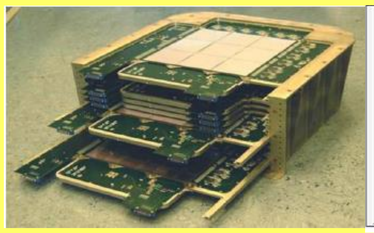
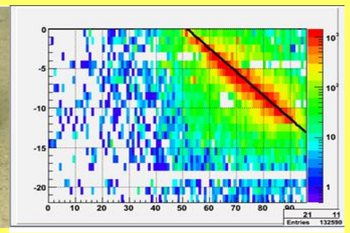
The search for electron anisotropy with the PAMELA calorimeter

A.V. Karelin on behalf of the PAMELA collaboration

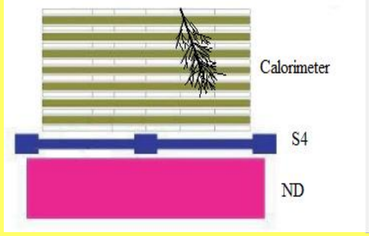
PAMELA [1]



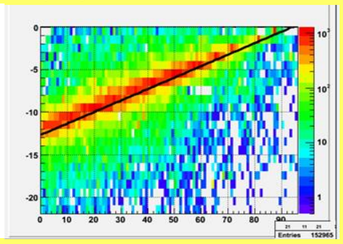
Calorimeter



Shower development. X projection

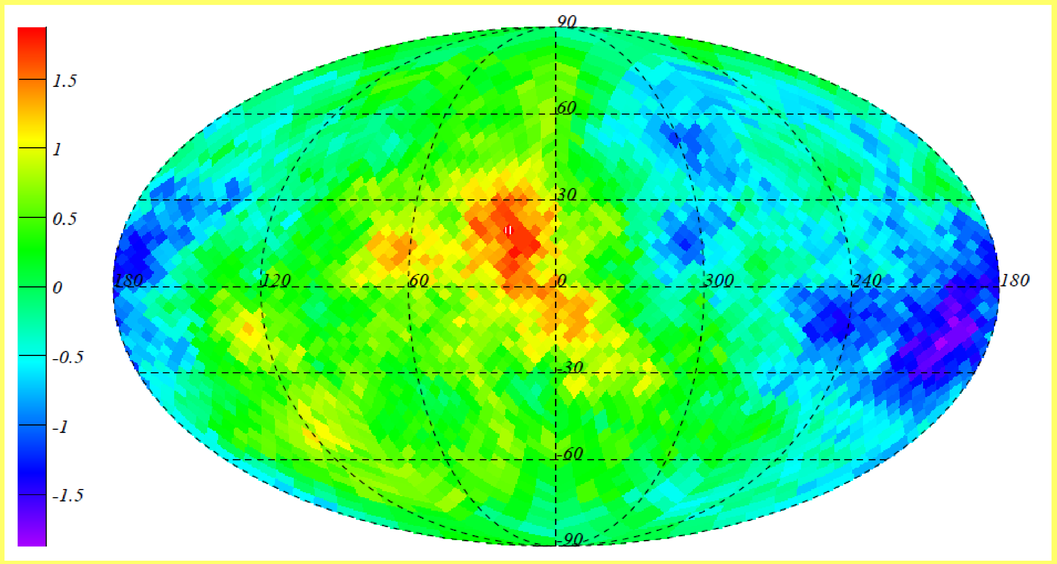


Detector subsystem for anisotropy study



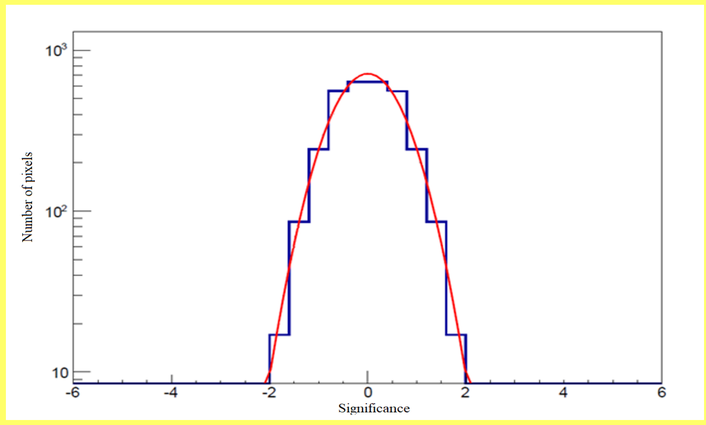
Shower development. Y projection

The work is dedicated to the study of the anisotropy of total fluxes of electrons and positrons of high-energy galactic cosmic rays. We used the data of the magnetic spectrometer PAMELA that was launched into orbit in June 2006 and functioned on it until 2016. The selection of events and the measurements of the directions of particle's arrival direction were carried out by a position-sensitive microstrip calorimeter. The neutron detector was used to suppress additionally the background of protons and nuclei. The analysis was performed for two independent energy ranges: 25-100 GeV and 100 GeV-1 TeV. The magnitude of the total energy release in the calorimeter was used to establish the threshold energy of electrons and positrons.



A map of statistical significance S. This map was made according to the principle taken from [2] in the equatorial coordinate system.

The integration radius in the presented map corresponds to the angular size of the expected anisotropy. In the case of searching for large-scale anisotropy, this radius was taken as 90°.

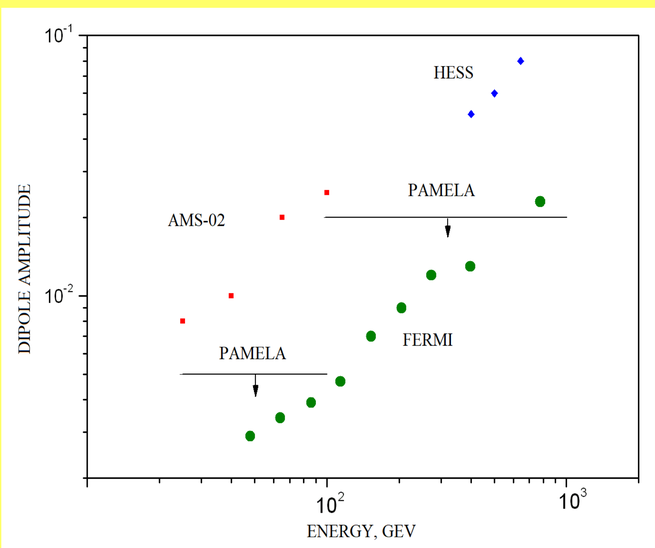


