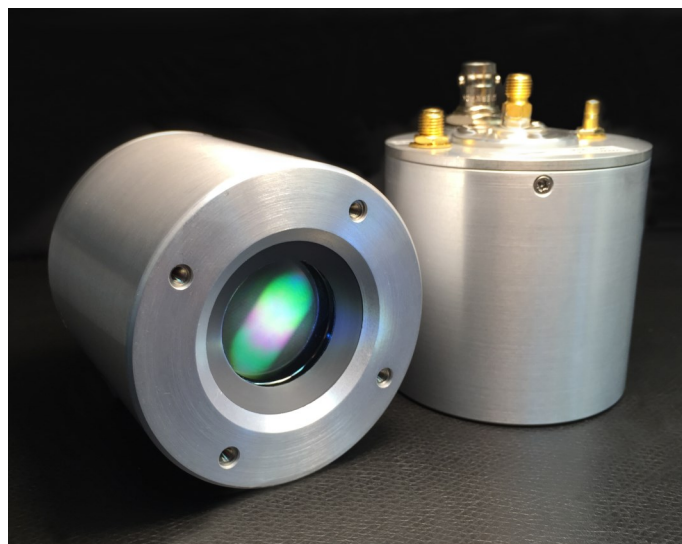




# Photomultiplier Tube

Photek's range of photomultiplier tubes (PMTs) provide solutions for analysing ultra fast optical phenomena in a range of applications, including LIDAR, nuclear physics and time correlated photon counting. Photek manufactures 10, 25, and 40 mm PMTs with a variety of photocathodes having high sensitivity in the UV, visible and NIR spectrum. A number of MCP configurations are available to ensure that Photek's PMTs satisfy all user gain requirements. Photek's PMTs are the fastest in the world with pulse rise times down to 60 ps and pulse FWHM down to 100 ps. For applications where fast gating is required, the Photek photomultipliers can provide gated speeds to 2 ns.



## APPLICATIONS

- ◆ Analysis of fast optical pulses
- ◆ Cherenkov light detection
- ◆ Fluorescence spectroscopy
- ◆ LIDAR
- ◆ Particle & Nuclear physics
- ◆ Single photon counting fluorescence
- ◆ Time correlated photon counting

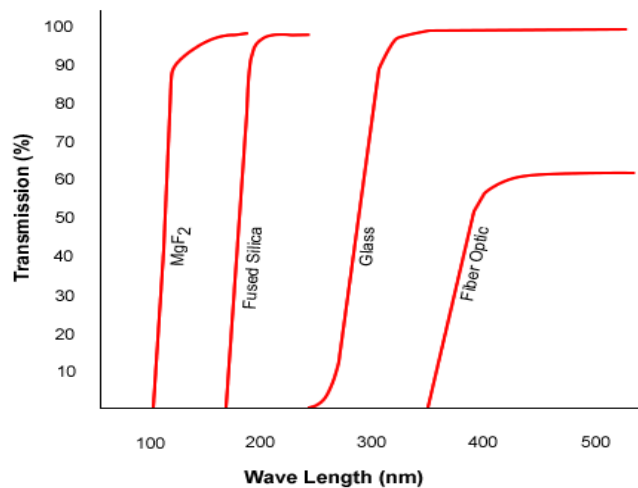
## KEY ATTRIBUTES

- ◆ 10, 25 and 40 mm areas as standard, other sizes available upon request
- ◆ Single, chevron or z-stack MCP options with gain greater than  $10^7$
- ◆ Wide range of photocathodes including UV, solar blind, visible and NIR response
- ◆ Rise time to 60 ps (model dependant)
- ◆ FWHM to 100 ps (model dependant)
- ◆ Single photon jitter to 28 ps
- ◆ Multi-photon jitter below 10 ps
- ◆ Fast pulse output linear up to 1 A
- ◆ Fast gating to 2 ns
- ◆ Integral 50 ohm output

