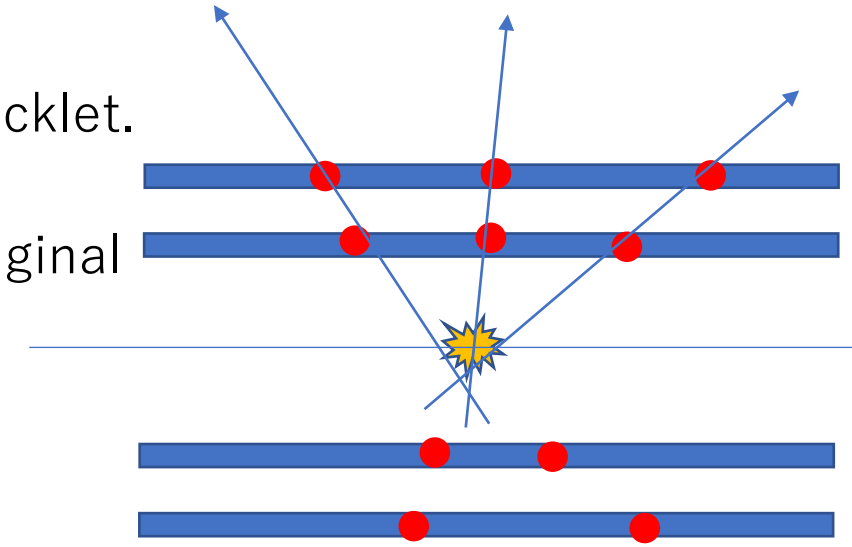
INTT vertex study

Takashi Hachiya
Nara Women's University

Toward the Z-vertex reconstruction with INTT

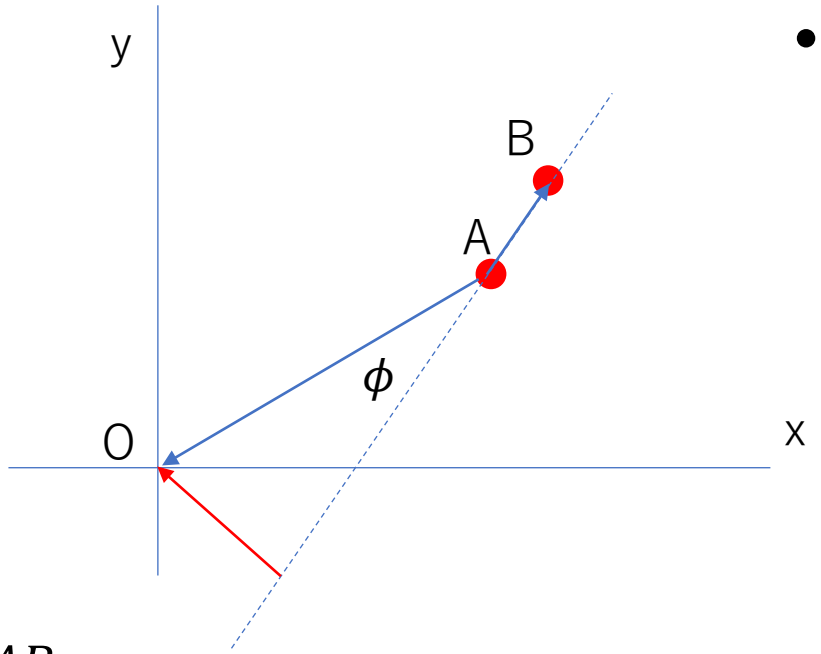
- Z-vertex reconstruction
  1. Connect two hits at the inner and outer layers to make a tracklet.
  2. Calculate the focal point of these tracklets in 3D

  Before the calculation, I check the distance of tracklet to the original point (0,0) in X-Y plane. (Beam spot)



- To do this, I made some useful code
  - Use EventBase tree as input to reconstruction DST(Offline reconstruction)
    - I started with MC reconstruction code and modified it
      - The issue in the decoder still remain. I cannot use Joseph's decoder class
        - Hits are not grouped in to single BCO_FULL
      - No synchronization among 8 FELIX
  - **I made the code to input the event-based tree to DST reconstruction**

