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SDC
SOLENOIDAL DETECTOR NOTES

CORRELATED LEVEL 1 MUON TRIGGER DESIGN FOR THE SDC

December 30, 1991

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1 Introduction

The SDC Level 1 Muon Trigger must be able to identify and place p_t cuts on muon tracks. The muon trigger is one of the basic building blocks of the SDC trigger system[1]. Muons are used to trigger on Z's and W's, as well as to indicate heavy quarks in jets. The muon trigger should result in good efficiencies for these signals without having backgrounds saturate the total Level 1 target output rate of 10 KHz[2], which must be shared by all triggers. An important concern is whether this goal can be achieved using the muon system by itself or if correlation with tracking or calorimetry is required. The focus of this concern is whether the dependence of the level 1 muon trigger on muon p_t is strong enough to permit setting a reasonably efficient rate by adjusting the muon p_t threshold. If it is not, then the required threshold sharpness may be produced by using the p_t from the outer tracker. Another alternative would be to use the calorimeter to provide an isolation critereon for filtering the muon candidates. The muon trigger design presented in this note provides for both of these options. The purpose is to provide a feasibility study as input for costing and trigger timing investigations.

The basic idea behind the design that correlates the muon and tracking systems is to match the ϕ coordinate from the muon ϕ wires with the ϕ coordinate from the outer tracker on a .00625 mrad scale. The matched track is then required to have its p_t as found by the tracker pass a threshold in order to trigger. The basic idea behind the design that correlates the muon and calorimeter systems is to use the p_t from the muon theta wires in a .2 η bin as assigned to a .2 ϕ bin by a scintillator match. After the theta wire p_t passes a threshold, the corresponding .2 x .2 calorimeter region is checked to see if it passed a "quiet" requirement consistent with the deposition of a few times minimum ionizing energy.

2 General Overview

Figure 1 shows a block diagram for the Correlated Muon Trigger. The basic inter-system correlation occurs within a $.2\phi$ slice of the detector. Since each Muon octant is divided into 4 sections, a $.2\phi$ slice corresponds to one section of the Muon system. The η dimension of this slice is $|\eta| < 1.6$ in the barrel region, and $1.6 < |\eta| < 2.5$ in the intermediate regions. Muon hits are located within a slice using the θ-wires, the ϕ-wires, and scintillators, as described

in [8]. The θ-wires and scintillators are used to establish the p_T and bunch crossing of each hit. The ϕ-wires and scintillators are used to establish the $.2\phi$ slice within an octant, the $.00625\phi$ bin, the $.2\eta$ location within that slice, and the bunch crossing. This latter combination is used for linking with the Tracker.

The Muon system front end crates will transmit the trigger primitives as defined below to the Level 1 Trigger system using two fiber optic cable formats:

ϕ-hit cable: This cable format includes a single hit flag for each $.00625\phi$ region as reported by the Muon chamber ϕ-wires. The ϕ-wires cover the entire η length of the $.2\phi$ slice (either $|\eta| < 1.6$ or $1.6 < |\eta| < 2.5$). An active hit flag corresponds to a muon track detected at that ϕ location. Each 16-bit cable format uses 16 bins of $.00625\phi$ each to cover a $.1\phi$ region, or one-half of the $.2\phi$ slice.

p_T/η-hit cable: This cable format reports the raw p_T value and the η value for the highest two p_T hits in the $.2\phi$ slice. The p_T is obtained from the θ-wires in the Muon chambers. The η value is obtained from the scintillators. Each 16-bit cable format contains two hits, each occupying up to 8 bits. Each hit reports 3-bits of η, to locate the hit to within a $.2\eta$ region in the wedge, and up to 5 bits of p_T.

p_T and ϕ hits from the Tracker, and $.2\eta$ x $.2\phi$ region Quiet flags from the Calorimeter are correlated with the Muon trigger primitives. The Tracker, via the Track/Shower Max Hit card (TSM card) described in [4], provides p_T and ϕ-location hits to be correlated with the Muon ϕ-hits. The Calorimeter, via the Region Match card (RMC card) also described in [4], provides Quiet flags for correlating the Muon p_T hits for $.2\eta$ x $.2\phi$ regions.

Using a Memory Lookup table (MLU) for final correlation of all three subsystems, each 1.6η x $.2\phi$ wedge produces a maximum of 2 Muon hits, which are assigned to one of four histograms according to the results of the Tracker/Calorimeter correlation, and to one of 4 bins in the histogram according to p_T. Each 3-bit bin can contain as many as 7 candidate Muons. The four histogram types are defined as follows:

p_T-Match, Quiet. This histogram contains p_T bins of those Muon hits which were matched with both a p_T hit in $.00625\phi$ from the Tracker, and isolated within a $.2\eta$ x $.2\phi$ quiet region of the Calorimeter. The Tracker p_T is used to select the bin.

p_T-Nomatch, Quiet. This histogram contains p_T bins of those Muon hits which were not matched with a p_T hit from the Tracker, but were still isolated within a $.2\eta$ x $.2\phi$ quiet region of the Calorimeter. The Muon p_T is used to select the bin.

p_T-Match, Not Quiet. This histogram contains p_T bins of those Muon hits which were matched with a p_T hit in $.00625\phi$ from the Tracker, but not isolated within a quiet region of the Calorimeter. The Tracker p_T is used to select the bin.

p_T-Nomatch, Not Quiet. This histogram contains p_T bins of those Muon hits which were not matched with either the Tracker or the Calorimeter. The Muon p_T is used to select the bin.

The histograms are summed over the entire Muon detector surface, and the resulting histogram bins are used in association with the other trigger subsystems, the Total/Missing Transverse Energy trigger, the Jet Threshold trigger, and the Isolated Electron trigger, to produce the Level 1 Accept. See [2] and [4] for a description of these other trigger subsystems.

The physical implementation of the Muon Trigger Decision logic consists of a new crate design, the Correlated Muon Trigger crate, a new card type, the Correlated Muon Trigger Card (CMLC card), and revisions to the HSC, TSM, and RMC cards originally described in [4]. These new designs and revisions are described below.

3 Tracker/Shower Maximum TSM Card

Figure 2 shows the revised Track/Shower Max Hit card (TSM card). The card receives the Tracker p_Ts and Shower Max hits and correlates them in ϕ. The result is a Shower Max hit flag and associated Tracker p_T code for each $.2\eta$ x $.2\phi$ region, which is delivered to the RMC cards for correlation with the Isolated Electron candidate hits from the Calorimeter. The card operates on a 1.6 η x .2 ϕ region of the detector. Each card is double-width, and receives 16 optical fibers containing shower max hits and 8 optical fibers containing p_T information from the tracker. Each shower max fiber delivers 16 bits of binary hit information for a $.2\eta$ x $.1\phi$ region, where each bit corresponds to a hit/no hit in a $.2\eta$ x $.00625\phi$ region. Each tracker fiber delivers 4 ϕ bins of 4-bit p_T information, where each bin corresponds to 1.6η x $.00625\phi$, and the area covered by the data on each fiber is 1.6η x $.025\phi$.

For correlation with the Muon system, only the tracker p_T information is used. For this purpose, the TSM card has been revised from [4] to include a set of p_T–to–3-bit threshold code conversion MLUs for each of the 32 Tracker p_T values in the 1.6η x $.2\phi$ region, and sorting logic which reports the highest two threshold codes in the region, with an associated 5-bit $.00625\phi$ address.

This sorting logic is a tree constructed from a comparator node shown in Figure 2.1. Each node compares two threshold codes, and propagates the "Winner", the input with the higher magnitude code, to one output port, and the "Loser" to the other. Along with each threshold code, it propagates a 5-bit ϕ address, which is assigned in a hard-wired fashion to each threshold code at the input to the tree.

