

Status on ECL Trigger simulation

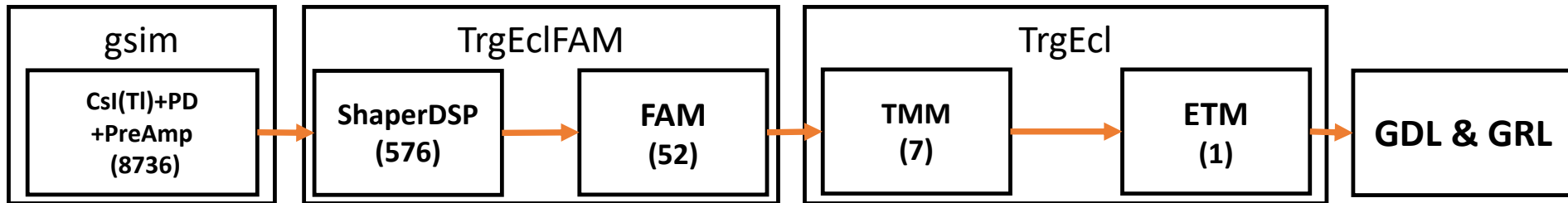
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Software configuration



- Fast simulator

- Basic scheme of fast simulator is ready.
- GSim part (8736 Xtals + PD + preAmp)
 - Use ECLHit table in ECL software package
- TrgECLFAM module (ShaperDSP + FAM)
 - **Shaping** and **digitization**
 - 3 types noise generation(serial, parallel, pile-up)
 - **Measure energy and timing**(1 method + 2 backup methods)
- TrgEcl module (TMM+ETM)
 - Decide **trigger conditions**(Physics, Bhabha, beam-background) and event-timing.
 - Belle trigger logics decision method are implemented.
 - New event-timing logic is implemented with resolution $\sigma \sim 3.7$ ns.

- Firmware simulator

- Standalone package of FAM is made by Unno san
- Basf2 version development is not started yet

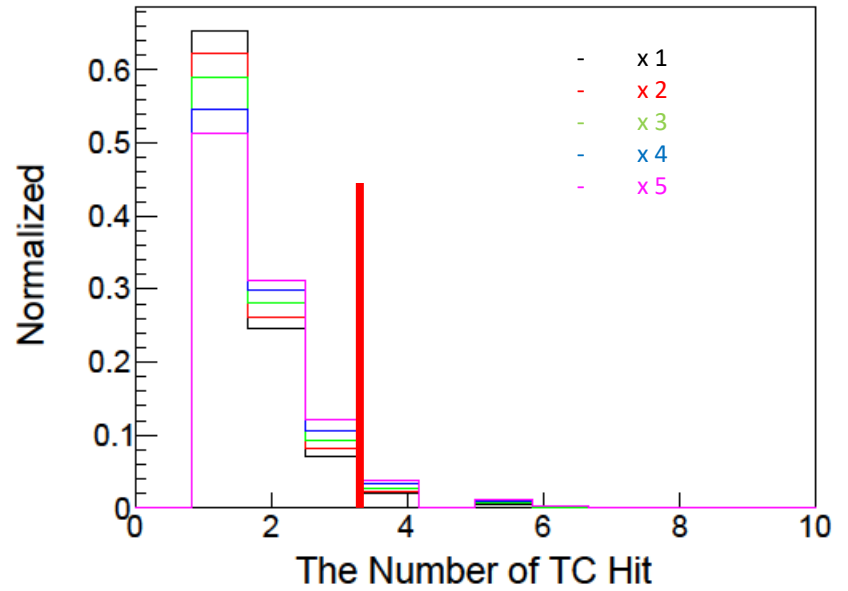
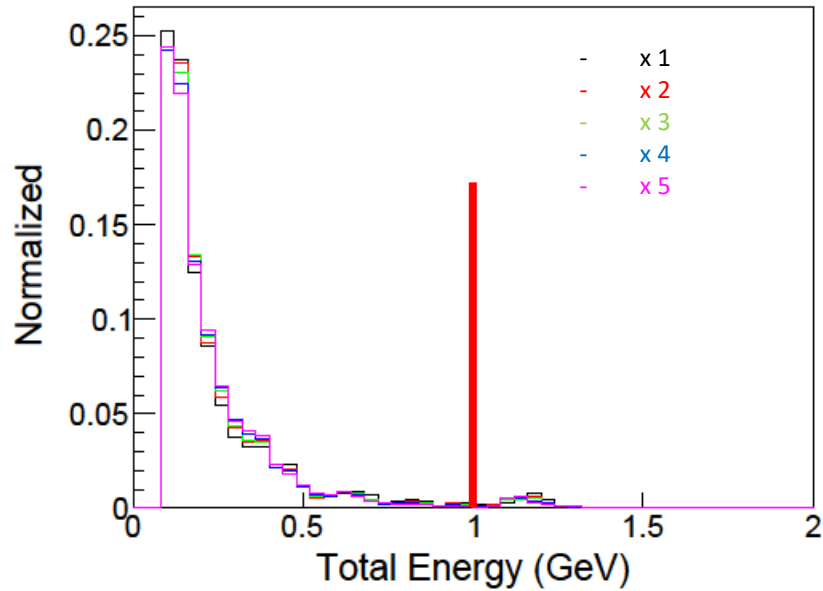
Background Trigger rate in ECL Trigger

