Beam Instrumentation III What Was Built

B. Bassalleck, G. H. Coombes, P. Kitching, J. A. Macdonald, T. Numao,
S. Sugimoto, Y. Tamagawa

1 New B4 Hodoscope

B4 (see Figure 1) comprises 2 layers (B4U and B4V) of 16 hodoscope elements each, together with 2 ring veto counters (RV1 and RV2). It is separated by about 6mm from the upstream target face .Each hodoscope element is made up of a pair of staggered rectangles (Figure 2), glued together and read out by 3 WLS double- clad fibers (Bicron BCF99-29-AA-MC) going to a single Hamamatsu H3165-10 tube. The phototubes were tested at KEK by varying the HV and light intensity. Each hodoscope layer is 6.35 mm thick. The orientation and dimensions are shown in Figures 1,2 and 3. The outline of B4 is not completely circular because B4 packed together more tightly than we anticipated (the glue took up less room),The tighter packing results in a hodoscope pitch of 7.2 mm (Figure 3).

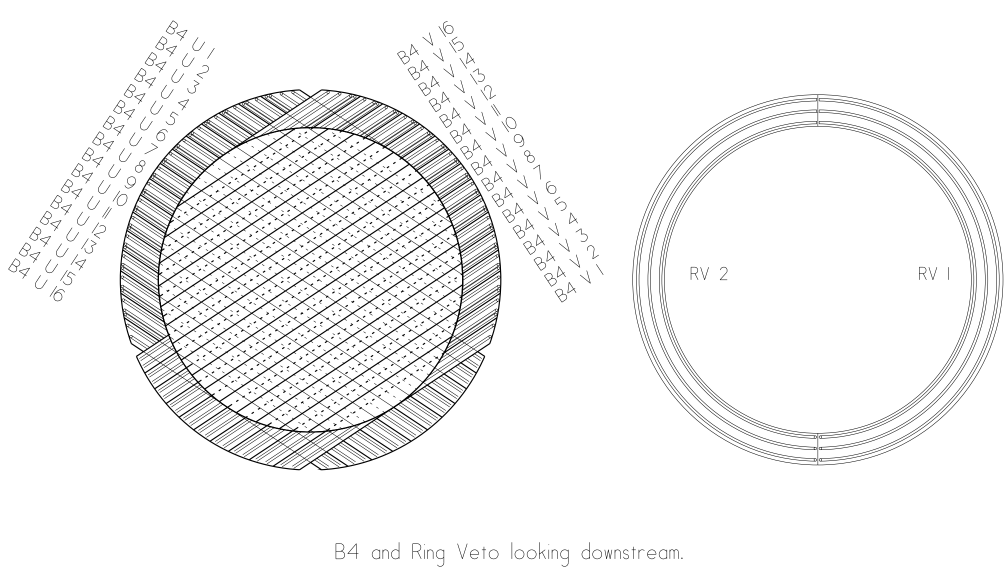

Figure 1: B4 hodoscope – general arrangement

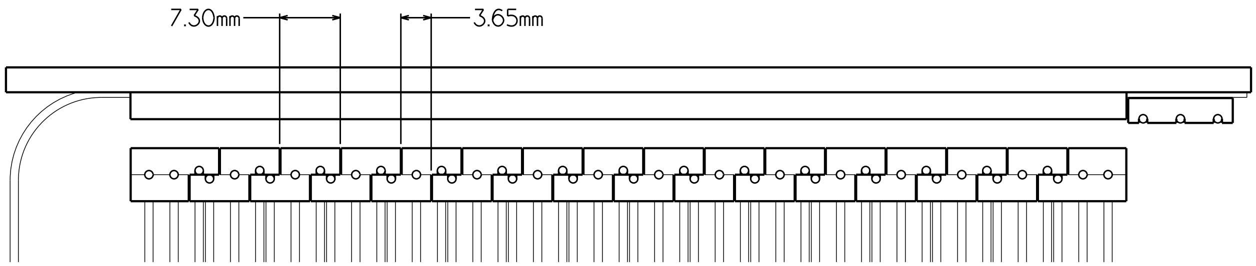

Figure 2: B4 hodoscope -top view

The Ring Veto,split vertically in 2 pieces, is made of BC404 scintillator, 3.27 mm thick. Its outside diameter is 145.5 mm. The inside diameter varies between 119.95mm and 118.45 mm, to fit the tighter than expected packing of B4.

