

Photon position reconstruction

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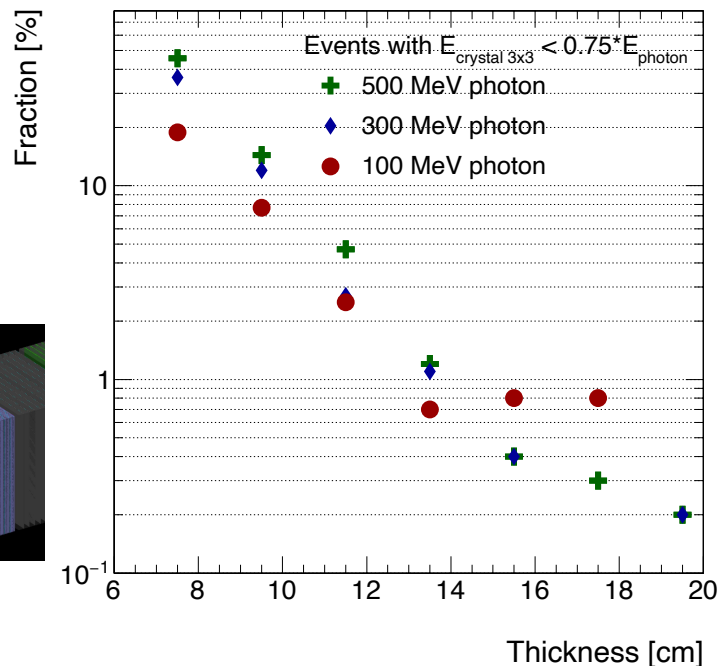
Recap: Soft photon tagging

Thickness scan

- Look at the fraction of events failing to measure 75 % of photon energy in crystal.

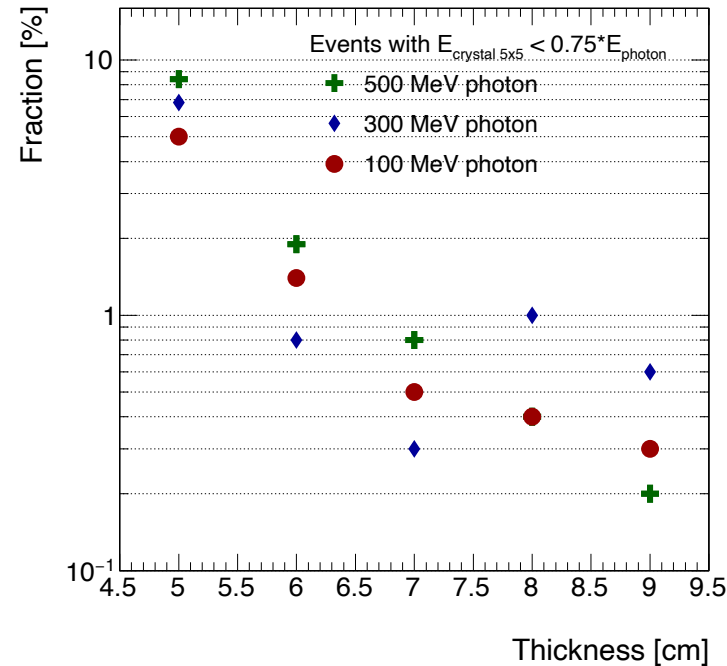
Single crystal layer

3 x 3 towers,
seed = tower with highest energy



Double crystal layers

5 x 5 towers,
seed = tower with highest energy



→ Reasonable choice: 15 cm of crystal for single-layer case.

7 cm of crystals for double-layer case*.

