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Status of the Russian Laser Tracking Network

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Goals of Laser Tracking by Russian Stations

- Estimation of the GLONASS ephemeris and frequency/time accuracy during the navigation system operation period.
- Upgrade of spacecraft motion models.
- Calibration of microwave SC tracking systems .
- Better precision in Earth rotation parameter determination .
- Better precision of measurements for space geodesy and Earth gravity field parameter determination.
- Angular and photometric monitoring of spacecraft in high elliptical orbits (including SC failure cases).
- Failure-case backup of microwave SC tracking systems.
- Participation in international SC laser tracking programs for geodesy and geophysics, as well as for producing catalogues of SC and space debris.

Laser Tracking Station near Komsomolsk-on-Amur

Upgrade completed:

- Introduction of a coude path
- New laser transmitter:

  _ = 0,532 nm
  _ = 250 ps
  E = 2,5 mJ
  Rep. rate = 300 Hz

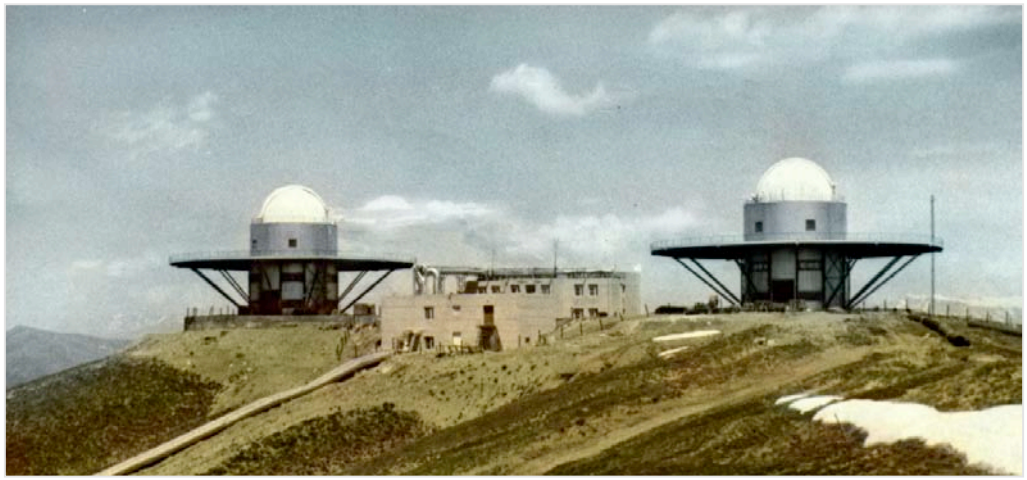
RMS of normal points: 5 mm

Telescopes

Technical Building

SLR station on top of Maidanak mountain (Usbekistan)

Telescopes.
1,1 m in diameter



General view

2750 m above the sea level.

The station is operable. Since December, 2002, it operates under the Russia/Usbekistan agreement on its joint control and use.

SLR station near Moscow

Telescope, dome, and operator room

Receive telescope diameter: 60 cm

The station is in regular operation since 2003.

Data delivery to ILRS will be provided after permission to participate in international programs.

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Basic Parameters

Range	Angular Measurements	Photometry
Orbit height: Nighttime – up to 36 000 km Daytime – up to 6 000 km RMS NP error: 3 – 5 mm	Visual star magnitude: 14^m - 15^m RMS measurement error for SC: 2 arc sec	Visual star magnitude: 12^m - 13^m Brightness determination error: max $0,2^m$

Frequency drift monitoring of GLONASS on-board oscillators

- The accumulated experience on GLONASS operation shows that the navigation field quality depends primarily on time/frequency errors caused by the on-board frequency standard instability.
- Thus, currently it is important to estimate the on-board standard frequency drift and to find the corresponding time/frequency correction values.
- To implement this technology, the SLR station near Moscow is additionally equipped with H_2 –standard having a stability of 7 10^{-15} per day, as well as by a high-accuracy GLONASS/GPS signal receiver (ASHTECH Z-18) and corresponding software.

