D0 Upgrade Electronics

CTT Cable Routing on the Central Platform

- Version 1.3 -

by
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1 List of 'Needed Changes'

Correct calculation of sequencer cable lengths for the 4 GS scheme.
Re-check the LVDS channel link cable lengths.

2 Introduction

This note outlines the routing of the assorted cables needed by the Central Tracking Trigger, CTT, on the D0 Detector Platform. It gives the most general description of the platform cable plant and references other notes, which contain more detail.

The CTT cable-plant on the Platform includes the sequencer cables, the LVDS channel link cables, the MUON L1 cables, the low voltage power distribution cables, and other smaller sets of cables. The major cable-plant, in terms of volume, is the sequencer cabling. These cables connect the SVX chips on the Analog Front End boards, AFE, with the sequencer boards. The lvds channel links carry the digital information from the AFE boards to the mixing box, on to the Digital Front End boards, DFE, and finally to the various layers of the trigger system on the platform. These cables constitute a relatively small volume but their lengths are critical. The third major grouping constitutes the remainder of the cables. Included in this group are the fast trigger signals from the CFT DFE boards to the L1MUON system. These cables are very time critical. Also included are the fiber optic cables that link the sequencer boards to the VRB

boards in the counting house. This cable set is small in volume but needs to be protected from damage. Several types of cables are associated with bringing the low voltage power, LV PS, to the hardware and the voltage sense signal back to the LV PS. This system is routed between the power supplies and the crate backplanes and between the power supplies and the monitoring interfaces.

3 Sequencer Cabling

The cable routing from the AFE backplane to the rear of the sequencer crates is as follows:

1. Dress Cables horizontally from AFE BP connection to AFE Crate supports. *Here they are bundled into one of 14 bundles.*
2. Run, within bundle, down crate supports and cryostat to under floor of isle between cryostat and south row of racks. *Here they are laid into one of the east-west under-floor cable trays.*
3. Re-bundle the cables into bundles by sequencer half-crate destination under floor.
4. Run under floor east/west towards north-south cable tray. *Put S-curve in this run to take up any excess cable length.*
5. Run north/south to sequencer rack.
6. Run up inside the side-of-rack to crate height.
7. Run horizontal from side-of-rack to back of crate.

The calculated cable lengths for the sequencer cables are given in table 1 below. The longest cable runs are 27', while the shortest are 17'.

3.1 Sequencer cable details

The sequencer cables have a cross section of about 2" by 0.09". They are relatively stiff but can be folded. The routing of the cables uses two types of fold, which we call the short fold and the long fold. The short fold has no twist and can either be a folding of the cable back upon itself (half of an S-curve) or into a 90 degree angle. This fold can fit into a box of 2" by 0.6". The 2" is simply the width of the cable, while the 0.6" is the most the cable can be squashed down at the fold. The long fold bends the cable by 90 degrees and gives it a 90-degree twist. This fold can fit into a box of 2" by 3". Figure 1 shows a stylized version of each of these folds. Note that a logical sequencer crate is 10 boards, while the physical crate size is 20 boards. Each physical crate holds two sequencer crates, xA and xB.

The cables which plug vertically into the back plane that is the 2" length is oriented vertically only require short folds to be dressed down to the sub-floor. The cables, which plug into the back plane horizontally, require one long fold to be dressed down to the sub-floor.

The total number of sequencer cables is about 150. If they were to be dressed into a single bundle, this bundle would be 2" by 14". Each sequencer crate has 40 cables connected to the back plane in 4 horizontal rows. The bundle for each row of a crate contains 10 cables is 2" by 1" in cross section. Thus, each horizontal row for a crate can be dressed up the inside of a crate

between the outside cover and the crate supports inside the rack. A 90-degree short fold is used to switch the bundle from horizontal to vertical at the base of the rack and a second short fold is used to convert from vertical to horizontal at the height of the crate. The size of this fold, 2" by

3.2 Sequencer Cable Labeling

Each sequencer cable is individually labeled. Both ends have identical lables which give information of the source and destination and information about the detector.

One line of the label gives the AFE backplane half-crate ID and the connector ID followed by the rack, half-crate, slot and connector for the sequencer.

4 LVDS Cabling

Each LVDS cable consists of a twisted pair inside a ground shield within an insulated jacket. Two of these cables are joined at each end into a thin wafer with 6 pins for connection into a socket mounted on the PCB or backplane. The four outer pins carry the four signals and the center two pins carry the shield ground. These thin wafers are stacked to form the links.

Two types of links are used which are distinguished by their bandwidth. One link is 21 bits wide and uses two wafers and four cables. Of the four cables, three are signal pairs and one is the clock pair. The other link is 28 bits wide and uses three wafers and five (six) cables. Four of the cables are signal pairs and one is the differential clock. (The sixth cable is not used.) The 21 bit wide link is called 21w, the 28 bit wide link is called 28w.

The wafers are stacked vertically in the connectors at the AFE backplane, on the DFE motherboard, and on the Mixer board. In all of these uses, a 28w link is a three-wafer-stack and a 21w is a two-wafer-stack. In all cases for a 28w link the top two wafers have the same pin-out as a 21w link. Thus, all the backplane or board input/output connections for 28w links can be used for 21w links. A 28w driver however, cannot be linked to a 21w receiver or vice versa. Because of the time multiplexing used in the chip-sets more than 8 bits are dropped and the resulting bits are scrambled.

4.1 From AFE to DFE / Mixer

The scheme for cabling from the AFE backplane to the front of the DFE board or mixer board crates uses the following steps:

1. Dress Cables horizontally from AFE BP connectors to AFE Crate supports.
2. Run down crate supports and cryostat to under floor of isle between cryostat and south row of racks.
3. Run under floor east/west towards centerline.
4. Run north/south to DFE rack.
5. Run up inside the rack front panel to crate height.

The calculated cable lengths for the LVDS-Channel cables are given in a separate spreadsheet. The longest cable runs are 10m, while the shortest are 2m. The LVDS cable routing is shown in the figures at the end of this note. The numbers of cables and the grouping into bundles is discussed below and given in separate spreadsheets.

4.2 Cable Bundling and Labeling

Several links are stacked to form a cable (sub-)bundle. The hierarchy is bundle, sub-bundle, link, wafer, and shielded-twisted-pair.

Note that the DFE input connector numbers are scrambled relative to the internal bus numbers. Both sets of numbers are given in the tables below. Also not that figures at the end of this note diagram the channel flow from detector, through cassette, on through AFE board and finally into the DFE board or Mixer board.

4.2.1 FPS Cable Bundles

Each FPS AFE board has five output LVDS links. Figure 12a shows this in schematic form. Two of the links are 21w and three are 28w. These links are routed to connectors on the rear of the AFE backplane. See figures 16 and 17. The links at this connector are numbered from 1 to 5 starting from the top. The top two are 21w and the bottom three are 28w.

The LVDS links from two AFE boards located on the same cassette are routed to a single DFE motherboard. Figure 13 shows this routing in gereral terms. These ten links are bundled into a single cable. The five links from each AFE backplane connector constitute a sub-bundle of this bundle. However, the same five links are not in the same sub-bundles at both ends. Two of the five links at either end have 2 wafers and three of the links have 3 wafers. All of the wafers have two twisted-pairs except the third wafer in each of the 3-wafer links, which has a single twisted-pair.

The labels are located on the sub-bundle ends, four labels per bundle. These labels on the AFE backplane end give the crate and slot ID, on the DFE motherboard end the labels give the rack, crate, slot and connector ID.

Detector		**AFE**		**DFE**		**Link**	
Phi	Layer	sub-bndl	link	Int. bus	Connector	#	type
Wedge 1	MIP	left	1	bus 0	Conn a	0	21w
Wedge 2	MIP	left	2	bus 9	Conn b	9	21w
Wedge 1	Shower	left	3	bus 7	Conn a	6	28w
Wedge 1/2	Shower	left	4	bus 3	Conn a	4	28w
Wedge 2	Shower	left	5	bus 5	Conn b	5	28w
Wedge 1	MIP	right	1	bus 8	Conn a	8	21w
Wedge 2	MIP	right	2	bus 1	Conn b	1	21w
Wedge 1	Shower	right	3	bus 6	Conn a	7	28w
Wedge 1/2	Shower	right	4	bus 4	Conn b	3	28w
Wedge 2	Shower	right	5	bus 2	Conn b	2	28w

The above table gives the routing of links within each FPS cable bundle. Each cassette holds the MIP and Shower layers for two different phi wedges. At the AFE backplane end the cable sub-bundles are Left 1-5 and Right 1-5. At the DFE end the cable sub-bundles are Conn 0-4 and Conn 5-9. Wedges 1 and 2 are from the usage of figure 13 and represent the north and south phi wedges that share a cassette.

4.2.2 CPS Stereo Cable Bundles

Each CPS Stereo AFE board has three output LVDS links, which are 28w. Figure 12b shows this in schematic form. They are routed to connectors 3 through 5 on the AFE backplane. The LVDS links from two AFE boards located on the same cassette are routed to a single DFE motherboard. These six links are bundled into a single cable bundle. The three links from each AFE backplane connector constitute a sub-bundle of this bundle. However, the same three links are not in the same sub-bundles at both ends. All of the links have 3 wafers. The third wafer on each of the links has a single twisted-pair.

The labels are located on the sub-bundle ends. The labels on the AFE backplane end give the crate and slot ID. On the DFE motherboard end, the labels give the rack, crate, slot and connector ID.

Detector	**AFE**		**DFE**		**Link**	
Layer	sub-bndl	link	Internal bus	Connector	#	type
not used						21w
not used						21w
North u & v strips	left	3	bus 3	conn a	4	28w
North u & v strips	left	4	bus 5	con b	5	28w
North u & v strips	left	5	bus 7	conn b	6	28w
not used						21w
not used						21w
South u & v strips	right	3	bus 6	conn b	7	28w
South u & v strips	right	4	bus 4	conn a	3	28w
South u & v strips	right	5	bus 2	conn a	2	28w

The above table gives the routing of links within each CPS Stereo cable bundle. Each cassette holds both CFT Stereo fibers and CPS strips. The CFT fibers are not routed out of the AFE board, only the CPS strips are brought out. At the AFE backplane end the cable sub-bundles are Left 2-4 and Right 2-4. At the DFE end the cable sub-bundles are Conn 2-4 and Conn 5-7.

