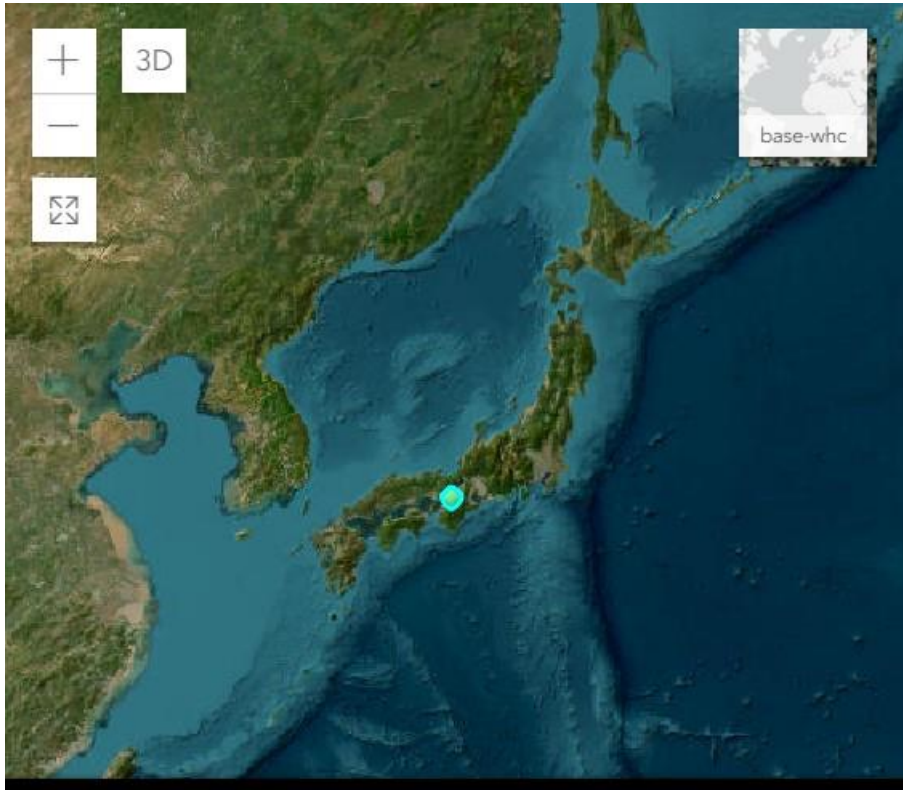
Welcome to the annual Belle II TRG/DAQ workshop at Nara, 2022

Nov. 29(Tue) - Dec. 02(Fri), 2022

Hisaki Hayashii
for the NWU LOC

Belle II TRG/DAQ workshop



- We are honored to held the annual Belle II

TRG/DAQ workshop 2022 at Nara.

Welcome to Nara, Japan.

- This workshop has been held annually in

several places in the world since beginning of the Belle experiment in 1995.

- Under on-going CoViD-19 situation, the workshop in this year is held in a hybrid-style with both face-to-face and remote connection.

Nara

- Nara is the first capital in Japan. It was the center of Japan in 6-8 centuries, and you can see many old temples and shrines built in that time.
- The name "Belle" (proposed by A. Abashian, Virginia Tech), was adopted by a group vote at the third group meeting held in January 1994 at Nara Women's University

