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P4 — THE PRE-PRODUCTION PROTOTYPE OF THE **ME1/1 CSC**

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1. Introduction

ME1/1 is a first muon station of the CMS Endcap [1]. It is composed of 36 six-layer cathode-strip chambers, CSCs, [2] in each Endcap. The full-scale prototype of ME1/1 CSC, P3, has been designed and constructed in Dubna [3]. Later the main design of CMS Endcap has been optimised. As a result the mechanical parameters of ME1/1 CSC changed too. This paper describes the design of new, P4 prototype optimised for mass-production.

2. Layout and main parameters of the P4 prototype

P4 is a prototype of ME1/1 10° φ-sector. It is a unit of 6 identical proportional chambers of trapezoidal shape, layers, with cathode strip readout. Each layer is formed by two cathode electrodes with gap of 6mm and anode wires electrode in the middle (see Fig. 1). The P4 layout is shown in Fig. 2 and the basic chamber parameters are presented in Table 1.

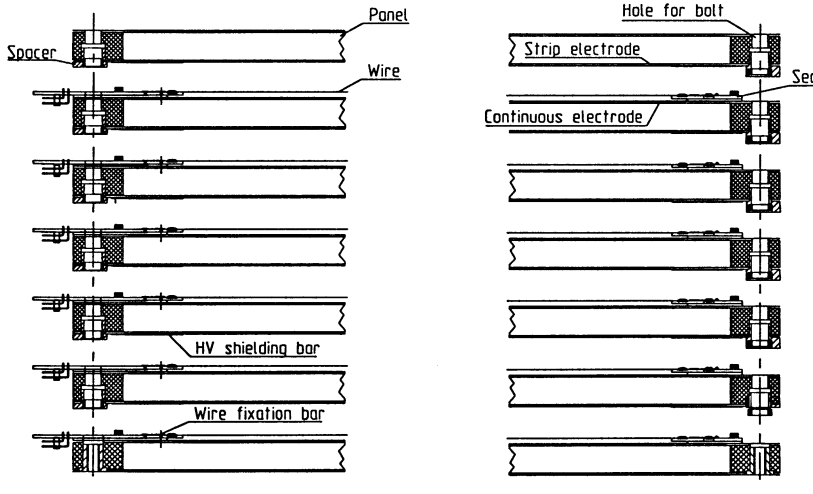

Fig. 1: P4 cross-section.

One cathode is flat while another one represents a system of strips. This radial strip structure covers the angle of $\varphi = \pm 5.42°$ to provide the overlap with the neighbouring CSCs.