- We check a physics trigger rate of Beam background using Tsim-ecl.
 - Physics trigger condition
 - $(E_{total} > 1 \text{ GeV} \ || \ ICN > 3) \ \&\& \ ! \text{ Bhabha}$
 - Sample : Beam background – 40,000 events(240 ms data)
 - Result

Background level	Physics trigger rate(KHz)
x 1	6.7 ± 0.2
x 2	9.7 ± 0.2
x 3	12.7 ± 0.3
x 4	17.4 ± 0.3
x 5	23.6 ± 0.4

- Trigger rate is proportional to beackground level.

Effective cut ?



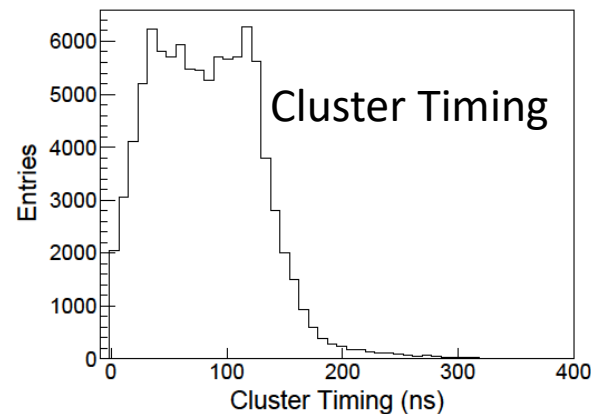
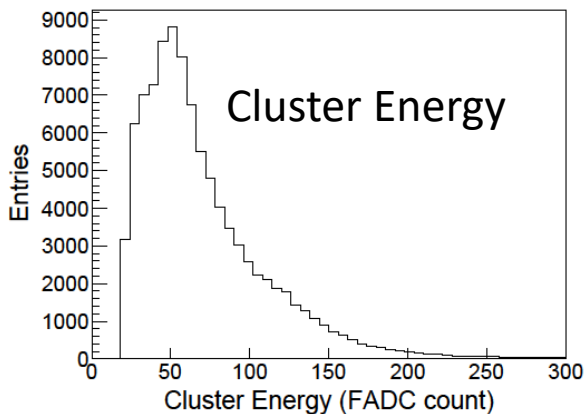
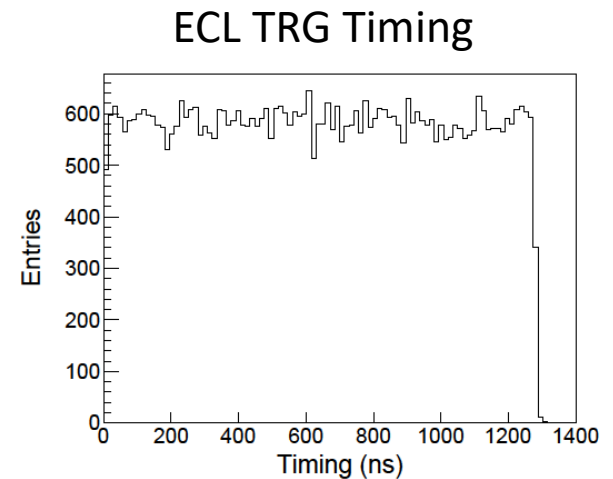
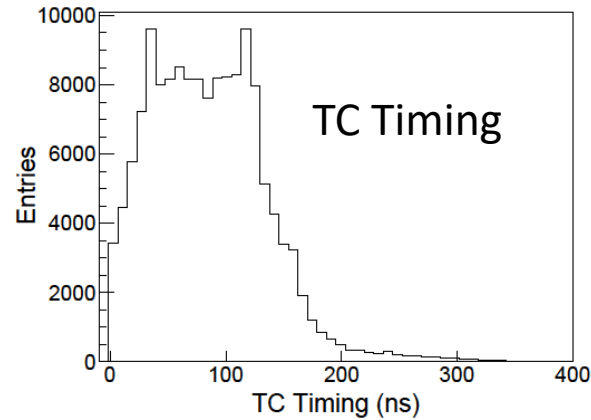
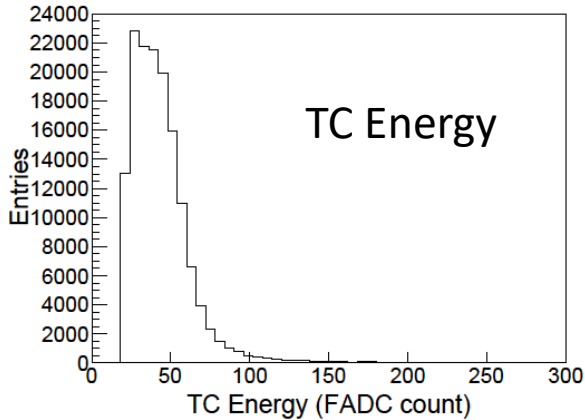
Background level	Trigger rate(kHz) selected by TotalEnergy >1 GeV	Trigger rate (kHz) Selected by ICN > 3
x 1	5.9	1.0
x 2	8.0	1.9
x 3	9.5	3.6
x 4	11.6	6.5
x 5	13.2	11.4

