

Hamamatsu Photonics K.K.



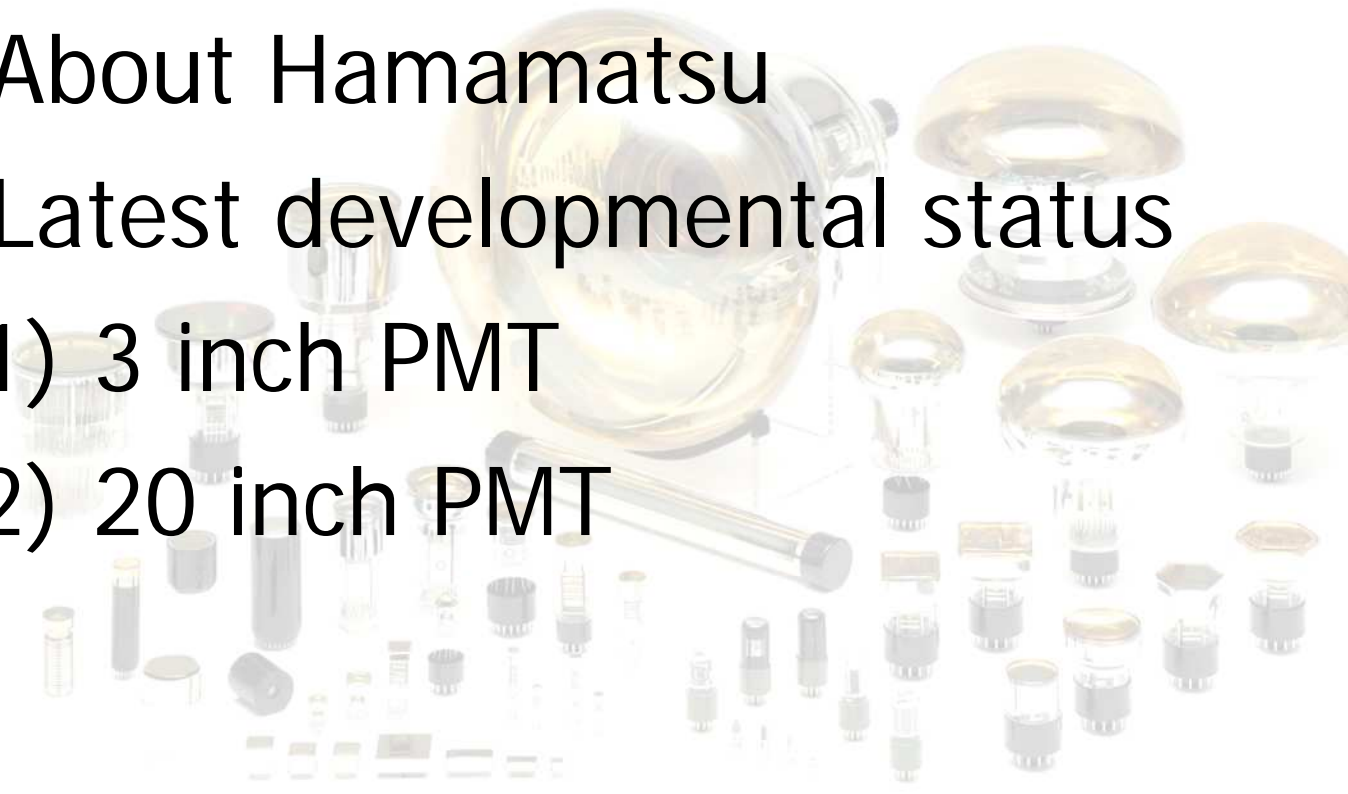
LIGHT17 on October 19, 2017

Yuji Hotta

Electron Tube Division

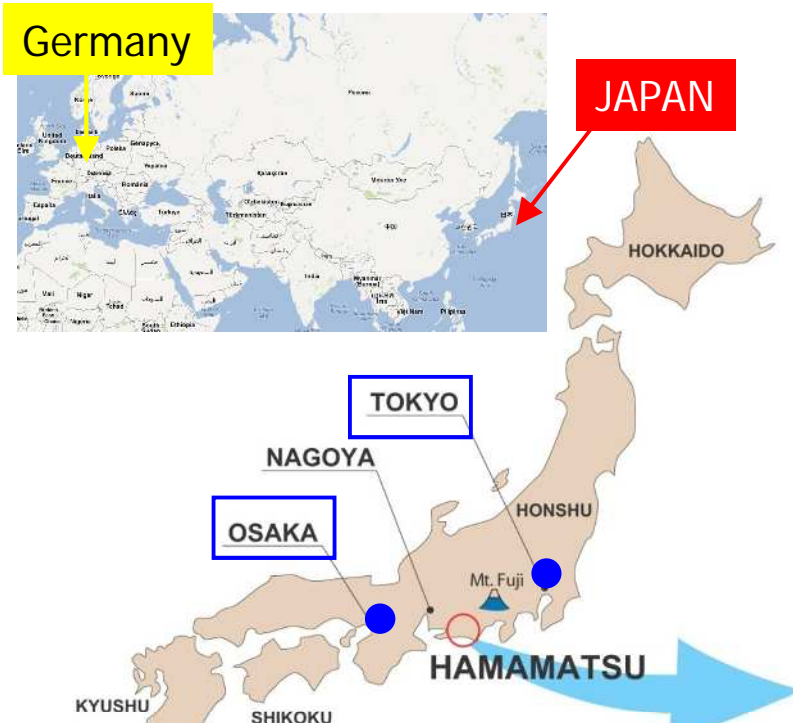
Hamamatsu Photonics K.K.

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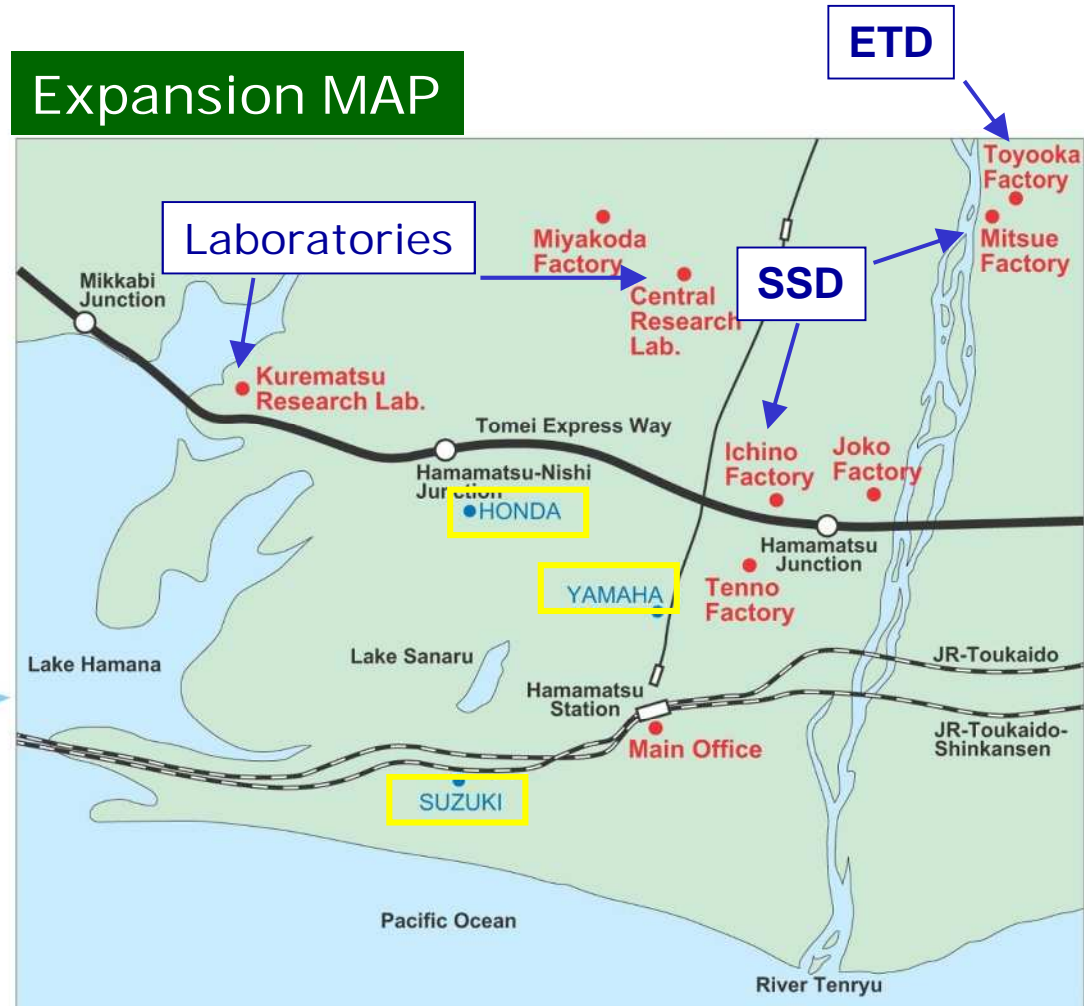
1. About Hamamatsu
 2. Latest developmental status
 - (1) 3 inch PMT
 - (2) 20 inch PMT
- 

1. About Hamamatsu

Where is Hamamatsu located ?



Hamamatsu City
Population: 807K
(As of Oct. 1st, 2017)



HONDA, YAMAHA and SUZUKI are located in the same area.

Hamamatsu Photonics K.K.

