If the arrows do not appear to open a problem, go to preferences. Under the interface make sure the "show open/close icon for cell groups" is selected.

Background Noise Integrated

In this section the slope and the y-intercept where taken from the custom gaussian (gaus) + first order polynomial (pol1) fit of the energy peak and integrating over an energy range determined by +/- 2σ the mean of the signal. The integral will give the area of the background noise under the signal.

898 keV

r6978

```
n1 = Integrate[-0.274308 * x + 256.727, {x, 895, 900}]
```

```
52.67785
```

r6980

```
n2 = Integrate[-0.466126 * x + 626.402, {x, 893, 898}]
```

```
1044.930835
```

r7022

```
n3 = Integrate[0.00185989 * x + 17.1513, {x, 895, 899}]
```

```
75.27848532
```

r7023

```
n4 = Integrate[-0.148602 * x + 184.187, {x, 894, 899}]
```

```
254.826535
```

r7107

```
n5 = Integrate[-0.345539 * x + 323.534, {x, 895, 900}]
```

```
67.0637375
```

r7108

```
n6 = Integrate[-0.0223200 * x + 82.6422, {x, 894, 900}]
```

```
375.72696
```

r7203

```
n7 = Integrate[0.0369262 * x - 23.8649, {x, 891, 904}]
```

```
120.5927385
```

r7204

```
n8 = Integrate[1.02463 * x - 833.156, {x, 901, 907}]
```

```
558.65712
```

r7235

```
n9 = Integrate[-1.89265 * x + 1727.56, {x, 902, 904}]
```

```
36.9941
```

r7236

```
n10 = Integrate[0.236392 * x + 94.2954, {x, 904, 912}]
```

```
2471.514688
```

1836.1 keV

r6978

```
n11 = Integrate[-0.0367690 * x + 69.5478, {x, 1835, 1840}]
```

```
9.9238125
```

r6980

```
n12 = Integrate[-0.0289860 * x + 73.3522, {x, 1829, 1837}]
```

```
161.766896
```

r7022

```
n13 = Integrate[0.00899005 * x - 15.1294, {x, 1835, 1841}]
```

```
8.3658714
```

r7023

```
n14 = Integrate[-0.0806490 * x + 155.393, {x, 1832, 1840}]
```

```
58.571488
```

r7107

```
n15 = Integrate[0.0595069 * x - 107.776, {x, 1836, 1841}]
```

```
8.13717825
```

r7108

```
n16 = Integrate[-0.0245740 * x + 56.6525, {x, 1834, 1842}]
```

```
91.883904
```

r7203

```
n17 = Integrate[-0.00212520 * x + 5.14499, {x, 1829, 1849}]
```

```
24.734944
```

r7204

```
n18 = Integrate[0.295440 * x - 526.173, {x, 1820, 1828}]
```

```
101.67648
```

r7235

```
n19 = Integrate[0.154287 * x - 281.948, {x, 1847, 1853}]
```

```
20.8977
```

r7236

```
n20 = Integrate[0.0813157 * x - 106.932, {x, 1850, 1872}]
```

```
976.7233894
```

Things to note. The coincidence run r7236 has some peak shifting that was probably caused by the liquid nitrogen being refilled in the tanks during counting. Runs 7203 and 7204 have some broader peaks that are shifted as well.

Integrating Gaussian

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

Used the equation for a gaussian with an unknown area along with values obtained from fitting the signals peak after the background noise 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

```
μ = 897.416;
σ = 1.12141;
g1 = Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 292.5, A][[
     1]][[1]][[2]]
```

```
822.2052189
```

r7022

```
μ = 897.481;
σ = 0.750439;
g2 = Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 362.7, A][[
     1]][[1]][[2]]
```

```
682.264675
```

r7107

```
μ = 897.581;
σ = 1.09091;
g3 = Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 130.5, A][[
     1]][[1]][[2]]
```

```
356.8530136
```

r7203

```
μ = 897.352;
σ = 2.97881;
g4 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 17.4328, A][[
    1]][[1]][[2]]
```

```
130.1666971
```

r7235

```
μ = 902.984;
σ = 0.310328;
g5 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 67.2, A][[1]][[
   1]][[2]]
```

```
52.27333031
```

