

The microNet (μ Net) project: Status Report

L. Xiros, A. Tsirigotis, S. Nonis, A. Marantis, A. Leisos
Physics Laboratory, School of Science and Technology
Hellenic Open University



Educational Cosmic Ray Telescopes

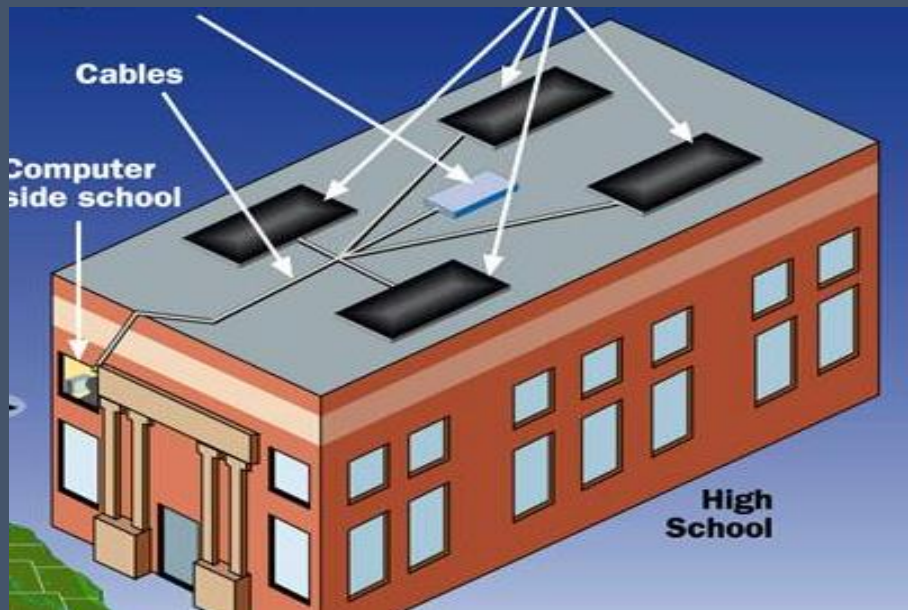
μ Cosmics Detector

The μ Net Project

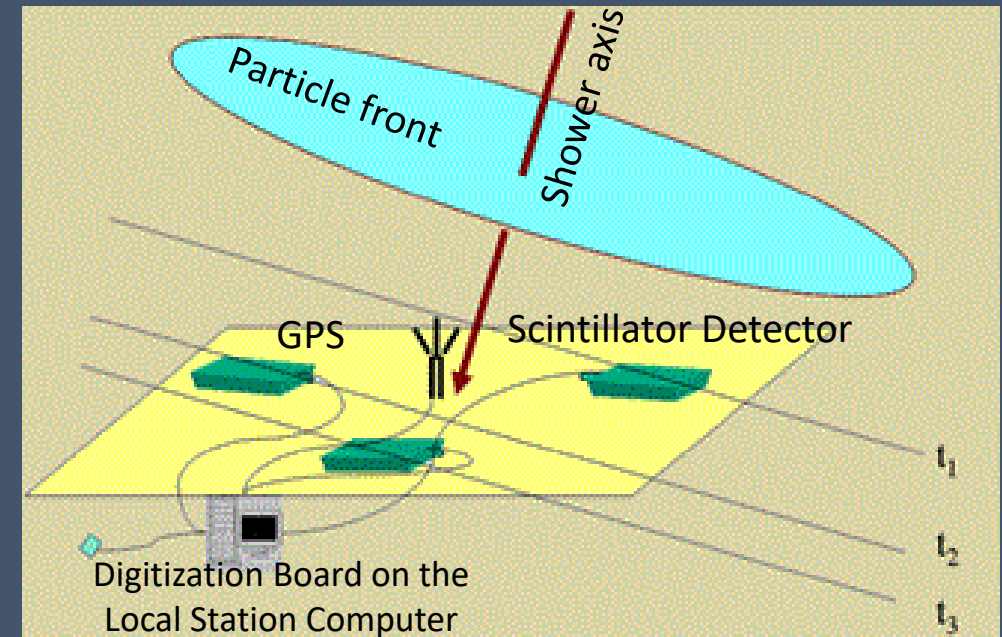
μ Net Pilot Runs

μ Net 1st Year of Operation

A typical educational Cosmic Ray Telescope



Reconstruction of the shower direction



3-4 plastic scintillator detectors

Local Coincidence, Relative Timing and Triangulation

Shower axis reconstruction with an accuracy of a few degrees.

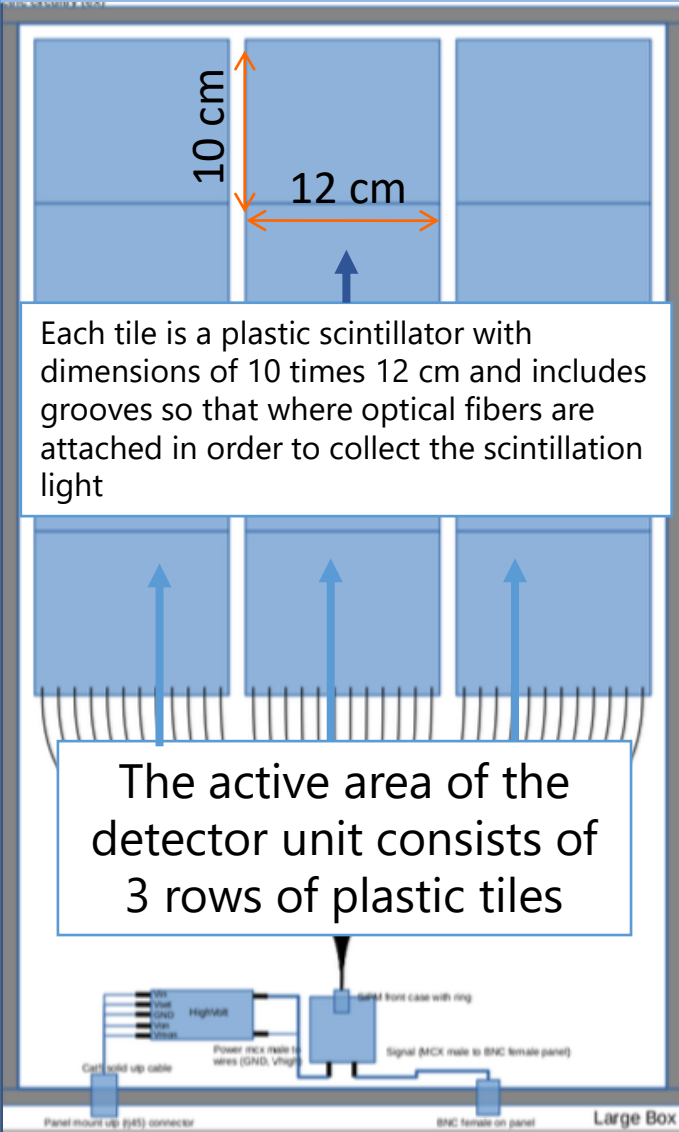
For the development of the corresponding Greek network of educational cosmic ray telescopes, the Physics Laboratory of HOU designed and developed a small, cheap and portable telescope called the μ Cosmics detector.

