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Remote Control of Muon Walls in the Extended Barrel Module 0 Tilecal Beam Test

July – August 1997

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Abstract

New computer controlled positioning system of muon walls is described. Suitable setting for the leakage detection during the extended barrel module 0 beam test is explained in details.

Contents

1 Introduction

The muon walls [1] were newly equipped with a motor movement and a remote control for Tilecal 1997 beam test of two extended barrel modules 0, the lower one BCN and the upper one ANL, see Fig. 1.

This paper concerns only the July - August test beam period, for the second part of the 1997 beam test the walls will be rearranged and it will be described in another note.

The back wall slides parallel to the modules' girders and the side wall slides perpendicular to them. Both muon walls can together fully cover leaking particles for η around -1.1, when the beam axis passes through the corner of the extended barrel. The back wall, see Fig. 2, is composed of 2 rows of 7 pieces of scintillator detectors, the so called 'Prague' counters [2] with active area 132×80 cm^2. The active area is in its base lower position and can detect leak from the BCN module; in this position the ANL module is not covered.

The side muon wall, see Fig. 3, consists of 5 Michigan State University (MSU) scintillator pairs [3] used in the April 1996 combined beam test as MidSamplers and in the September 1996 beam test as a part of the back muon wall. Contrary to the beam test at September 1996 all 'MSU' counters are fixed in one plane and their active area 98×102 cm^2 has geometrical inefficiency of 4 %. The horizontal axis of the wall is parallel to the middle plane of the BCN module, its geometrical centre is 14 cm above this plane, the side muon wall covers both BCN and ANL extended barrel modules.

A group of three scintillator pairs of the side wall can be folded to allow the drawer insertion into the girder.

The muon walls cabling and the data acquisition labels are summarised in Table 1.

The walls are moved with the use of engines and their position is electronically read. The walls positioning may be operated either remotely from the control room by PC or locally on the scanning table as explained in Section 2. The recommended positions for different test beam geometries are summarised in Section 3 . The typical response of these scintillators to the muon beam is presented in Section 4. Only the ntuple variables MuBack and MuSide [1], given in non-amplified and amplified ADC counts respectively, contain the relevant muon wall counters information for the August – July 1997 beam test period.

