NDIP2011
6th International Conference on
New Developments In Photodetection
Lyon, France in 4-8 July, 2011

Highlights of Poster Session II

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IPN Lyon – CNRS - France

Poster Session II

Details

- **13 contributions (originally 22 - 9 withdrawn)**
- ***Covered technologies and fields are:***
  - XRay detectors : 6 contributions
  - Camera : 2 contributions
  - Avalanche Photo-diode : 1 contribution
  - Hybrid detectors: 1 contribution
  - Solid State detectors : 1 contribution
  - Other detectors : 2 contributions

Acknowledgments and disclaimer

- Many thanks to all contributors for their highlight slides
- Order of presentation is « random » – no preference !
- Apologies for possible inconsistencies – be tolerant !

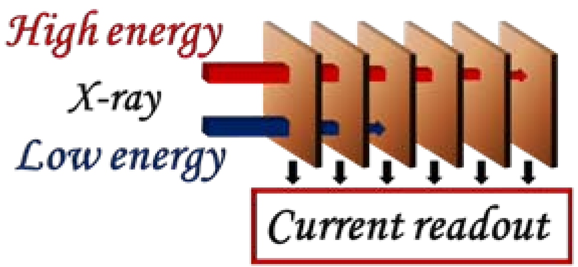
XRay detectors

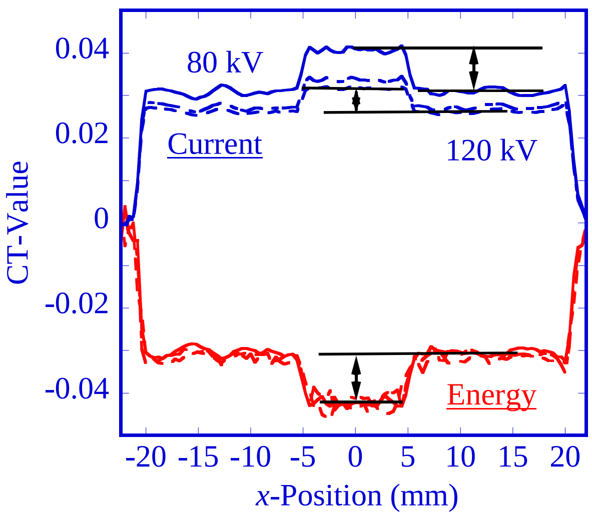
6 contributions

Third Generation Computed Tomography with Energy Information of X-rays using CdTe Flat Panel Detector

Ikuo Kanno *et al.* – Kyoto University, Japan

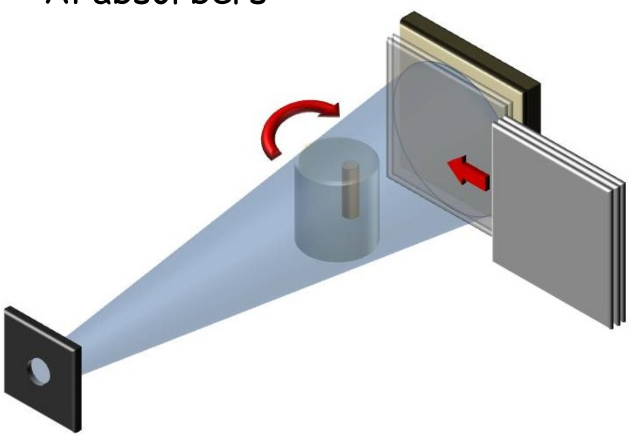
- **Motivation:** Computed Tomography (CT) is a wonderful method to detect cancers but when cancers are marked by iodine it becomes difficult to be observed with high tube voltage diagnosis
- **The idea:** to exploit the energy information of X-rays in transmission measurements
- **This work:** a novel detector which measures X-rays as current and gives energy distribution of incident X-rays called transXend detector





1 st → 3 rd Generation CT

- For measurement time reduction (human diagnostic)
- With CdTe flat panel detector + Al absorbers



Method to deduce energy information with flat panel detector is shown on Poster 14

Poster ID 25

Photon detection by an InSb compound semiconductor detector with reduced leakage current

Yuki Sato *et al.* – Kyoto University, Japan

- **Motivation:** photon detector with compound semiconductor InSb in order to detect hasardous elements such as Li, Be and Pb (environmental preservation)

- **Why InSb ?** → **High detection efficiency**

  High atomic numbers (In:49,Sb:51) and high density (5.78 gcm^{-3}): Photon absorption efficiency

