ECL trigger fine event for DQM

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The ECL trigger fine event.

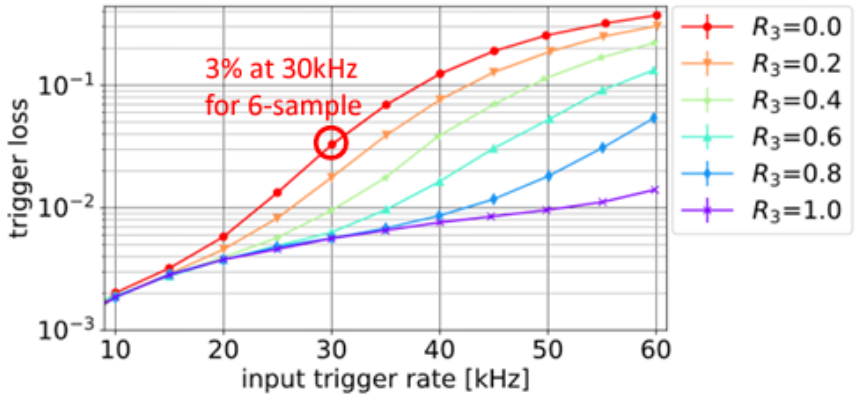
- The ECL trigger is the main L1 trigger timing source.
  - ~81% of e26r1260 events have the L1 timing determined by ECL trigger.

- Event T0 in ECL trigger
  - The ECL trigger determines trigger timing as the timing of the highest energy TC.
  - Not only physics trigger region (θ ID = 2~15), but also both endcap part(θ ID = 1,16~17).
  - Use two data clocks (256ns)

- ECL trigger fine event
  - Fine event is the energy of the most energetic TC is larger than 200 ADC.
  - $E_{MaxTC} > 200$ ADC

Benefits of 6/3-mixed sample mode

- **Mitigation of trigger deadtime**
  - Trigger deadtime in 6-sample mode:
    - more than 1% at 25kHz trigger rate
    - about 3% at 30kHz trigger rate
  - Trigger deadtime in 3-sample mode:
    - less than 1% at 30kHz
    - about 1% at 50kHz



- **Reduction of the DAQ data size**
  - Expected total SVD data rate at 30kHz: 2.7 GB/s
  - In the COPPER system, the ROPC bandwidth was merginal.
    - ~250MB/s x 9 ROPCs = ~2.3GB/s
  - In the new PCIe40 system, the bandwidth should be enough.
    - ~870MB/s x 5 ROPCs = ~4.4GB/s

Not mandatory
for the PCIe40 readout system

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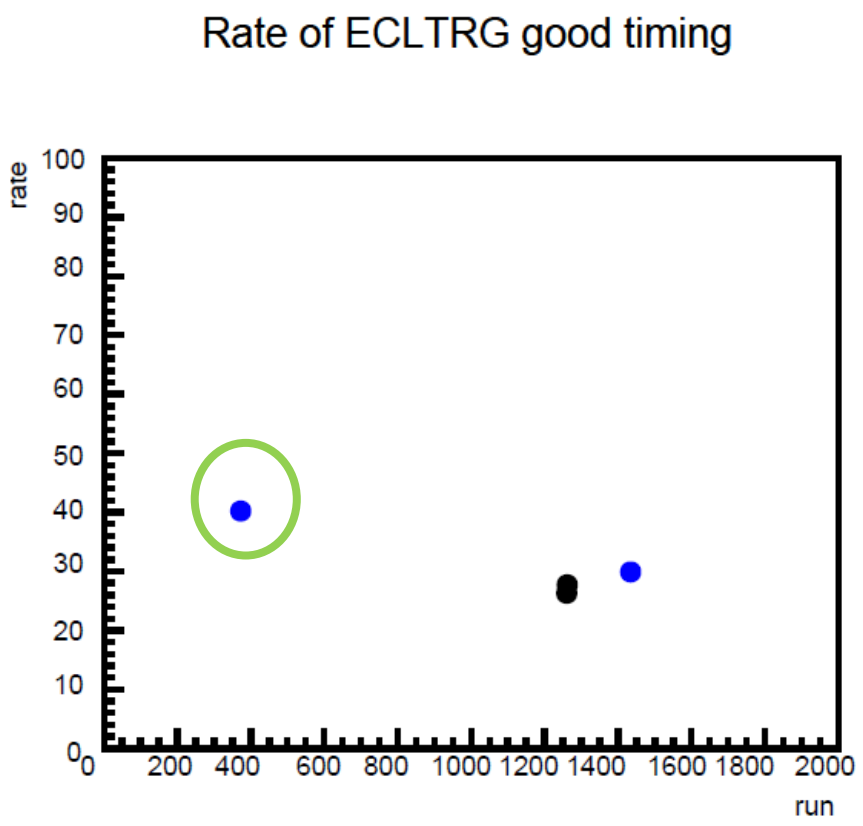
Tracking performance: 6-sample vs. 3-sample

