HIPEx
Heavy Ion Physics Experiment

PNU RICH Detector

R&D Status

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- Concept of PNU RICH v.2.5
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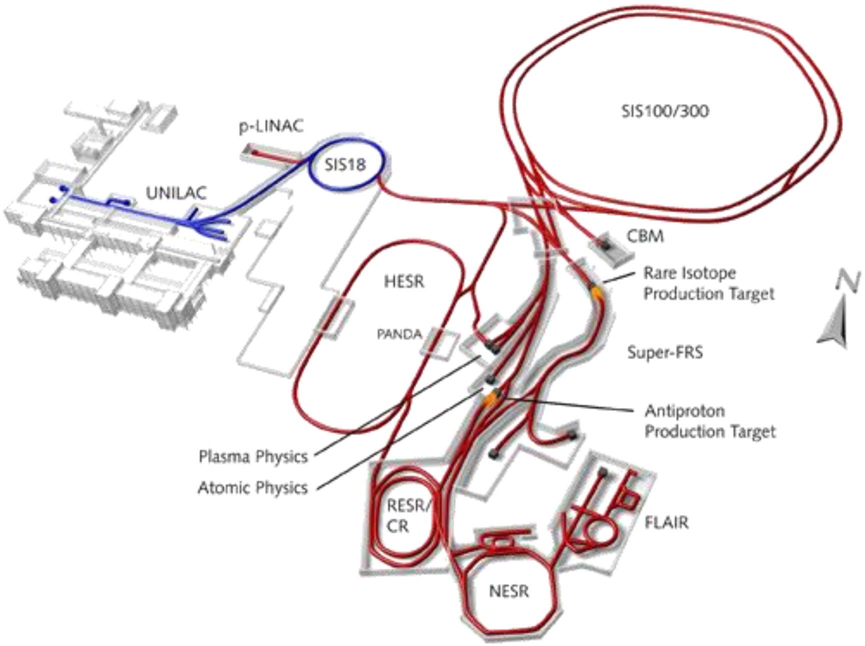
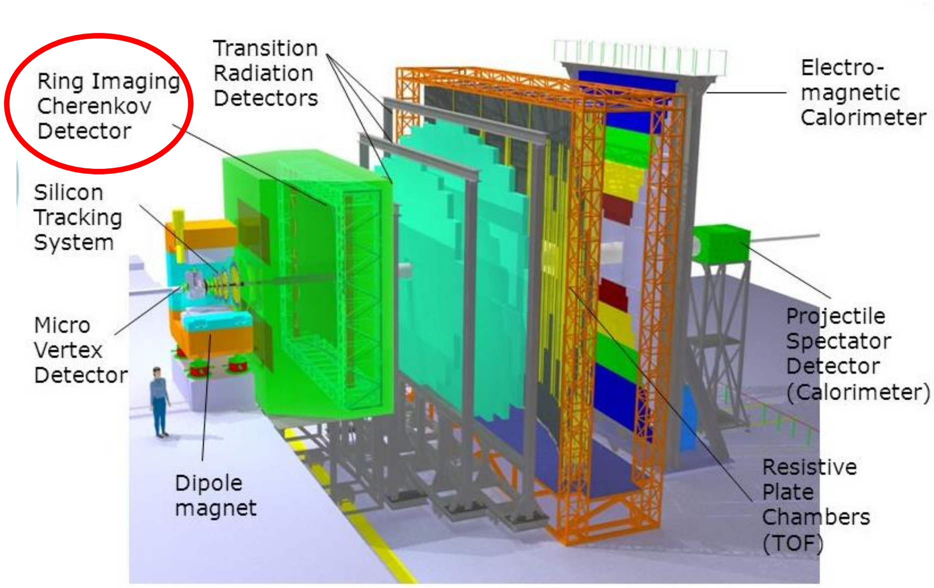
Motivation

- **Introduction to CBM RICH**

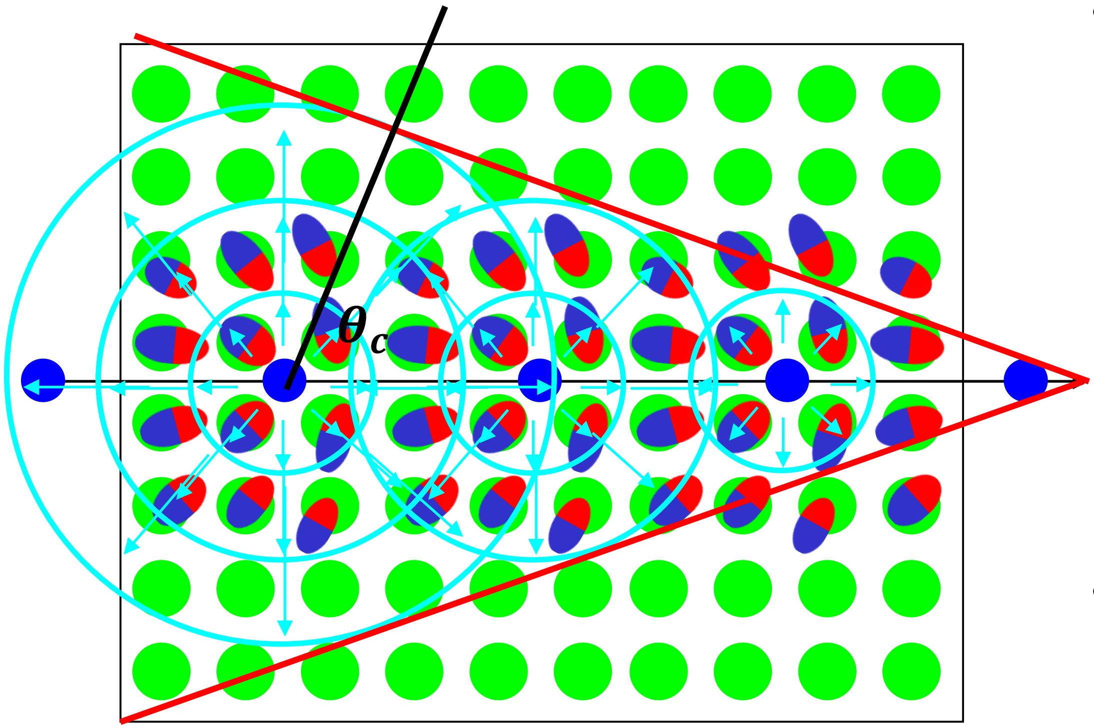




- CBM interested in QCD phase diagram (deconfinement & chiral PT.)
- **Prototype of RICH detector** is developed in PNU
- RICH detector for **electron ID** (J/Ψ , ρ mesons decay to e+ e-)
- Au+Au collision from **2-45 GeV** in 2016

Motivation

- **Cherenkov radiation**



Medium (radiator: CO_2)

Neutral Atom **↑ Dipole** **charged particle**

Image courtesy of [Yi Jungyu]

- Charged particles travelling in medium(n>1)

