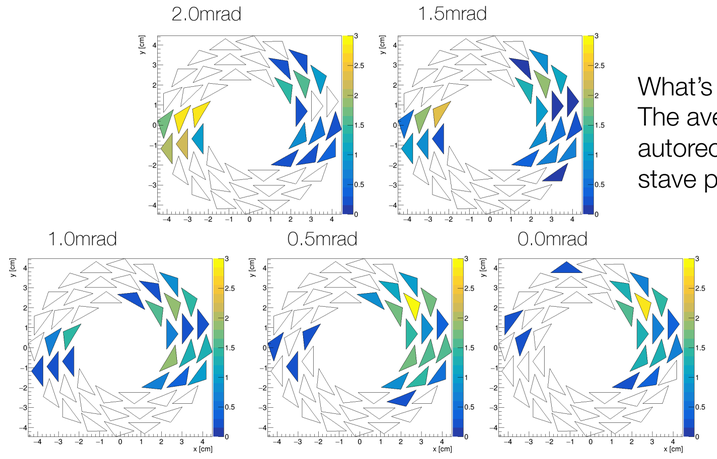
Evaluation of effect on INTT by the additional material around the beam line for bg suppression with MC simulation

Genki Nukazuka (RIKEN)

Au beam background affects MVTX a lot

X-ing angle summary, 1x1 bunches

Plots by M. Peters

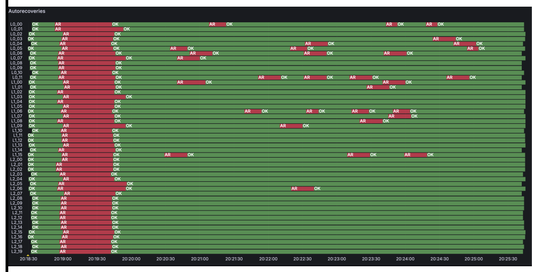


What's shown here?
The average number of autorecoveries per stave per minute

12/12/24 MVTX status, C. Dean 15

MVTX autorecoveries/stave/min

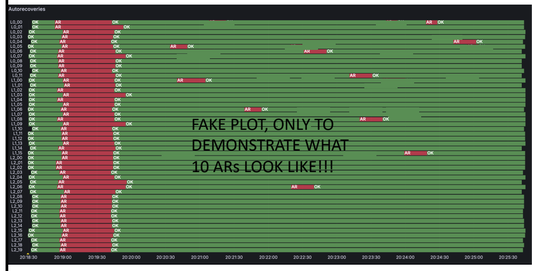
Where did we end



- October 18th 2024
- 56x56
- MVTX in "extended readout" mode
  - Background sensitivity ~ 3x higher than true triggered mode
  - 10 μs strobe after each trigger
- GL1 rate was 8 kHz
- 30 AR's in 5 minutes
  - Would be about 10 in true triggered mode

12/12/24 MVTX status, C. Dean 19

Where did we end



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12/12/24 MVTX status, C. Dean 20

The background situation got better by the beam optimization

Request

- Kin requested Yuko to check effect to INTT by the additional material with MC. She contacted me, and I agreed to work on it.

RE: passing the GEANT4 to INTT group

YK

Yip, Kin<kinyip@bnl.gov>

宛先: Nouicer, Rachid <nouicer@bnl.gov>; 他 +3 件

Cc: Yuko Sekiguchi; Genki Nukazuka

2024/12/18 (水) 0:46

Dec/18/2024 midnight (JST)

2024/12/18 (水) 17:16 に返信しました。

Hello,

I'd just like to inform you that I've discussed with Yuko and Genki about trying to investigate the adverse effect of
adding the 1.2 m polyethylene on INTT.

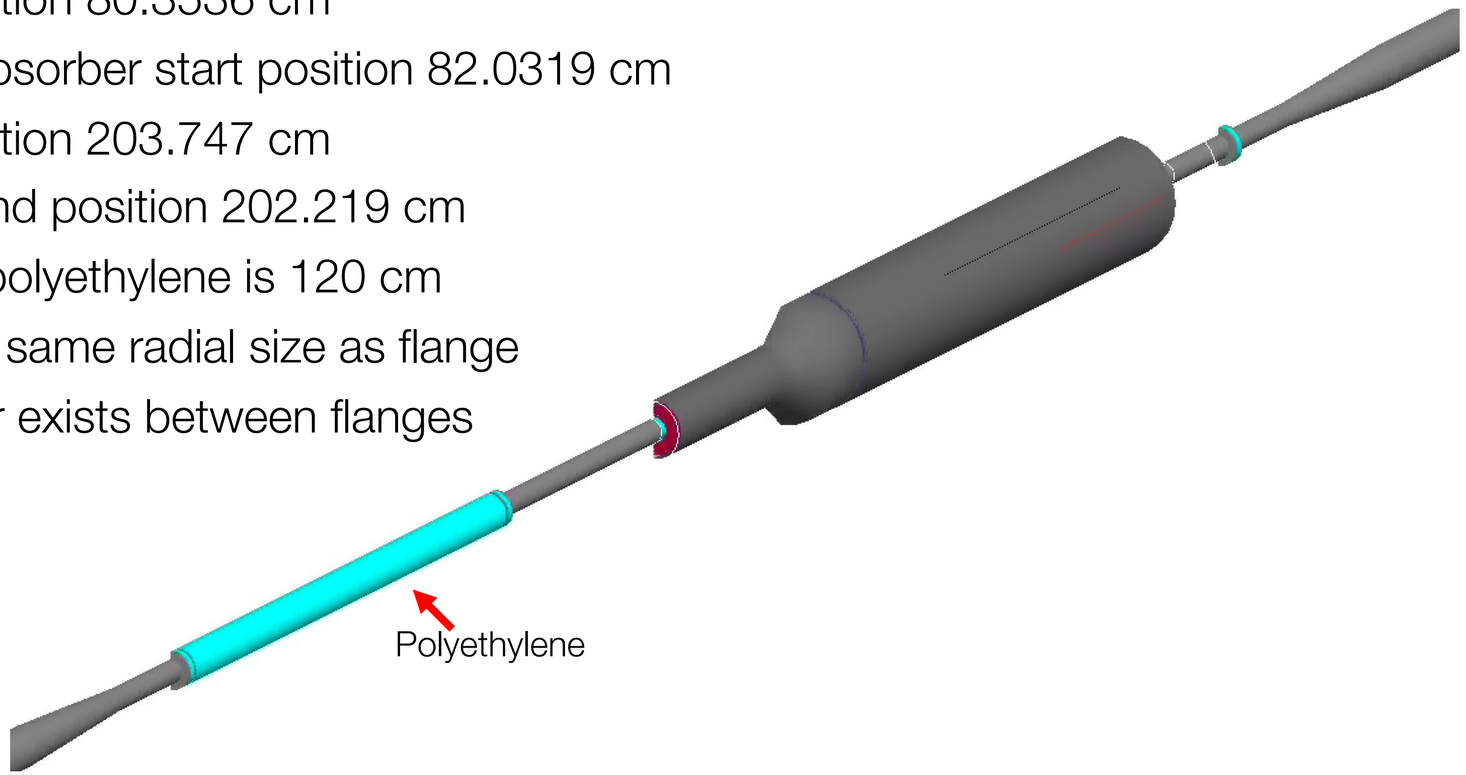
(I have tried to subscribe to INTT mailing list but I've never got a reply and so I can't send to INTT mailing list.)

Kin

Additional material: MVTX absorber

Addition of polyethylene around BP

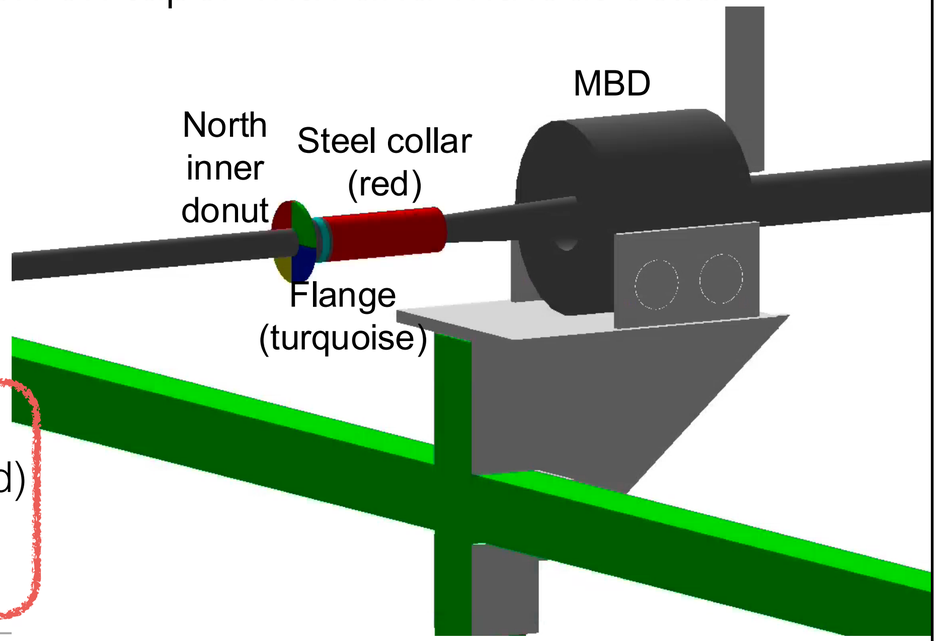
- Flange 1 z position 80.3536 cm
- Polyethylene absorber start position 82.0319 cm
- Flange 2 z position 203.747 cm
- Polyethylene end position 202.219 cm
- Max length of polyethylene is 120 cm
- Polyethylene is same radial size as flange
- In reality, spider exists between flanges



Additional material: Donut counters

Setup

- sPHENIX Geant4 simulation with new additions:
  - Steel collar on north side, between MBD and flange
  - Inner donut counters on north and south (split into 4 quadrants)
- Simulations: AuAu collision (hijing), Au ion on taper with and without collar
- Donut counter readout
  - Each quadrant has independent readout
  - Count geant truth hits
    - Reconstructed hits would be too much time to develop for a short study
- Collar is same radius as flange
  - 20cm in length (~ 1.2λ)
- Donut
  - Z = roughly +/- 2m (beam pipe is misaligned)
  - Thickness is 7mm
  - ID/OD 1.75" and 5"



MC simulation

- Cameron shared some files with us
  - G4_Pipe.C
    - Updated beam pipe geometry with the absorber wrap made by Cameron.
  - G4_Donut.C
    - Geometry of the inner donut (bagel) counters made by J. Haggerty. Cameron is working on this now.
  - G4Setup_sPHENIX.C
    - A setup macro to use G4_Pipe.C and G4_Donut.C.
  - Fun4All_G4_goldGun.C
    - Cameron’s Fun4All macro for the simulation of beam background with the updated geometry.

