

# Multi-Pixel Photon Counter (MPPC)

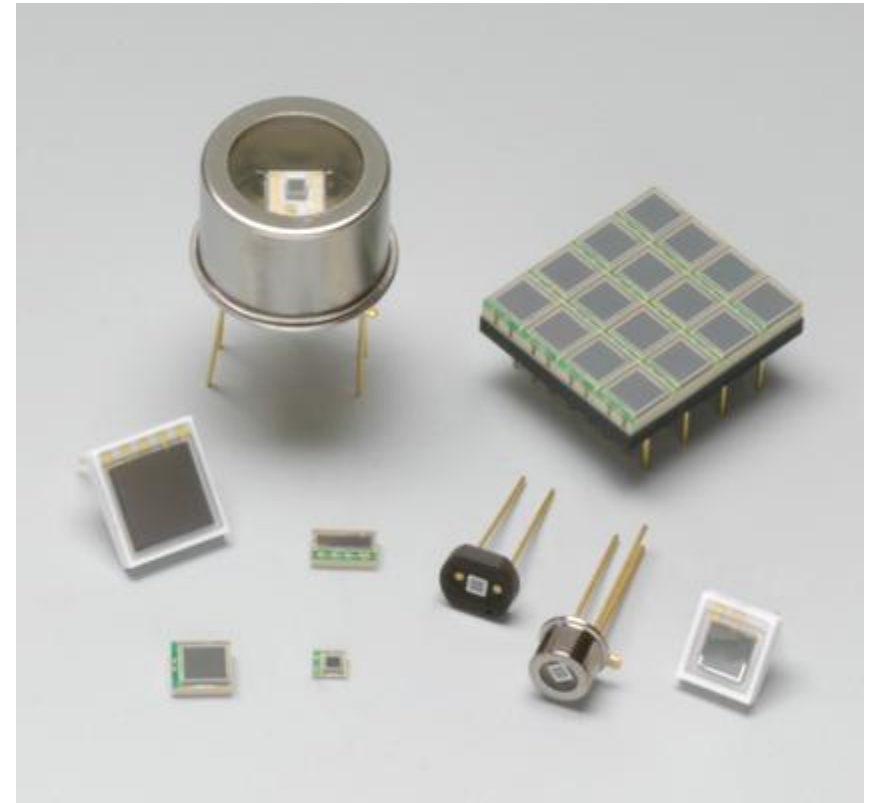
2011.10

**HAMAMATSU PHOTONICS K.K.**

Solid State Division

# Multi-Pixel Photon Counter (MPPC)

MPPC<sup>®</sup> is the solid state photon counter having Multi pixelated Geiger-mode APDs with self-quenching resistance.



# The feature of MPPC

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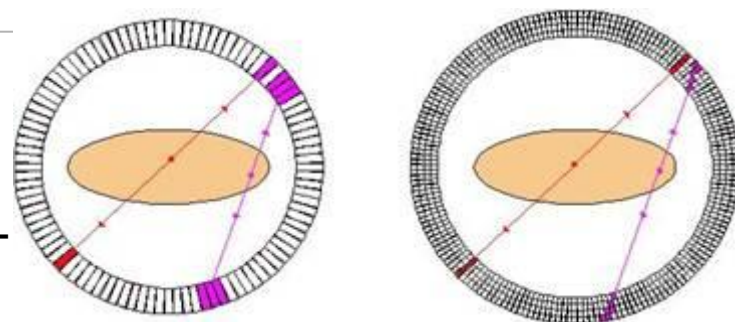
- Low bias voltage operation
- Room temperature operation
- High gain :  $10^5 - 10^6$
- Insensitive to magnetic fields
- Small size
- Simple readout circuit operation
- High Photon Detection Efficiency (PDE)

# Targeting Applications

## ■ Medical

- PET

TOF-PET, MR-PET, DOI-PET

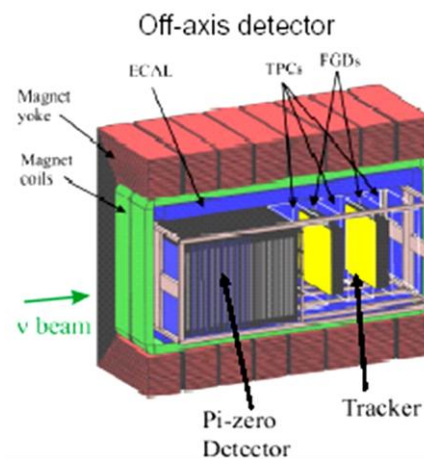


## ■ Academic

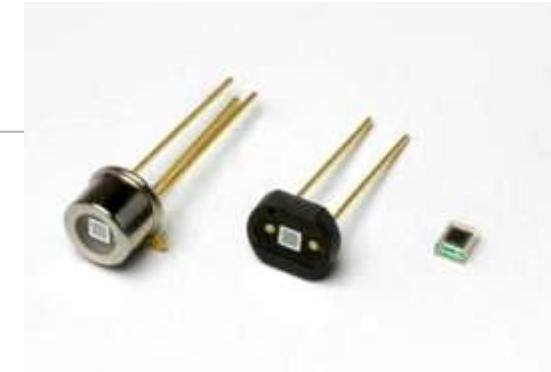
- High energy physics experiment
- Elementary particle physics  
dark matter, neutrino, hadron (neutron) • • •
- Astronomy physics