  + velocity of particles(v>c/n)

$$\cos \theta_c = \frac{1}{\beta n}$$

  → Cherenkov radiation

- Emission of photon by varying dipole momentum

$$\frac{d^2 N}{dE dl} = \frac{\alpha z^2}{\hbar c} \sin^2 \theta_c$$

z : electric charge in units of e

$$\alpha = \frac{e^2}{\hbar c}$$

Motivation

- **R**ing **I**maging **CH**erenkov Detector

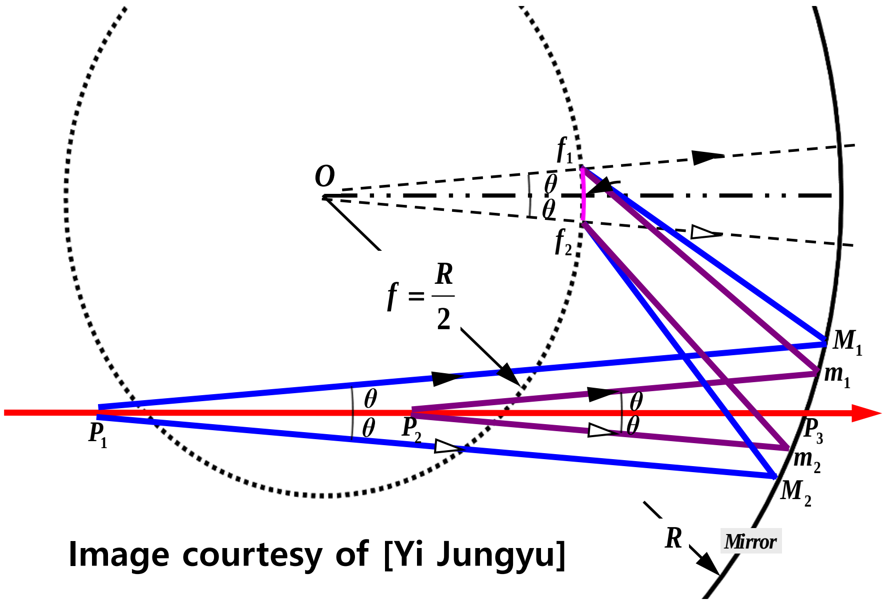
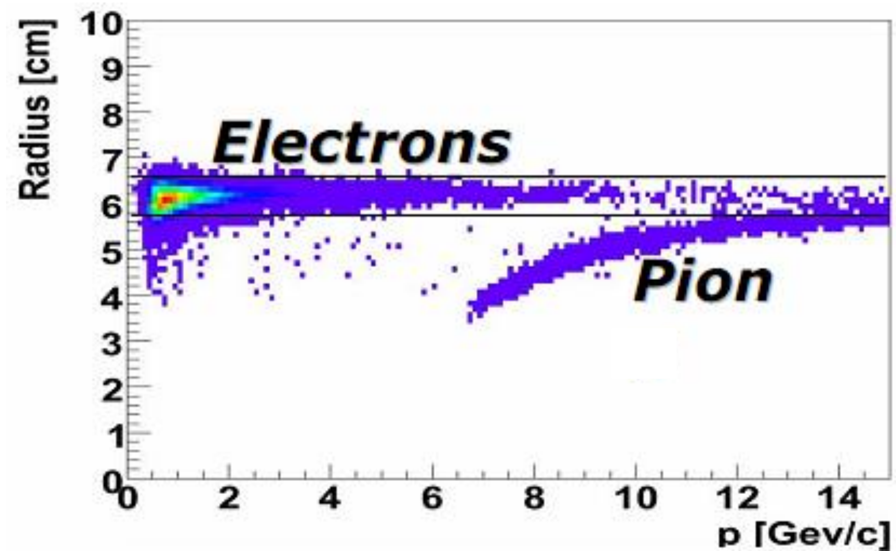


Image courtesy of [Yi Jungyu]



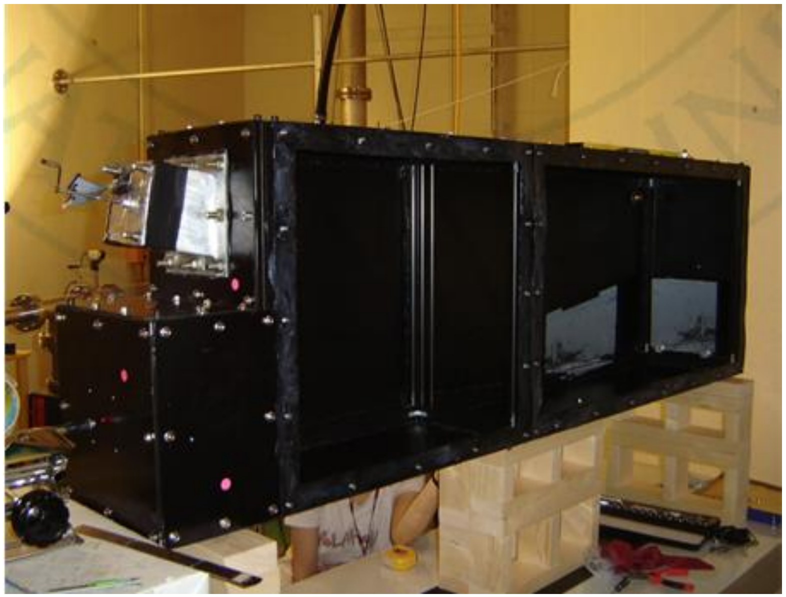
Result of CBM simulation

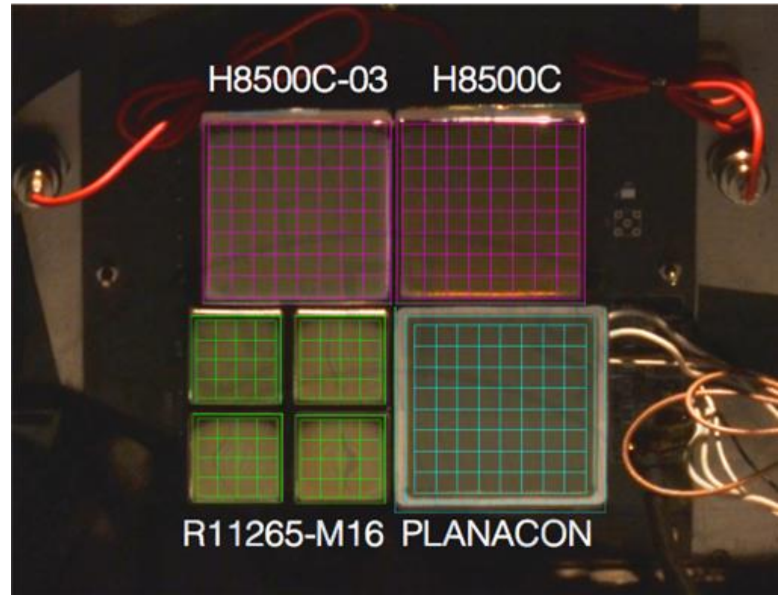
- Particle ID is possible by measuring a radius of ring
- Radius is given by (small angle approximation)

$$r = F \tan \theta_c \sim \frac{R}{2}\sqrt{2 - \frac{2}{n}\sqrt{1 + \frac{(mc)^2}{p^2}}}$$

Concept of PNU RICH2.5

▪ Prototype concept





- RICH detector is consist of 3 parts : **Radiator, Mirror, MAPMT**

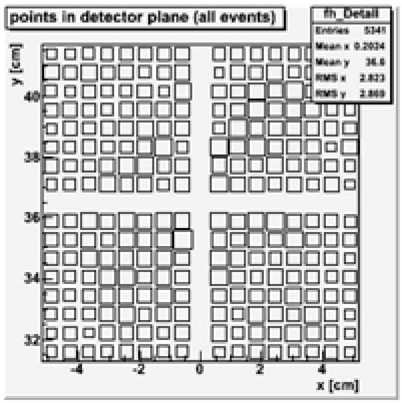
Parameter	PNU-RICH2.5
Radiator length	1.76 m
Radiator	N_2, CO_2
Curvature	3.2 m
Reflexibility	>85% (λ>200 nm)
Ring radius(60MeV)	36.61mm, 45.96

