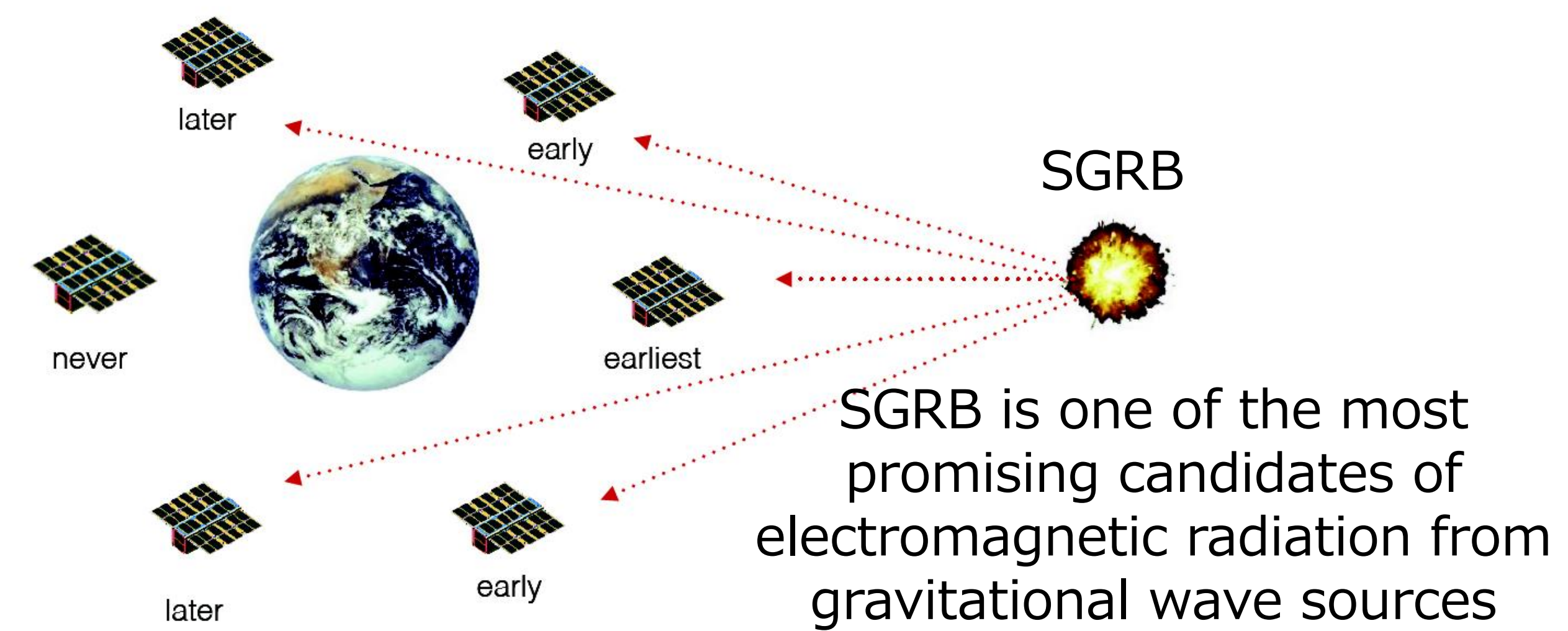
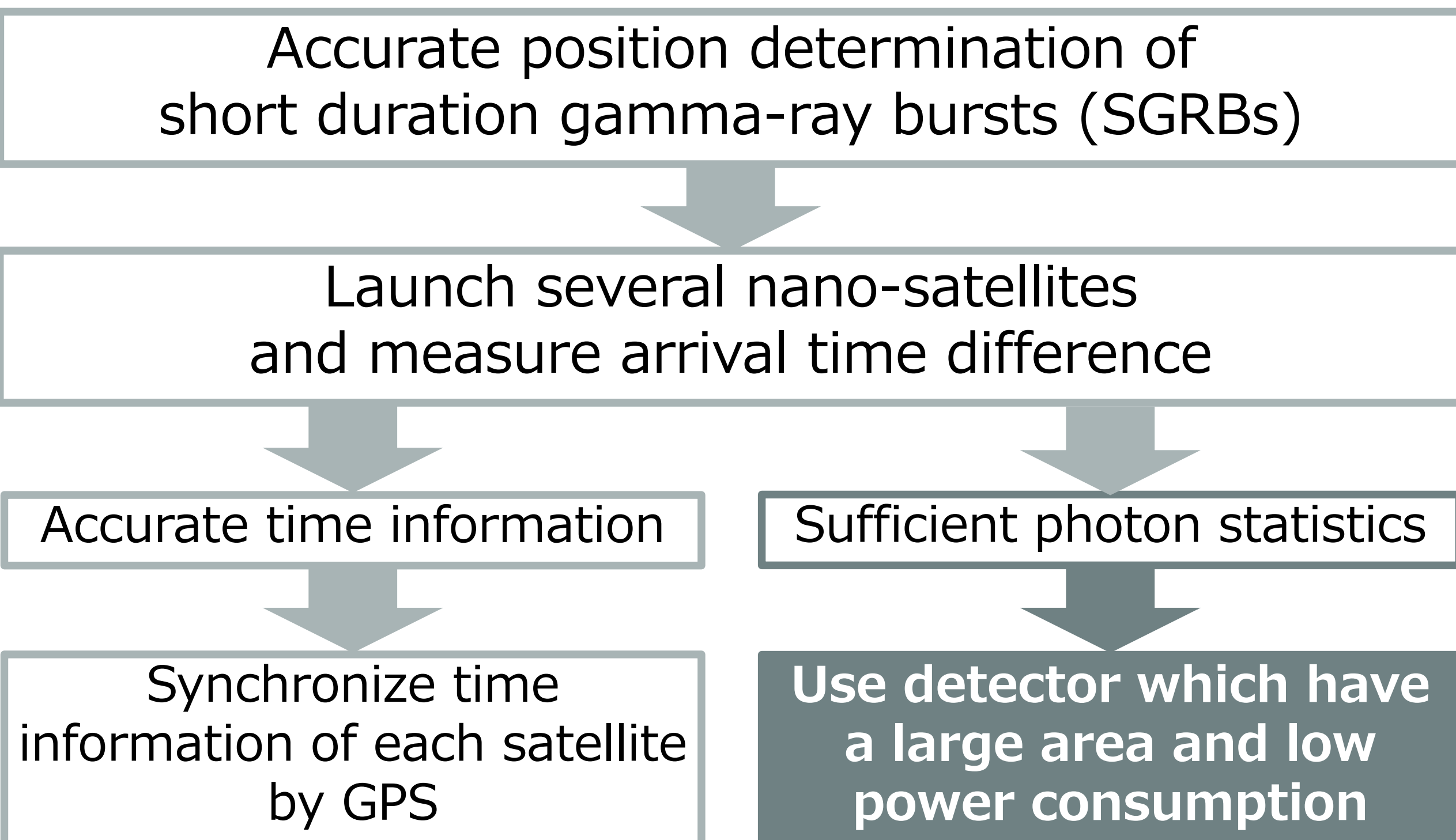


