Set the directory to where the data file is loacted

In[5476]:=
```
SetDirectory["~white/Desktop/ATF_100429"]
```

Out[5476]=
```
/Users/white/Desktop/ATF_100429
```

Target in, APD at 40 cm

Load the data (collect the 40 cm target in runs: 5,6,11,12). First Run 5:

In[5477]:=
```
data = Import["RTF_5_matrix_APD.dat", "Data"];
```

Data contain 21 scope traces triggered on the strip line and are stored as 42 columns of alternating time stamps and signal samples.
Delete the last 100 rows of time samples since they are beyond range of the scope.

In[5478]:=
```
data1 = Drop[data, -100]; Dimensions[data1]
```

Out[5478]=
```
{501, 42}
```

Extract time stamps from 1st row (all time stamps are identical). Convert to nanoseconds.

In[5479]:=
```
timenano = data1[[All, 1]]; (* First column is time *)
time = 10^9 * timenano;
```

- **Discard time stamps, leaving only an array of traces.**

In[5481]:=
```
waveforms = Drop[Transpose[data1], {1, 41, 2}];
```

Load the data (Run 6):

In[5482]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_6_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
```

- **Discard time stamps, leaving only an array of traces. Append run 6 to the data set.**

In[5485]:=
```
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5488]=
```
{42, 501}
```

Load the data (Run 11):

In[5489]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_11_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5495]=
```
{63, 501}
```

Load the data (Run 12):

In[5496]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_12_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5502]=
```
{84, 501}
```

- **Now do a simple search for hits using peak time without signal reconstruction**

In[5503]:=
```
bin = ConstantArray[0, 84]; i = ConstantArray[0, 84];
maxamp = Table[Max[-waveforms[[n]]], {n, 84}];
Do[
  bin[[n]] = Position[-waveforms[[n]], maxamp[[n]], 1, 1];
  i[[n]] = bin[[n, 1, 1]];
  , {n, 84}];
```

- **We found repeats in the data set which are likely due to misfires of the Linac. In these cases the stripline signal wouldn' t trigger the scope. So you just see waveform from the last Linac pulse.**
  I discard these using a simple algorithm. If the maximum bin is the same as in the last trace it is a repeat.