*Note: With a requirement of 20 MeV for a seed tower, the thicker is the better. (backup)

Position reconstruction

- ◆ Requirement:

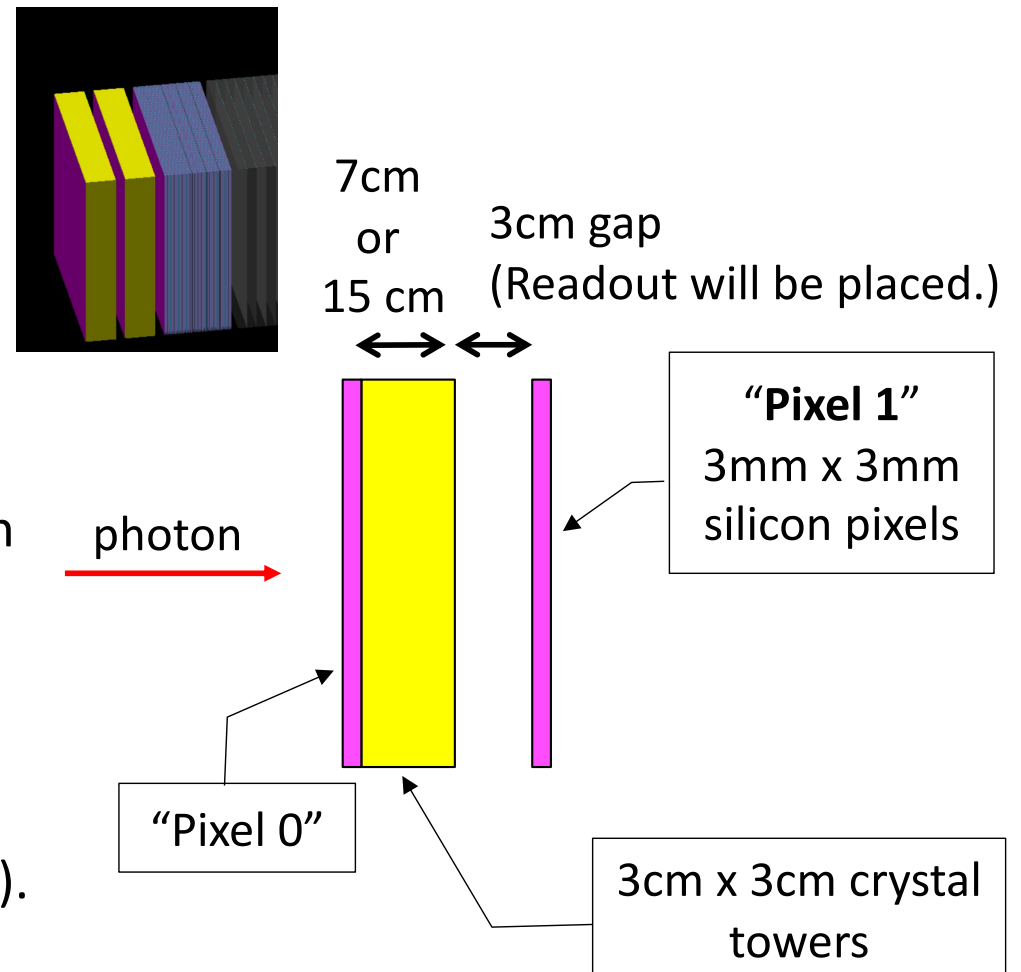
Position resolution of (0.5~) 1 mm ← Meson structure measurements

- ◆ Checked with two setups:

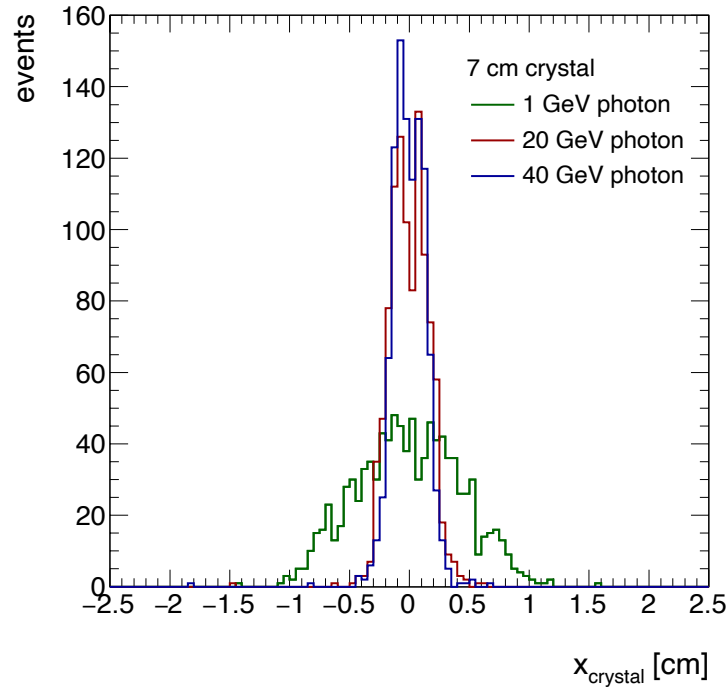
- 7 cm ($7.9X_0$) thickness of Crystal
- 15 cm ($16 X_0$) thickness of Crystal