- **Coincidence:**

r6980

```
μ = 895.417;
σ = 1.19573;
g6 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 4132.5, A][[
    1]][[1]][[2]]
```

```
12 386.13822
```

r7023

```
μ = 896.893;
σ = 1.00875;
g7 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 1232.2, A][[
    1]][[1]][[2]]
```

```
3115.693199
```

r7108

```
μ = 897.483;
σ = 1.24805;
g8 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 707.85, A][[
    1]][[1]][[2]]
```

```
2214.436112
```

r7204

```
μ = 903.99;
σ = 1.06558;
g9 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 309, A][[1]][[
   1]][[2]]
```

```
825.3430037
```

r7236

```
μ = 908.035;
σ = 1.78833;
g10 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 608, A][[1]][[
   1]][[2]]
```

```
2725.468554
```

1836.1 keV:

- **Singles:**

r6978

```
μ = 1837.6;
σ = 1.19410;
g11 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 185, A][[1]][[
   1]][[2]]
```

```
553.7354922
```

r7022

```
μ = 1837.72;
σ = 1.28517;
g12 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 174.2, A][[
    1]][[1]][[2]]
```

```
561.1754507
```

r7107

```
μ = 1838.56;
σ = 1.22172;
g13 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 71.8, A][[1]][[
   1]][[2]]
```

```
219.8801689
```

r7203

```
μ = 1839.05;
σ = 4.91678;
g14 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 6.75824, A][[
    1]][[1]][[2]]
```

```
83.29219764
```

r7235

```
μ = 1850.02;
σ = 1.13536;
g15 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 28.9, A][[1]][[
   1]][[2]]
```

```
82.24724631
```

- **Coincidence:**

r6980

```
μ = 1833.39;
σ = 1.72362;
g16 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 2160.9, A][[
    1]][[1]][[2]]
```

```
9336.113621
```

r7023

```
μ = 1836.02;
σ = 1.63517;
g17 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 515.5, A][[
    1]][[1]][[2]]
```

```
2112.91251
```

r7108

```
μ = 1838.12;
σ = 1.87659;
g18 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 402, A][[1]][[
   1]][[2]]
```

```
1890.973249
```

r7204

```
μ = 1824.15;
σ = 1.66372;
g19 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 226.5, A][[
    1]][[1]][[2]]
```

```
944.5791998
```

r7236

```
μ = 1861.15;
σ = 5.35845;
g20 =
 Solve[A * MaxValue[1/(σ * √(2 * π)) * Exp[-1/2 ((x - μ)/σ)^2], x] == 384.281, A][[
    1]][[1]][[2]]
```

```
5161.524926
```

Activity

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

898 keV

Singles:

```
a1 = g1 / 279 // N
a2 = g2 / 359 // N
a3 = g3 / 283 // N
a4 = g4 / 236 // N
a5 = g4 / 244 // N
```

```
2.946972111
```

```
1.900458705
```

```
1.260964712
```

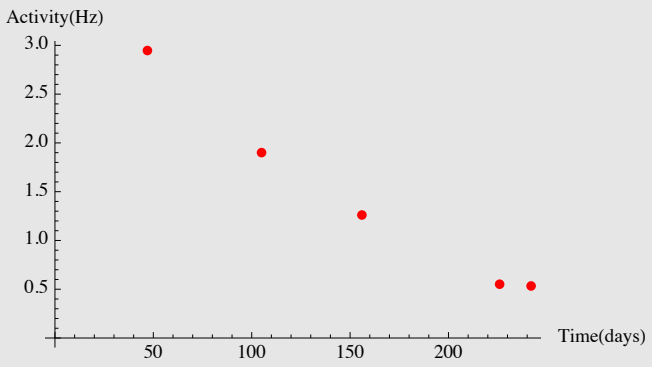
```
0.5515538012
```

```
0.53347007
```

Decay Plot

```
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]}]
```



Coincidence:

```
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
```

```
0.1536512953
```

```
0.04913025213
```

```
0.02700400118
```