MC simulation: G4_Pipe.C

```
[nukazuka@sphnx07 07:44:38 common] $ diff G4_Pipe.C ../../../analysis/beam_background/G4_Pipe.C
19a20
>   bool MVTX_ABSORBER = false;
170a172,173
>   float absorberStartPos = flange_place_z + 1.25*G4PIPE::flange_length;
>
261a265
>   float absorberEndPos = flange_place_z - 1.25*G4PIPE::flange_length;
745a750,777
>   if (Enable::MVTX_ABSORBER)
>   {
>     float absorberPos = 0.5*(absorberEndPos + absorberStartPos);
>     float absorberLength = absorberEndPos - absorberStartPos;
>     cyl = new PHG4CylinderSubsystem("MVTX_ABSORBER", ilayer++);
>     if (Enable::PIPE_MISALIGNMENT)
>     {
>       cyl->set_double_param("place_x", G4PIPE::pipe_xshift);
>       cyl->set_double_param("place_y", G4PIPE::pipe_yshift);
>       cyl->set_double_param("place_z", absorberPos + G4PIPE::pipe_zshift);
>     }
>     else
>     {
>       cyl->set_double_param("place_z", absorberPos);
>     }
>     cyl->set_double_param("radius", G4PIPE::al_pipe_radius + G4PIPE::al_pipe_thickness);
>     cyl->set_int_param("lengthviarapidity", 0);
>     cyl->set_double_param("length", absorberLength);
>     cyl->set_string_param("material", "G4_POLYETHYLENE");
>     //cyl->set_string_param("material", "G4_STAINLESS-STEEL");
>     cyl->set_double_param("thickness", G4PIPE::flange_thickness);
>     cyl->set_color(1,0,0,1.);
>     cyl->SuperDetector("PIPE");
>     if (AbsorberActive) cyl->SetActive();
>     cyl->OverlapCheck(OverlapCheck);
>     g4Reco->registerSubsystem(cyl);
>   }
>
763c795
< #endif
---
> #endif
```

←polyethylene

MC simulation: Runs and analysis

- I tried 2 types of simulation:
  - Run0
    - 100k events
    - 100 GeV p going to the flange of the beam pipe on the north side
    - Current geometry
  - Run1
    - 100k events
    - 100 GeV p going to the flange of the beam pipe on the north side
    - Updated geometry
- Analysis
  - TrkrCluster was checked. Truth information was not used.

MC simulation: Beam

$R_{[min, max),uniform}$ means a uniformly distributed random number from min to max.

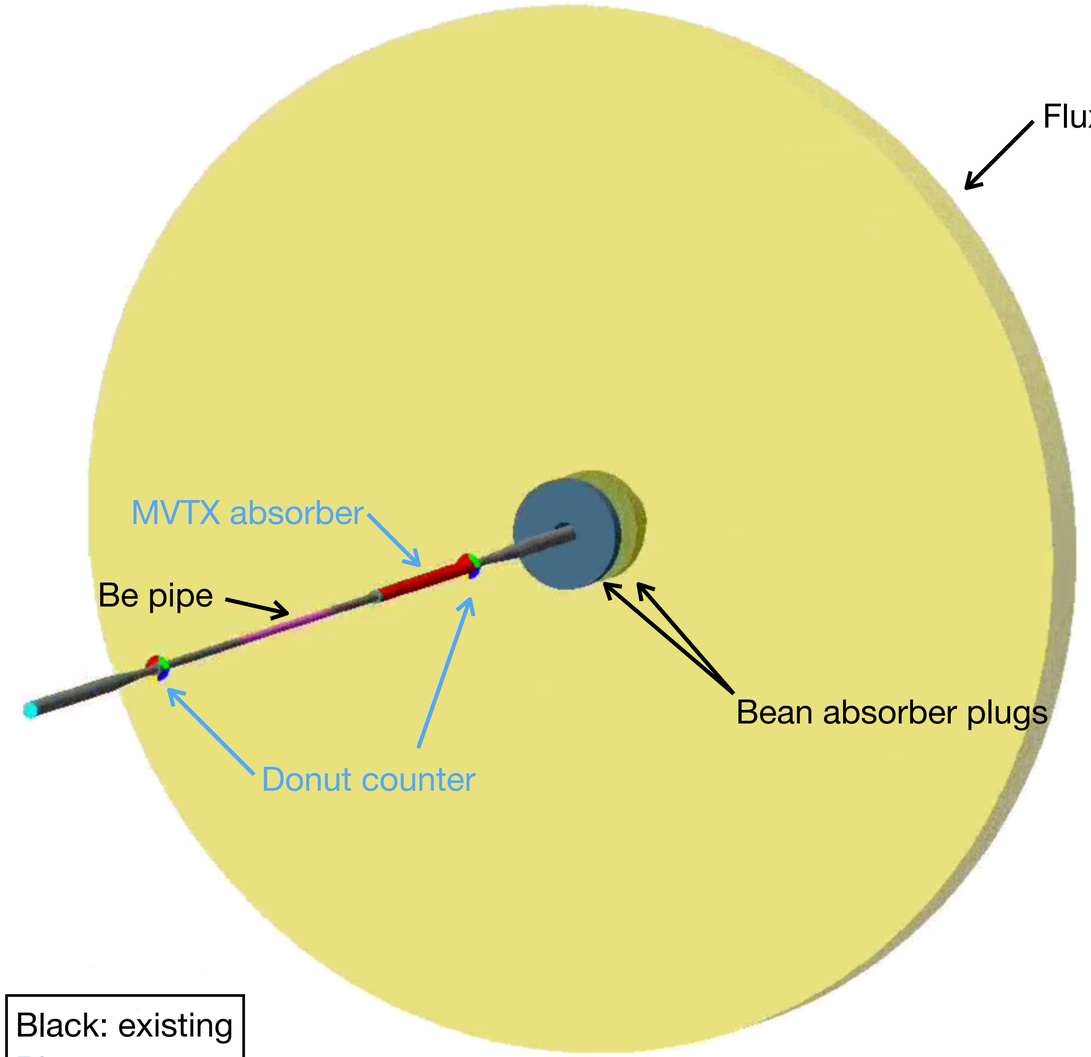
- A particle gun is used to shoot a single proton in each event
  - Momentum
    - p_z = -100 GeV/c
    - $p_x = p_z \times dp_x$ = $-100 \times R_{[-0.5, 0.5),uniform} \times 0.002$ GeV/c = $R_{[-0.1, 0.1),uniform}$ GeV/c
    - $p_y = p_z \times dp_y$ = $R_{[-0.1, 0.1),uniform}$ GeV/c
  - Position of the beam origin
    - x = -3.26745 + dx = $-3.26745 + R_{[-0.5, 0.5),uniform} \times 0.05$ = $-3.26745 + R_{[-0.025, 0.025),uniform}$ cm
    - y = 0.6 + dy = 0.6 + 0 = $0.6 + R_{[-0.025, 0.025),uniform}$ cm
    - z = 310 cm

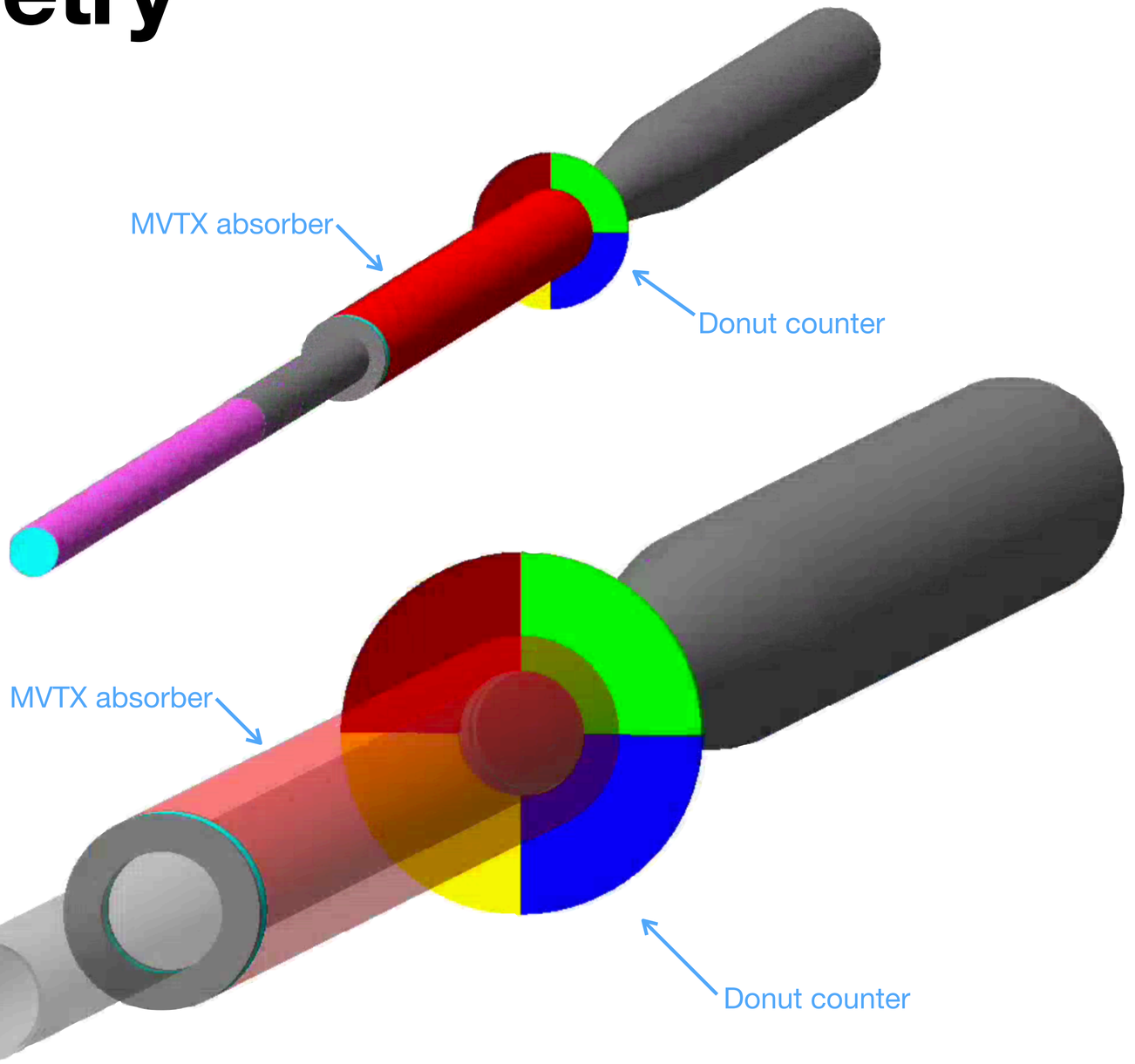
MC simulation: Setup

- Detectors/Materials in the simulation
  - Detector
    - MVTX
    - INTT
    - TPC
    - TPOT
    - MBD
    - sEPD
    - (Donut counter)
  - Material
    - Beam pipe and beam pipe absorber
    - (MVTX absorber)
    - (Donut absorber)
    - Plug door and plug door absorber

```
268   Enable::MBD = true;
269   Enable::MBD_SUPPORT = true; // save hist in MBD/BBC support structure
270
271   Enable::PIPE = true;
272   Enable::PIPE_ABSORBER = true;
273
274 #ifdef NEW_GEOMETRY
275   Enable::DONUT = true;
276   Enable::DONUT_ABSORBER = true;
277 #endif // NEW_GEOMETRY
278
279   // central tracking
280   Enable::MVTX = true;
281   Enable::MVTX_CELL = Enable::MVTX && false;
282 #ifdef NEW_GEOMETRY
283   Enable::MVTX_ABSORBER = false; // true;
284 #endif
285
286   Enable::EPD = true;
287   Enable::EPD_TILE = Enable::EPD && true;
288
289   //! forward flux return plug door. Out of acceptance and off by default.
290   Enable::PLUGDOOR = true;
291   Enable::PLUGDOOR_ABSORBER = true;
292   Enable::BEAMPIPE_ABSORBER = true;
293
294   // new settings using Enable namespace in GlobalVariables.C
295   Enable::BLACKHOLE = true;
296
297   Enable::INTT = true;
298   Enable::INTT_CELL = Enable::INTT && true;
299   Enable::INTT_CLUSTER = Enable::INTT_CELL && true;
300
301   Enable::TPC = true;
302   Enable::MICROMEGAS = true;
303
```

