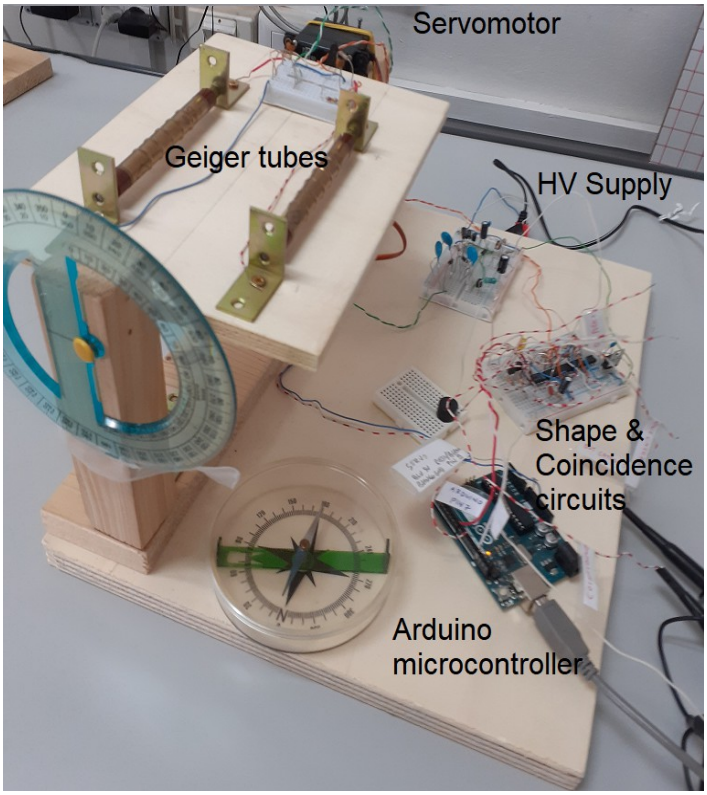


Introduction

Our Institute is a high secondary school (Scientific Lyceum "Lorenzo Mossa") with around 1000 students located in Olbia, a town of around 60,000 inhabitants in the north of Sardinia, an insular region of Italy in the western Mediterranean Sea.

We are an interclass group (15-17 years old) of 8 students interested in scientific topics.

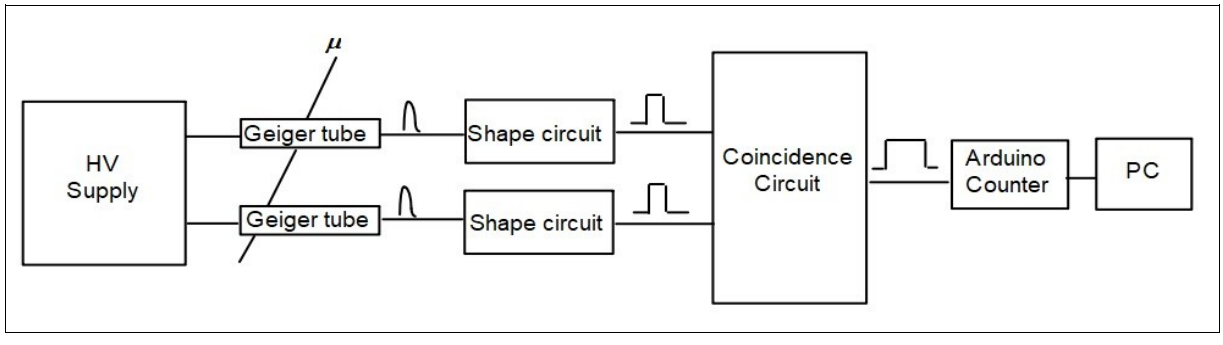
Experimental Set-up



We used a home-built detector (muon telescope), already used last year, consisting of two SBM-20 Geiger tubes placed on a rotating tablet using a servomotor controlled by a PC via the Arduino microcontroller. The measurements can be carried out remotely by controlling the PC with the Teamviewer software.

The signals from the two tubes are sent to some shape circuits and a coincidence circuit. When there is a coicidence a LED flashes and a buzzer beeps. The coincidence signals are counted by Arduino.

We addressed some questions regarding cosmic rays: a) the origin of secondary cosmic rays and how to detect them with a muon telescope using the coincidence technique; b) their angular distribution with respect to the zenith; c) the interaction of charged particles with the magnetic field and how they are deflected d) the East-West asymmetry of the cosmic ray flux.

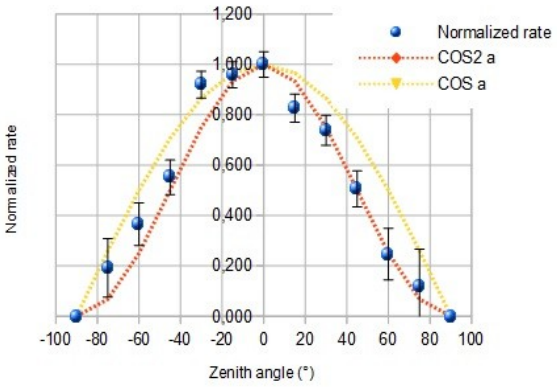




Report of our results

Rate measurements were carried out at different zenith angles, each lasting 24 hours. From each value we subtracted the flux measured for an angle of 90° which corresponds to the random coincidences between the two Geiger tubes. Finally we normalized the data with respect to the maximum value obtained at 0°.

Rate 24 h (raw data)	Rate with subtracted background	Relative error √N/N	Zenith angle α	Normalized rate	COS^2 α	COS α
			-90	0,000	0,000	0,000
360	74	0,12	-75	0,192	0,067	0,259
427	141	0,08	-60	0,365	0,250	0,500
499	213	0,07	-45	0,552	0,500	0,707
641	355	0,05	-30	0,920	0,750	0,866
656	370	0,05	-15	0,959	0,933	0,966
672	386	0,05	0	1,000	1,000	1,000
605	319	0,06	15	0,826	0,933	0,966
571	285	0,06	30	0,738	0,750	0,866
481	195	0,07	45	0,505	0,500	0,707
381	95	0,10	60	0,246	0,250	0,500
332	46	0,15	75	0,119	0,067	0,259
286	0		90	0,000	0,000	0,000



The rate distribution with respect to the zenith angle follows the typical bell shape, due to the fact that thickness of atmosphere increases with low values of zenith angle, therefore the flux of muons at the earth's surface decreases.

The data fit well with curve $\cos^2\alpha$ rather then $\cos\alpha$ as theory predicts.

Data on the graph show a slight difference in the number of counts in 24 hours between West (negative angles) and East (positive angles), this could be an evidence of the East-West asimmetry in agreement with the fact that most cosmic rays are positive particles. Error bars are the square root of counts over counts, $\sqrt{N}/N$ according to a Poissonian distribution.