CMS Internal Note

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Modification of the CMS Regional Calorimeter Trigger Electron Identification Card for RCT Crate Slot 6 to Control Regional Boundary Data Sharing for Towers of Identical Energy

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Abstract

A minor modification to the Electron Identification Card for crate slot 6 has been made to correct an error in the implementation of the data sharing for calorimeter towers of identical energy along a regional boundary. The problem is described, as well as the results of the correction.

1 Introduction

The CMS Regional Calorimeter Trigger (RCT) has been described extensively in the Level-1 Trigger TDR and documents referenced therein [1]. The algorithm to find e/γ candidates is implemented on the Electron Identification Card (EIC), the bulk of which is performed by the custom EISO ASIC. The algorithm as implemented is fully explained in the Level-1 Trigger TDR [1].

The e/γ algorithm adds two tower energies together to find the candidate energy: a central tower, plus one with the highest energy of four adjacent towers. This adjacent tower can have energy equal to or less than the central tower, and can be in another region (See Figure 1). Most of the time the candidate is assigned to the region with the central tower, except in the case when the central and adjacent tower are equal. In this case a choice must be made, the total energy must be assigned to one region or the other, but not both. A bit in the EISO ASIC determines to which region the candidate energy will be assigned. It is called TP_LF, and is set during the initial configuration of the card.
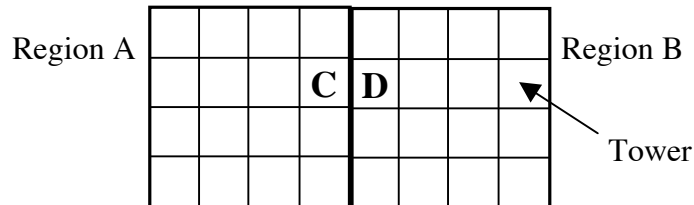

Figure 1: Region Sharing Example

Figure 1: For example, if C>D, there will be an e/γ candidate in Region A with total energy C+D. If C<D, that candidate will be in Region B with energy C+D. When C=D, a choice needs to be made. The TP_LF bit will set the preferential region for the candidate.

2 About TP_LF

TP_LF is a control bit on the CMS RCT EISO ASIC. There is only one of these bits per ASIC, which is one per region. As built, there is one value of TP_LF for both regions on the EIC.

The TP_LF bit sets which region will be assigned the e/γ candidate if there is a pair of towers with equal energy along a regional boundary. For region zero of an EISO card in slot 3, the grey towers in Figure 2 will be included in the candidate energy inside of the region if the energies across the regional boundaries are equal, and TP_LF is set to the value shown next to the region.
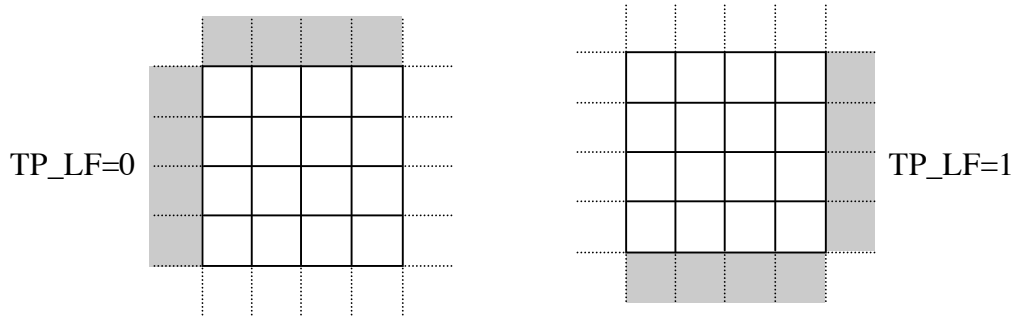
Figure 2: A candidate with energy evenly distributed over two towers, one inside the region, and the other adjacent to it in a neighboring region shown by the grey towers will be an e/γ candidate for this region (this is RC/EIC slot 3, region 0).

