S1 Poster review

Detector Techniques for Cosmology, Astroparticle and Fundamental physics

PM2018 Monday may 28, La Biodola
Mosè Mariotti INFN and Padova University

Cosmic-rays, gamma-rays and x-rays astroparticle detectors

Gravitational waves

Accelerator experiments for hidden-exotics particles and processes

Liquid / double phase argon detectors Neutrino beam experiments

Nuclear decay for precision measurement and rare channel

Atomic transition

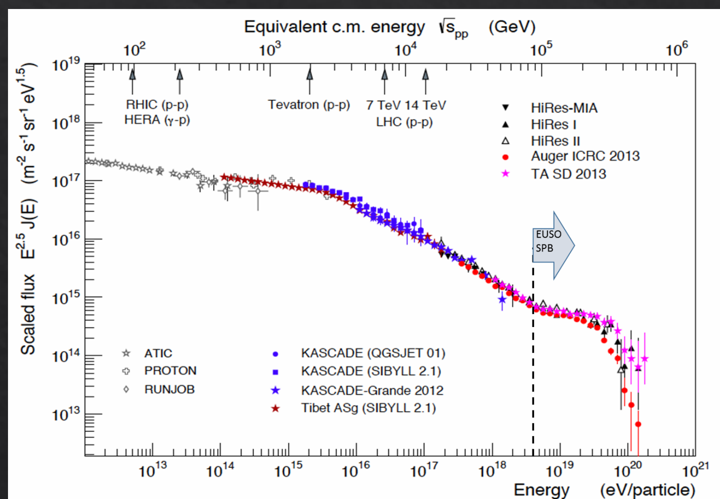
Cosmic-rays, gamma-rays and x-rays astroparticle detectors

EUSO-SPB: in-flight performance

Giuseppe Osteria [1*] and Valentina Scotti[1] for the JEM-EUSO Collaboration
[1]INFN Napoli, *presenter: giuseppe.osteria@na.infn.it

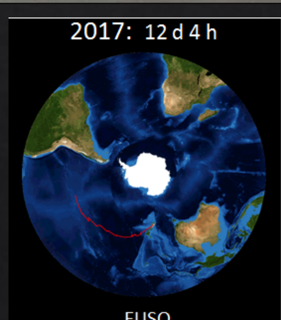
Main scientific objectives

- First fluorescence observations of cosmic ray from above
- Measure UV background light at night from space



The flight

The launch occurred on April 24th 23:30 UTC.



The instrument

Optics:

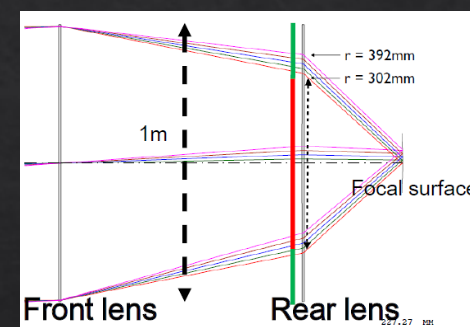
- 2 x Φ 1m Fresnel type lenses
- UV filter (330-400 nm)
- FoV = ±5.5°
- Axis elevation: 26°
- Concave focal surface

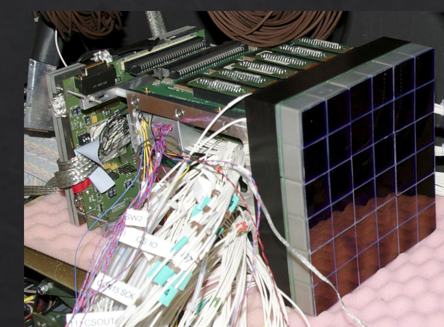
Photo Detector Module:

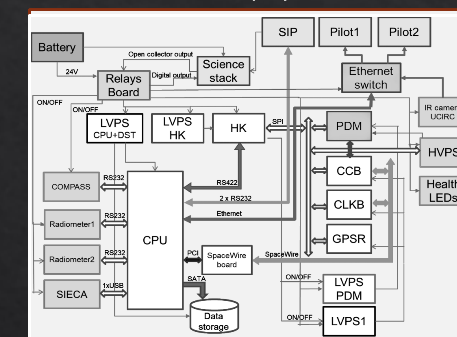
- array of 36 Multi-Anode Photomultiplier Tubes (MAPMTs) of 64 pixels:

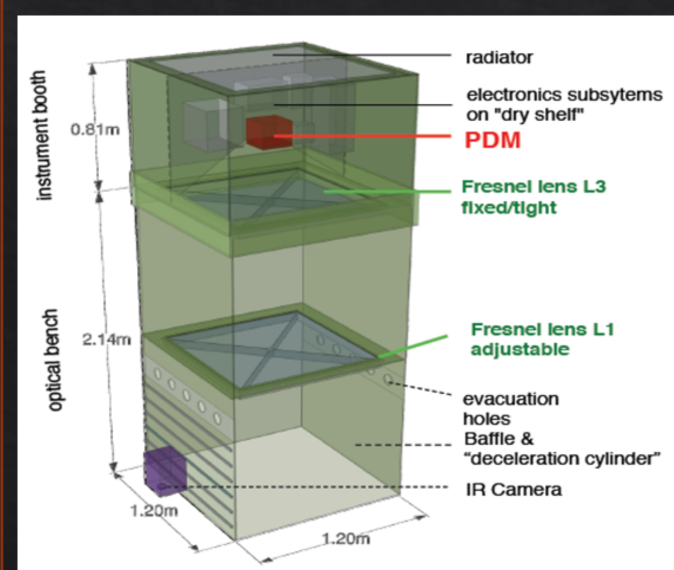
Electronics:

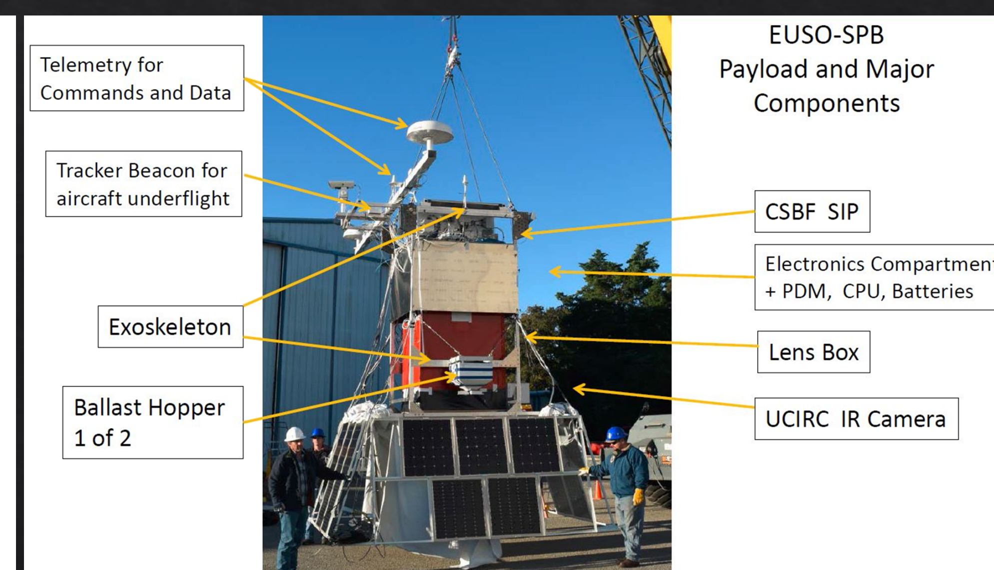
- readout performed by one ASIC per MAPMT: 2304 channels in total
- multiple trigger levels
- interface with the NASA telemetry system











exp typology	keywords	Content
detector in space/ balloon	EUSO, balloon detectors	12 days flight (year 2017) results

JEM-EUSO path finder

- first time detection of UHCR with fluorescence air-shower seen from atmosphere edge
- Measure UV background at night from space

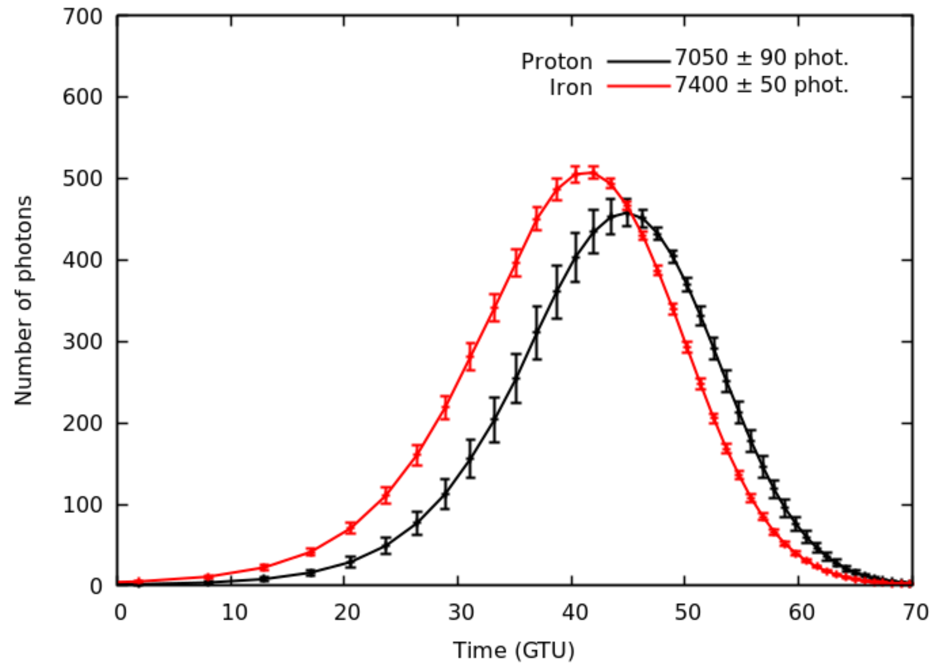
Space fluorescence detection of ultra-high energy cosmic rays based on CORSIKA simulation

Dr. Taoufik Djemil, Badji Mokhtar University

- Space detection of extreme energy cosmic rays ($E \geq 10$ EeV) provide us with higher statistics and a coverage of the whole sky.

- Using the CORSIKA code for extreme energy typical events, we have calculated the number of fluorescence photons and their arrival time distribution to an ideal space telescope aboard the ISS.

- Primary particle discrimination (light and heavy nuclei) but high statistics and quality measurements required.



exp typology	keywords	Content
detector in space	Air shower simulation	light/heavy nuclei discrimination

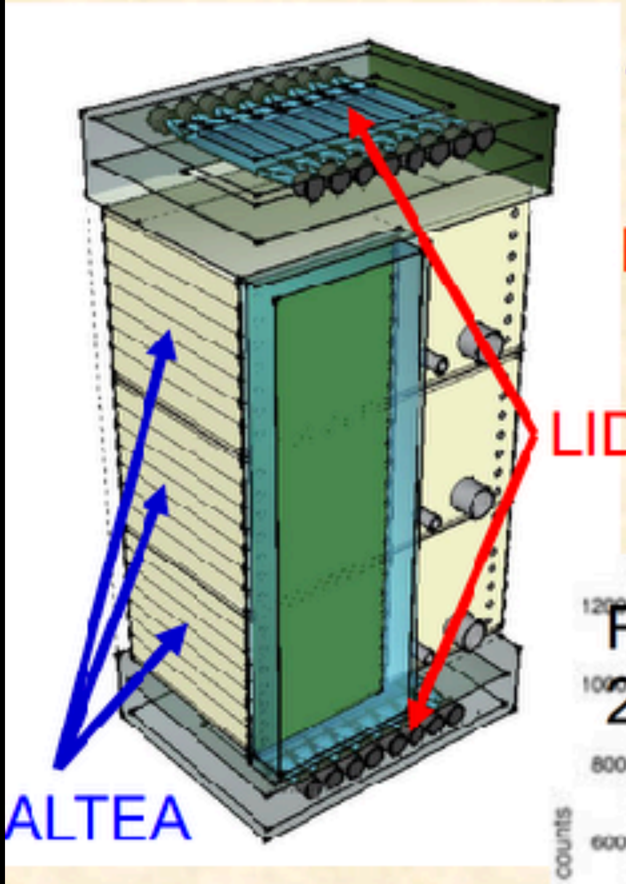
- **Simulation of fluorescence light and time profile seen from ISS**
- **profile discrimination from light and heavy nuclei**

A compact Time Of Flight detector for radiation measurements in a space habitat: LIDAL-ALTEA

Università di Roma Tor Vergata

M.Cristina Morone, on behalf of the LIDAL ALTEA collaboration

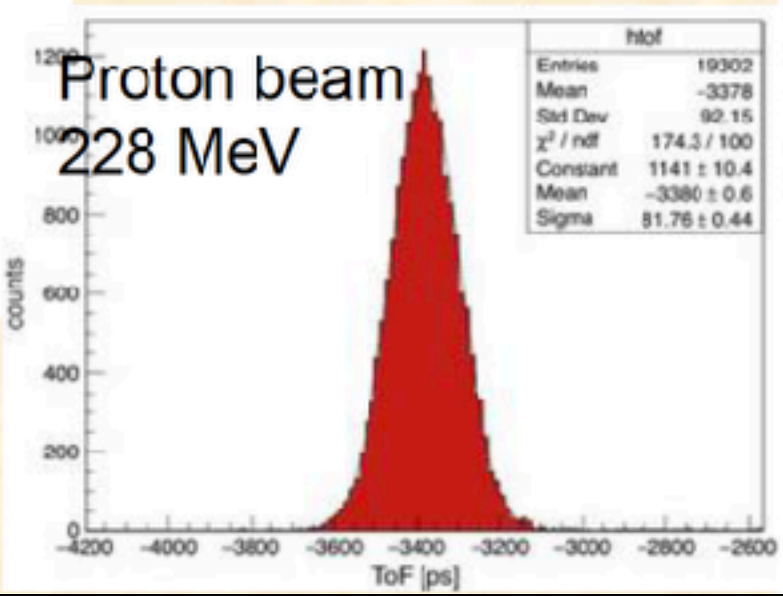
LIDAL ALTEA will measure the radiation flux onboard of ISS and the dose to astronauts. It is scheduled to fly in 2019, is composed by 2 subsystems: ALTEA, which already took data on ISS, and LIDAL, under development, will enhance the ALTEA performances expanding the energy acceptance window and improving particle ID.

