



JLab Hypernuclear Collaboration Meeting 2021

# Scintillation fiber detector for angle calibration

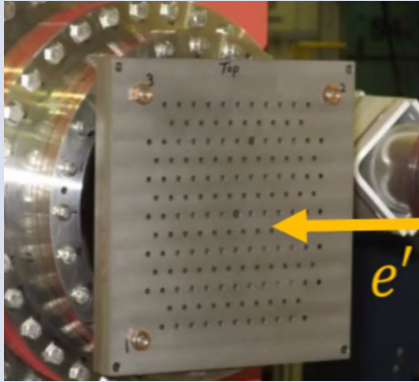
Ryoko Kino

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Dec. 8<sup>th</sup>, 2021

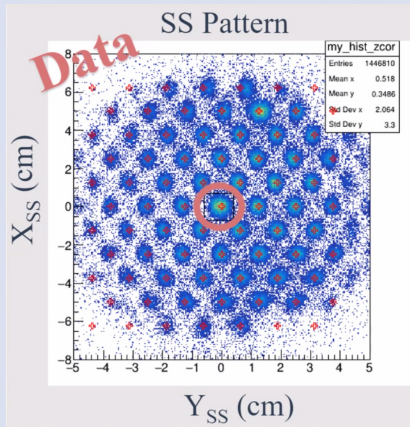
# Benefits of Sci-Fi Sieve Detector

## Passive Sieve Slit



Some drawbacks...

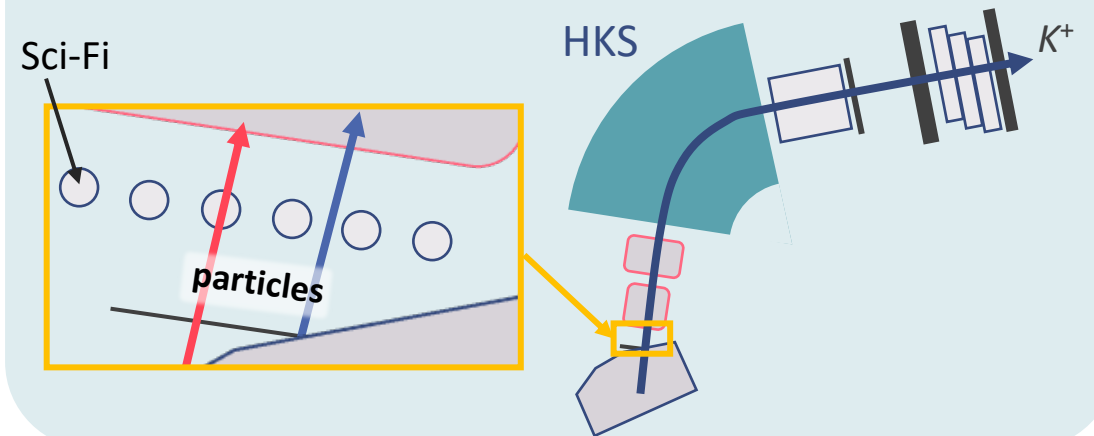
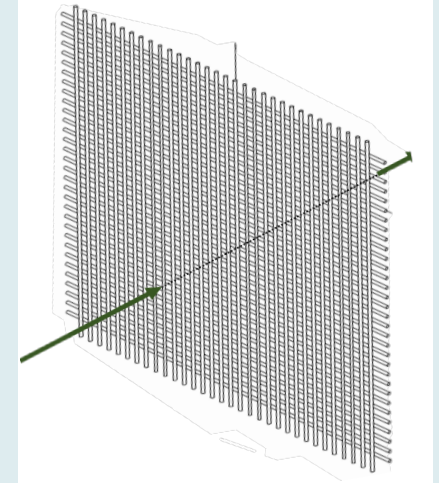
- Only hole position information
- Panch-through events make background.
- If z position changes, the shape of the hole from the particle's perspective changes.