## OPTIONS AVAILABLE

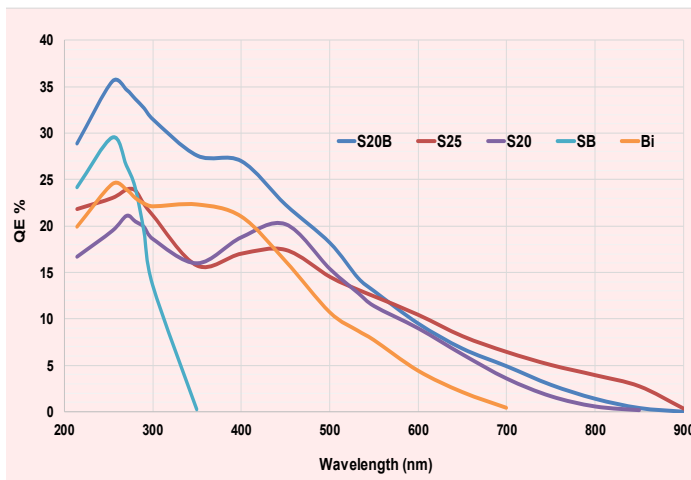
### INPUT WINDOW

Photek PMTs are available with a choice of input window materials. These include MgF<sub>2</sub>, fused silica, glass and fibre optic, among others.



### QUANTUM EFFICIENCY CURVES

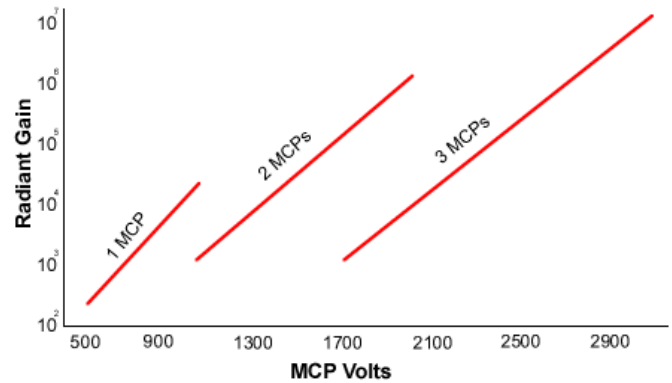
Photek offers a full range of second generation photocathodes. These include CsI, Solar Blind, Bi-alkali, Low Noise S20, S20 and S25 which demonstrate the broad spectral response that can be achieved, as seen below:



Note: Detectors with fibre optic input windows will have no response below 300 nm. Specific gating requirements may alter the QE. Please contact the Sales Office to discuss your exact requirements.

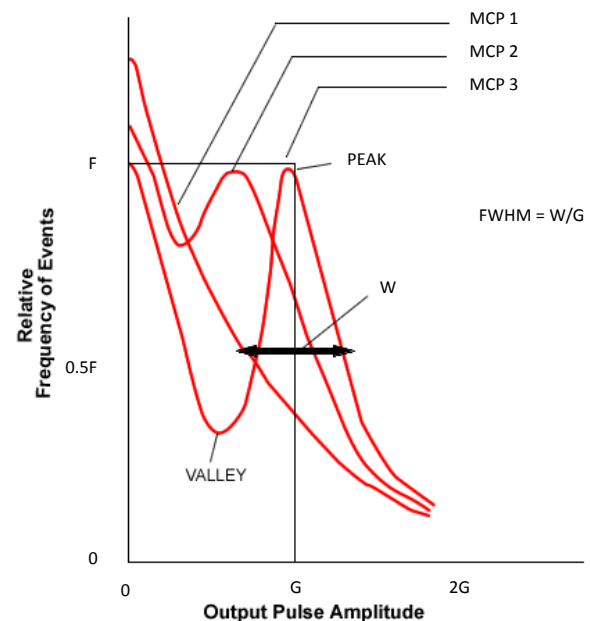
### GAIN

The Photek PMT can be provided with 1, 2 or 3 micro channel plates for gain greater