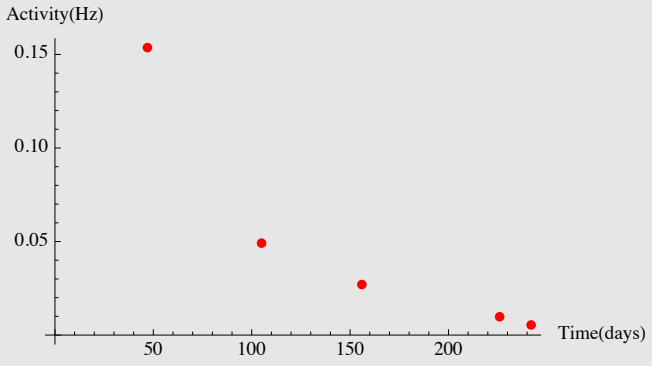
```
0.009790197308
```

```
0.00540343015
```

Decay Plot

```
decay2 = {{47, a6}, {105, a7}, {156, a8}, {226, a9}, {242, a10}};
```

```
ListPlot[decay2, AxesOrigin → {0, 0},
 PlotStyle → Directive[PointSize[Medium], Red],
 AxesLabel → {Time [days], Activity [Hz]}]
```



1836.1 keV

Singles:

```
a11 = g11 / 279 // N
a12 = g12 / 359 // N
a13 = g13 / 283 // N
a14 = g14 / 236 // N
a15 = g15 / 244 // N
```

```
1.984715026
```

```
1.563162815
```

```
0.7769617276
```

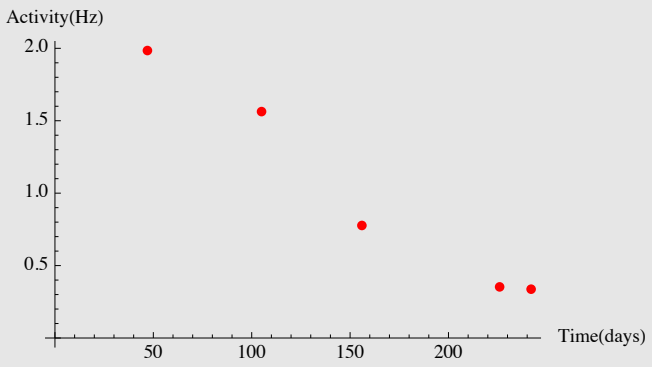
```
0.3529330409
```

```
0.3370788783
```

Decay Plot

```
decay3 = {{47, a11}, {105, a12}, {156, a13}, {226, a14}, {242, a15}};
```

```
ListPlot[decay3, AxesOrigin → {0, 0},
 PlotStyle → Directive[PointSize[Medium], Red],
 AxesLabel → {Time [days], Activity [Hz]}]
```



Coincidence

```
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
```

```
0.1158154322
```

```
0.03331776196
```

```
0.02305952452
```

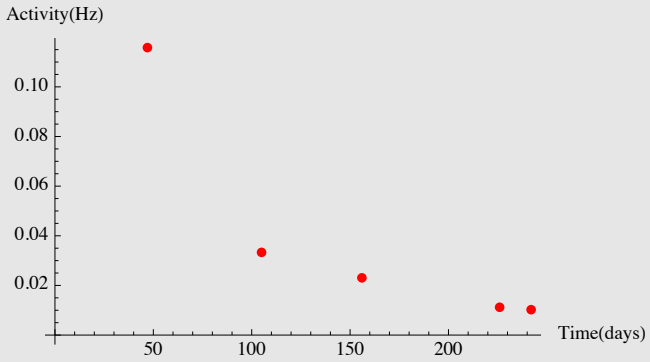
```
0.01120457398
```

```
0.01023308061
```

Decay Plot

```
decay4 = {{47, a16}, {105, a17}, {156, a18}, {226, a19}, {242, a20}};
```

```
ListPlot[decay4, AxesOrigin → {0, 0},
 PlotStyle → Directive[PointSize[Medium], Red],
 AxesLabel → {Time [days], Activity [Hz]}]
```



Plots and Fits

Graphs of $\frac{\text{Signal}}{\text{Noise}}$ vs. Activity along with linear fits. After the first runs, 6978 and 6980, where taken, the base platform was changed from cinder blocks to poly-wax blocks to try to reduce background noise. This is a change of the set-up that would affect the area of the background. At the end of each subsection I removed these points to see how the fit changed.

