Analysis of alpha event

2019/03/18

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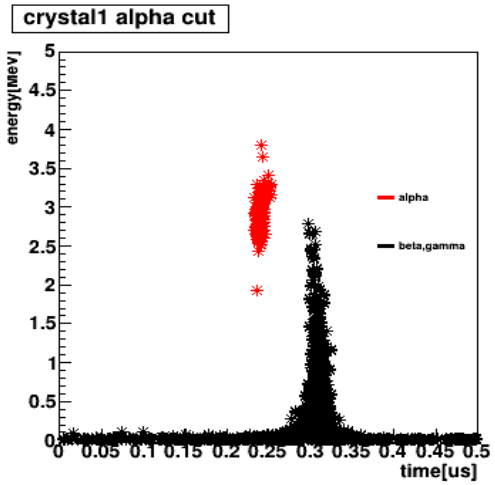
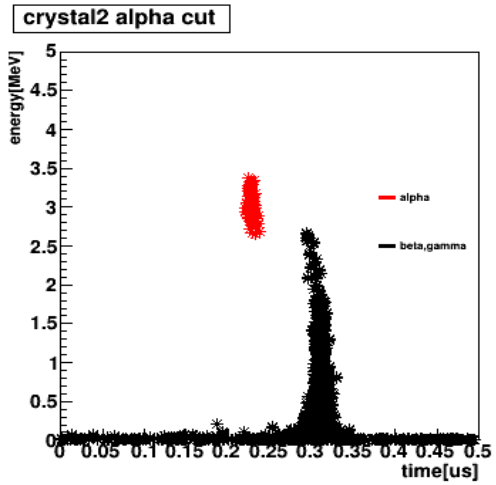
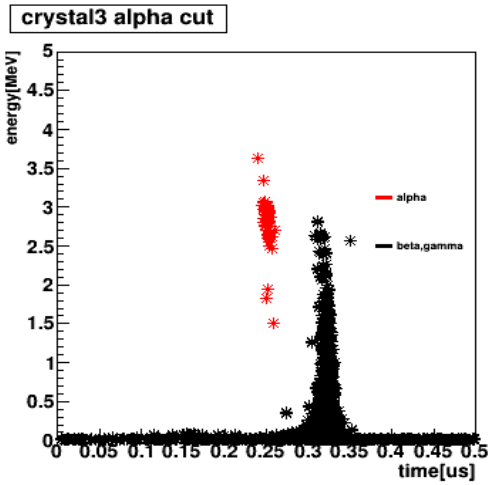
Motivation

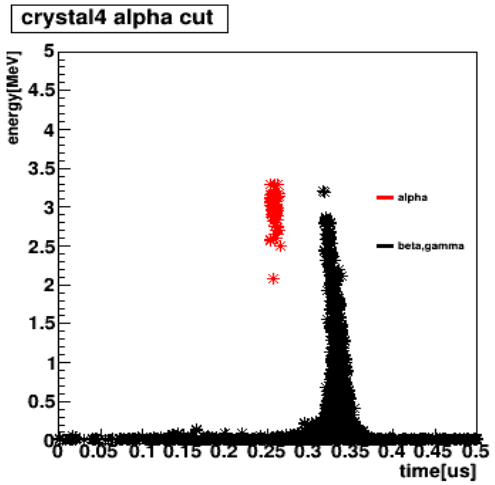
- To figure out quenching factor of alpha particles in NaI crystal
- To estimate contamination of U-238 and Th-232 in NaI crystal
- Where are dominant two peak alpha events from?
  - One peak could be Pb-210 decay, what is the other?

