



6th International Conference on New Developments In Photodetection

Lyon, France, 4-8 July 2011

International Advisory Committee

A. Breskin (Israel)
J-L. Faure (France)
T. Gys (Switzerland)
C. Joram (Switzerland)
D.W. Kim (Korea)
R. Lecomte (Canada)
E. Lorenz (Switzerland)
C. Manolo (Brazil)
A. Migdall (USA)
Y. Musienko (Russia)
E. Nappi (Italy)
A. Owens (Netherlands)
T. Patzak (France)
L. Strueder (Germany)
T. Takahashi (Japan)
Y. Wang (China)

Local Organizing Committee

P. Bourgeois (CEA-IRFU)
B. Cordier (CEA-IRFU)
L. Coudray (CEA-IRFU)
M. Crolzé (IN2P3-IPNL)
S. Daghlani (CEA-IRFU)
A. Dominjon (IN2P3-IPNL)
H. El Mamouni (UCBL-IPNL)
O. Limousin (CEA-IRFU)
P. Nédélec (UCBL-IPNL)
S. Normand (CEA-DCS)
A. Penquer (CNES)
V. Puhli (IN2P3-LAL)

J-C. Vanel (CNRS-PICM)

Realisation M. Croize - IPNL

HIGHLIGHTS on Poster Session 3 Thursday, 15:20 – 16:30 Rémi Chipaux CEA/IRFU

<http://www.ndip.fr>

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





6th International Conference on

New Developments In Photodetection

Lyon, France, 4-8 July 2011

18 posters

16 highlight slides received

2 noshow

PMT (11, PSPMT 6)

APD, PD, SiPM

in astro- and high-energy physics (7)

Crystals (2)

International Advisory Committee

A. Breskin (Israel)
J-L. Faure (France)
T. Gys (Switzerland)
C. Joram (Switzerland)
D.W. Kim (Korea)
R. Lecomte (Canada)
E. Lorenz (Switzerland)
C. Manolo (Brazil)
A. Migdall (USA)
Y. Musienko (Russia)
E. Nappi (Italy)
A. Owens (Netherlands)
T. Patzak (France)
L. Strueder (Germany)
T. Takahashi (Japan)
Y. Wang (China)

Local Organizing Committee

P. Bourgeois (CEA-IRFU)
B. Cordier (CEA-IRFU)
L. Coudray (CEA-IRFU)
M. Crolzé (IN2P3 -IPNL)
S. Daghlian (CEA-IRFU)
A. Dominjon (IN2P3 -IPNL)
H. El Mamouni (UCBL-IPNL)
O. Limousin (CEA-IRFU)
P. Nédélec (UCBL-IPNL)
S. Normand (CEA-DCS)
A. Penquer (CNES)
V. Puhli (IN2P3 -LAL)

J-C. Vanel (CNRS-PICM)

<http://www.ndip.fr>

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





Multi-PMT optical module for the KM3NeT neutrino telescope

Description,
comparison,
optimisation,
simulation
of KM3Net
optical modules

International
Advisory Committee

A. Breskin (Israel)

J.-L. Faure (France)

T. Gysels (Belgium)

C. Joram (Switzerland)

D.W. Kim (Korea)

R. Kotlyar (USA)

E. Lorenz (Switzerland)

C. M. M. (France)

A. Miedall (USA)

Y. (France)

E. Nappi (Italy)

A. Owens (USA)

T. (France)

L. Strueder (Germany)

T. (France)

Y. Wang (China)

Local Organizing
Committee

P. Bourgeois (CEA-IRFU)

B. Cordier (CEA-IRFU)

L. Coudray (CEA-IRFU)

M. Crolzé (IN2P3 -IPNL)

S. Daghlian (CEA-IRFU)

A. Dominjon (IN2P3 -IPNL)

H. El Mamouni (UCBL-IPNL)

O. Limousin (CEA-IRFU)

P. Nédélec (UCBL-IPNL)

S. Normand (CEA-DCS)

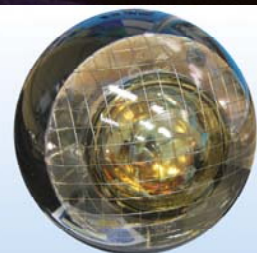
A. Penquer (CNES)

V. Puiu (IN2P3-IAL)

J.-C. Vanel (CNRS-PICM)

6th International Conference

Realisation M. Croize - IPNL



One 10-inch PMT



31 3-inch PMTs

Advantages of Multi-PMT OM

- + wide-angle photon acceptance
- + reduced environmental background by requiring local coincidences
- + good QE and transit time spread
- + increased photocathode area by reflective rings surrounding PMTs
- + longer PMT lifetime
- + no magnetic shielding needed
- + colour point-to-point connections
- ! advantageous also for other projects
- ! based on single-photon detection

Status: prototypes and pre-production models

I Oleg Kalekin

(ID40)

Photomultipliers for the KM3NeT optical modules

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

International
Advisory Committee

- A. Breskin (Israel)
- J-L. Faure (France)
- T. Gys (Switzerland)
- C. Joram (Switzerland)
- D.W. Kim (Korea)
- R. Lecomte (Canada)
- E. Lorenz (Switzerland)
- C. Manolo (Brazil)
- A. Migdal (USA)
- Y. Musienko (Russia)
- E. Nappi (Italy)
- A. Owens (Netherlands)
- T. Patzak (France)
- L. Strueder (Germany)
- T. Takahashi (Japan)
- Y. Wang (China)

Results of test of 3" PMTs

R6233-01 from Hamamatsu

D783KFLA from ETEL

Local Organizing
Committee

- P. Bourgeois (CEA-IRFU)
- B. Cordier (CEA-IRFU)
- L. Coudray (CEA-IRFU)
- M. Crolzé (IN2P3 -IPNL)
- S. Daghlian (CEA-IRFU)
- A. Dominjon (IN2P3 -IPNL)
- H. El Mamouni (UCBL-I)
- O. Limousin (CEA-IRFU)
- P. Nédélec (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Puhli (IN2P3 -IAL)

J-C. Vanel (CNRS-PICM)

Realisation M. Croize - IPNL



Multidimensional fiber optic radiation sensor for ocular proton therapy

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

International Advisory Committee

- A. Breskin
- J.-L. Faure
- T. Gys (Swi)
- C. Joram (S)
- D.W. Kim (K)
- R. Lecomte
- E. Lorenz (S)
- C. Manolopoulos
- A. Migdal
- Y. Musienko
- E. Nappi (It)
- A. Owens(N)
- T. Patzak (F)
- L. Strueder
- T. Takahashi
- Y. Wang (Ch)