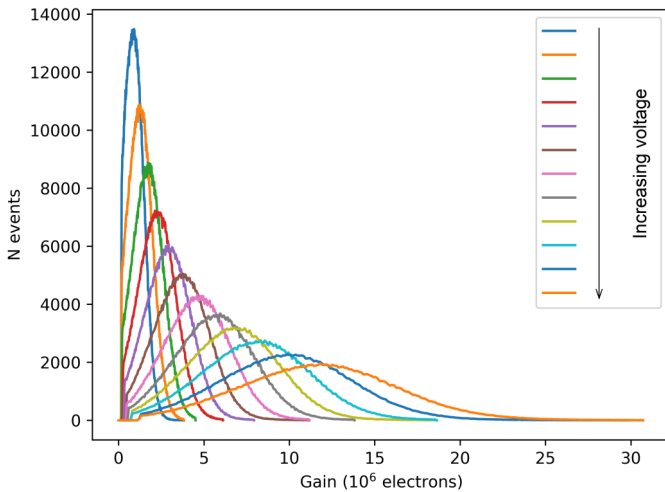
### TYPICAL PHD

The diagram below shows how the pulse height distribution (PHD) changes with gain. Both the peak/valley ratio and the full width half maximum (FWHM) of the pulse height distribution are used to characterise photon counting tubes.



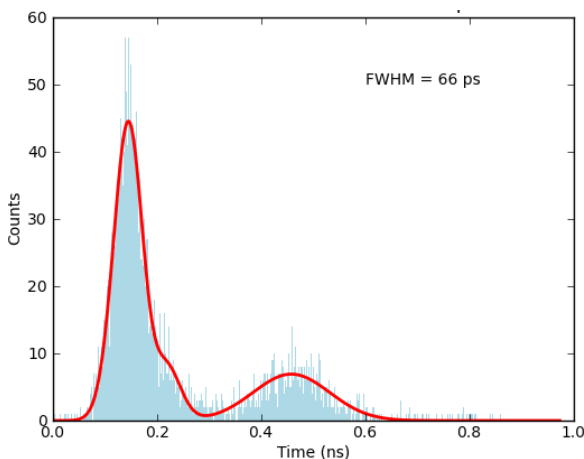
## EXAMPLE PHD FOR PHOTON COUNTING TUBE

Below is a graph showing the typical single photon PHD for a 2 MCP PMT for increasing voltages. This is a demonstration of how the FWHM can improve with higher voltage:



## TRANSIT TIME SPREAD

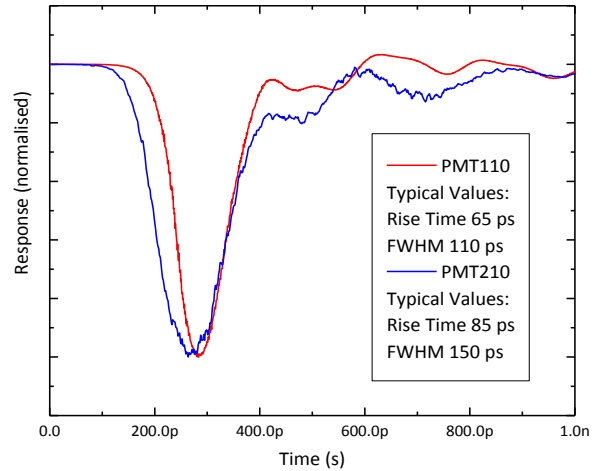
Below is a graph showing the typical single photon transit time spread (TTS) for a 10 mm 2 MCP PMT:



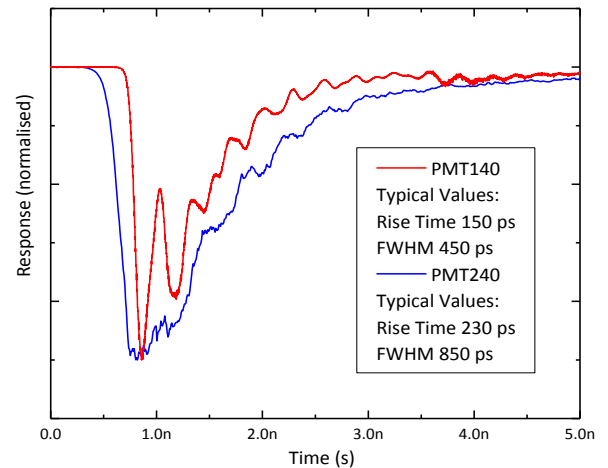
## TYPICAL OUTPUT WAVEFORM

The following two graphs to the right show how the typical output waveform changes with gain and size. The pulse rise time and FWHM are tabulated on the next page.

