

The L2 CPS System (Axial & Stereo)

communication protocols
and
data encoding

Version 6.1

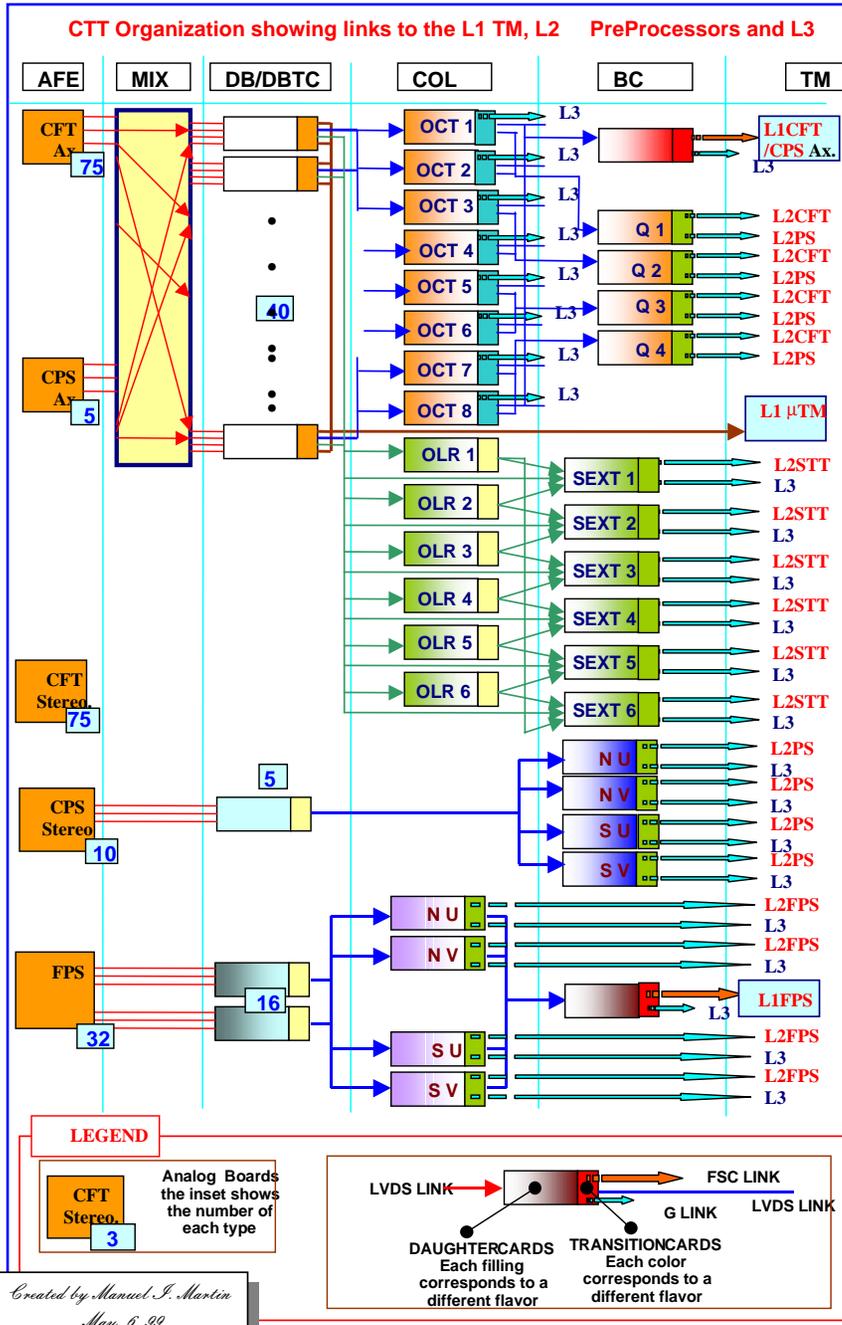
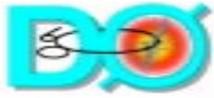
This document is written as a result of lengthy discussions with members of the DØ Collaboration and after the Seattle Workshop.

Please read it carefully and send comments/ suggestions to
J. Blazey, P. Grannis and M. Martin.

**The DØ Collaboration at the Seattle Workshop
adopted this final version !!**

July 7, 1999

Created by Manuel J. Martin



July 7, 1

Created by Manuel J. Martin
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Diagram of the CTT System.

For a better view go to Manuel's Web pages at

<http://D0server1.fnal.gov/users/manuel/protocols/diagram.doc>

GLOSSARY

AFE	Analog Front End Board
MIX	Mixing Box
DB	Digital Board
DBTC	DB Transition Card
COL	Collector Board
BC	BroadCaster Board
TM	Trigger Manager
OCT	COL serving an Octant
Qx	BC serving Quadrant x
OLR	COL serving the Overlapping Regions of the SI match
SEXT	BC covering a Sextant
N/Sx	board serving the North/South side
xU/V	Refers to the U V orientation of the PS strips



L2 CPS Axial and Stereo

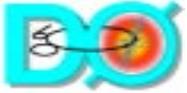
GENERAL

The CPS Axial Trigger is organized into Octants and Quadrants while the CPS Stereo is organized into North/South halves and U/V strip orientation.