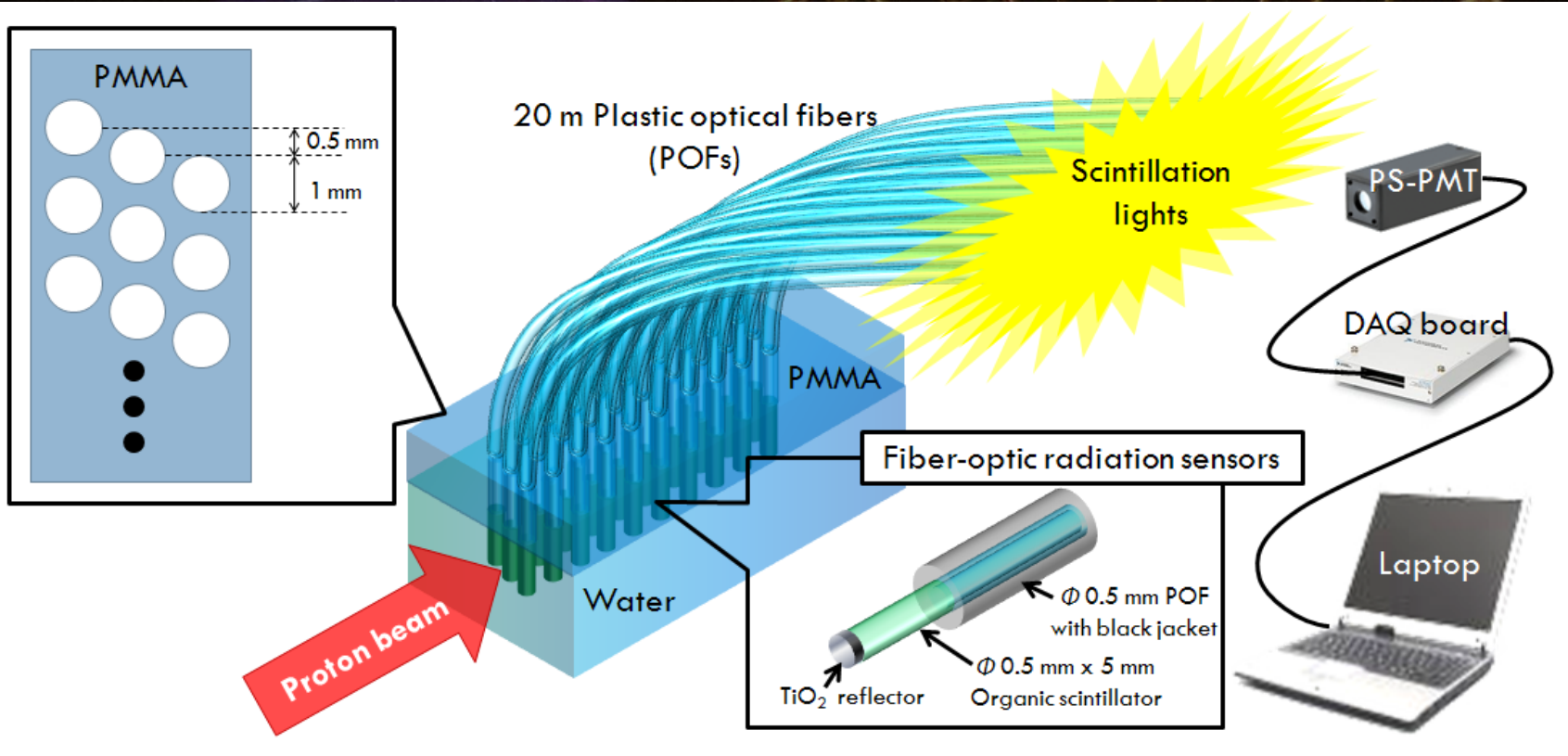
Local Organizing Committee

- P. Bourgeois
- B. Cordier
- L. Coudray
- M. Crolzé
- S. Daghlarian
- A. Dominjon
- H. El Mami
- O. Limousin
- P. Nédélec

- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Pelli (IN2P3-LAL)

J.-C. Vanel (CNRS-PICM)

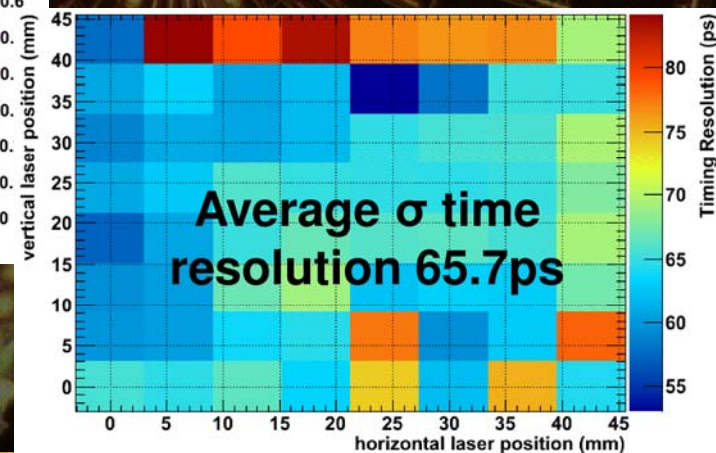
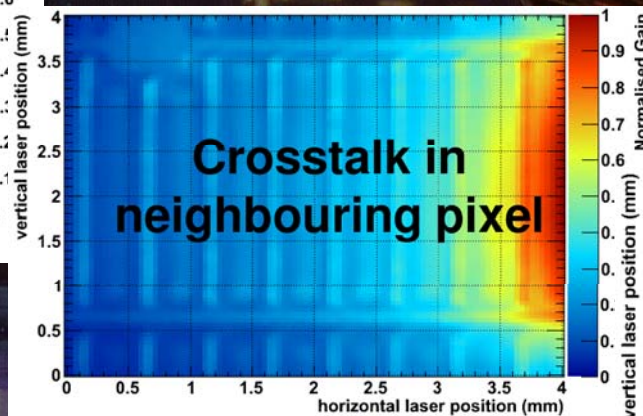
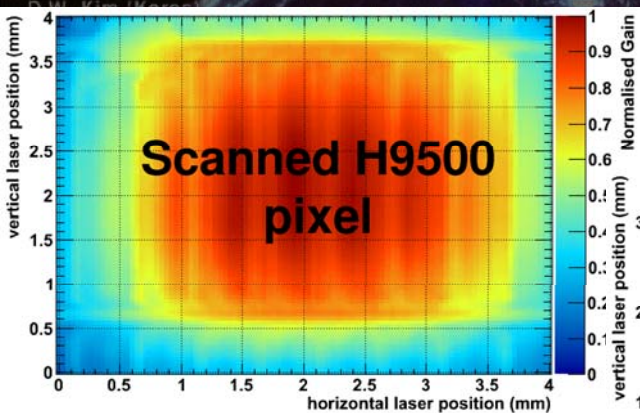
Realisation M. Croize - IPNL



IV Rachel Montgomery (ID67)

Multi-anode photomultiplier tubes studies for imaging applications

Precise study of homogeneity of H9500 and H8500 Hamamatsu MAPMTs



P. Bourgeois (CEA-IRFU)
B. Cordier (CEA-IRFU)
L. Coudray (CEA-IRFU)
M. Croizé (IN2P3-IPNL)
S. Daghlani (CEA-IRFU)
A. Dominjon (IN2P3-IPNL)
H. El Mamouni (UCBL-IPNL)
O. Limousin (CEA-IRFU)
P. Nédélec (UCBL-IPNL)
S. Normand (CEA-DCS)
A. Penquer (CNES)
V. Puhli (IN2P3-LAL)

J-C. Vanel (CNRS-PICM)
Realisation M. Croizé - IPNL

Characterization and calibration of a scintillating fibre detector

How do you calibrate a fibre detector with ~20000 scintillating fibres and 4600 channels?

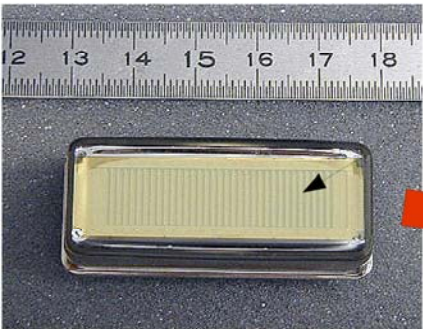


Solution:
Automatize the **entire** process!



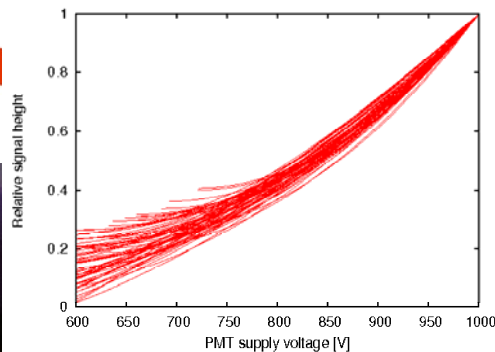
Automated source positioning:
accuracy: 0.1 mm

144 Hamamatsu H7259K



32 channels

144 multianode PMTs calibrated



- Automated data acquisition, analysis, detector operation and source positioning
- ~ 10000 spectra measured and analyzed
- ~ 100 faulty channels identified
- 2300 discriminator thresholds determined

A. Dominjon (IN2P3-IPNL)
 H. El Mamouni (UCBL-IPNL)
 O. Limousin (CEA-IRFU)
 P. Nédélec (UCBL-IPNL)
 S. Normand (CEA-DCS)
 A. Penquer (CNES)
 V. Pohl (IN2P3-LAL)