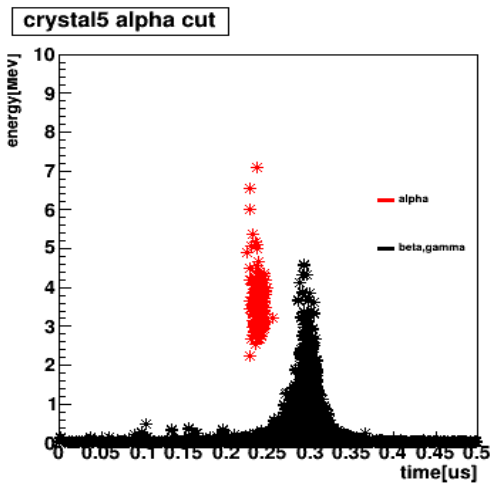
Alpha Monitoring

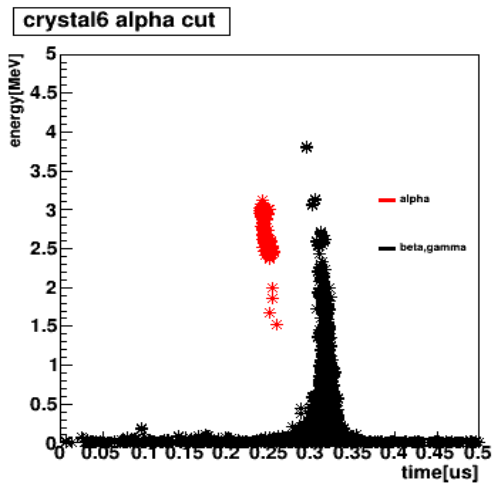


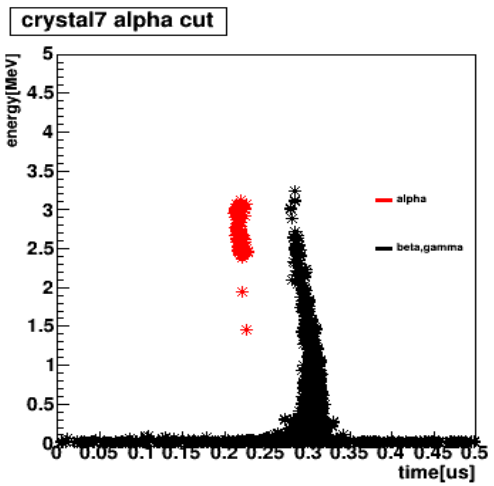