The rate of Good(fine) events



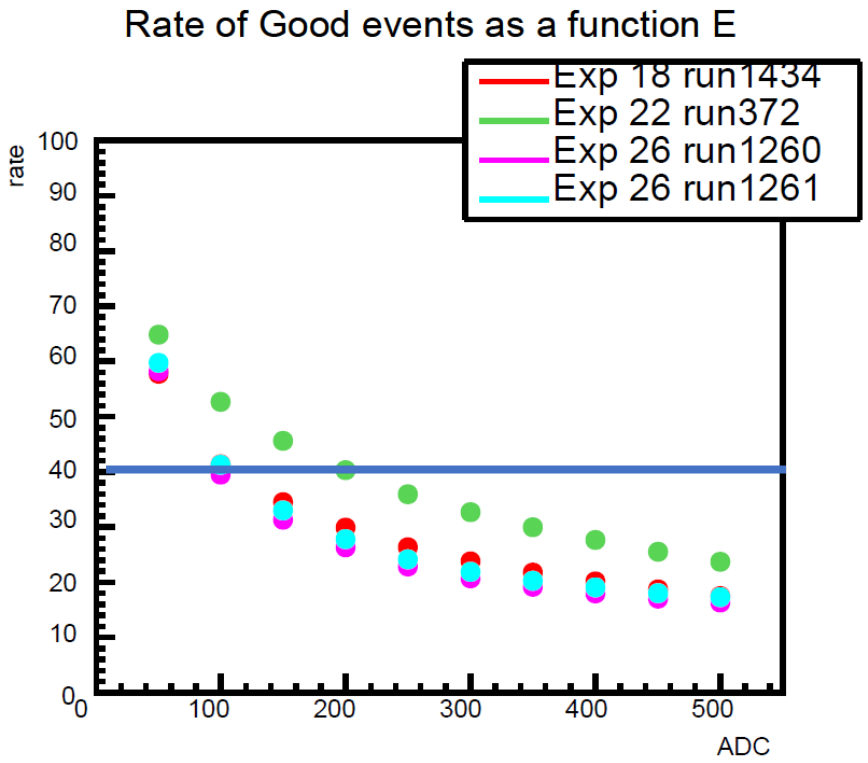
More than 40% of "fine" triggers are preferable to reduce the deadtime at 30kHz enough.

Current fine condition have the rate of fine events lower than 40%.

$$Rate = \frac{\#\ of\ fine\ events\ \ \&\&\ \ L1\ timing = ecl}{\#\ of\ events\ \ \&\&\ \ L1\ timing = ecl}$$

EXP	Run	HLT script	L1 rate	Rate (%)
18	1434	HLT monitor	~ 5.8 kHz	29.80945695
22	372	HLT monitor	~ 5.2kHz	40.1284441
26	1260	HLT monitor	~ 11kHz	26.28124
26	1261	HLT monitor	~ 10.4kHz	27.78248

The fine event rate as a function E



- The rate of fine events as a function fine condition.
- The fine condition from 0 to 500 ADC per 50 ADC.