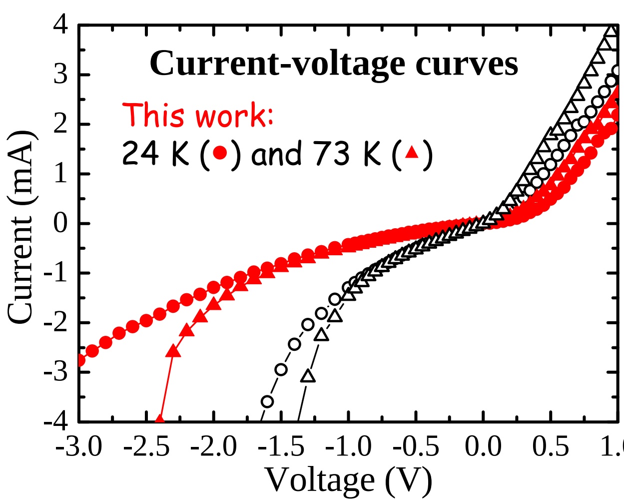
  Si × 1000 → InSb
  Ge X 10 → InSb

  → **High energy resolution**

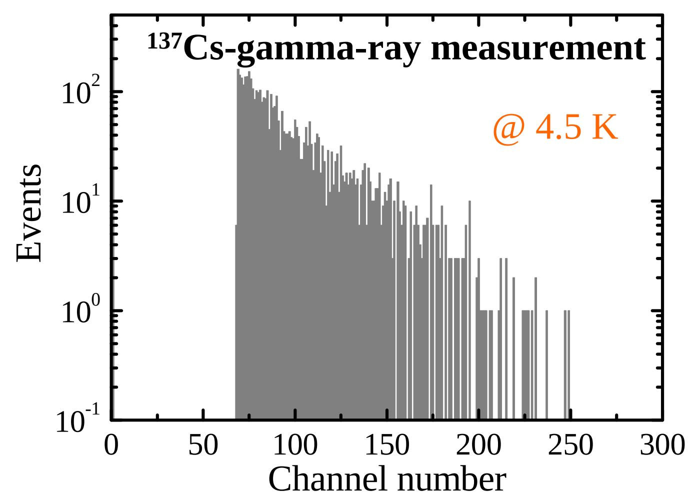
  Smallest band gap energy 0.6 ev (at room temperature): Energy resolution

  Si, Ge X 2 → InSb

- **This work:** reducing leakage current by cooling and with changing the electrode design



Leakage current was decreased



Gamma-ray was measured by the InSb detector

→ Changing InSb wafer size, active area…

Details shown on Poster 25

Poster ID 95

Synchrotron radiation studies of spectral features caused by Te inclusions in CdZnTe

Conny Hansson *et al.* – European Space Agency/ESTEC, the Netherlands

❖ CdZnTe (CZT): recognised as a high energy X-ray and γ-ray detection medium due to its high stopping power and wide band gap.

❖ Problem:

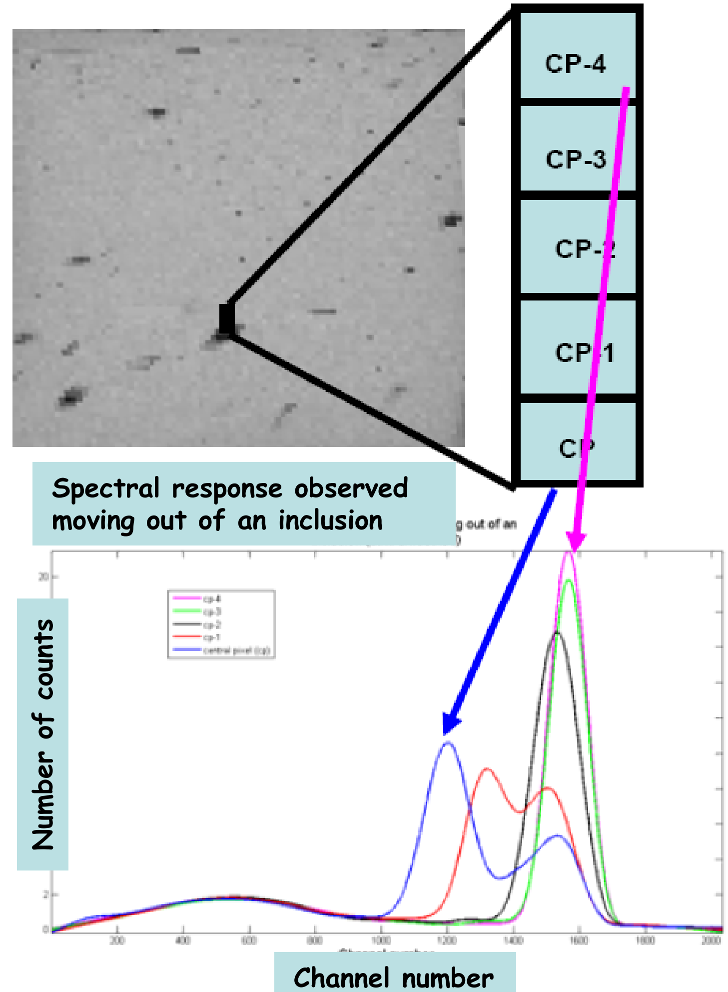
- detector perf. limited by defects in the crystal structure
- spectroscopic performances are limited by Te inclusions

❖ This study: 10 mm thick CZT coplanar grid detector having large Te inclusions exposed to pencil beam synchrotron radiation in order to study spectroscopic features introduced by Te inclusions at different X-ray energies

❖ Results:

- small inclusions <3μm : compensated by depth sensing techniques
- larger inclusions: variation in collected charge carrier number
  - ✓ introducing trapping levels
  - ✓ affecting the electric field profile inside the detector

