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Cabling Scheme of the Central Preshower Detector

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Abstract

This note summarizes the channel mapping of the central preshower detector from the detector to the front end electronics. The mapping assumes that the detector shares 15 VLPC cassettes equally with the central fiber tracker. For the detector-to-cassette connection, axial U and V stereo layers are each divided into 5 azimuthal super-sectors with each super-sector connected to a cassette through two 256-fiber waveguides, one each for north and south readout ends. The two readout ends of the same 16-fiber ϕ-sector are routed to the same cassette and to the same front end electronics board for the axial layer. However, same is not true for the two stereo layers. The basic parameters of the waveguides are also specified.

The central preshower (CPS) detector consists of a flat layer of lead radiator plus three layers of finely segmented triangular scintillating strips with wavelength shifting (WLS) fiber readout. The solenoid and the lead serve as the pre-radiator and are together two radiation length thick at normal incidence. To help understanding the notation below, we first briefly describe the DØ coordinate system. The DØ coordinate system has been in place since 1986. The origin is set to be the nominal beam crossing point at the center of the detector. The $x-$, $y-$, and $z-$axes point to east, up and south (proton beam direction) respectively. The azimuthal angle ϕ is defined by the right-hand rule with $\phi = 0$ along the positive $x-$axis.

CONNECTION FROM THE DETECTOR TO VLPC

The three layers are arranged in axial (Z) and stereo views (U and V) in increasing radius with stereo angles of $\sim \pm 24°$ with respect to the beam direction. The stereo angles are chosen such that every stereo strip rotates 90° in ϕ from one end to another. Each layer is constructed with 8 modules and each module is divided into 10 sectors with 16 fibers/sector. These 16-fiber sectors are referred as the $\phi-$sectors. The WLS fibers are split in the middle of the strips and are attached to 16-fiber optical connectors at both north and south ends of the detector. Table 1 summarizes the basic segmentation of the detector. The 80 16-fiber $\phi-$sectors, each covers an azimuth of 4.5°, are aligned with those of the central fiber tracker (CFT) and serve as basic trigger roads. They are labeled from 1 to 80 in the order of increasing ϕ at $z = 0$ in the DØ coordinate system for all three layers as shown in Fig. 1. The strips are labeled similarly, starting from 1 for the first strip of the sector 1 and ending with 1,280 for the last strip of the sector 80 in increasing ϕ.

Layers	Radius (cm)	Length (cm)	Stereo Angle (in °)	No. of $\phi-$sectors	No. of Fibers (Each End)	Total No. of Channels
Z	72.2	260.2	0	80	1,280	2,560
U	73.0	260.2	+23.8	80	1,280	2,560
V	73.8	260.2	−24.0	80	1,280	2,560

Table 1: Basic geometric parameters and segmentations of the detector.

The WLS fibers are connected to visible light photon counters (VLPC) located at the platform through long clear waveguide bundles. The VLPCs are grouped into cassettes with 1024 channel/cassette. The connection to the photodetector in the cold-end is provided by 8 128-channel connector arranged in a column at the warm end of the cryostat as shown in Fig. 2. Four of the 8 connectors in a cassette are assigned to CPS while the rest are used by CFT stereo. Therefore, five cassettes are needed for each CPS layer.

There are two analog front end (AFE) boards on each cassette. Each board sees 64 channels of each 128-fiber connector on the cassette as shown in Fig. 2. To ensure that fibers from north and south ends of the same axial scintillating strips go to the same AFE board for Level-1 trigger, the sixteen 16-fiber connectors are connected *counter-clockwise* from $a1, a2, ..., a8, b1, b2, ..., b8$ at the south end and *clockwise* at the north end as shown in Fig. 6. At the cassette, A and B connectors from the south end are connected to connectors 2 and 3. The A and B connectors from the north end are connected to connectors 6 and 7 as shown in Fig. 3.

