ATF APD Data Analysis

Data are organized as

4 Positions: (iposition=1,4)
each with 2 target states: (itarget=1,2)
each with 20 waveforms (iwaveform=1,20)
each is 1 file with 5000 points (ipoint=1,5000)
the first file name is : "RTF_0_APD.dat"
the next file name is : "RTF_1_APD.dat"
each point is a coordinate (time, Amplitude)

we convert time, Amplitude to nanoseconds, millivolts with the following matrix and subtract baseline

```
In[118]:= << PhysicalConstants`
m = {{10^9, 0}, {0, 10^3}};
```

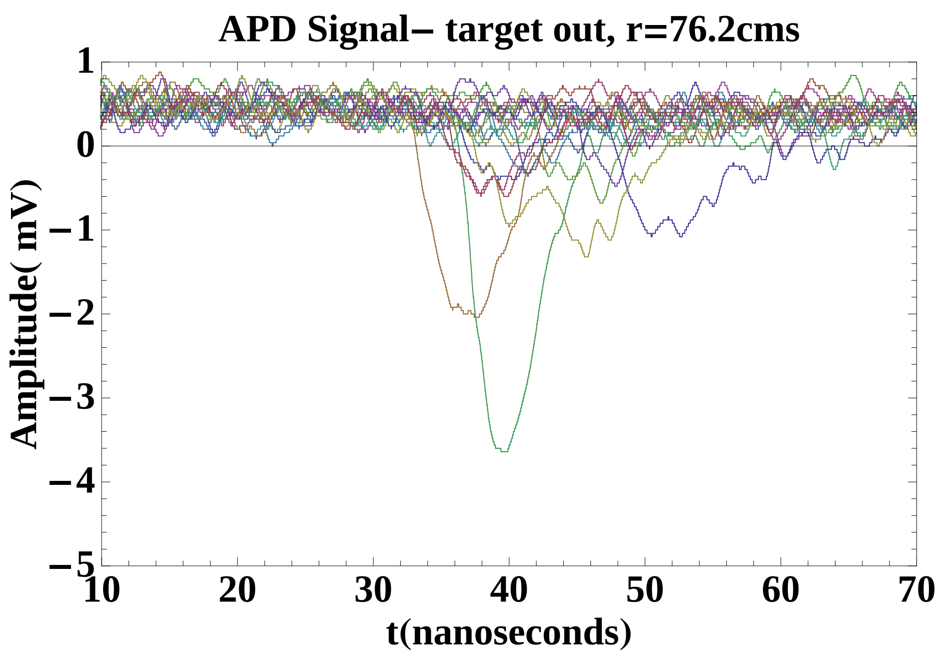
Fix some data records that were garbled by Matlab

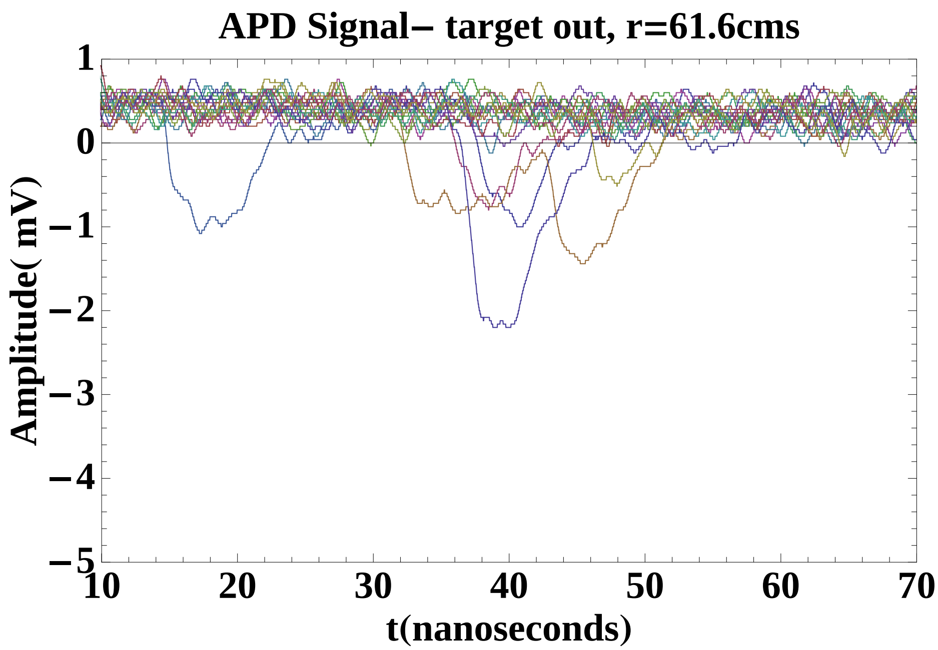
```
In[120]:= spl[{s_String}] := Module[{loc = StringPosition[s, {"e-", "e+"}]},
              First[ImportString[
         StringTake[s, 4 + loc[[1, 1]]] <> " " <> StringDrop[s, 4 + loc[[1, 1]]], "Table"]] ]
spl[s__] := Identity[
   s]
```

