

Discover Cosmic Rays

INTERNATIONAL COSMIC DAY

Università del Salento e INFN Lecce
6 Novembre 2019
VII EDIZIONE

Viviana Scherini

Photo credit: DESY

International Cosmic Day

Progetto internazionale per gli Istituti Superiori organizzato da DESY Accelerator Laboratory (Amburgo), FERMI National Laboratory (USA) e CERN (Ginevra)

Gli studenti entrano in contatto con le attività di ricerca:

- portano a termine un piccolo esperimento sui raggi cosmici
- analizzano i dati
- confrontano i propri risultati con gli altri gruppi collegati da altre università o centri di ricerca nel mondo

per un giorno come in una collaborazione internazionale!

All over the world



In Italia



I ricercatori

Alessandro Corvaglia, Antonio De Benedittis, Antonio Surdo, Carlo Pinto, Daniele Martello, Emanuele De Vito, Federica Oliva, Federico Santoro, Gabriele Chiodini, Gabriella Cataldi, Gianluigi Chiarello, Giovanni Marsella, Isabella Oceano, Lorenzo Perrone, Margherita Di Santo, Maria Rita Coluccia, Paolo Bernardini e Viviana Scherini

In collegamento esterno:

Gabriella e Rita @ Auger (Argentina),

Elena Vannuccini @ Firenze,

Mirko Boezio e Riccardo Munini @Trieste,

Quiang Yuan @ PMO (Cina)

Ivan De Mitri @ GSSI

Gli studenti

117 studenti da 15 istituti superiori di Lecce Brindisi Taranto

IISS "Galileo - Ferraris" – Taranto, Liceo "Q. Ennio" – Gallipoli (LE), Liceo "A. Vallone" – Galatina (LE), Liceo "F. Capece" – Maglie (LE), Liceo Classico "B. Marzolla" – Brindisi, Liceo Scientifico "C. De Giorgi" – Lecce, IISS "Virgilio - Redi" – Lecce, ITT "G. Giorgi" – Brindisi, IISS "G. Salvemini" Alessano (LE), IISS "E. Majorana" – Brindisi, Liceo Scientifico "G. Stampacchia" – Tricase (LE), Liceo Statale "Don Tonino Bello" – Copertino (LE), IISS "E. Ferdinando" – Mesagne (BR), Liceo Scientifico e Linguistico "G.C. Vanini" – Casarano (LE), Liceo "De Sanctis - Galilei" – Manduria (TA)

La giornata @ UniSalento - INFN LE

Presentazioni:

- Introduzione ai raggi cosmici: Daniele Martello
- La misura con CORAM: Viviana Scherini
- Report dallo stage OCRA 2019: Salvatore Spinelli

Collegamenti:

- ore 10: welcome call con DESY
- ore 11: call con Firenze e Trieste GSSI e con Argentina e Cina
- ore 12: vidyo call con DESY e presentazione dei risultati

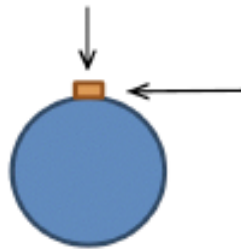
2 studenti – 3 min di presentazione + 1 min per le domande

Extra: la camera a nebbia (Carlo Federica Gabriele e Isabella)

L'esperimento

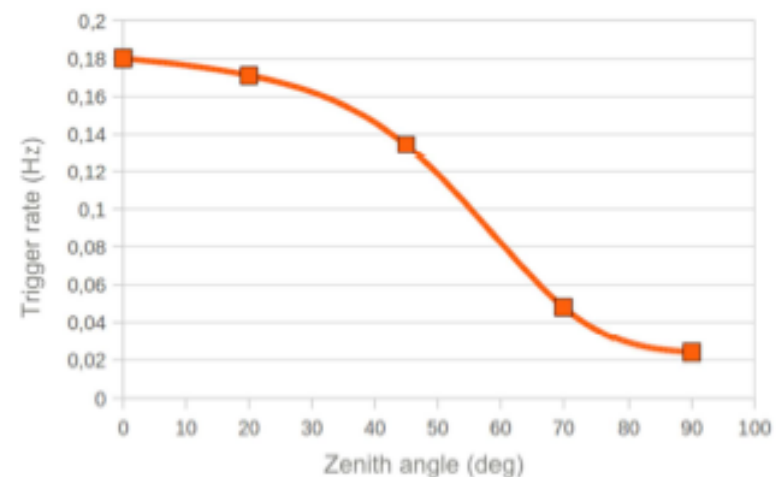
Zenith Angle Distribution of Air Shower Particles

The goal is to measure the rate of air shower particles as a function of the zenith angle.



