Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN

Astroparticle Science Communication: INFN Cosmic Ray public engagement

https://collisioni.infn.it/

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Advances in Modeling High-Energy Astrophysical Sources: Insights from recent multimessenger discoveries - Sexten, 02/07/2025

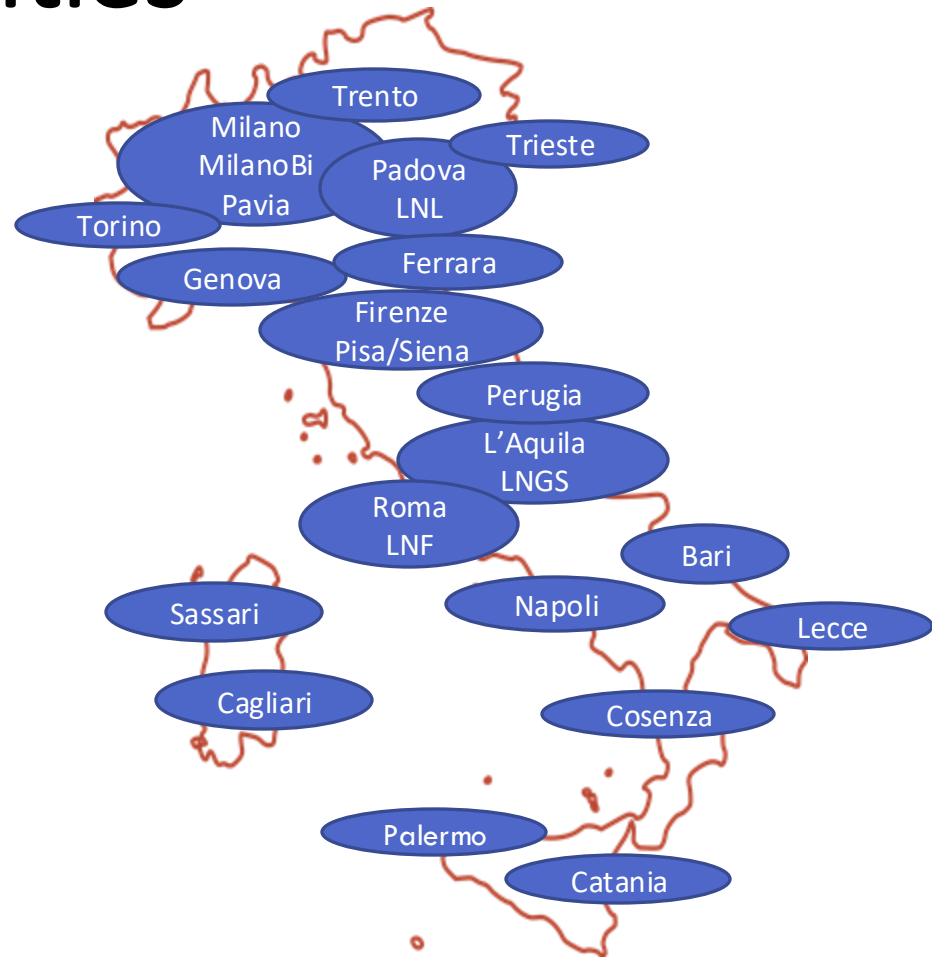
Progetto PNRR CTA+
Proposta IR0000012
CUP: C53C22000430006

Missione 4 Istruzione e Ricerca
Componente 2 Dalla ricerca all'impresa
Linea di investimento 3.1

OCRA – Outreach Cosmic Ray Activities

OCRA was founded in **2018 as an outreach project of the INFN**, with the aim of coordinating and bringing together the many public engagement activities in cosmic ray physics.

Today, **OCRA counts 24 of the INFN divisions and laboratories as members**, with more than 160 people involved.



Ocra INFN Ocra INFN https://web.infn.it/OCRA/

OCRA during seven years of activities

For students:

- ✓ International Cosmic Day
- ✓ Student Science Camps
- ✓ Online laboratories
- ✓ Local activities: hand-on labs, competitions
- ✓ Pierre Auger Observatory Masterclasses

For high school teachers:

- ✓ Online course with interactive labs on OCRA webpage
- ✓ In-presence course on technology and science

For general public:

Participation in events like

- ✓ the European Researchers' Night
- ✓ science festival: Futuro Remoto, Festival of Genova, Galassica, Didacta, Comicon, etc.