Its main feature is that it can be assembled by students and operated within the classroom or school laboratory.

It consists of 3 detection units (white boxes), a PC-base Digital Oscilloscope and a computer for controlling its operation.



MDPI, Universe 2019, 5(1), <https://doi.org/10.3390/universe5010023>



Active area of the detector unit

The Sipmt is supplied with a voltage of less than 40V

The whole construction is easy to assemble and disassemble.

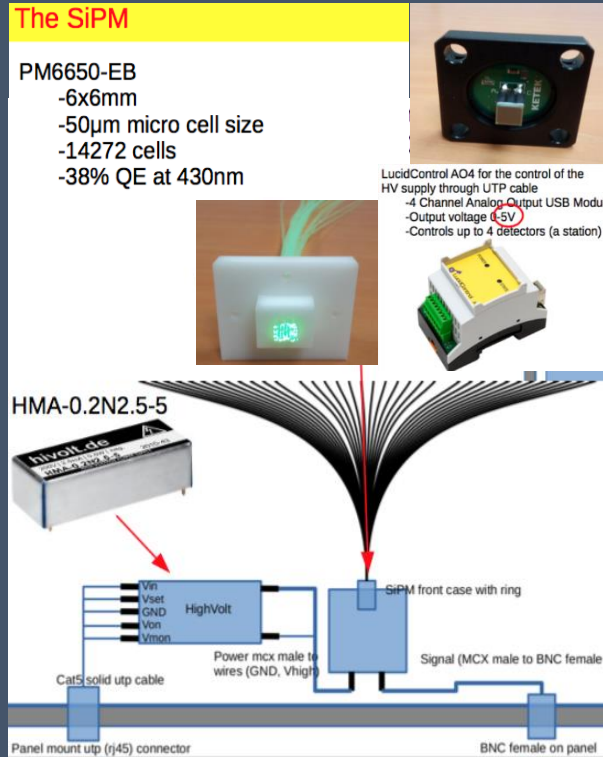
A total of 36 optical fibers run through the channels and their edges are coupled to a Silicon Photomultiplier tube in order to convert the light collected into an electrical signal

- Portable (67x42x7 cm³, light (6 kg)
- No high voltages (<40 V)
- Easy to construct

In order to reduce light losses we wrap the tiles with reflective paper

The basic components of the detector are divided into 2 categories

Detection Unit



The detection unit is contained in the white box and includes the scintillation tiles, optical fibers and Sipmt

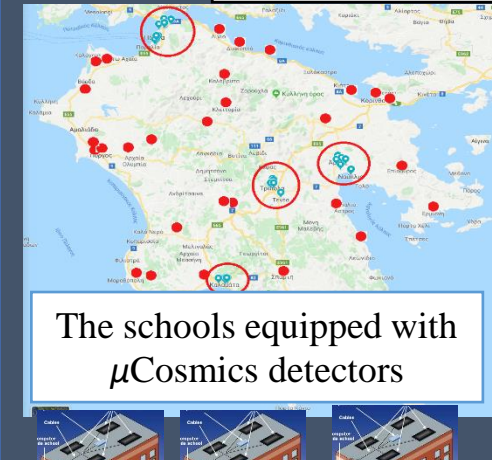
Data Acquisition System



- 1 Gsa/s acquisition rate
- 250 MHz Analog Bandwidth
- 4 input channels with amplification.
- It is operated through the USB port of the PC
- Full waveform digitization

The data aquisition system consists of a pC-based digital oscilloscope

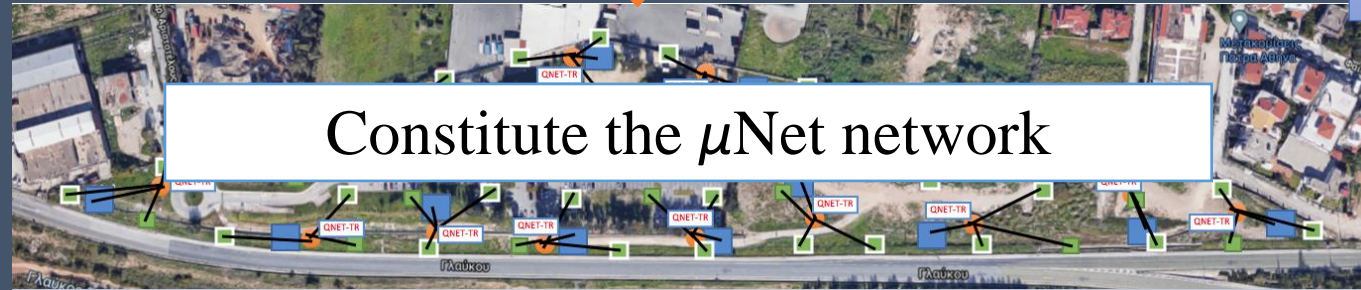
Int. Journal of Modern Physics A Vol. 35, No. 34n35, 2044022 (2020), <https://doi.org/10.1142/S0217751X20440224>



The 1st Greek school network of educational cosmic ray telescopes.



μ Cosmics detectors at high schools



Utilization of the detection stations deployed at the HOU university campus

Remote operated experimental setups of the HOU Physics Lab

while remote operated devices deployed at the HOU campus are available to schools for educational activities by distance

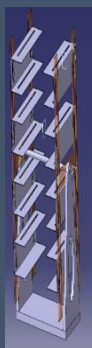
In the framework of the μ Net project, 20 educational cosmic ray telescopes have been installed at high school laboratories in the area of Peloponnese