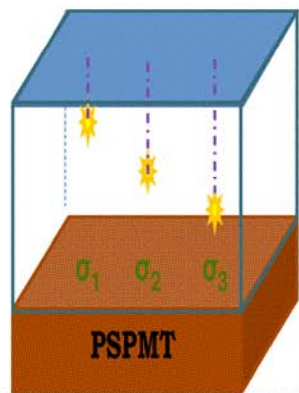
J-C. Vanel (CNRS-PICM)

Performance results of a DOI-encoding small animal PET system with monolithic scintillators

INTRODUCTION : DOI information to correct PARALLAX ERROR

The width of the light distribution scintillator collected on the PMT entrance window depends on the DOI.

$$\sigma = f(\text{DOI}) \quad \sigma_1 > \sigma_2 > \sigma_3$$



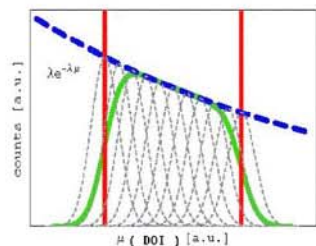
★ Interaction point
 --- DOI: normal distance between the entrance surface of the crystal and the interaction point

σ width of the light distribution collected on the PMT entrance surface.

$$\text{DOI} = f^{-1}(\sigma)$$

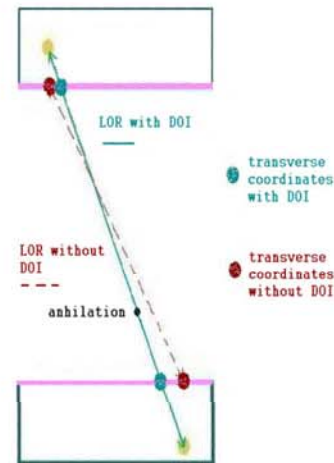
Enhanced
 CDR
 measures
 σ

We have a DOI-encoding system, where the theoretical model for the DOI distribution is the Erf function.



--- attenuation law for the photons in the crystal
 | interval limits of possible DOIs, corresponds to the limit surfaces of the crystal width: (entrance and PMT coupled surfaces)
 --- DOI distribution for specific depth
 | expected DOI distribution when all possible DOI are considered

The DOI information is included in the LOR parameterization to correct the parallax error.



VII

Sune Jakobsen

(ID82)

Calibration, testing, commissioning and first data of ALPHA at LHC

International Advisory Committee

A. Breskin (Israel)

J.-L. Faure (France)

T. Gys (Switzerland)

C. Lippmann (France)

D. W. Kim (Korea)

R. Konecny (Czechia)

E. Lorenz (Switzerland)

C. Mariani (Brazil)

A. Nigam (India)

Y. Musienko (Russia)

E. Napier (UK)

A. Owens (Netherlands)

T. Papp (France)

L. Stiller (Germany)

T. Takahashi (Japan)

Y. Wang (China)

Local Organizing Committee

P. Bourgeois (CEA-IRFU)

B. Goussard (CEA-IRFU)

L. Courday (CEA-IRFU)

M. Croizé (IN2P3-IPNL)

S. Daghlani (CEA-IRFU)

A. Dominjon (IN2P3-IPNL)

H. El Mamouni (UCBL-IPNL)

O. Limousin (CEA-IRFU)

P. Nédélec (UCBL-IPNL)

S. Normand (CEA-DCS)

A. Penquer (CNES)

V. Puhl (IN2P3-LAL)

J.-C. Vanel (CNRS-PICM)

Realisation M. Croizé - IPNL

Layers of scintillating fibers read by PSPMT's (Hamamatsu R7600) + trigger tiles read by PMT's (R74000P and R9880-100) via clear fibers

to measure LHC luminosity for ATLAS experiment.

Calibration, testing, commissioning and first data of ALPHA at LHC
Sune Jakobsen (Jakobsen@nbi.dk) for the Absolute Luminosity For ATLAS community
CEBN, FN-ADO, NIELA BOHR INSTITUTE, UNIVERSITY OF COPENHAGEN

Luminosity determination from elastic scattering

LHC

240 m

ATLAS

240 m

ALFA Monitor: the absolute luminosity independent from beam parameters.

Method: Measuring elastic scattering in the Coulomb region (only a small angle $\sim 5 \mu\text{rad}$).

Small Edgeless tracking detector very close to the system at large distance from the interaction point.

ALFA Pot: Modular vessel surrounding the detector from the ultra-high beam vacuum.

Edgeless

Beam pipe

Measuring position

Garage position

The ALPHA detector system

Edgeless tracking detector: Scintillating fibers has been chosen which are fully active already at $\sim 200 \mu\text{m}$ from the end edge. The fibers are positioned in a 12×12 configuration with 64 fibers in each layer.

Fiber cladding: To improve detector resolution the wire-wrapped copper scintillating fibers (Hamamatsu RCFP-75, 8 type, $0.5 \times 0.5 \times 0.007$ mm) arranged in staggered layers gives an overall detector resolution of $\sim 30 \mu\text{m}$.

Gain equalization: The gain of MAPMT channels differs up to a factor 3 and is within the gain variation about a factor 2 from one MAPMT to another. The position of the photoelectron (PE) is therefore measured using low intensity subpixel LED light. Amplification in the MARCO-2 chip was applied to equalize all channels.

Test with cosmic particles

The detectors with full Front-End electronics was tested with cosmic particles before installation and the light yield of each scintillating fiber determined.

Average light yield in one detector layer

Fiber crosstalk - blackening of Roman Pot window

First beam data showed more higher than expected fiber crosstalk. Laboratory tests found that the additional fiber crosstalk back to reflections on the Roman Pot window. Before installation on LHC, the Roman Pot window was therefore blackened with $\sim 100 \text{ nm}$ SiO₂ (graphite) layer.

First data from LHC

All detectors have been installed in the LHC tunnel left and right of ATLAS and the very first data for commissioning have been taken. Left is shown a track in a detector channel as it has indication MAPMT crosstalk, which is expected at low level and right a track ring taking with the detector in garage position.

VIII

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

Julien Chabaud, Paris (ID88)

Studies of anticoincidence systems: application to Simbol-X and IXO/HXI

International Advisory Committee

A. Breskin (Israel)
J-L. Faure (France)
T. Gys (Switzerland)
C. Joram (Switzerland)
D.W. Kim (Korea)
R. Lecomte (Canada)
E. Lorenz (Switzerland)
C. Manolo (Brazil)
A. Migdal (USA)
Y. Musienko (Russia)
E. Nappi (Italy)
A. Owens (Netherlands)
T. Patzak (France)
L. Strueder (Germany)
T. Takahashi (Japan)
Y. Wang (China)

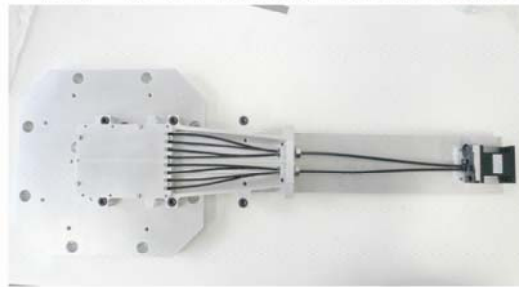
Local Organizing Committee

P. Bourgeois (CEA-IRFU)
B. Cordier (CEA-IRFU)
L. Coudray (CEA-IRFU)
M. Crolzé (IN2P3 -IPNL)
S. Daghilan (CEA-IRFU)
A. Dominjon (IN2P3 -IPNL)
H. El Mamouni (UCBL-IPNL)
O. Limousin (CEA-IRFU)
P. Nédélec (UCBL-IPNL)
S. Normand (CEA-DCS)
A. Penquer (CNES)
V. Puhl (IN2P3-LAL)

J-C. Vanel (CNRS-PICM)

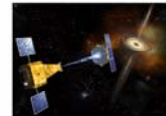
Simbol - X Concept

Hamamatsu H8711-100MOD MAPM
Kuraray Wavelength shifting optical fibers
BC-400 Plastic scintillator



In the poster :

- ⇒ Experimental results
- ⇒ GEANT4 simulation results
- ⇒ Vibration tests



IXO/HXI Concept

Hamamatsu S664-1010 APD
St-Gobain BGO crystal



In the poster :

