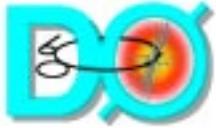


The BROADCASTER

communication protocols
and
data encoding

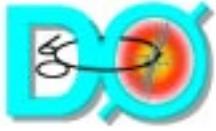
Version 2.0

These ideas have evolved over a long period of time and are the result of many meetings as well as formal and informal conversations with many people. Specifically, the following people have contributed to the evolution of these ideas: F. Borcharding, P. Grannis, M. Johnson, J. Linnemann, A. Lucotte, D. Toback, M. Vaz.



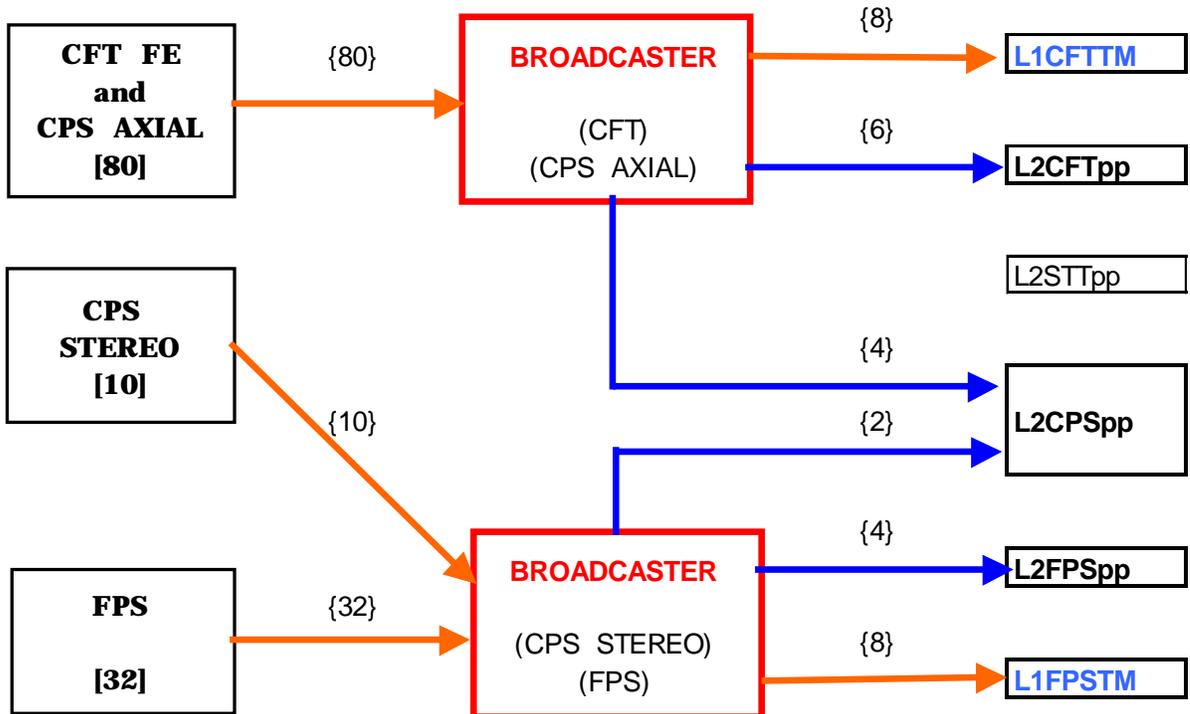
Version 2.0

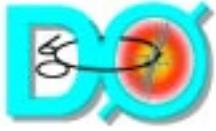
- Why Revision 2.0
 - To show the ongoing dialog among the people involved. Specifically between J. Linnemann and myself
 - To have a closer "final" protocol
- What is it new in version 2.0
 - A reordering of the bits to reflect the way the ALPHAs see them
 - An explanation of the byte ordering
 - A revision of the header and trailer for the BROADCASTER to FIC transfers
 - A revision of the meaning of some fields on header, trailer and data



