

Fiber and SiPM Tests

In-Person Barrel Imaging Calorimeter Meeting

Argonne National Lab

June 12-16, 2023

Z. Papandreou



University
of Regina



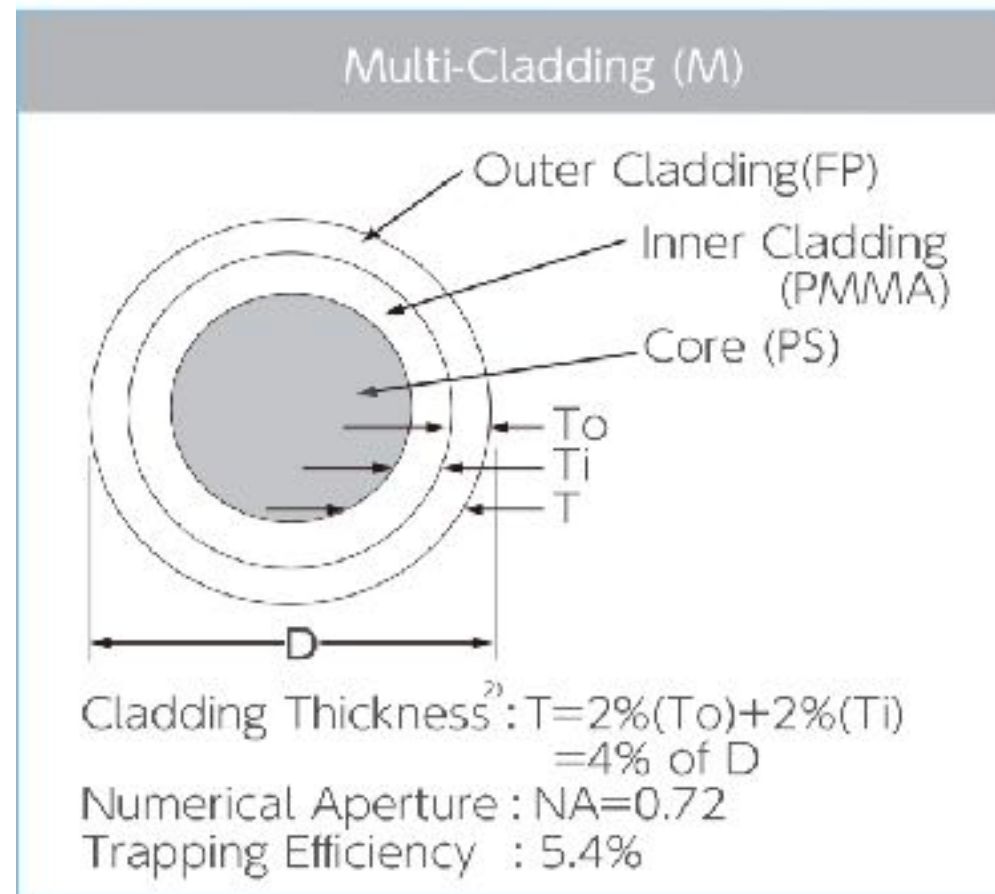
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Science



**NSERC
CRSNG**



Kuraray SCSF-78MJ



Formulations¹⁾

Description	Color	Emission Spectra	Peak[nm]	Decay Time [ns]	Att.Leng. ²⁾ [m]	Characteristics
SCSF-78	blue	See the following figure	450	2.8	>4.0	Long Att. Length and High Light Yield
SCSF-81	blue		437	2.4	>3.5	Long Attenuation Length
SCSF-3HF(1500)	green		530	7	>4.5	3HF formulation for Radiation Hardness

1) Test fibers are Non-S type, 1 mm ϕ .

2) Measured by using bialkali PMT and UV light(254nm).

Quality control is made by another measurement of the transmission loss every batch.

