



STATUS REPORT

2017.8.10

NJ PARK

THINGS DONE

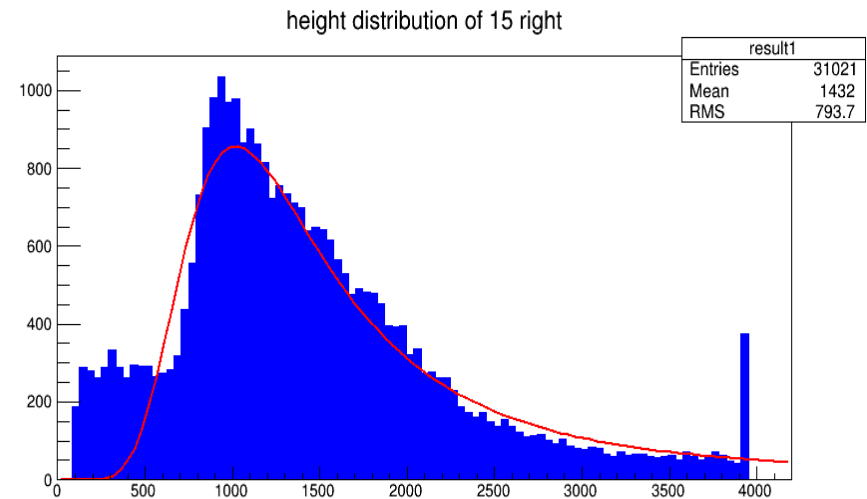
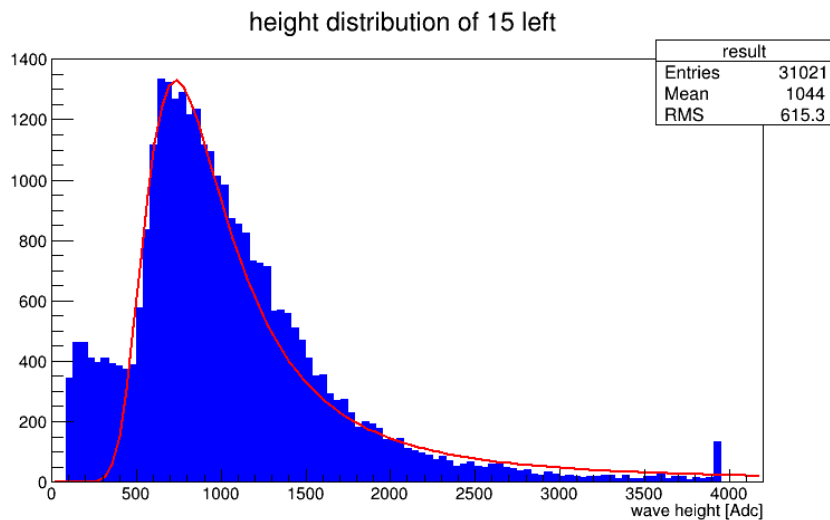
- Study
- Data analysis

STUDY

- **Scintillation detector**
 - Read leo & Data analysis
- **Photomultiplier tube**
 - Read(ing) leo
- **Cosmic ray height distribution**
 - Read PDG, but I couldn't figure out why height distributions show like that

DATA ANALYSIS

- Copy what JJ & KH did
 - Height distribution of cosmic ray & lamdau fitting



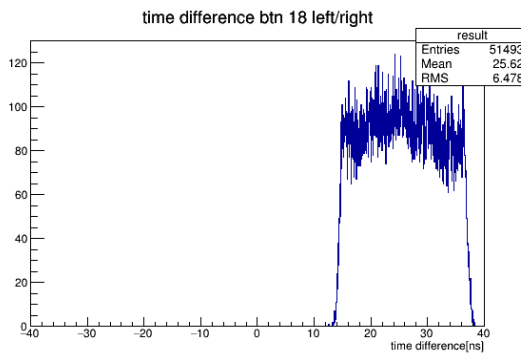
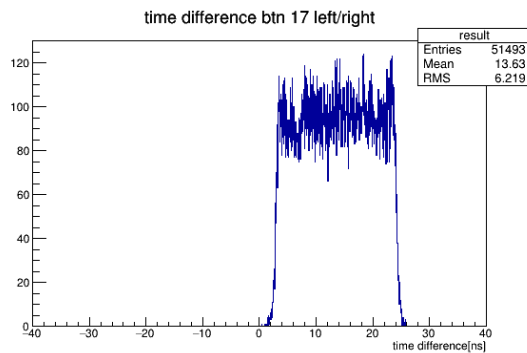
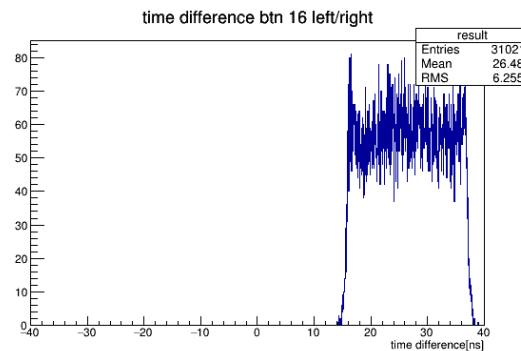
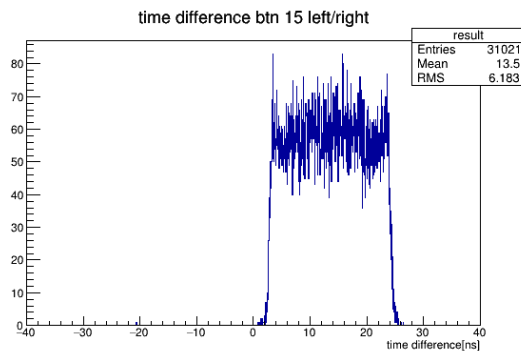
DATA ANALYSIS

