Liceo San Giuseppe Calasanzio Carcare

A COSMIC BOX TO STUDY COSMIC RAYS ATTENUATION IN OUR SCHOOL IN ORDER TO STUDY MUON ABSORPTION FOR OUR EEE DETECTOR

EEE project a. s. 2025/2026

Run coordination meeting 27/05/2026

Cosmic Box N.1

THE REASON BEHIND THE PROJECT

The detector

It is currently inactive, waiting to be operative again after a long pause since the Covid-19 pandemic

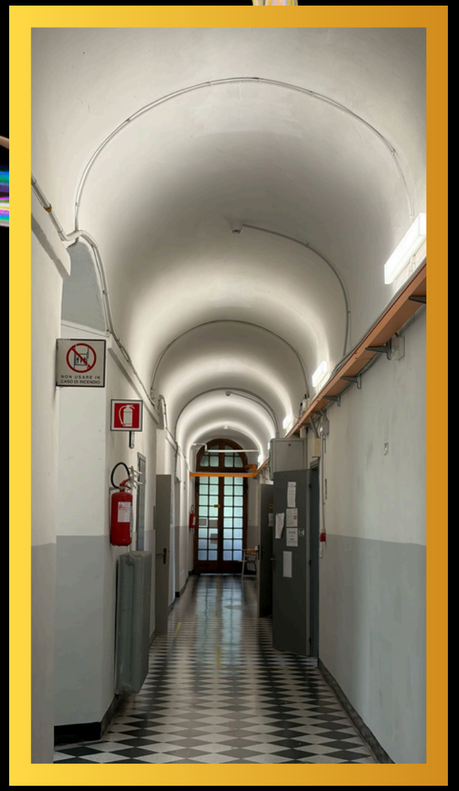
Its location

Placed at ground floor (aula 10) and fixed there, the two stories (aula 21 and aula 34) above it are surely going to interfere with its measurements

The proposal

Envisioning a future usage of the detector, we'd like to calibrate it accounting for any interference.

We want to compare the interference which our detector is subject to compare it with other measurements made at different floors in the same building and outside in order to better calibrate our detector.



THE HISTORY OF THE BUILDING

The foundation

In 1621 the College of Pious Schools was founded, adjacent to the church of Anthony the Great, built in the same period as part of the monastic complex

The XIX century

During the 19th century the school saw a period of greatness, having also been the learning place for important Risorgimento figuers such as Goffredo Mameli and Cesare Abba

The evolution of the building

The original 17th century structure has been left largely unchanged, but new stories have been added, all constructed with different tecniques and materials.

ABOUT THE SCHOOL

The building

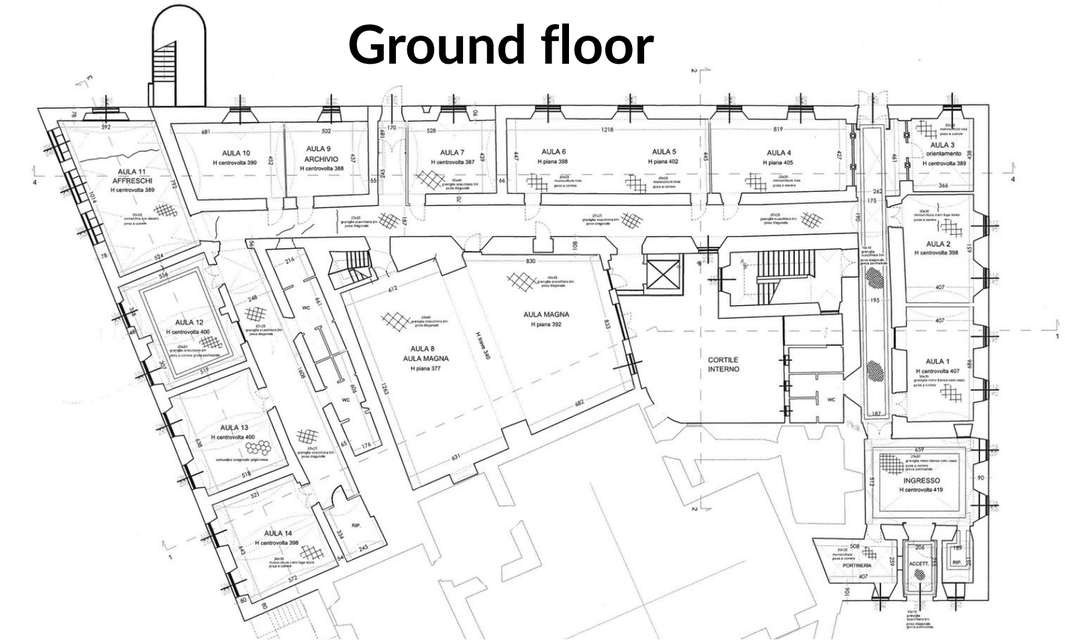
The State High School “S.G. Calasanzio” in Carcare (Savona) has a long history that began in 1621 with the College of the Pious Schools, founded by St. Joseph Calasanzio.
It became a State High School in 1962.