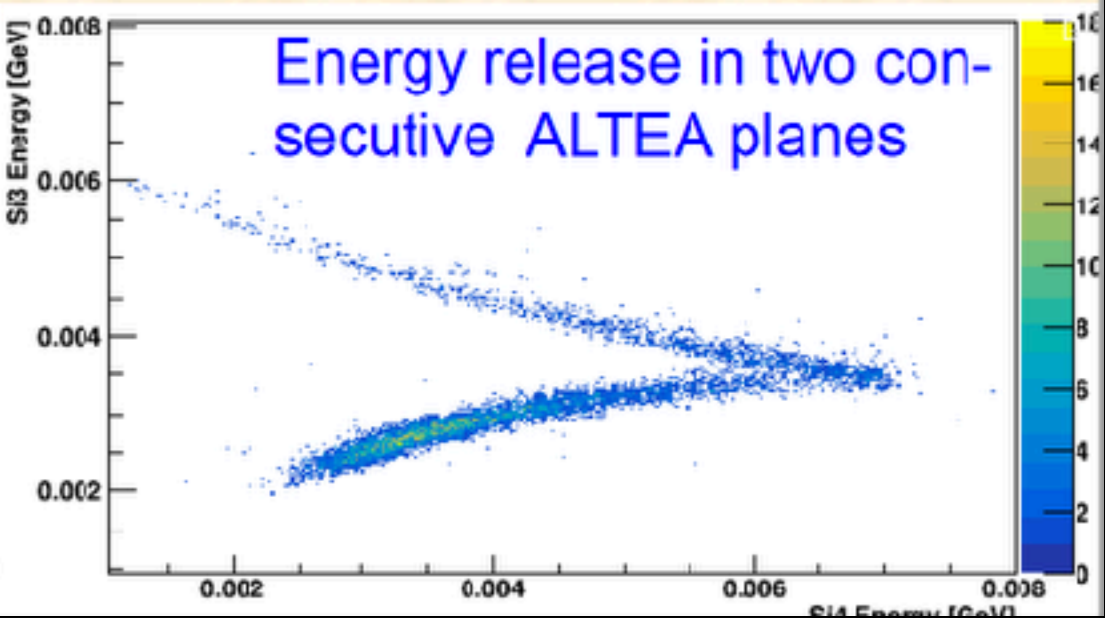


ALTEA : 18 Silicon strip detectors 380 mm thick measures deposited energy and tracks.

LIDAL: 2 arrays of fast scintillators at 49 cm distance, measures TOF and provides trigger for light and fast particle the whole system.

FLUKA simulation validated against Exp.data.





Measured time resolution 92ps

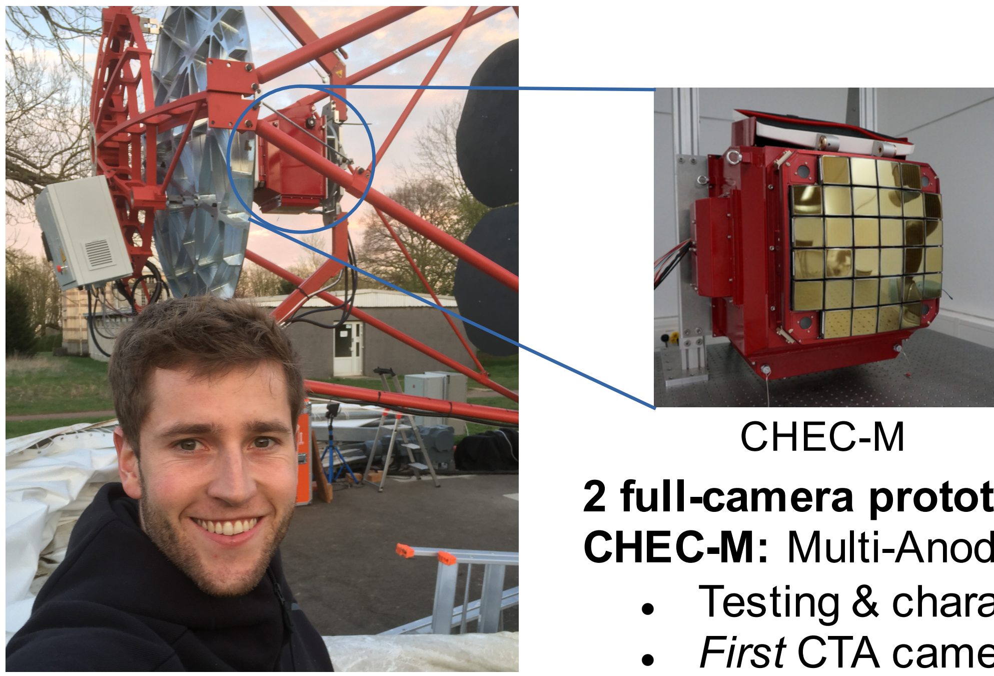
exp typology	Keywords	Content
detector in space	protons and helium ions in ISS	prototyping, detector description

- Light Ion Detector to extend ALTEA performances in PID P/He
- Fast scintillator and custom electronic to achieve <100 ps time resolution
- Manifested to fly 2019 to ISS

CHEC – a Compact High-Energy Camera for CTA

cherenkov telescope array

MAX-PLANCK-INSTITUT FÜR KERNPHYSIK



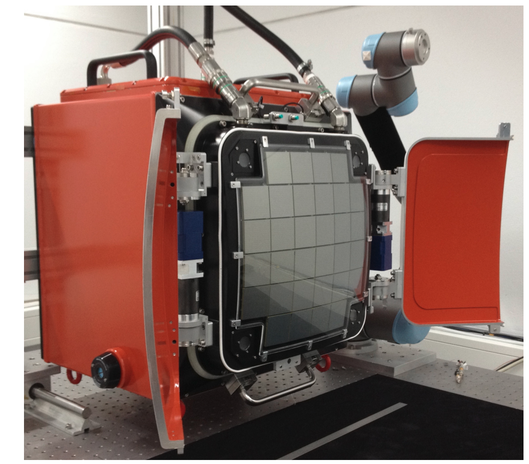
CHEC-M

Justus Zorn

for the CTA GCT project

CHEC:

- Design option for Small-Sized Telescopes of CTA based on Schwarzschild-Couder (SC) optics
- Very compact (0.5 diameter)
- Low-cost (150 k€)
- 2048 pixels, each 0.15°
- Sampling and digitising at 1 GSa/s
- Full waveform readout



CHEC-S

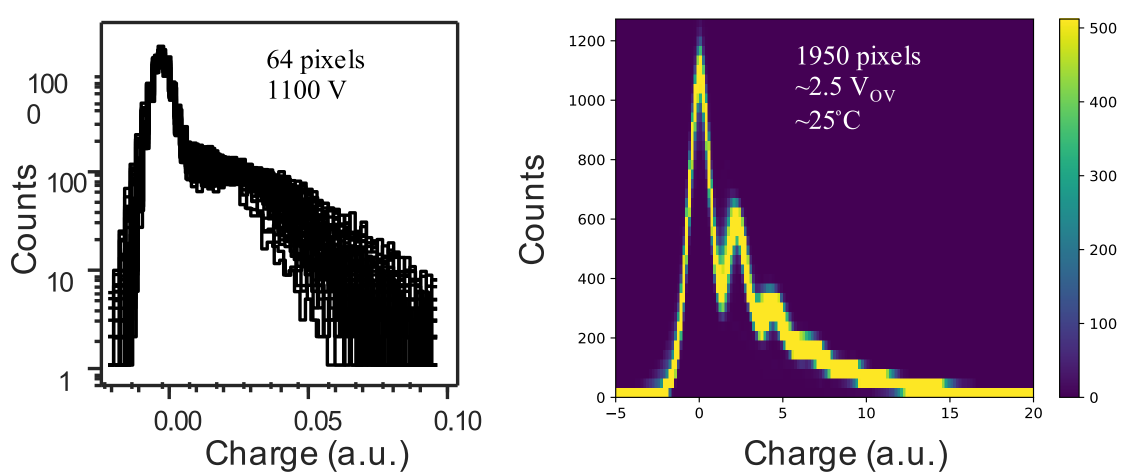
2 full-camera prototypes:

CHEC-M: Multi-Anode Photomultipliers (PM)

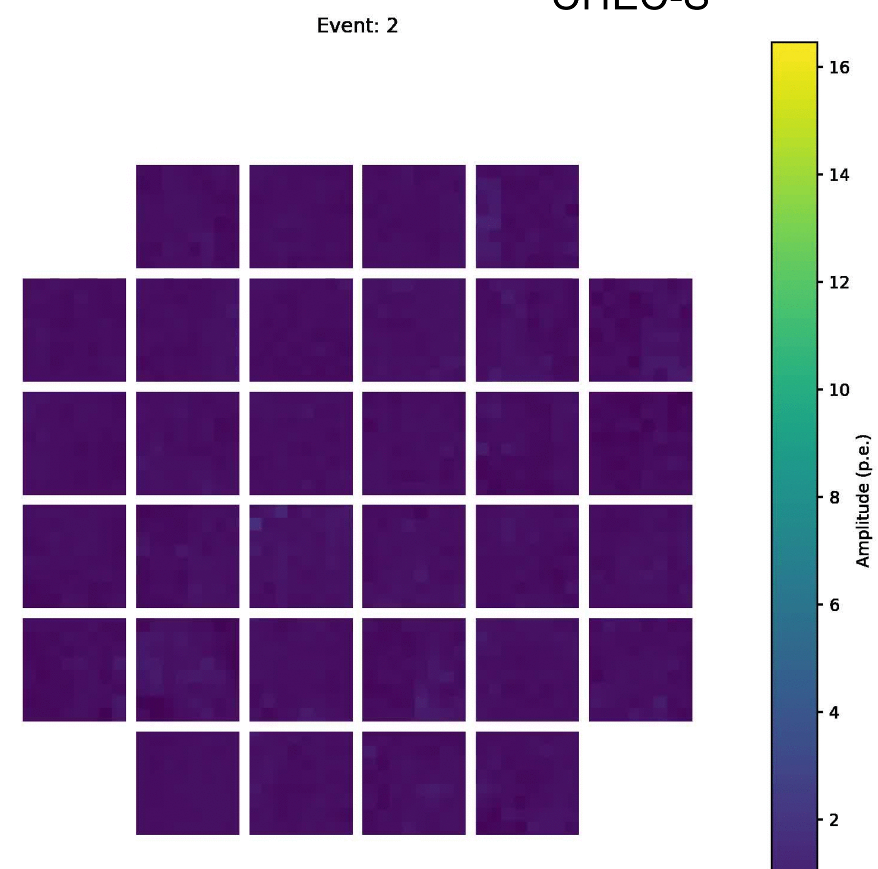
- Testing & characterisation completed
- *First* CTA camera prototype & *first* SC camera ever seeing Cherenkov light

CHEC-S: Silicon PM + upgraded electronics

- Commissioning & testing on-going
- *Better performance* in many aspects



CHEC-M & CHEC-S single photoelectron spectra



CHEC-M Cherenkov images

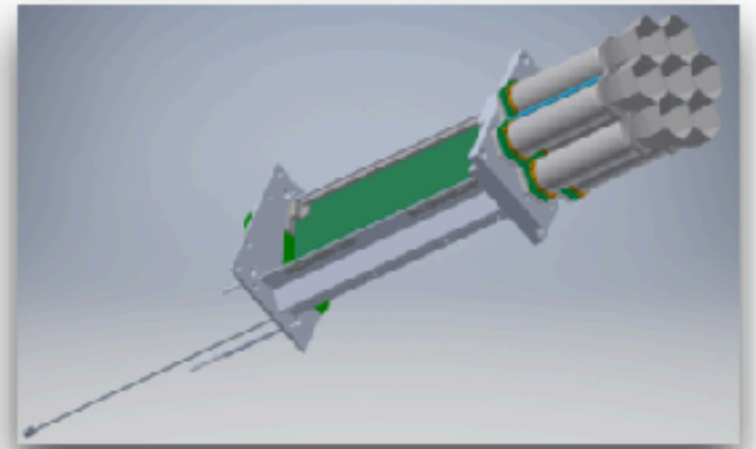
exp typology	keywords	Content
Ground based IACT	High energy gamma ray	SiPm based camera for small telescope

- 2 fully equipped camera prototypes for SST of CTA
- PM tested and SiPM in commissioning
- 2040 channels 600 Hz, target chip sampler

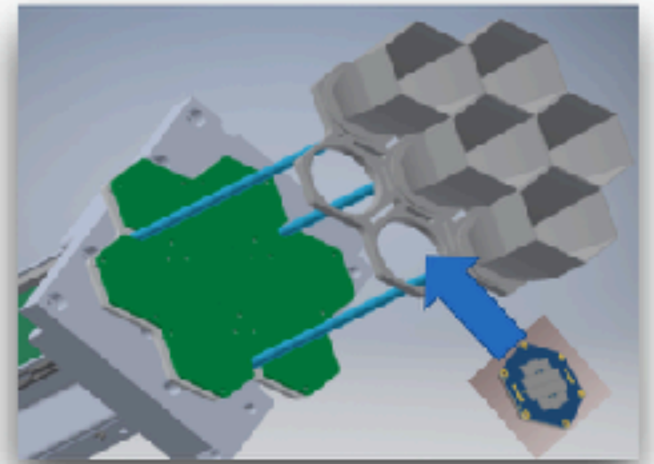
Design of a SiPM-based cluster for the Large Size Telescope camera of CTA

Manuela Mallamaci, Daniele Corti, Luigi Lessio, Mosè Mariotti, Riccardo Rando, Bagdat Baibussinov, Giovanni Busetto, Alessandro De Angelis, Federico Di Pierro, Michele Doro, Elisa Prandini, Piero Vallania, Carlo Francesco Vigorito