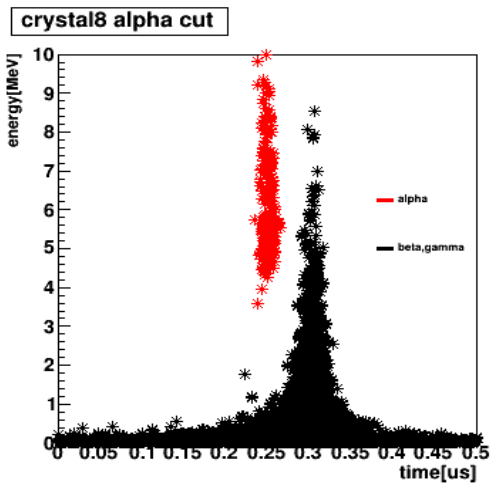






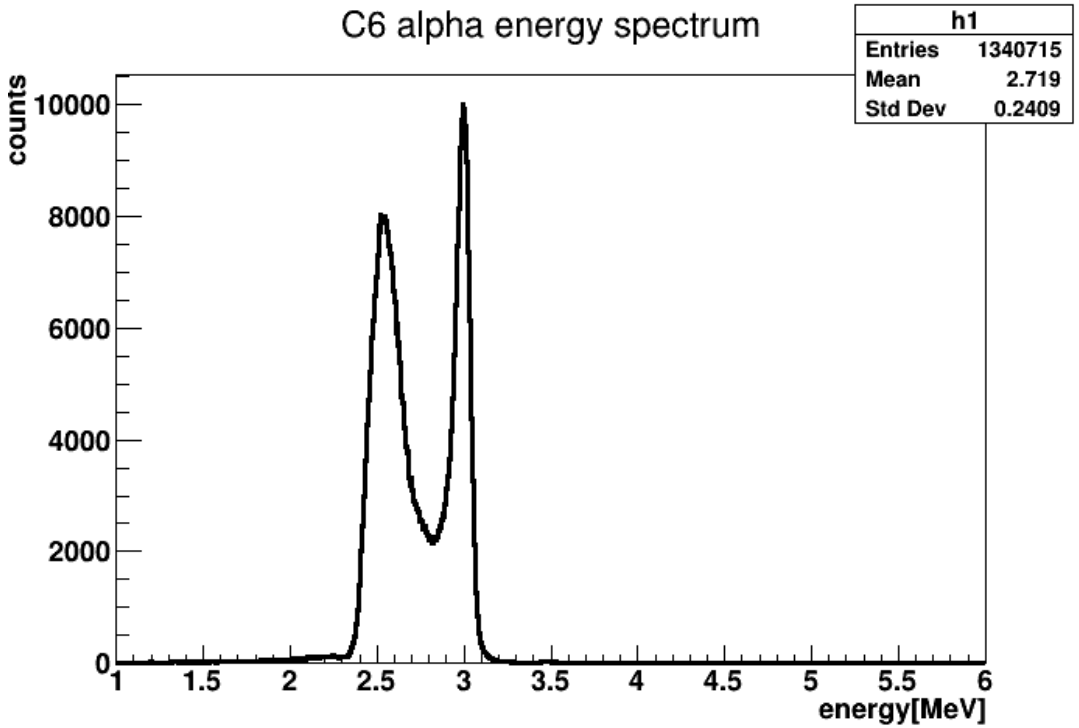


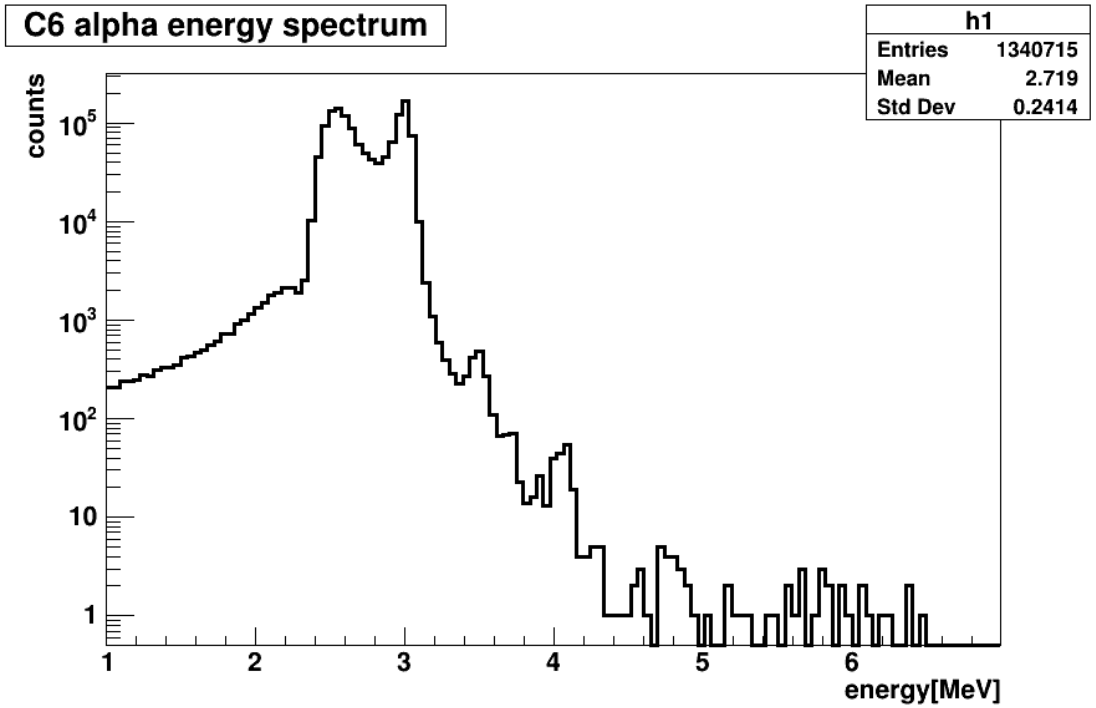




Meantime vs energyD

Alpha Analysis(C6)