- Scintillation detector analysis
 - EJ-200 spec.

PROPERTIES	EJ-200	EJ-204	EJ-208	EJ-212
Light Output (% Anthracene)	64	68	60	65
Scintillation Efficiency (photons/1 MeV e ⁻)	10,000	10,400	9,200	10,000
Wavelength of Maximum Emission (nm)	425	408	435	423
Light Attenuation Length (cm)	380	160	400	250
Rise Time (ns)	0.9	0.7	1.0	0.9
Decay Time (ns)	2.1	1.8	3.3	2.4
Pulse Width, FWHM (ns)	2.5	2.2	4.2	2.7
No. of H Atoms per cm ³ (x10 ²²)	5.17	5.15	5.17	5.17
No. of C Atoms per cm ³ (x10 ²²)	4.69	4.68	4.69	4.69
No. of Electrons per cm ³ (x10 ²³)	3.33	3.33	3.33	3.33
Density (g/cm ³)	1.023	1.023	1.023	1.023
Polymer Base	Polyvinyltoluene			
Refractive Index	1.58			
Softening Point	75°C			
Vapor Pressure	Vacuum-compatible			
Coefficient of Linear Expansion	7.8 x 10 ⁻⁵ below 67°C			
Light Output vs. Temperature	At 60°C, L.O. = 95% of that at 20°C No change from 20°C to -60°			
Temperature Range	-20°C to 60°C			

DATA ANALYSIS

- Scintillation detector analysis
 - Time difference btn left and right PMT

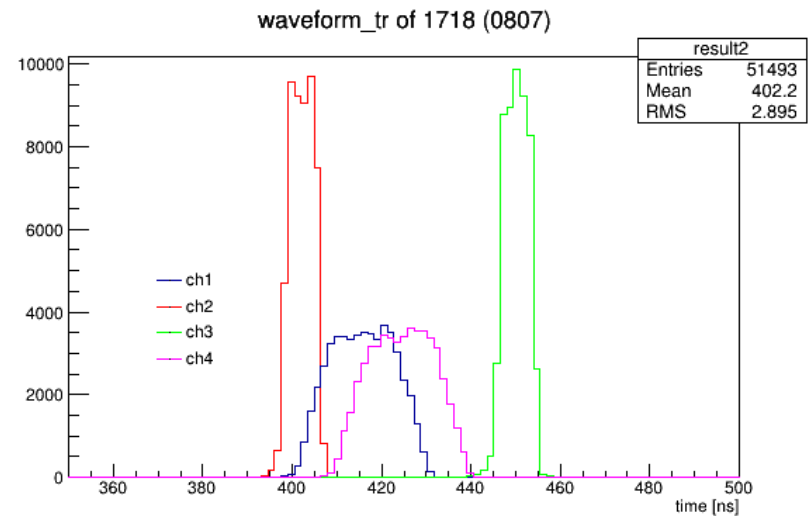
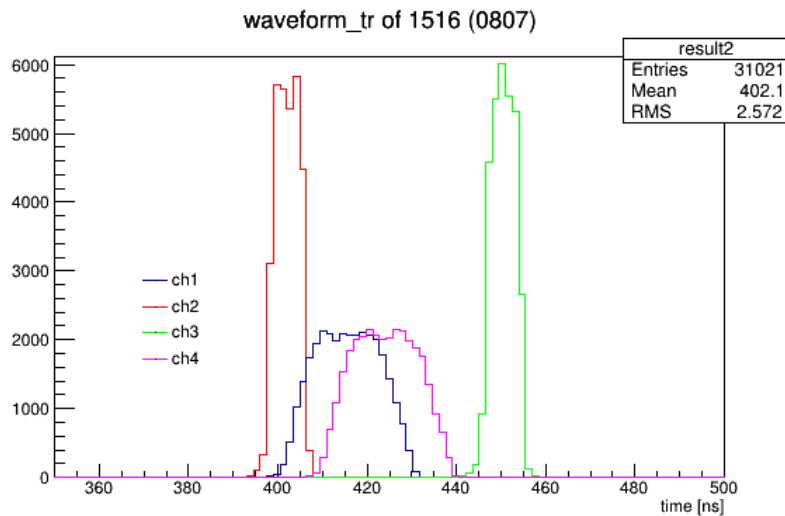