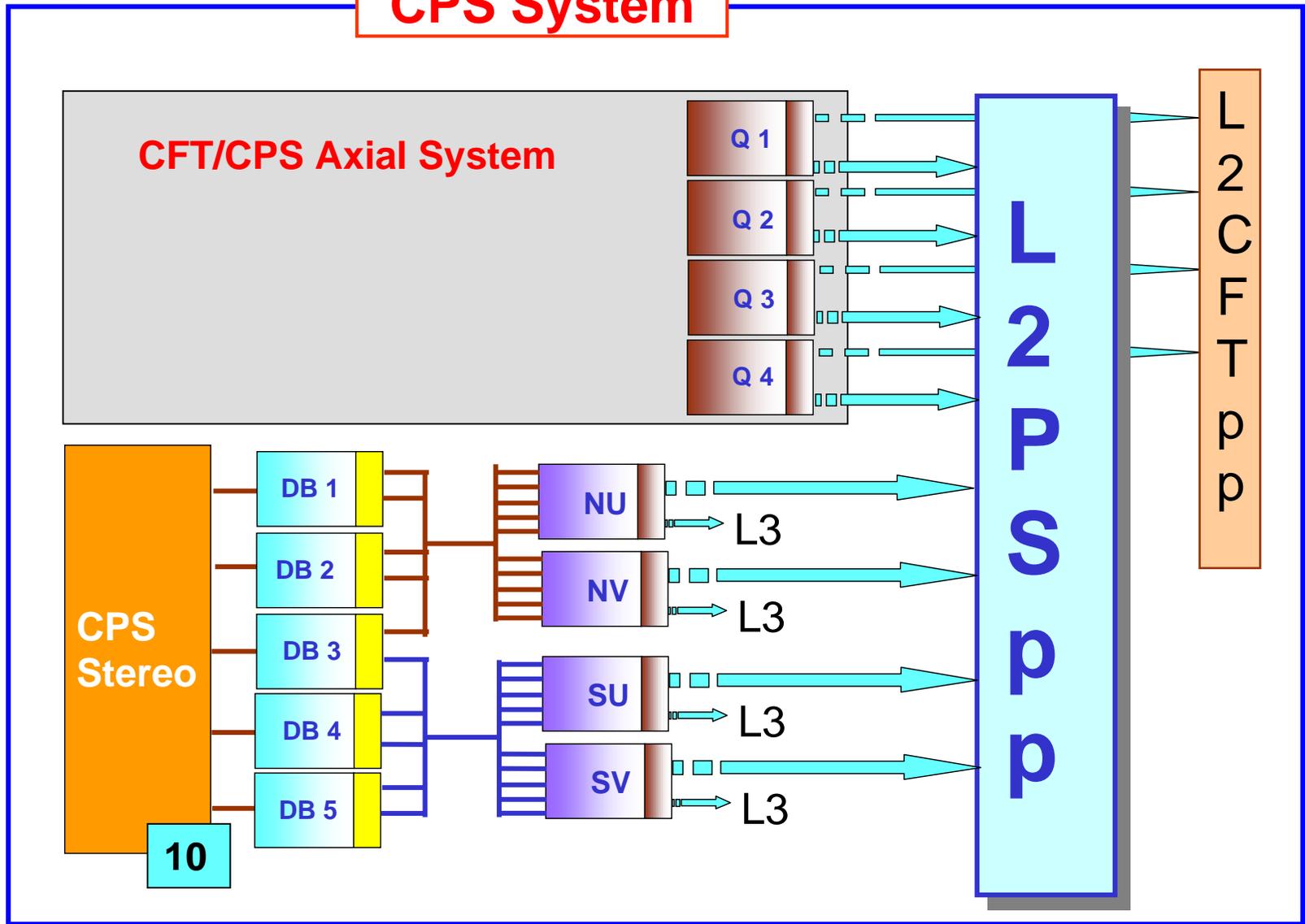
In the case of the CPS Axial, each Octant collects data from five Digital Front End boards (ten Front And Analog boards) via ten LVDS links. Each LVDS link carries L1 and L2 information from a 4.5° sector of the CFT and the CPS. The DFE boards send L1 information until it detects a L1 Accept. When the L1 accept is detected the DFE sends a record of L2CFT information followed by a record of L2CPS Axial information. The CPS Axial is part of the L1 and L2 Triggers.

In the case of the CPS Stereo, each Broadcaster board receives information from five Front End Analog boards with U and V data from the North or South half. The Stereo part of the CPS sends information to the L2 Trigger only.

NOTE.- The document titled “The CTT System” explains the organization of Broadcaster System for the L1 and L2 CPS Axial. This document shall repeat the L2 part of the CPS Axial and describes the L2 CPS Stereo .

