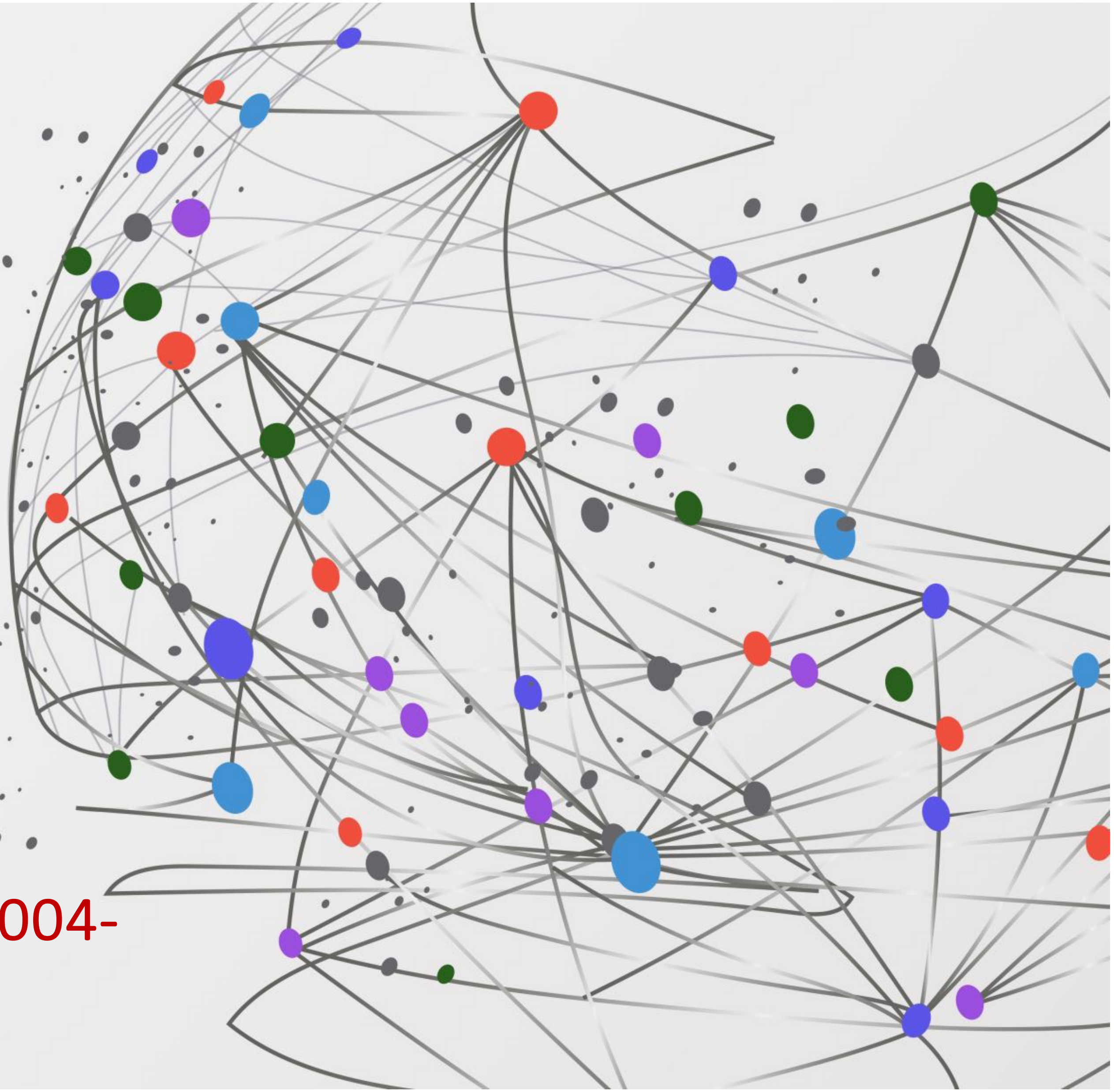
EEE Meeting, 25-27 Nov, 2024



20 years of the EEE activity (2004-2024)

F.Riggi

Physics experiments

What is a physics experiment?

Physics, and natural science in general, is a reasonable enterprise based on valid experimental evidence, criticism, and rational discussion.

It provides us with knowledge of the physical world, and it is experiment that provides the evidence that grounds this knowledge.

Experiment plays many roles in science. One of its important roles is to test theories and to provide the basis for scientific knowledge.

(A.Franklin and S.Perovic, Stanford Encyclopedia of Philosophy, 2023)

The principle of science, the definition, almost, is the following: *The test of all knowledge is experiment*. Experiment is the *sole judge* of scientific ‘truth’.

(Feynman, Leighton and Sands, Lectures in Physics, 1963)

A possible cross-disciplinary homework for our students?

Experiments lifetime

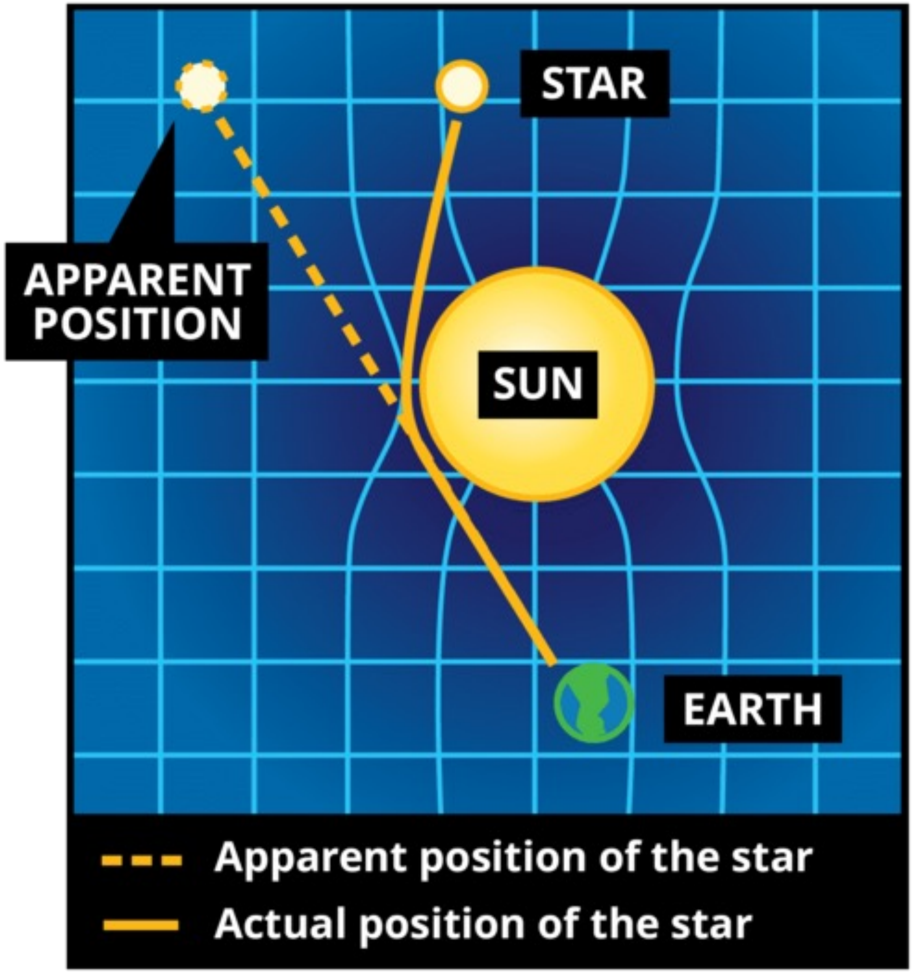
How long physics experiments last?

Sometimes even a single, fast measurement may give the right answer to the question being discussed..

An example:

Eddington experiment to verify predictions from Einstein general relativity..

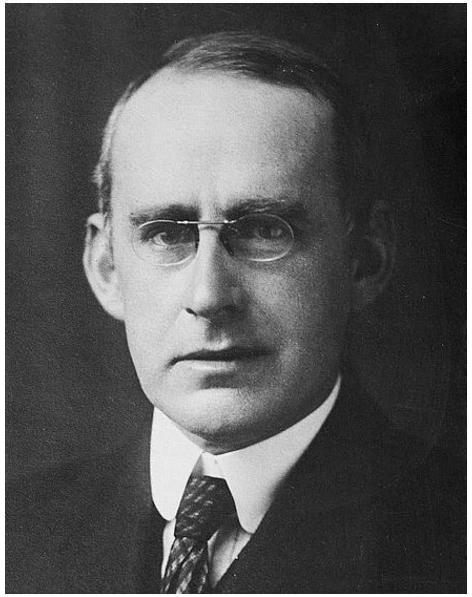
Gravitational deflection of light passing close to massive objects

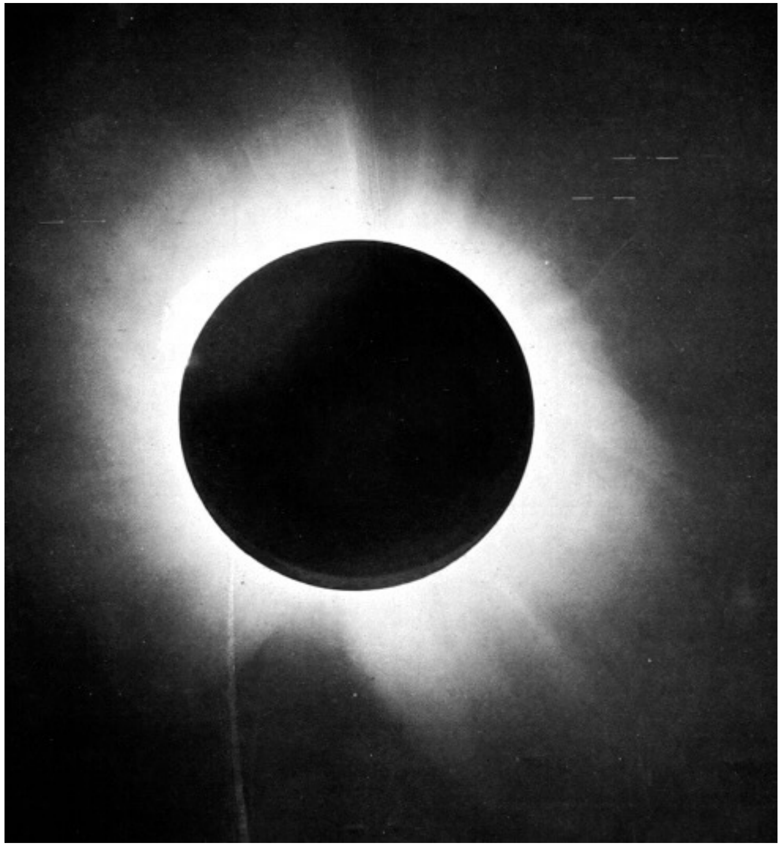


Eddington experiment

Organized by Arthur Eddington and Frank Dyson during the solar eclipse of May 29, 1919 on the West African island of Principe, to take pictures of the stars close to Sun direction and check possible shifts from their standard positions.