DATA ANALYSIS

- **Scintillation detector analysis**
 - Time difference btn left and right PMT ~ about 20ns
 - Length of scintillation detector ~ 1.7m
 - Refraction factor = $c * (\text{time difference}/2) / \text{length} \sim 1.76$
with **11.3%** error wrt 1.58 in spec

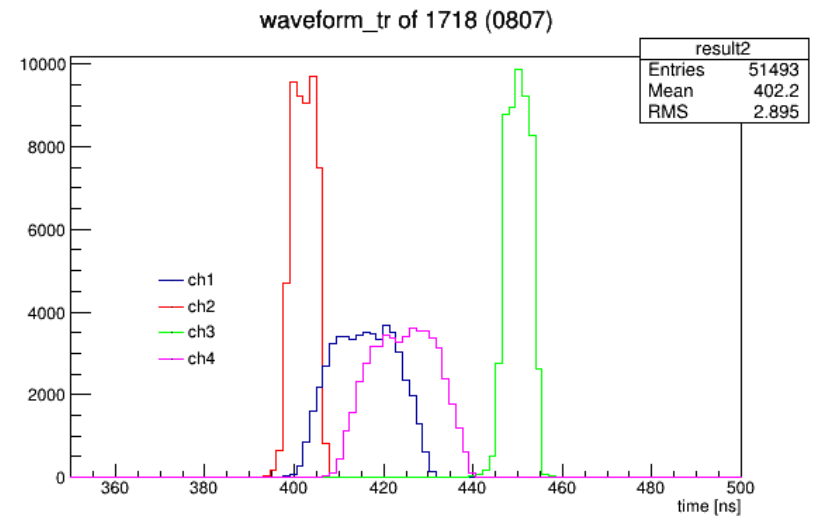
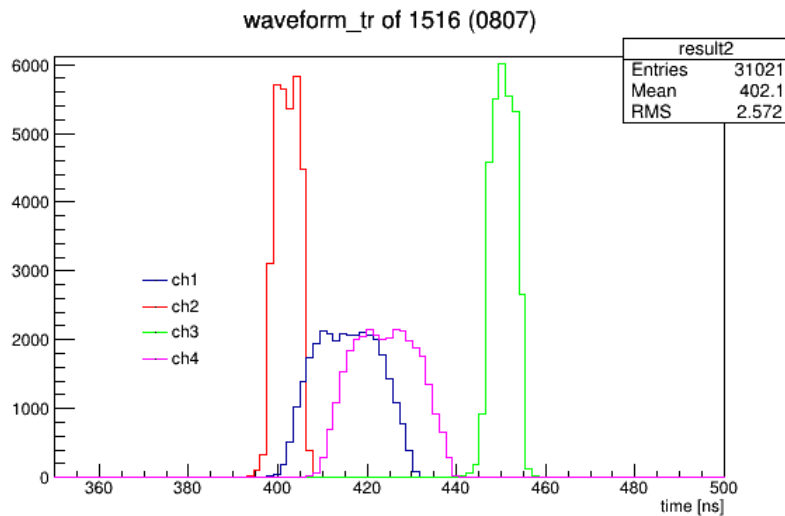
DATA ANALYSIS

- **Scintillation detector analysis**
 - But there are some errors
 - Comparing each time signal was detected at PMT



DATA ANALYSIS

- **Scintillation detector analysis**
 - They are different with depending on channel
 - Not related with scintillator or PMT

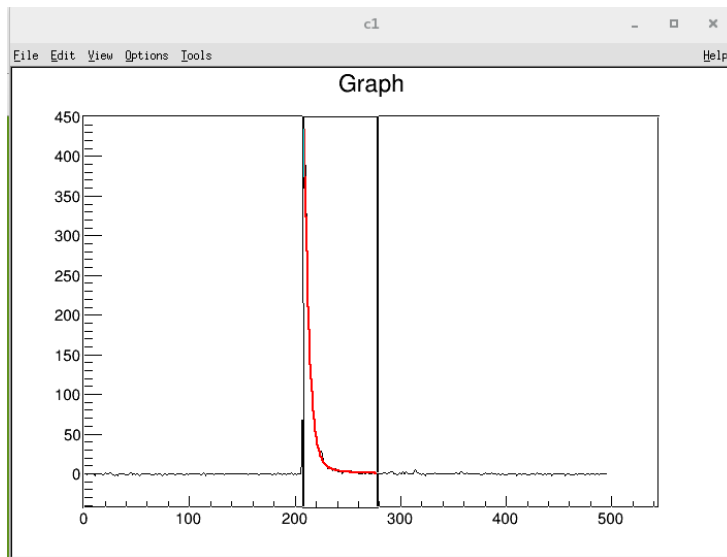


DATA ANALYSIS

- **Scintillation detector analysis**
 - Calculating decay const
 - 1st approx. expression $N(t) = \frac{N_0}{\tau} \exp(-\frac{t}{\tau})$
 - 2nd approx. expression
 - $N(t) = A \exp\left(-\frac{t}{\tau_f}\right) + B \exp(-\frac{t}{\tau_s})$
 - $N(t) = N_0 f(\sigma) \exp(-\frac{t}{\tau})$ where f is Gaussian dist.