Solid State Division



Electron Tube Division



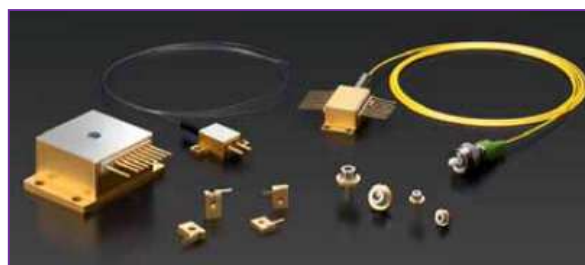
Research Laboratories



Systems Division



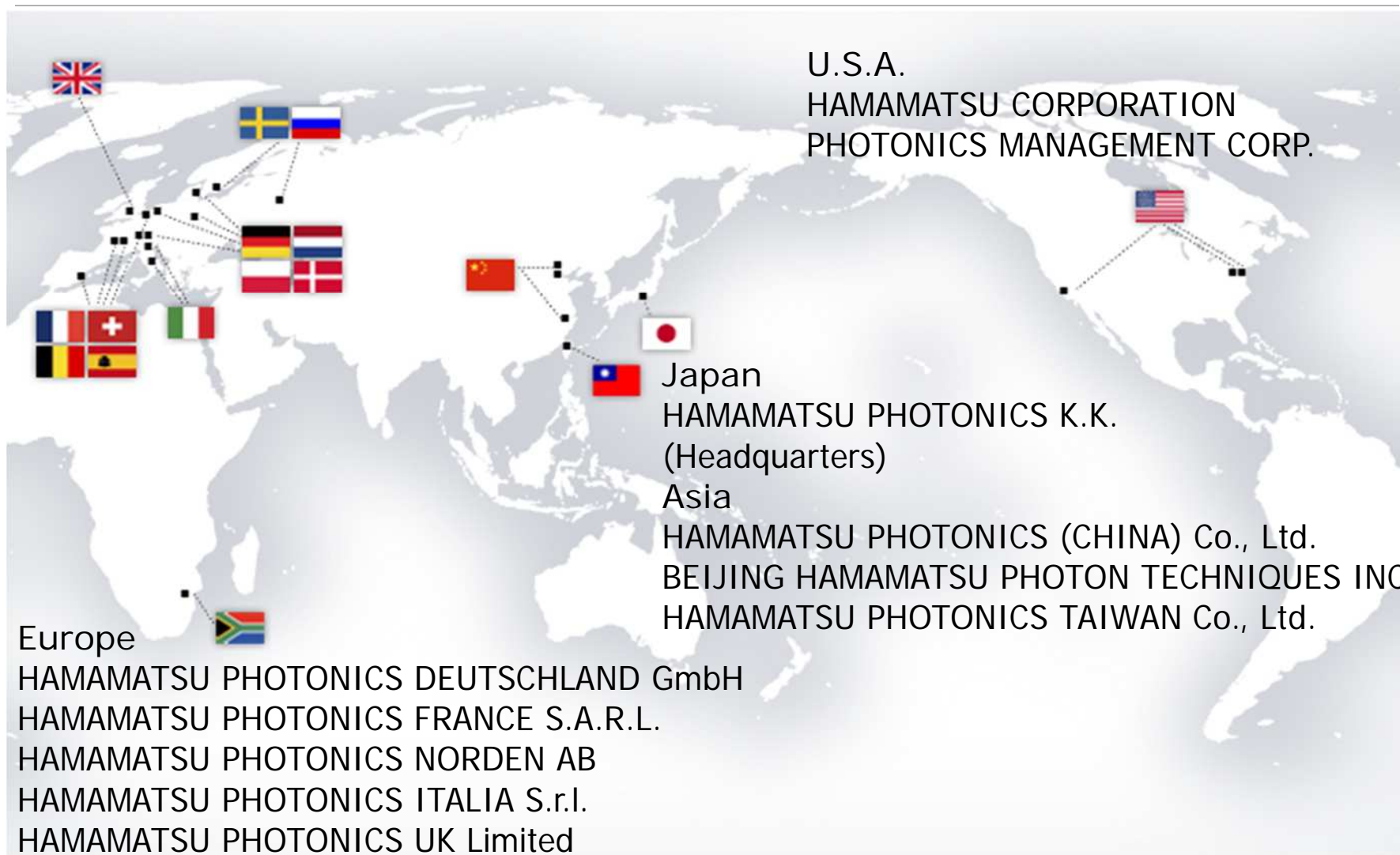
Laser Group



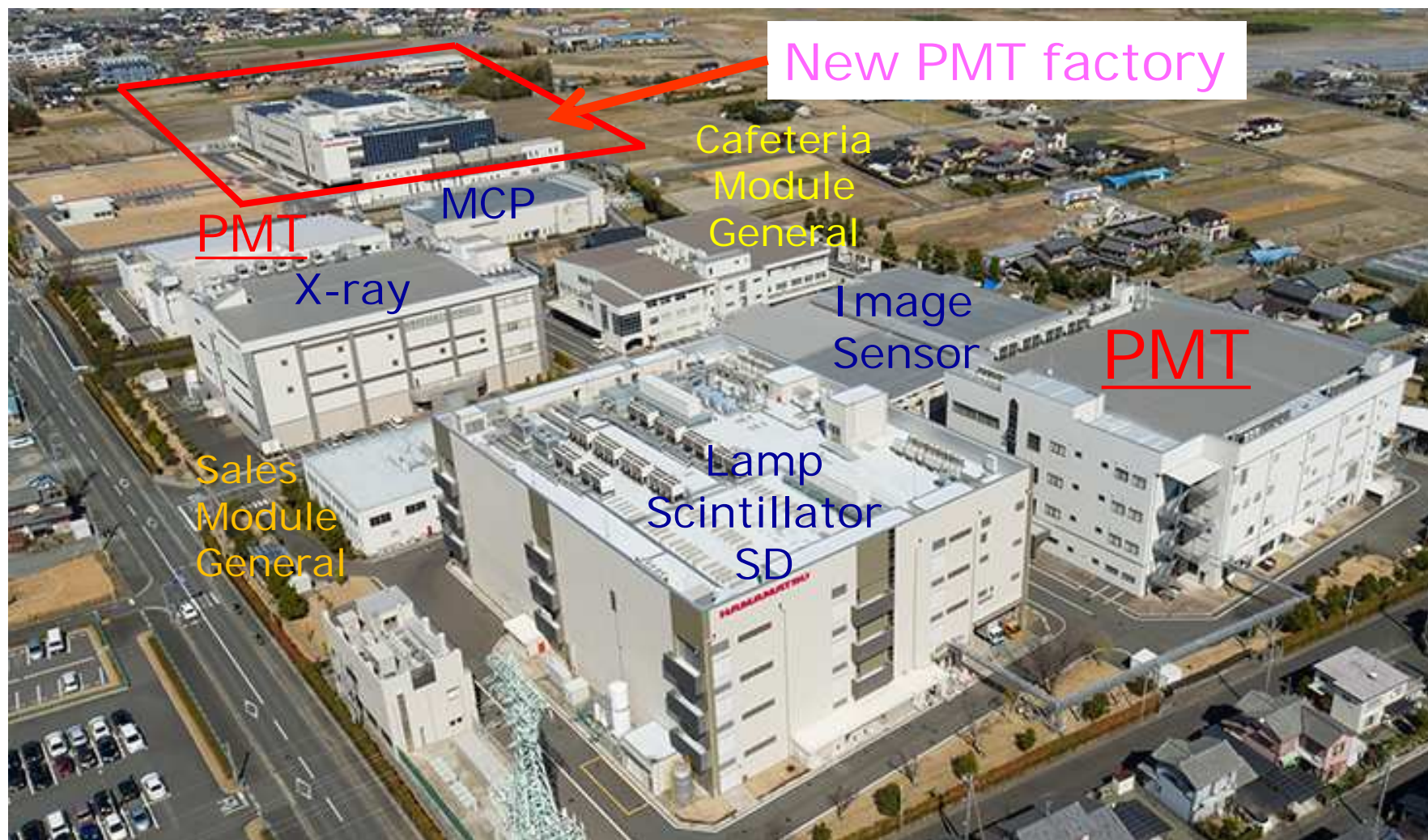
Established : Sept.29.1953 (64 years old)
Net Sales : (FY2016) Yen 122B (\$1.4B / €0.9B)
Employees : 4,592 (Group) (As of Sept. 2016)

Exc. Rate
¥112/\$
¥133/€

Global subsidiaries



Electron Tube Division



Electron Tube Division / New Factory

New PMT factory



IEEE Milestone for 20-inch PMT

20-inch PMT, which was used for KAMIOKANDE Neutrino Experiment, was authorized as IEEE Milestone on Oct.15.2014.

Milestones Program (established in 1983) recognizes a significant technical achievement that occurred at least 25 years ago in an area of technology represented in IEEE and having at least a regional impact on community and industry.



IEEE : The Institute of Electrical and Electronics Engineers

Location of IEEE Milestone Plaque



2. Latest developmental status

(1) 3 inch PMT

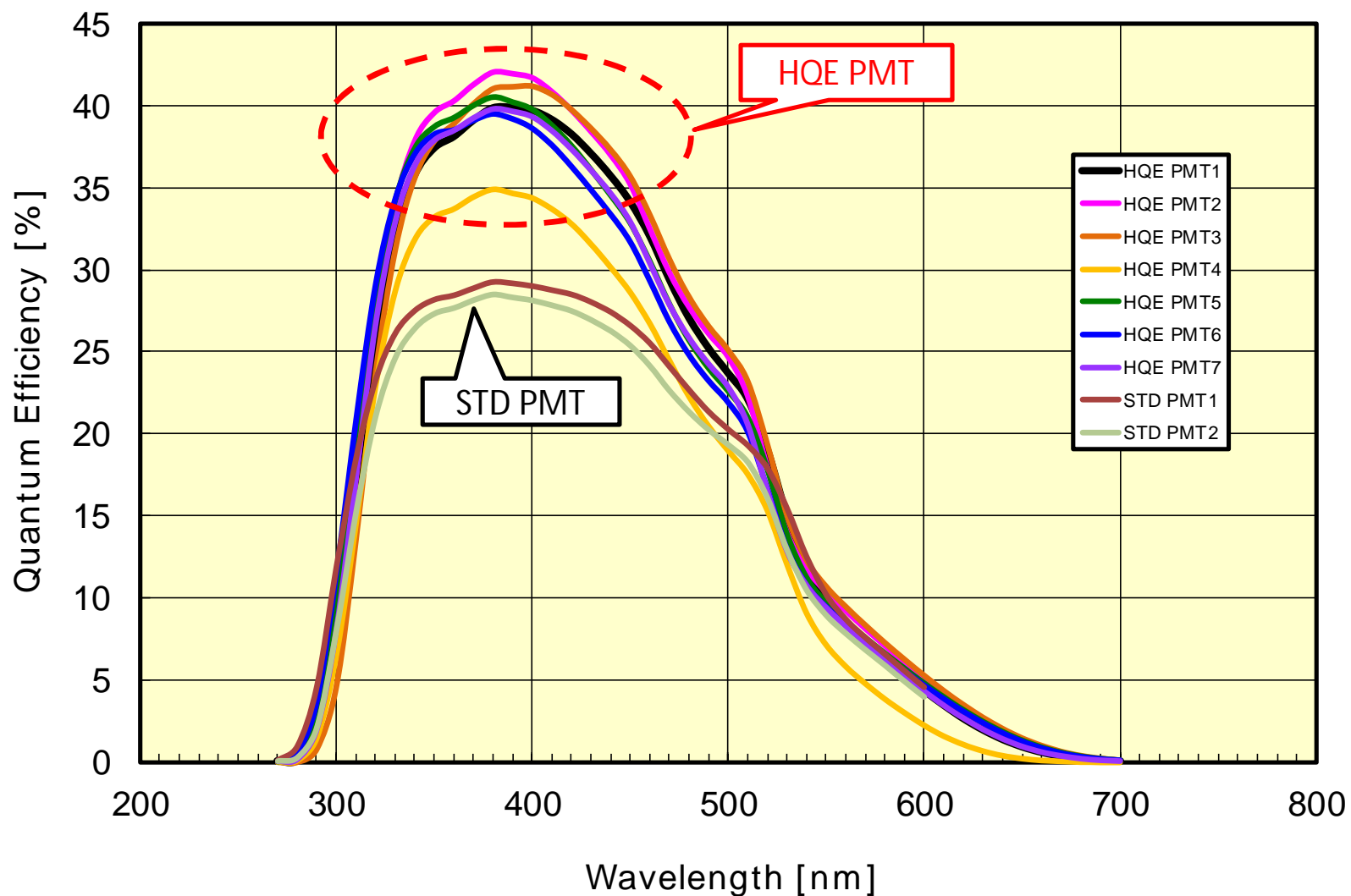
R12199 (3 inch PMT)



