Research Activities

G. Stavropoulos

INPP Demokritos, July 2019

Software development for KM3Net

- GEANT4-based Simulation
- Chameleon reconstruction
- Analyses sw.

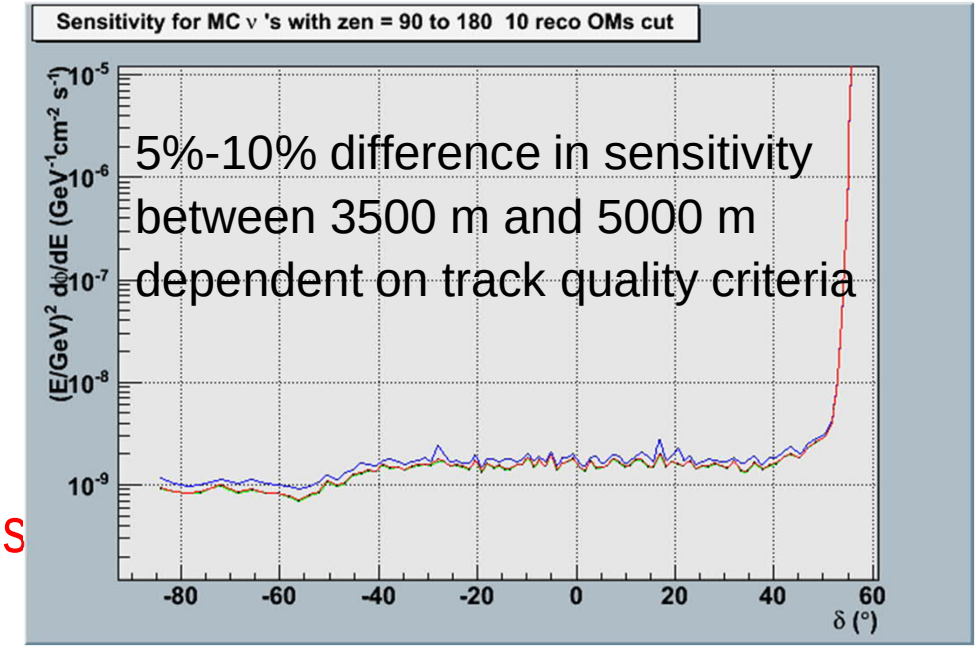
Work done by D. Lenis and G. Stavropoulos.

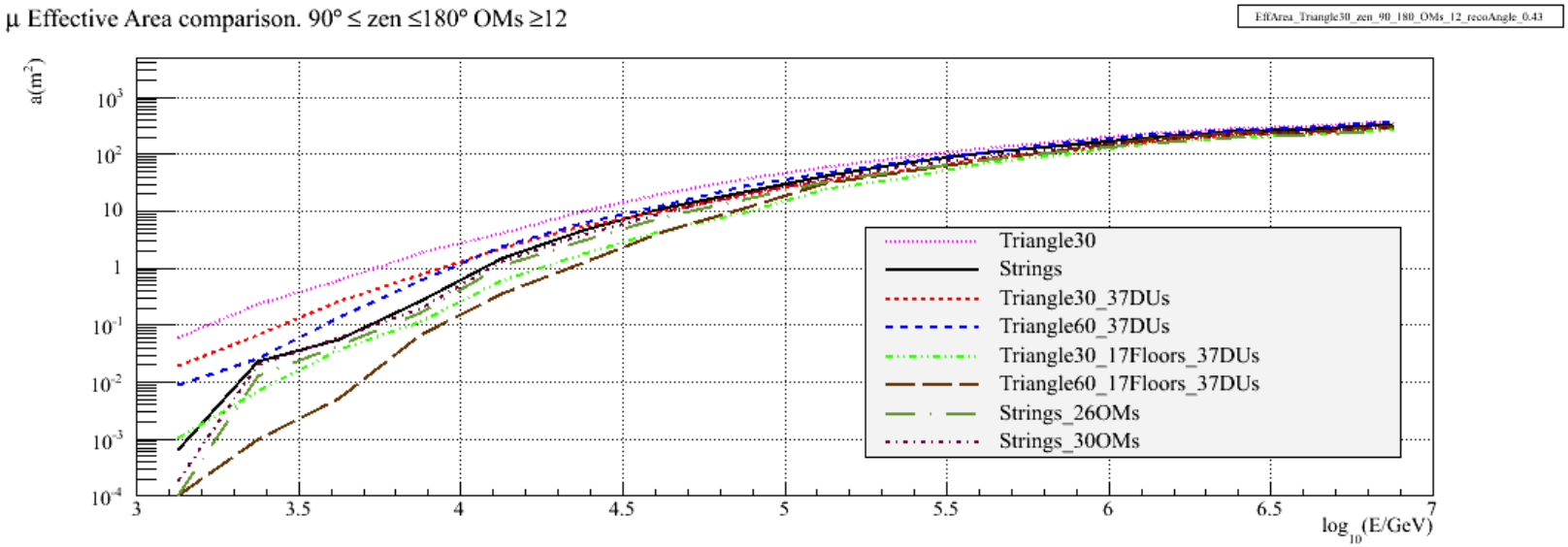
Work at NESTOR/INP/INPP directly related to KM3NeT

Slide from Rapidis talk during the 2014 review meeting of INPP

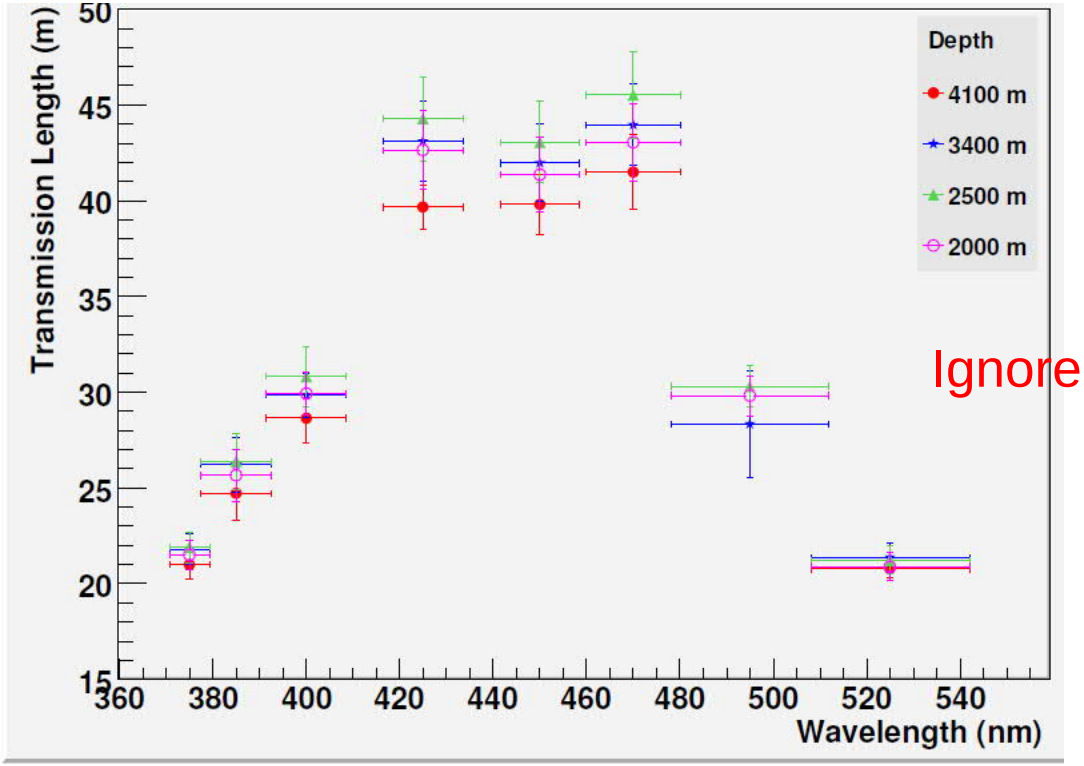
- μ track reconstruction
- detector layout optimization studies
- study of the depth dependence

Work by D. Lenis, G. Stavropoulos





Light transmission measurements



Astropart.Phys. 34 (2010) 187-197

Ignore the horizontal error bars

Electronics: Th. Athanasopoulos and M. Maniatis, G. Kiskiras

Mechanics: D. Vakondios and the machine shop staff, V. Zhukov

Pre- and Post-Deployment tests: M. Maniatis, S. Koutsoukos, A. Psallidas, V. Zhukov, G.S.

Deployments and data taking: M. Maniatis, D. Vakondios, A. Vougioukas, G. Stavropoulos with the invaluable help of the Aegeo crew.

Data Analysis: A. Psallidas, G. Stavropoulos

A Method for Measuring the Optical Parameters of Deep-Sea Water

Front. Phys., 21 November 2018 | https://doi.org/10.3389/fphy.2018.00132

Konstantia G. Balasi, Dimitrios Lenis, Manolis Maniatis, Nikolaos Maragos

and Georgios Stavropoulos

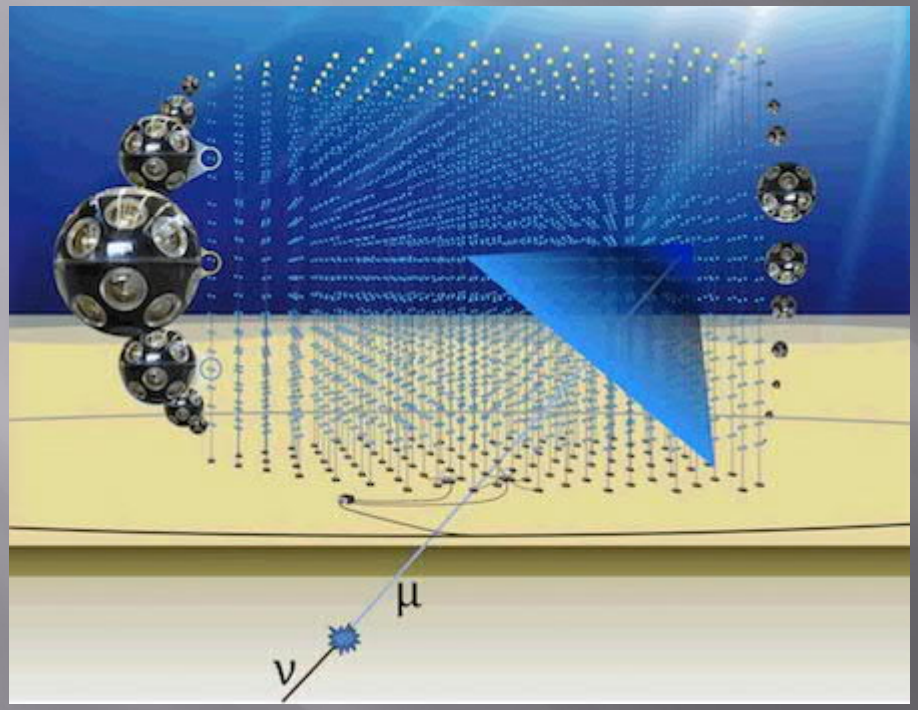
Institute of Nuclear and Particle Physics,

National Centre of Scientific Research Demokritos, Athens, Greece

Η εργασία χρηματοδοτήθηκε από το ΚΡΗΠΙΣ με 65000 €.

