The precision of the IACT mechanical mounts of the TAIGA observatory

The features of the new gamma observatory TAIGA (Tunka Advanced Instrument for Cosmic Ray Physics and Gamma Astronomy), created in the Tunka Valley 50 km from Lake Baikal, are presented. One of the main tasks of the TAIGA observatory is the study of the high-energy part of gamma radiation and the search for Galactic sources – PeVatrons. Currently, the first stage of a gamma-ray observatory with an area of 1 sq.km consisting of 3 gamma telescopes (TAIGA-IACT) and ~ 100 wide-angle Cherenkov detectors (TAIGA-HiSCORE). The expected integral sensitivity for recording gamma radiation with an energy of 100 TeV when observing for 300 hours per session will be ~ $2\text{-}5\cdot10^{-13}$ $TeV\cdot cm^{-2}\cdot sec^{-1}$.

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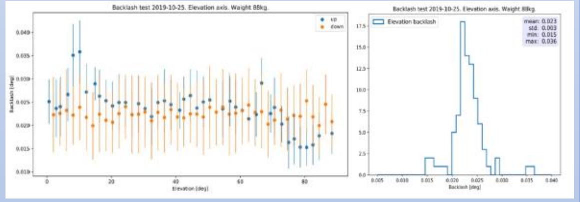
One of the priority tasks of the observatory is the study of gamma quanta in the range from several TeV to 1 PeV. A distinctive feature of the TAIGA observatory is the combined measurement of a hadron-nuclear or electromagnetic EAS in an atmospheric Cherenkov telescope (TAIGA-IACT) and an array of wide-angle Cherenkov detectors (TAIGA-HiSCORE). Currently, the observatory has two blackbody telescopes, the third telescope is expected to be commissioned in the summer of 2020. In the combined installation TAIGA, the distance between telescopes can be 600-800 meters, since the simultaneous measurement of EAS by several telescopes to create its stereoscopic image is not required. These features significantly reduce the cost of creating a large-area installation, which is necessary for measuring weak fluxes of ultrahigh-energy Cosmic Rays, including the observation of PeVatrons responsible for galactic cosmic rays. TAIGA is the northernmost gamma ray observatory.

Measurement of the gear unit backlash when turning around the horizontal axis

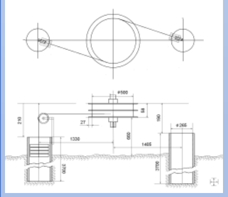
The backlash value Dependence of the horizontal axis on its position.

Bar graph of the backlash measured values of the horizontal axis.

A weight is suspended from the axis, which creates an additional moment when the telescope tube is positioned within 0 – 90 degrees. The backlash was the difference between the encoder position and the step position. The average value of the backlash was ~0.025°, which is caused by the irreparable backlash of the planetary gearbox.



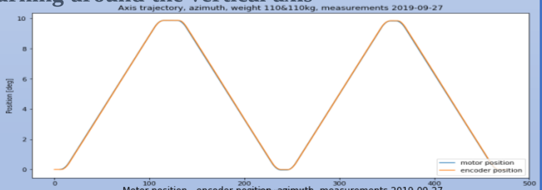
Measurement of the gear unit backlash when turning around the vertical axis



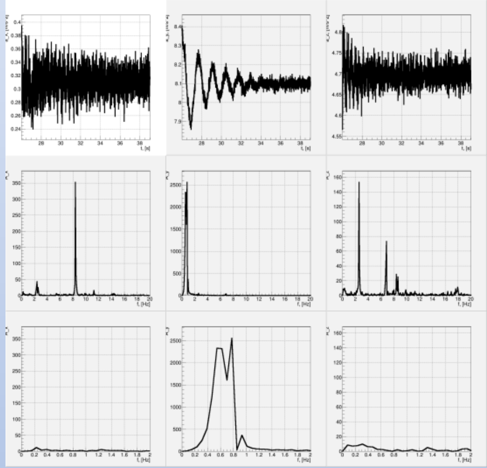
The anti-backlash system of the vertical axis consists of a drum of the vertical axis of the telescope with a diameter of 560 mm and cables with weights stretched on it in opposite directions, which move inside the pipes, buried ~ 3 meters to provide a rotation of ±210 degrees.

An example of the trajectory of movement of the axis position in the angle-time plane when measuring the backlash around the vertical axis. The telescope axis rotates 10 degrees, first in one direction, then in the opposite direction.

With a weight of 11 and 33 kg, the angle difference is ~ 0.4 degrees, which is not enough to eliminate backlash. With a cargo weight of 55 kg and more, the angle difference is ~ 0.08 degrees, which is due to the inevitable backlash of the planetary gearbox. That is, the anti-backlash system eliminates backlash near the vertical axis with a load weight of at least 55 kg on each side.



Measuring natural frequencies of a telescope



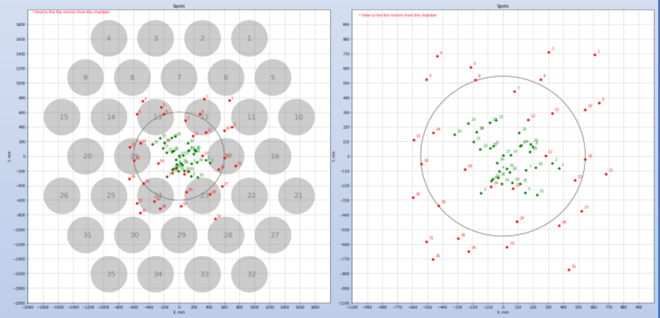
The natural frequencies were measured using accelerometers mounted on the telescope in various places: near the focal plane on the camera mounting ring, on the vertical fork post from the gearbox mounting side.

The measured value was the acceleration value m/s^2.

The figures show an example of measuring the oscillation of a telescope around the horizontal axis. The telescope is tilted down to sample the gear backlash and then released.

The graphs show the time base of the values from the accelerometers in three coordinates. The second line of the table shows the power spectra of oscillations up to a frequency of 20 Hz, in the third – up to 2 Hz.

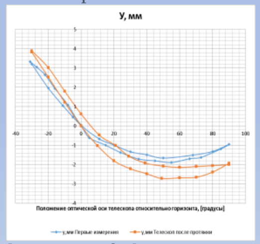
Measuring the positions of the mirror pedestals focal point in the focal and dual focal planes of the telescope

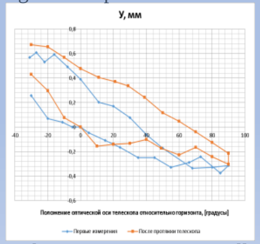


The mirror pedestal focal point positions at a distance of 4.75 m (red) and 9.5 m (green) from the reflector surface. The dot numbers correspond to the pedestal numbers. The view of the drawing is from the camera side.

Measurements of the camera assembly displacement when changing the elevation angle of the telescope optical axis

The measurements were carried out with a change in the position of the horizontal axis of the telescope from -30° to 90° with an interval of 10° upwards and then downwards. The horizontal position of the optical axis of the telescope was taken as the beginning of the report.





Displacement of the camera attachment point vertically and horizontally. Blue lines – before broaching the bolts of the telescope camera rods, orange - after.