Things to note. 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. The liguid nitrogen tank on the HpGe detector was refilled at some point during the run. Possibly a time cut will be needed. Errors also need to be included.

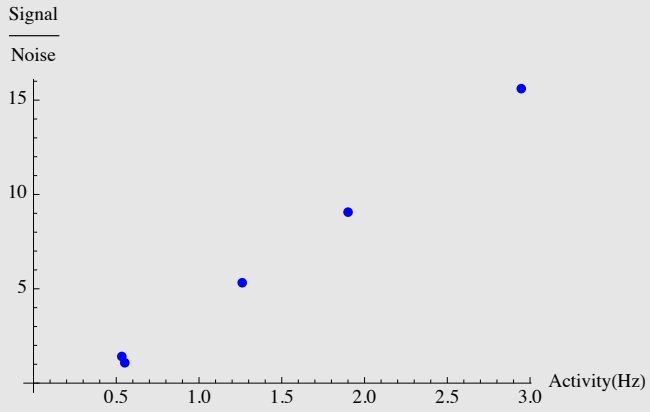
898 keV

- **Singles:**

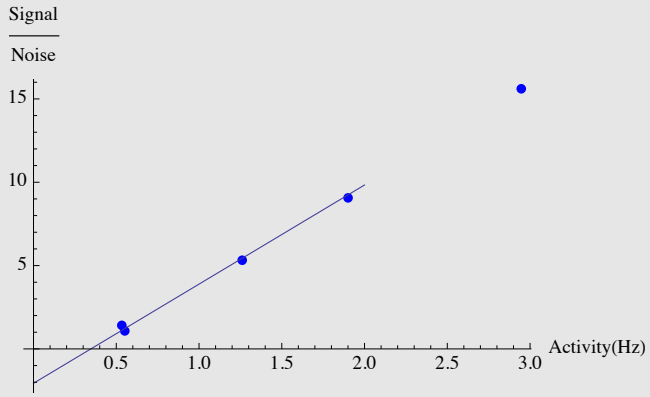
```
signalnoise1 = {{a1, g1 / n1}, {a2, g2 / n3},
    {a3, g3 / n5}, {a4, g4 / n7}, {a5, g5 / n9}} // N
```

```
{{2.946972111, 15.60817723}, {1.900458705, 9.06320939},
 {1.260964712, 5.321102385}, {0.5515538012, 1.079390838}, {0.53347007, 1.41301803}}
```

```
p1 = ListPlot[signalnoise1, AxesOrigin → {0, 0},
   PlotStyle → Directive[PointSize[Medium], Blue],
   AxesLabel → {Activity [Hz], Signal/Noise}]
line1 = Fit[signalnoise1, {1, x}, x]
p2 = Plot[{line1}, {x, 0, 2}];
Show[{p1, p2}]
```




```
-2.061028794 + 5.94849813 x
```

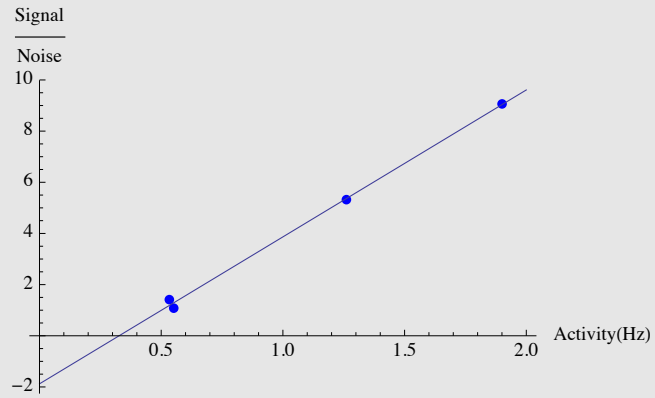


Removing first run (r6978)

```
sn1 = {{a2, g2 / n3}, {a3, g3 / n5}, {a4, g4 / n7}, {a5, g5 / n9}} // N
plot1 = ListPlot[sn1, AxesOrigin → {0, 0},
    PlotStyle → Directive[PointSize[Medium], Blue],
    AxesLabel → {Activity [Hz], Signal / Noise}];
l1 = Fit[sn1, {1, x}, x]
plot2 = Plot[{l1}, {x, 0, 2}];
Show[{plot1, plot2}]
```

```
{{1.900458705, 9.06320939}, {1.260964712, 5.321102385},
 {0.5515538012, 1.079390838}, {0.53347007, 1.41301803}}
```

```
-1.878655705 + 5.743941184 x
```