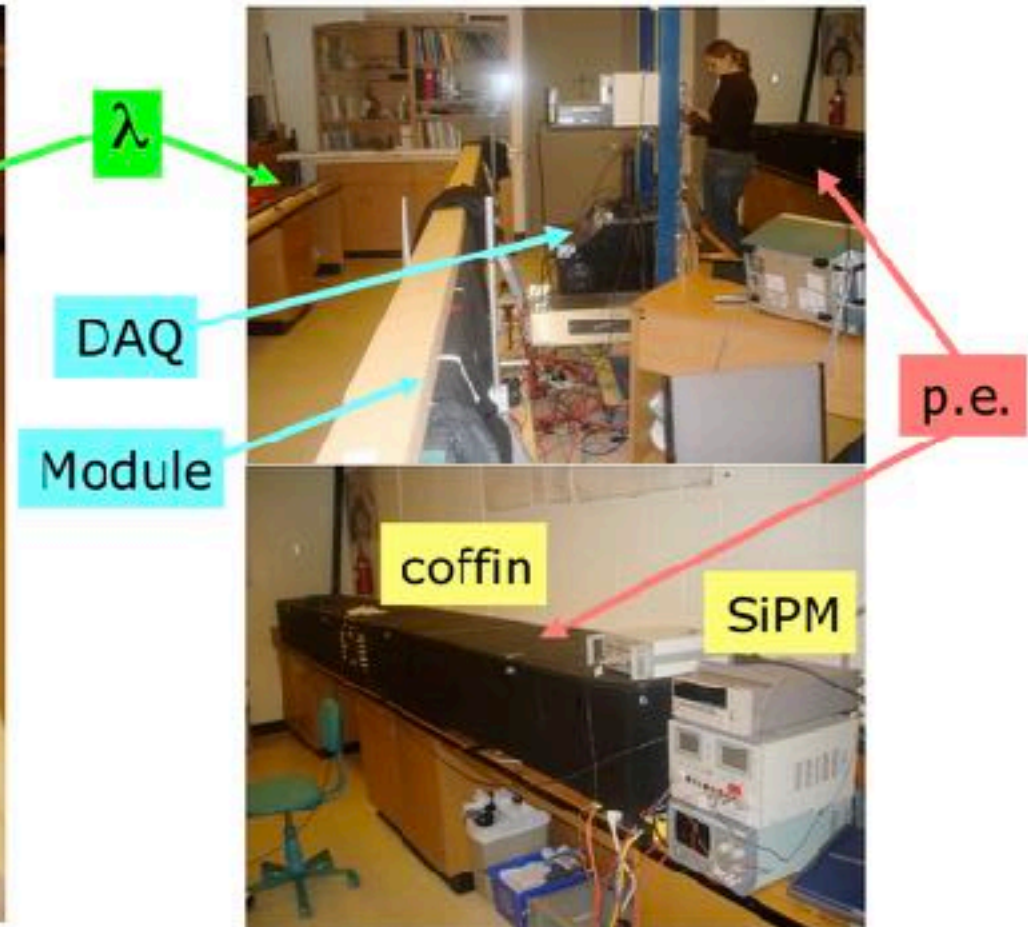
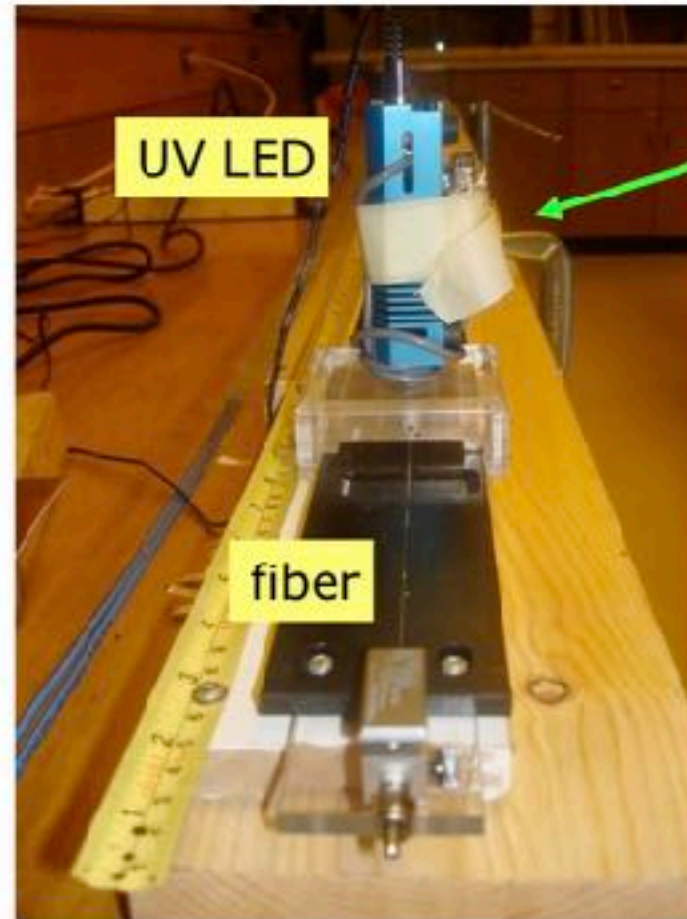
Fibre Testing lab

- First article

- Regina data
- JLab data
- GlueX-doc-1317
- Bench Reference

- Production (Regina)

