

The STT System

[CFT information]

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 !!**

September 3, 1999

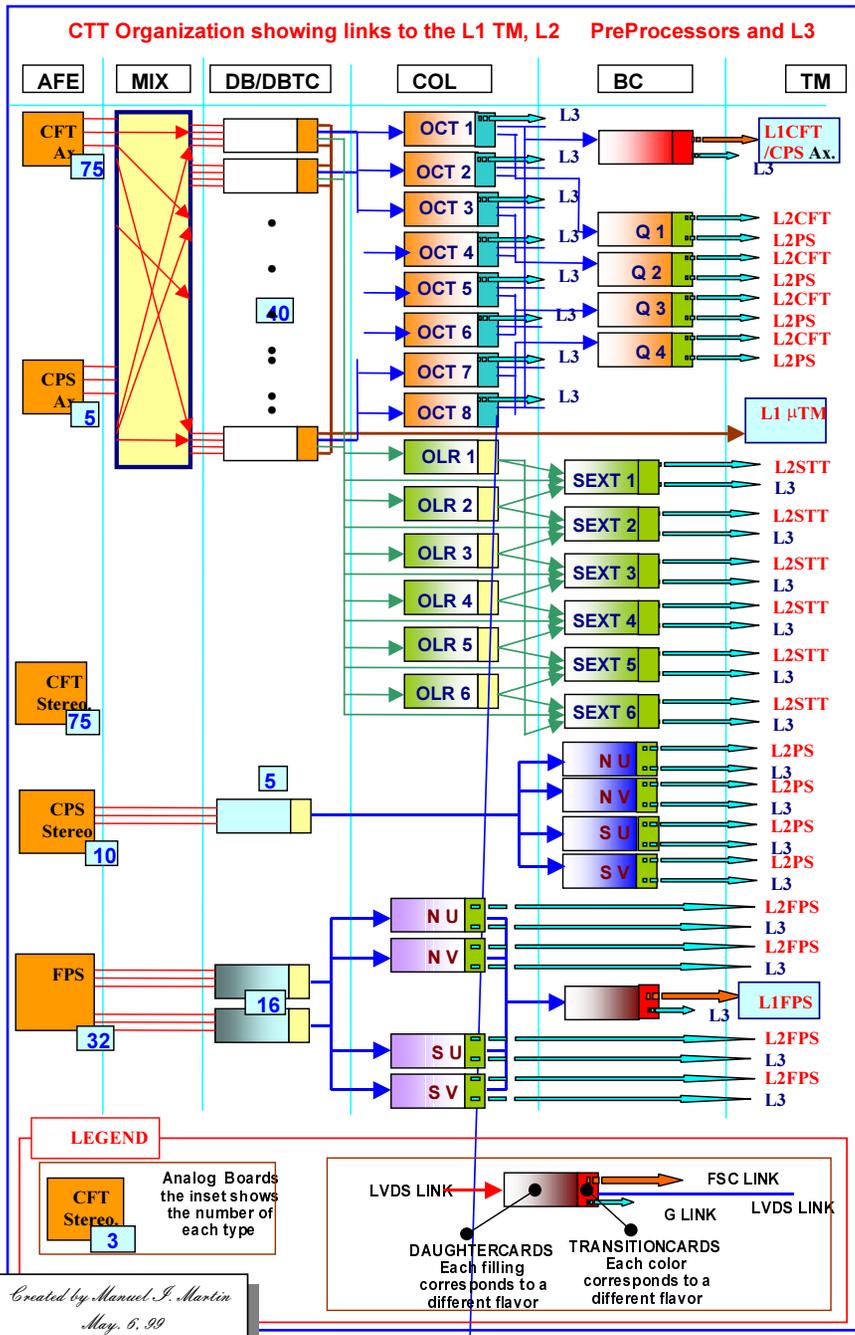
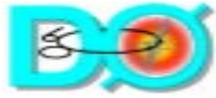


Diagram of the CTT System.

