



Research of near-Earth asteroids which are carried out with the participation of the Russian Federation

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UNITED NATIONS
Office for Outer Space Affairs

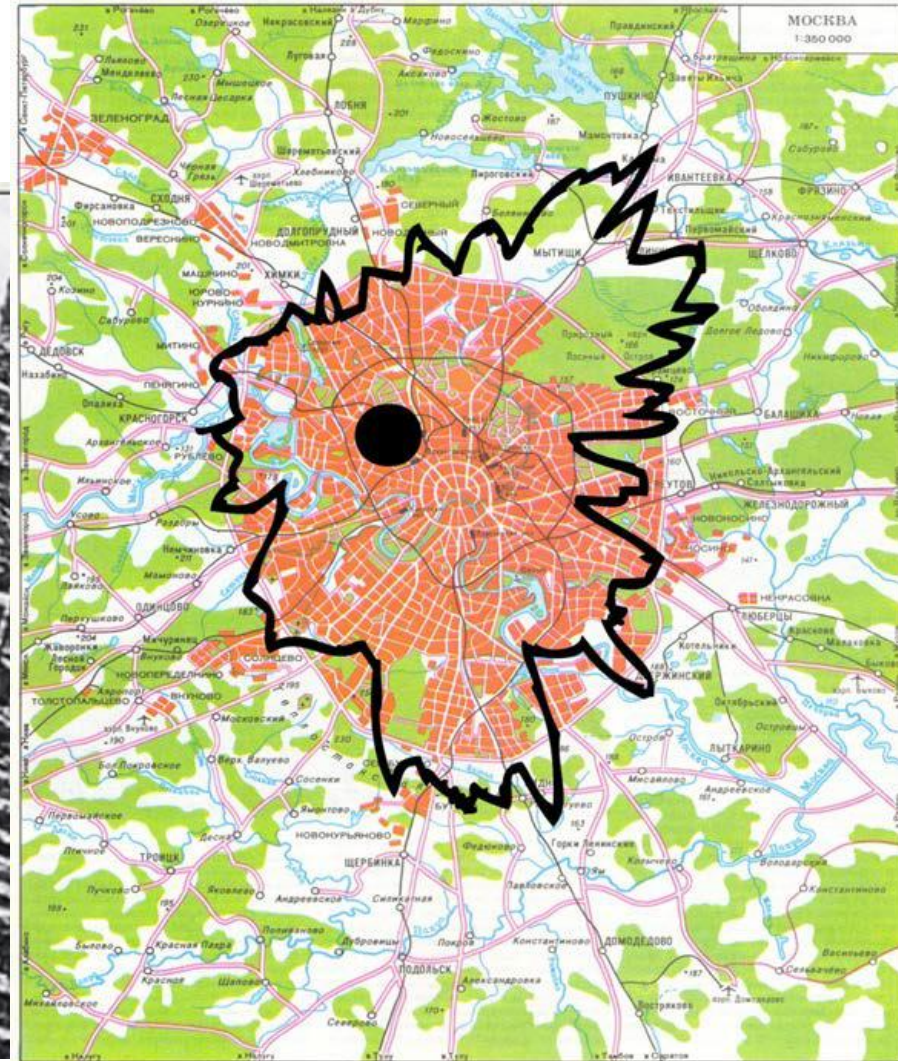
Scientific and Technical Subcommittee: 2019
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Asteroid problem

- Among the many small planets found in the Solar system, there is a special population of near-Earth asteroids (NEAs) and its investigations is very important for several reasons:
 - existence of the NEAs population indicates the presence of an asteroid hazard, these cosmic bodies could potentially collide with the Earth;
 - NEAs is an opportunity to study the physical properties of the smallest celestial bodies due to their periodic rapprochements with the Earth. Their research provides scientific information about the origin and evolution of asteroids and allow to study the migration of small bodies in the Solar system;
 - asteroid are targets of space missions, therefore, it is necessary to know the size, shape and composition of asteroids selected for sending the automatic stations to them. And NEAs are the possible source of extraterrestrial raw materials for space exploration.
- Number of detected NEAs has increased dramatically (19571 NEA on January 31, 2019) thanks to special asteroid surveys in USA. But in addition to the discovery of new objects, it is necessary to track them to measure the accurate orbits and determine the physical characteristics
- In the Russian Federation, scientists research the asteroids in various aspects