The nodes are connected together to form the equivalent of a "double-elimination tournament" scheme, as shown in the example in Figure 2.2. In this scheme, the highest p_T threshold code is the winner, and the second highest code has only one loss, that being to the eventual winner at some point. The highest threshold code is obtained through a simple binary tree, in which the winners of the previous level are linked to the inputs of the next level. The second-highest threshold code is obtained by linking the first-time losers from the basic tree, and only propagating forward the winners of these comparisons. Any threshold code which loses more than once cannot by definition be the highest or second-highest code.

The actual tree implemented on the TSM card would have 32 threshold code inputs,

one for each .00625ϕ bin in the .2ϕ slice, instead of the 8 shown in the example in Figure 2.2 This increased number of bins would require two additional layers of nodes on the tree, bringing the total number of nodes to 61, as opposed to the 13 nodes shown in the example.

To meet space and power requirements on the TSM, it is likely that the comparison node shown in Figure 2.1 will have to be implemented in an ASIC. This ASIC would have an as yet undetermined number of nodes per package, with 16 inputs and 16 outputs per node, plus a number of power and ground connections. The node architecture within the ASIC could be pipelined, with a latency which is non-critical, but would be required to have an accept rate of 16ns for each new pair of threshold code inputs. This ASIC is the major contributor to the cost increase in the TSM card as a result of providing information for the Correlated Muon trigger. Even so, this ASIC is considered to be fairly straightforward to build, not requiring unusually high density or speed or complex functionality.

Once the two 3-bit p_T threshold codes and 5-bit ϕ addresses are delivered from the sorting logic, they are transmitted to the CMLC card for correlation with the ϕ-wire hits from the Muon chambers.

4 Isolated Electron RMC Card

Figure 3 shows the revised Isolated Electron Region Match card (RMC card). This card is used to correlate candidate isolated electron hits from the Calorimeter with Shower Max hits and Tracker p_Ts from the corresponding region of the detector. The output is a series of histograms which catagorize the Isolated Electrons according to p_T and the degree of match/mismatch with the Tracker [4]. This card provides the Calorimeter Quiet flags for the .2η x .2ϕ regions for the Correlated Muon trigger from the internal calculations of the Isolated Electron trigger logic. The RMC operates on a .8η x. 8ϕ region of the detector, which is offset .1 in η and .1 in ϕ from the .8η x .8ϕ region covered by the Pattern Recogntion ASIC cards (PRA cards), described in [4]. This offset is equivalent to one trigger tower in both directions. The RMC receives 75 bits of isolated electron threshold 3-bit codes for 25 fully confined and edge/corner partial regions from 4 PRA cards. 45 of those bits represent 9 fully confined .2x.2 regions, 6 edge .1x.2 or .2x.1 regions, and a single .1x.1 corner region from from a single PRA card. 12 bits each from two other PRA cards represent three .1x.2 or .2x.1 edge regions and one .1x.1 corner region, which will be combined with corresponding edge or corner regions from the first PRA card to a single threshold code for each composite .2x.2 region. The last PRA card contributes 3 bits for a single .1x.1 corner region, and forms a composite .2x.2 region with the corner regions from the other 3 PRA cards. For a further description of the Isolated Electron partial regions, see [3].

The threshold code for any region indicates the p_T of an isolated electron that was detected in that region. A threshold code of 0 indicates that the region was completely quiet. For Muon correlation, the production of the .2η x .2ϕ Quiet flags from the region threshold codes is straightforward:

- For .2η x .2ϕ regions which are fully confined, the Quiet flag is active if the threshold code for that region has a value of zero. The flag is produced as the logical NOR of the three threshold code bits.

- For $.2\eta$ x $.2\phi$ regions which are a composite of smaller edge or corner regions, the flag is active if *all* of the individual threshold codes for each partial region have a value of zero. The flag in this case is produced as the logical NOR of the 6 (for edge) and 12 (for corner) threshold code bits of the partial regions.

These flags are delivered through a frontpanel connector to 2 CMLC cards, each of which would cover the full $.8\eta$ range of the RMC card by $.4\phi$. See section 5.1 on the CMLC card.

The production of the Quiet flags on the RMC card for Muon correlation is considered to have a minimal impact on the cost and complexity of the RMC card, since these flags have to be internally generated in the Isolated Electron logic anyway.

5 Correlated Muon Trigger Crate

Figure 4 shows the Correlated Muon Trigger crate. There are 8 of these crates: 4 for the barrel and 4 for the intermediate regions of the detector. Each barrel crate covers 1.6η x 3.2ϕ. A crate contains 8 CMLC cards, each of which handles a 1.6η x $.4\phi$ region. The CMLC cards receive the trigger primitives from the Muon system front end via fiber optic cables. The primitives are correlated with p_T/ϕ hits from the Tracker and Quiet flags from the Calorimeter, to produce up to 4 Muon hits per card, coming as up to two hits each from the two $.2\phi$ slices covered by the CMLC. The hits are assigned to one of the four histograms defined above in Section 2, and to one of the four p_T bins within the histogram. With up to 4 hits counted per card, and 8 CMLC cards per crate, each crate can count as many as 32 Muons, organizing them into 16 Histogram bins, with as many as 7 Muons in a single bin.

Each crate also contains 4 revised HSC cards, each of which sums the four bins of one of the histograms, as well as a Level 1 Clock/Control Board (L1CCB), a Level 2 Interface card, and a DAQ Interface/Processor card.

5.1 CMLC Card

Figure 5 shows the Correlated Muon Logic card. It operates on a 1.6η x $.4\phi$ region in the barrel region of the detector. 4 optical fibers using the ϕ-hit cable format and 2 fibers using the p_T/η format are connected at the front panel. With the coverage described in Section 2, these fibers transmit the raw ϕ-hits, with $.00625\phi$ resolution, and the top 2 p_T hits and associated η, with $.2\eta$ resolution, for the $.2\phi$ region. This raw data from the Muon system is buffered for subsequent readout by the Level 2 Trigger system.

The cards also receive p_T/ϕ hits for the two corresponding 1.6η x $.2\phi$ regions from two TSM cards. Each TSM card sends the top two p_T threshold code values, and their associated ϕ address, with .00625 ϕ resolution. Each tracker hit occupies 8 bits, for a total of 32 bits input to the CMLC through the frontpanel on two 16-bit cables.

Finally, from the RMC cards come the Calorimeter Quiet Flags for each $.2\eta$ x $.2\phi$ region covered by the CMLC. These flags come from two RMC cards, each of which covers the full

range of ϕ by up to .8 η. Each RMC card sends 8 flags for a .8η x .4ϕ region, for a total of 16 bits input to the CMLC through the frontpanel on two 8-bit cables.

The output of the CMLC is summary of Muon hits received by the card, orgainized into the four histograms described in the *General Overview* section. Each histogram consists of four 3-bit bins, each for a different p_T threshold. The total histogram output of the card is 48 bits wide.

When the data from the TSM and RMC cards is received on the CMLC, it is first buffered in a set of delay FIFOs. This delay is necessary to align the data from the other two cards with the data from the Muon front end system to the same crossing. The data streams must be aligned to the same crossing for proper correlation. As shown on Figure 5, and from [7], the necessary delay has been estimated to be 84 cycles for the TSM card data, and 79 cycles for the RMC card data. These are estimates only, for use in setting the range for the design. It is anticipated that the actual design will possess a programmable FIFO delay capability of 0 to 128 cycles, which should be adequate to cover all contingencies.

Correlation of the Muon front end, the TSM card, and the RMC card data occurs simultaneously and independently on the two 1.6η x .2ϕ regions covered by the card. This correlation consists of three phases: a preparatory phase, a correlating MLU phase, and a hit decoding phase.