Please follow the convention: particles arriving perpendicular to the Earth's surface have a zenith angle of 0 deg; particles arriving parallel to the surface are assigned a zenith angle of 90 deg.

Each group decides at how many different angles measurements are taken. The results should be presented in a graph and a short concluding paragraph. Additional information on the setup and data acquisition can be provided.



Booklet

Risultati pubblicati su booklet con quelli dei colleghi delle altre scuole di tutto il mondo

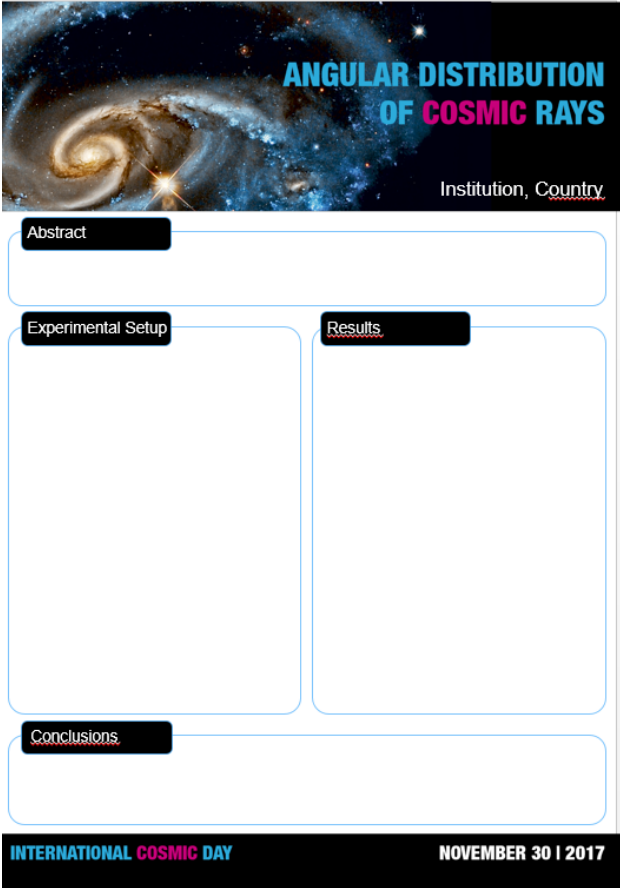
Ogni gruppo di studenti deve:

Analizzare i dati e produrre un grafico

Preparare una pagina pdf con:

- Introduzione alla misura e al rivelatore
- Risultati ottenuti e grafico
- Nome dell'istituto e dei partecipanti
- Foto

Consegna dei lavori **Dicembre 2019**



The image shows a booklet template for the 'ANGULAR DISTRIBUTION OF COSMIC RAYS' project. The top header features a cosmic background with a galaxy and the title 'ANGULAR DISTRIBUTION OF COSMIC RAYS' in blue and pink text. Below the title is a field for 'Institution, Country'. The main body of the booklet is divided into four sections: 'Abstract', 'Experimental Setup', 'Results', and 'Conclusions', each with a corresponding label in a black box. The bottom footer contains the text 'INTERNATIONAL COSMIC DAY' and 'NOVEMBER 30 | 2017'.

<https://agenda.infn.it/e/icd-infn-lecce-2019>

Booklet edizioni precedenti

ANGULAR DISTRIBUTION OF COSMIC RAYS

Institution, Country

Abstract

Experimental Setup

Results

Conclusions

INTERNATIONAL COSMIC DAY **NOVEMBER 30 | 2017**

LICEO SCIENTIFICO "GALILEO FERRARIS" - TARANTO

International Cosmic Day

Six students from Liceo "Ferraris" have participated in the III International Cosmic Day and, with the help of some professors, have performed an experiment. In this way we understood how the cosmic rays flux at sea level (mostly muons) depends on zenith angle. We have used a detector made of four planes of plastic scintillators supported by iron absorbers.

We measured the rate of cosmic rays hitting our detector as a function of zenith angle (between 0 and 90 degrees) and for different detector configurations. We made several measurements using a single layer of the detector (named as X, Y, Z, W) and then a combination of two (XY, XZ, YZ, XW, YZ, YW) and four layers (XYZW), revealing the different behavior of the counting rate. Almost every ten minutes, we have changed the zenith angle distribution.

