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DRAFT

Muon Walls Setup in the Tilecal Module 0 Beam Test (August – September 1996)

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Abstract

The setup of the two movable muon walls during the module 0 beam test in 1996 is described. The walls can be positioned to detect the leakage from the module 0 during the beam test scans. The basic data consistency check is performed and muon wall data in the standard ntuples are described.

1 Introduction

For the August – September 1996 beam test of Tilecal module 0, two movable muon walls were installed – a back one and a side one (see Fig. 1). The back wall slides parallel to the module 0 girder and the side one slides

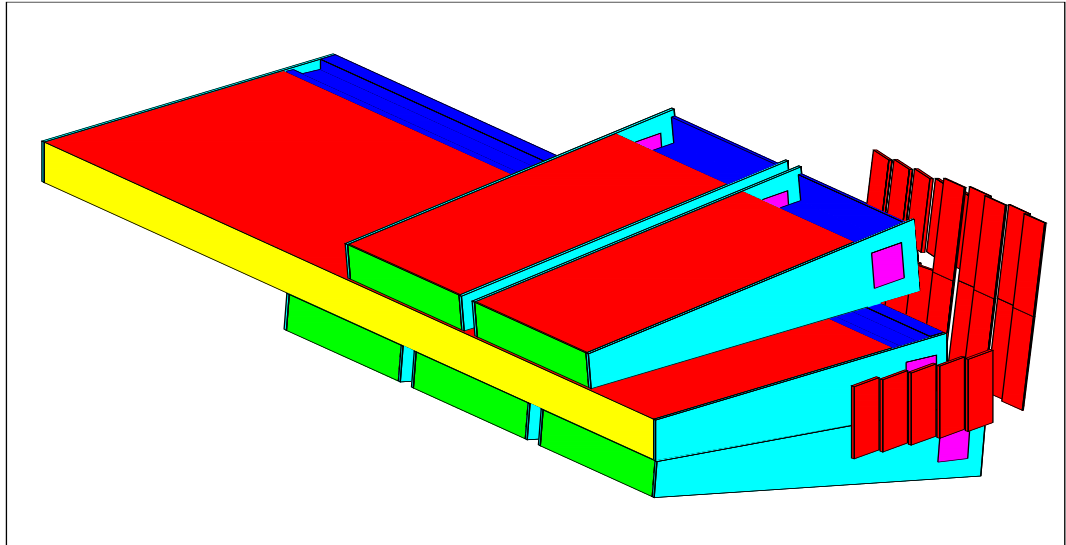


Figure 1: The August – September 1996 beam test setup with the movable muon walls. The back muon wall is drawn in the position -0.3 , the side muon wall in the position -0.76 .

perpendicular to it. The back wall can be positioned beyond the scanning table surface.

The back muon wall, see Fig. 2, is composed of 2 rows of 5 pieces of scintillator, the so called Prague paddles [1] (active area $96 \times 80 \text{ cm}^2$), and of 5 Michigan State scintillator pairs [2] (active area $92 \times 102 \text{ cm}^2$) used in the April 1996 combined beam test as MidSamplers. Each of the Michigan State scintillators is read via optical fibers from both the top and bottom directions to two photomultipliers. The back muon wall has thus 20 counters, both types of detectors together span an active area 185 cm wide. The side muon wall (see Fig. 3) consists of 5 Prague paddles (active area $96 \times 40 \text{ cm}^2$).

The muon walls and the data acquisition labels are summarised in Table 1. The typical response of these scintillators to the muon beam is presented in Section 3. The last section describes the muon wall data in the standard ntuples.