- ⇒ Experimental results
- ⇒ GEANT4/SLitran simulation results



X

NDIP

6th International Conference on New Developments in Photodetection Yury Musienko, (ID15)

Hadron calorimeter with MAPD readout in the NA61/Shine experiment

International Advisory Committee

- A. Breskin (Israel)
- J-L. Faure (France)
- T. Gys (Switzerland)
- C. Joram (Switzerland)
- D.W. Kim (Korea)
- R. Lecomte (Canada)
- E. Lorenz (Switzerland)
- C. Manolo (Brazil)
- A. Migdal (USA)
- Y. Musienko (Russia)
- E. Nappi (Italy)
- A. Owens (Netherlands)
- T. Patzak (France)
- L. Strueder (Germany)
- T. Takahashi (Japan)
- Y. Wang (China)

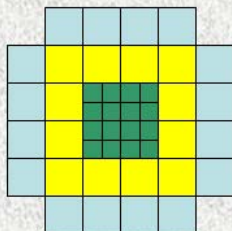
Local Organizing Committee

- P. Bourgeois (CEA-IRFU)
- B. Cordier (CEA-IRFU)
- L. Coudray (CEA-IRFU)
- M. Crolzé (IN2P3-IPNL)
- S. Daghlian (CEA-IRFU)
- A. Dominjon (IN2P3-IPNL)
- H. El Mamouni (UCBL-IPNL)
- O. Limousin (CEA-IRFU)
- P. Nédélec (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Puiu (IN2P3-LAL)

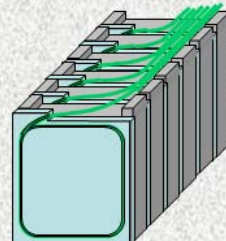
J-C. Vanel (CNRS-PICM)

Realisation M. Croize - IPNL

Hadron calorimeter structure and readout

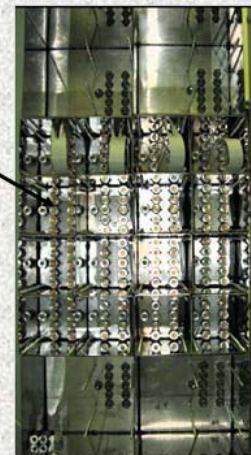
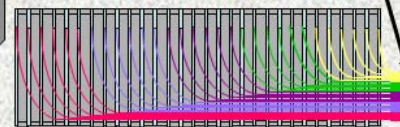


44 individual modules with longitudinal segmentation in 10 sections



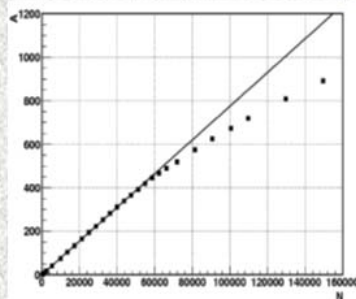
Each module consists of 60 lead-scintillator sandwiches with WLS-fibers

10 MAPD-3A per module

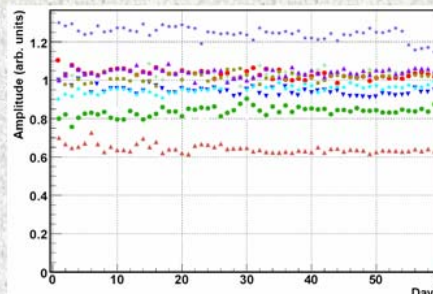


Rear side during assembling. 440 MAPD are used.

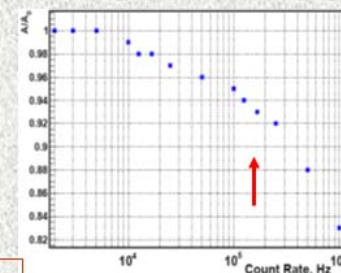
Some properties of MAPD-3A



Dependence of MAPD amplitude on the number of falling photons.



Long-term test: 10 MAPDs were illuminated by LED pulses with $f=1$ MHz and amplitude $\sim 10^4$ ph.e at $T \sim 30$ °C during 2 months. No changes in gain and dark current were observed.



Dependence of MAPD amplitude on the frequency of ~ 2000 ph.e signal

Extensive studies of MRS APD for plastic scintillator muon veto detector of cryogenic experiments



EXTENSIVE STUDIES OF MRS APDs FOR PLASTIC SCINTILLATOR MUON VETO DETECTOR OF CRYOGENIC EXPERIMENTS

Characterization of MRS APDs

Extensive studies of the main parameters of MRS APDs have been performed:

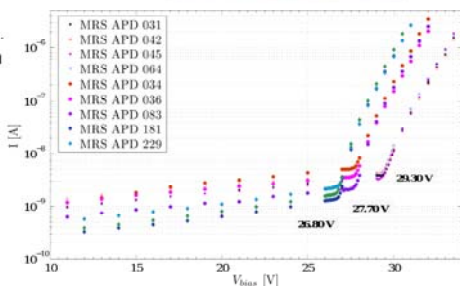
- I-V Characteristics

- Reverse I-V Characteristics

- Determination of breakdown voltages.
- Temperature dependency of V_{bd} .
- Identification of damaged MRS APDs.
- For some MRS APDs a strange dip in the I-V curve just preceding the V_{bd} value has been observed.

- Forward I-V Characteristics

- Values of the quenching resistors.
- Temperature dependencies of the quenching resistor.

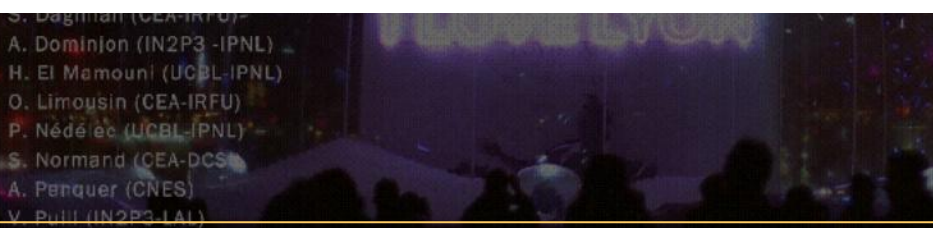
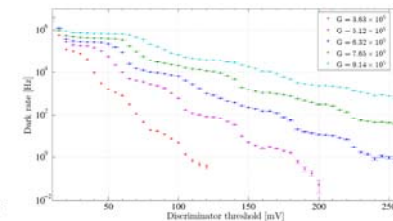
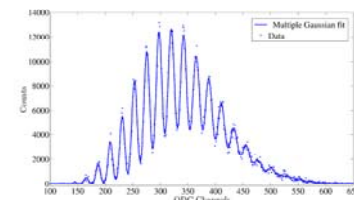
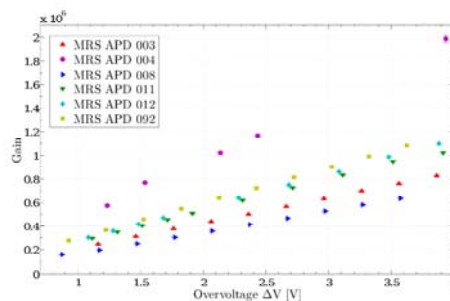


EXTENSIVE STUDIES OF MRS APDs FOR PLASTIC SCINTILLATOR MUON VETO DETECTOR OF CRYOGENIC EXPERIMENTS

- Gain measurements

- Dependency on the bias voltage.
- Temperature dependency.


- Dark rate measurements



Characterization and performance of multi-pixel photon counters in T2K experiment

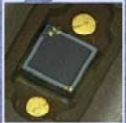

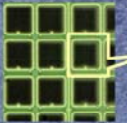
6th International Conference on New Developments In Photodetection
Lyon, France, 4-8 July 2011

Characterization and performance of multi-pixel photon counters in T2K experiment



Multi-pixel Geiger mode photodiode for T2K
Hamamatsu trademark is MPPC (Multi-Pixel Photon Counter)

26 x 26 pixel array,
9 pixels occupied by an electrode.

