HELLENIC OPEN UNIVERSITY

School of Science & Technology

# Educational Activities with the μCosmics detector

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# OUTLINE

HELYCON and ASTRONEU Projects

μCosmics Detector

The μNet Project

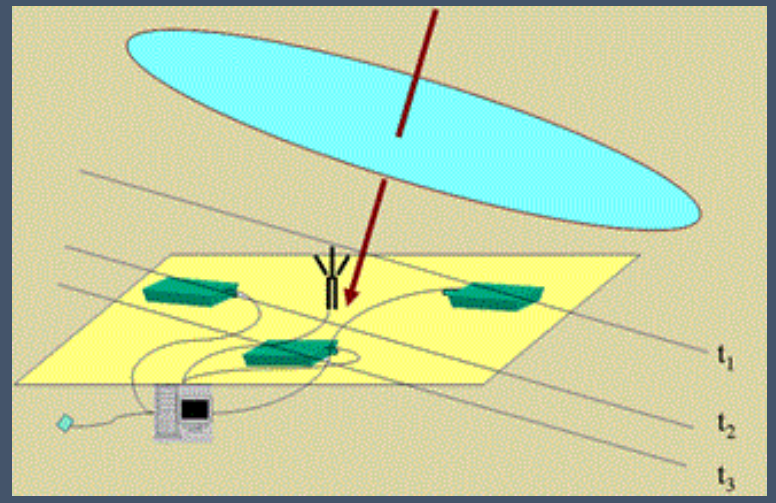
Educational Activities

Near Future Plans

# HELYCON

## HEllenic Lyceum Cosmic Observatories Network

**HELYCON Station**




3-4 plastic scintillator detectors

**Local Coincidence, Relative Timing**

**Shower axis reconstruction with an accuracy of a few degrees.**

Hellenic Lyceum Cosmic Observatories Network

HELYCON

Physics Laboratory

School of Science & Technology

Hellenic Open University

**Helycon Detector Module**

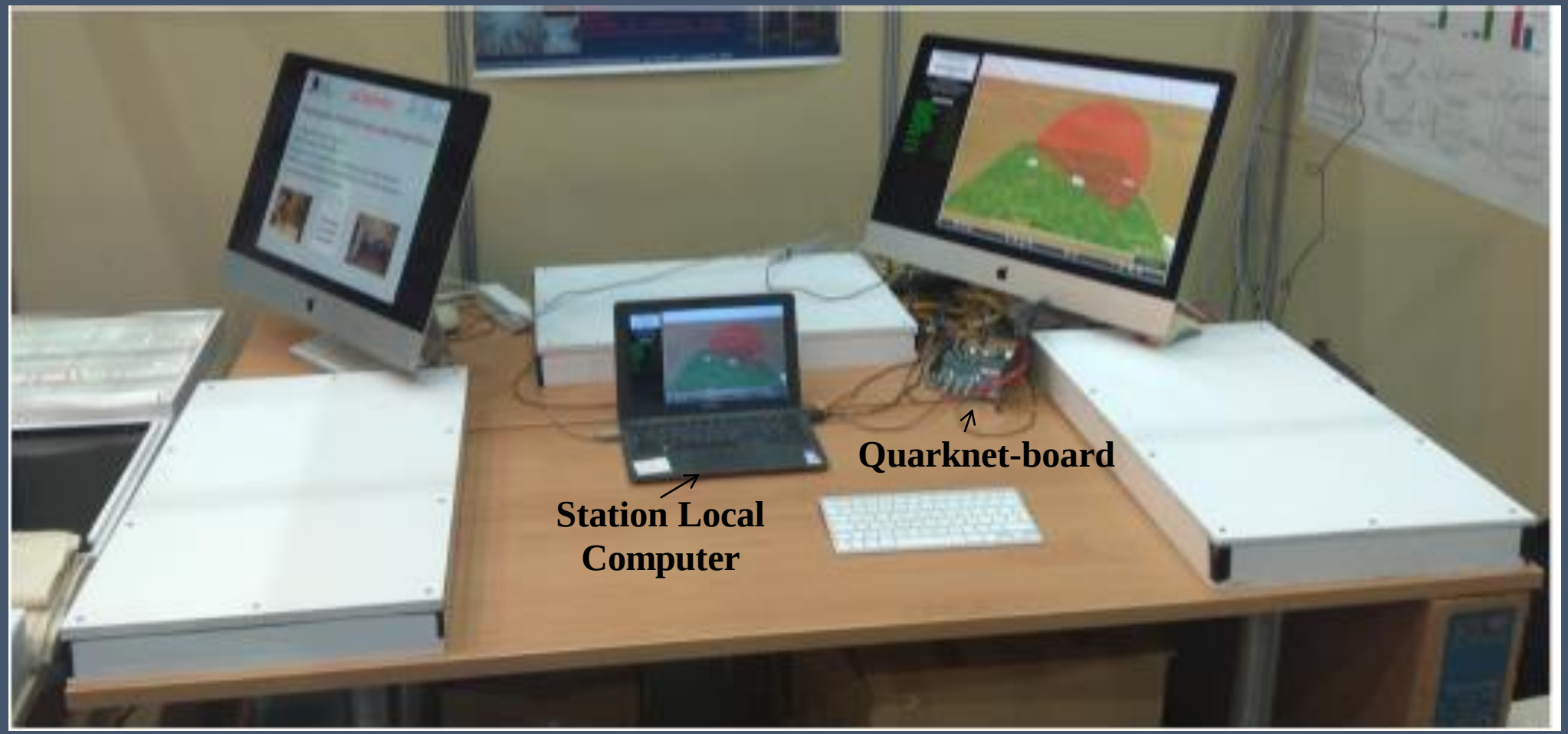
# Astroneu

Each station consists of

- 3 scintillator counters (~30 m spacing)
- **RF antenna** (autonomous station)
- **DAQ and Slow Control electronics**
- Power Supply, Monitoring system