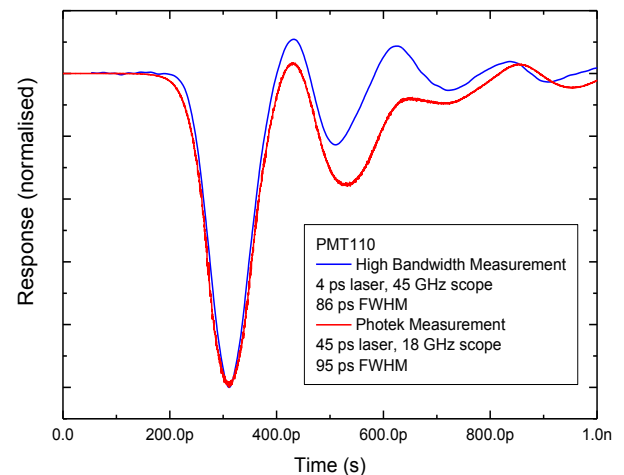
### Results for a 10 mm 1 MCP PMT



### Results for a 40 mm 1 MCP PMT



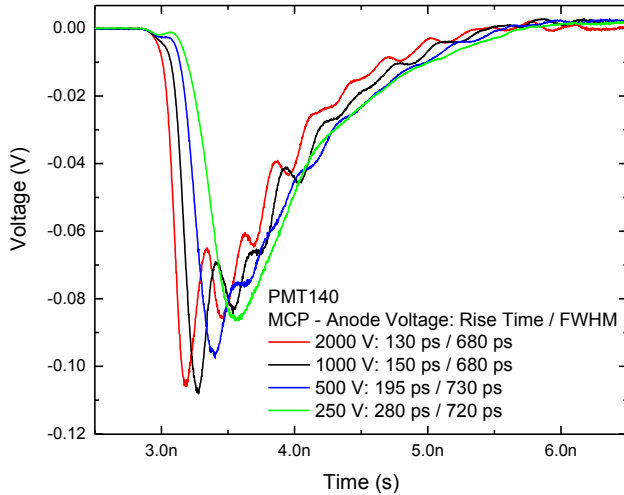
The figure below shows the influence of the laser pulse width and measurement bandwidth on the observed result.\*



\*Results taken from *J. Milnes et al., Recent Developments in Ultra-High Speed and Large Area Photomultiplier Tubes, PoS(ECPD2015)005* of a 1 MCP, 10 mm PMT.

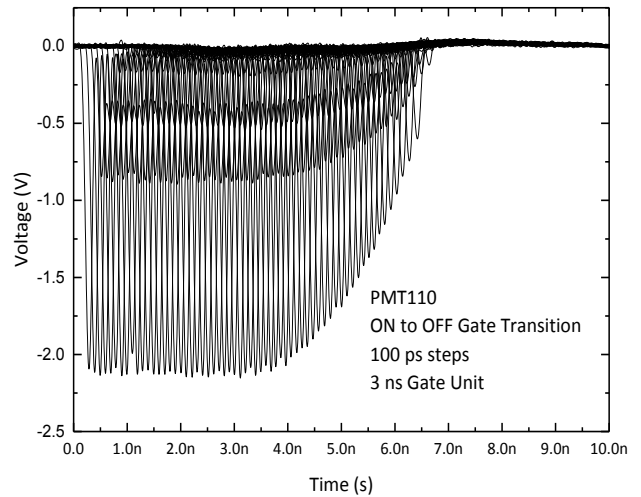
## ANODE VOLTAGE

The graph below shows the effect that the anode voltage can have on the pulse shape.



## GATE TRANSITION

The ON-OFF gate transition for a PMT110 can be seen below using a GM300-3N 3 ns, 300 kHz gate unit.



## TIME RESPONSE

PULSE RISE TIME (ps)									
MCPs	Detector Diameter								
	10			25			40		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
1	60	65	70		115		100	150	200
2	75	85	95		190		180	230	280
3		105		300	400	500		320	

## PULSE FWHM (ps)

FWHM (ps)									
MCPs	Detector Diameter								
	10			25			40		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
1	100	110	120		700		300	450	600
2	130	150	170		840		600	850	1100
3		170		800	1000	1200		920	

## ENVIRONMENTAL

Operational Limits: -40 °C to +45 °C

Storage: -40 °C to +60 °C

## ENVIRONMENTAL TESTING

For applications where the PMT is exposed to temperature and shock conditions Photek has the appropriate facilities to offer environmental stress screening. Our vibration system offers shock, sine, random, and sine-on-random testing. Our thermal chamber has a temperature range of -75 °C to +160 °C and can control humidity from 10% to 98%.

