

Analysis of alpha event

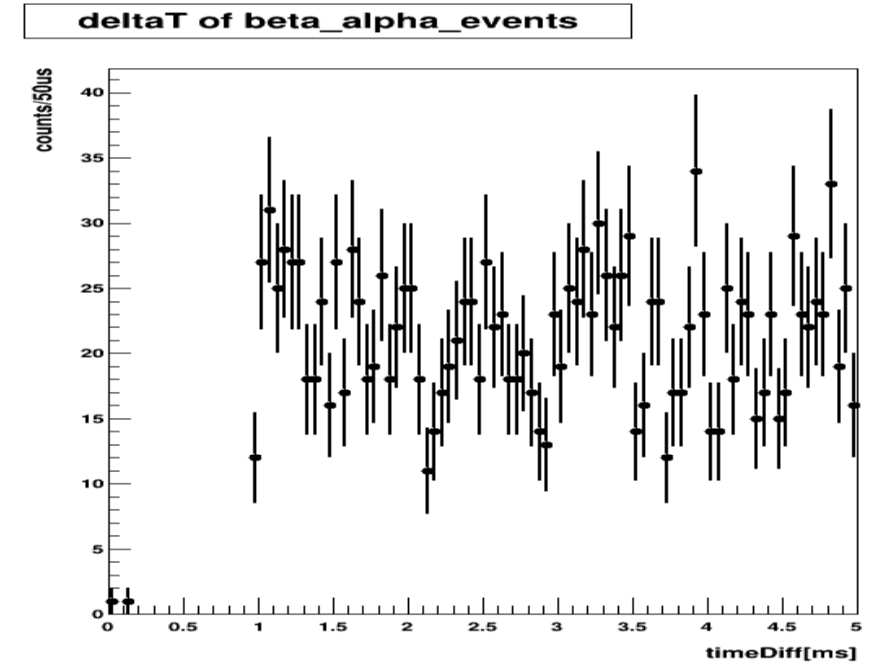
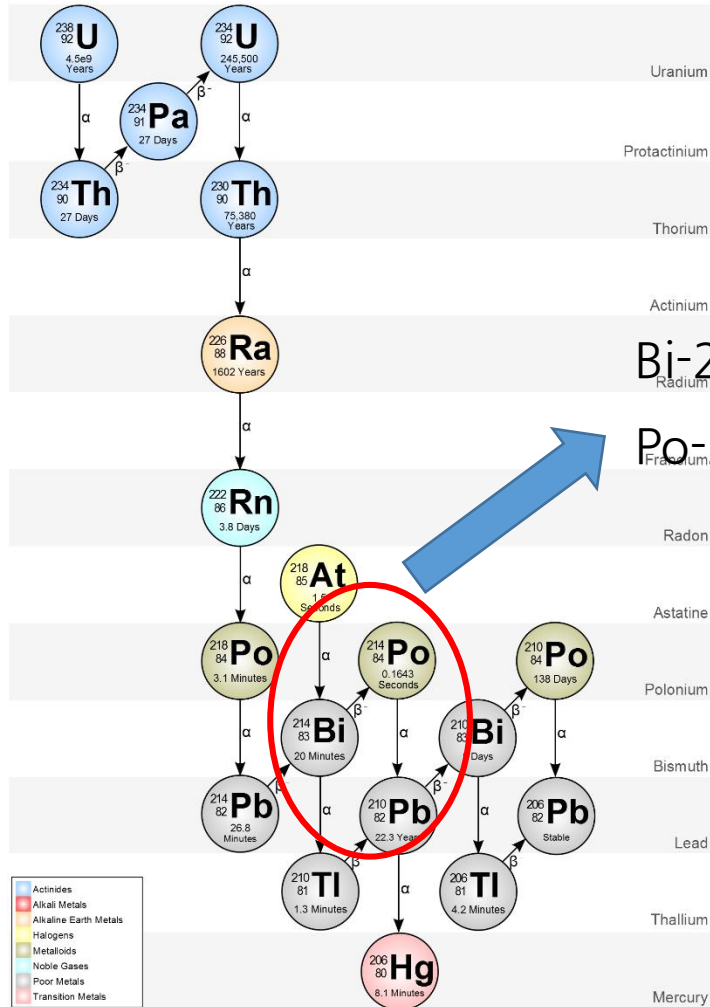
2019/03/29
Jae Jin Choi



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?

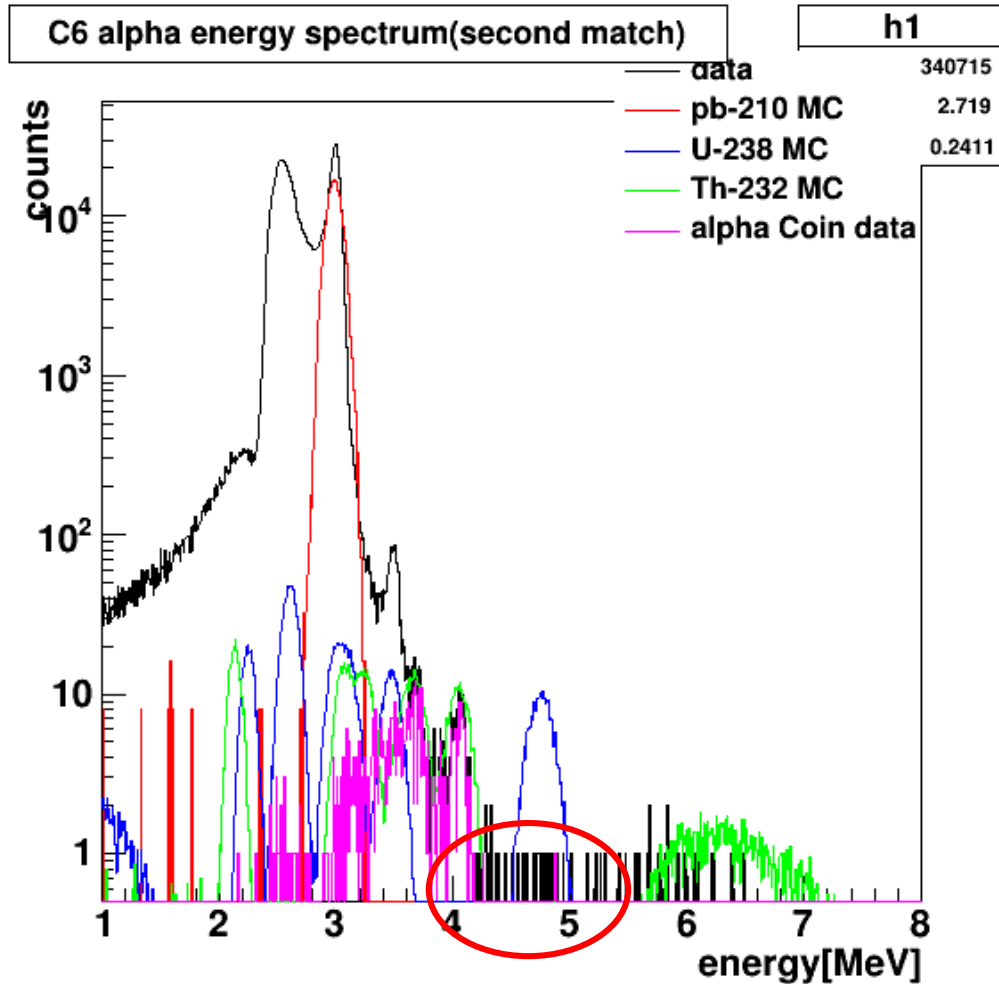
Beta-alpha coincidence



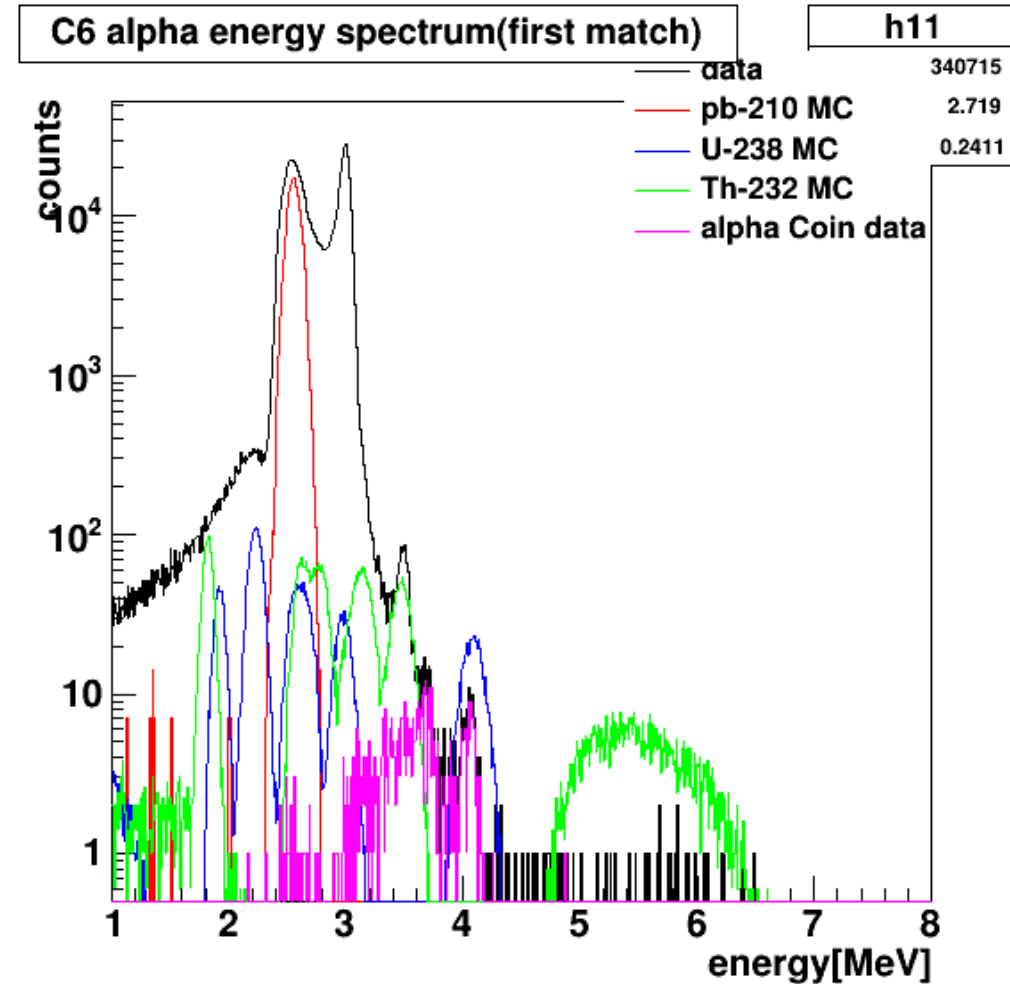
Deadtime < 1ms

-> we can take Po-214 events around 1.5%
(dT>1ms events)

