Fermi National Accelerator Laboratory

D0 Engineering Note #XXX

Mapping of Fibers from CFT Axial Front End Cards To CFT Digital Boards

Note: Color is used within this document. If printing, a color printer is recommended. This document is also quite long. Printing is not recommended for casual perusal.

John T. Anderson

Available on-line at

http://d0server1/users/janderson/Public~1/default.html

And

http://d0server1/users/janderson/Public~1/a990209a.doc

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1. Introduction

This document analyzes the routing of signals within the 'non-handed' CFT Front End boards in order to present the trigger data to the CFT Digital boards. This note is a logical follow-up to Jamieson Olsen's engineering note #990105A, available on the Internet at http://d0server1.fnal.gov/users/jamieson/www/notes/990105a.pdf.

A companion note to this one is available at http://d0server1.fnal.gov/users/janderson/Public~1/a990208b.pdf. Document a990208b analyzes the routing path from the Warm End fiber optic connections of the cassette to the CFT Front End boards.

Assuming that fibers from the detector are routed to the cassettes as described in document a990208b, this document shows how the pattern of fibers proceeds into the MCM modules on the Front End boards and out to the Digital boards via high-speed serial links. A pattern of MCM connections is given which satisfies the following requirements:

1. All MCM readouts to level 3 (SVX readout) shall occur in a simple raster-scan order to facilitate channel-to-physical position mapping;
2. Connections from the Cin:apse connectors to the MCMs shall have a minimum number of twists and bends;

In addition, the MCM outputs must be mapped into various high-speed serial links. Once the MCM channels are identified with certain fibers, the necessary logic to connect these MCM channels to the correct Digital board links is provided.

2. Connector Orientation

The 'non-handed' CFT Front End boards each have eight Cin:Apse connector patterns which correspond to the eight Warm End cassette fiber optic connectors. If the fibers are connected to the cassettes as described in http://d0server1.fnal.gov/users/janderson/Public~1/a990208b.pdf, the charge signals from the VLPCs arrive in a fixed pattern at the Cin:Apse connector. This pattern is shown in Table 1. From the earlier document, when the non-handed Front End board is inserted in the 'left-hand' position the desired readout order is from Warm End connector pin 64 down to pin 1; when inserted as the 'right-hand' board the preferred readout order is from optical pin 68 up towards optical pin 128.

The result of this setup is that, regardless of the orientation of the Front End board, the preferred readout direction is from pin 14 of the Cin:Apse connector, up through Table 1 towards pin 80 of the Cin:Apse connector. Figure 1 shows the Cin:Apse connector which indicates that the general flow of readout is from left to right when viewing the connector from the component side of the PC board, irrespective of the orientation within the cassette.

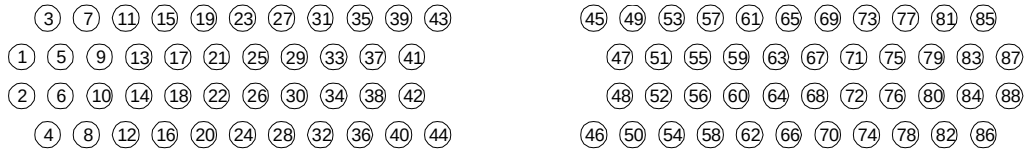

Figure 1

Optical connector position (LH insertion)	Cin:Apse pin on board	Optical connector position (RH insertion)
1	80	125
2	79	126
3	81	127
4	82	128
5	74	121
6	75	122
7	77	123
8	76	124
9	71	117
10	70	118
11	72	119
12	73	120
13	65	113
14	66	114
15	68	115
16	67	116
17	62	109
18	61	110
19	63	111
20	64	112
21	56	105
22	57	106
23	59	107
24	58	108
25	53	101
26	52	102
27	54	103
28	55	104
29	47	97
30	48	98
31	50	99
32	49	100

Optical connector position (LH insertion)	Cin:Apse pin on board	Optical connector position (RH insertion)
33	43	93
34	44	94
35	45	95
36	46	96
37	37	89
38	40	90
39	42	91
40	39	92
41	36	85
42	33	86
43	35	87
44	38	88
45	30	81
46	29	82
47	31	83
48	32	84
49	25	77
50	26	78
51	28	79
52	27	80
53	19	73
54	22	74
55	24	75
56	21	76
57	18	69
58	15	70
59	17	71
60	20	72
61	12	65
62	11	66
63	13	67
64	14	68

Table 1

The left-to-right flow of the readout in the Cin:Apse connector matches well with the layout of the MCM, where the input pins are located along three sides of the part. Lower-numbered channels (which are first to be read out of the SVX during Level 3 readout) are at the left, and the highest-numbered channels are located at the right, as shown in Figure 2.

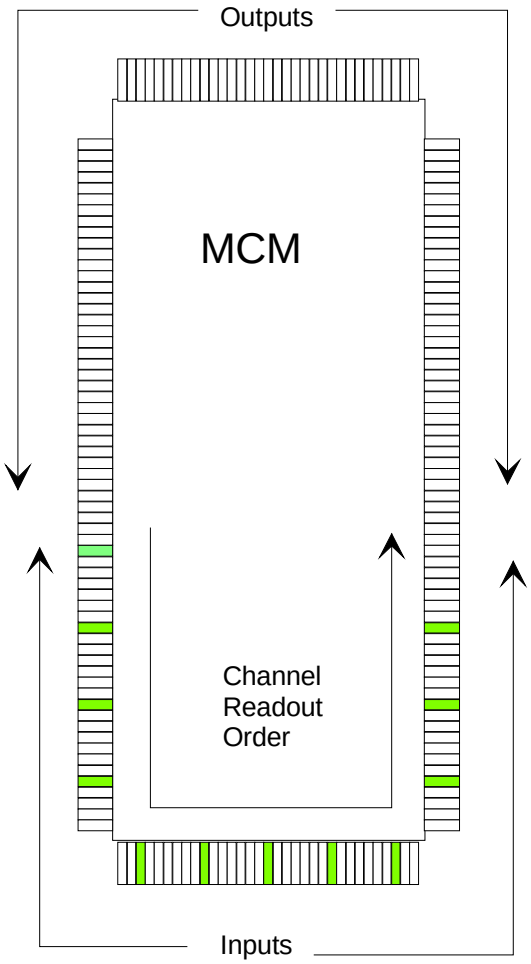

Figure 2

3. Detailed Readout Sequence

Given the information above, the next logical step is to map every fiber seen by the Front End board in both 'left-hand' and 'right-hand' orientations to the correct MCM chip. While this is being done, attention should be paid to which serial link to the Digital Board each fiber must speak to. For reference, Figure 3 repeats Jamieson Olsen's drawing showing which link is driven by each fiber in a sector pair.