Each B4 element is wrapped with 0.05 mm aluminized mylar and the whole assembly held by a can whose downstream face is made of 0.3 mm G10 covered on both sides by .0175 mm copper

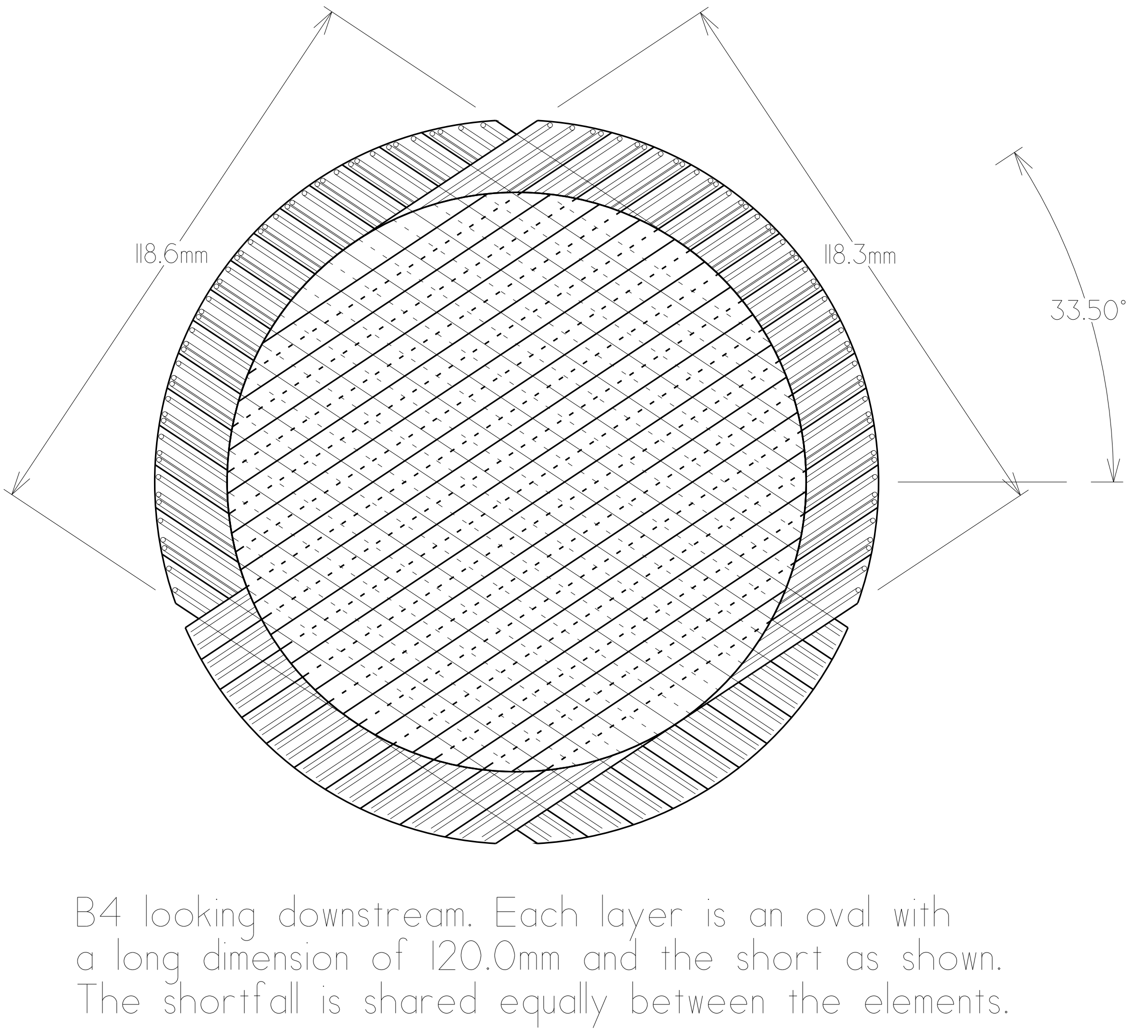

Figure 3: B4 hodoscope – layout

2 Active Degrader (AD)

This detector,located just upstream of B4, is constructed of 40 layers of 139 mm diameter by 2mm thick scintillator disks(Bicron BC404) interspersed with 136 mm diameter by 2.2 mm thick copper disks. Each layer of scintillator is split into 12 azimuthal segments, with each segment read out by 14 Bicron BCF99-29-AA-MC WLS fibers, running in grooves cut into the perimeter of the disks and going to a single Hamamatsu R1924 tube. The general arrangement is shown in Figure 4 and the labelling scheme in Figure 5. The assembly is held in a can whose downstream face is made of 0.25 mm PVC.