16 photos taken during 5 minutes…

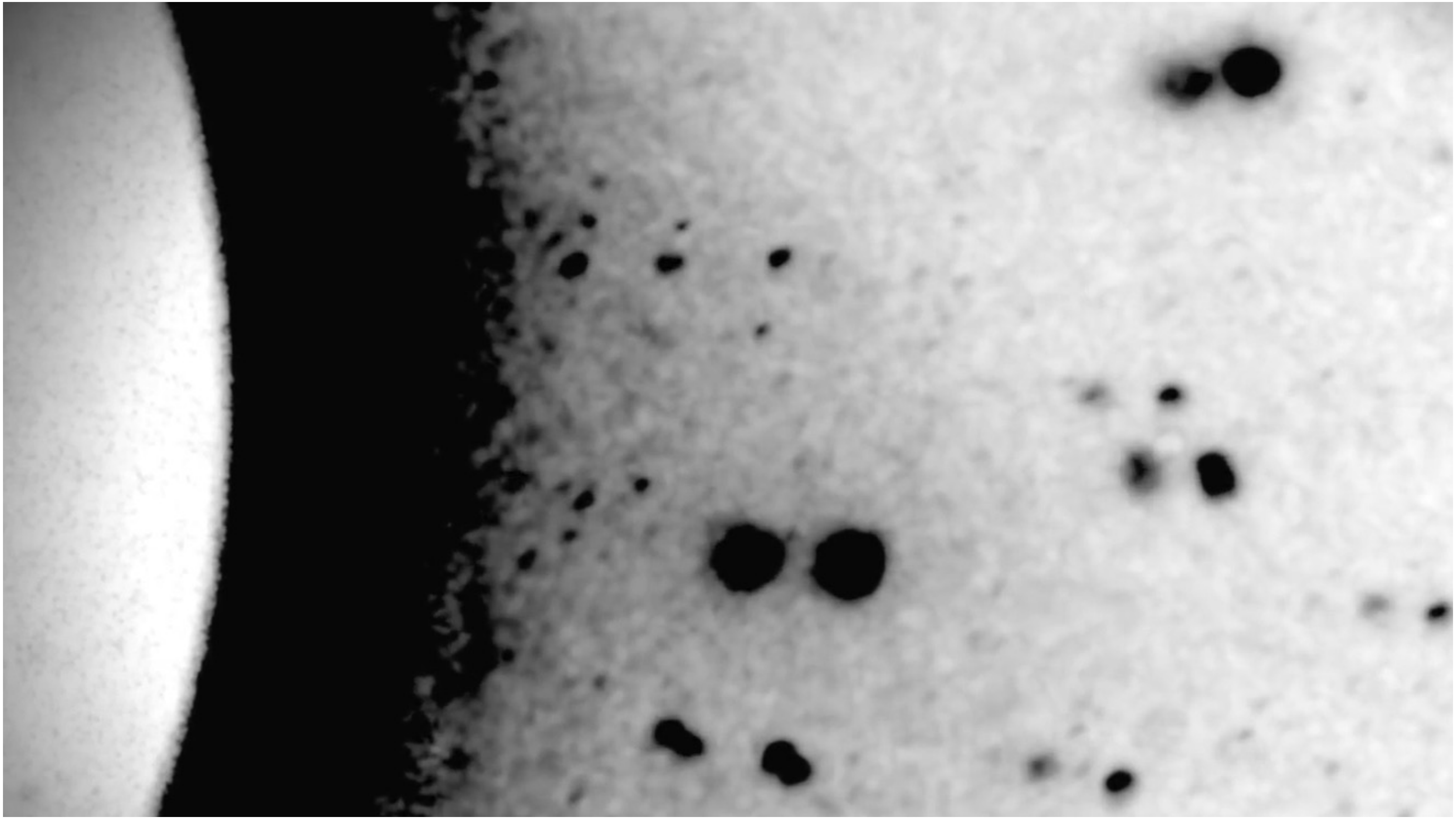




Solar eclipse on May 29, 1919

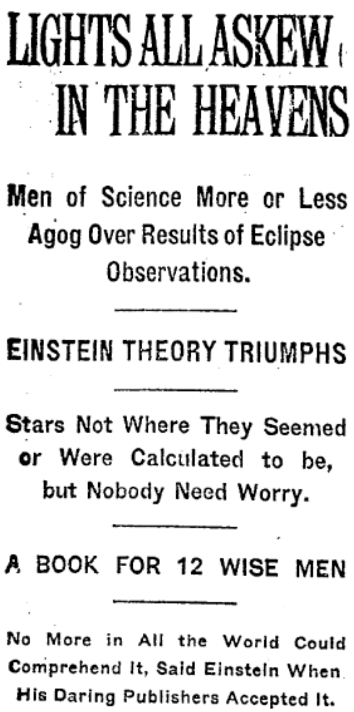
A few pictures from the movie *Einstein and Eddington*,

by Philip Martin (2008)



Eddington experiment

Results presented at the meeting of the Royal Society in November 2019 and published in 1920



LIGHTS ALL ASKEW IN THE HEAVENS

Men of Science More or Less Agog Over Results of Eclipse Observations.

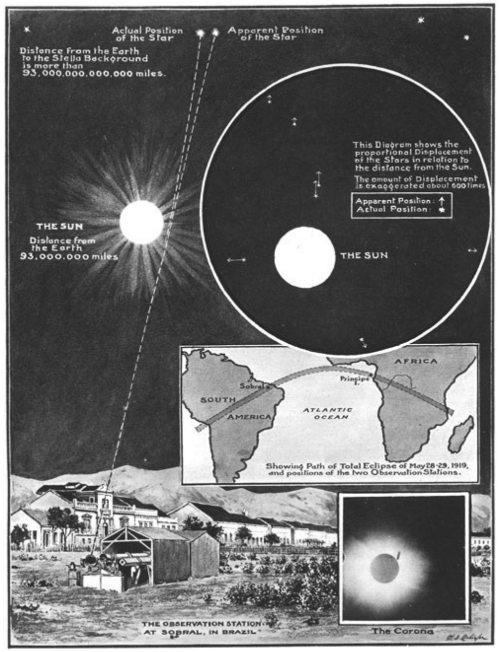
EINSTEIN THEORY TRIUMPHS

Stars Not Where They Seemed or Were Calculated to be, but Nobody Need Worry.

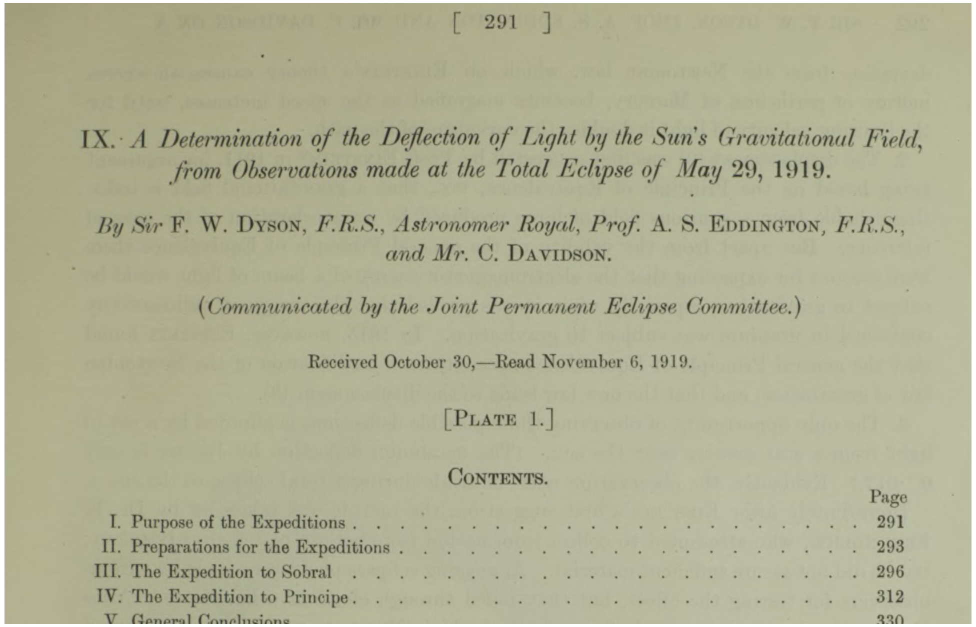
A BOOK FOR 12 WISE MEN

No More in All the World Could Comprehend It, Said Einstein When His Daring Publishers Accepted It.

New York Times, November 10, 1919



London News, November 22, 1919



[291]

IX. *A Determination of the Deflection of Light by the Sun's Gravitational Field, from Observations made at the Total Eclipse of May* 29, 1919.

By Sir F. W. Dyson, *F.R.S., Astronomer Royal, Prof.* A. S. Eddington, *F.R.S., and Mr.* C. Davidson.

(*Communicated by the Joint Permanent Eclipse Committee.*)

Received October 30,—Read November 6, 1919.

[Plate 1.]

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V.	General Conclusions	330

Philosophical Transaction of the Royal Society A, Vol.220(1920)291.

Experiments lifetime

How long physics experiments last?

Most experiments are designed to be done quickly. Get data, analyze data, publish data, move on. But the universe doesn't work on nice brief timescales. For some things you need time. Lots of time.

Several long experiments are related to agriculture, biology,… since they require many generations to observe the effects.

Nuclear and astroparticle physics experiments are now usually carried out on a time scale of 10-30 years, whereas first experiments in nuclear and cosmic ray physics – about a century ago – required a time scale from a few days to a few years.

Experiments lifetime

A few examples in cosmic ray physics..

Wulf measurement of the air ionization on the Eiffel Tower by means of electroscopes (1910)

Provides evidence that some additional radiation comes from above

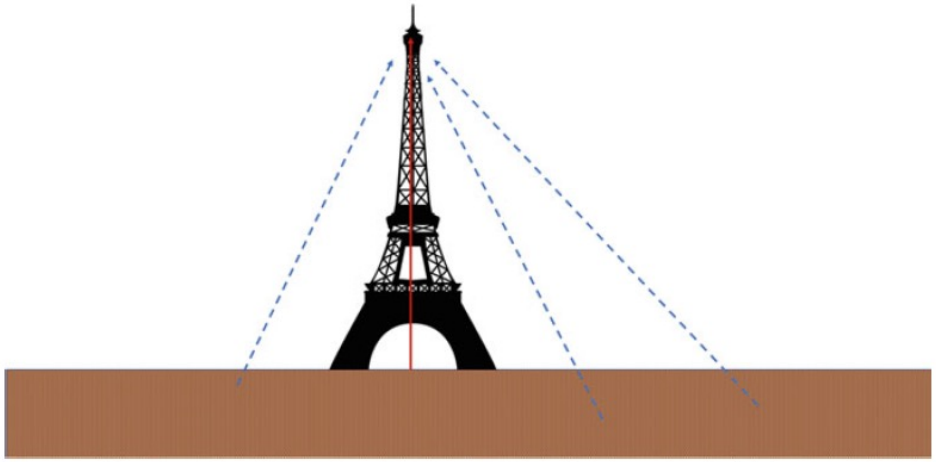


Table 1.2 Values of the air ionization rate, obtained by Wulf during the measurements conducted on the Eiffel Tower [Wulf1910]

Date	Location	Ionization rate (ions cm^{-3} s^{-1})
29.03.1910	Ground	17.5
30.03.1910	300 m	16.2
31.03.1910	300 m	14.4
01.04.1910	300 m	15.0
02.04.1910	300 m	17.2
03.04.1910	Ground	18.3
Average	Ground	17.9
Average	300 m	15.7

Experiments lifetime

A few examples in cosmic ray physics..

Hess balloon flights (1912) demonstrated the extra-terrestrial origin of the cosmic radiation

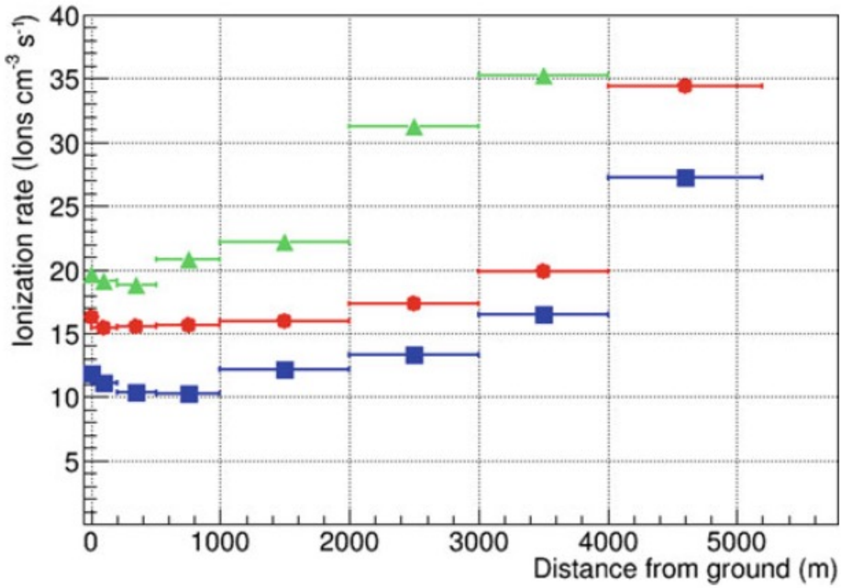


Table 1.3 Summary of balloon flights performed by Hess in 1912 [Hess1912]

Date	Max height (m)	Notes
17.04.1912	2750	Measurements made also during a partial solar eclipse, no effect observed. Slight rise around 2000 m
26–27.04.1912	2100	Measurements carried out also during the night; no appreciable difference observed compared to the day. Values reported up to an altitude of 1800 m
20–21.05.1912	1200	Night flight, values reported up to an altitude of 500 m
03–04.06.1912	1900	Short duration night flight due to weather conditions. Values reported up to an altitude of 1100 m
19.06.1912	950	Solo flight, only one instrument used
28–29.06.1912	360	Low altitude flight at night, with long duration measurements at the same altitude. Slight decrease observed relative to the ground
07.08.1912	5350	High-altitude flight, with hydrogen balloon. Detailed results reported in the text and in Table 1.4

Experiments lifetime

A few examples in cosmic ray physics..

