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High Temporal Resolution Multi-Mode Panoramic Photospectropolarimeter

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Abstract—The paper describes a new stage in the development of the hardware-software complex of the MANIA experiment to search for and study the brightness variability of astrophysical objects with a temporal resolution of 10^{-6} s. The panoramic photospectropolarimeter uses the remotely mounted optical units—the color separation modules which allow one to carry out observations in five modes: the most transparent, multi-band, photo-polarimetric, spectroscopic, and spectro-polarimetric. Two photodetectors (PDs) based on position sensitive detectors (PSDs) with the S-20 and GaAs cathodes, the multiplication of photocurrents with microchannel plates (MCPs), and detection using collectors with the number of elements from 4 up to 16 and an EMCCD camera allow one to detect light fluxes from objects and reference stars in a field of view of up to 1 in several color bands in the low resolution spectroscopic mode, and at the same time to measure the linear polarization in three Stokes parameters. The detection system accumulates the observed data: the digitized photocount fluxes from both PDs with a temporal resolution of 1 μs; while the EMCCD camera accumulates video sequences with a subsecond resolution simultaneously with the reception of ultraviolet quanta with a microsecond resolution on a single PD. We present some research results obtained in observations with the 6-m SAO RAS telescope.

Keywords: instrumentation: detectors, photometers, polarimeters

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1. INTRODUCTION

Solution of a number of astrophysical issues including: the study of the temporal evolution of the rotation periods of radio pulsars, the search for and study of fast optical transients, the search for single black holes, the study of the rapid variability of X-ray binaries, etc., requires using the high temporal resolution methods which make it possible to detect individual photons and obtain the maximum spectroscopic, photometric, and polarization data on the observed objects from the fluxes of the detected quanta.

In our opinion, for the totality of qualities, the Position Sensitive Detector (PSD) is over the past decade the best temporal resolution detector for the search and study of faint objects at short time intervals. Based on the PSD, the photodetectors (PDs) were developed in SAO RAS (Beskin et al., 2008, 1999; de-Bur et al., 2008a; de Bur et al., 2019; Debur et al., 2003, 2009; Plokhotnichenko et al., 1999, 2020b,