In the preparatory phase, a limited correlation of the subsystems is performed, to condition the data for input to the full correlating MLU. The preparatory phase consists of three independent, simultaneous operations. The first of these is to convert each of the two Muon p_T hit values to a 3-bit threshold code, which is on a scale compatible to that used for the Tracker threshold codes. The second operation is to filter the Tracker p_T/ϕ hits against the hits in the Muon ϕ-wires to verify that tracker p_T hit corresponds to a Muon. This is accomplished with 32-input multiplexers, which select the Muon .00625 ϕ hit flag corresponding to the ϕ address of each tracker hit. If the selected Muon hit flag is active, then there is a match with the Tracker in ϕ, and the Tracker p_T for the hit is propagated to the next phase. If there is not a match, then the Tracker p_T is zeroed out, indicating no hit. The third operation is to examine the Calorimeter Quiet flag for the .2η x .2ϕ region corresponding to the Muon p_T hit. Again, a multiplexer is used to select the Quiet flag using the η address associated with the Muon p_T hit as a select. This selected Quiet flag is passed to the next phase.

In the correlating MLU phase, the two ϕ-filtered 3-bit Tracker p_T threshold codes, the two Muon 3-bit p_T threshold codes, and the associated Quiet flags, all for the 1.6η x .2ϕ region, are applied as inputs (14 bits total) to a 16K x 12-bit correlating MLU. Within this MLU, the threshold codes for the two potential tracker hits are cross-correlated with the codes and associated Quiet flags for the two potential Muon hits to determine the histogram and bin assignments for each of the up to two correlated hits.

In the hit decoding phase, the Muon hits from the MLUs are decoded to a hit flag which corresponds to one of the 16 histogram bins.

The hit flags for the entire 1.6η x .4ϕ region covered by the card are then summed into 3-bit histogram bins. These bins, a total of 48 bits in all, are delivered through the frontpanel to a HSC card, which continues the histogram summation.

5.2 Revised HSC Card

Figure 6 shows the Hit Summary Card (HSC card), revised from that described in [2] and [4]. Originally, the HSC was a double-width card that summed a total of 18 independent 3-bit histogram bins, from 4 input sources. In the original architecture, the card was intended to sum the 18 bins total from the three different Isolated Electron histograms. The new architecture employs a module that has been modified to be a single-width card, which sums 6 independent 3-bit histogram bins, from *8* input sources.

4 HSCs are used in each Correlated Muon Trigger crate, and in the Muon trigger section of the Final Decision crate, with one card assigned to each of the 4 histograms. On each card, only 4 of the 6 available bin summation trees are used, as each Muon Histogram has only 4 bins.

Although the original HSC architecture was potientially usable by the Correlated Muon Trigger system, the enhancement of the new HSC on the number of inputs to the bin adder trees from 4 to 8 has the effect of reducing the number of layers of HSCs used in the entire Muon histogram summation tree from 3 HSCs to 2. This change saves approximately 10 cycles of latency in a critical path of the Level 1 Pipeline [7].

The HSC is also used for the summation of Isolated Electron histograms, in both the Isolated Electron Match crates and Final Decision crates, as described in [4]. The Isolated Electron trigger uses 3 histograms, with 6 bins each. In this application, 3 HSCs are used in the above-mentioned crates, with one HSC assigned to each of the 3 histograms, and all 6 bin summation trees on each card used to sum the 6 bins of each histogram.

6 Final Decision Crate

Figure 7 shows the Final Decision crate, revised from [4]. This figure shows the individual HSCs as they are allocated for the final level of summation for the Isolated Electron and Muon histograms. Each HSC is assigned to a single histogram, with the Isolated Electron histograms being 6 bins each, and the Muon histograms being 4. The total capacity for the HSC is 6 bins.

This design varies from the Final Decision crate design described in [4] only in the the allocation of the HSCs, and in the number of histogram bins which will be transmitted to the FDM card from the Muon trigger. The previous design featured 4 uncorrelated 3-bit Muon p_T bins, for a total of 12 bits. The present design features 16 correlated 3-bit bins, for a total of 48 bits. The increase puts the Muon trigger data volume on a scale similiar to the 18 3-bit bins delivered to the FDM card by the Isolated Electron trigger. Given that the FDM and FDL card designs are still in the early conceptual stages, this is not considered to be a major impact.

References

[1] A. Lankford *et al.*, *Conceptual Design of the SDC Trigger from the SDC Trigger Group*, SDC Note SDC-91-00098, 1991.

[2] W. H. Smith, T. Gorski, J. Lackey, *SDC Trigger Preliminary Conceptual Design*, U. Wisconsin SDC Note SDC-91-00089, 1991.

[3] T. Gorski, J. Lackey, W.H. Smith, W. Temple, *Isolated Electron Pattern Logic Design and Performance at the SSC*, U. Wisconsin SDC Note SDC-91-00087, 1991.

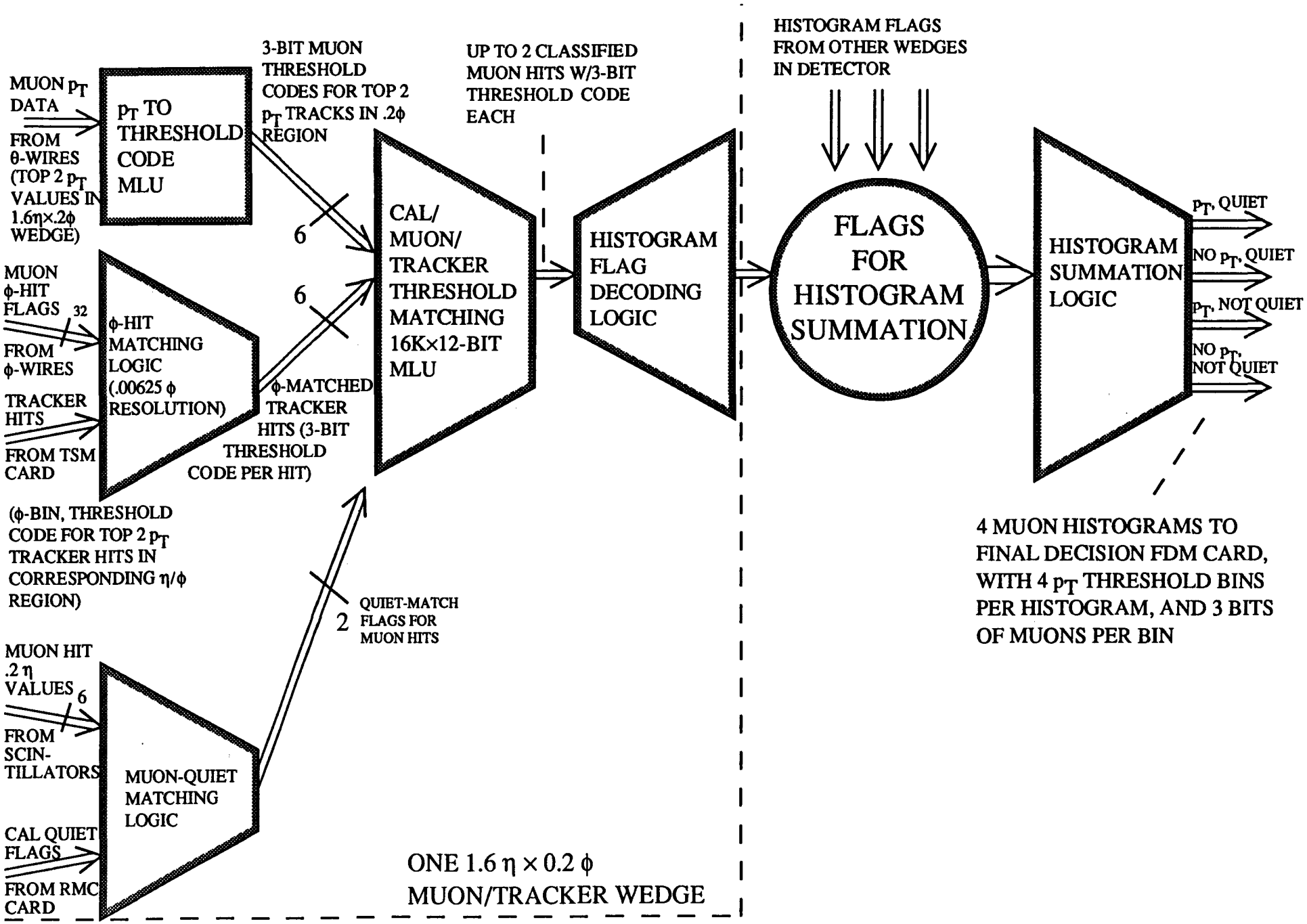
[4] T. Gorski, J. Lackey, W.H. Smith, *Level 1 Trigger Decision Design for the SDC*, SDC Note SDC-91-00088, 1991.