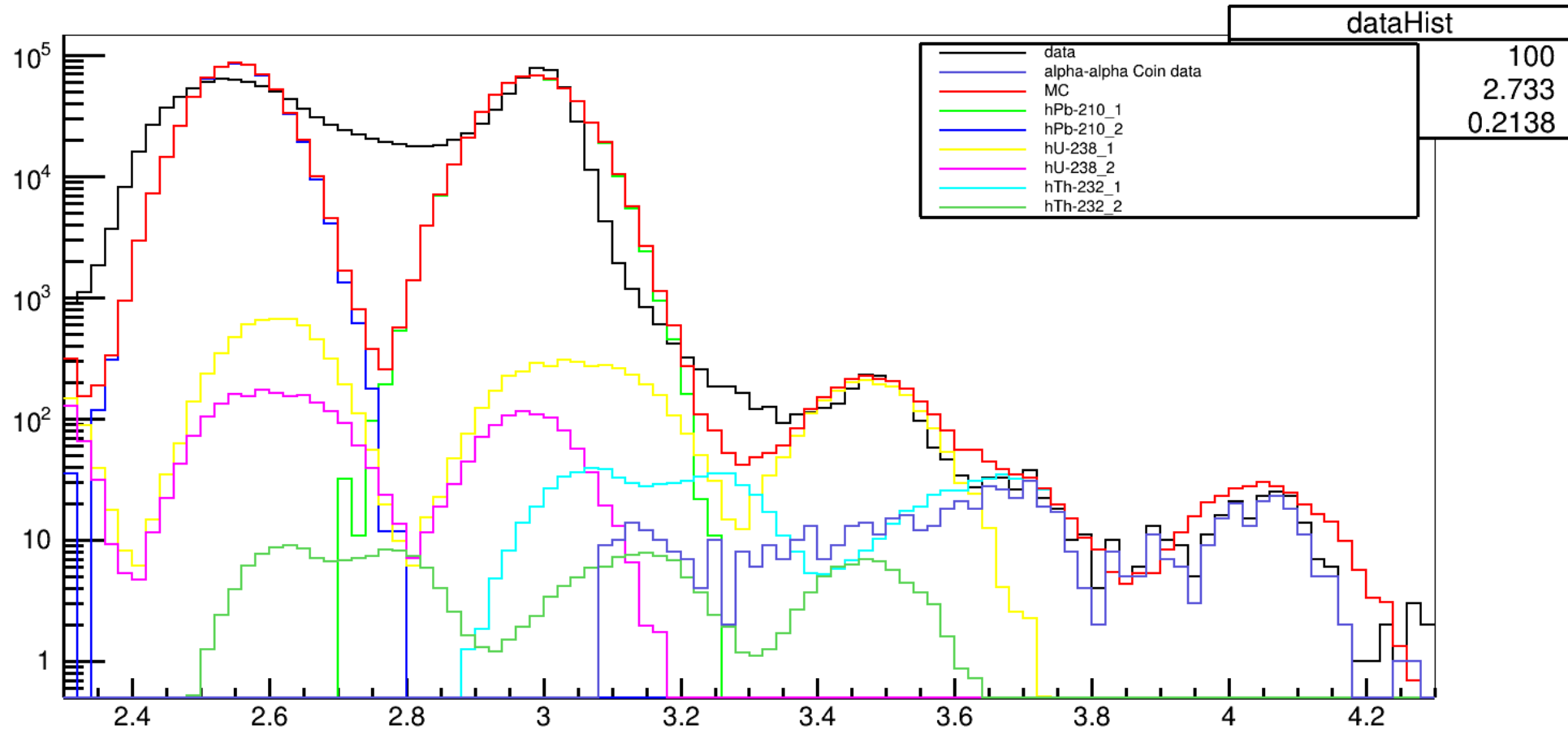
Beta-alpha coincidence



1.5% Po-214 events



Alpha MC fit(2.3MeV to 4.3MeV)



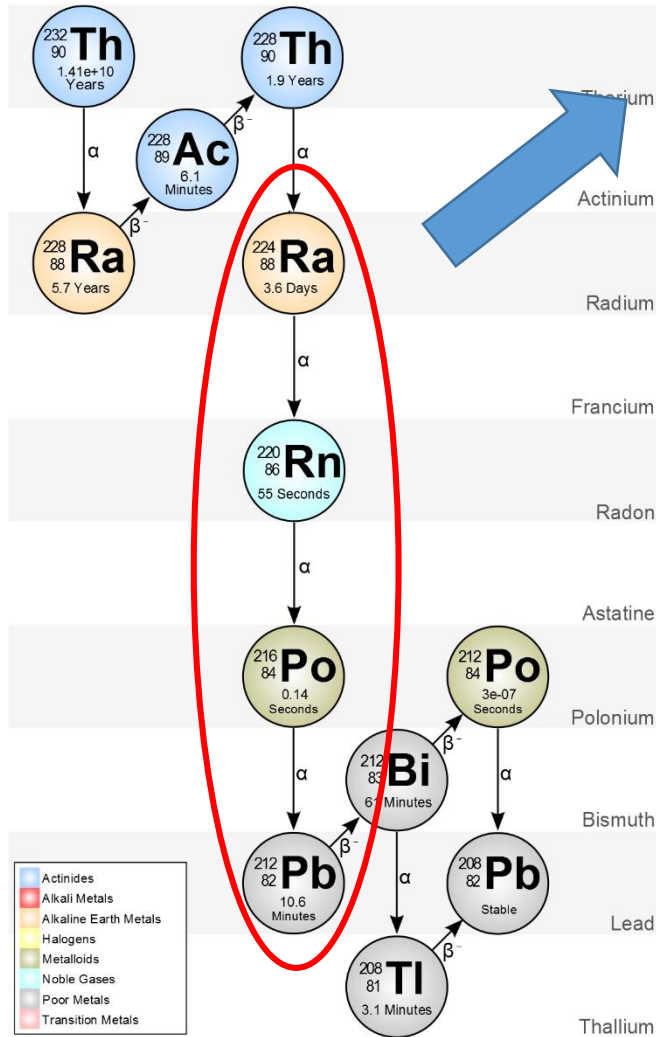
Exclude above 4.3 MeV(exclude Po-218 decay events)

Summary

- DAQ system can't take most Po-214 decay events (around 99% events) because deadtime is below than 1ms
- Third peak is from U-238 contamination(Po-218 alpha decay second peak)
- Need to fit MC more exquisitely

Backup

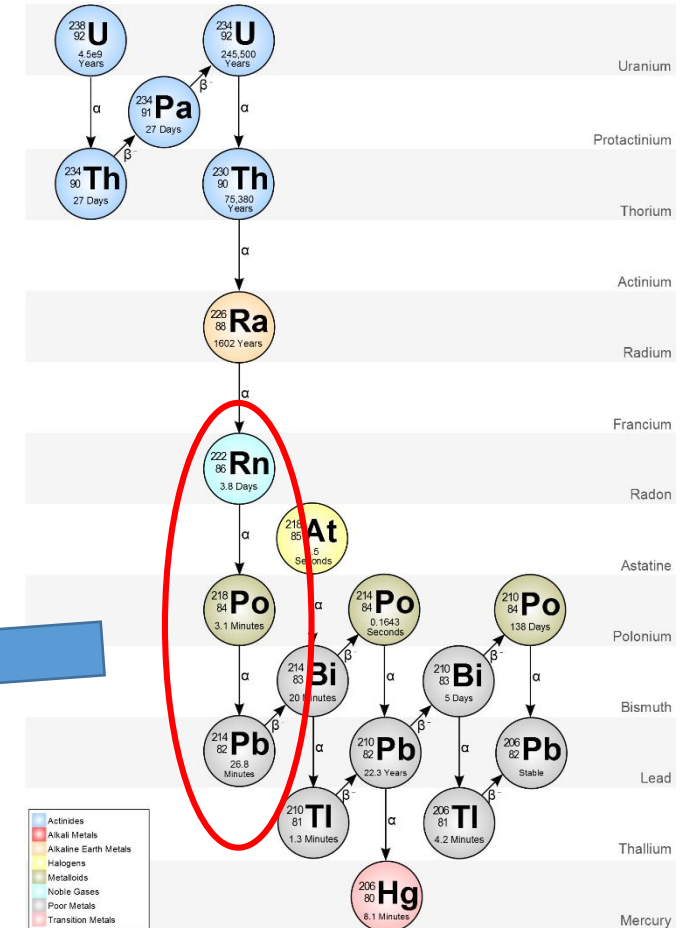
Alpha-alpha coincidence



- Ra-224 : 3.66d , 5.789MeV
- Rn-220 : 55.6s , 6.405MeV
- Po-216 : 0.145s , 6.906MeV