GLONASS frequency drift monitoring operator workplace

GPS time-scale drift 01-05-04 to 31-05-04

Transportable SLR station

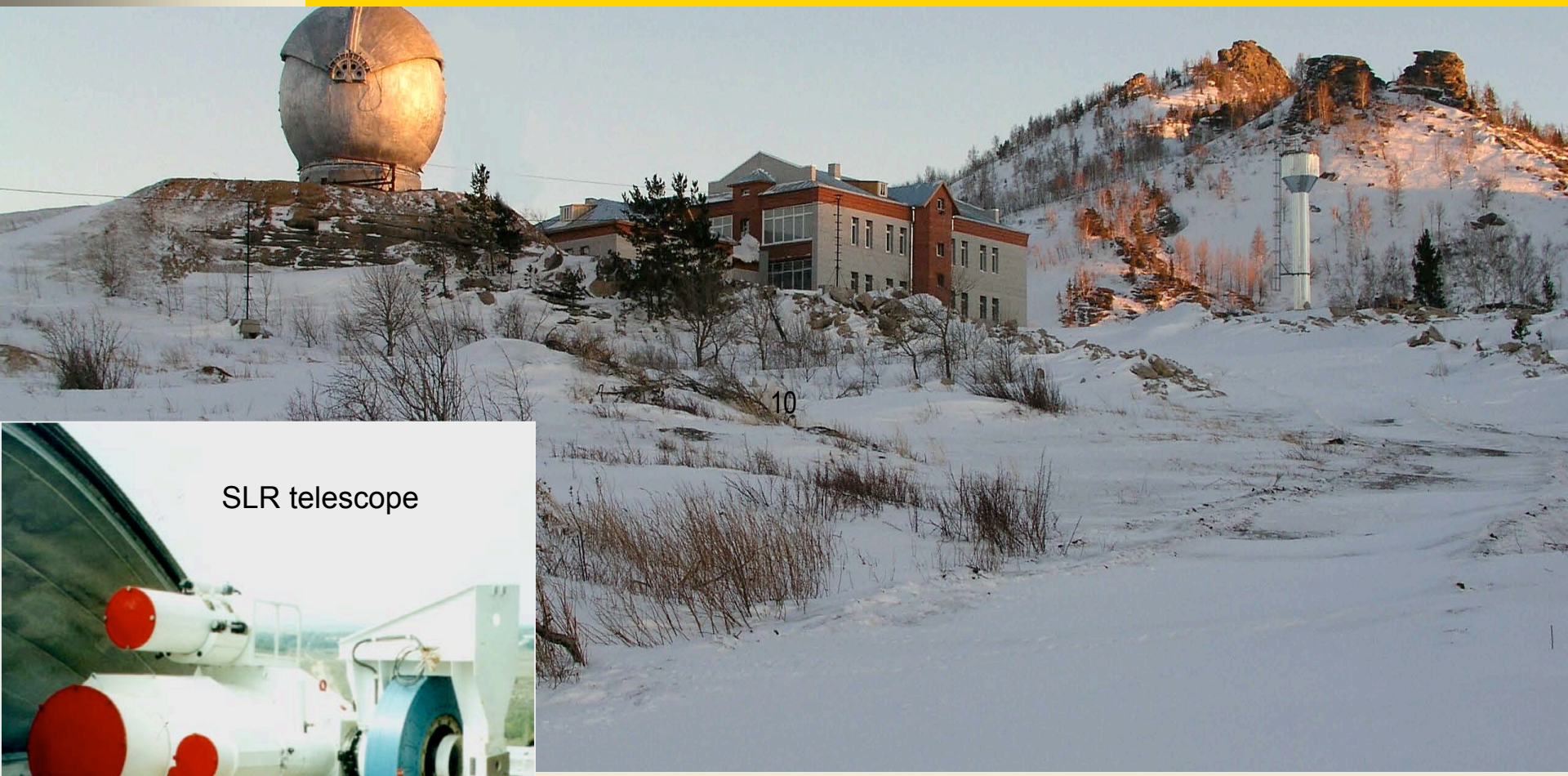
Under cover

During transportation

In operation state

It is planned to install the station at the Baikonur launching site during 2005.

