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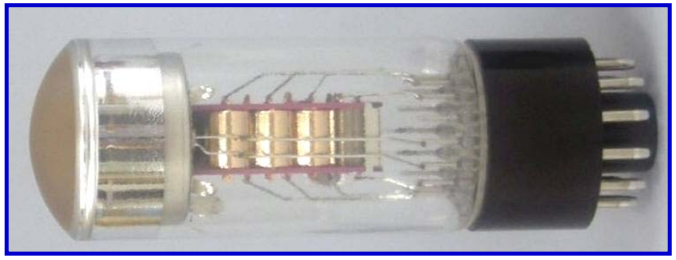
Recent Progress in Vacuum Photon Detectors at Hamamatsu

at LIGHT 2011 on Nov.01 2011

Hamamatsu Photonics
Electron Tube Division
Yuji Yoshizawa

Contents in this talk (1)

R11780 / 12-inch PMT
for Neutrino Experiment

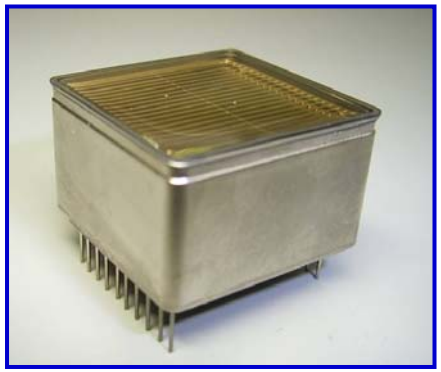


R11920-100 / 1.5-inch PMT
for Gamma-ray Telescope

R11919 / 1.5-inch Fast PMT
for HEP & Medical Instrument

Contents in this talk (2)

3-inch Metal Bulb PMTs
for Dark Matter Experiment

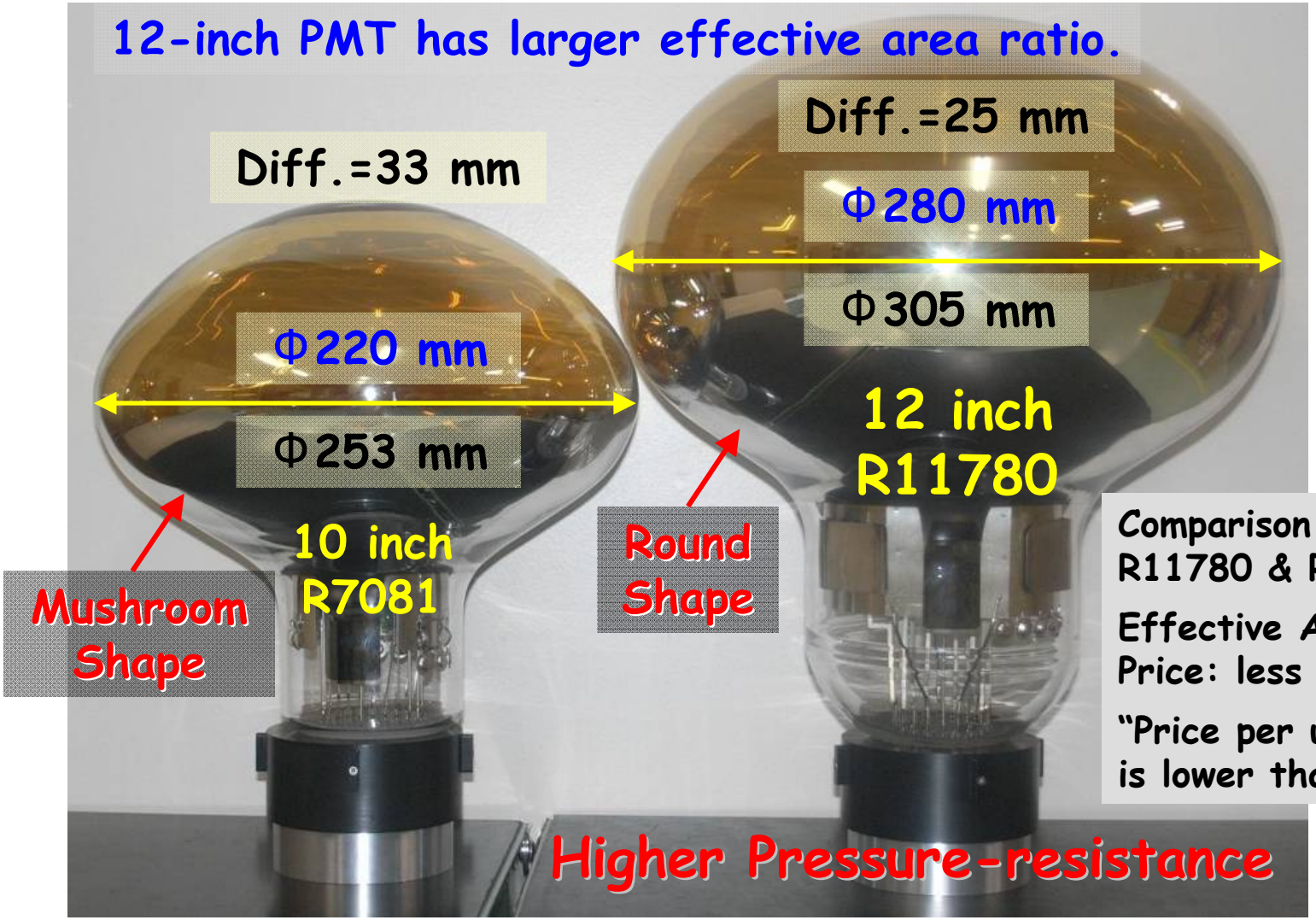


R11265 / New Metal Package PMT
for HEP & Medical Instrument

R10467U / Fast HPD
for Microscope

μ-PMT (micro PMT)
for Biomedical

Comparison of Dimension between R11780 (12") and R7081 (10")



Comparison between R11780 & R7081

Effective Area: 1.62
Price: less than 1.5

"Price per unit area" is lower than R7081.

