



## **Development of a mosaic type array formed by Si photodiodes for charged-particle detection in heavy ion collisions**

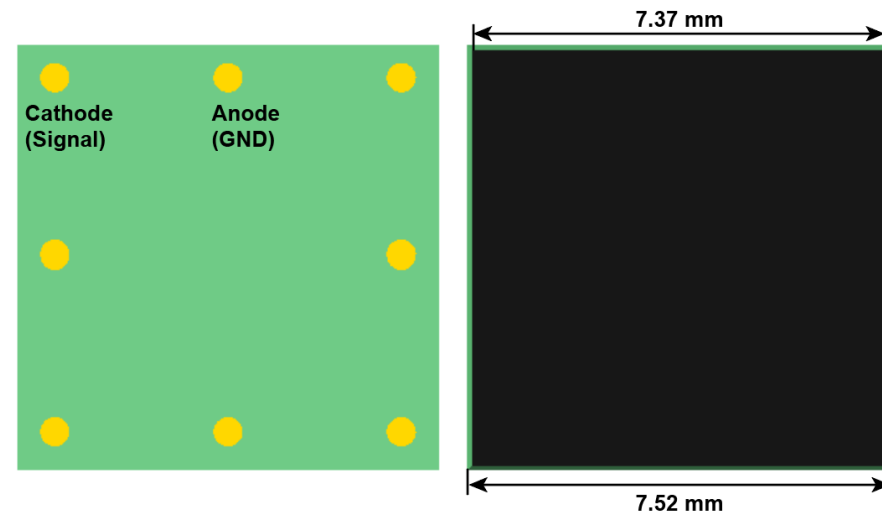
Jiatai Li

*CNS, University of Tokyo*

*RIKEN Nishina Center*

# Motivation

- Si detectors
  - Extensive application in various nuclear & particle physics experiments
- Limitation of conventional Si detector
  - High cost (DSSD)
  - Radiation damage
  - Fixed shape
- Aim: A **low cost, position sensitive, geometrically customizable** Si array
  - Hamamatsu S13955-01
    - 3000 JPY
    - Small size
      - photo sensitive area:  $7.05 \times 7.05 \text{ mm}^2$
    - Back-placed electrodes

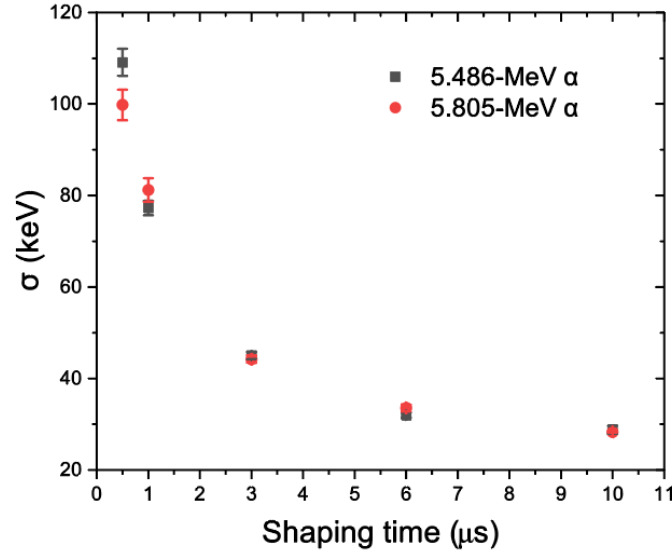


# Characteristics of Hamamatsu S13955-01

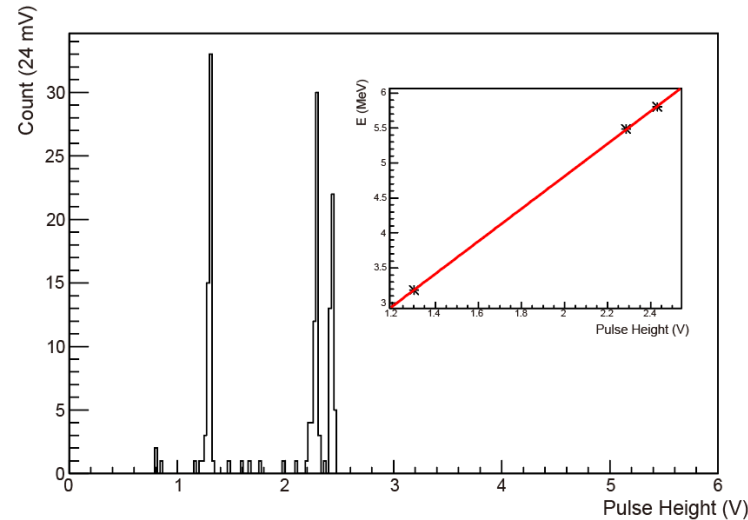
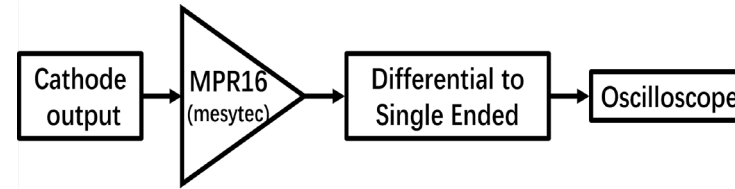
## Intrinsic energy resolution