1908, on the Tunguska river, 10 Megatons explosion

In a deserted taiga suffered 3 people



Number of victims could be more than 15 mln. people

2013, city of Chelyabinsk, 0.5 Megatons explosion



1613 people were injured, 1,000 buildings were damaged, 1 billion rubles of financial damage

Research of NEAs with the participation of the RF

- Survey program - MASTER project + amateurs
- Adjusting radar technique – IAA RAS (32-m dish radio telescopes in Svetloe, Zelenchuck and Badary) jointly with JPL (Goldstone)
- Collaboration with IAWN (5 Russian observatories - Mondy, Kourovka, Arkhyz, Terskol and Simeiz)
- Polarimetry - Far Eastern Federal University jointly with Ussuriysk observatory
- ASPIN program of the ISON project (survey, photometry and follow up)

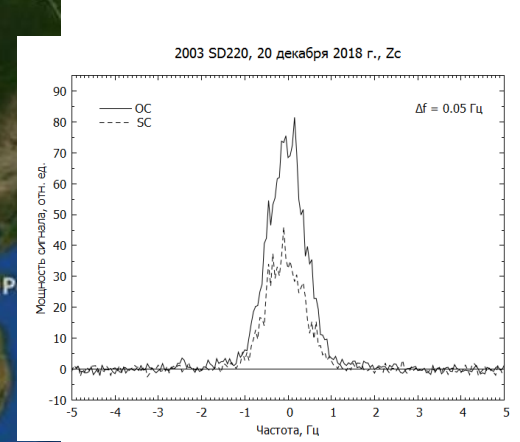
MASTER project (SAI MSU)

8 telescopes of 2x40 cm with field of view 2x4 degrees provide survey for searching the optical transients including asteroids with **magnitude of 18**. Try to detect fast and bright NEAs. 4 NEAs and 3 comets were discovered for all time. During 10 months **2018 - 192718** measurements, but no discoveries even main belt asteroids, during **2017- 223381** measurements.






Trial participations of IAA RAS in radar experiments of JPL USA – receiving of echo-signals of asteroids from DSS-14

Three 32-m dish radio telescopes in Svetloe, Zelenchuck and Badary, X-band, two polarizations, bistatic radar with narrow-band signal



Collaboration with IAWN

Photo	Aperture and place	FOV	Work in 2018
	1.6 m AZT-33VM in Mondy, Sayan mountains	30'x30' May be enlarged with CCD mosaic	4002 measurements, 12 main belt asteroids
	43 cm SBG in Kourovka, Ural	40'x60'	470 measurements, photometry
	60 cm Zeiss-600 in peak Terskol, Kabardino-Balkaria	12'x12'	304 measurements

Photometry of NEAs is already collecting with 1-m **Zeiss-1000** in **Simeiz**
 Spectrometry may be collected in future with 2-m **Zeiss-2000** at **Terskol**

ASPIN program of the ISON project

Asteroid Search and Photometry Initiative

ASPIN program is part of ISON project for:

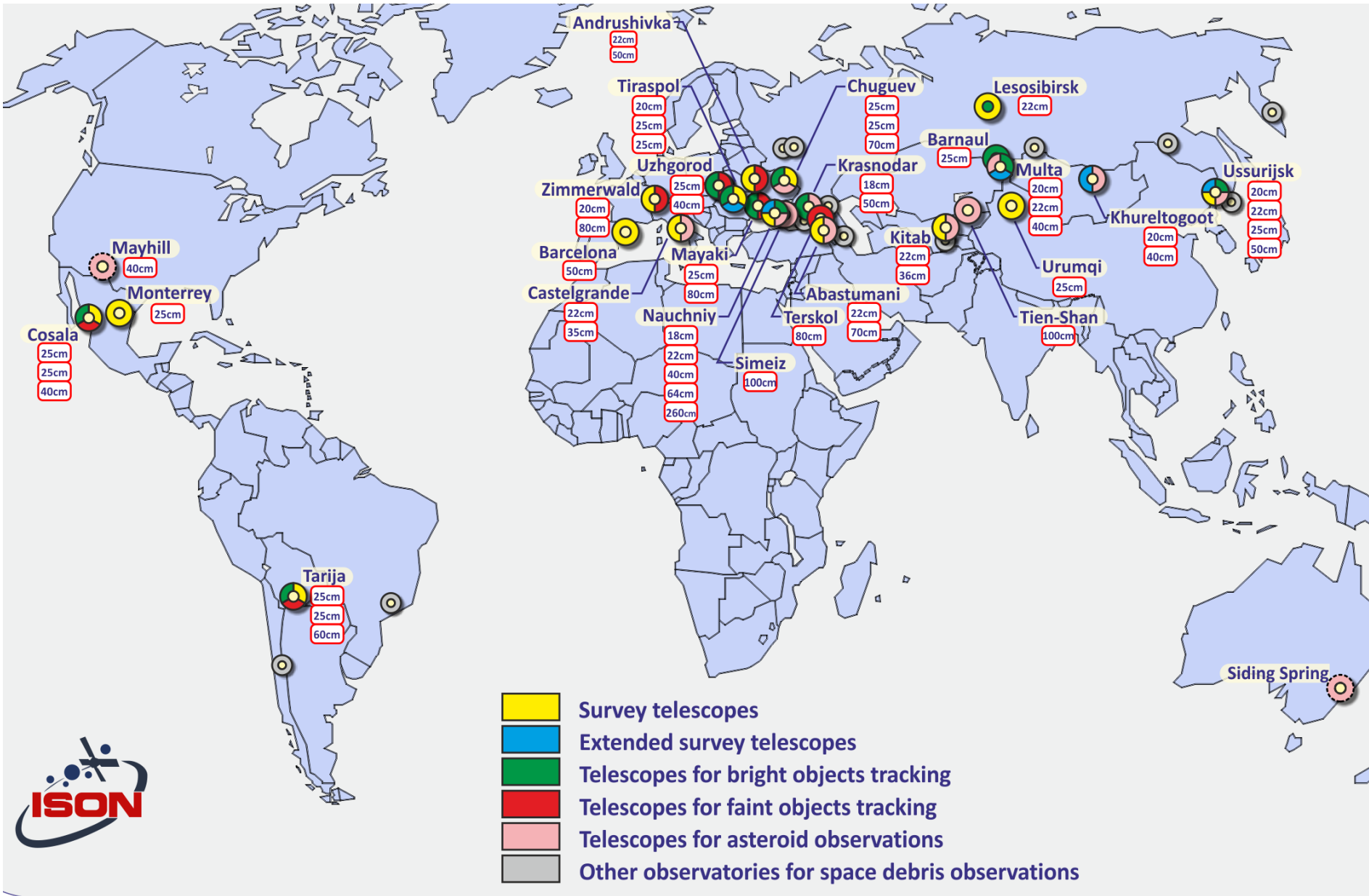
- developing asteroid survey technology using small wide-field telescopes that provide full sky coverage during night to detect fast NEAs
- regular photometric observation campaign on NEAs for obtaining its physical properties
- follow-up Near-Earth asteroids (NEA) with dedicated subsystem of telescopes of 35-cm - 50-cm aperture class
- arranging the photometry observations of bright NEAs with subnetwork of very small telescopes (25 cm aperture)
- obtaining MPC codes for ISON observatories (12 codes to the date)
- ISON (International Scientific Optical Network) project coordinated with the Keldysh Institute of Applied Mathematics, RAS/MSHE RF,
- Photometry campaigns are coordinated with IA KhNU



Status of ASPIN asteroid observations

- **Two surveys with 40 cm telescopes** in New Mexico, USA (**1.65x1.65 degree**) and Siding Spring, Australia (**2x2 degree**) (joint project with AIUB team) with centralized scheduling and processing in KIAM allowed adjust technique and software, and **stopped in end of 2018**
- **New survey with new 40 cm telescope in Multa**, Republic Altai (**4x5.5 degree**) **will start in this summer**. Expected rate of survey is 2000-3000 sq.degr/night with work magnitude – 20^m - 19^m.
- **New ISON subsystem for follow up of new NEAs is arranged** from 5 telescopes of 35-cm – 50 cm for work, if submitted grant proposal will be adopted. Test observations were arranged in Dec. 2018.
- **10 telescopes of aperture 60-cm to 2.6 m** participate in ASPIN/ISON campaign on photometry observations for the goals:
 - observations of new NEAs (especially PHA) for characterization;
 - searching for binary asteroids and determining parameters of the binary systems;
 - investigation of the YORP effect: detection of the influence on asteroid's rotation;
 - support of radar observations of NEAs by optical observations

