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NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

ELSEVIER

# Multiwire drift tubes with jet-cell geometry for muon detection at LHC

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**Abstract**

Recent results from test measurements with cosmic rays of jet-cell chamber prototypes, developed and studied for the $\mu$ detector of the ATLAS apparatus, are reported.

## 1. Introduction

The design of the muon detector for the ATLAS experiment at the planned LHC collider has led to the development, among others, of a multiwire drift tube concept of detector [1]. It combines the advantage of the jet-cell geometry with an easy modular construction. It is well suited to match the requirements of a project which aims at a resolution of better than 70 $\mu$m per chamber with a total surface covered of about 5000 m$^2$. A detailed description can be found in Ref. [1].

## 2. The jet-cell chamber design

The basic element, shown in Fig. 1, is a "bi-cell", containing two drift cells of $\pm 2$ cm size, with 6 to 8 sense wires each. The wires are supported by combs about every 1 m.

The cathodes are realized by a central aluminium sheet and two lateral C-shaped aluminium covers.

The support combs positioned on a precision bench, form an open structure, on which the wires are positioned. Finally, the cathodes are mounted and glued.

The detector is realized by precisely mounting the bi-cells on a stable, rigid support. The position of the wires is determined by the position of the combs on the support, and does not rely on the position of the tube wall, which has to satisfy much looser specifications.

Characteristics of this design are the high precision on wire positioning, the low wire tension needed (30% of the elastic limit), the simplicity of the construction procedure, the adaptability to any required length (two 9 m long chamber prototypes have been built).

## 3. Performances

The main performance features due to the choice of the jet-cell geometry are a good intrinsic single wire resolution, with a saturated mode of drift operation, and a multitrack reconstruction capability. A test run with a $\mu$ beam at CERN in 1993 has provided first results [1]. The gas mixture used was Ar (65%), $C_2H_6$ (35%). The result concerning the two track resolution is shown in Fig. 2.

In this paper new results from a cosmic rays test at the INFN Frascati Laboratory are reported. The gas mixture

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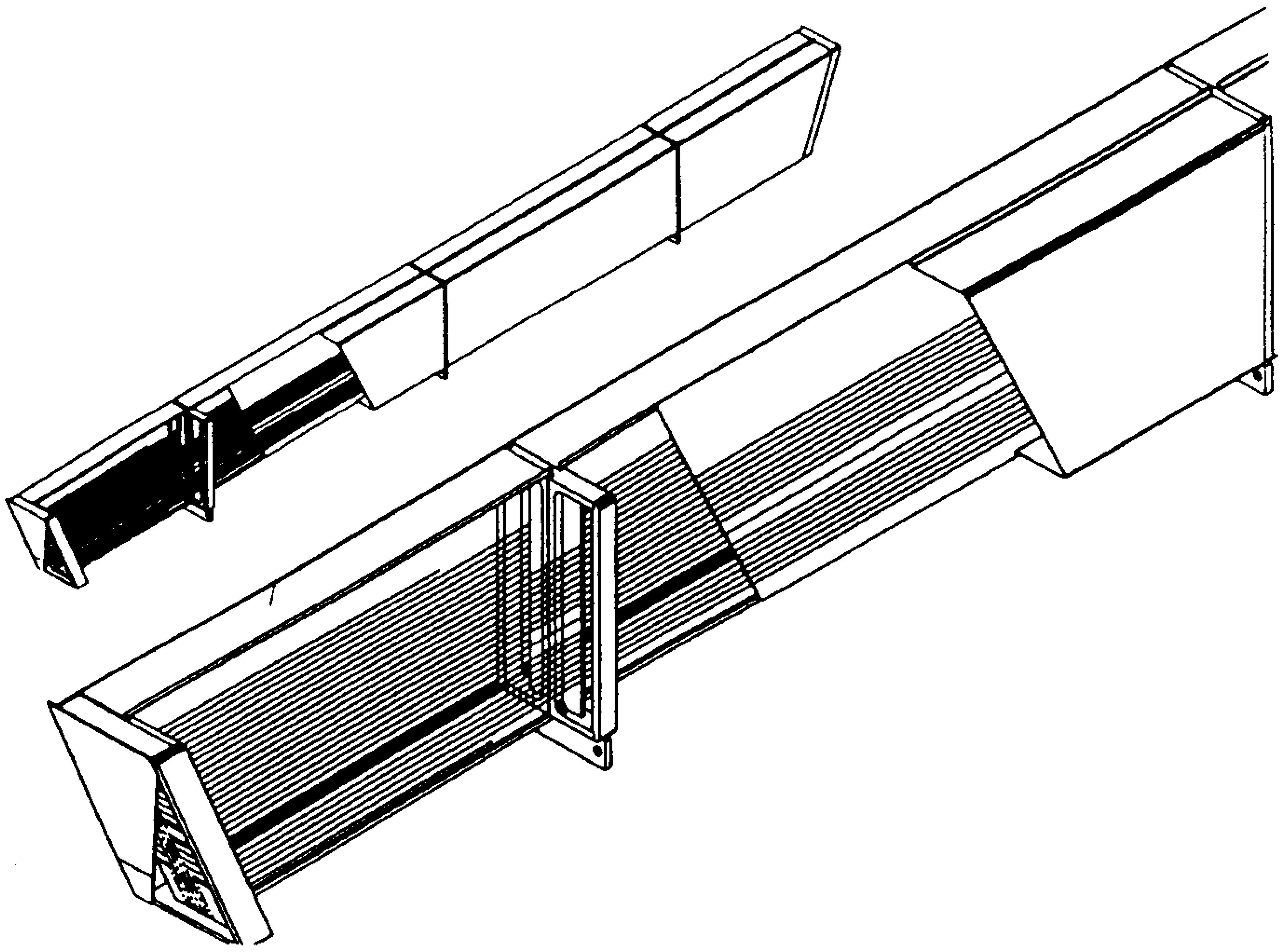

