

# TRG Efficiency DQM

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October 2, 2024

B2GM TRG Parallel



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## How to get the trigger efficiency?

- For MC

The trigger efficiency of a certain trigger bit (ff<sub>y</sub>, for example) can be calculated as

$$\epsilon = \frac{N_{\text{ff}_y}}{N_{\text{all}}}$$

where  $N_{\text{all}}$  is the number of all generated events, and  $N_{\text{ff}_y}$  is the number of ff<sub>y</sub> satisfied events.

- For data

With data, we do not know the number of generated events. One general way to solve this problem is to use a reference trigger bit, which is independent from the interested trigger bits, i.e.,

$$\epsilon_{\text{exp}} = \frac{N_{\text{mask\_bits}} \text{ and } N_{\text{sig\_bit}}}{N_{\text{mask\_bits}}}$$

# TRG efficiency DQM ( merge request !3664 )

- For TRGEFFDQMModule:

Add more trigger bits to estimate the CDC TRG, ECL TRG and KLM TRG efficiency, and also remove the bha\_veto requirement for some trigger bits to observe the change in efficiency.

- For DQMHistAnalysisTRGEFFModule:

Use TEfficiency to calculate the trigger bit efficiency, and also add the MonitoringObject to monitor these trigger objects.

- CDC TRG

$$\epsilon_{\text{exp}} = \frac{N_{\text{ECL\_bits}} \text{ and } N_{\text{CDC\_bit}}}{N_{\text{ECL\_bits}}}$$

- ECL TRG

$$\epsilon_{\text{exp}} = \frac{N_{\text{CDC\_bits}} \text{ and } N_{\text{ECL\_bit}}}{N_{\text{CDC\_bits}}}$$

- KLM TRG

$$\epsilon_{\text{exp}} = \frac{N_{\text{ECL\_bits}} \text{ and } N_{\text{KLM\_bit}}}{N_{\text{ECL\_bits}}}$$

CDC\_bit, ECL\_bit and KLM\_bit refer to the CDC trigger bit, ECL trigger bit and KLM trigger bit, respectively.

## Event selection

### For CDC TRG:

- The number of degrees of freedom of the track fit is greater than or equal to 20.
- The z-coordinate of the point-of-closest-approach:  $|z_0| < 1$  cm.
- The signed distance to the IP in the  $r$ - $\phi$  plane:  $|d_0| < 1$  cm.
- The first hit layer is less than 5, and the last hit layer is greater than 50.

### For ECL TRG:

- The energy for each ECL cluster is greater than or equal to 0.1 GeV.

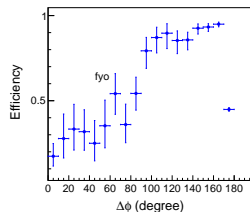
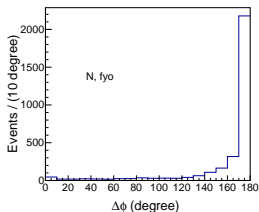
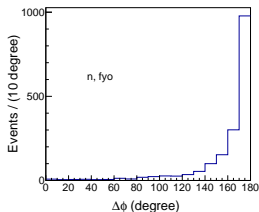
### For KLM TRG:

- The hit layer of the KLM cluster is greater than 6.

# CDC TRG - “fyo” bit with $\Delta\phi$

- fyo: (t2\_1 or t2\_2 or t2\_3) and (ty\_0 or ty\_1 or ty\_2 or ty\_3) and cdc\_open90 and !bha\_veto and !veto
- Here, the efficiency can be calculated by  $\epsilon = \frac{n}{N}$  for the corresponding figures and the subsequent slides are similar.

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{c4} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm10}}) \text{ and } N_{\text{fyo}}}{N_{\text{hie}} \text{ or } N_{c4} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm10}}}$$

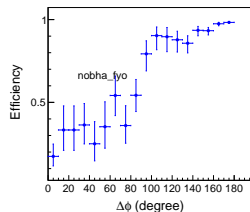
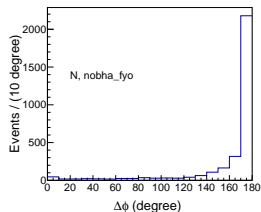
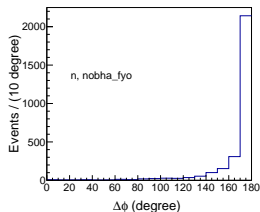


CDC TRG with fyo bit. Saving the largest  $\Delta\phi$  from the all combinations in an event.

