Analysis of June 2, 2013 PSI data.
This notebook starts from reduced data (after noise analysis and baseline subtraction).
SNW-July 15, 2013

In[176]:=
```
SetDirectory["~seb/Desktop/PSI_data/"];
Namelist = FileNames[]
Namelist // Length;
nfiles = %
filename = Namelist[[2]]
Timing[scopedata = Import[filename, "csv"];]
```

Out[177]=
```
{.DS_Store, LeCroy-compress-2013-06-02-045.csv,
 LeCroy-compress-2013-06-02-046.csv, LeCroy-compress-2013-06-02-047.csv,
 LeCroy-compress-2013-06-02-048.csv, LeCroy-compress-2013-06-02-049.csv}
```

Out[179]= 6

Out[180]= LeCroy-compress-2013-06-02-045.csv

Out[181]= {7.061840, Null}

In[182]:=
```
phase = Table[scopedata[[i, 1]], {i, 2500}];
ampl = Table[scopedata[[i, 2]], {i, 2500}];
v1 = Table[Take[scopedata[[i]], {3, 402}], {i, 2500}];
v2 = Table[Take[scopedata[[i]], {403, 802}], {i, 2500}];
v3 = Table[Take[scopedata[[i]], {803, 1202}], {i, 2500}];
```

Combine data from multiple runs.

In[187]:=
```
Do[
  Clear[scopedata];
  filename = Namelist[[nfil]];
  Print[filename];
  scopedata = Import[filename, "csv"];
phase = Join[phase, Table[scopedata[[i, 1]], {i, 2500}]];
  ampl = Join[ampl, Table[scopedata[[i, 2]], {i, 2500}]];
  v1 = Join[v1, Table[Take[scopedata[[i]], {3, 402}], {i, 2500}]];
  v2 = Join[v2, Table[Take[scopedata[[i]], {403, 802}], {i, 2500}]];
  v3 = Join[v3, Table[Take[scopedata[[i]], {803, 1202}], {i, 2500}]];
  , {nfil, 3, 6, 1}];
```

```
LeCroy-compress-2013-06-02-046.csv

LeCroy-compress-2013-06-02-047.csv

LeCroy-compress-2013-06-02-048.csv

LeCroy-compress-2013-06-02-049.csv
```

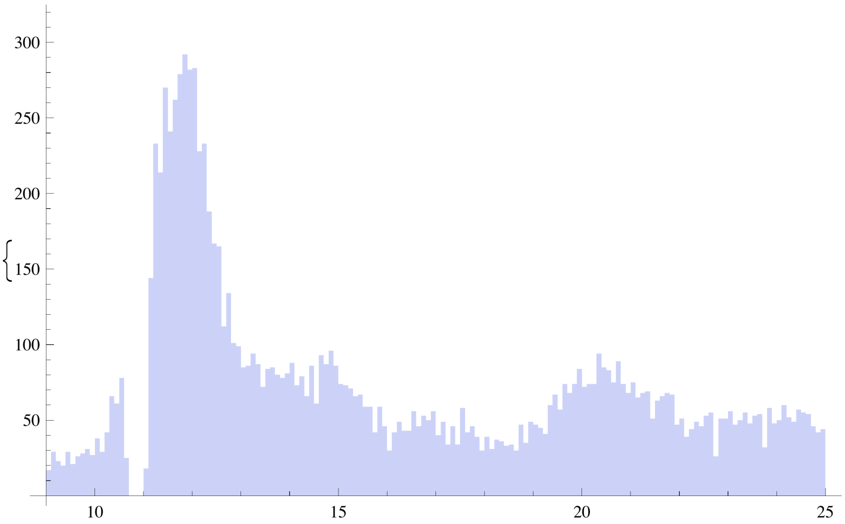
In[229]:=
```
outfile = StringReplace[filename, {"compress" → "ntuple"}]
```