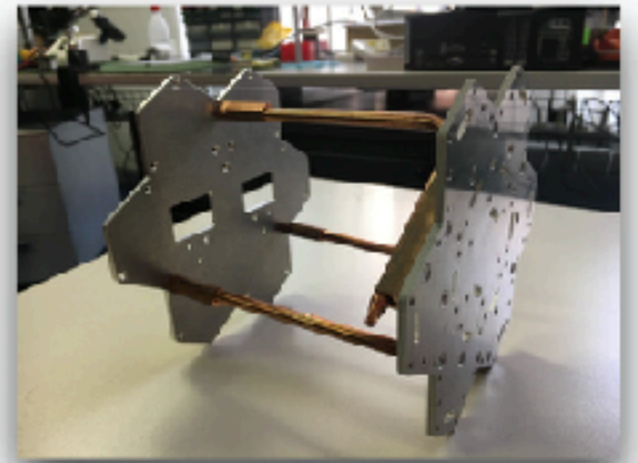
Mechanical structure of a PMT cluster for LST

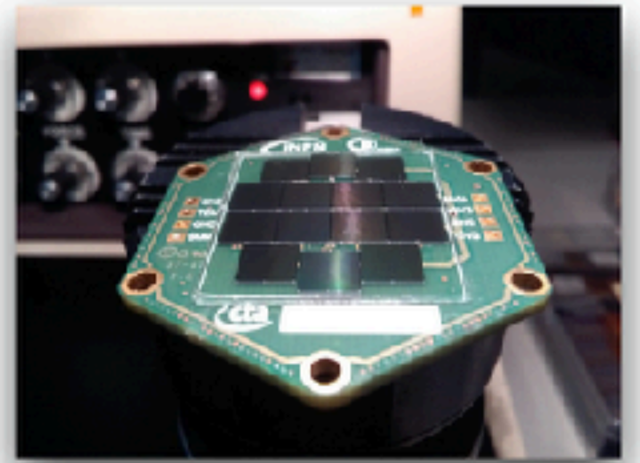


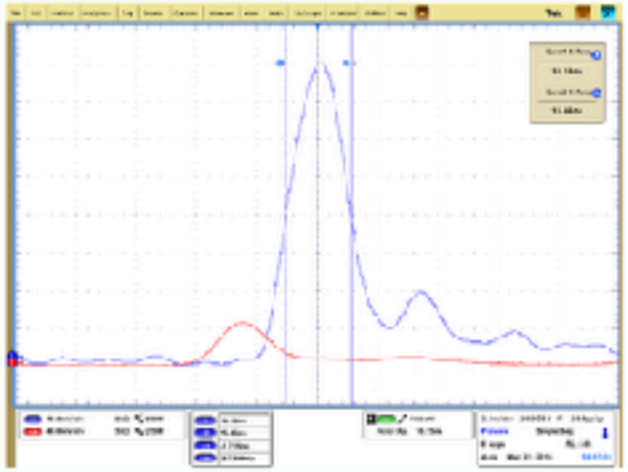
Mechanical structure for a SiPM cluster



Design e characterization of a pixel:
14 SiPMs FBK NUV HD3_2







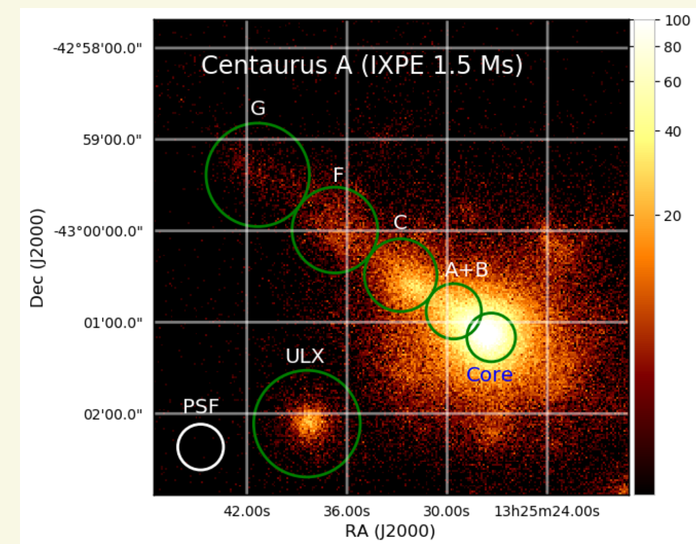
exp typology	keywords	Content
Ground based IACT	Low energy gamma ray cherenkov	R&D SiPm based camera for big telescopes

- **Large surface SiPM matrix for LST pixels**
- **Cluster prototype to be interchangeable with PM one**
- **Good timing performances, expected better PDE**

An observation-simulation and analysis framework for the Imaging X-ray Polarimetry Explorer (IXPE)

Melissa Pesce Rollins[1], Niccolò Di Lalla[1,2], Nicola Omodei[3], Luca Baldini[1,2]
[1]INFN-Pisa, [2] Università di Pisa, [3]Stanford University

ixpeobssim is a simulation framework specifically developed for the Imaging X-ray Polarimetry Explorer (IXPE) mission, based on the Python programming language and the SciPy stack. It is meant to produce fast and yet realistic observation-simulations, given as basic inputs:



- an arbitrary source model including morphological, temporal,
- spectral and polarimetric information;
- the response functions of the detector, i.e., the effective area,
- the energy dispersion, the point-spread function and the
- modulation factor.

The framework produces output files that can be directly fed into the standard visualization and analysis tools used by the X-ray community--making it a useful tool for simulating physical systems, to develop and test end-to-end analysis chains.
We will give an overview of the basic architecture of the software and we will present a few physically interesting case studies in the context of the IXPE mission.

exp typology	keywords	Content
X-ray satellite	X-ray polarimetry	Pyton based simulation framework

- **Simulation and analyst framework for x-ray Polarimetry explorer IXPE**
- **Complete response function of detector**
- **Fast and realistic observation-simulation**

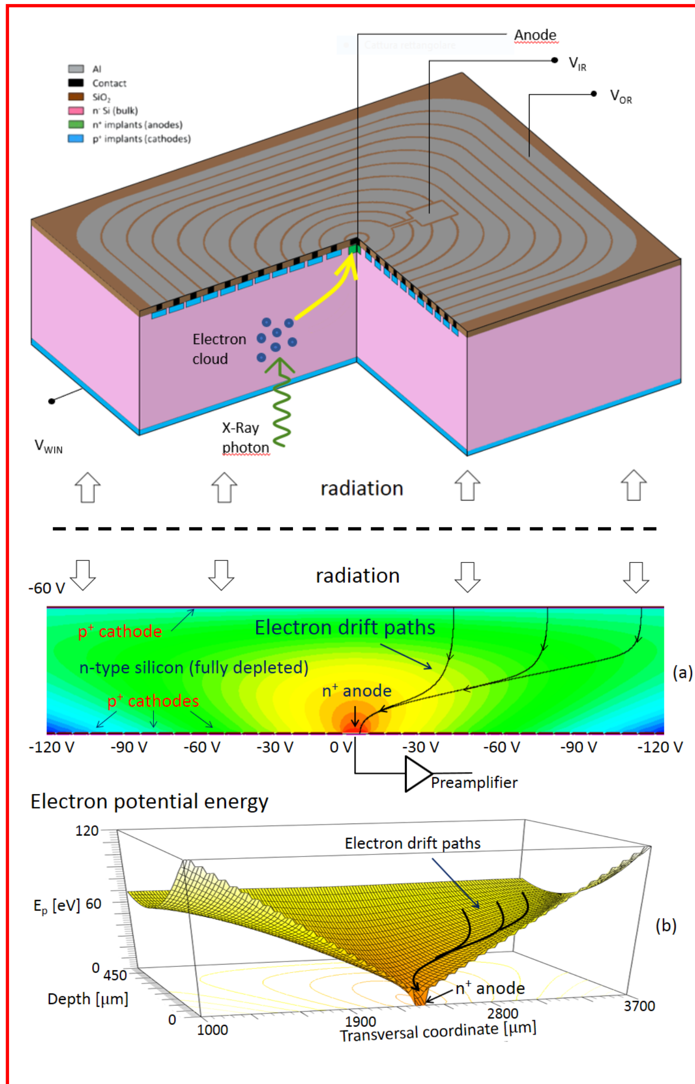
High precision mapping of single-pixel Silicon Drift Detector for application in astrophysics and advanced light source

D. Cirrincione[1,2], M. Ahangarianabhari[3,4], F. Ambrosino[5], I. Bajnati[6,5], P. Bellutti[7,8], G. Bertuccio[3,4], G. Borghi[7,8], J. Bufon[9,1], G. Cautero[9,1], F. Ceraudo[6,5], Y. Evangelista[5,10], S. Fabiani[5,10], M. Feroci[5,10], F. Ficorella[7,8], M. Gandola[3,4], F. Mele[3,4], G. Orzan[1], A. Picciotto[7,8], M. Sammartini[3,4], A. Rachevski[1], I. Rashevskaya[8], S. Schillani[9,1], G. Zampa[1], N. Zampa[1], N. Zorzi[7,8] and A. Vacchi[1,2]

1 INFN Trieste – 2 Dipartimento di Matematica ed Informatica, Università di Udine – 3 Politecnico di Milano – 4 INFN Milano – 5 INAF-IAPS, Roma – 6 CEA Saclay, Paris – 7 Fondazione Bruno Kessler, Trento – 8 TIFPA – INFN Trento – 9 Elettra-Sincrotrone Trieste – 10 INFN Roma Tor Vergata

ReDSoX collaboration

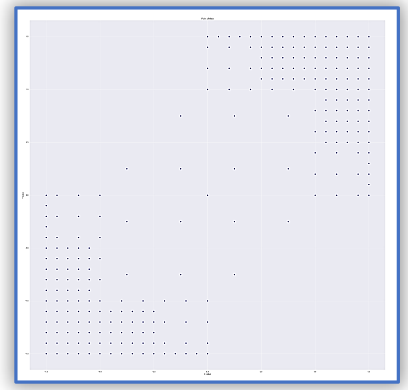
https://web.infn.it/redsox2



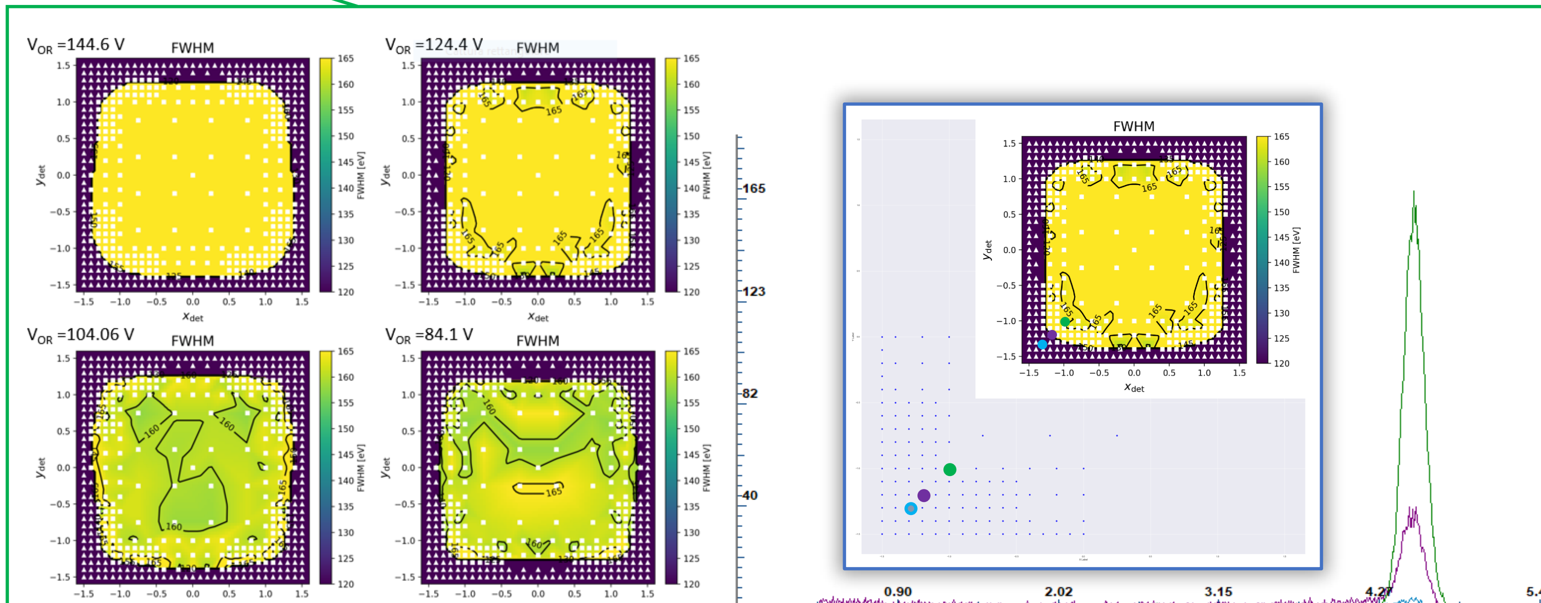
SDD with 3x3 mm^2 sensitive area

Point-by-point mapping tests in different positions and bias condition

Analysis of complete charge collection to optimize new design of detectors



Outer ring voltage (V_{OR})	Windows voltage (V_{WIN})	Inner ring voltage (V_{IR})
-144,6 V	-85,10 V	-23,8 V
-124,4 V	-80,66 V	-21,13 V
-104,06 V	-80,85 V	-19,81 V
-84,1 V	-80,97 V	-18,59 V



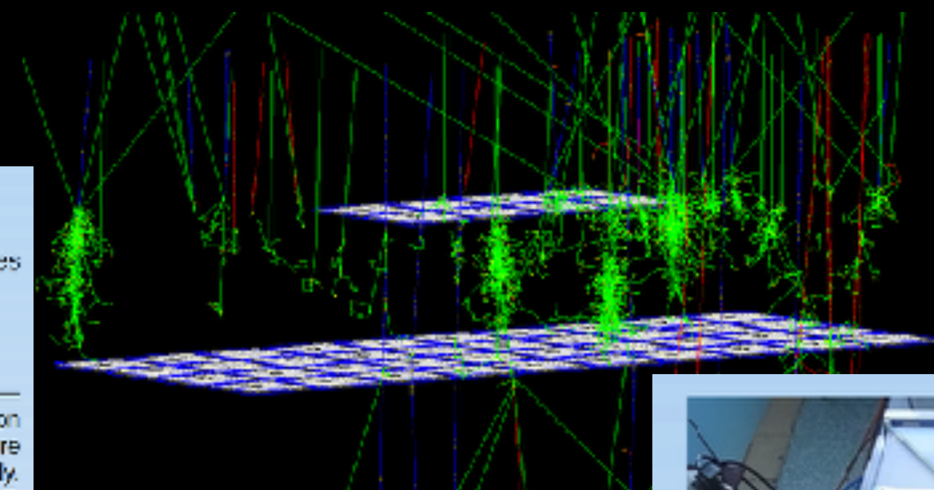
exp typology	keywords	Content
detector for astrophysics	silicon detectors, PixDD, XAFS High energy resolution soft x	proposal of a new monolithic designs of multicell Silicon Drift Detector