➡ Spectral performance evaluated as a function of inclusion size



Explanations on Poster 95

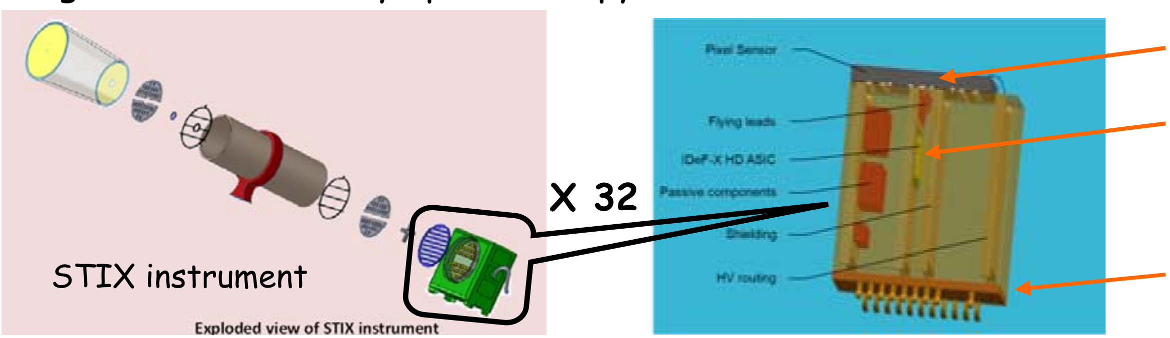
Poster ID 98

Caliste-SO X-ray micro-camera for the STIX instrument on-board Solar Orbiter mission

Aline Meuris *et al.* – CEA / Irfu, France

❖ STIX (Spectrometer Telescope for Imaging X-rays): will provide information on the timing, location, intensity and spectra of accelerated electrons near the sun

❖ Caliste-SO: an hybrid component integrating the sensor material and dedicated front-end electronics for high resolution X-ray spectroscopy



- One Cd(Zn)Te pixel detector
- IDeF-X front ASIC(s) placed perpendicular to the detection surface for performance optimization
- A bottom interface to get a space-qualified component for X-ray spectroscopy

❖ Applications:
- **Hard X-ray astronomy**: see Talk Caliste-256, session **S14** Thursday PM
→ use advantages of small pixels and possibility to place several units side by side for a large focal plane
- **Solar physics**: Caliste-SO on board Solar Orbiter ESA mission (phase B)
→ use advantages of a compact design, low power (new ASIC version: IDeF-X HD)

❖ Challenges for this device:
- **High count rate** of solar flares (up to 105 counts/s/detector)
- **1 keV FWHM @ 6 keV** with large pixels (8 mm2) moderate cooling (–20°C) and strong radiation level (1011 10 MeV equivalent protons/cm2 during the whole mission).

See Poster 98 & Listen Talk Session 14

Spectroscopic and non-spectroscopic diagnostics of radiation detectors

Poster ID 153

Mikhail Bryushinin *et al.* – Ioffe Physical Technical Institute, St. Petersburg

❖ This work: study CdTe and $Cd_xZn_{1-x}Te$ radiation detectors with a non-destructive optical method which uses the effect of non-steady-state photoelectromotive force (photo-EMF)

❖ Method: the non-steady-state photocurrents can be excited in widegap semiconductors illuminated by an oscillating light pattern.

Such illumination is created by 2 coherent light beams one of which is phase modulated with frequency ω.

This technique allows the direct transformation of phase modulated optical signals into the electrical current.

A lot of photoelectric parameters can be measured: carriers' lifetime τ and mobility μ, diffusion L_D and drift lenghts L_0, concentration of trapping centers N_D....

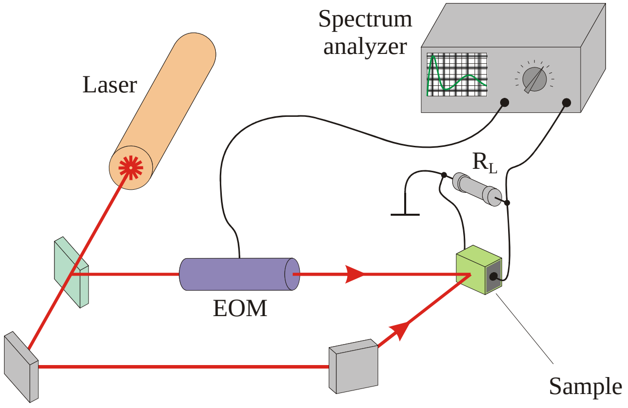


Photo-EMF experimental setup

❖ Experimental results:

- characterization of transport parameters of CdTe and CdZnTe
- μτ-product calculated using experimental data

Photoelectric parameters of CdTe and CdZnTe radiation detectors (λ=1.15 μm, I_0=3.0-24 mW/cm^2):

	Dark conductivity	Photoconductivity	Diffusion length of holes
CdTe	0.83x10^{-9} Ω^{-1}cm^{-1}	(1.1-2.5)x10^{-9} Ω^{-1}cm^{-1}	>18 μm
CdZnTe	0.64x10^{-9} Ω^{-1}cm^{-1}	(0.8-2.8)x10^{-9} Ω^{-1}cm^{-1}	5.9 μm

More results on Poster 153

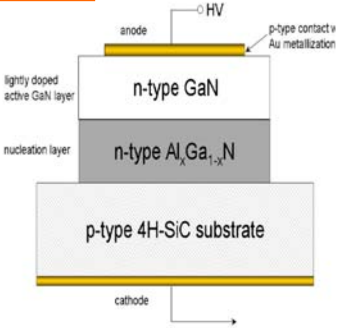
GaN detector development for particle and X-ray detection