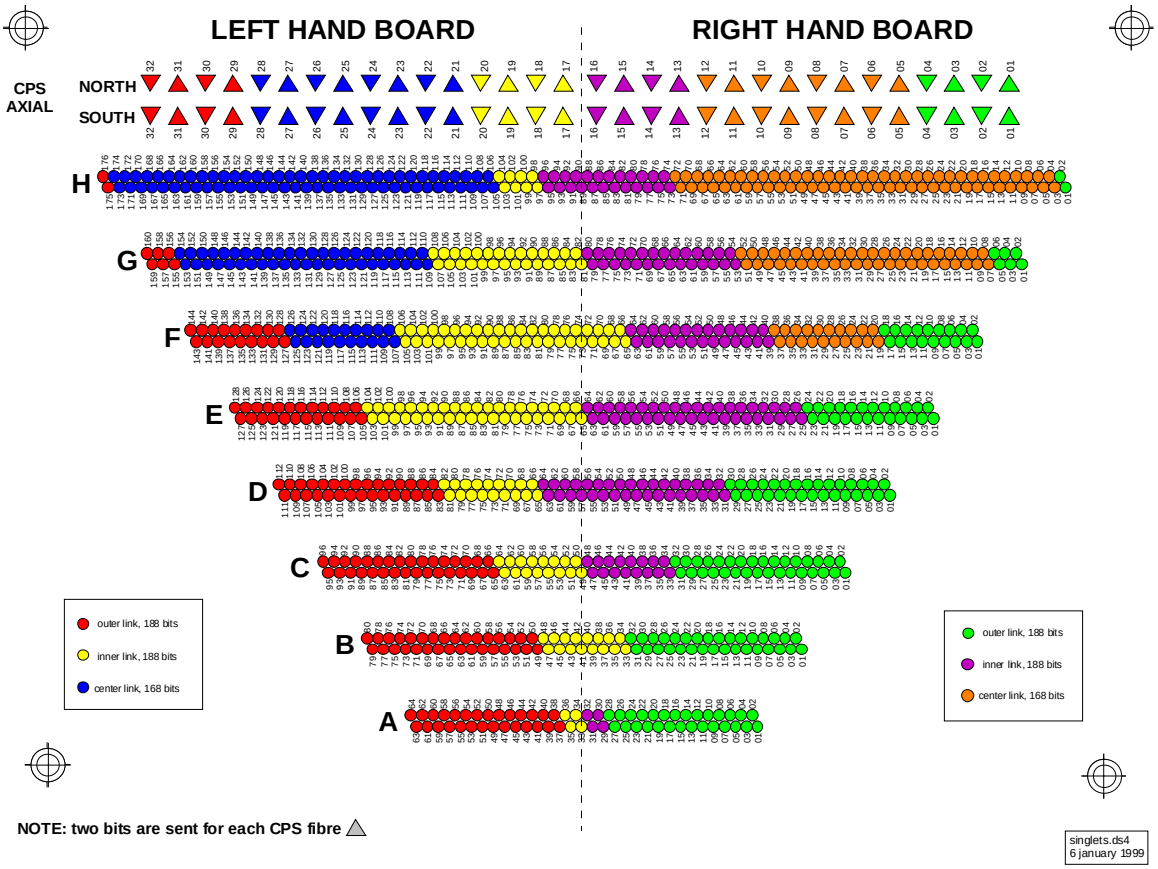

Figure 3

Figure 3 indicates that there are six links (Red, Blue, Yellow, Purple, Orange and Green) and gives the fiber number which must be transmitted for each link. The colors have been arranged such that the Red and Green links contain all the fibers necessary for passing into the next sector over, the Blue and Orange are those fibers that only need be compared against other fibers within the same sector, and the Yellow/Purple are those which are used in track finding within the sector pair. The number of fibers in each color group is limited by the number of bits which can be transmitted over a single serial link, which is (28 * 7) = 196 bits. A few bits are reserved in the links for synchronization, and so the maximum data load is defined as 189 bits per crossing per link.

To obtain the readout, one then combines the information from document #a990208b, Table 1, Figure 3 and the exact pinout of the MCM(D0 drawing number 3823.113-MB-330195) to obtain Tables 2-11 for the both 'left-handed' and 'right-handed' insertion. Tables 7 and 8 detail the connections for the Preshower fibers. These fibers are special in that each fiber drives two different MCM channels via a charge splitter, to allow dual-threshold measurements.

Each table indicates which fiber is connected to which MCM channel for both insertions, plus also derives the nominal readout order of the channels based upon SVX channel number. This readout order is, of course, only valid if no zero-suppression is in force; if zero suppression is enabled in the SVX chips then the relative order of channels is preserved but only those with data will show up.

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
8--1	80	B64	2	5	B32	1--125	A-118	A-21	A-51	64
8--2	79	B63	2	5	B31	1--126	A-117	A-20	A-52	63
8--3	81	B62	2	5	B30	1--127	A-114	A-18	A-53	62
8--4	82	B61	2	5	B29	1--128	A-113	A-17	A-54	61
8--5	74	B60	2	5	B28	1--121	A-110	A-16	A-55	60
8--6	75	B59	2	5	B27	1--122	A-109	A-15	A-56	59
8--7	77	B58	2	5	B26	1--123	A-108	A-14	A-57	58
8--8	76	B57	2	5	B25	1--124	A-107	A-13	A-58	57
8--9	71	B56	2	5	B24	1--117	A-104	A-11	A-59	56
8--10	70	B55	2	5	B23	1--118	A-103	A-10	A-60	55
8--11	72	B54	2	5	B22	1--119	A-102	A-9	A-61	54
8--12	73	B53	2	5	B21	1--120	A-99	A-8	A-62	53
8--13	65	B52	2	5	B20	1--113	A-98	A-7	A-63	52
8--14	66	B51	2	5	B19	1--114	A-97	A-6	A-64	51
8--15	68	B50	2	5	B18	1--115	A-94	A-4	A-28	50
8--16	67	B49	2	5	B17	1--116	A-92	A-3	A-29	49
8--17	62	B48	4	5	B16	1--109	A-91	A-2	A-30	48
8--18	61	B47	4	5	B15	1--110	A-88	A-1	A-31	47
8--19	63	B46	4	5	B14	1--111	A-87	A-228	A-32	46
8--20	64	B45	4	5	B13	1--112	A-84	A-227	A-33	45
8--21	56	B44	4	5	B12	1--105	A-83	A-225	A-34	44
8--22	57	B43	4	5	B11	1--106	A-82	A-224	A-35	43
8--23	59	B42	4	5	B10	1--107	A-81	A-223	A-36	42
8--24	58	B41	4	5	B9	1--108	A-78	A-222	A-37	41
8--25	53	B40	4	5	B8	1--101	A-77	A-221	A-38	40
8--26	52	B39	4	5	B7	1--102	A-74	A-220	A-39	39
8--27	54	B38	4	5	B6	1--103	A-73	A-218	A-40	38
8--28	55	B37	4	5	B5	1--104	A-72	A-217	A-41	37
8--29	47	B36	4	5	B4	1--97	A-71	A-216	A-42	36
8--30	48	B35	4	5	B3	1--98	A-68	A-215	A-43	35
8--31	50	B34	4	5	B2	1--99	A-67	A-214	A-44	34
8--32	49	B33	4	5	B1	1--100	A-66	A-213	A-45	33

8--33	43	A64	2	7	A32	1--93	A-62	A-211	A-168	32
8--34	44	A63	2	7	A31	1--94	A-59	A-210	A-167	31
8--35	45	A62	2	7	A30	1--95	A-58	A-209	A-166	30
8--36	46	A61	2	7	A29	1--96	A-57	A-208	A-165	29
8--37	37	A60	2	5	A28	1--89	A-56	A-207	A-164	28
8--38	40	A59	2	5	A27	1--90	A-53	A-206	A-163	27
8--39	42	A58	2	5	A26	1--91	A-52	A-204	A-162	26
8--40	39	A57	2	5	A25	1--92	A-49	A-203	A-161	25
8--41	36	A56	2	5	A24	1--85	A-48	A-202	A-160	24
8--42	33	A55	2	5	A23	1--86	A-47	A-201	A-159	23
8--43	35	A54	2	5	A22	1--87	A-46	A-200	A-158	22
8--44	38	A53	2	5	A21	1--88	A-43	A-199	A-157	21
8--45	30	A52	2	5	A20	1--81	A-42	A-197	A-156	20
8--46	29	A51	2	5	A19	1--82	A-41	A-196	A-155	19
8--47	31	A50	2	5	A18	1--83	A-38	A-195	A-154	18
8--48	32	A49	2	5	A17	1--84	A-37	A-194	A-153	17
8--49	25	A48	2	5	A16	1--77	A-36	A-193	A-152	16
8--50	26	A47	2	5	A15	1--78	A-32	A-192	A-151	15
8--51	28	A46	2	5	A14	1--79	A-29	A-190	A-149	14
8--52	27	A45	2	5	A13	1--80	A-28	A-189	A-148	13
8--53	19	A44	2	5	A12	1--73	A-27	A-188	A-147	12
8--54	22	A43	2	5	A11	1--74	A-26	A-187	A-146	11
8--55	24	A42	2	5	A10	1--75	A-23	A-186	A-145	10
8--56	21	A41	2	5	A9	1--76	A-22	A-185	A-144	9
8--57	18	A40	2	5	A8	1--69	A-21	A-183	A-143	8
8--58	15	A39	2	5	A7	1--70	A-20	A-182	A-142	7
8--59	17	A38	2	5	A6	1--71	A-17	A-181	A-141	6
8--60	20	A37	2	5	A5	1--72	A-16	A-180	A-140	5
8--61	12	A36	4	5	A4	1--65	A-13	A-179	A-139	4
8--62	11	A35	4	5	A3	1--66	A-12	A-178	A-138	3
8--63	13	A34	4	5	A2	1--67	A-11	A-176	A-137	2
8--64	14	A33	4	5	A1	1--68	A-10	A-175	A-136	1