[5] W.H. Smith, T. Gorski, J. Lackey, *SDC Global Level 1 Processor: Clock and Control*, SDC note SDC-91-00090, 1991.

[6] M. Thompson, *Fiber Optic Data Transmission for the SDC Detector*, U. Wisconsin SDC Note SDC-91-00092, 1991.

[7] T. Gorski, J. Lackey, W.H. Smith, *The First Four Microseconds: SDC Level 1 Pipeline Length*, SDC note SDC-91-00139, 1991.

[8] J. Chapman, R. Thun, *SDC Muon Trigger Preliminary Conceptual Design*, University of Michigan, 1991.



CORRELATED MUON TRIGGER BLOCK DIAGRAM

Figure 1

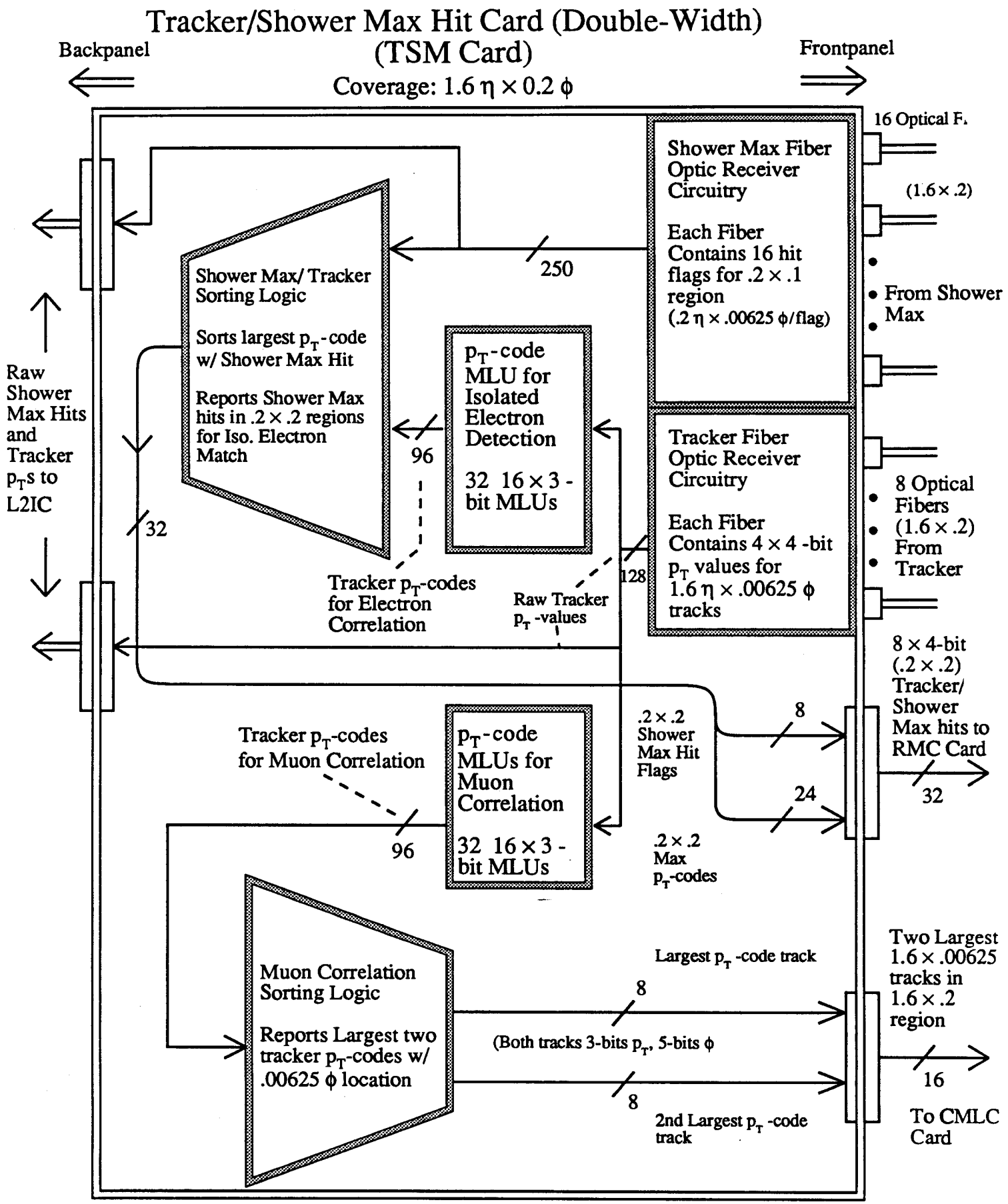

Tracker/Shower Max Hit Card (Double-Width)
(TSM Card)
Coverage: 1.6 η × 0.2 φ
Backpanel
Frontpanel
16 Optical F.
(1.6 × .2)
Shower Max Fiber Optic Receiver Circuitry
Each Fiber Contains 16 hit flags for .2 × .1 region (.2 η × .00625 φ/flag)
250
Shower Max/ Tracker Sorting Logic
Sorts largest p_T-code w/ Shower Max Hit
Reports Shower Max hits in .2 × .2 regions for Iso. Electron Match
p_T-code MLU for Isolated Electron Detection
32 16 × 3 -bit MLUs
96
From Shower Max
Raw Shower Max Hits and Tracker p_Ts to L2IC
32
Tracker Fiber Optic Receiver Circuitry
Each Fiber Contains 4 × 4 -bit p_T values for 1.6 η × .00625 φ tracks
128
8 Optical Fibers (1.6 × .2) From Tracker
Tracker p_T-codes for Electron Correlation
Raw Tracker p_T -values
8 × 4-bit (.2 × .2) Tracker/ Shower Max hits to RMC Card
8
24
32
Tracker p_T-codes for Muon Correlation
p_T-code MLUs for Muon Correlation
32 16 × 3 -bit MLUs
96
.2 × .2 Shower Max Hit Flags
.2 × .2 Max p_T-codes
Muon Correlation Sorting Logic
Reports Largest two tracker p_T-codes w/ .00625 φ location
Largest p_T -code track
8
(Both tracks 3-bits p_T, 5-bits φ
8
2nd Largest p_T -code track
Two Largest 1.6 × .00625 tracks in 1.6 × .2 region
16
To CMLC Card

