FRONTIER DETECTORS FOR FRONTIER PHYSICS
13th Pisa Meeting on Advanced Detectors

Detector Techniques for Cosmology, Astroparticle and General Physics Poster Review

Aldo Morselli
INFN Roma Tor Vergata

Detector Techniques for Cosmology, Astroparticle and General Physics : 24 Posters

The Tunka Radio Extension (Tunka-Rex) – Radio Measurements of Cosmic Rays in Siberia
Frank G. Schröder (Karlsruhe Institute of Technology (KIT))

TITUS: An Intermediate Distance Detector for the Tokai-to-Hyper-Kamiokande Neutrino Beam and Physics with Gadolinium
David Hadley (University of Warwick)

Search for sterile neutrinos at the ILL reactor
Caroline Lahonde-hamdoun (cea)

Looking for Charged Lepton Flavour Violation with the COMET experiment
Jordan Nash (Imperial College London)

Ultra-Sensitive γ-Ray Spectroscopy Set-Up for Investigating Primordial Lithium Problem.
Gianpiero Gervino (Dipartimento di Fisica and INFN Torino)

The rearch of aging test for the 20inch MCP-PMT
Shuguang Si , Dong Li

The POLIS interferometer for ponderomotive squeezed light generation
Martina De Laurentis (NA)

The Large Synoptic Survey Telescope Corner Raft Readout Electronics
Sven Herrmann (SLAC)

The EEE Project: an extended network of muon telescopes for the study of cosmic rays
Ms. Maria Paola Panetta (INFN Lecce)

Detector Techniques for Cosmology, Astroparticle and General Physics : 24 Posters (2)

The Archimedes Experiment
Paola Puppo (ROMA1)

The Advanced Virgo monolithic fused silica suspension
Paola Puppo (ROMA1)

Test of Weak Equivalence Principle on Antimatter with AEgIS
Daniel Krasnicky (GE)

Possible usage of Cherenkov photons to reduce the background in a 136Xe neutrinoless double-beta decay experiment
Giovanni Signorelli (PI)

Phase camera experiment
Kazuhiro Agatsuma (National Institute for Subatomic Physics)

PandaX III, a Proposed Double Beta Decay Experiment with 200 kg Gaseous Xenon
Xiangdong Ji (Shanghai Jiao Tong University)

Measurement of a polarised gamma ray beam from 1.7 to 74 MeV with the HARPO TPC
Philippe Gros (LLR, Ecole Polytechnique)

INFN Camera demonstrator for the Cherenkov Telescope Array
Riccardo Paoletti (SI)

Experimental study of breakdown electric fields in liquid argon
Roberto Acciarri (FNAL)

Detector Techniques for Cosmology, Astroparticle and General Physics : 24 Posters (3)

Evaluation of Photo Multiplier Tube Candidates for the Cherenkov Telescope Array
Mr. Dominik Müller (Max-Planck-Institute for Physics)

Euso Balloon: the first flight
Valentina Scotti (INFN Napoli)

EUSO-TA prototype telescope
Ms. Francesca Bisconti (Karlsruhe Institute of Technology)

Development of a super-resolution optical microscope for directional Dark Matter search experiment
Andrey Alexandrov (NA)

A simple technique for gamma ray and cosmic ray spectroscopy using plastic scintillator
Ms. Sharmili Rudra)University of Calcutta) , Saikat Biswas (Institute of Science Education and Research)

A scintillating bolometer array for double beta decay studies: the LUCIFER experiment
Luca Gironi (MIB)

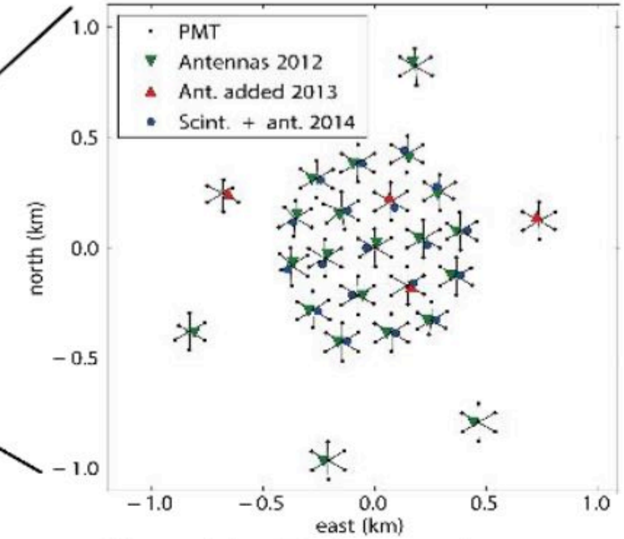
The Tunka Radio Extension
Radio Detection of Air Showers in Siberia

Frank G. Schröder for the Tunka-Rex Collaboration

Tunka-Rex

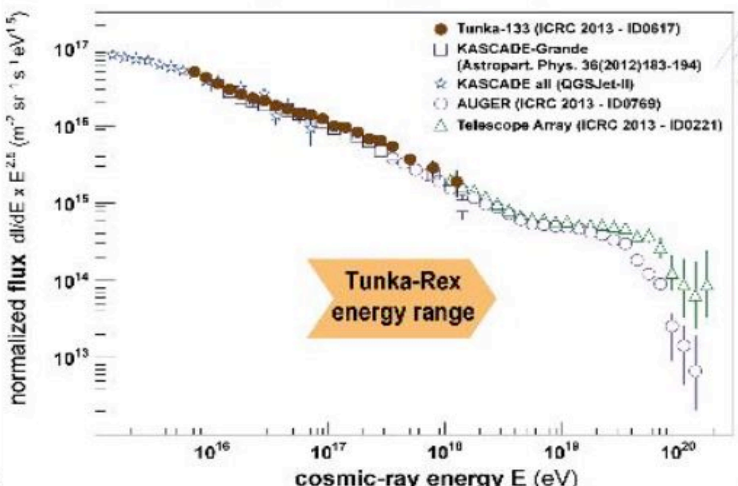
Take home message

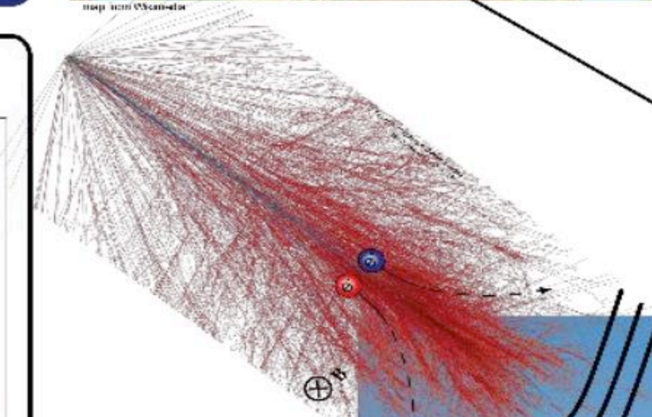
- Cross-calibration of air-Cherenkov and radio measurements of the same air showers
- Both have similar energy precision: ~ 15%
- 24/7 operation possible due to trigger by new scintillator extension Tunka-Grande



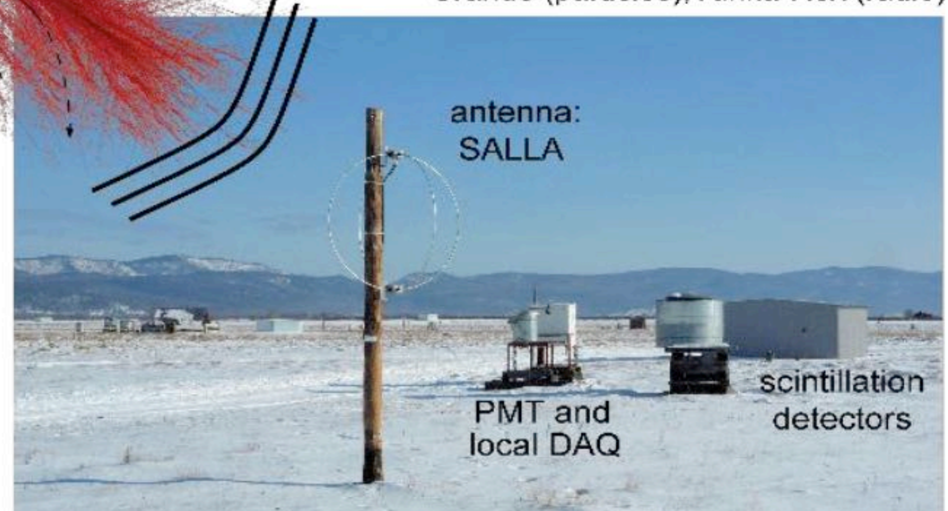
Map of the Tunka experiments: Tunka-133 (air-Cherenkov), Tunka-Grande (particles), Tunka-Rex (radio)

Cosmic-Ray energy range



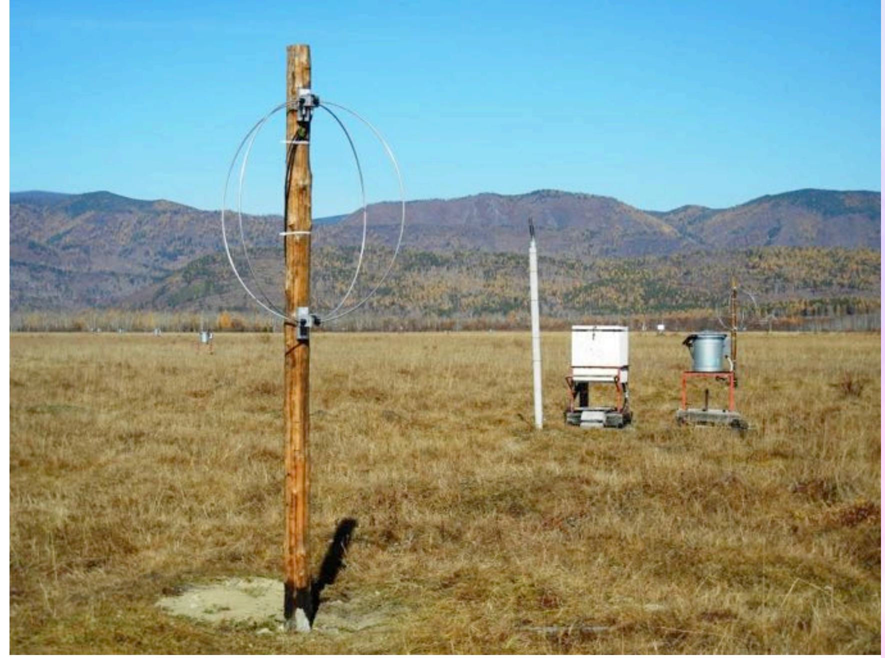


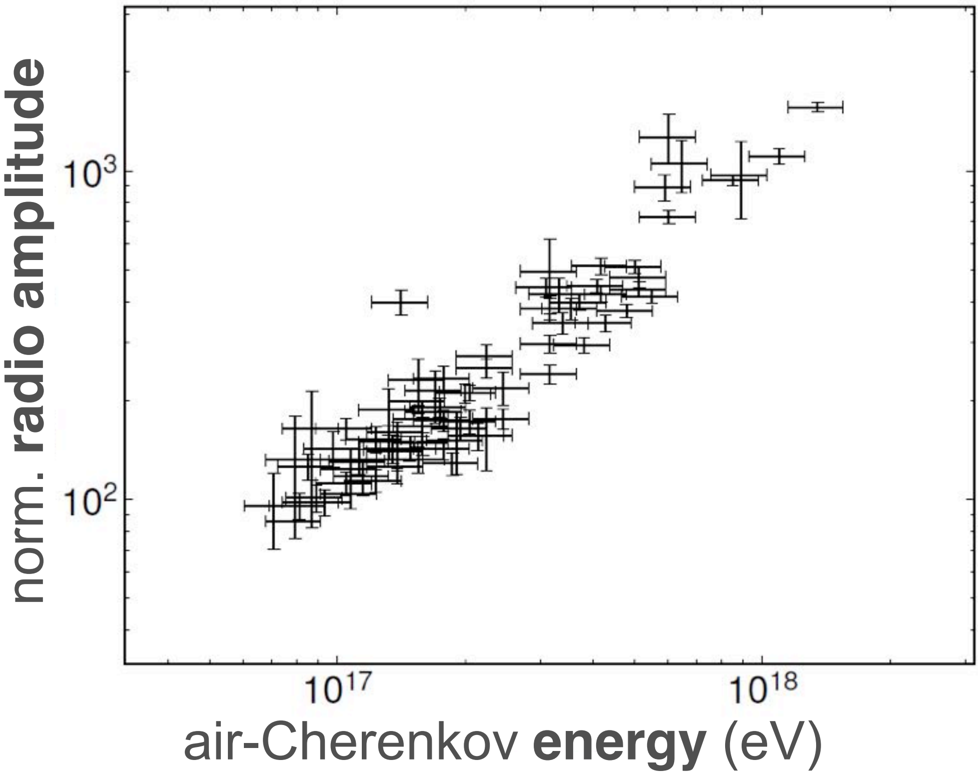
Radio emission of air showers mainly caused by deflection of e^- and e^+ in geomagnetic field.

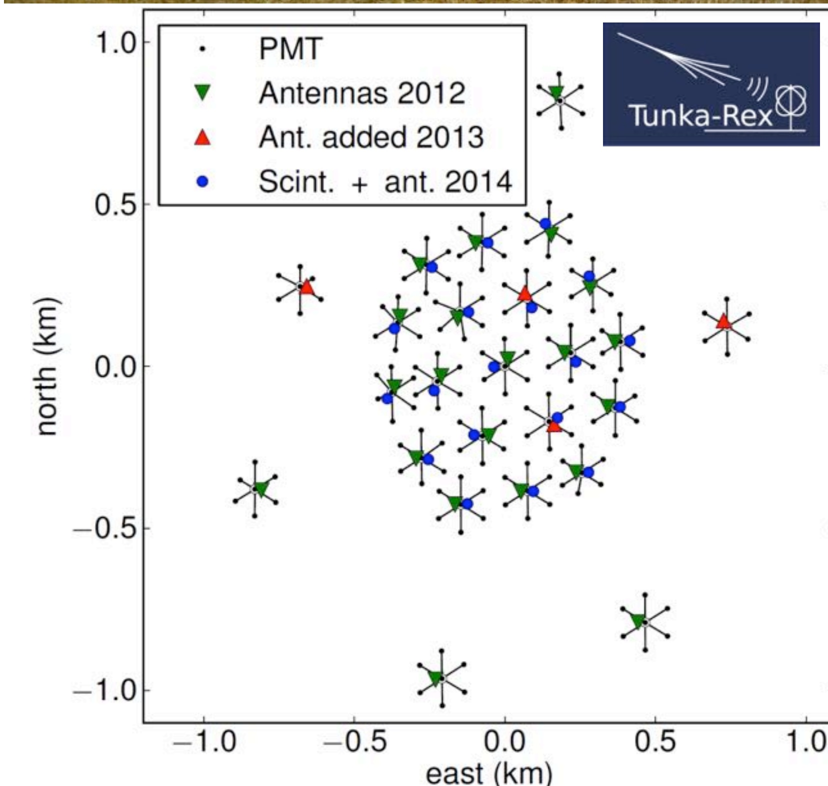


Tunka-Rex

- Cost-effective antenna array at Tunka experiment for cosmic rays in Siberia
- Cross-calibration of Radio and air-Cherenkov signal



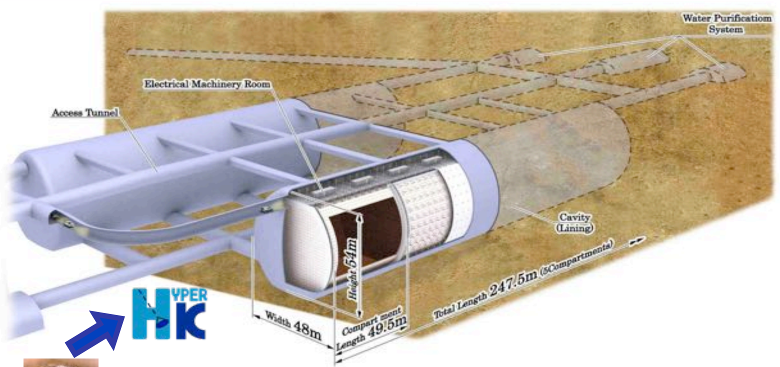




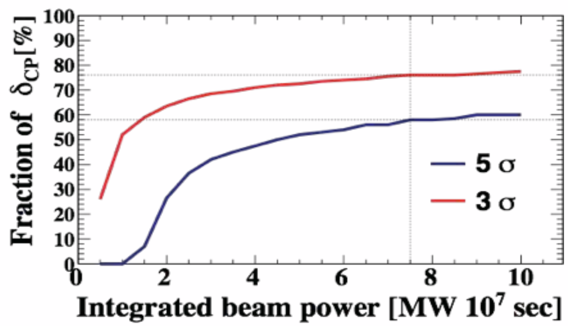
TITUS : An Intermediate Detector for the Hyper-K Experiment

THE UNIVERSITY OF WARWICK

Tokai-to-Hyper-K Experiment

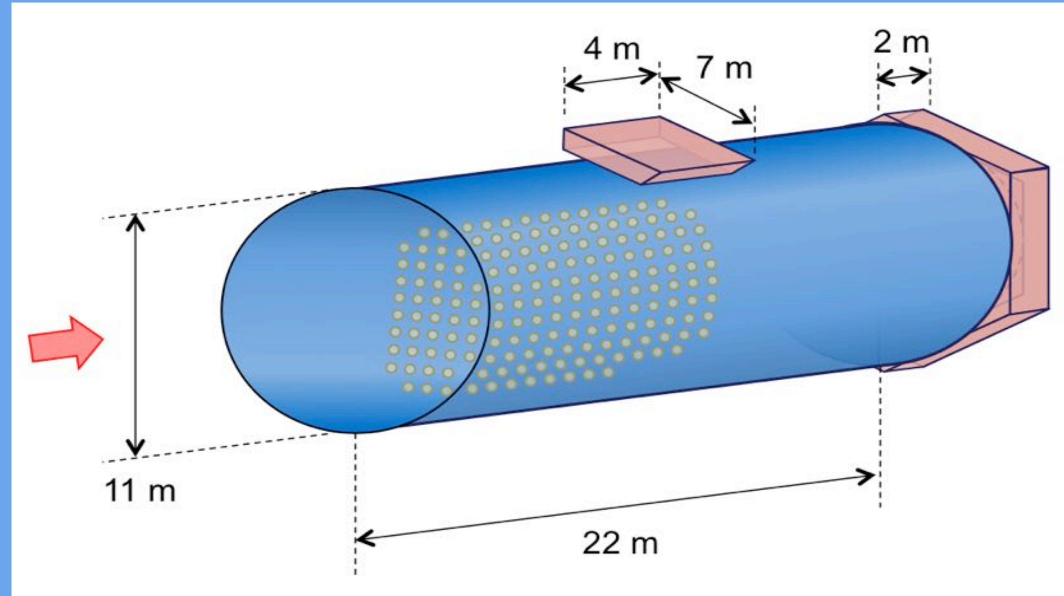


Megaton scale Water Cherenkov detector x25 larger fiducial volume than Super-K.



