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**Efficiency study on the cross section measurement of  
 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$  through the radiative return method at Belle II**

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**Abstract**

This note presents plots of efficiency study for the cross section measurement of  $e^+e^- \rightarrow \pi^+\pi^-\pi^0$ . This study is performed with Phase III Monte Carlo samples of  $e^+e^- \rightarrow \pi^+\pi^-\pi^0\gamma$  process.

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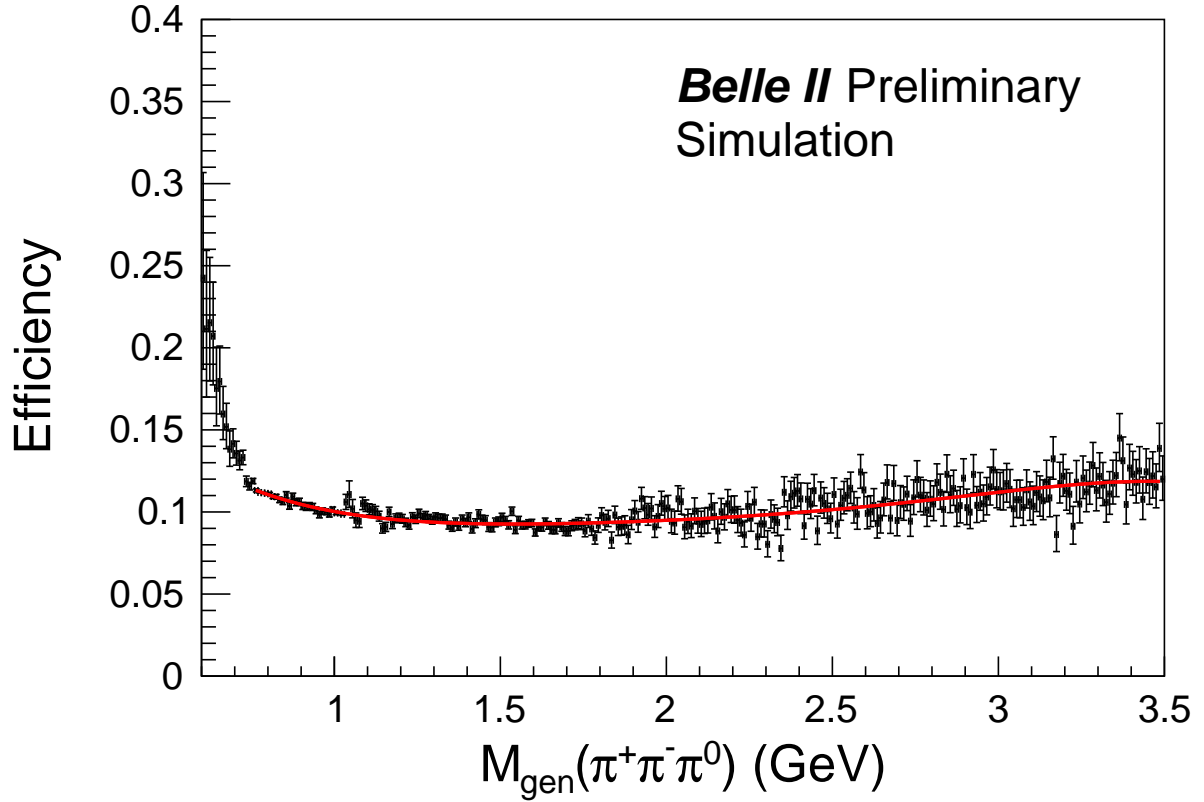


FIG. 1. Detection efficiency dependence on the generated invariant mass of  $\pi^+\pi^-\pi^0$  using  $e^-e^- \rightarrow \pi^+\pi^-\pi^0\gamma$  MC. The generated event, denominator, is required to have the invariant mass of  $\pi^+\pi^-\pi^0$  is more than 8 GeV and a ISR photon whose energy is more than two GeV and the polar angle is within 20 to 160 degree in the centre-of-mass frame. Selection criteria of observed event is dedicated on Table I. The red line shows the result of fitting with a quintic function to the range of  $0.75 < M(\pi^+\pi^-\pi^0) < 3.5$  GeV.