1.3 mm


Single pixel: $50 \times 50 \mu\text{m}^2$
 $C_{\text{pix}} = 90 \text{ fF}$
 $R_{\text{quench}} = 150 \pm 2 \text{ k}\Omega$

Hamamatsu type : S10362-13-50C

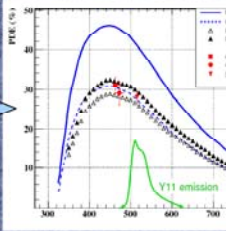
Number of pixels :	667
Pixel size :	$50 \times 50 \mu\text{m}^2$
Total sensitive area :	$1.3 \times 1.3 \text{ mm}^2$
Operational bias voltage :	$\sim 70 \text{ V}$
Operational overvoltage ΔV :	$\sim 1.3 \text{ V}$
PDE at 520 nm ($\Delta V = 1.3 \text{ V}$) :	$\sim 28 \%$
Gain at $\Delta V = 1.3 \text{ V}$:	0.75×10^6
Dark rate (thr=0.5 pe) :	$0.5 - 1.2 \text{ MHz}$
Recovery time τ :	13.4 ns
Optical crosstalk :	9 - 12 %
Afterpulsing :	14 - 16 %

$V_{\text{breakdown}}$ temp. coefficient:

Coupling of MPPCs to fibers in FGD detector



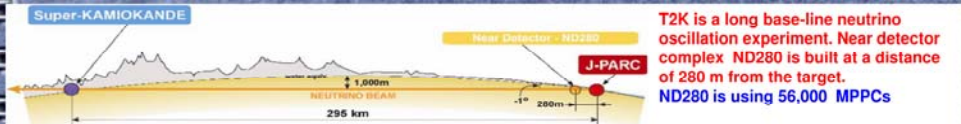
- MPPCs for T2K were developed to read out light from Y11 (Kuraray) WLS fibers of 1 mm diameter
1. Photon Detection Efficiency (PDE) is matched to the emission spectrum of Y11 fiber and reaches 28 % at 520 nm.
 2. Front size of MPPC ($1.3 \times 1.3 \text{ mm}^2$) is well suited for a coupling to 1 mm fibers.
 3. Number of pixels (667) is sufficient to provide the energy resolution for typical T2K signals.



Oleg Mineev (INR RAS, Moscow, Russia) on behalf of the T2K collaboration



First large scale application of multi-pixel Geiger mode photodiodes in the experiment.



History of MPPC application:

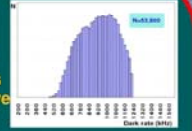
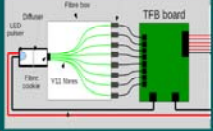
- Around 1996 first prototypes of multi-pixel Geiger mode photodiodes were patented in Russia.
- 2005 Hamamatsu had started to design the MPPC structure.
- 2008 Hamamatsu has started the mass production for T2K.
- 2009 MPPCs are successfully operating in beam runs.



- M. Croizé (IN2P3 -IPNL)
- S. Daghlian (CEA-IRFU)
- A. Dominjon (IN2P3 -IPNL)
- H. El Mamouni (UCBL-IPNL)
- O. Limousin (CEA-IRFU)
- P. Nédélec (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Puiu (IN2P3-IAL)
- J-C. Vanel (CNRS-PICM)

Quality Assurance

1. Hamamatsu tested all MPPCs before shipping to T2K. Hamamatsu specified the bias voltages for each MPPC to have the same gain at 25°C.
2. MPPCs were distributed among T2K groups for quality assurance tests.

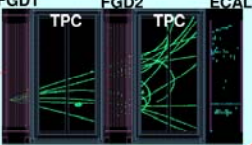
Average rejection rate by T2K was 0.1 % of all tested MPPCs.

Performance in the neutrino beam

ND280 detectors were running in the beam from December 2009 to March 2011. Failure rate in readout channels was found to be 0.17 % in average. The rate includes all possible reasons: MPPCs, cabling, front-end electronics.

First T2K result:
(on June 15, 2011)

Indication for $\nu_{\mu} \rightarrow \nu_e$ appearance



FGD1 TPC FGD2 TPC ECAL

Single photoelectron timing resolution of SiPM in function of the wavelength and the temperature

International Advisory Committee

- A. Breskin (Israel)
- J-L. Faure (France)
- T. Gys (Switzerland)
- C. Joram (Switzerland)
- D.W. Kim (Korea)
- R. Lecomte (Canada)
- E. Lorenz (Switzerland)
- C. Manolo (Brazil)
- A. Migdal (USA)
- Y. Musienko (Russia)
- E. Nappi (Italy)
- A. Owens (Netherlands)
- T. Patzak (France)
- L. Strueder (Germany)
- T. Takahashi (Japan)
- Y. Wang (China)

Local Organizing Committee

- P. Bourgeois (CEA-IRFU)
- B. Cordier (CEA-IRFU)
- L. Coudray (CEA-IRFU)
- M. Crolzé (IN2P3-IPNL)
- S. Daghlian (CEA-IRFU)
- A. Dominjon (IN2P3-IPNL)
- H. El Mamouni (UCBL-IPNL)
- O. Limousin (CEA-IRFU)
- P. Nédélec (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Puill (IN2P3-LAL)

J-C. Vanel (CNRS-PICM)

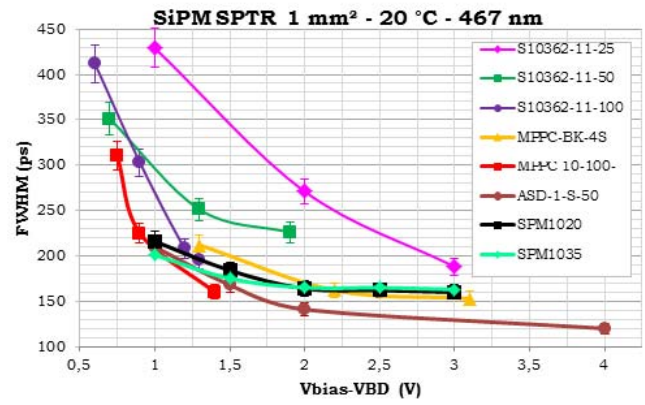
SPTR of SiPMs in function of the voltage, the wavelength and the temperature

Véronique PUILLE, CNRS-IN2P3-LAL

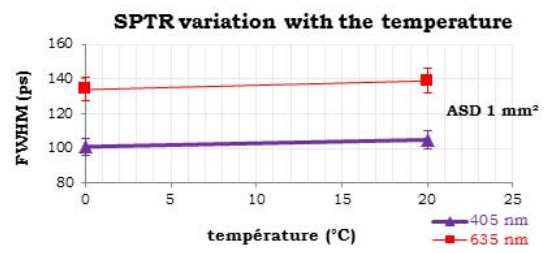
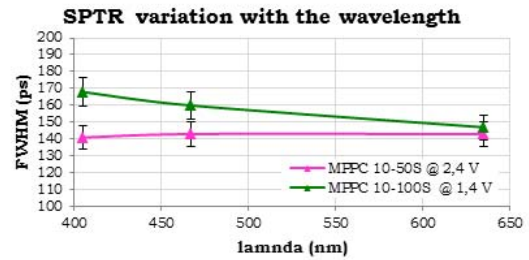
Study of the **SiPM Single Photoelectron Timing Resolution** variations with:

- ❖ the bias voltage
- ❖ the wavelength of the pulsed incident light : 405 – 467 - 635 nm
- ❖ the temperature : 0°C to 20 °C

13 devices from:



- best SPTR with high overvoltage
- small impact of the temperature on the timing resolution
- variation of the SPTR with the wavelength (dependant on the detector)



LaBr₃ and phoswiches LaBr₃+NaI or CsI for PARIS calorimeter at GANIL

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

International Advisory Committee

- A. Breskin (Israel)
- J-L. Faure (France)
- T. Gys (Switzerland)
- C. Joram (Switzerland)
- D W. Kim (Korea)
- R. Lecomte (Canada)
- E. Lorenz (Switzerland)
- C. Manolo (Brazil)
- A. Migdal (USA)
- Y. Musienko (Russia)
- E. Nappi (Italy)
- A. Owens (Netherlands)
- T. Patzak (France)
- L. Strueder (Germany)
- T. Takahashi (Japan)
- Y. Wang (China)