Participating Teachers: Roberto Spada, Paolo Sebeto, Gaetano Sciarfina, Lorenzo Bellini, Salvatore Spinelli, Concetta Basconi

| X | Y | Z | W | XY | YZ | XZ | YW | XYZW | Counting Rate | Expected Rate |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------------|---------------|
| 4,565 | 4,103 | 3,883 | 4,522 | 1,241 | 1,173 | 1,291 | 0,64 | 0,451 | 0,39 | 0,1 |
| 4,488 | 3,816 | 3,689 | 4,241 | 1,276 | 1,158 | 1,258 | 0,463 | 0,39 | 0,09 | 0,11131323 |
| 4,292 | 3,715 | 3,477 | 4,18 | 9,879 | 9,885 | 9,547 | 0,483 | 0,339 | 0,59 | 0,043666667 |
| 3,982 | 3,476 | 3,538 | 4,249 | 9,729 | 9,792 | 9,734 | 0,338 | 0,232 | 0,21 | 0,15 |
| 3,977 | 3,388 | 3,269 | 4,372 | 9,626 | 9,465 | 9,481 | 0,295 | 0,428 | 0,41 | 0,040666667 |
| 3,664 | 3,203 | 2,889 | 3,812 | 9,394 | 9,367 | 9,367 | 0,416 | 0,467 | 0,659 | 0,372666667 |
| 3,567 | 3,207 | 2,939 | 3,847 | 9,372 | 9,294 | 9,388 | 0,492 | 0,499 | 0,836 | 0,378 |

In the end, we are able to say that with the increase of the zenith angle and of the number of crossed scintillator layers the counting rate decreases. This is in agreement with a larger absorption of the atmosphere at higher zenith angle and of the detector for a combination of more than one layer.

Liceo Scientifico "Ennio De Giorgi"

INTERNATIONAL COSMIC DAY

Zenith Angle Distribution of Air Shower Particles

The aim of this activity was to introduce us to cosmic rays physics. In order to have a clear evidence of this class of phenomena, we used two different muon detectors. Both devices were composed by four scintillating layers, interspersed by iron absorbers. The first one, designed mainly for didactic purposes, gave us the possibility of handling directly its components. However, we performed more accurate measurements using the second one, in order to analyze the ratio of the inclined to the vertical muon flux as a function of the zenith angle θ (Fig. 1) or of $\cos^2 \theta$ (Fig. 2). The signals released by the muons in the scintillators were processed by its software, which gave us their count rates, at different angles, taken over ten minutes long time intervals. To maximize the signal to background ratio, we considered the rate of two, three and four-fold coincidences, as shown in the graphs on the left and in the chart on the top. Graphs in Fig. 1 show a vertical shifting, if compared with a $\cos^2 \theta$ function, because of the finite detector angular acceptance. However, graphs in Fig. 2, as expected, show a linear behavior.

LICEO SCIENTIFICO "COSIMO DE GIORGI" - LECCE

INTERNATIONAL COSMIC DAY 2014

Cosmic rays are subatomic particles coming from outer space, representing 20% of planetary natural radioactivity. Victor Hess and Domenico Pacini's experiments discovered their extra-terrestrial origin. Cosmic rays outside our atmosphere are made of protons, helium nuclei, electrons, photons, neutrinos, anti-matter and more, while inside terrestrial atmosphere they shower into millions of particles. Measuring their number and arrival times, we can deduce their direction, nature and energy.

Fig. 1 - Cosmic rays schema.

During the ICDD2014 we performed cosmic ray measurements with a detector made of four tiles of plastic scintillator interspersed with iron absorbers (see Fig. 2).

The graphs analyze the amount of particles that cross the detector depending on the tilt angle, represented on the x-axis (degrees). The y-axis represents the counting rate (Hz), referred to the detector layers x, y, z and w (from top to bottom).

We performed the single count rate measurements and the two, three, four-fold coincidences measurements as a function of the zenith angle from 0 to 90 degrees.

The results are as expected, taking into account the effect of the detector acceptance (large field of view) and the noise effect on the single layer detector.

Fig. 2 - The detector setup.

The students who participated in the third edition of the Cosmic Day, from "Cosimo De Giorgi" Scientific High School in Lecce:

Federica Totaro Aprile (V A), Simone De Spoto (V A), Alessandro Sciarfina (V D), Francesco Merenda (V C), Mariarosa Bardocchia (V D) and Stefano Martano (V F).

We'd like to thank our teacher Giovanni Paolo Fakácska (in the picture), who helped us during the experiment; our teacher and contact person Antonio Sarracino; the Liceo Physics Department organizers: Lorenzo Perrone, Gianluigi Chiarillo, Maria Rita Colucci, Alessandra Corvaglia, Nara De Mili, Marco Panero, Maria Paola Panetta, Aurora Pezzolo, Carlo Piro, Viviana Scherini.