DATA ANALYSIS

- Scintillation detector analysis
 - Parameters depend on Range



```
Invalid FitResult (status = 4)
*****
Minimizer is Minuit / Migrad
Chi2      =      1915.2
NDf       =      120
Edm       =      6.01884
VCalls    =      296
>0        =      41.1285 +/- 3.92824
>1        =      -0.224858 +/- 0.353847
>2        =      48.4893 +/- 0.0039018
>3        =      -0.203069 +/- 1.84885e-05
*****
Minimizer is Minuit / Migrad
Chi2      =      1456.85
NDf       =      83
Edm       =      1.43142e-07
VCalls    =      1375
>0        =      51.5389 +/- 1.23678
>1        =      -0.217787 +/- 0.00598133
>2        =      12.6544 +/- 4.23767
>3        =      -0.0475706 +/- 0.0177727
*****
Minimizer is Minuit / Migrad
Chi2      =      1444.73
NDf       =      65
Edm       =      6.53629e-08
VCalls    =      188
>0        =      51.6055 +/- 0.0806226
>1        =      -0.218112 +/- 0.00038653
>2        =      13.024 +/- 1.06033
>3        =      -0.0491415 +/- 0.00464055
|
```

DATA ANALYSIS

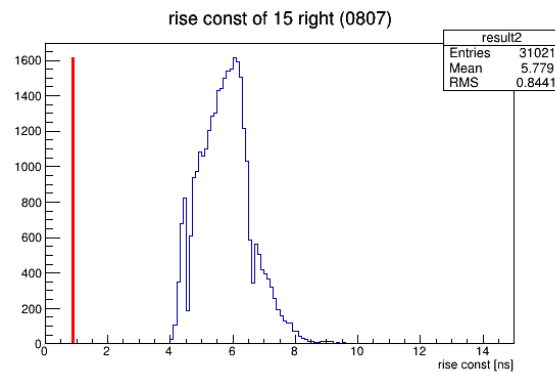
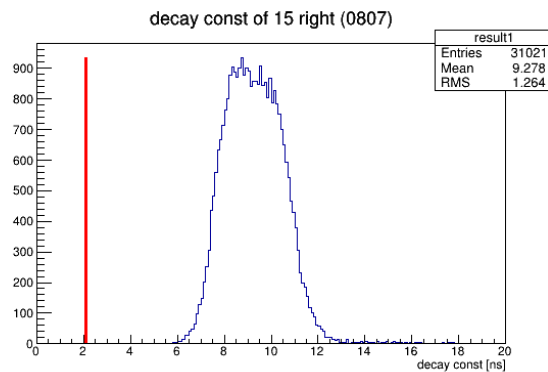
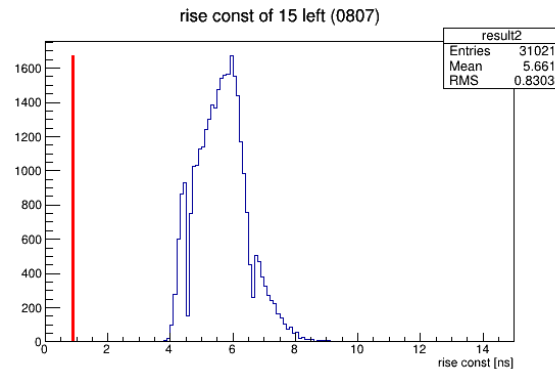
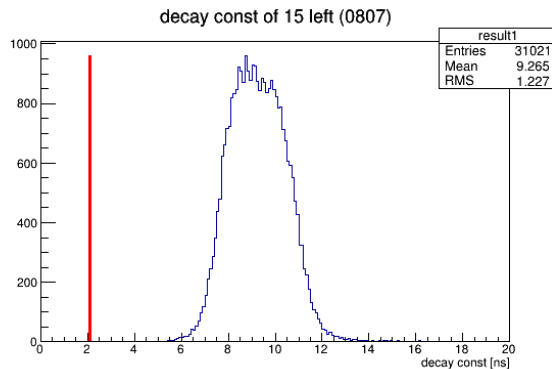
- **Scintillation detector analysis**
 - Rise time = max time – waveform_tr
 - Decay time calculated from
(waveform-waveform_ped) to waveformtime graph

```
for(int i=0; i!=entries; i++) {
    chain->GetEntry(i);
    for(int j=0; j<496; j++){
        x[j]=waveformtime[n][j];
        y[j]=(waveform[n][j]-waveform_ped[n])/2.0;
    }
    max=max_t=0;
    for(int j=0; j<496; j++){
        if(waveform[n][j]>max){
            max=waveform[n][j];
            max_t=waveformtime[n][j];
        }
    }

    TGraph* gr=new TGraph(496, x, y);
    TF1* f1 = new TF1("f1", "expo", max_t, max_t+200);
    gr->Fit("f1","RQ");
    double rise_const=max_t-waveform_tr[n];
    double decay_const=(-1.0/(f1->GetParameter(1)));
    result2->Fill(rise_const);
    result1->Fill(decay_const);
}
```

