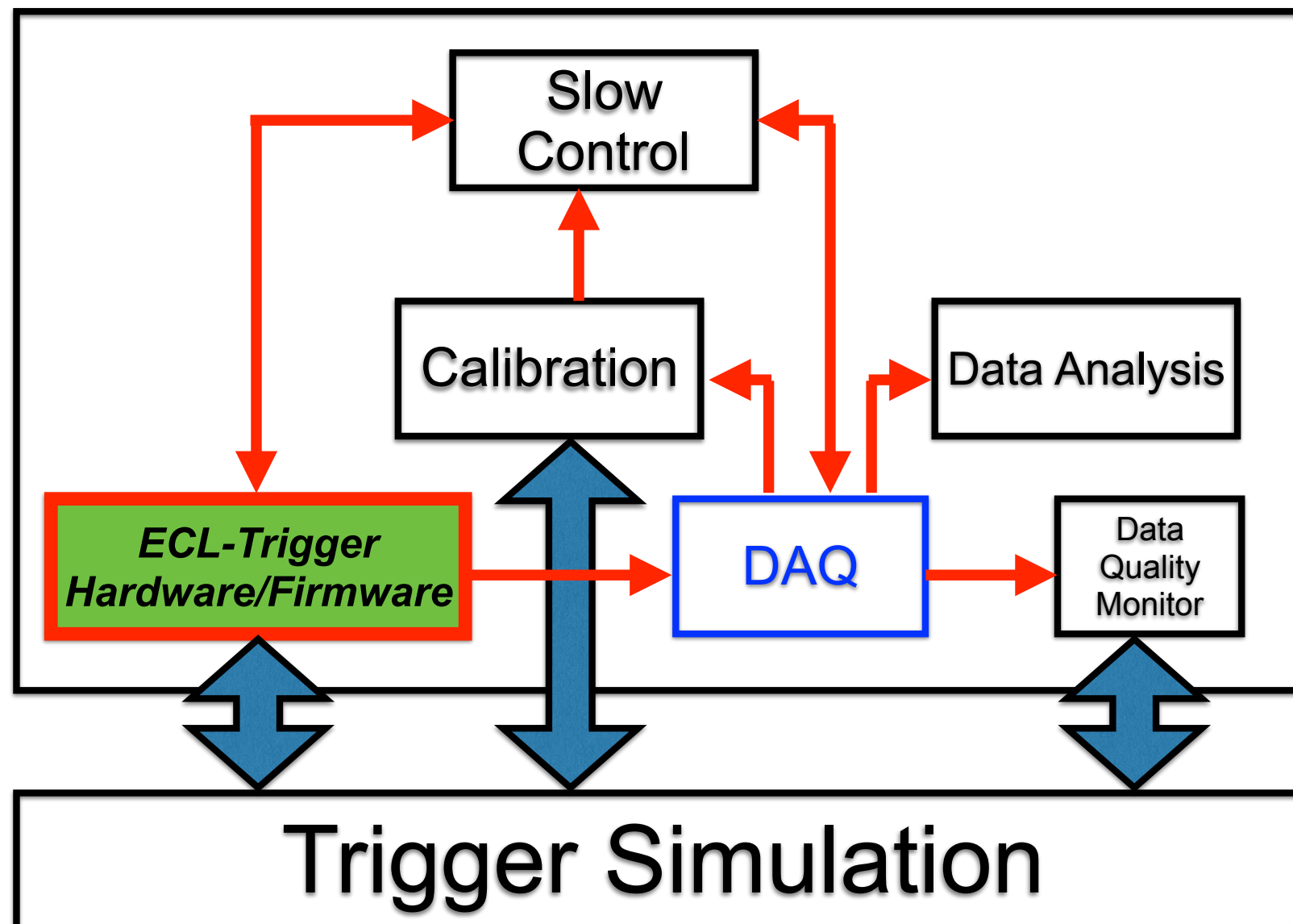


Status on ETM Firmware



SungHyun Kim

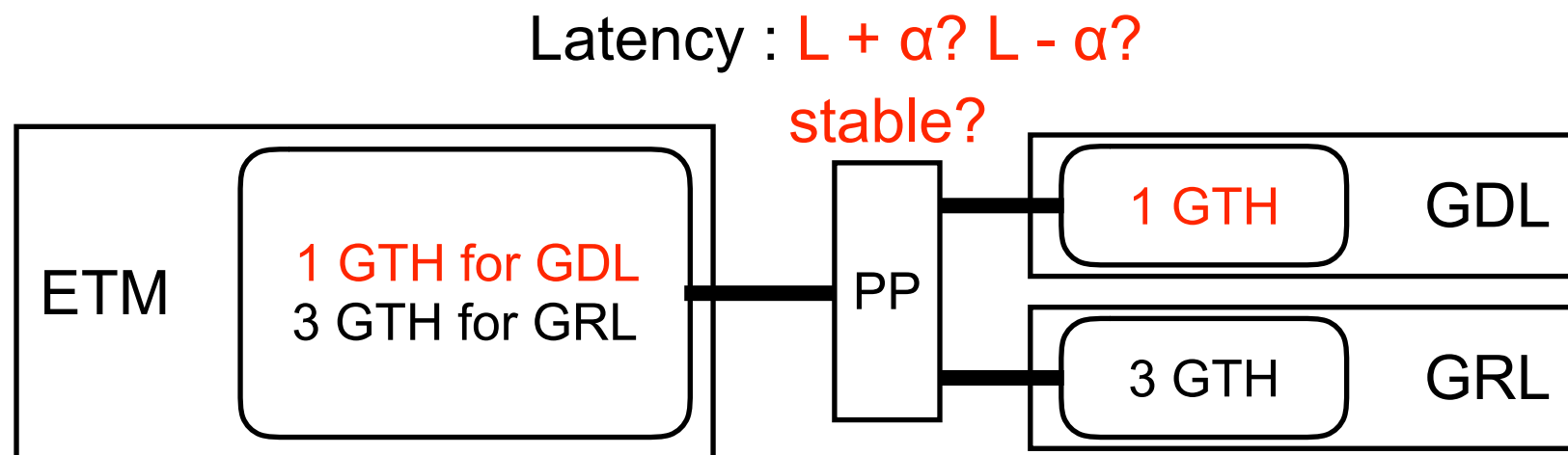
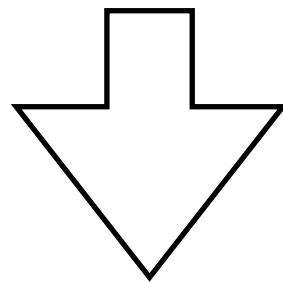
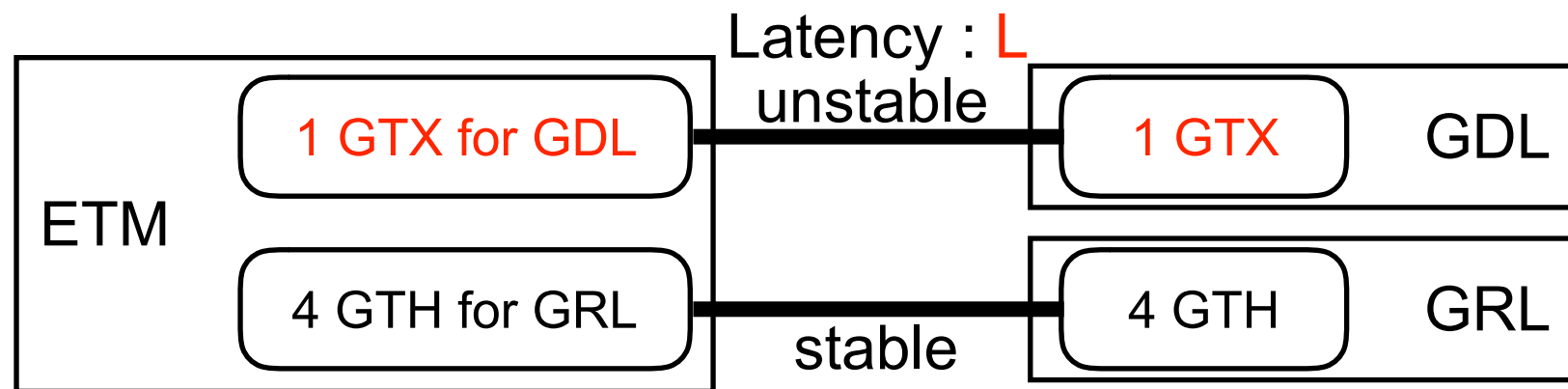
Hanyang University

TRG/DAQ Workshop Aug. 2019

ETM Status

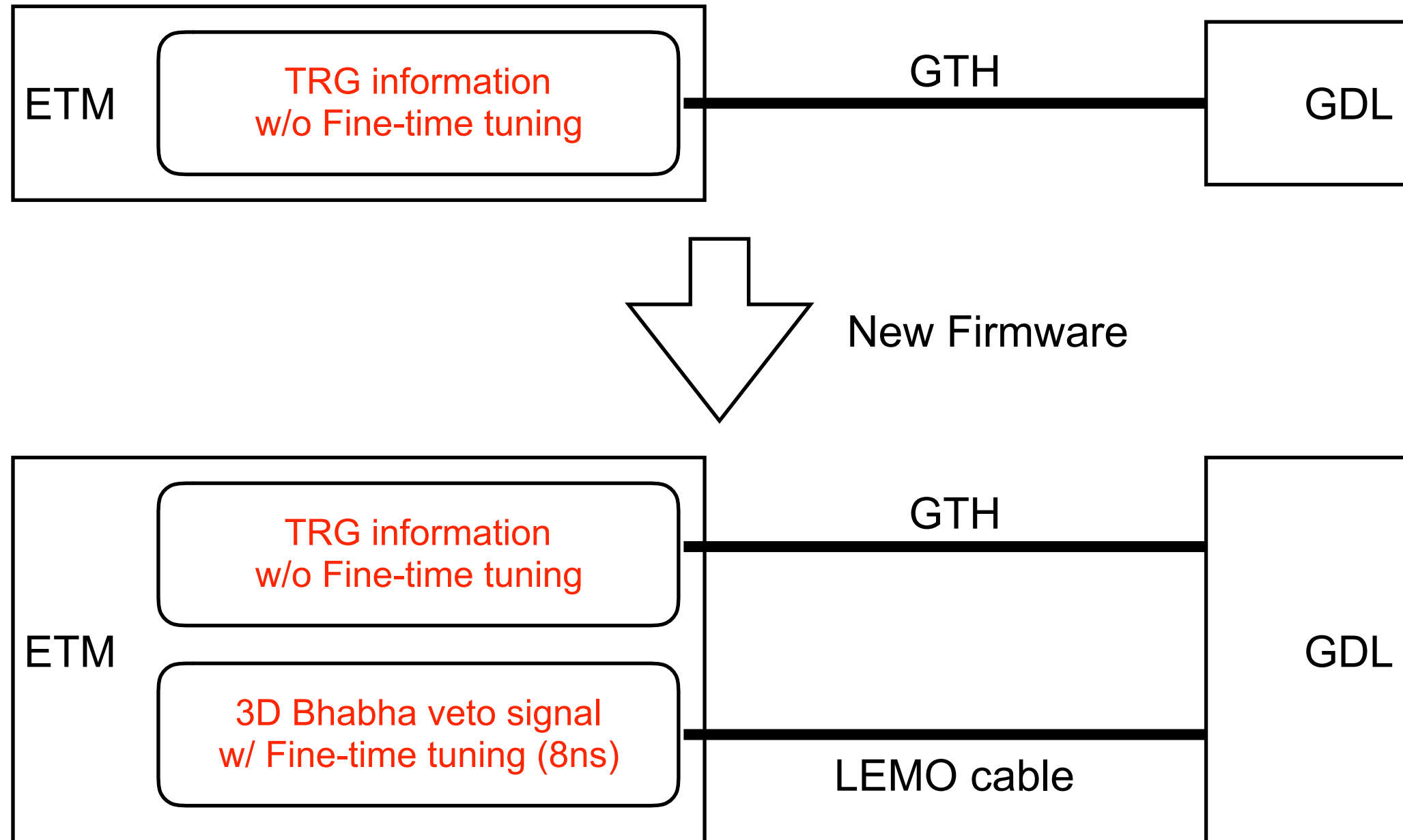
ETM Status

- ETM-GDL GTX → GTH to avoid instability of GTX protocol on GDL



ETM Firmware Status

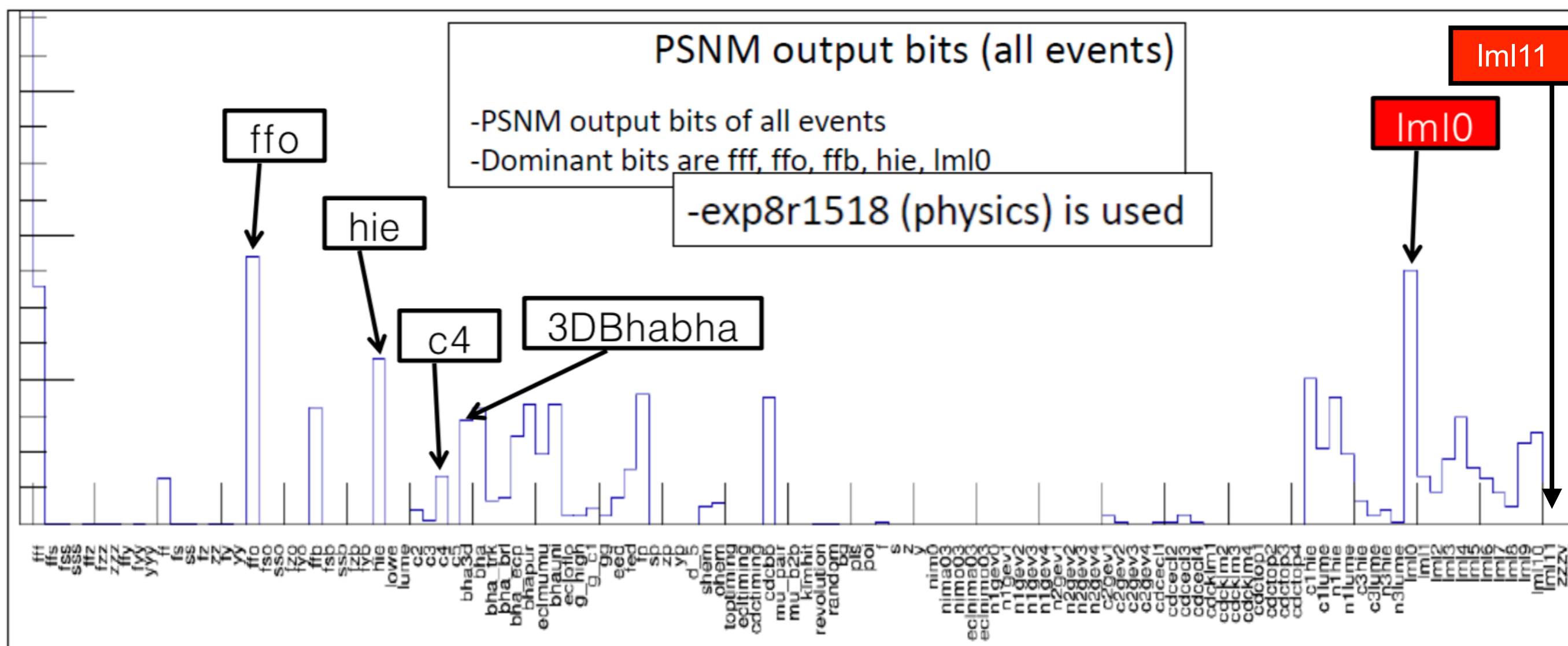
- There is no latency budget between ETM-GDL link to veto Bhabha events.



- Test is needed.

Low Multiplicity bit

- LM0
 - $N(\text{CL}) \geq 3$ in $\theta[1-17]$, at least 1 $\text{CL} \geq 300$ MeV (Lab), not ECL 3D Bhabha
- New proposal by Chris
 - $N(\text{CL}) \geq 3$ in $\theta[2-16]$, at least 1 $\text{CL} \geq 500$ MeV (Lab), not ECL 3D Bhabha
- LM 11 : No 2 GeV (CM) CL in an event (psv : 0)



New Firmware

- ETM to GDL thru LEMO cable
 - 3D Bhabha veto bit w/ Fine-time (8ns) tuning
- Keep LM 0 bit
- Replace LM 11 bit
 - Current : No 2 GeV (CM) CL in an event
 - New : $N(\text{CL}) \geq 3$ in $\theta[2-16]$, at least 1 $\text{CL} \geq 500$ MeV (Lab), **not** ECL 3D Bhabha
- Test is needed

Data consistency

ECL & ECL-TRG

Data Analysis

- Data consistency check between ECL & ECL-TRG (TRG)
 - Cosmic Data
 - Data : e9r0712, w/o GDL (Mid. July)
 - Analyze 23M events
 - TRG threshold : 40 ADC (= 0.21 GeV)
 - Beam Data
 - Data : e8r3115, Last day run of Phase-III.
 - Analyze 3.6 M events
 - TRG threshold : 19 ADC (= 0.10 GeV)
- There is discrepancy between ECL and TRG data set
 - Timing : ECL ($\pm 1 \mu\text{s}$) vs TRG ($\sim \pm 0.5 \mu\text{s}$)
 - Energy threshold : ECL (low threshold for Xtal) vs TRG (0.21 / 0.10 GeV for TC)

Events selection

- Events selection/procedure

- ECL : Xtal data $\rightarrow$ TC data using TC mapping utility

- Xtal “Quality flag” from ECLDigitizer and Xtal Calibration “Status flag” from ECLDigitCalibrator are used.

