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The Tunka Radio Extension, an antenna array for high-energy cosmic-ray detection

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The study of primary cosmic rays in the energy range 10^{16} - 10^{19} eV is of special interest since in this range a transition from galactic to extragalactic sources is supposed. The Tunka-133 array in the Tunka Valley (close to lake Baikal, Russia) detects air-Cherenkov emission of extensive air showers (EAS) initiated by cosmic rays in the energy range of $10^{16.5}$ - 10^{18} eV. In 2012, it was extended with Tunka Radio Extension (Tunka-Rex), which now consists of 44 antennas detecting the radio emission of EAS in the frequency range of 30-80 MHz. Three years of joint operation of Tunka-Rex and Tunka-133 have shown that a calibrated radio array can be used for independently test the scale of the cosmic-ray energy. Furthermore, by direct comparison of the reconstructed depth of the shower maximum measured by Tunka-133 and Tunka-Rex, it was shown that the precision of the radio technique for the shower maximum is at least 40 g/cm². As next step the cross-calibration of Tunka-Rex and the recently deployed array of scintillation stations Tunka-Grande is planned, which provides the possibility of a combined measurement of the muonic and electromagnetic components of air-showers with sensitivity to the shower maximum and full duty-cycle. Exploiting the complementary muon/radio information, it should be possible to improve the mass separation in cosmic-ray spectra.

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