Measurement of the forward MWPC

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1 Introduction

Below we bring the results of a measurement of the dimensions and the wire position of the MWPC2 and MWPC3. The measurement was performed on September 20–26, 2002. Each of the chambers was opened so that there was a direct access to the thick chamber frame, and to the wire, and the strip planes.

The measurement was done with metal rulers of 0.5 m and 1 m length, having 0.5 mm ticks, and plastic rulers of 30 cm length with 1 mm ticks. It has been found that the rulers differ from each other by $\approx 0.2 - 0.3$ mm on the length of 30 and 50 cm.

The wire and strip position measurement was done with a ruler laying right on the wires, thus a possible parallax effect was negligible compared to the overall measurement precision. The precision of a single position measurement was not worse that 0.5 mm, not including the precision of the rulers used.

The wire numbering in all the X planes starts from the beam side, and it starts from the bottom in all the Y planes. Everywere in the text the wire numbers start from 0.

References to the "nominal" values mean the ones obtained from Boris Zalikhanov.

2 X2 chamber

In fig. 1 the measurement chamber view is shown. A part of the thin frame was removed for the measurement. The measured dimensions of the thin and thick frames are given in the figure, all sizes are in cm.

2.1 Wire position

The wires were counted, and the ground wires were found by measuring the resistance between the wires and the frames. One ground wire was found at each side of the wire plane. The plane contained several groups of missing wires. The number of wires missing was evaluated by the gaps size, there were two large groups of ≈ 15 and ≈ 5 missing wires in the beginning, and few smaller groups of 2-3 wires missing. Since all the observed deviations in the wire step were within $\approx 1\%$, it can be stated that the number of missing wires could be determined exactly.

The counting of wires was done directly (except for the missing wires), i.e. not by measuring the total distance and dividing it by the wire step, and 416 signal wires have been found (including the missing ones). Every 5th wire was marked, and the wire counting was checked. Finally, the distance from the 0th signal wire to every tenth wire was measured, and the average wire step has been evaluated. This measurement for X2 plane was done with a 30 cm long, 1 mm ticks plastic ruler.

2.1.1 Wire step

Calculation of the average wire step was done in the following way. Each of the measured distances to the 0th wire was taken into account. We assigned an error of 0.5 mm (± 0.25 mm) to a single measurement, and a 0.5/(number of wires) mm error for a wire step value calculated from this measurement. Then, the average wire step was found as a weighted average of all measurements. Such a measurement was done four times: twice at $d = 4.5$ cm position (see fig. 1), starting from the 0th, and from the last (415th) wires, and twice at $d = 37$ cm position in the same fashion. In figs. 2-5 the difference between the measured wire position and the position calculated using the obtained wire step is shown. The "bottom side" in the figures means measurement at $d = 4.5$ cm, and the "top side" at $d = 37$ cm.