- At least one Xtal shows strange flag, exclude corresponding “TC”.

- Add up Xtal deposit energy to convert TC-like energy. (Apply 0.21 GeV threshold)

- Timing selection is applied.

- 1) TRG timing selection ± 50 ns.

- 2) ± 500 ns

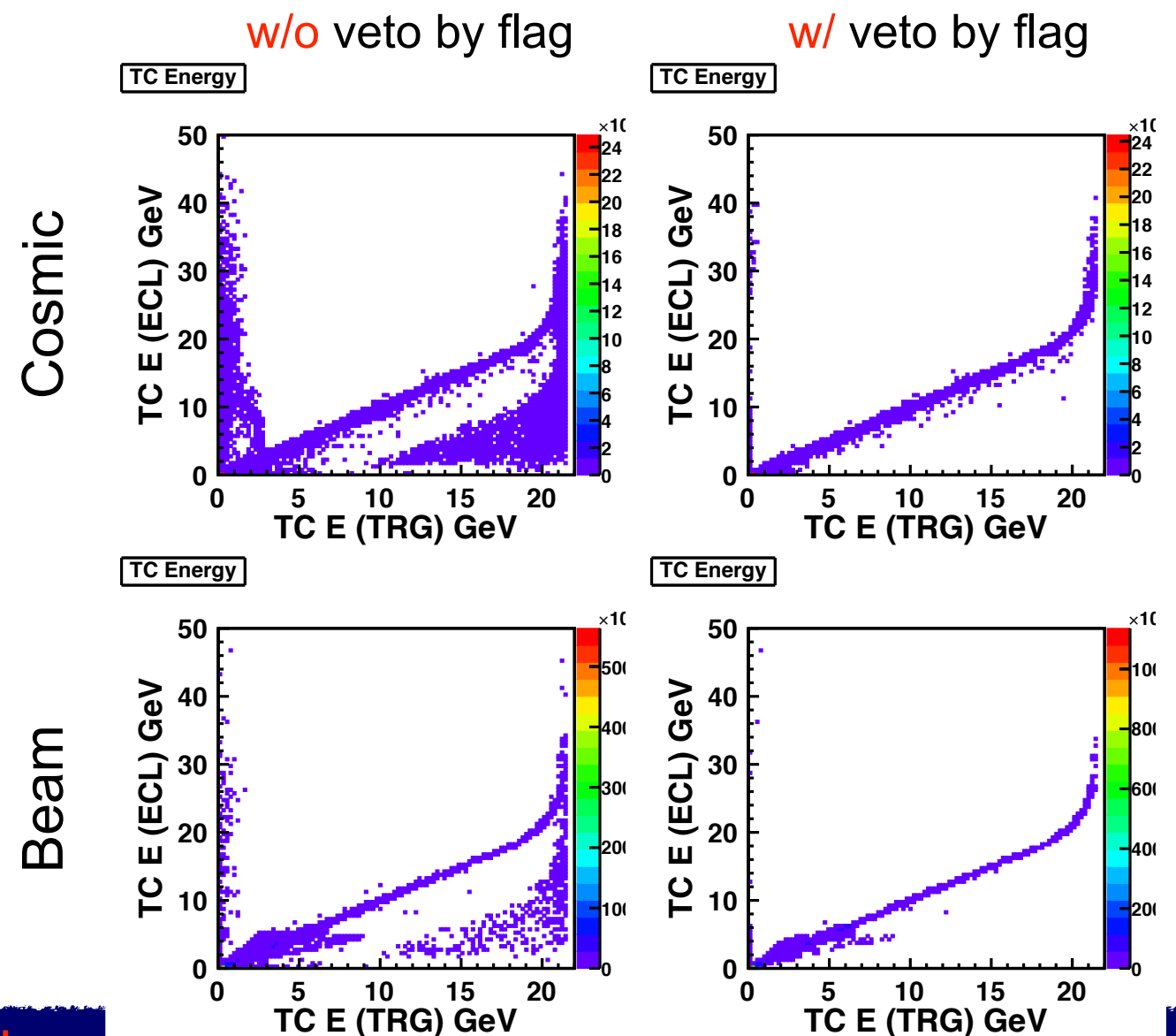
- TRG :

- Timing selection

- 1) Exactly same as ETM logic.

- 2) Whole data ($\sim \pm 500$ ns)

- Exclude some TCs which corresponding to excluded ECL-TC by Quality & Status flag.



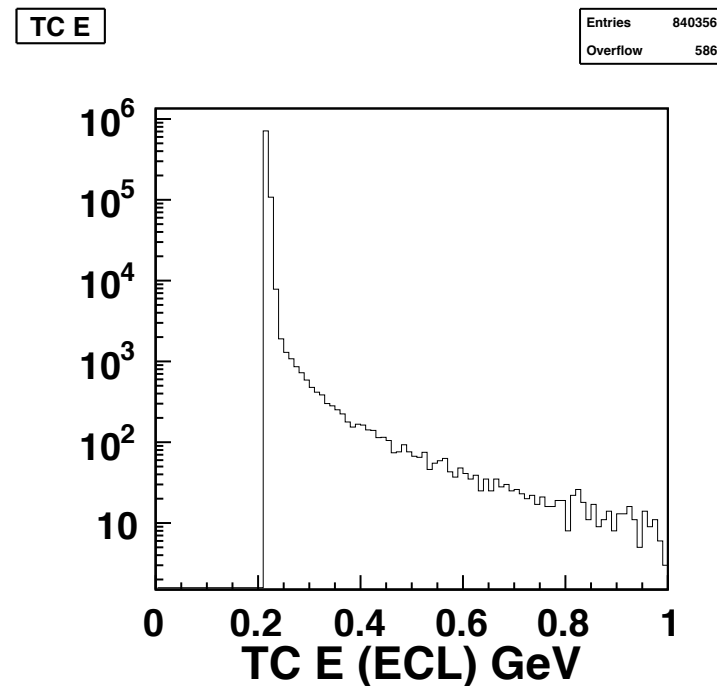
Cosmic data analysis (1)

- Timing Selection

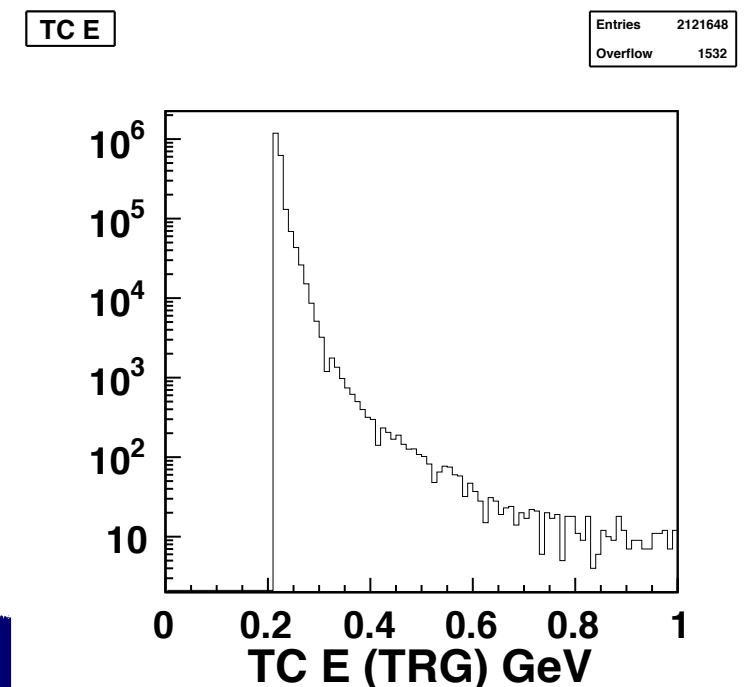
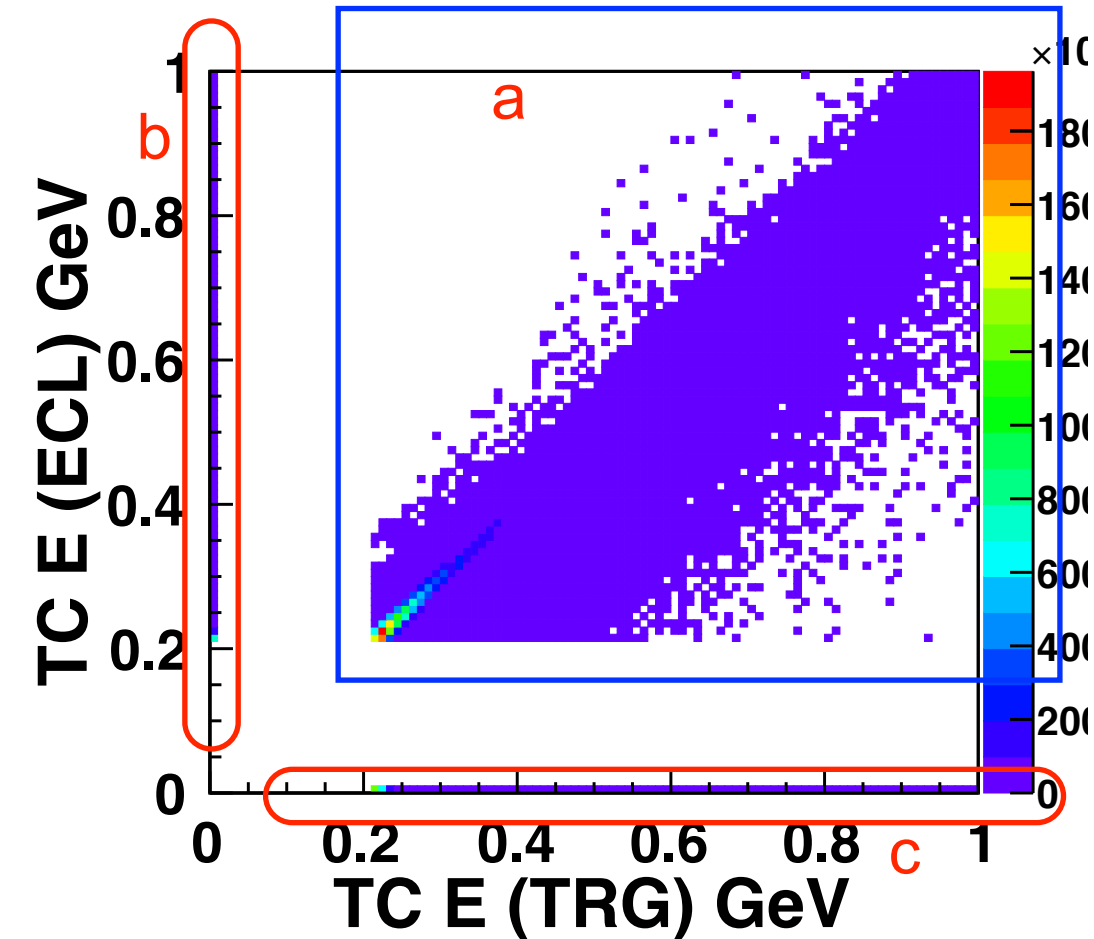
- TRG : Same as ETM
- ECL : TRG ± 50 ns

- Consistency check

- Total TC hit (31492172 : 31.5M)
- a : ECL TC and TRG TC are matching (28530168)
- b : ECL TC fired, but no TRG TC hit (840356)
 - Threshold < ECL TC < Threshold + 50 MeV (0.26 GeV) (831266 : 99%)
- c : TRG TC fired, but no ECL TC hit (2121648)
 - Threshold < TRG TC < Threshold + 50 MeV (0.26 GeV) (2051045 : 97%)
- mis-matching TC = 9.4% (low E region **97.4%**)



TC Energy

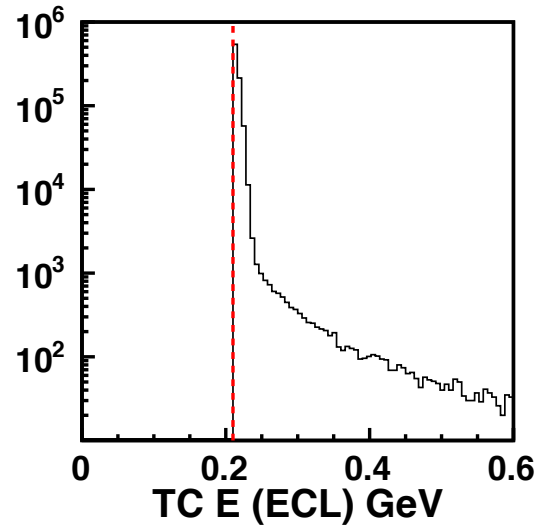


Cosmic data analysis (1) (cont'd)

- Region (b) : No TRG, but ECL

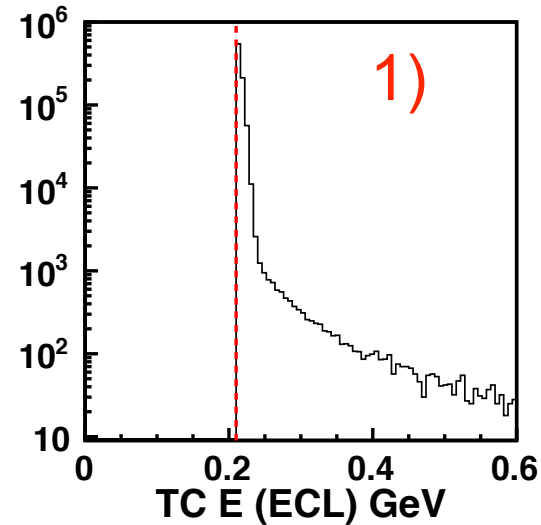
TC E (ECL) w/o Timing cut

Entries 840356
Overflow 1448



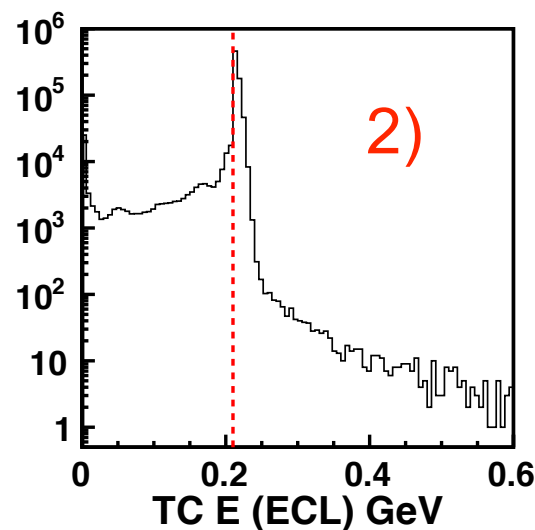
TC E (ECL) on Timing cut

Entries 840356
Overflow 1348



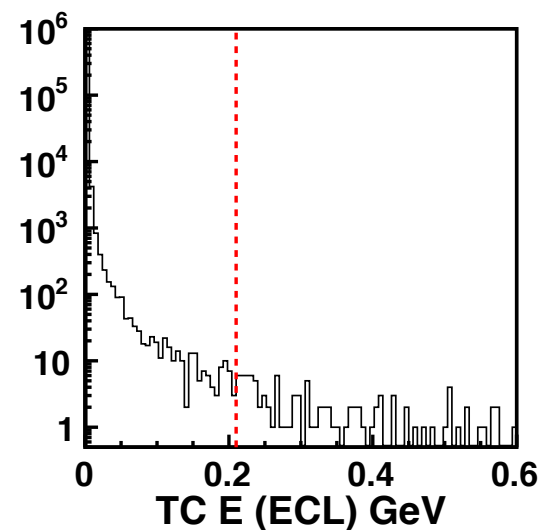
TC E (ECL) on Timing cut (tight)

Entries 840356
Overflow 158



TC E (ECL) off Timing cut

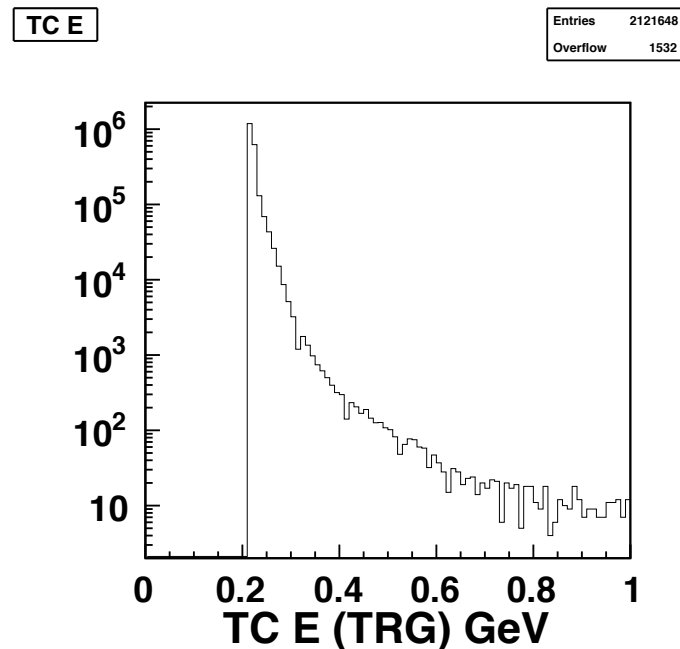
Entries 840356
Overflow 46



- Summary of region (b)
 - condition 1) TRG timing ± 50 ns
 - condition 2) TRG timing
 - Timing selection affect near threshold region