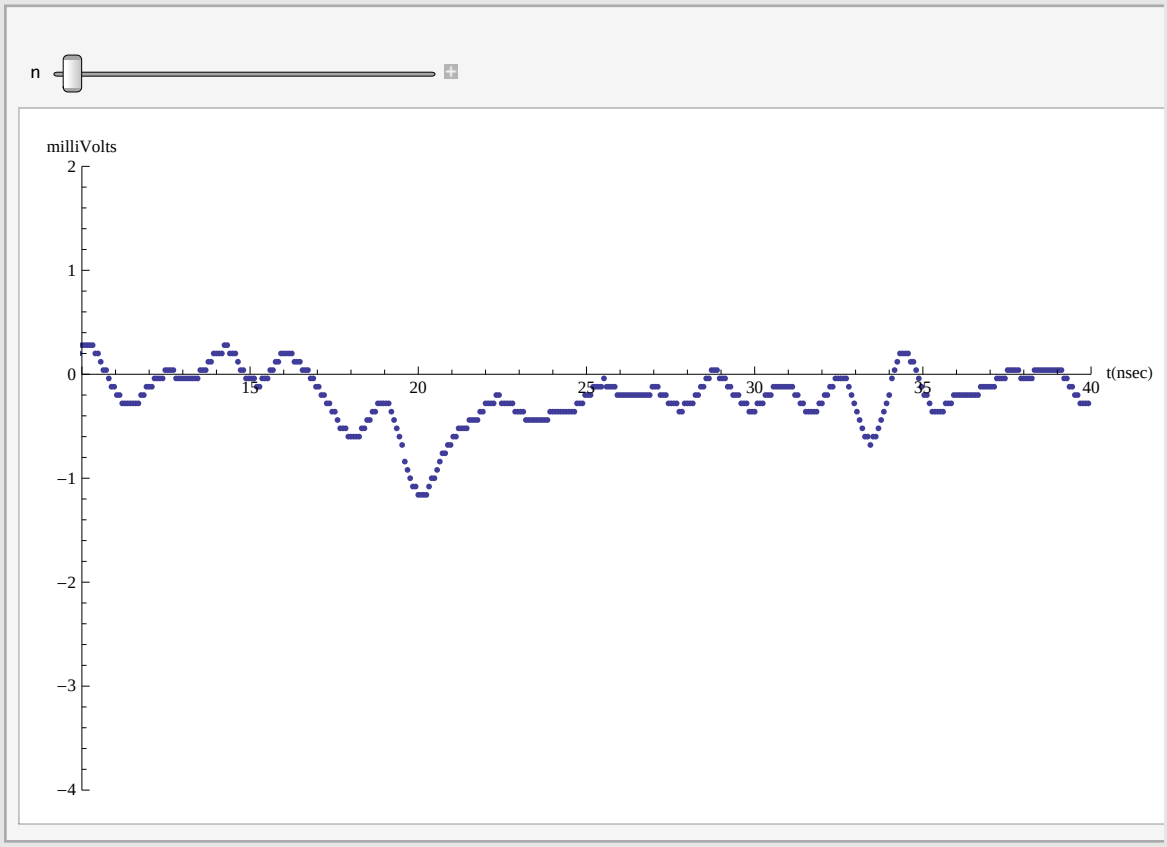
In[5506]:=
```
ndrop = 0; newwave40in = {};
AppendTo[newwave40in, waveforms[[1]]];
Do[
 l = waveforms[[n]];
 If[i[[n]] == i[[n - 1]], ndrop++, AppendTo[newwave40in, l]], {n, 2, 84}]
Print["number of empty linac pulses=", ndrop]
newdim = 84 - ndrop;
```

```
number of empty linac pulses=29
```

Inspect the waveforms

In[5511]:=
```
Manipulate[ListPlot[Transpose[{time, 1000 * newwave40in[[n]]}],
  PlotRange -> {{10, 40.}, {-4, 2}}, ImageSize → Large,
  AxesLabel -> {"t(nsec)", "milliVolts"}], {n, 1, newdim, 1}, SaveDefinitions → True]
```

Out[5511]=



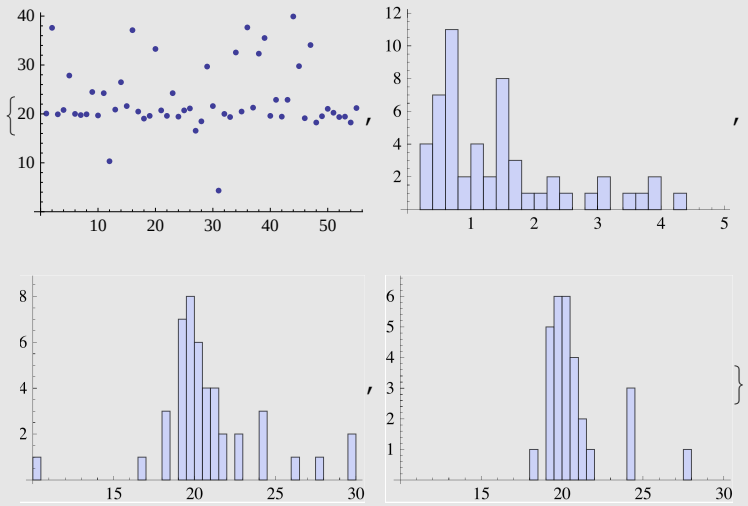
In[5512]:=
```
bin = ConstantArray[0, newdim]; peakchan = ConstantArray[0, newdim];
maxamp = Table[Max[-newwave40in[[n]]], {n, newdim}];
Dimensions[maxamp]
```

Out[5514]=
```
{55}
```

In[5515]:=
```
Do[
  bin[[n]] = Position[-newwave40in[[n]], maxamp[[n]], 1, 1];
  peakchan[[n]] = bin[[n, 1, 1]];
  , {n, 1, newdim}];
peakmvolts = 1000. * maxamp;
timepeak = .08 * peakchan;
cuttime = Pick[timepeak, Thread[peakmvolts > .8]];
```