- Long shaping time
- Best resolution

$\sigma \sim 30$  keV



## Dead layer

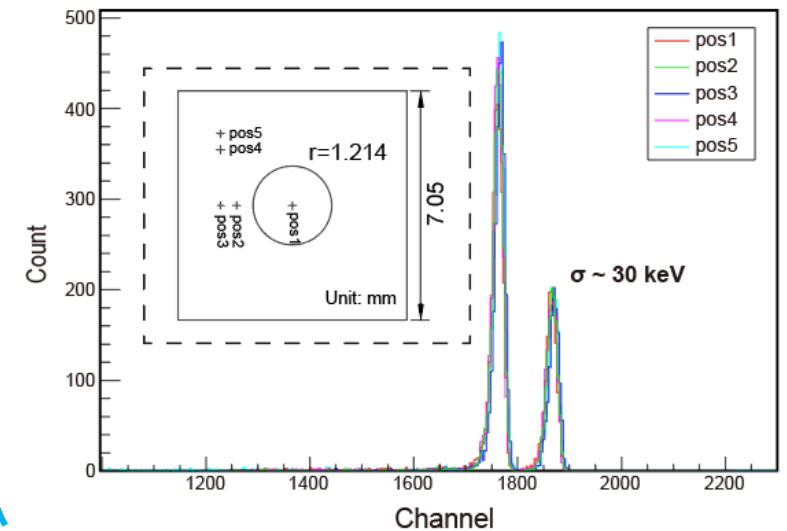


- Thickness of the dead layer:  
 $1.1 \pm 0.1 \mu\text{m}$

## Intrinsic position uncertainty

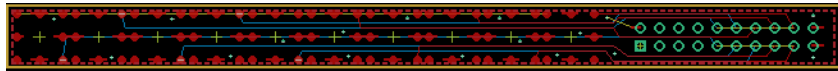
- Measured using a collimator
- Maximum deviation of peak center

$\sim 15$  keV



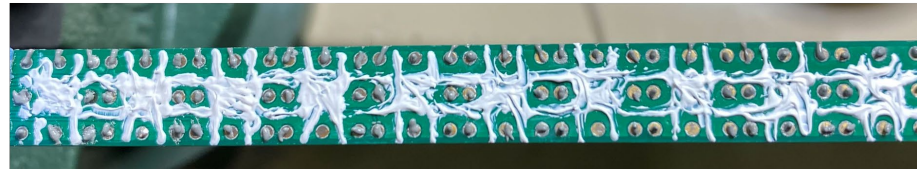
# Detector Development

- Readout PCB
  - 10 slots
  - Common GND
  - 2 layers of signal lines

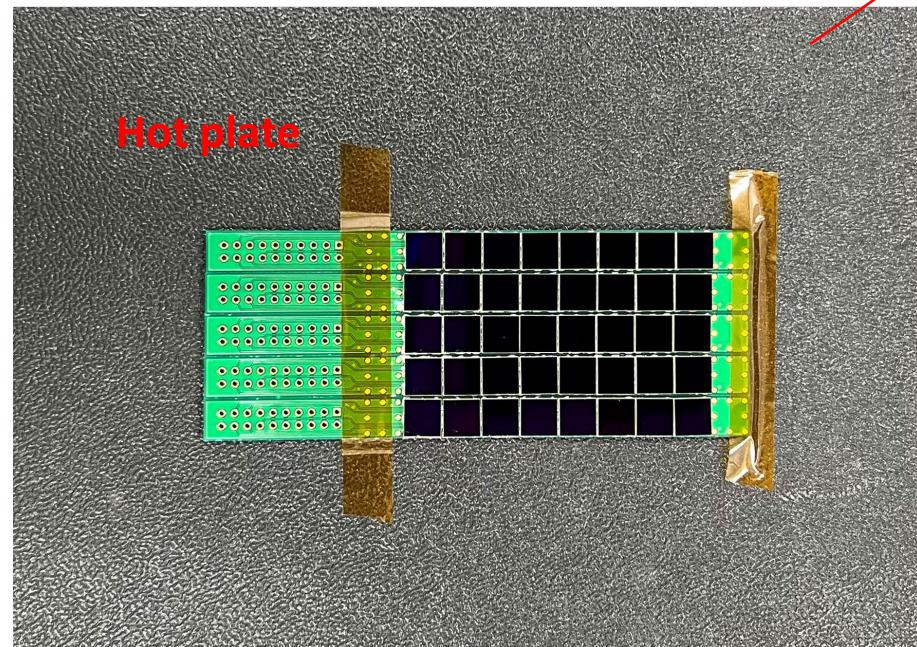


- Reflow soldering
  - Lead-free cream solder (grey) and slow curing adhesive (white)
  - Easily performed using a hot plate
  - Optimized temperature condition:
    - Pre-heat until 230 °C
    - Take out PCBs 30 s after last step

