Worldwide Cosmic Ray Flux Study
February 13-24, 2023

Is the cosmic ray flux the same all over the world?

International Muon Week (IMW) 2023 participants share data worldwide.

By sharing data in this way, we are developing a detector research community and connecting students around the world.

Google map of participants

http://tinyurl.com/3v5ny78y

Results from the 10th Annual International Muon Week

International Muon Week 2023

Report from State School Simon Bolívar
(Public School in São Paulo - Brazil)

Note from Coordination : For this activity we used two detector modules. Each module is formed by stacking 2 slabs of 20 cm x 20 cm x 4mm plastic Scintillator (ISMA UPS923A) . Each scintillator slab is read out by a pair of 3.7 mm x 3.7mm Silicon Photomultipliers (Broadcom AFBR-S4N44C013) with the signals summed analogically. A coincidence of the discriminated signals coming out from the two stacked slabs within a window of ~ 150ns is considered an event (this window represents the average pulse width above threshold. The threshold was set to limit the dark counting of the SiPM placed in a dark box without a scintillator attached) . A logical OR between the events of the two modules is used to increase the detection area (twice of a single module). The two modules were laid horizontally, and only a few centimeters apart from each other. The detector is housed inside a building under a concrete ceiling (about 10cm thick) . There were some "blackouts" of data but the students were instructed to do a "data quality" by selecting the data accordingly. We also asked the students to write a few lines about the activity. We are still waiting for a second school result but since they looked at the same data the results will be similar.

Results:

Data Collection Period : **February 13, 2023 to February 25, 2023**
Cosmic Ray Flux found by the class: **7.68 events/s**

Opinions of the students regarding their participation in the International Muon Week event during the week of February 13, 2023 to February 25, 2023, aided by specific computer software and the use of the database generated by data collected through muon detectors.

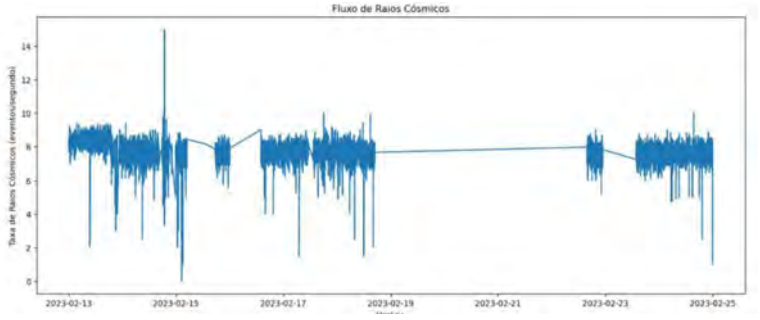
Student 1

On March 3rd, 2023, I had the opportunity to participate in an activity for the Cosmic Rays project. I found it very cool, but also a bit complicated to go through the process of entering Activity 2. The system of changing dates after the update process was interesting. Exploring the data collected by the cosmic rays detector was a unique experience. Although it was a bit confusing because I hadn't accessed it before, with the guidance of the teacher and based on previous activities (Activity 0 and Activity 1), everything went well.

Database is the beginning of everything, as it is the foundation of this program that allows changing the dates to explore the data from all stages.

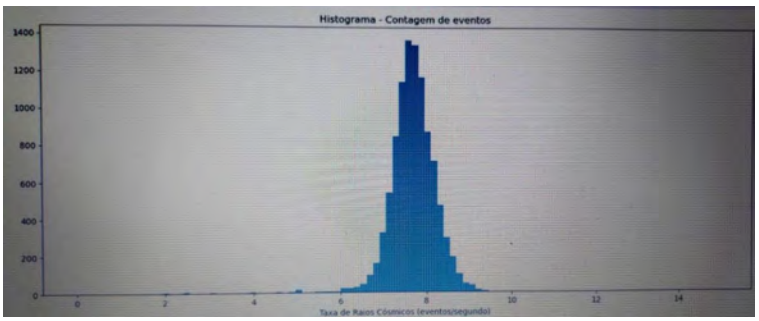
The average flux value for the event was: 7.68 events per second.

The following graphs were generated based on Dates 13/02/2023 at 00:00:00 until Date 25/02/2023 at 23:59:59:



Student 2

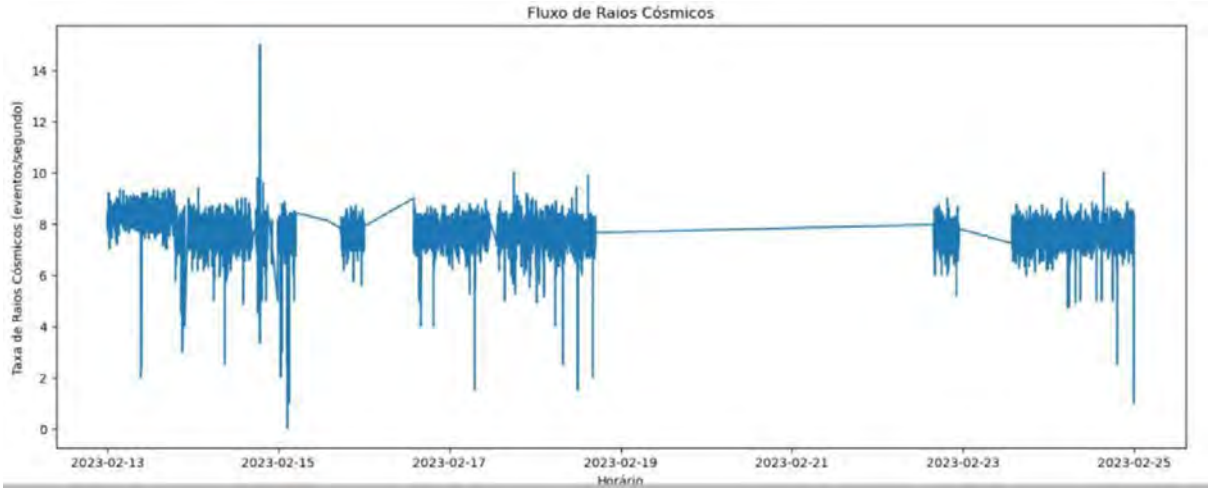
I had easy access to the
activities since I had already
witnessed and completed
activities 0, 1, and 2 of the
program before. Then, I made
changes to more recent dates,



which was very simple and fast. With the information from the database and the average data, it becomes very easy to understand the "Cosmic Ray fluxes" and "Histogram" graphs, which were well-chosen for this type of data comparison. I liked having a specialized program for better understanding and visualizing how muons behave in each detector since it would be too tiring to record point by point every second, given that there are 7.68 events per second, which are too many events to be written down. Even in the face of some technical problems, I found the access to be very easy, and it doesn't seem as complicated now as it did when I first saw it. The proposal of the website was a good investment for participating students and teachers of the project.

Student 3

I liked the activity. The fact that it is possible to analyze and produce these graphs in a simple way using codes that other people have made to facilitate such analysis impresses me. I am also impressed by the amount of data involved in a single graph. It is very easy to understand the increase and decrease in the number of particles over the course of days, and it is possible to see that for most of the time, they follow a pattern.



Student 4

I had already participated in this activity previously when I went to USP for the second workshop. This activity was again a very interesting experience. It's always good to test our knowledge and learning. I won't say it's complicated because it's not, but I did have some difficulties in the process due to the two dates. However, with the guidance of the teacher, it worked out in the end.

Student 5

It was a great experience in which we had teacher Carlos to assist us throughout the project. The classes were held during the evening period where I analyzed the flow of cosmic rays using USP's JupyterLab. I registered on USP's JupyterLab and ran the Update, after which I entered Activity 2 and observed the two graphs. The event rate per second is 7.69. I would like to express my gratitude to USP and Carlos for providing students with this incredible event.

Student 6

During the nighttime period between the dates of 13/02/2023 - 25/02/2023, I was analyzing the cosmic ray flux through the JupyterLab from USP (University of São Paulo).

- Firstly, I registered on the website;
- Updated the update.ipynb;
- Accessed activity 2;
- Changed the variables;
- Obtained the graphs;
- Cosmic ray rate (Events/Second) = 7.68 Events/Second.

One thing I noticed was the pattern that the graph followed for most of the time, with only a few deviations from this pattern, such as 14 detections/second. It was an incredible process, and our teacher Carlos gave us all the necessary support to carry out the project. I want to thank everyone involved in this project for allowing me to participate.

Student 7

After changing the start and end dates, we had access to the data collected by the detector in the form of graphs. The first information presented is the average rate of cosmic rays, which was 7.68 events/second detected between "2023-02-13" and "2023-02-25".

In the cosmic ray flux graph, using the same dates, it shows that there were initially few particles detected, but around 2023-02-15, there seems to be a peak in particles detected, exceeding 14. Later, there are straight lines that may indicate a blackout or when the device was turned off.

In the histogram, it presents the same data as the previous one, only the graph format changes, and the detection starts to show a scale from "6" to close to "10", which is the highest rate it reaches at 6 events/second.

I really enjoyed the activity, it sparked my interest in learning more about cosmic rays, and although I had difficulty at first, the teacher was able to explain and help me with my doubts, and the USP website was also very helpful.

Student 8

By performing the activity, I was able to identify the mode of events in the histogram, thus being able to discover, by also observing the flow, the average rate of cosmic rays per second. The activity was very cool, I really enjoyed working with programming. I think it's

important for us students to be able to interact with the website so that when the device is at our school, we'll know how to analyze the graphs on the site.

Student 9

During the execution of the activities carried out in JupyterLab, I was able to analyze and learn more deeply about the incidence of cosmic rays. At first, I found some difficulty with the codes, especially in understanding what was going wrong if there was an error.

However, I quickly got used to making the necessary updates and executing the lines with their proper date changes. Observing the histogram, I noticed that the data tends to follow a certain "pattern", with some peaks here and there, and I thought that this might be related to the location of the detectors, with possible influences from climate factors, altitude, location, etc. I must say that the Python language made my train of thought a bit difficult at times, but nothing that made the experience bad.

Overall, I can say that I enjoyed it very much and I can't wait to analyze and compare the data when the devices are in different locations, such as the school I attend, for example.

Student 10

Participating in this experience was quite interesting, from giving commands to the program to analyzing the graphs, with the help of teacher Carlos. I followed these steps:

1 - Logged in to Jupyter;

2 - Updated the program and Activity 2;

3 - Modified the date of the graphs;

4 - Analyzed the graphs and information proposed, with 7.68 being the cosmic ray rate per second.

It is noticeable that the graph has a very constant flow, with few peaks and drops, only having parts without data due to blackouts or errors in the devices. The program is quite intuitive, easy to understand, and manage. I am very grateful for the opportunity to participate in the project.