- ◆ Analyses:

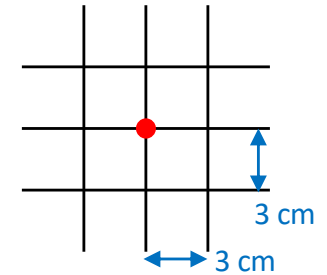
1. Photons are shot at the center of the plane (0,0).
2. Reconstruct the photon position using the 1st crystal layers. Energy weighted mean of 3 x 3 towers → $(x_{\text{Crystal}}, y_{\text{Crystal}})$
3. Look into the pixel cells on the next layer, around $(x_{\text{Crystal}}, y_{\text{Crystal}})$.



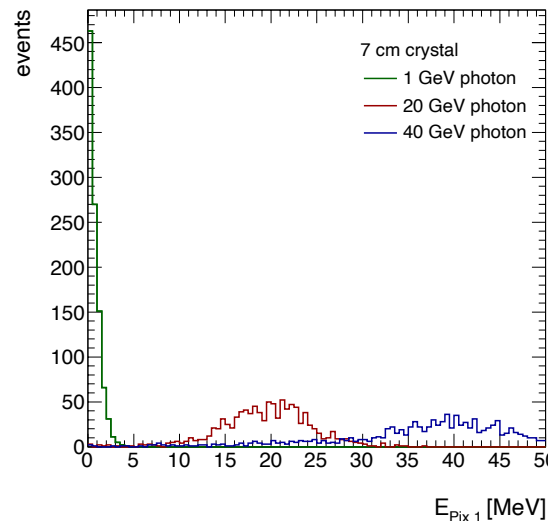
Position reconstructed on Crystal: x_{Crystal}



- ◆ Energy weighted mean in 3 x 3 towers.
- ◆ As the photon is shot on the edge, double peak structure is seen.
- ◆ resolution is \sim a few mm for O(10) GeV photons .



Energy deposits on the Pixel 1 layer



Not enough energy for 1 GeV photons
→ Look into **20 GeV** and **40 GeV** photons only.

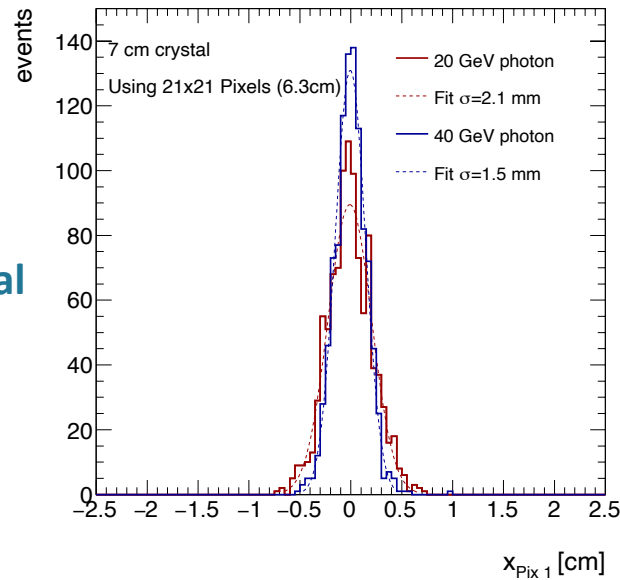
Photon position reconstruction on Pixel 1