Leptonic CP violation can be established at 3σ (5σ) for 76% (58%) of δ_{CP} space.
New near detectors are needed to maximise physics potential of the T2HK beam programme.

TITUS Detector Concept



A proposed Water Cherenkov Near Detector

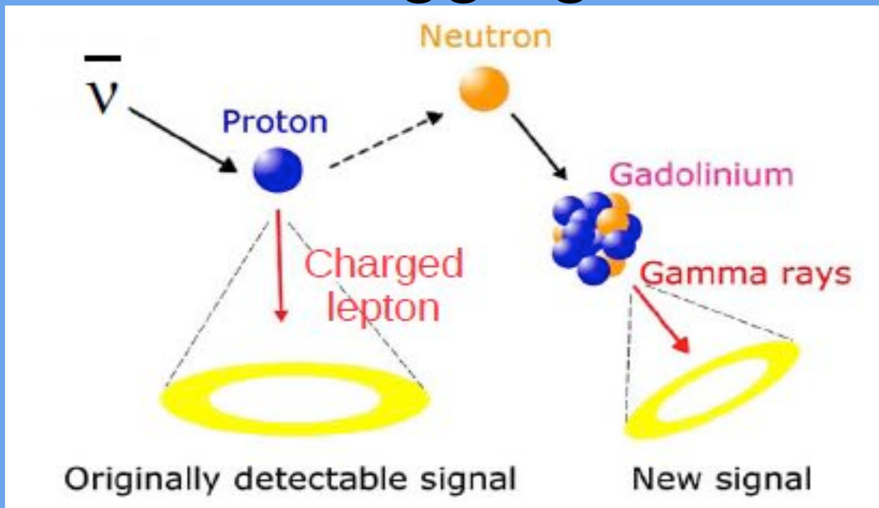
Main features:

- 2km from the neutrino beam source to match the far detector flux.
- Identical target nucleus and detector technologies as the far detector to maximise the cancelation of systematic uncertainties.
- Neutron tagging by capture on Gadolinium.
- Magnetised Muon Range detector for sign selection and measure escaping muons.

TITUS : An Intermediate Detector for the Hyper-K Experiment

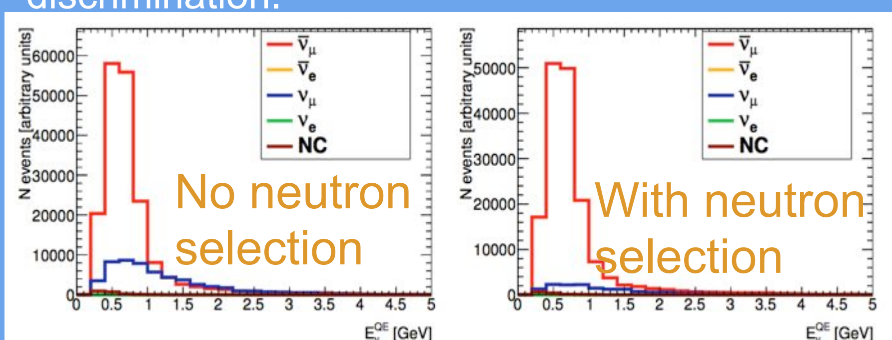
THE UNIVERSITY OF WARWICK

Neutron Tagging



Neutron capture on Gd produces visible gamma signal.

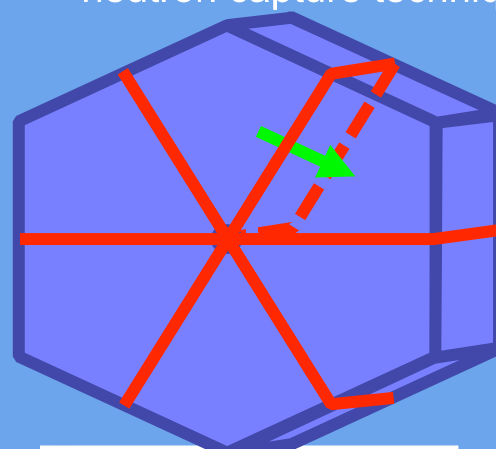
Neutron tagging allows neutrino-anti-neutrino discrimination.

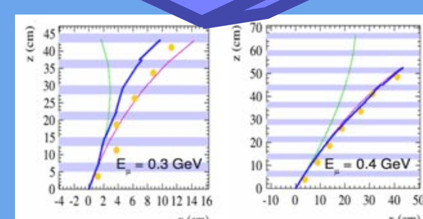


Muon Range Detector

A magnetised iron-scintillator sandwich

- measure momentum of escaping muons.
- allows sign-selection.
  - in-situ validation of the neutron capture technique.





Please find my poster if you would like to know more!

David Hadley on behalf of the TITUS working group

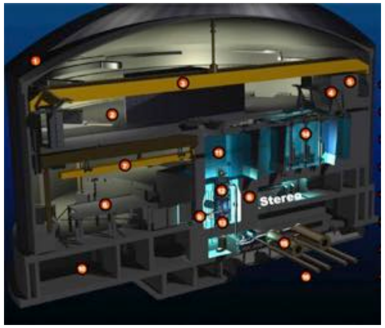
Caroline Lahonde-hamdoun

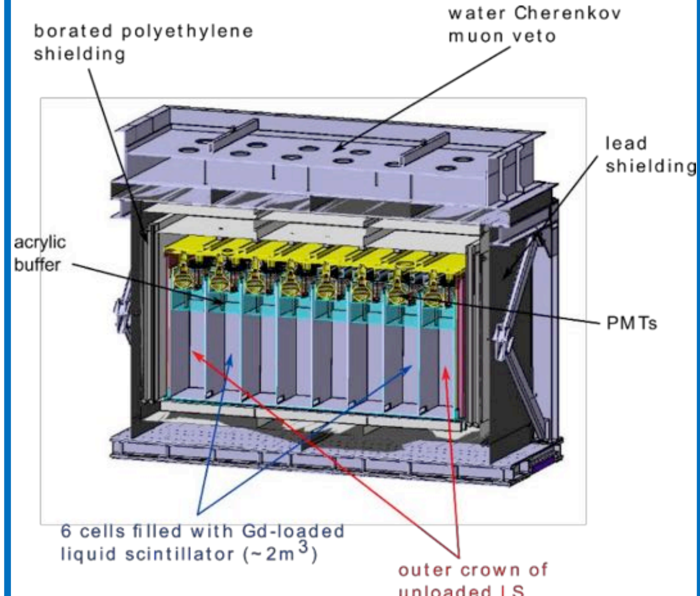
CEA - Saclay

STEREO

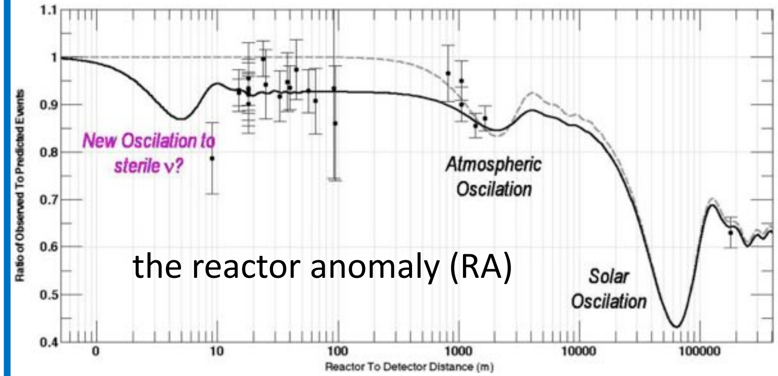
STErile Reactor nEutrino Oscillation

- Sensibility cover 99% of the C.L. contour of the RA
- L0 = 10.0 m
- Thresold : E_{prompt}>2 MeV | $E_{delayed}$>5 MeV
- Efficiency 60% | ΔEscale = 2% | FoM = 1.2 | S/B = 1.5
- All syst. of predicted spectra
- Norm: 3.7% absolute | 1.7% relative between cells



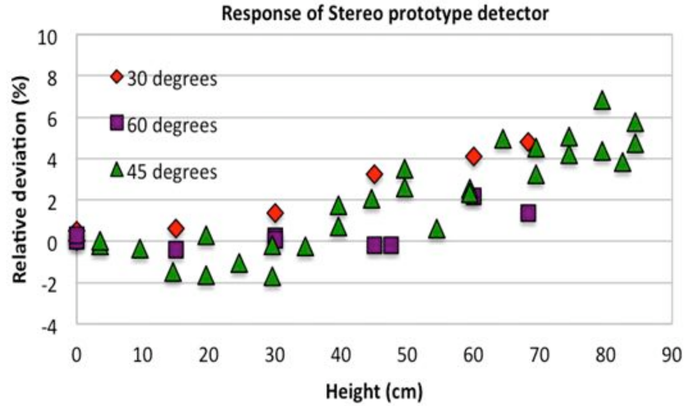


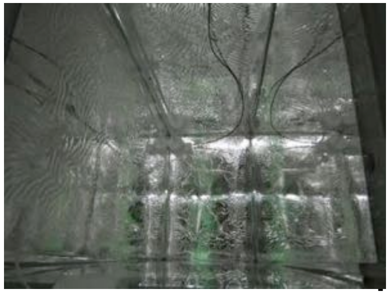
Search for sterile neutrinos at the ILL Reactor (inverse beta decay method)



Prototype cell

Development of reflective plates
(increase the light collection (bot/ up effect))

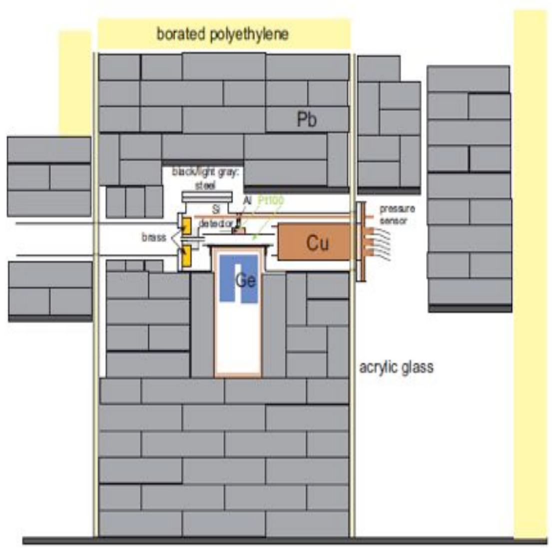




Ultra-Sensitive -Ray Spectroscopy Set-Up for Investigating Primordial Lithium Problem

G. Gervino for LUNA Collaboration
Dipartimento di Fisica, Università di Torino and INFN Torino

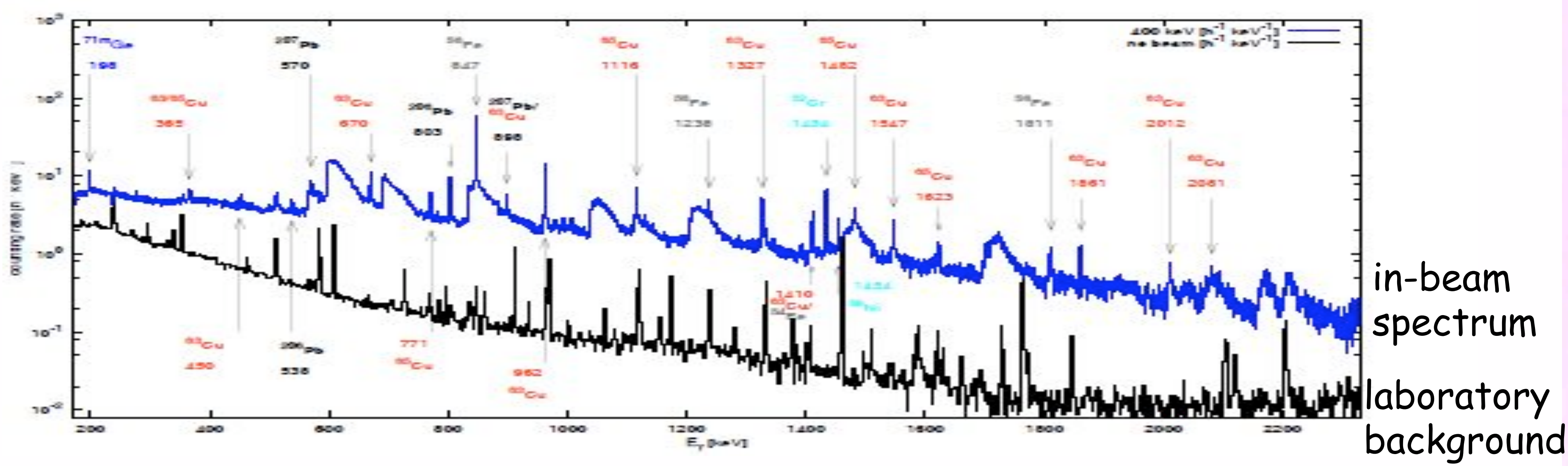
To precisely determine BBN ^{6}Li production, the cross section of the nuclear reaction ^{2}H(α,γ)^{6}Li must be directly measured within the astrophysical energy range of 30 - 400 keV. This measurement requires an ultra-low -ray background. We have realized these conditions at LUNA, in the INFN Gran Sasso National Laboratory (LNGS), Italy.



Experimental setup, as seen from the side. The central chamber of the windowless gas target is seen near the center of the plot

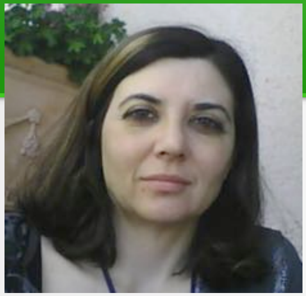
LUNA2 400 kV accelerator

Mostly of the remaining γ-ray background seen in the spectra are coming from the energetic deuterons scattered in the gas target by the beam. Thanks to the low neutron environmental background at LUNA, the effect of this weak flux of 2-3 MeV neutrons on HpGe detectors has been studied in details and the results are presented and discussed.



Spectra taken with the HpGe (130% efficency). Blue line: in-beam spectrum at E = 400 keV, pTarget= 0.3 mbar, laboratory background subtracted. The quantity plotted is the counting rate. Black line: Laboratory background. The most important in-beam lines due to (n,n') and (n,γ) processes on structural and shielding materials are marked with arrows, and the relevant target nuclide is given, as well as the gamma-ray energy in keV.