## Sci-Fi Sieve Detector

- High detection efficiency
- High accuracy
- Regardless of z position
- Also use as veto counter

T. Gogami, Hall-A weekly meeting, Dec. 5, 2017



# Consideration for placing a scintillator

Placing some matter near the quadrupole magnet affect the resolution.

Angle distribution of multiple scattering caused by charged particles in a material:

$$P(\theta) \simeq \frac{1}{2\pi\theta_0^2} \exp\left(-\frac{\theta_{\text{space}}^2}{2\theta_0^2}\right) d\Omega$$

$$\left\{ \begin{array}{l} \theta_0^2 = 2 \frac{\chi_c^2}{1+F} \left[ \frac{1+v}{v} \ln(1+v) - 1 \right] \text{rad}^2 \\ \chi_c^2 = 0.157z \left( \frac{Z(Z+1)}{A} \right) \frac{x}{p^2\beta^2} \end{array} \right.$$

path length in a material

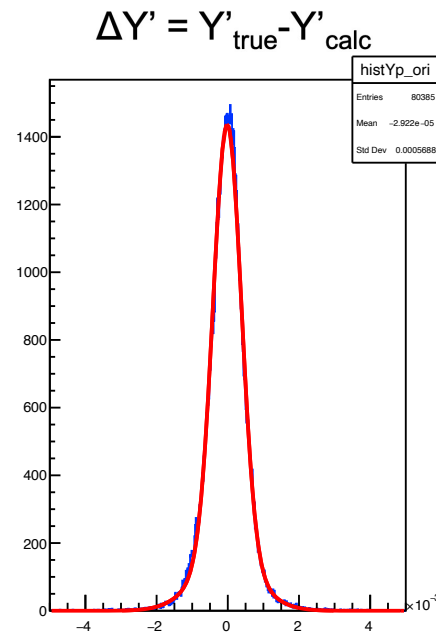
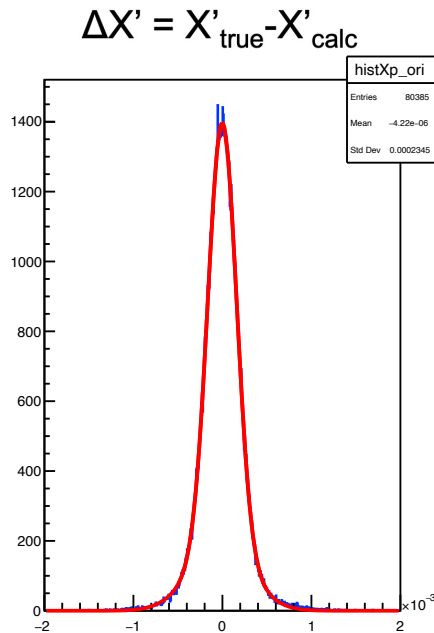
- ◆ The thickness of the scintillator ( $\equiv x$ ) affects the angular resolution due to the effect of  $\sqrt{x}$ .