Table 2

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
7--1	80	C96	2	5	D16	2--65	B-118	B-21	B-51	128
7--2	79	C95	2	5	D15	2--66	B-117	B-20	B-52	127
7--3	81	C94	2	5	D14	2--67	B-114	B-18	B-53	126
7--4	82	C93	2	5	D13	2--68	B-113	B-17	B-54	125
7--5	74	C92	2	5	D12	2--69	B-110	B-16	B-55	124
7--6	75	C91	2	5	D11	2--70	B-109	B-15	B-56	123
7--7	77	C90	2	5	D10	2--71	B-108	B-14	B-57	122
7--8	76	C89	2	5	D9	2--72	B-107	B-13	B-58	121
7--9	71	C88	2	5	D8	2--73	B-104	B-11	B-59	120
7--10	70	C87	2	5	D7	2--74	B-103	B-10	B-60	119
7--11	72	C86	2	5	D6	2--75	B-102	B-9	B-61	118
7--12	73	C85	2	5	D5	2--76	B-99	B-8	B-62	117
7--13	65	C84	2	5	D4	2--77	B-98	B-7	B-63	116
7--14	66	C83	2	5	D3	2--78	B-97	B-6	B-64	115
7--15	68	C82	2	5	D2	2--79	B-94	B-4	B-28	114
7--16	67	C81	2	5	D1	2--80	B-92	B-3	B-29	113
7--17	62	C80	2	7	C48	2--81	B-91	B-2	B-30	112
7--18	61	C79	2	7	C47	2--82	B-88	B-1	B-31	111
7--19	63	C78	2	7	C46	2--83	B-87	B-228	B-32	110
7--20	64	C77	2	7	C45	2--84	B-84	B-227	B-33	109
7--21	56	C76	2	7	C44	2--85	B-83	B-225	B-34	108
7--22	57	C75	2	7	C43	2--86	B-82	B-224	B-35	107
7--23	59	C74	2	7	C42	2--87	B-81	B-223	B-36	106
7--24	58	C73	2	7	C41	2--88	B-78	B-222	B-37	105
7--25	53	C72	2	7	C40	2--89	B-77	B-221	B-38	104
7--26	52	C71	2	7	C39	2--90	B-74	B-220	B-39	103
7--27	54	C70	2	7	C38	2--91	B-73	B-218	B-40	102
7--28	55	C69	2	7	C37	2--92	B-72	B-217	B-41	101
7--29	47	C68	2	7	C36	2--93	B-71	B-216	B-42	100
7--30	48	C67	2	7	C35	2--94	B-68	B-215	B-43	99
7--31	50	C66	2	7	C34	2--95	B-67	B-214	B-44	98
7--32	49	C65	2	7	C33	2--96	B-66	B-213	B-45	97

7--33	43	C64	4	5	C32	2--97	B-62	B-211	B-168	96
7--34	44	C63	4	5	C31	2--98	B-59	B-210	B-167	95
7--35	45	C62	4	5	C30	2--99	B-58	B-209	B-166	94
7--36	46	C61	4	5	C29	2--100	B-57	B-208	B-165	93
7--37	37	C60	4	5	C28	2--101	B-56	B-207	B-164	92
7--38	40	C59	4	5	C27	2--102	B-53	B-206	B-163	91
7--39	42	C58	4	5	C26	2--103	B-52	B-204	B-162	90
7--40	39	C57	4	5	C25	2--104	B-49	B-203	B-161	89
7--41	36	C56	4	5	C24	2--105	B-48	B-202	B-160	88
7--42	33	C55	4	5	C23	2--106	B-47	B-201	B-159	87
7--43	35	C54	4	5	C22	2--107	B-46	B-200	B-158	86
7--44	38	C53	4	5	C21	2--108	B-43	B-199	B-157	85
7--45	30	C52	4	5	C20	2--109	B-42	B-197	B-156	84
7--46	29	C51	4	5	C19	2--110	B-41	B-196	B-155	83
7--47	31	C50	4	5	C18	2--111	B-38	B-195	B-154	82
7--48	32	C49	4	5	C17	2--112	B-37	B-194	B-153	81
7--49	25	B80	2	5	C16	2--113	B-36	B-193	B-152	80
7--50	26	B79	2	5	C15	2--114	B-32	B-192	B-151	79
7--51	28	B78	2	5	C14	2--115	B-29	B-190	B-149	78
7--52	27	B77	2	5	C13	2--116	B-28	B-189	B-148	77
7--53	19	B76	2	5	C12	2--117	B-27	B-188	B-147	76
7--54	22	B75	2	5	C11	2--118	B-26	B-187	B-146	75
7--55	24	B74	2	5	C10	2--119	B-23	B-186	B-145	74
7--56	21	B73	2	5	C9	2--120	B-22	B-185	B-144	73
7--57	18	B72	2	5	C8	2--121	B-21	B-183	B-143	72
7--58	15	B71	2	5	C7	2--122	B-20	B-182	B-142	71
7--59	17	B70	2	5	C6	2--123	B-17	B-181	B-141	70
7--60	20	B69	2	5	C5	2--124	B-16	B-180	B-140	69
7--61	12	B68	2	5	C4	2--125	B-13	B-179	B-139	68
7--62	11	B67	2	5	C3	2--126	B-12	B-178	B-138	67
7--63	13	B66	2	5	C2	2--127	B-11	B-176	B-137	66
7--64	14	B65	2	5	C1	2--128	B-10	B-175	B-136	65

Table 3

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
6--1	80	E80	4	5	E16	3--125	C-110	C-16	C-55	192
6--2	79	E79	4	5	E15	3--126	C-109	C-15	C-56	191
6--3	81	E78	4	5	E14	3--127	C-108	C-14	C-57	190
6--4	82	E77	4	5	E13	3--128	C-107	C-13	C-58	189
6--5	74	E76	4	5	E12	3--121	C-104	C-11	C-59	188
6--6	75	E75	4	5	E11	3--122	C-103	C-10	C-60	187
6--7	77	E74	4	5	E10	3--123	C-102	C-9	C-61	186
6--8	76	E73	4	5	E9	3--124	C-99	C-8	C-62	185
6--9	71	E72	4	5	E8	3--117	C-98	C-7	C-63	184
6--10	70	E71	4	5	E7	3--118	C-97	C-6	C-64	183
6--11	72	E70	4	5	E6	3--119	C-94	C-4	C-28	182
6--12	73	E69	4	5	E5	3--120	C-92	C-3	C-29	181
6--13	65	E68	4	5	E4	3--113	C-91	C-2	C-30	180
6--14	66	E67	4	5	E3	3--114	C-88	C-1	C-31	179
6--15	68	E66	4	5	E2	3--115	C-87	C-228	C-32	178
6--16	67	E65	4	5	E1	3--116	C-84	C-227	C-33	177
6--17	62	D112	2	7	D64	3--109	C-83	C-225	C-34	176
6--18	61	D111	2	7	D63	3--110	C-82	C-224	C-35	175
6--19	63	D110	2	7	D62	3--111	C-81	C-223	C-36	174
6--20	64	D109	2	7	D61	3--112	C-78	C-222	C-37	173
6--21	56	D108	2	7	D60	3--105	C-77	C-221	C-38	172
6--22	57	D107	2	7	D59	3--106	C-74	C-220	C-39	171
6--23	59	D106	2	7	D58	3--107	C-73	C-218	C-40	170
6--24	58	D105	2	7	D57	3--108	C-72	C-217	C-41	169
6--25	53	D104	2	7	D56	3--101	C-71	C-216	C-42	168
6--26	52	D103	2	7	D55	3--102	C-68	C-215	C-43	167
6--27	54	D102	2	7	D54	3--103	C-67	C-214	C-44	166
6--28	55	D101	2	7	D53	3--104	C-66	C-213	C-45	165
6--29	47	D100	2	7	D52	3--97	C-62	C-211	C-168	164
6--30	48	D99	2	7	D51	3--98	C-59	C-210	C-167	163
6--31	50	D98	2	7	D50	3--99	C-58	C-209	C-166	162
6--32	49	D97	2	7	D49	3--100	C-57	C-208	C-165	161

6--33	43	D96	2	7	D48	3--93	C-56	C-207	C-164	160
6--34	44	D95	2	7	D47	3--94	C-53	C-206	C-163	159
6--35	45	D94	2	7	D46	3--95	C-52	C-204	C-162	158
6--36	46	D93	2	7	D45	3--96	C-49	C-203	C-161	157
6--37	37	D92	2	7	D44	3--89	C-48	C-202	C-160	156
6--38	40	D91	2	7	D43	3--90	C-47	C-201	C-159	155
6--39	42	D90	2	7	D42	3--91	C-46	C-200	C-158	154
6--40	39	D89	2	7	D41	3--92	C-43	C-199	C-157	153
6--41	36	D88	2	7	D40	3--85	C-42	C-197	C-156	152
6--42	33	D87	2	7	D39	3--86	C-41	C-196	C-155	151
6--43	35	D86	2	7	D38	3--87	C-38	C-195	C-154	150
6--44	38	D85	2	7	D37	3--88	C-37	C-194	C-153	149
6--45	30	D84	2	7	D36	3--81	C-36	C-193	C-152	148
6--46	29	D83	2	7	D35	3--82	C-32	C-192	C-151	147
6--47	31	D82	4	7	D34	3--83	C-29	C-190	C-149	146
6--48	32	D81	4	7	D33	3--84	C-28	C-189	C-148	145
6--49	25	D80	4	7	D32	3--77	C-27	C-188	C-147	144
6--50	26	D79	4	7	D31	3--78	C-26	C-187	C-146	143
6--51	28	D78	4	5	D30	3--79	C-23	C-186	C-145	142
6--52	27	D77	4	5	D29	3--80	C-22	C-185	C-144	141
6--53	19	D76	4	5	D28	3--73	C-21	C-183	C-143	140
6--54	22	D75	4	5	D27	3--74	C-20	C-182	C-142	139
6--55	24	D74	4	5	D26	3--75	C-17	C-181	C-141	138
6--56	21	D73	4	5	D25	3--76	C-16	C-180	C-140	137
6--57	18	D72	4	5	D24	3--69	C-13	C-179	C-139	136
6--58	15	D71	4	5	D23	3--70	C-12	C-178	C-138	135
6--59	17	D70	4	5	D22	3--71	C-11	C-176	C-137	134
6--60	20	D69	4	5	D21	3--72	C-10	C-175	C-136	133
6--61	12	D68	4	5	D20	3--65	C-7	C-174	C-135	132
6--62	11	D67	4	5	D19	3--66	C-6	C-173	C-134	131
6--63	13	D66	4	5	D18	3--67	C-5	C-172	C-133	130
6--64	14	D65	4	5	D17	3--68	C-2	C-171	C-132	129