The POLIS interferometer for ponderomotive squeezed light generation



Andrea Conte*, **Martina De Laurentis°**, Luca Naticchioni*, Paola Puppo* *on behalf of POLIS collaboration***

*Università di Roma La Sapienza, INFN Roma1 Gruppo Roma1 - °Università di Napoli Federico II, INFN Napoli

** (Università di Roma Tor Vergata) INFN Roma2 - (Università di Pisa - INFN Pisa) Gruppo Pisa - (INFN Genova), (INFN Perugia), (INFN Pisa), (Università del Sannio, INFN Napoli) Gruppo INFN

(Università di Firenze, INFN Firenze, CNR) Gruppo Firenze - (Università di Salerno, INFN Napoli) Gruppo di Salerno - (Università di Napoli Federico II, INFN Napoli, CNR) Gruppo Napoli-

(Università di Trento, INFN Padova-Trento, *Fondazione B. Kessler) Gruppo di Trento

(Università di Camerino, INFN Perugia) Gruppo di Camerino - (Università di Urbino, INFN Firenze) Gruppo di Urbino

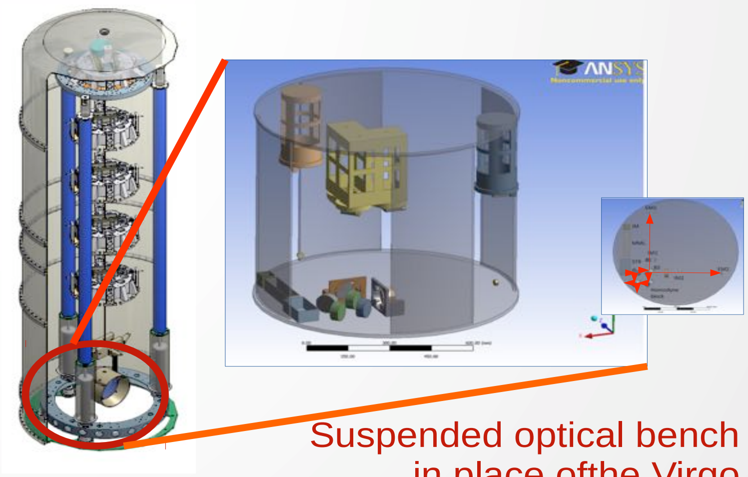
Project to realize a completely suspended low frequency independent ponderomotive squeezer in the low frequency range

moving from the pioneers' work made in the LIGO laboratory at the MIT

[*Corbitt et al.* Phys. Rev. A **73** (2 Feb. 2006), p. 023801]

and

taking the advantage of the available Virgo Super Attenuator Facility at EGO, SAFE to control the main noises source in the low frequencies range



Suspended optical bench in place ofthe Virgo suspended mirror

The POLIS interferometer for ponderomotive squeezed light generation

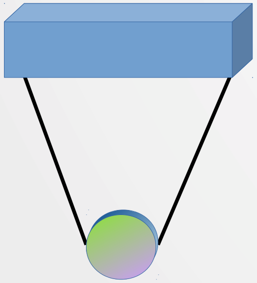
Ponderomotive Squeezing:

large squeezing values *without use* high laser power and/or very high cavity finesse *requires* very small suspended mirrors mass

very critical point is the mass suspension, suspension and coating thermal noise

higher chance of success:

A relative large mass allows us to use the available well consolidate technologies of Virgo to control the low frequency noise

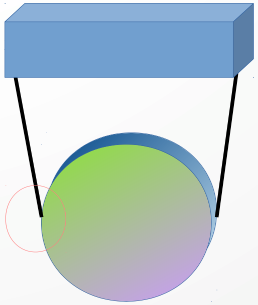


Low value of mass

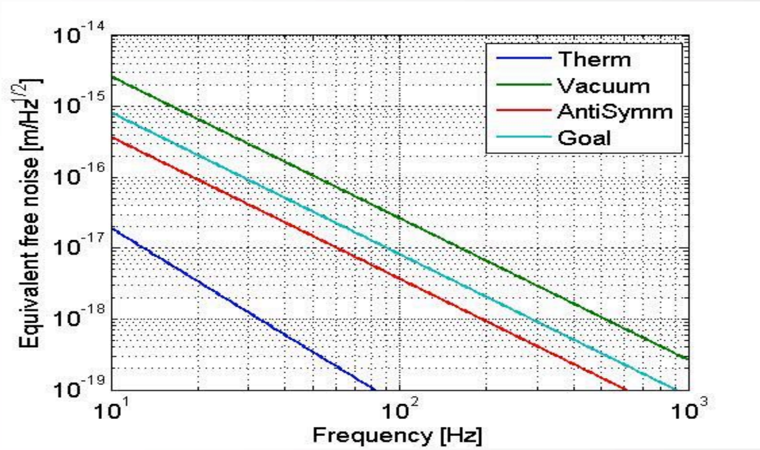
- Large optical Spring resonance (*frequency independent squeezing Band)*

High value of mass

- ease of construction;
- ease to sense and actuate motion;
- use commercial size



Thermal noise reduction



Maximum equivalent interferometer noise on the differential mode in order at least to reach the non-squeezed noise level.

In case of **7 db of squeezin**g (taken as *realistic value* due to losses) the **interferometer sensitivity limit** is **10^{-15} m/sqrt(Hz) @ 10 Hz** and **10^{-17} m/sqrt(Hz)@100 Hz**. These requirements can be fulfilled by careful design of the interferometer.

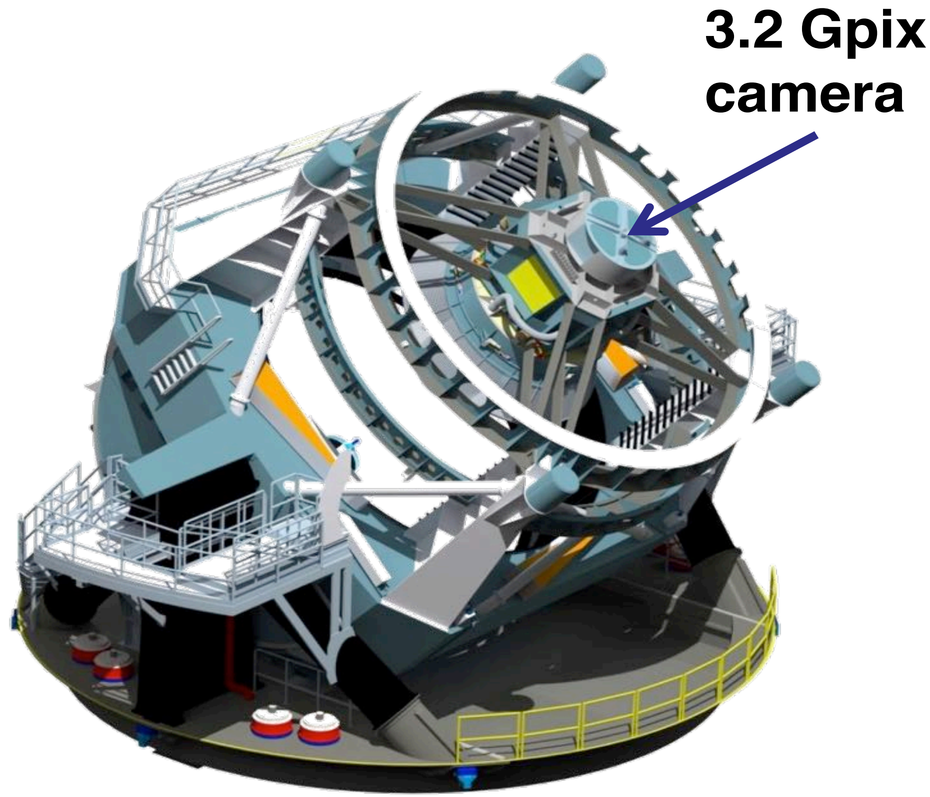
The Large Synoptic Survey Telescope Corner Raft Readout Electronics

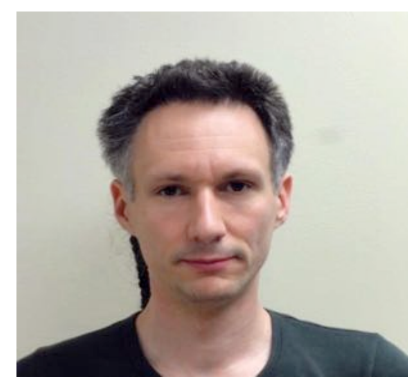
LSST in a Nutshell

- The telescope will be located in **northern Chile**.

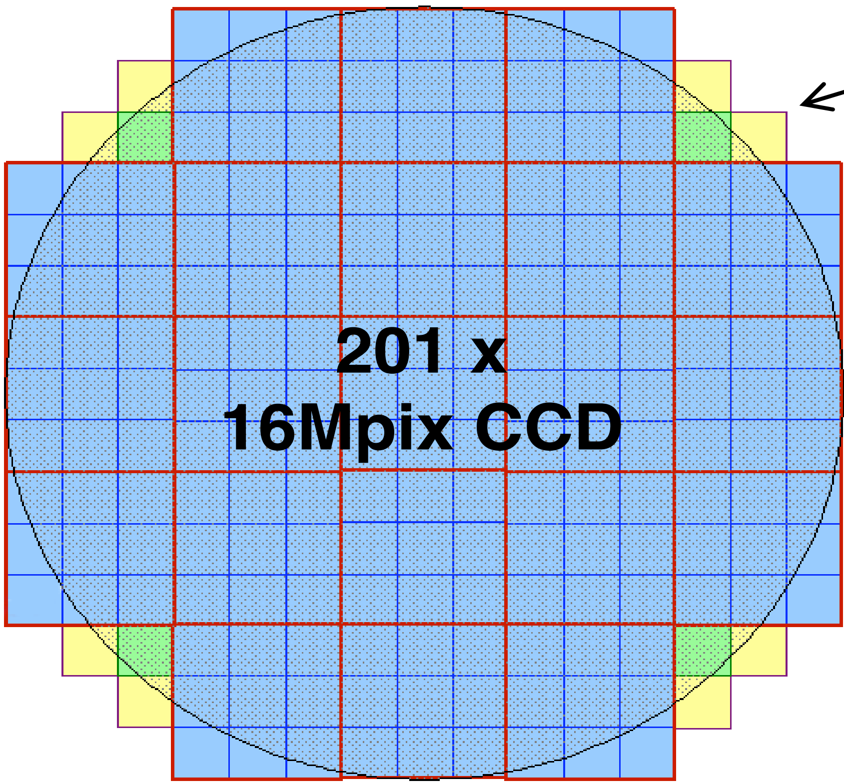
- The LSST is an integrated survey system designed to conduct a decade-long, deep, wide, fast time-domain survey of the optical sky. It consists of an 8-meter class wide-field ground based telescope, a **3.2 Gpix camera**, and an automated data processing system.

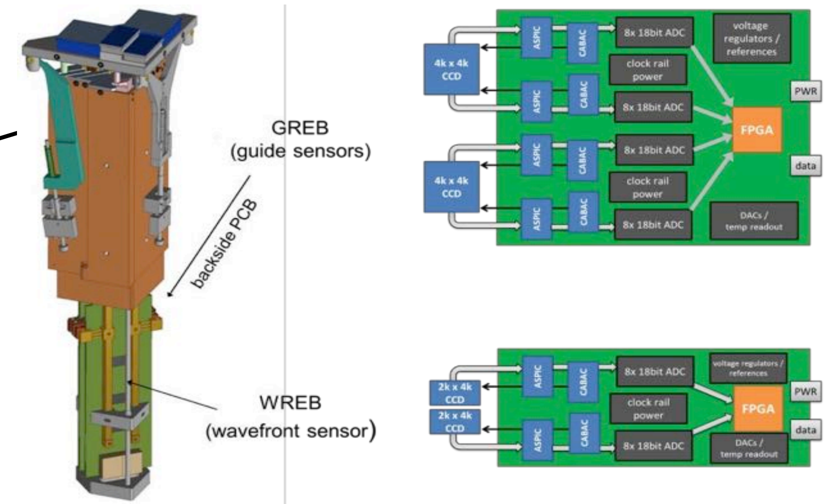
- The LSST will enable a wide variety of complementary scientific investigations, utilizing a common database and alert stream. These range from searches for small bodies in the Solar System to precision astrometry of the outer regions of the Galaxy to systematic monitoring for transient phenomena in the optical sky. LSST will also provide **crucial constraints on our understanding of the nature of dark energy and dark matter.**





The Large Synoptic Survey Telescope
Corner Raft Readout Electronics



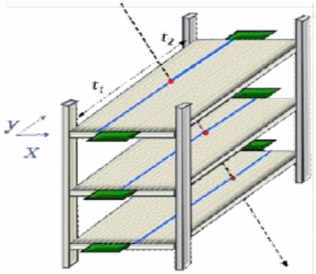


3.2Gpix camera includes 4 corner rafts:

- guide sensors provide input for the pointing servo loop
- wavefront sensors provides input for the active optics system

Corner Raft Tower includes all electronic for a
48 channel CCD controller with a 18bit video chain (@500kHz pixel clock per channel)

CENTRO FERMI
Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi



The EEE Project: an extended network of muon telescopes for the study of cosmic rays

M.P.Panetta on behalf of the EEE Collaboration

The EEE (Extreme Energy Event) Project

An array of more than 40 muon telescopes to study High Energy Extensive Air Showers
The stations are installed inside Italian high school buildings, INFN sections and at CERN, spread over a area of 3×10^5 km^2

The EEE Telescope

- 3 Multi Resistive Plate Chambers (MRPC) for particle tracking – each with 24 readout strips
- A 6-fold coincidence of both strip ends of the 3 MRPCs generates the data acquisition Trigger
- GPS UNIT gets the event time stamp to synchronize informations from different telescopes
- VME BRIDGE. DAQ connected to a PC via USB
- …

The particle impact point is reconstructed by the hit strip (x) and **by the difference of signal arrival times** at the strip ends (y) **measured by TDCs**

The EEE telescopes have been independently taking data since several years, and have been able to produce significant scientific outcomes:
search of coincidences, study of cosmic rays flux, …

45 days RUN 1

RUN 1

23 February 2015 – 30 April 2015

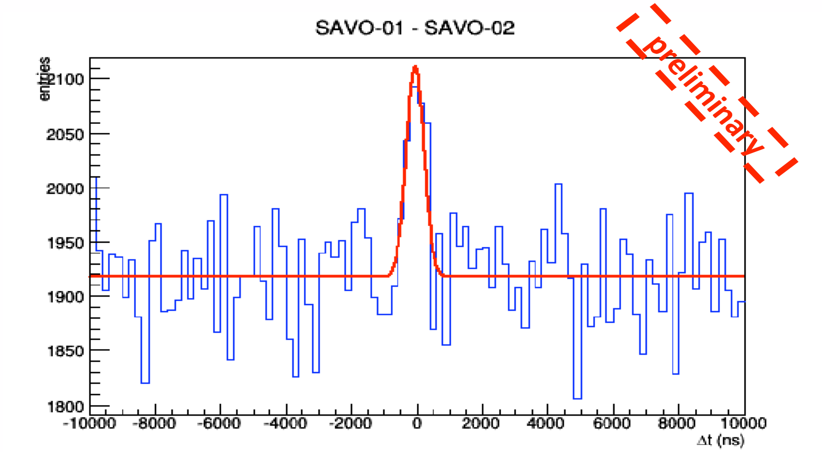
For the first time 35 telescopes have been contemporaneously taking data. Data are transferred and stored to CNAF where events and tracks are analyzed:
4×10^9 GOOD TRACKS have been collected

Additional info in the poster presented by F. Noferini (FEE Trigger DAQ Session)

Frontier Detectors for Frontier Physics
13th Pisa Meeting on Advanced Detectors
24–30 May 2015 • La Biodola, Isola d'Elba (Italy)

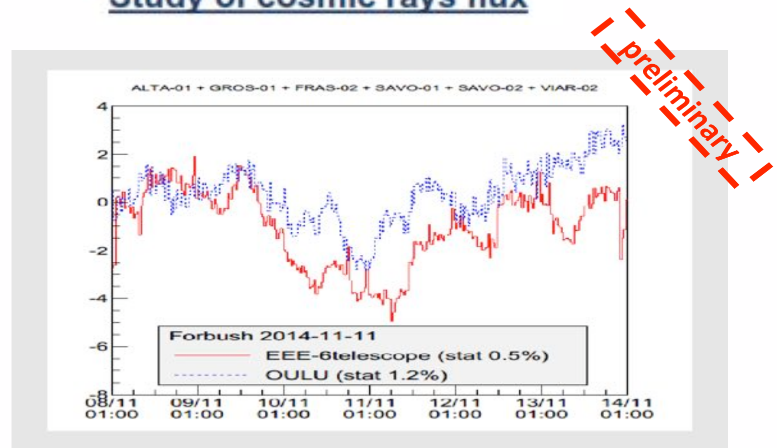
At the present, data transfer to CNAF, allowing a direct way to store and access all data, **makes it easier to analyse contemporaneously all the EEE network results**

Search for Coincidences



Extensive Atmospheric Shower (EAS) Detection: Muon coincidences detected (5.4 +/- 1.0 σ) by stations placed at 1.2 km distance

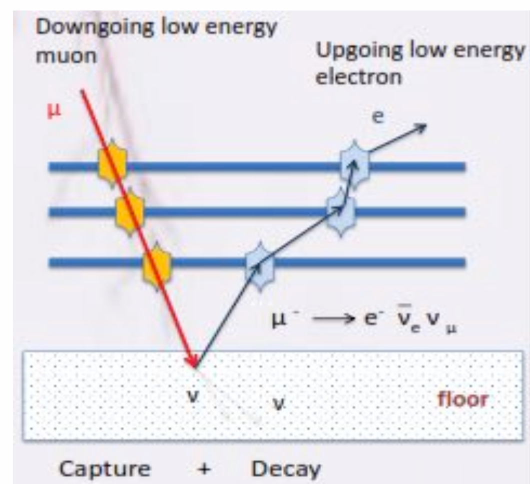
Study of cosmic rays flux



Forbush decrease observations:
Muon rates averaged on 6 EEE telescopes (red), Neutron rates (blu)

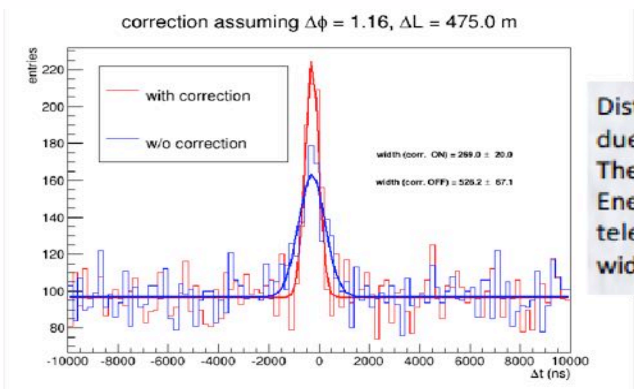
Upgoing tracks

Most of them might be electrons from μ-Decay



Distance Correction

CAGL-01/02



Distance correction reduces background due to accidental coincidences (S/N and σ) These corrections are important for High Energy EAS research among faraway telescopes (>2km) since coincidences peak width is proportional to ΔL.

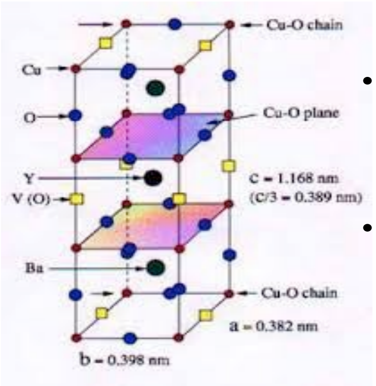
The Archimedes Experiment

P. Puppo[3] for Archimedes' collaboration

From the cosmological constant problem:

why does vacuum energy exibit a gravitational contribution enormously lower than the predicted one? Does vacuum gravitate or not?