	다중채널광전자증배관			
	H8500C[13]	H8500C-03[13]	R11265-103-M16[15]	PLANACON[14]
증폭방법	다이노드	다이노드	다이노드	MCP
픽셀 배열	8×8	8×8	4×4	8×8
파장 반응	300 - 650 nm	185 - 650 nm	200 - 650 nm	200 - 650 nm
입사창 재질	보로실리케이트 유리 (Brosilicate glass)	자외선유리 (UV glass)	자외선유리 (UV glass)	용융석영 유리(Fused silica glass)
광음극	BA	BA	SBA	BA

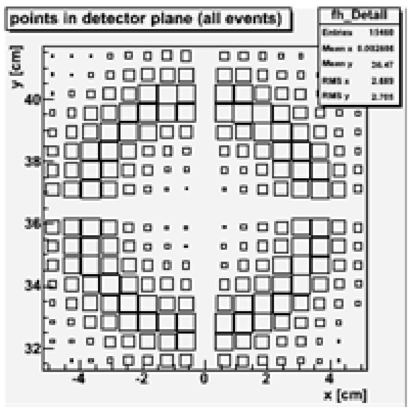
From J.S Eum's thesis

Previous Results

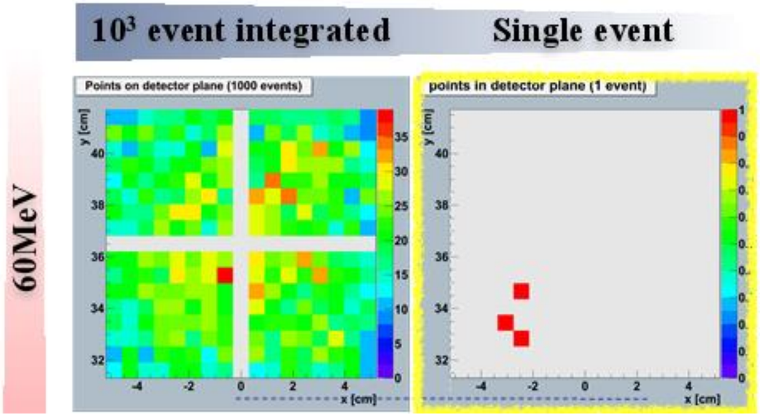
- **Simulation for PNU RICH(Integrated events)**



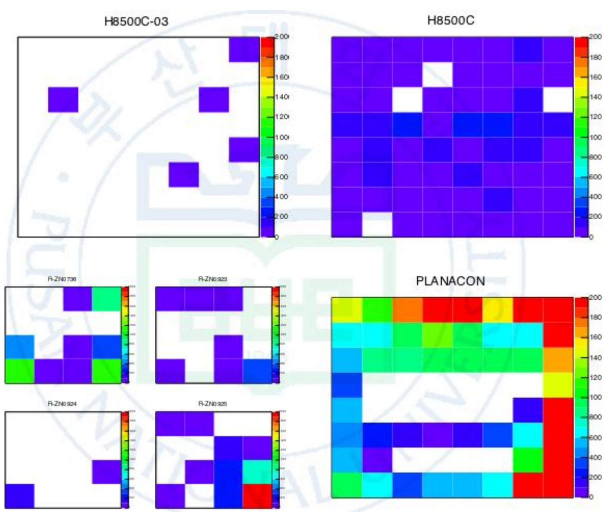
60MeV



400MeV



- **Experiment @PAL (Integrated events)**



- To get high resolution is impossible by inte.

→ To select single event(1 electron) is needed

→ But # of electron ~10^{10} in 1 bunch of beam

→ Using a **time difference** to reduce # of electron

Beam test @ PAL

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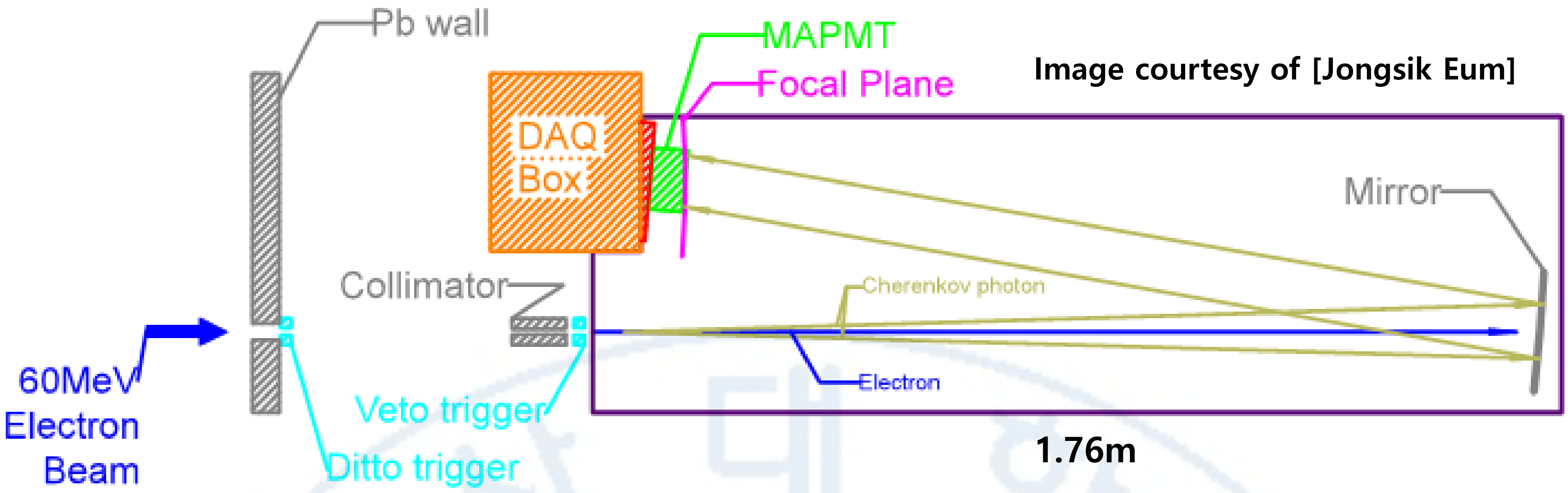
- **Setup of PNU RICH2.5**



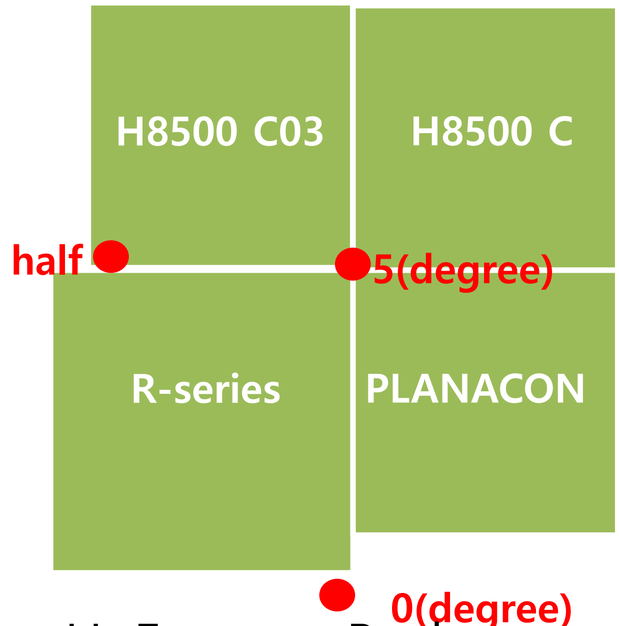
- DITTO, VETO trigger are coincidence to count beam
- Size of beam is about 5.5*7cm^2 -> Collimator is needed