Out[229]= LeCroy-ntuple-2013-06-02-049.csv

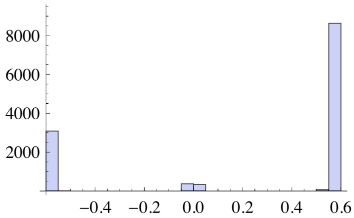
tof distributions

In[231]:= `{Histogram[phaseshift = Mod[phase, 19.75, 8.], {9, 25, .1}], Histogram[ampl]}`

Out[231]= {



,

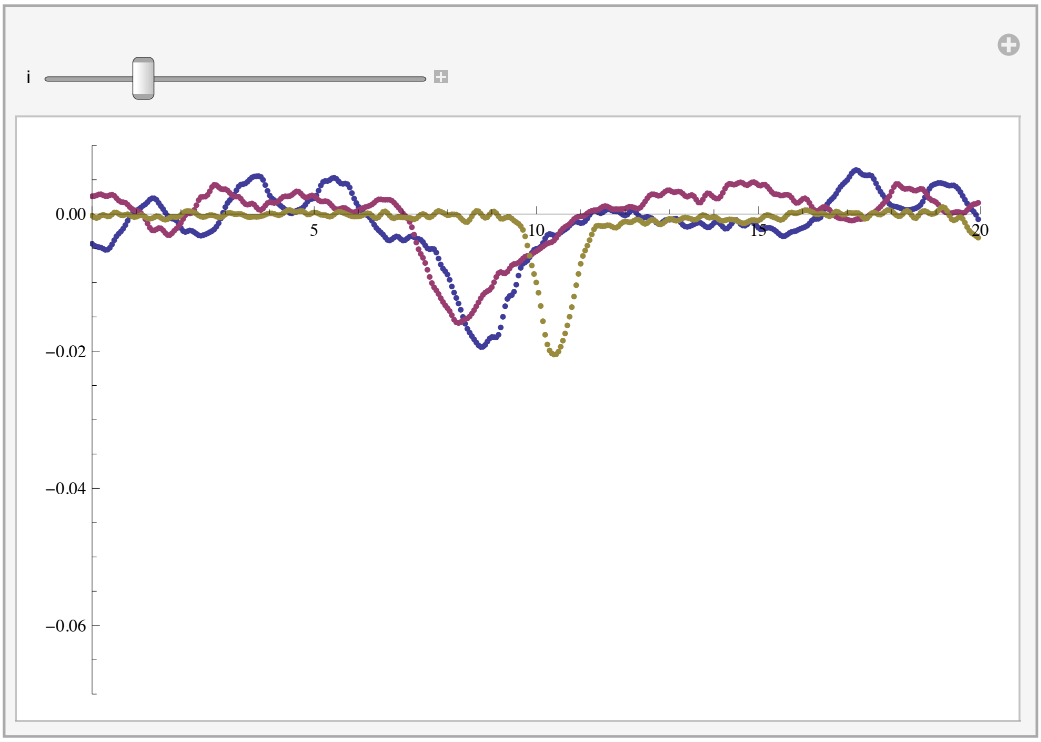


}

Inspect APD data.

```
time = Range[0, 399] * .05;
Manipulate[ListPlot[{Transpose[{time, v1[[i]]}],
   Transpose[{time, v2[[i]]}], Transpose[{time, v3[[i]]}]},
  PlotRange → {{0, 20.}, {-.07, .01}}, ImageSize → Large], {i, 1, 2500, 1}]
```

Out[196]=

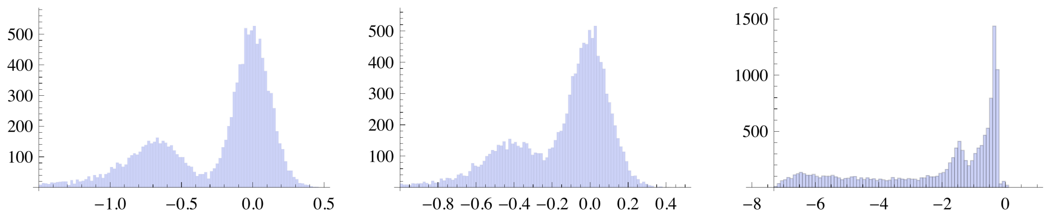


Integrate to find pulse area.