- Around 100 ADC the rate of all is higher than 40%.
  - will check from 0 to 200 ADC per 20 ADC.

of events discrepancy between GDL log and TRGECL unpacking

Expriment 18

run	GDL log-ecl timing	ETM-ecl timing	Rate(%)	HLT script
1434	11060178	10440900	94.40083	HLT monitor

Expriment 22

run	GDL log-ecl timing	ETM-ecl timing	Rate(%)	HLT script
372	8975110	8317400	92.67073	HLT monitor

$$Rate = \frac{\#\ of\ events\ from\ ETM}{\#\ of\ events\ from\ GDL\ log}$$

Expriment 26

run	GDL log-ecl timing	ETM-ecl timing	Rate(%)	HLT script
1260	9274812	8537758	88.58974	HLT monitor
1261	13699701	6883050	81.80725	HLT monitor

E26r1261 # of events from elog : 8413741

Plan for ECL trigger DQM

- Make DQM plots for checking the number of fine and coarse events.
  - Add trggdlunpacker to ECL trigger DQM module for checking whether ECL L1 timing or not.
- Make QAM plots for checking the fraction run by run.
- Checking the runtime of ECL trigger DQM.

Summary

- SVD group needs the events taken with ECL trigger timing for reducing deadtime in max trigger rate.
- The rate of fine events look larger than 40% with the fine condition Max E > 100 ADC.
- There is the number of ECL trigger L1 timing events discrepancy between GDL log and ETM.

Back up

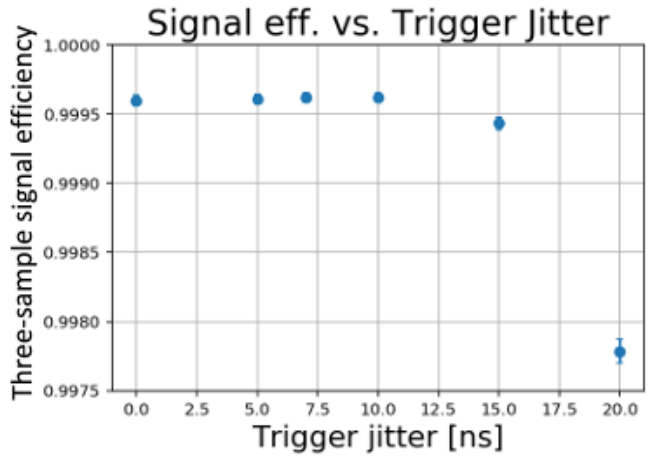
3-sample mode and TRG group activity

- **The possibility of using the SVD 3-sample mode effects the TRG group activity**
  - It changes the requirement of the trigger timing resolution.
    - Small trigger timing jitter is required (less than about 15ns (TBC))
      - A large fraction of ECL and CDC triggers have already good time resolution less than 10ns, good enough for the 3-sample mode.
  - If the 3-sample mode will be not used, they can modify the CDCTRG format to replace some of the CDC event T0 information with the CDC ADC information.
    - It improves the noise rejection in the CDC trigger by a lot, while it degrades the CDC trigger time resolution down to about 25ns (it is enough for the 6-sample mode).

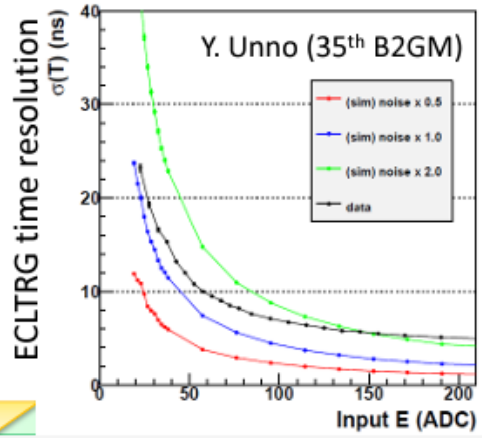
Comment by Giulia:
If the ECLTRG timing still can determine the trigger timing well, it can be possible to give up the CDC trigger timing to improve the CDCTRG noise rejection.
How much fraction of the current ECLTRG is coarse (6-sample) or fine (3-sample)?

