

BOOMS Instrumentation

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Nal(Tl) Crystal Scintillator

Saint-Gobain

Dimensions: 15.2 cm x 15.2 cm x 0.64 cm

Aluminum Housing

23mm thick Optical Window

Cost: \$2,952.00

They will do phoswich designs.

Photomultiplier Tubes

Hamamatsu

Models inquired about	Cost
R6236	\$ 571.00
R6236-01	\$ 571.00
R6237	\$ 588.00
R2248	\$ 757.00
R1548-07	\$ 851.00

Lead time was about 1.5 months; the parts ship from factory in Japan.

R6237 is the largest square PMT they had, 76 ± 1.5 mm per side. The glass casing was about 3mm thick per side. A fair amount of information would be lost through this.

The -01 is an option for the R6237 as well. The difference is the -01 has a semi-flexible lead.

Photonis

No square PMT

Electronics.net

No square PMTs, also true of other places, like Bridgeport Instruments and Saint-Gobain.

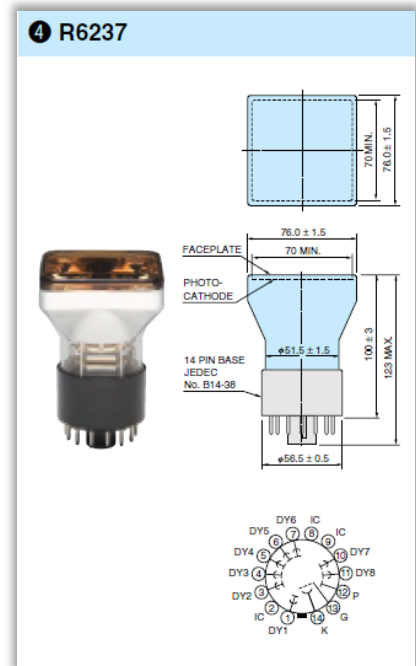


Figure 1

Multichannel PMT (MCPMT) / Position Sensitive PMT (PSPMT)

These are a lot of very small anodes of a PMT put together in a grid. Effectively is a lot of small PMTs

Photonis

Type	Array Size	Pad size/pitch	Cost
XP85012	64 Anode	5.9 / 6.5	\$ 8,830.00
XP85022	1024 Anode	1.1 / 1.6	\$ 11,070.00

Both have effective area of 53 mm per side, with about 3 mm thick casing per side. Total dimensions: 59 ± 0.3 mm

25 micron pore

Lead time is ~ 120 days

Hamamatsu

R8900U-00-C12

23.5 x 23.5 mm

Comparison of PMT and MCPMT

Below both of these options are discussed, and here is my main source: [Hamamatsu article](#).

Today, all types of photosensors — PMT, sCMOS, APD, SPAD and Si-PM (MPPC) — are capable of detecting the arrival of a single photon. In cases where a large number of very small (micron-sized) pixels are required, only sCMOS technology is an option. Conversely, when it is necessary to know also the exact arrival time of an individual photon, only PMT, APD, SPAD and Si-PM (MPPC) solutions are possible. If a very large dynamic range of the time-of-arrival measurement capability is required, only PMT and Si-PM (MPPC) technology can provide the necessary performance. In cases where a large photosensitive area, long exposure times, accurate time-of-arrival information and a high dynamic range are needed — and strong cooling is not permitted — only PMTs with suitable photocathode materials are an option. And Si-PM (MPPC) is the only possibility when image sensing with single-photon resolution, exact time-of-arrival determination, a high dynamic range, low power consumption and digital output in a single-chip solution are required.

SiPM

- Operate at a much lower voltage
- between 1-2 orders of magnitude faster response and rise times than the 76 mm square PMT.
- don't do as well over long exposure times, dark noise becomes a problem
- can be cooled to reduce dark noise, which is the major problem with these devices

MCPMT

- already gives spatial data
- option for digital output
- between 1-2 orders of magnitude faster response and rise times than the 76 mm square PMT
- crosstalk and dark noise is more of an issue than the regular PMTs

Comparison Matrix:

name	R6237	R8900U-00-C12	Planacon	MPPC S13360-6050VE
dimensions (side)	76 mm	30 mm	59 +/- 0.3 mm	25.2 +/- 0.05 mm
spectral response	300-650 nm	300-650 nm	200-650 nm	320-900 nm
curve code	400K	-		
peak wavelength	420 nm	420 nm		450 nm
photo-cathode material	BA	BA	BA	-
window material	K	K	Schott 837B	Epoxy Resin
dynode structure	B+L	MC	MCP chevron	-
dynode stages	8	11	-	-
socket assembly	E678-14W	E678-32B		?
anode to cathode voltage max	1500 V	1000 V		56 V
average anode current	0.1 mA	0.1 mA		
anode to cathode supply voltage	1000 V	800 V		
blue sensitivity index	11.5	10	8.5	
gain (anode)	2.7x10 ⁵	0.7x10 ⁵		1.7 x 10 ⁶
dark current typ.	2 nA	1/ch (nA)		500 kcps
dark current max	20 nA	10/ch (nA)		1500 kcps
rise time	9.5 ns	2.2 ns	0.6 ns	
transit time	52 ns	11.9 ns		
notes	semiflexible lead option	small square	temp 0 to 50 C	temp 0 to 40 C
	3 mm gap per side	3.5 mm gap per side	3 mm per side	0.2 mm per side
		position sensitive	position sensitive	position sensitive