Items	R12199 3 inch PMT
Diameter	80 mm
Effective Area	72 mm min.
Tube Length	98 mm
Quantum Efficiency	28%
Dynodes	C&L/10-stage
Gain*	3.0E+06
Rise Time*	3.6 ns
T.T.S.* (FWHM)	3.4 ns
P/V Ratio*	2.5

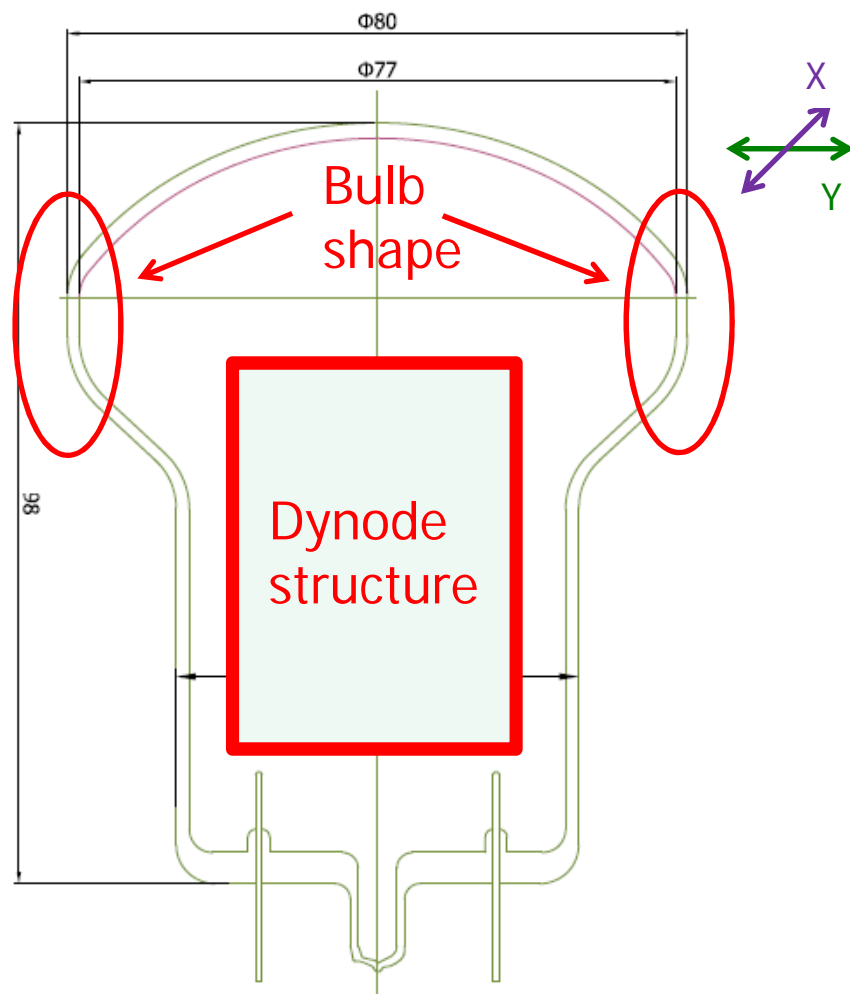
*Supply Voltage : 1000 V

R12199 Quantum Efficiency



Improvement in TTS

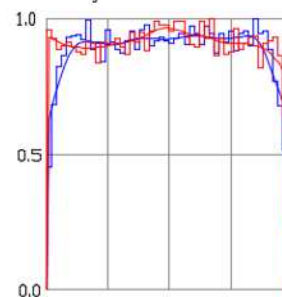
Blue: Current Type
Red: New Type



Uniformity

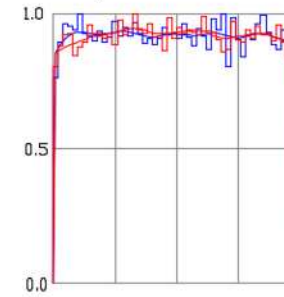
Y-Axis

Dynode-6 (in)



X-Axis

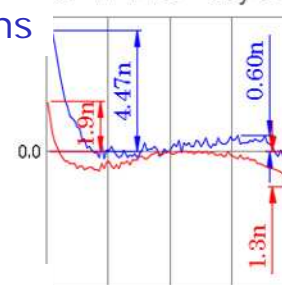
Dynode-6 (in)



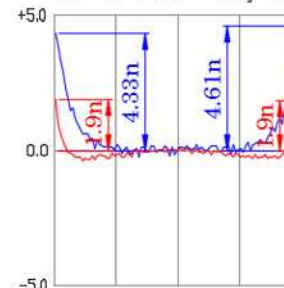
C.T.T.D

+5 ns

C. T. T. D (Dy6)

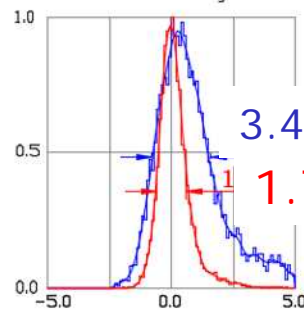


C. T. T. D (Dy6)



T.T.S

T. T. S (Dy6)



CE : 96.8%
(Dy6 Full)

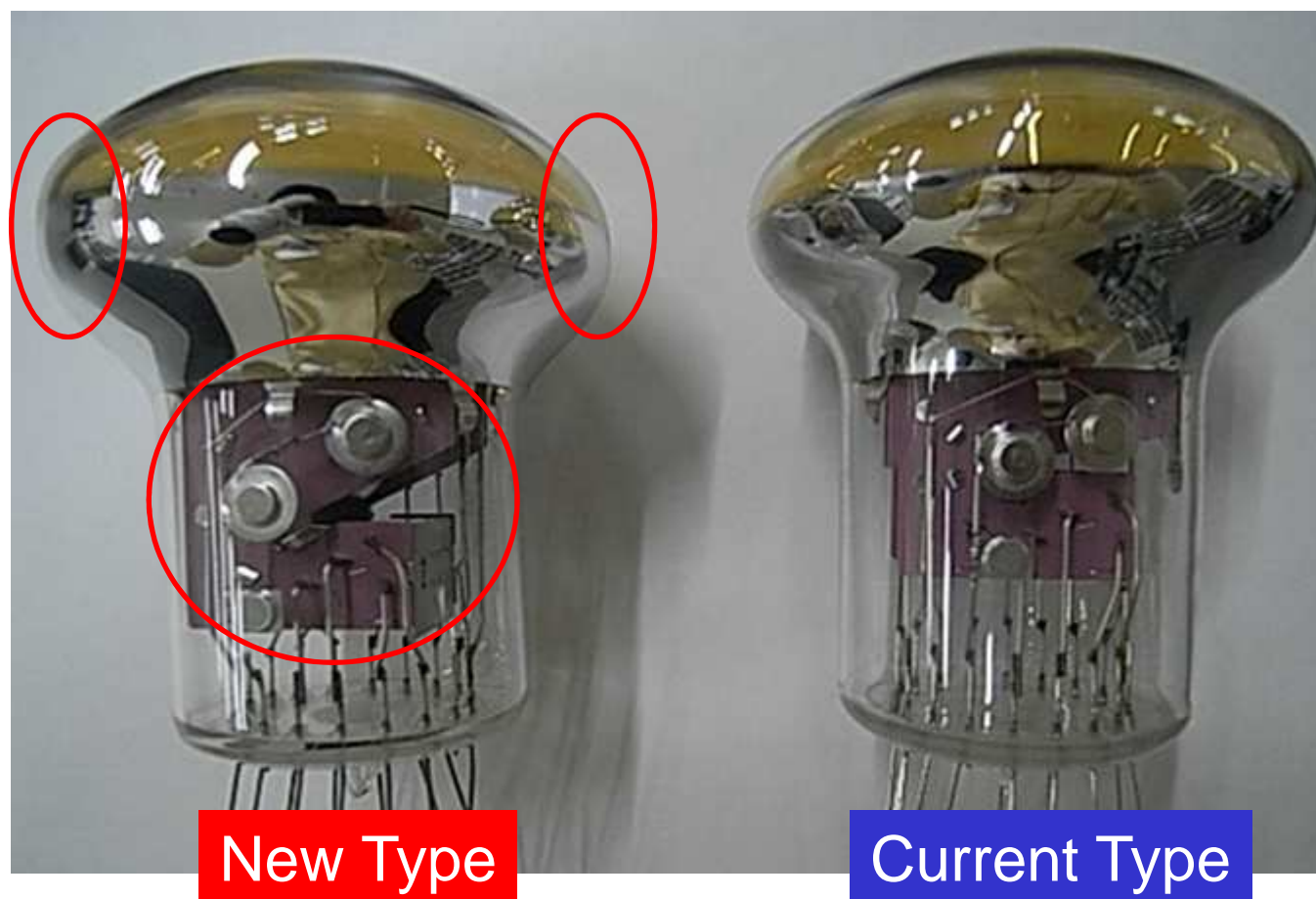
3.4 ns

1.7 ns (FWHM)

Full Illumination

Voltage divider ratio: 3-1---1 => 3-2-1---1

Current type vs. New Type



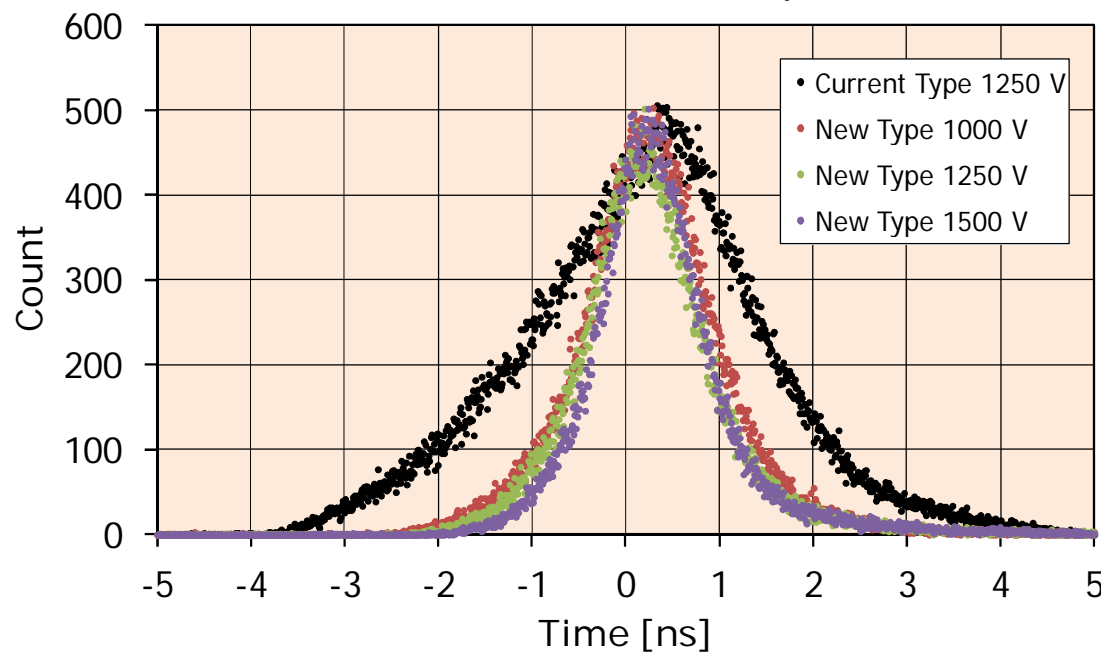
Transit Time Spread (TTS)