Beam test @ PAL

▪ Dataset(CO_2)

Run	Dipole(A)	Mirror
Focus	13.7	5°
Half	13.7	half
Unfocus	14.3	0°

▪ Position of mirror

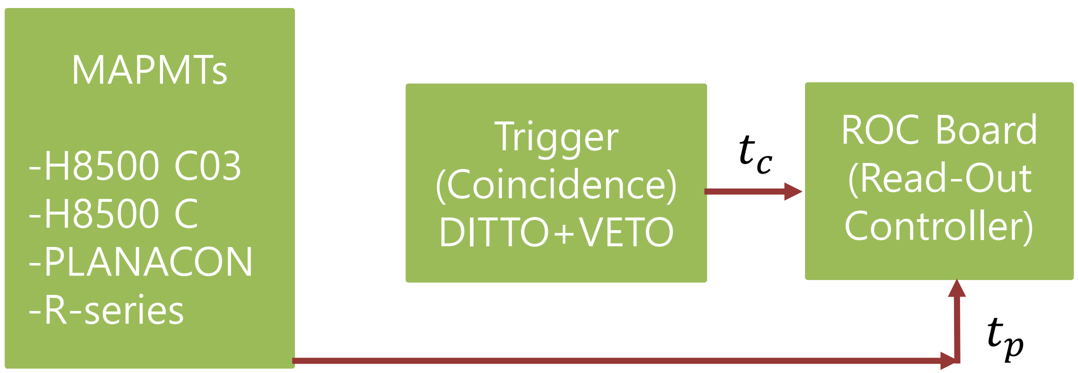


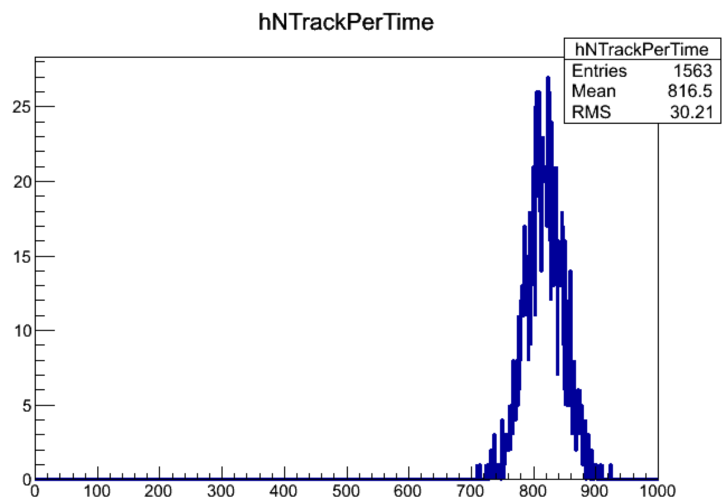
- Focus = Background + Cherenkov, UnFocus = Background only
- Dipole current change the energy of electron beam
  - 13.7A ->32.6 MeV , 14.3A ->34.0 MeV
- The reason using ~30MeV beam is to **reduce trigger rate**

Analysis using time difference

▪ Time difference

- Time difference = coincidence time(t_c) – MAPMT hits(t_p)





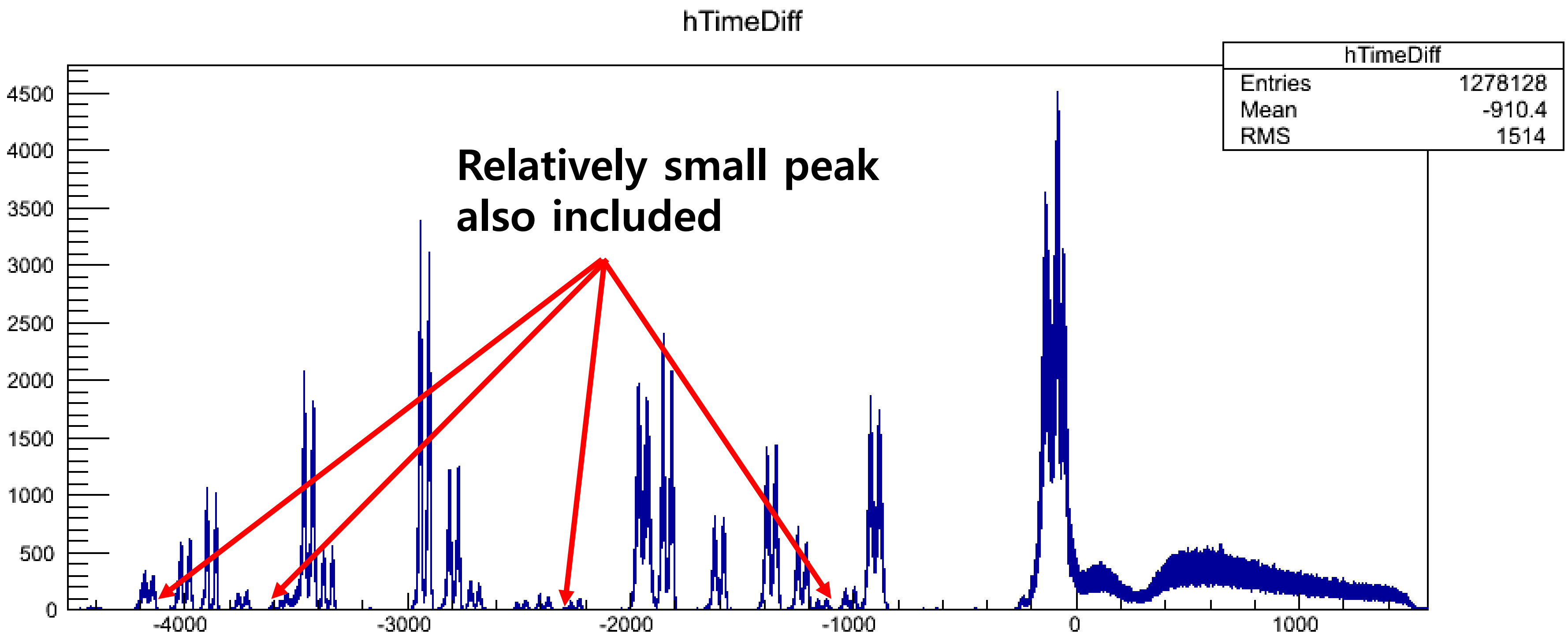
- Single t_c has ~816 time difference in interval -8000 ~ 8000 ns

→ ~816 MAPMT hits each t_c !!!

