

Theme : Photodetection

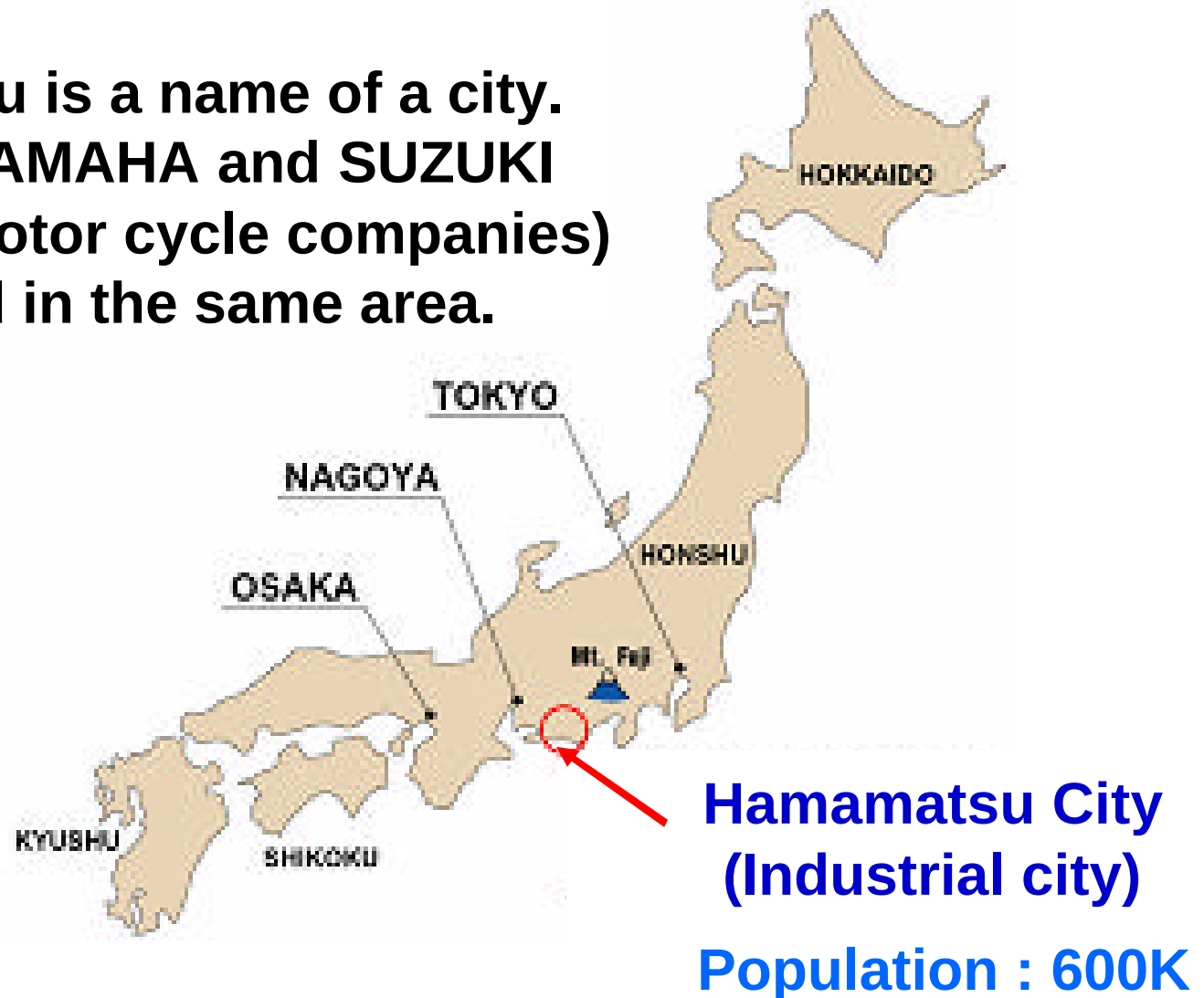
<Contents>

1. What is Hamamatsu ?? 😊
2. Latest Trend in Vacuum Devices 😊
3. Examples of Neutrino Experiments 😊

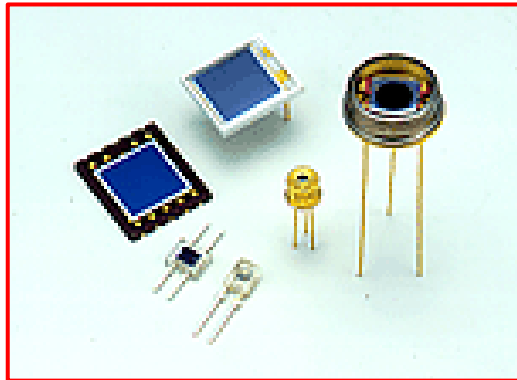
**Hamamatsu Photonics
Electron Tube Center
Yuji Yoshizawa
Date : Oct. 2003**

Where is Hamamatsu Photonics ?

Hamamatsu is a name of a city.
HONDA, YAMAHA and SUZUKI
(famous motor cycle companies)
are located in the same area.



Hamamatsu Photonics



Solid State Division



Electron Tube Center



System Division



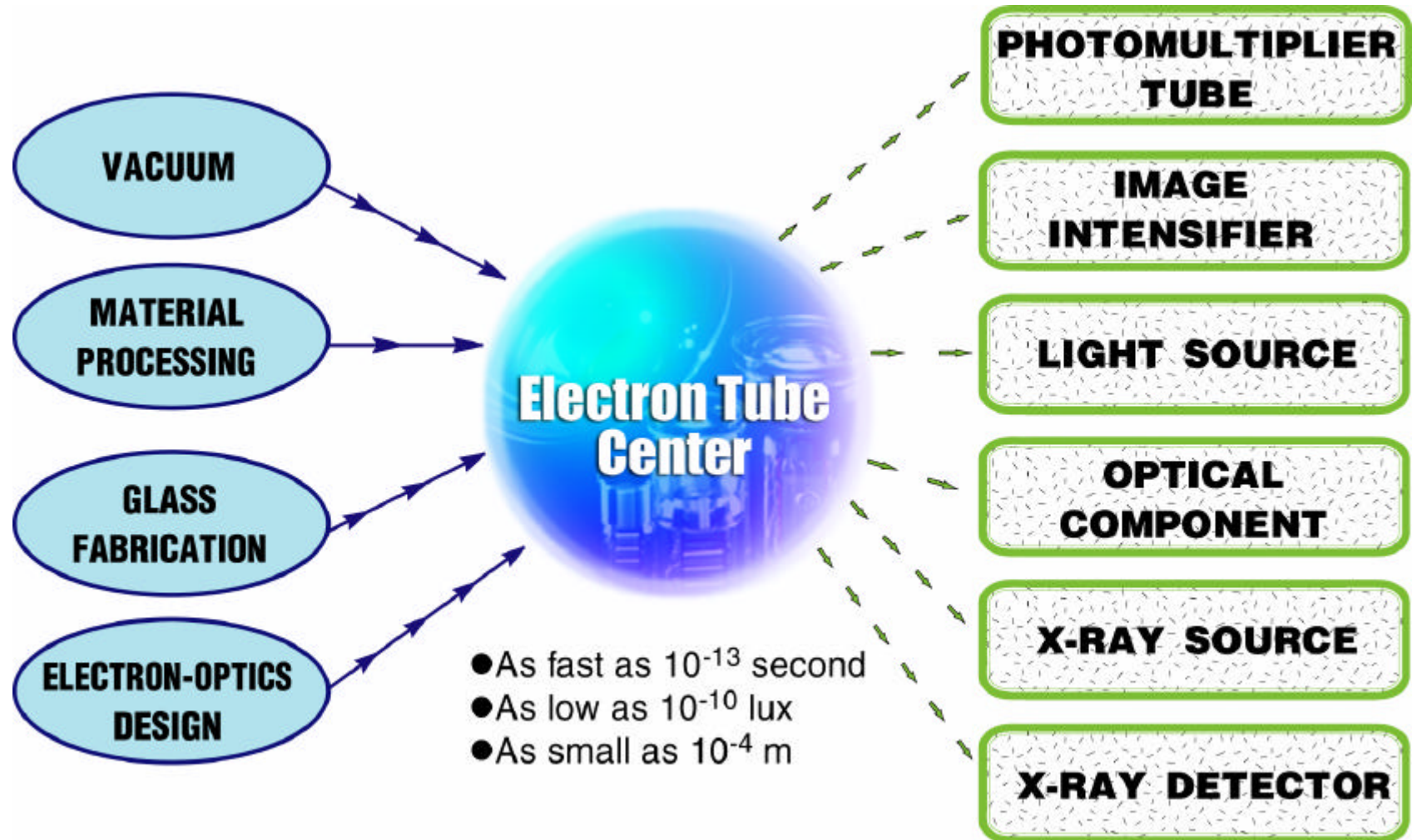
Central Research Lab



Laser Group

Established :
Sept 29, 1953
Net Sales :
50,583 M yen
Employees : 2130
As of Dec 2002

Technology and Products



Latest Trend in Vacuum Devices



Categories of Developments

Photocathode 😊

Higher sensitivity, Shorter and Longer Wavelength

Unique Shape 😊

Metal Package PMT, Flat Panel PMT

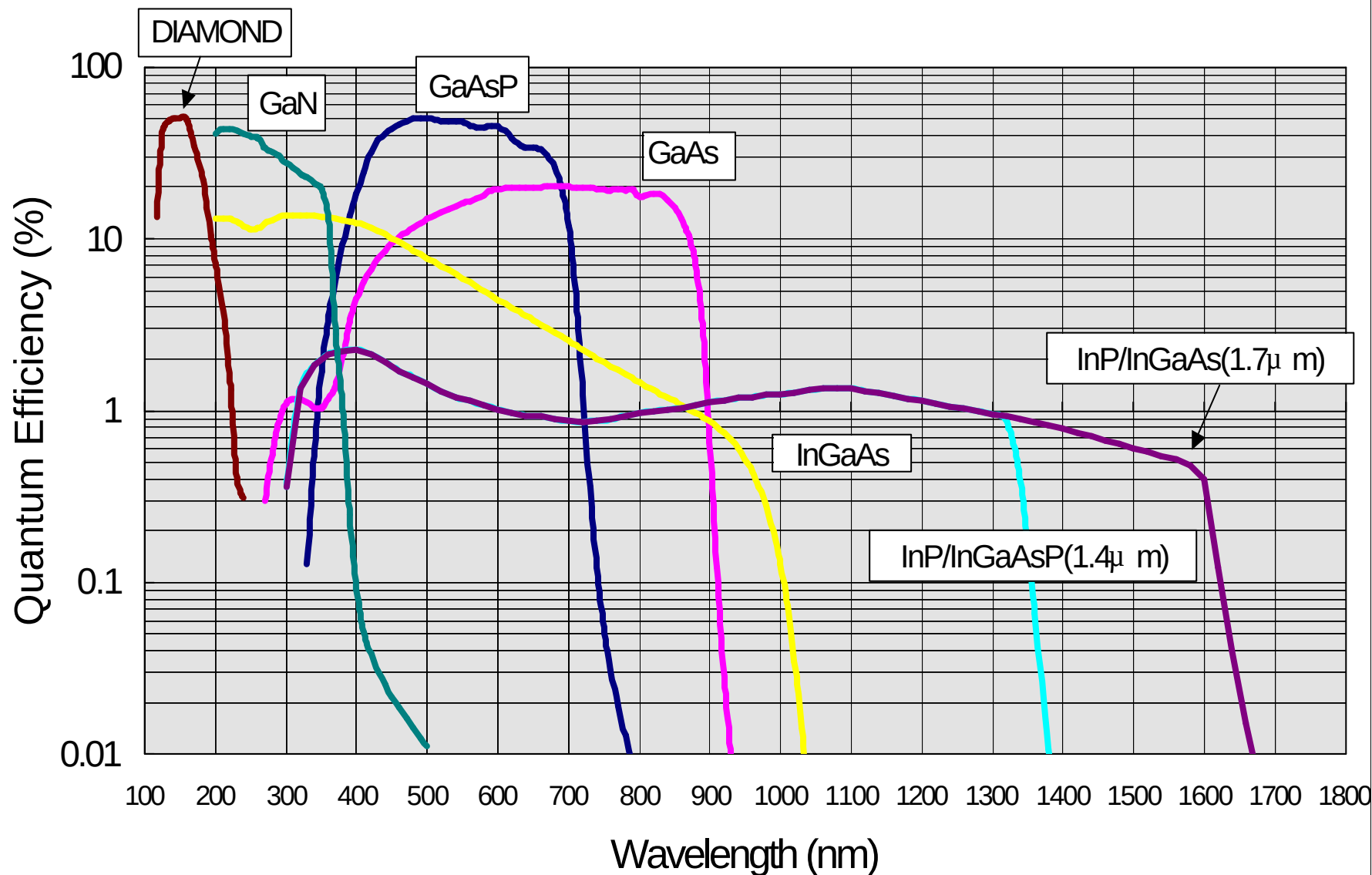
Combination with Solid State Devices 😊

HPD and EBCCD

Module (Easy Handling) 😊

with AMP, Photon Counting Head, USB, ASIC

Semiconductor Photocathode



GaAsP Photocathode

Lineup (TO-8 type Package)

R7110U-40 (HPD), R7400U-40 (H7421-40)
(Effective area is 5 mm in diameter.)