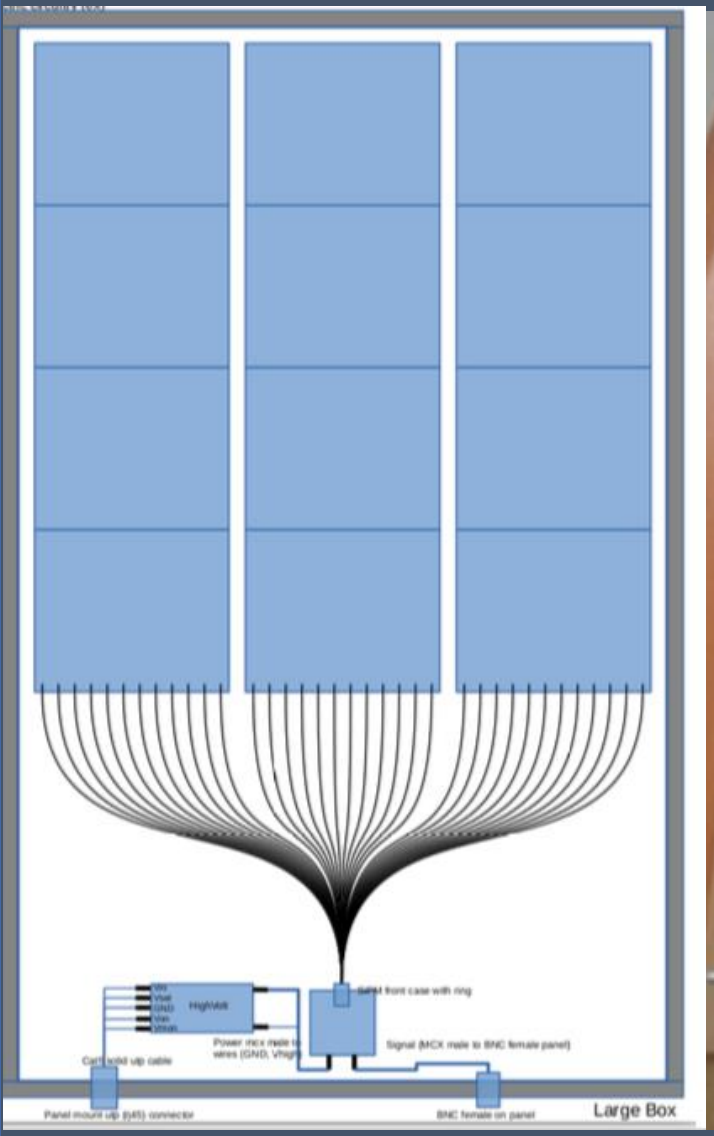
# The μCosmics Detector





# The μCosmics Detector

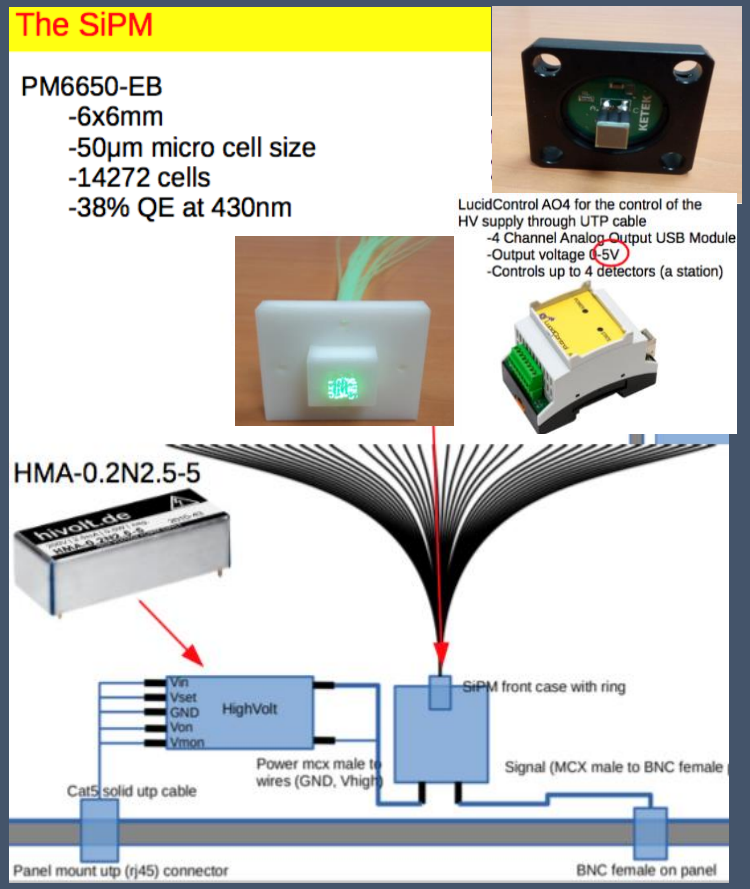




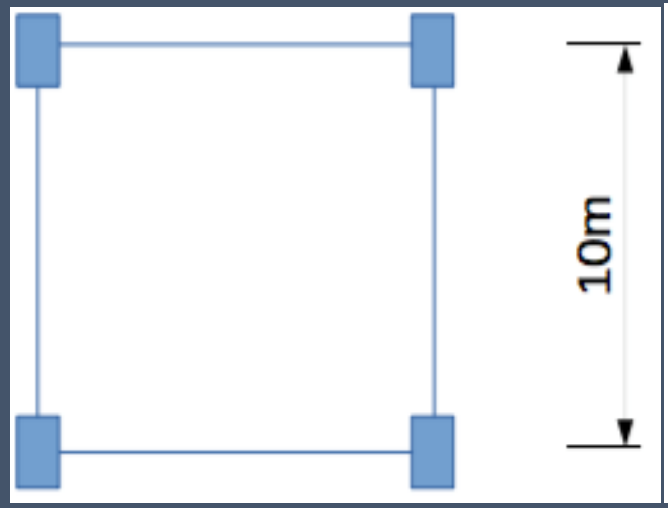
# The μCosmics Detector

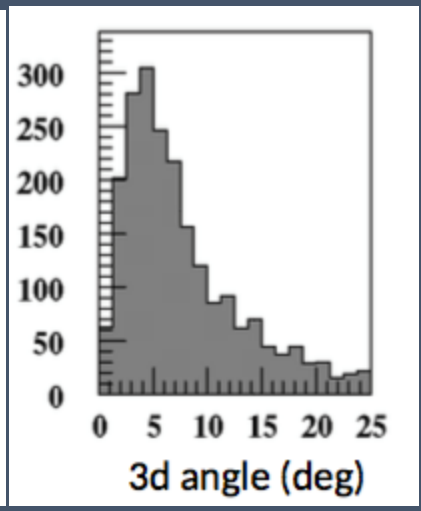


## Integrated Detector




## Performance Studies




Threshold 20 mV (1 MIP)
Timing @ 6 mV
Median 6.5 deg
236 per day, 10 per hour

# The μCosmics Detector



## Quarknet DAQ

### Quarknet-Board

- 4 input channels with amplification.
- Time tagging is performed in one adjustable threshold.
- The time resolution for timing and ToT measurement is 1.25 ns.
- The trigger logic is based on the level of coincidence.
- It provides a trigger out signal
- It is operated through the USB port of the PC
- it is connected with an External GPS receiver.

## Hantek DAQ

### Hantek DSO3204A

- 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
- no GPS time-tagging.
- No trigger out

# The μNet Project

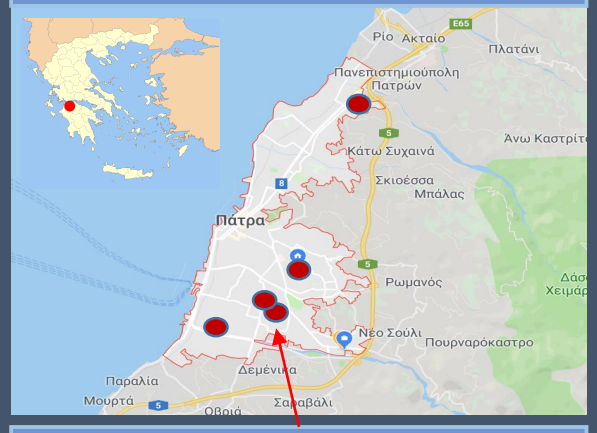
HELLENIC OPEN UNIVERSITY

School of Science & Technology

| μNet |
| --- |
| 5 μCosmics Detectors deployed at High Schools of Patras |
| 15 months duration |
| Educational Tools |
| Educational Activities |
| Training |
| Feedback and Evaluation |

| Detector Array |
| --- |
| Construction |
| Calibration |
| Deployment and Operation at school |

Deployment at 5 High Schools of Patras




2 station in adjacent schools for double station coincidence studies

| Research Team (RT) |
| --- |
| 1 Faculty member |
| 1 Post Doc Researcher |
| 1 PhD Student |

| Educational Activities |
| --- |
| Detector Unit Assembly |
| Response Calibration |
| Timing Synchronization |
| Muon Telescope |
| Operation & Monitoring |
| Station-Geometry Study |
| Data Analysis |

| Educational Tools |
| --- |
| Offline & Online Software |
| Educational Material and MOOCS |
| Manuals & Questionnaires |

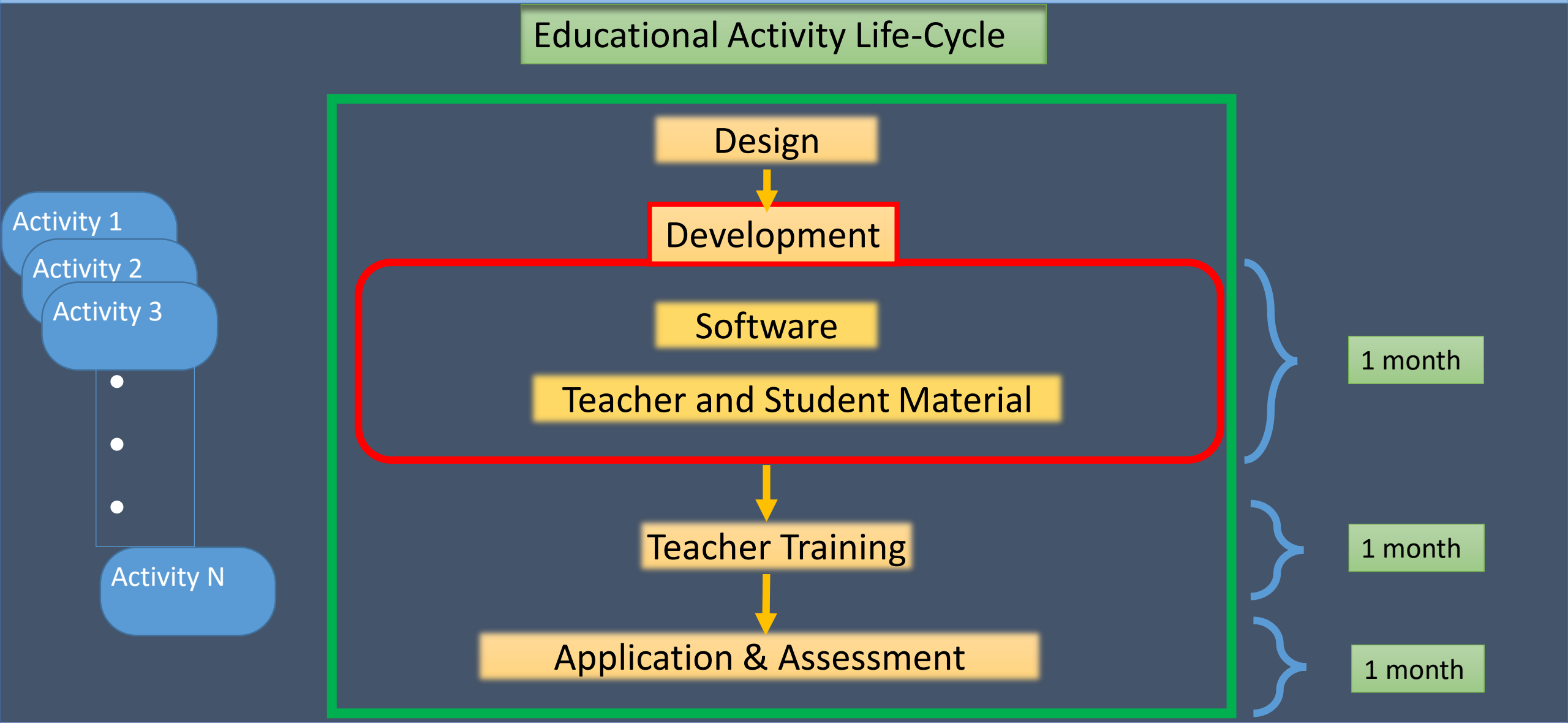
| Training |
| --- |
| Distant Learning |
| Top Down approach (RT→Teachers→Students) |