Μελετήθηκε με μεθόδους Monte Carlo η βέλτιστη ανιχνευτική διάταξη, αναπτύχθηκε μια νέα μέθοδος προσδιορισμού των οπτικών ιδιοτήτων του θαλασσινού νερού, σχεδιάσθηκαν και αναπτύχθηκαν τα απαραίτητα ηλεκτρονικά καθώς και η μηχανική διάταξη του ανιχνευτή, πραγματοποιήθηκαν όλοι οι απαραίτητοι εργαστηριακοί έλεγχοι για τη καλή λειτουργία της συσκευής, έγινε η πόντιση της συσκευής και η λήψη δεδομένων καθώς και η λεπτομερής ανάλυσή τους. Αποτελεί προϊόν της προσπάθειας πέντε ερευνητών αποκλειστικά από το Ι.Π.Σ.Φ.

KM3NeT



Neutrino interactions

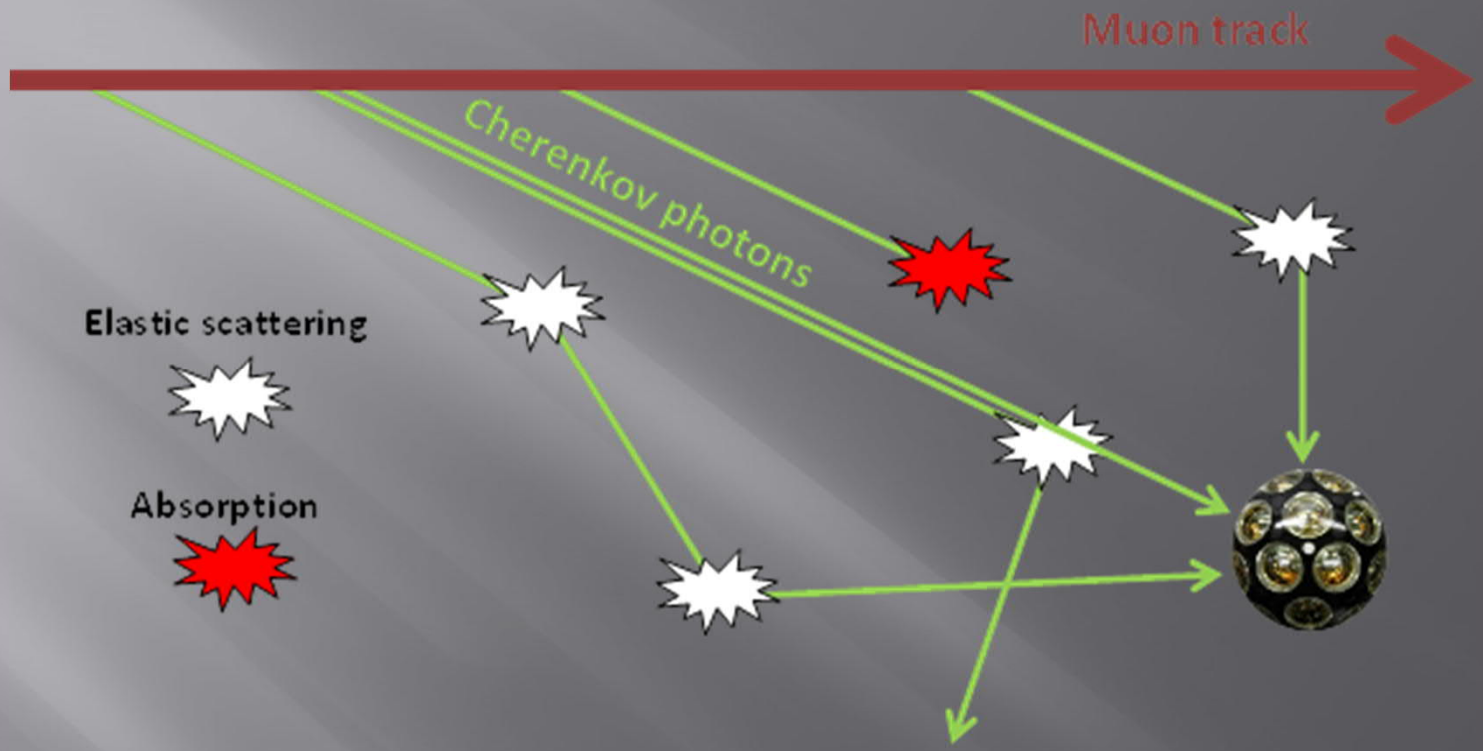
Energetic charged particles propagation

Cherenkov light emission, Photons detected

Reconstruction

Neutrino direction and energy estimation

Cherenkov photons propagation



Suppression of systematics in the reconstruction

Good estimation of the parameters describing the optical properties of the deep sea water

Parameters that describe the optical properties

Absorption length $\mathbf{L_a}$ → $P_a(r) = e^{-r/L_a}$

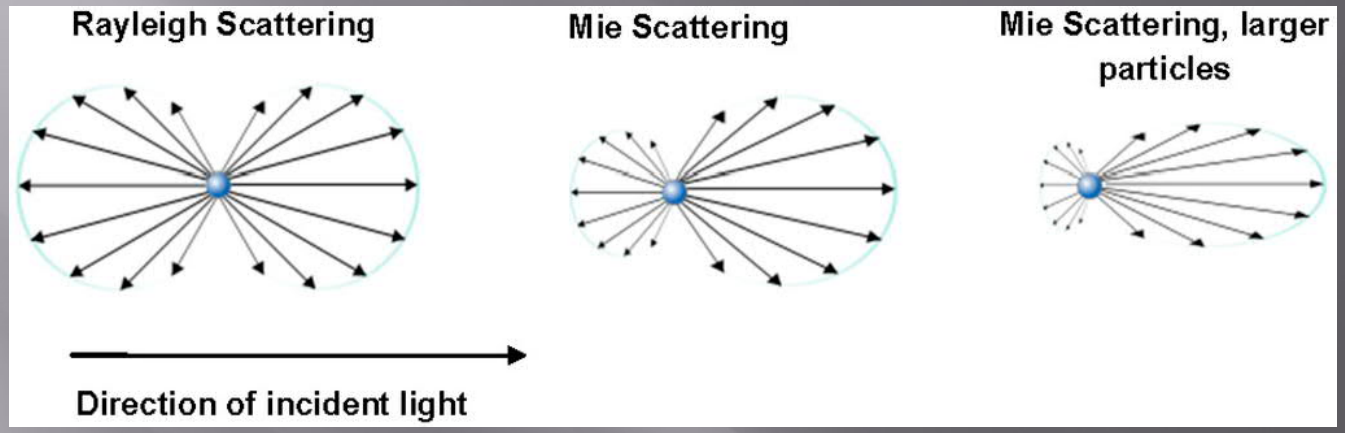
probability of a photon not to suffer absorption in a r distance travel

Scattering length $\mathbf{L_s}$ → $P_s(r) = e^{-r/L_s}$

probability of a photon not to suffer scattering in a r distance travel

Parametrization of scattering phase function $\frac{dP}{d\Omega_s}$ (next slide →)

Parametrization of scattering phase function

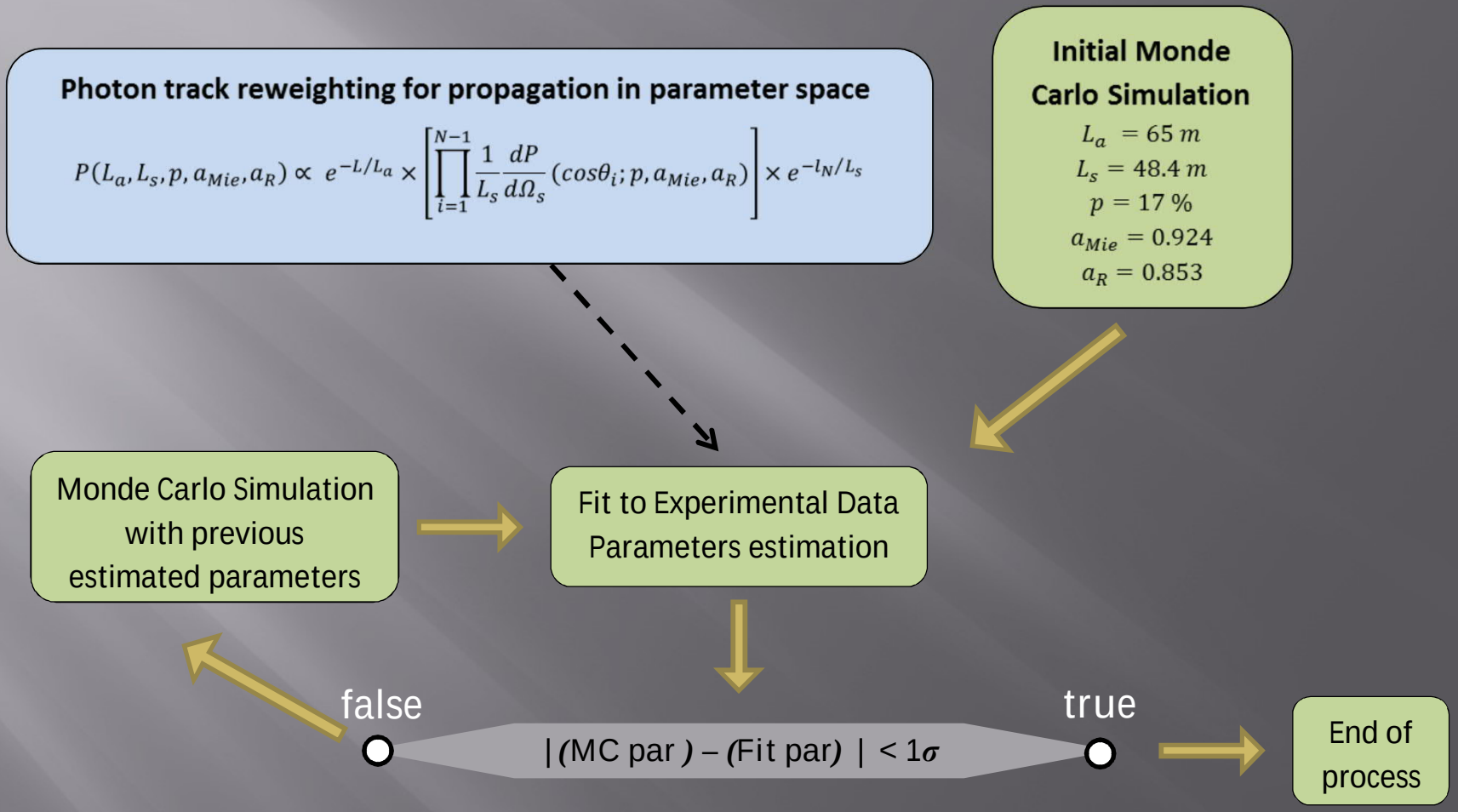


Rayleigh scattering $g(\cos\theta_s) = \frac{(1+a_R\cos^2\theta_s)}{4\pi\left(1+\frac{1}{3}a_R\right)}$ $a_R = 0.853$