Performance Study of Large CsI (TI) Scintillator with MPPC Readout

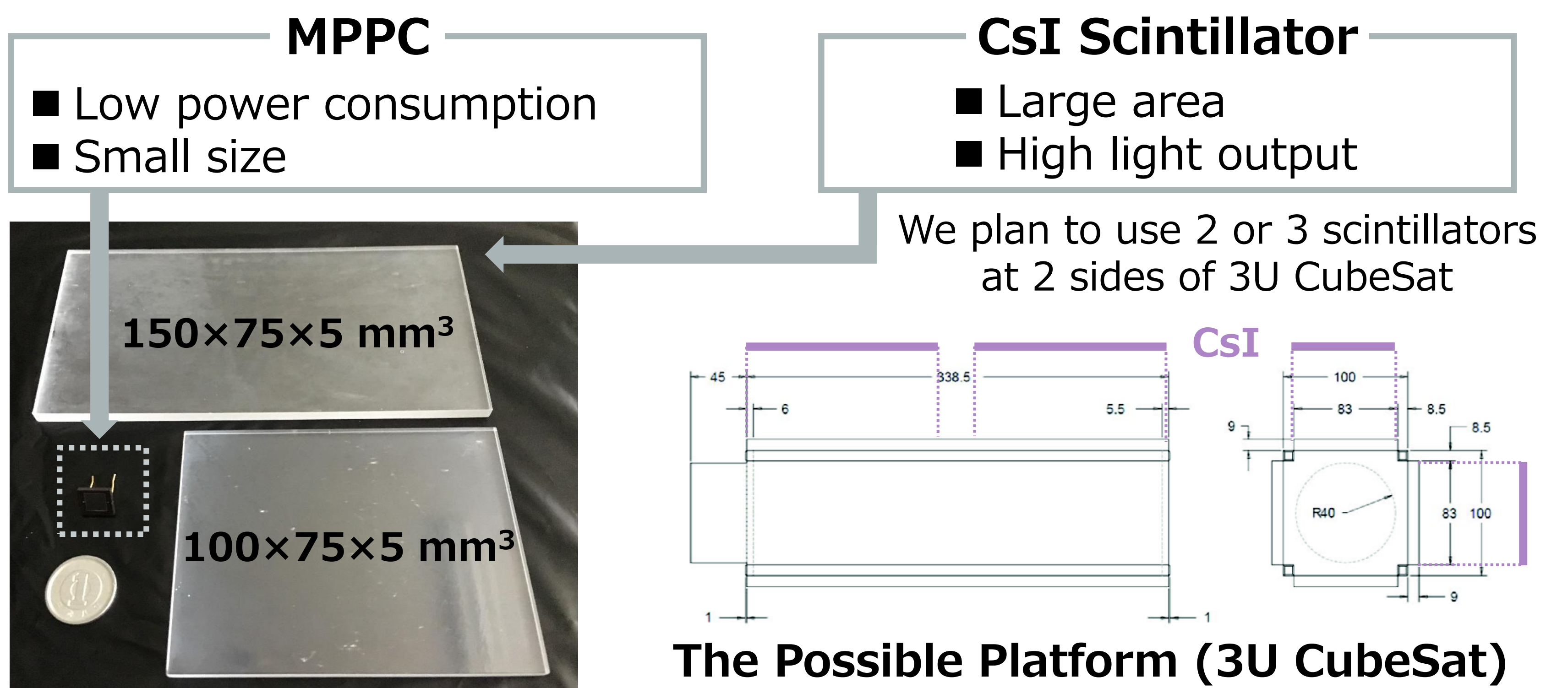
Kento Torigoe, Yasushi Fukazawa, Tsunefumi Mizuno, Hiromitsu Takahashi, Ohno Masanori, Koji Tanaka, Nagomi Uchida (Hiroshima U.), Norbert Werner (MTA-Eotvos U./Masaryk U./Hiroshima U.), Andras Pal, Laszlo Kiss (Konkoly Observatory), Zsolt Frei (Eotvos U.), Norbert Tarcai (C3S LLC), Kazuhiro Nakazawa (Tokyo U.), Teruaki Enoto (Kyoto U.), Hirokazu Odaka (RIKEN), Yuto Ichinohe (Tokyo Metropolitan U.)