In[197]:=
```
ph1 = Table[Sum[v1[[i, j]], {j, 100, 299, 1}], {i, 12 500}];
ph2 = Table[Sum[v2[[i, j]], {j, 100, 299, 1}], {i, 12 500}];
ph3 = Table[Sum[v3[[i, j]], {j, 100, 299, 1}], {i, 12 500}];
```

In[378]:=
```
GraphicsRow[{Histogram[ph1, {-1.5, .5, .02}],
  Histogram[ph2, {-1, .5, .015}], Histogram[ph3, {-8, 1, .1}]}, ImageSize → Large]
```

Out[378]=



Now calculate expected pulse area from Q = qe*ne*APDGain*Ampgain, V/50 Ohms = i
Gains and detector Capacitance dependent deficit from Voltage Amplifier Model.

Looks like there is a factor of 4 less integrated charge than would predict for either 64mm^2
or 4mm^2 detectors.
The discrepancy is possibly even larger since the APD gain is likely a bit more than 600 at this bias.

```
In[216]:= qe = -1.60217 * 10^-19;
          ne = 6000; APDgain = 600;
          defecit4mm = 0.5; defecit64 = 0.09;
          NSolve[13 == 20 Log10[vgain], vgain] /. Rule → List;
          Ampgain13 = %[[1, 1, 2]]
          NSolve[20 == 20 Log10[vgain], vgain] /. Rule → List;
          Ampgain20 = %[[1, 1, 2]]

Out[220]= 4.46684

Out[222]= 10.

In[223]:= NSolve[vsum == 50 / (.05 * 10^-9) * qe * ne * APDgain * Ampgain13, vsum] /. Rule → List
          pulsearea3 = %[[1, 1, 2]] * defecit4mm

Out[223]= {{{vsum, -2.57639}}}

Out[224]= -1.28819

In[225]:= NSolve[vsum == 50 / (.05 * 10^-9) * qe * ne * APDgain * Ampgain13 * Ampgain20, vsum] /.
            Rule → List
          pulsearea1 = %[[1, 1, 2]] * defecit64

Out[225]= {{{vsum, -25.7639}}}

Out[226]= -2.31875
```

Now create an n - Tuple to fish out the characteristics of the MIP signal and write it to file.
Also define some obvious cuts.

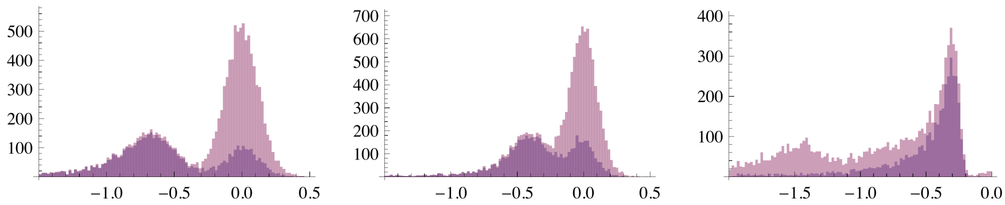
```
In[232]:= ntuple = Transpose[{phaseshift, ampl, ph1, ph2, ph3}];

In[233]:= Export[outfile, ntuple, "csv"]

Out[233]= LeCroy-ntuple-2013-06-02-049.csv
```

In[352]:=
```
phasepos = 1; amplpos = 2;
ph1pos = 3; ph2pos = 4; ph3pos = 5;
ph1and2ok[datum_List] :=
 (-1 < Part[datum, ph2pos < -.2]) && (-1.3 < Part[datum, ph1pos] < -.3)
phasepi[datum_List] := (11 < Part[datum, phasepos] < 13)
ph3ok[datum_List] := (-1.2 < Part[datum, ph3pos] < -.2)
ph1ok[datum_List] := (-1.3 < Part[datum, ph1pos] < -.3)
ph2ok[datum_List] := (-1 < Part[datum, ph2pos] < -.2)
amplok[datum_List] := (.4 < Part[datum, amplpos]) &&
  (-1.3 < Part[datum, ph1pos] < -.3) && (-1.3 < Part[datum, ph1pos] < -.35)
```

