TRG Efficiency on DQM, Mirabelle

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B2GM TRG Parallel

Outline

How to get the trigger efficiency

- For MC

  The trigger efficiency of a certain trigger bit (ffy, for example) can be calculated as

  $$\epsilon = \frac{N_{\text{ffy}}}{N_{\text{all}}}$$

  where N_{all} is the number of all generated events, and N_{ffy} is the number of ffy 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.,

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

Event selection

Following the previous study, only the requirements for klmhit and eklmhit with ϕ have changed (to achieve higher trigger efficiency).

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-ϕ plane: $|d_0| < 1$ cm.
- The first hit layer is less than 5, and the last hit layer is greater than 50.

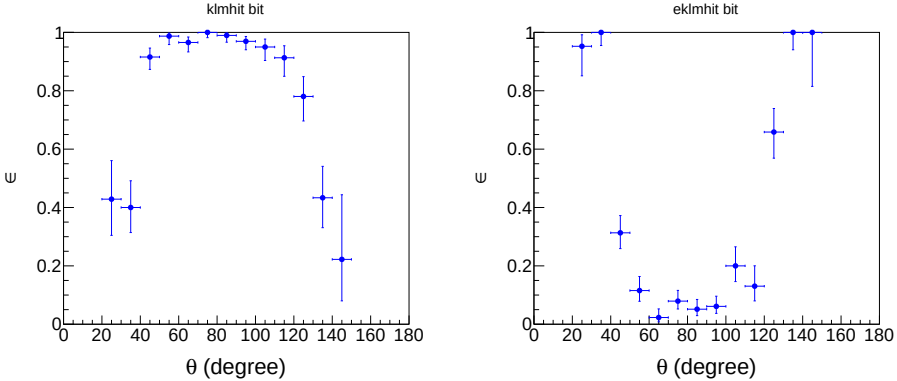
For ECL TRG:

- 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.
- For klmhit ϕ distribution: require $50^\circ < \theta < 120^\circ$
- For eklmhit ϕ distribution: require $20^\circ < \theta < 40^\circ$ or $120^\circ < \theta < 160^\circ$

klmhit and eklmhit bits



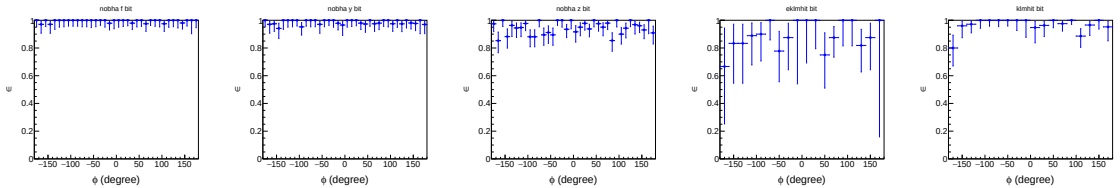
The efficiency for eklmhit, klmhit bits with θ distribution.

- For klmhit ϕ distribution: require $50^\circ < \theta < 120^\circ$
- For eklmhit ϕ distribution: require $20^\circ < \theta < 40^\circ$ or $120^\circ < \theta < 160^\circ$

TRG efficiency DQM (Link)

It provides a convenient way to monitor the efficiency of the trigger bits.

- Remove the f, y, z bit with the Pt distribution
- Remove the fyo with $\Delta\phi$ distribution
- Remove the stt with ϕ, P, θ distribution
- Remove the hie with E distribution
- Add the f, y, z bit for the ϕ distribution, with the Bhabha veto requirement removed.



The efficiency for f, y, z, eklmhit, klmhit bits with ϕ distribution.

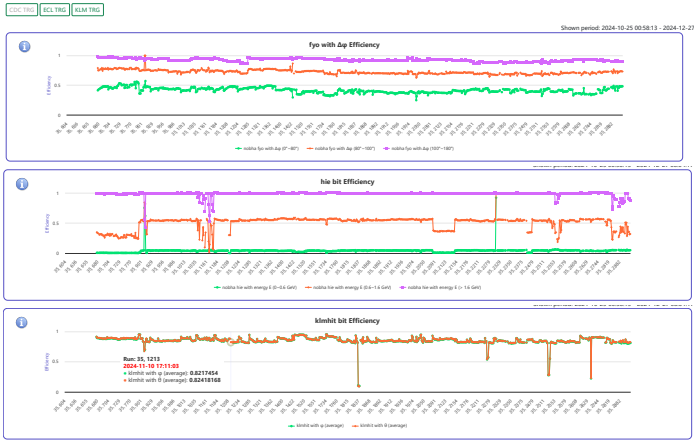
TRG efficiency Mirabelle (Link)

- nobha fyo efficiency average at $\Delta\phi = [0, 80°], [80°, 100°], > 100°$, total 3 variables.
- nobha stt with P average at P =[0,0.5],[0.5,1], more than 1 GeV, total 3 variables.

- nobha hie efficiency average at E=[0,0.5], [0.5,1.5], more than 1.5 GeV, total 3 variables.
- eklmhit with θ efficiency average at forward, backward ($\theta = [0, 90°], [90°, 180°]$), total 2 variables.
- For other trigger bits, average of all bins, each with total 1 variable.

TRG efficiency Mirabelle

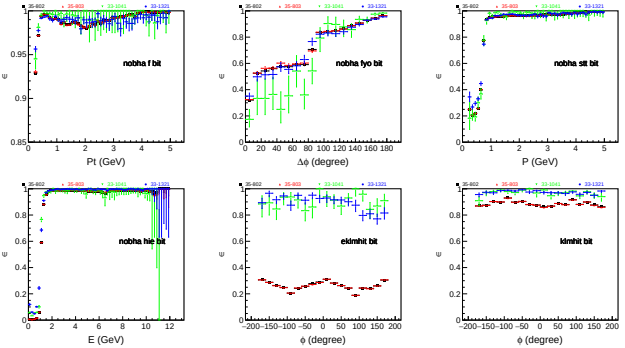
- It provides a convenient way to identify which detector may have an issue.



