HAMAMATSU
PHOTON IS OUR BUSINESS

Current status of Hamamatsu Si detectors for High Energy Physics Experiments

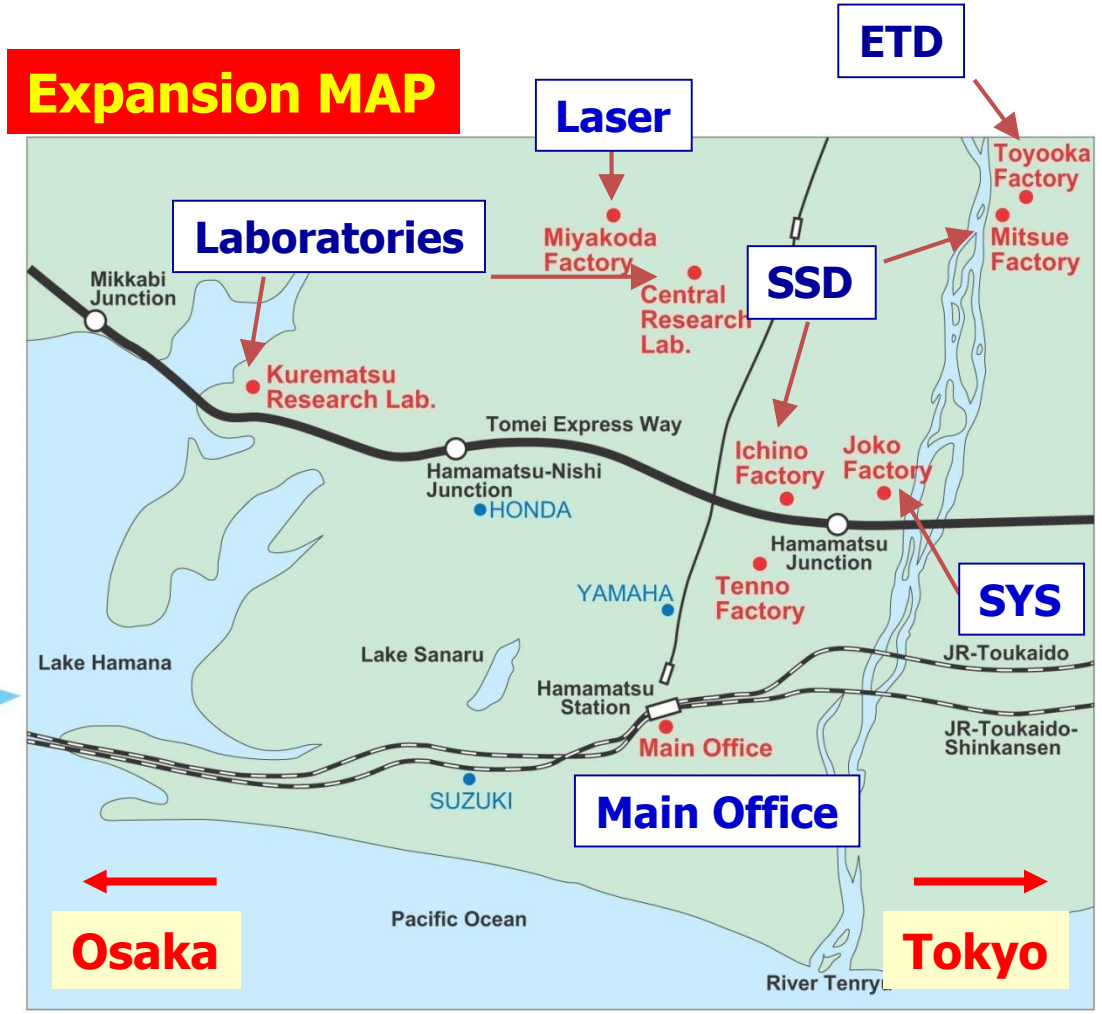
ALCW 2018　Fukuoka

May 29th, 2018

HAMAMATSU PHOTONICS K.K.
Solid State Division Yuto Ohashi

Where is Hamamatsu located ?

Hamamatsu City
Population: 804K
(As of May 1st, 2018)



Famous industry of Hamamatsu city

SUZUKI

HONDA
The Power of Dreams

YAMAHA
SHARING PASSION & PERFORMANCE

KAWAI

Roland

HAMAMATSU

HAMAMATSU
PHOTON IS OUR BUSINESS

Hamamatsu Photonics K.K.

Electron Tube Division

Solid State Division

Systems Division

Development Headquarter
(Laser & Integral Optics)

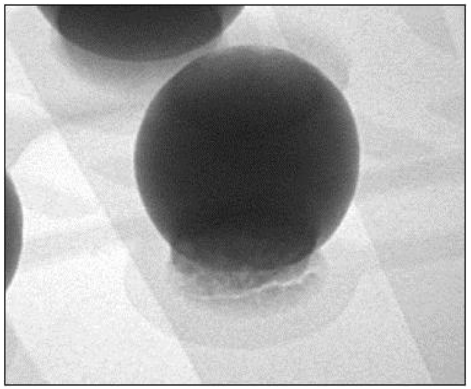
Central Research Laboratory

Electron Tube Division
Solid State Division
Systems Division
Development Headquarter
Central Research Lab.

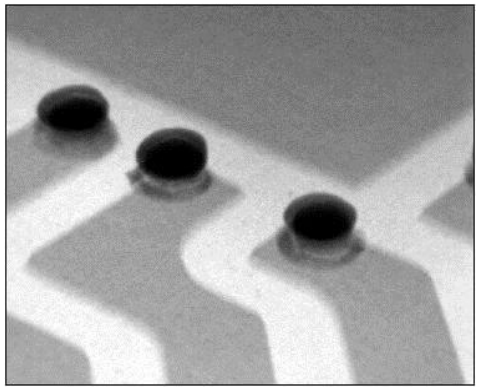
Optical Sensors (Photomultiplier Tubes)