## ■ Measurement

- Distance measurement
- DNA Sequencer
- Diagnosis of blood
- Fluorescence measurement



# MPPC product lineup



- Small size and low dark count

S10362-11 series (1x1mm active area)

- Large area and high dynamic range

S10362-33, S10931 series (3x3mm active area), small pixels

- Low dark count using by peltier cooler

S11028 series (1x1mm active area, 2 stage peltier cooling)

- Large area covering with high uniformity (using discrete MPPC chip)

S11064 series (3x3mm – 4x4ch.)

- Large area covering with low cost (using monolithic MPPC chip)

S11984 series (1x1mm – 1x4ch.)

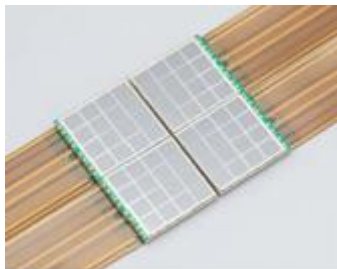
S11985 series (3x3mm – 2x2ch.)

S11827 series (3x3mm – 4x4ch., w/ pin)

S11828 series (3x3mm – 4x4ch., chip sized package)

S11829 series (3x3mm – 4x4ch., w/ long FPC)

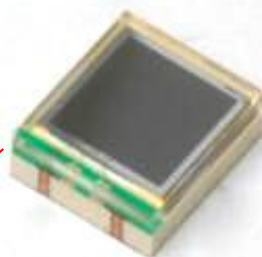
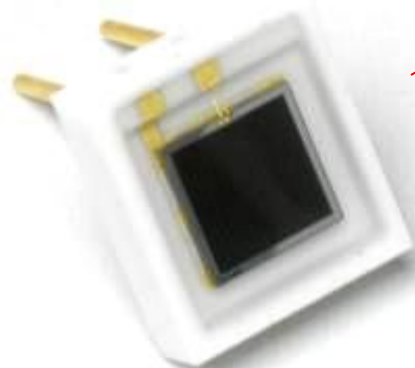
S11830 series (3x3mm – 4x4ch., w/ short FPC)



