

Status Report

Shota Izumiyama (Tokyo Tech.)

10 Jan. 2020

mPMT-Japan meeting

Updates

- Made large MC to evaluate “miss-reconstructed events fraction”
 - Generated the events near only the wall
- Compared other dark rate case, 300 Hz
- Left slide is one of presented at the HK software meeting of yesterday

Status Report

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9 Jan. 2020

HK software meeting

Contents

- Simulation of mPMT hybrid configurations
 - It is confirmed that the mPMT make better configuration for low energy events by Benjamin-san.
 - I checked the vertex reconstruction performance with different photo-coverages and dark-rate of mPMT in detail.
 -

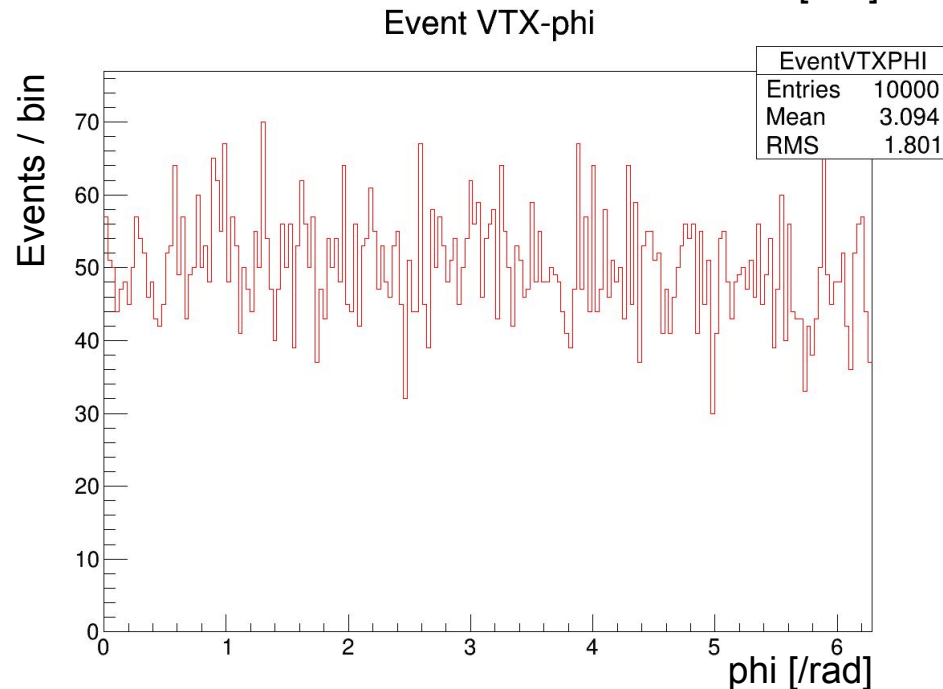
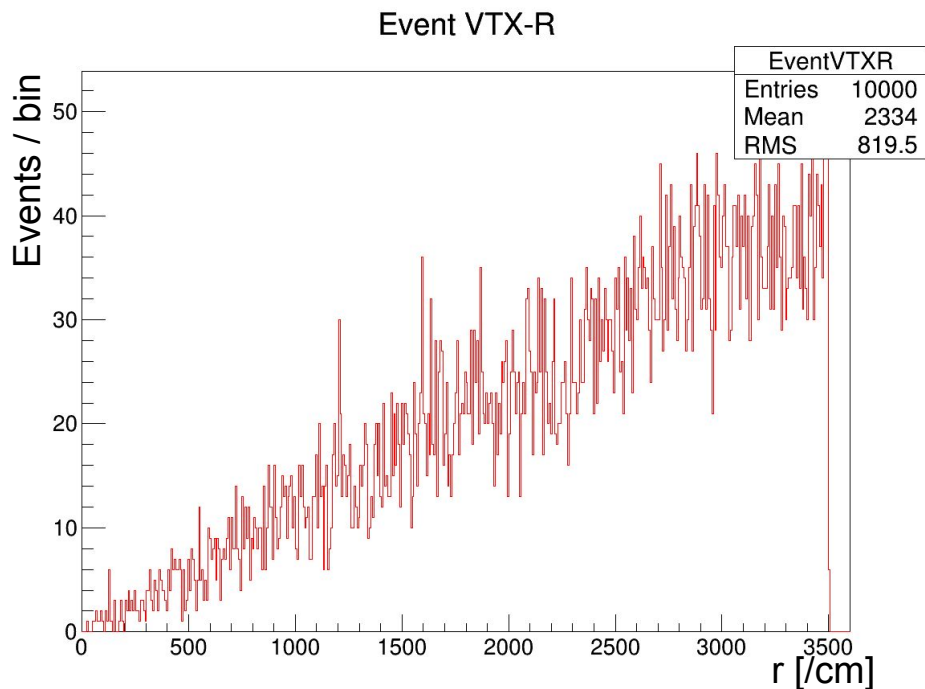
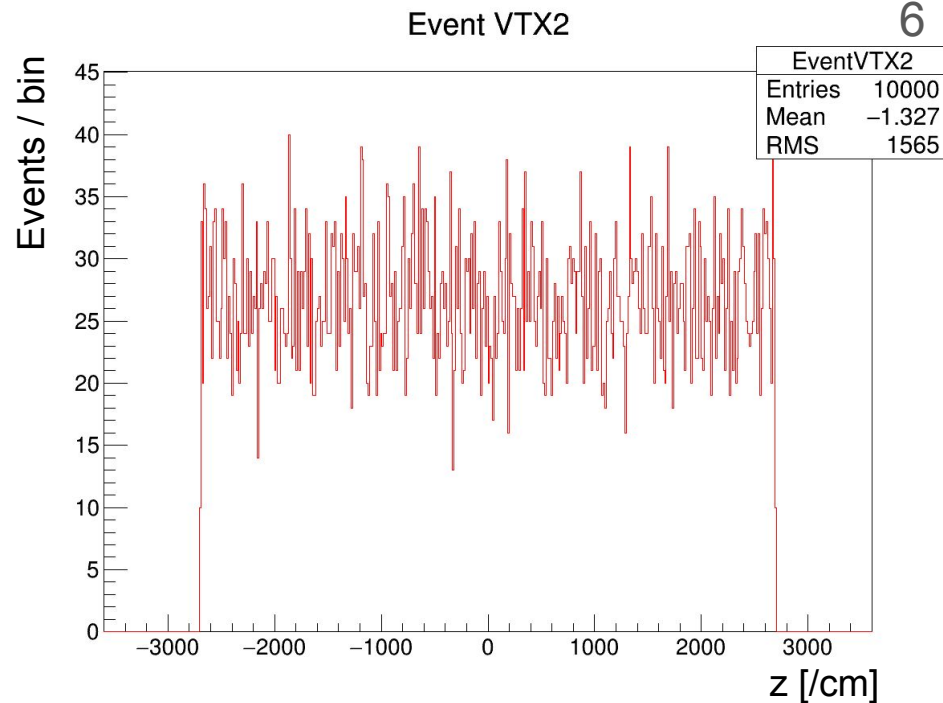
MC production

- Reproduced MC after the modification
- Configuration: HK mPMT hybrid
 - B&L: DR = 4.2 kHz, # = 20 k
 - mPMT: DR = 50 / 100 / 200 Hz, # = 10 k
 - To simulate lower photo-coverage, I used the masking method validated by Benjamin-san.
- Particle: electron
 - Energy: 3 / 4 / 5 / 6 / 8 / 10 / 15 MeV
 - Vertex: uniform in the tank (cylinder of 54 m height and 35 m diameter)
 - To calculate miss-reconstructed events fraction, the events are generated only near the tank wall.
 - Direction: isotropy
 - # of events: 10,000 for vertex resolution, 50,000 for miss-rec. events fraction

Vertex distribution

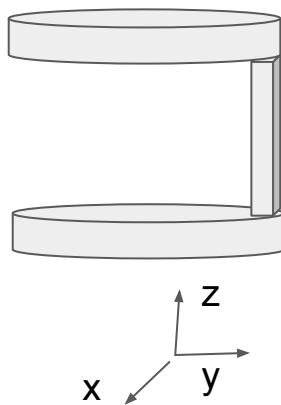
- $E = 3 \text{ MeV}$
- $DR = 50 \text{ Hz}$

6



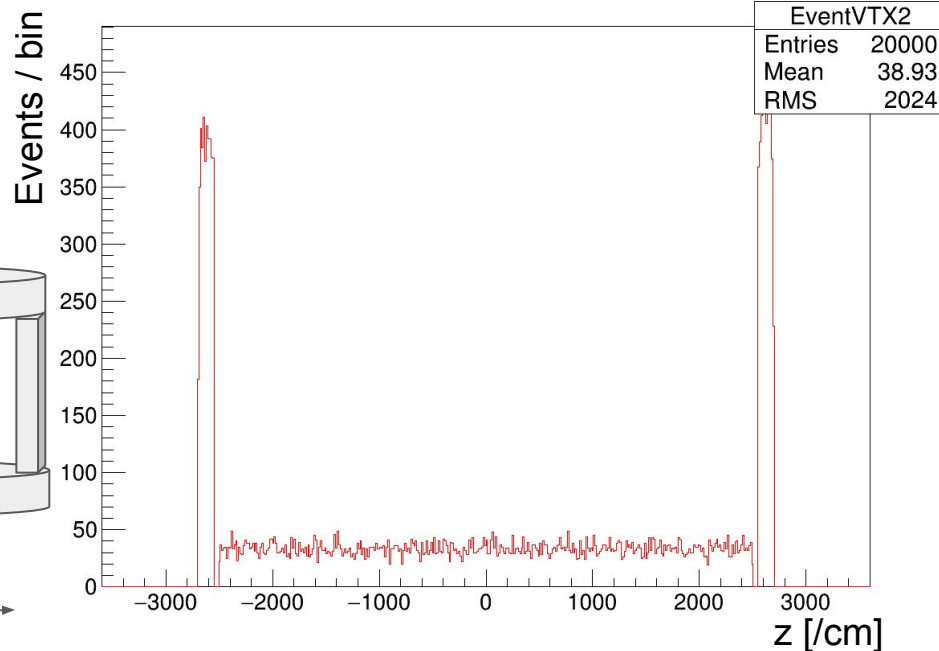
Vertex distribution

- $E = 3 \text{ MeV}$
- $DR = 50 \text{ Hz}$
- Near the tank wall like right shape