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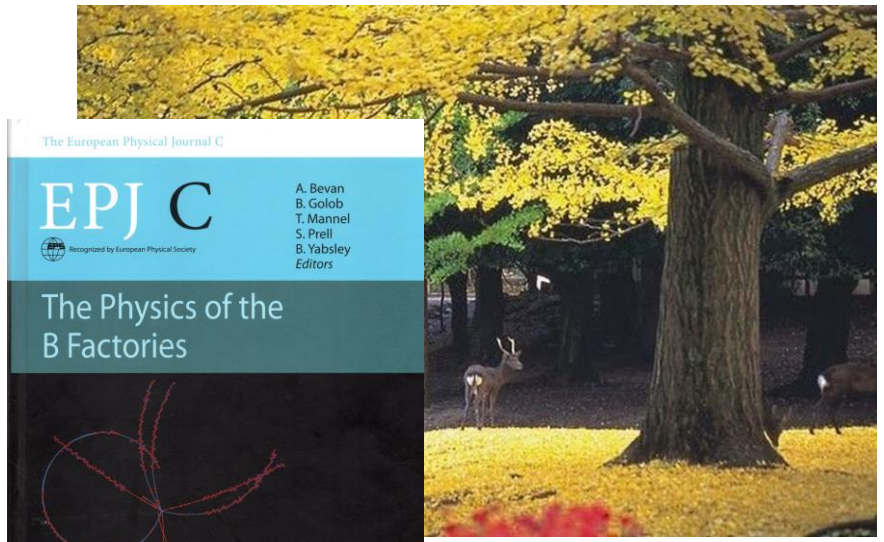
Nara Park



Topics in this WS: Trigger rates and Bhabha

- The trigger rate is already about 5kHz (to 10kHz depending on beam cond.) at 4 x 10^{34} cm^{-2} s^{-1}
- What is the sources of this trigger rate? Beam BG, remaining Bhabha, fake track in Track Segment(TS)?

- The rate of Bhabha events are still high even after applying the 3D-Bhabha vetos.
- Do we need more "looser" condition to identify the Bhabha?
- However more looser condition for Bhabha identification is potentially dangerous for many low multiplicity processes.

$e^+e^- \to \tau^+\tau^-.\ single-photon,\ DMs$

$ISR\ (e^+e^- \to \gamma\pi\pi,\ \gamma 3\pi \ldots),$

$e^+e^- \to e^{\pm}(e^{\mp})\pi^0 \ldots$ $\leftarrow need\ to\ tag\ e^{\pm}$ in endcap regio

Trigger rates and Dilemma

- Useful triggers for these processes are hie (high-energy trigger), STT (single track trigger), lmx …
- But more tighter Bhabha vetos will be needed for these relatively “loose” trigger bits.

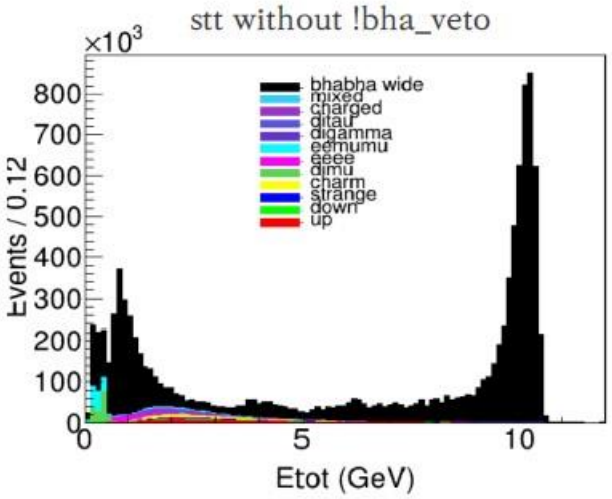
- How to solve these dilemmas?

- There is a hint by a YongHeon and JoonNyong’s talk at B2GM 2022/Oct/07:

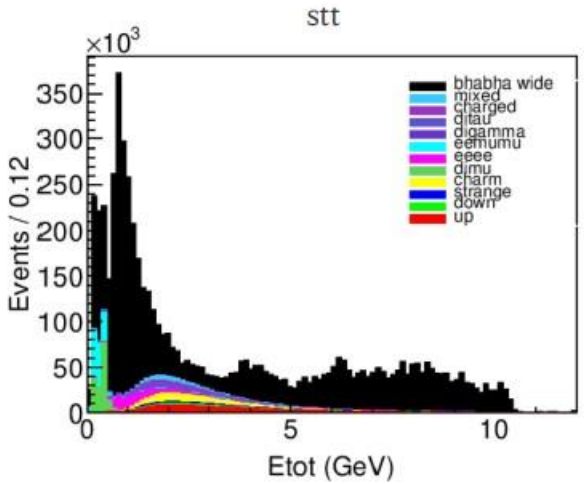
“STT Bhabha background Study”

