Pulse Shape

22 March, 2018

Feedback

Attenuation Length at WSF

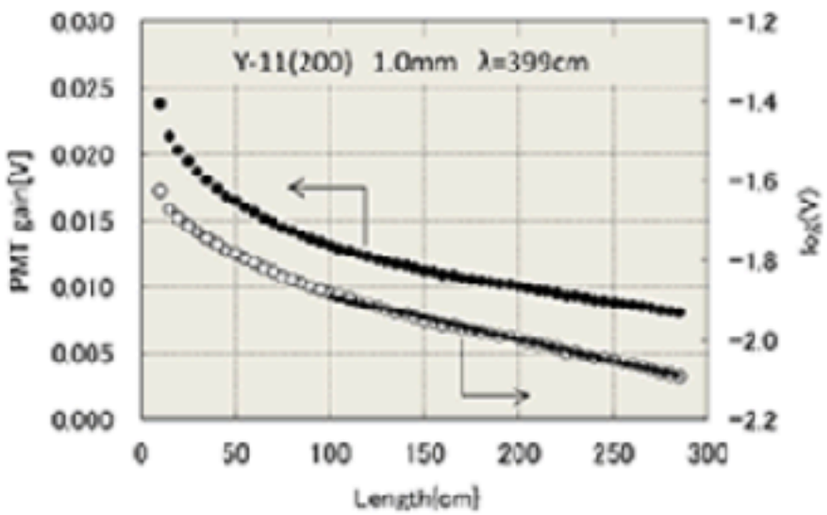
Formulations [1]

Description	Emission			Absorption Peak[nm]	Att.Leng.[2] [m]	Characteristics
	Color	Spectra	Peak[nm]			
Y-7(100)	green	See the following figure	490	439	>2.8	Blue to Green Shifter
Y-8(100)	green		511	455	>3.0	Blue to Green Shifter
Y-11(200)	green		476	430	>3.5	Blue to Green Shifter (K-27 formulation) Long Attenuation Length and High Light Yield
B-2(200)	blue		437	375	>3.5	UV to Blue shifter
B-3(200)	blue		450	351	>4.0	UV to Blue shifter
O-2(100)	orange		550	535	>1.5	Green to orange shifter
R-3(100)	red		610	577	>2.0	Green to red shifter