2D-DCA (x-y plane) from (0,0) by INTT tracklets

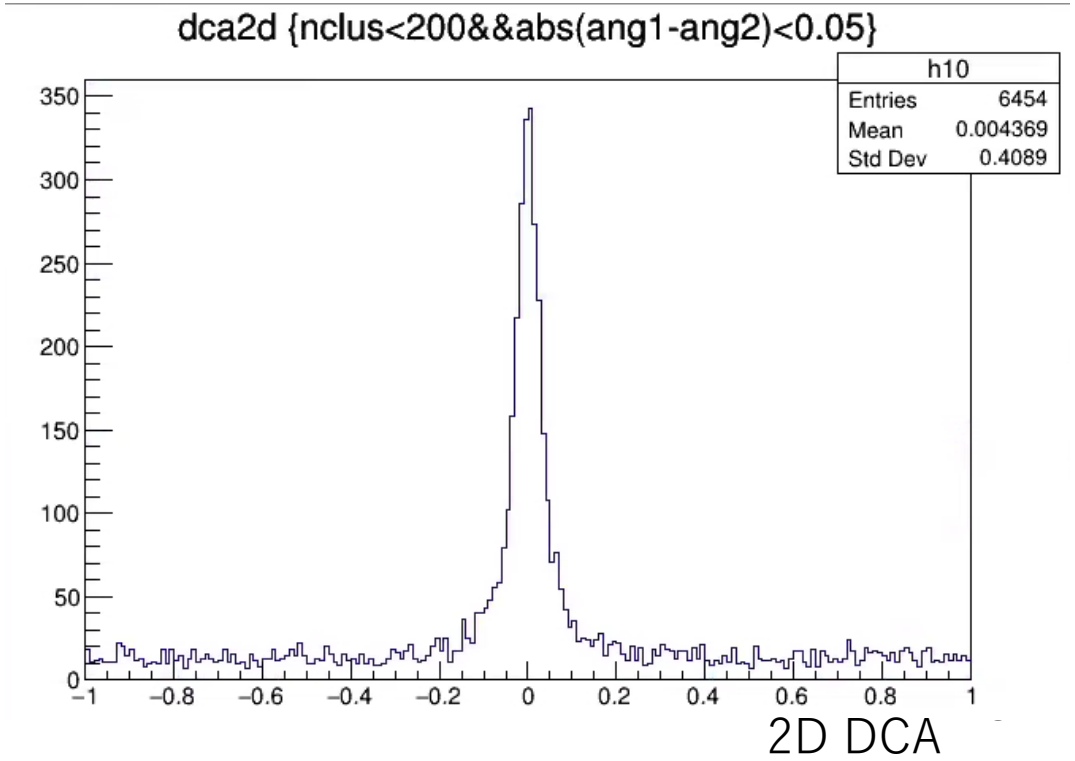


- To be simple, 2D DCA from (0,0) is calculated

$$u = \frac{AB}{|AB|}, \qquad v = AO$$

$$2D - DCA = v \times u = v \cdot \sin\phi$$

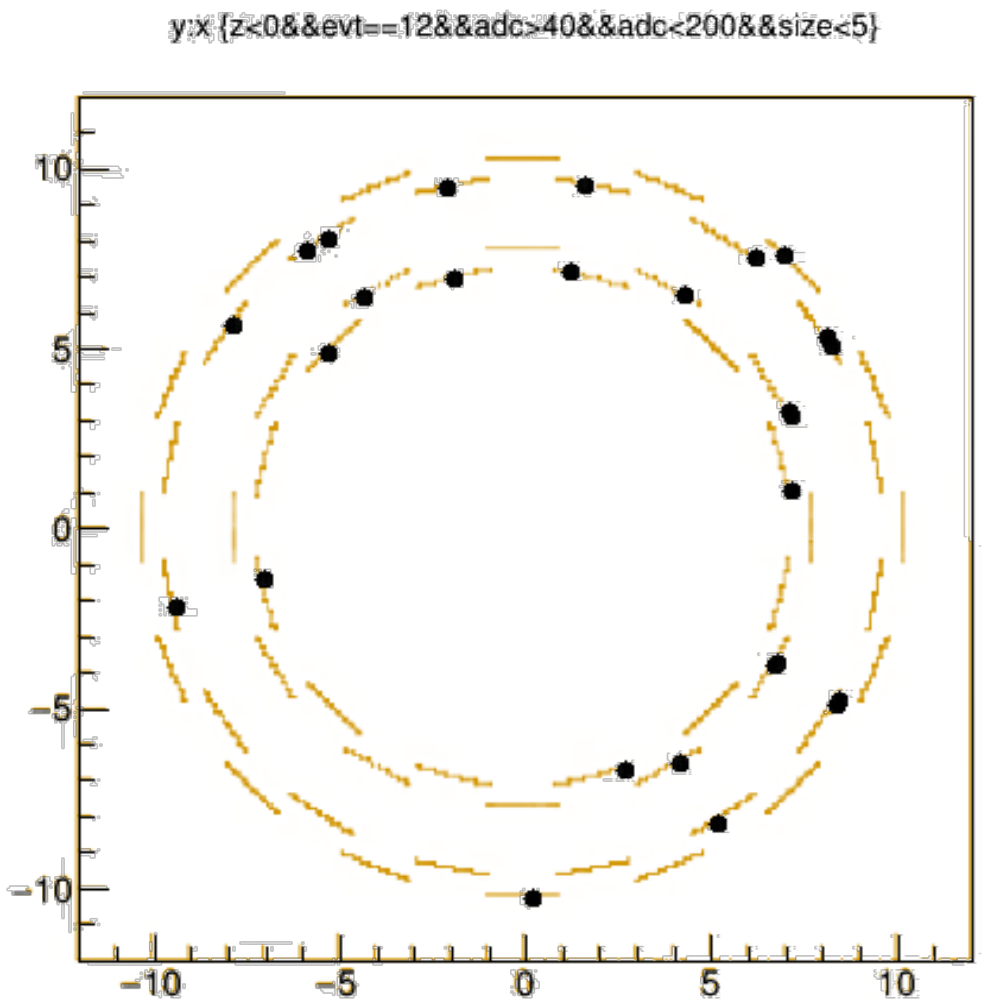
Zero field SIM (PYTHIA) w/ (0,0)

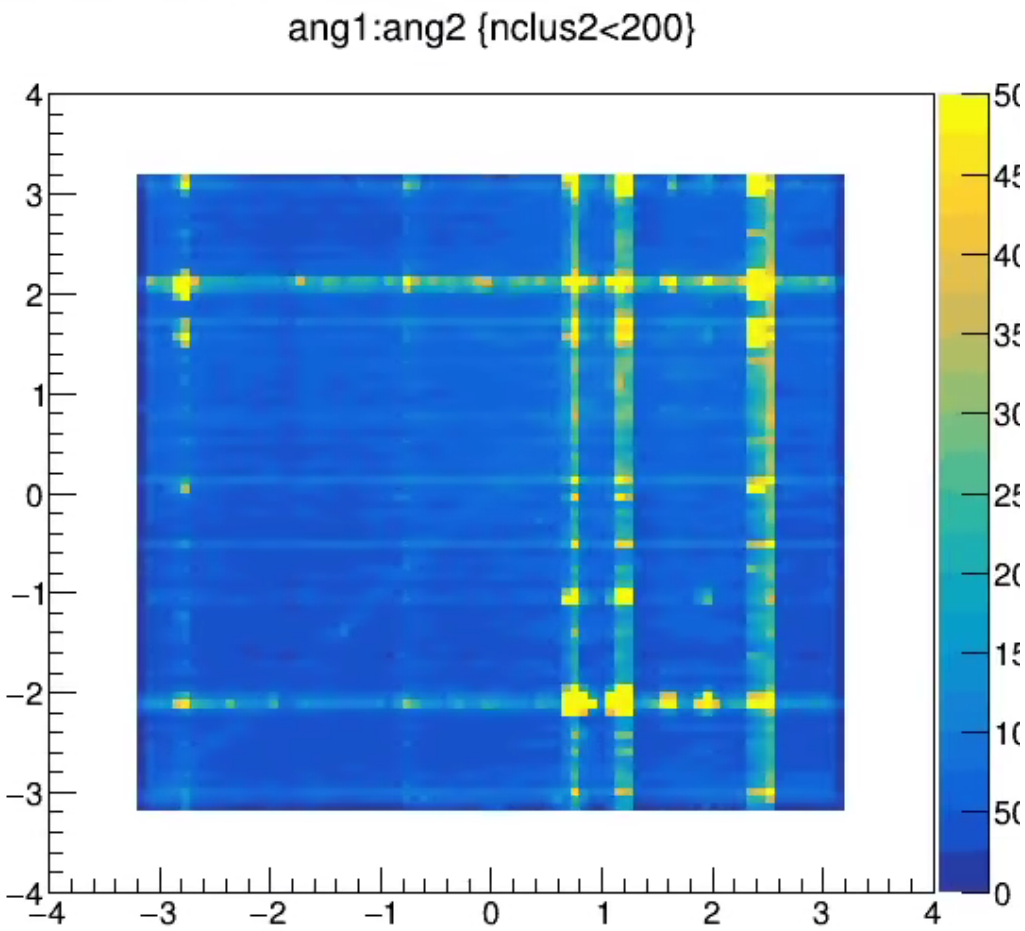


2D DCA

Hit correlation among inner and outer layers

Data: Run20869 (ZF)