4.2.3 CPS Axial Cable Bundles

Each CPS Axial AFE board has two output LVDS links, which are 28w. Four LVDS links, two each from the two AFE boards located on the same cassette, are bundled into a single cable and are each routed to a different mixer board. The two links from each AFE backplane connector constitute a sub-bundle at the AFE end. The four single links constitute sub-bundles at the mixer board end.

The labels are located on the sub-bundle ends. These labels on the AFE backplane end give the crate and slot ID, on the mixer board end the labels give the rack, crate, slot and connector ID.

Detector Layer	AFE sub-bndl	link	Mixer Input brd	Connector	Link type
not used					21w
not used					21w
North axial strips	left	3	slot n+2	conn x	28w
not used					28w
North axial strips	left	5	slot n	conn x	28w
not used					21w
not used					21w
South axial strips	right	3	slot n+1	conn x	28w
not used					28w
South axial strips	right	5	slot n+3	conn x	28w

This table gives the routing of links within each CPS Axail cable bundle. Each cassette holds both CFT Stereo fibers and CPS strips. The CFT fibers are not routed out of the AFE board, only the CPS strips are brought out. At the AFE backplane end the cable sub-bundles are Left 2 & 4 and Right 2 & 4. At the DFE end the four cable sub-bundles are Conn 2, Conn 4, Conn 5, and Conn 7.

4.2.4 CFT Axial Cable Bundles

Each CPS Axial AFE board has four output LVDS links, which are 21w. Eight LVDS links, four each from the two AFE boards located on the same cassette, are routed to four different mixer boards. These eight links are joined into a single cable. The pattern of mixer boards is different for each of the eight cassettes within a super sector. The four links from each AFE backplane connector constitute a sub-bundle at the AFE end. The eight single links constitute a sub-bundle at the mixer board end.

The labels are located on the sub-bundle ends. These labels on the AFE backplane end give the crate and slot ID, on the mixer board end the labels give the rack, crate, slot and connector ID.

Detector module	AFE bp	link	Mixer Input brd	Connector	Link type
LVDS 1	left	1	slot x	conn x	21w
LVDS 2	left	2	slot x	conn x	21w
LVDS 3	left	3	slot x	conn x	28w as 21w
LVDS 4	left	4	slot x	conn x	28w as 21w
not used					28w
LVDS 1	right	1	slot x	conn x	21w
LVDS 2	right	2	slot x	conn x	21w
LVDS 3	right	3	slot x	conn x	28w as 21w
LVDS 4	right	4	slot x	conn x	28w as 21w
not used					28w

The above table gives the links within each cable bundle for the CFT Axial at the AFE backplane end. The destination mixer box slot and connector are different for each of the eight bundles within each super sector. Therefor the mixer box end of the bundles cannot be listed in such a simple table as above. The five bundles from each corresponding cassette in the five super sectors, however, do have the same cable bundle routing and the same labeling scheme.

LVDS channels 3 and 4 use two of the three 28w wafer slots on the AFE backplane to drive a 21w line.

4.3 From DFE to Collector and onward

The

5 LV PS Cabling

The

6 Cable Trays

This section calculates the fill of the cable trays at six critical points. These points are shown in figure 1 that shows the 'general cable tray layout', and figures 2 through 6 that show the different cable plants.

Contents of East Primary N/S @ N-A				
Cable Type	Number	Area Factor sq in per	Cross Sect Area sq in	Running Sum sq in
SEQ	30	0.2	6.0	6.0
Optical	320	0.017	5.4	11.4
LVDS AFE	208	0.11	22.9	34.3
LVDS DFE	0	0.11	0.0	34.3
Muon	96	0.038	3.6	38.0

Table 1.

Contents of Northeast E/W @ N-C				
Cable Type	Number	Area Factor sq in per	Cross Sect Area sq in	Running Sum sq in
SEQ	14	0.2	2.8	2.8
Optical	0	0.017	0.0	2.8
LVDS AFE	80	0.11	8.8	11.6
LVDS DFE	0	0.11	0.0	11.6
Muon	96	0.038	3.6	15.2

Table 2.

Contents of West Primary N/S @ N-B				
Cable Type	Number	Area Factor sq in per	Cross Sect Area sq in	Running Sum sq in
SEQ	26	0.2	5.2	5.2
Optical	28	0.017	0.5	5.7
LVDS AFE	160	0.11	17.6	23.3
LVDS DFE	160	0.11	17.6	40.9
Muon	0	0.038	0.0	40.9

Table 3.

Contents of Northwest E/W at the east end N/S @ N-D				
Cable Type	Number	Area Factor sq in per	Cross Sect Area sq in	Running Sum sq in
SEQ	10	0.2	2.0	2.0
Optical	28	0.017	0.5	2.5
LVDS AFE	32	0.11	3.5	6.0
LVDS DFE	184	0.11	20.2	26.2
Muon	0	0.038	0.0	26.2

Table 4.

Contents of East Primary N/S @ S-A				
Cable Type	Number	Area Factor sq in per	Cross Sect Area sq in	Running Sum sq in
SEQ	40	0.2	8.0	8.0
Optical	320	0.017	5.4	13.4
LVDS AFE	112	0.11	12.3	25.8
LVDS DFE	0	0.11	0.0	25.8
Muon	0	0.038	0.0	25.8

Table 5.

Contents of West Primary N/S @ S-B				
Cable Type	Number	Area Factor sq in per	Cross Sect Area sq in	Running Sum sq in
SEQ	44	0.2	8.8	8.8
Optical	0	0.017	0.0	8.8
LVDS AFE	128	0.11	14.1	22.9
LVDS DFE	24	0.11	2.6	25.5
Muon	0	0.038	0.0	25.5

Table 6.

7 Summary

This note

8 Acknowledgements

The ideas for this note

9 References and related documents

PPD/MECHANICAL SUPPORT 900602 bundle sector layout - shows the routing of the waveguide fibers from the drop downs to the top of the cassettes

PPD/MECHANICAL SUPPORT 900626 west VLPC waveguide connector layout - shows the routing of the waveguide fibers into the top of the VLPC cassettes

PPD/MECHANICAL SUPPORT 900627 east VLPC waveguide connector layout - shows the routing of the waveguide fibers into the top of the VLPC cassettes

PPD/MECHANICAL SUPPORT 900628 barrel/waveguide naming scheme south end - shows the CFT ribbon numbering system on the south end of the detector and the CPS bundling scheme

PPD/MECHANICAL SUPPORT 900636 barrel/waveguide naming scheme north end - shows the CFT ribbon numbering system on the north end of the detector and the CPS bundling scheme

The rack layout for the platform can be found at:
http://d0server1.fnal.gov/Projects/MCH_and_Platform/Index.htm

Source	Destination	dwn	n/s	e/w	n/s	up	horz	Max Total inches	feet	
Bundle 1	PC19	54	12	108	48	72	24	318	26	1/2
Bundle 2	PC19	54	12	94	48	72	24	304	25	1/3
Bundle 3	PC04	54	42	63	42	72	24	297	24	3/4
Bundle 4	PC04	54	42	49	42	72	24	283	23	4/7
Bundle 5	PC04	54	42	35	42	72	24	269	22	3/7
Bundle 6	PC04	54	42	21	42	72	24	255	21	1/4
Bundle 7	PC04	54	42	7	42	72	24	241	20	
Bundle 8	PC04	54	42	18	42	72	24	252	21	
Bundle 9	PC04	54	42	32	42	72	24	266	22	1/6
Bundle 10	PC04	54	42	46	42	72	24	280	23	1/3
Bundle 11	PC04	54	42	60	42	72	24	294	24	1/2
Bundle 12	PC04	54	42	78	42	72	24	312	26	
Bundle 13	PC19	54	12	76	48	72	24	286	23	5/6
Bundle 14	PC19	54	12	90	48	72	24	300	25	
	Maximum =							318	26	1/2

Table 1 - This table shows the calculation of the Sequencer cable lengths on the platform. 'dwn' is the vertical distance from the AFE BP to the sub-floor. 'n/s' is the north/south distance to the center of an e/w cable tray. 'e/w' is the east/west distance towards the platform centerline. The second 'n/s' is the distance in the n/s cable tray. 'up' is the vertical rise from the sub-floor to the crate height. 'horz' is the distance within the rack to be BP of the crate.

Detector		Sequencer Rack	Sequencer Crate	MB Rack	MB Crate	DFE Rack	DFE Crate
FPS	east	PC19	C2A	-	-	PC20	C3A
FPS	west	PC19	C2A	-	-	PC19	C3B
CPS	east	PC04	C2B	-	-	PC20	C3B
CPS	west	PC04	C2B	-	-	PC19	C3A
CFT Ax	east	PC19	C2B	PC04	C3B	PC03	C3
CFT Ax	west	PC19	C2B	PC04	C3A	PC03	C4
CFT St	east	PC04	C2A	-	-	-	-
CFT St	west	PC04	C2A	-	-	-	-

Table 3 - This table shows the location of hardware in the platform for each of the detectors in the CTT. The 'A' and 'B' designations on the crates mean 'A = left hand half' and 'B = right hand half'.

Muon L1 Cable Lengths to the most distance MUON crate							
	Rack	Crate	s/n	w/e	h (max)	inches	meters
CFT							
DFE	PC03	C3/C4	-68	4	36		
L1 Muon	PE09*	C1*	-34	-308	84		
Diff			34	312	120	466	11.8

Table 5 - This table, in the same format as table 4, calculates the lengths of L1 Muon cable from the DFE to the most distance Muon rack and crate.

