

Background Noise Integrated

Taking the slope and the y-intercept from the custom gaussian and first order polynomial fit and integrating over the same range of energies to get the area of the background.

898 keV

r6978

```
In[819]:= n1 = Integrate[-0.274308 * x + 256.727, {x, 870, 930}]
```

```
Out[819]= 590.988
```

r6980

```
In[820]:= n2 = Integrate[-0.466126 * x + 626.402, {x, 870, 930}]
```

```
Out[820]= 12413.316
```

r7022

```
In[821]:= n3 = Integrate[0.00185989 * x + 17.1513, {x, 870, 930}]
```

```
Out[821]= 1129.51206
```

r7023

```
In[822]:= n4 = Integrate[-0.148602 * x + 184.187, {x, 870, 930}]
```

```
Out[822]= 3026.712
```

r7107

```
In[823]:= n5 = Integrate[-0.345539 * x + 323.534, {x, 870, 930}]
```

```
Out[823]= 752.934
```

r7108

```
In[824]:= n6 = Integrate[-0.0223200 * x + 82.6422, {x, 870, 930}]
```

```
Out[824]= 3753.252
```

r7203

```
In[825]:= n7 = Integrate[0.0369262 * x - 23.8649, {x, 870, 930}]
```

```
Out[825]= 562.1208
```

r7204

```
In[826]:= n8 = Integrate[1.02463 * x - 833.156, {x, 870, 930}]
```

```
Out[826]= 5340.66
```

r7235

```
In[827]:= n9 = Integrate[-0.049086 * x + 50.3451, {x, 870, 930}]
```

```
Out[827]= 370.062
```

r7236

```
In[828]:= n10 = Integrate[0.236392 * x + 94.2954, {x, 870, 930}]
```

```
Out[828]= 18422.892
```

1836.1 keV

r6978

```
In[829]:= n11 = Integrate[-0.0367690 * x + 69.5478, {x, 1800, 1860}]
```

```
Out[829]= 135.6318
```

r6980

```
In[830]:= n12 = Integrate[-0.0289860 * x + 73.3522, {x, 1800, 1860}]
```

```
Out[830]= 1218.4692
```

r7022

```
In[831]:= n13 = Integrate[0.00899005 * x - 15.1294, {x, 1800, 1860}]
```

```
Out[831]= 79.34349
```

r7023

```
In[832]:= n14 = Integrate[-0.0806490 * x + 155.393, {x, 1800, 1860}]
```

```
Out[832]= 468.3198
```

r7107

```
In[833]:= n15 = Integrate[0.0595069 * x - 107.776, {x, 1800, 1860}]
```

```
Out[833]= 67.29762
```

r7108

```
In[834]:= n16 = Integrate[-0.0245740 * x + 56.6525, {x, 1800, 1860}]
```

```
Out[834]= 700.9248
```

r7203

```
In[835]:= n17 = Integrate[-0.00212520 * x + 5.14499, {x, 1800, 1860}]
```

```
Out[835]= 75.35244
```

r7204

```
In[836]:= n18 = Integrate[0.295440 * x - 526.173, {x, 1800, 1860}]
```

```
Out[836]= 868.932
```

r7235

```
In[837]:= n19 = Integrate[0.154287 * x - 281.948, {x, 1800, 1860}]
```

```
Out[837]= 23.8326
```

r7236

```
In[939]:= n20 = Integrate[0.0813157 * x - 106.932, {x, 1800, 1860}]
```

```
Out[939]= 2512.54386
```

May want to adjust the integration limits. The coincidence run 7236 has some peak shifting that was probably caused by the liquid nitrogen being refilled in the tanks during runs. Runs 7203 and 7204 have some broader peaks that are shifted as well.

Integrating Gaussian

$$f = \frac{1}{\sigma\sqrt{2\pi}} * \text{Exp}\left[-\frac{1}{2} \left(\frac{x-\mu}{\sigma}\right)^2\right]$$

Used the equation for a gaussian with values obtained from fitting the peak after the background had been subtracted to find the area under the curve. Values calculated are smaller than those given by the ROOT fit.