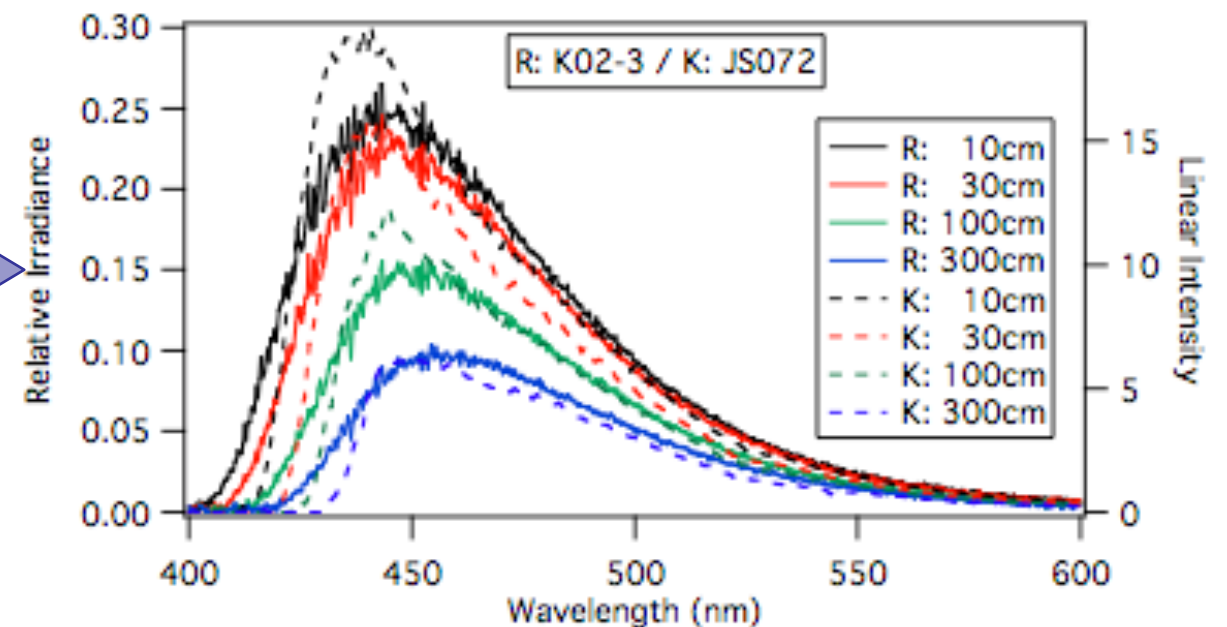
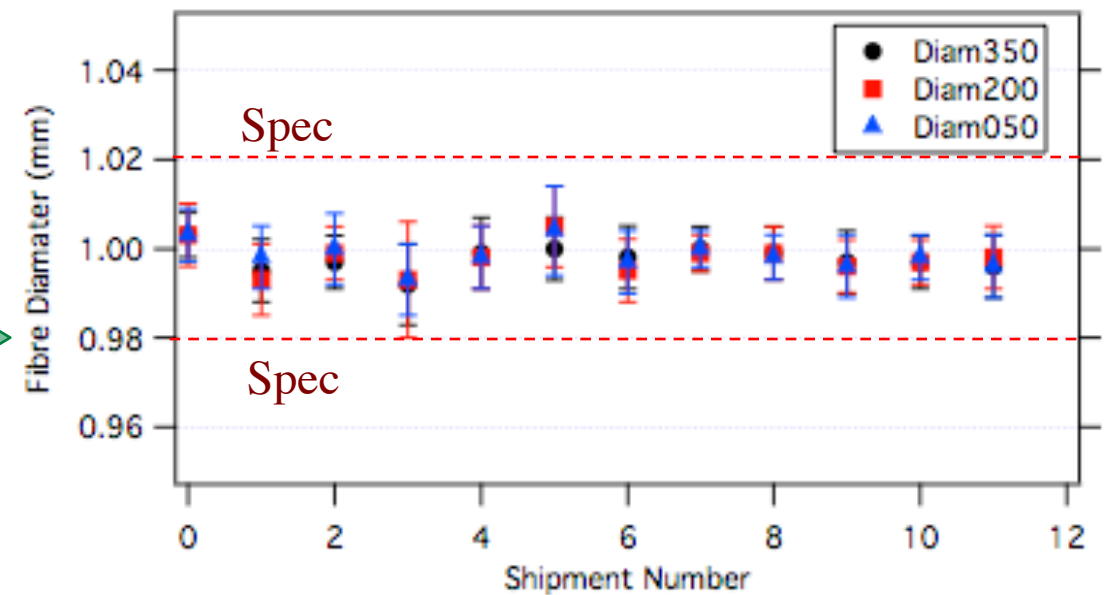
- ☒ Condition/packaging
- ☒ Diameter
- ☒ Attenuation length: LED, photodiode current
- ☒ N_{pe} at 200cm: ^{90}Sr , PMT, external trigger