Y. Uematsu (35th B2GM)

Three-sample signal efficiency:
(#signal hits in three-sample)/(#original signal hits in six-sample)



Trigger jitter: σ of Gaussian



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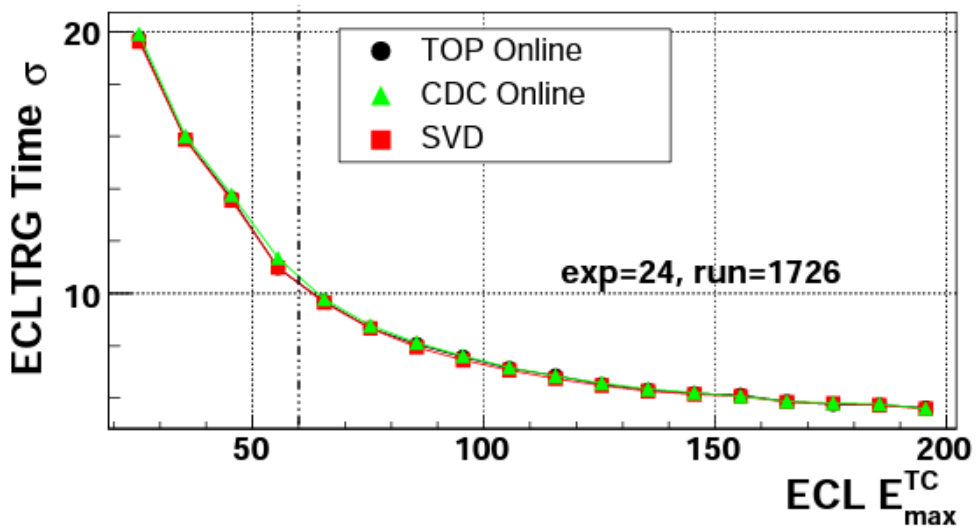
Benefits of 6/3-mixed sample mode

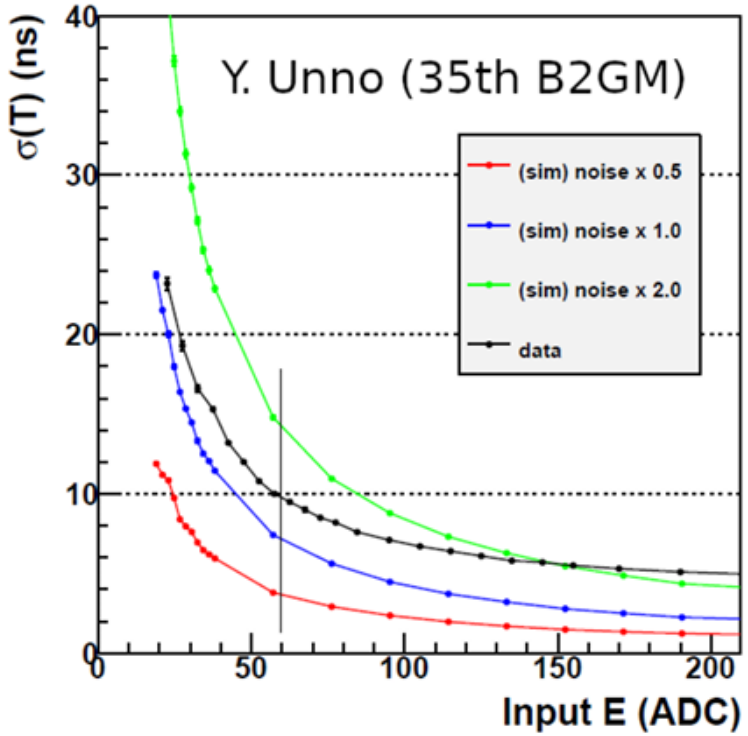
SVD group study

ECL TC E_{max} vs TOP Online EventT0

We have reconstructed ECL TC E_{max} in data to check with Unno-san's result.