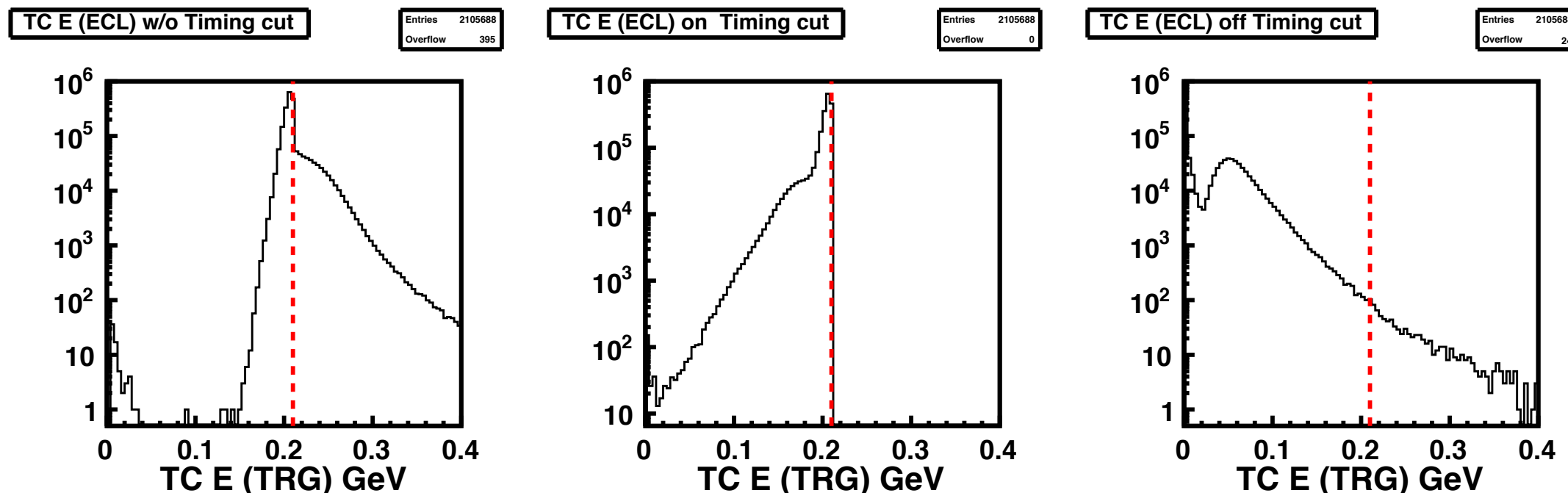
Cosmic data analysis (1) (cont'd)

- Region (c) : No ECL, but TRG



- Summary of region (c)
 - Most of ECL TCs are vetoed by
 - Threshold cut and Timing selection
 - No output from “ECLDigitCalibrator” : 10751 / 23M (event)
 - No fired Xtal but TRG TC fired : 16K (TC) / 23M (event)

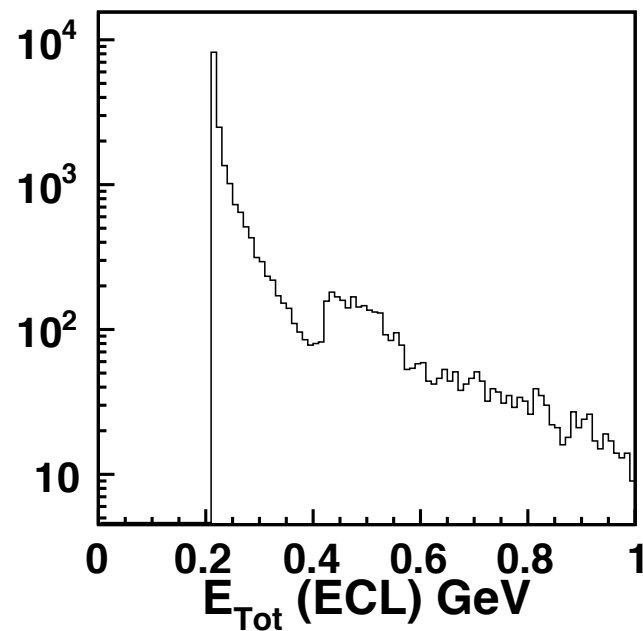
Corresponding ECL TC energy



Cosmic data analysis (1) (cont'd)

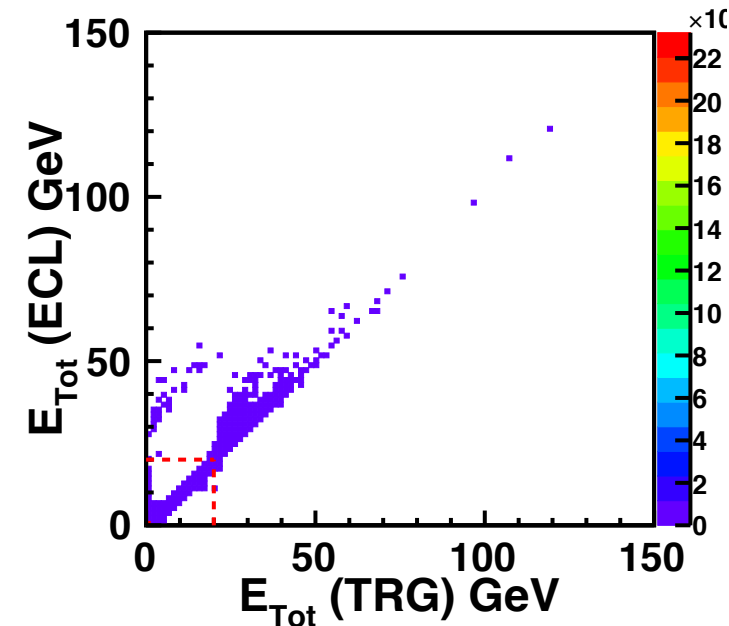
- Total Energy : Mis-matching 5.9%

E_{Tot} ECL



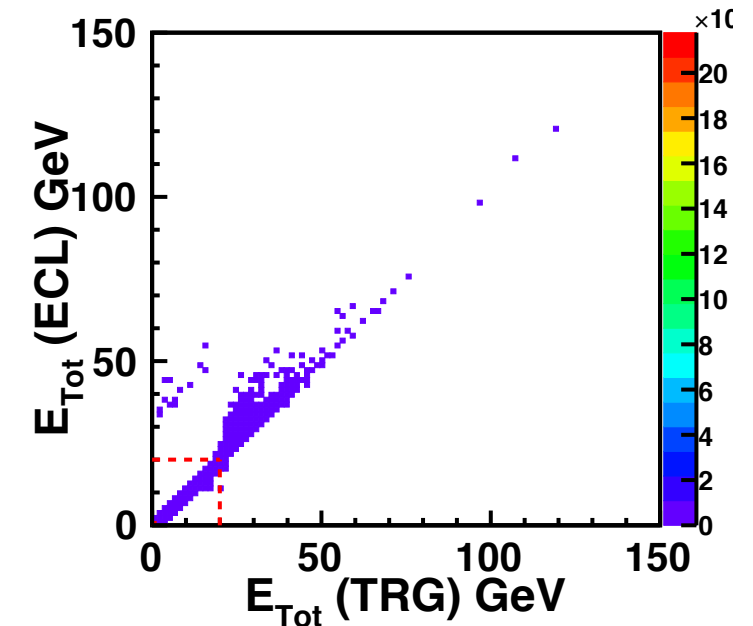
E_{Tot}

Region : a + b + c

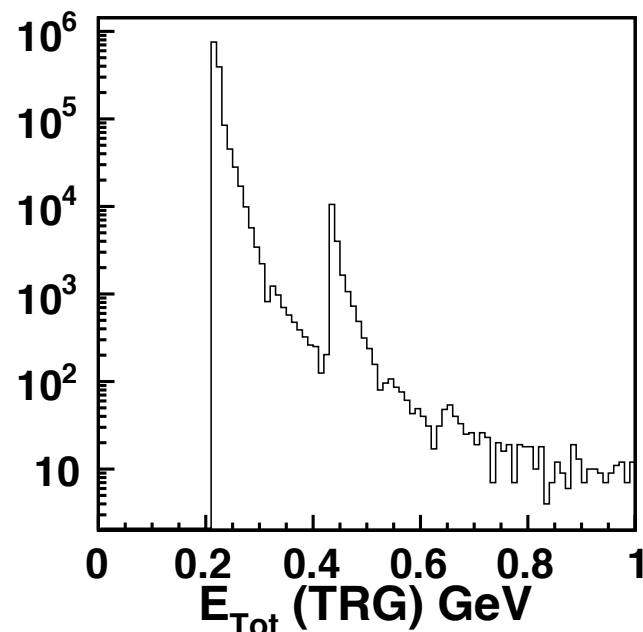


E_{Tot} Matching

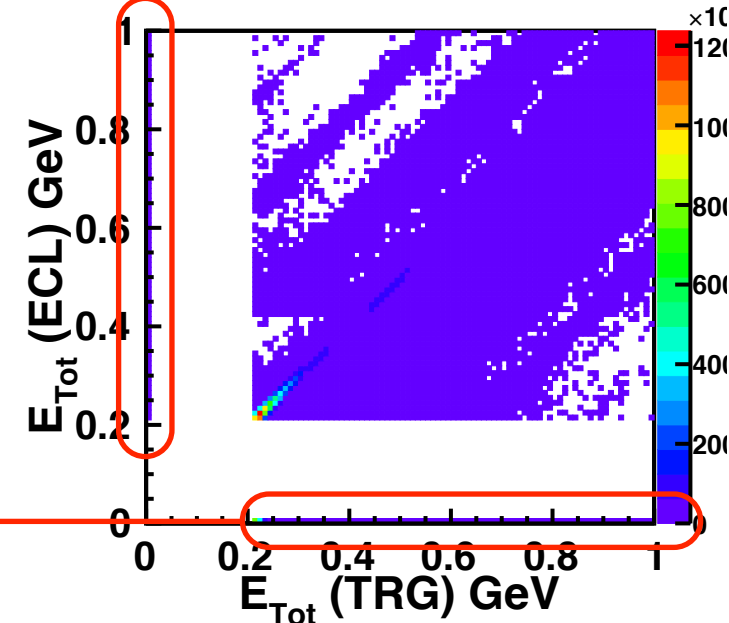
Region : a



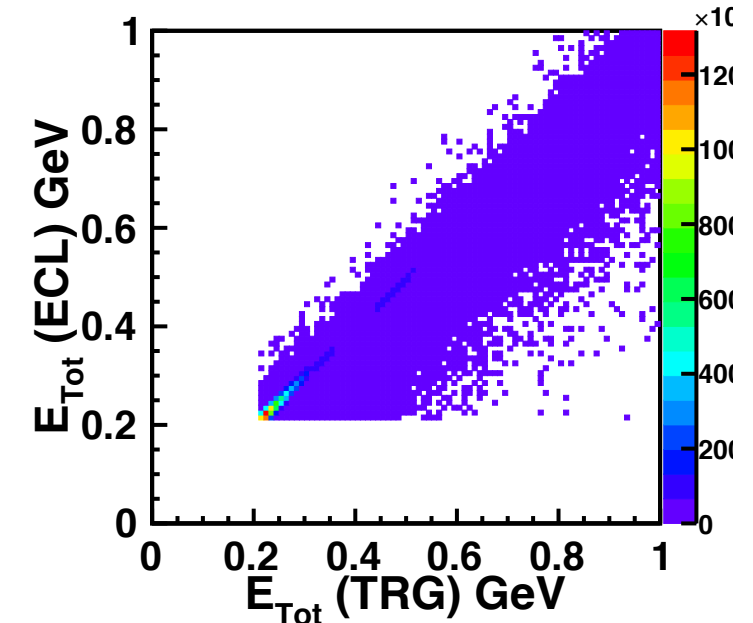
E_{Tot} TRG



E_{Tot}

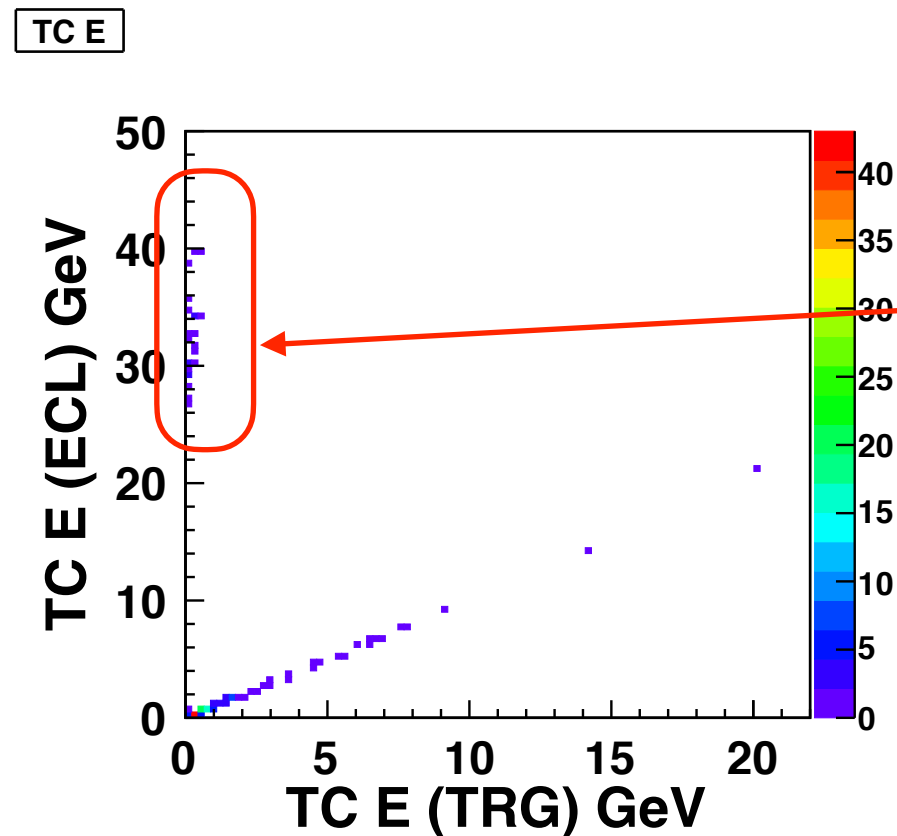


E_{Tot} Matching

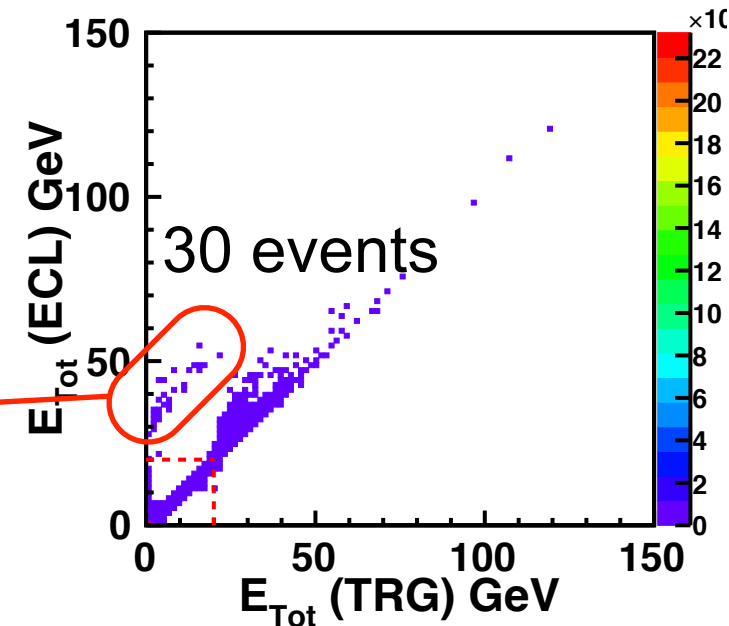


Cosmic data analysis (1) (cont'd)