LINKS between FE and BROADCASTER BROADCASTER and TRIGGERS

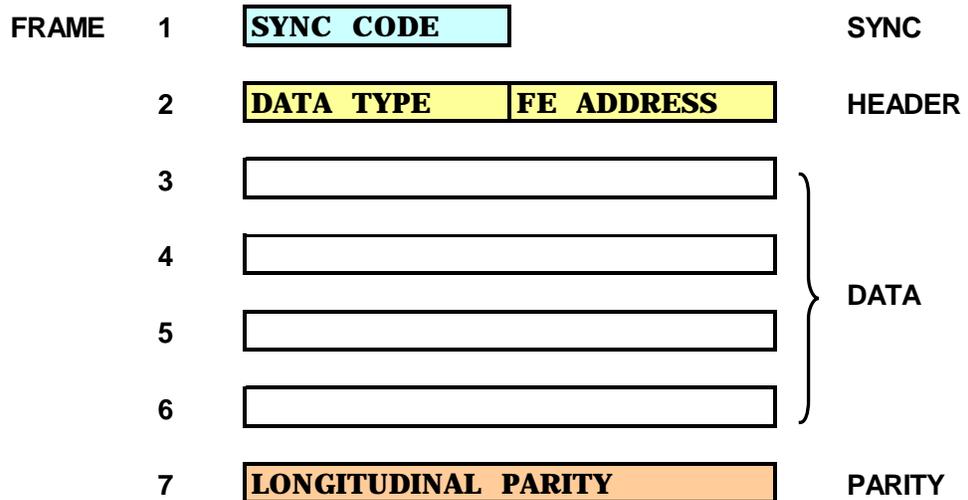
— Fast Copper Serial Link
— G Link



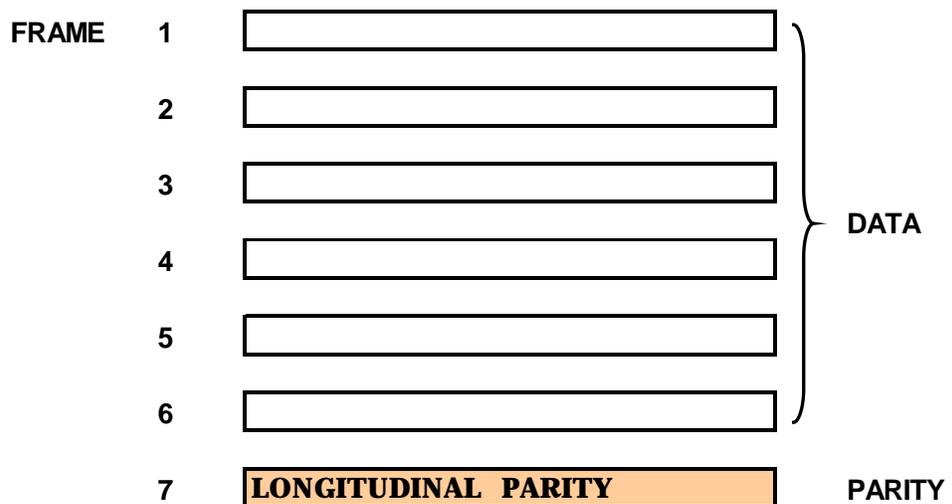


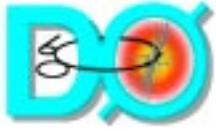
L1 PROTOCOLS for the FCSL

FE to BROADCASTER



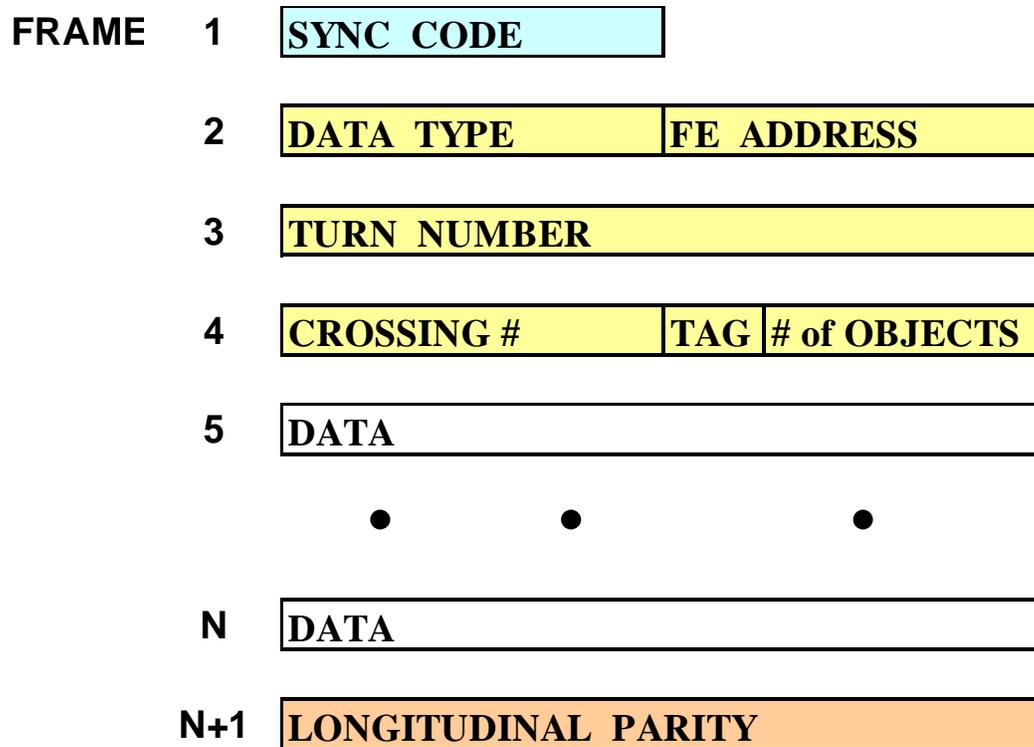
BROADCASTER to TM (L1)

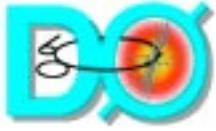




L2

PROTOCOLS for the FCSL





L1 DATA

Assignment of Frames and Fields

FCSL between CFT FE and BROADCASTER

Seven (L1) frames of 20 bits each. Use 16B/20B code.