Map of ISON telescopes&observatories



ISON asteroid subsystem



**Old and new 40-cm telescopes
for asteroid survey**

**2.6-m ZTSh in Nauchniy, 70-cm AS-32
in Abastumani, 1-m Zeiss-1000 in
Simeiz, 1-m Zeiss-1000 in Tien-Shan,**

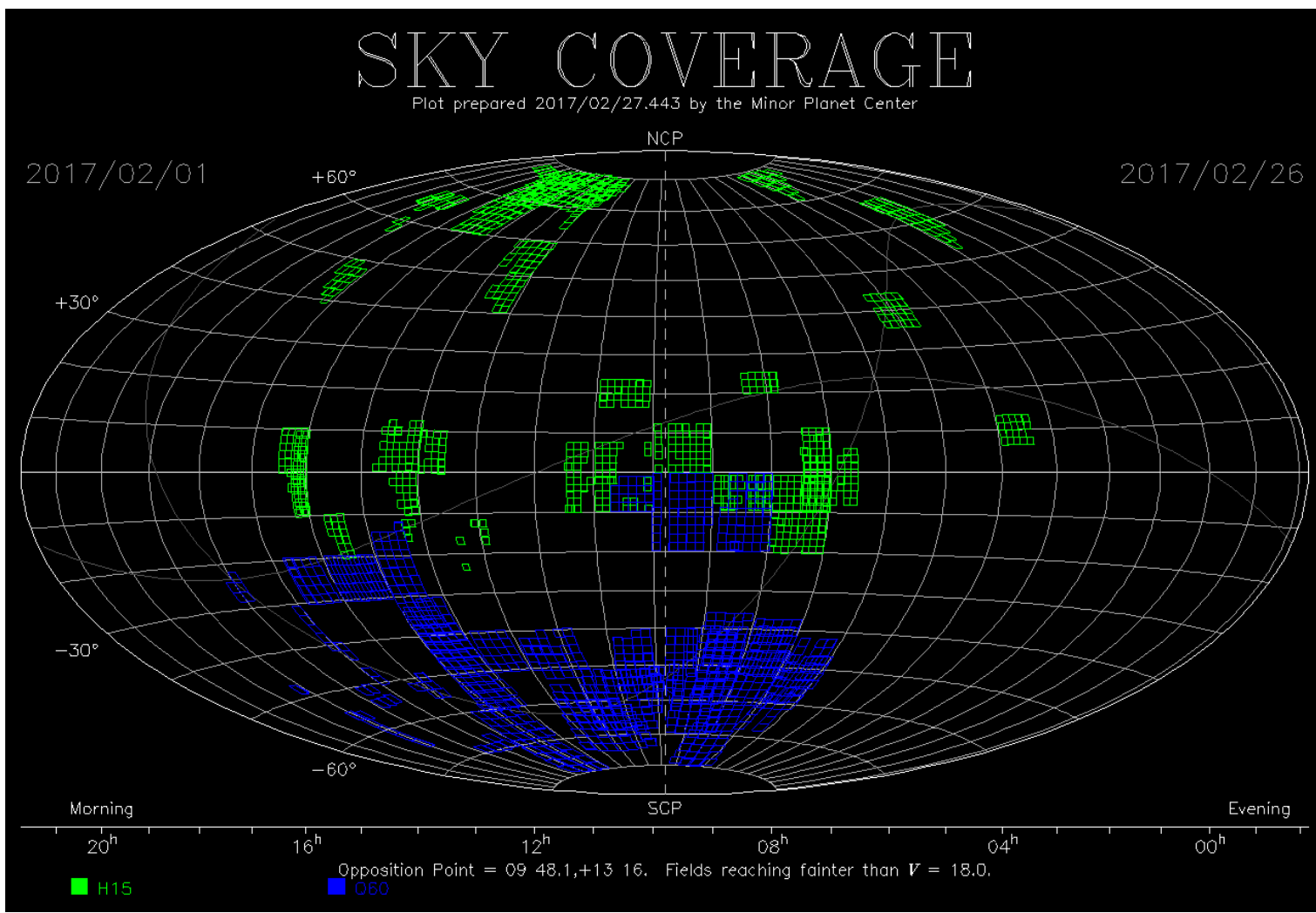


**50-cm ChV-500 in Ussiriysk, 36-cm RC-360 in Kitab, 40-cm
ChV-400 in Cosala, ORI-40 in Mongolia, RC-500 in Krasnodar**



Coverage with two ISON surveys in February 2017 with limiting magnitude of 20.5

Surveys with new 40 cm telescopes will provide such coverage
per single night!

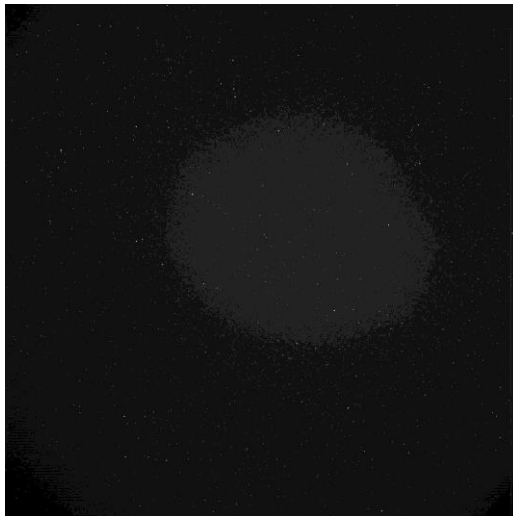