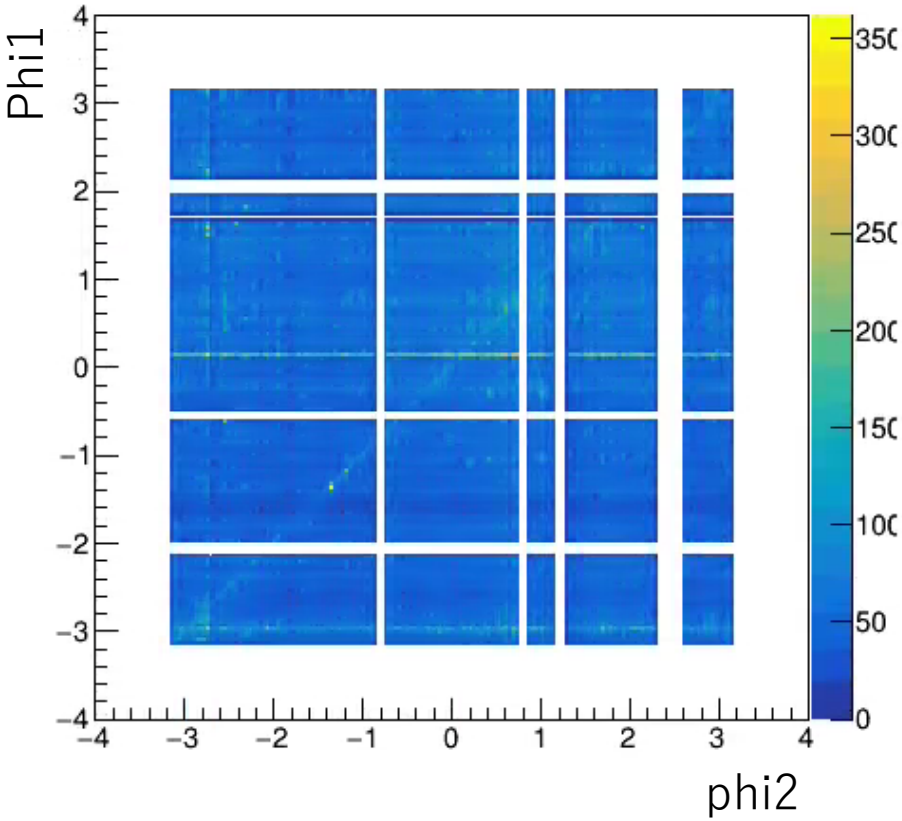




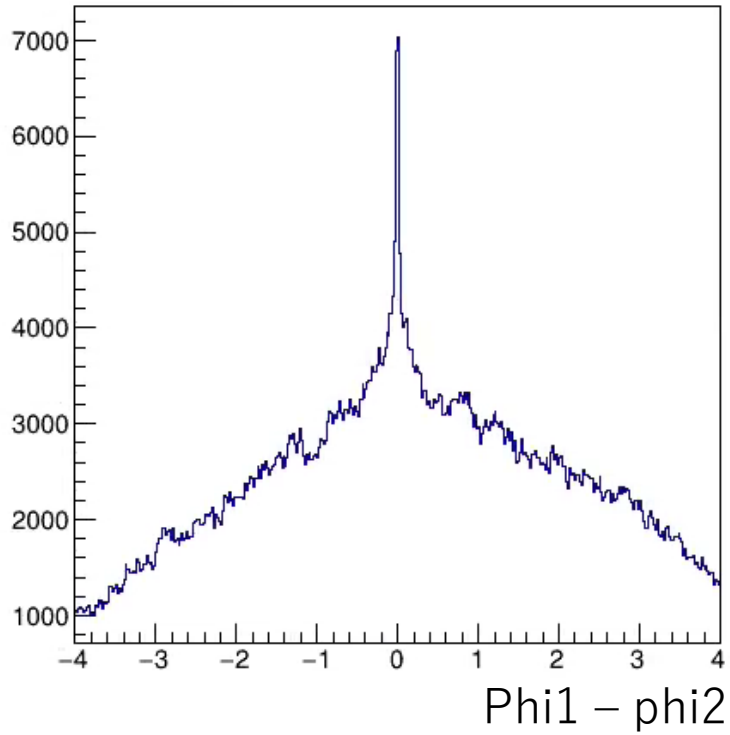
- Y=X correlation is slightly seen
  - Primary particle makes Y=X correlation
  - Hot(warm) channels : horizontal & vertical lines