Mie scattering $f(cos\theta_s; \boldsymbol{a_{Mie}}) = \frac{1}{4\pi}\frac{1-\boldsymbol{a_{Mie}^2}}{(1+\boldsymbol{a_{Mie}^2}-2\boldsymbol{a_{Mie}}cos\theta_s)^{3/2}}$

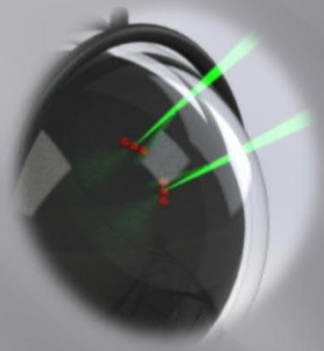
Combined $\frac{dP}{d\Omega_s} = \boldsymbol{p} \times g(cos\theta_s) + (1-\boldsymbol{p})f(cos\theta_s; \boldsymbol{a_{Mie}})$

Parameters' Extraction Method



Experimental setup

5 m titanium girder



6 diode lasers
2 → 405 nm
2 → 450 nm
2 → 520 nm

Field stop

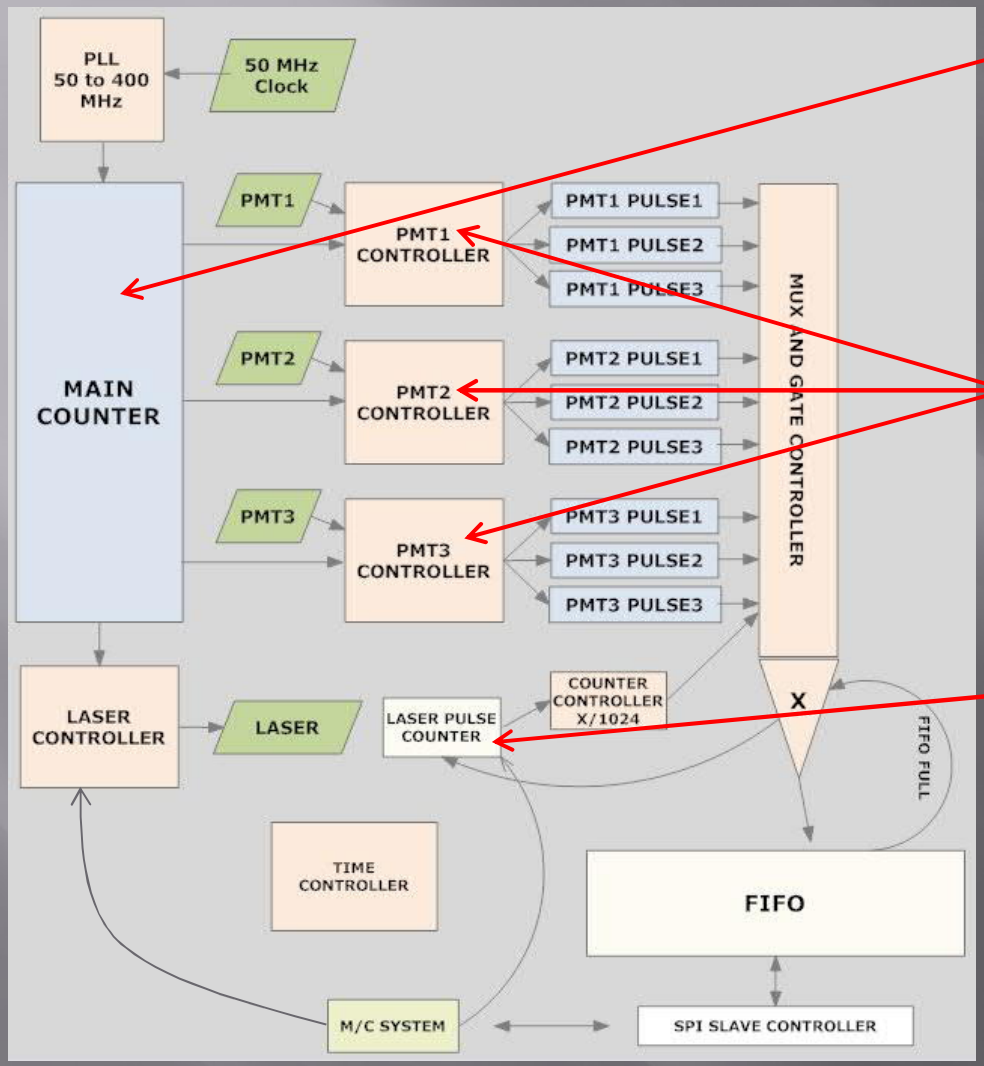
4 PMTs
PMT0 → ~ -20º
PMT1 → ~ 40º
PMT2 → ~ 80º
PMT3 → ~ 120º

Pulse width ~ 10 ns
Repetition ~ 1 MHz
Emission angles ~ 30º and 45º

QE = 0.303 at 400 nm
Effective area = ∅ 8 mm

Trigger electronics →

Experimental setup - Electronics



MAIN COUNTER

Works at 400 MHz (2.5 ns resolution)
Restarts every 1280 ns (time window)
At this point a laser is triggered to emit a light pulse

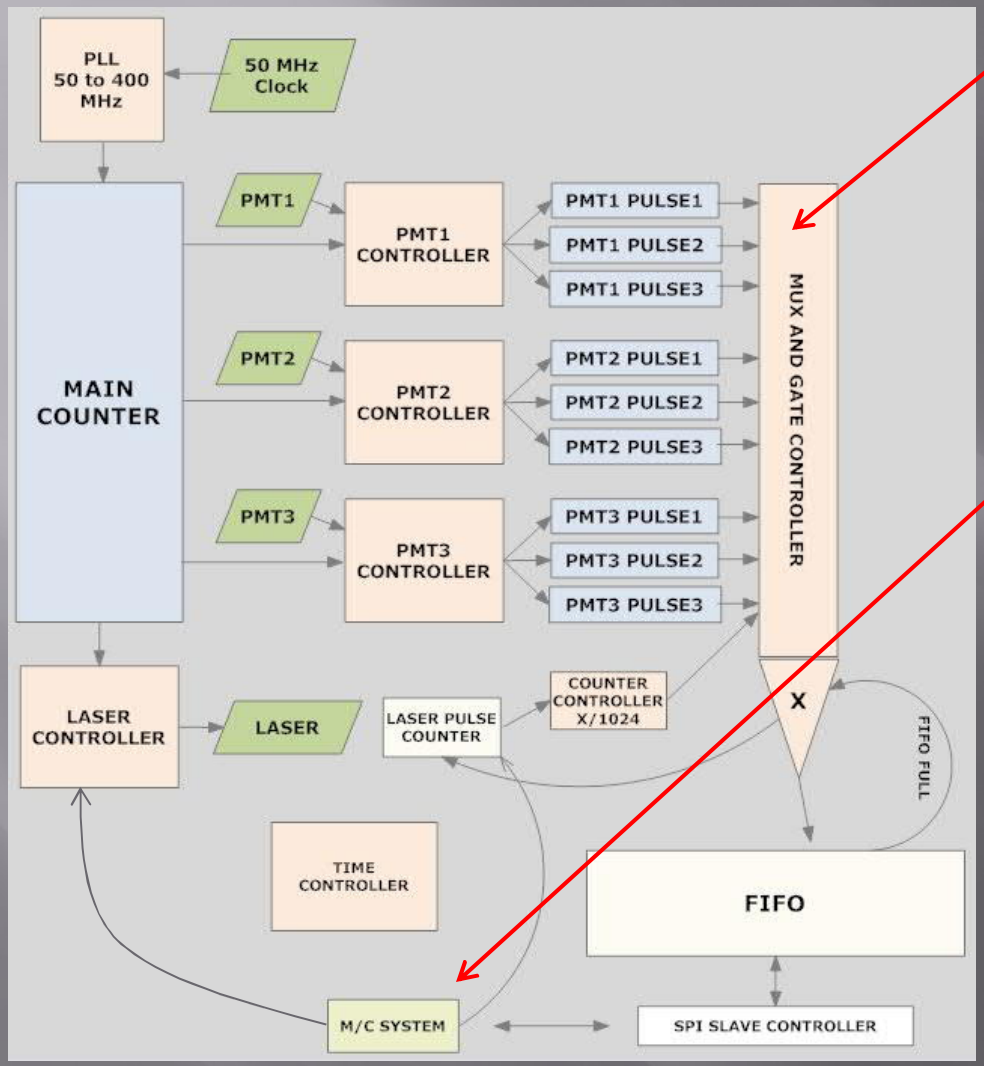
PMT CONTROLLERs

Each time a PMT gives a signal a buffer holds the MAIN COUNTER value (→ time of hit in time window)

LASER PULSE COUNTER & CONTROLLER

The laser pulses are also counted and there is a record every 1024 pulses along with a mask indicating the active laser

Experimental setup - Electronics



MUX AND GATE CONTROLLER

Just before the MAIN COUNTER restarts registers are guided to FIFO along with a mask indicating witch PMT gave the hit.

