

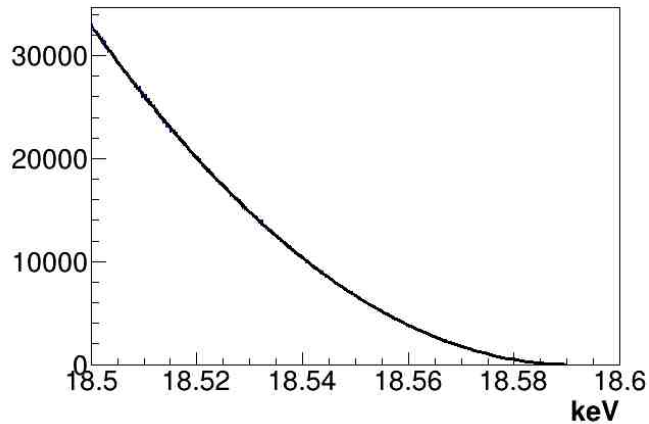
Weekly Report

2018-01-25

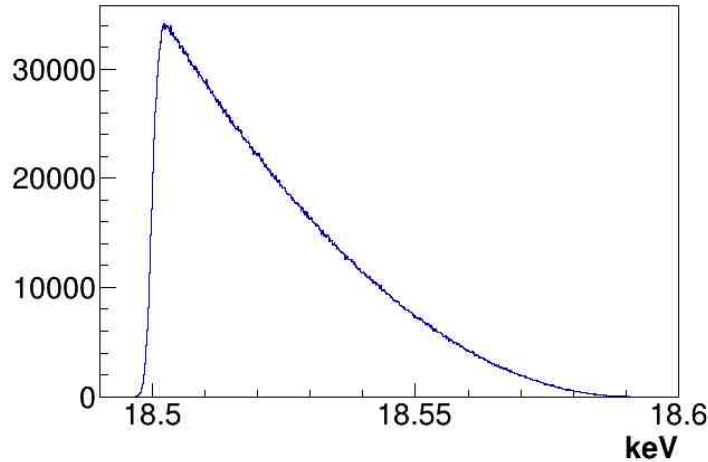
Kim, Hanbeom

Geant4 Simulation $m_\nu=1$ eV with detector resolution

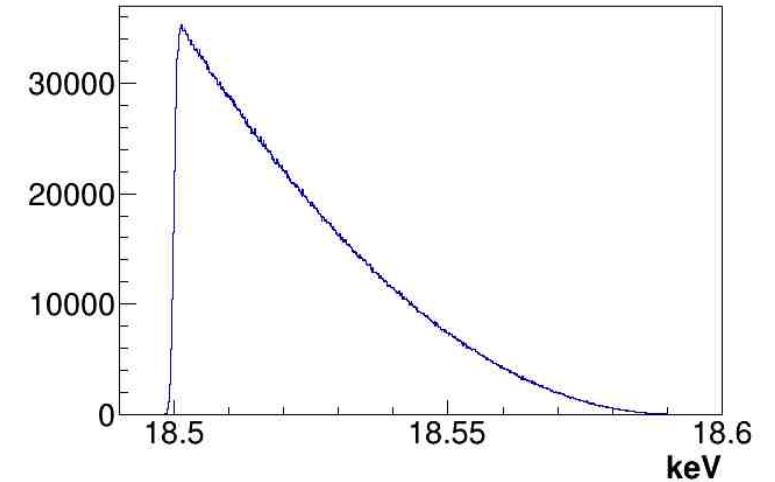
18.5-18.591 keV, 10^7 e-



18.5-18.591 keV, 1 eV, 1 eV



18.5-18.591 keV, 1 eV, 0.5 eV



Simulation Input:

$Q=18.591$ keV

$m_\nu=1$ eV

Output (from fitting result spectrum):