X-Ray Related Products

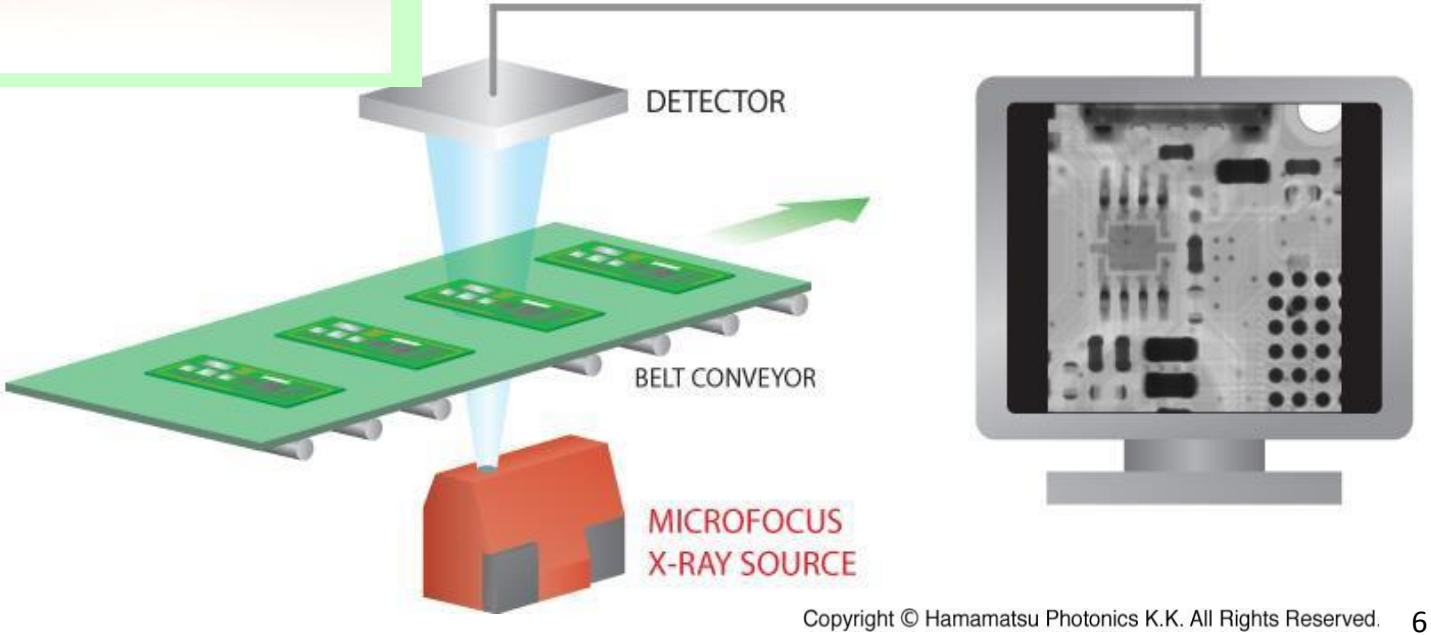
Microfocus X-ray source
(non-destructive X-ray inspection)



BGA joint



IC bumps (50μm)



Pharmaceutical & Medical Research

HAMAMATSU
PHOTON IS OUR BUSINESS

Systems Division

Kinetic plate reader

. Assists developing new drugs synthesizing large amounts of chemical compounds using high-speed, cell-based assay screening systems and functional analysis..

- Kinetic Plate Reader for Cell-based Assay

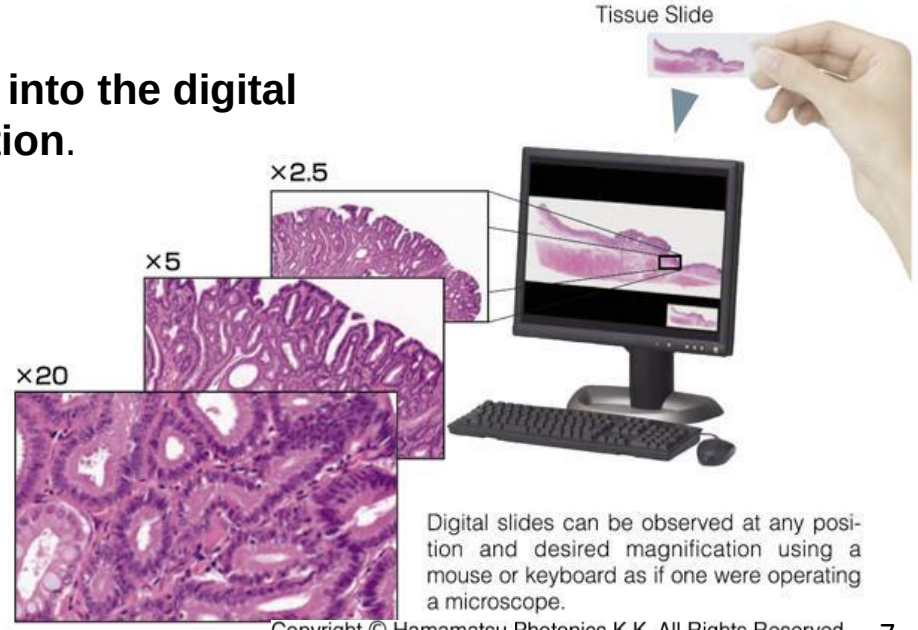
- Cell-based Assay System

Digital slide scanner

The NanoZoomer 2.0 converts glass slides into the digital format by quick scanning with high resolution.

NanoZoomer-XR
(Process up to 320 slides automatically)

NanoZoomer-SQ
(Desktop and light weight)



Digital slides can be observed at any position and desired magnification using a mouse or keyboard as if one were operating a microscope.

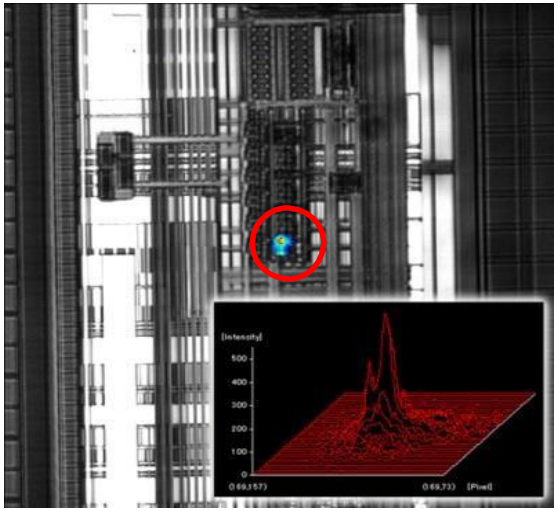
Semiconductor QC and Process

HAMAMATSU
PHOTON IS OUR BUSINESS

Failure detection and analysis

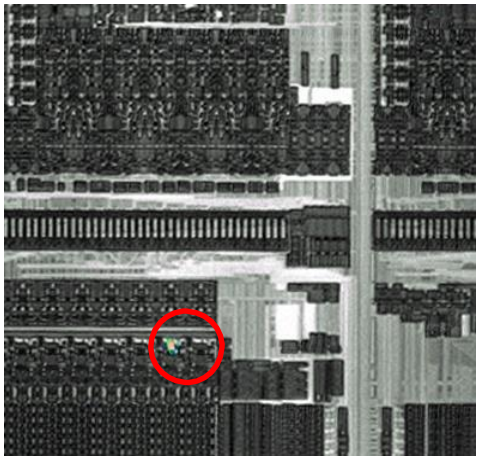
This system visualizes and analyzes failures semiconductor devices by detecting weak light emissions, heat emissions or electrical changes caused by failures.