898 keV:

■ Singles:

r6978

```
In[839]:=  $\mu = 897.416;$   

 $\sigma = 1.12141;$   

g1 = Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}[-\frac{1}{2} (\frac{x - \mu}{\sigma})^2]$ , x] == 292.5, A] [[  

  1]] [[1]] [[2]]
```

Out[841]= 822.2052189

r7022

```
In[842]:=  $\mu = 897.481;$   

 $\sigma = 0.750439;$   

g2 = Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}[-\frac{1}{2} (\frac{x - \mu}{\sigma})^2]$ , x] == 362.7, A] [[  

  1]] [[1]] [[2]]
```

Out[844]= 682.264675

r7107

```
In[845]:=  $\mu = 897.581;$   

 $\sigma = 1.09091;$   

g3 = Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}[-\frac{1}{2} (\frac{x - \mu}{\sigma})^2]$ , x] == 130.5, A] [[  

  1]] [[1]] [[2]]
```

Out[847]= 356.8530136

r7203

```
In[848]:=  $\mu = 897.352;$   

 $\sigma = 2.97881;$   

g4 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}[-\frac{1}{2} (\frac{x - \mu}{\sigma})^2]$ , x] == 17.4328, A] [[  

  1]] [[1]] [[2]]
```

```
Out[850]= 130.1666971
```

r7235

```
In[851]:=  $\mu = 903.293;$   

 $\sigma = 1.03909;$   

g5 = Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}[-\frac{1}{2} (\frac{x - \mu}{\sigma})^2]$ , x] == 84.64, A] [[  

  1]] [[1]] [[2]]
```

```
Out[853]= 220.4543913
```

■ Coincidence:

r6980

```
In[854]:=  $\mu = 895.417;$   

 $\sigma = 1.19573;$   

g6 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}[-\frac{1}{2} (\frac{x - \mu}{\sigma})^2]$ , x] == 4132.5, A] [[  

  1]] [[1]] [[2]]
```

```
Out[856]= 12386.13822
```

r7023

```
In[857]:=  $\mu = 896.893;$   

 $\sigma = 1.00875;$   

g7 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}[-\frac{1}{2} (\frac{x - \mu}{\sigma})^2]$ , x] == 1232.2, A] [[  

  1]] [[1]] [[2]]
```

```
Out[859]= 3115.693199
```

r7108

```
In[860]:=  $\mu = 897.483;$   

 $\sigma = 1.24805;$   

g8 =  

Solve[A * MaxValue[ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}\left[-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2\right]$ , x] == 707.85, A][[1]][[1]][[2]]
```

```
Out[862]= 2214.436112
```

r7204

```
In[863]:=  $\mu = 903.99;$   

 $\sigma = 1.06558;$   

g9 =  

Solve[A * MaxValue[ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}\left[-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2\right]$ , x] == 309, A][[1]][[1]][[1]][[2]]
```

```
Out[865]= 825.3430037
```

r7236

```
In[866]:=  $\mu = 908.035;$   

 $\sigma = 1.78833;$   

g10 =  

Solve[A * MaxValue[ $\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}\left[-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2\right]$ , x] == 608, A][[1]][[1]][[1]][[2]]
```

```
Out[868]= 2725.468554
```

1836.1 keV:

■ **Singles:**

r6978

```
In[869]:=  $\mu = 1837.6;$   

 $\sigma = 1.19410;$   

g11 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 185, A] [[1]] [[1]]
```

```
Out[871]= 553.7354922
```

r7022

```
In[872]:=  $\mu = 1837.72;$   

 $\sigma = 1.28517;$   

g12 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 174.2, A] [[1]] [[1]] [[2]]
```

```
Out[874]= 561.1754507
```

r7107

```
In[875]:=  $\mu = 1838.56;$   

 $\sigma = 1.22172;$   

g13 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 71.8, A] [[1]] [[1]] [[2]]
```

```
Out[877]= 219.8801689
```

r7203

```
In[878]:=  $\mu = 1839.05;$   

 $\sigma = 4.91678;$   

g14 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 6.75824, A] [[1]] [[1]] [[2]]
```

```
Out[880]= 83.29219764
```

r7235

```
In[881]:=  $\mu = 1850.02;$   

 $\sigma = 1.13536;$   

g15 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 28.9, A] [[1]] [[1]]
```

```
Out[883]= 82.24724631
```

