DCV simulation

Problem

- Compared with real data, the number of photon is not enough.
- The reason for this is that the WLS absorption length were set too small.
- After correcting the value, it was confirmed that normal value appeared.

Results

```
root [3] t1 -> Scan()
************************************************
*    Row   * Scintilla *  Cerenkov *       WLS *
************************************************
*        0 *      7389 *        72 *      8180 *
************************************************
(long long) 1
root [4] t3 -> Scan()
************************************************************
*    Row   * Total_Ene * ScintCoun * Nelectron *     ratio *
************************************************************
*        0 * 0.7524054 *    586431 *         0 * 779408.24 *
************************************************************
(long long) 1
root [5] t6 -> Scan()
************************
*    Row   * MPPC1coun *
************************
*        0 *       117 *
************************
```

```
root [6] t8 -> Scan()
************************
*    Row   * MPPC2coun *
************************
*        0 *       106 *
************************
(long long) 1
root [7] t10 -> Scan()
************************
*    Row   * MPPC3coun *
************************
*        0 *       104 *
************************
(long long) 1
root [8] t12 -> Scan()
************************
*    Row   * MPPC4coun *
************************
*        0 *       111 *
************************
(long long) 1
```

Energy spectrum of beta decay

Beta decay of Strontium source

- Strontium and yttrium are radioactive elements that emit electron from beta decay.
- Strontium decays into yttrium, and yttrium also decays into zirconium.
- Half-life time of 90-strontium is 28.79 years, and maxium electron energy from strontium is 0.546 MeV.
- Half-life time of 90-yttrium is 64.6 hours, and maxium electron energy from yttrium is 2.28 MeV.
- By making use of 'Fermi's golden rule', we can derive the energy spectrum of electron from beta decay.

Fermi’s golden rule

- Fermi’s golden rule is a formula that describes the transition rate(probability of transition per unit time) from one energy eigenstate of a quantum system to a group of energy eigenstates in a continuum.

$$\Gamma_{i\to f} = \frac{2\pi}{\hbar}\left|\langle f|H'|i\rangle\right|^2 \rho(E_f)$$

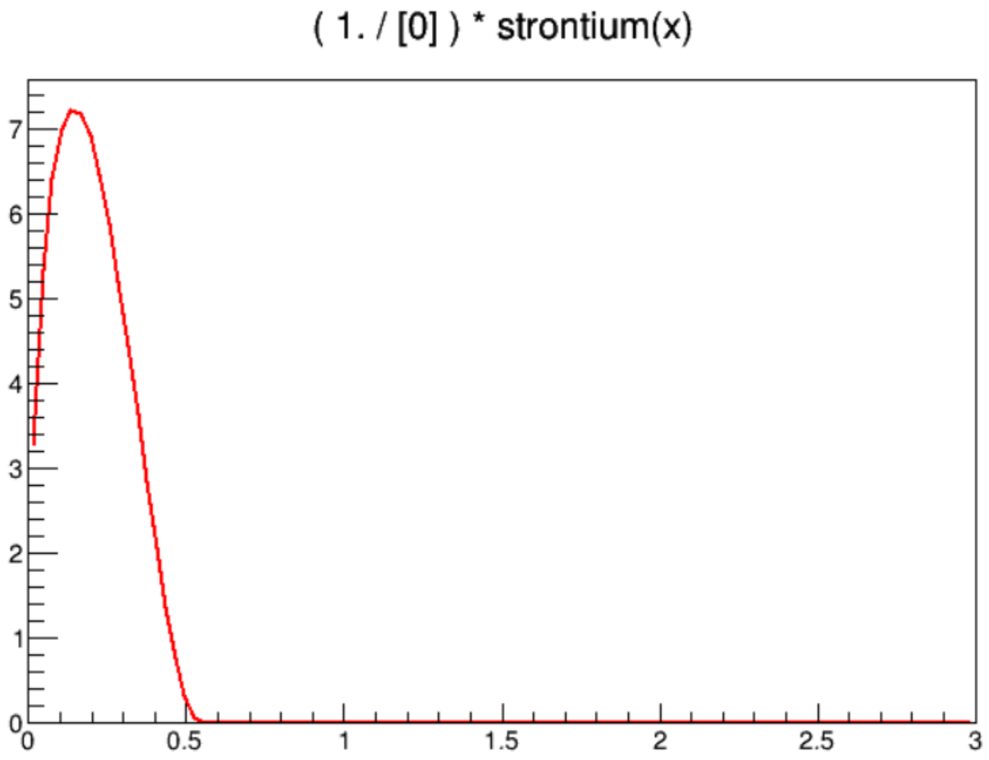
Energy spectrum of beta decay

- According to Fermi's golden rule, energy spectrum of beta decay is expressed below.