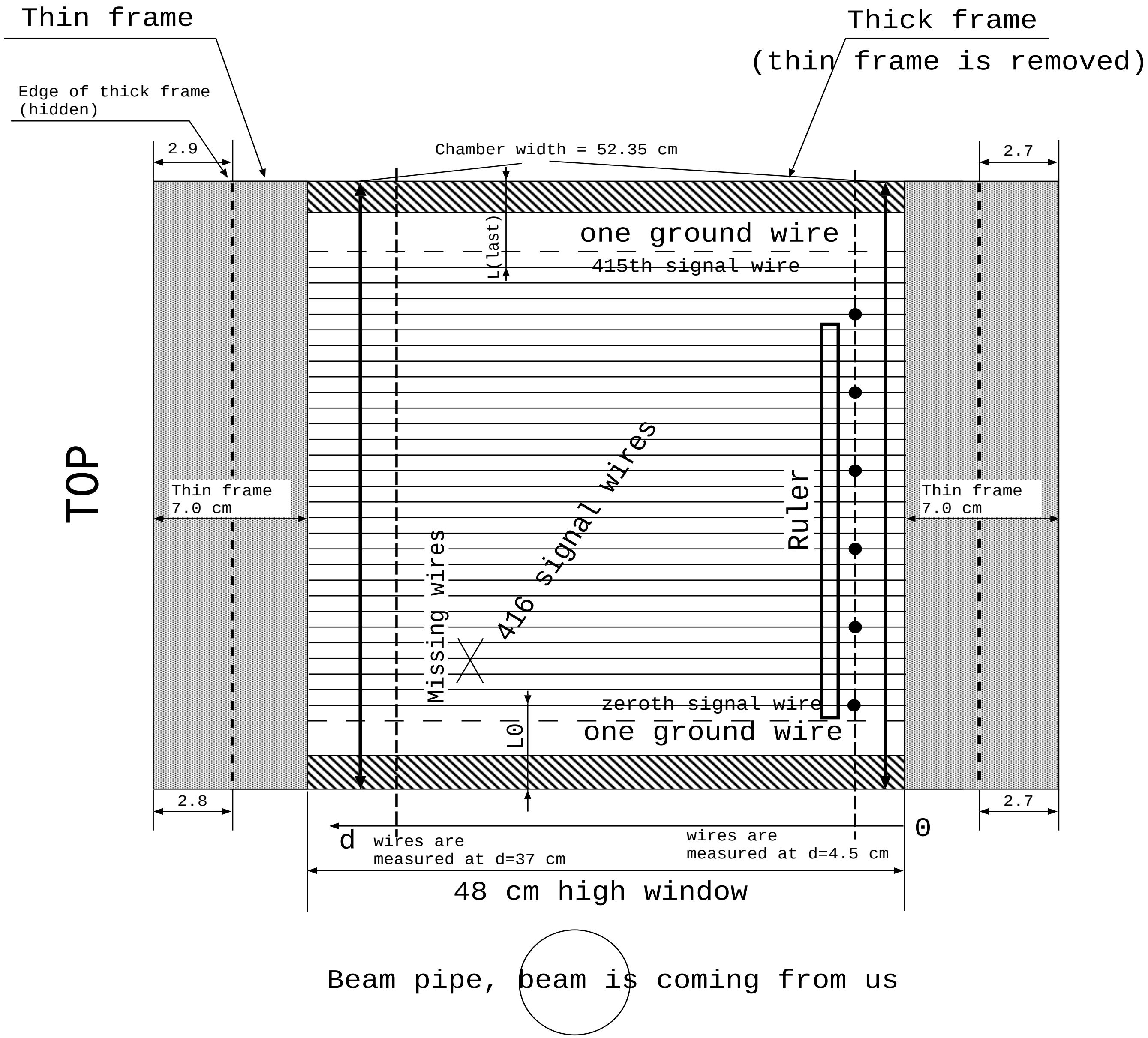

Figure 1: Scheme of X2 plane measurement

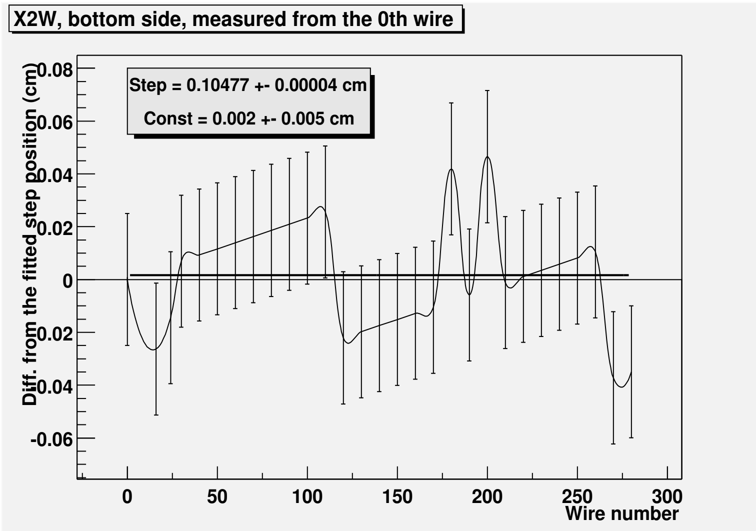

Figure 2:

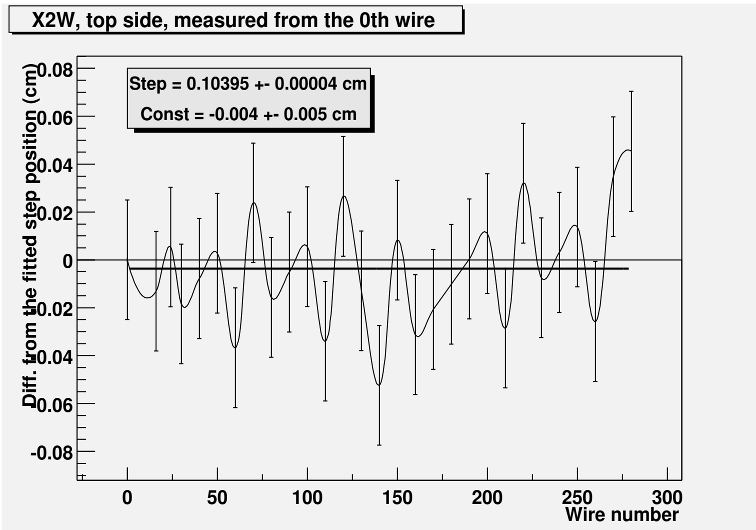

Figure 3:

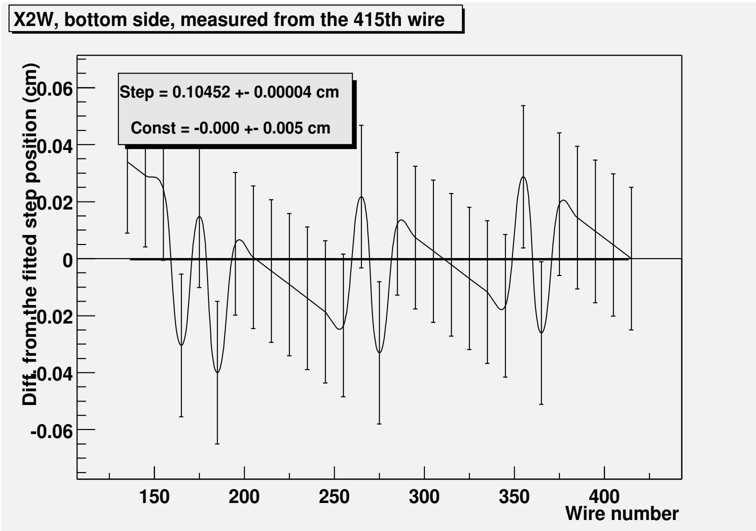

Figure 4:

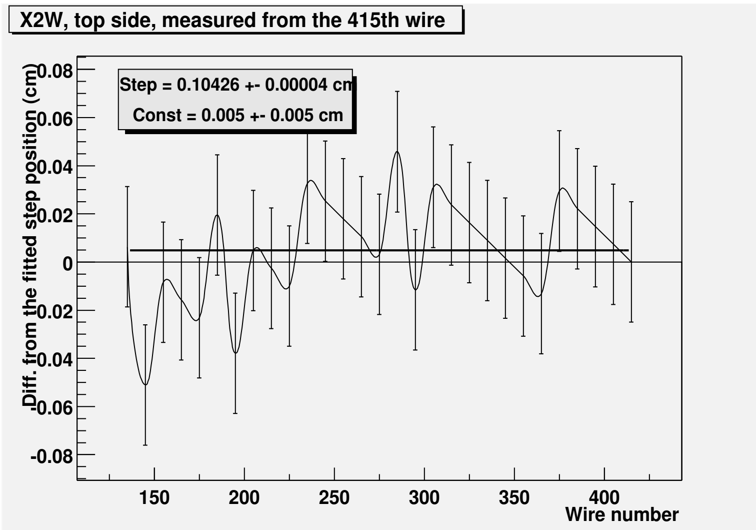

Figure 5:

The nominal wire step is 1.054 mm, and the one obtained from the data under assumption of nominal step in X1, X3 planes is 1.048 mm. As one can see, all the measured step values not only differ much from the nominal value more then the measurement error, but also are less then 1.048. The latter fact can be explained by a deviation in the measured X3 wire step. The step also differs significantly for different measurement points.

One can see "linear" intervals and jumps in the figures. They should not be related to the real step inhomogeneity, but rather to a rounding effect, that is, the numbers read from the ruler were rounded to the nearest 0.5 mm value. The same rounding was done during X3 plane measurement.

2.1.2 First and last wires position

The distances $L0$ and $L(last)$ (see fig. 1) were measured at different d coordinate values. Here are the values of $L0$ (the nominal value is 3.55 cm):

d, cm	6	18	30	42
$L0$, cm	3.4	3.46	3.4	3.37

... and for $L(last)$:

d, cm	6	24	36
$L(last)$, cm	5.53	5.67	5.76

One can see that $L0$ is fluctuating around 3.4 within 0.5 mm, but $L(last)$ is growing with d, and changes by $\approx$ 2 mm on the 30 cm length. Taking into account the equal frame width, also measured from the top and bottom sides, one can evaluate the difference in the average wire step, which appears to be close to the one given in figs. 2-5.

The numbers and information about strip position measurement are to be added...

3 Y2 chamber

The Y2 plane was measured in a similar way as X2. The frames dimensions are practically equal for these two planes.