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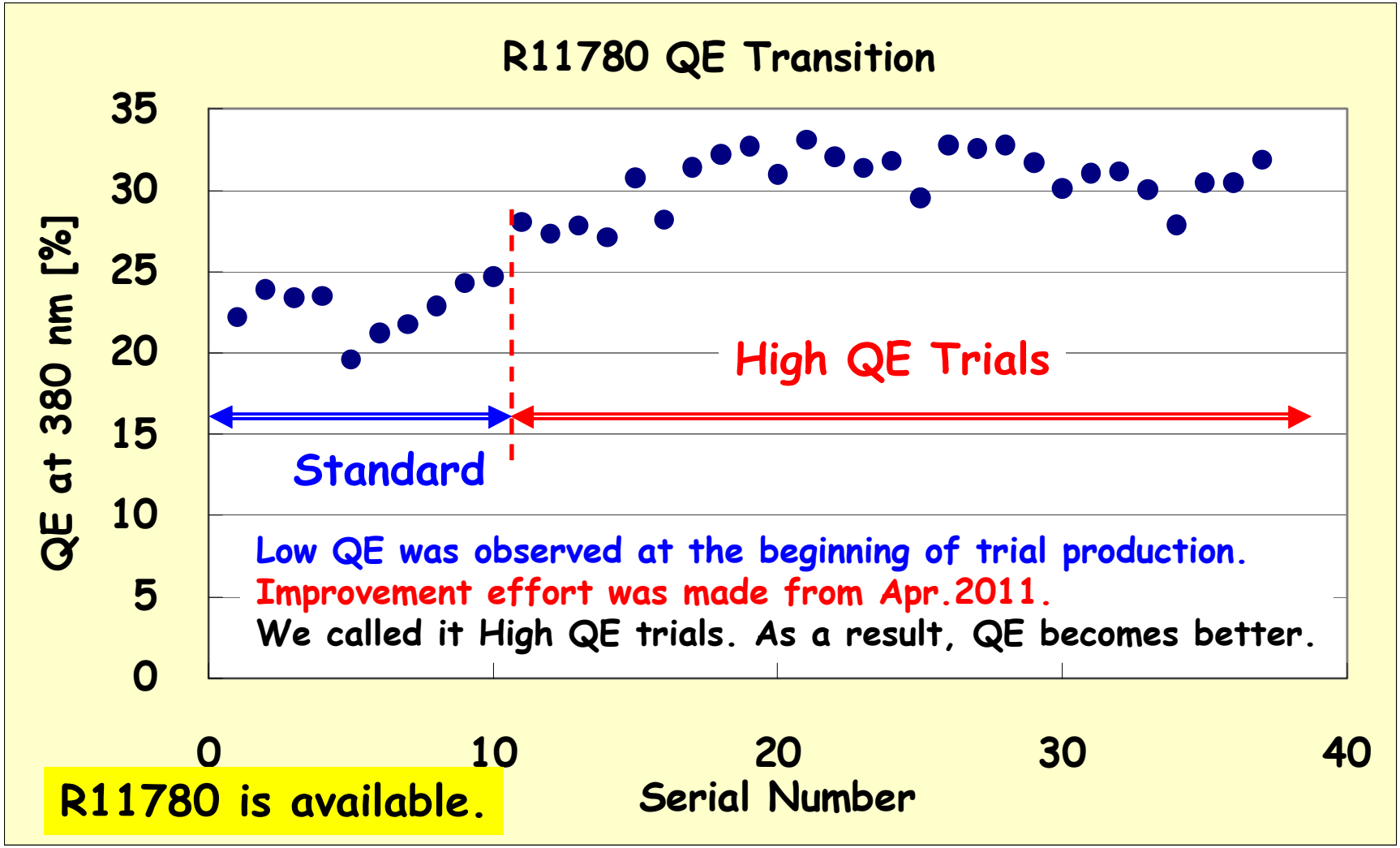
Comparison of Characteristics

Items	R11780 12-inch PMT	R7081 10-inch PMT
Diameter	305 mm	253 mm
Effective Area	280 mm min.	220 mm min.
Effective Area Ratio	84.3%	74.6%
Tube Length	385 mm	300 mm
Dynodes	LF/10-stage	LF/10-stage
GAIN	1.0E+07 at2000V	1.0E+07 at 1500V
T.T.S. (FWHM)	2.7 ns	2.9(3.4) ns
P/V Ratio	3.0	2.5(2.8)
Dark Counts	10,000 cps	7,000 cps