Best resolution: 1.1 mm
for

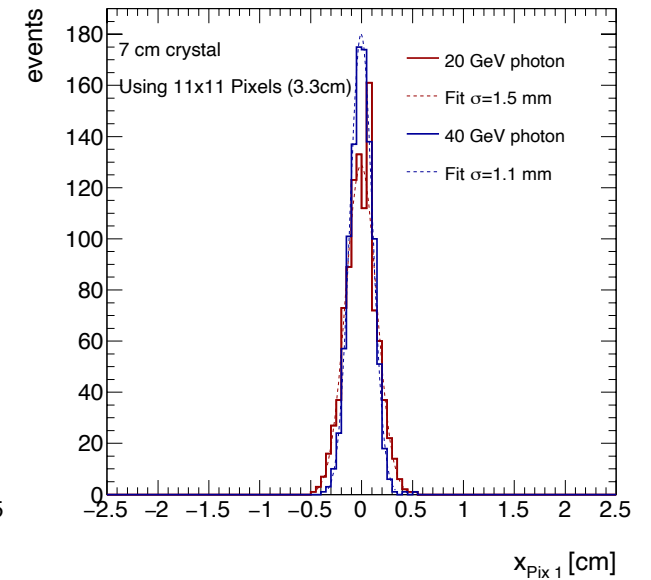
- 40 GeV photon.
- 7 cm thickness.
- in 3.3 cm square.
(11 x 11 chns)

7 cm
crystal

looking at 21 x 21 pixels

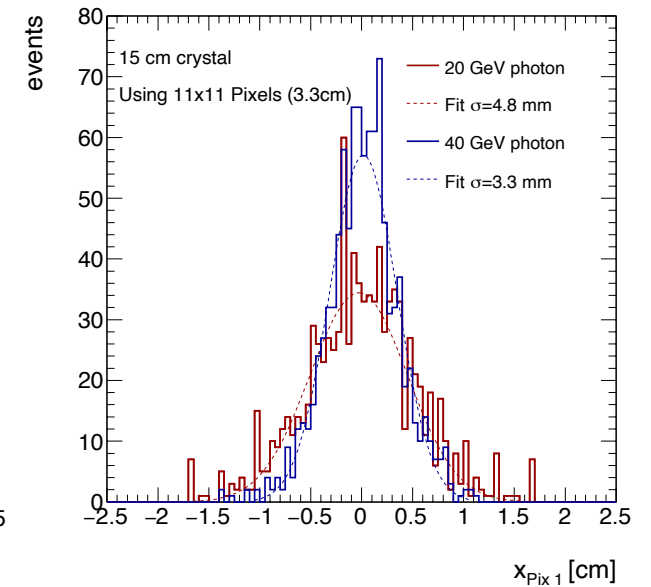
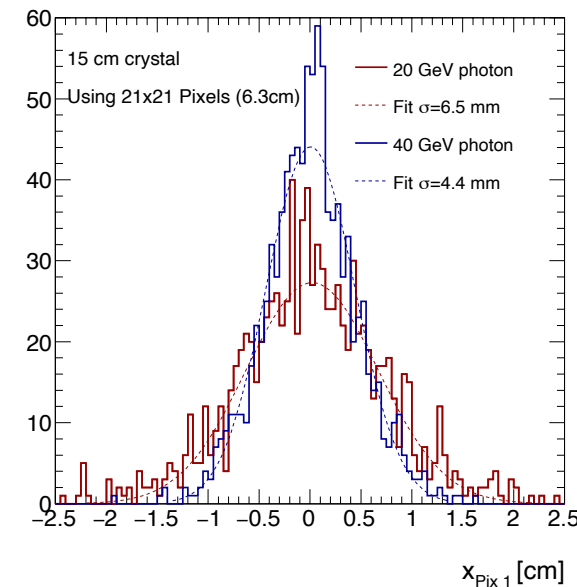


looking at 11 x 11 pixels



- 20 GeV \rightarrow 1.5 mm
- 15 cm thickness \rightarrow 3.3 mm
- 6.3 cm square \rightarrow 1.5 mm
(21 x 21 chns)