The resistance measurement showed that there are 9 ground wires at the bottom of the chamber, and 7 at the top. Between these wires, 320 signal wires has been found. Fig. 6 shows the wire positions in the same way as figures for X2. One should note that the wire step obtained from scanning of Y2 plane by Y1 and Y3, was 0.104339 cm, that is, nearly coinciding with the measurement result.

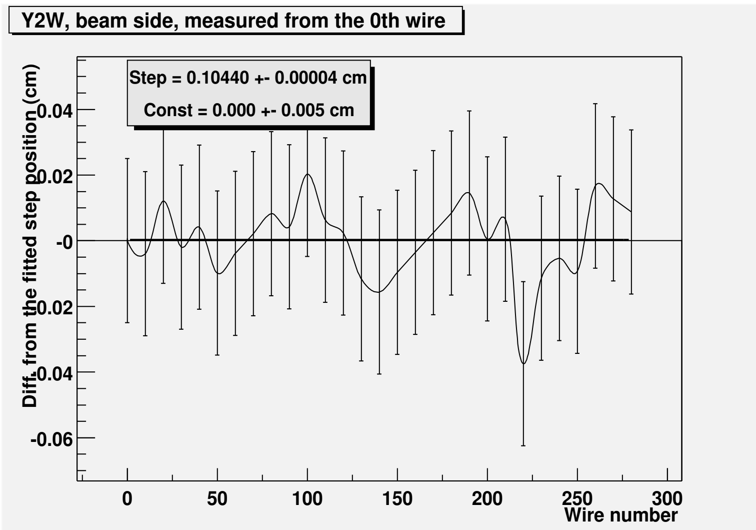

Figure 6:

The distance from the 0th to the 319th wires was measured at two sides of the chamber using two 30 cm rulers. It is equal to 33.3 cm at the beam side, and 33.35 at the opposite side, what is essentially the same for the data processing.

The distance from the outer edge of the thick frame to the 0th signal wire was measured at two points, after removing the lower part of the thin frame. The points were located at 10 cm distance from the opposite (vertical) sides of the thick frame, that is at $\approx$ 32 cm distance between each other. The measurement from the beam side yielded 11.74 cm, and from the opposite side there was a 11.61 cm distance. The value used up to now in the data processing was 11.65 (that is, 14.35 cm to the thin frame edge), and it was obtained from the symmetry of the wire plane condition.

4 X3 chamber

The width of the chamber thick frame (see fig. 1), measured at two sides of the frame was equal to 66.1 cm. Counting of wires resulted in 504 wires, including the ground ones. Results of a measurement of every 10th wire coordinate are presented in fig. 7.

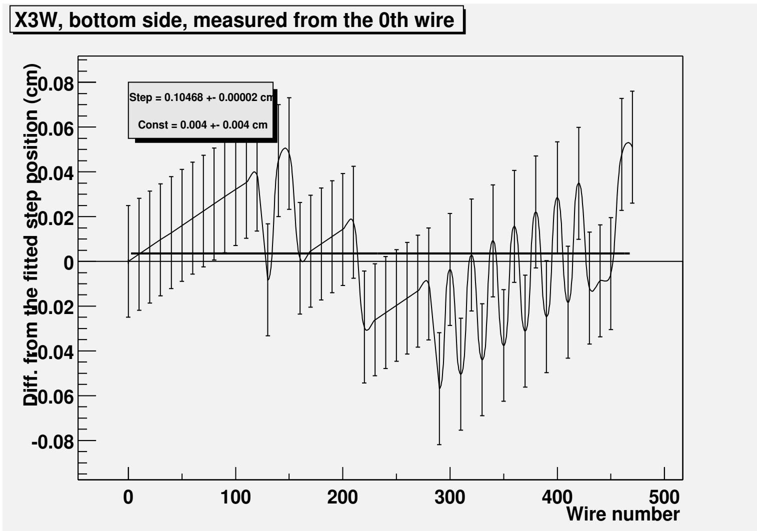

Figure 7:

The measurement was done with a 50 cm long metal ruler. Measurement of the distance between the 0th and the 470th wires at the opposite chamber sides produced results coinciding within 0.5 mm.

The number of ground wires was not determined as it was done for the X2 and Y2 planes, but the number of signal wires stated is 500. It seem likely that there is one ground wire in the beginning of the plane, and 3 in the end. We measured the distance from the thick frame edge to the second wire (probably, the first signal one) from the beam side $L0$=5.52 cm (this coinsides with the nominal value of 5.5 cm), and to the second wire on the other side (that is, one of the ground wires) $L(last)$ = 8.07 cm. The definition of $L0$ and $L(last)$ are the same as in fig. 1. These distances were practically (within 0.5 mm) constant along the wires.