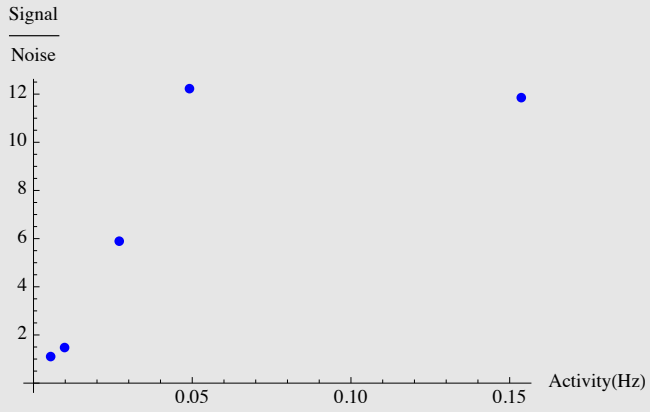


Coincidence

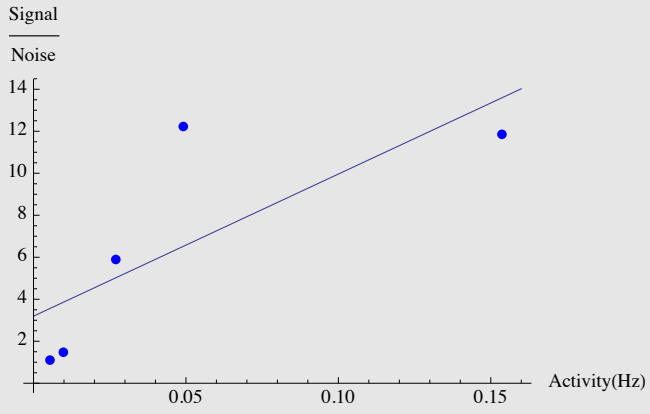
```
signalnoise2 = {{a6, g6 / n2}, {a7, g7 / n4},
    {a8, g8 / n6}, {a9, g9 / n8}, {a10, g10 / n10}} // N
```

```
{{0.1536512953, 11.85354839}, {0.04913025213, 12.22672199},
 {0.02700400118, 5.893737603}, {0.009790197308, 1.477369524}, {0.00540343015, 1.102752319}}
```

```
p3 = ListPlot[signalnoise2, AxesOrigin → {0, 0},
   PlotStyle → Directive[PointSize[Medium], Blue],
   AxesLabel → {Activity [Hz], Signal/Noise}]
line2 = Fit[signalnoise2, {1, x}, x]
p4 = Plot[{line2}, {x, 0, 0.16}];
Show[{p3, p4}]
```




```
3.195064392 + 67.67435556 x
```

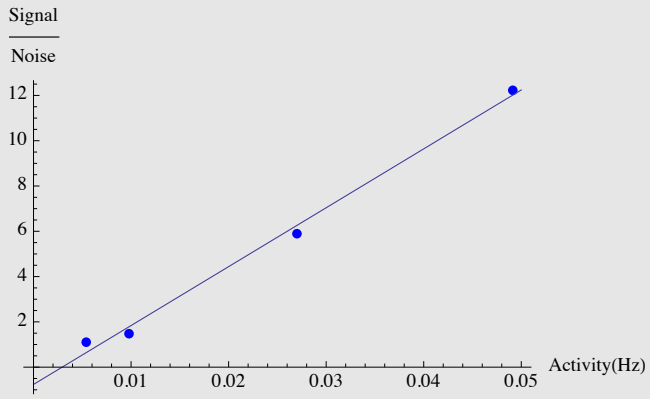


Remove first run (r6980)

```
sn2 = {{a7, g7 / n4}, {a8, g8 / n6}, {a9, g9 / n8}, {a10, g10 / n10}} // N
plot3 = ListPlot[sn2, AxesOrigin → {0, 0},
    PlotStyle → Directive[PointSize[Medium], Blue],
    AxesLabel → {Activity [Hz], Signal / Noise}];
l2 = Fit[sn2, {1, x}, x]
plot4 = Plot[{l2}, {x, 0, 0.05}];
Show[{plot3, plot4}]
```

```
{{0.04913025213, 12.22672199}, {0.02700400118, 5.893737603},
 {0.009790197308, 1.477369524}, {0.00540343015, 1.102752319}}
```

```
-0.7631638005 + 260.0874611 x
```