Other Update

- Condition data base for Tsim-ecl
 - 1st version of condition database for Tsim-ecl has been prepared.
 - TC Threshold is supported.
 - To do list
 - TC Geometry
 - Fitting Parameters

Other Update (cont'd)

- Raw data Analysis module (TRGECLRawdataAnalysis Module) w/ SH's support
 - Raw data → TRGECUnpacker → Raw data Analysis Module
 - TC Energy & Timing
 - Cluster Energy & Timing
 - ECL Trigger timing



8th May cosmic data

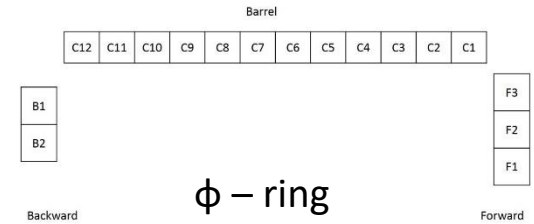
Plan

- Fast simulation
 - 3-D Bhabha veto logic
 - Optimize cut
 - Purity study
 - Single photon event
 - Beam background study
 - HanEol take over the beam background study.
 - Noise covariance matrix
 - Diode hit study
- Firmware simulation
 - Development will be start in September.

Back up

Bhabha logic study

- Belle (2-D)
 - Check Back to back topology though θ direction.
 - 18 φ ring combination
- New 2-D logic (Belle note #477)
 - Apply asymmetric energy to forward part and backward part in a combination



Belle

Combination(θ id)	Energy cut(GeV)
F1 + F2 + F3 + B1 + B2	5.0
F3 + C12	3.0
F2 + F3 backward gap	5.0
C1 + backward gap	4.0
C1 + C11 + C12	5.0
C2 + C11 + C12	5.0
C1 + C2 + C11	5.0
C2 + C10 + C11	5.0
C2 + C9 + C10	5.0
C2 + C3 + C10	5.0
C2 + C3 + C9	5.0
C3 + C4 + C9	5.0
C3 + C4 + C8	5.0
C4 + C5 + C8	5.0
C5 + C7 + C8	5.0
C5 + C6 + C7	5.0
C11 + C12 + forward gap	3.0
B1+ forward gap	3.0