Student 11

I enjoyed participating in the activity, and teacher Carlos assisted us by showing how to execute commands and access the website. I followed the commands in the following order:

- Signed up/logged in to the JupyterLab.
- Updated the "update.ipynb".
- Accessed Activity 2.
- Changed the dates.
- Obtained results from the graphs and written information.

The rate of cosmic rays found is 7.68 events/second. The graph shows almost constant flux with few increases or decreases, and with some parts without data due to the device being off. The program loaded quickly, was intuitive and easy to use. I am grateful for the opportunity to participate in the activity.

Student 12

I particularly had a very cool and fun experience, it is very good and interesting to be able to learn more about cosmic rays, the various existing particles and accelerators, I am really enjoying participating in the project.

I had already worked with graphs in one of the visits I made to USP, so it was something that I was already somewhat familiar with, but there was only a small problem with the comma, which we didn't know at first, but was resolved with the help of teacher Carlos.

Student 13

I found the activities good and easy to understand. My only complaint is that the software was not working properly and caused some delays.

Student 14

Cosmic rays are actually high-energy particles coming from space and going in all directions, and they reach the Earth at all times. Some cosmic rays have tremendous energy. A large part of them are particles (protons, electrons, and neutrons) that decompose into others.

Cosmic rays can affect living beings through mutations, such as aviation professionals, for example. Fortunately, we have an atmospheric layer that protects the Earth and everything that lives here.

Regarding Activity 2, after selecting the data to be analyzed, scatter plots and a histogram were constructed. We can observe in the graphs that there are peaks and drops in the frequency of the rays, showing their flux per second, making it possible for us to understand that there is a significant quantity of cosmic rays in the atmosphere every second.

Student 15

I really enjoyed participating in these classes, it's very interesting to learn a little more about physics. I had already done something similar when I went to USP in 2022.

I had some difficulties, but I received help from my colleagues and the professor. The first time I tried it, it didn't work because of a comma, but after that everything was fine.

Student 16

It's been really cool using internet resources to see the amount of cosmic rays per second. The program is very interesting, although a bit complicated, but with updates in the libraries, everything works out fine.

In addition to the technology, working with cosmic rays sparks my curiosity to know more. For example, I wonder if there is a higher incidence of cosmic rays in higher places like the Andes Mountains. Also, does the climate affect cosmic rays?

The program is fascinating because it can arrange a graph with an average of 10,000 events. This is very interesting because in addition to working with cosmic rays, we are also working with computer science.

It's interesting to see the graphs because sometimes there are large spikes, and it makes me wonder what happened at that moment. Was it a more energetic cosmic ray, or was there a large flow passing through, and the detector picked it up? If we change the angle, will the result be the same? These are things that give me a lot of curiosity because the graph has very high and very low peaks.

Student 17

Between the days of February 13th, 2023 and February 25th, 2023, we analyzed the Cosmic Ray Fluxes that passed through Earth using the USP (University of São Paulo) JupyterLab.

- I accessed the USP website and logged into my account.
- Updated the update.ipynb.
- Entered the 2nd activity.
- Updated the dates.
- Obtained the data from the graphs.
- The result was: 7.69 events per second, with its highest flux on February 14th, 2023, and its lowest flux on February 15th, 2023.

Being part of this project is a childhood dream come true, and I hope to continue contributing to physics within my capabilities. My thanks to everyone who made this project happen and helps to keep it going.

Student 18

Cosmic rays are high-energy particles that hit the Earth. Using sensors, it is possible to analyze how many cosmic rays passed at that moment and location.

With the cosmic ray analysis platform from USP, I was able to understand how the reading of these particles is done and learn much more about the subject, especially because applying theory into practice helps a lot in understanding, as well as fixing the content better. It was

also possible to learn a little about the programming language Python, which is the language used on the platform.

Activity 0 explains about the Python programming language, used to perform analyses on the platform. Even those who have difficulty with the subject could understand at least a little about how this language works, and were able to use the platform correctly.

With Activity 1, I understood how histograms are made and how to read these graphs. I was also able to better understand how to analyze the data present in these graphs.

In Activity 2, we put into practice everything we learned in the previous activities and, in this manner, analyzed the cosmic rays coming directly from the detector. By entering the correct codes and dates in the program, it was possible to read the graphs. However, unfortunately, I couldn't read the graphs in my Jupyter, since an error occurred and the graphs that were supposed to appear didn't show up.

However, with the help of the teacher and classmates, I was able to analyze the graphs together with them. In the "Cosmic Ray Flux" graph, it is possible to observe that from February 13th, 2023 to February 15th, 2023, the detector obtained a high rate of rays per second, reaching a moment when it obtained more than 14 events per second. Between February 17th and February 19th, the detector also obtained an excellent reading, and the same occurs between February 23rd and February 25th.

In the "Event Count" graph, we also obtained a great result, reaching a very high rate of cosmic rays per second in one period, and in others, a slightly lower quantity.

With this, it is possible to conclude that the platform is very good, with educational content that teaches about data analysis and the cosmic ray detector itself.

PROGRAMA ENSINO INTEGRAL
E. E. PROFª ANA PINTO DUARTE PAES
Diretoria de Ensino - Região de Jundiaí
Rua Carlos Gomes, 770 - Bairro Ponte São João Jundiai - SP
CEP 13.218-005 Telefone / Fax: (11) 4587-0702
E-mail: e019550a@educacao.sp.gov.br
SÃO PAULO GOVERNO DO ESTADO
Secretaria da Educação

International Muon Week 2023

Report from State School Ana Pinto Duarte Paes (Public School in São Paulo - Brazil)

Note from Coordination : For this activity we used two detector modules. Each module is formed by stacking 2 slabs of 20 cm x 20 cm x 4mm plastic Scintillator (ISMA UPS923A) . Each scintillator slab is read out by a pair of 3.7 mm x 3.7mm Silicon Photomultipliers (Broadcom AFBR-S4N44C013) with the signals summed analogically. A coincidence of the discriminated signals coming out from the two stacked slabs within a window of ~ 150ns is considered an event (this window represents the average pulse width above threshold. The threshold was set to limit the dark counting of the SiPM placed in a dark box without a scintillator attached) . A logical OR between the events of the two modules is used to increase the detection area (twice of a single module). The two modules were laid horizontally, and only a few centimeters apart from each other. The detector is housed inside a building under a concrete ceiling (about 10cm thick) . There were some "blackouts" of data but the student
s were instructed to do a "data quality" by selecting the data accordingly. We also asked the students to write a few lines about the activity. We are still waiting for a second school result but since they looked at the same data the results will be similar.

Cosmic Ray Station Coordinates : -23.56212177556658, -46.734904765326675

Results:

Data Collection Period : **February 13th, 2023 to February 25th, 2023**

Cosmic Ray Flux found by the class: **7.54 events/s**

Objectives:

To answer the question "Is the cosmic ray flux the same all over the world?".

Feedback from the students

Introduction

But what are cosmic rays? They are high-energy particles that travel through the universe, and some of them end up reaching our planet. In addition to learning what they are, we saw how they are detected, as well as learning the Python programming language. In the programming activities, we learned the language for analysis of the histograms in the platform, to understand the data passed by the graphs, and after that, we started searching for information, putting dates, months, hours to display corresponding graphs of cosmic ray fluxes. It was very interesting and fun.

As for the detectors, they are not as large as I thought at first, but their size is great for the research carried out. They serve to detect the radiation produced by the charged particle when it passes through the material. There are a lot of activities and experiences we have done, but my favorite was the one with the Schweppes tubes.

Methodology

But how was this experience with Schweppes? And how were the activities in the demonstration laboratory at IFUSP? Well, the materials used were: two tubes, a laser, Schweppes(Tonic Water), and water. The two had different results: for water (classified as A), the laser did not show its path through the water, with its light appearing underneath the tube, whereas for Schweppes (classified as B), the path of light was formed, and it looked more beautiful. This result occurred due to their compositions; Schweppes is a citric acid with an ingredient called quinine, which gives a different result from water. It was a beautiful explanation! Both the explanatory and practical parts were ingenious, expanding our knowledge of science about such an interesting and curious field. When we went to the experimental room, there were things that left me curious, while others were easy to understand, especially when seeing them work in practice. It was so cool to experience the shock as a group! It was a surprise!!

As for the detectors, they are two sets of two plastic scintillators type ISMA UPS-923A measuring 20cm x 20cm x 0.4cm each. Each one is read by two SiPMs of 4x4mm (Broadcom AFBR S4N44C013). We consider an event as the coincidence of the signal in any set of two scintillators. It would be almost equivalent to having a scintillator of 20cm x 40cm x 0.4cm. It is not entirely correct because as they are read separately, the efficiency is slightly higher (also double the area of sensors).

Analysis of the Detector Graphs

We gathered in the library to analyze the graphs of the cosmic ray flux. We observed them as a group, and some things we had seen before at USP, while others, such as the straight lines that indicated a stop in the flux, made us curious and led us to ask questions to the professors and monitors.

Observations

It's quite interesting to see the changes in the fluxes on each graph, as well as not only the fluxes, but also the times when they occurred. The stops were really interesting because we wondered why they happened, whether it was because the detectors were turned off or for some other reason that caused the graphs to look like that.

In addition to us who are already in the group and went to USP, other students were also interested and wanted to learn more about cosmic rays, which is quite nice, since it is always good to have more people interested in science.

Final Comments

Regarding the provocation made by the teachers: Was there a change in location of the detectors? For example, were they moved to the 1st floor or another room? Does anyone know why this question was asked (before the answer)?

According to what we thought and discussed here, yes, there was a change (figures 1 and 2). Especially on different days, since on each day, every hour, every second, and even smaller time intervals, we had different data. However, these were not significant changes, as they did not alter the histogram profile (figure 3) and were not significant when comparing the average of 7.65 counts per second with the values that appeared "live" in the Grafana profile (figure 4).

Positive points: we loved interacting with other researchers, observing graphs and results, and everything was very interesting. A great experience that we wish to experience again. We realized that we have an easier time learning through practical parts (research and observation) than just theory.

Negative points: some graphs, even with correct data, still gave errors, and we had to ask for help several times because of this error. I think there could be a tutorial on Discord that would make it much easier for all of us.

Answering the question of the International Cosmic Ray Week, we can admit that yes, because we compared our data with others and the flux does not seem to be very different, at least during the period studied.

We are very grateful for the opportunity provided by HEPIC, and we hope to actively participate in other events of this size and continue in the Cosmic Rays in Schools group.

Figure 1 - It is possible to observe a small drop at the beginning of the graph, with noticeable variations at various moments, and apparently random.

Figure 2 - Example of strange peaks in station data, in this case indicative of intense rainfall during the analyzed period.

Figure 3 -These are the same data, but in a different arrangement, making it possible to better observe the histogram. We obtained an average of 7.54 counts per second.