| Feedback and Evaluation |
| --- |
| Online Meetings |
| Discussion Forum |

Approved Project

# The μNet Project

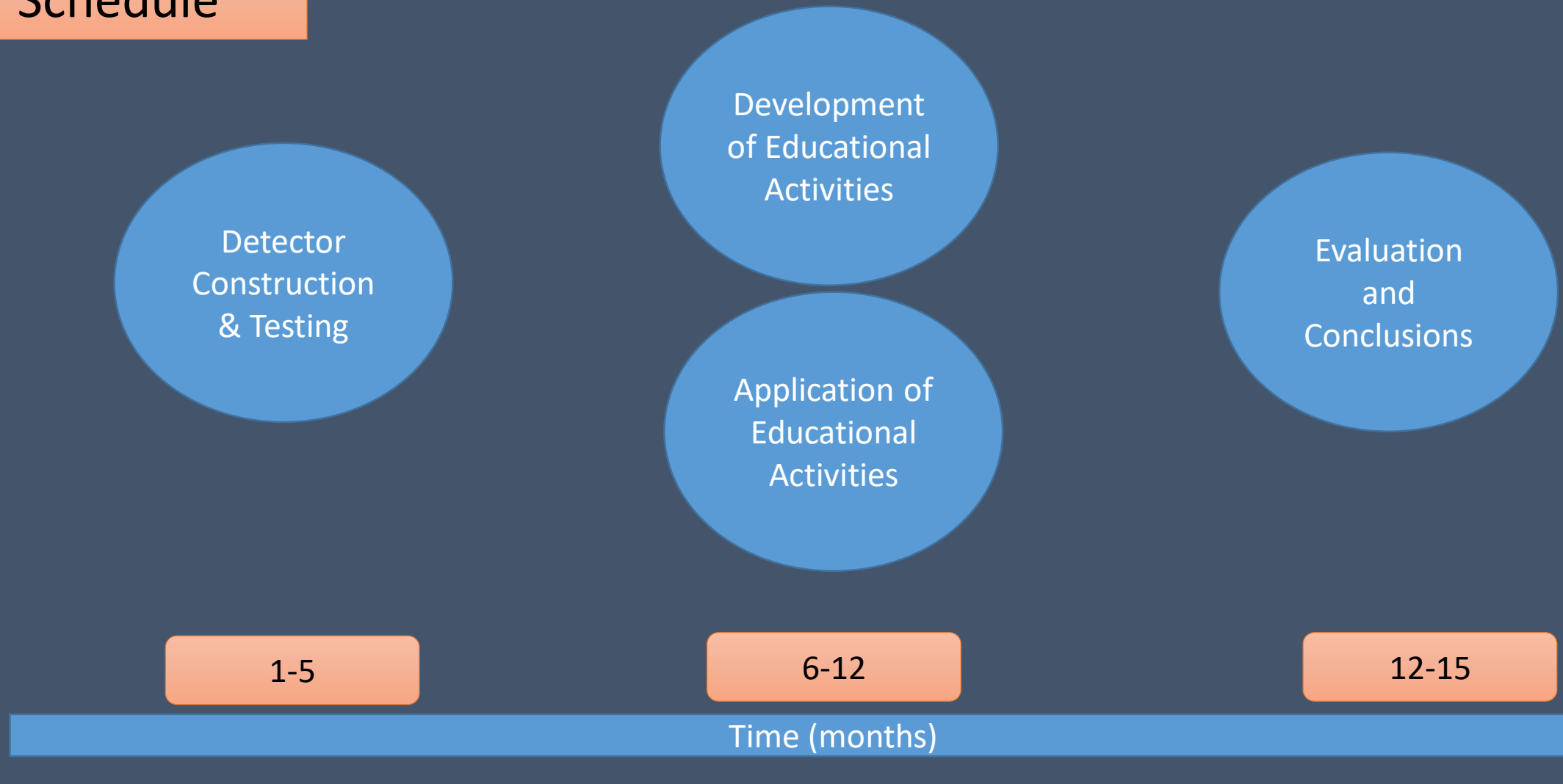




# The μNet Project



## Schedule

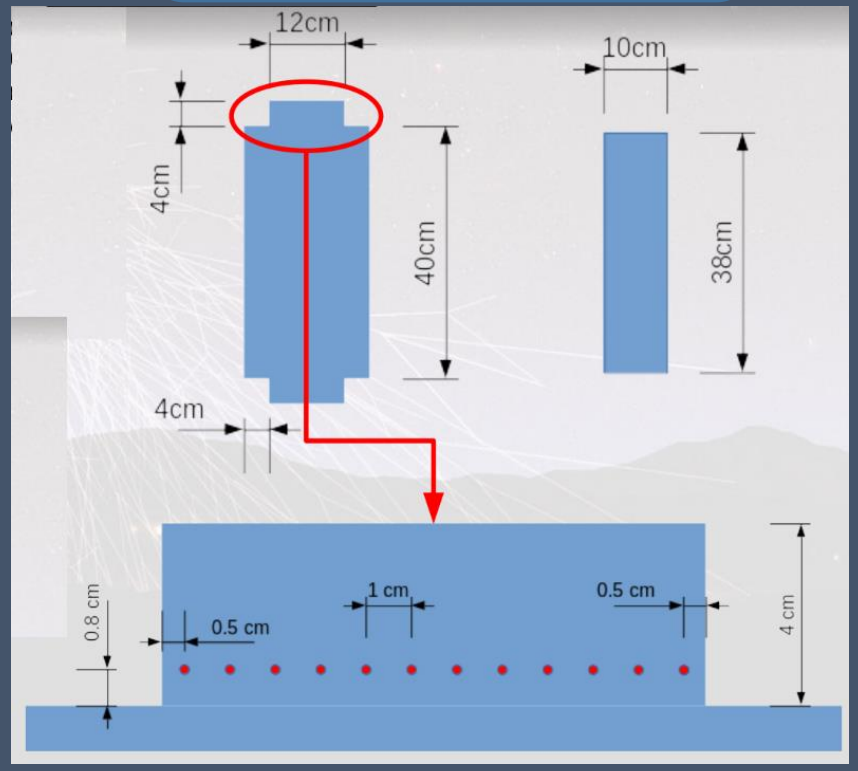


# μNet Activities

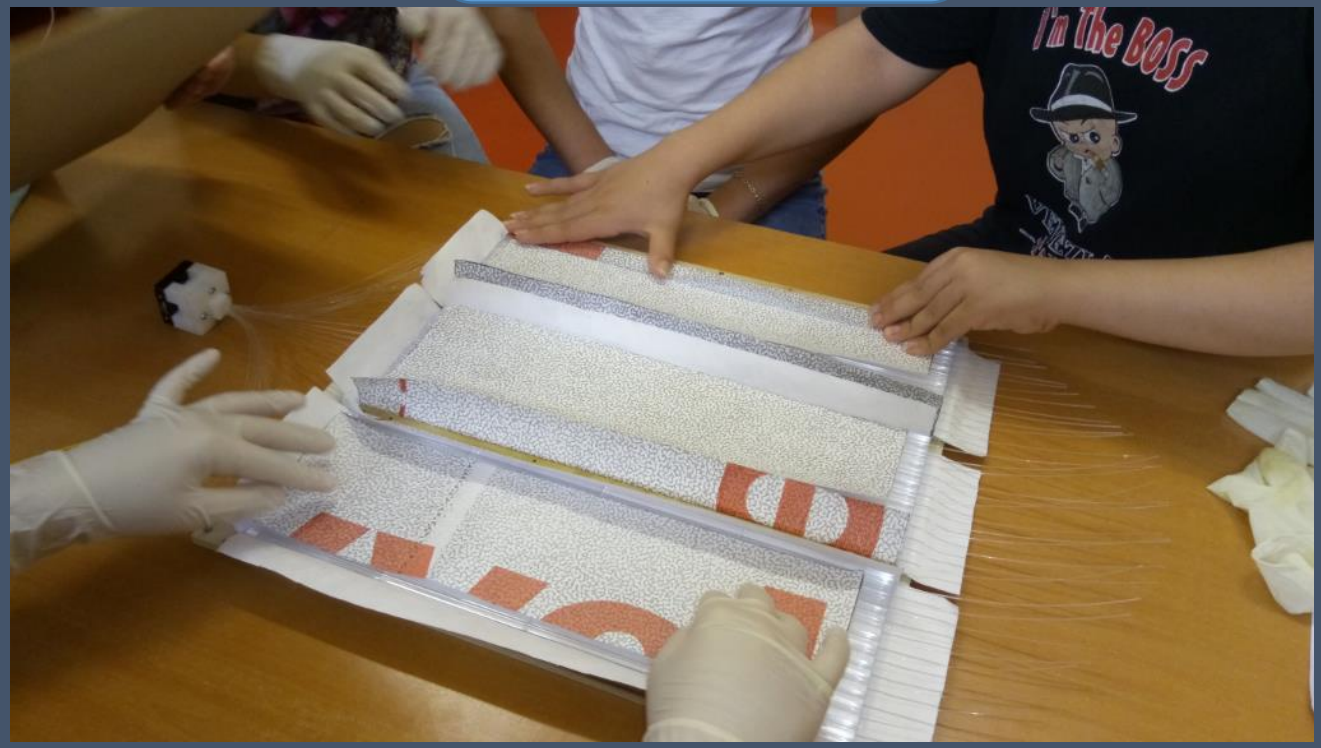


## Detector Assembly

Scintillator Cleaning
Tyvek Cut




Tile Positioning
WLS fibers insertion
Tyvek positioning