In[5519]:=
```
{ListPlot[timepeak], Histogram[peakmvolts, {0, 5, .2}],
 Histogram [timepeak, {10, 30, .5}], Histogram[cuttime, {10, 30, .5}]}
```

Out[5519]=



In[5520]:=
```
fitregion = Pick[timepeak, Thread[Abs[timepeak - 20] < 3]];
q = FindDistributionParameters[fitregion, NormalDistribution[μ, σ]]
targin40cm = {μ /. q, σ /. q};
targin40cmtime = targin40cm[[1]];
```

Out[5521]=
```
{μ → 20.16, σ → 1.08041}
```

Target in, APD at 20 cm

Load the data (collect the 20 cm target in runs: 18-21). First Run 18:

In[5524]:=
```
Clear[data]; Clear[data1]; Clear [waveforms];
Clear[waveform2]; Clear[bin]; Clear[maxamp];
data = Import["RTF_18_matrix_APD.dat", "Data"];
```

In[5526]:=
```
data1 = Drop[data, -100]; Dimensions[data1];
```

- **Discard time stamps, leaving only an array of traces.**

In[5527]:=
```
waveforms = Drop[Transpose[data1], {1, 41, 2}];
```

Load the data (Run 19):

In[5528]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_19_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5534]=
```
{42, 501}
```

Load the data (Run 20):

In[5535]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_20_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5541]=
```
{63, 501}
```

Load the data (Run 21):

In[5542]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_21_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5548]=
```
{84, 501}
```

- **Now do a simple search for hits using peak time without signal reconstruction**

In[5549]:=
```
bin = ConstantArray[0, 84]; i = ConstantArray[0, 84];
maxamp = Table[Max[-waveforms[[n]]], {n, 84}];
Do[
  bin[[n]] = Position[-waveforms[[n]], maxamp[[n]], 1, 1];
  i[[n]] = bin[[n, 1, 1]];
  , {n, 84}];
```

- **We found repeats in the data set which are likely due to misfires of the Linac. In these cases the stripline signal wouldn' t trigger the scope. So you just see waveform from the last Linac pulse.**
  I discard these using a simple algorithm. If the maximum bin is the same as in the last trace it is a repeat.

In[5552]:=
```
ndrop = 0; newwave20in = {};
AppendTo[newwave20in, waveforms[[1]]];
Do[
 l = waveforms[[n]];
 If[i[[n]] == i[[n - 1]], ndrop++, AppendTo[newwave20in, l]], {n, 2, 84}]
Print["number of empty linac pulses=", ndrop]
newdim1 = 84 - ndrop;
```

