TRG efficiency Measurement with $\mu\mu\gamma$

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Contents

Direction of Study

- The $e^+e^- \rightarrow \mu^+\mu^-\gamma$ interaction was the focus of this study
    - These events containins information from subdetectors
    - Can be triggered by a variety of L1 Triggers.
    - To check that this interaction is an appropriate sample for the CDC/ECL triggers.
- Attempts in reconstruction of previous efficiency calculation has been done
- Dataset:
    - Data: bucket16 to bucket36 (skim:all)
    - Experiment: 18,20,22
- Goal: Further analysis will be done regarding other experiments along with run-wise evaluation. Once this is done, the CDC-ECL matching will be worked on.

Muon reconstruction requirements

- The muons were reconstructed based off the following conditions through gbasf2

- Track requirements:

$$|dz| < 2.0\ , |dr| < 0.5, muonID > 0.5$$

- Photon requirements:

inCDCAcceptance, clusterErrorTiming < 10^{-6},[clusterE1E9 > 0.4 or E > 0.075]

stdPhoton listtype: ‘loose’

Efficiency Calculations

- The efficiency was based off the below equation, and the trigger bits which were used was based off the chart below.

$$\epsilon_{target} = \frac{N_{target\&reference}}{N_{reference}}$$

	CDC	CDC	ECL	KLM
Target(FTDL)	ffo	fy30	hie	mu_b2b
Reference(PSNM)	hie	hie	mu_b2b	hie

- The cuts regarding each of the reference bits were defined based off the study BELLE2-NOTE-TE-2020-014 and Xuyang Gao: Trigger efficiency study with $ee \rightarrow \mu\mu\gamma$

Variables

- The variables are organized below

Variable	Definition
$\Delta\phi$	The azimuthal angle difference between the two muon tracks
$\min p_T$	The smaller transverse momentum between the two muons
$cos\theta_{\mu 1,\mu 2,\gamma}$	The cosine of the polar angle for the muons or photon tracks within the detector
$\phi_{\mu,\gamma}$	The azimuthal angle for the muons or photon tracks within the detector
E_γ	The energy of the photon emitted during the $e^+e^- \rightarrow \mu^+\mu^-\gamma$ interaction

Cuts

The Cuts corresponding to the target Triggers were defined below.

Target Trigger	Additional cut
ffo	$\Delta\phi > 90° \,\&\, \min p_T > 0.4$ GeV
fy30	$\Delta\phi > 30° \,\&\, \min p_T > 0.4$ GeV
hie	$E_\gamma > 1$ GeV, $\cos\theta_\gamma$ in Barrel Region
mu_b2b	$\min p_T > 1$ GeV & $\cos\theta_\mu \in [-0.4, 0.62]$

Each additional cut was constructed based on the definitions of each trigger bit.