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



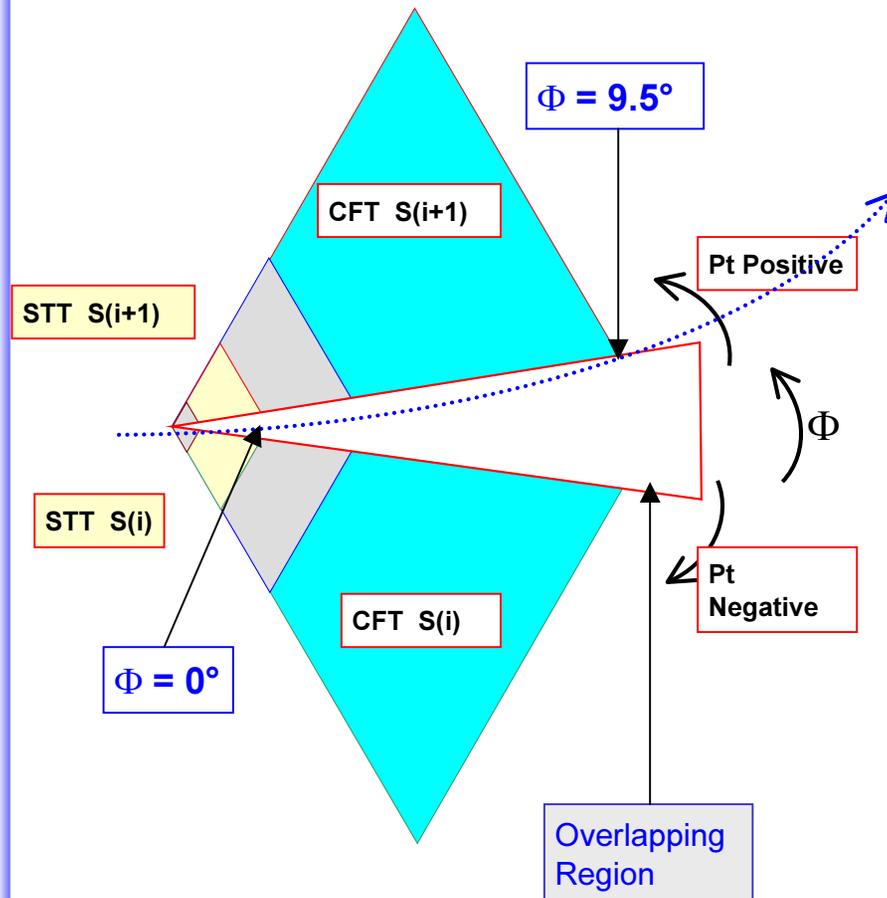
L2 STT

GENERAL

The STT is organized into Sextants while the CFT is organized into Octants and Quadrants. While the geometry and organization of Central Fiber Tracker into sectors of 4.5° provides a perfect match with the CFT Trigger this organization does not allow for a good match to the geometry of the Silicon Tracker. Thus, a reorganization of data needs to be done in the Broadcaster System. This is accomplished by the architecture described in the following pages.



Need for Overlapping Regions in the STT/CFT



A track which:

- has a displaced vertex of $\approx 2\text{mm}$
- has a Pt of $+1.5\text{GeV}$
- and passes through the Si strip with higher Φ of the most outer layer of the Si Tracker ($\Phi=0$ in the figure)

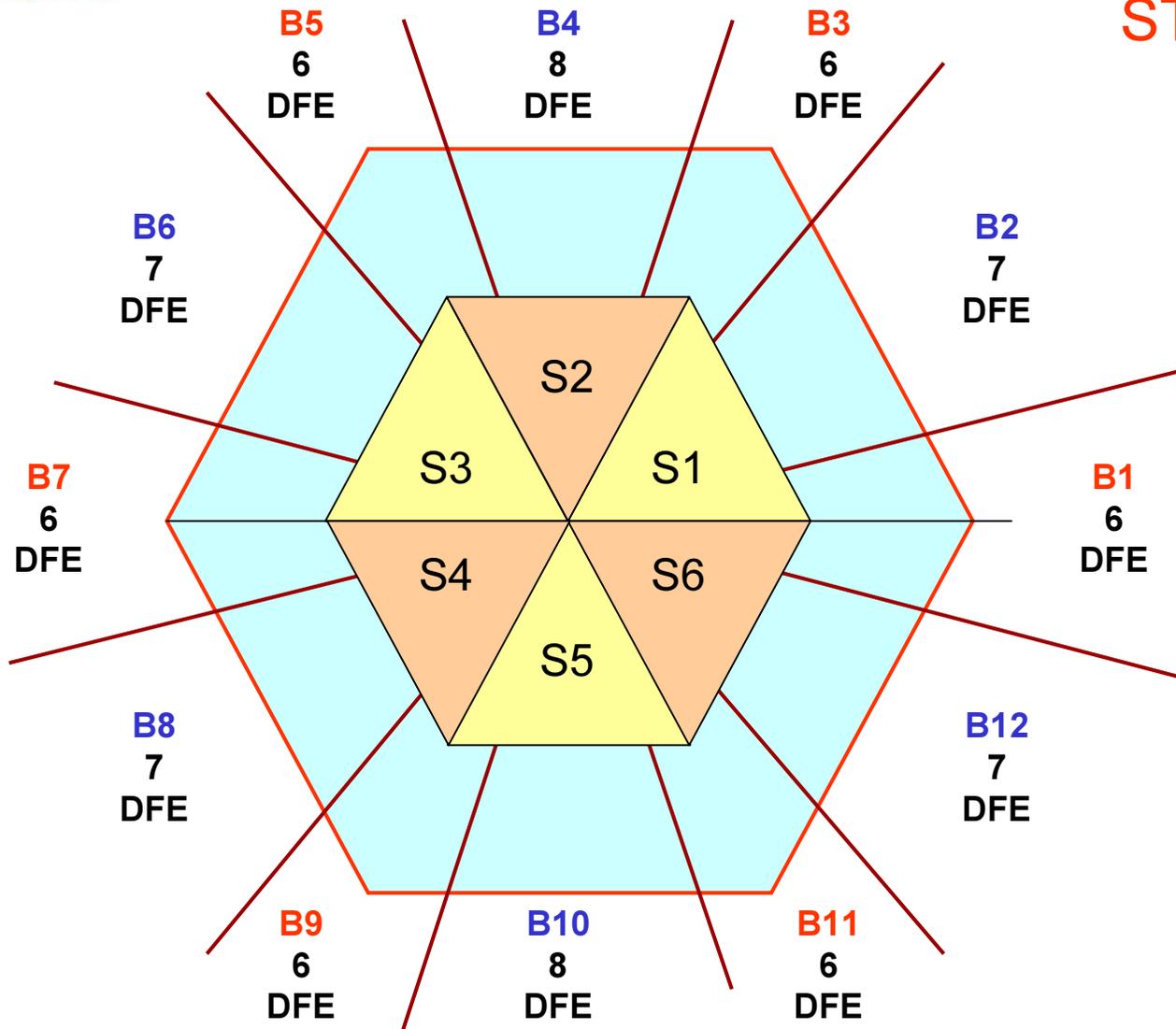
is fully contained in a Sextant $S(i)$ of the Si Tracker

but

it is also fully contained in the Sextant $S(i+1)$ of the Central Fiber Tracker passing through a fiber in the H layer with $\Phi \approx 9.5^\circ$