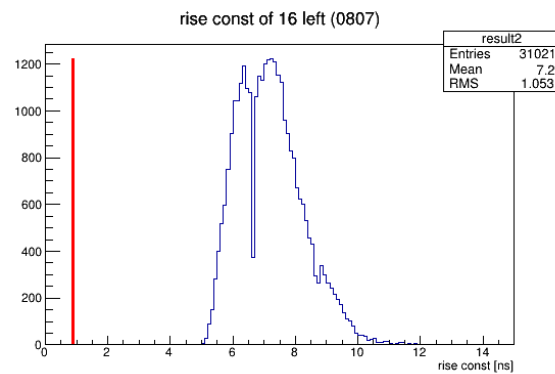
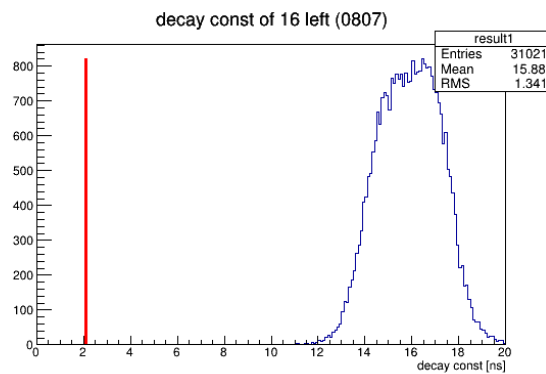
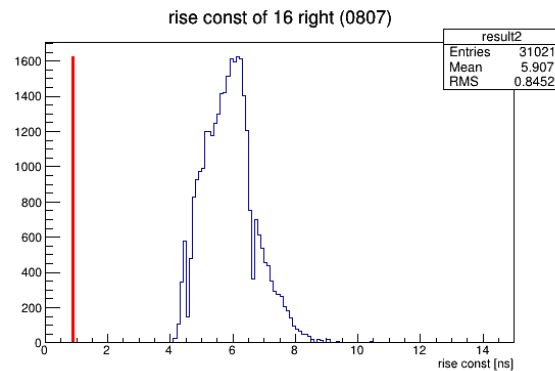
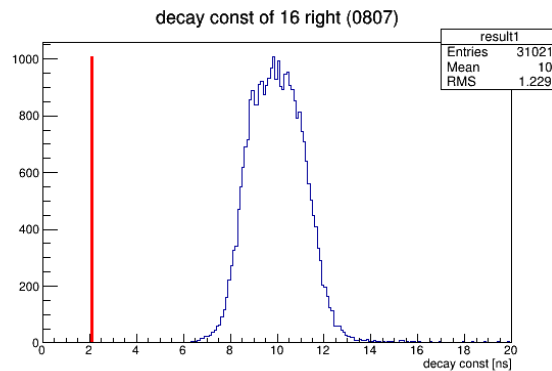
DATA ANALYSIS

- Scintillation detector analysis
 - results



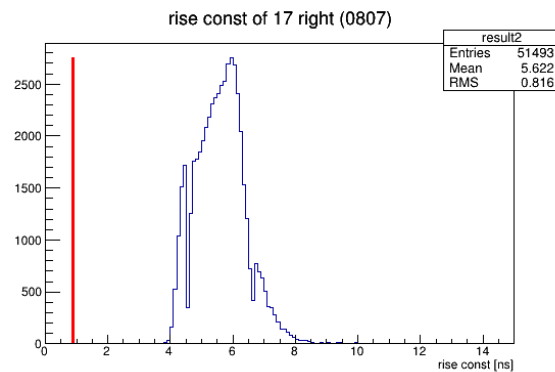
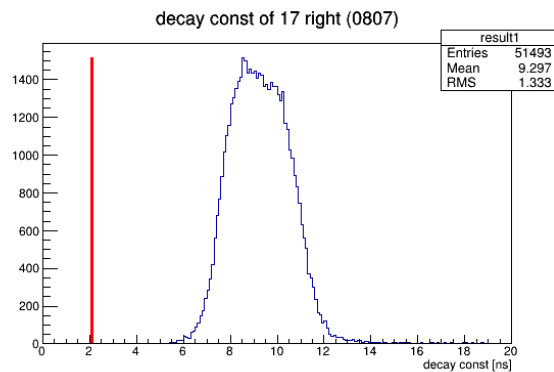
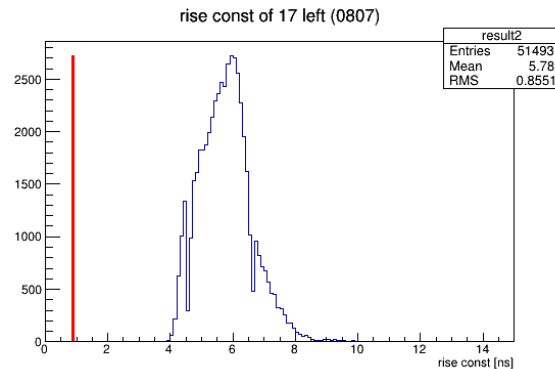
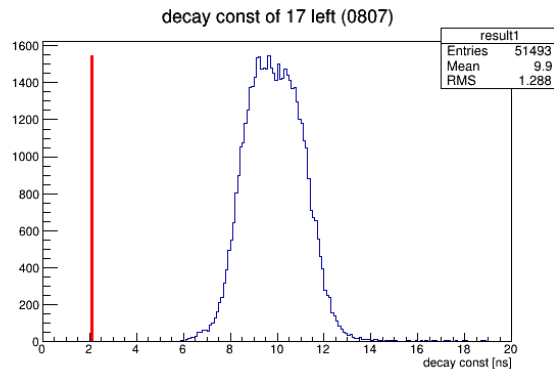
DATA ANALYSIS