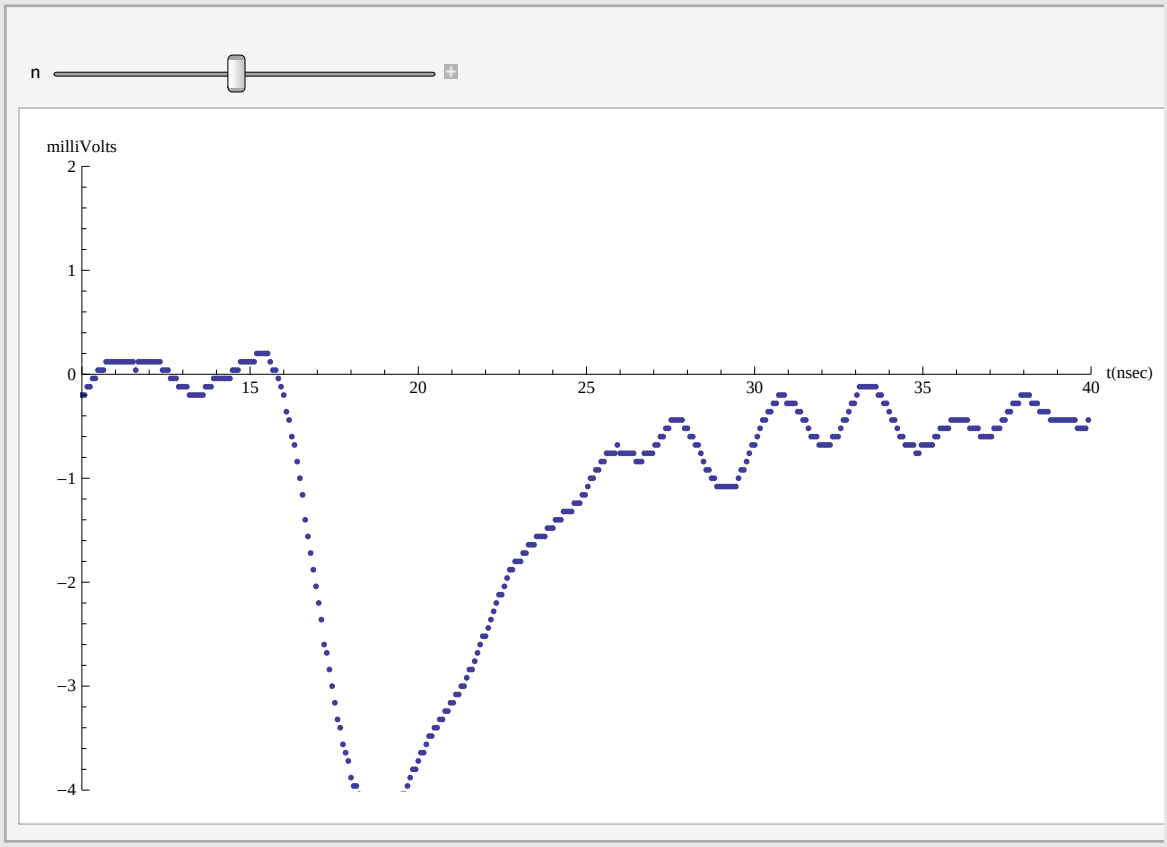
```
number of empty linac pulses=39
```

Inspect the waveforms

In[5557]:=

```
Manipulate[ListPlot[Transpose[{time, 1000 * newwave20in[[n]]}],
  PlotRange → {{10, 40.}, {-4, 2}}, ImageSize → Large,
  AxesLabel → {"t(nsec)", "milliVolts"}], {n, 1, newdim1, 1}, SaveDefinitions → True]
```

Out[5557]=

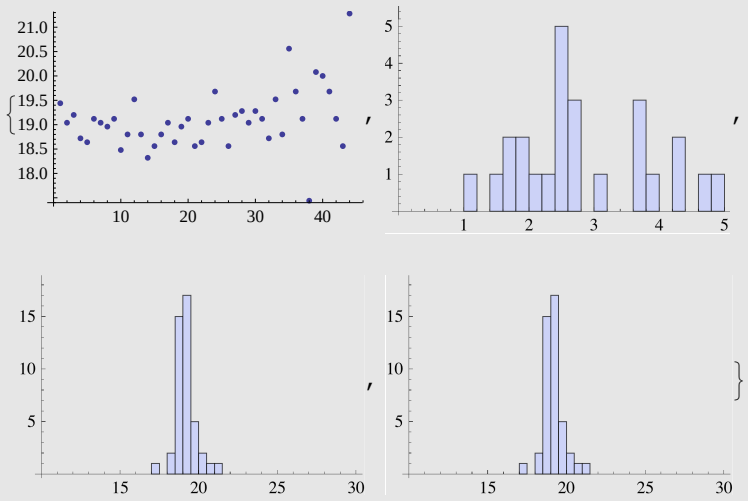


In[5558]:=

```
bin = ConstantArray[0, newdim1]; peakchan = ConstantArray[0, newdim1];
maxamp = Table[Max[-newwave20in[[n]]], {n, newdim1}];
Do[
  bin[[n]] = Position[-newwave20in[[n]], maxamp[[n]], 1, 1];
  peakchan[[n]] = bin[[n, 1, 1]];
  , {n, 1, newdim1}];
peakmvolts = 1000. * maxamp;
timepeak = .08 * peakchan;
cuttime = Pick[timepeak, Thread[peakmvolts > .5]];
```

In[5564]:=
```
{ListPlot[timepeak], Histogram[peakmvolts, {0, 5, .2}],
 Histogram [timepeak, {10, 30, .5}], Histogram[cuttime, {10, 30, .5}]}
```

Out[5564]=



Calculate Speed of Electron. A couple problems with this are pileup at the 20 cm position and crudeness of using peak channel for time.

