

## Energy Resolution of UCNA scintillator

Early calibration made by Kellogg electron gun: 354 P.E.s/MeV

*Junhua's thesis, Sec. 3.2.1.1*

$$N.P.E. = \left( \frac{\text{signal}}{\sigma} \right)^2$$

Using the calibration data with Sn and Bi sources, Brad extracted (using the formula above):

$$N.P.E. (Sn) \sim 90 \quad E \sim 364 \text{ keV}$$

$$N.P.E. (Bi) \sim 170 \quad E \sim 975 \text{ keV}$$

Don't make sense ...

However, both Sn and Bi have multi-line emission spectra:

Sn: 364 keV, 29%; 388 keV, 6%

Bi: 481 keV, 2%; 975 keV, 7%; 1047 keV, 2%

Furthermore, need to take into account the E loss in MWPC, etc

# GEANT4 simulation

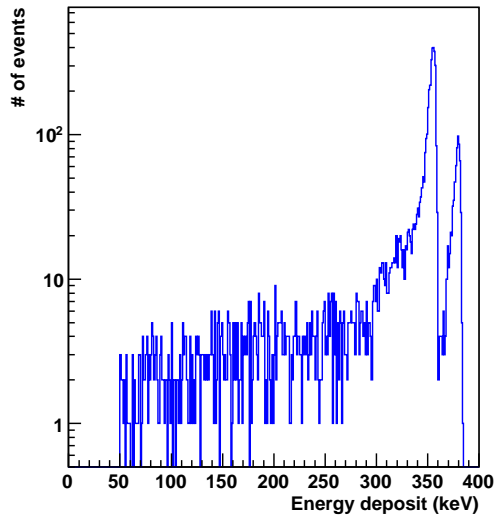
- Based on Junhua's UCNG4, added scintillation processes and generate optical photons.
- Added Sn and Bi generator according to the electron energy and emission probability.
- Note, not a real optical simulation here. **NO** light guides and PMTs!  
Simply **demand** the average yield in the scintillator = **354** photons/MeV (instead of 10,400/MeV), and let GEANT randomize the process.

## From the MC, average energy loss budget (upstream of the scintillator):

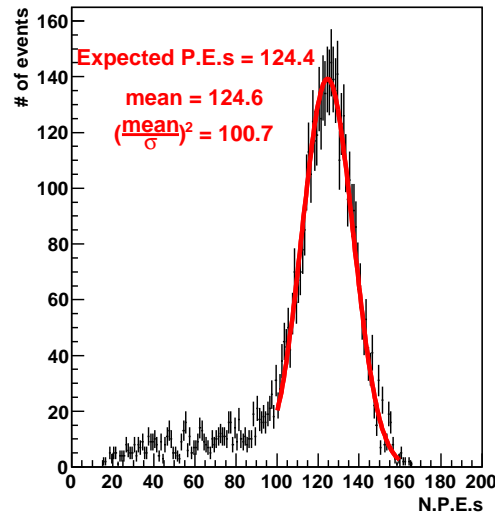
- 6 micron Mylar windows of wire chamber (front+back): 10.7 keV
- Wire chamber (dead layer + wires + gas): 11.0 keV
- Dead layer of the scintillator: 4.0 keV
- Total: 25.7 keV

# Results

Deposit energy in scint., Sn source



P.E. yield in scint., Sn source



$$\langle \Delta E \rangle = 351.4 \text{ keV}$$

$$\text{N.P.E. (expected)} =$$

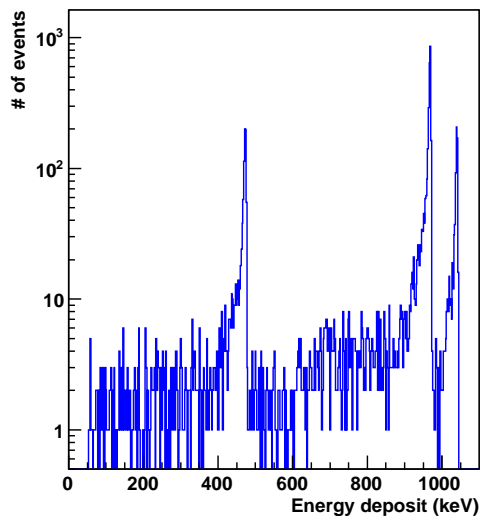
$$351.4/1000 * 354 = 124.4$$

$$\text{N.P.E. (observed)} = 124.6(0.2)$$

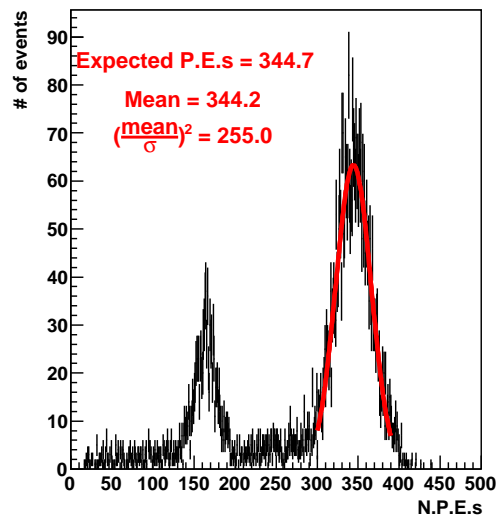
Based on the width of P.E.s,

$$\text{N.P.E. (poisson)} = 101(3)$$

Deposit energy in scint., Bi source



P.E. yield in scint., Bi source



$$\langle \Delta E \rangle = 973.6 \text{ keV}$$

$$\text{N.P.E. (expected)} =$$

$$973.6/1000 * 354 = 344.7$$

$$\text{N.P.E. (observed)} = 344.2(0.4)$$

Based on the width of P.E.s,

$$\text{N.P.E. (poisson)} = 255(10)$$

## **Conclusion**

The multi-line structure in the Sn and Bi emission spectra is mostly responsible for the “non-Poisson” distribution of the scintillator ADC spectra. The energy loss in the media before the scintillators are not significant, especially for Bi source.