PHEMOS series

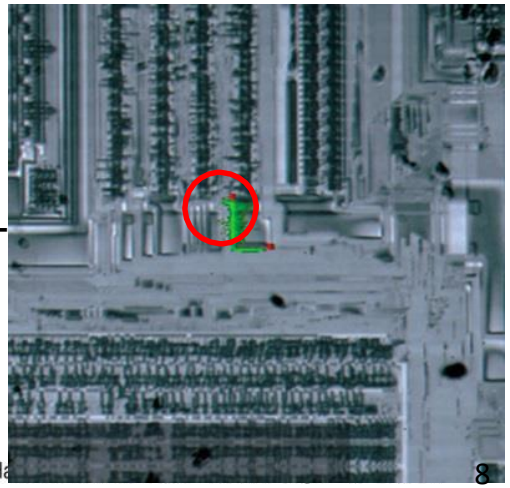


ESD damage localization

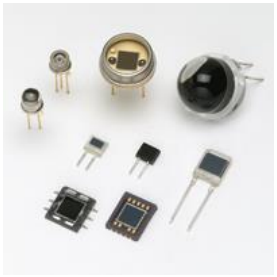
FET rush current caused by a short or open circuit



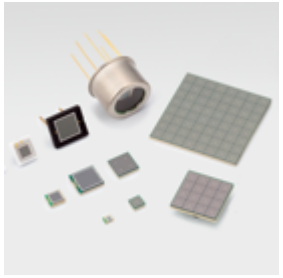
Metal wiring defect analysis using the IR-OBIRCH method



Semiconductor products



Si photodiodes



APD/ MPPC

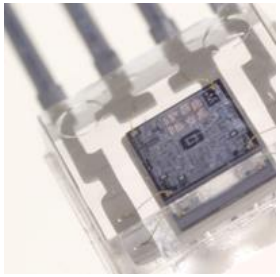
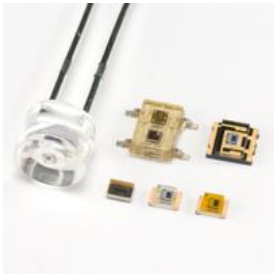


Photo ICs

Image sensors

PSD

Infrared detectors

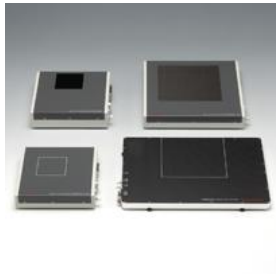


Visible sensors

Color sensors

LED

Optical communication devices



Flat panel sensors

Mini-spectrometers

Opto-semiconductor modules

Automotive devices

LCOS-SLM

Solid State Division

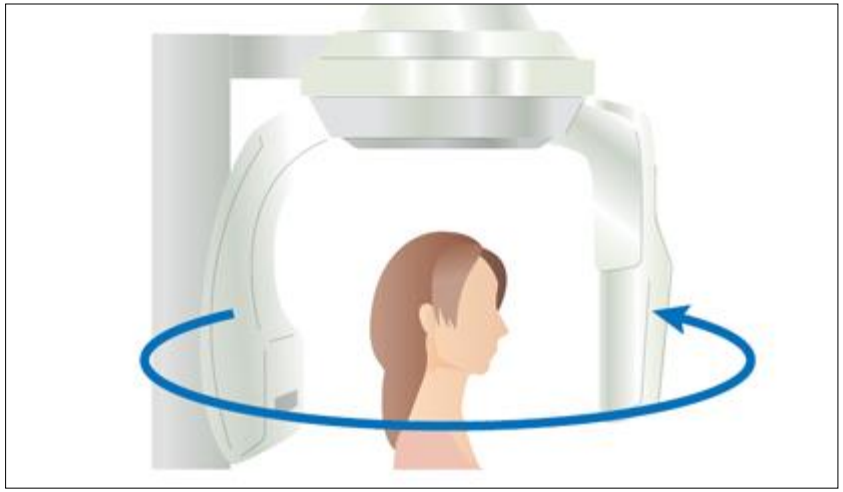
Silicon detectors for medical and dental field

