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Four-channel wide-field cluster for survey tasks and synchronous multicolor photometry

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Abstract. A new wide-field optical instrument of the Institute of Astronomy of the Russian Academy of Sciences (INASAN) is described. It has been implemented under the bilateral Russia–Uzbekistan collaboration in astronomy in 2023–2025. The instrument comprises four identical wide-field 28-cm aperture telescopes on a common mount designed for all-sky surveys and photometry. For a single exposure, the cluster takes an image of a 7 square degree field in four photometric bands simultaneously with a 1.26 ″/px scale. The technical and optoelectronic characteristics of the cluster are presented and discussed. The plan is to install the cluster at the Maidanak Astronomical Observatory, which has a large amount of clear night time (about 2500 hours per year) with a median seeing of 0.″7. The INASAN cluster will become one of the most informative positional photometric multiband observing systems in Russia. It will also be useful in a global network of multiband wide-field optical instruments including the BRICS astronomical network.

Keywords: surveys; telescopes; methods: observational; techniques: photometric; instrumentation: photometers; stars: variables: general

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1 Introduction

Currently, the concept of building a survey telescope using several small telescopes mounted on a common mount is gaining popularity. This approach is often more economical and faster to implement, since telescopes of smaller apertures and detectors of smaller formats are often available as mass-produced commercial products.

The new INASAN four-channel cluster is created for the Russian-Uzbekistan joint project in 2023–2025 (Ibrahimov et al. 2023). The instrument is a cluster of four identical telescopes (a four-channel cluster) coaxially mounted on a common mount and designed for all-sky multicolor surveys and photometric monitoring. During one exposure, the cluster provides imaging simultaneously in four photometric bands.

According to the technical specification, the INASAN cluster is almost identical to such well-established but operating in "white light" systems as the European–Mexican cluster of the DDOTI project (Watson et al. 2016) and the US–European cluster telescopes of the second generation of the ATLAS project (Licandro et al. 2023). The fundamental scientific advantage of the INASAN cluster over the mentioned clusters is the operation in four photometric bands simultaneously. It is assumed that the INASAN cluster will become one of the most informative and demanded multicolor photometric instruments in Russia and will be included in the astronomical networks of the BRICS countries.

To maximize the scientific efficiency, the cluster is planned to be installed in Uzbekistan at the Maidanak Astronomical Observatory of the Ulugh Beg Astronomical Institute (UBAI) of the Uzbek Academy of Sciences with excellent astroclimate.

2 INASAN four-channel cluster

Since 2021 at the Zvenigorod observatory Celestron RASA 11 (Fig. 1, right panel) with the ZWO ASI6200MM Pro camera on a direct drive ASA DDM85 mount has been successfully operating as a robotic telescope. The observations are carried out in the V band, the accuracy of photometric measurements is up to RMS $= 0\overset{\mathrm{m}}{.}005$. The experience gained by INASAN during the implementation of this telescope is used in the current project to build the four-channel cluster.

The new wide-field INASAN cluster has four identical wide-field 28-cm aperture Celestron RASA 11 telescopes[1] mounted on a single mount (Fig. 1, left panel). The cluster is built primarily with commercially available components (COTS, commercial-off-the-shelf). The four 11-inch Celestron RASA 11 telescopes pointed coaxially are equivalent to one telescope with an effective aperture of 56 cm.

The new INASAN four-channel cluster will provide:

[1] https://s3.amazonaws.com/celestron-site-support-files/support_files/rasa_white_paper_web.pdf