Note

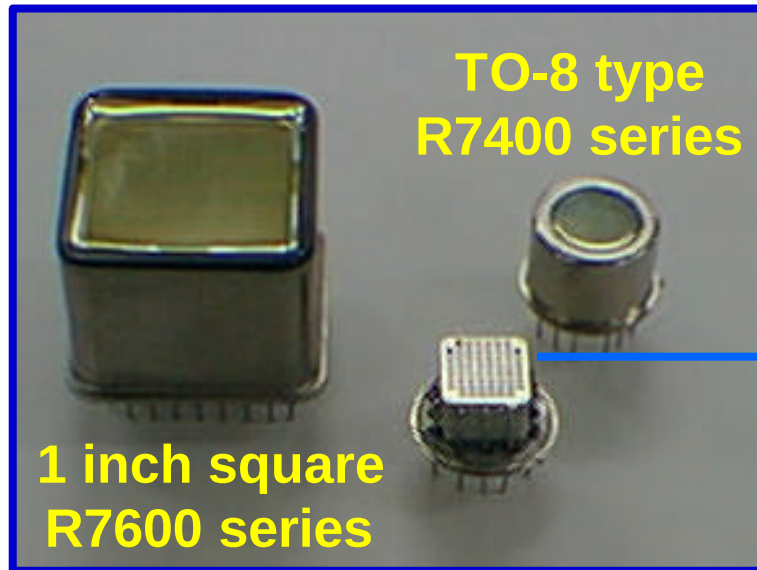
Transfer equipment is necessary.

Price is depending on its size.

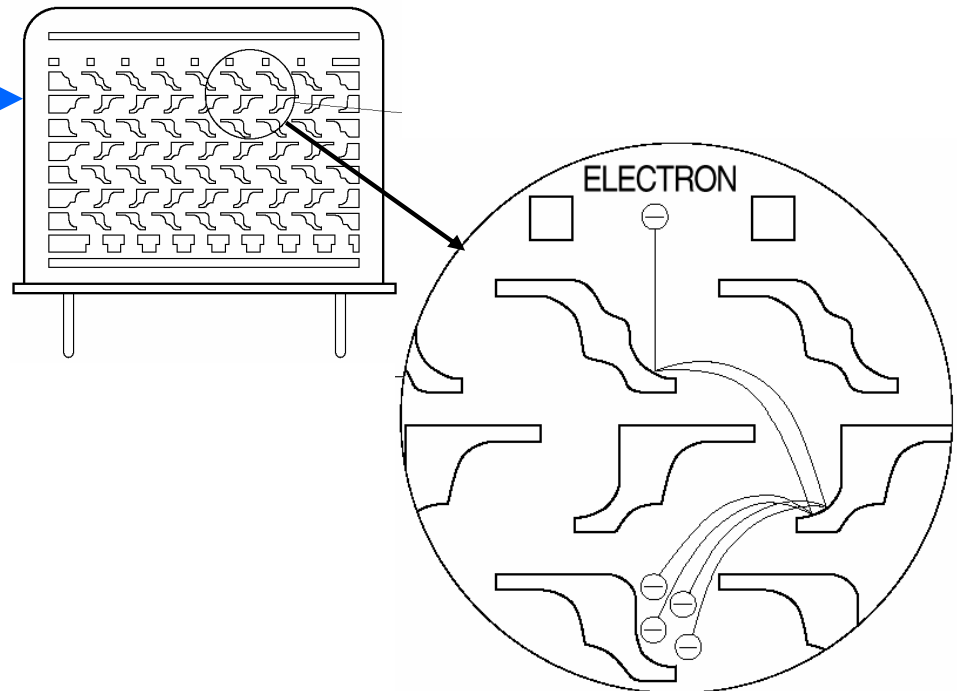
Maximum size is 18 mm in diameter right now.
(Examples : Proximity I I and EBCCD)



Metal Channel Dynode & Metal Package PMT



Metal Channel Dynodes
Electron Trajectory Design by PC
Microprocessing technology



Features

Compact

Fast Time Response

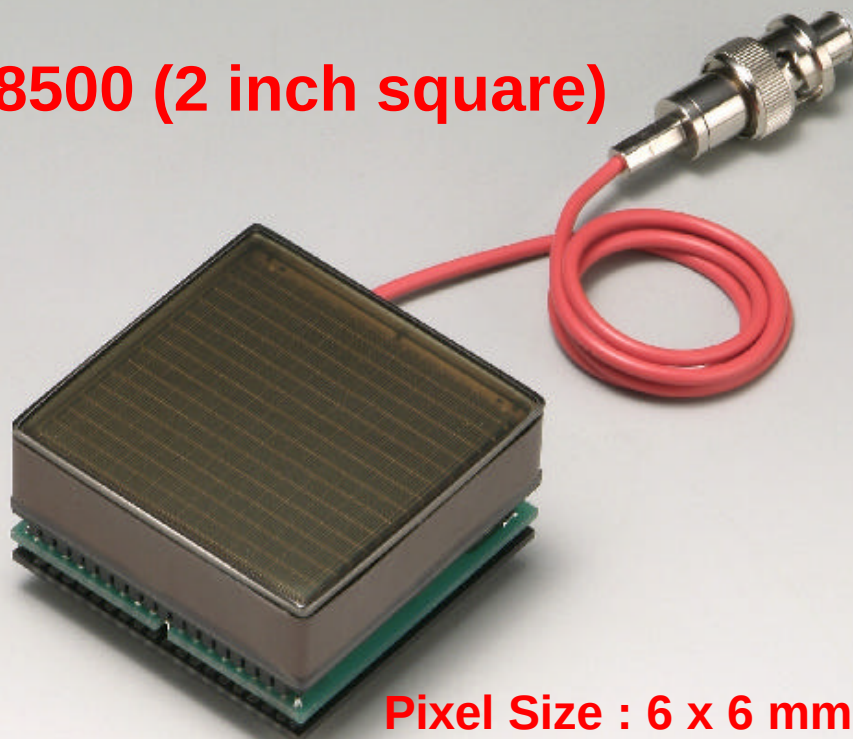
Position Sensitive

Immunity to magnetic field

Flat Panel PMT / H8500 (64ch)

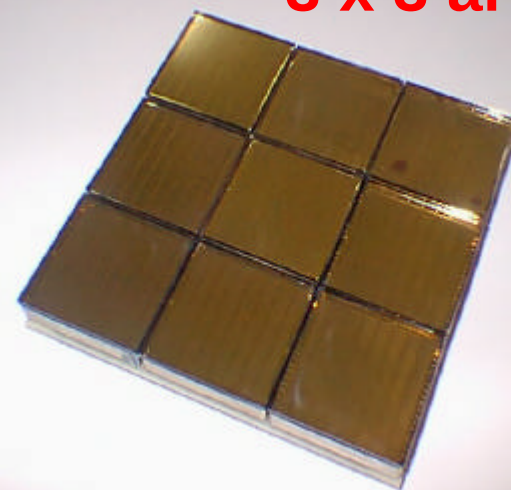
Product Release : from Oct. 2003

H8500 (2 inch square)



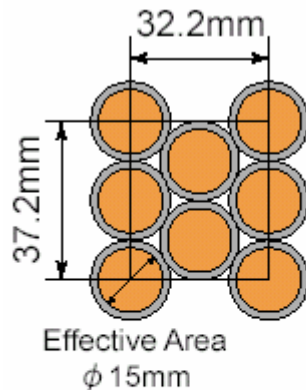
Pixel Size : 6 x 6 mm

3 x 3 array



Comparison of Effective Area Ratio

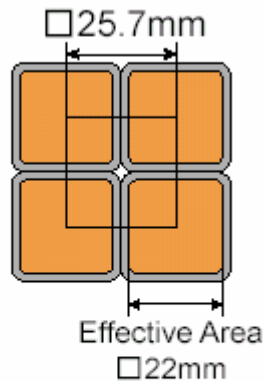
R1450
(19 mm dia.)



Effective Area Ratio

59%

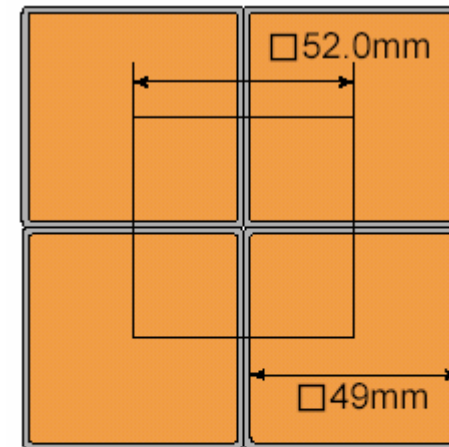
R8520-C12
(1" square)



Effective Area Ratio

73%

H8500
(Flat Panel PMT)



Effective Area Ratio

89%

Effective area ratio = [effective area] / [external dimension]

Summary of Modification

H8500 is modified again as Version 4.

H8500	Issued Date	Terminal Pin number	ASSY Length	Window Thickness	Focusing Electrode
Ver 1	Jun-02	32 pins	31.7 mm	2.0 mmt	for 256ch
Ver 2	Oct-02	36 pins	33.0 mm	2.0 mmt	for 256ch
Ver 3	Jun-03	36 pins	33.2 mm	2.0 mmt	for 256ch
Ver 4	Oct-03	36 pins	32.7 mm	1.5 mmt	for 64ch

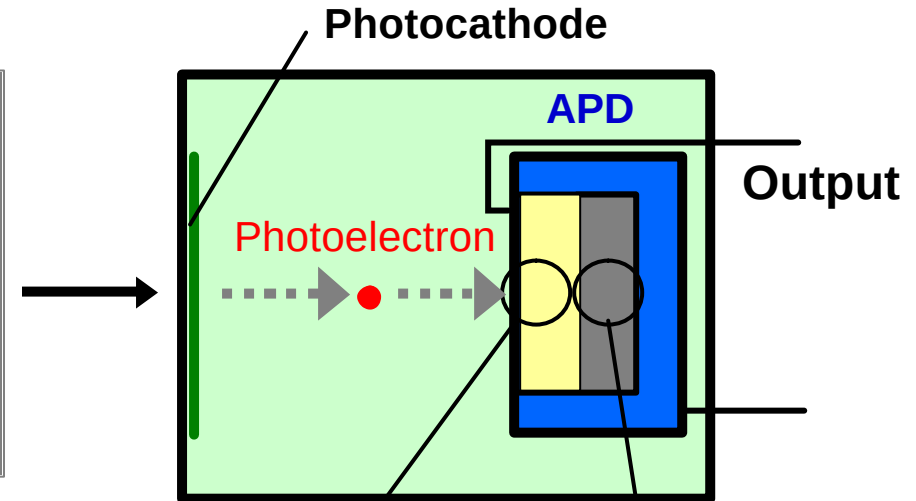
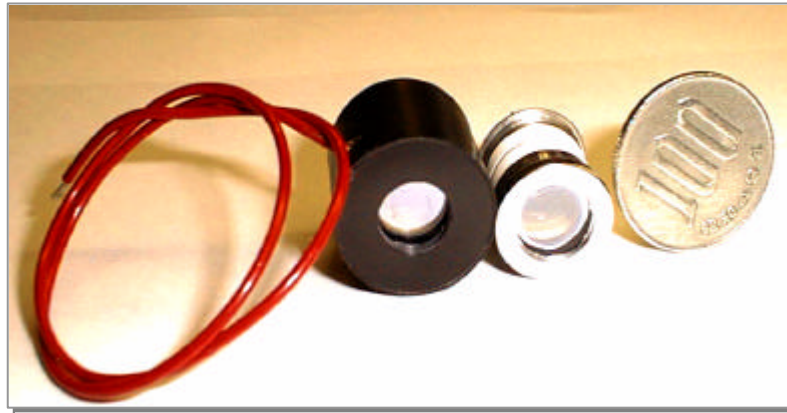
Sample Release : from July 2002

Product Release : from Oct. 2003

(New data sheet is ready right now.)