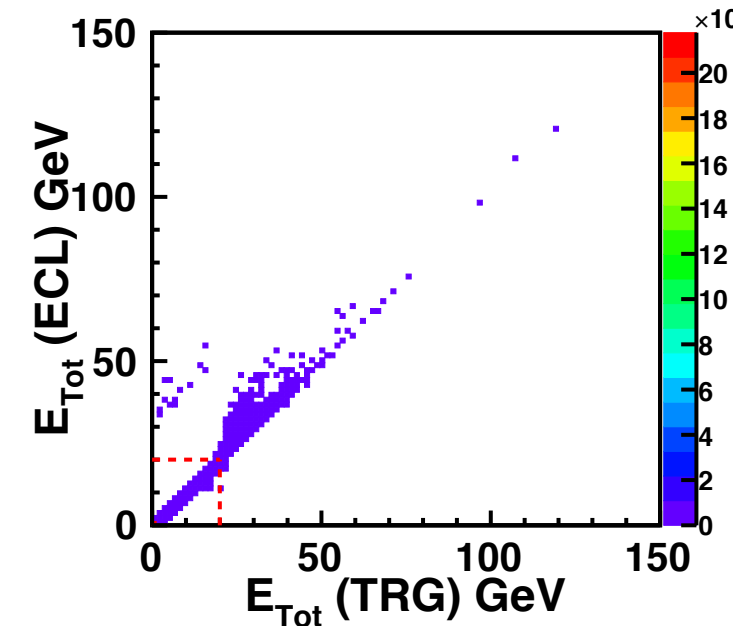
- Total Energy : Mis-matching 5.9%



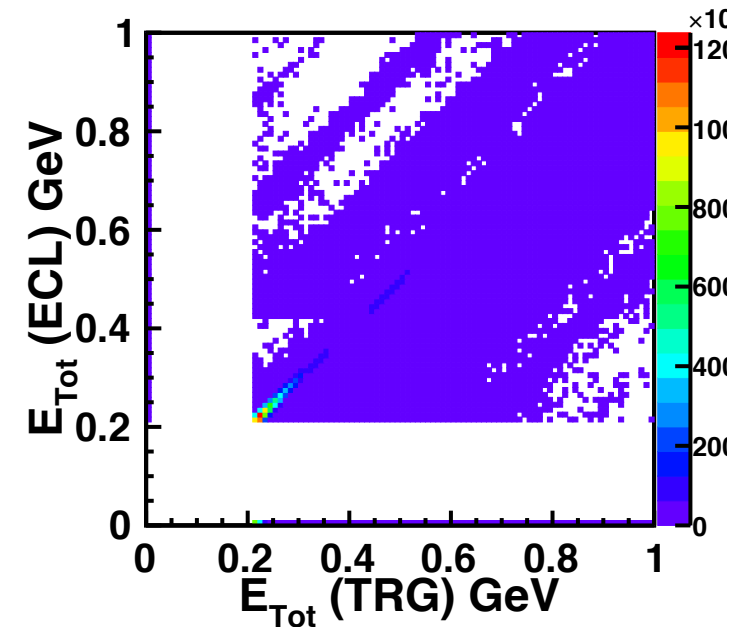
E_{Tot} Region : a + b + c



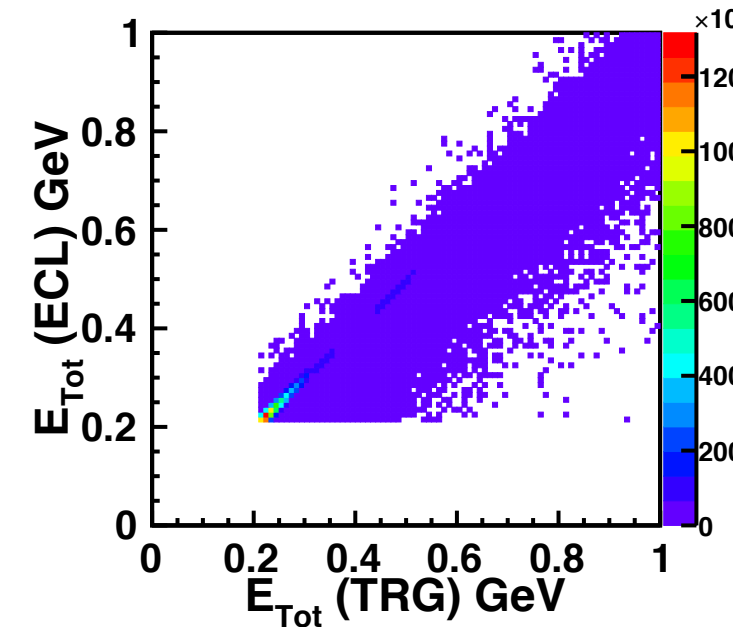
E_{Tot} Matching Region : a



E_{Tot}



E_{Tot} Matching



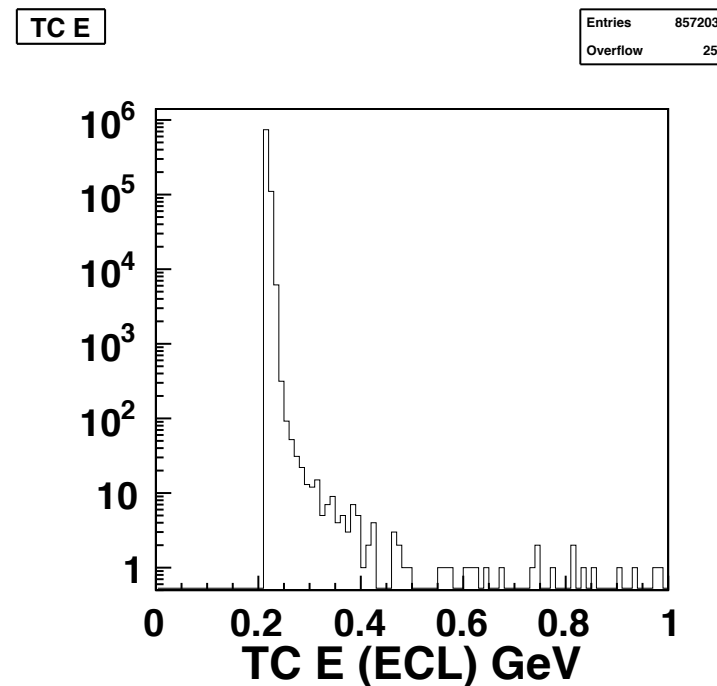
Cosmic data analysis (2)

- Timing Selection

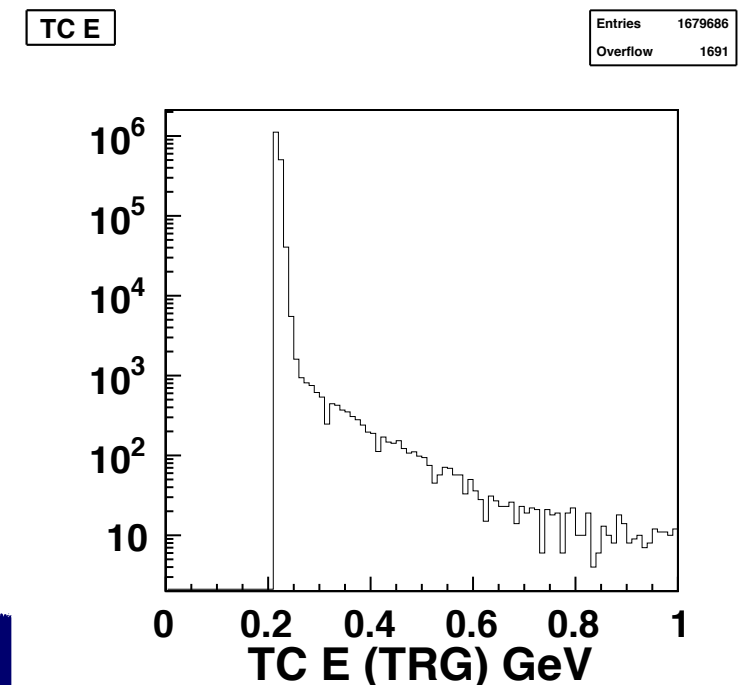
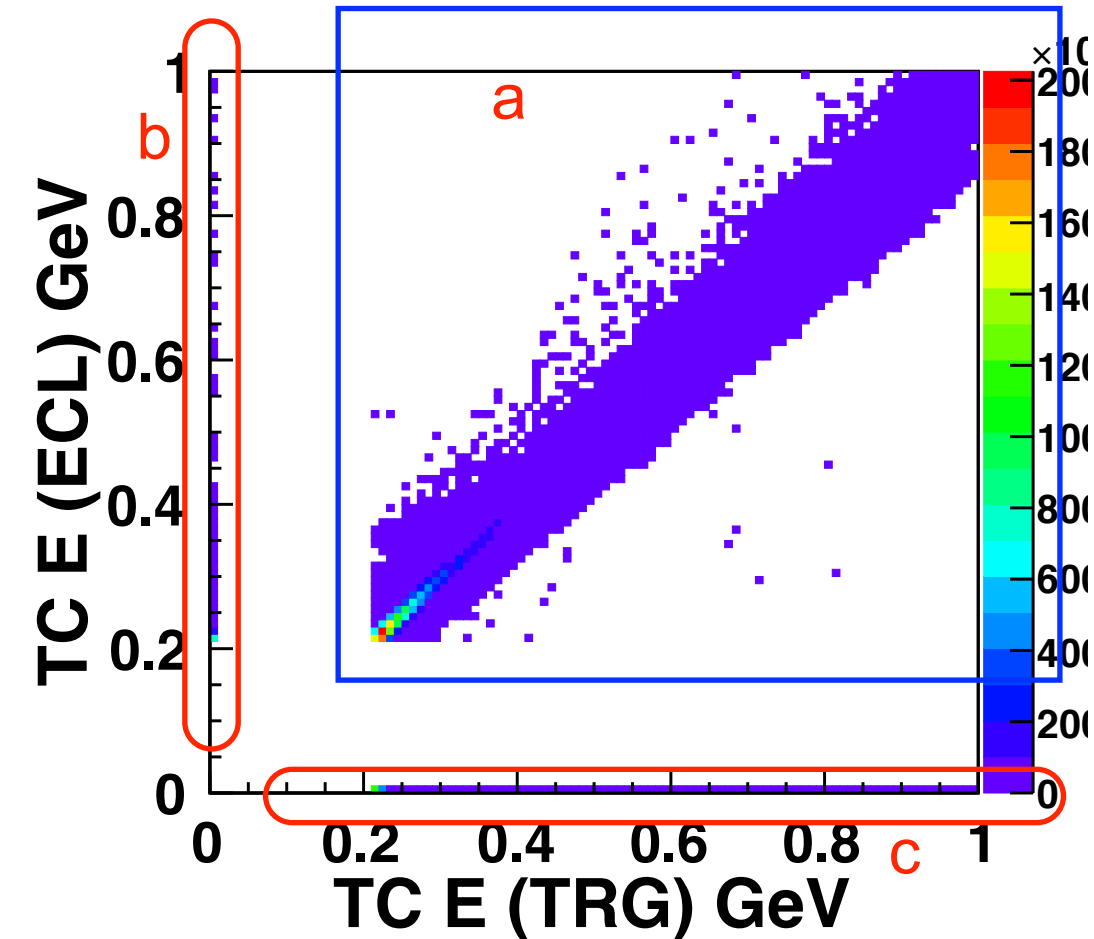
- TRG : $\sim 1 \mu\text{s}$
- ECL : $\pm 500 \text{ ns}$

- Consistency check

- Total TC hit (31546314 : 31.5M)
- a : ECL TC and TRG TC are matching (29009425)
- b : ECL TC fired, but no TRG TC hit (857203)
 - Threshold < ECL TC < Threshold + 50 MeV (0.26 GeV) (856954 : 100%)
- c : TRG TC fired, but no ECL TC hit (1679686)
 - Threshold < TRG TC < Threshold + 50 MeV (0.26 GeV) (1668893 : 99%)
- mis-matching TC = 8.0% (low E region 100%)



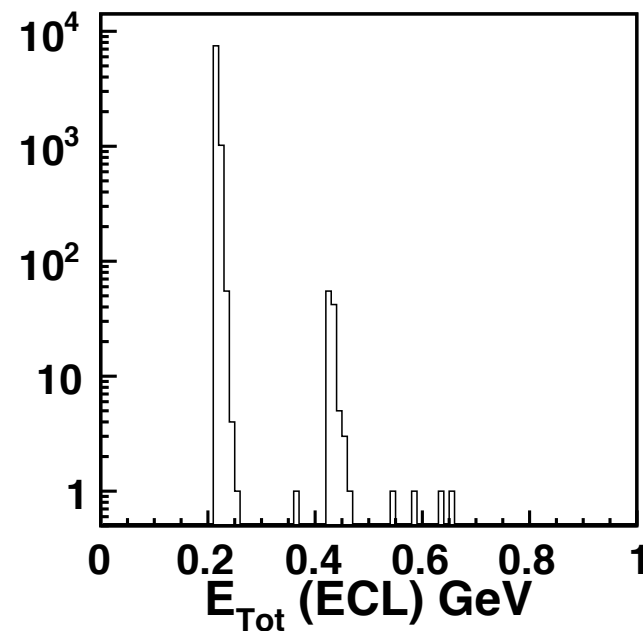
TC Energy



Cosmic data analysis (2) (cont'd)

