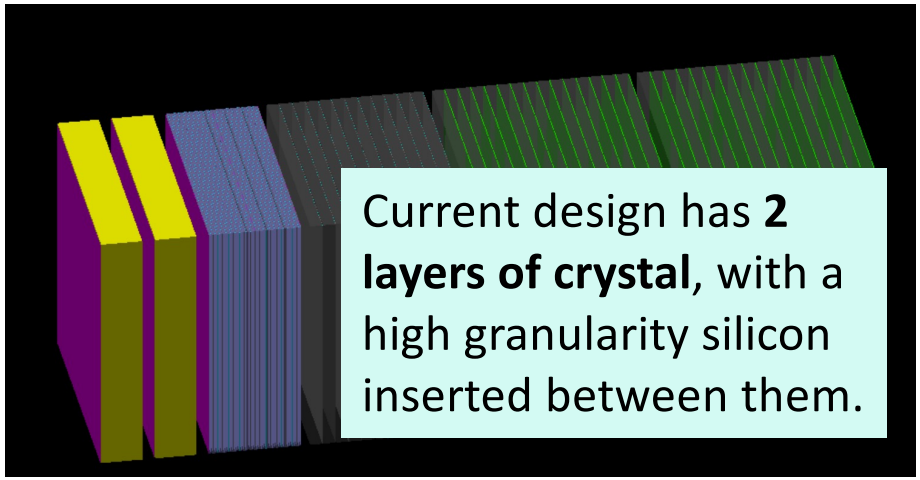
Crystal

Introduction



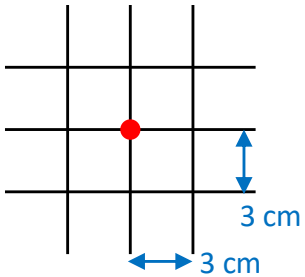
Soft photons don't require very good position / energy resolution.
→ Can be a single layer?

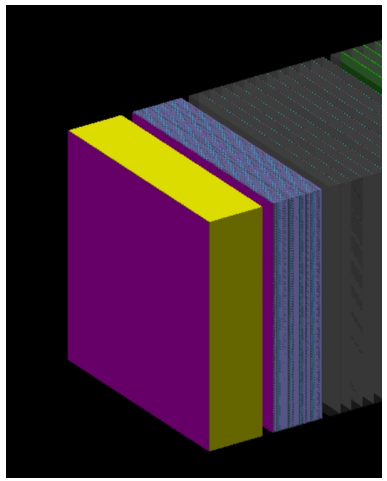
Still, ~40 GeV photons require good position resolution of O(1) mm.

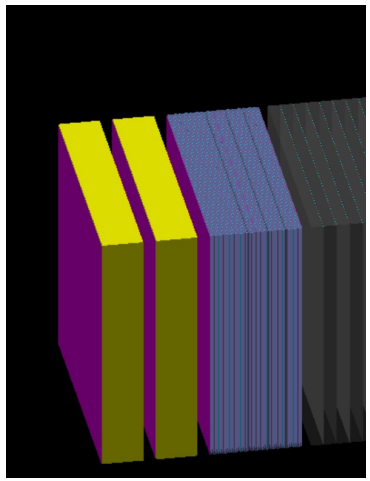
Readout of crystal will sit behind them.
- 3 cm x 3 cm tower structure.

Study today:

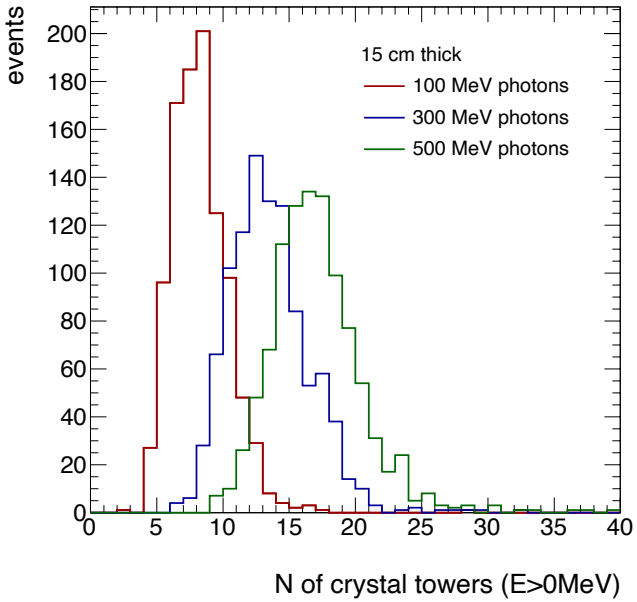
- **Single crystal layer** with the thickness of: 7 cm (7.9 X_0) – 19 cm (21 X_0)
- **Two crystal layers** with the thickness of: 5 cm – 9 cm
- Shot 100 MeV, 300 MeV, 500 MeV photons at the center of the surface.
  - Photons induced at the edge of towers.