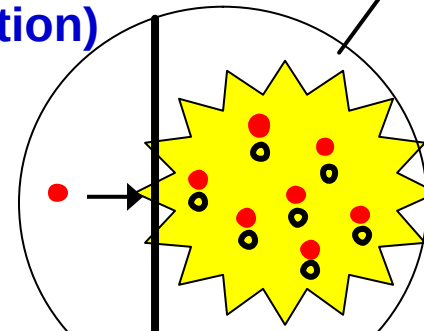


Hybrid Photo-detector (HPD)

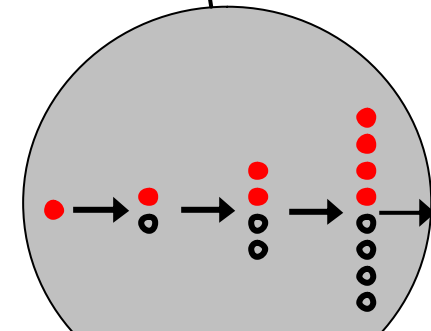


Good PHD (Pulse Height Distribution)
Good Uniformity
Immunity to Magnetic Field
Fast Time Response
Compact (16mm in dia x 16mm)

<Photocathode>
Multi-Alkali, GaAsP, GaAs



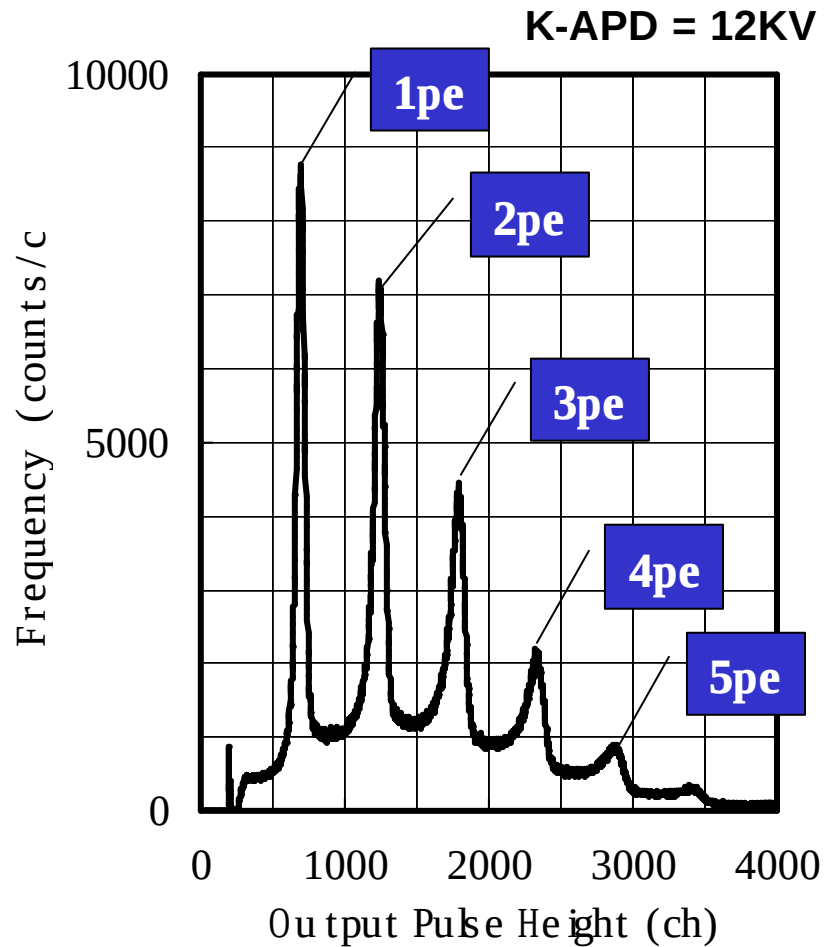
Electron Bombardment
X 1200



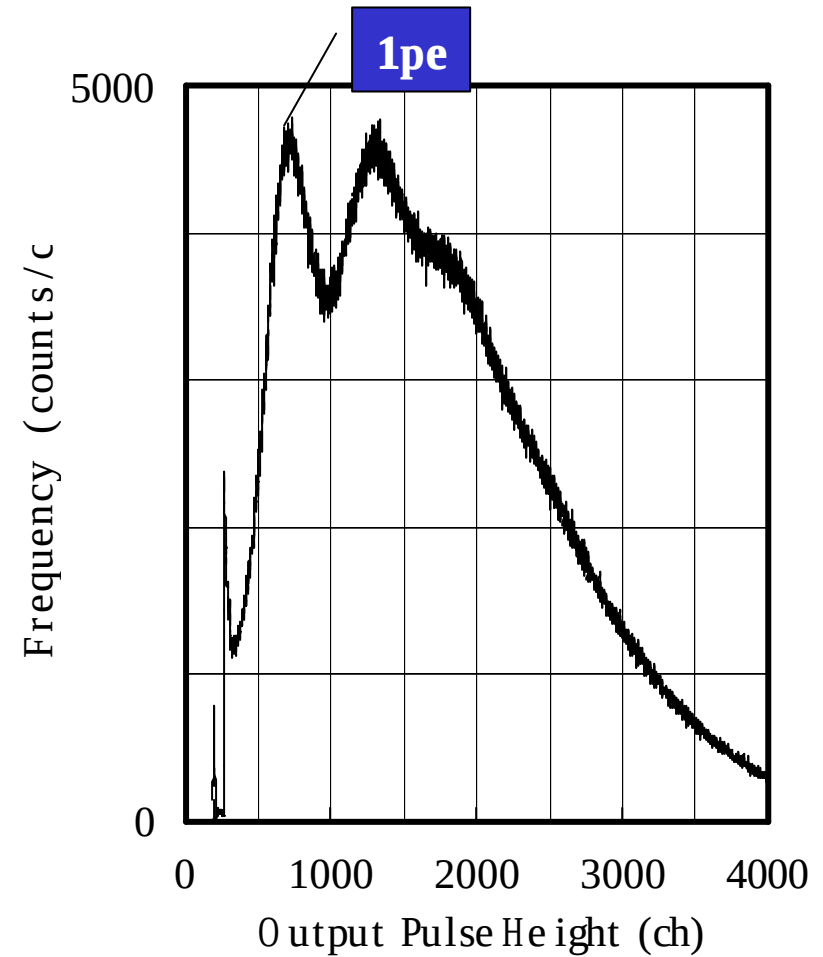
Avalanche Gain
X 50

Combination of EB and avalanche gain

Pulse Height Distribution

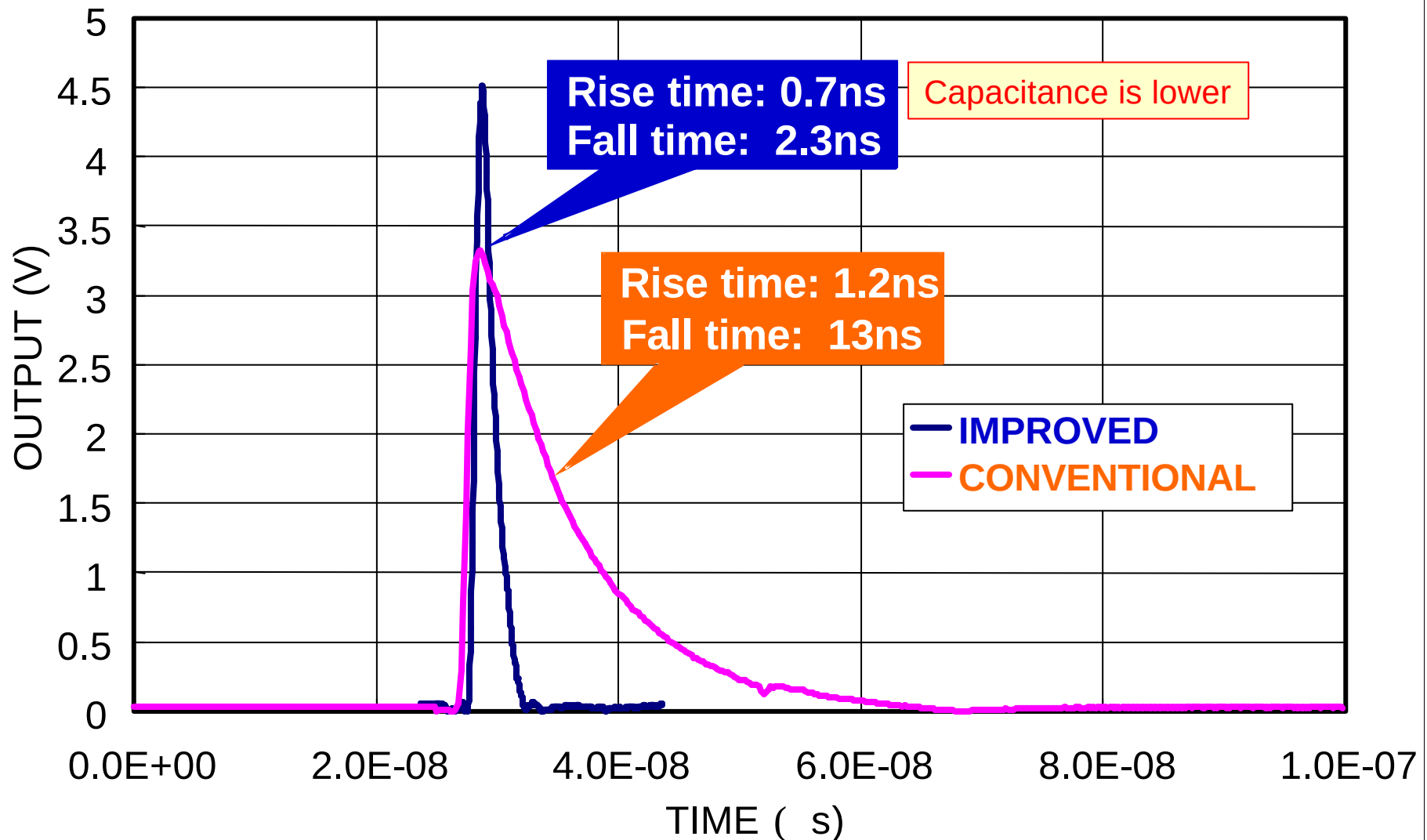


HPD



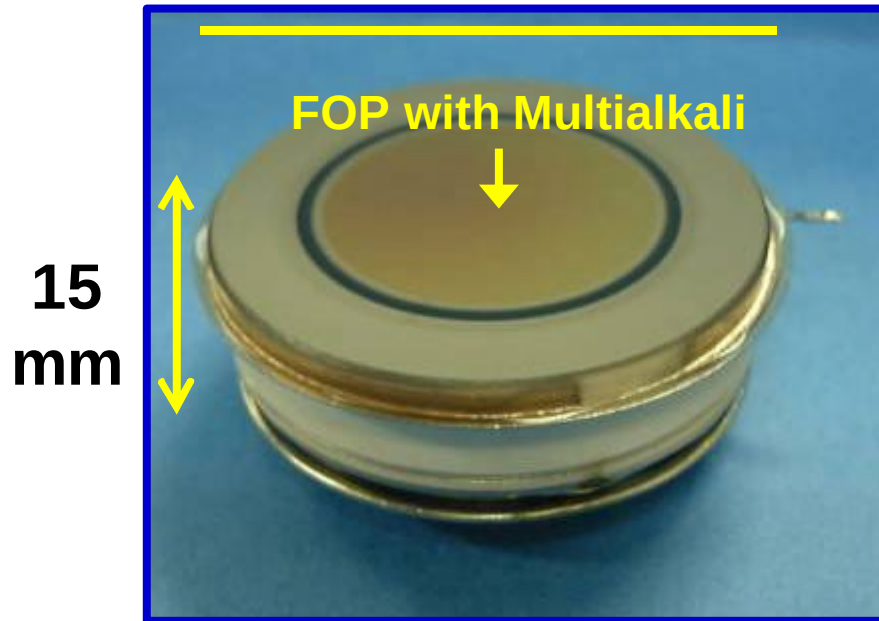
PMT

Faster Response with smaller APD



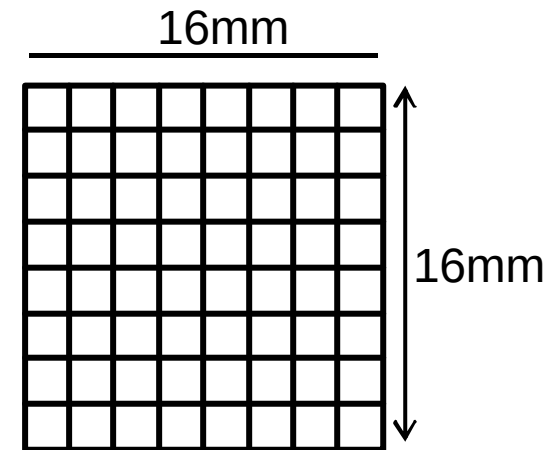
Multi-pixel HPD (8x8 matrix)

43mm in diameter



15
mm

8x8 Matrix (64 Pixels)
2x2 mm / Pixel



APD Format



Functional Photosensor Module for Easy Handling

SIGNAL PROCESSING SYSTEM

PHOTON COUNTING CIRCUITS
ASIC
A/D CONVERTER
POSITION SENSITIVE CIRCUITS
MULTICHANNEL READ-OUT PROCESSOR

PHOTO SENSOR

LARGE FORMAT TYPE
THIN TYPE
COMPACT TYPE
POSITION SENSITIVE SENSOR
LINEAR IMAGE SENSOR
ULTRA-HIGH SENSITIVE TYPE
GATING TYPE