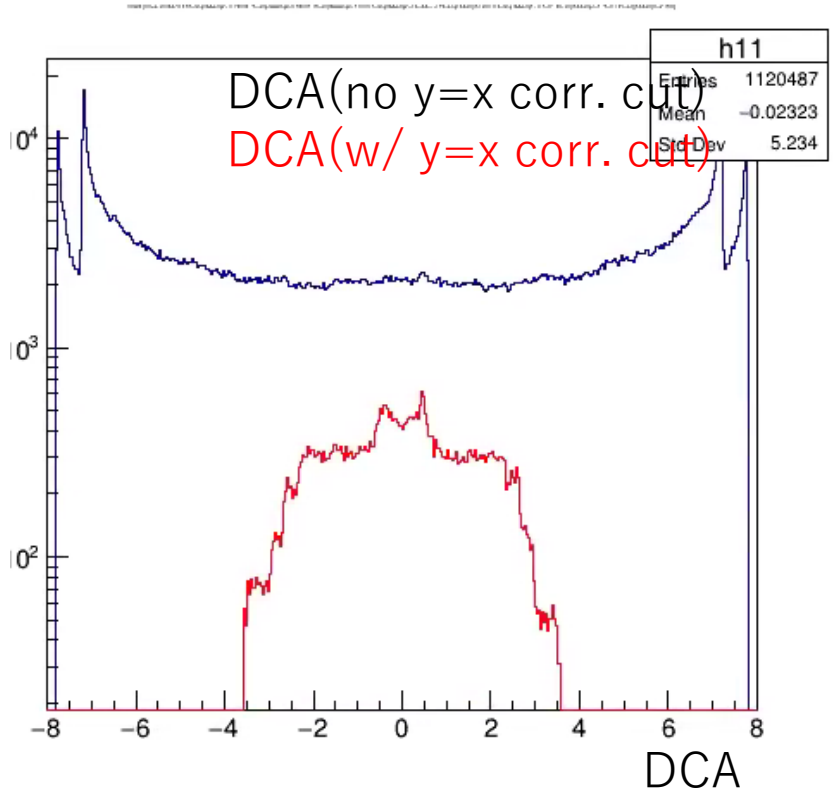
Correlation 2

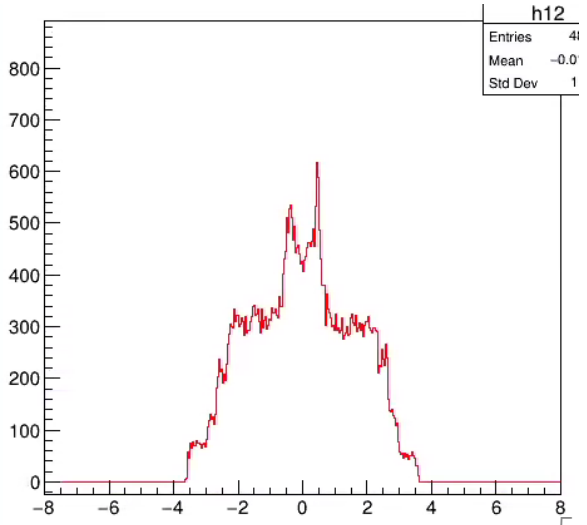
Hot ch removed



Clear peak at 0

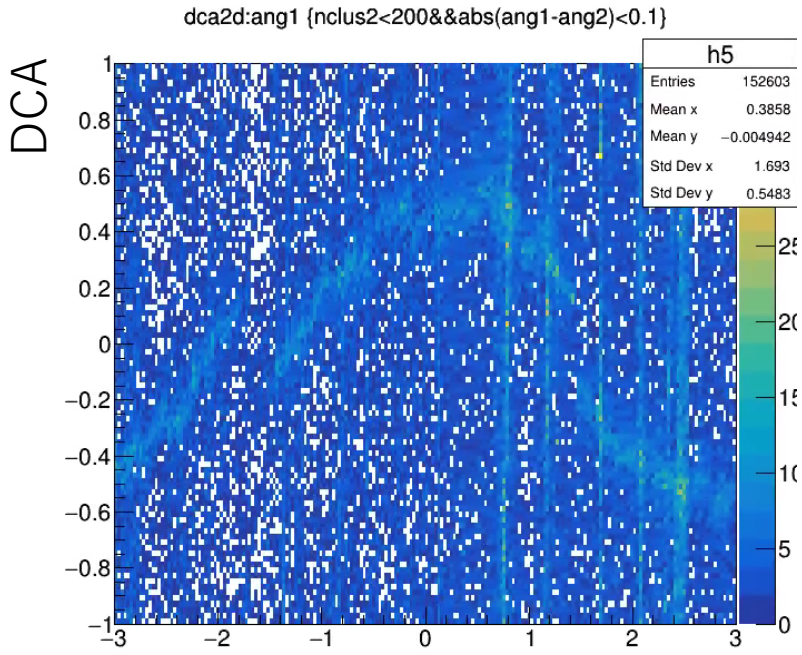




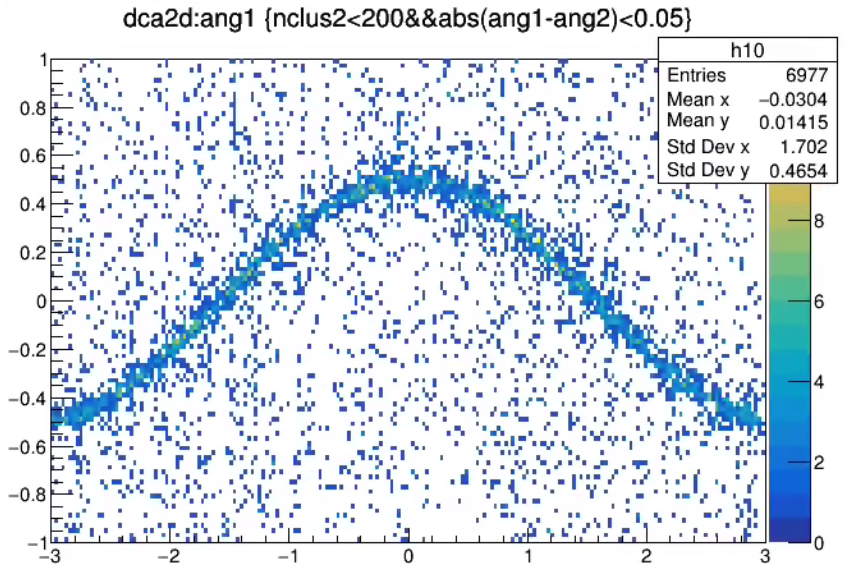


Beam Spot in X-Y plane

- Run 20869 (ZeroField)
  - INTT Tracklet (made from a cluster at inner and other at outer layer)
- Calculate DCA from (0,0) and estimate thebeam spot



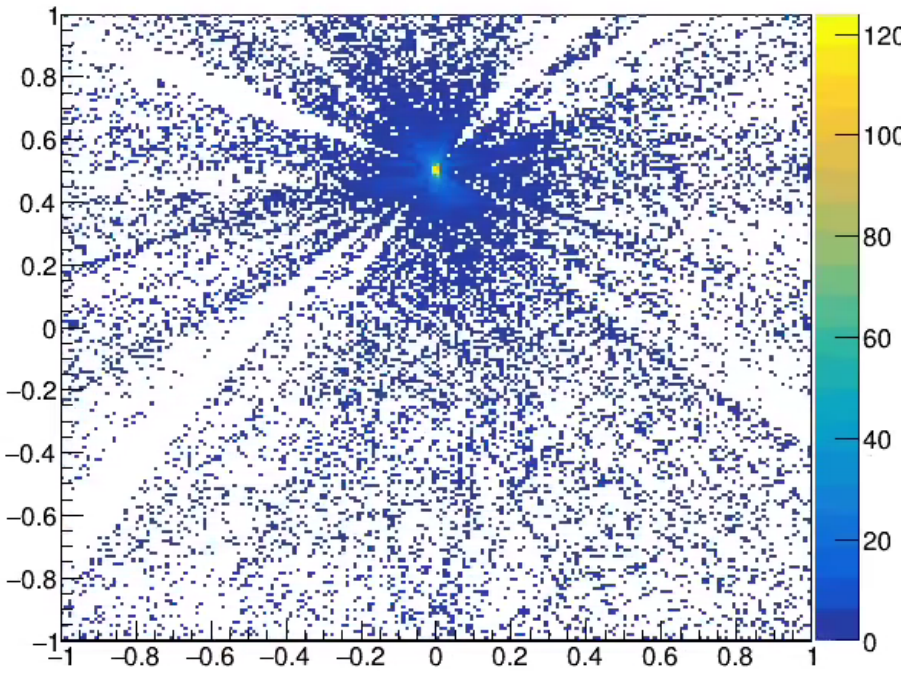
SIM(PYTHIA + Zerofield) @ BeamSpot (0, -5mm)

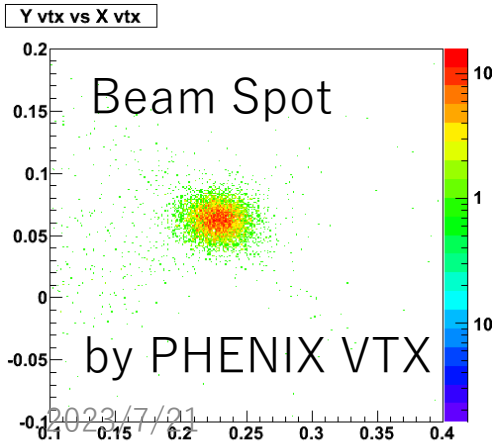


Sim is generated at (0,0) but calculate DCA (0, -5mm)

These shapes are similar and indicate beam spot is (0, 5mm)