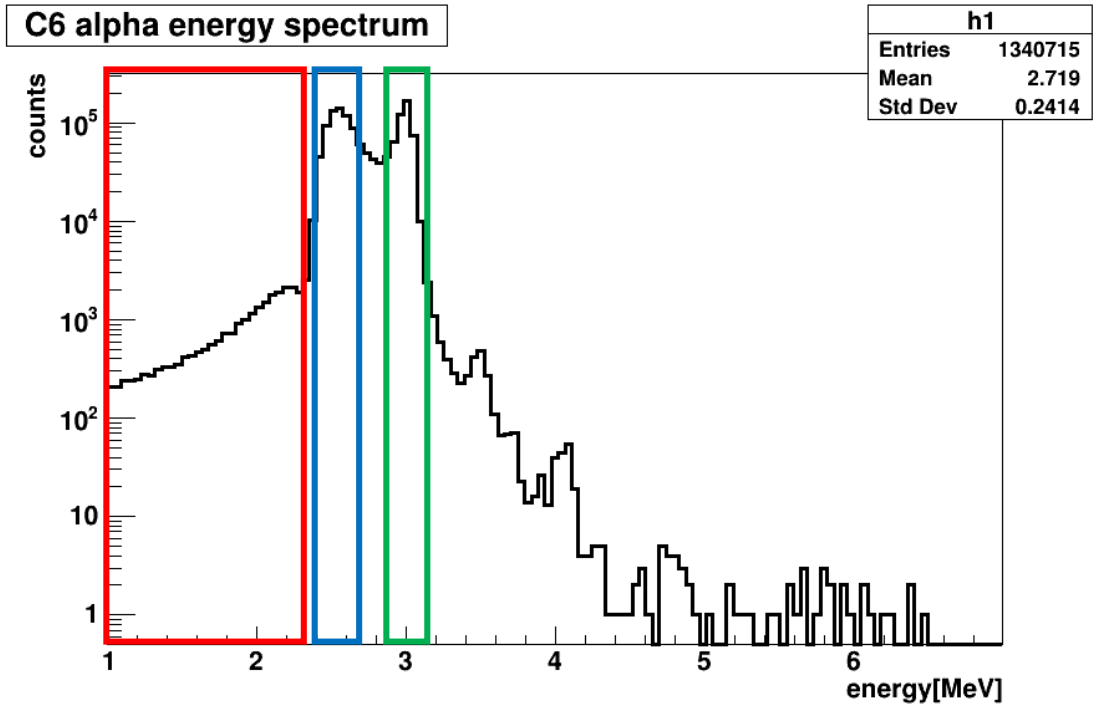


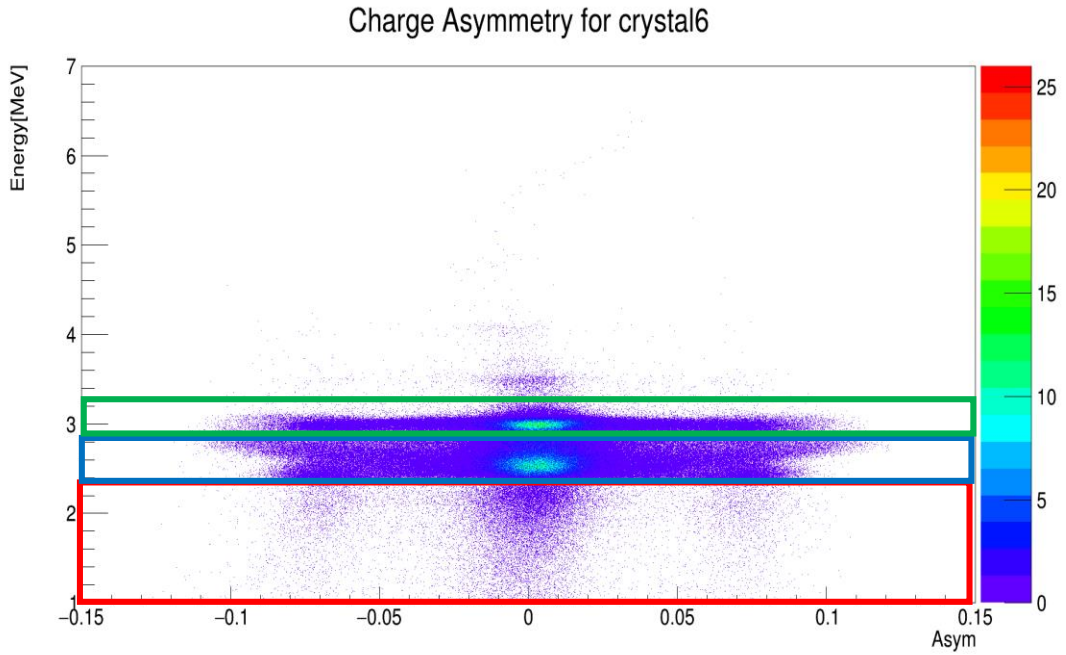


Crystal 6 alpha energy spectrum for 2 years

Alpha Analysis(C6)