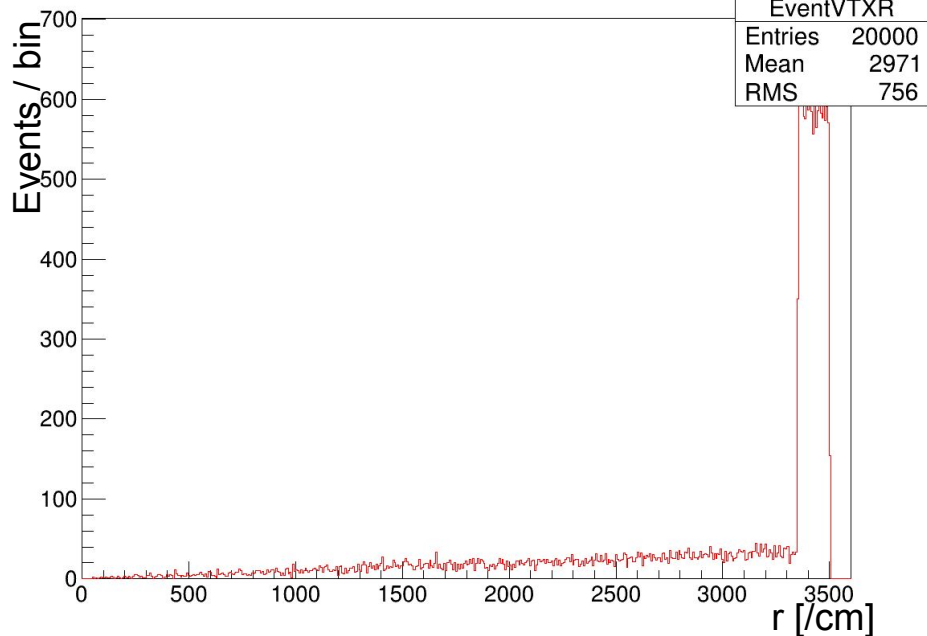


Event VTX2

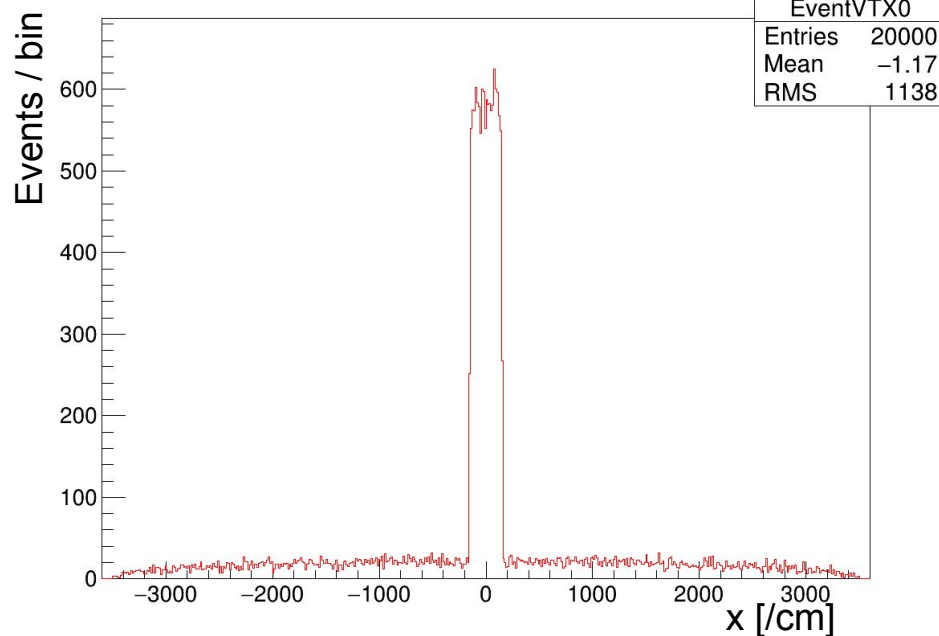
7



Event VTX-R

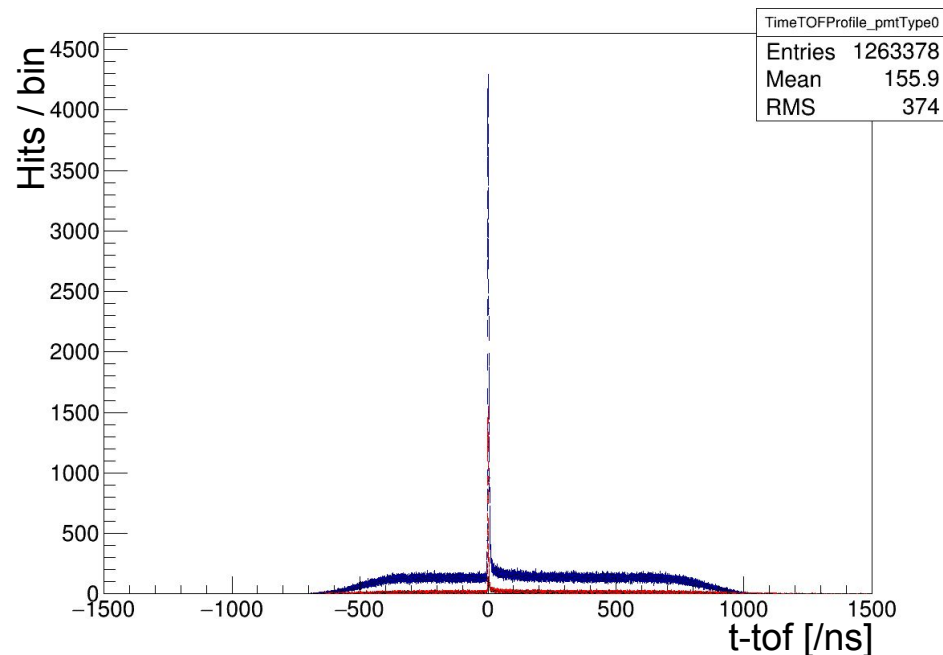
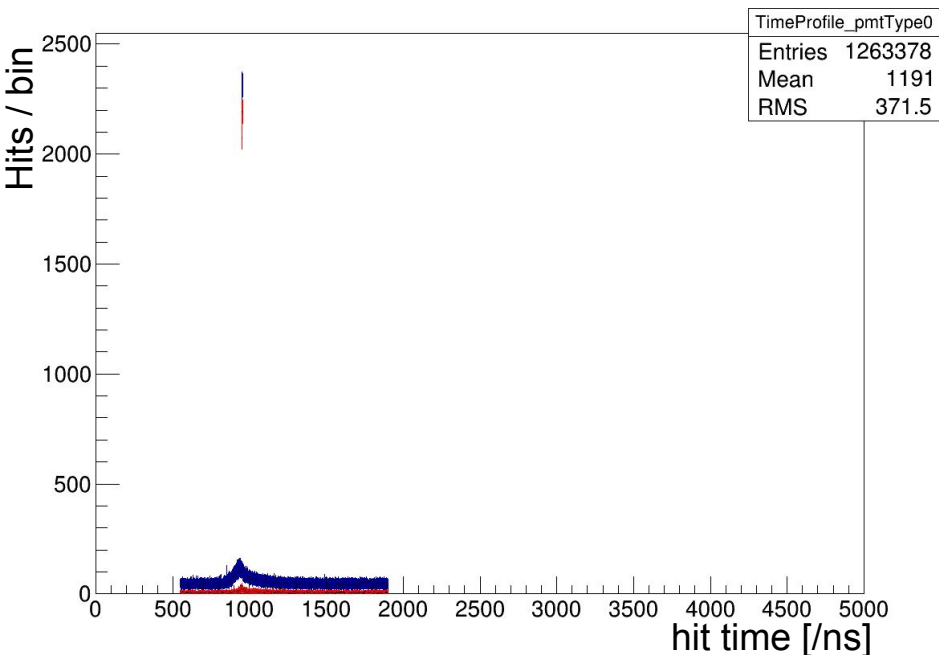
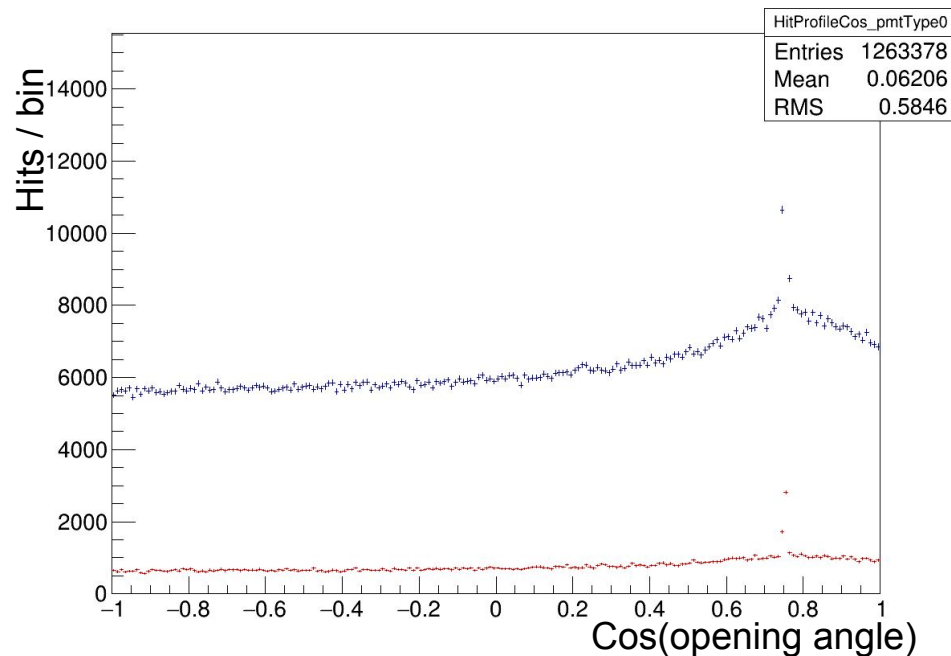


Event VTX0



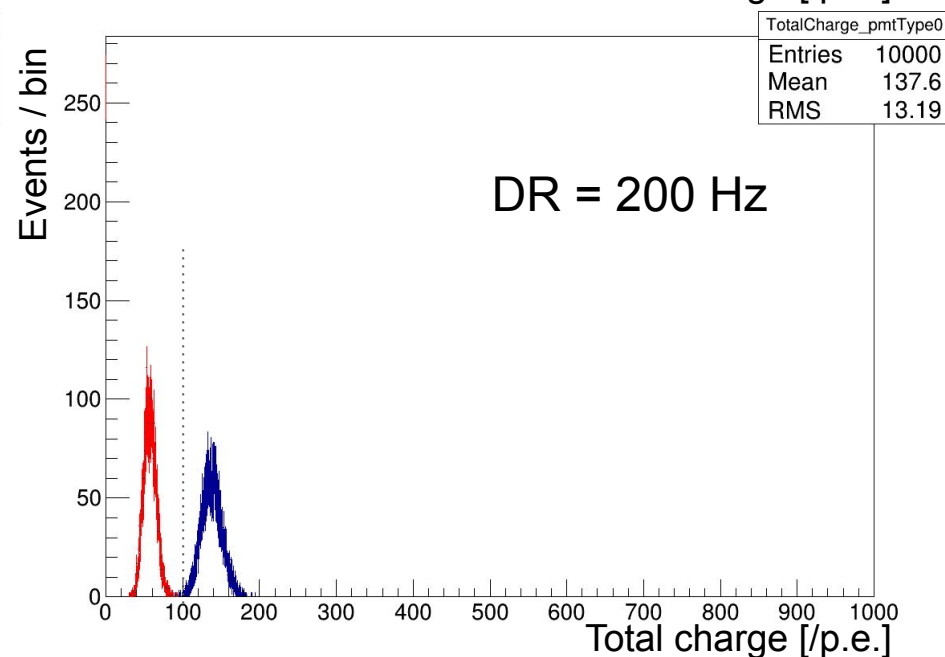
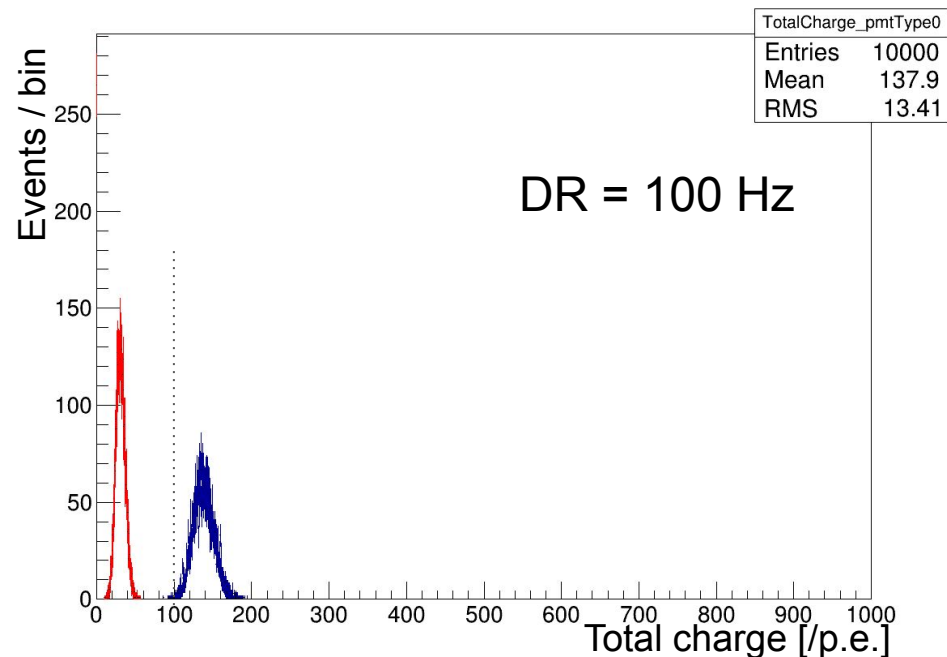
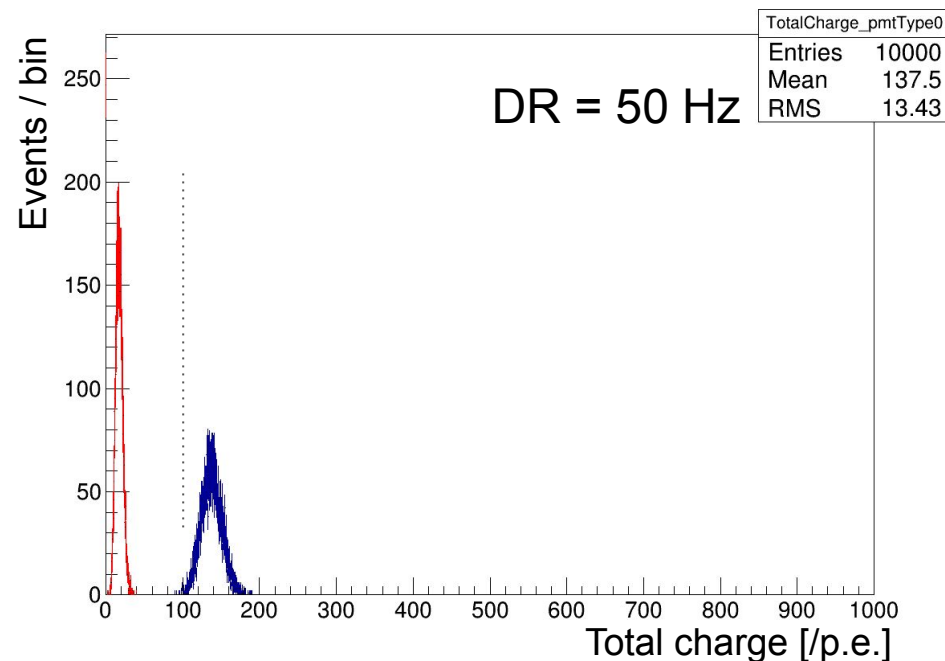
Time / hit profiles