Figure 4 - Entrance profile of Grafana with real-time data from both stations. In this case, station 2 was disconnected.

Figure 5 - Students interacting with HEPIC staff.

References

https://raioscosmicos.if.usp.br/ - Accessed in March 27th, 2023

The time-dependent variation of strength of μ flux though observation and data analysis

Research group: Ziyan Hong, Jiaqi Deng, Longxi Xiao, Shiya Yu

Class2123, High School Attached to Hunan Normal University

Adviser: Shuncun Ma, Yiming Yang

High School Attached to Hunan Normal University

Dear sir or madam,

We are very happy to participate with you in 2023 International muon weeks. With the guidance of Prof.Shen Changquan, the dean of the Institute of High Energy Physics of the Chinese Academy of Sciences and Prof.Zhang Chuang, we started the cosmic ray μ flux Experimental study of the variation of the subflow intensity with time. The data we use is collected by the cosmic ray detector array which locates in the campus of Beijing Dongzhimen Middle School, Beijing, China (116.439 degrees east longitude and 39.951 degrees north latitude), with an altitude of 46.4 meters. The array consists of 9 detectors, with 3 × 3 square layout with a spacing of 10 meters. Each detector has an area of 0.5 square meters. Dongzhimen Middle School Array has been running for 7 years, and the data has been collected since the New Year's Day of 2018. We selected the data from February 13, 2022 to February 24, 2022 to carry out the experiment and obtained the 12 days μ The experimental data of the image of sub-intensity changing with time are as follows.

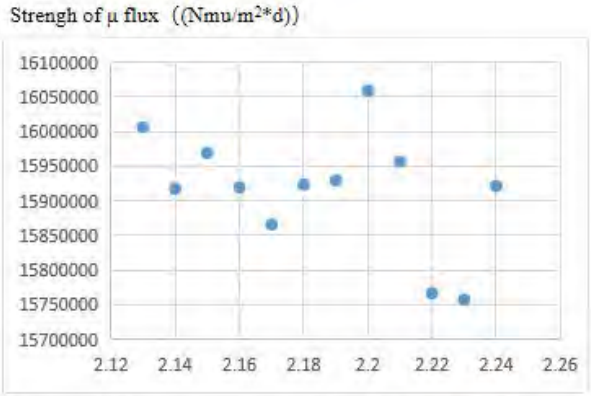
We considered that the strength of μ flux during the 12 days is between 15766966.67 and 16059064.67Nmu/m^2*d, with maximum fluctuation range calculated as (16059064.67-15766966.67)/16059064.67=1.82%. The experimental results reveals that the variation of the strength of μ flux is very small during the 12 days we studied.

We are very happy to participate in this event.

Thank you!

Yours

Date	Strengh of μflux(Nmu/m^2*d)
2.13	16006042.67
2.14	15917565.78
2.15	15969328
2.16	15919379.56
2.17	15866074.89
2.18	15923592
2.19	15929572.44
2.20	16059064.67
2.21	15956644
2.22	15766966.67
2.23	15757596.44



The graph of time-dependent variation of strength of μ flux

International Muon Week 2023 - Muon Flux Study

北京汇文中学朝阳垂杨柳分校

校园宇宙线观测联盟 Campus Cosmic-ray Observation Collaboration

Peking Academy Chaoyang Chuiyangliu Middle School

1. Introduction

- Our school joined Campus Cosmic-ray Observation Collaboration (CCOC) in China in July 2022.
- The open data from Dongzhimen Middle School is used by us.

2. Equipment

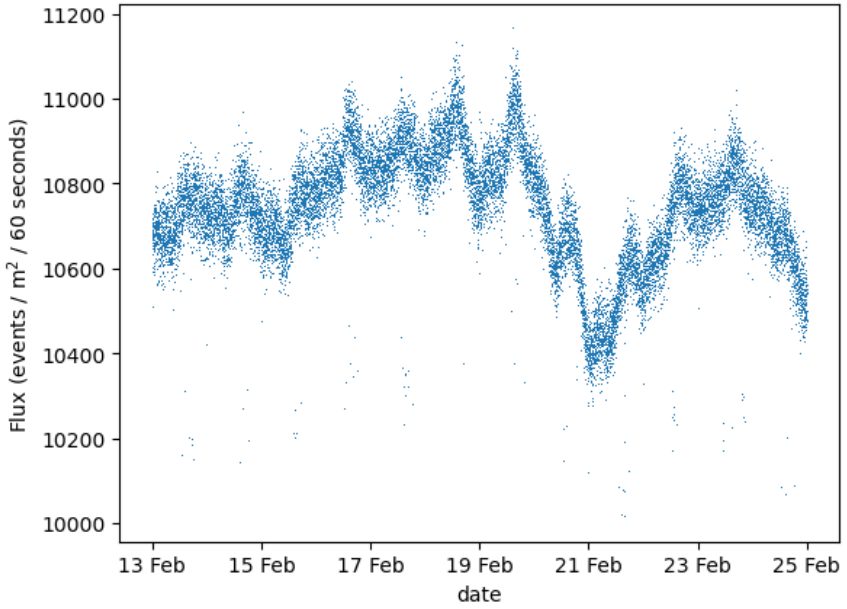
- A detector array is built on the roof of Dongzhimen Middle School.
- 9 scintillator detectors, spaced 10 meters apart as a 3×3 matrix and each detector has a sensitive area of 0.5 m^2.

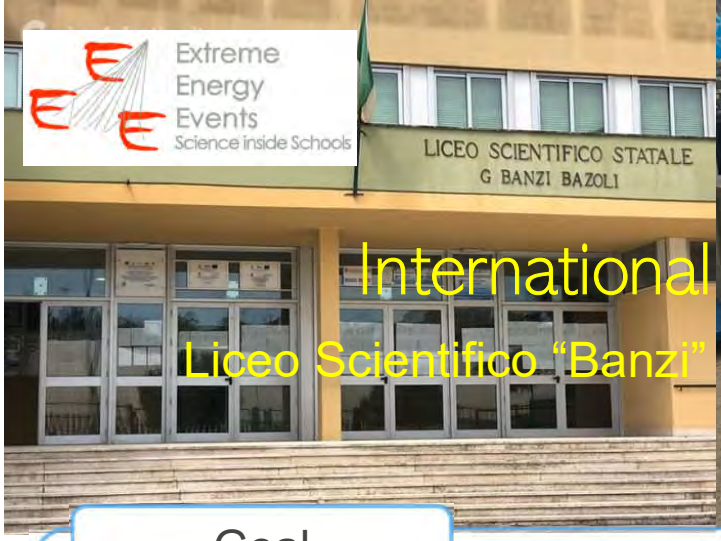
latitude 39.933°N, longitude 116.417°E

3. Data Analysis

- We select data between 13-24 Feb 2023.
- Flux = $\frac{N}{S}$
  - N = number of events in 60 seconds
  - S = 4.5 m^2

4. Result





International Muon Week 2023

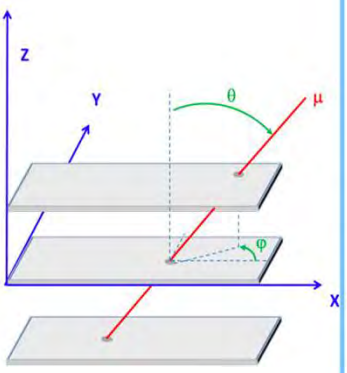
Liceo Scientifico "Banzi" Lecce (Italy)

Goal

In this report, we extimate the muon speed in the Extensive Atmospheric Showers, as the mean value of ratio between the track length (TL) and Time-of-Flight (ToF). The data set we used was acquired from Extreme Energy Events station [1], placed in our school.

Experimental Setup

For our purpose we used a data sample acquired from 13/03/2023 to 24/03/2023, by a three MRPC (*Multigap Resistive Plate Chamber*) telescope. This telescope provides us with the track-length (TL) and the time-of-flight of each incoming muon, as well as the angular coordinates (φ, ϑ) which identify the direction of its trajectory.



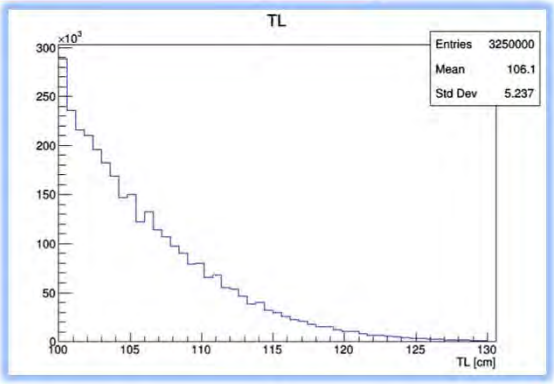
Analysis

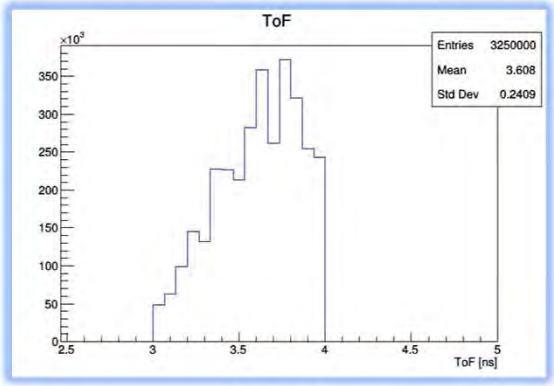
We ran our analysis by means of the ROOT software, by performing the following cuts $0 < \theta < 40°, \chi^2 < 5,\ \mathrm{TL} < 180\mathrm{cm}, 3\mathrm{ns} < \mathrm{ToF} < 4\mathrm{ns}$. In our histograms, we present the distributions for $N = 3.25\ 10^6$ events, concerning respectively, TL, ToF and the muon speed v, evaluated as the ratio between TL and the corresponding ToF. We found the following ToF mean value

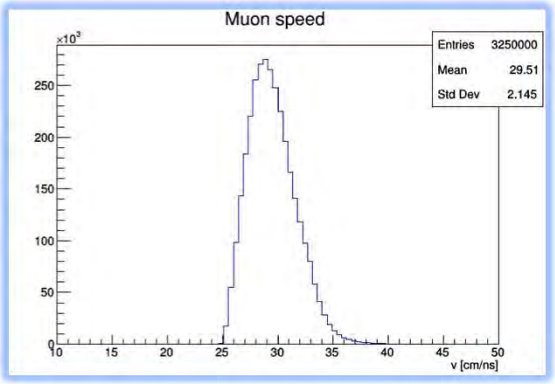
$$\boldsymbol{ToF = 3.608\ ns},$$

with a standard deviation of $\sigma = 0.2409\ ns$

Histograms







Results

The histogram of the ratios between TL and ToF gave us a muon speed mean value of

$$\mathbf{v = 29.51\ cm/ns}$$

(quite close to the speed of light), with a standard deviation of $\sigma = 2.145\ cm\ /\ ns$.

