Discover Cosmic Rays

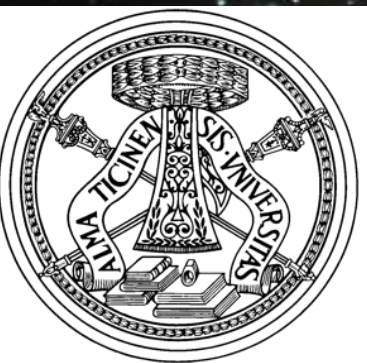
INTERNATIONAL COSMIC DAY

November 02 | 2016

International Cosmics Day

Università e INFN Pavia

A. Menegolli



INFN

Istituto Nazionale di Fisica Nucleare

- Nel 2016 e 2017 Pavia ha partecipato, insieme ad altre Sezioni INFN, all'International Cosmics Day (ICD): https://icd.desy.de/

- 18 + 18 studenti da 8 scuole superiori della Provincia di Pavia (ma anche Milano e Piacenza!)

- Giornata tipo di Pavia:

  - Seminario introduttivo sulla fisica dei raggi cosmici;
  - Utilizzo di un telescopio per raggi cosmici per la misura del flusso angolare;
  - Analisi dati e presentazione via skype;
  - Redazione del booklet;
  - Rinfresco e fine lavori.

ICD2016, 18 studenti

ICD2017, 18 studenti

- Attività svolta presso un laboratorio didattico di Fisica Nucleare del Dipartimento di Fisica dell'Università di Pavia.

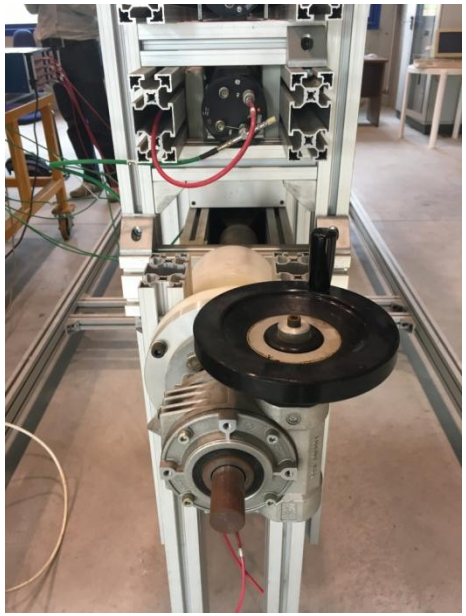
- Telescopio per raggi cosmici già utilizzato per la didattica alla laurea magistrale costituito da:

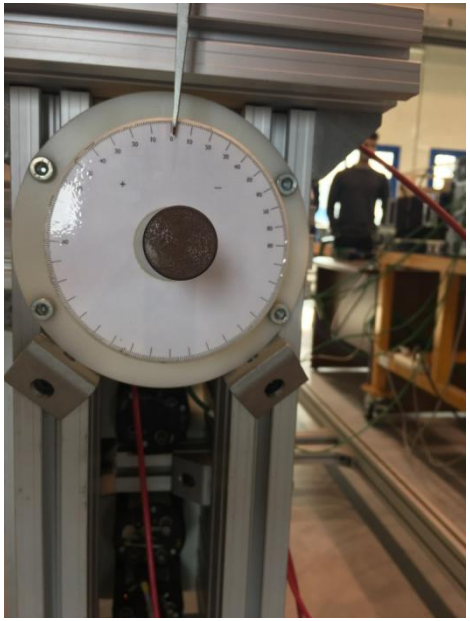
  - tre slab di scintillatore plastico lette ad entrambi i lati da PMT XP2020 Philips.
  - Piombo per assorbire componente e.m.
  - Manopola e goniometro per selezionare angoli da -90° a +90°.
  - Elettronica NIM per discriminazione, logiche e scaler.
  - Inoltre: modulo custom che fa scattare un cicalino quando ha in ingresso un segnale NIM (bip per ogni raggio cosmico!).

- Il numero di studenti è stato volontariamente tenuto basso in modo che tutti potessero mettere le mani sull'apparato per:

  - impostare le tensioni di lavoro dei PMT;
  - modificare l'inclinazione del telescopio;
  - far partire l'acquisizione allo scaler;
  - analizzare i dati.

- ICD_C3M_PV - Responsabile Locale : Alessandro Menegolli.





I risultati e il booklet...

Angular distribution of cosmic muons in Pavia (Italy)

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Introduction

In this report results on the angular distribution of the cosmic muons at sea level from the measurements carried out by the students of the INFN Pavia group are shown. A cosmic ray telescope already available in a dedicated laboratory of INFN Pavia (Italy) was used. This telescope consists of three parallel slabs of NE102 plastic scintillator read by both ends by Photo-Multiplier Tubes (PMTs), XP2020 model by Philips, see Fig. 1. A control knob, see Fig. 2 (left), allows for the rotation of the telescope of a selected angle as read on an angle meter, see Fig. 2 (right).

Figure 1: The cosmic ray telescope inside the dedicated laboratory of INFN Pavia (Italy).

1 Measurements and results

After having turned on all the six PMTs, setting them at the proper High Voltage, the rate of the cosmic muons crossing the three slabs of scintillators put in coincidence was measured as a

Figure 2: Left: the control knob of the telescope. Right: the angle meter.

function of the zenith angle. PMT signals were sent through dedicated electronic modules for the signal discrimination and to generate a coincidence signal to be put on a scaler to count the muons, see Fig. 3. Muon number was measured for thirteen selected angles, ranging from zero to ninety degrees, each one for few minutes.
Cosmic muon rate as a function of the zenith angle is shown in Fig. 4 (left): the decrease of the rate due to the inclination of the telescope is evident. The rate has to be then converted to a flux by introducing some correction factors: the scintillator area (0.144 m^2), the solid angle subtended by the scintillators (0.38 srad) and the six PMT system overall efficiency (0.5). By doing this, the plot of Fig. 4 (right) is obtained: a best fit curve with a function of the type:

$$\phi(\theta) = A\cos(\theta)^b \qquad (1)$$

is superimposed to the experimental points. The best fit values for the amplitude A and the cosine exponent b are $A = 101.5 \pm 2.4\ m^{-2}\ s^{-1}\ srad^{-1}$ and $b = 1.9 \pm 0.1$, consistent with the expectation of a maximum flux A of about 100 $m^{-2}\ s^{-1}\ srad^{-1}$ and an exponent b roughly 2 [1].

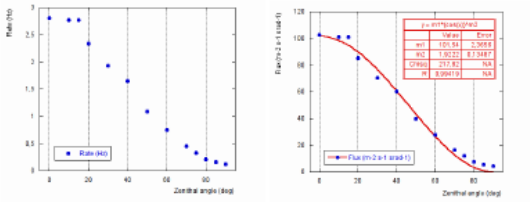

Figure 4: Left: Cosmic muon rate. Right: cosmic muon flux with the best fit curve superimposed to the experimental points.

2 Conclusions

INFN Pavia group of students measured cosmic ray flux at sea level as a function of the zenith angle with a telescope made of plastic scintillator slabs read by PMTs at both ends. Results were consistent with expectations, confirming the values found in literature.

References

[1] P. K. F. Grieder, *"Cosmic Rays at Earth"*, Elsevier, 1st Edition (2001).

Analisi dati e struttura generale del paper insieme agli studenti, redazione finale a cura del responsabile... non c'è tempo durante ICD!