- $E = 3 \text{ MeV}$
- $DR = 50 \text{ Hz}$
- Blue = B&L, red = mPMT



Total charge

- $E = 3 \text{ MeV}$
- Blue = B&L, red = mPMT
- Dotted line shows 100 p.e.
- At 3 MeV, almost all charge is of the DR.

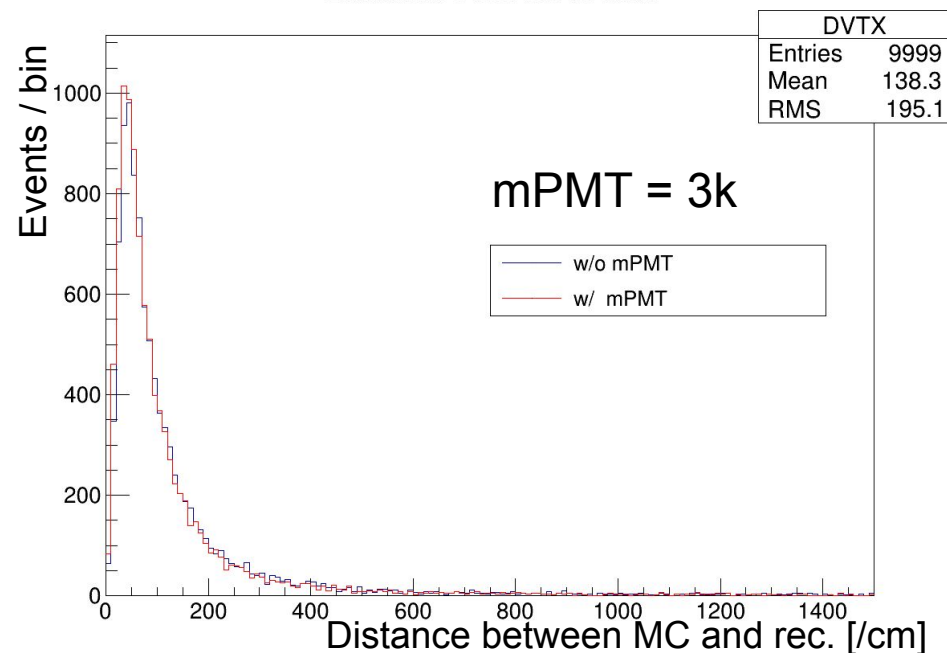
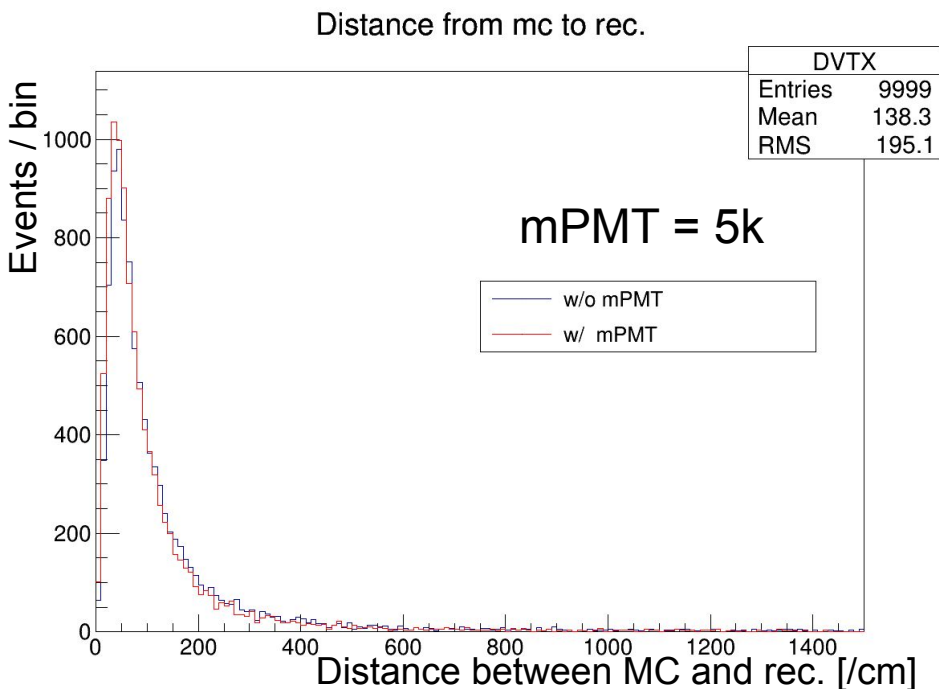
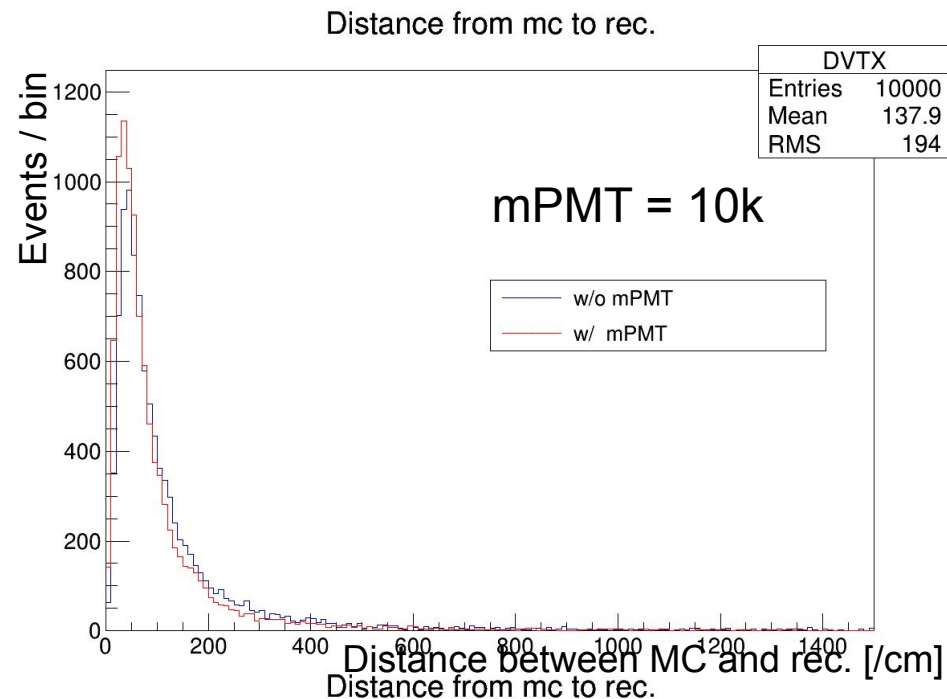


Reconstruction

- I used the LE fitter developed by Benjamin-san. It is not BONSAI but it works in same strategy.
- To compare different photo-coverages of mPMTs (# of mPMTs), I reconstructed with masking method
 - # of mPMT = 5k, 3k
 - In masking method, 5k (7k) mPMTs are selected randomly and not used for the reconstruction.

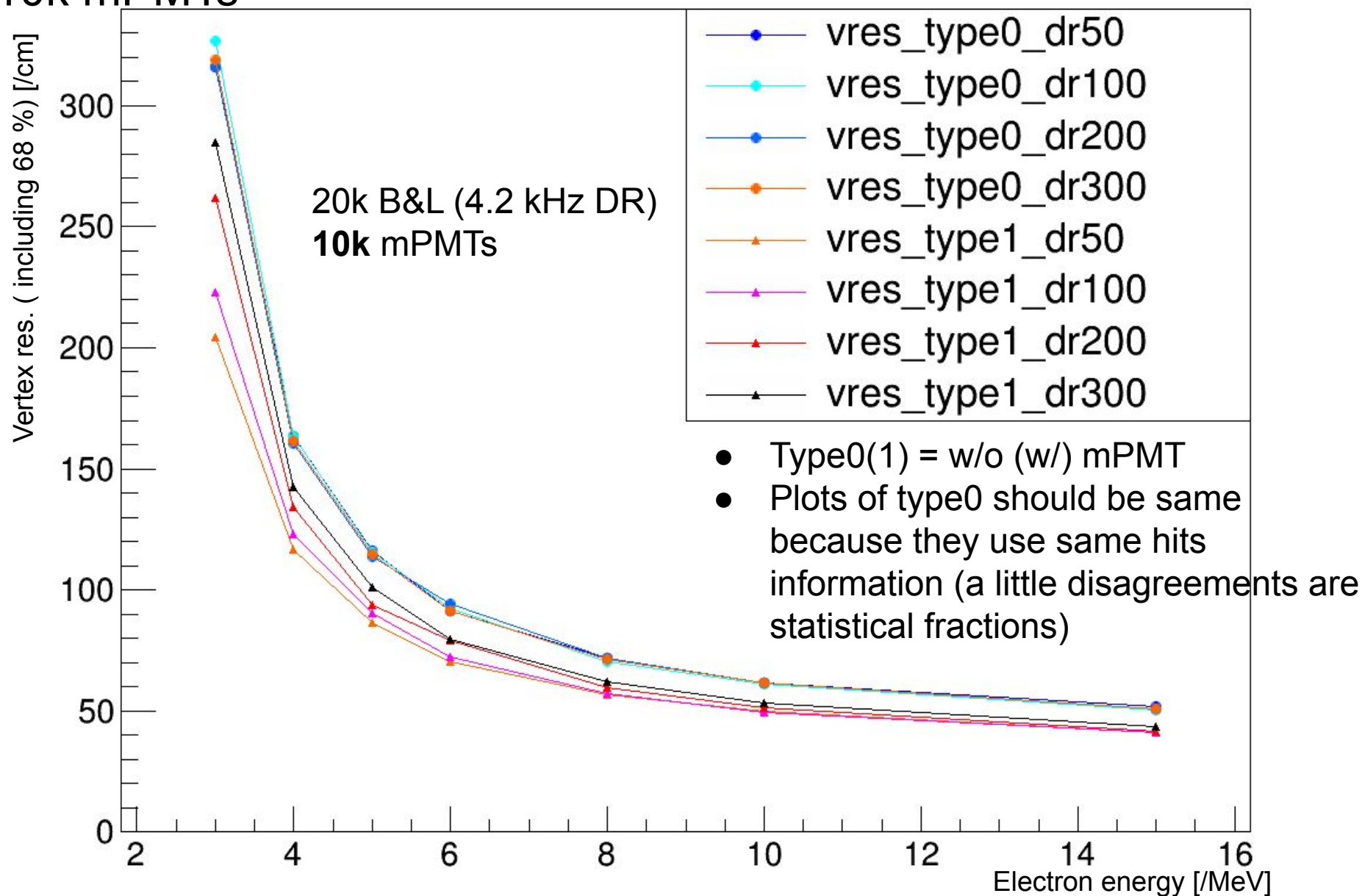
Distance between MC and rec.