MICRO CONTROLLER

- Responsible for transferring data from FPGA to an SD card
- USB to sent data to PC
- Chooses witch laser will be active and for how much time (30 s per laser)
- Controls the powering of the PMTs and the FPGA

Setup characterization

Detailed setup Geometry measurements

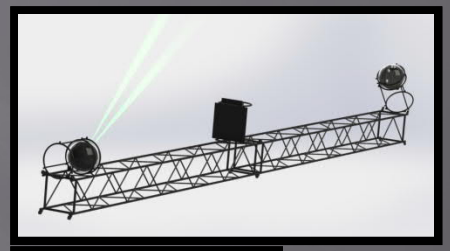
Laser pulse time distribution measurements

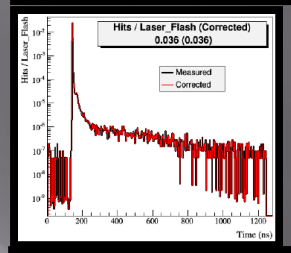
Laser emission angle distribution measurements

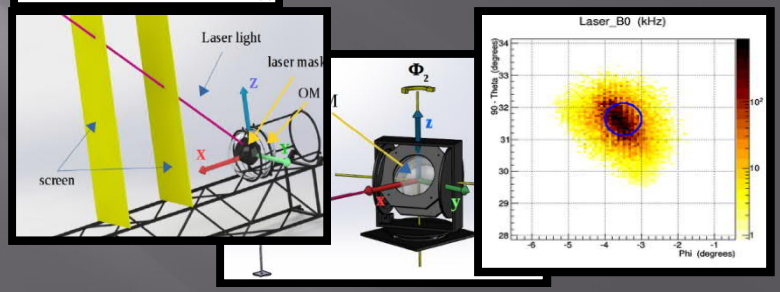
Underwater cable delay and voltage drop measurements

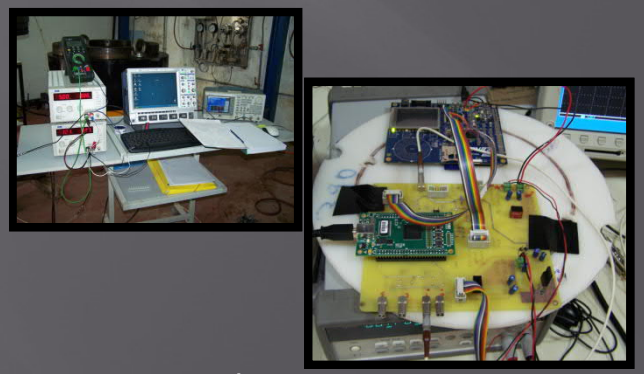
PMT dark rate measurements

Other electronics characterization measurements…

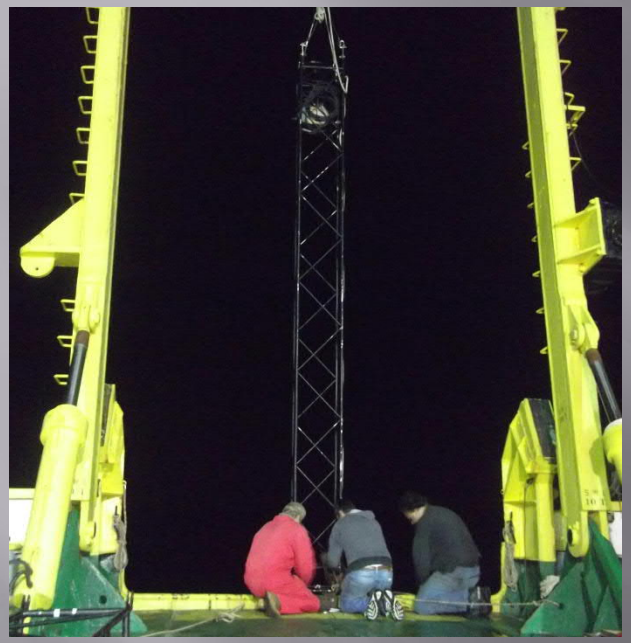


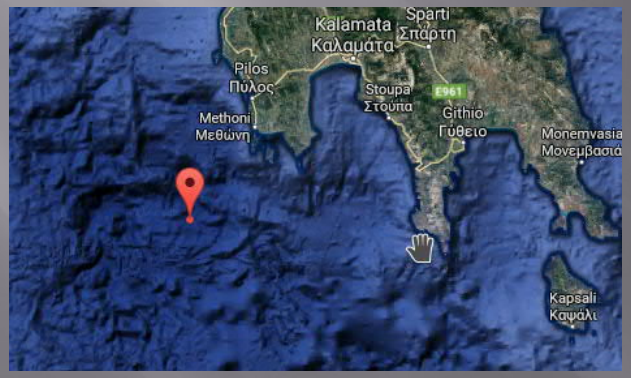






Experimental setup - Deployment





Date: 28 October 2015
Boat: AEGEON (HCMR)
Place: 36°31'N 21°26'E (SW of Pilos - Greece)
Depth: 3500 m

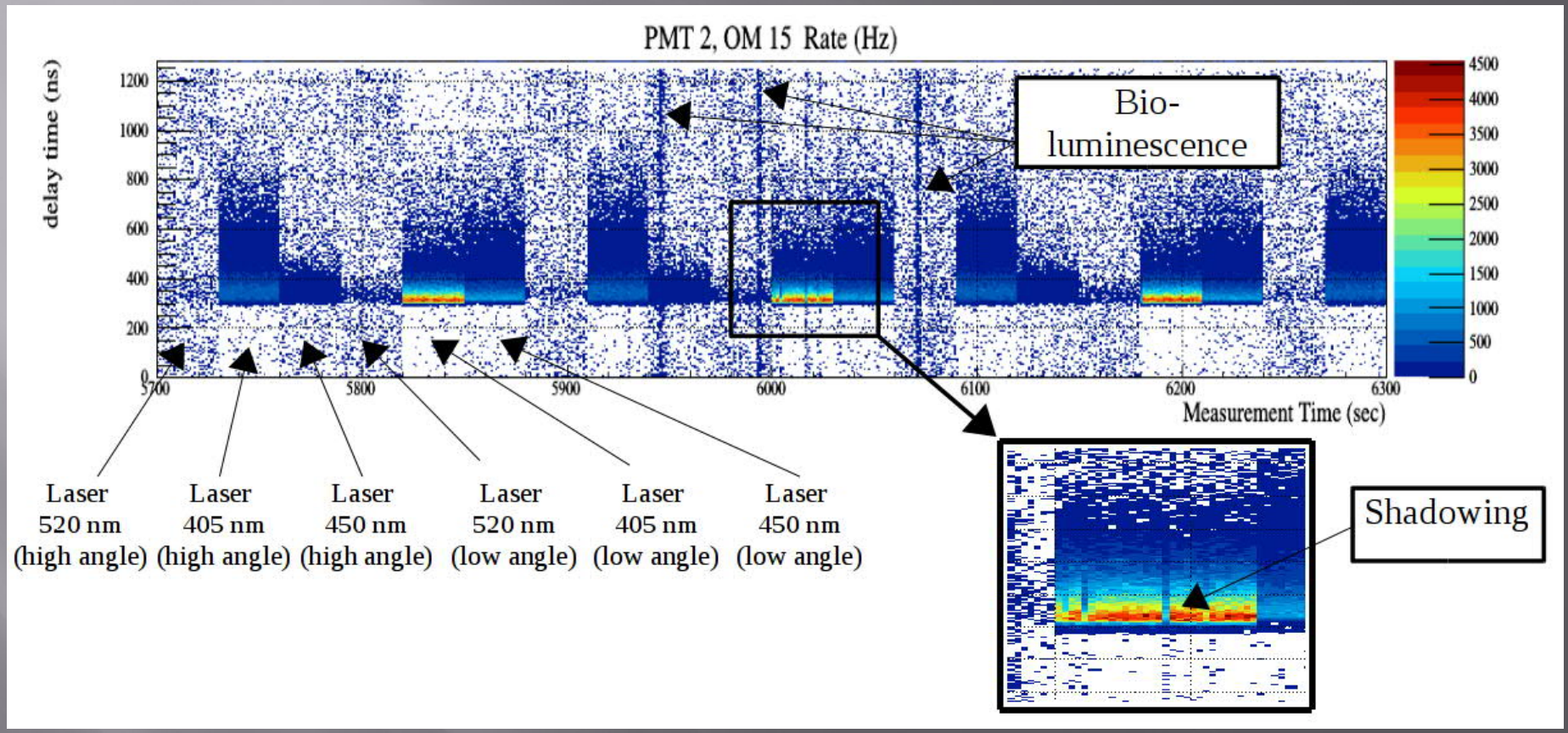
Number of Deployments = 3

1st → ~20 m OM to OM distance (4 girders)
2nd → ~15 m OM to OM distance (3 girders)
3rd → ~10 m OM to OM distance (2 girders)

Deployment Duration = 4 h

90 min from 0 m to 3500 m
60 min measurement
- 30 sec each laser (30 s x 6 lasers = 3 min / cycle)
- 20 cycles
90 min from 3500 m to 0 m

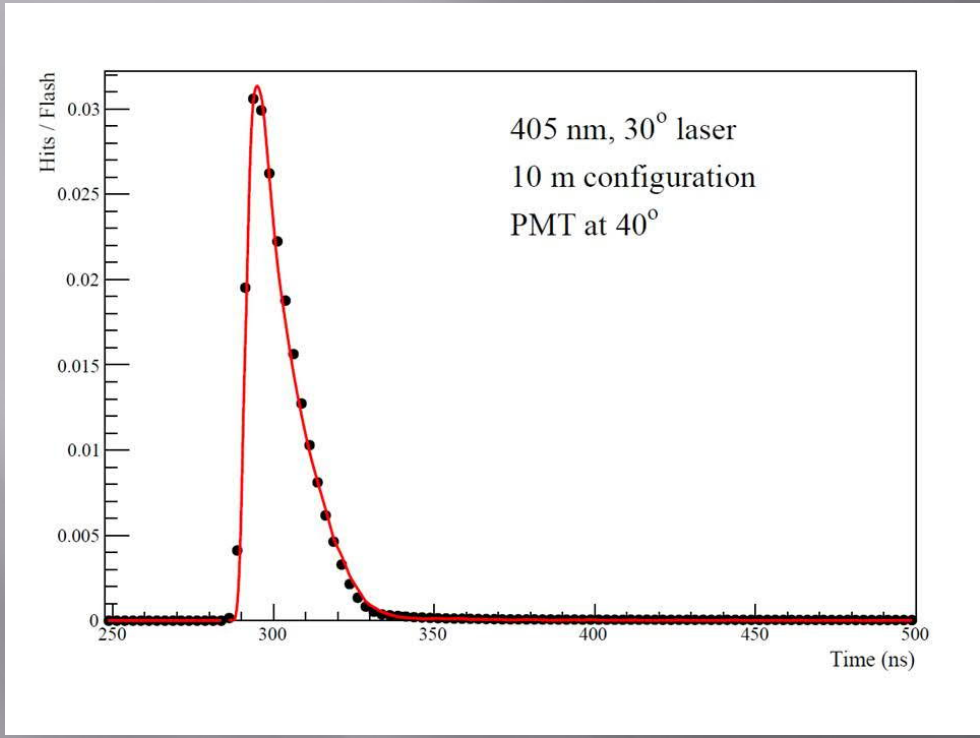
Data overview

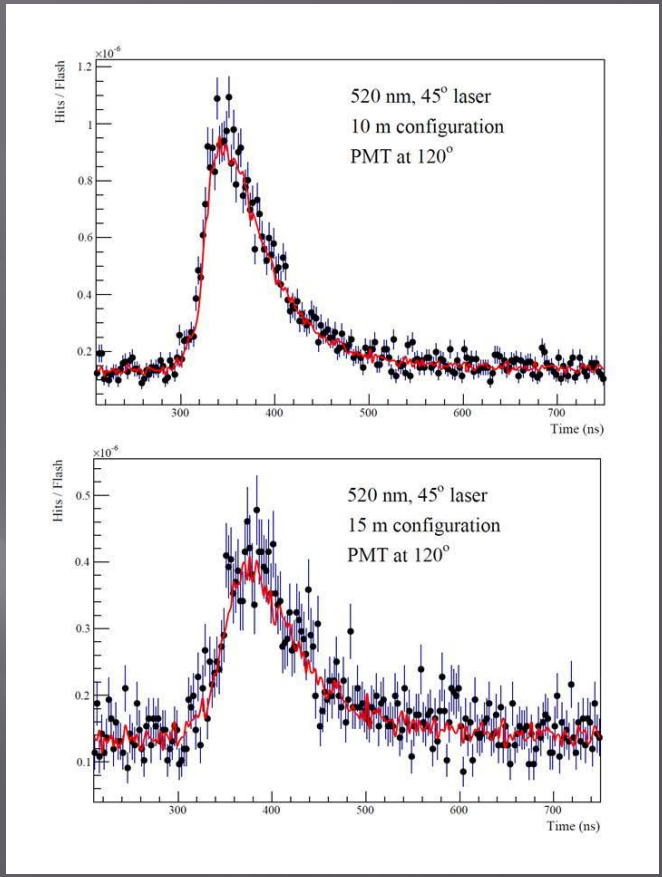


System stability tests

All the system tests described previously were performed before and after deployment, so as to control the stability of the system. Unfortunately, a technical problem at the time of sealing the lasers' glass sphere caused the damage (significantly different time and intensity distributions of the emitted light) of both the 450 nm lasers, and of the 405 nm and 520 nm lasers pointing to the '45° direction' and '30° direction' respectively. The remaining lasers (405 nm, '30° direction' and 520 nm, '45° direction') demonstrated a rather good stability in the aforementioned tests and were used for analysis.