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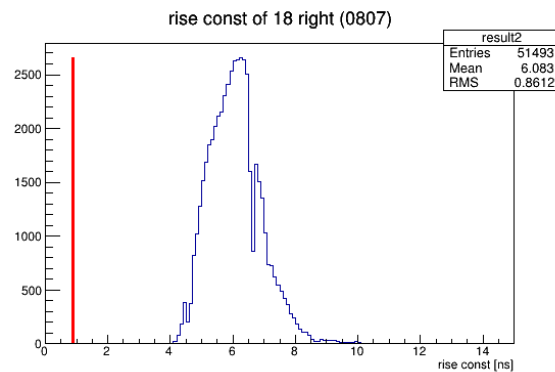
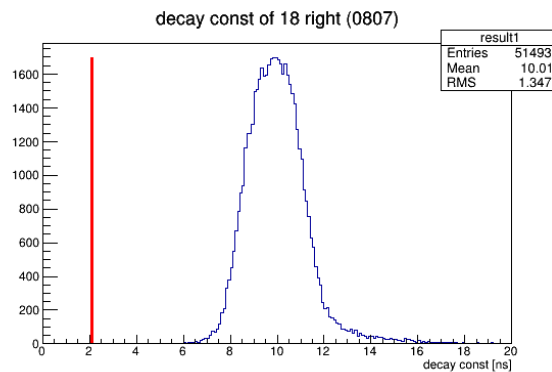
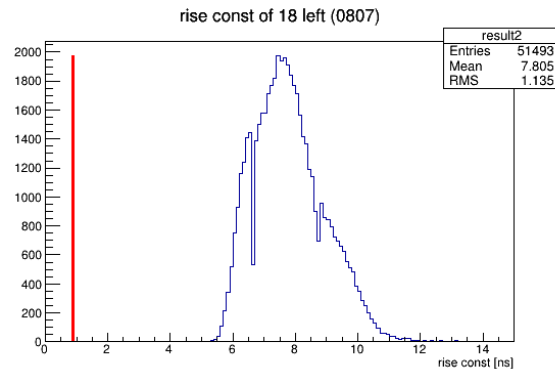
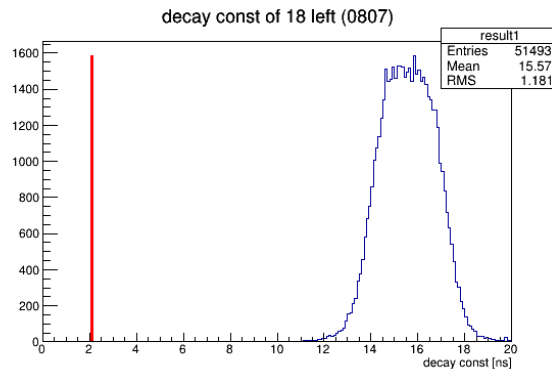
DATA ANALYSIS