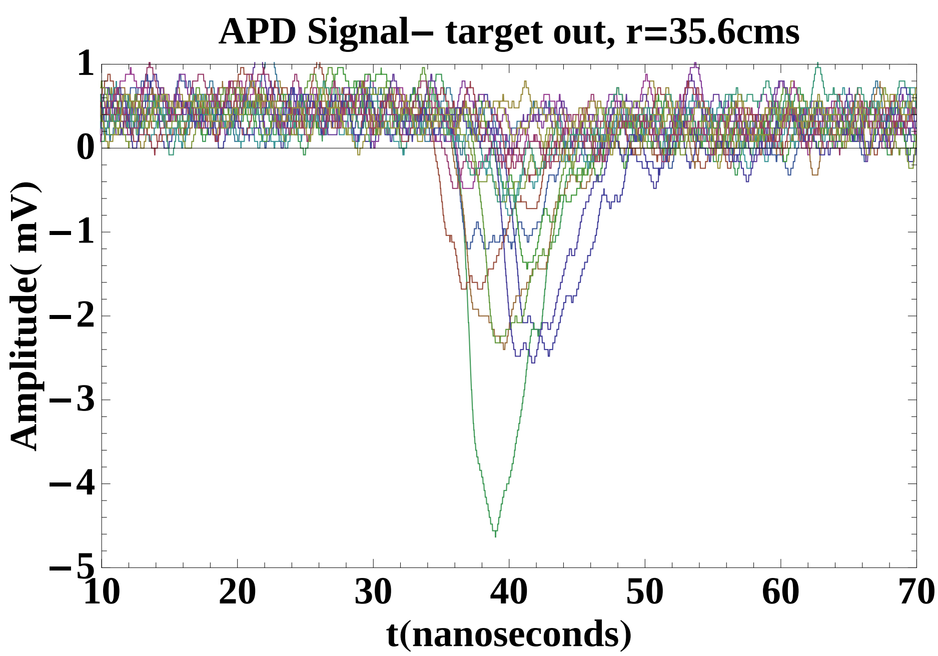
waveform2 holds the 20 waveforms at 1 position
newwave holds all 4 positions
Amps hold fitting results

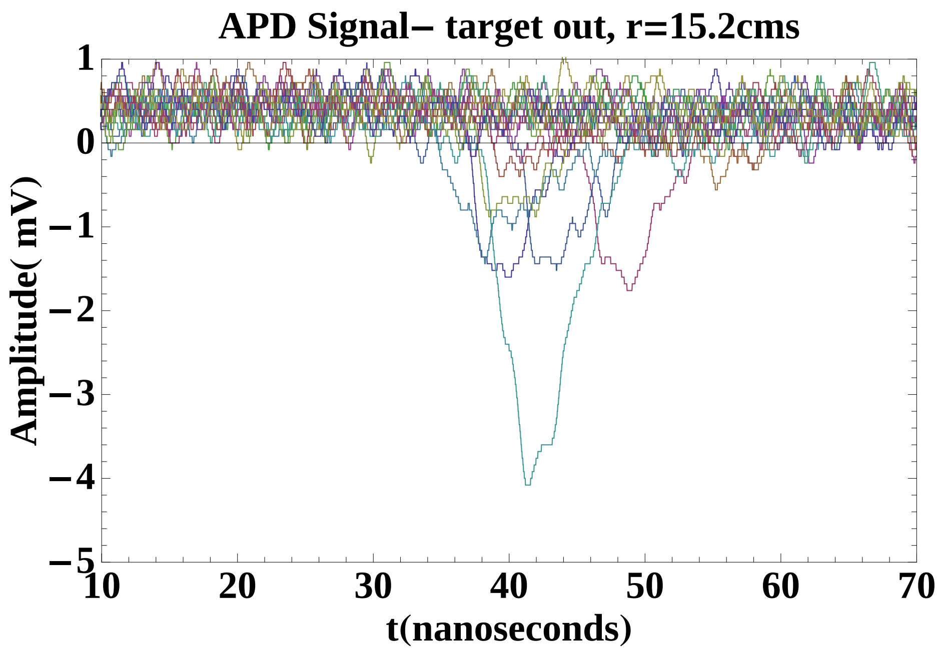
```
In[122]:= waveform = Array[0 &, {5000, 2}]; waveform1 = Array[0 &, {5000, 2}];
waveform2 = Array[0 &, {20, 5000, 2}];
aveAmp = ConstantArray[0, {2, 4}]; rmsAmp = ConstantArray[0, {2, 4}];
q = ConstantArray[0, {4, 20}]; h1 = Range[20]; h2 = Range[20];
Amplitude = Range[20];
state = {"out", "in"};
position = {61.6, 35.6, 15.2, 76.2};
iorder = {4, 1, 2, 3};
jtarget = {{1, 2}, {2, 1}, {1, 2}, {2, 1}};
plotrange = {-5, -20};
index = 1;
qmip = ElectronCharge[[1]] * 200 * 6000 * 10^12

Out[132]= 0.192261
```