Results





Fitted Parameter	λ (nm)	
	405	520
L_a (m) ± (stat) ± (syst)	35± 1± 4	25.5± 0.8± 3
L_s (m) ± (stat) ± (syst)	45± 1± 5	37.5± 0.9± 4
p ± (stat) ± (syst)	0.299± 0.003± 0.006	0.126± 0.002± 0.004
a_{Mie} ± (stat) ± (syst)	0.935± 0.004± 0.007	0.925± 0.004± 0.006

Management and Outreach activities

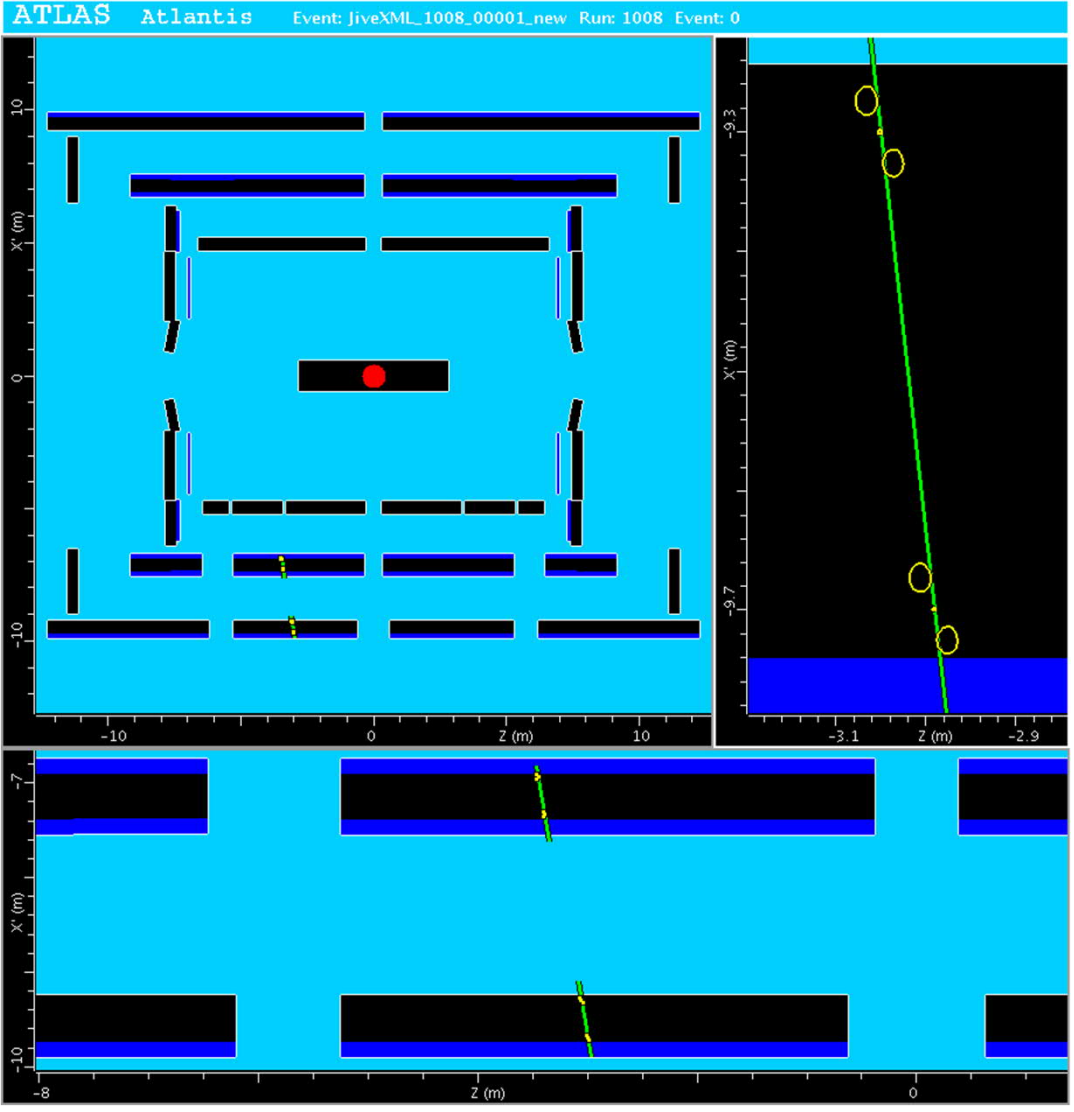
- DIONAS proposal. 10 Greek Institutes, > 40 research staff, ~50 M€
- Management and Outreach activities
  - Proposal to renovate the Pylos Buildings
  - Upgrade of the conference facilities
  - Creation of a small science museum
  - Development of educational activities

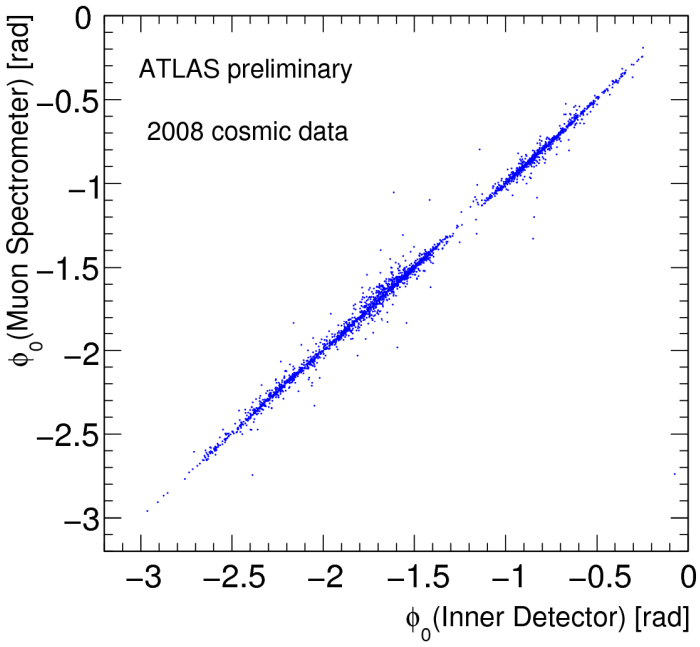
Total budget ~600 k €. Submitted to the local authorities for funding

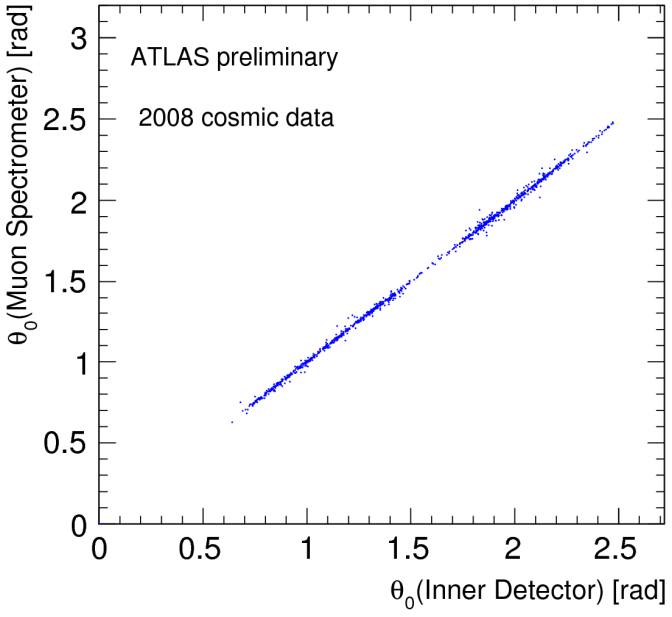
NO response.

ATLAS - The past

- Work on the development of iPatRec, a pattern recognition and track reconstruction algorithm for the ATLAS Inner Detector.
- Coordinator of the ATLAS Muon Physics and Software group. Organize the work of the group in order to produce the necessary simulation-reconstruction-analysis software in time for the Physics Performance TDR studies. In parallel, I elaborated a medium and long-term plan for the Muon Software group.
- Development of the necessary interfaces and tools for the various physics generators (Pythia, Herwig, Isajet, Hijing, and others) to work within the ATLAS Common Framework, Athena.
- Quality Assurance/ Quality Checking (Qa_Qc) of the Monitored Drift Tubes (MDT) for the ATLAS Muon detector.
- Development of Muon Reconstruction (MOORe) and Muon Identification (MuID) software for the ATLAS Detector.