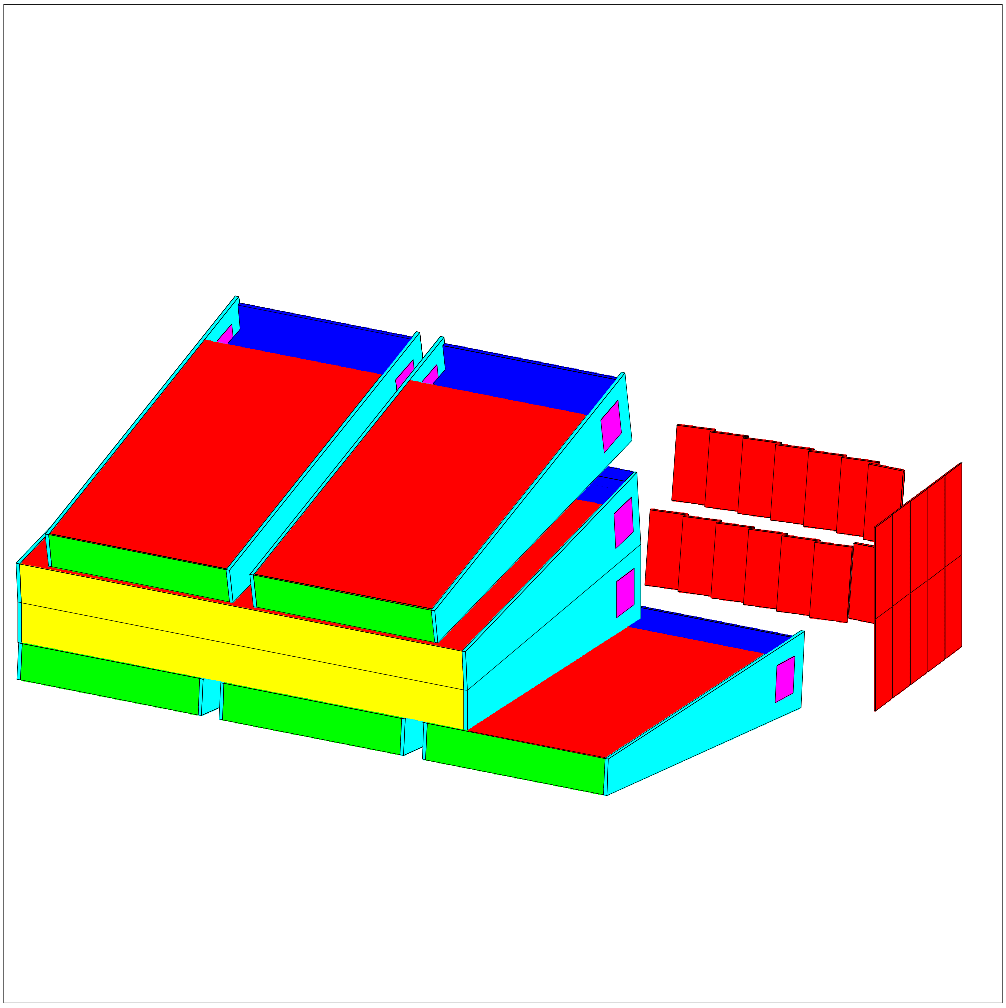

Figure 1: The August – July 1997 beam test setup with the automatically movable remotely controlled muon walls. The walls are in the position for pseudorapidity scan at $\eta = -1.07$.

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BACK MUON WALL
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         |-|  |-|  |-|  |-|  |-|  |-|  |-|
         | |  | |  | |  | |  | |  | |  | |
         |_|  |_|  |_|  |_|  |_|  |_|  |_|
         / \  / \  / \  / \  / \  / \  / \
......./___\/___\/___\/___\/___\/___\/___\
 .     |    |    |    |    |    |    |    |
 .     |    |    |    |    |    |    |    |
 .     | 2  | 4  | 6  | 8  | 10 | 12 | 14 |
 .     |    |    |    |    |    |    |    |
80 cm  |____|____|____|____|_x__|____|____|
 .     |    |    | x  |    |    |    |    |
 .     |    |    |    |    |    |    |    |
 .     | 1  | 3  | 5  | 7  |  9 | 11 | 13 |
 .     |    |    |    |    |    |    |    |
 ......|____|____|____|____|____|____|____|
       :                                  :
       :                                  :
       :              132 cm              :
      >:==================================:<
```

Figure 2: The back muon wall for the beam test of extended barrel module 0 in July – August 1997. The beam entrance for pseudorapidity scan of BCN module at $\eta = -1.0$ is marked by x. The beam enters two detectors due to their positions in space.

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SIDE MUON WALL
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       .......________________________
        .     |    |    |    |    |    |
        .     | 2  | 4  | 6  | 8  | 10 |
        .     | x  |    |    |    |    |
        .     |    |    |    |    |    |
        .     |    |    |    |    |    |
        .     |    |    |    |    |    |
      102 cm  |.........................|
        .     |    |    |    |    |    |
        .     |    |    |    |    |    |
        .     |    |    |    |    |    |
        .     |    |    |    |    |    |
        .     | 1  | 3  | 5  | 7  |  9 |
       ......|____|____|____|____|____|
             :                        :
             :                        :
             :         98 cm          :
            >:========================:<
```

Figure 3: The side muon wall for the August – July 1997 beam test as seen by the beam at $\theta = -90$ deg. Beam entrance is marked by x for the test of tile number 10 of the ANL module.