We consider nano-satellites for accurate position determination of short duration gamma-ray bursts (SGRBs) by measuring arrival time difference. In order to achieve sufficient photon statistics to precisely measure the arrival time, we plan to use CsI scintillator which has a large area and high light output and multi-pixel photon counter (MPPC) which has a small size and low electricity consumption. We compared light output of two scintillators of different sizes ($150 \times 75 \times 5 \text{ mm}^3$, $100 \times 75 \times 5 \text{ mm}^3$) and found they showed similar light output and archived an energy threshold $< 10 \text{ keV}$. We also found that the uniformity of light output was improved by using 2 MPPCs for readout.

1. Introduction



2. Scintillators and Photodetectors

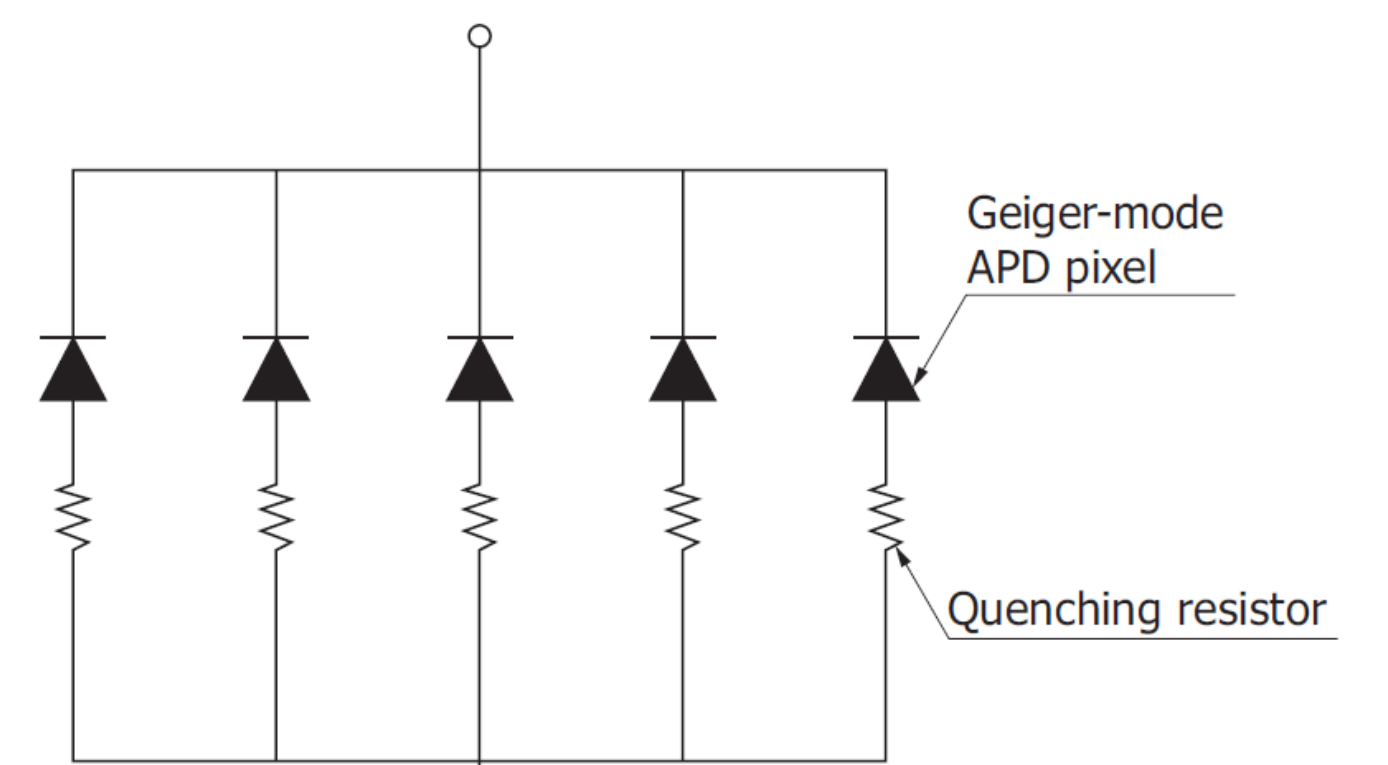


Multi-Pixel Photon Counter (MPPC)

- Photon-counting device using multiple avalanche photodiode
- Output charge is proportional to number of detected photons

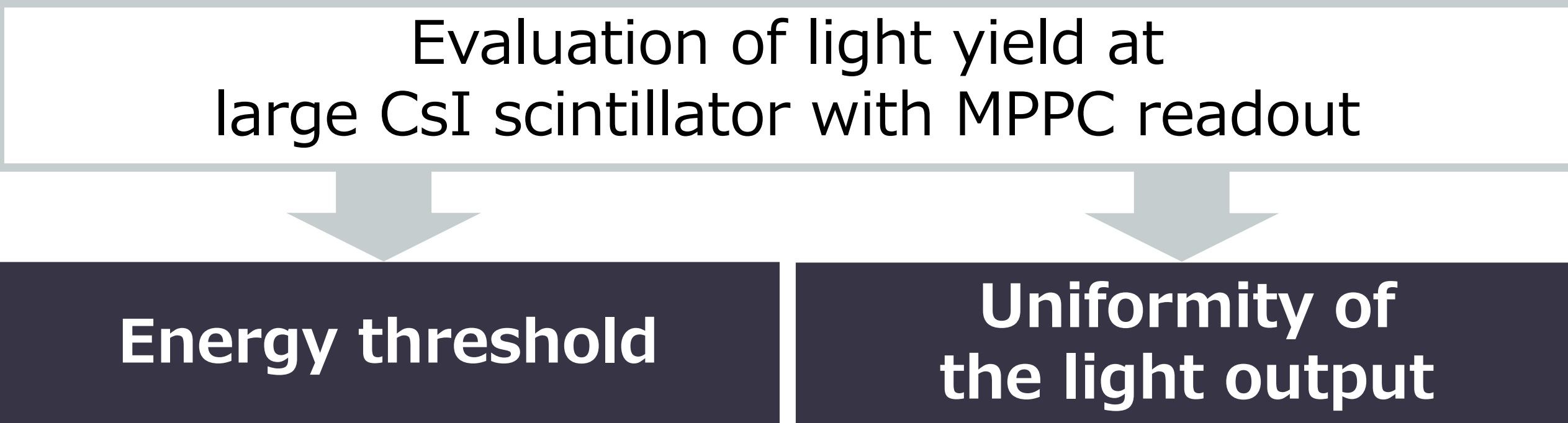
Use S13360-6050CS by HPK (window size: $6 \times 6 \text{ mm}^2$)