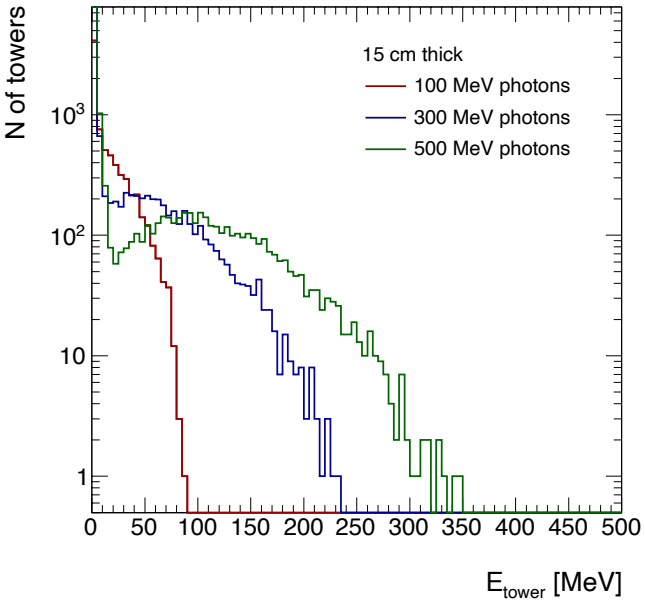




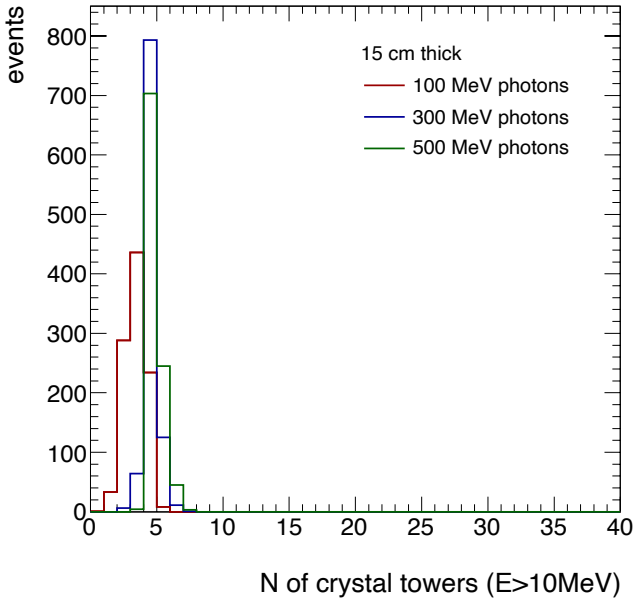


Single Layer: Distribution of towers





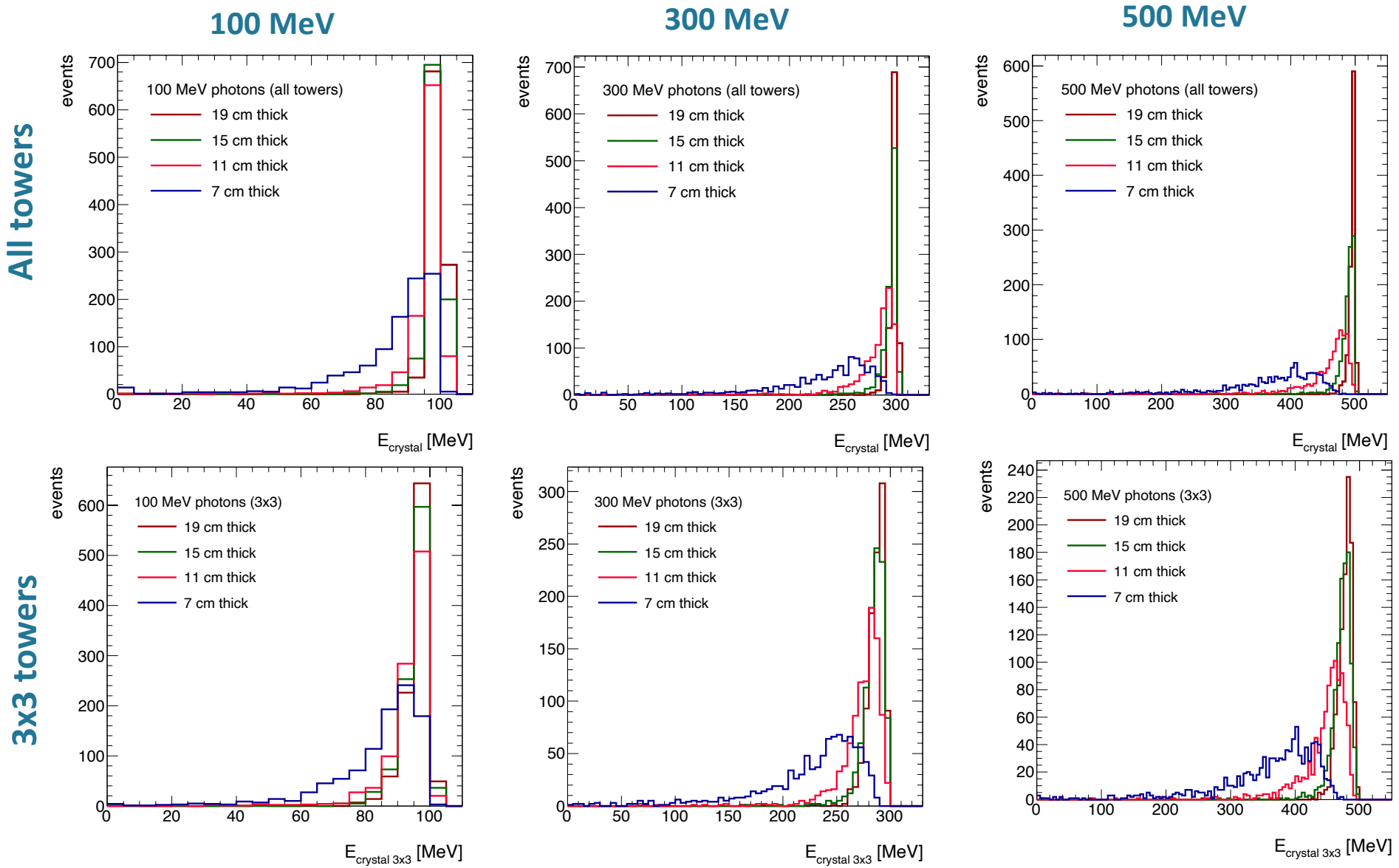
Events have O(10) towers with E_{tower} >0 MeV, but most of them have small energies.



- With a requirement of E_{tower} >10 MeV, the number of towers per events is ~4.
  - Reasonable, as photons are shot on (0,0).