Remaining Bhabha events in STT trigger

STT w/o 3D-Bhabha veto



STT event after 3D-Bhabha veto



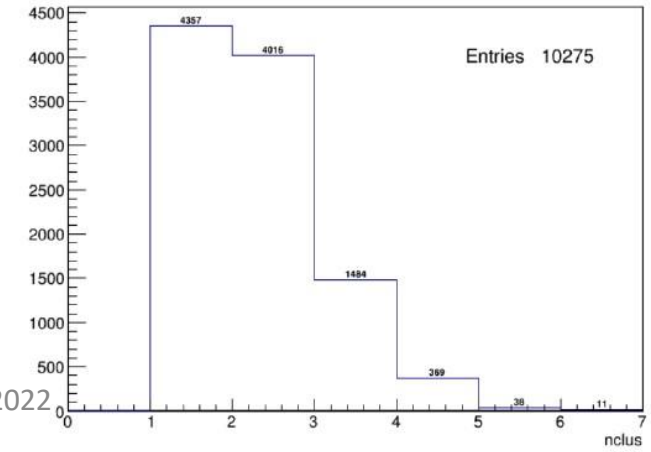
Taken from YongHeon Ahn and JoonNyong Jang slide at B2GM 2022/Oct/07

Expected Bhabha rate by MC is 380 Hz after applying 3D-Bhabha veto at $3\times10^{34}cm^{-2}s^{-1}$

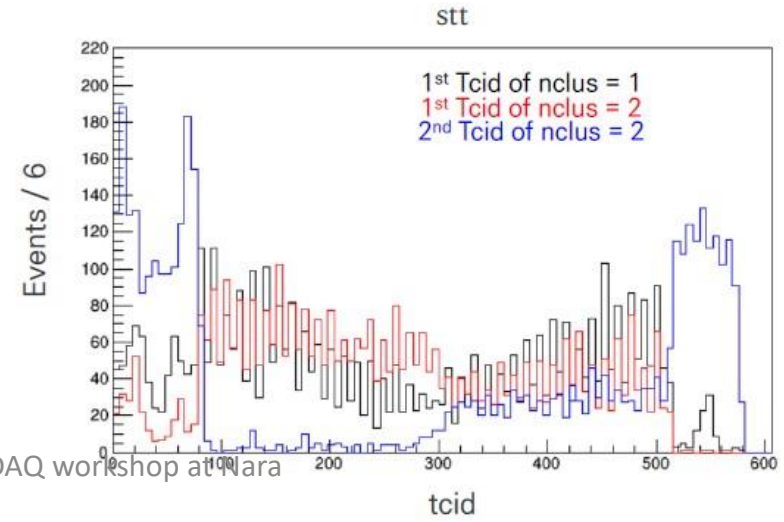
One orther smaller than the actual STT rate ? Due to Bhabha generation condition?