Fig. 1. The jet-cell bi-cell.

used in this case was Ar (75%), $CO_2$ (20%), $C_2H_6$ (5%). The prototype length was 0.5 m. The setup is shown in Fig. 3.

A sample of 9000 events with tracks in the angular interval between 15° and 20° with respect to the plane of the wires was selected out of 45 000 triggers. The residuals from a linear fit to the tracks of the event sample were evaluated. An iterative procedure was used to determine the distance–time $(x–t)$ relations:

– the starting relation was assumed to be linear:

$x = v_d t_d$;

– the average residuals from a straight line fit of the track were fitted with a second order polynomial:

$x' = ax^2 + bx + c$;

– a correction was applied, a new fit of the track performed and the procedure was iterated a few times (five iterations).

A correction for slewing effects was also applied.

The RMS width of the Gaussian fit to the residual distribution is plotted as a function of the drift distance in Fig. 4.

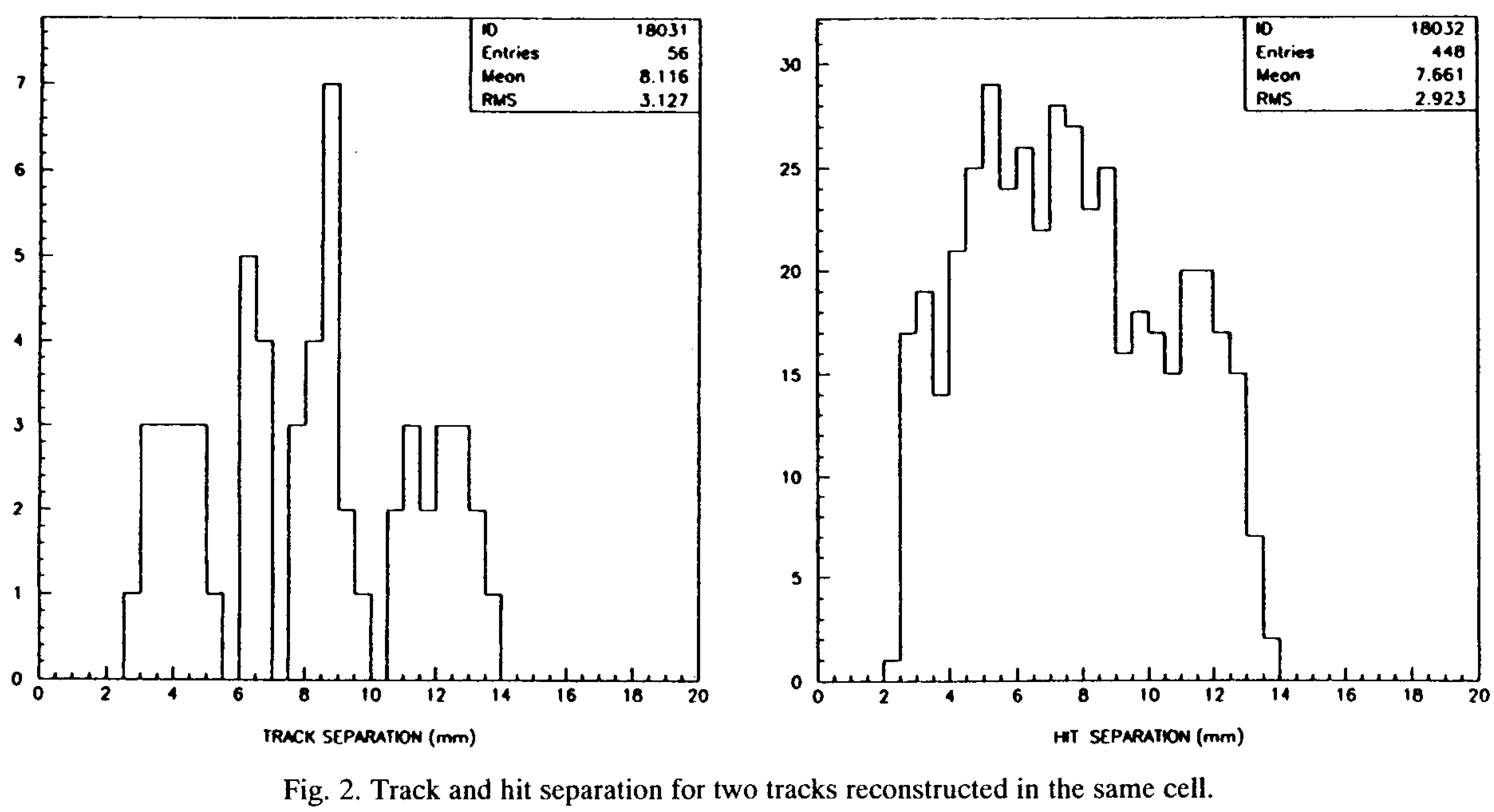


Fig. 2. Track and hit separation for two tracks reconstructed in the same cell.