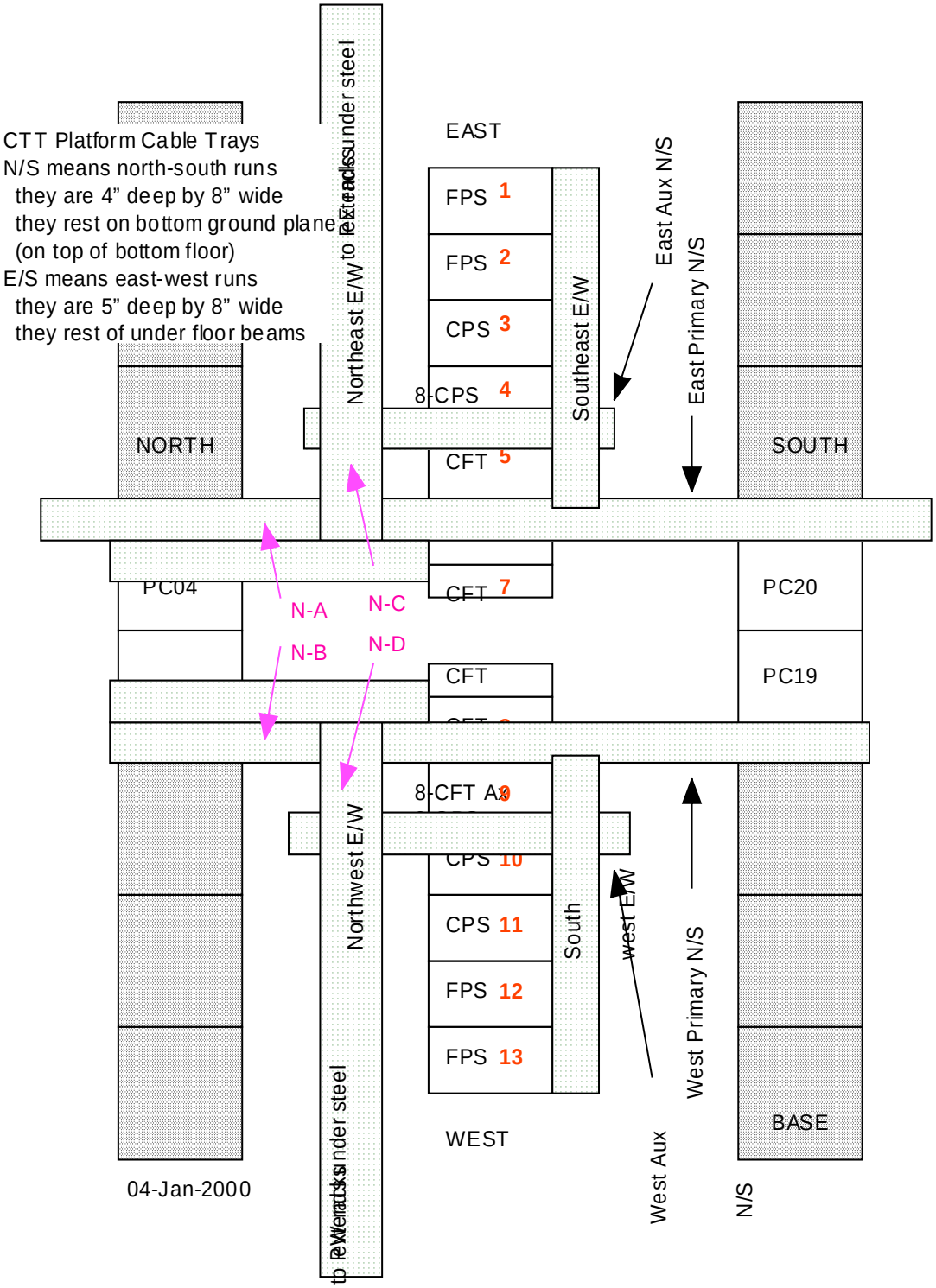


Figure 1 - Plan drawing of the D0 Central Detector platform, showing the two rows of racks, the LVPC cryostats and crates and the under floor cable trays.

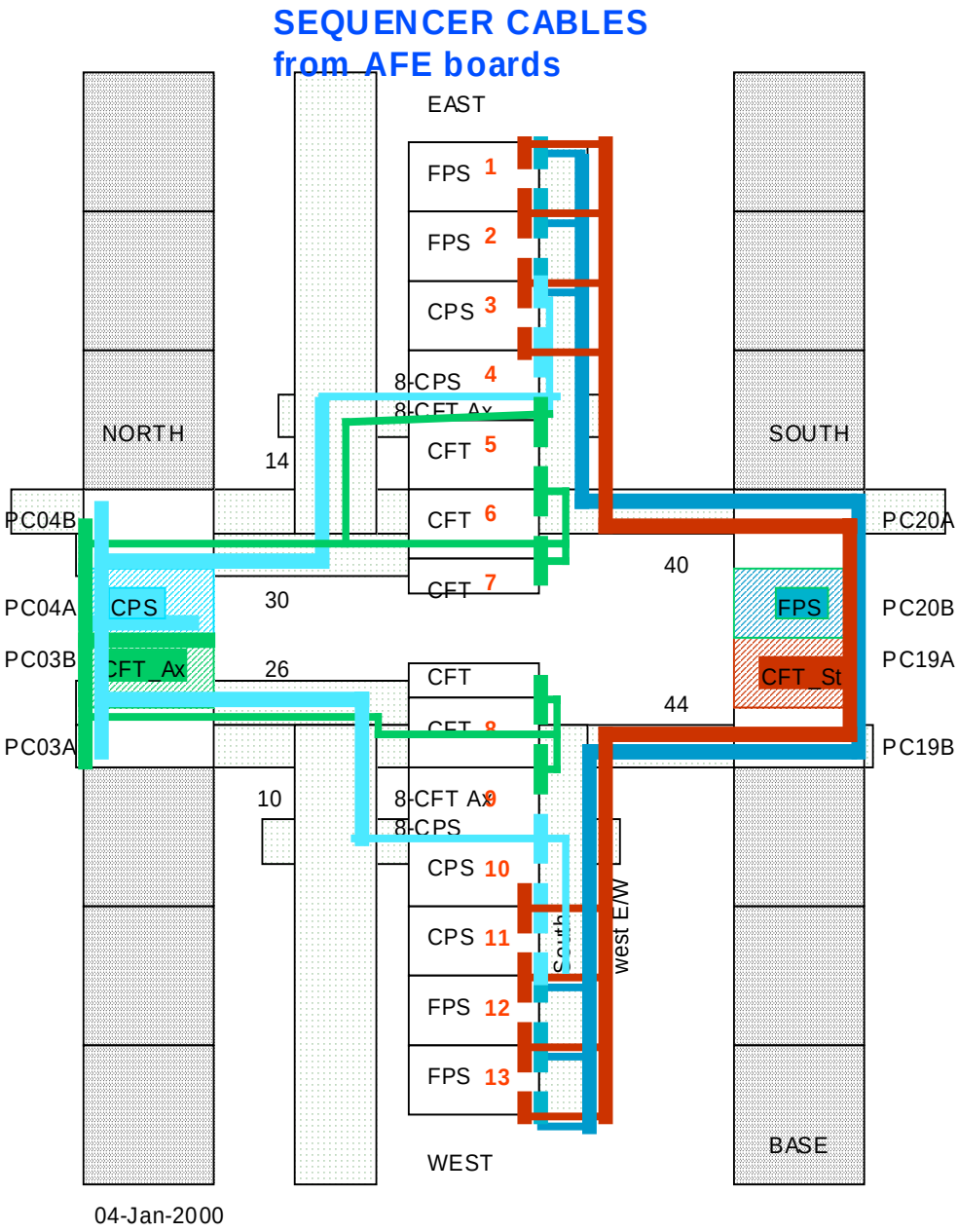


Figure 2 - Sequencer cable routing from the AFE to the Sequencer Crates. The extreme east and west AFE crates are routed to the south row or racks to minimize the sequencer cable lengths.

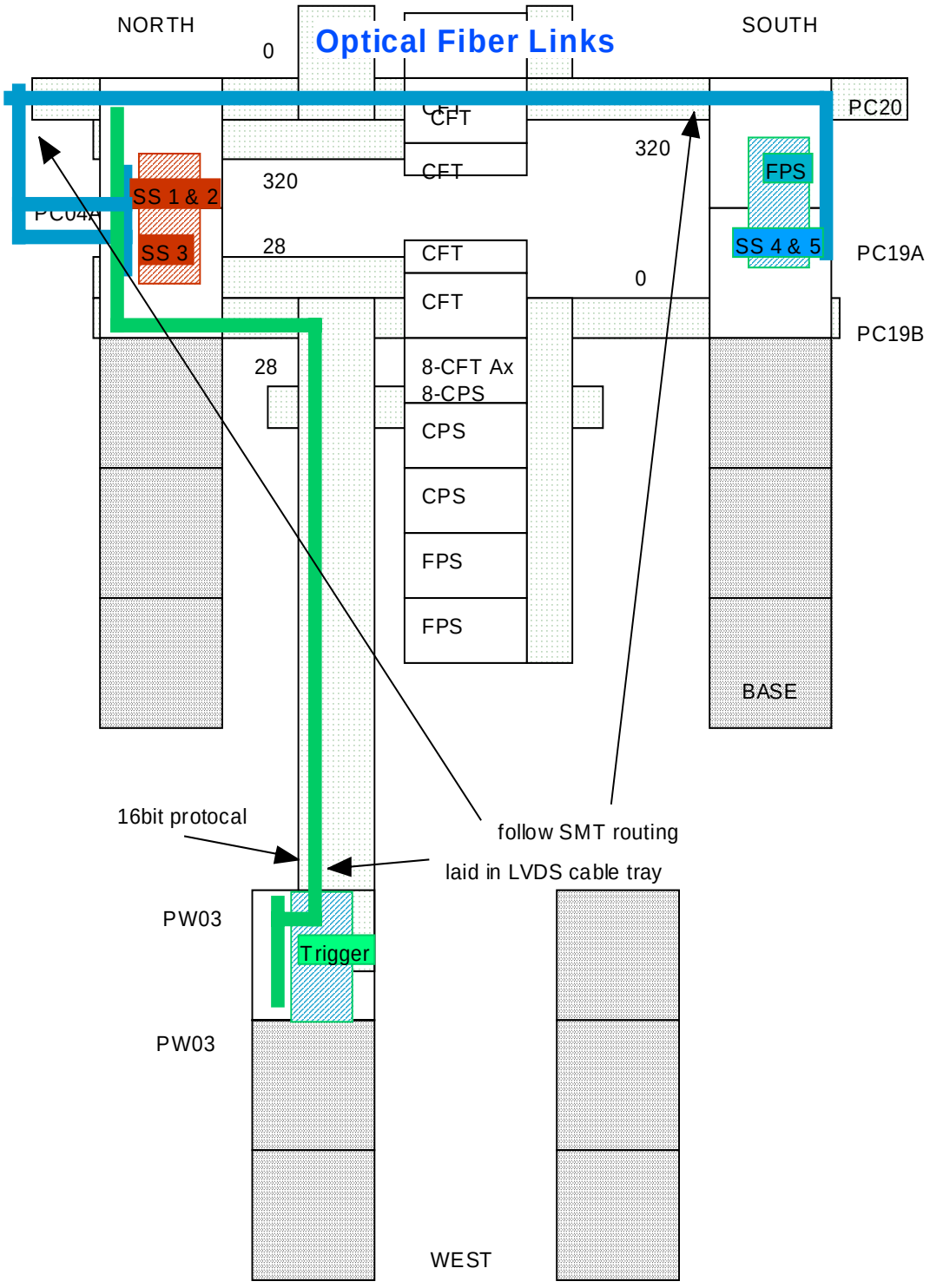


Figure 3 - Routing for the fiber optic cables from the sequencer and trigger crates on the platform. They all connect to VRB crates in the moving counting house.