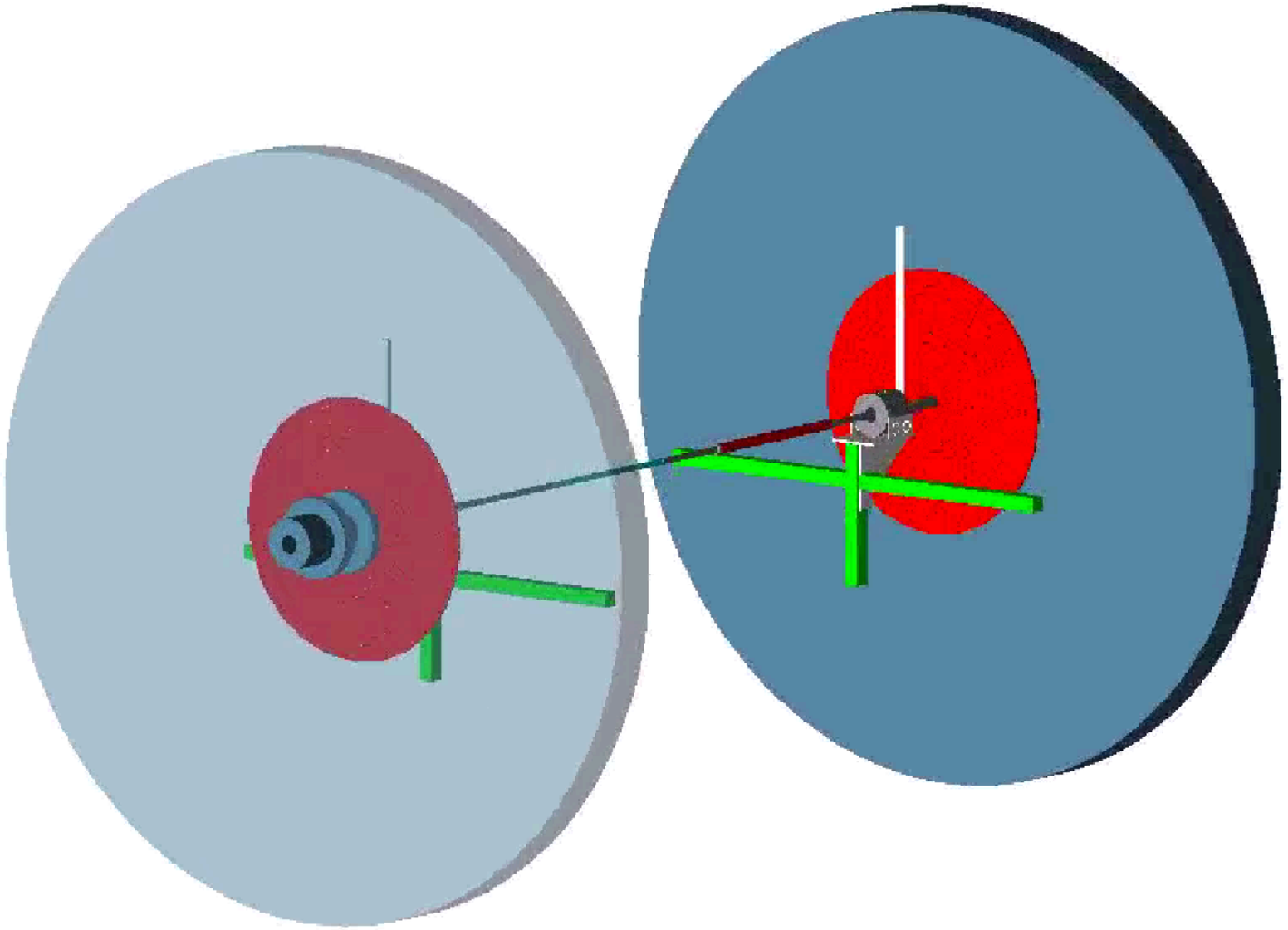
MC simulation: Geometry





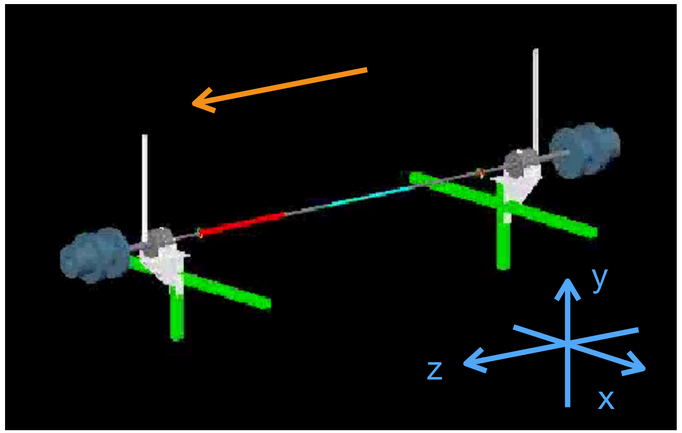
Black: existing
Blue: new

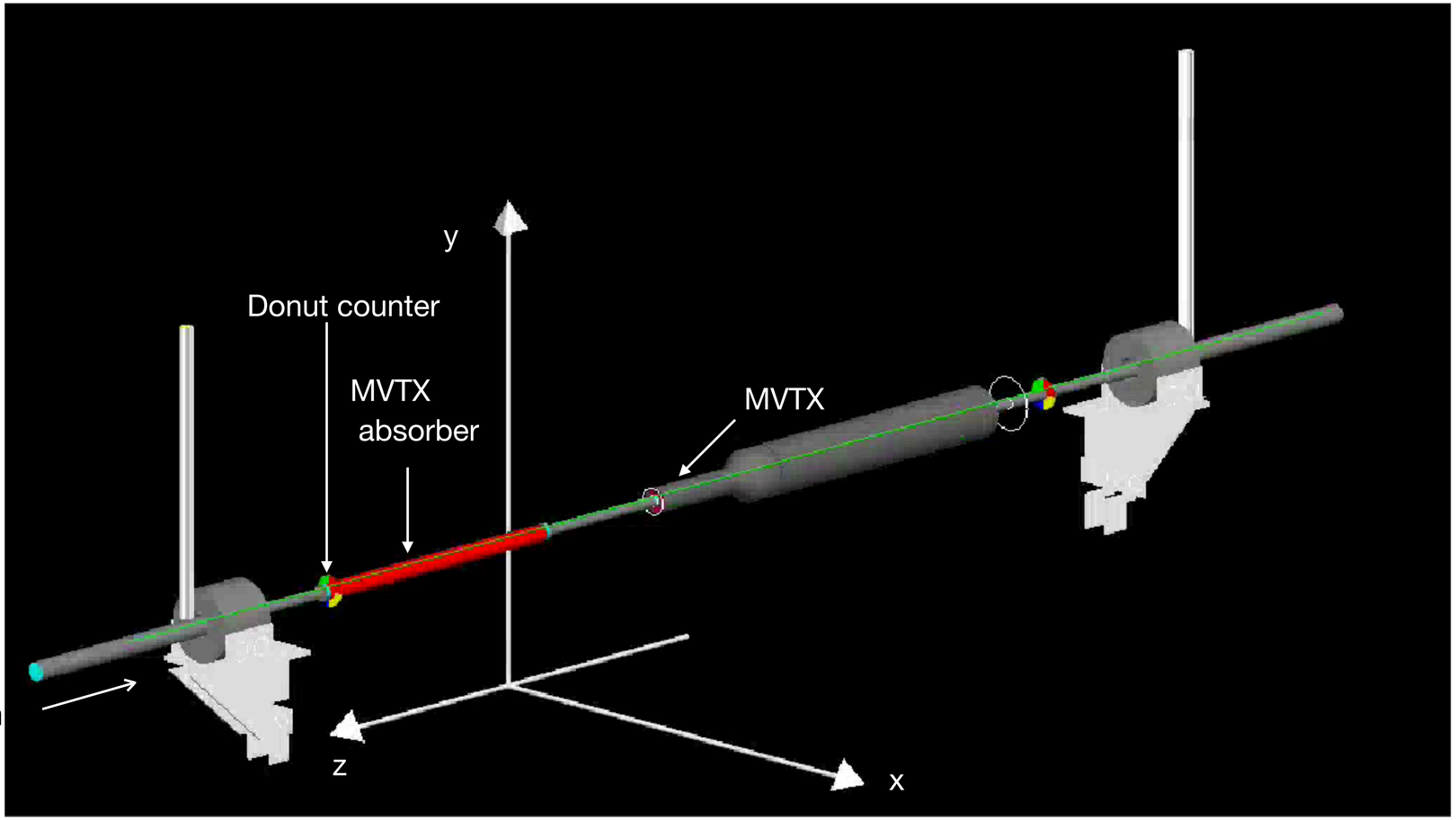
MC simulation: Geometry



MBD and sEPD are also shown

MC simulation: Setup

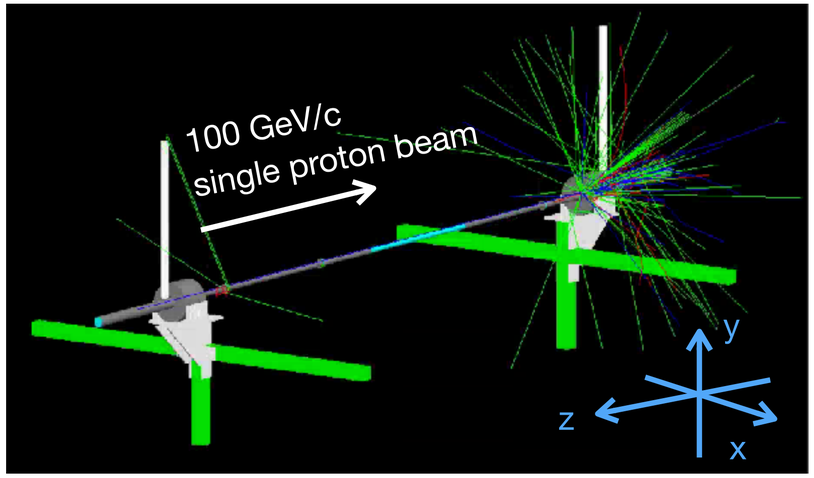


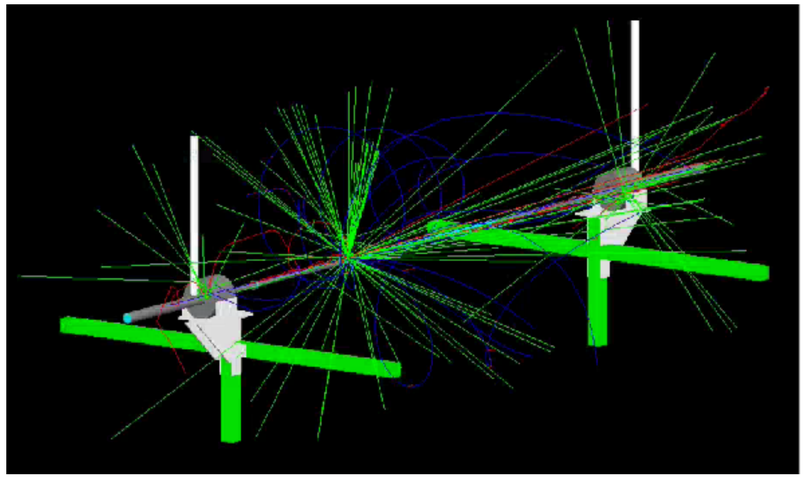


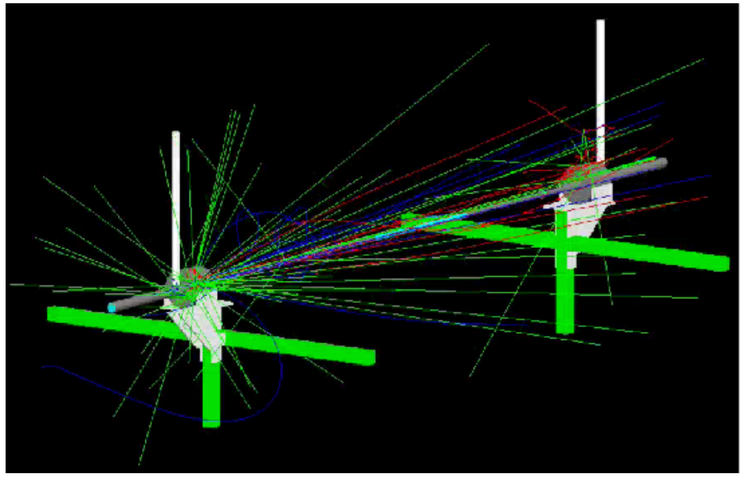
100 GeV/c
single proton beam

Geantino is used here.
Only beam pipe, MBD, MVTX, the new MVTX absorber, and the new donut counters are shown here.