ISTITUTO DI ISTRUZIONE SECONDARIA SUPERIORE "LUIGI EIBEL"

INTERNATIONAL COSMIC DAY

Cosmic rays are high-energy radiation, mainly made of charged particles, such as protons and alpha particles, which are respectively hydrogen nuclei and helium ones. There are also beta particles, other heavier nuclei and small quantity of antineutrino particles.

We can discover the points of origin of the most energetic cosmic rays because their trajectory is not influenced by galactic magnetic fields (except the most energetic cosmic rays).

When an high energy cosmic ray (the primary cosmic ray) impacts the Earth's atmosphere, it produces a shower of many secondary particles (several thousand of them). Most of them doesn't reach the Earth's surface, mostly muons similar to electrons but heavier. For every angle we took the average of many measurements. Moreover we measured the two, three and four-fold coincidences. The results are in good agreement with the expectation.

| Angolo | X | Y | Z | W | XY | YZ | XZ | YW | XYZW |
|--------|-------|--------|-------|-------|---------|-------|-------|--------|-------|
| 0° | 4,565 | 4,103 | 3,883 | 4,522 | 1,241 | 1,173 | 1,291 | 0,64 | 0,451 |
| 15° | 4,707 | 4,0818 | 3,711 | 4,518 | 4,26446 | 5,12 | 4,077 | 4,0985 | 0,33 |
| 30° | 4,202 | 3,715 | 3,477 | 4,18 | 3,978 | 3,978 | 4,04 | 4,04 | 0,29 |
| 45° | 3,982 | 3,476 | 3,538 | 4,249 | 3,88375 | 6,728 | 6,714 | 6,7216 | 0,21 |
| 60° | 3,977 | 3,388 | 3,269 | 4,372 | 3,92275 | 6,526 | 6,481 | 6,4895 | 0,15 |
| 75° | 3,664 | 3,203 | 2,889 | 3,812 | 3,292 | 6,334 | 6,367 | 6,3895 | 0,09 |
| 90° | 3,567 | 3,207 | 2,939 | 3,847 | 3,44 | 6,372 | 6,318 | 6,345 | 0,036 |

It was useful to compare collected data, by Videocast, with students, involved in similar experiments, from other Universities around the world. Among this: Fermilab, Bologna University of Birmingham, University of Roma "Sapienza".

This experience has shown us that research, overcoming cultural and linguistic limits, space and time, is founded on discussion and collaboration in order to achieve a common goal.

Students: Ala Benedetti, Attarullo, Laura De Gali, Gerbaldi Elisabetta, Impalà Amanda, Neri Erika, Passaro Giorgia
Professor: Pierluigi Totano

Università del Salento, Dipartimento di Matematica e Fisica "Ennio De Giorgi"

INTERNATIONAL COSMIC DAY 2014

THIRD EDITION

Liceo Classico "Virgilio" Lecce

The third edition of the International Cosmic Day took place on October 8th 2014. The Salento University, involved in this project, allowed us, students of high schools, to take part to this event, the aim of which was to enable students to get in contact with cosmic rays. The basic questions addressed are:

- What are cosmic particles?
- Where do they come from?
- How can they be measured?

After a short historical and theoretical introduction, the university staff explained us the techniques for particles detection. After that we set-up our own experiment using a suitable detector.

| Angolo | X | Y | Z | W | XY | YZ | XZ | YW | XYZW |
|--------|-------|--------|-------|-------|---------|-------|-------|--------|-------|
| 0 | 4,565 | 4,103 | 3,883 | 4,522 | 6,22225 | 1,24 | 1,04 | 0,2015 | 0,20 |
| 15 | 4,707 | 4,0818 | 3,711 | 4,518 | 4,26446 | 5,12 | 4,077 | 4,0985 | 0,33 |
| 30 | 4,202 | 3,715 | 3,477 | 4,18 | 3,978 | 3,978 | 4,04 | 4,04 | 0,29 |
| 45 | 3,982 | 3,476 | 3,538 | 4,249 | 3,88375 | 6,728 | 6,714 | 6,7216 | 0,21 |
| 60 | 3,977 | 3,388 | 3,269 | 4,372 | 3,92275 | 6,526 | 6,481 | 6,4895 | 0,15 |
| 75 | 3,664 | 3,203 | 2,889 | 3,812 | 3,292 | 6,334 | 6,367 | 6,3895 | 0,09 |
| 90 | 3,567 | 3,207 | 2,939 | 3,847 | 3,44 | 6,372 | 6,318 | 6,345 | 0,036 |

This experience has shown us that research, overcoming cultural and linguistic limits, space and time, is founded on discussion and collaboration in order to achieve a common goal.