$\geq 1^{\circ}$

Number of clusters in Bhabha MC

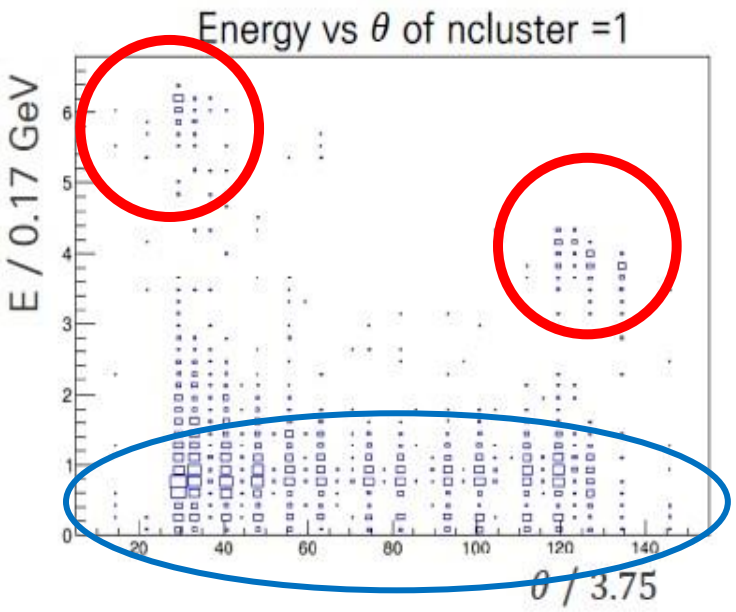


Polar angle of clusters (Bhabha MC)