# Simulation by GEANT4

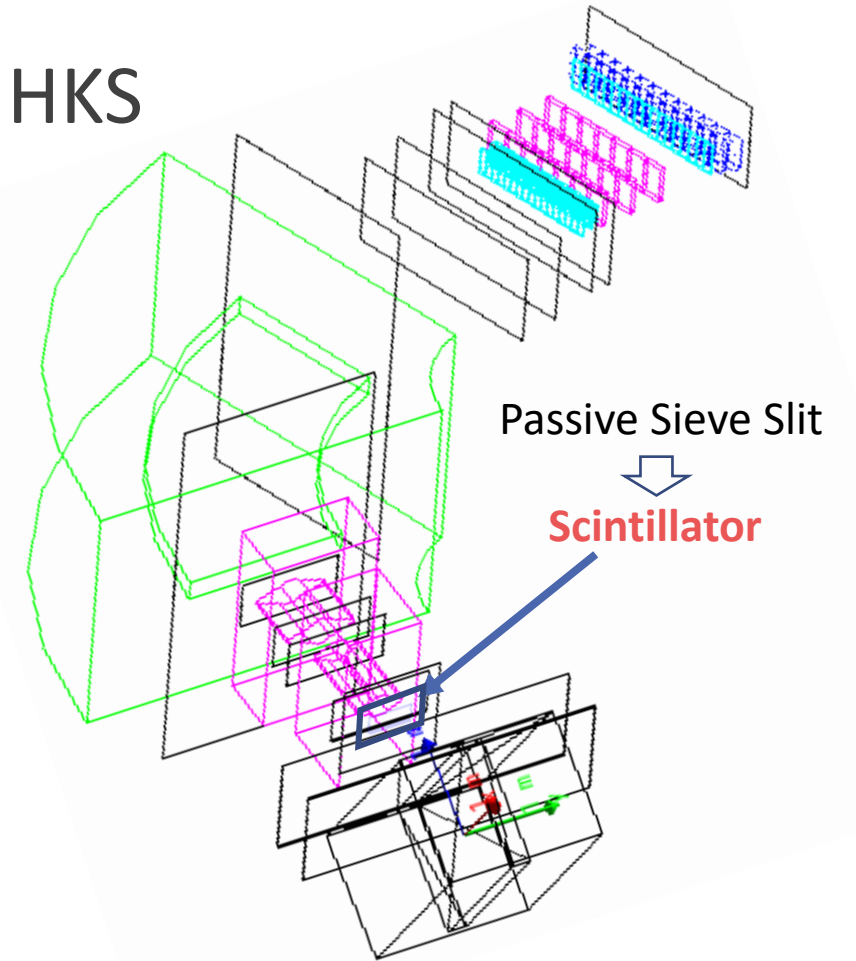
- ◆ Is it possible to replace Sieve Collimator with Sci-Fi Sieve Detector?

Replace Sieve Slit with a scintillation plate on HKS side