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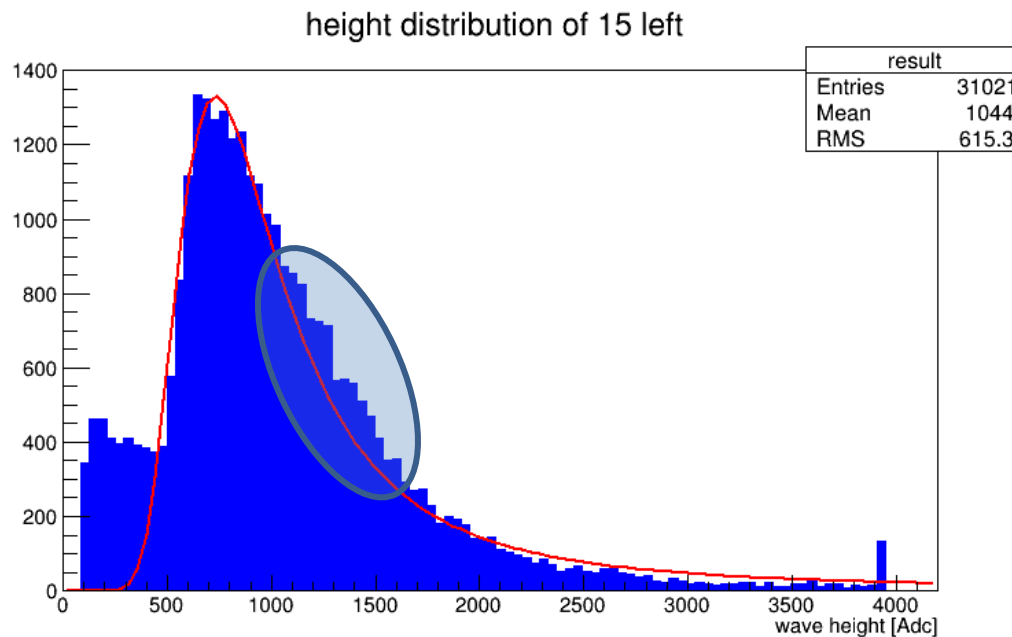
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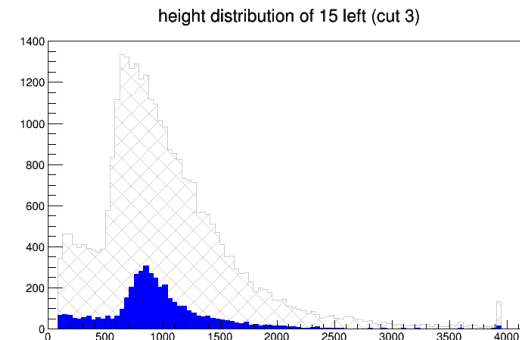
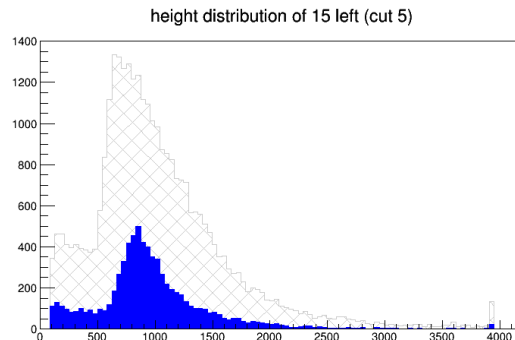
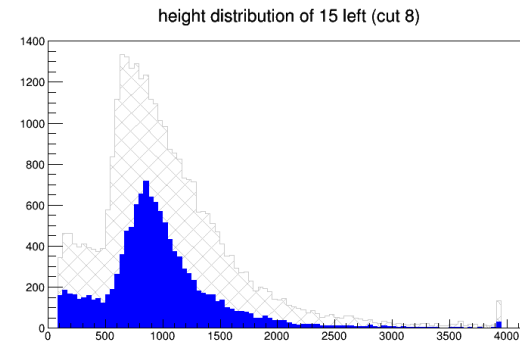
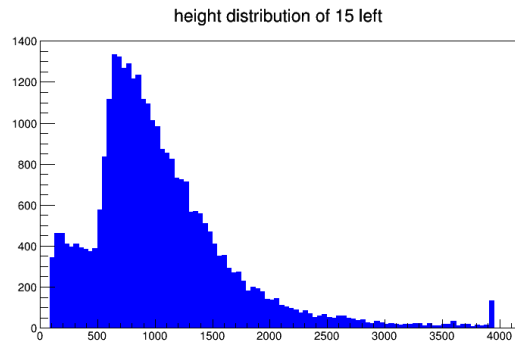
DATA ANALYSIS

- **Improve height distribution**
 - If cosmic ray incident close to horizontal direction, signals are exaggerated.