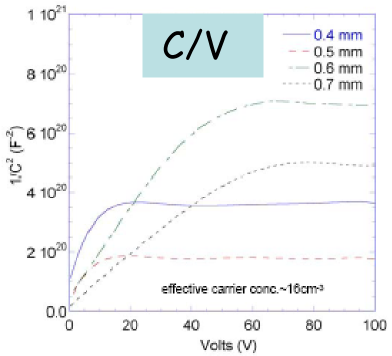
Alan Owens *et al.* – European Space Agency/ESTEC, The Netherlands

- **GaN:** widely used in optoelectronics area
  little work on its particle and X-ray detection properties
- **Properties:**
  - wide band gap = 3,39 eV
  - high density = 6,15 g cm-3
  - large displacement energy = 20 eV
  - thermal stability

Should be an ideal radiation detection medium operating in extreme thermal and radiation environments

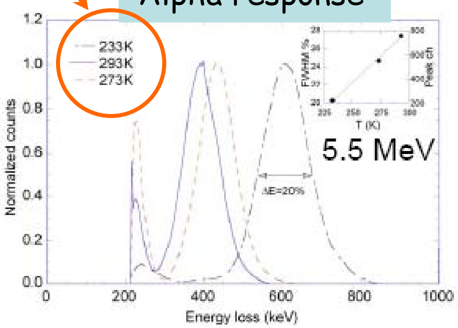
- **Devices:** Si-GaN PIN diodes
  - 2 μm thick epitaxial layer on p-type 4H-SiC substrate
  - 400, 500, 600, 700 μm diameter diodes tested
  - full depletion for biases 20-60 Volts
  - tests carried out from -40°C to +20°C





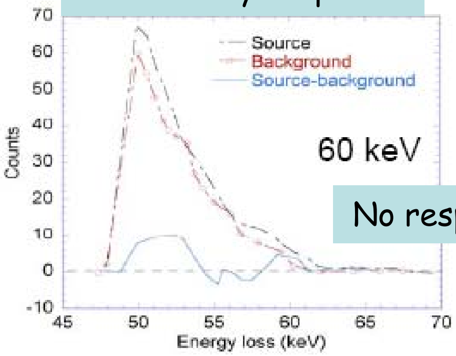
- **Spectroscopy measurements:**

Alpha response



Energy resolution ~ 10% FWHM

Hard X-ray response



No response !

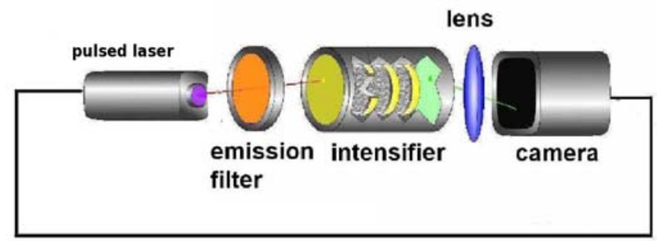
Let's see on Poster 179

Camera

2 contributions

Wide-Field Single Photon Counting Imaging with an Ultrafast CMOS-Camera and an Image Intensifier

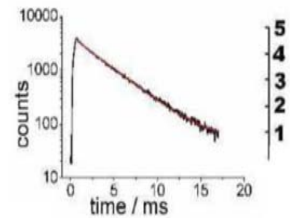
Gianmarco Zanda *et al.* – King's College London

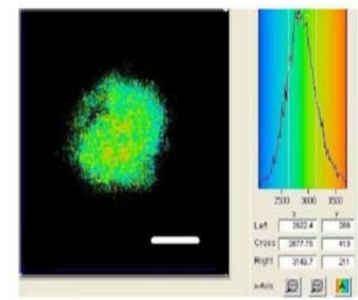


❖ Aim: to design a system with positional, temporal information and high sensitivity (single photon)

❖ Setup : Ultra-Fast CMOS camera coupled with a photon counting Image Intensifier (3-stage)

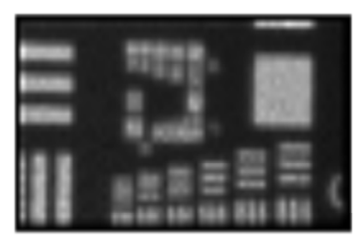
- Acquisition with a pulsed laser allows luminescence decay measurements
- Phosphor decay can be exploited for photon arrival timing below camera exposure time

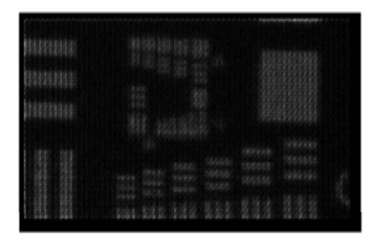




❖ Advantages:

- Ultra high frame rate
- Single photon sensitivity, photon event is amplified BEFORE accumulation
- Wide Field technique (positional information and faster than PMT scanning: parallel processing of all pixels)
- High signal to noise ratio (yes/no in the event localization)
- Temporal Information – photon arrival time with Microsecond Resolution
- Centroiding techniques to improve spatial resolution but introduces fixed pattern noise (FPN)





Discussion on centroiding, timing of the events and FPN on Poster 181

Charge Diffusion Measurement in Fully Depleted CCD using X-rays

Ivan Kotov *et al.* - Brookhaven National Laboratory, USA

❖ Context: specialized CCD sensors are being developed for the Large Synoptic Survey Telescope. LSST requires sensor contribution to Point Spread function (PSF) to be small and well characterized.