Compton and Millikan survey of the latitude dependence of the cosmic ray flux (1930-1933

Many different expeditions over the world

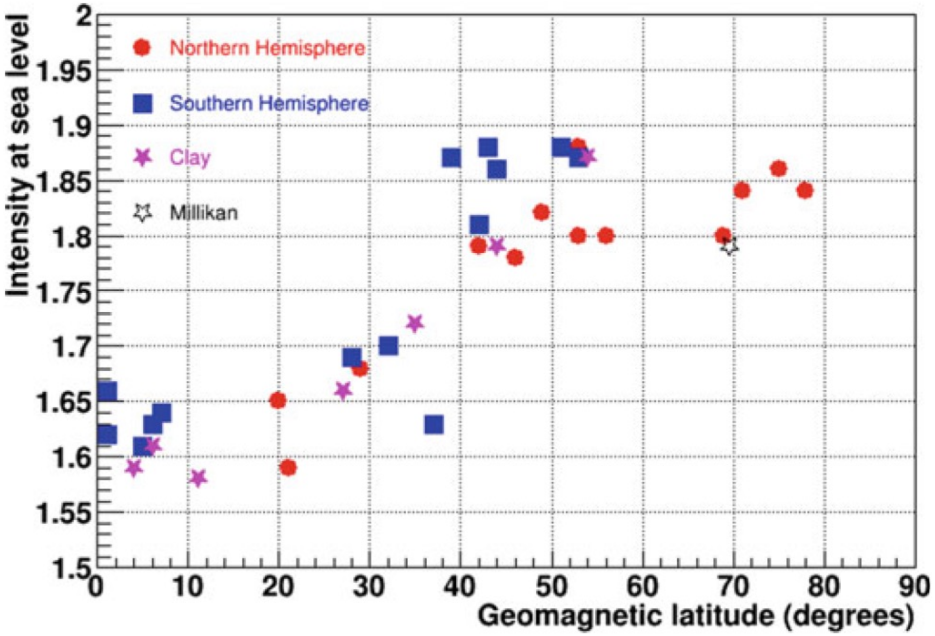


Fig. 3.8 Approximate location (blue dots) of the main stations for measuring the intensity of cosmic radiation, used during the measurement campaign organized by Compton [Compton1933]

Experiments lifetime

Modern experiments at CERN

Pre-LHC experiments (for instance experiments at the SPS accelerator) lasted about 10 years (preparation, construction, data taking, analysis, results)

LHC experiments were conceived more than 30 years ago:

- ALICE Letter of intent: 1993
- Construction: About 10 years
- First data with ALICE in November 2009
- Future planning of ALICE till 2030 and beyond

LHC experiments however employ multi-purpose detectors, to investigate different processes and phenomena. How much time is required for each of them?

- A few seconds for «easy» measurements (for instance particle multiplicity)
- A few months to collect enough events from rare processes

The pitch drop experiment: probably the longest physics experiment

What is it?

The Pitch Drop Experiment has been running since 1927 at the University of Queensland, Australia, initiated by Prof. Thomas Parnell.

It consists of black pitch contained in a glass funnel, with the entire apparatus enclosed in a container.

It demonstrates that pitch is actually an extremely viscous liquid an allows to evaluate its viscosity coefficient.

Thomas Parnell (1880-1948)

The experimental setup

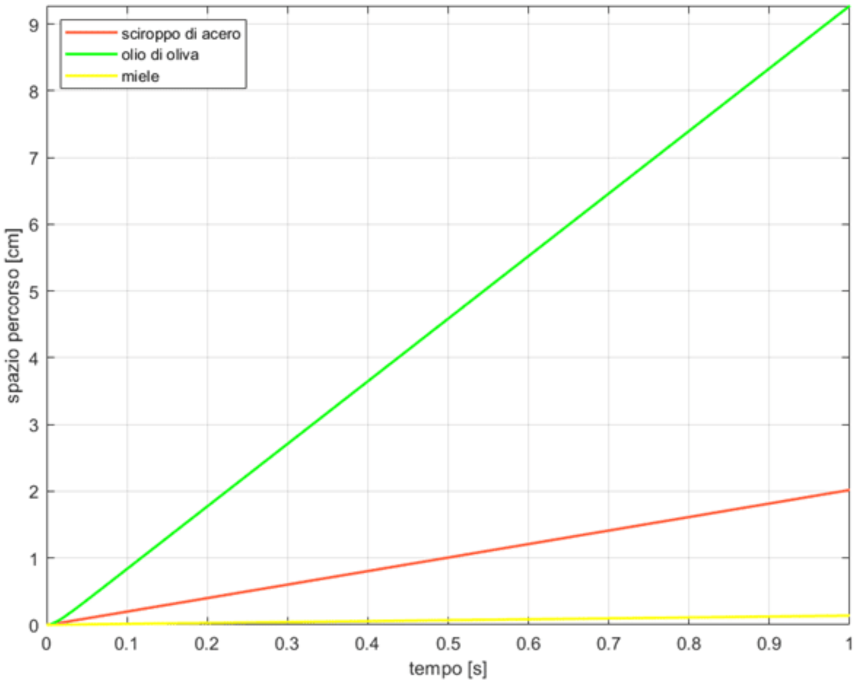
Viscosity measurements: an introductory lab experiment

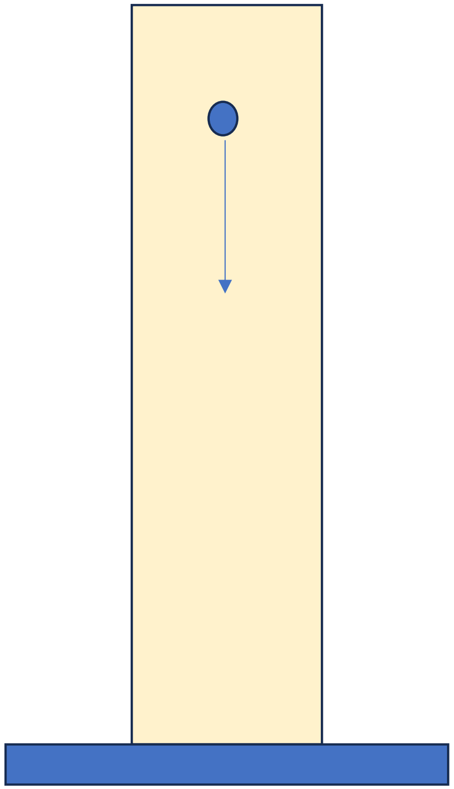
Free fall viscosimeter

A small metal sphere (radius **r**, density **ρ**) reaches a limit velocity **v** in the fluid (density $\boldsymbol{\rho_0}$)

Under realistic assumptions the viscosity coefficient η is

$$\eta = 2\, r^2\, g\, (\rho - \rho_0) / 9\, v$$





Viscosity measurements

Material	Viscosity coefficient (mPa s)
Water	1
Olive oil	84
Engine oil	200
Glycerine	1490
Pitch	?

The pitch drop experiment: probably the longest physics experiment

How does it work?

In 1927 Parnell heated a sample of pitch and poured it into a glass funnel with a sealed stem. He allowed the pitch to cool and settle for three years, and then in 1930 he cut the funnel's stem.

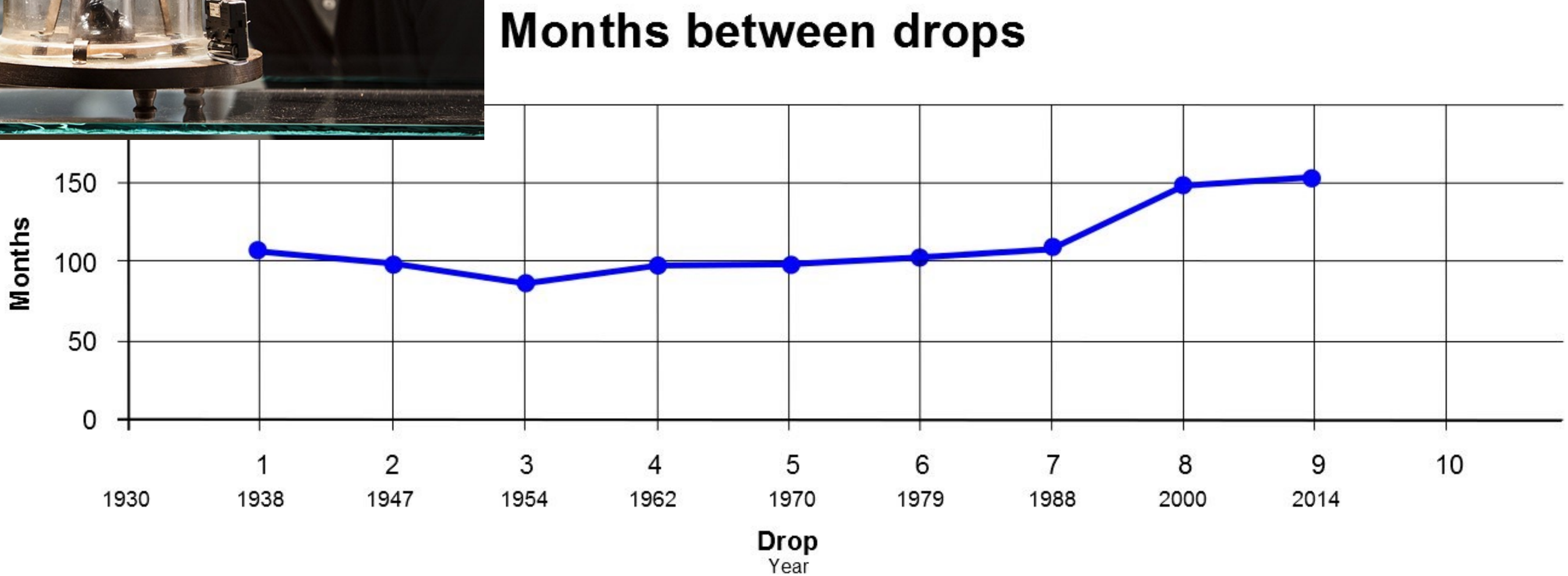
Since then, the pitch has slowly dripped out of the funnel - so slowly that it took eight years for the first drop to fall, and more than 40 years for another five to follow.

Prof. John Mainstone became the second custodian of the experiment.

Now, 94 years after the funnel was cut, only nine drops have fallen - the last drop fell in April 2014 and we expect the next one to fall sometime in the 2020s.

John Mainstone (1935-2013)

The pitch drop experiment: probably the longest physics experiment



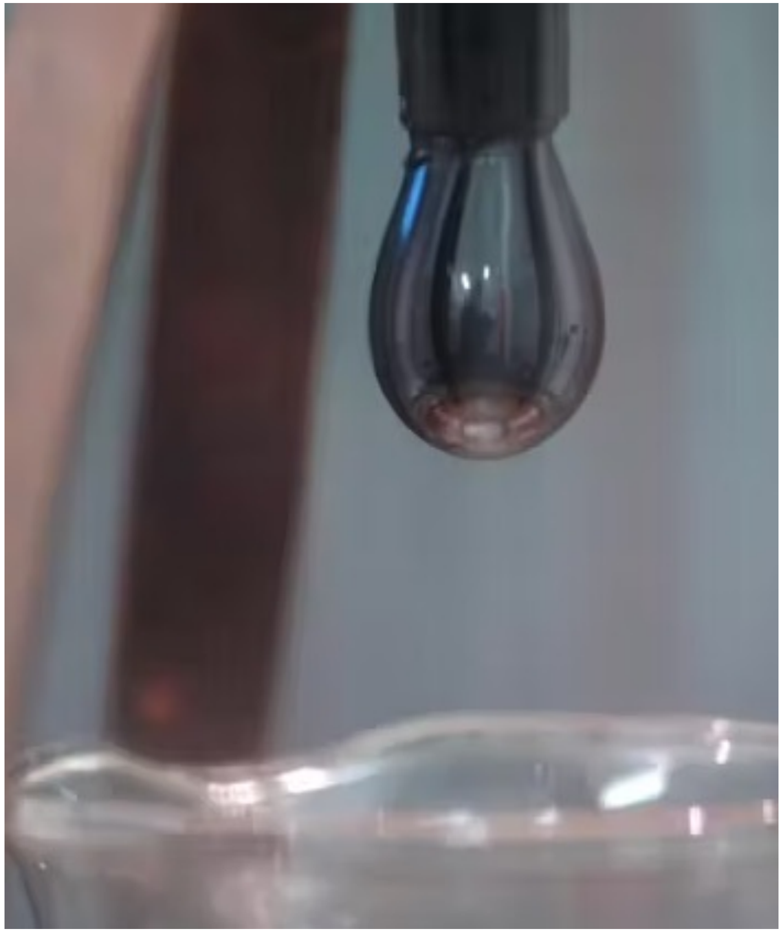
The pitch drop experiment: probably the longest physics experiment

Some additional curiosity

There is enough pitch still in the funnel to run for another hundred years

John Mainstone and Thomas Parnell were awarded with the IGNobel prize in 2005

No one has ever seen a drop falling down. A webcam has been installed close to the setup for anyone wishing to control the experiment



The pitch drop experiment: http://thetenthwatch.com/feed/

Estimated result from pitch drop experiment

Material	Viscosity coefficient (mPa s)
Water	1
Olive oil	84
Engine oil	200
Glycerine	1490
Pitch	$(2.3 \pm 0.5) \times 10^{11}$

About 200 billion times than the water!

Quite a long story…

May 3rd, 2004: The EEE Project officially presented to MIUR at CERN

Letizia Moratti (Ministry for Education and Research), Robert Aymar (CERN Director General) and Antonino Zichichi meet at CERN

Parte il Progetto Scienza nelle Scuole.