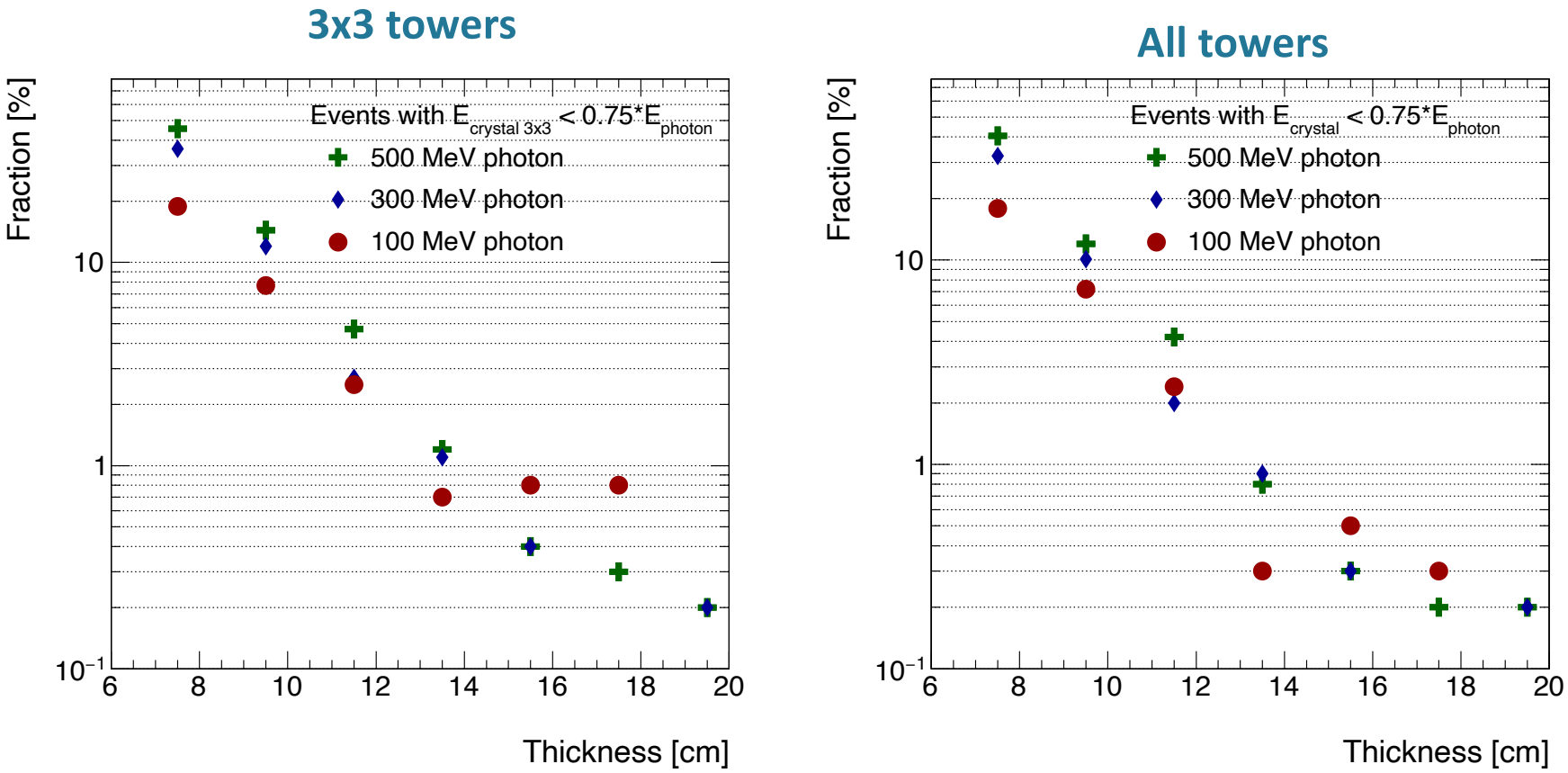
→ Look at 3x3 towers, taking the tower with the highest energy as a seed tower.

Single Layer: Thickness scan -1



→ Look at the fraction of events failing to measure 75 % of the photon energy. (next slide)

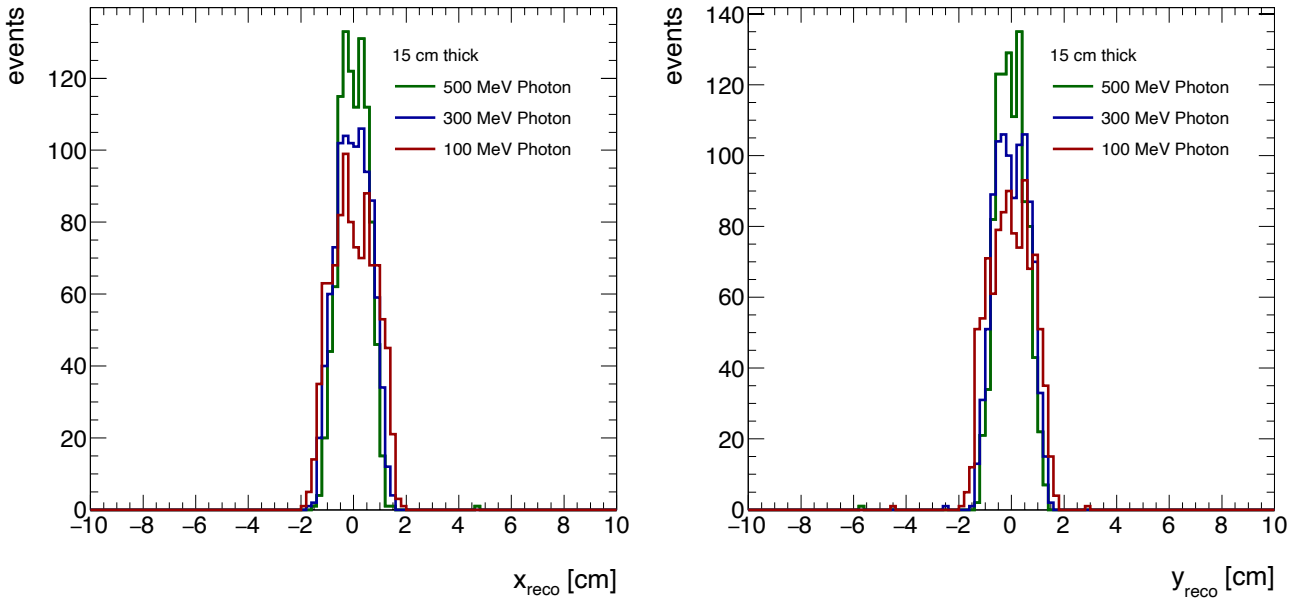
Single Layer: Thickness scan-2



- 15 cm would be a reasonable choice.

Single Layer: Position reconstruction from crystal

- Take the energy-weighted mean position of 3x3 towers.