Construction of a detector unit



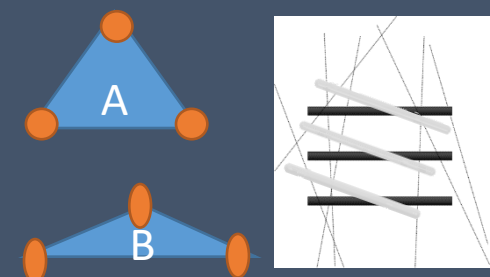
Calibration of the telescope



Estimation of the
atmospheric muon flux



Operation of the Data Acquisition system and Data Analysis, online monitoring



Detector geometry studies

Summer Schools

September 2020 - June 2021

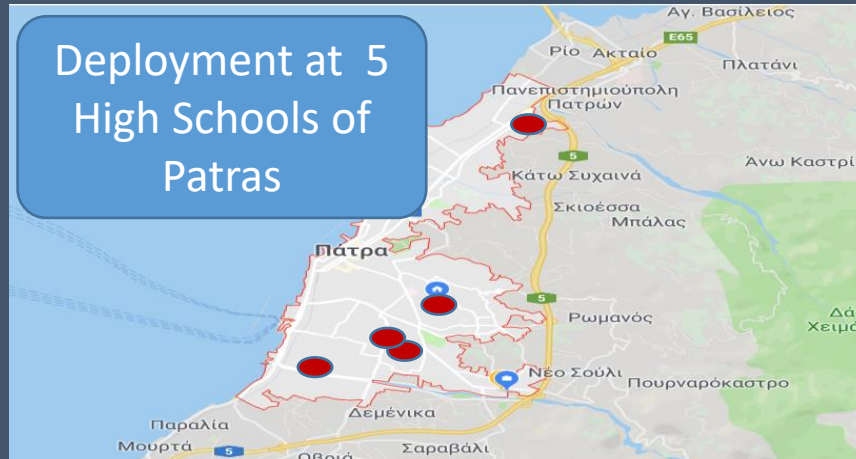
February 2022- June 2022



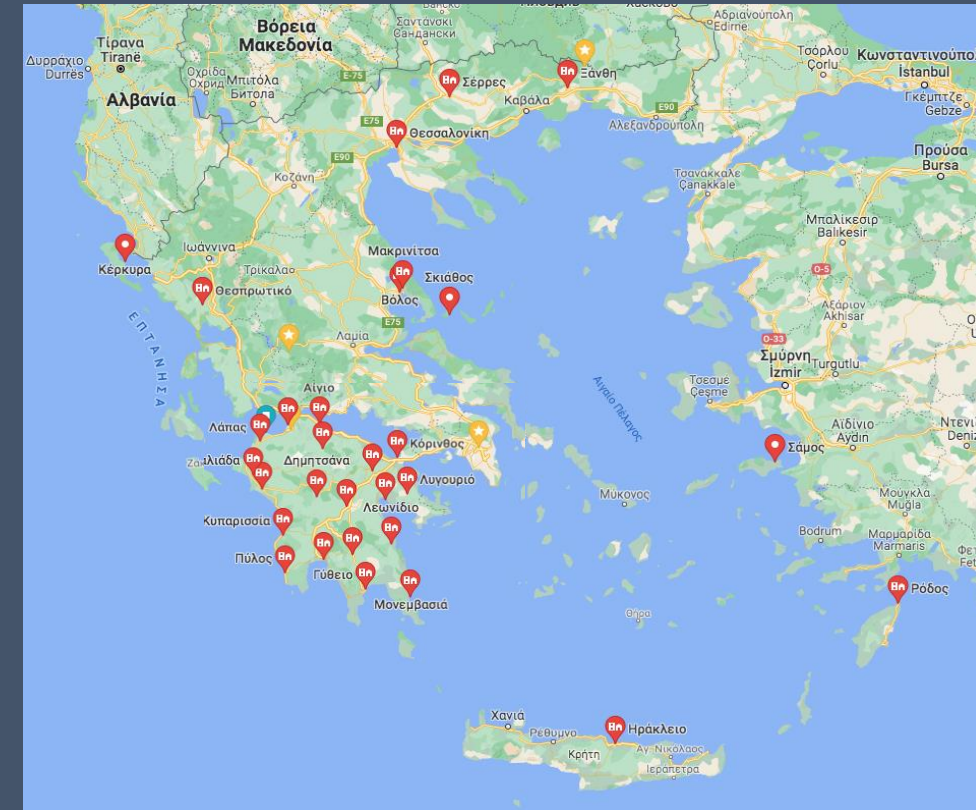
First Summer School (2018)



Second Summer School (2019)



Experimental devices located at the HOU Physics Laboratory and remotely accessed by the students



150 Students
15 Schools
22 School Teachers

Each telescope uses 3 out of 4 stacks. From each stack the telescope uses 1 detector unit (same row)

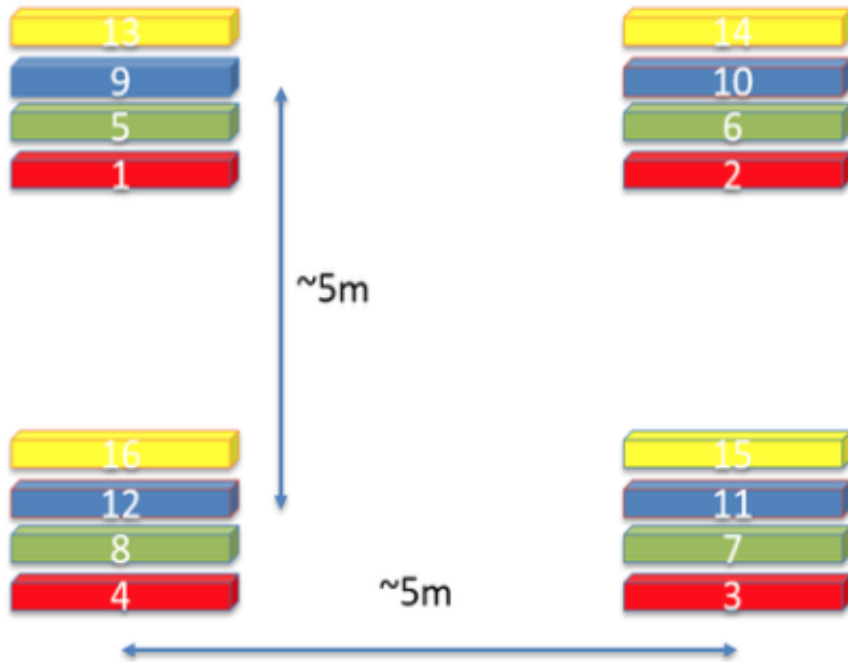


Figure 7

Telescope	Detector Units
1	2,3,4
2	1,3,4
3	1,2,4
4	1,2,3
5	6,7,8
6	5,7,8
7	5,6,8
8	5,6,7
9	10,11,12
10	9,11,12
11	9,10,12
12	9,10,11
13	14,15,16
14	13,15,16
15	13,14,16
16	13,14,15

For the remote users 16 detection units were arranged at the Physics Laboratory as shown in this sketch.

Four stacks of detectors were placed at the tips of a square of side ~5 meters. In each stack there were 4 detectors one on top of the other. That way 16 different telescopes were formed following 4 different geometries

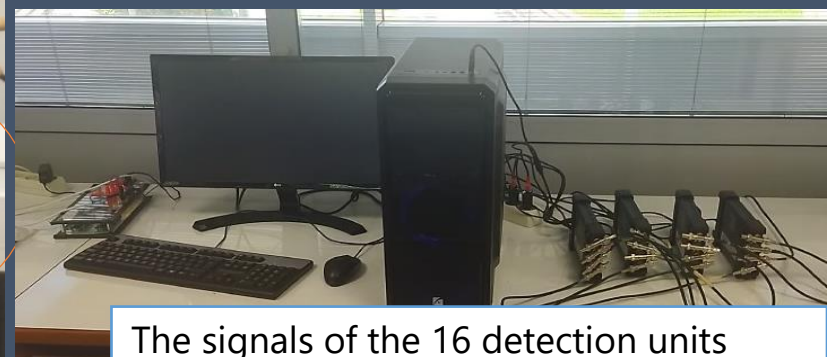
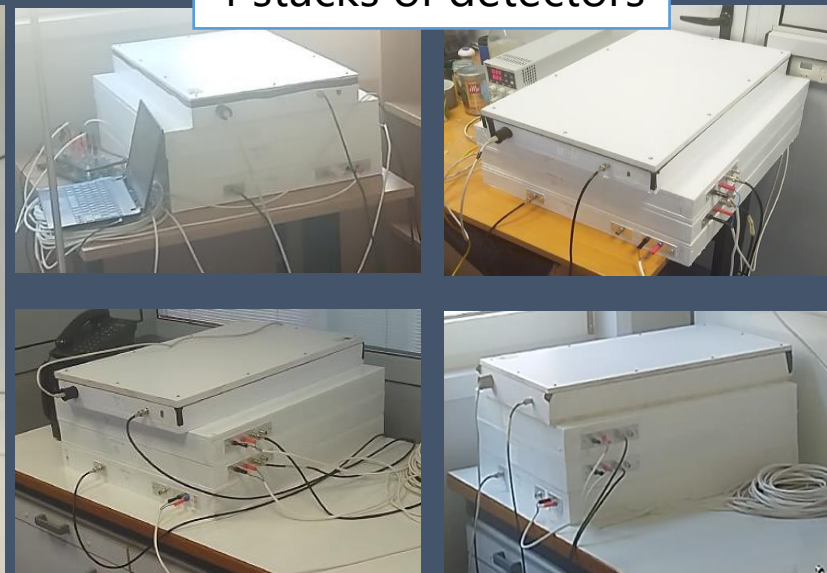
For example, telescope 1 consisted of detectors 2,3 and 4 which is actually the same with telescope 5 which consists of detectors 6, 7 and 8