Outreach Cosmic Ray Activities

Programma stage OCRA 2019

19-22 Aprile 2020 presso i Laboratori Nazionali di Frascati

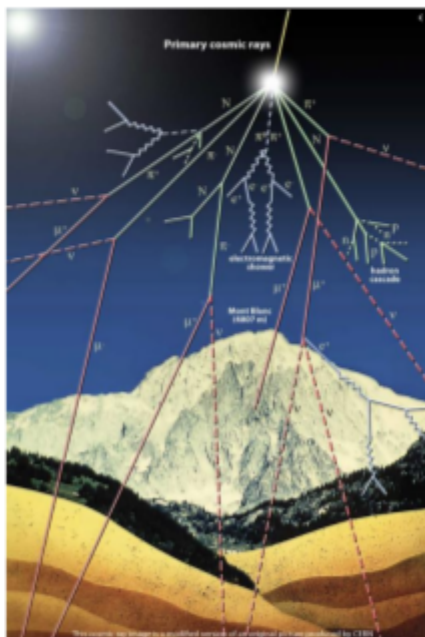
- **Domenica 19:** arrivo nel pomeriggio presso l'hotel a Frascati
- **Lunedì 20:**
 - Mattina: Presentazione dello stage e seminario sui raggi cosmici e sulla loro rivelazione
 - Pomeriggio: Misura del flusso dei raggi cosmici a terra e preparazione strumentazione per il lancio
- **Martedì**
 - Lancio di un pallone stratosferico equipaggiato per la misura dei raggi cosmici in quota
 - Visita ai Laboratori Nazionali di Frascati in attesa del recupero della sonda
 - Analisi dei dati raccolti dalla sonda
- **Mercoledì** : Evento conclusivo dello stage e partenza nel primo pomeriggio

<https://web.infn.it/OCRA/>



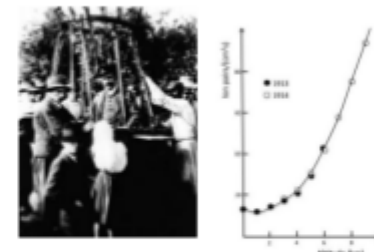
La misura dello Stage OCRA 2020

I raggi cosmici primari sono principalmente costituiti da protoni (adroni), che incidendo sull'atmosfera terrestre danno origine a cascate di particelle. Tra il 1913-1914, Victor Hesse (Nobel 1937), con delle ascensioni in pallone fino alla quota di 5300 metri, scoprì che la radiazione ionizzante aumentava con l'altitudine. Nel 1935, tramite l'uso dei palloni aerostatici, Regener e il suo studente Pfitzer scoprirono che tale radiazione aumentava fino alla quota di 17000-20000 metri per poi diminuire, scoprendo quello che viene chiamato massimo di Regener-Pfotzer. Nel 2018 e nel 2019, l'INFN, grazie alla collaborazione con le scuole di Nicotera e Cariati, ha portato due rivelatori di particelle del tipo ArduSiPM, con delle ascensioni su pallone, fino a quota di 27000 metri (EOS Project) e 34111 metri (MoCRiS project).

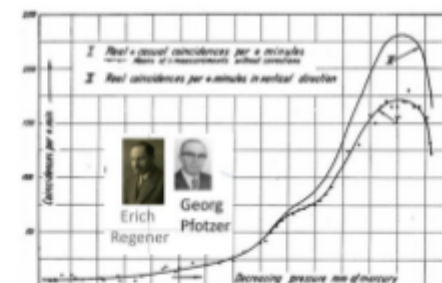


Stage OCRA 2020
INFN Roma - LNF INFN-OCRA

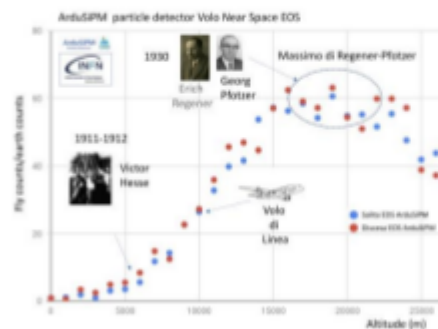
Misure del 1913-1914



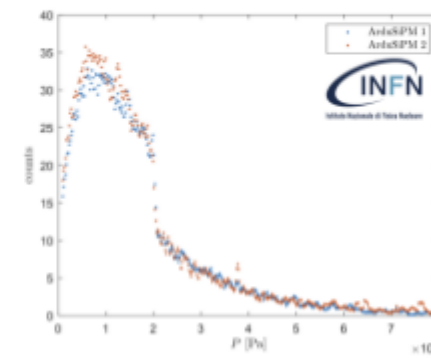
Misura del 1935



Durante lo stage OCRA del 2020, presso i Laboratori Nazionali di Frascati, sarà effettuato un nuovo lancio con pallone aerostatico, relativo recupero dei rivelatori e analisi dei dati raccolti.



