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Project of space research and technology center in Engelhardt astronomical observatory

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Abstract

Today on the basis of Engelhardt astronomical observatory (EAO) is created Space research and technology center as consistent with Program for expansion of the Kazan University. The Centre has the following missions:

- EDUCATION
- SCIENCE
- ASTRONOMICAL TOURISM

1. Introduction

Today there are in EAO territory [1]:
1) Complex 12 telescopes; 2) Security systems; 3) Communications; 4) Autonomous life support systems.
Space research and technology center will be:
1) Building first in Russia of the multisectoral cosmic astrometry observatory. It will serve for effective using cosmic results and education skills; 2) Making the effective support for cosmic program GLONASS, Luna-Glob, Phobos - grunt etc. 3) Development of the metrological polygon for testing satellite equipment.
Multisectoral cosmic astrometry observatory will include:
1) GPS/GLONASS systems; 2) 12 meters antenna “Patriot” for Long Baseline Interferometry (VLBI); Systems of satellite laser ranging (SLR) for a global network of observation stations measure the round trip time of flight of ultrashort pulses of light to satellites equipped with retroreflectors.; 4) Wide-angled Space Debris Scaner “Megatartora”; 5) Seismic Systems in 10 meters EAO seismic vault.
Education part will be Astropark and Planetarium: 1) Making base of geodesic and astronomy practice; 2) Complex high-tech equipment for working students and postgraduate;

2. SLR/LLR station in EAO

Known that Satellite Laser Ranging give precise range measurement between an SLR ground station and a retroreflector - equipped satellite using ultrashort laser pulses corrected for refraction, satellite center of mass, and the internal delay of the ranging system [2]. We plan to have a 60cm - 1 meter class telescope integrated into a precision pointing, low jitter, and fast tracking ALT/AZ gimbal designed for tracking low earth orbiting and higher satellites. Similar systems of this size and design have been deployed to various international customers and are listed among the most accurate SLR sites according to International Laser Ranging Service (ILRS) data. We plan to construct an open slit, rotating type dome to provide protection against weather when closed and to provide wind and sun loading protection when open. It should provide full viewing of the sky throughout all observation angles of the telescope and be free of azimuth rotation limits.
In accordance with recent technology trends within the ILRS SLR network, we plan to construct a kHz rate, low energy laser transmitter. Such a laser would have the ability to track a wide range of satellites from Low Earth Orbiters (LEOs) to Geosynchronous Satellites (GEOs) equipped with retroreflector arrays conforming with ILRS optical cross-section standards as a function of
We plan to have a microchannel plate photomultiplier tube (MCP/PMT) to detect the received laser energy from the retroreflector target. The MCP/PMT provides low transit time jitter and fast recovery times following a photon event due to the fact that a very small percentage of the microchannels respond to a single photon event leaving thousands of other channels to respond to
We plan to have that the temporal positioning and width of the range gates (both PMT and electronic) be controlled by a precision programmable range gate generator (RGG).
We propose that the base frequency for the station will be derived from a GPS steered frequency standard. The output from the frequency standard will be provided to system equipment using a frequency distribution unity gain amplifier. A GPS receiver with a 1 pulse per second

output in conjunction with the time interval counter should be

Road map of Kazan SLR/LLR station: SLR station will be at 2013yr, LLR station - 2017yr.

The Kazan SLR/LLR station will meet all requirements of ILRS 2010.

3. Joint project of the VLBI2010 system of Moscow and Kazan universities

The goals of this project is application of new radio astronomical technologies for tracking of the future Russian space missions: Radioastron (2011), Millimetron (2017), "Luna-Glob", (2015) and joint Russian-Indian mission "Luna-Resource" - "Shandrayan-2" (2015) as well as support of the satellite navigation system GLONASS [3]. These new space missions are to be launched in 2015-2025 need a serious improvement of the tracking, navigation and data transmission system.

The main navigational task is to determine the present position and velocity of a spacecraft and to predict its future trajectory. This is done by tracking of the received radio signal and making corrections of the predicted spacecraft trajectory. Modern-day spacecraft navigation must satisfy increasing demands for high-precision on its orbit reconstruction: a few 10-3 m, 10-6 m/s and 10-9 m/s2 for spacecraft's position, velocity and its acceleration correspondingly.

Improvement of the International Celestial Reference Frame (ICRF) is a cornerstone to achieve all the technical requirements. By now, in Russia there is a lack of observational facilities suitable for measuring positions of the reference radio sources. It is expected that development of the new network based on the small size fast slewing rate antennas will result in improvement of the accuracy by 2020.

To enable immediate application of the results of scientific objectives above and to provide a long-lasting impact of our presence for the host university, we propose to undertake a major upgrade to the existing facilities at the Engelhard Astronomical Observatory (EAO) of the Kazan Federal University (KFU) and new Kavkazskaya Gornaja Observatoria (KGO) of the Lomonosov Moscow State University (MSU). We are going to build up a twin radio telescope (two dishes of 12-meter diameter) in KGO and one radio telescope in EAO equipped by the modern technological systems to detect a weak radio signal, record the signal and transfer to the correlation center. Both systems in EAO and KGO will be funded by the Russian Ministry of Education. Equipment needs to be purchased and installed at the site together with the dish

1. Active hydrogen maser (Russian manufacture "Vremya-CH")
2. Cooled broad band receiver covering all frequencies in a range 2-15 GHz.
3. Recording system Mark5B+ or Mark5C supporting data recording rate >1 Gbps.
4. System of the signal digitization, i.e. DBBC (Digital Base Band Converter).
5. Local GPS network to tie VLBI and GPS reference frames with accuracy 1 mm or less.
6. Field system software to operate the telescope in accordance with schedule.
7. Phase calibration system.
8. Meteo station to measure and record the local meteo parameters
9. Disk packs for data recording.

Other important goal of our project is training for students and post-graduate students of both universities.

3. Summary and Conclusions

The laying of Astropark and Planetarium foundation stone was fulfilled August 22, 2011 during International conference “Astrokazan 2011”.

We hope that the official opening of the new Space research and technology center and Astropark will be fulfilled within the bounds of Kazan World Student Games in 2013.

References

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