The cosmic ray all-particle spectrum in the wide energy range from $10^{14}$ eV to $10^{17}$ eV observed with the Tibet-III air shower array

THE TIBET ASγ COLLABORATION


1Department of Physics, Hirosaki University, Hirosaki 036-8561, Japan.
2Key Laboratory of Particle Astrophysics, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, China.
3Faculty of Engineering, Yokohama National University, Yokohama 240-8501, Japan.
4Department of Physics, Hebei Normal University, Shijiazhuang 050016, China.
5Department of Mathematics and Physics, Tibet University, Lhasa 850000, China.
6Department of Physics, Shandong University, Jinan 250100, China.
7Institute of Modern Physics, SouthWest Jiaotong University, Chengdu 610031, China.
8Department of Physics, Yunnan University, Kunming 650091, China.
9Faculty of Education, Utsunomiya University, Utsunomiya 321-8505, Japan.
10Faculty of Education, Utsunomiya University, Utsunomiya 321-8505, Japan.
11Institute for Cosmic Ray Research, University of Tokyo, Kashiwa 277-8582, Japan.
12Department of Physics, Konan University, Kobe 658-8501, Japan.
13Research Institute for Science and Engineering, Waseda University, Tokyo 169-8555, Japan.
14Department of Physics, Shinshu University, Matsumoto 390-8621, Japan.
15Center of Space Science and Application Research, Chinese Academy of Sciences, Beijing 100080, China.
16Physics Department and Tsinghua Center for Astrophysics, Tsinghua University, Beijing 100084, China.
17Department of Physics, Saitama University, Saitama 338-8570, Japan.
18Advanced Media Network Center, Utsunomiya University, Utsunomiya 321-8585, Japan.
19National Institute of Informatics, Tokyo 101-8430, Japan.
20Tochigi Study Center, University of the Air, Utsunomiya 321-0943, Japan.
21Tokyo Metropolitan College of Industrial Technology, Tokyo 116-8523, Japan.
22Max-Planck-Institut für Physik, München D-80805, Deutschland.
23Shonan Institute of Technology, Fujisawa 251-8511, Japan.
24RIKEN, Wako 351-0198, Japan.
25School of General Education, Shinshu University, Matsumoto 390-8621, Japan.
26chen@icrru-tokyo.ac.jp

Abstract: We present an updated all-particle energy spectrum using data collected in the period from 2000 November through 2004 October by Tibet-III air-shower array. The energy determination of the air showers is made by fitting the lateral density distribution of the shower particles to the modified NKG function which is optimized by simulation calculation using interaction models of QGSJET01c and SIBYLL2.1 taking into account of the detector configurations. It is shown that the model dependence in the energy determination is not significant being less than 5% in the absolute flux value and we obtained the cosmic ray energy spectrum in a wide range over 3 decades between $10^{14}$ eV and $10^{17}$ eV, in which the position of the knee is clearly seen at around 4 PeV. Based on these calculations, we briefly discuss the systematic errors involved in our experimental results due to the Monte Carlo simulation.