- High energy resolution Silicon drift detector for soft X
- X-ray spectroscopy
- precursor of matrix detector for astrophysical application

Scintillation detectors for TAIGA experiment

Kirilenko P.S., Kravchenko E.A. for TAIGA collaboration

Novosibirsk State University
Budker's Institute of Nuclear Physics

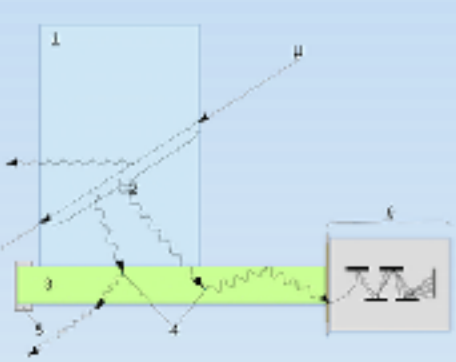


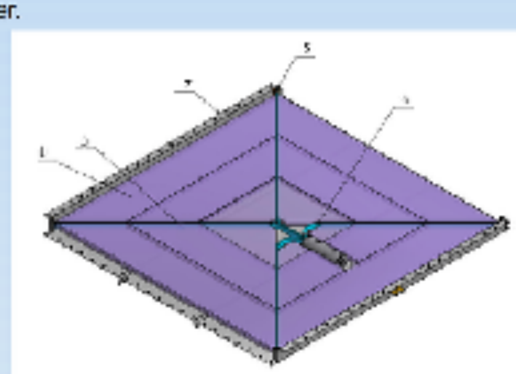
Scintillation detector

Operation conditions of Tunka valley, like groundwater and extremely low temperatures dictate some technical requirements for detector, as

- Impermeability
- Resistance to large temperature changes
- No service requirements

In addition to this, big number of detectors in final muon system creates last requirement — low cost of each detector. Main idea comes from colliding experiments of BINP. For collection of Cherenkov light in detectors KEDR and SND, wavelength shifters are used[1]. Shifters are plastic bars with special dye that molecules adsorbs light and re-emmit it isotropically. Emitted light is being captured in full internal angle of shifter bar and transported to PMT. Shifters make collection of scintillation light more efficiant and allow us to use PMTs with small photocathode, which are much cheaper.





Scintillation detector scheme: 1-Scintillator, 2-Muon energy loss, 3-Shifter bar, 4-BBQ dye molecules, 5-Diffuse reflector, 6-PMT, 7- Container.

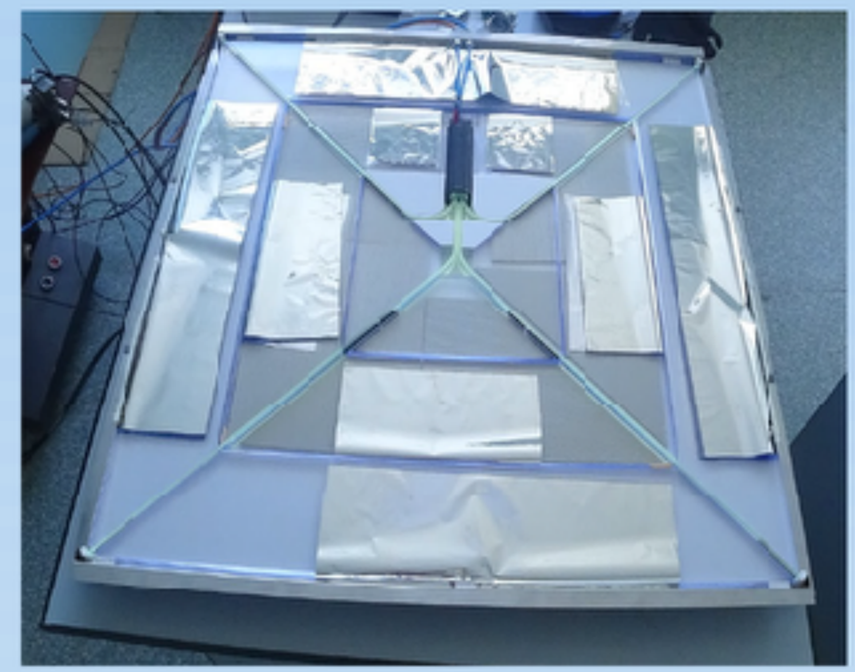


Photo of serial detector

exp typology	keywords	Content
Ground based front shower detector	TAIGA, em and hadronic showers, scintillation	first prototype before massive production

- **Plastic scintillator for TAIGA observatory**
- **Cheap and reliable by segmenting the scintillator in sectors with different thickness to have homogeny flat response**

Plastic scintillator detector array for detection of cosmic ray air shower

S. Roy[1], S. Shaw[2], N. Nandi[3], R. P. Adak[1], P. Chawla[1], S. Chatterjee[1], S. Chakraborty[1], S. Biswas*[1], S. Das[1], S. K. Ghosh[1], A. Maulik[1], S. Raha[1], S. Singh[1]

[1]Department of Physics and CAPSS, Bose Institute, EN-80, Sector V, Kolkata-700091, India

[2]Vidyasagar University, Vidyasagar University Road, Rangamati, Medinipur, West Bengal-721102, India

[3]Raja Peary Mohan College, 1 Acharya Dhruba Pal Road, Uttarpara, Hooghly, West Bengal- 712258, India

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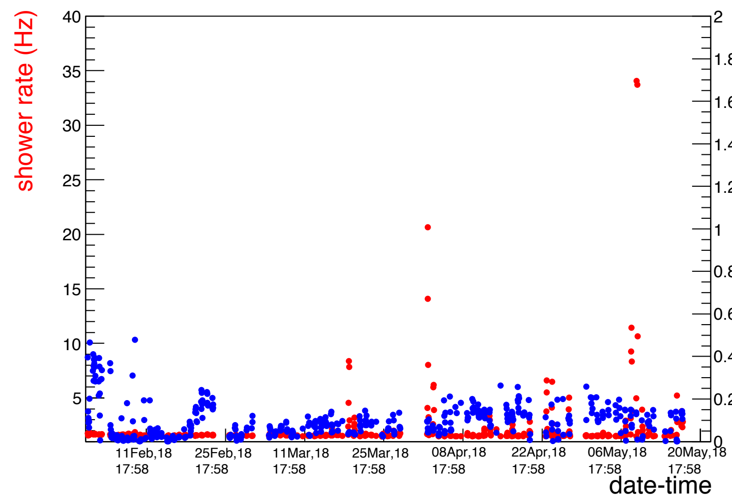
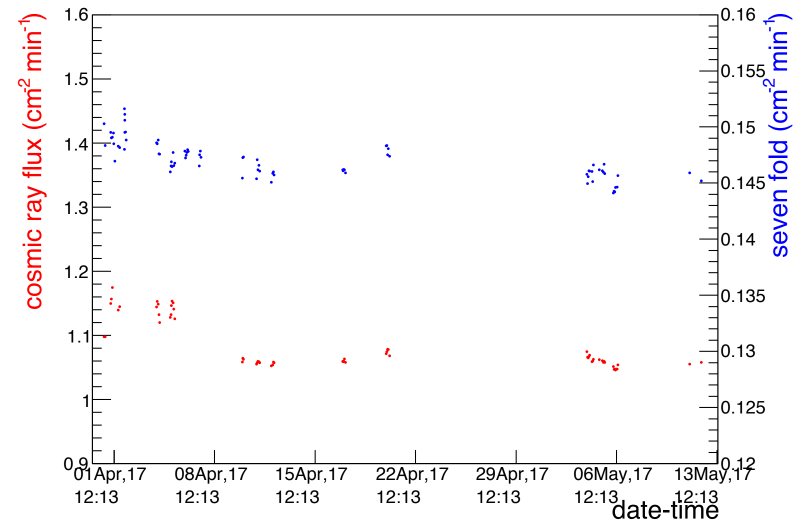
Cosmic shower detection array at Darjeeling



Cosmic shower rate Vs. time



Cosmic ray flux vs. time in 2017 at Darjeeling

- An array of 7 active detectors have been developed to study cosmic ray extended air showers at an altitude of about 2200 meter above sea level in the Eastern Himalayas (Darjeeling).
- In the first experiment the average air shower rate has been found to be ~1.6 Hz. An oscillating nature of shower rate is also observed with time.
- The cosmic ray flux is also measured at Kolkata (altitude ~11 m above sea level) and at Darjeeling (altitude of about 2200 meter above sea level).
- The cosmic ray flux at Darjeeling and Kolkata are found to be ~ 1.077 and 1.007 per cm^2 per minute respectively.

exp typology	keywords	Content
ground based front shower detector	scintillator counter cosmic ray flux	sea level and mountain flux measurement

- small shower front experiment with 7 detectors
- data taken at 2200m shows some modulation

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Measurement of Cosmic Muons angular distribution in Abu Dhabi at sea level

Presenter: Gianmarco Bruno

Co-authors: Francesco Arneodo
Mohamed Lotfi Benabderrahmane
Osama Fawwaz
Adriano Di Giovanni
Marcello Messina

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United Arab Emirates

https://nyuad.nyu.edu

Originally meant for outreach purpose, this muon tracking system based on 200 scintillator bars coupled to SiPMs through WLS fibers, turned out to be suitable for both measuring the angular distribution of cosmic muons and for muon imaging applications.
In this work we are going to present the first cosmic muon measurement performed in the Arabian gulf area.

exp typology	keywords	Content
ground based muon detector	muons angular distribution	First cosmic muons measurement in Arabian gulf area

- **Outreach Muon tracking of 200 scintillator bars**
- **fist time muons angular distribution measured in the Gulf area**

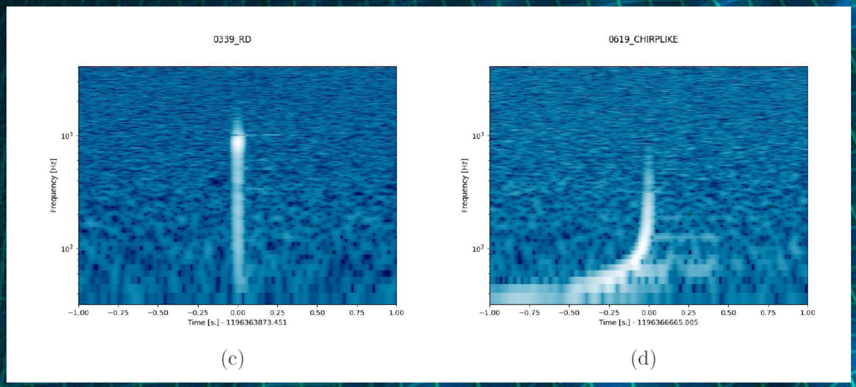
Gravitational waves

Deep Learning
to study noise in gravitational wave interferometers

Massimiliano Razzano[1,2]
E. Cuoco[2,3]
[1]University of Pisa [2]INFN-Pisa [3]EGO

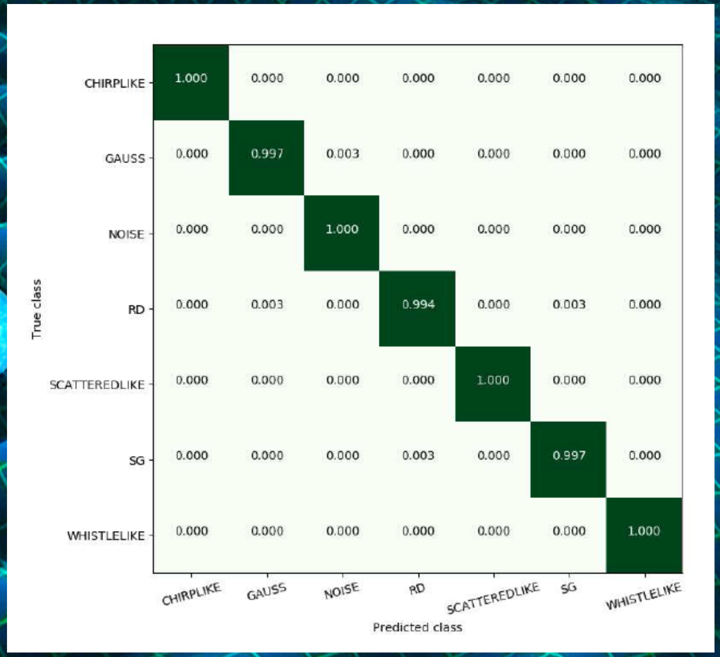
Ref: Razzano & Cuoco 2018, Classical and Quantum Gravity, 35,9

Transient noise events (glitches) impact data quality and mimic real astrophysical signals
Automatic methods to classify glitches are mandatory
Deep learning is a promising tool for classification
4-blocks deep Convolutional Neural Network
Performance tested on simulated signals
Very high (>98%) classification accurcaty



