



# ON THE NATIONAL PROGRAM TO COUNTERACT SPACE THREATS

*Boris Shustov<sup>1</sup> & Yuri Makarov<sup>2</sup>*

<sup>1</sup>) Russian Academy of Sciences

<sup>2</sup>) Federal Space Agency



**2013 IAA Planetary Defense Conference:  
Gathering for Impact**

*15-19 April 2013  
Flagstaff, Arizona, USA*

# Life and the human civilization on the Earth exist in the environment of cosmic threats

These are:

- space debris (everyday problem),
- asteroid/comet impact hazard (typical time interval - centuries),
- space weather anomalies (one event in a some decades or centuries),
- astrophysical catastrophes,
- biological invasions.

# The Asteroid/Comet Impact Hazard (ACH) in comparison with other global threats

Average calculated number of victims per year does not exceed 1000 (*A.Harris*). This is much lower in compare to ecological, medical, social etc. problems.

## HOWEVER

When it happens it becomes most important event for the humankind.

Collisions are rare but consequences can be very serious. Quick growth of population, expansion of dangerous technologies make ACH factor more important.

# **National program to counteract space threats is a practical way to the effective international cooperation**

We believe that for the effective participation of Russia in the international cooperation on space threats problem we need to develop a comprehensive national (federal) program.

NEO (sub)program – is important part of this.

A good example of completed national NEO program is the Space Guard Survey (1998-2008) funded and controlled by NASA. The European “Space Situational Awareness (SSA) Programme” (started in 2009) includes the NEO issue.

# Arguments pro national program in Russia (NEO aspects)

1. The NEO problem is a multi-problem. Various organizations (ministries) are to be involved (coordinated);
2. The expensive technologies of massive detection of NEO, preventing collisions and mitigation can be proposed but cannot be realized under the responsibility of individual research institution;
3. Cooperation of countries on the NEO problem implies the involvement of Russia Government (or authorized body);
4. Regular funding is vitally important for real progress.

## Premises of the national NEO (sub) program

In June 2010 a joint meeting of the heads of Roscosmos and the Space Council of the Russian Academy of Sciences (RAS) was held. Roscosmos and RAS expressed their wish to integrate their efforts to study issues of NEO and space debris. It was recommended to prepare a concept of the national (federal) program.

The (draft) concept of the long-term federal NEO program was prepared by the Expert Working Group on Space Threats by Space Council of the RAS.

To remind: The Expert group includes representatives of the RAS, universities, Roscosmos, industry, EMERCOM, Rosatom, Ministry of defense etc.

([http://www.inasan.ru/eng/asteroid\\_hazard/](http://www.inasan.ru/eng/asteroid_hazard/)).

# Three basic aspects of the ACH problem

- Detection, characterization
- Risk assessment
- Protection and mitigation

Same for space debris problems.

A cooperative approach is required.

In November 2012 Roscosmos gave start of systemic approach to elaboration of program of construction the **system of detection and monitoring** of dangerous objects (space debris and NEOs).

Two major partners:

- Roscosmos - for space debris
- RAS - for ground based facilities for detection and studies of NEOs.

Roscosmos is considered either to be in charge for all the NEO related space missions. This seems to be the first and most important step to the construction of a national system.



# Comparision of NEOs and space debris populations

Objects Parameter (typical value of)	Dangerous NEOs	Dangerous fragments of space debris
Size	<b>&gt; 50 m</b>	<b>&gt; 1cm</b> at LEO <b>&gt; 5 cm</b> at GEO
<u>Albedo</u>	<b>0.1</b> for asteroids <b>0.3</b> for (young) comets	wide range
Linear velocity at approach to the Earth	<b>20 km/s</b> for asteroids <b>up to 71 km/s</b> for comets	<b>8 km/s</b> at LEO <b>3,2 km/s</b> at GEO
Angular velocity	<b>&lt; 10<sup>-5</sup> deg/sec</b> at distance <b>1 A.U.</b>	<b>&lt; 2 deg/sec</b> at LEO <b>0,005 deg/sec</b> at GEO
Stellar magnitude (for reasonable exposure time)	<b>V &lt; 23 – 24<sup>m</sup></b>	<b>V &lt; 19 – 20(22)<sup>m</sup></b>
Spatial distribution	Asteroids at large distances are concentrated to ecliptic plane Comets and asteroids at approach – almost uniformly over celestial sphere.	at LEO – almost uniformly over celestial sphere. at GEO – concentrated to the GEO area.