[1] https://eee.centrofermi.it/en/

Waseda University Honjo Senior High School
(Miki OHTSUKA)

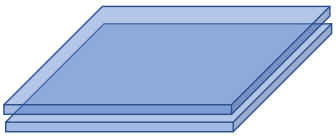
Location

Latitude: 36:12.6955 N

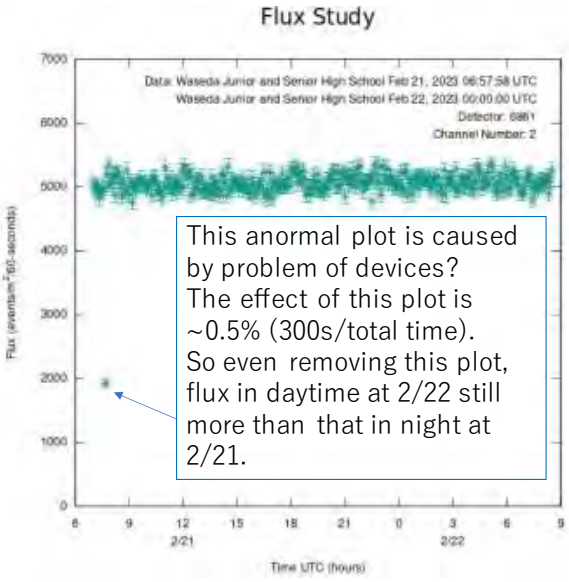
Longitude:139:10.5474 E

Set up

2 stacked folds



Flux plot :Bin Width 300s



Result & analysis

Flux is almost constant around 5000 event/㎡/min during 2days.

Date	2/21	2/22	total
Average flux event/㎡/min	5023	5060	5036

Measurement is mainly done in night at 2/21, daytime at 2/22 in Japan.

Sunrise in Japan 21:24 UTC

Sunset in Japan 8:29-30 UTC

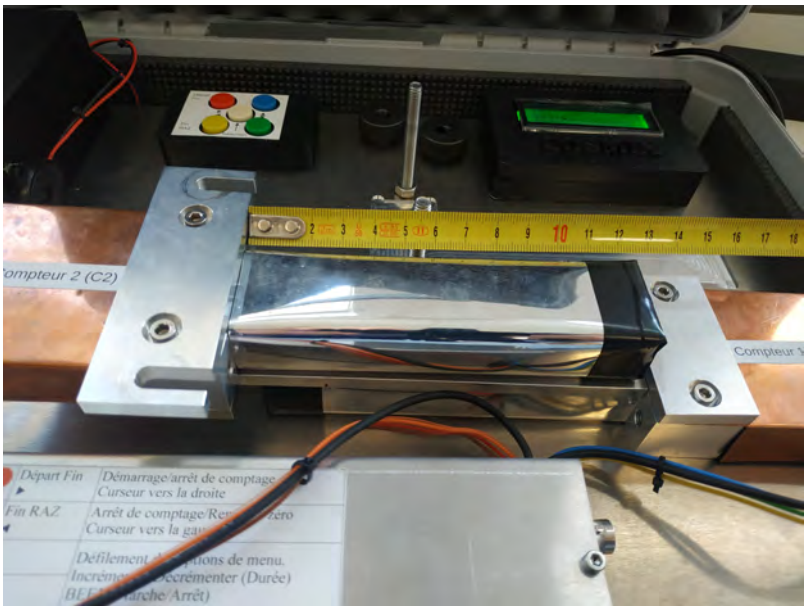
Flux in daytime at 2/22 looks like more than that in night at 2/21.

- Possible causes of the difference between night at 2/21 and daytime at 2/22
  - Sun's effect
  - Astronomical phenomena
  - Temperature
  - ~~Weather~~ ← Weather was sunny during 2/21-22.

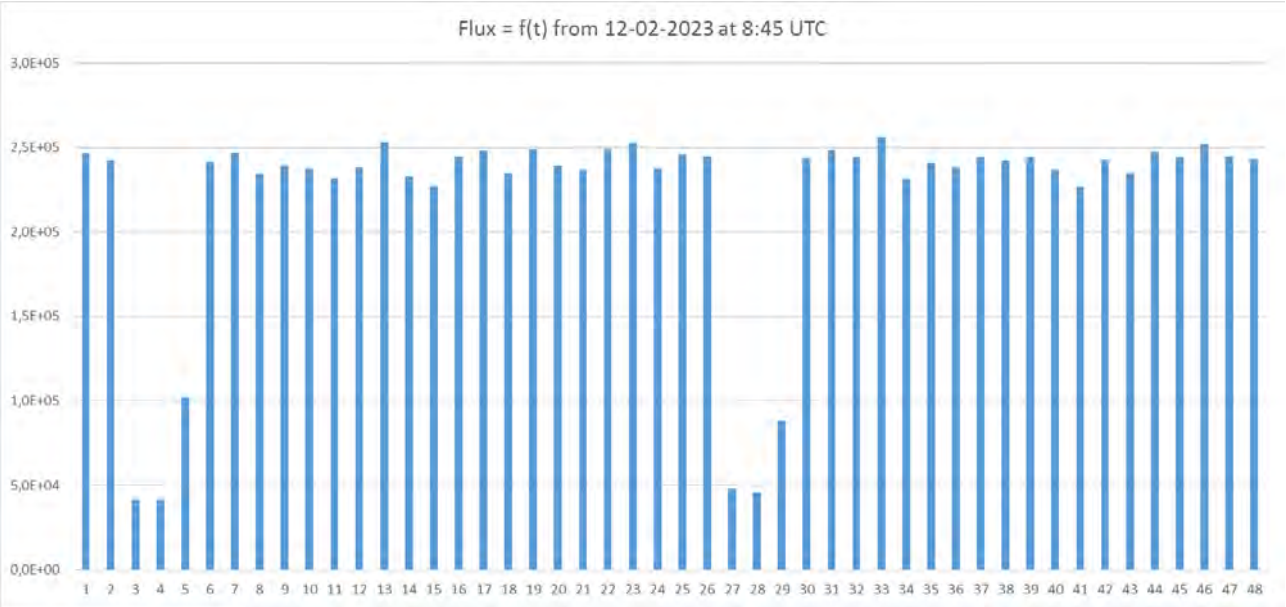
Further investigation and measurement is needed to determine the contributing factors.

Barcelona,
Latitude : 41.39274
Longitutde : 2.11894

Measurements from monday 12-02-2023 at 8h45 (UTC) to wednesday 14-02-2023
The detectors placed one above the other (as shown in the picture below) are 12.5cmx3.2cm and 2.4cm high.



We calculated the flux F = $\frac{N}{0{,}125 * 0{,}032}$ where N is the number of muons in the last hour.



I think the detector may be broken, because we have very different results during H3 to 5 and H27 to 29.

EVENT

MUON WEEK

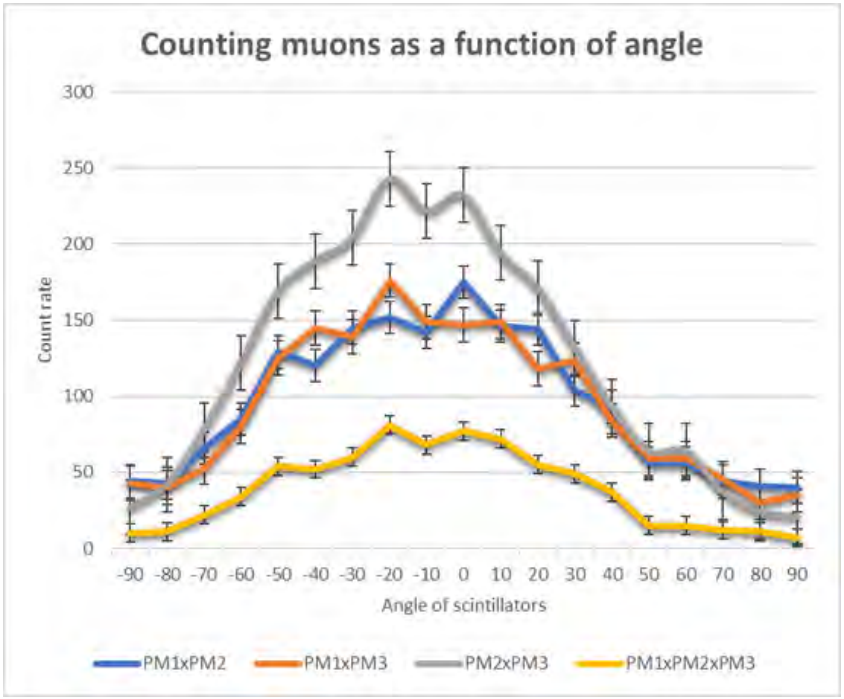
VILLANUEVA DE LA CAÑADA - SPAIN

On the occasion of Muon Week, we carried out a series of measurements thanks to the "Roue Cosmique" cosmodetector kindly lent by the French association "Sciences à l'école".

The measurements were taken by a group of students from the "Club Espace" of the french high school Lycée Français Moliere of Villanueva de la Cañada in Spain near Madrid.

(40.46014205802859, -3.996113686376203)

STUDENTS AT WORK WITH THE COSMODETECTOR, CARNIVAL DAY



STUDIES

These were our very first cosmodetection measurements and we carried out the following protocol:

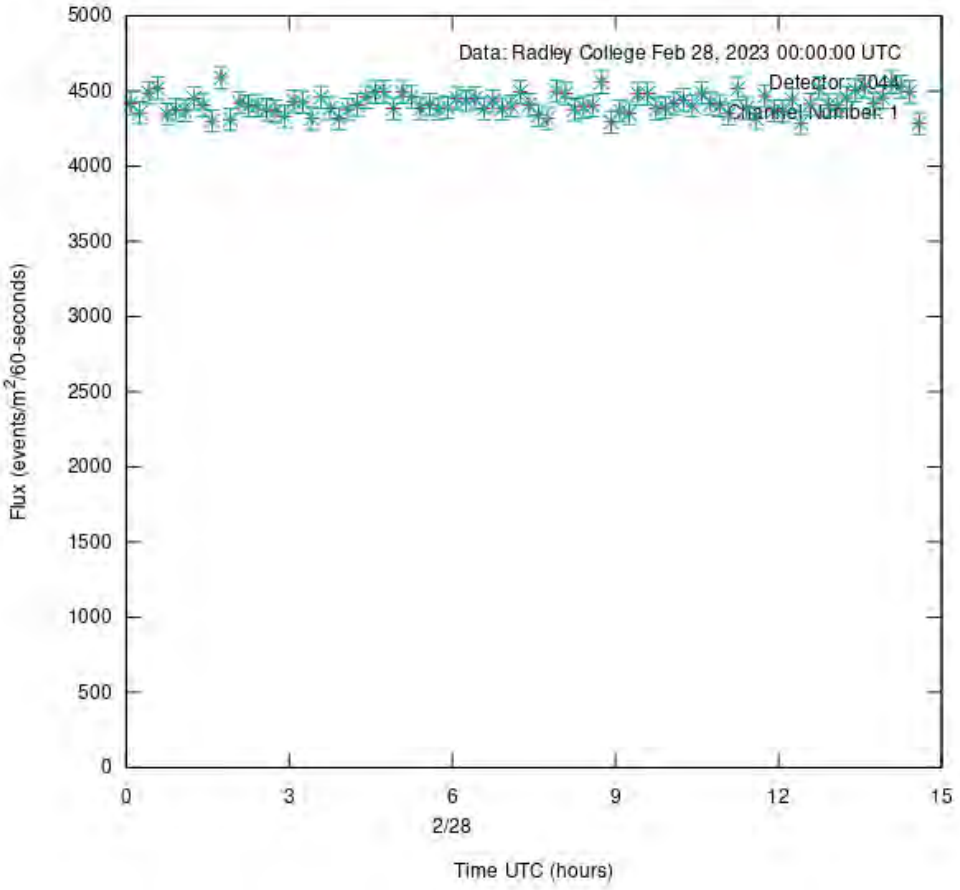
19 measures of 3 minutes each with a count of coincidences every 10 seconds between 1:10 p.m. and 2:17 p.m. (UTC+1) by tilting the scintillators each time by a value different from 10° between -90° and +90°

The position 0° corresponds to the horizontal of the place. The direction of the cosmodetector is North South.

Date: Friday, February 17, 2023
13:10 to 14:17 (UTC+1)
N.THEVENET - B.ALBERT - F. CALMONT - S.PAUPY
LYCEE MOLIERE - Villanueva de la Cañada - España 40.46014205802859, -3.996113686376203

Time	ANGLE	VOIE 1	VOIE 2	VOIE 3	VOIE 4	PM1xPM2	PM1xPM3	PM1xPM4	PM2xPM3	PM2xPM4	PM3xPM4	PM1xPM2xPM3
23.57	-90	468	1663	1329	0	44	43	0	27	0	0	10
00.00	-80	485	1714	1357	0	43	40	0	42	0	0	11
00.05	-70	460	1783	1347	0	66	53	0	78	0	0	22
00.08	-60	483	1820	1479	0	85	80	0	122	0	0	34
00.12	-50	520	2022	1528	0	129	125	0	169	0	0	54
00.17	-40	527	2066	1474	0	120	145	0	189	0	0	52
00.21	-30	567	2130	1723	0	145	139	0	204	0	0	60
00.24	-20	527	2048	1673	0	152	176	0	243	0	0	81
00.28	-10	542	2039	1653	0	142	149	0	222	0	0	68
00.31	0	546	2176	1694	0	175	147	0	232	0	0	77
00.35	10	575	2032	1629	0	146	149	0	194	0	0	72
00.38	20	563	1982	1540	0	144	118	0	171	0	0	55
00.42	30	559	1990	1536	0	104	124	0	132	0	0	49
00.47	40	555	1945	1505	0	93	84	0	93	0	0	37
00.50	50	502	1827	1319	0	56	59	0	64	0	0	15
00.54	60	502	1827	1319	0	56	59	0	64	0	0	15
00.57	70	456	1803	1296	0	44	46	0	37	0	0	12
01.00	80	469	1751	1215	0	41	30	0	24	0	0	11
01.04	90	488	1705	1305	0	40	35	0	21	0	0	7
TOTAL	180	9794	36323	27921	0	1825	1801	0	2328	0	0	742

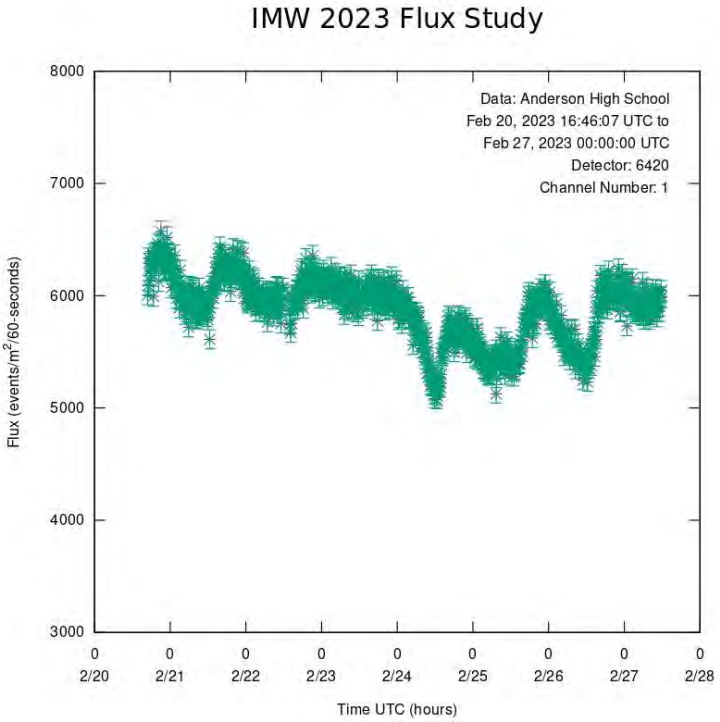
Flux Study


Data: Radley College Feb 28, 2023 00:00:00 UTC
Detector: 7044
Channel Number: 1
Flux (events/m2/60-seconds)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
3
6
9
12
15
2/28
Time UTC (hours)

Cincinnati Ohio USA
2023 International Muon Week.

Research question- Will the cosmic ray rate be different during the day verses the evening due to the influence of the sun?

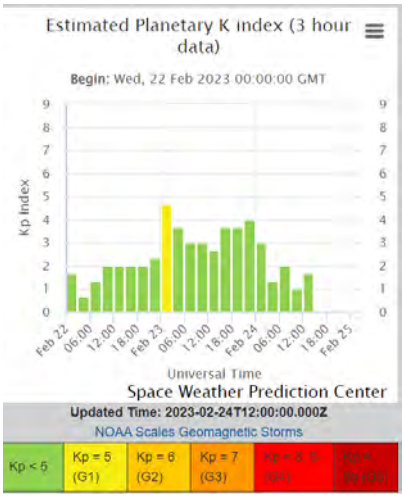
Students looking at cosmic ray in a Cloud chamber

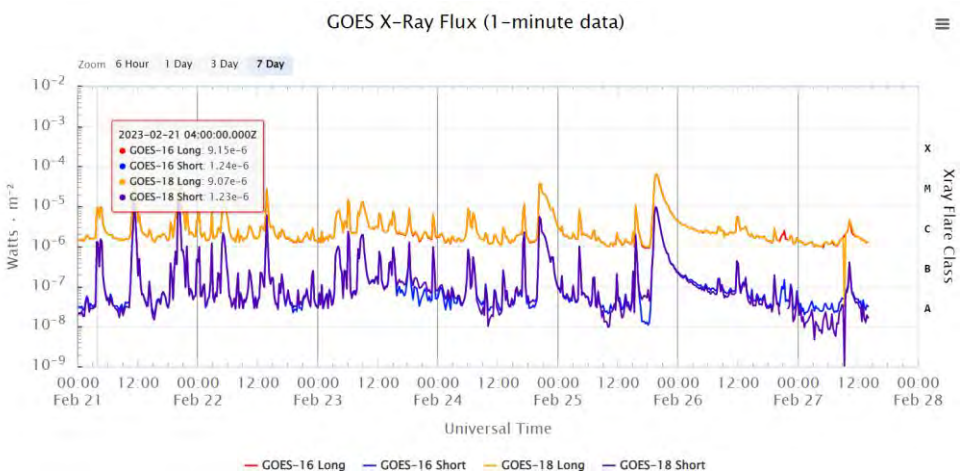


RESULTS- Possible space weather correlation

The first few days it looked like there was a correlation between the sun and cosmic ray rate. Wednesday and Thursday there was no correlation. On Friday, we noticed a dramatic change in the rate. There was a big weather system change. Could that have been the reason? Could space weather effect cosmic ray counts? This begun a discussion on the possible effects of space weather on cosmic ray rate. Using data organized at spaceweather.com, a discussion and a correlation was hypothesized. Four other participants in IMW noticed similar drop in cosmic ray rate after the geomagnetic storm Thursday evening. The sun does effect cosmic ray rate, but not in a way that the students expected.

The cosmic ray rate is effected by the sun but not on a consistent basis. The rate is not drastically different during the day and the evening. But solar wind fluctuations and geomagnetic storms do cause a significant difference in the rate of cosmic rays on the surface.