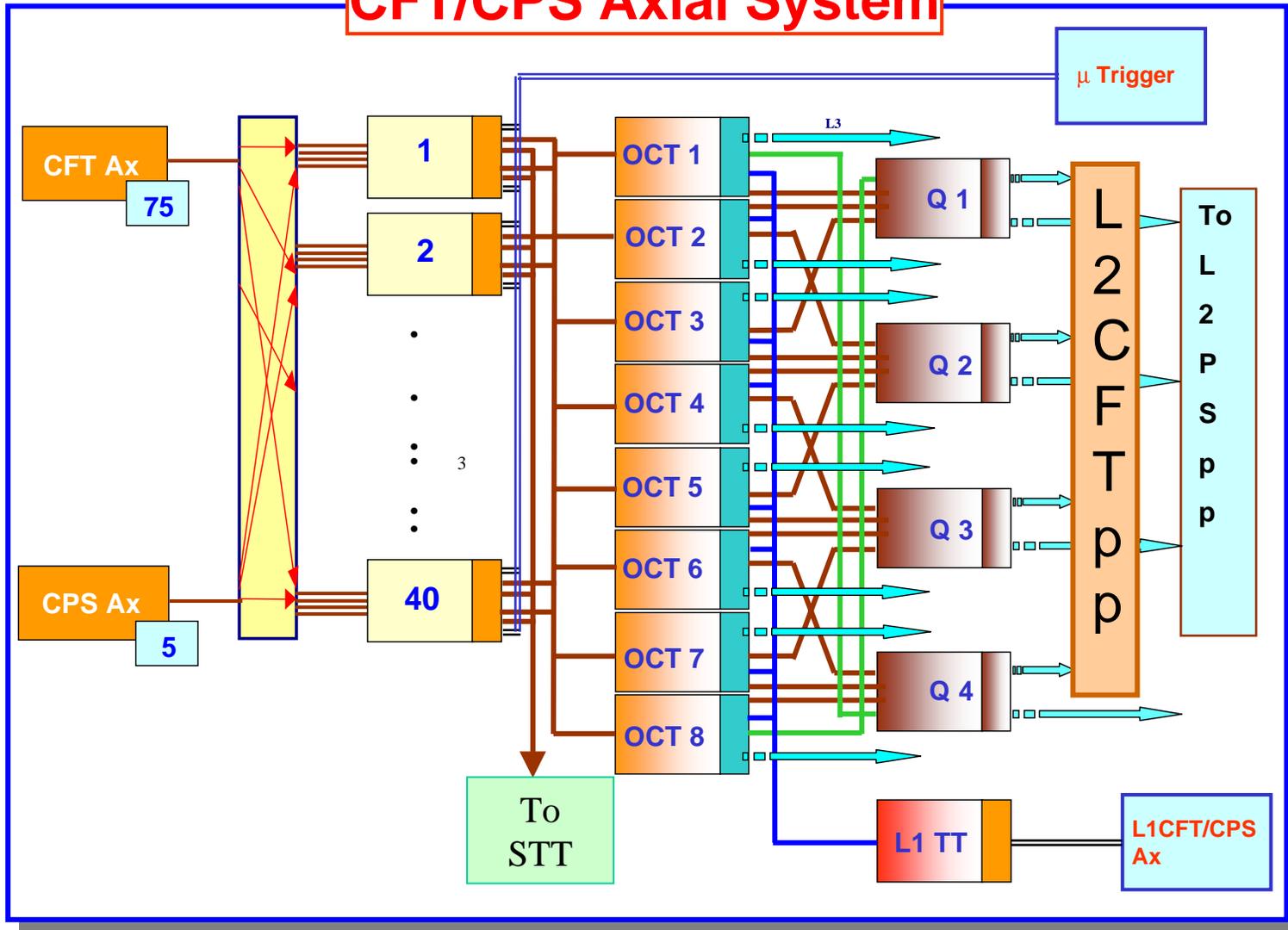


CPS System





CFT/CPS Axial System





L2 CPS Axial

FUNCTIONS PERFORMED BY THE BOARDS

DB Front End Digital Board

Collects hits on CFT and CPS Axial. Finds Tracks and Clusters. Associates Tracks with Clusters. Obtains number of Tracks found in each Pt Bin. Identify Isolated Tracks or Isolated electrons. Sends an ordered list of Tracks to the μ -Trigger for L1. Sends number of Tracks, isolated objects, total sum of Pt of all found Tracks and a Occupancy number to the Collector Boards for L1CFT/CPS Axial. When L1 Accept is received, sends two concatenated records of information to the Collector Boards: an ordered list by Pt Bin of Tracks with PS cluster association, an ordered list in Φ of Clusters with possible Track association. The Track list has a maximum of six Tracks per Pt Bin. If truncation is necessary, Tracks with lower Φ are selected. The Cluster list has a maximum of eight Clusters and no truncation is needed.

COL Collector Board

Each COL receives information from 5 DBs (one completed Octant). When L1 information is detected, adds the numbers of Tracks in each Pt Bin, review the list of isolated objects and modify it if necessary, calculates Occupancy for the Octant and calculates the sum of Pt for the Octant. Send this information to a single BC board for further manipulations. When L2 information is detected the COL acts on the Track lists and the Cluster lists before it sends the information to BCs.



FUNCTIONS PERFORMED BY THE BOARDS

(L2 CPS Axial Continuation)

COL Collector Board

CFT Tracks The COL merges the ten Track lists into a single list ordered by Pt including the extended Pt. This list reports a maximum of twenty four Tracks regardless of Pt Bin. If the total number of tracks exceeds twenty four, the list is truncated. Truncation follows two criteria: first the Tracks with higher Pt (including extended Pt) are selected, if further truncation is needed the Tracks with lower Φ are selected.

CPS Clusters The COL merges eight of the ten Clusters list into a single one and corrects it so the proper Cluster/Track association is reported. The maximum number of clusters reported within this list is twenty four. If truncation is required it is done by selecting Clusters according to the following priority: Clusters associated with high Pt Tracks over Clusters associated with low Pt Tracks, over Clusters without Track association, over Clusters with lower Φ .

BC BroadCaster Board

There are two types of Broadcaster boards: CFT/CPS Axial L1 (L1TT) and CFT Quadrants (Qx).

L1TT It receives L1 information from the eight Octants and generates a exhaustive list of up to 96 L1 AND/OR terms. This list is sent to the L1CFT/CPS Axial Trigger Manager via a FSC Link. The Trigger Manager will select a subset of forty eight to use in the L1 Trigger.



FUNCTIONS PERFORMED BY THE BOARDS

(L2 CPS Axial Continuation)

BC **BroadCaster Board**

Qx CFT Tracks Each Quadrant BC collects information from two adjacent Octants. The two Track list are merged and its contents reorder in order of Pt in a single list with no more than Forty six Tracks. The possibility exist of discarding up to two tracks from the original lists. When this is necessary, truncation is done as in the Octants. The resulting list is sent to the L2CFTpp and to the L2CPSpp via separated G Links.