Il Ministro Moratti: "Ragazzi, costruite in classe il rilevatore di raggi cosmici"

(Roma, 3 maggio 2004) Parte il Progetto EEE Scienza nelle scuole. Il Ministro dell'Istruzione, dell'Università e della Ricerca, Letizia Moratti, e il professor Antonino Zichichi, hanno presentato oggi al Cern di Ginevra, in videoconferenza con 200 scuole italiane, questa iniziativa didattica fortemente innovativa.

"È per me significativo presentare questo progetto dal Cern", ha detto il Ministro Letizia Moratti. "Il Cern è un centro di ricerca internazionale di altissimo livello, alle cui attività partecipano oltre 1500 ricercatori italiani. Rilevo con soddisfazione", ha aggiunto il Ministro, "le positive ricadute che hanno le ricerche qui effettuate sulla società civile. La ricerca al Cern è davvero al servizio dell'uomo, delle sue necessità nella vita quotidiana, ma anche delle sue esigenze di conoscenza, quali i grandi interrogativi sulla composizione della materia e sull'universo. La fisica subnucleare porta a risolvere problemi legati alla cura dei tumori, alla sicurezza dei cittadini e alla difesa dell'ambiente".

Passando ad illustrare il Progetto Scienza nelle Scuole il Ministro ha detto: "Dobbiamo stimolare i ragazzi ad avere idee nuove, a essere protagonisti nell'apprendimento delle scienze non soltanto attraverso i libri, ma con esperienze dirette. Con questo progetto, per esempio, gli studenti potranno costruire in classe con i loro insegnanti uno strumento meraviglioso per il rilevamento dei raggi cosmici, utilizzando pochi materiali quali plastica e fili. Inoltre potranno elaborare i dati attraverso il Progetto Grid. Questa iniziativa", ha aggiunto il Ministro, "va ad aggiungersi alle altre promosse dal Miur quali il canale satellitare Explora dedicato alla diffusione della cultura scientifica e il canale interattivo Web Spazio, realizzato in collaborazione con l'Agenzia Spaziale Italiana".

MIUR Newspress, 2004

The year 2024 marks 20-years activity of the EEE Project

Quite a long story…

APPRENDRE AVEC LES RAYONS COSMIQUES

CERN Webcast donne le coup d'envoi à un projet italien

Sur le plateau, face à la caméra, Letizia Moratti (à gauche), la ministre italienne de l'éducation, des universités et de la recherche, et Antonino Zichichi, à l'origine du projet "Extreme Energy Events" pour les établissements secondaires.

Letizia Moratti (au centre) en compagnie du Directeur général du CERN, Robert Aymar (à gauche), et d'Antonino Zichichi.

Le 3 mai, à l'occasion d'une visite prolongée au CERN de Letizia Moratti, la ministre italienne de l'éducation, des universités et de la recherche, une importante retransmission sur le Web a relié le CERN à des établissements secondaires dans toute l'Italie. Cette retransmission devait marquer le coup d'envoi du projet "Extreme Energy Events", approuvé par la ministre pour promouvoir la culture scientifique dans les écoles italiennes.

Sur le plateau, face à la caméra, Moratti a été rejointe par l'initiateur du projet, Antonino Zichichi, de l'université de Bologne. Parmi le public réuni au sein du bâtiment LAA au CERN figuraient une importante délégation du ministère italien de l'éducation, des universités et de la recherche, l'ambassadeur d'Italie, des collaborateurs de l'université de Bologne et des étudiants de l'école italienne de Lausanne. En Italie, les étudiants et enseignants de centaines d'établissements secondaires ont pu suivre cette retransmission sur le Web.

Durant cette Web-émission, Zichichi a présenté le premier module de la chambre à plaques résistives multiétages (MRPC) construit dans le laboratoire LAA au CERN. Dans le cadre d'un nouveau projet visant à amener les lycéens au contact d'outils scientifiques modernes, les MRPC seront construites par les étudiants des établissements participants, puis mises en réseau pour mesurer et analyser les données sur les rayons cosmiques à travers l'Italie. Luisa Cifarelli, professeur à l'université de Bologne, a évoqué la physique sous-tendue par le projet et expliqué l'origine des rayons cosmiques en présentant des données simulées de gerbes atmosphériques d'ultra-haute énergie sur l'Italie. L'équipe de Bologne qui participe à ALICE a ensuite démontré les différentes étapes de la construction des MRPC, de l'assemblage de l'électronique de lecture et des essais à l'aide de rayons cosmiques qui ont été effectués dans le laboratoire LAA et à l'Institut de physique de l'université de Bologne.

Zichichi a également présenté les activités aux frontières de la recherche fondamentale préparées au CERN pour le Grand collisionneur de hadrons (LHC), qui cherchent des réponses aux questions posées par notre compréhension actuelle de la physique subnucléaire. Lucio Rossi, chef du groupe en charge des aimants du LHC au CERN, a décrit les activités dans le hall d'assemblage des aimants et rappelé aux Internautes la longue histoire du développement des aimants supraconducteurs, qui a débuté en Italie sous l'impulsion de Zichichi.

A l'issue de la retransmission sur le Web, Moratti s'est entretenue avec le directoire du CERN et a visité le hall d'assemblage des aimants du LHC, la cavité du détecteur ALICE et le centre de calcul du CERN, où Fabrizio Gagliardi et son équipe ont présenté leurs activités concernant le projet de grille de calcul.

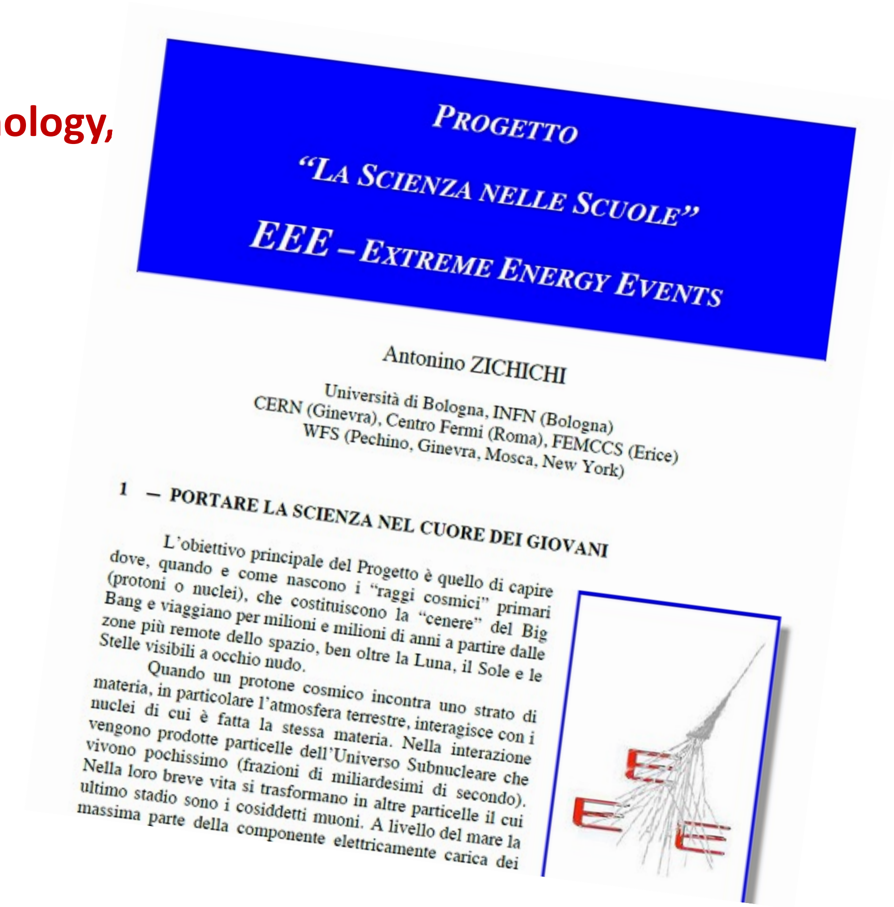
Presentation of the Project also broadcasted to many Italian schools

CERN Courier, July 2004

The goals of the Project

The main goals of the Project and the planned steps:

- **Build a number of cosmic ray telescopes based on MRPC technology, with direct involvement of school teams**
- **Install and operate them in Italian high schools**
- **Measure cosmic ray data, analyze and discuss the results**



PROGETTO
"LA SCIENZA NELLE SCUOLE"
EEE – EXTREME ENERGY EVENTS

Antonino ZICHICHI

Università di Bologna, INFN (Bologna)
CERN (Ginevra), Centro Fermi (Roma), FEMCCS (Erice)
WFS (Pechino, Ginevra, Mosca, New York)

1 — PORTARE LA SCIENZA NEL CUORE DEI GIOVANI

L'obiettivo principale del Progetto è quello di capire dove, quando e come nascono i "raggi cosmici" primari (protoni o nuclei), che costituiscono la "cenere" del Big Bang e viaggiano per milioni e milioni di anni a partire dalle zone più remote dello spazio, ben oltre la Luna, il Sole e le Stelle visibili a occhio nudo.

Quando un protone cosmico incontra uno strato di materia, in particolare l'atmosfera terrestre, interagisce con i nuclei di cui è fatta la stessa materia. Nella interazione vengono prodotte particelle dell'Universo Subnucleare che vivono pochissimo (frazioni di miliardesimi di secondo). Nella loro breve vita si trasformano in altre particelle il cui ultimo stadio sono i cosiddetti muoni. A livello del mare la massima parte della componente elettricamente carica dei

Requirements of the detectors

6A.1 – Progettazione di un telescopio con MRPC

L'apparato utilizzato per la rivelazione dei muoni cosmici deve soddisfare le seguenti condizioni:

i) deve poter coprire una grande superficie e di conseguenza essere a basso costo;

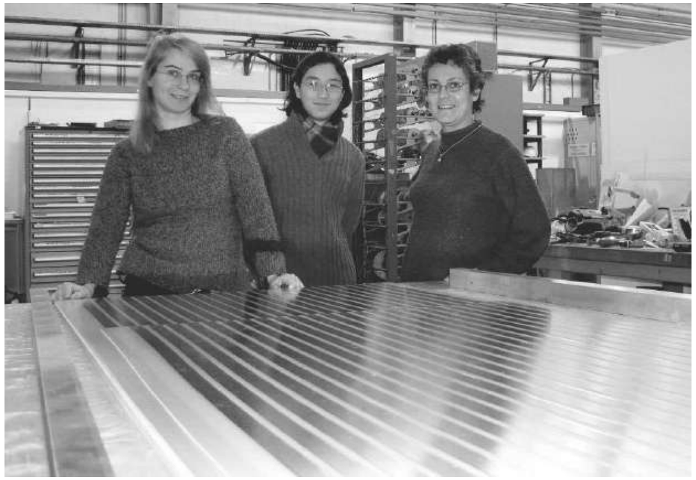
ii) deve essere resistente, ossia capace di operare per molti anni con un minimo di interventi di manutenzione;

iii) deve fornire un'efficienza di rivelazione quanto più prossima al 100%;

iv) deve consentire la ricostruzione di tracce di muoni cosmici ed essere quindi costituito da (almeno) tre piani di rivelazione;

v) deve possedere una risoluzione spaziale di qualche centimetro (in entrambe le coordinate orizzontali) per la localizzazione in ogni piano di rivelazione del punto di attraversamento di un muone; ciò consentirà l'estrapolazione della traccia ricostruita del muone a parecchi chilometri di quota nell'atmosfera e quindi l'individuazione, per più tracce ricostruite in diversi rivelatori, di un punto comune di produzione degli eventi di energia estrema costituiti da sciami cosmici;

vi) deve possedere una risoluzione temporale sufficiente per permettere che muoni cosmici rivelati in diversi apparati situati a grande distanza l'uno dall'altro possano essere messi in correlazione l'uno con l'altro tramite un dispositivo GPS (questo implica una risoluzione temporale di alcune decine di nanosecondi) e per garantire inoltre la discriminazione, tramite coincidenze tra almeno tre piani di rivelazione, del fondo accidentale generato da segnali di rumore (ovviamente una risoluzione dell'ordine del nanosecondo è utile a questo scopo).