Today, the school has 414 students, 55 teachers, and 22 classes divided into three programs:

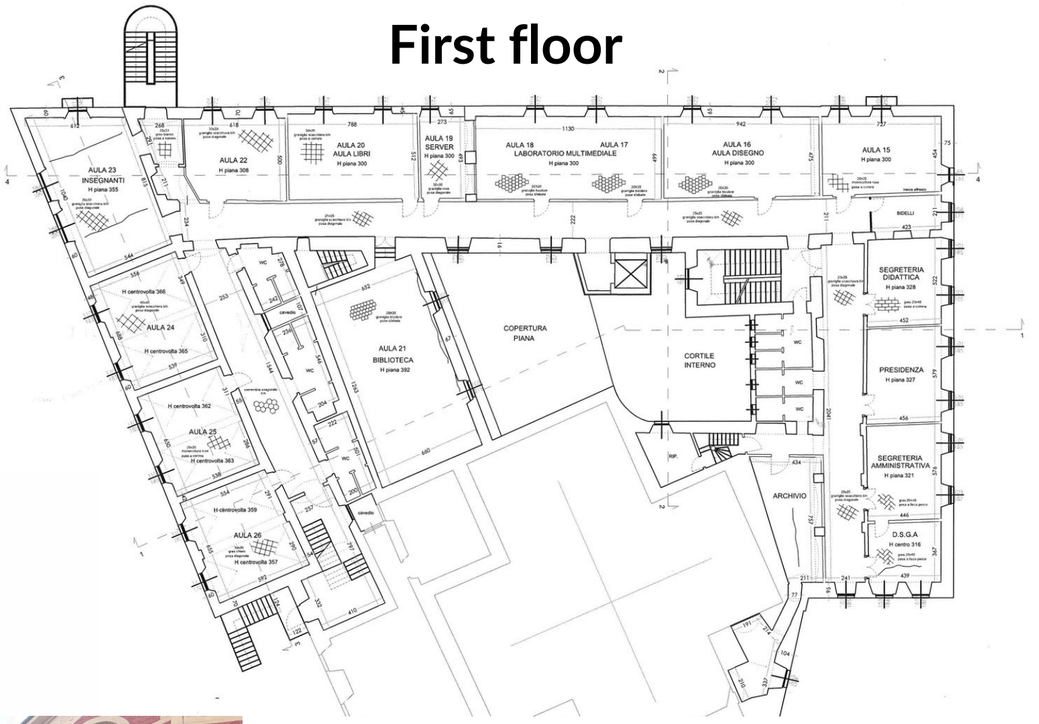
- Classical High School
- Scientific High School
- Linguistic High School (Esabac curriculum)

The Institute includes several facilities:
a classical library, computer and science labs (chemistry, physics), two multimedia language labs, a drawing room, a gym, an Aula Magna, and a thematic library on history and philosophy.

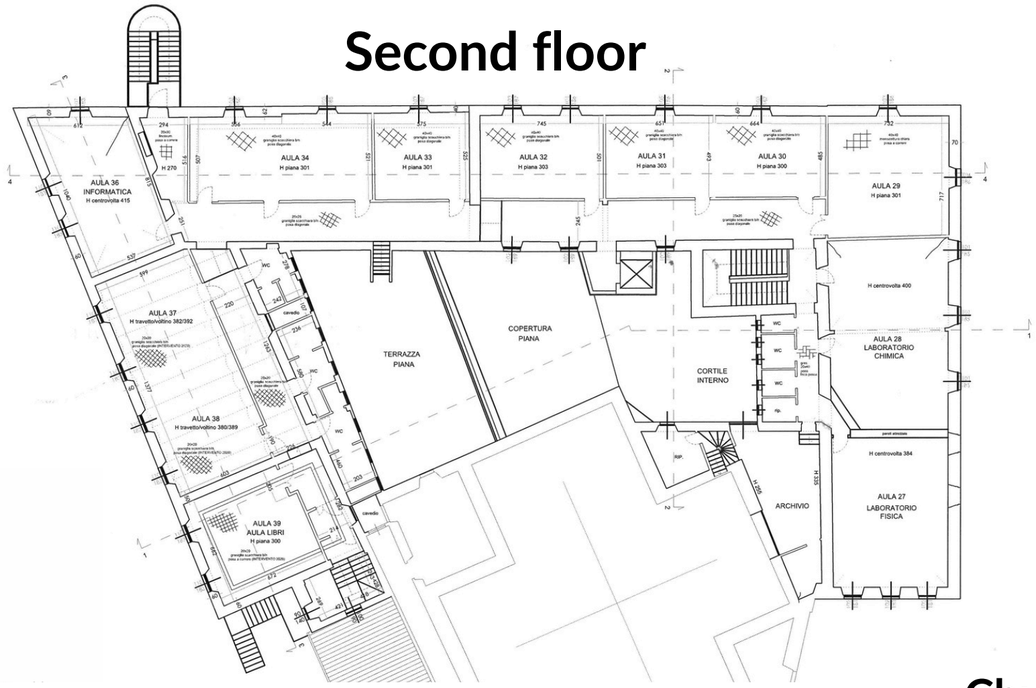
Ground floor



First floor



Second floor



Church of Sant'Antonio Abate

The walls gradually become thinner between floors, with the ground one having the widest. Interference is also going to be due to this factor