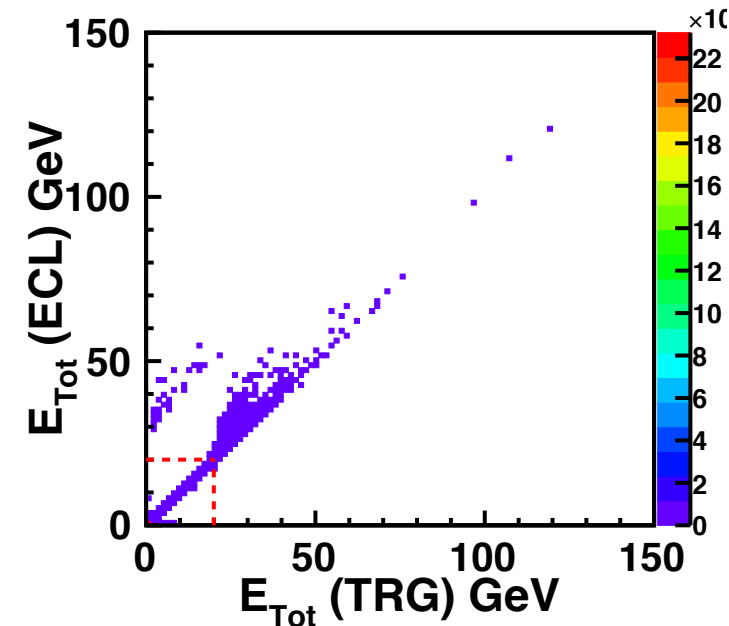
- Total Energy : Mis-matching 4.5%

E_{Tot} ECL



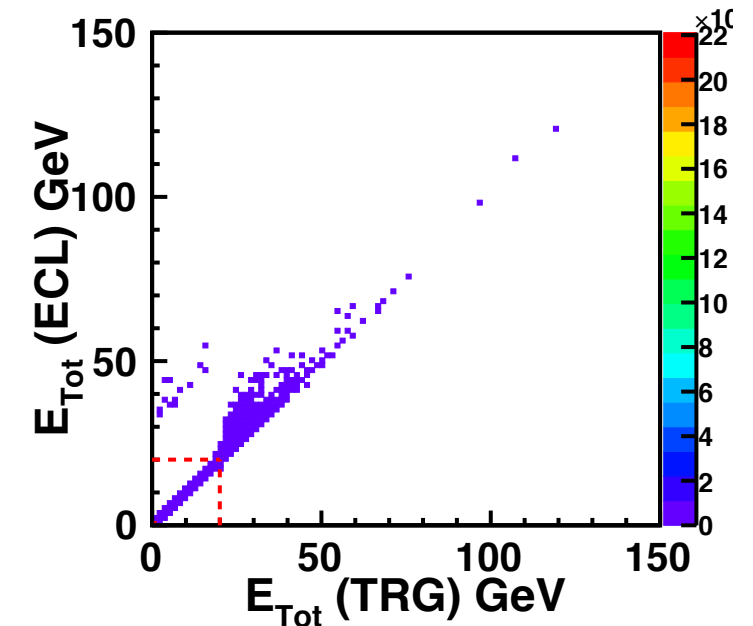
E_{Tot}

Region : a + b + c

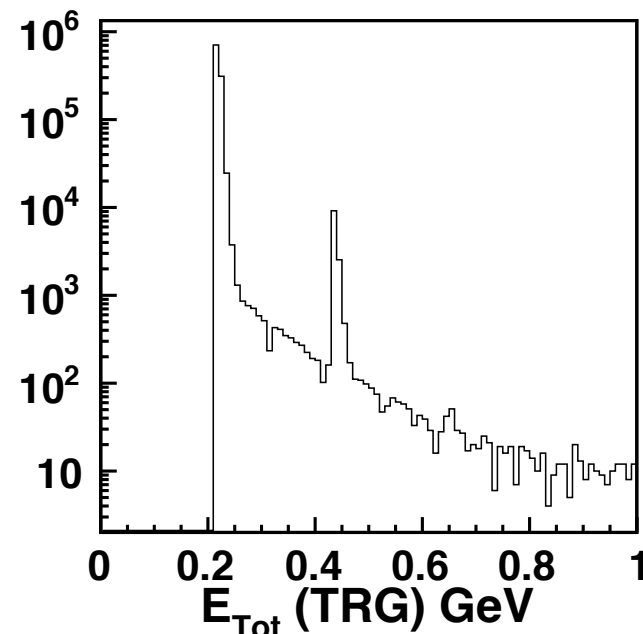


E_{Tot} Matching

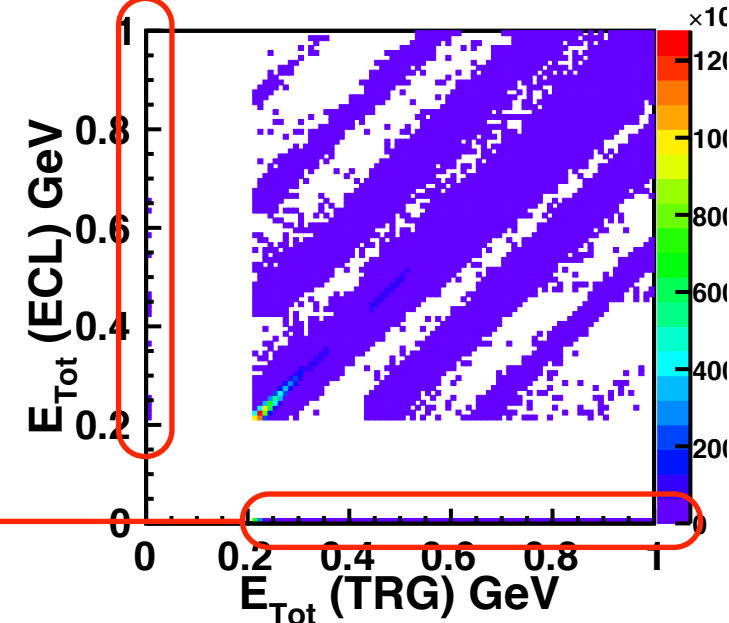
Region : a



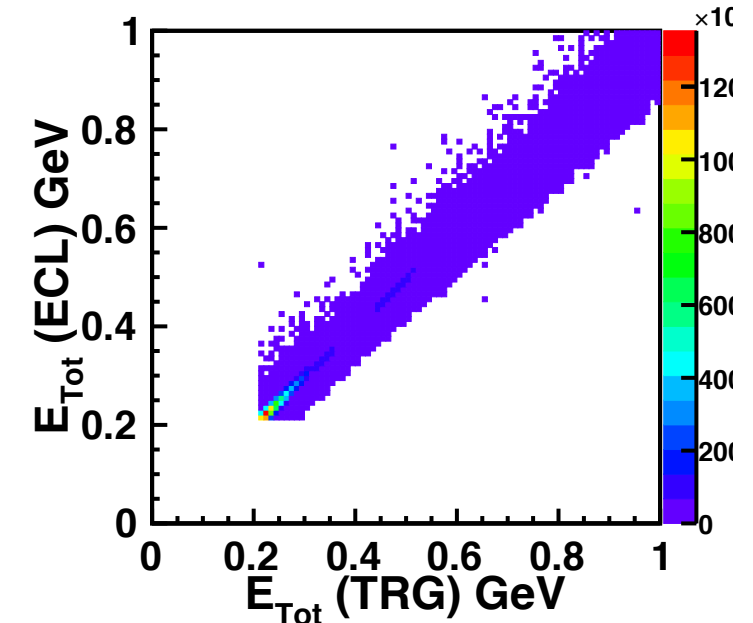
E_{Tot} TRG



E_{Tot}



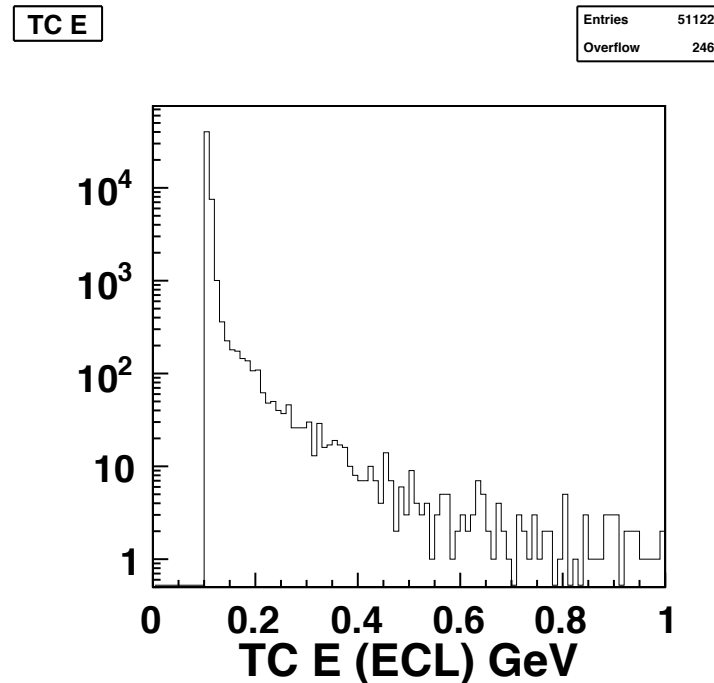
E_{Tot} Matching



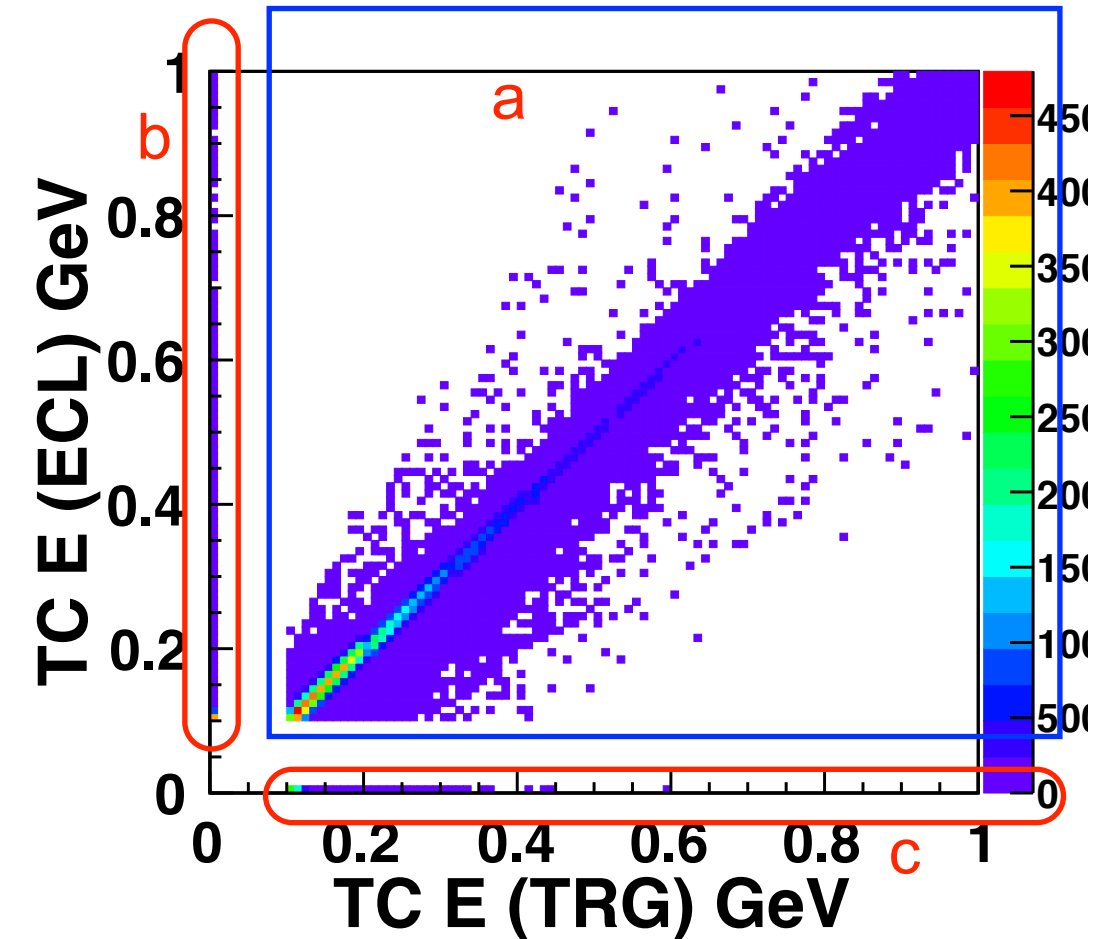
Beam data analysis (1)

- Timing Selection

- TRG : Same as ETM
- ECL : TRG ± 50 ns

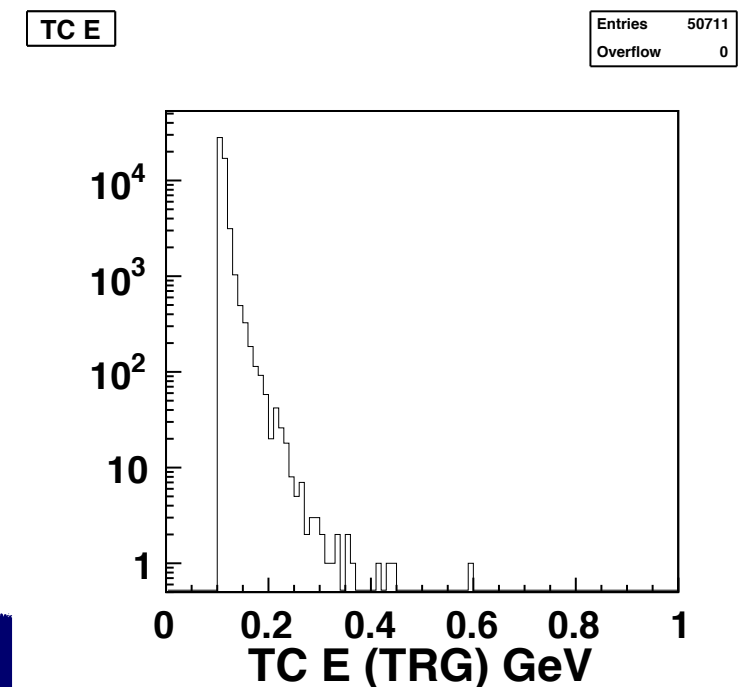


TC Energy



- Consistency check

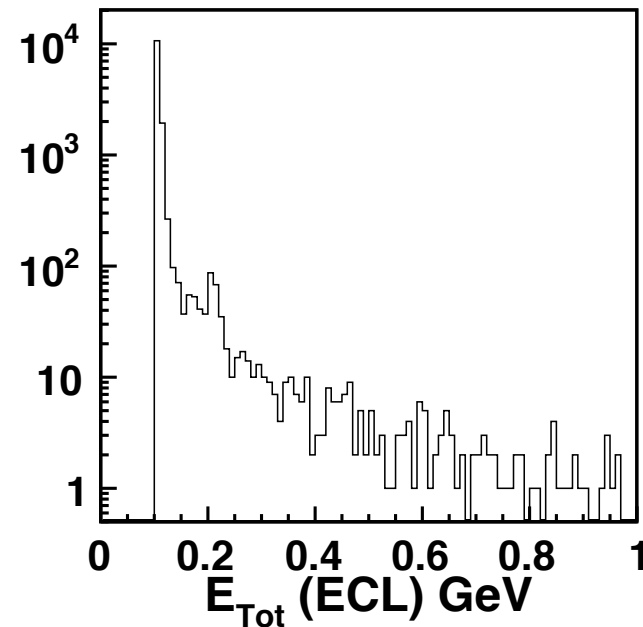
- Total TC hit (3583084 : 3.6M)
- a : ECL TC and TRG TC are matching (3481251)
- b : ECL TC fired, but no TRG TC hit (51122)
 - Threshold < ECL TC < Threshold + 50 MeV (0.15 GeV) (49306 : 96%)
- c : TRG TC fired, but no ECL TC hit (50711)
 - Threshold < TRG TC < Threshold + 50 MeV (0.15 GeV) (49790 : 98%)
- mis-matching TC = 2.8% (low E region **97.3%**)



Beam data analysis (1) (cont'd)

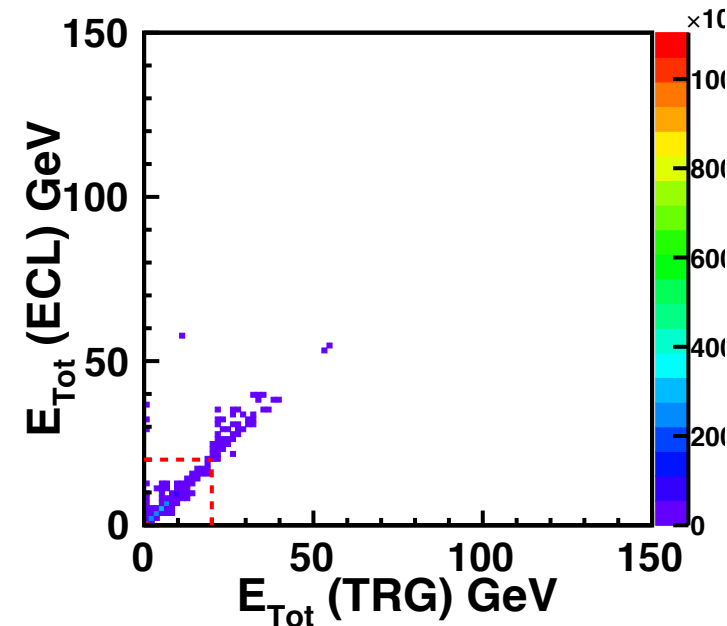
- Total Energy : Mis-matching 1.3%

E_{Tot} ECL



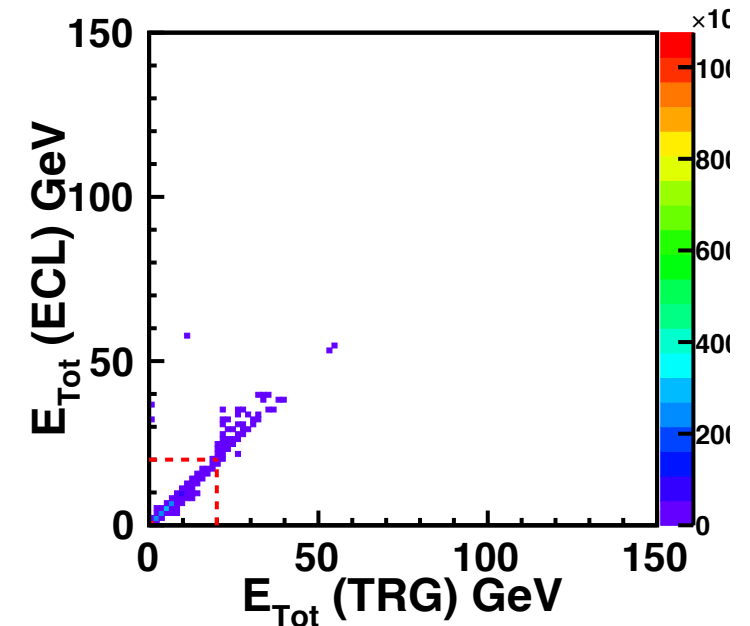
E_{Tot}

Region : a + b + c

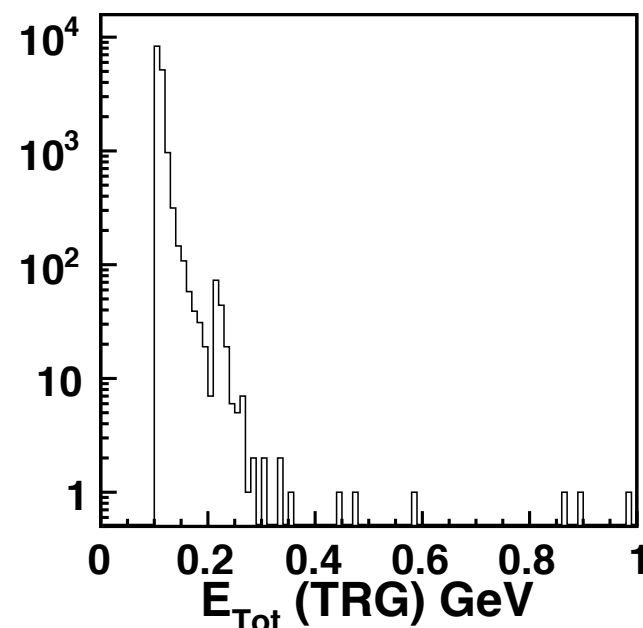


E_{Tot} Matching

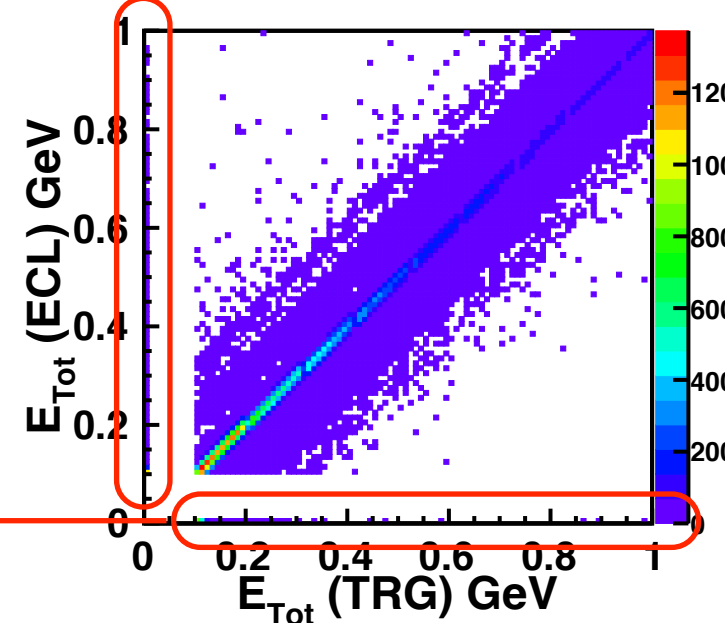
Region : a



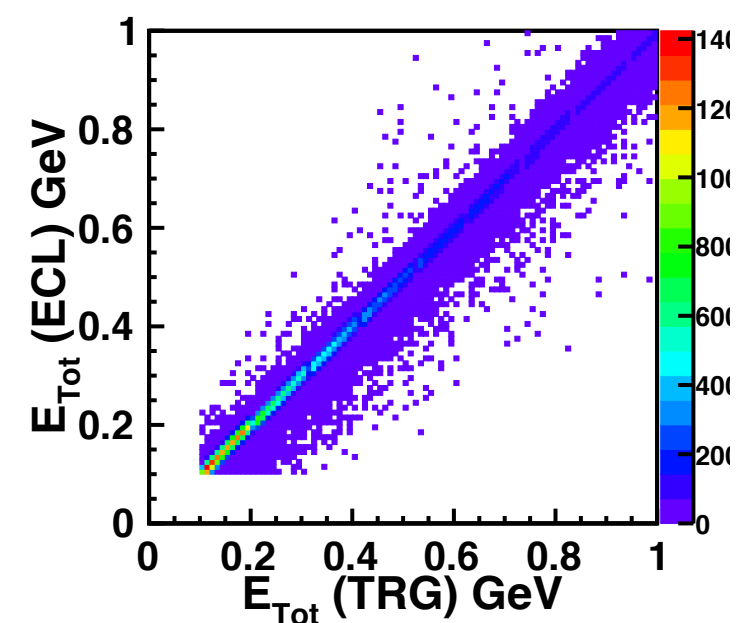
E_{Tot} TRG



E_{Tot}



E_{Tot} Matching



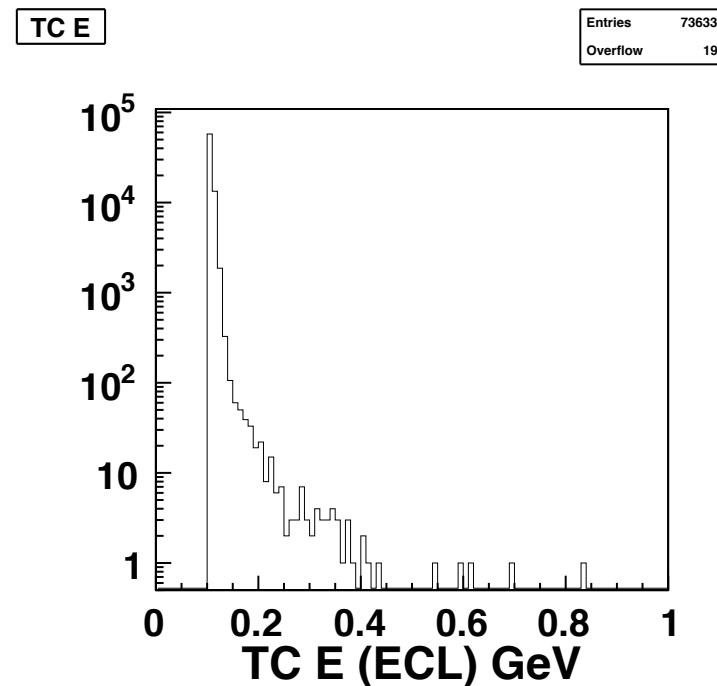
Beam data analysis (2)