Involving scientific Institutions and high school teams

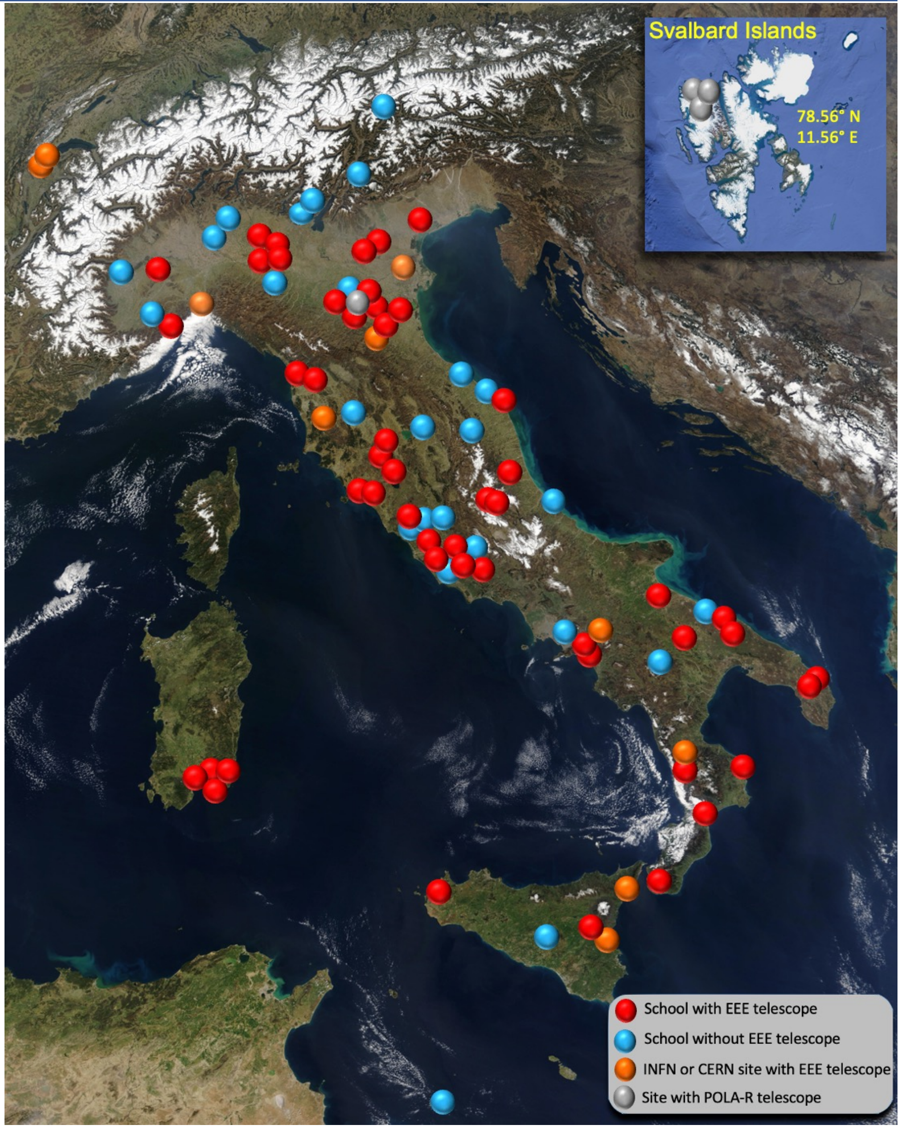
- A large effort since the beginning to involve scientific Institutions (CERN, INFN, Centro Fermi, University Physics Depts, EMFCSC, SIF, INGV, CNR, INRIM, several foreign Institutions,…)

- … and High Schools, with the 7 pilot schools which firstly joined, up to the present number (about 100) of participating teams over the Italian territory.

- EEE project mainly handled by Centro Fermi over the past years

- October 2020: INFN-Centro Fermi agreement signed to share contributions from the two Institutions for equipment, consumables, personnel, travel and meeting organization, fellowship,…

- Many other important steps over the years



The architecture of the EEE detector network

How to accomplish the scientific and educational goals of the Project?

Overall architecture of the EEE network based on:

- **MRPC telescopes + Electronics to reconstruct muon tracks from the cosmic radiation**
- **A synchronized system, based on GPS, to correlate data from distant stations**
- **Data acquisition and storage**
- **Data reconstruction and analysis framework**

and, more important,

- **Manpower to build, install, test, operate, repair, improve,.. hardware and software**
- **A large community of researchers, teachers and students to analyze and discuss results**
- **A flexibile system to disseminate knowledge within and outside the Collaboration**

Construction of the MRPC telescopes @ CERN

- 2005: A first batch of MRPC built at CERN for the first 7 pilot school installation
- Since then, a long term involvement of researchers and school teams at CERN

- For many years, high school teams spent typically one week at CERN, being involved in the different steps of the construction of the MRPC chambers, and at the same time having a first-hand experience of CERN, its technology and physics

CERNCOURIER | Reporting on international high-energy physics

Physics ▾ | Technology ▾ | Community ▾ | In focus | Magazine

EDUCATION AND OUTREACH | FEATURE

The EEE Project: big science goes to school

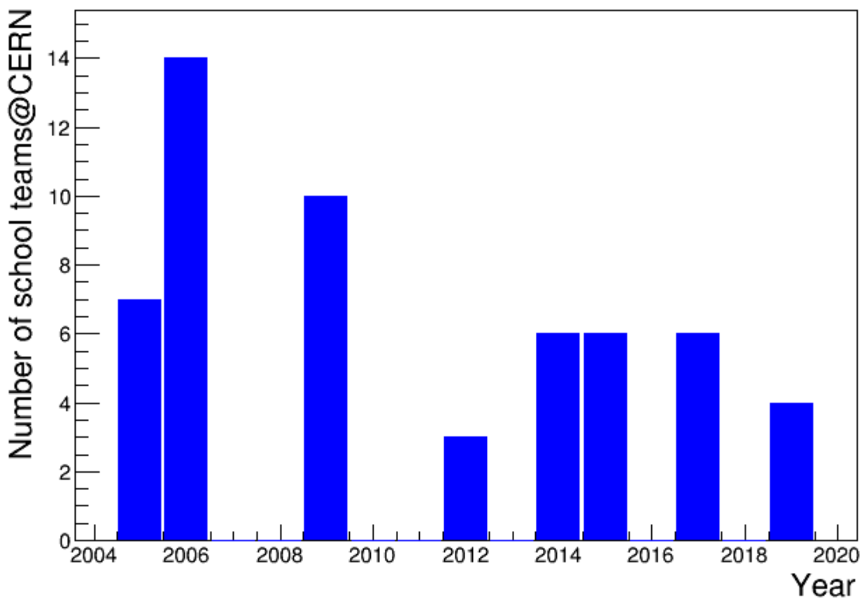
2 March 2007

Antonino Zichichi tells Bob Swarup about his initiative to bring frontier research in physics into the heart of Italian schools and to encourage the next generation of physicists.

In May 2004, a major webcast linked CERN and high schools all over Italy to inaugurate the Extreme Energy Events (EEE) Project. Launched on the occasion of the visit to CERN of the Italian Minister of Education, University and Research, the project is the initiative of Antonino Zichichi from Bologna University and CERN.

CERN Courier, 2007

Construction of the MRPC telescopes @ CERN



- From 2005 to 2019 56 school teams came to CERN
- Each team from 5 to 10 students & 1-2 teachers
- A total of 300-400 students and 60-90 teachers participated to MRPC construction

- In addition, we had students from Albania, Russia, France, Sweden, Greece, Austria, Norway, Germany,…
- High school teams also followed 1-3 weeks internship programs (HSSIP), visits to CERN and ALICE and other activities

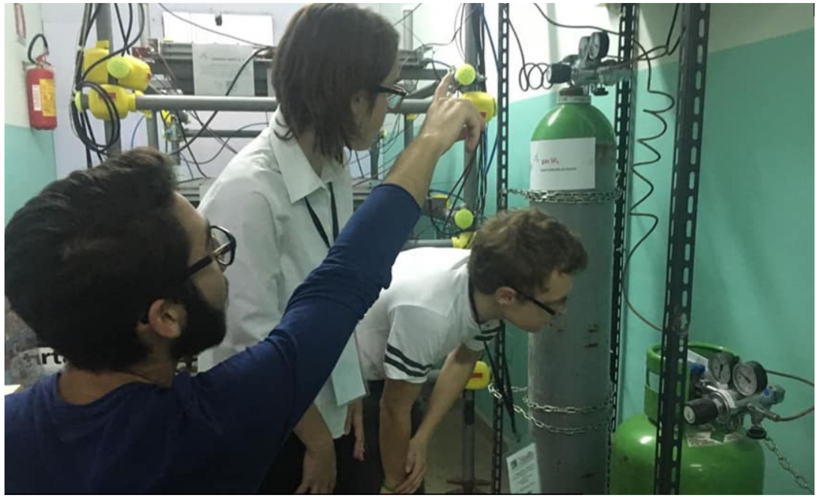
Installing telescopes and be ready for data taking

Since 2005, following the MRPC construction at CERN, school teams and EEE researchers have installed and commissioned telescopes at home

Many aspects required a lot of work and careful solutions

- **Political and administration issues**
- **Technical problems with gas handling**
- **Electrical noise and ground connections**
- **Monitoring the working conditions**
- **Take care of the setup also during weekends and summer**
- **Train new students and teachers over the years**

….



Finally, measuring cosmic rays!

The EEE telescopes are able to measure the cosmic ray flux as a function of the

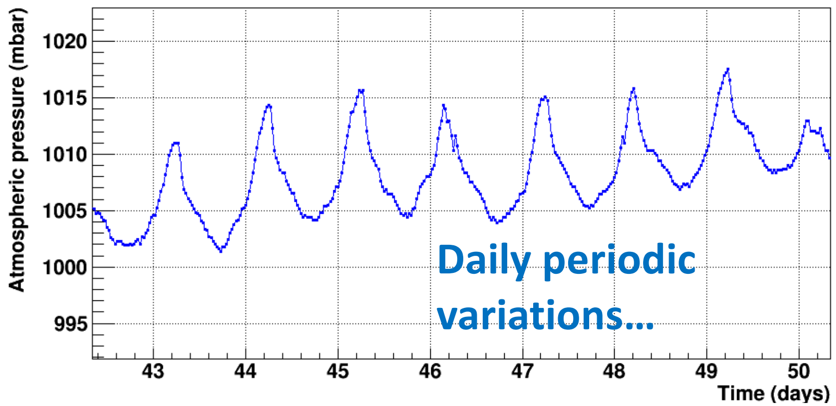
- **Zenithal direction (polar angular distribution)**
- **Azimuthal direction (azimuthal angular distribution)**
- **Time**
- **Geographical location (lat. & long.)**
- **Elevation above the sea level**
- **Possible time and geographical correlations with additional detectors**

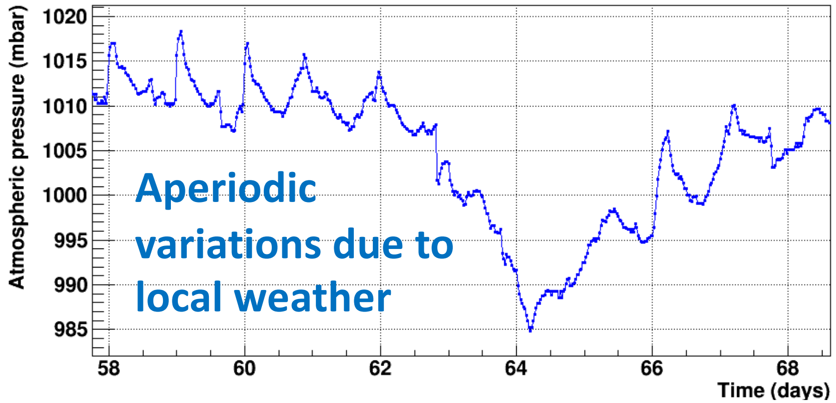
These (and other) possibilities allow to carry out a variety of different investigations

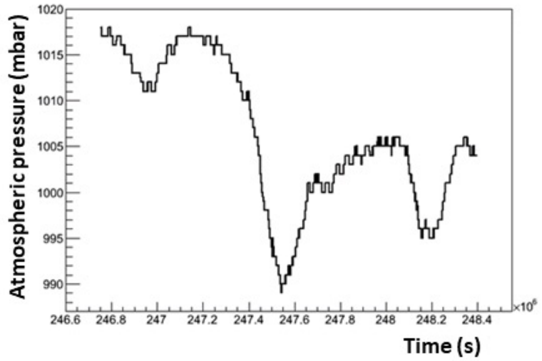
Only a few examples are here reported

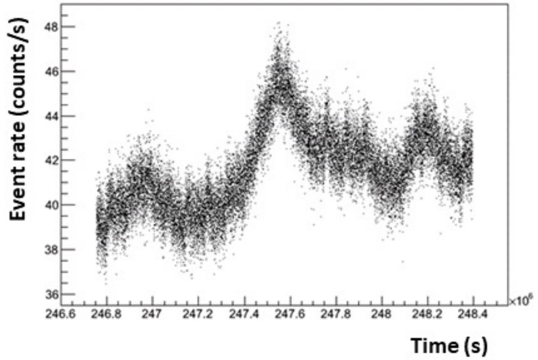
Cosmic ray flux and the effect of the atmospheric pressure

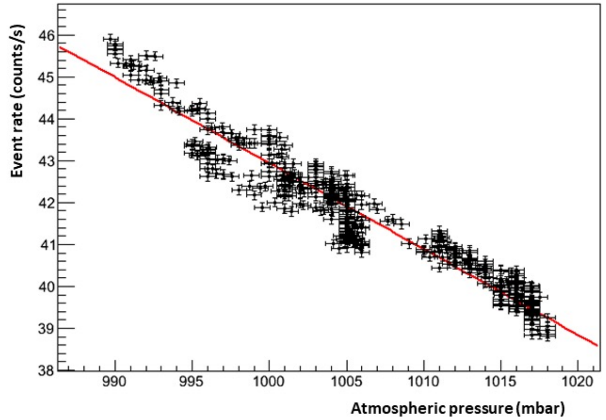
One important aspect of the cosmic ray flux measured with a detector at ground is the influence of the atmospheric pressure