# CDC TRG - “fyo” bit with $\Delta\phi$ with the bha\_veto removed

- fyo with bha\_veto removed: (t2\_1 or t2\_2 or t2\_3) and (ty\_0 or ty\_1 or ty\_2 or ty\_3) and cdc\_open90 and !veto

- $$\epsilon_{\text{exp}} = \frac{N_{\text{ECL\_bits}} \text{ and } N_{(\text{fyo with bha\_veto removed})}}{N_{\text{ECL\_bits}}}$$

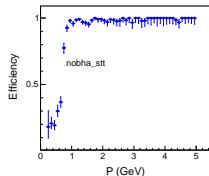
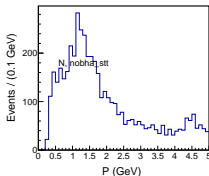
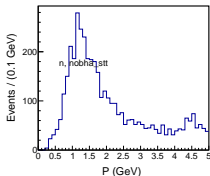
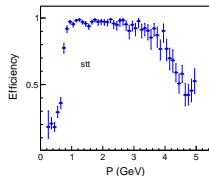
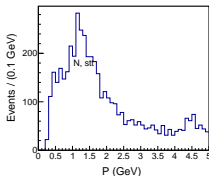
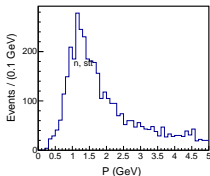


CDC TRG with fyo bit with the bha\_veto removed. Saving the largest  $\Delta\phi$  from the all combinations in an event.

# CDC TRG - “stt” bit with momentum p

- stt: typ and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}) \text{ and } N_{\text{stt}}}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}}$$



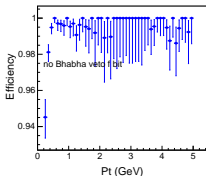
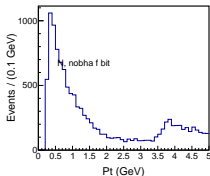
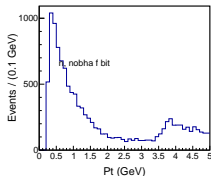
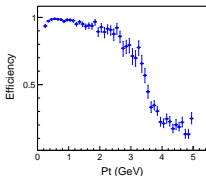
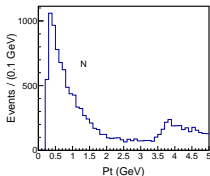
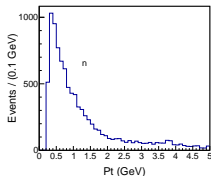
CDC TRG with stt bit. Saving the largest momentum p in an event. stt (top), stt with the bha\_veto removed (bottom).



# CDC TRG - "f" bit with transverse momentum Pt

- f:  $t_2 > 0$  and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}) \text{ and } N_f}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}}$$

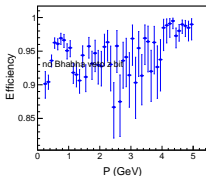
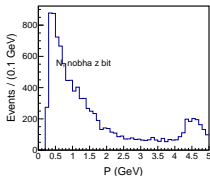
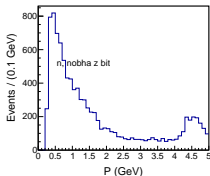
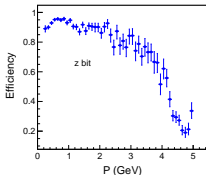
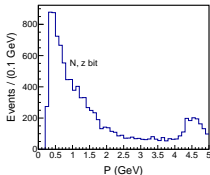
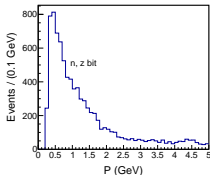


CDC TRG with f bit. The transverse momentum Pt distribution for f (top), f with the bha\_veto removed (bottom).