Cuprates are «natural» stacks of Casimir cavity



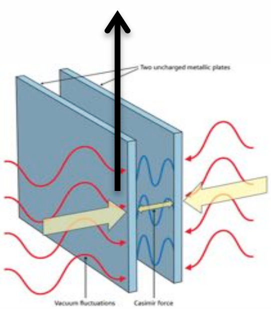
- The cuprate, when makes the transition, has parallel superconducting planes separated by dielectric planes.
- These planes expel part of the vacuum energy due to the increased reflectivity.

How to measure it?

- **The idea is to weigh a <u>rigid Casimir</u> cavity when the vacuum energy is modulated by changing the reflectivity of the plates.**
- **High Tc layered superconductors as natural multi Casimir-cavities**
- **High variation of Casimir energy at the transition → Taking advantage from the fact that in normal state the plane (that will become superconducting) is a very poor conductor**

The Vacuum Weight

- **The Casimir effect is a <u>macroscopic</u> manifestation of vacuum fluctuations.**
- **If the vacuum «weights» then there is a force, directed upward, equal to the weight of the modes expelled from the cavity when it becomes superconducting.**



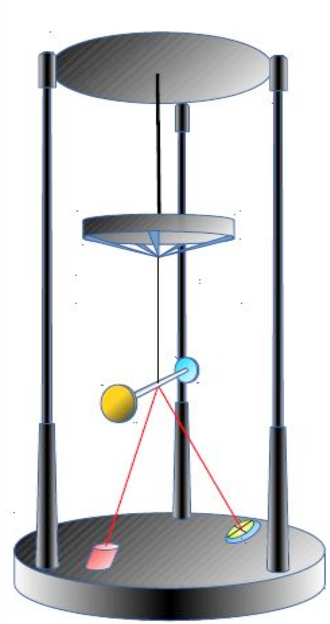
$$\vec{F}_{tot} = \frac{|E_C|}{c^2} g \ \hat{z}$$

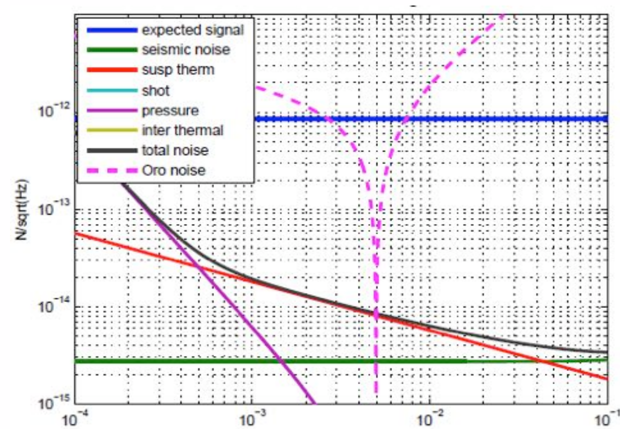
E_c :Casimir Energy

Expected force 10^{-16} N

The Experiment

- **Seismically isolated balance**
- **Temperature modulation around Tc**
- **Balance tilt possibly read with an optical lever**





Signal and Sensitivity for Archimedes)

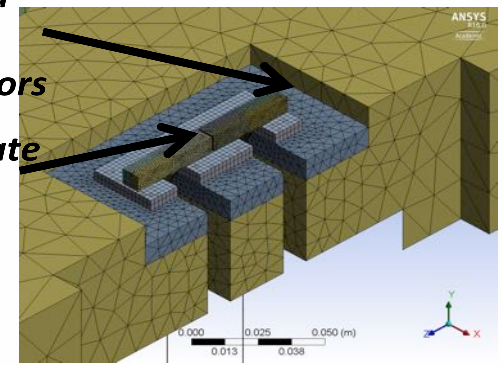
The Advanced Virgo monolithic fused silica suspension

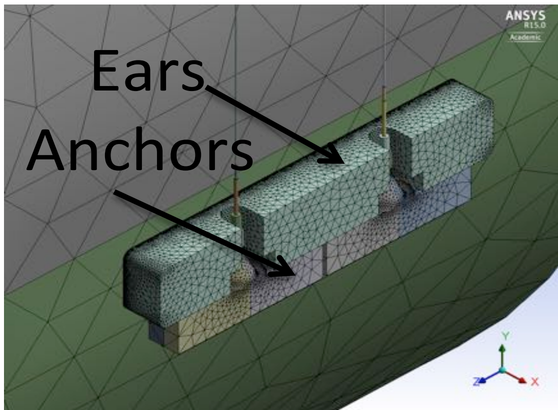
P. Puppo[3] for the monolithic suspension team
INFN Roma

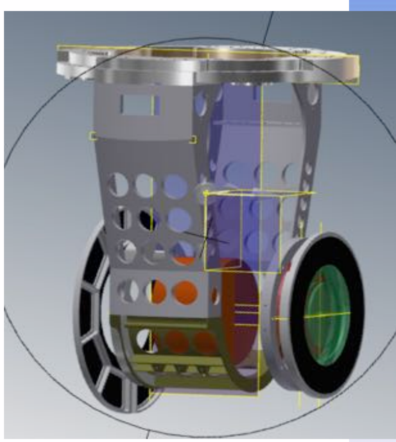
Monolithic suspensions of the Advanced Virgo Mirror

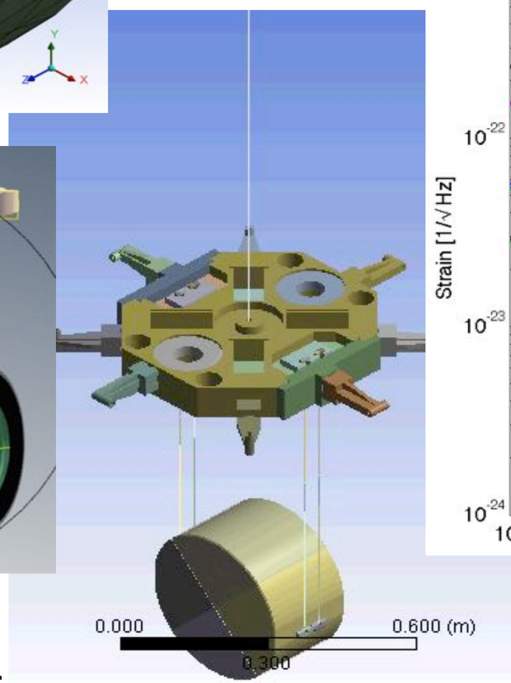
- Double pendulum system;
- 40 kg mirror suspended with fused silica fibers;
- new wire clamping with the upper stage, silica-steel interface at the level of the upper stage;
- new ears and wire upper and lower T-clamps;

Upper Clamps

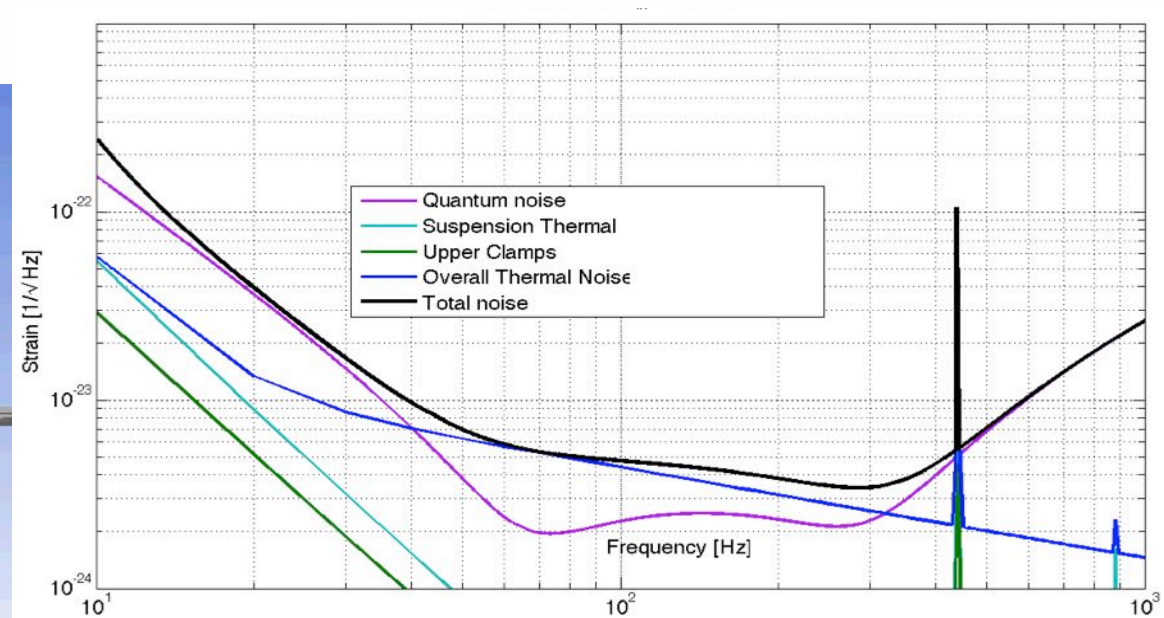








Thermal Noise Calculation with FEM



The mirror and suspension thermal noise calculated with FEM (blue) is compared with the Advanced Virgo sensitivity curve (black).

Details in the poster

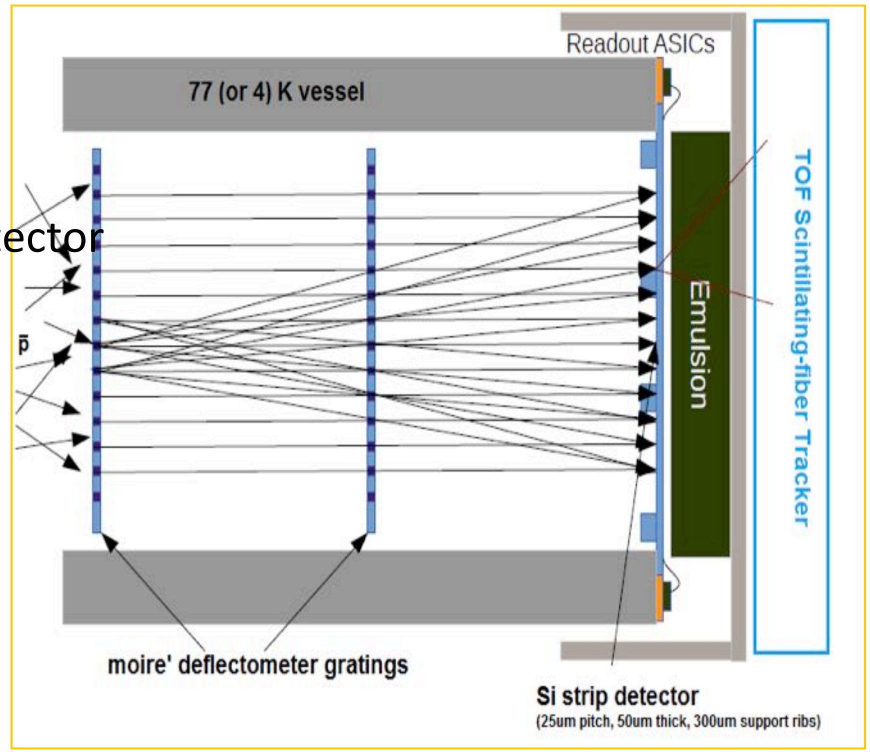
Test of Weak Equivalence Principle on Antimatter in AEgIS

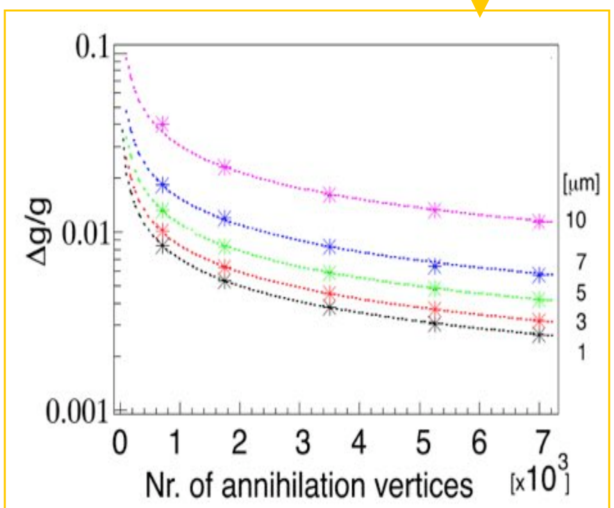
Daniel Krasnický (on behalf of AEgIS collaboration [1])
INFN - Sezione di Genova, Via Dodecaneso 33, 16146 Genoa, Italy
Istituto Nazionale di Fisica Nucleare

AEgIS is an experiment located at the Antiproton Decelerator at CERN whose goal is to measure gravitational acceleration *g* of cold antihydrogen to 1% precision.

We show:

- The experiment overview
- The detector scheme for the gravity measurement
- The importance of a micron precise pos. sensitive detector
- Use of nuclear emulsions in vacuum for high precision annihilation vertex measurement





Test of Weak Equivalence Principle on Antimatter in AEgIS

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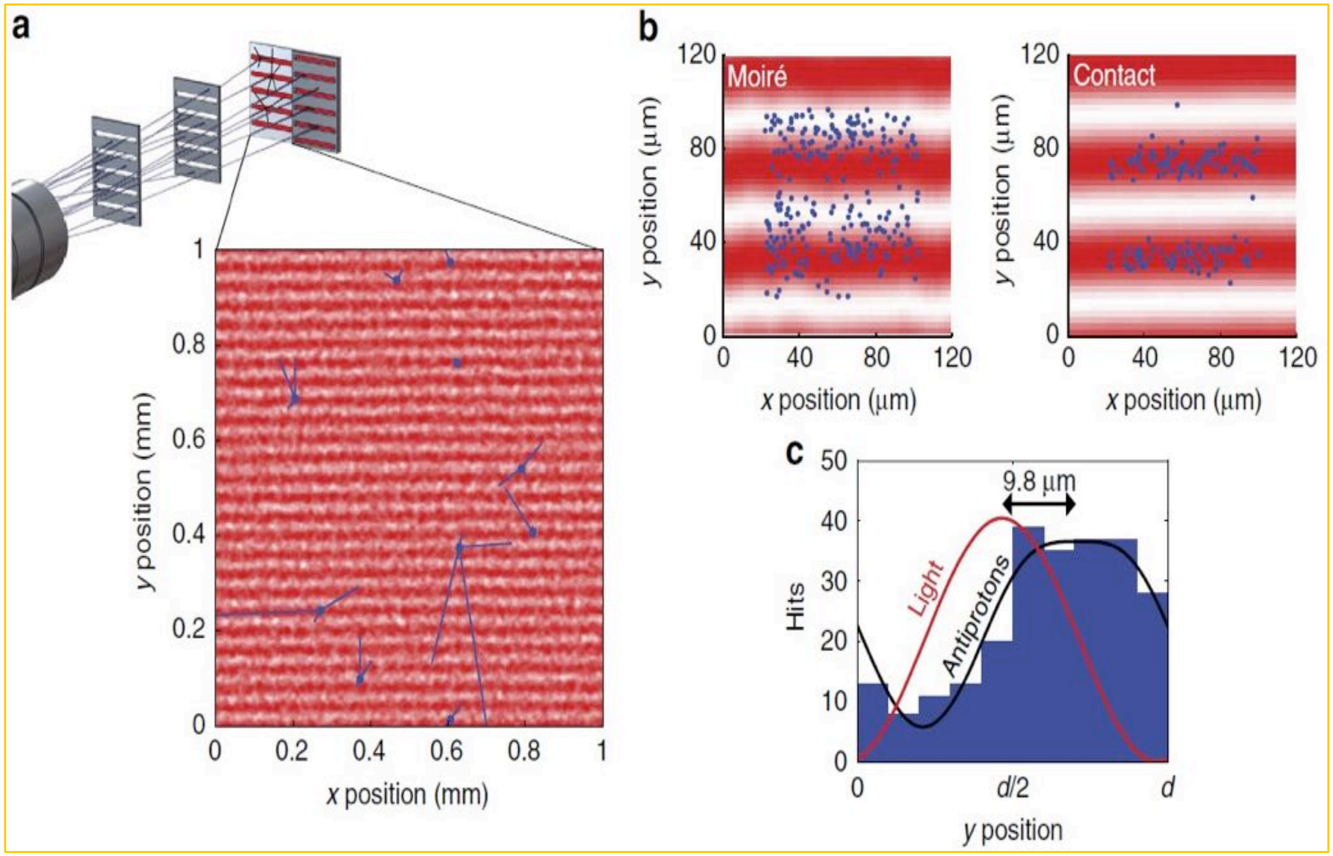
INFN - Sezione di Genova, Via Dodecaneso 33, 16146 Genoa, Italy

Istituto Nazionale di Fisica Nucleare

Proof-of-principle measurement of Lorentz force on antiprotons

- Nuclear emulsion was coupled to two small moiré deflectometer gratings with 40μm grating pitch
- Slow (100keV) antiproton beam passed through the deflectometer
- A Lorentz force of the order of 500aN was measured by observing a 9.8 μm shift of the antiproton pattern with respect to an undeflected light pattern.



Possible usage of Cherenkov photons to reduce the background in a ^{136}Xe neutrinoless double-beta decay experiment

S. Dussoni and G. Signorelli
INFN Sezione di Pisa, Largo B. Pontecorvo 3, 56127 Pisa, Italy

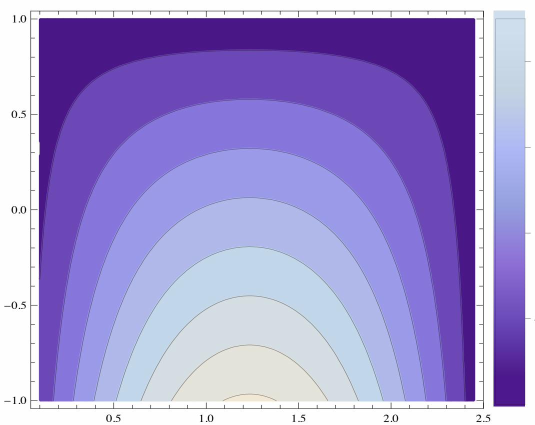
The main background to ^{136}Xe nutrinoless double-beta decay (0νββ) is the signal from Compton scattering of photons with energy around the decay end point at 2.458 MeV.