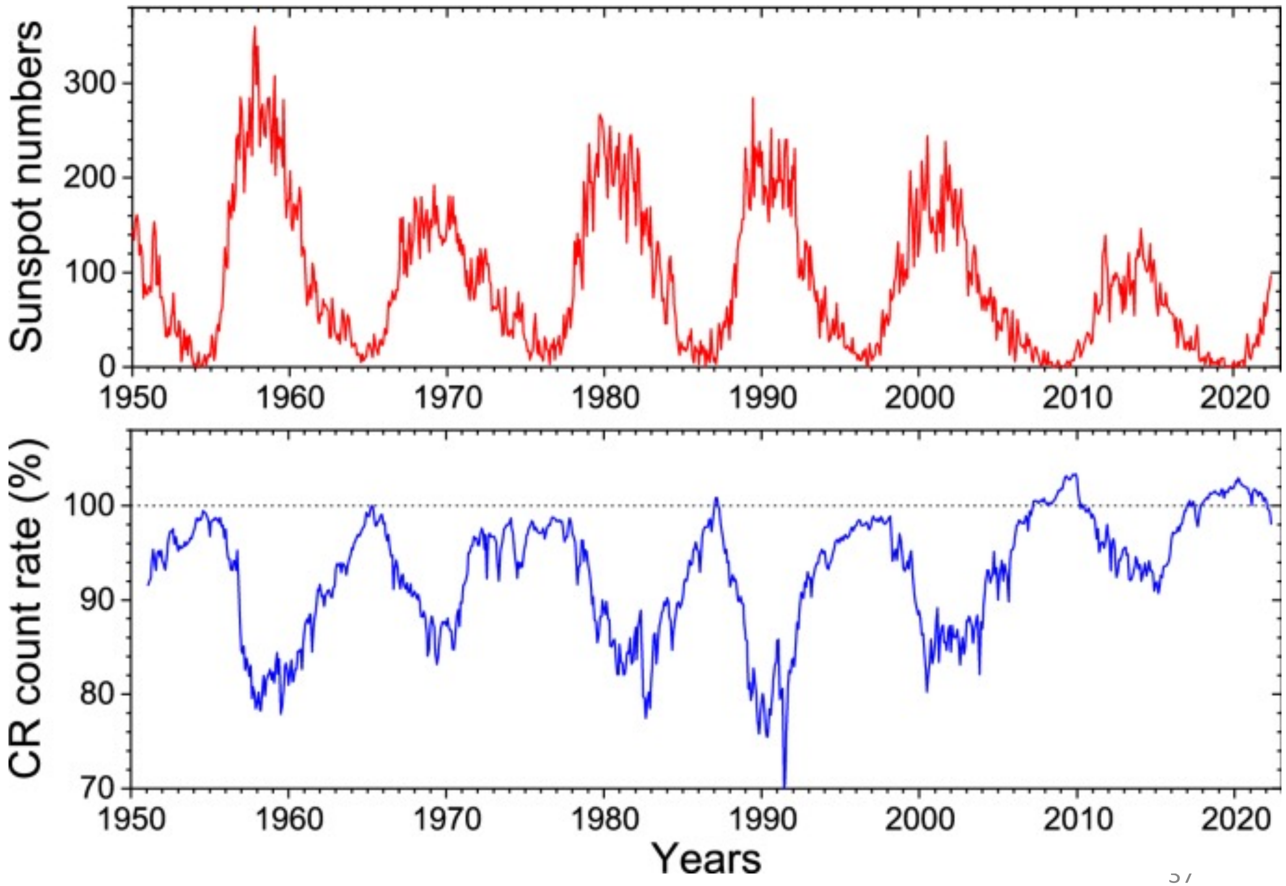
A «barometric» coefficient may be extracted from data to correct them before additional analyses.

School teams involved in such analysis from the very beginning..

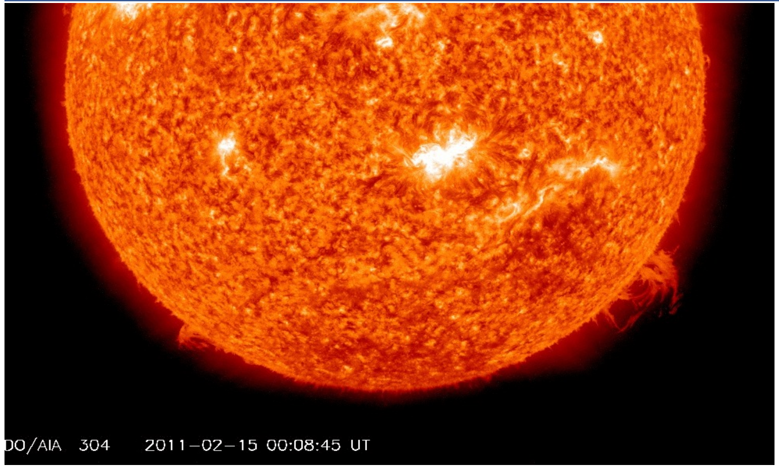
The influence of the Sun

The Sun also affects in different ways the cosmic ray flux through its periodic and catastrophic (aperiodic) phenomena

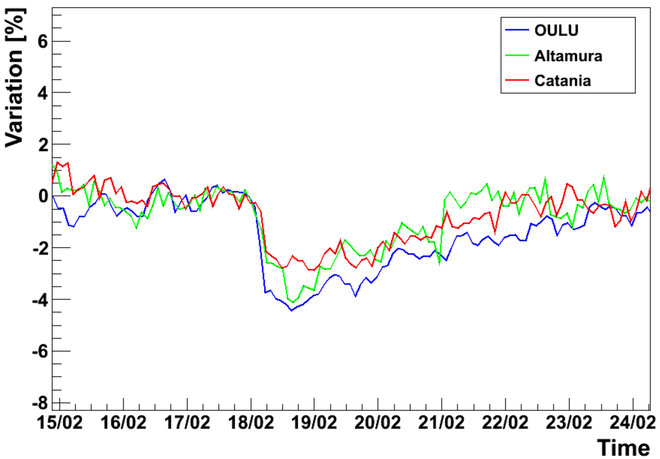
The cosmic ray flux on Earth is anticorrelated with the number of sunspots (11-years cycle)



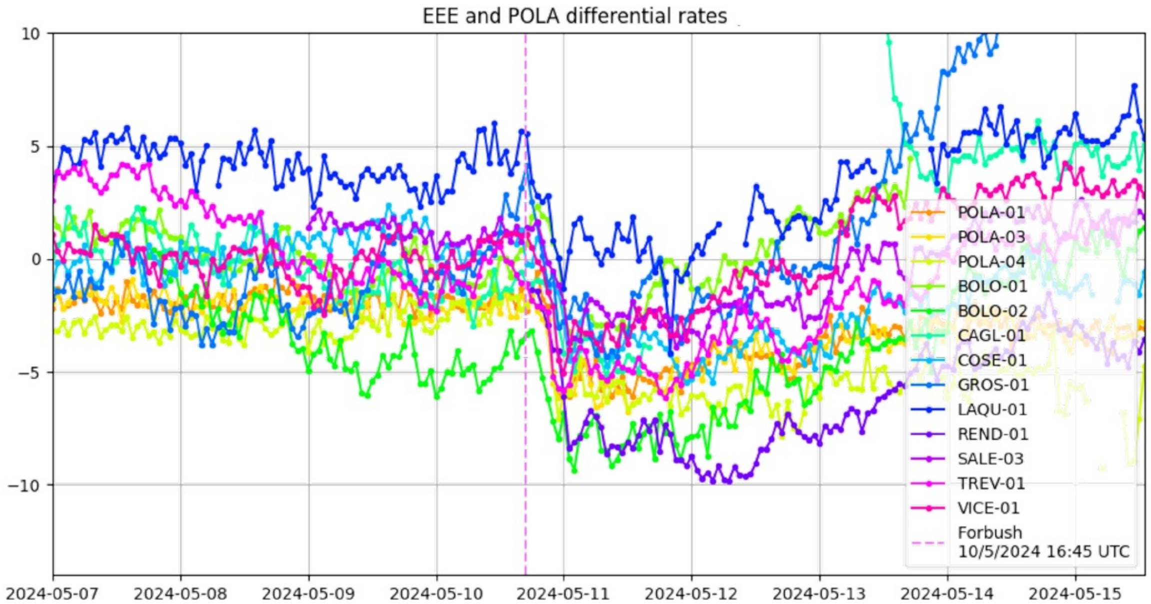
Aperiodic phenomena: the Forbush decreases



Forbush decreases are usually observed through neutron monitor stations, but they are also seen in the muon component.



The first Forbush event observed by two EEE telescopes in 2011



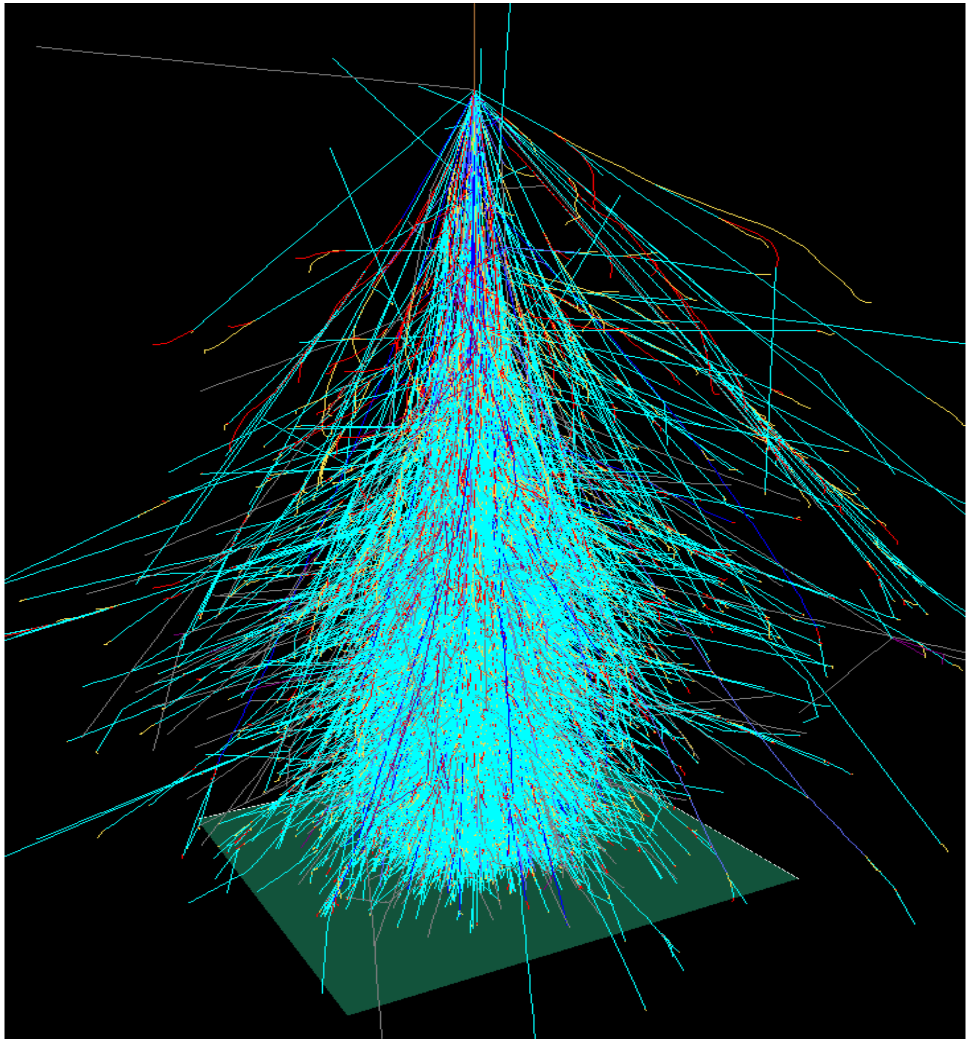
Work in progress on the Forbush event in May 2024

Extensive air showers by telescope coincidences

What we observe on Earth is the result of extensive air showers induced by primary particles (mostly protons) in the Earth atmosphere.

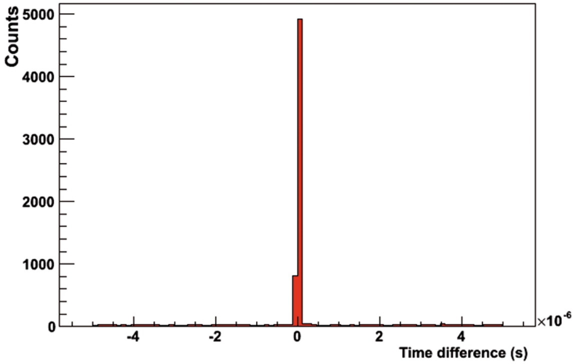
We may also have coincidence events in two or more telescopes some distance apart.

Time syncronization (through GPS) between individual telescopes is an essential part of the game.