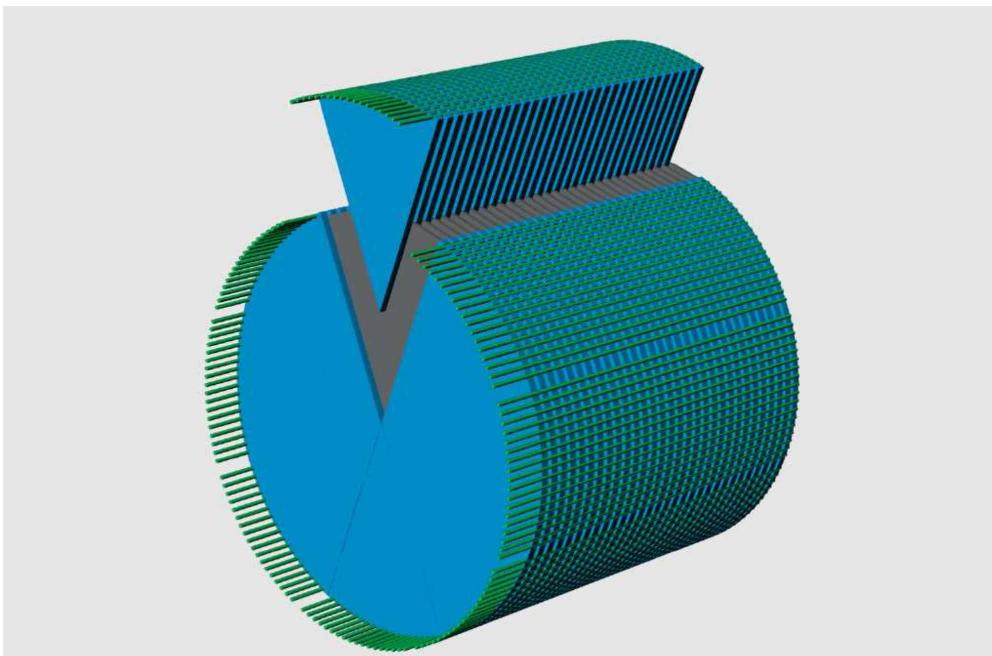

Figure 4: Active Degrader (AD)

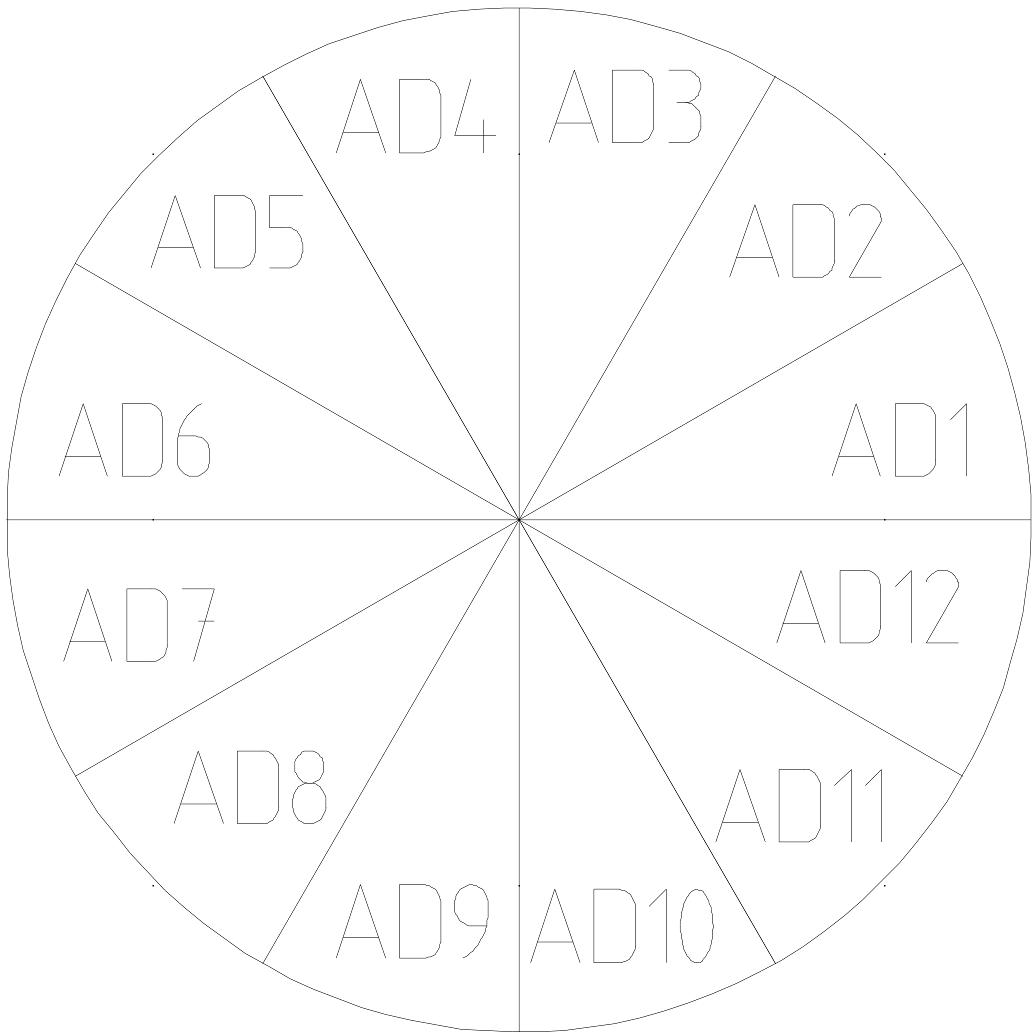

Figure 5: Active Degrader – beams eye view

3 Inactive degrader

The inactive degrader as of July,2001, consisted of 111.1 mm of Beryllium Oxide,plus 4.76mm of lucite. This amount of degrader should be appropriate for a kaon momentum of 710 MeV/c. The same Monte Carlo, Geant-based code discussed in II was used to calculate the number,(Kstop), of K-stops and the beam momentum,(Kp), needed to centre the stopping K's in the target for BeO thicknesses between zero and 10 inches. The results of these calculations are shown in Table 1 and Figure 6. Figure 6 also displays linear fits to the results. The best fits are given by:

Kp(MeV/c) = 616.9+7.60*beo

Kstop = 1459-24.5*beo
where beo is the thickness of inactive degrader in cms.