→ select **narrow interval** of time difference

Analysis using time difference

- **How to separate intervals of time difference**

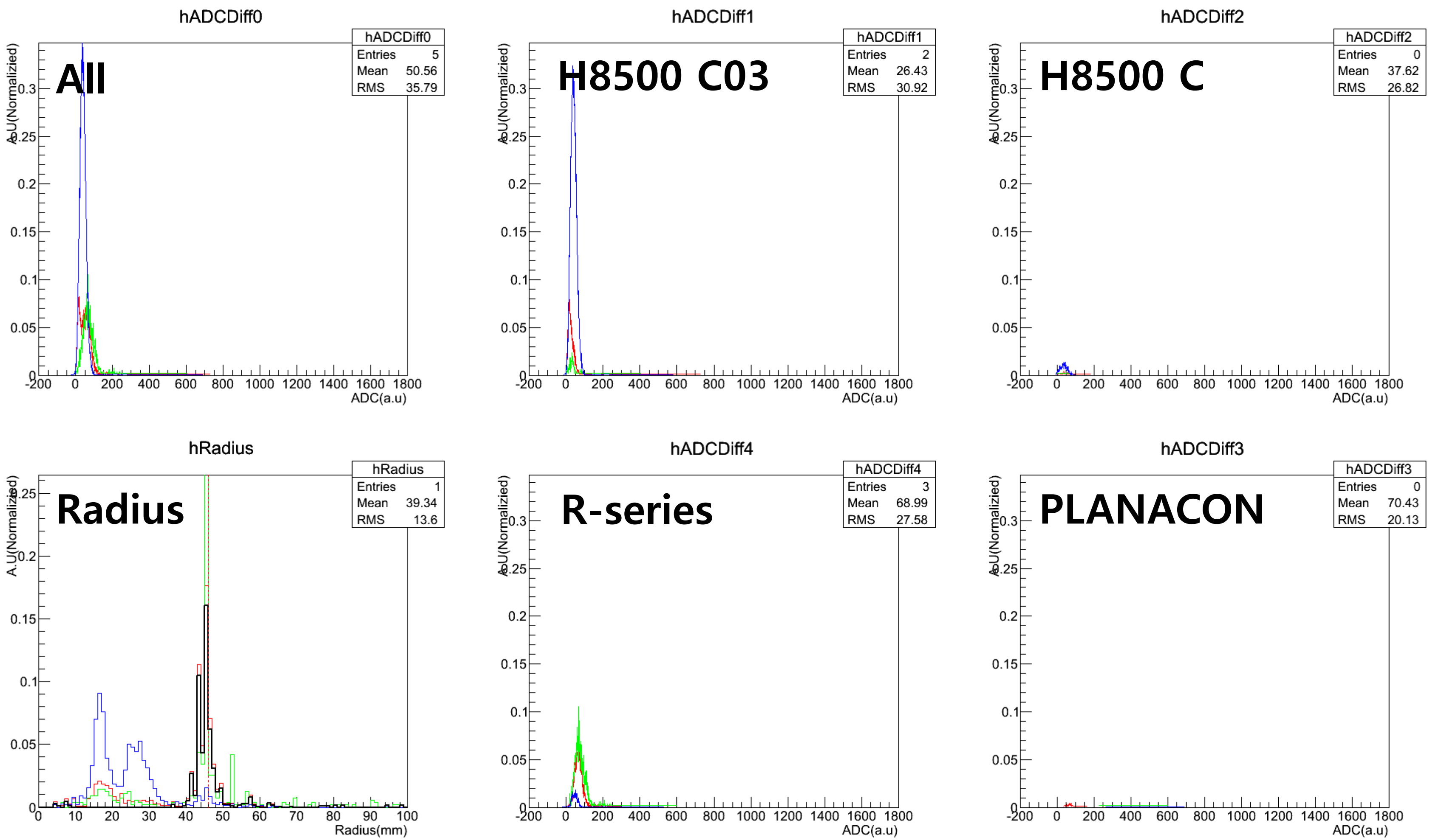


- These distribution is separated by **47 intervals(all peak)**
- **Size of Intervals** are about **40~90 ns**
- ADC distribution is normalized by **total # of coincident time(t_c)**

Analysis using time difference

- **Background dominant interval(pedestal only)**

Red:Focus, Green:Half(C03), Blue:Unfocus



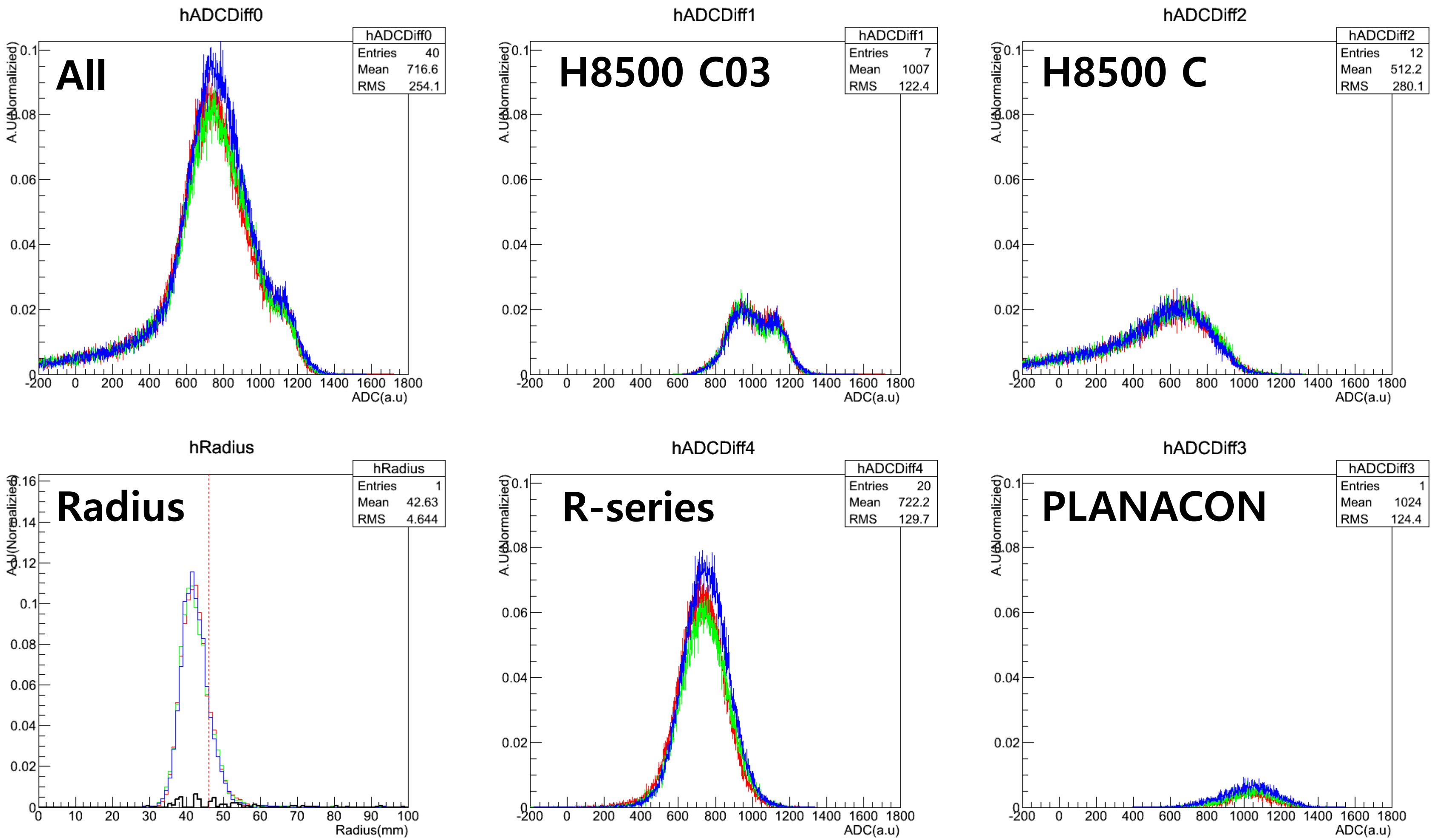
Black:Focus-Unfocus

Interval(-3555,-3525)

Analysis using time difference

- Background dominant interval(unfocus>focus)