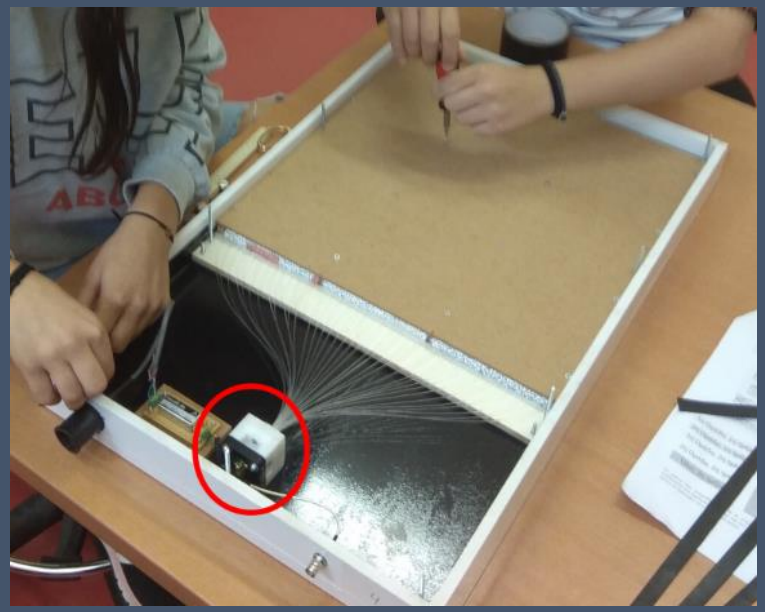


# μNet Activities



## Detector Assembly

Connectors positioning
SiPM attachment



Light Proofing

Final Test
Dark Current measurement

# μNet Activities

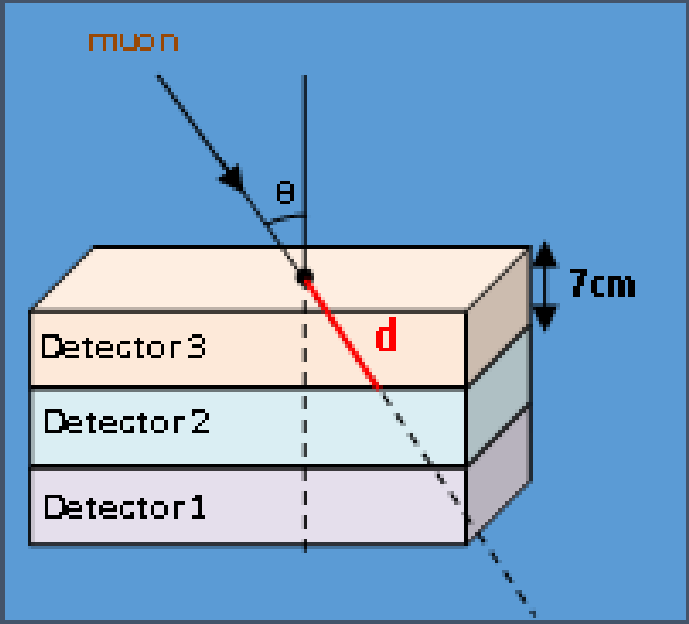


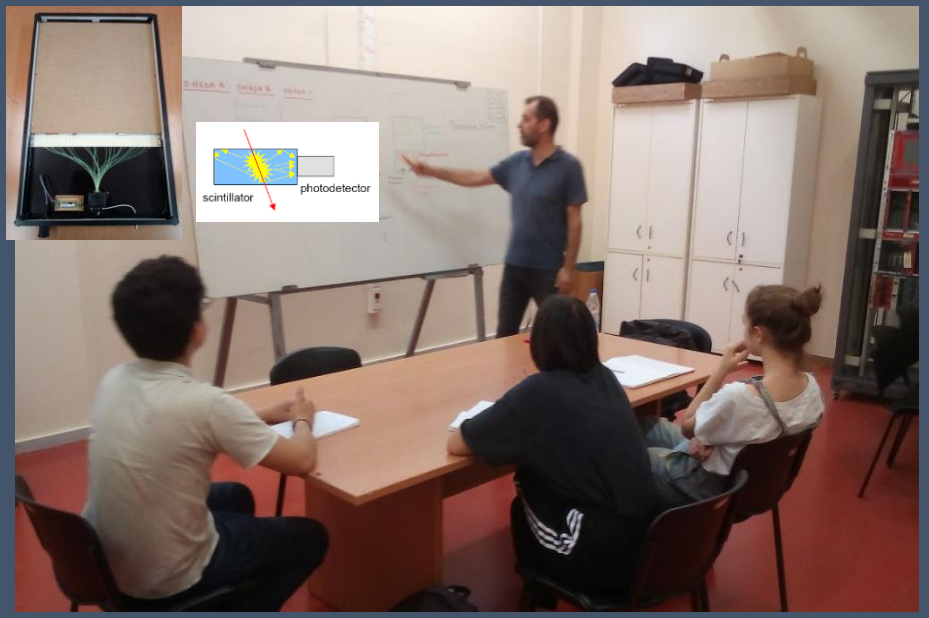
## Detector Calibration

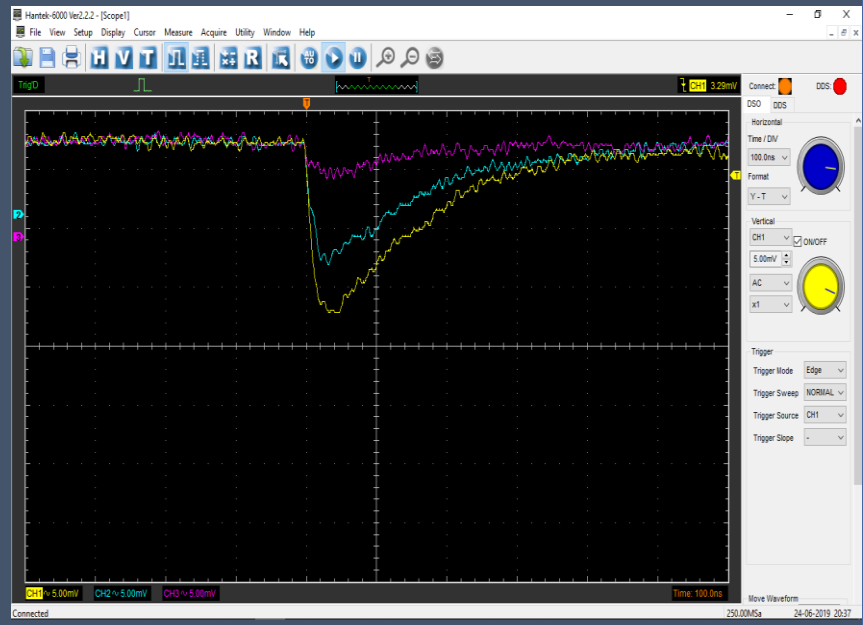
Experimental Setup

Principle of operation

Data acquisition