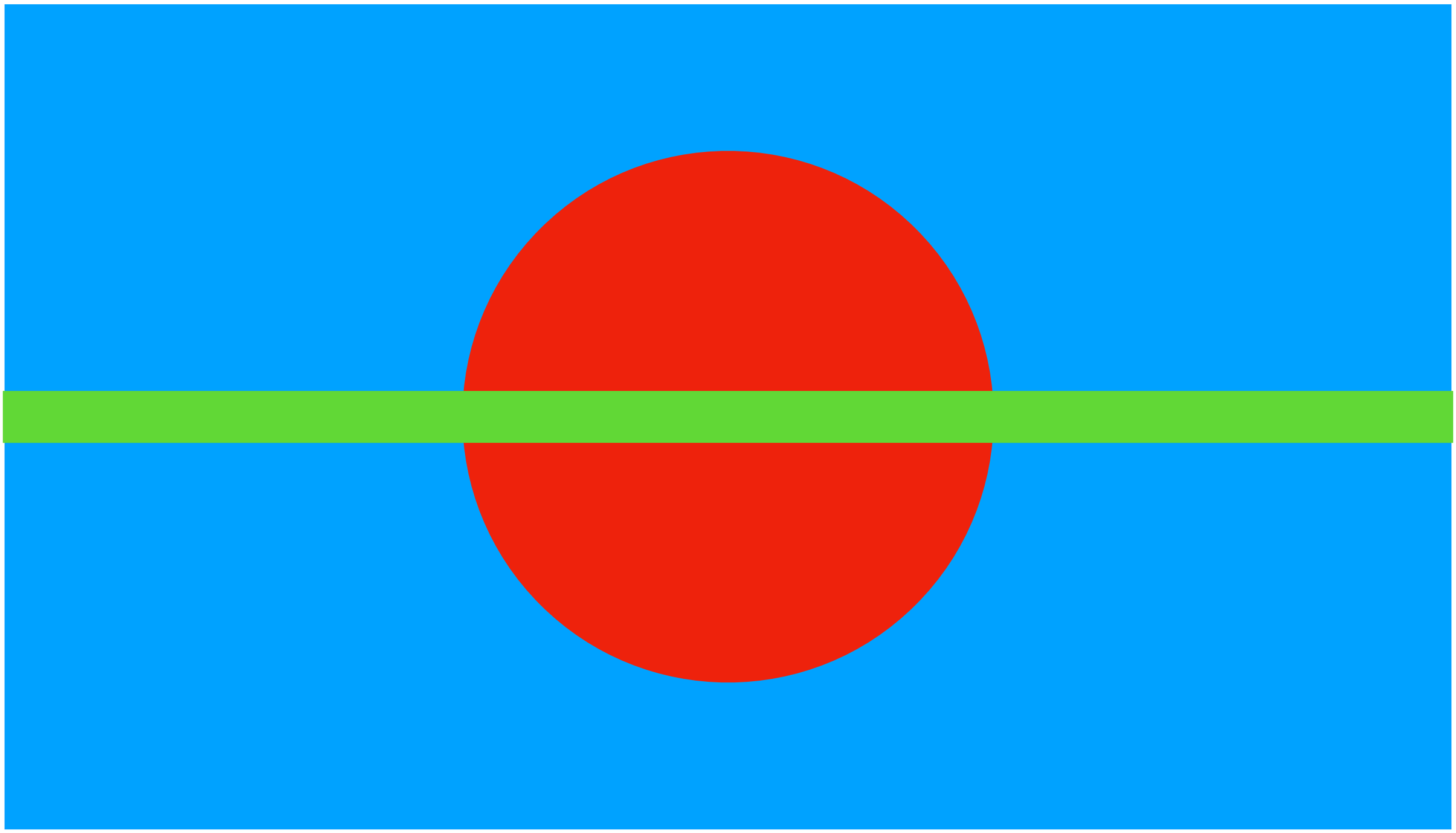
1) Test fibers are Non-S type, 1mmϕ.
2) Measured by using bialkali PMT.
Attenuation length measurement method is the same with scintillating fibers which can be confirmed on Page 5.

Attenuation Length Measurement

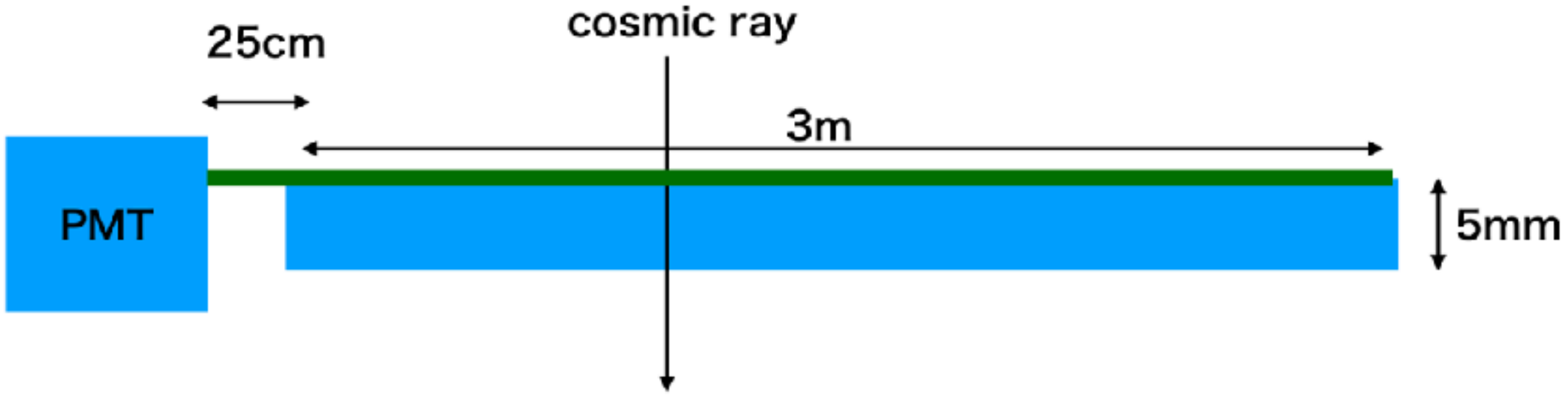
We routinely measure attenuation length by 3m fiber sample for all production.
The attenuation curve (for example) in the figure is approximated by the one exponential expression $I(x)=I_0\exp(-\frac{x}{\lambda})$ except very near distance. The attenuation length λ is calculated using the data between x=100cm and x=300cm.