In[133]:=
```
ipos = 1;
Do[
 iposition = iorder[[ipos]];
 Do[waveform = Import[ToFileName[NotebookDirectory[], "RTF_" <> ToString[
       i + 40 * (iposition - 1) + 20 * (jtarget[[iposition, index]] - 1)] <> "_APD.dat"], "Table"];
waveform1 = Map[spl, waveform];
  waveform2[[i]] = Map[(m.# &), waveform1];
  waveform2[[1, 1000]];
  q[[ipos, i]] = -(Sum[waveform2[[i, j, 2]], {j, 701, 1400}] - 700 * .52) * .02 / 50 / qmip;
  , {i, 20}];
 Print[ListPlot[Table[waveform2[[i]], {i, 20}], ImageSize → {500, 300},
   Frame → True, Joined → True, PlotStyle → PointSize[.05], FrameLabel →
    {Style["t(nanoseconds)", 18], Style["Amplitude( mV)", 18], Style["APD Signal- target " <>
       state[[index]] <> ", r=" <> ToString[position[[iposition]]] <> "cms", 18]},
   LabelStyle → Directive[Black, Bold, FontSize → 18],
   PlotRange → {{10, 70}, {plotrange[[index]], 1}}]]
 ,
 {ipos,
  4}]
```



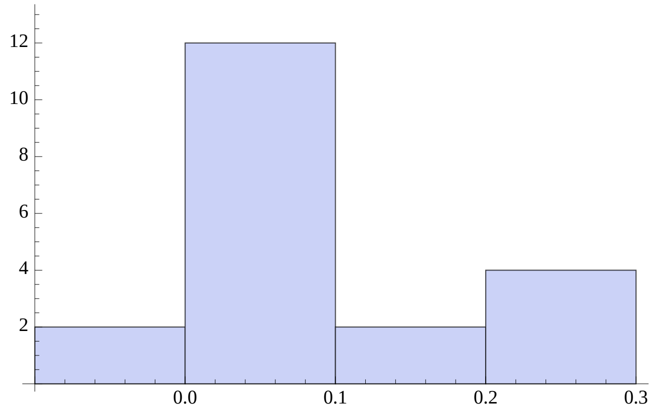

APD Signal– target out, r=61.6cms
Amplitude(mV)
1
0
−1
−2
−3
−4
−5
10
20
30
40
50
60
70
t(nanoseconds)

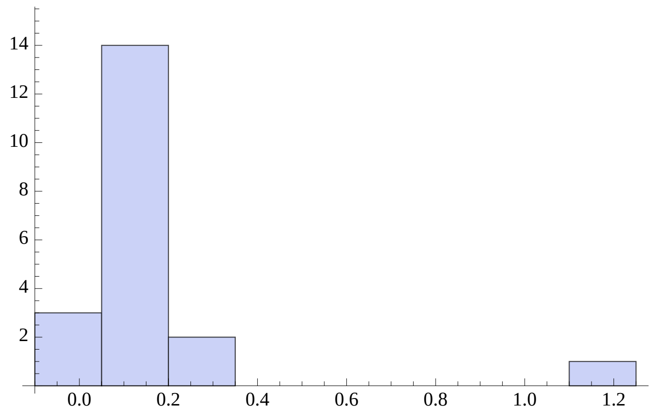

APD Signal– target out, r=35.6cms
Amplitude(mV)
1
0
−1
−2
−3
−4
−5
10
20
30
40
50
60
70
t(nanoseconds)

