INTT tracklet study

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INTT tracklet is useful for detector performance study

We have to make sure that INTT works properly.

- Looking at distributions by eye is the easiest way. It's fine to see the detector phenomenologically but not so scientific.
- Parameter correlations are easy way to see, but it doesn't guarantee the normality hit by hit.
- Checking dedicated parameters (detection efficiency, MIP, etc.) is a very reliable way to see healthiness of the detector.
- Tarcklet finding is the ultimate tool for tracking detectors to confirm whether the detector takes real hits.

The great demonstration has already been performed by Hinako, and the study got some preliminary plots.

We have to maintain/update this activity to check the detector performance. I inherited Hinako's codes to make tracklets using the streaming data.

Note: We have to rely on it at least for local runs as other detectors were not run. Local runs are the ones we are interested in.

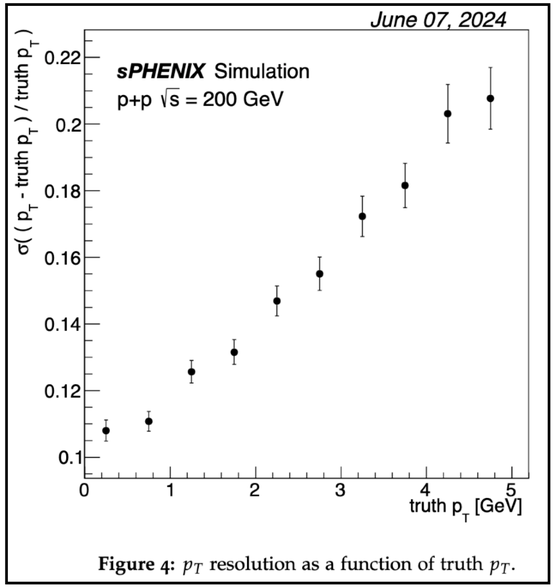
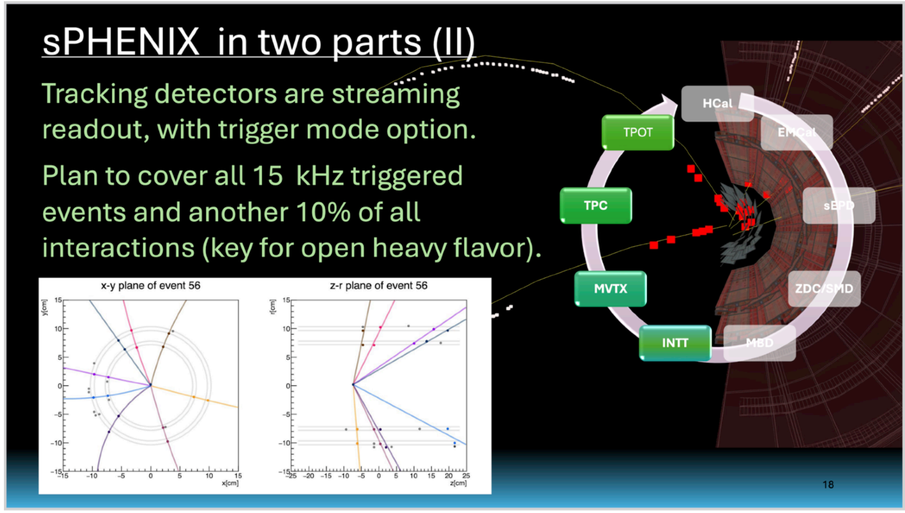


Figure 4: p_T resolution as a function of truth p_T.

Jamie's slide shown at the RHIC/AGS meeting →



Analysis: Starting point

See the analysis note for the details.

Remarkable points:

- Only INTT data was used. No GL1 match required.
- Hot channel rejection is done by Jaein's module + some modification. I'll use the latest version.
- Vertex determination is done by Takashi's modules.
- not all

As a demonstration, I reproduced Hinako's event display (Run 41981, event 56). Mine looks consistent with hers.

