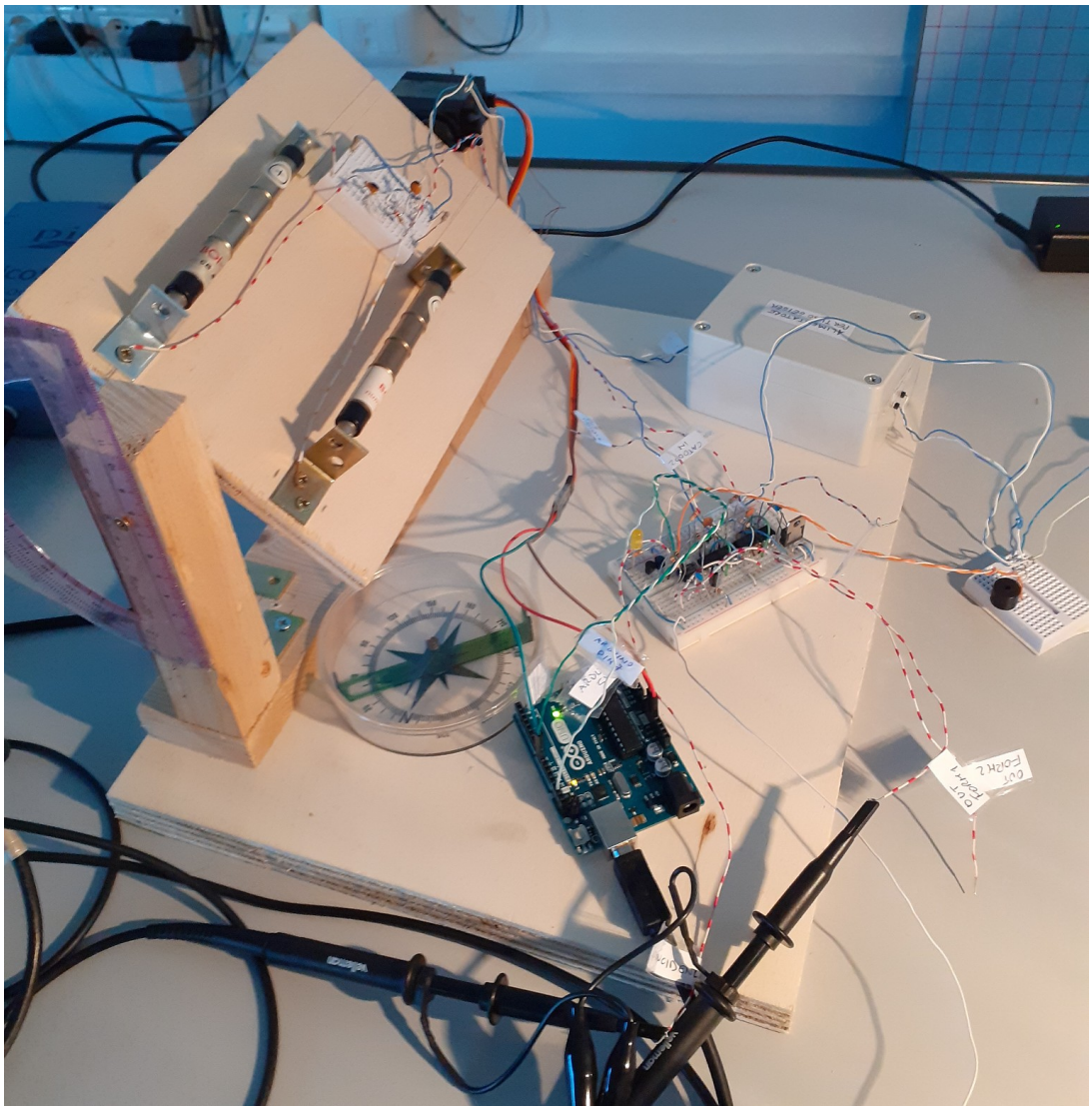
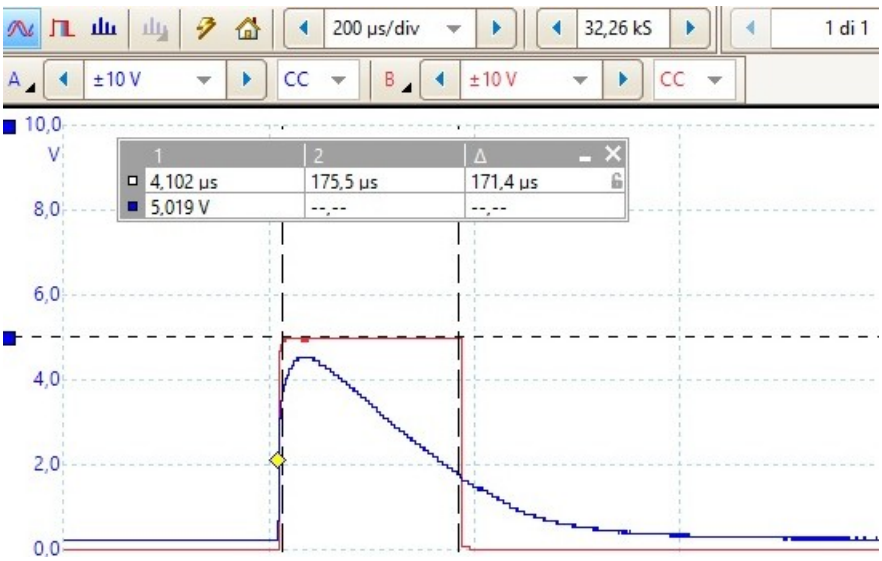
Introduction