Local Organizing Committee

- P. Bourgeois (CEA-IRFU)
- B. Cordier (CEA-IRFU)
- L. Coudray (CEA-IRFU)
- M. Crolzé (IN2P3 -IPNL)
- S. Daghlian (CEA-IRFU)
- A. Dominjon (IN2P3 -IPNL)
- H. El Mamouni (UCBL-IPNL)
- O. Limousin (CEA-IRFU)
- P. Nédélec (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Puhl (IN2P3-IAL)

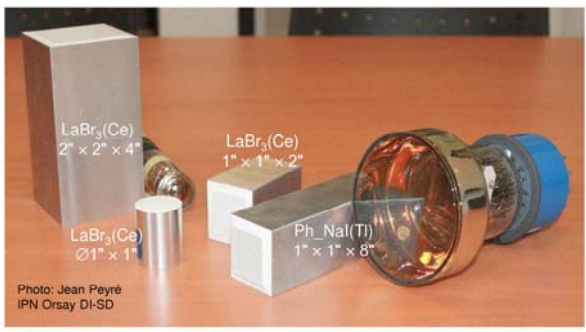
Energy resolution of LaBr₃:Ce in a Phoswich configuration with CsI:Na and NaI:Tl scintillator crystals

G. Hull, B. Genolini, M. Josselin, I. Matea, J. Peyré, J. Pouthas, T. Zerguerras
Institut de Physique Nucléaire d'Orsay - IN2P3-CNRS - Université Paris Sud 11

LaBr₃(Ce) bright and fast scintillator but really expensive → PHOSWICH SOLUTION to reduce the price without compromise the performances

We studied the performance of the LaBr₃(Ce) scintillator when optically coupled to NaI(Tl) and CsI(Na) for the R&D of the gamma ray calorimeter PARIS at SPIRAL2

Light yield and energy resolution measurements under γ excitation were performed by coupling the phoswiches with various photomultiplier tubes



Crystals	
LaBr ₃ (Ce)	1" × 1" × 2"
LaBr ₃ (Ce)	2" × 2" × 4"
LaBr ₃ (Ce)	Ø 1" × 1"
Ph_(1")NaI(Tl)	1" × 1" × 2" LaBr ₃ (Ce) 1" × 1" × 6" NaI(Tl)
Ph_(2")NaI(Tl)	2" × 2" × 2" LaBr ₃ (Ce) 2" × 2" × 6" NaI(Tl)
Ph_CsI(Na)	1" × 1" × 2" LaBr ₃ (Ce) 1" × 1" × 6" CsI(Na)

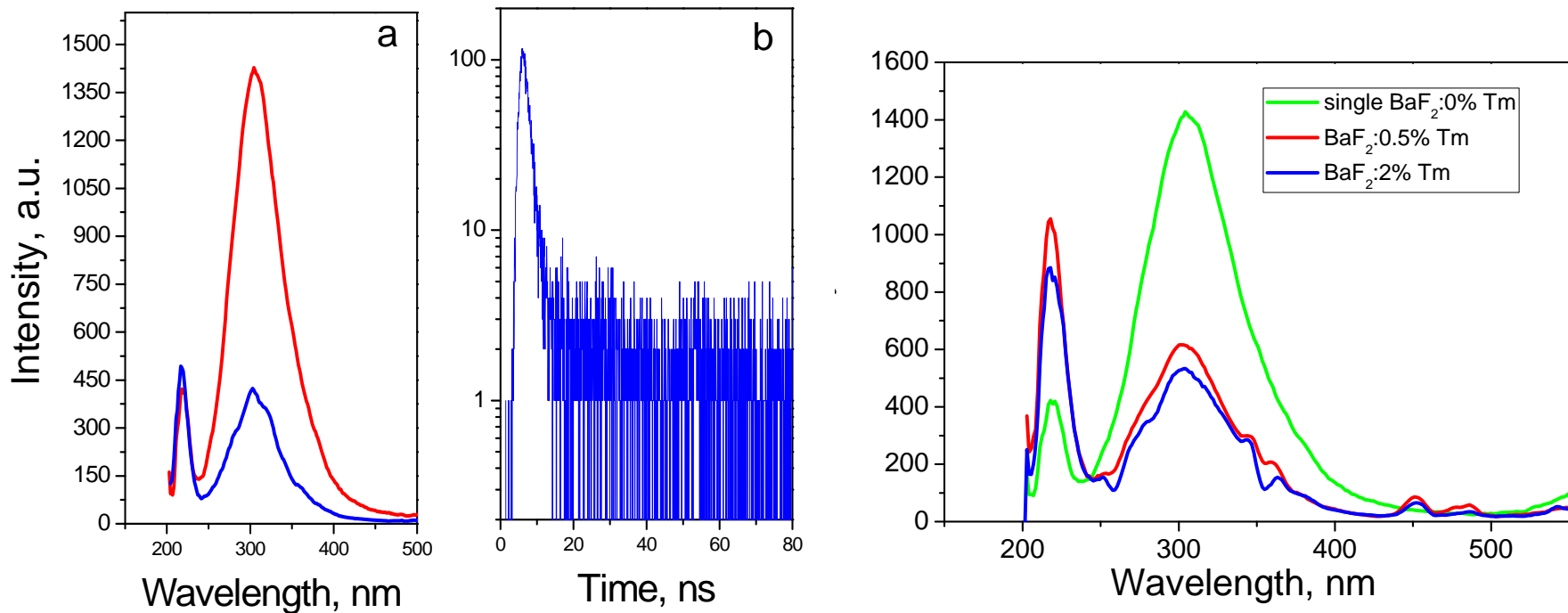
We are interested in investigating the possible degradation of the scintillation light produced by the LaBr₃(Ce) due to the fact that it has to pass through all the coupled crystal, before being detected at the PMT's the photocathode.

New fast scintillators on the base of BaF₂ crystals with increased light yield of 0.9 ns luminescence for TOF PET

International
Advisory Committee

A. Breskin (Israel)
J. J. Brodeur (Canada)
T. Gys (Switzerland)
C. Joram (Switzerland)
D. Kim (Korea)
R. Lecomte (Canada)