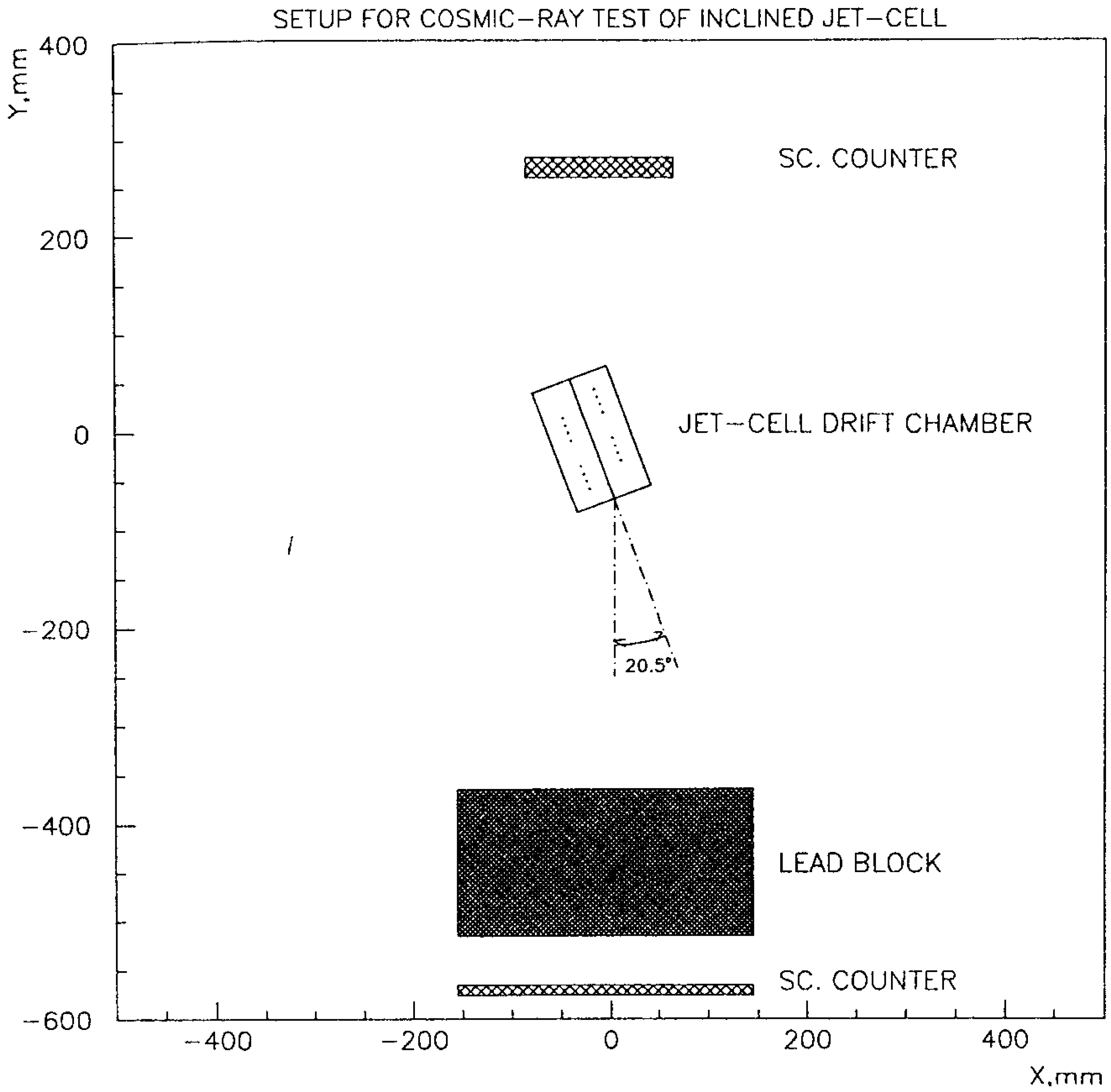


Fig. 3. Setup used for the test with cosmic rays.