In both cases, ~10 ns jitters corresponds to 60 ADC.
1 ADC = 5.25 MeV



* ECLTRG Resolution from CDC EventT0.

of events discrepancy among e-log, gdl log, and trgecl unpacking

Expriment 26

$$Rate = \frac{ecl\ timing}{\#\ of\ events\ from\ E-log}$$

run	Elog	GDL log-ecl timing	Rate(%)	ETM-ecl timing	Rate(%)	HLT script
272	6374523	5999098	94.11053972	1262314	19.80249	HLT filter
671	16884729	14659456	86.82079529	2793176	16.54262	HLT filter
1121	19272856	16612643	86.19710021	3158565	16.38867	HLT filter
1260	9637412	9274812	96.23757913	8537758	88.58974	HLT monitor
1261	8413741	13699701	162.8253235	6883050	81.80725	HLT monitor
1893	28910259	26198223	90.61912244	4825775	16.69226	HLT filter

ETM-ecl timing rate is 16~19% when HLT filter run. The events loss occurred in unpacking process.

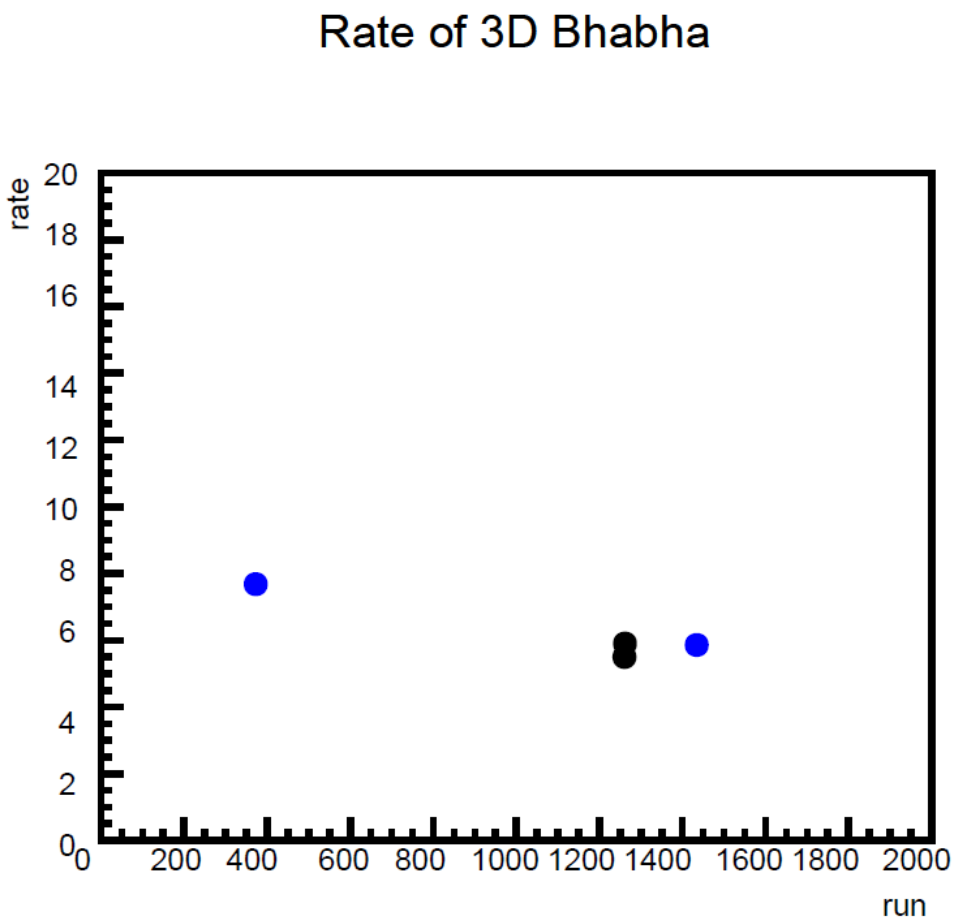
Run	HLT	#F	# of events		Rate(%)
			Raw	Unpacked	Unpacked/Raw
1893	02	12	68869	11375	16.51687
	02	11	235713	38555	16.35676
1260	02	18	51307	51266	99.92009
	02	17	50101	50001	99.8004

