The Network “PHOBOS” - **P**otentially **H**azardous **OB**jects **O**bservation **S**ystem.

Ministry of Science and Higher Education,
Russian Academy of Sciences
Russian Federation

Basic aspects of the NEO problem

Near-Earth Objects (NEOs) are asteroids and comets that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighborhood.

Asteroid/Comet impact hazard – is a threat of collision of the cosmic body with the Earth.

Major constituents of the NEO (Asteroid/Comet Impact Hazard - ACH) problem are:

- **Detection and characterization**
- Risk assessment
- Protection and mitigation

Two tasks and modes of detection

Large Distant Detection (LDD).

Major goal is to detect “all” PHO larger than ~ 50 m well beforehand (to ensure possibility of active counteraction).

Near Earth Detection (NED).

Major goal – to detect “all” PHO larger than ~ 10 m in the near space (1 mln. km from the Earth). This makes possible warning only.

“All” means > 90% of Potential Hazardous Objects (PHO)

LDD mode of NEO detection
(general requirements for design of detection instrument)

- Time interval between detection+characterisation and rendez-vous must be not less than warning time t_w ~ 30 days.
- V of a NEO 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 as PHO.
- Limiting magnitude V < 23^m – 24^m
- This mode requires some ~2 m class wide field ground based telescopes.

NED mode of NEO detection
(general requirements for design of detection instrument)

- Time interval between detection and rendez-vous must be not less than warning time t_w ~10h.
- V is typically 20 km/s .
- Limiting magnitude V < 19^m-20^m
- A properly located system of $\leq$ 1-m aperture wide field telescopes required (in visual domain). Whole sky should be surveyed in hours!
- The mode requires for system of reasonable number of ~ 1 m class wide field telescopes.

NEO detection instruments: examples

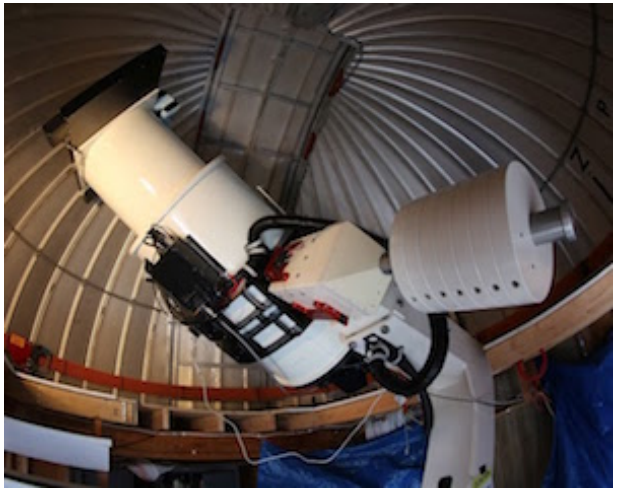
LDD mode: **Pan-STARRS 1** (Panoramic Survey Telescope and Rapid Response System):

- Aperture – 1.8 m;
- Magnitude – 22^m;
- Location – Hawaii, USA.

NED mode: **ATLAS** (Asteroid Terrestrial-impact Last Alert System):

- Aperture – 0.5 m;
- Magnitude – 20^m;
- Location – Hawaii, USA.

Pan-STARRS 1



ATLAS

The network “PHOBOS”

