Complications:

Position reconstruction

long drift time = more squeezing

drift time -> z (mm) mapping is not one-to-one, and absorption cross section is velocity dependent so we can’t really define an electron lifetime anymore

Field induced recombination variation

Lower field leads to more recombination, and therefore less S2 signal (at bottom of det)

Effect is energy dependent (figure 3), so corrections based solely on Kr83 like in Run03 are no long valid

Results of Run03 KrypCal

Floating g1 and EE to get the optimal Kr and CH3T energy spectra in Sep 2014 and Sep 2015 (similar to what we do for the new corrections)

EE of 0.98, 20-40% higher than our expectation of 60-80%.

Total reduced chi2 of 3.37 (5.07 for CH3T, and 1.67 for Kr)

DD peaks do not line up (fig 6)

Electron lifetime reaches a plateau at ~400 uSec, when it should be much higher (~1200)

Goal

Separate field effects for detector inefficiency effects, and correct only for the later.

We need to do this at all points in time, so we will try to relate the strength of the field effect to the Kr S1a/S1b ratio.

Should end up with data that has good energy reconstruction, but spatial and time dependence in the S1 and S2 signal from recombination variation

Measuring the field effect

We’d like to measure detector inefficiency in Kr data, but we can’t use NEST to remove field effects

First remove field effects from tritium data with NEST.

Measure detector inefficiency corrections in tritium data (can only do this with S2 data)

Apply those detector inefficiency corrections to Kr data

Measure the residual pulse area variation, which is due to field effects alone.

Relate the residual to S1a/S1b (Fig 20). Y axis is the strength of the field effect (S2\_E(xyz)/S2\_E(center)), \_E is for efficiency corrected

To get the S1 field effect to S1a/S1b relationship we tried using recombination physics, but didn’t work. (section III.6)

Instead, turn to a chi2 method. (section 7)

Use the measured S2 field to S1a/S1b field relationship, and float the S1 field to S1a/S1b field relationship

Remove the field from Kr data with these relationships

Produce efficiency corrections for Kr and CH3T data

Float G1 and G2, and find the optimal Kr and CH3T energy spectra in Sep 2014 and Sep 2015 by minimizing chi2 between expected and observed energy spectra

Note, the “total” chi2 that is minimized is the average of the CH3T and Kr chi2.

Result: with a reasonable extraction efficiency of 0.78, get a reduced chi2 of 1.54 for Kr, and 2.4 for CH3T – not great, but way better than what we started with. Why the low p-value:

Looks like NEST underestimates the detector smearing, based on figure 25

Also, we can get much better p-values for Kr and CH3T separately, but if we focus on one the other one becomes much, much worse (ex, for Kr reduced chi2 of 0.2, but for ch3t reduced chi2 of 35.5)… suggests the poor p-value results from balancing Kr and CH3T at the same time.

Not sure what we would get if we did this with Run03 data, but the total, unbinned Kr spectrum is within one standard deviation of the Run03 Kr energy peak variation… so that suggests we’re dealing with similar energy reconstruction

Section V