Table 4

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
5--1	80	F80	4	5	F16	4--125	D-98	D-7	D-63	256
5--2	79	F79	4	5	F15	4--126	D-97	D-6	D-64	255
5--3	81	F78	4	5	F14	4--127	D-94	D-4	D-28	254
5--4	82	F77	4	5	F13	4--128	D-92	D-3	D-29	253
5--5	74	F76	4	5	F12	4--121	D-91	D-2	D-30	252
5--6	75	F75	4	5	F11	4--122	D-88	D-1	D-31	251
5--7	77	F74	4	5	F10	4--123	D-87	D-228	D-32	250
5--8	76	F73	4	5	F9	4--124	D-84	D-227	D-33	249
5--9	71	F72	4	5	F8	4--117	D-83	D-225	D-34	248
5--10	70	F71	4	5	F7	4--118	D-82	D-224	D-35	247
5--11	72	F70	4	5	F6	4--119	D-81	D-223	D-36	246
5--12	73	F69	4	5	F5	4--120	D-78	D-222	D-37	245
5--13	65	F68	4	5	F4	4--113	D-77	D-221	D-38	244
5--14	66	F67	4	5	F3	4--114	D-74	D-220	D-39	243
5--15	68	F66	4	5	F2	4--115	D-73	D-218	D-40	242
5--16	67	F65	4	5	F1	4--116	D-72	D-217	D-41	241
5--17	62	E128	2	7	E64	4--109	D-71	D-216	D-42	240
5--18	61	E127	2	7	E63	4--110	D-68	D-215	D-43	239
5--19	63	E126	2	7	E62	4--111	D-67	D-214	D-44	238
5--20	64	E125	2	7	E61	4--112	D-66	D-213	D-45	237
5--21	56	E124	2	7	E60	4--105	D-62	D-211	D-168	236
5--22	57	E123	2	7	E59	4--106	D-59	D-210	D-167	235
5--23	59	E122	2	7	E58	4--107	D-58	D-209	D-166	234
5--24	58	E121	2	7	E57	4--108	D-57	D-208	D-165	233
5--25	53	E120	2	7	E56	4--101	D-56	D-207	D-164	232
5--26	52	E119	2	7	E55	4--102	D-53	D-206	D-163	231
5--27	54	E118	2	7	E54	4--103	D-52	D-204	D-162	230
5--28	55	E117	2	7	E53	4--104	D-49	D-203	D-161	229
5--29	47	E116	2	7	E52	4--97	D-48	D-202	D-160	228
5--30	48	E115	2	7	E51	4--98	D-47	D-201	D-159	227
5--31	50	E114	2	7	E50	4--99	D-46	D-200	D-158	226
5--32	49	E113	2	7	E49	4--100	D-43	D-199	D-157	225
5--33	43	E112	2	7	E48	4--93	D-42	D-197	D-156	224
5--34	44	E111	2	7	E47	4--94	D-41	D-196	D-155	223
5--35	45	E110	2	7	E46	4--95	D-38	D-195	D-154	222
5--36	46	E109	2	7	E45	4--96	D-37	D-194	D-153	221

5--37	37	E108	2	7	E44	4--89	D-36	D-193	D-152	220
5--38	40	E107	2	7	E43	4--90	D-32	D-192	D-151	219
5--39	42	E106	2	7	E42	4--91	D-29	D-190	D-149	218
5--40	39	E105	2	7	E41	4--92	D-28	D-189	D-148	217
5--41	36	E104	4	7	E40	4--85	D-27	D-188	D-147	216
5--42	33	E103	4	7	E39	4--86	D-26	D-187	D-146	215
5--43	35	E102	4	7	E38	4--87	D-23	D-186	D-145	214
5--44	38	E101	4	7	E37	4--88	D-22	D-185	D-144	213
5--45	30	E100	4	7	E36	4--81	D-21	D-183	D-143	212
5--46	29	E99	4	7	E35	4--82	D-20	D-182	D-142	211
5--47	31	E98	4	7	E34	4--83	D-17	D-181	D-141	210
5--48	32	E97	4	7	E33	4--84	D-16	D-180	D-140	209
5--49	25	E96	4	7	E32	4--77	D-13	D-179	D-139	208
5--50	26	E95	4	7	E31	4--78	D-12	D-178	D-138	207
5--51	28	E94	4	7	E30	4--79	D-11	D-176	D-137	206
5--52	27	E93	4	7	E29	4--80	D-10	D-175	D-136	205
5--53	19	E92	4	7	E28	4--73	D-7	D-174	D-135	204
5--54	22	E91	4	7	E27	4--74	D-6	D-173	D-134	203
5--55	24	E90	4	7	E26	4--75	D-5	D-172	D-133	202
5--56	21	E89	4	7	E25	4--76	D-2	D-171	D-132	201
5--57	18	E88	4	5	E24	4--69	C-124	C-25	C-47	200
5--58	15	E87	4	5	E23	4--70	C-123	C-24	C-48	199
5--59	17	E86	4	5	E22	4--71	C-120	C-23	C-49	198
5--60	20	E85	4	5	E21	4--72	C-119	C-22	C-50	197
5--61	12	E84	4	5	E20	4--65	C-118	C-21	C-51	196
5--62	11	E83	4	5	E19	4--66	C-117	C-20	C-52	195
5--63	13	E82	4	5	E18	4--67	C-114	C-18	C-53	194
5--64	14	E81	4	5	E17	4--68	C-113	C-17	C-54	193

Table 5

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
4--1	80	F112	6	7	F48	5--125	E-27	E-188	E-147	288
4--2	79	F111	6	7	F47	5--126	E-26	E-187	E-146	287
4--3	81	F110	6	7	F46	5--127	E-23	E-186	E-145	286
4--4	82	F109	6	7	F45	5--128	E-22	E-185	E-144	285
4--5	74	F108	6	7	F44	5--121	E-21	E-183	E-143	284
4--6	75	F107	6	7	F43	5--122	E-20	E-182	E-142	283
4--7	77	F106	4	7	F42	5--123	E-17	E-181	E-141	282
4--8	76	F105	4	7	F41	5--124	E-16	E-180	E-140	281
4--9	71	F104	4	7	F40	5--117	E-13	E-179	E-139	280
4--10	70	F103	4	7	F39	5--118	E-12	E-178	E-138	279
4--11	72	F102	4	3	F38	5--119	E-11	E-176	E-137	278
4--12	73	F101	4	3	F37	5--120	E-10	E-175	E-136	277
4--13	65	F100	4	3	F36	5--113	E-7	E-174	E-135	276
4--14	66	F99	4	3	F35	5--114	E-6	E-173	E-134	275
4--15	68	F98	4	3	F34	5--115	E-5	E-172	E-133	274
4--16	67	F97	4	3	F33	5--116	E-2	E-171	E-132	273
4--17	62	F96	4	3	F32	5--109	D-124	D-25	D-47	272
4--18	61	F95	4	3	F31	5--110	D-123	D-24	D-48	271
4--19	63	F94	4	3	F30	5--111	D-120	D-23	D-49	270
4--20	64	F93	4	3	F29	5--112	D-119	D-22	D-50	269
4--21	56	F92	4	3	F28	5--105	D-118	D-21	D-51	268
4--22	57	F91	4	3	F27	5--106	D-117	D-20	D-52	267
4--23	59	F90	4	3	F26	5--107	D-114	D-18	D-53	266
4--24	58	F89	4	3	F25	5--108	D-113	D-17	D-54	265
4--25	53	F88	4	3	F24	5--101	D-110	D-16	D-55	264
4--26	52	F87	4	3	F23	5--102	D-109	D-15	D-56	263
4--27	54	F86	4	3	F22	5--103	D-108	D-14	D-57	262
4--28	55	F85	4	3	F21	5--104	D-107	D-13	D-58	261
4--29	47	F84	4	3	F20	5--97	D-104	D-11	D-59	260
4--30	48	F83	4	3	F19	5--98	D-103	D-10	D-60	259
4--31	50	F82	4	5	F18	5--99	D-102	D-9	D-61	258
4--32	49	F81	4	5	F17	5--100	D-99	D-8	D-62	257