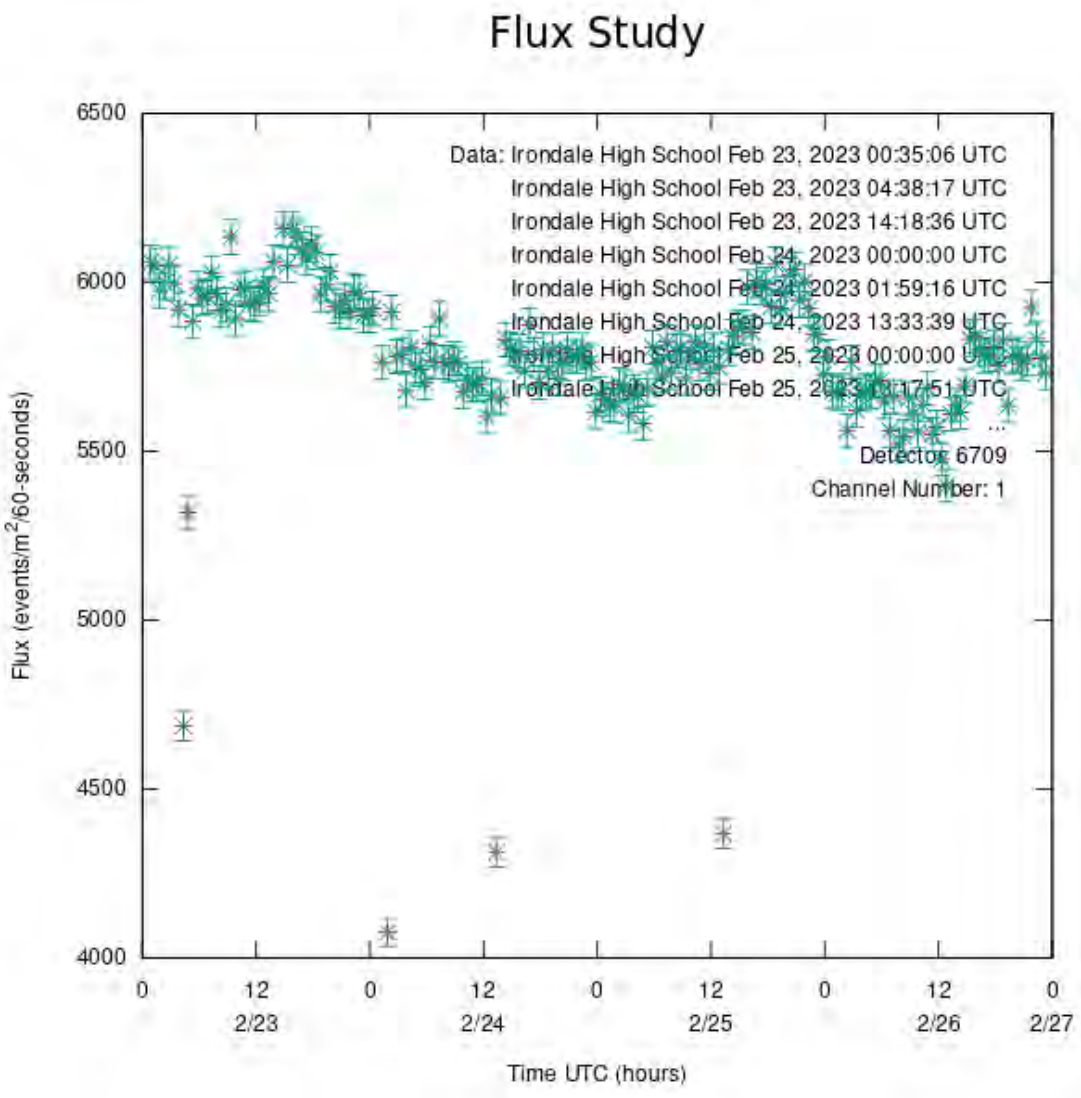


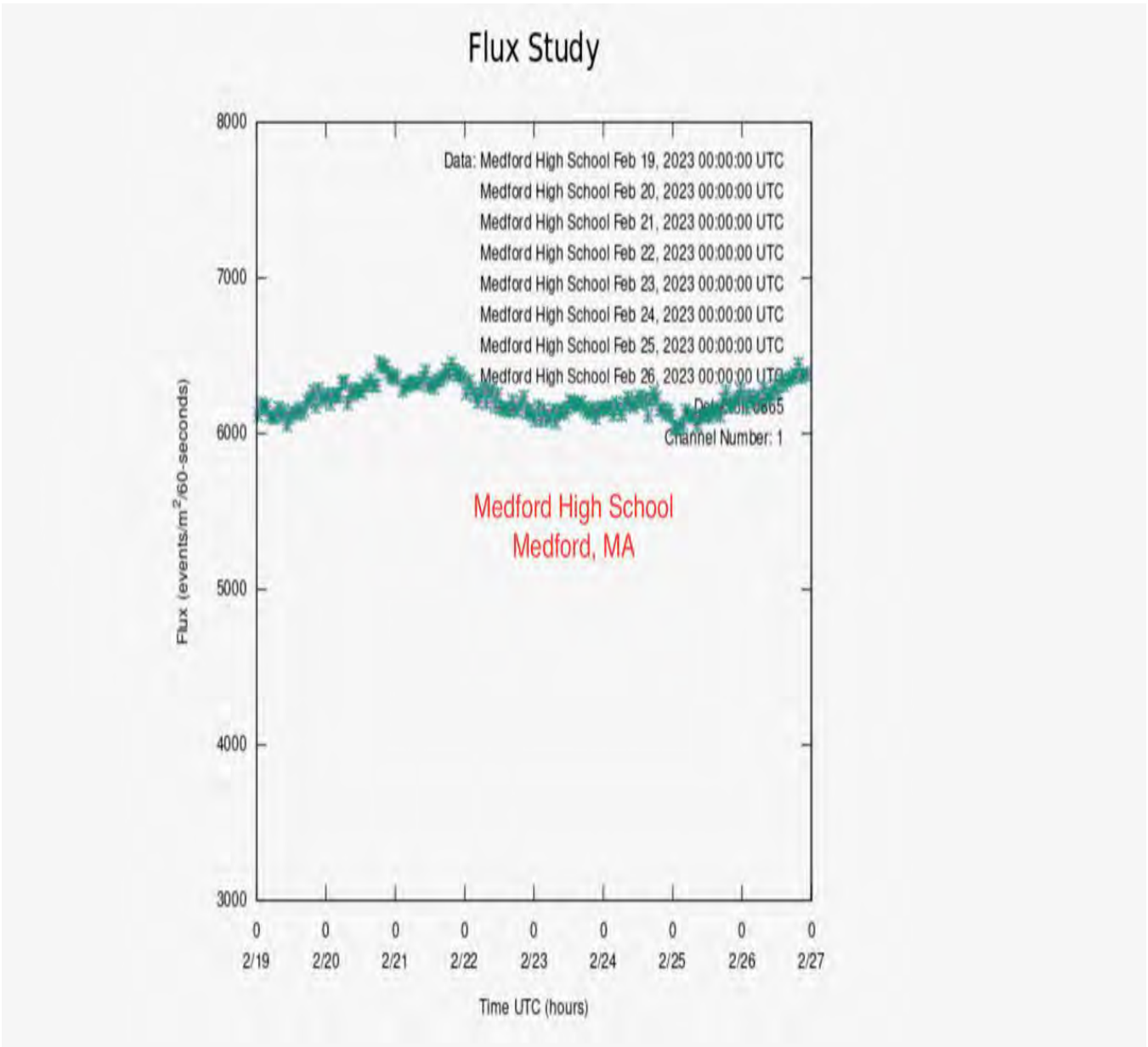


Irondale High School Detector DAQ #6709

Data collected in Minneapolis, Minnesota

Average flux: Approximately 5800 events/m^2/min




Flux Study
Data: Medford High School Feb 19, 2023 00:00:00 UTC
Medford High School Feb 20, 2023 00:00:00 UTC
Medford High School Feb 21, 2023 00:00:00 UTC
Medford High School Feb 22, 2023 00:00:00 UTC
Medford High School Feb 23, 2023 00:00:00 UTC
Medford High School Feb 24, 2023 00:00:00 UTC
Medford High School Feb 25, 2023 00:00:00 UTC
Medford High School Feb 26, 2023 00:00:00 UTC
Channel Number: 1
Medford High School
Medford, MA
Flux (events/m²/60-seconds)
8000
7000
6000
5000
4000
3000
2/19
2/20
2/21
2/22
2/23
2/24
2/25
2/26
2/27
Time UTC (hours)

Muon Flux in Northfield IL

Joe Volk, Jack Porter, Myles Luciano, Adam Tynkov, Brian Yufan Ren, Devin Hazan
New Trier High School, Northfield, IL USA
27.February.2023

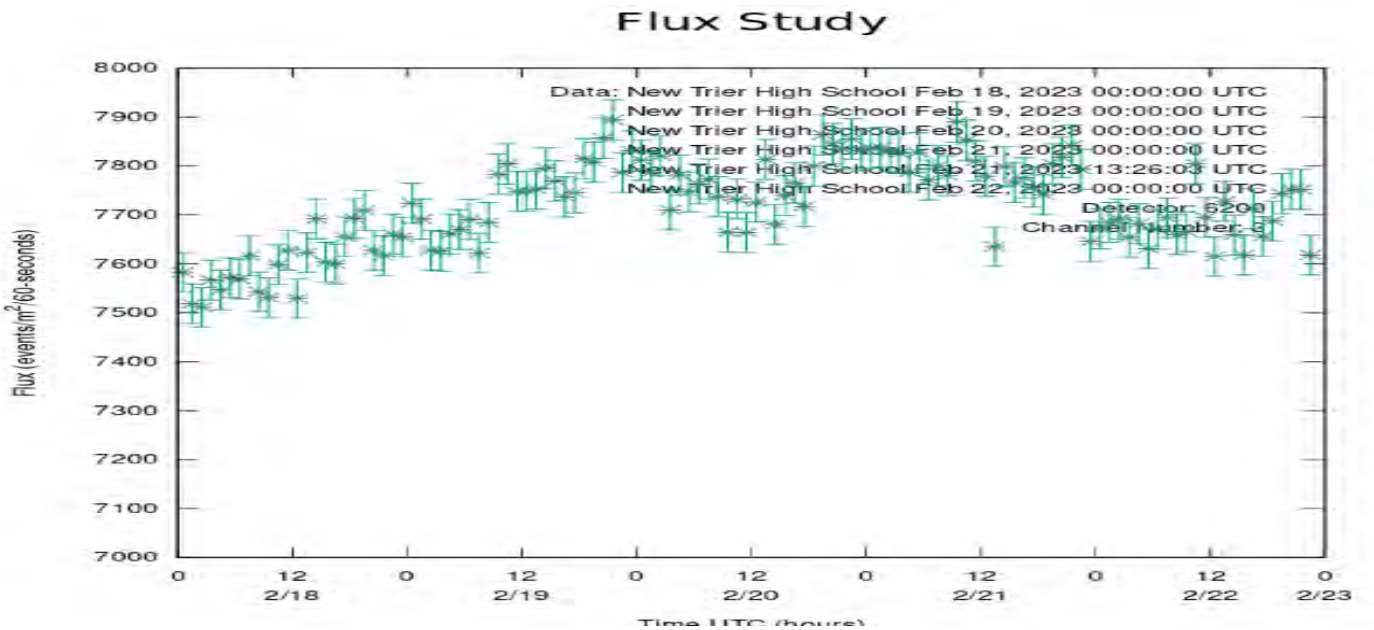
What is the muon flux in Northfield IL with a Quarknet detector?

Measurements were made using a cosmic ray detector with four separated counters in a stack. We conducted a study to record the flux of counters 3-4. Measurements were made 234 m above sea level.