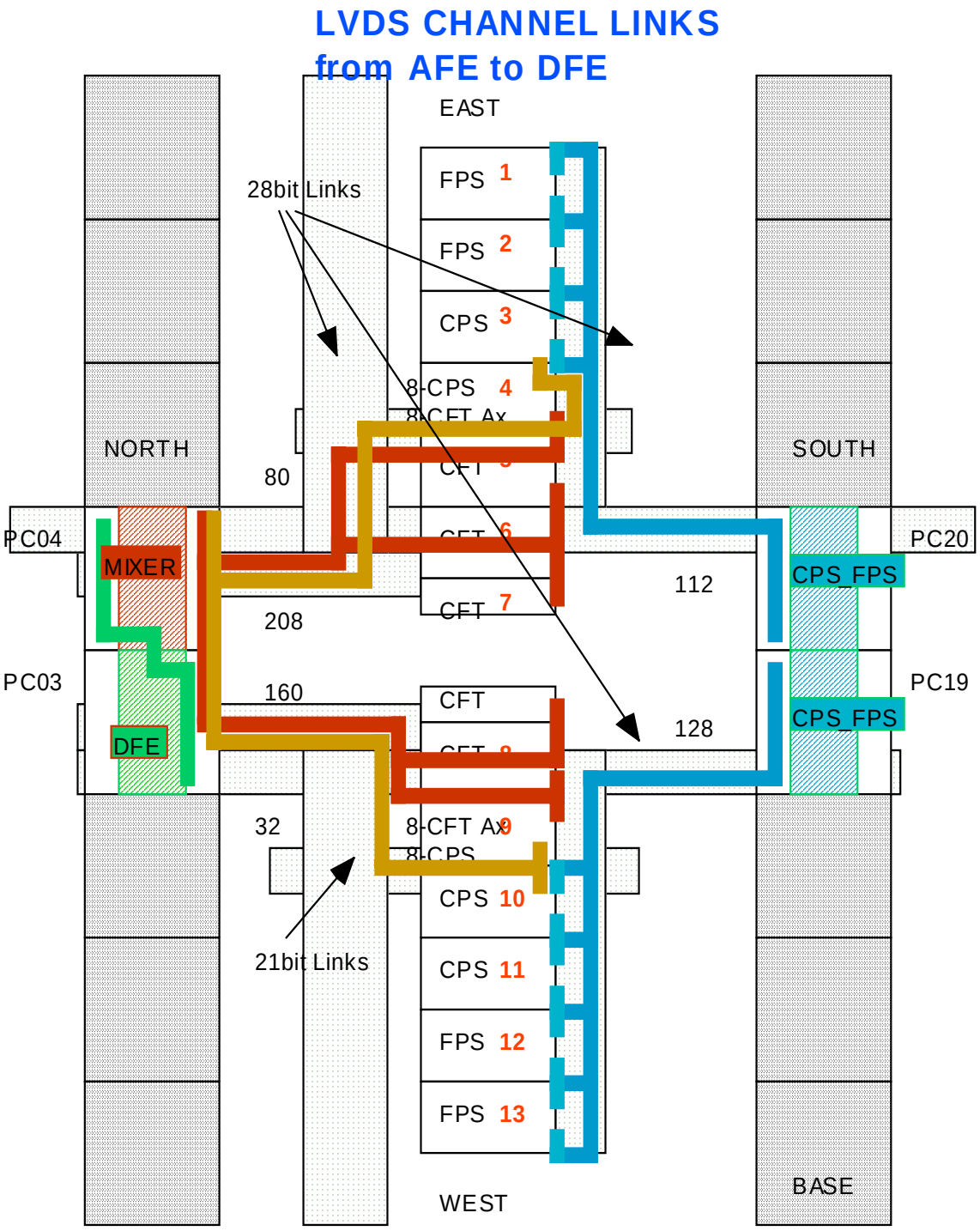


Figure 4 - LVDS Channel cable routing from the AFE to the DFE boards, some via the mixer box. The CPS Axial channels are used in the L1 trigger and are routed to the mixer box. The CPS U and V layers are not in the L1 and are routed to the south crates that are shared with the FPS.

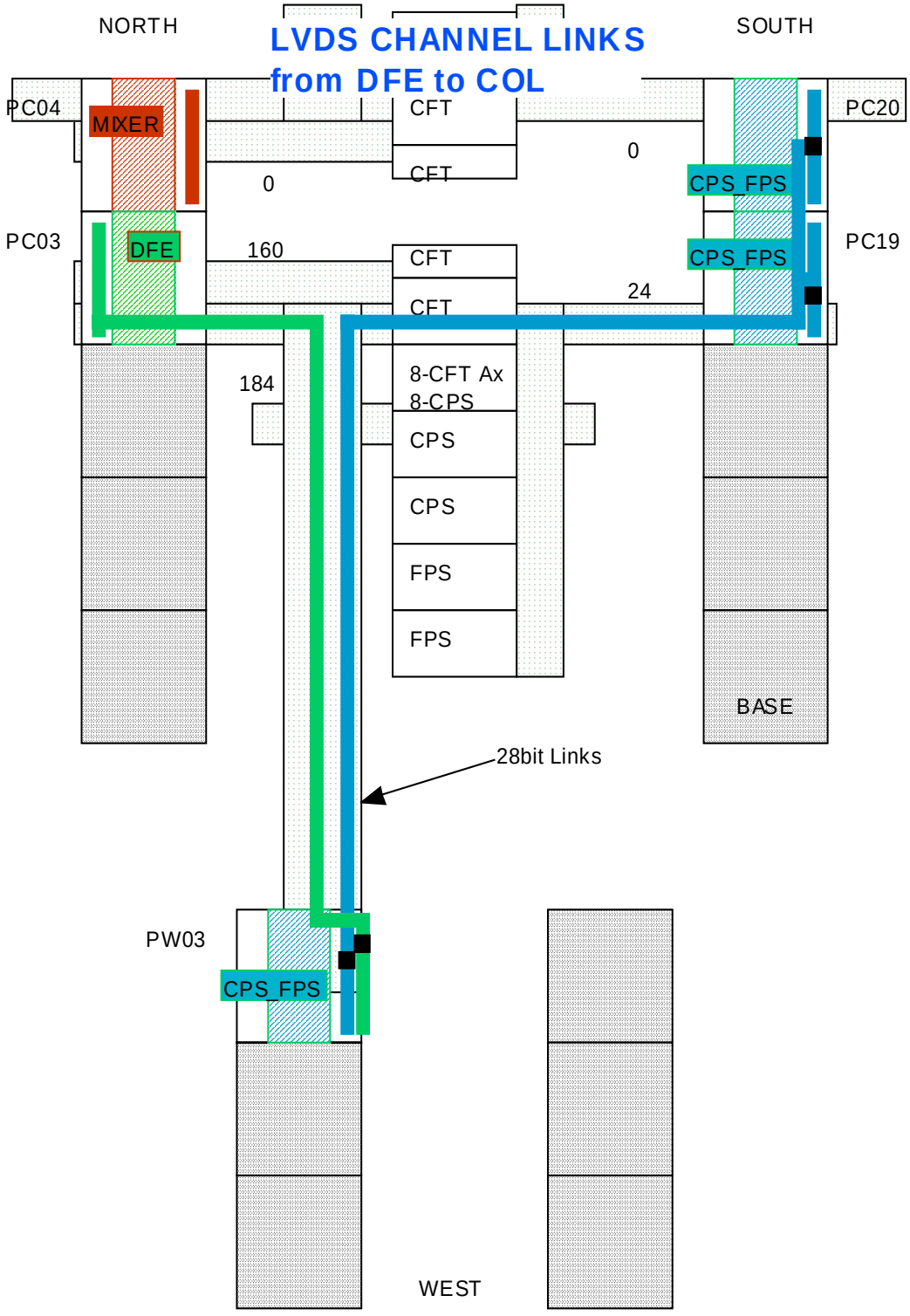


Figure 5 - LVDS channel cable routing from the DFE boards to the Collector boards