❖ Setup: sensor PSF is determined by the lateral charge diffusion on the drift path from the CCD window to the gate → use of an X-ray source (^{55}Fe) to measure charge diffusion

❖ Method: charge distribution described by 4 parameters

- x- and y-position
- sigma
- total amplitude

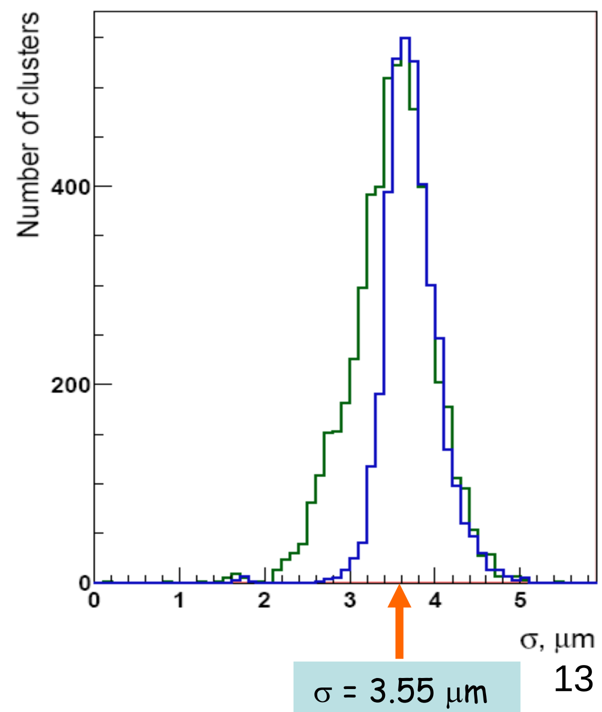
} Criterion : parameters are determined if the cluster contains at least 4 pixels with amplitude above the noise

Clusters with sufficient signal to noise ratio → Selected as pixel "fired"

❖ Results: distribution of sigma values measured

- with a prototype device (green)
- with simulated X-rays (blue)

} Good agreement for the "window" peak



More explanations on Poster 138

Avalanche Photo-Diode (APD)

1 contribution

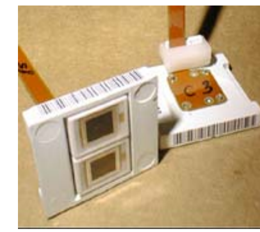
Poster ID 109

Anomalous APD signals in the CMS ECAL

David Petyt *et al.* – STFC Rutherford Appleton Lab.

❖ Setup: The main component of the Compact Muon Solenoid (CMS) to detect and measure the energies of electrons and photons from proton-proton collisions is the Electromagnetic Calorimeter (ECAL).

- ECAL consists of 75848 PbWO4 crystals, organized into a barrel and 2 endcap detectors
- Scintillation light emitted by the crystal is converted in electrical signals by Avalanche Photo-diodes (APDs) glued to the rear face of the crystal.

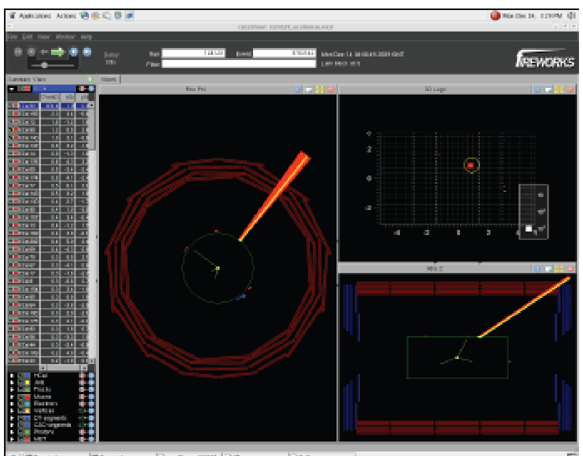


❖ Problem: Anomalous signals, consisting of isolated large signal, have been observed during LHC 2009-11 data taking. "ECAL spikes" are observed to be proportional to the proton beam intensity.

❖ Understanding: Spikes are ascribed to direct energy deposition by particles striking the APDs and causing occasionnally large signals through direct ionization of the silicon.