ffo : opening angle >$90°$

fy30: opening angle >$30°$

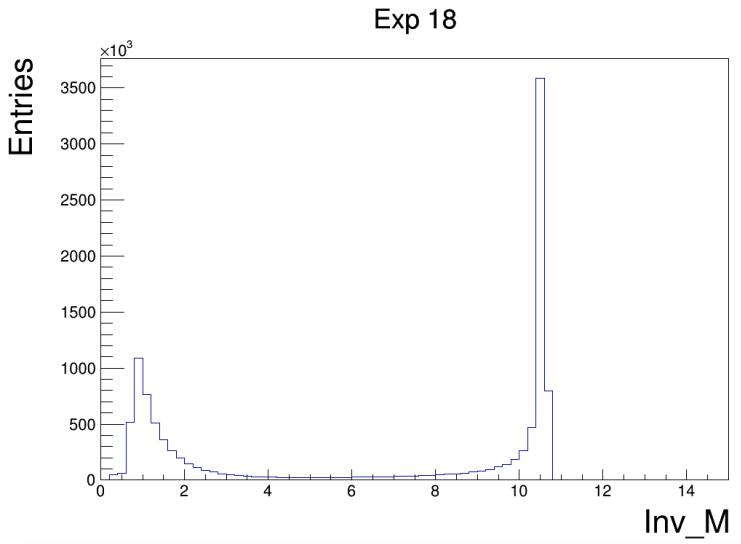
hie : $E_\gamma > 1$ GeV

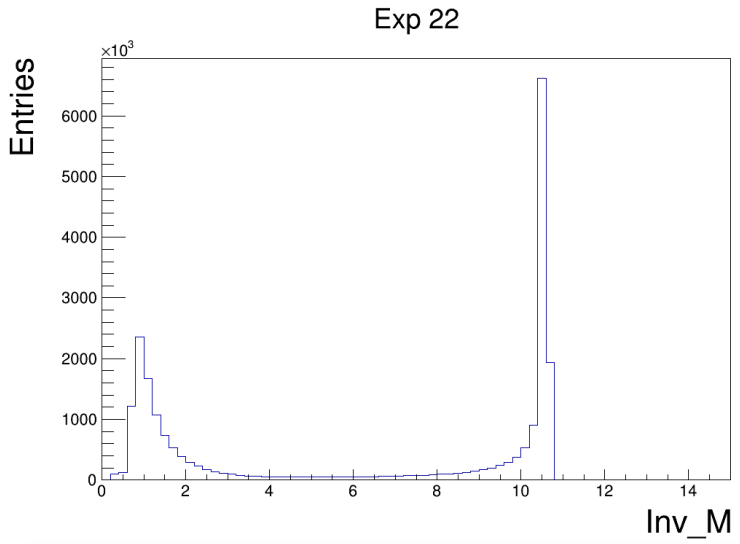
mu_b2b: p_T > 1 GeV, and back to back conditions

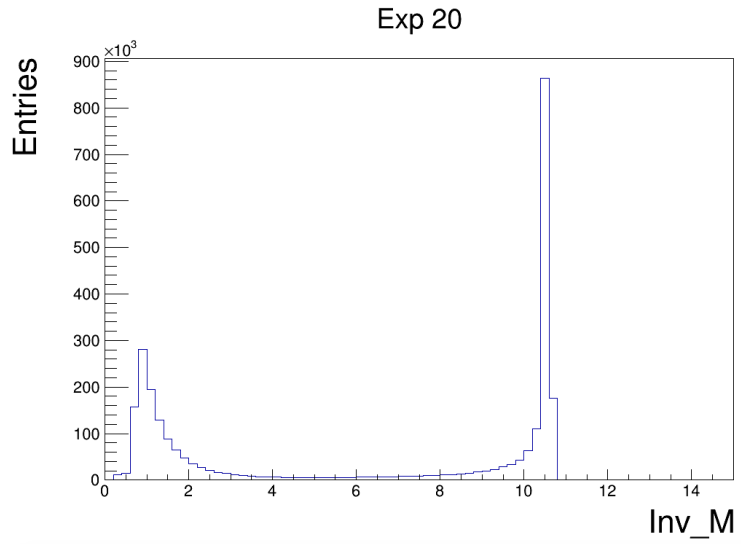
The $\min p_T > 0.4$ GeV condition was applied to remove a large amount of muons which has far too small transverse momenta

Cuts(Invariant Mass)

- Also, for each experiment, I selected the Invariant mass to be in the range of the dimuon signal by adding the cut Inv_M > 4







Cuts

The Results of the cut applied for each experiment is shown below,

Target Trigger	Additional cut
ffo	$\Delta\phi > 90° \,\&\, \min p_T > 0.4$ GeV
fy30	$\Delta\phi > 30° \,\&\, \min p_T > 0.4$ GeV
hie	$E_\gamma > 1$ GeV, $\cos\theta_\gamma$ in Barrel Region
mu_b2b	$\min p_T > 1$ GeV & $\cos\theta_\mu \in [-0.4, 0.62]$