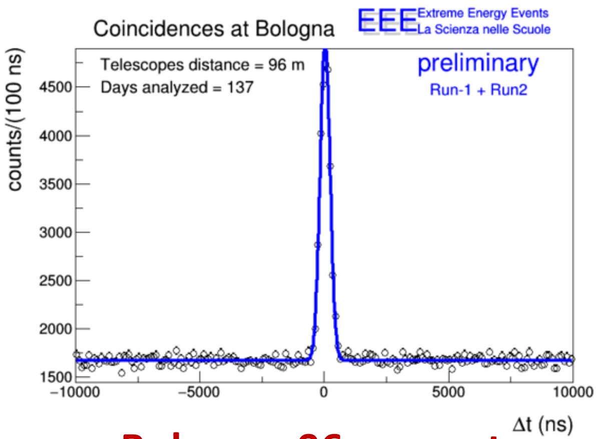


Extensive air showers by telescope coincidences

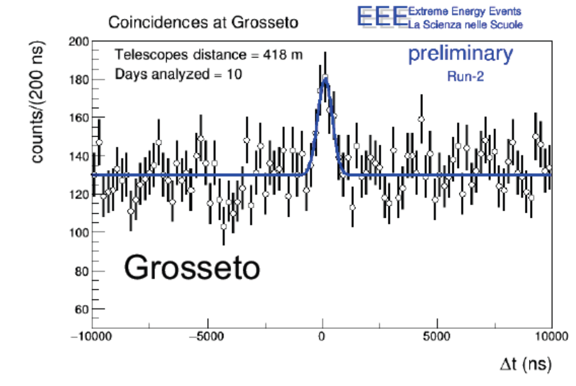
First shower detection in L'Aquila at ~200 m distance (2008-2009), now observed even at larger distances



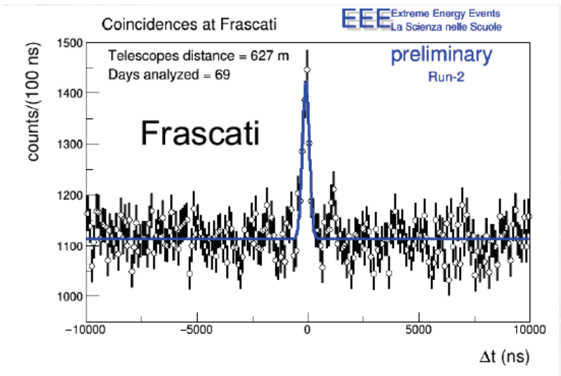
CERN, 15 m apart



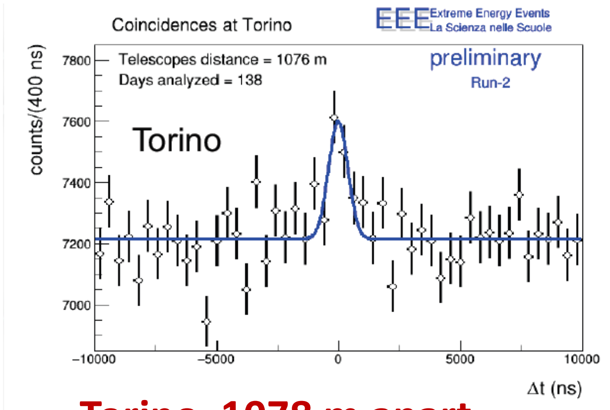
Bologna, 96 m apart



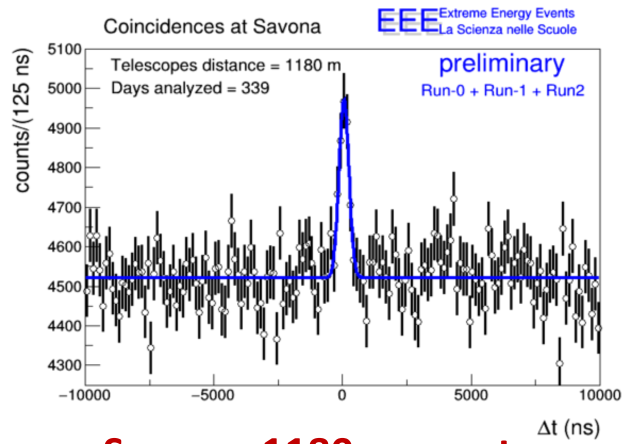
Grosseto, 418 m apart



Frascati, 627 m apart



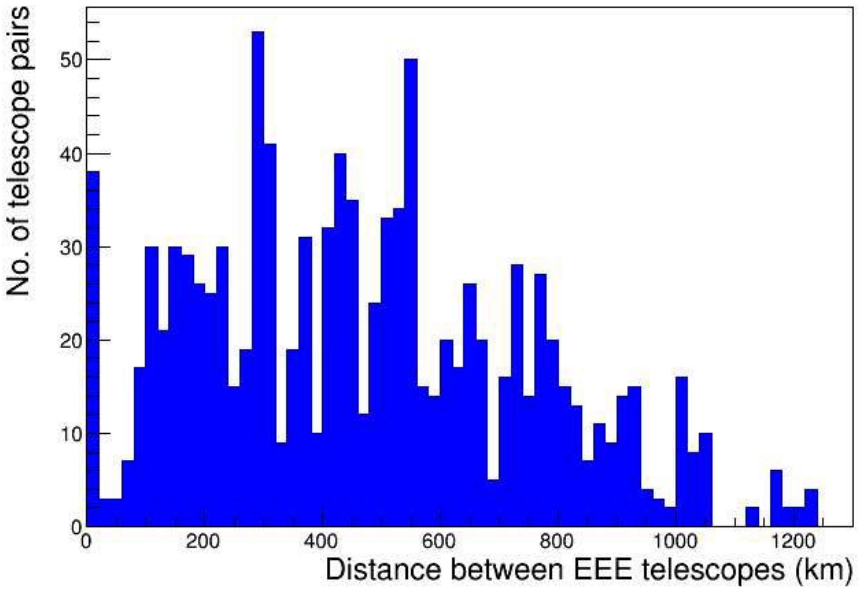
Torino, 1078 m apart



Savona, 1180 m apart

Searching for long distance correlations

The possibility to observe «exotic» events due to correlated showers at large distance has been debated, but no clear evidence found so far



Distribution of distances between EEE sites

The EEE network, with its sparse topology, has the capability at least to search for these events (A few candidates found?)

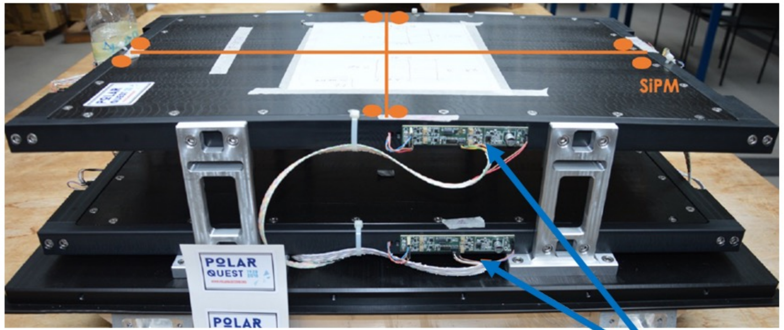
Upgrade activities of the EEE network

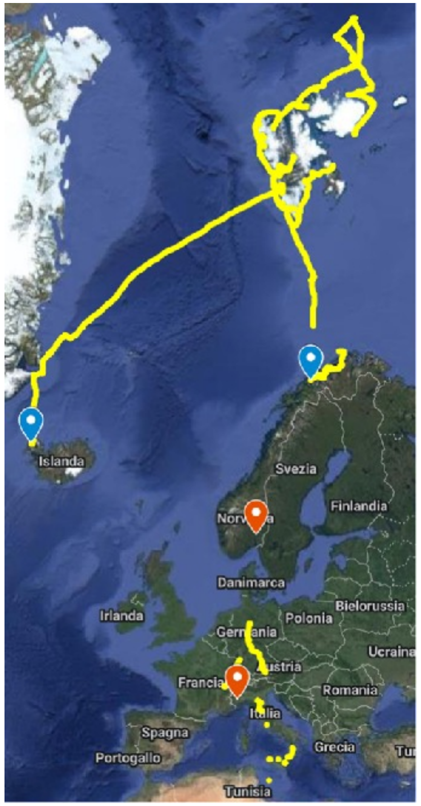
A variety of upgrade activities undertaken along two decades:

- **New trigger modules**
- **Different GPS system**
- **Weather stations**
- **MRPC with reduced (250 micron) gas gap**
- **Software upgrade (data acquisition, reconstruction, analysis framework,…)**
- **New, eco-friendly, gas mixtures (several telescopes now operating with the new mixture)**

Complementing the EEE network with the POLA-R detectors

A set of small scintillator-based telescopes were also built and employed in different environments and measurement campaigns

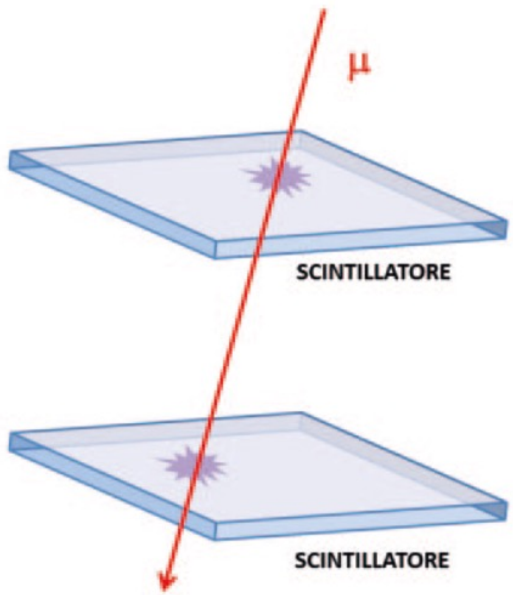


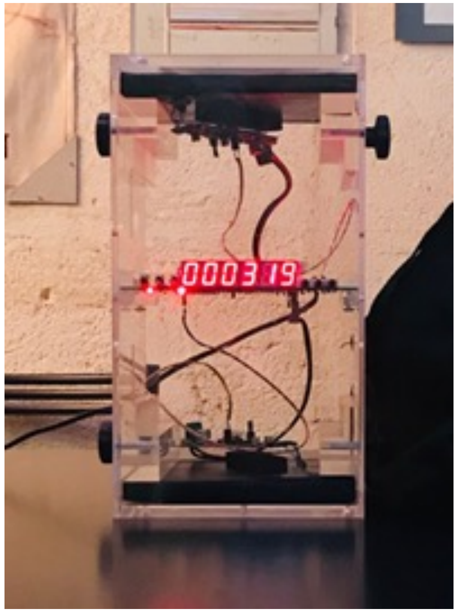


- **Operated onboard of a sailboat and in different locations to measure latitude dependence of the cosmic ray flux.**
- **Three detectors taking data since 2019 at the Svalbard are now part of the EEE network.**
- **Several ongoing analyses with such detectors, including correlation with neutron detectors in the same site.**

Additional detection tools: the COSMIC BOX

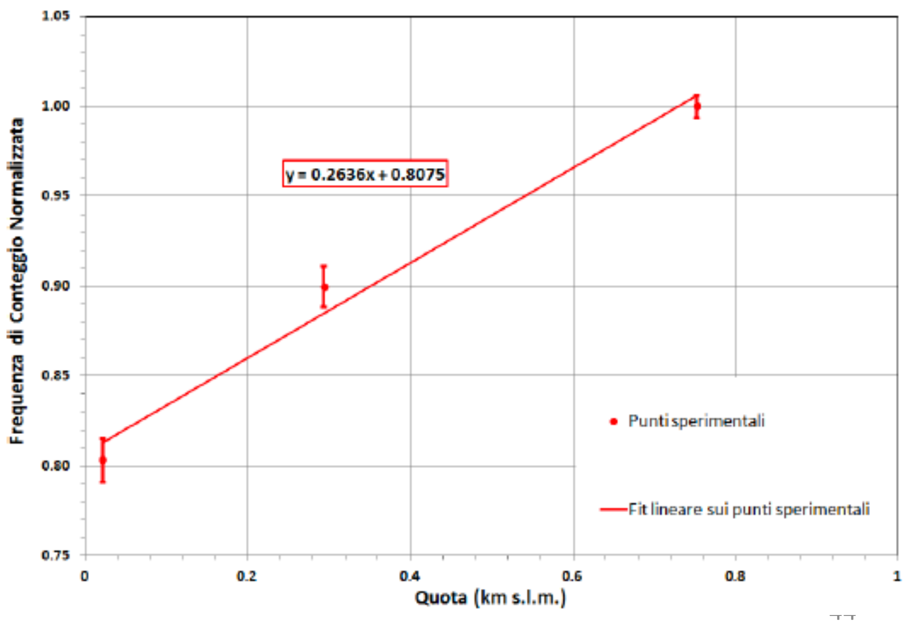
A number of additional detectors (Cosmic Box) were also built and employed in different measurements with cosmic rays, mostly built and operated by students