MC simulation: Some event displays



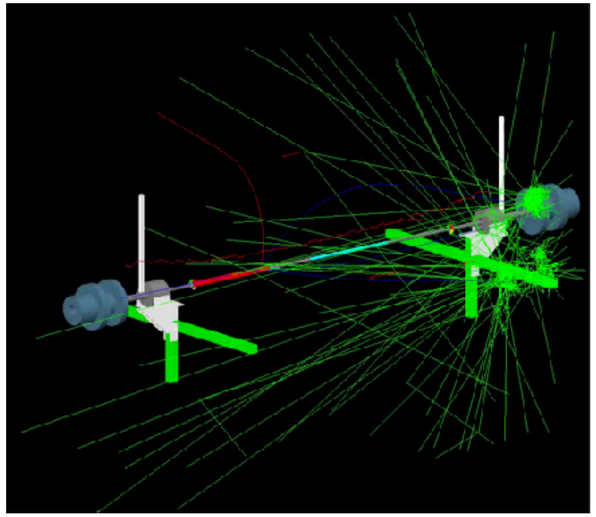


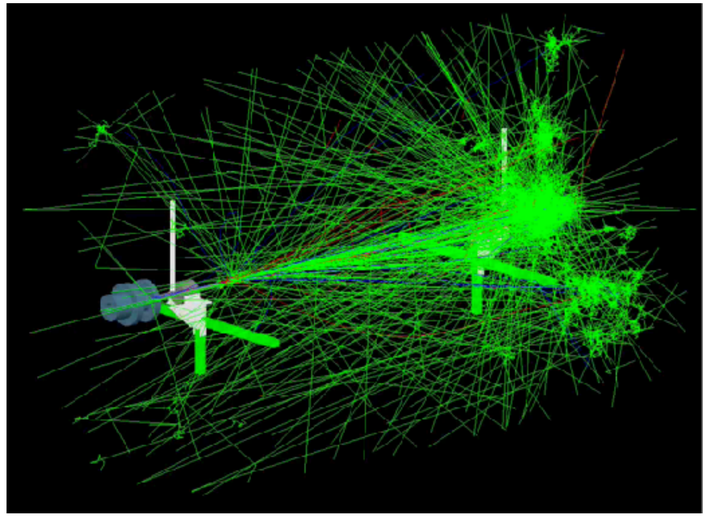


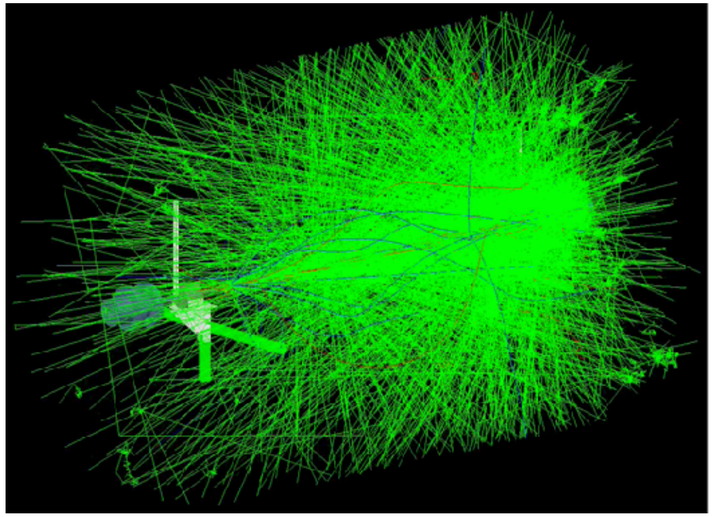
with the current geometry

---

with the new geometry

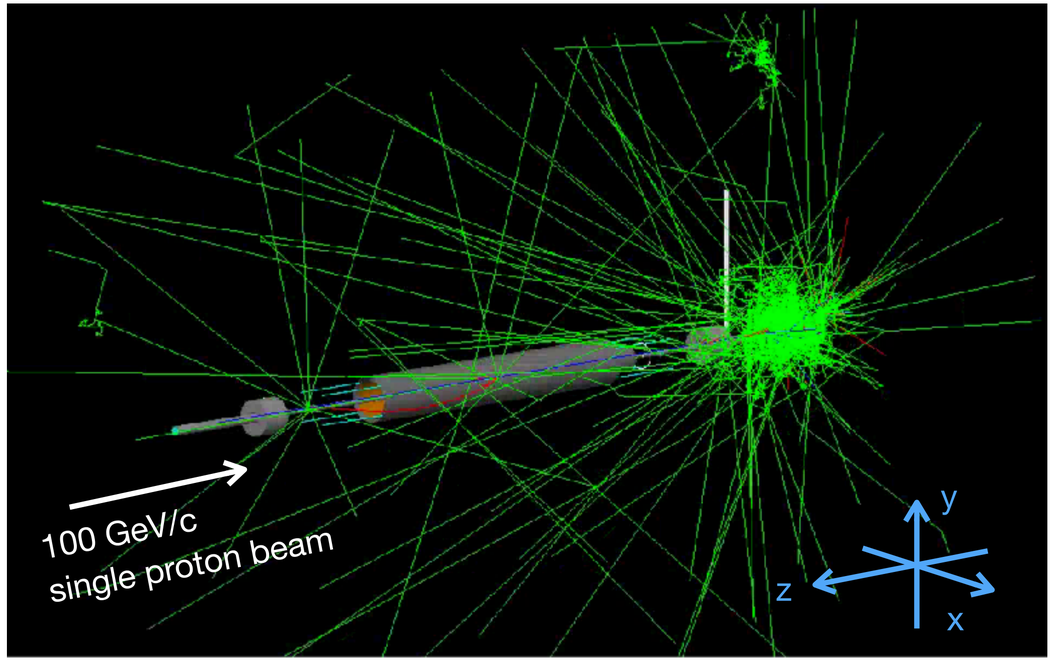


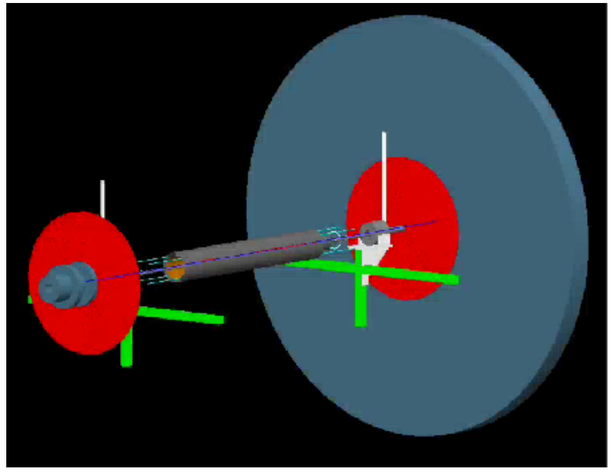


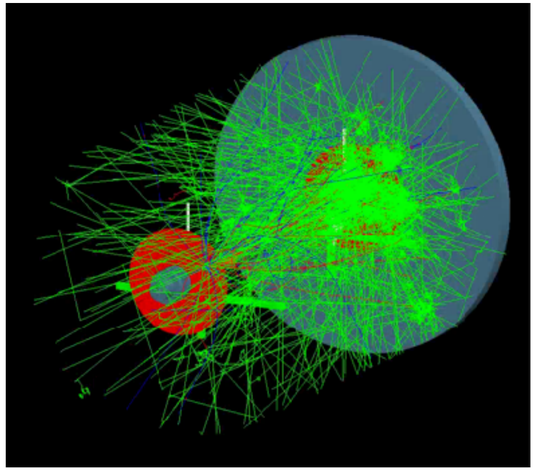


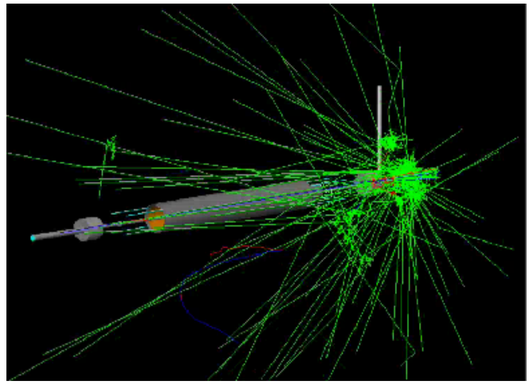
MC simulation: Some event displays

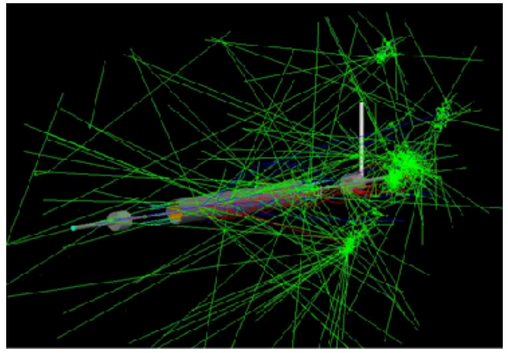
With the current geometry and detectors as many as possible
All different event