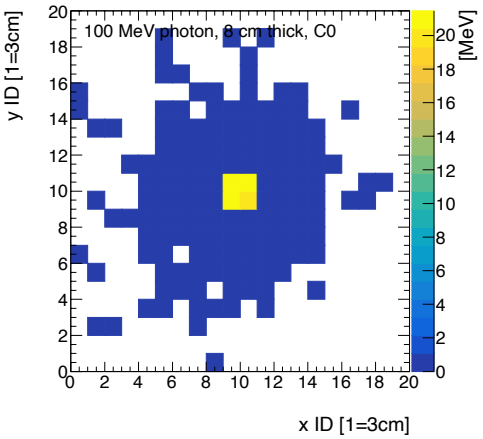


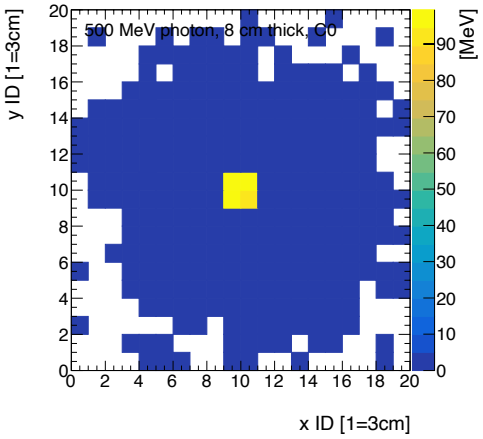
As expected from the tower size of 3 cm, position resolution in crystal would be O(1) cm.

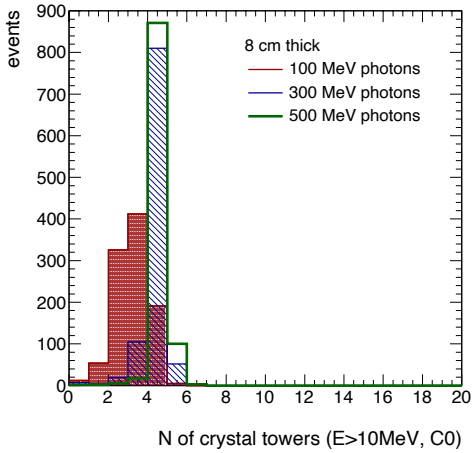
- (A position scan would provide a proper resolution.)

Two Layers: Tower distributions on the second layers

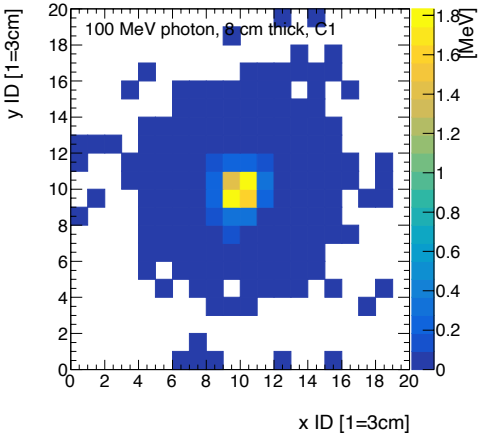
Crystal Layer 0

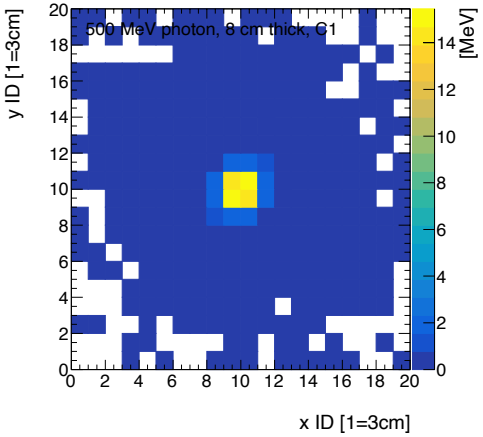


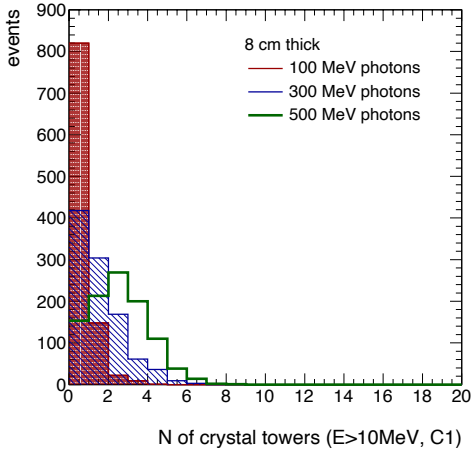


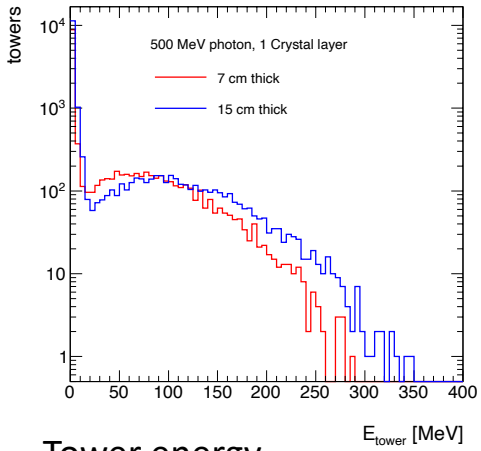


Crystal Layer 1









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

2nd layer has wider distribution and smaller energy deposits.

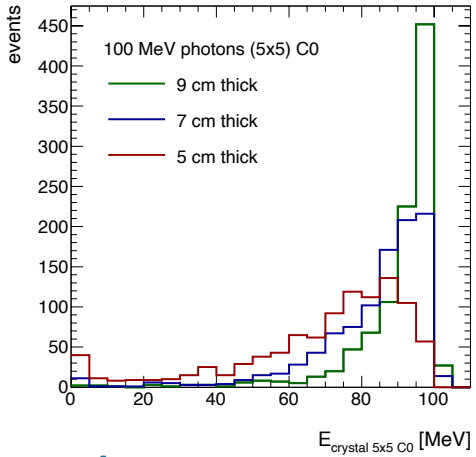
→ Use - 5x5 towers

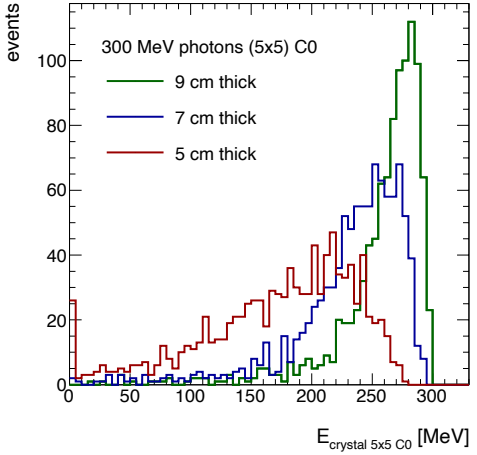
- Seed: a tower with the highest energy, w/ and w/o a threshold of **20 MeV**.