15 cm
crystal

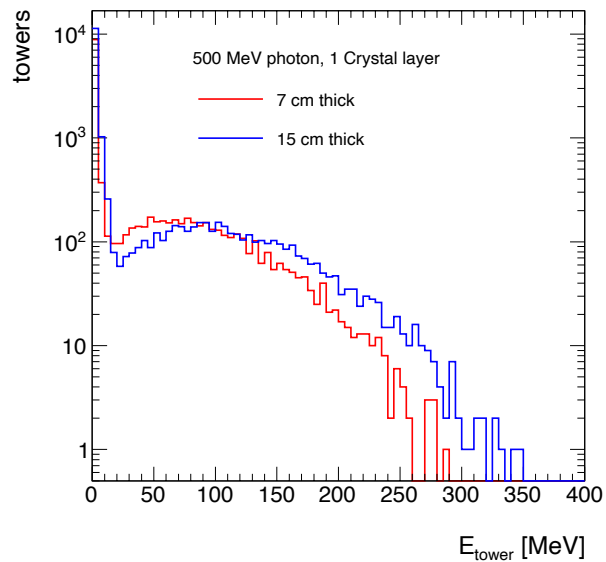


Summary

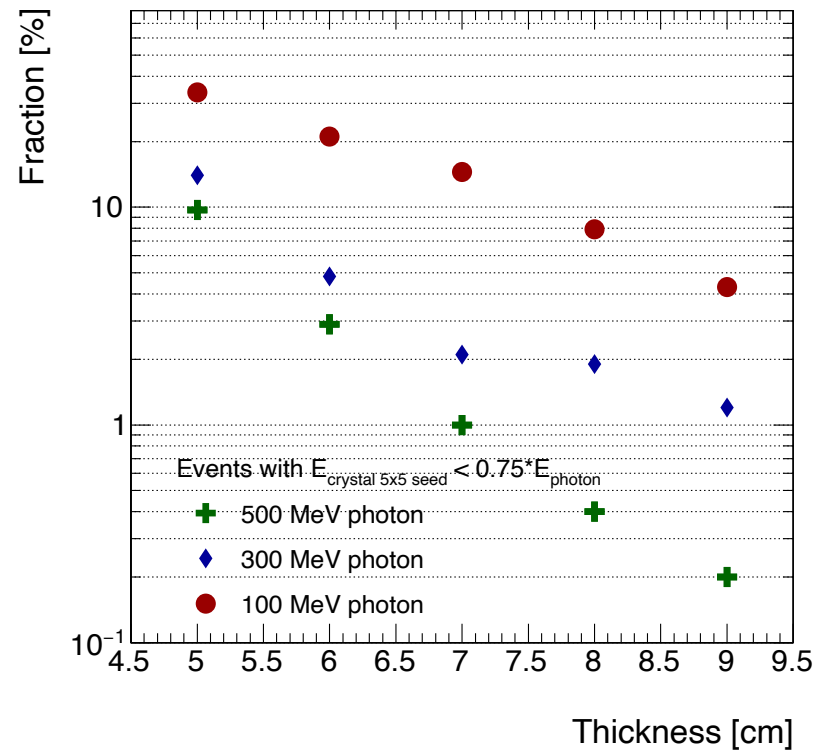
- ◆ While soft photon tagging prefers thicker crystal layer(s), good position resolution can be provided by a thinner crystal layer.
 - **Single crystal layer of 15 cm thick** is:
 - preferable by soft photon tagging.
 - no reasonable position measurement by Pixel.
 - Option could be the position measurement in front of crystal, by adding a few layers of detector?
 - **Double crystal layers of 7 cm thick** is:
 - will have less tagging efficiency of soft photons, especially with a seed energy requirement for the crystal tower clusters.
 - position resolution could be 1.1 mm for 40 GeV photons.
 - Try a narrower RoI to see if better resolution is possible.
- ◆ In any case, 0.5 mm – 1mm resolution is not easy.
 - Readout materials for crystal is not in the simulation
 - can worsen the resolution.
 - Should contact physics group for details of the required values.