# μNet Activities

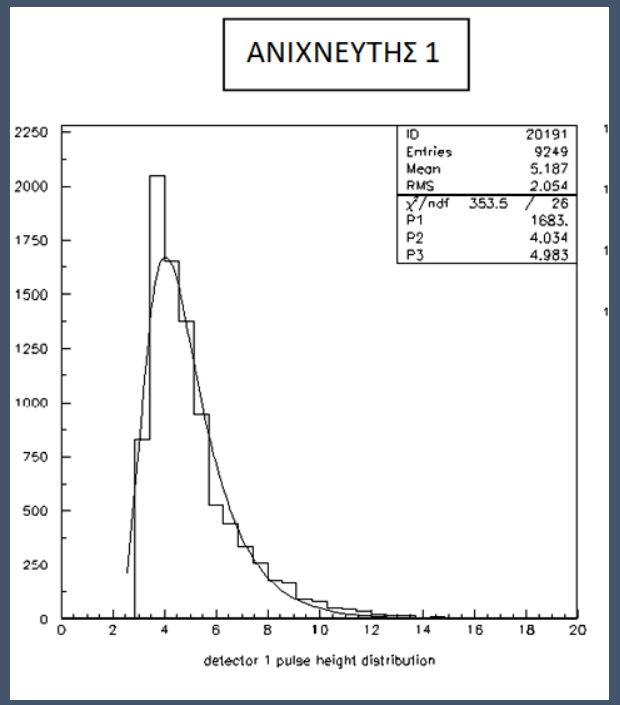


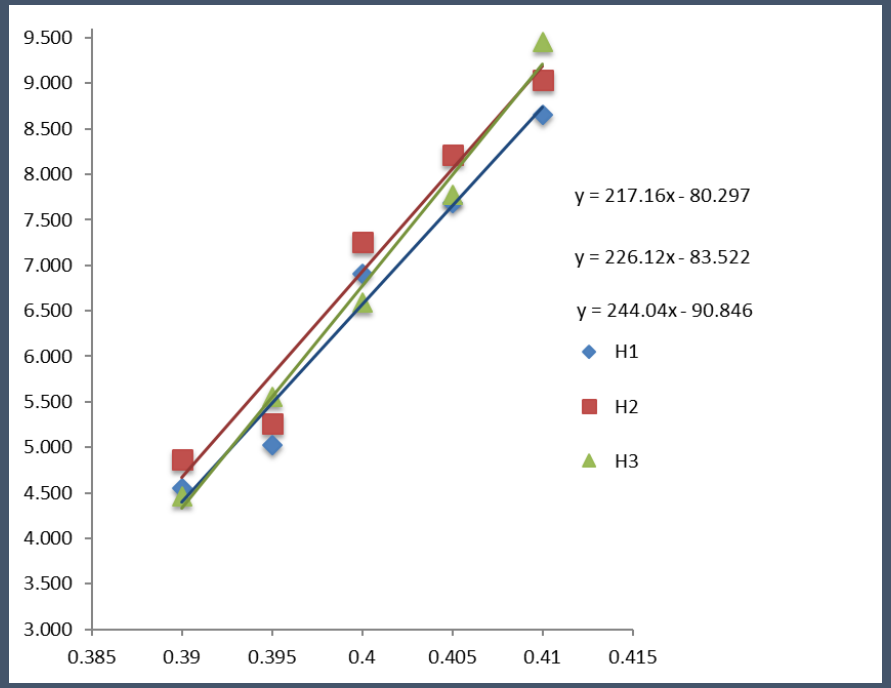
## Detector Calibration

Data Analysis

Calibration Curve

Computation

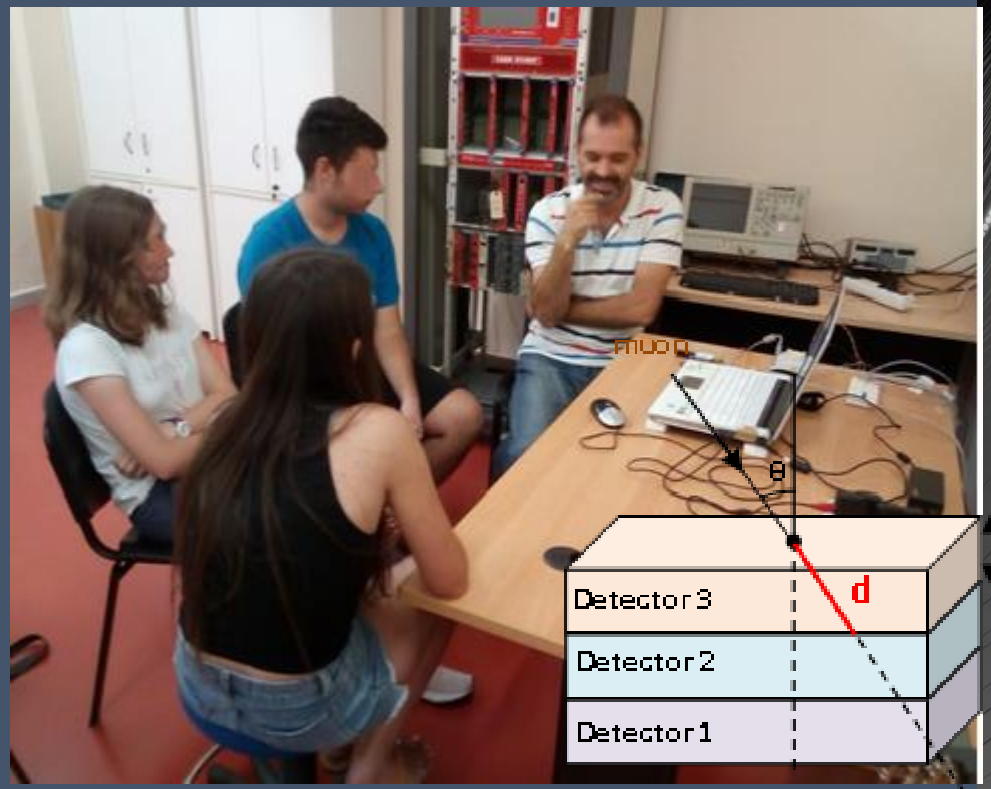


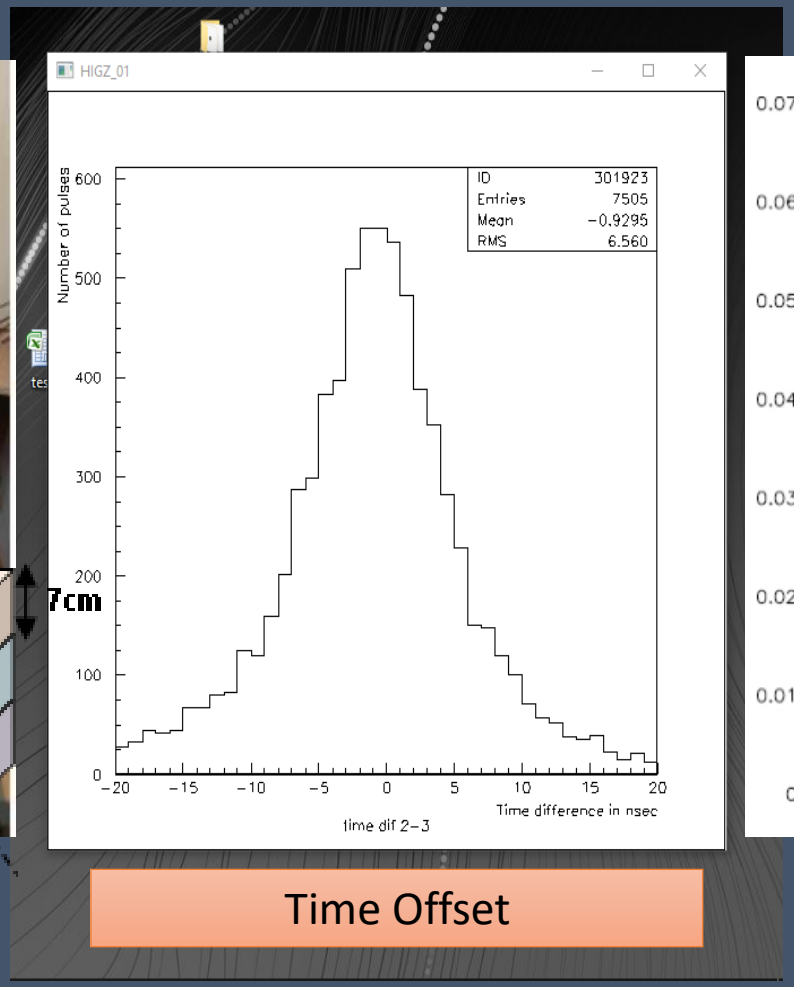



# μNet Activities

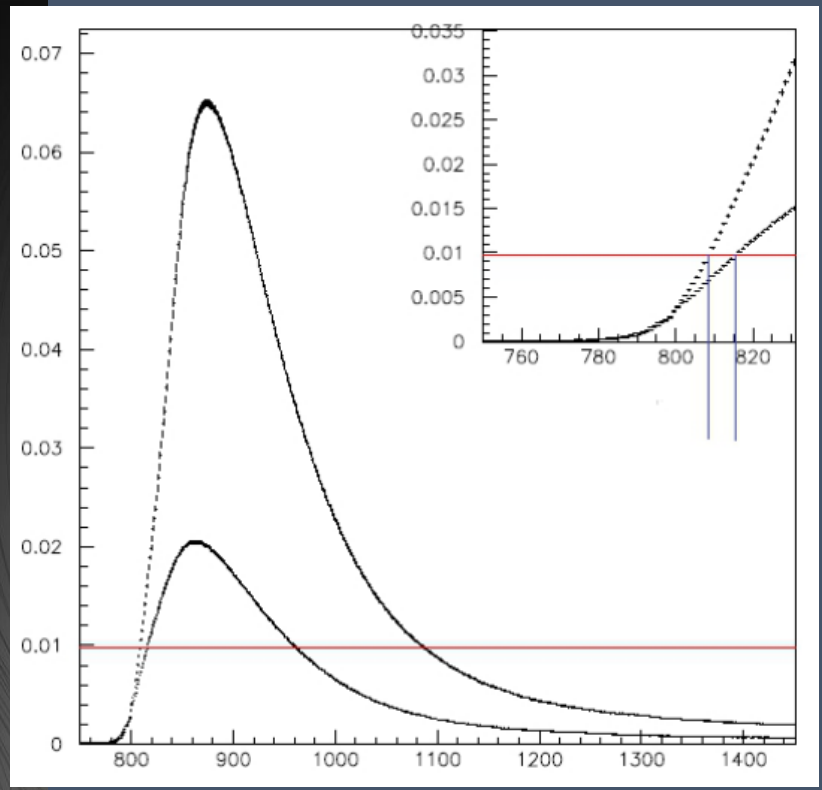


## Detector Timing Synchronization




Time Offset

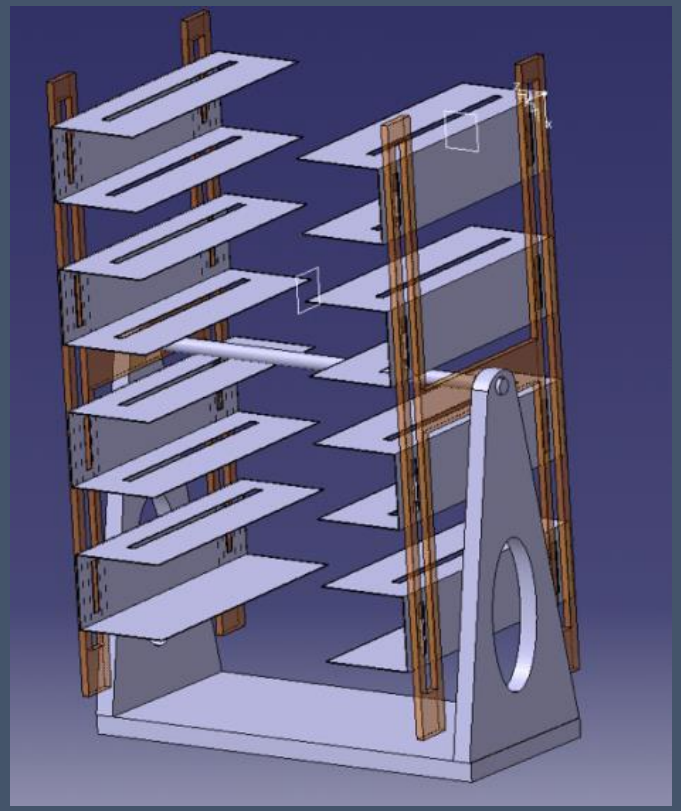



Slewing Correction