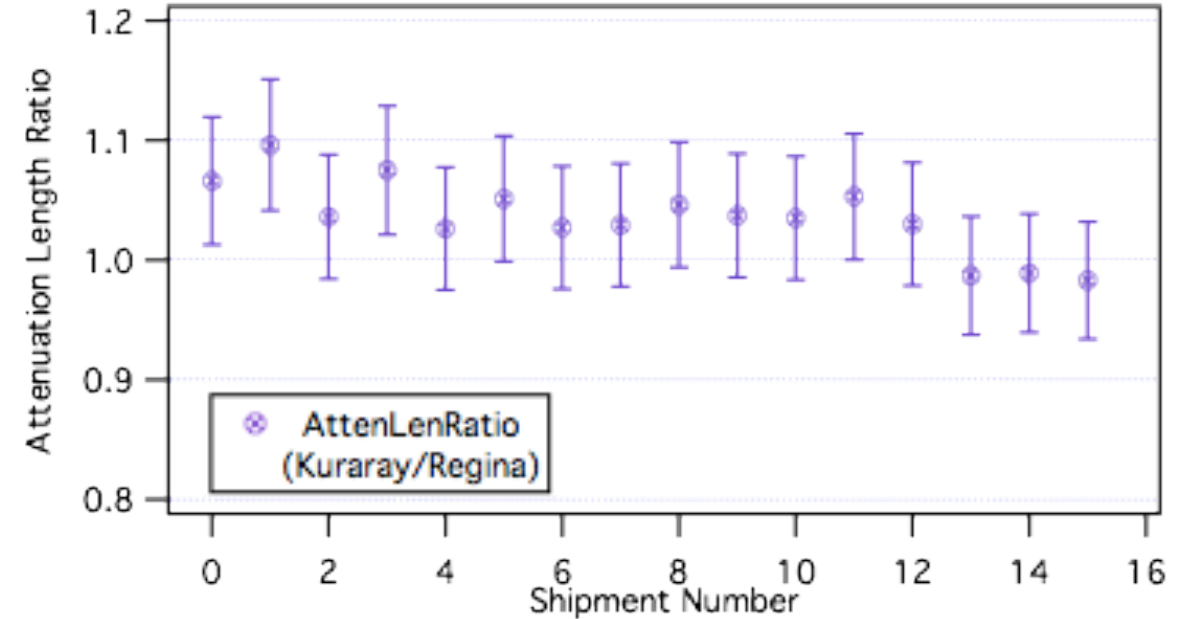
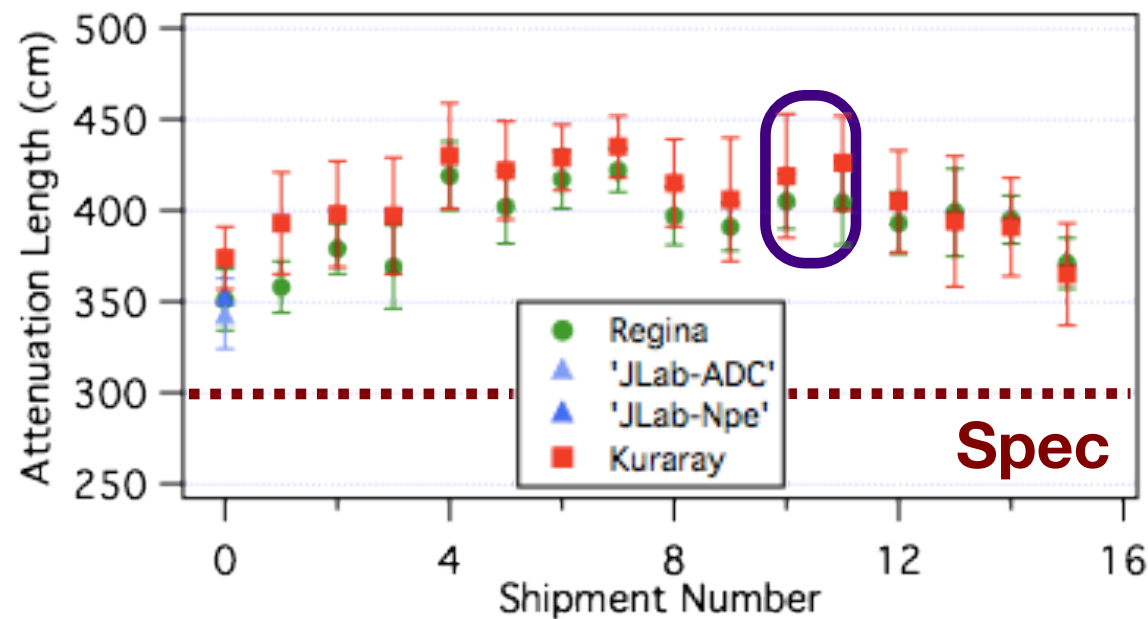
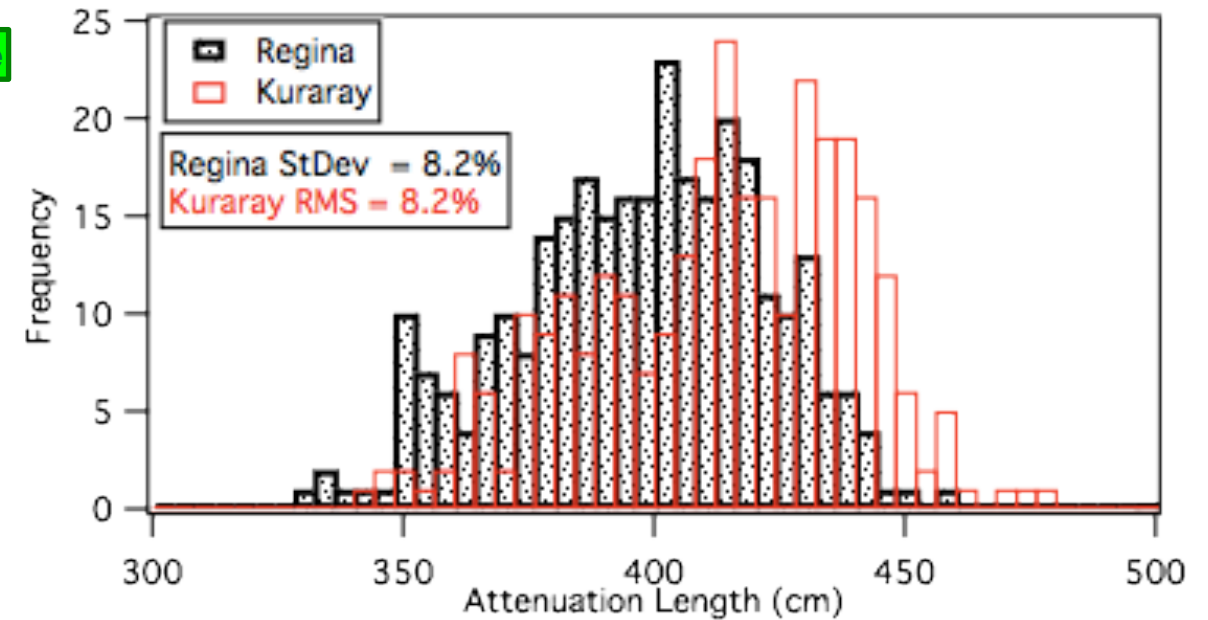
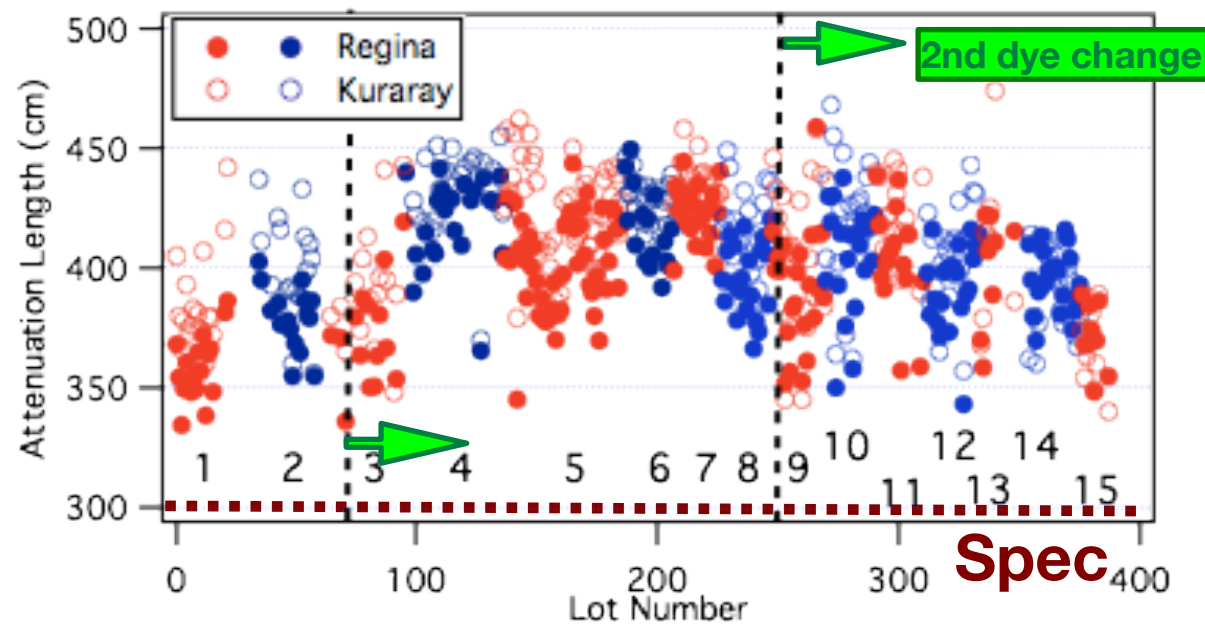
Fiber QA