STT Topology

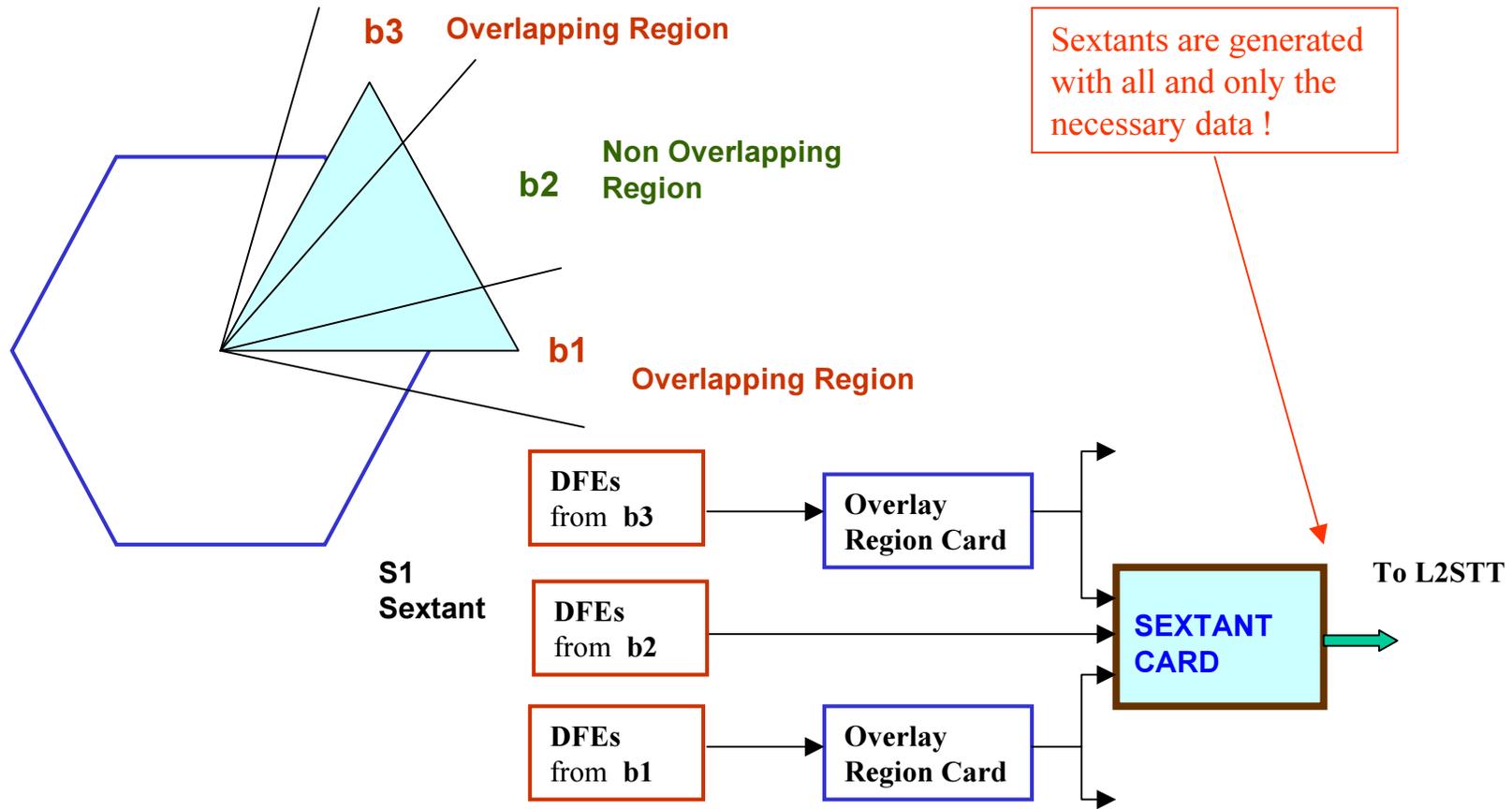


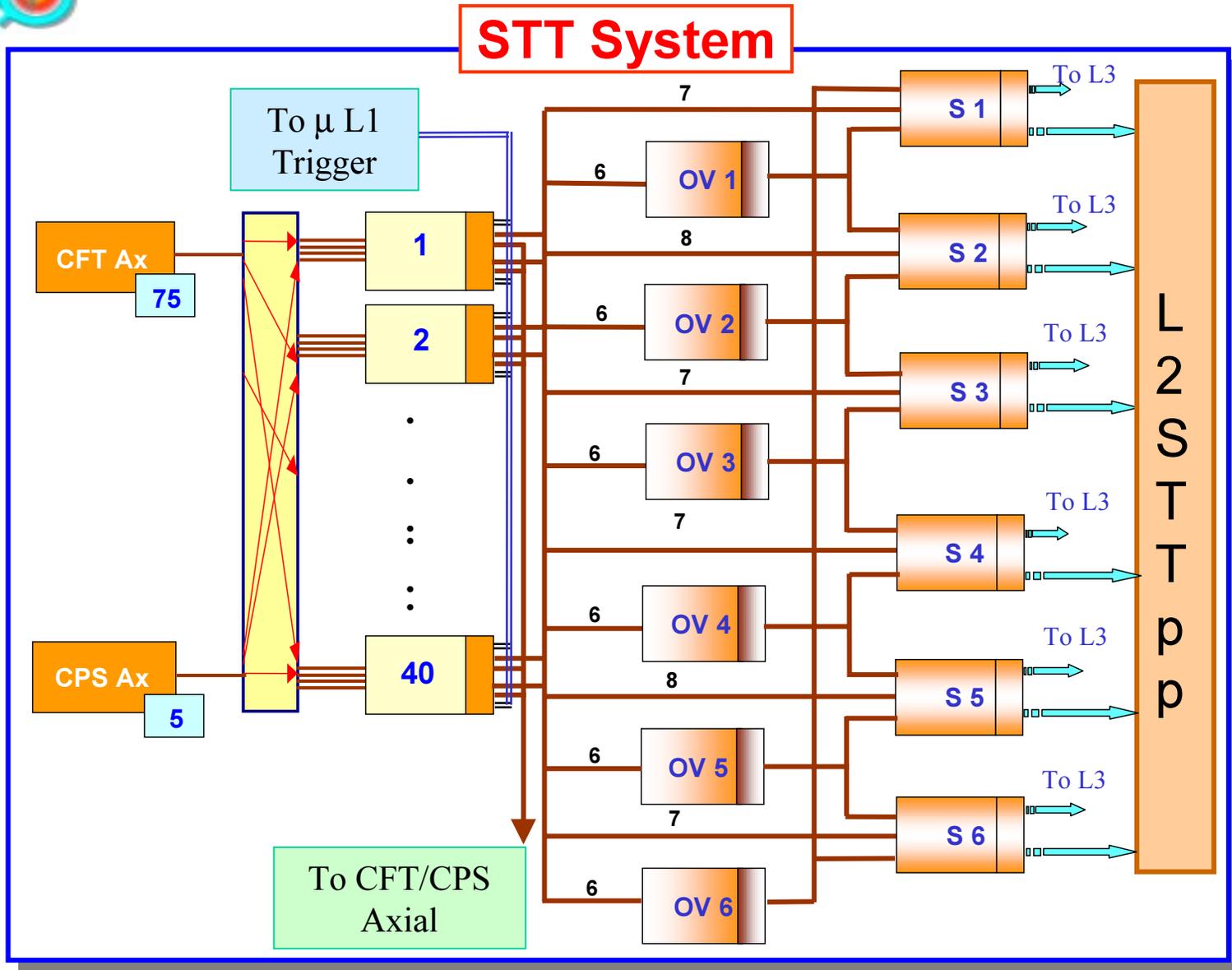
Odd regions are Overlapping Regions. Each has 6 DFE cards

Even regions are Non overlapping regions. They have eight or seven DFE Cards.



Organization of the STT data paths (only one Sextant shown)







CFT information pertaining to the STT

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 (Overlay x Board)

Each Overlay Board receives information from six AFEs via three or four DBs. When L2CFT information is detected the OVx acts on the six