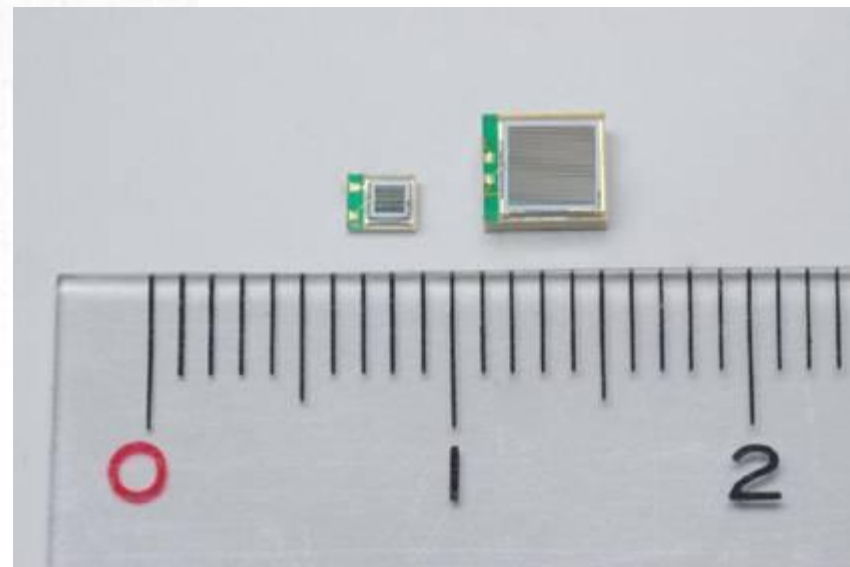
## MPPC line-up, 3x3mm

3mm□, CERAMIC-PKG, SMD-PKG

S10362-33  
-025C/-050C/-100C



S10931  
-025P/-050P/-100P

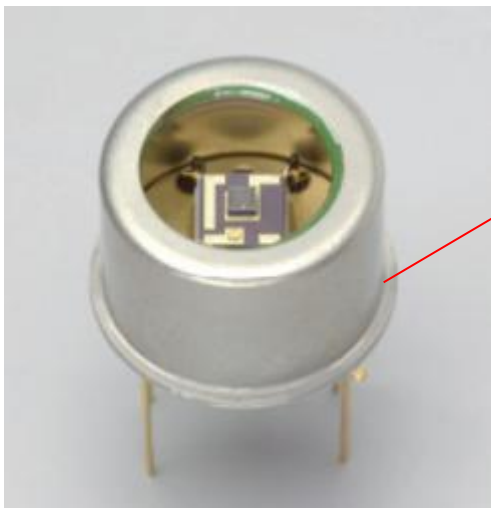


# Peltier cooled type (1x1mm) / Peltier cooled type module / Discrete array type (3x3mm – 4x4ch.)

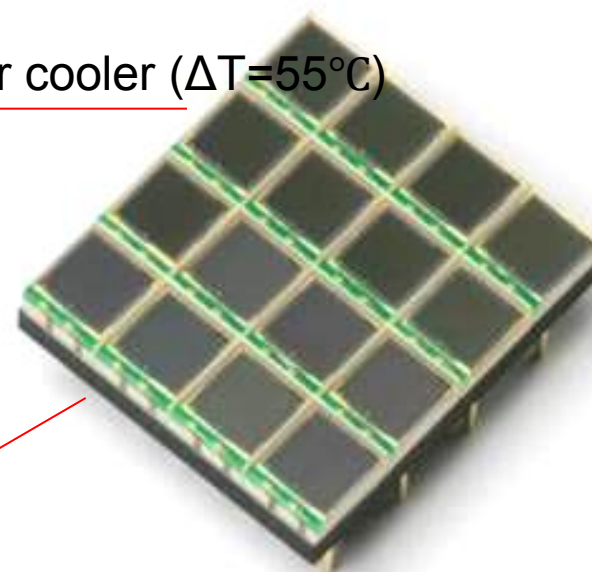
S11028 series,  
2 stage Peltier cooled type module



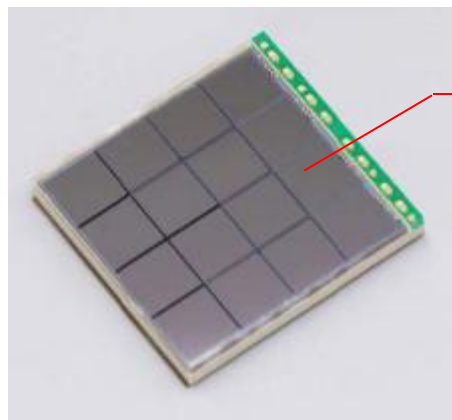
S11028 series,  
2 stage Peltier cooler ( $\Delta T=55^{\circ}\text{C}$ )



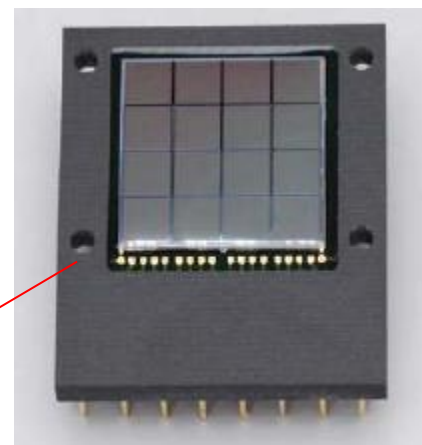
S11064 series,  
3mm  $\square$  16ch.array



## Monolithic array line-up, 3x3mm – 4x4ch.



S11828-3344M, CSP



S11827-3344MG  
w/ contact pins

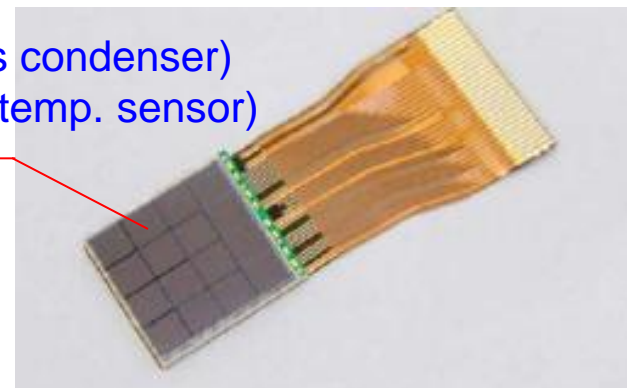


Long FPC type  
S11829-3344MF

S11829-3344MB (w/ Bias condenser)  
S11829-3344MT (MB w/ temp. sensor)

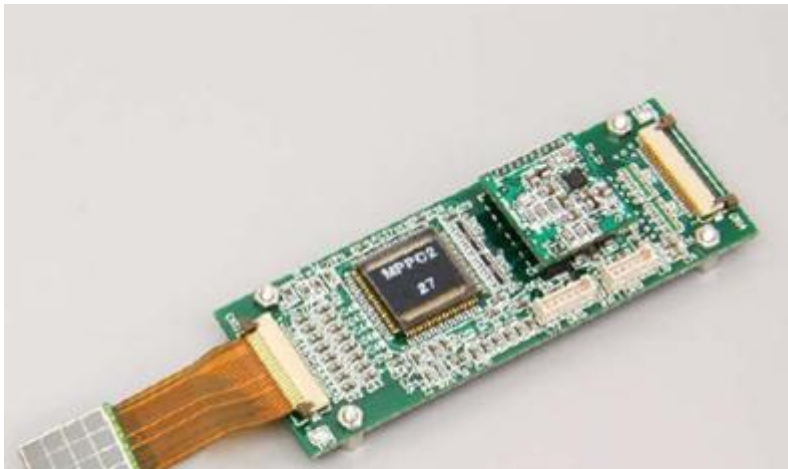
Short FPC type  
S11830-3344MF

S11830-3344MB (w/ Bias condenser)  
S11830-3344MT (MB w/ temp. sensor)