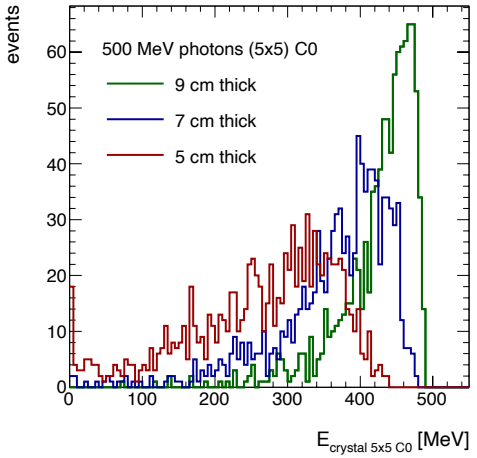
Two Layers: 5x5 energy distributions

No energy threshold on 5x5 cluster seeds

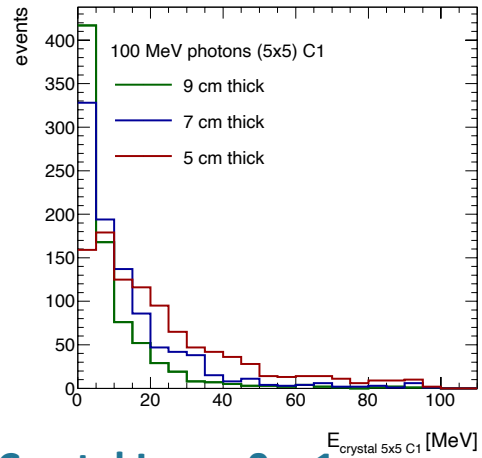
Crystal Layer 0

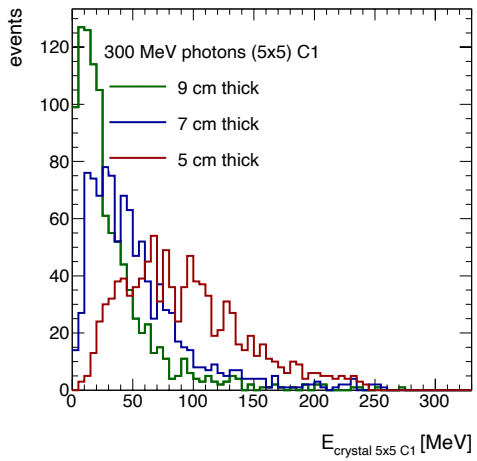


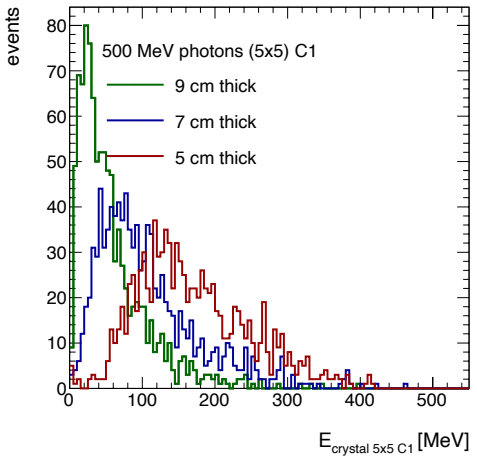




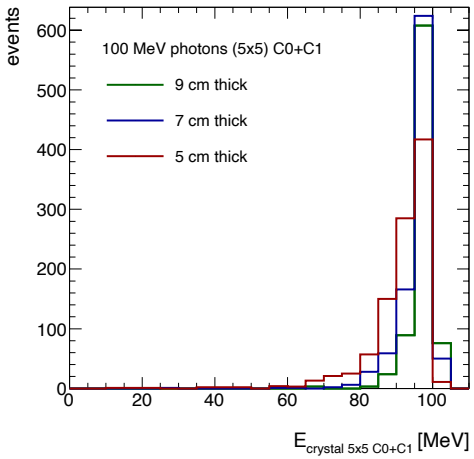
Crystal Layer 1

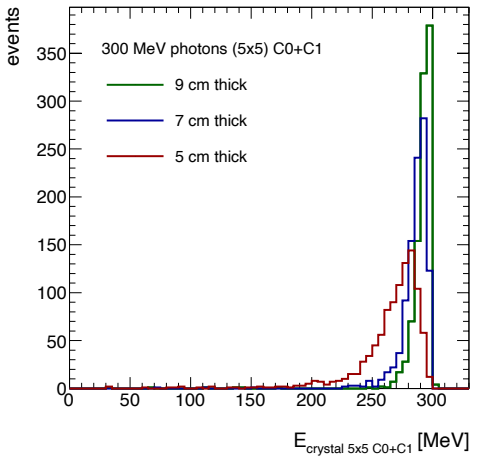


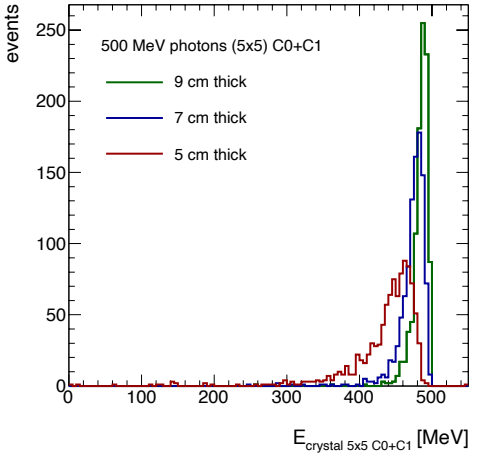




Crystal Layer 0 + 1





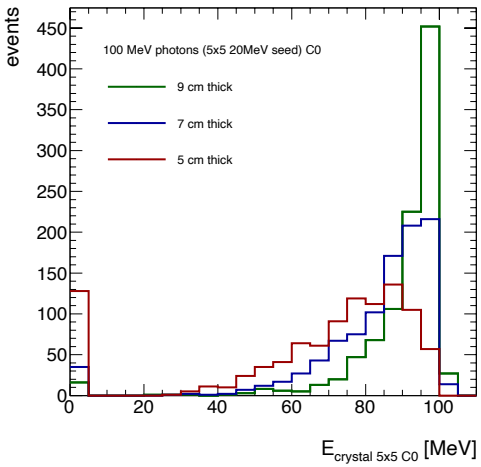


