Cryogenic/Supeconductive Devices
Poster Session

- Silicon PhotoMultipliers at low-temperature (4 posters)
- Sub-kelvin low temperature detectors and electronics (5 posters)
- Scintillation Physics (4 posters)
- Others more difficult to fit in the previous « categories » (2 posters)

Silicon PhotoMultipliers (SiPM):

- Study on breakdown voltage, quenching resistance and gain from room temperature **down to 50 K** (**Alessandro Menegolli** - Pavia)

- Characterization of SiPM arrays with common bias and common readout for applications **in liquid argon** (**Marta Babicz** - CERN/Cracow)

- Precise measurement of 3D-position of SiPMs **in the liquid xenon** γ ray detector for the MEG II experiment (**Satoru Kobayashi** - Tokyo)

- New developments in Silicon Photomultipliers **for cryogenic applications** (**Giovanni Paternoster** – Trento)

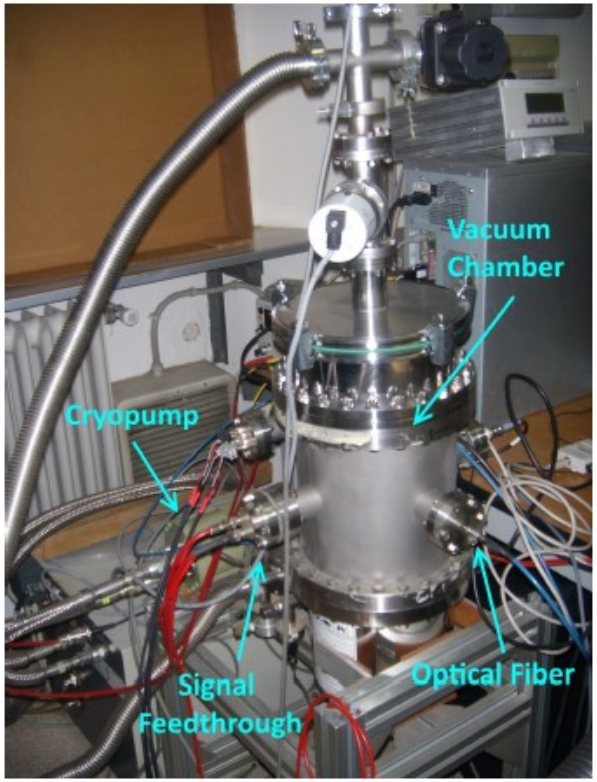
14th Pisa Meeting on Advanced Detectors - La Biodola, Isola d'Elba (Italy), 27th May - 2nd June 2018

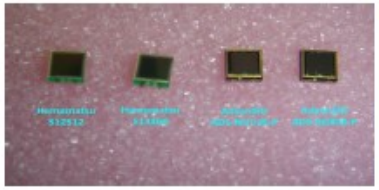
Study on SiPM breakdown voltage, dark current and gain from room temperature down to 50 K

M. Bonesini[1], T. Cervi[2,3], A. Falcone[4], A. Menegolli[2,3], M.C. Prata[3], G.L. Raselli[3], M. Rossella[3], M. Torti[1], A. Villa[2]

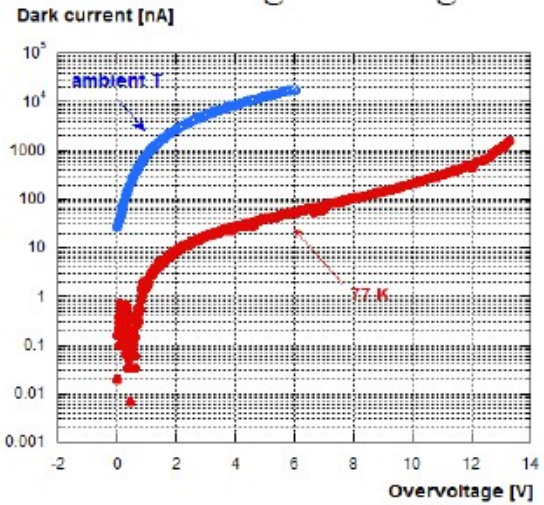
[1]Istituto Nazionale di Fisica Nucleare, Sezione di Milano Bicocca (Italy), [2]Università degli Studi di Pavia (Italy),
[3]Istituto Nazionale di Fisica Nucleare, Sezione di Pavia (Italy), [2]University of Texas Arlington (USA)

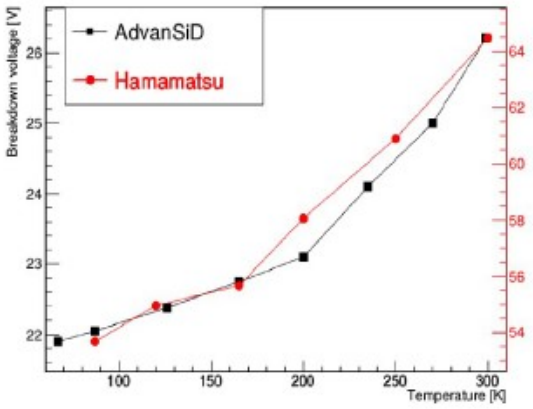
Silicon Photo-Multipliers (SiPMs) at cryogenic temperatures are very promising for the realization of scintillation light detectors to be adopted in particle physics experiments. We tested several devices from different manufacturers with particular emphasis to breakdown voltage, dark current and gain changes at different temperatures.

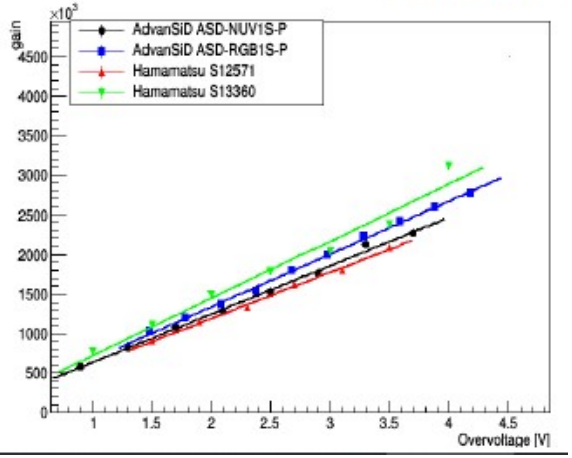




Vacuum chamber and cryo-pump with cold head connected to a copper cylinder to achieve the down to 50 K at the level of SiPMs.