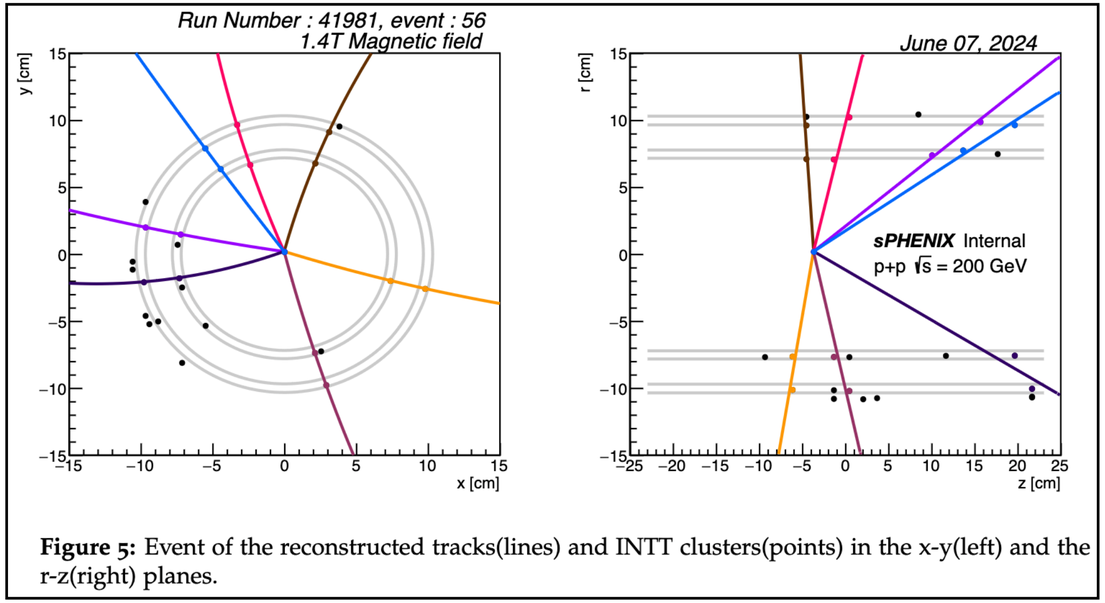
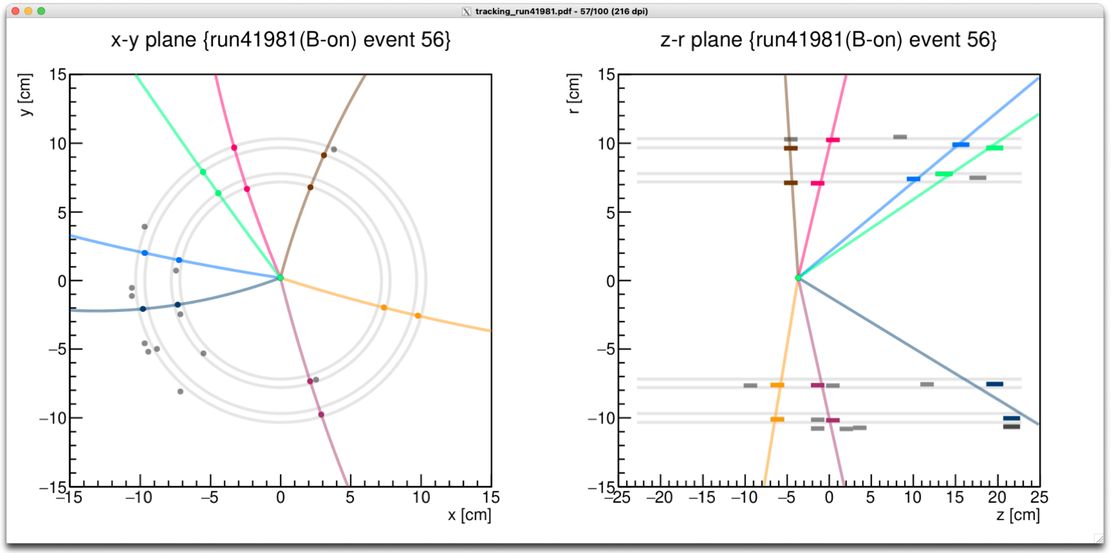


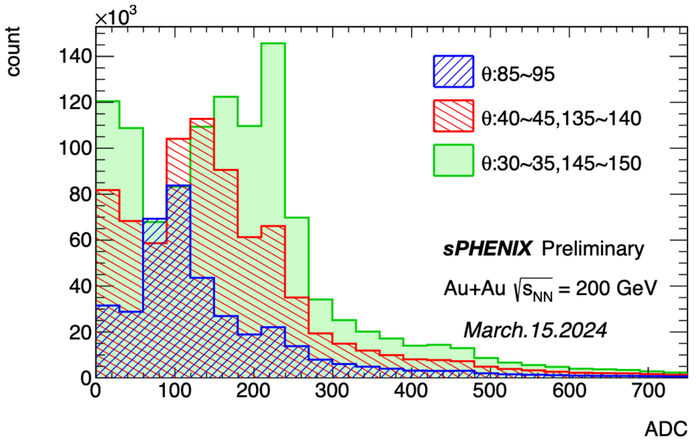
Figure 5: Event of the reconstructed tracks(lines) and INTT clusters(points) in the x-y(left) and the r-z(right) planes.

