^{9}Li/^{8}He generator

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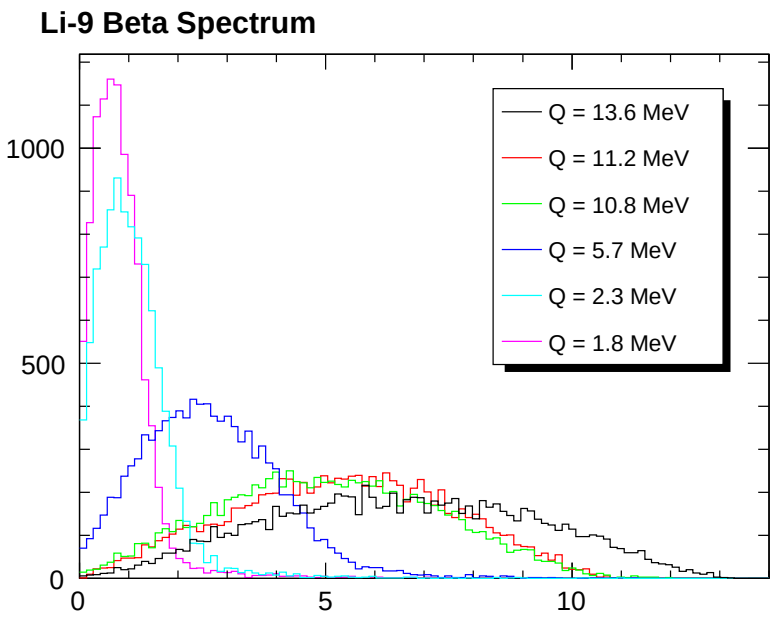
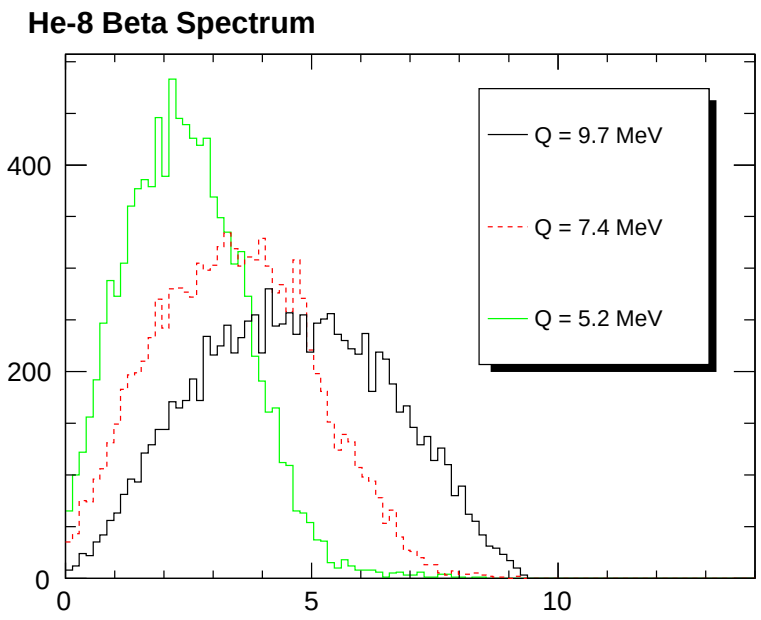
^{9}Li/^{8}He decay channels

Mother	Inter-state	Width(MeV)	BR(%)	α	β	γ	neutron
^{9}Li	^{9}Be(ground)	0	49.2		♣		
^{9}Li	^{9}Be(2.43 MeV)	0.00077	29.7	♣	♣		♣
^{9}Li	^{9}Be(2.78 MeV)	1.08	15.8	♣	♣		♣
^{9}Li	^{9}Be(7.94 MeV)	1.0	1.5	♣	♣		♣
^{9}Li	^{9}Be(11.28 MeV)	0.575	1.1	♣	♣		♣
^{9}Li	^{9}Be(11.81 MeV)	0.40	2.7	♣	♣		♣
^{8}He	^{8}Li(0.98 MeV)	0	84		♣	♣	
^{8}He	^{8}Li(3.21 MeV)	1.0	12		♣	◇	♣
^{8}He	^{8}Li(5.4 MeV)	0.65	4		♣	◇	♣

- ◇ means only 1/3 has γ decay.
- Referenece
  - Nuclear Physics A510 (1990) 189-208
  - Nuclear Physics A366 (1981) 461-468
  - Nuclear Physics A487 (1988) 269-278