Characterization of SiPM arrays with common bias and common readout for applications in liquid argon

M. Babicz[1,2], T. Cervi[3,4], A. Menegolli[3,4], M.C. Prata[4], G.L. Raselli[4], M. Rossella[4]

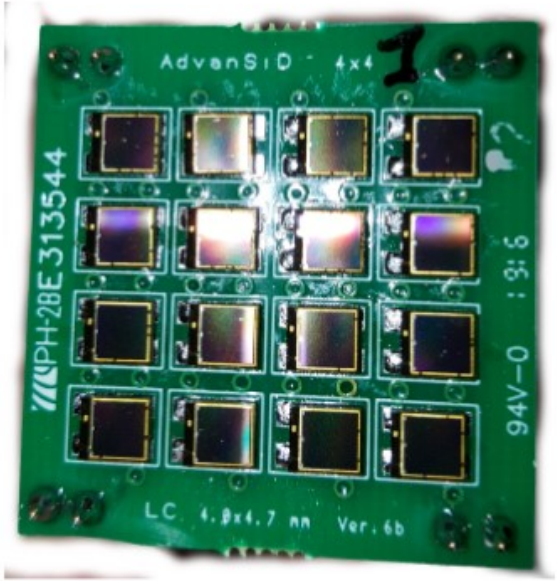
[1]CERN, Geneva (Switzerland)
[2]Institute of Nuclear Physics PAN, Cracow (Poland)
[3]University of Pavia, Pavia (Italy)
[4]INFN Sezione di Pavia, Pavia (Italy)

16 pixels (per array) in series

marta.babicz@cern.ch

14th Pisa Meeting on Advanced Detectors

We studied different series/parallel configuration of Silicon Photomultiplier (SiPM) arrays to obtain the best performance. Test are performed both at room and cryogenic temperature in terms of pulse amplitude, charge, noise and temporal features. This last feature is crucial to realize devices to be used for triggering and timing in detectors that exploit the scintillation light produced by liquid argon.



Precise measurement of 3D-position of SiPMs in the liquid xenon gamma-ray detector for the MEG II experiment

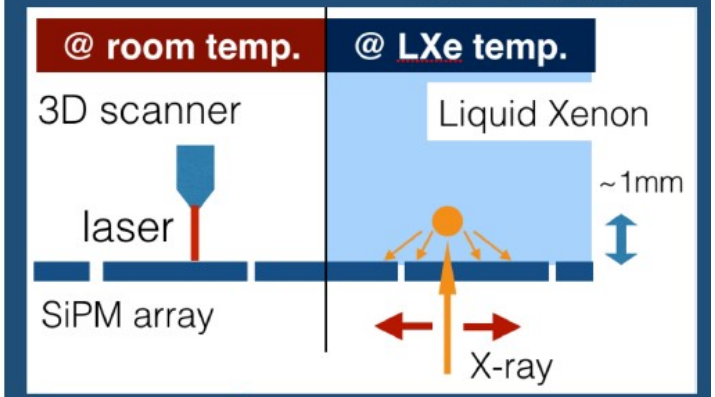
Innovation:

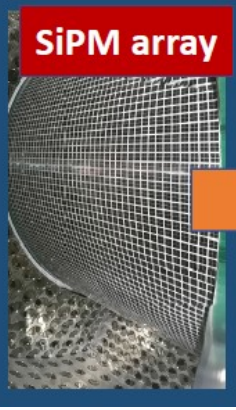
3D-alignment of 4,092 SiPMs in liquid xenon detector (T=170 K) to an accuracy of 320 μm.

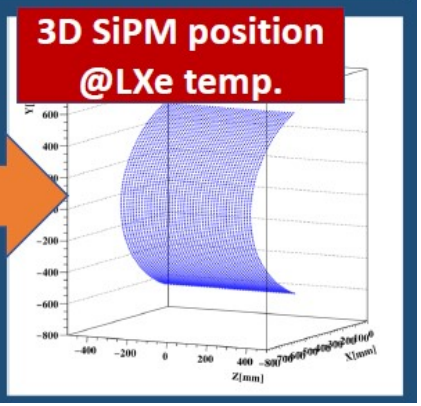
- 3D-image of the inner wall by a laser scanner
- 2D-position measured with a X-ray beam from outside the detector

are combined.

By comparing both results, we observed reasonable thermal contraction of the SiPM array.







Authors: **Satoru Kobayashi**[1], K.Ieki[1], T.Iwamoto[1], T.Libeiro[2], W.Molzon[2], T. Mori[1], M.Nakao[1], S.Ogawa[1], R.Onda[1], W.Ootani[1]
[1]The University of Tokyo(UTokyo) [2]University of California, Irvine(UCI)

THE UNIVERSITY OF TOKYO

UCI University of California, Irvine

New developments in Silicon Photomultipliers for Cryogenic Applications

G. Paternoster on behalf of DarkSide-20k collaboration
Fondazione Bruno Kessler (FBK), Trento, Italy
e-mail: paternoster@fbk.eu