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International Cosmic Day

Every year, thousands of students participate, both in person and online.

International Cosmic Day (ICD) organized every year by DESY and partner institutions within IPPOG

- Seminars
- Measurements with a muon telescope
- Data analysis
- Video call and discussion of the results

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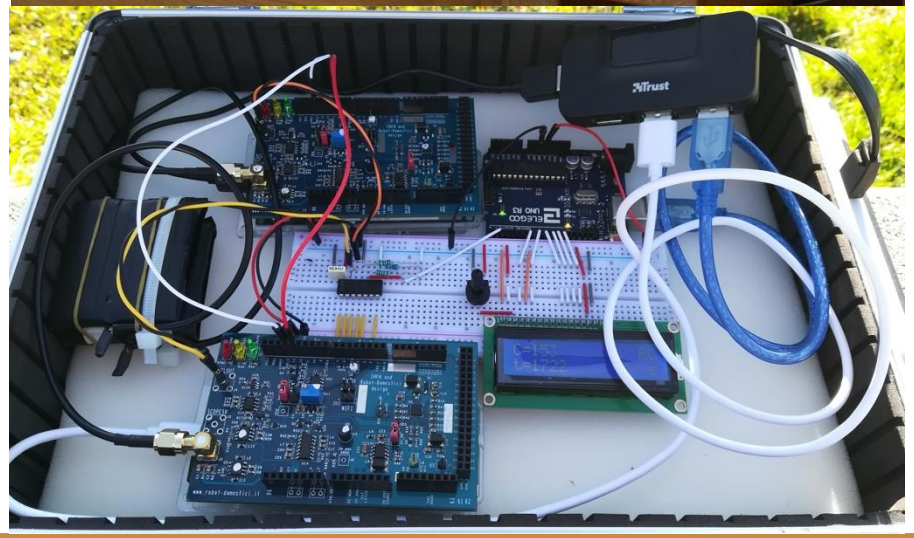
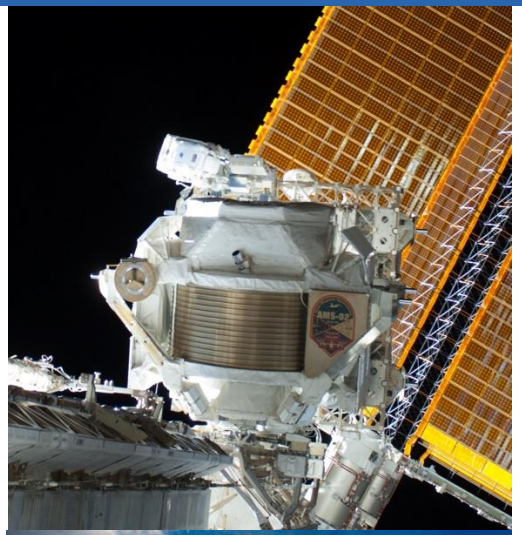
Student Science Camps – Gran Sasso and Frascati Lab