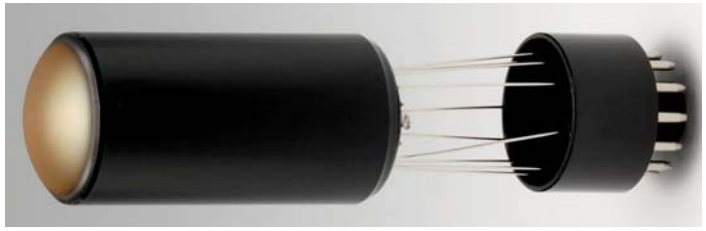
R11780 QE Improvement



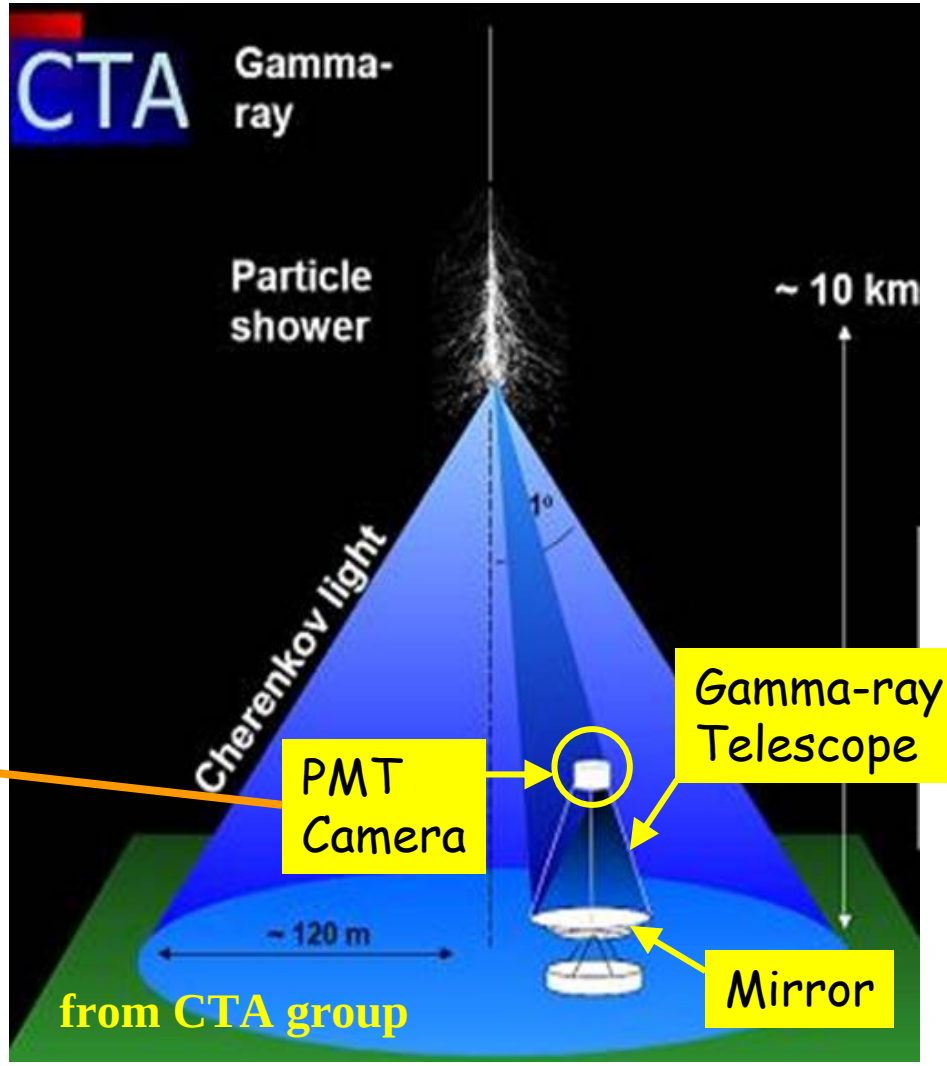
R11920-100 / 1.5-inch PMT

R11920-100

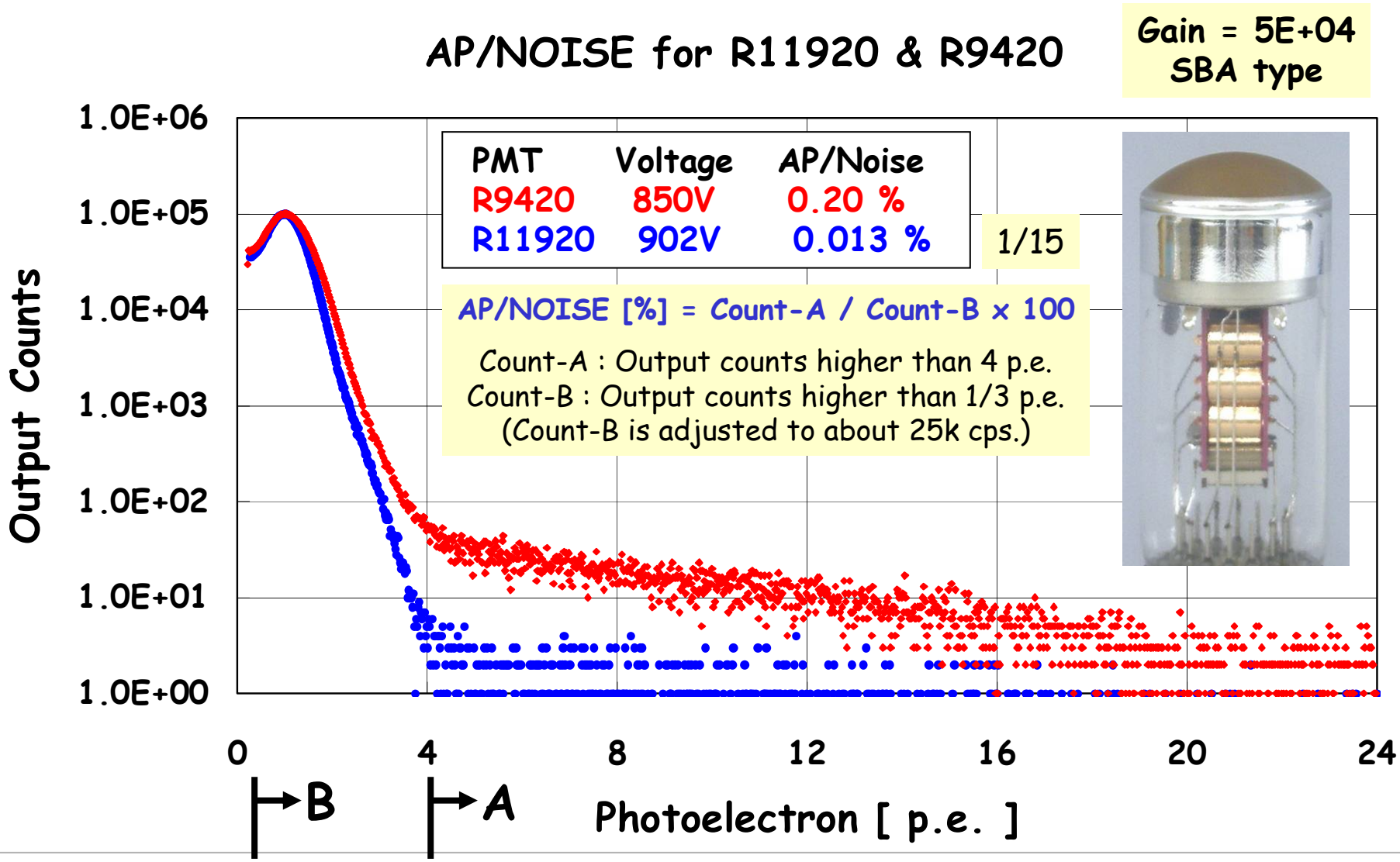
CC window



PMT Camera (Magic)



Comparison of AP/NOISE



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Optimazation of Divider Ratio

Window Curvature and K-DY1 voltage are important factor to determine the CE and TTS/Time Response of PMT/R11920.
Window Curvature of R20 was selected. Next is divider ratio.

Divider Ratio (DR)		K-DY1 Voltage (V)	Mark	Simulation WL=400nm, 30 mm in dia.		Measurement	
				CE (%)	TTS (ns)	AP/NOISE	Applied Voltage
1	V-1-2-1-1-1-1-2-1	300	A	92.8	1.6	100	100
		350	B	94.6	1.5	105	104
		400	C	95.5	1.4	110	108
2	V-2-2-1-1-1-1-2-1	300	D	96.0	1.7	114	99
		400	E	99.0	1.6	125	108

Monte Carlo Simulation
Wavelength: 400 nm

AP/NOISE : DR-1 is better.
CE : B is better but…A should be OK.
(discussion is necessary)

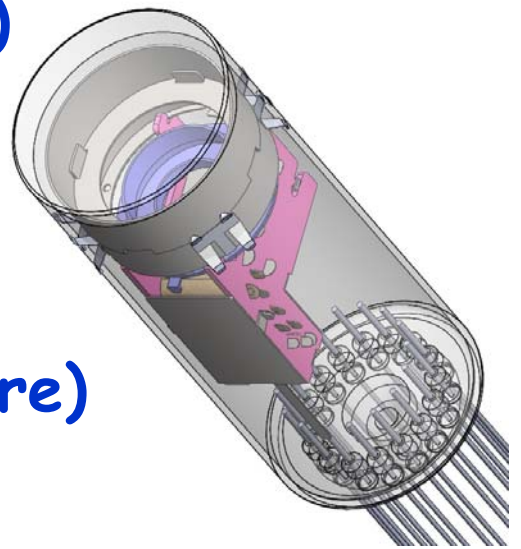
R11919 / 1.5-inch FAST PMT

Fast Time Response
with Acceleration electrode
for TOF-PET (next generation)
and HEP experiments

Transit Time Spread = around 270 ps
(R9420 = 550 ps, R11194 = 400 ps)

Gain = 1E+06
(Gain is adjustable by request)

Cathode Blue Sensitivity = 11
(SBA type could be available in future)



Fast Time Response PMT Series

R9779 (2")
TTS: 250 ps
Rise: 1.8 ns
at 1500V

Applications:
TOF-PET and HEP Experiments

< Concept >
Simple Structure For Low Cost and Mass Production

R11919 (1.5")
TTS: 270 ps
Rise: 1.7 ns
at 1500V

R9800 (1")
TTS: 270 ps
Rise: 1.0 ns
at 1300V

All tubes are available.