■ **Coincidence:**

r6980

```
In[884]:=  $\mu = 1833.39;$   

 $\sigma = 1.72362;$   

g16 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 2160.9, A] [[1]] [[1]] [[2]]
```

```
Out[886]= 9336.113621
```

r7023

```
In[887]:=  $\mu = 1836.02;$   

 $\sigma = 1.63517;$   

g17 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 515.5, A] [[1]] [[1]] [[2]]
```

```
Out[889]= 2112.91251
```

r7108

```
In[890]:=  $\mu = 1838.12;$   

 $\sigma = 1.87659;$   

g18 =  

Solve [A * MaxValue [ $\frac{1}{\sigma * \sqrt{2 * \pi}}$  * Exp [ $-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2$ ], x] == 402, A] [[1]] [[1]] [[2]]
```

```
Out[892]= 1890.973249
```


r7204

In[893]:=

 $\mu = 1824.15;$ $\sigma = 1.66372;$

g19 =

$$\text{Solve}\left[A * \text{MaxValue}\left[\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}\left[-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2\right], x\right] == 226.5, A\right][[1]][[1]][[2]]$$

Out[895]=

944.5791998

r7236

In[896]:=

 $\mu = 1861.15;$ $\sigma = 5.35845;$

g20 =

$$\text{Solve}\left[A * \text{MaxValue}\left[\frac{1}{\sigma * \sqrt{2 * \pi}} * \text{Exp}\left[-\frac{1}{2} \left(\frac{x - \mu}{\sigma}\right)^2\right], x\right] == 384.281, A\right][[1]][[1]][[2]]$$

Out[898]=

5161.524926

Activity

Using the area to the gaussian for each peak found above, I divided by the time of counting run. I also graphed to the activity vs. the days since activation.

898 keV

■ Singles:

```
In[899]:= a1 = g1 / 279 // N
          a2 = g2 / 359 // N
          a3 = g3 / 283 // N
          a4 = g4 / 236 // N
          a5 = g4 / 244 // N
```

```
Out[899]= 2.946972111
```

```
Out[900]= 1.900458705
```

```
Out[901]= 1.260964712
```

```
Out[902]= 0.5515538012
```

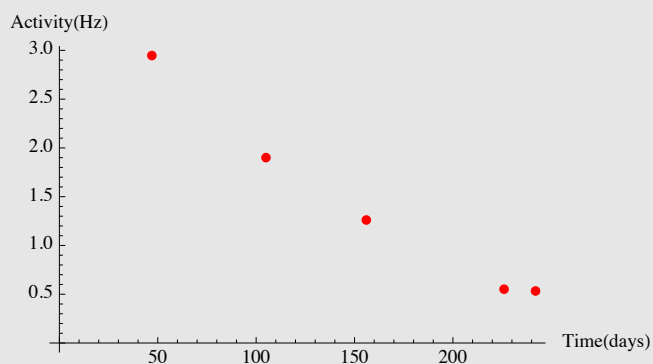
```
Out[903]= 0.53347007
```

□ Decay Plot

```
In[947]:= decay1 = {{47, a1}, {105, a2}, {156, a3}, {226, a4}, {242, a5}};
```

```
ListPlot[decay1, AxesOrigin -> {0, 0},
          PlotStyle -> Directive[PointSize[Medium], Red],
          AxesLabel -> {Time [days], Activity [Hz]}]
```

```
Out[953]=
```



