COMET-CDC
cosmic ray data analysis

Saki Ohta
2019/12/23

Topics

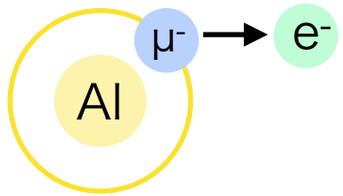
- Introduction
    - COMET Experiment (Phase-I)
    - CDC Cosmic Ray Test
- Data Analysis
    - Tracking
    - Residual
- Summary

COMET experiment (Phase-I)

Place：J-PARC (Ibaraki prefecture)

Looking for μ-e conversion

$$\mu^- + N(A,Z) \rightarrow e^- + N(A,Z)$$



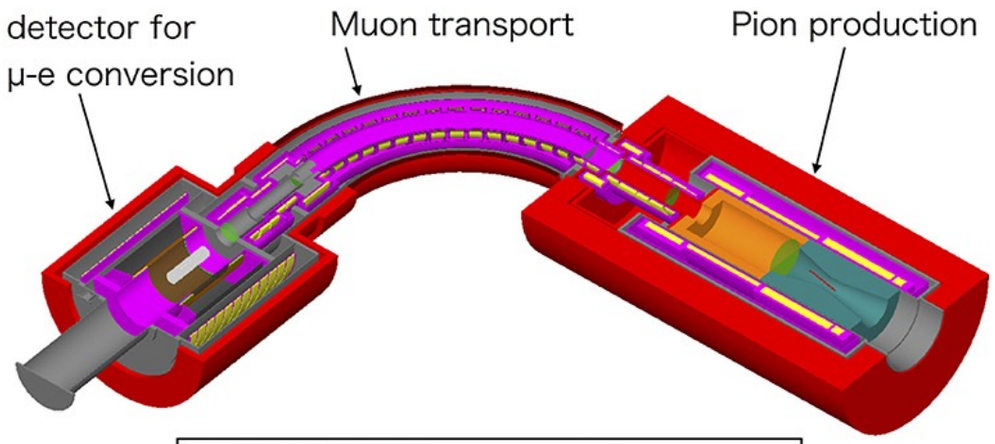
SM：BR O(~10^{-54})

new physics：BR O(~10^{-15}~10^{-17})

Previous research

SINDRUM-II @PSI BR<7×10^{-13}

COMET Phase-I (S.E.S) 3×10^{-15}

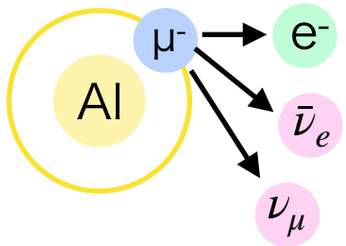


COMET Phase-I Layout

Back ground

DIO(Decay In Orbit)

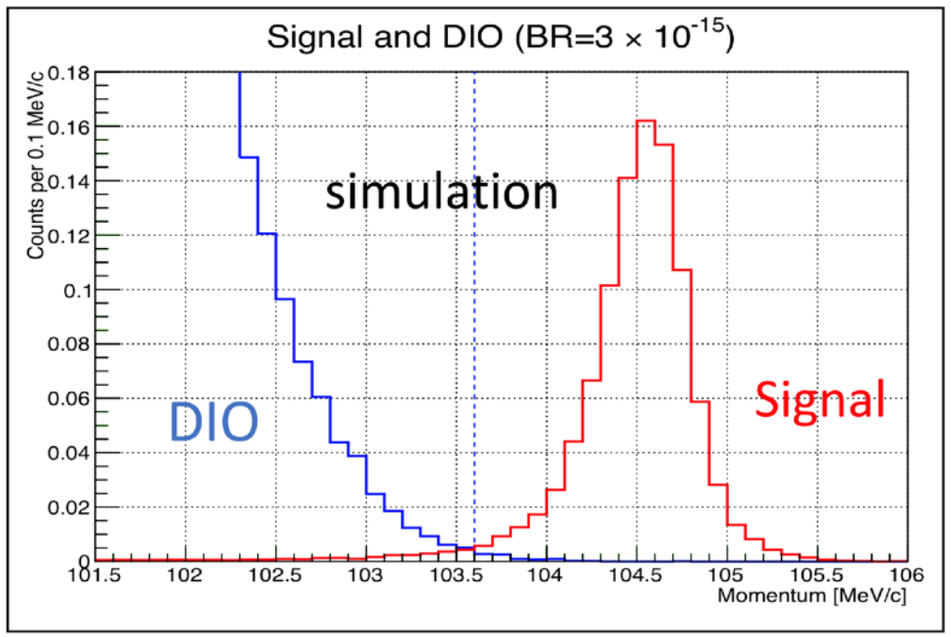
$$\mu^- + N(A,Z) \rightarrow e^- + \bar{\nu}_e + \nu_\mu + N(A,Z)$$