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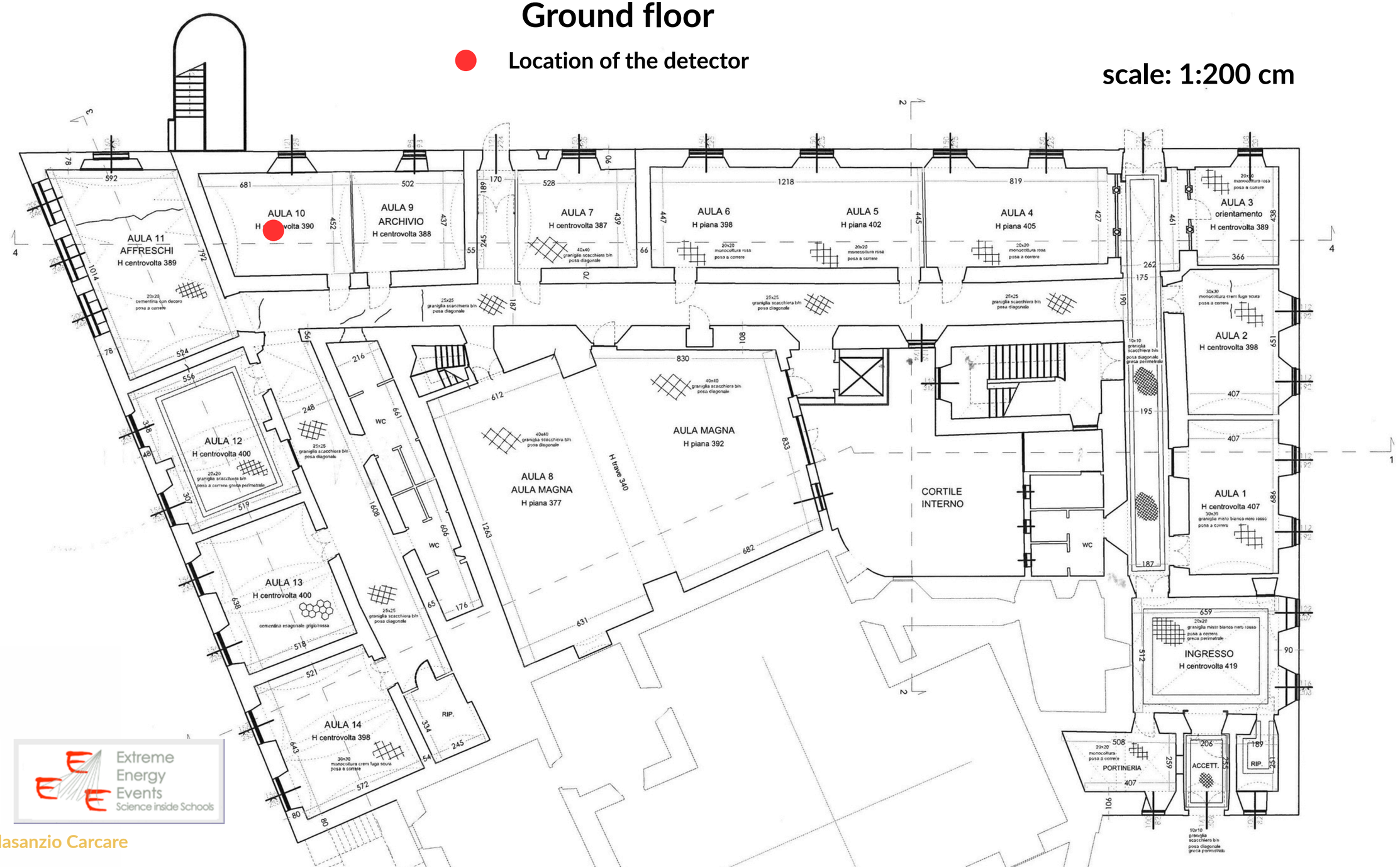
Ground floor

