

Measurement of the cosmic radiation rate in water as a function of detector depth

id #141

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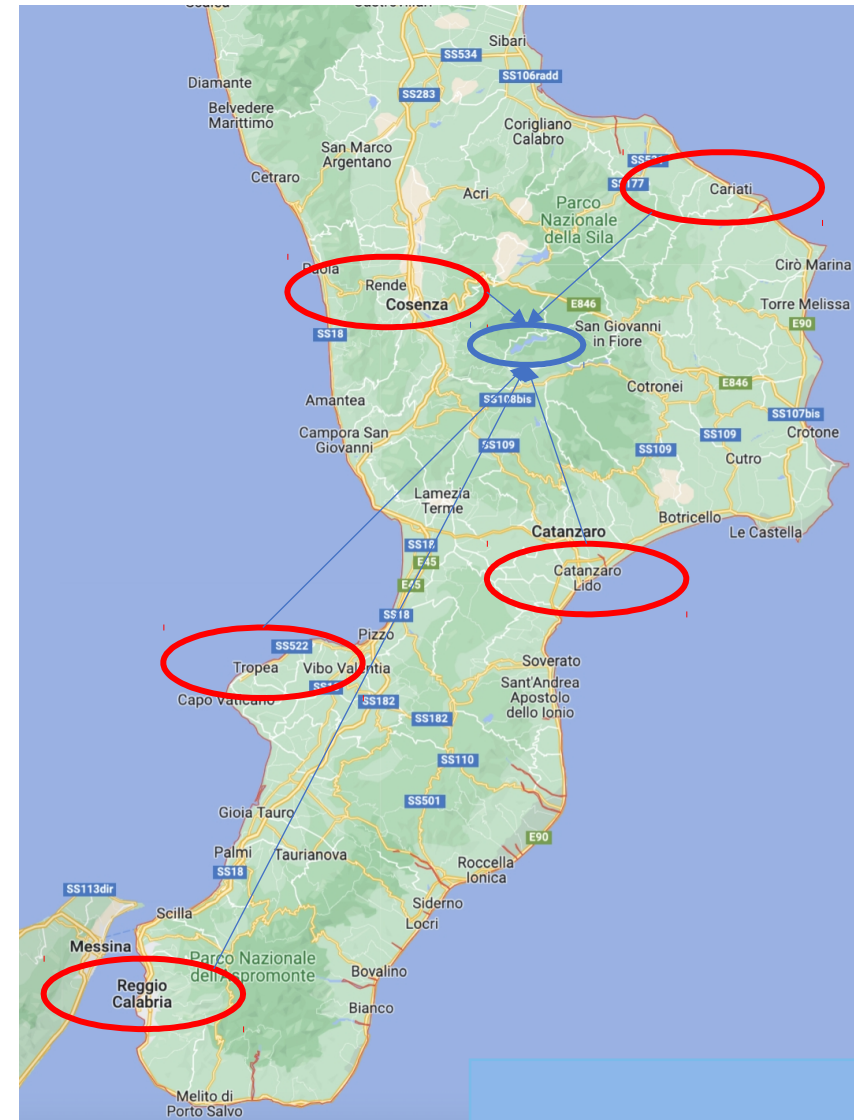
MoCRiL PROJECT

(Measurements of Cosmic Rays in Lake)