Track it lists receives creating two distinct Track List. Tracks in the generated lists are ordered by Pt. Each List contains only these Tracks that possibly belong to one Sextant and is sent to a different BC. Because at this level the impact parameter is not known, it is important possible that some Tracks appear in both lists; these Tracks are Tagged to indicated that duplicated information has been sent. Each list is limited to a maximum of 24 Track.



FUNCTIONS PERFORMED BY THE BOARDS

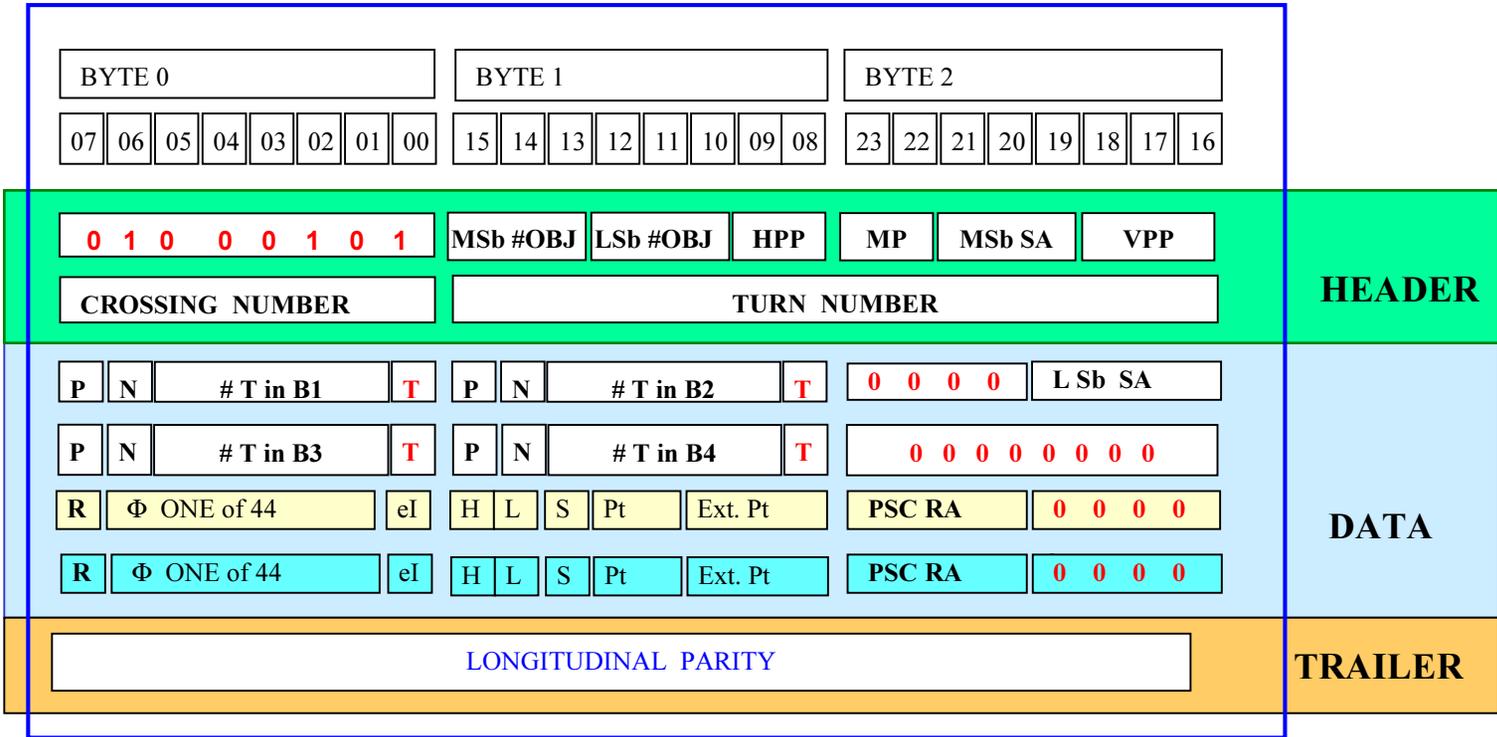
(Continuation)