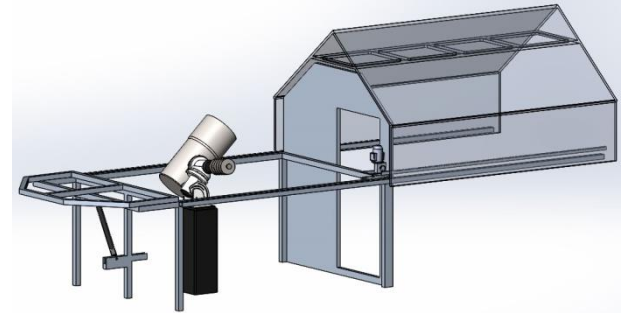


Survey with new 40 cm telescope in Multa, Republic Altai, RF begins in this summer

Second similar 40 cm telescope with FOV of 22 sq. deg. is ordered and must be ready in 2020. **The place with good astroclimate for its installation is searched. Please propose!!** 4 of such telescopes will be able to cover with survey the entire sky for two or three nights.



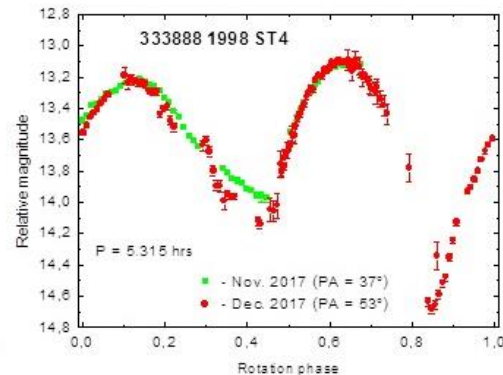
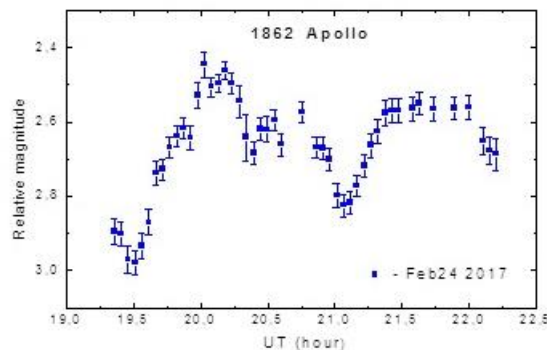
Test first light near
Moscow with
CCD-chip 36x36 mm
FOV is 4x4 degree