3-inch Metal Bulb PMTs for Dark Matter Experiments

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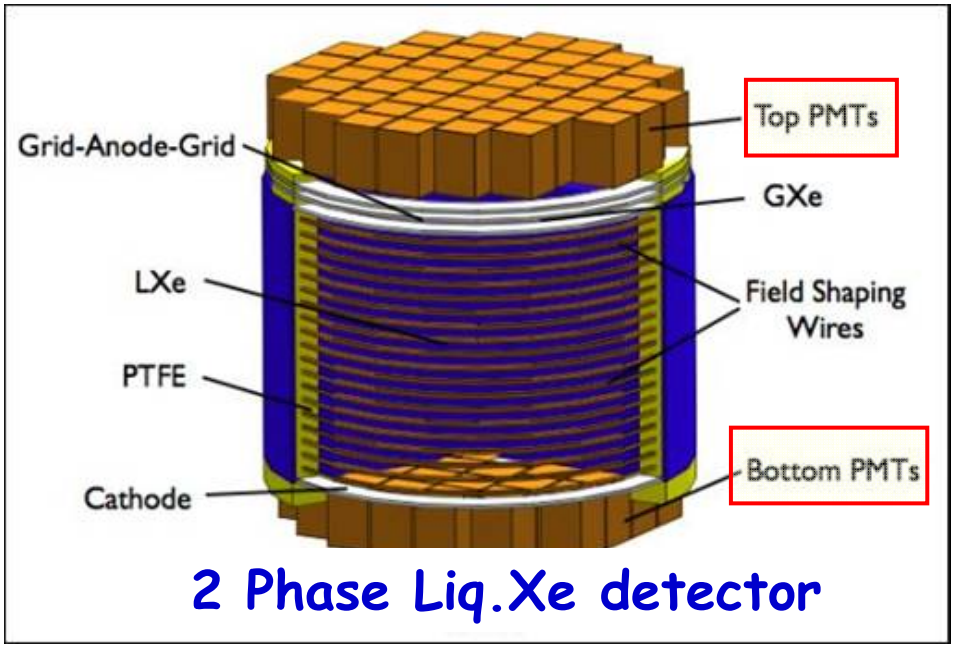
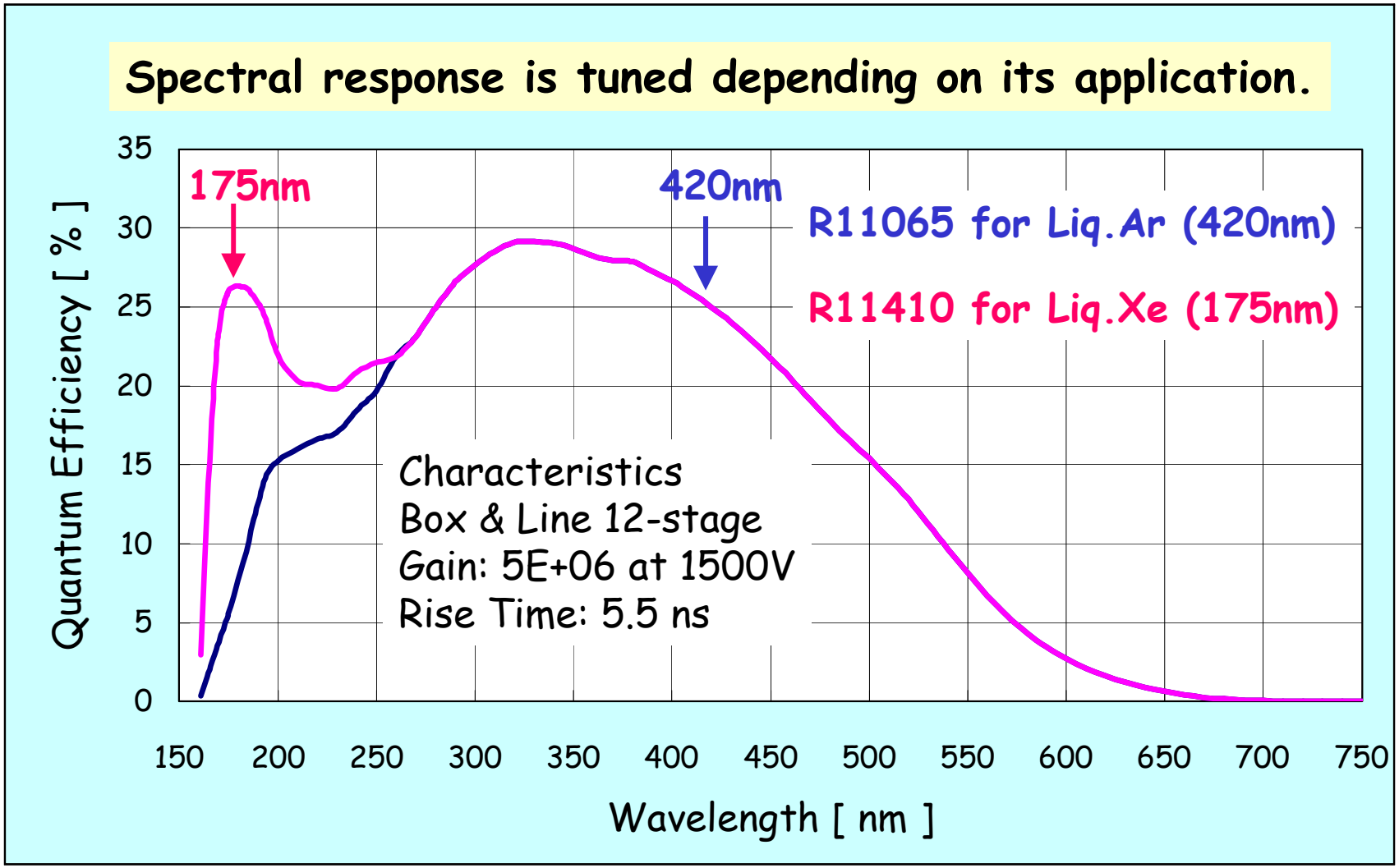
3-inch Metal Bulb PMT (R11065 / R11410)