## POWER SUPPLY & GATE UNITS

Photek designs and manufactures a range of power supplies and gate modules for our PMTs. Our power supplies use the very latest in power supply design and are available in bench top format. Our gate modules can gate down to 3 ns with a 300 kHz repetition rate (model dependant) and are used for high brightness or fast optical shutter applications.

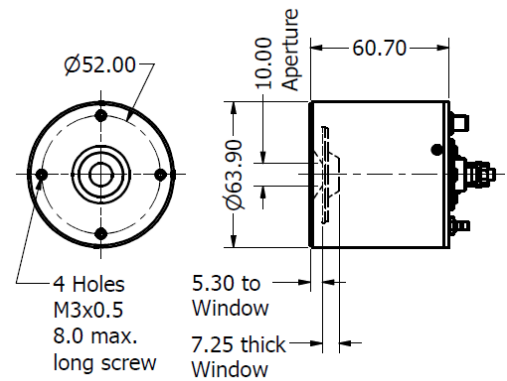
## PART NUMBERS

PMT part numbers start with PMT and are built up as follows:

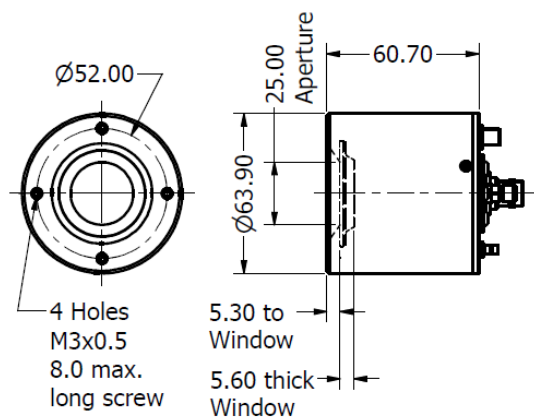
MCP	Size	Input	Cathode	Gating
1	10	F (fibre optic)	CsI	G (gated—standard)
2	25	Q (fused silica)	SB	NG
3	40	M (MgF2)	BI	TCU
		G (glass)	S20B	
			S20	
			S25	

## MECHANICAL OUTLINE DRAWING

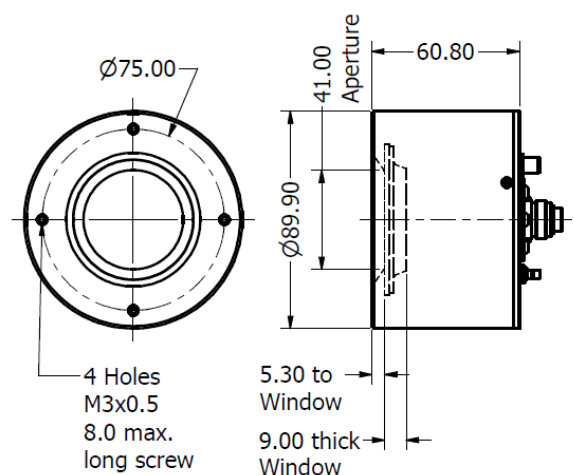
10 mm



25 mm



40 mm



Dimensions are indicative and may vary depending on the optics, number of MCPs and housing required.





## About Photek

Photek is a specialist manufacturer of vacuum based tubes and camera systems for photon detection. Our product range includes; Camera Systems, Image Intensifiers, Photomultiplier Tubes, Streak Tubes plus a range of associated electronics. We are experts in large area and ultra-high speed imaging and advanced photon counting camera systems.

Our continuing success is built upon continuous innovation and product development and by harnessing and applying knowledge to find solutions for all of our customers' applications.

Photek is accredited to ISO 9001 and ISO 14001



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**Photek Ltd** reserves the right to update and improve this specification without prior notice

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