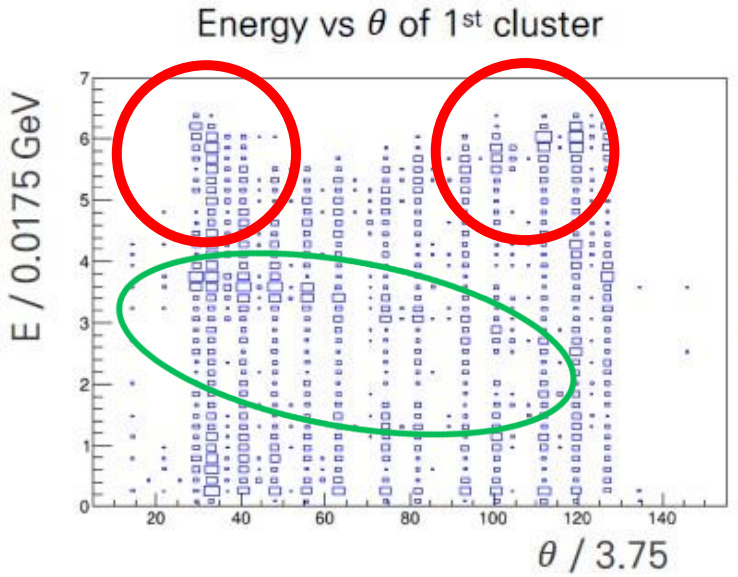


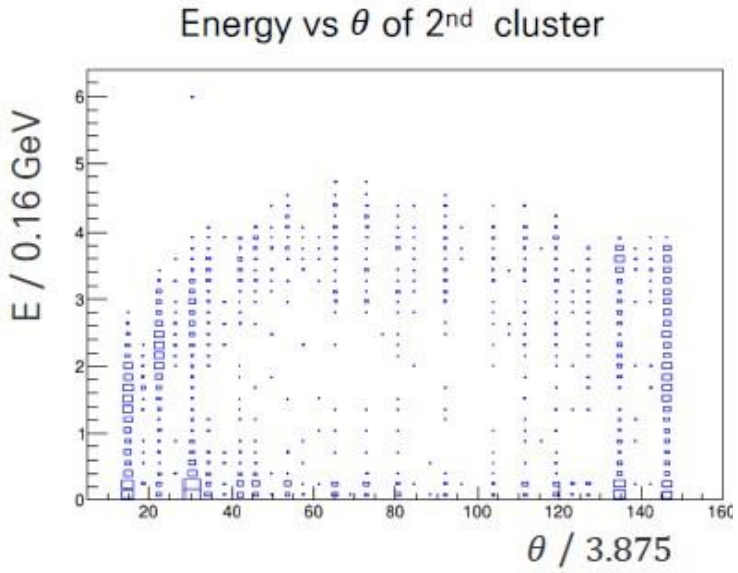
Many clusters even in the Barrel region

STT single-cluster events

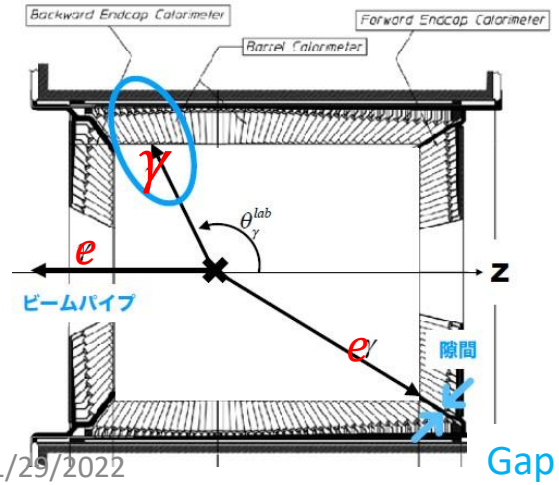


STT two-cluster events

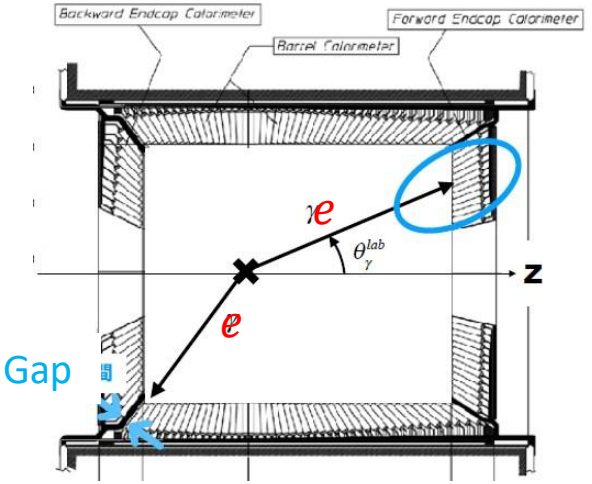




Blue region

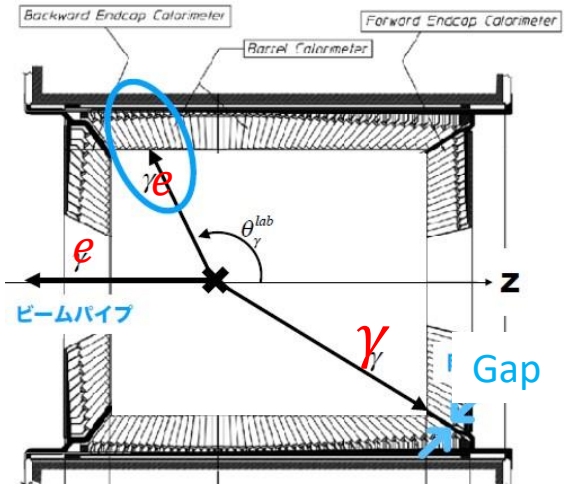


Red region



One electron track is low angle

Green region



Then How to reduce these Bhabha's ?

My Idea

How to identify the remaining Bhabha events

- Idea: use the CDC information to identify the (remaining) Bhabha events. It is identified as “Bhabha” if either (1) or (2) is satisfied.

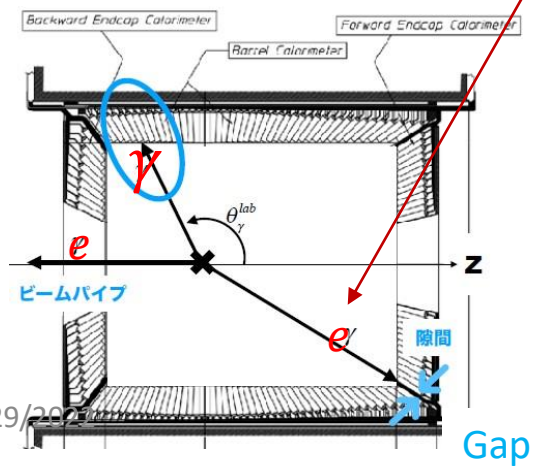
(1) There is a single-track in CDC and it’s direction is pointing to ECL gap.
（Blue and Red cases)

(2) Only single-track in CDC. Calculate the missing momentum assuming one electron is scattered to the beam-direction having the same beam energy.