Hinako's



Genki's

Analysis: What to (can) be done

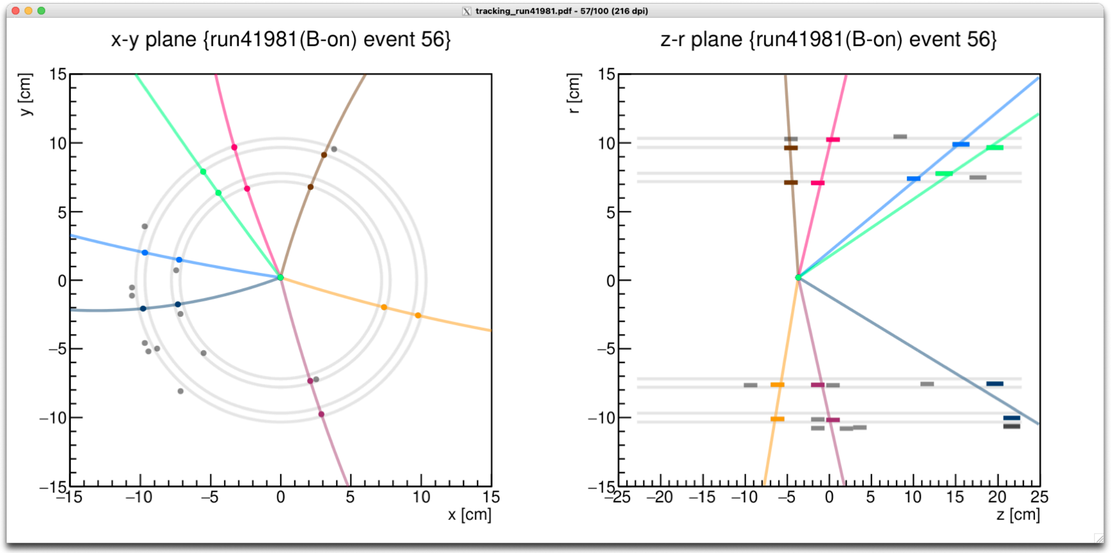


MIP with AuAu by Misaki

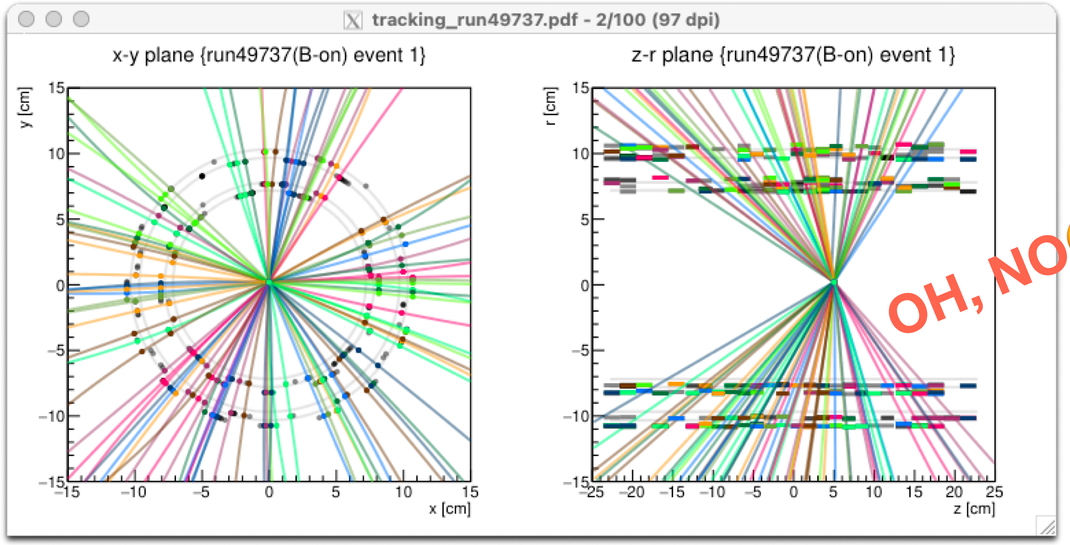
- Event display:
  - Confirmation whether INTT takes real hits properly
  - Recent triggered runs and streaming runs.
  - Very urgent
- MIP:
  - DAC distribution of INTT clusters that associated to INTT tracklets as a function of tracklet angles
  - MIP position might be changed by radiation damage. We have to monitor it if the results are precise enough.
  - It can be shown in HardProbe 2024 (late Sep.) and the JPS meeting.
- Detection efficiency:
  - Enabled if an additional point is given from other detector.
  - Ryota may work on it?
- Timing scan analysis
  - Timing performance analysis eventually uses hits associated to INTT tracklets to reject noise for the best estimation of the performance.
- etc.

Analysis: Extended readout data & streaming data

- With the current definition of an event,
  - triggered data: no problem
  - extended readout data: triggered collision and collisions happen in the extended readout time are included
  - streaming data: collisions happen in a single RHIC turn (120 BCO, 111 bunch crossing) are included
- Collisions need to be separated. It's necessary to confirm validity of our streaming data, so I'm working on it though it's not easy…