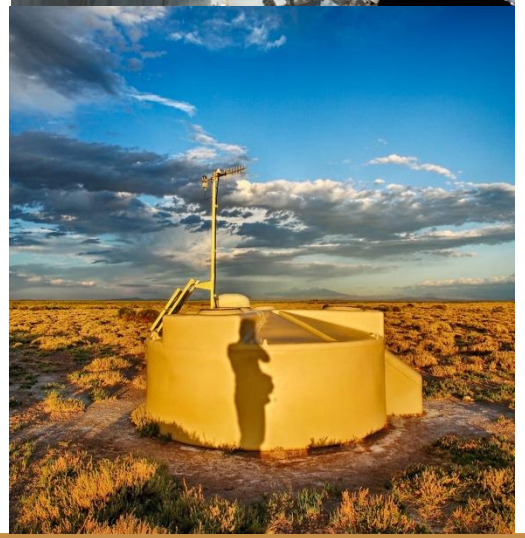


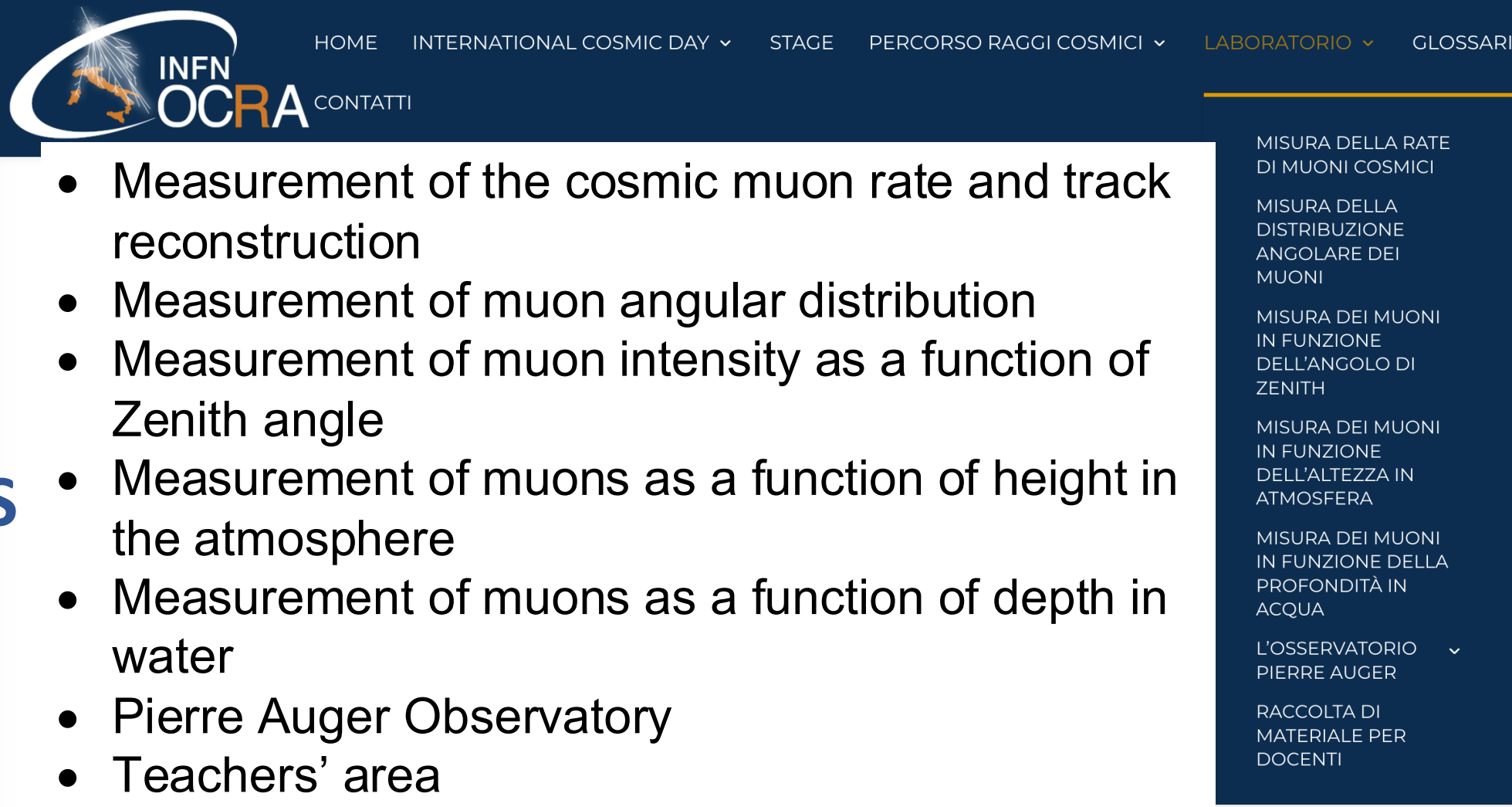
The cosmic ray pathway

- Use of instrumentation and of experimental data to create an online pathway to allow **students** to acquire the notions useful to understand what cosmic rays, extensive air shower, muons and other quantities useful to understand cosmic radiation are.
- Introduction also to the **instruments for cosmic ray detections** , especially to perform measurements of atmospheric muons under different conditions.