New Belle

Combination(θ id)		Energy cut(GeV)	
F1 + F2 + F3	B1 + B2	3.5	1.0
F3	C12	3.0	1.0
F2 + F3 backward gap		5.0	
C1 + backward gap		4.0	
C1	C11 + C12	3.5	1.5
C2	C11 + C12	3.5	1.5
C1 + C2	C11	3.5	1.5
C2	C10 + C11	3.5,	1.5
C2	C9 + C10	3.5	1.5
C2 + C3	C10	3.5,	1.5
C2 + C3	C9	3.5,	1.5
C3 + C4	C9	3.5,	1.5
C3 + C4	C8	3.5	1.5
C4 + C5	C8	3.5,	1.5
C5	C7 + C8	3.5,	3.0
C5 + C6	C6 + C7	3.5	3.0
C11 + C12 + forward gap		3.0	
B1+ forward gap		3.0	

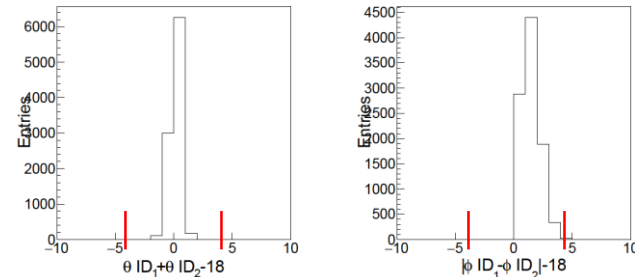
Bhabha logic study

- 3D Bhabha logic

- Find the maximum energy clusters in FWD region ($\theta_{id} 1\sim 8$) and BWD region($\theta_{id} 8\sim 17$).
- Bhabha tag : $E_{two\ clusters} > 4\ GeV$ && $E_{clusters1} > 1\ GeV$ && $E_{clusters2} > 1\ GeV$, if two clusters are satisfied back-to-back condition,

- $|(\theta_{id_{FWD}} + \theta_{id_{BWD}}) - 19| < 4$
- $||\phi_{id_{FWD}} - \phi_{id_{BWD}}| - 18| < 4$

- ICN < 4



- Sample (10,000 events) w/o Beam background

- Bhabha, Radiation bhabha, $ee \rightarrow \gamma\gamma$, $ee \rightarrow \mu\mu$

ISR($ee \rightarrow (\gamma)\mu\mu$), ISR($ee \rightarrow (\gamma)\pi\pi$), $\tau \rightarrow$ generic, $\tau \rightarrow \mu\gamma$, $\tau \rightarrow e\gamma$, $Y(4s)$

Comparison of all method.

