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Mini-MegaTORTORA – multichannel system for wide-field optical monitoring with high temporal resolution

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Abstract. We report on a multi-objective and transforming 9-channel monitoring system, the Mini-MegaTORTORA (MMT-9). This system combines a wide field of view with a subsecond temporal resolution in the monitoring regime, and is able to reconfigure itself, in fractions of a second, to a follow-up mode which has better sensitivity and provides us with multi-color and polarimetric information on detected transients simultaneously.

Key words: Instrumentation: photometers – Instrumentation: polarimeters – Techniques: high temporal resolution

The systematic study of night sky variability on subsecond time scales still remains an important, but practically unsolved problem. The detection and investigation of rapid optical transients of various classes, both astrophysical and artificial, is an important task (Beskin *et al.*, 2010, Beskin *et al.*, 2013), which may be accomplished by means of continuous monitoring of the sky with wide-field optical cameras. Zolotukhin *et al.* (2004) and Karpov *et al.* (2005) demonstrated that it is possible to achieve the subsecond temporal resolution in a reasonably wide field with small telescopes equipped with fast CCDs, to perform fully automatic searching and classification of fast optical transients.

A 9-channel system for wide-field monitoring of the sky with a subsecond temporal resolution was designed and is being manufactured (Karpov *et al*, 2013). The system is similar to the smaller, 6-channel (MMT-6) one we started to develop earlier (Karpov *et al.*, 2012), and shares most of its constructive and operational properties. Each channel of Mini-MegaTORTORA consists of a Canon objective (diameter – 71 mm, lens aperture – 1/1.2), a 2560 x 2160 Andor Neo sCMOS detector (quantum efficiency 30-60% in the 4000-8000Å range) with a pixel size of 6.5 x 6.5 microns (which gives 15.5″ per pixel angular resolution) and a frame rate of 10 frames per second.

For photometric and polarimetric studies of the detected transients filters B, V, R and a polaroid are used. They are mounted behind the coelostat mirror. Its rotation to change FOV position (±20 degrees around two axes), as well as switching between the filters and polaroid in 0.2-0.3 seconds, is facilitated by a set of servo-motors. A separate computer is used to collect data and control the operation of each channel; a separate computer controls the entire system. The developed software allows collecting and reducing data in real time, as well as controlling individual channels and the monitoring system as a whole (Beskin *et al.*, 2010). In the monitoring mode (all channels are pointed at different regions of the sky) the area of the system's field of view is about 900 square degrees. The limiting magnitude in the filter B is about 12 mag at 0.1 s.

In the follow-up mode (all channels are pointed at the same sky region) three-band photometry and linear polarimetry of the detected optical transient with a magnitude of up to 10-11 mag at 0.1 seconds and 15-16 mag at 1000 seconds are carried out simultaneously. Both the classification of the optical transients detected in the monitoring regime and the switchover to the follow-up mode are executed in 0.2-0.5 seconds.

MMT will use custom fork mounts based on a Skywatcher EQ6 head, each carrying two channels simultaneously.

MMT will be installed at the Engelgardt observatory of the Kazan Federal University, Kazan, Russia in summer 2014.

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