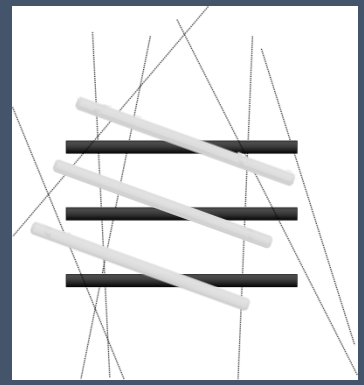
# μNet Activities

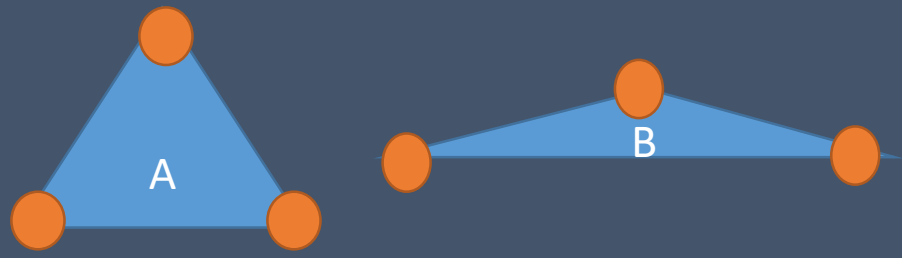


## Muon Telescopy



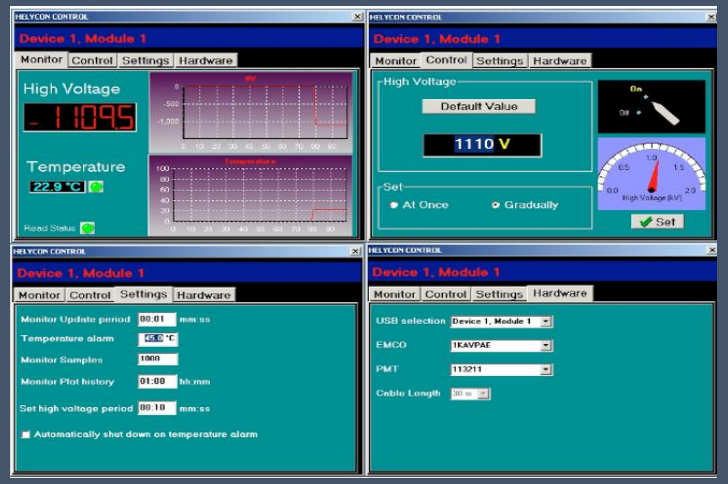
## Geometry Studies

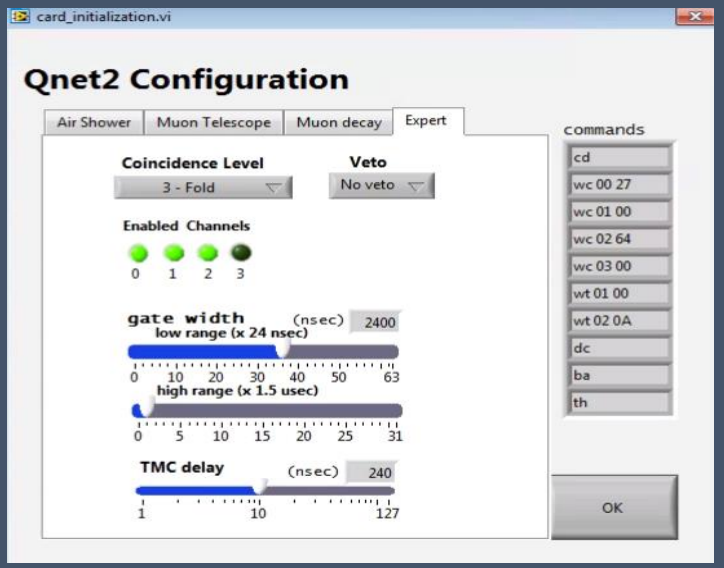




# μNet Activities

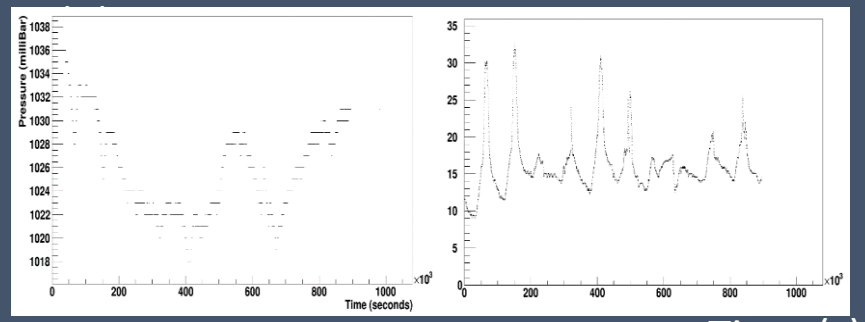
## DAQ-Data Quality Monitoring



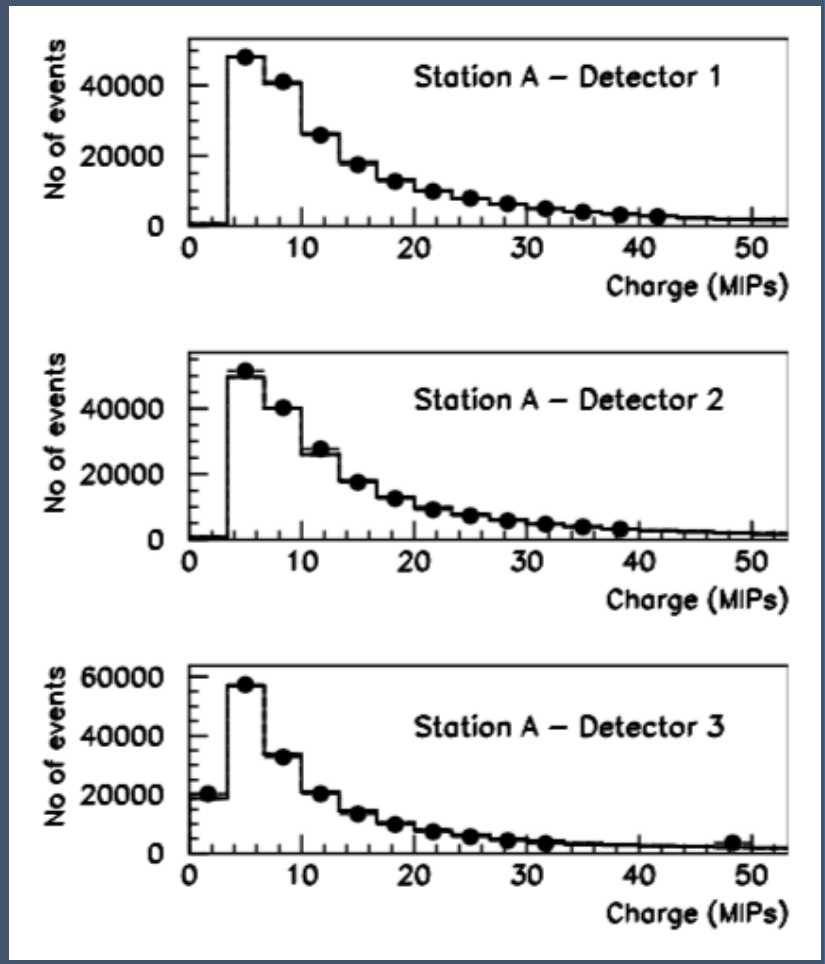




Temperature

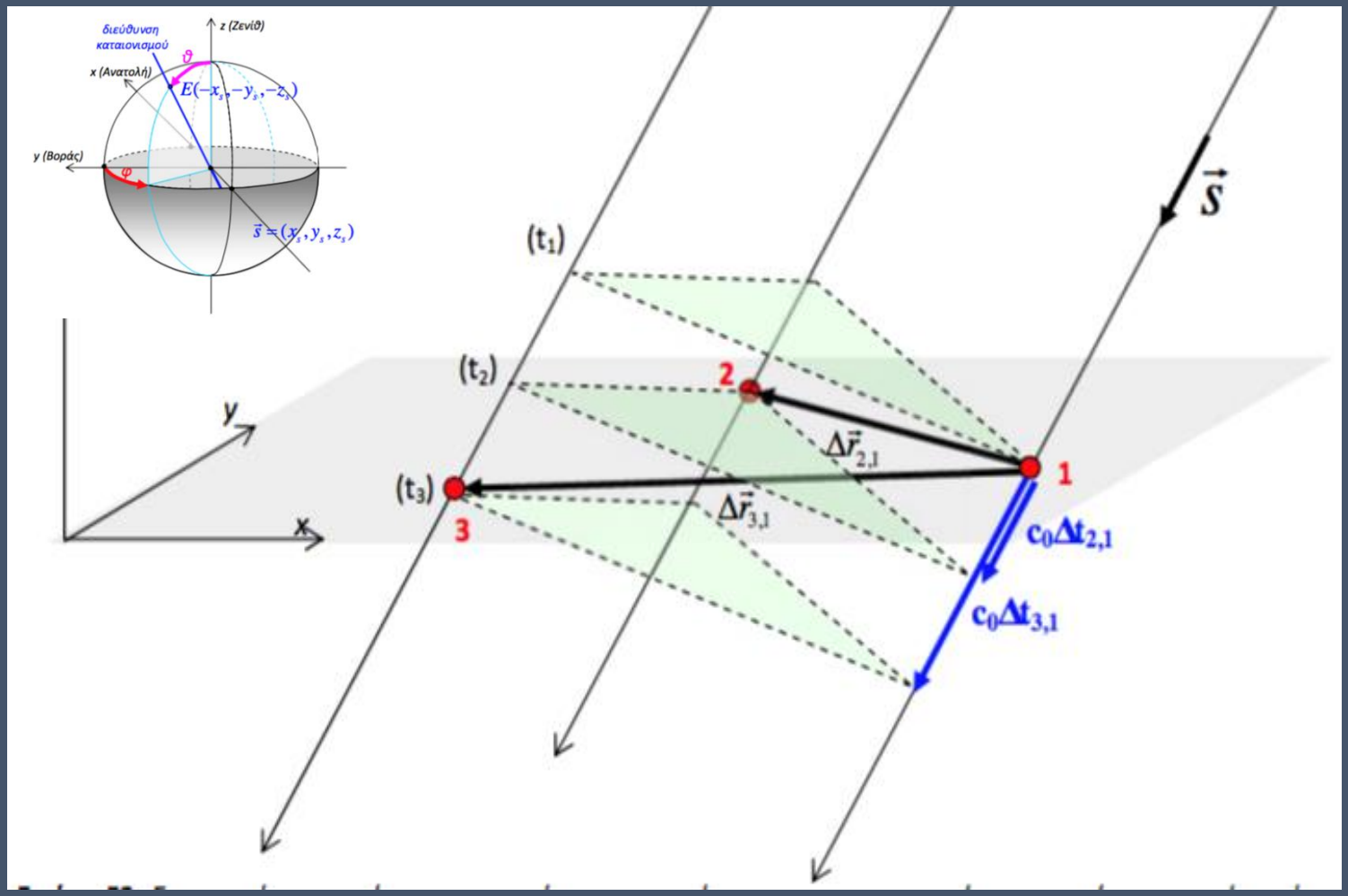
Pressure (mbar)