CFT/CPS L1

b0 | b1 | b2 | b3 | b4 | b5 | b6 | b7 | b8 | b9 | b10 | b11 | b12 | b13 | b14 | b15

SYNC CODE

DATA TYPE CODE | FE SECTOR ADDRESS

HEADER

TOTAL NUMBER OF HITS | # OF PHOTONS | ISOLATED TRACKS

OF TRACKS PT1 | # OF TRACKS PT2 | # OF TRACKS PT3 | # OF TRACKS PT4

NO PS

OF TRACKS PT1 | # OF TRACKS PT2 | # OF TRACKS PT3 | # OF TRACKS PT4

H PS

OF TRACKS PT1 | # OF TRACKS PT2 | # OF TRACKS PT3 | # OF TRACKS PT4

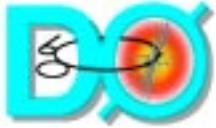
L PS

LONGITUDINAL PARITY

ISOLATED TRACKS

b12 ISO
b13 eISO
b14, b15 Pt of ISOLATED TRACK

Track information limited to: 6 tracks per Pt bin
24 maximum number of tracks



L1 DATA

Assignment of Frames and Fields

FCSL between BROADCASTER and L1CFTTM

CFT/CPS L1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----

TOTAL NUMBER OF FIBERS HIT	
----------------------------	--

V	P	Pt BIN									
---	---	--------	---	---	--------	---	---	--------	---	---	--------

V	P	Pt BIN		# OF ELECTRON CANDIDATES
---	---	--------	--	--------------------------

# OF TRACKS PT1	# OF TRACKS PT2	# OF TRACKS PT3	# OF TRACKS PT4	NO PS
-----------------	-----------------	-----------------	-----------------	--------------

# OF TRACKS PT1	# OF TRACKS PT2	# OF TRACKS PT3	# OF TRACKS PT4	H PS
-----------------	-----------------	-----------------	-----------------	-------------

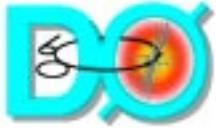
# OF TRACKS PT1	# OF TRACKS PT2	# OF TRACKS PT3	# OF TRACKS PT4	L PS
-----------------	-----------------	-----------------	-----------------	-------------

LONGITUDINAL PARITY	LONGITUDINAL PARITY
---------------------	---------------------

ISOLATED TRACKS

V Valid
P PS/ Not PS
Pt BIN Pt of ISOLATED TRACK

Track information limited to: 15 tracks per Pt bin
48 maximum number of tracks



L1 DATA

Assignment of Frames and Fields

FCSL between FE L1FPS and BROADCASTER

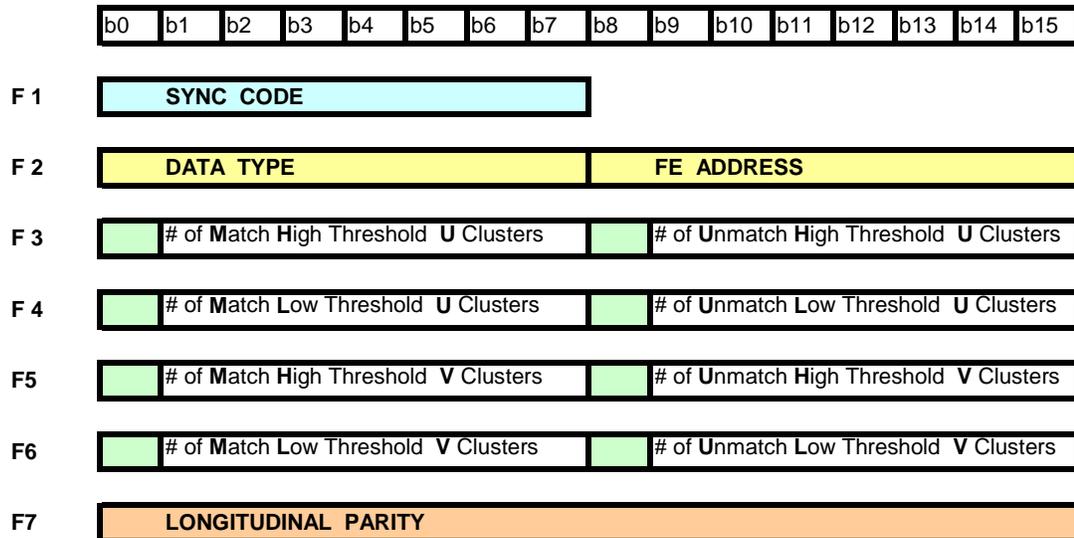
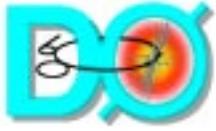


Fig.7 Data Fields for L1 Transfers between the FPS and the BROADCASTER.
Case requiring ONE Fast Cooper Serial Links per FE Board but more coding