Simulated glitches

Classification accuracy



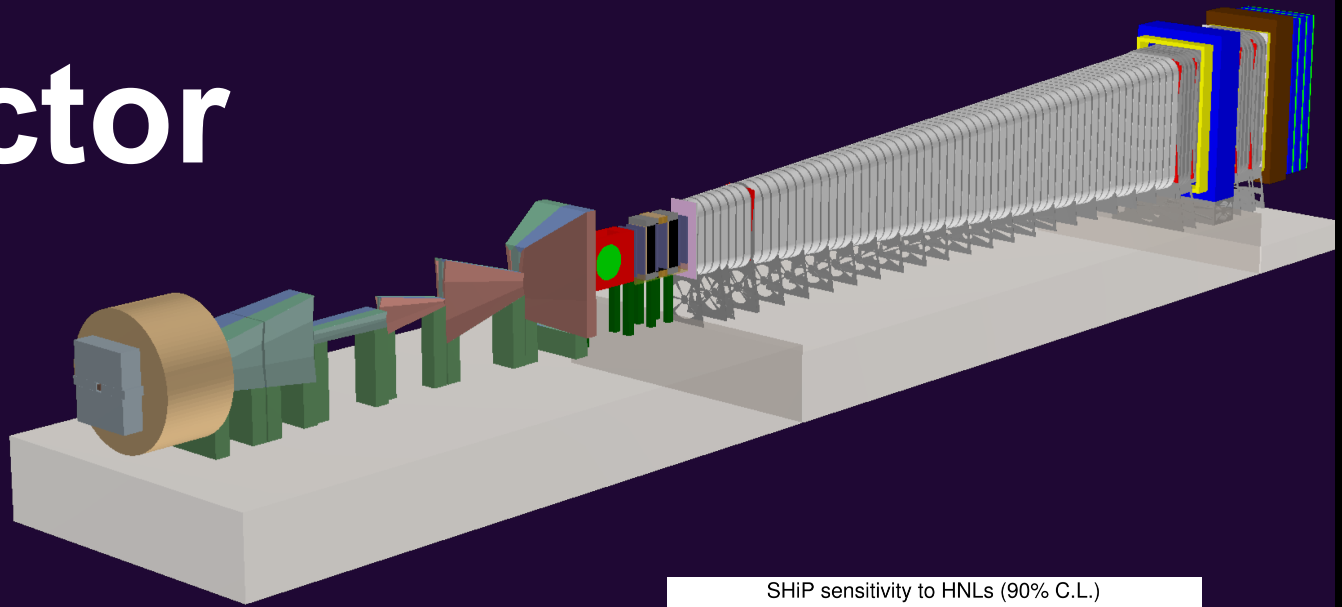
- **deep learning for event/noise (glitches) classification in the frequency- time space of signals**
- **Performances: >98% classification accuracy and fast execution time**

exp typology	keywords	Content
Gravitational waves interferometer	astrophysical signal vs transient noise classification	deep learning classification with neural network

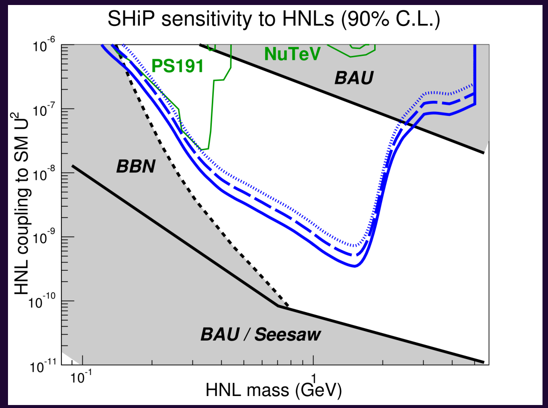
Accelerator experiments for hidden-exotics particles and processes

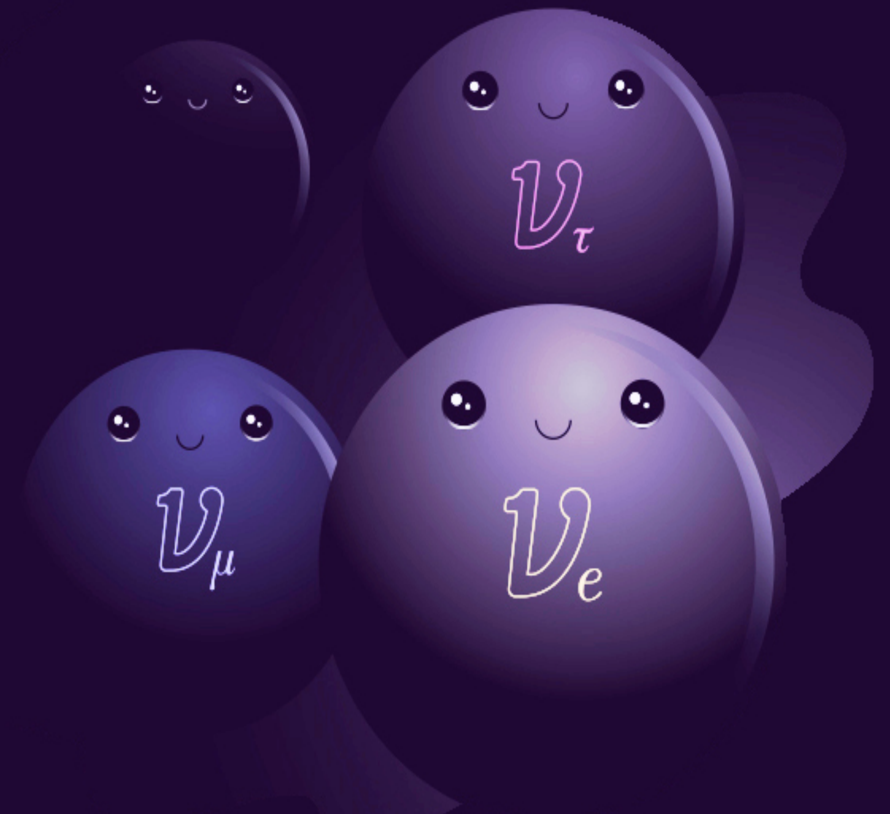
The SHiP detector

Elena Graverini



Proposal for a new, high-intensity experiment to detect hidden particles and study the ν_τ properties.





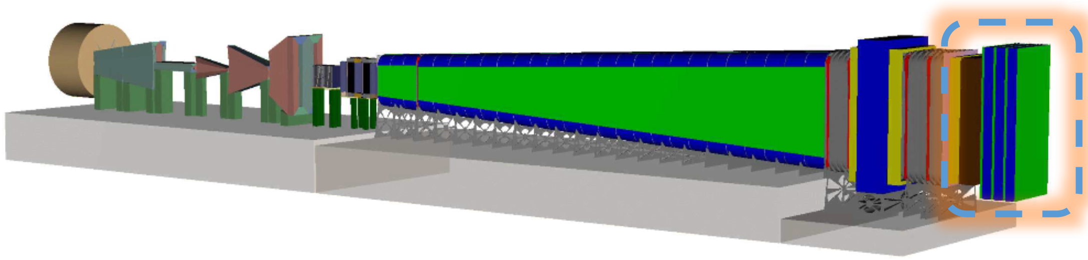
- optimization of the shape of a ~60 m long pyramidal vacuum tank surrounded by background taggers
- simulation of the detector response to hidden particles decays and to SM events
- design of a signal selection strategy and evaluation of the physics potential

exp typology	keywords	Content
accelerator	exotic particles searches, neutrinos	proposed experiment for hidden particles

- **Fixed target facility spectrometer and advanced PID**
- **long lived Exotics particles O(10) GeV: search for Dark Photons, Light scalars and pseudo scalars Heavy neutrinos**
- **Technical proposal reviewed by CERN SPS committee**

The downstream μ detector of the **SHiP** experiment

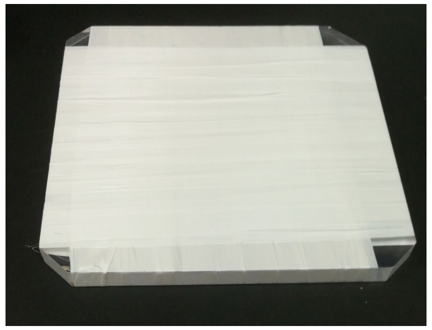
Nicolò Tosi, INFN Bologna
SHiP collaboration



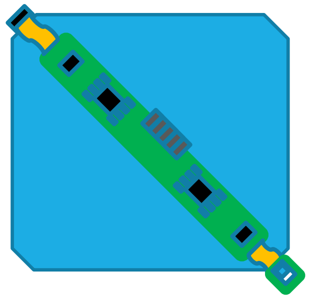
4 active layers
12m (h) x 6m (w)
Total absorber ~16 λ_I

INFN Sezione di Bologna

Main goals: μ/π separation, reduction of backgrounds through **timing cuts (σ<1ns)**



~ 15x15x1 cm Scintillator tile
2(4) direct SiPM readout
Target: < 400 ps/tile
(< 200 ps all layers)



Readout: On tile preamplifier
Low hit rate, low σ_t → switched capacitor digitizer/TDC (SAMPIC)

exp typology	keywords	Content
accelerator	Muon detector, scintillators tiles	Mu/pi separation through precise timing

- **PID mu/pi via timing cuts**
- **timing resolution key element < 400 ps/tile**

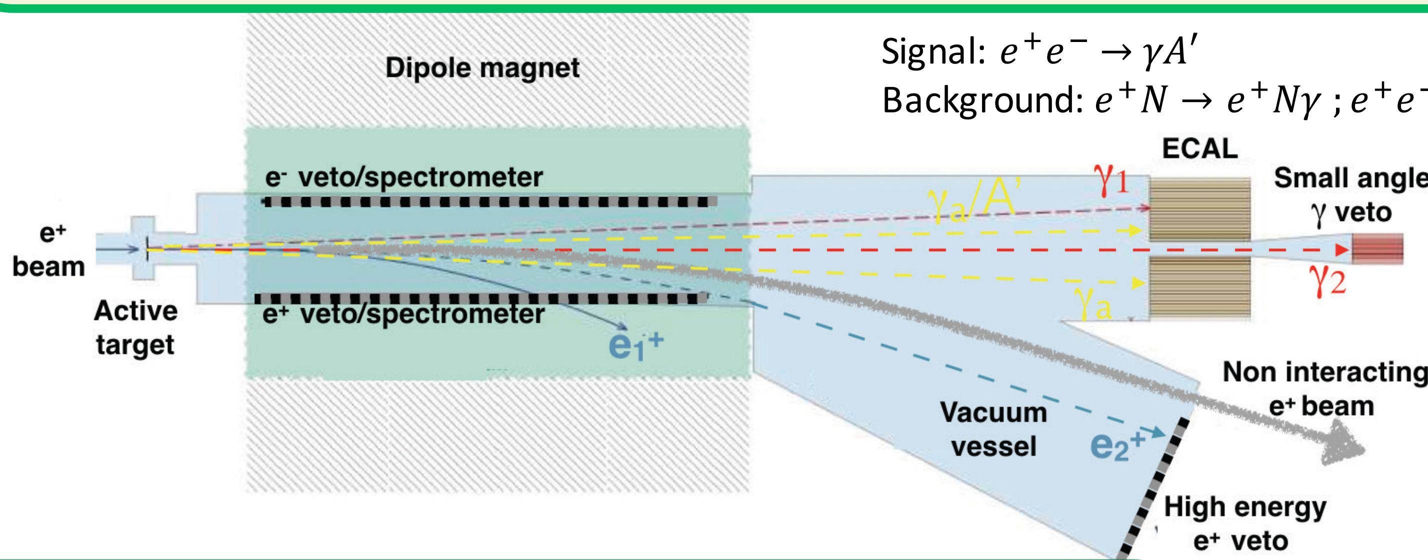
The investigation on the dark sector at the PADME experiment

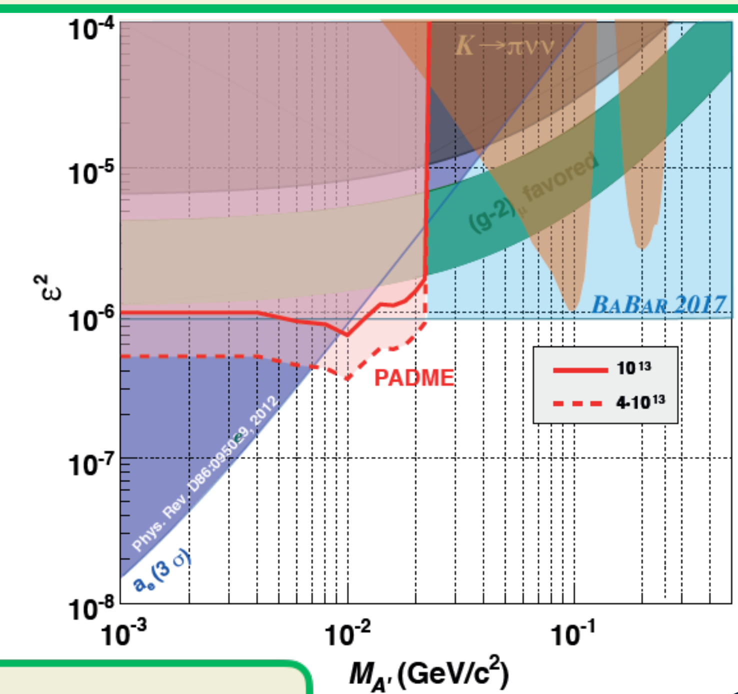
Summary

The PADME experiment [1],at Laboratori Nazionali di Frascati (LNF) of INFN, is designed to be sensitive to the production of a low mass gauge boson A' of a new U(1) symmetry holding for dark particles [2]. The DAΦNE Beam-Test Facility of LNF [3] is providing a high intensity, mono-energetic positron beam impacting on a low Z target to provide e^+e^- annihilations, where the dark photon can be produces along with an ordinary photon. Simulation studies predict a sensitivity on the interaction strength (ε^2 parameter) down to 10^{-6}, in the mass region 1 MeV $< M_{A'} <$ 23.7 MeV, for one year of data taking with a 550 MeV beam. In 2018 the first run will take place, and early data will give the opportunity to compare the detector performance with the design requirements. Right now, an intense activity is taking place to install and commission the PADME experimental apparatus on site.

Signal: $e^+e^- \rightarrow \gamma A'$

Background: $e^+N \rightarrow e^+N\gamma$; $e^+e^- \rightarrow \gamma\gamma(\gamma)$





Contact information

paola.gianotti@lnf.infn.it

More information are available

http://www.lnf.infn.it/acceleratori/padme/

References

[1] M. Raggi e V. Kozhuharov, Adv. High Energy Phys. 2014 (2014) 959802.
[2] B. Holdom, Phys. Lett. B 166 (1986) 196.
[3] G. Mazzitelli et al., Nucl. Instrum. Meth. A 515, 524 (2003).