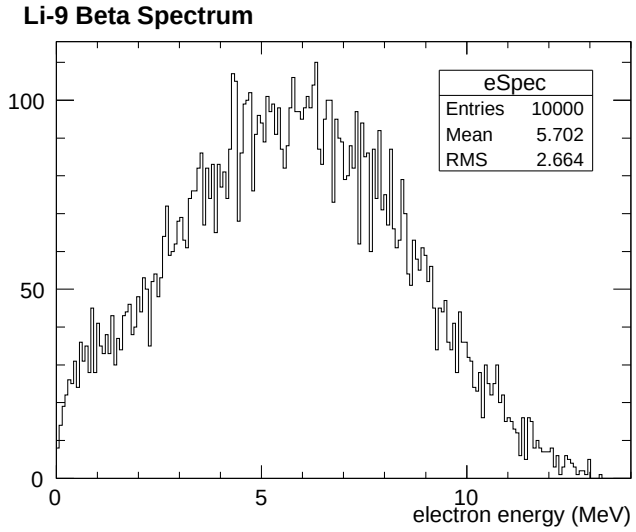
^{9}Li/^{8}He beta spectrum

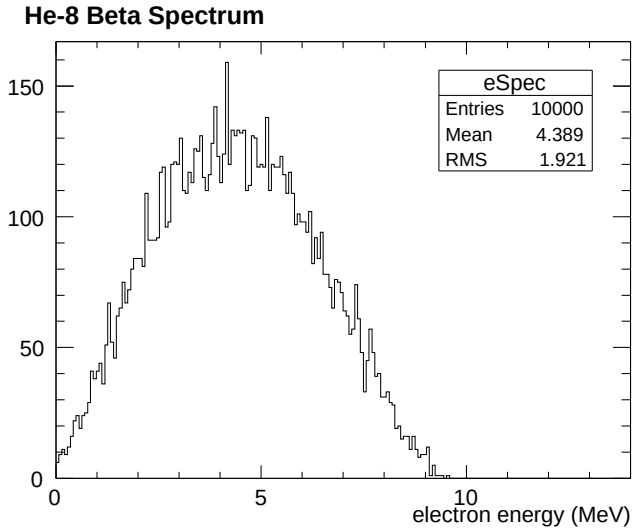




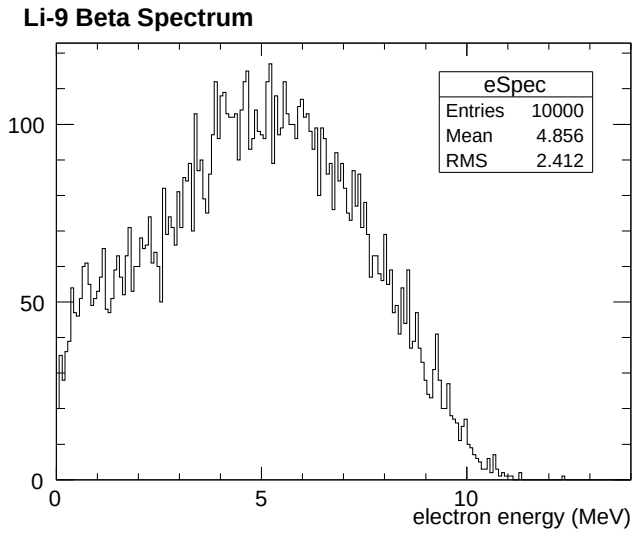
- β spectrum: $\sqrt{E^2 + 2m_e E}(E + m_e)(Q - E)^2 F(Z, E)$
- Fermi function, $F(Z, E)$, is same as GenDecay package (from Geant4).
- Broad levels are considered according Breit-Wigner function.