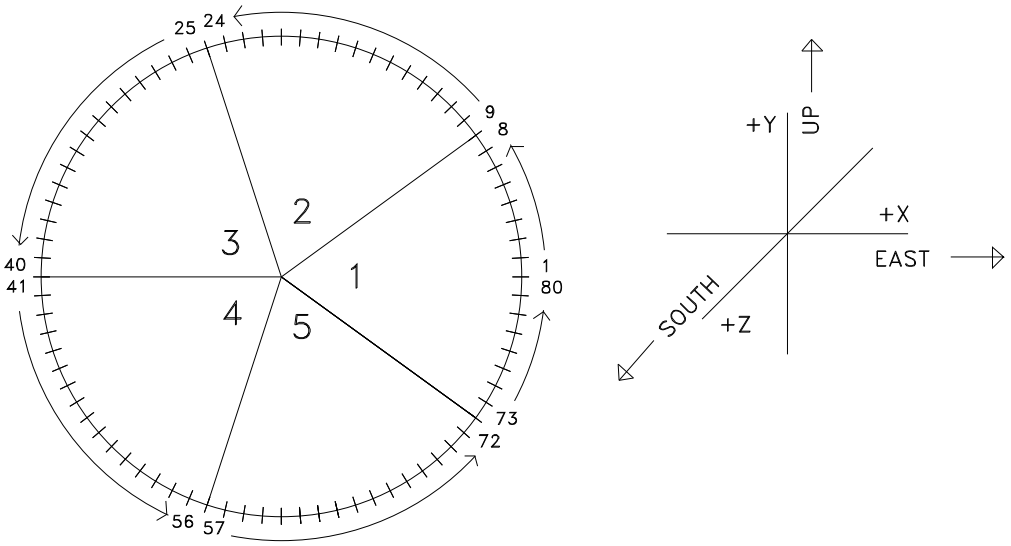

Figure 1: Definitions of ϕ–sectors at $z = 0$ and super-sectors. Note that the ϕ–sectors are defined based on sets of scintillating strips while the super-sectors are defined for the fixed ϕ ranges. Therefore ϕ–sectors are z–dependent for stereo layers.

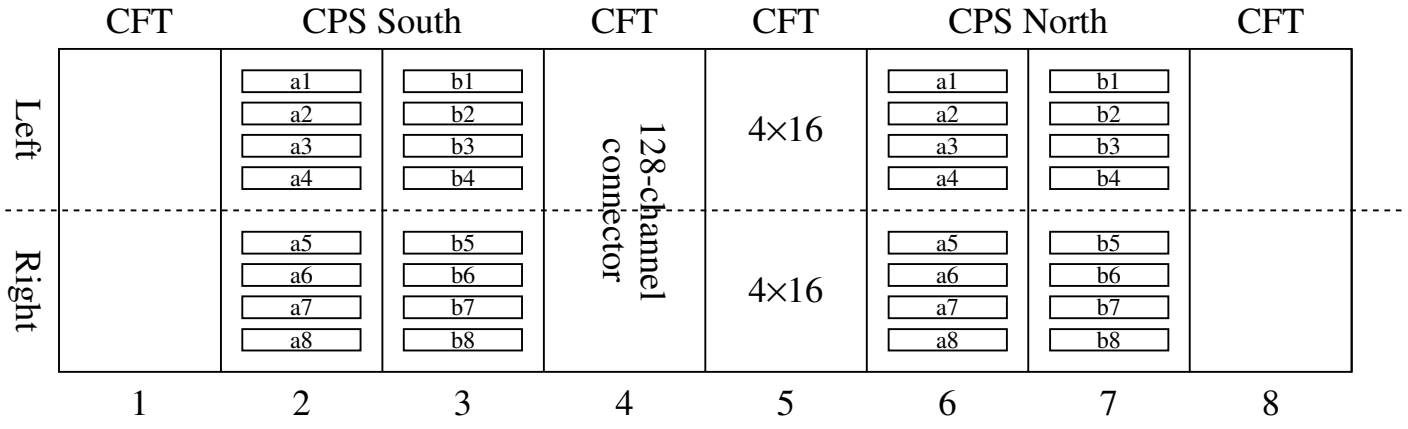

Figure 2: Layout of 8 128-fiber connectors on the cassette. Connectors 2,3,6, and 7 are assigned to CPS, the rest are used by CFT stereos. The dashed line separates the channel assignments for the two analog front end boards. The fibers from the north and south ends of the same super-sector are routed to the same cassette.