Supply Voltage	1000 V	1250 V	1500 V	
Current Type	3.4	2.8	2.5	N = 10
New Type	1.5	1.3	1.1	N = 5

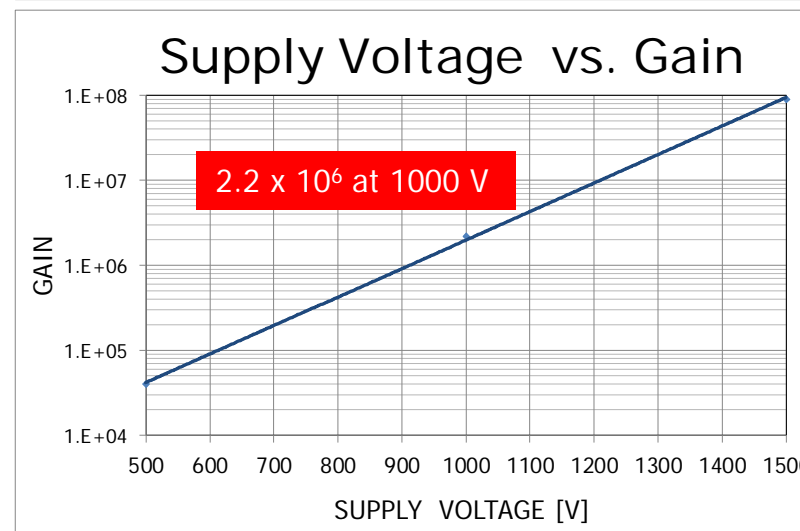
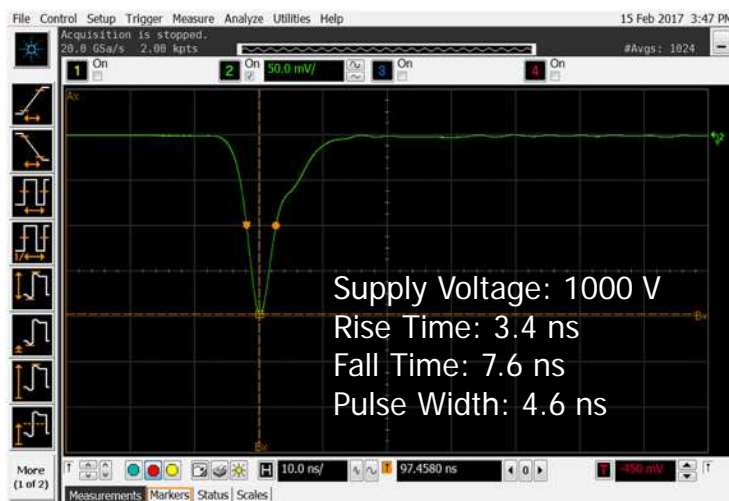
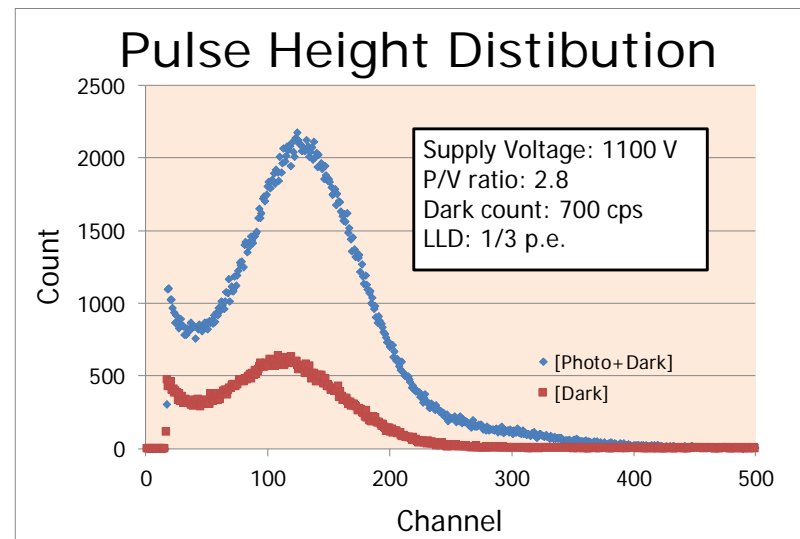
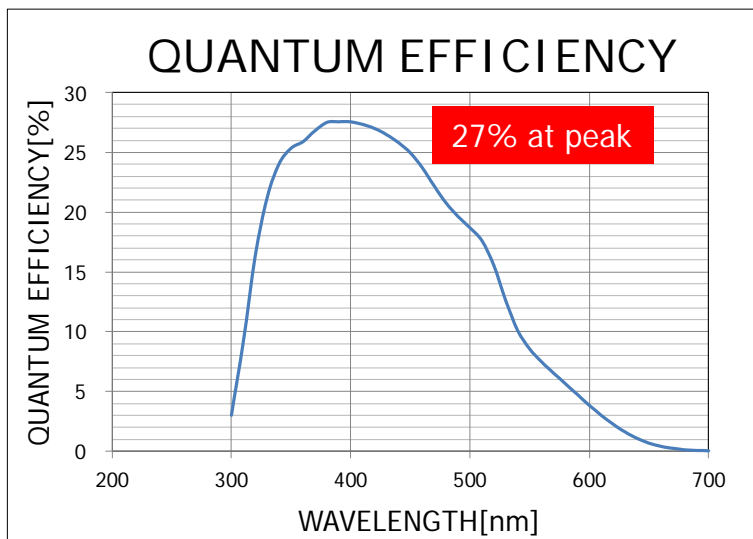
Single pe. FWHM

Unit : ns

R12199 Transit Time Spread



R14374 (New) Electrical characteristics



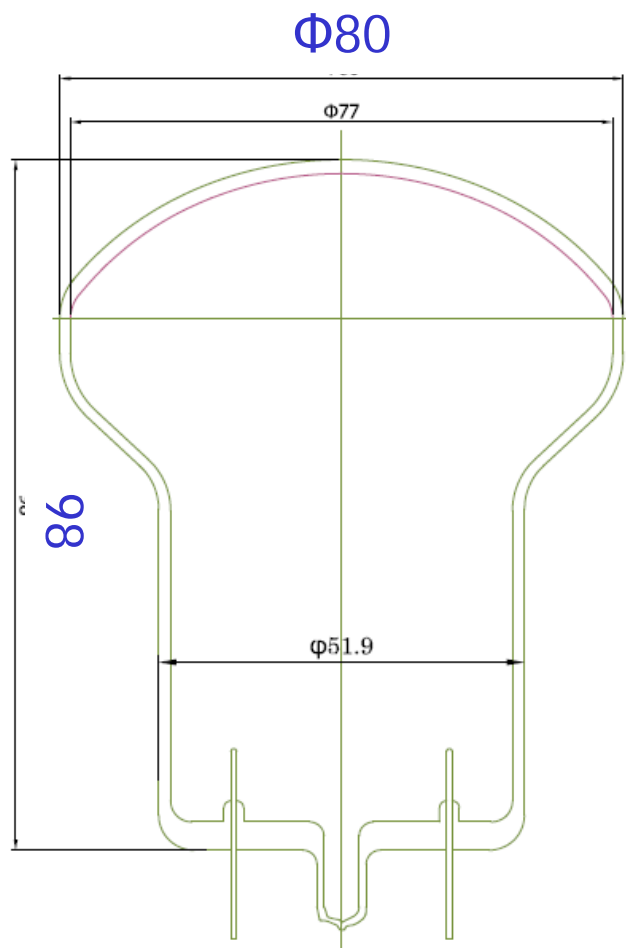
New

R14374 vs. R12199

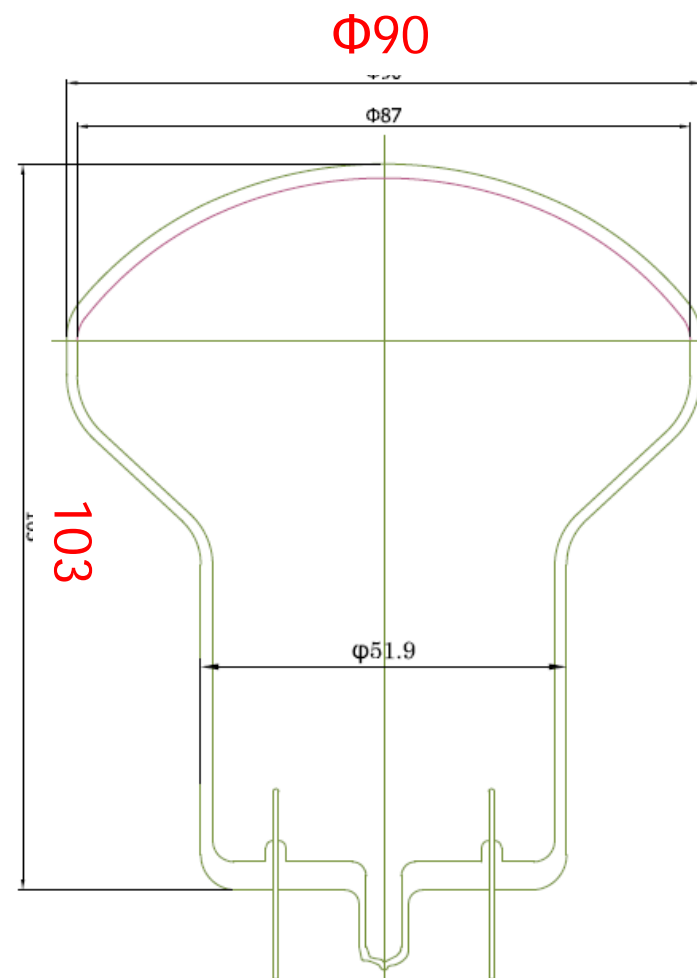
Items	R14374 New 3 inch PMT	R12199 Current 3 inch PMT
Diameter	80 mm	80 mm
Effective Area	72 mm min.	72 mm min.
Tube Length	98 mm	98 mm
Quantum Efficiency	27%	28%
Dynodes	C&L/10-stage	C&L/10-stage
Gain*	2.2E+06	3.0E+06
Rise Time*	3.4 ns	3.6 ns
T.T.S. *(FWHM)	1.5 ns	3.4 ns
P/V Ratio*	2.5	2.5
Voltage Divider Ratio	3-2-1---1	3-1-1---1