BC BroadCaster Board (Sextant x Board)

There are 6 BC boards collecting information from two COL boards and seven or eight AFE boards via DFEs. The Sextant board (Broadcaster Board) generates a single list from the nine (ten) partial list it receives and sends it to the L2STTpp. The Track list generated includes all found Tracks that possible belong to the Sextant. It is important to notice that Tracks from the adjacent regions may or may not belong to the Sextant. For instance, a very low Pt Track ($Pt \approx 1.5$ GeV) passing through an H layer fiber located about 9.5° outside the geometrical boundary of the Sextant will belong to the Sextant only if its impact parameter is ≥ 2 mm. Otherwise, this Track will belong to the Sextant were the H layer fiber is located.



Bit Fields allocation for L2 CFT data transfers between the Digital Front End boards and the Collector Boards (Overlay Regions Boards) or the Broadcaster Boards (Sextant boards) using LVDS Links



NOTES The Maximum number of Tracks reported per 4.5° Wedge is 6 per Pt Bin (24 Max. Total)
 The Track List is ordered in Pt Bin



Bit Fields allocation for L2 CFT data transfers between the DFE boards and the CB using LVDS Links

Frame 1

Bits		
[0:7]	Data type	{01000101} = L2CFT
[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 [28:51])	
[53:55]	Control {000}	This is not the first frame



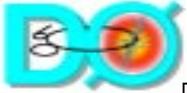
Bit Fields allocation for L2 CFT data transfers between the DFE boards and the CB using LVDS Links

Frame 3

Bits	
[56]	Set to 1 if there are more than 6 Tracks
[57:59]	Number of Positive Tracks in the High Pt Bin
[60:61]	Null {00}
[62]	There are some Tracks with Negative Pt
[63]	There are some Tracks with Positive Pt
[64]	Set to 1 if there are more than 6 Tracks
[65:67]	Number of Positive Tracks in the Medium Pt Bin
[68:69]	Null {00}
[70]	There are some Tracks with Negative Pt
[71]	There are some Tracks with Positive Pt
[72:75]	Relative Address of the AFE Board in the Octant
[76:79]	Null {0000}
[80]	Transverse Parity (Parity of [56:79])
[81:83]	Control {000} This is not the first frame

Frame 4

[84]	Set to 1 if there are more than 6 Tracks
[85:87]	Number of Positive Tracks in the High Pt Bin
[88:89]	Null {00}
[90]	There are some Tracks with Negative Pt
[91]	There are some Tracks with Positive Pt
[92]	Set to 1 if there are more than 6 Tracks
[93:95]	Number of Positive Tracks in the Medium Pt Bin
[96:97]	Null {00}
[98]	There are some Tracks with Negative Pt
[99]	There are some Tracks with Positive Pt
[100:107]	Null {00000000}
[108]	Transverse Parity (Parity of [84:107])
[109:111]	Control {000} This is not the first frame



Bit Fields allocation for L2 CFT data transfers between the DFE boards and the CB using LVDS Links

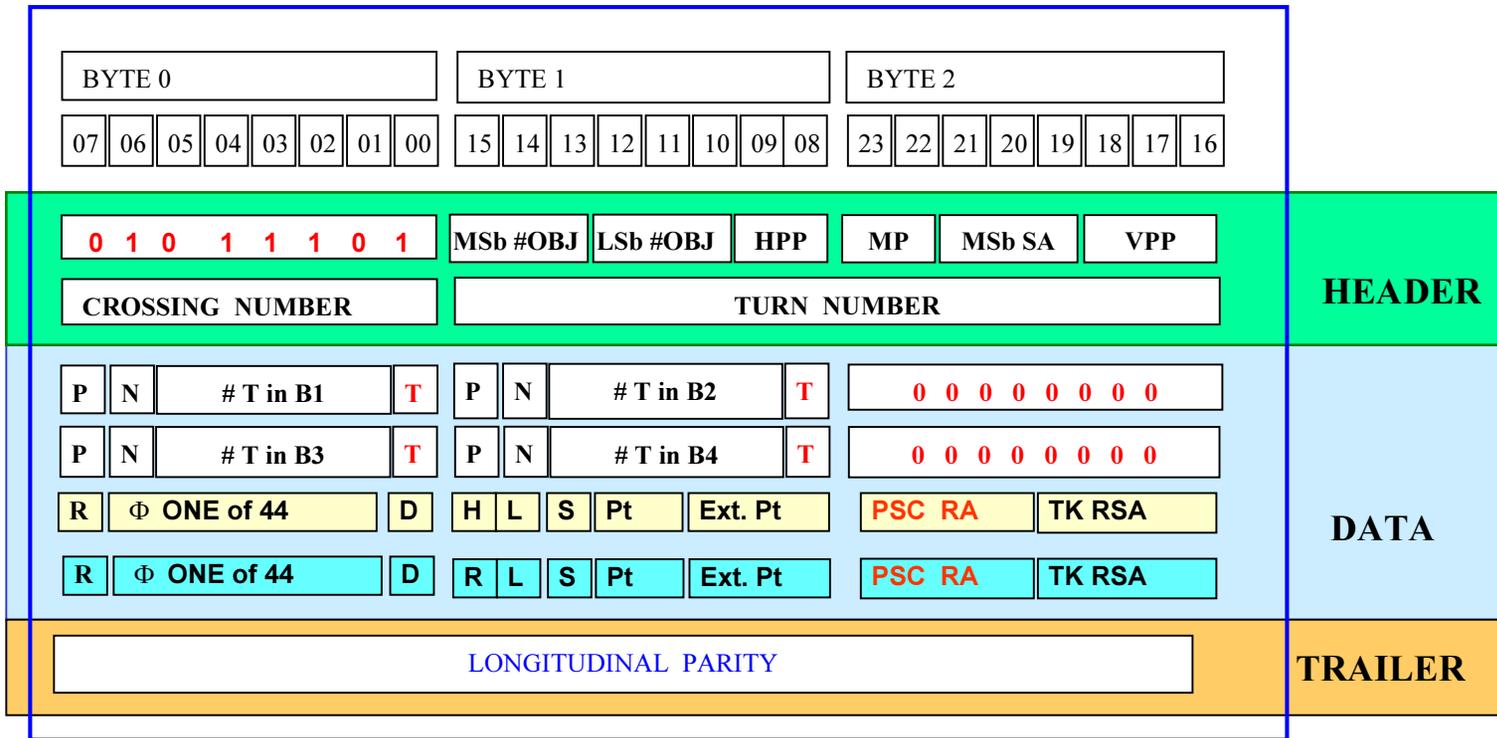
If there is at least one Track to report