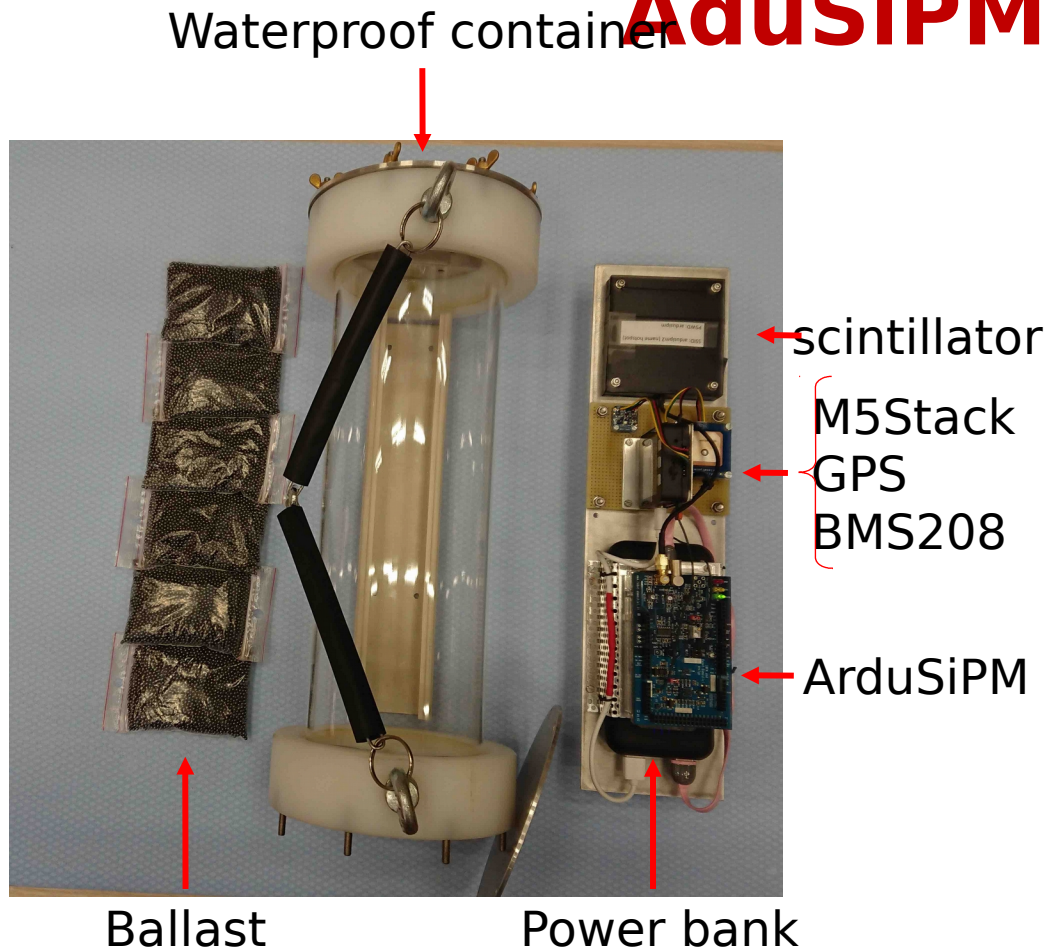
Students and teachers from 4 high schools in the Calabria region performed Domenico Pacini's experiment in a modern key on the origin of the natural ionizing radiations that surround us. With the collaboration of the INFN and University researchers, the schools prepared for about 2 months for this event, collecting a large amount of data in the air with a small-sized scintillation detector and then analysing them. On 31 May 2022 they went to Lake Arvo 1300 m above sea level, where they performed the measurements by immersing the detector at different depths. This activity is one of the many organized by INFN-OCRA awareness raising activities.

The students involved in the project MoCRiL comes from

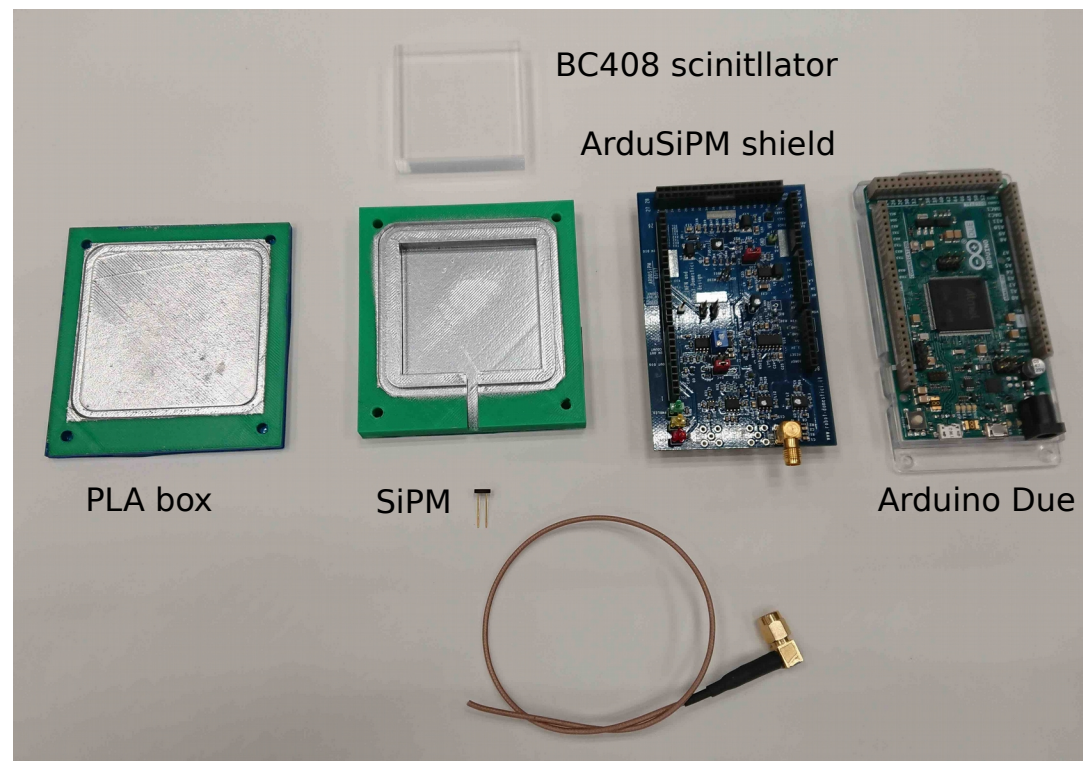
- Higher education institution of
 - “Patrizi” di Cariati (CS)
 - “Galluppi” di Tropea (VV)
 - “Fermi” di Catanzaro (Cz)
 - “Volta” di Reggio Calabria (RC)
- Dip. Fisica Unical Rende (CS)