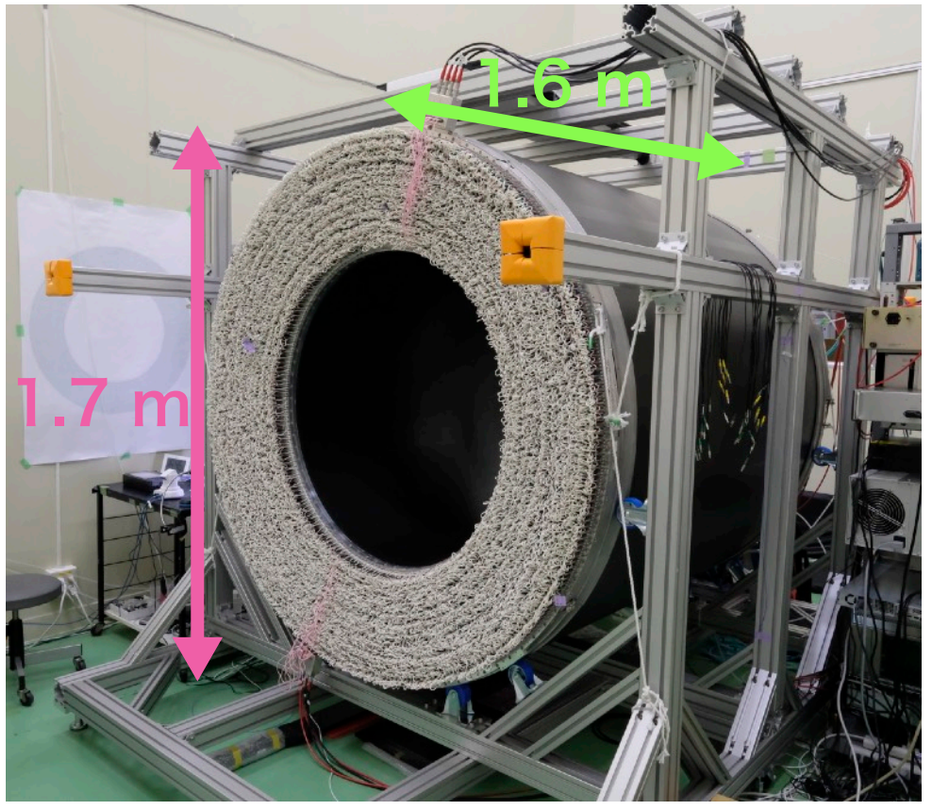
Required performance for CDC

momentum resolution for 105 MeV/c electron

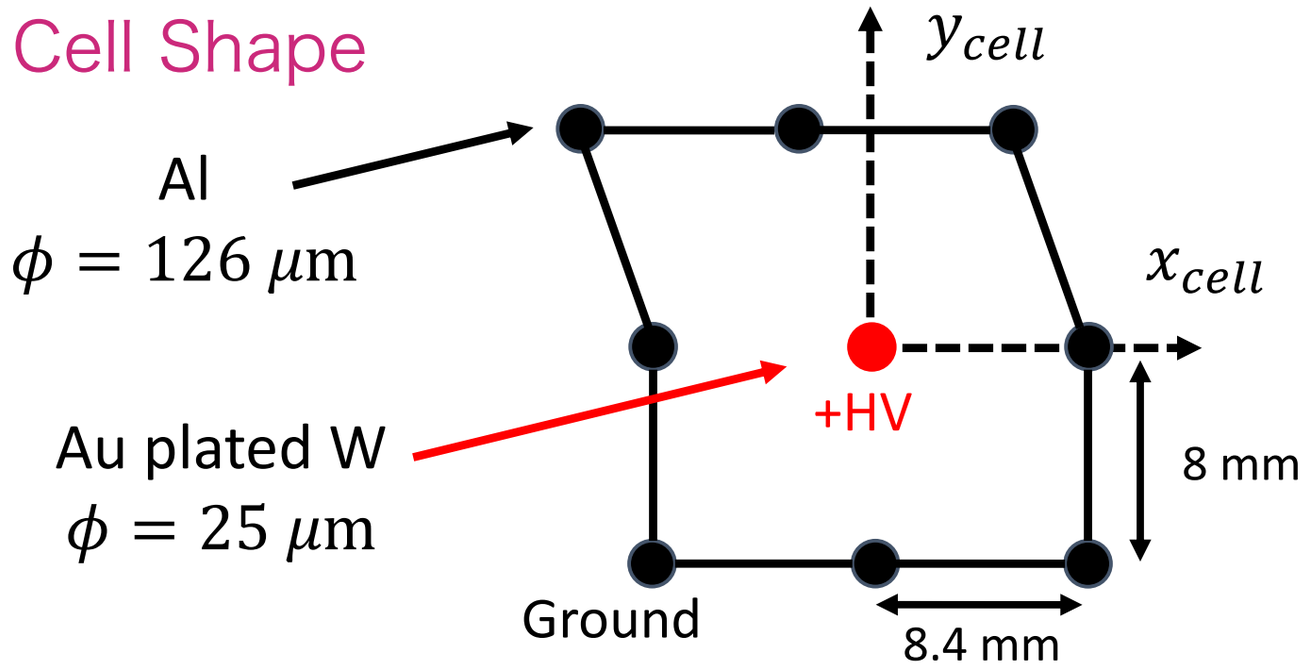
< 200 keV/c



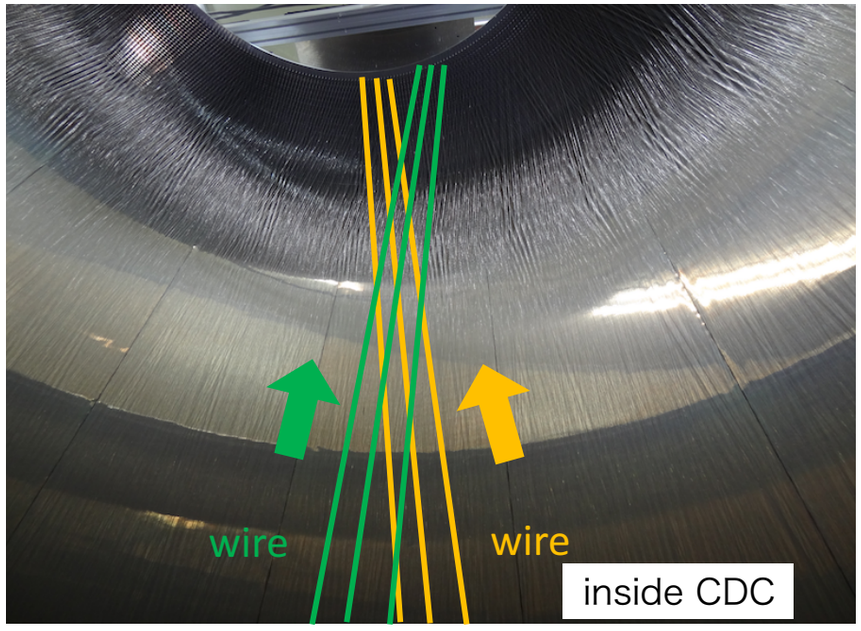
COMET-CDC



Cell Shape



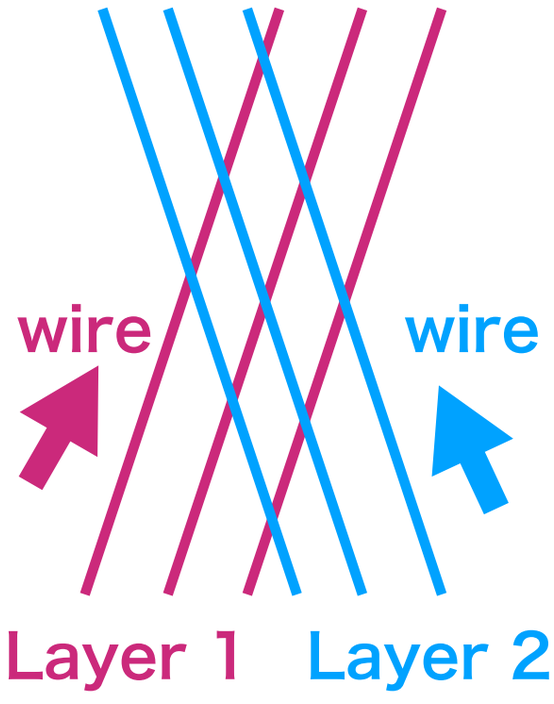
Layer Structure



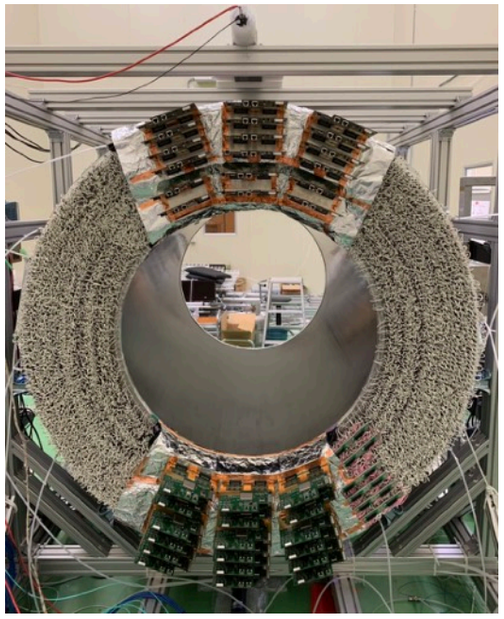
All wire has stereo angle

⇩

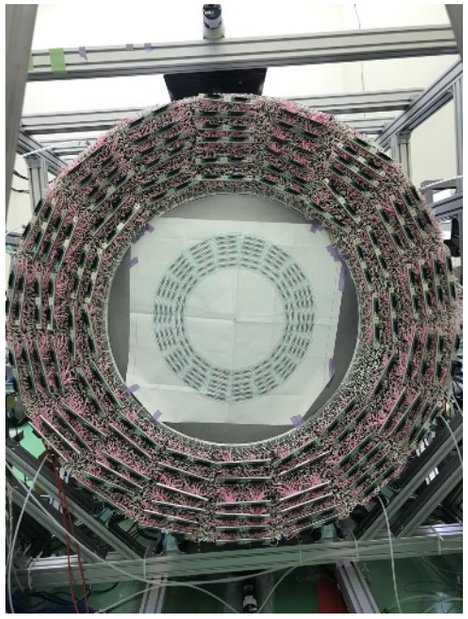
get Z information



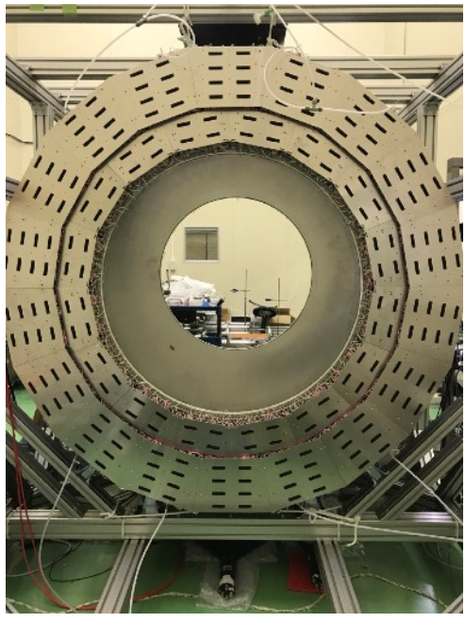
Update Cosmic Ray Test



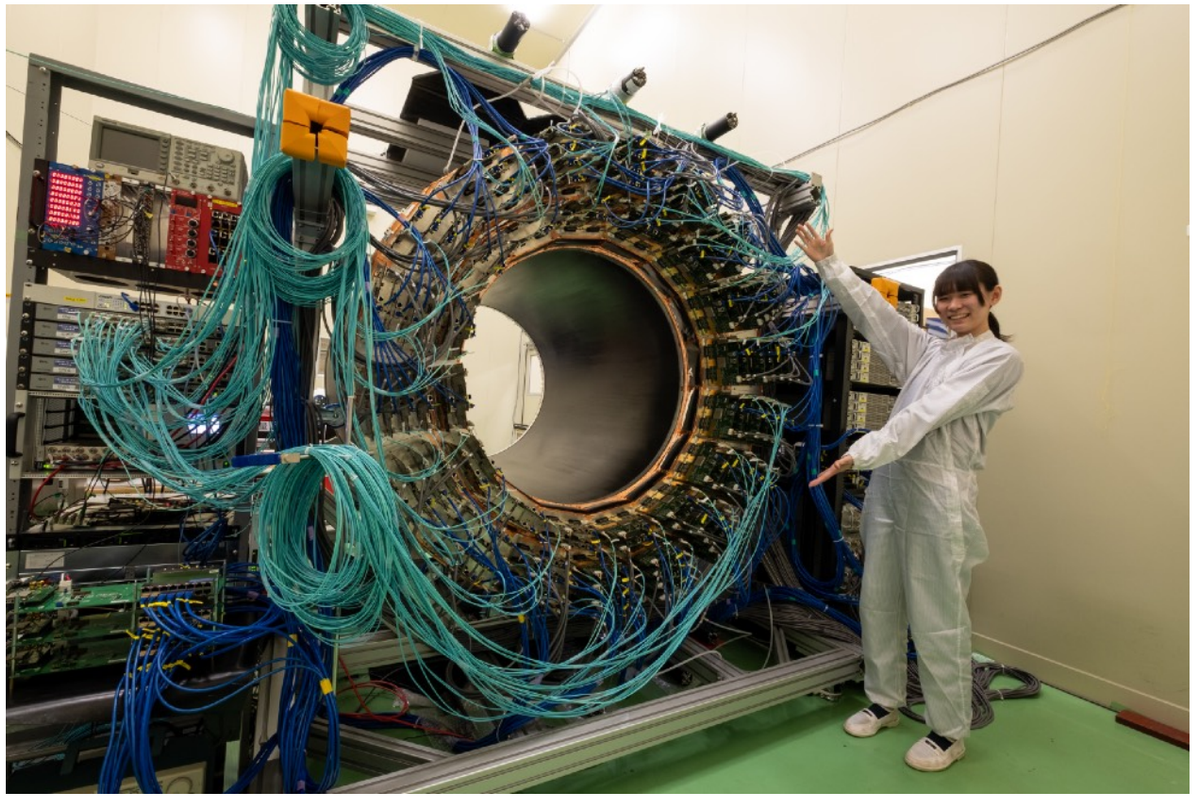
previous setup



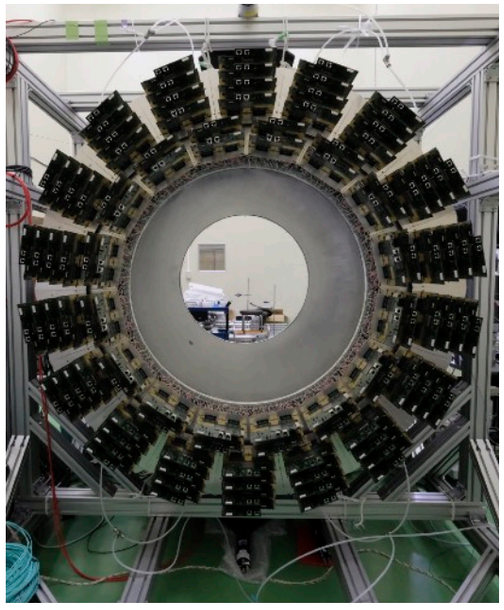
wiring all read out cable



attached RECBE fixed plate

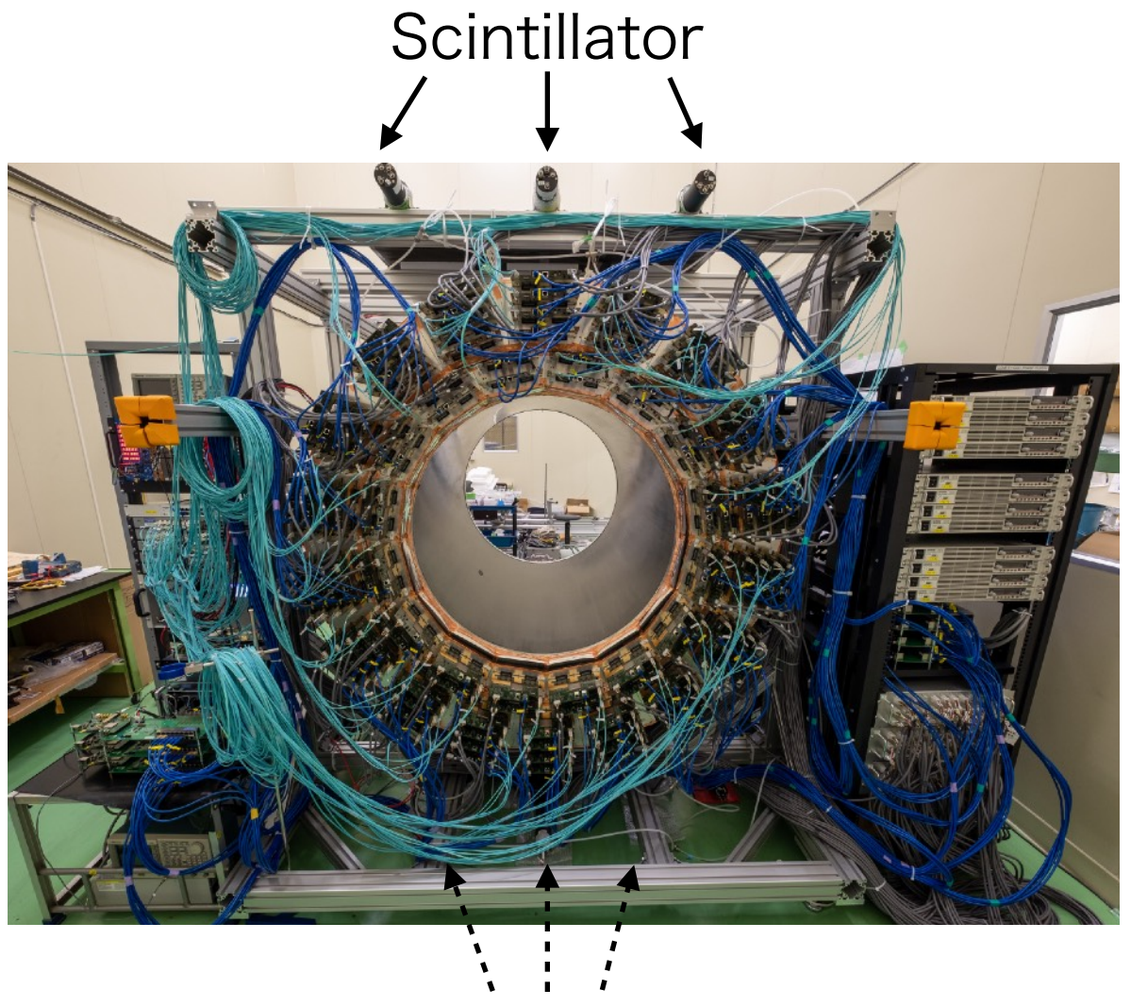


cabling all cables **Finished!!!**



attached all RECBE

Cosmic Ray Test



Trigger Scintillator



×6

1130 mm x 440 mm x 6.5 mm

Motivation

Previously, only about 30% of CDC was used. We can use all areas now, so I want to evaluate the performance of CDC using cosmic ray.
In particular, I want to evaluate the events with a large incidence angle on the cell or events along the layer.