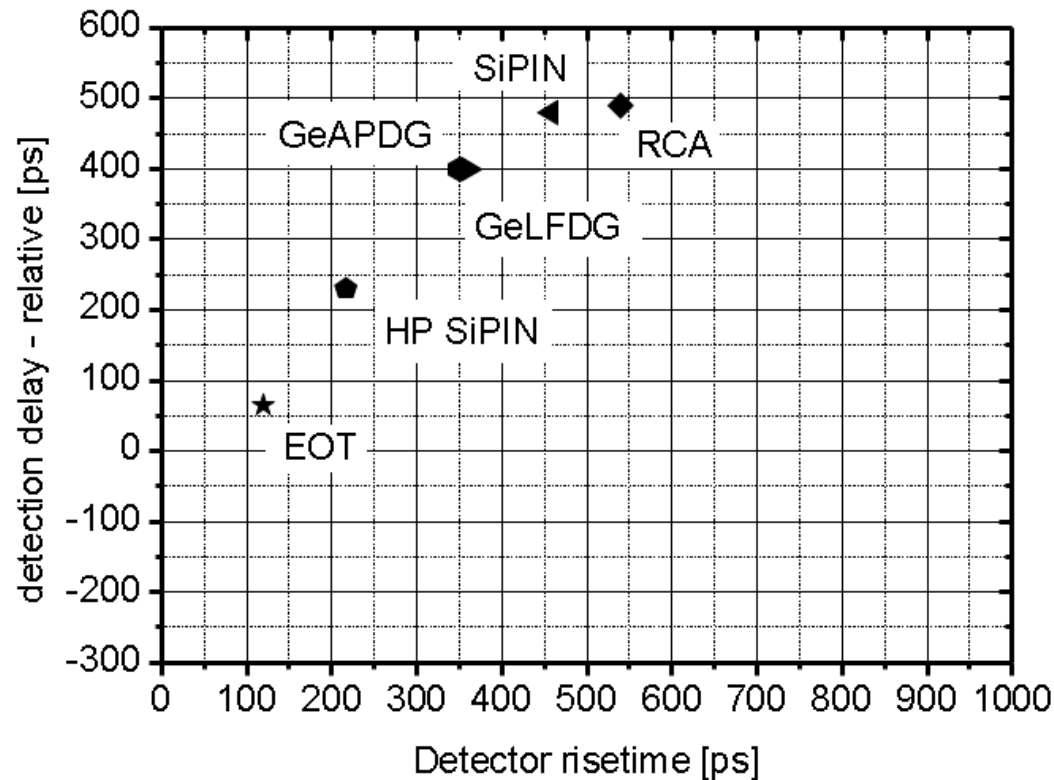
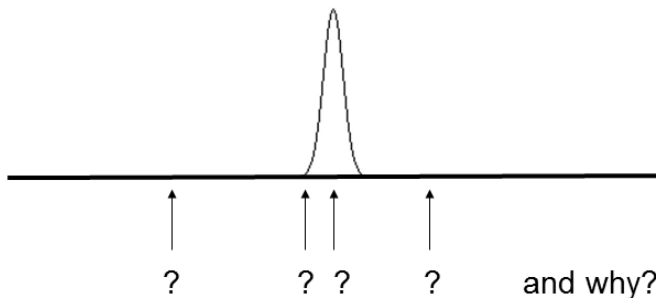
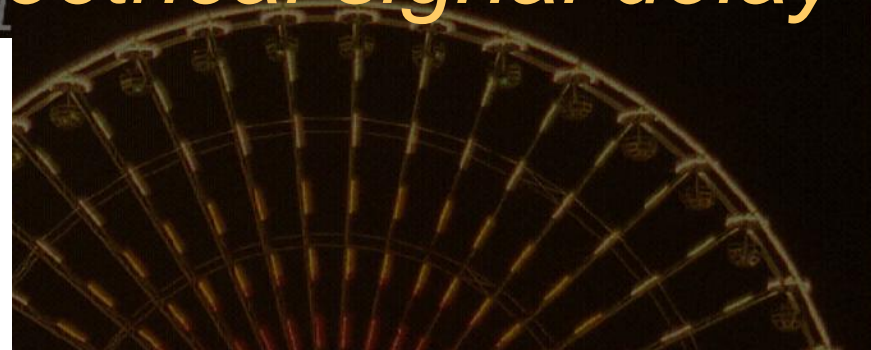
*enhancement of fast/slow ratio
in ceramics and Tm-doped barium fluoride crystals*



Photodiode optical to electrical signal delay

In the most measurements the delay of electrical signal generated by photodetector (photodiode in linear mode has been investigated) is determined only as relative

But what is the time position of electrical output with respect to time position of detected optical signal? (when the transient delay in cables and circuit structure is subtracted)



Local Organizing Committee

- P. Bourgeois (CEA-IRFU)
- B. Cordier (CEA-IRFU)
- L. Coudray (CEA-IRFU)
- M. Crolzé (IN2P3 -IPNL)
- S. Daghlilan (CEA-IRFU)
- A. Dominjon (IN2P3 -IPNL)
- H. El Mamouni (UCBL-IPNL)
- O. Limousin (CEA-IRFU)
- P. Nédélec (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Puhl (IN2P3-LAL)

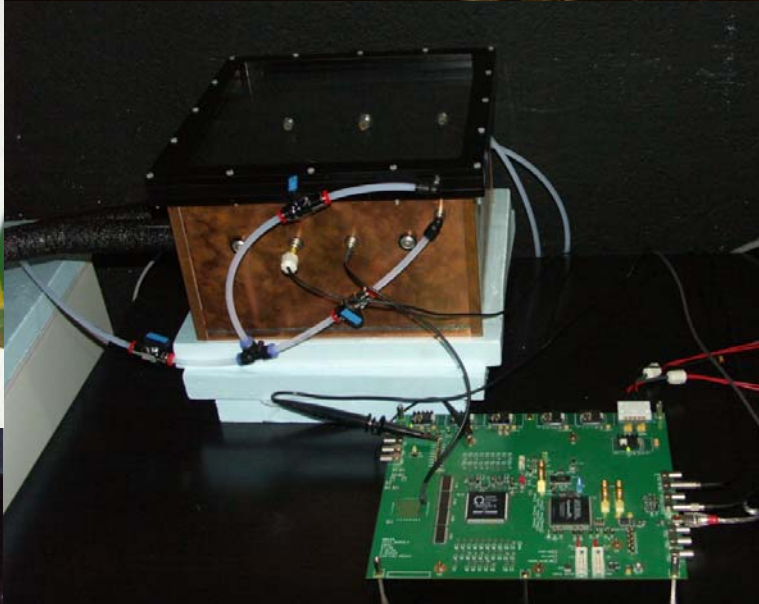
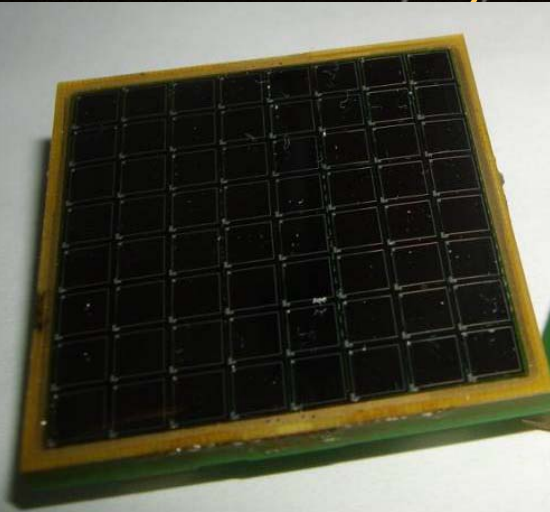
J-C. Vanel (CNRS-PICM)

XX

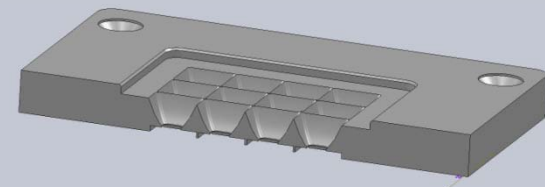
Pedro Rodrigues

(ID154)

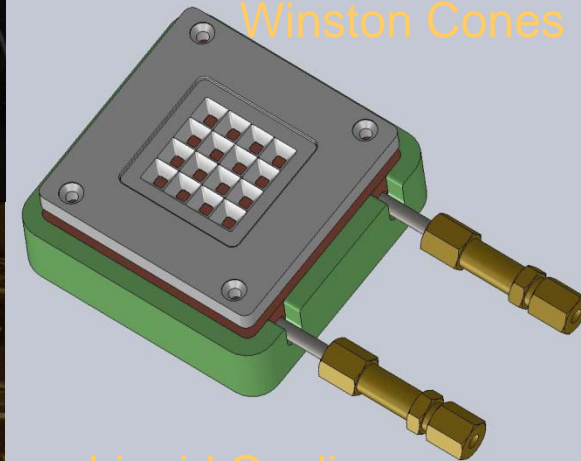
R&D in photosensors and data acquisition systems for the new generation of cosmic ray Cherenkov and fluorescence imaging focal plane



4x4 Array Prototype



Winston Cones



Liquid Cooling Plate

L. Strueder (Germany)
T. Takahashi (Japan)
Y. Wang (China)

Local Organizing Committee

P. Bourgeois (CEA-IRFU)
B. Cordier (CEA-IRFU)
L. Coudray (CEA-IRFU)
M. Crolzé (IN2P3 -IPNL)
S. Daghlian (CEA-IRFU)
A. Dominjon (IN2P3 -IPNL)
H. El Mamouni (UCBL-IPNL)
O. Limousin (CEA-IRFU)
P. Nédélec (UCBL-IPNL)
S. Normand (CEA-DCS)
A. Penquer (CNES)
V. Pühl (IN2P3-LAL)

J-C. Vanel (CNRS-PICM)

IX Roman Poleshchuk (ID142)

The observation of a new class of afterpulses in classical vacuum photomultipliers