Table 1: Kp and Kstops vs BeO thickness

BeO thickness	Kp	Mean Z-stopping pos	Kstops	Error
0.00	618	9.97	1444	38.00
1.27	629	10.06	1399	37.40
2.54	638	9.86	1377	37.10
3.81	649	10.21	1365	36.95
5.08	659	10.13	1341	36.61
6.35	668	10.00	1313	36.24
7.62	678	10.15	1278	35.75
8.89	687	10.01	1272	35.67
10.16	697	10.08	1234	35.13
11.43	707	10.00	1163	34.10
12.70	716	10.00	1079	32.85
13.97	724	9.8	9 1119	33.45
15.24	733	9.99	1041	32.26
16.51	742	10.24	1077	32.81
17.78	751	10.11	1041	32.26
19.05	760	10.15	1015	31.86
20.32	768	10.16	959	30.97
21.59	777	9.92	929	30.48
22.86	785	9.97	943	30.71
24.13	794	9.89	831	28.83
25.40	803	9.90	896	29.93

Note that the fraction of K-stops falls by over 40% as the BeO thickness is increased from zero to 10 inches.

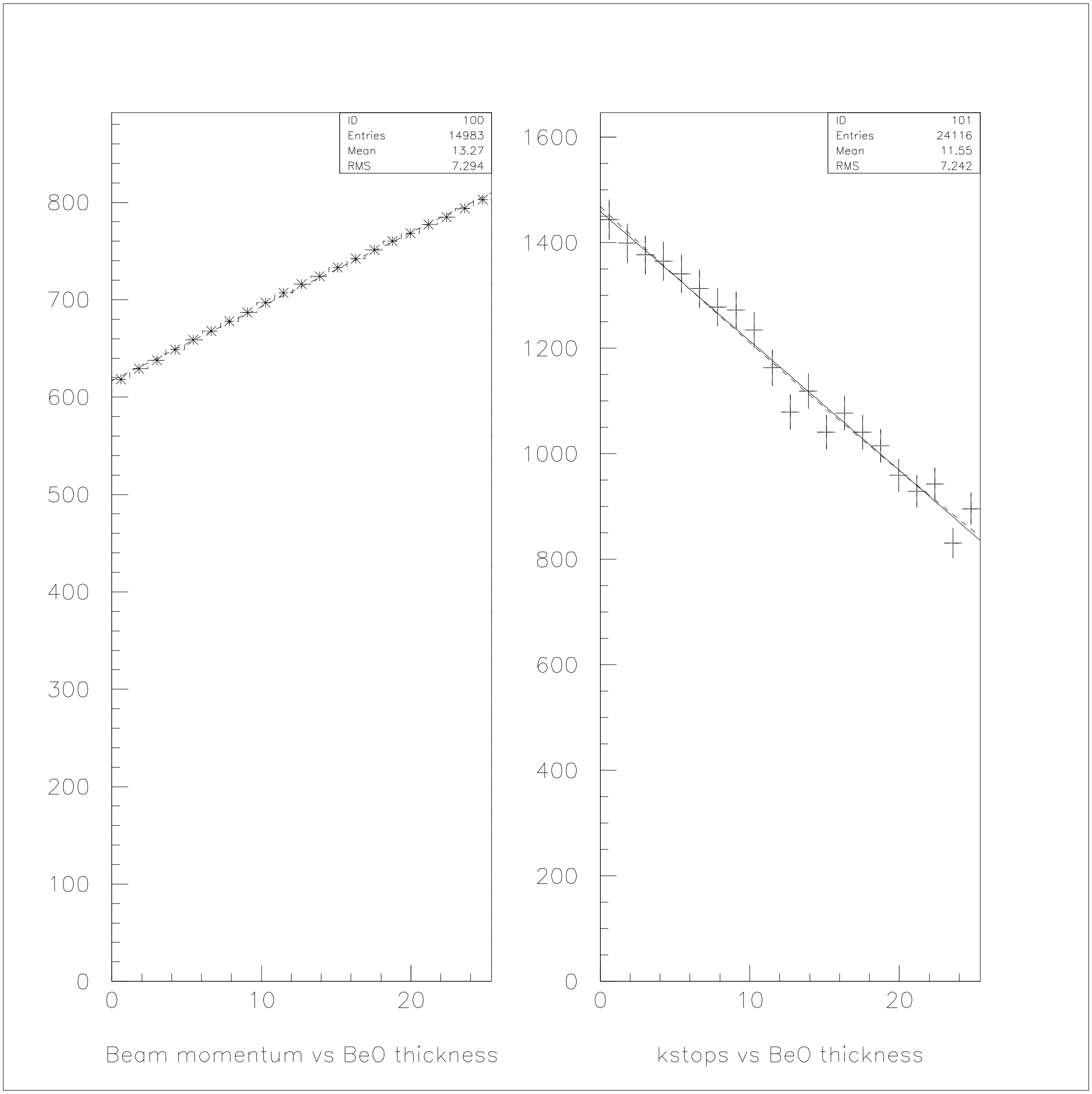

Figure 6: Inactive Degrader (BeO)

4 Upstream Photon Veto

This is made of 12 layers of 28.4 cm square by 2mm thick BC404 plastic scintillator interspersed with 28.4 cm square pieces of lead 1 or 2 mm thick (Figure 7). The downstream-most layer of lead was replaced by 2.2mm thick copper which formed part of the box holding the layers together.The upstream side of the box is 3.175 mm Aluminum The first 6 layers of lead after the copper layer are 1 mm thick, and the last 5 layers are 2mm thick Each scintillator layer was read out by 21 WLS fibers going to one of 2 Hamamatsu R1924 tubes. All elements of the detector contain a slot 175 mm wide by 40 mm high to allow the beam to pass through.The slot is covered by 0.25 mm PVC at entrance and exit to make the assembly light-tight, so 0.5 mm of this material is in the path of the beam. The detector is located betweenthe Princeton Cerenkov counter and the first beam wire chamber, BWC1.