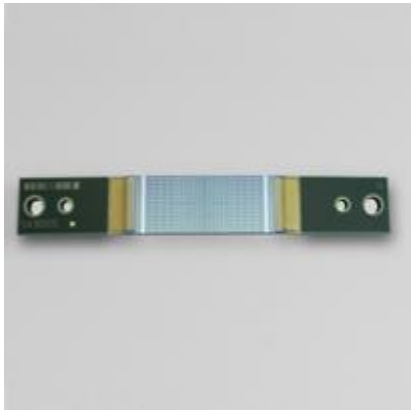
HAMAMATSU
PHOTON IS OUR BUSINESS

Solid State Division

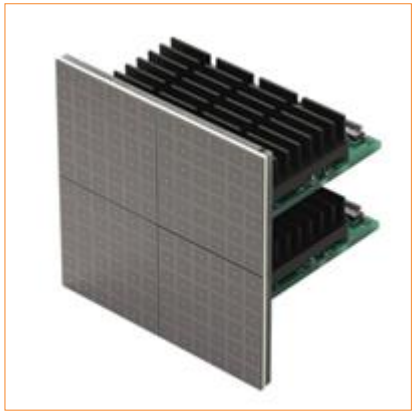
CT / PET scanner

Dental diagnosis

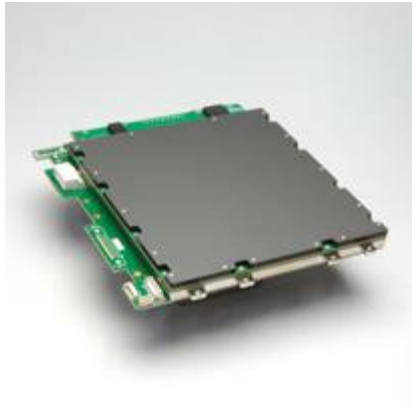




Si photodiode array



MPPC module for PET



X-ray flat panel sensor

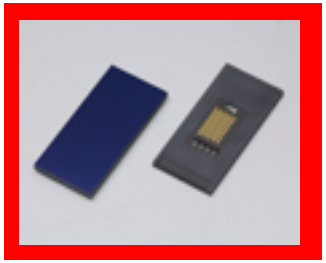
CMOS area image sensor

HAMAMATSU
PHOTON IS OUR BUSINESS

Silicon detectors for Academic research

Observation of outer galactic space

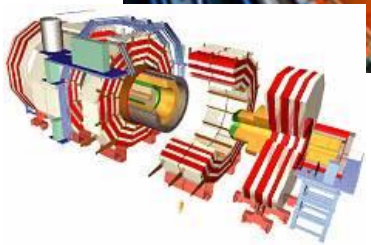
Image example taken by HPK CCD /SUBARU observatory (courtesy of National Astronomical Observatory of Japan)



CCD area image sensor

High- energy particle detection

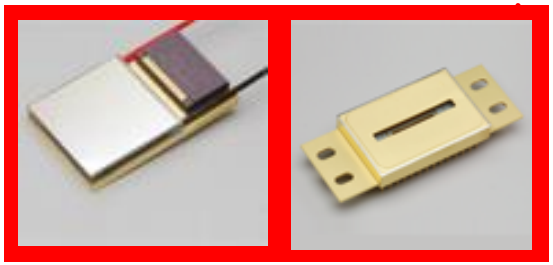
SSD **Si APD**



CMS tracker (courtesy of CERN)

Detection of substances on asteroid surfaces

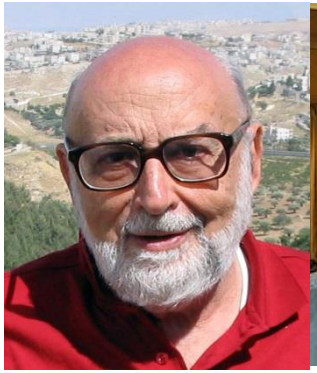
Asteroid explorer "HAYABUSA" (courtesy of JAXA)

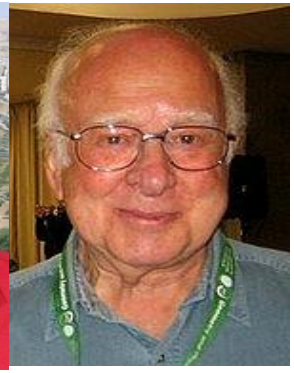


CCD image sensor **InGaAs image sensor**

Contribution to Nobel Prize

2002 **Dr. Koshiba, was awarded the Nobel Prize in physics, as a result of research conducted at the Kamiokande for Neutrino detection using Hamamatsu 20”PMT.**