Location of the detector

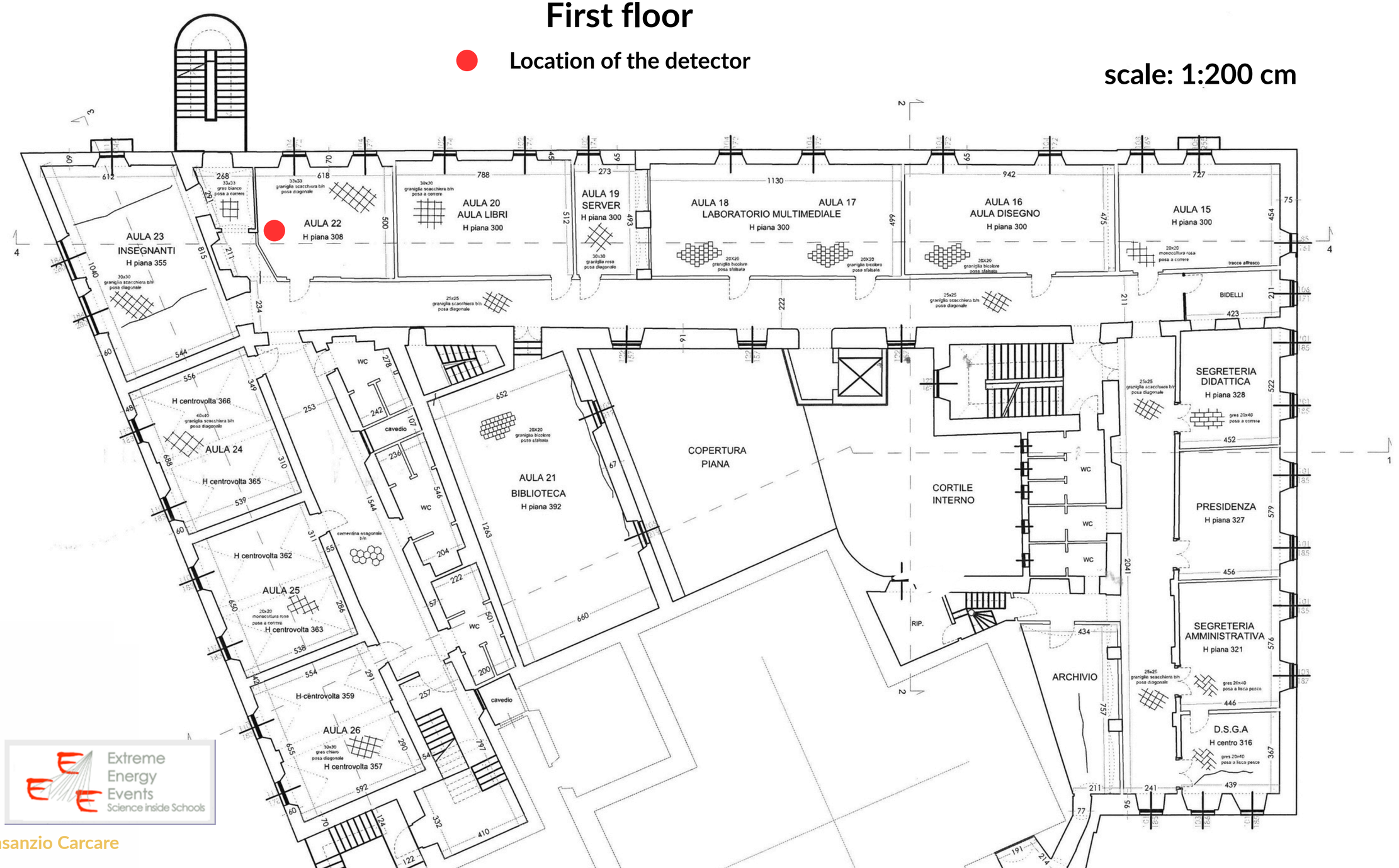
scale: 1:200 cm



First floor

Location of the detector

scale: 1:200 cm



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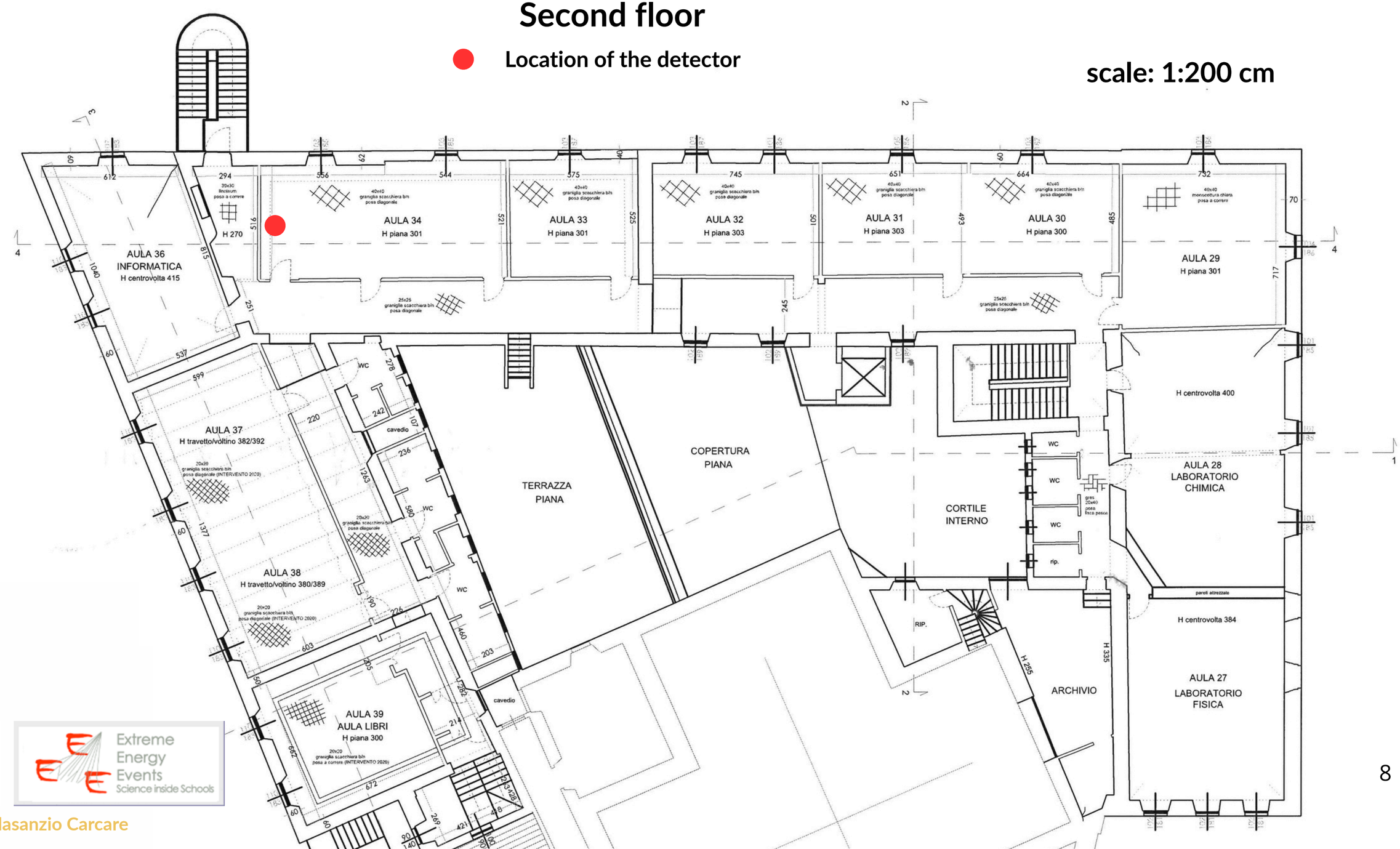
Second floor