$Q=18.5910 \pm 0.00002$ keV

$m_\nu=1.02472 \pm 0.044720$ eV

Fit from 18.51 keV to the endpoint

Resolution = 1 eV

$Q=18.5910 \pm 0.00002$ keV

$m_\nu=0.000066 \pm 73.0844$ eV

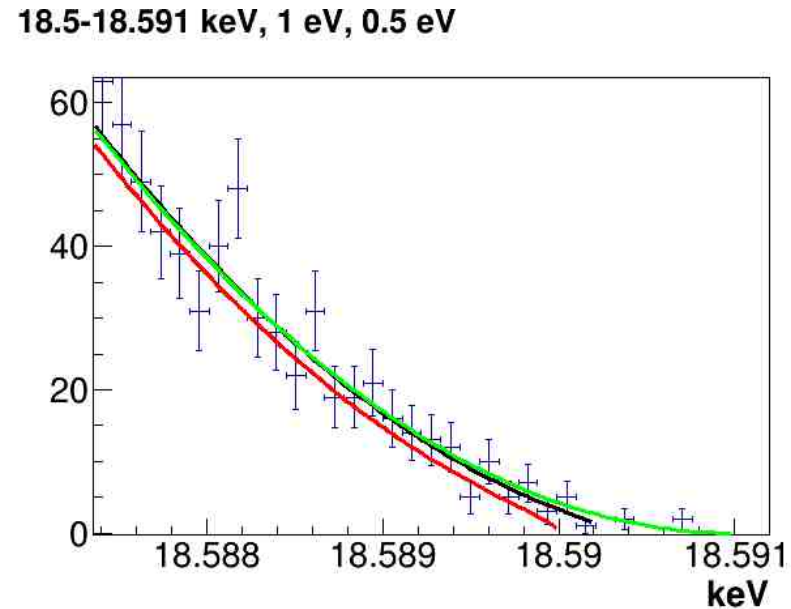
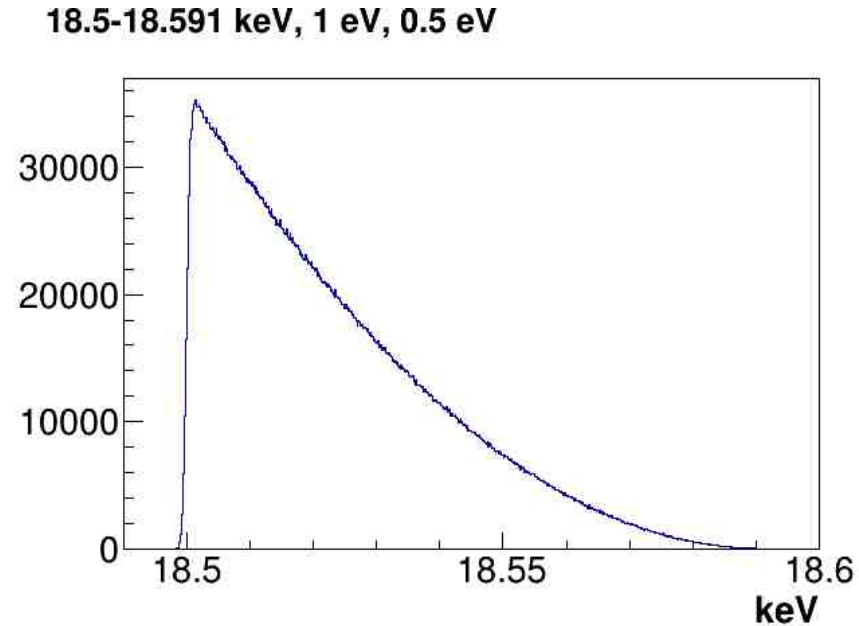
Weird!!

Resolution = 0.5 eV

$Q=18.5910 \pm 0.00002$ keV

$m_\nu \approx 0.75$ eV.....

Geant4 Simulation $m_\nu=1$ eV with detector resolution



As the fitting range changes near the endpoint, the error of the mass also changes (but the mean value does not change much).

18.51-18.5900 keV: $m_\nu=0.725922 \pm 0.241754$ eV

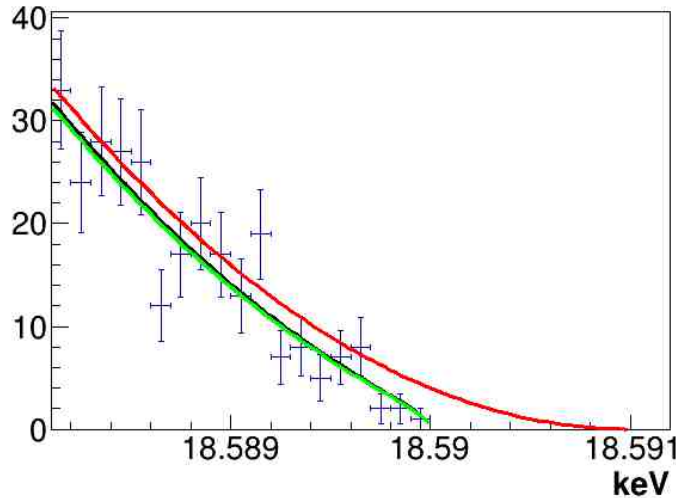
18.51-18.5902 keV: $m_\nu=0.750794 \pm 0.132226$ eV

It seems to need more events.

Geant4 Simulation $m_\nu=1$ eV with detector resolution

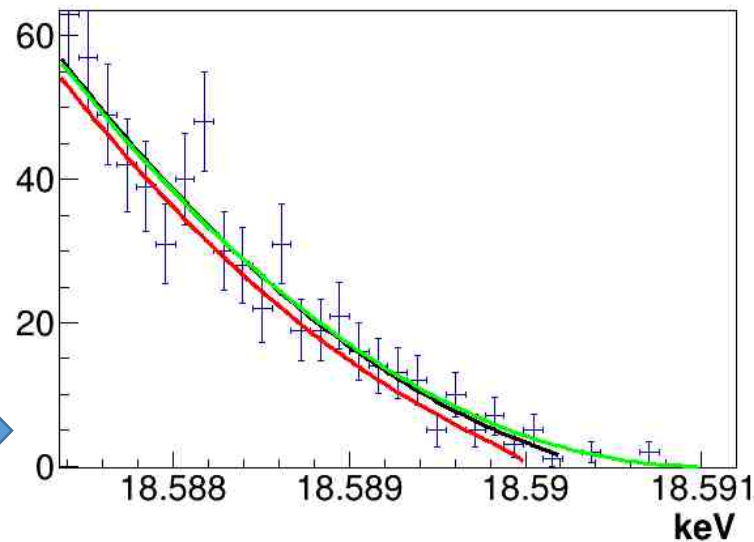
Near the endpoint:

18.5-18.591 keV, 10^7 e⁻



Fitted one and
calculated one
almost overlap.