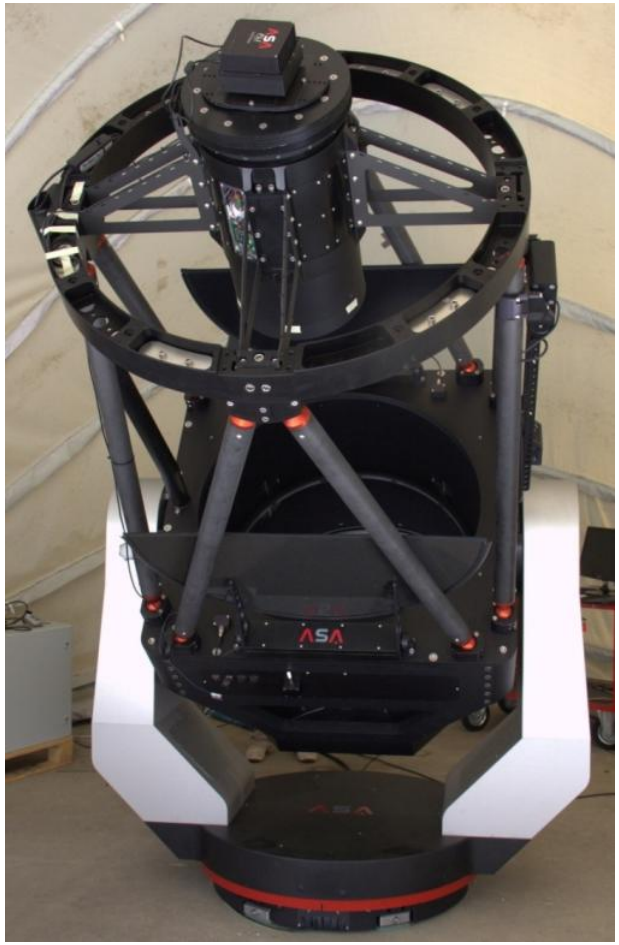
We propose to create a network of wide-angle 1-meter telescopes for solving a wide range of astronomical issues, including the detection of potentially dangerous asteroids and comets:

- Discovery of 10 m class impactors one day before possible collision
- Discovery and characterization of 50 m class NEOs 15-20 days before
- Search for new comets
- Monitoring, discovery and characterization of space debris

- Study of
  - Gravitational wave sources
  - Supernovae, Gamma ray bursts
  - Transiting exoplanets
  - Variable stars
  - Young and active stars
  - AGN / QSO variations
  - Microlensing events