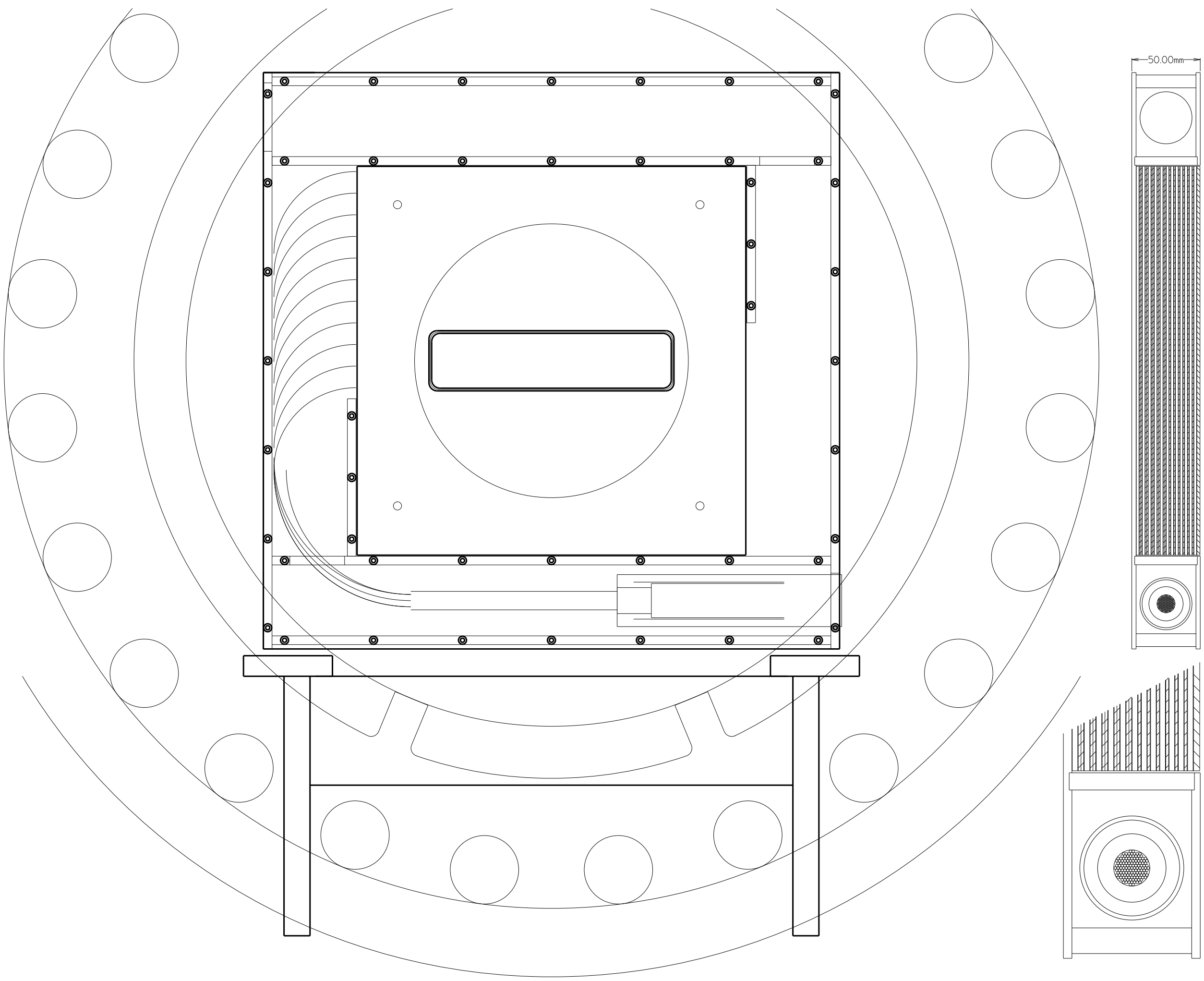

Figure 7: Upstream Photon Veto

5 Electronics

- B4 and RV signals go through X10 amplifiers located in NIM crate at upstream end of detector
- B4 - 32 channels (16 U and 16 V) each channel split 4 ways to CFD,TDC,CCD,ADC, Figure 8-C
- B4 analog signals are going to CFD are multiplexed by 4 according to the scheme: U1-4, U5-8, U9-12, U13-16, V1-4, V5-8, V9-12, V13-16. The two RV analog signals are also multiplexed.
- Cerenkov- 14 K and 14 pi - 28 channels split 2 ways to disc,CCD, Figure 8-A
- Ring veto - 2 channels (L and R) each channel split 3 ways to TDC,CCD,ADC, Figure 8-B
- Segmented Live Degrader 12 channels split 3 ways, TDC,CCD,ADC, fIGURE 8-B
- Upstream Photon Veto 2 channels split 3 ways, TDC,CCD,ADC, Figure 8-B

Cabling after the splitters is as follows:

- B4 (order is B4U1-6,B4V1-16):
  1. Trigger - cables unlabelled, to 2 analog sum modules
  2. TDC (see Table 2 for map)
     - - B4U: cables 37-52 to disc L6-2-1 (cr20) to BM1 cable
     - - B4V: white PbG cable to L6-2-5 (cr20) to C2 cable
  3. CCD (see Table 3 for map)
     - - B4U: cables B401-16
     - - B4V: cables BV01-16
  4. ADC
     - - B4U: cables B4U1-8,B4V1-8 (100ns delay cables),* then to Fera cables 111:15-0