U/V indicate the orientation of the fibers



L1 DATA

Assignment of Frames and Fields

FCSL between BROADCASTER and L1FPSTM

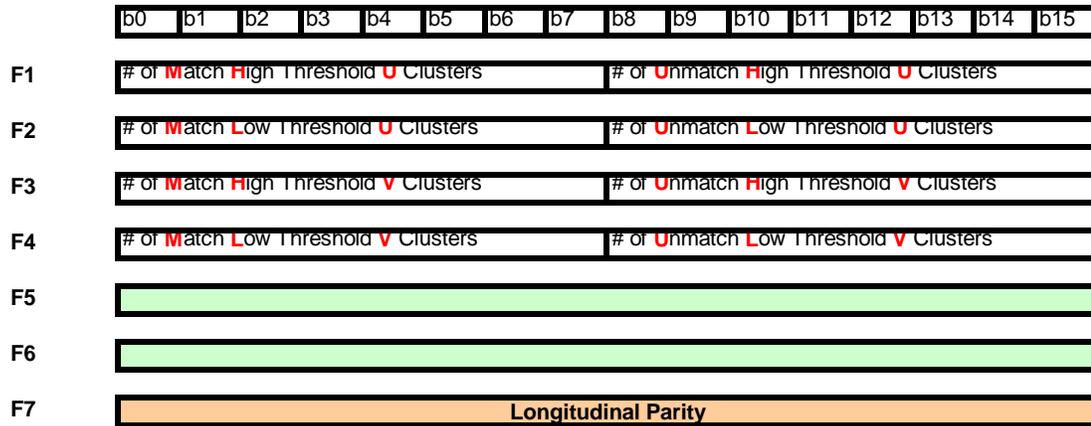
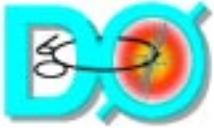


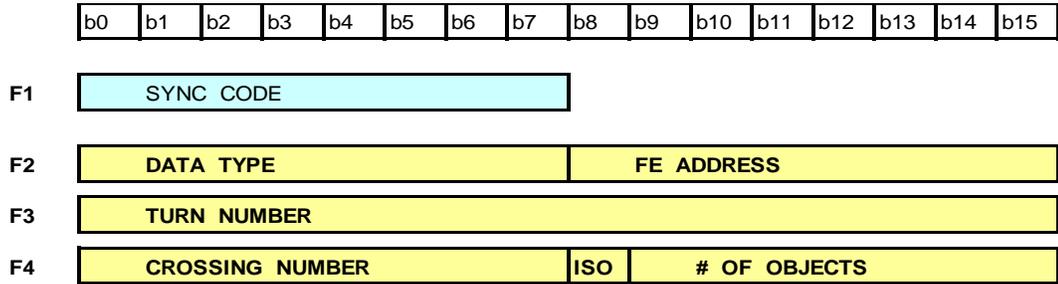
Fig. 8 Data transfer from the BROADCASTER to the L1FPSTM

U/V indicate the orientation of the fibers

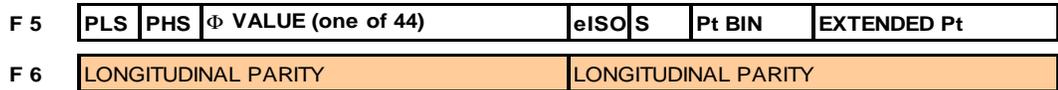


L2 DATA

Assignment of Frames and Fields FCSL between FE CFT and BROADCASTER



CASE A: AN ISOLATED TRACK



CASE B; NO ISOLATED TRACK(S)

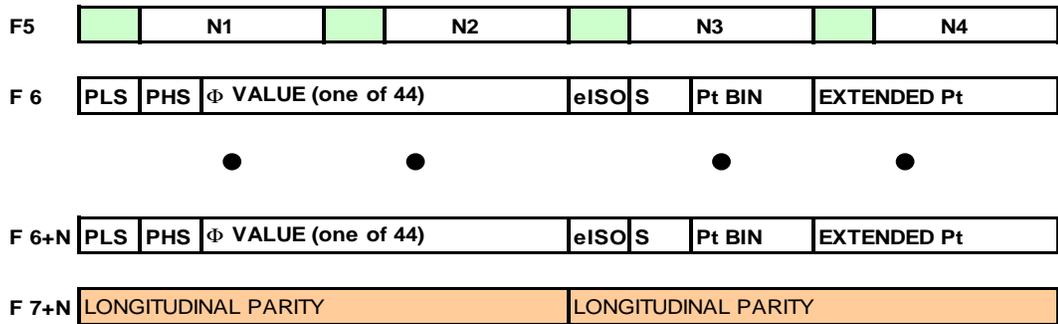
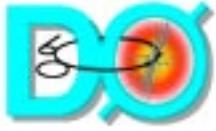


Fig. 11 Data Fields for L2 Transfers between the CFT FE and the BROADCASTER

- PSL** If set, the track is associated with a Low Threshold PS cluster
- PSH** If set, the track is associated with a High Threshold PS cluster
- eISO** If set, this track corresponds to a candidate for an isolated electron
- S** Sign of the Pt of the track
- Φ value** Relative address of the fiber from layer H that belongs to the track.
- Pt BIN** One of four Pt ranges to which the track belongs
- EXTENDED** Information to give a finer Pt range within the one defined by the Pt BIN.