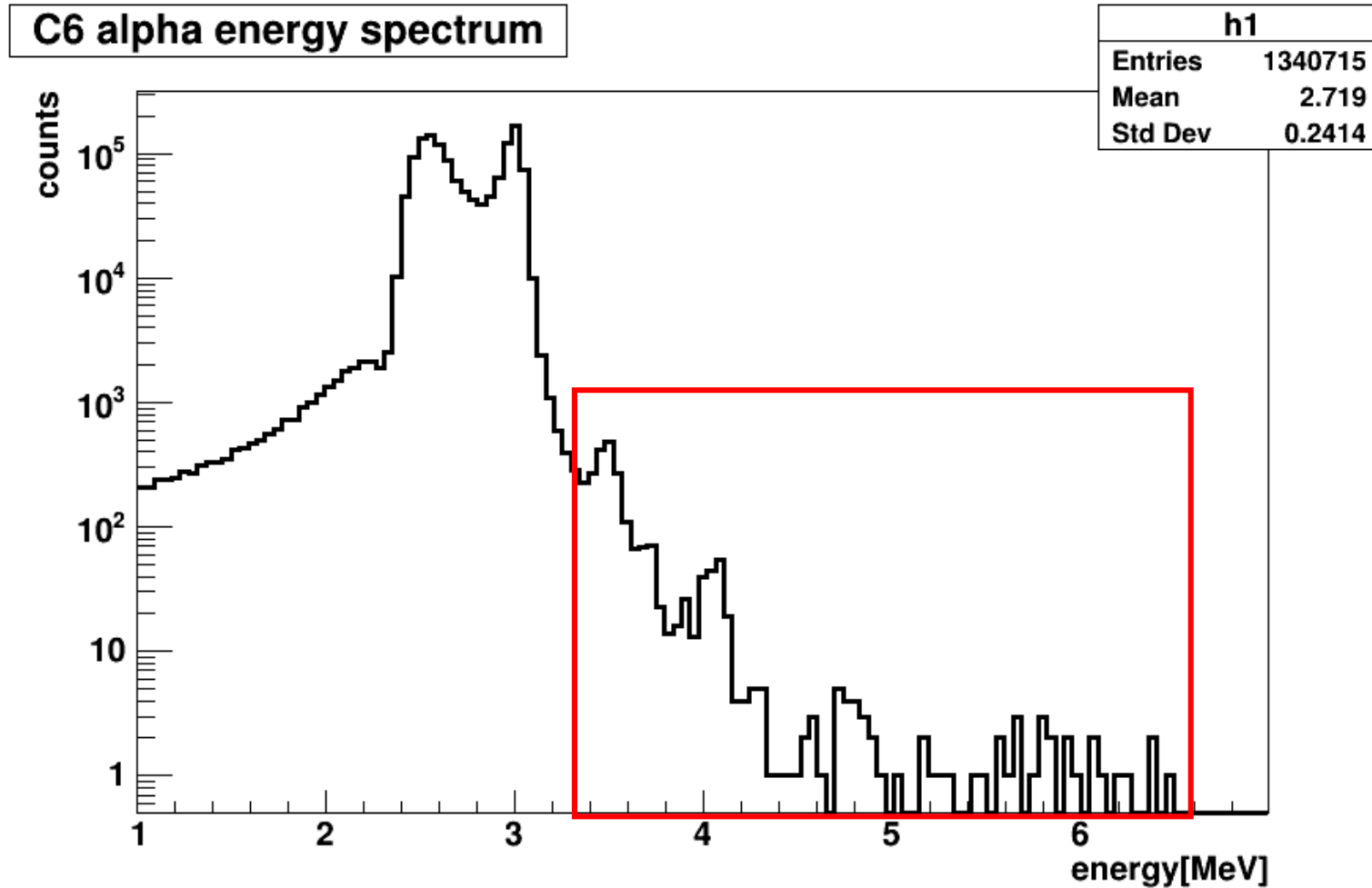
Alpha-alpha coincidence

- Rn-222 : 3.82d , 5.590MeV
- Po-218 : 3.1m, 6.115MeV



Alpha Analysis(C6)

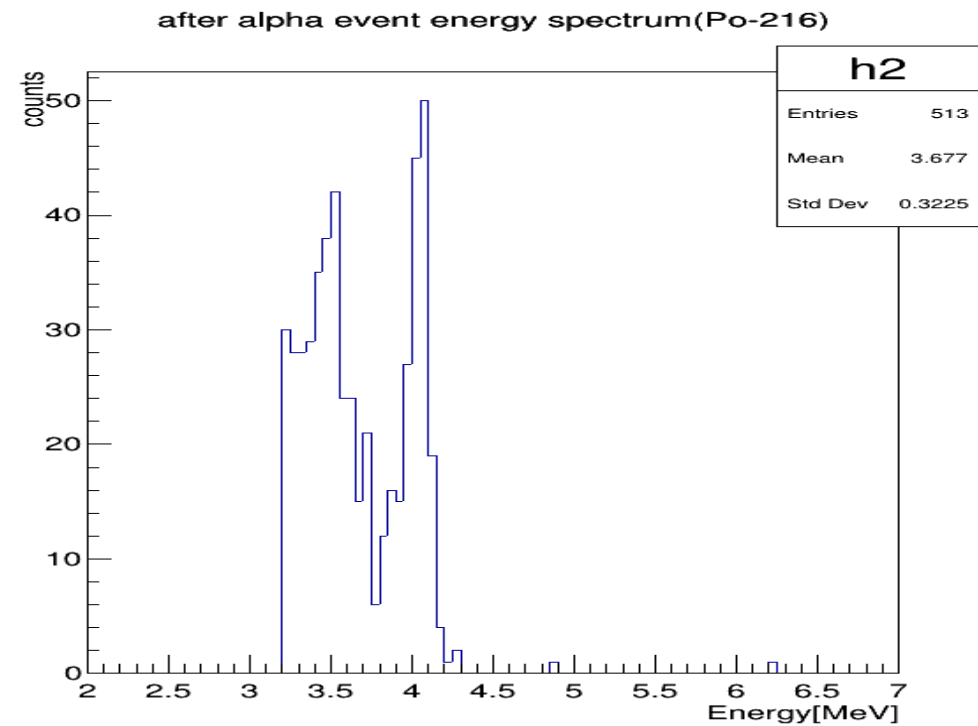
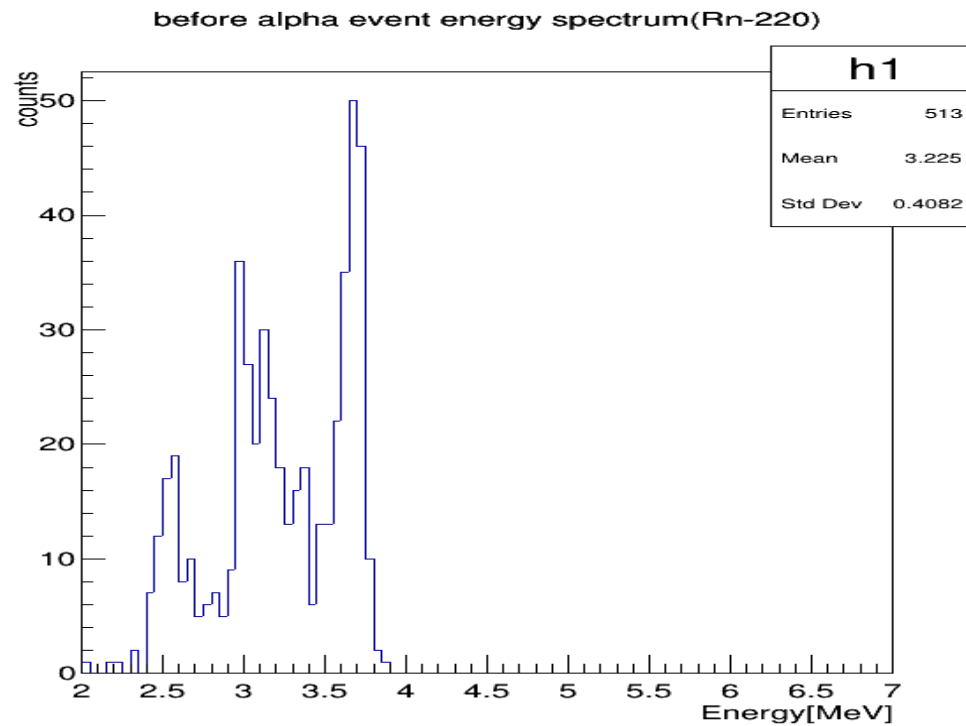
Divide region



Analysis high energy events to select alpha-alpha coincidence events

Alpha-alpha coincidence

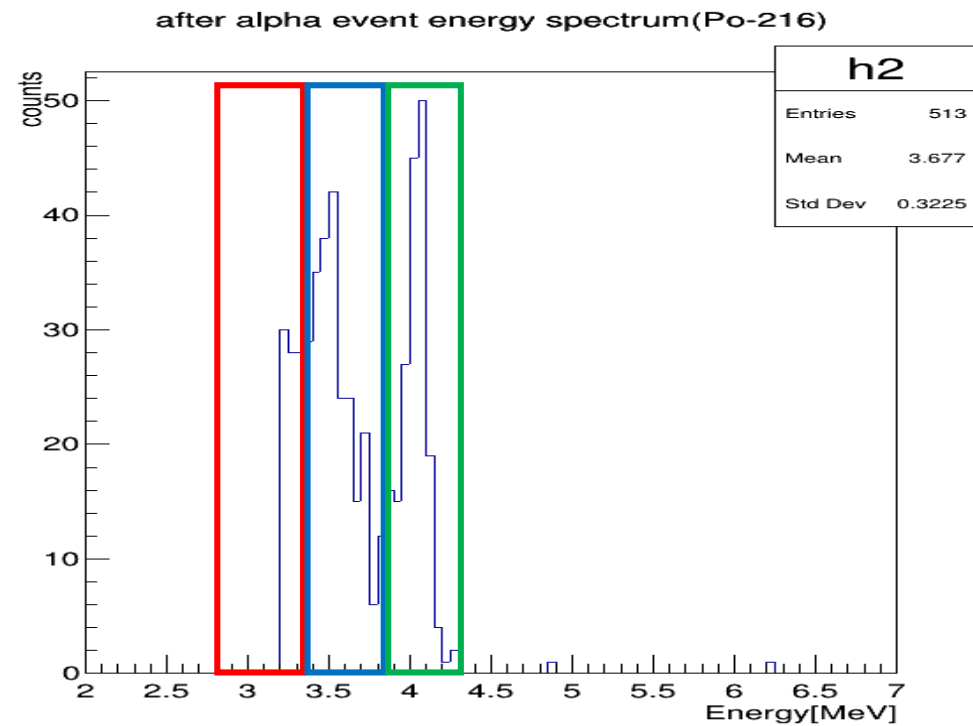
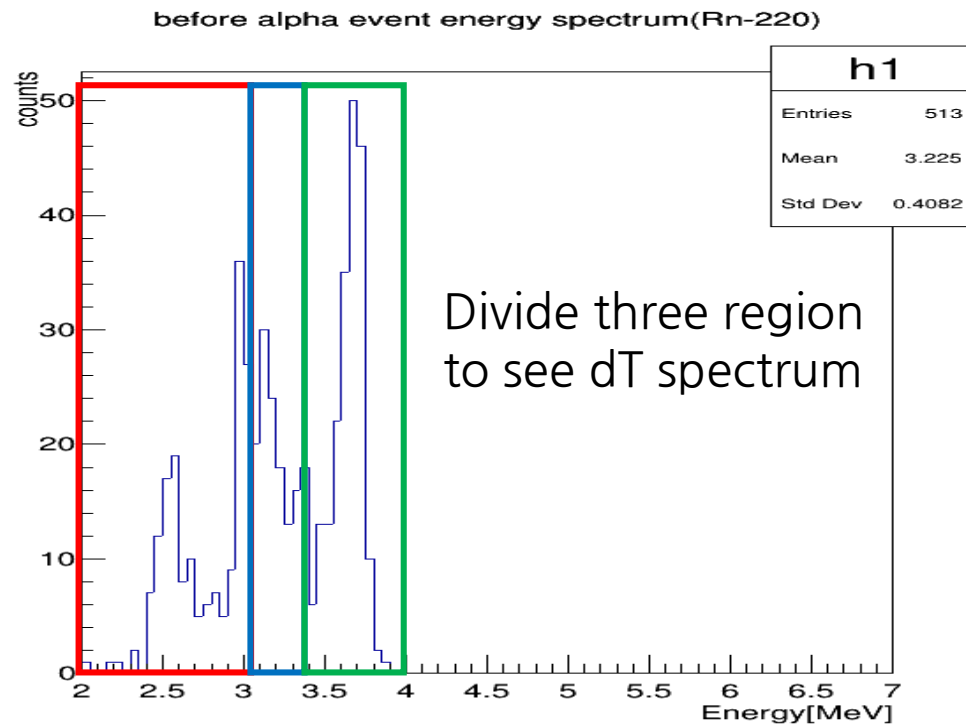
- alpha-alpha Coincidence
- Cut condition : time difference < 2 sec(99% alpha coin events in a second)
 - After alpha deposited energy($\text{energyDA} > 3.3 \text{ MeV}$ (Po-216 : 6.9 MeV))