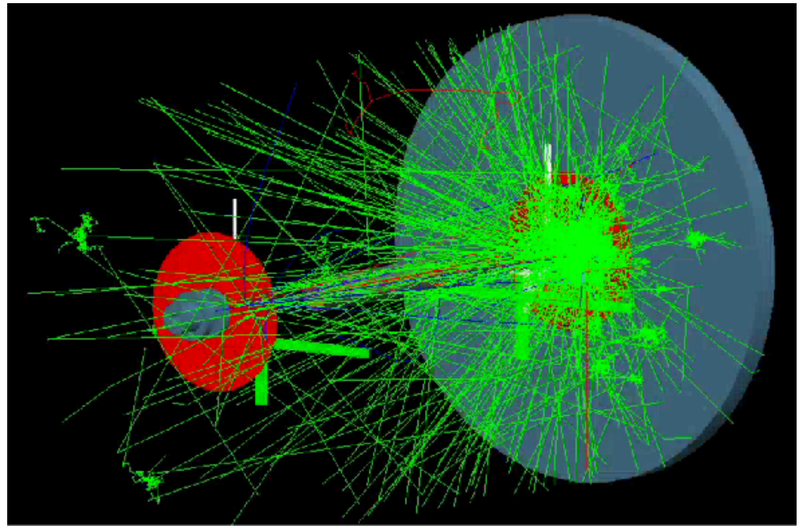


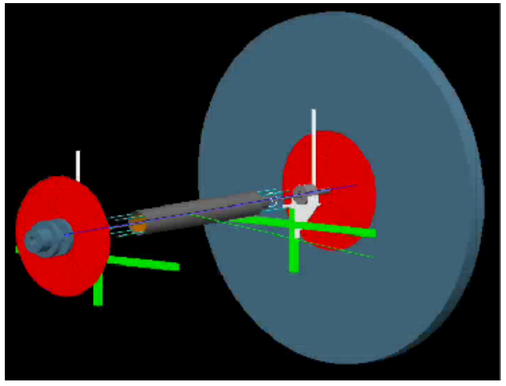




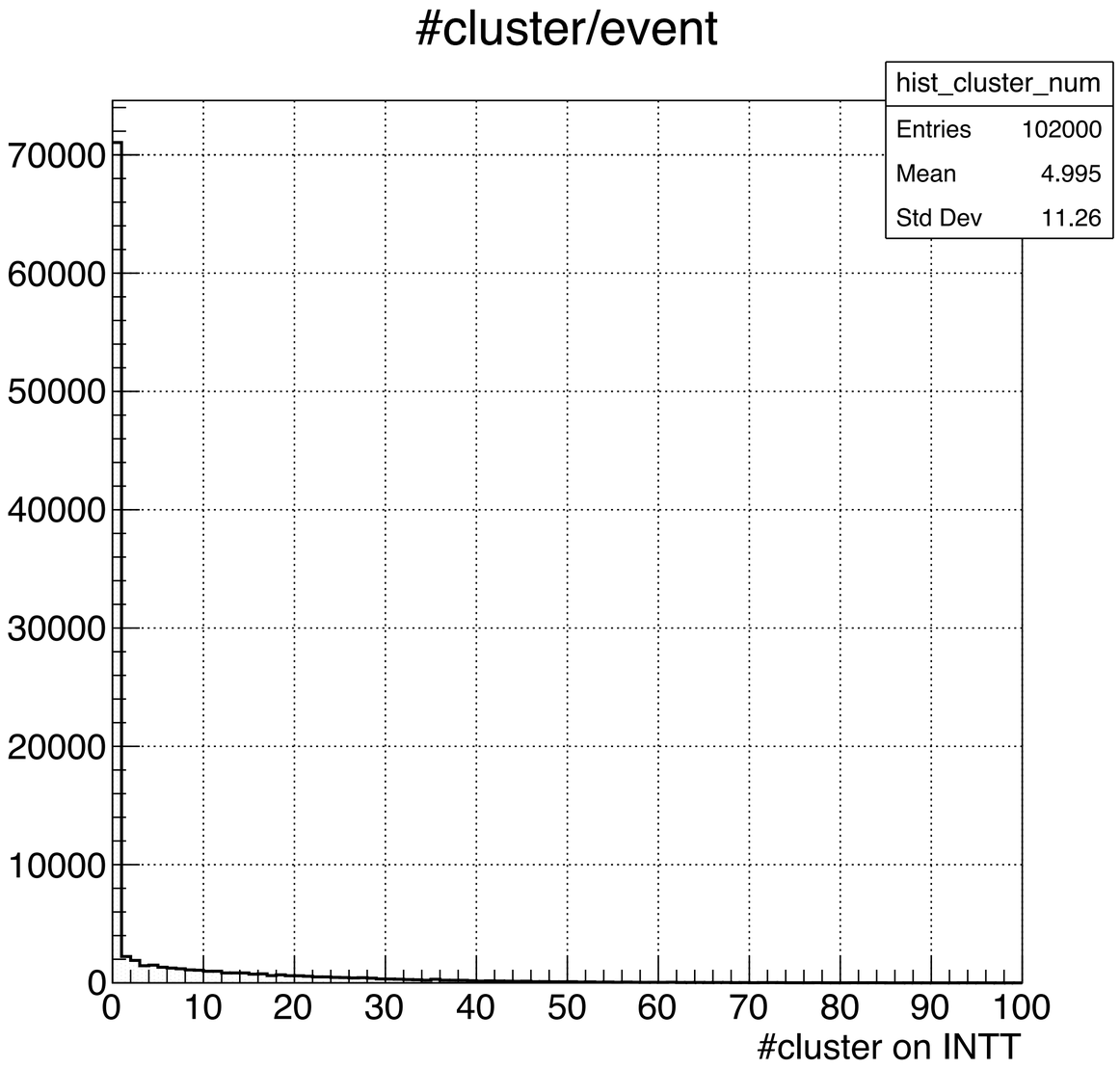








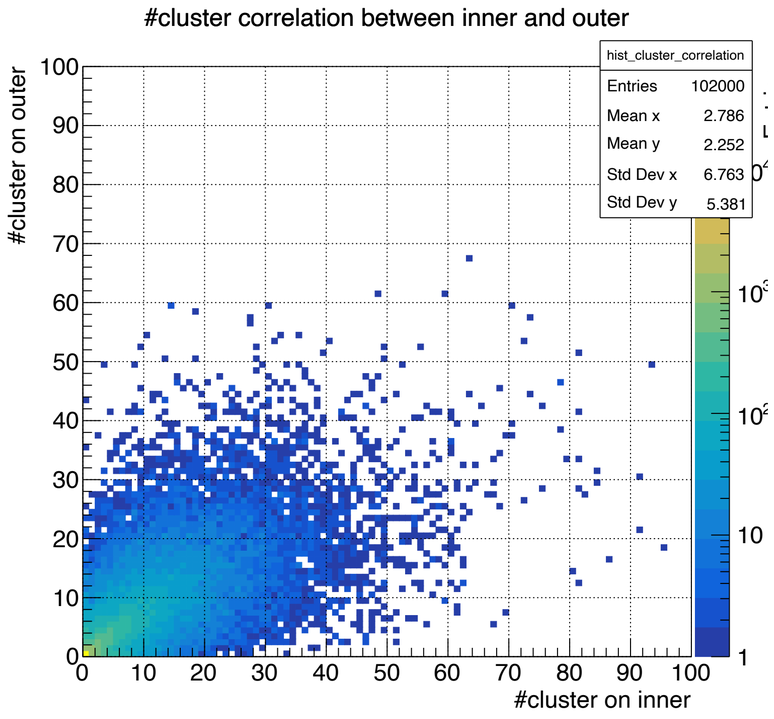
Results

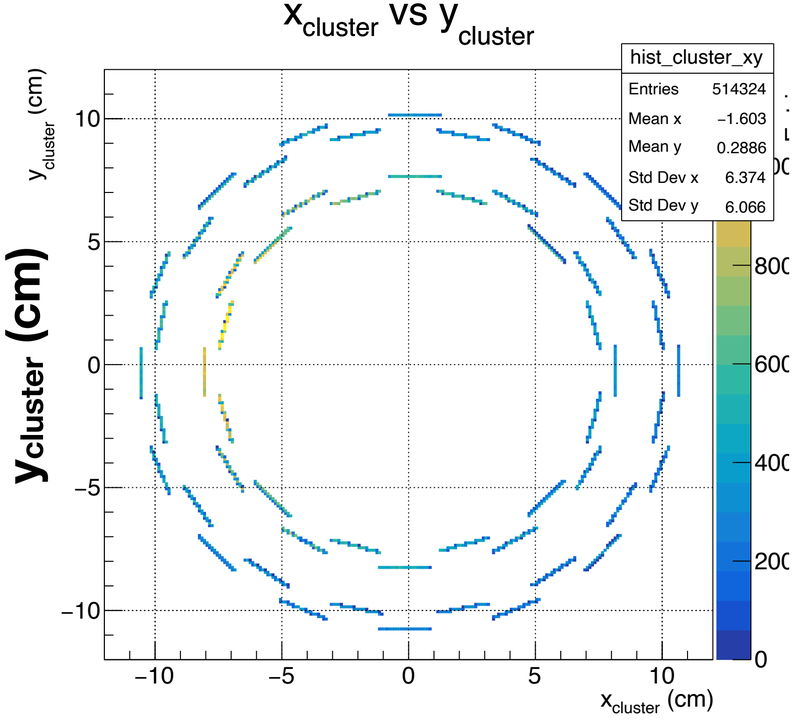


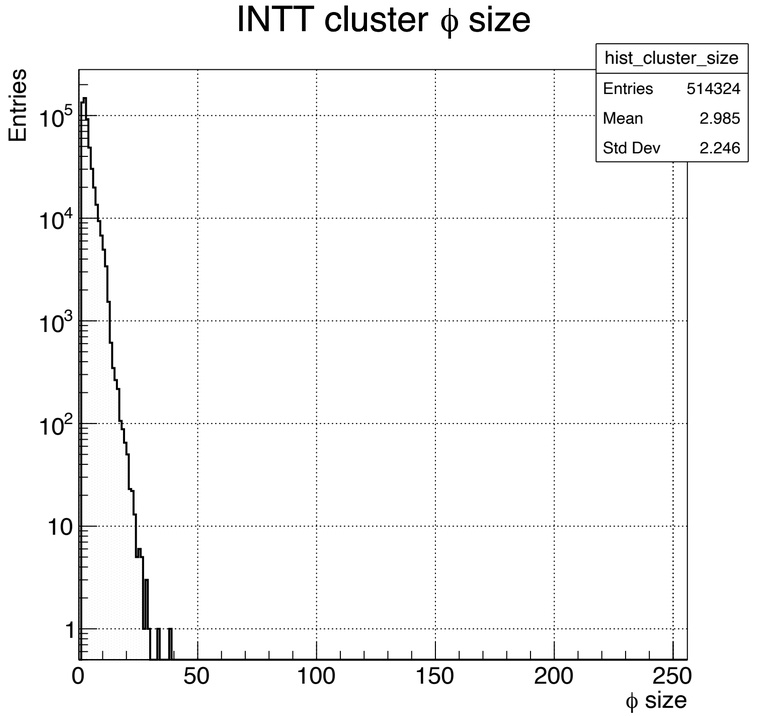
- A result of Run0 is shown.
  - ~100k events
  - 100 GeV p going to the flange of the beam pipe on the north side
  - Current geometry
- #INTT cluster/event is quite low. There is no cluster on INTT for 70% of events.
  (Can you believe?)