Figure 3 shows the configuration of cards and regions for two crates, the upper for η<0 and the lower for η>0. Each arrow represents which region or card a pair of towers with identical energy would be assigned to, with TP_LF=1 for cards 0,2,4,6 and TP_LF=0 for Cards 1,3,5 (η<0) and TP_LF=0 for Cards 0,2,4,6 and TP_LF=1 for Cards 1,3,5 (η>0). However card 6 has a problem. Setting TP_LF=1 for η<0 causes duplication of candidates at the cable sharing boundary (the double arrow), and anything at the center boundary disappears (the "x"). Setting TP_LF=0 as shown for η>0 causes candidates on the internal region boundary to be duplicated (one in each region) and will make the cable sharing ones disappear! Changing the value for either card 6 to its opposite affects the 4/6 and 5/6 boundaries, either causing duplication, or disappearance.
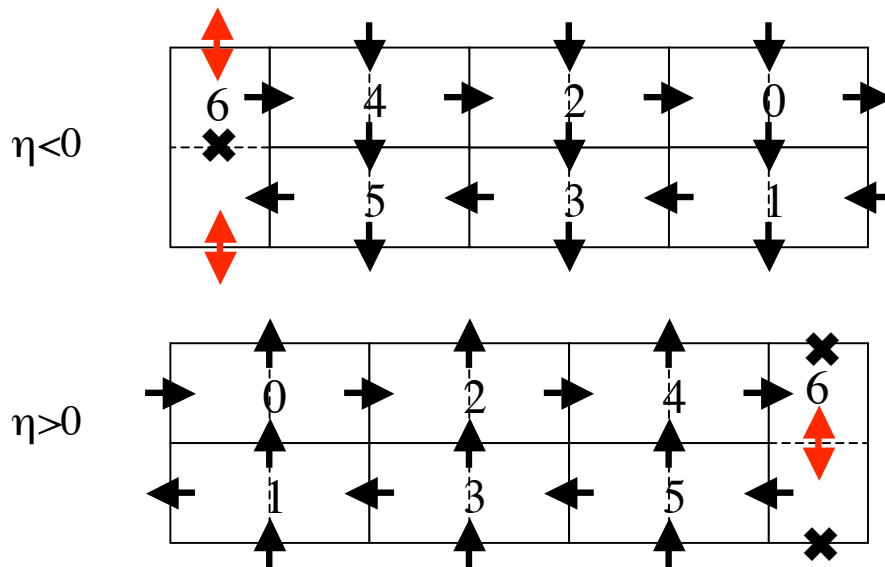

Figure 3: If the cards are left as built and only one value of TP_LF is set for each card. The single arrows show to which region a candidate would be assigned if the two towers have equal energy. For EIC 6, this becomes a problem, as candidates are duplicated in two regions (double arrows) or lost outright (crosses).

3 Change to EIC 6

A change of the implementation of TP_LF for only Electron Identification Card 6 was made. The two EISO ASICs are now able to have their TP_LF set separately. The modification is described in the appendix to this document. A card will be identifiable as an EIC for slot 6 by a jumper added to the vector of the board (SW5). On the front panel of each cardwill be a large number "6" in white or a bright yellow, either painted or stuck on so that one may easily identify it.

A new TP_LF bit was created – one that only accessed the EISO for Region 1. The original bit now only accesses the EISO for Region 0. This is only implemented on certain cards to be used in EIC slot 6 of the RCT crate. Address \$00 bit 0x40 is either 0 or 1 depending on the choice of TP_LF for Region 1. Configuring the EIC's as in Table 1 causes no candidates to be lost, and a duplication of candidates along the RC/EIC 6 Region 0 and RC/EIC 4 Region 1 ($\eta<0$) and RC/EIC 6 Region 1 and RC/EIC 5 Region 1 ($\eta>0$) boundaries. No perfect solution could be found, so this was preferred to losing candidates.
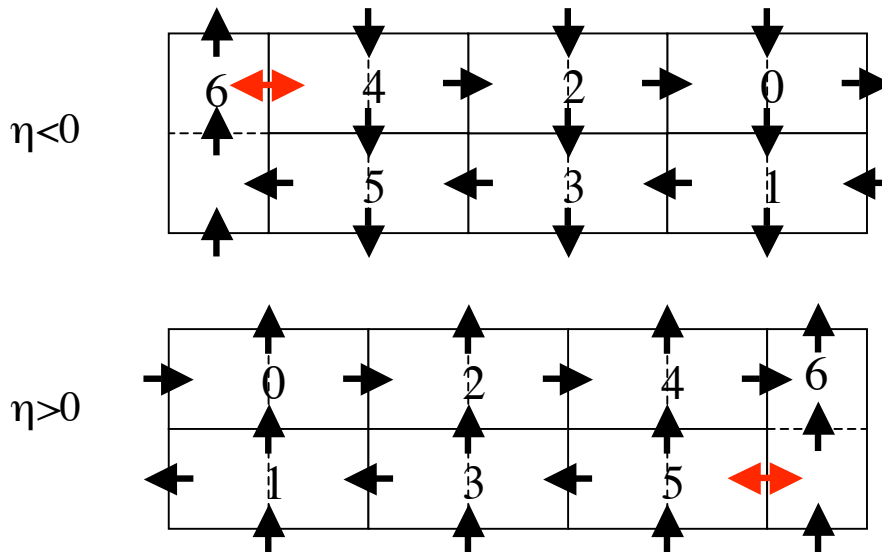