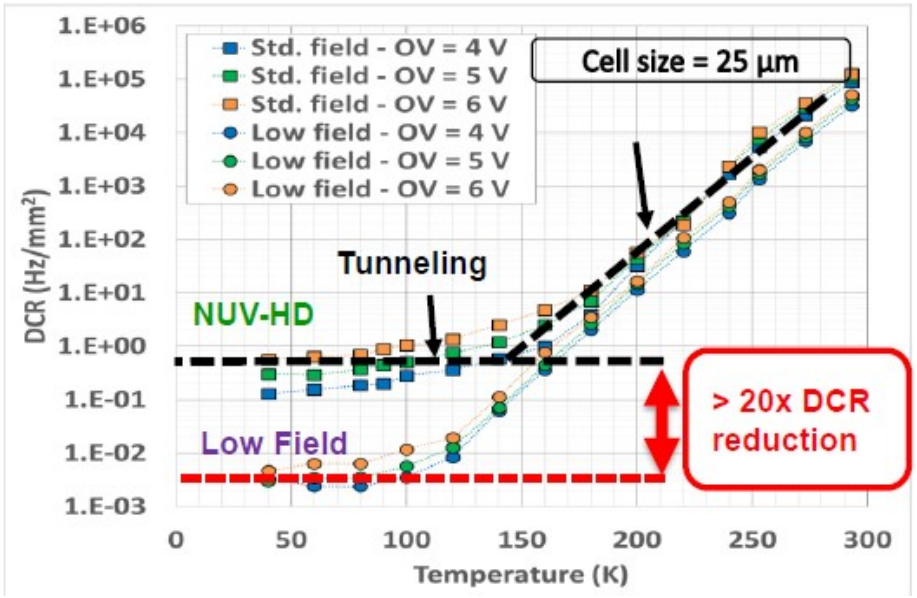
Look for me at the Poster session

- NUV-HD SiPM technology has been optimized to work at cryogenic temperature in the framework of DarkSide-20k project
- An exhaustive characterization of the new SiPM technology has been carried out as a function of T down to 40 K.
- The new technology meets the Darksid-20k experiment requirements in terms of PDE, DCR and correlated noise

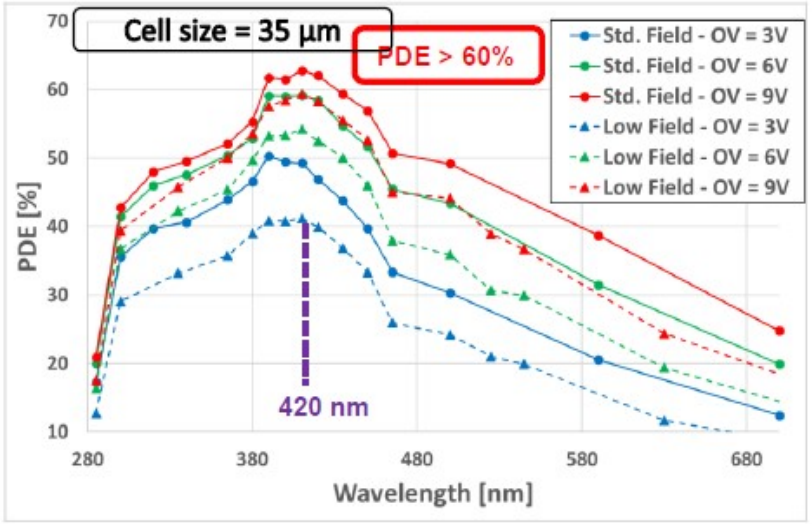
Dark matter search

Main results

1. Dark Count Rate < 0.01 Hz/mm² at 87 K



2. PDE reaches the 60%



Sub-Kelvin detectors and electronics:

- Cryogenic light detectors for rare event searches (**Elizabeth Mondragon** - Munich)

- High energy resolution thermal microcalorimeters for the HOLMES experiment (**Marco Faverzani** - Milano)

- Thermal kinetic inductance detectors for soft X-ray spectroscopy (**Marco Faverzani** - Milano)

- A frequency domain multiplexing system to readout the TES bolometers on the LSPE/SWIPE experiment (**Davide Vaccaro** – Siena)

- maXs: Micro-calorimeter Arrays for high resolution x-ray spectroscopy in atomic Physics (**Uwe Spillmann** - GSI)

Cryogenic Light Detectors for Rare Event Searches

ELIZABETH MONDRAGÓN[1]✿, A. KINAST[1], A. LANGENKÄMPER[1], A. MÜNSTER[1], T. ORTMANN[1], L. PATTAVINA[1], F. PETRICCA[2], W. POTZEL[1], S. SCHÖNERT[1,2]

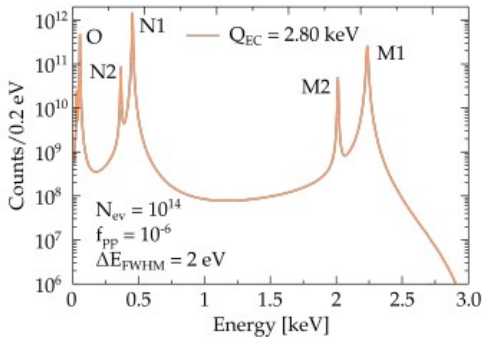
Doped Si crystals modify the transmission properties of pure Si and open up the detection range without loosing much of the benefits in using Si, i.e., price and phonon mobility. By changing the reflective index the maximum angle of incidence also changes and allows for longer wavelengths to be absorbed. In CRESST the TES is evaporated directly onto the Si which results in a better performance and allows to reduce the energy threshold. Nb films are superconducting at mK temperatures and become completely black to radiation. The Nb films can be sputtered onto sapphire and Si. Sapphire has very good thermal properties and it is not as delicate as Si.

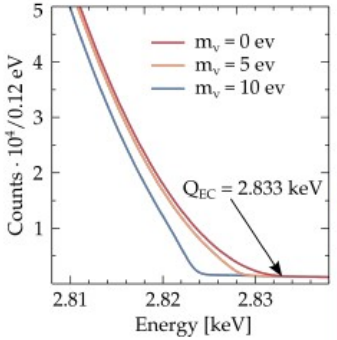
High energy resolution thermal microcalorimeters for the HOLMES experiment

M. Faverzani (*on behalf of the HOLMES collaboration*)

GA n. 340321

Direct and calorimetric assessment of the neutrino mass: the end-point of the spectrum of a beta-decaying source is affected by $m\nu$