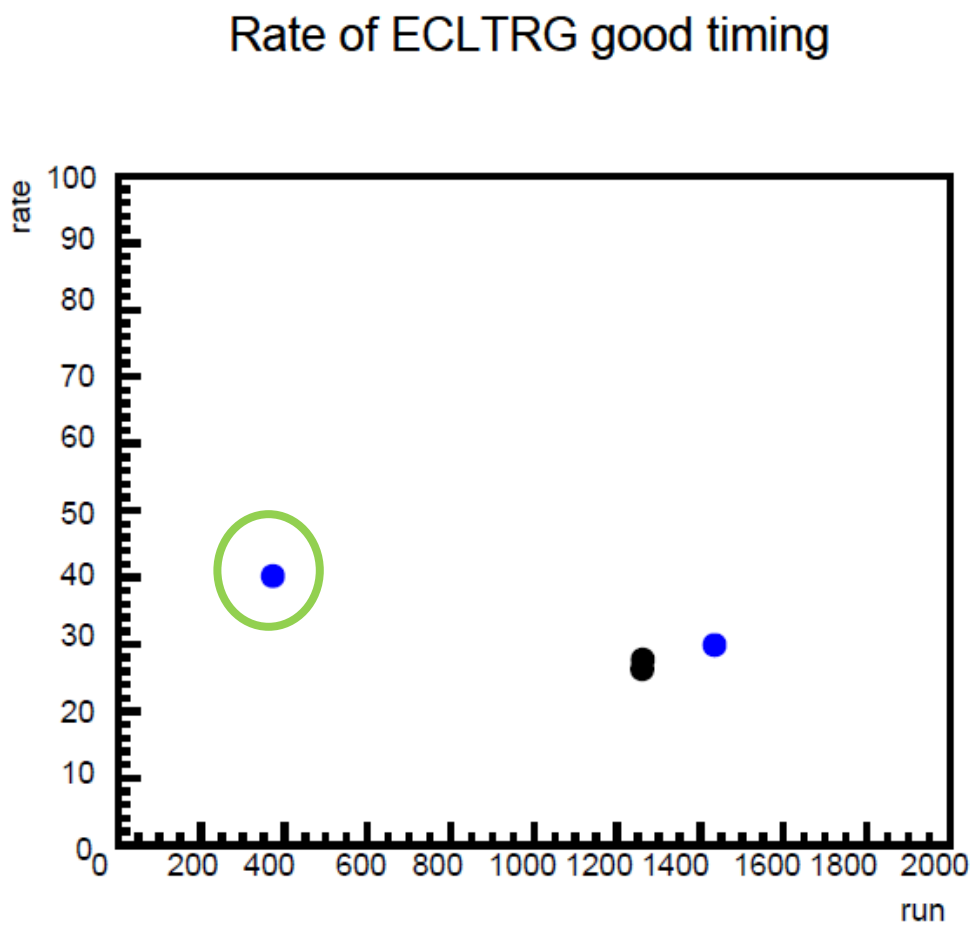
Test version: release-06-01-10

E22r372 condition

```
Run was started at 2021/12/10 12:56 JST
Run was stopped at 2021/12/10 13:24 JST
Experiment: 22
Runnumber: 372
Run type: physics
Trigger type: gdl
HLT Script: beam_reco_monitor

HV state: PEAK
Subsystems in PEAK: CDC KLM SVD TOP ARICH PXD
Subsystems masked:

HER/LER current at the start: 697.8285625 / 874.56615 mA
Number of HER/LER bunches: 1272.0 / 1272.0
Luminosity at start [10^30 /cm^2/sec]: 30323.5775216
Rate (Trig. output) at start [Hz]: 5209.2351888
Solenoid: ON (1.5 T, 4094 A)
Total events: 8871657
Integrated Luminosity [10^33 /cm^2]: 48801.0211028

Stopped because of: Switch hlt script back to beam_reco_filter

Run Registry: https://rundb.belle2.org/webview/run/22/372
```

The Rate of 3D Bhabha





Most energetic TC distribution