- $E = 10$ MeV
- $DR = 100$ Hz
- More mPMTs,
sharper peak of red hist.



Comparison of DR 10k mPMTs

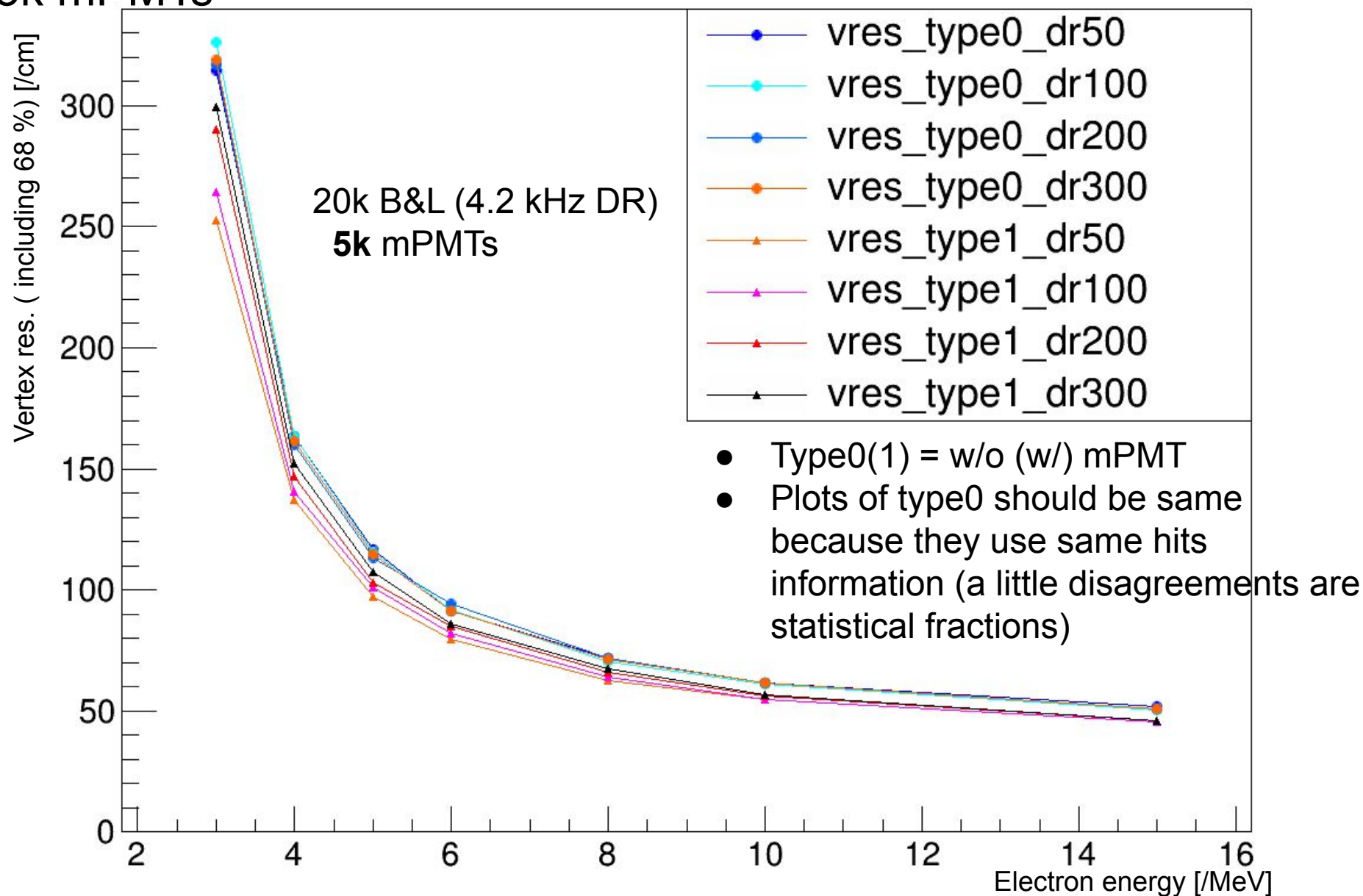
vertex resolution



Comparison of DR

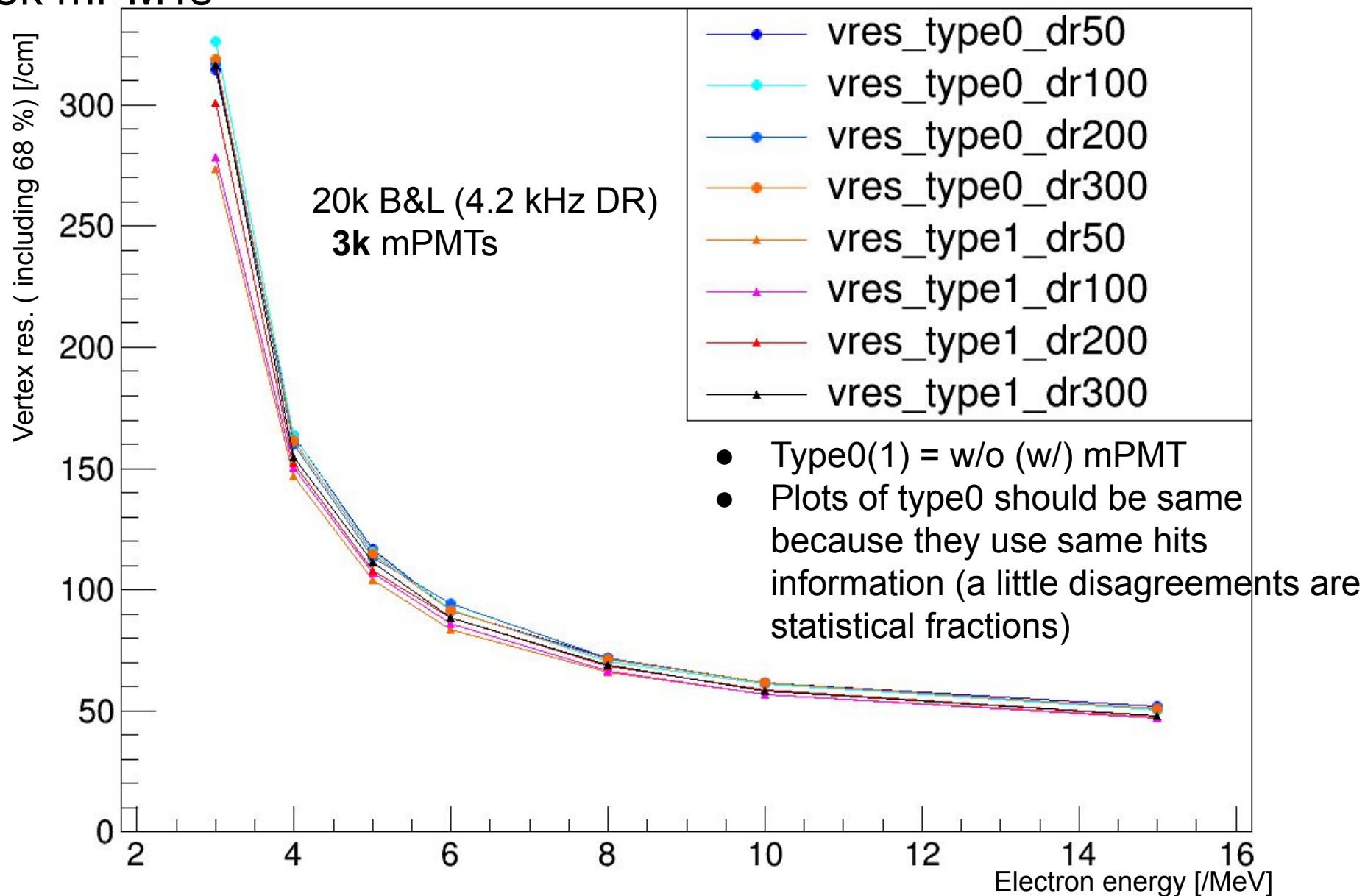
vertex resolution

5k mPMTs



Comparison of DR 3k mPMTs

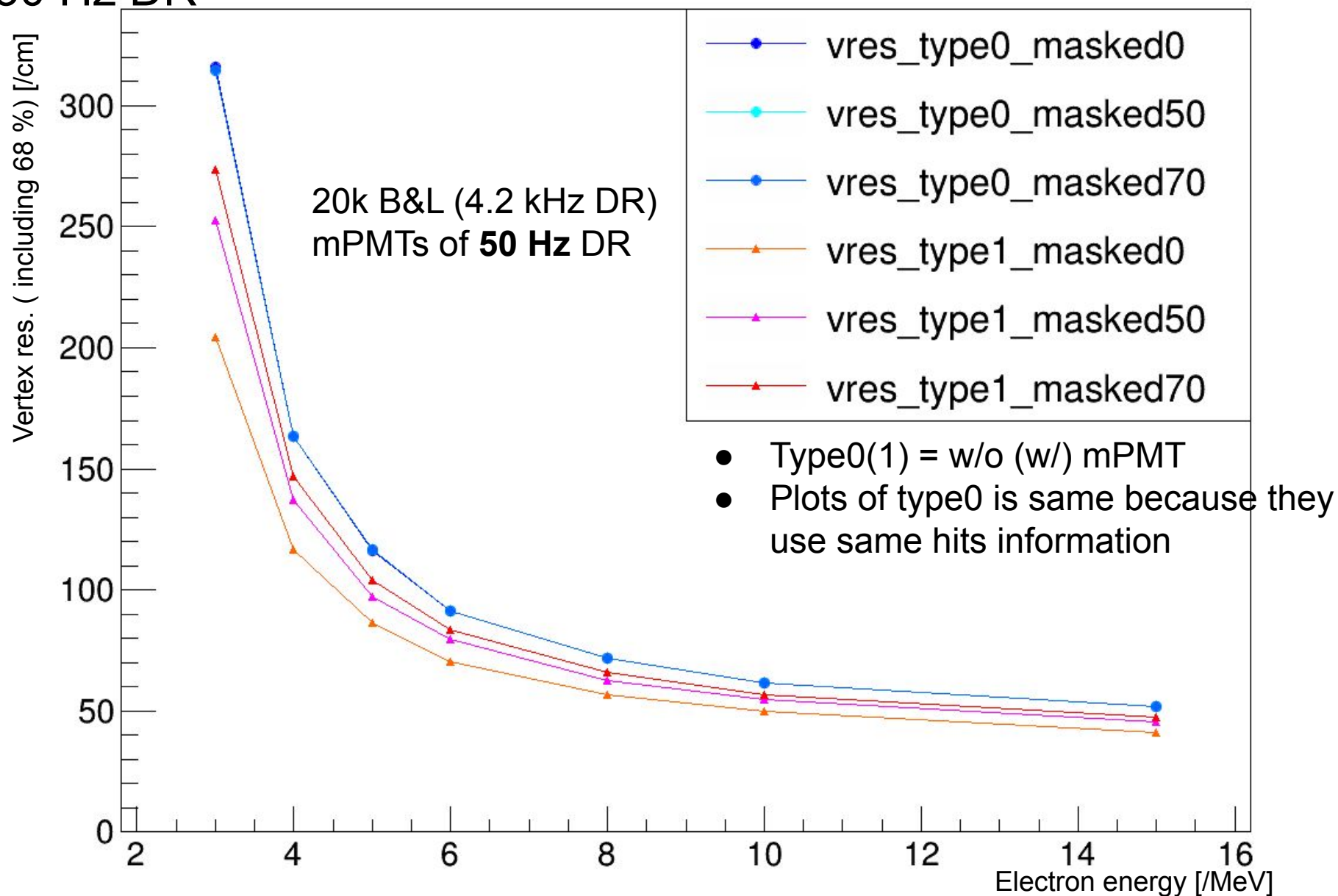
vertex resolution



Comparison of PC

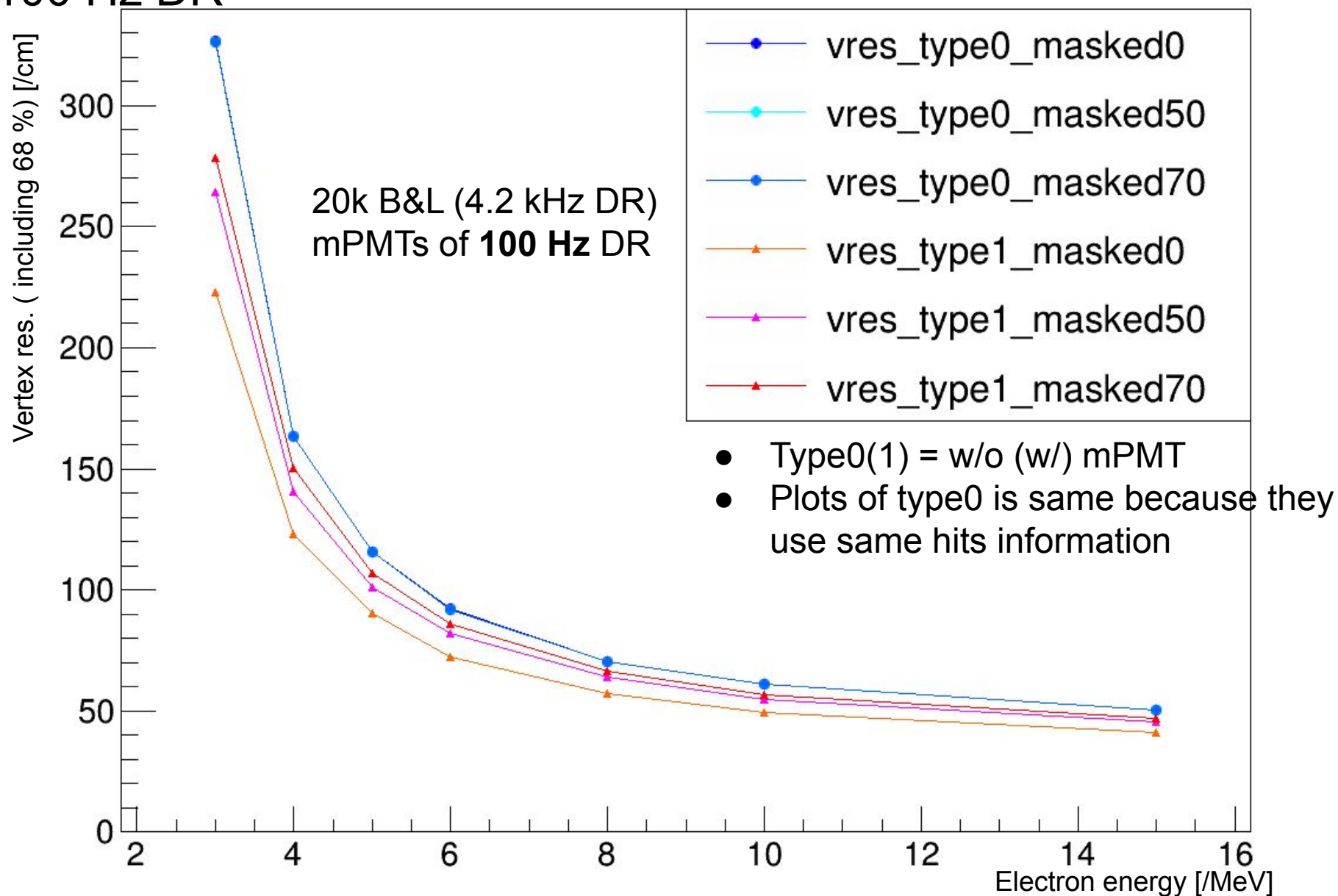
