THE WELLBLECH CHAMBER: A SELF SUPPORTING COMPACT TRACKING DEVICE

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ABSTRACT

A compact multi-cellular vertex drift chamber is proposed, made of thin-walled plastic cells in a self-supporting structure needing no heavy flanges nor massive walls. Single wire resolutions of 30 to 40 μm are possible. To cope with very high momentum tracks additional layers of silicon detectors are foreseen.

Vertex detection and tracking at future high energy colliders, e.g. at CLIC, will require new types of tracking chambers providing very good space resolution for handling high momentum tracks and large particle multiplicities at potentially strong radiation backgrounds. Fine-grained vertex chambers of high resolution have for instance been built at SLAC on basis of the so-called straw tubes[1,2]. Such a "Straw-Chamber" combines several important features: simplicity of a self-supporting construction, realiability, high single-wire space resolution, easy self-calibration and toleration of large radiation backgrounds.

We here propose a similar system as a combined vertex and track detector. Its constructional basis will be our "Wellblech" set-up, shown in fig. 1, consisting of three thin (∿ 60 μm) metallized plastic foils (PVC) of which the middle (corrugated) one, the Wellblech, has been deep-drawn under vacuum suction in a precisely machined mould at a temperature of ∿ 110 degree centigrade. The three foils are glued together, presenting a fairly rigid plate*). Omitting one of the outer foils the wellblech can be rolled to a cylinder which after glueing results in a very stiff structure, see fig. 2. In this way a very compact multicellular drift chamber of low mass is feasible which, due to its self-supporting structure, does not need heavy flanges.

Fig. 3 shows the possible lay-out of a vertex chamber. Here we have chosen a diameter of only 1.0 meter, equal to the diameter of the LEP L3

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*) These plates are actually used as detection gaps in a TEC (time expansion chamber) prototype chamber. For that purpose the two outer foils carry narrow slits for the entrance of electrons from the drift field.

vertex chamber. The length is divided in two parts with a 1.8 meter long outer part and a shorter inner one providing an opening angle of $\theta = 30^o$ with respect to the beam line. As, however, no massive flanges are needed the end caps could also be tapered more gradually.

We propose cell sizes of 6×8 mm^2 in the inner part and 10×15 mm^2 in the outer one*), resulting in a total of 56 radial cell layers and a total mass of 5% of the radiation length at $\theta = 90^o$. Filled with a low diffusion gas at 2 bar pressure the space resolution of these cells will be 30 to 40 μm averaged over the track position in the cell[3]. This means that with such a chamber an excellent pattern recognition is possible as well as good momentum measurement for not too high energy particles.

To cope also with very high momentum tracks, e.g. at p = 1 TeV/c and B = 2 Tesla, having a sagitta of merely 20 μm, additional layers of high resolution silicon detectors appear to be necessary, as shown in fig. 3. Employing e.g. CCD's of the type to be installed at SLD[4], having pixel sizes of 22×22 μm^2 and giving resolutions of 6 μm by 6 μm, high momentum measurements can be achieved (as well as z read-out) at least in principle - although in view of the requested detector area the actual price of the order of ∿ 15 MSFr appears prohibitively high. Yet there are chances for considerable price reduction for those silicon devices within the coming years.
The sandwich of silicon detectors and the Wellblech chamber would be satisfactory, even working at normal pressure with a reduced resolution of ∿ 70 μm. The chamber would be used for track finding, whereas the silicon detectors give a very good momentum measurement.

REFERENCES

1) D.R. Rust: Recent Developments in High Precision Vertex Chamber at SLAC, SLAC-PUB-3311, April 1984.

2) E. Fernandez et al., Prototype Tests for a Vertex Chamber, SLAC-PUB-3390, August 1984.

3) V. Commichau et al., Nucl. Instr. and Meth. A239 (1985) 487.

4) D. Imrie, contribution to Tracking Group No 5 (Jan. 1987).

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*) We have checked that wellblech cells are electrostatically stable with 1 meter long sense wires and at cell sizes as small as 4×4 mm^2.