Manuel J. Martin

12/14/1998



L2 DATA

Assignment of Frames and Fields FCSL between FE CPS AXIAL and BROADCASTER

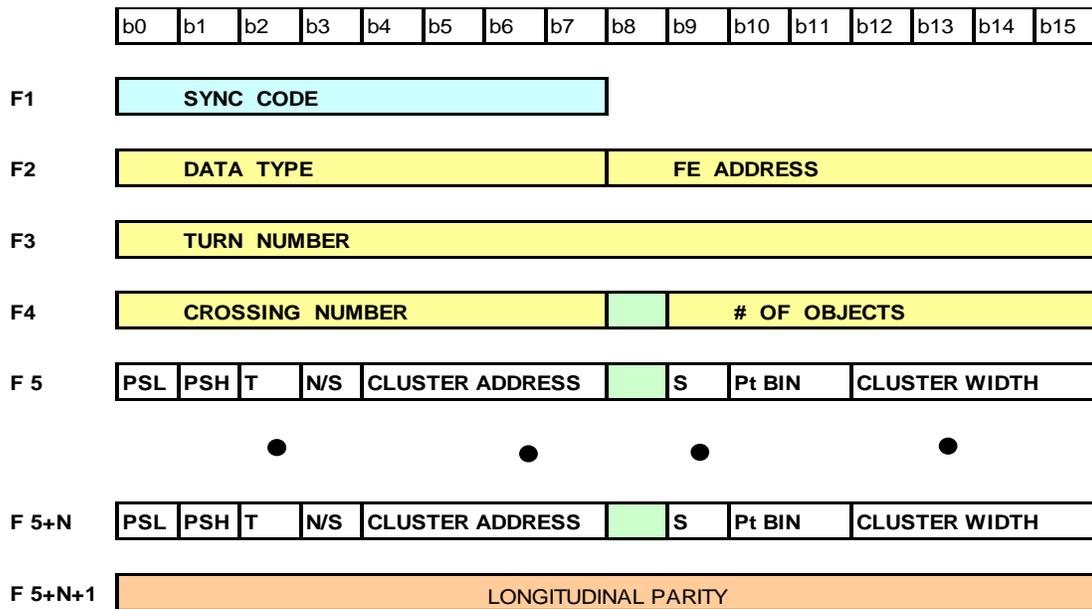
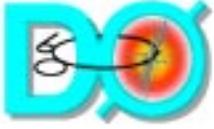


Fig. 12 Data Fields for L2 Transfers of CPS AXIAL data to the BROADCASTER

- PSL** If set the cluster is a Low Threshold PS cluster
- PSH** If set the cluster is a High Threshold PS cluster
- T** If set there is a track associated with this cluster
- N/S** Gives information about the Z position of the cluster
- C. ADDRESS** Relative address of the "first" element of the cluster. One of 16.
- S** Sign of the Pt of the track associated with the cluster
- Pt BIN** One of four Pt ranges to which the track associated with the cluster belongs
- C. WIDTH** Cluster width, the maximum width is 8 elements.



L2 DATA

Assignment of Frames and Fields FCSL between FE CPS STEREO and BROADCASTER

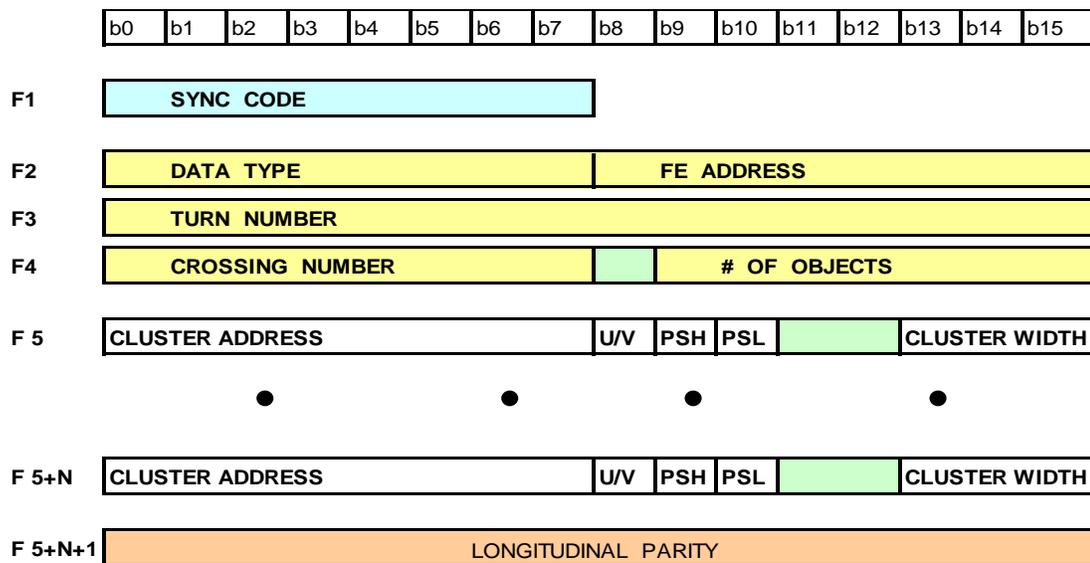
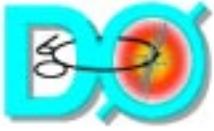