Beam Spot in X-Y plane





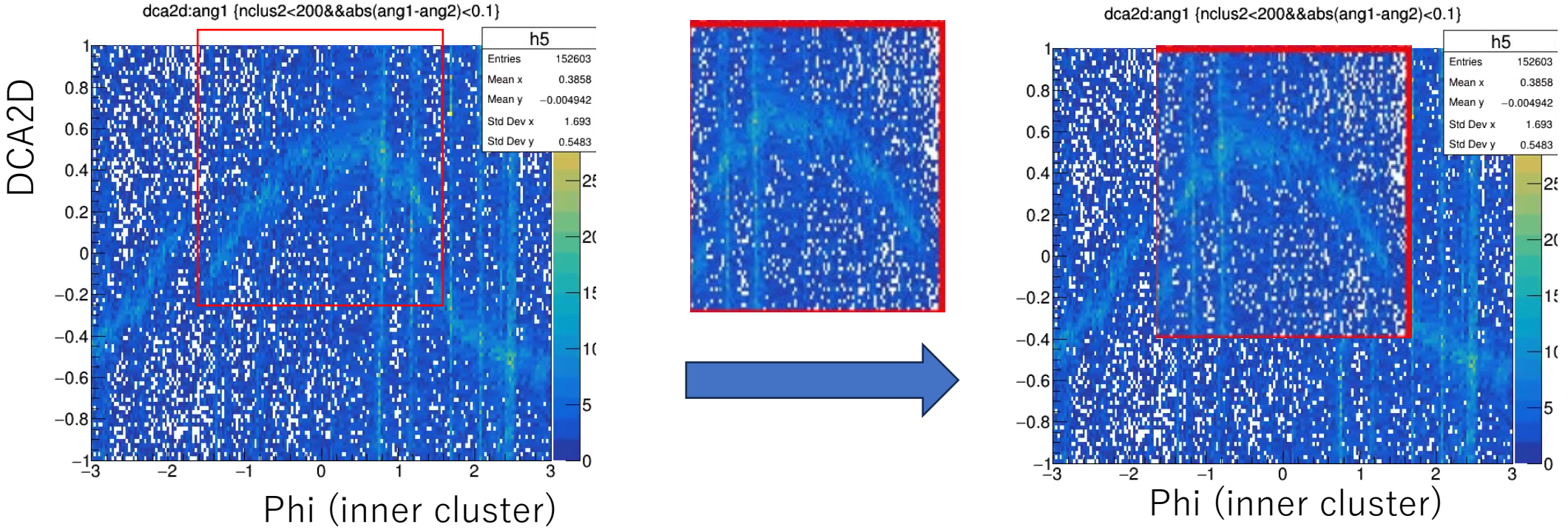
~2mm away from (0,0)

- DCA position(x,y) of the INTT tracklet
  - Indicate the beam spot
- Beam spot is seen at (0, 5mm)
  - Away from (0,0)
- Joseph found INTT position is 3mm downward from the design position
- Next is to calculate Zvertex

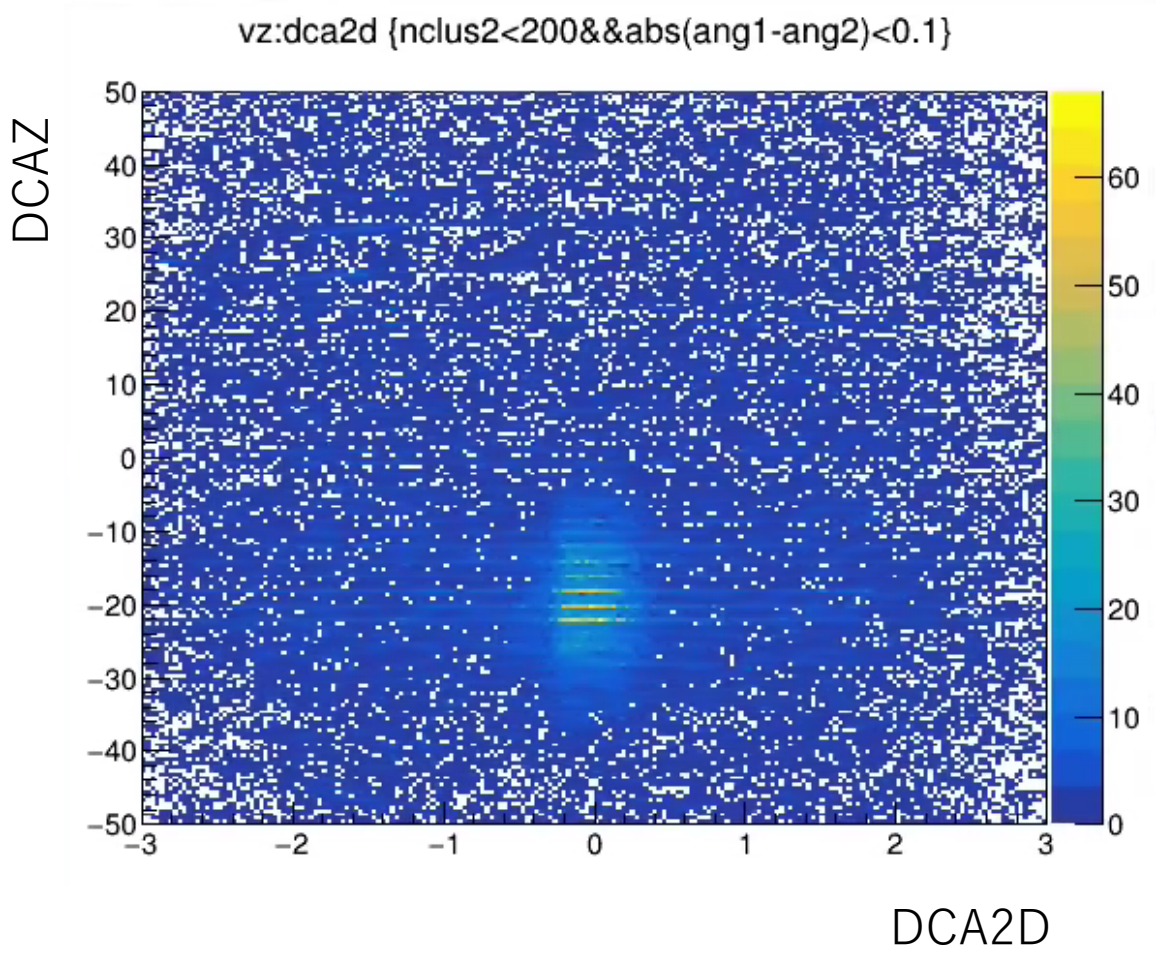
Ch-conversion issue

- DCA2D vs phi seems discontinuity
  - We suspect ch-conversion might have issue. Should be checked in detail.

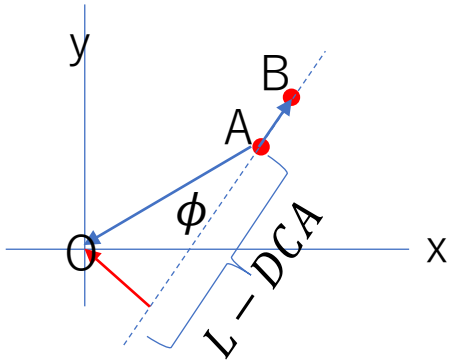
Sign of phi in the box flipped. Then, it looks smooth