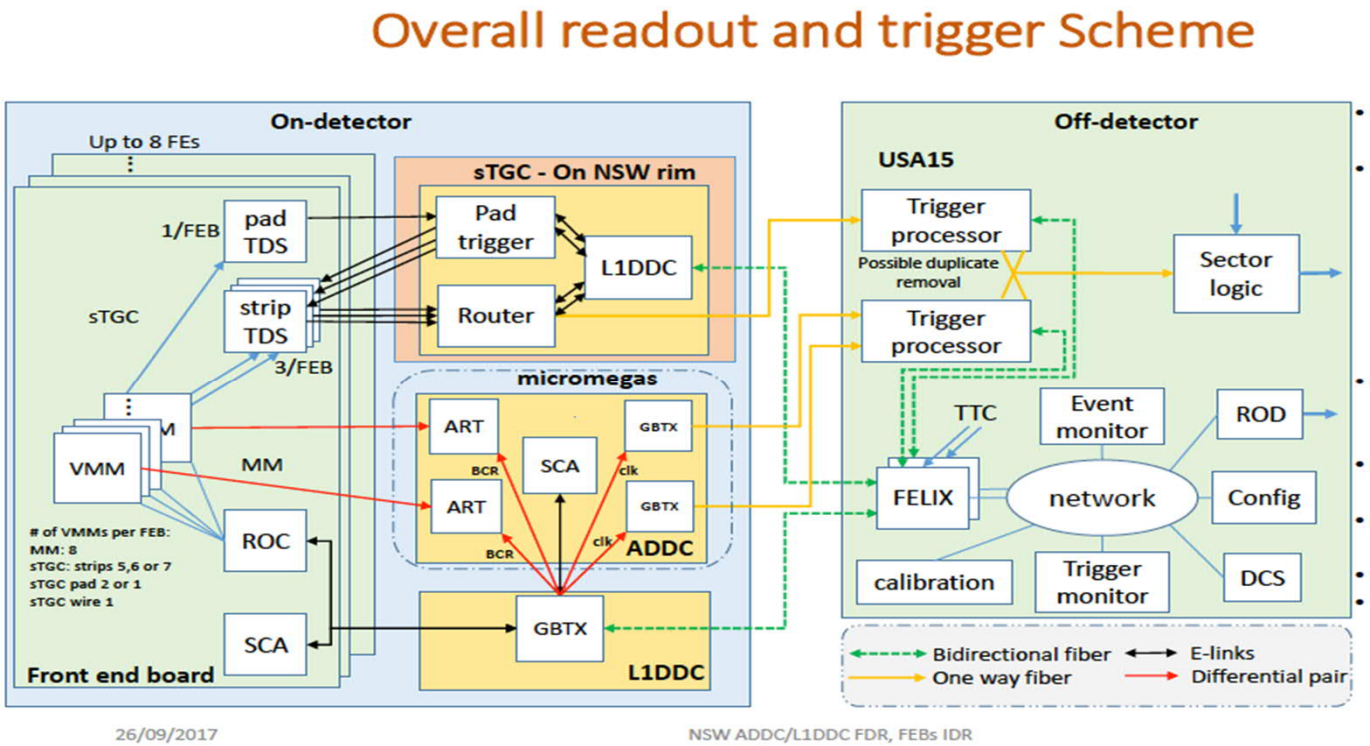

ATLAS Atlantis Event: JiveXML_1008_00001_new Run: 1008 Event: 0
X' (m)
Z (m)


ATLAS preliminary
2008 cosmic data
ϕ_0(Muon Spectrometer) [rad]
ϕ_0(Inner Detector) [rad]

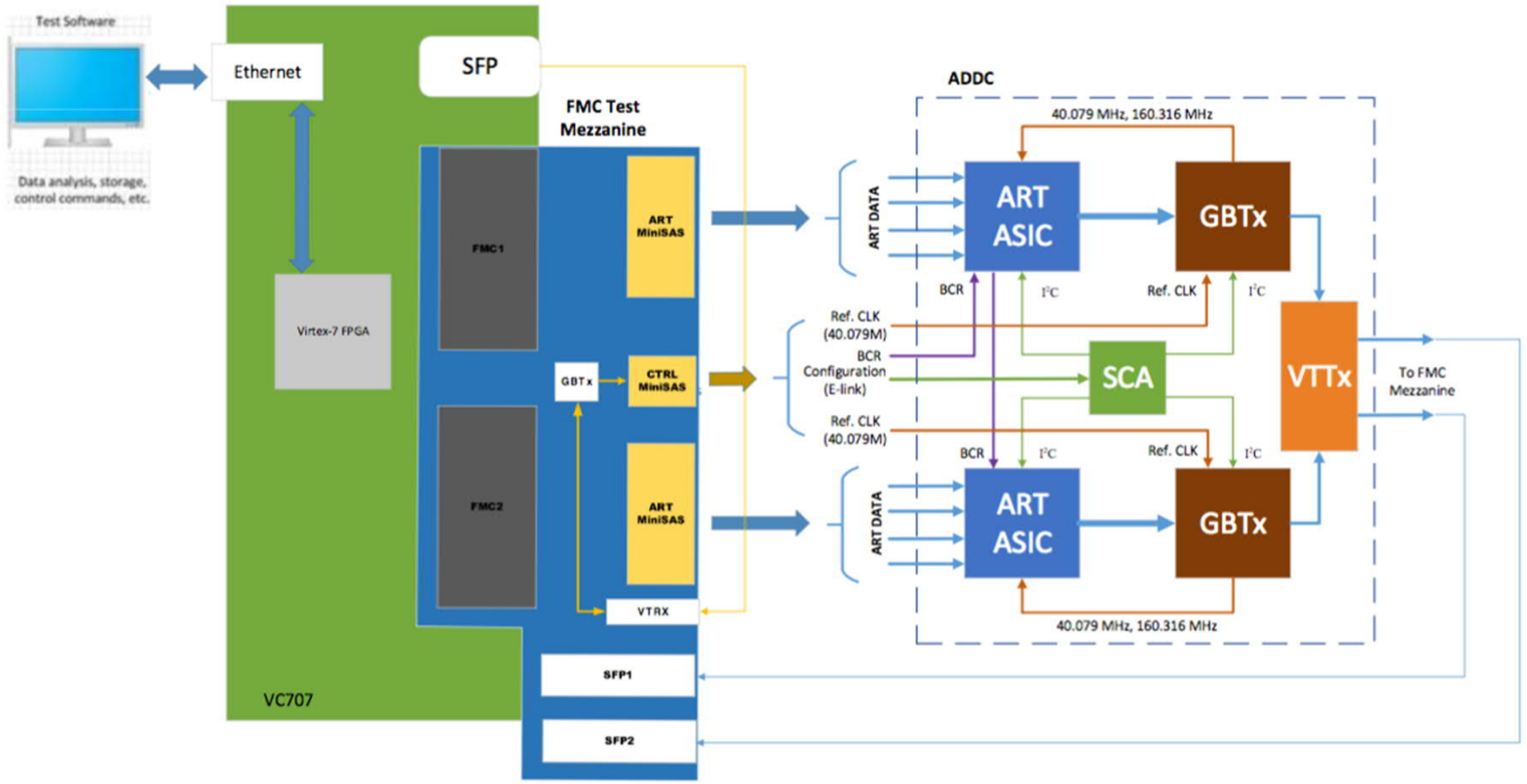

ATLAS preliminary
2008 cosmic data
θ_0(Muon Spectrometer) [rad]
θ_0(Inner Detector) [rad]

ATLAS

The Task: *Series tests for NSW ADDC cards and database logging: Build setup for testing i.e. Virtex 7, VC707 platform with connection to the ADDC card via the FMC Test mezzanine card. VC707 will be connected to a host PC for testing, analysis data storage etc. Detailed test of the ADDC cards which will consist of testing the ART asic, the SCA and VTTX functionalities in a closed loop. Update the database for every ADDC card that is tested and validated. A total of 150 ADDC cards will be tested.*



The Test Setup



- The test data are sent through the 8 minisas channels and the results will be received through the two SFP connectors;
- The minisas connector located at the center of the mezzanine board will be used to simulate the configuration signals from L1DDC and provide the reference clock.


The GTPcmx system
PCI control
Counters
JTAG
SLINK-64 control
GTP emulation
The GTPcmx system's user interface
ADDC Test Software
BROOKHAVEN
SAMSUNG

Cosmic Stand

4 επίπεδα:

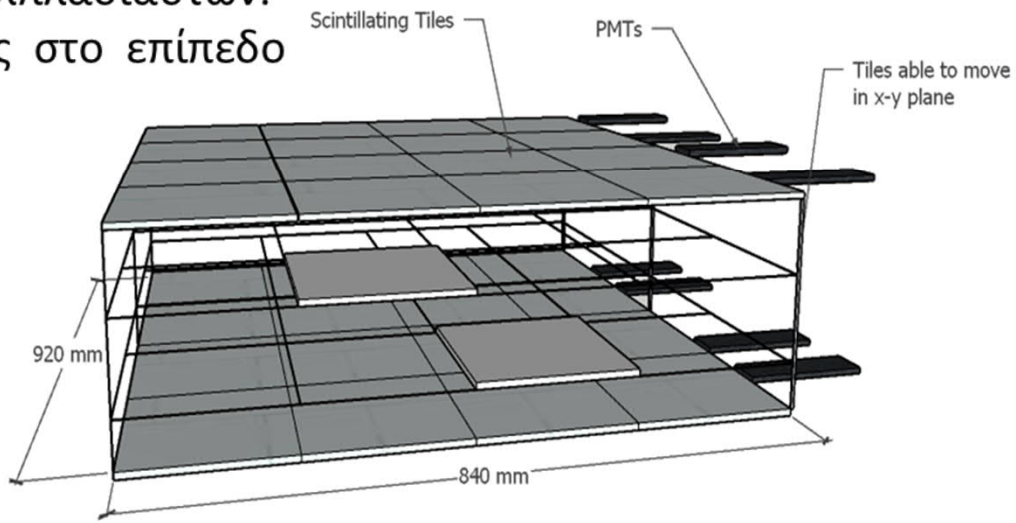
1° και 4°

4 σειρές με 4 σπινθηριστές συζευγμένοι με φωτοπολλαπλασιαστή
διαστάσεις: 84 cm × 92 cm

2° και 3°

Κατασκευή με ράγες πάνω στις οποίες θα τοποθετηθούν ανιχνευτές Micromegas ή ζεύγη σπινθηριστών-φωτοπολλπλασιαστών. Δυνατότητα μετακίνησής τους στο επίπεδο x-y

Eva Eleftheriou (Patra)
Olga Zormpa (NTUA)
Stathis Logothetis (NTUA)



Κατασκευή του Cosmic Stand
Φωτοπολλαπλασιαστές

Eva Eleftheriou (Patra)
Olga Zormpa (NTUA)
Stathis Logothetis (NTUA)