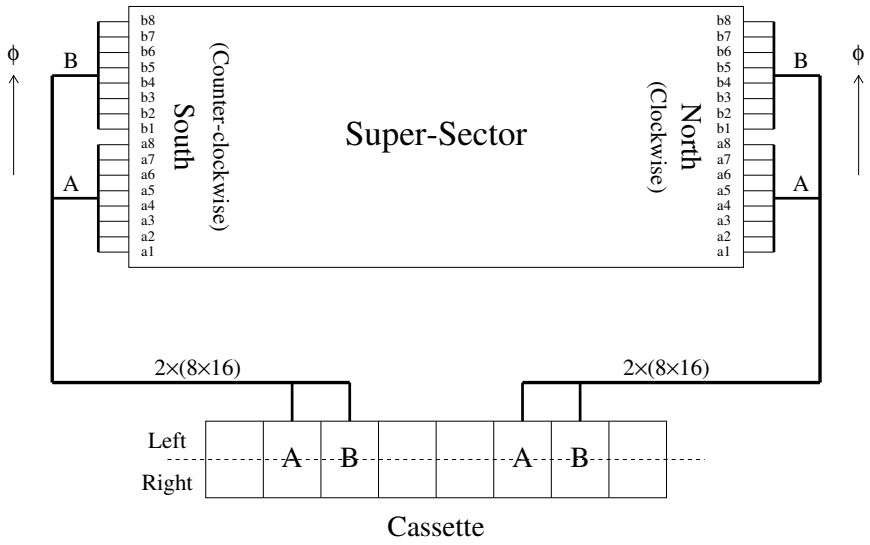

Figure 3: Schematic drawing of the detector-to-cassette connection for one super sector. The north and south fibers of the same super-sector are routed to the same cassette by two slightly different bundles (see Fig. 5). The north and south fibers of the same ϕ–sector are connected to the same cassette for Z layers, but not for the two stereo layers.

Super Sector		1	2	3	4	5
Z Layer	Cassette	20W	22W	24W	18W	16W
	Waveguide	Z1	Z2	Z3	Z4	Z5
	South ϕ–sectors	73-80, 1-8	9-24	25-40	41-56	57-72
	North ϕ–sectors	73-80, 1-8	9-24	25-40	41-56	57-72
U Layer	Cassette	22E	18E	30W	26W	26E
	Waveguide	U1	U2	U3	U4	U5
	South ϕ–sectors	63-78	79-80, 1-14	15-30	31-46	47-62
	North ϕ–sectors	3-18	19-34	35-50	51-66	67-80, 1-2
V Layer	Cassette	24E	20E	32W	28W	28E
	Waveguide	V1	V2	V3	V4	V5
	South ϕ–sectors	3-18	19-34	35-50	51-66	67-80, 1-2
	North ϕ–sectors	63-78	79-80, 1-14	15-30	31-46	47-62

Table 2: Cassette assignments taken from F. Borcherding's spread sheet and ϕ–sector coverage for the five super-sectors of the three CPS layers. Note that the ϕ–sectors are defined at $z = 0$ for all three layers.