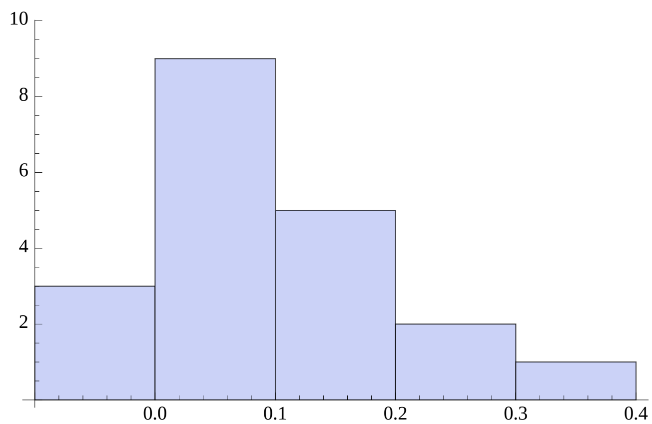


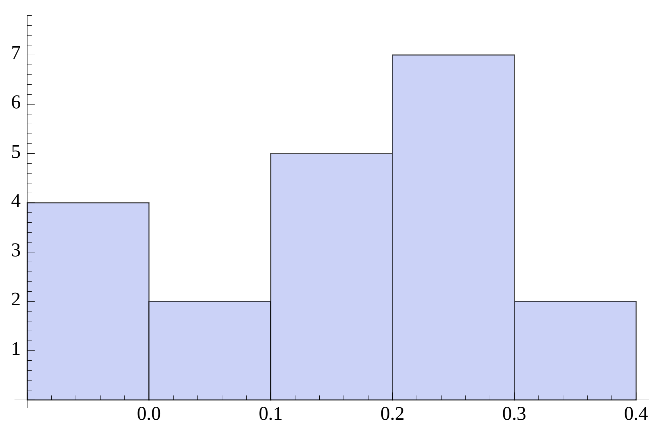
In[135]:=

In[136]:=
```
Do[Print[Histogram[q[[jj]], 20]], {jj, 4}]
```

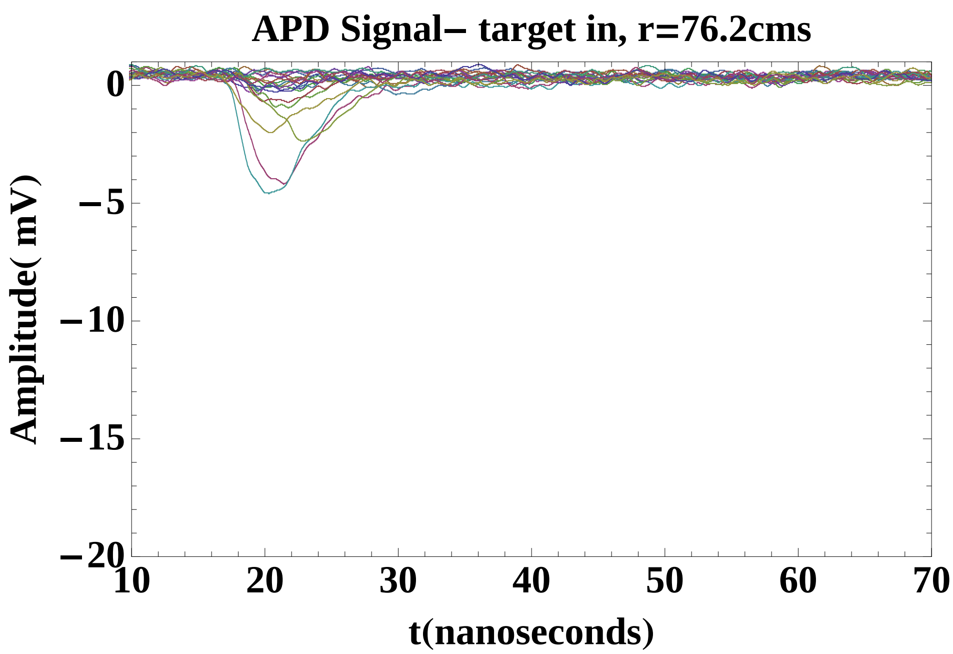

12
10
8
6
4
2
0.0
0.1
0.2
0.3

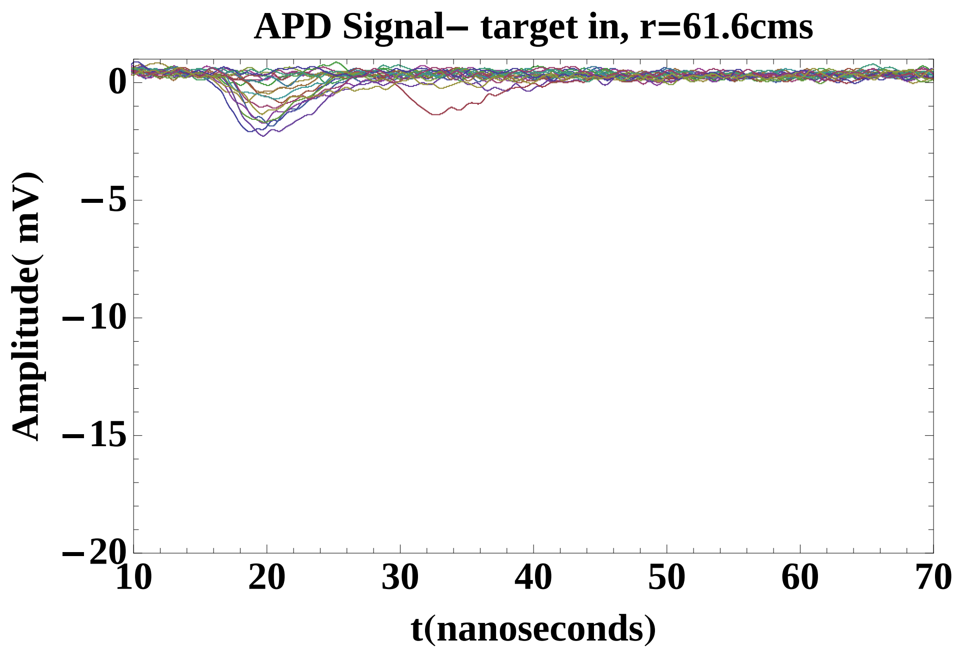

14
12
10
8
6
4
2
0.0
0.2
0.4
0.6
0.8
1.0
1.2

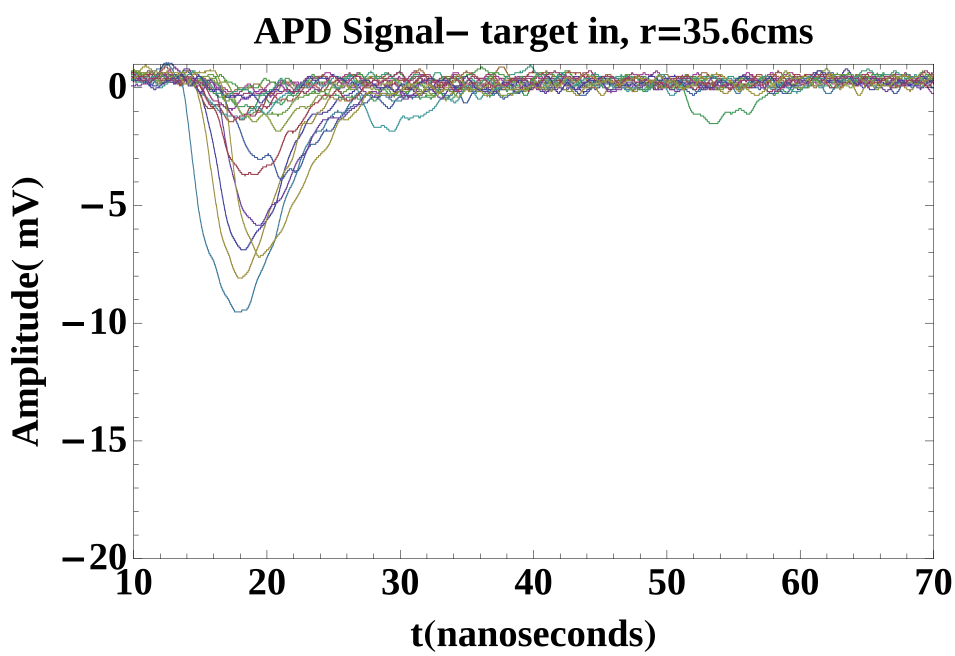