- spike properties and rates
- Monte Carlo simulations
- laboratory and test beam

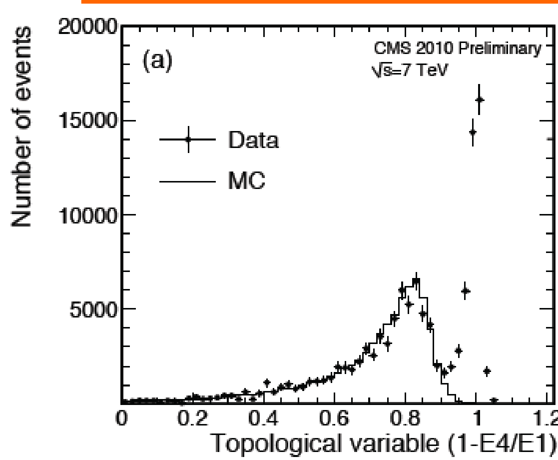
} Used to understand the spikes origin

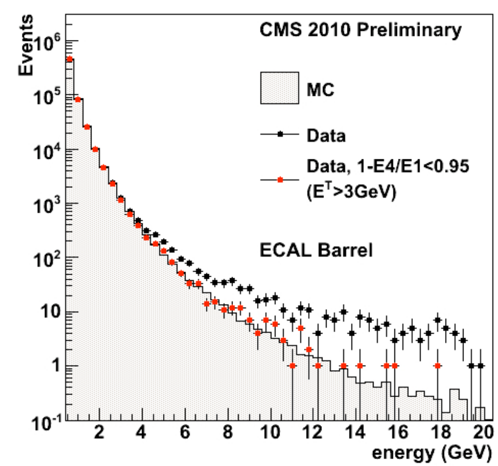


CMS Event Display of a pp collision event, showing an isolated ECAL spike simulating a 600 GeV transverse energy deposit

→ A method to reject these signals in the trigger has been founded

Rejected method presented on Poster 109





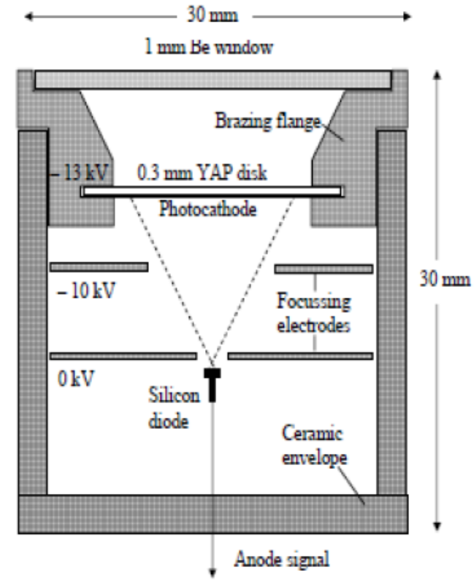
Hybrid Photodetector

1 contribution

Poster ID 37

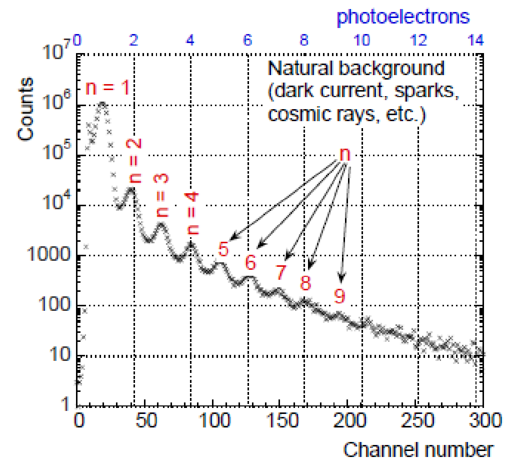
Use of Hybrid Photon Detectors in scintillations studies and imagin applications

Jiri A. Mares *et al.* – Institute of Physics, AS CR, Czech Republic

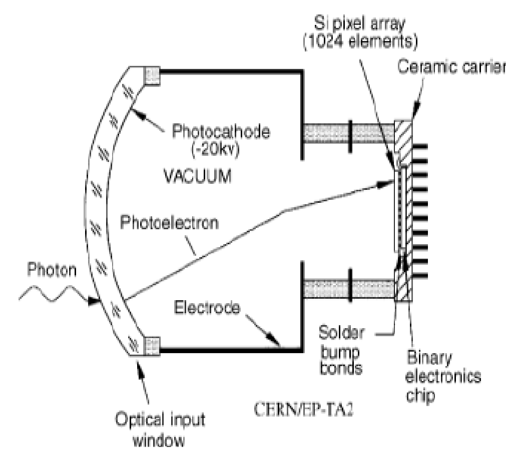


- **Detector:** HPMT = a photocathode + one Si-PIN diode used as an anode
  Photoelectrons electrostatically focused on Si-PIN diode

- **Aim:** HPMT used in characterization of scintillating materials
  - energy resolution
  - non linearity
  - reliable photoelectron calibration
  - less noise respect to classical PMT's



- **Applications:**
  - largest use: at LHCb experiment at CERN at the RICH detectors for particle identification (500 HPD's used)
  - imaging application: γ-ray optoelectronic camera
    ISPA tube = YAP:Ce photocathode + array of Si-diode pixels