In[5565]:=
```
fitregion = Pick[timepeak, Thread[Abs[timepeak - 20] < 3]];
q = FindDistributionParameters[fitregion, NormalDistribution[μ, σ]]
targin20cm = {μ /. q, σ /. q};
targin20cmtime = targin20cm[[1]];
<< PhysicalConstants`
<< Units`
c = SpeedOfLight[[1]] × 10^{-7};
β = 20 / (targin40cmtime - targin20cmtime) / c
```

Out[5566]=
```
{μ → 19.1, σ → 0.611912}
```

Out[5572]=
```
{0.629366}
```

Target out, APD at 40 cm

Load the data (collect the 40 cm target out runs: 7-10). First Run 7:

In[5573]:=
```
Clear[data]; Clear[data1]; Clear [waveforms];
Clear[waveform2]; Clear[bin]; Clear[maxamp];
data = Import["RTF_7_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
```

- **Discard time stamps, leaving only an array of traces.**

In[5576]:=
```
waveforms = Drop[Transpose[data1], {1, 41, 2}];
```

Load the data (Run 8):

In[5577]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_8_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
```

- **Discard time stamps, leaving only an array of traces. Append run 19 to the data set.**

In[5580]:=
```
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5583]=
```
{42, 501}
```

Load the data (Run 9):

In[5584]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_9_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5590]=
```
{63, 501}
```

Load the data (Run 10):

In[5591]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_10_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5597]=
```
{84, 501}
```

- **Now do a simple search for hits using peak time without signal reconstruction**

In[5598]:=
```
bin = ConstantArray[0, 84]; i = ConstantArray[0, 84];
maxamp = Table[Max[-waveforms[[n]]], {n, 84}];
Do[
  bin[[n]] = Position[-waveforms[[n]], maxamp[[n]], 1, 1];
  i[[n]] = bin[[n, 1, 1]];
  , {n, 84}];
```

- **We found repeats in the data set which are likely due to misfires of the Linac. In these cases the stripline signal wouldn' t trigger the scope. So you just see waveform from the last Linac pulse.**
  I discard these using a simple algorithm. If the maximum bin is the same as in the last trace it is a repeat.