Results

- A result of Run0 is shown.
  - ~100k events
  - 100 GeV p going to the flange of the beam pipe on the north side
  - Current geometry



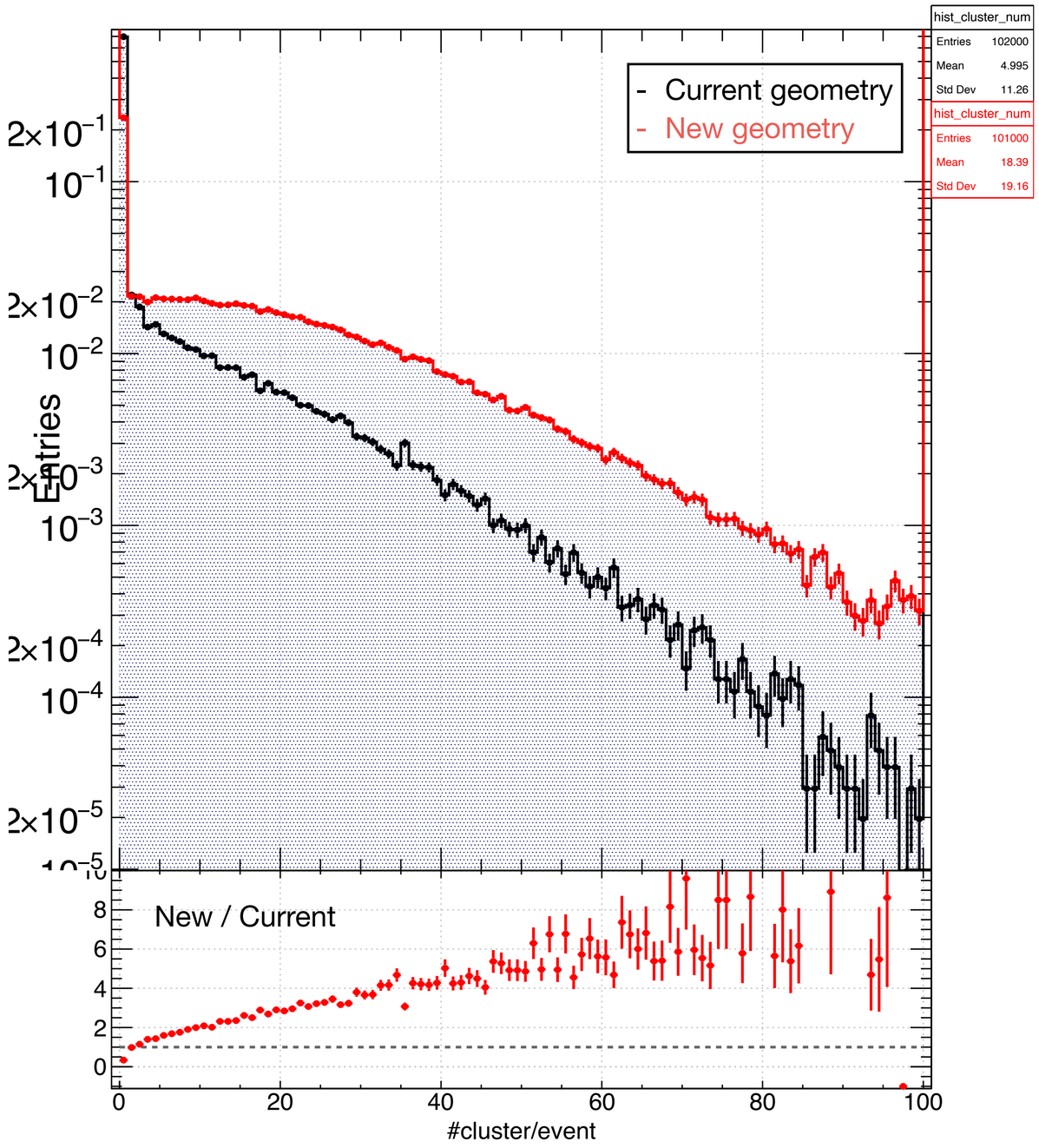




Results: Comparison

- Both run0 (current geom) and run1 (new geom) are shown. Both histograms on the top panel are normalized with their entires.
- Ratio of new/current is shown on the bottom panel.

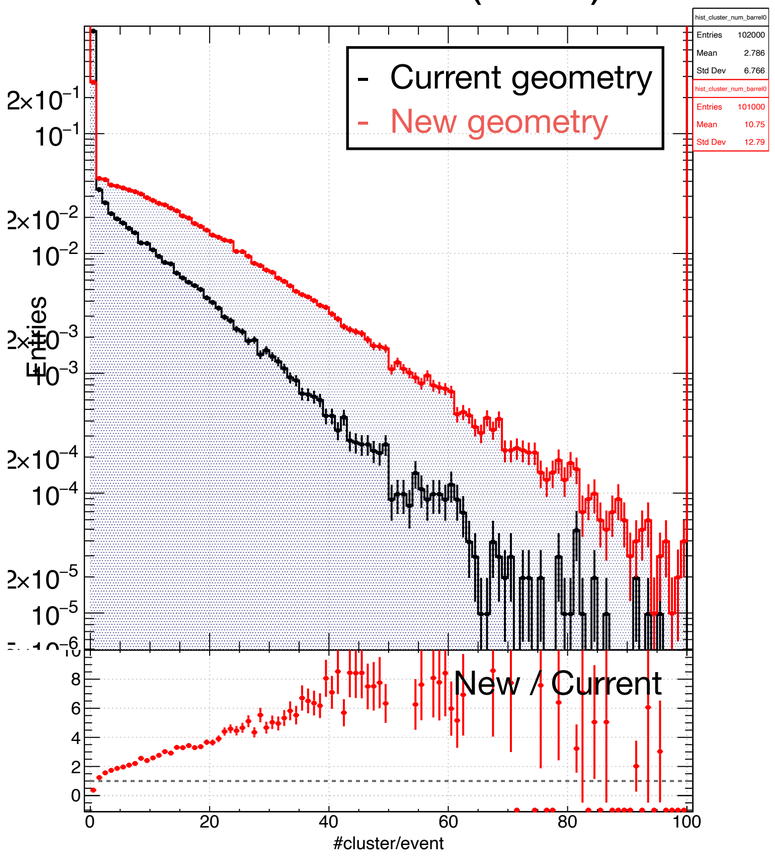
- The result from the new geometry makes more clusters than that from the current geometry. The mean value gets more than ×4 higher.



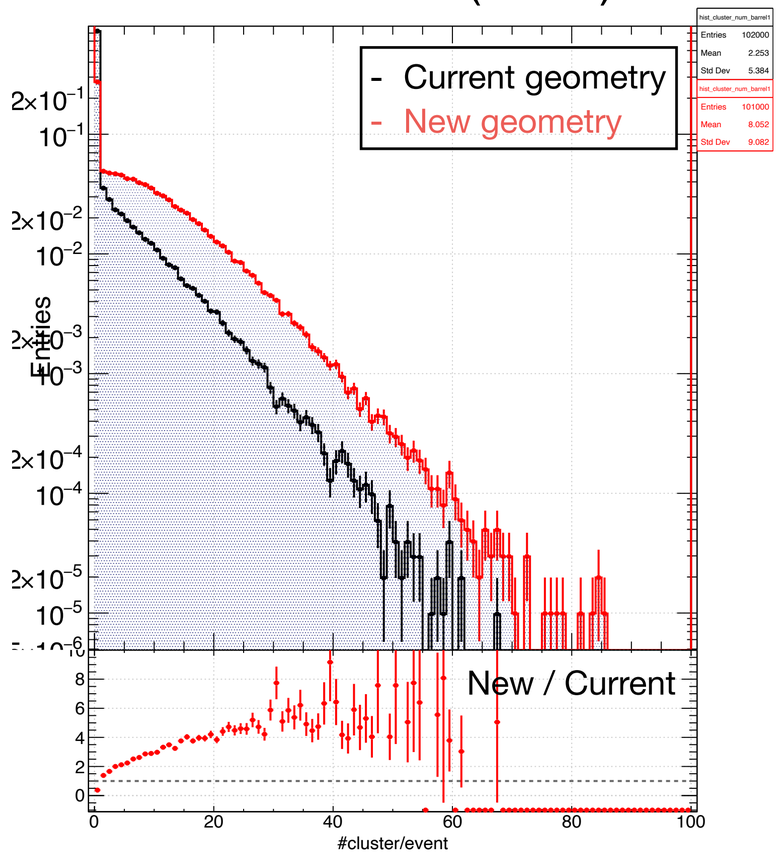
Results: Comparison

- Both run0 (current geom) and run1 (new geom) are shown. Both histograms on the top panel are normalized with their entires.
- Ratio of new/current is shown on the bottom panel.

#cluster/event(Inner)



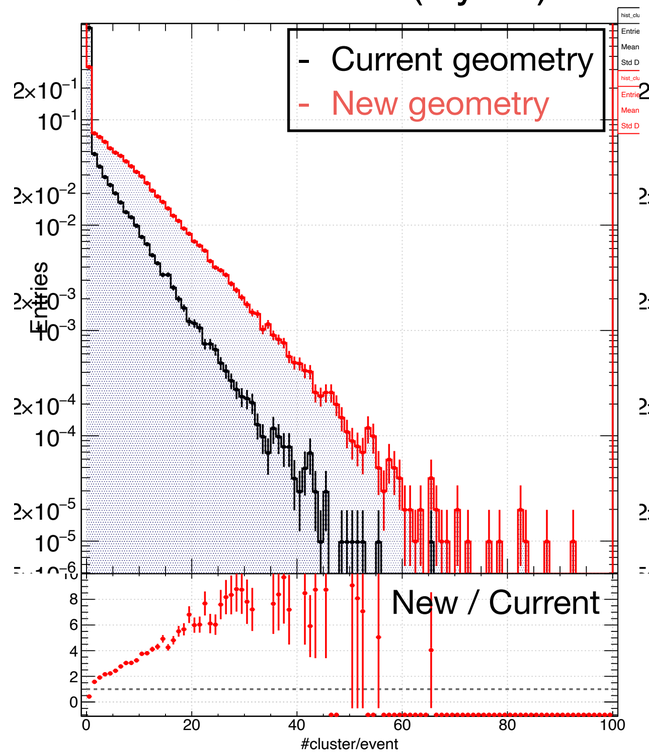
#cluster/event(Outer)



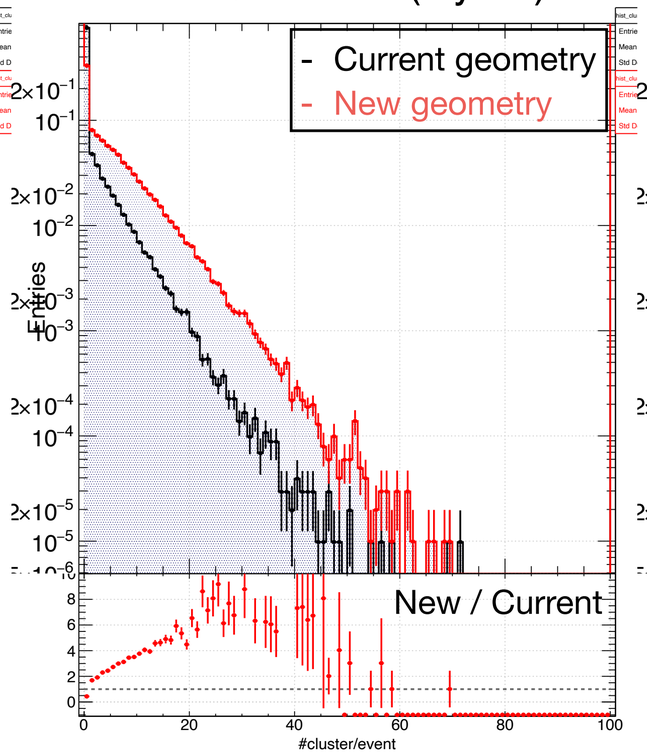
Results: Comparison

- Both run0 (current geom) and run1 (new geom) are shown. Both histograms on the top panel are normalized with their entires.
- Ratio of new/current is shown on the bottom panel.