Four years ago a group of students of the Scientific High School "Lorenzo Mossa" of Olbia in Northern Sardinia - Italy, started to build a low-cost home-made Cosmic Ray Detection System (inspired by similar ideas that are shown in science education literature) and participated to ICD 2018 edition.

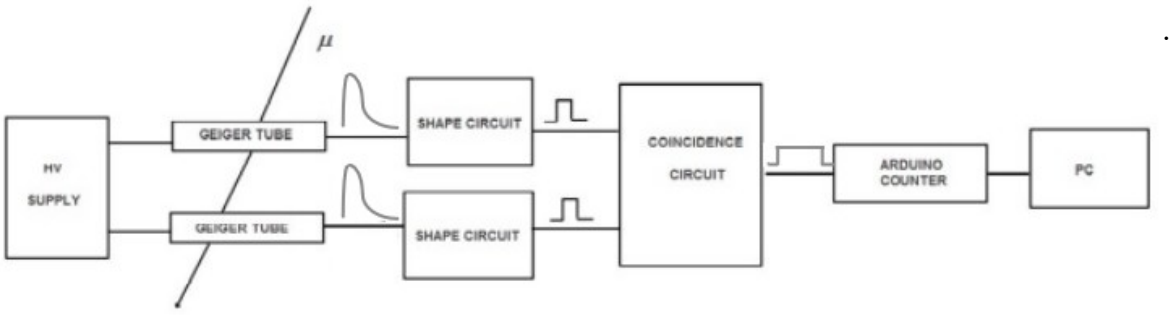
Experimental Set-up



The design of our equipment uses two Geiger SBM-20 tubes powered by about 400 volts at low current intensity, mounted on a support that can rotate in a programmed manner by means of a servo motor driven by Arduino, in order to orientate the two tubes at different zenithal angles whose acceptance is of 15°.
The output signals of the tubes are shaped by a squaring off circuit obtaining pulse with amplitude 5 V e duration 170 µs.

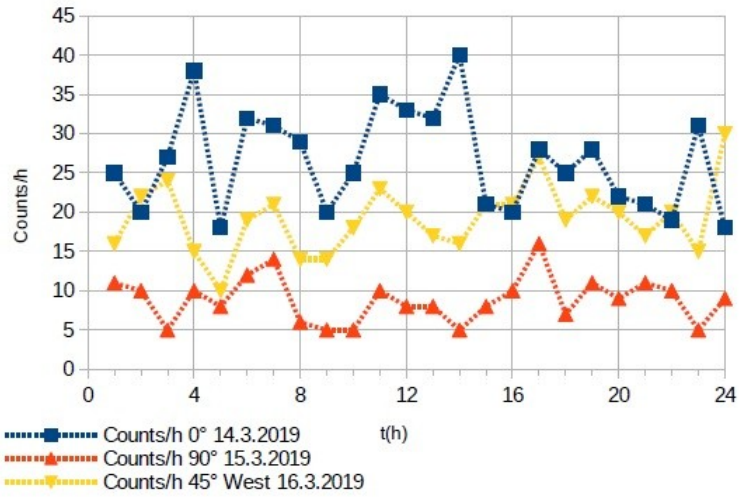


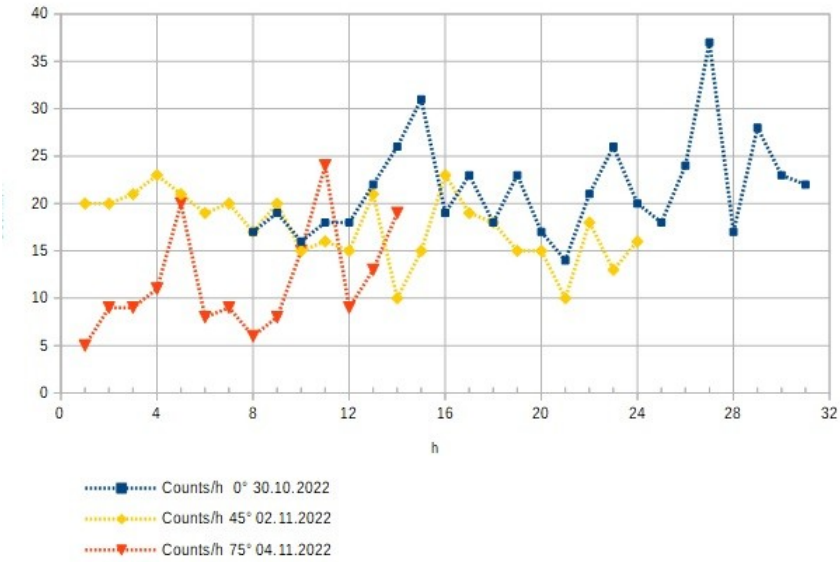
A coincidence circuit was realized with the integrated circuit 555 that intercepts the signals of the two Geiger tubes within a time window of 5 milliseconds and finally an Arduino microcontroller counts theese coincidence signals that are sent to a PC and stored in a file. The experimental apparatus is located in the school laboratory and controlled remotely using the Teamviewer software, so that students can take measurements from home.