780,000 fibres!

- Kuraray SCSF-78MJ (blue-green); selected in late 2008
- **diameters: within specs**
- Spectra measured at Regina qualitatively agree with Kuraray's
- integrals are close, but shapes are different; response is acceptable and scales by distance in a similar fashion



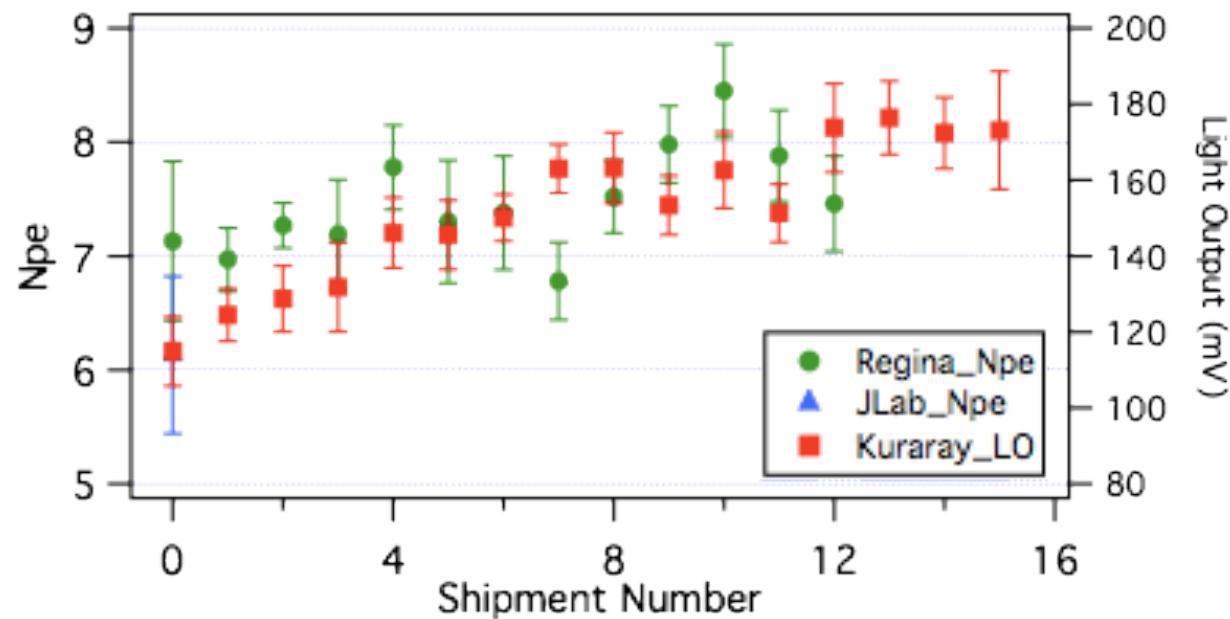
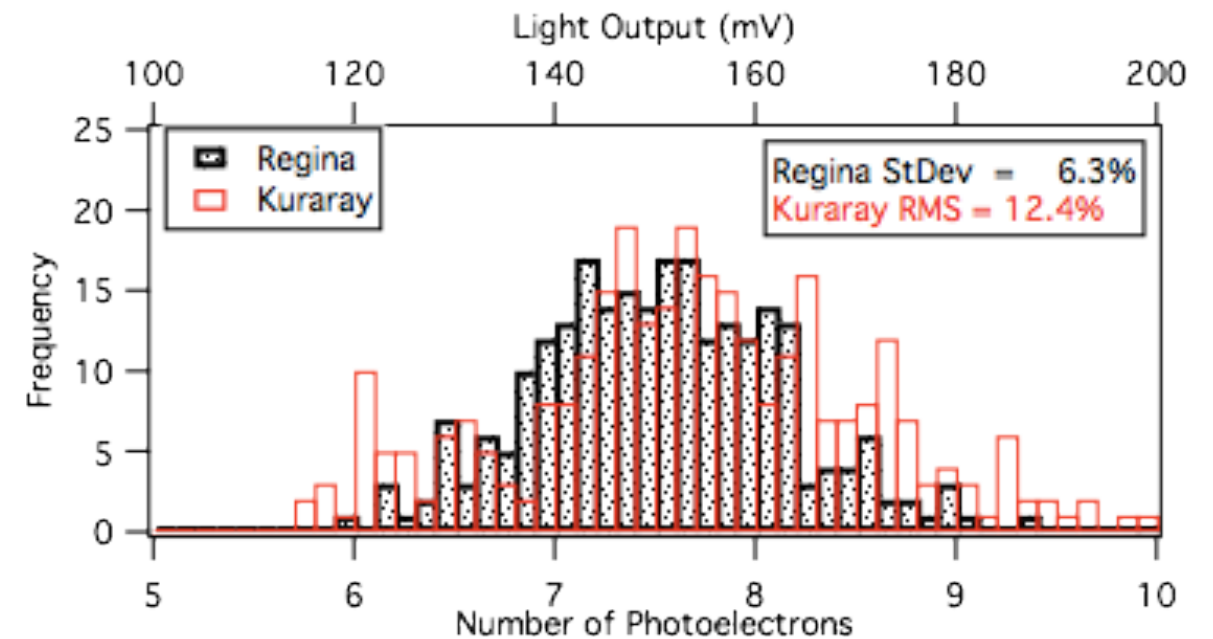
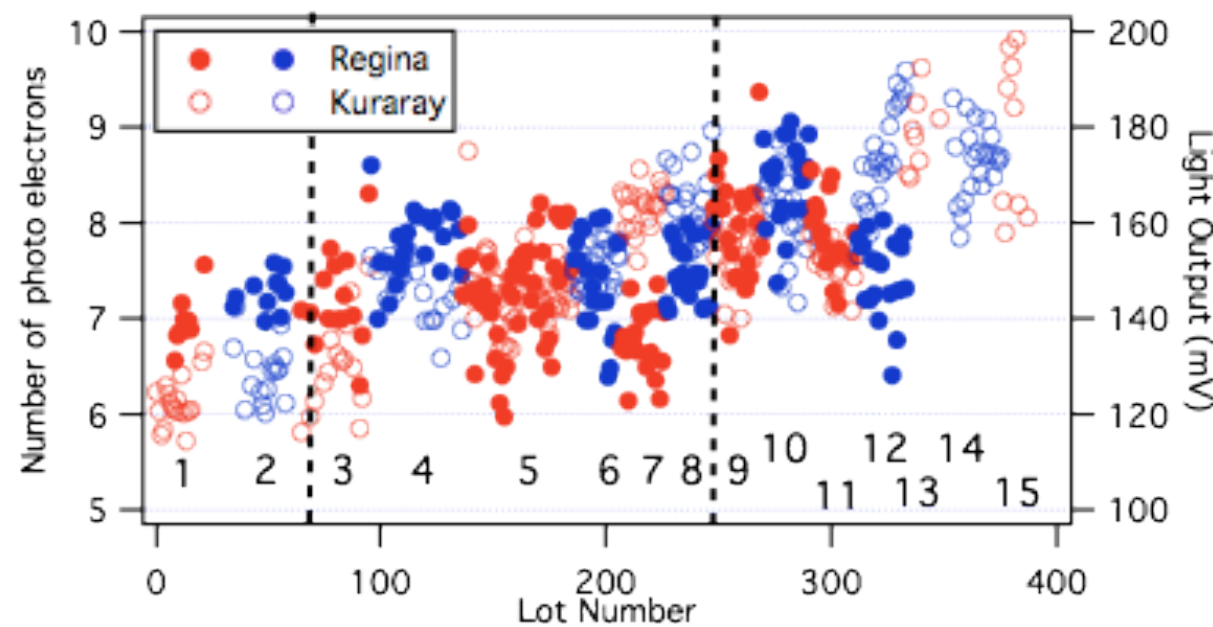
Attenuation Length