Wide–angle 1-m telescope ASA 1000

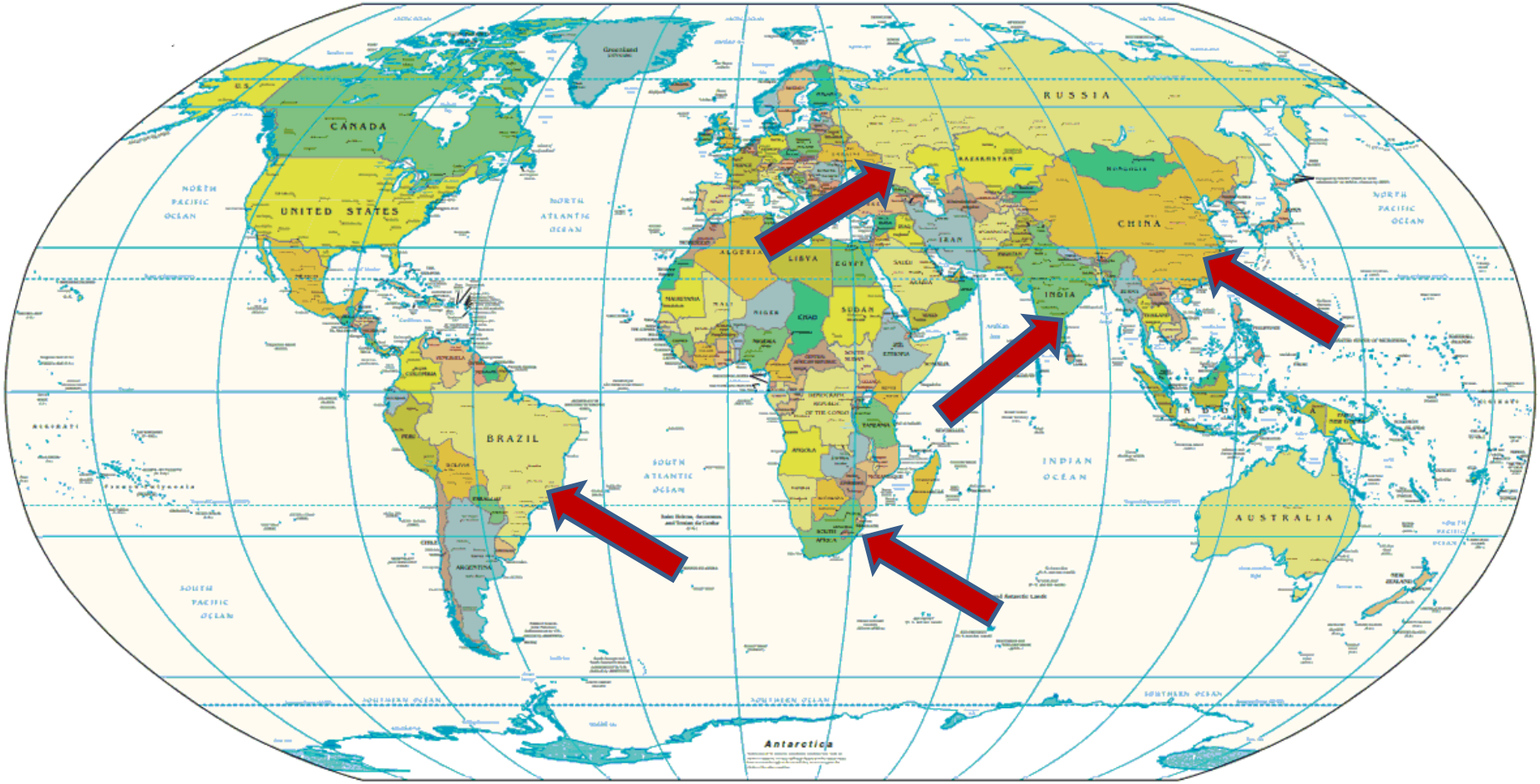
AZ1000WF telescope is 1m-class wide field survey telescope **with one of the best price/performance ratio**.



Main telescope parameters:

- Aperture 1 m
- Fast direct drive alt-azimuth mount (10 deg/s slewing speed)
- Field of view 3 deg (130 mm diagonal)
- Optical quality: ~1 arcsec @ 400-700 nm
- Design to operate with largest single-chip 10k × 10k CCD detector
- Survey efficiency:
  - half-sky in two days down to 20.5^{m}
- Derotator, focuser

The location of the observatories in the BRICS network “PHOBOS”



The main advantage of the network – is longitudinal and latitudinal distribution of observatories.

Potential contribution of participating countries

- Brazil, Russia, India, China, South Africa – dedicated 1-m class wide field telescopes;
- All participants – science observational programs;
- ? – Science Coordination Center.

Tasks of Science Coordination Center

- Coordination of observation programs.
- Collection, processing, and analysis of observational data and other information on potential hazardous objects.
- Reliable determination of the probability of collisions.
- Assessment of the consequences of collisions.
- Development of science-based risk assessment.
- Reaching a decision on the notification of federal authorities about the level of threat in situations of asteroid and comet hazard.
- Participation in the development of recommendations on the use of various means to counter space threats.
- Interaction with agencies and organizations (including international ones) on the situation analysis and countermeasures to space threats in a specific field of competence (IAWN, Minor Planet Center, SSA NEO ESA, CNEOS NASA) .

Timeline for proposed implimention, rought total cost

Timeline for proposed implimention – 3-5 years.

Rought total cost:

4-5 mln USD per node.

Suggested collaborators from Russia

- Institutions of the Russian Academy of Sciences:
  - Institute of Astronomy
  - Special Astrophysical Observatory
  - Central Astronomical Observatory (Pulkovo)
  - Crimea Astrophysical Observatory
  - Institute of Applied Astronomy
  - Institute of Applied Mathematics
- Emercom of Russia
- Roscosmos