Backup: thickness scan

With a requirement of $E_{\text{seed}} > 20$ MeV



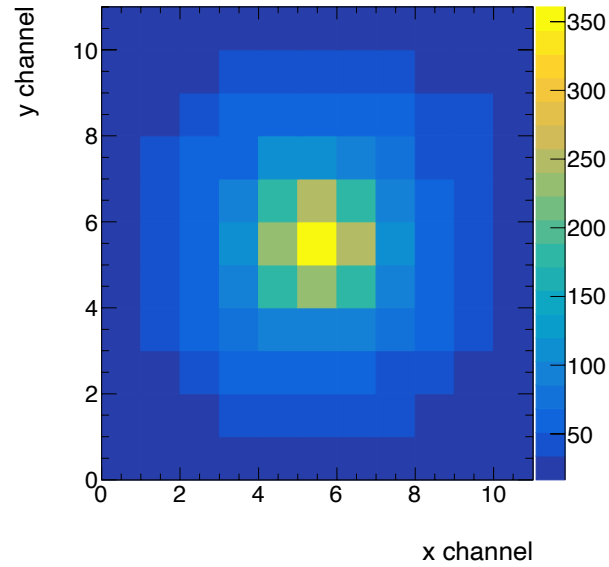
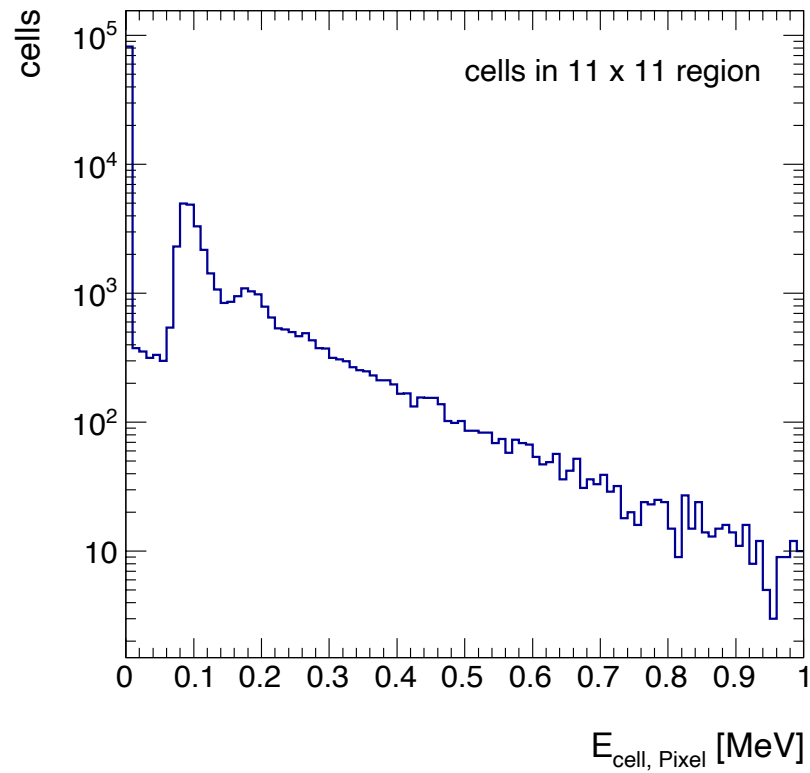
Tower energy distribution from single layer analysis, for 500 MeV photons



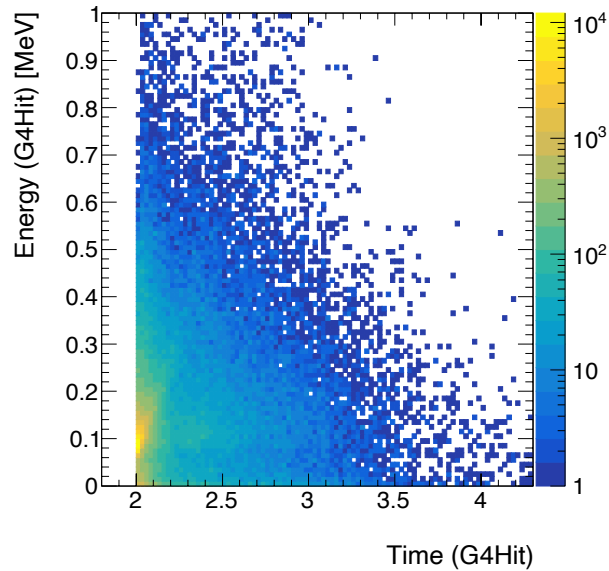
Backup: Pixel energy

Crystal 7 cm, 20 GeV photon

Pixel cell energy in 11 x 11 channels



Energy map in
11 x 11
channels



G4Hits on Pixel 1
Energy vs Time