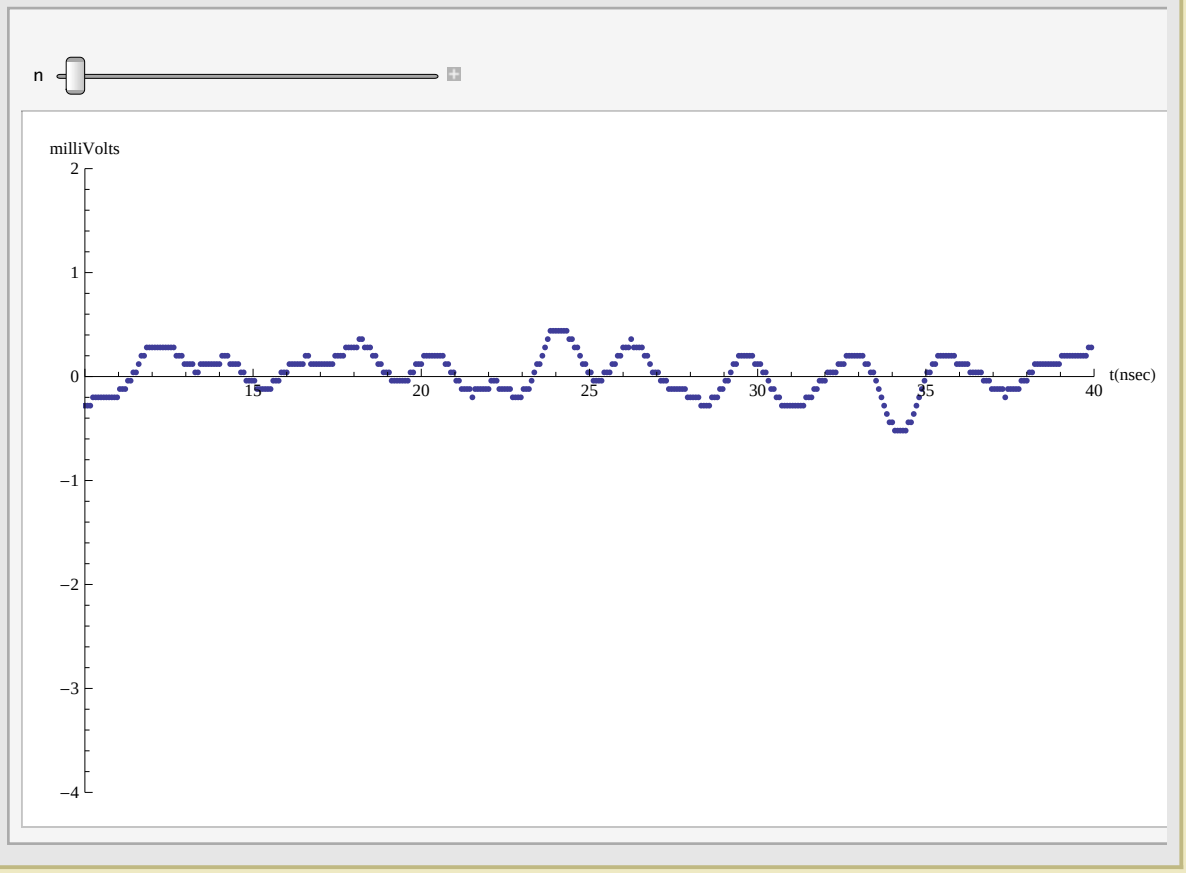
In[5601]:=
```
ndrop = 0; newwave40out = {};
AppendTo[newwave40out, waveforms[[1]]];
Do[
 l = waveforms[[n]];
 If[i[[n]] == i[[n - 1]], ndrop++, AppendTo[newwave40out, l]], {n, 2, 84}]
Print["number of empty linac pulses=", ndrop]
newdim2 = 84 - ndrop;
```

```
number of empty linac pulses=32
```

- **Inspect the waveforms**

In[5606]:=
```
Manipulate[ListPlot[Transpose[{time, 1000 * newwave40out[[n]]}],
  PlotRange → {{10, 40.}, {-4, 2}}, ImageSize → Large,
  AxesLabel → {"t(nsec)", "milliVolts"}], {n, 1, newdim2, 1}, SaveDefinitions → True]
```