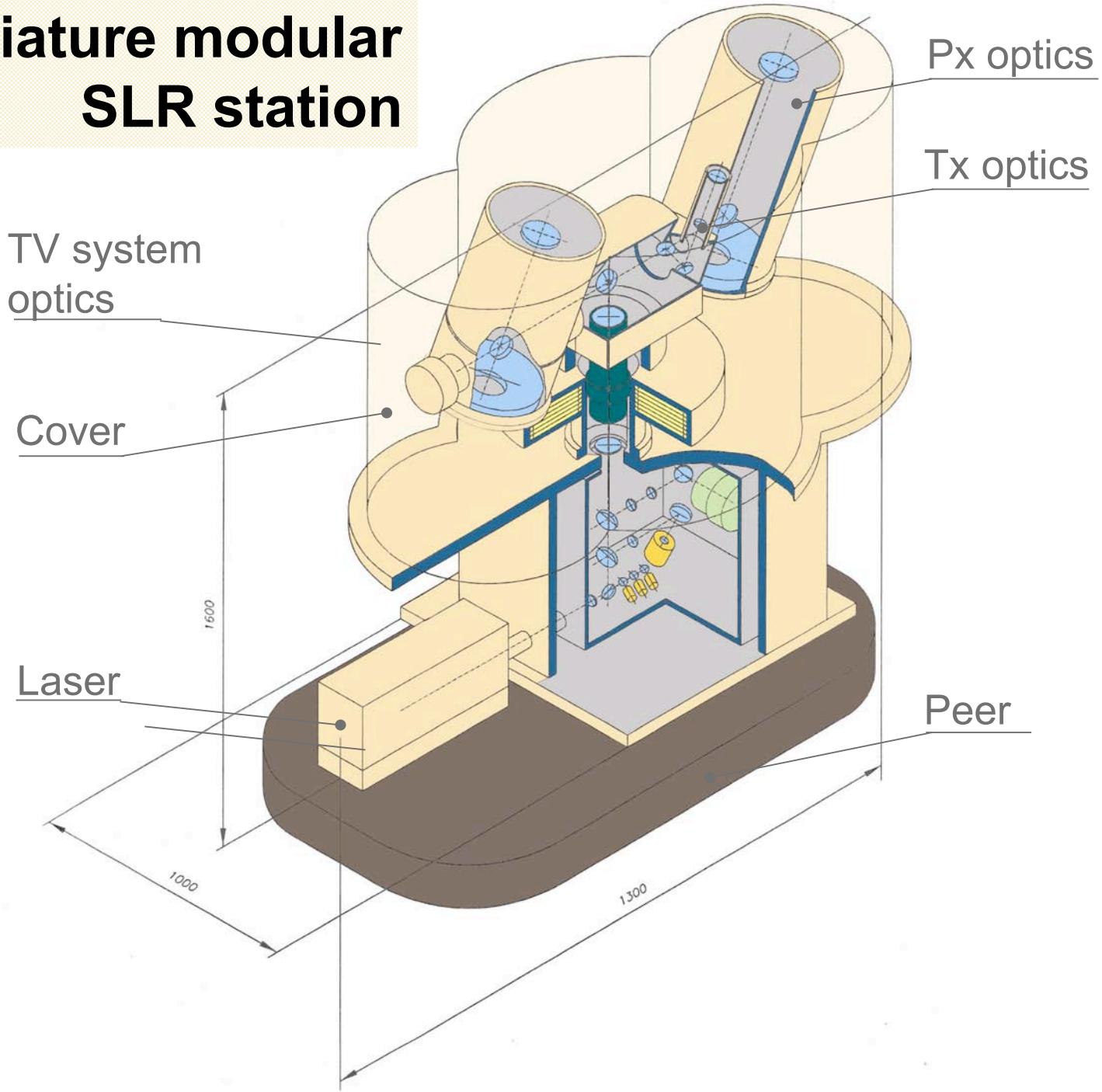
Altay Optical/Laser Ranging Center



Regular operation is planned to start:

3-rd quarter of 2004.

Miniature modular SLR station



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Basic specifications

- Ranging of CCR-equipped SC in orbits as high as 23 000 km (nighttime) and 6000 km (daytime)
- Angular measurements of SC with brightness as low as 14^m
- SC photometry
- NP RMS (30 sec averaging):