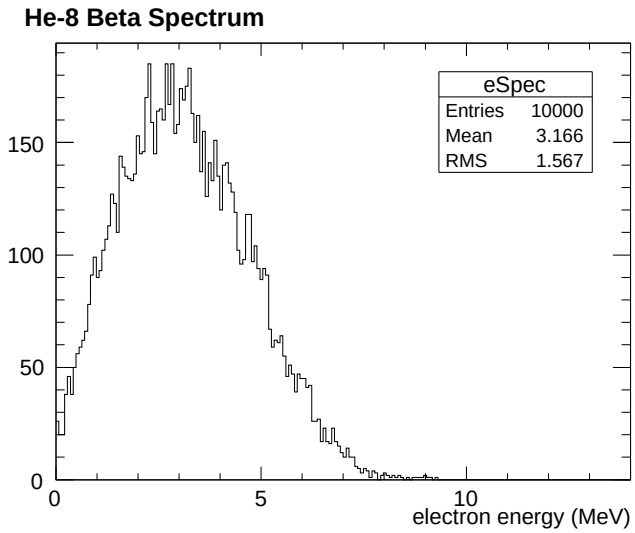
^{9}Li/^{8}He beta spectrum





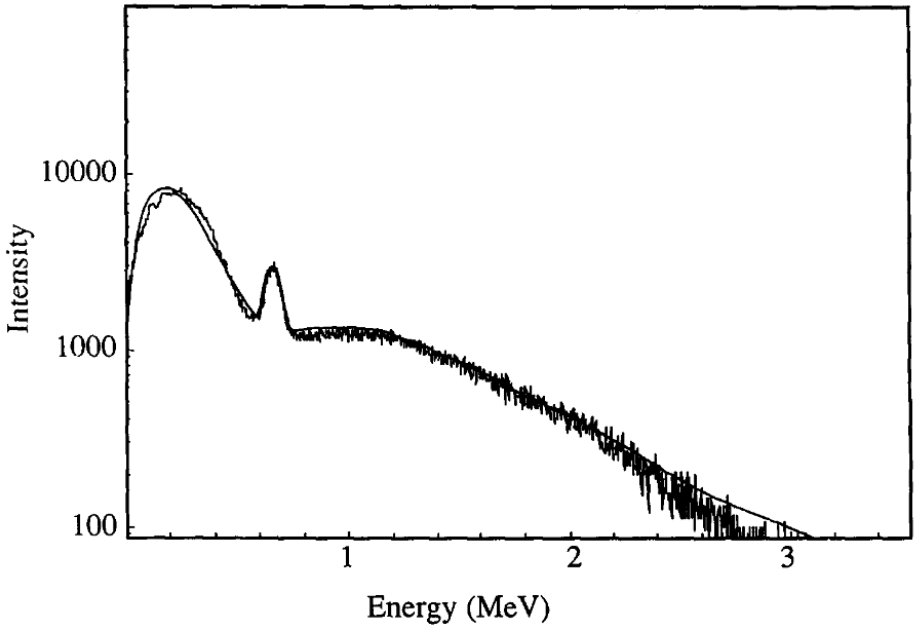
All channels

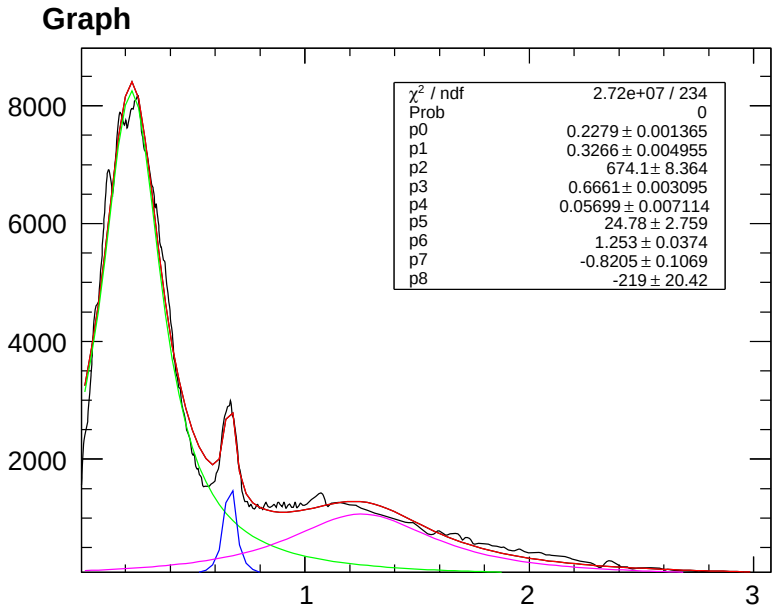




Channels with neutron

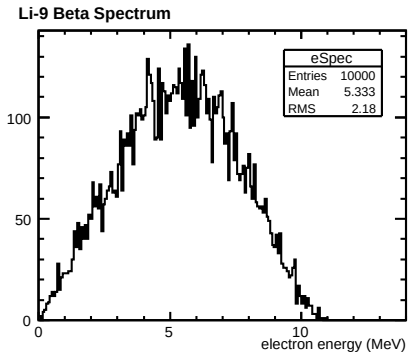
^{9}Li neutron spectrum

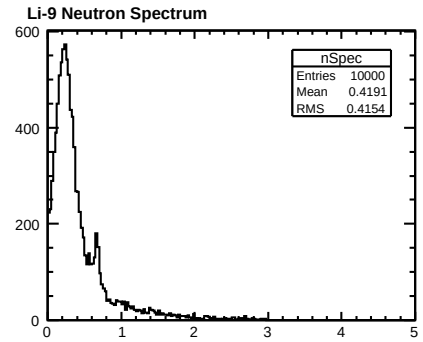


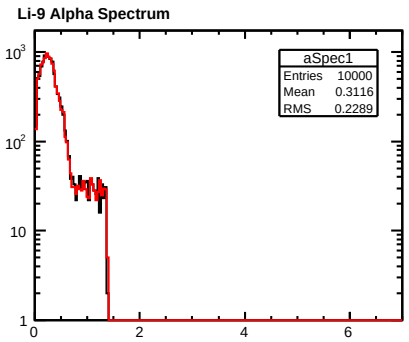


- The first peak comes from: ^{9}Be*(2.43 MeV)$\rightarrow$^{8}Be(2$^+$)$+n$, ^{8}Be(2$^+$)$\rightarrow \alpha + \alpha$.
- The second peak comes from: ^{9}Be*(2.43 MeV)$\rightarrow$^{5}He$+\alpha$, ^{5}He$\rightarrow n + \alpha$.
- High energy bump mainly comes from: ^{9}Be*(2.78 MeV)$\rightarrow \alpha + \alpha + n$
- Fit with three Breit-Wigner function. Use the obtained lineshape to produce neutron spectrum.