The experimental setup for the determination of the telescope's resolution. The combination of the detection units for each telescope is shown on the table.

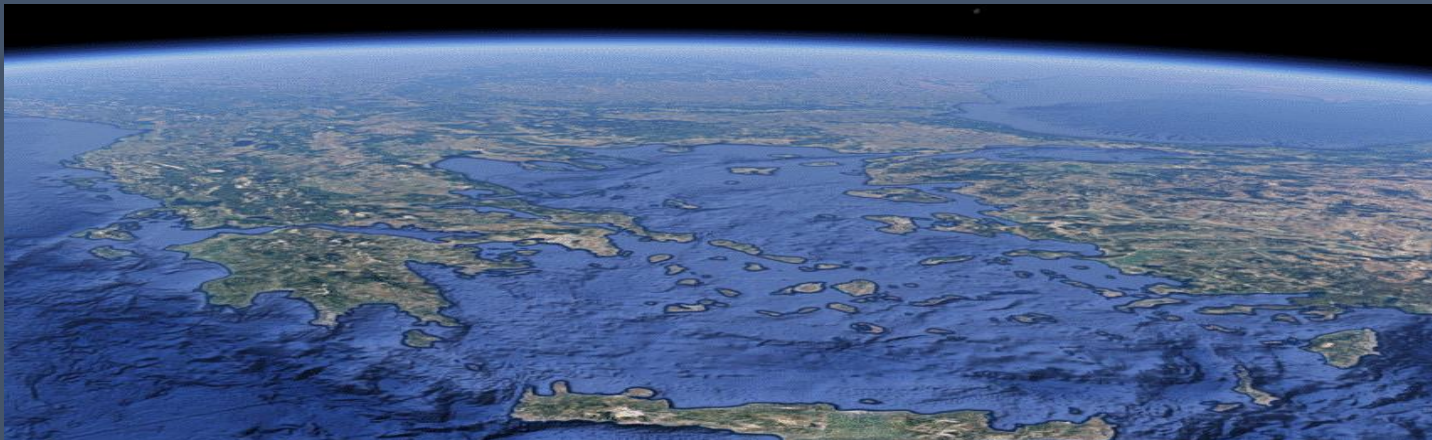
The 16 Telescopes at the Physics Laboratory



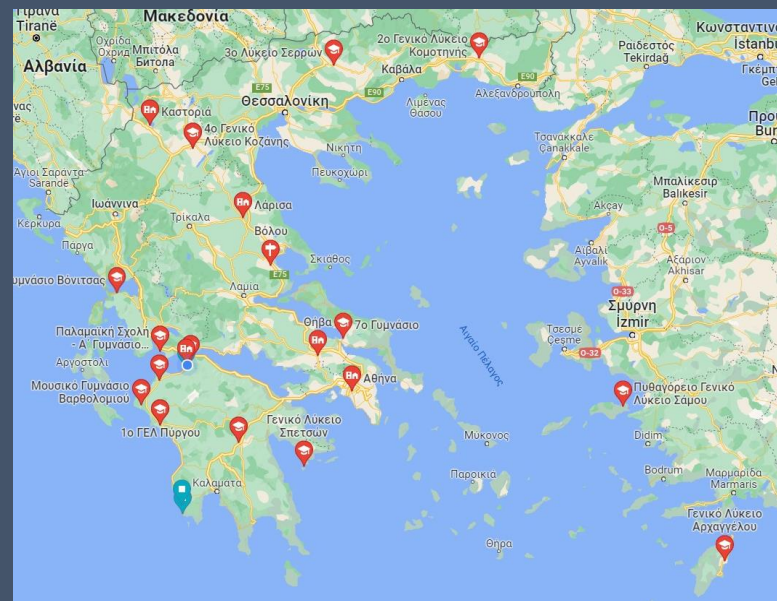
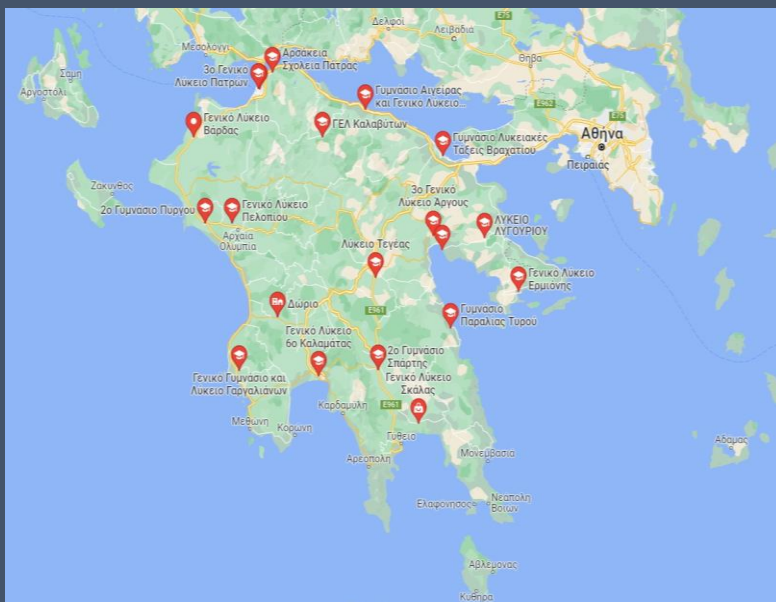
4 stacks of detectors



The signals of the 16 detection units were acquired by 4 digital oscilloscopes



- 20 school units from Peloponnese hosting a μCosmic detector in their laboratory.



- 40 school units from all over Greece operating telescopes located at the Physics Laboratory of HOU.

