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The switching device for external and internal calibration at the station «Katzively»

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Abstract

In this report one of the ways to improve the results of the location presents. Especially according to this purpose, we developed special device and included it in the optical scheme of the telescope. It allows us quickly switch with internal calibration mode to external calibration mode without additional external alignment procedures. We also describe in depth the original optical scheme of matching system laser-telescope, which is very well justified.

In the composition of the SLR-system “Katzively“ telescope TPL–1 (Fig. 1) with diameter of the main mirror of 1 m and alt-azimuth mount includes. As a radiation source pulsed laser with the following characteristics used: frequency doubling and wavelength output 0,5320 microns, pulse duration ~250 PS, the pulse frequency of 3 to 10 Hz, registration systems and signal processing, automatic tracking with the possibility of visual observation and manual correction of reference. The system of visual observation is conjugated with the main optical axis of the telescope. At the output of the system there is the electronic-optical converter (EOC). EOC improves visibility of weakly illuminated objects and locks the channel at the time of the outbreak of the laser, thereby protecting the eyes of the operator and EOC from stray lighting of scattered laser radiation. Design of system of visual observation gives the possibility to install the eyepiece or cameras for transmitting the image on a computer monitor.

Station «Katzively» 1893

Telescope TPL-1

Figure 1. General view of the station.

To enter the laser in optical system of the telescope optical system of matching of laser - telescope was designed. This system allows directing the laser beam along the main optical axis of the telescope with a deviation not exceeding 1". Figure 2 shows the optical scheme of the

telescope and optical system of matching. Mirrors 1, 2, 3, 4, 5 are elements of the telescope, 6 - the device of visual observation with EOC. Adjusting mirrors 15, 16, 17, 18 of optical system of matching are used for input laser beam in a telescope. Diverging lens 14 is used to combine the imaginary laser focus with the focus of the telescope along the optical axis. For this purpose, lens 14 is supplied by the device for moving along the optical axis. This method of coordination imaginary focus of laser with the real focus of the telescope allows to avoid focusing of a laser beam and the emergence of a laser spark. The correctness of conjugating is controlled by device type «artificial star» (we call it a «cat's eye»), consisting of items 10, 11, 12 and ocular 20. This device is conjugated with the image of a real star, which aims telescope. In the following, this artificial star is used as a stable point source for accurate alignment and coordination of all parts of the optical system. Aperture 11 with diameter 8", the part of the artificial star, is in the conjugated focus of the telescope. When you configure a system, laser radiation, focused by lens 13 with the help of adjusting screws mirrors 16 and 17, while observing through the ocular of 20, coincides with the center of the diaphragm 11, and that automatically provides the direction of the laser radiation along the optical axis of the telescope. The value of the divergence of a laser beam at the output of the telescope is determined by the size of the image of the focused laser radiation in the plane of the diaphragm 11 on the measurement scale eyepiece 20. For visual observation of the focused laser beam in front of the diaphragm 11 subtle frosted glass is placed. As a rocker mirrors 8, which send part of the laser radiation on the diaphragm 11, we use optical quality glass plate without reflecting coating. This system allows checking the quality of the coordination of the direction of the laser radiation with an optical axis of the telescope at any time.

This system has been operating since 1984 [1]. This system was modernized several times [2]. The quality of the work of this scheme allowed to spend, for example, measurement of the anomalous deviations of a laser beam [3] and to identify some of the regularities of this phenomenon [4].

In normal mode calibration procedure is carried out inside of the location system. For calibration between items 14 and 15 add reflector (retroreflector) used. This retroreflector is set in such a way, that is, the reflected beam, moving horizontally, «bypasses» mirror 15 and falls in a photodetector. For the attenuation of radiation simultaneously with a reflector between PMT «stop» and lens 19 a debilitating filter introduces. In the initial design and optical scheme of TPL–1 external calibration was not foreseen. To allow for both internal and external calibration additional device was developed and made.