Divide region





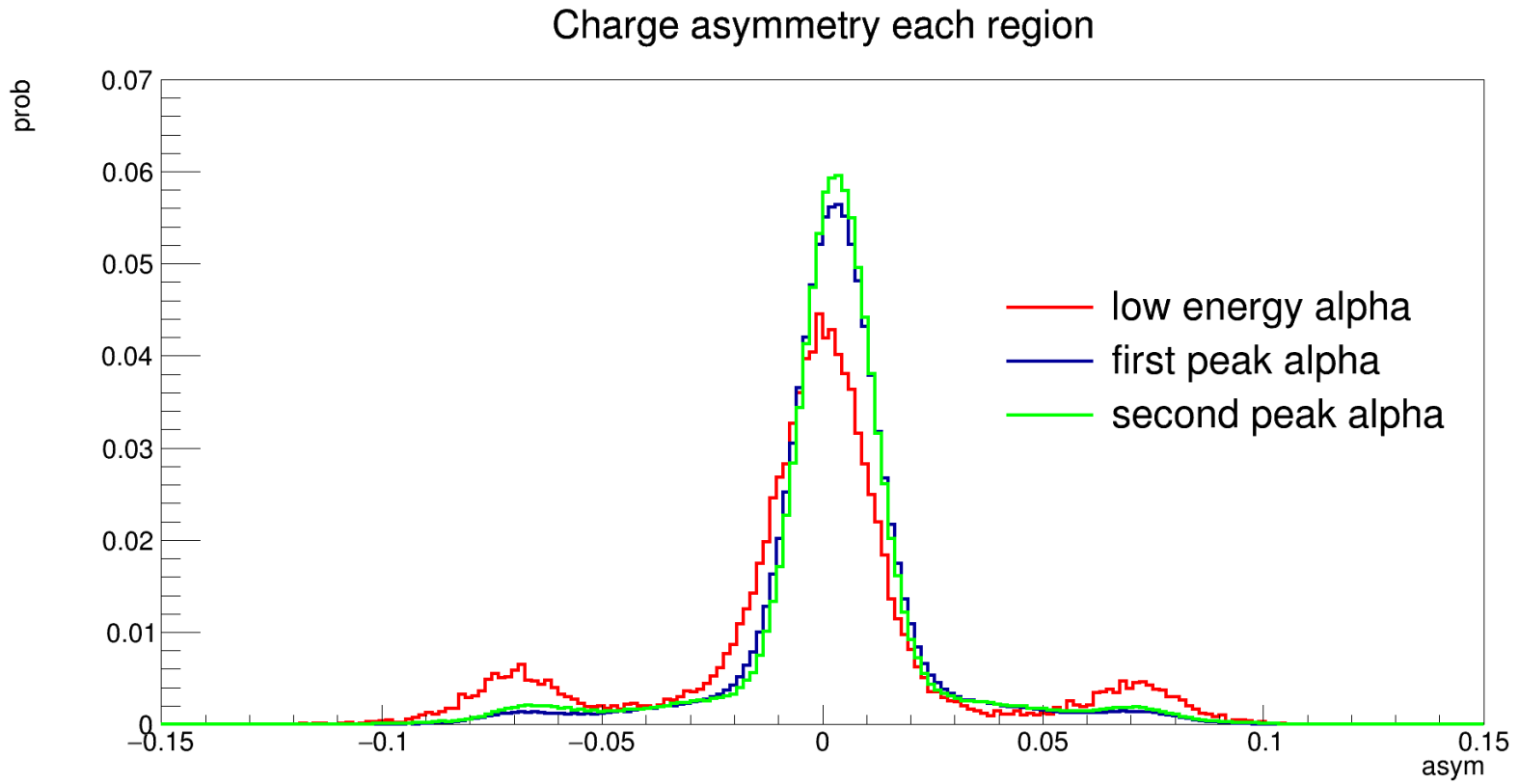
Low energy alpha events(1< energyD <2.3 [MeV])

First peak alpha events(2.4< energyD <2.7 [MeV])

Second peak alpha events(2.9< energyD <3.1 [MeV])

Alpha Asymmetry(C6)