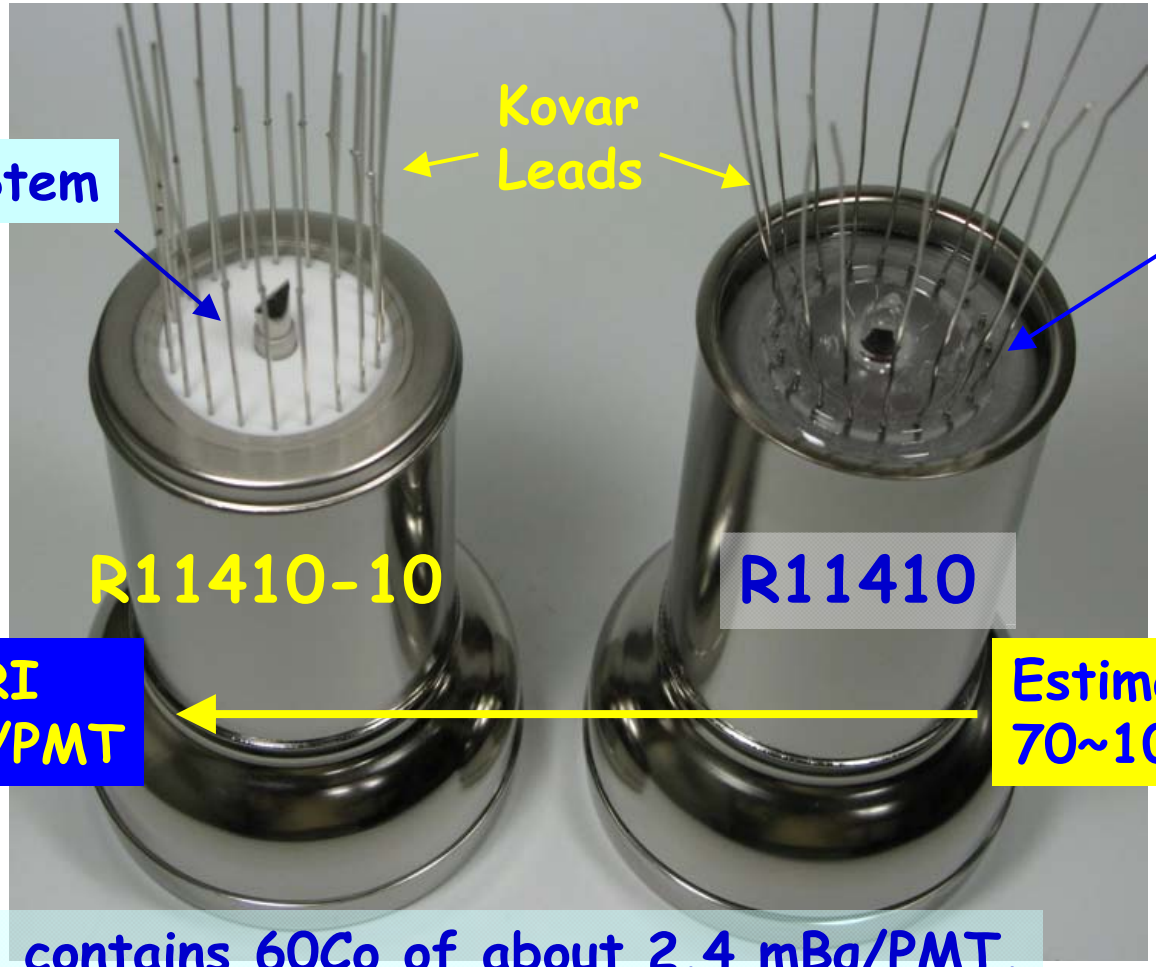
2 Phase Liq.Xe detector

< Prime Features >
LT-Bialkali for Low Temp.
High QE, LOW RI (100mBq)
R11065 for Liq.Ar (-186℃)
R11410 for Liq.Xe (-110℃)

Difference of QE Curves



Further Reduction of RI



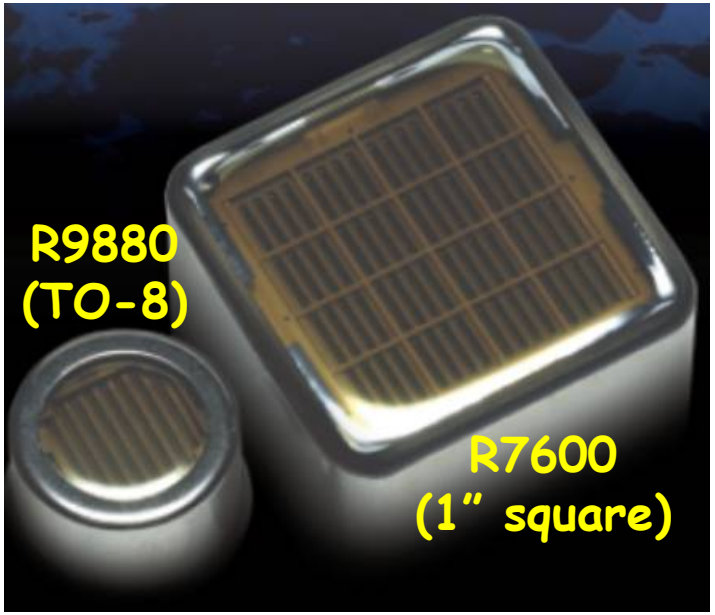
Estimated RI
10~30 mBq/PMT

Estimated RI
70~100 mBq/PMT

Both tubes
are available.

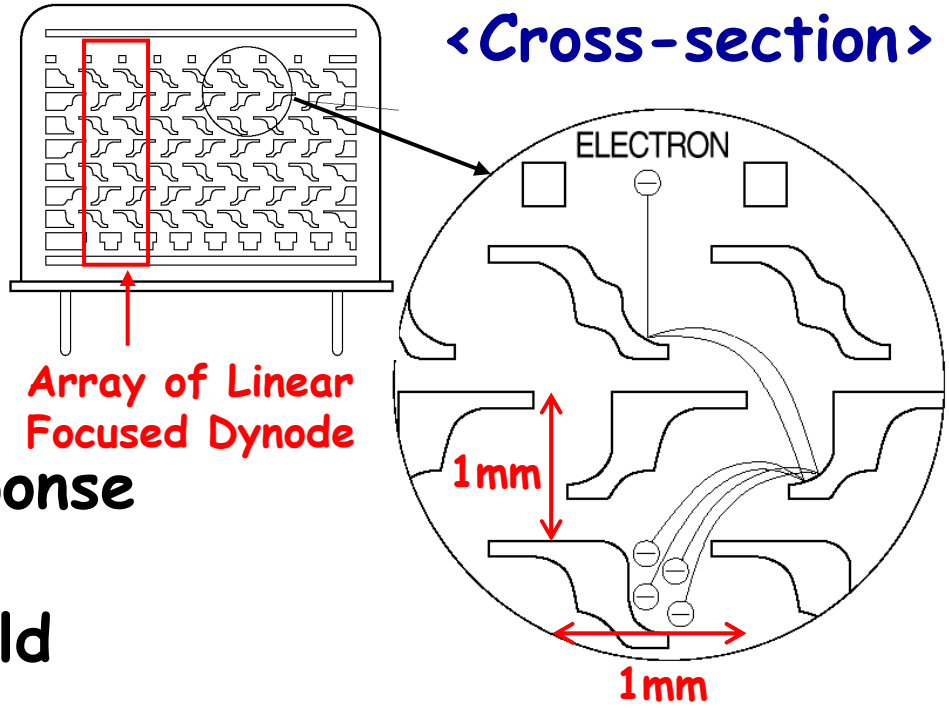
Kovar metal contains 60Co of about 2.4 mBq/PMT.
Alternative metal can reduce it to 0.4 mBq/PMT.