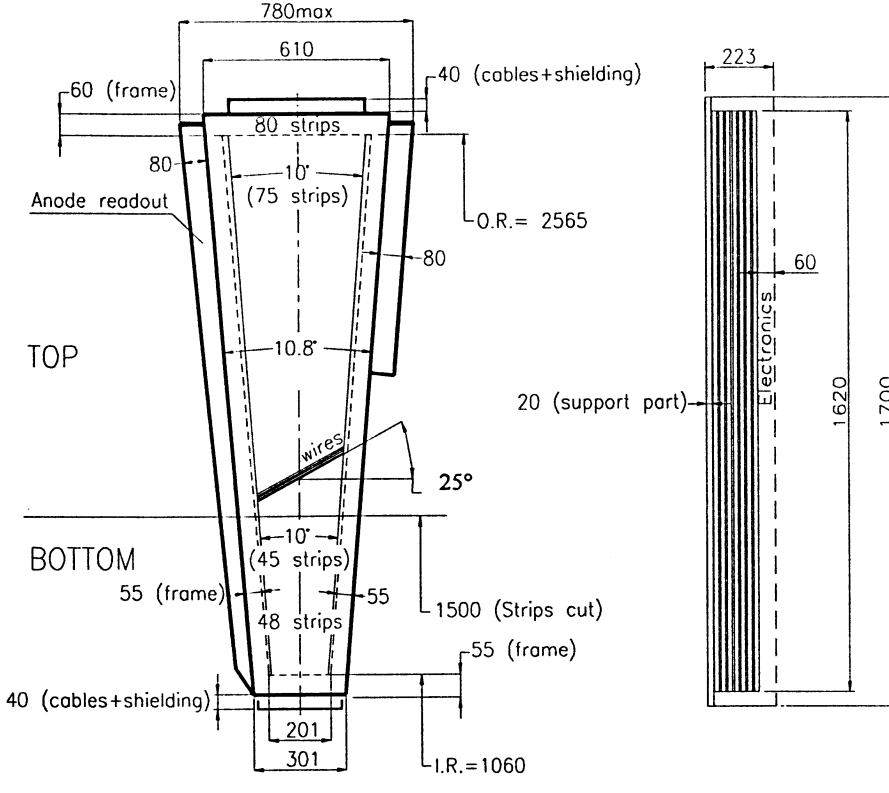

Fig. 2: Overall dimensions of P4 (in mm).

The effect of the avalanche shift in CSC due to the presence of magnetic field should be compensated by wires inclination. Taking into account that nominal value of the field in the CMS solenoid could be in the range of 3.5 – 4.0 T, the anode wires are positioned at the effective incline angle of 25° in respect to the perpendicular to the chamber axis. The groups of 11-12 anode wires are connected to one readout channel providing radial coordinate measurements, while the interpolation of charges induced on strips gives the precise measurement of φ-coordinate.

The background rate at the bottom part of the chamber is expected to be significantly higher than that at the top one. Taking this into account, strip electrode is mechanically separated in two groups: with length of 1065mm in the top part and 440mm – in the bottom (see Fig. 2). Cathode readout electronics of the top part will be implemented with fast channel chips to provide muon Level-1 trigger.

Table 1. P4 parameters.

P4 CSC	Layers / CSC		6
	Inner radius	m	0.965
	Outer radius	m	2.665
	Height	m	1.700
	Bottom width	m	0.38
	Top width	m	0.78
	Area	m^2	0.986
	Sensitive area	m^2	0.52
	Strip channels		768
	Anode channels		288
P4 Layer	Anode-Cathode distance	mm	3.0
	Wire Spacing	mm	2.5
	Cathode strips:		
	Shape		Radial
	Number of channels		128
	top part		80
	bottom part		48
	Readout pitch width : top	mm	6.0
		mrad	2.33
	bottom	mm	4.1
		mrad	3.88
	Strip length: top	mm	1065
	: bottom	mm	440
	Anode wires:		
	Diameter	μm	30
	Number of wires		602
	Number of channels		48
	Wires/ group		11-12
	Incline angle	degree	25

3. P4 panel design

The basic mechanical construction element of CSC, a "honeycomb" self-supporting panel, is shown in Fig. 3. The main requirements for the ME1/1 panel are flatness and rigidity.

The panel consists of a "honeycomb-like" structure sandwiched between two electrodes, one with continuous copper surface and the other with milled strip pattern. The "honeycomb-like" filler of rectangular shape grid is made out of 0.5mm FR4 strips. The size of a cell is 20×40mm^2. Electrodes are made out of 0.8mm single side copper clad FR4 sheets. The thickness of the copper lamination is 18μm.

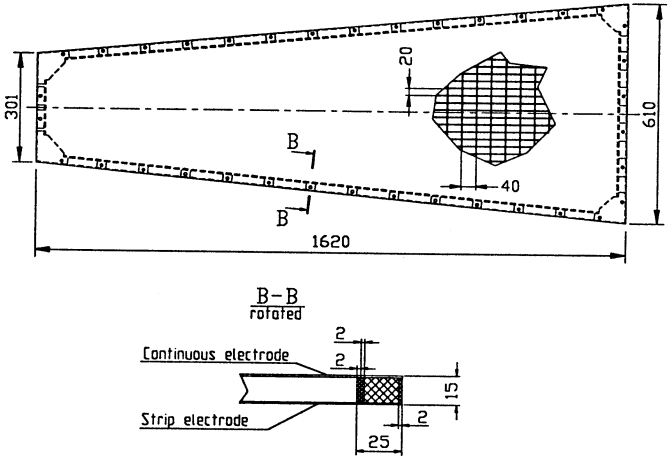

Fig. 3: P4 self-supporting "honeycomb" panel.