60 schools are already participating

Construction of a detection unit from students

Construction and light proof testing

Video of the Construction and light proof testing



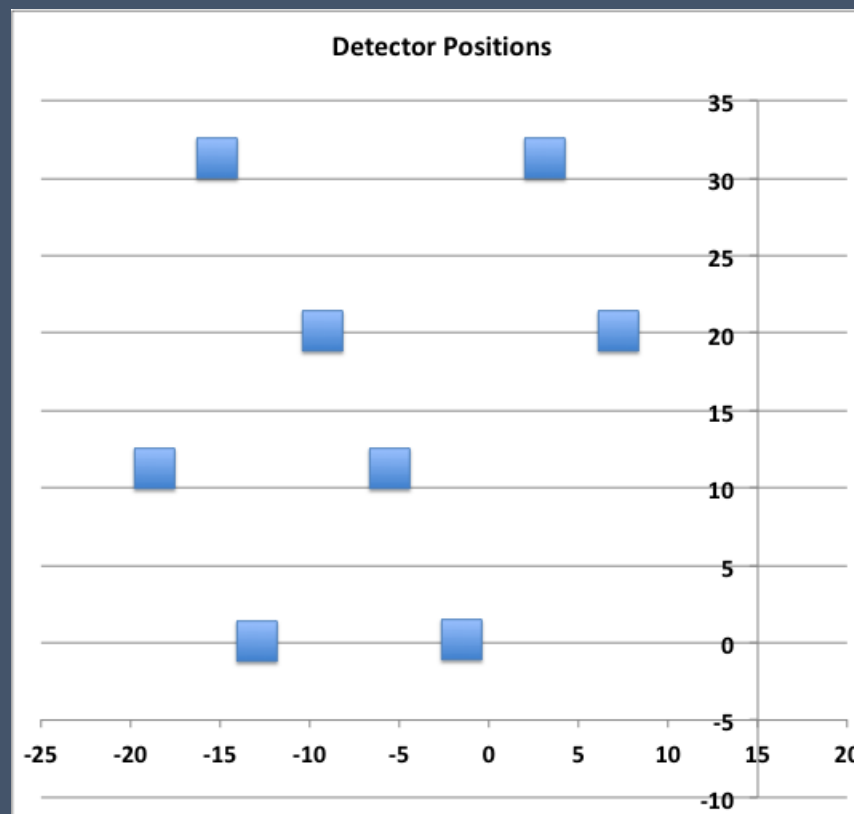
Students working during the construction of the detection unit.

Schools attending by distance operate the telescopes deployed at the HOU campus

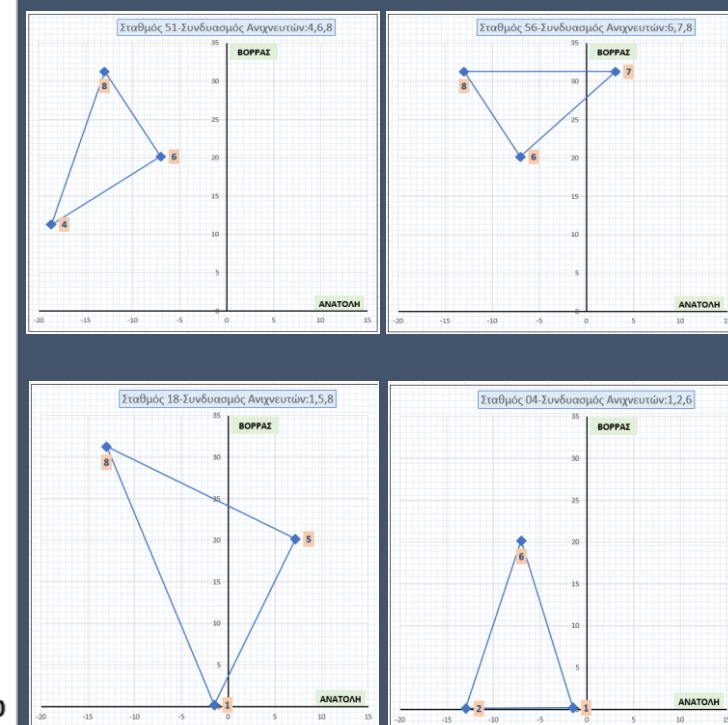
Eight detection units were arranged as it is shown in the figure, offering 56 different μCosmics telescopes (3 out of 8 combinations).

The 56 telescopes are available for high school students that participate to μNet as remote users, by assigning one telescope for each school.

Each combination has different geometry offering the opportunity to study the effect of the geometry to shower reconstruction rate and angular resolution.