Qx CPS Clusters Each Quadrant BC collects information from four adjacent Octants as follows:
the two Cluster lists generated in the two Octants that form the Quadrant
the four Cluster lists from the 4.5° sectors that are at the edges of the Octants
the eight Track list from the 4.5° sectors that are adjacent to the previously defined Cluster lists.

The four Cluster and eight Track are used to correct for possible γ/e mislabeling. Once these four cluster list are corrected they are merged with the two corrected Cluster list from the Octants into a single list with a maximum of forty six Clusters. Truncation, if required, is done as before. The resulting Cluster list is sent to the L2CPSpp via a G Link.



CPS Stereo

FUNCTIONS PERFORMED BY THE BOARDS

DB Front End Digital Board

There are ten DBs, five for the North and five for the South ends of the CPS Stereo Tracker. Each DB generates a list of Clusters tagged with information pertaining to the threshold level of the Cluster, its orientation (U/V), its length and its geographical position defined as N/S and index of the first PS strip of the Cluster. The information collected is sent to two BC when a L1 Accept is received.

BC BroadCaster Board

Each BC receives information from the five DB and merges and reorganizes the information in a single list. The four list generated by the four BC boards are organized as follows:

NU List contains up to 46 Clusters with **U** orientation from the **N**orth half of the CPS

SU List contains up to 46 Clusters with **U** orientation from the **S**outh half of the CPS

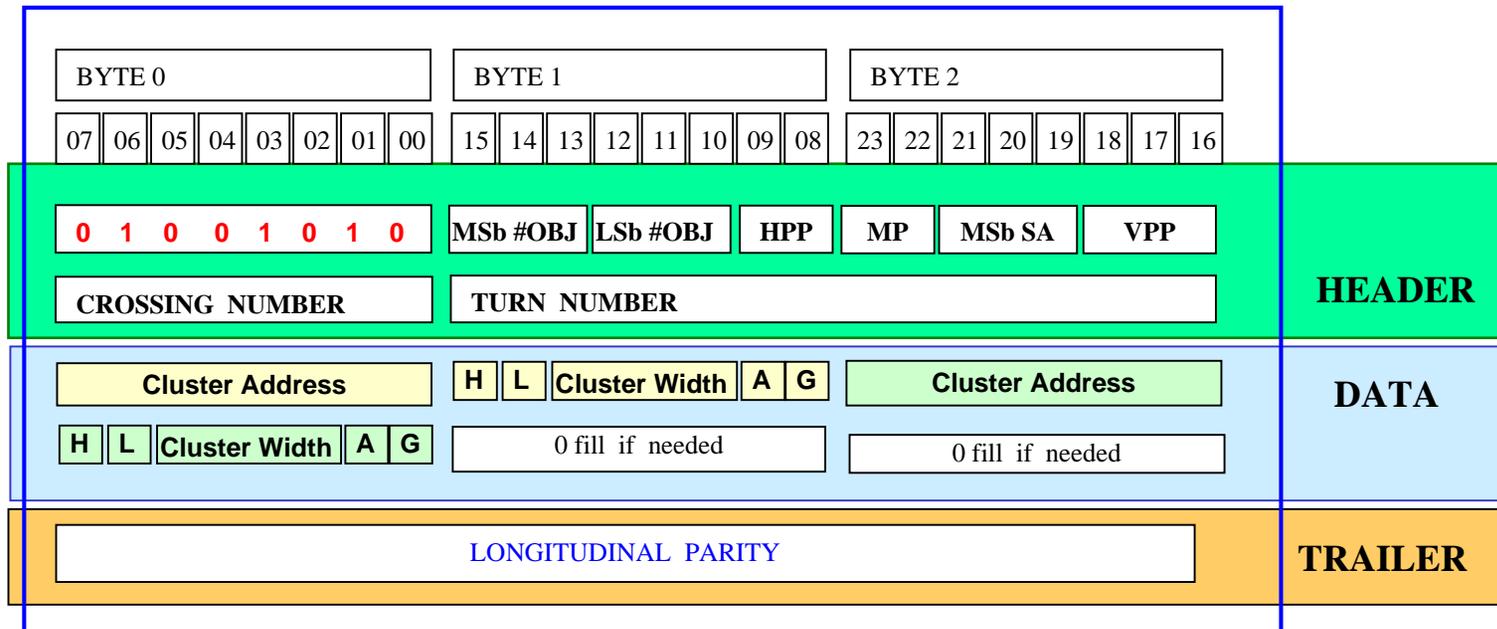
NV List contains up to 46 Clusters with **V** orientation from the **N**orth half of the CPS

SV List contains up to 46 Clusters with **V** orientation from the **S**outh half of the CPS

The lists are sent to the L2PSpp via four G Links.



**Bit Fields allocation for L2 CPS Stereo data transfers
between the Digital Front End boards and the Broadcaster Boards
using LVDS Links**



NOTES The Maximum number of Clusters reported per Digital Front End board is 16.
The Cluster List is ordered in increasing stereo strip index.
To decrease the time required to transfer the information, two frames can carry the information of three clusters.