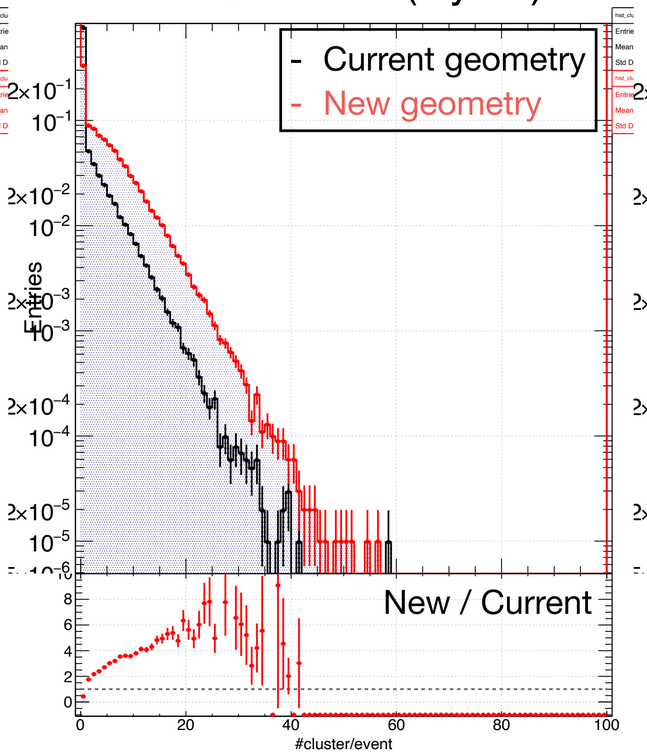
#cluster/event(layer0)



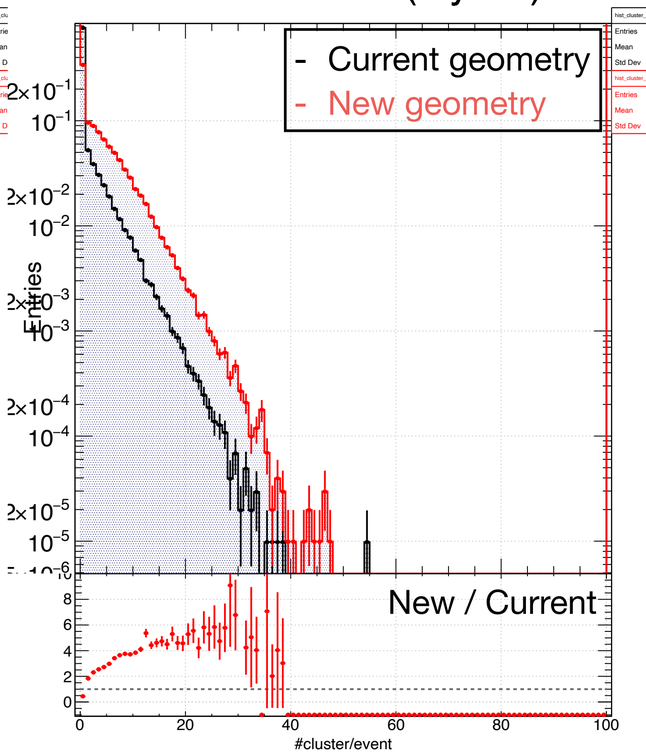
#cluster/event(layer1)



#cluster/event(layer2)

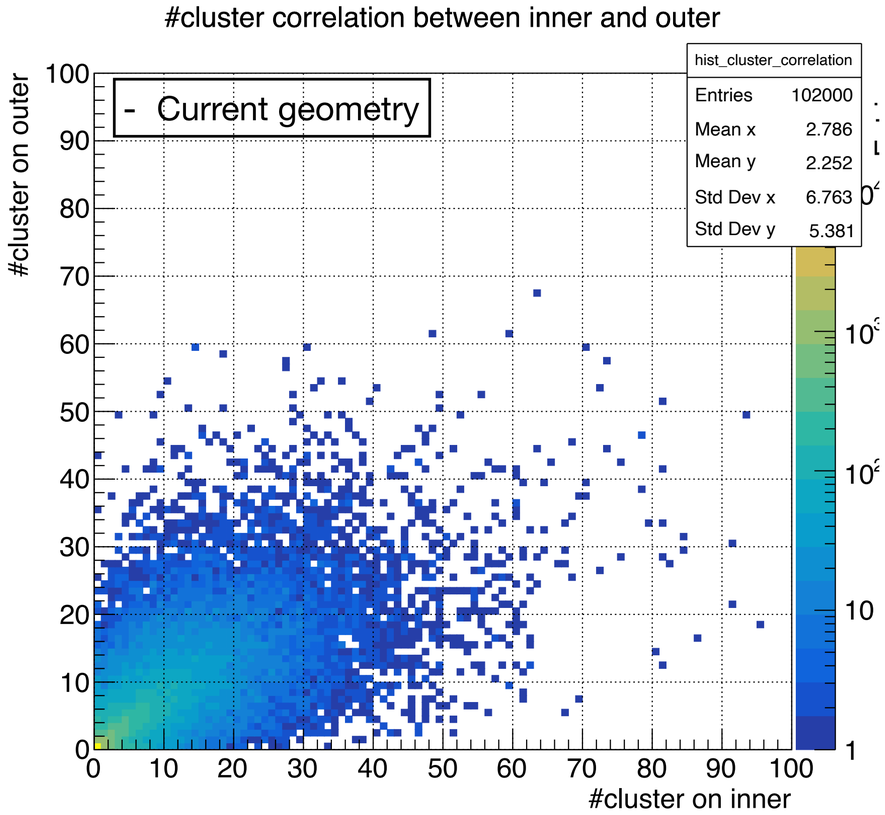


#cluster/event(layer3)



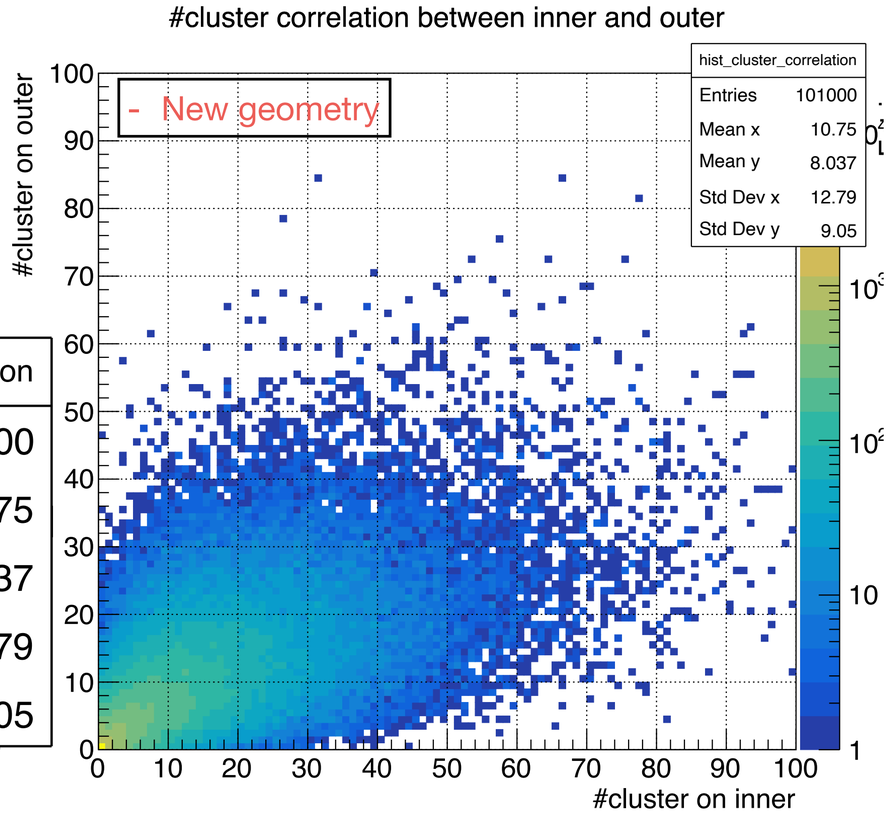
Results: Comparison

- Both run0 (current geom) and run1 (new geom) are shown. Both histograms on the top panel are normalized with their entires.
- Ratio of new/current is shown on the bottom panel.



hist_cluster_correlation	
Entries	102000
Mean x	2.786
Mean y	2.252
Std Dev x	6.763
Std Dev y	5.381

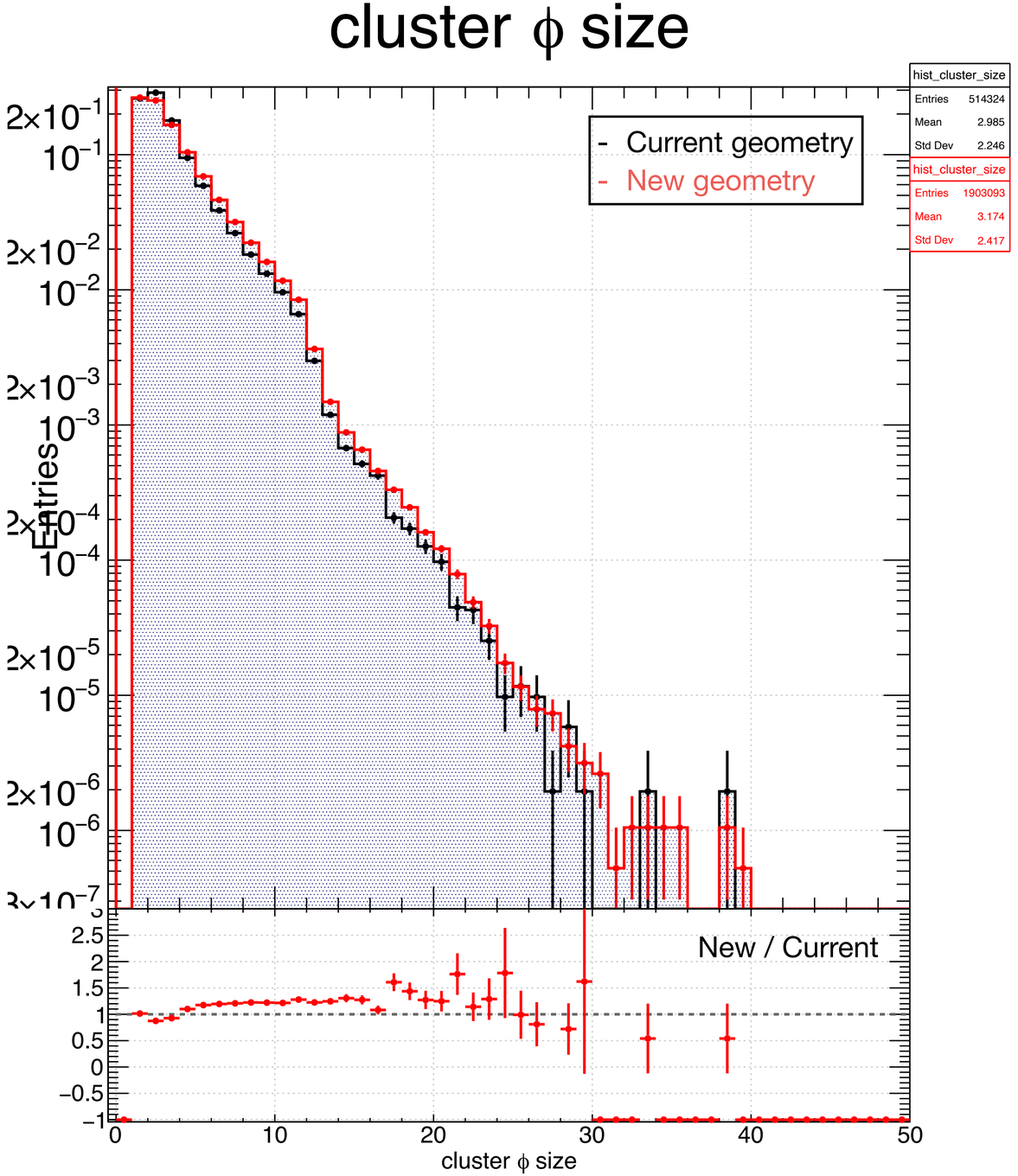
hist_cluster_correlation	
Entries	101000
Mean x	10.75
Mean y	8.037
Std Dev x	12.79
Std Dev y	9.05