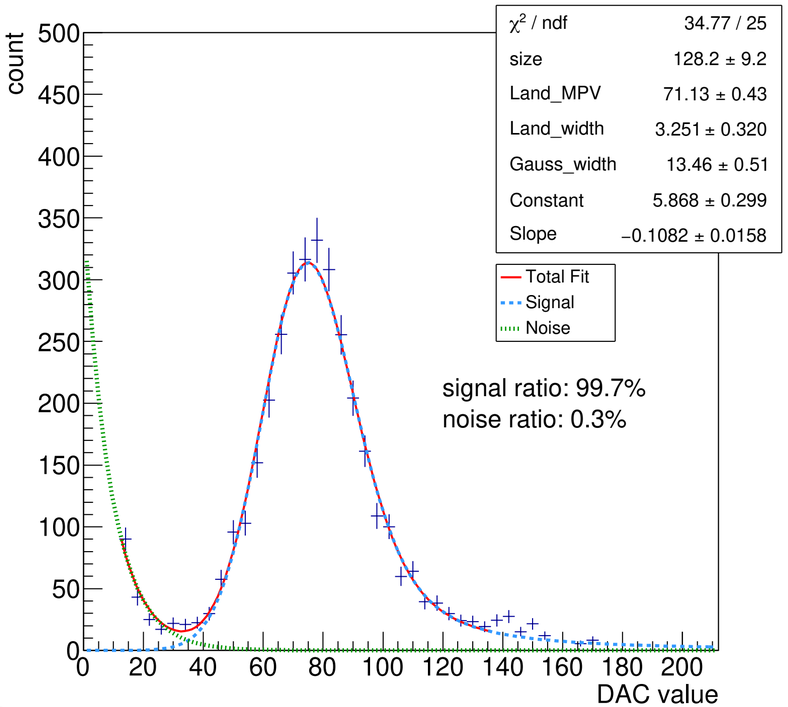
Single collision



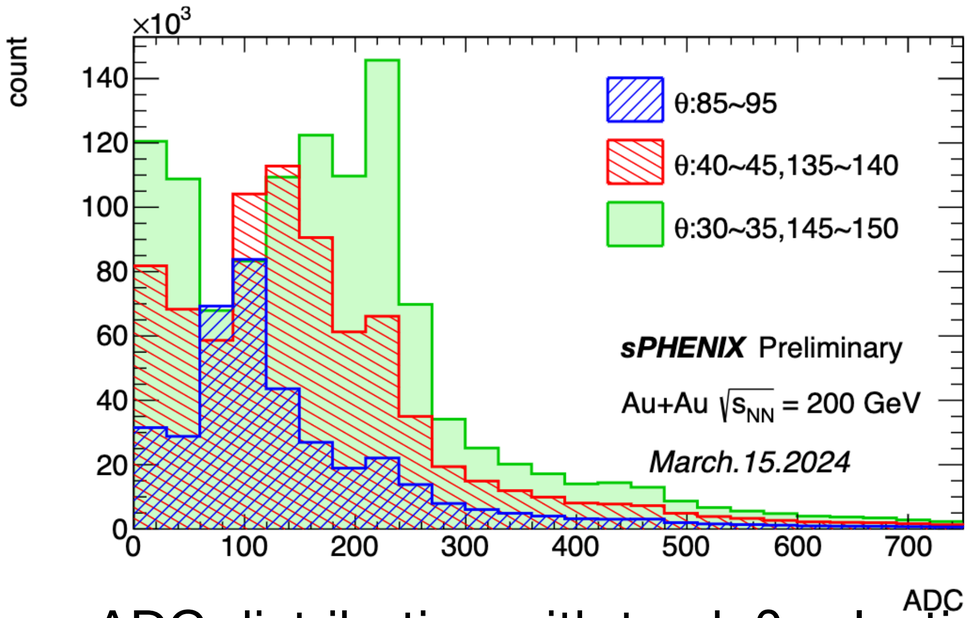
Multiple collisions

Analysis: MIP analysis

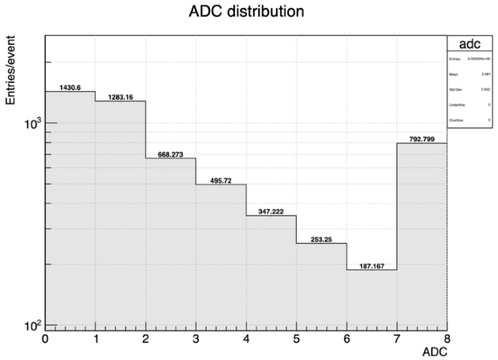
- We are also interested in MIP peak. We confirmed it with test beam data and Au+Au data last year very nicely, but no dedicated study has been made with data this year.
- There are 2 ways to see a MIP peak
  - use DAC scan data: The best way but a decent effort is needed
  - check adc of TrkrCluster: Noise rejection and track angle selection are mandator



DAC scan with 3rd test beam data by Yuka



ADC distribution with track θ selection with 2023 AuAu data by Misaki



Raw hit's ADC of 2023 AuAu (run 20869)

Analysis: MIP: DAC configuration

- Originally, the DAC configuration is well planned, and the one was used in 2023.
- Due to higher noise condition, which should come from out of INTT, we changed the DAC configuration. We modified it again for streaming readout mode.
- Currently, the INTT decoder (InttCombinedRawDataDecoder) uses the original DAC configuration.
- We should be able to modify the DAC configuration by giving CDB file.

DAC config 2023

DAC	Value
0	15
1	30
2	60
3	90
4	120
5	150
6	180
7	210

DAC config 2024

DAC	Value
0	30
1	45
2	60
3	90
4	120
5	150
6	180
7	210

DAC config 2024

DAC	Value
0	35
1	45
2	60
3	90
4	120
5	150
6	180
7	210

for streaming mode

Analysis: MIP: DAC configuration

- We can generate a CDB file for DAC calibration using InttDacMap in coresoftware/offline/packages/intt.
- I made 3 CDB files:
  - 2023 default: /sphenix/tg/tg01/commissioning/INTT/data/CDB_files/2023/dac_map/cdb_intt_dac_15_30_60_90_120_150_180_210.root
  - 2024 default: /sphenix/tg/tg01/commissioning/INTT/data/CDB_files/2024/dac_map/cdb_intt_dac_30_45_60_90_120_150_180_210.root
  - 2024 Streaming readout (current): /sphenix/tg/tg01/commissioning/INTT/data/CDB_files/2024/dac_map/cdb_intt_dac_35_45_60_90_120_150_180_210_streaming.root
- The macro to make them:
  - /sphenix/tg/tg01/commissioning/INTT/work/genki/analysis/dac_map/make_dac_map.cc
- I tested a CDB file, but no adc TrkrHit is affected… Why?

```
 96  ////////////////////////////////////
 97  InttCombinedRawDataDecoder* inttdecode = new InttCombinedRawDataDecoder();
 98  //inttdecode->Verbosity(1);
 99  inttdecode->runInttStandalone( true );
100  inttdecode->writeInttEventHeader( true );
101
102  //inttdecode->LoadHotChannelMapRemote("INTT_HotMap");
103  //inttdecode->LoadHotChannelMapLocal("/sphenix/tg/tg01/commissioning/INTT/QA/ho
   020869_30.root");
104  inttdecode->LoadHotChannelMapLocal( cdb_hot_list );
105
106  //inttdecode->SetCalibBCO("cdb_bco_20869.root", InttCombinedRawDataDecoder::FIL
107  inttdecode->SetCalibBCO( cdb_bco, InttCombinedRawDataDecoder::FILE);
108
109  //inttdecode->SetCalibDAC("CDBTTree_INTT_DACMAP.root", InttCombinedRawDataDecod
110  inttdecode->SetCalibDAC( cdbtree_name_dac, InttCombinedRawDataDecoder::FILE );
111
112  se->registerSubsystem(inttdecode);
```