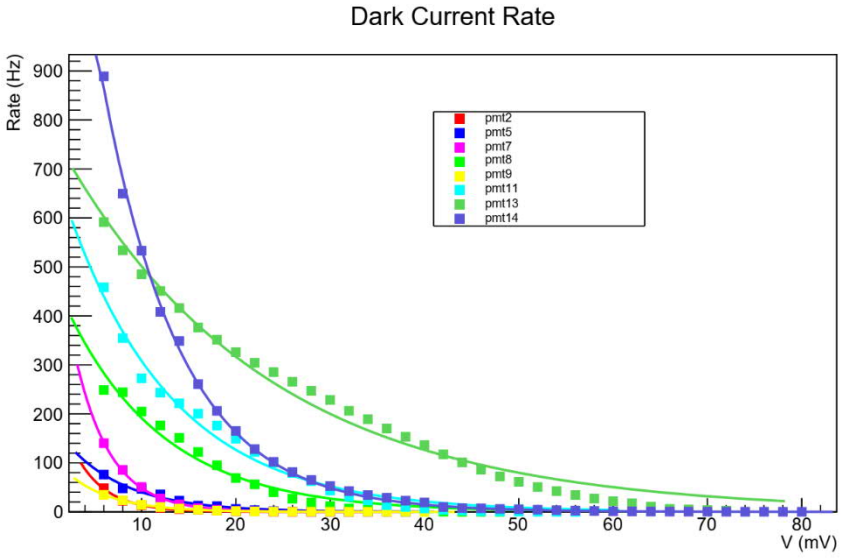
24 PMTs Hamamatsu Photonics R580-12

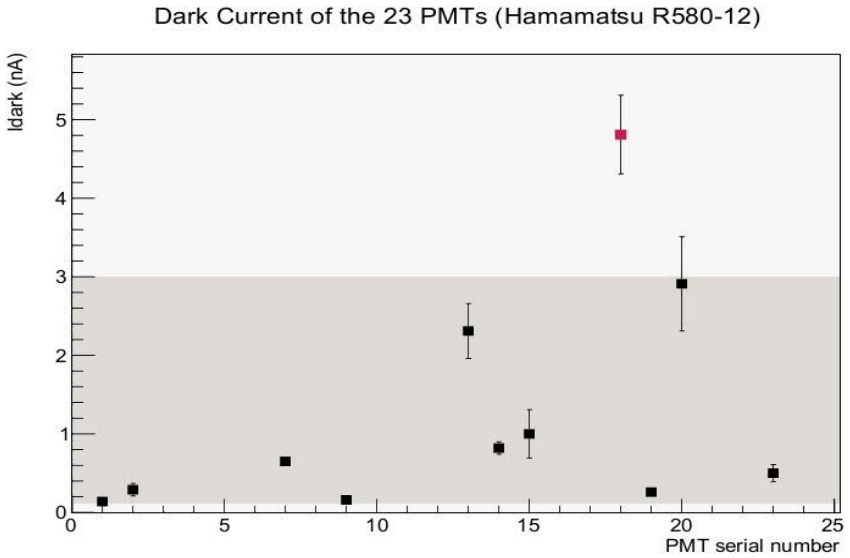
- Spectral response range : 300-650 nm
- Number of stages : 10
- Useful photocathode diameter : 34 mm
- Photocathode type : bi-alkaline
- $V_{in} = 18\,V - 24\,V$
- $V_{pmt} = 1200\,V - 1600\,V$
- $QE = 12 \sim 17\%$ for $\lambda = 520\,nm$

(πηγή : *T. Ishii et al. "Automatic test of photomultiplier tubes for the ZEUS forward and rear calorimeters"*)

Κατασκευή του Cosmic Stand Μετρήσεις

Eva Eleftheriou (Patra)
Olga Zormpa (NTUA)
Stathis Logothetis (NTUA)





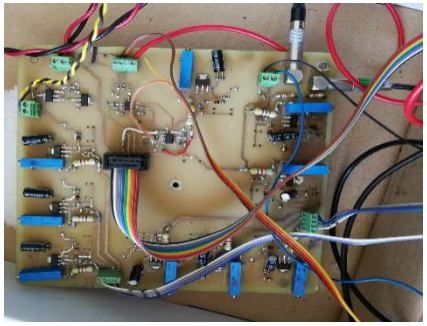
Πειραματικά δεδομένα dark current για τους 11 λειτουργικούς φωτοπολλαπλασιαστές R580-12. Στην εικόνα αριστερά φαίνεται η εκθετική πτώση της συχνότητας των σκοτεινών παλμών. Στην εικόνα δεξιά φαίνεται το εύρος του σκοτεινού ρεύματος, για τους R580-12 (πηγή: T. Ishii et al. "Automatic test of photomultiplier tubes for the ZEUS forward and rear calorimeters") και οι δικές μας μετρήσεις.

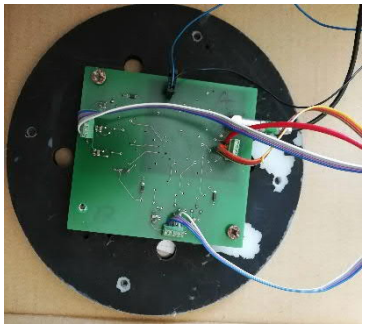
Κατασκευή του Cosmic Stand LASER

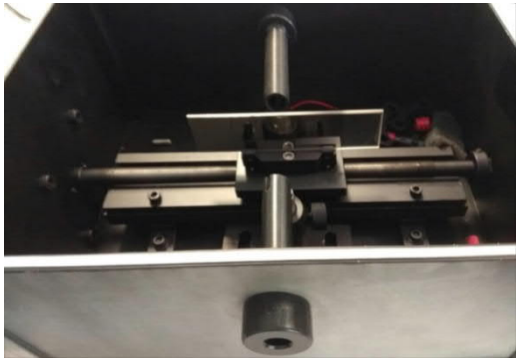
Eva Eleftheriou (Patra)
Olga Zormpa (NTUA)
Stathis Logothetis (NTUA)

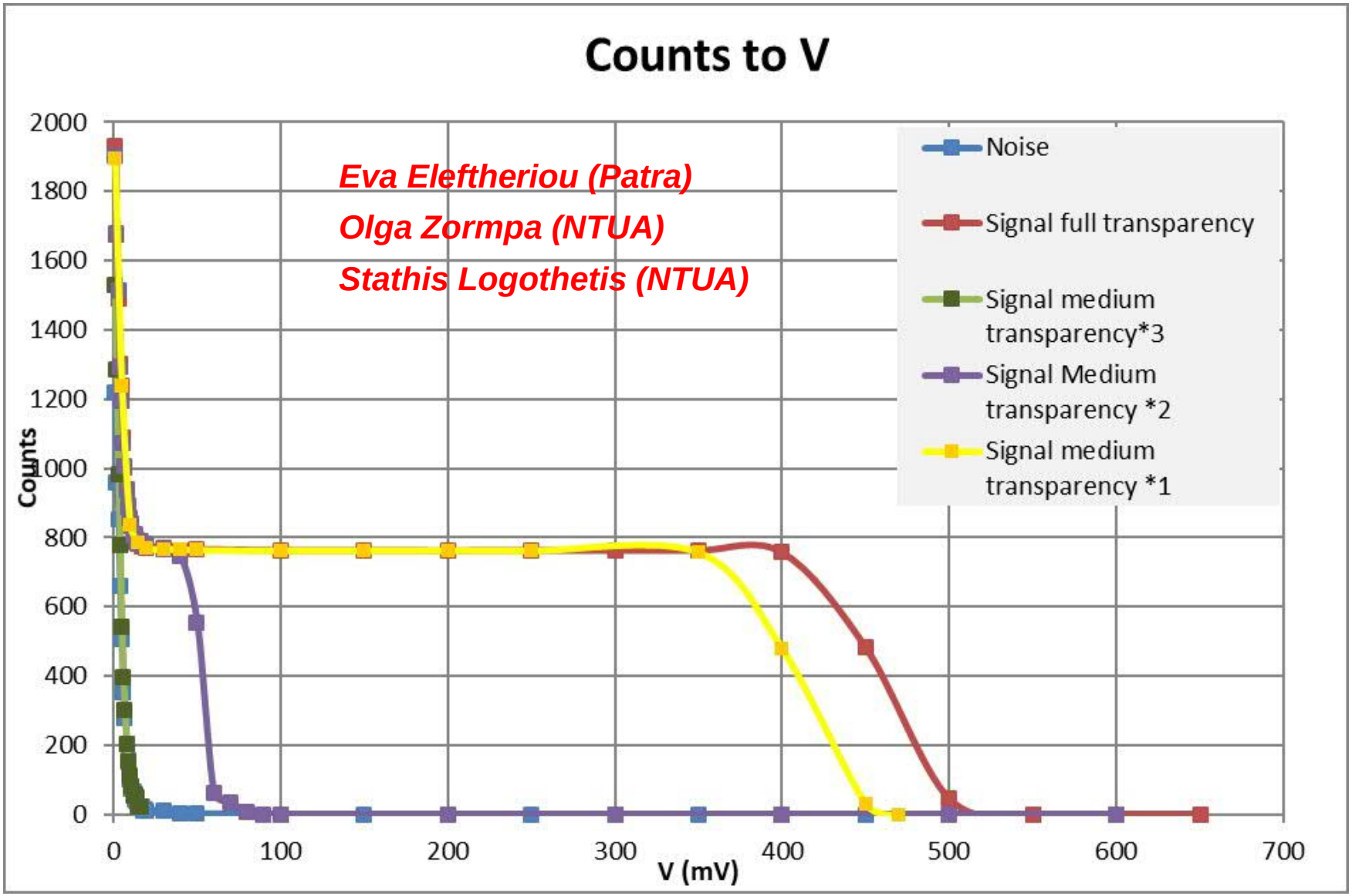
$\lambda_1 = 405\ nm$
$\lambda_2 = 450\ nm$
$\lambda_3 = 520\ nm$

- Ενεργοποίηση με τη χρήση τετραγωνικού παλμού:
  - V=2V
  - Δt=500 ns
  - 10 ns light pulse
- Χρήση λογαριθμικού φίλτρου
- Χρήση οπτικής ίνας για τη σύνδεση PMT και φίλτρου



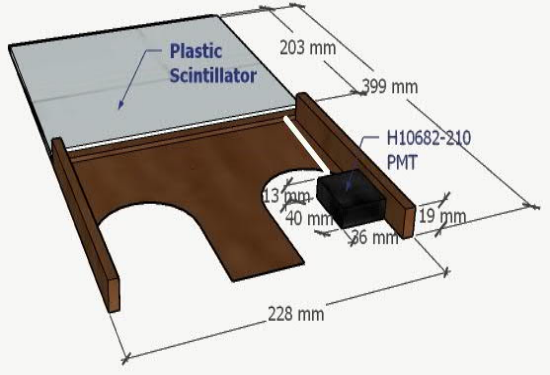


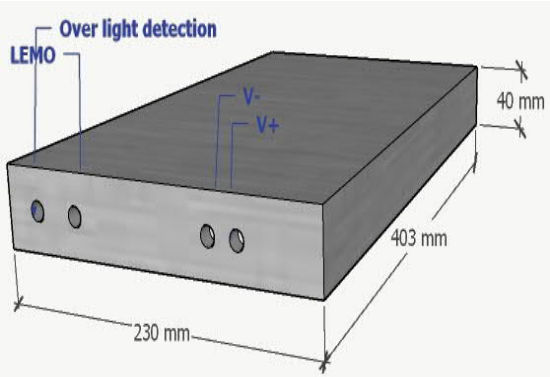



Counts to V
Eva Eleftheriou (Patra)
Olga Zormpa (NTUA)
Stathis Logothetis (NTUA)
Noise
Signal full transparency
Signal medium transparency*3
Signal Medium transparency *2
Signal medium transparency *1
Counts
V (mV)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
100
200
300
400
500
600
700

Olga Zormpa

Κατασκευή του πρωτοτύπου
Σχεδιασμός





Olga Zormpa

Κατασκευή του πρωτοτύπου Φωτοπολλαπλασιαστές

Hamamatsu H10682-210

Μετρητές φωτονίων που αποτελούνται από φωτοπολλαπλασιαστή με κύκλωμα ταχείας μέτρησης φωτονίων και κύκλωμα παροχής υψηλής τάσης.