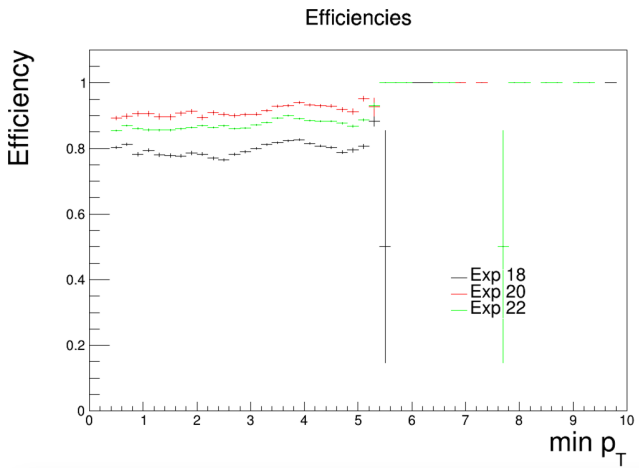
$$\epsilon_{target} = \frac{N_{target\&reference}}{N_{reference}}$$

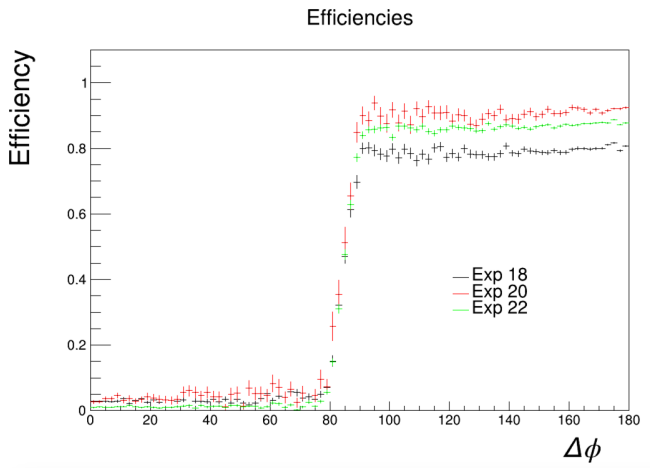
	Exp 18		Exp 20		Exp 22	
Trigger	Before cut	After cut	Before cut	After cut	Before cut	After cut
ffo	371454	185402	102461	50898	892951	444352
fy30	368623	184275	101960	50720	891801	444392
hie	265551	148316	65829	36849	596635	338739
mu_b2b	265313	167038	65793	41376	596159	376130