Setup

HV	: 1800V
Gas Mix	: He:i-C_4H_{10} = 90:10
Trigger	: scintillator
Trigger Rate	: ~30Hz

run information

run239 ~237000 events

Tracking ：T0 Determination

How to get drift time

$$\text{drift time} = (\underbrace{\text{TDC(Hit wire)}}_{\text{we know}} - \underbrace{\text{Trigger timing}}_{\text{we know}} - \underbrace{\text{T0}}_{??}) \times \frac{1000}{960}\ \text{ns}$$

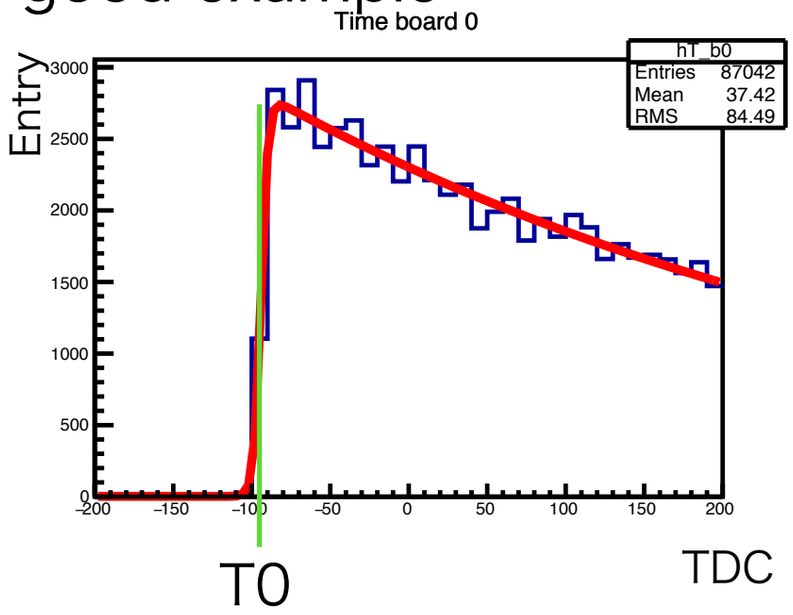
Get T0 value by fitting the TDC histogram

Fit Function

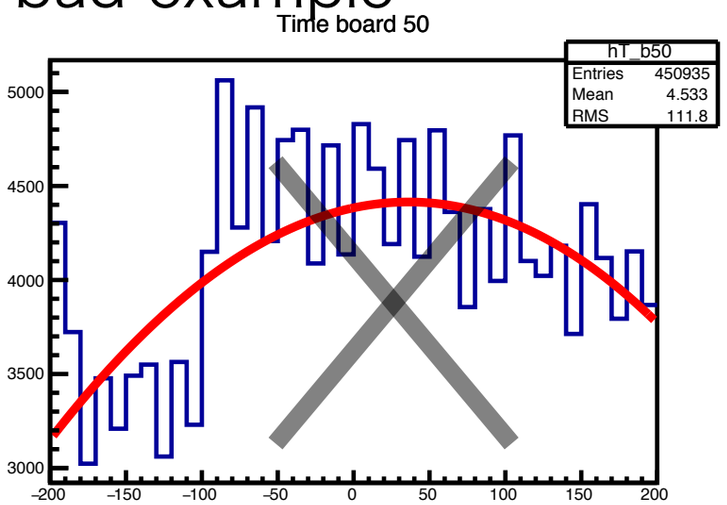
$$p_0 + p_1 \frac{e^{p_2(t-p_3)}}{1+e^{-\frac{t-p_4}{p_5}}} \leftarrow \text{T0} \qquad \text{(by Belle II)}$$

T0 was not calculated correctly in some RECBE.
It is because they have noisy data.
This time I use the average value of T0 that I could calculate.
→I will apply some noise cuts.

good example



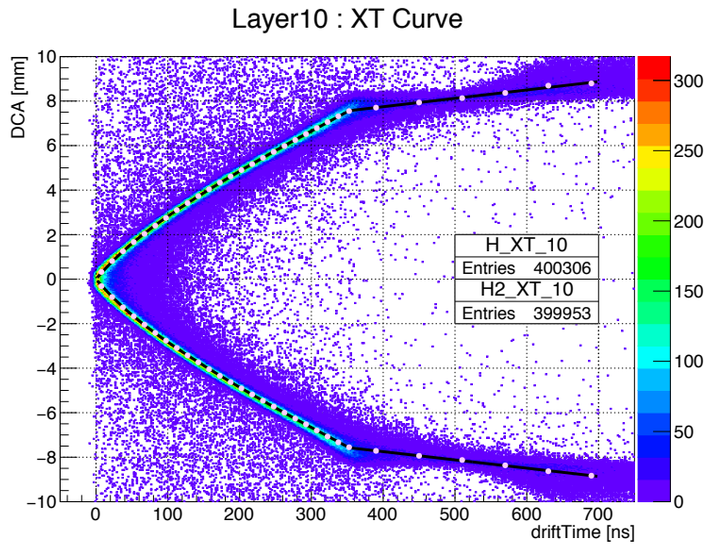
bad example



Tracking : Reconstruction

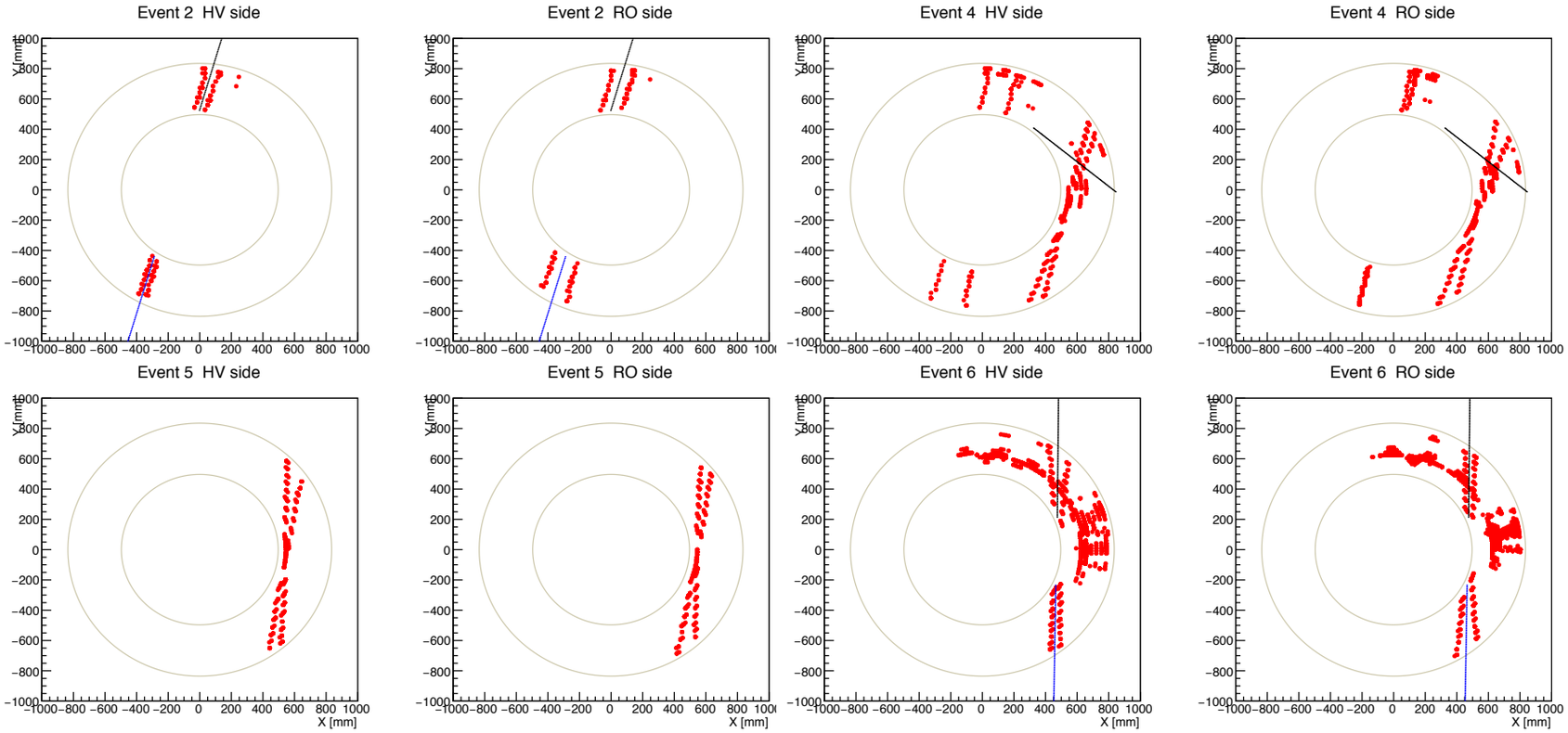
How to get drift distance

Use the XT curve to convert drift time to drift distance.
This time I use the XT curve which Matsuda-san made.
→I will make new one.



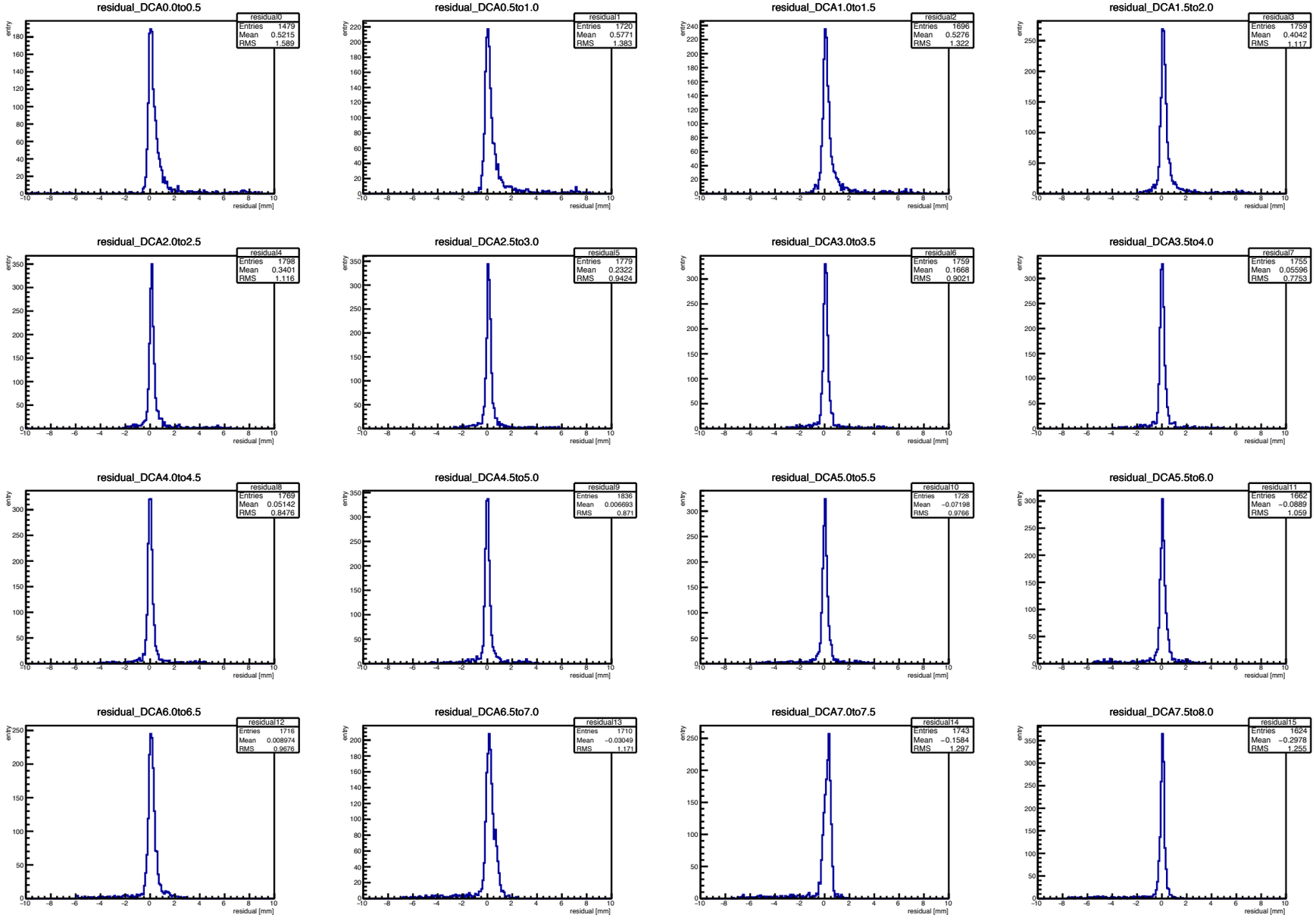
from Matsuda-san's master thesis

Event Display



If a layer has multi hits, or one event has more than two cosmic rays, sometimes I can't find the true track.