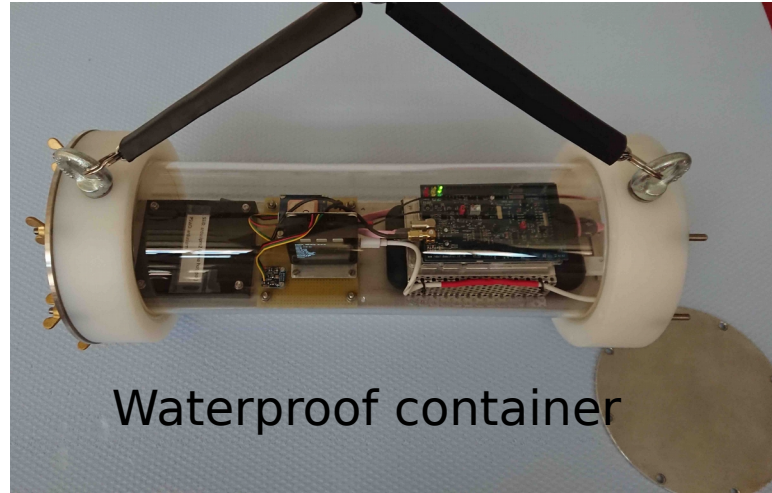
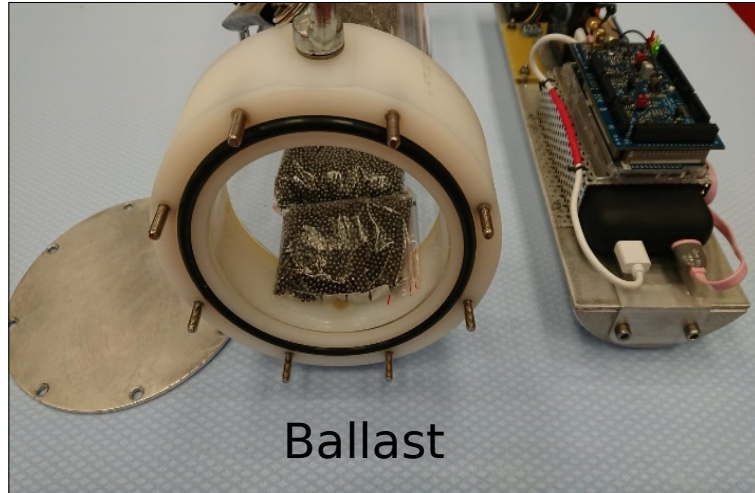
The detector: AduSiPM