Meaning of Terms used

Each reported Cluster carries the following information

G	Set to 1 if North, set to 0 if South
A	Information about the orientation (U/V) of the strips
Cluster Address	The relative Address of the first element of the Cluster (Offset)
Cluster Width	The number of elements in the Cluster
H	If set, the Cluster is a High Threshold PS Cluster
L	If set, the Cluster is a Low Threshold PS Cluster



Bit Fields allocation for L2 CPS STEREO data transfers of list of Clusters between the DFE boards and the BC boards using LVDS Links

Frame 1

Bits		
[0:7]	Data type	{01010010} = L2CPS STEREO
[8:9]	Horizontal Parity of the 2x3 matrix giving the # of Objects	
[10:12]	Less Significant bits of the # of Objects (first Row of the matrix address)	
[13:15]	Most Significant bits of the # of Objects (first Row of the matrix address)	
[16:18]	Vertical Parity of the 2x3 matrix giving the # of Objects	
[19:21]	Most Significant bits of the 4.5° Sector = Relative Address of the Octant	
[12:23]	Pass and Mark {00}	Normal Data, Normal Event
		{01} Normal Data, Pass Event (unbiased data)
		{10} Debug Data Type "a"
		{11} Debug Data Type "b"
[24]	Transverse Parity (Parity of [0:23])	
[25:27]	Control {111}	This is the first frame

Frame 2

[28:35]	Crossing Number	
[36:51]	Turn Number	
[52]	Transverse Parity (Parity of [0:23])	
[53:55]	Control {000}	This is not the first frame



Bit Fields allocation for L2 CPS STEREO data transfers of list of Clusters between the DFE boards and the BC boards using LVDS Links

If there is at least one PS Cluster to report

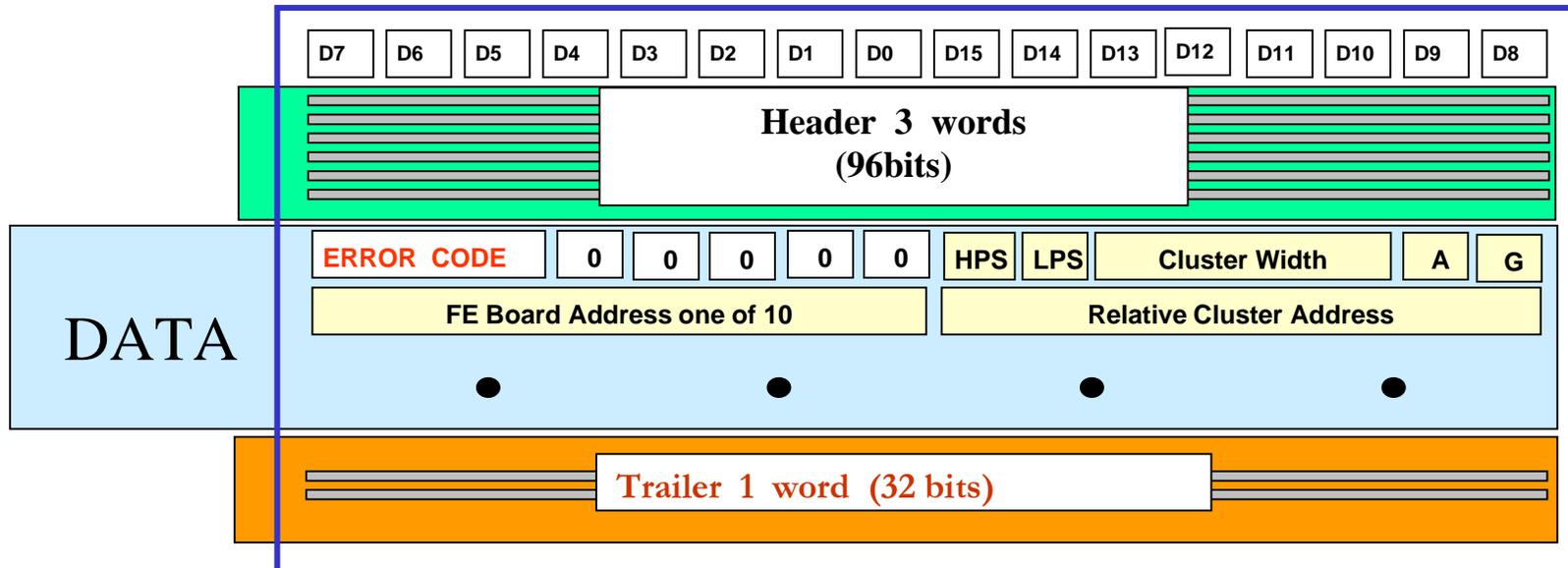
The example contains two Clusters

Frame 3

Bits		
[56:53]	Relative Cluster Address	
[64]	Set to 1 if the PS Cluster is in the North end	
[65]	U/V information set to 1 if U	
[66:69]	Width of the Cluster	Cluster 1
[70]	The Cluster is a Low PS Cluster	
[71]	The Cluster is a High PS Cluster	
[72:79]	Relative Cluster Address	
[[80]	Transverse Parity (Parity of [56:79])	
[81:83]	Control {000} This is not the first frame	
[84]	Set to 1 if the PS Cluster is in the North end	Cluster 2
[85]	U/V information set to 1 if U	
[86:89]	Width of the Cluster	
[90]	The Cluster is a Low PS Cluster	
[91]	The Cluster is a High PS Cluster	
[92:107]	Filler {0000000000000000}	
[[80]	Transverse Parity (Parity of [56:79])	
[81:83]	Control {000} This is not the first frame	



Bit Fields allocation for L2 CPS Stereo data transfers between the Broadcaster Boards and the L2 Pre Processors (via FIC) using G Links



List of Clusters with tagging and address $n \times 32$ bits for a maximum of 46 Clusters
If truncation of data is necessary the reporting is done moving counter clock wise, this will result in a possible bias of the efficiency.