This can be reduced by self-shielding. Another proposed method is tagging the daughter barium nucleus. This is an extremely challenging task and, although feasible, presently suffers from very low efficiency.

Xenon scintillates at 178 nm (VUV) but liquid xenon is extremely transparent to ultra violet light.

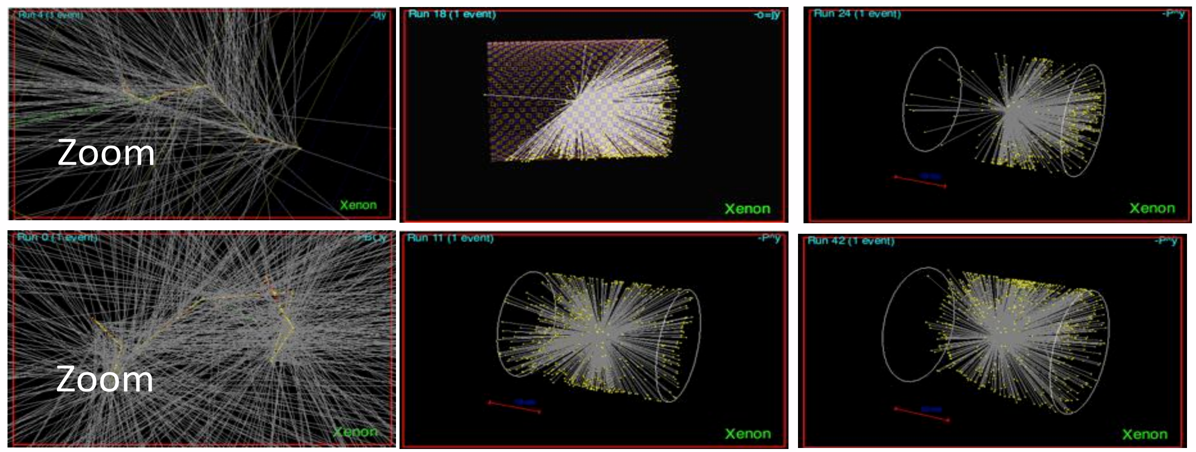
We studied the possibility to distinguish 1-electron Compton background from 2-electron 0νββ by combining scintillation and Cherenkov light amount (2 electrons go below threshold faster) and topology (two electron events are more symmetric).

The energy-angle distribution of the 0νββpair peaks at Q/2 and 180°

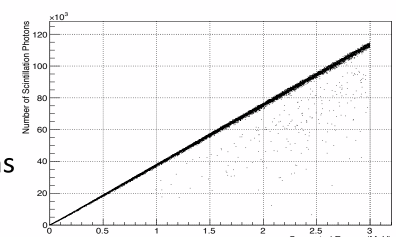


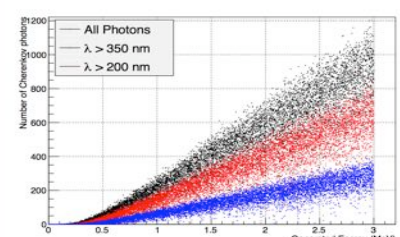
One electron event

Two Electrons event

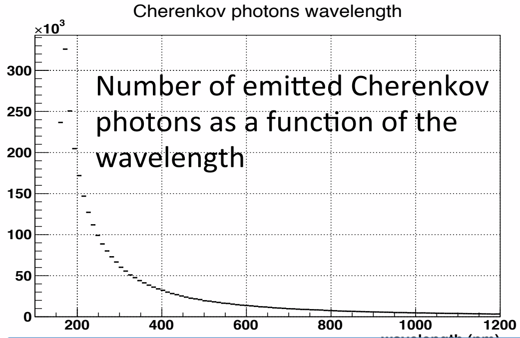


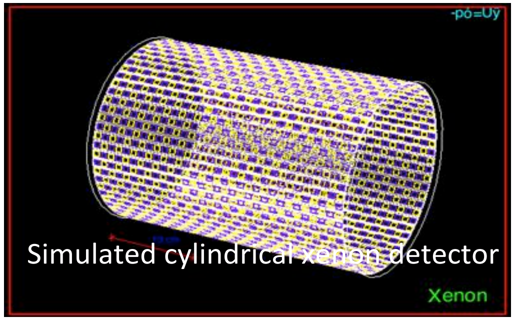
Scintillation yield and Cherenkov yield with different detector wavelength threshold. Cherenkov light is much less but can be enhanced by integrating only prompt photons

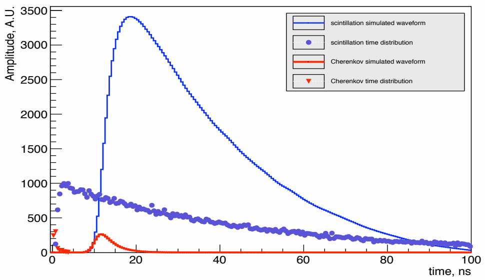




A simple simulation of a cylindrical detector read out by alternating SiPM sensitive to scintillation or cherenkov light only show that in a 2D plane one electron and two electron events cluster in different regions.



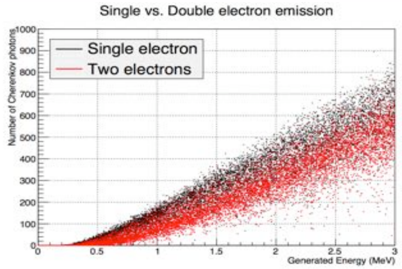


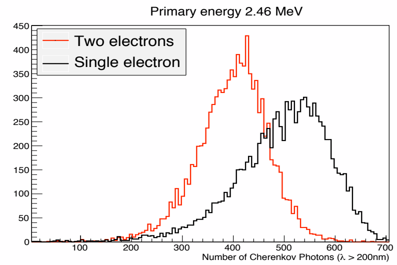


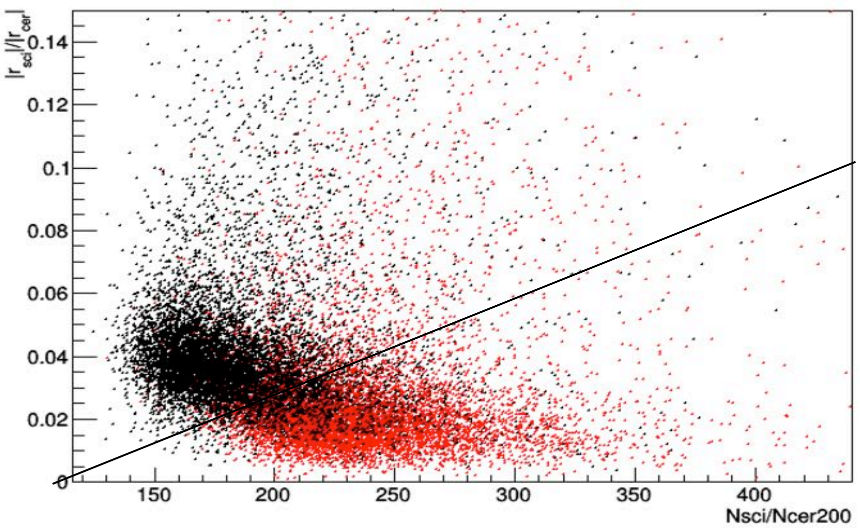
Simulation of Cherenkov (red) and scintillation (blue) light time structure before and after being detected by a SiPM

Cherenkov vs scintillation yield and topology

The plots below show the difference in Cherenkov light yield above 200 nm for one and two electrons cases. In the 2D plot a simple topological variable (the ratio of the centroid of Cherenkov vs scintillation light) is plotted against the ratio of scintillation/Cherenkov emitted photons. It is clear that a cut in this plane is effective in distinguishing the signal from the background.





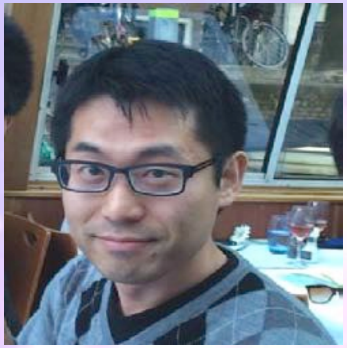


The background from a single site Compton electron has both more Cherenkov light and a less symmetric shape.
The cut in figure, for instance, retains 75% of the signal events by rejecting 90% of the background

Phase camera experiment

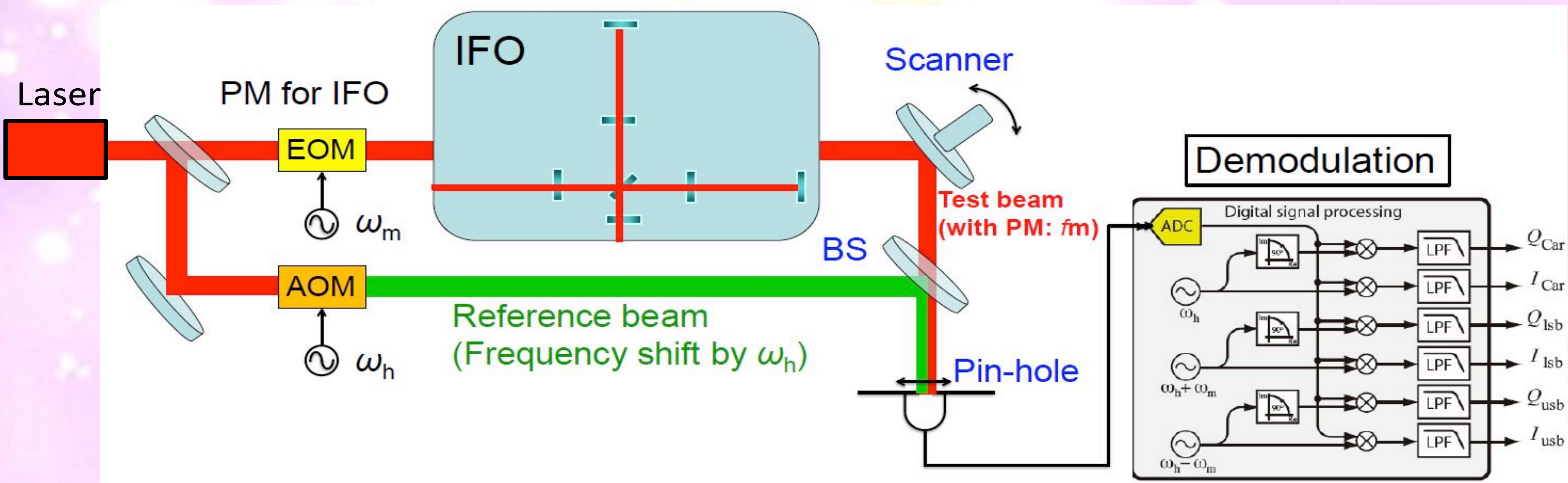
(for Advanced Virgo)

Kazuhiro Agatsuma, Martin van Beuzekom, Mesfin Gebyehu, Laura van der Schaaf, Jo van den Brand

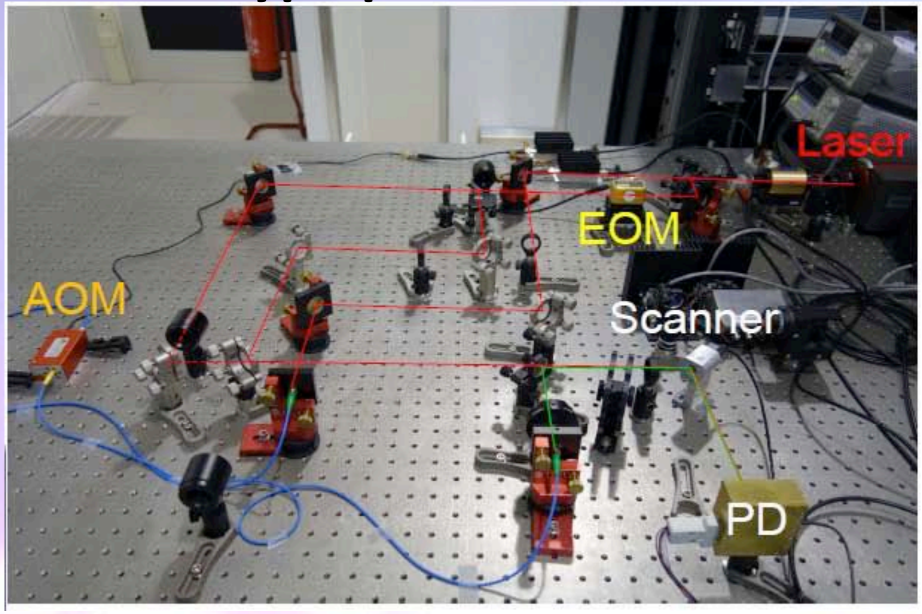


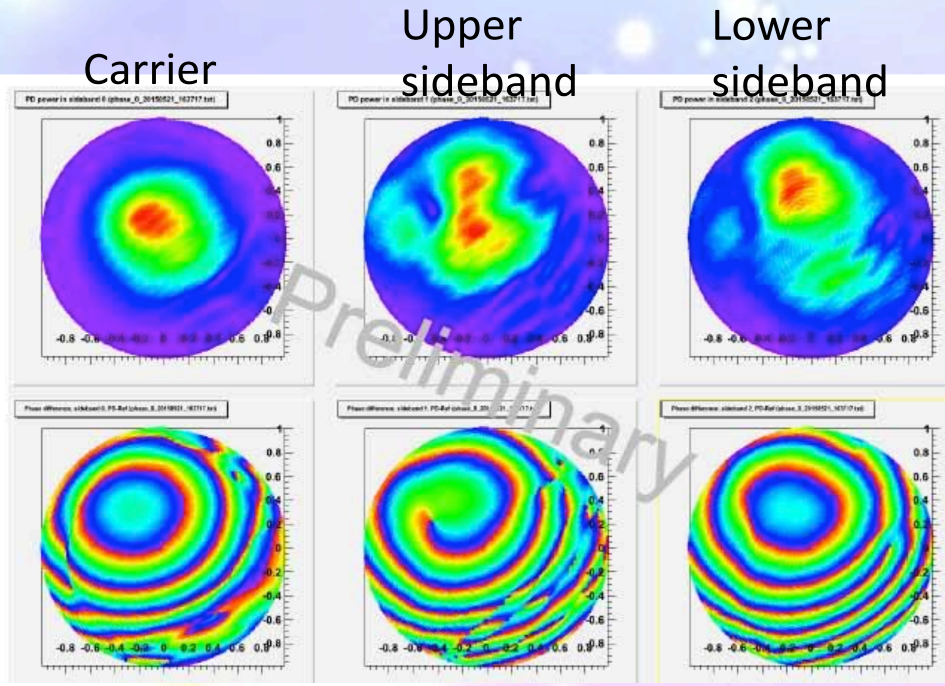
We report on a **frequency selective wave front sensor** used for monitoring **sidebands** and **aberrations** in a gravitational wave detector

- Heterodyne detection
- Scanning wave front with pin-hole PD



●Prototype phase camera



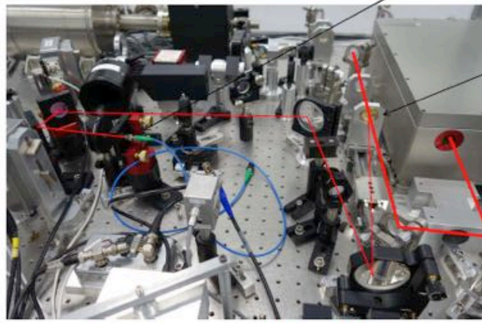


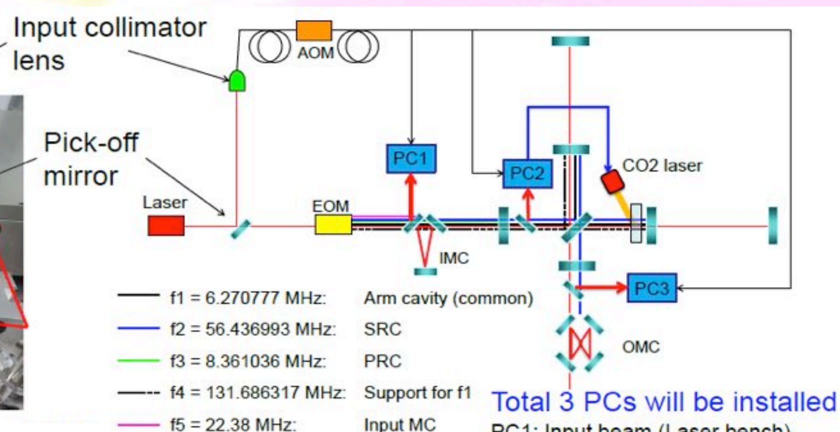
We have developed a prototype phase camera and are checking integrated performance

Expected sensitivity is better than 2 nm

●Installation in Advanced Virgo

Advanced Virgo
is a gravitational
wave detector in Pisa





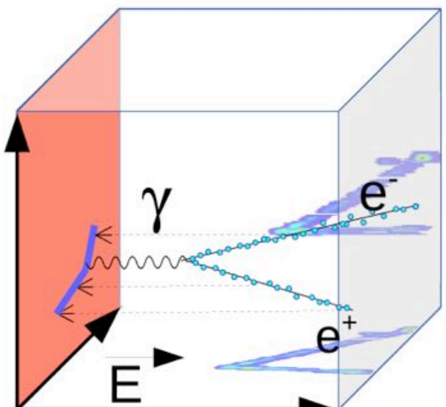
Total 3 PCs will be installed
PC1: Input beam (Laser bench)
PC2: Power recycling cavity (EPRB)
PC3: Output beam (EDB)