The wire step on this plane has already been measured by R. Koch, and was found equal to 1.052. It is very much likely that this result was obtained assuming presence of only 2 ground wires, one at each side, what is not the case.

5 Y3 chamber

Totally 392 wires were found. The number of ground wires and position of the first wire was not measured. The result of the measurement of every 10th wire position is presented in fig. 8, the 0th wire means the lowest one found. The total length across 392 wires was 41.23 cm from the beam side, and 41.18 cm from the opposite side, that gives a 1.3μ difference in wire step, that is, practically negligible.

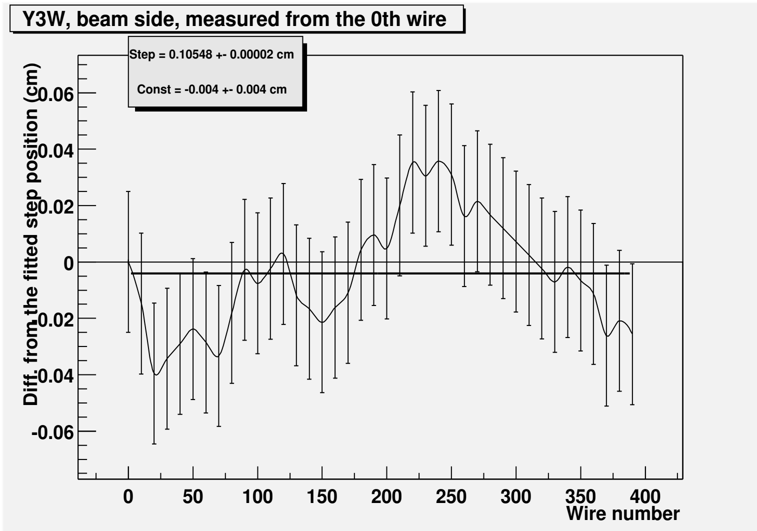

Figure 8:

The author was extremely happy to find such a good coincidence of the measured wire step with the nominal one in this plane, and started to feel a solid ground under the feet once again :).

6 To be done

Checking! It would be very good if someone could check all these measurements. The most astonishing fact of strongly varying wire step in X2 plane has been checked by S. Barsov.

More detailed frame measurement. At the moment, only the most essential dimensions have been measured.

Ground wires. It is necessary to determine the number of ground wires in X3 and Y3 planes, and the position of the first wires.

Strip position. The position of strips has been measured in X2 plane, but it still has to be evaluated. It is necessary to measure the strips position on the other planes. The positions used in the data processing are obtained from the data itself and depends on assumptions about the chamber position.

Measurement of the first chamber. It is particularly important in view of the difference in X2 wire step at the opposite chamber sides. It contradicts to the fact that X3 chamber shows a much smaller difference (if any), and the scanning of X2 with X1 and X3 at different height (using experimental data) does not show the observed difference in X2 step. This is related also to the question of stability of the wire step in time. Additionally, the position of the first Y1 wire must measured at last.

Wire connection to the readout boards. It has been found that several planes (X2W, X2S, Y2S, X3W) have errors in the available connection schemes. Although the errors can be observed clearly enough in the data analysis (in most cases :( ), this way always leaves the results questionable.

A more precise wire position/step measurement. This measurement does not allow one to understand the behavior of the wire step within already 50 wires distance. On the other hand, it shows that the step is not constant (see figures for X2 plane). There are also few "strange" things seen in the data which let one suspect a change in the wire step, mostly important, in X wire planes.

7 Conclusion

1) The most important conclusion is that the measurement confirmed existence of strong deviations in the wire step. Only one (Y3) plane of four had a step close to the nominal 1.054 mm. The deviations on the other planes lead to significant problems in data analysis. The step in Y2 and Y3 planes appeared very close to the values used in the analysis, and one can foresee a step close to the nominal in Y1. The deviations in X planes differ significantly from what was assumed, to the worse side. It is not even clear at the moment how one can exploit the results of this measurement without the information about X1 plane.

2) Another result is a confirmation of the first wire position in Y2 plane used in the data analysis. The value used was calculated from the symmetry consideration, and was approximately confirmed by the data on pd-elastic measurement with the spectator detector. It (11.65 cm) differs significantly from the nominal value of 12.35 cm.

3) An independent and accurate measurement of the new chambers IS needed.