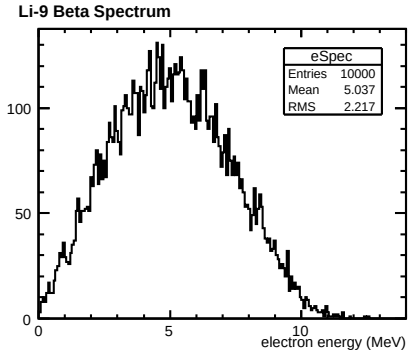
^{9}Li decay channels with neutron

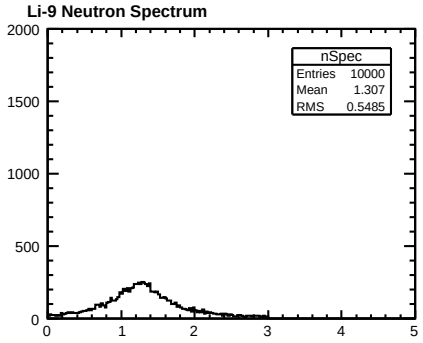


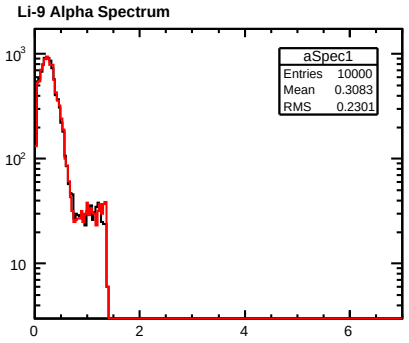




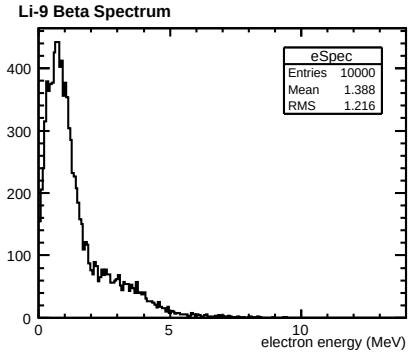
^{9}Be(2.43 MeV) 58.5%

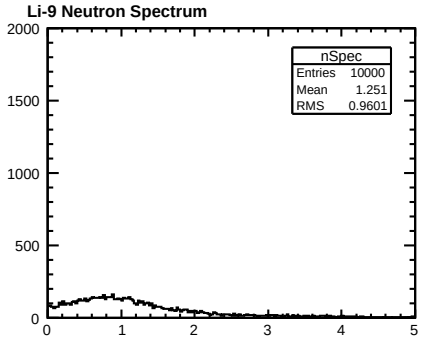


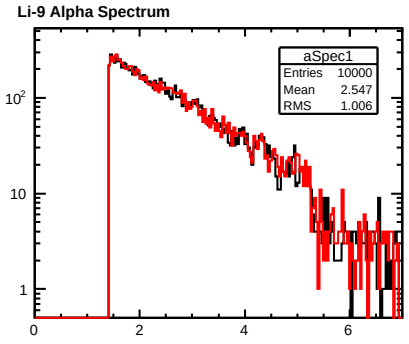




^{9}Be(2.78 MeV) 31.1%