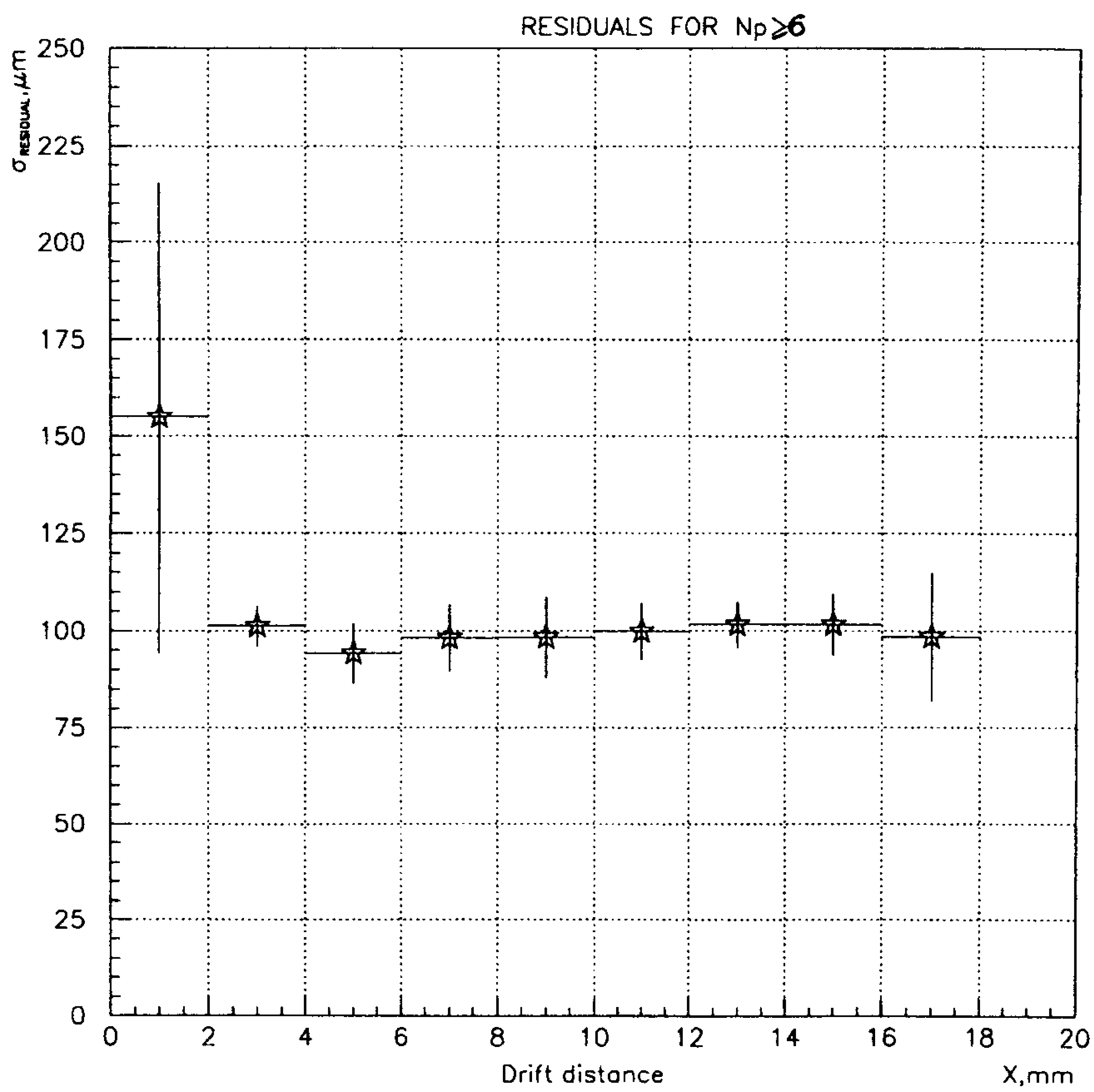


Fig. 4. RMS width of Gaussian fit to residuals from track fit vs drift distance.