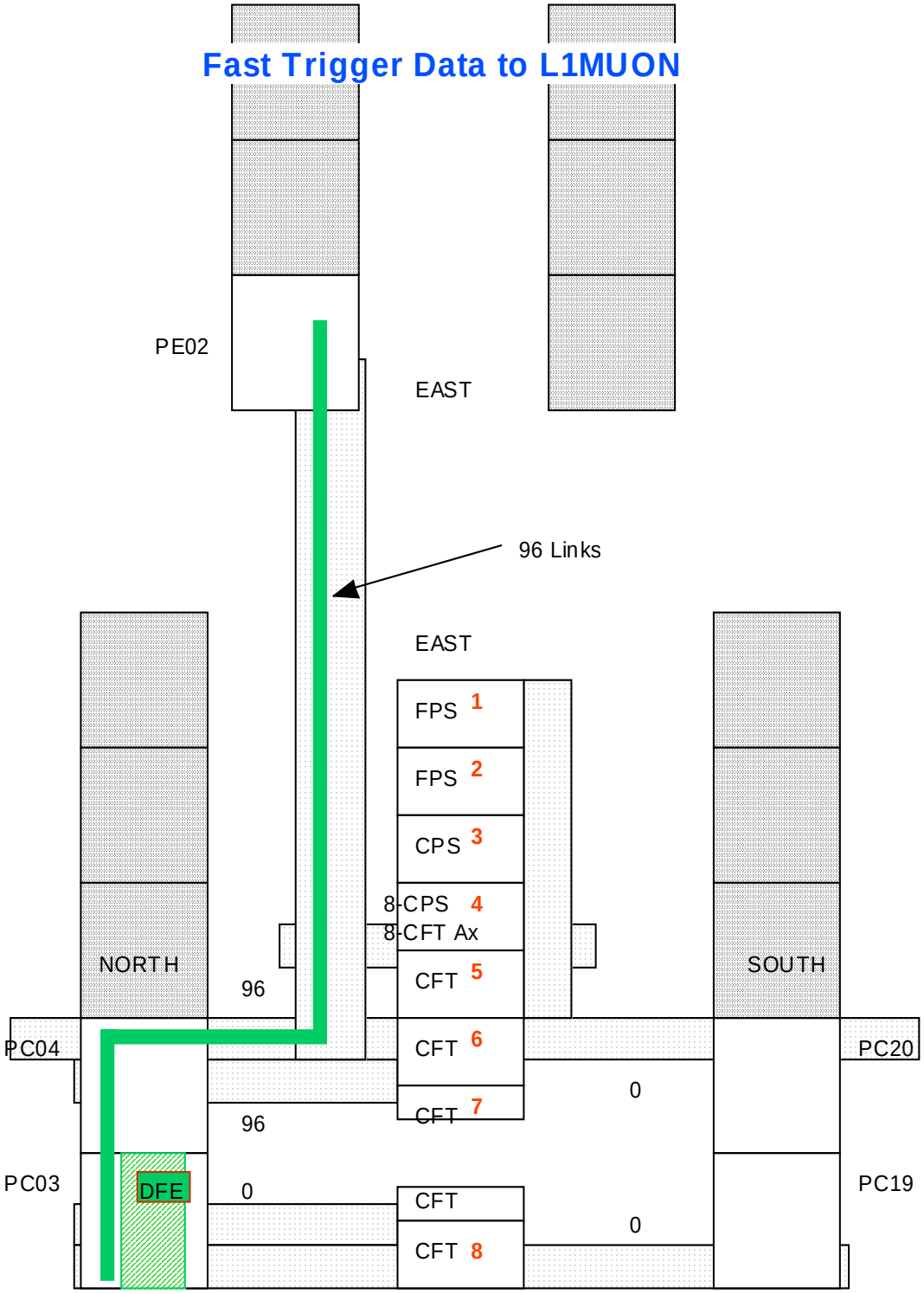


Figure 6 - The routing for the cables for the L1MUON trigger.

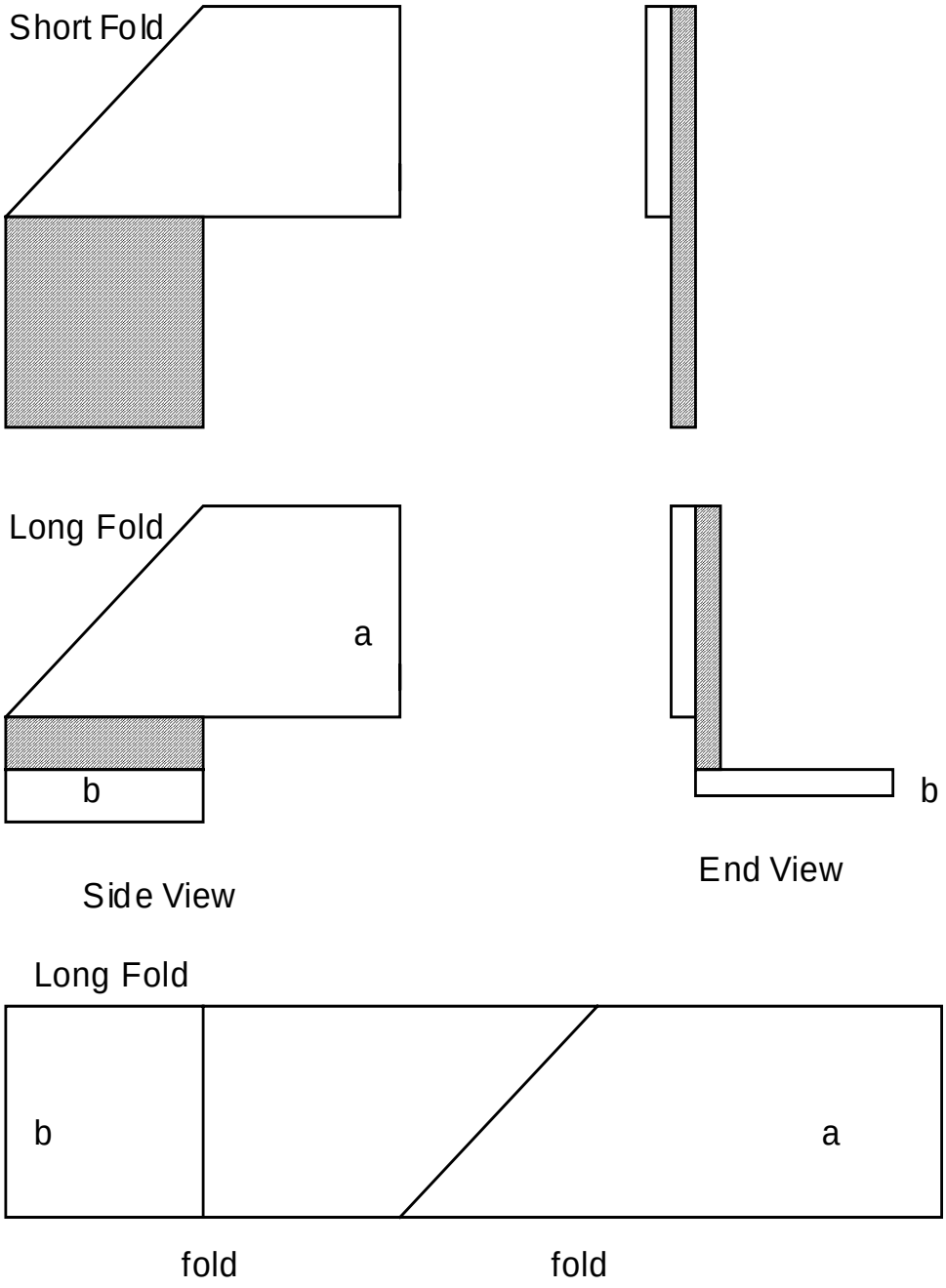


Figure 7 - This figure shows a stylized view of a short fold and a long fold. The long fold is a short fold combined with a bend. The strip at the bottom illustrates where the cable is folded.

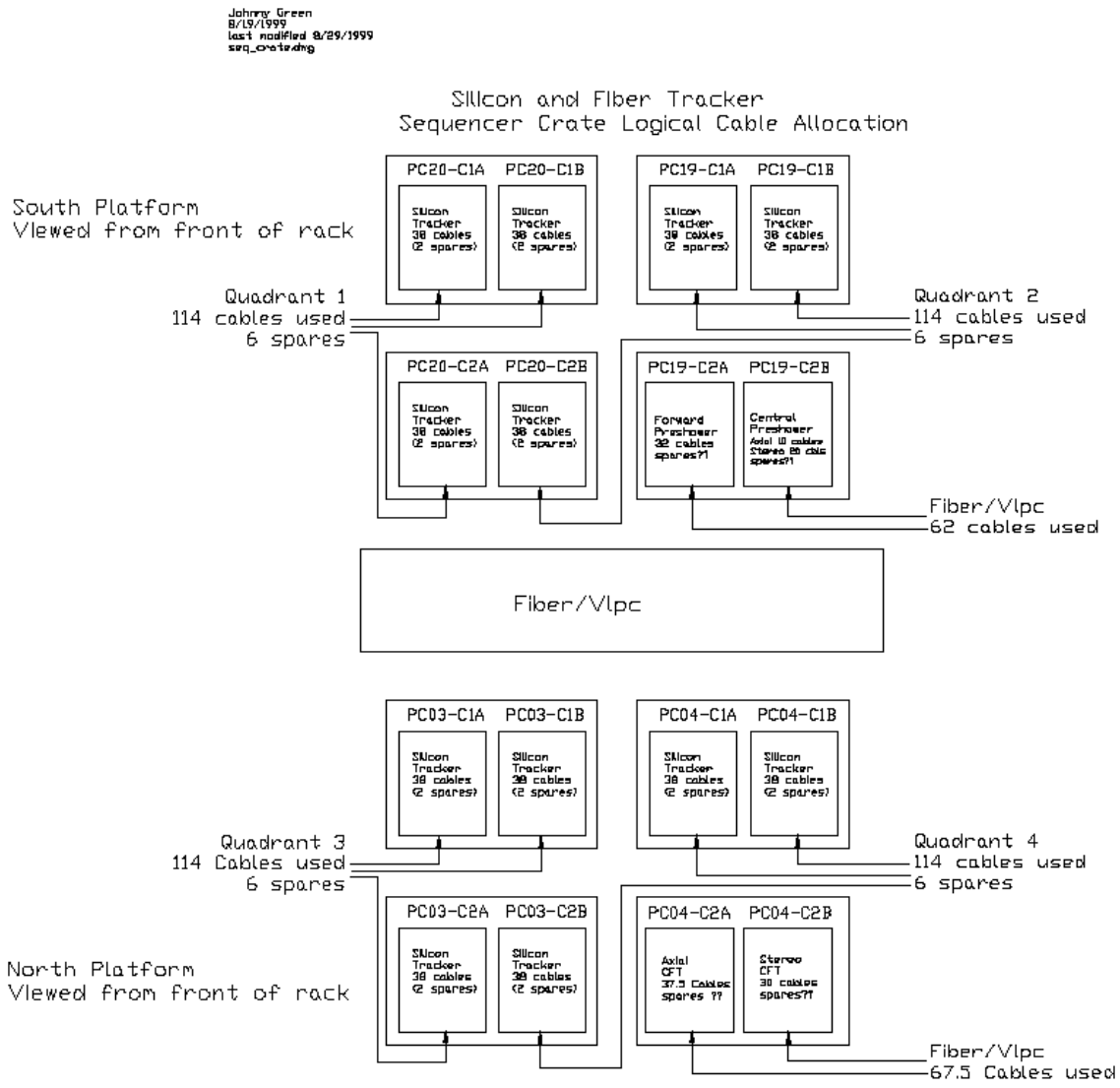


Figure 8 - This figure shows the assignment of the sequencer crates.