Red:Focus, Green:Half(C03), Blue:Unfocus



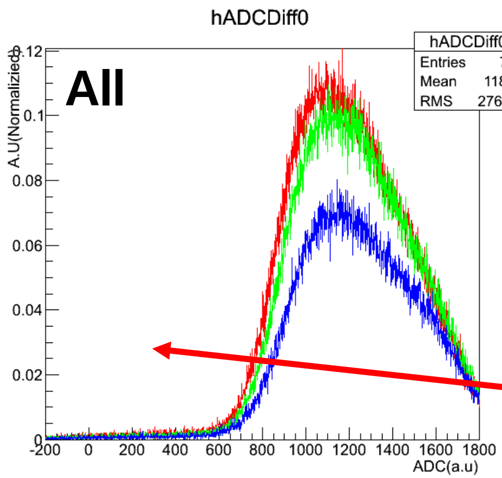
Black:Focus-Unfocus

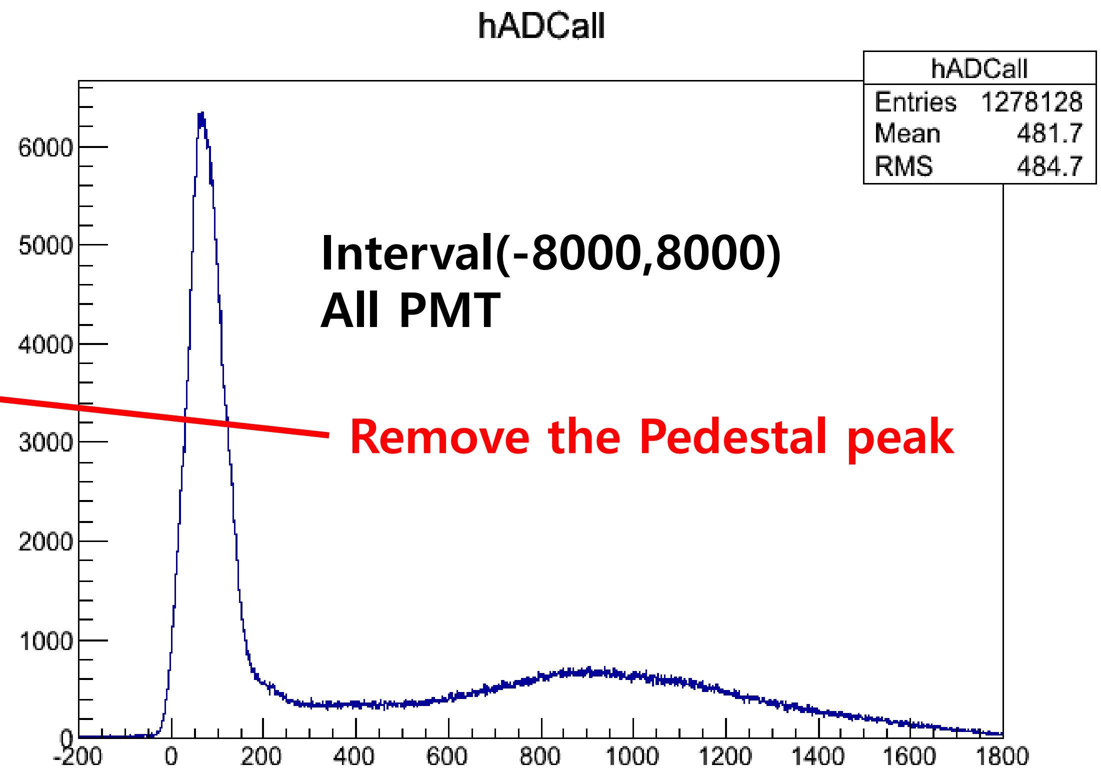
Interval(-70,-30)

Analysis using time difference

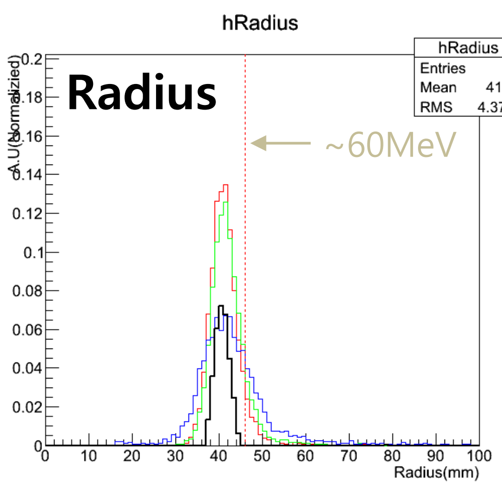
- Signal Dominant interval(focus>half>unfocus)

