TO DETECT HAZARDOUS NEOS: PROGRESS IN RUSSIA.

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Introduction: The issue of the defence of our planet against impacts by Near Earth Objects (NEOs) is a complex problem which consists of three main components: (1) the problem of detection (identification) of dangerous celestial bodies and revealing their properties (characterization); (2) the problem of risk assessment and (3) the problem of counteracting and mitigation. The first problem is an obvious priority. It can be solved on the basis of the international cooperation only. In [1] it was argued that establishing of national NEO program seems to be the most practical way to the real international cooperation. Good examples are the NASA's NEO program ([2]) and the European SSA program ([3]). More than 98% discoveries of NEOs are made in these programs. In Russia a concept of the long-term national NEO program was suggested by initiative of expert group (see [1]). The main goal of a special project named Dozor (Patrol) is to construct an efficient system for NEO detection. The system is considered to be incorporated in the international cooperation. In the spirit of this leading Russian astronomical research institutions joined the International Asteroid Warning Network (IAWN) (see http://iawn.net/about/members.shtml). Here I present examples of recent progress in Russia in ground based instruments for observation of NEOs and mention prospects of space born facilities.

Ground based instruments: In 2016 a new 1.6 m wide field (FoV 2.8^o) telescope AZT-33VM (first described in [4]) began to observe NEOs at the Mondy observatory in Siberia. A general view of the telescope is presented in fig.1 (left panel). Small aperture ground based instruments that are devoted to detection and monitoring NEOs in the near Earth space are working in networks ISON [5] and MASTER [6]. A number of new robotic small aperture telescopes is under construction. In October 2017 the 2-m telescope of Terskol observatory (see fig.1) was successfully used in the IAWN TC4 Observing Campaign. The goal of the campaign was to recover, track, and characterize 2012 TC4 asteroid as a potential impactor in order to exercise the international Planetary Defense system from observations, modeling, prediction, and communication ([7]). In fig.1 a frame with an image of 2012 TC4 asteroid (in a circle) observed at Terskol observatory is presented.

On prospects of space born facilities: In [8] the project of space system SODA (System of Observation of Day-time Asteroids) for exhaustive detection of decameter and larger bodies coming from the Sun direction to the near Earth space (Chelyabinsk type meteoroids) is suggested. The set of medium-size (30 cm) wide field telescopes will be put into vicinity of L1 (Earth-Sun) point. The Moscow University satellite "Lomonosov" (launched in 2016) that was equipped with cameras for detecting bodies in the near space has brought first results. Images made with 8 cm ultra-wide field cameras SHOK (see http://lomonosov.sinp.msu.ru/ scientific-equipment-2/shok for details) are presented in fig.1. This experience can be used in future space born instruments designed for NEO and space debris detection and monitoring.

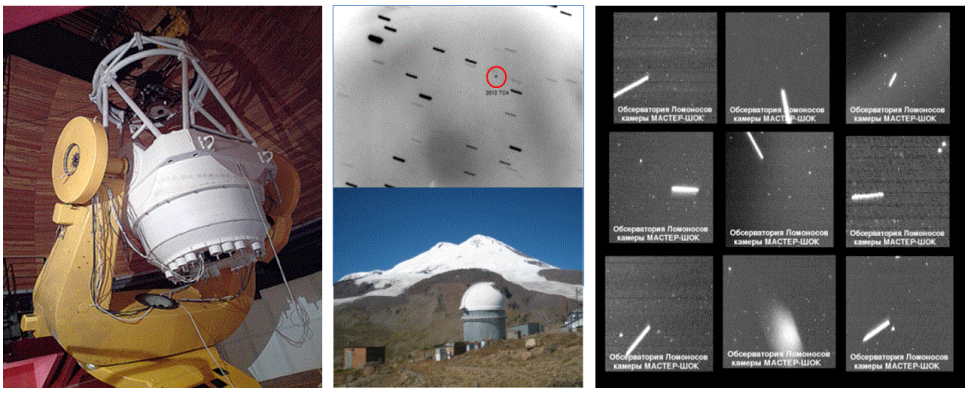

Fig.1. General view of the telescope AZT-33VM (left panel), observations of 2012 TC4 at Terskol observatory (middle panel) and the first frames from SHOK camera onboard "Lomonosov" satellite (right panel).

References: [1] Shustov B.M., et al. (2013) *Solar System Research* 47:327-340. [2] Chodas P.W. (2015) *IAU General Assembly, Meeting #29*: id.2258467. [3] Flohrer T. and Krag H. (2017) *Proceedings of the Advanced Maui Optical and Space Surveillance (AMOS) Technologies Conference*: id.38. [4] Nosov V.V. et al. (2009) *Proceedings of the SPIE* 7296: id.729608. [5] Elenin L. et al. (2014*) Proceedings of the conference Asteroids, Comets, Meteors*: 145. [6] Gorbovskoy E. S. et al. (2013) *Astronomy Reports* 57: 233. [7] Reddy V. et al. (2017) *Proceedings of the Advanced Maui Optical and Space Surveillance (AMOS) Technologies Conferenc*: id.111. [8] Shustov B. M. et al. (2015) *Astronomy Reports* 59:983-996.