Meaning of Terms used

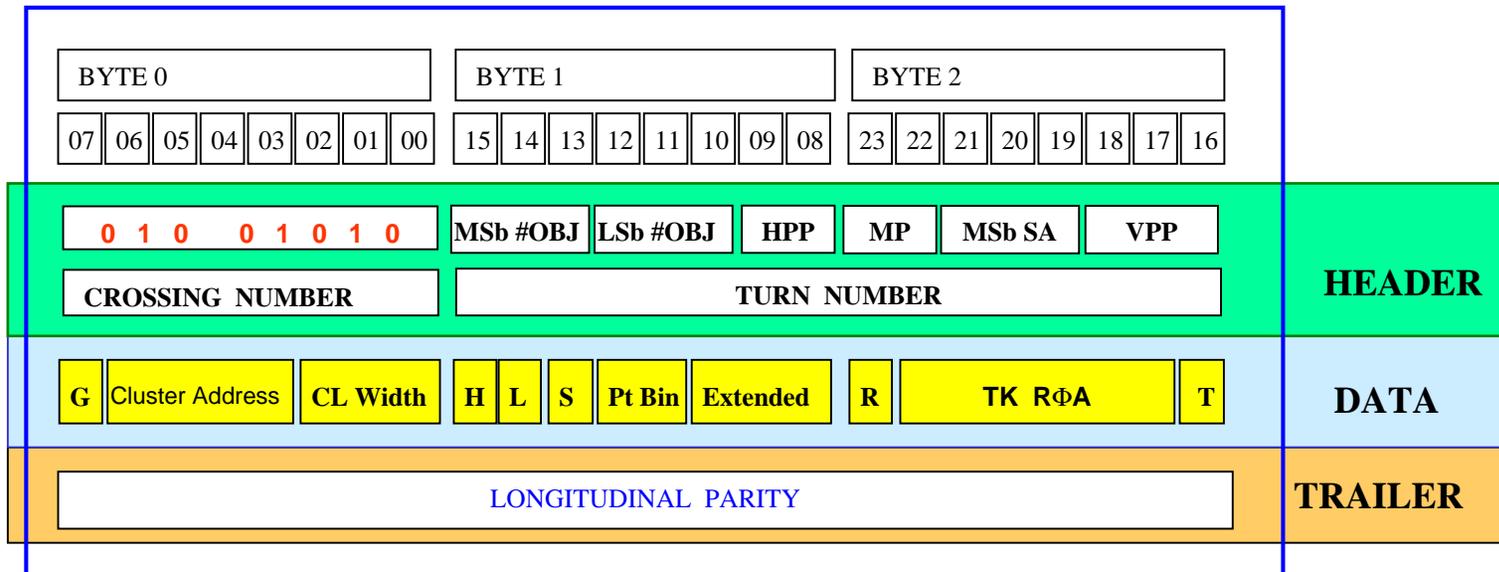
In this case the Header has three Frames.

Each reported Cluster carries the following information

Error Code	A three bit code reporting possible errors (same as before)
H P S	If set the Cluster is a High Threshold PS Cluster
L P S	If set the Cluster is a Low Threshold PS Cluster
Cluster Width	The number of elements in the Cluster
A	Orientation of the Cluster. Set to 1 for U, set to 0 for V
G	Set to 1 if North, set to 0 if South
FE Board Address one of 10	The address of the Analog Front End Board
Relative Cluster Address	The relative Address of the first element of the Cluster



**Bit Fields allocation for L2 CPS Axial data transfers between
the Digital Front End boards
and the Collector Boards (Octants) using LVDS Links**



NOTES The Maximum number of Clusters reported per 4.5° Wedge is 8



Meaning of Terms used

Each reported Cluster carries the following information

G	Set to 1 if North, set to 0 if South
Cluster Address	The relative Address of the first element of the Cluster (Offset)
Cluster Width	The number of elements in the Cluster
H	If set, the Cluster is a High Threshold PS Cluster
L	If set, the Cluster is a Low Threshold PS Cluster
S	Sign of the Pt of the associated Track
Pt	The Pt Bin of the associated Track
Extended	The Extended Pt Value of the associated Track
R	Set to 1 if the associated track belongs to an adjacent sector
TK RΦA	The Address of the 4.50 wedge were Clusters are native within an Octant
T	Set to 1 if there is a valid Track



Bit Fields allocation for L2 CPS AXIAL data transfers of list of Clusters between the DFE boards and the COL (Octants) boards using LVDS Links

Frame 1

Bits		
[0:7]	Data type	{01001010} = L2CPS AXIAL
[8:9]	Horizontal Parity of the 2x3 matrix giving the # of Objects	
[10:12]	Less Significant bits of the # of Objects (first Row of the matrix address)	
[13:15]	Most Significant bits of the # of Objects (first Row of the matrix address)	
[16:18]	Vertical Parity of the 2x3 matrix giving the # of Objects	
[19:21]	Most Significant bits of the 4.5° Sector = Relative Address of the Octant	
[12:23]	Pass and Mark {00}	Normal Data, Normal Event
		{01} Normal Data, Pass Event (unbiased data)
		{10} Debug Data Type "a"
		{11} Debug Data Type "b"
[24]	Transverse Parity (Parity of [0:23])	
[25:27]	Control {111}	This is the first frame

Frame 2

[28:35]	Crossing Number	
[36:51]	Turn Number	
[52]	Transverse Parity (Parity of [0:23])	
[53:55]	Control {000}	This is not the first frame