10
8
6
4
2
0.0
0.1
0.2
0.3
0.4

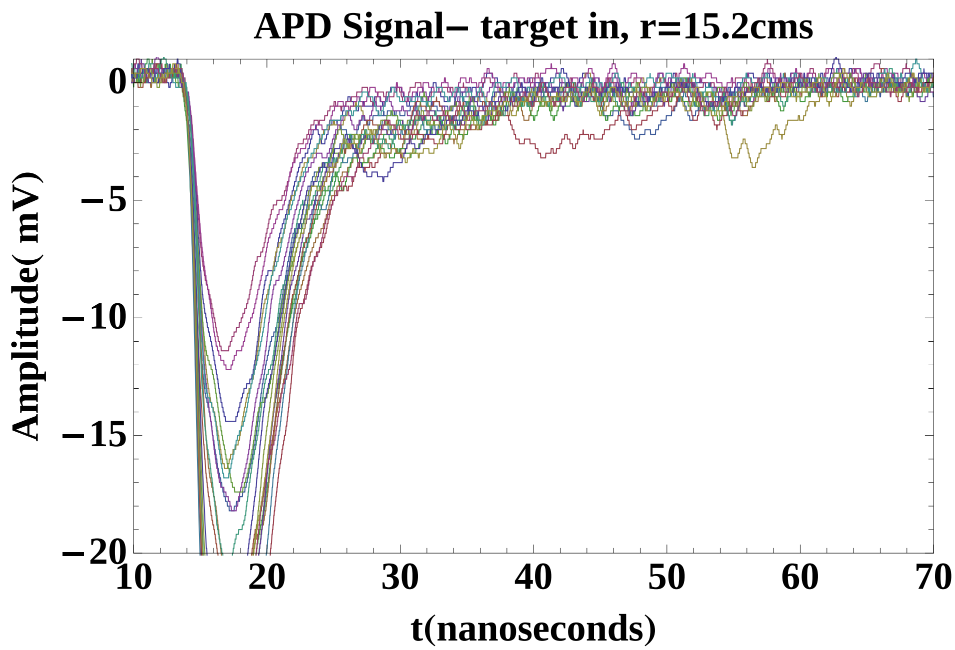

7
6
5
4
3
2
1
0.0
0.1
0.2
0.3
0.4

In[137]:=

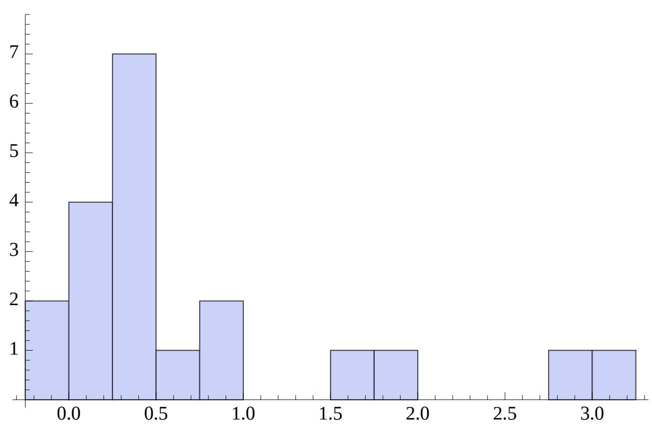

APD Signal− target in, r=76.2cms
Amplitude(mV)
0
−5
−10
−15
−20
10
20
30
40
50
60
70
t(nanoseconds)

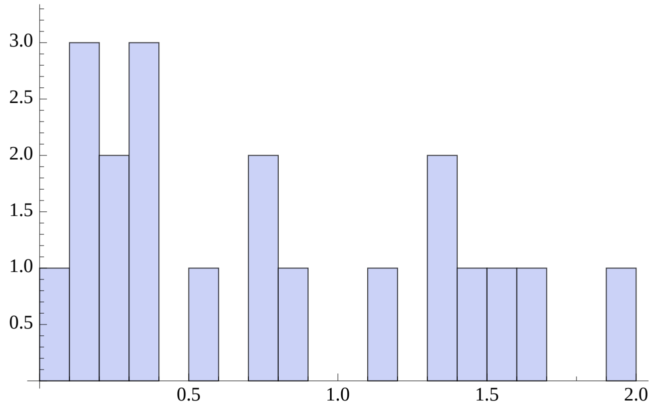

APD Signal– target in, r=61.6cms
Amplitude(mV)