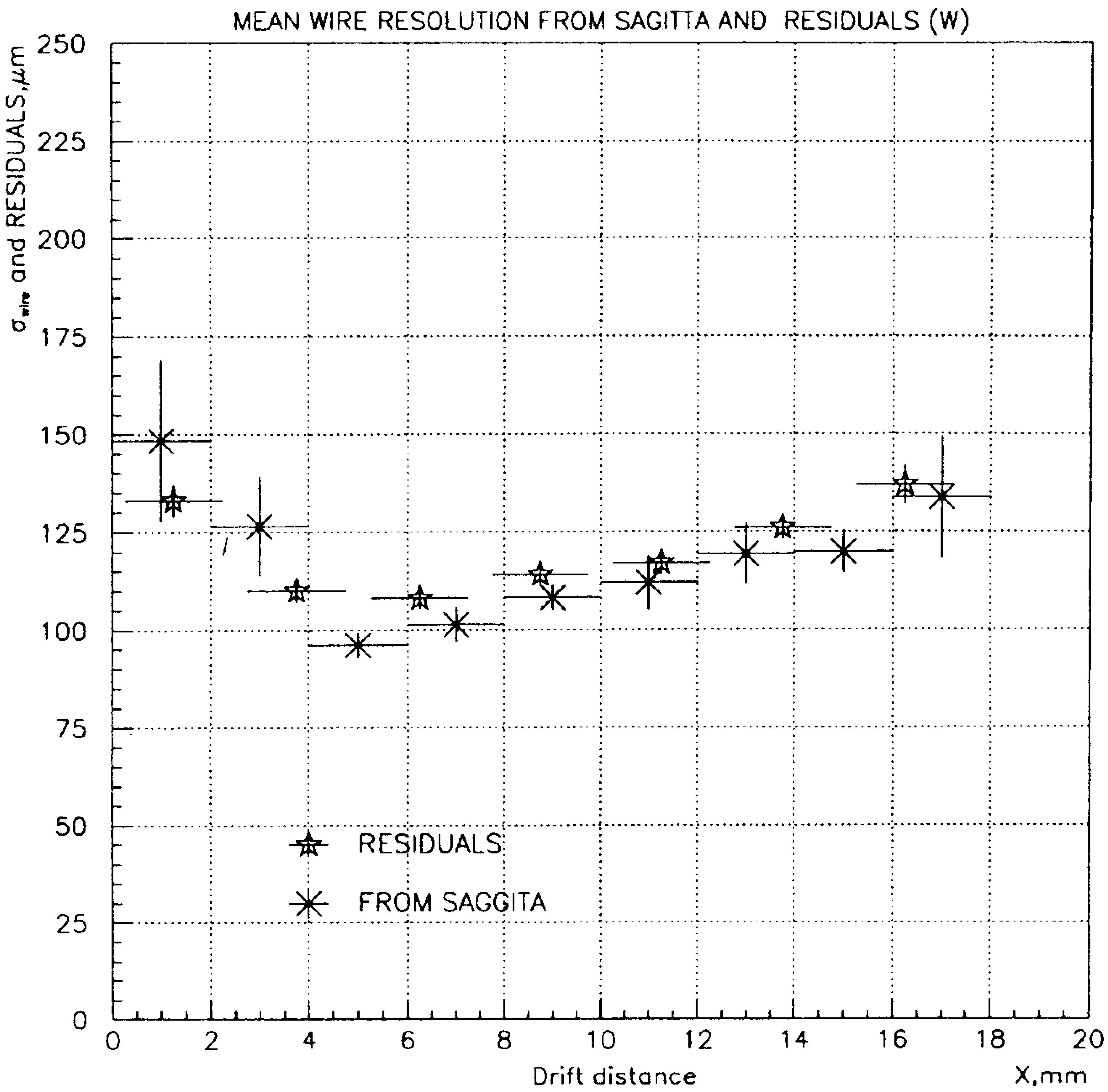


Fig. 5. Resolution estimated from residuals and from sagitta vs drift distance.