→ Deterioration of the position resolution at the target with the Sci-Fi sieve detector.



HKS



# Effect of the scintillator

Result of the simulation:

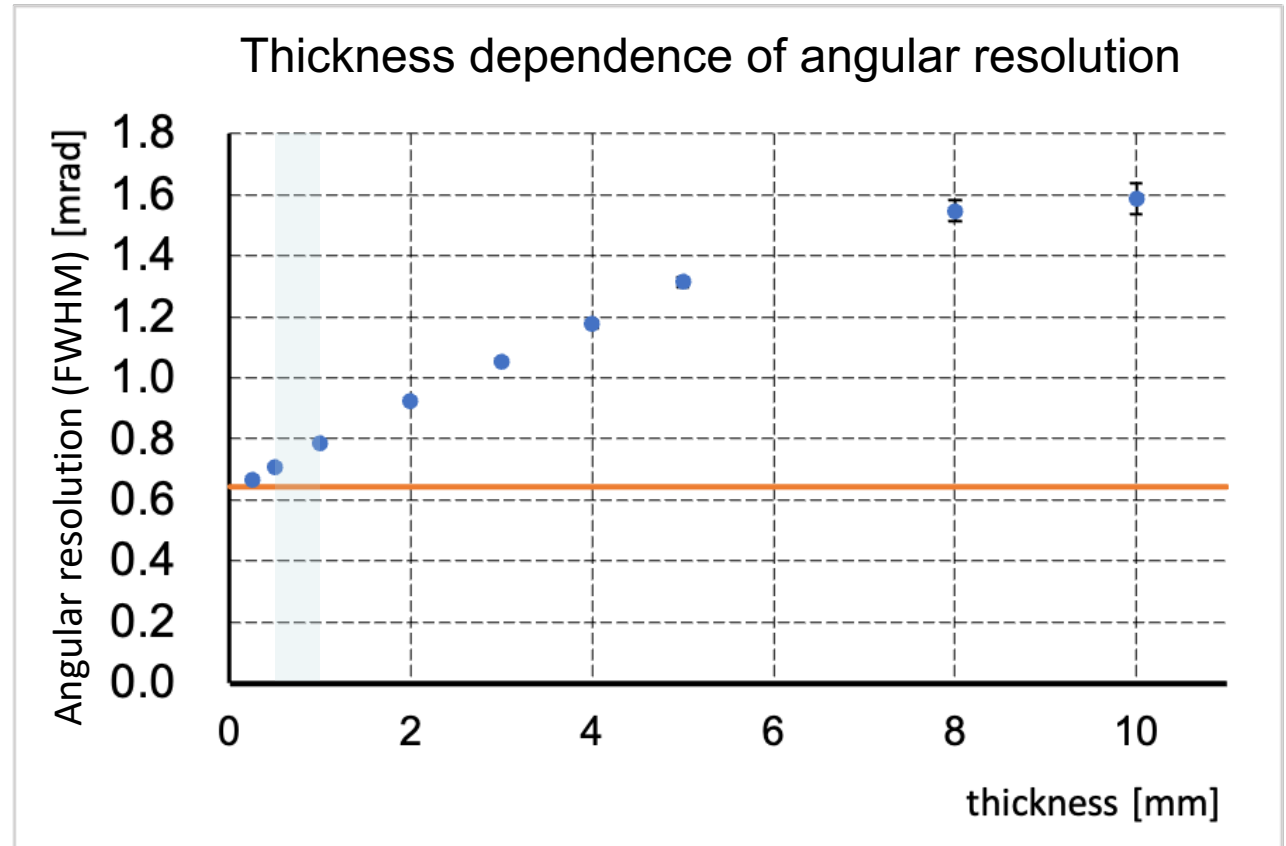
We can see the effect of energy loss and multiple scattering.