Figure 2

Silicon Photomultiplier (SiPM) / Multi Pixel Photon Counter (MPPC)

SensL

Summary of Types - source (<http://sensl.com/product-selection-guide/>)

C -type

- MLP package
- lowest cost
- blue peak sensitive
- PDE 42%
- rise times 0.3 - 0.6 ns
- lowest cross-talk and noise
- dark count 30 kHz/mm²

J-type

- TSV chip scale package (least dead space)
- blue sensitive
- PDE - 50% at 420 nm
- website claims improved rise times, but doesn't give a number
- dark count 45 kHz/mm²

R-type

- Red and NIR (near infrared region) sensitive
- useful for LIDAR applications

Definitions:

PDE - Photon Detection Efficiency

MLP - micro leadframe package

TSV - through silicon via

Below is the comparison chart for the three available varieties:

Parameter	C-Series	J-Series	R-Series
Peak sensitivity	420nm	420nm	550nm
Sensitivity range	300nm - 800nm	300nm - 800nm	380nm - 1100nm
Breakdown voltage (Typical)	24.5V	24.5V	24.5V
Recommended operating voltage	Vbr + 5V	Vbr + 5V	Vbr + 5V
Gain	6x10 ⁶	6x10 ⁶	6x10 ⁶
Peak PDE	41%	51%	52%
Dark count rate (typical)	60 kHz/mm ²	70 kHz/mm ²	70 kHz/mm ²
Microcell recharge time constant (RC)	82ns	49ns	49ns
Fast output terminal	yes	yes	yes
Temperature stability	21.5mV/°C	21.5mV/°C	21.5mV/°C
Package	MLP	TSV	MLP

Figure 3

Below are two varieties of the largest possible arrays:

Array C - \$2,880



Figure 4

can order up to 12x12 with 6mm pixels (72 mm to a side). The above is an 8x8 with 6mm pixels. Can resolder

Array J - \$3,456



Figure 5

can order up to 8x8 with 6mm pixels (48mm to a side, above). 90% fill factor, so very little dead space. Can't resolder.

The items shown above are for testing, and are available from their website. Other dimensions can be custom-ordered, but would require a quote.

Evaluation Boards



- ✓ SMT (or TSV) SiPM mounted on a small evaluation board
- ✓ Standard and fast outputs
- ✓ SMA connector I/Os

Figure 6

These cost
~ \$550 for 6mm
~ \$370 for 3mm
~ \$280 for 1mm



- ✓ SMT (or TSV) packaged SiPM mounted onto a pin adapter board
- ✓ Easy access to the fast and standard outputs

Figure 7

These cost
~ \$150 for 6mm
~ 100 for 3mm or 1mm

code for ordering SensL SiPM array:

Name - (1)(2)_(3)-(4)

0. ArrayC or ArrayJ
1. side of pixel in 10^{-5} m. Options are: 1mm, 3mm, 6mm
2. number of microcells/pixel, usually 20 or 35
3. number of pixels in array. Options are: 4, 16, 64, 144
4. other
 - a. PCB -
 - b. EVH - Evaluation Board
 - c. BGA - ball grid array

Hamamatsu

Makes SiPMs, only calls them MPPCs. I never got quotes, but they make comparable sizes and arrays.

Comparison of SensL and Hamamatsu SiPM

looking at dark count rate, 60 kHz/mm², and a detector size of 6 x 6 mm² yields a dark count rate of 2160 kcps, which is much higher than the Hamamatsu MPPC array S13361-6050AE-04 dark current of 500 kcps typical to 1500 kcps max. This is a similar product with the same pixel size. It may be worth considering Hamamatsu.

PMT Sockets

Hamamatsu

Socket types which are available from Hamamatsu are:

Socket Type	Description	Socket for R6237	Cost
D	<ul style="list-style-type: none">• Voltage divider	E1198-26 (- Voltage) E1198-27 (+ Voltage)	\$ 200.00
DA	<ul style="list-style-type: none">• Voltage divider• Converts current to voltage and amplifies	Couldn't find one to fit R6237	-
DP	<ul style="list-style-type: none">• Voltage divider• High Voltage power supply	C12843-01	\$ 602.00
DAP	<ul style="list-style-type: none">• Voltage divider• Converts current to voltage and amplifies• High Voltage power supply	C12843-01	\$ 671.00

Bridgeport Instruments

Socket fits on the Hamamatsu R6237

Type	Cost
USB base	\$2850
USB base with GPIO	\$2800

Lead time is 3-5 days.

Note: a sales associate told me their website hadn't been updated in 10 years. Information may be outdated.

qMorpho

by Bridgeport Instruments, this device is a DAQ and multi-channel analyzer. It can also do signal processing, pulse shape analysis, and coincidence spectroscopy. Has an ADC on board.

when ordering, must specify speed and size of ADC, in MSPS (mega samples per second) and bits. Options are 20, 40, and 80 MSPS; 10 or 12 bit ADC.

Note: a sales associate told me their website hadn't been updated in 10 years. Information may be outdated, for example, the associate told me that the 80 MSPS option was available, though it is not listed online, and the documentation online may not be correct, the location of the mounting holes has changed.