ASPIN-ISON asteroid results

- Surveys: 1 230 500 astrometry measurements, it is discovered **17 NEAs, 8 comets**, 20 Trojans of Jupiter, 4 objects from the family of Hilda, 4 objects of family Centaur, and **1605 main belt** asteroids.
- Photometry: in average of up to 250 nights of observations and up to 80 asteroids per year are investigated since 2010
- Approximately **700 light curves for 300 NEAs** were obtained
- **2018 - for 100 NEAs** were obtained 300 light curves **on 278 nights** (Simeiz 1 m – 47 NEAs on 59 nights, Abastumani 70-cm – 56 NEAs on 100 nights, Nauchniy 2.6 m – 32 NEAs on 29 nights).
- **2017 – 79 NEAs on 270 nights** (including 20 new NEAs, 15 PHAs, 9 suspected binaries, 10 asteroids to investigate the YORP effect, 3 binaries for testing BYORP, NEA 496018 2008 NU that showed two-periodic light curve)

NEA 1862
Apollo with
YORP effect,
Feb. 24, 2017



NEA 333888
1998 ST4, rot.p.
5.315 ± 0.001 h
Nov.-Dec. 2017



АСТЕРОИДНО-КОМЕТНАЯ ОПАСНОСТЬ: СТРАТЕГИЯ ПРОТИВОДЕЙСТВИЯ

Под общей редакцией
В.А. Пучкова

Москва
2015



Characteristics of the territory of Russia according to the degree of danger

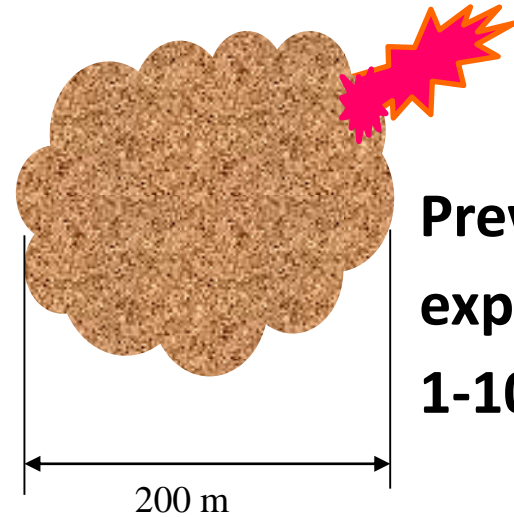
The number of victims and other consequences were calculated according to population density and the availability of industrial facilities.

Similar model risk calculations are also possible for any country in the world.