ArduSiPM



The detector: AduSiPM

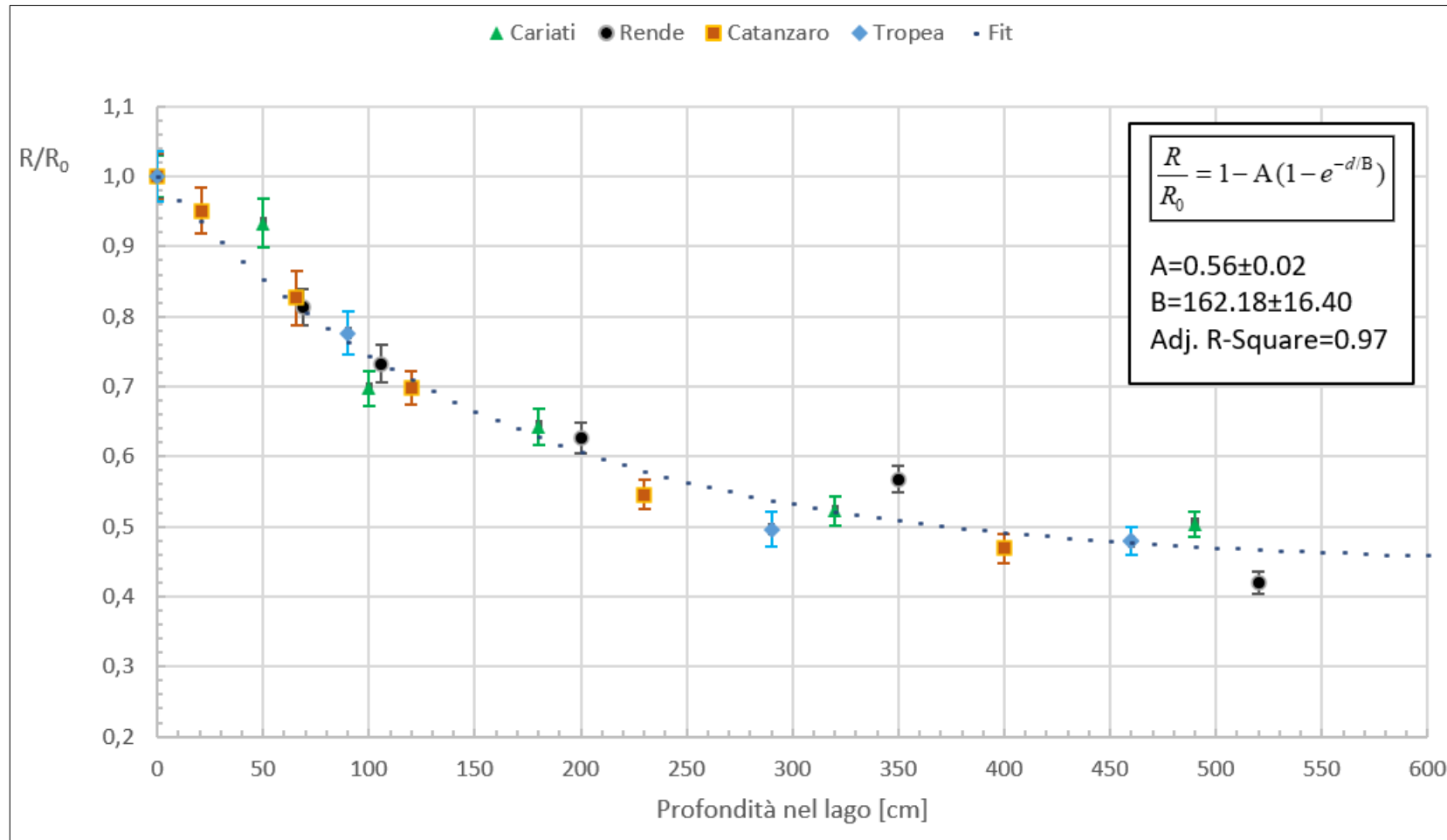


The lake and the students of the 5 groups of the MoCRiL project



Arvo lake – Sila (1300 m osl)

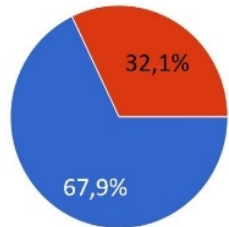
Results



Didactic impact

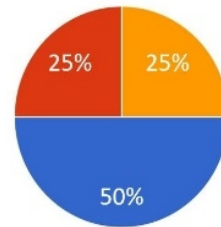
Sample who did not participate in the experience (113 students of which 76 boys and 37 girls)

in your high school years have you ever participated in any physics experiment?