# counter see Fig.2,3		HV cable	Signal cable	ADC channel	#DET	# PMT CASE	HV [V]	CAEN Crate 04 channel	Comment
	1	211	225	225	1	4279	1850	19	Prague
	2	212	226	226	2	4315	1790	20	Prague
	3	213	227	227	3	4316	1820	21	Prague
B	4	214	228	228	20	374	1550	22	Prague
A	5	215	229	248	7	4262	1850	23	Prague
C	6	216	230	230	8	4282	1850	24	Prague
K	7	217	231	249	10	4289	1730	25	Prague
	8	218	232	232	11	4290	1770	26	Prague
W	9	219	233	233	12	4277	1830	27	Prague
A	10	220	234	234	14	4385	1820	28	Prague
L	11	221	235	235	15	4261	1750	29	Prague
L	12	222	236	236	16	4311	1740	30	Prague
	13	223	240	240	17	4317	1830	31	Prague
	14	224	242	242	18	4293	1750	32	Prague
S	1	201	215	215	1down	1	1650	08	Michigan
I	2	206	220	220	1up	6	1450	13	Michigan
D	3	202	216	216	2down	2	1548	09	Michigan
E	4	207	221	221	2up	7	1497	14	Michigan
	5	203	217	217	3down	3	1648	10	Michigan
W	6	208	222	222	3up	8	1675	15	Michigan
A	7	204	218	218	4down	4	1625	11	Michigan
L	8	209	223	223	4up	9	1646	16	Michigan
L	9	205	219	219	5down	5	1575	12	Michigan
	10	210	224	224	5up	10	1649	18	Michigan

Table 1: The muon walls and DAQ labels for the July – August beam test. The second column contains the counter logical numbers for the back and the side walls as marked in Fig. 2 and Fig. 3. The sixth and seventh columns give the production serial numbers of Prague counters and PMT's, respectively. For the Michigan State University PMT's, the number in the seventh column is the label attached to the PMT-case.

2 Remote control of muon walls

2.1 Description

The walls are moved by 220V engines. Each wall has its own steering electronics box fixed respectively directly on the back wall or just under the side wall. The box contains display that shows the position in some local relative units and knobs for display operation. The box further contains main switch ON/OFF and a toggle REMOTE/LOCAL. An operation box with a yellow light and 2 green push buttons for manual wall movement in respective directions is located close to the steering box. Manual operation can be used only in the toggle position LOCAL. For a remote control the toggle must be in the REMOTE position.

The back wall is moved by DC 220V engine over a chain fixed to the scanning table floor. The engine is controlled with the help of relay. The relay is steered via simple diodes logic directly by pushing green knobs on the steering box. For the remote control the relay is operated by steering electronics. The position is measured by an IRC element. The element precision is 0.05 mm, the wall positioning precision due to gear box and chain and steering system is on the level of 15 mm.

The side wall is moved by AC asynchronous 220V engine over long screw. The control is practically the same as for the back wall. The position is measured by the IRC method, but the element is realised by mechanical switches. The positioning precision is similar to the back wall.

Remote control personal computer located in the control room sets two target position values for each wall. The steering electronics will start the engine motion in correct direction to move the wall between the set target positions. The target position values are sent from the personal computer over serial line RS422 (2x twisted pair). One cable connects both walls, because each wall has its own address. C-language program resides on PC and sends the target position values, computed from requested η values for projective scan or from θ and z values for non-projective scan. It is also possible to set directly the walls positions in Atlas coordinates. The final walls positions can be displayed on the PC.

Each wall has two sets of end switches. First switch stops the wall movement in current direction and enables to move it in the opposite direction. The second end switch is an emergency switch that switches off the engine but the relay logic still remains operational. A technical intervention is required when the second emergency end switch is activated. Both walls have manual emergency switches that switch off the whole wall. They may be used for emergency stop of the walls and complete electronics switch off. Moreover, one emergency switch stopping and switching off both walls is located on the fence of the experimental zone close to the control room entrance.

2.2 Operation

Remote control is provided by PC-Olivetti placed in the control room of H8 test beam with the program 'muonwall.exe' placed in directory `C:\muonwall`. The values of parameters necessary for program initialisation are read from the file 'muonwall.ini'. All distances are given in Atlas reference system coordinates in cm.