Frame 5

Bits		
[112]	Set to 1 if the Track is an Isolated electron	
[113:117]	Relative Address of the fiber in the H Layer which the Track hits	
[118]	Set to 1 if the Track is associated with a cluster outside the 4.5° Sector	
[119:122]	Extended Pt of the Track	
[123:124]	Pt Bin of the Track	
[125]	Sign of the Pt of the Track	First Track
[126]	The Track is associated with a Low PS Cluster	
[127]	The Track is associated with a High PS Cluster	
[128:131]	Null {0000}	
[132:135]	Relative Address of the associated PS cluster in its 4.5° Sector	
[136]	Transverse Parity (Parity of [112:135])	
[137:139]	Control {000} This is not the first frame	



Bit Fields allocation for L2 STT data transfers of merged list of Tracks between the Overlay Region Boards (CL) and the Sextant Boards (BC) using LVDS Links



NOTES The Maximum number of Tracks reported per Overlay Region is 24 (The 24 with higher Pt) The Track List is ordered in Pt If truncation of data is necessary the reporting is done moving counter clock wise, this could result in a possible Φ dependence.



**Bit Fields allocation for L2 STT data transfers of
merged list of Tracks between the Overlay Region Boards (CL) and the
Sextant Boards (BC) using LVDS Links**

Frame 1

Bits		
[0:7]	Data type	{01011101} = L2CFT
[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 [28:51])	
[53:55]	Control {000}	This is not the first frame



**Bit Fields allocation for L2 STT data transfers of
merged list of Tracks between the Overlay Region Boards (CL) and the
Sextant Boards (BC) using LVDS Links**

Frame 3

Bits		
[56]	Set to 1 if there are more than 24 Tracks	
[57:61]	Number of Positive Tracks in the High Pt Bin	
[62]	There are some Tracks with Negative Pt	
[63]	There are some Tracks with Positive Pt	
[64]	Set to 1 if there are more than 24 Tracks	
[65:69]	Number of Positive Tracks in the Medium Pt Bin	
[70]	There are some Tracks with Negative Pt	
[71]	There are some Tracks with Positive Pt	
[72:79]	Null	{0000}
[80]	Transverse Parity (Parity of [56:79])	
[81:83]	Control	{000} This is not the first frame

Frame 4

[84]	Set to 1 if there are more than 24 Tracks	
[85:89]	Number of Positive Tracks in the Low Pt Bin	
[90]	There are some Tracks with Negative Pt	
[91]	There are some Tracks with Positive Pt	
[92]	Set to 1 if there are more than 24 Tracks	
[93:97]	Number of Positive Tracks in the Very Low Pt Bin	
[98]	There are some Tracks with Negative Pt	
[99]	There are some Tracks with Positive Pt	
[100:107]	Null	{00000000}
[108]	Transverse Parity (Parity of [84:107])	
[109:111]	Control	{000} This is not the first frame



**Bit Fields allocation for L2 STT data transfers of
merged list of Tracks between the Overlay Region Boards (CL) and the
Sextant Boards (BC) using LVDS Links**

If there is at least one Track to report

Frame 5

Bits

[112]	Set to 1 if the Track is duplicated (sent also to the other Sextant served by this Overlay Region)	
[113:117]	Relative Address of the fiber in the H Layer which the Track hits	
[118]	Set to 1 if the associated Cluster is located in a adjacent 4.5° Sector	
[119:122]	Extended Pt of the Track	
[123:124]	Pt Bin of the Track	First Track
[125]	Sign of the Pt of the Track	
[126]	The Track is associated with a Low PS Cluster	
[127]	The Track is associated with a High PS Cluster	
[128:131]	Relative Address of the AFE 4.5° Sector in the Octant where the Track was found	
[132:135]	Relative Address in the Octant where the cluster is located	
[136]	Transverse Parity (Parity of [112:135])	
[137:139]	Control {000} This is not the first frame	



Meaning of Terms used

In this case the Header consists of two Frames.