- Timing Selection

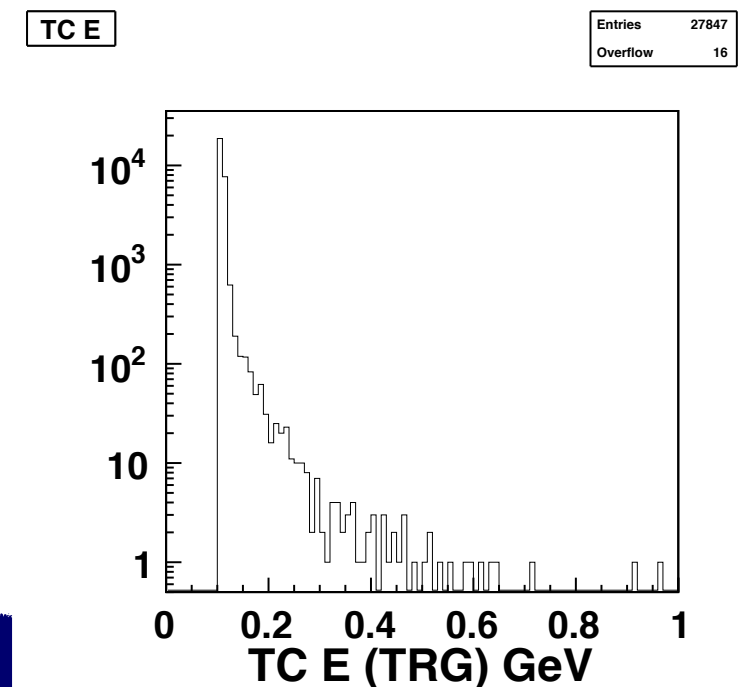
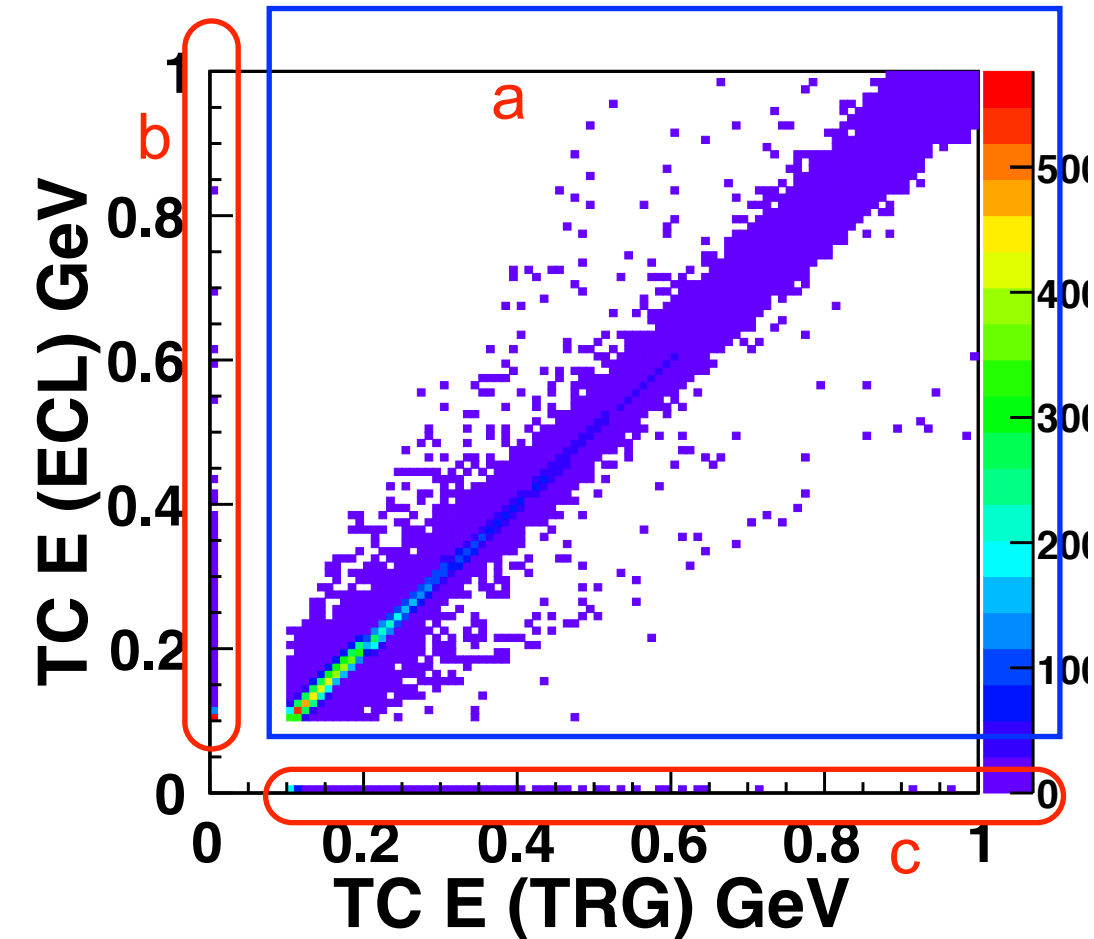
- TRG : $\sim 1 \mu\text{s}$
- ECL : $\pm 500 \text{ ns}$

- Consistency check

- Total TC hit (3622396 : 3.1M)
- a : ECL TC and TRG TC are matching (3520916)
- b : ECL TC fired, but no TRG TC hit (73633)
 - Threshold < ECL TC < Threshold + 50 MeV (0.15 GeV) (73304 : 100%)
- c : TRG TC fired, but no ECL TC hit (27847)
 - Threshold < TRG TC < Threshold + 50 MeV (0.15 GeV) (27306 : 98%)
- mis-matching TC = 2.8% (low E region 99.1%)



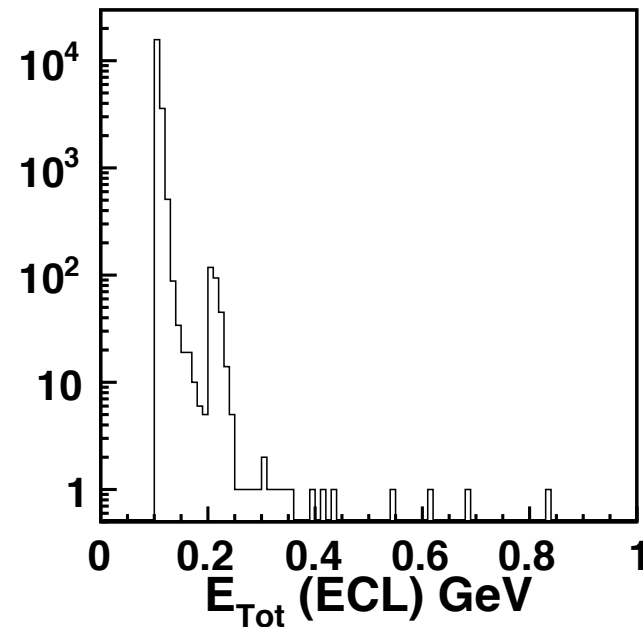
TC Energy



Beam data analysis (2) (cont'd)

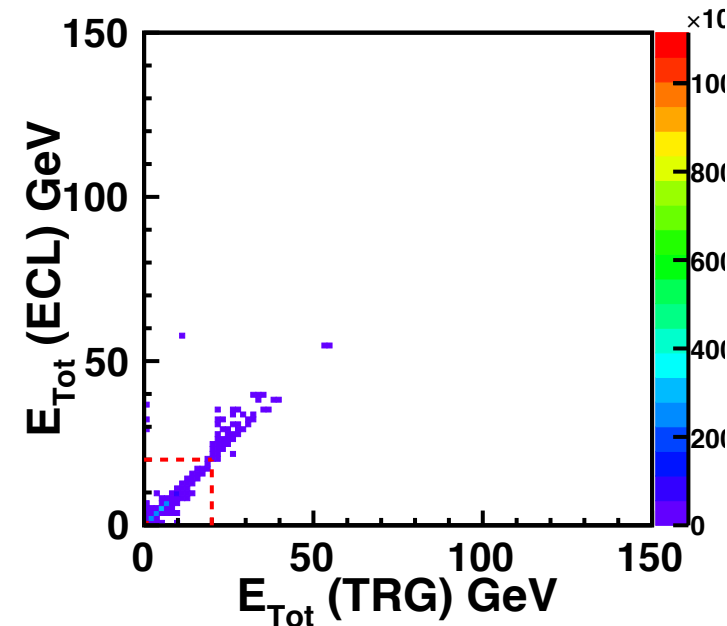
- Total Energy : Mis-matching 1.2%

E_{Tot} ECL



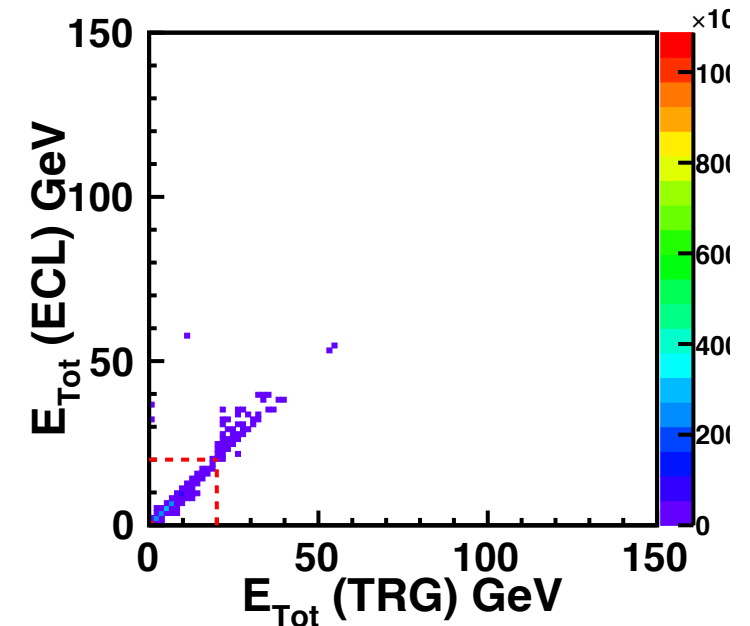
E_{Tot}

Region : a + b + c

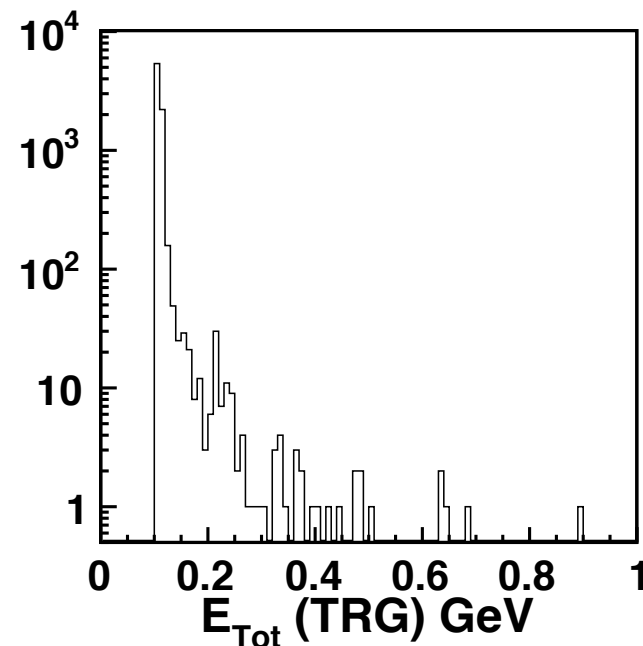


E_{Tot} Matching

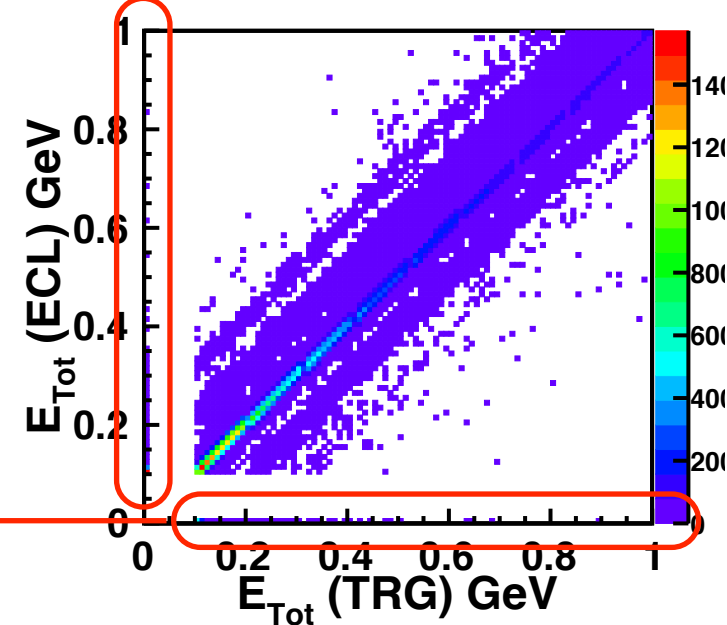
Region : a



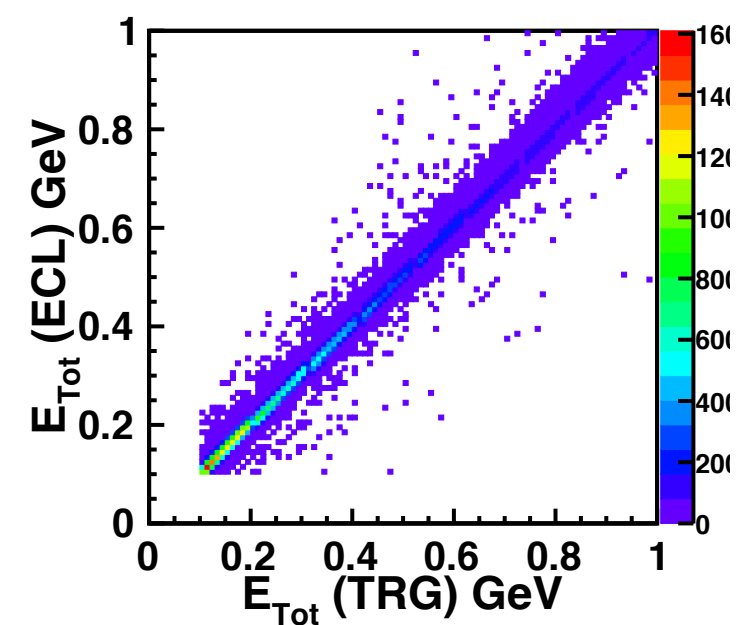
E_{Tot} TRG



E_{Tot}



E_{Tot} Matching



Summary : Data analysis

- Most of inconsistent events between ECL and TRG are due to
 - 1) ECL Status (ECL Quality & Calibration Status)
 - 2) Timing selection
 - 3) Low Energy (near threshold) → Energy measurement inconsistent.

Backup

Im10

Dear Unno-san; here are the numbers from my HLT study for experiment 8 run 1539. The HLT was in monitoring mode for this run.

Existing cluster trigger:

- ≥ 3 clusters with $E_{\text{cms}} > 0.2$ GeV, including ≥ 1 with $0.3 \text{ GeV} < E_{\text{cms}} < 2 \text{ GeV}$
- cross section = 24.9 nb
- exclusive cross section (i.e. event passes no other filter) = 19.7 nb
- overall generic tau efficiency = 89.5%
- efficiency of cluster triggers for tau pairs = 46.0%

Proposed cluster triggers:

- clusters must satisfy $\theta_{\text{Lab}} > 18.5$ deg and $\theta_{\text{Lab}} < 139.3$ deg (= trigger $\theta_{\text{ID}} [2, 16]$)
- ≥ 4 clusters with $E_{\text{lab}} > 0.18$ GeV, including ≥ 1 with $E_{\text{lab}} > 0.3$ GeV and none with $E_{\text{cms}} > 2$ GeV
- OR exactly 3 clusters with $E_{\text{lab}} > 0.18$ GeV, including ≥ 1 with $E_{\text{lab}} > 0.5$ GeV and none with $E_{\text{cms}} > 2$ GeV
- cross section = 10.3 nb
- exclusive cross section = 4.9 nb
- overall generic tau efficiency = 87.6%
- efficiency of cluster triggers for tau pairs = 45.9%

ImI0

The proposed changes reduce the exclusive cluster trigger rate by a factor of four, at the cost of 1.9% in generic tau pair efficiency. On the other hand, as Torben noted, the new configuration has good efficiency for physics events that contain a muon pair plus another cluster, whereas the existing configuration has poor efficiency.