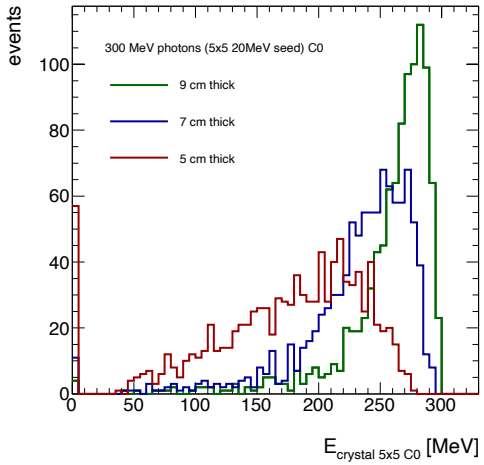
Two Layers: 5x5 energy distributions

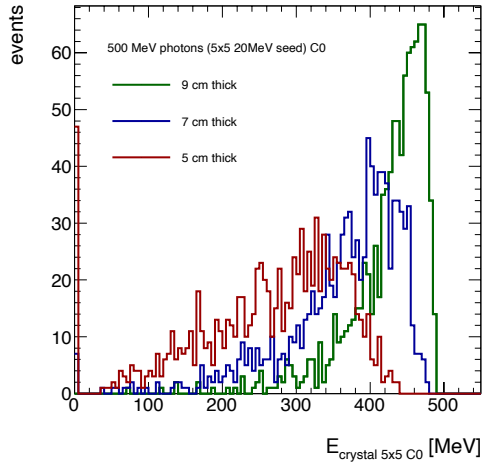
Seeds should have E_{Tower} > 20 MeV

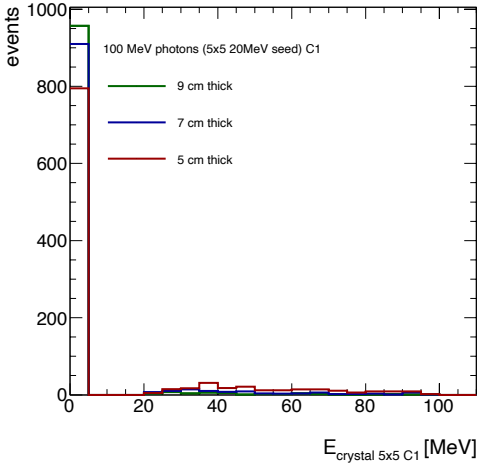
<u>100 and 300 MeV</u>:
the thicker the better.
→ The 1st layer can measure most of the energy.

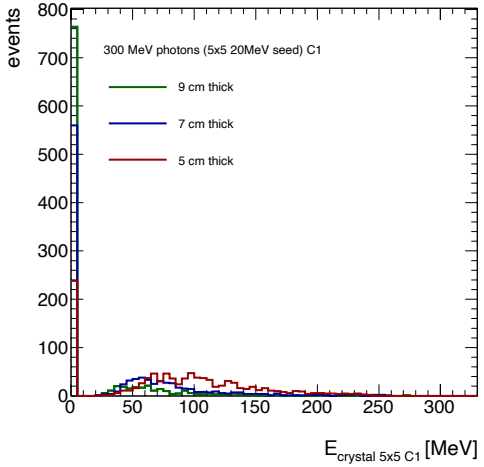
<u>500 MeV</u>:
7cm has the slightly higher peak than 9cm.
→ Sizable energy deposits in both layers might give better resolution.