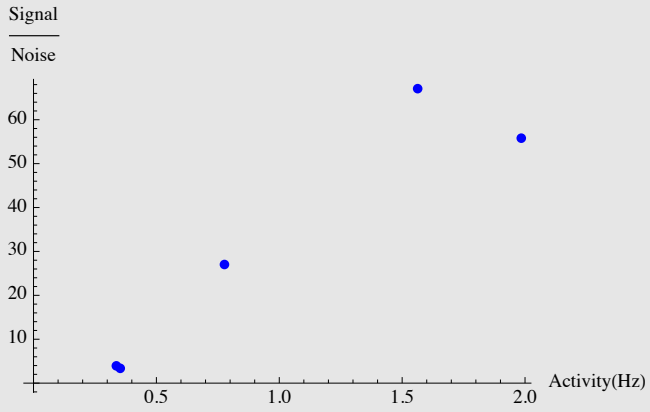
1836.1 keV

Singles

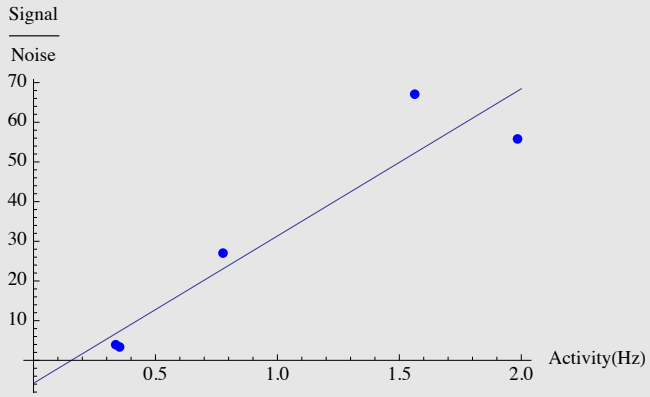
```
signalnoise3 = {{a11, g11 / n11}, {a12, g12 / n13},
    {a13, g13 / n15}, {a14, g14 / n17}, {a15, g15 / n19}} // N
```

```
{{1.984715026, 55.7986653}, {1.563162815, 67.07913902},
 {0.7769617276, 27.02167289}, {0.3529330409, 3.36738978}, {0.3370788783, 3.935708059}}
```

```
p5 = ListPlot[signalnoise3, AxesOrigin → {0, 0},
   PlotStyle → Directive[PointSize[Medium], Blue],
   AxesLabel → {Activity [Hz], Signal/Noise}]
line3 = Fit[signalnoise3, {1, x}, x]
p6 = Plot[{line3}, {x, 0, 2}];
Show[{p5, p6}]
```




```
-5.777867273 + 37.10816001 x
```