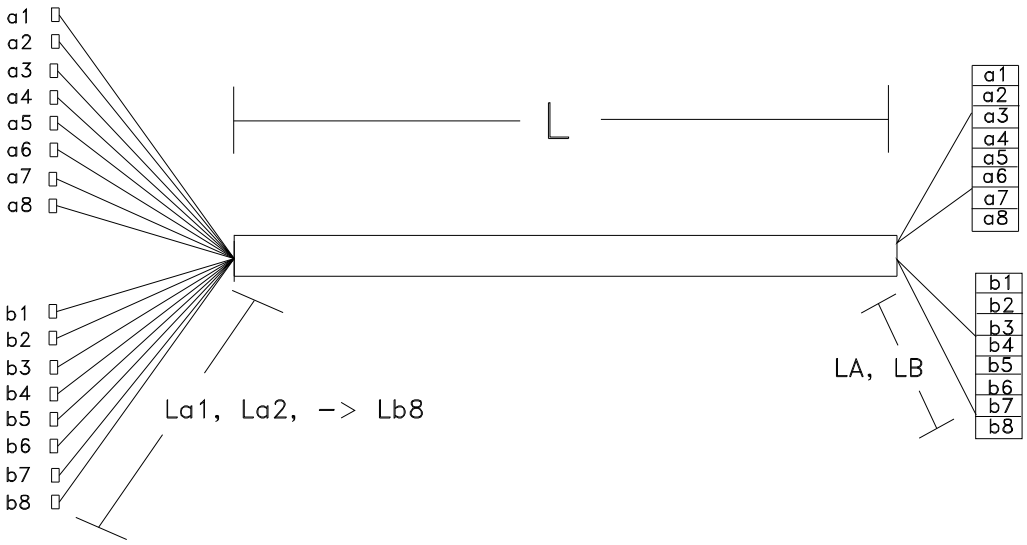

Figure 4: Schematic drawing of the clear waveguide bundle of the central preshower detector. Each bundle has sixteen 16-fiber detector-side connectors and two 128-fiber cassette-side connectors. The overall length L's are different for different supersectors. Moreover, the orientation of the 16-fiber connectors are different for north and south waveguides.

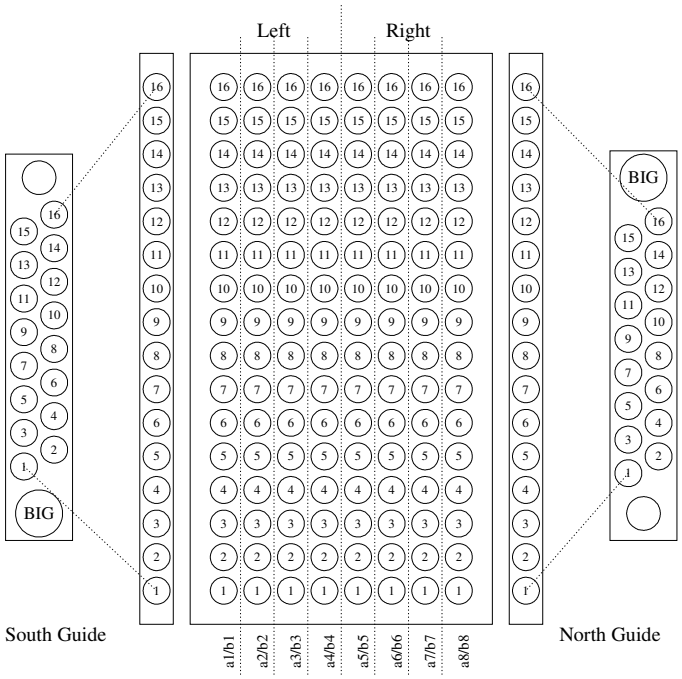

Figure 5: Fiber mapping from the 16-fiber detector-side connector to 128-fiber cassette-side connector. Note different orientation of the detector-side connectors for the north and south waveguides to match what is on the detector.

L_A	$a1$	$a2$	$a3$	$a4$	$a5$	$a6$	$a7$	$a8$
L_B	$b8$	$b7$	$b6$	$b5$	$b4$	$b3$	$b2$	$b1$
0.00	33 4/8	31 5/8	29 7/8	28 1/8	26 7/8	25 5/8	25	24 3/8

Table 3: Pig-tail lengths in inches for the two 128-fiber connectors A and B and for the sixteen 16-fiber connectors $a1, a2, ..., a8$ and $b1, b2, ..., b8$. These lengths are the same for all bundles. The lengths of the sixteen 16-fiber pig-tails are determined assuming that the waveguides split at a radius of 45" on the CC wall.