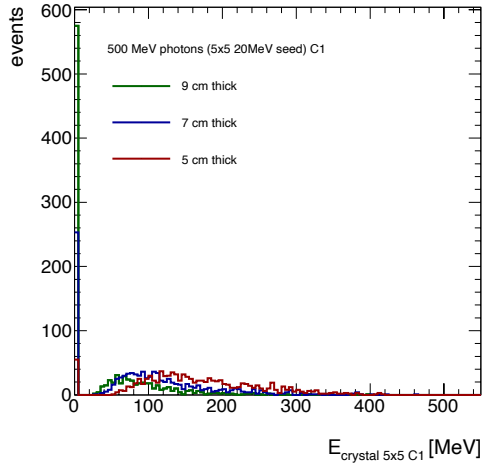


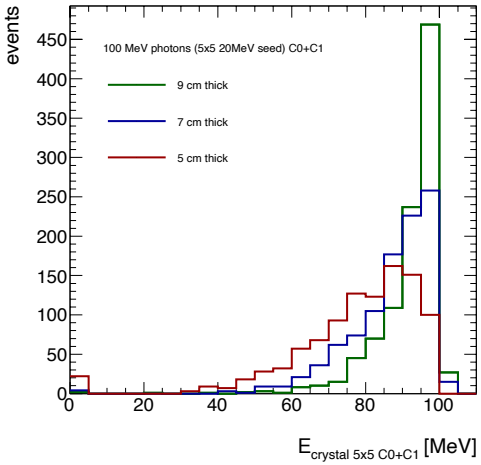


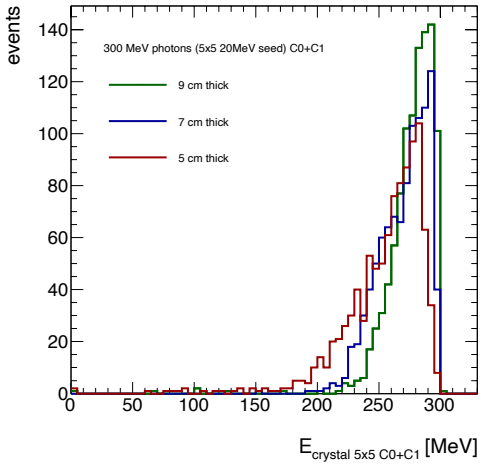


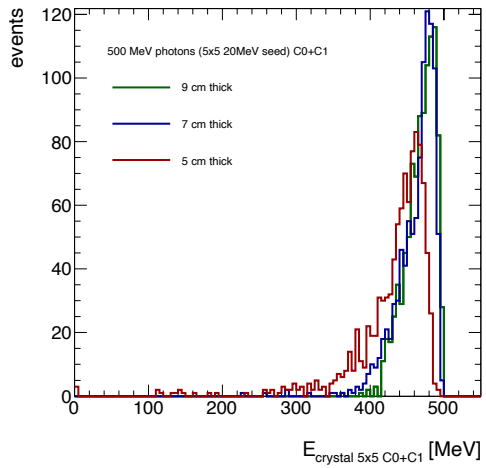






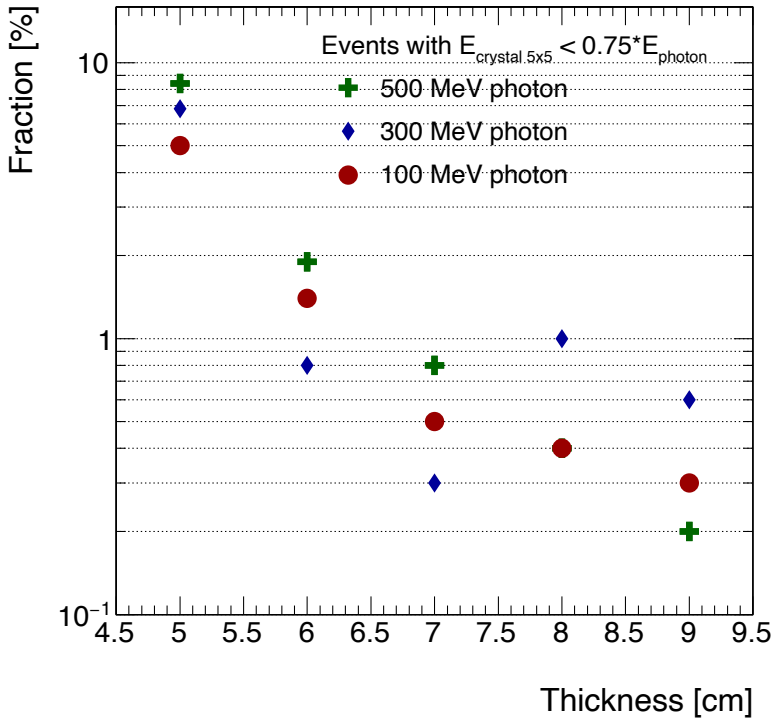




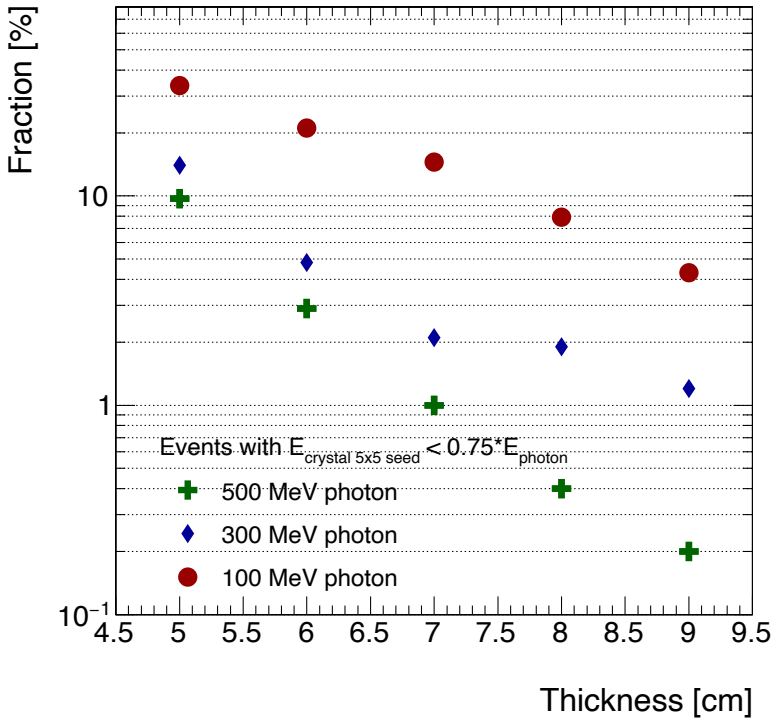


Two layers

w/o minimum energy requirement



w/ minimum energy requirement



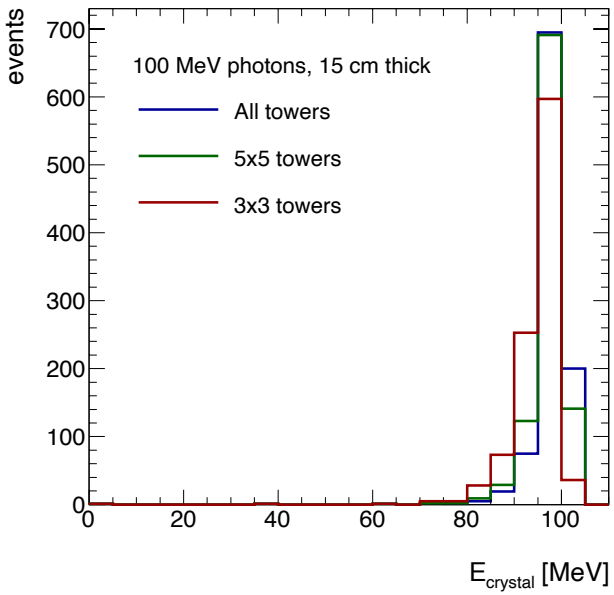
- If low energy clusters are measurable, 7 cm is a reasonable thickness for the two-layer structure.
- Performance against low energy photons gets worse with a requirement of a minimum energy for cluster seeds.
  - It is better to measure the photon energy as much as possible in the first layer.