Metal Package PMTs with MCD



Metal Channel Dynodes

Micro processing technology



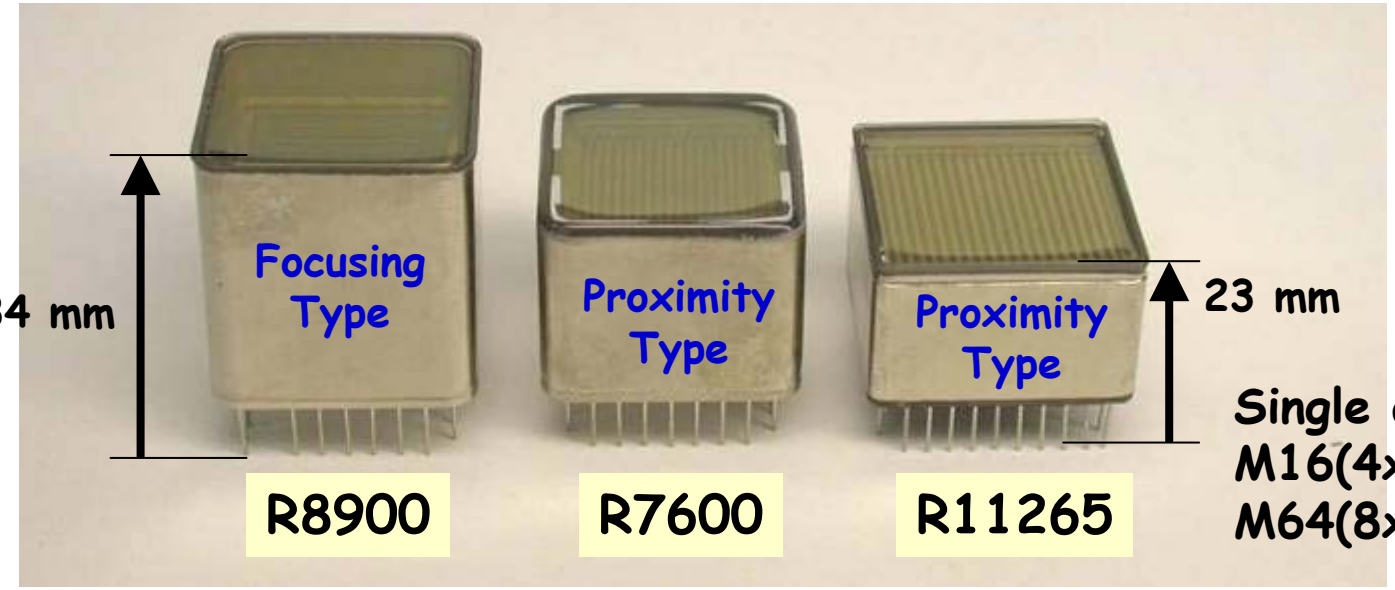
Prime Features

Compact, Fast Time Response
Position Sensitive
Immunity to magnetic field

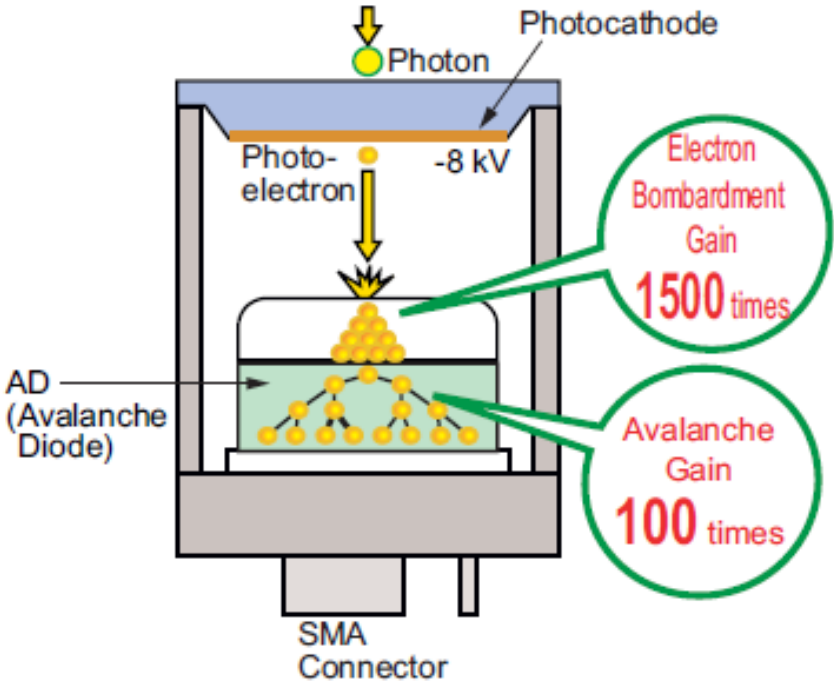
R11265 / New Metal Package PMT

	R8900	R7600	New R11265
Total Tubbe Length (mm)	34	27	23
Effective Area (mm x mm)	23.5	18	23
Collection Efficiency (%) *	75	80	90
Rise Time (ns)	1.8	1.4	1.3
Transit Time Spread (ns)	0.80	0.35	0.27
Available Photocathode	BA, SBA	BA, SBA, UBA	BA, SBA, UBA

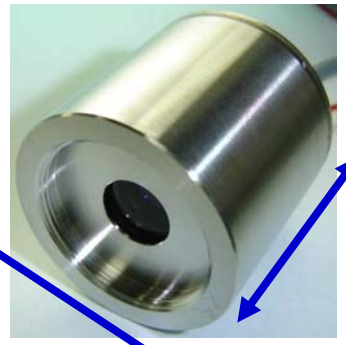
* CE values are based on our simulation data.



R10467U / HPD with Fast Time Response



R10467U-06
(Assembly Type)