OPTICAL SYSTEM

LENS
SPECTROMETER
OPTICAL FIBER LIGHT GUIDE
FILTER
SCINTILLATOR

EXTERNAL INTERFACE

RS-232C
SCSI
GP-IB
USB

SUPPLEMENTARY FUNCTION

COOLING UNIT
MAGNETIC SHIELD CASE

Y-ray
X-ray
UV
VIS
NIR

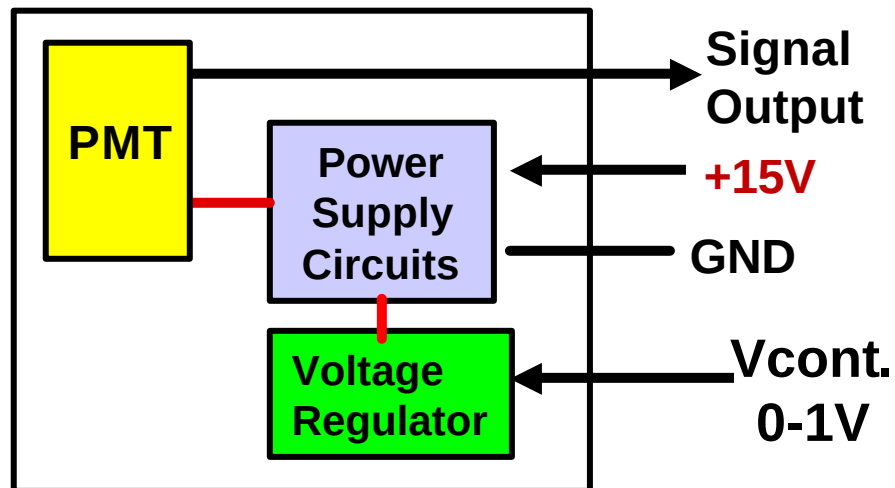
PMT Module (built in HVPS)

PMT, Divider and HVPS

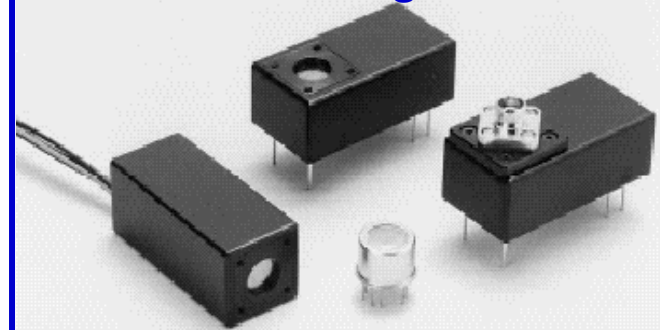
<Features>

Low Voltage Operation

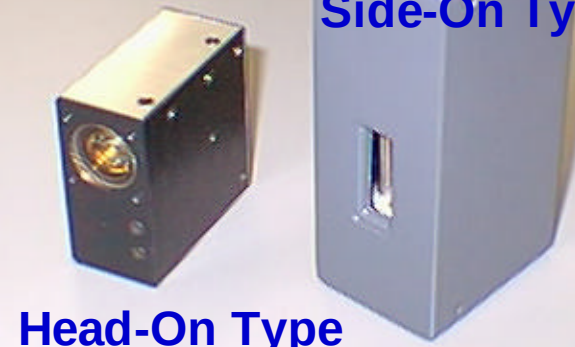
Easy Gain Control



Metal Package PMT



Side-On Type



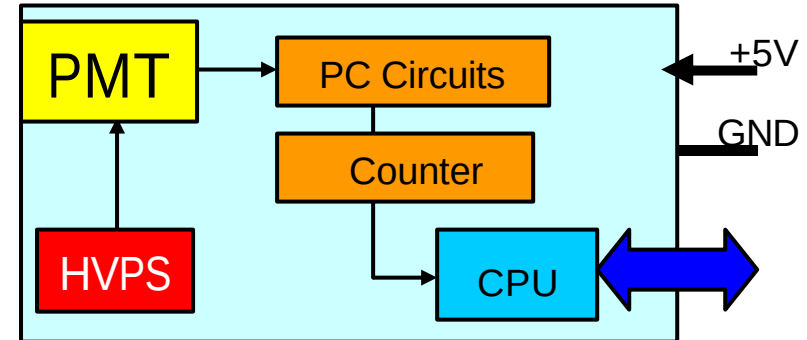
Head-On Type

Photon Counting Head with CPU & I/F

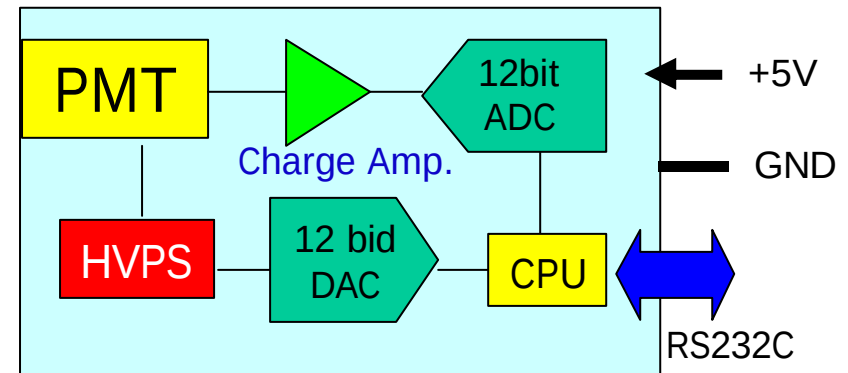


Compact & Light Weight
No adjustment required
RS-232C interface included
Only +5Vdc source

Photon Counting : H7467

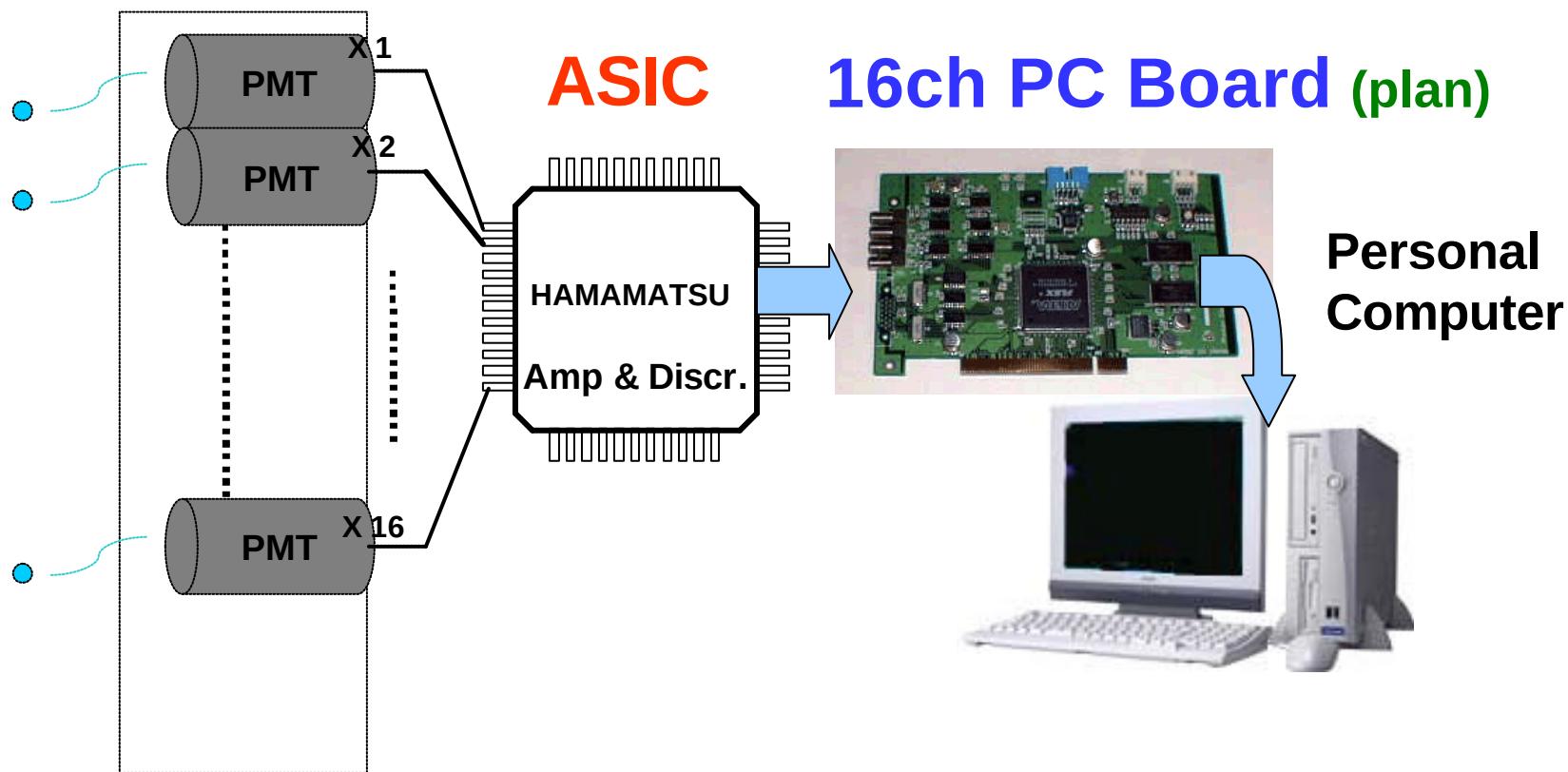


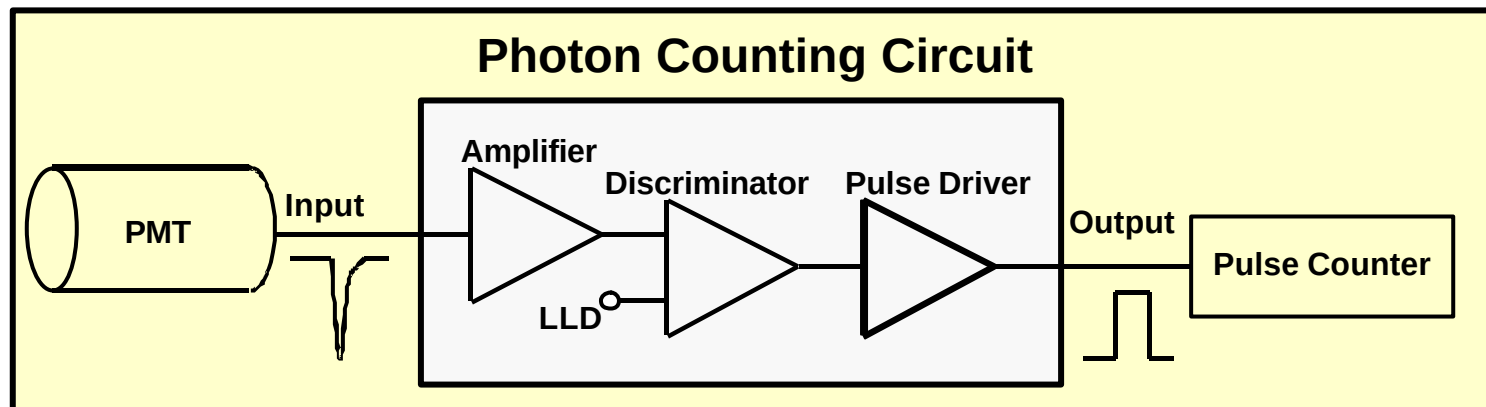
Charge Amp+ ADC : H7468



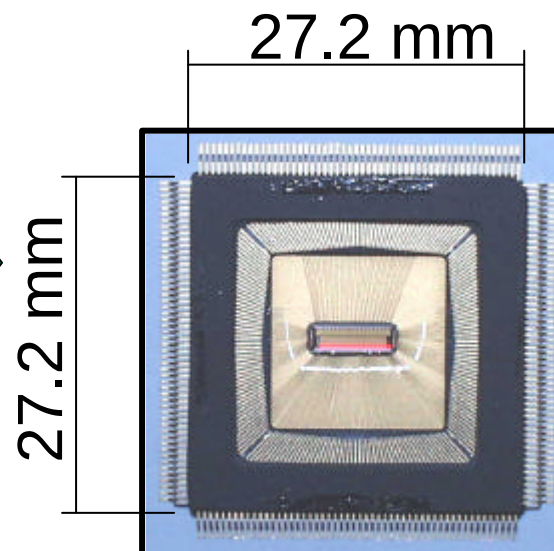
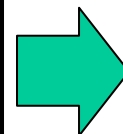
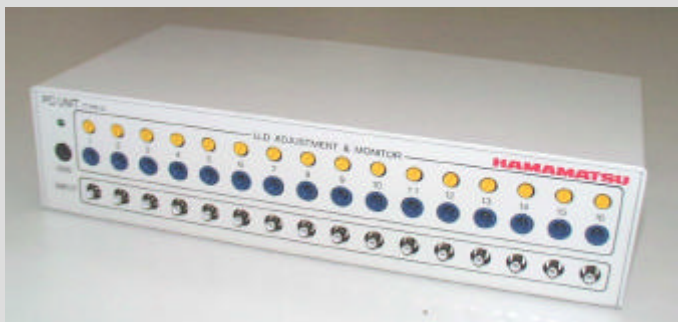
Multi Channel Photon Counting