Six out of the seven panels carry strip artwork on one side. For strip electrode production a milling machine has been designed and assembled. The radial shape of strips is made by a 0.35mm thick rotating diamond disk. The strips cover the φ-angle range of ±5.42° to provide the overlapping with the neighboring CSCs. A crosscut of the strips provides a radial split of strips into two groups in order to minimize background rate per cathode channel: with length of 1065mm in the top part and 440mm – in the bottom (see Fig. 4). The top part strip width in φ-coordinate is 2.33mrad (3.5-6.0mm) while that for the bottom part is 3.88mrad (4.1-5.8mm). Such a structure makes the spatial resolution of the layer more uniform.

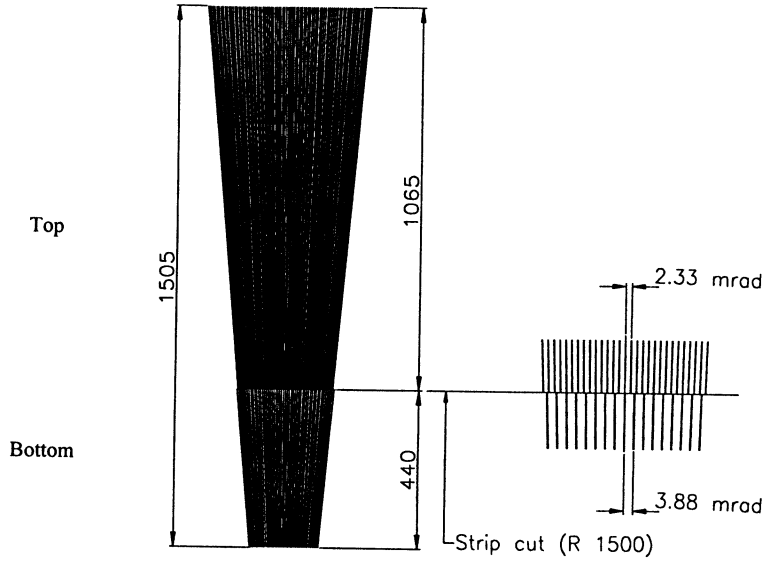

Fig. 4: P4 strip electrode.

4. P4 assembly

The tools and machines for the strip and wire electrode production, wire fixation bar production and gluing are the same as described in [3]. There are 3 different types of the ready panels with electrodes (see Fig. 1). The five internal panels are interchangeable. P4 is assembled in the same way as P3 [3].

5. Mechanical parameters control

The mechanical parameters such as wire tension, plane flatness and strip linearity have been tested. Fig. 5 shows the residuals distribution of geometrical and measured groove positions for P4 strip electrode. The r.m.s. of this distribution is equal to 0.025mm. The unflatness of the each side of the P4 panel is illustrated by Fig. 6 and lies in a range of ± 0.05mm.

Anode planes consist of 30μm wires. The elastic limit of wires is 125g while the breaking tension is around 160g. Wire tension is chosen as 80g and is delivered with accuracy of ±5g by the wire-stretching machine. A wire plane is transferred from the stretching machine by using transfer frames and then soldered on the wire fixation bars with precision combs which ensure 2.5mm wire spacing with an accuracy of ±25μm. The results of the wire tension measurements for P4 layer are shown in Fig. 7.

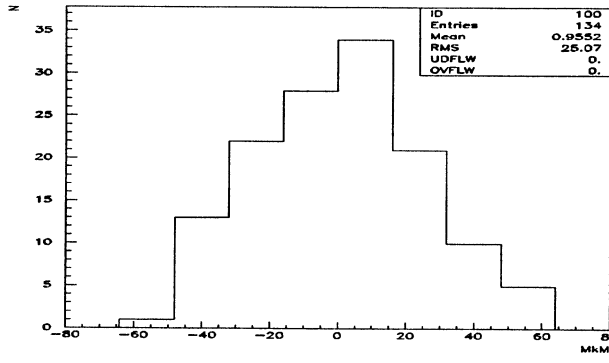

Fig. 5: Grooves position residuals.