# CDC TRG - “z” bit with momentum p

- z:  $t3 > 0$  and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}) \text{ and } N_z}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}}$$

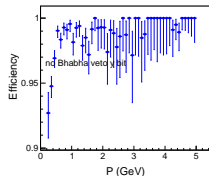
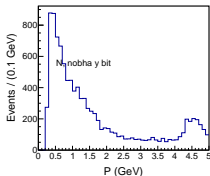
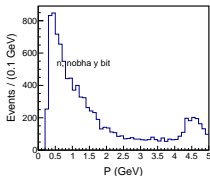
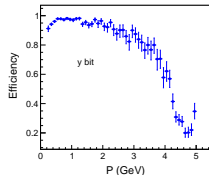
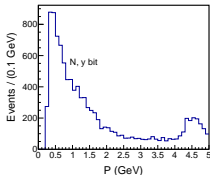
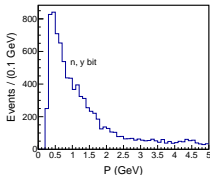


CDC TRG with z bit. The momentum p distribution for z (top), z with the bha\_veto removed (bottom).

# CDC TRG - “y” bit with momentum p

- y:  $t\bar{y} > 0$  and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}) \text{ and } N_y}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}}$$

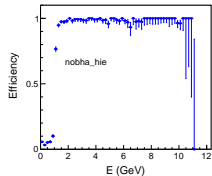
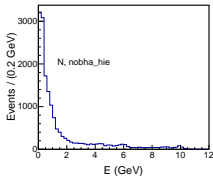
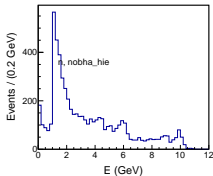
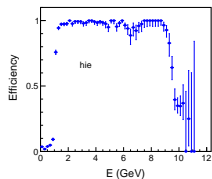
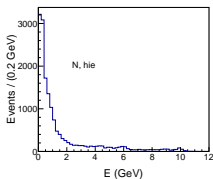
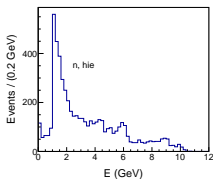


CDC TRG with y bit. The momentum p distribution for y (top), y with the bha\_veto removed (bottom).

# ECL TRG - “hie” bit with summing energy E

- hie: ehigh and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{ffy}} \text{ or } N_{\text{fyo}} \text{ or } N_{\text{stt}}) \text{ and } N_{\text{hie}}}{N_{\text{ffy}} \text{ or } N_{\text{fyo}} \text{ or } N_{\text{stt}}}$$

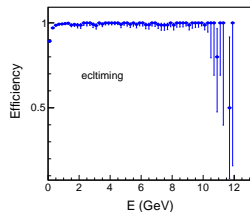
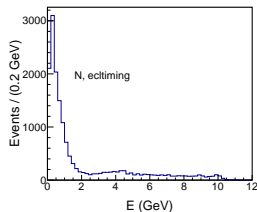
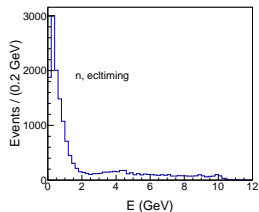


ECL TRG with hie bit. Saving the summing energy E within the  $\theta_{ID} = 22.49^\circ \sim 126.8^\circ$  of all ECL cluster in an event. hie (top), hie with the bha\_veto removed (bottom).

# ECL TRG - “ecltiming” bit with summing energy E

- ecltiming: ecl\_active and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{ffy}} \text{ or } N_{\text{fyo}} \text{ or } N_{\text{stt}}) \text{ and } N_{\text{ecltiming}}}{N_{\text{ffy}} \text{ or } N_{\text{fyo}} \text{ or } N_{\text{stt}}}$$

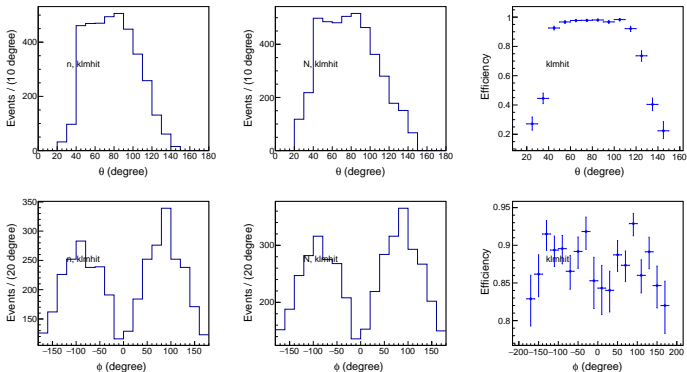


ECL TRG with ecltiming bit. Saving the summing energy E of all ECL cluster in an event.