Alpha-alpha coincidence

alpha-alpha Coincidence

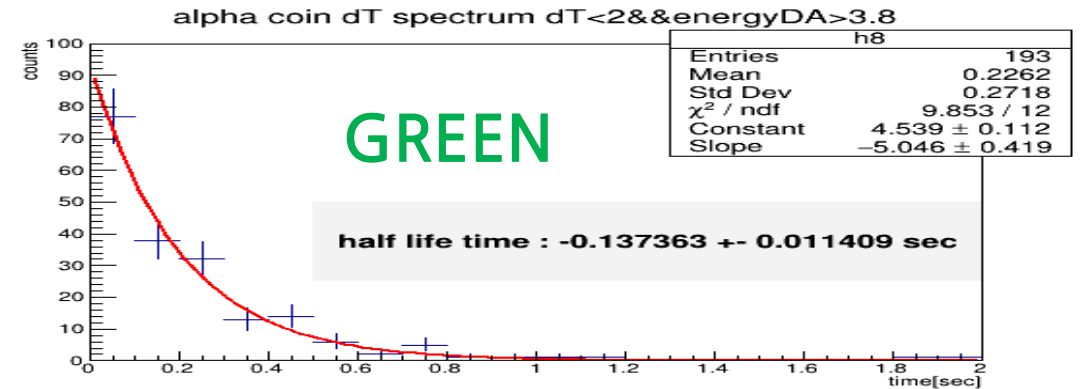
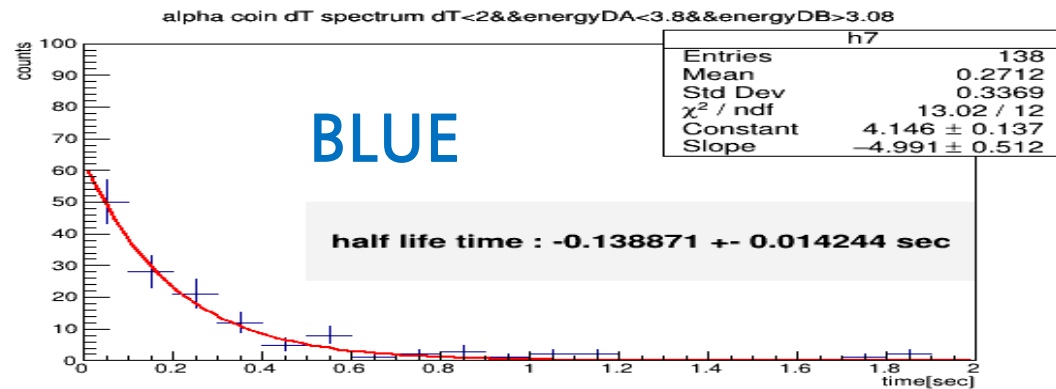
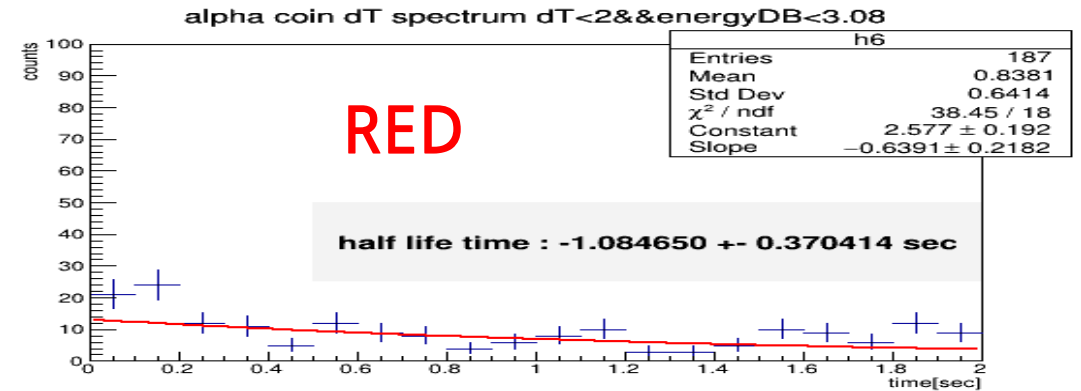
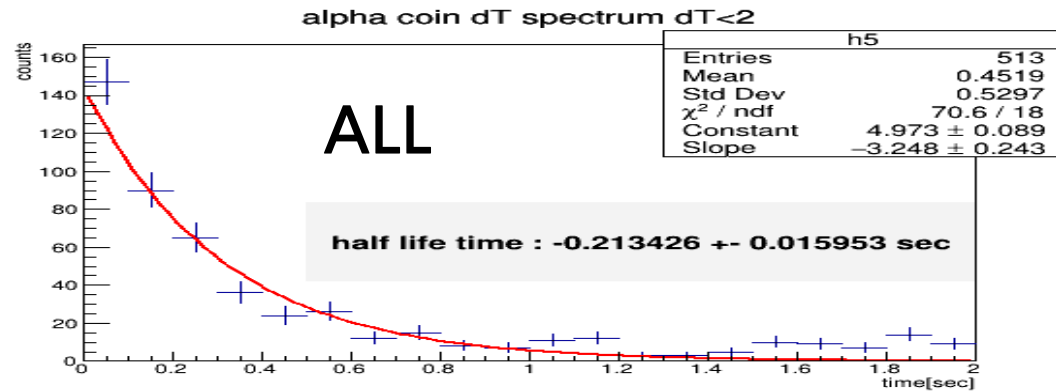
- Cut condition : time difference(dT) < 2 sec(99% alpha coin events in a second)
- After alpha deposited energy($energyDA$) > 3.3 MeV(Po-216 : 6.9 MeV)



Alpha-alpha coincidence dT spectrum

alpha-alpha dT spectrum

- Red region : Po-210 events(background)
- Half life time of Po-216 : 0.145 sec



Blue & green : alpha-alpha coincidence (there are also two peak like Po-210 events)