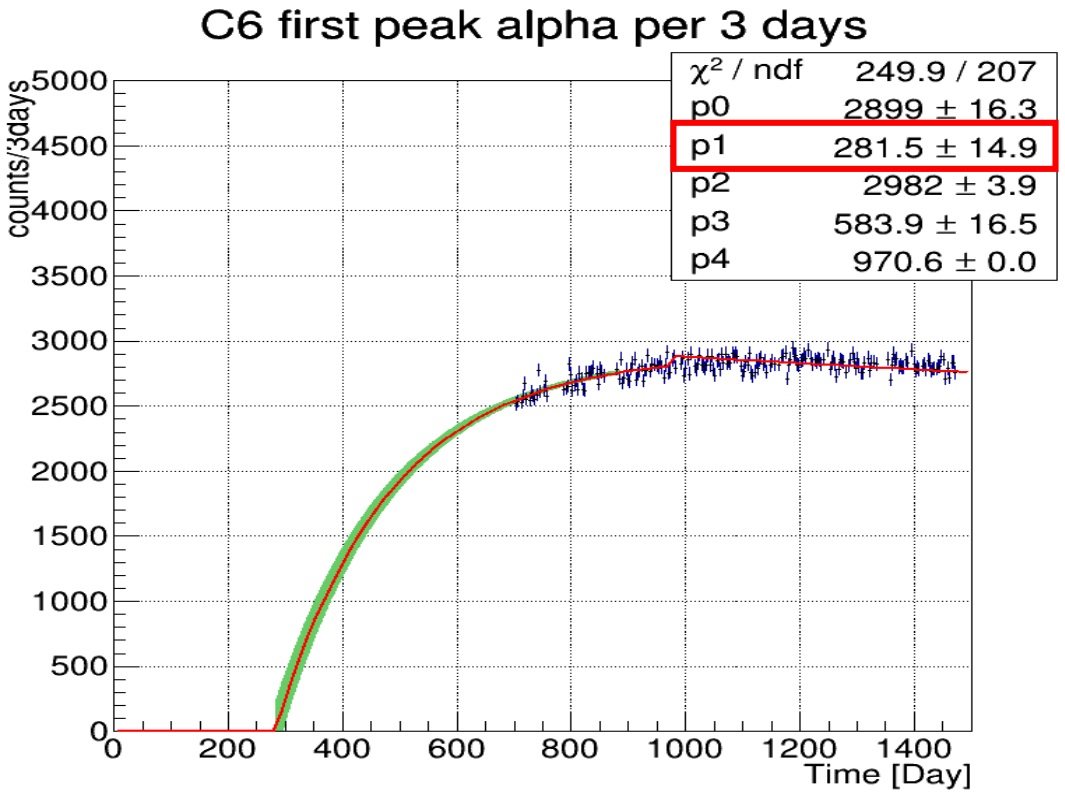
Asymmetry each region

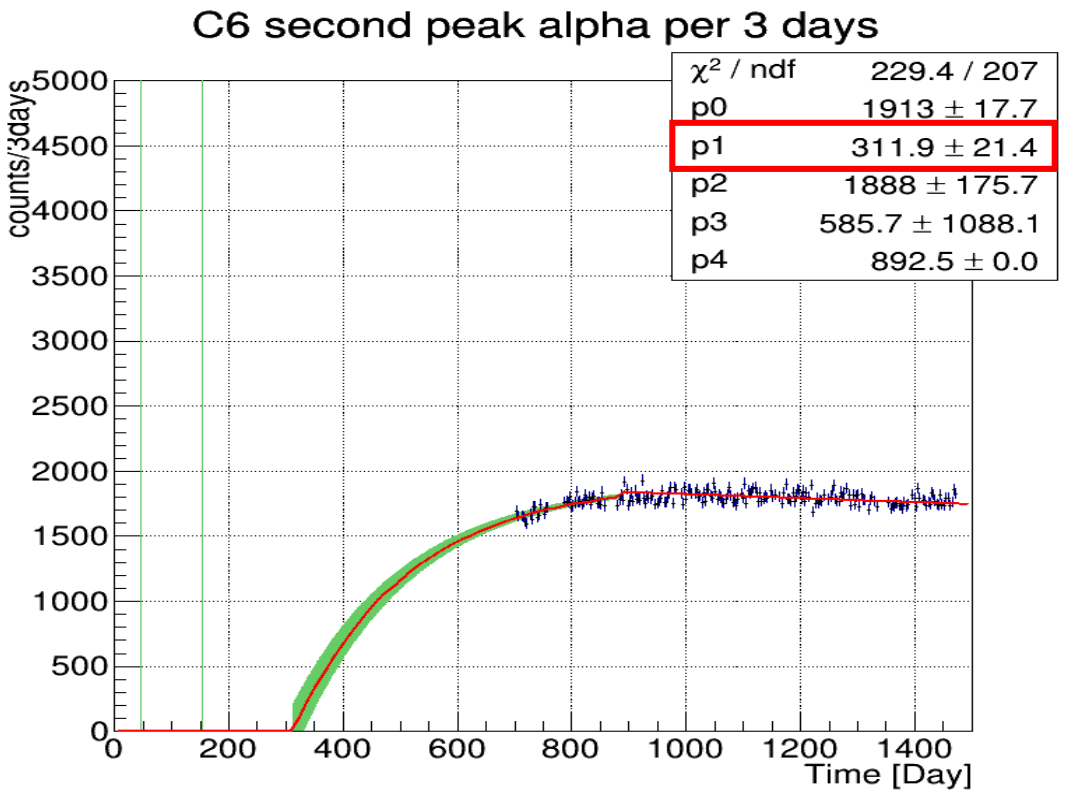


Red asymmetry ratio is higher than blue and green
Red region is surface alpha events
Blue and green look similar

Alpha Analysis(C6)

Alpha decay per 3 days each region





701 day : 2016/10/20
p1 : fit function start day
300 day : around 2015/09

NaI-011(C6)
Production powder : 2015/08/06
Growth : 2015/10/02

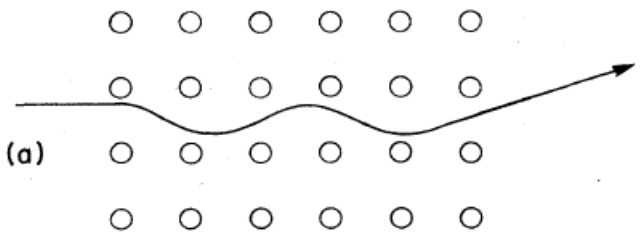
Reasonably correct

They are from Po-210

Hypothesis(channeling)

