Trying to fit source calibration spectra

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First Thought: Describe analytically

• Describe spectrum with Compton edge function + three Gaussian (6.1 MeV + 1st + 2nd escape peak)

• Cross-section ratio known:
  attenuation due to incoherent scattering (Compton scattering) over attenuation due to pair production

• Correct description for initial interaction

• But not complete: scattered photon can still deposit energy

⇒ No full description
Second Thought:  
Use noise run to subtract background

- Noise believed to be
  - electronics noise at low energies ($\lesssim 4$ MeV)
  - cosmic background (visible $\gtrsim 7$ MeV)
- Cosmic rate proportional to live-time
- Noise run:
  Accumulating data without neutron generator

Noise samples:
Algorithm (for each crystal)

- Take noise run right before or after run with NG on
  \[ \downarrow \text{noise spectrum} \quad \downarrow \text{signal+background spectrum} \]
- Fit noise spectrum to exponential (electronics noise)
  \[ + \text{constant (cosmics)} \]
- Fit signal+background spectrum at high end to constant (cosmics)
- Scale noise spectrum fit to have same size in high end
- Subtract noise spectrum fit from signal+background fit

\[ \Rightarrow \text{Only signal should remain} \]
Example:

Run 183 taken July 1, 2002  1:15am with NG
Run 184 taken July 1, 2002  1:30am without NG

- Fit to noise spectrum (Crate 0 Slot 9 Channel 0):

  (final fit = binned maximum likelihood fit)

  here constant term: 0.33165
• Fit to signal+background spectrum:
  ○ first rough fit to signal+bkgd spectrum
to find bin with exponential 1/1000 of peak
  ○ then fit constant to bins above

Here bin fitting bins 146 to 200
constant term: 1.29086 $\Rightarrow$ scale factor 3.89
Blue: Noise

Red: Signal + Background

Black: Background estimated from Noise

full spectrum

high end only
Everything in one plot:

Pink: Noise (scaled)  Red: Signal + Background (original)
Black: Fit to noised (scaled)  Blue: Background (Red minus Black)

Looks reasonable
• Similarly high at other crystals (Crate 0 Slot 9 Channel 1):
- Endcap Crate 9 Slot 7 Channel 13:
Endcap Crate 9 Slot 9 Channel 34:

⇒ Appears to be fine
Another set of runs:

Jan 23, 2003: Sum of good parts in Runs 216 to 219
Jan 23, 2003: Run 215 taken without NG \(\sim 3\) minutes

- Crate 0 Slot 9 Channel 0:

![Graphs showing noise and signal-background data](image)

(Algorithm looks for highest local maximum)
Noise spectrum:  \[ \text{Constant term} = 0.51203 \]

Sig+Bkgd spectrum:  \[ \text{Fitting bins 154 to 200} \rightarrow \text{Constant term} = 12.681 \]

\[ \Rightarrow \text{scale factor 24.8} \]

Subtracting too much!

(If fitting noise spectrum bins 154 to 200 with constant:  \[ \text{constant term} = 0.361702 \Rightarrow \text{scale factor 35.1} \])
Crate 0 Slot 9 Channel 1:

Also subtracting too much…
Endcap Crate 9 Slot 9 Channel 34:
Endcap Crate 9 Slot 9 Channel 34:
Mixing runs

Jan 23, 2003: Sum of good parts in Runs 216 to 219 (with NG)
Jul 01, 2002: Run 184 noise \(\sim 3\) minutes (without NG)

Not much better...
Conclusion

• First idea not working, but might provide guidance to fitting function
  Matt: 6 MeV MC generator available in BABAR code

• Second idea seems to be working for old run (with NG working well),
  not good for new run b/c scale factor too large

• Why can noise run not predict background?
  ○ Why is background peaked sharper for noise runs?
  ○ Or why are 'more' cosmics in run with NG on?
  ○ Are they really cosmics? (Matt: some higher E decays from $^{16}$N)

• Another way to subtract background?
  ○ How about using only shape of noise?
    * Use this shape + flat Compton distribution at low energy
      + Gaussian peaks as fit function?
    * Letting bkgd normalization float as one fit parameter?
      (similar to presentation Nov 13, 2002,
       but no good signal function at that time)

⇒ Needs more work...