Per lot and shipment change; but Kuraray and Regina track

... and fibres meet specs

Light Output



Methods are very different:

- K: scope
- R: Npe w. 90Sr

Per lot and shipment change; Kuraray and Regina roughly track

... and fibres meet specs

SiPM Schematic

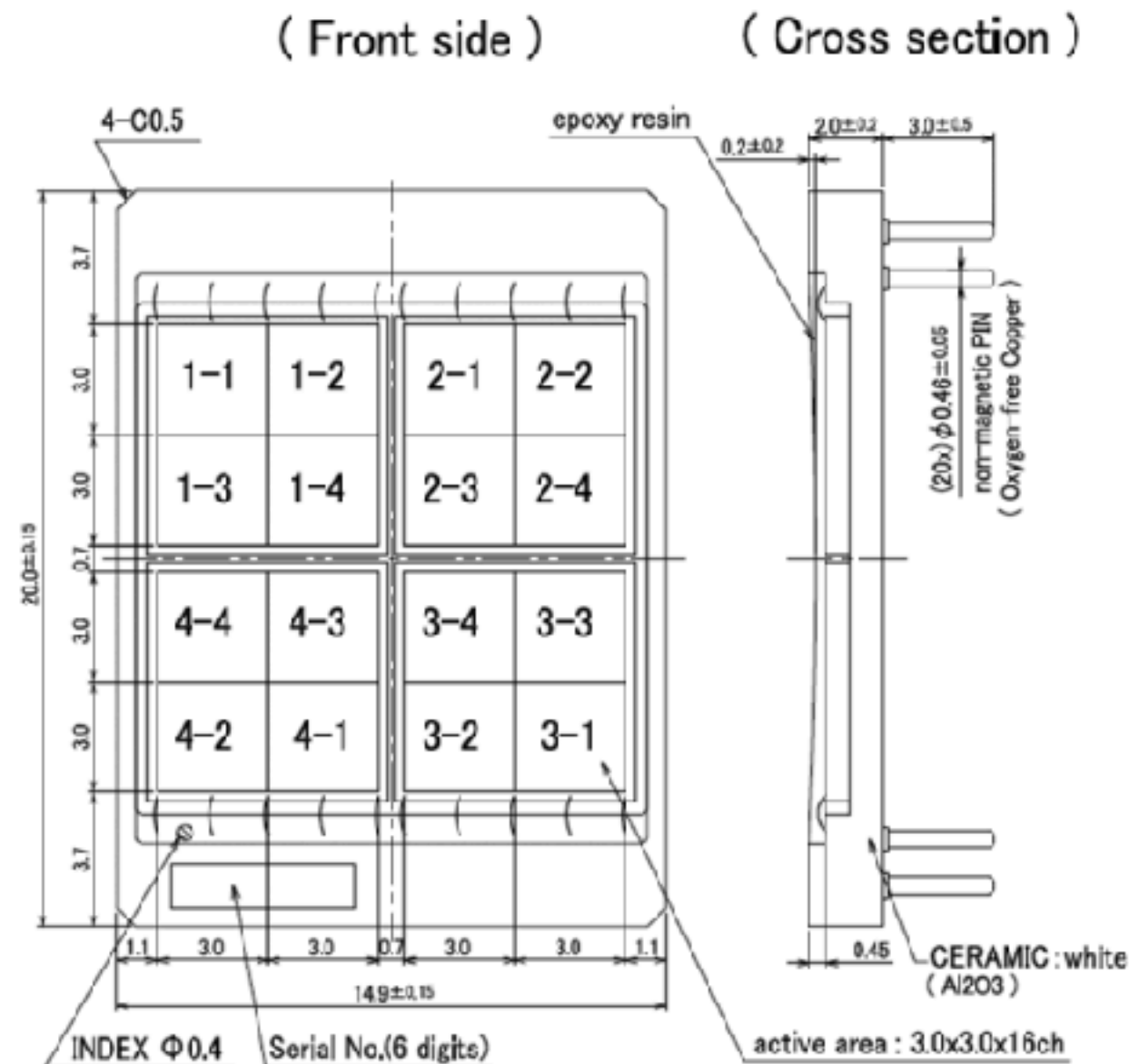


Fig. 1. A schematic drawing of the front and side views for the Hamamatsu MPPCs for the GlueX experiment is shown, detailing the tiling of the $3 \times 3 \text{ mm}^2$ cells into a 4×4 configuration. The numbered cells are active; all other areas and spacings are inactive. (Courtesy of Hamamatsu).

SiPM Assessment

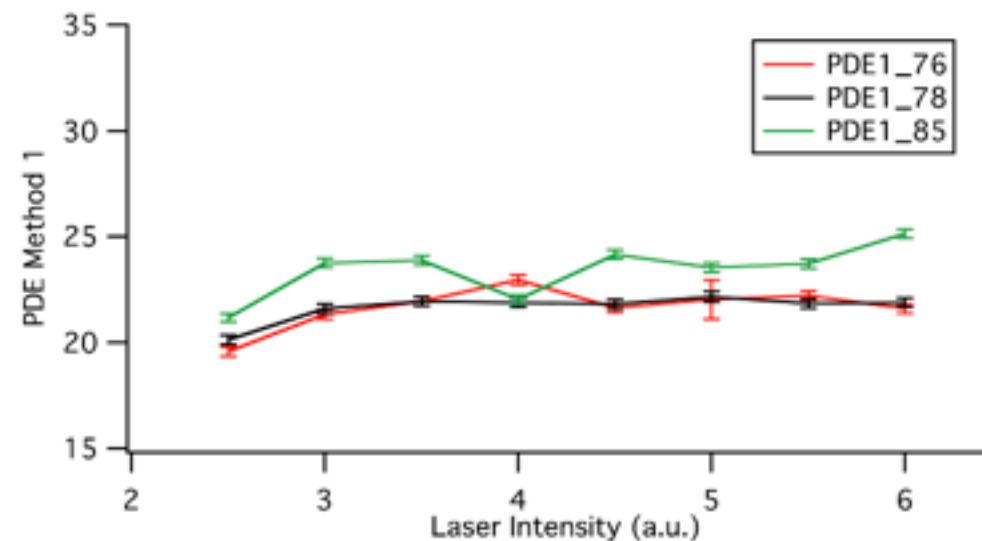
Photon Detection Efficiency

$$\text{PDE} = \text{QE} \times \text{FF} \times \alpha_p$$

QE – quantum efficiency (pixels)

