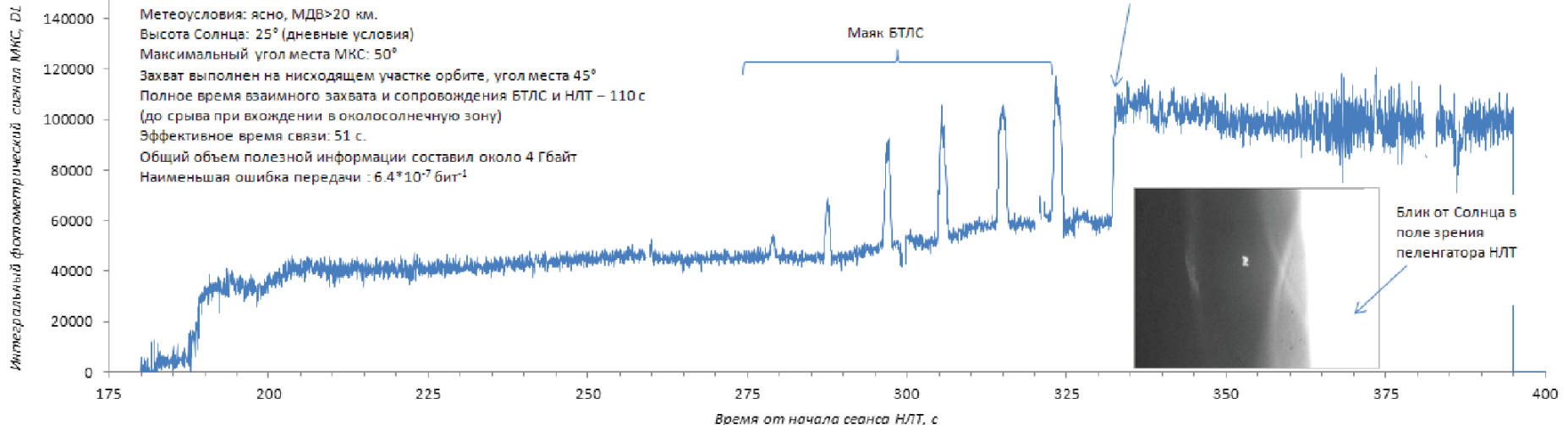
# Experimental results

## Characteristics of test information in 125 Mbit/s channel



## Characteristics of test information in 622 Mbit/s channel

Сеанс №140 25.06.2013 06:48:14ДМВ НЛТ-1 Архыз  
 БТЛС: Большое сканирование, ПСП-622 Мбит/с







## Experimental data obtained from the ISS during SE «LCS»



**Test frame transmitted during session**



**Goal information transmitted during session**

**Transmitted science information – photographs of Earth taken from space as well as telemetry were received completely and without errors. Total 420 MBytes (38 photos 6034x4032) at the rate of 125 Mbit/s.**



## Results of SE «LCS»

- 1. Performed demonstration of Russian technology for laser communication between On-Board Laser Communication Terminal (OBLCT) installed on the International Space Station and Ground Laser terminal (GLT) placed at the optical observations station “Arkhyz” (Northern Caucasus).**
- 2. Performed 143 communication sessions.**
- 3. Successfully obtained results of laser communication at 125 Mbit/s and 622 Mbit/s. Demonstrated operation of GLT-OBLCT channel at 3 Mbit/s.**
- 4. GLT operation was performed during day and night, with ISS illuminated by the Sun and in the Earth shadow, with up to 75% overcast and in near-ground fog with meteorological visibility range < 5 km.**
- 5. Performed science study of the influence of the Earth atmosphere on information transmission quality in laser communication channel.**





**Thank you  
for your attention**