Laboratories from didactics
... to research







OCRA ONLINE LABORATORIES

- Measurement of the cosmic muon rate and track reconstruction
- Measurement of muon angular distribution
- Measurement of muon intensity as a function of Zenith angle
- Measurement of muons as a function of height in the atmosphere
- Measurement of muons as a function of depth in water
- Pierre Auger Observatory
- Teachers' area

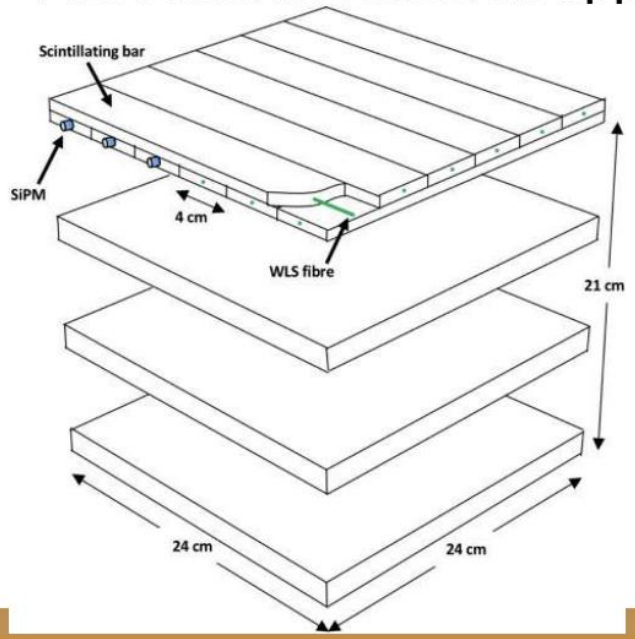
CTA+ outreach program

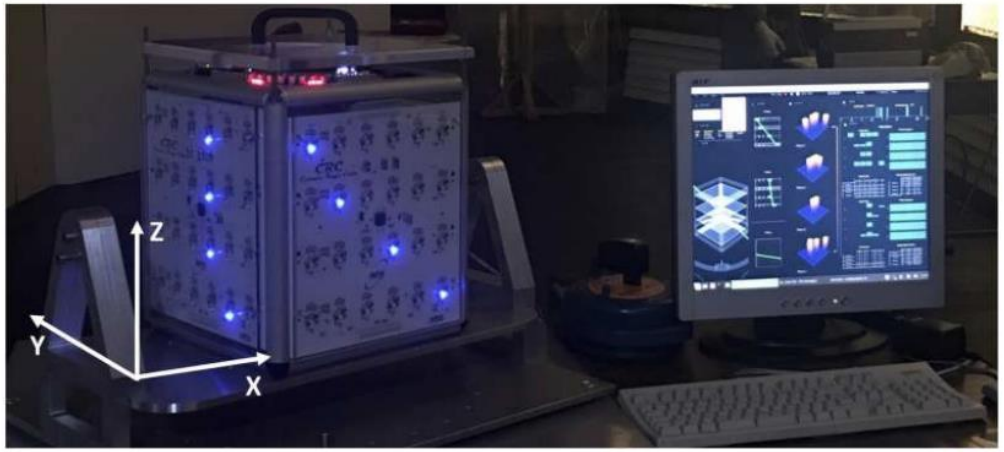
- The CTA+ program includes many outreach and science communication activities, with events for the general public, but above all with activities for students and training for teachers to bring them closer to the fascinating world of gamma rays and astroparticle physics.

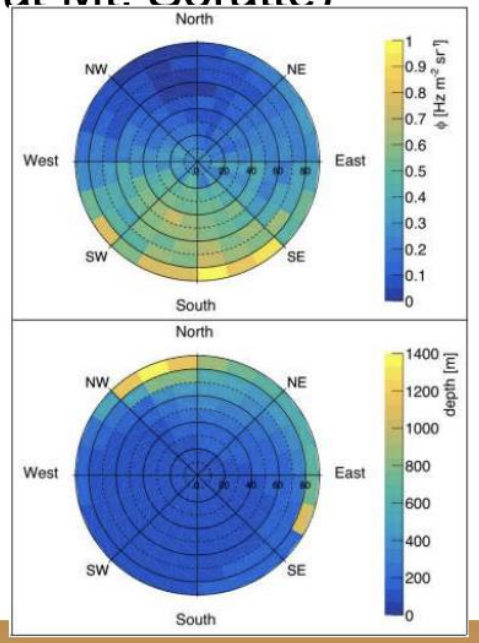
- Of all these activities, I will briefly describe two courses dedicated to Italian high school teachers, which use the Cosmic Ray Cube telescopes founded by the CTA+ programme. I will also mention some other gaming activities.