0
−5
−10
−15
−20
10
20
30
40
50
60
70
t(nanoseconds)

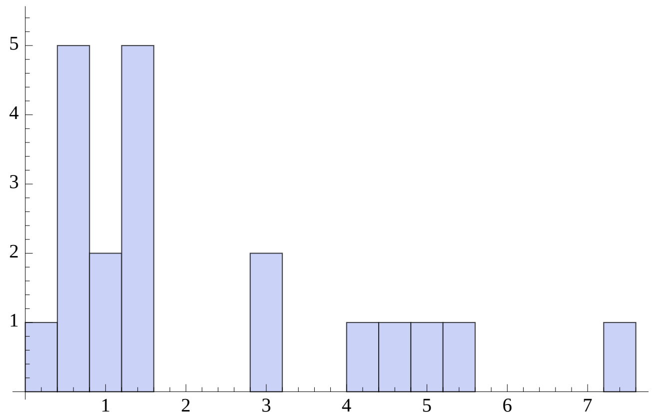

APD Signal– target in, r=35.6cms
Amplitude(mV)
0
−5
−10
−15
−20
10
20
30
40
50
60
70
t(nanoseconds)

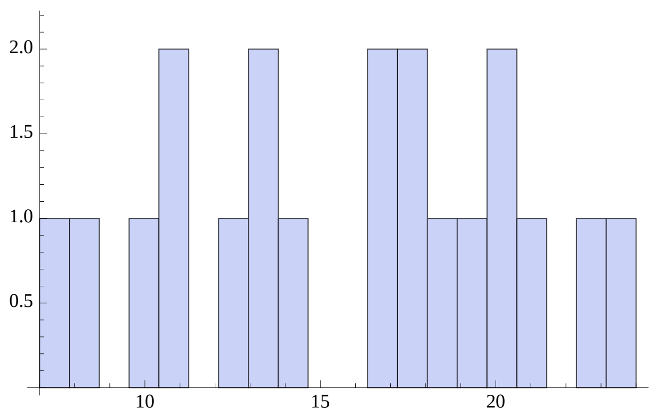



```
Do[Print[Histogram[q[[jj]], 20]], {jj, 4}]
Do[
 qmean[[ii]] = Mean[q[[ii]]]
 , {ii, 4}]
Print[qmean]
```