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

exp typology	keywords	Content
accelerator	exotic particles searches, positron beam	proposed experiment

- positron beam (550 MeV) on active target to search for dark photons in mass region 1MeV<M_A'<22.5MeV in e+e- annihilation
- 2018 first run will take place

PM2018

14th Pisa Meeting

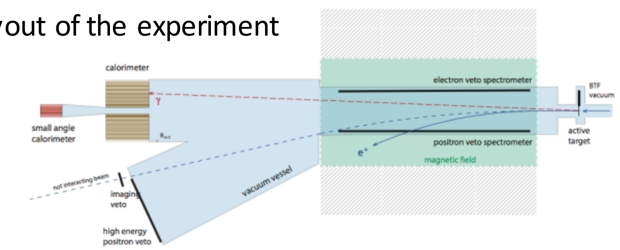
"The charged particle veto system of the PADME experiment"

Federica Oliva on behalf of the PADME Collaboration

The **PADME experiment**[1] at the DAΦNE Beam-Test Facility (BTF) will search for the dark photon production in the annihilation $e^+e^- \rightarrow \gamma A'$ using the intense positron beam hitting a diamond target.

MAIN BACKGROUND $e^+N \longrightarrow e^+N\gamma$

Layout of the experiment



POSITRON VETO
Covering the angular region between the beam dump and the magnet

HEP (High Energy Positron) VETO
in the magnetic field, covering the internal left vertical wall (1 m long) of the dipole magnet

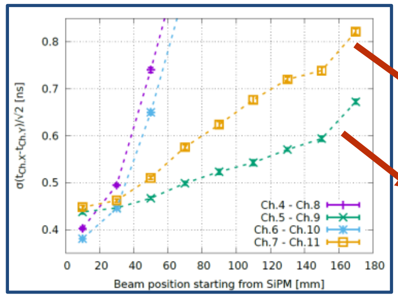
✓ Full assembly of the veto detectors ready to be integrated in the final layout of the experiment

Array of 96(16) polystyrene-based scintillating plastic bars equipped with BCF-92 optical fibers housed in a longitudinal groove.

Front-End electronics made of SiPMs Hamamatsu 13360
GAIN≈10^5 -10^6

A prototype with the same scintillators (with and without optical fiber readout) and previous generation SiPMs (SiPMs Hamamatsu S12572) was tested in April 2017 at the Beam Test Facility of LNF, Frascati[2].

Time resolution from Δt for pairs of scintillators as a function of the distance of the hit from the SiPM well below 1ns when optical fiber readout is available. Good efficiency with optical fiber readout and noise under control for all channels.



Federica Oliva
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INFN Lecce
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For more info on the PADME experiment:
http://www.lnf.infn.it/acceleratori/padme/
https://web.le.infn.it/padme/

TURN THE DARK ON!

[1]M. Raggi and V. Kozhuharov, *"Proposal to Search for a Dark Photon in Positron on Target Collisions at DAΦNE Linac"*, Adv. High Energy Phys., 2014;
[2]F.Ferrarotto et al., *"Performance of the prototype of the charged particle veto system of the PADME experiment"*, DOI 10.1109/TNS.2018.2822724, IEEE Transactions on Nuclear Science.

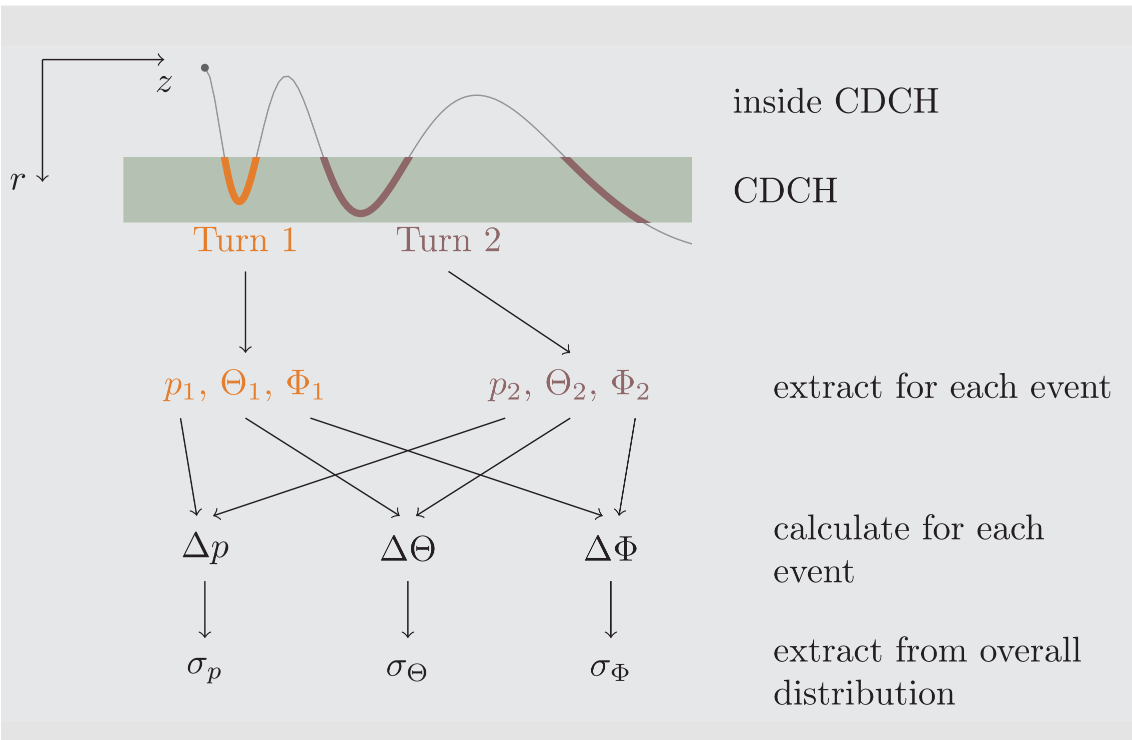
exp typology	keywords	Content
accelerator	exotic particles searches, positron beam	Scintillating bars positrons Veto system

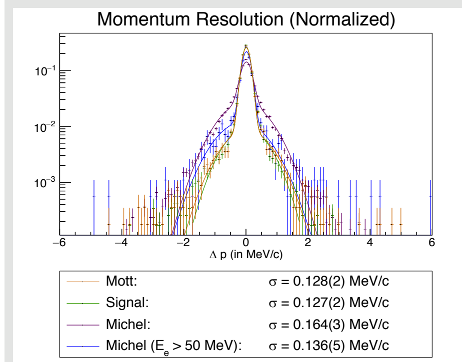
- **Veto system fo PADME 2 regions: -covering region between beam dump and magnet - in the dipole magnet (HEP veto)**
- **veto system made by scintillator plastic bars SiPM equipped with**

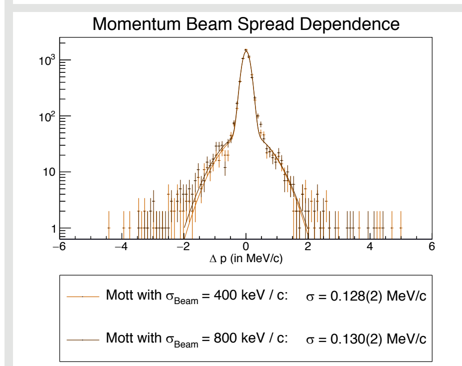
The Double Turn Method
for the
MEG II Spectrometer Characterisation

Angela Papa[1,2], Patrick Schwendimann[1,3] on behalf of the MEG II Collaboration

[1] Paul Scherrer Institute, [2]University Pisa and INFN, [3]Swiss Federal Institute of Technology Zurich
Contact: angela.papa@psi.ch, patrick.schwendimann@psi.ch







Double Turn Algorithm

- Used to characterise MEG II drift chamber
- Compare two turns of same track, extract resolutions in:
  - Momentum
  - Polar angle
  - Azimuth angle
- Best results for mono-energetic positrons from Mott scattering process

exp typology	keywords	Content
accelerator	LFV, calibration with positrons	calibrations with positron low energy Mott scattering

- **Mott scattered e+ from beam to be very close to expected signal**
- **2 turns to double measure twice e+ kinematics and derive spectrometer experimental resolution/characterization**

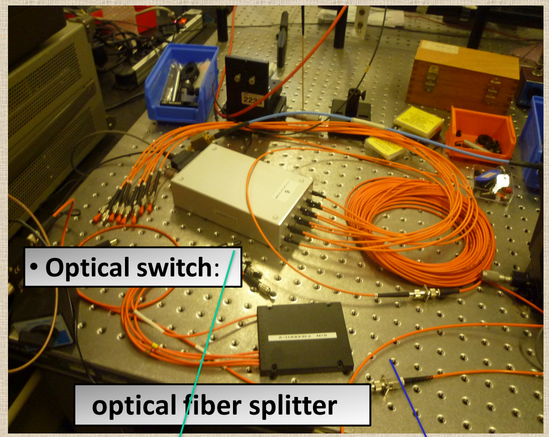
Liquid / double phase argon detectors Neutrino beam experiments

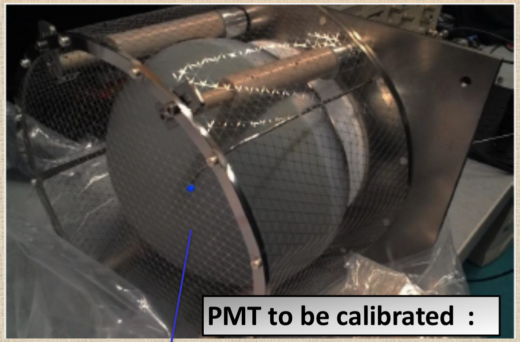
The development of the Icarus T600 laser diode calibration system

M. Bonesini[1], R. Benocci[1], R. Bertoni[1], R. Mazza[1], T. Cervi[2], A. Menegolli[2], G. Raselli[2], M. Rossella[2], M. Torti [1,2]

INFN Milano Bicocca, Dipartimento di Fisica G. Occhialini, Milano, Italy[1], INFN Pavia, Dipartimento di Fisica, Pavia, Italy [2]

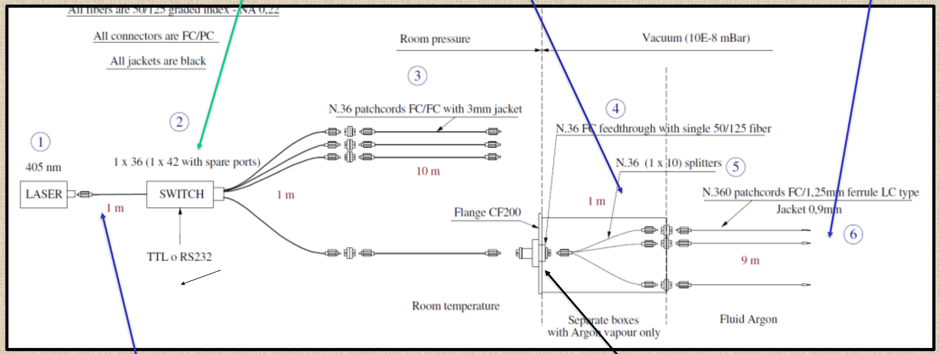
- As Icarus T600 will be installed with a minimal overburden, cosmics background has to be strongly reduced.
- Use timing properties of the 360 Icarus PMTs to reduce it → needs PMT's timing at better than 1 ns → requires time calibration of PMTs at better than 100-200 ps [channel time delays drifts due to temperature effects, …]





The PMT timing/gain equalization is performed by using fast light pulses from a laser source. The laser pulse is sent to each PMT (360) via a distribution system based on fiber patch cords, optical vacuum feedthrough, fused fiber splitters and optical switches.

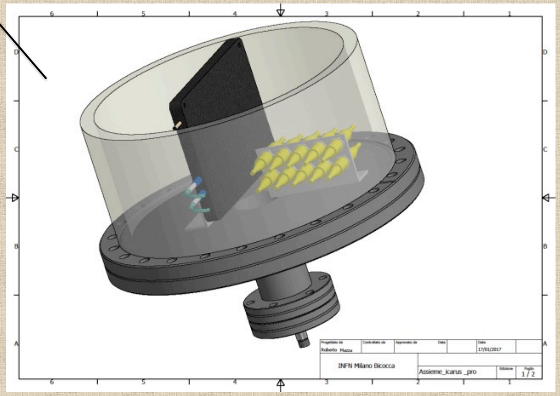
Problem: light pulses must have minimal time dispersion and signal attenuation at delivery point in front of the PMTs



Layout of the laser cal system

- *All components needed characterized at 405 nm wavelength*
- *No major problems seen*
- *Expected calibration resolution < 100-200 ps*

Hamamatsu PLP10 laser diode



Optical feedthrough

exp typology	keywords	Content
neutrino beam	laser calibration in visble range in Lar	power budget, optical feedthrough

- Large cosmic ray background > 400 PM for background rejection
- PMT time calibration crucial -> laser diode pulse on fused fibers splitters: low energy budget, used telecom technology non easily available in visible range. Suitable optical feedthrough

ProtoDUNE:

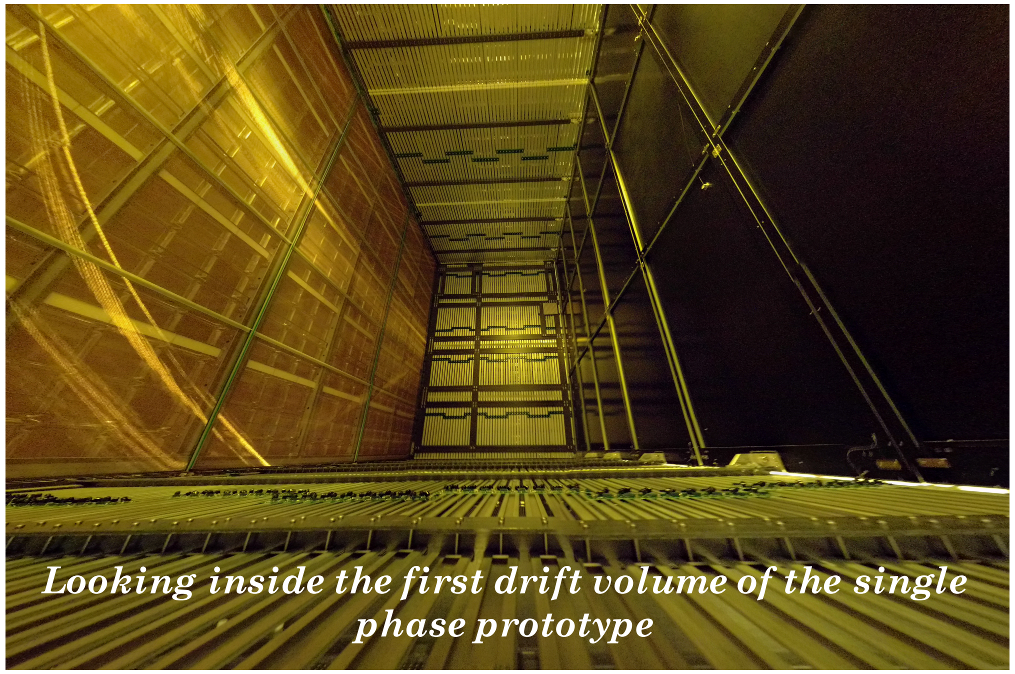
Prototyping the ultimate MeV – GeV neutrino detector