Sample	Bhabha tagging efficiency(%)			Physics efficiency (%)			Physics efficiency w/o bhabha veto(%)
	Belle	New Belle	3-D	Belle	New Belle	3-D	
Bhabha	98.52 ± 0.12	98.34 ± 0.12	91.57 ± 0.27	1.37 ± 0.12	1.55 ± 0.12	8.12 ± 0.12	99.89 ± 0.03
Radiation Bhabha	92.59 ± 0.26	89.73 ± 0.30	81.96 ± 0.26	7.19 ± 0.26	10.06 ± 0.20	18.19 ± 0.26	99.77 ± 0.05
$ee \rightarrow \gamma\gamma$	90.43 ± 0.29	87.70 ± 0.39	81.10 ± 0.39	8.38 ± 0.28	11.12 ± 0.39	17.73 ± 0.38	98.82 ± 0.11
$ee \rightarrow \mu\mu$	0.86 ± 0.09	0.56 ± 0.07	0.10 ± 0.09	8.38 ± 0.27	8.51 ± 0.28	9.07 ± 0.29	9.08 ± 0.29
ISR($ee \rightarrow (\gamma)\mu\mu$)	4.50 ± 0.22	2.52 ± 0.16	0.44 ± 0.07	14.04 ± 0.38	16.04 ± 0.39	18.16 ± 0.41	18.55 ± 0.42
ISR($ee \rightarrow (\gamma)\pi\pi$)	27.48 ± 0.75	13.10 ± 0.56	9.26 ± 0.48	20.45 ± 0.67	34.82 ± 0.80	38.67 ± 0.82	47.93 ± 0.84
$\tau \rightarrow$ generic	2.49 ± 0.15	1.44 ± 0.11	2.14 ± 0.15	79.09 ± 0.21	78.90 ± 0.40	78.17 ± 0.21	80.33 ± 0.40
$\tau \rightarrow \mu\gamma$	9.69 ± 0.30	5.44 ± 0.24	5.94 ± 0.30	82.56 ± 0.38	86.14 ± 0.35	85.71 ± 0.35	91.58 ± 0.28
$\tau \rightarrow e\gamma$	20.29 ± 0.40	10.57 ± 0.34	9.05 ± 0.40	78.41 ± 0.41	87.11 ± 0.36	78.17 ± 0.41	98.54 ± 0.11
$\Upsilon(4s)$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	99.99 ± 0.01	99.96 ± 0.02	99.99 ± 0.01	99.99 ± 0.024

- Physics trigger condition
 - ($E_{total} > 1\text{GeV}$ or $ICN > 3$) and !Bhabha tagged
- Expected bhabha trigger rate?
 - Belle method : 480 Hz
 - New Belle : 542 Hz
 - 3-D : 2842 Hz

DB status in ECL Trigger?

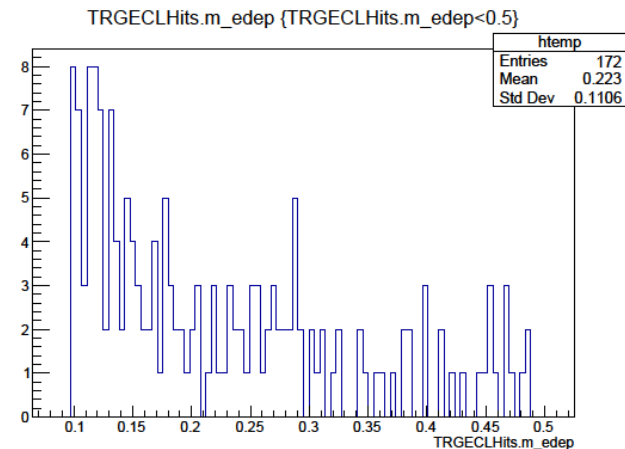
- I made a DBObject named “TRGECLFAMPara.h”
 - TC Threshold is supported.
 - example)

Threshold > 100 MeV

```
1 100
2 100
3 100
4 100
5 100
6 100
7 100
8 100
9 100
10 100
11 100
12 100
```