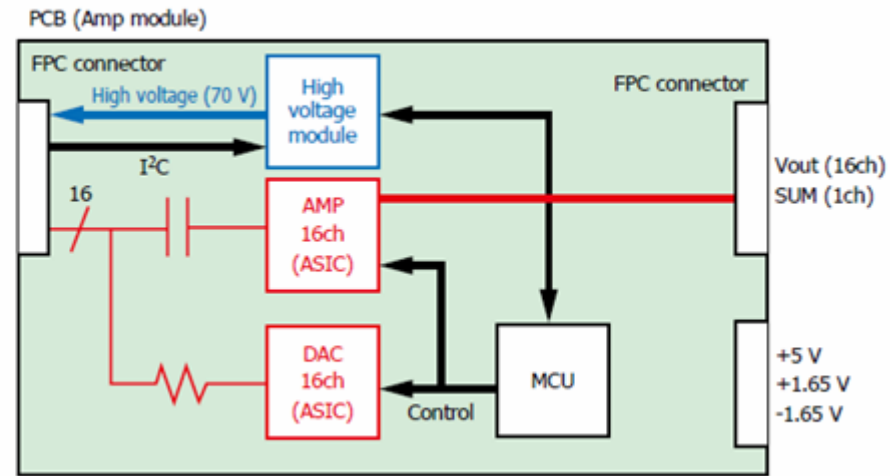
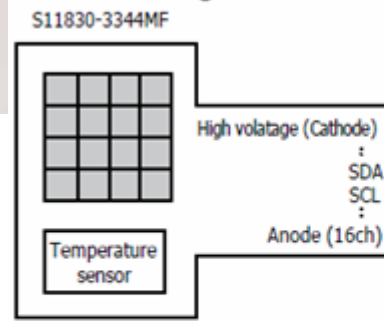
# S11206-0404FB, 3x3mm – 4x4ch. Monolithic ASIC include type



DAC array enable to adjust the bias voltage for each channels.  
It is suitable for improving the uniformity of gain, PDE to the whole channels.

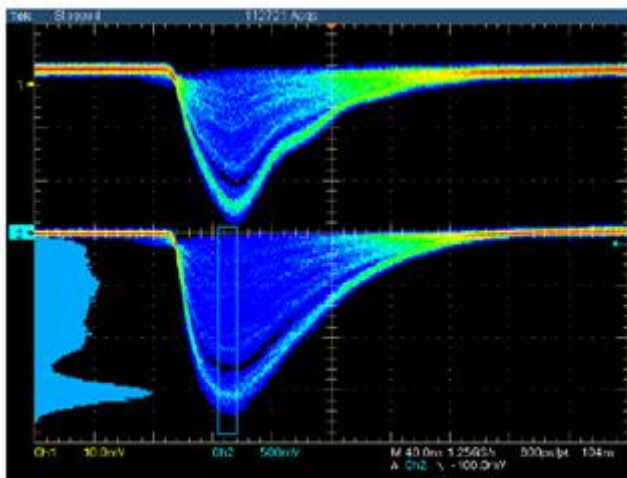
S11830-3344MT(X)

### Block diagram



# S11206-0404FB (Energy resolution and time resolution)

## Output wave form



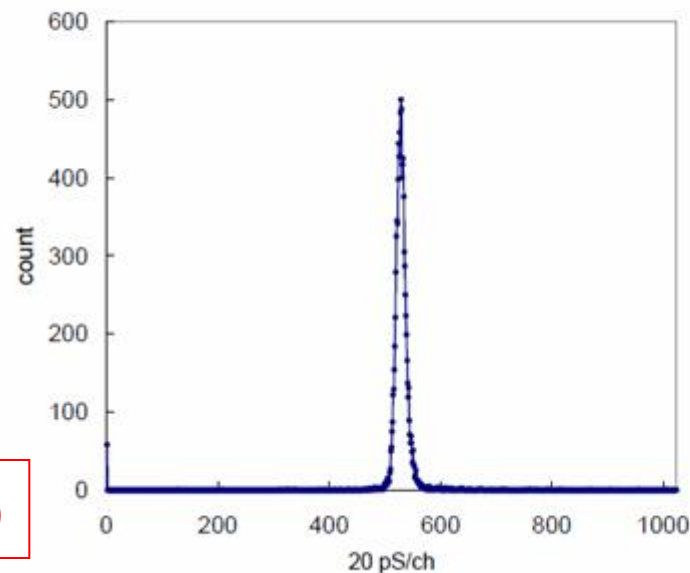
Upper: 16ch SUM output  
Lower: 1ch output