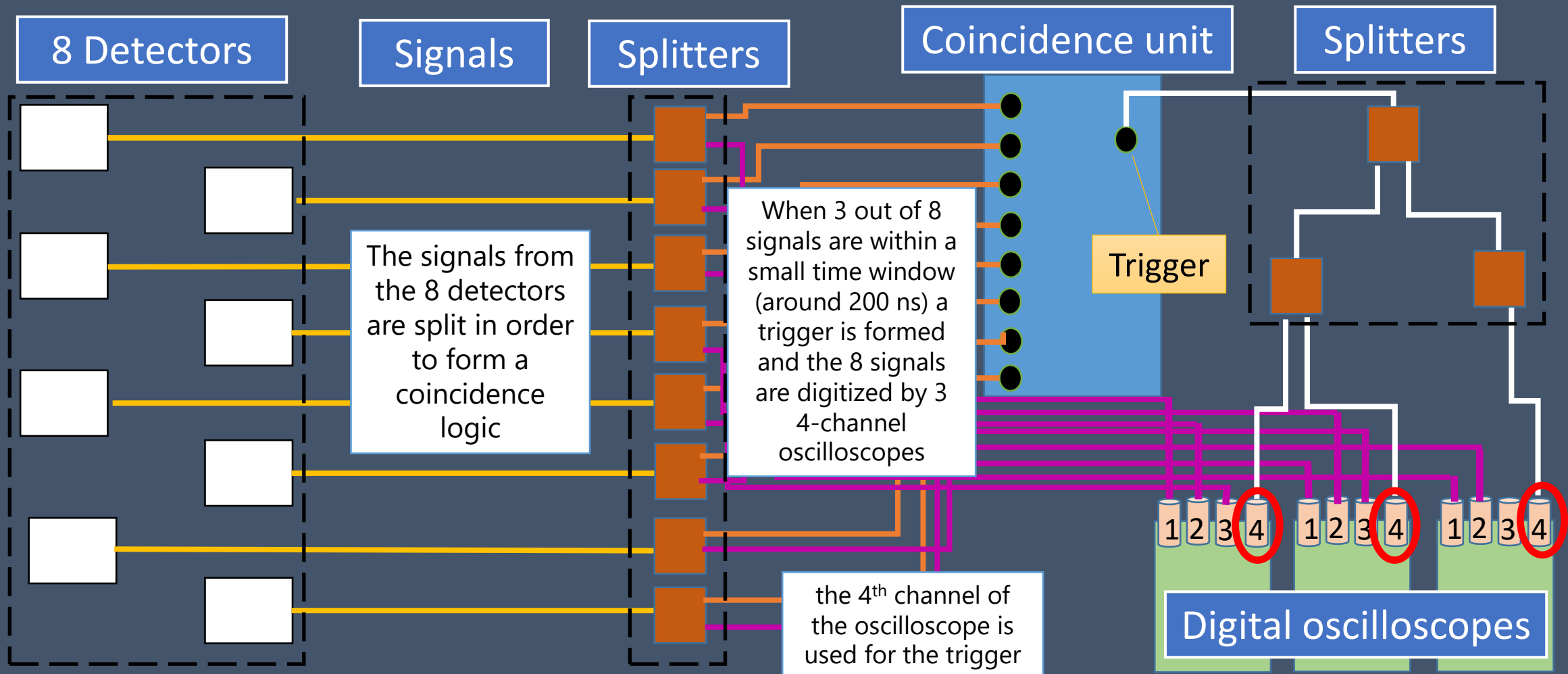


The arrangement of 8 detection units at the HOU campus



The 56 stations have different geometrical layout

The architecture of the Data Acquisition System of the detector array



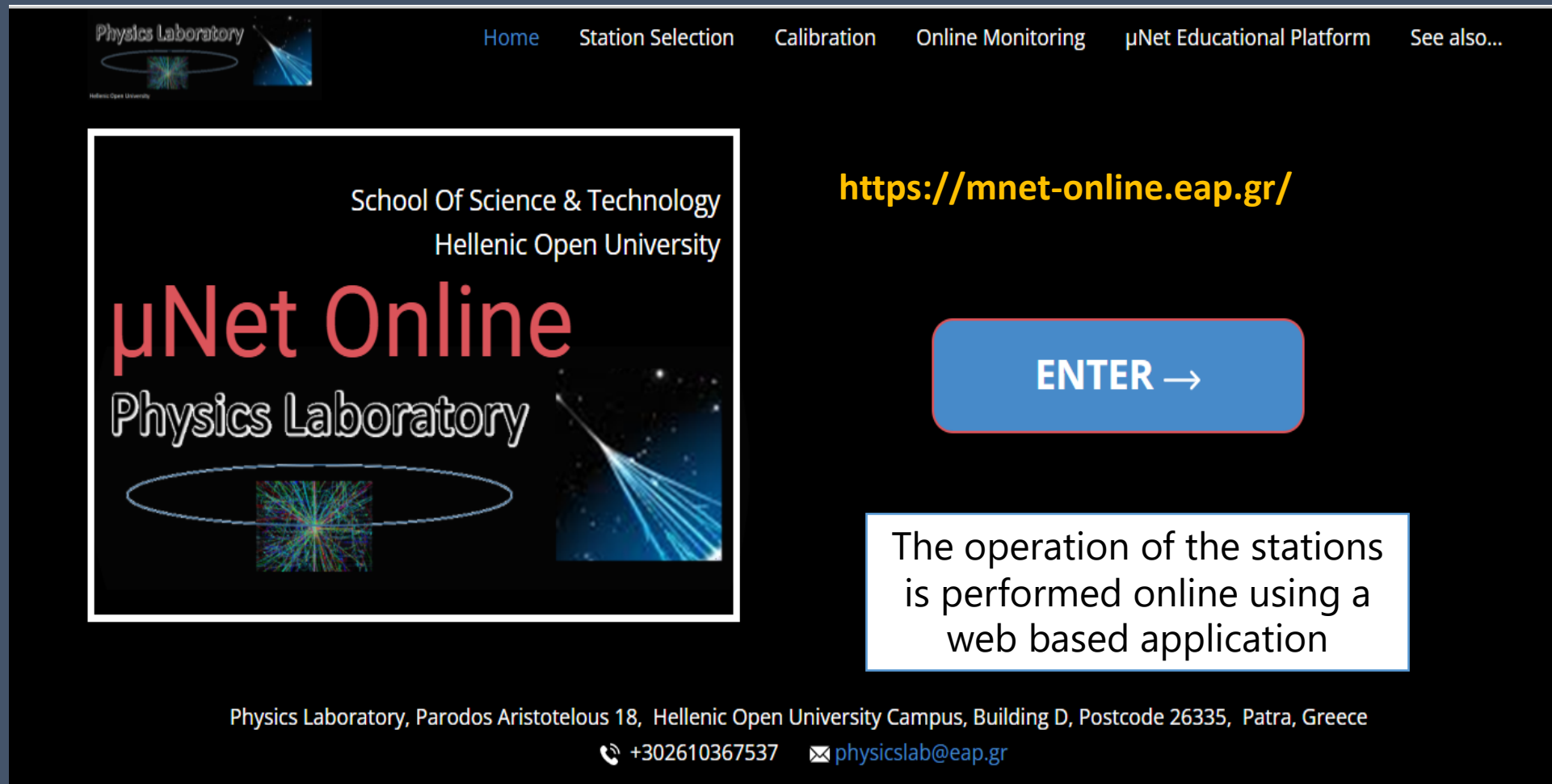
The arrangement of 8 detection units at the HOU campus



Data Acquisition System



The μ Net online web application



The screenshot shows the web application interface for μNet Online. At the top, there is a navigation menu with links: Home, Station Selection, Calibration, Online Monitoring, μNet Educational Platform, and See also... The main content area features a large banner with the text "School Of Science & Technology Hellenic Open University" and "μNet Online Physics Laboratory". To the right of the banner is the URL <https://mnet-online.eap.gr/> and a blue button labeled "ENTER →". Below the button, a white box contains the text: "The operation of the stations is performed online using a web based application". At the bottom of the page, contact information is provided: "Physics Laboratory, Parodos Aristotelous 18, Hellenic Open University Campus, Building D, Postcode 26335, Patra, Greece", along with a phone number (+302610367537) and an email address (physicslab@eap.gr).

Station Selection

Physics Laboratory

Home Station Selection Calibration Online Monitoring μNet Educational Platform See also...

Choose Station

No Station ▾
 No Station
 Station 1
 Station 2
 Station 3
 Station 4
 Station 5
 Station 6
 Station 7
 Station 8
 Station 9
 Station 10
 Station 11
 Station 12
 Station 13
 Station 14
 Station 15

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n data, etc)
re.

Laboratory, Parodos Aristotelous 18, Hellenic Open University Campus, Building D, Postcode 26335, Patra, Greece

+302610367537 physicslab@eap.gr

After selecting the appropriate telescope we can start either the calibration procedure or the Online monitoring of the normal operation

Calibration

Window of the web application during calibration



Means pulse and the pulse height distribution of each detector unit



Time differences of the pulses for the two pairs of detectors

Online Monitoring

Phyllos Laboratory Home Station Selection Calibration Online Monitoring μNet Educational Platform See also...

Telescope Parameters Event Display Data Quality

Parameters

Detector Threshold 1	5.0 mV
Detector Threshold 2	5.0 mV
Detector Threshold 3	5.0 mV
Timing Threshold 1	5.0 mV
Timing Threshold 2	5.0 mV
Timing Threshold 3	5.0 mV
Timing Offset 1	1.9 ns
Timing Offset 2	0.02 ns
Timing Offset 3	0 ns
MIP mean peak 1	15.0 mV
MIP mean peak 2	15.0 mV
MIP mean peak 3	15.0 mV

Use Constant Fraction Timing

Run Info

Operation started at: 00/00/00 00:00:00

Running time: 0 days, 0 hours, 0 minutes

Detection Rate: 0 per hour

Reconstruction Rate: 0 per hour

Total Number of events detected: 0

Total number of events reconstructed: 0

Reconstruction failure rate: 0%

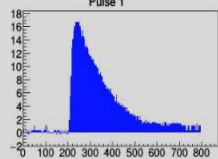
START **STOP**

Phyllos Laboratory Home Station Selection Calibration Online Monitoring μNet Educational Platform See also...