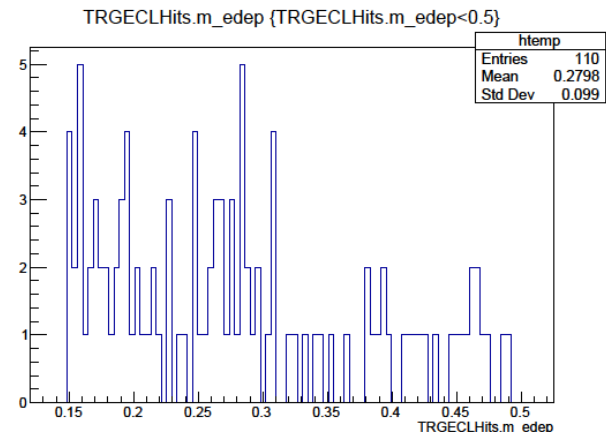


Result

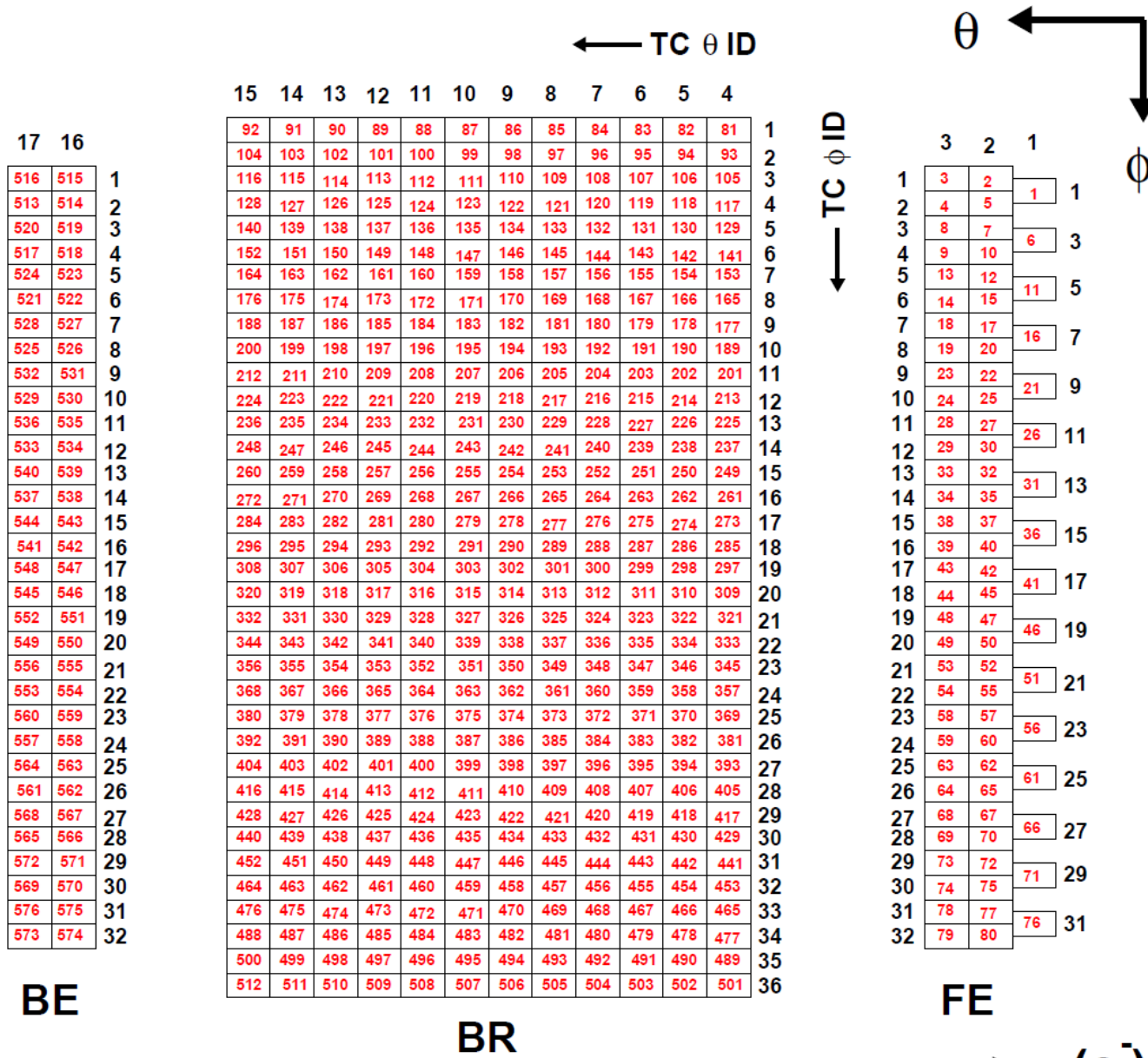


Threshold > 150 MeV

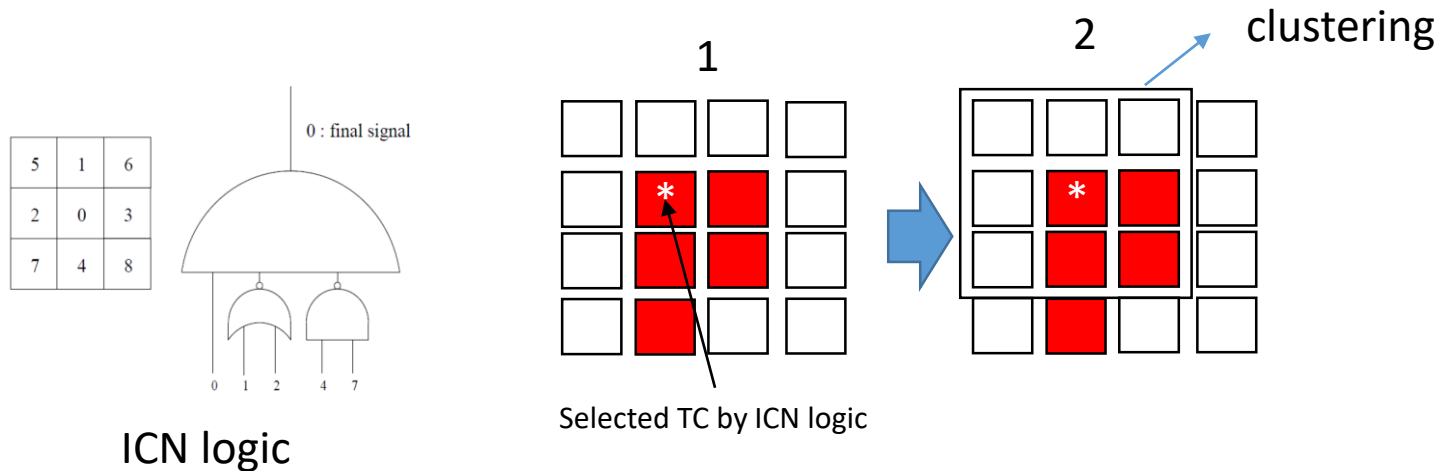
```
1 150
2 150
3 150
4 150
5 150
6 150
7 150
8 150
9 150
10 150
11 150
12 150
```



TC Map



Clustering method(1)