Figure 2

p_T -Threshold Code Sorting Node

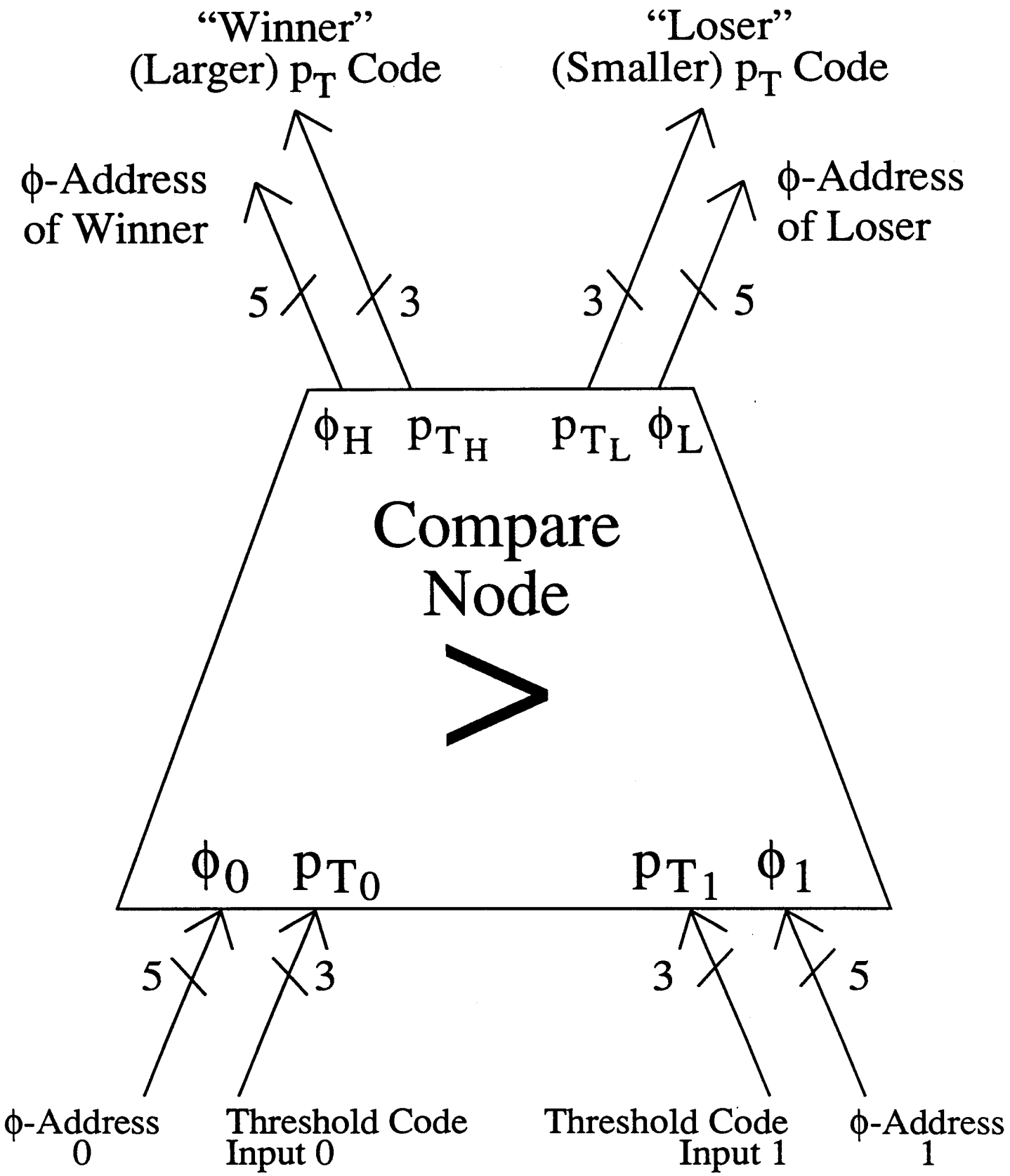
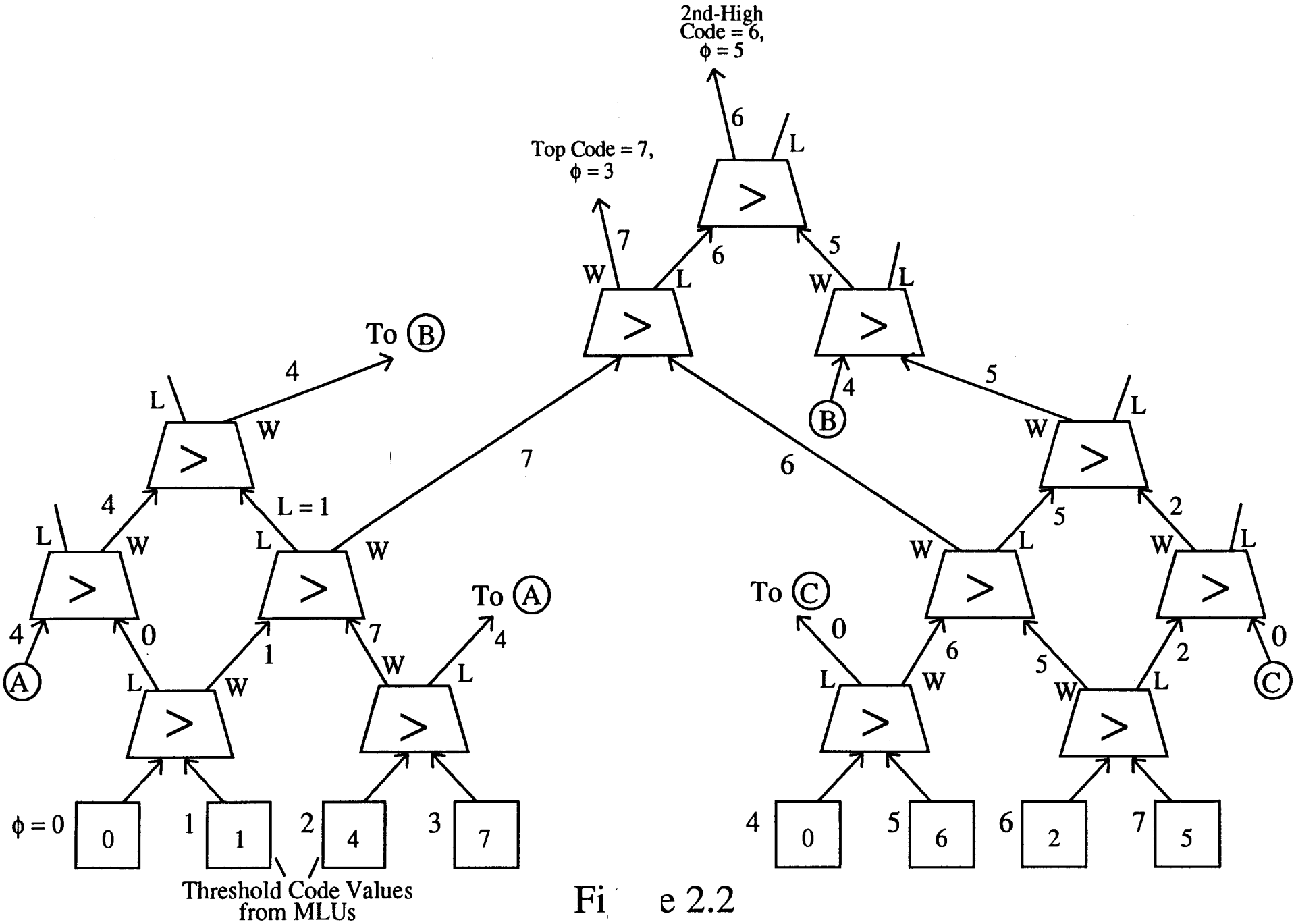


Figure 2.1

Tracker p_T -Threshold Sorting Tree

Double-Elimination Tournament Example Using 8 Input p_T -Threshold Codes



Fi e 2.2

.2 × .2 Region Match Card (RMC Card)