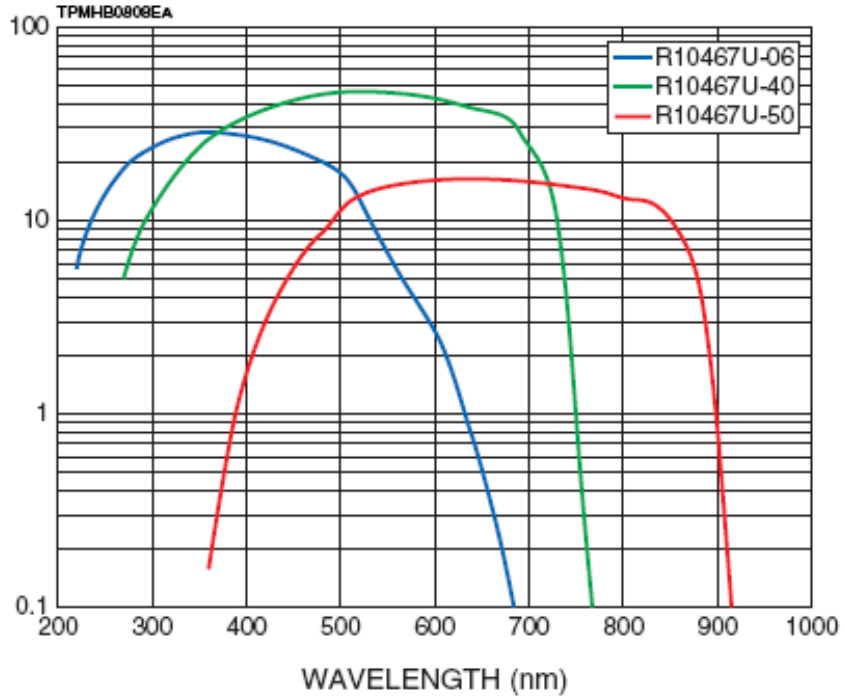


32 mm
in length

33 mm
in diameter

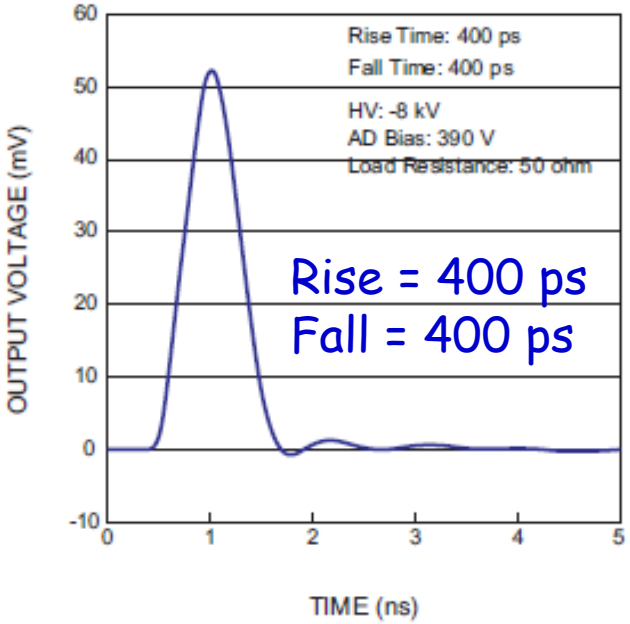
R10467U-06
(Bialkali : 6mm in dia.)
R10467U-40
(GaAsP : 3mm in dia.)
R10467U-50
(GaAs : 3mm in dia.)

■Quantum Efficie

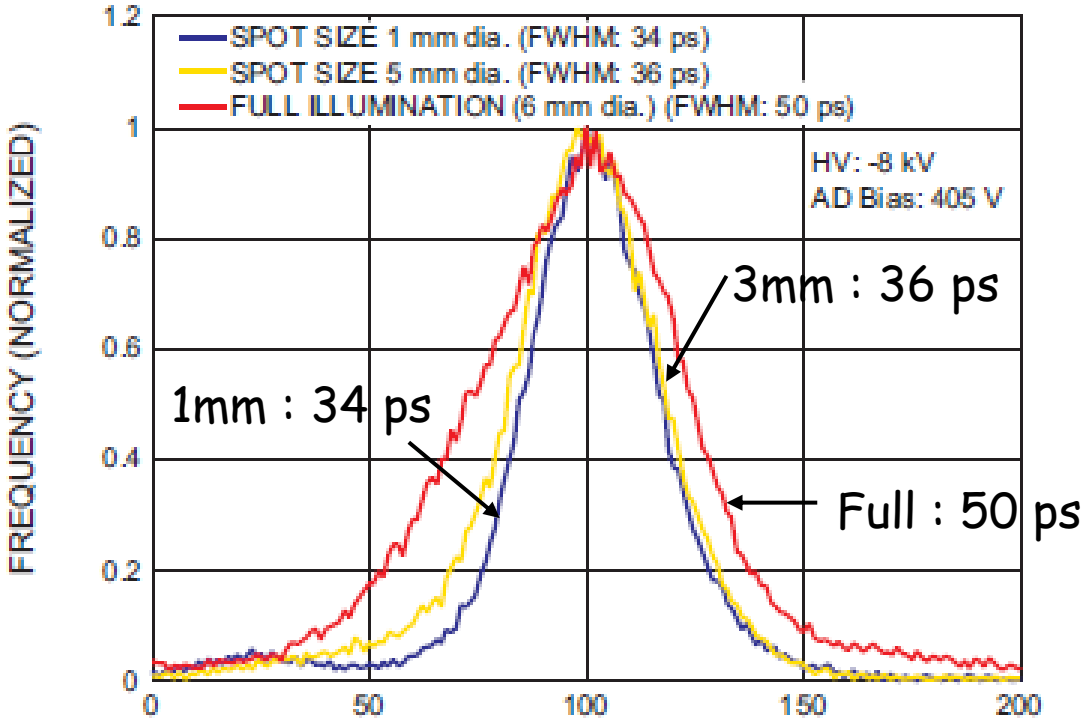


R10467U-06 Time Response

■Output Waveform (R10467U-06)



■T.T.S. : Transit Time Spread (R10467U-06)