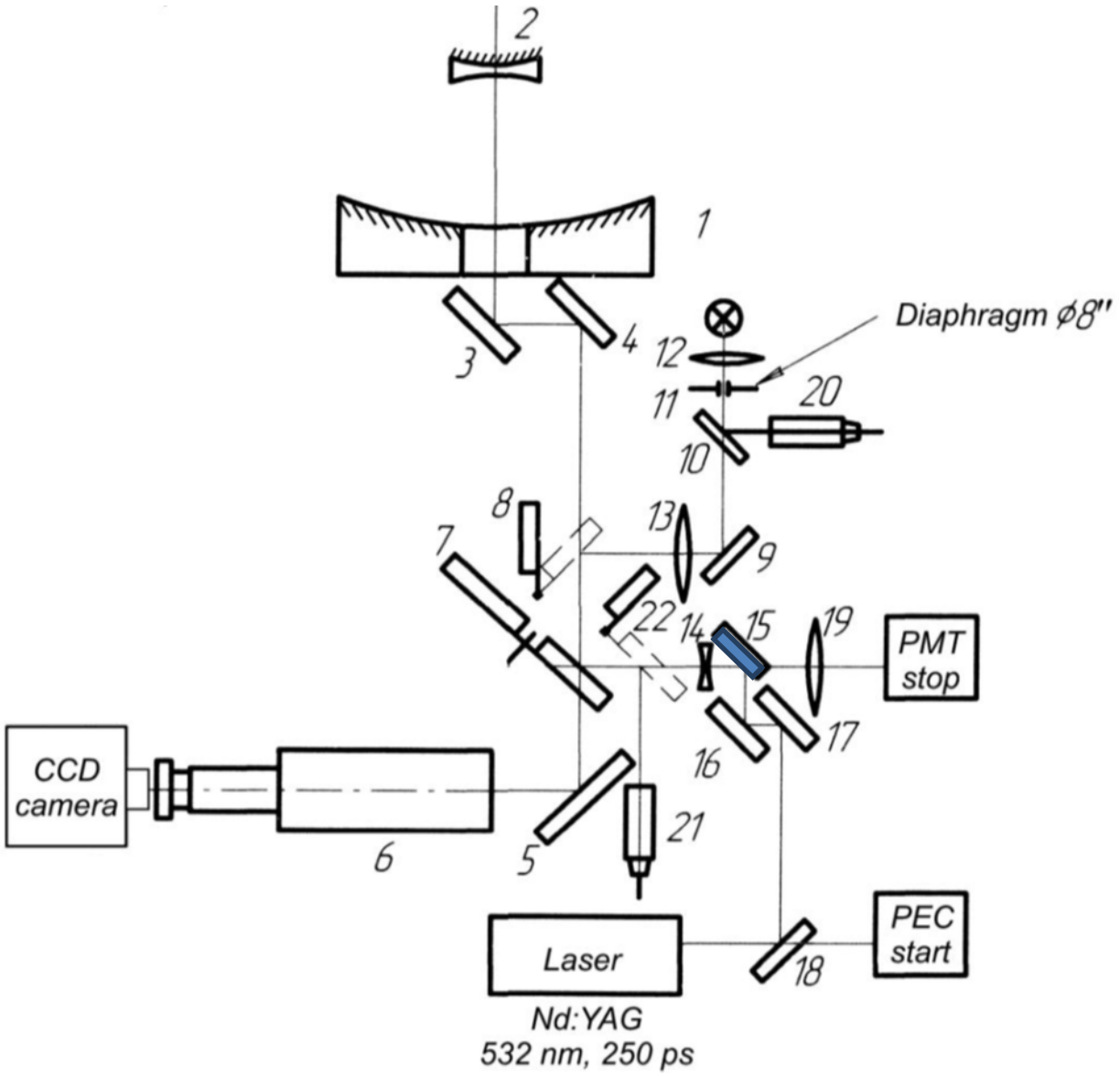

Figure 2. Optical scheme of the SLR-system « Katzively »

i) TPL-1 telescope: 1 – primary mirror; 2 – secondary mirror; 3, 4, 5 – diagonal mirrors; 6 – main guide with chromatic aberrations compensator and image intensifier;

ii) Optical matching system: 7 – rotating mirror; 8, 22 – tuning switch mirrors; 13, 14, 19 – matching lenses; 9, 15..18 – mirrors; 10, 11, 12, 20 – artificial star; 20, 21 – oculars