Location of the detector

scale: 1:200 cm



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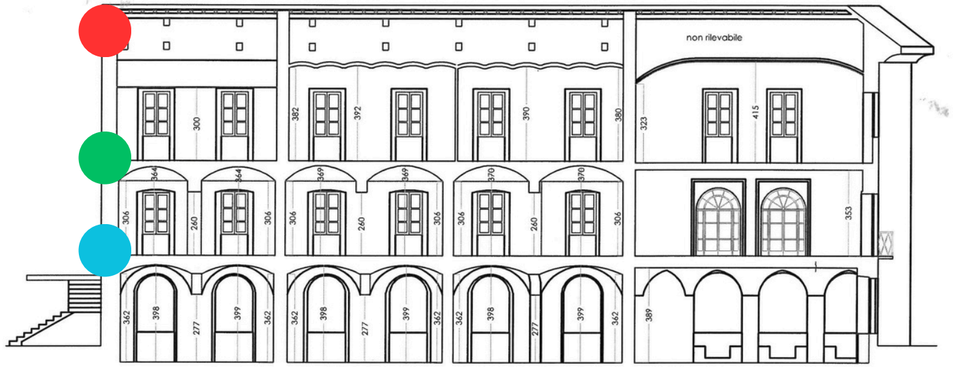
SEZIONE 1-1

SEZIONE 2-2

Ground/first floor

First/second floor

Attic and roof



SEZIONE 3-3

SEZIONE 4-4

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THE BUILDING MATERIALS

Given the long history of the building, the different floors vary wildly based of the time of construction. There are differences both in the materials used and the width of the peripheral walls, which are almost the widest at the ground floor but a lot narrower at the highest one

Ground/first floor

Full bricks (18 cm)
Embankment in various materials (varying with, 20/120 cm)
Lime layer (6 cm)
Grit pavimentation