18.5-18.591 keV, 1 eV, 0.5 eV



Less similar

Black: fitted spectrum

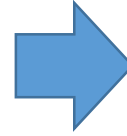
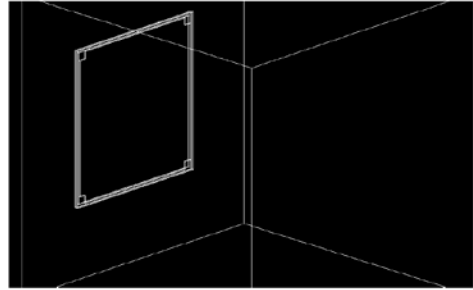
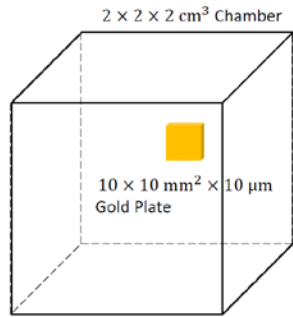
Green: calculated spectrum with $m_\nu=0$ eV

Red: calculated spectrum with $m_\nu=1$ eV

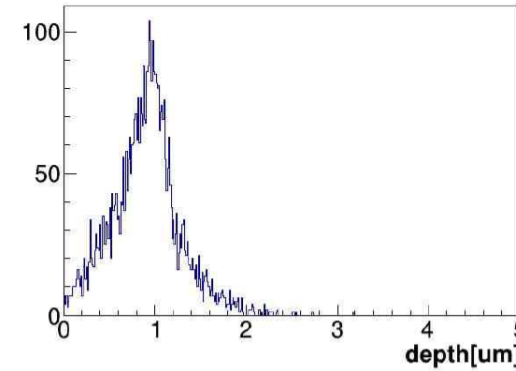
(Colors are different in the previous one.)

We can make another simulation with more events/better resolution.

Geant4 Simulation $m_\nu=1$ eV (previous meeting)



Triton Implantation [4930/10000000]



$4930/10^7$

19 out of 10^8 electrons throughout the spectrum are between 18.5 and 18.591 keV.

We have an error scale of ~ 0.01 eV with 10^7 electrons in the range of 18.5~18.591 keV.


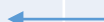


For an error scale of ~ 0.01 eV,
of implanted ^3H decay: $\sim 5 \cdot 10^{13}$
of $^3\text{He}(n,p)^3\text{H}$ nuclear reaction need = $\sim 10^{17}$

Event rates

$$A_{Bq} = nN_A \frac{\ln(2)}{t_{1/2}}$$

$$t_{\frac{1}{2}} = 12.32 \text{ yr} = 3.89 \times 10^8 \text{ s}$$

# of implanted ^3H decay (one sensor?)	Mass/g	Frequency/Hz	Fall time
$\sim 5 \cdot 10^{13}$	2.49×10^{-13} 	89.1 ($\sim 0.1\text{k}$)	$\sim 10 \text{ ms}$
$\sim 5.6 \cdot 10^{15}$	2.8×10^{-11} 	10k	100 μs

More events are allowed, so the expected resolution can be higher.

Relic neutrino events

Isotope	Decay	Q_β (keV)	Half-life (sec)	$\sigma_{\text{NCB}}(v_\nu/c)$ (10^{-41} cm ²)	
³ H	β^-	18.591	3.8878×10^8	7.84×10^{-4}	Rate ≈ 75 yr ⁻¹ kg ⁻¹
⁶³ Ni	β^-	66.945	3.1588×10^9	1.38×10^{-6}	
⁹³ Zr	β^-	60.63	4.952×10^{13}	2.39×10^{-10}	
¹⁰⁶ Ru	β^-	39.4	3.2278×10^7	5.88×10^{-4}	
¹⁰⁷ Pd	β^-	33	2.0512×10^{14}	2.58×10^{-10}	
¹⁸⁷ Re	β^-	2.64	1.3727×10^{18}	4.32×10^{-11}	
¹¹ C	β^+	960.2	1.226×10^3	4.66×10^{-3}	
¹³ N	β^+	1198.5	5.99×10^2	5.3×10^{-3}	
¹⁵ O	β^+	1732	1.224×10^2	9.75×10^{-3}	
¹⁸ F	β^+	633.5	6.809×10^3	2.63×10^{-3}	
²² Na	β^+	545.6	9.07×10^7	3.04×10^{-7}	
⁴⁵ Ti	β^+	1040.4	1.307×10^4	3.87×10^{-4}	

A. Cocco, G. Mangano, and M. Messina,
hep-ph/0703075 (2007).

PTOLEMY: 100 g \rightarrow ~ 8 events/yr