*Supply Voltage : 1000 V

Development of large diameter type



Simulated TTS : 1.7 ns



Simulated TTS : 2.0 ns

2. Latest developmental status

(2) 20 inch PMT

R3600 (20 inch PMT)

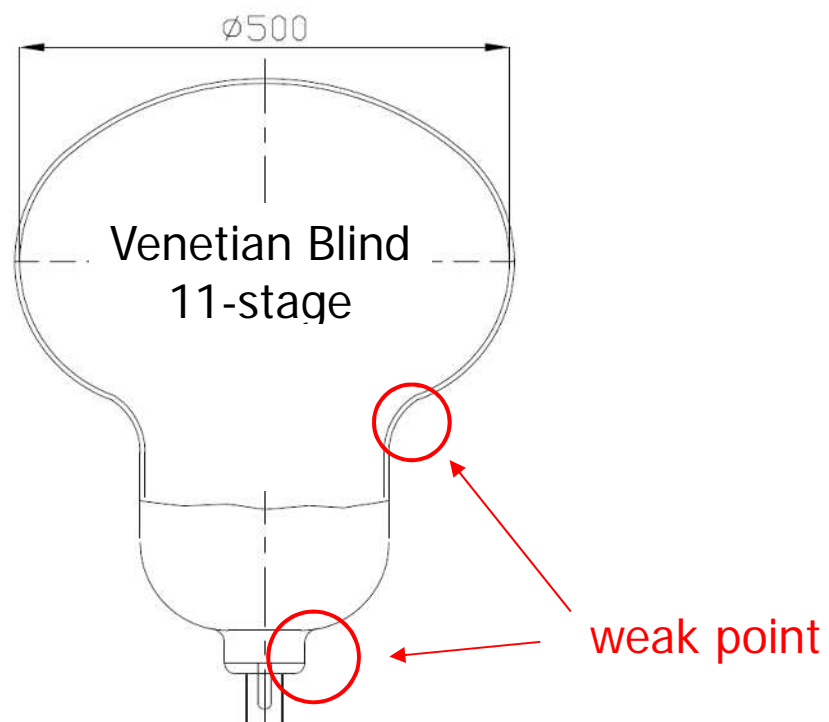


Items	R3600 20-inch PMT
Diameter	508 mm
Effective Area	460 mm min.
Tube Length	610 mm
Collection Efficiency	70%
Dynodes	VB/11-stage
GAIN	1.0E+07 at 2000 V
T.T.S. (FWHM)	5.5 ns
P/V Ratio	1.7
Pressure Resistance	0.6 MPa

New

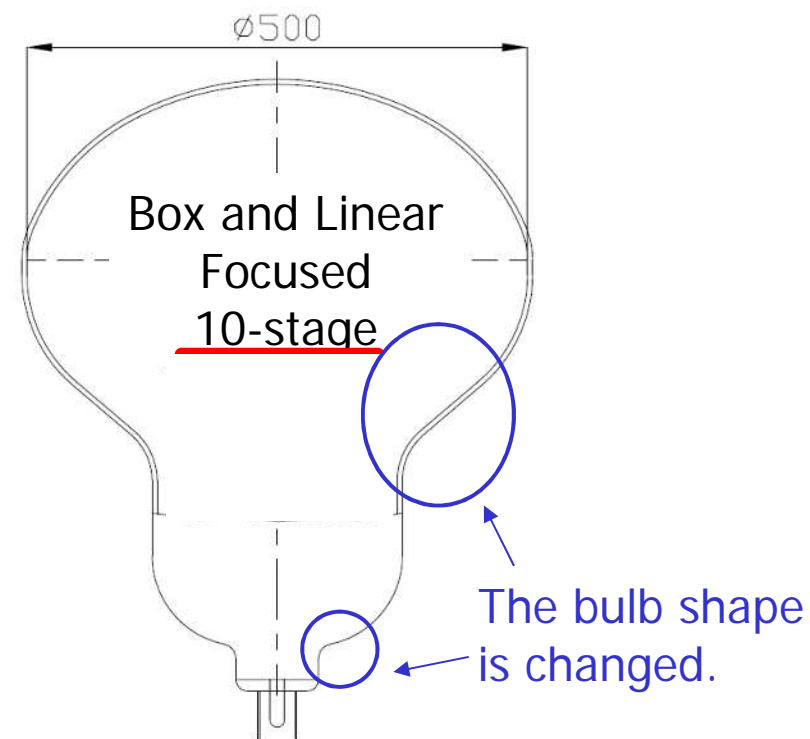
R3600 vs. R12860

R3600 (Current Type)



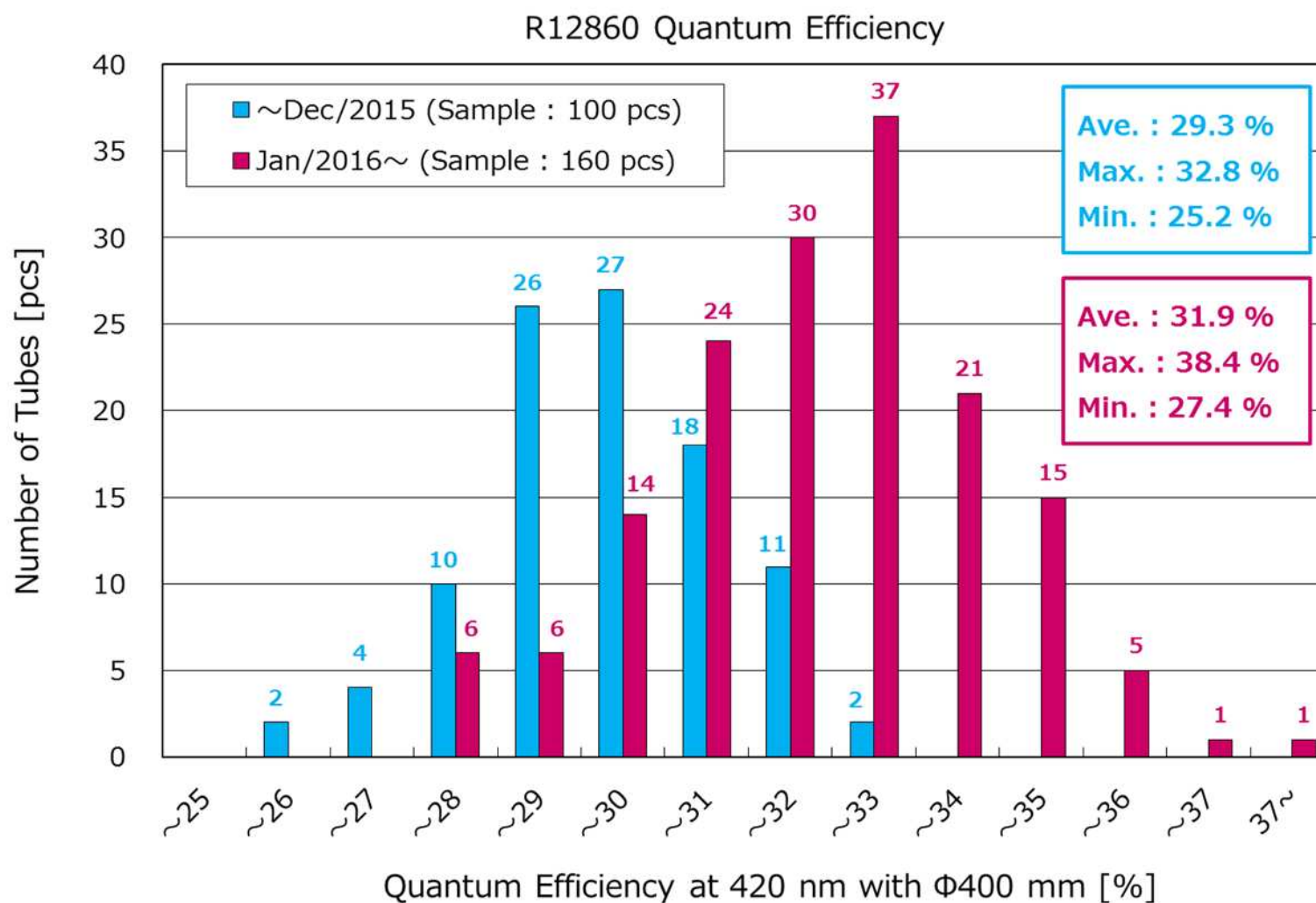
Pressure resistance
0.6 MPa

R12860 (New Type)