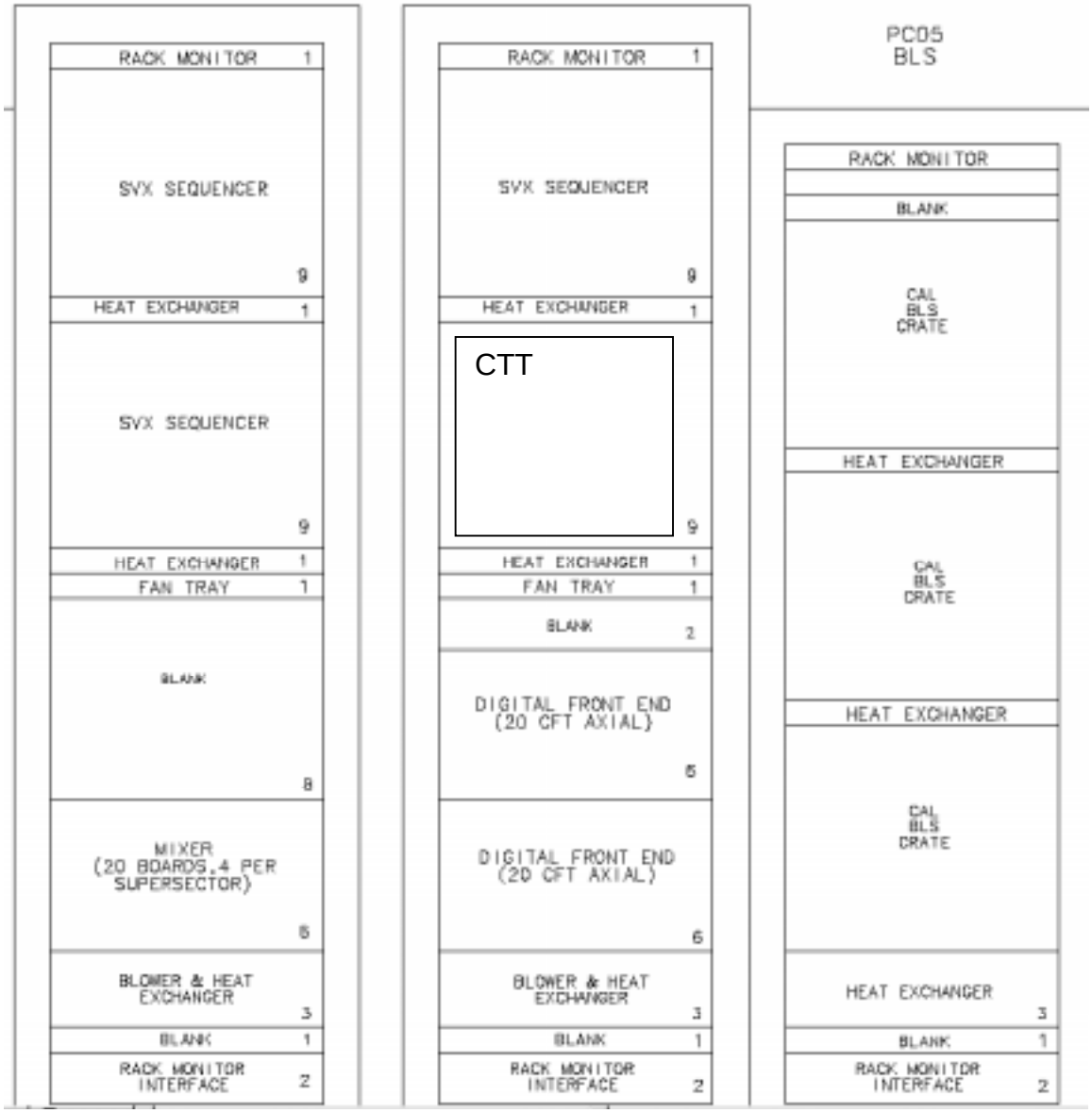


Figure 9 - Layout of Sequencer and CTT racks in the center platform, the north and south rows.

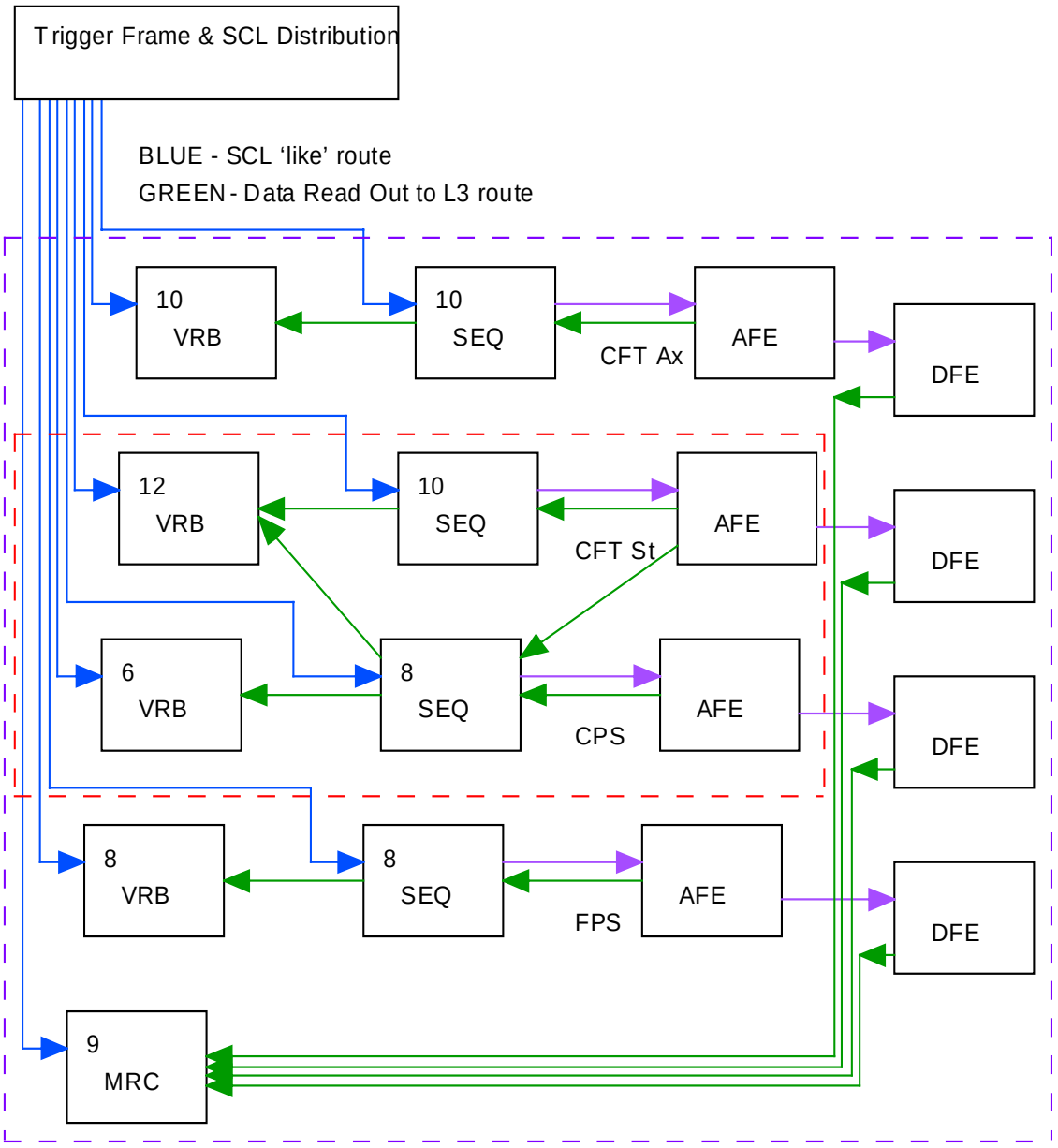


Figure 11 - Schematic of the five Geographical Sectors which make up the CTT system. The routing for the Serial Command Link Information is shown in blue, SCL derived information in purple, and the L3 data path in green.

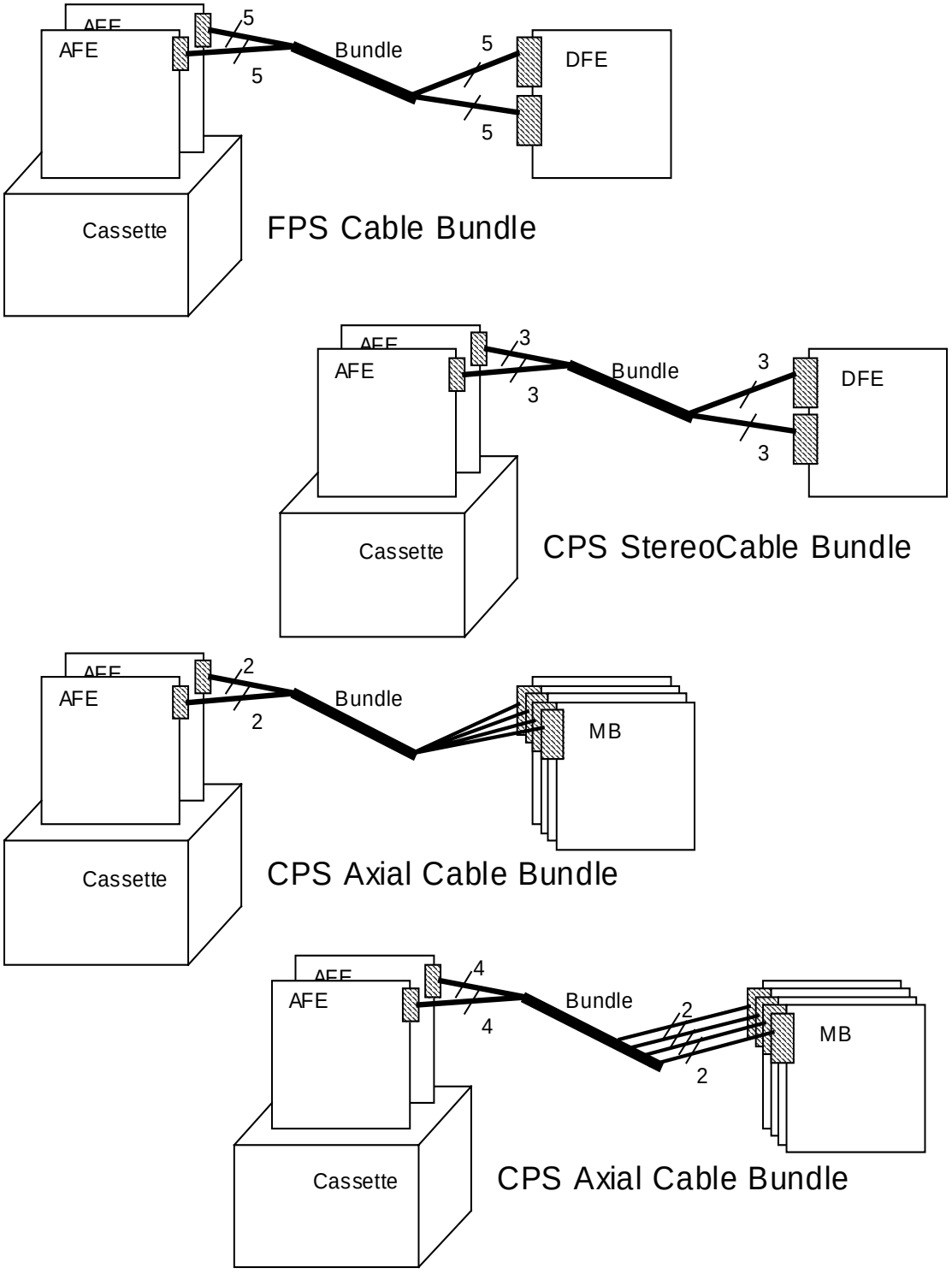


Figure 12 - Cable bundle scheme for the LVDS cables from the AFE boards.