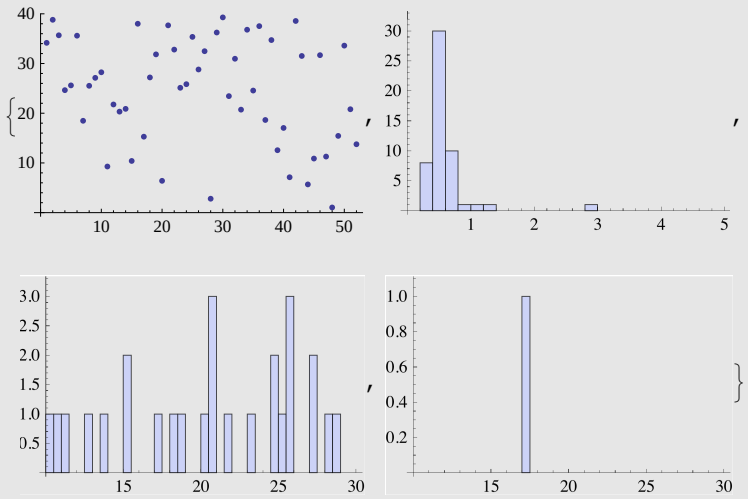
Out[5606]=



In[5607]:=
```
bin = ConstantArray[0, newdim2]; peakchan = ConstantArray[0, newdim2];
maxamp = Table[Max[-newwave40out[[n]]], {n, newdim2}];
Do[
  bin[[n]] = Position[-newwave40out[[n]], maxamp[[n]], 1, 1];
  peakchan[[n]] = bin[[n, 1, 1]];
  , {n, 1, newdim2}];
peakmvolts = 1000. * maxamp;
timepeak = .08 * peakchan;
cuttime = Pick[timepeak, Thread[peakmvolts > .8]];
```

In[5613]:=
```
{ListPlot[timepeak], Histogram[peakmvolts, {0, 5, .2}],
 Histogram [timepeak, {10, 30, .5}], Histogram[cuttime, {10, 30, .5}]}
```

Out[5613]=



In[5614]:=
```
```

Target in, APD at 20 cm, 6mm Pb absorber

Load the data (collect the 20 cm target in, Pb absorber runs: 14-17). First Run 14:

In[5615]:=
```
Clear[data]; Clear[data1]; Clear [waveforms];
Clear[waveform2]; Clear[bin]; Clear[maxamp];
data = Import["RTF_14_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
```

- **Discard time stamps, leaving only an array of traces.**

In[5618]:=
```
waveforms = Drop[Transpose[data1], {1, 41, 2}];
```

Load the data (Run 15):

In[5619]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_15_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
```

- **Discard time stamps, leaving only an array of traces. Append run 19 to the data set.**

In[5622]:=
```
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5625]=
```
{42, 501}
```

Load the data (Run 16):

In[5626]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_16_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5632]=
```
{63, 501}
```

Load the data (Run 17):

In[5633]:=
```
Clear[data]; Clear[data1];
data = Import["RTF_17_matrix_APD.dat", "Data"];
data1 = Drop[data, -100];
waveform2 = Drop[Transpose[data1], {1, 41, 2}];
Do[
  AppendTo[waveforms, waveform2[[i]]];, {i, 21}];
Clear[waveform2];
Dimensions[waveforms]
```

Out[5639]=
```
{84, 501}
```

- **Now do a simple search for hits using peak time without signal reconstruction**

In[5640]:=
```
bin = ConstantArray[0, 84]; i = ConstantArray[0, 84];
maxamp = Table[Max[-waveforms[[n]]], {n, 84}];
Do[
  bin[[n]] = Position[-waveforms[[n]], maxamp[[n]], 1, 1];
  i[[n]] = bin[[n, 1, 1]];
  , {n, 84}];
```

- **We found repeats in the data set which are likely due to misfires of the Linac. In these cases the stripline signal wouldn' t trigger the scope. So you just see waveform from the last Linac pulse.**
  I discard these using a simple algorithm. If the maximum bin is the same as in the last trace it is a repeat.

In[5643]:=
```
ndrop = 0; newwave20Pb = {};
AppendTo[newwave20Pb, waveforms[[1]]];
Do[
 l = waveforms[[n]];
 If[i[[n]] == i[[n - 1]], ndrop++, AppendTo[newwave20Pb, l]], {n, 2, 84}]
Print["number of empty linac pulses=", ndrop]
newdim3 = 84 - ndrop;
```