Fig. 12 Data Fields for L2 Transfers of CPS STEREO data to the BROADCASTER

- C. ADDRESS** Relative address of the "first" element of the cluster. One of 256
- C. WIDTH** Cluster width, the maximum width is 8 elements.
- U/V** Orientation of the PS strips.
- PSH** If set the cluster is a High Threshold cluster
- PSL** If set the cluster is a Low Threshold cluster



L2 DATA

Assignment of Frames and Fields

FCSL between FE FPS and BROADCASTER

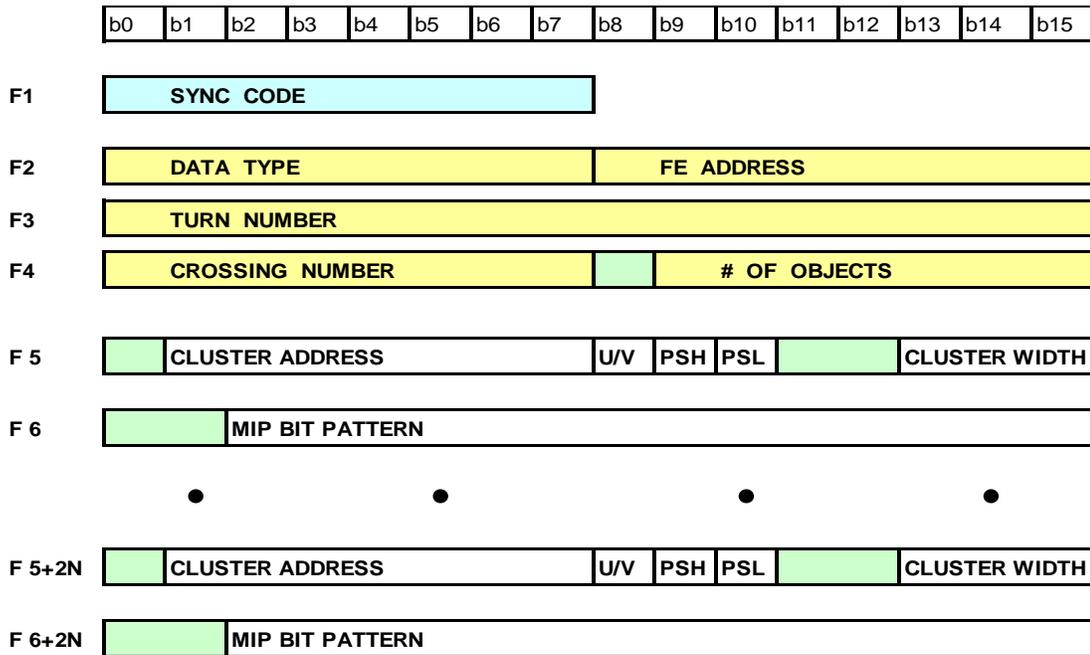
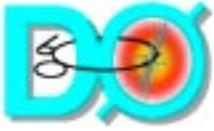


Fig. 13 Data Fields for L2 Transfers from FE FPS to BROADCASTER



PROPOSAL

Protocol for

BROADCASTER to FIC Transfers

It is assumed that the Glink implemented by HP in its HDMP-1012,14 chip set is followed.

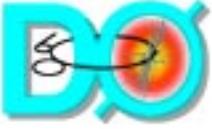
The Operating Mode is

- ① M20SEL 1 \Rightarrow 20 bit data (20 bit mode)
- ② FLAGSEL 0 \Rightarrow error checking

The Data Frame Structure is as follows

DATA STATUS	FLAGSEL	D-FIELD	C-FIELD
TRUE	1	D0-D19	1011
INVERTED	1	$\overline{\text{D0-D19}}$	1000