In the case when anisotropy is not being observed, the distribution of S value strictly obeys the Gaussian distribution.

As a result of analyzing the data of the practically ten-year measurement period of the PAMELA spectrometer (2006-2016), the anisotropy of the total flux of electrons and positrons has not been detected. However the following values were obtained as the upper limits of the amplitude of the large-scale dipole anisotropy:

25 GeV - 100 GeV 0.5×10^{-2};
100 GeV - 1000 GeV 2×10^{-2}.

Such close sources as Vela, Geminga or Monogem possibly have an influence on the isotropy of the observed fluxes of $(e^+ + e^-)$. However, this fact has not been yet proved. The experimentally established upper limits on the anisotropy of the total fluxes of electrons and positrons do not completely eliminate the existence of such an effect. They only impose certain restrictions on the free parameters within the models of the cosmic ray generation by these sources.



The upper limits were found to be located between the results of the AMC-02 [3] and Fermi [4] experiments, yielding to both of them in the discreteness of the energy range. HESS [5] was directed on Vela and Monogem location.

Literature
[1] O. Adriani , et al., Physics Reports, 544, 4, 323 (2014)
[2] T. P. Li and Y. Q. Ma, Astrophys. J. 272, 317 (1983)
[3] J. Casaus, Anisotropy of Elementary Particle Fluxes in Primary Cosmic Rays Measured with AMS on the ISS, ICHEP 2018, Seoul
[4] S. Abdollahi et al. Phys. Rev. Lett. 118, 091103 (2017)
[5] M. Kraus, The Cosmic-Ray ElectronAnisotropy Measured with H.E.S.S. and Characterization of a Readout System for the SST Cameras of CTA, phd theses (2018)