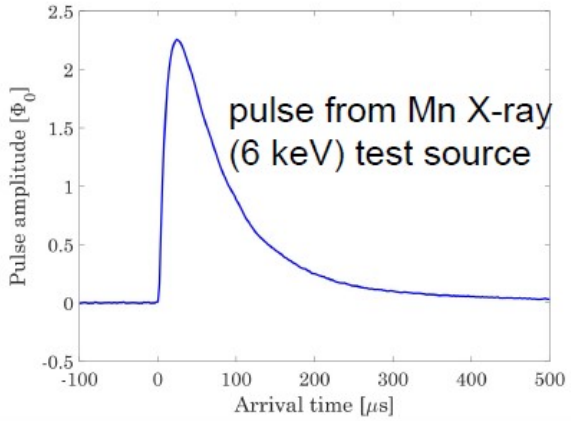


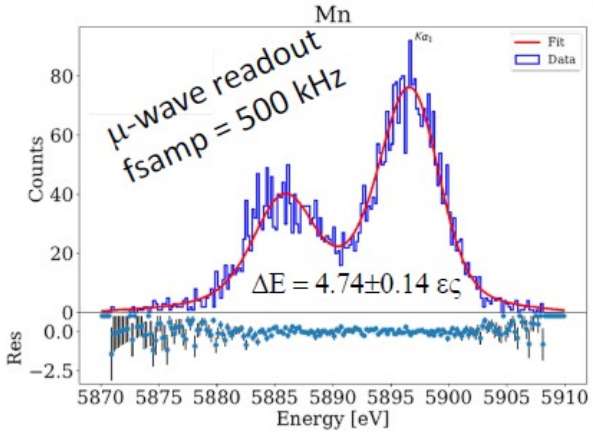


HOLMES aims at measuring $m\nu$ with a sensitivity of ≈ 2 eV/c2 through the measurement of the end-point of the Eletron Capture spectrum of 163Ho (Q = 2.8 keV)

Detectors to achieve high sensitivity:

- high energy resolution (≈ 1eV @ Q-value)
- short time resolution for pile-up discrimination
- high multiplex factor to gather large statistics





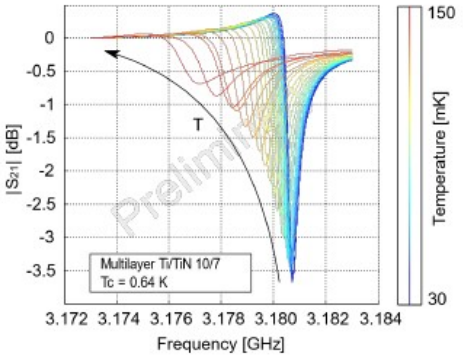
Transition Edge Sensors combined with ramp-modulated microwave multiplexing

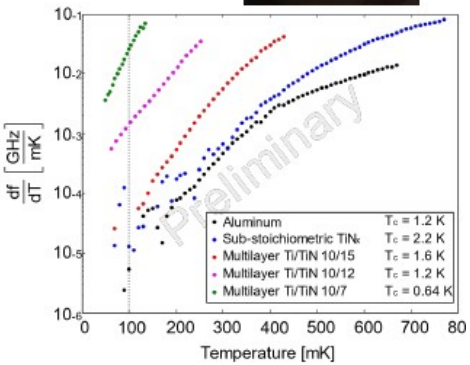
Thermal kinetic inductance detectors for soft X-ray spectroscopy

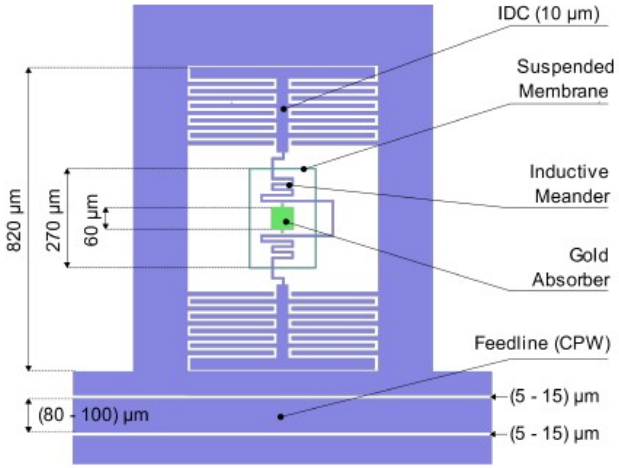
M. Faverzani

Aim: combine mutiplexability of microwave kinetic inductance detectors (MKIDs) with the high sensitivity of quasi-thermal equilibrium low temperature detectors

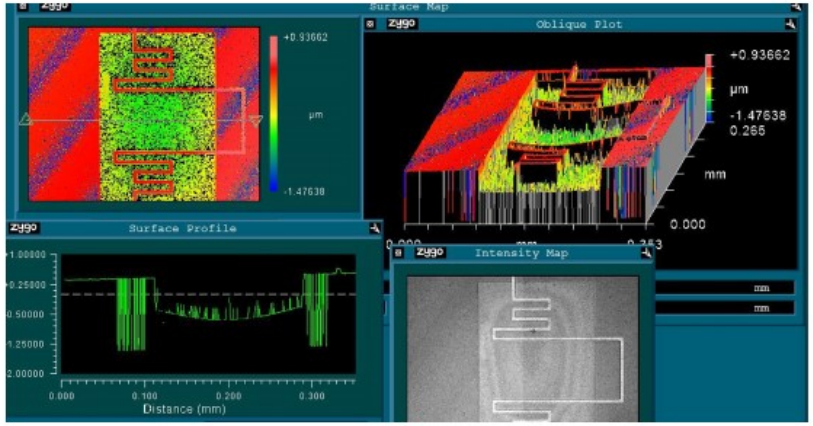
operate the resonators in their temperature-sensitive region to use them as sensitive thermometers of an absorbing material







First prototypes have been produced and are in the testing phase



A frequency domain multiplexing system to readout the TES bolometers on the LSPE/SWIPE experiment

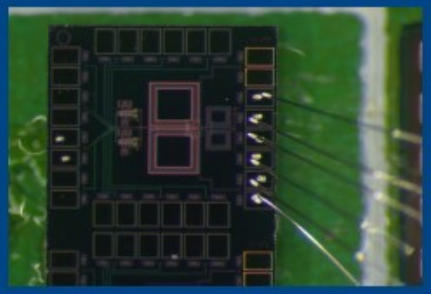
D. Vaccaro[a,b], A.M. Baldini[a], F. Cei[a,c], L. Galli[a], M. Grassi[a], D. Nicolò[a,c], M. Piendibene[a,c], F. Spinella[a], A. Tartari[a], G. Signorelli[a].