More details on Poster 37

Solid State Detectors

1 contribution

NDIP

Poster ID 184

Single photon avalanche diode radiation tests

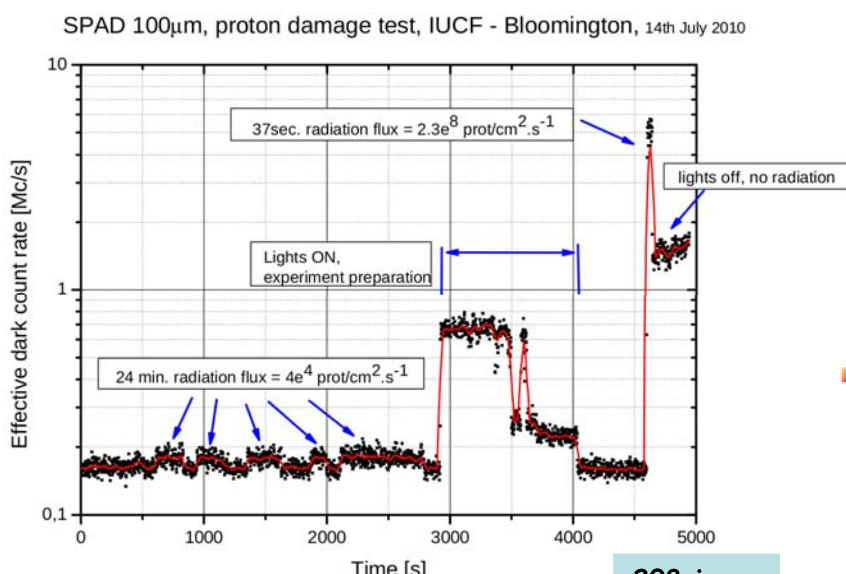
Josef Blazej *et al.* – CTU Prague, Czech Republic

- **Single Photon Avalanche Diode (SPAD):** provided by Czech Technical University (structure on Silicon)
- **Context:** generally used in lidar or various ranging experiments

  recently planned for applications in deep space missions that is why radiation damage tests were carried out.

  - Expected source of radiation = trapped and solar protons and electrons and gamma ray
  - Expected to change after radiation = SPAD effective dark count rate (increasing)
  - Not expected to change = other parameters such as QE, breakdown voltage, speed…
- **Tests using 2 radiations:** proton radiation and gamma ray

1 – Indiana University Cyclotron Facility: 54 MeV energy protons



208 jours

- low proton flux: no changes in DC rate
- high proton flux: DC increases from 0.3Mc/s to 1.6Mc/s

  ➡ DC rate depends on the radiation flux
- slow annealing effects in time: decrease slope of 0.8Mc/s in 100 days after irradiation.

2 – Nuclear Research institute in Rez: ^{60}Co source

➡ Gamma ray radiation did not caused any significant changes in diodes performance:
DC rate = 0.2Mc/s before and after irradiation

Measurements results on Poster 184

Other Photodetectors

2 contributions

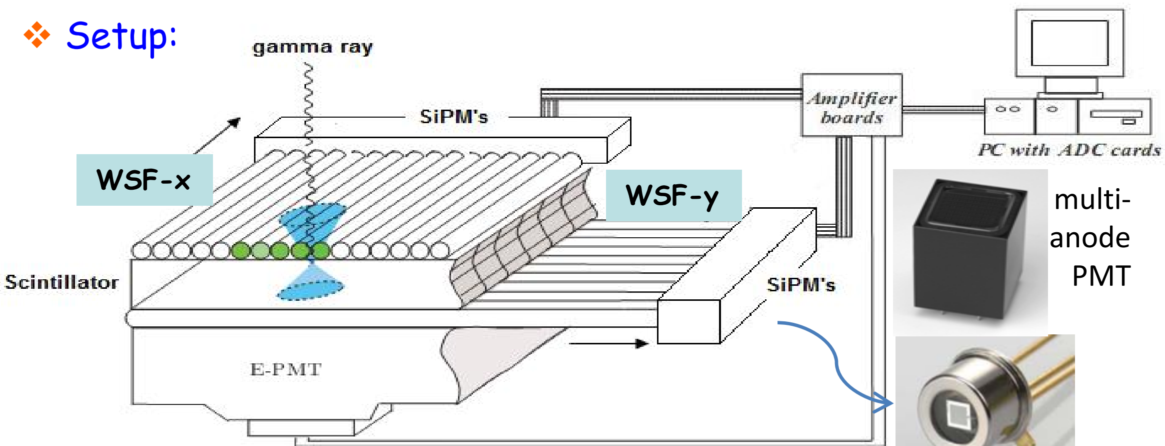
Poster ID 168

First steps towards small prototype gamma camera based on wavelength shifting fibers

I.F.C. Castro and L.M. Moutinho *et al.* – i3n, Physics Dept, Univ. of Aveiro, Portugal

- **Context:** development of higher resolution gamma cameras is interesting in cancer diagnosis

- **Setup:**



CsI(Na) crystal and 1 mm Ø Bicron BC-91A fibers

1x1 mm^2 Hamamatsu MPPC

Gamma camera :

- based on optical fibers (1mm ø)
- coupled to both sides of inorganic scintillation crystals (CsI-Na)
- readout of the scintillation light by means of light guides, namely **Wavelength Shifting Fibers**