Roberto Acciarri - Fermilab

- DUNE is a leading-edge, international experiment for neutrino science and proton decay studies foreseen to start taking data in 2024. Its ambitious physics program requires a careful prototyping of the engineering solutions envisaged for the scale-up of two order of magnitude of the LArTPC technology, as well as the acquisition of a deep knowledge of the detector response and performance: this is the core of the ProtoDUNE program
-
- The poster presents the two kiloton-size prototypes currently being build at CERN for the two variants of the LArTPC technology under consideration: single and dual phase LArTPC

- A side by side comparison of the detectors and detection techniques is shown, with an emphasis on the charge readout solutions adopted and the technological innovation introduced to bring LArTPCs to the tens-of-kiloton stage

- Finally, the current status and near-term schedule for the two prototypes are shown



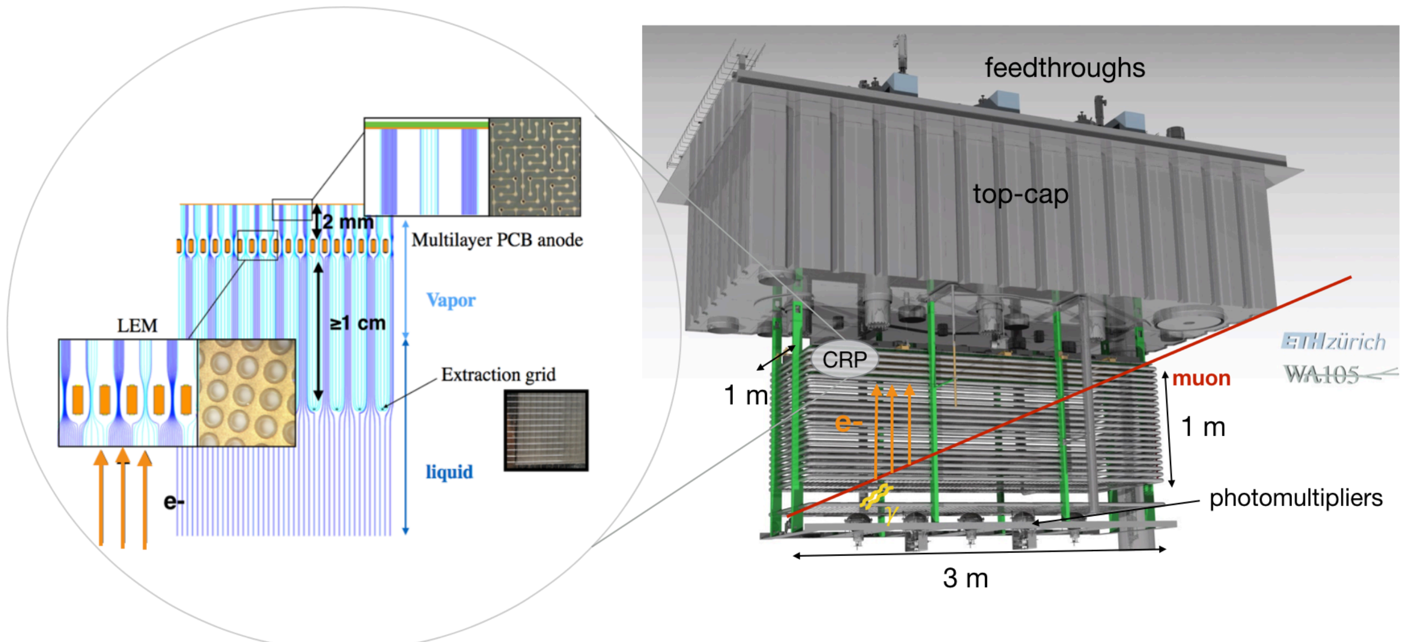
Looking inside the first drift volume of the single phase prototype

exp typology	keywords	Content
neutrino beam	LArTPC, DUNE	single vs dual phase comparison

- 2 x 800 ton LArTPCs   one for liquid one for dual phase
- comparison of the 2 options and engineering solution for the scale-up

Charge Imaging Performance of a 3×1×1 m^3 Dual Phase TPC

Caspar Schloesser
ETH Zurich, Institute for Particle Physics and Astrophysics



- Operation Principle of a dual Phase TPC
- Description of electron attenuation during drift through liquid argon due to impurities
- Charge sharing properties of the two collection views
- Estimation of the liquid argon purity using MIP tracks
- Description of LEM gain and its dependence on temperature, pressure and density of the gas argon

exp typology	keywords	Content
neutrino beam	neutrino scillations, LAr, DUNE	large volume LAr operations

- **A first experiment towards large scale Dual-Phase LArTPC 4.2 tons have been commissioned and operate at CERN**
- **first results achieved are shown**

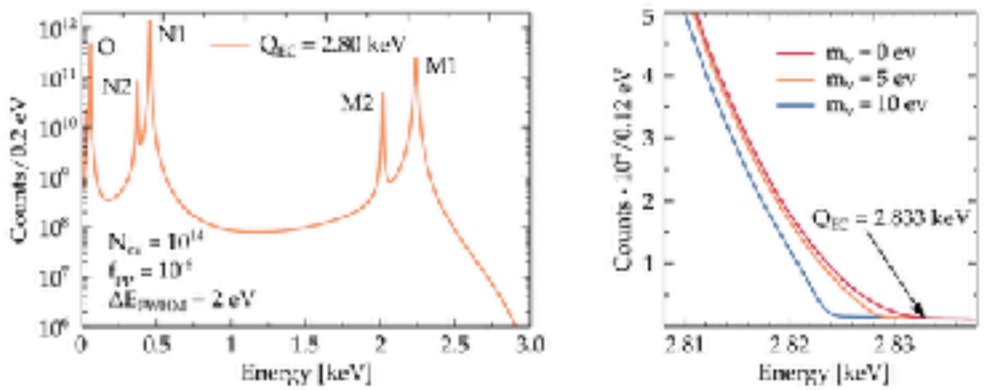
Nuclear decay for precision measurement and rare channel

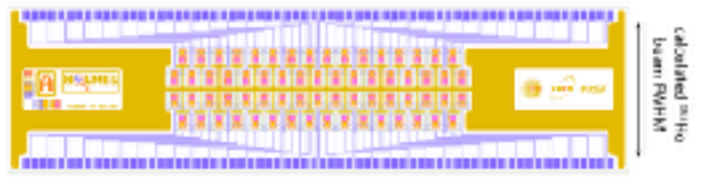
Probing the absolute neutrino mass scale with ^{163}Ho: the HOLMES project.

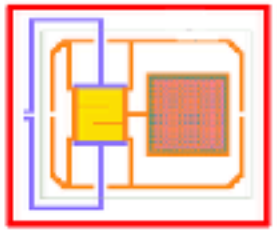
De Gerone Matteo

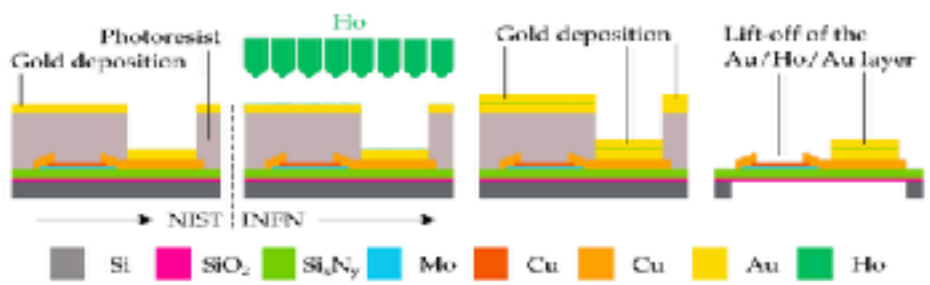
$$^{163}\mathrm{Ho} + e^- \rightarrow {}^{163}\mathrm{Dy}^* + \nu_e$$

The HOLMES project aims to directly measure the neutrino mass using the e⁻ capture decay (EC) of ^{163}Ho down to the eV scale. It will perform a precise measurement of the end-point of the Ho calorimetric energy spectrum to search for the deformation caused by a finite electron neutrino mass. The choice of ^{163}Ho as source is driven by the very low Q-value of the EC reaction, which allows for high sensitivity with low activities (O(10^2)Hz/detector), thus reducing the pile-up probability. A large array made by thousands of TES based micro-calorimeters will be used. The calorimetric approach eliminates systematic uncertainties arising from the use of an external beta-source, and minimizes the effect of the atomic de-excitation process. The commissioning of the first implanted sub-array is scheduled for the end of 2018. It will provide useful data about the EC decay of ^{163}Ho together with a first limit on neutrino mass. In this presentation the current status of the main tasks will be summarized: the TES array design and engineering, the isotope preparation and embedding, and the development of a high speed multiplexed SQUID read-out system for the DAQ.









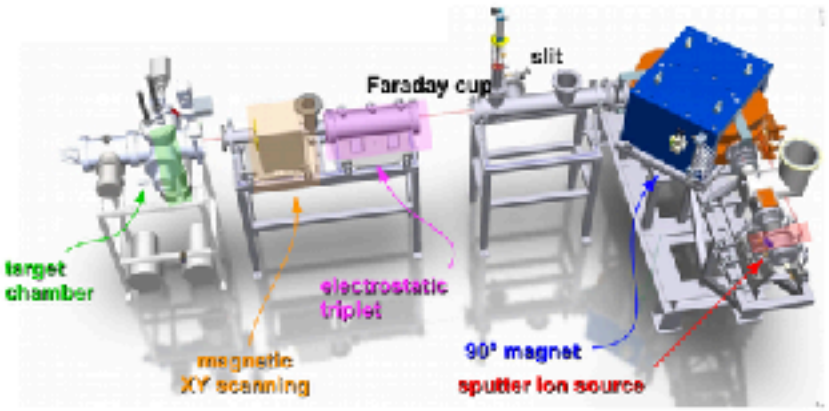
exp typology	keywords	Content
nuclear decay	neutrino mass, TES detectors	new exp, TES detectors large arrays, squids

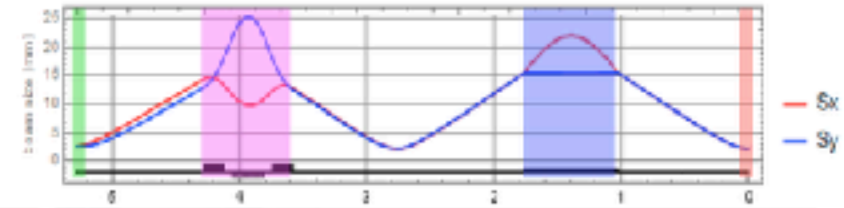
- electron neutrino mass measurement: electron capture on 163 Holmium energy released measured by a large array of Transition Edge Sensors down to the eV scale
- TES array engineering + high speed multiplexed SQUID readout system presented

^{163}Ho distillation and implantation for the HOLMES experiment

De Gerone Matteo

The HOLMES experiment aims to directly measure the ν mass with a calorimetric approach [1]. The choice of 163Ho as source is driven by the very low decay Q-value (~ 2.8 keV), which allows for high sensitivity with low activities (O(102)Hz/detector), thus reducing the pile-up probability. 163Ho will be produced by neutron irradiation of 162Er2O3 then chemically separated; anyway, traces of others isotopes and contaminants will be still present. In particular 166mHo has a beta decay (τ ~ 1200y) which can induce background below 5 keV. The removal of the contaminants is critical so a dedicated system has been set up. It is designed to achieve an optimal mass separation @163 a.m.u. and consists of two main components: an evaporation chamber and an ion implanter. The first item is used to reduce Ho in metallic form providing a target for the ion implanter source. The implanter is made by the sputter source, an acceleration section, a magnetic dipole, a x-y scanning stage and a focusing electrostatic triplet. In this contribution we will describe the procedures for the Holmium "distillation" process and the status of the machine commissioning.