The drop in tau efficiency is from the reduction in the angular acceptance of the trigger, but it is partial compensated by the increased efficiency for minimum ionizing particles.

I also tried a variation in which the 3 cluster trigger was “exactly 3 clusters with $E_{lab} > 0.18$ GeV, including ≥ 2 with $E_{lab} > 0.3$ GeV and none with $E_{cms} > 2$ GeV”. The exclusive cross section increases from 4.9 nb to 5.7 nb, and the tau pair efficiency drops from 87.6% to 87.3%.

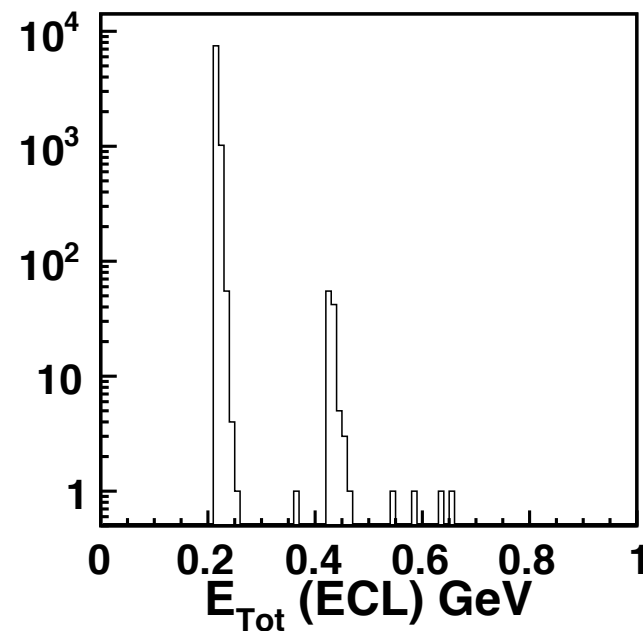
The looser variation, exactly 3 clusters with $E_{lab} > 0.18$ GeV, including ≥ 1 with $E_{lab} > 0.3$ GeV and none with $E_{cms} > 2$ GeV” would have better physics efficiency, but the exclusive cross section is 12.6 nb.

– Chris

Cosmic data analysis (2) (cont'd)

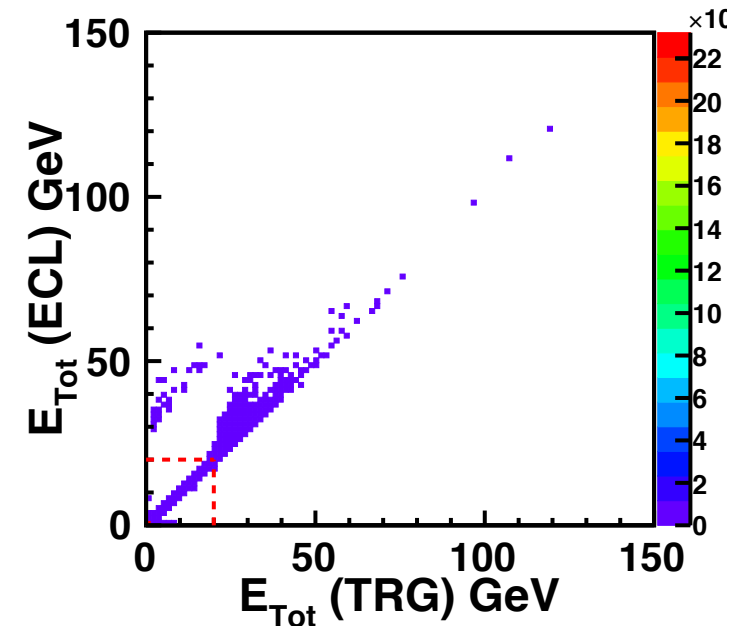
- Total Energy : Mis-matching 4.5%

E_{Tot} ECL



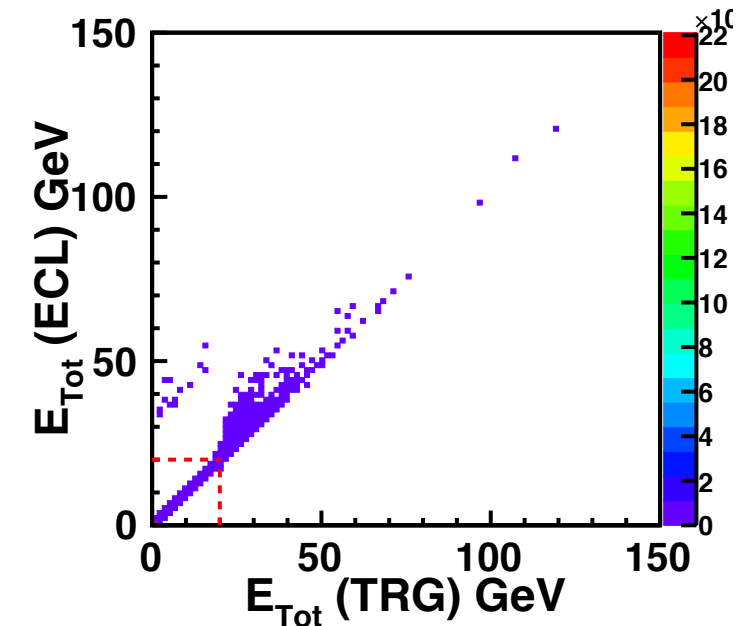
E_{Tot}

Region : a + b + c

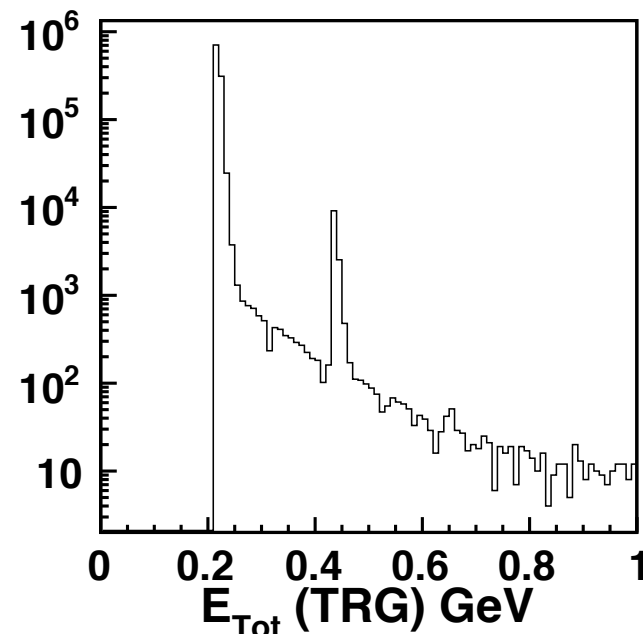


E_{Tot} Matching

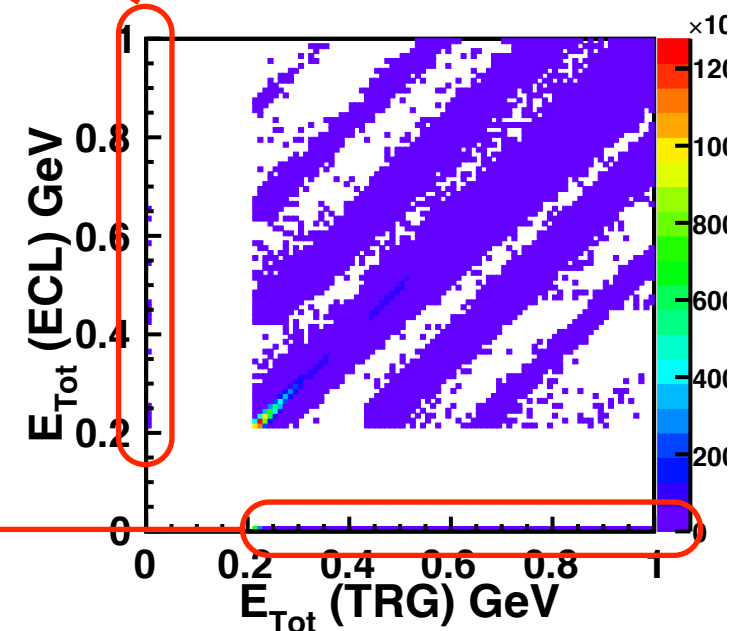
Region : a



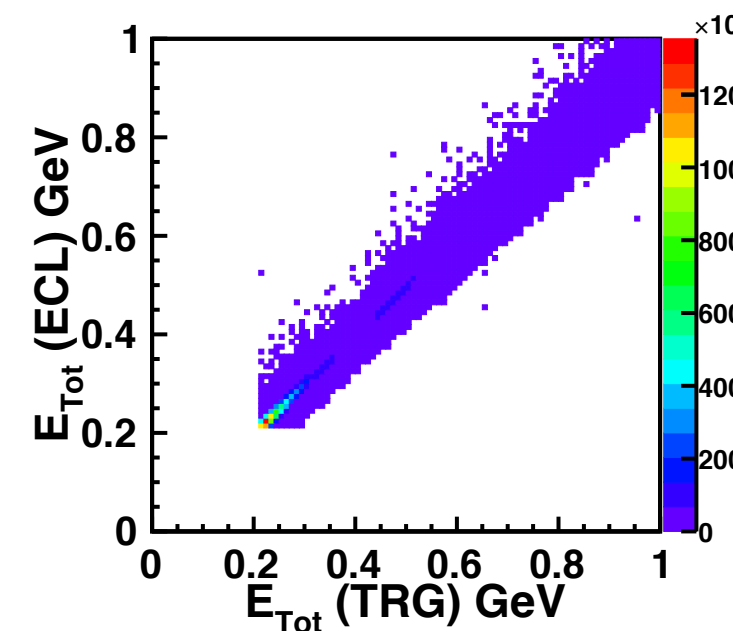
E_{Tot} TRG



E_{Tot}



E_{Tot} Matching

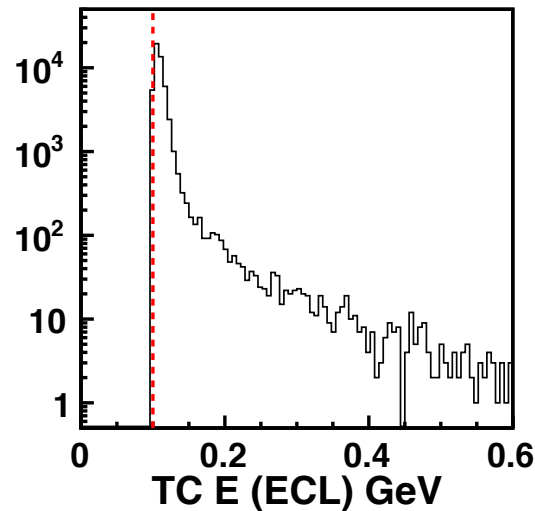


Beam data analysis (1) (cont'd)

- Region (b) : No TRG, but ECL

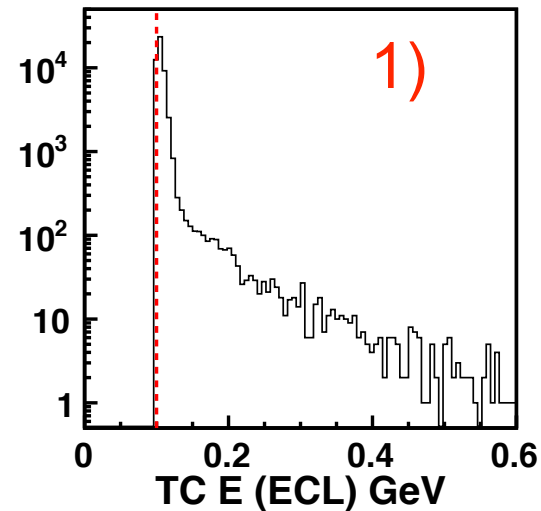
TC E (ECL) w/o Timing cut

Entries 51122
Overflow 348



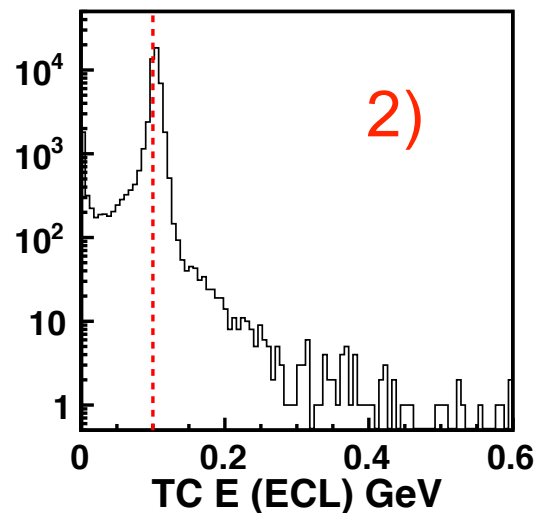
TC E (ECL) on Timing cut

Entries 51122
Overflow 324



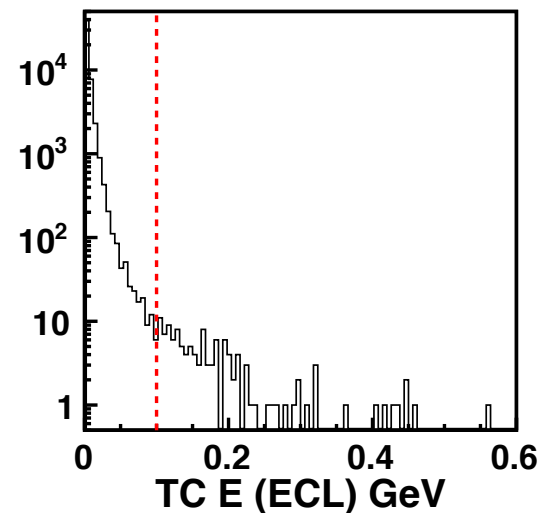
TC E (ECL) on Timing cut (tight)

Entries 51122
Overflow 84



TC E (ECL) off Timing cut

Entries 51122
Overflow 17

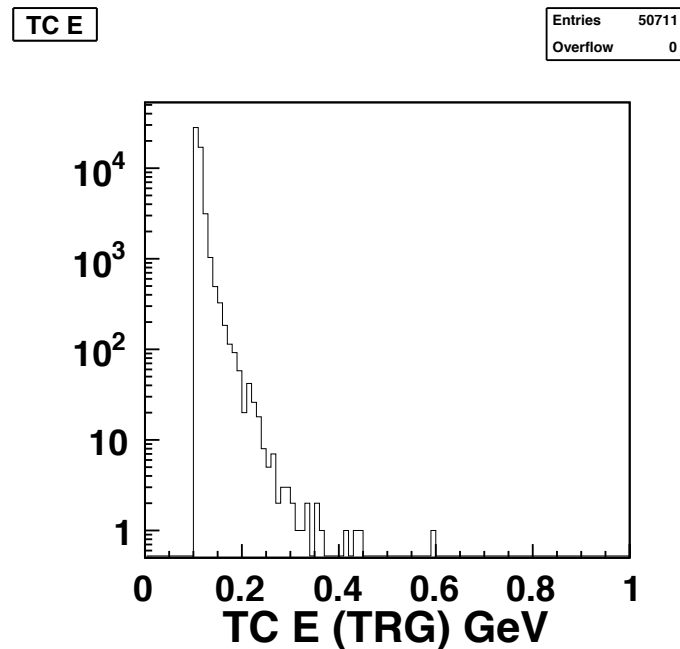


- Summary of region (b)

- condition 1) TRG timing ± 50 ns
- condition 2) TRG timing
- Timing selection affect near threshold region

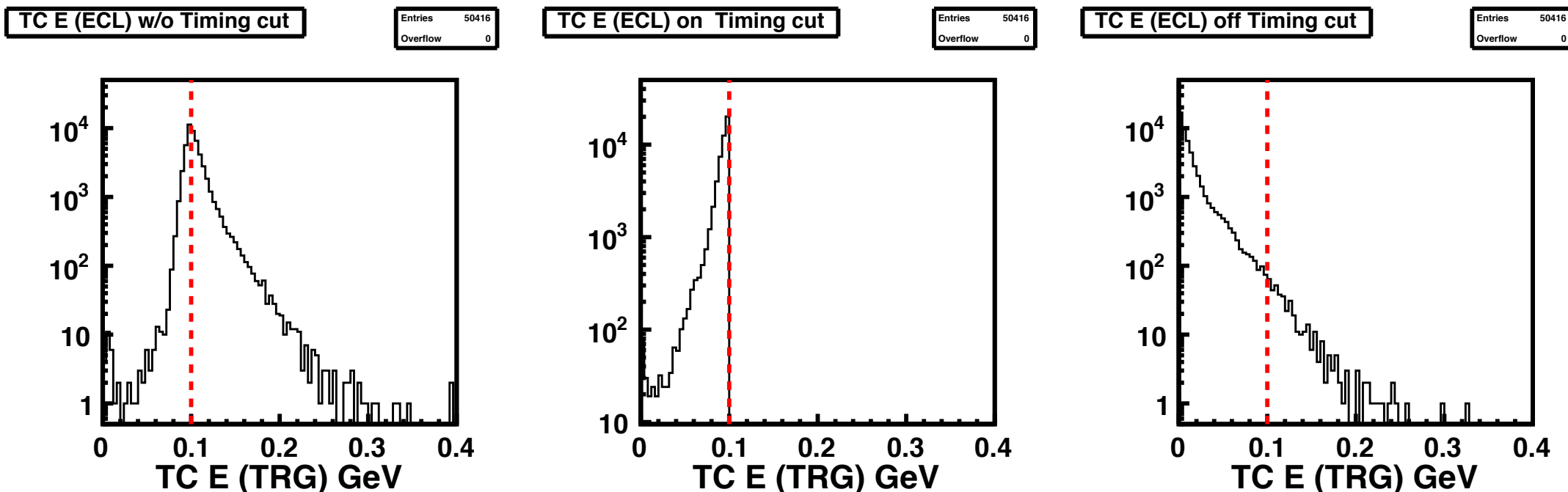
Beam data analysis (1) (cont'd)