The efficiency of the fyo, hie and klmhit trigger bits efficiency displayed on MiraBelle.

TRG efficiency between Exp33 and Exp35

- Efficiency differences exist between Exp33 and Exp35. For most trigger bits (after removing the Bhabha veto), these differences are minor, and can be considered negligible.
- For the eklmhit and klmhit bits (bottom middle, bottom right), after applying the θ cut requirement, the efficiency increases and closes to 1.

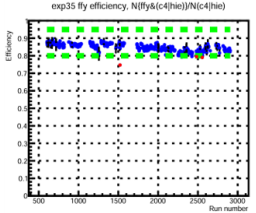


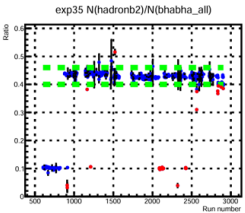
Some trigger bits efficiencies for different runs between Exp33 and Exp35.

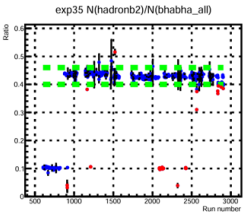
QAM check for Exp35 (Also see @Jing Yuan)

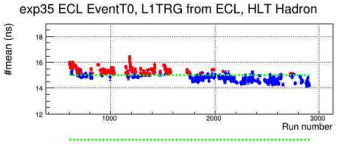
Data Quality Flag

- TRG system has known problem and major physics bits are affected
- Trigger efficiency measured with hadron or mumu2trk skim is too low or too high
- Hadronb2/Bhabha or mumu2trk/Bhabha ratio is too low or too high
- Event T0 is too low or too high









List of runs with trigger related problems

Run number	Quality flag	Problem
736-740	BAD	Dead and strange TC channels
911,912	BAD	ECL detector issue, hadron/Bhabha etc. is out of limit
1317	RECOVERABLE	Efficiency of f is low
1521	RECOVERABLE	Injection BG is very high
1836-1838	BAD	KLM efficiency is low due to KLM detector issue
1971-1976	RECOVERABLE	CDCTRG short track efficiency is low due to bad MGR
2273-2274	BAD	BKLMTRG efficiency is low (Reason is not understood yet)
2321	BAD	Strange hadron/Bhabha (Probably it is not TRG issue)
2528-2529	BAD	low KLMTRG efficiency
2564	RECOVERABLE	hadronb2, mumu2trk, hadron are out of limits
2566	RECOVERABLE	hadronb2 is out of limit
2581	RECOVERABLE	lml10 is out of limit
2654	BAD	low KLMTRG efficiency
2772	RECOVERABLE	lml12 is out of limit
2833,2835,2840,2876,2903	RECOVERABLE	hadronb2 is out of limit

Summary

- The CDC, ECL and KLM TRG efficiencies for exp35, 2024c data are studied.
- Existing monitored histograms have been displayed on the DQM (TRG_eff) and Mirabelle web pages, which provide a convenient way to check the quality of run data.
- The data quality flags from QAM for bad run are listed.
- These modules will undergo ongoing improvements in the future.

Thanks!

Outline

TRG efficiency definition

- 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.

CDC TRG bits

- 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

$$\epsilon_{\mathrm{fyo}} = \frac{(N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}) \text{ and } N_{\mathrm{fyo}}}{N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}}$$

- stt: typ and !bha_veto and !veto

$$\epsilon_{\mathrm{stt}} = \frac{(N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}) \text{ and } N_{\mathrm{stt}}}{N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}}$$

- f: t2 $>$ 0 and !bha_veto and !veto

$$\epsilon_{\mathrm{f}} = \frac{(N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}) \text{ and } N_{\mathrm{f}}}{N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}}$$

- z: t3 $>$ 0 and !bha_veto and !veto

$$\epsilon_{\mathrm{z}} = \frac{(N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}) \text{ and } N_{\mathrm{z}}}{N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}}$$

- y: ty $>$ 0 and !bha_veto and !veto

$$\epsilon_{\mathrm{y}} = \frac{(N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}) \text{ and } N_{\mathrm{y}}}{N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}}$$

ECL TRG bits

- hie: ehigh and !bha_veto and !veto

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

- ecltiming: ecl_active and !veto

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

KLM TRG bits

- klmhit: klm_hit and !veto

$$\epsilon_{\mathrm{klmhit}} = \frac{(N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}) \text{ and } N_{\mathrm{klmhit}}}{N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}}$$

- eklmhit: eklm_hit and !veto

$$\epsilon_{\mathrm{eklmhit}} = \frac{(N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}) \text{ and } N_{\mathrm{eklmhit}}}{N_{\mathrm{hie}} \text{ or } N_{\mathrm{c4}} \text{ or } N_{\mathrm{eclmumu}} \text{ or } N_{\mathrm{ecltaub2b3}} \text{ or } N_{\mathrm{hie4}} \text{ or } N_{\mathrm{lml1}} \text{ or } N_{\mathrm{lml2}} \text{ or } N_{\mathrm{lml6}} \text{ or } N_{\mathrm{lml7}} \text{ or } N_{\mathrm{lml8}} \text{ or } N_{\mathrm{lml9}} \text{ or } N_{\mathrm{lml10}}}$$