Th-232 contamination

BLUE : 138

GREEN : 193

ALL : 331

Data period : about 17912 hour

Crystal mass : 12.5 kg

Activity : 4.106×10^{-4} mBq/kg

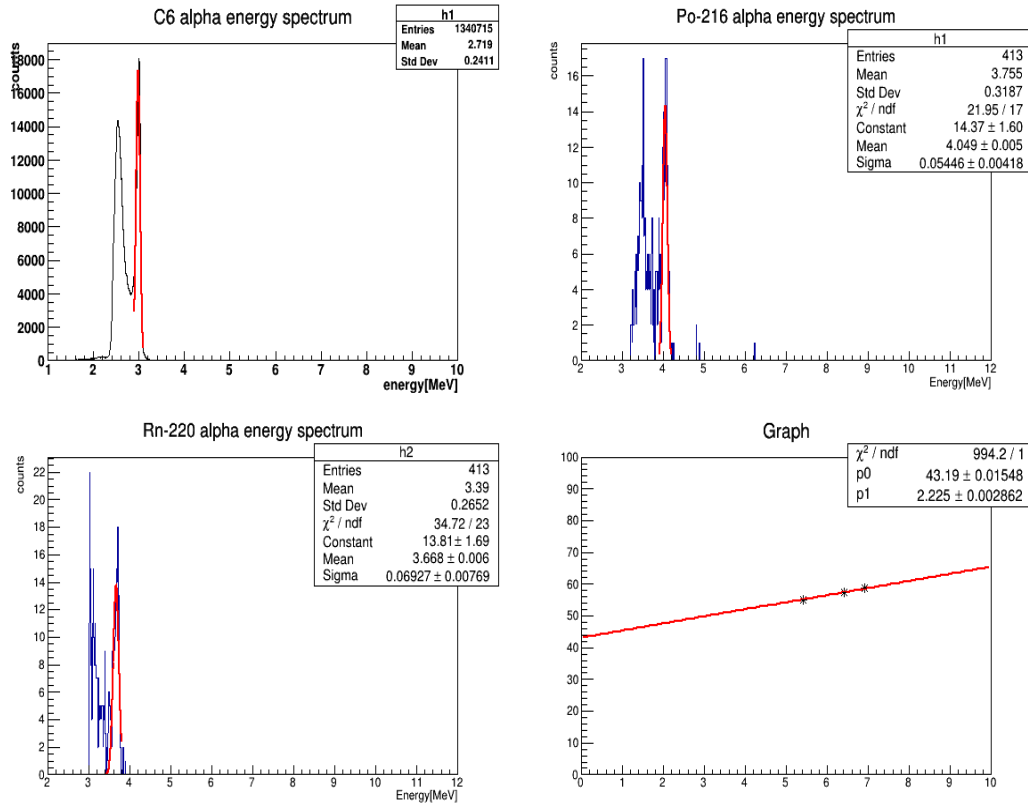
Conversion to ppt : 0.1 ± 0.005 ppt

Foswiki data: Nal-011 (C6) Th-232 upper limit < 0.072 ppt

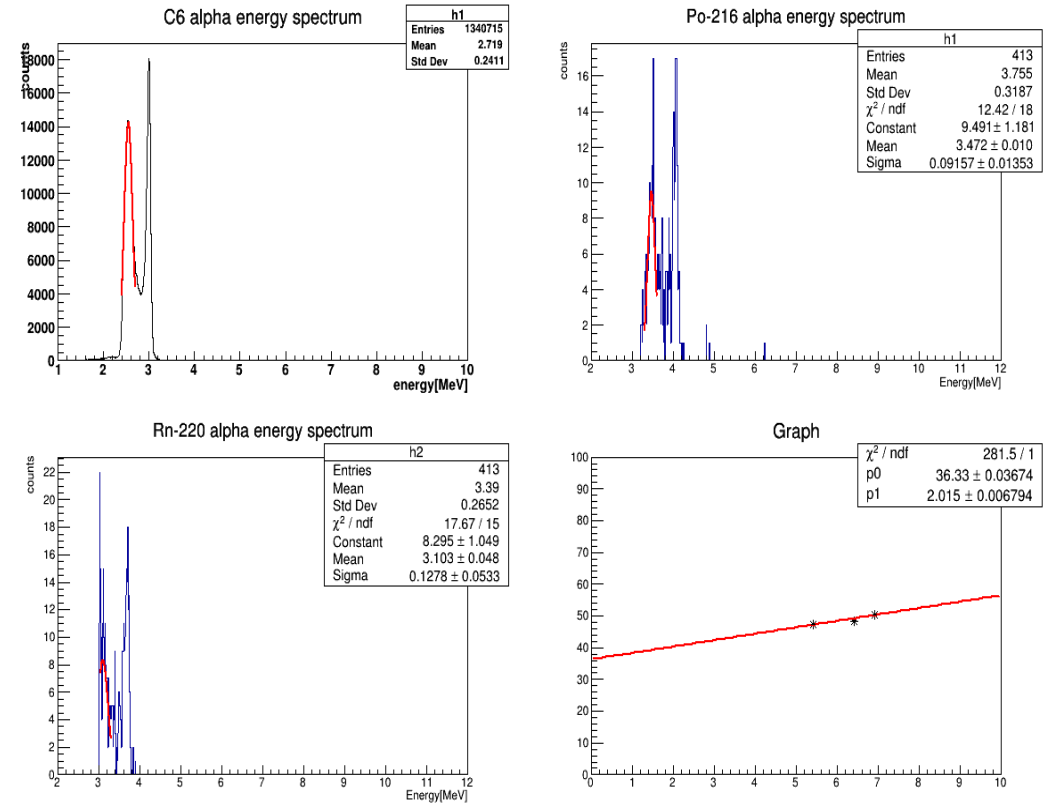
-> quite similar !

Alpha quenching factor

Second peak matched

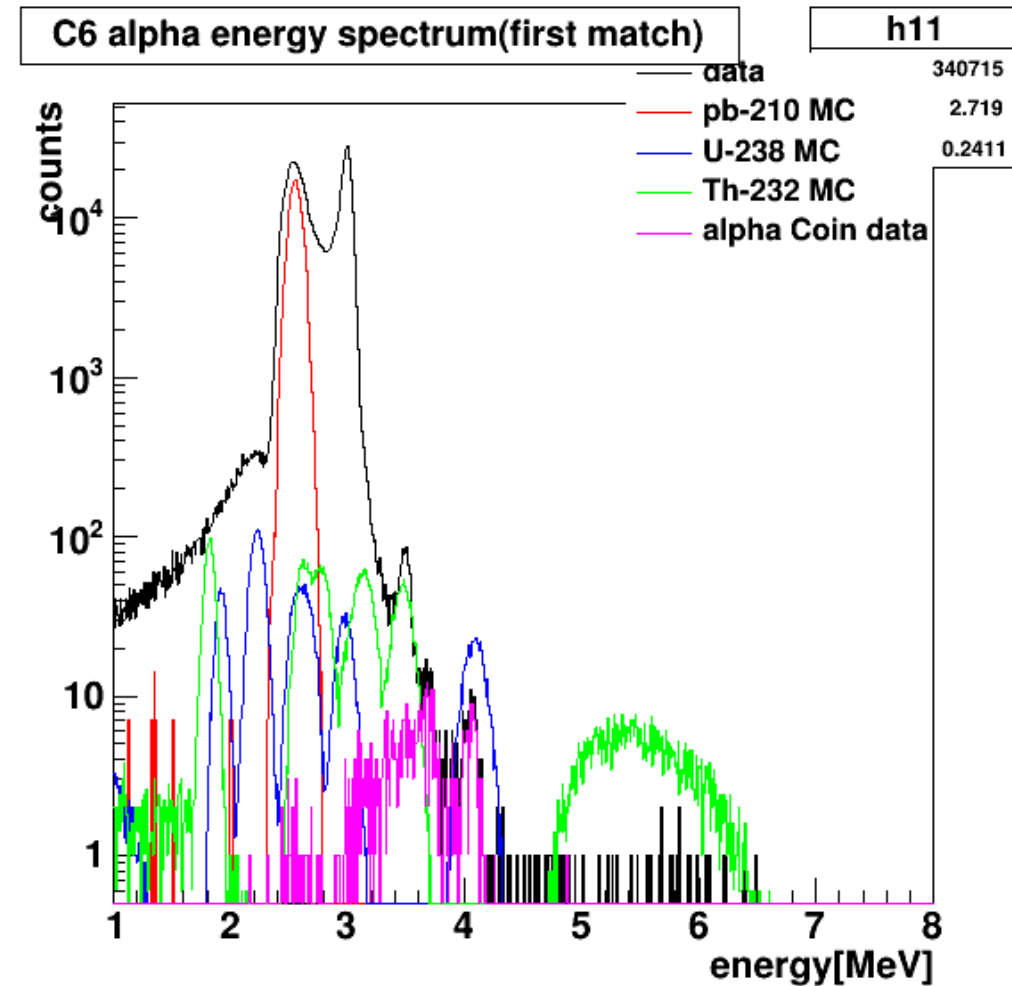
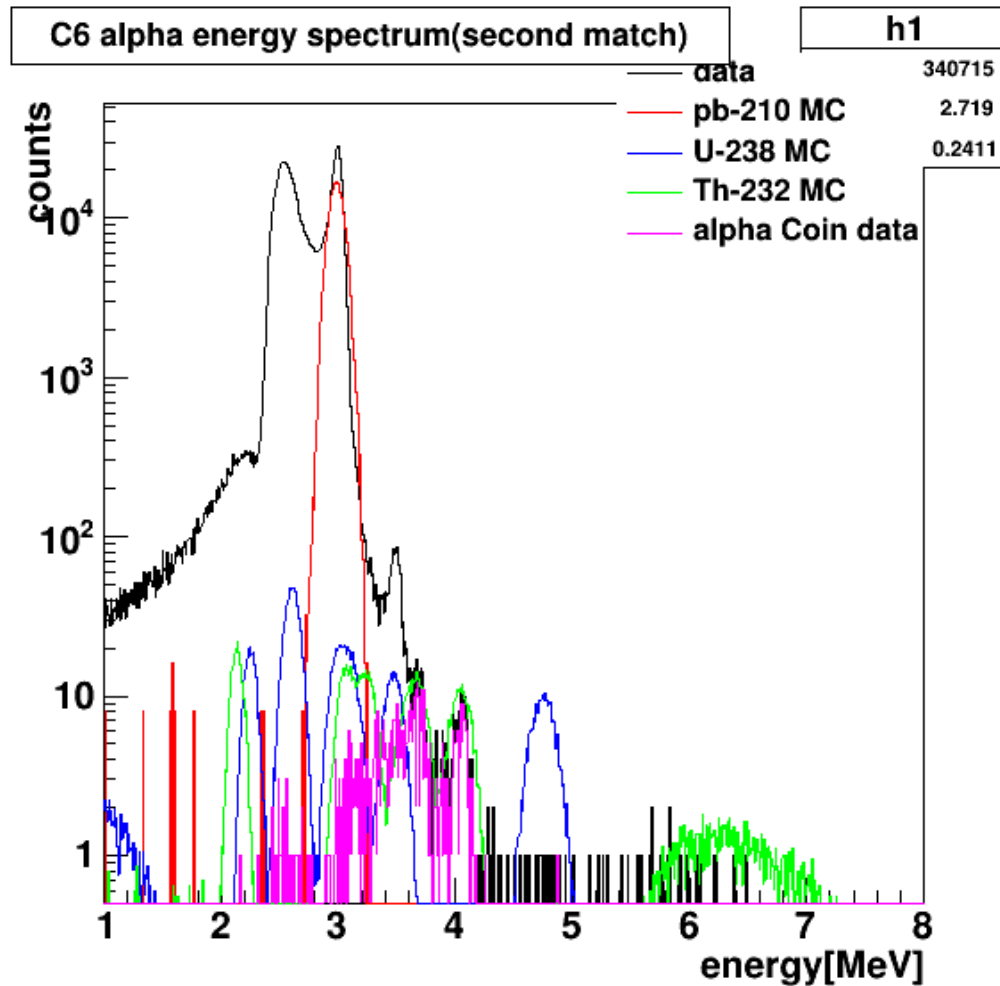