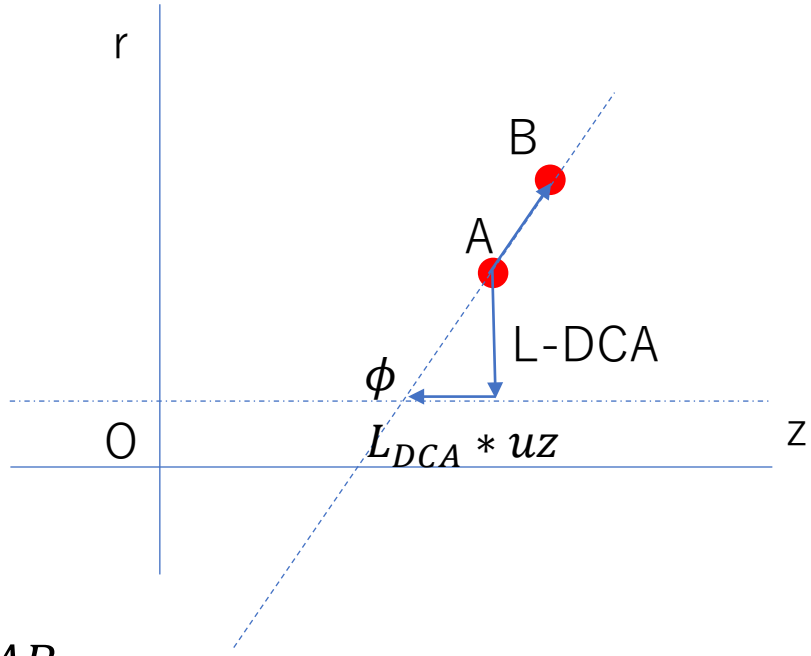
Run20869 ZF



Clear correlation is seen



$$L - DCA = v \cdot \cos\phi$$

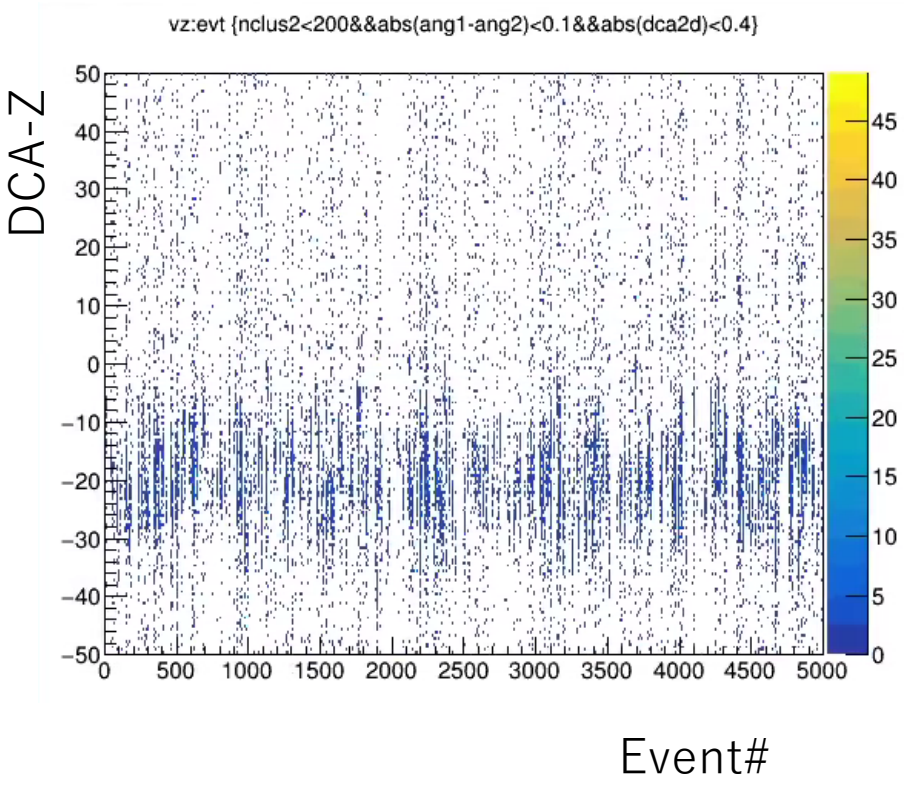


$$u = \frac{AB}{|AB|}, \qquad v = AO$$

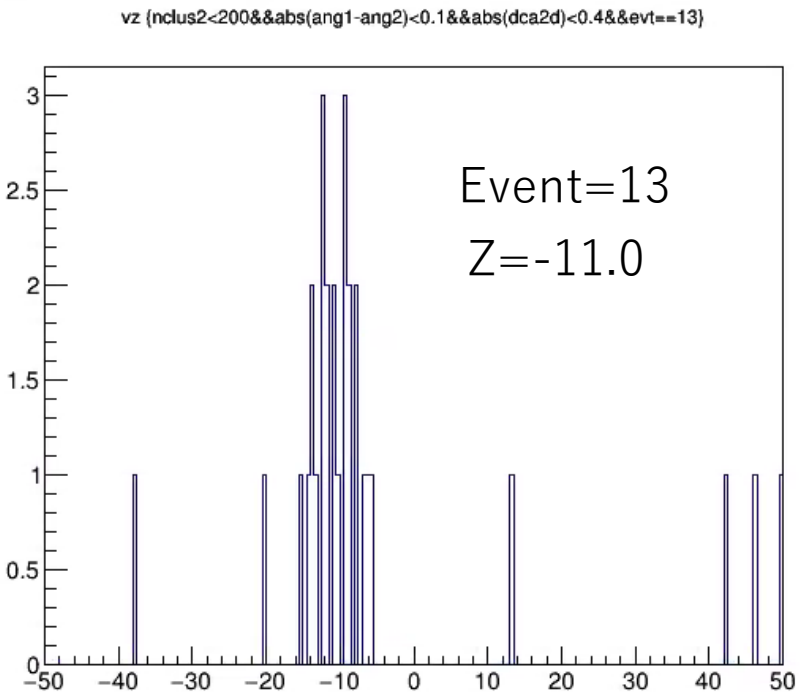
$$Z - DCA = L_{DCA} * uz + zA$$

Run 20869 ZF

- Calculate Z-vertex in an event

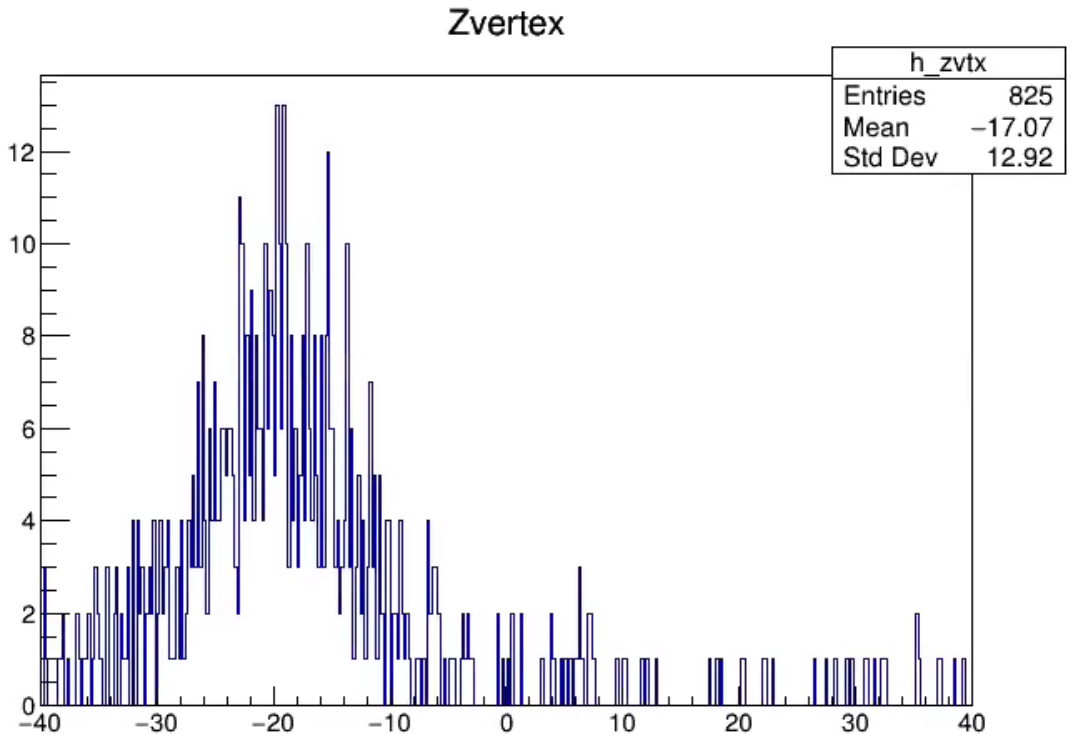


DCA-Z distribution in an event

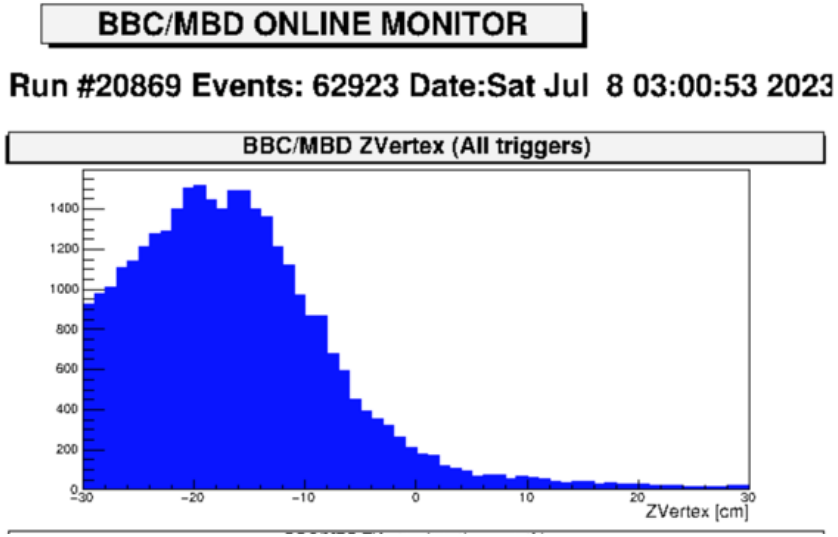