[a]*INFN Sezione di Pisa, Largo B. Pontecorvo 3, 56127 Pisa, Italy*

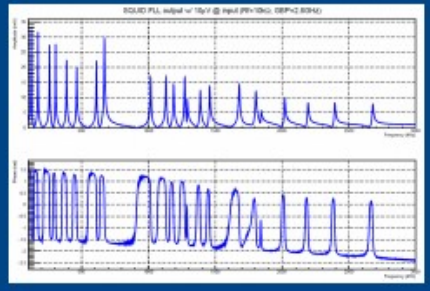
[b]*Dipartimento di Fisica, Università di Siena, Strada Laterina 8, 53100 Siena, Italy*

[c]*Dipartimento di Fisica, Università di Pisa, Largo B. Pontecorvo 3, 56127 Pisa, Italy*

Presenter: *Davide Vaccaro*



We present our design and experimental demonstration of a frequency domain multiplexing (FDM) system to readout the transition-edge sensor bolometers of the LSPE/SWIPE balloon-borne experiment, for measuring the B-mode polarization of the Cosmic Microwave Background (CMB) exploiting the reionization peak at $l < 10$, with the primary target of improving the tensor-to-scalar ration limit down to r = 0.03 at 99.7% CL. The FDM readout system has been devised consists of LC resonators composed of custom Nb superconducting inductors and SMD capacitors.
We describe the fabrication process and qualification tests of both cold and warm readout electronics. The cold section (0.3K - 1.6K) is composed of boomerang-shaped PCBs hosting the SQUIDs and the superconducting LC filters for the FDM channels. The warm section is based on a modular solution, with mezzanine plug-ins for DAC (comb generation), ADC (demodulation) and a SoC FPGA (Altera Cyclone V SoC) for data reduction.



maXs: Micro-Calorimeter Arrays for High Resolution X-Ray Spectroscopy

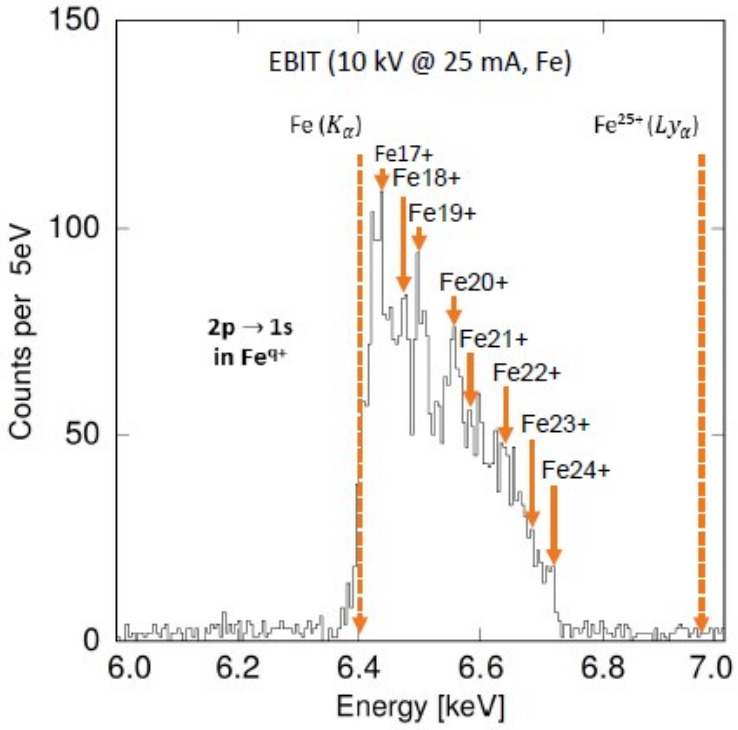
Microcalorimeters are energy dispersive particle detectors operated at low temperatures

Intrinsically high energy resolution + wide energy range
→ Well suited for x-ray spectroscopy

Currently ongoing experiment at *GSI*, Darmstadt: *maXs-30* calorimeter array detector @ *S-EBIT*

First results available with energy resolution of 35 eV (FWHM) @ 6 keV and low noise level

Experiment proposal for 2019: Microcalorimeter array detectors at CRYRING @ ESR electron cooler, Lamb-shift measurement on highly charged uranium ions



M. O. Herdrich[1,2,3], D. Hengstler[4], C. Schötz[4], J. Geist[4], M. Keller[4], A. Fleischmann[4], S. Kempf[4], L. Gastaldo[4], C. Enss[4], S. Trotsenko[3], T. Morgenroth[3], R. Märtin[2,3], G. Weber[2,3], R. Schuch[5], T. Stöhlker[1,2,3]

1 Institut für Optik und Quantenelektronik, FSU Jena, Germany
2 Helmholtz-Institut Jena, Germany
3 GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany
4 Kirchhoff-Institut für Physik, RKU Heidelberg, Germany
5 Manne Siegbahn Institut, Stockholm, Sweden

HI JENA
Helmholtz Institute Jena

Photosensors at low temperature:

- **Cryogenic electronics** for photosensors operating in Liquid Xenon (**Adriano di Giovanni** – NYU Abu Dhabi)