First peak matched



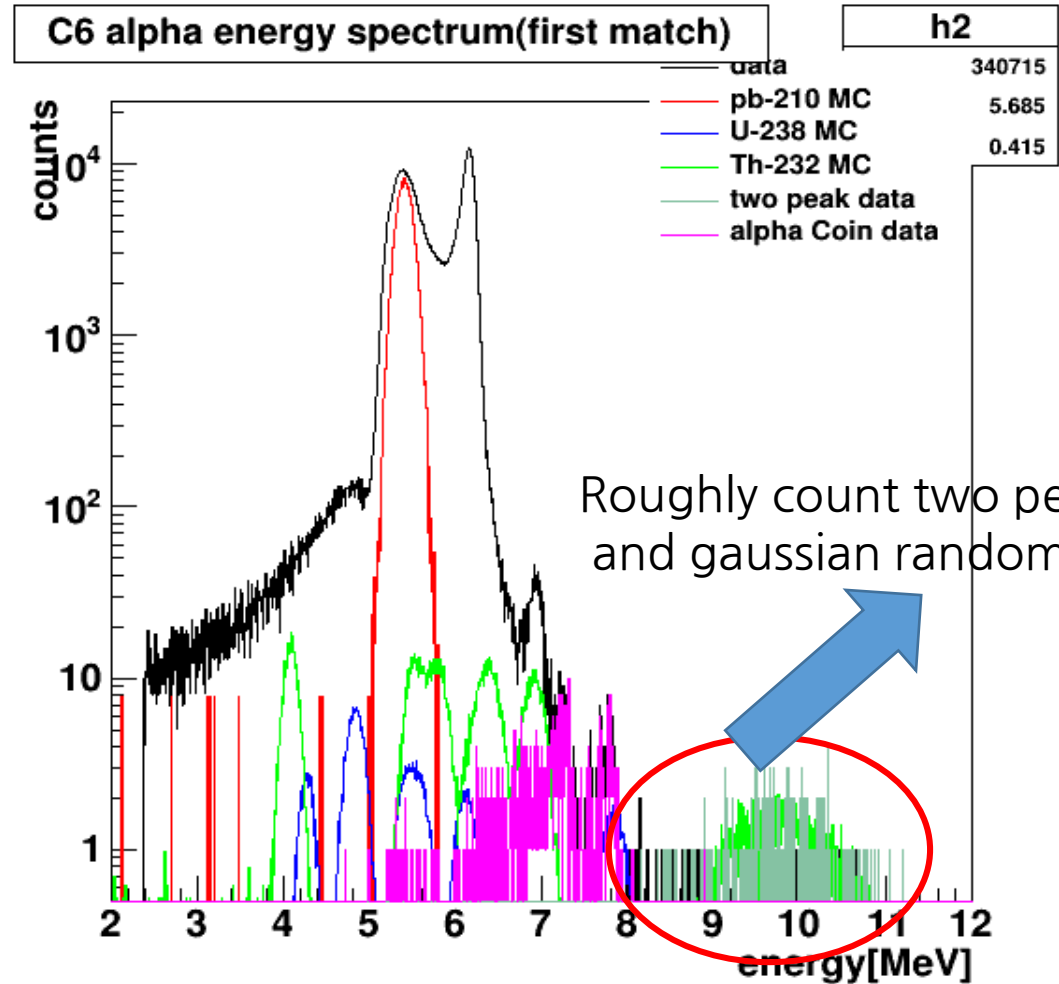
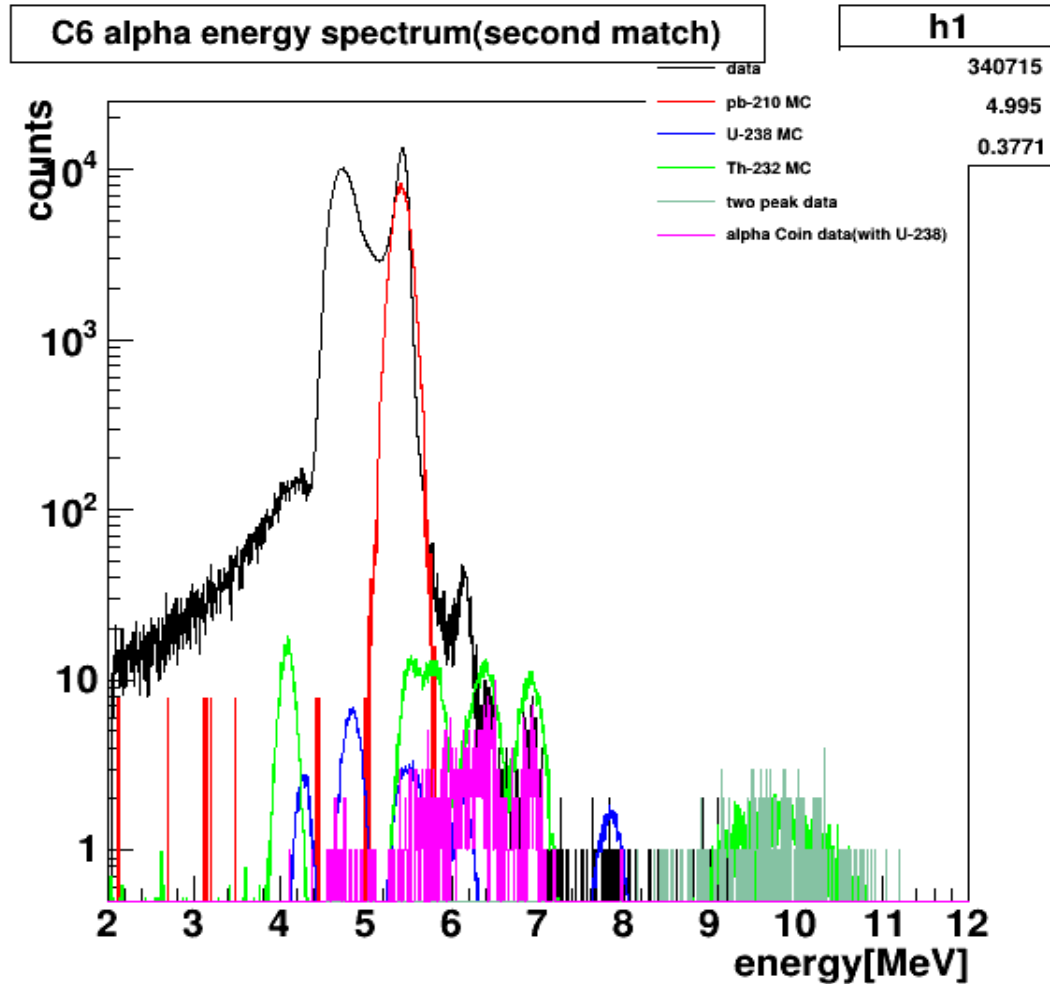
Get quenching factor using Po-210, Rn-220, Po-216(first linear polynomial)

Alpha energy spectrum with MC



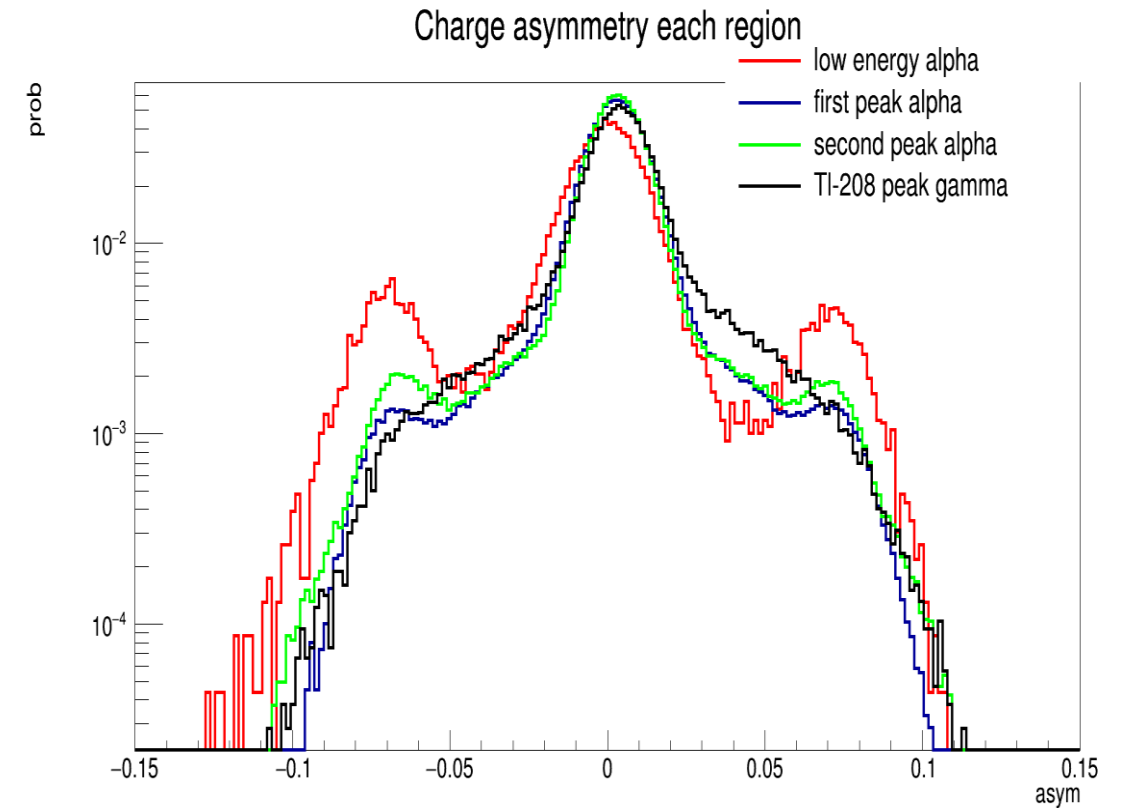
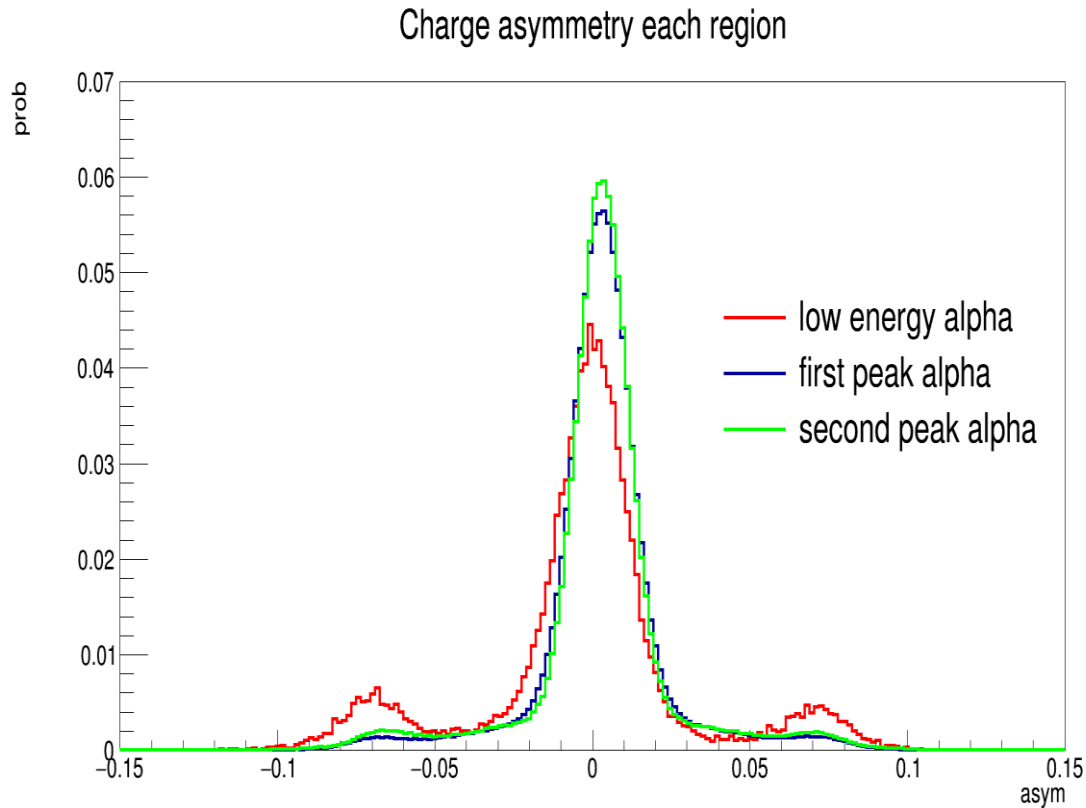
Pink line from Rn-220 and Po-216 decay(fit MC data arbitrary)

