SNOLAB Background Counting Exercise:

Instructor's Notes

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Students will be analyzing the samples that they counted the previous day.

SNOLAB staff will prepare the data by:

1. Combining and cleaning the data files on Science1 using the HPGE software or the web-interface version.
2. Cleaning up the header file information using the HPGE software:
    a. Simplify the sample name
    b. Change the detector name to PGT
    c. Apply the "newcal" energy scaling
3. Providing a .chn and .csv file for each sample.
4. Producing MC simulations of the samples. Students will be provided with a file containing MC efficiencies at ~15 energies.

Students will:

1. Use InterSpec to explore their data and perform initial peak fits
2. Use InterSpec and the Lund database to identify the source isotopes for their lines. We expect to see:
    a. K-40
    b. Products of the Th-232 and U-238 chains.
3. Calculate the total counts (with error) for each peak.
    a. The fitting from InterSpec should be good enough.
    b. If not, the lecture demonstrates an integration method.
    c. Students can use excel or python to read in the .csv file, apply the energy calibration, and integrate the peaks.
4. Convert the total counts into an Activity.
    a. Interpolate the efficiency at their energy from the MC efficiency file.
    b. Estimate an error on their interpolation
    c. Look up the line intensity from the Lund Database.
    d. Use the sample mass they measured
    e. Use the LiveTime from the data.
5. If they find multiple lines in a chain, they should compare the activities of those lines.
    a. Look for 36% BR of Pb-212 to Tl-208
    b. Look for increased or decreased line intensities due to Rn diffusion out of source or Rn contamination of source.

Worked Example:

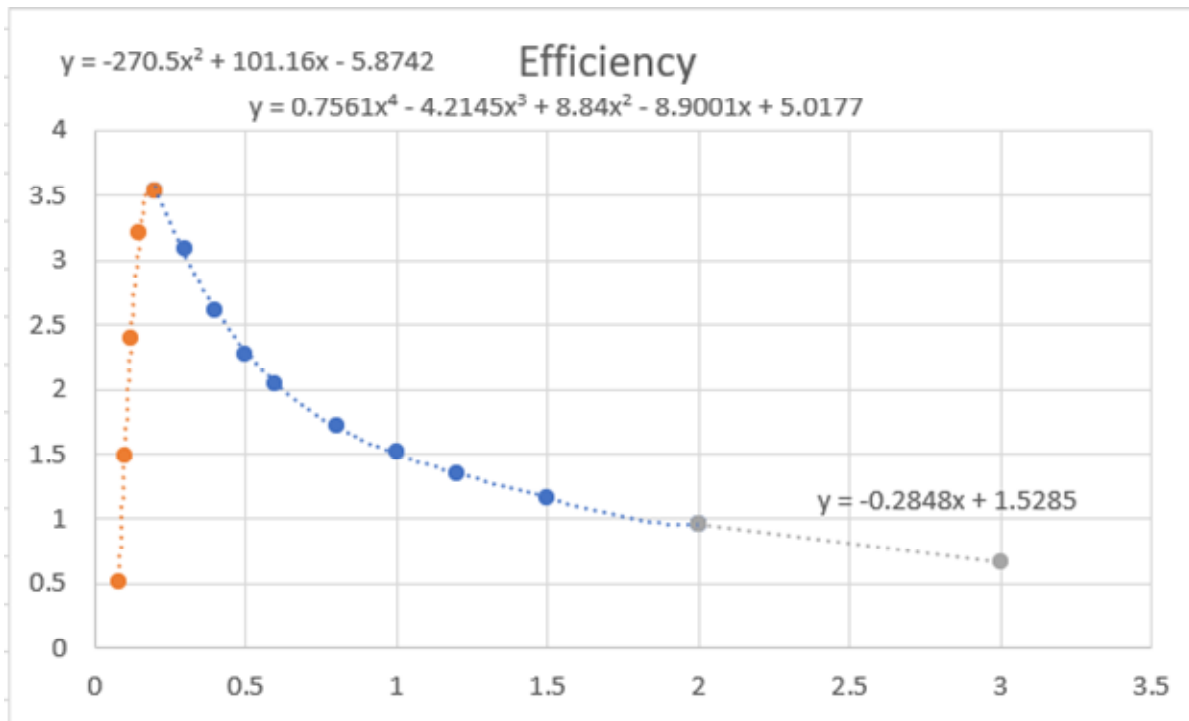Analyzing K-40 from the September 16, 2013 run with 884.4 g of mine dust.

The run had a livetime of 5160 seconds.

Total Counts = 1720 +/- 42

InterSpec has a good fit for the 1460.8 keV K-40 line: **1720 +/- 42** counts.

Efficiency = 0.0119 +/- 0.0012

Imported Mine_Dust_Efficiency into excel. Created fit curves. Estimate 10% uncertainty on curves. This is greater than the 5% uncertainty on the MC.

Ig = 11 +/- 0.2 %

11% from Lund database. No uncertainties given, so assume 0.2%.

M = 884.4 +/- 0.1 g

t = 5160 +/- 1 s

Activity = 288.9 Bq/kg

A = 1720 / 0.0118 /.11 /0.8844 /5160 = 288.9 Bq/kg

Activity Uncertainty = 30.2 Bq/kg

279.9 * sqrt((42/1720)^2 + (.0012/.0118)^2 + (0.002/.11)^2 + (0.1/884.4)^2 + (1/75160)^2)

The dominant uncertainties are:

1. Efficiency Correction
2. Counting Statistics
3. Literature value of Line Intensity