IL NUOVO CIMENTO Vol. 33 C, N. 6 Novembre-Dicembre 2010
DOI 10.1393/ncc/i2011-10785-1

Colloquia: IFAE 2010

Simulations for the PAMELA space experiment

C. Pizzolotto(*) on behalf of the PAMELA Collaboration
INFN, Sezione di Trieste - Padriciano 99, I-34149 Trieste, Italy

(ricevuto l' 8 Ottobre 2010; pubblicato online l'8 Febbraio 2011)

Summary. — The Payload for Antimatter Matter Exploration and Light Nuclei Astrophysics (PAMELA) apparatus is in orbit since June 2006 on the Russian satellite Resurs-DK1. One of the main scientific goals of the experiment is the precise measurement of the positrons energy spectra. Robust particle identification and an accurate background extimation are required. To achieve this goal a new simulation program, which describes the entire PAMELA apparatus, based on GEANT4 was optimized and tested. This simulation is used in a multivariate analysis to extract the positron signal from a vast background of cosmic-ray protons.

PACS 07.20.Fw – Calorimeters.
PACS 96.50.S- – Cosmic rays.
PACS 07.87.+v – Spaceborne and space research instruments, apparatus, and components (satellites, space vehicles, etc.).

1. – Introduction

PAMELA is a satellite-borne apparatus designed to study charged particles in the cosmic radiation with particular focus on antiparticles. The apparatus comprises (from top to bottom): a time-of-flight system, a magnetic spectrometer, an anticoincidence system, an electromagnetic imaging calorimeter, a shower tail catcher scintillator and a neutron detector. A detailed description of the PAMELA experiment can be found in several publications, *e.g.* [1].

Tests on a simulation program based on GEANT4 are presented here.

2. – GEANT3 and GEANT4 simulations

At present there are two simulation software codes which reproduce the entire PAMELA apparatus: the official simulation software which is based on the GEANT3 package version 3.21 [2] and a second simulation program which has been recently developed with

(*) E-mail: cecilia.pizzolotto@ts.infn.it

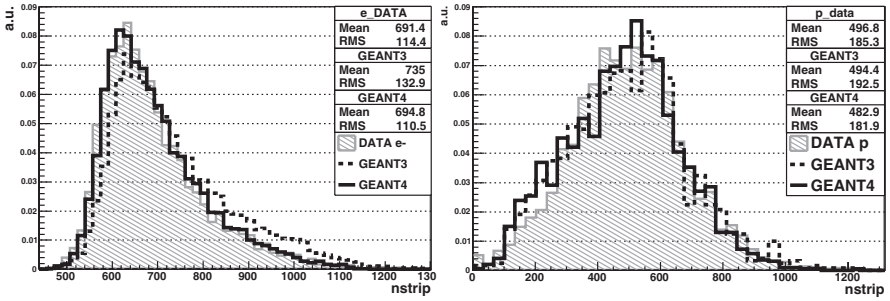

Fig. 1. – Number of strips hit in the calorimeter for flight data (grey), GEANT3 (dotted) and GEANT4 (solid line) PAMELA simulations in the energy range 20–75 GeV. Left panel: electron sample; right panel: proton sample.

the GEANT4 package [3]. The optimization and testing of this program from the point of view of the calorimeter is here briefly reported.

Electron and proton samples produced with GEANT4 with different physics lists have been compared. Among the tested lists, LHEP seems to be the best choice to match the shower topology even if, also in this case, not all the observables are in perfect agreement with experimental data.

Some significative distributions of the calorimeter variables at given rigidities have been considered, their mean and root mean square taken as a term for comparison (see example in fig. 1). Kolmogorov tests have also been performed to check the compatibility of the results.

The proton data are well reproduced both by GEANT3 and by GEANT4 with a discrepancy of about 3% for all checked observables with the exception of the transversal profile which shows differences up to 10%.

The agreement between simulation and data is very good for electrons. GEANT4 provides a better description than GEANT3 and has differences of the order of one percent or less.

Multivariate analysis is used to improve the background estimation in the positron sample and extend the analysis of the positron electron ratio to energy larger than 100 GeV [4, 5]. First results of this approach are under analysis.

3. – Conclusion

The new GEANT4 simulation program for PAMELA has been tested from the point of view of the calorimeter. Data are reproduced by GEANT4 with the same or higher precision than the previous simulation with GEANT3. Results of this GEANT4 simulation program are used with multivariate methods for the cosmic-ray positrons analysis.

REFERENCES

[1] Picozza P. *et al.*, *Astropart. Phys.*, **27** (2007) 296.
[2] GEANT - Detector description and simulation tool, CERN Program Library Long Write-up W5013, CERN, Geneva, 1993.
[3] Agostinelli S. *et al.*, *Nucl. Instrum. Methods A*, **506** (2003) 250.
[4] Adriani O. *et al.*, *Nature*, **458** (2009) 607.
[5] Adriani O. *et al.*, *Astropart. Phys.*, **34** (2010) 1.