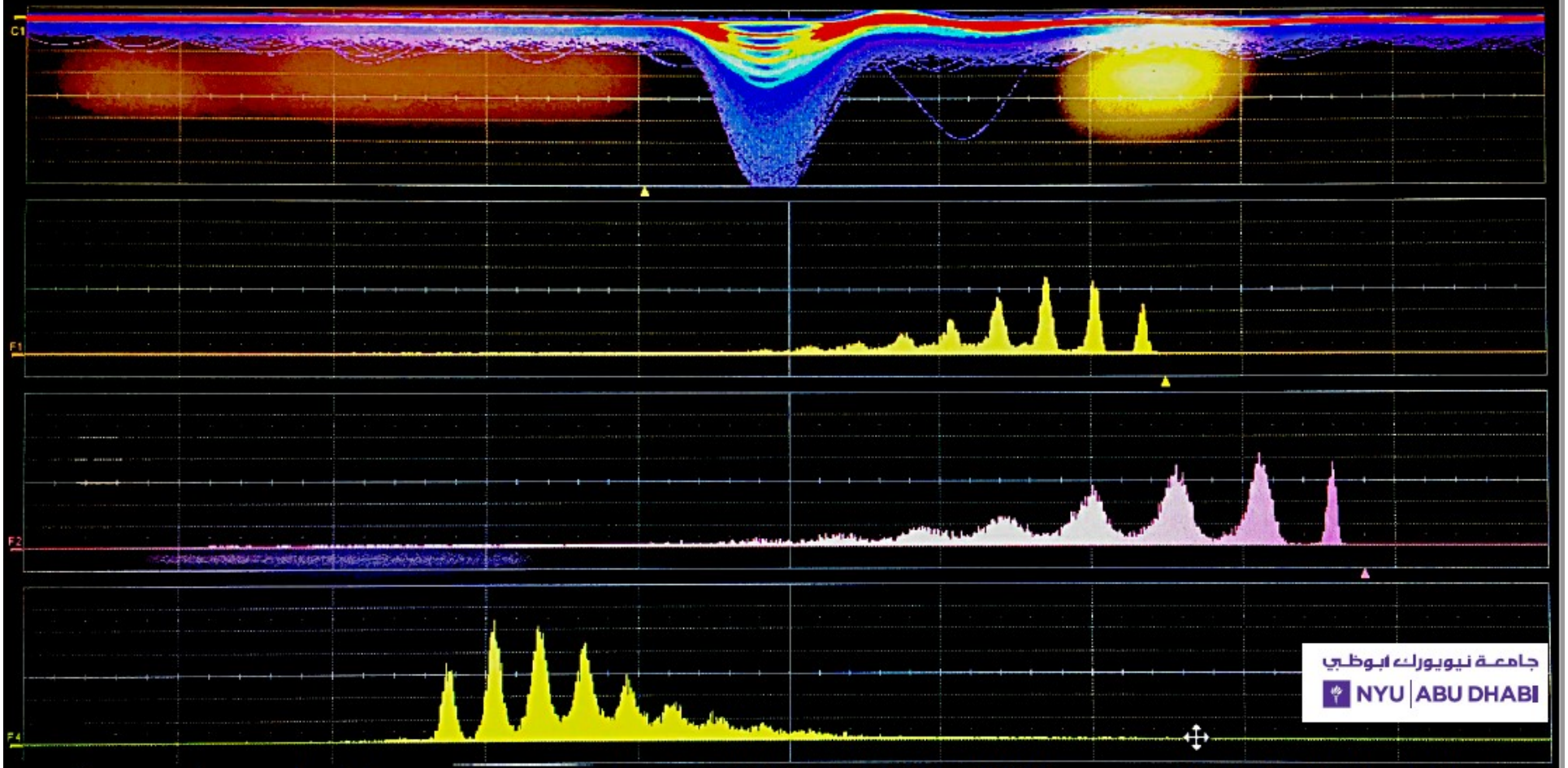
- The ICARUS T600 detector overhaul at CERN (**Andrea Zani** - CERN)

- Experimental study of the propagation of scintillation light **in liquid argon** (**Stefania Bordoni** - CERN)

- Optical Properties of TetraPhenylButadiene as wavelength shifter for the detection of VUV scintillation light from **liquefied noble gases** (**Massimo Rossella** - Pavia)

Cryogenic electronics for photosensors operating in Liquid Xenon

Presented by: Adriano Di Giovanni

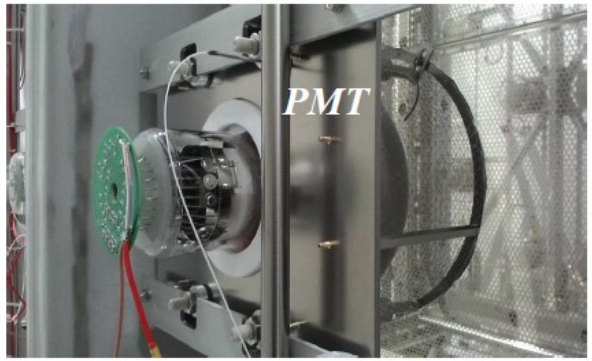


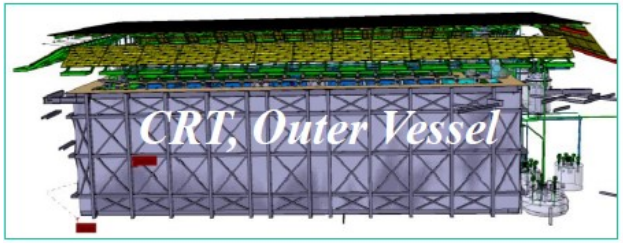
جامعة نيويورك ابوظبي
NYU ABU DHABI

- Cryogenic readout for an array made of S13370-3050CN (**VUV4 generation**) Multi-Pixel Photon Counters (MPPC) operated at liquid xenon conditions.
- A matrix of many individual MPPCs readout as a single channel.
- Based on a commercial current feedback operational amplifier (Analog Devices AD8011)

ICARUS T600 Detector Overhauling

Andrea Zani – CERN EP-NU
(for the ICARUS/NP01 Collab.)





More on the T600:
1) The development of the Icarus T600 laser diode calibration system (M.Bonesini)

2) Scintillation light DAQ and trigger system for the ICARUS T600 experiment at Fermilab (M. Babicz)

*First **Large Volume Liquid Argon TPC** successfully operated at Gran Sasso Labs (Italy).*
***At CERN** for complete overhaul in 2015-2017: Light Detection System (PMTs), Read-out Electronics, Cryogenics and cryostats…*
*Equipped with Cosmic Ray Tagger, to tag cosmic ray-induced events. **Sent to FNAL in 2017***
*Far station on the FNAL Booster Neutrino Beam in the search for Sterile Neutrinos within the **Short Baseline Neutrino Program**.*