Alpha Analysis(C6)



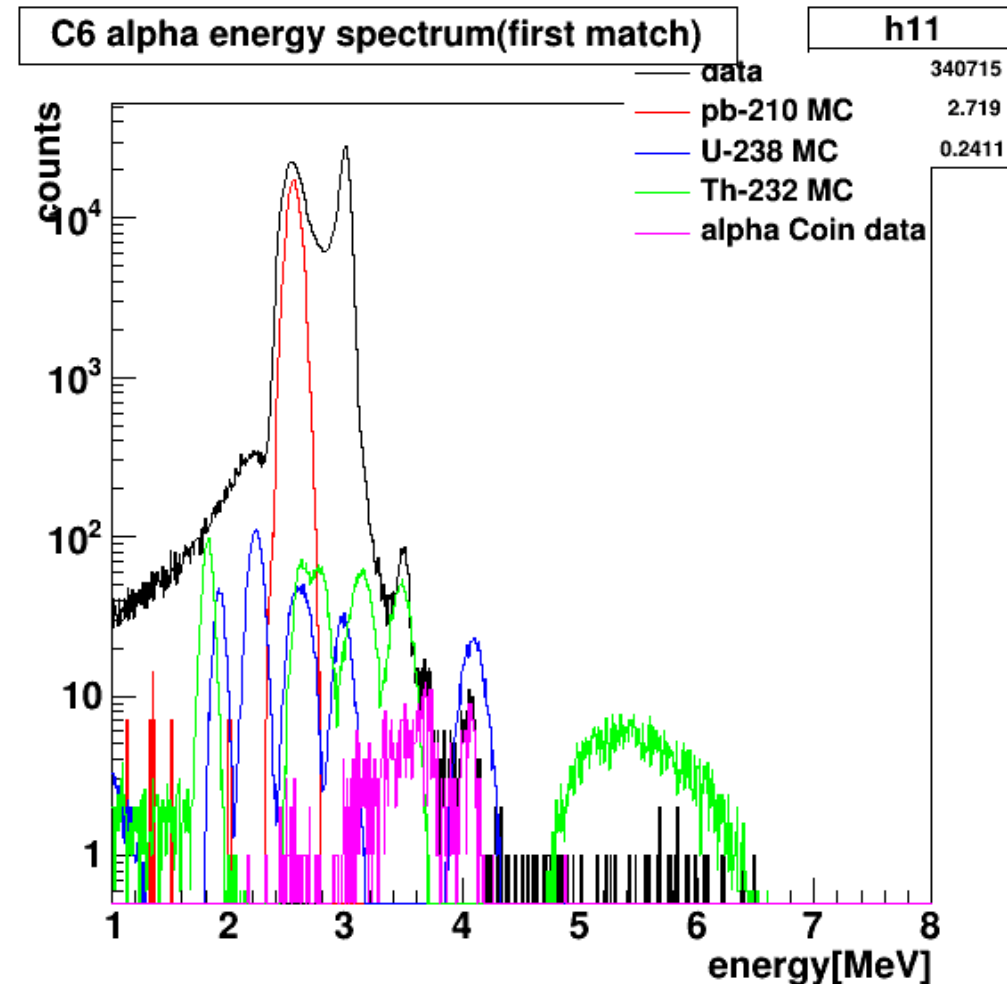
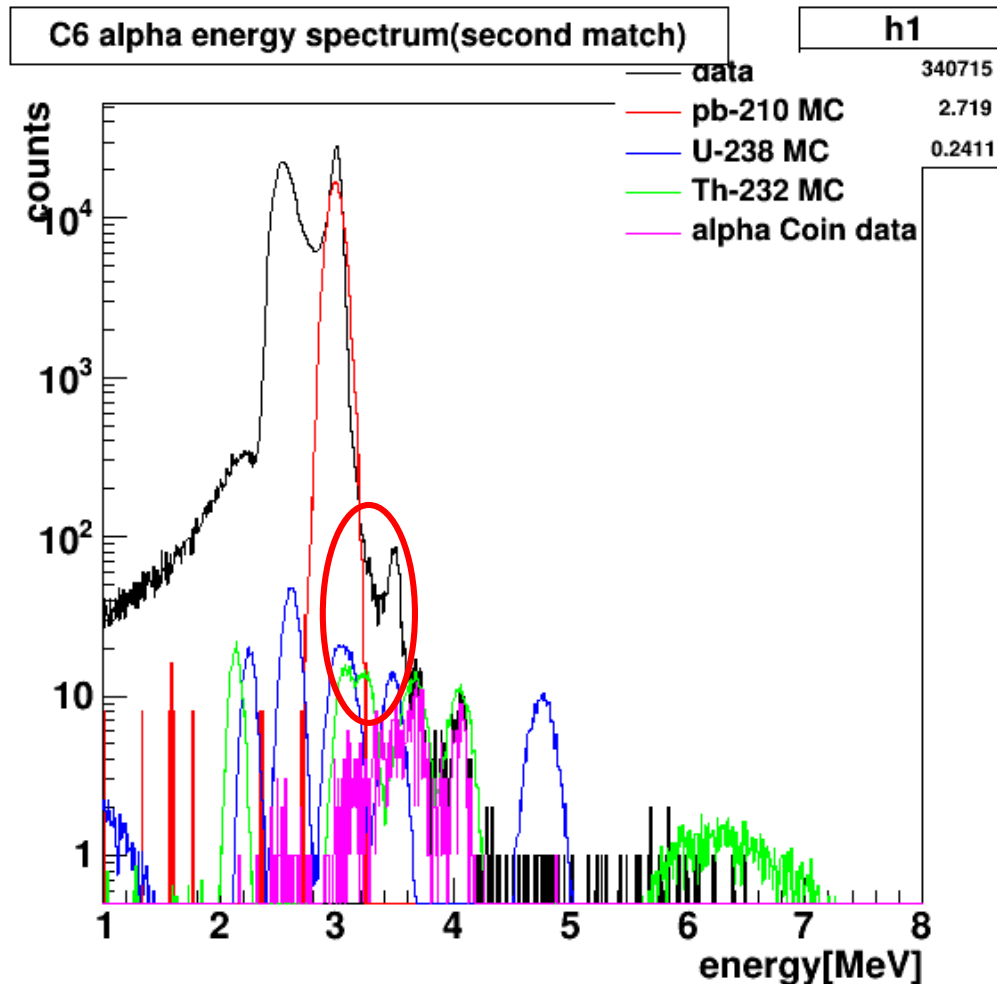
Alpha Asymmetry(C6)