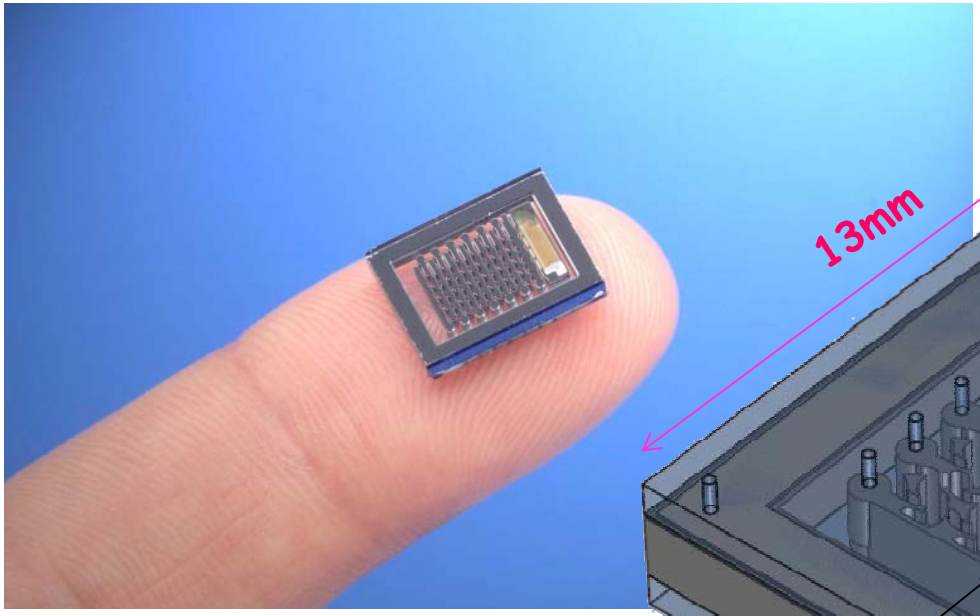


Jitter of Light Source and Readout are included

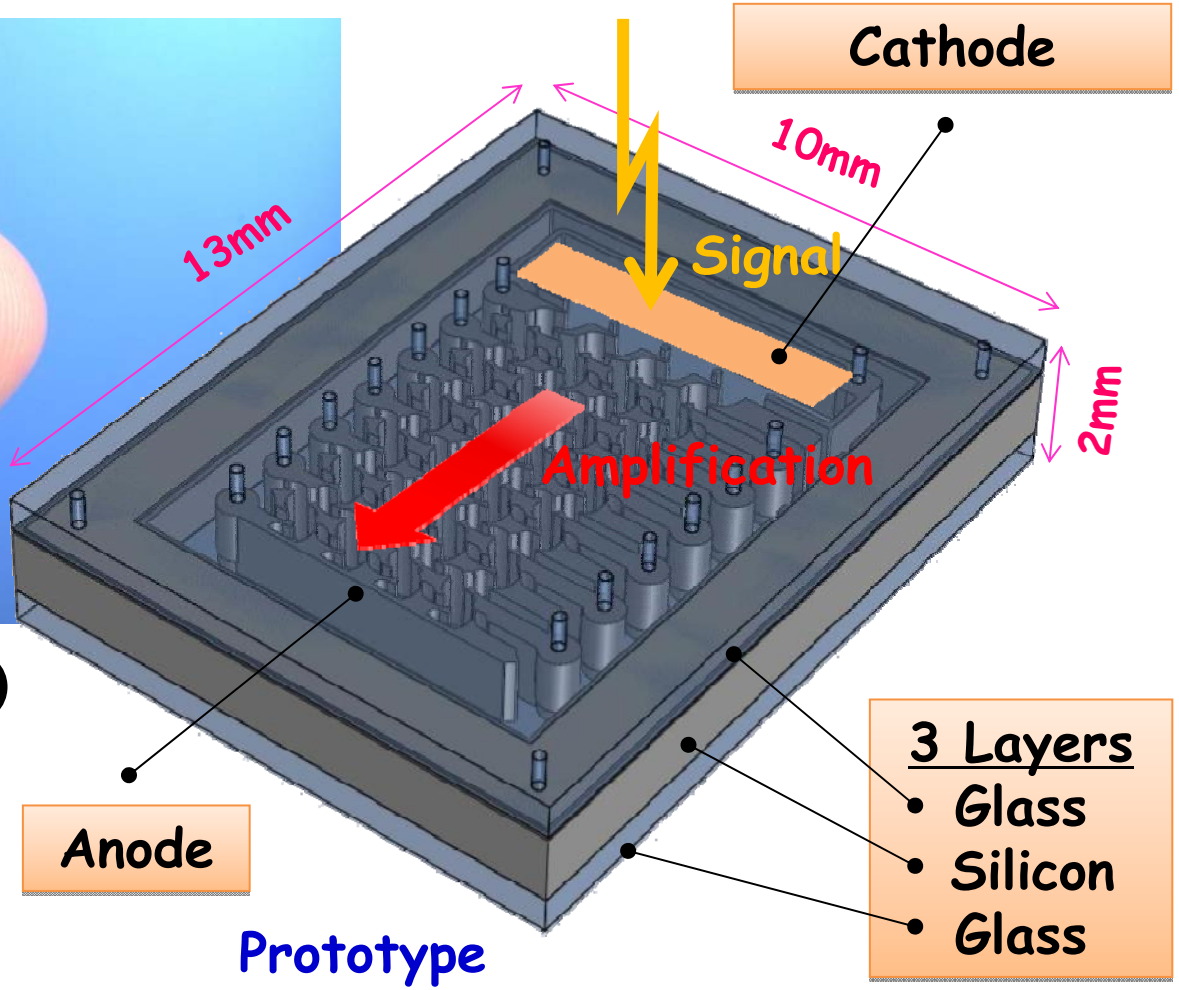
Applications:
Microscope, HEP, Biomedical

Dimensional Outline of μ-PMT

The world's tiniest, thinnest, and lightest PMT !



micro μPMT®



Summary

Hamamatsu developed following products,
which are available right now.

1) 12-inch PMT / R11780
2) 1.5-inch PMT / R11920-100
3) Fast 1.5-inch PMT / R11919
4) 3-inch Metal Bulb PMT / R11410 & R11065
5) New Metal Package PMT / R11265
6) Fast HPD / R10467 series

7) The μ-PMT is still at developement stage.
Its sample could be available next spring (2012).

Thank you for your attention !!

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Hamamatsu Photonics K.K.

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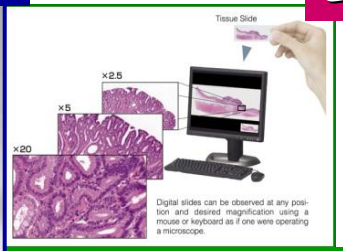
Solid Sate Division

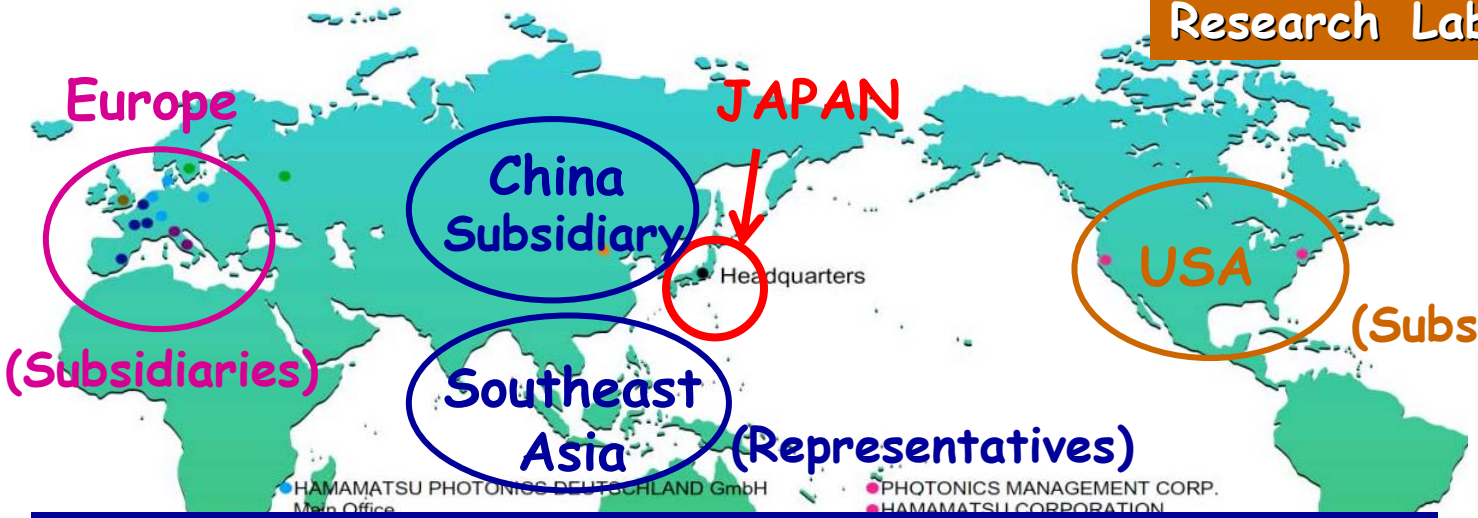
Electron Tube Division

Laser Group



Systems Division

Research Laboratories



Established : Sept.29.1953
Net Sales : (FY 2011) Yen 100B ($1.25B / €900M)
Employees : 4,000 (Group) (As of Sept.2011)

¥80/$
¥110/€

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Picture of ETD (bird's-eye view)