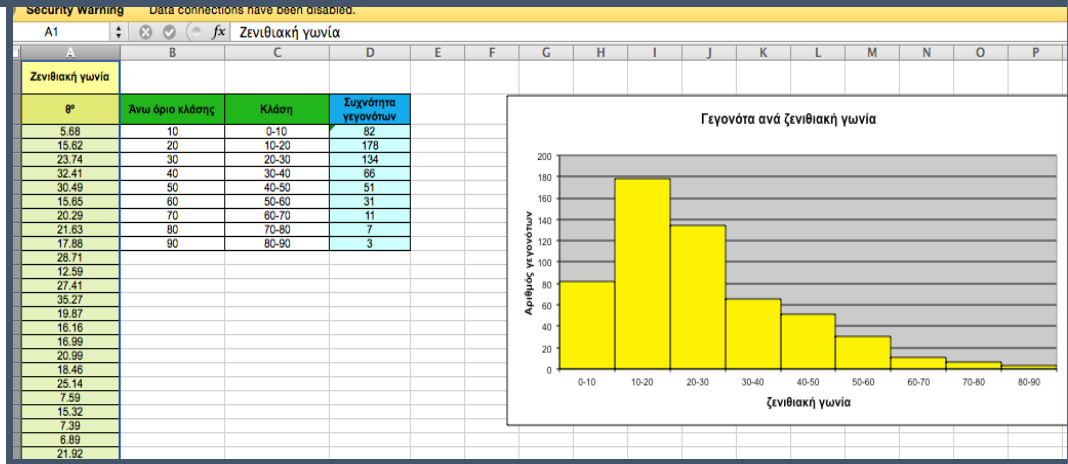



Time (s)

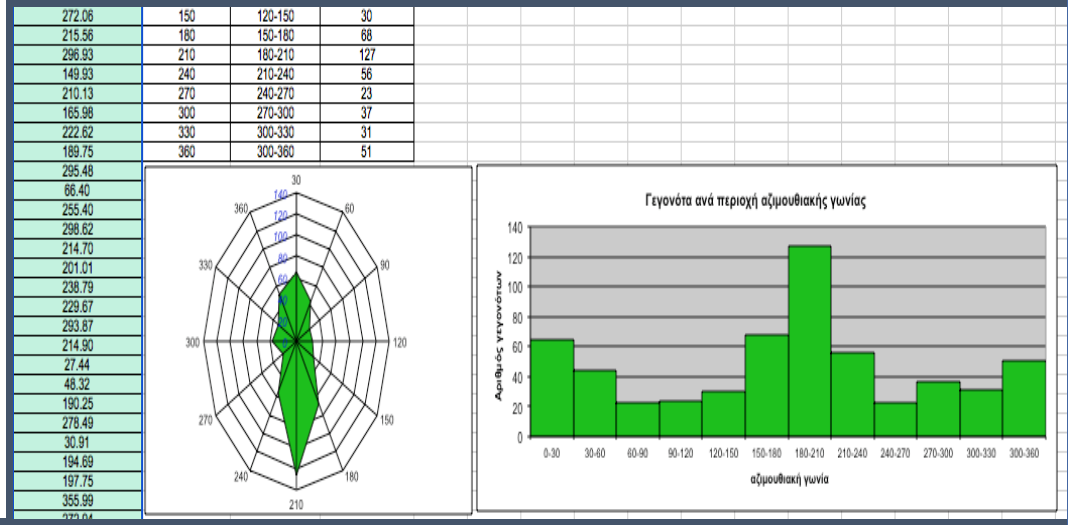


## Shower Reconstruction-Data Analysis




| Ζενιθιακή γωνία | Άνω όριο κλάσης | Κλάση | Συχνότητα γεγονότων |
|---|---|---|---|
| 5.68 | 10 | 0-10 | 82 |
| 15.62 | 20 | 10-20 | 178 |
| 23.74 | 30 | 20-30 | 134 |
| 32.41 | 40 | 30-40 | 66 |
| 30.49 | 50 | 40-50 | 51 |
| 15.65 | 60 | 50-60 | 31 |
| 20.29 | 70 | 60-70 | 11 |
| 21.63 | 80 | 70-80 | 7 |
| 17.88 | 90 | 80-90 | 3 |




| | | | |
|---|---|---|---|
| 272.06 | 150 | 120-150 | 30 |
| 215.56 | 180 | 150-180 | 68 |
| 296.93 | 210 | 180-210 | 127 |
| 149.93 | 240 | 210-240 | 56 |
| 210.13 | 270 | 240-270 | 23 |
| 165.98 | 300 | 270-300 | 37 |
| 222.62 | 330 | 300-330 | 31 |
| 189.75 | 360 | 300-360 | 51 |

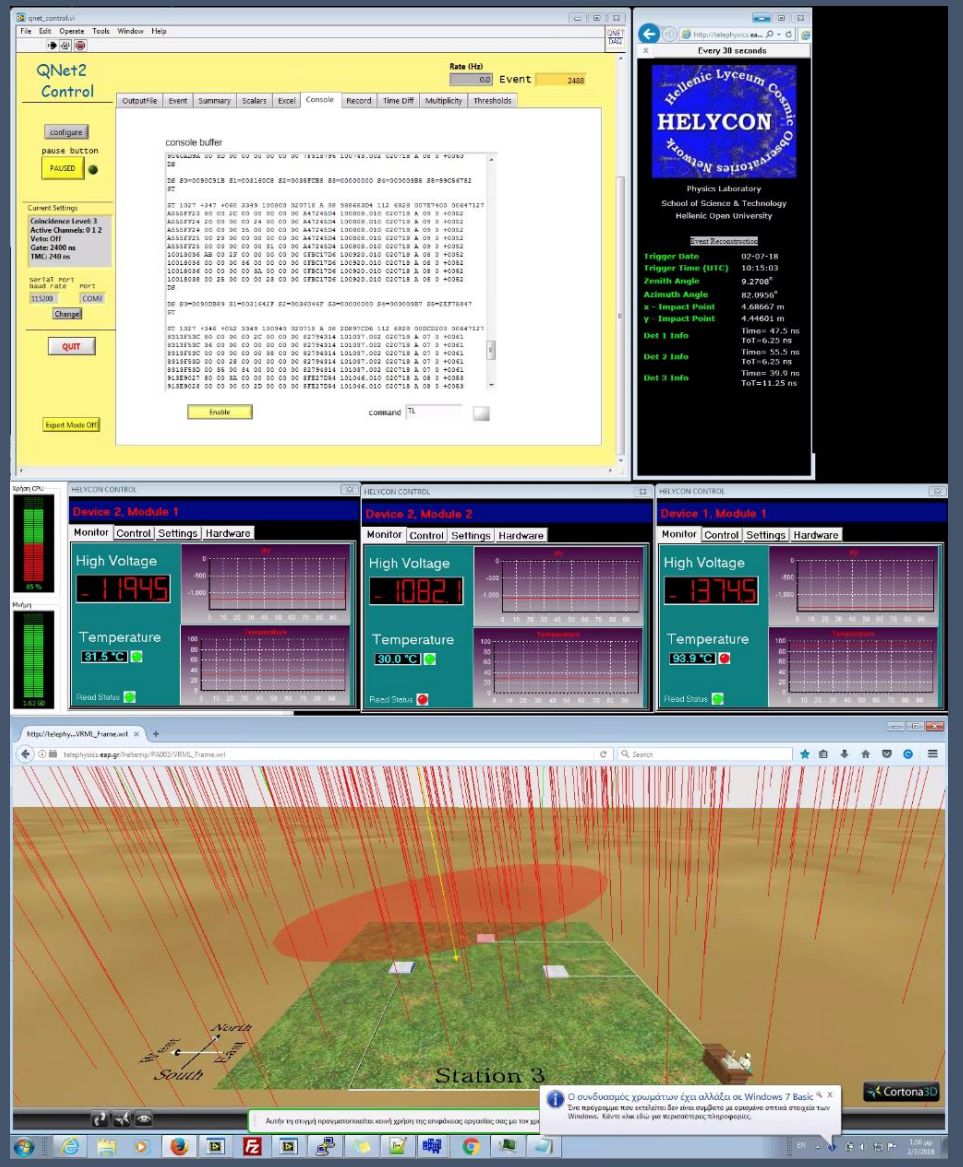
# Helycon Remote

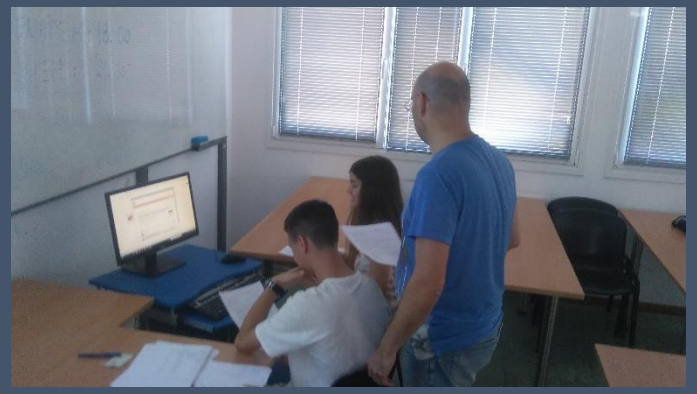


## Remote operation of an Astroneu station

Complete set of educational material

- Physics of cosmic rays
- Architecture of a Helycon station
- Step by step instruction manual
  - Setting of operational parameters
  - DAQ, Control and Monitoring
  - Data analysis
- Evaluation tests and exercises