Resolution(FHWM)

0.71 mrad at thickness = 0.5 mm

0.79 mrad at thickness = 1.0 mm

It contributes less than the effect of the spectrometer.



— : w/o scintillator

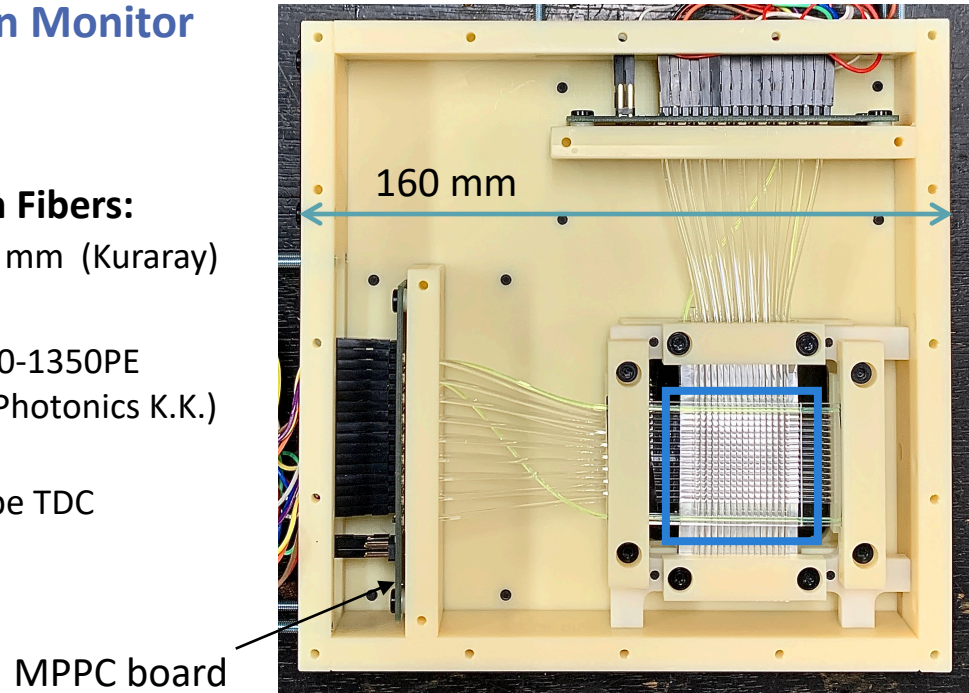
# Operation check of Sci-Fi detector

Developed a Sci-Fi detector to monitor the ELPH photon beamline

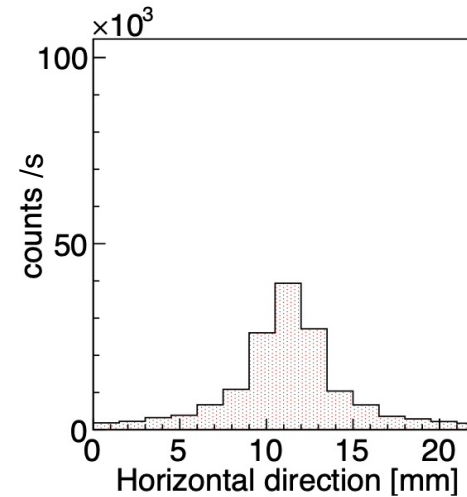
## Beam Position Monitor

### Basic Structure

- **Scintillation Fibers:**  
SCSF-78  $\phi$ 1.5 mm (Kuraray)
- **SiPM:**  
MPPC S13360-1350PE  
(Hamamatsu Photonics K.K.)
- **DAQ:** HUL  
streaming type TDC

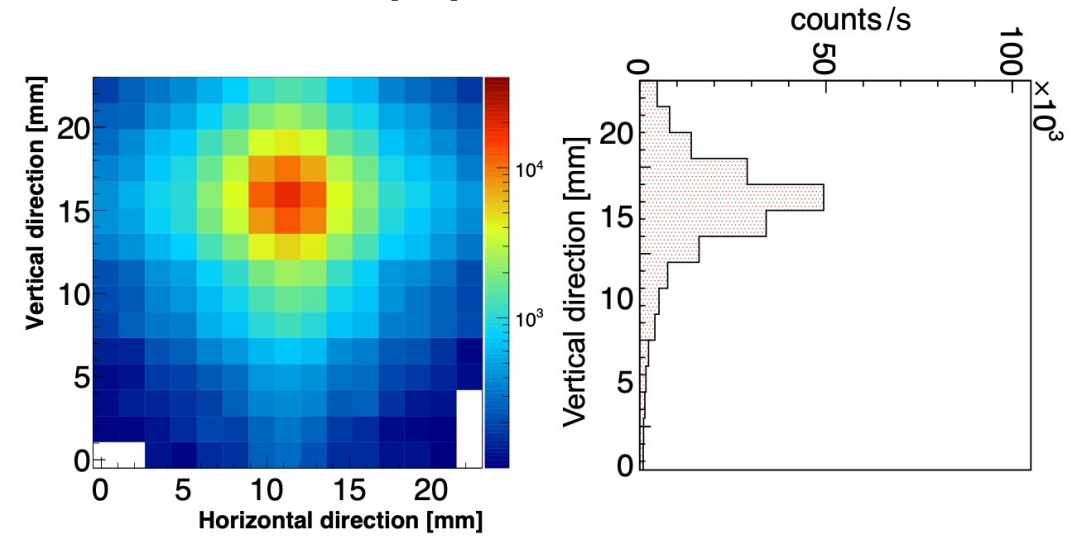


- ✓ Number of photoelectron  $\sim$  20 photons  
→ Estimated value of NPE is  $\sim$ 7 photons when using 0.5 mm fiber



Hit distribution /1.0 sec

beam current: 0.5 [mA]  
bias voltage: 55 [V]  
converter: 300 [ $\mu$ m]



# Summary

- ◆ Considering particle position detector using Sci-Fi
- ◆ Simulation
  - The thicker the scintillator, the worse the resolution.
  - Resolution: 0.64 → 0.79 mrad at thickness = 1.0 mm
- ◆ Performance test with the prototype Sci-Fi detector
  - The fiber diameter used is 1.5 mm.
  - Estimator of NPE is sufficient.
- ◆ Future Tasks
  - Simulation: how much it can be used when simulating as a sensitive detector.
  - Prototype test bench that is closer to the actual machine.
  - Examination of SiPM that can be used in a radiation environment.