We need small and low power consumption photodetectors for nano-satellites



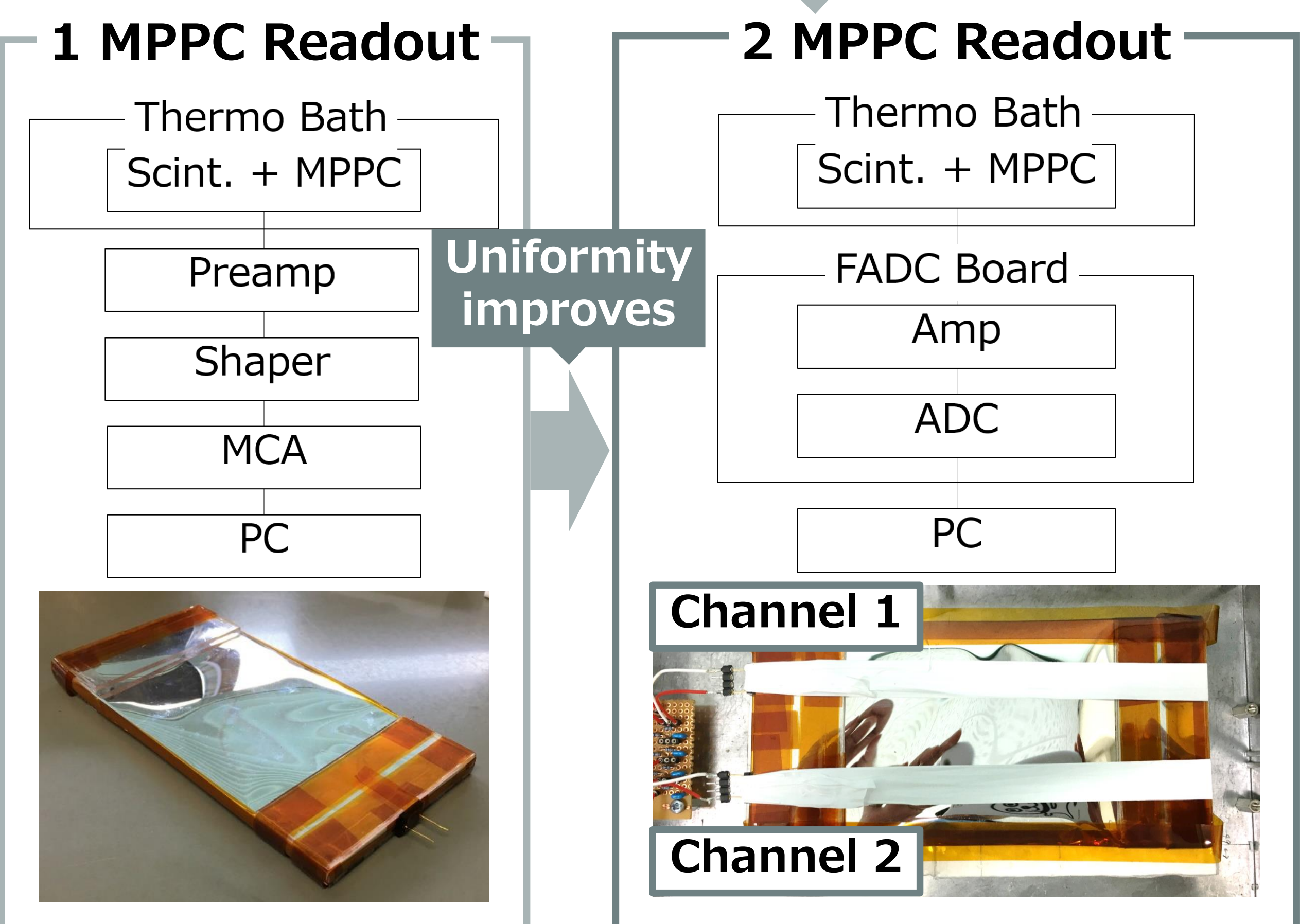
Structure of MPPC

3. Key Parameters



4. Setup

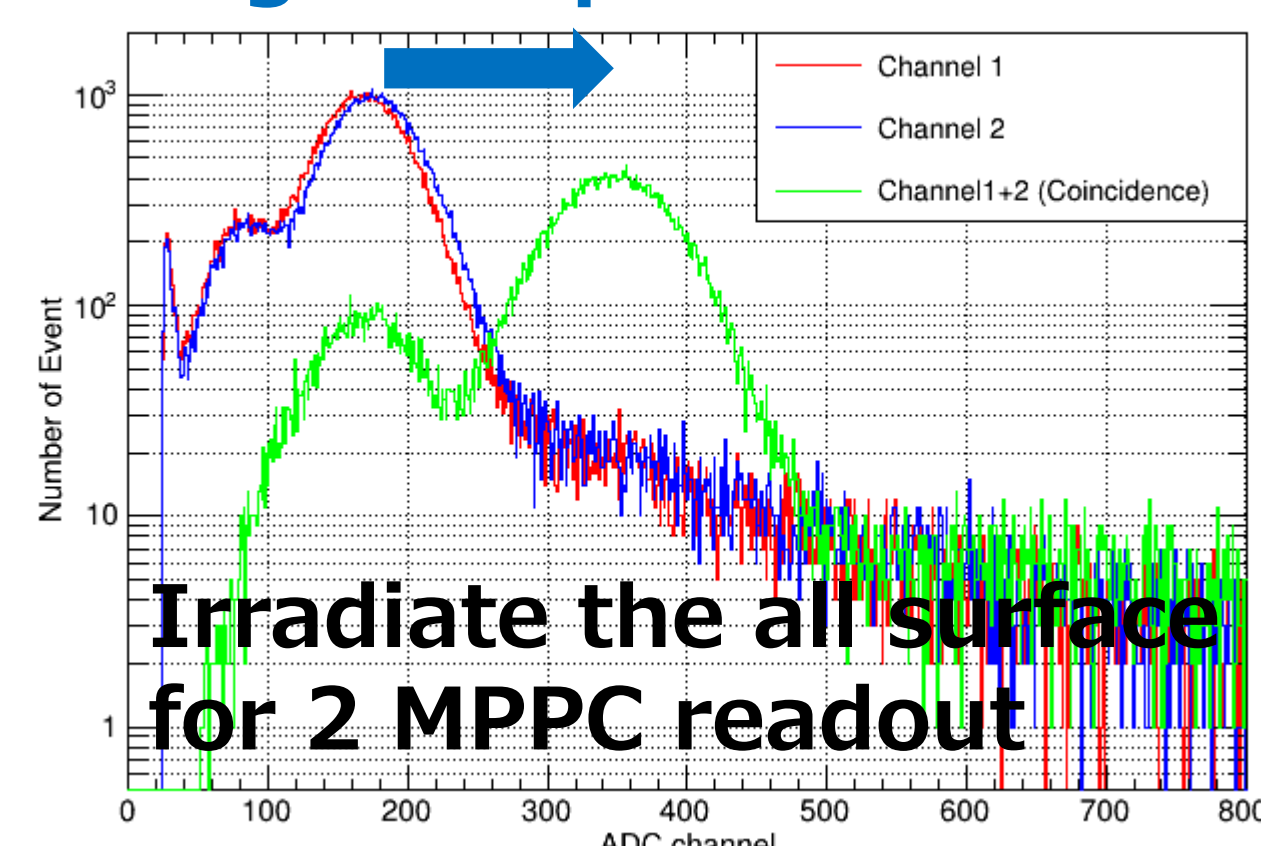
We sum coincidence events at 2 MPPCs



Configurations