14th Pisa Meeting on Advanced Detectors

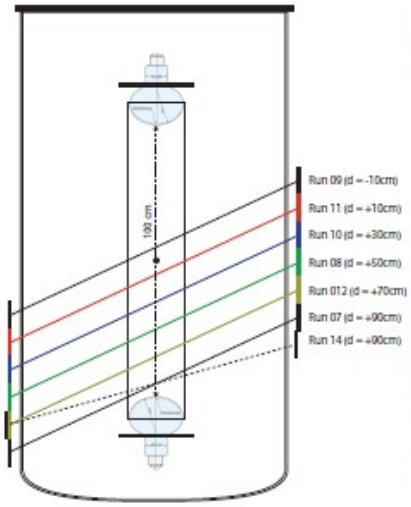
Experimental study of the propagation of scintillation light in liquid Argon

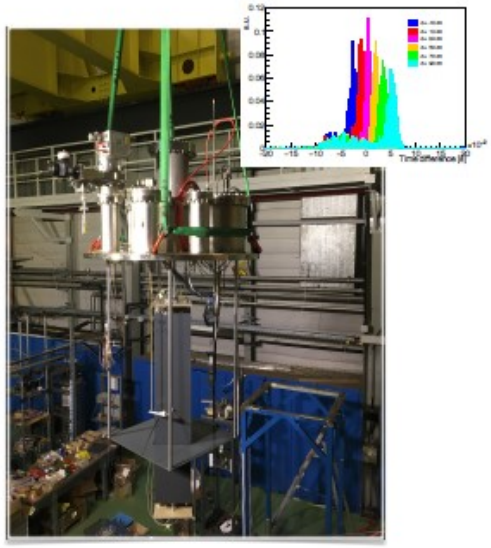
M. Babicz (CERN), S. Bordoni (CERN), T. Cervi (INFN), Z. Collins (CERN/BU), A. Fava (FNAL), U. Kose (CERN), M. Meli (CERN), A. Menegolli (INFN), M. Nessi (CERN), F. Pietropaolo (CERN/INFN) , G. Raselli (INFN), F. Resnati (INFN), M. Rosella, P. Sala (CERN/INFN), F. Stocker (CERN), A. Zani (CERN)

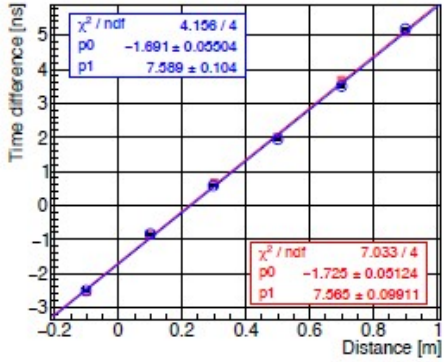
- **Aim:** improve the current knowledge of the propagation of scintillation light in LAr

Dedicated setup: two PMTs at 1m distance in LAr

- Cosmic tracks selected with an external trigger at a number of distances from the PMTs and at two inclinations
- PMT signals are recored with waveform digitisers (5GHz) and their timing determined using a software constant fraction technique
- The measurement relies only on the external trigger position. No calibration of the PMT transit time is required
- Scintillation photon velocity determined from the difference in time of the signals in the two PMTs as a function of the track position







Framework	Track sample 1 [ns/m]	Track sample 2 [ns/m]
A	7.6 ± 0.1	7.6 ± 0.1
B	7.4 ± 0.1	7.4 ± 0.1

$1/v_g = 7.50 \pm 0.07$ (stat) ns/m

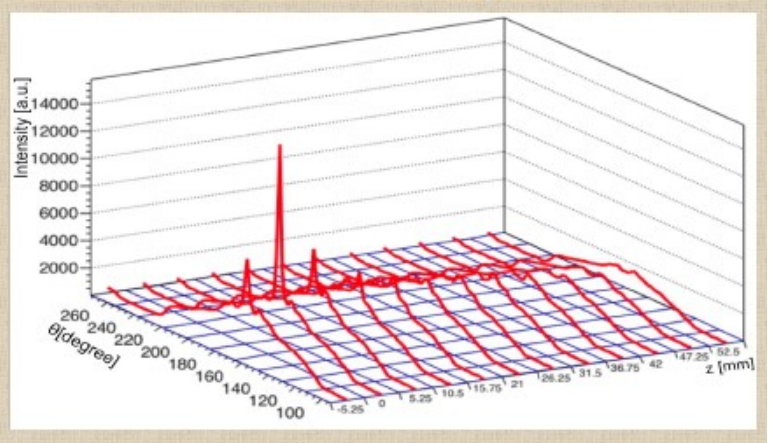
From the velocity measurement, estimation of the Refractive index Rayleigh scattering length for liquid Argon at 128 nm are inferred

Optical Properties of TetraPhenylButadiene as wavelength shifter for the detection of VUV scintillation light from liquefied noble gases

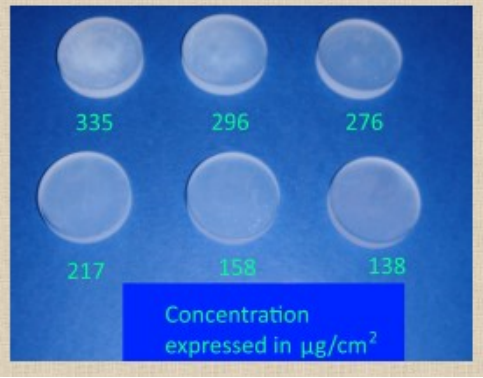
T. Cervi2, A. Menegolli2, M. C. Prata2 , G.L. Raselli2, M. Rossella2, A. Falcone3, M. Torti1, A. Villa2
1Istituto Nazionale di Fisica Nucleare, Sezione di Milano Bicocca
2Istituto Nazionale di Fisica Nucleare, Sezione di Pavia and Università degli Studi di Pavia
3University of Texas at Arlington, Arlington, USA