Misura del 2018 EOS Project



Misura del 2019 MoCRiS Project

Social and Cosmic Games

Kahoot: International Cosmic Day Quiz has the pin number: 0837639

We have created an online quiz that everybody can join

Download the Kahoot app on your mobile phone. You don't need to create an account; Using the "maybe later" button will lead you likewise to the game with no restrictions later on.

You will be asked to enter a user name and the pin number, the pin number will directly connect you to the quiz

There are two options to play:

- you can play against all the International Cosmic Day participants,

- you can share the quiz via WhatsApp or email with other students, colleagues, friends, and parents to start a 1:1 competition.

During the ICD we will have a contest: "**Best Cosmic Selfie**: take a selfie of your group with your detector or your nicest Cosmic Ray plot. Post it on Facebook and use the hashtag **#CosmicDay**. The best one will get a prize!".

Checkout at <https://icd.desy.de> and Facebook at <https://www.facebook.com/InternationalCosmicDay/>

Feedback

Da compilare durante la giornata

Questionario per studenti:

<https://forms.gle/Ctuf3xQ5rYckwQFy8>

Questionario per docenti:

<https://forms.gle/jgfsh9cCJGYXtCR97>

Links

<https://icd.desy.de>

<https://www.facebook.com/InternationalCosmicDay/>

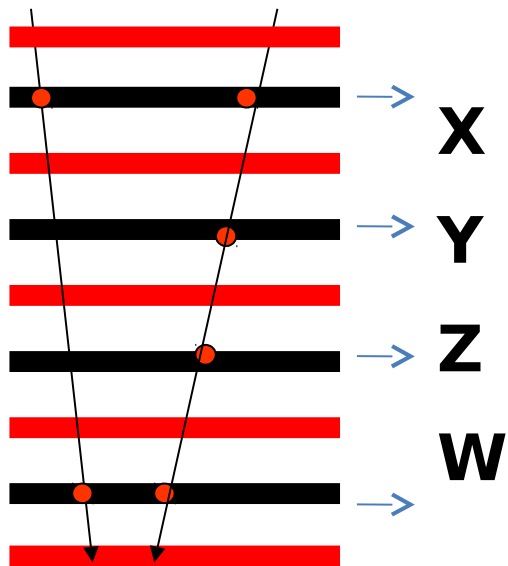
<https://web.infn.it/OCRA/>

<https://agenda.infn.it/e/icd-infn-lecce-2019>

Have Fun!

La misura con CORAM

Un dispositivo per la misura del flusso dei raggi cosmici anche in funzione dell'angolo



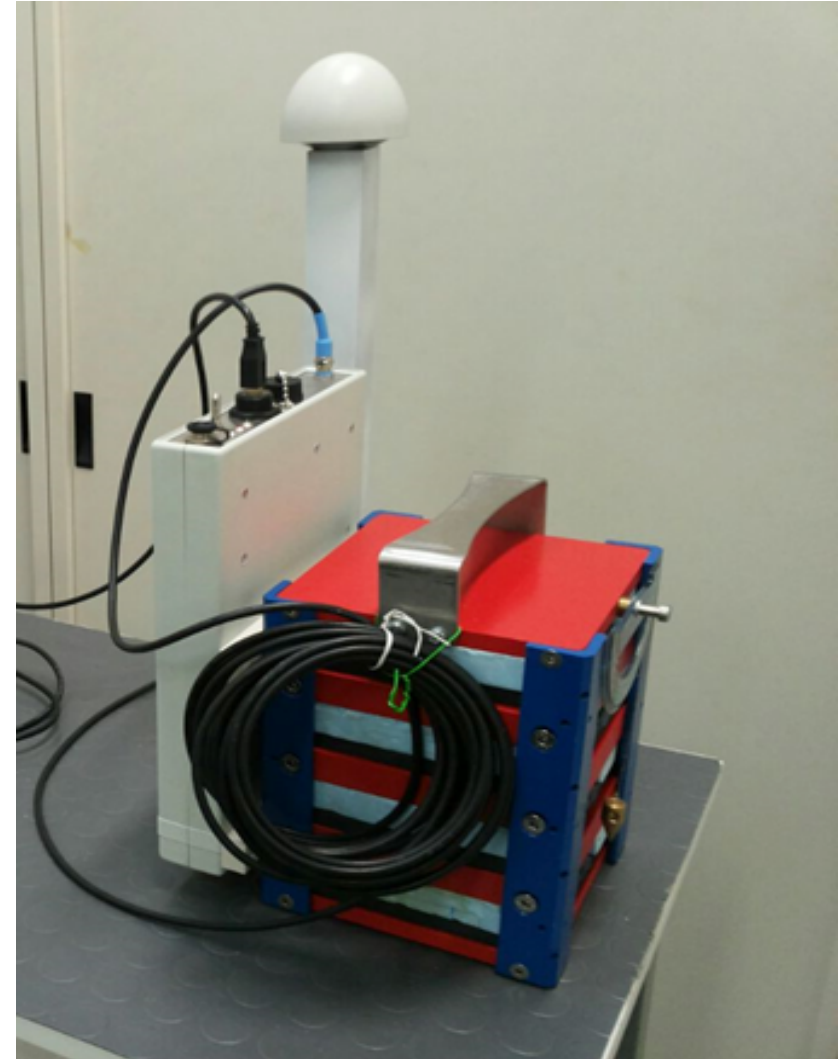
misuriamo il rate di
singola, doppia, tripla
e quadrupla