■ Coincidence:

```
In[904]:= a6 = g6 / 80 612 // N  
a7 = g7 / 63 417 // N  
a8 = g8 / 82 004 // N  
a9 = g9 / 84 303 // N  
a10 = g10 / 504 396 // N
```

```
Out[904]= 0.1536512953
```

```
Out[905]= 0.04913025213
```

```
Out[906]= 0.02700400118
```

```
Out[907]= 0.009790197308
```

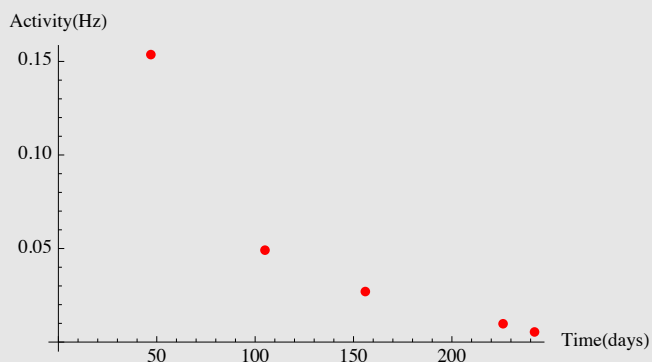
```
Out[908]= 0.00540343015
```

□ Decay Plot

```
In[946]:= decay2 = {{47, a6}, {105, a7}, {156, a8}, {226, a9}, {242, a10}};
```

```
In[948]:= ListPlot[decay2, AxesOrigin -> {0, 0},  
PlotStyle -> Directive[PointSize[Medium], Red],  
AxesLabel -> {Time [days], Activity [Hz]}]
```

```
Out[948]=
```



1836.1 keV

■ Singles:

```
In[909]:= a11 = g11 / 279 // N
          a12 = g12 / 359 // N
          a13 = g13 / 283 // N
          a14 = g14 / 236 // N
          a15 = g15 / 244 // N
```

```
Out[909]= 1.984715026
```

```
Out[910]= 1.563162815
```

```
Out[911]= 0.7769617276
```

```
Out[912]= 0.3529330409
```

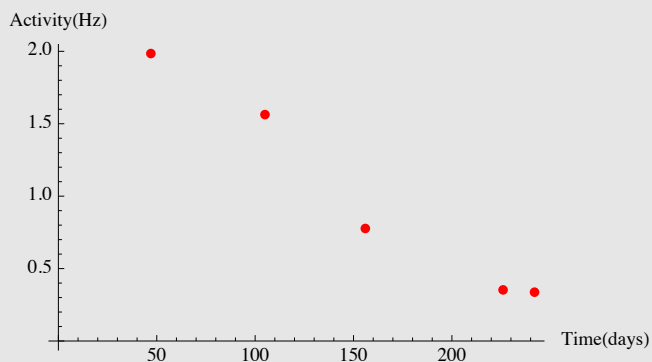
```
Out[913]= 0.3370788783
```

□ Decay Plot

```
In[949]:= decay3 = {{47, a11}, {105, a12}, {156, a13}, {226, a14}, {242, a15}};
```

```
In[950]:= ListPlot[decay3, AxesOrigin -> {0, 0},
                  PlotStyle -> Directive[PointSize[Medium], Red],
                  AxesLabel -> {Time [days], Activity [Hz]}]
```

```
Out[950]=
```



■ Coincidence

```
In[914]:= a16 = g16 / 80 612 // N
a17 = g17 / 63 417 // N
a18 = g18 / 82 004 // N
a19 = g19 / 84 303 // N
a20 = g20 / 504 396 // N
```

```
Out[914]= 0.1158154322
```

```
Out[915]= 0.03331776196
```

```
Out[916]= 0.02305952452
```

```
Out[917]= 0.01120457398
```