vertex resolution

50 Hz DR



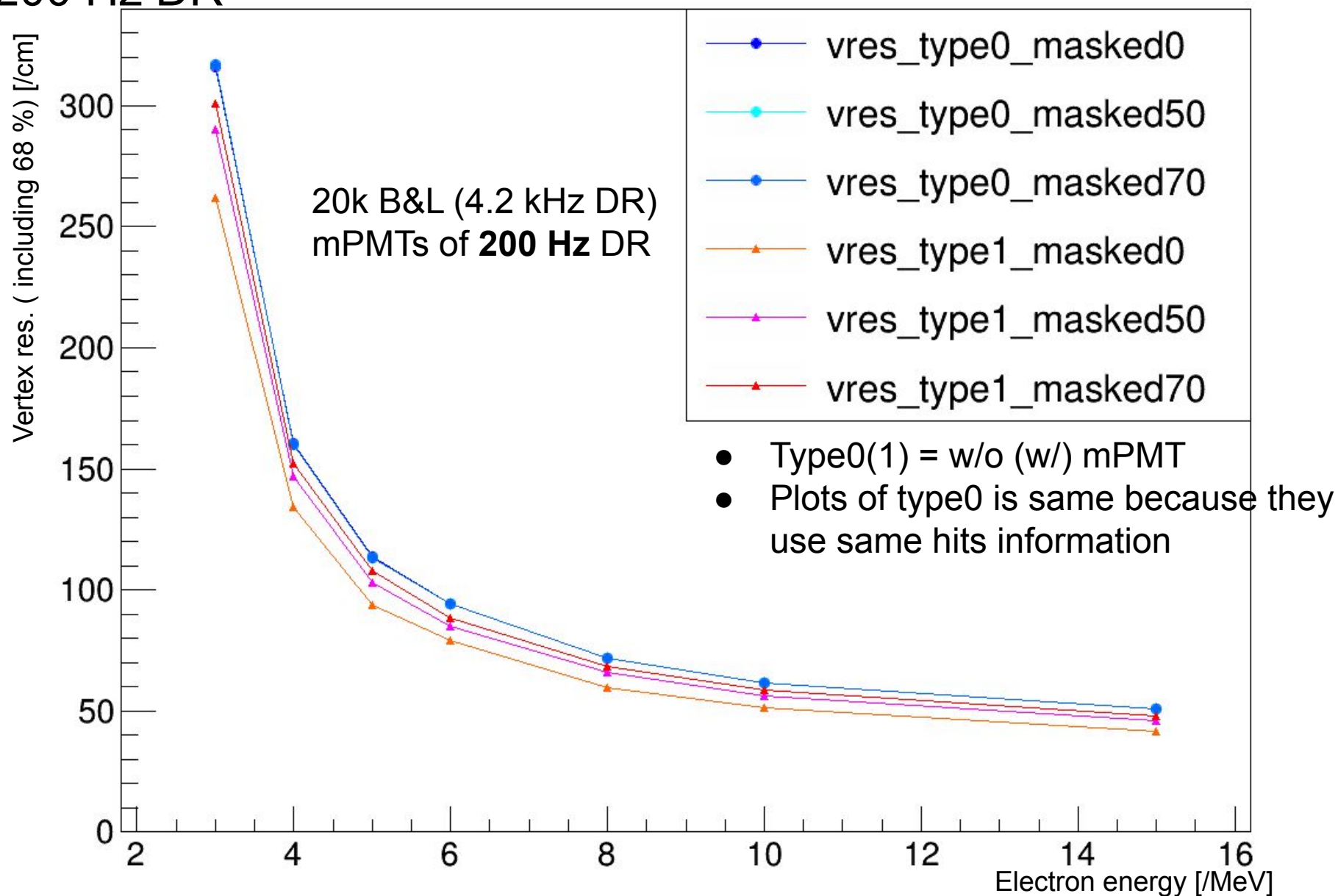
Comparison of PC 100 Hz DR

vertex resolution



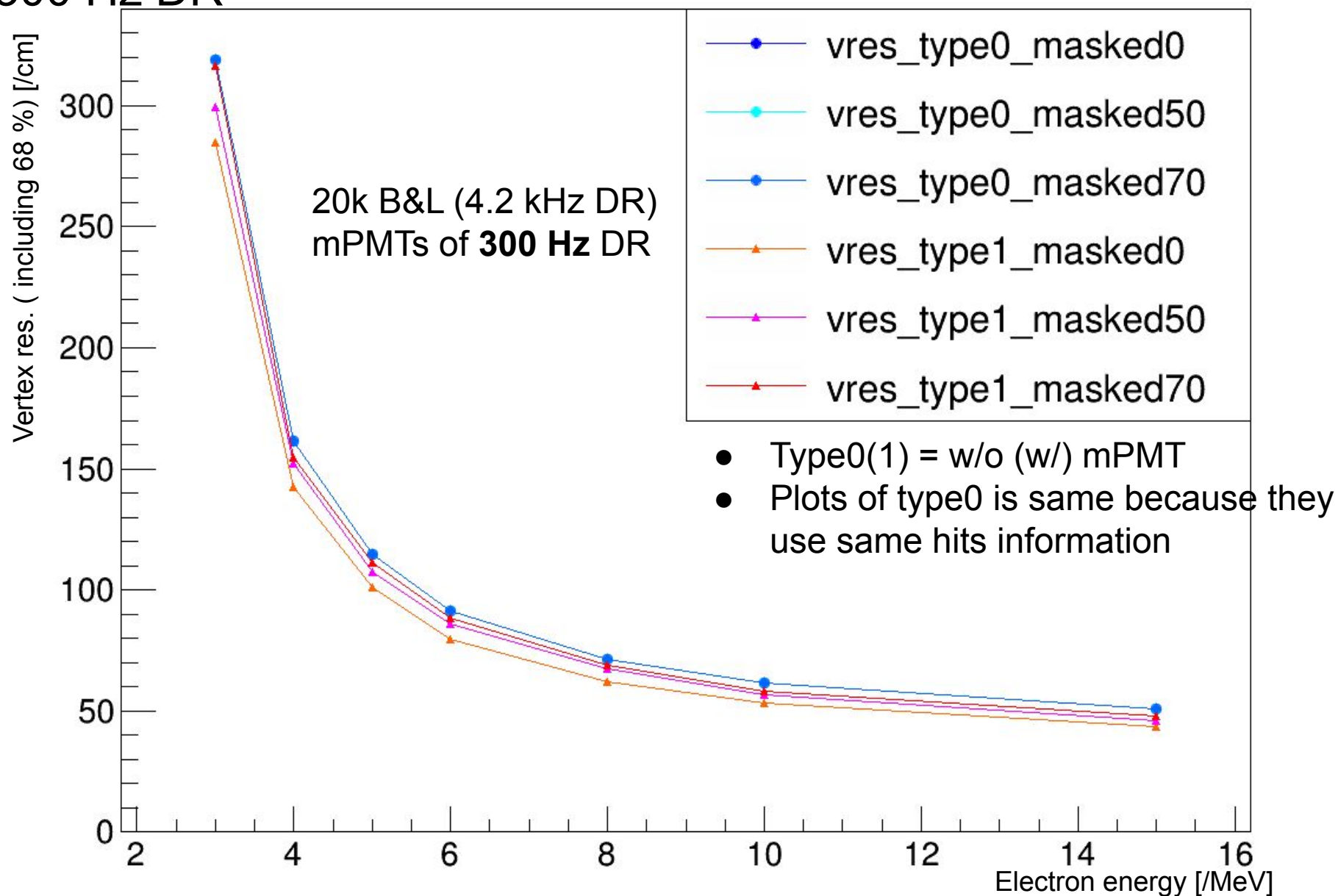
Comparison of PC 200 Hz DR

vertex resolution



Comparison of PC 300 Hz DR

vertex resolution



Miss-reconstruction rate

Slide of 1st Nov.
mPMT-Japan meeting

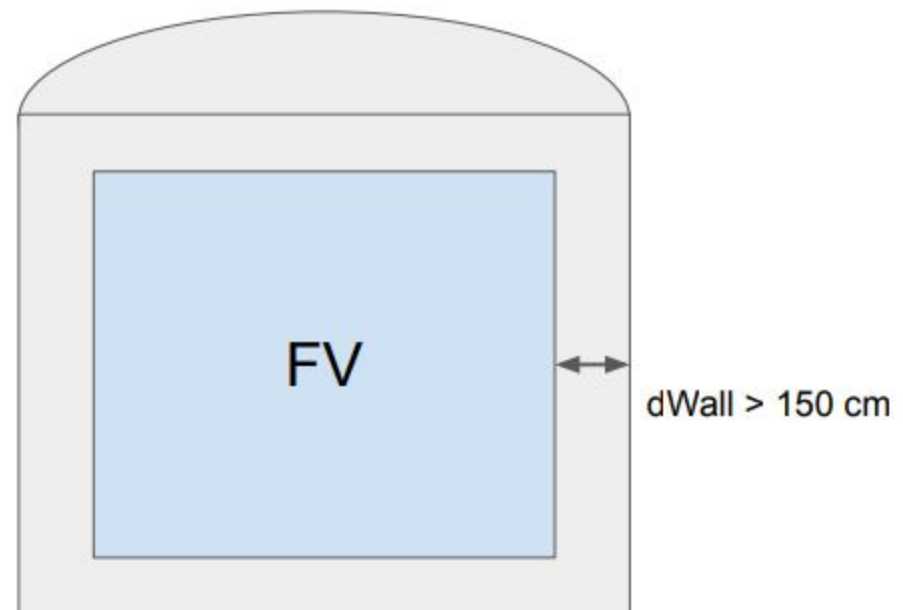
4