Red:Focus, Green:Half(C03), Blue:Unfocus

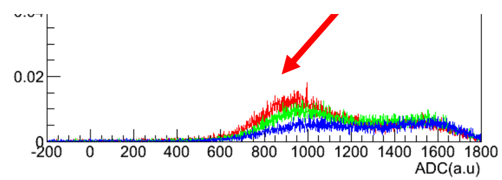


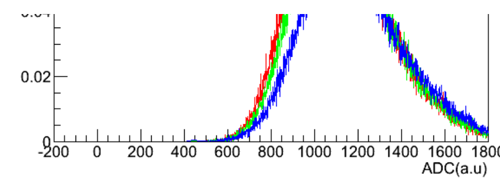


Remove the Pedestal peak



Black:Focus-Unfocus



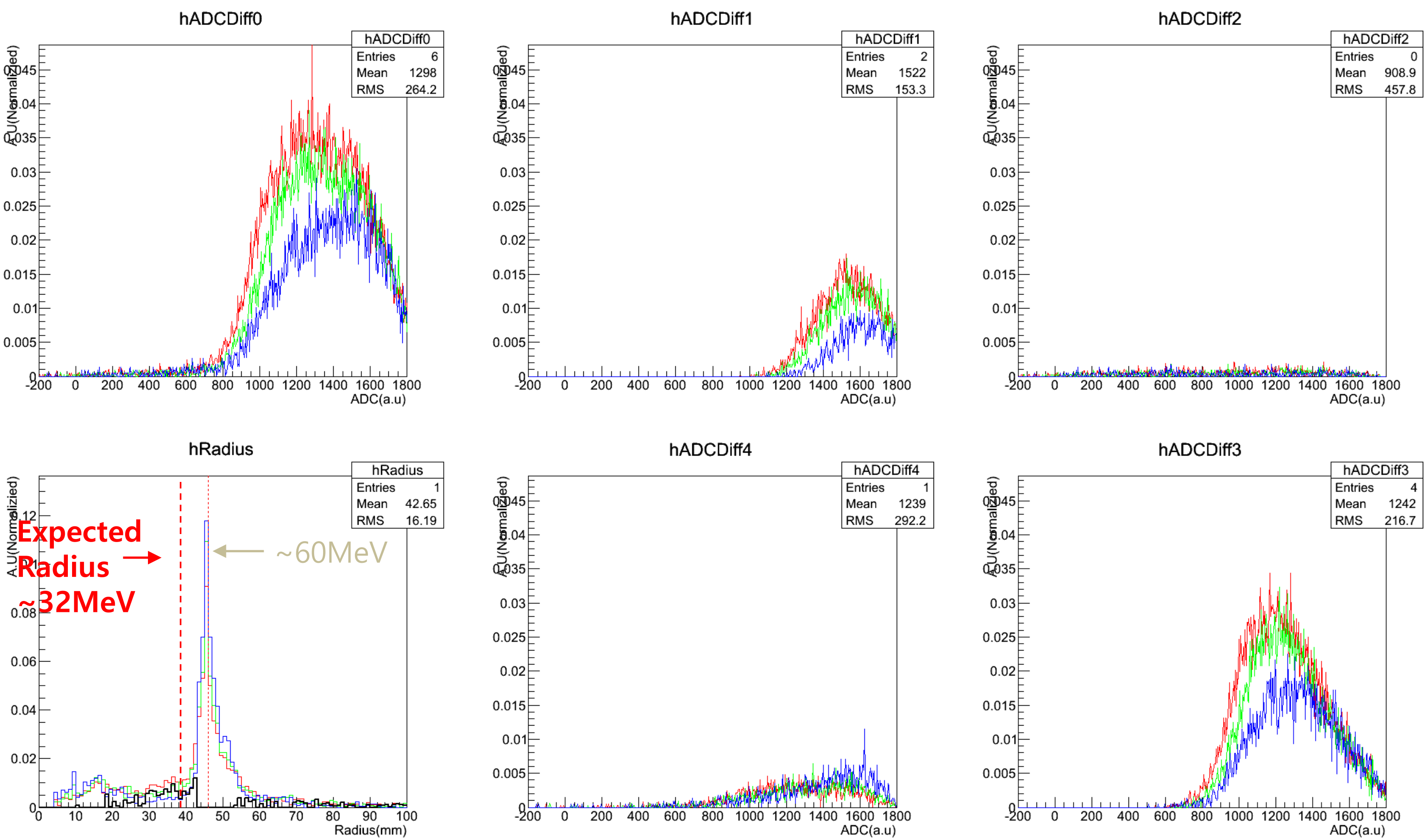


Interval(-200,-110)