PMTs or Multi Anode PMT





16ch PC unit



Size : 220 mm x 110 mm x 55 mm

Power Consumption : 2.6 W

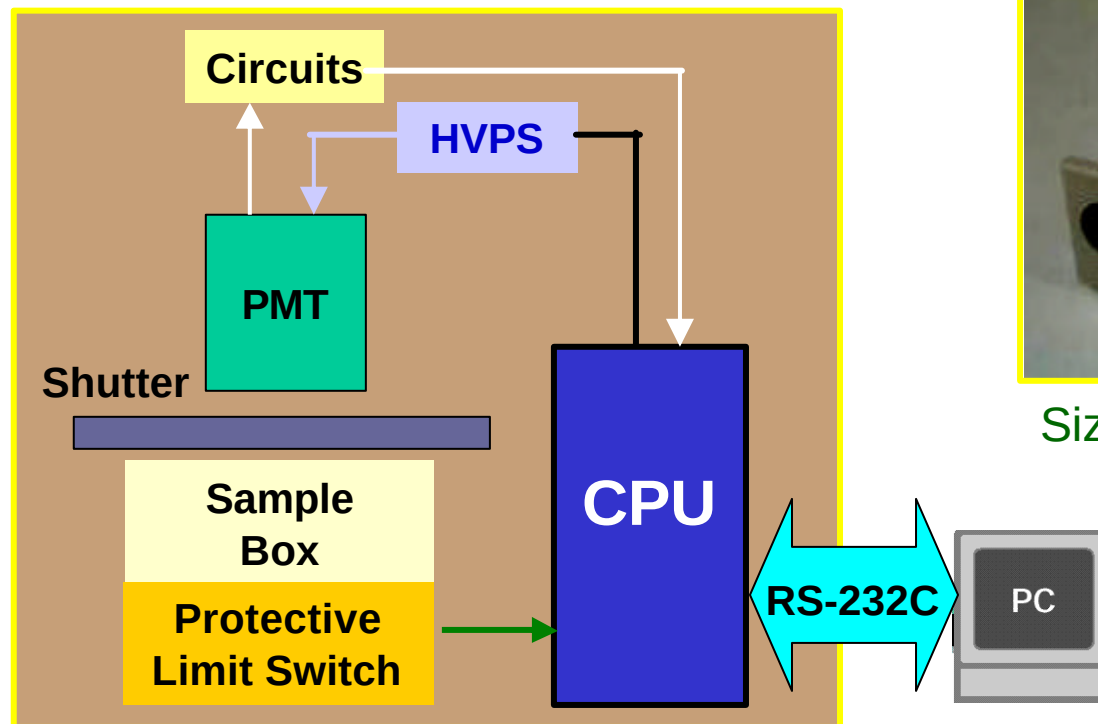
Low Light Detection Unit

1 inch Head On PMT

Low Dark Count : ~ 100cps

Measurable Size: ~25 mm in dia.

RS232C interface

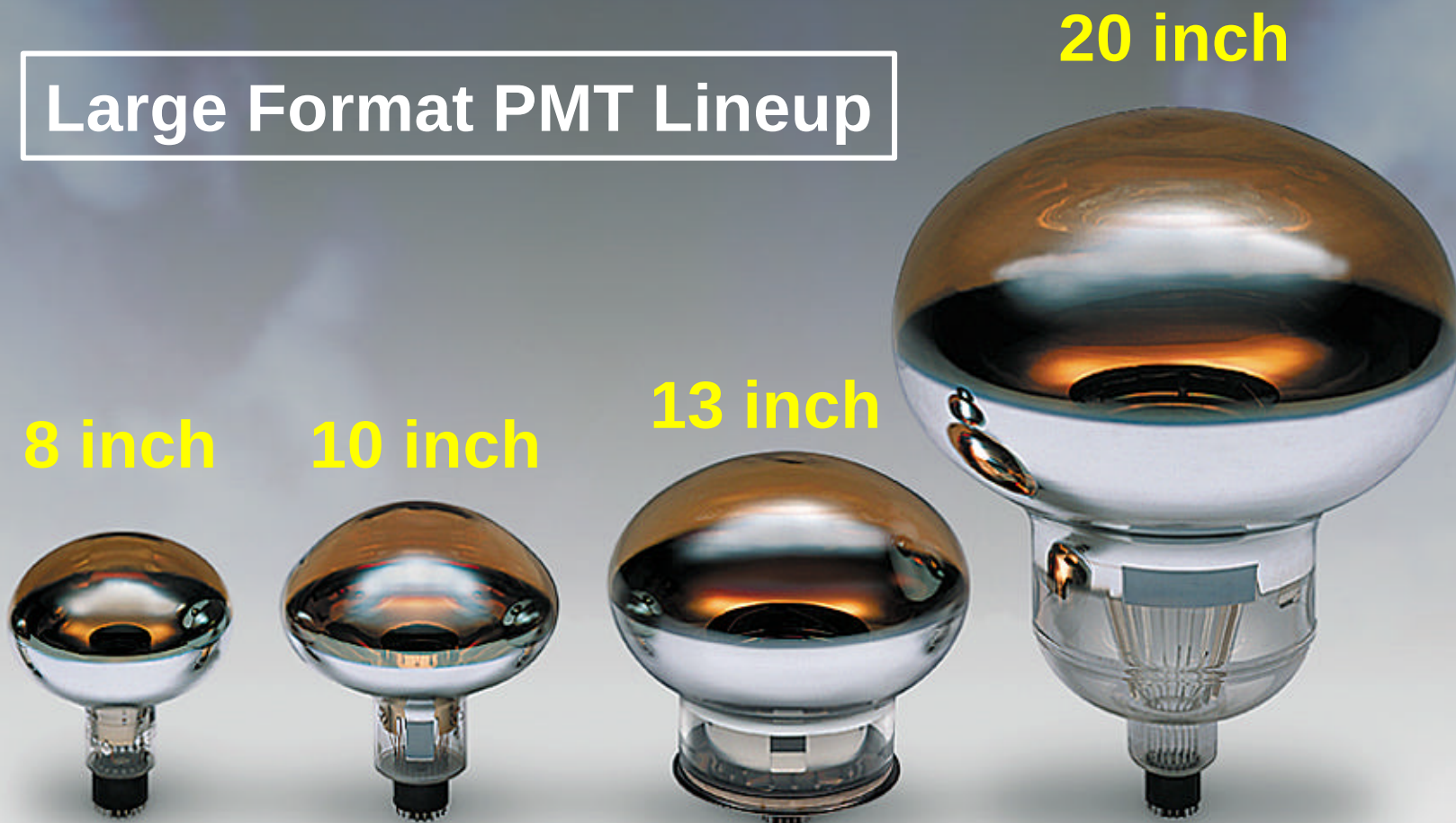


Size : 90(W)X200(D)X130(H)



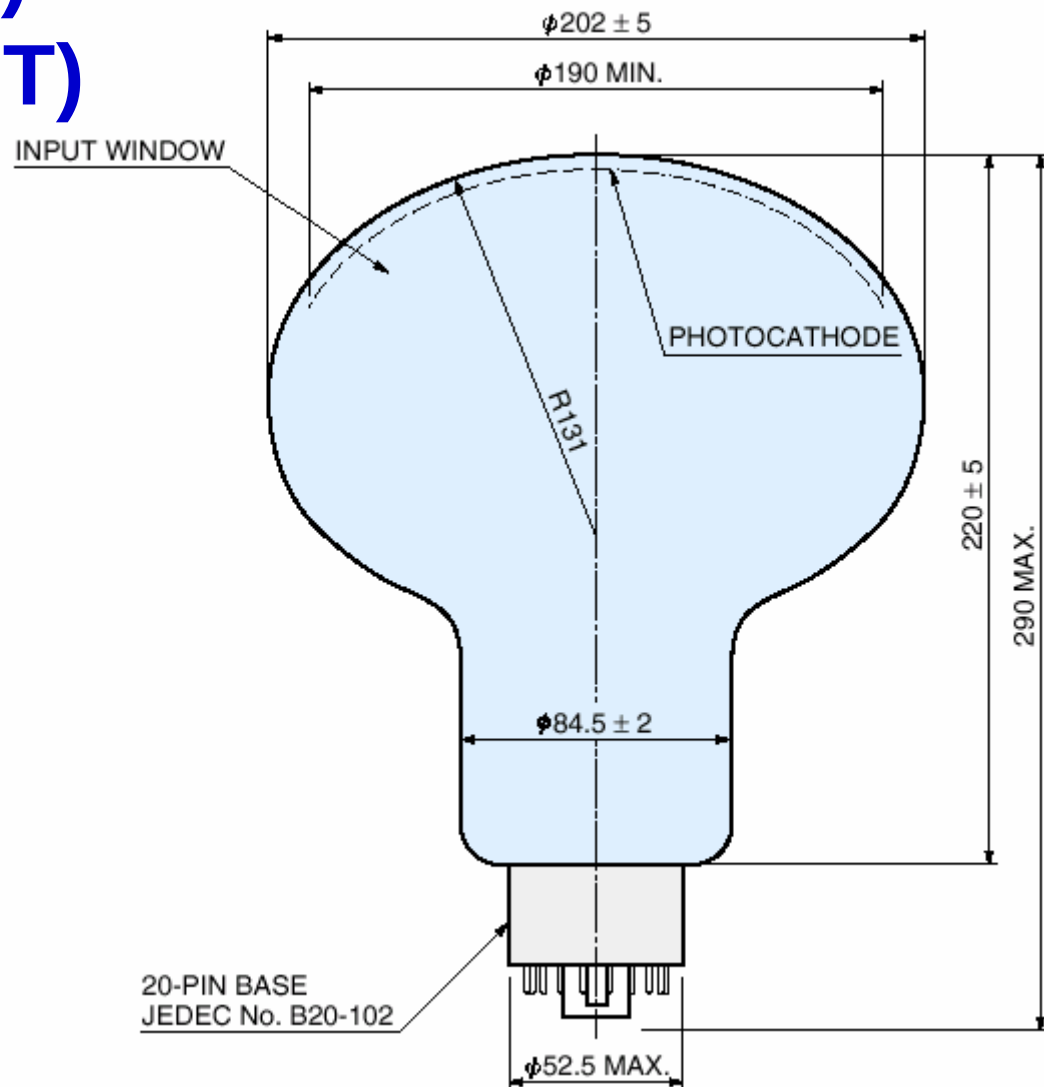
Large Format PMTs for Neutrino Experiments

Large Format PMT Lineup



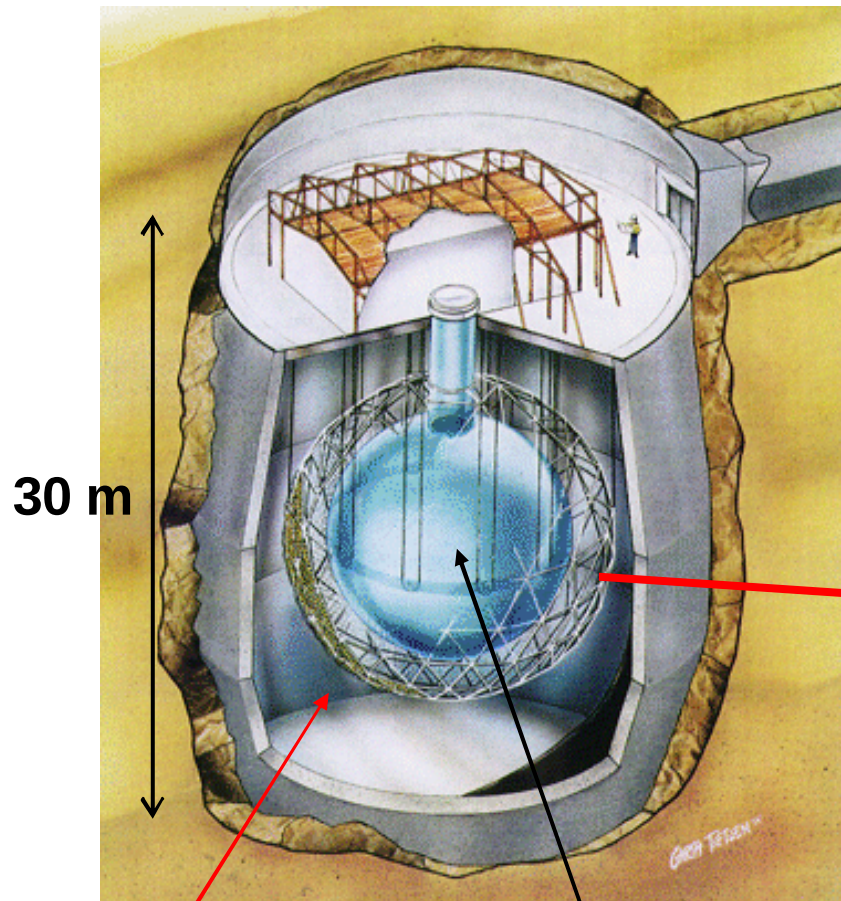
R5912 (8 inch) R5912-02 (14-ST)