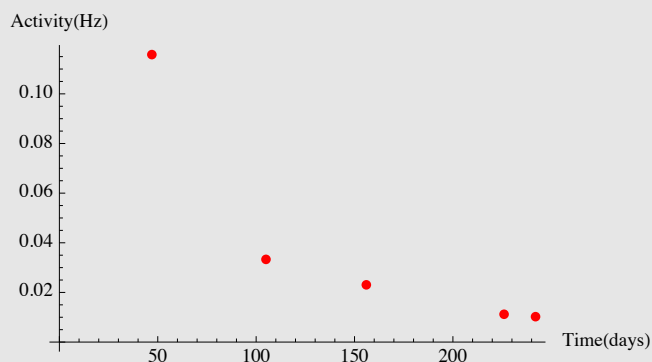
```
Out[918]= 0.01023308061
```

□ Decay Plot

```
In[951]:= decay4 = {{47, a16}, {105, a17}, {156, a18}, {226, a19}, {242, a20}};
```

```
In[952]:= ListPlot[decay4, AxesOrigin -> {0, 0},
PlotStyle -> Directive[PointSize[Medium], Red],
AxesLabel -> {Time [days], Activity [Hz]}]
```

```
Out[952]=
```



Plots and Fits

Graphs of $\frac{\text{Signal}}{\text{Noise}}$ vs. Activity along with linear fits. After the runs 6978 and 6980 were taken, the base platform was changed from cinder blocks to poly-wax blocks to try to reduce background noise. Removing these points could result in a better fit. Also, some additional considerations may be needed for the last run, 7236, that has a broad peak that was shifted to higher energies during the run. Errors also need to be included.

898 keV

■ Singles:

In[919]:=

```
signalnoise1 = {{a1, g1 / n1}, {a2, g2 / n3},  
                {a3, g3 / n5}, {a4, g4 / n7}, {a5, g5 / n9}} // N
```

Out[919]=

```
{{2.946972111, 1.391238433}, {1.900458705, 0.6040348742},  
 {1.260964712, 0.473949926}, {0.5515538012, 0.2315635662}, {0.53347007, 0.5957228554}}
```

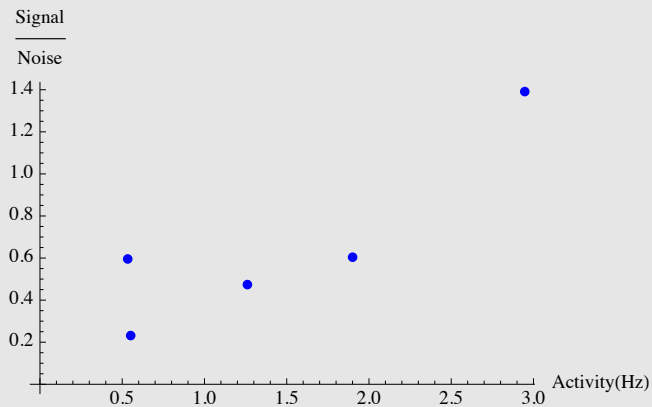
In[920]:=

```

p1 = ListPlot[signalnoise1, AxesOrigin -> {0, 0},
  PlotStyle -> Directive[PointSize[Medium], Blue],
  AxesLabel -> {Activity [Hz],  $\frac{\text{Signal}}{\text{Noise}}$ }]
line2 = Fit[signalnoise1, {1, x}, x]
p2 = Plot[{line2}, {x, 0, 2}];
Show[{p1, p2}]

```

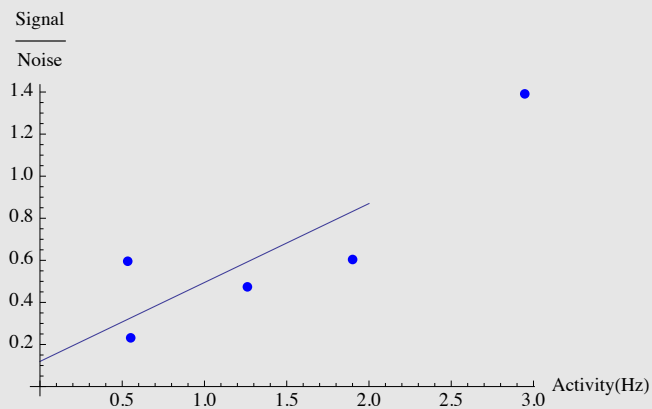
Out[920]=



Out[921]=

$$0.1194150315 + 0.3752644392 x$$

Out[923]=



■ Coincidence

In[924]:=

```

signalnoise2 = {{a6, g6 / n2}, {a7, g7 / n4},
  {a8, g8 / n6}, {a9, g9 / n8}, {a10, g10 / n10}} // N