The control electronics system of muon walls has to be initialised in the beginning by means of steering and operation boxes:

- Release the red emergency stop buttons.
- Flip main switch to 'ON' position.
- Flip toggle to 'REMOTE' position. Remark: The wall may automatically begin to move to some previously set position!
- Start the program muonwall.exe.
- Send the command "o" to origin the positions of both walls. The walls start to move and each wall will automatically stop in its limit position.The Back wall is moved in the direction of side wall (to the highest Atlas z) and the side wall in the direction of back wall (to the highest Atlas r).
- Press the red emergency stop to switch off both walls.
- After few seconds release this emergency stop to switch on. Both displays will be set to 0.
- Now the walls are ready to be set to desired positions.

The program is operated from the keyboard by single character commands with the following meanings (see also a hint inside the program window on the screen):

g GO - both walls start to move to positions which can be set by 'e','s','b' or 't'+'z' commands

q QUIT the program

e ETA - set a value of pseudorapidity. Type 'enter' after delivering η value. Program will calculate positions of walls. Then you can press button 'g' and walls start to move to computed positions. You can check the position of walls by pressing 'r'.

r READ - the program will continuously read the positions of the walls. To stop reading press any key.

s SIDE - set the position of the sidewall separately. After typing a number press 'enter'.

b BACK - set the position of the back wall separately. After typing a number press 'enter'.

t THETA - set the angle theta for non-projective scan. After typing a number press 'enter'.

z ZETA - set z-coordinate for non-projective scan (Atlas z-coordinate of the beam entrance into the extended barrel 0). After typing a number press 'enter'.

3 Muon wall positioning

The active surface centre of either wall is normally positioned against the beam spot. If it is not possible respective wall remains in its corner limit position.

3.1 Pseudorapidity scan

For extended barrel 0 beam test the back muon wall can detect secondary particles with Atlas pseudorapidities from -1.15 to -0.7. The side muon wall covers range -1.5 to -1.13. More exactly, the values depend on module under test. For the lower BCN module the beam enters the centre of the module at an angle of ≈ 8.2 deg to the scanning table surface while for the upper ANL module the angle is ≈ 13.9 deg and the counters of back muon wall are in larger distance from back plate of extended barrel module 0 because the back muon wall is perpendicular to the scanning table surface.

Tabs. 2 and 3 show the real coverage possibilities of either wall by means of the three values of pseudorapidities corresponding to the edges (η_{max} and η_{min}) and to the centre (η_{centre}) of the wall for several pseudorapidities planned for the test beam. Further, they show positions of walls edges and centres in the Atlas coordinates z and r for back and side muon walls, respectively. This values are shown both for the BCN and the ANL modules. For the ANL module, the side wall is not in symmetrical position and thus the radius values are measured in the middle plane of the ANL module.

3.2 Scan at $\theta = -90$ deg

During the scan at $\theta = -90$ degrees by electron beams the side muon wall must be outside the beam trajectory. This can be simply achieved by the wall positioning as for rapidity scan with $\eta = -1.2$. (Side wall will be in the position closest to the back muon wall).

The side muon wall can detect muon and pion beams only for the test of tiles number 10 and 11 if it is positioned to its limit upstream position. Alternatively, for a fine scan, the desired side wall position may be set by 's' SIDE command.