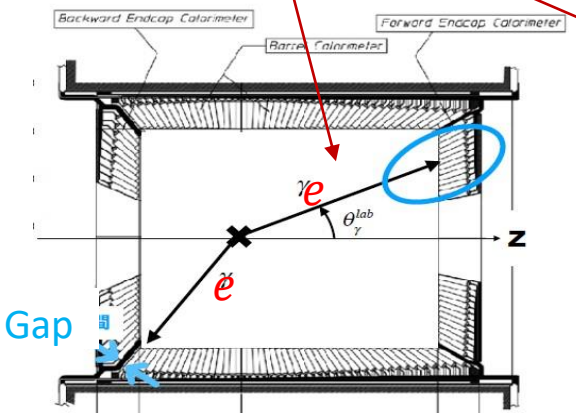
$$\boldsymbol{p}_{miss}^{lab} = \boldsymbol{p}_{ini} - \boldsymbol{p}_{escap} - \boldsymbol{p}_{e}$$ ← Use ECL info.

The direction of $\boldsymbol{p}_{miss}^{lab}$ is pointing to the ECL gap. (Green case)

Blue region

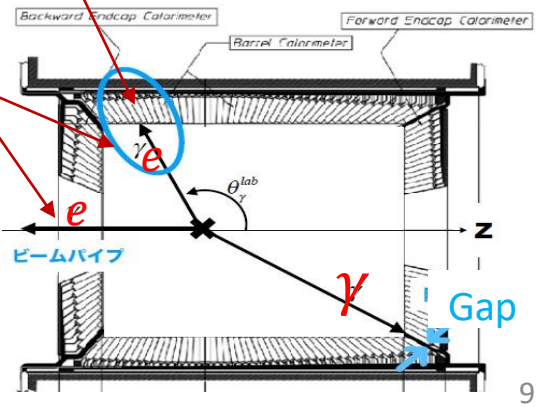


Red region



One electron track is low angle

Green region



- Identification of the background (Bhabha) is easier than identifying the various kind of Low-mulitiplicity processes $\tau^+\tau^-$. DMs, ISR.

- It is important to understand the source of the events triggered by STT and others, quantitatively. remaining Bhabha?, fake TS tracks?

Tigger rates and their sources @ L=$3 \times 10^{34}\ cm^{-2}s^{-1}$

Trigger	Trigger rate (Exp)	Remaining Bhabha (MC)	Fake tracks (TS)	Beam BG(track/photons)
L1 All	5 (10) kHz			
fyo				
stt		0.38 + …. kHz		
hie			-	
lm1			-	
lmx			-	

Please enjoy the workshop

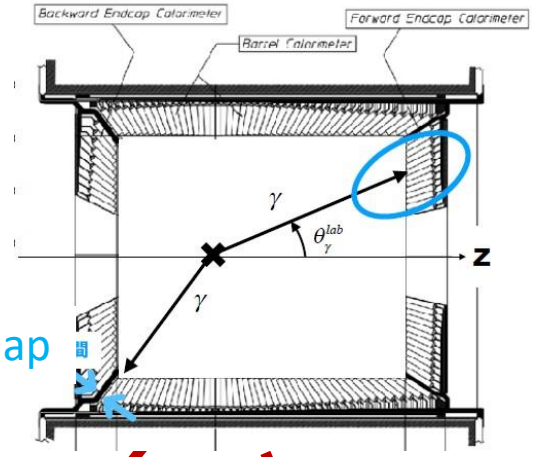
Backup

Why I think so?