Conditions  
 •MPPC: S11830-3344MF  
 •HV: 70.9V  
 •Radiation source: Cs137  
 •Scintillator: LYSO  
 (3 × 3 × 20 mm)

Energy resolution  
 FWHM: 11.86% (Peak 662 KeV)

**11.86%(FWHM)  
@662keV**

## Time resolution

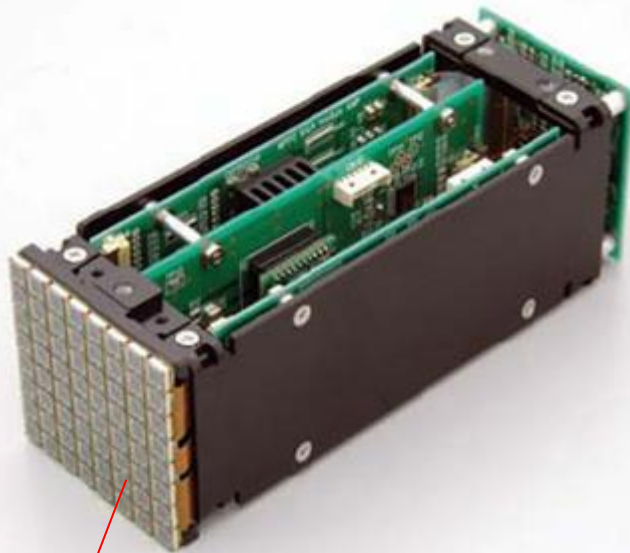


Conditions  
 •MPPC : S11830-3344MF  
 •HV : 70.9V  
 •Radiation source: Na22  
 •Scintillator : LYSO  
 (3 × 3 × 20mm)  
 •Reference : BF2+PMT  
 •Output : Single

Time resolution  
 FWHM : 368ps

**368ps(FWHM)**

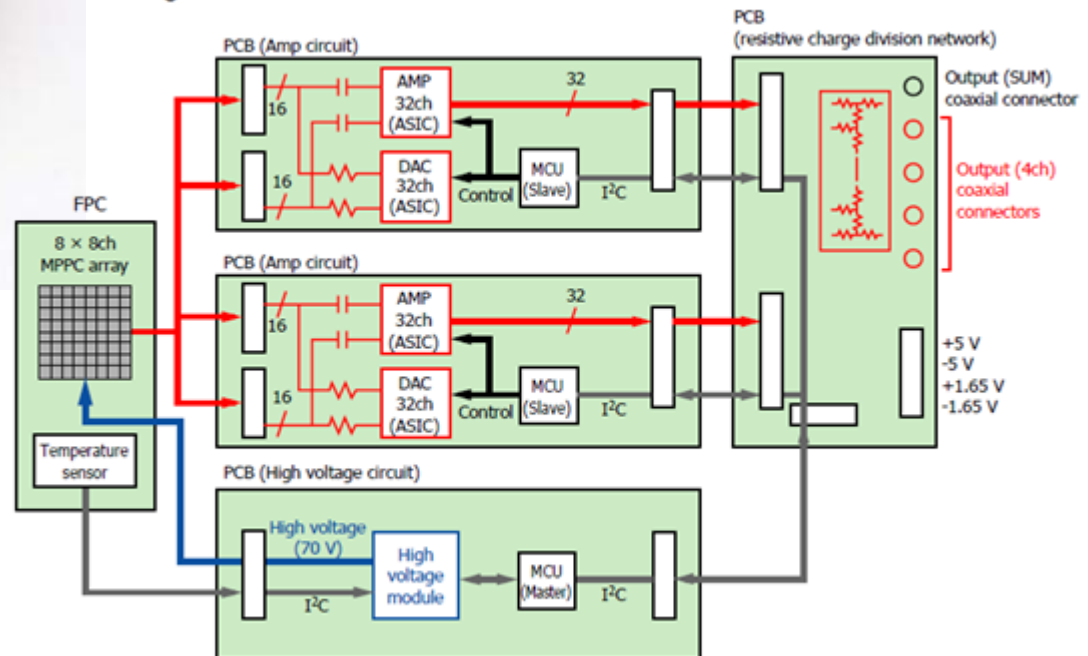
# S11206-0808FA, 3x3mm – 8x8ch., ASIC include type



3x3mm, 50 $\mu$ m  
8x8ch. array

DAC array enable to adjust the bias voltage for each channels.  
It is suitable for improving the uniformity of gain, PDE to the whole channels.