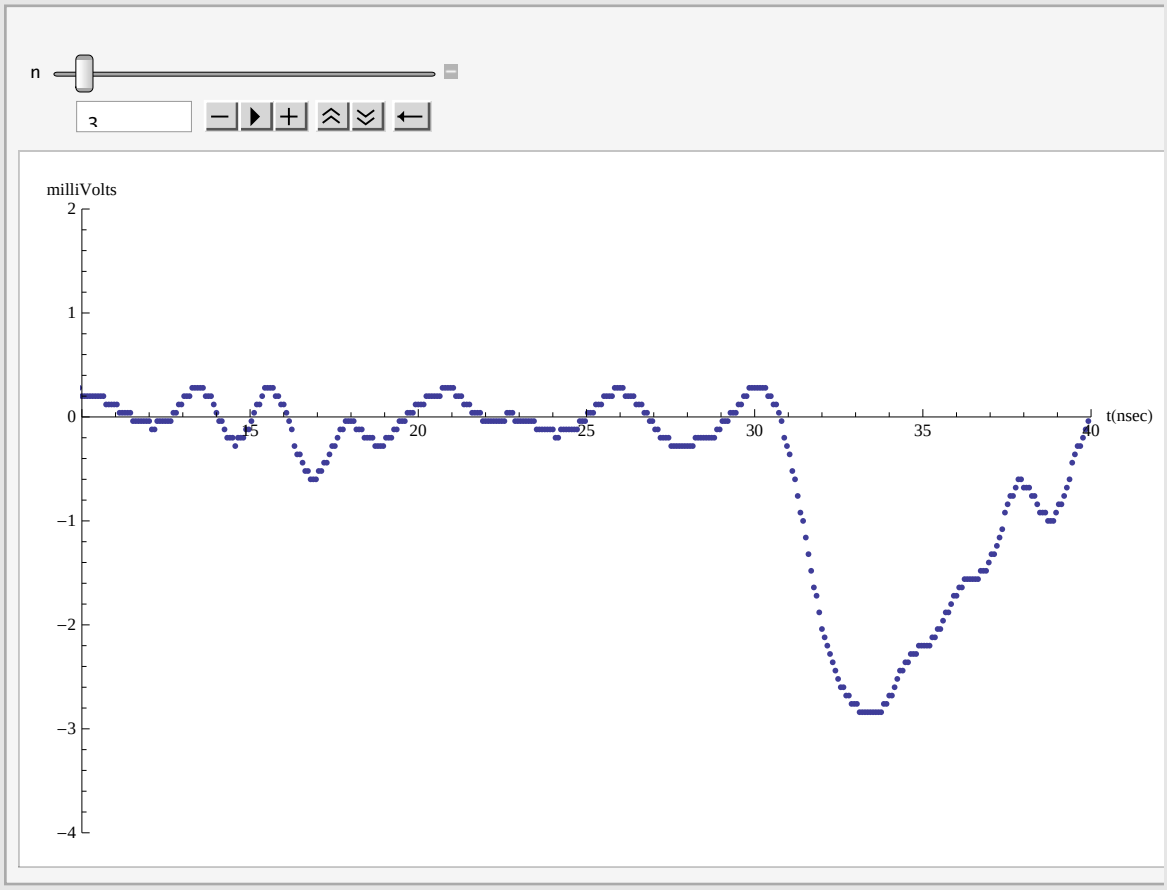
```
number of empty linac pulses=23
```

Inspect the waveforms

In[5648]:=

```
Manipulate[ListPlot[Transpose[{time, 1000 * newwave20Pb[[n]]}],
  PlotRange → {{10, 40.}, {-4, 2}}, ImageSize → Large,
  AxesLabel → {"t(nsec)", "milliVolts"}], {n, 1, newdim3, 1}, SaveDefinitions → True]
```

Out[5648]=



In[5649]:=

```
bin = ConstantArray[0, newdim3]; peakchan = ConstantArray[0, newdim3];
maxamp = Table[Max[-newwave20Pb[[n]]], {n, newdim3}];
Do[
  bin[[n]] = Position[-newwave20Pb[[n]], maxamp[[n]], 1, 1];
  peakchan[[n]] = bin[[n, 1, 1]];
  , {n, 1, newdim3}];
peakmvolts = 1000. * maxamp;
timepeak = .08 * peakchan;
cuttime = Pick[timepeak, Thread[peakmvolts > .8]];
```

In[5655]:=

```
{ListPlot[timepeak], Histogram[peakmvolts, {0, 5, .2}],
 Histogram [timepeak, {10, 30, .5}], Histogram[cuttime, {10, 30, .5}]}
```

Out[5655]=