Residual Distribution



I made residual distributions separated by Distance of Closest Approach (DCA)

Fit them with gaussian → get spatial resolution

I will create residual distributions for each incident angle with respect to the cell and check the dependence of the spatial resolution on the incident angle

summary

Updated Cosmic Ray Test(CRT) using full readout area of CDC.
There was a problem with the DAQ system, now I had only one run data which include a lot of noise event and analyzed it.

We could start data taking from last Friday.
I will start to analyze full setup CRT data.

TODO

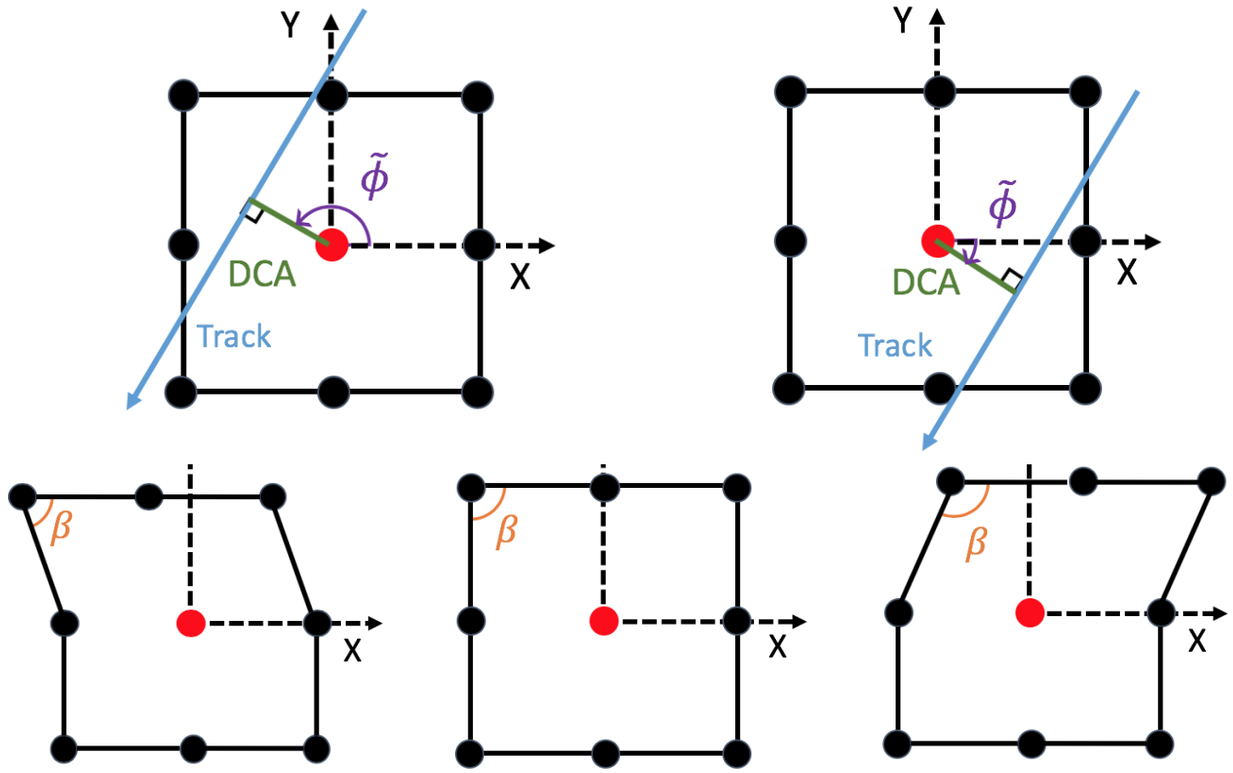
- apply noise cut conditions
- determine T0 value for all RECBEs
- make new XT curve
- make new spatial resolution graph
- evaluate incident angle dependence
- etc.

back up

見積もり

どのくらいの統計があれば良いか？

データ自体は30Hz程度で取れている



一番統計が貯まりにくいのはセルに対する入射角が90度付近のイベント

これはCDCのY=0付近で真上から宇宙線が入射するイベント

去年のデータでセルに対する入射角が0度or180度のものと同程度のイベントレートだと考えられる

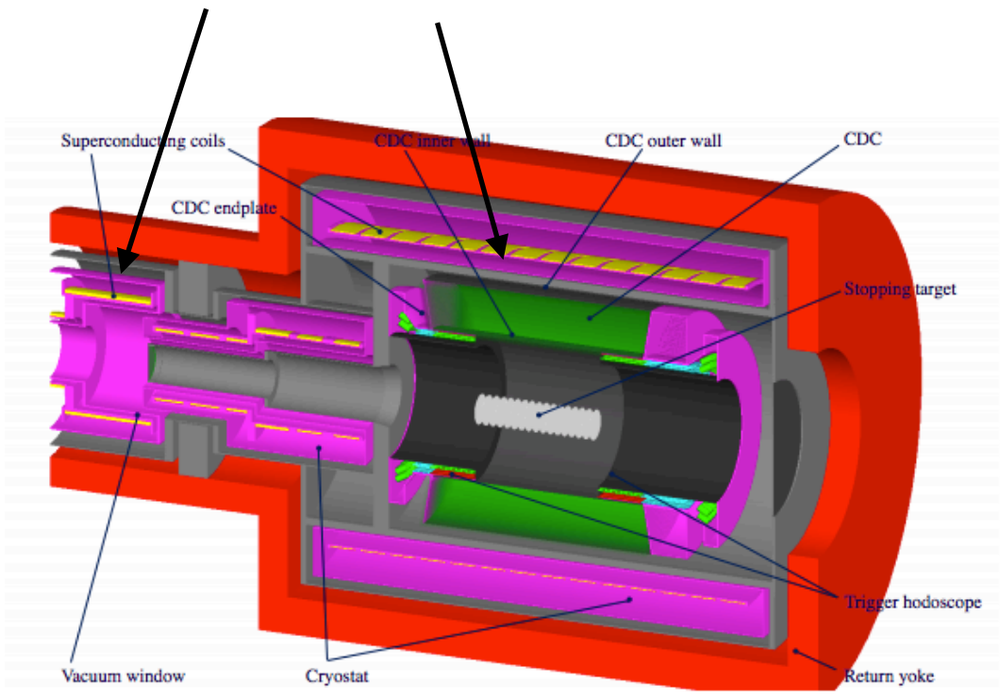
去年の解析と同じイベント数になるには8日間

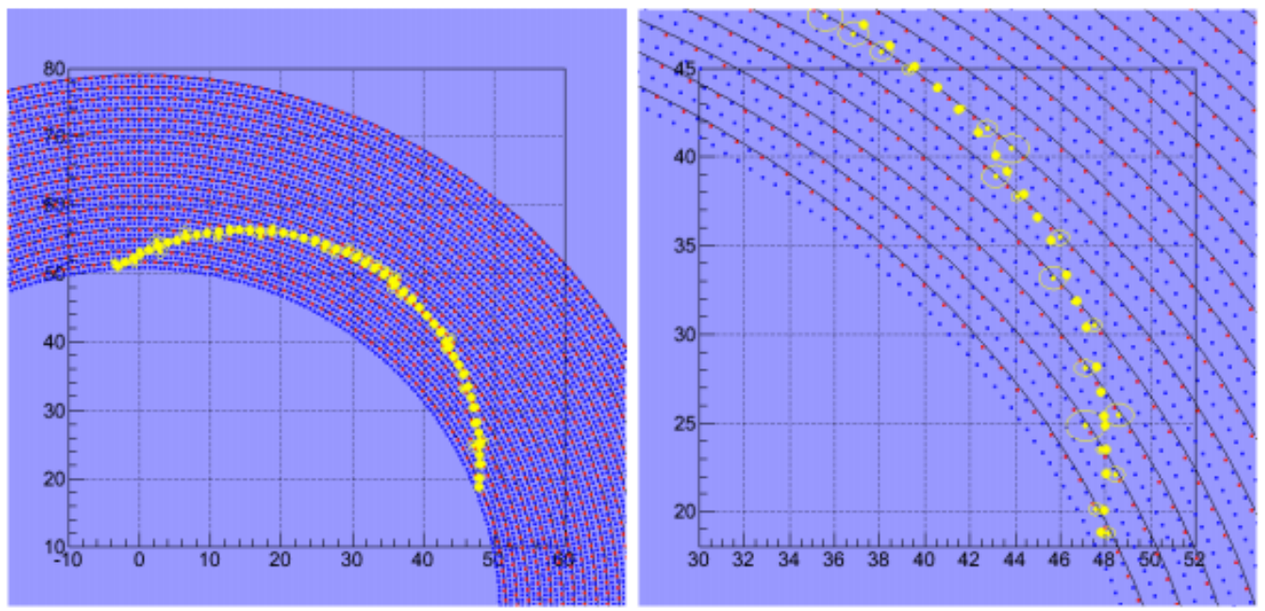
COMET-CDC

main parameters of the CDC

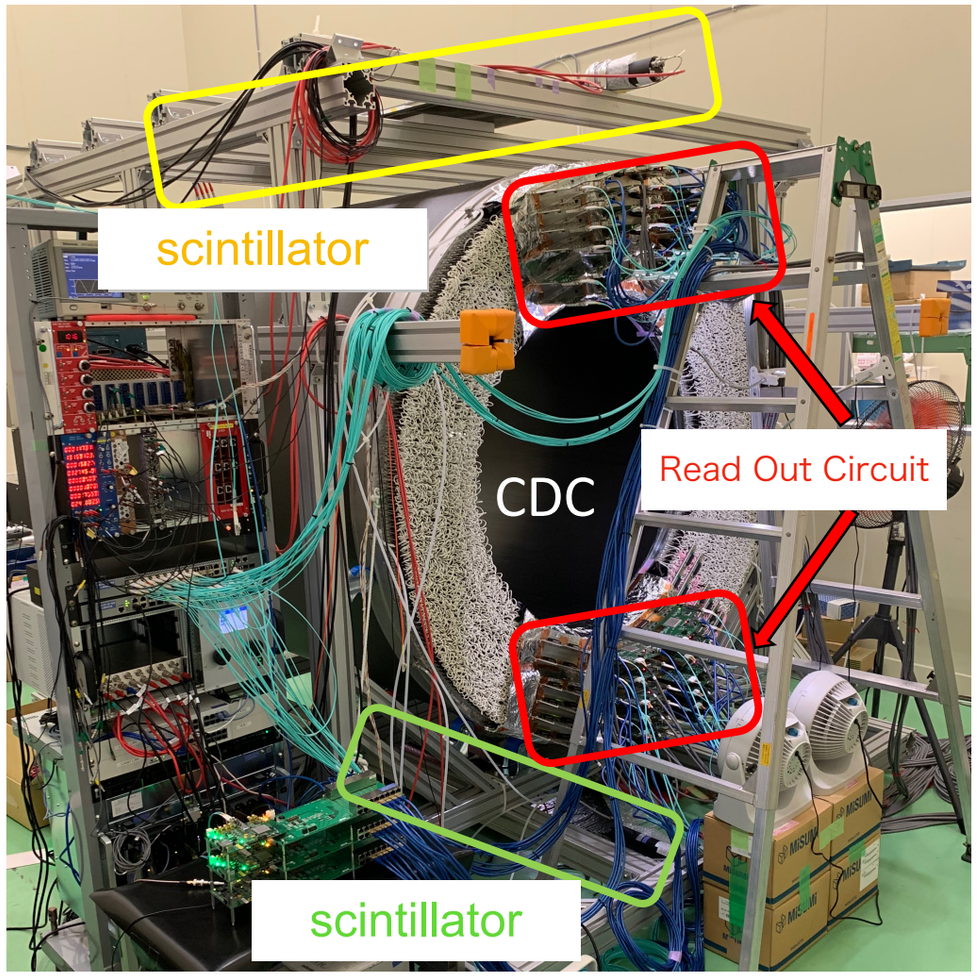
Number of sense layers	20	
Sense wire	Material	Au plated W
	Diameter	25μm
	Number of wires	4986
Field wire	Material	Al
	Diameter	126μm
	Number of wires	14562
Gas	Mixture	He:i-C4H10 (90:10)