Table 6 – Cin:Apse connector #5 Axial Fibers

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
4--33	43	PSS32	2	7	PSS16	5--93	H-118	H-21	H-51	544
4--34	44	PSS31	2	7	PSS15	5--94	H-117	H-20	H-52	543
4--35	45	PSS30	2	7	PSS14	5--95	H-114	H-18	H-53	542
4--36	46	PSS29	2	7	PSS13	5--96	H-113	H-17	H-54	541
4--37	37	PSS28	6	3	PSS12	5--89	H-110	H-16	H-55	540
4--38	40	PSS27	6	3	PSS11	5--90	H-109	H-15	H-56	539
4--39	42	PSS26	6	3	PSS10	5--91	H-108	H-14	H-57	538
4--40	39	PSS25	6	3	PSS9	5--92	H-107	H-13	H-58	537
4--41	36	PSS24	6	3	PSS8	5--85	H-104	H-11	H-59	536
4--42	33	PSS23	6	3	PSS7	5--86	H-103	H-10	H-60	535
4--43	35	PSS22	6	3	PSS6	5--87	H-102	H-9	H-61	534
4--44	38	PSS21	6	3	PSS5	5--88	H-99	H-8	H-62	533
4--45	30	PSS20	4	5	PSS4	5--81	H-98	H-7	H-63	532
4--46	29	PSS19	4	5	PSS3	5--82	H-97	H-6	H-64	531
4--47	31	PSS18	4	5	PSS2	5--83	H-94	H-4	H-28	530
4--48	32	PSS17	4	5	PSS1	5--84	H-92	H-3	H-29	529
4--49	25	PSN32	2	7	PSN16	5--77	H-91	H-2	H-30	528
4--50	26	PSN31	2	7	PSN15	5--78	H-88	H-1	H-31	527
4--51	28	PSN30	2	7	PSN14	5--79	H-87	H-228	H-32	526
4--52	27	PSN29	2	7	PSN13	5--80	H-84	H-227	H-33	525
4--53	19	PSN28	6	3	PSN12	5--73	H-83	H-225	H-34	524
4--54	22	PSN27	6	3	PSN11	5--74	H-82	H-224	H-35	523
4--55	24	PSN26	6	3	PSN10	5--75	H-81	H-223	H-36	522
4--56	21	PSN25	6	3	PSN9	5--76	H-78	H-222	H-37	521
4--57	18	PSN24	6	3	PSN8	5--69	H-77	H-221	H-38	520
4--58	15	PSN23	6	3	PSN7	5--70	H-74	H-220	H-39	519
4--59	17	PSN22	6	3	PSN6	5--71	H-73	H-218	H-40	518
4--60	20	PSN21	6	3	PSN5	5--72	H-72	H-217	H-41	517
4--61	12	PSN20	4	5	PSN4	5--65	H-71	H-216	H-42	516
4--62	11	PSN19	4	5	PSN3	5--66	H-68	H-215	H-43	515
4--63	13	PSN18	4	5	PSN2	5--67	H-67	H-214	H-44	514
4--64	14	PSN17	4	5	PSN1	5--68	H-66	H-213	H-45	513

Table 7 – Cin:Apse Connector #5, Preshower Low Threshold

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
4--33	43	PSS32	2	7	PSS16	5--93	H-62	H-211	H-168	512
4--34	44	PSS31	2	7	PSS15	5--94	H-59	H-210	H-167	511
4--35	45	PSS30	2	7	PSS14	5--95	H-58	H-209	H-166	510
4--36	46	PSS29	2	7	PSS13	5--96	H-57	H-208	H-165	509
4--37	37	PSS28	6	3	PSS12	5--89	H-56	H-207	H-164	508
4--38	40	PSS27	6	3	PSS11	5--90	H-53	H-206	H-163	507
4--39	42	PSS26	6	3	PSS10	5--91	H-52	H-204	H-162	506
4--40	39	PSS25	6	3	PSS9	5--92	H-49	H-203	H-161	505
4--41	36	PSS24	6	3	PSS8	5--85	H-48	H-202	H-160	504
4--42	33	PSS23	6	3	PSS7	5--86	H-47	H-201	H-159	503
4--43	35	PSS22	6	3	PSS6	5--87	H-46	H-200	H-158	502
4--44	38	PSS21	6	3	PSS5	5--88	H-43	H-199	H-157	501
4--45	30	PSS20	4	5	PSS4	5--81	H-42	H-197	H-156	500
4--46	29	PSS19	4	5	PSS3	5--82	H-41	H-196	H-155	499
4--47	31	PSS18	4	5	PSS2	5--83	H-38	H-195	H-154	498
4--48	32	PSS17	4	5	PSS1	5--84	H-37	H-194	H-153	497
4--49	25	PSN32	2	7	PSN16	5--77	H-36	H-193	H-152	496
4--50	26	PSN31	2	7	PSN15	5--78	H-32	H-192	H-151	495
4--51	28	PSN30	2	7	PSN14	5--79	H-29	H-190	H-149	494
4--52	27	PSN29	2	7	PSN13	5--80	H-28	H-189	H-148	493
4--53	19	PSN28	6	3	PSN12	5--73	H-27	H-188	H-147	492
4--54	22	PSN27	6	3	PSN11	5--74	H-26	H-187	H-146	491
4--55	24	PSN26	6	3	PSN10	5--75	H-23	H-186	H-145	490
4--56	21	PSN25	6	3	PSN9	5--76	H-22	H-185	H-144	489
4--57	18	PSN24	6	3	PSN8	5--69	H-21	H-183	H-143	488
4--58	15	PSN23	6	3	PSN7	5--70	H-20	H-182	H-142	487
4--59	17	PSN22	6	3	PSN6	5--71	H-17	H-181	H-141	486
4--60	20	PSN21	6	3	PSN5	5--72	H-16	H-180	H-140	485
4--61	12	PSN20	4	5	PSN4	5--65	H-13	H-179	H-139	484
4--62	11	PSN19	4	5	PSN3	5--66	H-12	H-178	H-138	483
4--63	13	PSN18	4	5	PSN2	5--67	H-11	H-176	H-137	482
4--64	14	PSN17	4	5	PSN1	5--68	H-10	H-175	H-136	481

Table 8 – Cin:Apse connector #5, Preshower High Threshold

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
3--1	80	G112	6	3	G48	6--125	F-13	F-179	F-139	352
3--2	79	G111	6	3	G47	6--126	F-12	F-178	F-138	351
3--3	81	G110	6	3	G46	6--127	F-11	F-176	F-137	350
3--4	82	G109	6	3	G45	6--128	F-10	F-175	F-136	349
3--5	74	G108	4	3	G44	6--121	F-7	F-174	F-135	348
3--6	75	G107	4	3	G43	6--122	F-6	F-173	F-134	347
3--7	77	G106	4	3	G42	6--123	F-5	F-172	F-133	346
3--8	76	G105	4	3	G41	6--124	F-2	F-171	F-132	345
3--9	71	G104	4	3	G40	6--117	E-124	E-25	E-47	344
3--10	70	G103	4	3	G39	6--118	E-123	E-24	E-48	343
3--11	72	G102	4	3	G38	6--119	E-120	E-23	E-49	342
3--12	73	G101	4	3	G37	6--120	E-119	E-22	E-50	341
3--13	65	G100	4	3	G36	6--113	E-118	E-21	E-51	340
3--14	66	G99	4	3	G35	6--114	E-117	E-20	E-52	339
3--15	68	G98	4	3	G34	6--115	E-114	E-18	E-53	338
3--16	67	G97	4	3	G33	6--116	E-113	E-17	E-54	337
3--17	62	G96	4	3	G32	6--109	E-110	E-16	E-55	336
3--18	61	G95	4	3	G31	6--110	E-109	E-15	E-56	335
3--19	63	G94	4	3	G30	6--111	E-108	E-14	E-57	334
3--20	64	G93	4	3	G29	6--112	E-107	E-13	E-58	333
3--21	56	G92	4	3	G28	6--105	E-104	E-11	E-59	332
3--22	57	G91	4	3	G27	6--106	E-103	E-10	E-60	331
3--23	59	G90	4	3	G26	6--107	E-102	E-9	E-61	330
3--24	58	G89	4	3	G25	6--108	E-99	E-8	E-62	329
3--25	53	G88	4	3	G24	6--101	E-98	E-7	E-63	328
3--26	52	G87	4	3	G23	6--102	E-97	E-6	E-64	327
3--27	54	G86	4	3	G22	6--103	E-94	E-4	E-28	326
3--28	55	G85	4	3	G21	6--104	E-92	E-3	E-29	325
3--29	47	G84	4	3	G20	6--97	E-91	E-2	E-30	324
3--30	48	G83	4	3	G19	6--98	E-88	E-1	E-31	323
3--31	50	G82	4	3	G18	6--99	E-87	E-228	E-32	322
3--32	49	G81	4	3	G17	6--100	E-84	E-227	E-33	321