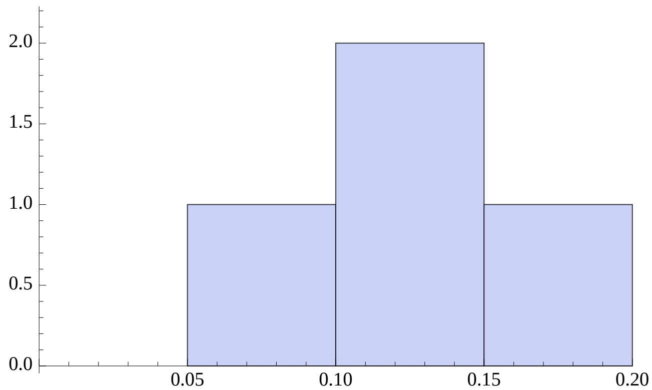


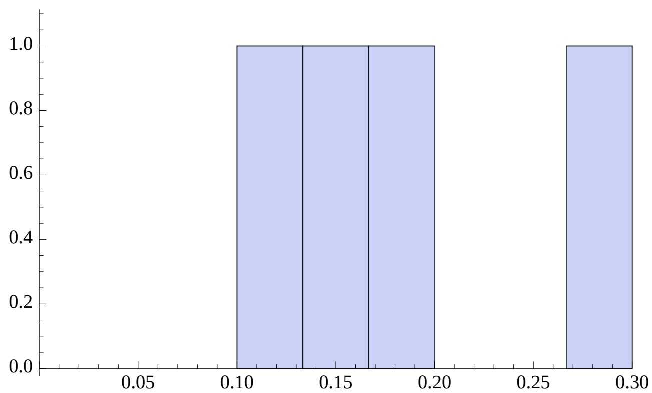




{0.719355, 0.763607, 2.22362, 15.7795}

```
Do[
 list = Table[q[[i, jj]], {jj, 20}];
 qmean[[i]] = Mean[list];
 qrms[[i]] = RootMeanSquare[list];
 , {i, 1, 4}]
Histogram[qmean, 20, PlotRange → {{0, .2}, Automatic}]
Histogram[qrms, 30, PlotRange → {{0, .3}, Automatic}]
Print[qmean];
Print[qrms];
```





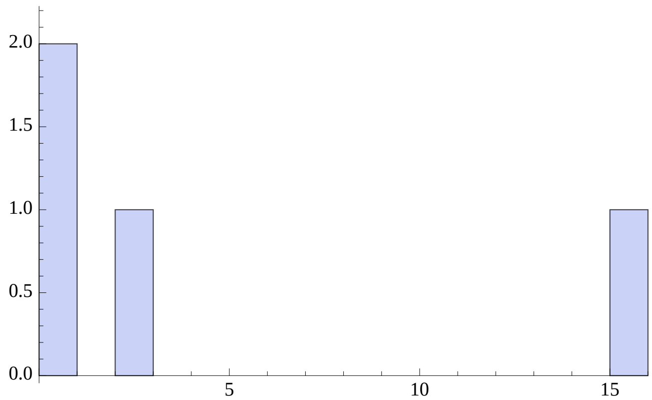
{0.0893701, 0.170331, 0.103002, 0.145926}

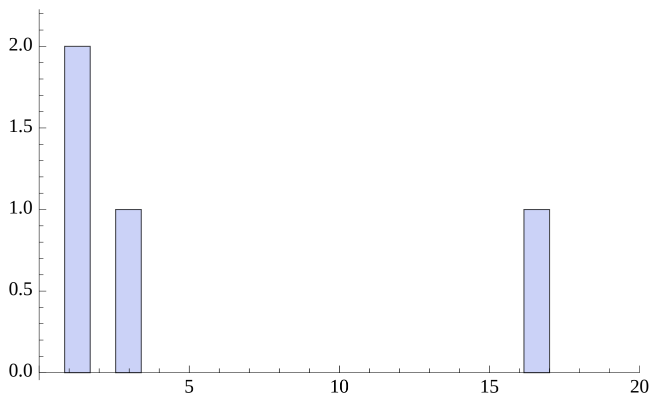
{0.118785, 0.296198, 0.146584, 0.184878}

```
Do[
 list = Table[q[[i, jj]], {jj, 20}];
 qmean[[i]] = Mean[list];
 qrms[[i]] = RootMeanSquare[list];
 , {i, 1, 4}]
Print[qmean];
Print[qrms];
Histogram[qmean, 16, PlotRange → {{0, 16}, Automatic}]
Histogram[qrms, 20, PlotRange → {{0, 20}, Automatic}]
```