- Calculated the miss-rec. rate: how many events are reconstructed inner volume.

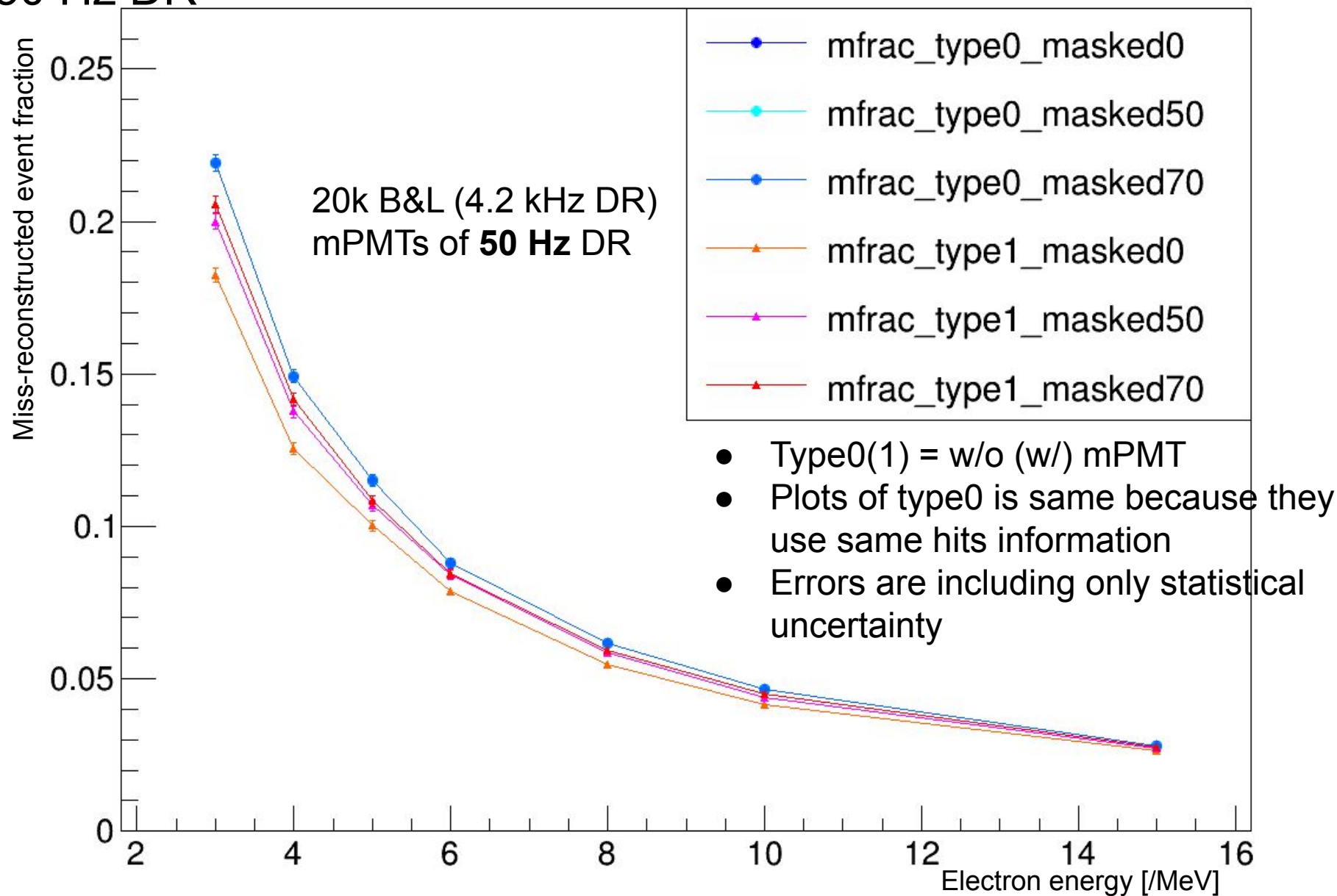
$$(\text{miss-rec. rate}) = \frac{(\# \text{ of events generated out of FV and reconstructed in FV})}{(\# \text{ of events generated out of FV})}$$

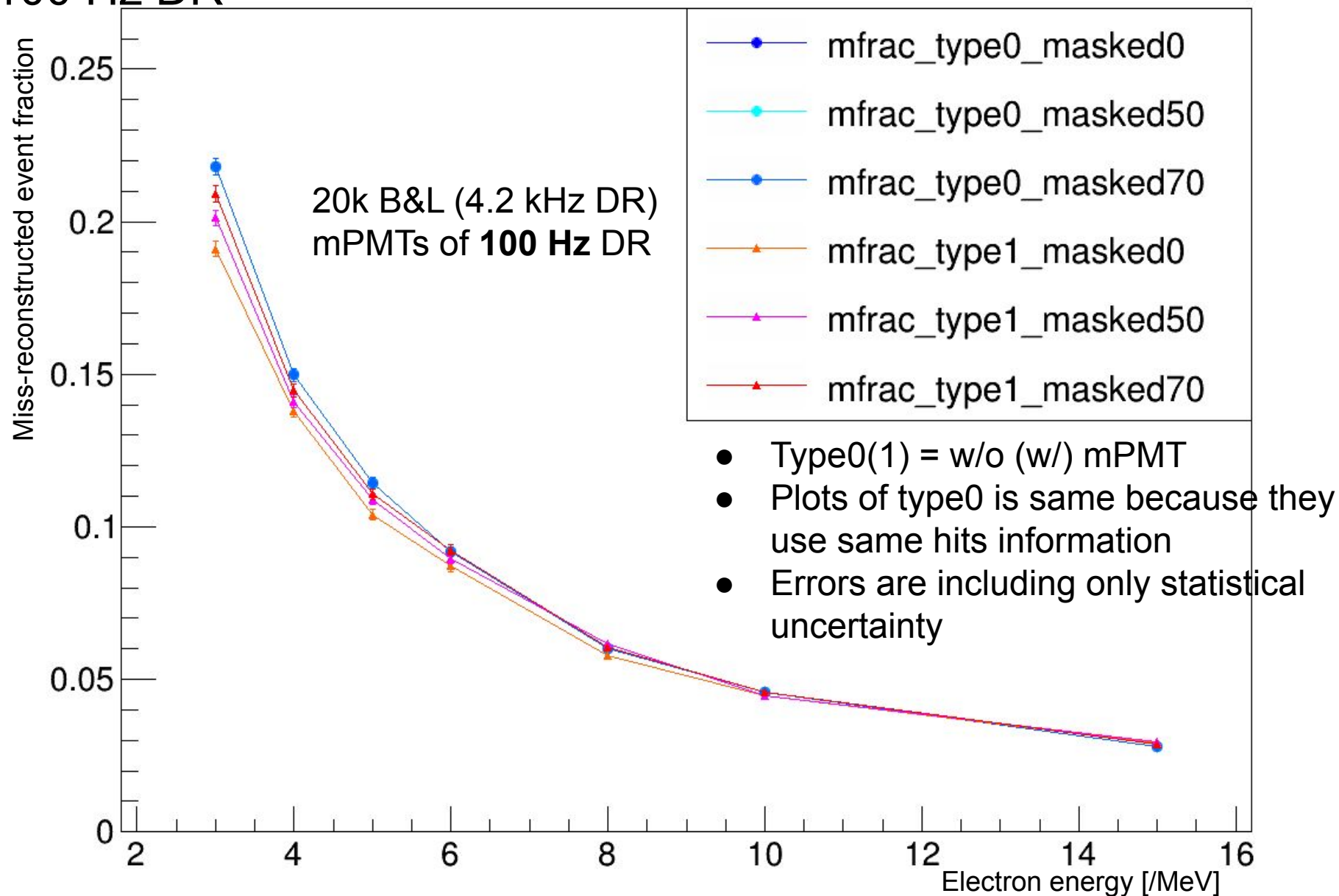
- FV := {volume | dWall > 150 cm}
- Calculated it at some energies: 3,4,5,6,8,10,15 MeV