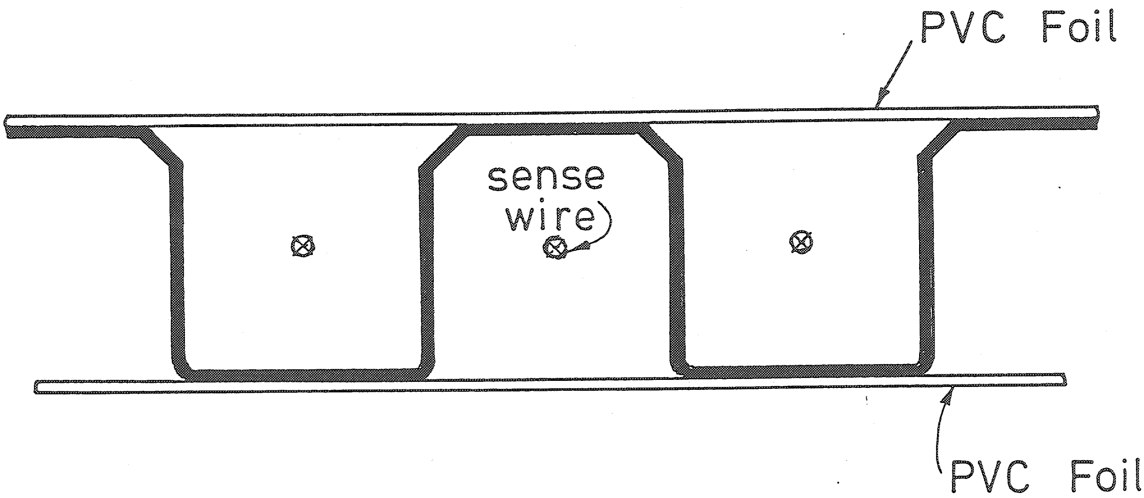

Fig. 1 The wellblech structure

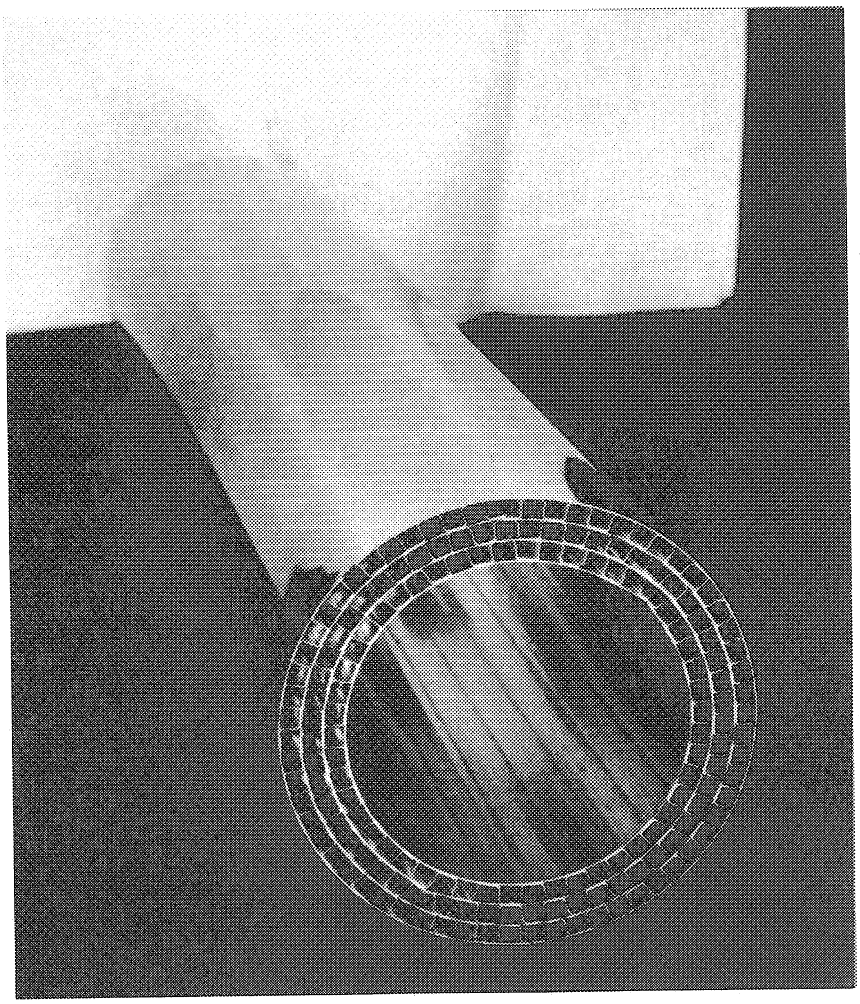

Fig. 2 A Wellblech of 6 x 6 mm^2 cells rolled to a cylinder of 20 cm diameter.

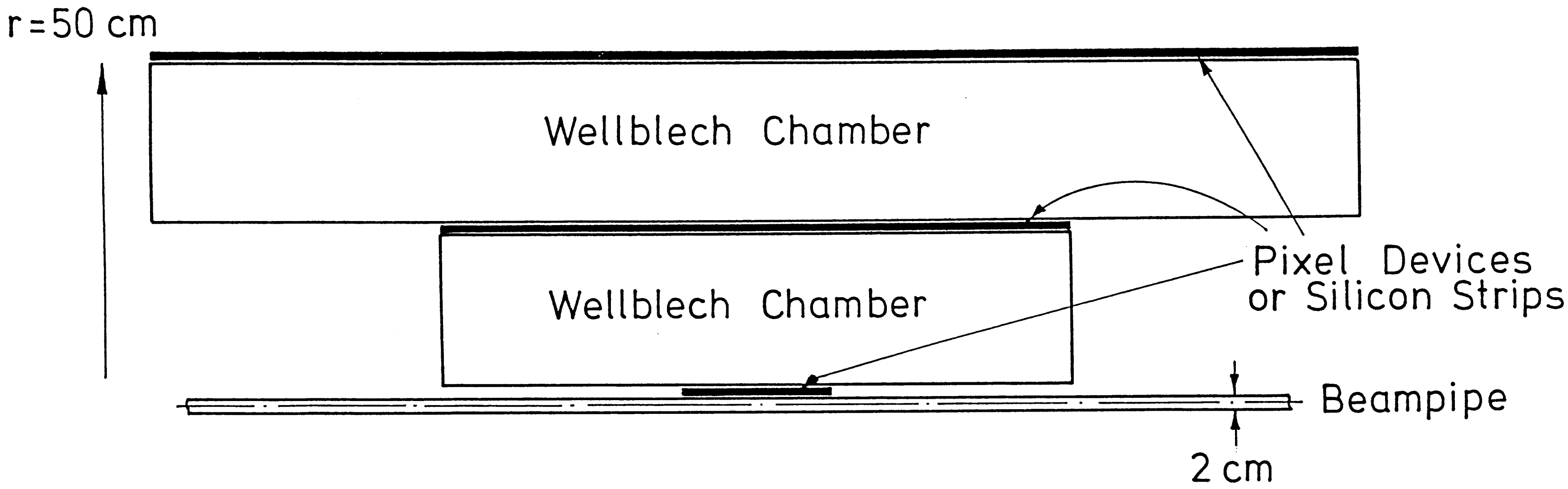

Fig. 3 The proposed tracking chamber. For details see text.