Apply a magnetic field (1T)





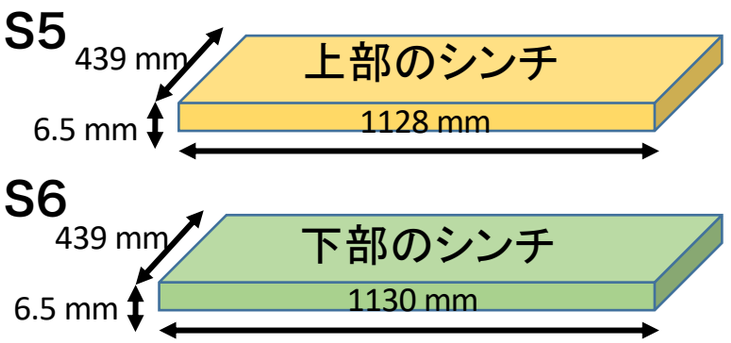
Cosmic Ray Test



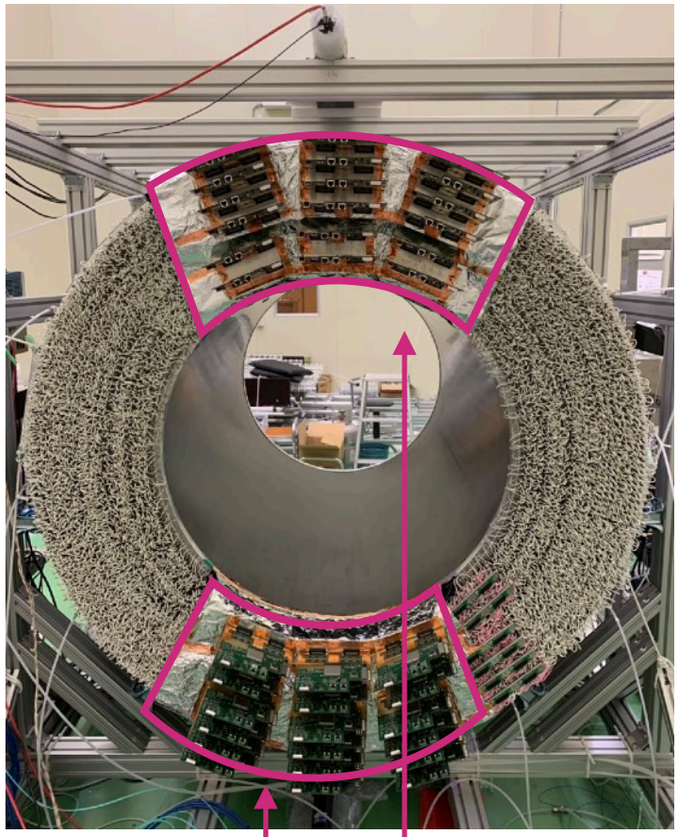
条件

- **印加電圧** : 1825 V
- **ガス比率** : $He:i-C_4H_{10} = 90:10$
- **読み出し領域** : 全体の約 35 %
- **トリガー** : シンチのコインシデンス
- **トリガーレート** : 約 4.5 Hz