Improved type
of former R1408



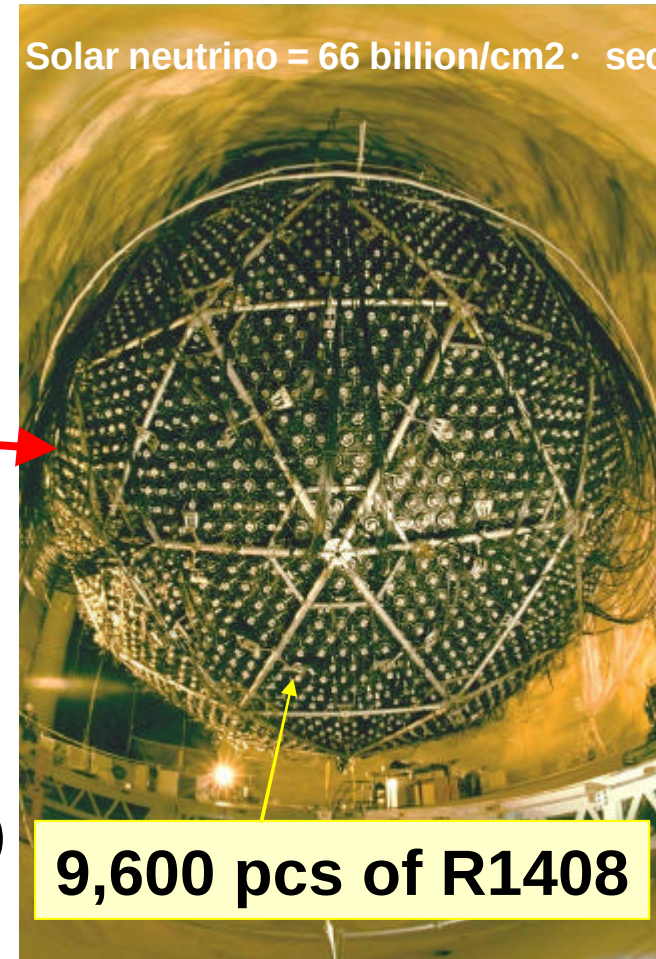
SNO at Sudbury/Canada

Solar Neutrino Experiment



Pure Water

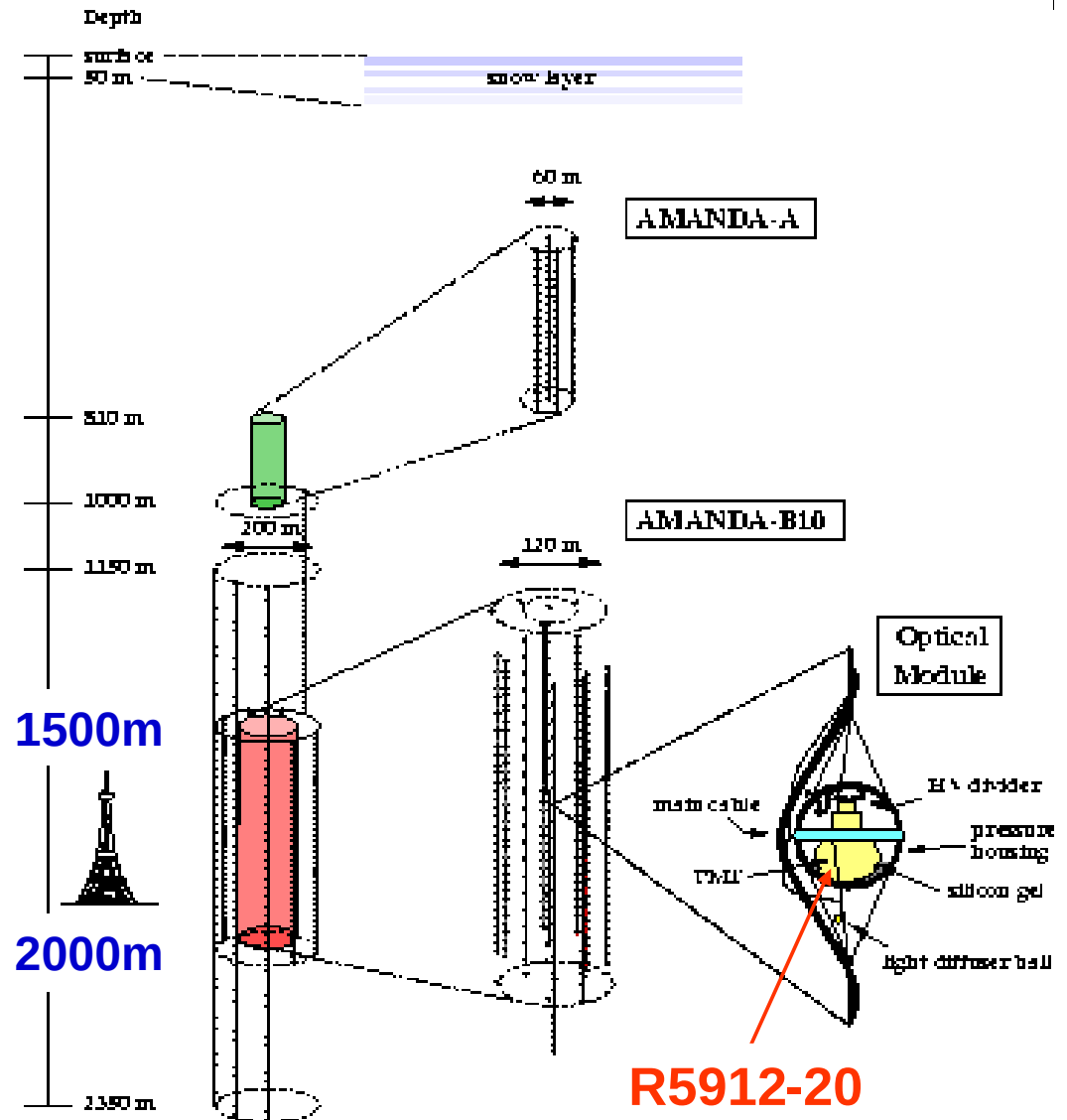
**Heavy Water (1000 ton)
in 12 m acrylic vessel
(NaCl is included)**



9,600 pcs of R1408

Solar neutrino = Electron neutrino

AMANDA at South Pole



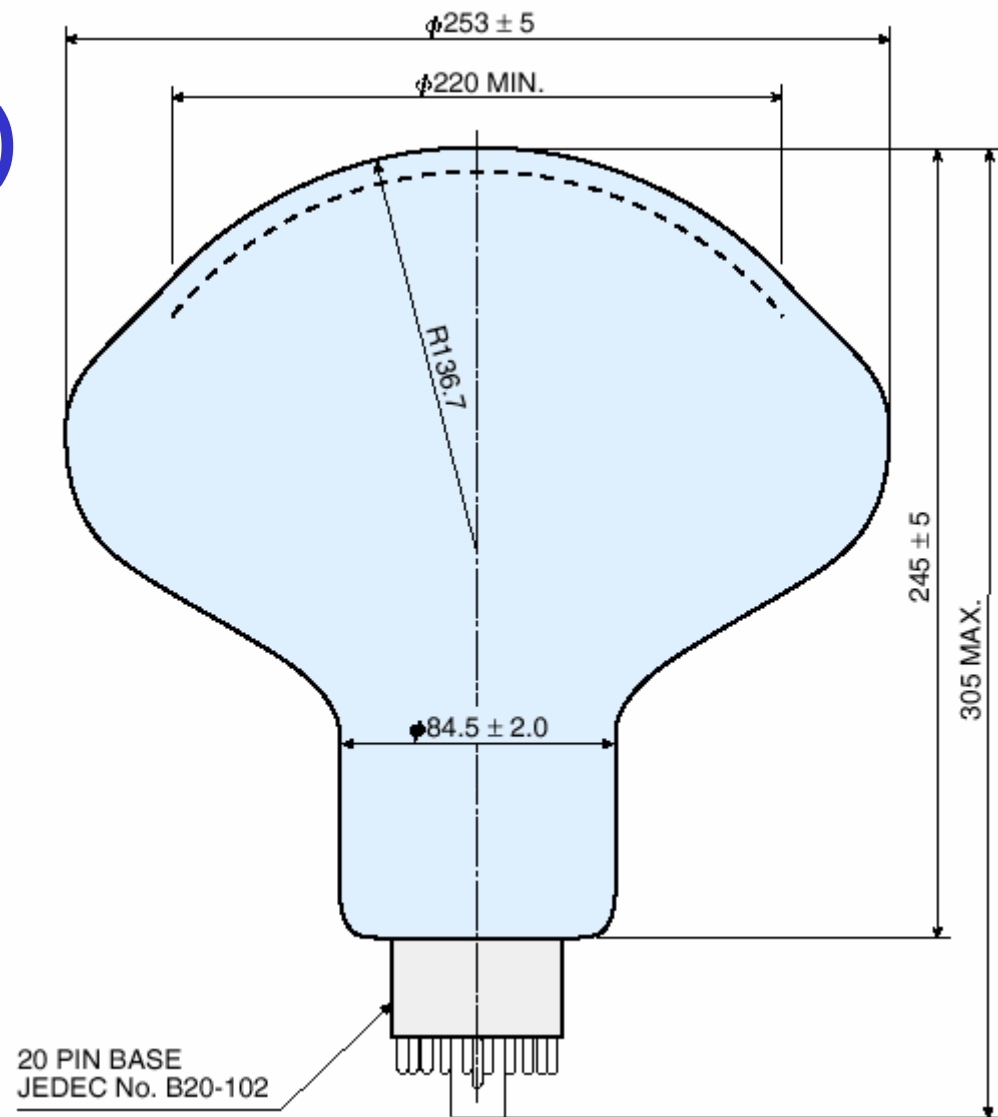
AMANDA as of 2000
Eiffel Tower as comparison
(true scaling)

zoomed in on
AMANDA-A (top)
AMANDA-B10 (bottom)

zoomed in on one
optical module (OM)

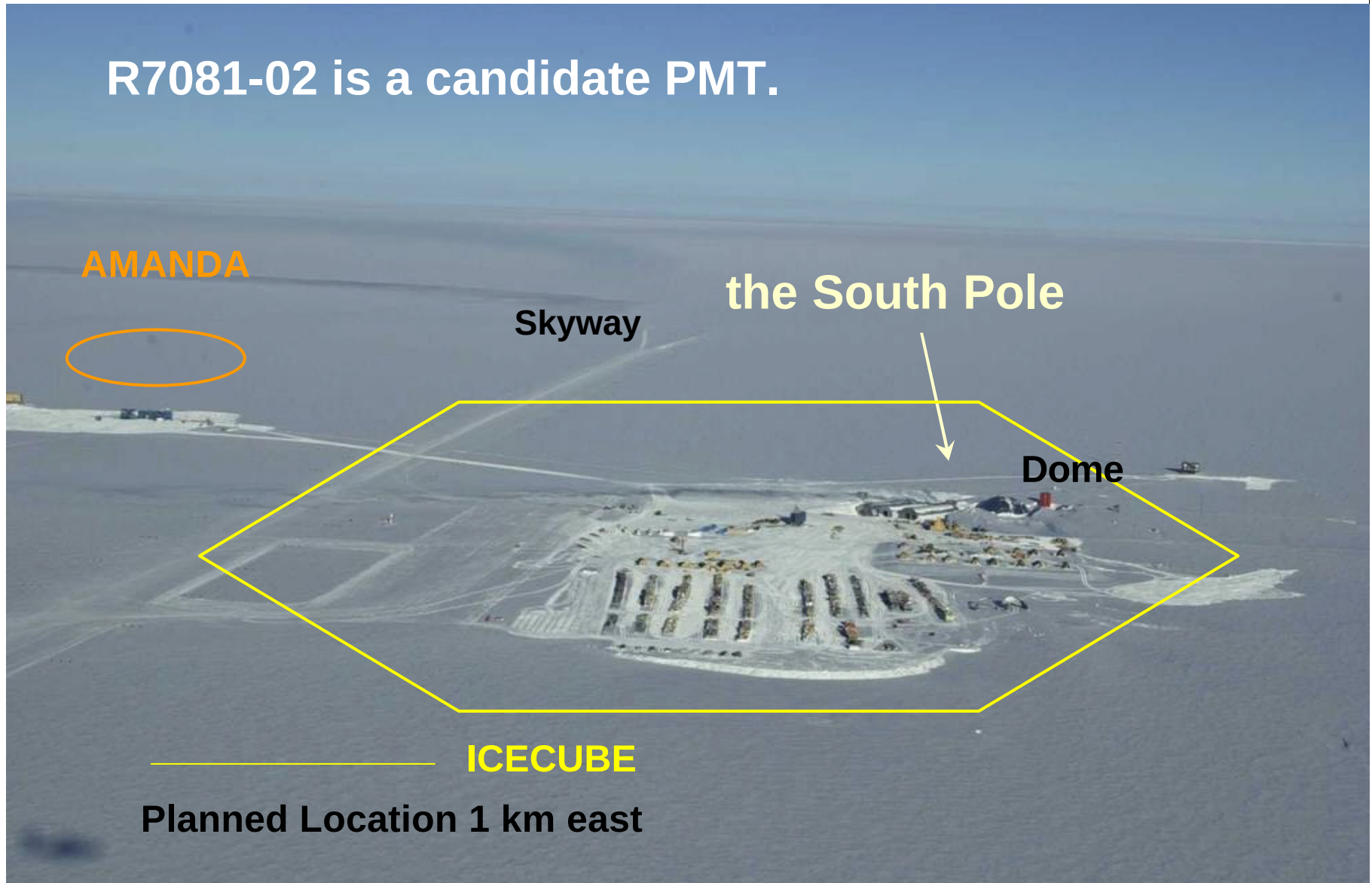
R7081 (10 inch) R7081-20 (14-ST)