The Cosmic Rays Cube Network

- Compact and portable muon telescope designed by INFN – LNGS (Laboratori Nazionali del Gran Sasso)
- Based on layers of plastic scintillators, highlight muon trajectory in both coordinate with optical LED
- Suited for public events, both high school education and outreach for the general public
- Design of a user-friendly interface for detector assembly and customization of its trigger options
- Professional research applications such as muon radiography (measurements at Mt. Soratte)

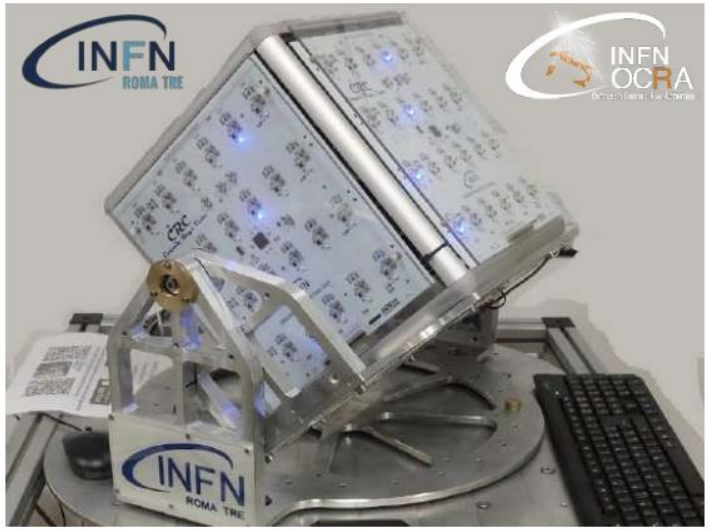


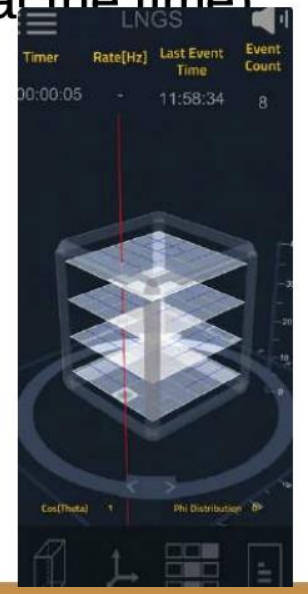




The Cosmic Rays Live Application

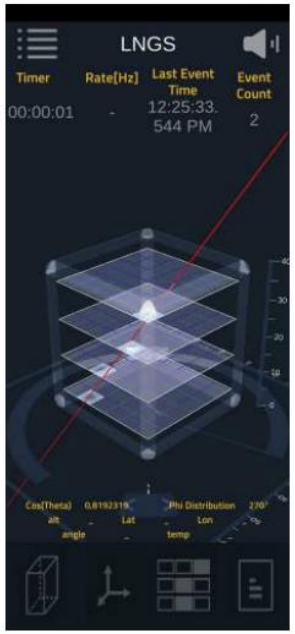
- Cosmic Rays Cube in real time data available to everyone online
- More than 20 detectors registered in the network
- Mobile phone applications to select the location of the detectors, inspect tracks and download tables
- Available to both Android and iOS devices, as well as Linux and Windows clients
- New update currently in test phase: remote rotation of CRC detectors mounted to electronic supports, to let the user choose its zenith angle freely (only allowing one control for each telescope at the time)