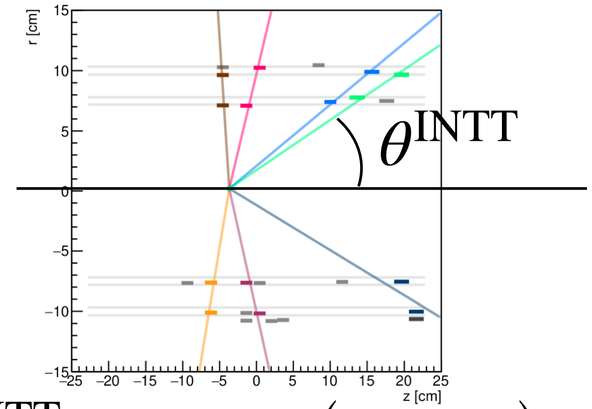
A part of Fun4All macro to generate a DST containing TrkrHit using InttRawHit.

```
120
60
90
90
180
90
210
15
15
210
90
210
15
60
90
120
30
```

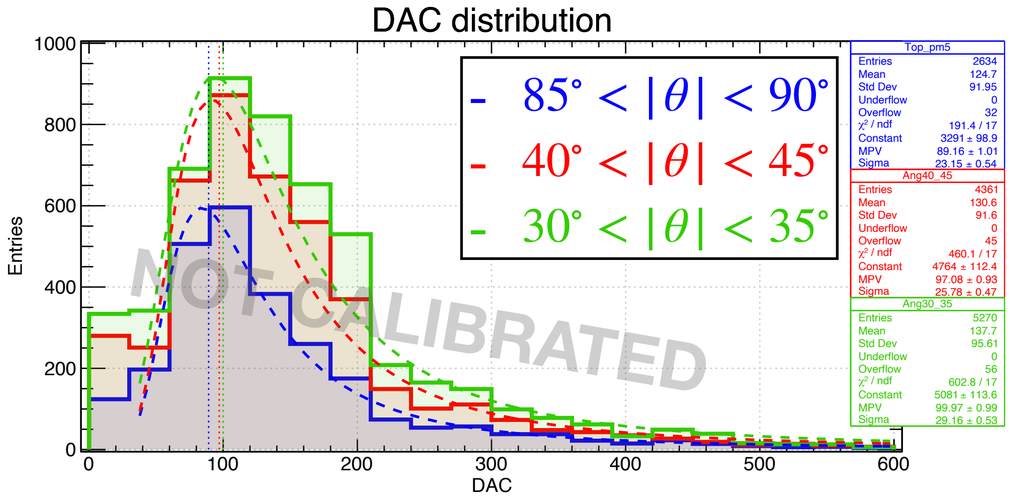
ADC of some TrkrHit. There are some 15.
It means the DAC configuration wasn't changed.

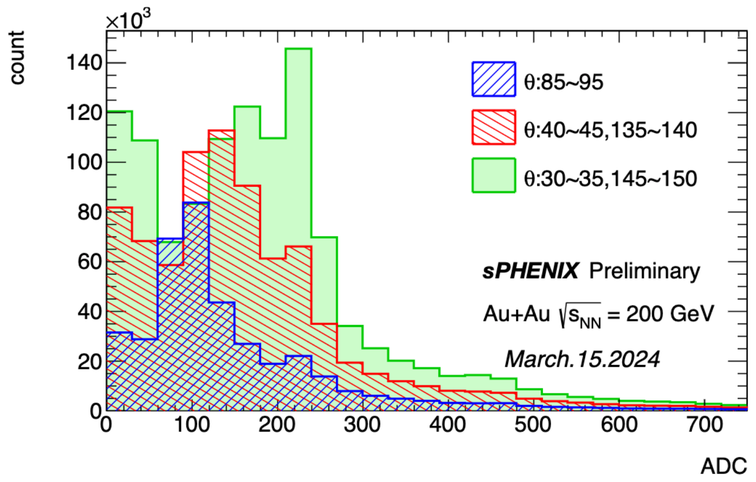
Analysis: MIP: Let's go anyway

- I checked DAC distribution with incorrect DAC configuration. It may be fine to see MIP peaks.
- Run: 41981
- #event: 10k
- Cut
  - Noisy channel rejection
  - BCO difference cut: Only the peak in the BCO diff distribution
  - Clusters only on the inner barrel were used (meaningless but I didn't have time)
  - $|\ z_{vtx}\ | < 23$ cm
  - clusters with (DAC=210 AND cluster size =1) are not used. They are overflow bin entries.
  - Clusters associated with Hinako's tracklets are used