# Read-out channel	HV cable	Signal cable	ADC channel	#DET	#PMT	HV [V]	CAEN Crate 04 channel	Comment
1	209	201	219	1	4279	1850	9	Backward Prague
2	210	207	220	2	4315	1790	10	Backward Prague
3	211	202	221	3	4316	1820	11	Backward Prague
4	212	208	222	7	4262	1850	12	Backward Prague
5	213	203	223	11	4290	1770	13	Backward Prague
6	214	209	224	12	4277	1830	14	Backward Prague
7	215	204	206	8	4282	1850	15	Backward Prague
8	216	210	207	10	4289	1730	16	Backward Prague
9	224	205	208	20	374	1550	24	Backward Prague
10	223	206	212	13	4294	1850	19	Backward Prague
11	D1	225	225	1	1	1650	33	Backward Michigan State
12	D6	230	230	1	6	1450	38	Backward Michigan State
13	D2	226	226	2	2	1548	34	Backward Michigan State
14	D7	231	231	2	7	1497	39	Backward Michigan State
15	D3	227	227	3	3	1648	35	Backward Michigan State
16	D8	232	232	3	8	1675	51	Backward Michigan State
17	D4	228	228	4	4	1625	36	Backward Michigan State
18	D9	233	233	4	9	1646	52	Backward Michigan State
19	D5	229	235	5	5	1575	37	Backward Michigan State
20	D10	234	234	5	10	1649	52	Backward Michigan State
1	204	214	214	14	4385	1820	26	Side Prague
2	205	215	215	15	4261	1760	27	Side Prague
3	206	216	216	16	4311	1740	28	Side Prague
4	207	217	217	17	4317	1830	29	Side Prague
5	208	218	218	18	4293	1750	30	Side Prague

Table 1: The muon walls and DAQ labels. The first column contains the counter logical numbers for the back and the side walls. The fifth and sixth columns give the production serial numbers of counters and PMT's, respectively. For the Michigan State PMT's, the number in the sixth column is the label attached to the PMT-sockets.

2 Muon wall positions

Both muon walls slide in rails and can be repositioned as the table is moved to correspond to a pseudorapidity range from -1.0 to 0.2 . The back muon wall can cover pseudorapidities from -0.65 to 0.2 , whereas the side muon wall covers -1.0 to -0.65 . Each wall can be fixed in one of several equally spaced positions.

The back wall is labelled on both sliding rails with numbers -0.5 , -0.4 , -0.3 , -0.2 , -0.1 and 0.0 . One leg of the support frame is marked with red triangles that are positioned against the tick marks on the rail. The position is fixed to the table floor by means of the plug with red handle at the bottom of the frame. The wall is perpendicular to the table surface; i.e. the angle between the wall normal and module 0 axis is ≈ 8.4 deg (see Fig. 1).

The side wall has tick marks on its lower part with numbers -0.86 , -0.81 , -0.76 , -0.72 and -0.68 . The yellow triangles of a handle can be positioned against the tick marks and the position fixed with a screw with a red handle and a nut.

The counter geometry is shown in the Figs. 1,2. The back muon wall is drawn in the position 0.0 as seen by the test beam at $\eta = 0.0$, whereas the side wall in the position -0.68 as seen by the beam at $\theta = -90$ deg.

The correspondence between several ATLAS detector pseudorapidities and the positions of the muon walls is shown in Table 2. The position numbers correspond approximately to η values the the center of the walls.

During the scan at $\theta = -90$ degrees, the side muon wall is supposed to be at the position -0.86 .

Tabs. 3 and 4 give more information on the positions for both walls. Table 3 shows the three values of pseudorapidities corresponding to the the edges (η_{max} and η_{min}) and center (η_{centre}) of the back wall. Three similarly defined lengths (z_{min} , z_{centre} and z_{max}) measured perpendicularly from the axis of module 0 (test beam at $\eta = 0.0$) to the edges and center of the back wall also given in the Table 3. The sign is same as for pseudorapidities. The back wall is treated as one wall of width 185 cm.

Similarly, Table 4 shows for each position of the side wall the three values of pseudorapidity and the relative radius rr , the perpendicular distance from the front plane of module 0 (i.e. from TILECAL minimum radius value $R_{min} = 2283$ mm).

Pseudorapidity	Backward wall position	Side wall position
-0.80	-0.5	-0.81
-0.75	-0.5	-0.76
-0.65	-0.5	-0.68
-0.55	-0.5	-0.68
-0.45	-0.5	-0.68
-0.35	-0.3, -0.4	-0.68
-0.25	-0.2	-0.68
-0.15	-0.1	-0.68
-0.05	0.0	-0.68

Table 2: Correspondence of the ATLAS detector pseudorapidities and the muon walls positions as marked on the support rails. The positions roughly correspond to the η values at the centres of the walls.

Position	η_{min}	η_{centre}	η_{max}	z_{min} [cm]	z_{centre} [cm]	z_{max} [cm]
-0.5	-0.641	-0.485	-0.316	-348	-255	-163
-0.4	-0.558	-0.395	-0.221	-298	-205	-113
-0.3	-0.471	-0.302	-0.124	-248	-155	-63
-0.2	-0.381	-0.207	-0.026	-198	-105	-13
-0.1	-0.288	-0.109	0.073	-148	-55	37
0.0	-0.192	-0.018	0.171	-98	-5	87

Table 3: The correspondence between the ATLAS detector pseudorapidities and the η and z values of the edges and center of the 185 cm wide back wall.