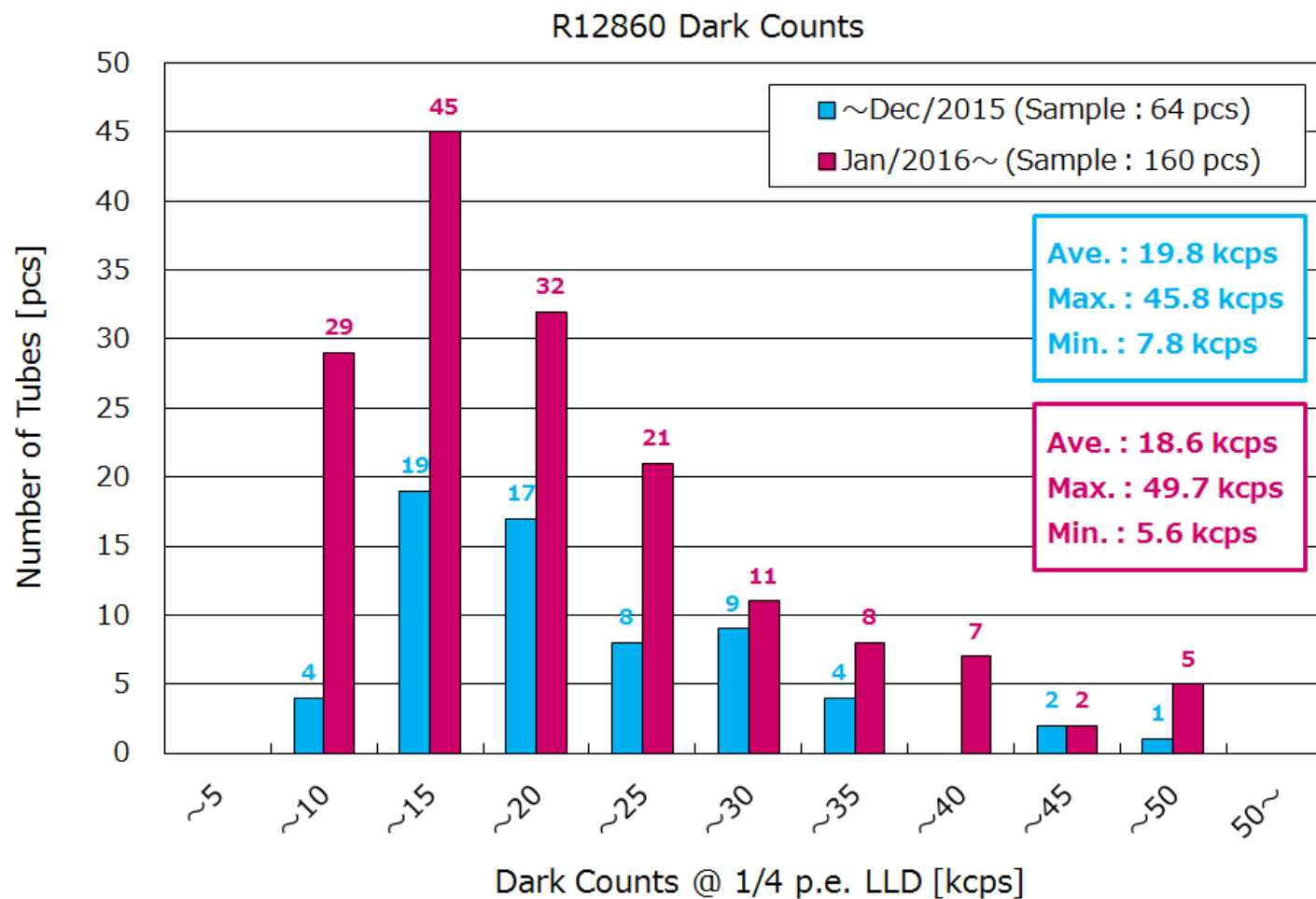
Pressure resistance
0.9 MPa

R12860 Improvement of QE



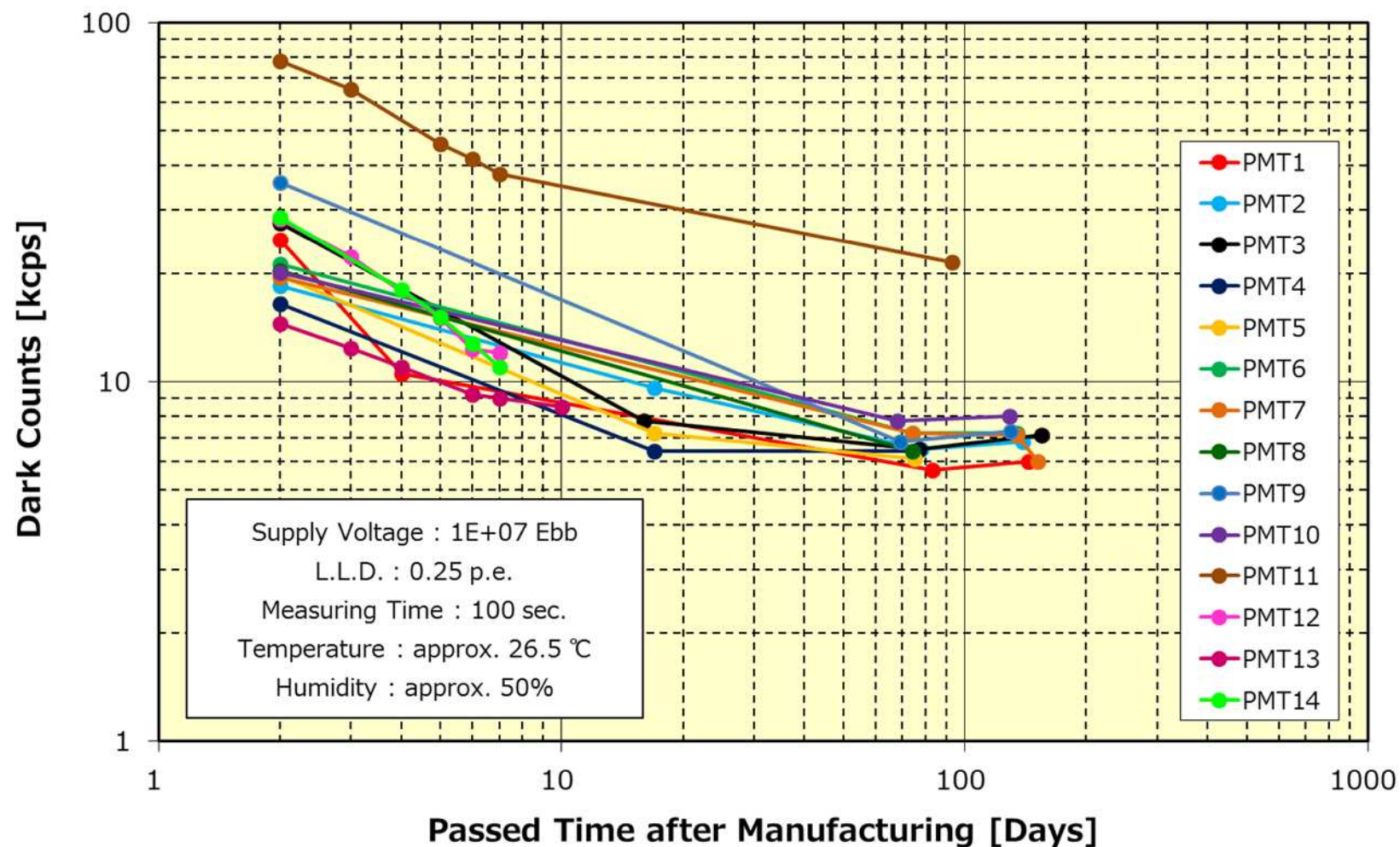
R12860 Dark Count

LLD : 1/4 p.e. , Gain : 1E+07, Temperature : 25 degree C, Storage time in darkness : 2 days