Fits for 13 inch
Glass Sphere



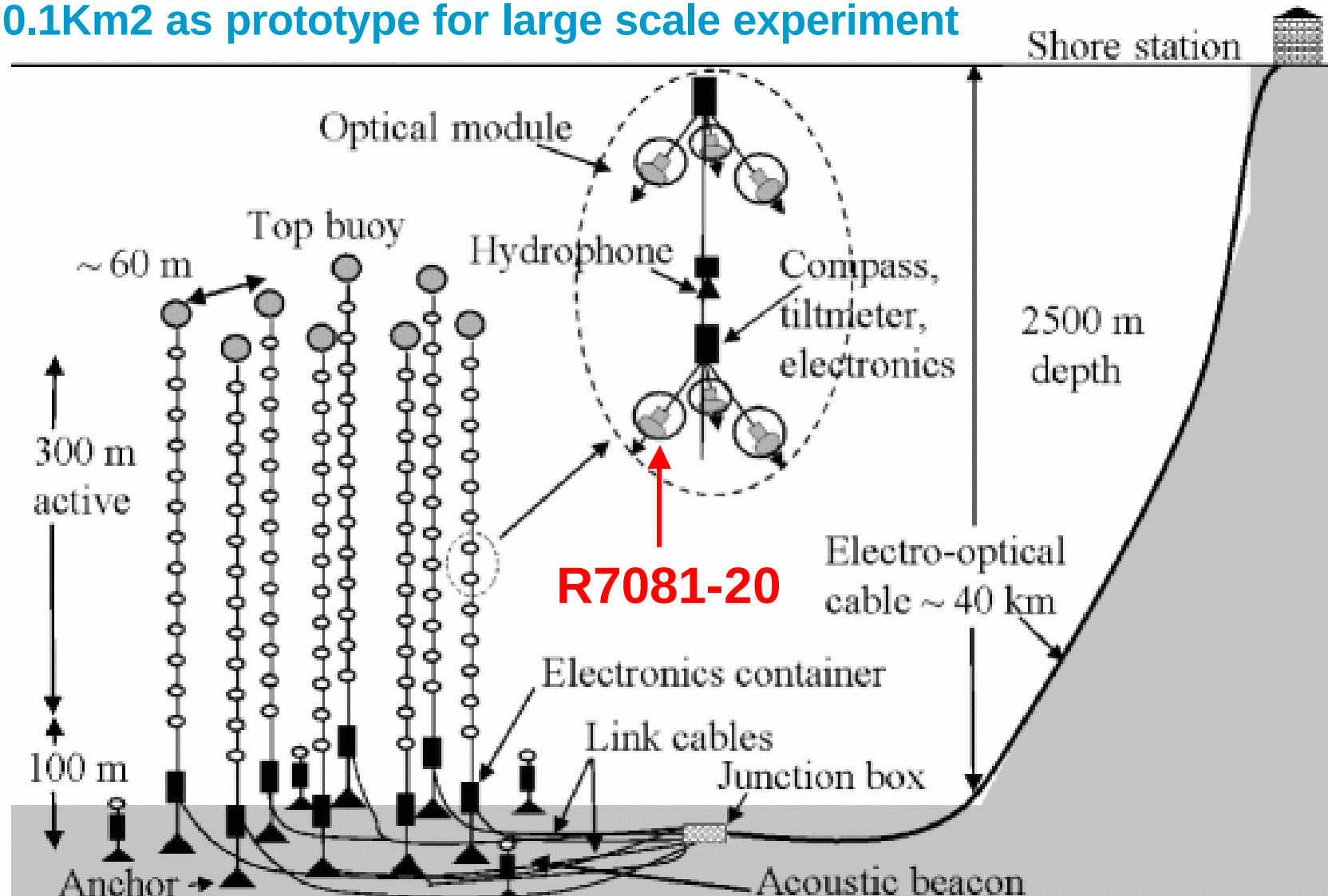
ICECUBE at the South Pole

R7081-02 is a candidate PMT.



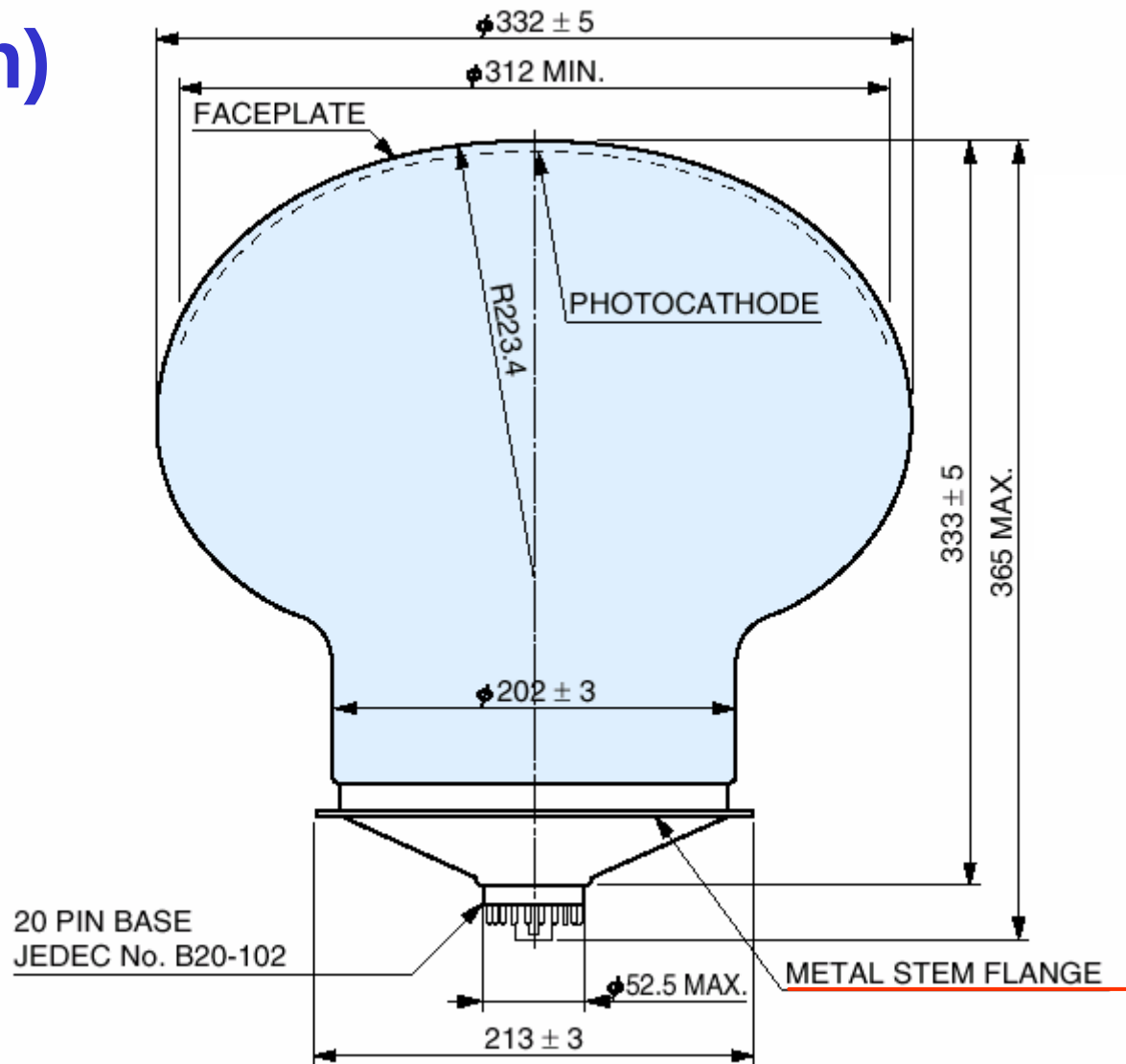
ANTARES at Marseille in the Mediterranean Sea

0.1Km² as prototype for large scale experiment



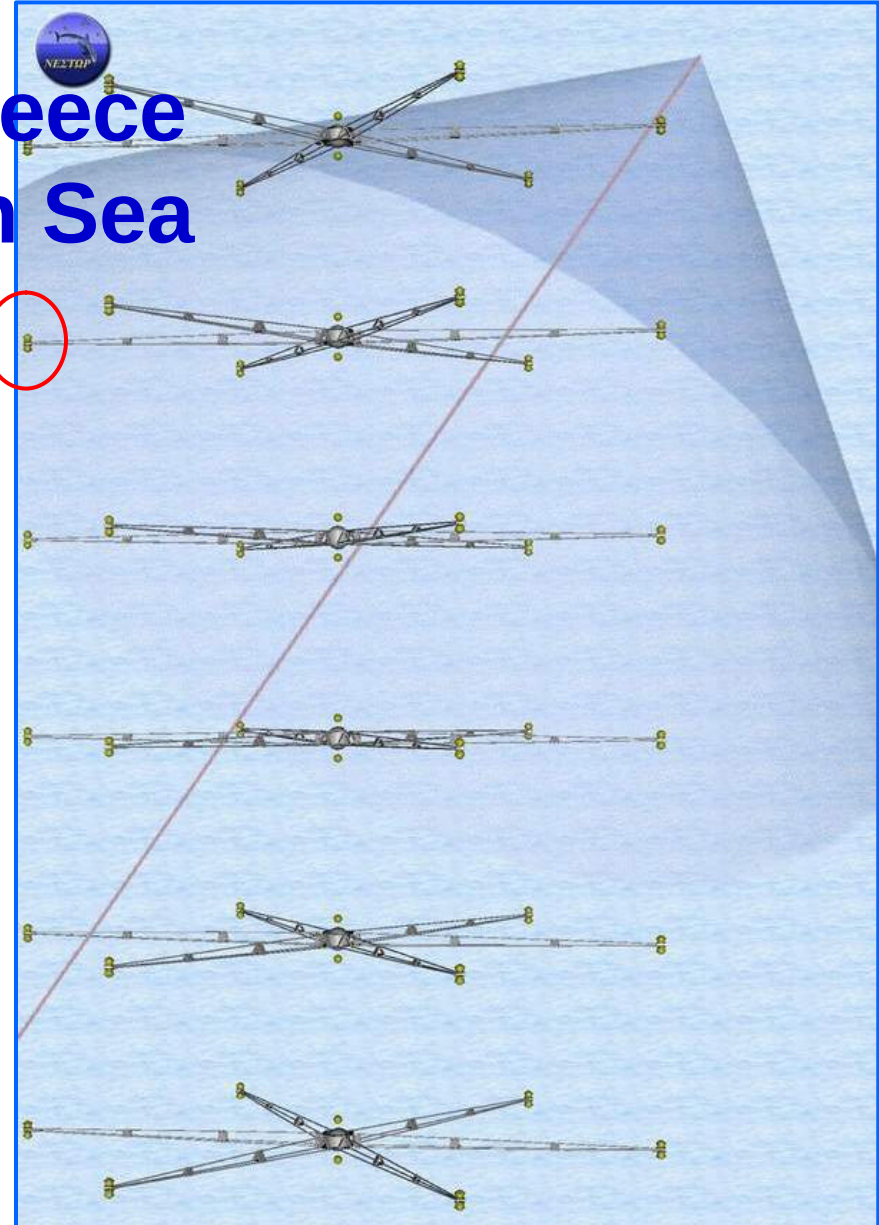
R8055 (13 inch)