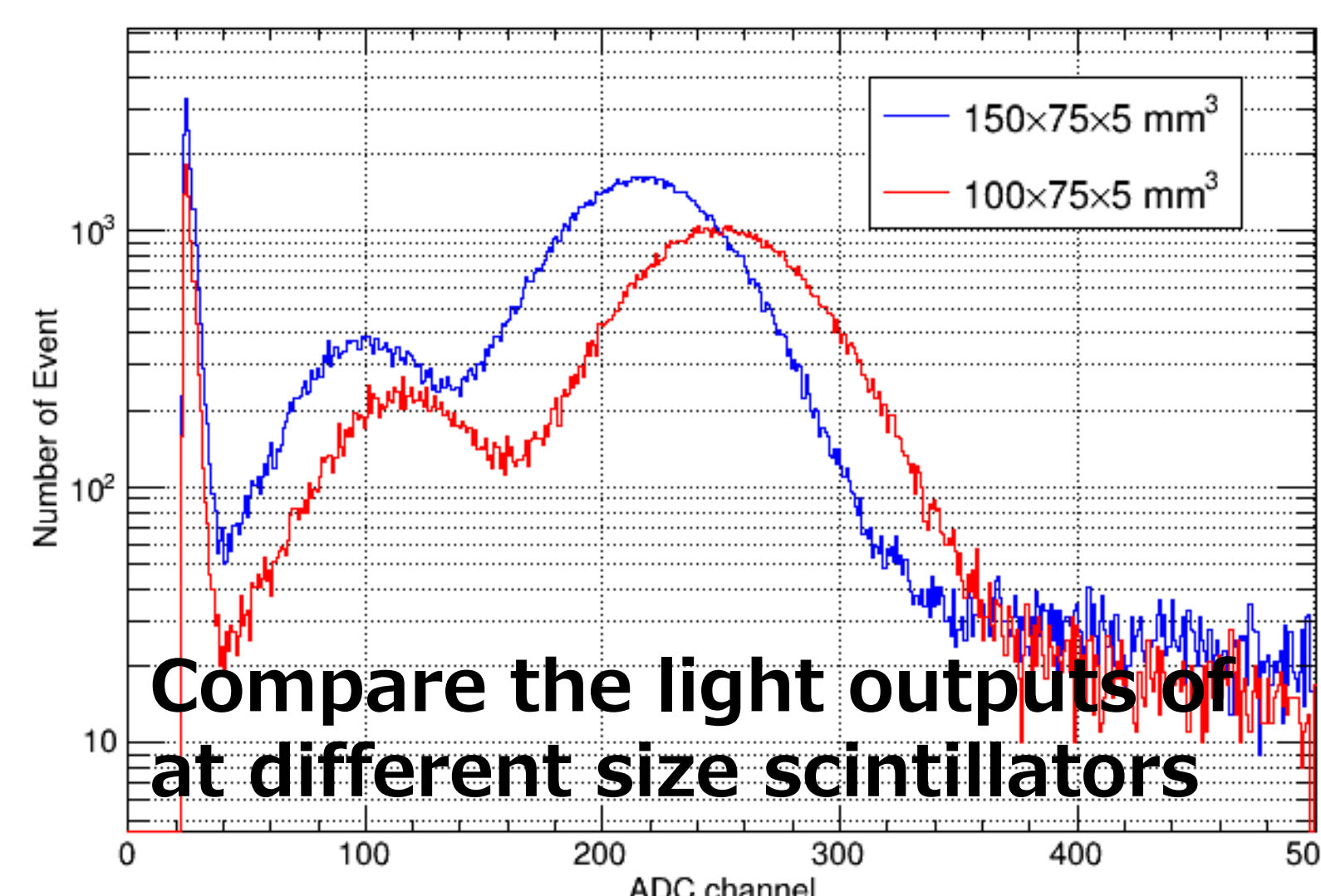
- Shaping time: $1 \mu\text{s}$ (1 MPPC readout), $2.2 \mu\text{s}$ (2 MPPC readout)
- Temperature: $25 \text{ }^\circ\text{C}$
- Operational voltage: 53.4 V
- Breakdown voltage: 50.87 V , 50.82 V
- Radiation source: ^{241}Am (59.5 keV)