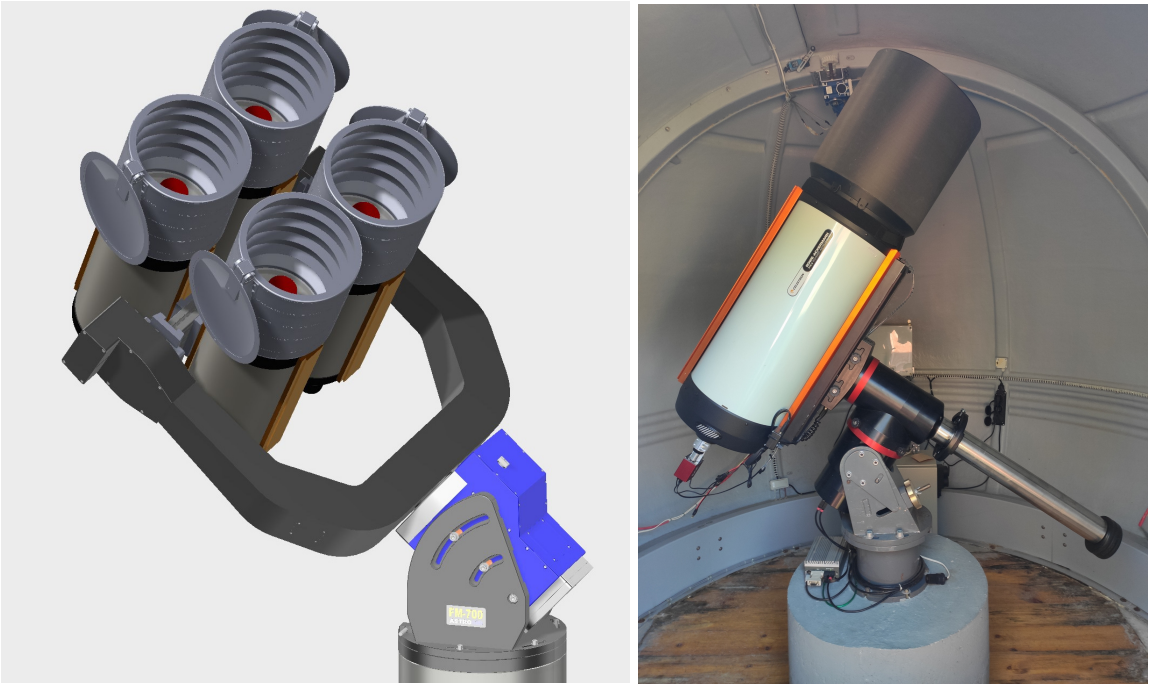

Fig. 1. Left: layout of four Celestron RASA 11 telescopes on a fork-type equatorial mount; right: the prototype of the four-channel cluster: a robotic telescope at the INASAN Zvenigorod observatory based on the Celestron RASA 11 telescope and ZWO ASI6200MM Pro camera.

– photometric measurements of objects in a field of $3\overset{\circ}{.}3 \times 2\overset{\circ}{.}2$ simultaneously in the spectral bands $UBVR$ or $BVRI$, for objects brighter than 16^{m} the photometric accuracy is expected to be up to $0\overset{\mathrm{m}}{.}005$;
– astrometric measurements for objects brighter than 19^{m} with an accuracy of $0\overset{\prime\prime}{.}15$–$0\overset{\prime\prime}{.}20$;
– detection of near-Earth objects brighter than 19^{m} with an exposure time of 30 s and SNR = 3.

The main components of the four-channel cluster are:

– equatorial mount with a direct drive and the absolute encoders Astrosib FMDD-700, which provides fast repointing at a speed of 10 deg/s and accurate tracking without the need for guidance;
– Celestron RASA 11 wide-wield telescope with an additional light baffle (4 pcs);
– ZWO ASI6200MM Pro camera (4 pcs);
– ZWO 5V-EAF focuser (4 pcs);
– set of the $UBVR$ or $BVRI$ photometric filters;

- control computer, computing server with graphics cards and data storage system;
- software package that provides the receiving, processing, and storage of the scientific data;
- dome with an automated sliding roof.

3 Summary

According to calculations, the new INASAN four-channel cluster under ideal conditions (zenith, dark night, sky background $V = 21.5$ mag/arcsec) for a 30-s exposure time and SNR = 3 is going to have a limiting sensitivity of $20\overset{\mathrm{m}}{.}13$ without a filter, and $18\overset{\mathrm{m}}{.}1$, $18\overset{\mathrm{m}}{.}6$, $19\overset{\mathrm{m}}{.}35$, $19\overset{\mathrm{m}}{.}32$, $18\overset{\mathrm{m}}{.}07$ with the U, B, V, R, I filters, respectively.

The cluster will be manufactured and tested at INASAN, thereafter it is going to be installed at the Maidanak Astronomical Observatory in Uzbekistan.

Summing up, despite the small aperture of the telescope and a small camera, the angular resolution of the cluster installed at the Maidanak Observatory is expected to be $1\overset{''}{.}5$ across the entire field of view of 7 sq. deg with a 1.26 $''$/px scale, which is enough for many scientific applications. The cluster is expected to effectively monitor objects of up to 20^{m} with a single exposure and up to 21^{m} when co-adding the frames.

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