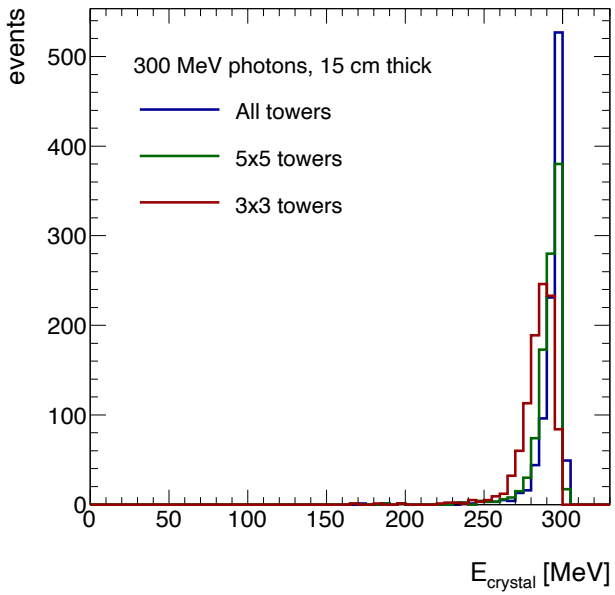
Summary

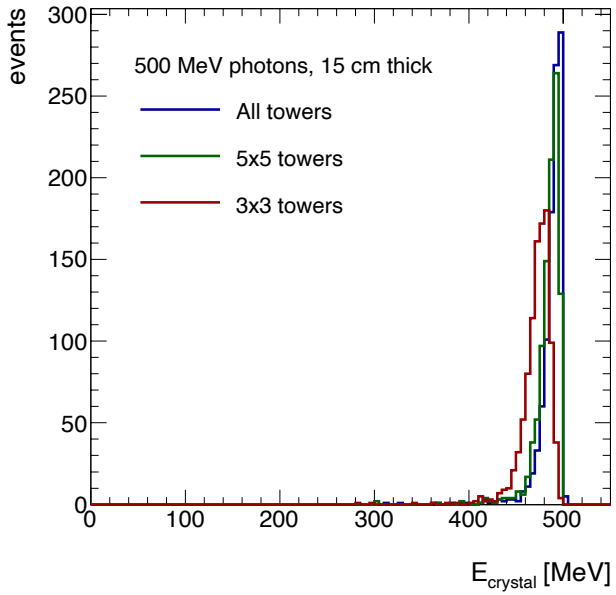
- Crystal will measure O(100) MeV photons.
  - Concept:
    - No good energy resolution is needed, but a reasonable energy deposits in the crystal is needed for the identification.
    - No good position resolution is needed.
- Thickness scan with 100, 300 and 500 MeV photons.
  - Single layer:
    - Energy is measured from 3x3 towers.
    - 15 cm thickness allows to measure 75 % of photon energies for > 99% of events.
    - Position resolution will be O(1) cm.
  - Double layers:
    - Energy is measured from 5x5 towers from seeds w/ and w/o energy threshold.
    - w/o energy threshold → 7 cm thickness for each is fine.
    - w/ energy threshold → the thicker is the better
- Next: See performance against ~40 GeV photons.
  - Can we have a good position resolution for 40 GeV photons?

Energy from all/3x3/5x5 towers

- Comparison of energies measured using all / 3x3 / 5x5 towers.



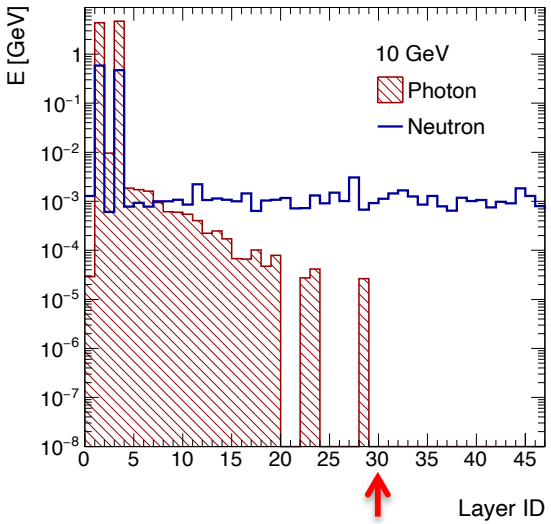


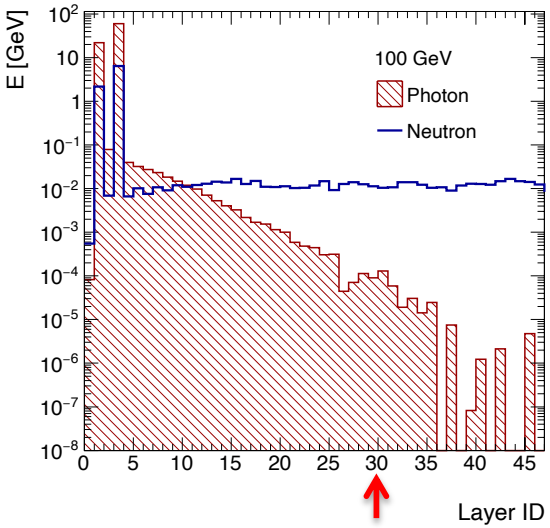


Recap of my previous study: W/SI layers

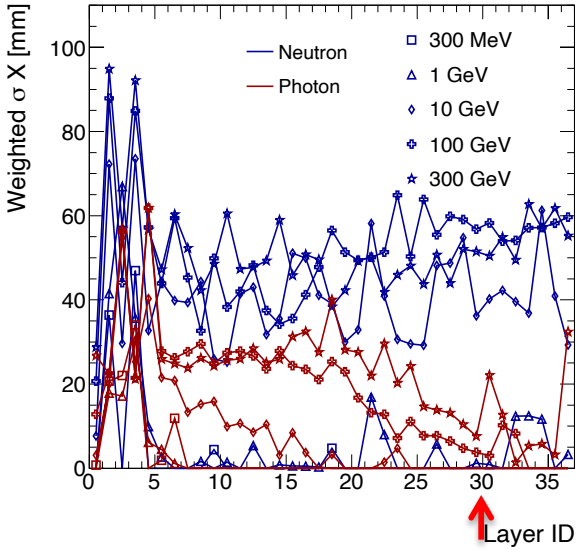
Previous study: Looked at the number of W/SI layers with <u>16 X_0 crystal layers.</u>

Energy deposits





Shower width (x)



Previous conclusion:

Reduction to layer ID=30, i.e. 26 W/SI layers, is quite safe with 16 X_0 crystal layers.

Study today suggests <u>17 X_0 of a single crystal layer/ 16 X_0 crystal layers</u>

→ We can use the same number of W/SI layers.

Or, even we can reduce more:

Further reduction of 4 layers won't harm (cf. layer ID =26).

Thickness scan with a threshold of 66%