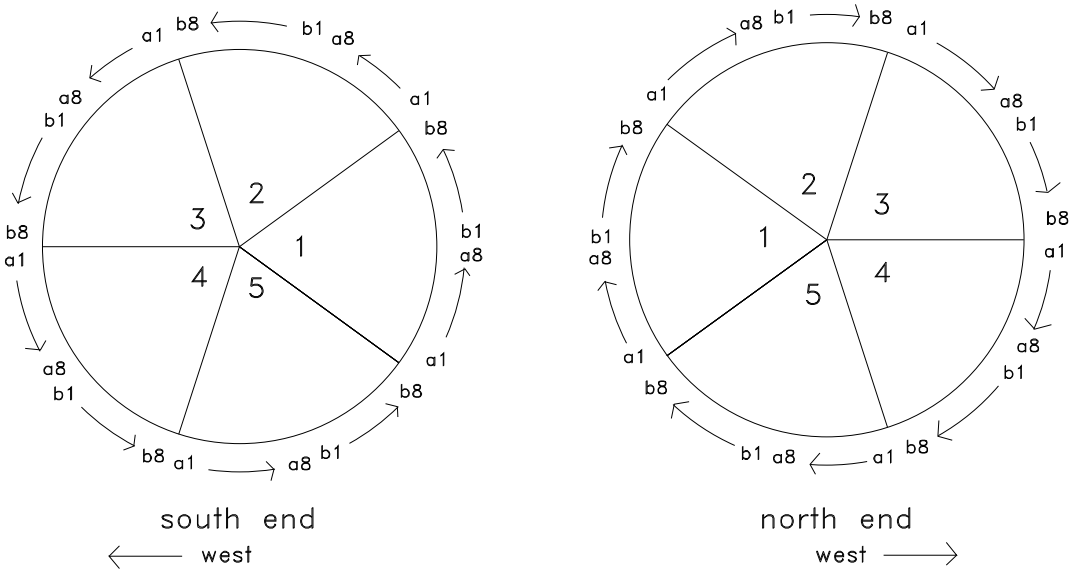

Figure 6: The order of the sixteen 16-fiber connectors for the south and north ends. Each super-sector in a layer is connected to one bundle.

For the purpose of detector-to-cassette connections, the detector is divided into 5 equal super-sectors in ϕ as shown in Fig. 1. Consequently, each super-sector has 32 ϕ−sectors (16 per end). The north and south fibers of the same super-sector are routed to the same cassette as shown graphically in Fig. 3 by two slightly different clear waveguide bundles (see Fig. 5), one for each end. In this scheme, the north and south fibers of the same ϕ−sectors are connected to the same cassette for the Z layer, but not for the two stereo layers. The corresponding cassettes (taken from Fred B.'s spreadsheet) and ϕ−sectors of each super-sector for all three layers are shown in Table 2. Each bundle has 256 fibers with sixteen 16-fiber detector-side connectors and two 128-fiber cassette-side connectors. The sixteen 16-fiber connectors are labeled as $a1, a2, ..., a8$ and $b1, b2, ..., b8$ respectively. The two 128-fiber connectors are named as A and B. The A connector groups all the fibers from $a1, a2, ..., a8$ while the B connector has all the fibers from $b1, b2, ..., b8$. The $(a1, ..., a8) \rightarrow A$ and $(b1, ..., b8) \rightarrow B$ mappings are identical and are shown in Figs. 2 and 3. A schematic design of the waveguide bundle is shown in Fig. 4. Apart from the different overall lengths, the north and south waveguides are also different in terms of the orientation of the 16-fiber connectors at the detector end (see Fig. 5). The overall lengths will be fixed as soon as the cable routing scheme is fixed for both CFT and CPS. A total of 30 bundles are needed. The pig-tail lengths as tabulated in Table 3 are the same for all bundles.

MAPPING FROM THE DETECTOR TO THE FRONT END

The ϕ−sectors are mapped to the groups of 16 fibers on a cassette identified using $k.\ell.m.n$. Here k is the super-sector number, $k = 1, ..., 5$. ℓ identifies the left and right AFE board with $\ell = 0$ for the left board and $\ell = 1$ for the right board. m is the connector number on the cassette, $m = 2, 3$ for the south end and $m = 6, 7$ for the north end. n is an internal index of 16-fiber groups, $n = 1, ..., 4$. These naming conventions are illustrated in Fig. 7 for super-sector k.