BACKPLANE ⟸ Coverage: 0.8 η × 0.8 ϕ ⟹ FRONTPANEL

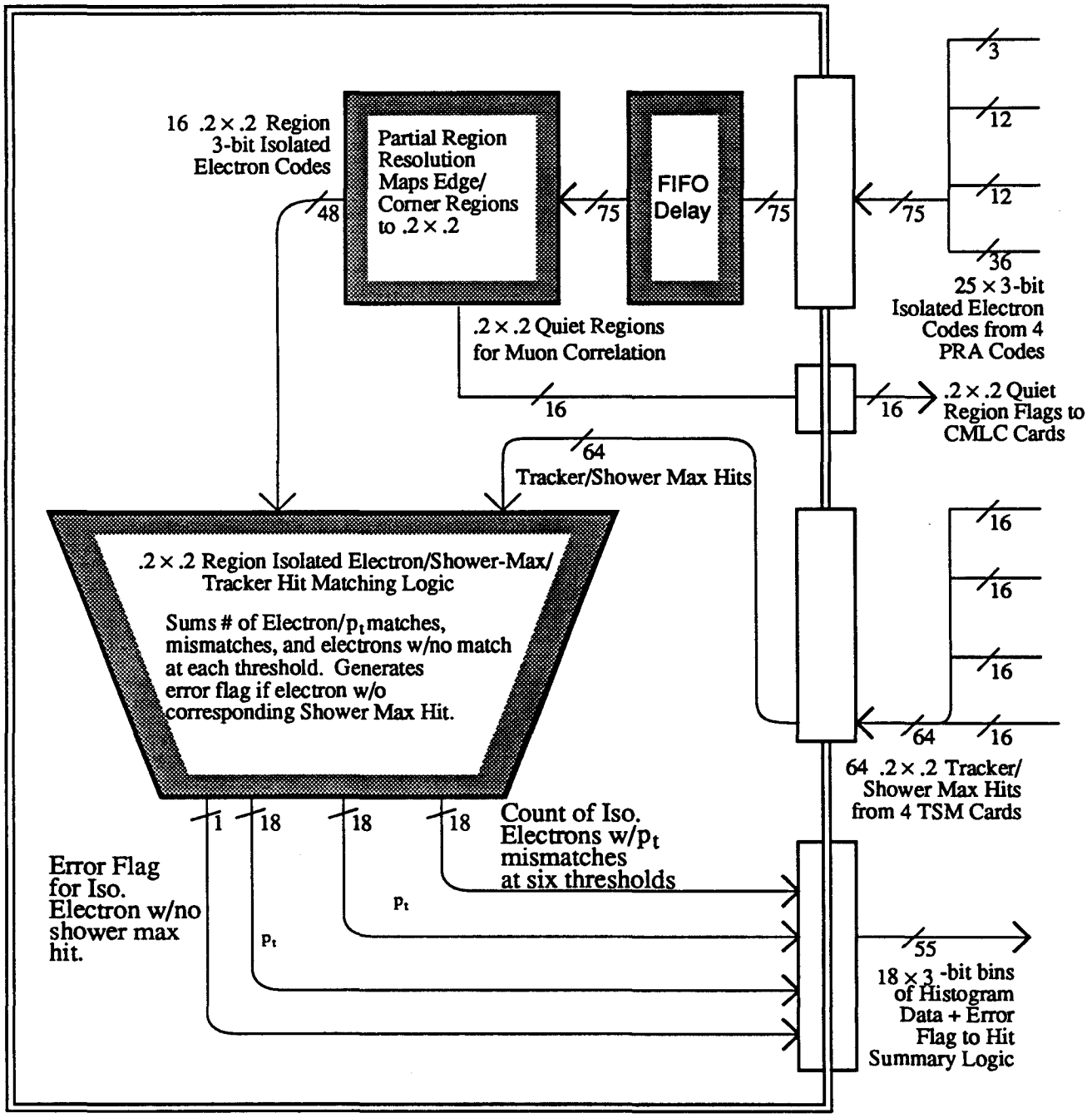


Figure 3

Correlated Muon Trigger Crates

Number of Crates: 4 Barrel, 4 Intermediate

Coverage: $1.6\ \eta \times 3.2\ \phi$

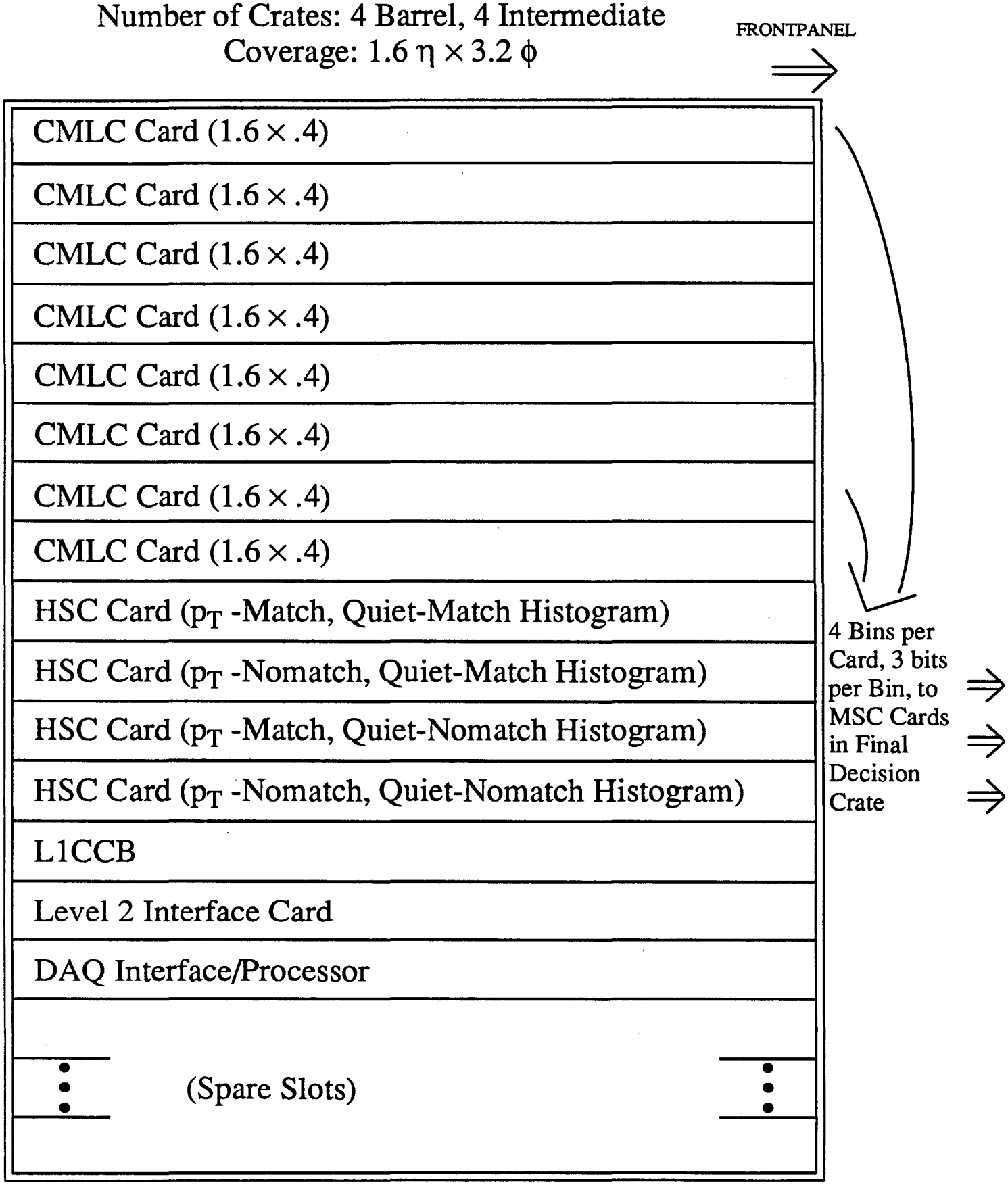


Figure 4

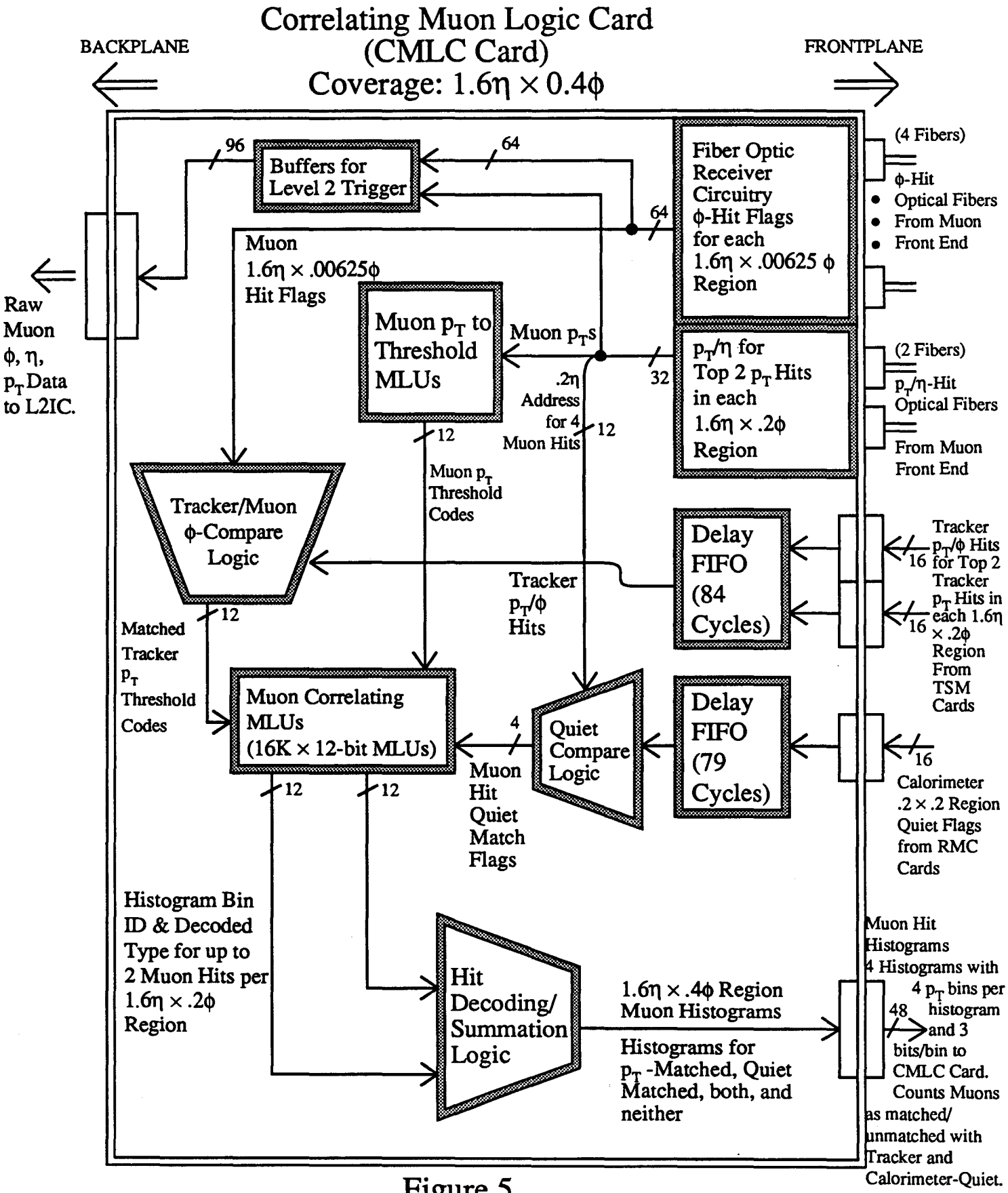

Correlating Muon Logic Card
(CMLC Card)
Coverage: 1.6η × 0.4ϕ
BACKPLANE
FRONTPLANE
Raw Muon ϕ, η, p_T Data to L2IC.
96
Buffers for Level 2 Trigger
64
64
Fiber Optic Receiver Circuitry ϕ-Hit Flags for each 1.6η × .00625 ϕ Region
(4 Fibers)
ϕ-Hit Optical Fibers From Muon Front End
Muon 1.6η × .00625ϕ Hit Flags
Muon p_T to Threshold MLUs
Muon p_Ts
32
p_T/η for Top 2 p_T Hits in each 1.6η × .2ϕ Region
(2 Fibers)
p_T/η-Hit Optical Fibers From Muon Front End
.2η Address for 4 Muon Hits
12
12
Muon p_T Threshold Codes
Tracker/Muon ϕ-Compare Logic
Delay FIFO (84 Cycles)
Tracker p_T/ϕ Hits
16
16
Tracker p_T/ϕ Hits for Top 2 Tracker p_T Hits in each 1.6η × .2ϕ Region From TSM Cards
12
Matched Tracker p_T Threshold Codes
Muon Correlating MLUs (16K × 12-bit MLUs)
4
Quiet Compare Logic
Delay FIFO (79 Cycles)
16
Calorimeter .2 × .2 Region Quiet Flags from RMC Cards
12
12
Muon Hit Quiet Match Flags
Histogram Bin ID & Decoded Type for up to 2 Muon Hits per 1.6η × .2ϕ Region
Hit Decoding/ Summation Logic
1.6η × .4ϕ Region Muon Histograms
Histograms for p_T -Matched, Quiet Matched, both, and neither
Muon Hit Histograms 4 Histograms with 4 p_T bins per histogram and 3 bits/bin to CMLC Card. Counts Muons as matched/ unmatched with Tracker and Calorimeter-Quiet.
48