Fits for 17 inch
Glass Sphere

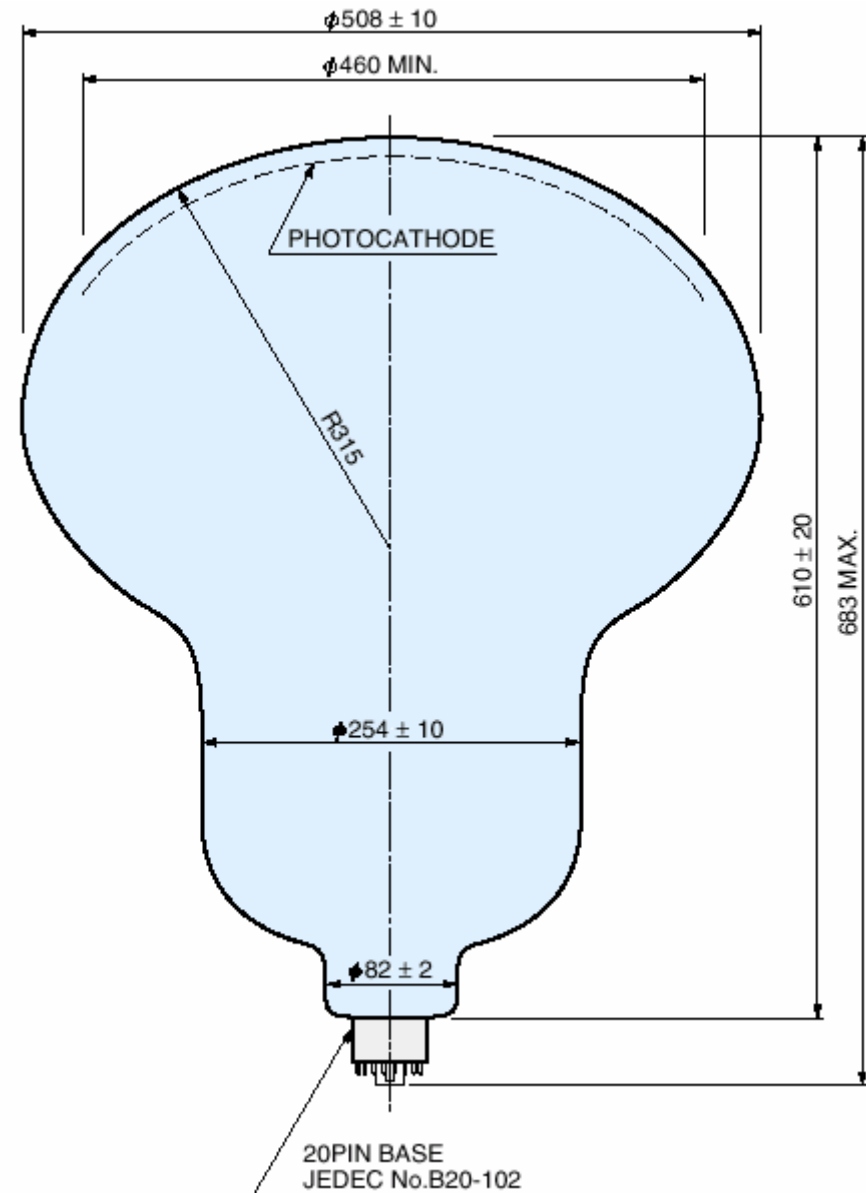


NESTOR at Pilos/Greece in the Mediterranean Sea

R8055 (2 tubes) →

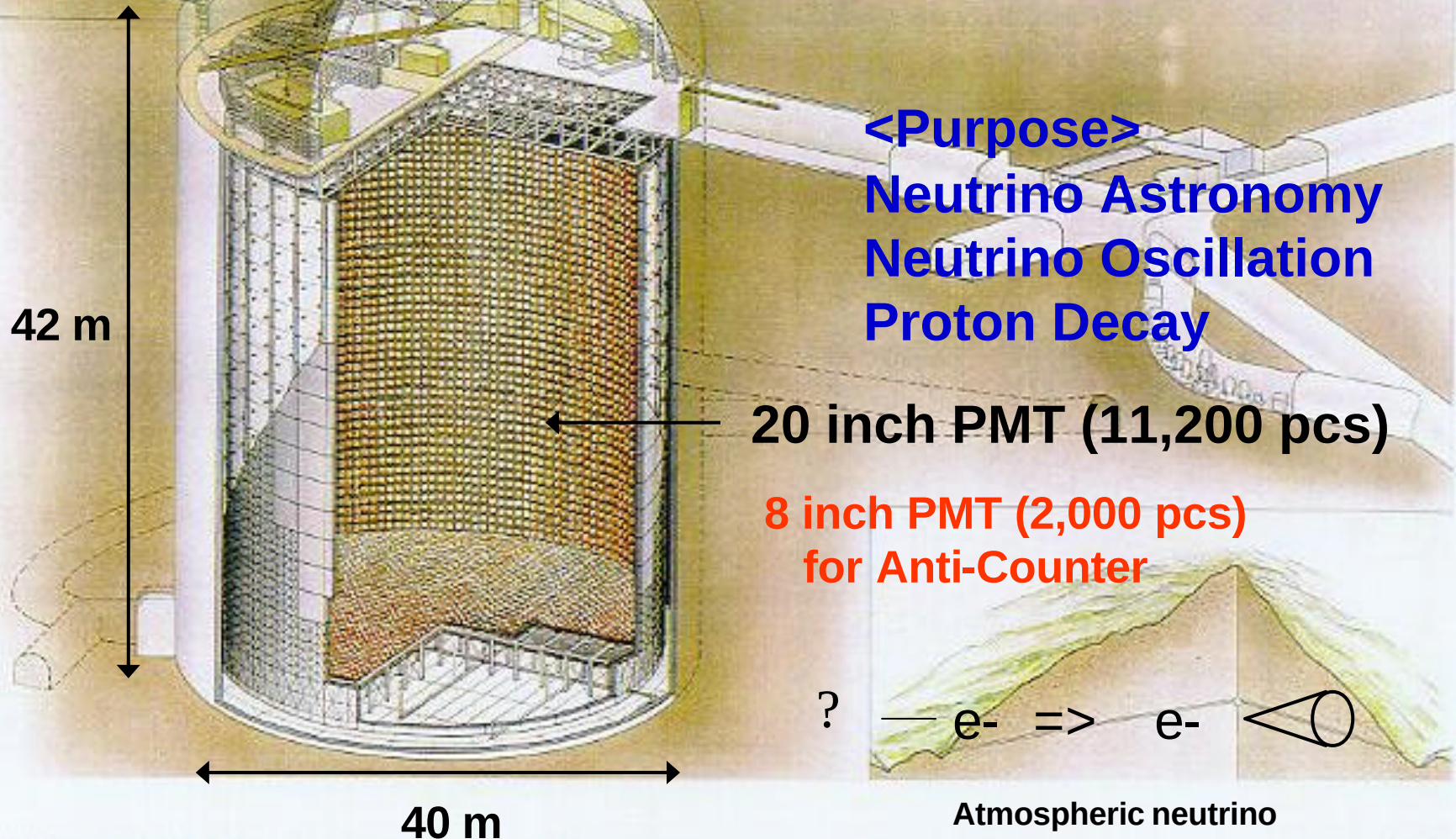


R3600-02 (20 inch)



SUPER-KAMIOKANDE

Kamioka mine in Japan

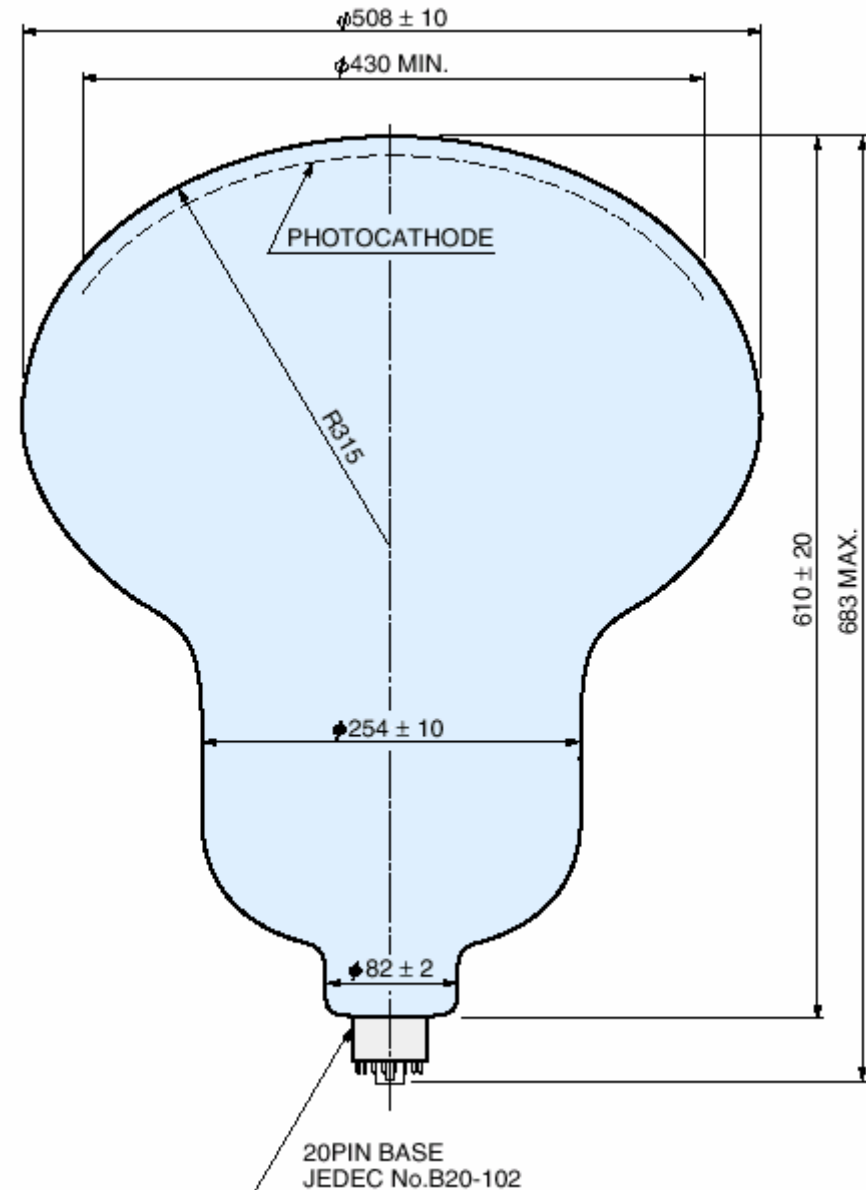




SUPER-KAMIOKANDE
Kamioka mine in Japan

R7250 (20 inch)

New electrode
for fast timing.
Effective area
is 17 inch.



KamLAND at Kamioka mine in Japan

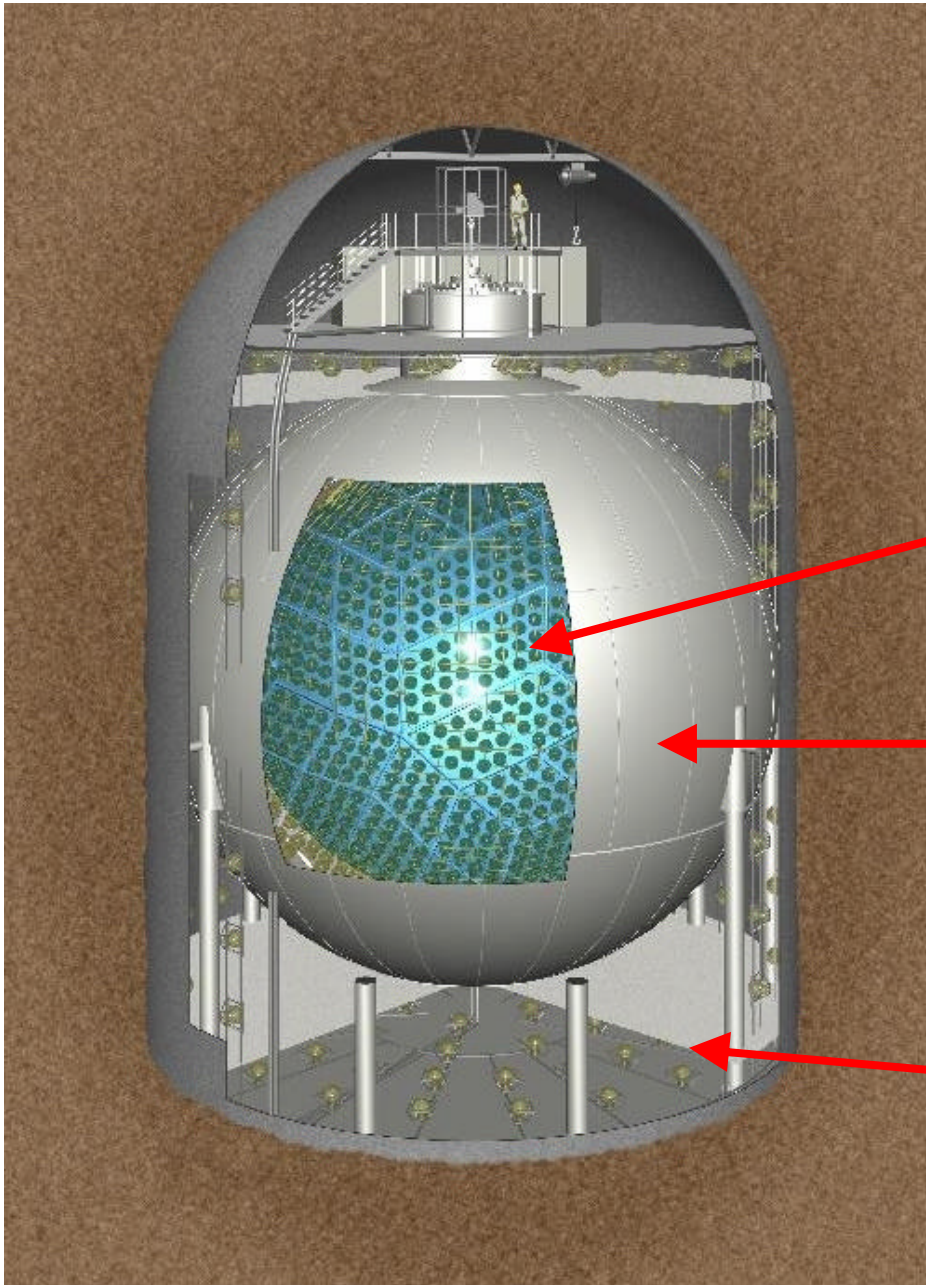
Detection of neutrinos come from Nuclear Power Plants

Liq. Scintillator (1000 ton)
in 13 m dia. Balloon

Stainless Steel Tank
with 1,330 pcs R7250
and 550 pcs of R3600

Pure water with
250 pcs of R3600

anti-electron neutrino



SUMMARY

< Type numbers and Examples of Experiments >

8 inch **R1408** : SNO / CANADA, LSND / LANL
 R5912 : MILAGRO / LANL, mini-Boone / FNAL
 R5912-02 : AMANDA / South-Pole

10 inch **R7081-20** : ANTARES (0.1km²) / Marseille
 R7081-02 : **ICECUBE / South-Pole**

? inch **PMT?** : **KM3 EXPERIMENT**

13 inch **R8055** : NESTOR

17 inch **R7250** : KamLAND / Japan

20 inch **R3600-02** : SUPER-KAMIOKANDE / Japan