     - - B4V: cables B1X1-6,B2X1-6,B4U1-4 (100ns delay cables),* then to Fera cables 112:15-0

  * 100ns delay cables are connected to Fera cables at the top of rack L8.
- RV/AD/UPV (order is RV1-2,AD1-12,UPV1-2):

1. TDC - cables 51-66 to disc L6-3-1 (cr21) to BM3 cable (see Table 2 for map).
2. CCD - cables BV31-32,BV17-30 see Table 3
3. ADC
   - - cables Fera-114:7-8, 1-12, Fera-114:5-6
   - - cables 1,4,7,10 to analog sum and to Fera-114:9
   - - cables 2,5,8,11 to analog sum and to Fera-114:10
   - - cables 3,6,9,12 to analog sum and to Fera-114:11
   - - 3 analog sums to final sum and to Fera-114:1

- Ck/Cpi (order is Ck1-14, Cpi1-14):
  1. TDC - cables 1-14, 1-14 to disc L8-1-20, L8-1-21 to cables Ck and Cpi (see Table 2 for map).
  2. CCD - cables 1-28 to amplifiers and Ck01-14 and Cpi01-14 (see Table 3 for map).

Note that there are 12 channels of TDC for the AD system, but only 3 channels of ADC. Thus, for example, there is a AD TDC channel for xy=0, layer=7, segment=2 in the beam TDC map but there is no such ADC channel. Channels 1-4 of the AD would show up in the ADC arrays as xy=0, layer=7, segment=1. Channels 5-8 are in xy=0, layer=7, segment=5. Channels 9-12 are in xy=1, layer=7, segment=1.