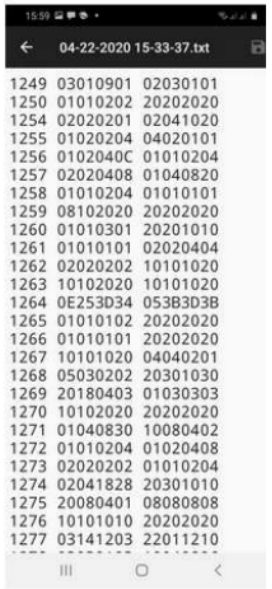
Quick starts to Cosmic Rays Live

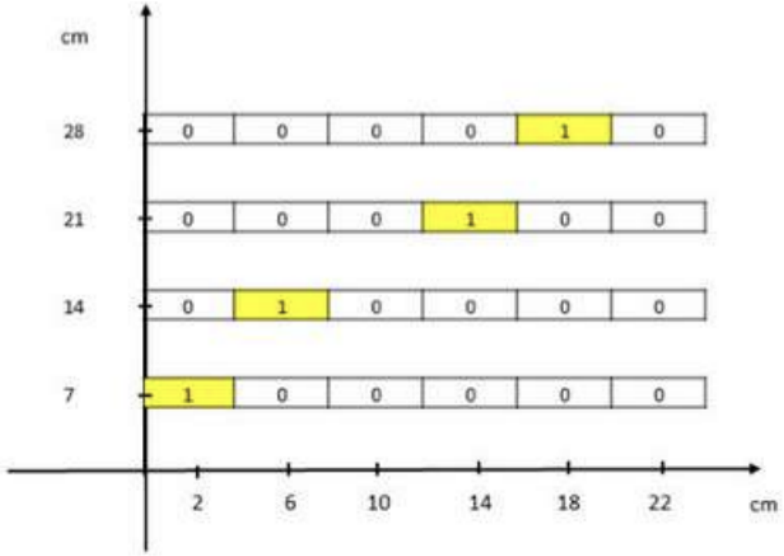
- Download the app on your mobile phone
- Go to Live Event and choose the site of your preference (LNGS is usually online continuously)
- Inspect the data tracks with the different panels at the bottom
- Go to SHARE/SAVE DATA option to retrieve the output file



Data format and analysis

- Each event provides, in hexadecimals, the information of the triggered bars in the two planes
- Example of data conversion and visualization available in this Google Colab notebook: https://colab.research.google.com/drive/14vl10tnXFD4i2vImmAE029m1vDxYe3hV?usp=sharing
- Contribute to it yourself by collecting and comparing data at different times and in different conditions





Discovering cosmic rays" for in-service high school physics teachers

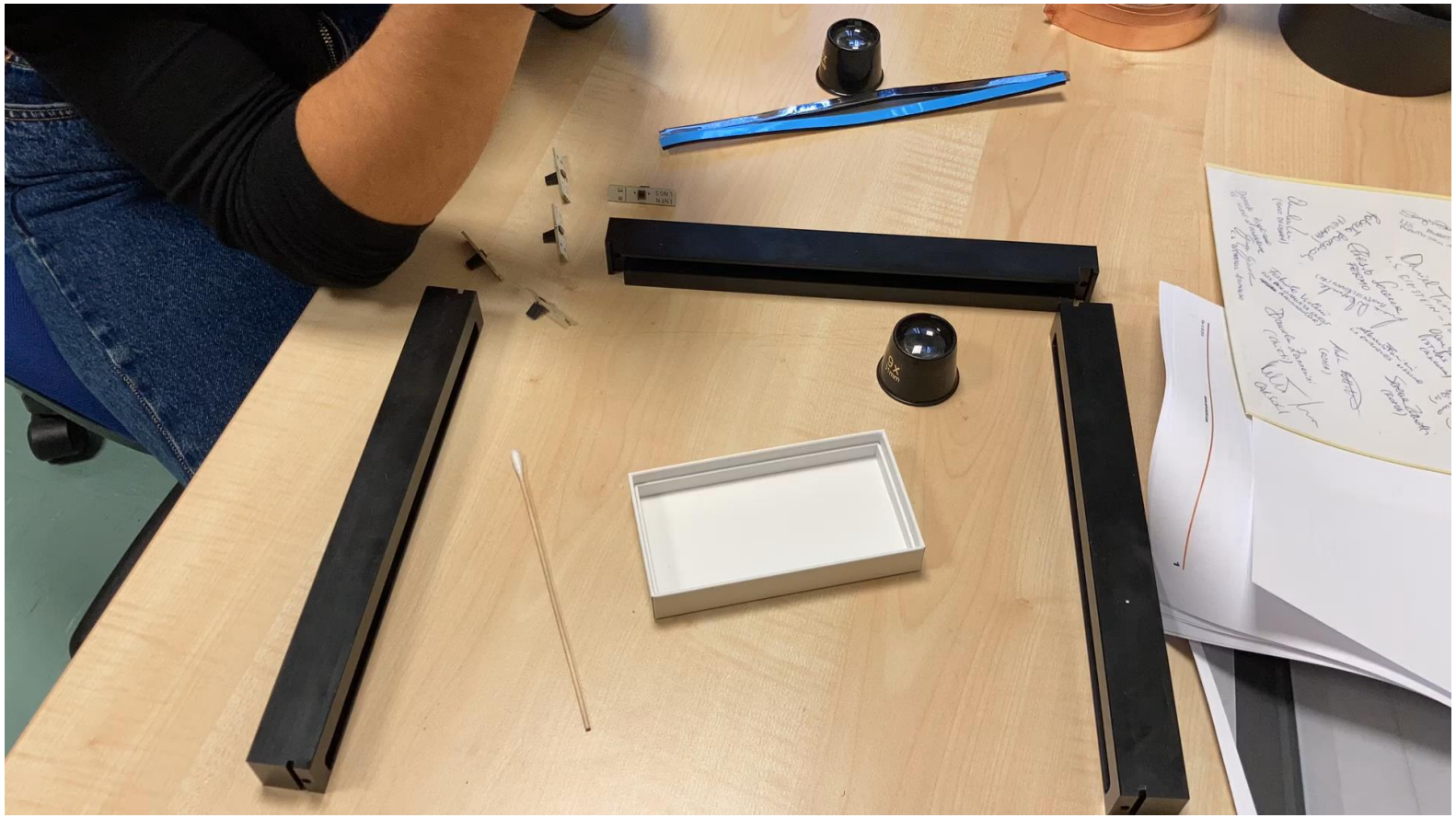
From 10 to 13 December 2023, 17 secondary school teachers from all over Italy attended the "Discovering Cosmic Rays" a course at the Gran Sasso National Laboratories.