Near Earth meteoroids are similar to largest space debris objects

## Two modes of detection

1. Large Distant Detection (LDD). Major goal is to detect hazardous bodies larger than  $\sim 50$  m well beforehand. This requires powerful instruments and sufficient time for detection and characterization (orbit determination).
2. Near Earth Detection (NED). Major goal – to detect bodies: space debris and meteoroids in the near space (say inside lunar orbit). This mode does not require for powerful telescopes as LDD does but the relevant instruments should be very fast.

## LDD mode: NEO detection

(general requirements and other inputs for design of detection instrument )

- Massive ( $> 90\%$ ) detection of PHOs larger than 50 m.
- Time interval between detection and rendez-vous must be not less than warning time ( $t_w$ ).  $t_w \sim 30$  days.
- $V$  at approach  $< 40$  km/s.
- For the object (at 1 A.U. from the Earth) an observational time interval of 7 days is sufficient for classification of any orbit.
- Limiting magnitude  $H < 23 - 24$
- 1-2 m aperture wide field telescope required (in visual domain)

**Instrument for detection:  
telescope AZT-33VM ( $\varnothing$  1.6 m,  $\omega=3^\circ$ )**



**AZT-33IR**

**AZT-33VM**



**Mondy Observatory  
December 2012**

## Follow up observations

We plan to establish a network for the follow-up observations of the discovered NEOs. There exist premises for this: programs of NEO observations at Pulkovo Observatory (RAS), in the Institute of Solar-Terrestrial Physics (RAS), Special Astrophysical Observatory (RAS), Kazan University, Institute of Astronomy (RAS), etc

There works efficient observational network ISON established by Institute of Applied Mathematics of the RAS and funded by Roscosmos. ISON is developing and internationally demonstrating its efficiency for space debris studies.

These facilities, as well as specially designed ones, are suggested to constitute the national network.

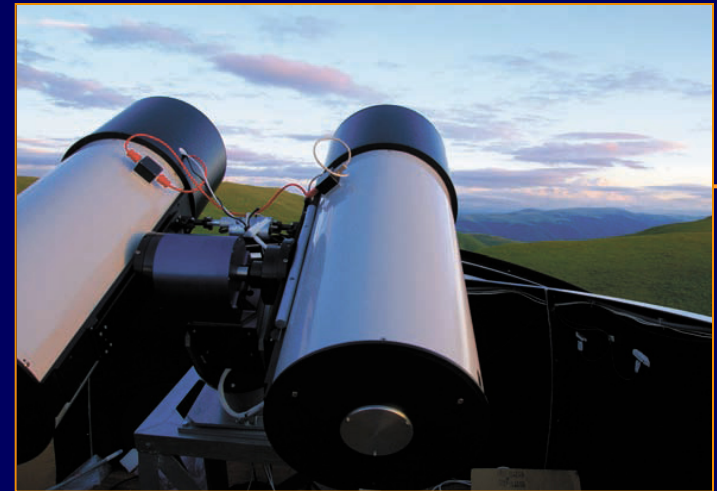


# Some telescopes suggested for a follow-up system



VAU

Zeiss-2000



telescope MASTER



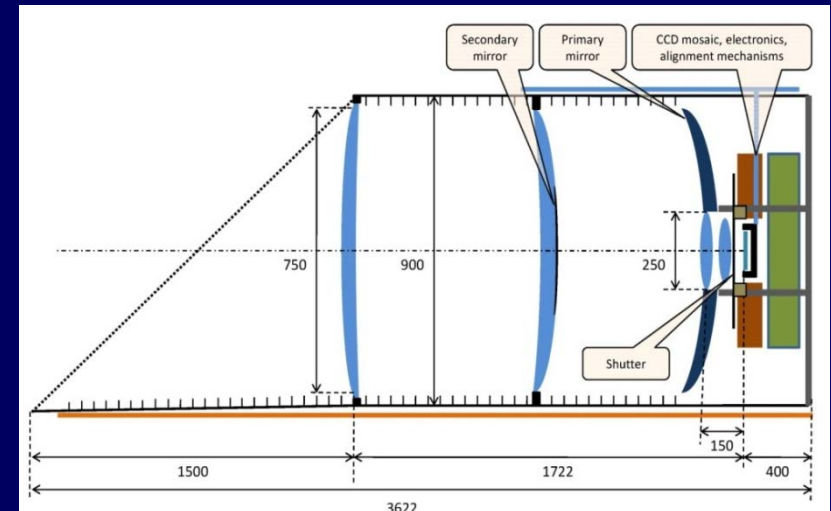
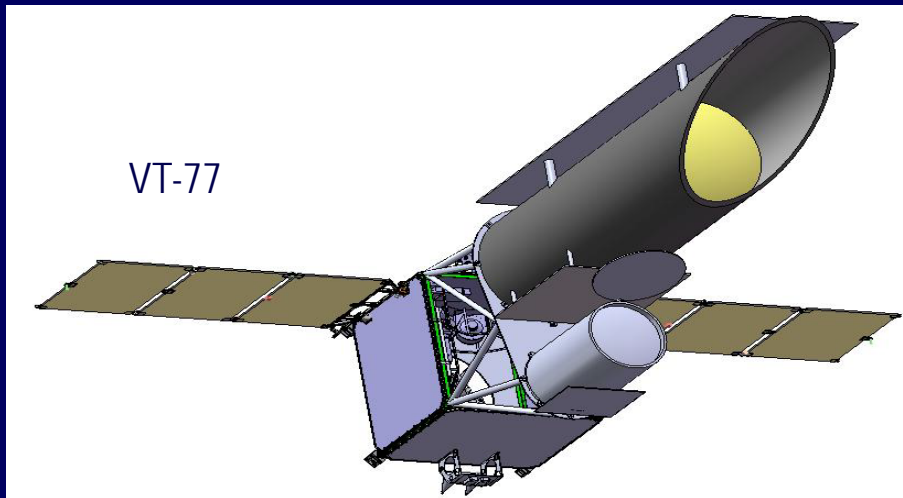
“Okno”