シンチレーター



ビーム軸方向を約70%カバー



Read out area

Trigger Scintillator

S5

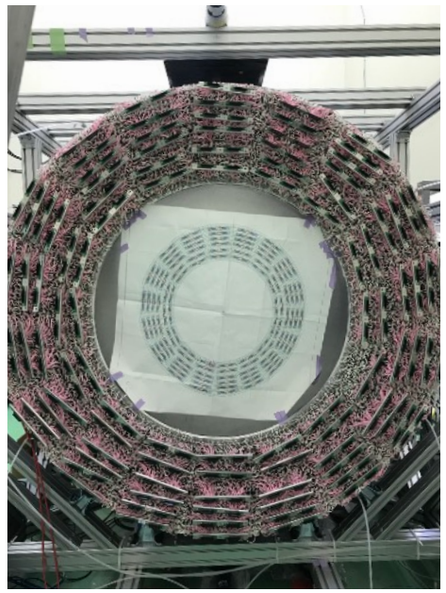


1128mm x 439mm x 6.5mm

S6

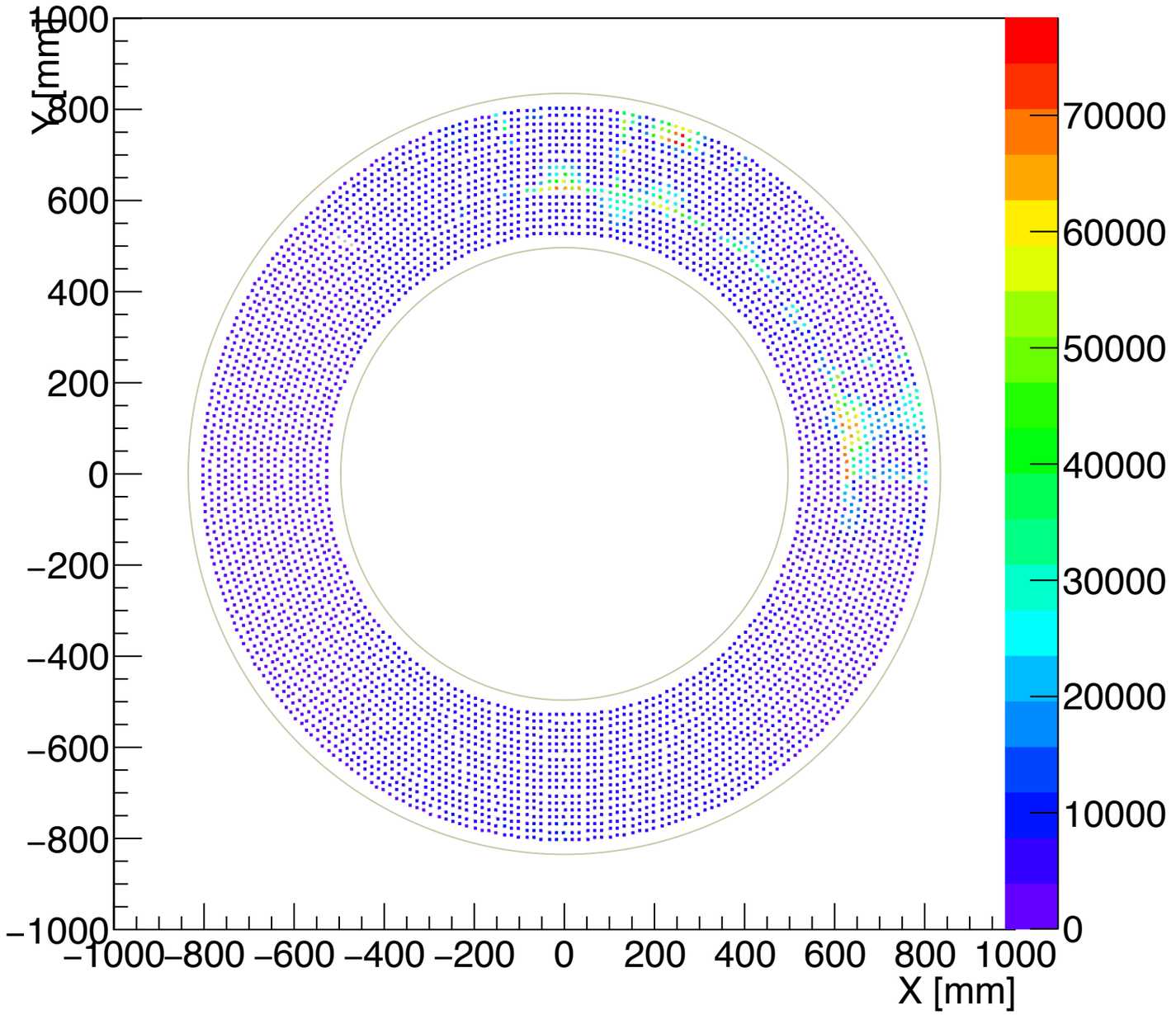


1130mm x 439mm x 6.5mm



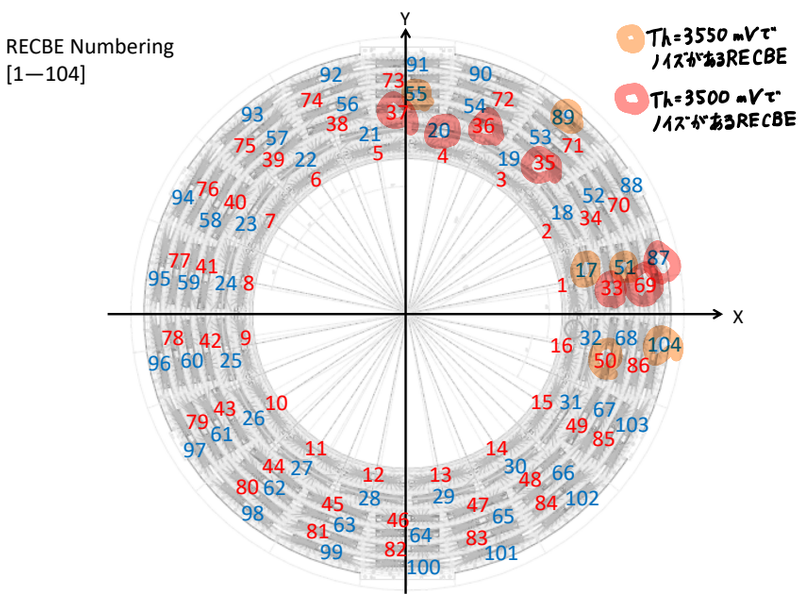
HitMap

中津川さんが新しい形式のroot fileを読んでトラッキングするコードを開発
gitからとってきて自分のbranchで解析
HitMapのコードを走らせてみた



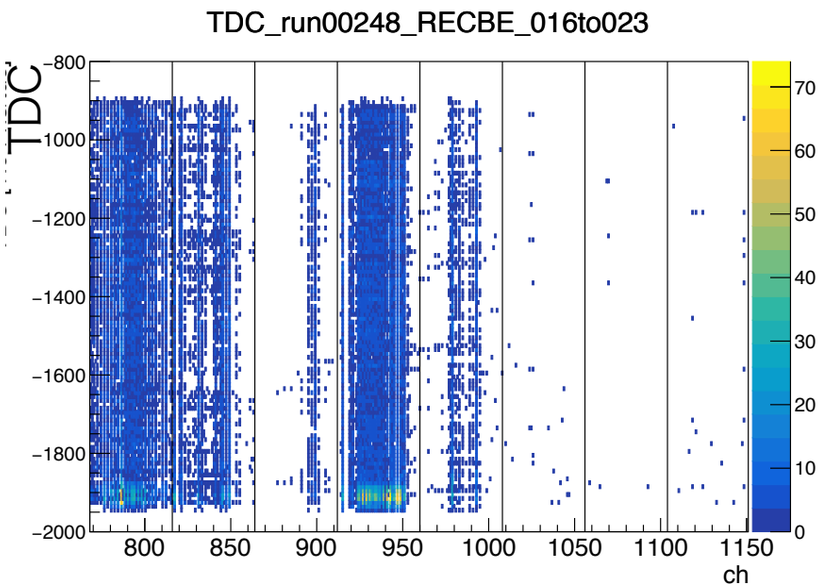
run00239
Th=3600 mV
237364 イベント

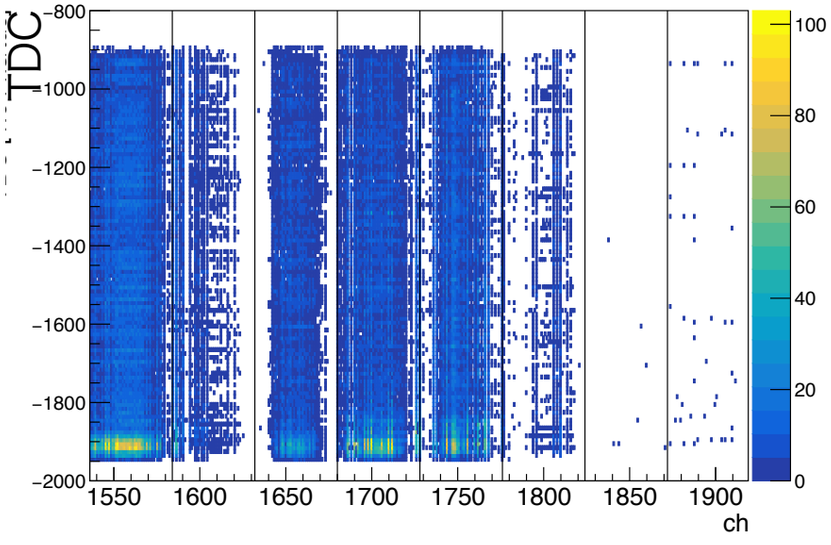
ヒットが多い場所は
前回と一致



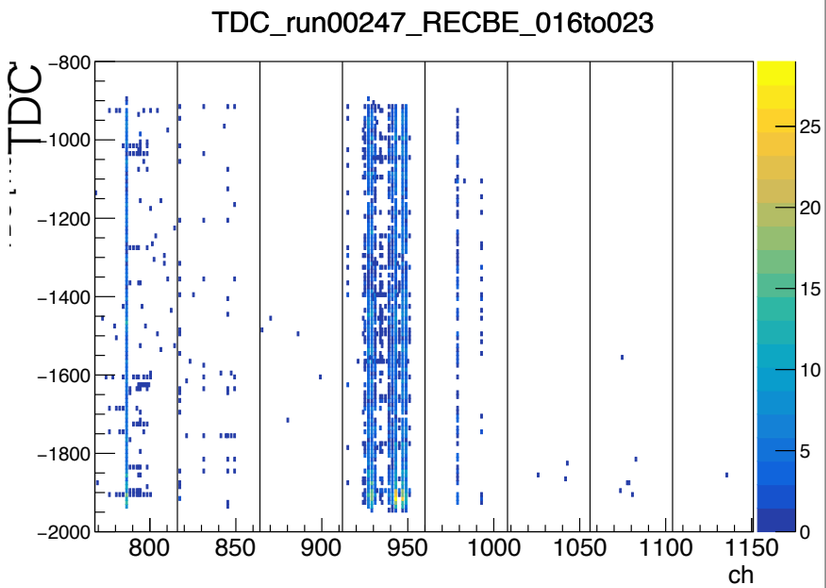
Threshold

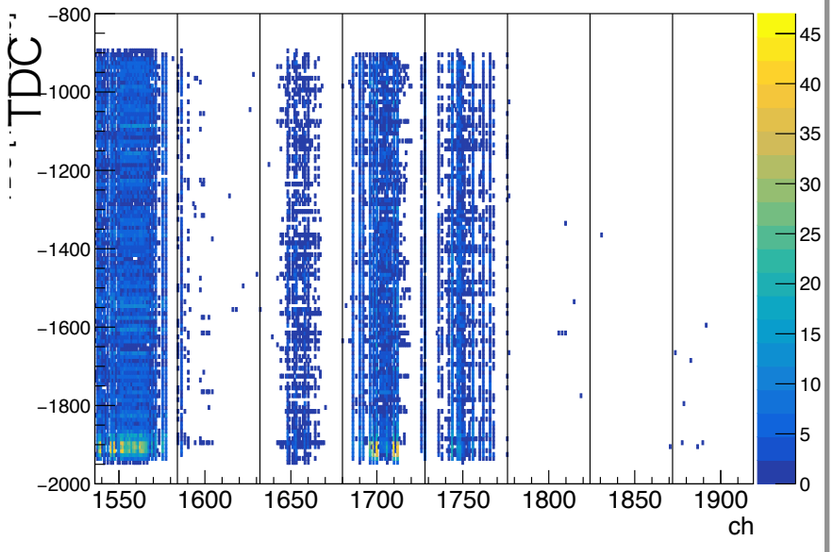
Th=3650 mV



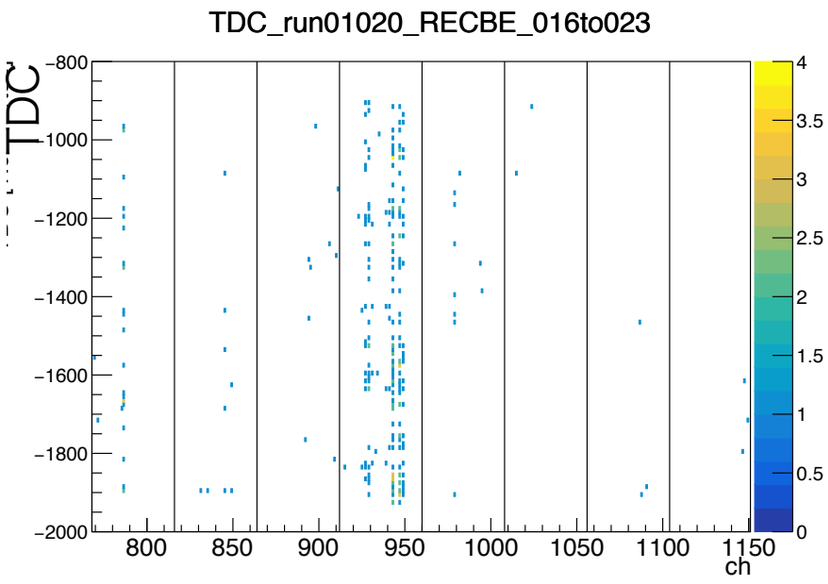


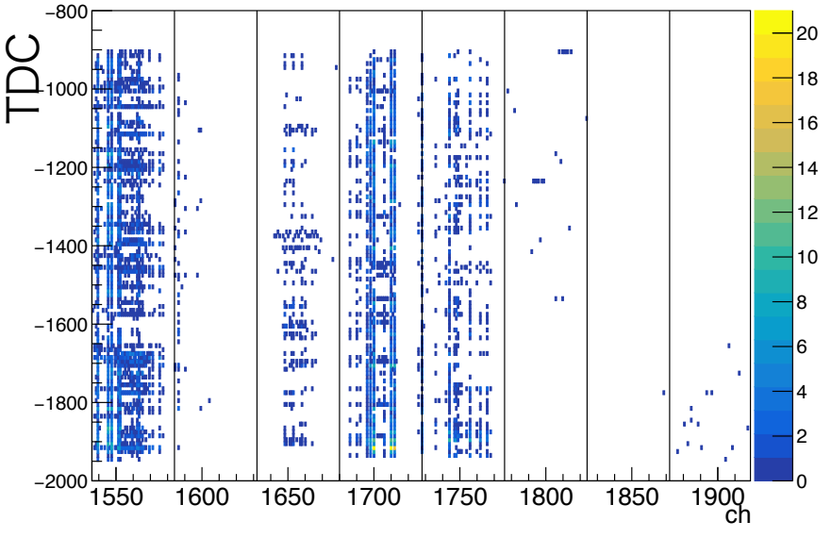
Th=3550 mV





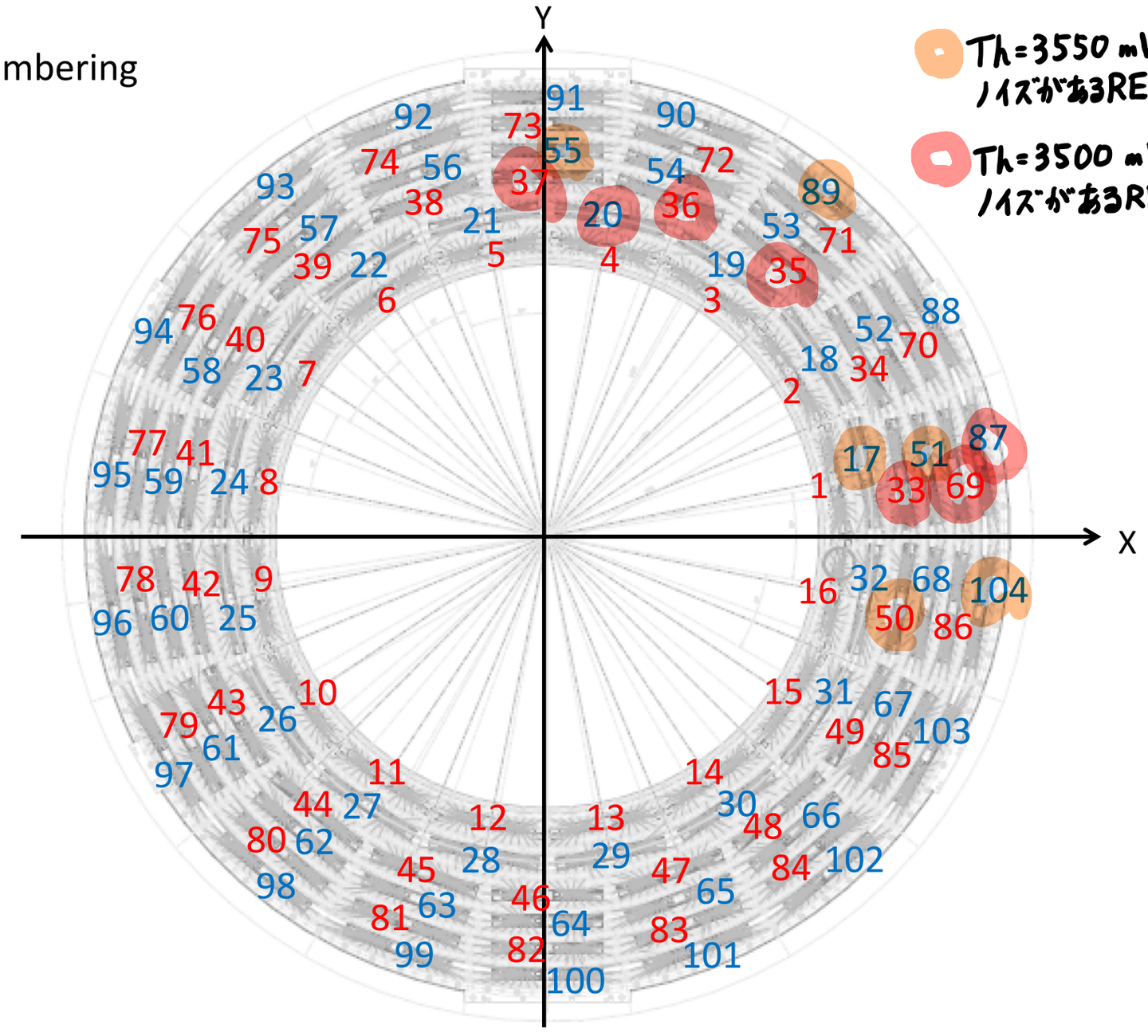
Th=3500 mV





RECBEの位置

RECBE Numbering
[1—104]