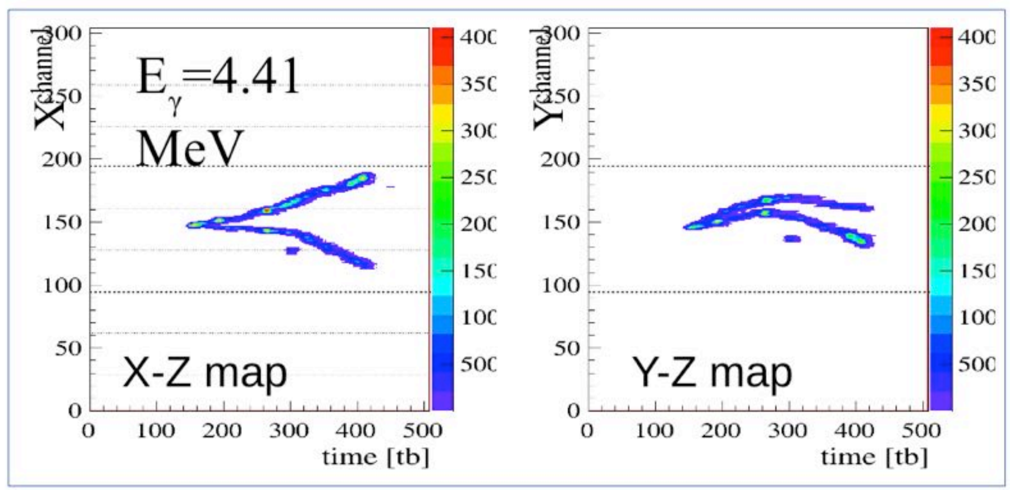
We have just started to install optics

Measurement of a polarised γ ray beam 1.7 to 74 MeV with the HARPO TPC

- HARPO: **TPC** as a **gamma-ray** telescope and **polarimeter** in space
- Tracking e^+e^- pairs converted in 2bar gas
- Tested in polarised photon beam 1.7 to 74MeV

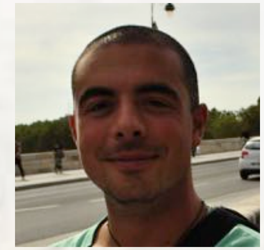
- **First beam data**





Experimental study of breakdown electric fields in liquid argon

Roberto Acciarri - Fermilab



- Study of breakdown electric field in liquid argon as a function of argon electronegative contamination level, cathode-anode distance and electrode size.
- Motivation: dielectric strength of liquid argon not precisely determined, yet its value is crucial for the design of the next generation liquid argon neutrino and dark matter detectors.
- An electrode sphere-plate geometry was implemented using spheres with diameters of 1.3 mm, 5.0 mm, and 76 mm.
- The cathode–anode distance was varied from 0.1 mm to 25 mm.
- Each set of measurements was repeated at different liquid argon contamination levels, ranging from 1.5 parts-per-million of O_2 equivalent to less than 100 parts-per-trillion.

Breakdown test setup

Feedthrough

Delivers up to -150 kV to the probes

Translator

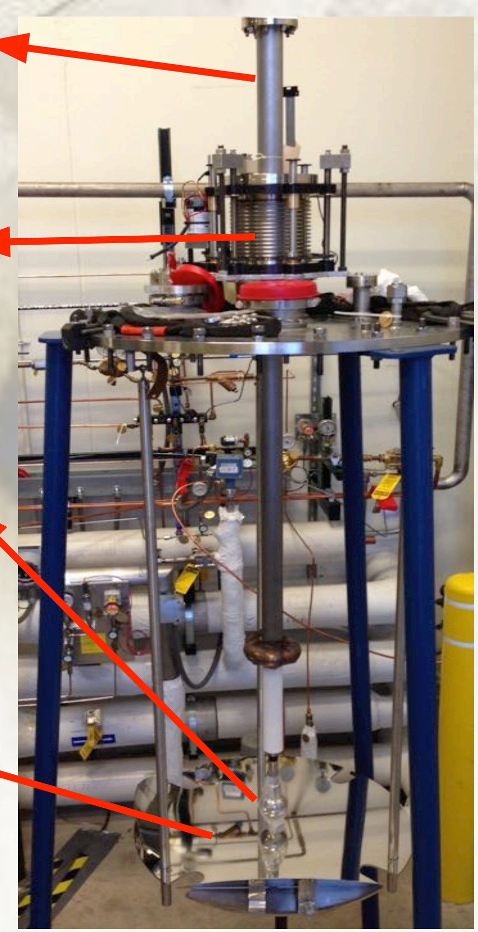
Regulates cathode-anode distance

Cathode

Three swappable spherical probes of different diameter

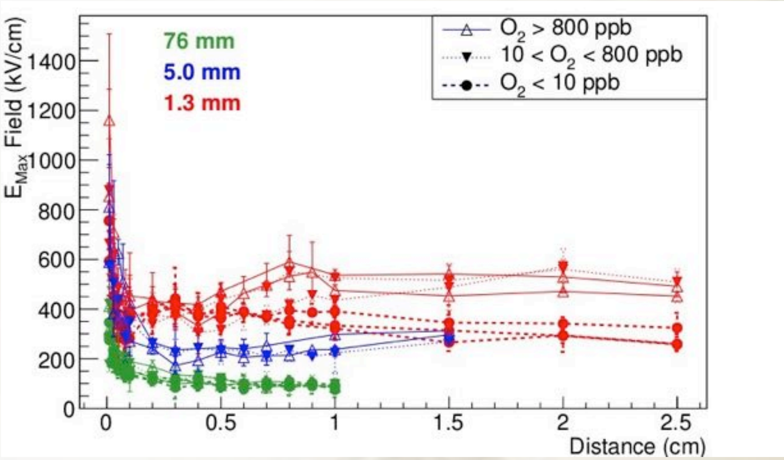
Anode

74 cm diameter grounded plate



(some of the) Results

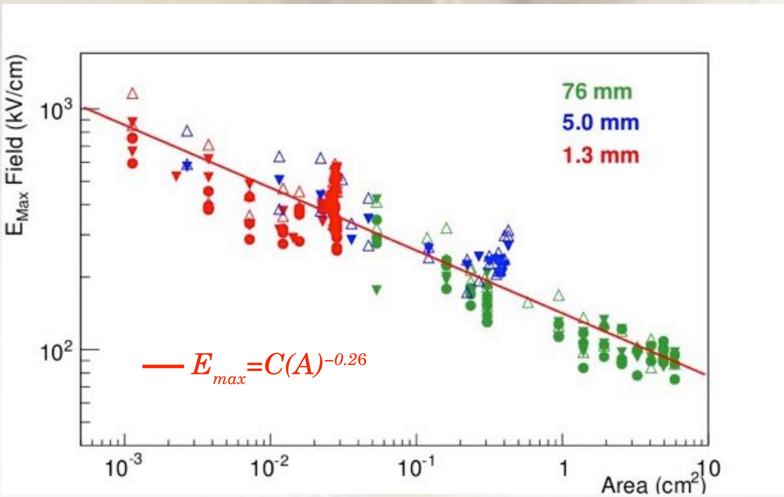
Average breakdown E-field



- ✔ A dependence of the breakdown E-field on liquid argon electronegative contamination level is mostly evident with the 1.3 mm probe. Similar dependence is not clearly visible for the other probes.
- ✔ A stronger dependence of the E field on the probe size becomes evident when comparing these results with studies present in literature, conducted at a variety of argon contamination levels and electrode sizes (*relative plot present in the poster*).

E-field vs stressed cathode area

- ✔ Defining <u>*stressed cathode area*</u> as the area of the probe with E-field above 80% of the max E-field, a clear dependence of the breakdown E-field on the stressed area is observed for all the probes.
- ✔ This is the first time such dependence is shown for liquid argon.
- ✔ The observed geometric effects are of critical importance in the design of LArTPC detectors for future neutrino experiments, where drift distances on the scale of meters are required.



Evaluation of PMT Candidates for CTA

Max-Planck-Institut für Physik (Werner-Heisenberg-Institut)

ICRR Institute for Cosmic Ray Research University of Tokyo

cta cherenkov telescope array

KONAN

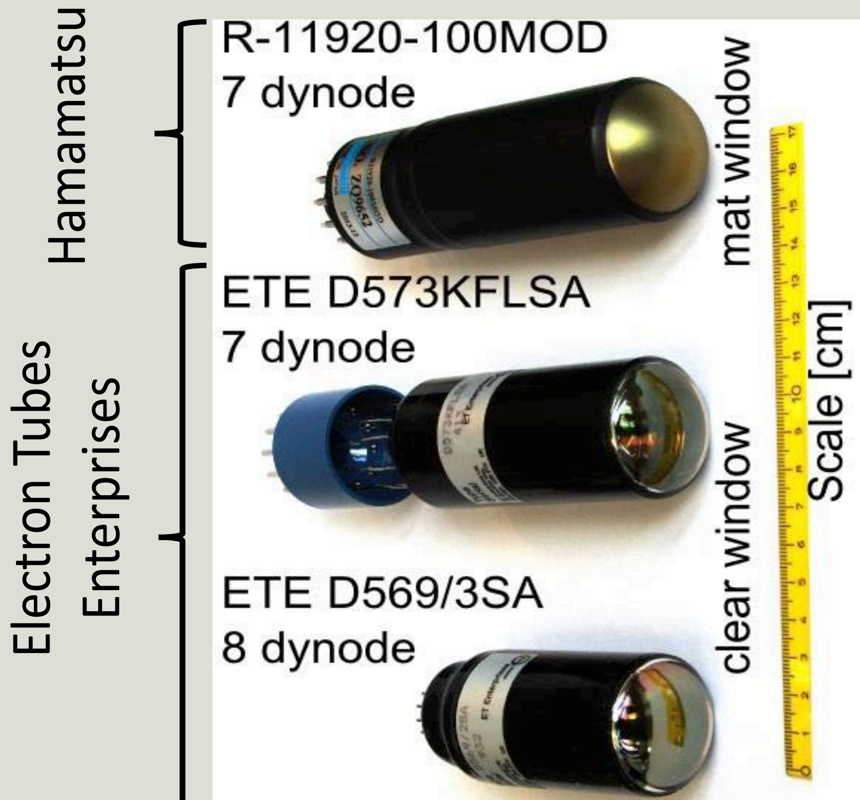
Presenter: Dominik Müller
dmueller@mpp.mpg.de

CTA requirements for PMTs:

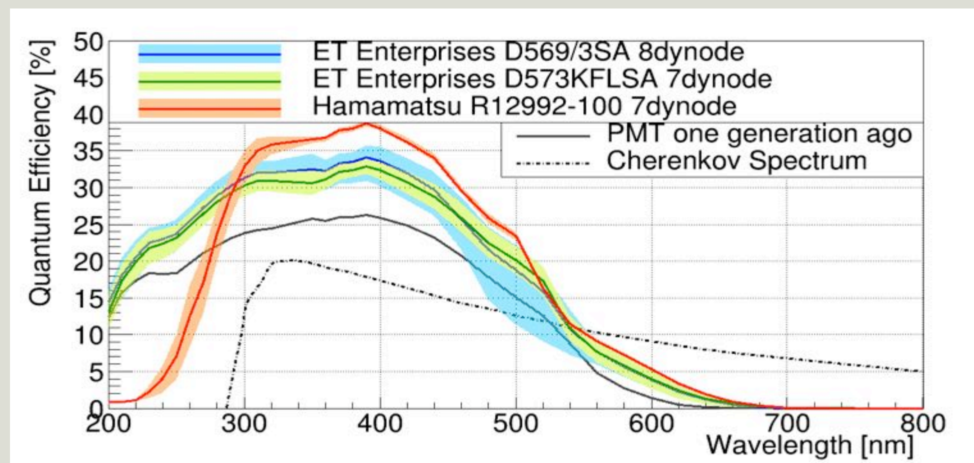
- High Quantum Efficiency
- High Photoelectron Collection Efficiency
- Short Pulse Width
- Small Transit Time Spread
- Low After Pulse Probability

→ High Sensitivity & Low Threshold Energy for γ-rays

Tested PMT Candidates:



Quantum Efficiency measurement:



Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

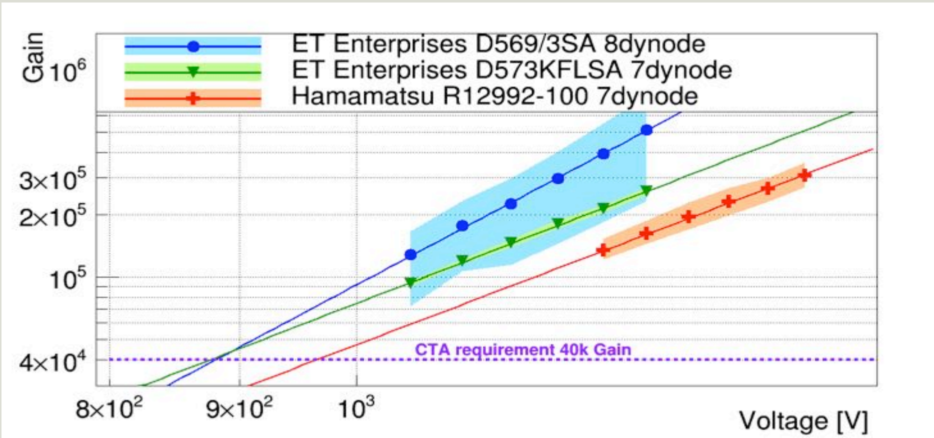
Evaluation of PMT Candidates for CTA

ICRR Institute for Cosmic Ray Research University of Tokyo

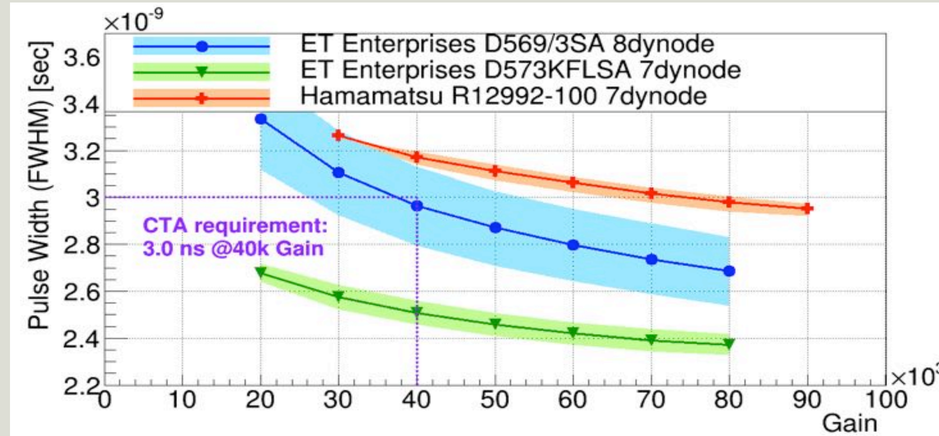
cta cherenkov telescope array

KONAN

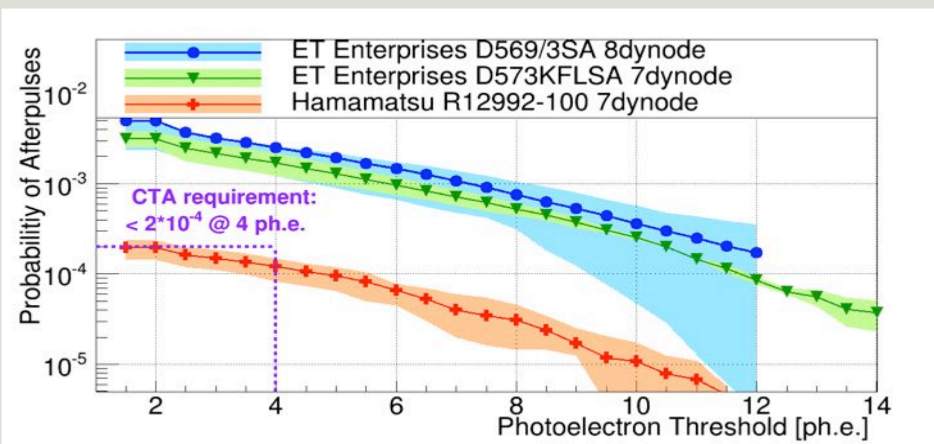
Gain Measurement:



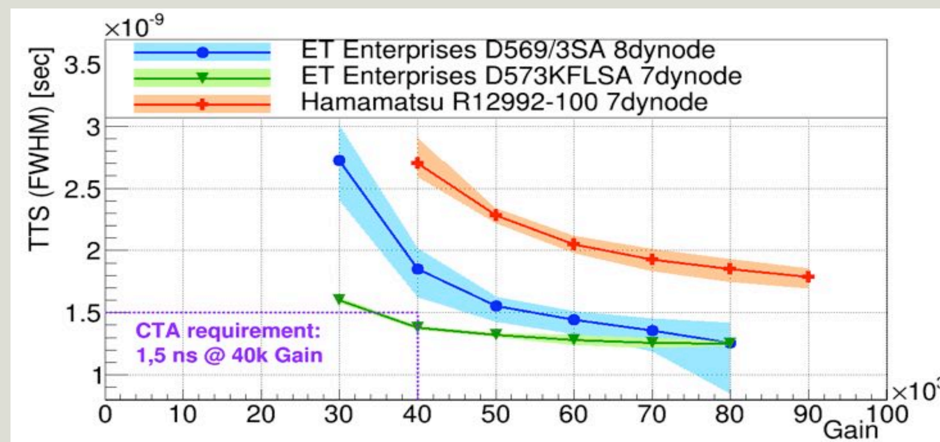
Pulse Width (FWHM of Signal):



Probability of Afterpulses:

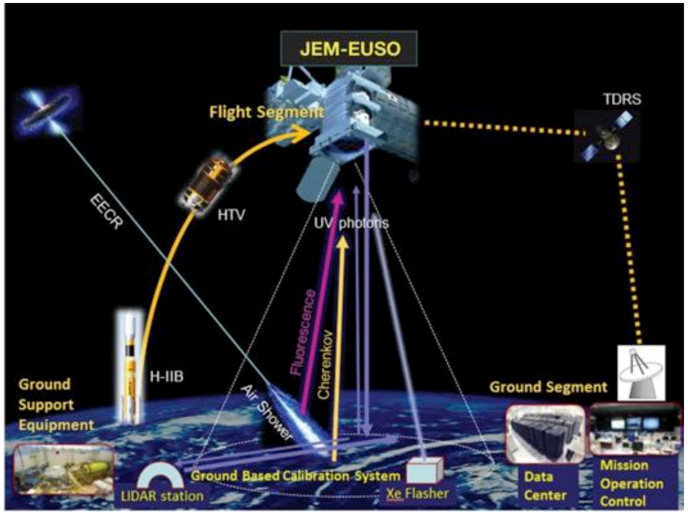


Transit Time Spread:



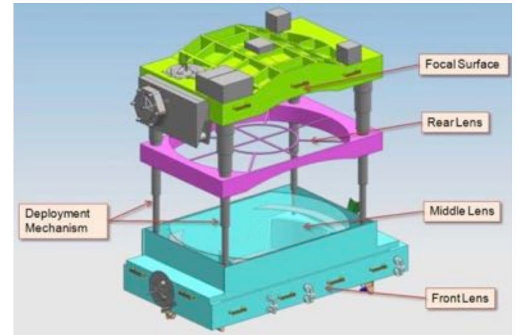
EUSO-Balloon: the first flight

V. Scotti* and G. Osteria*
for the JEM-EUSO collaboration
* INFN of Naples



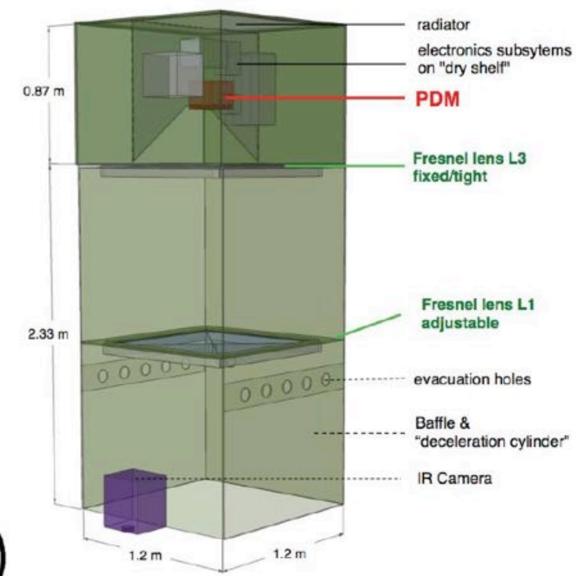
JEM-EUSO is a new type of observatory which aims to study the Extreme Energy Cosmic Rays, EECR (**E > 5×10^{19} eV**), which are the most energetic component of the cosmic radiation.

JEM-EUSO telescope will observe fluorescence and Cherenkov **UV** photons generated by Extensive Air Showers (EAS) created by EECR.



EUSO-Balloon is a pathfinder mission developed by the JEM-EUSO collaboration: a balloon-borne instrument designed to fly to an altitude of 40 km.

- Technology demonstrator: full scale test of JEM-EUSO's key technologies
- Trigger studies
- UV background studies
- Observation of artificial calibrated sources
- 1st detection of EAS by looking down from the edge of space



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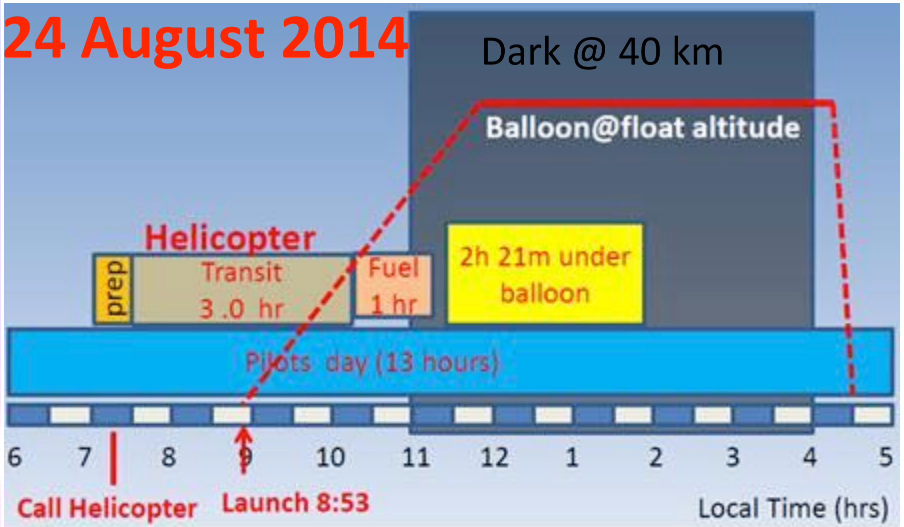
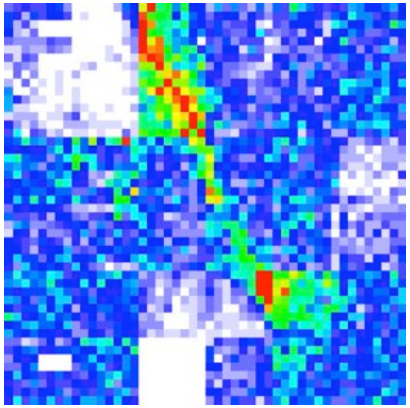
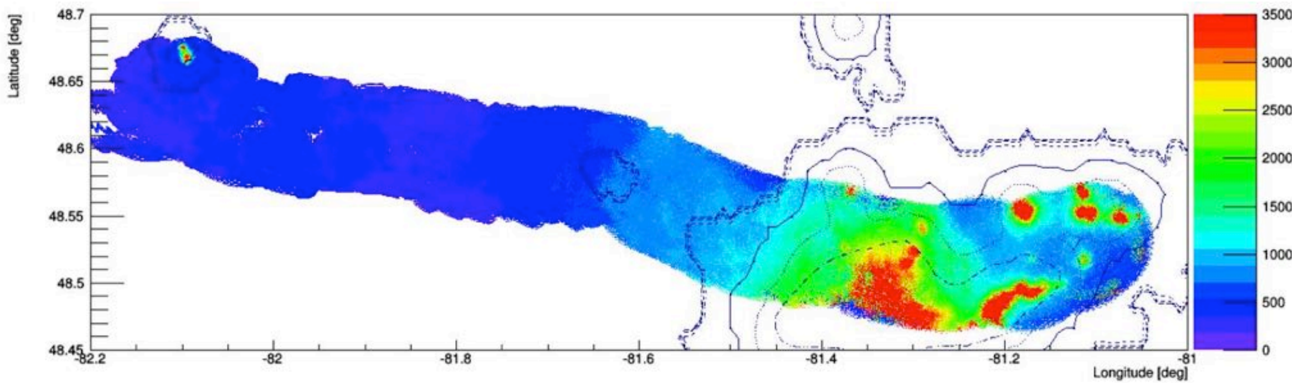


The time schedule of the balloon flight



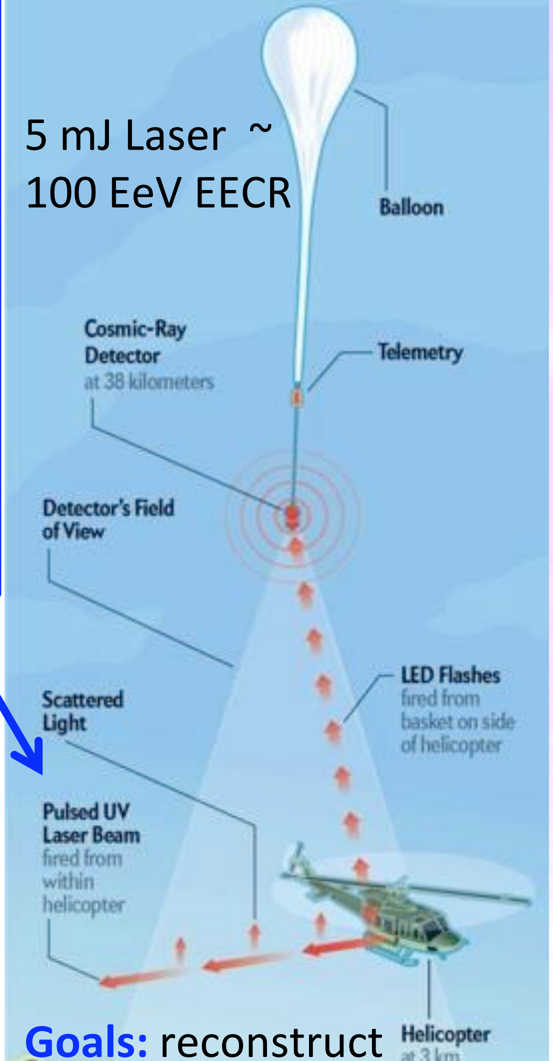
A laser track reconstructed by the instrument



Preliminary measured UV background map compared with the positions of man-made visible lights observed by satellites

UV in flight calibration

5 mJ Laser ~ 100 EeV EECR



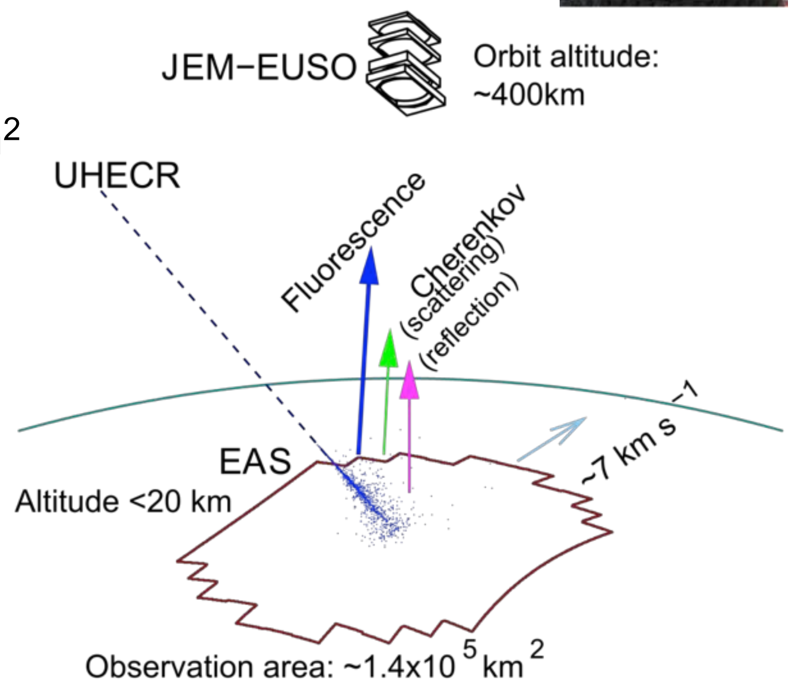
Goals: reconstruct laser energy and direction, monitor sensitivity to EASs

EUSO-TA prototype telescope

Francesca Bisconti for the JEM-EUSO Collaboration

JEM-EUSO experiment

- Designed for the International Space Station
- First instrument able to observe an area ~10^5 km^2
- Full-sky observation



Scientific objectives

- Detection of UV photons of fluorescence and Cherenkov light from extensive air showers
- A high statistics measurement of the trans-GZK spectrum
- Identification of sources and source regions

JEM-EUSO prototypes

- **EUSO-Balloon**
  30 km altitude, first flight from Timmins, Canada in August 2014
- **EUSO-TA**
  Telescope Array site, Utah (USA)
  First campaigns in March and May 2015

EUSO-TA prototype telescope

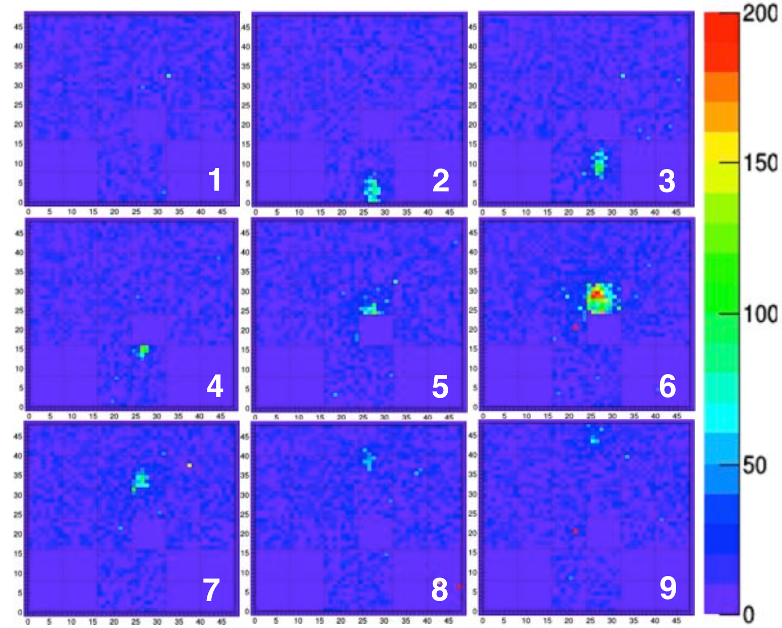
Francesca Bisconti for the JEM-EUSO Collaboration

Karlsruhe Institute of Technology

EUSO-TA objective

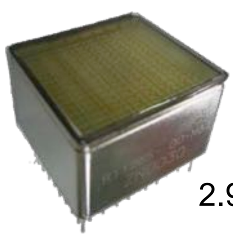
Validation of the JEM-EUSO prototype

- Calibration with Central Laser Facility and Electron Light Source
- Cross-calibration with TA fluorescence detectors through comparison of noise and signal
- Observation of extensive air showers triggered by TA

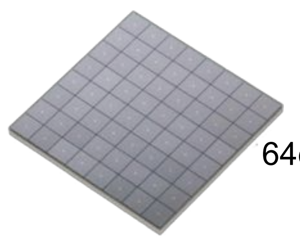


Laser shot from the Central Laser Facility of TA.
One image/GTU (2.5 μs)

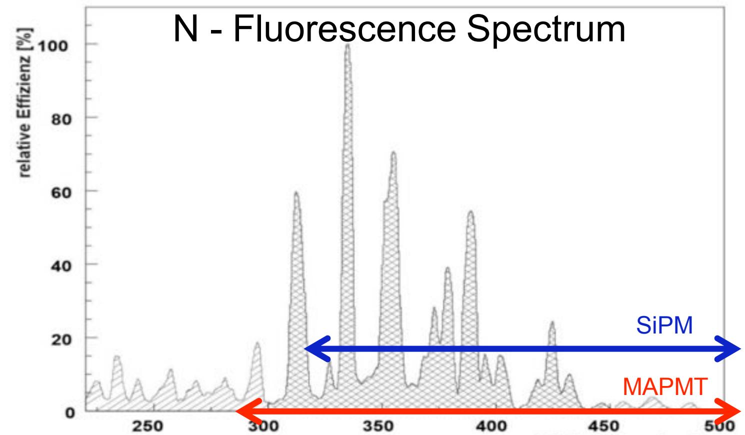
Sensors for the Photon Detection Module



64ch MAPMT
2.9x2.9 mm^2 /ch



64ch TSV SiPM
3x3 mm^2 /ch



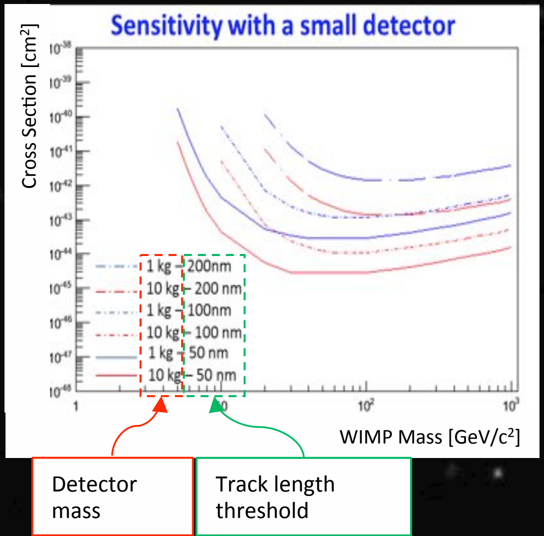
AUGER Design Report 1997

Current sensor MAPMT
or new generation SiPM?