Analysis using time difference

- **Finding specific interval**

Red:Focus, Green:Half(C03), Blue:Unfocus

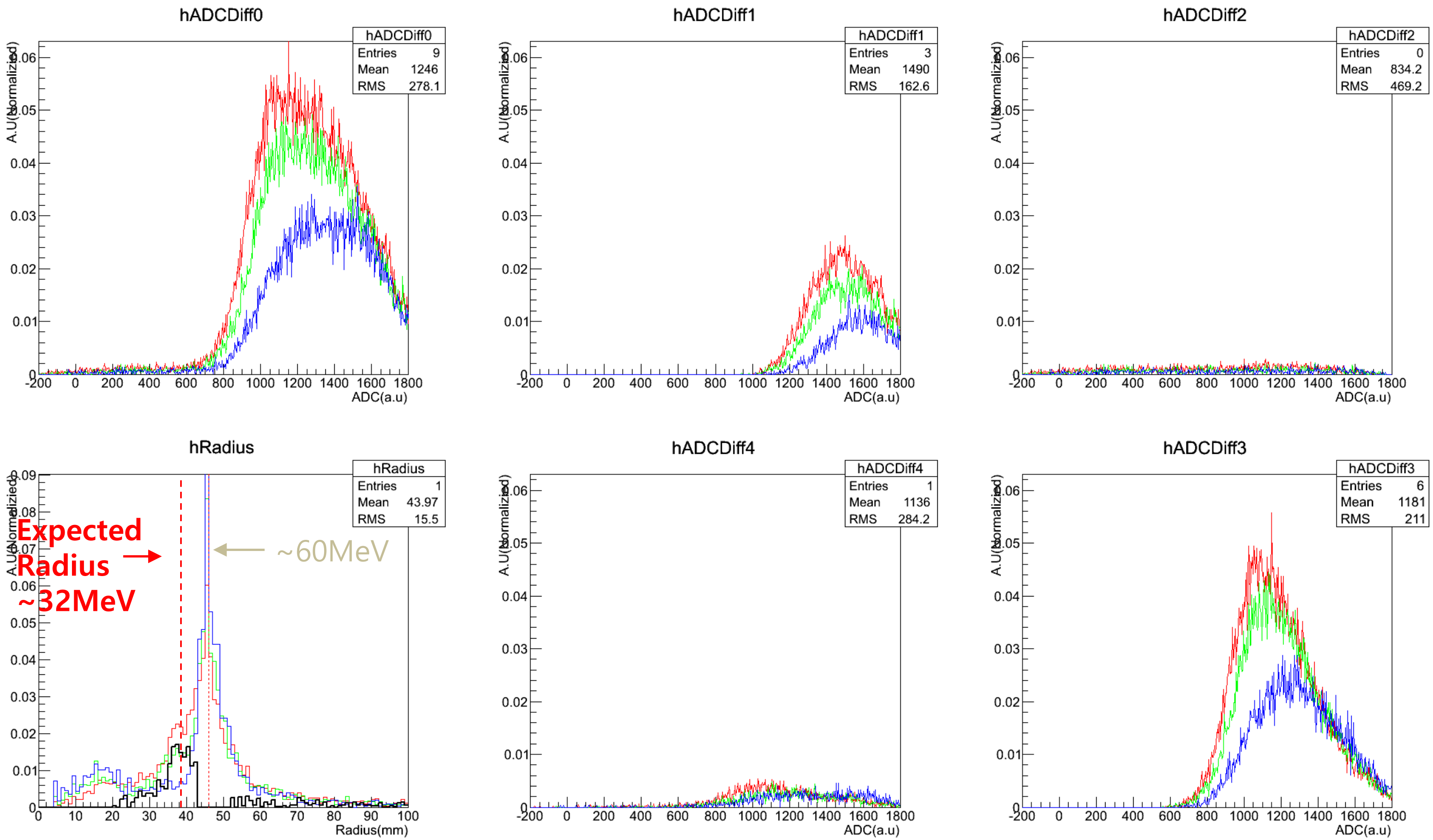


Black:Focus-Unfocus **Interval(-170,-160)**

Analysis using time difference

- **Finding specific interval**

Red:Focus, Green:Half(C03), Blue:Unfocus

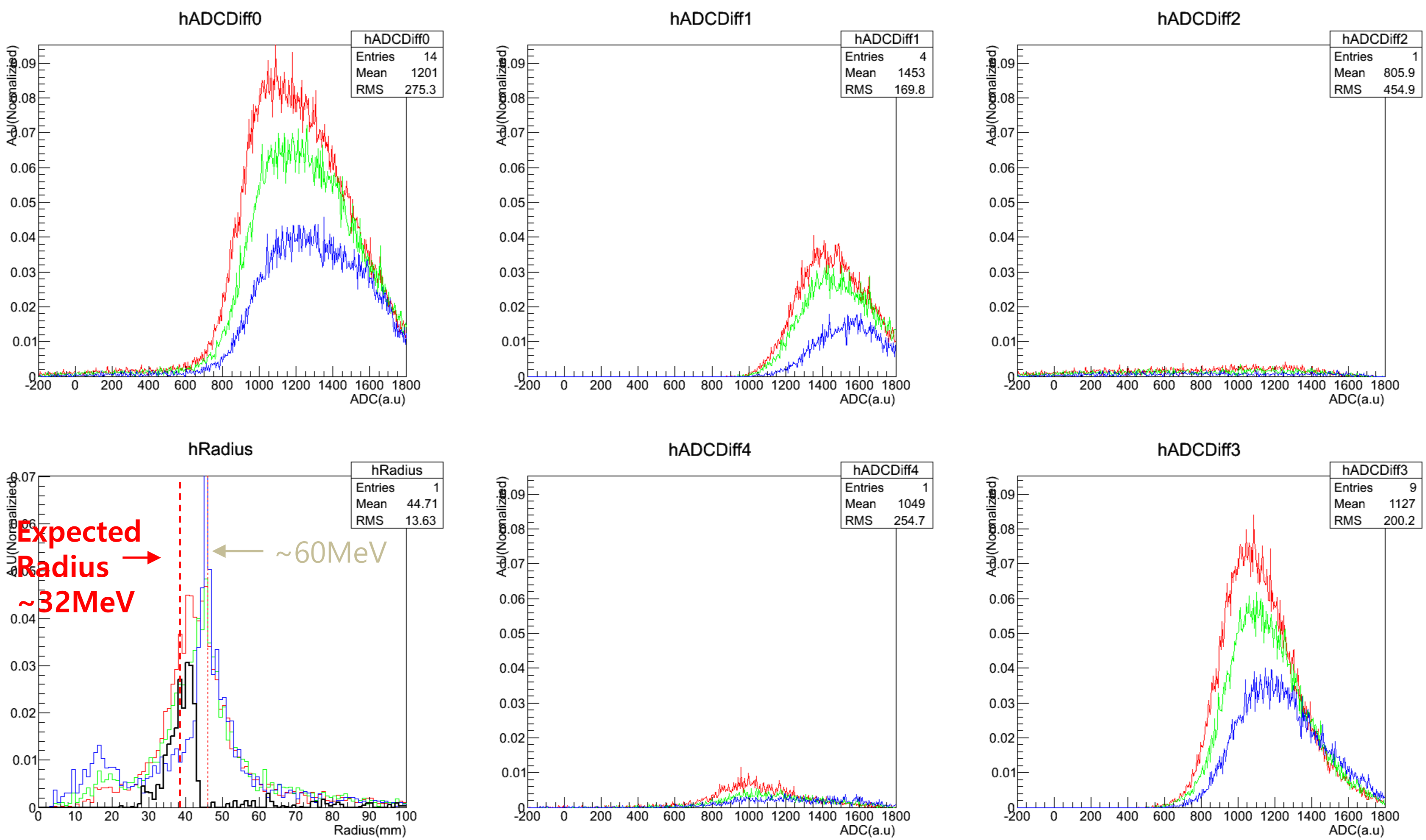


Black:Focus-Unfocus **Interval(-160,-150)**

Analysis using time difference

- **Finding specific interval**

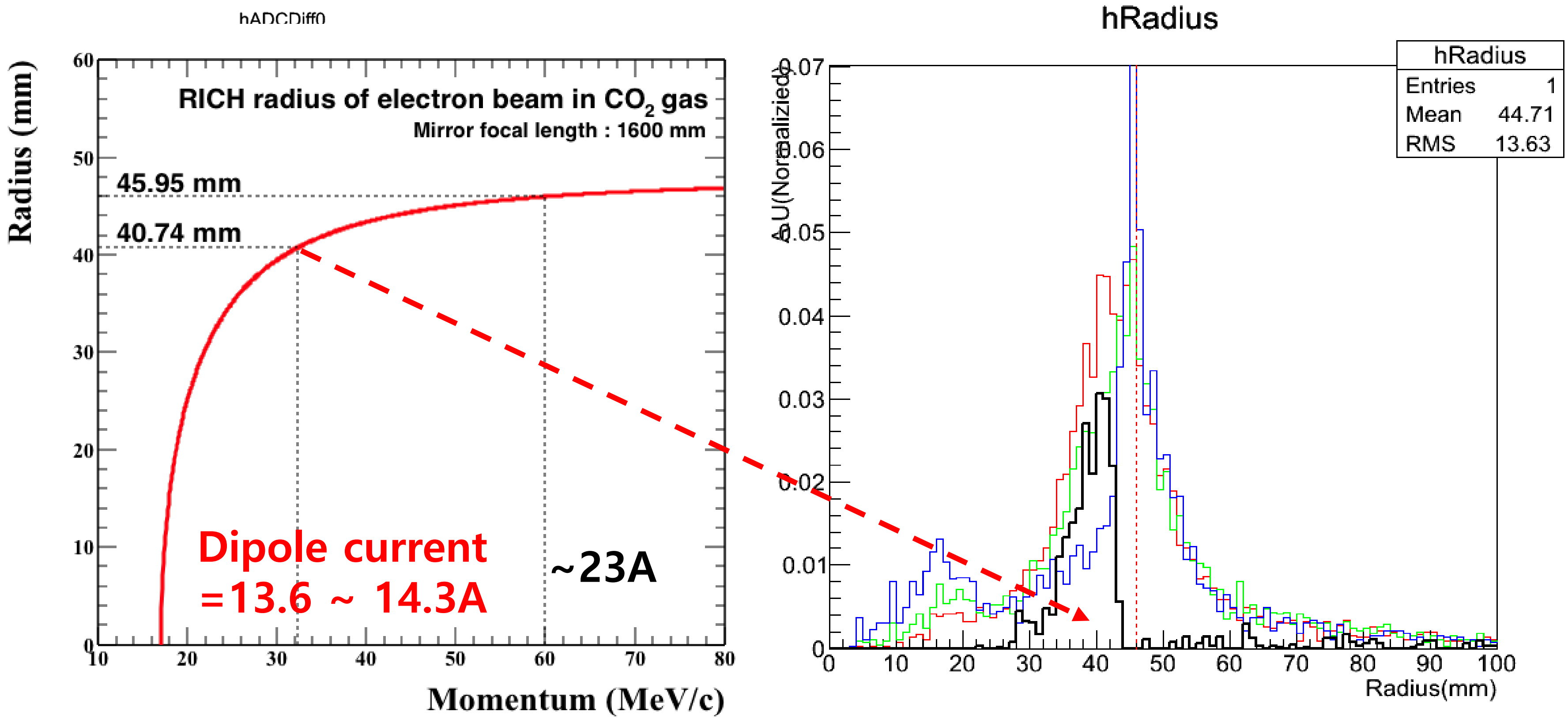
Red:Focus, Green:Half(C03), Blue:Unfocus



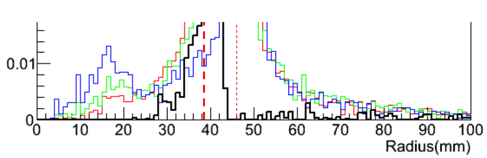
Black:Focus-Unfocus **Interval(-150,-140)**

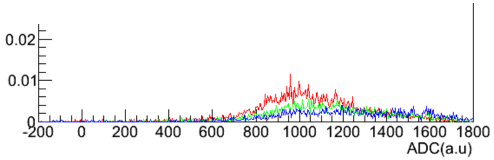
Analysis using time difference

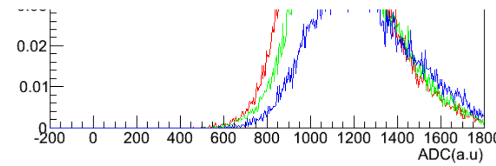
- Finding specific interval



Red:F







Black:Focus-Unfocus

Interval(-150,-140)

Summary & Outlook

HIPEx Heavy Ion Physics Experiment

- **Summary(case of CO_2)**
  - In ~32MeV we have to use time difference
  - **Signal dominant interval** is **(-160,-130)ns**
  - Cherenkov ring will be **statistically** found
  - Result of N_2 don't agree with our approach -> more studying
- **Outlook**
  - Fit Quality cut makes the results more meaningful
  - Cross-check about N_2 & look the ring directly over hundred MeV

→ Confirm the operation of PNU RICH Detector !

Back up

Time difference window