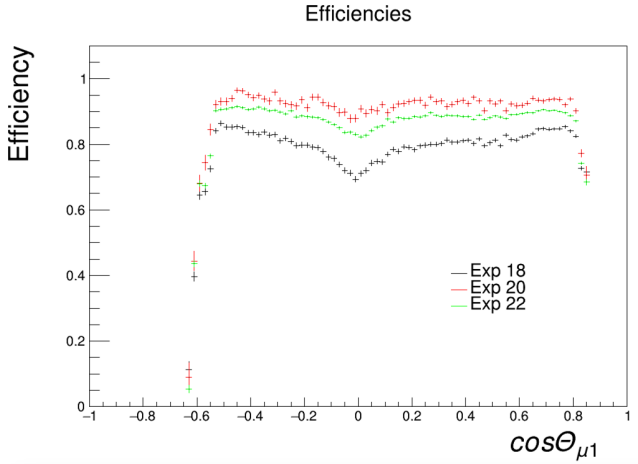
ffo bit Efficiency

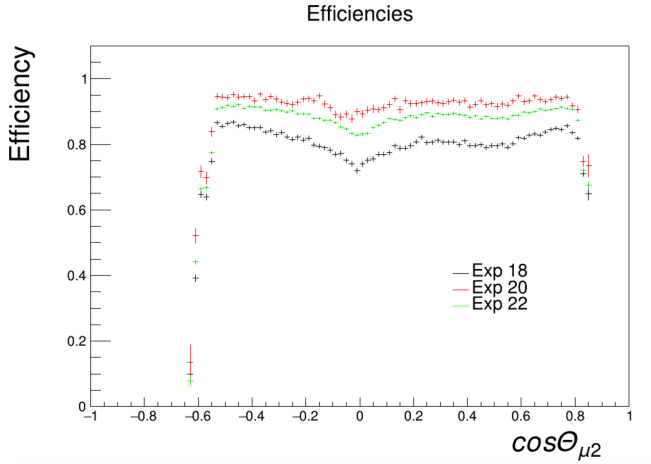
Reference bit: hie

Cut:$\Delta\phi > 90$ & $\min p_T > 0.4GeV$







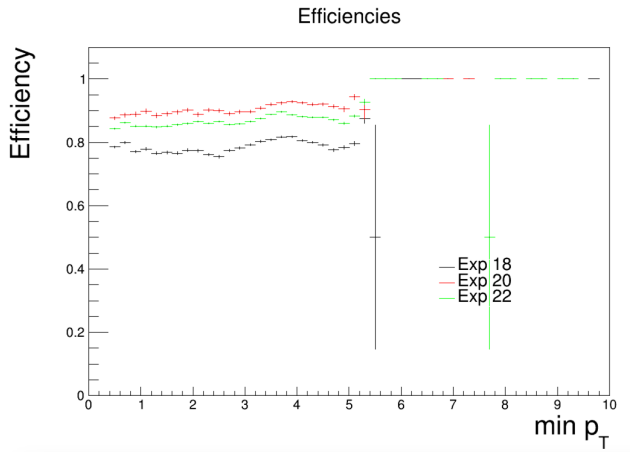


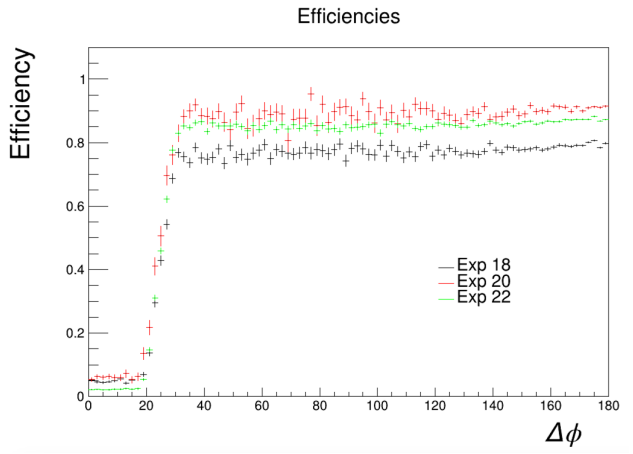
fy30 bit Efficiency

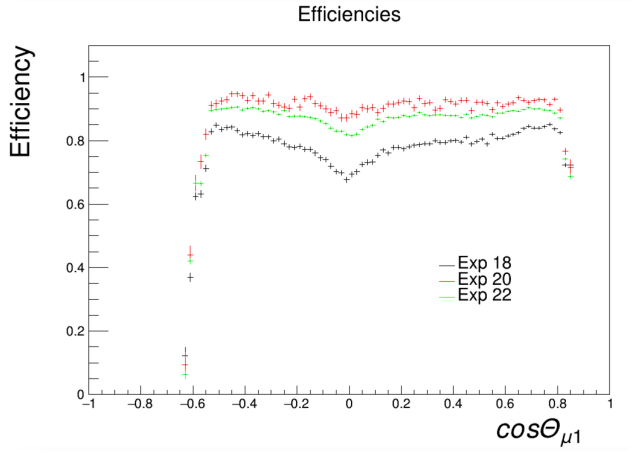
Reference bit: hie

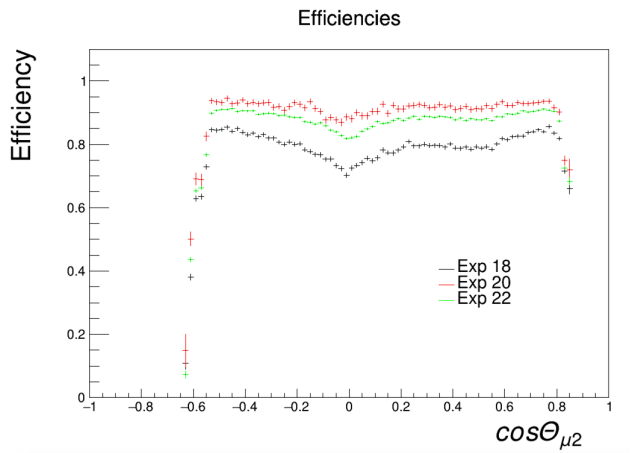
Note: Xuyang's result was for ffo30