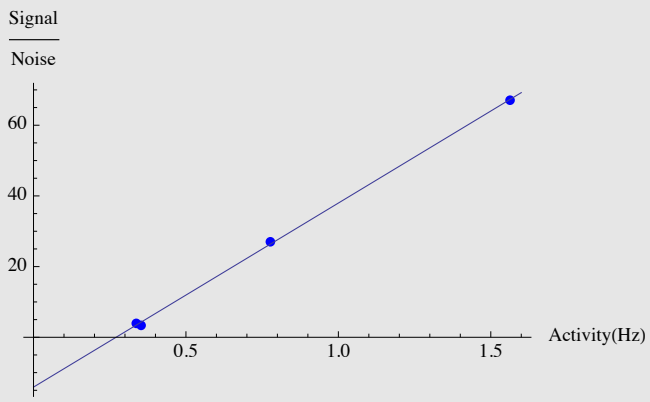


Remove first run (r6978)

```
sn3 = {{a12, g12 / n13}, {a13, g13 / n15},
    {a14, g14 / n17}, {a15, g15 / n19}} // N
plot5 = ListPlot[sn3, AxesOrigin → {0, 0},
    PlotStyle → Directive[PointSize[Medium], Blue],
    AxesLabel → {Activity [Hz], Signal / Noise}];
l3 = Fit[sn3, {1, x}, x]
plot6 = Plot[{l3}, {x, 0, 1.6}];
Show[{plot5, plot6}]
```

```
{{1.563162815, 67.07913902}, {0.7769617276, 27.02167289},
 {0.3529330409, 3.36738978}, {0.3370788783, 3.935708059}}
```

```
-14.09729192 + 52.07457796 x
```

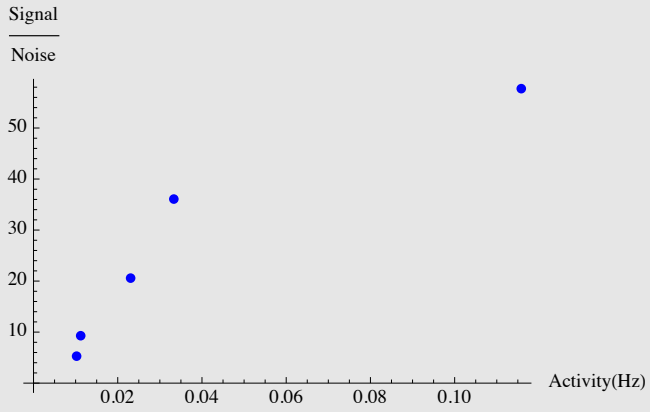


Coincidence

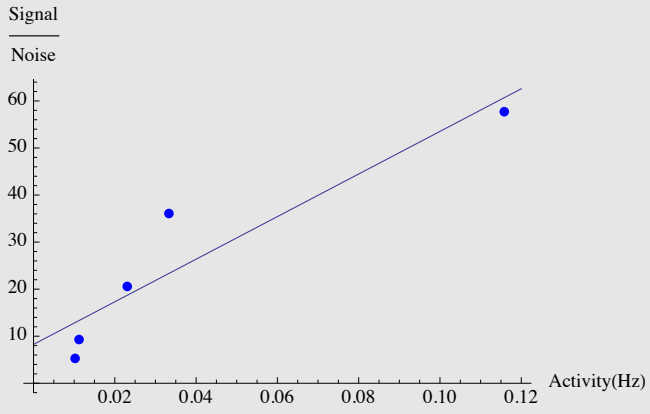
```
signalnoise4 = {{a16, g16 / n12}, {a17, g17 / n14},
    {a18, g18 / n16}, {a19, g19 / n18}, {a20, g20 / n20}} // N
```

```
{{0.1158154322, 57.71337555}, {0.03331776196, 36.07407942},
 {0.02305952452, 20.58002726}, {0.01120457398, 9.290046231}, {0.01023308061, 5.284530894}}
```

```
p7 = ListPlot[signalnoise4, AxesOrigin → {0, 0},
   PlotStyle → Directive[PointSize[Medium], Blue],
   AxesLabel → {Activity [Hz], Signal/Noise}]
line4 = Fit[signalnoise4, {1, x}, x]
p8 = Plot[{line4}, {x, 0, 0.12}];
Show[{p7, p8}]
```




```
8.255813586 + 452.7336799 x
```



Remove first run (r6980)

```
sn4 = {{a17, g17 / n14}, {a18, g18 / n16},
    {a19, g19 / n18}, {a20, g20 / n20}} // N
plot7 = ListPlot[sn4, AxesOrigin → {0, 0},
    PlotStyle → Directive[PointSize[Medium], Blue],
    AxesLabel → {Activity [Hz], Signal / Noise}];
l4 = Fit[sn4, {1, x}, x]
plot8 = Plot[{l4}, {x, 0, 0.04}];
Show[{plot7, plot8}]
```

```
{{0.03331776196, 36.07407942}, {0.02305952452, 20.58002726},
 {0.01120457398, 9.290046231}, {0.01023308061, 5.284530894}}
```

```
-6.571066736 + 1253.139171 x
```