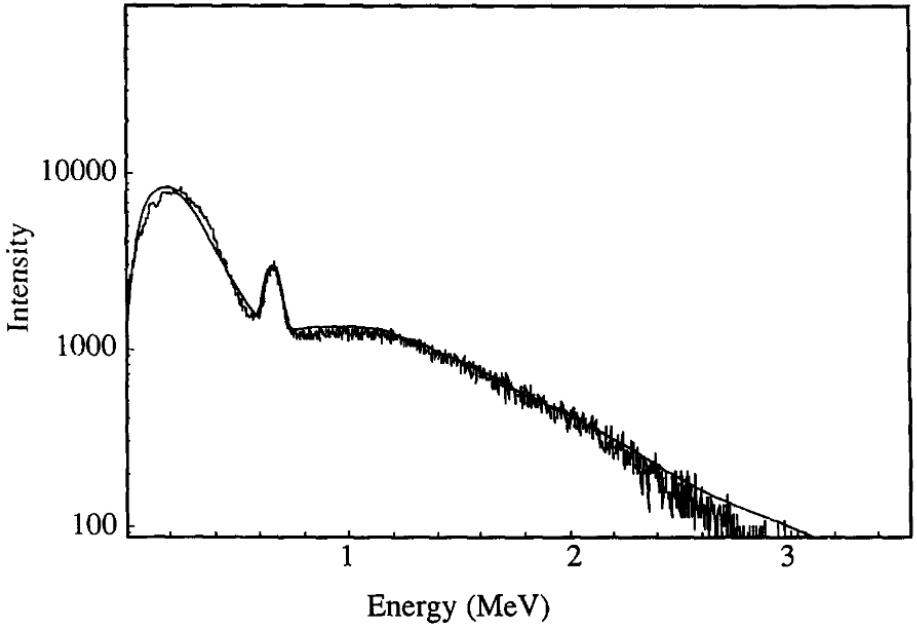


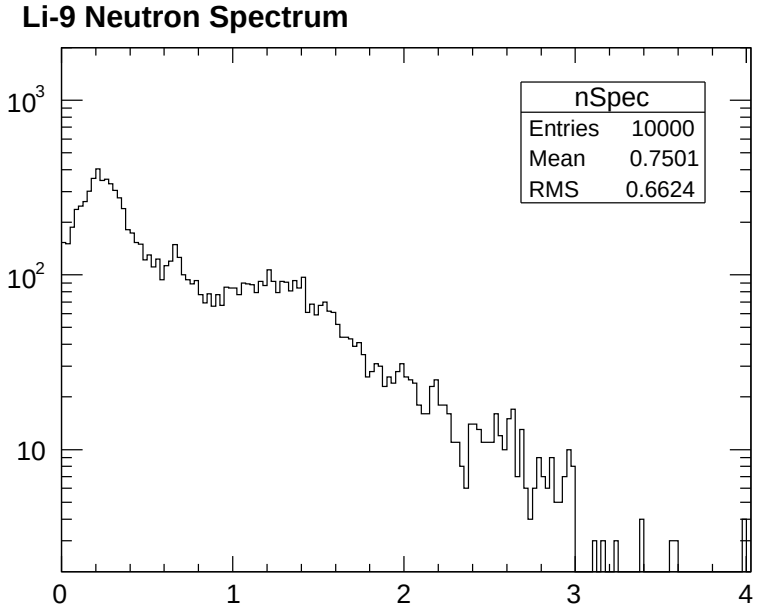




^{9}Be(7.94, 11.28, 11.81 MeV) 10.4%

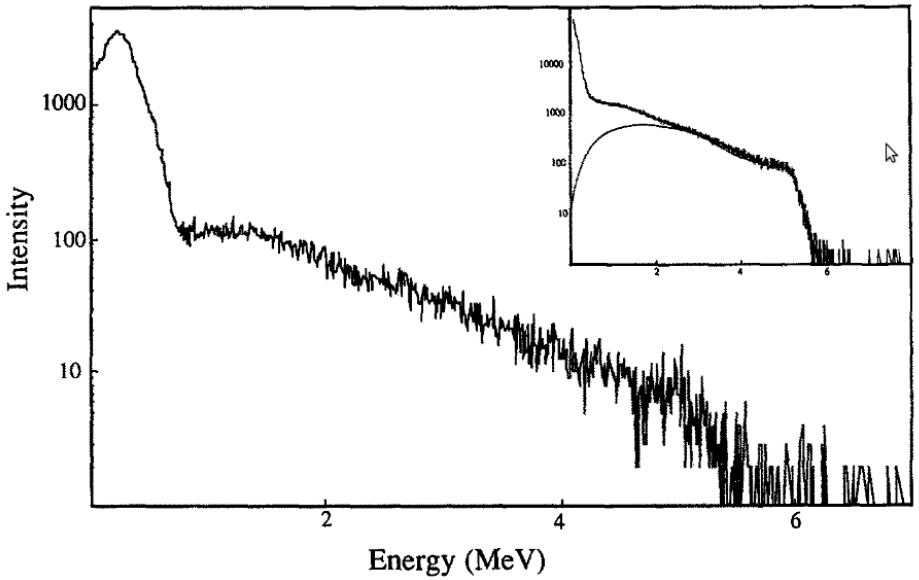
^{9}Li neutron spectrum

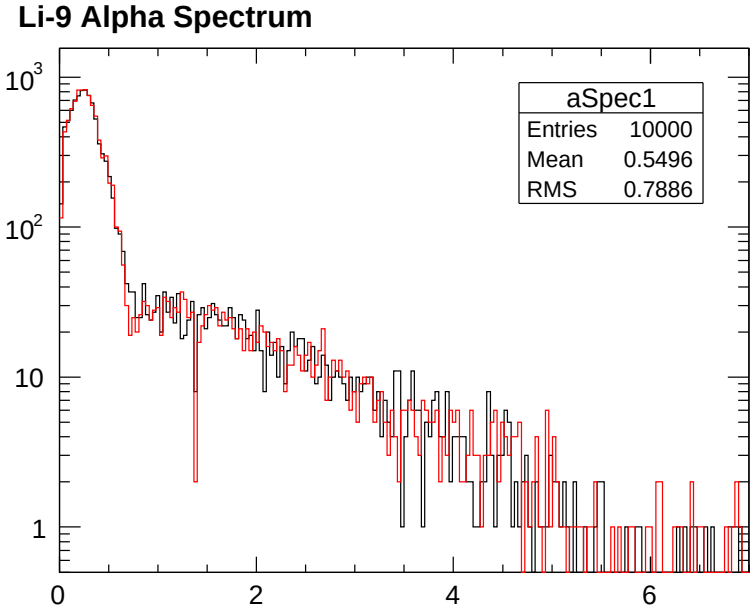




- Left: Nuclear Physics A510 (1990) 189-208
- Right: Generated neutron spectrum

