INASAN 1-m Class Wide-Field Telescopes: Experience and Prospects

M. Ibrahimov, A. Shugarov, V. Shmagin, D. Bisikalo, B. Shustov, M. Nalivkin, S. Naroenkov, and I. Savanov

Institute of Astronomy, Russian Academy of Sciences, Moscow, Russia
mansur@inasan.ru

Abstract. We present INASAN's existing and suggested 1 m class wide field observational facilities to be included in the BRICS Intelligent Telescope and Data Network (BITDN). As an example of important application we consider the problem of detection of potentially hazardous objects (asteroids and comets).

Keywords: telescopes

DOI:10.26119/978-5-6045062-0-2_2020_174

1 Scientific Rationale for 1-m Class Telescope Network

The global network of 1 m class wide field telescopes will allow to access to the whole sky, allows both high time resolution and continuous monitoring observations of transients objects. It is proposed to build international BRICS Intelligent Telescope and Data Network (BITDN). This network will use existing and future modern facilities within the BRICS countries. The program will start by networking existing optical facilities within BRICS to allow for automated discovery and follow-up of transients, including existing INASAN 1 m wide field telescope. Next step include an array of about 12x 1 m class (1.0–1.5 m) telescopes. Larger telescopes within BRICS countries will be used for characterization of the objects discovered.

In longer term (10 years) the aim is to develop a dedicated network of globally distributed 1 m class telescopes within all of the BRICS countries which would provide the enhanced capability of all-sky coverage at high cadence.

The top-level requirements for the BITDN are as follows:

- The survey rate >5000 deg^2 hr^{-1}
- 24 h operational time
- Limiting magnitude not less than 20^m-21^m
- Angular resolution <2 arcsec

– Observation with scientific filters
– Fast readout cameras

The main objectives of BITDN are as follows:

– Fundamental knowledge of physical laws and astrophysical processes in the Universe
– Neutron star – neutron star mergers
– Core-Collapse and Super-Luminous Supernovae, Long γ-ray Bursts and Fast Transients
– Optical and ultraviolet flares in galactic nuclei
– Optical counterpart of Fast Radio Bursts
– Reverberation mapping: estimating black hole masses AGNs
– Outbursts and state transitions in X-ray binaries
– Detecting hazardous near-Earth objects of >10 m size
– Detecting space debris

The BRICS-OTN should be capable to detect potentially hazardous objects (PHOs), asteroids and comets, with size larger 10 m approaching the Earth at distance <10 million km. The all-sky (at first stage all available sky) coverage should be carried out 2-3 times per 24 hours. It looks that BITDN will be one of the best instrument to detect 10 m class PHOs few days before possible collision with the Earth.

2 Upgrading of INASAN ZEISS-1000

Zeiss-1000 telescope was installed at Simeiz observatory in 1987. The telescope is ready for remote control to be used in the global world wide network. INASAN propose to use this telescope at first phase of BITDN program. Now the cassegrain focus wide field lens corrector in under production. The corrector provides the field of view of 0.8° (50×50 mm). We plan to use standard UBVRI filters (FLI CL1-10) with FLI PL 16803 CCD camera or CMOS camera with GSENSE4040 or GSENSE6060 sensors.

3 INASAN Experience with AZ1000WF

In 2015-2018 INASAN was build up a new cost-effective 1 m telescope (AZ1000WF) with a 3° FoV and modern focal unit design to operate with largest available CCD camera of 10.5×10.5 Kpixel, together with custom 120 mm filter set. The telescope has fast direct drive mount with slewing speed up to 10 deg s^{-1}. Filter unit has 8 slots: 7 for scientific filters and one for neutral filter to maximize telescope sensitivity. This telescope could be considered as typical low-cost prototype for the BITDN program. The parameters of the telescope could be improved in terms of the field of view and detector, e.g. the field of view can be increased up to 4° in case of use advanced prime focus corrector. Instead of traditional CCD camera the modern CMOS camera with fast readout can be used.

4 INASAN Proposal of the Next Generation 1-m Aperture Wide Field Telescope

To achieve optimum price/field of view ratio, we propose an optimal combination of a new large-format single chip CMOS detector and fast optical scheme telescope. We propose few optical schemes (modified Hamilton and Sonnefeld design) with F-ratio of 1:1.5 to 1:1 with field of view from 5° to 7.3°.

The detector is one of the main elements of a wide field telescope. Chinese company GPIXEL has developed the new CMOS detector with format of 9×9 K with 10 μm pixel based on GSENSE6060 series. The focal unit will be a custom design assembly of derotator, filter unit and camera. The filter unit for the new 1 m telescope can be similar that was made for AZ1000WF telescope.

The cost of a CMOS is mainly proportional to its area, not pixel size, thus, a CMOS with a smaller pixel is characterized by lower cost per pixel. GPIXEL has capability to manufacture single chip CMOS with the format of 20×20 K (90×90 mm) and pixel size of 4.6 μm. This single chip CMOS has a resolution of 400 Mpixel, which is comparable with the resolution of a large CCD mosaics. At the same time, the cost of such CMOS chip, camera and cooling system will be significantly lower than cost of a classical CCD mosaic. If such a chip is available, the sampling and optical resolution of 1 m telescope can be improved.

5 Wide Field 1.7-m Aperture 3° Field of View Telescope

Based on AZ1000WF design and production experience, INASAN together with ASA Astrosysteme GmbH (Austria) evaluate the possibility of production of 1.7 m aperture wide field telescope with similar prime focus lens corrector design. The telescope will use high accuracy direct-drive Alt-Az mount with maximum slew speed 6° s^{-1} (both axes). The detector should be the mosaic of 4x CMOS of 9×9 K. The expected production time of the telescope is 2 year.

Acknowledgements. The research funded by RFBR, Project No. 19-29-11013 and RSF 19-29-11027.