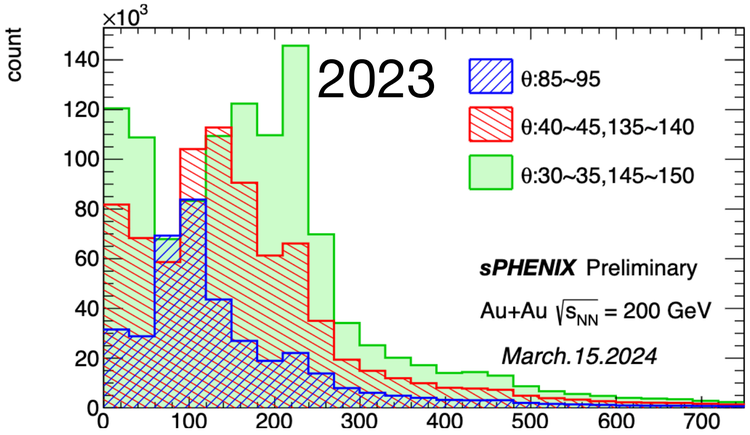


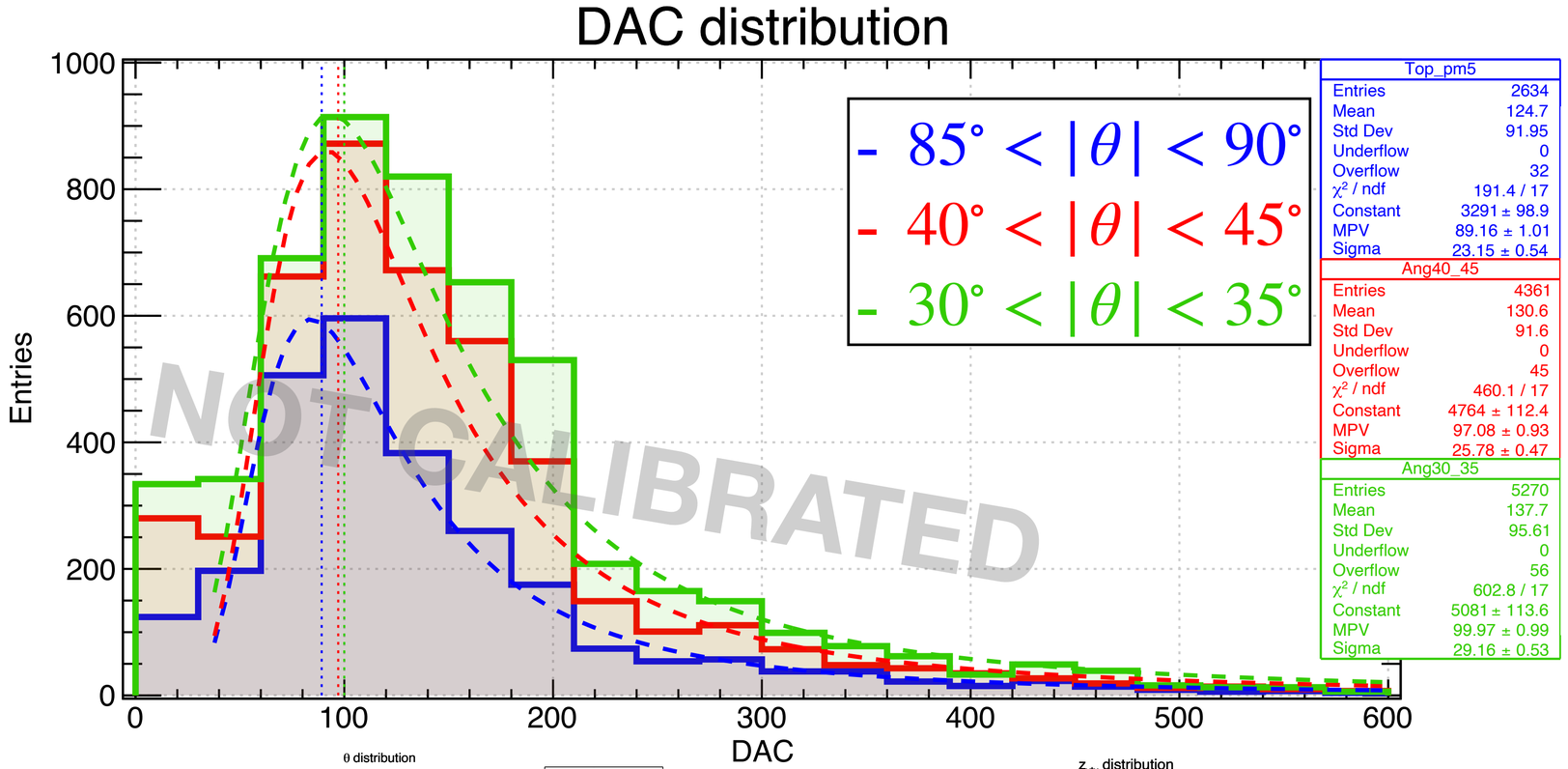
$$\theta^{\mathrm{INTT}} \equiv \arctan\left(\mathrm{slope}_{zr}\right)$$