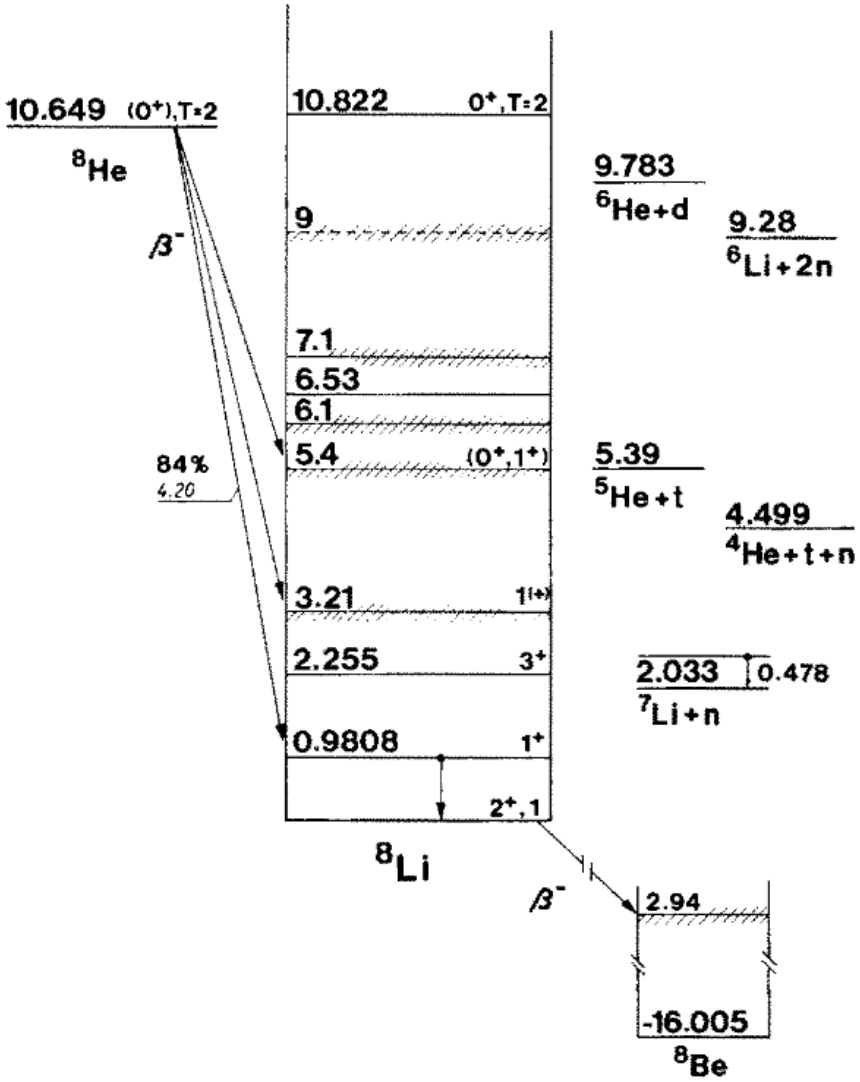
^{9}Li α spectrum





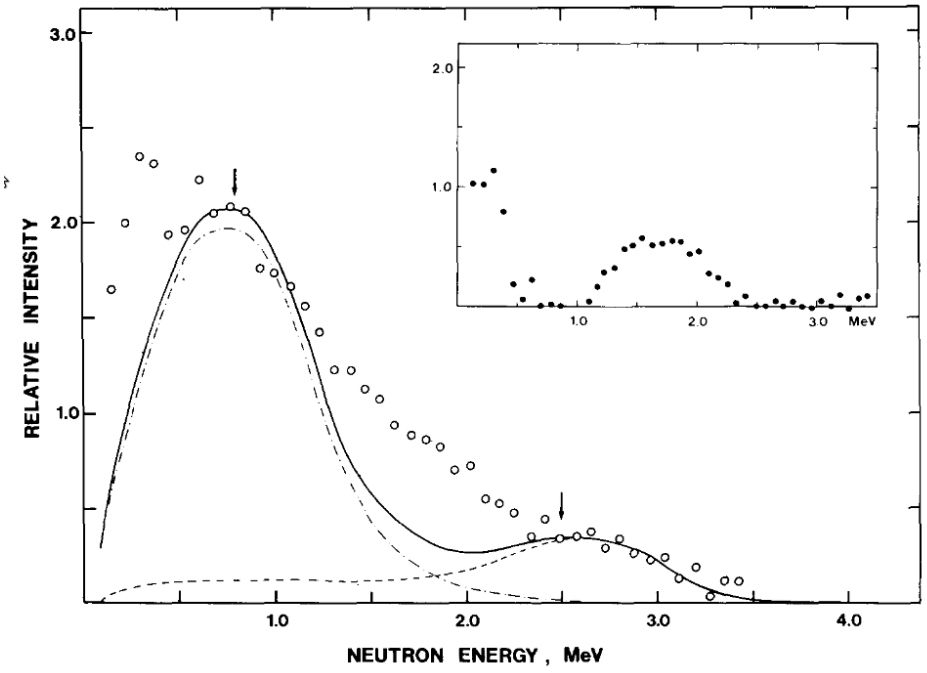
- Left: Nuclear Physics A510 (1990) 189-208
- Right: Generated α spectrum
- Most low energy α's. No correlation is considered between the two α's, both generated according the same spectrum.

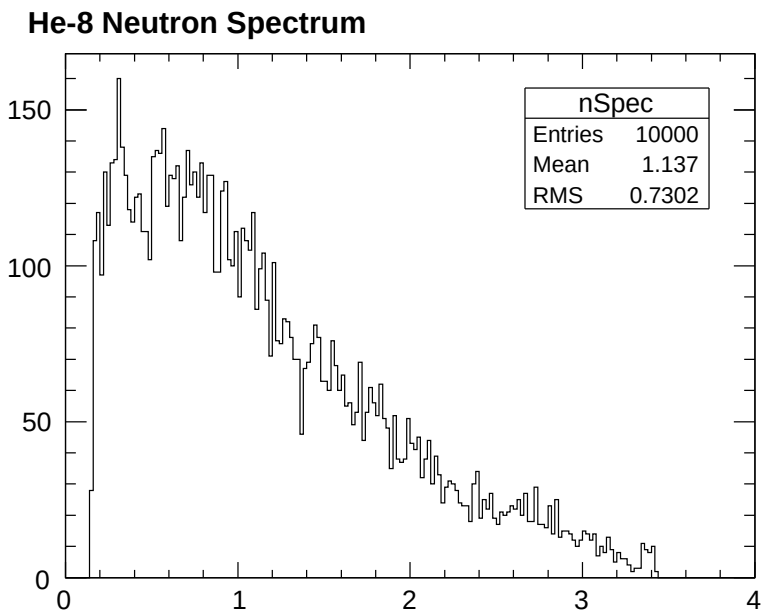
^{8}He decay



- Nuclear Physics A366 (1981) 461-468
- 16% branching fraction to produce neutrons.
- ^{8}He$\rightarrow^8$Li(3.21 MeV), ^{8}Li(5.4 MeV) br. set to 3:1 according Nuclear Physics A487 (1988) 269-278
- Accompanying γs. 32% radiate a gamma (0.478 MeV) when there is neutron in the decay.
- No α is included in the generator.