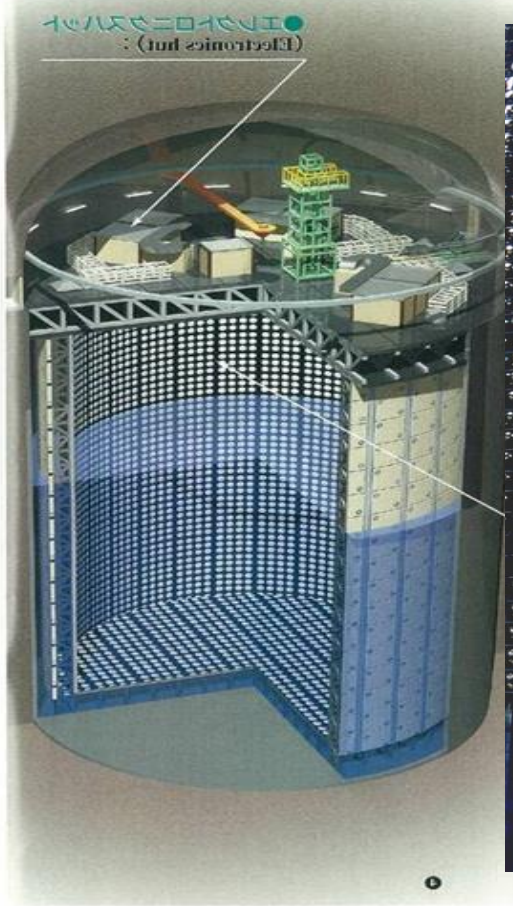


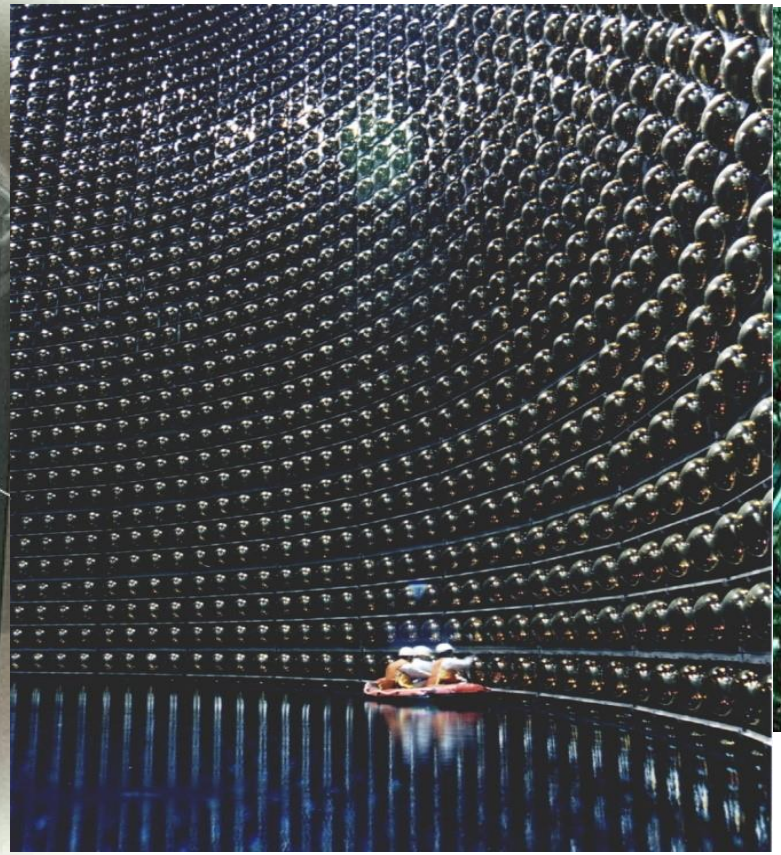


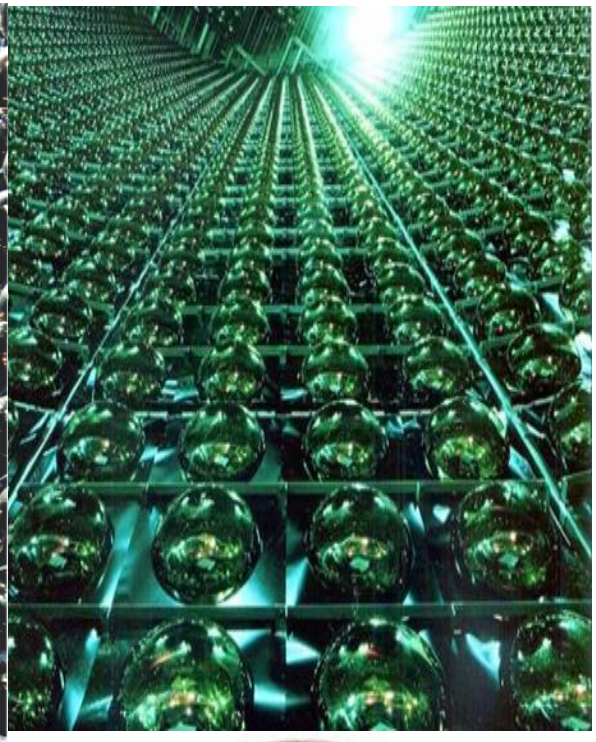
2013 **Dr. Englert and Dr.Higgs won the Nobel Prize in Physics. The Higgs boson, which is predicted by the standard model, was discovered in the experiment at LHC. Hamamatsu contributed to detect the Higgs boson as the main detector supplier (SSDs, APDs, and PMTs)**

2015 **Dr. Kajita and Dr. McDonald, were awarded the Nobel Prize in physics, working two different neutrino observatories. Dr. Kajita worked on neutrino oscillations at the Super-Kamiokande using Hamamatsu 20” PMT.**

Neutrino Detection “Super Kamiokande”





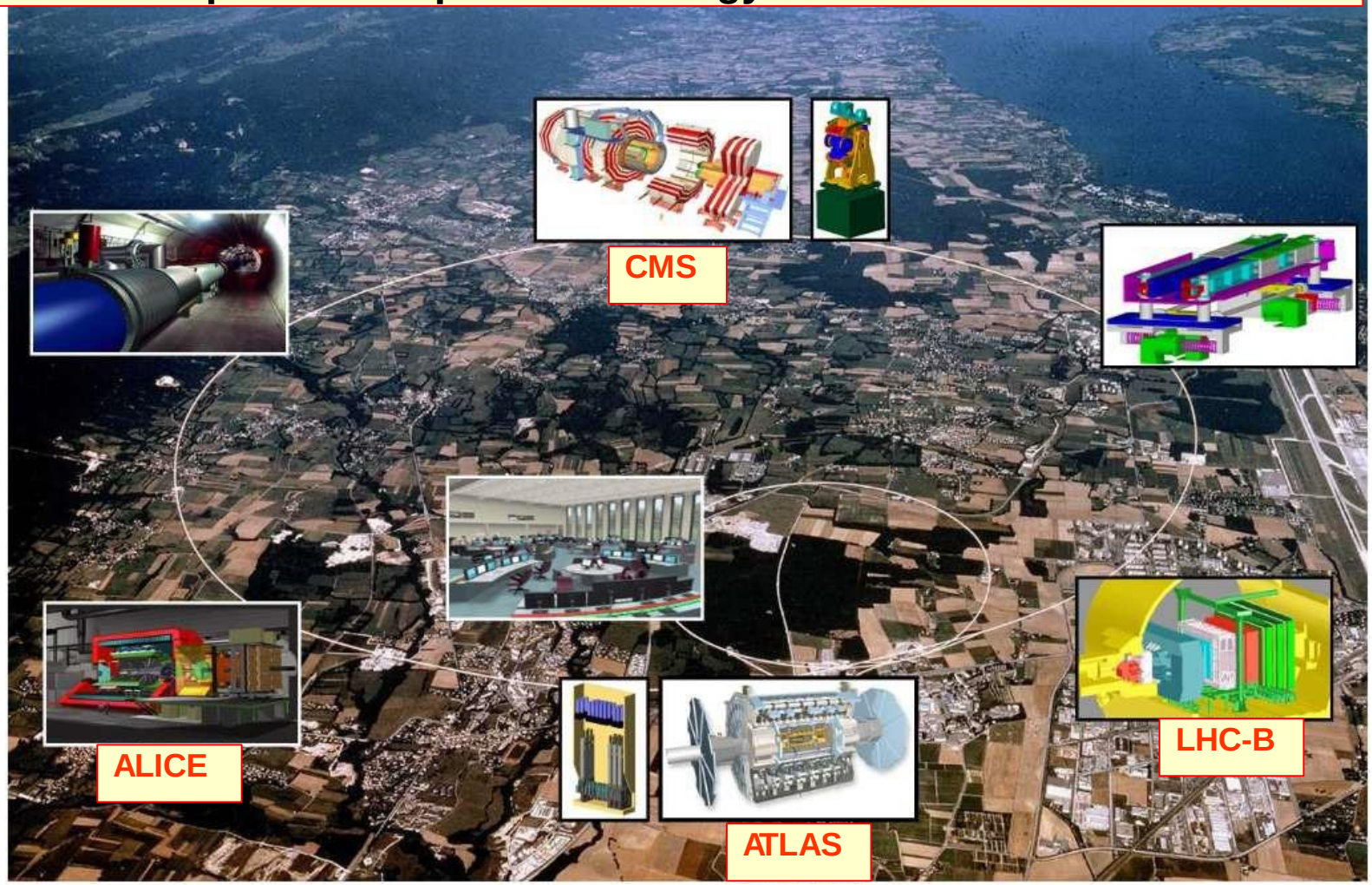


20” PMT

There are 11,200 20”PMTs in 13-million gallon steel water tank buried nearly a mile beneath a mountain to detect light produced when neutrinos interact with the water.