This shows the reconstruction performance near the wall



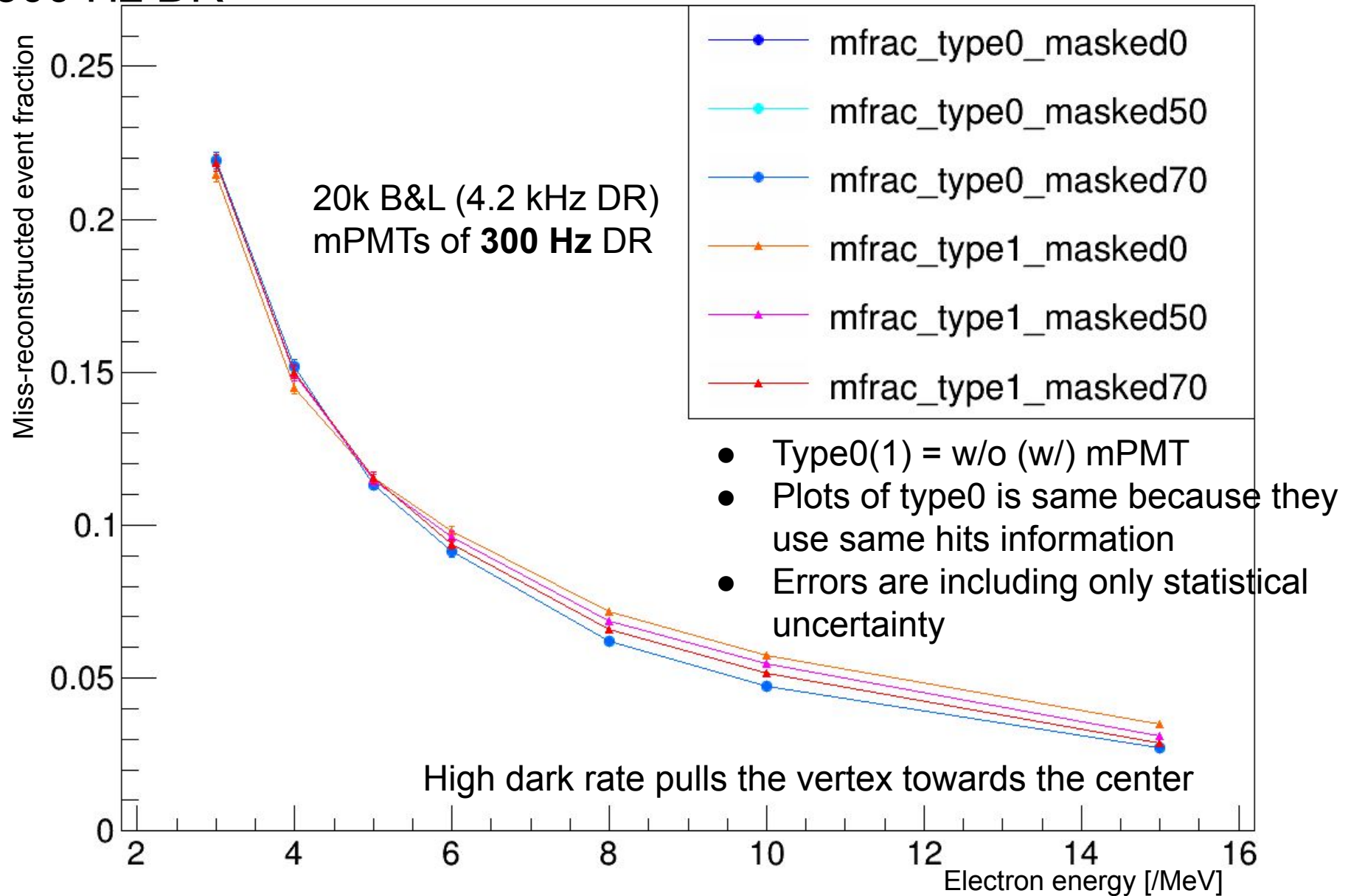
Comparison of PC mis-reconstructed fraction 50 Hz DR





Comparison of PC mis-reconstructed fraction

300 Hz DR

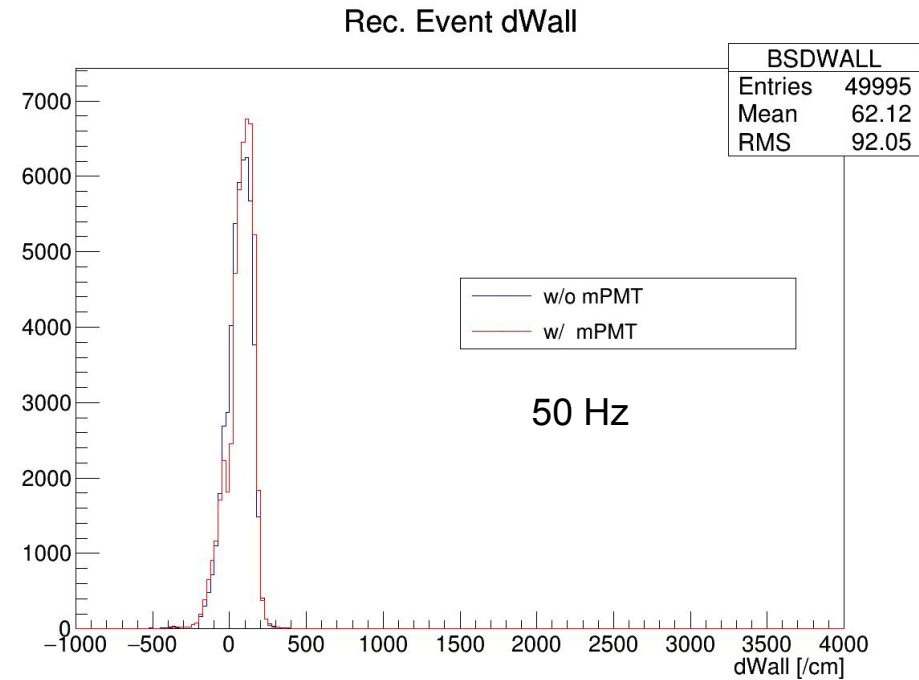


Summary

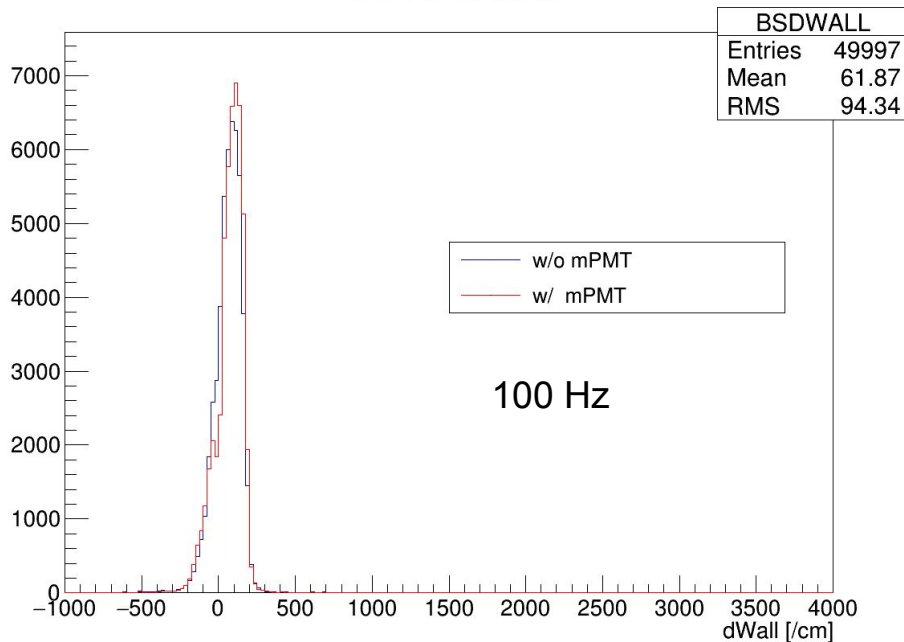
- Calculated and compared vertex resolution and miss-reconstructed fraction
- Vertex resolution
 - More mPMTs make better performance.
 - 5k mPMTs gives significant improvements while 3k mPMTs has little.
 - Lower dark rate is better. However above 10 MeV, there are little differences.
- Miss-reconstructed events fraction
 - High dark rate (> 200 Hz) pulls the more events into the FV.
- Todo:
 - Re-format the design of plots (color, symbol etc.)
 - Add the point of 15 MeV and 200 Hz DR

Reconstructed dWall

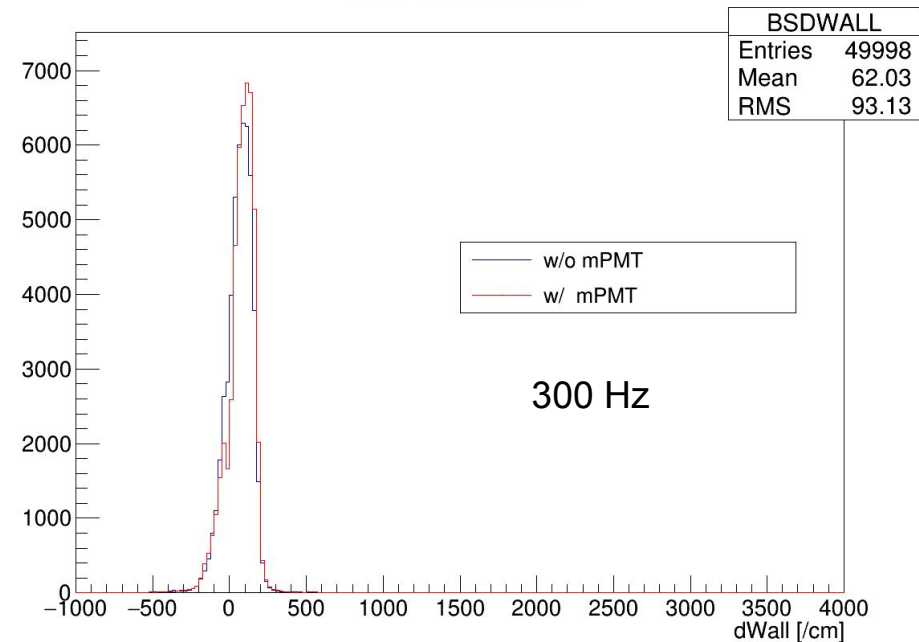
- $E = 15 \text{ MeV}$
- # of mPMTs = 10k



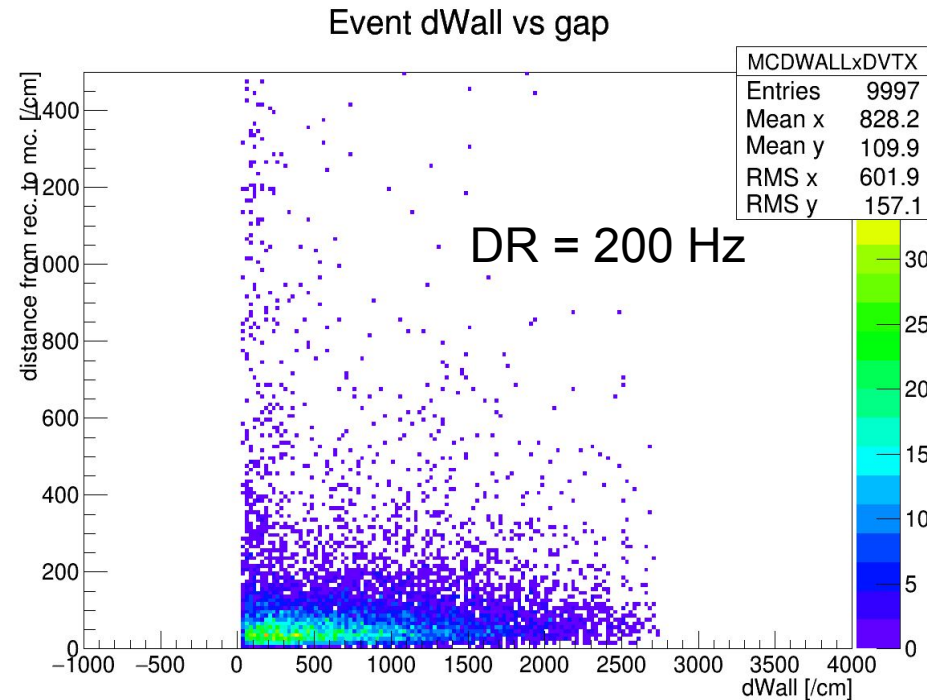
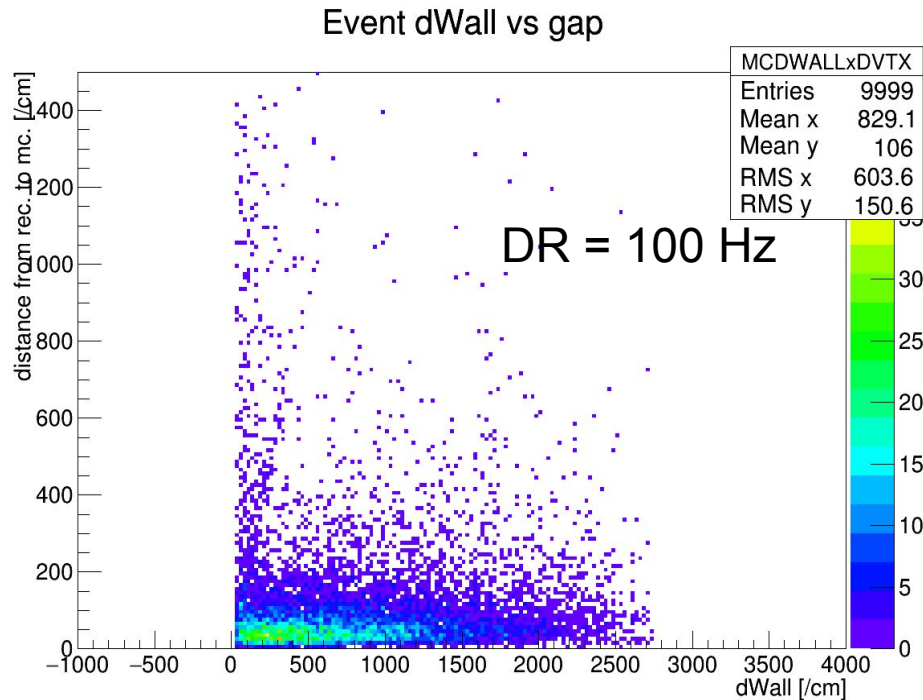
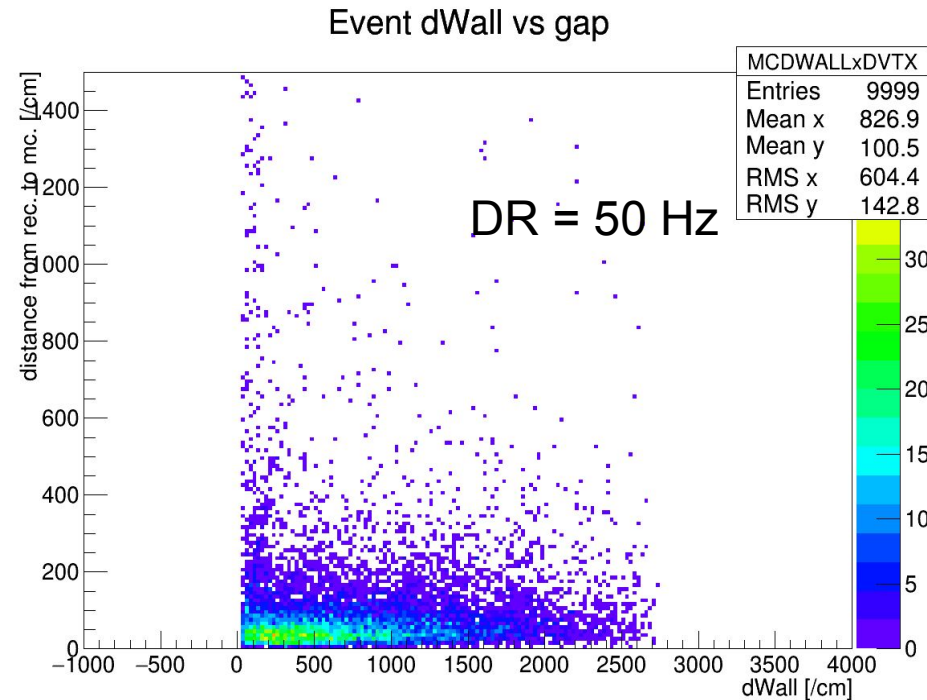
Rec. Event dWall