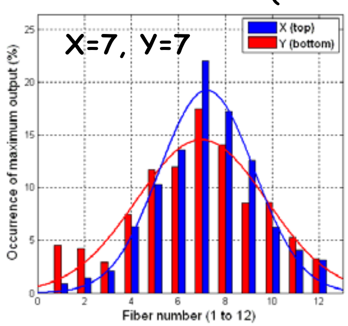
Spatial resolution = 1-2 mm FWHM

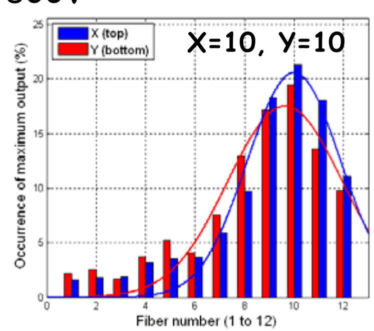
Go to Poster 168

- **Test of small prototypes using collimated Co^{57} (122 keV)**

12 fibers prototype with MaPMT

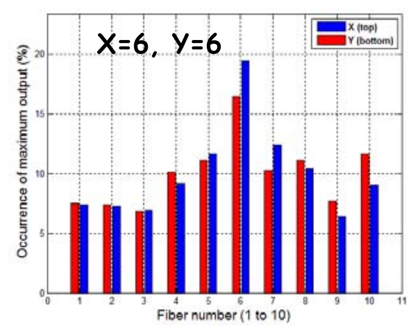
V(MaPMT)= -800V

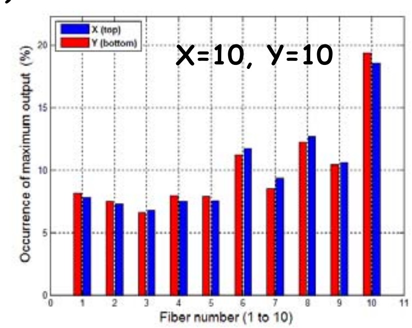




10 fibers prototype with SiPMs

T ~ 20°C, V_b(common to all)= -70.5V





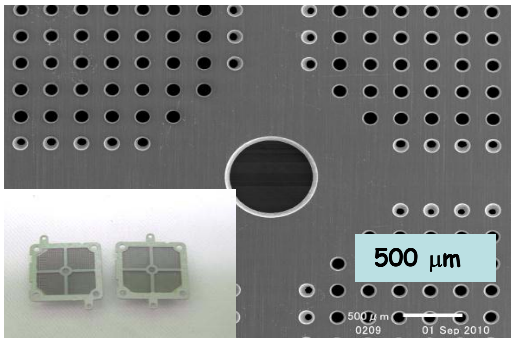
Position of maximum output signal for different collimator hole positions

New Micromesh Gas Detector for Gaseous Photomutiplier

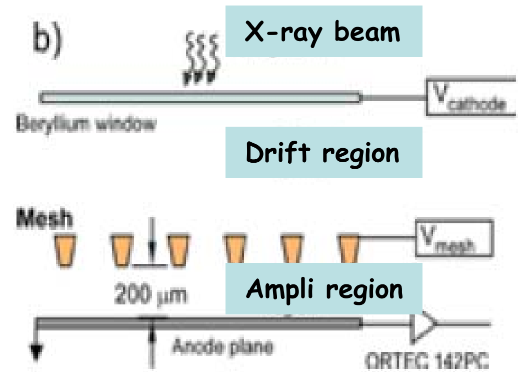
F Tokanai *et al.* – Dept of Physics, Yamagata University, Japan

- **Gaseous PMT:** can achieve a very large effective area *but* moderate position and timing resolutions

Development of a New Micro Mesh Gas (Micromegas) detector

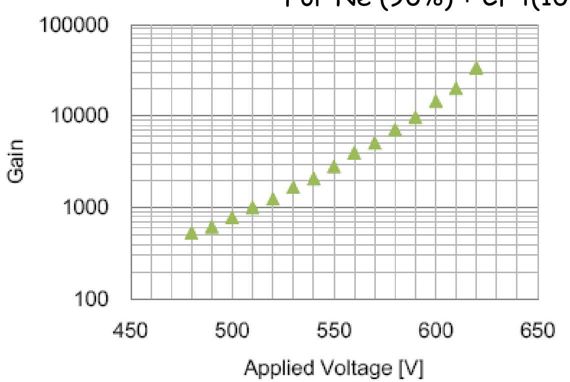


- fabricated by chemical etching in conical holes on the metal of 46μm thickness
- holes diameters = 80 and 120 μm - Pitch = 250 μm
- drift and absorption region for X-rays = 5 mm
- amplification region (between mesh and anode) where a high electric field is formed to induce electron avalanches = 150 to 200 μm

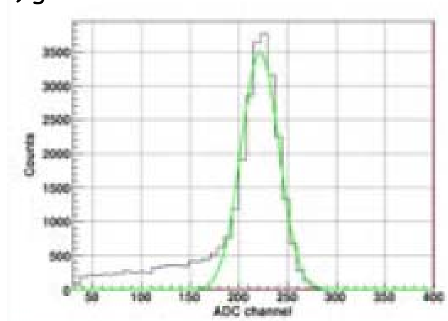


Performance test using X-rays (6keV)

For Ne (90%) + CF4(10%) gaz mixture at 1 atm



Gain up to 2×10^4



Energy resolution of 18%

Performance test using UV light

Development of a gaseous PMT composed of a CsI photocathode and the Micromegas detector

Gain up to 2×10^4 for $V_{applied}$ = 500V

Encouraging results to develop a gaseous PMT with a bialkali photocathode sensitive to visible light !

More results on Poster 45

WELCOME TO POSTER SESSION II !

All contributors are looking forward to seeing you in the Poster and Exhibition Hall