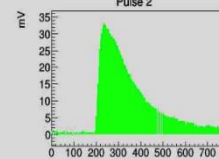
Telescope Parameters Event Display Data Quality

Event Recorded Pulses

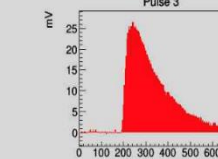
Pulse 1



Pulse 2



Pulse 3



Last event occurred at: 27/07/2022 14:04:34

Pulse arrival times: (t1, t2, t3) = (209.65, 201.06, 198.53) ns

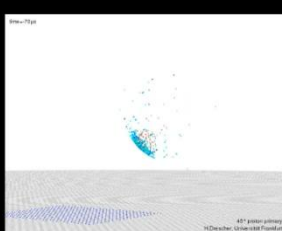
Pulse peak voltages: (p1, p2, p3) = (16.70, 33.50, 26.50) mV

Pulse charge: (q1, q2, q3) = (59.20, 130.10, 97.23) pC

Reconstructed zenith angle: 33.87 deg

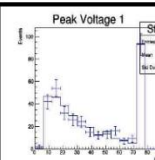
Reconstructed azimuth angle: 11.62 deg

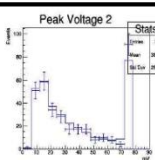
Detector positions:
 (x1, y1, z1) = (0.00, 0.00, 0.00)
 (x2, y2, z2) = (4.80, -0.70, 0.00)
 (x3, y3, z3) = (5.40, 5.25, 0.00)

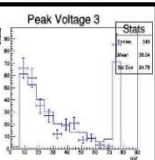


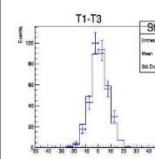
Phyllos Laboratory Home Station Selection Calibration Online Monitoring μNet Educational Platform See also...

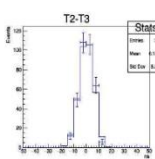
Telescope Parameters Event Display Data Quality

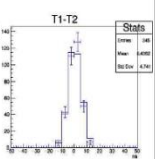


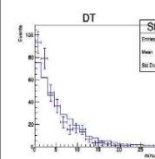


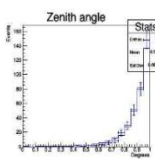


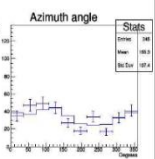












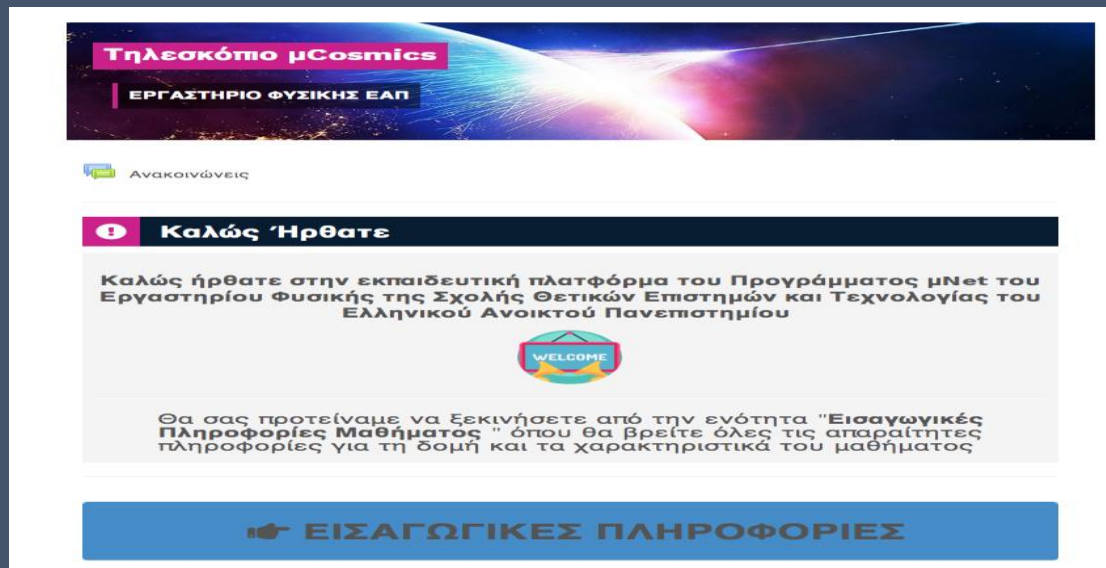
Select Reference Period HIDE REFERENCE DATA SHOW REFERENCE DATA

Each school monitors the detection rate and the reconstruction rate of air showers, the acquired pulses for each detected shower, along with some other characteristics i.e. timing of the pulses, peaks of the pulses etc.

The calculated direction of the reconstructed shower is presented in terms of the zenith and azimuth angle and an animation of the shower is also presented

In this tab the online monitoring page is used to show histograms that presented the data quality of the telescope. These histograms are also presented on top of corresponding history histograms in order to compare directly the acquired data with data from previous periods of operation