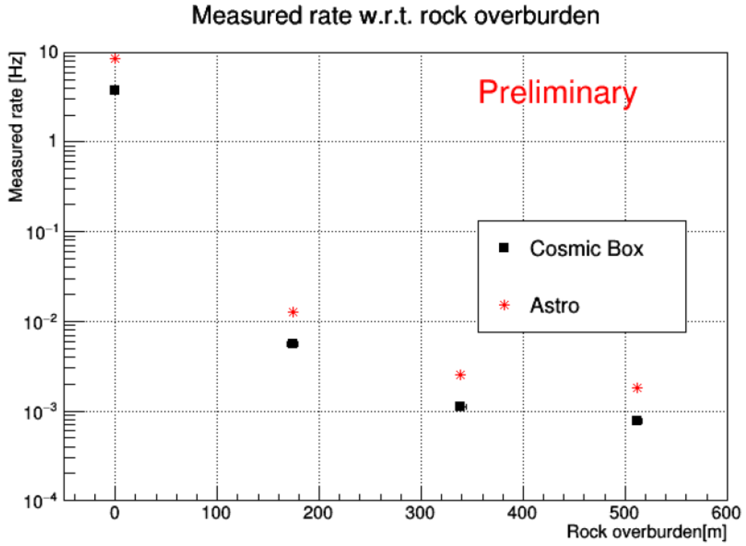
2 planes 15x15x1 cm^3 scintillators operated in single or coincidence mode

- **Measurements at different altitudes**
- **Underground investigation of cosmic ray flux**
- **Many proposal from school teams**
- **Yearly contexts organized**

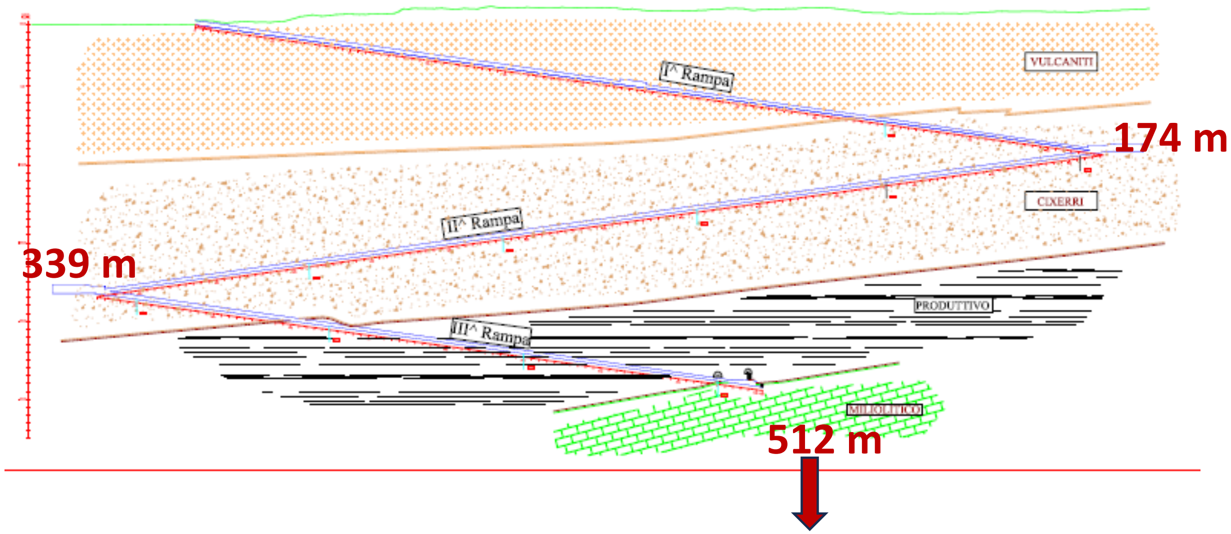


Underground measurements with the Cosmic Box

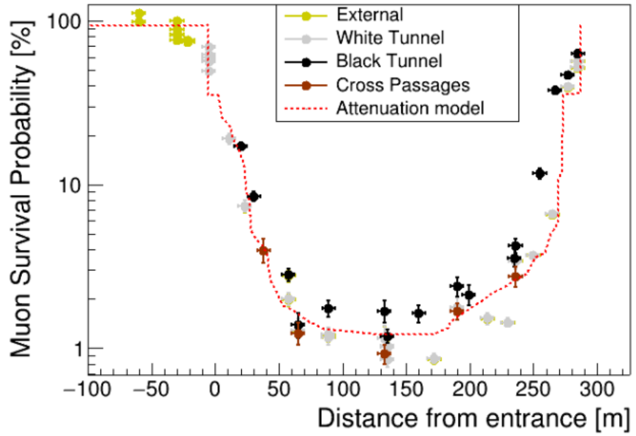
- **Measurements with 3 Cosmic Box detectors carried out in the Nuraxi Figus-Seruci mine complex (Cagliari), and in Trento hill tunnels.**



More than 3 orders of magnitude between outside and 512 m underground



In both cases large student participation



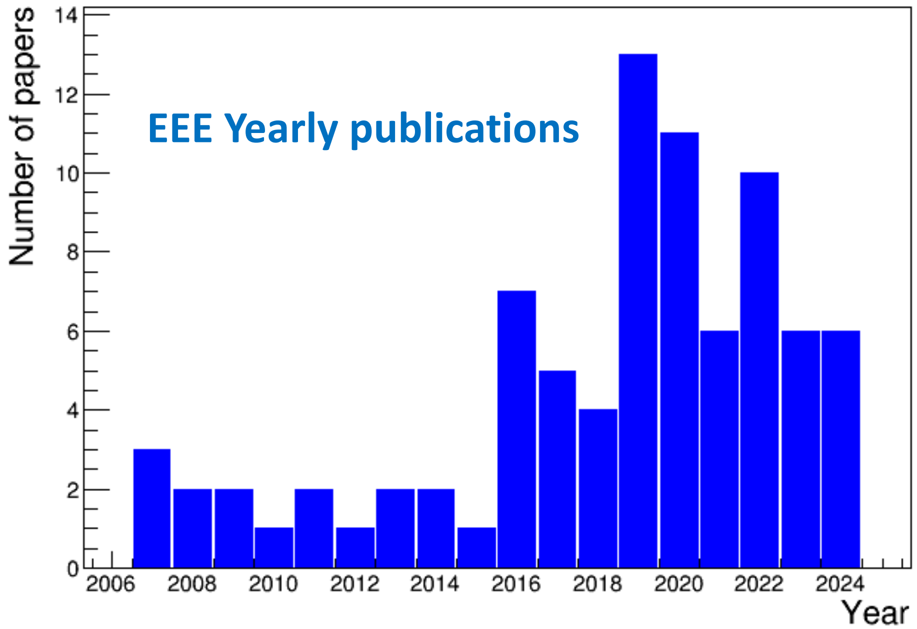
Muon absorption by a factor 100 observed in Trento

Publishing scientific results

As of today, more than 80 scientific papers and ~ 100 contributions to international conferences from the EEE activity

Most of them acknowledge the helpful contribution of high school students and teachers

Some of them even report the name of students and teachers as coauthors and hopefully others will follow..



Disseminating news about activities

EEE activities are regularly disseminated by various channels:

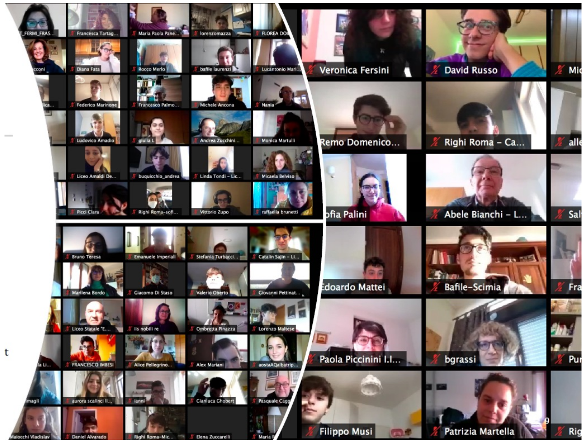
EEE Web site, including EEE News section

More than 15 News published on this channel so far

Involving the high school community

- A large part of our project is addressed to involve the high school community in the scientific and technical aspects of an advanced research activity

- This is usually done in different ways
  - Taking part in the construction, operation of detectors, checking the status of data taking,…
  - Participate to monthly meeting and presenting the results of their work
  - Attend general EEE meetings with lectures, masterclasses, exp.activities…
  - Prepare and submit projects



- The pandemic has introduced a further challenge for a few years in all EEE activities

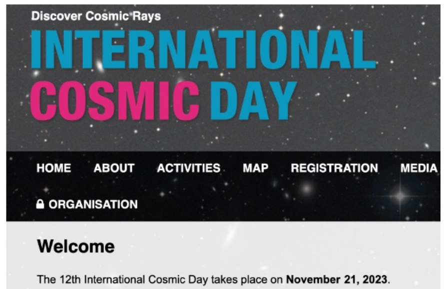
- EEE events in person have been restarted as done in the past…

Outreach activities outside the EEE environment

Lab boat, Sardegna

International Cosmic Day/International Muon Week

Science festival, Cagliari



2023 European Research Night

Outreach activities outside the EEE environment

Astronomy Olimpic Games

Exchange program Trinitapoli-Moscow

LA GAZZETTA DEL MEZZOGIORNO

NORDBARESE PROVINCIA | IX

LA SCUOLA CHE PIACE

GEMELLAGGI E CONDIVISIONE

LO SCIENZIATO VLADIMIR PESKOV L'interscambio tra l'istituto pugliese e il «Chemical Liceum» russo è stato favorito dallo scienziato russo Vladimir Peskov

IL DIRIGENTE CARMINE GISSI «Una esperienza didattica, culturale ed umana unica. Il confronto con la realtà scolastica ed educativa russa ci ha arricchito»

Da Trinitapoli a Mosca studiando i raggi cosmici

Lo «Staffa» approfondisce la materia al Moscow Chemical Lyceum

EEE and mass media

Day of the Art

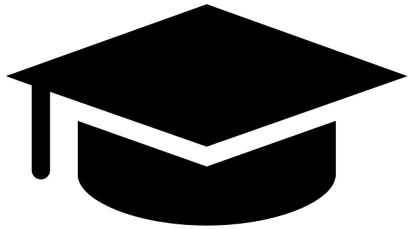
Outreach activities outside the EEE environment

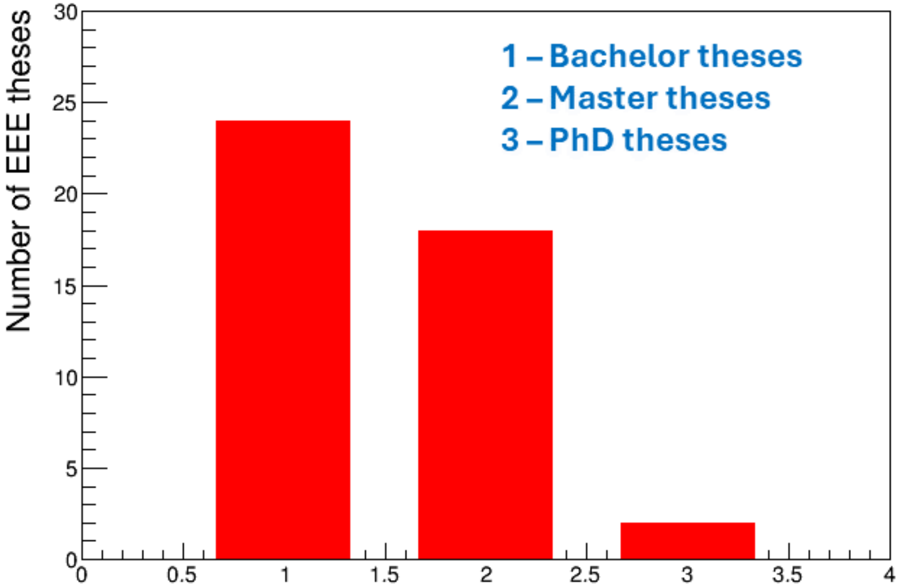
Several events locally organized during visits of EEE members to the schools

Profile reports from schools show plenty of examples…

Degree and PhD theses within EEE

Recent survey carried out about degree (Bachelor/Master) and PhD theses prepared within EEE activities, almost 50





Not negligible, in terms of contribution to university teaching activities and formation

Bringing Science in the Heart of the Young, EEE 2004-2024 paper

Recalling the long list of steps, activities and achievements over such period, we prepared a summary paper, to be distributed to schools and people involved in the Project.

- Origin, goals and motivations of the Project
- Basic components of the detection setup, its development and upgrade
- Physics items of interest and analyses carried out so far
- List of EEE scientific publications
- Complete list of degree and PhD theses within EEE
- Involvement of the high school community
- Main achievements of the project in education and research
- Contributions from high schools

This Report is now ready and will be soon published by the Italian Physical Society (Vol. 65, 2024)

SUPPLEMENTO
GIORNALE
DI FISICA

Waiting for the publication, a present to all of us