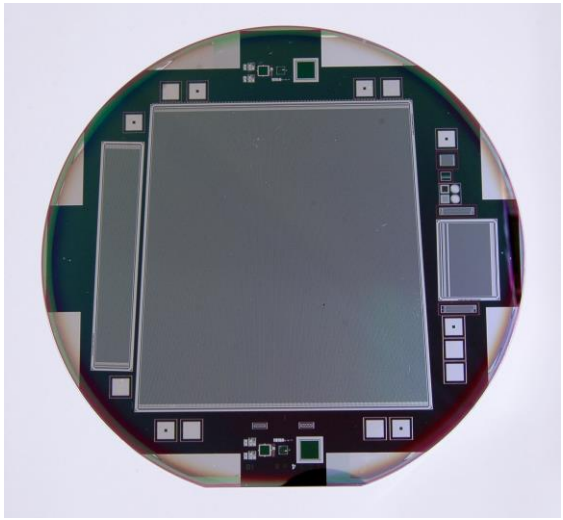
CERN LHC (Large Hadron Collider)

underground 100m, circumference 27km and with the ability to collide the proton and proton of energy to maximum 7TeV.

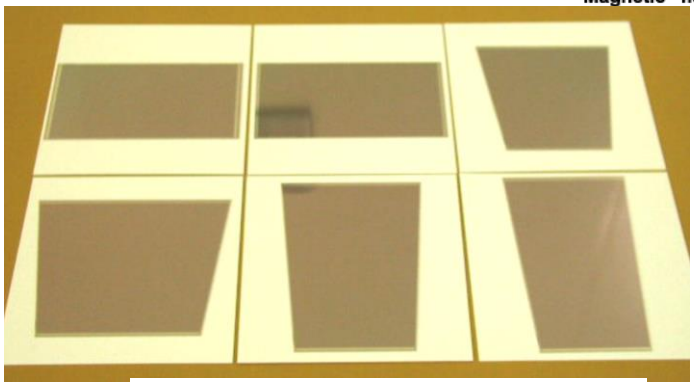


provided from CERN experiment groups

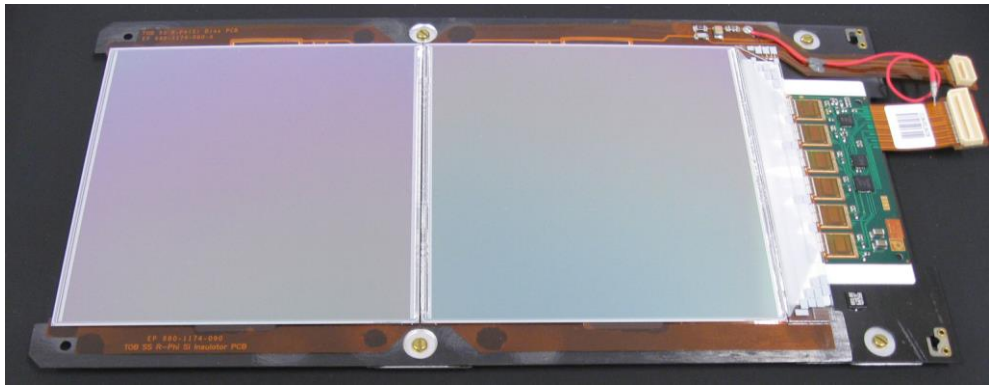
CMS-SSSDs



1 Sensor on 6 inch wafer

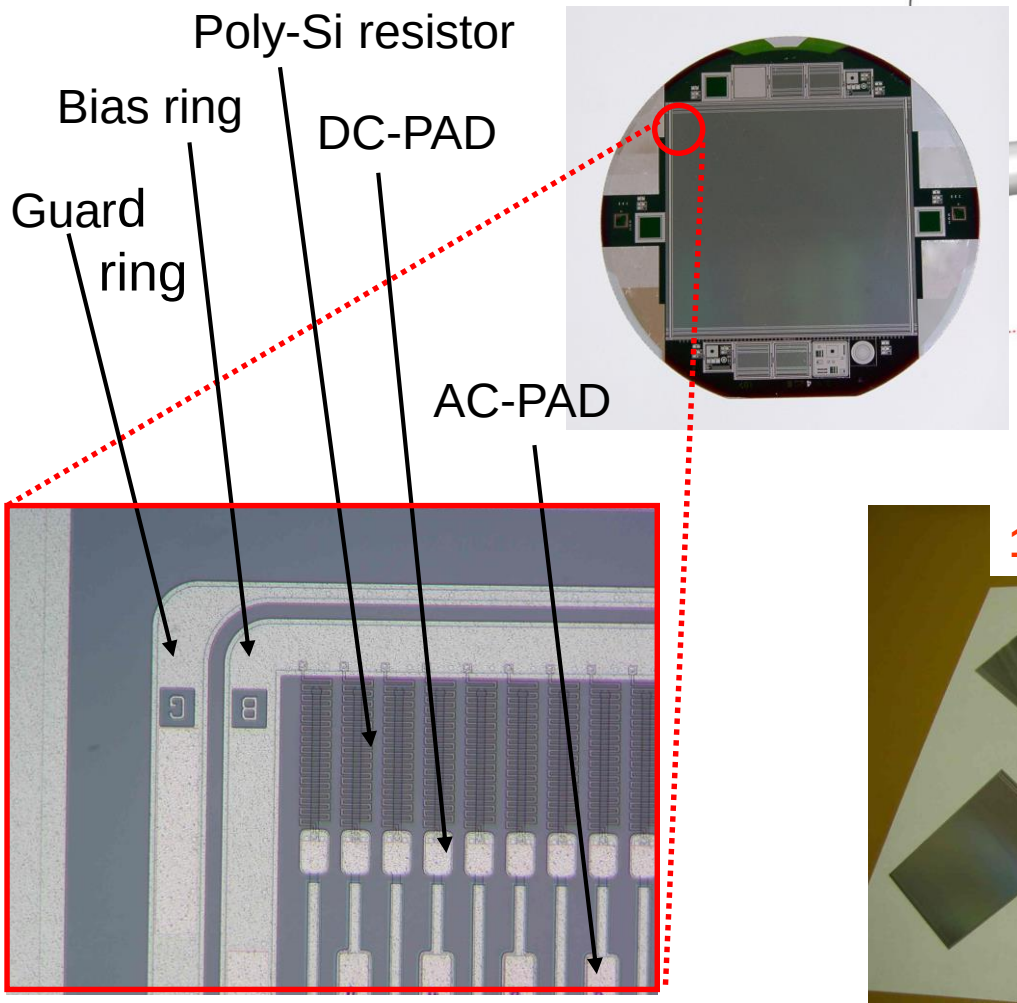


S9153, S9154 series

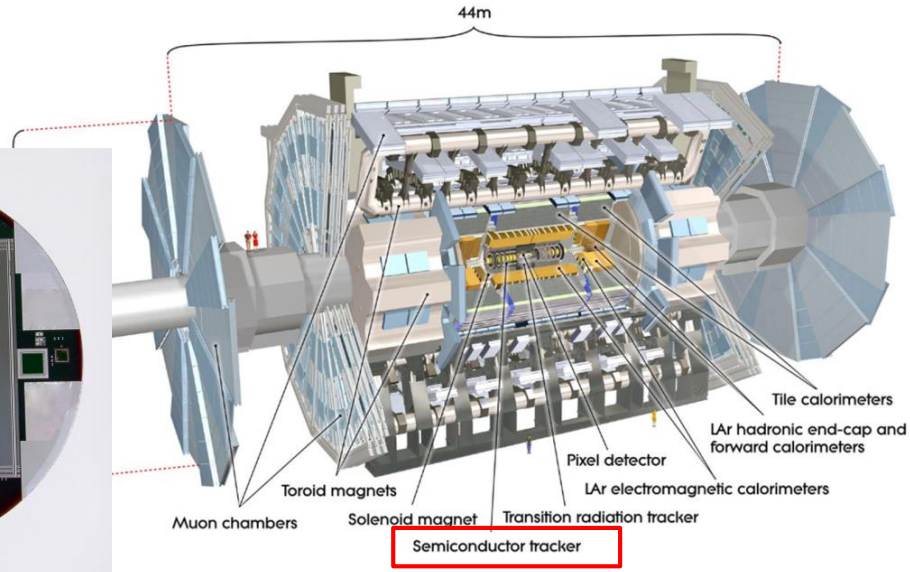