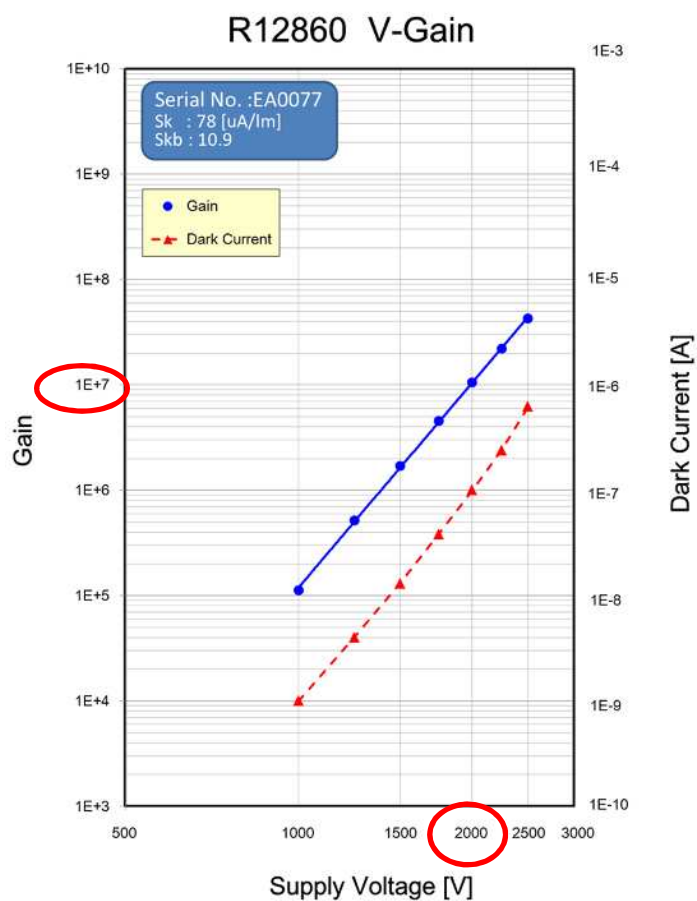
R12860 Dark Counts

R12860 Transition of Dark Counts

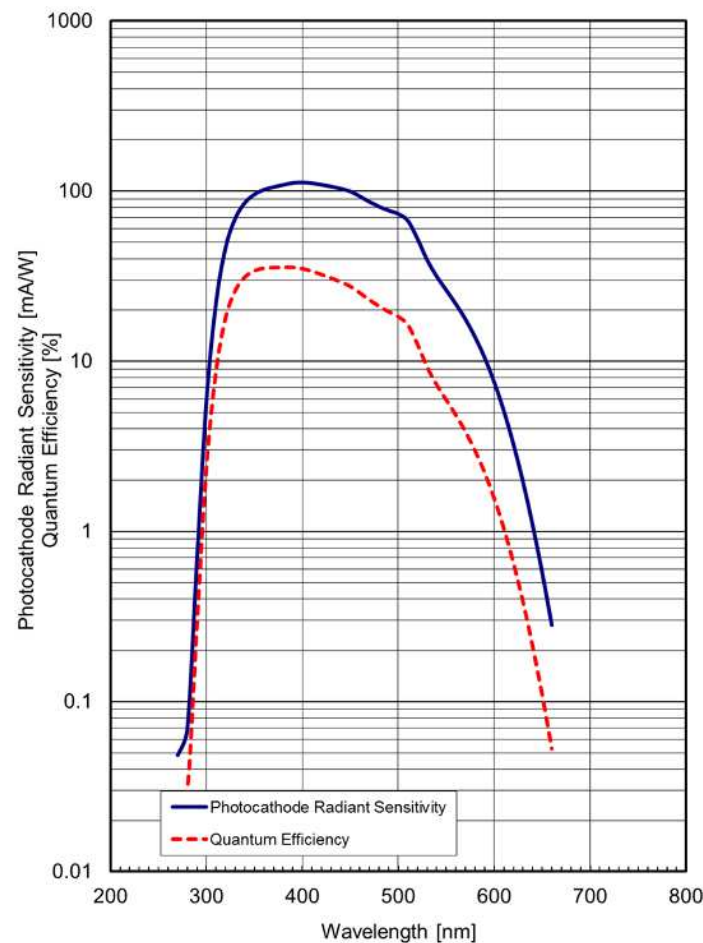


R12860 Gain and QE

Typical Data



Gain 1E+07 at 2000 V

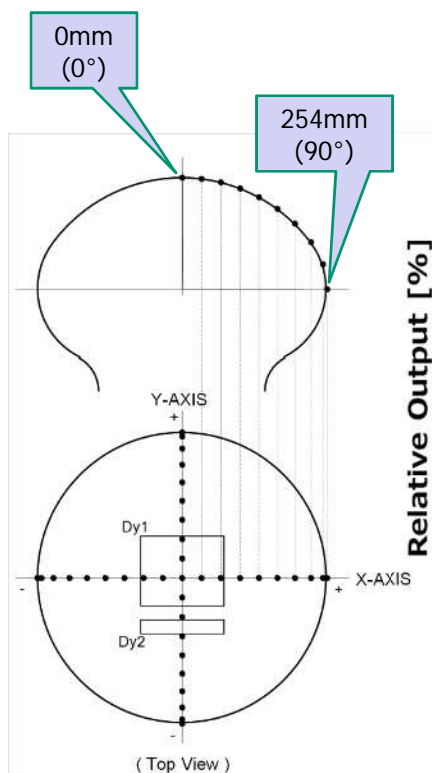


35% at 390 nm

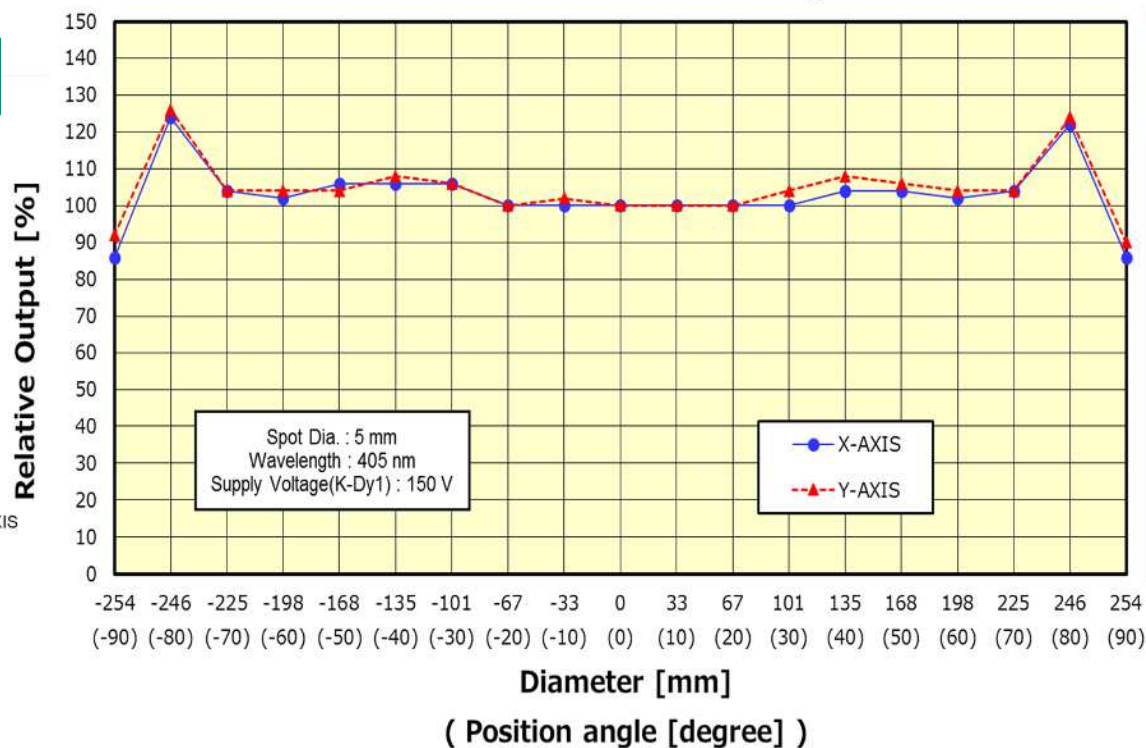
32% at 420 nm

R12860 Cathode Uniformity

Typical Data



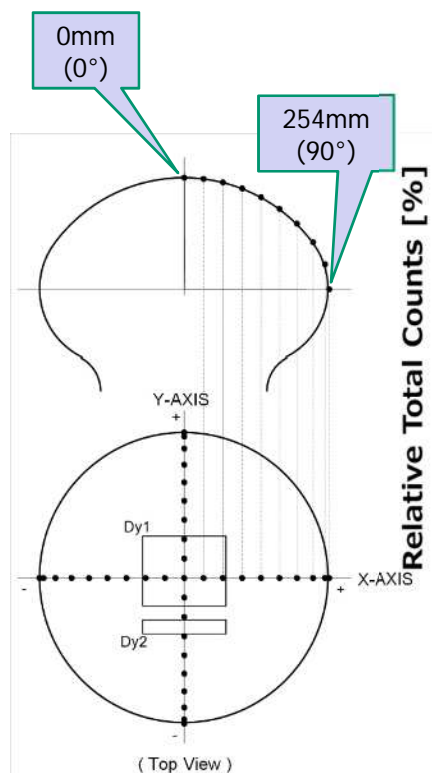
R12860 Cathode Uniformity



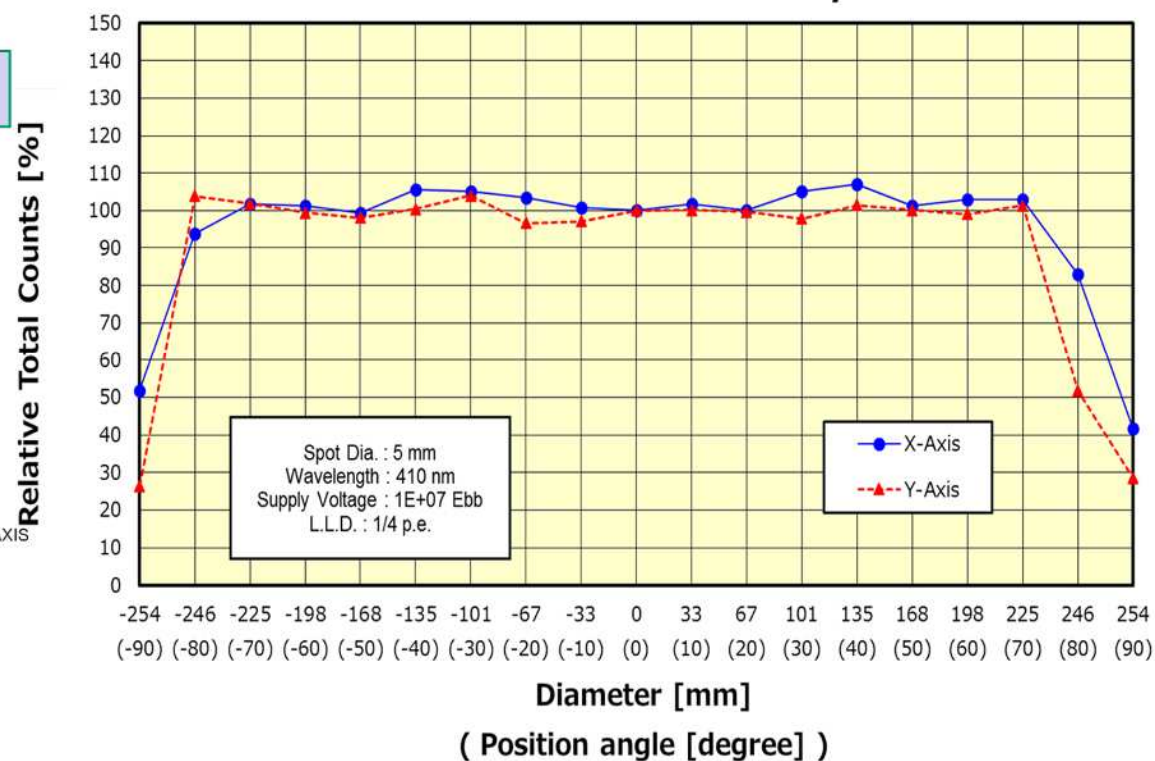
Position angle [degree]	Diameter [mm]
0	0
10	32
20	63
30	95
40	128
50	161
60	192
70	220
80	243
90	254

R12860 Anode Uniformity

Typical Data



R12860 Anode Uniformity

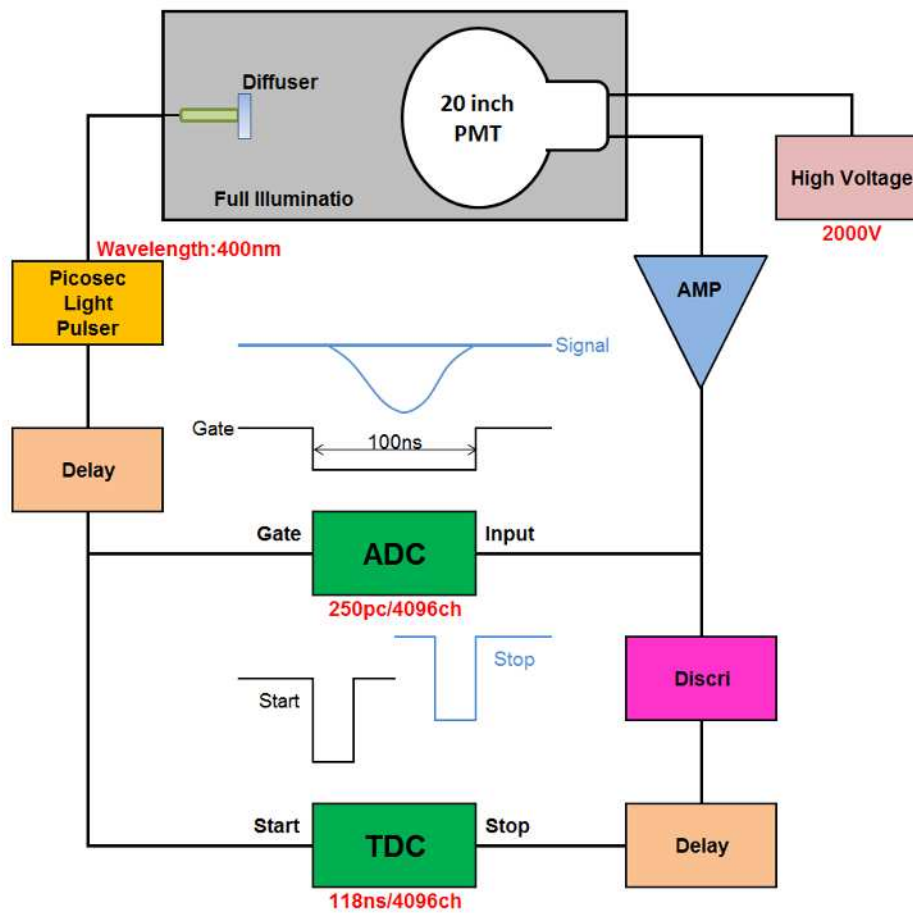


Position angle [degree]	Diameter [mm]
0	0
10	32
20	63
30	95
40	128
50	161
60	192
70	220
80	243
90	254