Cut: $\Delta\phi > 30$ & $\min p_T > 0.4GeV$





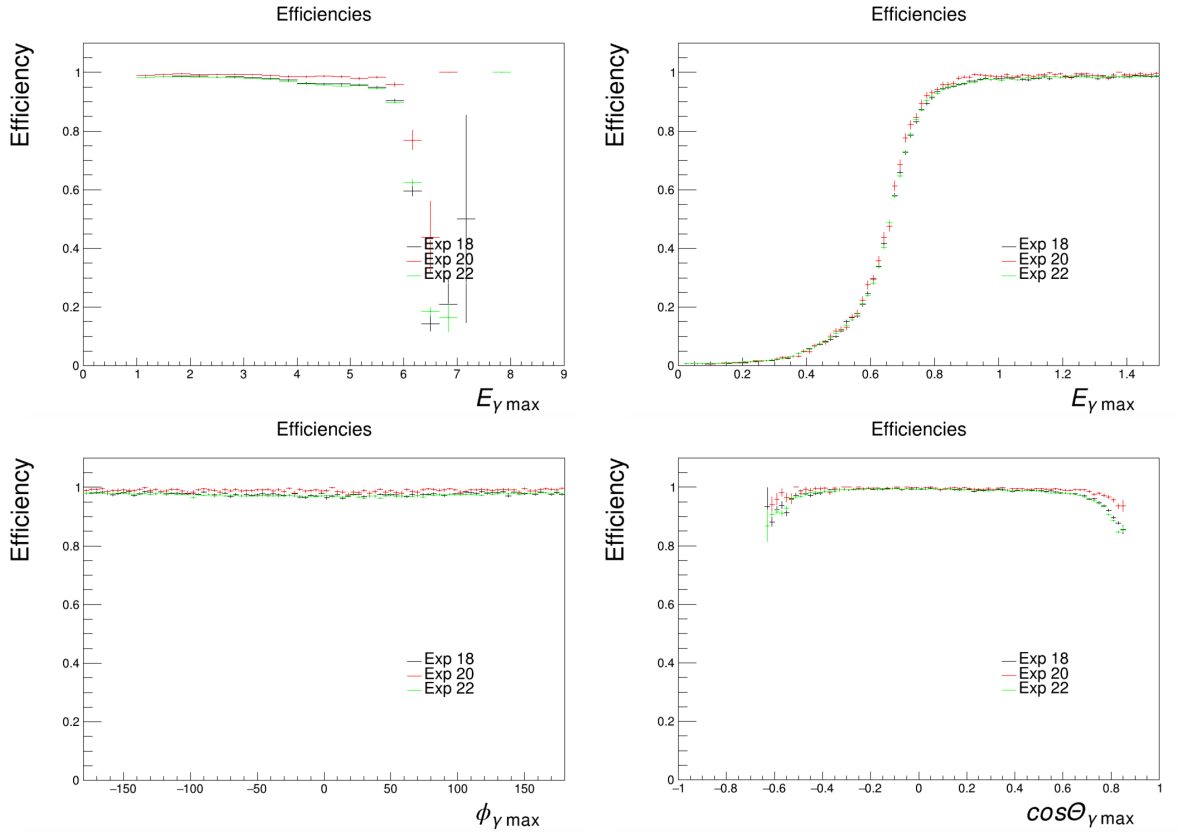




hie bit Efficiency

Reference bit: mu_b2b

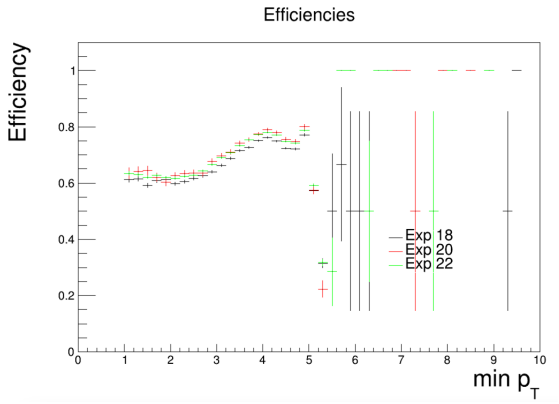
Cut: $E_\gamma > 1GeV, cos\theta_\gamma \; in \; Barrel \; Region$

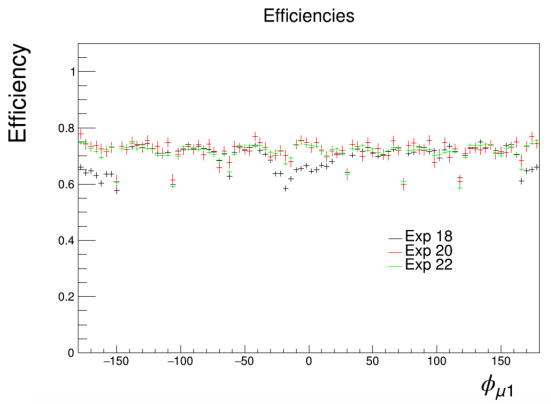


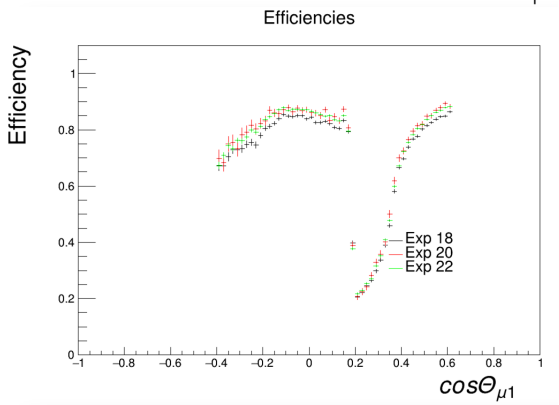
mu_b2b bit Efficiency

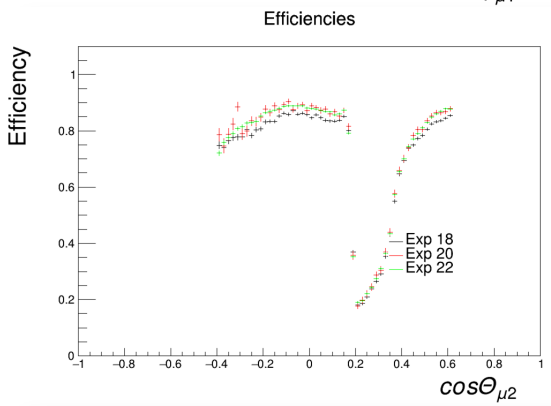
Reference bit: hie

Cut: $\min p_T > 1GeV$ & $cos\theta_\mu \in [-0.4,\ 0.62]$









Summary

- The efficiency calculations for experiments 18,20,22 were very much in line with the results from preceding studies of the same type.
- Other experiments(14,16,17,24,25) will be checked for consistency with Xuyang's results.
- In depth analysis for the experiments will be done once the efficiency check is complete.