Rec. Event dWall



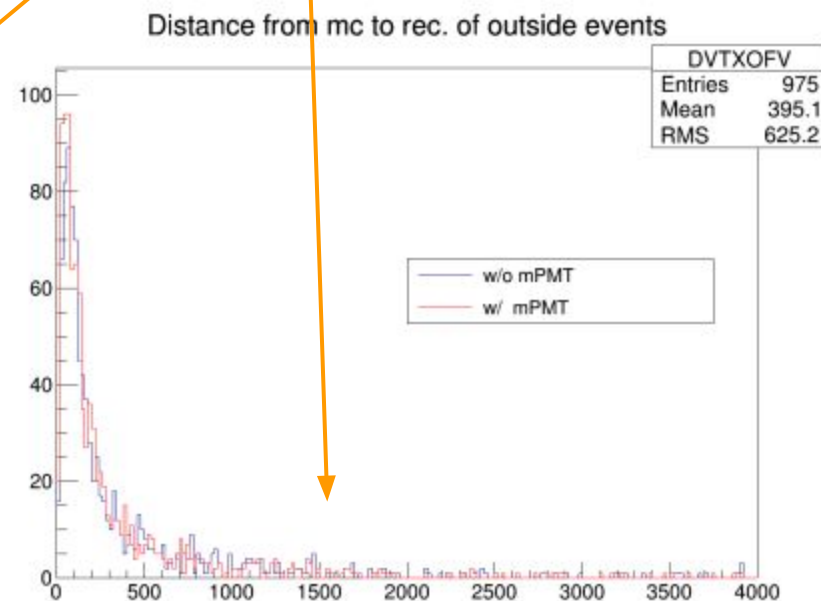
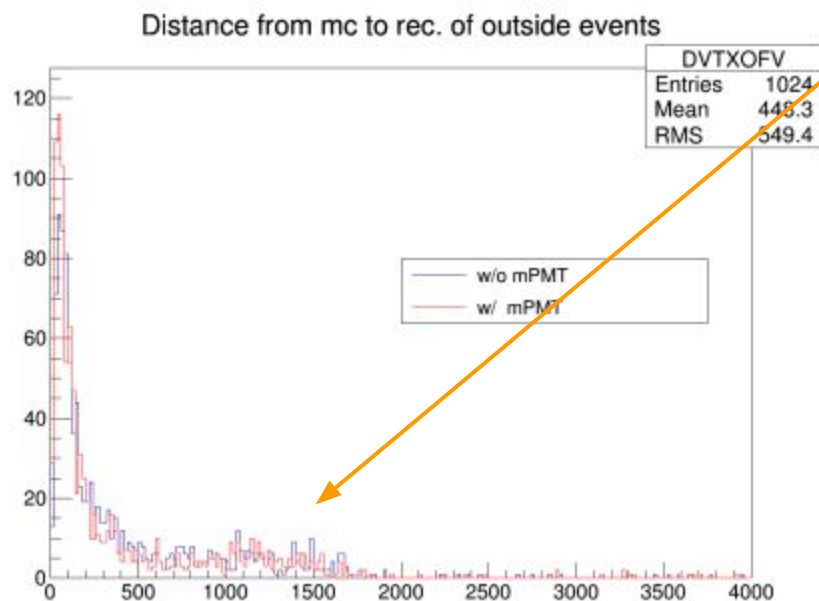
- $E = 5 \text{ MeV}$
- W/ 10k mPMT



$E=3$ MeV, 100 Hz (Left), 200 Hz (Right)

There are some inconsistency in the result w/o mPMT

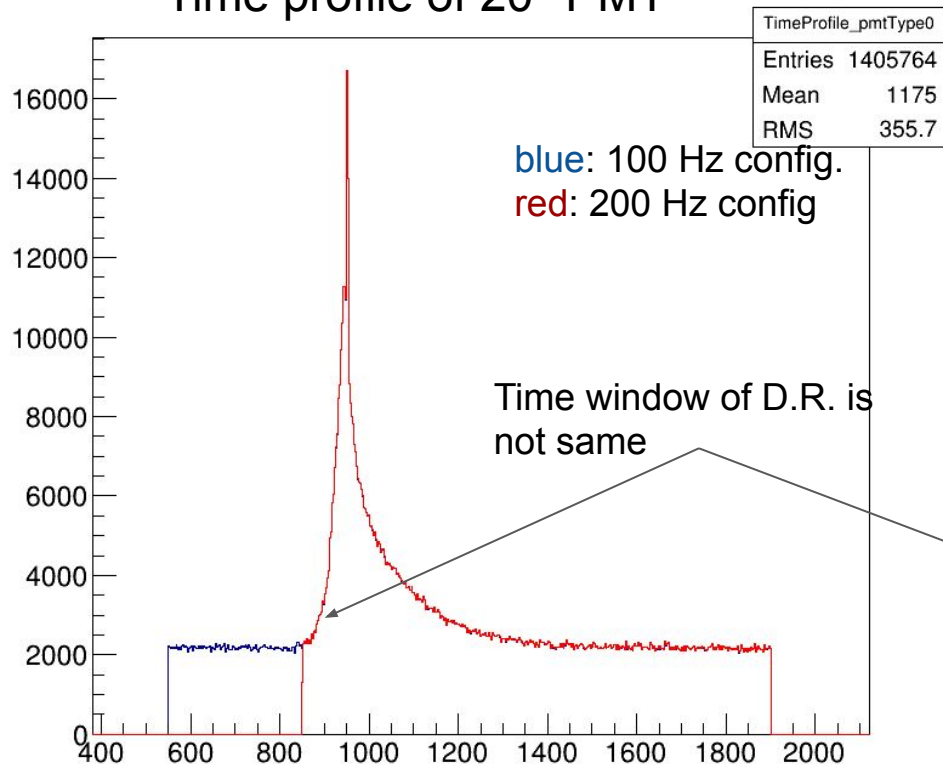
- Distance between rec. and MC vertex (unit = cm).
- Only events out of FV



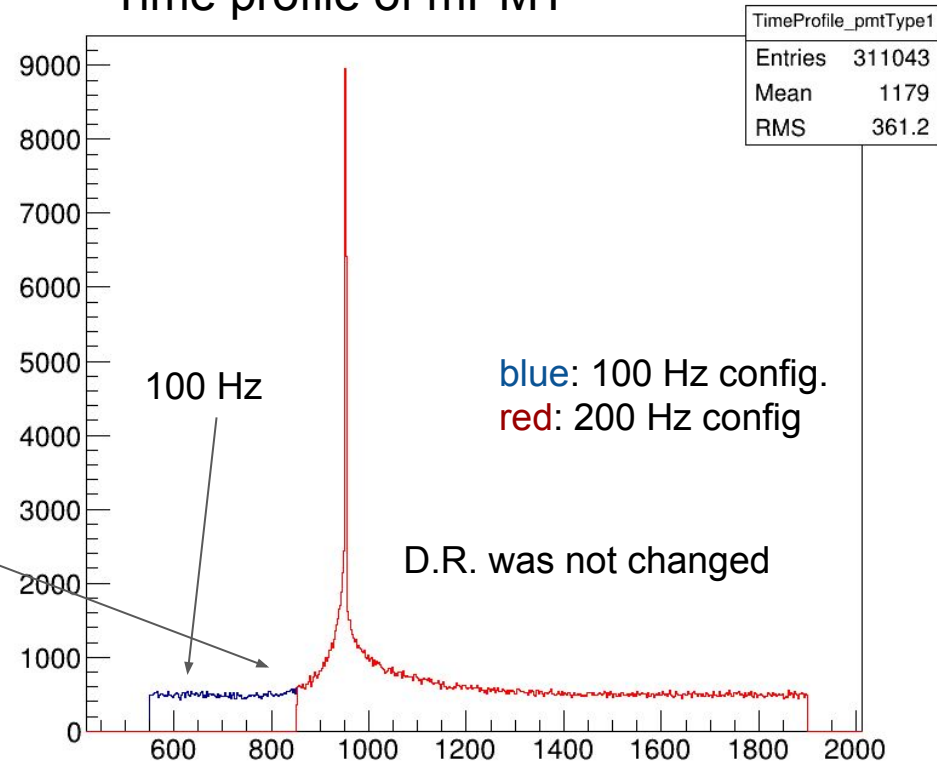
D.R. (100 / 200 Hz) (remind of last meeting)

- I found that dark rate was not generated correctly.
 - I will check the mac-file again and reproduce the MC
 - Chaged only “WCSimPMTObject.cc”

Time profile of 20" PMT



Time profile of mPMT



Modifications for DR issue

- Noticed from log that the pretrigger time window was set as -99 ns (should be -400 ns)
- Applied “/DAQ/TriggerNDigits/PreTriggerWindow -400” etc. explicitly in “macros/daq.mac”
 - These configurations are commented out in original WCSim(/_hybrid)
 - I have no idea of this reason...
- → DR is generated correctly
 - Right plot: time profile of 3 MeV electrons with DR of mPMT = 200 Hz