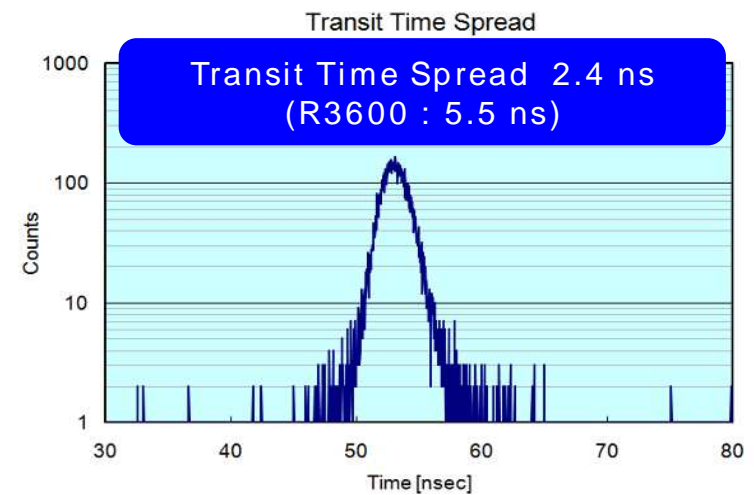
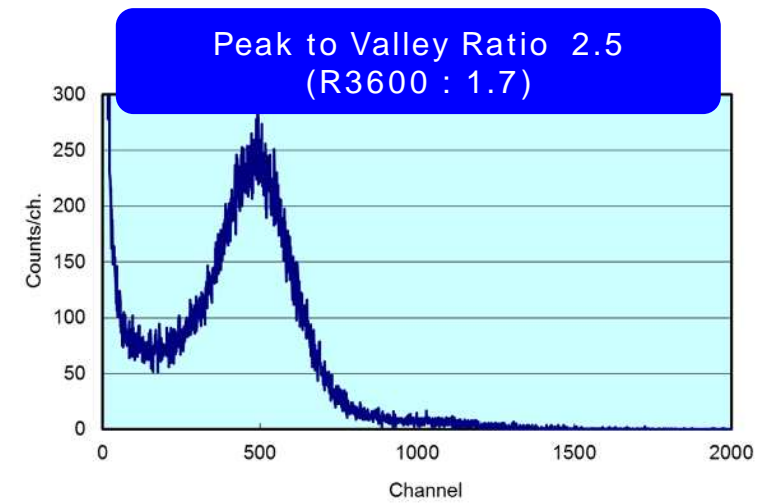
New

R12860 PHD and TTS

Supply Voltage : 2000V
Single [p.e] (PLP:400nm)
Full illumination



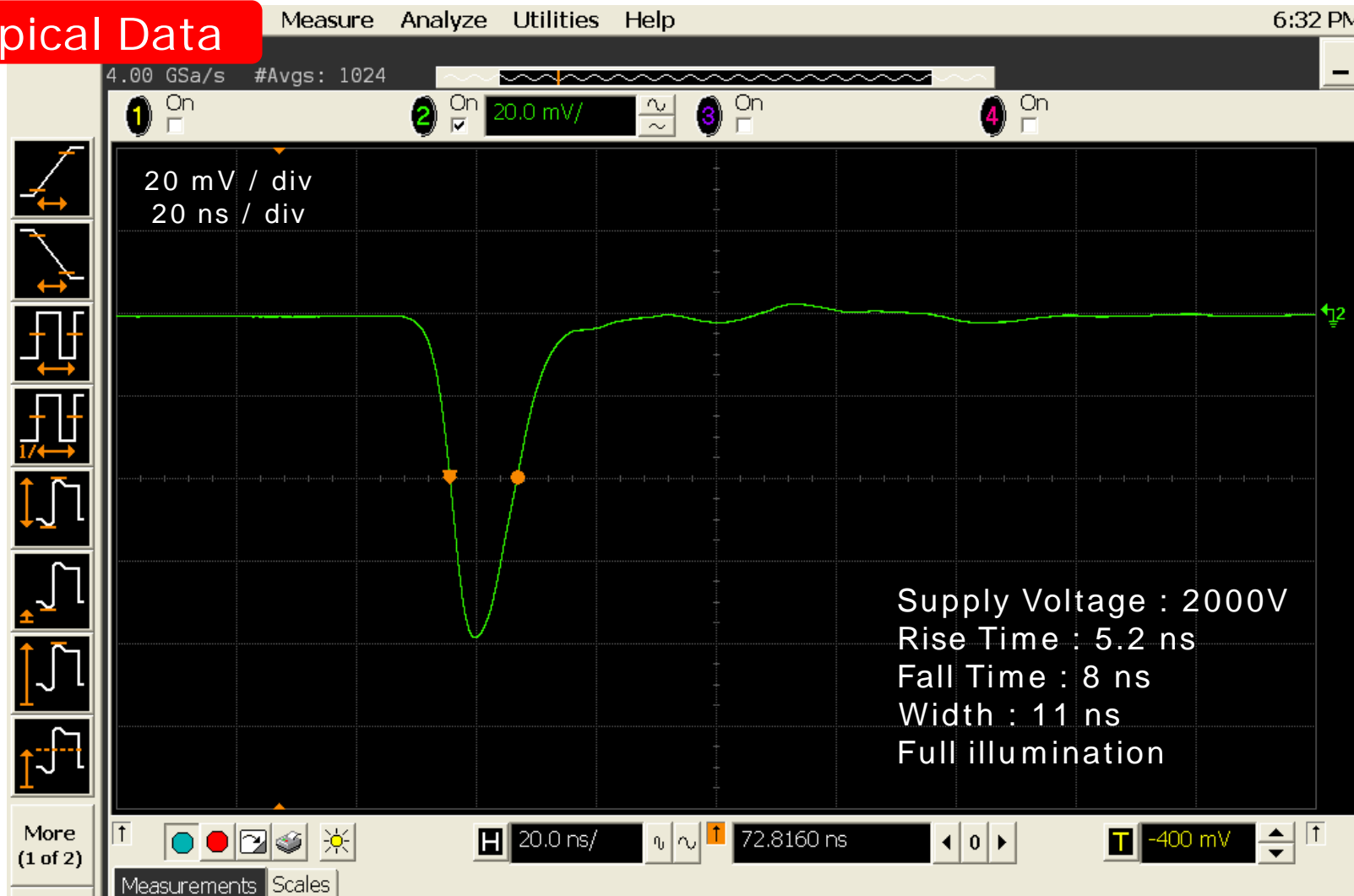
Typical Data



New

R12860 Anode Output Waveform

Typical Data

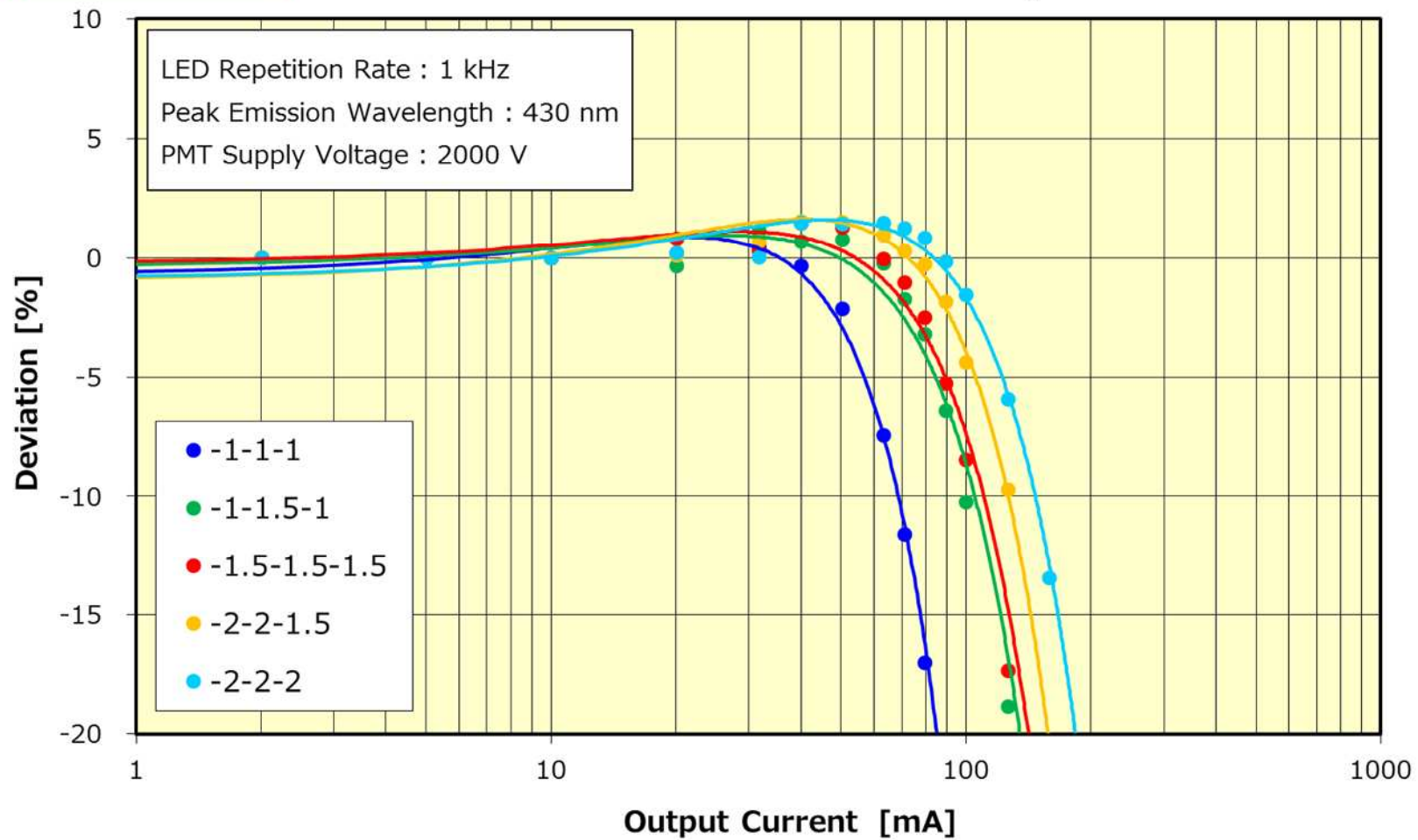


New

R12860 Pulse Linearity

Typical Data

R12860 Pulse Linearity



R3600 vs R12860 New

Items	R12860 New 20 inch PMT	R3600 Current 20 inch PMT
Diameter	508 mm	508 mm
Effective Area	460 mm min.	460 mm min.
Tube Length	610 mm	610 mm
Collection Efficiency*	95%	70%
Dynodes	B&L/10-stage	VB/11-stage
GAIN	1.0E+07 at 2000 V	1.0E+07 at 2000 V
T.T.S. (FWHM)	2.4 ns	5.5 ns
P/V Ratio	2.5	1.7
Pressure Resistance	Approx. 0.9 MPa	0.6 MPa

*Simulation result

Summary

- Hamamatsu has developed a new 3 inch PMT having a better TTS. A larger type will be available in the near future.
- Hamamatsu has developed a new 20 inch PMT having better CE, TTS and pressure resistance. The QE of the new 20 inch PMT is high.

A photograph of two men in business suits shaking hands over a desk. The desk is cluttered with two laptops, papers, a camera, and other office supplies. The background is a plain, light-colored wall.

HAMAMATSU

PHOTO NOIS OUR BUSINESS