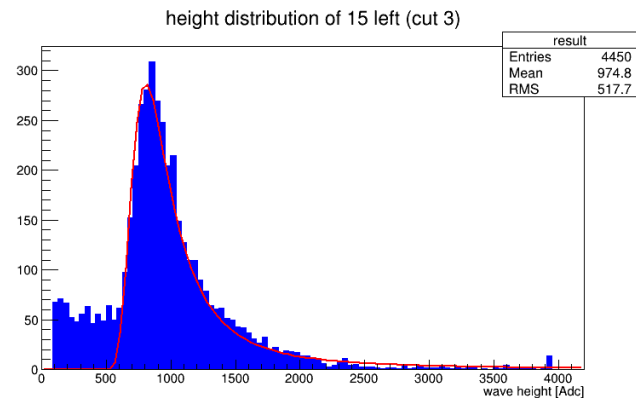
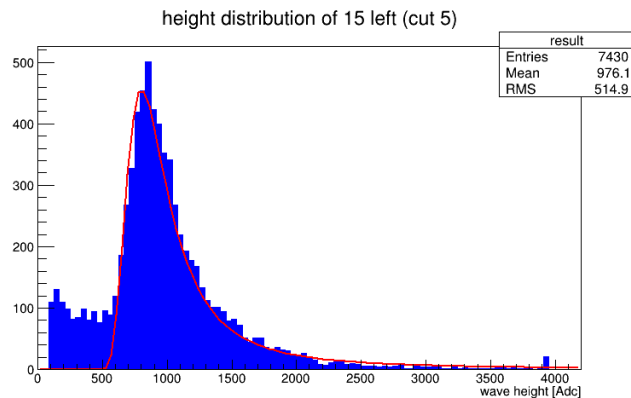
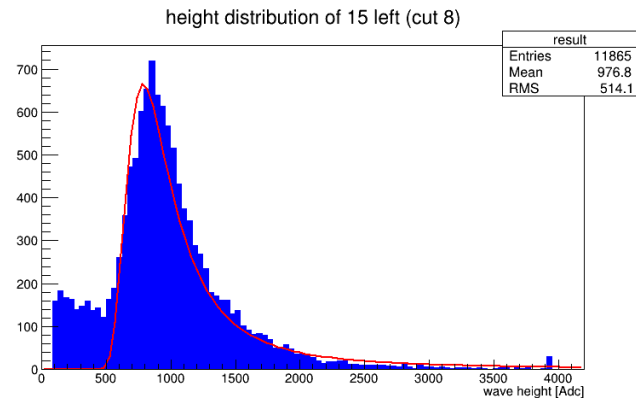
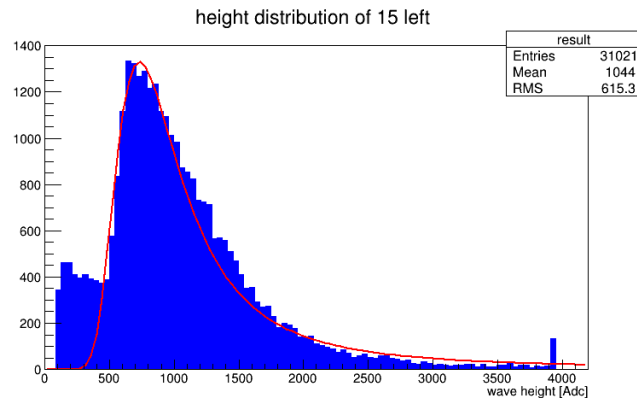
DATA ANALYSIS

- Improve height distribution
 - Cut if 2 bars' time difference are different so much.



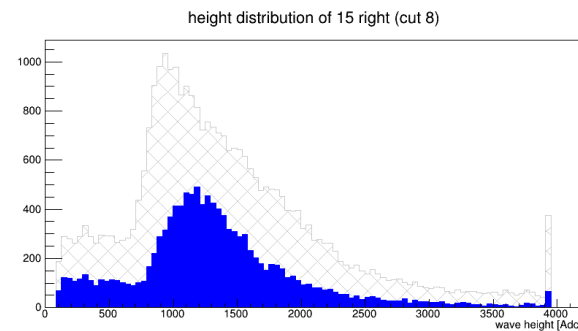
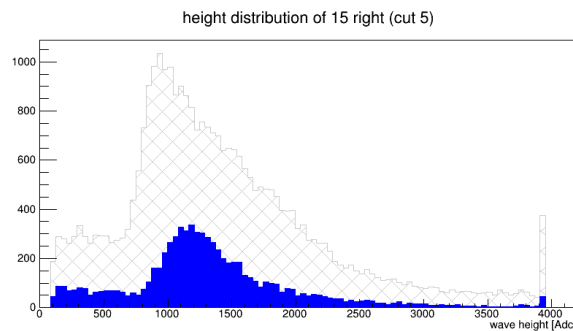
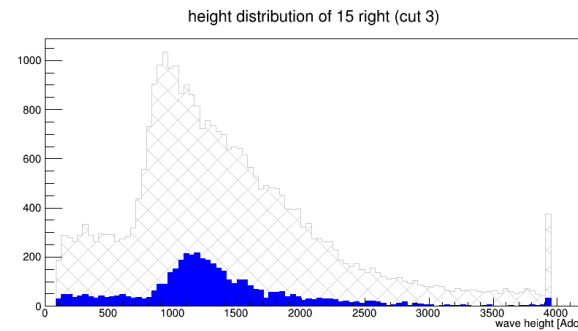
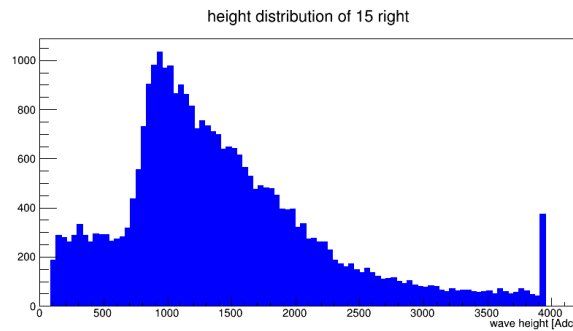
DATA ANALYSIS

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