Truncated mean calculated as Zvertex in this event

Run 20869 ZF Z-vertex distribution



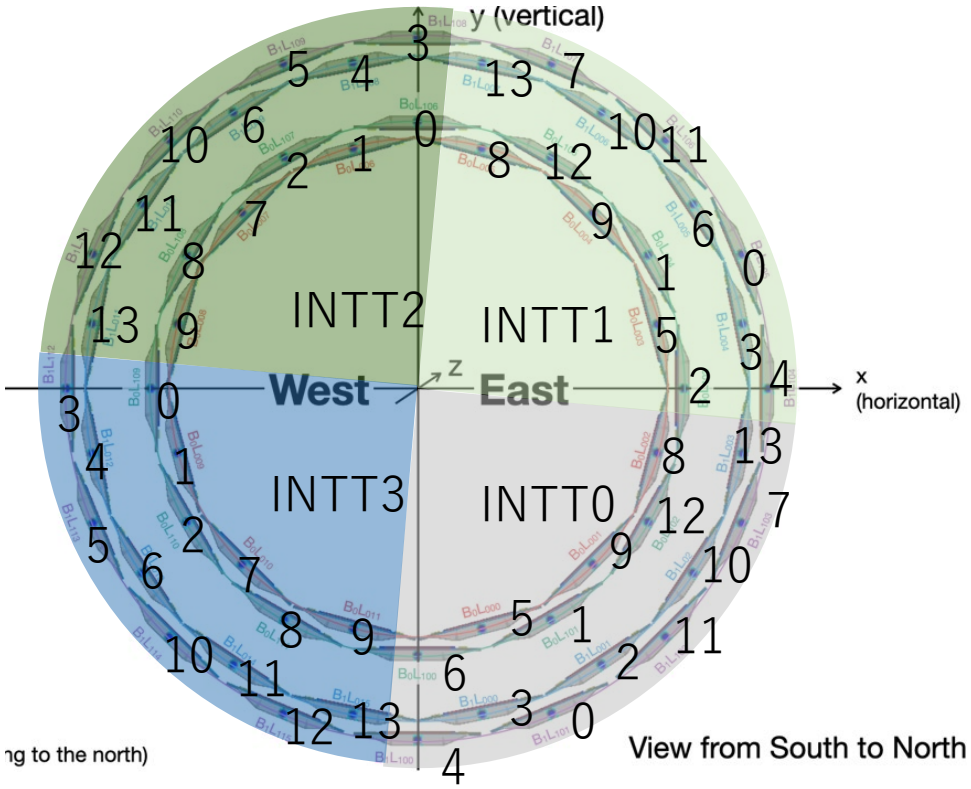
- First measurement of INTT Z-vertex distribution
  - Software needs to be tuned
- Z-vertex position is -20 cm off from zero
  - This result is consistent with MBD



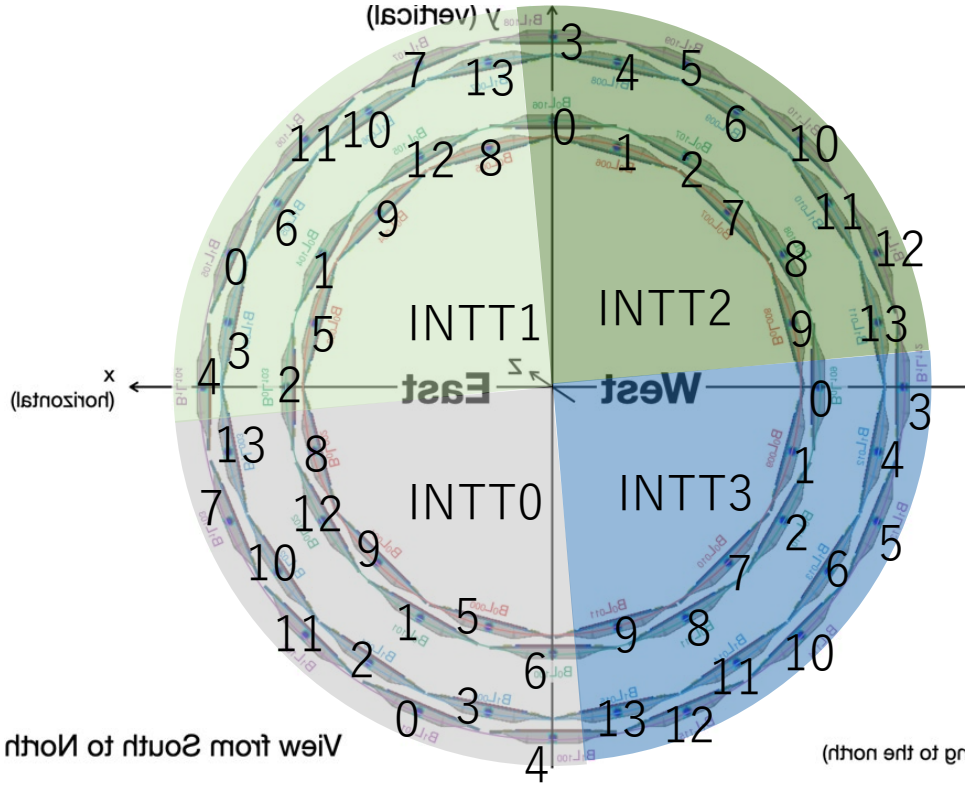
Issues on geometry conversion

Thank you, Joseph, Genki and all for finding the issue, we realized X-axis direction is inverted in the left-hand figure