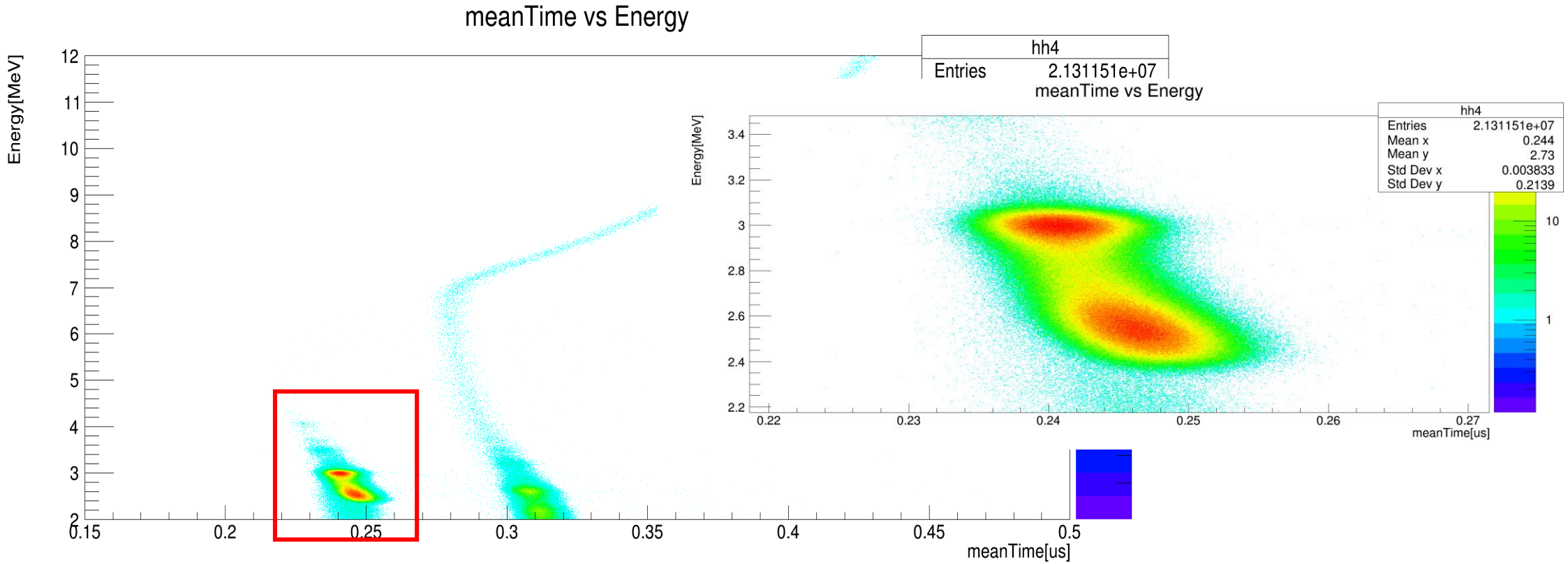
Channeling

- This is an effect which occurs only when the particle is incident at angles less than critical angle with respect to a symmetry axis of the crystal
- As it passes through the crystal planes, the particle suffers a series of correlated small-angle scattering
- When the particle undergoes channeling, its rate of energy loss is reduced.



- Two options
  1. Energy loss is reduced -> deposited energy is reduced
  2. Energy loss is reduced
  -> dipole interaction of electron-hole pair is reduced
  -> quenching is increased

Alpha Analysis(C6)