# KLM TRG - “klmhit” bit with $\theta$ and $\phi$

- klmhit: klm\_hit and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1l}} \text{ or } N_{\text{lm2l}} \text{ or } N_{\text{lm6l}} \text{ or } N_{\text{lm7l}} \text{ or } N_{\text{lm8l}} \text{ or } N_{\text{lm9l}} \text{ or } N_{\text{lm10l}})}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1l}} \text{ or } N_{\text{lm2l}} \text{ or } N_{\text{lm6l}} \text{ or } N_{\text{lm7l}} \text{ or } N_{\text{lm8l}} \text{ or } N_{\text{lm9l}} \text{ or } N_{\text{lm10l}}}$$

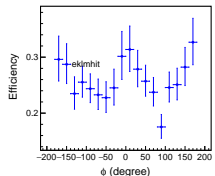
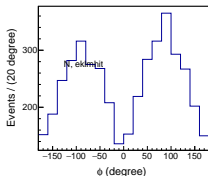
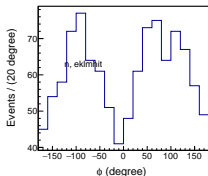
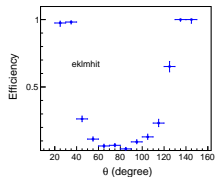
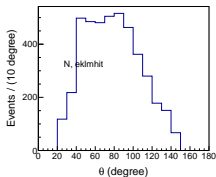
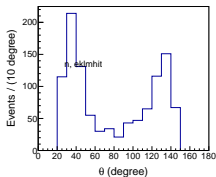


KLM TRG with klmhit bit. The  $\theta$  distribution (top) and the  $\phi$  distribution (bottom).

# KLM TRG - “eklmhit” bit with $\theta$ and $\phi$

- eklmhit: eklm\_hit and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}) \text{ and } N_{\text{eklmhit}}}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}}$$



KLM TRG with eklmhit bit. The  $\theta$  distribution (top) and the  $\phi$  distribution (bottom).

## Summary

- The CDC, ECL and KLM TRG efficiencies for exp 33, 2024b data are studied.
- The TRGDQM analysis module for kinematics dependent efficiency estimation will be merged into the release/08-02 and release/09-00.
- All the histograms that will be shown in DQM and Mirabelle web pages are listed. (including the **backup slides**)
  - “fyo” bit with  $\Delta\phi$
  - “stt” bit with momentum  $p$ ,  $\theta$  and  $\phi$
  - “f” bit with transverse momentum  $P_t$  and  $\phi$
  - “z” bit with momentum  $p$
  - “y” bit with momentum  $p$
  - “hie” bit with suming energy  $E$
  - “ecltiming” bit with suming energy  $E$ ,  $\theta$  and  $\phi$
  - “klmhit” bit with  $\theta$  and  $\phi$
  - “eklmhit” bit with  $\theta$  and  $\phi$
- The module will continue to be improved in the future.



Thanks!

# Backup slides

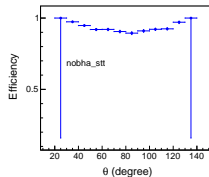
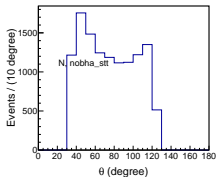
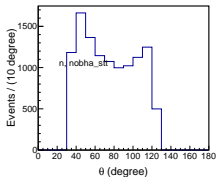
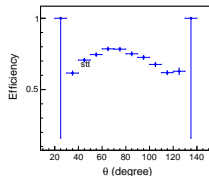
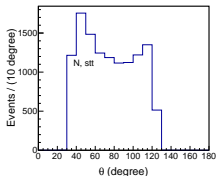
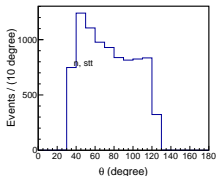
## 7 Backup

- stt bit with  $\theta$
- stt bit with  $\phi$
- f bit with  $\phi$
- ecltming bit with  $\theta$  and  $\phi$

# CDC TRG - “stt” bit with $\theta$

- stt: typ and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}) \text{ and } N_{\text{stt}}}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}}$$