Th=3550 mVで
ノイズがあるRECBE

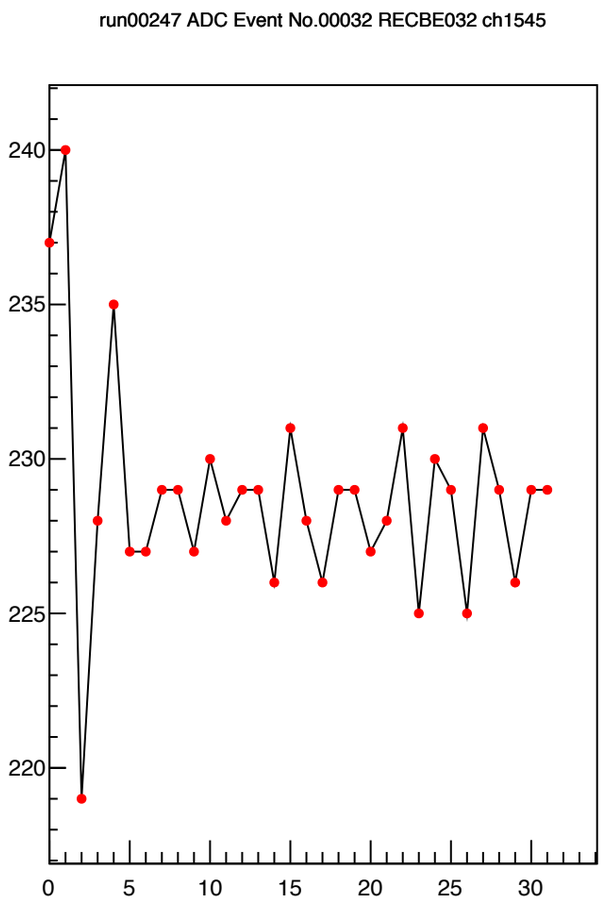
Th=3500 mVで
ノイズがあるRECBE

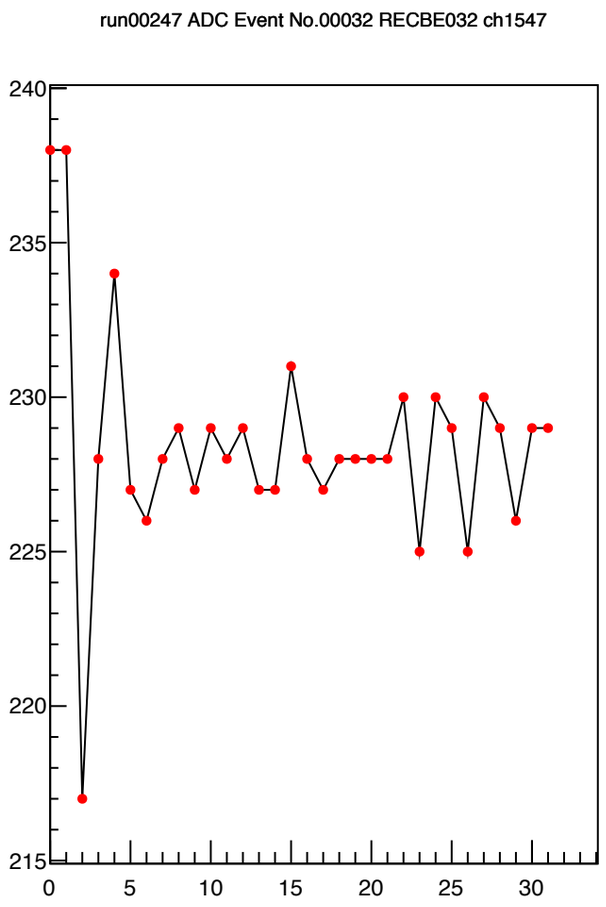
波形確認

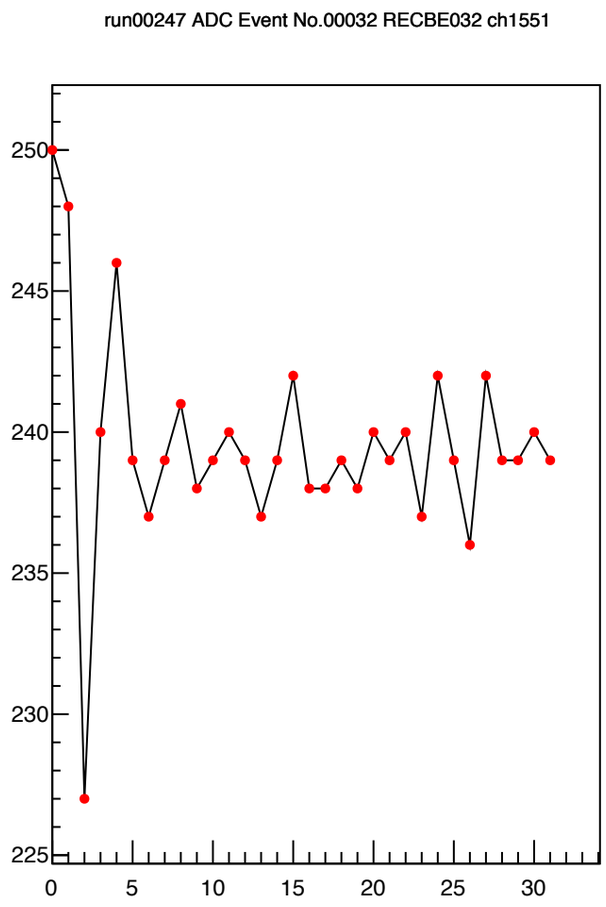
TDCNhitが1以上のイベントの波形を確認

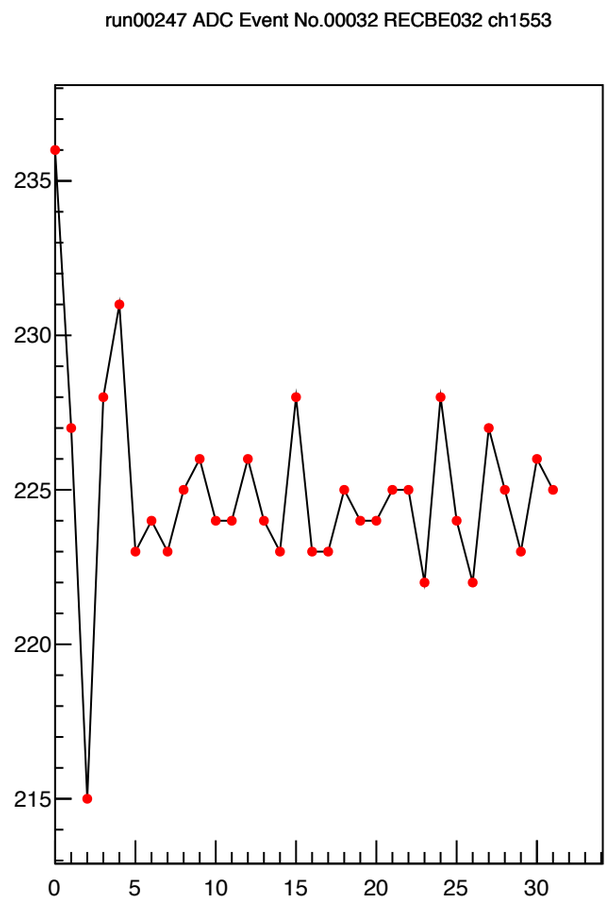
解析したrunは外部トリガーなので、ほぼノイズだと思われる

TDCヒットが多いRECBEでは、同じイベントで違うchに同じ波形のノイズが入っている





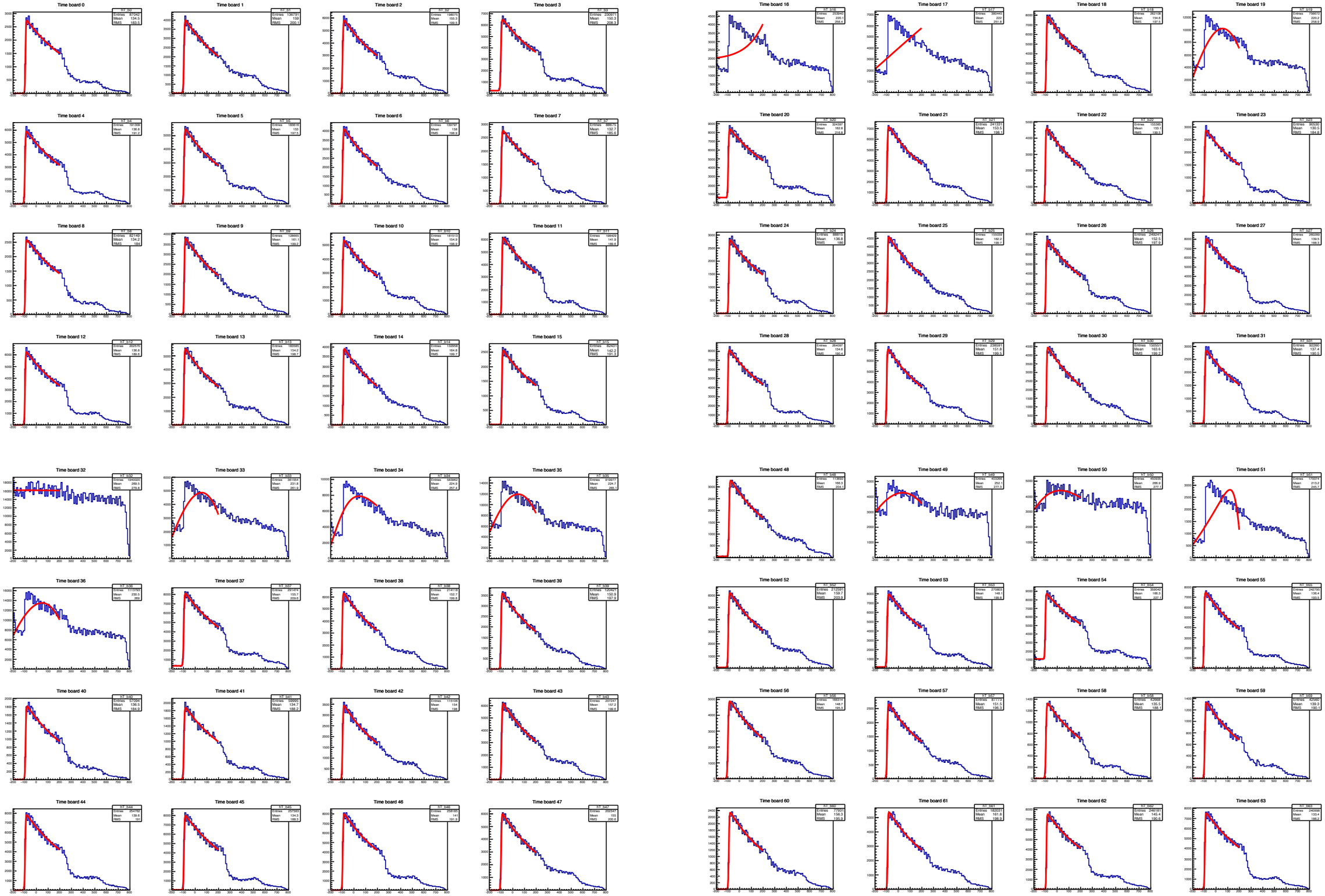




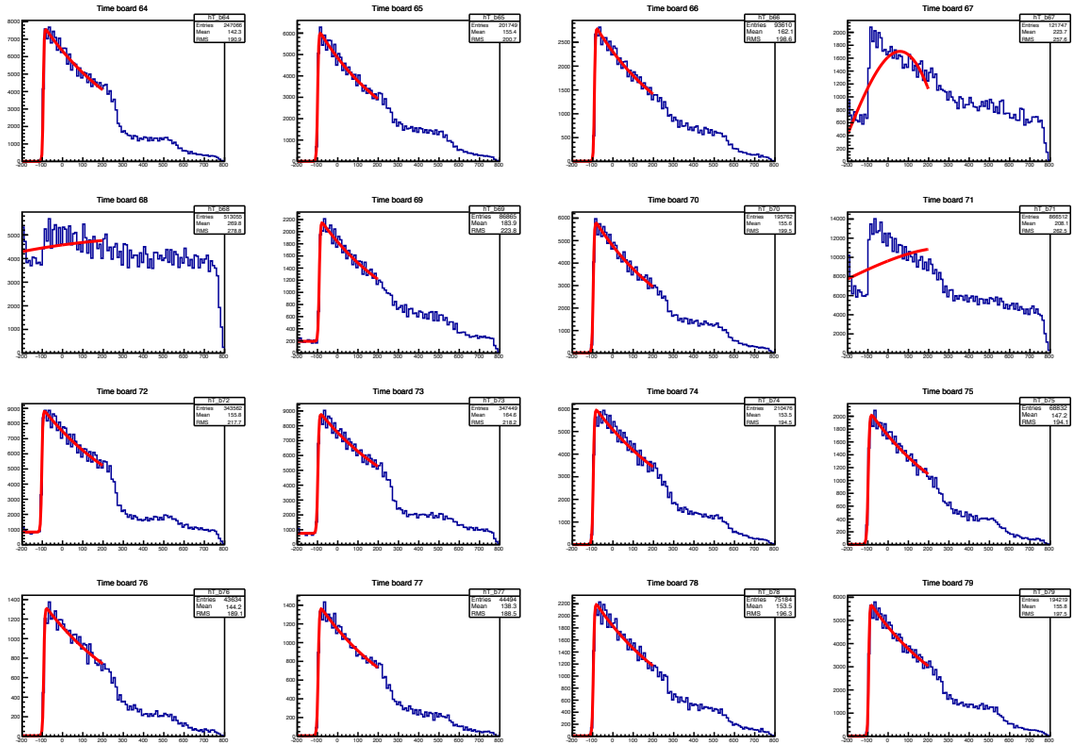
RECBE30.pdfとRECBE32.pdfを参照

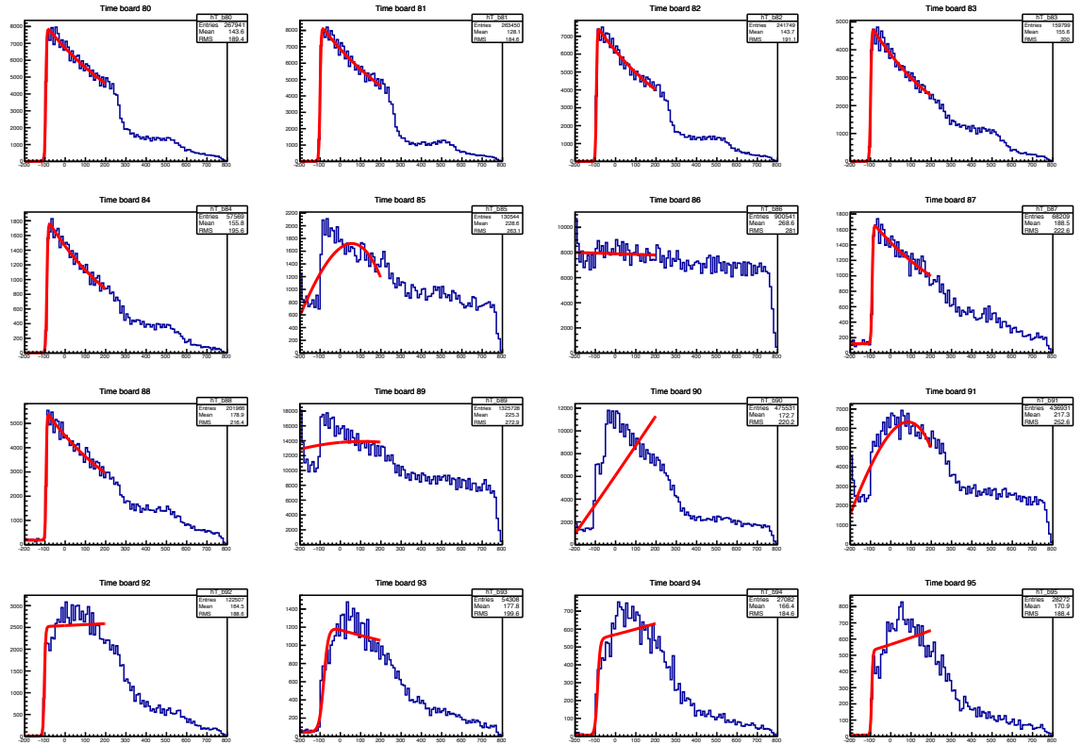
→グラウンドが揺れていている？

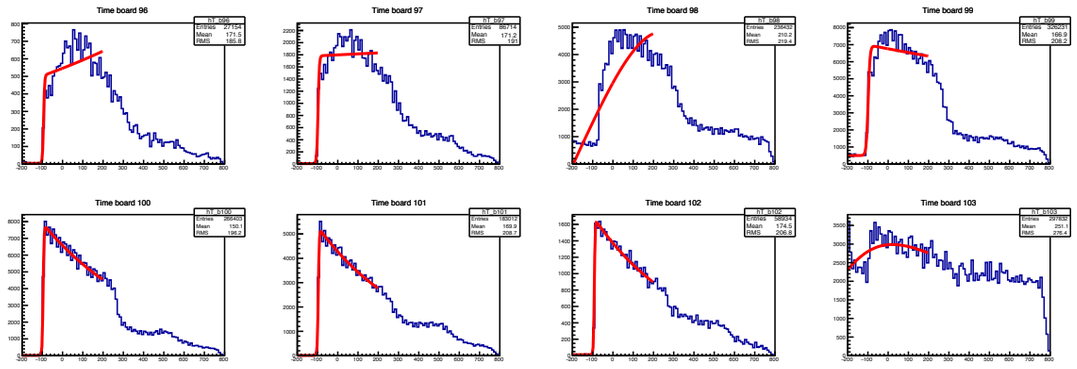
T0


Time board 0
Time board 1
Time board 2
Time board 3
Time board 4
Time board 5
Time board 6
Time board 7
Time board 8
Time board 9
Time board 10
Time board 11
Time board 12
Time board 13
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Time board 61