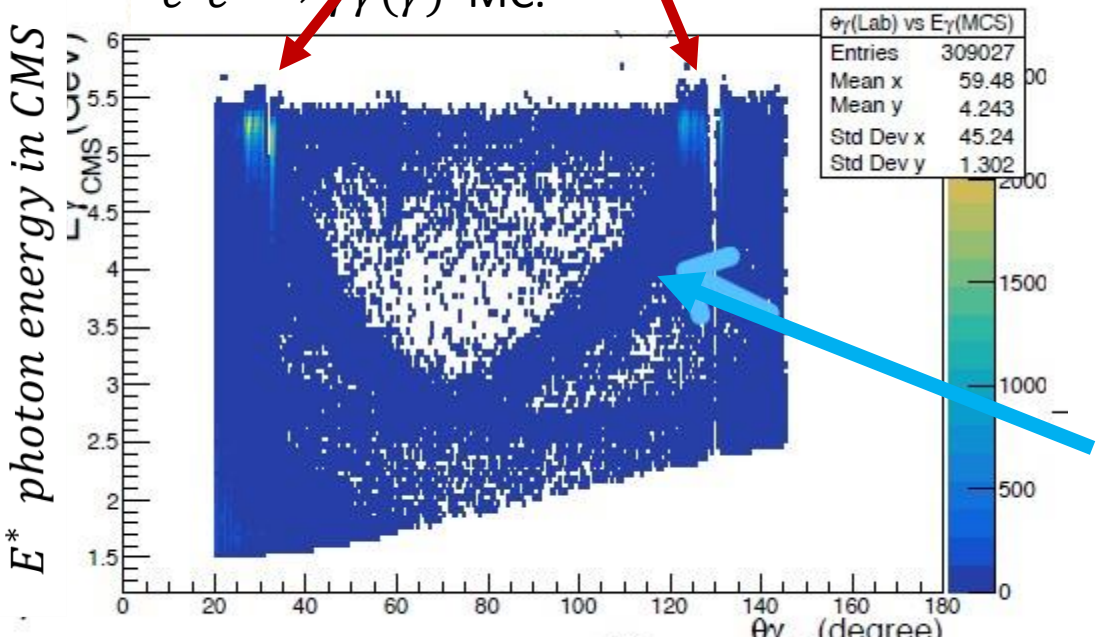
In the analysis of single-photon events, $e^+e^- \to \gamma$+ nothing, clear band structures are observed in the $e^*e^- \to \gamma\gamma(\gamma)$ MC.

Although angular distribution is different between $e^*e^- \to \gamma\gamma(\gamma)$ a $e^*e^- \to ee(\gamma)$, similar event pattern expected for both.

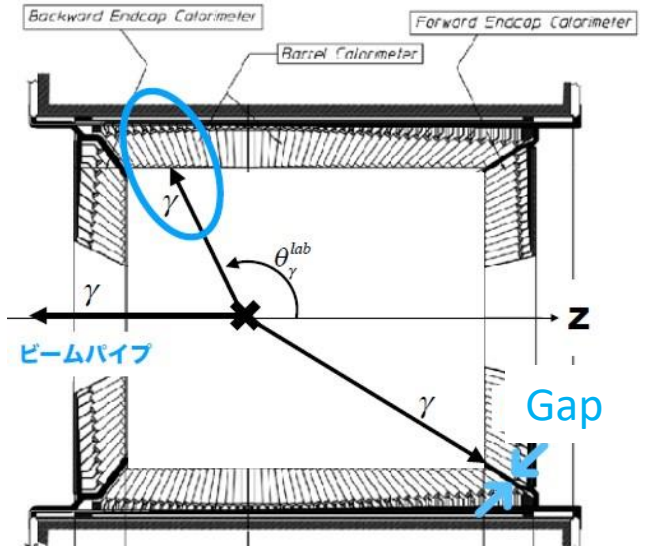
Please check the unobserve particles are scattered in which direction by Bhabha MC !



$e^*e^- \to \gamma\gamma(\gamma)$ MC.