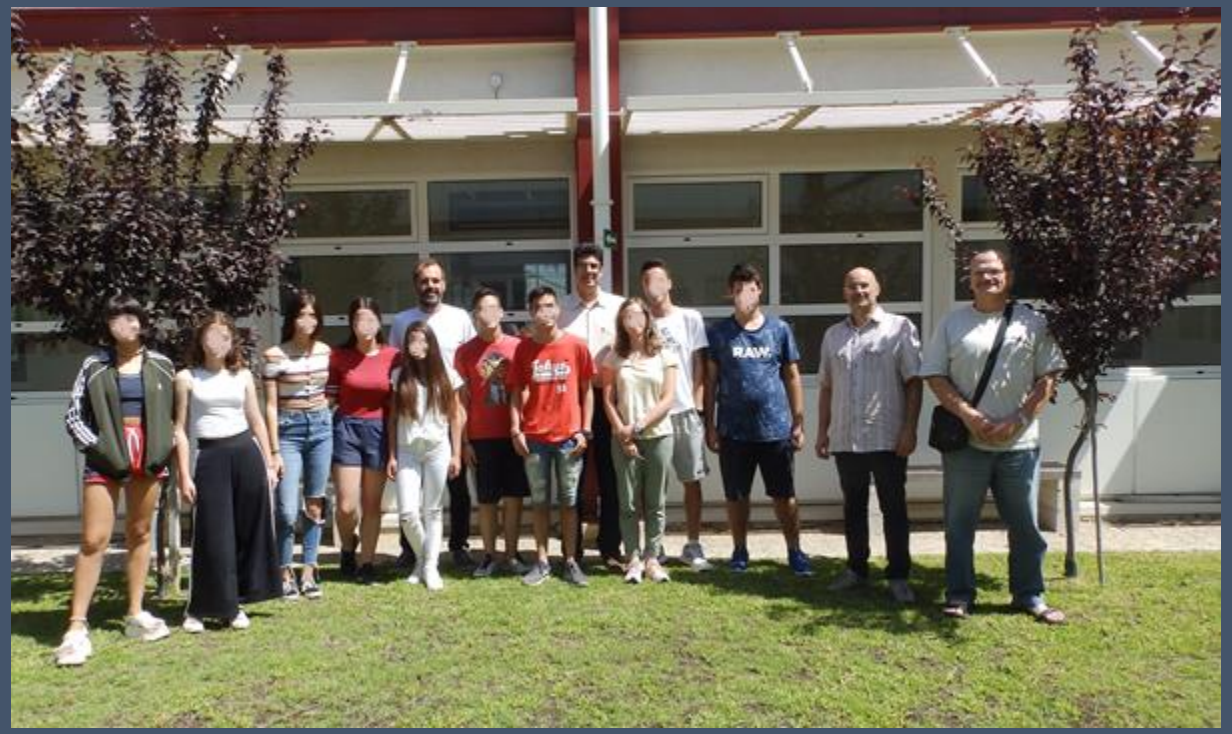
# Summer Schools



Astroparticle physics summer schools for students from Achaia

1st summer school (2018)

2nd summer school (2019)

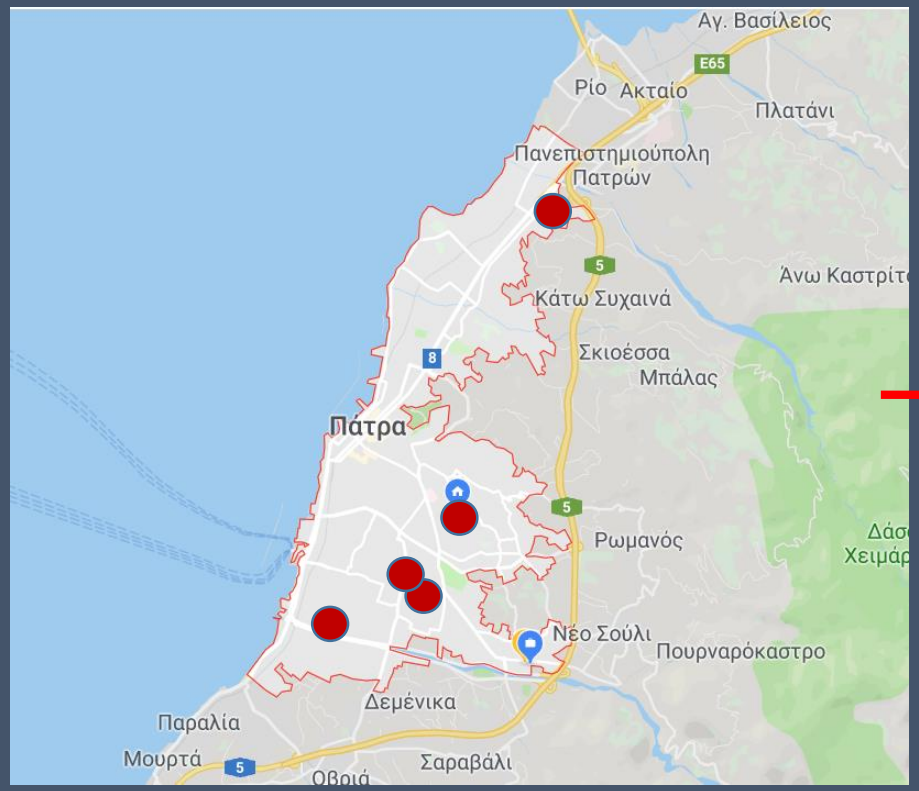


# Near Future Plans



## Installation of μCosmics detectors

### μNet project (5 detectors)



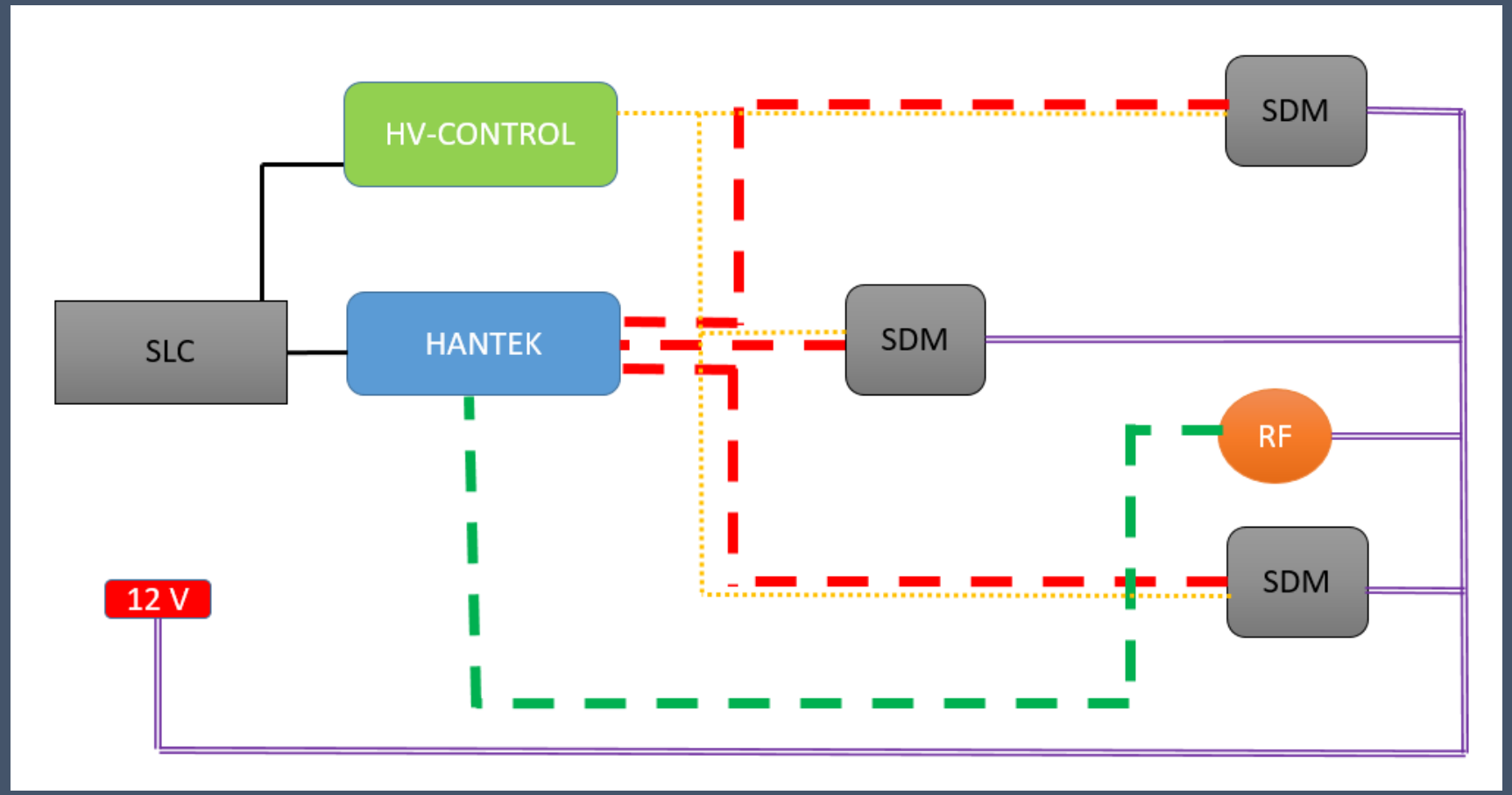

### 3 more detectors outside Achaia (Zakynthos, Tripoli, Athens)

By end of 2019

# Near Future Plans



## μCosmics II: Upgraded μCosmics with RF antenna




RG58-PMT SDM Signal
RG58-EW RF Signal
UTP Control Voltage
UTP Power
USB

# Conclusions



| |
|---|
| The μCosmics Detector is suitable as a school EAS detector |
| The 1st array of educational air shower detectors in Greece is under construction (μNet) |
| A complete set of educational activities and educational material will be available through the μNet project |
| Increasing interest for the μCosmics detector as well as for the remote operation of an Astroneu station |
| Design of educational hybrid arrays (particle detectors and RF antennas) |