Technical Note: ^{11}C Spallation Production Measurement

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Abstract

This technical note describes the ^{11}C measurement in KLZ and how the rate is extracted.

Spallation Event Selection

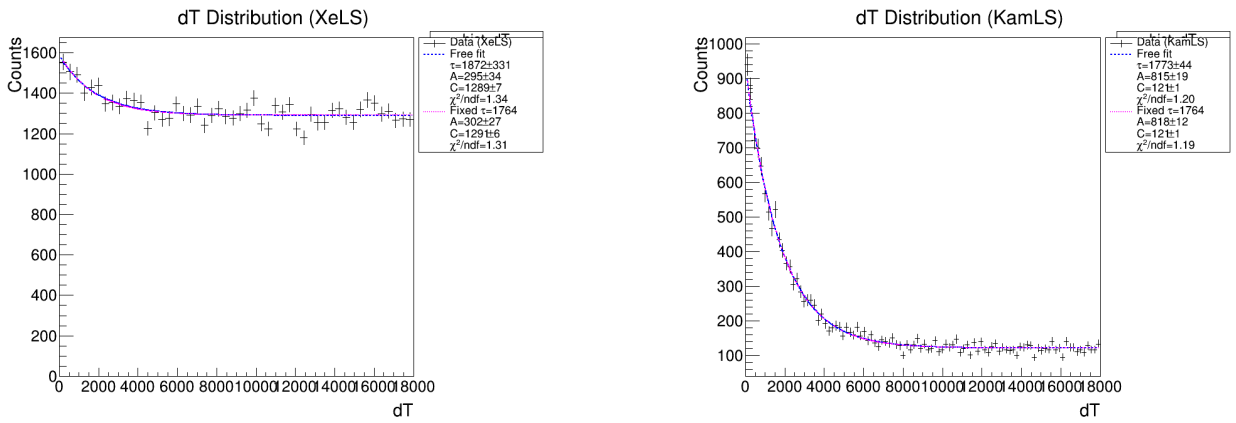
- FBE muon selection cuts
- MoGURA neutron selection cuts
- Neutron Shower Cuts ($N_n = 1$)
- ^{11}C Candidate cuts
  - Energy Range
  - FBE Run Start Delay
  - Radius
- dR Cut

Fit to dT

dT of muon-event pairs where the neutron shower contained 1 observed neutron is shown in Figure 1.

Rate Calculation

- Exposure, Livetime
- MoGURA Deadtime
  - simply scale up based on the deadtime since muons that occur during deadtime will not be able to create accurate pairs.
  - Have to go through the MoGURA/FBE runs and check for overlap. (May be some function of the integral of ^{11}C half-life?)



(a) XeLS (b) KamLS

Figure 1: dT of muon-event pairs where the neutron shower contained 1 observed neutron.

- Neutron Production : How many muons that create ^{11}C create exactly 1 **observed** neutron
  - Muons that create ^{11}C and create 1+ neutrons, some fraction of those have only one detected (Toy MC calculation using Neutron Tagging Efficiency)
  - The rate of muons creating other isotopes is not important, because those are not in the "good" exponential distribution of $\mu-^{11}$C pairs.
- dR cut efficiency (from FLUKA tuned with ^{11}C), for each data period
- Fiducial Volume Cut Efficiency (from MC)
- Energy Cut Efficiency

Systematic Errors

- Exposure Uncertainty, from theses FV uncertainty 4%
- Neutron Tagging Efficiency Error: $74.5\% \pm 0.4\%$
- FLUKA simulation Systematic : dR Cut, Neutron Production
- FLUKA simulation Statistical (small)
- Energy Scale Uncertainty? (use 1 sigma of kB, R contour)

Result