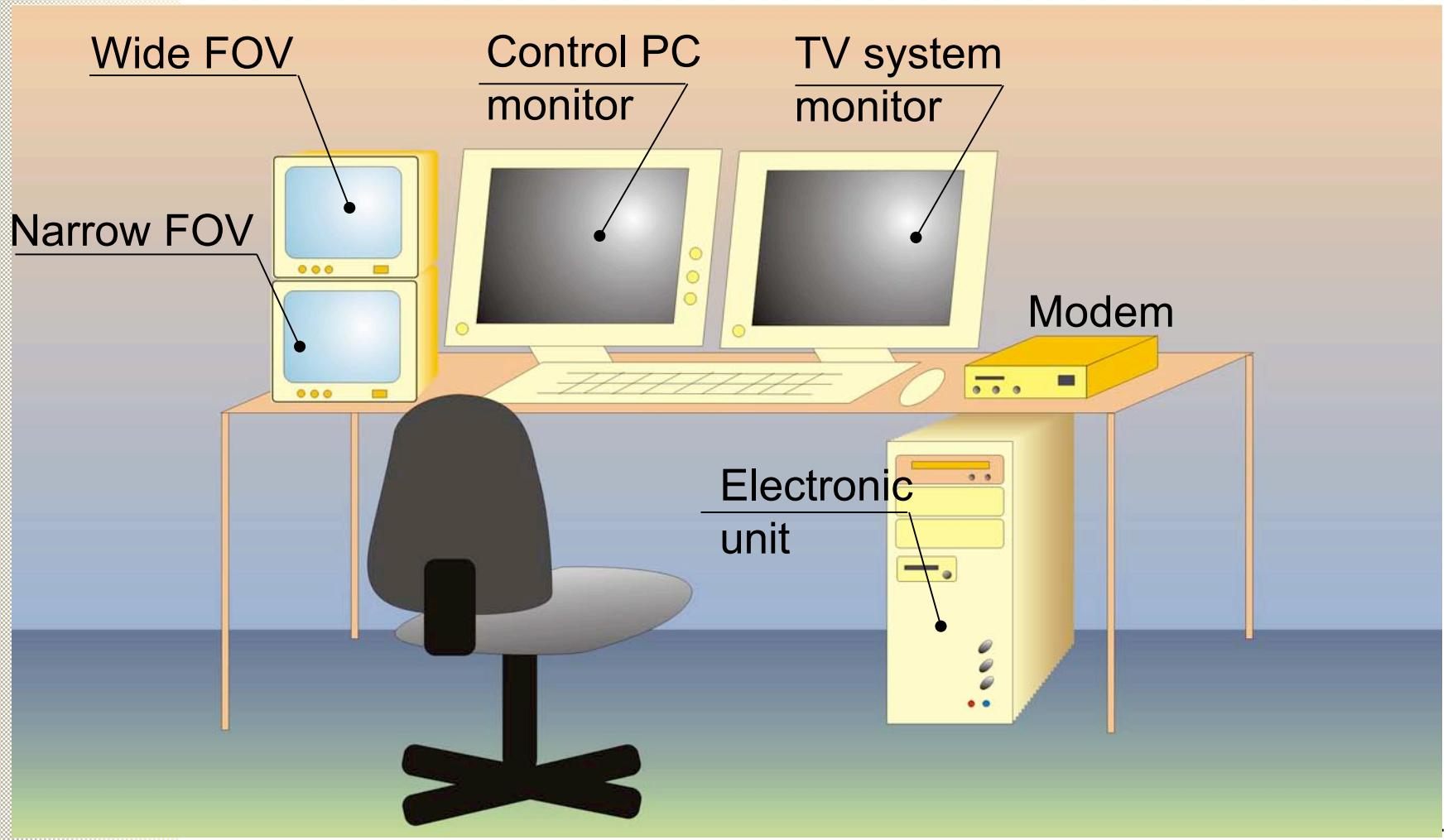
  Range: less than 0.4 cm

  Angles: less than 2…5 arc sec

Modular SLR station subsystems

- Az/El mount with cover and tracking systems (2 arc sec accuracy)
- laser transmitter with optics unit: _ = 0,532 nm
  E = 2,5 mJ
  Rep. rate = 300 Hz
- Rx/Tx collimator (250 mm diameter)
- High-sensitivity TV system for angular measurements
- 250-mm diameter objective
- TV photometer
- GLONASS/GPS – controlled time/frequency standard
- Automatic Weather Station

Operator workplace



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Technical Features

With the small (250-mm-diam.) receive optics, measures are taken to enhance the power budget:

- Miniature diode-pumped laser TX, 0.75 W average output power at 532 nm (2.5 mJ, 300 Hz)
- MCP PMT (Hamamatsu)
- TX beamwidth 10…15 arc sec (2 arc sec pointing accuracy)
- Holographic narrow-band filter (1 _ bandwidth, transmission 85%)
- High-sensitivity TV camera (MCP image intensifier+CCD) operating in photon-counting mode, FOV=1°)

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Technical Features

- Transportation: dissembled, single module weight less than 50 kg.
- System total weight: less than 350 kg.
- Assembling and adjustment by two qualified operators: during 1 work day.
- After assembling, automatic angular sensor alignment using catalogue stars takes 30 min. (at nighttime).
- Ranging bias determination: using a built-in calibration system.
- Cable length aloes placing the optical system as far as 50 m from the other equipment.
- Manufacturing is plan of more than 10 such stations starting from 2005 (one station per year).

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Conclusion

The Russian SLR tracking network is currently in rapid development. After the next five years, it will comprise 12-14 stations, uniformly distributed over the state territory.