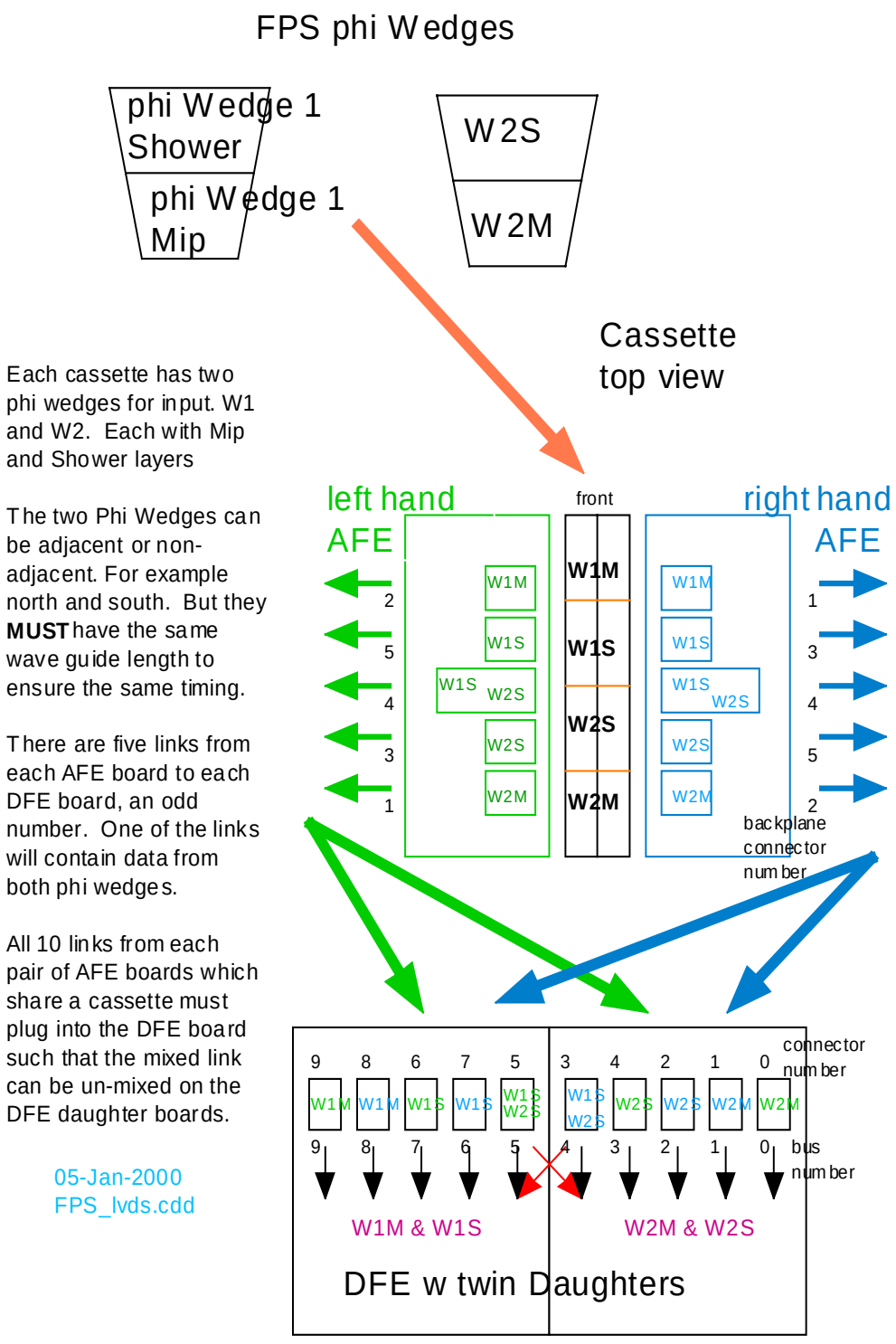


Figure 13 - General scheme of the trigger signal routing for the FPS, from detector to cassette to AFE Board to DFE Board.

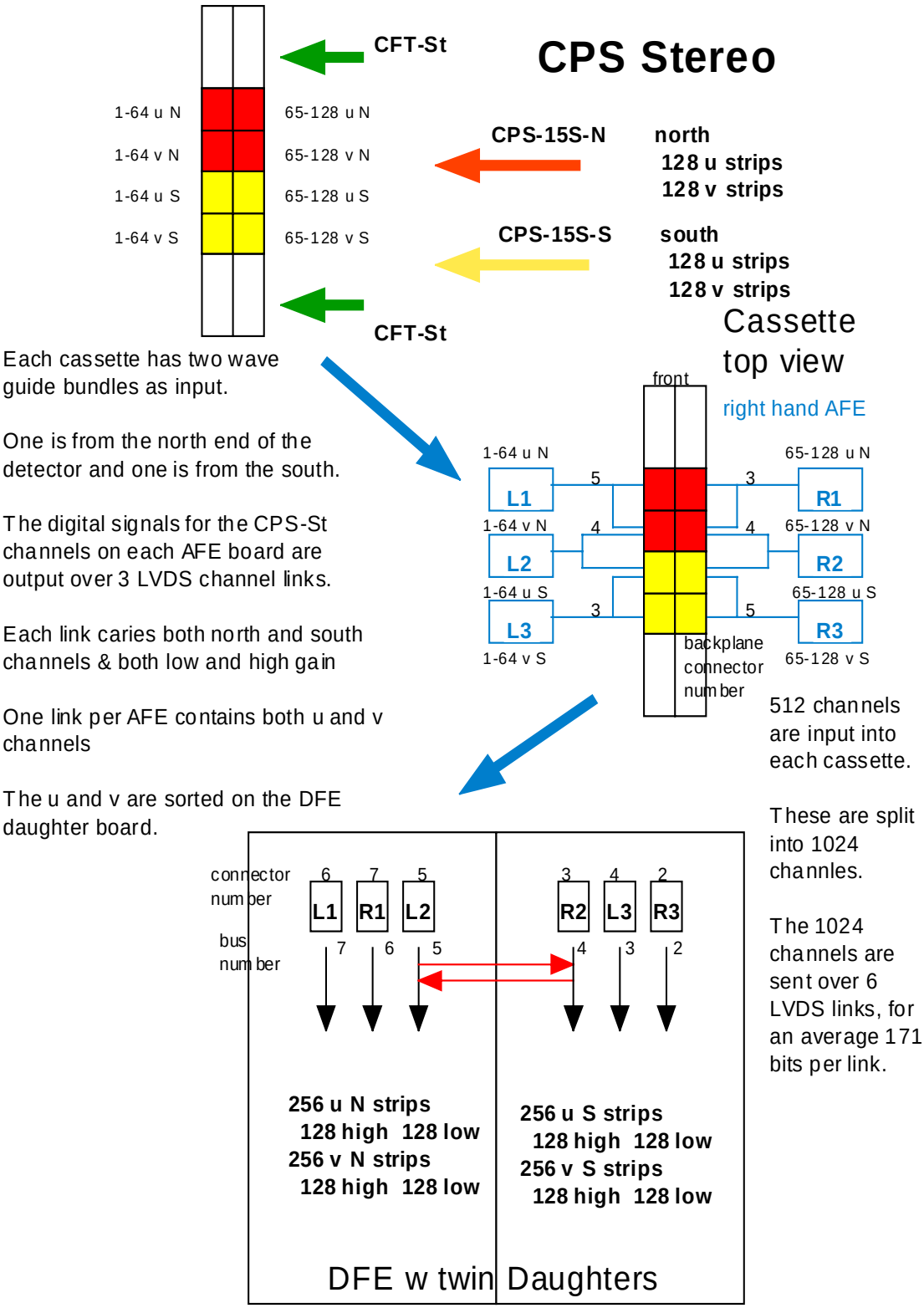


Figure 14 - General scheme of the trigger signal routing for the CPS Stereo, from detector to cassette to AFE Board to DFE Board.