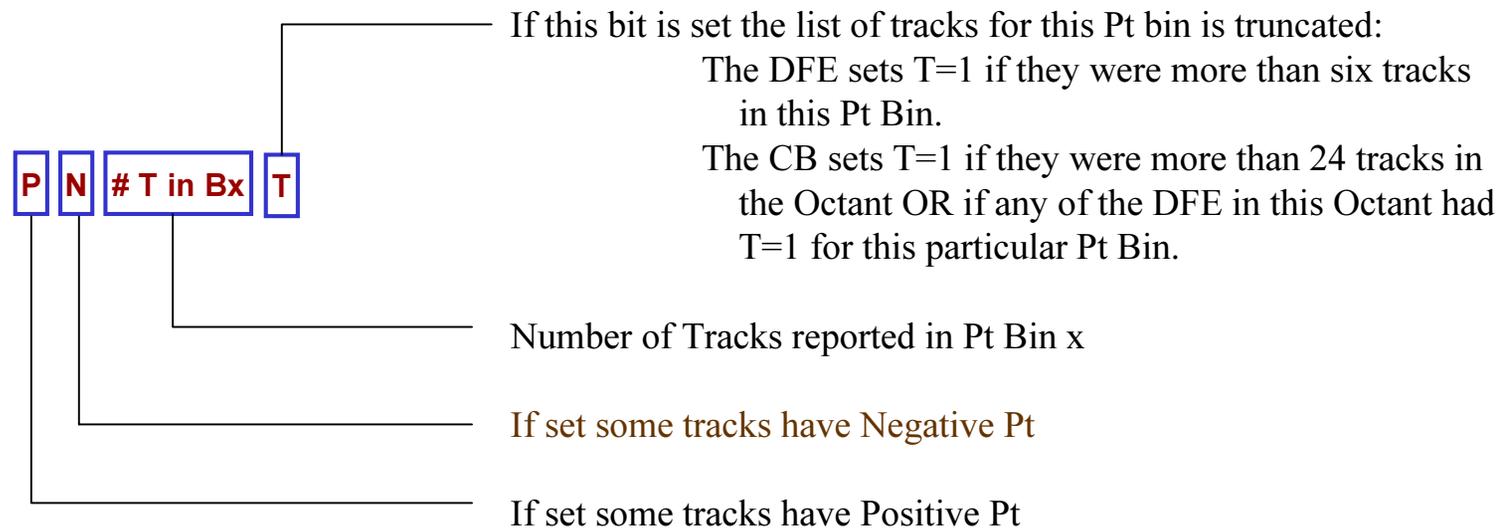
The minimum number of frames in a record (when no tracks are found) is five:

2 Header Frames

2 Data frames (all zeros)

1 Trailer Frame (Vertical Parity).

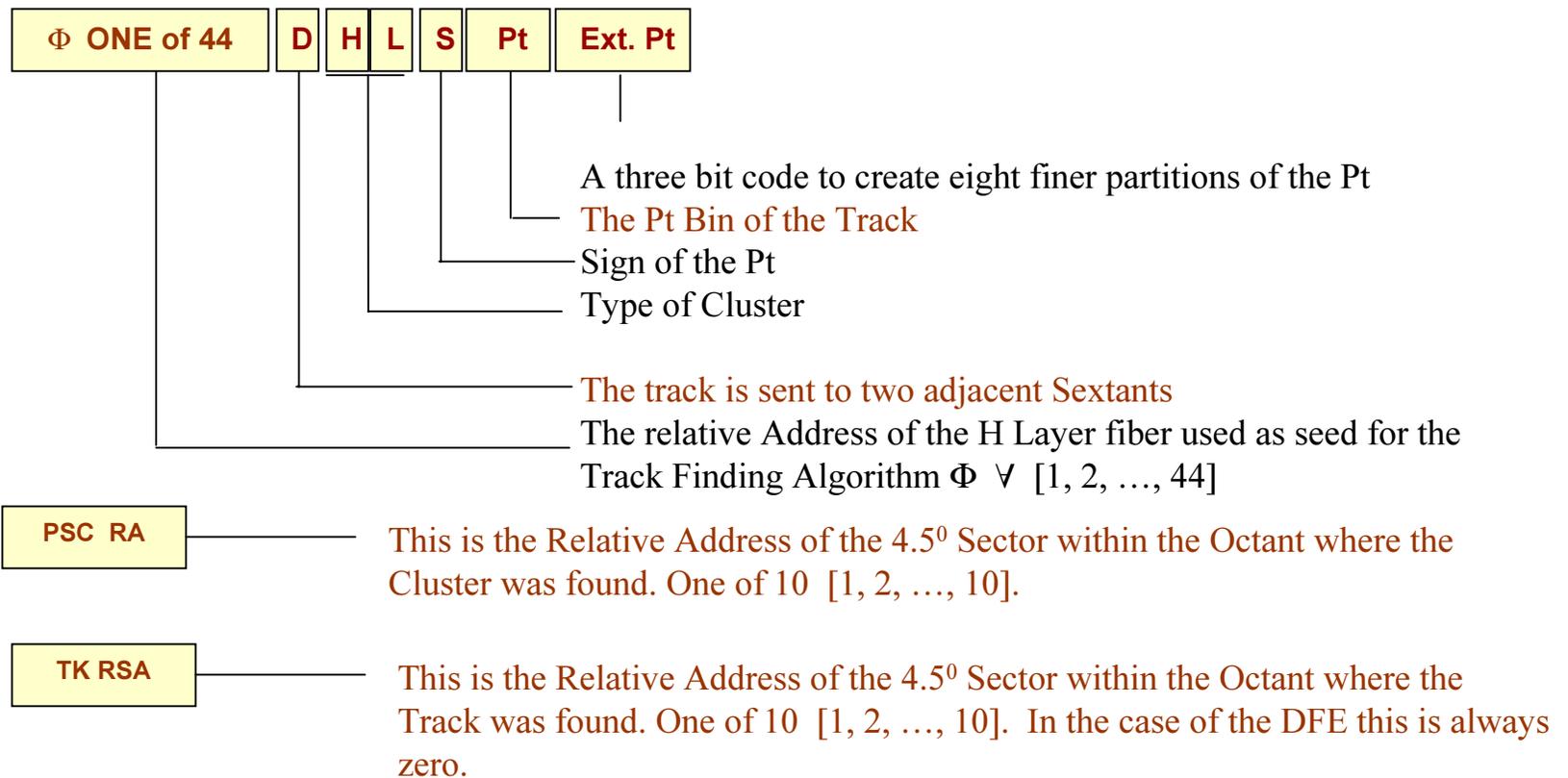
When one or more tracks are found the first two data frames carry specific information about the number of tracks reported. In this case the minimum number of frames in a record (when only one track is found) is six.