Time board 62
Time board 63

T0





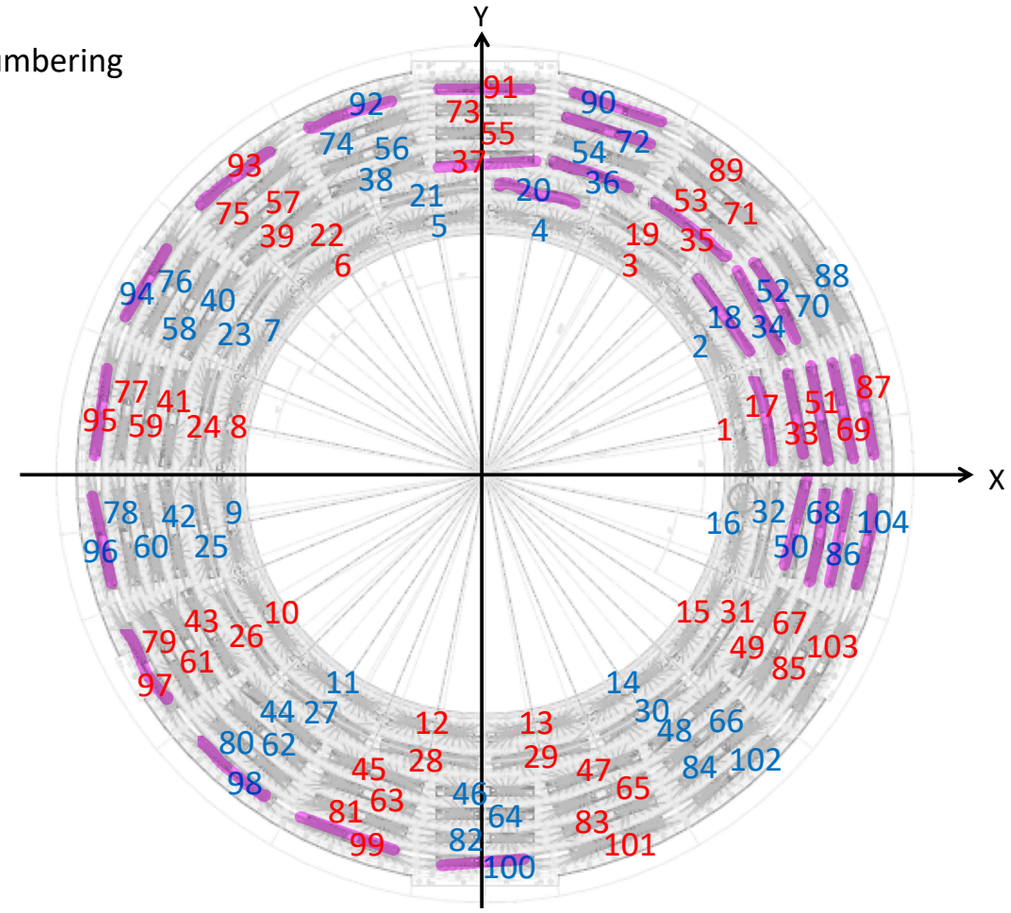


明らかにフィットできていないボードがたくさんある

フィットがうまくいかないボード

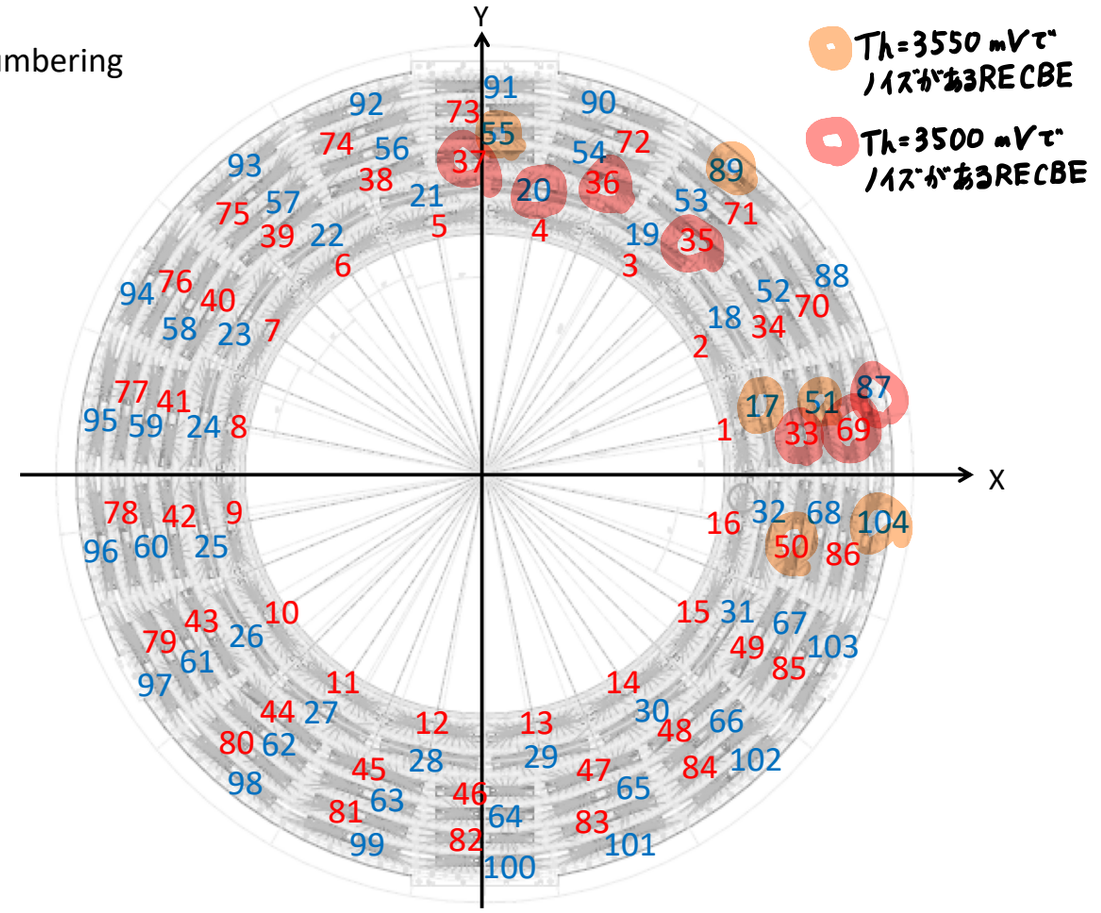
フィットがうまくいかないRECBE

RECBE Numbering
[1—104]



前回見せていたノイズが多いRECBE

RECBE Numbering
[1—104]



ノイズが多いRECBEとほぼ一致する
フィットがうまくいかない左側のボードはHVが印加できないu7の領域を含むため
イベント数が足りないことが原因だと考えられる
フィットできていないRECBEは一律でT0=-96とした
これはうまくフィットができていると思われるRECBEのT0の平均値

Tracking

トラッキングの方針
各レイヤーから1ヒット取ってくる
隣接するレイヤーそれぞれで最近接位置を求める
最近接位置を結んで線を引く
chi^2が一番よくなるようにフィットパラメータを決める

run info

run No.	mode	Threshold (mV)	Trigger	Event
236	raw	3600	scintillation counter	
238	suppress	3600	scintillation counter	
239	raw	3600	scintillation counter	
247	raw	3550	clock generator	5948
248	raw	3650	clock generator	5468
1020	raw	3500	clock generator	4467