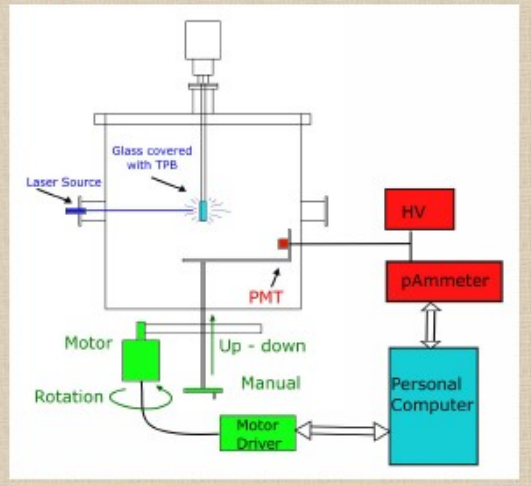
· TetraPhenylButadiene (TPB) is the most common wavelength shifter used in liquefied noble gases experiments, due to its extremely high efficiency to convert VUV light in visible photons. The conversion can occur directly on the sensitive surface of photon detectors or on the wall of the experimental apparatus, in both cases coated with TPB. Considering that converted light is isotropic emitted, visible photons might be reflected or diffused by other TPB coated surfaces before being absorbed or detected. A study of transparency, diffusion and reflection properties of TPB at its emission wavelength was carried on and presented as function of the thickness of the TPB surface evaporated on 1 inch glass disks.

Diffused light in cylindrical coordinates at TPB concentration of 200μg/cm2



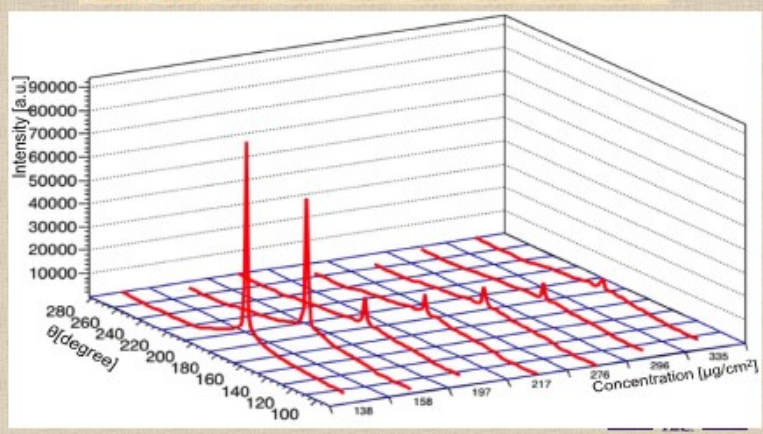
1 inch glasses covered by TPB





Experimental set-up

Diffused light as function of TPB concentration



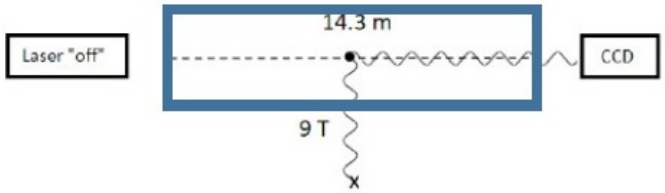
Others:

- OSQAR chameleon afterglow search experiment (**Miroslav Sulc** - Liberec)

- Commissioning of a Si(Li) Compton polarimeter (**Marco Vockert** – Jena)

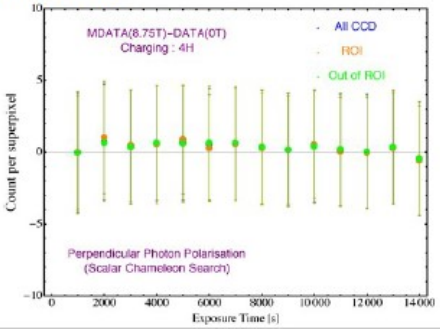
OSQAR chameleon afterglow search experiment

Miroslav Sulc
on behalf of **OSQAR** collaboration
M. Sulc, P. Pugnat, R. Ballou, G. Deferne, J. Hosek, S. Kunc, A. Siemko

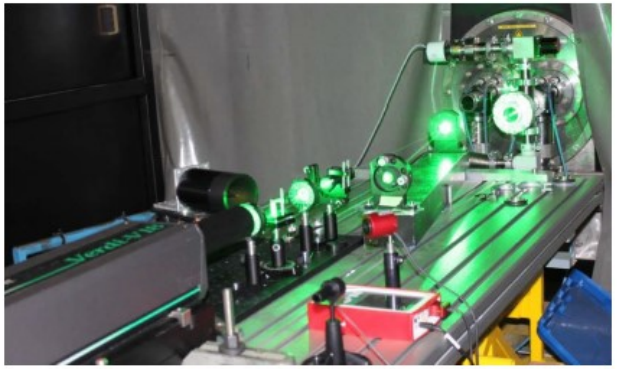


Chameleons hypothetical scalar particle can be produced when photons interact with magnetic field in vacuum chamber. Chameleon can escape from closed chamber only by inverse Primakoff effect which manifest as afterglow signal coming from chamber after switch-off photon source.

No magnetic afterglow signal was observed for the frequency higher than 1 Hz.



OSQAR-CHASE experiment has followed the pioneering work of the GammeV collaboration but it used spare LHC magnet 8.5 T with evacuated pipe, 18 W laser (532 nm) and sensitive, low noise CCD detector.



Increasing of the sensitivity of the OSQAR-CHASE experiment over the previous GammeV reference experiment assumes that the present coupling constant limit will be reduced around factor of 4.

Commissioning of a Si(Li) Compton polarimeter

M. Vockert, G. Weber, U. Spillmann, T. Krings, M. O. Herdrich, Th. Stöhlker

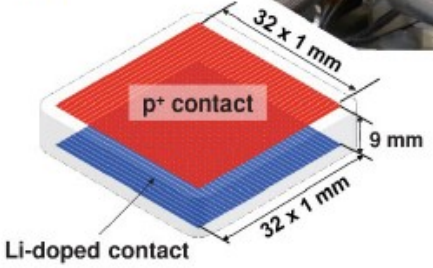
(LN2)

A New Compton polarimeter with cryogenic first stage of preamplifiers was built

- Reduction of electronic noise
- Increased energy resolution (≈900 eV FWHM @ 60 keV), selectivity and energy range

Results of commissioning experiment at GSI **(Synchrotron)**

- Linear polarization measurement of K-REC at 56 keV photon energy
- analysis is still ongoing, but first results indicate values of close to full linear polarization



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