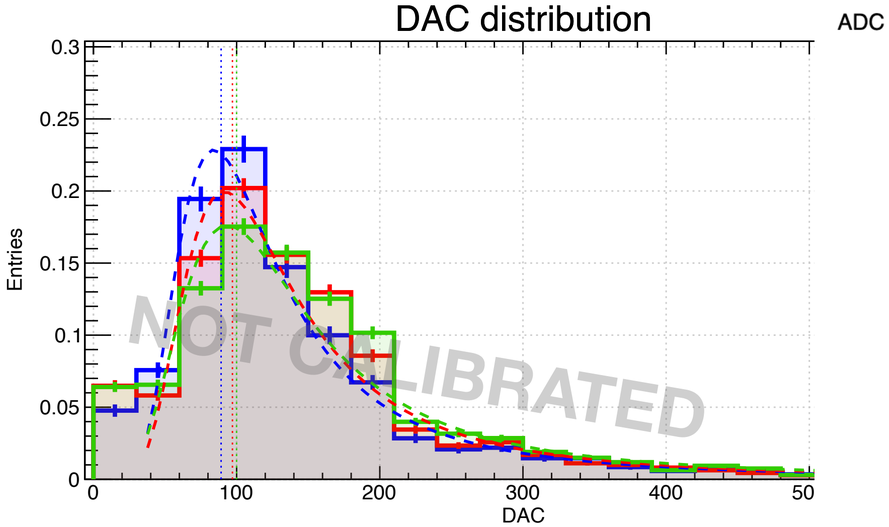




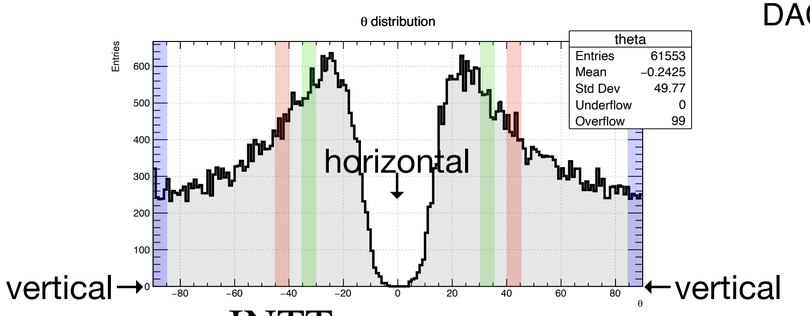
Analysis: MIP: Let's go anyway



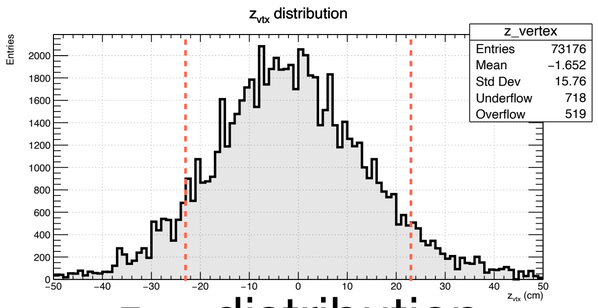




Normalized version by their area



θ^{INTT} distribution



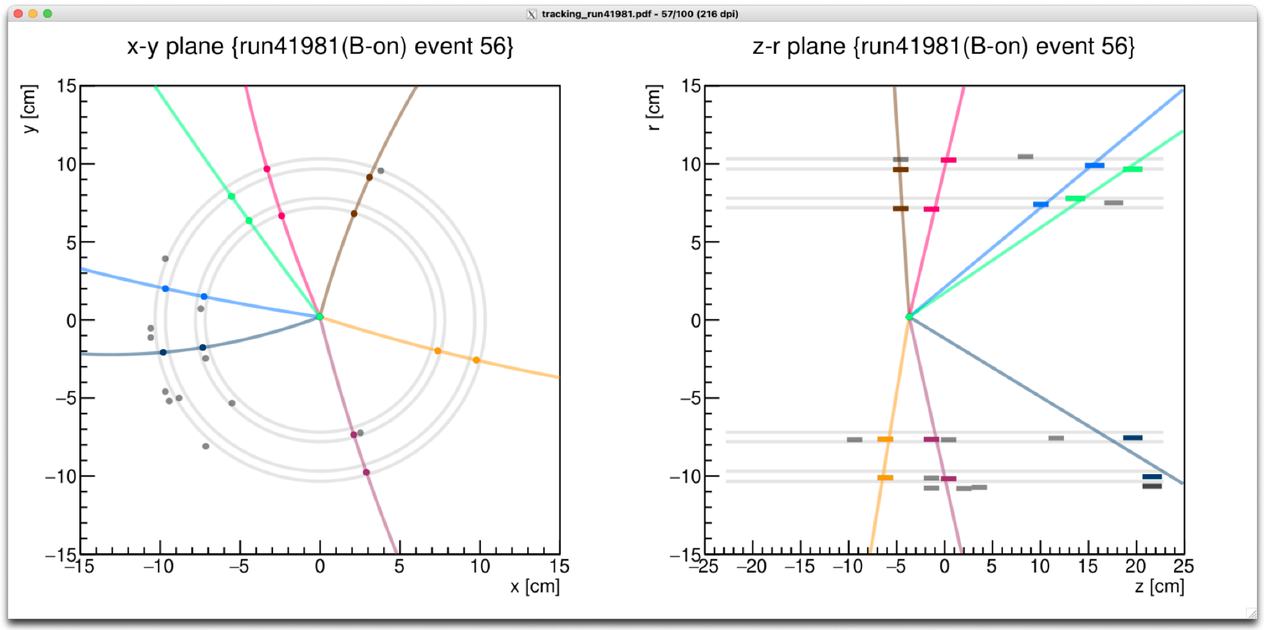
z_{vtx} distribution

- 85° < |θ| < 90°: MPV = 89
- 40° < |θ| < 45°: MPV = 97
- 30° < |θ| < 35°: MPV = 100

The MPV values are not so reliable, but they depends on θ.