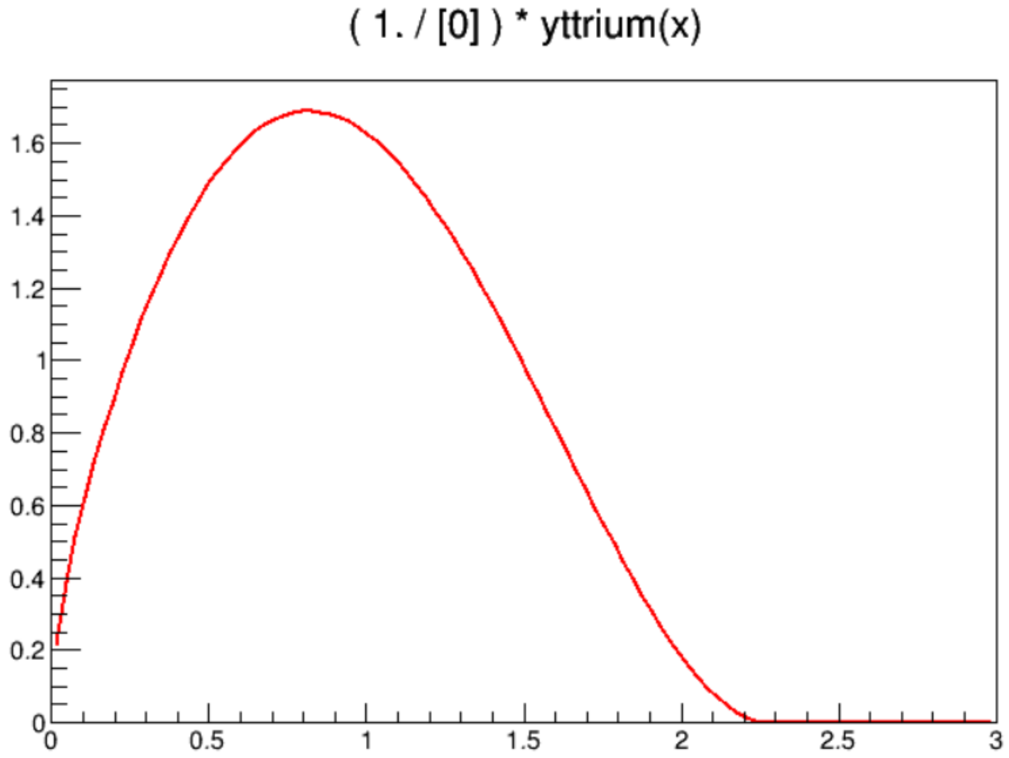
$$\frac{dN_e}{dE_e} = \frac{G_F^2 |\mathcal{M}_{fi}|^2}{2\pi^3 \hbar^7 c^5} E_e \sqrt{E_e^2 - m_e^2 c^4} (E_{\max} - E_e)^2$$

- Since the half-life of yttrium is much shorter than that of strontium, it can be considered that when strontium decays into yttrium, yttrium decays immediately into zirconium.

Result

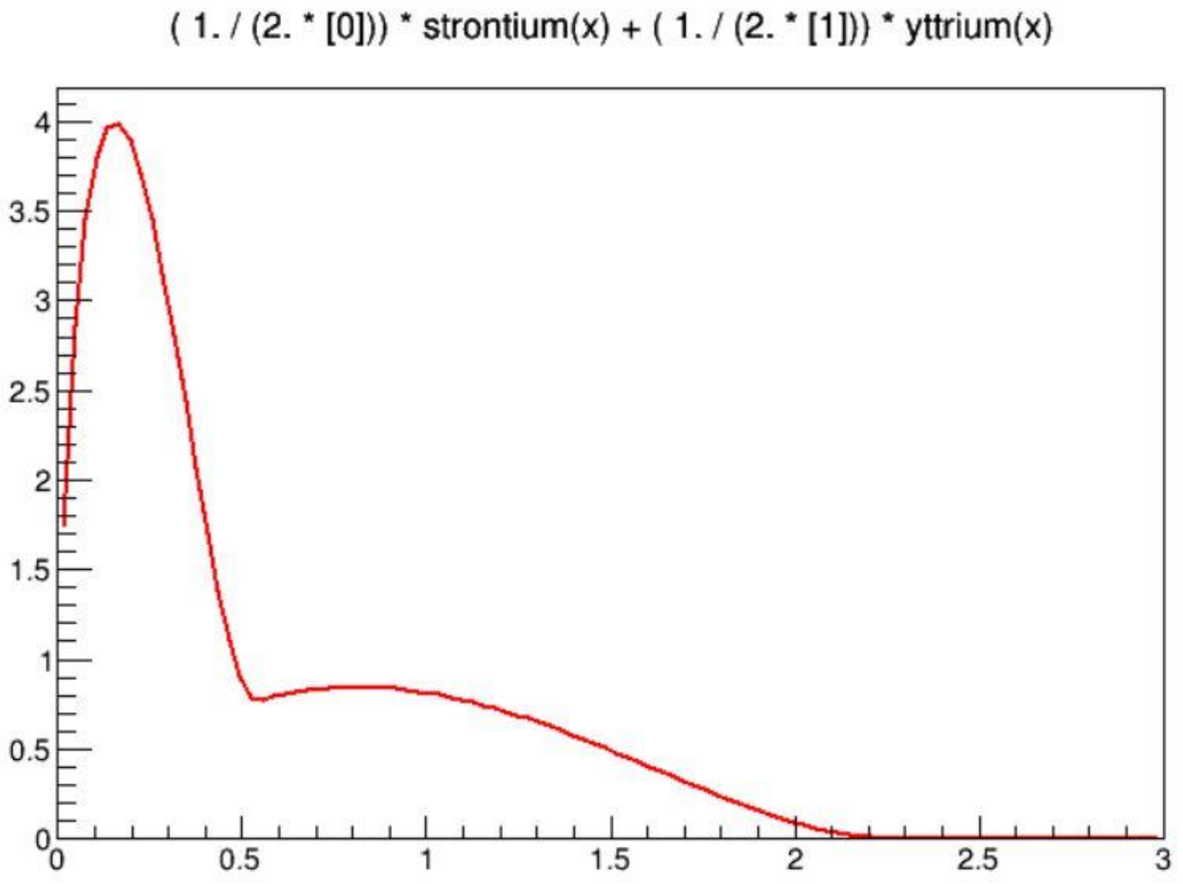


Energy spectrum of strontium



Energy spectrum of yttrium

Energy distribution of Sr source



Electron energy shot and energy deposit