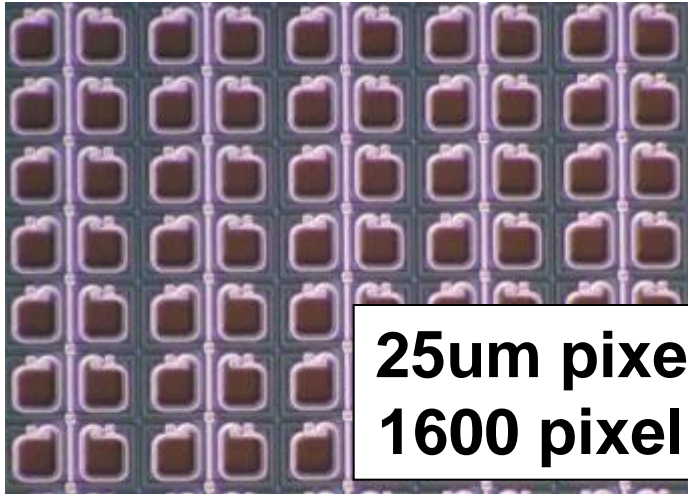
## Block diagram



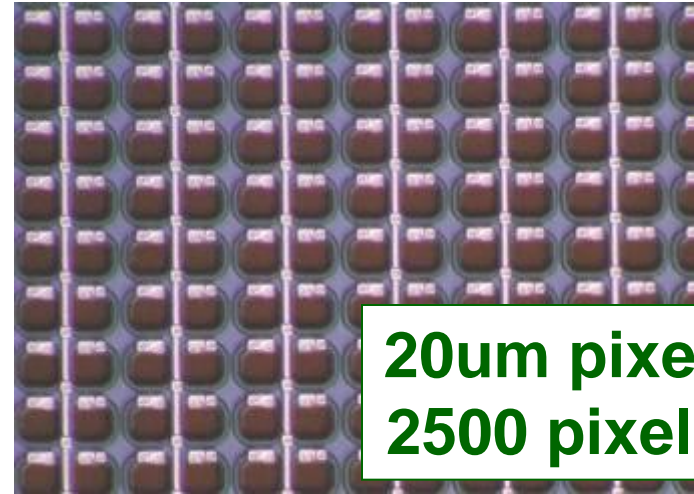
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# Recent development

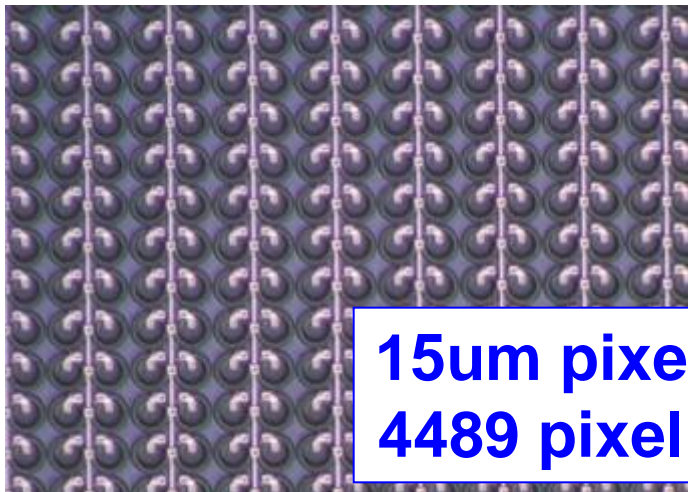
# Wide dynamic range by small pixel MPPC



**25um pixel pitch**  
**1600 pixel / mm<sup>2</sup>**



**20um pixel pitch**  
**2500 pixel / mm<sup>2</sup>**



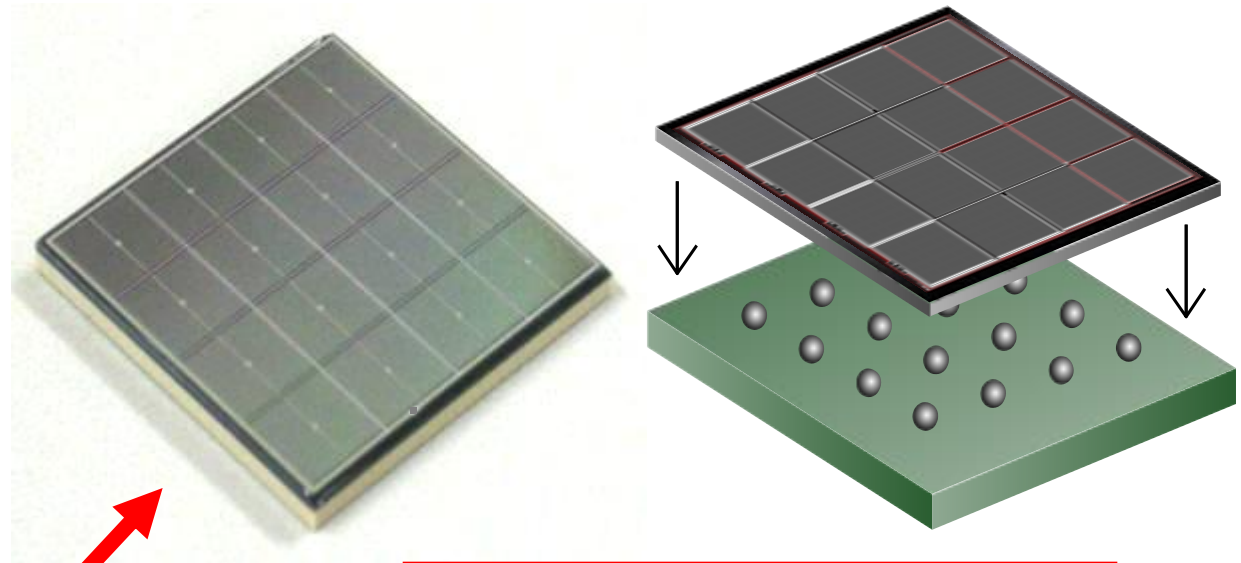
**15um pixel pitch**  
**4489 pixel / mm<sup>2</sup>**