Results

Here some results of our collected data in 2019 and in November 2022.

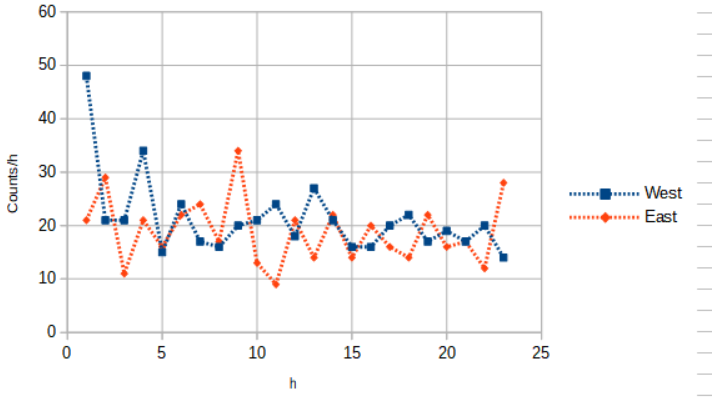




The graphs show the coincidence rate per hour in a 24-hour time interval at different zenithal angles. We can see the decreasing trend of the rate as the zenith angle increases.

East-West effect

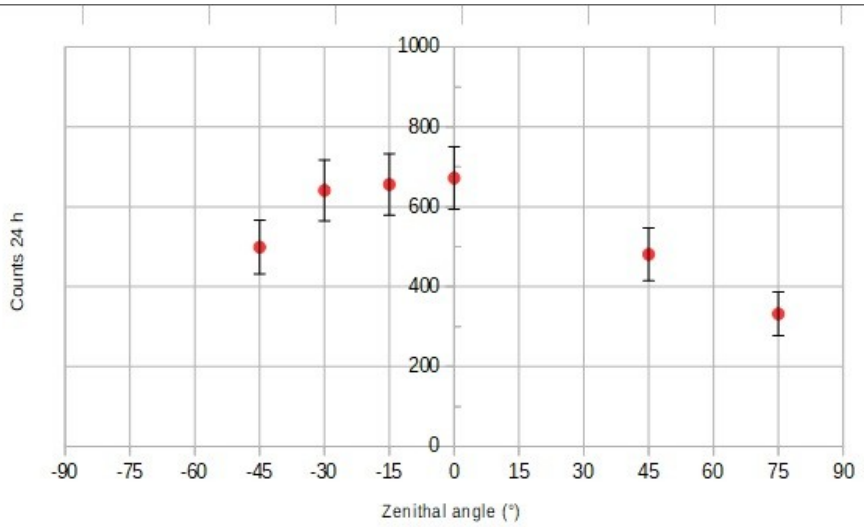
h	West	σ	East	σ
1	48	7	21	5
2	21	5	29	5
3	21	5	11	3
4	34	6	21	5
5	15	4	16	4
6	24	5	22	5
7	17	4	24	5
8	16	4	17	4
9	20	4	34	6
10	21	5	13	4
11	24	5	9	3
12	18	4	21	5
13	27	5	14	4
14	21	5	22	5
15	16	4	14	4
16	16	4	20	4
17	20	4	16	4
18	22	5	14	4
19	17	4	22	5
20	19	4	16	4
21	17	4	17	4
22	20	4	12	3
23	14	4	28	5
total time	**488**	**22**	**433**	**21**



There is a slight difference in the number of counts in 24 hours between West and East: 488 versus 433 in agreement with the fact that most cosmic rays are positive particles, even if the difference is not statistically significant: the number of measurements should be increased.

The angular distribution

	Zenithal angle (°)	Counts in 24 h	N-sigma	N
WEST	-75		0	3
	-60		0	
	-45	499	67	
	-30	641	76	
	-15	656	77	
	0	672	78	
EAST	15		0	
	30		0	
	45	481	66	
	60		0	
	75	332	55	



The rate distribution versus the zenithal angle follows the typical bell shape. Error bars are +/- 3σ with σ being the square root of counts according to a Poissonina distribution. Further measurements were needed to verify that the muon rate is proportional to $\cos^2 \theta$ with θ the zenithal angle.

Next projects

In the future we are going to expand our experimental set-up with measurements of temperature and atmospheric pressure to correlate them with muon rates and will build another identical set-up to make measurements simultaneously and in the same place from two opposite zenithal angles to verify the East-West effect.