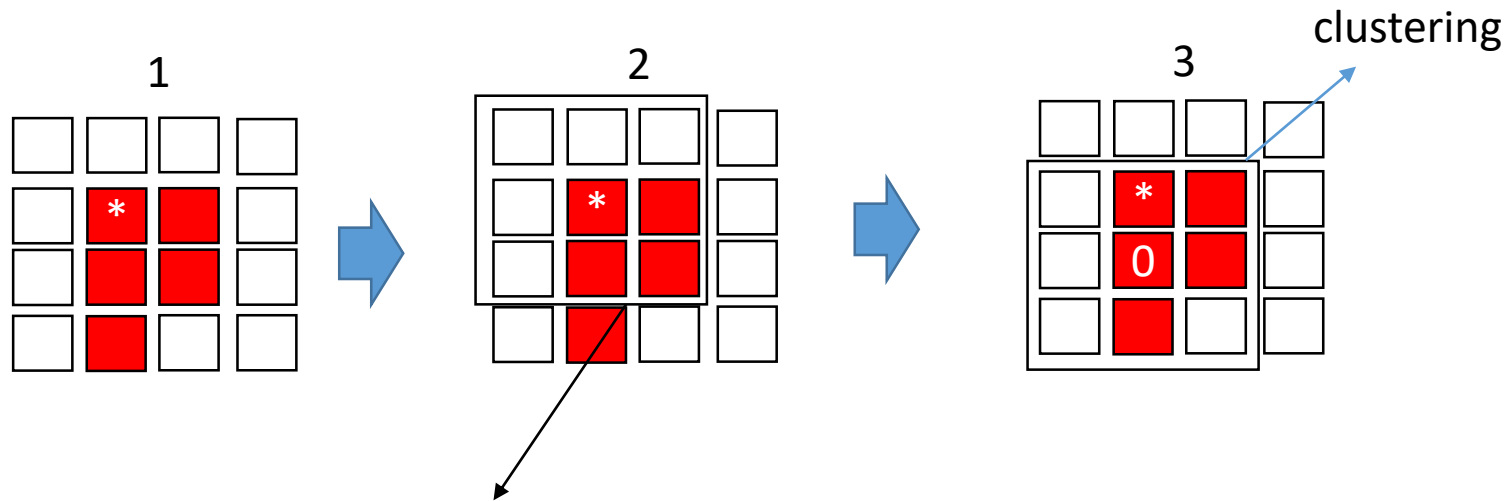
- **Method1**

1. Find TC Hits * satisfy the ICN logic,
2. Grouping 8TCs + selected TC * as 1 cluster.

- **Problem**

- Consider only ICN logic condition to find cluster.
- Don't consider energy of TC 0. → Center may not have the highest energy than other TCs in cluster.