3.3 Non-projective scan

The non-projective scan is defined by two variables θ and z_{in} (on computer display marked as 'z'). The z_{in} is Atlas z coordinate of the beam entrance to the extended barrel module 0 face and θ is angle between this face normal and the beam axis. Table 4 shows the corresponding muon walls centres setting for specified beams.

a) BCN module

Pseudorapidity of test beam	η_{min}	η_{centre}	η_{max}	z_{min} [cm]	z_{centre} [cm]	z_{max} [cm]
−.8	−.70	−.80	−.89	397.	463.	529.
−.9	−.81	−.90	−.99	469.	535.	601.
−1.0	−.92	−1.00	−1.08	546.	612.	678.
−1.1	−.99	−1.07	−1.15	606.	672.	738.
−1.2	−.99	−1.07	−1.15	606.	672.	738.
−1.3	−.99	−1.07	−1.15	606.	672.	738.
−1.4	−.99	−1.07	−1.15	606.	672.	738.
−1.5	−.99	−1.07	−1.15	606.	672.	738.
−1.6	−.99	−1.07	−1.15	606.	672.	738.

b) ANL module

Pseudorapidity of test beam	η_{min}	η_{centre}	η_{max}	z_{min} [cm]	z_{centre} [cm]	z_{max} [cm]
−.8	−.70	−.80	−.89	406.	472.	538.
−.9	−.81	−.90	−.98	479.	545.	611.
−1.0	−.92	−1.00	−1.08	558.	624.	690.
−1.1	−.98	−1.06	−1.13	606.	672.	738.
−1.2	−.98	−1.06	−1.13	606.	672.	738.
−1.3	−.98	−1.06	−1.13	606.	672.	738.
−1.4	−.98	−1.06	−1.13	606.	672.	738.
−1.5	−.98	−1.06	−1.13	606.	672.	738.
−1.6	−.98	−1.06	−1.13	606.	672.	738.

Table 2: The correspondence between the test beam pseudorapidities and the η and z values of the edges and centre of the BACK MUON WALL positioned according to η scan values.

a) BCN module

Pseudorapidity of test beam	η_{min}	η_{centre}	η_{max}	r_{min} [cm]	r_{centre} [cm]	r_{max} [cm]
−.8	−1.31	−1.21	−1.13	433.	483.	533.
−.9	−1.31	−1.21	−1.13	433.	483.	533.
−1.0	−1.31	−1.21	−1.13	433.	483.	533.
−1.1	−1.31	−1.21	−1.13	433.	483.	533.
−1.2	−1.31	−1.21	−1.13	433.	483.	533.
−1.3	−1.41	−1.30	−1.21	386.	436.	486.
−1.4	−1.52	−1.39	−1.29	342.	392.	442.
−1.5	−1.52	−1.39	−1.29	342.	392.	442.
−1.6	−1.52	−1.39	−1.29	342.	392.	442.

b) ANL module

Pseudorapidity of test beam	η_{min}	η_{centre}	η_{max}	r_{min} [cm]	r_{centre} [cm]	r_{max} [cm]
−.8	−1.30	−1.21	−1.13	433.	483.	533.
−.9	−1.30	−1.21	−1.13	433.	483.	533.
−1.0	−1.30	−1.21	−1.13	433.	483.	533.
−1.1	−1.30	−1.21	−1.13	433.	483.	533.
−1.2	−1.30	−1.21	−1.13	433.	483.	533.
−1.3	−1.41	−1.30	−1.21	384.	434.	484.
−1.4	−1.51	−1.39	−1.28	342.	392.	442.
−1.5	−1.51	−1.39	−1.28	342.	392.	442.
−1.6	−1.51	−1.39	−1.28	342.	392.	442.

Table 3: The correspondence between the beam test pseudorapidities and the η and r values of the edges and centre of the SIDE MUON WALL positioned for several η scan values.

a) BCN module

θ [deg]	z_{in} [cm]	z_{centre} [cm]	r_{centre} [cm]
10.	380.	450.	485.
10.	500.	552.	485.
10.	520.	572.	485.
20.	380.	487.	485.
20.	500.	607.	485.
20.	520.	627.	485.

b) ANL module

θ [deg]	z_{in} [cm]	z_{centre} [cm]	r_{centre} [cm]
10.	380.	450.	485.
10.	500.	553.	485.
10.	520.	573.	485.
20.	380.	490.	485.
20.	500.	610.	485.
20.	520.	630.	485.