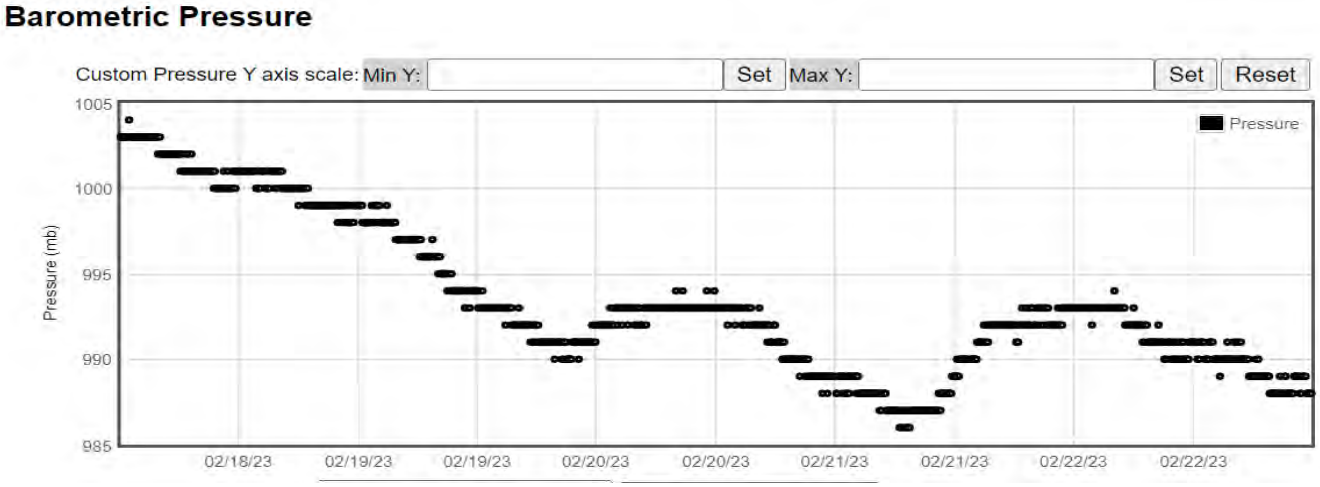
Counter 3-4 with 3 cm separation, 24-Hour Events

Date	Counts 3-4: Correction to flux graph's units
18.February.2023	824435 : 7695
19.February.2023	840046 : 7840
20.February.2023	842915 : 7867
21.February.2023	845099 : 7888
22.February.2023	833874 : 7783
AVERAGE	837273 : 7815

Flux Study and Barometric Pressure Graphs Feb.18-22, 2023

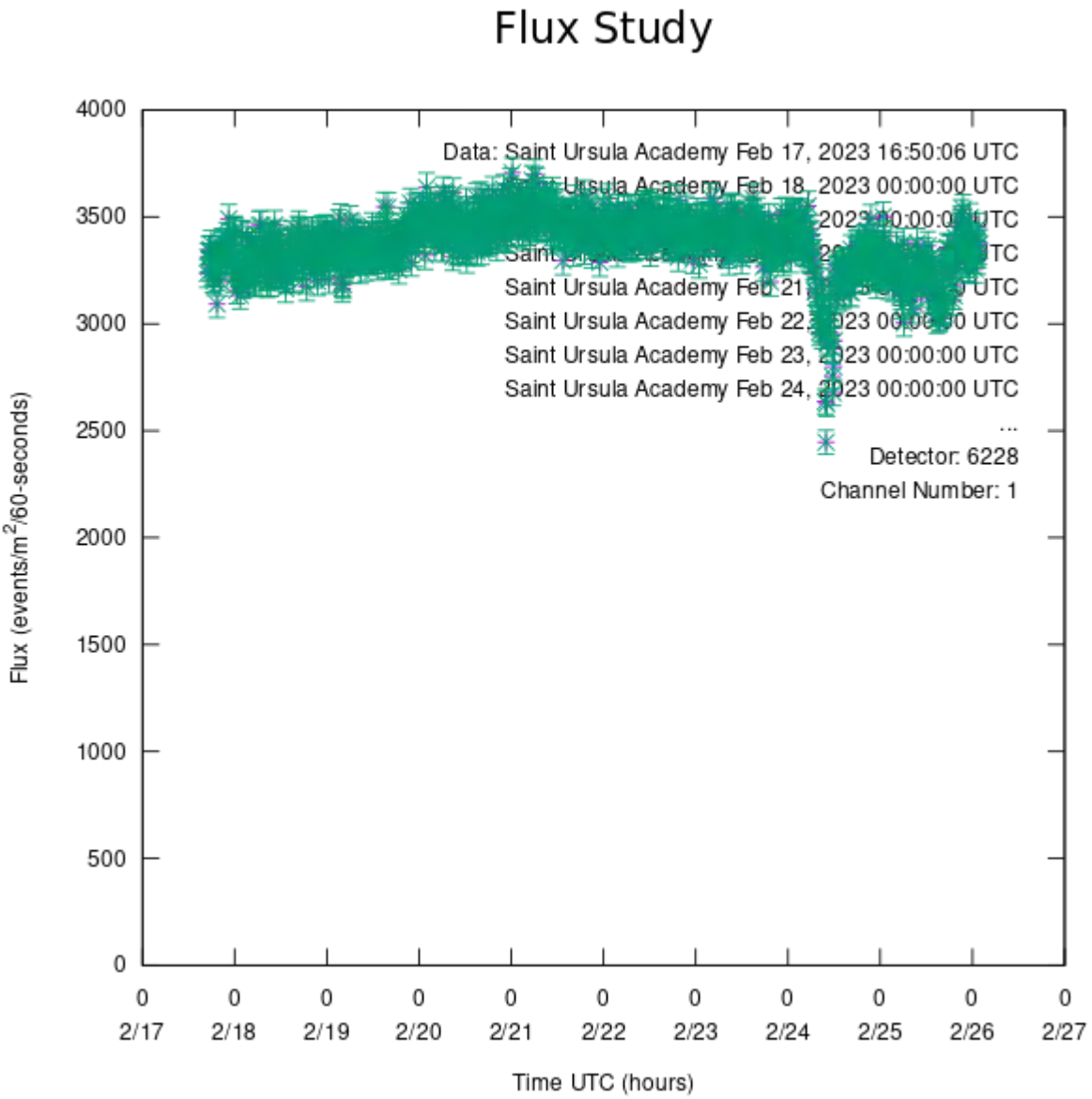


Barometric Pressure graph



Conclusion

The lower the barometric pressure is, the higher the muon flux count per square meter is per minute. The average flux over 5 days was 7815 events per m^2 per minute.


Flux Study
Data: Saint Ursula Academy Feb 17, 2023 16:50:06 UTC
Ursula Academy Feb 18, 2023 00:00:00 UTC
Saint Ursula Academy Feb 21,
Saint Ursula Academy Feb 22,
Saint Ursula Academy Feb 23,
Saint Ursula Academy Feb 24,
...
Detector: 6228
Channel Number: 1
Flux (events/m2/60-seconds)
4000
3500
3000
2500
2000
1500
1000
500
0
2/17
2/18
2/19
2/20
2/21
2/22
2/23
2/24
2/25
2/26
2/27
Time UTC (hours)

University of Notre Dame Report on International Muon Week**, 4 March 2023**

Going into Internation Muon Week 2023, Notre Dame used 3 counters at 3-fold coincidence in a vertical stack 1 m high at latitude 41:42.554494 N, longitude 86:14.231789 W, and elevation 227 m. The array was indoors directly under the roof of the Reyniers Life Building on campus.

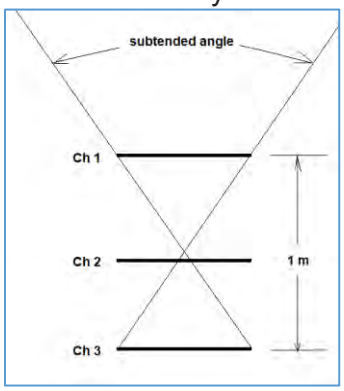


Figure 1. Diagram of array geometry.

Figure 2. Image of array.

Data taking was with ran with three counters until 21 February when, due to fluctuations in Channel 2, that channel was taken offline and went to 2-fold with Channels 1 and 3 only. The rate, which has been below 300 cts/min/m^2 went up to ~700 cts/min/m^2 after the change, as can be seen in Figure 3 below.