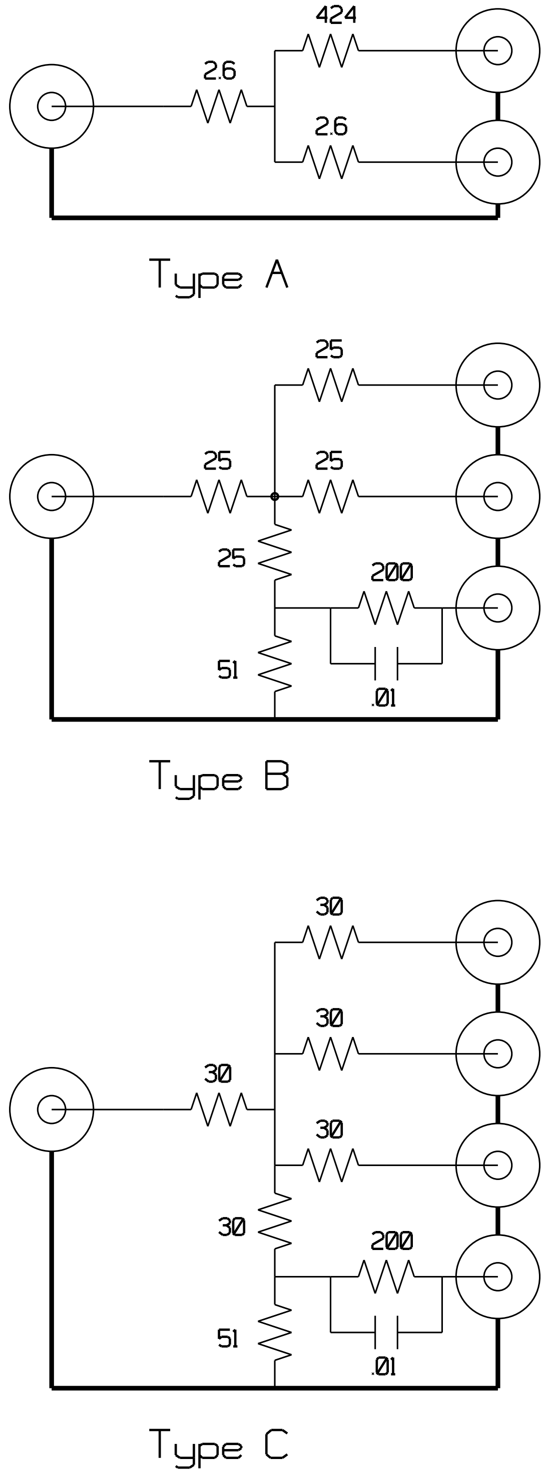

Figure 8: Splitter circuits A,B and C

Table 2: Beam FB-TDC Map

Fastbus Address		Component Address			Mnemonic
Module	Channel	X/Y	Layer	Segment	Name
		2	15	8	
6	16	0	5	1	CK-1
6	17	0	5	2	CK-2
6	18	0	5	3	CK-3
6	19	0	5	4	CK-4
6	20	0	5	5	CK-5
6	21	0	5	6	CK-6
6	22	0	5	7	CK-7
6	23	0	5	8	CK-8
6	24	1	5	1	CK-9
6	25	1	5	2	CK-10
6	26	1	5	3	CK-11
6	27	1	5	4	CK-12
6	28	1	5	5	CK-13
6	29	1	5	6	CK-14
6	32	0	6	1	CPI-1
6	33	0	6	2	CPI-2
6	34	0	6	3	CPI-3
6	35	0	6	4	CPI-4
6	36	0	6	5	CPI-5
6	37	0	6	6	CPI-6
6	38	0	6	7	CPI-7
6	39	0	6	8	CPI-8
6	40	1	6	1	CPI-9
6	41	1	6	2	CPI-10
6	42	1	6	3	CPI-11
6	43	1	6	4	CPI-12
6	44	1	6	5	CPI-13
6	45	1	6	6	CPI-14
6	48	1	4	1	B4V01
6	49	1	4	2	B4V02
6	50	1	4	3	B4V03
6	51	1	4	4	B4V04
6	52	1	4	5	B4V05
6	53	1	4	6	B4V06
6	54	1	4	7	B4V07
6	55	1	4	8	B4V08
6	56	1	3	1	B4V09

Table 2: (continued)

Fastbus Address		Component Address			Mnemonic
Module	Channel	X/Y	Layer	Segment	Name
6	57	1	3	2	B4V10
6	58	1	3	3	B4V11
6	59	1	3	4	B4V12
6	60	1	3	5	B4V13
6	61	1	3	6	B4V14
6	62	1	3	7	B4V15
6	63	1	3	8	B4V16
6	64	0	4	1	B4U01
6	65	0	4	2	B4U02
6	66	0	4	3	B4U03
6	67	0	4	4	B4U04
6	68	0	4	5	B4U05
6	69	0	4	6	B4U06
6	70	0	4	7	B4U07
6	71	0	4	8	B4U08
6	72	0	3	1	B4U09
6	73	0	3	2	B4U10
6	74	0	3	3	B4U11
6	75	0	3	4	B4U12
6	76	0	3	5	B4U13
6	77	0	3	6	B4U14
6	78	0	3	7	B4U15
6	79	0	3	8	B4U16
6	80	1	15	7	
6	81	1	15	8	
6	82	0	15	1	CK sum
6	83	0	15	2	CPI sum
6	84	0	15	8	
6	85	0	15	4	B4U sum
6	86	0	15	5	B4V sum
6	87	0	15	6	B4UV sum
6	88	0	15	3	T*2
6	89	0	15	7	IC-CFD sum
6	90	1	15	1	IC1-CFD
6	91	1	15	2	IC2-CFD
6	92	1	15	3	IC3-CFD
6	93	1	15	4	IC4-CFD
6	94	1	15	5	IC5-CFD
6	95	1	15	6	IC6-CFD