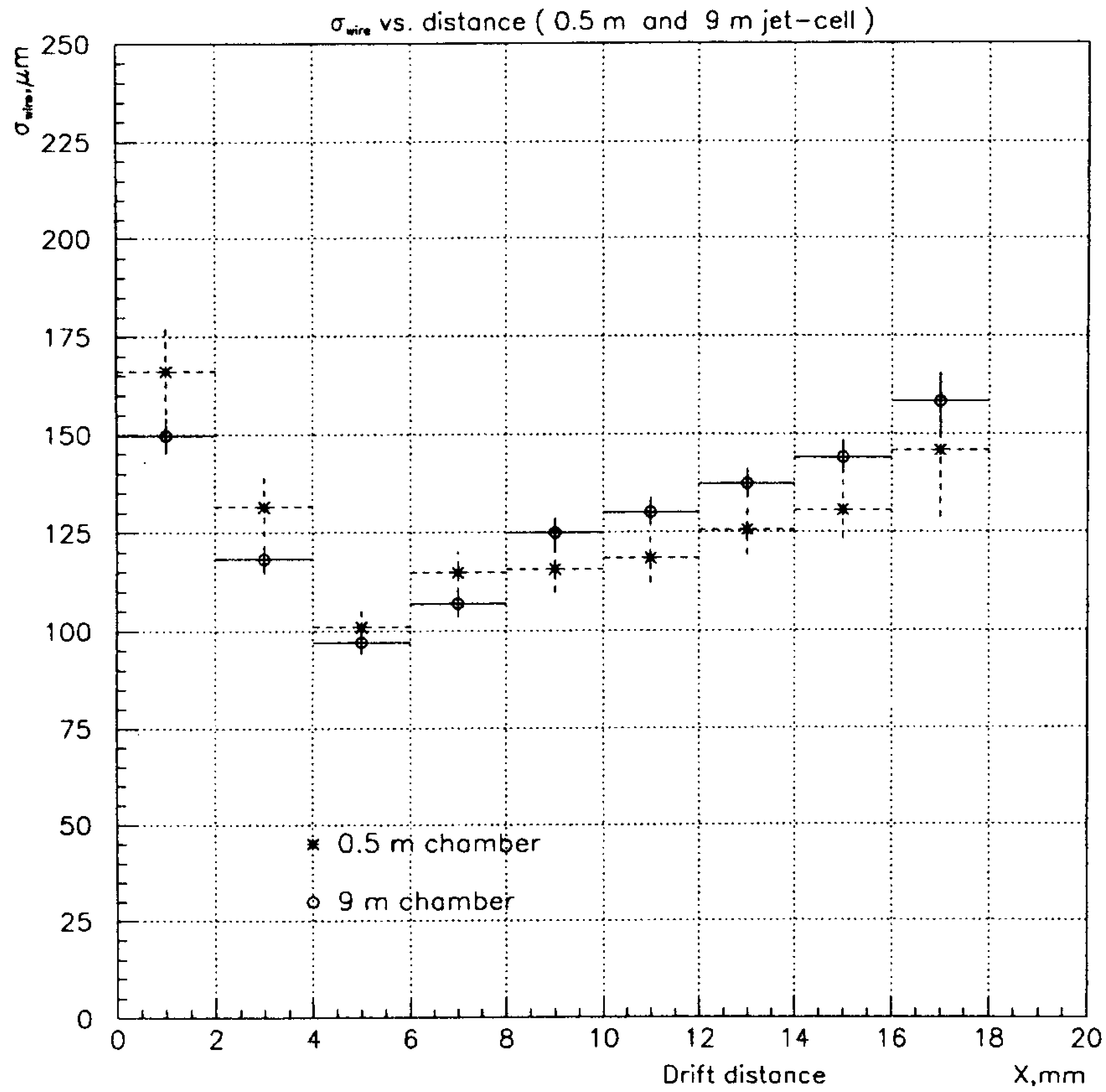


Fig. 6. Resolution from sagitta for the 0.5 m and 9 m prototype, before slewing correction.

The single wire resolution was estimated both from residuals, by applying weighting factors which take into account the bias of the fit, and from the "sagitta" method, i.e. from three consecutive wires sagitta

$$y_2 - (y_1 + y_3)/2,$$

by applying the correction factor $\sqrt{2/3}$. The results are shown in Fig. 5.

An improved resolution is obtained with respect to the previous test beam results [1]. The improvement is mainly due to the use of different electronics.

Preliminary results from a 9 m prototype, not corrected for slewing effects, were compared with those from the smaller prototype, giving a slightly worse resolution, very likely due to smaller amplitude of the signals. The results are shown in Fig. 6.

## 4. Conclusions

Prototypes of jet-cell bi-cells have been tested on beam and with cosmic rays. The main features of the design are:

– Precision positioning of the wire and good control of the systematics.

– Multitrack capability with two track resolution of 2–2.5 mm.

– Single wire intrinsic resolution of about 120 μm.

Further work on correcting systematic effects near the wires and the cathode walls, on improving the cell design for more uniformity between wires, and on the performance of the readout electronics, could lead to further improvement of the overall cell resolution performance.

## References

[1] M. Dris et al., ATLAS Internal Note Muon-No-32 (1994).