- **Wide dynamic range**
- **Short recovery time**
- **Low dM/dV**

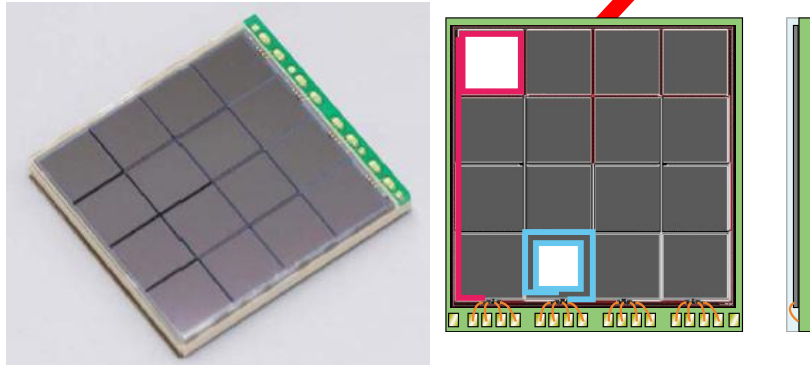


# Through Silicon Via (TSV) technology

## 4-side buttable



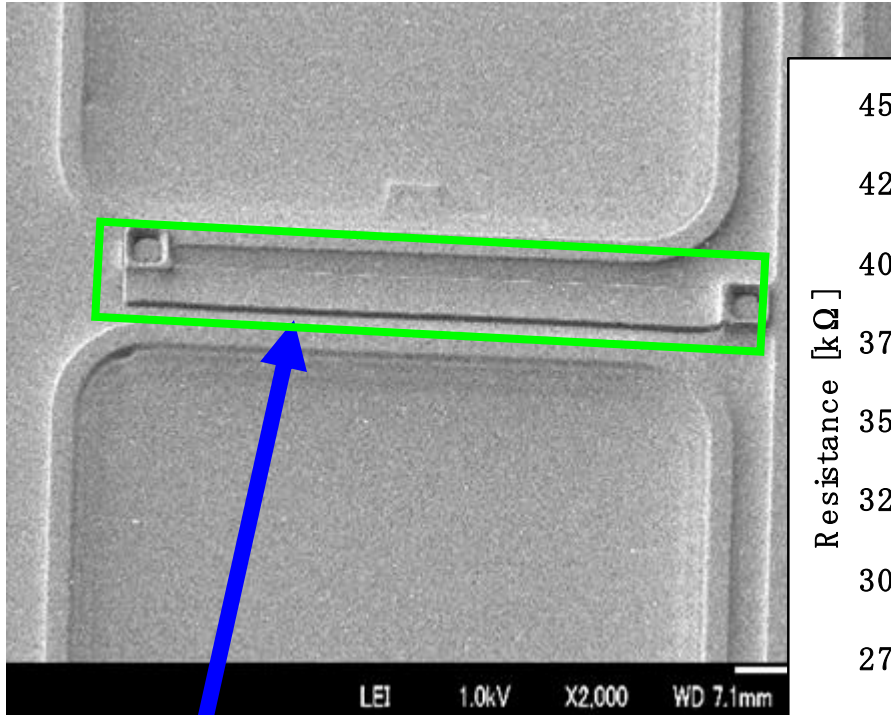
## 3-side buttable



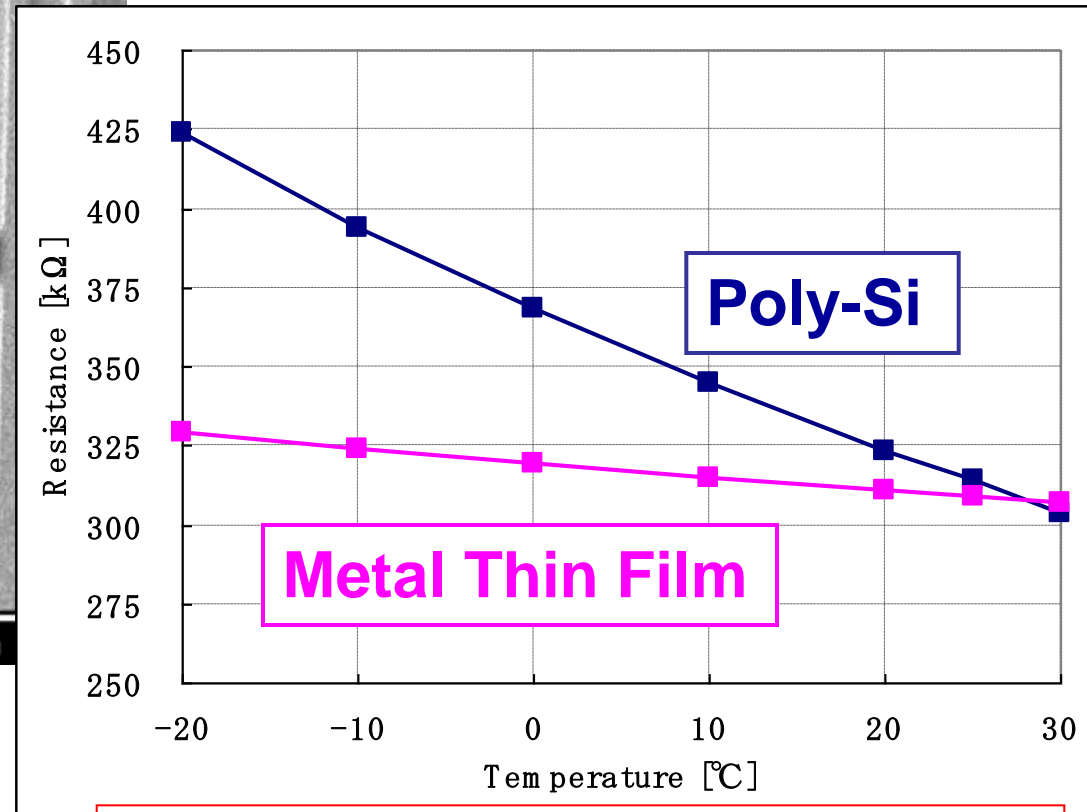
- No trace
- No wire bonding pad