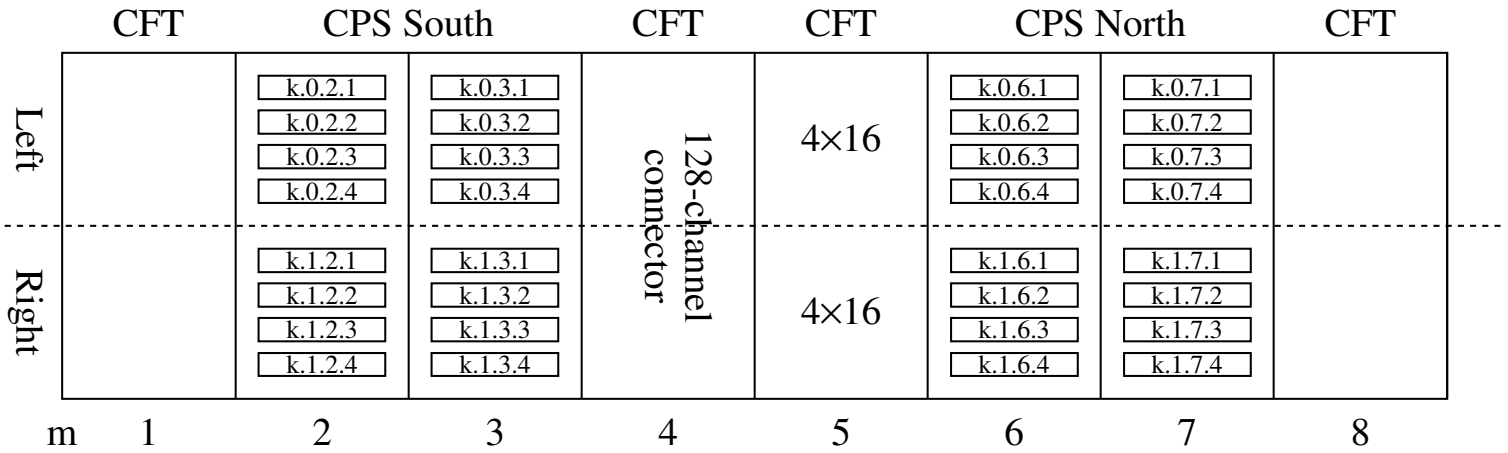

Figure 7: Naming convention for groups of 16 channels on the cassette of super-sector k.

The corresponding ϕ−sector $(S\phi)$ of the group $k.\ell.m.n$ is calculated using the equations in Table 4. Note that $S\phi$ should be a modulo of 80. Therefore $S\phi = S\phi - 80$ if $S\phi > 80$ and $S\phi = S\phi + 80$ if $S\phi \leq 0$. In this scheme, the first and the last axial ϕ−sectors are represented by

1.0.3.1 and 1.1.2.4 respectively. The fiber mapping within a $\phi-$sector is shown in Fig. 5.

Layer	End	$\phi-$sector $(S\phi)$ of the group $k.\ell.m.n$
Z	South	$(k-1)\times 16+(\ell-1)\times 4+(m-2)\times 8+n-4$
	North	$(k-1)\times 16+(\ell-1)\times 4+(m-6)\times 8+n-4$
U	South	$(k-1)\times 16+(\ell-1)\times 4+(m-2)\times 8+n-4-10$
	North	$(k-1)\times 16+(\ell-1)\times 4+(m-6)\times 8+n-4+10$
V	South	$(k-1)\times 16+(\ell-1)\times 4+(m-2)\times 8+n-4+10$
	North	$(k-1)\times 16+(\ell-1)\times 4+(m-6)\times 8+n-4-10$

Table 4: Translation equations between the 16-channel group $k.\ell.m.n$ on a cassette and the $\phi-$sector of the detector. Note that $S\phi$ is a modulo of 80.