```

Out[924]=

```

{{0.1536512953, 0.9978105943}, {0.04913025213, 1.029398634}, {0.02700400118, 0.5900046446},
  {0.009790197308, 0.1545395145}, {0.00540343015, 0.1479392353}}

```

In[925]:=

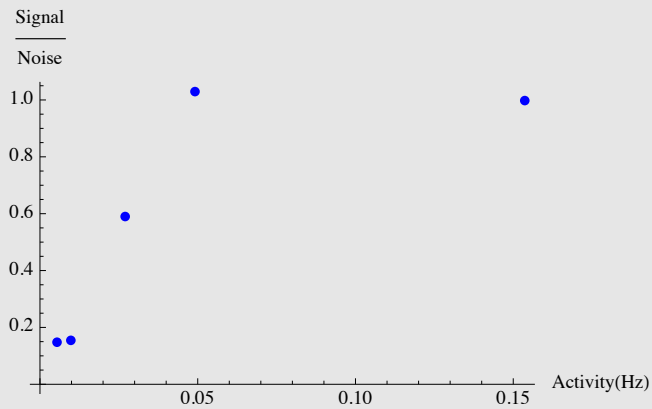
```

p3 = ListPlot[signalnoise2, AxesOrigin -> {0, 0},
  PlotStyle -> Directive[PointSize[Medium], Blue],
  AxesLabel -> {Activity [Hz],  $\frac{\text{Signal}}{\text{Noise}}$ }]

line2 = Fit[signalnoise2, {1, x}, x]
p4 = Plot[{line2}, {x, 0, 0.16}];
Show[{p3, p4}]

```

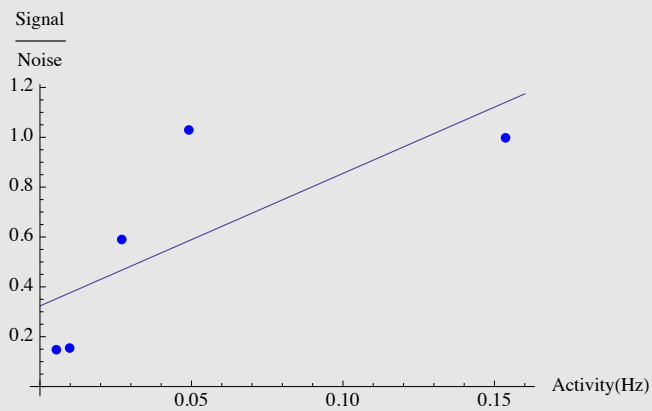
Out[925]=



Out[926]=

$$0.3234357455 + 5.316835155 x$$

Out[928]=



1836.1 keV

■ Singles

In[929]:=

```
signalnoise3 = {{a11, g11 / n11}, {a12, g12 / n13},  
                {a13, g13 / n15}, {a14, g14 / n17}, {a15, g15 / n19}} // N
```

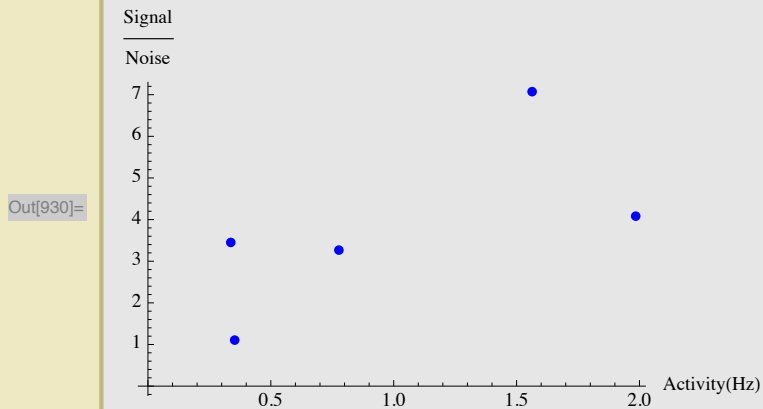
Out[929]=

```
{{1.984715026, 4.082637643}, {1.563162815, 7.072734646},  
 {0.7769617276, 3.267280015}, {0.3529330409, 1.105368289}, {0.3370788783, 3.451039597}}
```