The 2.5-day residential course was an opportunity to learn more about the fascinating topic of cosmic rays and gamma rays, the experiments that observe them and the messages they can bring us from space.

During the practical sessions, **participants were actively involved in building a muon telescope**, performing a muon flux measurement and analysing the data. A lot of space was given to the development of learning pathways in order to have a concrete and usable output.

The aim of the course was to provide an overview of the subject matter, enabling participants to familiarise themselves with the activities, experience them first hand and build on their prior knowledge and skills, **thus facilitating immediate implementation of the activities in the classroom.**

Teachers building the CRC during the course at LNGS



Second Teachers' Course: 8-11 September 2024 - Department of Physics and Astronomy, University of Padua.

- The 2.5-day residential course was attended by 30 high school teachers and aimed to introduce them to the topic of gamma rays, the experiments that observe them and the astronomical sources that produce them.
- **During the practical sessions, the participants used an online astronomical portal "firmamento" to obtain data from the latest astronomical observatories.**
- Some data analysis activities were then proposed and carried out in small groups.

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NEWS SCUOLA

NEWS SCUOLA 09 SETTEMBRE 2024

INSEGNANTI ALLA SCOPERTA DELL'UNIVERSO DELLE ALTE ENERGIE

Al via oggi, 9 settembre, fino all'11 settembre, il corso promosso dall'INFN "Alla scoperta dell'universo delle alte energie" dedicato a docenti delle scuole superiori di tutta Italia. Tre giorni di seminari, analisi di dati astrofisici e studio delle sorgenti di raggi cosmici di altissima energia, il tutto nella cornice del Dipartimento di Fisica e Astronomia dell'Università degli Studi di Padova e della Sezione di Padova dell'INFN.

Dopo il successo della prima edizione, lo scorso anno, questa volta sono stati selezionati, tra 180 docenti candidati, 30 docenti da 15 regioni italiane, con l'obiettivo di far loro conoscere più da vicino l'affascinante tema dei raggi cosmici per conoscere gli esperimenti che li osservano e le sorgenti astrofisiche che li producono. Le docenti e i docenti stanno partecipando in prima persona all'analisi di dati di osservatori astronomici attraverso l'uso di portali dedicati. Il corso ha, infatti, anche l'obiettivo di consentire ai docenti di prendere dimestichezza con le attività sperimentali, provarle in prima persona e accrescere conoscenze e competenze pregresse, per facilitare la loro condivisione in classe. Un momento significativo sarà la visita ai Laboratori Nazionali di Legnaro dell'INFN, dove i docenti potranno osservare da vicino le attività sperimentali in corso.

Gamma… hunting

During the 4 days of Futuro Remoto in Napoli we organised a treasure hunt involving more than 200 students and dozens of visitors.