single \rightarrow X, Y, Z, W

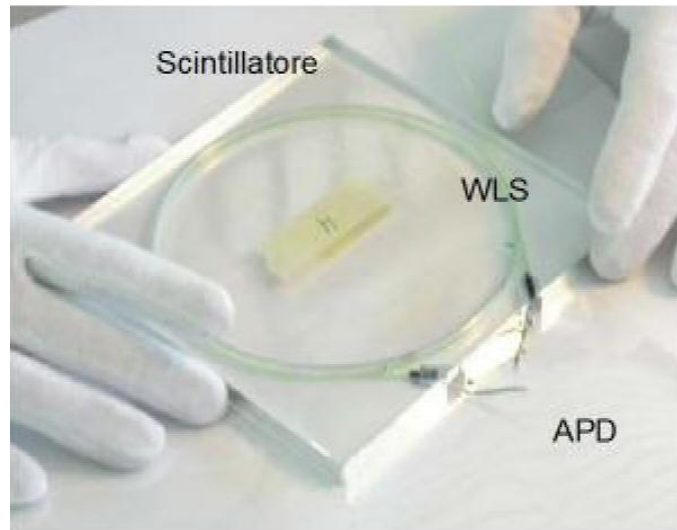
doppie (adiacenti)
 \rightarrow XY YZ ZW

triple (adiacenti) \rightarrow
XYZ, YZW

quadrupla \rightarrow XYZW



L'apparato sperimentale



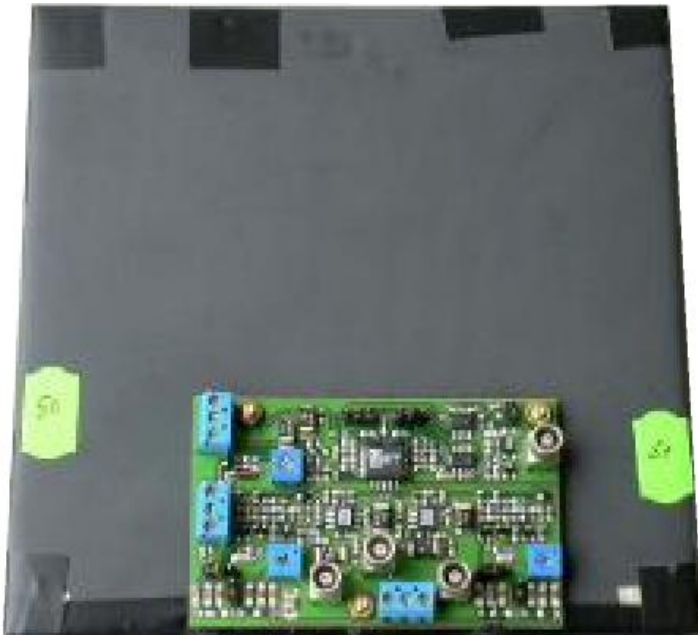
Quattro piani di rivelatore a scintillazione (BC-412) di circa $14,5 \times 14,5 \times 1 \text{ cm}^3$, letti con fibre WLS e APD (A.Akimedov et al., ITEP Mosca), intervallati da assorbitori in ferro.

I segnali dei vari detector vengono messi in coincidenza in finestre temporali di 80ns.