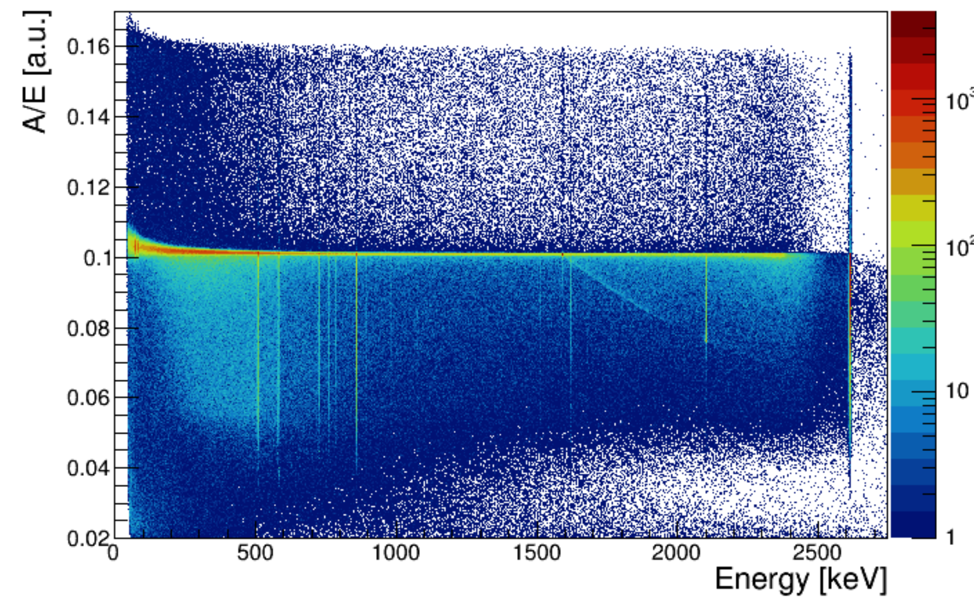
- Isotope preparation by distillation for the HOLMES experiment

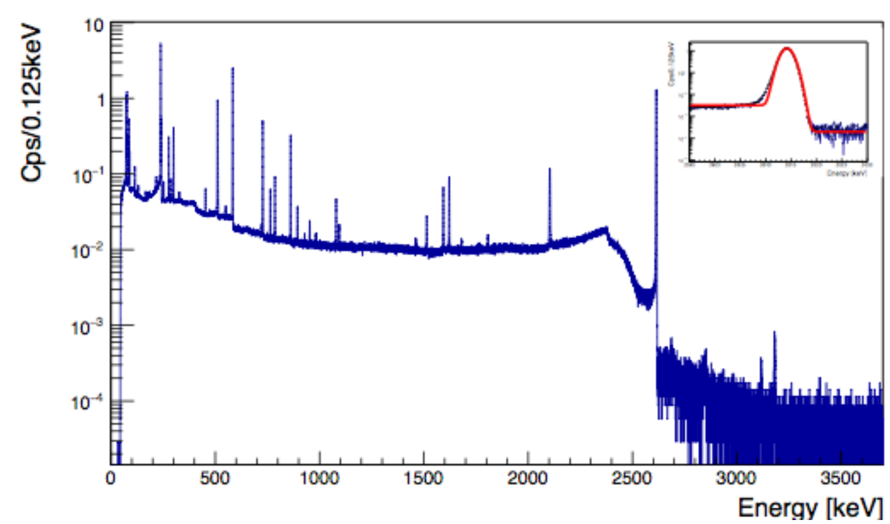
exp typology	keywords	Content
nuclear decay	isotope preparation	Holmium "distillation"

Performance of custom designed HPGe detectors for GERDA and LEGEND

Tommaso Comellato[1], Yoann Kermaidic[2], Matteo Agostini[1], Andrea Lazzaro[1], Christoph Wiesinger[1], and Stefan Schönert[1]
[1]TU Munich, [2]Max-Planck-Institut für Physik Heidelberg,

- Search for Neutrinoless Double Beta Decay of ^{76}Ge
- Large Mass (~1.5 Kg) HPGe detectors with new geometry
- Pulse Shape Analysis and comparison with simulations





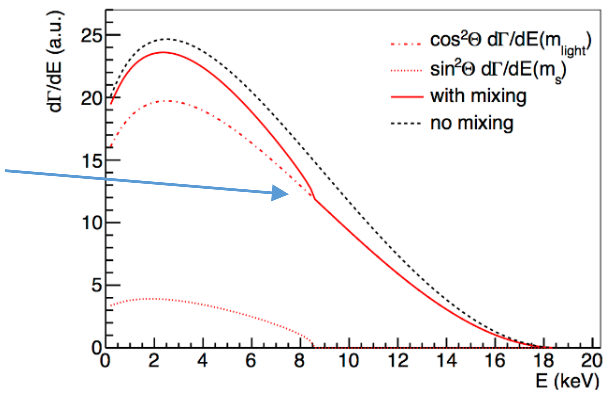
exp typology	keywords	Content
nuclear decay	neutrinoless double beta, Legend experiment,	upgrade of enriched 76Ge germanium detectors

- Inverted coaxial design for a better HPGe detector leading a larger mass (1.5kg) detector element
- detector for the Legend collaboration aiming 200 Kg of enriched germanium detector
- Performances of these detectors are presented

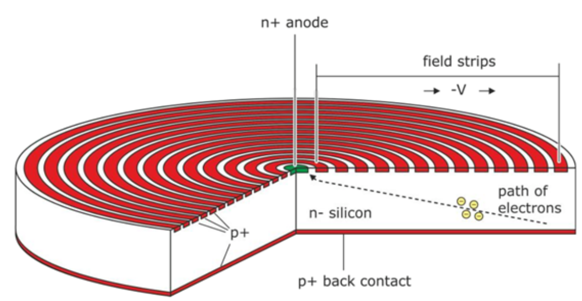
Development of a silicon drift detector system for the TRISTAN project - Future search for sterile neutrinos

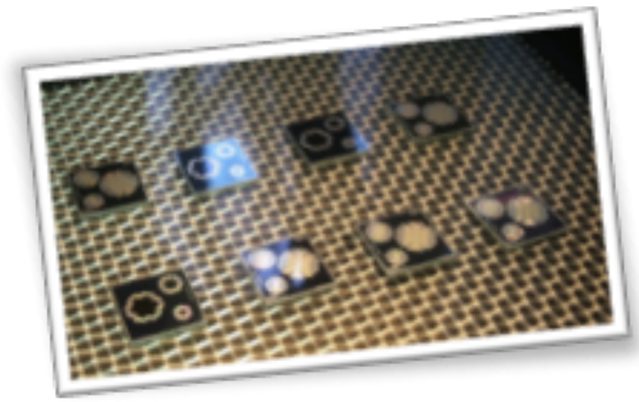
Tim Brunst[1], Luca Bombelli[2], Marco Carminati[3], Carlo Fiorini[3], David Fink[1], Thibaut Houdy[1], Peter Lechner[4], Susanne Mertens[1,5]
[1]Max-Planck-Institut für Physik, [2]XGLab S.R.L. Bruker Nano Analytics, [3]Politecnico di Milano, [4]Halbleiterlabor der Max-Plack-Gesellschaft, [5]Technische Universität München

The TRISTAN project is an upgrade of the KATRIN detector system to search for a sterile neutrino signature in the entire tritium beta decay spectrum.

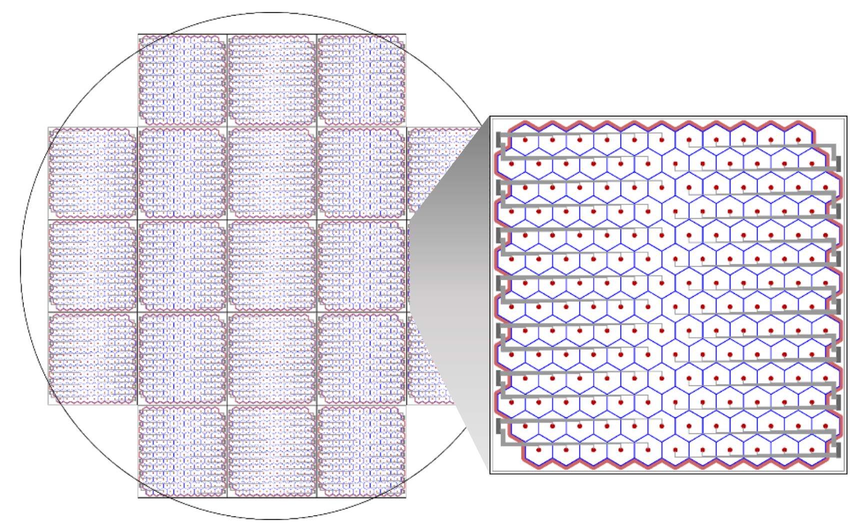


Amoung others, this requires the handling of rates up to 10^8 cps, an energy resolution better than 300 eV @ 20 keV and an energy threshold smaller 1 keV for which the silicon drift detector (SDD) is best suited.





First prototype detectors have been produced and tested in order to optimize the production parameters and guarantee the best performance of the final detector system.

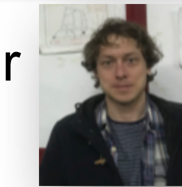


- **Sterile neutrino search in tritium beta decay -> signature as a kink-like spectrum "distortion"**
- **Silicon drift detector development with energy resolution better than 300 eV @ 20 KeV, detector system handle rate up to 100 Mcps**
- **Prototype produced and tested**

exp typology	keywords	Content
nuclear decay	neutrino mass, pixel silicon drift detectors	novel multi-pixel silicon drift detector system

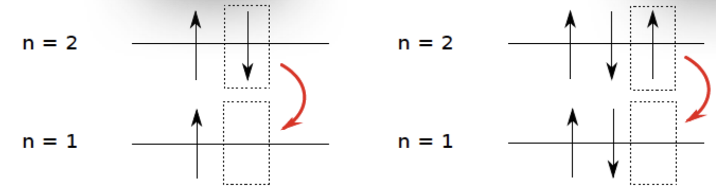
Atomic transition

ÖAW AUSTRIAN ACADEMY OF SCIENCES

J. Marton  and A. Pichler 

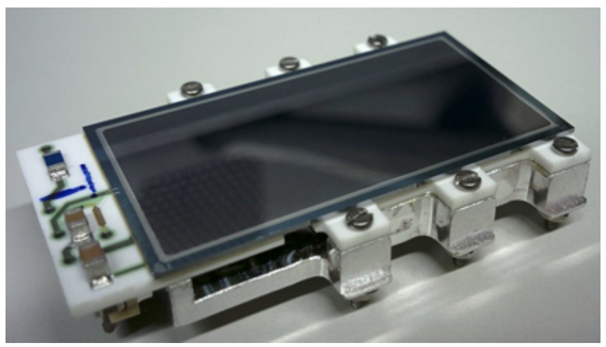
VIP/VIP2 at LNGS

This experiment is searching for Pauli-forbidden X-ray transition in Copper in the low-background environment of LNGS (low cosmics background) following a method first used by Ramberg-Snow. We use new SDDs for X-ray detection at highest sensitivity.



The Pauli forbidden X-ray transition at 8 keV is shifted by 300 eV

X-ray detector

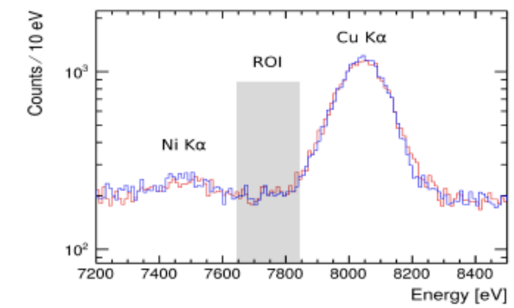


SDD characteristics:

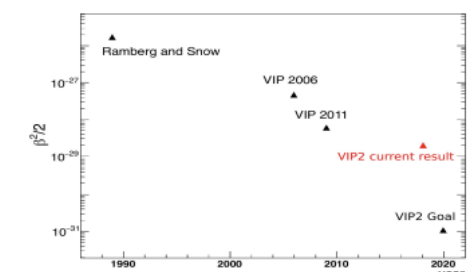
- area/cell = 64 mm^2
- total area = 512 mm^2
- T = - 100°C
- drift time < 500 ns

Setup of VIP2

Inner part inside insulation vacuum



Comparison of data taken with and without current at LNGS. The region of interest where the PEP violating transition is expected is marked in gray. The data corresponds to around



The results of the VIP experiment, compared to the limit we can set with the data taken by the VIP2 experiment. The envisioned final result after the full data taking time is shown including a planned upgrade [4].

VIP used CCDs, follow-up VIP2 uses SDDs because

- SDDs developed for exotic atom research
- Good energy resolution at 8 keV
- Trigger capability → active shielding
- Compact design → large solid angle

WWW:OEAW.AC.AT/SMI

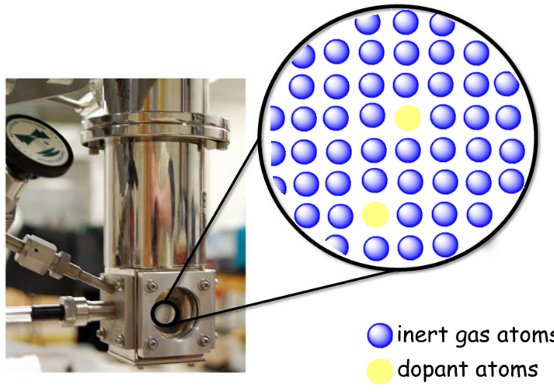
exp typology	keywords	Content
atomic transition	forbidden atomic transitions, X-ray silicon detectors	proposed experiment for Pauli exclusion principle

- **Pauli exclusion forbidden atomic transition in K-alpha X ray tradition in copper**
- **forbidden transition is 300 eV shifted with respect 8KeV can be resolved by SDD (150 eV @ 6KeV and) + active shield + compact design**

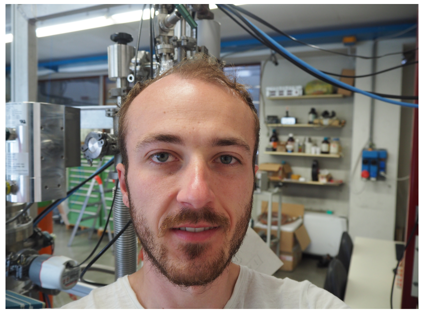
Novel approaches in low energy threshold detectors for Dark Matter searches

Guarise Marco (INFN Laboratori Nazionali Legnaro & Università di Ferrara)

The Axioma R&D experiment is a project for the development of a novel scheme of low energy threshold particle detector based on both undoped and doped matrices of inert gases solidified at cryogenic temperature.



- An energy threshold of tens of eV could be reached in undoped matrices, exploiting the electrons emission from the solids-vacuum interface combined with high efficiency electron detectors.
- Energy threshold in the eV and meV range could instead be reached in doped matrices using laser-driven upconversion and laser-induced ionization processes combined with single electron detectors in vacuum.



Axioma Matrix Group:
R. Calabrese, A. Khanbekyan, E. Luppi, L. Tomassetti (INFN Ferrara & Università di Ferrara)
C. Braggio, G. Carugno (INFN Padova & Università di Padova)
A. Dainelli, M. Poggi (INFN Laboratori Nazionali Legnaro)

MATRIX

- Solid crystals doped and un-doped at low temperature
- laser assisted transition triggered by incident particle
- able to detect energy released in the range sub-eV , tens of eV

exp typology	keywords	Content
atomic transition	dark matter, very low energy threshold detectors	laser-assisted transitions applied to DM low energy

Coffee