Η παροχή υψηλής τάσης και το όριο (threshold) του διευκρινιστή, είναι προρυθμισμένα

καταμέτρηση φωτονίων παρέχοντας στη διάταξη τάση ~5V

λειτουργία over light detection

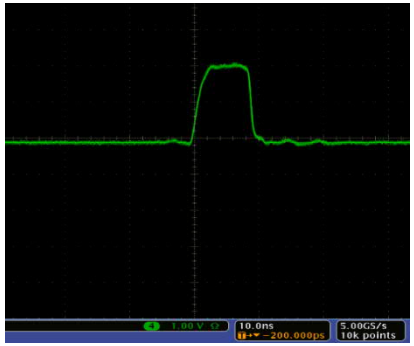
Effective area: ϕ8 mm

Peak Sensitivity Wavelength: 400 nm

Max Dark Count: 100 Hz

Output pulse Width: 10 ns

Output pulse Height: ~2 V



	Rate (Hz)
PMT1	3.07 ± 0.53
PMT2	13.4 ± 3.36
PMT3	3.41 ± 0.61
PMT4	9.75 ± 1.82

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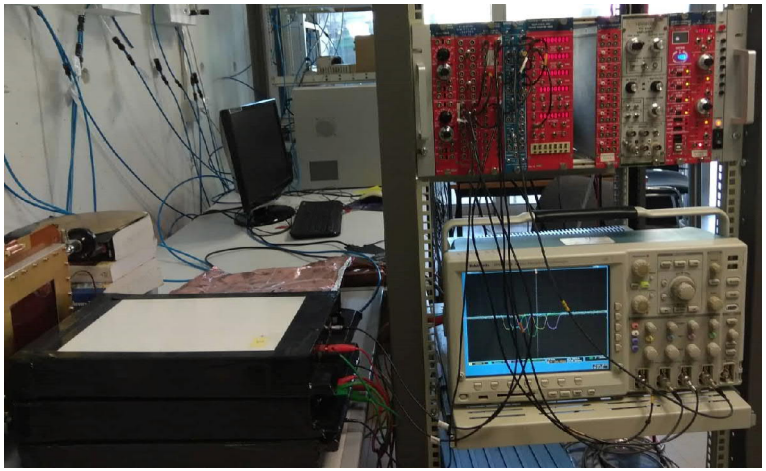
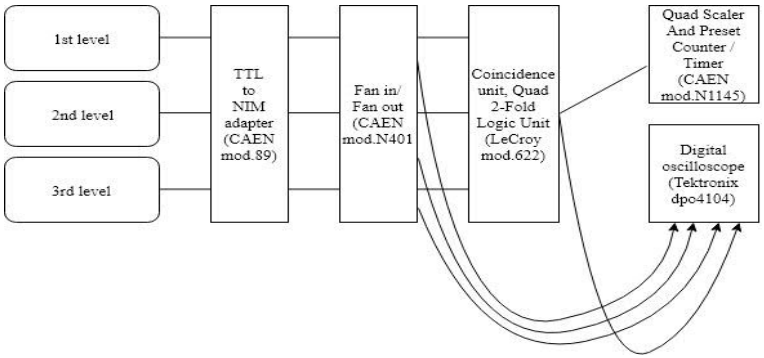
Κατασκευή του πρωτοτύπου
Μετρήσεις σύμπτωσης

		Rate R (Hz)	δR
Separately	B	37.491	0.472
	C	42.115	0.400
	A	5545.325	4959.889
Coincidence	B+A	2.199	0.020
	C+A	2.172	0.053
	B+C	3.825	0.053
	B+C+A	0.584	0.019
Random Noice Experimental	B+A	0.045	0.006
	C+A	0.033	0.007
	B+C	0.146	0.004
	B+C+A	0.000	0.000

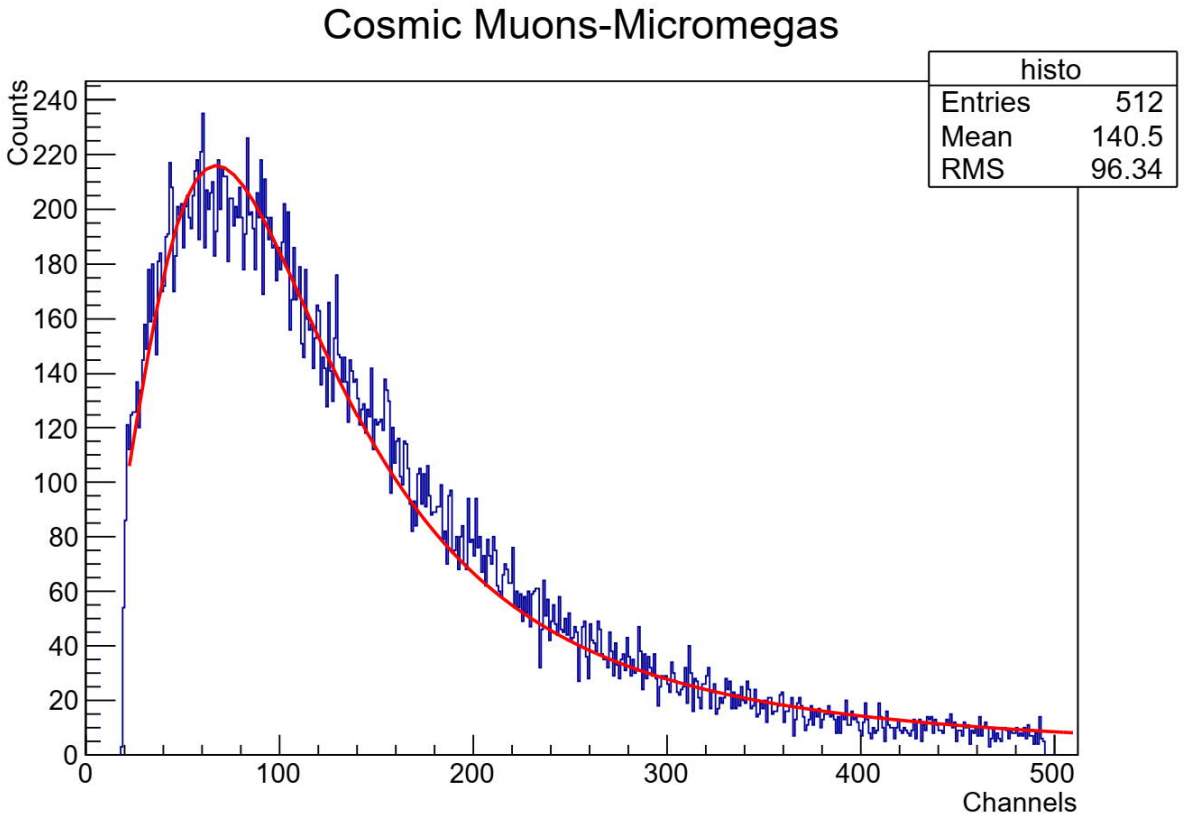
Δεδομένου ότι το εμβαδόν του σπινθηριστή είναι 461 cm^2, αναμένεται συχνότητα κοσμικών μιονίων f_h=6 Hz, αφού σύμφωνα με τη βιβλιογραφία η ροή των κοσμικών μιονίων είναι $J_h = 130\, m^{-2} s^{-1}$.





Κατασκευή του πρωτοτύπου Ανιχνευτής Micromegas

Olga Zormpa



	Value	Error
Constant	1195.36	9.69
MPV	74.53	0.49
Sigma	32.52	0.26

Βαθμονόμηση με Fe-55:
Channel 351 → 5.9 keV

Landau MPV:
channel 75 → 1.26 keV

Online Optical Probes for Quality Control and Safety Assessment of Olive and Other Edible Oils

- Is funded by : Δράση "ΣΥΝΕΡΓΑΣΙΑ 2011 – Συμπράξεις Παραγωγικών και Ερευνητικών Φορέων σε Εστιασμένους Ερευνητικούς & Τεχνολογικούς Τομείς" - "Online Optical Probes for Quality Control and Safety Assessment of Olive and Other Edible Oils« (ΓΓΕΤ 11ΣΥΝ_2_1613 /Ε1750)", 01/04/2013-30/06/2015, 1.794.316 € (Δ.Δ. 1.355.916 €)
- Participants :
  - Institute of Nuclear and Particle Physics, NCSR Demokritos
  - Mass Spectrometry and Dioxin Analysis Laboratory, NCSR Demokritos
  - Laboratory of Organic Chemistry, Department of Chemistry, National and Kapodistrian University of Athens
  - ΚΑΡΟΥΜΠΑΛΗΣ Α.Ε.
  - VECTOR Technologies Ε.Π.Ε
- Project duration : 1/4/2013 to 30/6/2015. Proposed June 2011. Funding secured June 2013.
- The INPP group:
  - D. Lenis, Physicist PhD, Data analysis
  - S. Koutsoukos, Physicist MSc, Applied optics
  - Th. Domvoglou, M. Maniatis, Electronicians
  - S. Dimou, Computer Engineer MSc, end-user software, accounting.
  - I. Kiskiras, Technician.

Aristometro – A portable device to detect the concentration of oleocanthal and oleacein in olive oil.

Kiskiras I., Maniatis M., Stavropoulos G.

- Phenolic compounds identified as health protective (heart attack and stroke, high blood pressure, rheumatoid arthritis, obesity, Alzheimer's, Parkinson's, Type II Diabetes and cancer.
- Oleocanthal is known for its anti-inflammatory properties and Oleocein is a known antioxidant. These compounds are only found in olive oil. In 2012, the EU made a health claim labelling regulation 432-2012. In it is stated that olive oils with polyphenols over 250 mg/kg can put a health claim on the label as it reduces LDL oxidation.
- Prof. Prokopios Magiatis of the University of Athens discovered a method to measure the combined phenolic compounds Oleocanthal and Oleacein.
- In the heart of this method stands the Aristometro, a specially designed and built by INPP, portable spectrometer to detect the concentration of oleocanthal and oleacein in olive oil.

Aristometro – A portable device to detect the concentration of oleocanthal and oleacein in olive oil.

Aristometro – A portable device to detect the concentration of oleocanthal and oleacein in olive oil.

The developed spectrometer succeeded a remarkable performance and gained the first prize of competition “INNOVATION & ENTREPRENEURSHIP 2018” in olive oil sector.

Μελλοντικά Σχέδια

- **KM3NeT.** No active participation in the near future.
- **ATLAS.**
  - Continue on developing lab's infrastructure.
  - Continue working on the NSW commissioning.
  - Recently started a sw activity on Reconstruction.
- **Applications.**
  - Many things have moved to the industrial/commercial level.
  - Remain highly interested on application at the R&D level.