pad

# Metal Thin Film



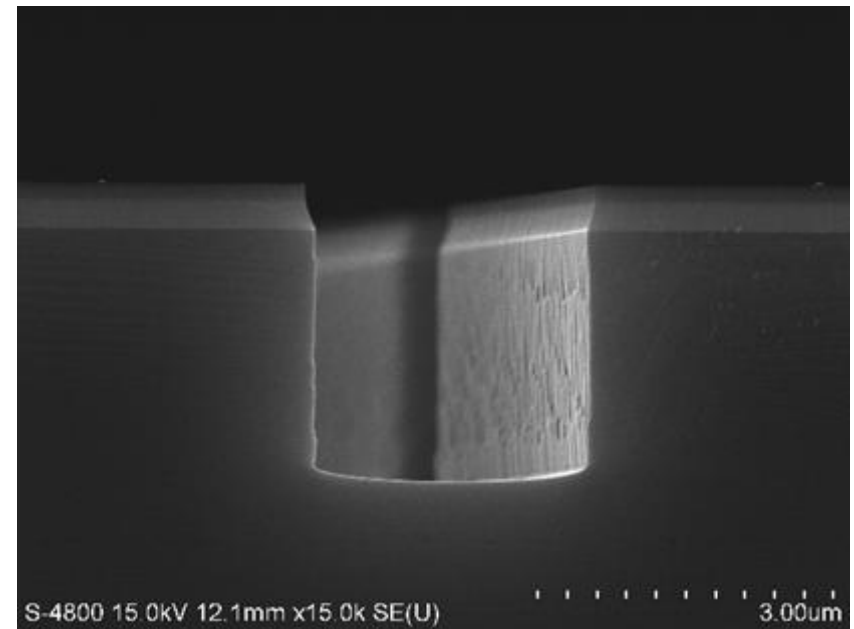
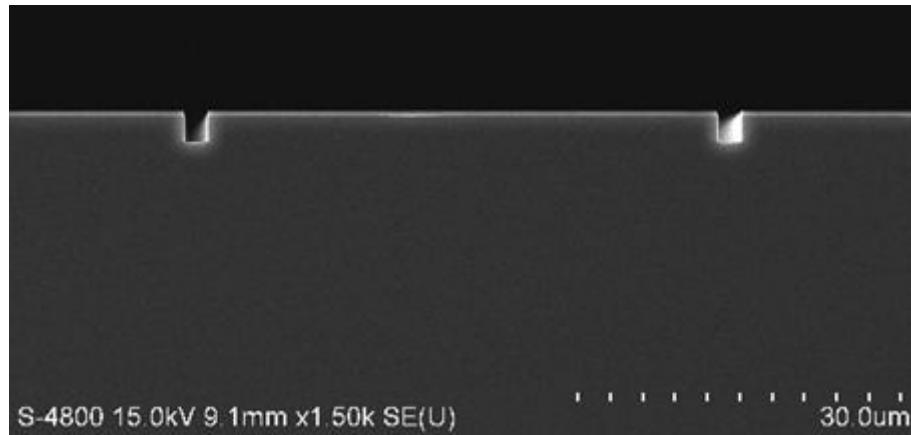
Metal quenching resistor



**Low temperature dependence**

# Base technology - Trench -

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[www.hamamatsu.com](http://www.hamamatsu.com)