Clustering method(2)



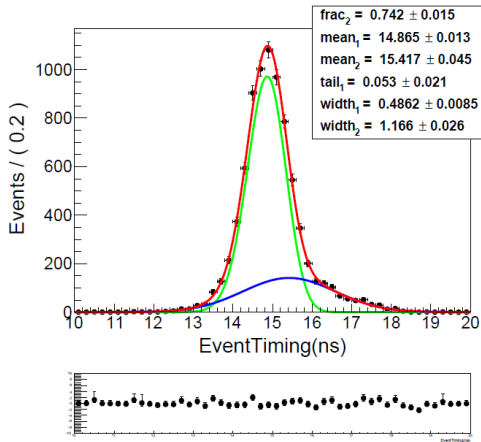
Find the highest energy TC in 3x3 TCs from selected center.

• Method2

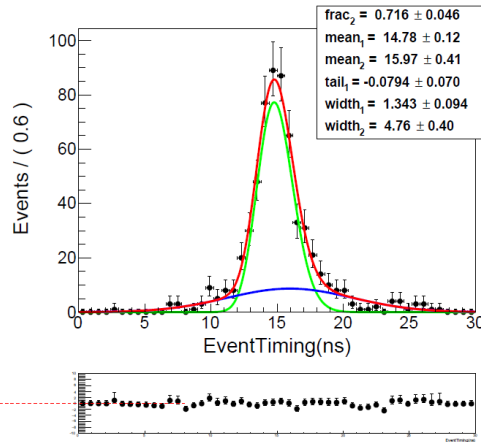
1. Find TC Hits * satisfy the ICN logic,
2. Find the highest energy TC 0 in 3x3 TCs from selected TC*.
3. Group 3x3 TCs from the highest energy TC as 1 cluster.

Event timing of other physics events

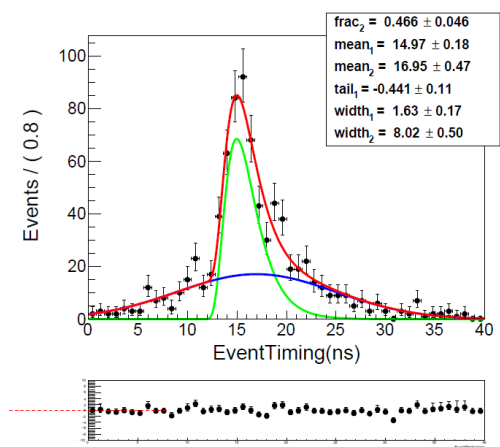
Bhabha



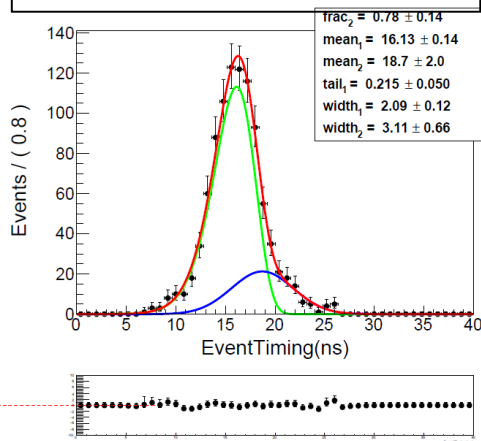
ISR($ee \rightarrow \mu\mu$)



ISR($ee \rightarrow \mu\mu$)



Continuum



Sample : physics events + bkg(10,000 events)

	μ_{tot}	σ_{tot}
Bhabha	15.01	0.66
ISR($ee \rightarrow \mu\mu$)	15.12	2.31
ISR($ee \rightarrow \mu\mu$)	16.03	5.04
Continuum	16.69	2.31