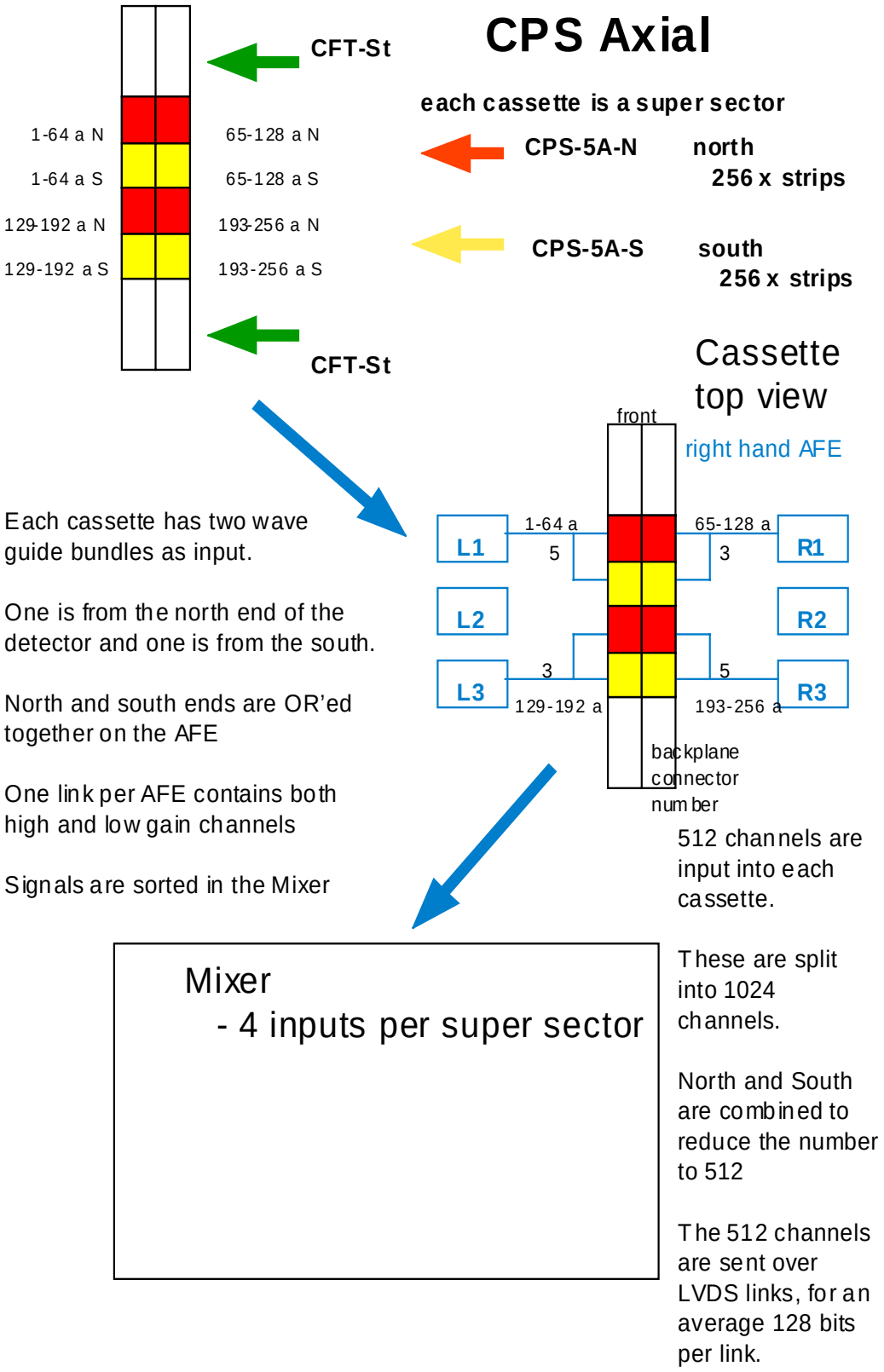


Figure 15 - General scheme of the trigger signal routing for the CPS Axial, from detector to cassette to AFE Board to Mixer Board.

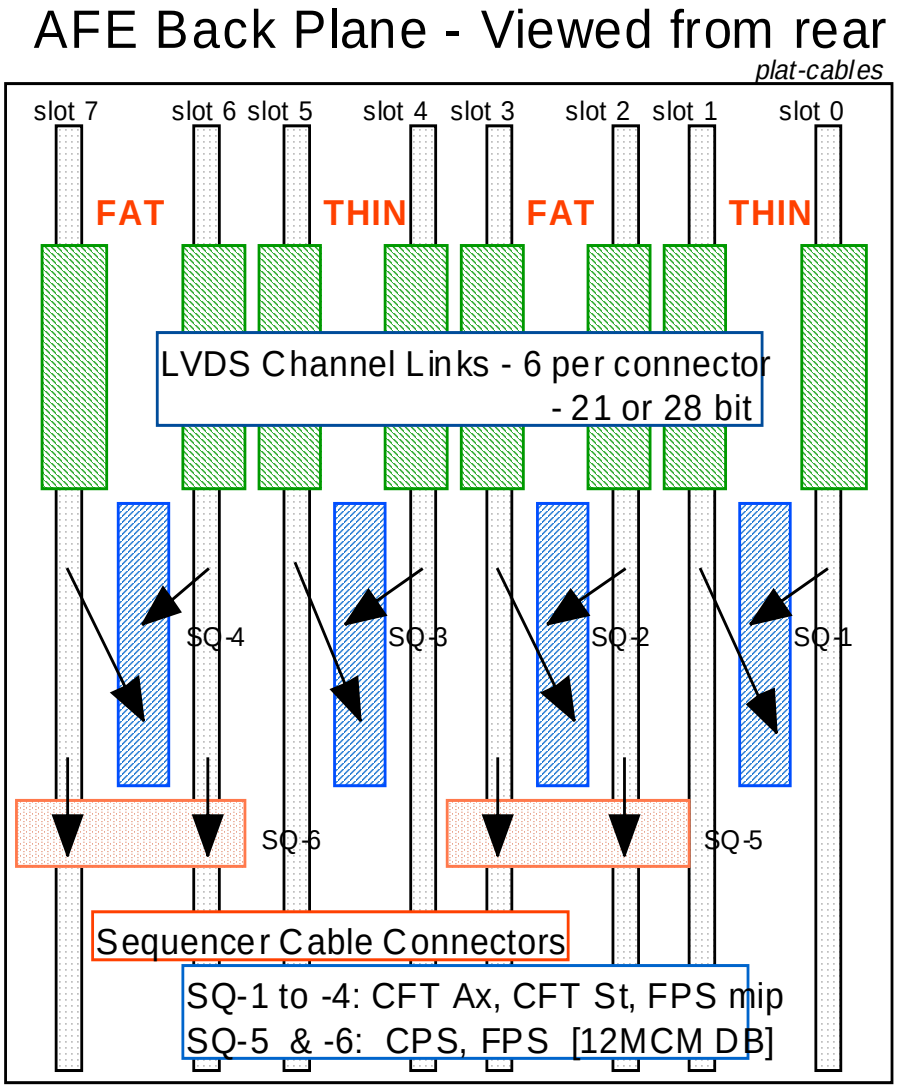
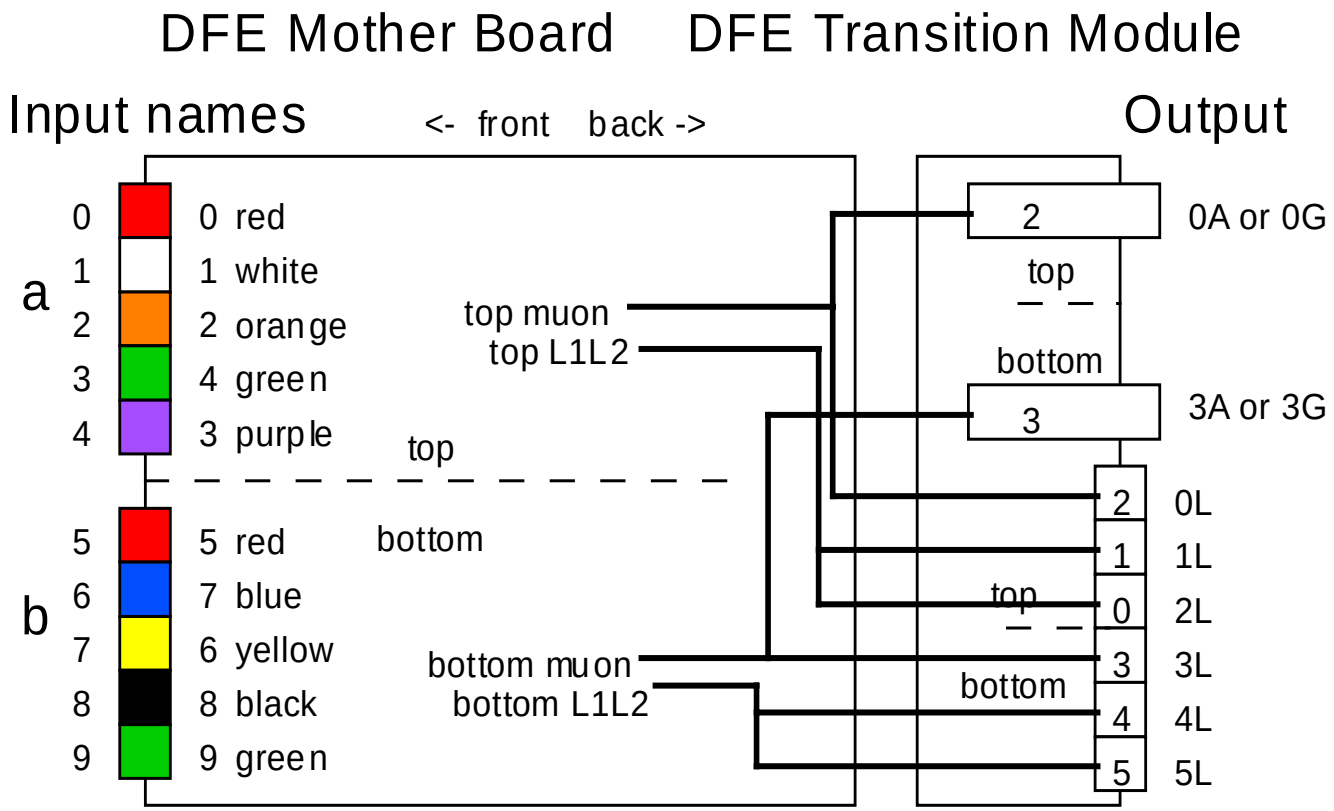


Figure 16 - Analog Front End Crate Backplane. This is a half backplane, with two of these per crate.

Figure 17 - Analog Front End Crate Backplane showing the LVDS connections.



Each MB has 10 inputs numbered 0-9
Each TM has 4 independent outputs
All 4 go to LVDS links named 0L-3L
Two go to a plug in slot slaved to output 0 or 2
The A prefix signifies an AU board in place
The G prefix signifies a G-link board in place
NOTE that when the 0(2) A or G link is in place the 0L (2L) link cannot be used

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Fred Borcherding

Data cannot flow between top and bottom on MB equipted with single wide daughter boards, it can on those with double wide daughter boards

Figure 18 - LVDS I/O cable connector naming conventions for the DFE Mother-Transition Board pair.