Figure 4: After reconfiguring EIC 6, no candidates are lost. Duplicate candidates are possible on the Card 6 Region 0 – Card 4 Region 1 boundary for $\eta<0$ and the Card 6 Region 1 – Card 5 Region 1 boundary for $\eta>0$. This is only when the tower energies are identical.

EIC	η > 0		η < 0	
	$00	$02	$00	$02
0	44	9	04	49
1	84	49	C4	9
2	44	9	04	49
3	84	49	C4	9
4	44	9	04	49
5	84	49	C4	9
6	44	89	44	89

Table 1: Default values for addresses $00 and $02 for all seven EICs in a crate, depending on the crates coverage in η, for normal operation.

4 Consequences

The consequences of the duplication of the electron candidates is expected to be minimal. There must be identical energy deposit in two adjacent towers across a regional boundary, and it must occur on the boundary of RC/EIC 6 Region 0 and RC/EIC 4 Region 1 for η < 0, and RC/EIC 6 Region 1 and RC/EIC 5 Region 1 for η > 0. This is expected to be quite rare. However, this effect will be implemented in the simulation of the RCT.

5 Conclusions

A modification has been made to about 18 RCT Electron Identification cards to fix a small problem with sharing of data across a boundary region in the case of identical energy deposits in two towers across that boundary. The consequences are that along one regional border in each crate, there exists the possibility of duplicate candidates. This effect will be included in the emulation/simulation of the RCT, but is expected to be very rare.

6 References

[1] CMS, *The TRIDAS Project Technical Design Report, Volume 1: The Trigger Systems*, CERN/LHCC 2000-38, CMS TDR 6.1.

A Appendix

The Modification

To modify an EIC for operation in slot six (for reference only – no boards should need modification):
  a. Drill out the via by the C197 negative terminal from the back of the board with a 0.8 mm drill bit, just enough to break the connection of U130, pin 392, without

disrupting the connection of U129 to U49 and the pull down at U173. One doesn't have to drill very much, so go very slowly. Use an ohmmeter from U129 pin 392 to U130 pin 392. Ideally, it would be best to have one from U129 pin 392 to R73 pin 4 as well. If the connection from U129 pin 392 to R73 pin 4 is broken, a wire will have to be installed.

b. Connect U39 pin 11 to U49 pin 11 with a wire on the top of the board.

c. Connect U49 pin 10 to U130 pin 392, going through a open jumper (part of SW10) so that it arrives on the back of the board, and use the via for U130 pin 392 accessible only from the back of the board.

d. Connected U139 pin 392 to pin 4 of the R279 to pull it down to VTT (very short wire on the back of the board).

In total 3 wires and one drilled out via. Wires were stuck to the board with some small pieces of Kapton tape.

Pictures of the modification are available at: http://hep.wisc.edu/~pamc/EICmod/.

Checking the Modification

A program was written to check if the modification is working okay. On any CMS RCT machine, run the program `RCTTestWithJCC –t 10` at the command line, after initializing the crate controller and booting the crate. It will determine if the modification was installed correctly. There is also a script `run_TP_LF_test` that will do everything for the user. Simply change directories to the `RCTtest` directory and type the script name.