Conditional Histograms

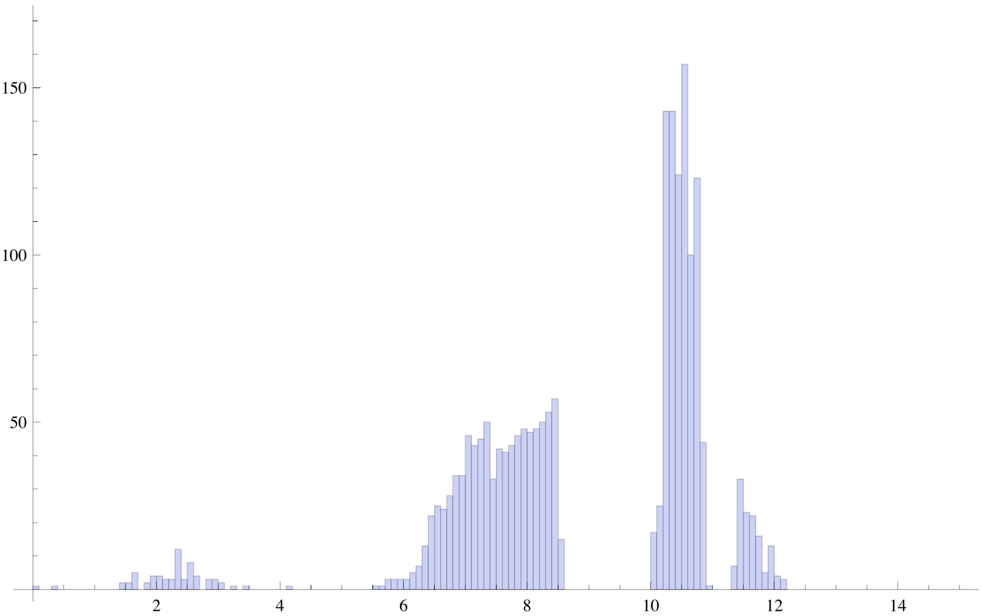
In[381]:=
```
GraphicsRow[
 {Histogram[{Select[ntuple, ph3ok][[All, ph1pos]], ntuple[[All, ph1pos]]},
   {-1.5, .5, .02}], Histogram[{Select[ntuple, ph3ok][[All, ph2pos]],
    ntuple[[All, ph2pos]]}, {-1.5, .5, .02}], Histogram[
   {Select[ntuple, ph1ok][[All, ph3pos]], ntuple[[All, ph3pos]]}, {-2, 0, .02}]}]
```

Out[381]=



In[363]:=
```
shiftedTOF = -(Select[ntuple, amplok][[All, phasepos]] - 22);
Histogram[shiftedTOF, {0, 15, .1}]
```

Out[364]=



The Tof Spectrum has roughly the expected time difference for e, mu, and pions - see below.
The pion peak itself is split, probably because the clock period falls in the middle of the peak.

Clearly the clock phase analysis could use a little cleaning up.

In[365]:=
```
mu = ParticleData["Muon", "Mass"]; mpi = ParticleData["PiPlus", "Mass"];
me = ParticleData["Electron", "Mass"];
Solve[250 == mpi * beta / Sqrt[1 - beta * beta], beta] /. Rule → List;
vpi = %[[1, 1, 2]]
```

Out[367]= 0.87314524

In[368]:=
```
Solve[250 == me * beta / Sqrt[1 - beta * beta], beta] /. Rule → List;
ve = %[[1, 1, 2]]
```

Out[369]= 0.99999791

In[370]:=
```
Solve[250 == mu * beta / Sqrt[1 - beta * beta], beta] /. Rule → List;
vmu = %[[1, 1, 2]]
```

Out[371]= 0.921113762

In[372]:=
```
Solve[tofe == 2360 / 30 * (1 / ve - 1 / vpi), tofe]
```

Out[372]= {{tofe → -11.42891}}

In[373]:=
```
Solve[tofmu == 2360 / 30 * (1 / vmu - 1 / vpi), tofmu]
```

Out[373]= {{tofmu → -4.691885}}

End of Notebook so far