Light output 2x

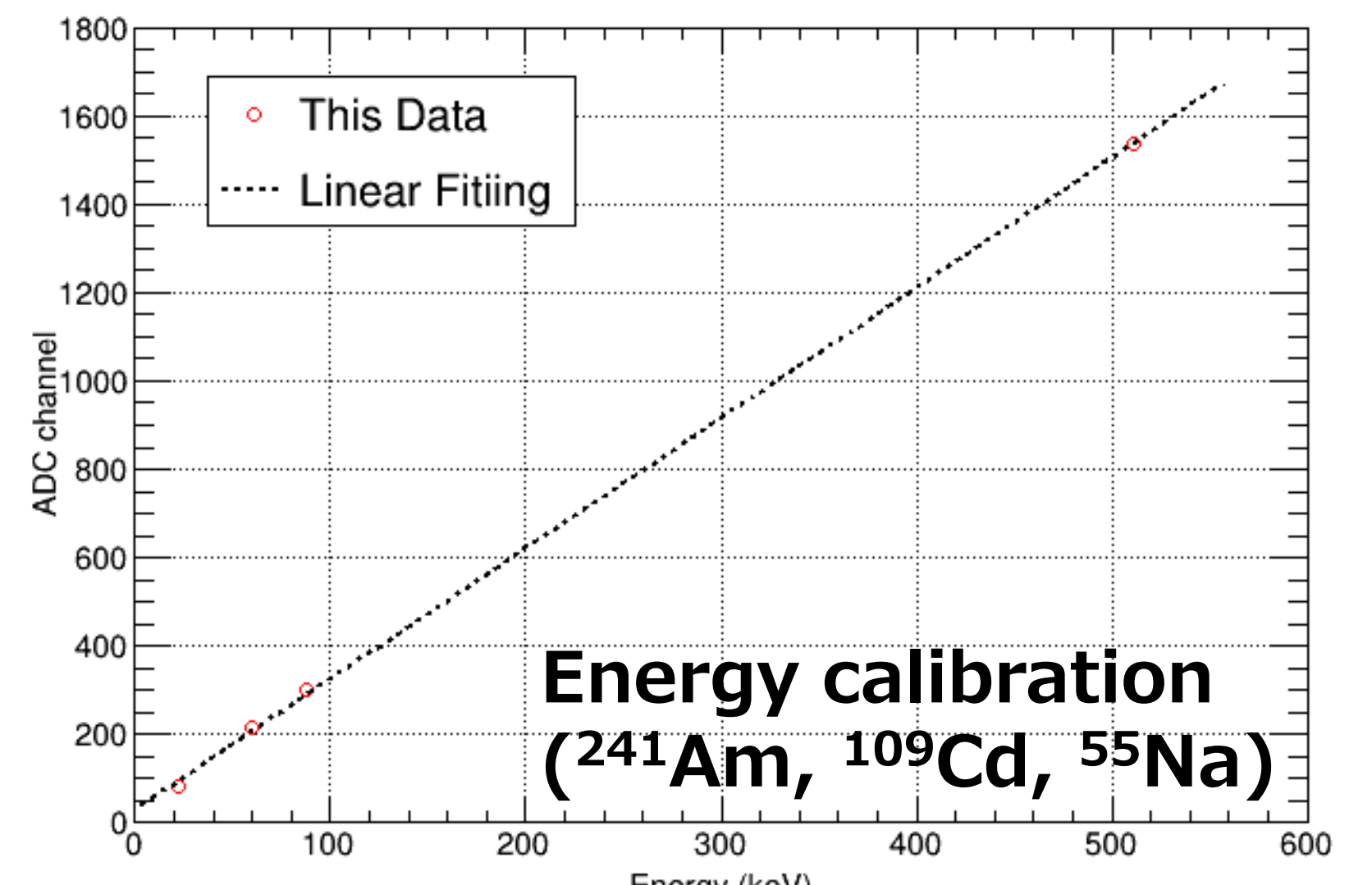


Red and blue are outputs from each MPPC
Green is sum of them

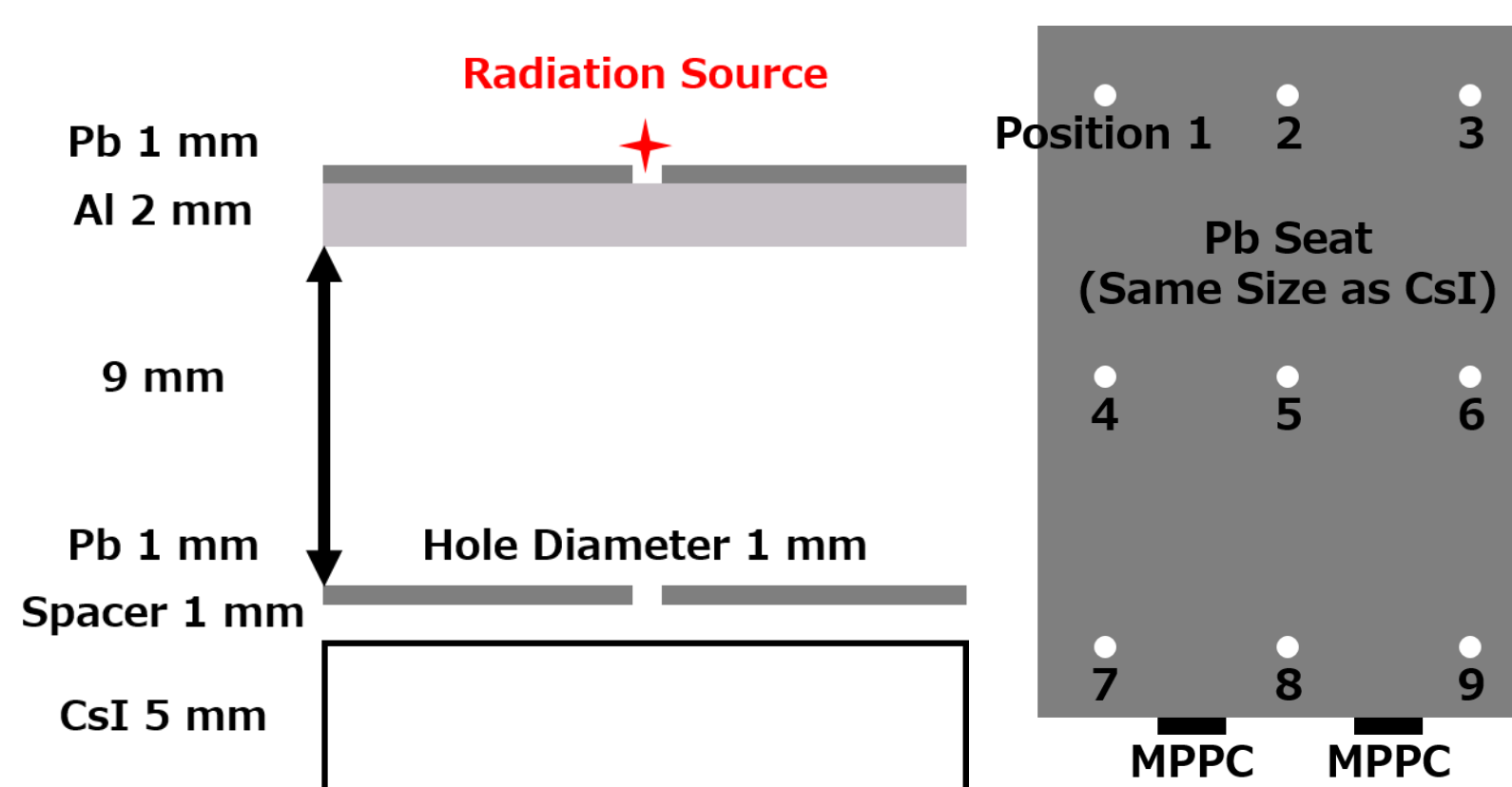
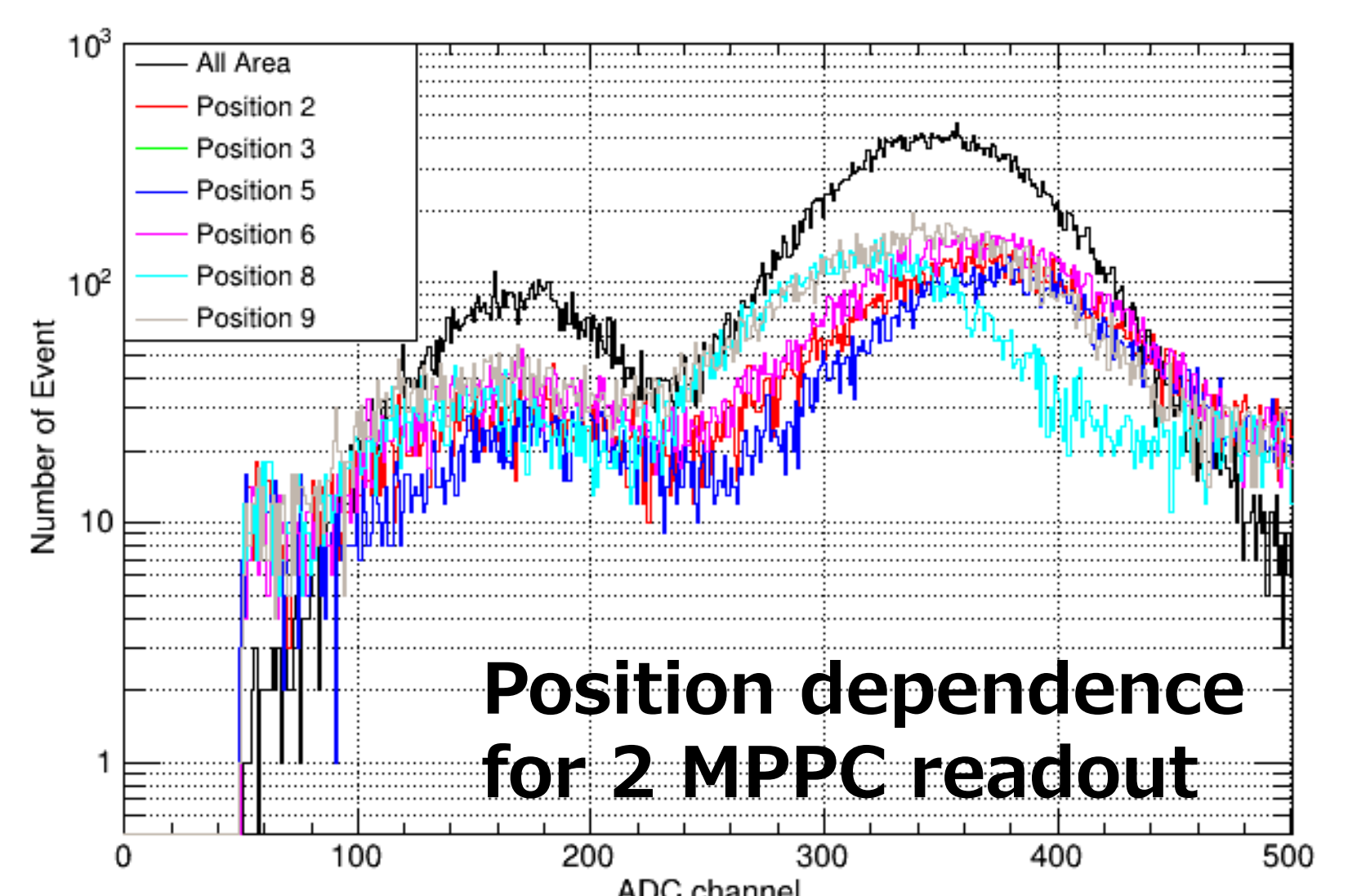
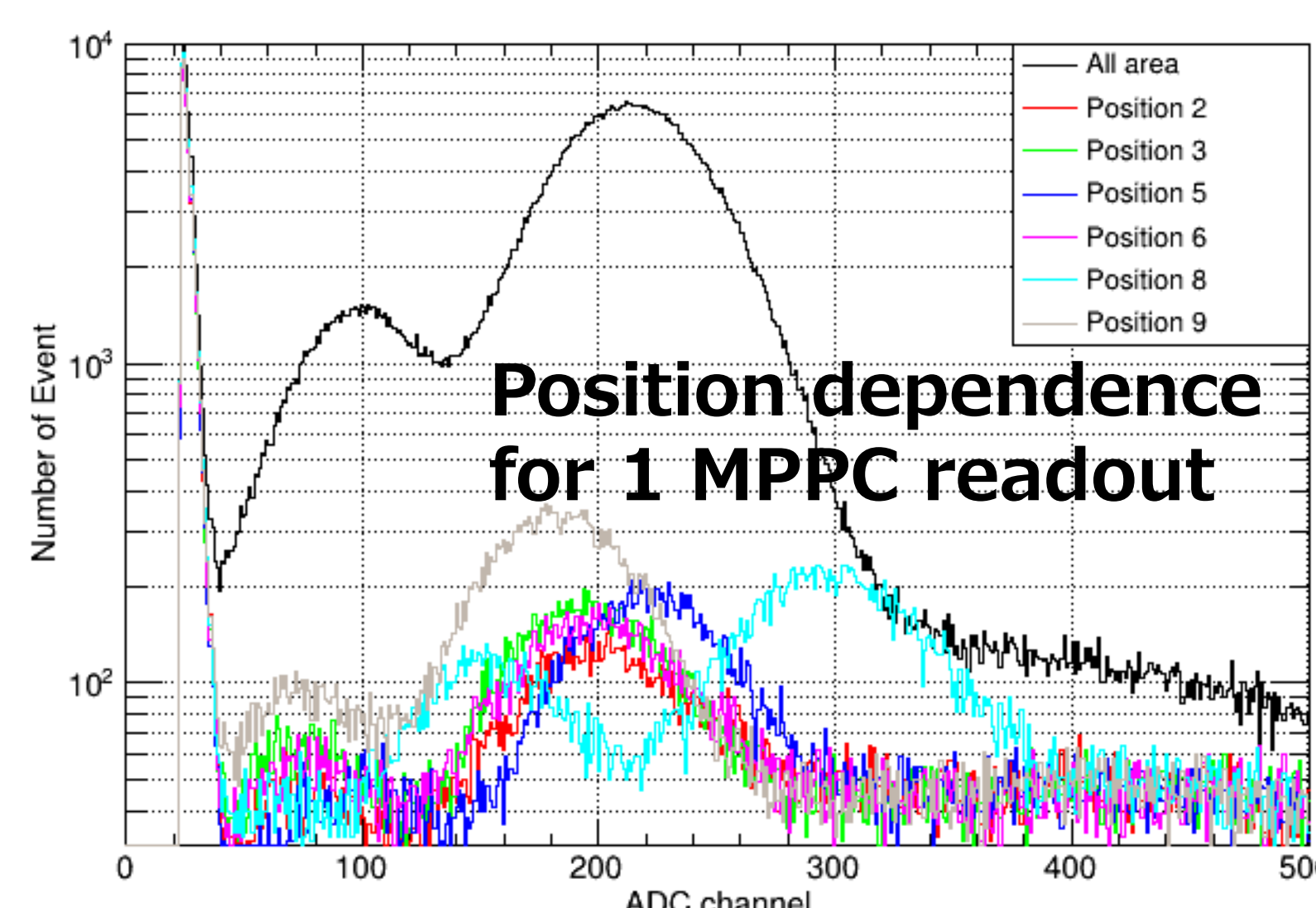
5. Result



Scintillator size ratio: 33 %
Difference in the light output: 13 %
→ Use bigger one



Energy threshold: $< 10 \text{ keV}$
Target value: $\sim 100 \text{ keV}$
→ Achieved low energy threshold



To reduce noise rate, we increased the trigger thresholds and summed signals of 2 MPPCs

Peak-to-peak difference of light outputs in 9 positions:
40 % for 1 MPPC readout
15 % for 2 MPPC readout
→ Uniformity improved

Conclusion and Future Works

- Achieved low energy threshold $< 10 \text{ keV}$
- Uniformity improved for 2 MPPC readout

- Detailed measurement of non-uniformity
- Evaluate the energy threshold for 2 MPPC readout (considering noise)