μNet – Educational Platform



Τηλεσκόπιο μCosmics
ΕΡΓΑΣΤΗΡΙΟ ΦΥΣΙΚΗΣ ΕΑΠ

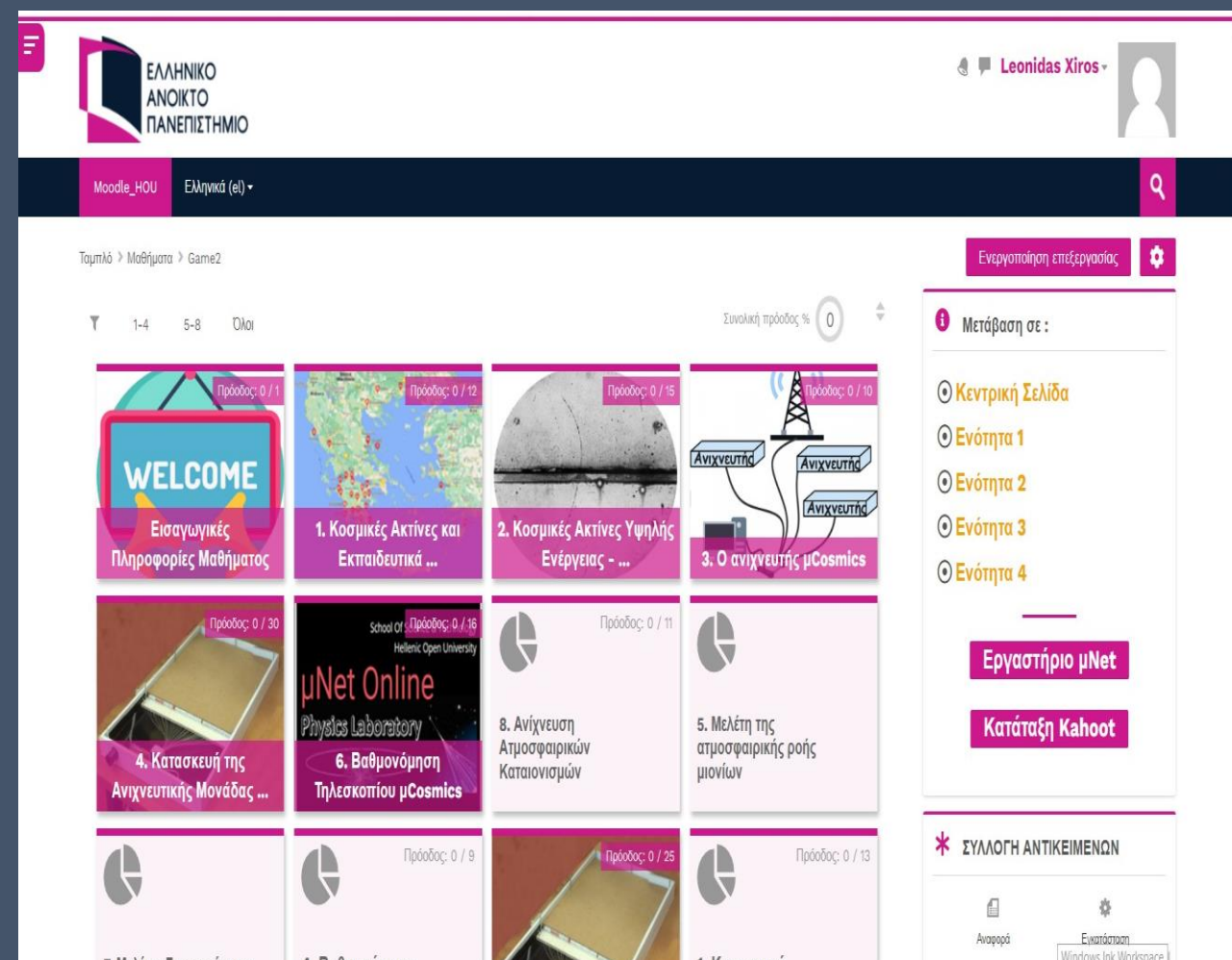
Ανακοινώσεις

Καλώς Ήρθατε

Καλώς ήρθατε στην εκπαιδευτική πλατφόρμα του Προγράμματος μNet του Εργαστηρίου Φυσικής της Σχολής Θετικών Επιστημών και Τεχνολογίας του Ελληνικού Ανοικτού Πανεπιστημίου

Θα σας προτείνουμε να ξεκινήσετε από την ενότητα "Εισαγωγικές Πληροφορίες Μαθήματος" όπου θα βρείτε όλες τις απαραίτητες πληροφορίες για τη δομή και τα χαρακτηριστικά του μαθήματος

ΕΙΣΑΓΩΓΙΚΕΣ ΠΛΗΡΟΦΟΡΙΕΣ



ΕΛΛΗΝΙΚΟ ΑΝΟΙΚΤΟ ΠΑΝΕΠΙΣΤΗΜΙΟ

Moodle_HOU Ελληνικά (el)

Leonidas Xiros

Ταμπλό > Μαθήματα > Game2

Συνολική πρόοδος % 0

1-4 5-8 Όλοι

Ενεργοποίηση επεξεργασίας

Μετάβαση σε :

- Κεντρική Σελίδα
- Ενότητα 1
- Ενότητα 2
- Ενότητα 3
- Ενότητα 4

Εργαστήριο μNet

Κατάταξη Kahoot

ΣΥΛΛΟΓΗ ΑΝΤΙΚΕΙΜΕΝΩΝ

Ανοραρά Εγκατάσταση Windows Ink Workspace

- The educational program is implemented using Moodle as LMS where all the developed educational materials and technological tools are in place
- Moodle platform includes Gamification methods, assignments, forum, Videos, games, powerpoints, tests etc in order to enhance students attendance

μNet – Educational Platform

Home > Courses > Εκπαιδευτική πλατφόρμα για Μαθητές

(Εκπαιδευτική πλατφόρμα για Μαθητές)

Order	Name	Activities	Modules	Sections	Bonus of day	Badges	Total
1 ^o	3ο ΓΕΛ ΣΕΡΡΩΝ(8)	9,753.13sco					
2 ^o	ΓΕΛ ΛΑΓΚΑΔΑ(13)	9,451.54sco					
3 ^o	ΓΕΛ ΕΡΜΙΟΝΗΣ(7)	8,845.29sco					
4 ^o	ΓΕΛ ΠΕΛΟΠΟΥ(14)	8,676.79sco					
5 ^o	ΓΕΛ ΑΙΓΕΙΡΑΣ(22)	7,044.14sco					
6 ^o	3ο ΓΕΛ ΑΡΓΟΥΣ(18)	6,529.06sco					
7 ^o	3ο ΓΕΛ ΠΑΤΡΩΝ(10)	6,367.90sco					
8 ^o	ΓΕΛ ΛΥΓΟΥΡΙΟΥ(23)	6,108.65sco					
9 ^o	ΓΕΛ ΑΡΧΑΓΓΕΛΟΥ ΡΟΔΟΥ(5)	5,899.40sco					
10 ^o	1ο ΓΕΛ ΠΥΡΓΟΥ(5)	5,666.40sco					

Visible groups: All participants

(Εκπαιδευτική πλατφόρμα για Μαθητές)

Order	Name	Activities	Modules	Sections	Bonus of day	Badges	Total
1 ^o	Αννα Μαρία Ζωβοίλη	5870	6850	430	0	0	13150sco
2 ^o	Γκόραβ Μάλλ Ταρλοκ	5852	6850	430	0	0	13132sco
3 ^o	Ιωάννης Ηλιόπουλος	5827	6850	430	0	0	13107sco
4 ^o	Αναστασία Καραλή	5783	6850	430	0	0	13063sco
5 ^o	Φωτεινή Λίλλη	5755	6850	430	0	0	13035sco
6 ^o	Φρειδερίκη Καφτάνη	5701	6850	430	0	0	12981sco
7 ^o	Δημήτριος Καβαρινός	5889	6750	340	0	0	12979sco
8 ^o	Γιάννης Πασχαλίδης	5679	6850	430	0	0	12959sco
9 ^o	ΣΩΚΡΑΤΗΣ ΠΑΠΑΝΑΣΤΑΣΟΠΟΥΛΟΣ	5754	6750	340	0	0	12844sco
10 ^o	Νικολέτα Θεοδοσία Παρασκευοπούλου	5843	6650	340	0	0	12833sco
11 ^o	Παναγιώτης Γεώργας	5693	6750	340	0	0	12783sco
12 ^o	Μάριος Αθανασιάδης	5879	6550	340	0	0	12769sco
13 ^o	Γιώργος Γιαννέας	5439	6750	340	0	0	12529sco

The performance of the students is monitored through a series of activities that include also a kind of gaming collecting points and badges.

1st annual meeting of the μ Net Project



On April we had the 1st annual meeting of the microNet Project

More than 500 students attended in person and by distance

The students presented their results covering all their activities. From the construction of the detection units up to the operation of the telescope.

Thank you !!!