FF – “fill factor” (active area)

α_p - avalanche probability = $f(V - V_{br})$



Hamamatsu

- S2281 Photodiode

- R329 PMT

Calibrated
Photodiode

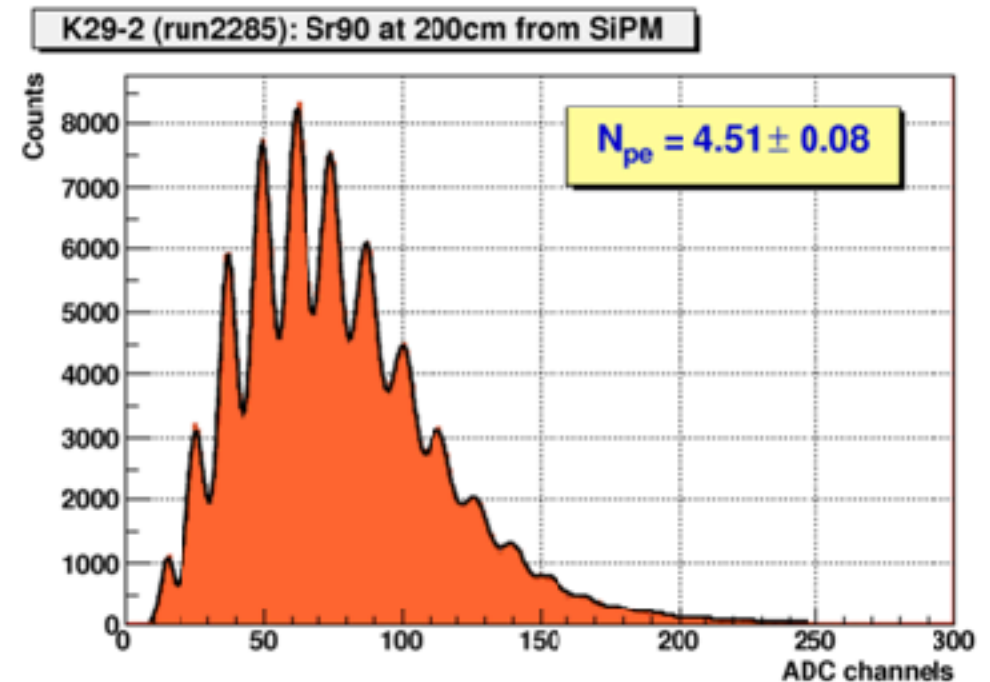
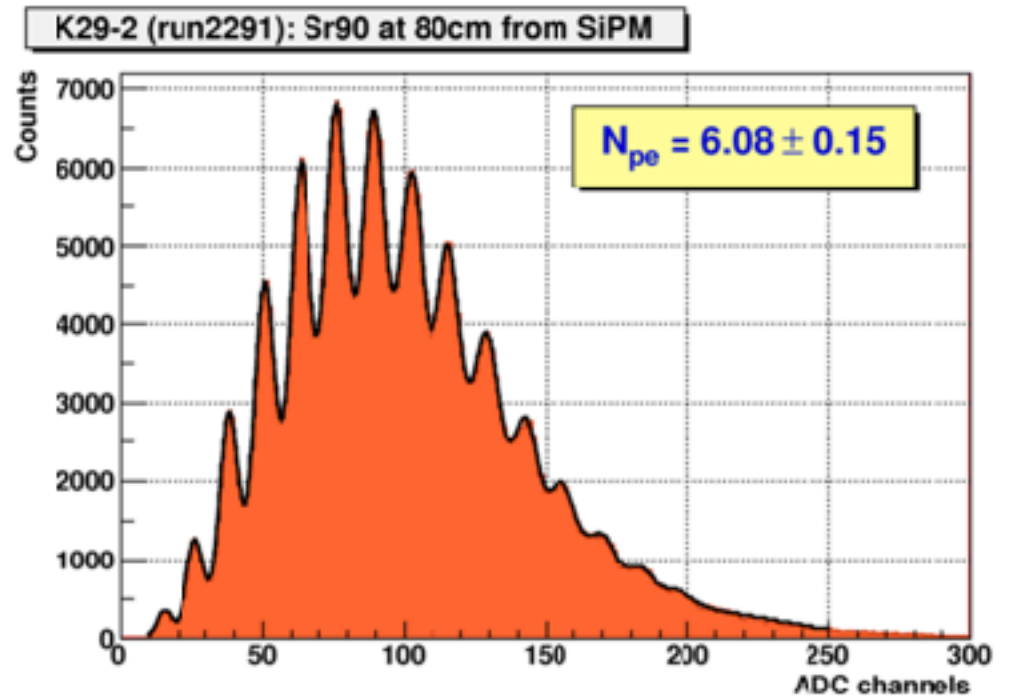
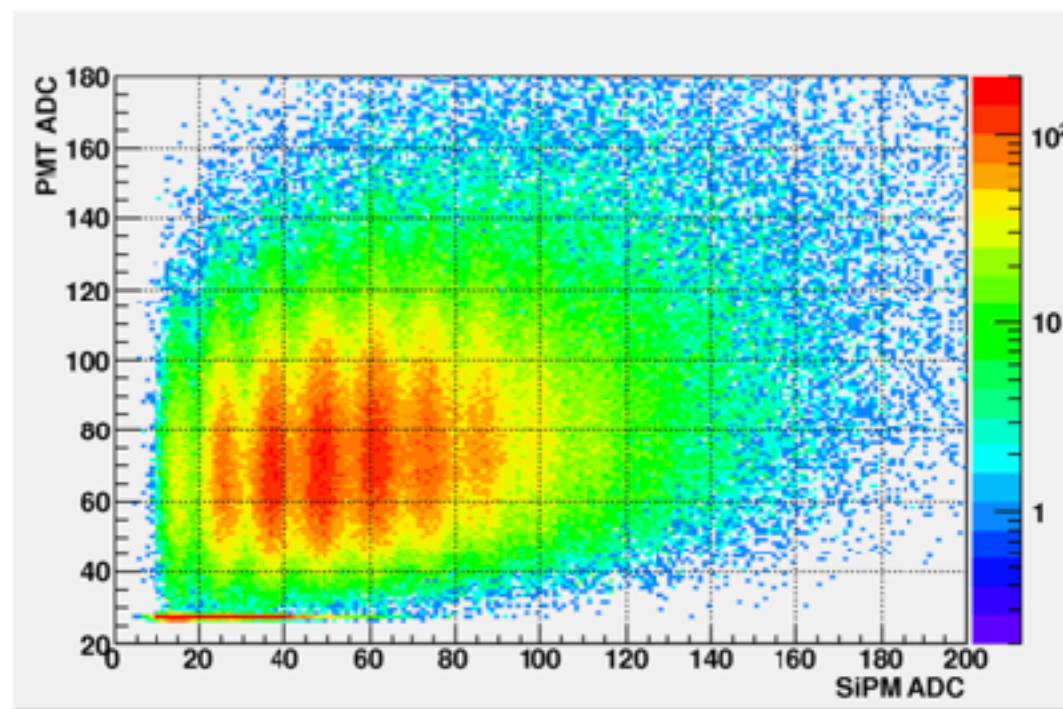
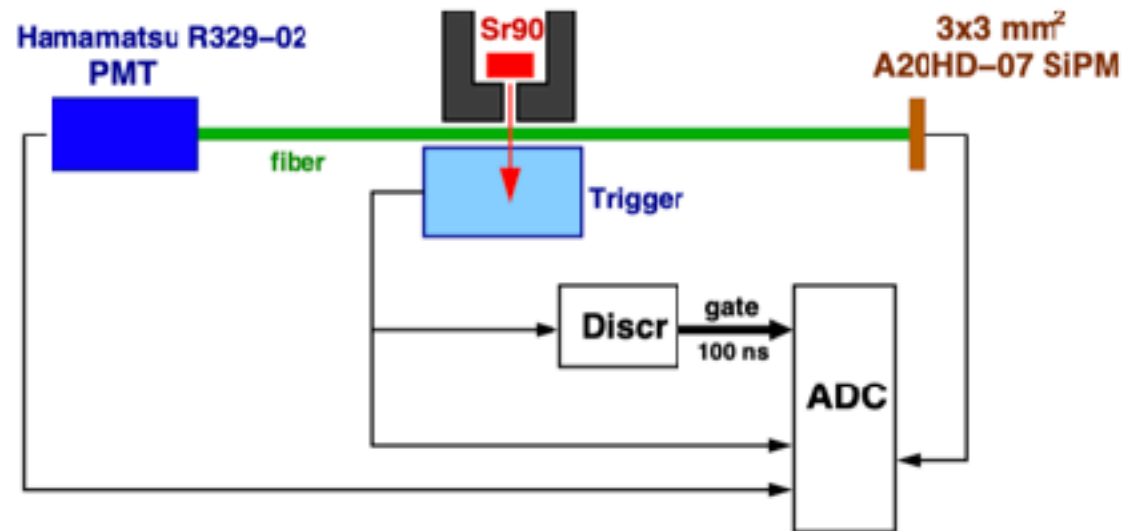
or
PMT