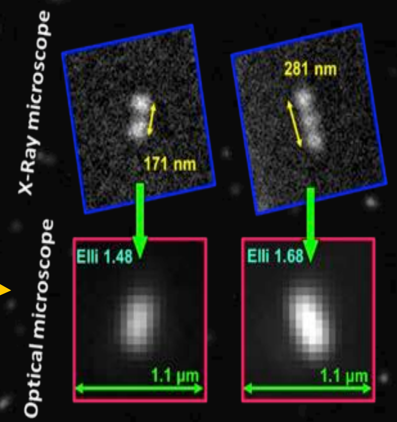
Development of a super-resolution optical microscope for directional Dark Matter search experiment

Andrey Alexandrov (INFN-Napoli) on behalf of the NEWS collaboration

- NEWS – **N**uclear **E**mulsion **W**imp **S**earch experiment will use a novel technique for DM search with a capability of detecting the directionality of recoils

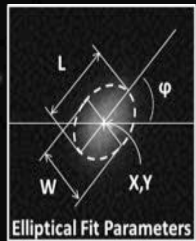


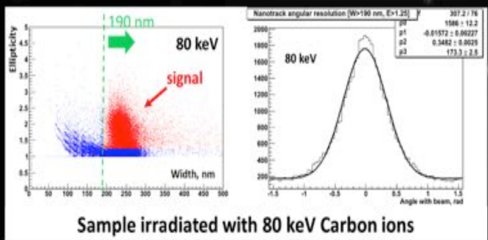
- Nuclear emulsion advantages:
  - High density, ~4 g/cm^3 (acts both as a target and a tracking detector)
  - Extreme spatial resolution (limited by a crystal size, few tens of nm)
  - No electronics is required in target area during the exposure
- Nano Imaging Tracker (NIT) - new emulsion type available:
  - Extremely low fog level (the number of thermally excited crystals)
  - Not sensitive to electrons
  - 20 nm crystal size, ~29 crystals/µm – under testing
- The goal of the presented R&D is to build a microscope capable of detecting 100nm-long recoil tracks in NIT emulsions and measuring their direction
- Problem: resolution of optical microscopes is limited by diffraction (to approx. 200 nm) –> Grains are not resolved and a track is seen as a single spot (a cluster)

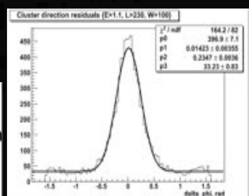


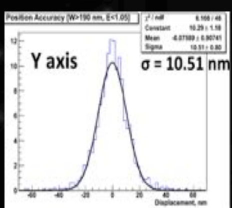
Development of a super-resolution optical microscope for directional Dark Matter search experiment

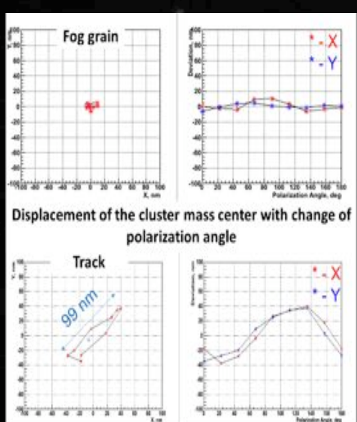
Andrey Alexandrov (INFN-Napoli) on behalf of the NEWS collaboration



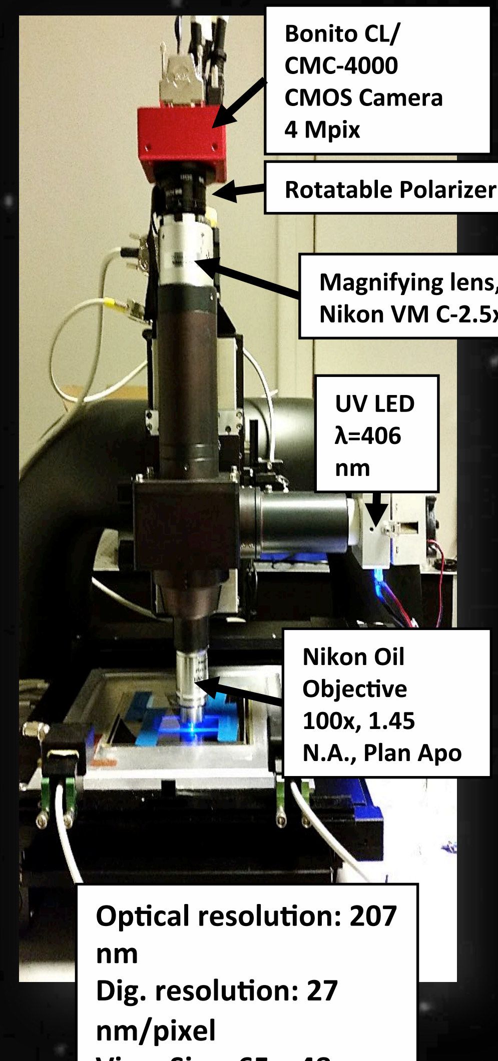








- Though the individual grains are not resolved the track's shape becomes elliptical while images of fog grains remain circular
- Use elliptical fit to detect direction and select track candidates
- Angular resolution by elliptical fit = 235 mrad = 13°
- Developed Ag grains are not spherical -> scattered light is polarized -> grain brightness changes with polarizer rotation
- Position accuracy = 10.5 nm
- By analyzing images of one and the same track under different polarization angles it is possible not only distinguish tracks from fog grains but also to isolate individual grains inside the track!
- **With the use of Elliptical Fit and Polarization Analysis the detection of 100nm-long tracks is possible!**



A simple technique for gamma ray and cosmic ray spectroscopy using plastic scintillator

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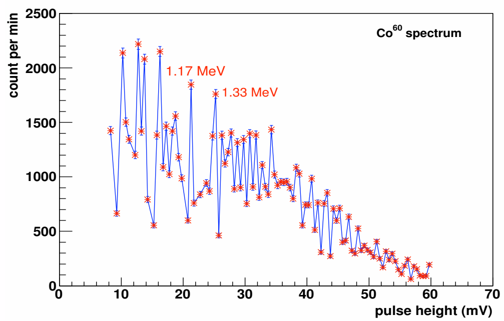
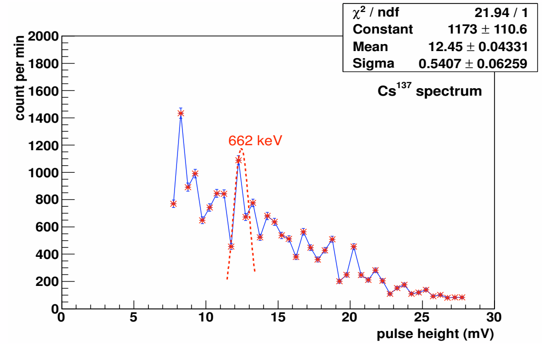
Summary

- **Gamma ray and cosmic ray muon pulse height spectroscopy has been done without using SCA or MCA.**
- **Only scintillator detector, a leading edge discriminator and a NIM scaler have been used in this technique.**
- **Gamma ray spectrum has been obtained for Co^{60} and Cs^{137} sources.**
- **Proportionality in energy and pulse height has been observed.**
- **The energy resolution for the detector has been found to be 9.3% and 7.6% for the Co^{60} 1.17 MeV and 1.33 MeV peak respectively and 10.2% for 662 keV peak of Cs^{137}.**
- **Cosmic ray spectrum has been obtained and fitted with Landau distribution.**
- **MPV increases exponentially with applied voltage to the PMT.**
- **Although the energy resolution is not so good but still using plastic scintillator detector gamma spectroscopy and cosmic ray muon pulse height spectroscopy can be done. Main drawback of this technique is that this process is time consumable and may not be useful for real experiment; however, this process is very useful and can be applied for laboratory measurement where MCA or SCA are not available.**

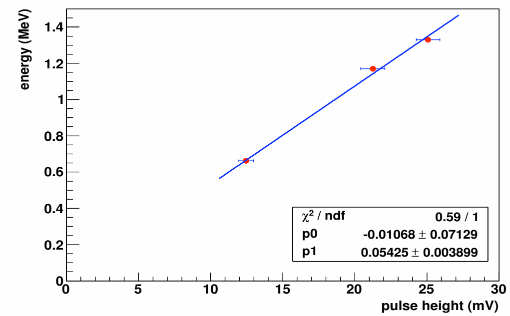
Results



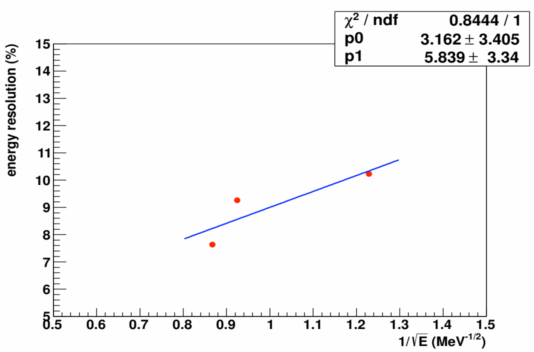
Co^{60} spectrum, a curve of count per minute as a function of pulse height



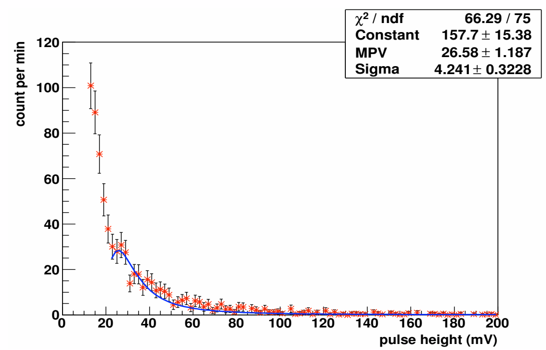
Cs^{137} spectrum, a curve of count per minute as a function of pulse height



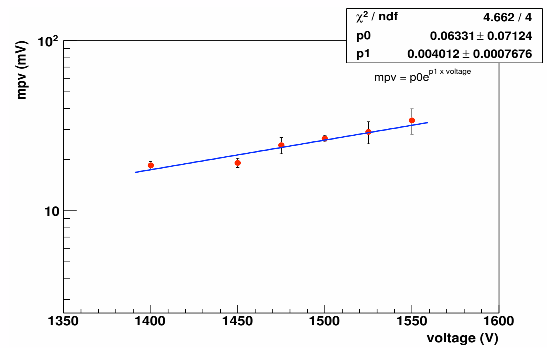
Energy vs. pulse height Calibration curve



Energy resolution as a function of 1/√E



Cosmic ray spectrum



MPV as a function of the applied voltage.

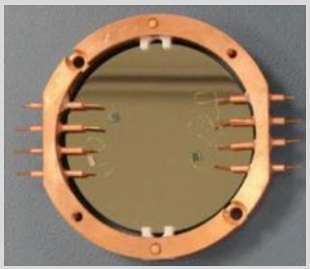
A scintillating bolometer array for double beta decay studies: the LUCIFER experiment

Luca Gironi on behalf of the LUCIFER collaboration

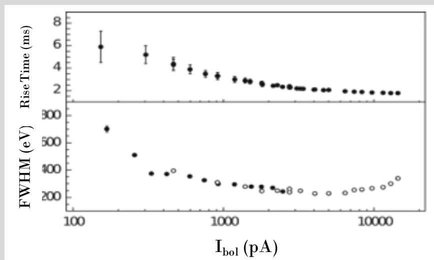
The Low-background Underground Cryogenics Installation For Elusive Rates (LUCIFER)

The LUCIFER setup will consist of an array of 30 individual module detectors, arranged in a tower-like structure installed underground in the Laboratori Nazionali del Gran Sasso. Each module will be composed by a ~0.5 kg enriched (95%) ZnSe scintillating crystal equipped with a Ge-crystal light detector operated as bolometers at ~10 mK. The goal of Lucifer is to reach sensitivity of few 10^{25} y for the search of the neutrinoless double beta decay and to be a demonstrator for a background free experiment.

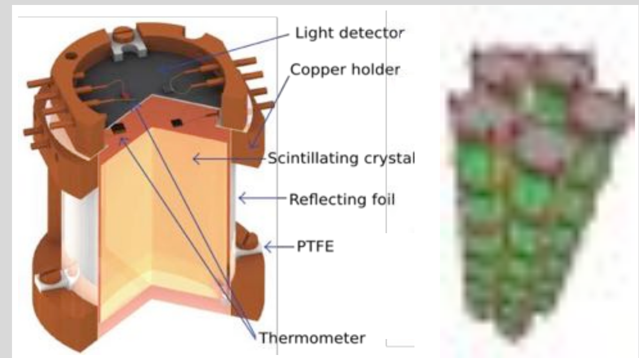
Light Detectors



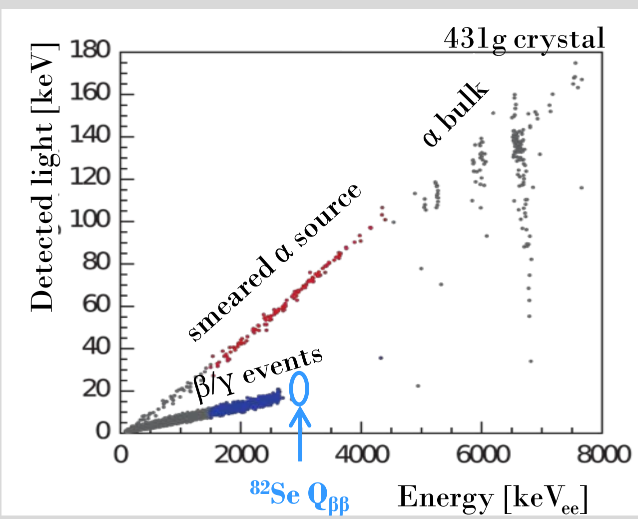
Ø=44.5 mm, h=0.175 mm

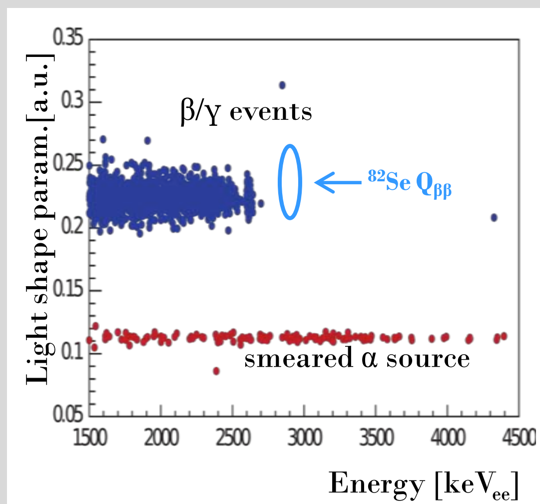


Performances as a function of the sensor polarization current.



ZnSe crystal





Isotope	Q-value	i.a.
^{82}Se	2996 keV	8.7 %

The light emitted and the shape of the same light pulses are reported as a function of the energy released in the ZnSe bolometer. A γ-source was used to produce events (blue) up to 2615 keV (^{208}Tl) while a smeared α source was placed under the crystal to provide a continuum of α's extending to lower energies (red).

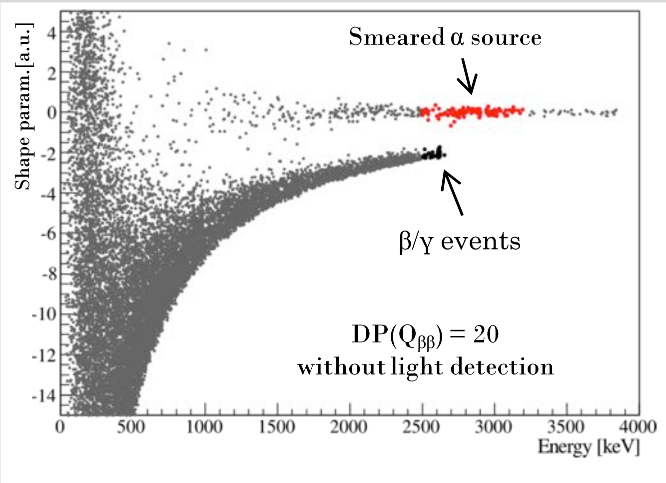
A scintillating bolometer array for double beta decay studies: the LUCIFER experiment

Luca Gironi on behalf of the LUCIFER collaboration

ZnMoO4

Successful R&D pursued within LUCIFER with Mo-based compound before choosing ZnSe.

Isotope	Q-value	i.a.
^{100}Mo	3034 keV	9.6 %



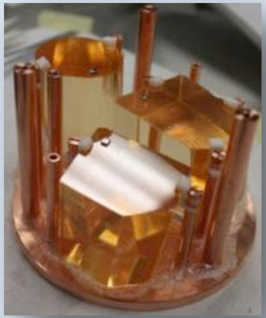
They demonstrate the very appealing possibility to discriminate particle through pulse shape analysis on the heat channel.

↓

Background reduction without a double readout.

2νDBD of ^{100}Mo

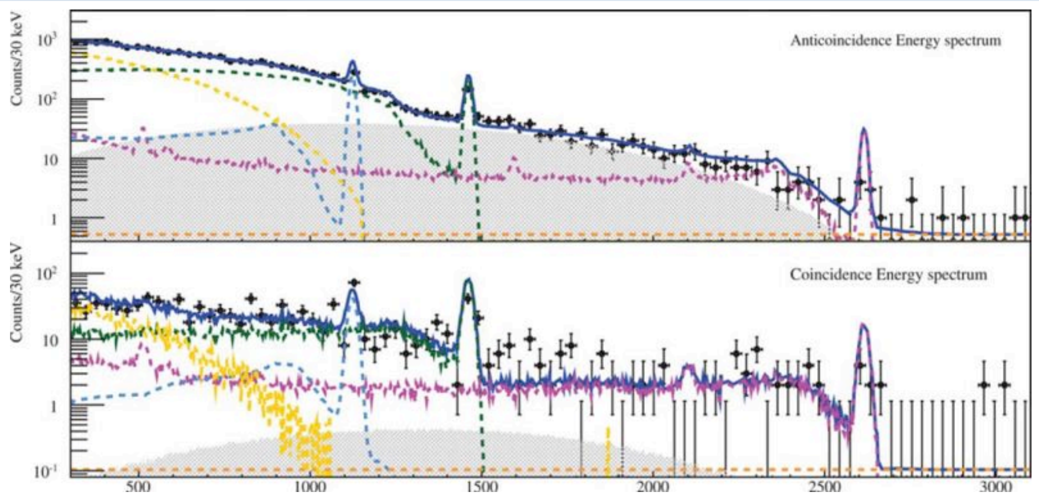
The large statistics collected during the operation of a $ZnMoO_4$ array, for a total exposure of 1.3 kg day of ^{100}Mo, allowed the first bolometric observation of the 2νDBD of ^{100}Mo. The analysis of coincidences between the crystals allowed the assignment of constraints to the intensity of the different background sources, resulting in a reconstruction of the measured spectrum down to an energy of ~300 keV.



$$T_{1/2}^{2\nu}(^{100}\mathrm{Mo}) = [7.15 \pm 0.37\,(stat) \pm 0.66\,(syst)] \times 10^{18}\ y$$

Crystal mass (g)	Anticoincidence	Coincidence
247	509 ± 26	4.4 ± 0.2
235	472 ± 24	5.4 ± 0.3
329	661 ± 34	6.2 ± 0.3

Number of events from the 2νDBD of ^{100}Mo in the anticoincidence spectrum and in the coincidence spectrum for each crystal.



So have a nice poster session !!