Bit Fields allocation for L2 CPS AXIAL data transfers of list of Clusters between the DFE boards and the COL (Octants) boards using LVDS Links

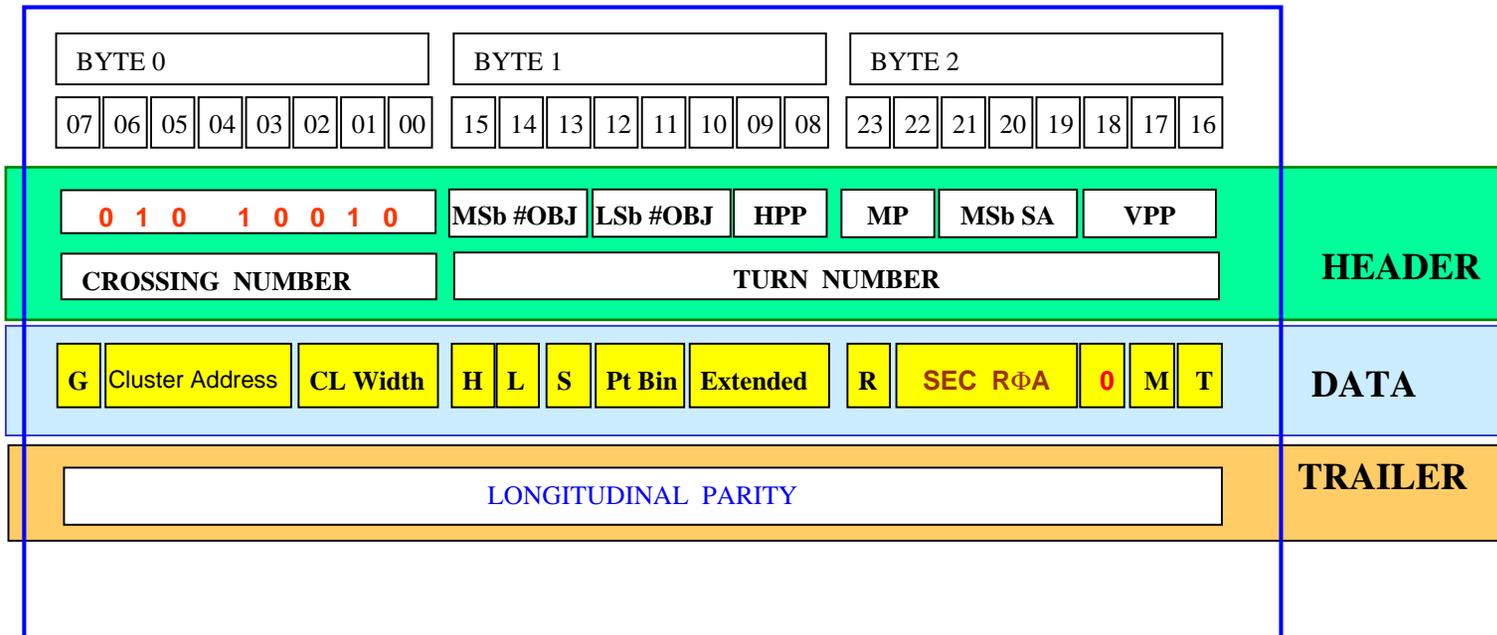
If there is at least one PS Cluster to report

Frame 3

Bits		
[56:58]	Cluster Width	
[59:62]	Relative Cluster Address	
[63]	Set to 1 if the PS Cluster is in the North end	
[64:66]	Extended Pt of the associated Track	
[67:68]	Pt Bin of the associated Track	
[69]	Sign of the Pt of the Track	
[70]	The Cluster is a Low PS Cluster	First Cluster
[71]	The Cluster is a High PS Cluster	
[72]	Set to 1 if there is a Track associated with the PS Cluster	
[73:78]	Relative Address of the fiber in the H Layer which the associated Track hits	
[79]	Set to 1 if the Track associated with the cluster is outside the 4.5° Sector of the PS Cluster	
[80]	Transverse Parity (Parity of [56:79])	
[81:83]	Control {000} This is not the first frame	



Bit Fields allocation for L2 CPS Axial data transfers of list of Clusters with corrected Track association between the Collector Boards (Octants) and the Broadcaster Boards (Quadrants) using LVDS Links



NOTE The Maximum number of Clusters reported per Octant is 24.

If truncation of data is necessary, priority is given first to HPS Clusters and then to Clusters with lower Φ . This could result in a possible Φ dependence of the efficiency.



Meaning of Terms used

Each reported Cluster carries the following information

G	Set to 1 if North, set to 0 if South
Cluster Address	The relative Address of the first element of the Cluster (Offset)
Cluster Width	The number of elements in the Cluster
H	If set, the Cluster is a High Threshold PS Cluster
L	If set, the Cluster is a Low Threshold PS Cluster
S	Sign of the Pt of the associated Track
Pt	The Pt Bin of the associated Track
Extended	The Extended Pt Value of the associated Track
R	Set to 1 if the associated track belongs to an adjacent sector
SEC RΦA	The Address of the 4.50 wedge were Clusters are native within an Octant
M	Set to 1 if there are more than one Track associated with the cluster
T	Set to 1 if there is at least one Track associated with the cluster



Bit Fields allocation for L2 CPS Axial data transfers of list of Clusters with corrected Track association between the Collector Boards (Octants) and the Broadcaster Boards (Quadrants) using LVDS Links