FELIX0-3 ladder map Current map



FELIX0-3 ladder map Reality



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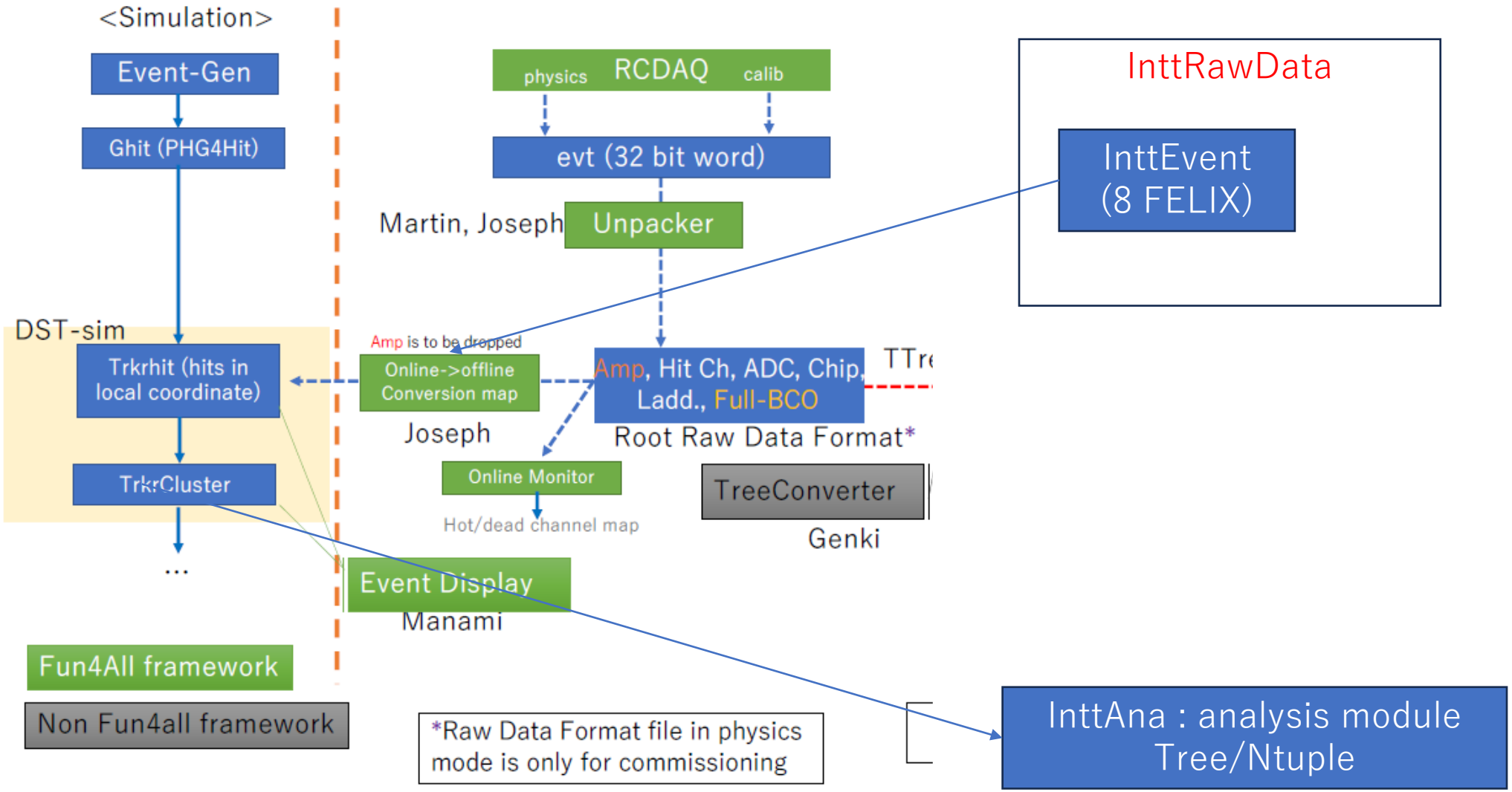
However, after fixing this issue, the geometry issue should be remained.
Need to investigate in more detail

Cut in the event-based tree to Fun4All



My analysis procedure

1. Merge 8 FELIX data @ INTT0(1008) (not necessarily at 1008)
   - Event-based tree is input
     - InttEvent class is a data container
       - Contain one event based on BCO_FULL
     - InttHit (eachhit) structure contained (TCloneArrays)

```
InttEvent
    int         evtSeq;
    Long64_t    bco;
    int         fNhits;
    TClonesArray* fhitArray;
```

```
InttHit :
   int pid;
   int adc;
   int ampl;
   int chip_id;
   int module;
   int chan_id;
   int bco;
   Long64_t bco_full;

   int evt;

   int roc;
   int barrel;
   int layer;
   int ladder;
   int arm;

   int full_fphx;
   int full_roc;
```

   - ROOT-macro to make a merged tree: runAnalysis.C
     - Under ~/INTT/hachiya/convertInttRaw/test2/analysis (I will move this to SDCC)
       - InttEventSync is a code to merge 8 felix
     - Input : list file which list the 8 file names
     - Outputfile : Event-based Tree：beam_inttall-000(RunNum)-0000.root

2. Copy them to SDCC
   - From /bbox/commissioning/INTT @ bbox0
     - /bbox/commissioning/INTT @ INTT0
   - To /sdcc/sphnxpro/commissioning/INTT @ bbox0 (1008)
     - /sphenix/lustre01/sphnxpro/commissioning/INTT @ SDCC

My analysis procedure 2

- Convert some Hit channels to clusters with the reconstruction code
  - Input: the merged EventBased Tree
  - Reconstruction macro based on Fun4All
  - Code location
    - /sphenix/user/hachiya/tutorial/tutorials/AnaTutorial/macro/Fun4All_AnaTutorial_INTT.C
    - Under /sphenix/user/hachiya/tutorial/tutorials/AnaTutorial/src/
      - InttRawData.h/cc : This module use to input Event-based Tree to the reconstruction code
    - InttAna.h/cc: This module is to analyze the clusters position and so on.
      - This module is used to calculate BeamSpot and Z-vertex as well

- There is no way to read several EVT files synchronized by BCO_FUL
  - Fun4All framework is designed to use “ONE” event which contain all the information in this event. In other word, Fun4All assume that “Event” is pre-packed by the event builder but sPHENIX doesn’t have it.

Summary

- BeamSpot and Z-vertex is successfully calculated for the first time
  - INTT-Zvertex distribution is consistent with MBD
    - Need to take event-by-event correlation
  - Some issues:
    - Geometry issue
      - Need to careful check: FELIX by FELIX, ladder by ladder,
    - Z-vertex calculation needs to be optimized
      - How it truncate?

- Next step
  - Prepare Z-vertex calculation for the field-ON data
  - Help to understand the serious problem on the huge beam background