provided from CERN experiment groups

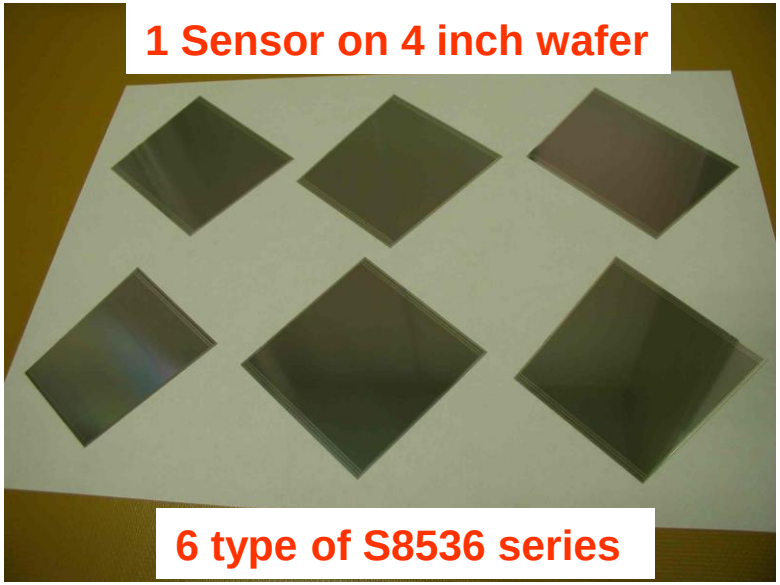
ATLAS-SSDs



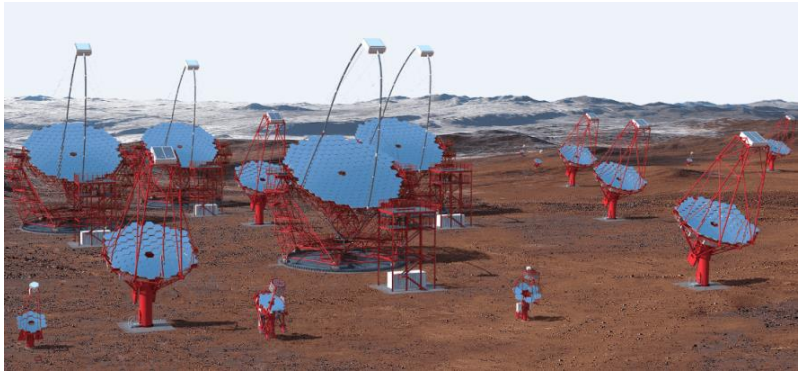
AC coupling-SSD



provided from ATLAS experiment groups



Development of Si detectors



Cherenkov telescope

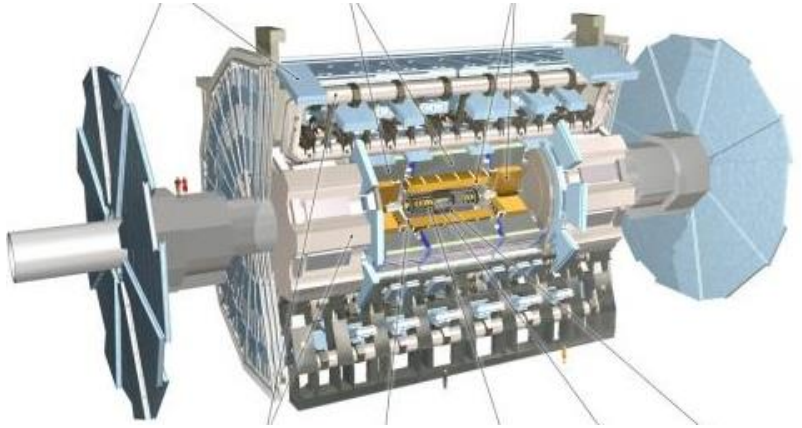
MPPC - High sensitivity for UV

MPPC - Lower dark count

Dark matter research

MPPC - High sensitivity for VUV

MPPC – Low RI



Calorimeter

MPPC – High dynamic range

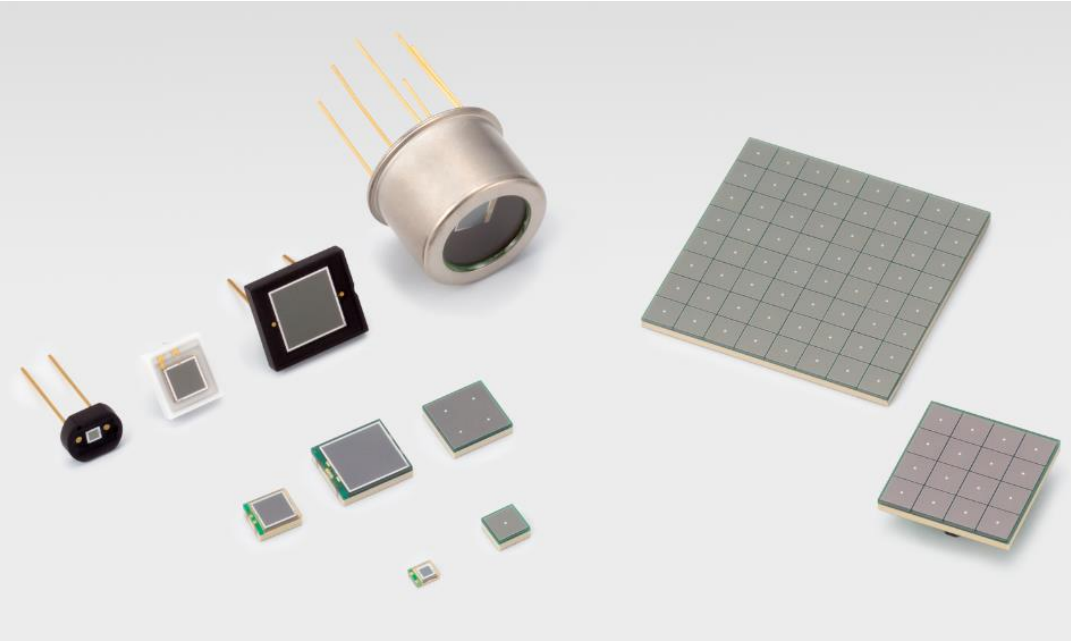