(a)



(b)



(c)

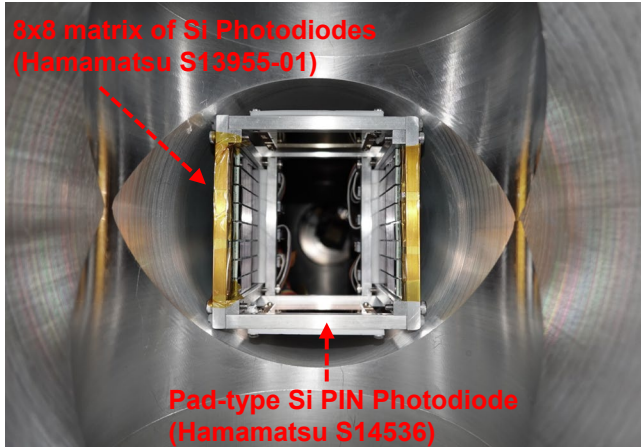


30s

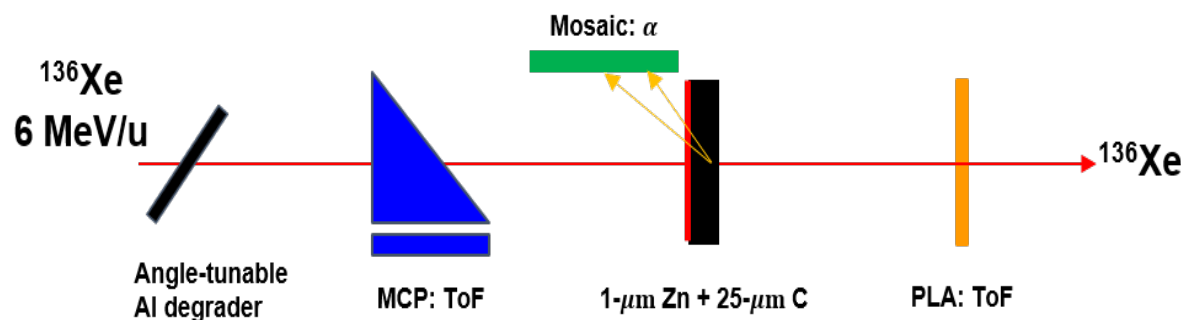


# Commissioning Experiment

- Constructed array
  - 128 photodiodes

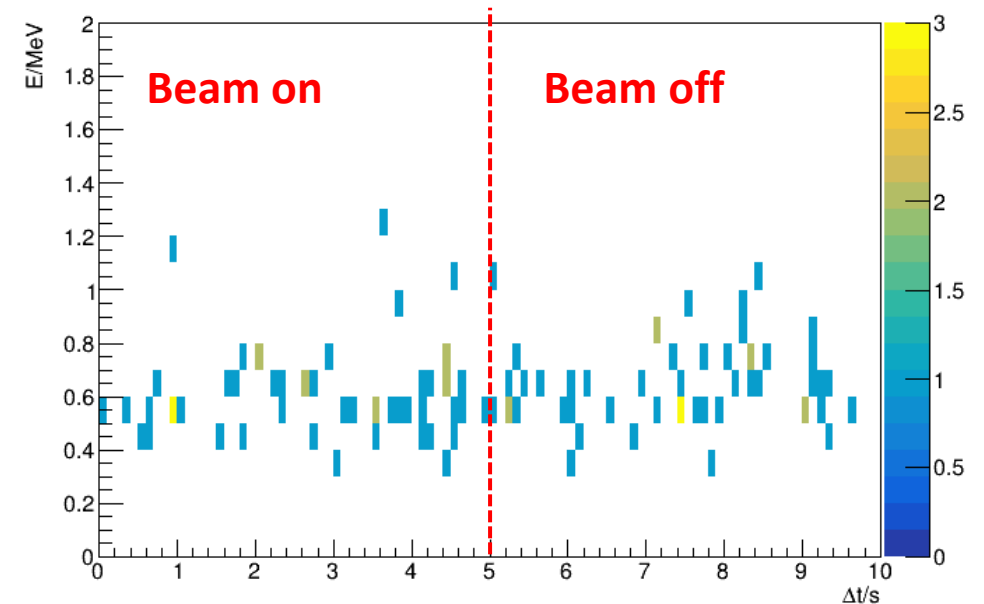


- Experimental setup
  - $^{136}\text{Xe} + \text{natZn}$  reaction @HIMAC



- Result

- The detector and DAQ was operated with the beam intensity up to  $4 \times 10^8$  ppp
- Both prompt and delayed  $\alpha$  particles were successfully measured



# Summary

- Hamamatsu S13955-01, originally designed for X-ray detection, was proven to be also effective for charged particle detection
- The characteristics of the photodiode has been studied thoroughly
- A mosaic type Si array was constructed and commissioned, revealing following advantages:
  - Low costs
  - Easy to fabricate
  - Operative against high-intensity beam
  - **High modularity**
- Features above make it a preferred choice for various nuclear physics experiment, especially for the budget-limited projects