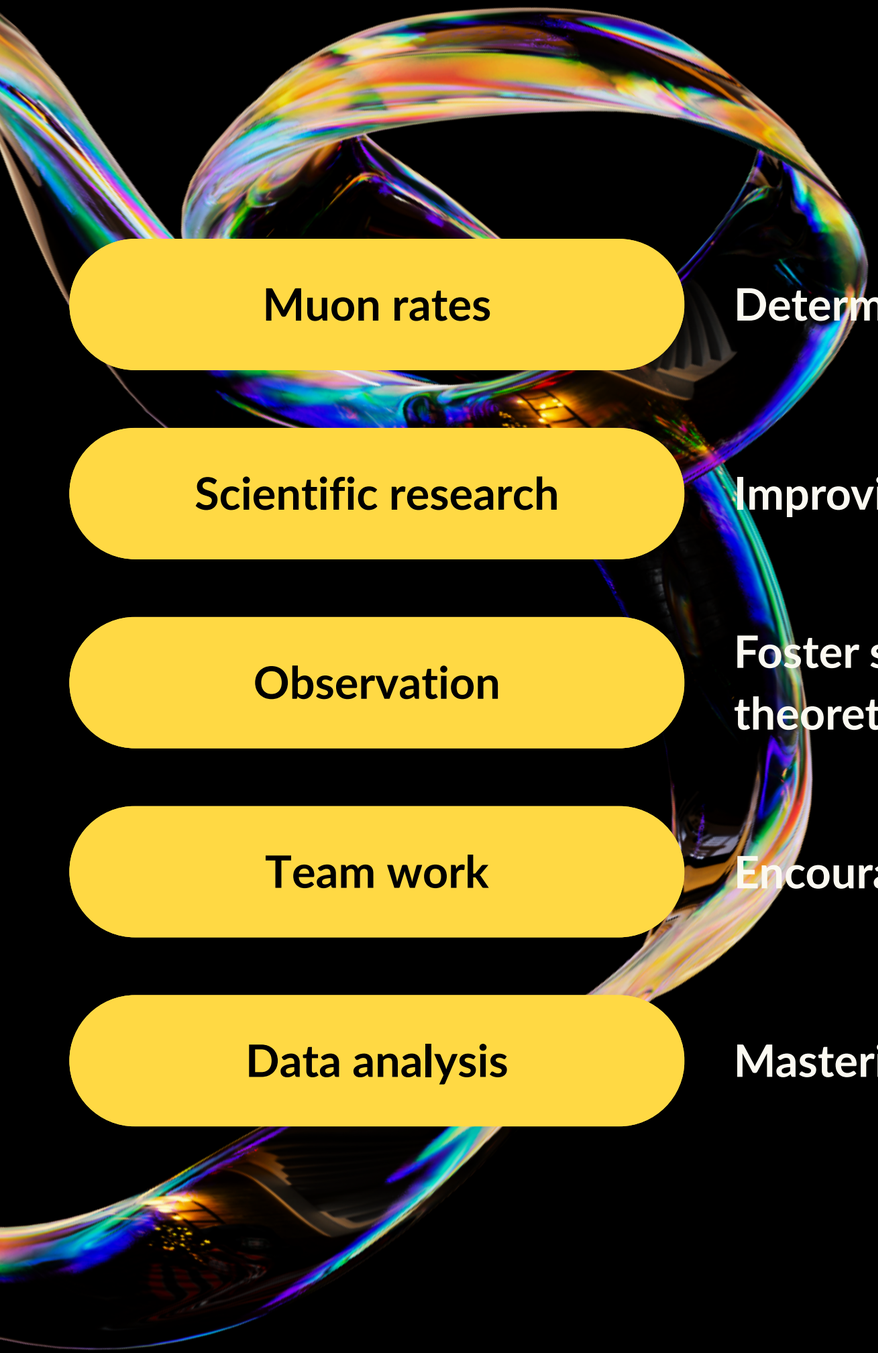
First/second floor

Wood reinforced with steel bars
Plank floor
Concrete layer (10 cm height)

Attic and roof

Calcium silicate layer (2/3 cm height)
Free space (150 cm height)
Wooden roof frame
Bitumen sheath (2 cm height)
Brick roof shingles

OUR GOALS



Muon rates	Determining muon count in the building and comparing it with external rates
Scientific research	Improving the students' understanding of scientific research and its methodology
Observation	Foster students' learning of scientific matters through theoretical models and data observation
Team work	Encouraging students' curiosity, their problem-solving skills and their teamwork
Data analysis	Mastering Excel as an instrument to analyze data

THE PROJECT'S PHASES

preliminary phase

Initially, we familiarized ourselves with the software Excel and the Cosmic Box.

measurements

We took measurements at the different floors of the school and out of it. We also used two VinciLabs in order to monitor ambient pressure and temperature

data analysis and conclusions

Data was analyzed through the software Excel and plotted through Root and special care was placed on errors

ERRORS

N= 3600 s x 0,5 Hz = 1800

$$E_a = \sqrt{n}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}}$$

Measurements suggest a 0.5 Hz rate of measurements at sea level.
Through this datum, applying the poissonian error model to 1 hour long sessions, we can see that the error rate would be at around 2.3%.

This low rate would allow us to ignore all other error origins, as time and surface should be irrelevant when compared to the poissonian error, since the statistical error would be of the same magnitude as systematic errors, which we evaluate to be around 5%.

We are also going to consider the standard deviation and take into consideration the bigger error between this one and the poissonian one.