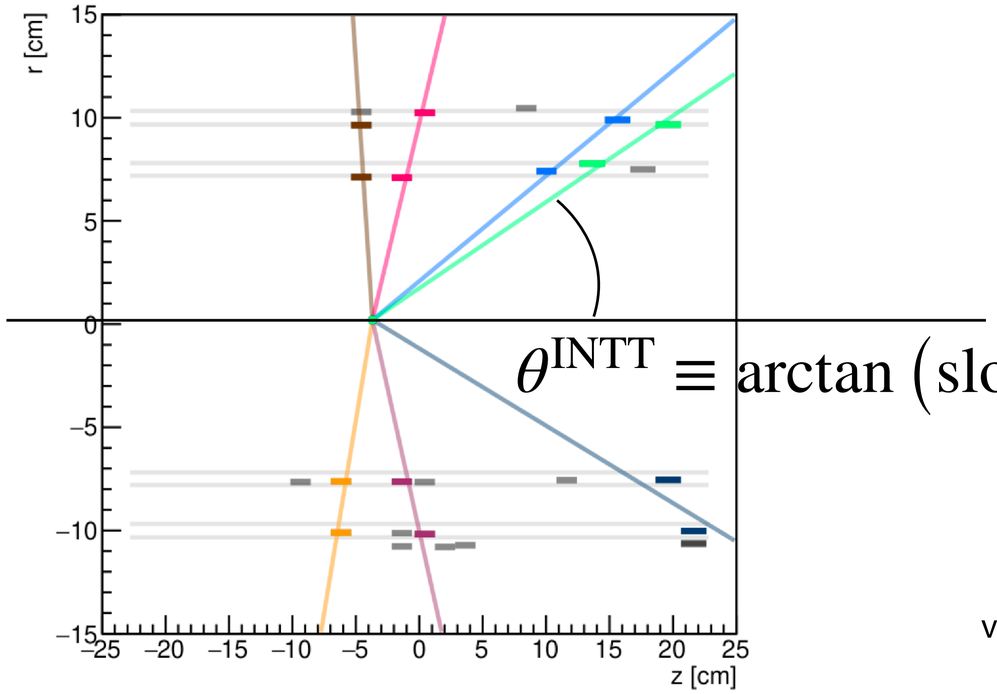
Summary

- INTT tracklet is vital tool for the INTT group to evaluate the detector performance.
- I successfully reproduced Hinako's event display.
- Some implementations are needed to apply it to the extended data and the streaming data.
- MIP peak could be found using INTT clusters associated with INTT tracklet.
- CDB files for DAC calibration were produced.
- Investigation of DAC calibration is necessary.



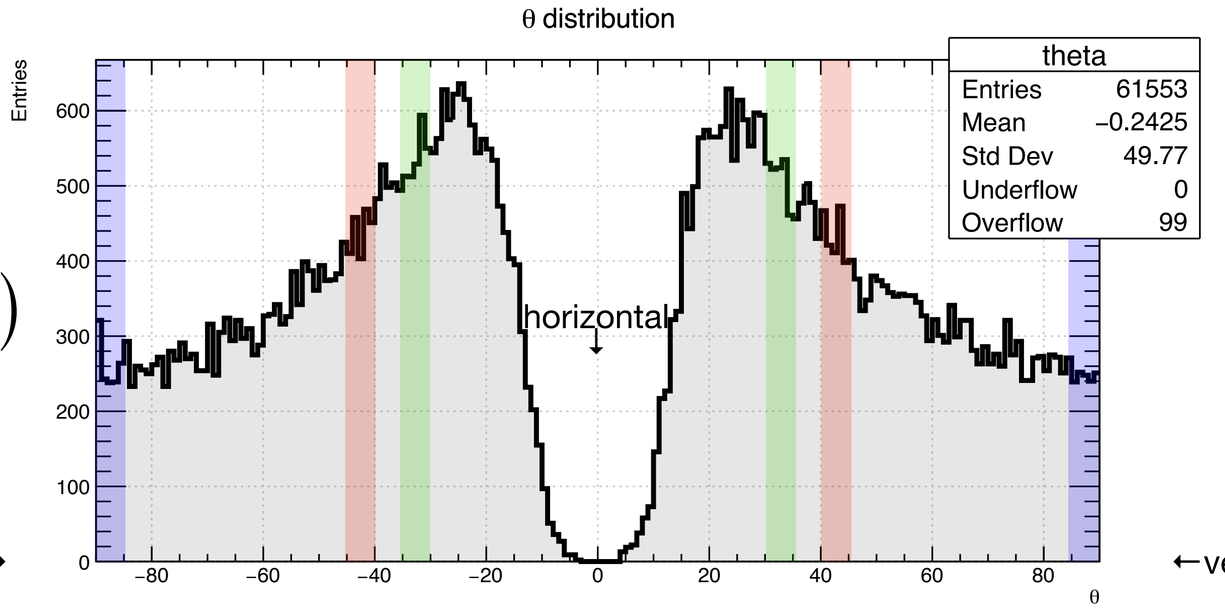
backup

Analysis: MIP: Which theta is acceptable?



$$\theta^{\mathrm{INTT}} \equiv \arctan\left(\mathrm{slope}_{zr}\right)$$

vertical→



←vertical

θ^{INTT} distribution

$$\theta_{min} = \arctan\left(\frac{10\mathrm{cm}}{40\mathrm{cm}}\right) \times \frac{180^{\circ}}{\pi} = 14^{\circ}$$