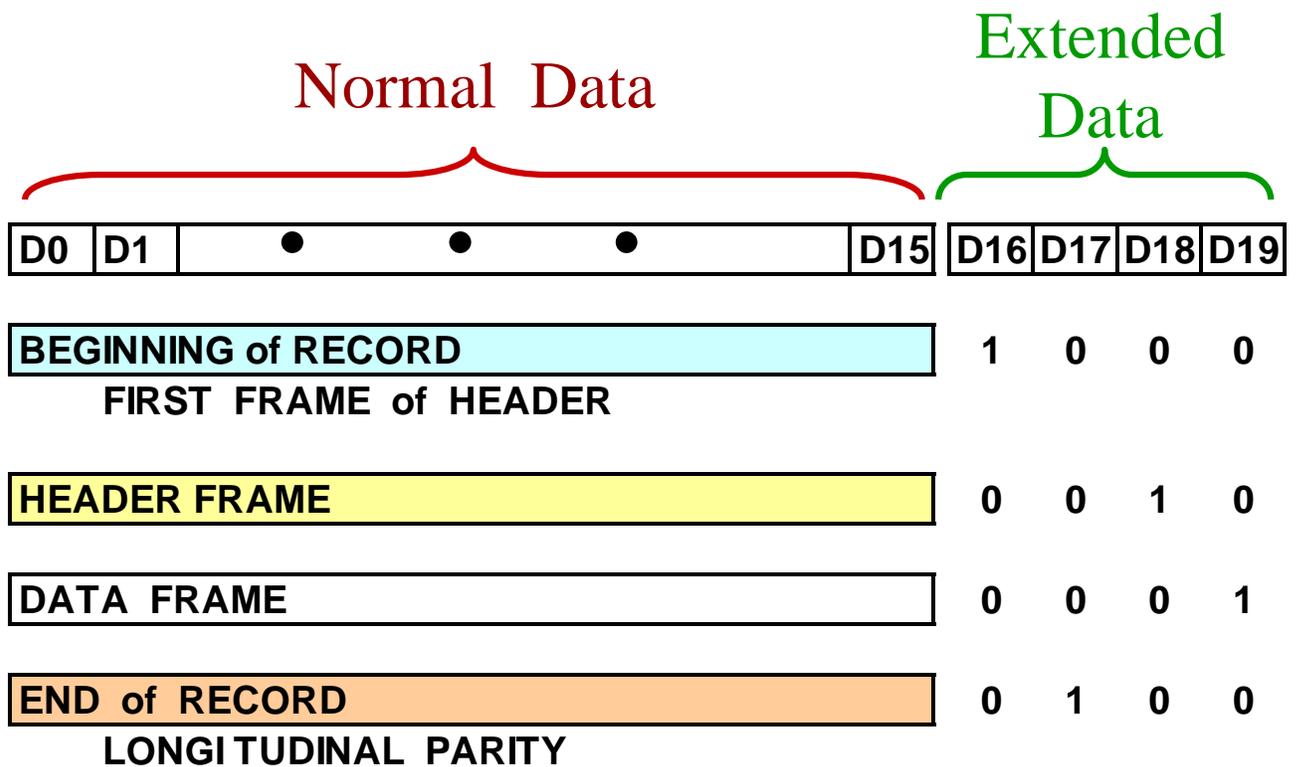
D0 is the LEAST significant bit
 D0 is the FIRST bit to be transmitted
 D0-D7 is the LEAST significant byte



PROPOSAL

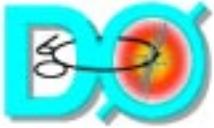
Protocol for

BROADCASTER to FIC Transfers



The following transparencies will show only the
“normal data”.

ALL (Header, Data, Trailer) **FRAMES**
FOLLOW the
DATA FRAME STRUCTURE



PROPOSAL

Protocol for

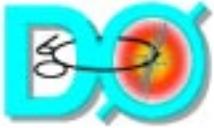
BROADCASTER to FIC Transfers

Field Assignments in the Header

Frame # 1	Record Length Information	Byte 0	Number of objects	
		Byte 1	D8-D11	Header Length
			D12-D15	Object Length
Frame # 2	Module Id and Crossing #	Byte 0	Source ID as in [3]	
		Byte 1	Bunch # as in [3]	
Frame # 3	Turn #		Turn #	
Frame # 4	Parameters	Byte 0	Processing Format	
		Byte 1	Global Error Code	

Field Assignments in the Trailer

Frame # 1	Repeated Information	Byte 0	Bunch # as in [3]
		Byte 1	Source ID as in [3]
Frame # 2	Parity	Byte 0	Longitudinal Parity
		Byte 1	Longitudinal Parity



PROPOSAL

Explanation of Fields in Header and Trailer

Number of Objects

Number of objects with valid data. It does not include Header, Trailer or Filler Frames.

Min = 0, Max = 255

Header Length

Number of 32bit words use in the Header.

Min = 2, Max = 17

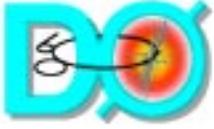
Object Length

Number of 32bit words required for the object. All objects within a transmission record have the same Length.

Min = 1, Max = 15

NOTE.-

The Header Length and the Object Length are coded in the same byte !



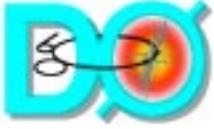
PROPOSAL

Why Split one Byte for Header and Object Length ?

- Decreases the minimum Header Length to 2 long words from 3
- Saves a minimum of 48ns in transmission time
- Simplifies the Broadcaster logic
- All needed information is present

Why NOT ?