Photoelectron



Pulse shape



What kinds of pulse we will get when cosmic ray passing through the 5mm-thick and 3m-long plastic scintillator ?
(6 points (0.5m, 1m, 1.5m, 2m, 2.5m, 3m from the MPT)

Needed input : Light yield & decay time of plastic scintillator
Trapping efficiency (1mm diameter WLS Fiber)
Absorption wave length of selected WLS Fiber
Light transportation inside the WLS Fiber
Quantum efficiency/TTS of the selected PMT

Result

x	**50cm**	**300cm**
Number of photoelectron	16	7

Check the Decay Time(EJ-200, Eljen technology)

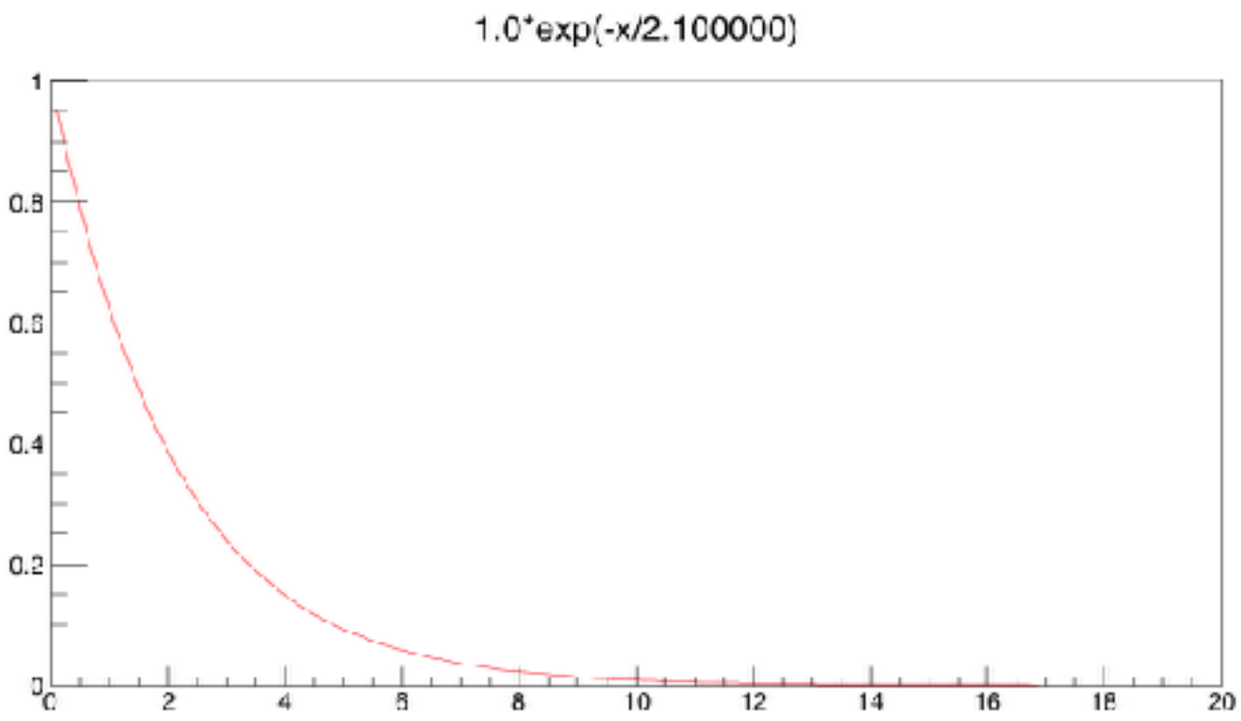
PROPERTIES	EJ-200	EJ-204	EJ-208	EJ-212
Light Output (% Anthracene)	64	68	60	65
Scintillation Efficiency (photons/1 MeV e^-)	10,000	10,400	9,200	10,000
Wavelength of Maximum Emission (nm)	425	408	435	423
Light Attenuation Length (cm)	380	160	400	250
Rise Time (ns)	0.9	0.7	1.0	0.9
Decay Time (ns)	2.1	1.8	3.3	2.4
Pulse Width, FWHM (ns)	2.5	2.2	4.2	2.7
No. of H Atoms per cm^3 ($x10^{22}$)	5.17	5.15	5.17	5.17
No. of C Atoms per cm^3 ($x10^{22}$)	4.69	4.68	4.69	4.69
No. of Electrons per cm^3 ($x10^{23}$)	3.33	3.33	3.33	3.33
Density (g/cm^3)	1.023	1.023	1.023	1.023
Polymer Base	Polyvinyltoluene			
Refractive Index	1.58			
Softening Point	75°C			
Vapor Pressure	Vacuum-compatible			
Coefficient of Linear Expansion	7.8×10^{-5} below 67°C			
Light Output vs. Temperature	At 60°C, L.O. = 95% of that at 20°C No change from 20°C to -60°			
Temperature Range	-20°C to 60°C			