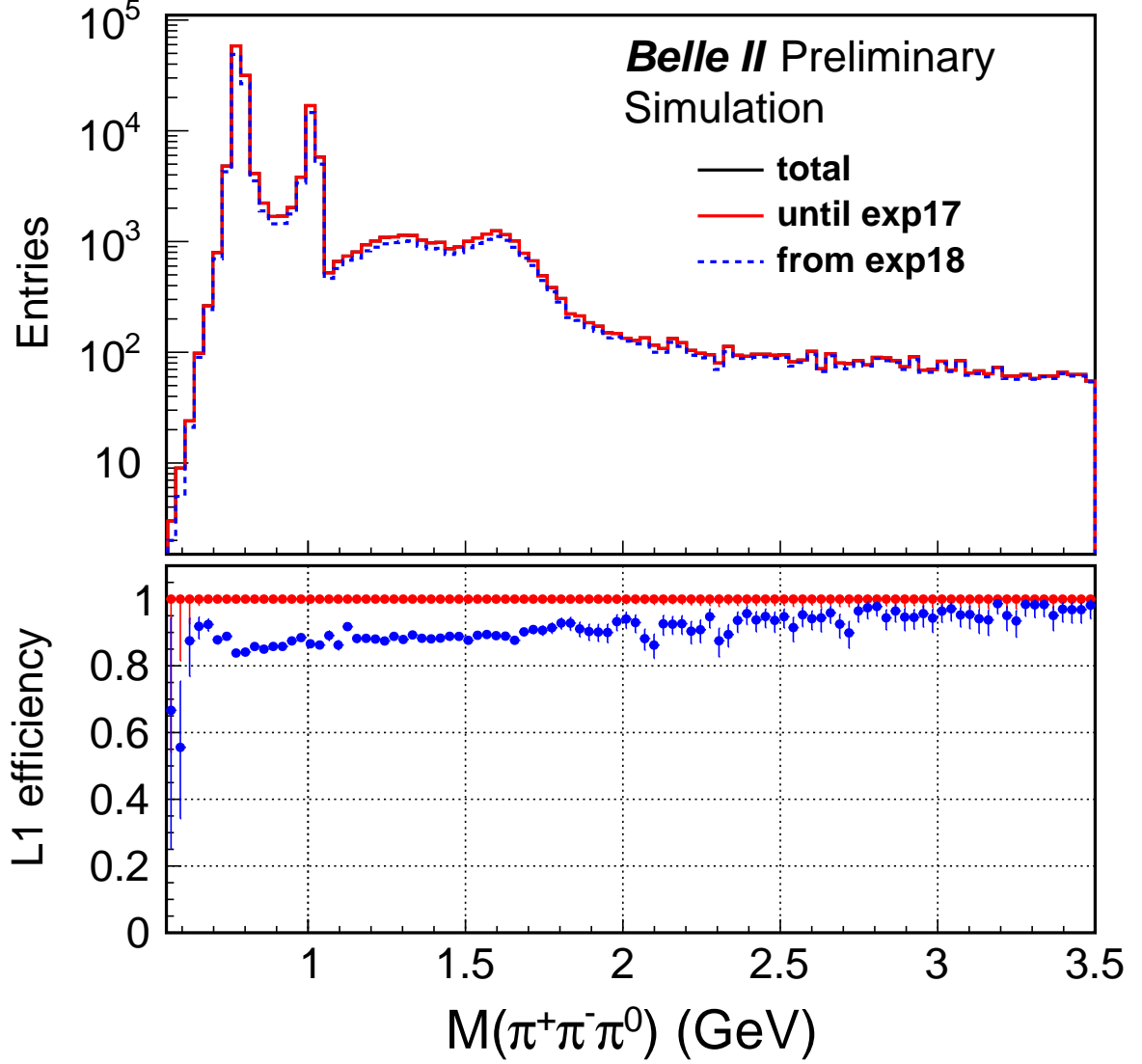


FIG. 2. Trigger efficiency dependence on the invariant mass of  $\pi^+\pi^-\pi^0$  using  $e^-e^- \rightarrow \pi^+\pi^-\pi^0\gamma$  MC. Selection criteria dedicated on Table I is applied. The black line shows total events with data of  $500 \text{ fb}^{-1}$ . The red line shows the number of events and trigger efficiency after requiring 1 GeV ECL energy trigger, which corresponds to data taking condition until experiment 17. The blue line shows the number of events and trigger efficiency after turning on 3D bhabha veto, which corresponds to data taking condition from experiment 18.

TABLE I. The summary of standard event selection for signal event.

Quantity	Cut
Level-1 trigger	
PSNM bit	<i>hie</i> OR <i>bha3d</i> (-exp.17) <i>hie</i> (exp.18-)
ISR photon	
CMS energy	$E^{\text{CMS}} > 2 \text{ GeV}$
Polar angle	$20^\circ < \theta^{\text{lab.}} < 126^\circ$
Tracks	
Momentum	$p^{\text{lab}} > 0.5 \text{ GeV}/c$
Polar angle	$17.0^\circ < \theta^{\text{lab.}} < 150^\circ$
Vertex	$dr < 0.5 \text{ cm}$ and $ dz  < 2 \text{ cm}$
CDC hits count	nCDCHits $> 20$
Binary electron veto	$R_{\pi/e} > 0.1$
Binary kaon veto	$R_{\pi/K} > 0.1$
$\gamma(\pi^0)$	
ECL cluster count	clusterNHits $> 1.5$
ECL cluster polar angle	$17^\circ < \theta_{\text{cluser}}^{\text{lab.}} < 150^\circ$
Energy	$E > 100 \text{ MeV}$
$\pi^0$	
Invariant mass	$0.123 \text{ GeV} < m(\gamma\gamma) < 0.147 \text{ GeV}$
Daughter opening azimuthal angle	$ \Delta\phi  < 1.5 \text{ rad}$
Daughter opening angle	daughterAngle $< 1.4 \text{ rad}$
$\pi^+\pi^-\pi^0\gamma$ selection	
Tracks count	$2 \geq N_{\text{track}} \geq 3$
Event charge	$ \Sigma Q_{\text{track}}  \leq 1$
Four-conservation KFit $\chi^2$	$\chi_{4C}^2 < 50$