MPPC – Radiation hardness

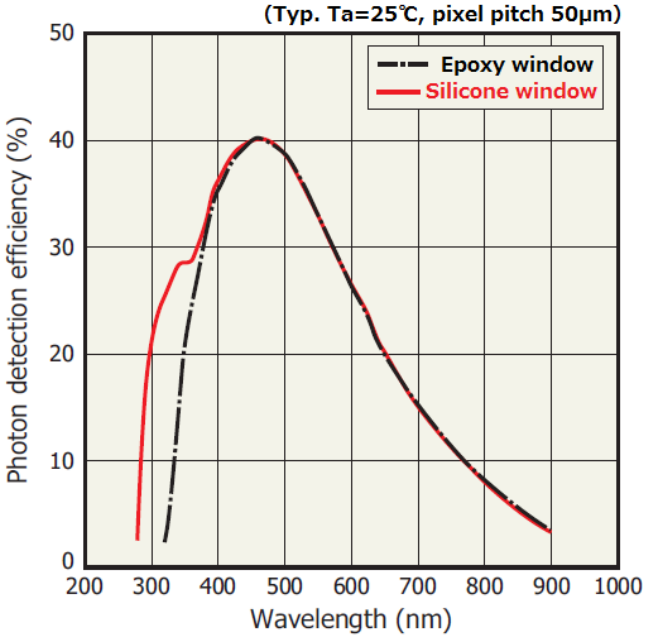
PAD – Larger size

www.hamamatsu.com

MPPC S13360/S13361 series

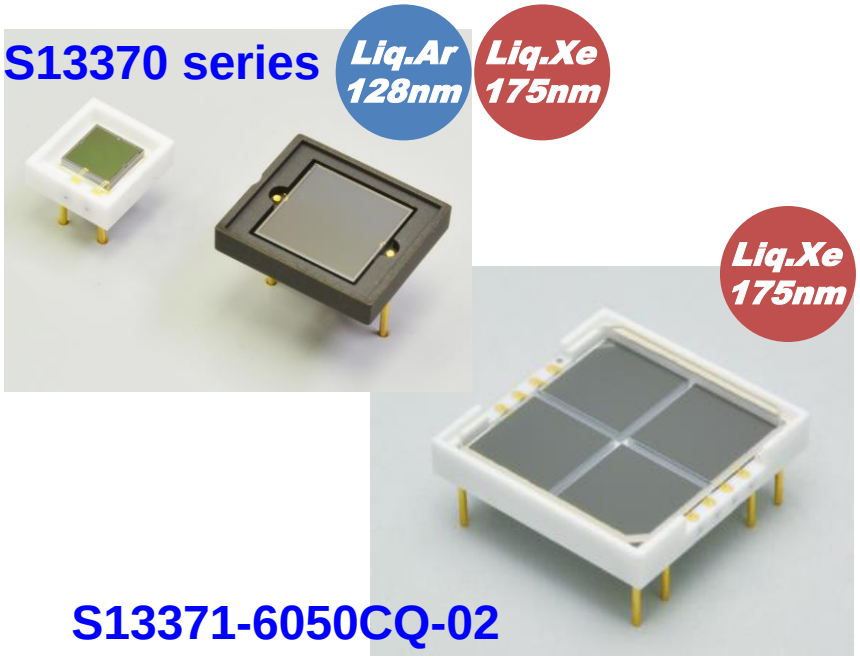
- ✓ High PDE
- ✓ High gain
- ✓ Low crosstalk
- ✓ Low dark count
- ✓ Single & Multi channel type





MPPC for VUV

- ✓ High sensitivity for VUV
- ✓ Suitable for cryogenic temperature
- ✓ Suitable for detection of Liq. Xe or Liq. Ar scintillation light



S13371-6050CQ-02
Designed for MEG-II experiment