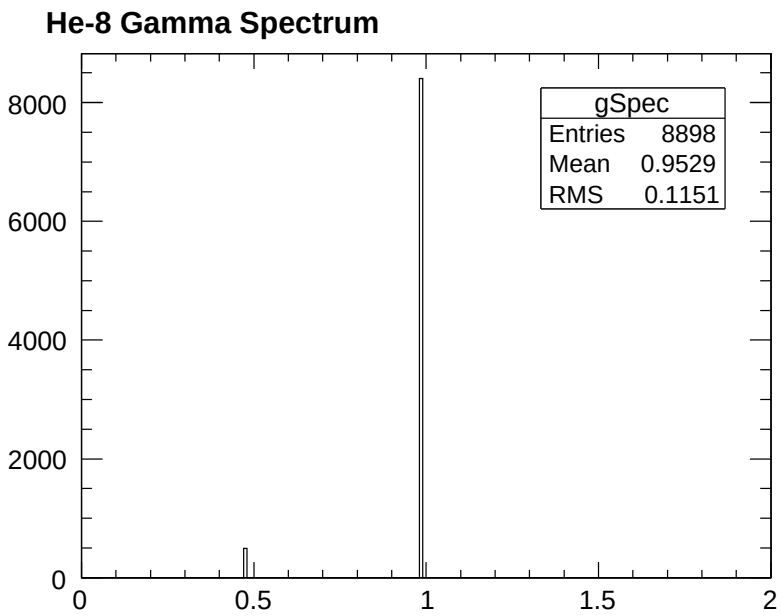
^{8}He neutron spectrum

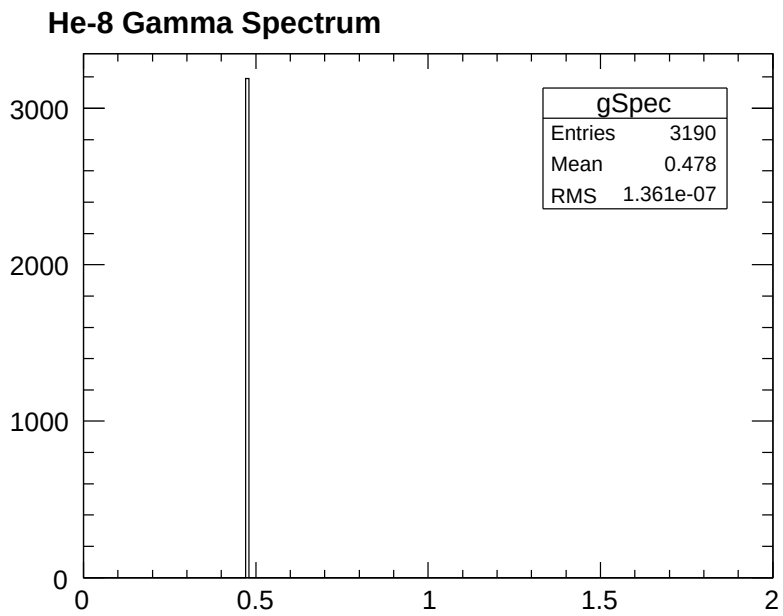




- Left: Nuclear Physics A366 (1981) 461-468
- Right: Generated neutron spectrum

^{8}He gamma spectrum





- Left: γ from all channels
- Right: γ spectrum when there is neutron

Use the generator

- Standalone generator
- Usage:

```
Li9He8.exe [-seed seed] [-o outfilename] [-n nevents]
[-Li9fraction fraction] [-complete_decay]
```

  - Can adjust ^{9}Li, ^{8}He mixture.
  - Pure ^{9}Li: "-Li9fraction 1.0"
  - Pure ^{8}He: "-Li9fraction 0.0"
  - Default is 0.85
  - If choose "-complete_decay" option, will include all channels of ^{9}Li, ^{8}He decays. Default setting only includes decays having neurons.
- `EsFrontEndAlg  ERROR SimHits span to much time (79.33 us). Simulate kinematics individually, or use the Fifteen algorithm.`

Useful documents

- Ry Ely and Jen-Chieh Peng, DYB-doc-1067
- Viktor Pec, DYB-doc-3566
- Liangjian Wen et al., NIM 564(2006) 471-474
- DYB-doc-3566 has a list of reference, will not repeat here.
- A couple of things for DYB-doc-1067: 1) The beta spectrum is $|P|$, not kinetic energy. 2) The Z value for daughters of ^{8}He, ^{9}Li should be 3 and 4, respectively, instead of 1 and 2.