3--33	43	F144	2	3	G16	6--93	E-83	E-225	E-34	320
3--34	44	F143	2	3	G15	6--94	E-82	E-224	E-35	319
3--35	45	F142	2	3	G14	6--95	E-81	E-223	E-36	318
3--36	46	F141	2	3	G13	6--96	E-78	E-222	E-37	317
3--37	37	F140	2	3	G12	6--89	E-77	E-221	E-38	316
3--38	40	F139	2	3	G11	6--90	E-74	E-220	E-39	315
3--39	42	F138	2	3	G10	6--91	E-73	E-218	E-40	314
3--40	39	F137	2	3	G9	6--92	E-72	E-217	E-41	313
3--41	36	F136	2	3	G8	6--85	E-71	E-216	E-42	312
3--42	33	F135	2	3	G7	6--86	E-68	E-215	E-43	311
3--43	35	F134	2	5	G6	6--87	E-67	E-214	E-44	310
3--44	38	F133	2	5	G5	6--88	E-66	E-213	E-45	309
3--45	30	F132	2	5	G4	6--81	E-62	E-211	E-168	308
3--46	29	F131	2	5	G3	6--82	E-59	E-210	E-167	307
3--47	31	F130	2	5	G2	6--83	E-58	E-209	E-166	306
3--48	32	F129	2	5	G1	6--84	E-57	E-208	E-165	305
3--49	25	F128	2	7	F64	6--77	E-56	E-207	E-164	304
3--50	26	F127	2	7	F63	6--78	E-53	E-206	E-163	303
3--51	28	F126	6	7	F62	6--79	E-52	E-204	E-162	302
3--52	27	F125	6	7	F61	6--80	E-49	E-203	E-161	301
3--53	19	F124	6	7	F60	6--73	E-48	E-202	E-160	300
3--54	22	F123	6	7	F59	6--74	E-47	E-201	E-159	299
3--55	24	F122	6	7	F58	6--75	E-46	E-200	E-158	298
3--56	21	F121	6	7	F57	6--76	E-43	E-199	E-157	297
3--57	18	F120	6	7	F56	6--69	E-42	E-197	E-156	296
3--58	15	F119	6	7	F55	6--70	E-41	E-196	E-155	295
3--59	17	F118	6	7	F54	6--71	E-38	E-195	E-154	294
3--60	20	F117	6	7	F53	6--72	E-37	E-194	E-153	293
3--61	12	F116	6	7	F52	6--65	E-36	E-193	E-152	292
3--62	11	F115	6	7	F51	6--66	E-32	E-192	E-151	291
3--63	13	F114	6	7	F50	6--67	E-29	E-190	E-149	290
3--64	14	F113	6	7	F49	6--68	E-28	E-189	E-148	289

Table 9

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
2--1	80	H112	6	3	H32	7--125	F-124	F-25	F-47	416
2--2	79	H111	6	3	H31	7--126	F-123	F-24	F-48	415
2--3	81	H110	6	3	H30	7--127	F-120	F-23	F-49	414
2--4	82	H109	6	3	H29	7--128	F-119	F-22	F-50	413
2--5	74	H108	6	3	H28	7--121	F-118	F-21	F-51	412
2--6	75	H107	6	3	H27	7--122	F-117	F-20	F-52	411
2--7	77	H106	6	3	H26	7--123	F-114	F-18	F-53	410
2--8	76	H105	6	3	H25	7--124	F-113	F-17	F-54	409
2--9	71	H104	4	3	H24	7--117	F-110	F-16	F-55	408
2--10	70	H103	4	3	H23	7--118	F-109	F-15	F-56	407
2--11	72	H102	4	3	H22	7--119	F-108	F-14	F-57	406
2--12	73	H101	4	3	H21	7--120	F-107	F-13	F-58	405
2--13	65	H100	4	3	H20	7--113	F-104	F-11	F-59	404
2--14	66	H99	4	3	H19	7--114	F-103	F-10	F-60	403
2--15	68	H98	4	3	H18	7--115	F-102	F-9	F-61	402
2--16	67	H97	4	3	H17	7--116	F-99	F-8	F-62	401
2--17	62	G160	2	3	H16	7--109	F-98	F-7	F-63	400
2--18	61	G159	2	3	H15	7--110	F-97	F-6	F-64	399
2--19	63	G158	2	3	H14	7--111	F-94	F-4	F-28	398
2--20	64	G157	2	3	H13	7--112	F-92	F-3	F-29	397
2--21	56	G156	2	3	H12	7--105	F-91	F-2	F-30	396
2--22	57	G155	2	3	H11	7--106	F-88	F-1	F-31	395
2--23	59	G154	6	3	H10	7--107	F-87	F-228	F-32	394
2--24	58	G153	6	3	H9	7--108	F-84	F-227	F-33	393
2--25	53	G152	6	3	H8	7--101	F-83	F-225	F-34	392
2--26	52	G151	6	3	H7	7--102	F-82	F-224	F-35	391
2--27	54	G150	6	3	H6	7--103	F-81	F-223	F-36	390
2--28	55	G149	6	3	H5	7--104	F-78	F-222	F-37	389
2--29	47	G148	6	3	H4	7--97	F-77	F-221	F-38	388
2--30	48	G147	6	3	H3	7--98	F-74	F-220	F-39	387
2--31	50	G146	6	5	H2	7--99	F-73	F-218	F-40	386
2--32	49	G145	6	5	H1	7--100	F-72	F-217	F-41	385
2--33	43	G144	6	7	G80	7--93	F-71	F-216	F-42	384
2--34	44	G143	6	7	G79	7--94	F-68	F-215	F-43	383
2--35	45	G142	6	7	G78	7--95	F-67	F-214	F-44	382
2--36	46	G141	6	7	G77	7--96	F-66	F-213	F-45	381

2--37	37	G140	6	7	G76	7--89	F-62	F-211	F-168	380
2--38	40	G139	6	7	G75	7--90	F-59	F-210	F-167	379
2--39	42	G138	6	7	G74	7--91	F-58	F-209	F-166	378
2--40	39	G137	6	7	G73	7--92	F-57	F-208	F-165	377
2--41	36	G136	6	7	G72	7--85	F-56	F-207	F-164	376
2--42	33	G135	6	7	G71	7--86	F-53	F-206	F-163	375
2--43	35	G134	6	7	G70	7--87	F-52	F-204	F-162	374
2--44	38	G133	6	7	G69	7--88	F-49	F-203	F-161	373
2--45	30	G132	6	7	G68	7--81	F-48	F-202	F-160	372
2--46	29	G131	6	7	G67	7--82	F-47	F-201	F-159	371
2--47	31	G130	6	7	G66	7--83	F-46	F-200	F-158	370
2--48	32	G129	6	7	G65	7--84	F-43	F-199	F-157	369
2--49	25	G128	6	7	G64	7--77	F-42	F-197	F-156	368
2--50	26	G127	6	7	G63	7--78	F-41	F-196	F-155	367
2--51	28	G126	6	7	G62	7--79	F-38	F-195	F-154	366
2--52	27	G125	6	7	G61	7--80	F-37	F-194	F-153	365
2--53	19	G124	6	7	G60	7--73	F-36	F-193	F-152	364
2--54	22	G123	6	7	G59	7--74	F-32	F-192	F-151	363
2--55	24	G122	6	7	G58	7--75	F-29	F-190	F-149	362
2--56	21	G121	6	7	G57	7--76	F-28	F-189	F-148	361
2--57	18	G120	6	7	G56	7--69	F-27	F-188	F-147	360
2--58	15	G119	6	7	G55	7--70	F-26	F-187	F-146	359
2--59	17	G118	6	7	G54	7--71	F-23	F-186	F-145	358
2--60	20	G117	6	7	G53	7--72	F-22	F-185	F-144	357
2--61	12	G116	6	3	G52	7--65	F-21	F-183	F-143	356
2--62	11	G115	6	3	G51	7--66	F-20	F-182	F-142	355
2--63	13	G114	6	3	G50	7--67	F-17	F-181	F-141	354
2--64	14	G113	6	3	G49	7--68	F-16	F-180	F-140	353

Table 10

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM channel driven (SVX channel)	MCM pin driven	MCM Output Pin	Readout Order
1--1	80	H176	2	7	H96	8--125	G-118	G-21	G-51	480
1--2	79	H175	2	7	H95	8--126	G-117	G-20	G-52	479
1--3	81	H174	6	7	H94	8--127	G-114	G-18	G-53	478
1--4	82	H173	6	7	H93	8--128	G-113	G-17	G-54	477
1--5	74	H172	6	7	H92	8--121	G-110	G-16	G-55	476
1--6	75	H171	6	7	H91	8--122	G-109	G-15	G-56	475
1--7	77	H170	6	7	H90	8--123	G-108	G-14	G-57	474
1--8	76	H169	6	7	H89	8--124	G-107	G-13	G-58	473
1--9	71	H168	6	7	H88	8--117	G-104	G-11	G-59	472
1--10	70	H167	6	7	H87	8--118	G-103	G-10	G-60	471
1--11	72	H166	6	7	H86	8--119	G-102	G-9	G-61	470
1--12	73	H165	6	7	H85	8--120	G-99	G-8	G-62	469
1--13	65	H164	6	7	H84	8--113	G-98	G-7	G-63	468
1--14	66	H163	6	7	H83	8--114	G-97	G-6	G-64	467
1--15	68	H162	6	7	H82	8--115	G-94	G-4	G-28	466
1--16	67	H161	6	7	H81	8--116	G-92	G-3	G-29	465
1--17	62	H160	6	7	H80	8--109	G-91	G-2	G-30	464
1--18	61	H159	6	7	H79	8--110	G-88	G-1	G-31	463
1--19	63	H158	6	7	H78	8--111	G-87	G-228	G-32	462
1--20	64	H157	6	7	H77	8--112	G-84	G-227	G-33	461
1--21	56	H156	6	7	H76	8--105	G-83	G-225	G-34	460
1--22	57	H155	6	7	H75	8--106	G-82	G-224	G-35	459
1--23	59	H154	6	7	H74	8--107	G-81	G-223	G-36	458
1--24	58	H153	6	7	H73	8--108	G-78	G-222	G-37	457
1--25	53	H152	6	3	H72	8--101	G-77	G-221	G-38	456
1--26	52	H151	6	3	H71	8--102	G-74	G-220	G-39	455
1--27	54	H150	6	3	H70	8--103	G-73	G-218	G-40	454
1--28	55	H149	6	3	H69	8--104	G-72	G-217	G-41	453
1--29	47	H148	6	3	H68	8--97	G-71	G-216	G-42	452
1--30	48	H147	6	3	H67	8--98	G-68	G-215	G-43	451
1--31	50	H146	6	3	H66	8--99	G-67	G-214	G-44	450
1--32	49	H145	6	3	H65	8--100	G-66	G-213	G-45	449