Table 2: (continued)

Fastbus Address		Component Address			Mnemonic
Module	Channel	X/Y	Layer	Segment	Name
5	0	1	1	3	RV 1
5	1	1	1	4	RV 2
5	2	0	7	1	AD01
5	3	0	7	2	AD02
5	4	0	7	3	AD03
5	5	0	7	4	AD04
5	6	0	7	5	AD05
5	7	0	7	6	AD06
5	8	0	7	7	AD07
5	9	0	7	8	AD08
5	10	1	7	1	AD09
5	11	1	7	2	AD10
5	12	1	7	3	AD11
5	13	1	7	4	AD12
5	14	1	1	1	UPV 1
5	15	1	1	2	UPV 2

Table 3: Beam CCD Cable Map

Element	Cable to CCD	Pigtail	Crate4(T) slot-inpt
Cpi01	Cpi01	BM-01	T1-0
Cpi02	Cpi02	BM-02	T1-1
Cpi03	Cpi03	BM-03	T1-3
Cpi04	Cpi04	BM-04	T1-5
Cpi05	Cpi05	BM-05	T1-7
Cpi06	Cpi06	BM-06	T1-13
Cpi07	Cpi07	BM-07	T1-14
Cpi08	Cpi08	BM-08	T2-0
Cpi09	Cpi09	BM-09	T2-1
Cpi10	Cpi10	BM-10	T2-2
Cpi11	Cpi11	BM-11	T2-3
Cpi12	Cpi12	BM-12	T2-6
Cpi13	Cpi13	BM-13	T2-11
Cpi14	Cpi14	BM-14	T2-13
CK01	CK-01	BM-15	T3-1
CK02	CK-02	BM-16	T3-3
CK03	CK-03	BM-17	T3-4
CK04	CK-04	BM-18	T3-7
CK05	CK-05	BM-19	T3-8

Table 3: (continued)

Element	Cable to CCD	Pigtail	Crate4(T) slot-inpt
CK06	CK-06	BM-20	T3-9
CK07	CK-07	BM-21	T3-10
CK08	CK-08	BM-22	T3-14
CK09	CK-09	BM-23	T3-15
CK10	CK-10	BM-24	T4-0
CK11	CK-11	BM-25	T4-1
CK12	CK-12	BM-26	T4-2
CK13	CK-13	BM-27	T4-3
CK14	CK-14	BM-28	T4-5
B4U01	B4-01	BM-31	T4-6
B4U02	B4-02	BM-32	T4-7
B4U03	B4-03	BM-33	T4-8
B4U04	B4-04	BM-34	T4-9
B4U05	B4-05	BM-35	T4-10
B4U06	B4-06	BM-36	T4-12
B4U07	B4-07	BM-37	T4-13
B4U08	B4-08	BM-38	T4-14
B4U09	B4-09	BM-39	T4-15
B4U10	B4-10	BM-40	T5-0
B4U11	B4-11	BM-41	T5-1
B4U12	B4-12	BM-42	T5-3
B4U13	B4-13	BM-43	T5-4
B4U14	B4-14	BM-44	T5-5
B4U15	B4-15	BM-45	T5-6
B4U16	B4-16	BM-46	T5-7
B4V01	BV-01	BM-51	T5-9
B4V02	BV-02	BM-52	T5-12
B4V03	BV-03	BM-53	T5-13
B4V04	BV-04	BM-54	T5-14
B4V05	BV-05	BM-55	T6-3
B4V06	BV-06	BM-56	T6-4
B4V07	BV-07	BM-57	T6-5
B4V08	BV-08	BM-58	T6-8
B4V09	BV-09	BM-59	T6-9
B4V10	BV-10	BM-60	T6-10
B4V11	BV-11	BM-61	T6-12
B4V12	BV-12	BM-62	T6-13
B4V13	BV-13	BM-63	T6-15
B4V14	BV-34	BM-64	T7-0
B4V15	BV-15	BM-65	T7-1

Table 3: (continued)

Element	Cable to CCD	Pigtail	Crate4(T) slot-inpt
B4V16	BV-16	BM-66	T7-3
AD01	BV-17	BM-67	T7-5
AD02	BV-18	BM-68	T7-7
AD03	BV-19	BM-69	T7-9
AD04	BV-20	BM-70	T7-10
AD05	BV-21	BM-71	T7-11
AD06	BV-22	BM-72	T7-13
AD07	BV-23	BM-73	T8-2
AD08	BV-24	BM-74	T8-3
AD09	BV-25	BM-75	T8-4
AD10	BV-26	BM-76	T8-6
AD11	BV-27	BM-77	T8-7
AD12	BV-28	BM-78	T8-8
RV01	BV-31	BM-49	T8-9
RV02	BV-32	BM-50	T8-10
UPV01	BV-35	BM-79	T8-11
UPV02	BV-36	BM-80	T8-13
B0	BV-30	BM-30	T8-14