Prevention to the collision with the Earth

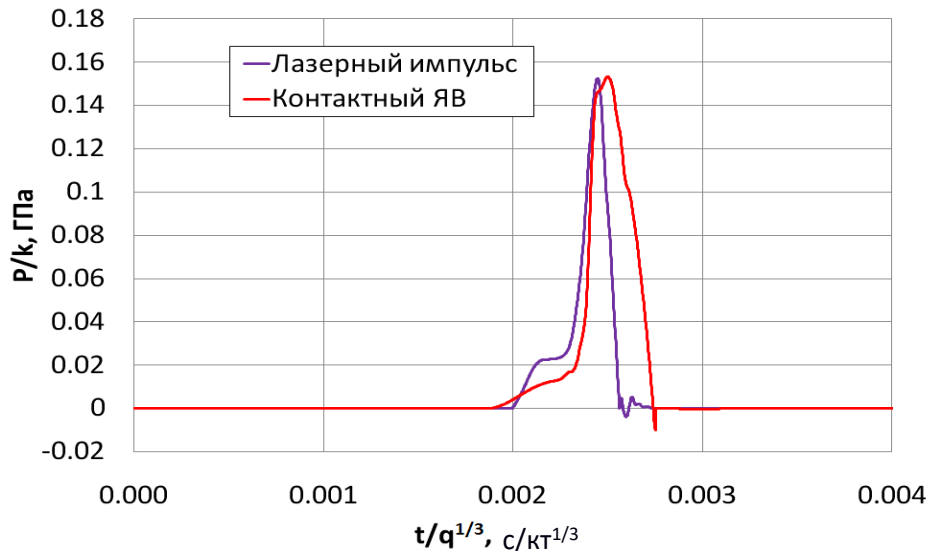


Asteroid



Preventive
explosion
1-10 MT

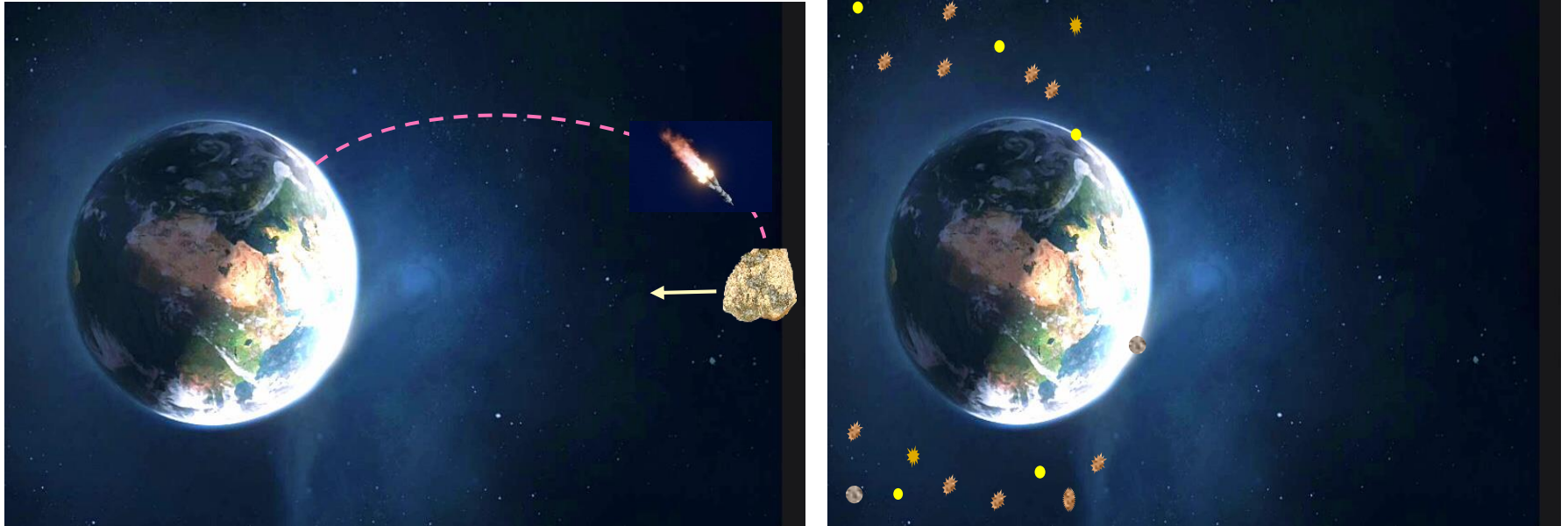
200 m



**Complete fragmentation.
Large fragments are absent**

$E/M = 3000 \text{ J/g.}$

ASTEROID SECURITY



On January 15, 2019, the Presidium of the Russian Academy of Sciences held a meeting devoted to the asteroid hazard and decided to prepare a program for risk assessment and their possible prevention.

Conclusion

- In the Russian Federation, scientists research the asteroids in various aspects
- Asteroid surveys obtained about 2.5 mln. astrometric measurements and discovered 29 NEAs and 19 comets. MASTER project is ahead in quantity of measurements, ASPIN/ISON project – in discoveries.
- More productive asteroid survey of the ASPIN/ISON project will start soon in Multa using 40-cm telescope with FOV of 22 sq.deg. **We are looking for a good place to install a second such telescope**
- Adjusting of the radar technology for NEA investigations is on the way with three 32-m dish antennas of IAA
- 5 Russian observatories make first steps to participate in IAWN
- Zeiss-1000 in Simeiz became the center of photometry NEAs research
- ASPIN/ISON international campaigns of photometry observations of NEAs provide significant scientific output, approximately **700 light curves for 300 NEAs** were obtained
- Dedicated subnetwork of 5 telescopes 35-cm -50-cm class for NEA follow up can start operation, if our grant proposal will be adopted.
- **Evaluation of asteroid hazard for regions of Russia is fulfilled, the methods to destroy the asteroid are estimated**