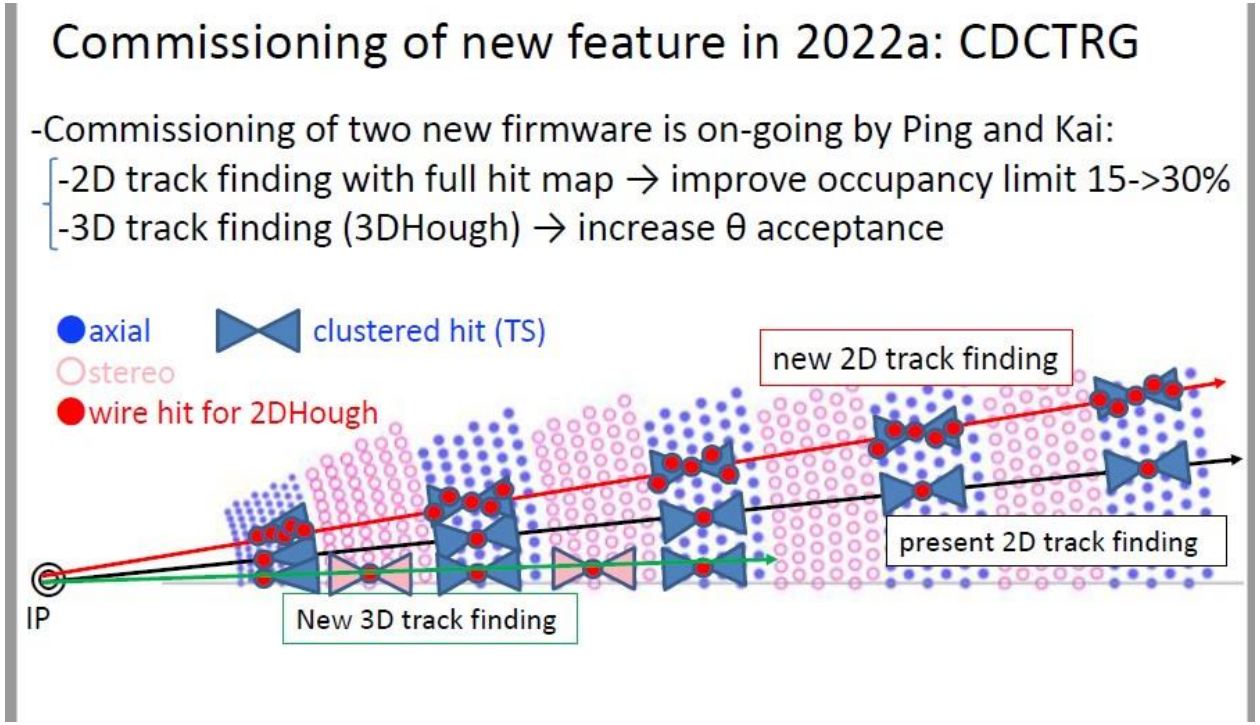
Polar angle of photon in lab. θ_γ^{lab}



Taken from a master thesis by Yabuuchi, NWU

More CDC hits to reduce fake TS tracks.

Use more CDC hits in Track Segment Finder (TSF) is crucial to reduce the fake TS track.



Bhabha veto in 2022

Commissioning of new feature in 2022a: ECLTRG

-Optimization of new trigger bits are on-going with many physics guys:

- -New Bhabha veto (https://agira.desy.de/browse/BIITRG-30)
  - -present Bhabha veto:
    E_{low}>2.5GeV & E_{high}>4GeV & 160<$\Delta\phi_{CM}$<200deg & 165<$\Sigma\theta_{CM}$<190deg
  - -new Bhabha veto:
    (E_{low}>2.5GeV & E_{high}>4GeV & 160<$\Delta\phi_{CM}$<200deg & 165<$\Sigma\theta_{CM}$<190deg)
    || (#cluster==1 & θ_{CM} is in FW) || (#cluster==2 & $\theta_{low\ CM}$ is in FW or BW)
  - -expect to reduce rate of E>1GeV trigger bit (hie) ~50%

- Independence between track-trigger and calorimeter-trigger is quite important.