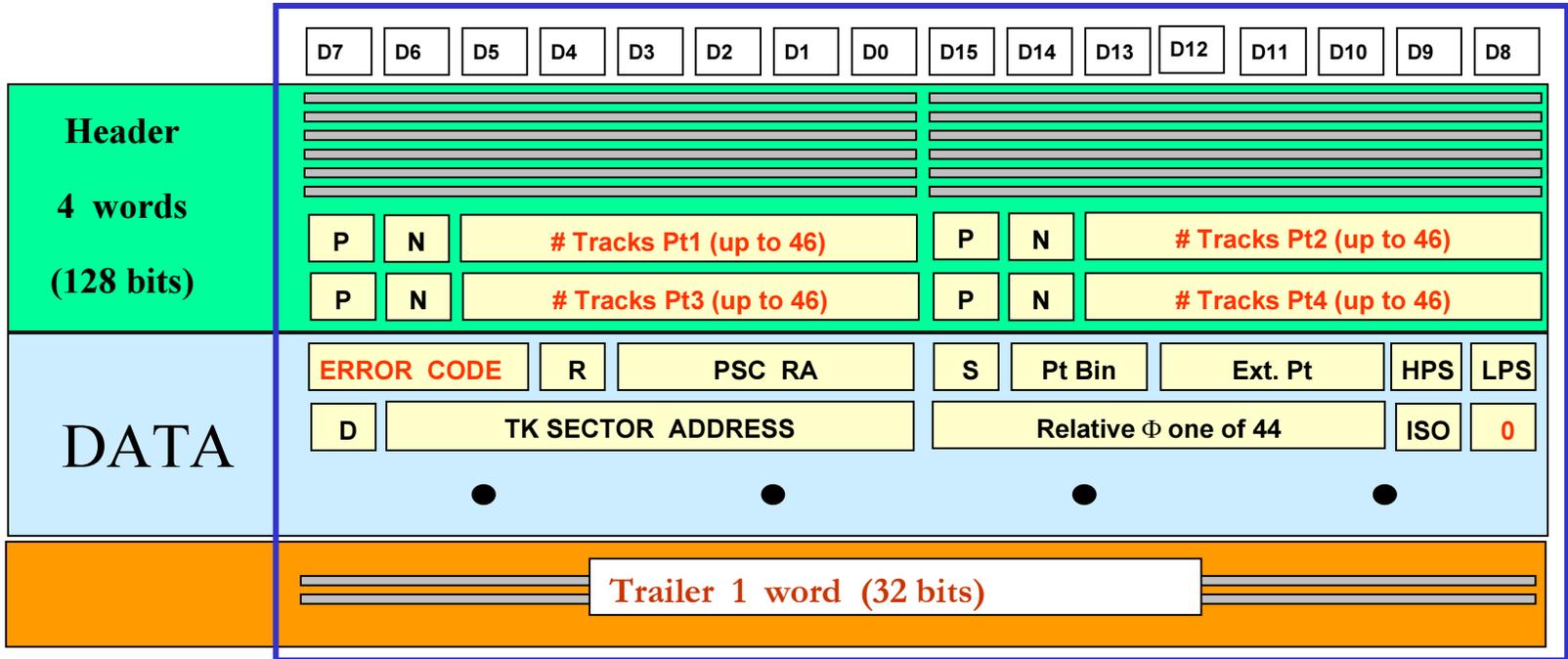
Meaning of Terms used

Each reported track carries the following information





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



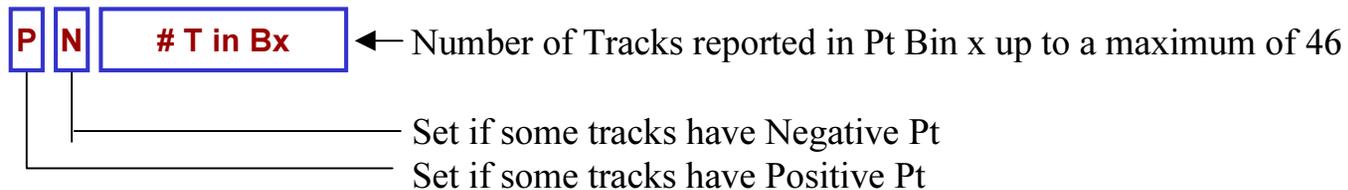
Number of Tracks per Pt bin 4*8 bits for a maximum of 32 tracks
 List of tracks with tagging and address n*32 bits for a maximum of 32 tracks
 If truncation of data is necessary the reporting is done moving counter clock wise,
 this could result in a possible Φ dependence of the Trigger.



Meaning of Terms used

Note that only the data used by the STTpp is sent to it !

In this case the Header has four Frames. The code for the four Frame is



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