Switching device of external calibration is installed instead of an opaque mirror 15. This device consists of two mirrors: one, as before, the rear mirror. Other mirror partly reflects, and the rest of the radiation passes. Both mirrors are fixed on a steel axis in the same plane so, that when you turn the axis, alternate take a position. Opaque mirror fixed rigidly. The second mirror has a positioning mechanism for combining both mirrors in one plane. Axis with the two sides has blind holes for fixing it with the help of two steel cones in a special case. The mount ensures rotation of axis without backlash to change the mirrors. Working position of each of the mirrors is fixed with magnets. Mirrors are switching manually. However, in the design of this device transition to automatically switch provides.

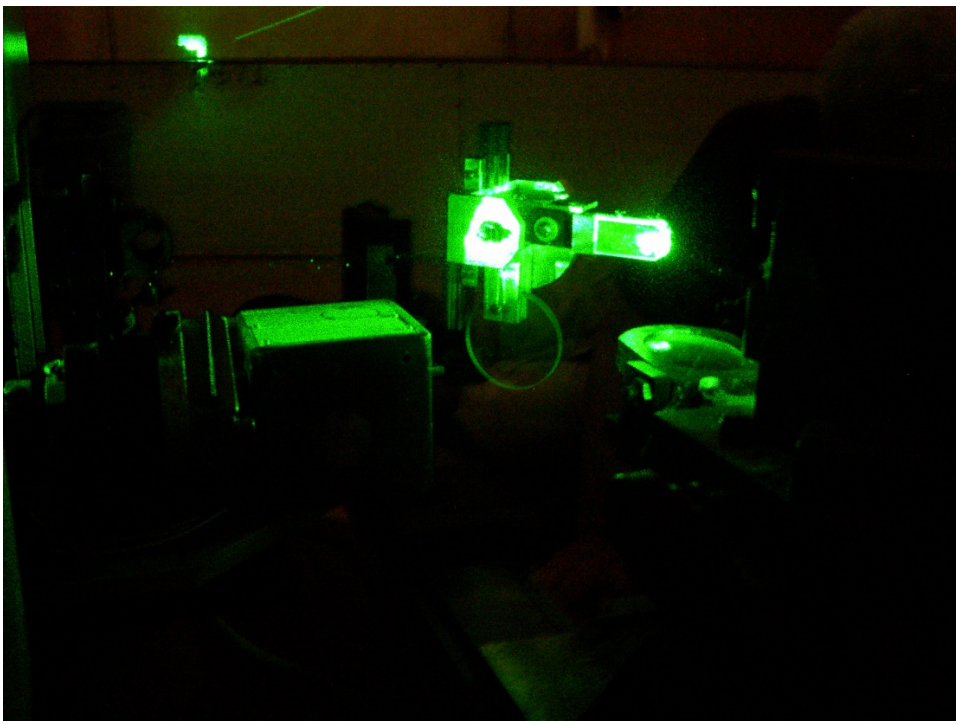

Figure 3. The switching device for external and internal calibration.

The device works as follows. When the opaque mirror is on the path of the laser beam, it is normal mode of locations and accordingly normal mode of internal calibration. In mode of external calibration, opaque mirror is replaced by a translucent mirror by rotation axis on 90 degrees. Part of the laser radiation from this mirror pass in a telescope, and next to an external reflector. The reflected laser radiation from an external reflector runs the telescope, passes through the semi-transparent mirror and fall on the photodetector. On Fig. 3 shows a picture of this device in location mode and internal calibration. At the bottom of this device you can see circular semi-transparent mirror, which is used in the mode of external calibration.

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