Position	η_{min}	η_{centre}	η_{max}	rr_{min} [mm]	rr_{centre} [mm]	rr_{max} [mm]
-0.86	-0.974	-0.859	-0.767	515	995	1475
-0.81	-0.906	-0.805	-0.723	785	1265	1745
-0.76	-0.851	-0.761	-0.687	1035	1515	1995
-0.72	-0.801	-0.720	-0.654	1285	1765	2245
-0.68	-0.757	-0.684	-0.623	1535	2015	2495

Table 4: The correspondence between position labels and pseudorapidity η and relative radius rr of the edges and center of the side muon wall.

Backward wall				Side wall	
Prague paddles		Michigan State counters		Prague paddles	
# det	Peak_position	# det	Peak_position	# det	Peak_position
1	194	11	42.8	1	166
2	245	12	47.2	2	280
3	272	13	25.7	3	280
4	284	14	43.5	4	183
5	123	15	40.2	5	202
6	189	16	67.2		
7	334	17	53.2		
8	226	18	29.2		
9	95	19	40.6		
10	253	20	41.6		

Table 5: The peak of the muon response ADC spectrum for all counters, obtained from the Moyal fit.

3 Tests of the scintillating counters with muon beams

The response of the muon wall scintillation counters to charged particles was tested using muon beams. Fig. 4 illustrates the response of two 'Prague' and two 'Michigan State' counters of the back muon wall. the Michigan State and Prague Energy losses in the scintillator corresponds to the Landau theory and were fitted by the Moyal function.

A slight dependence of the peak of the muon response on the distance of the muon beam from the light guide edge, 0.88 % per cm , was measured for Prague counters.

Peak positions for all counters of both muon walls are summarised in the Table 5. A correction for the position the muon beam was applied for the few runs where muons hit the scintillator very close to the light guide edge.

These values are used for the standard ntuple production in the following manner : We define that the counter was hit by at least one charged particle if the signal obeys the relation

$$ADC > 0.7 \times \text{Peak_position} \quad (1)$$

The number of counters with charged particle hits is given for the back and side muon walls separately. The sum of the normalised signals from all