{0.719355, 0.763607, 2.22362, 15.7795}

{1.15065, 0.963055, 2.98299, 16.4386}





Scattered rates for 10^9 beam intensity. Start from 1 / 2 Hz per 10^{-3} of solid angle with 0.92 mm Al as the target used in LBNE note. This produces 0.8^0 MCS. The cross section at 62 MeV is 2.6 times larger than at 80 MeV.

We will test with 1 mm Al tilted at 45^0. So rate = 0.5 * Csc[Pi / 4] * 1 / .92 * dΩ / 10^{-3}

In[64]:=

```
Needs["PlotLegends`"]
```

In[65]:=

```
r0 = 0.5 * Csc[Pi / 4] * 1 / .92;
RateAPD[l_] := (.8 * .8)/(l^2 * 10^-3) * r0
RateHPD[l_] := (π * (.3)^2)/(l^2 * 10^-3) * r0
```

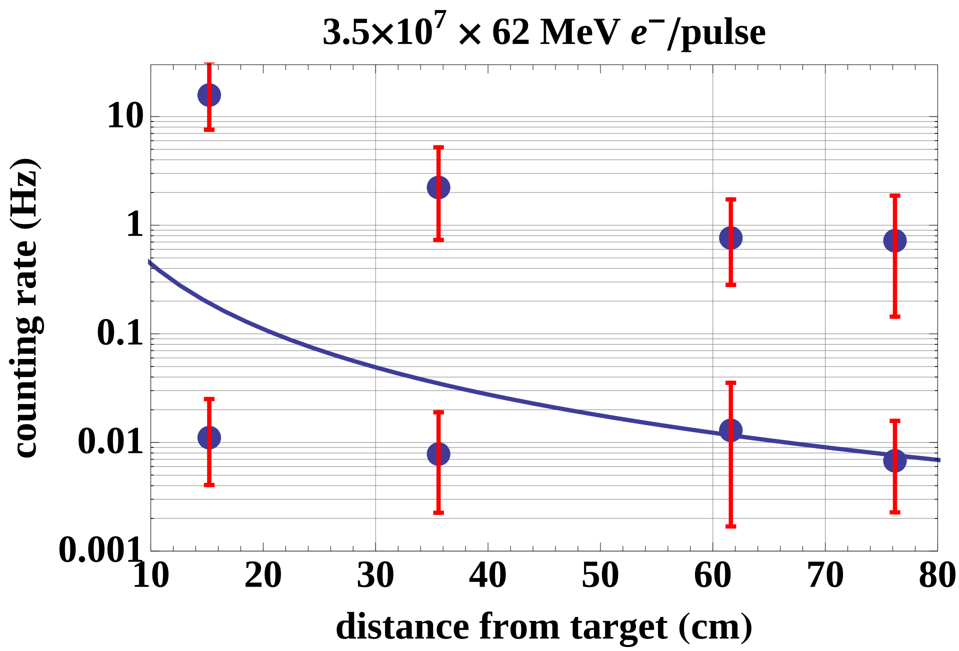
In[68]:=

```
σ62 = 2.6;
Fluxin = .0346;
Fluxout = .456;
```

In[72]:=

```
position = {76.2, 61.6, 35.6, 15.2}; qmeanin =
  {0.7193547918627854`, 0.7636070952608692`, 2.223616870908846`, 15.779451809335336`};
qmeaninxy = Table[{position[[i]], qmeanin[[i]]}, {i, 4}];
qrmsin = {1.150653577832128`, 0.9630550800880959`, 2.982989639327359`, 16.43861720173747`};
qmeanout =
   {0.08937009613390198`, 0.17033079826991637`, 0.10300155320321318`, 0.1459264955496759`};
qrmsout = {0.11878541018438911`, 0.29619788742895037`,
    0.1465844032511786`, 0.18487836972322316`};
qrmsout = qrmsout * Fluxin / Fluxout;
qmeanoutxy = Table[{position[[i]], Fluxin / Fluxout * qmeanout[[i]]}, {i, 4}];
qxy = {qmeaninxy, qmeanoutxy};
qxy = Flatten[qxy, 1];
qerr = {qrmsin, qrmsout};
qerr = Flatten[qerr, 1];
```

Out[85]=


$3.5\times10^7 \times 62$ MeV e^-/pulse
counting rate (Hz)
10
1
0.1
0.01
0.001
10
20
30
40
50
60
70
80
distance from target (cm)