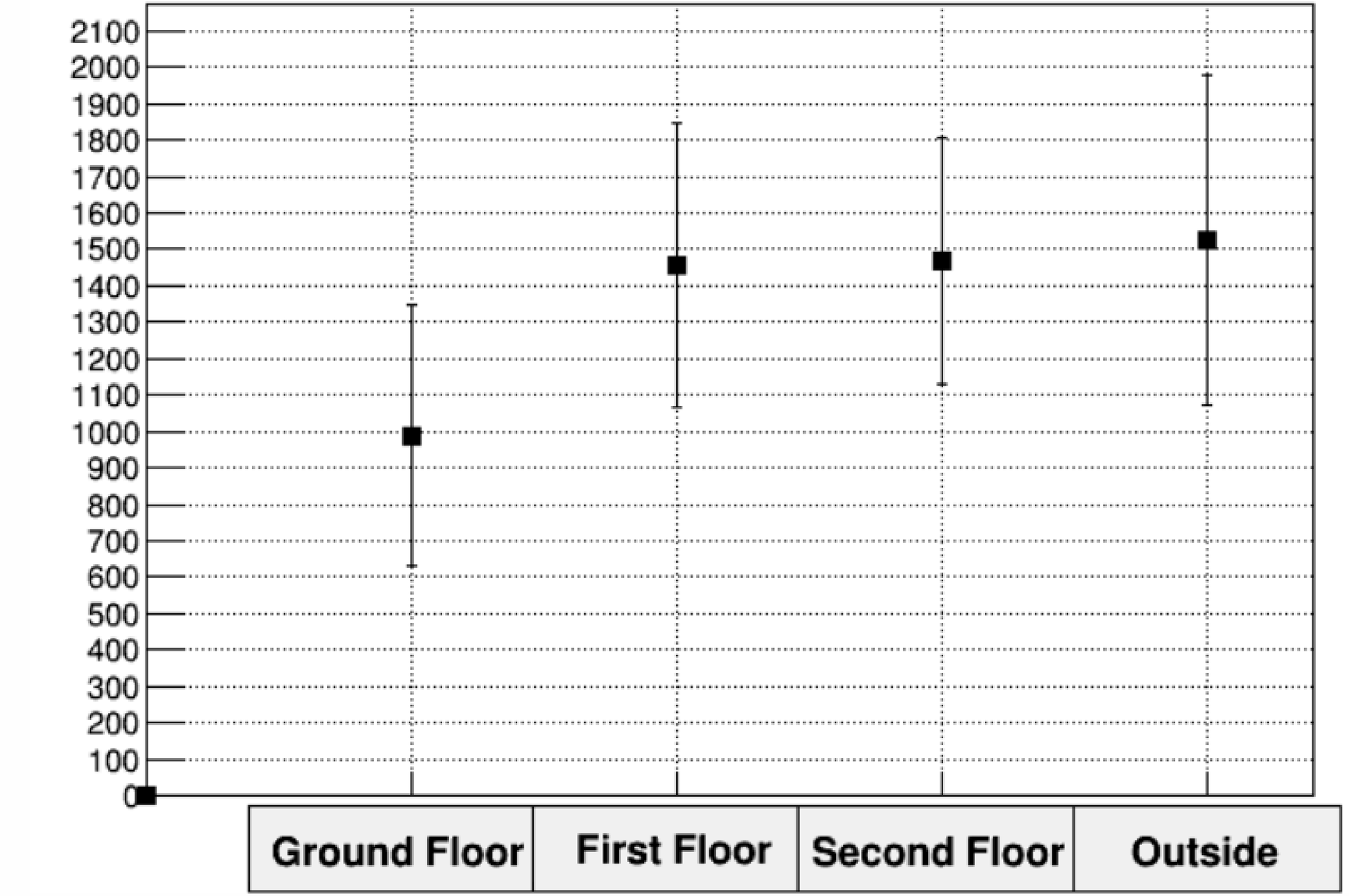
The data found

Though there were some problems with the data gathering, such as the CosmicBox overheating and a Forbush happening on 30/03, we managed to gather enough data in order to find some significative results.
Since we also monitored the ambient pressure and temperature, we are were able to determine that both those paremeters, especially ambient pressure, were extremely stable, thus rendering any barometric correction basically meaningless.
In paritcular, the maximum difference between the lowest and highest pressure values was less than 2%.

Measurement	Muon count
1	1578 ± 40
2	1807 ± 43
3	2115 ± 46
4	1413 ± 38
5	1112 ± 33
6	1416 ± 38
7	2105 ± 46
8	1850 ± 43
9	1693 ± 41
10	1255 ± 35
11	1174 ± 34
12	1607 ± 40
13	1076 ± 33
14	1010 ± 32
15	1713 ± 41
16	1087 ± 33
17	1115 ± 33
18	1419 ± 38
19	1345 ± 37

Place	Average count
Ground floor	989 ± 359
First floor	1456 ± 389
Second floor	1468 ± 336
Outside	1525 ± 451