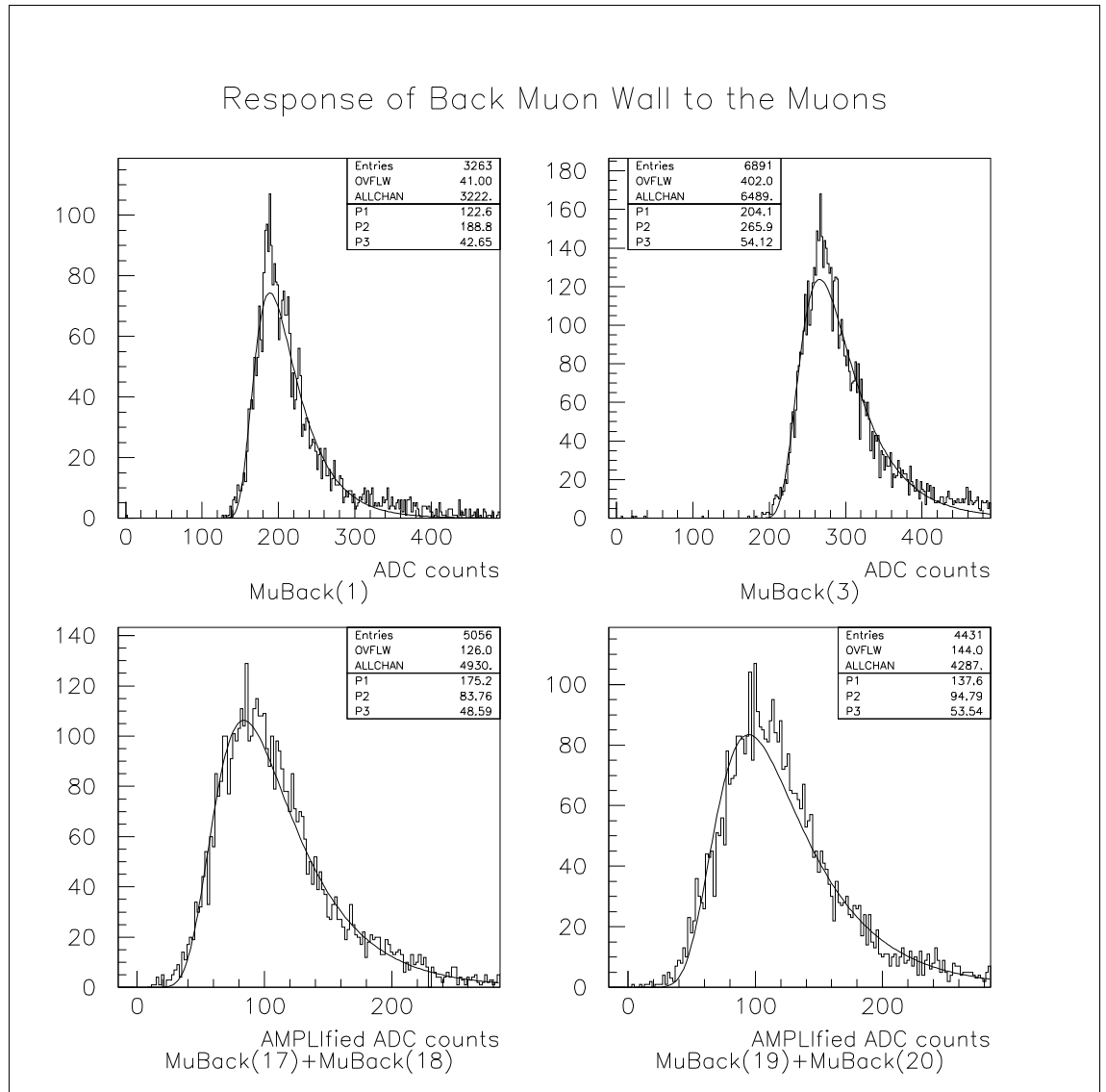


Figure 4: ADC spectra of muon response for Prague's (MuBack(1) and (3)) and Michigan State's (MuBack(17)+Muback(18) and Muback(19)+Muback(20)) back muon wall counters with a fit to the Moyal function. The events within 3σ of the pedestal region are removed.

counters is also calculated for the back and side muon walls separately using the formulae

$$MuBackSum = \sum_{i=1}^{20} MuBack(i)/Peak_position(i) \quad (2)$$

$$MuSideSum = \sum_{i=1}^5 MuSide(i)/Peak_position(i) \quad (3)$$

4 Muon wall data in the standard NTUPLEs

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The Muwall information in the standard N-tuple has following structure:

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*      1  * R*4  *      *      * MUWALL * MuBackSum
*      2  * R*4  *      *      * MUWALL * MuBackHit
*      3  * R*4  *      *      * MUWALL * MuSideSum
*      4  * R*4  *      *      * MUWALL * MuSideHit
*      5  * R*4  *      *      * MUWALL * dummy
*      6  * R*4  *      *      * MUWALL * MuBack(20)
*      7  * R*4  *      *      * MUWALL * MuSide(5)

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- MuBackSum contains the normalised sum of the 20 counters of the back muon wall.
- MuBackHit is the number of counters detecting at least one charged particle (m.i.p.) in the back muon wall.
- MuSideSum and MuSideHit are equivalent values for the side muon wall.
- The muon walls are described by 4 words and two vectors MuBack(20) and MuSide(5). The vectors contain ADC output for each counter (the vector sequence numbers correspond to the logical numbers shown in the Figs. 1,2).

For the Prague scintillators the values given are **NON-AMPLIFIED ADC** counts, for Michigan State scintillators the values are **AMPLIFIED ADC** counts.

5 Summary

The muon wall scintillation counters and their correspondence to the DAQ system is described for the August – September 96 module 0 beam test period in Table 1.

The suitable positions of the movable muon walls for the beam test of the Tilecal module 0 are given in Tabs. 3,4.

The Landau behaviour of the response of muon wall counters to the muon beam has been measured and the Moyal fit results to the ADC spectra are listed in Table 5.

The muon walls information in the standard ntuples is explained in Section 4.

6 Acknowledgements

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References

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- [2] R. Miller et al.: *Midsampler Scintillator Planes for LArCal + Tilecal Combined Tests*, TILE-TR-060, June 24, 1996.