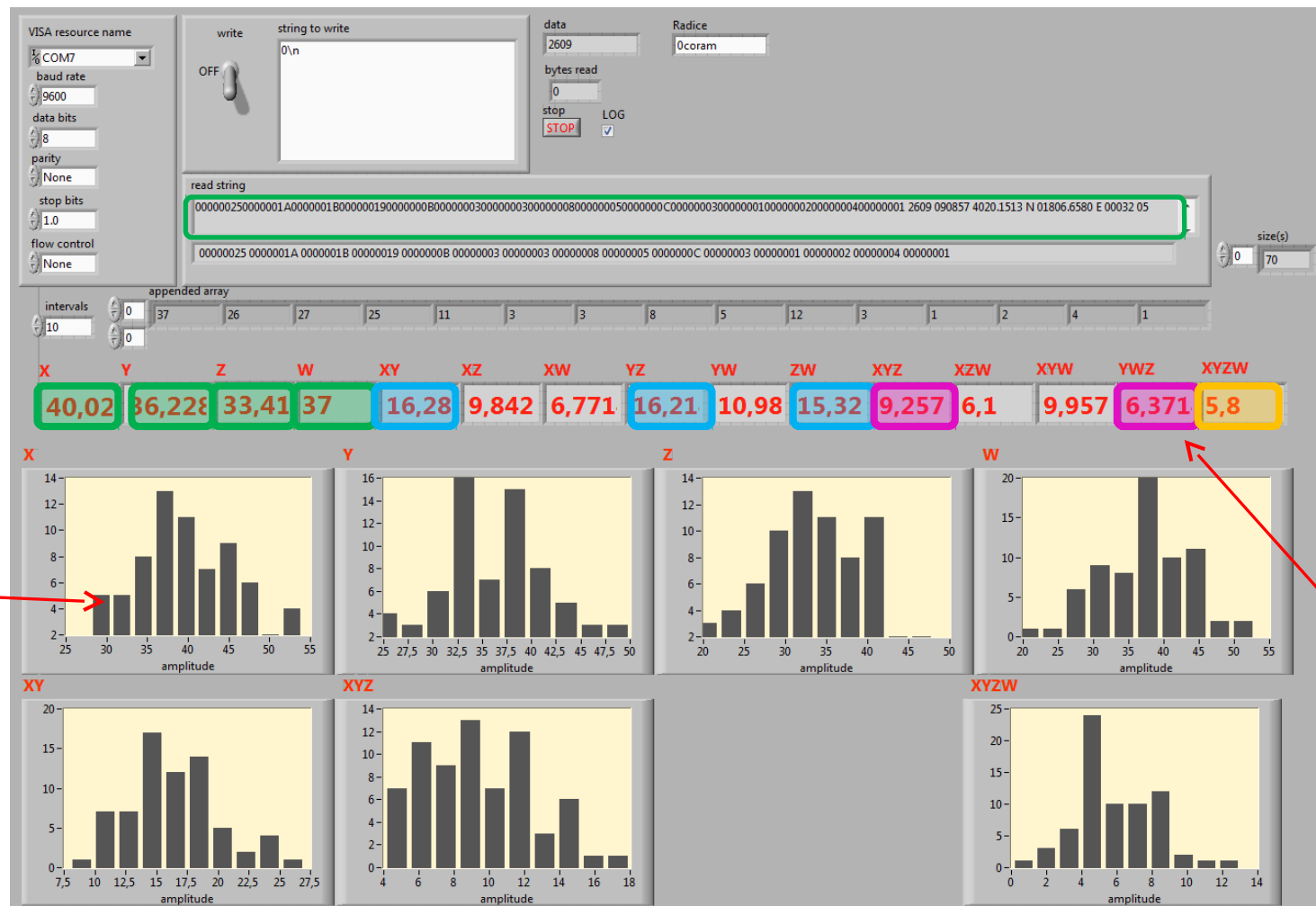
Ad intervalli regolari di tempo ΔT (di larghezza programmabile) viene registrato il numero di singole e di coincidenze doppie, triple e quadruple.

Il rate di coincidenze accidentali è estremamente bassa dato il valore della rate di fondo del singolo detector ($\approx 1 \text{ Hz}$)

Il sistema di acquisizione realizzato è stato ingegnerizzato per creare un oggetto compatto, ridondante e che può essere usato agevolmente sul campo per molteplici misure.



L'interfaccia grafica



Istogrammi delle coincidenze

Media delle coincidenze dei piani

SINGOLE

DOPPIE

TRIPLE

QUADRUPLA

Misura e analisi

- **Misuriamo i conteggi ad angoli variabili: 0° , 15° , 30° , 45° , 60° , 75° , 90°**
- **2/3 studenti per angolo per istituto vengono a effettuare le misure (controllo DAQ screenshot dei risultati e posizionamento rivelatore)**
- **uno studente salva i dati raccolti in un foglio Excel per effettuare l'analisi e ricavare il grafico**
- **dopo le misure VISITATE LA CAMERA A NEBBIA!**

Grazie e buon lavoro!