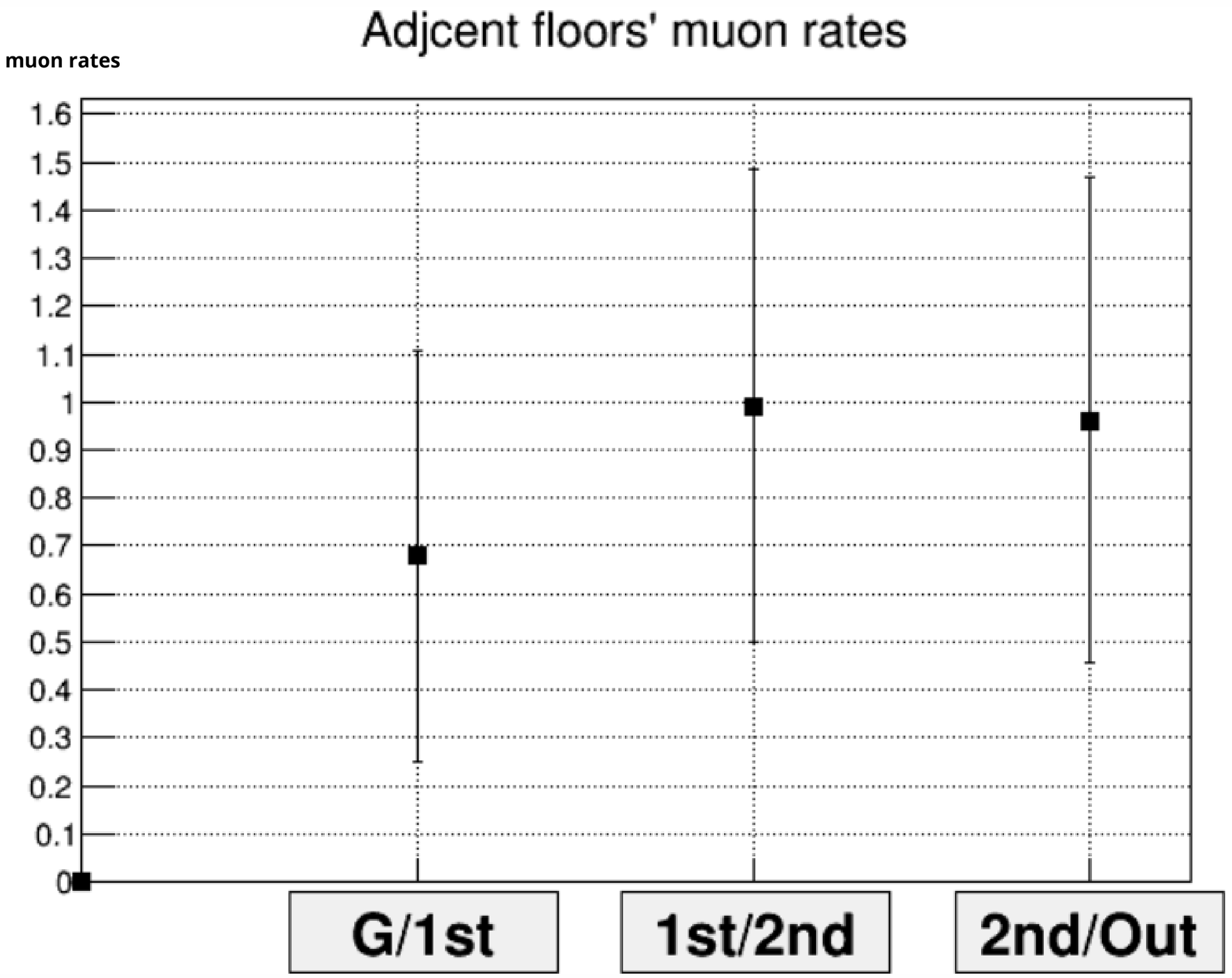
Muon count averages across floors



The error and the rates

Place	Rate
Ground/first floor	0,68± 0,43
First/second floor	0,99± 0,49
Second floor/outside	0,96± 0,50

The analysis yelded a poissonian error of about 36.68, or about 2.76%.
Instead, the standard deviation σ was 394.32, or about 29.31%.
SInce the latter is the greatest of the two errors, we considered that one for our analysis.
In particular, in the following graph, which plots the rates of the averages of muon counts between adjecent floors (and the second floor and the external measurements), we can see that the rates stadily decrease betweent floors, especially between the first and groud floor. There also is a basically non-existant decrease in muon count between the first and second floor.
The data found is compatible with the expected results, since the materials between those two floors are the thickest.


Adjcent floors' muon rates
muon rates
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
G/1st
1st/2nd
2nd/Out

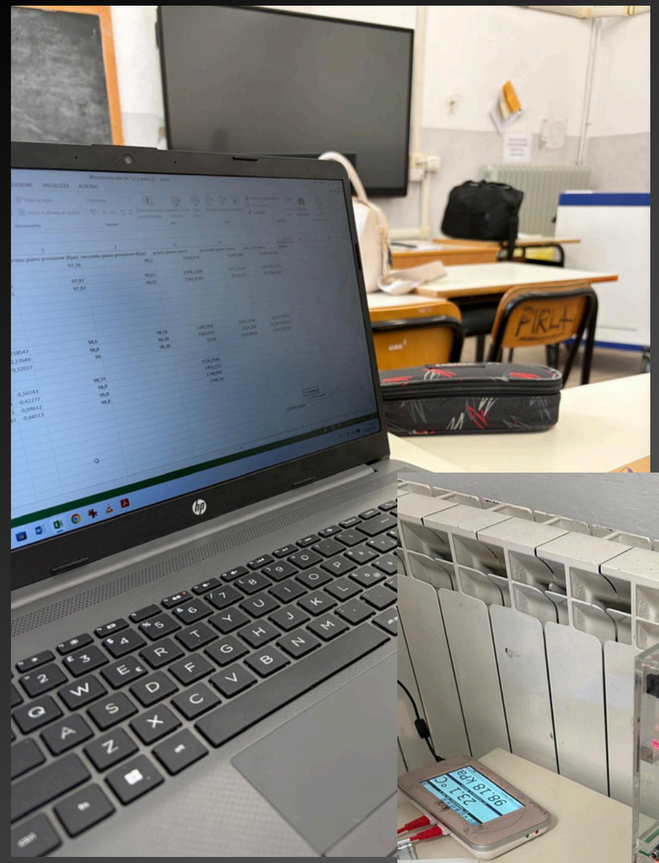
Conclusions

The results found were in line with the expected results, with a significant drop in the muon count between the floors were the material interference is most sensible (ground/first floor, second floor/outside). We also found that the attenuation between the outside and the ground floor was about 35%.

No particular mathematical model describing the drop at the various floors was found, nor was it expected to be, since the materials and their composition vary with no coherent structure.

The main objectives of our project were reached, especially those referring to improving the students' skills in data gathering and analysis and teamwork.

Unfortunately the error present in the data was extremely high, but this is the only data we managed to gather. However it should be noted that such an error was a great opportunity for the students to learn about managing errrors and the importance of keeepimg them low.

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Liceo Calasanzio Carcare (SV)

THANK YOU

for your time and attention

Presented by Barlocco J., Bernardini P.,Berretta G., Bertacchi F., Bolla S., Bortoletto N., Brahimi K., De Savi G., Giribone G., Haliga L., Hanciuc D., Iannuccelli E., Kamberay L., Marchisio P., Martini A., Monopoli M., Parodi F., Pessano G., Tessitore A., with the collaboration of prof.ssa Michela Occhetto and prof.ssa Noemi Ghio.