telescope ISON in NM

# Project of space telescope for the detection NEOs

Several proposals are under consideration:  
from 1,5 m aperture to 40 cm aperture space telescopes



See poster by *Shugarov*

# Space mission “Apophis”

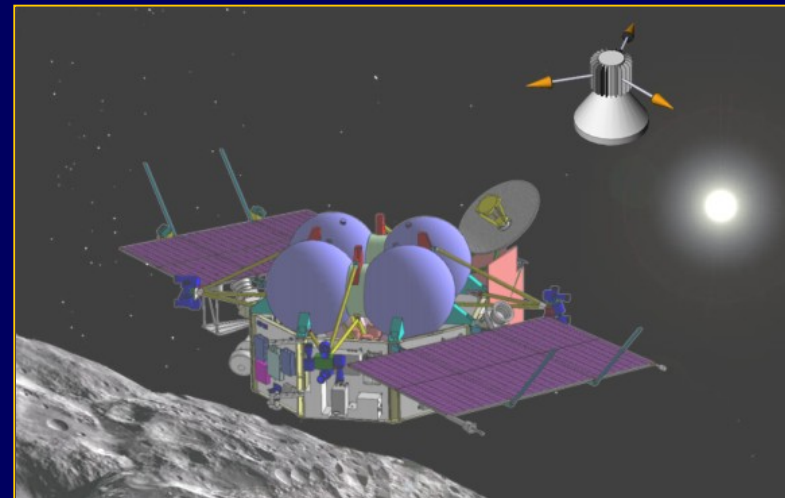
The major goals of the mission:

- to carry out a study of physical and chemical properties of PHA (Apophis as an option)
- to put a special radio beacon into circum-asteroid orbit aimed to precise determination of the asteroid's orbital parameters.

2018-2022 seems to be the most reasonable window for the launch. The total mass of payload is about 800 kg.

Both distant and contact modes of study are considered.

A possible matter of interagency discussions?





## **Data handling**

We consider the establishing of the national information center responsible for collection, storage, analysis, etc. of observational data from the Russia observatories to be a very important task.

The international cooperation and interaction with the MPC and other world centers is a cornerstone principle.

# Risk assessment

$$\text{risk} = \text{probability of collision} \times \text{consequences}$$

Technologies to estimate both:  
collision probability and consequences of impact  
are not still sufficiently developed.

The Program includes practical plans to support R&D  
activities in these directions

# About an initiative of construction the international bank of impact consequences

Experts of the three institutes of the RAS:

- Institute of Dynamics of Geospheres,
- Institute of Oceanology
- Institute of Astronomy

proposed to construct data-bank of impact consequences.  
The data bank is considered to be similar to those elaborated and/or being under creation for tsunami and climatic hazards in some countries.

The consequences of a collision are very dependent on many details:

- characteristics of the colliding body,
- parameters of atmospheric entry,
- relief details,
- density of populations,
- industrial environment
- etc.

The suggestion is to pre-calculate the consequences for all the most “sensitive” (to the ACH) regions on the Earth during “quiet age” (before the next serious collision). This will speed up and facilitate decision-making process. It is clear that for some countries it will be problematic to construct an own part of the relevant data bank. A dedicated international program would be helpful.

# **Space threats: time to work together!**

Resolution B3 of IAU (approved at IAU GA 2012 encourages astronomers to do their best for solving an important practical ACH problem both at national and international levels.

Interagency collaboration is vitally important!