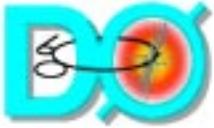
- The software needs to deal with split fields.
- At least three operations are required:
 - Two MASK operations
 - One DIVIDE operation (by 16)



PROPOSAL

BROADCASTER to FIC Transfers ERROR CODES

BIT	ERROR	G	L
7	Error Detected. Use Data at Own Risk.	✓	
6	Maximum number of consecutive parity errors reached	✓	
5	Maximum number of consecutive Frame Sync errors reached	✓	
4	Maximum number of consecutive Bit Sync errors reached	✓	
3	Parity Error detected	✓	✓
2	Frame Sync Error detected	✓	✓
1	Bit Sync Error detected	✓	✓
0	Test Data (no real data)	✓	



L2 DATA

Assignment of Frames and Fields

GLink between BROADCASTER and L2CFTpp (FIC)

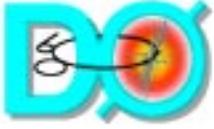
F #	LW#	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
1	1	OBJECT COUNT								1	1	0	0	1	0	0	0
2	1	SOURCE ID								CROSSING NUMBER							
3	2	TURN NUMBER															
4	2	PROCESSING FORMAT								GLOBAL ERROR CODE							
5	3	# of Tracks in Pt bin 1						# of Tracks in Pt bin 2									
6	3	# of Tracks in Pt bin 3						# of Tracks in Pt bin 4									
7	4	ERROR CODE		HPS	LPS	ISO	eISO	S	Pt BIN	EXTENDED Pt VALUE							
8	4	FE BOARD # (address)						Φ ADDRESS									
n-1	n/2	CROSSING NUMBER								SOURCE ID							
n	n/2	LONGITUDINAL PARITY								LONGITUDINAL PARITY							

Fig. 18 Fields assignments for data transfers from the BROADCASTER to the L2CFTpp and the L2STTpp FICs.

NOTE

n is the number of long words in the record excluding the three in the header.

Number of Tracks is limited to: a MAXIMUM of 48 per Pt Bin
a TOTAL MAXIMUM of 48



L2 DATA

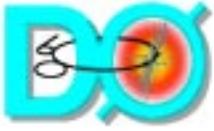
Assignment of Frames and Fields

GLink between BROADCASTER and L2CPSpp (FIC)

[AXIAL]

F #	LW#	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15		
1	1	OBJECT COUNT								0	1	0	0	1	0	0	0		
2	1	SOURCE ID								CROSSING NUMBER									
3	2	TURN NUMBER																	
4	2	PROCESSING FORMAT								GLOBAL ERROR CODE									
5	3	ERROR CODE			PSH		PSL		T		S		Pt BIN		CLUSTER WIDTH				
6	3	FE BOARD ADDRESS								N/S		CLUSTER ADDRESS							
		●		●		●		●		●									
n-1	n/2	CROSSING NUMBER								SOURCE ID									
n	n/2	LONGITUDINAL PARITY								LONGITUDINAL PARITY									

Fig. 19. Data Fields for CPS AXIAL BROADCASTER to L2CPS Transfers.



L2 DATA

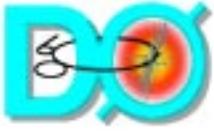
Assignment of Frames and Fields

GLink between BROADCASTER and L2CPSpp (FIC)

[STEREO]

F #	LW #	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15		
1	1	OBJECT COUNT								0	1	0	0	1	0	0	0		
2	1	SOURCE ID								CROSSING NUMBER									
3	2	TURN NUMBER																	
4	3	PROCESSING FORMAT								GLOBAL ERROR CODE									
5	4																		
6	4																		
7	4	ERROR CODE				PSH		PSL						CLUSTER WIDTH					
8	4	FE BOARD ADDRESS								U/V		CLUSTER ADDRESS							
		● ● ● ● ●																	
n-1	n/2	CROSSING NUMBER								SOURCE ID									
n	n/2	LONGITUDINAL PARITY								LONGITUDINAL PARITY									

Fig. 20. Data Fields for CPS STEREO BROADCASTER to L2CPS Transfers.



L2 DATA

Assignment of Frames and Fields

GLink between BROADCASTER and L2FPSpp (FIC)

F #	LW #	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
1	1	OBJECT COUNT								0	1	0	0	1	0	0	0
2	1	PROCESSOR ID								CROSSING NUMBER							
3	2	TURN NUMBER															
4	2	PROCESSING FORMAT								GLOBAL ERROR CODE							
7	4	ERROR CODE				PSH	PSL					CLSTR WIDTH					
8	4	FE BOARD ADDRESS								U/V	N/S	CLSTR ADDRESS					
9	5	MIP BIT PATTERN															
10	5																
		<div style="display: flex; justify-content: space-around; width: 100%;"> ● ● ● ● ● </div>															
n-1	n/4	CROSSING NUMBER								PROCESSOR ID							
n	n/4	LONGITUDINAL PARITY								LONGITUDINAL PARITY							

Fig. 21. Data Fields for FPS: BROADCASTER to L2FPS Transfers.

Note that each cluster requires three (3) full frames to carry the desired information. Following the rule of data being always transferred by long words, this implies that each cluster information is encoded into four (4) frames.