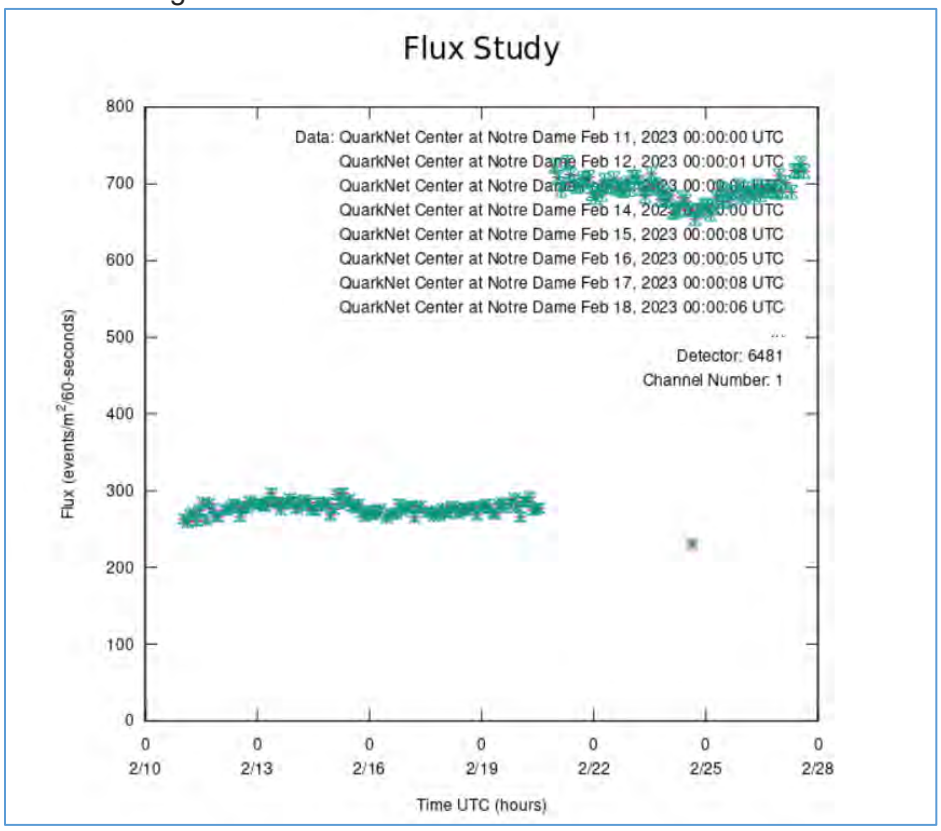


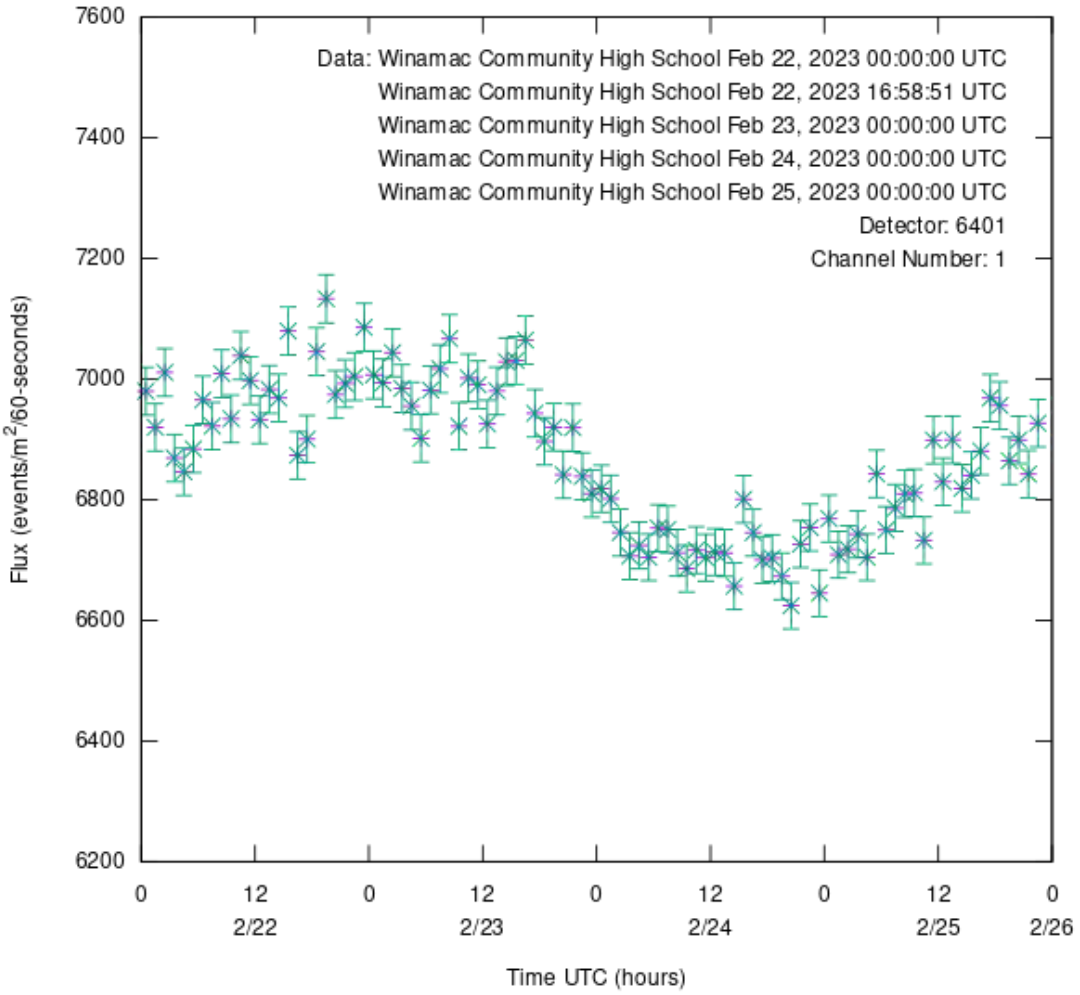
Figure 3. Flux of detector 6481, February 10-28.

Note the dip in 2-fold flux around 24-25 February, when a winter storm passed over much of the upper Midwest of the United States.

View blessing plots

View rate vs. pressure

Flux Study



Analysis run time: 00:01:09

Show analysis directory

Change your parameters

OR

To save this plot permanently, enter the new name you want.

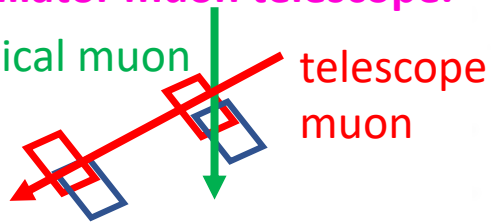
Then click **Save Plot**.

(View your saved plot names)

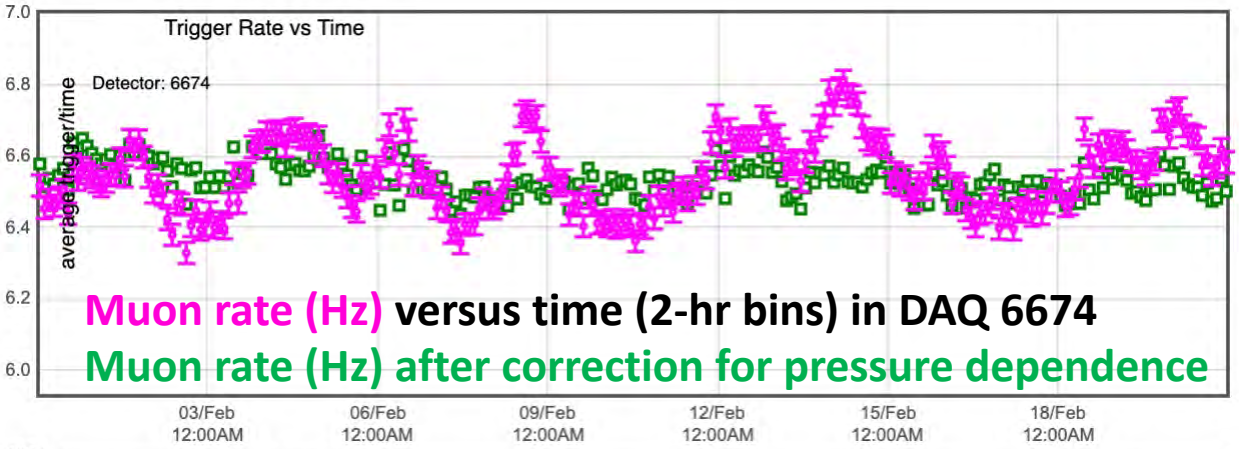
Save Plot

Muon Flux versus Pressure with Scintillator Telescope

Vertical muons traversing pairs of partially overlapped scintillators provide the majority of 2-fold monitoring triggers for a 4-scintillator muon telescope.

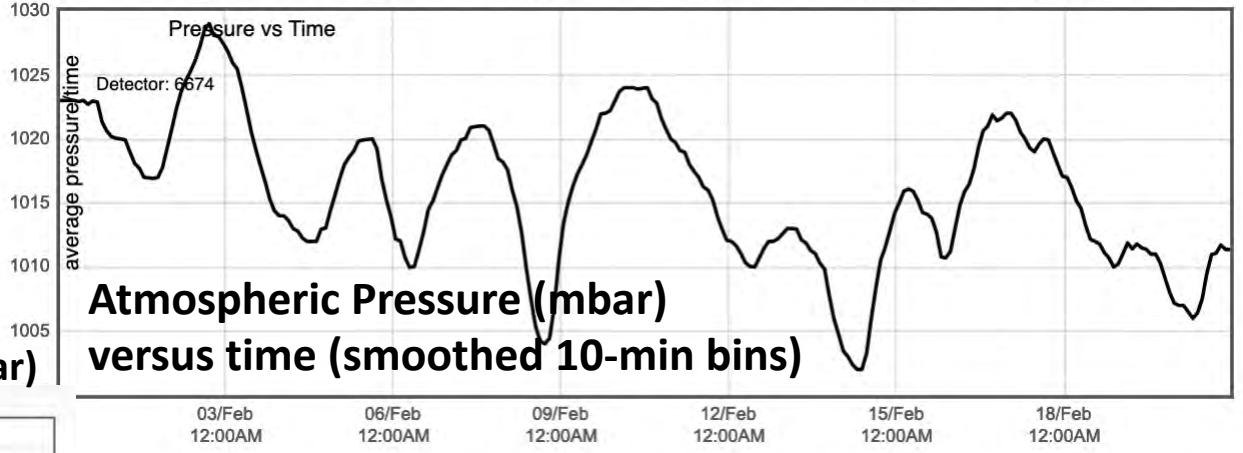


The dependency of the trigger rate on atmospheric pressure (shown below) corrects the muon rate.



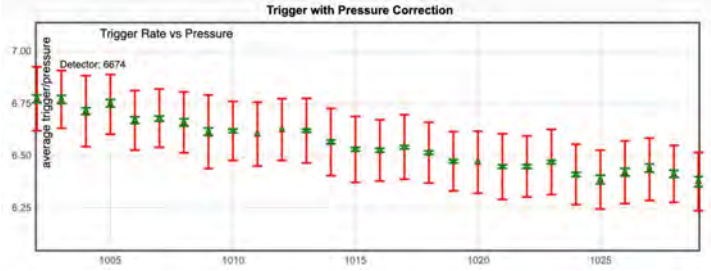
Muon rate (Hz) versus time (2-hr bins) in DAQ 6674

Muon rate (Hz) after correction for pressure dependence



Atmospheric Pressure (mbar) versus time (smoothed 10-min bins)

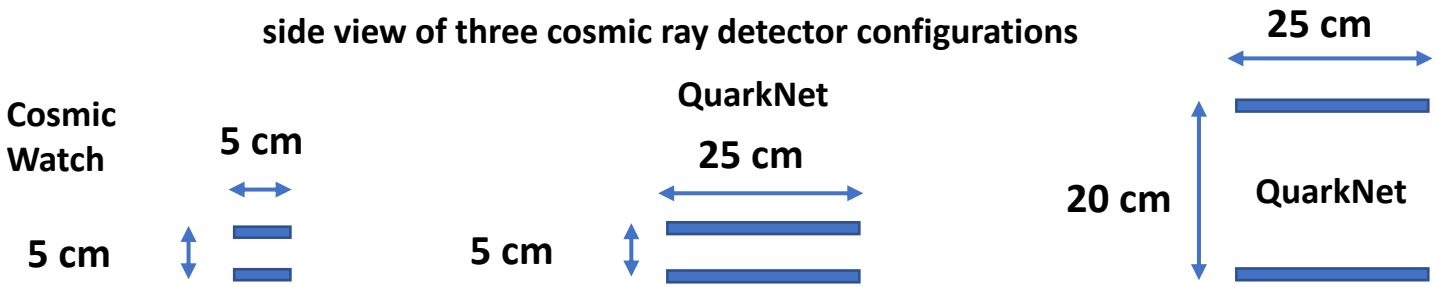
Rate (Hz) versus Atm Pressure (mbar)



-0.2% rate change per mbar of pressure

Mark Adams, Fermilab QuarkNet

Comparison of Muon Flux in Cosmic Watch and QuarkNet Detector for International Muon Week



Configuration	A	B	C
Detector set up	**Cosmic Watch (Designed by MIT)**	**QuarkNet Detector in "standard stack"**	**QuarkNet Detector in Watch-like geometry**
Muon Rate (counts/sec)	**0.15**	**8.25**	**4.6**

Statistical errors are <1%, although rates varied 3% during data taking periods due to atmospheric pressure changes.

Description and Results

- **B: muon rate for Muon Week. Represents the nominal QuarkNet geometry for IMW**
- A: muon rate for a pair of Cosmic Watches
- C: QuarkNet detector with vertical separation, so that angular acceptance matches A.
- **The ratio of C/A is found consistent with ratio of their areas.**
- Rate C/A = 30.7 and Area C/A = 750 cm^2/25 cm^2 = 30

Mark Adams
Fermilab QuarkNet