Figure 5

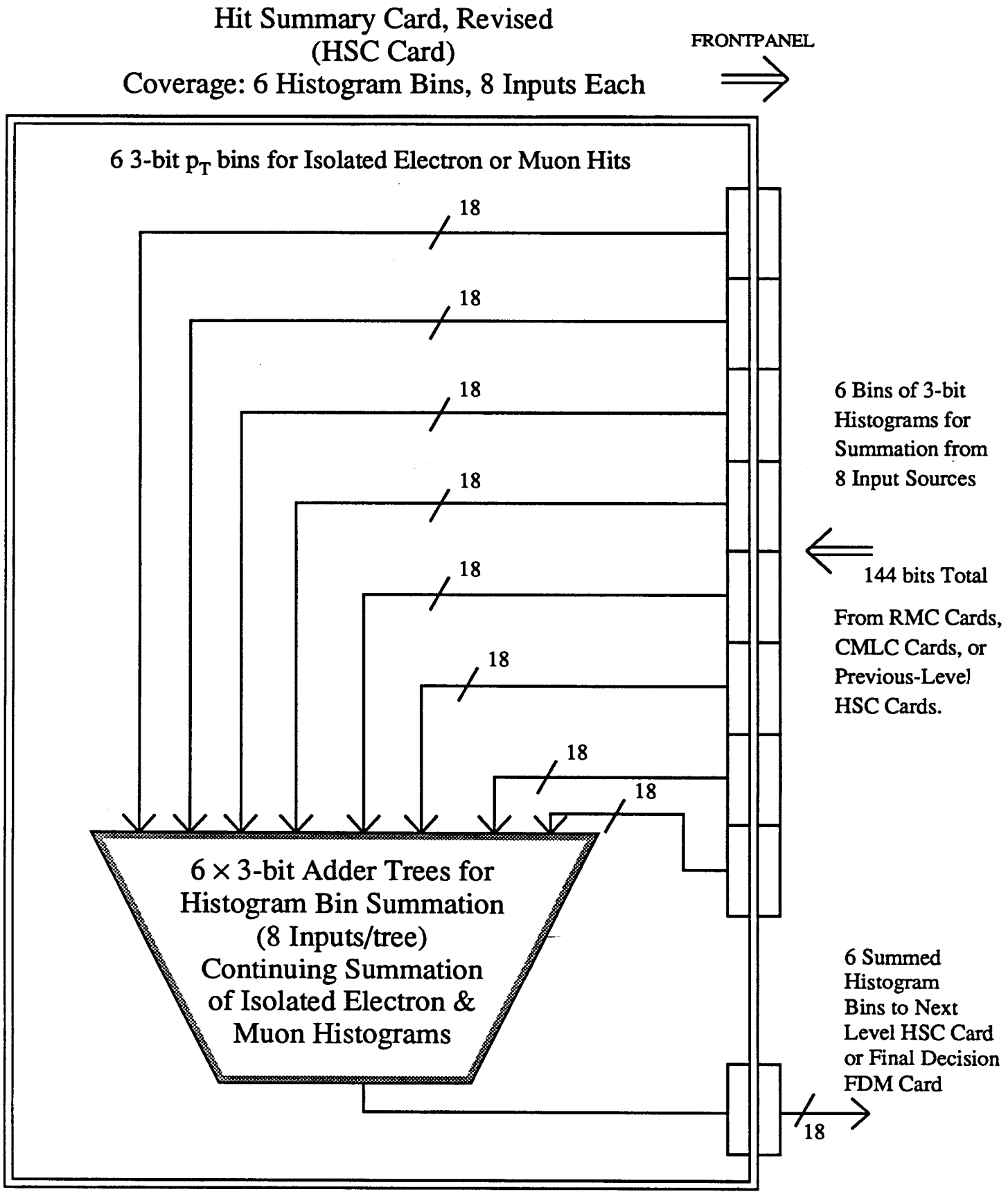

Hit Summary Card, Revised
(HSC Card)
Coverage: 6 Histogram Bins, 8 Inputs Each
FRONTPANEL
6 3-bit p_T bins for Isolated Electron or Muon Hits
18
18
18
18
18
18
18
18
6 Bins of 3-bit Histograms for Summation from 8 Input Sources
144 bits Total
From RMC Cards, CMLC Cards, or Previous-Level HSC Cards.
6 × 3-bit Adder Trees for Histogram Bin Summation (8 Inputs/tree) Continuing Summation of Isolated Electron & Muon Histograms
6 Summed Histogram Bins to Next Level HSC Card or Final Decision FDM Card
18

Figure 6

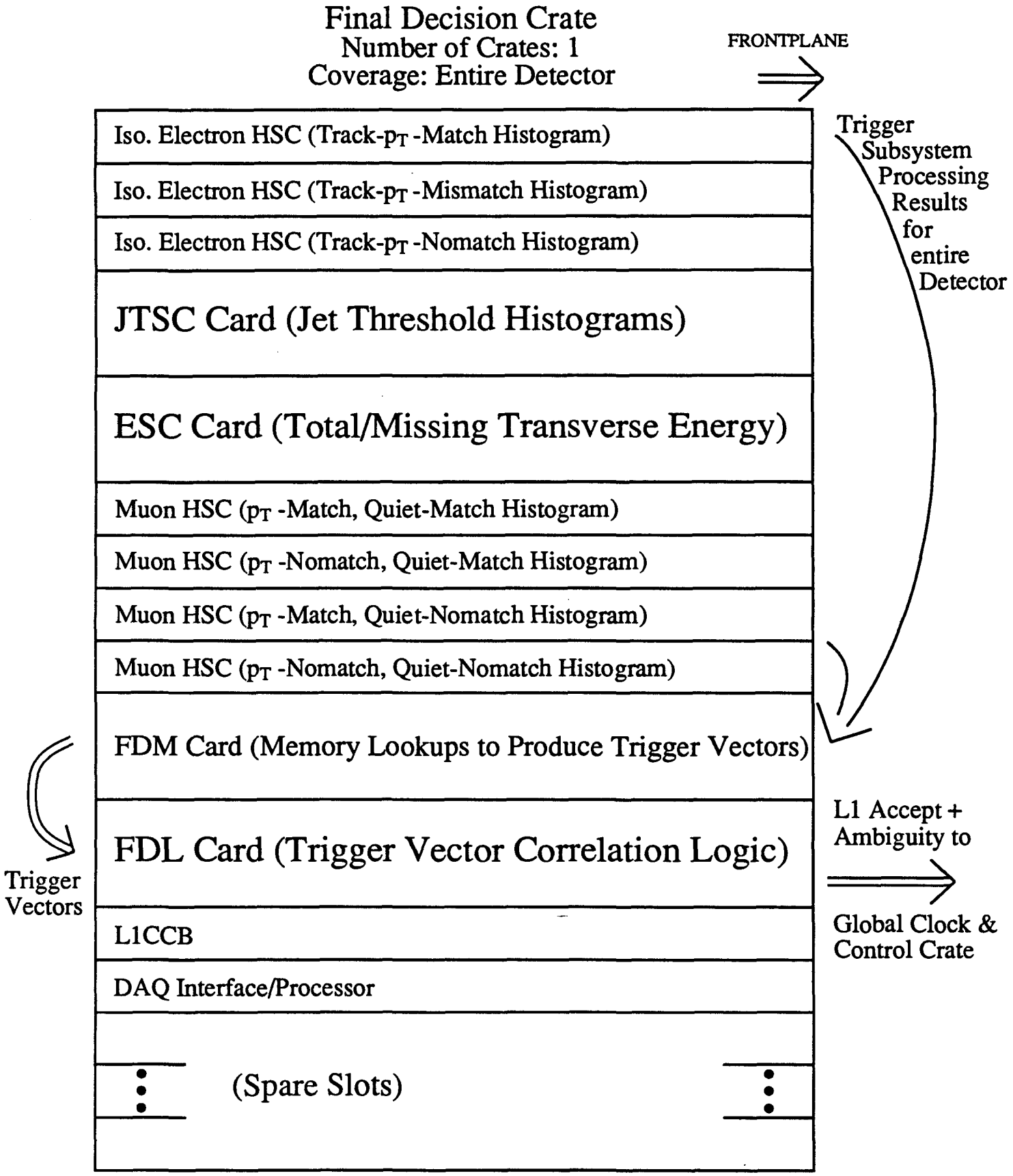

Final Decision Crate
Number of Crates: 1
Coverage: Entire Detector
FRONTPLANE
Iso. Electron HSC (Track-p_T -Match Histogram)
Iso. Electron HSC (Track-p_T -Mismatch Histogram)
Iso. Electron HSC (Track-p_T -Nomatch Histogram)
JTSC Card (Jet Threshold Histograms)
ESC Card (Total/Missing Transverse Energy)
Muon HSC (p_T -Match, Quiet-Match Histogram)
Muon HSC (p_T -Nomatch, Quiet-Match Histogram)
Muon HSC (p_T -Match, Quiet-Nomatch Histogram)
Muon HSC (p_T -Nomatch, Quiet-Nomatch Histogram)
FDM Card (Memory Lookups to Produce Trigger Vectors)
FDL Card (Trigger Vector Correlation Logic)
L1CCB
DAQ Interface/Processor
(Spare Slots)
Trigger Subsystem Processing Results for entire Detector
Trigger Vectors
L1 Accept + Ambiguity to
Global Clock & Control Crate

Figure 7