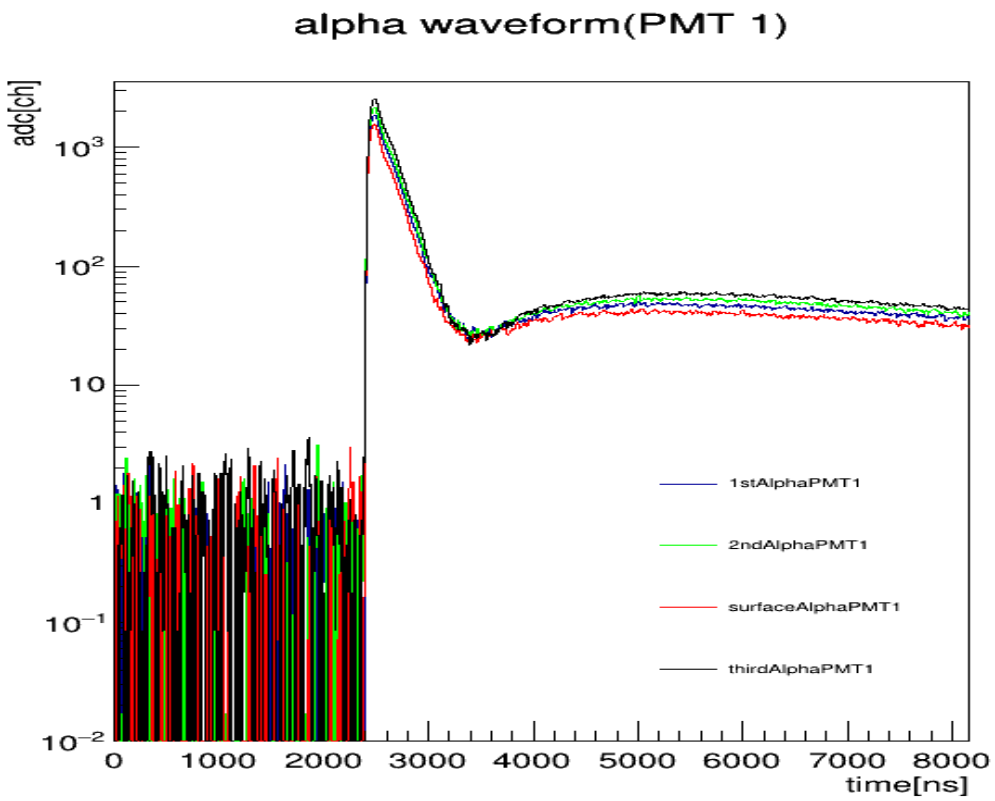


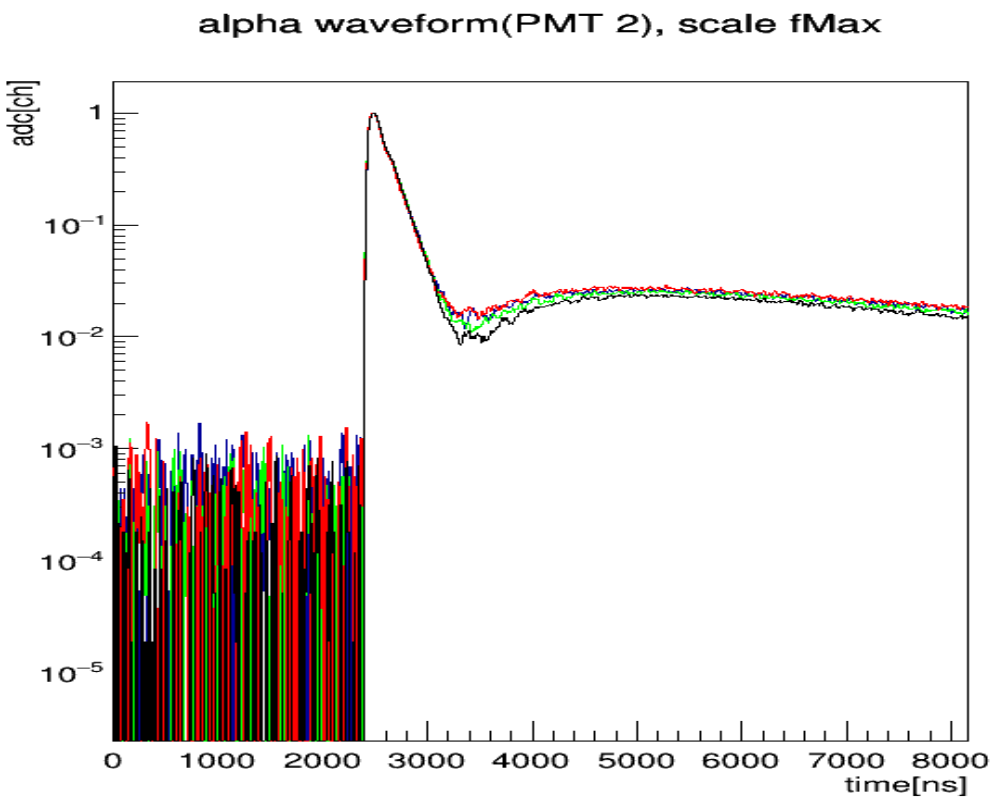
Summary

Backup

```
1  Double_t incf(Double_t *x,Double_t *par){//Here t & par are pointers to dimensional and parameters array.
2    Double_t arg = 0;
3    Double_t fitvalue;
4    if (x[0]<par[1]) fitvalue=0.0;
5    else
6      fitvalue = par[0]*(1.0 - TMath::Exp(-(x[0]-par[1])/200.) );//is model function where 200 is due to 138.4/0.693 is half life of Po
   -210. Parameter P0 is saturated alpha rate and P1 is date of contamination.
7    return fitvalue;
8  }
9
10 Double_t expof(Double_t *v, Double_t *p){
11   double x = v[0];
12
13   return p[0]*exp(-(x-p[1])/(22.2*365/0.693));//lifetime of Pb-210[day]
14 }
15
16 Double_t fitF(Double_t *v, Double_t *p){
17   Double_t val;
18   if(v[0]<p[4]){
19     val = incf(v,&p[0]);
20   }
21   else{
22     val = expof(v,&p[2]);
23   }
24   return val;
25 }
```

p[4] : start point of secular equilibrium





Need to study about slow component (stopping power)