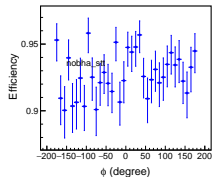
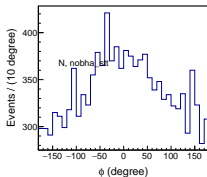
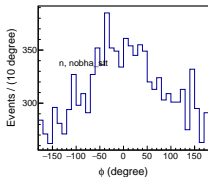
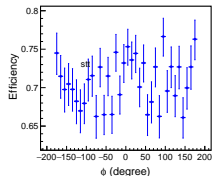
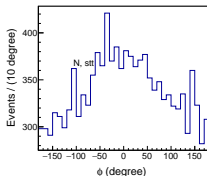
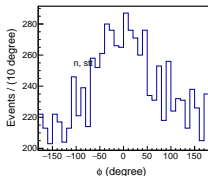


CDC TRG with stt bit. The  $\theta$  distribution for stt (top), stt with the bha\_veto removed (bottom).

# CDC TRG - “stt” bit with $\phi$

- stt: typ and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{C4} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}) \text{ and } N_{\text{stt}}}{N_{\text{hie}} \text{ or } N_{C4} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm11}} \text{ or } N_{\text{lm12}} \text{ or } N_{\text{lm16}} \text{ or } N_{\text{lm17}} \text{ or } N_{\text{lm18}} \text{ or } N_{\text{lm19}} \text{ or } N_{\text{lm110}}}$$

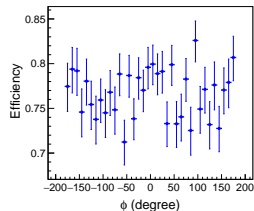
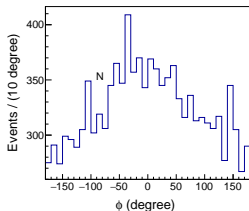
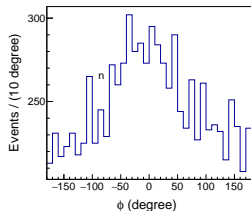


CDC TRG with stt bit. The  $\phi$  distribution for stt (top), stt with the bha\_veto removed (bottom).

# CDC TRG - "f" bit with $\phi$

- f:  $t2 > 0$  and !bha\_veto and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}) \text{ and } N_f}{N_{\text{hie}} \text{ or } N_{\text{c4}} \text{ or } N_{\text{eclmumu}} \text{ or } N_{\text{ecltaub2b3}} \text{ or } N_{\text{hie4}} \text{ or } N_{\text{lm1}} \text{ or } N_{\text{lm2}} \text{ or } N_{\text{lm6}} \text{ or } N_{\text{lm7}} \text{ or } N_{\text{lm8}} \text{ or } N_{\text{lm9}} \text{ or } N_{\text{lm10}}}$$

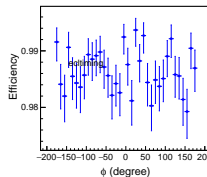
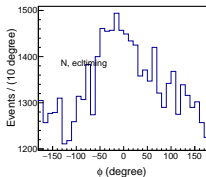
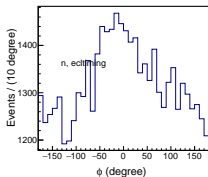
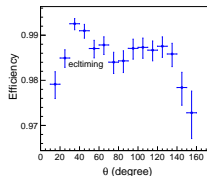
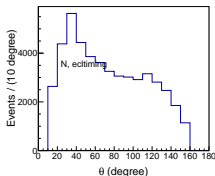
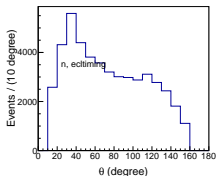


CDC TRG with f bit. The  $\phi$  distribution.

# ECL TRG - “ecltiming” bit with $\theta$ and $\phi$

- ecltiming: ecl\_active and !veto

$$\epsilon_{\text{exp}} = \frac{(N_{\text{ffy}} \text{ or } N_{\text{fyo}} \text{ or } N_{\text{stt}}) \text{ and } N_{\text{ecltiming}}}{N_{\text{ffy}} \text{ or } N_{\text{fyo}} \text{ or } N_{\text{stt}}}$$



ECL TRG with ecltiming bit. The  $\theta$  distribution (top) and the  $\phi$  distribution (bottom).