Never
1 to 5 times
More than 5 times

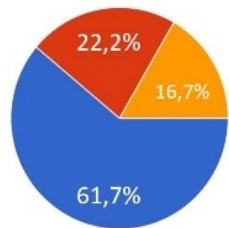
perceive physics as



boring
useless for everyday life
interesting and useful

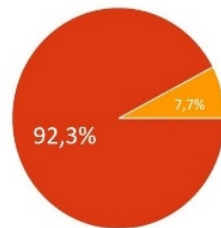
Statistics on the use of laboratories and on the perception of physics

would you like to deepen the study of physics?



yes
no
Yes, at the university

do you think physics is a subject to learn?



In the classroom
In the laboratory
It is however incomprehensible

Statistics on the will to deepen physics and its learning modality

Marco Schioppa

Points of weakness



- Poor use of the laboratory (the pupils interviewed were in the laboratory only once a year at most). Consequently, many of these pupils perceive physics as boring and useless for everyday life and do not believe in the usefulness of group work and only a few classic topics remain
- Little participation of all teachers and difficulties in their involvement (team)
- Few opportunities to work extra-curricular hours especially for commuters (pupils and teachers)
- Research of didactic techniques functional to the improvement of learning
- Specialized maintenance on laboratory instrumentation
- Targeted, updated and continuous training
- Synergistic work at departmental and class council level

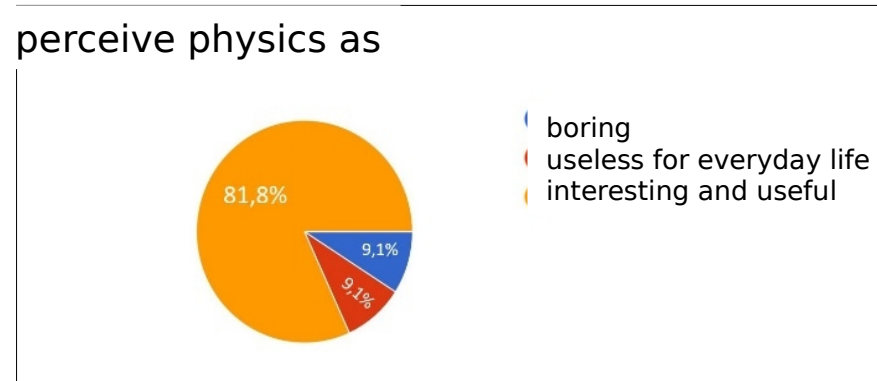
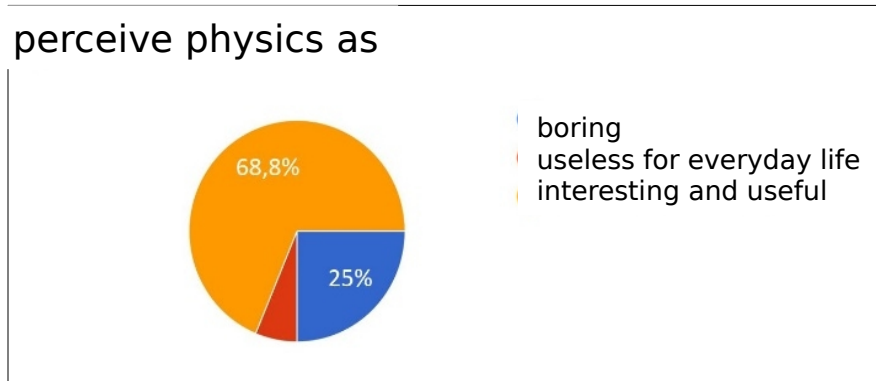
Strengths



- In many cases, there is a need for further study and the desire to be able to learn physics in the laboratory
- Involvement of students in research projects
- Group experiences, socialization, inclusion (Erasmus, PCTO and PON)
- Simplification of learning processes through the aid of laboratory practices
- Availability of equipment and laboratories
- Interaction with the territory

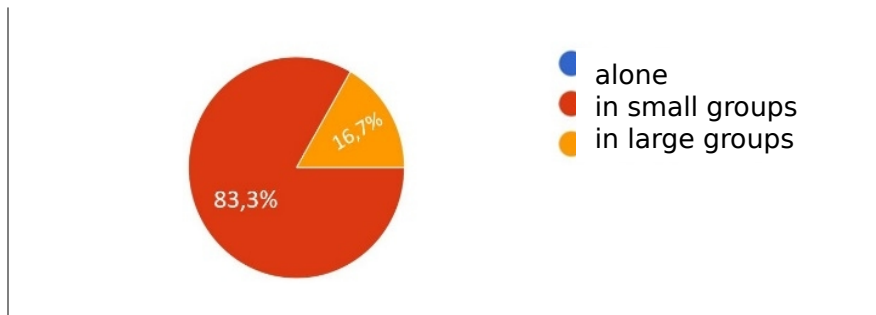
Didactic impact

Sample who participate in the experience (137 students of which 46 boys and 91 girls)