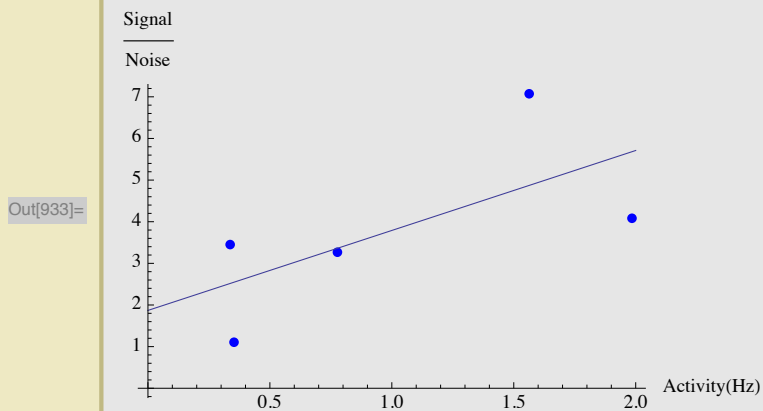
```

In[930]:= p5 = ListPlot[signalnoise3, AxesOrigin -> {0, 0},
  PlotStyle -> Directive[PointSize[Medium], Blue],
  AxesLabel -> {Activity [Hz],  $\frac{\text{Signal}}{\text{Noise}}$ }]
line3 = Fit[signalnoise3, {1, x}, x]
p6 = Plot[{line3}, {x, 0, 2}];
Show[{p5, p6}]

```



Out[931]= 1.869452069 + 1.920655052 x



■ Coincidence

```

In[934]:= signalnoise4 = {{a16, g16 / n12}, {a17, g17 / n14},
  {a18, g18 / n16}, {a19, g19 / n18}, {a20, g20 / n20}} // N

```

Out[934]= {{0.1158154322, 7.662166283}, {0.03331776196, 4.511687334},
 {0.02305952452, 2.697826141}, {0.01120457398, 1.087057675}, {0.01023308061, 2.054302418}}

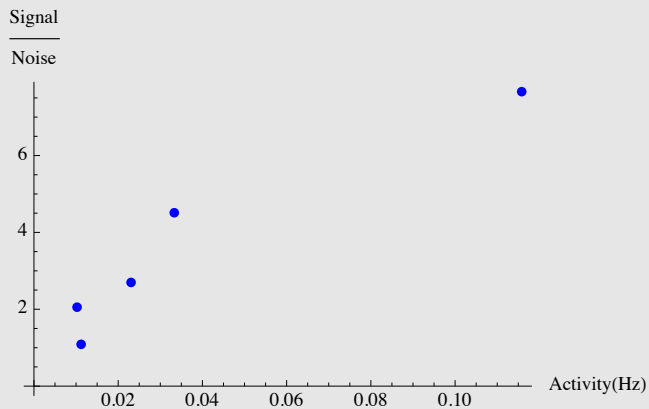
In[935]=

```

p7 = ListPlot[signalnoise4, AxesOrigin -> {0, 0},
  PlotStyle -> Directive[PointSize[Medium], Blue],
  AxesLabel -> {Activity [Hz],  $\frac{\text{Signal}}{\text{Noise}}$ }]
line4 = Fit[signalnoise4, {1, x}, x]
p8 = Plot[{line4}, {x, 0, 0.12}];
Show[{p7, p8}]

```

Out[935]=



Out[936]=

$$1.436449792 + 55.93539231 x$$

Out[938]=