1--33	43	H144	6	3	H64	8--93	G-62	G-211	G-168	448
1--34	44	H143	6	3	H63	8--94	G-59	G-210	G-167	447
1--35	45	H142	6	3	H62	8--95	G-58	G-209	G-166	446
1--36	46	H141	6	3	H61	8--96	G-57	G-208	G-165	445
1--37	37	H140	6	3	H60	8--89	G-56	G-207	G-164	444
1--38	40	H139	6	3	H59	8--90	G-53	G-206	G-163	443
1--39	42	H138	6	3	H58	8--91	G-52	G-204	G-162	442
1--40	39	H137	6	3	H57	8--92	G-49	G-203	G-161	441
1--41	36	H136	6	3	H56	8--85	G-48	G-202	G-160	440
1--42	33	H135	6	3	H55	8--86	G-47	G-201	G-159	439
1--43	35	H134	6	3	H54	8--87	G-46	G-200	G-158	438
1--44	38	H133	6	3	H53	8--88	G-43	G-199	G-157	437
1--45	30	H132	6	3	H52	8--81	G-42	G-197	G-156	436
1--46	29	H131	6	3	H51	8--82	G-41	G-196	G-155	435
1--47	31	H130	6	3	H50	8--83	G-38	G-195	G-154	434
1--48	32	H129	6	3	H49	8--84	G-37	G-194	G-153	433
1--49	25	H128	6	3	H48	8--77	G-36	G-193	G-152	432
1--50	26	H127	6	3	H47	8--78	G-32	G-192	G-151	431
1--51	28	H126	6	3	H46	8--79	G-29	G-190	G-149	430
1--52	27	H125	6	3	H45	8--80	G-28	G-189	G-148	429
1--53	19	H124	6	3	H44	8--73	G-27	G-188	G-147	428
1--54	22	H123	6	3	H43	8--74	G-26	G-187	G-146	427
1--55	24	H122	6	3	H42	8--75	G-23	G-186	G-145	426
1--56	21	H121	6	3	H41	8--76	G-22	G-185	G-144	425
1--57	18	H120	6	3	H40	8--69	G-21	G-183	G-143	424
1--58	15	H119	6	3	H39	8--70	G-20	G-182	G-142	423
1--59	17	H118	6	3	H38	8--71	G-17	G-181	G-141	422
1--60	20	H117	6	3	H37	8--72	G-16	G-180	G-140	421
1--61	12	H116	6	3	H36	8--65	G-13	G-179	G-139	420
1--62	11	H115	6	3	H35	8--66	G-12	G-178	G-138	419
1--63	13	H114	6	3	H34	8--67	G-11	G-176	G-137	418
1--64	14	H113	6	3	H33	8--68	G-10	G-175	G-136	417

Table 11

4. Time Multiplexing of Fiber Data onto Serial Links

Every beam crossing (132 nsec) the discriminator output pins of the MCMs present 544 bits of threshold detection data which must be shipped to the Digital Boards before the next beam crossing. This is accomplished using LVDS serial links that run at approximately 1.5 Gbit per second. The LVDS transmitter takes a 28 bit parallel data word every tick of the 53 MHz clock and ships that packet serially during the next 18.9 nsec.

Referring back to Figure 3, the Front End board must drive certain sets of bits onto certain links dependent upon whether it has been inserted as the 'left-hand' or the 'right-hand' board. This is accomplished by having two different sets of four links laid into the PCB traces of the Front End board, but only putting components into one of them. When the board is inserted as the 'left-hand' board it must multiplex the data from the MCMs onto the Red, Blue, Yellow and 2nd Red links; when inserted as the 'right-hand' board, the data must be presented onto the Purple, Orange, Green and 2nd Green. The 2nd Red and 2nd Green are literal duplicates of the Red and Green, and so require no extra logic; whatever bits are presented to the one LVDS driver are presented to the other at the same time.

Each link may send seven 28-bit words during the 132 nsec. To implement this time division, small programmable logic devices are used to pick off the necessary MCM outputs and multiplex them to the LVDS drivers. Tables 12, 13 and 14 give the order in which the fibers are delivered in the 'left-hand' orientation, while tables 15,16 and 17 describe the 'right-hand' order.

A moment's reflection on the structure of the Front End board suggests that for layout, the CPLDs which multiplex the data onto the Red links should be similar to those driving the Purple links. If one mentally overlays the pattern of Red fibers in Figure 3 over the Right-Hand section of the diagram, it is seen that the Red MCM channels mate in varying degrees to Purple, Orange and Green channels. However, the largest match is between the Red and the Purple. Similarly, the best sharing of resources for the other colors is Yellow/Green and Orange/Blue. This determines how the links wire up on the Front End board. Along the left edge of the PCB, as viewed from the component side, will be links for Green, Green(2), Orange and Purple. Along the right edge of the board, viewed from the component side, will be Red, Red(2), Blue and Yellow.

4.1. Left-Handed Fiber Order

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	B50	B49	B64	B63	B62	B61	B60	B59	B58	B57	B56	B55	B54	B53	B52	B51	A37	A38	A39	A40	A41	A42	A43	A44	A45	A46	A47	1
2	A48	A49	A50	A51	A52	A53	A54	A55	A56	A57	A58	A59	A60	A61	A62	A63	A64	C82	C81	C80	C79	C78	C77	C76	C75	C74	C73	0
3	C72	C71	C70	C69	C68	C67	C66	C65	C96	C95	C94	C93	C92	C91	C90	C89	C88	C87	C86	C85	C84	C83	B65	B66	B67	B68	B69	0
4	B70	B71	B72	B73	B74	B75	B76	B77	B78	B79	B80	D112	D111	D110	D109	D108	D107	D106	D105	D104	D103	D102	D101	D83	D84	D85	D86	0
5	D87	D88	D89	D90	D91	D92	D93	D94	D95	D96	D97	D98	D99	D100	E128	E127	E126	E125	E105	E106	E107	E108	E109	E110	E111	E112	E113	0
6	E114	E115	E116	E117	E118	E119	E120	E121	E122	E123	E124	F144	F143	F142	F141	F140	F139	F138	F137	F136	F135	F134	F133	F127	F128	F129	F130	0
7	F131	F132	G158	G157	G156	G155	G160	G159	H176	H175	PSN32	PSN31	PSN30	PSN29	PSS32	PSS31	PSS30	PSS29	PSN29	PSN30	PSN31	PSN32	PSS29	PSS30	PSS31	PSS32	spare	0

Table 12 – Data Sent on Red Links by Left-Hand Insertion of Board

When the Front End board is inserted in the 'left-hand' position, 188 fibers are transmitted every crossing over the Red links. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information.

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	F107	F108	F109	F110	F111	F112	F113	F114	F115	F116	F117	F118	F119	F120	F121	F122	F123	F124	F125	F126	G154	G153	G152	G151	G150	G149	G148	1
2	G147	G146	G145	G144	G143	G142	G141	H112	H111	H110	H109	H108	H107	H106	H105	G109	G110	G111	G112	G113	G114	G115	G116	G117	G118	G119	G120	0
3	G121	G122	G123	G124	G125	G126	G127	G128	G129	G130	G131	G132	G133	G134	G135	G136	G137	G138	G139	G140	H162	H161	H160	H159	H158	H157	H156	0
4	H155	H154	H153	H152	H151	H150	H149	H148	H147	H146	H145	H174	H173	H172	H171	H170	H169	H168	H167	H166	H165	H164	H163	H113	H114	H115	H116	0
5	H117	H118	H119	H120	H121	H122	H123	H124	H125	H126	H127	H128	H129	H130	H131	H132	H133	H134	H135	H136	H137	H138	H139	H140	H141	H142	H143	0
6	H144	PSN28	PSN27	PSN26	PSN25	PSN24	PSN23	PSN22	PSN21	PSS28	PSS27	PSS26	PSS25	PSS24	PSS23	PSS22	PSS21	PSN21	PSN22	PSN23	PSN24	PSN25	PSN26	PSN27	PSN28	PSS21	PSS22	0
7	PSS23	PSS24	PSS25	PSS26	PSS27	PSS28	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	0	0

Table 13 – Data Sent on Blue Link by Left-Hand Insertion of Board

When the Front End board is inserted in the 'left-hand' position, 168 fibers are transmitted every crossing over the Blue link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information. The 20 bits marked 'stat' are reserved for Front End board status and/or message passing from the Front End board to the Digital board.