UV laser
Stimulates
fibre

SiPM
array

(scope, ADC)

PDE Measurements



⇒SCSF-78MJ Attenuation Length ~400cm





Nuclear Instruments and Methods in Physics
Research Section A: Accelerators, Spectrometers,
Detectors and Associated Equipment



Volume 739, 1 March 2014, Pages 89-97

Novel Hamamatsu Multi-Pixel Photon Counter (MPPC) array studies for the GlueX experiment: New results

Orlando Soto, Rimsky Rojas, Sergey Kuleshov, Hayk Hakobyan  , Alam Toro, William K. Brooks, Rene Rios

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Nuclear Instruments and Methods in Physics
Research Section A: Accelerators, Spectrometers,
Detectors and Associated Equipment





Volume 732, 21 December 2013, Pages 431-436

Characterization of novel Hamamatsu Multi Pixel Photon Counter (MPPC) arrays for the GlueX experiment

Orlando Soto  , Rimsky Rojas, Sergey Kuleshov, Hayk Hakobyan, Alam Toro, William K. Brooks

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<https://doi.org/10.1016/j.nima.2013.06.071> 

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Methodology for the Determination of the Photon Detection Efficiency of Large-Area Multi-Pixel Photon Counters

Publisher: IEEE

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T. Beattie ; G. J. Lolos ; Z. Papandreou ; A. Yu. Semenov ; L. A. Teigrob [All Authors](#)

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Abstract
Document Sections
I. Introduction
II. Large-Area Mppcs for the Gluex BCAL
III. Evaluation and Quality Control
IV. Photon Detection Efficiency
V. Experimental Setup and

Abstract:
Large-area, multi-pixel photon counters will be used for the electromagnetic Barrel Calorimeter of the GlueX experiment at Jefferson Lab. These photo sensors are based on a $3 \times 3 \text{ mm}^2$ cell populated by $50 \text{ }\mu\text{m}$ pixels, with 16 such cells tiled in a 4×4 arrangement in the array. The 16 cells are summed electronically and the signals are amplified. The photon detection efficiency of a group of first-article units at room temperature under conditions similar to those of the experiment was extracted to be $(28 \pm 2(\text{stat}) \pm 2(\text{syst}))\%$, by employing an analysis methodology based on Poisson statistics carried out on the summed energy signals from the units.

Published in: [IEEE Transactions on Nuclear Science](#) (Volume: 62 , Issue: 4, August 2015)

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Date of Publication: 17 July 2015 ?

DOI: [10.1109/TNS.2015.2442262](#)



Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment





Volume 698, 11 January 2013, Pages 234-241

Technical Notes

Radiation hardness tests of SiPMs for the JLab Hall D Barrel calorimeter ☆

Yi Qiang  , Carl Zorn, Fernando Barbosa, Elton Smith

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<https://doi.org/10.1016/j.nima.2012.10.015> ↗

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