Table 4: The setting of the muon walls for the non-projective scan defined by the beam input θ angle and the z_{in} input point. The z_{centre} describes the position of the back muon wall centre and the r_{centre} describes the position of the side muon wall centre.

4 Response to the muons

The response of the muon wall scintillation counters to charged particles was tested using muon beams and using selected events of muon contamination of pions beams. Fig. 4 illustrates the response of two 'Prague' counters of the back muon wall, typical spectra of the two 'MSU' counters of the side muon wall are displayed in Fig. 5. Energy losses in the scintillator correspond to the Landau theory and were fit by the Moyal function and by the convolution of Landau and Gaussian distribution [4].

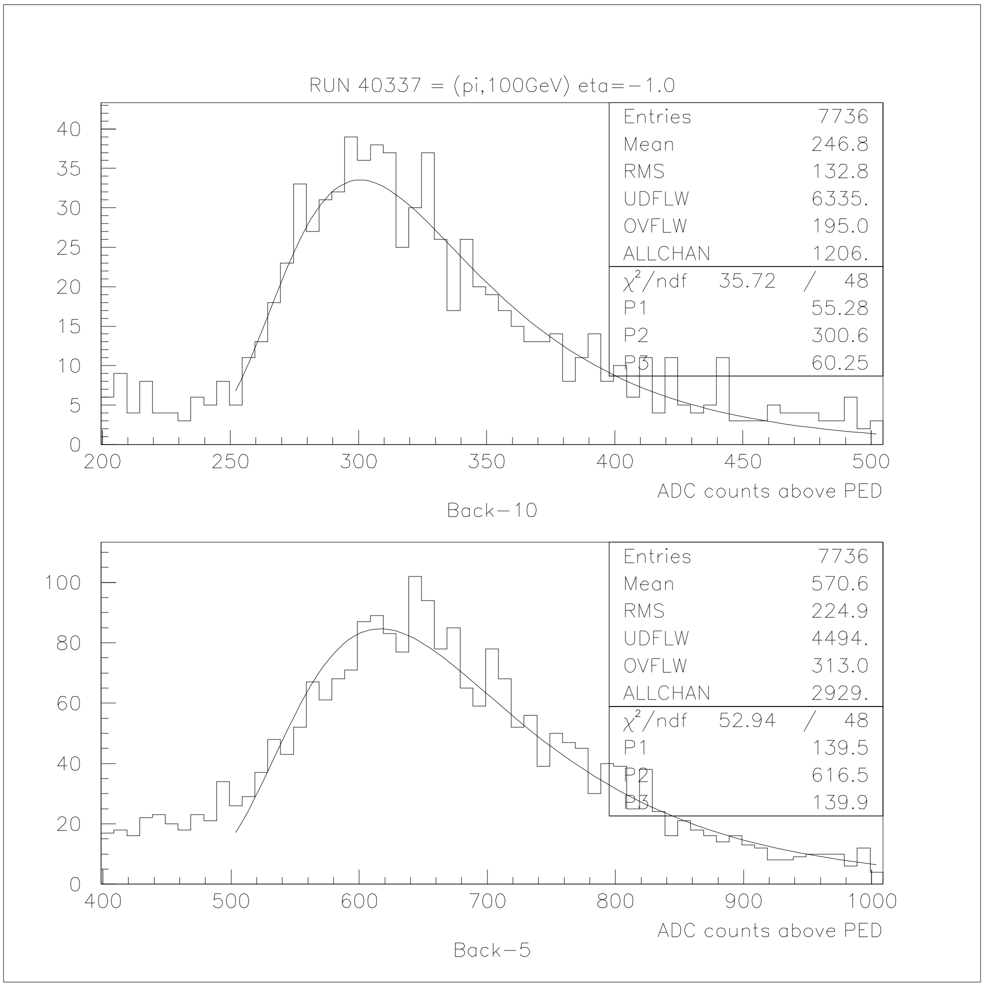

Figure 4: The ADC spectra of muon response for the Prague's counters placed in back muon wall (muons were extracted as a contamination from the pion beam). The Moyal function was fit to the data.