Table 3
Comparison of the wavelength shifter fiber properties

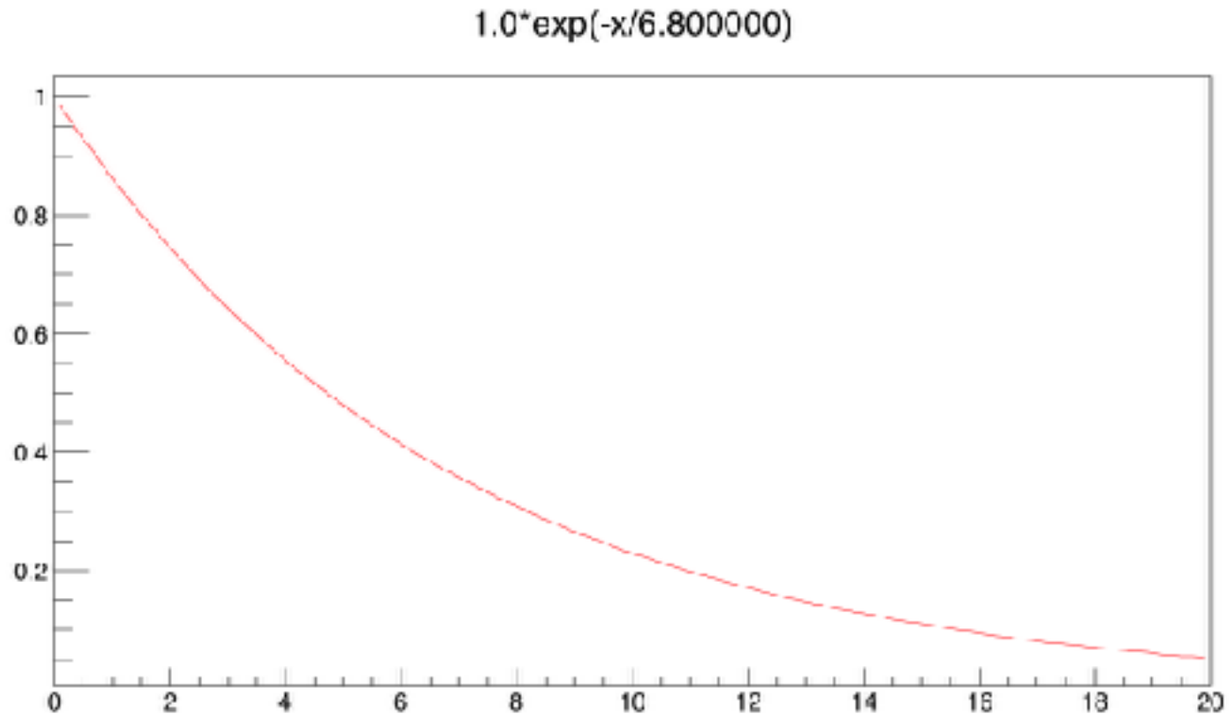
	Bicron BCF-91a	Kuraray Y-11
Light yield (relative)	1.00	1.53
Attenuation length		
λ_1 (m)	0.60	0.68
λ_2 (m)	4.47	4.48
Light decay time (ns)	6.6	6.8