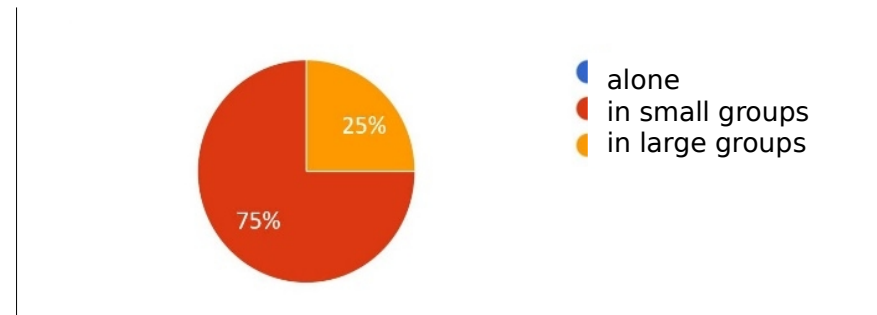


Statistics, before and after the experience, on the perception of physics

in your opinion, research is progressing better



in your opinion, research is progressing better



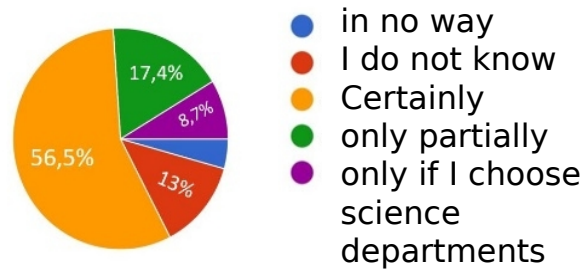
Statistics, before and after the experience, on the importance of collaboration in research.

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Didactic impact (cont.)

Sample who participate in the experience (137 students of which 46 boys and 91 girls)

think MoCRiL experience will be useful for my future studies

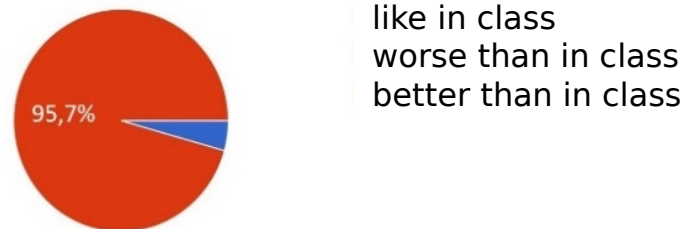


The MoCRiL experience has contributed in order to make me perceive the interest in physics



Statistics on the influence of the MoCRiL project on the orientation of studies and interest in physics

your learning in the MoCRiL experience was



Statistics on learning in the MoCRiL project

Observations on the results of the questionnaires completed by the students who participated in the project MoCRiL

It is confirmed:

- the effectiveness of laboratory teaching in learning processes;
- the perception of physics as a discipline present in our daily life also useful for the training of future aware citizens;
- the awareness, experienced in the field, of the importance of teamwork and collaborations between the school and research institutions and / or universities;
- a significant elimination of many misconceptions related to physics and harmful to university orientation;
- the improvement of interpersonal relationships with peers and teachers.

The interviewed students wish the possibility of carrying out other similar experiences and a significant percentage of them believe that the MoCRiL project will be useful to them for their future studies regardless of the university choice they will make and that it has contributed a lot to increase their interest in physics.

Conclusions

The results obtained are in line with what Domenico Pacini and physicists of his generation discovered:

1. the rate decreases moving from the mainland to the surface of the water, demonstrating that part of the penetrating radiation originates from the radioactive decay of the elements present in the earth's crust;
2. the rate decreases by immersing the detector at different depths with a mathematical law which is the sum of a constant and an exponential;
3. the two terms of the mathematical law that describes the data correspond to two components of the penetrating radiation present in the air, one (called soft) which is shielded by a few meters of water and one (called hard) much more penetrating.



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

Thank you for your attention