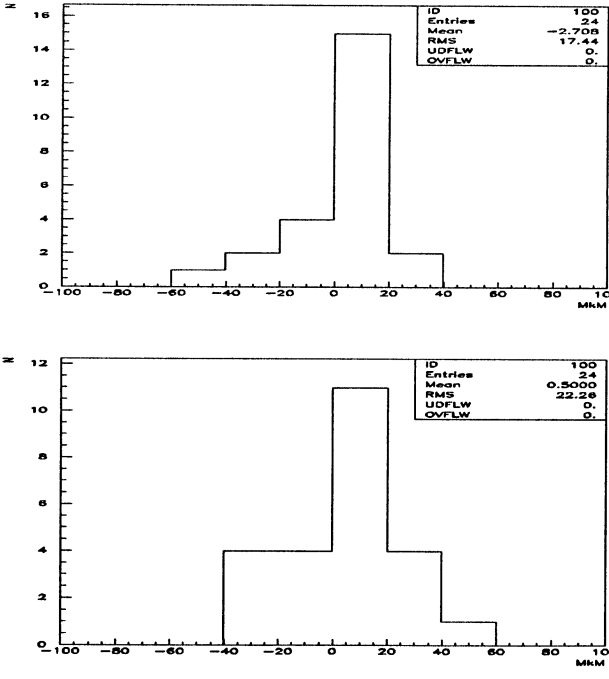

Fig. 6: Unflatness of the each side of P4 panel.

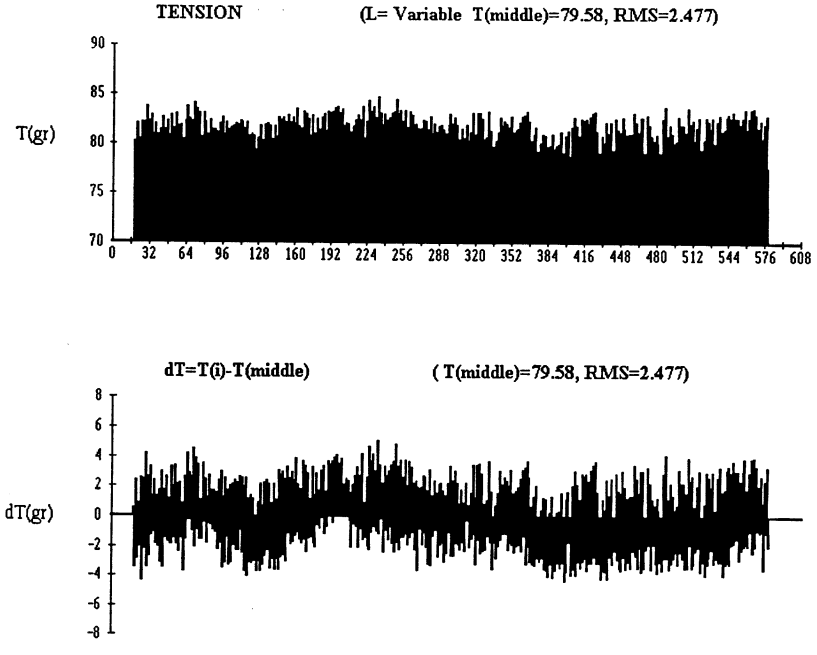

Fig. 7: Wire tension measurements for P4 layer.

6. Conclusion

P4, the pre-production prototype ME1/1 CSC has been designed and produced. The tests of it's wire tension, plane flatness and strip linearity have been done.

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P4 — предсерийный прототип КСК ME1/1

Разработан и изготовлен P4 — предсерийный прототип катодно-стриповой камеры мюонной станции ME1/1 установки CMS. Дано описание основных параметров и конструкции прототипа. Представлены результаты тестов механических параметров P4.

Работа выполнена в Лаборатории физики частиц ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна, 2000

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P4 — the Pre-Production Prototype of the ME1/1 CSC

The pre-production prototype of the CMS ME1/1 Cathode Strip Chamber, P4, has been designed and produced. This paper describes the basic parameters and design of the prototype. The test results of the P4 mechanical parameters are presented.

The investigation has been performed at the Laboratory of Particle Physics, JINR.

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