- Region (c) : No ECL, but TRG



- Summary of region (c)
 - Most of ECL TCs are vetoed by
 - Threshold cut and Timing selection
 - No output from “ECLDigitCalibrator” : 0 / 2.2M (event)
 - No fired Xtal but TRG TC fired : 295 (TC) / 2.2M (event)

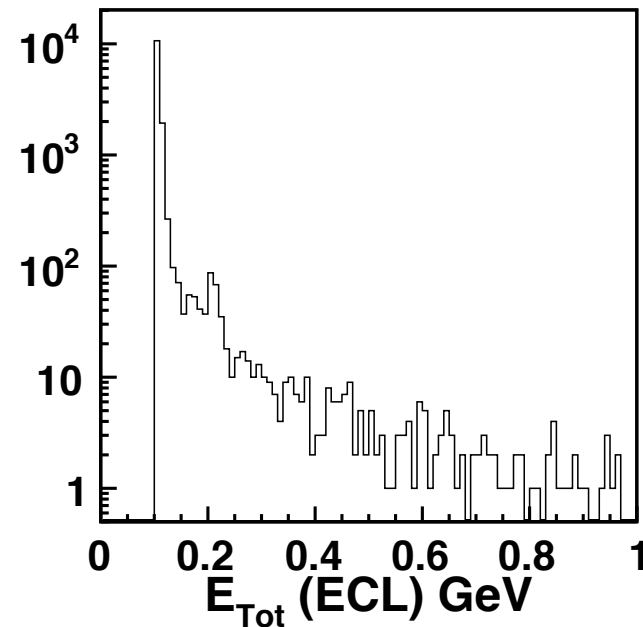
Corresponding ECL TC energy



Beam data analysis (1) (cont'd)

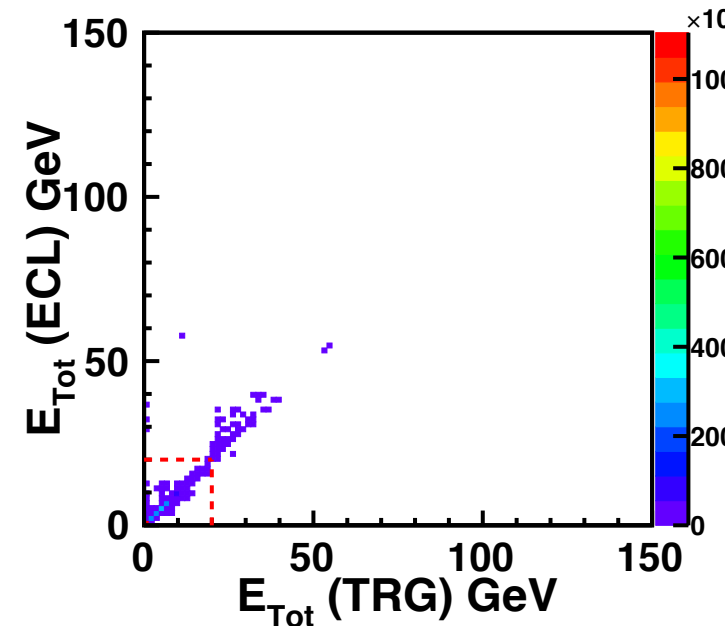
- Total Energy : Mis-matching 1.3%

E_{Tot} ECL



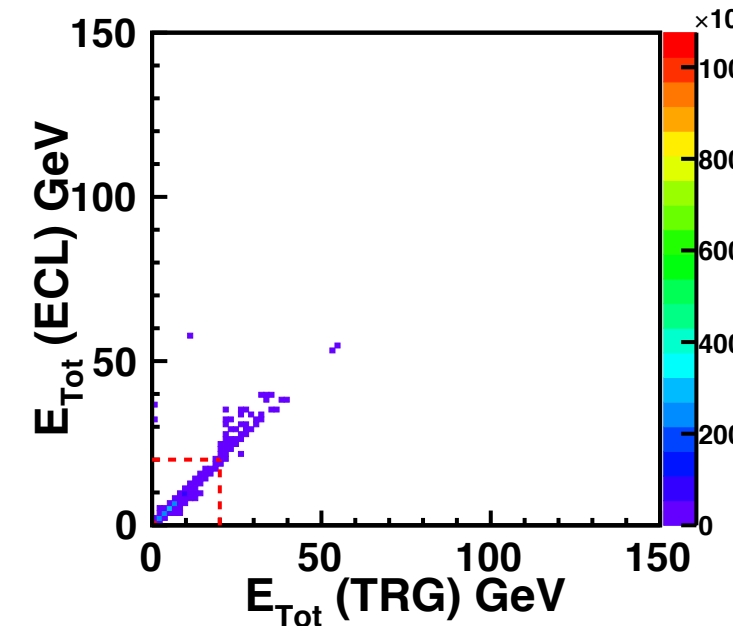
E_{Tot}

Region : a + b + c

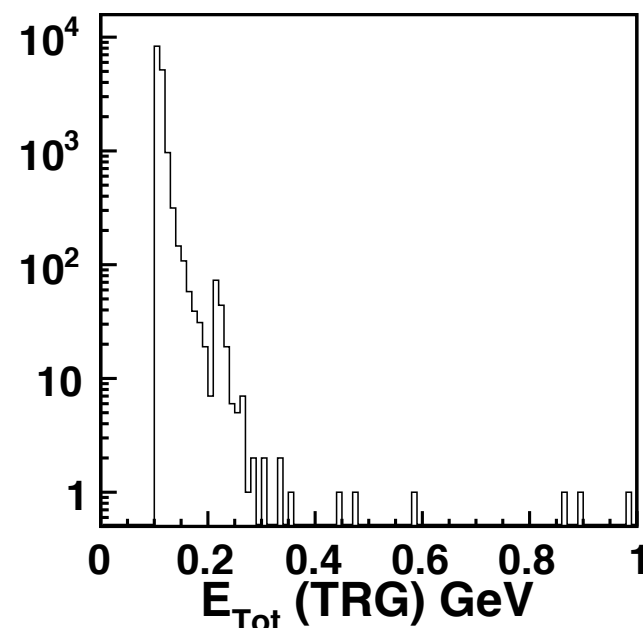


E_{Tot} Matching

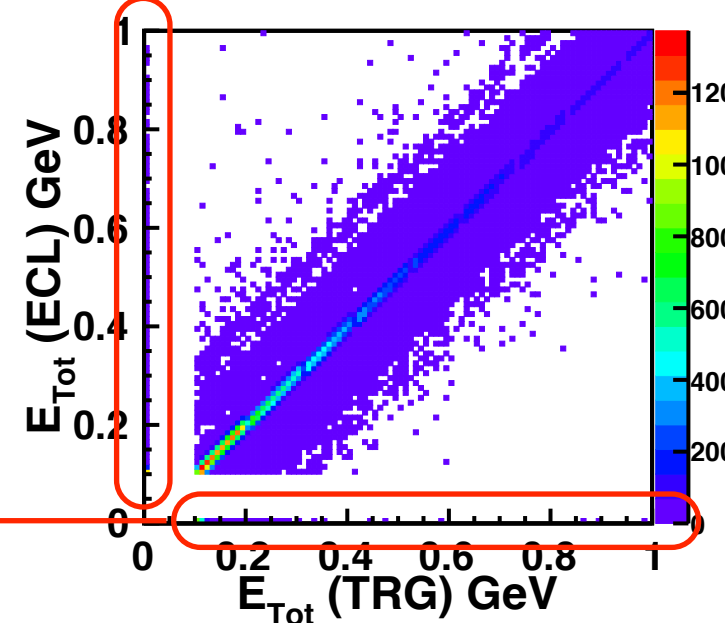
Region : a



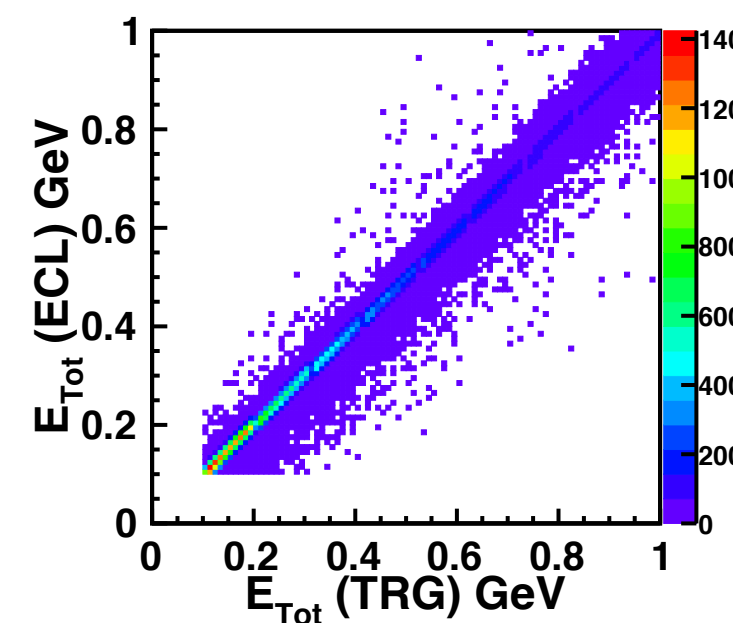
E_{Tot} TRG



E_{Tot}



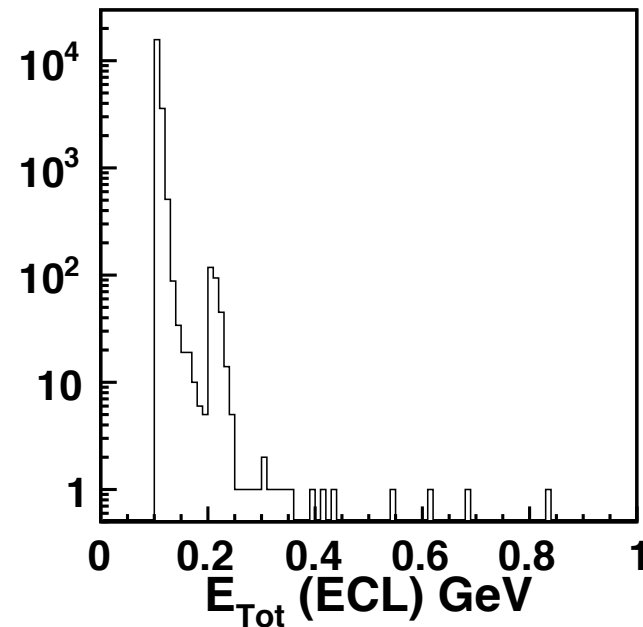
E_{Tot} Matching



Beam data analysis (2) (cont'd)

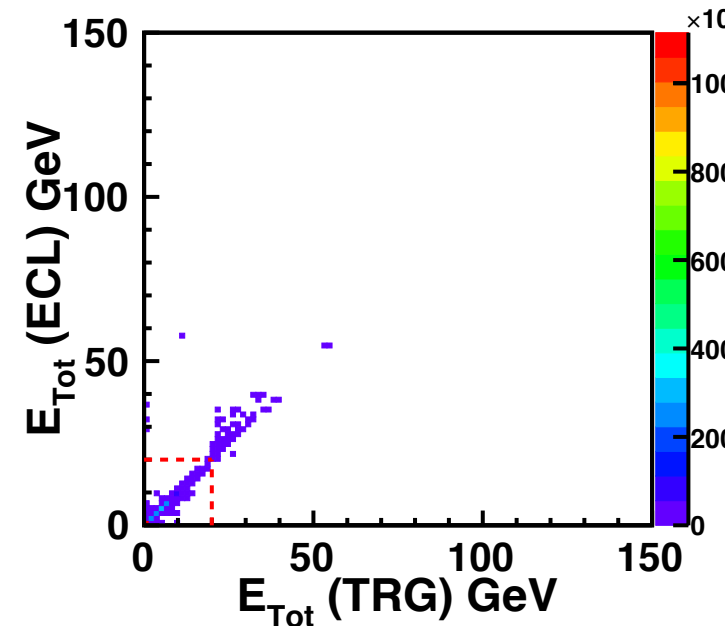
- Total Energy : Mis-matching 1.2%

E_{Tot} ECL



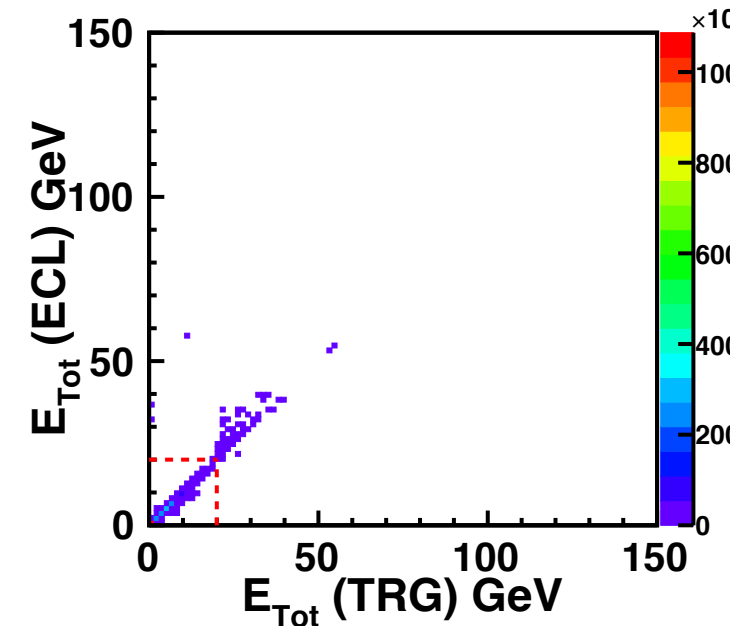
E_{Tot}

Region : a + b + c

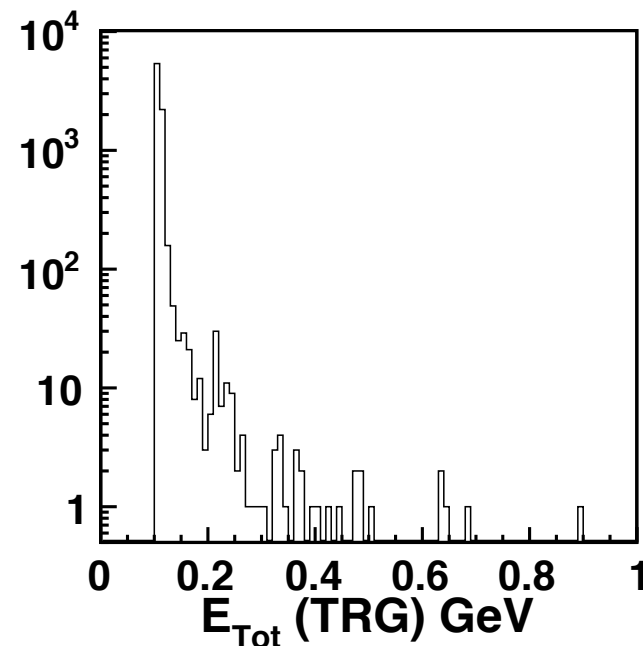


E_{Tot} Matching

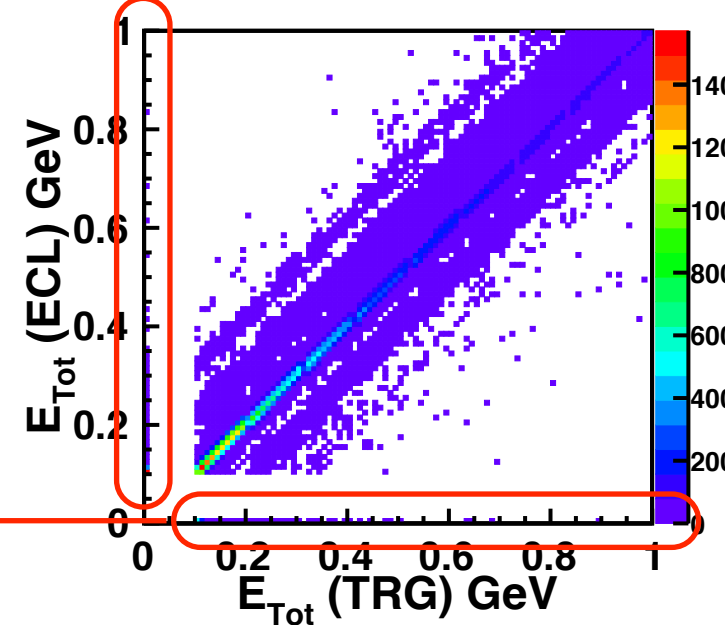
Region : a



E_{Tot} TRG



E_{Tot}



E_{Tot} Matching