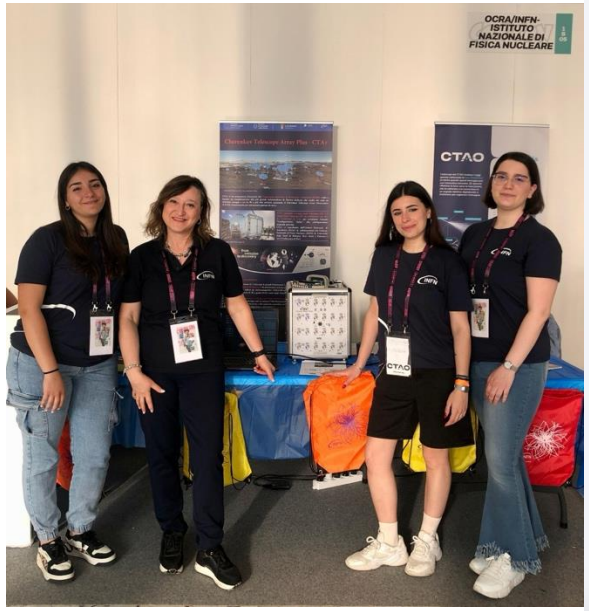
- **By retrieving 4 clues and composing a password, participants could access an escape room where they could, through virtual reality and immersive videos, solve questions to discover the gamma sky and how to observe it.**
- The participating teams had to identify 4 different locations, scattered around the Futuro Remoto site, run by researchers and each characterised by a particular activity: Cosmic Ray Cube, CTAO and CTA+, LST and ASTRI.

Comicon - May 1-4, 2025 - Napoli

At Comicon 2025, visitors were able to experience **the virtual reality developed by CTA+** and use visors to explore the Cherenkov Telescope Array Observatory.

During the activity, visitors were 'teleported' to 2035, the year in which the observatory is due to be completed. They could walk among the telescopes and observe them life-size, learning about their technology and operation through interactive games.

Additionally, they could observe the passage of cosmic muons live through the 'Cosmic Ray Cube-CRC' muon detector and its 'Cosmic Ray Live' app.



INFN - Istituto Nazionale di Fisica Nucleare
3 maggio alle ore 09:00 ·

🎉 Fino a domenica, alla Mostra d'Oltremare di Napoli, puoi giocare con la scienza!

In occasione della venticinquesima edizione di COMICON, il festival dedicato al fumetto e al mondo dell'intrattenimento, il progetto dell'INFN #OCRA Outreach Cosmic Ray Activities ha organizzato l'attività "Alla scoperta dei raggi gamma e del Cherenkov Telescope Array Observatory".

🚀 Ti basterà raggiungere lo stand 1S05 del padiglione 1, nel distretto GameLab, indossare il nostro visore VR, e prepararti a essere "teletrasportato" nel 2035! Tra dieci anni il CTAO Cherenkov Telescope Array Observatory, il più grande osservatorio al mondo per lo studio dei #RaggiGamma, raggiungerà la sua configurazione finale, e tu potrai ammirarla in anteprima passeggiando virtualmente tra i suoi 60 telescopi nel deserto di Atacama, in Cile, e sull'isola di La Palma alle Canarie.

Scopri tutti i dettagli: https://collisioni.infn.it/.../linfn-al-comicon-napoli-2025/

Transversal skills and orientation pathways - PCTO

- The activities offered by OCRA enable students to give concrete meaning to theoretical knowledge.

- **Direct, hands-on experiences promote active learning and the development of lasting skills and knowledge.**

- As a first activity, the students took part in the International Cosmic Day (ICD) to look beyond the usual stereotypes and participate in a real data-taking event. Students from all over Italy can also take part remotely.

- **The ICD enables students to explore the fascinating world of cosmic ray research, covering everything from its history to cutting-edge studies.**

Transversal skills and orientation pathways - PCTO

- ICD is one stage in a journey that runs throughout the school year.
- Through a series of meetings structured as a 40-hour PCTO, students become protagonists of the research, studying theory, conducting experiments, collecting and analysing data, and participating in critical discussions of results.
- Finally, they produce papers in the form of scientific articles to present their work and also participate in a competition, https://agenda.infn.it/event/46562/overview in order to determine the winners to the national INFN Summer Camp.

And now... it's your turn!

Working in groups of five, design a public engagement activity.

- Choose a target audience, such as children, secondary school students, university students or the general public.
- Choose a methodology (gaming, an in-person or online lab, a CRC, etc.).
- Then choose where you want to organise the activity (e.g. a festival, a school, a laboratory…..).

Acknowledgements

OCRA is supported by the INFN CC3M commission; it is also supported by the the European Union – NextGenerationEU" RFF M4C2 project IR0000012 CTA+ PNRR, CUP C53C22000430006.