Barrel photon detector of the KEK $K_L^0 \to \pi^0 \nu\bar{\nu}$ experiment

Decay Time



Time[ns]

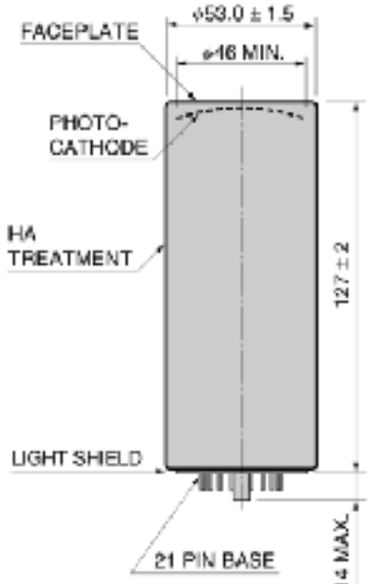


Time[ns]

Pulse Width, FWHM

Properties of Photomultiplier Tube

Hamamatsu R329-02



Parameter		Description / Value	Unit
Spectral response		300 to 650	nm
Wavelength of maximum response		420	nm
Photocathode	Material	Bialkali	—
	Minimum effective area	φ46	mm
Window material		Borosilicate glass	—
Dynode	Structure	Linear focused	—
	Number of stages	12	—
Operating ambient temperature		-30 to +50	°C
Storage temperature		-30 to +50	°C
Base		21-pin glass base	—
Suitable socket		E678-21C (supplied)	—

MAXIMUM RATINGS (Absolute maximum values)

Parameter		Value	Unit
Supply voltage	Between anode and cathode	2700	V
Average anode current		0.2	mA

CHARACTERISTICS (at 25 °C)

Parameter		Min.	Typ.	Max.	Unit
Cathode sensitivity	Luminous (2856 K)	60	90	—	μA/lm
	Blue sensitivity index (CS 5-58)	—	10.5	—	—
	Radiant at 420 nm	—	85	—	mA/W
Anode sensitivity	Luminous (2856 K)	30	100	—	A/lm
	Radiant at 420 nm	—	9.4×10^4	—	A/W
Gain		—	1.1×10^6	—	—
Anode dark current (after 30 min storage in darkness)		—	6.0	40	nA
Time response	Anode pulse rise time	—	2.6	—	ns
	Electron transit time	—	48	—	ns
	Transit time spread (T.T.S.)	—	1.1	—	ns
Pulse linearity	at 2 % deviation	—	15 (100)	—	mA
	at 5 % deviation	—	30 (200)	—	mA

NOTE: Anode characteristics are measured with the voltage distribution ratio shown below.
( ): Measured with the special voltage distribution ratio (Tapered Divider) shown below.

VOLTAGE DISTRIBUTION RATIO AND SUPPLY VOLTAGE

Electrodes	K	G	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	Dy11	Dy12	P
Ratio	4	0	1	1.4	1	1	1	1	1	1	1	1	1	1	1

Supply voltage: 1500 V, K: Cathode, Dy: Dynode, P: Anode, G: Grid
★ The shield pin should be connected to Dy5.