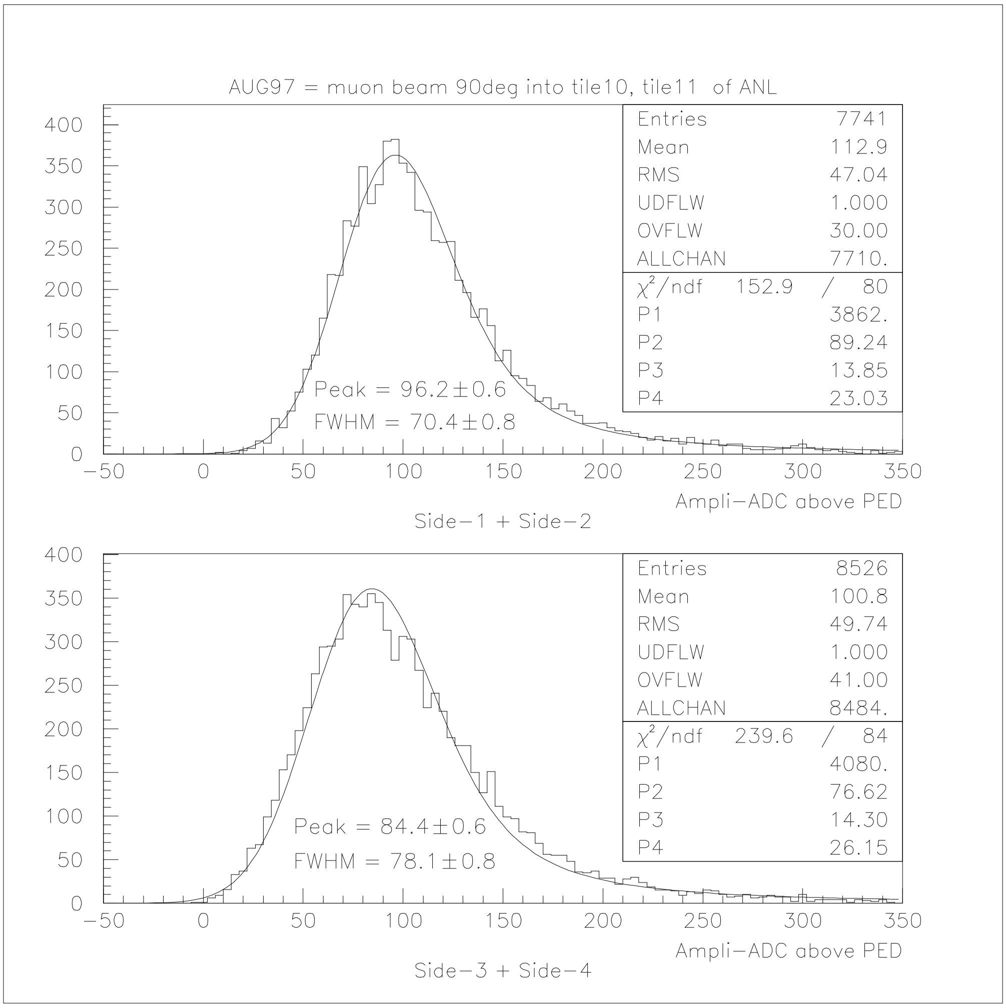

Figure 5: The Michigan State counters response to muon beam at $\theta = -90$ degrees impinging Tile-10 and Tile-11 on upper and down part of picture, respectively. The ADC spectra were fit by the convolution of Landau and Gaussian distribution.

5 Summary

The muon wall scintillation counters and their correspondence to the DAQ system for the July – August 97 extended barrel module 0 beam test period in Table 1 is described.

The remote control is explained and the suitable positions of the movable muon walls for the beam test of the Tilecal extended barrel module 0 are given in Tabs. 2,3.

The Landau behaviour of the response of the muon wall counters to the muon beam has been demonstrated on Figs. 4 and 5.

6 Acknowledgements

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References

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