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

International
Advisory Committee

- A. Breskin (Israel)
- J-L. Faure (France)
- T. Gys (Switzerland)
- C. Joram (Switzerland)
- D.W. Kim (Korea)
- R. Leromte (Canada)
- E. Mal'nev (Russia)
- C. Mariani (Italy)
- A. Migdal (USA)
- Y. Tsvetkov (Russia)
- E. Tsalikis (Italy)
- A. Owens (Netherlands)
- T. Patzak (France)
- L. Pusturjan (Spain)
- T. Takahashi (Japan)
- Y. Wang (China)

New class of after pulses

70 to 200 μ s delay

Amplitude is 1 pe

Probability is < 0.1%

Local Organizing
Committee

- P. Bourgeois (CEA-IRFU)
- B. Cordier (CEA-IRFU)
- L. Coudray (CEA-IRFU)
- M. Crolz  (IN2P3 -IPNL)
- S. Daghlani (CEA-IRFU)
- A. Dominjon (IN2P3 -IPNL)
- H. El Mamouni (UCBL-IPNL)
- O. Limousin (CEA-IRFU)
- P. N d e (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. P nquer (CNES)
- V. Puhl (IN2P3-IAI)

J-C. Vanel (CNRS-PICM)

Realisation M. Croiz  - IPNL

<http://www.ndip.fr>

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

The Observation of a New Class of Afterpulses in Classical Vacuum Photomultipliers
R.V. Poleshchuk¹, H.K. Lubsandorzhiev^{2,3}, R.V. Vasilyev¹
¹Institute for Nuclear Research of RAS, Moscow, Russia,
²Kepler Center for Atom and Particle Physics University of Tuebingen, Tuebingen, Germany

Introduction
Despite the fact that afterpulses in classical photomultipliers have been known for many decades [1-4], they are still not very well studied and usually debated. The issue is of unusual importance in the light of upcoming astroparticle physics experiments like JEM-EUSO [5], posing very strong requirements on the rate of afterpulses in vacuum photomultipliers.

Origin of afterpulses
There are several models explaining the origin of afterpulses. One can subdivide afterpulses into two groups: fast and long delayed afterpulses. The fast afterpulses occur up to 100 ns time distance after the main pulse, whereas the long ones occur in 100 ns - 10 μ s.

Fast afterpulses
The processes can be explained quite satisfactorily by backscattered electron production on ionization of atoms and molecules of the gas, which are ionized by the main pulse.

Long afterpulses
The long afterpulses are due to ions backscattered from the cathode and on the anode surface are accelerated back to photocathode and thereby emit secondary electrons. There are still a lot of questions that which ions (H⁺, He⁺, H₂⁺, H₃⁺, CH₃⁺, C₂⁺, ...) and where do they originate from? But nevertheless this class of afterpulses is one of the best studied and understood.

Extremely long afterpulses
We observed a new class of afterpulses with delay time in the range of 70-200 μ s from the main pulse in "GEM" tubes EM5850KH and EM5850KH (GEM). These afterpulses are delayed by 70-200 μ s measurements from the main pulse. The observation has been studied by both IEM of conventional type and EM5850KH of conventional type and EM5850KH (GEM) of conventional type and EM5850KH (GEM) of conventional type.

References
1. G.A. Sletten, H.M. Smith, R. Whiteman // IEEE Transactions on Nuclear Science, 1967, Vol. 14, P. 443-448.
2. P.R. Conley // Journal of Physics D: Applied Physics, 1971, Vol. 4, No. 10, P. 1199-1206.
3. P.R. Conley // J. Phys. D: Appl. Phys., 1975, Vol. 8, P. 1462-1476.
4. S. Tzeng, Y. Huang // Journal of Nuclear Science, Vol. 54, No. 12, December 1993, P. 1777-1780.
5. IJENA white paper, arXiv:1104.7629.

Conclusion
A new class of afterpulses with delay time in the range of 70-200 μ s from the main pulse in classical vacuum PMTs. These afterpulses are delayed by 70-200 μ s measurements from the main pulse. Their amplitude is at a single photoelectron level. The probability of these afterpulses is less than 0.1% per photoelectron. The origin of these afterpulses is not understood. But it is clear that they are not explained by ions which hit the main photocathode screen and so-called "backscattered" ions. The origin of these afterpulses is not understood. But it is clear that they are not explained by ions which hit the main photocathode screen and so-called "backscattered" ions.

XVII

6th International Conference on New Developments in Photodetection Denis Dauvergne (ID206)

Design and development of a TOF Compton camera for on-line control of hadron therapy

Lyon, France, 4-8 July 2011

International Advisory Committee

- A. Breskin (Israel)
- J-L. Faure (France)
- T. Gys (Switzerland)
- C. Joram (Switzerland)
- D.W. Kim (Korea)
- R. Lecomte (Canada)
- E. Lorenz (Switzerland)
- C. Manolo (Brazil)
- A. Migdal (USA)
- Y. Musienko (Russia)
- E. Nappi (Italy)
- A. Owens (Netherlands)
- T. Patzak (France)
- L. Strueder (Germany)
- T. Takahashi (Japan)
- Y. Wang (China)

Local Organizing Committee

- P. Bourgeois (CEA-IRFU)
- B. Cordier (CEA-IRFU)
- L. Coudray (CEA-IRFU)
- M. Crolzé (IN2P3-IPNL)
- S. Daghlani (CEA-IRFU)
- A. Dominjon (IN2P3-IPNL)
- H. El Mamouni (UCBL-IPNL)
- O. Limousin (CEA-IRFU)
- P. Nédélec (UCBL-IPNL)
- S. Normand (CEA-DCS)
- A. Penquer (CNES)
- V. Puhli (IN2P3-IAL)

J-C. Vanel (CNRS-PICM)

<http://www.ndip.fr>

6th International Conference on New Developments in Photodetection

Réalisation M. Croize - IPNL

IPNL *Creatis* **IPNL** **IPNL**

Design and development of a Time-of-Flight Compton camera for on-line control of hadrontherapy

M. Chauvaud¹, M. Hahnehbani², D. Dauvergne¹, G. Dethier¹, N. Dang¹, N. Engel¹, P. Ferry¹, J. Goussard¹, J. Guinard¹, J.M. Linaf¹, N. Mouton¹, G. Ray¹, M. H. Wernke¹, E. Yvon¹, A. H. Wulstschke¹, V. Zambelli¹

¹ Institut de Physique Nucléaire de Lyon, ² Centre de Recherche en Acquisition et Traitement de l'Image pour la Santé

Hadrontherapy control & prompt radiation

- Prompt radiation: induced by prompt neutrons, thermal neutrons, γ neutrons
- Prompt radiation: induced by prompt neutrons, thermal neutrons, γ neutrons
- Prompt radiation: induced by prompt neutrons, thermal neutrons, γ neutrons

Preliminary measurements (on prompt rays)

Prompt gamma camera design

Compton camera design

Beam telescope: requirements & prototype

Conclusions and perspectives



6th International Conference on New Developments In Photodetection

Lyon, France, 4-8 July 2011

Poster session III begins

now

in the exhibition hall.

International Advisory Committee

A. Breskin (Israel)
J-L. Faure (France)
T. Gys (Switzerland)
C. Joram (Switzerland)
D.W. Kim (Korea)
R. Lecomte (Canada)
E. Lorenz (Switzerland)
C. Manolo (Brazil)
A. Migdall (USA)
Y. Musienko (Russia)
E. Nappi (Italy)
A. Owens (Netherlands)
T. Patzak (France)
L. Strueder (Germany)
T. Takahashi (Japan)
Y. Wang (China)

Local Organizing Committee

P. Bourgeois (CEA-IRFU)
B. Cordier (CEA-IRFU)
L. Coudray (CEA-IRFU)
M. Croize (IN2P3 - IPNL)
S. Daghighi (CEA-IRFU)
A. Dominjon (IN2P3 - IPNL)
H. El Mamouni (UCBL-IPNL)
O. Limousin (CEA-IRFU)
P. Nédélec (UCBL-IPNL)
S. Normand (CEA-DCS)
A. Penquer (CNES)
V. Puhli (IN2P3 - IAL)

J-C. Vanel (CNRS-PICM)