Asymmetry each region



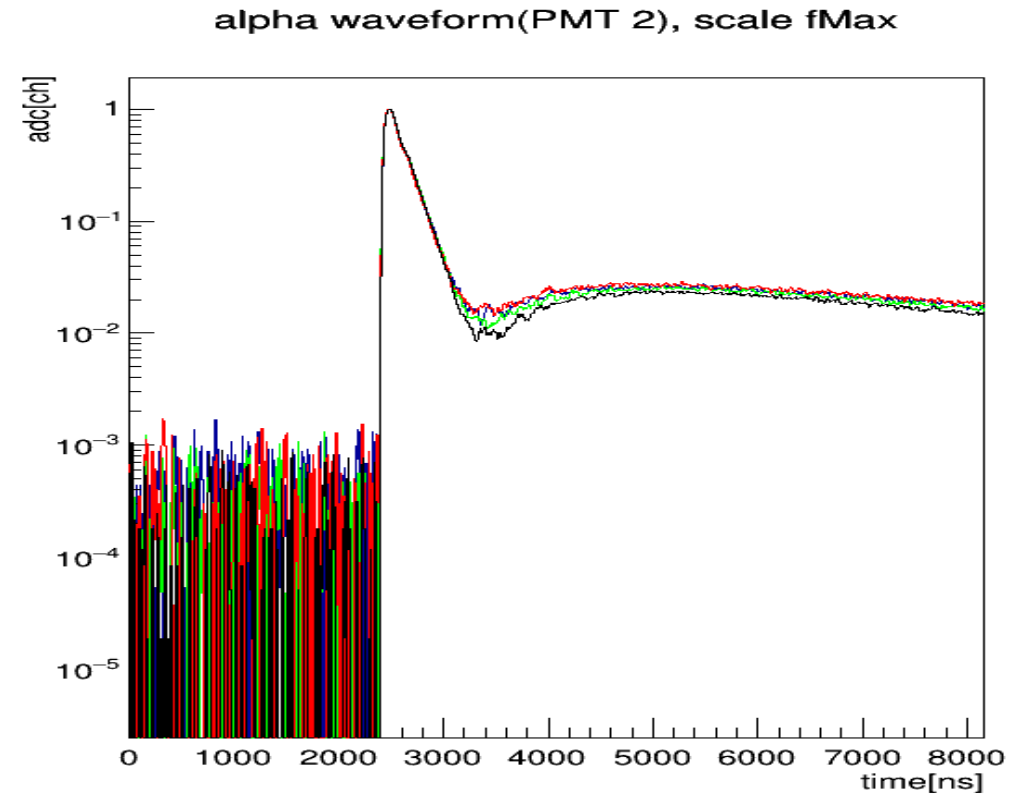
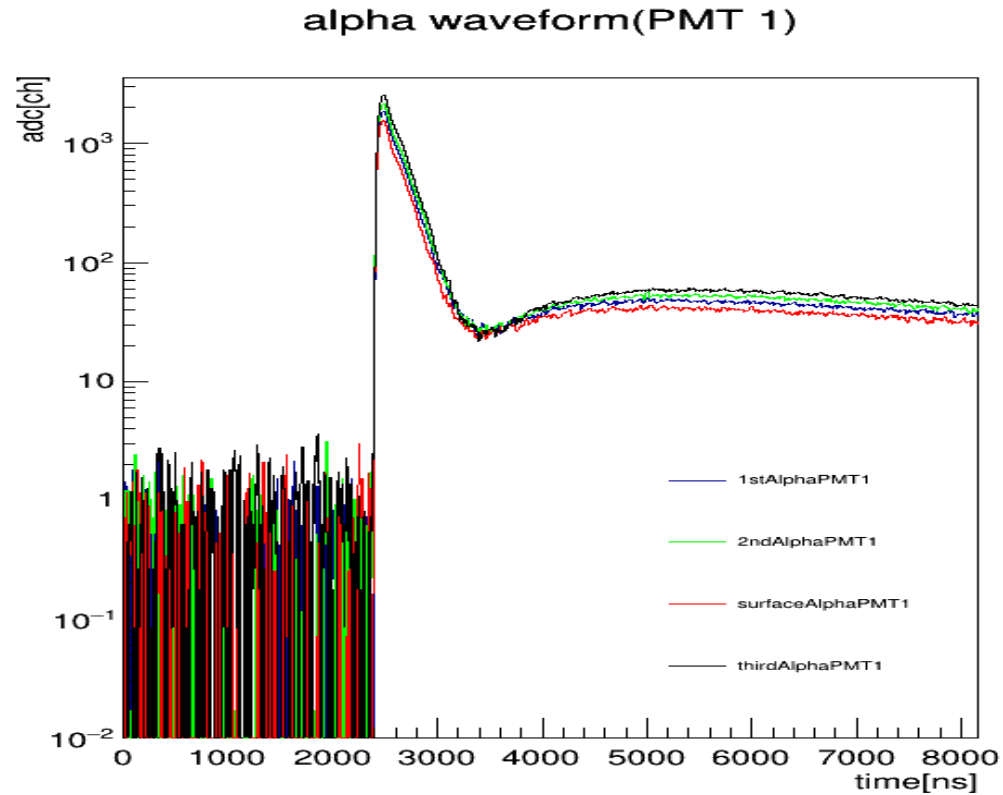
Red asymmetry ratio is higher than blue and green
Red region is surface alpha events
Blue and green look similar

Alpha energy spectrum with MC



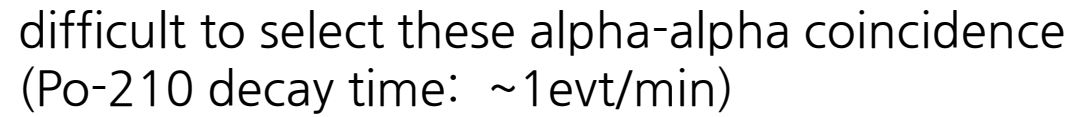
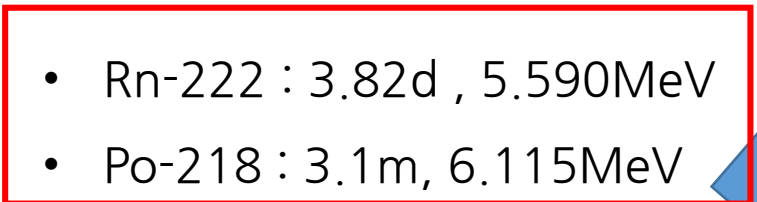
Need to study this peak

Alpha energy spectrum with MC



Third alpha seems like alpha events

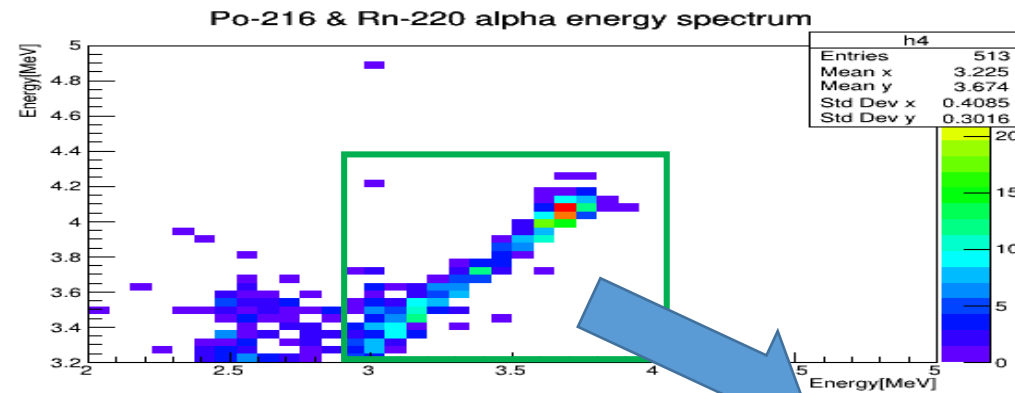
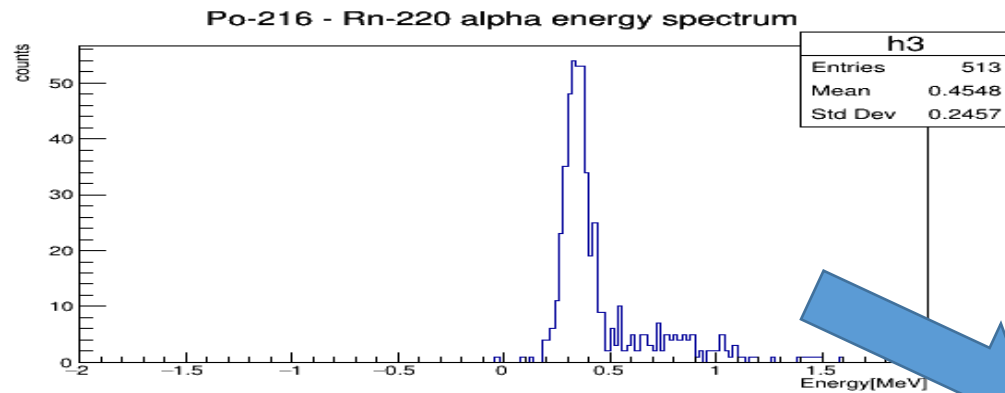
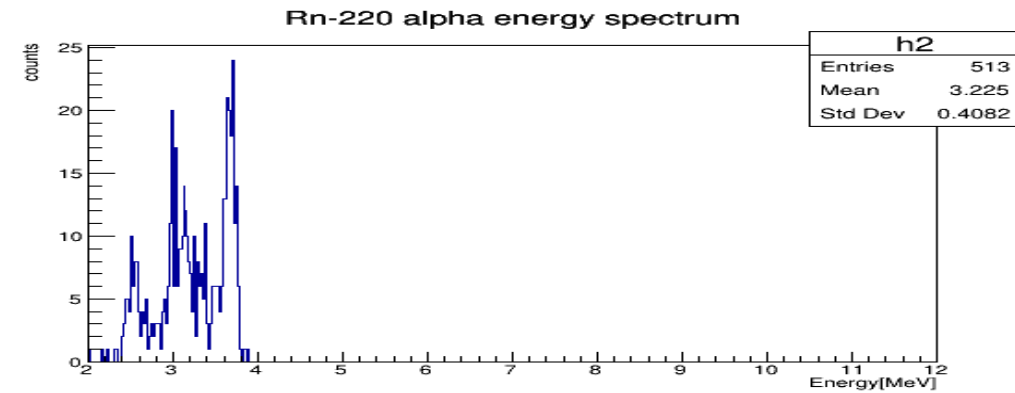
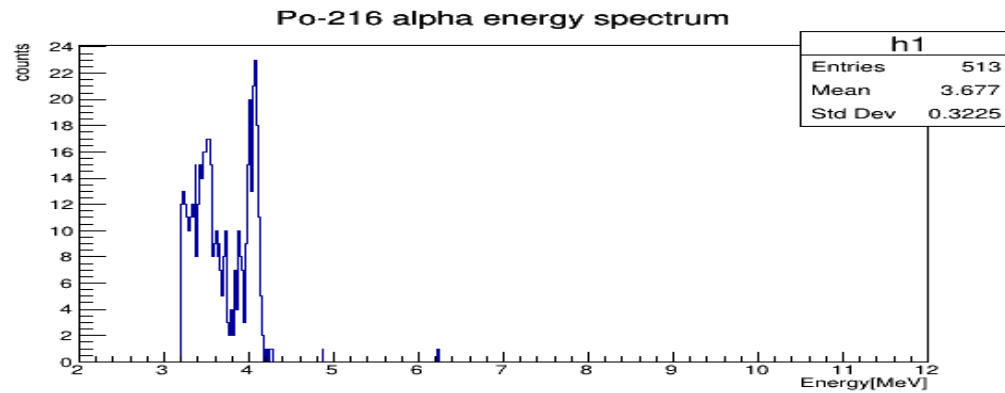
- Ra-224 : 3.66d , 5.789MeV
- Rn-220 : 55.6s , 6.405MeV



Alpha-alpha coincidence

alpha-alpha Coincidence

- Rn-220 $\rightarrow$ Po-216
- Condition : $dT < 2$ sec, after alpha deposited energy($energyDA$) >3.3 MeV



Might be not channeling issue

Correlation alpha-alpha