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	B48	B47	B46	B45	B44	B43	B42	B41	B40	B39	B38	B37	B36	B35	B34	B33	A33	A34	A35	A36	C49	C50	C51	C52	C53	C54	C55	1
2	C56	C57	C58	C59	C60	C61	C62	C63	C64	E70	E69	E68	E67	E66	E65	E88	E87	E86	E85	E84	E83	E82	E81	E80	E79	E78	E77	0
3	E76	E75	E74	E73	E72	E71	D65	D66	D67	D68	D69	D70	D71	D72	D73	D74	D75	D76	D77	D78	D79	D80	D81	D82	F78	F77	F76	0
4	F75	F74	F73	F72	F71	F70	F69	F68	F67	F66	F65	F96	F95	F94	F93	F92	F91	F90	F89	F88	F87	F86	F85	F84	F83	F82	F81	0
5	F80	F79	E89	E90	E91	E92	E93	E94	E95	E96	E97	E98	E99	E100	E101	E102	E103	E104	G86	G85	G84	G83	G82	G81	G104	G103	G102	0
6	G101	G100	G99	G98	G97	G96	G95	G94	G93	G92	G91	G90	G89	G88	G87	F97	F98	F99	F100	F101	F102	F103	F104	F105	F106	H104	H103	0
7	H102	H101	H100	H99	H98	H97	G105	G106	G107	G108	PSS18	PSS17	PSN20	PSN19	PSN18	PSN17	PSS20	PSS19	PSN17	PSN18	PSN19	PSN20	PSS17	PSS18	PSS19	PSS20	0	0

Table 14 – Data Sent on Yellow Link by Left-Hand Insertion of Board

When the Front End board is inserted in the ‘left-hand’ position, 188 fibers are transmitted every crossing over the Yellow link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information.

4.2. Right-Handed Order

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	B18	B17	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B32	B31	B30	B29	B28	B27	B26	B25	B24	1
2	B23	B22	B21	B20	B19	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	0
3	A23	A24	A25	A26	A27	A28	D2	D1	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	C1	C2	C3	C4	C5	0
4	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	0
5	E6	E5	E4	E3	E2	E1	E24	E23	E22	E21	E20	E19	E18	E17	E16	E15	E14	E13	E12	E11	E10	E9	E8	E7	D17	D18	D19	0
6	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	F14	F13	F12	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1	F18	F17	0
7	F16	F15	G6	G5	G1	G2	G3	G4	H2	H1	PSS2	PSS1	PSN4	PSN3	PSN2	PSN1	PSS4	PSS3	PSN1	PSN2	PSN3	PSN4	PSS1	PSS2	PSS3	PSS4	spare	0

Table 15 – Data Sent on Green Links by Right-Hand Insertion of Board

When the Front End board is inserted in the 'right-hand' position, 188 fibers are transmitted every crossing over the Green links. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information.

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	F32	F31	F30	F29	F28	F27	F26	F25	F24	F23	F22	F21	F20	F19	G22	G21	G20	G19	G18	G17	G16	G15	G14	G13	G12	G11	G10	1
2	G9	G8	G7	G40	G39	G38	G37	G36	G35	G34	G33	G32	G31	G30	G29	G28	G27	G26	G25	G24	G23	F33	F34	F35	F36	F37	F38	0
3	H14	H13	H12	H11	H10	H9	H8	H7	H6	H5	H4	H3	H32	H31	H30	H29	H28	H27	H26	H25	H24	H23	H22	H21	H20	H19	H18	0
4	H17	H16	H15	G41	G42	G43	G44	G45	G46	G47	G48	G49	G50	G51	G52	H72	H71	H70	H69	H68	H67	H66	H65	H33	H34	H35	H36	0
5	H37	H38	H39	H40	H41	H42	H43	H44	H45	H46	H47	H48	H49	H50	H51	H52	H53	H54	H55	H56	H57	H58	H59	H60	H61	H62	H63	0
6	H64	PSN12	PSN11	PSN10	PSN9	PSN8	PSN7	PSN6	PSN5	PSS12	PSS11	PSS10	PSS9	PSS8	PSS7	PSS6	PSS5	PSN5	PSN6	PSN7	PSN8	PSN9	PSN10	PSN11	PSN12	PSS5	PSS6	0
7	PSS7	PSS8	PSS9	PSS10	PSS11	PSS12	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	0

Table 16 – Data Sent on Orange Link by Right-Hand Insertion of Board

When the Front End board is inserted in the 'right-hand' position, 168 fibers are transmitted every crossing over the Orange link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information. The 20 bits marked 'stat' are reserved for Front End board status and/or message passing from the Front End board to the Digital board.

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	A29	A30	A31	A32	C48	C47	C46	C45	C44	C43	C42	C41	C40	C39	C38	C37	C36	C35	C34	C33	D64	D63	D62	D61	D60	D59	D58	1
2	D57	D56	D55	D54	D53	D31	D32	D33	D34	D35	D36	D37	D38	D39	D40	D41	D42	D43	D44	D45	D46	D47	D48	D49	D50	D51	D52	0
3	E64	E63	E62	E61	E25	E26	E27	E28	E29	E30	E31	E32	E33	E34	E35	E36	E37	E38	E39	E40	E41	E42	E43	E44	E45	E46	E47	0
4	E48	E49	E50	E51	E52	E53	E54	E55	E56	E57	E58	E59	E60	F39	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49	F50	F51	F52	0
5	F53	F54	F55	F56	F57	F58	F59	F60	F61	F62	F63	F64	G80	G79	G78	G77	G53	G54	G55	G56	G57	G58	G59	G60	G61	G62	G63	0
6	G64	G65	G66	G67	G68	G69	G70	G71	G72	G73	G74	G75	G76	H82	H81	H80	H79	H78	H77	H76	H75	H74	H73	H96	H95	H94	H93	0
7	H92	H91	H90	H89	H88	H87	H86	H85	H84	H83	PSN16	PSN15	PSN14	PSN13	PSS16	PSS15	PSS14	PSS13	PSN13	PSN14	PSN15	PSN16	PSS13	PSS14	PSS15	PSS16	0	0

Table 17 – Data Sent on Purple Link by Right-Hand Insertion of Board

When the Front End board is inserted in the ‘right-hand’ position, 168 fibers are transmitted every crossing over the Purple link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved and may be used for link synchronization information.

4.3. Status and Synchronization Information

Bit 28 of all links is used for link synchronization in all links. The first timeslice is marked by bit 28 equal to '1', and bit 28 is a '0' in all other timeslices. For the Orange and Blue links, 20 other bits in timeslice 7 are available for status and trigger information. These status bits provide a mix of SVX, Front End and Trigger information, all of which may be used by the Digital Board for conditional processing of data. Table 18 gives the breakdown.

Bit Position in Timeslice 7	Name	Interpretation if set (1)
7	HDI_EN	SVX Sequencer thinks SVX chips are being used
8	FIRST_CROSSING	SVX Sequencer timing bit, used to indicate first crossing in a bunch.
9	SYNC_GAP	Beam Gap; data may be diagnostic in nature
10	MCM_STAT0	MCM #0 power is on
11	MCM_STAT1	MCM #1 power is on
12	MCM_STAT2	MCM #2 power is on
13	MCM_STAT3	MCM #3 power is on
14	MCM_STAT4	MCM #4 power is on
15	MCM_STAT5	MCM #5 power is on
16	MCM_STAT6	MCM #6 power is on
17	MCM_STAT7	MCM #7 power is on
18	FAKE_DATA	Front End CPLDs are sending diagnostic patterns, not real data
19	DAC_UPDATE	Front End microcontroller is changing MCM DAC parameters
20	ADC_READ	Front End microcontroller is performing A/D conversions; noise floor may be different
21	LOCAL_CRYO	Front End microcontroller is controlling cryostat temperature; if not set, assume external controller.
22	CRYO_ERROR	Only valid if LOCAL_CRYO is set. If both this bit and LOCAL_CRYO are set, Front End microcontroller has determined that VLPCs are running at improper temperature and data is likely to be invalid.
23-25	FINE_TIMING	3-bit code indicating time offset, in 53MHz ticks, between CROSSING and when this data was loaded – for use in system timing analysis.
26	L1 ACCEPT	Level 1 Accept signaled by SVX Sequencer
27	CFT_RESET	CFT RESET from SVX Sequencer

Table 18