Frame 1

Bits		
[0:7]	Data type	{01001010} = L2CPS
[8:9]	Horizontal Parity of the 2x3 matrix giving the # of Objects	
[10:12]	Less Significant bits of the # of Objects (first Row of the matrix address)	
[13:15]	Most Significant bits of the # of Objects (first Row of the matrix address)	
[16:18]	Vertical Parity of the 2x3 matrix giving the # of Objects	
[19:21]	Most Significant bits of the 4.5 ^o Sector = Relative Address of the Octant	
[12:23]	Pass and Mark {00}	Normal Data, Normal Event
		{01} Normal Data, Pass Event (unbiased data)
		{10} Debug Data Type "a"
		{11} Debug Data Type "b"
[24]	Transverse Parity (Parity of [0:23])	
[25:27]	Control {111}	This is the first frame

Frame 2

[28:35]	Crossing Number	
[36:51]	Turn Number	
[52]	Transverse Parity (Parity of [0:23])	
[53:55]	Control {000}	This is not the first frame



Bit Fields allocation for L2 CPS Axial data transfers of list of Clusters with corrected Track association between the Collector Boards (Octants) and the Broadcaster Boards (Quadrants) using LVDS Links

If there is at least one PS Cluster to report

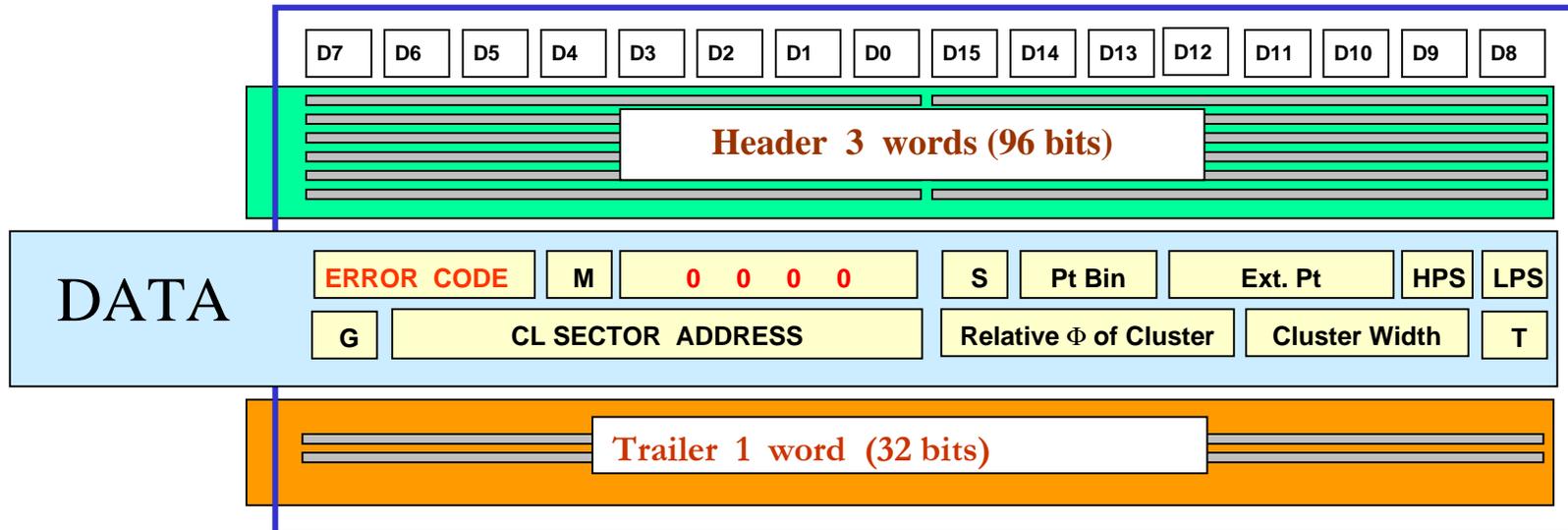
Frame 3

Bits	
[56:58]	Cluster Width
[59:62]	Relative Cluster Address
[63]	Set to 1 if the PS Cluster is in the North end
[64:66]	Extended Pt of the associated Track
[67:68]	Pt Bin of the associated Track
[69]	Sign of the Pt of the Track
[70]	The Cluster is a Low PS Cluster
[71]	The Cluster is a High PS Cluster
[72]	Set to 1 if there is a Track associated with the PS Cluster
[73]	Set to 1 if there is more that one Track associated with the PS Cluster
[74]	Null {0}
[75:78]	Relative Address of the 4.5° Sector within its Octant of the associated Track (This information is used by the BC board of the Quadrant only)
[79]	Set to 1 if the Track associated with the cluster is outside the 4.5° Sector of the PS Cluster
[80]	Transverse Parity (Parity of [56:79])
[81:83]	Control {000} This is not the first frame

This code is applied to the resulting list of “corrected Clusters” from the eight central 4.5° sectors of an Octant



Bit Fields allocation for **L2 CPS Axial** data transfers between the **Broadcaster Boards (Quadrants)** and the **L2 PSpp (via FIC) using G Links**



List of Clusters with tagging and address $n \cdot 32$ bits for a maximum of 46 Clusters
 If truncation of data is necessary, priority is given first to HPS Clusters and then to Clusters with lower Φ . This could result in a possible Φ dependence of the efficiency.



Meaning of Terms used

In this case the Header has only three Frames.

Each reported Cluster carries the same information that in the previous case plus the following

Error Code

A three bit code with the following meaning

b1 Transmission error(s) detected and corrected

b2 Transmission error(s) detected and not corrected

b4 Transmission resulted in a truncated list of clusters

where the “Transmission” refers to one used to send this data to the Broadcaster Board

CL SECTOR ADDRESS

The address of the 4.5° wedge where the Cluster is contained.