Results: Comparison

- Both run0 (current geom) and run1 (new geom) are shown. Both histograms on the top panel are normalized with their entires.
- Ratio of new/current is shown on the bottom panel.

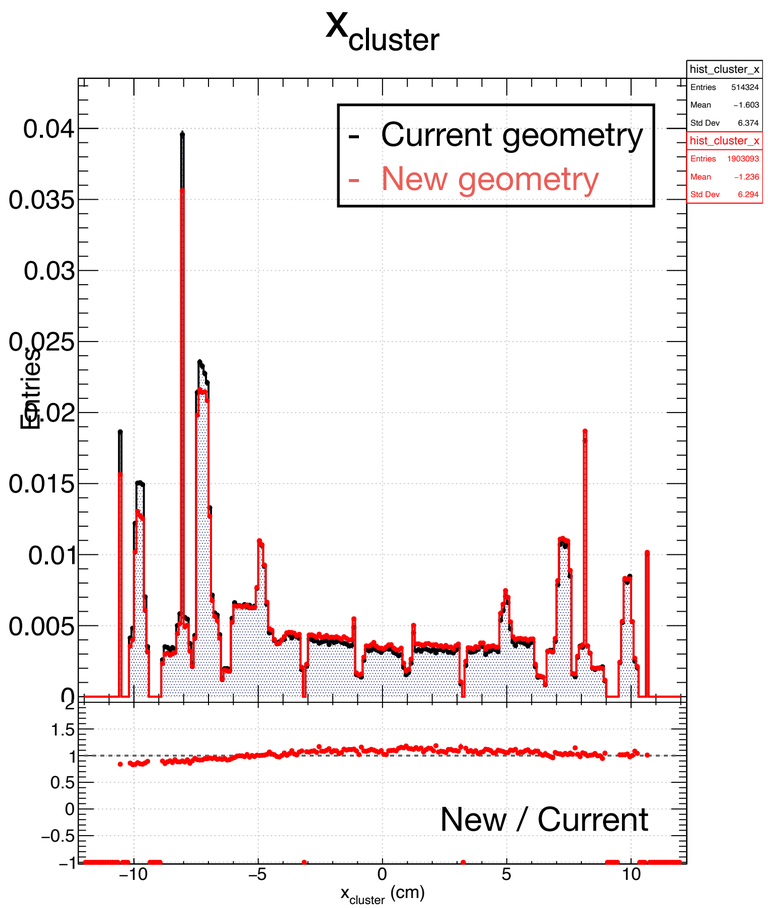
- The cluster ϕ size is also changed little bit. It probably suggests that more tracks traverse INTT in small angle by the new absorber.

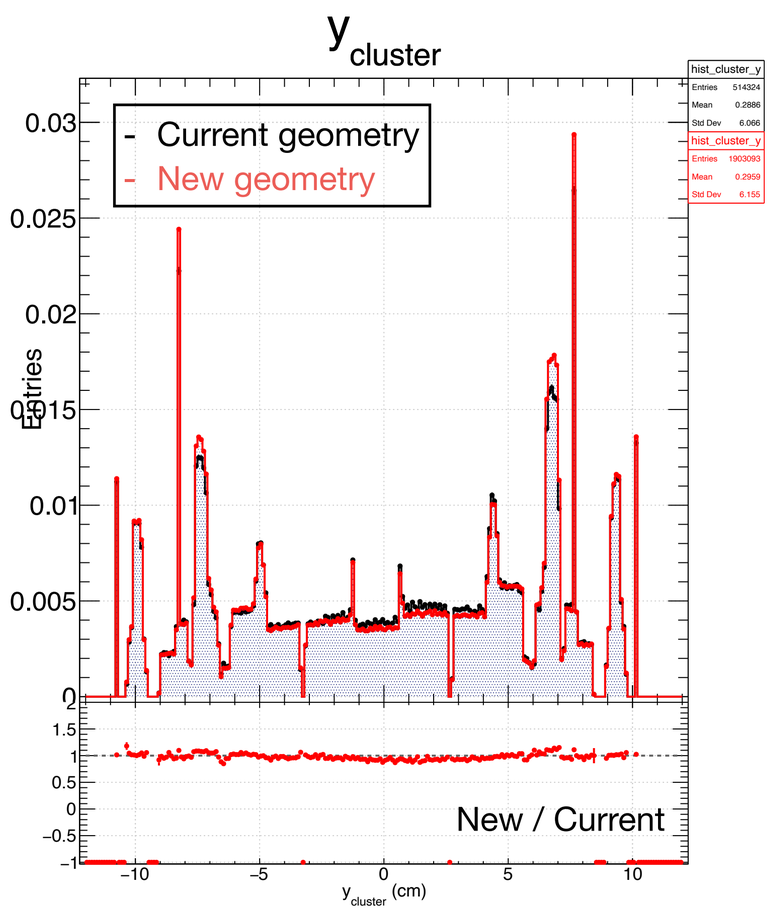


Results: Comparison

- Both run0 (current geom) and run1 (new geom) are shown. Both histograms on the top panel are normalized with their entires.
- Ratio of new/current is shown on the bottom panel.

- Comparisons of cluster position are shown. The distributions are slightly changed by the new geometry.

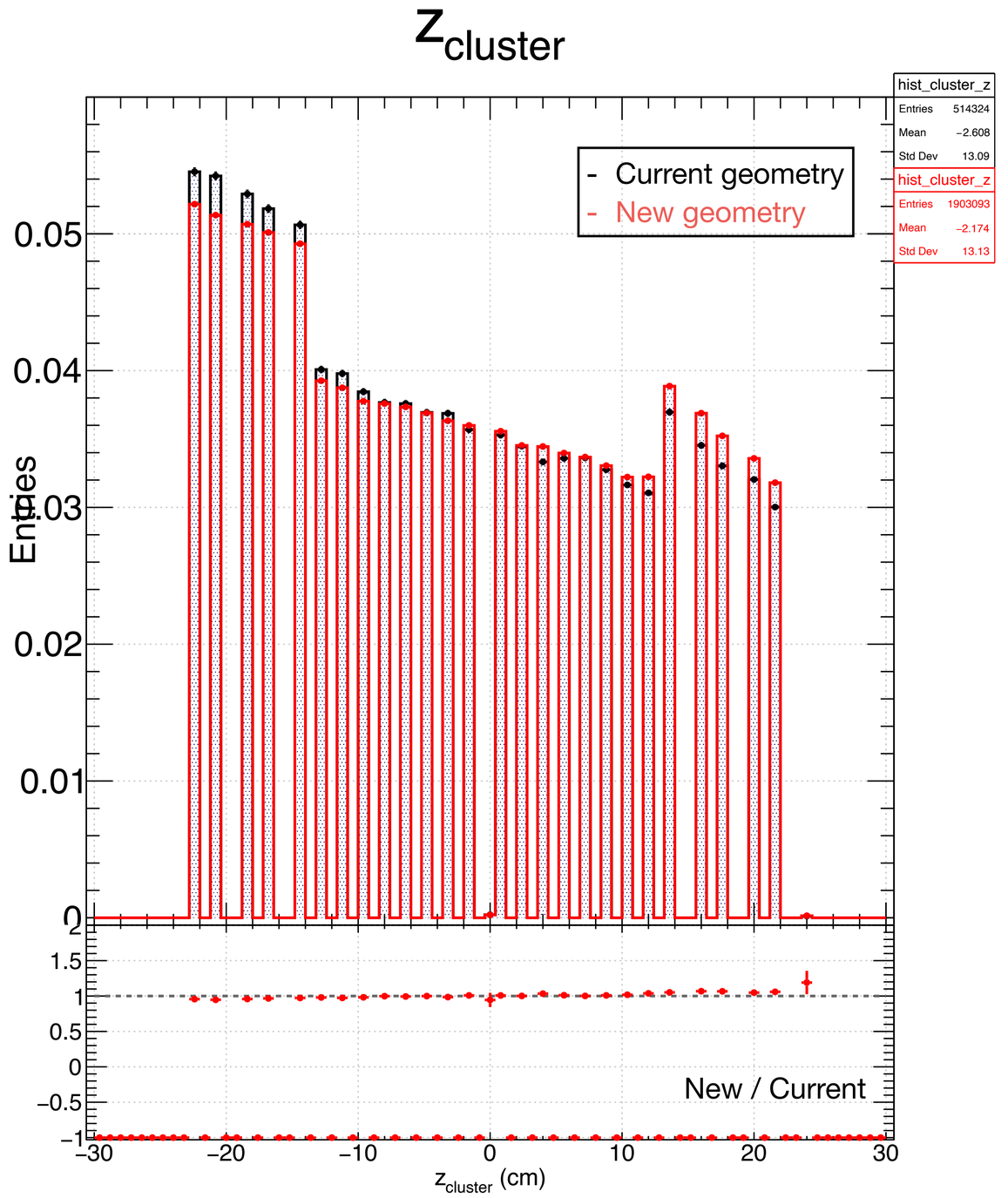




Results: Comparison

- Both run0 (current geom) and run1 (new geom) are shown. Both histograms on the top panel are normalized with their entires.
- Ratio of new/current is shown on the bottom panel.

- Comparisons of z position of clusters are shown. More clusters are found on the size of the MVTX absorber but not too much.



Summary

- Installation of the new absorber for MVTX and donut counters are being discussed now.
- Effect to INTT by them was evaluated by MC. It was quickly launched thanks to Cameron.
- TrkrCluster on INTT was checked.
- > ×4 times more clusters were found by the new materials = x4 more background to INTT.
- Property of clusters (position and size) is not changed by the new materials.
- This work was done in only 36h. There may be some mistakes…