CMS TN/94-157
24 March, 1993

Geometry of the Muon System and Extrapolation to the Tracker

V. Karimäki, M. Pimiä and G. Wrochna[1]
CERN

Abstract

Geometry of the CMS muon system is discussed in terms of momentum resolution and extrapolation of tracks to the inner tracker. Longer lever arm of MF1 improves "stand alone" momentum resolution at high p_t, but it does not help in the extrapolation to the tracker. In contrast, a gap between MS1 and MF1 deteriorates the extrapolation significantly.

Presented study is a continuation of the work described in [1]. The following questions have been addressed:

- influence of a gap between MS1 and MF1 on the momentum resolution,
- influence of the gap on the extrapolation to the tracker,
- significance of the MF1 lever arm for the extrapolation to the tracker.

The CMS detector geometry described in the Status Report [2] has been used. The measurement in the muon stations has been performed by two superlayers per station, 30 cm apart. In case of MF1 also a double version having 4 superlayers with 60 cm lever arm has been used, as described in [1]. Assumed resolutions are listed below:

	$r\varphi$	r, z
vertex	20 μm	5.3 cm
Silicon tracker	15 μm	0.1 cm
MSGC tracker	60 μm	0.1 cm
Muon stations	100 μm	0.2 cm

The track fitting and the extrapolation have been done using CMSIM program [3, 4] incorporating GEANE package [5]. Obtained transverse momentum resolution is plotted in Fig. 1 both for muon system alone and full CMS including tracking. It is seen that the gap between MS1 and MF1 ($1.35 < |\eta| < 1.50$) deteriorates significantly the "stand alone" resolution, but it does not affect the overall measurement. Moreover the fit across the gap is very unstable which can be seen from Fig. 2. Especially difficult are regions close to the edges of the muon station. This is well illustrated in Fig. 2 where $|\eta| = 1.5$ points corresponding to the stand alone measurement at $|\eta| = 1.5$ are split into two groups. If a

[1]on leave of absence from Institute of Experimental Physics, Warsaw University, Poland

muon cross the MF1 the measurement is quite prescise, but if the station is missed (e.g. due to multiple scattering) the precision is significantly worse.

Such an unstable behaviour may have immediate impact on the track matching between the muon system and the tracking. In order to estimate how sizable this effect is, tracks measured in the muon system have been extrapolated (or rather interpolated since the vertex position has also been used) down to the inner tracker. Results are shown in Fig. 4 and 5. As expected, errors both on $r\varphi$ and on the other coordinate are much larger in the region of the gap around $|\eta| = 1.4$.

Fig. 5 shows the comparison between the two versions of MF1. No significant difference is observed.

Discussion and conclusions

It has been shown in [1] that the longer lever arm of MF1 improves the "stand alone" momentum resolution but it does not change the quality of the full measurement. In fact the stand alone measurement can be approximately considered as a bending angle measurement in MF1. Therefore the length of the level arm is essential. In contrast, the full measurement can be approximated by sagitta measurement with three points at vertex, outermost tracker layer and MF1. Thus only the position in MF1 is used and the lever arm is less important.

A good stand alone measurement is necessary to extrapolate track down to the inner tracker. Unfortunately at low p_t, where the extrapolation is more difficult, precision is limited by multiple scattering and energy loss fluctuations. Therefore the longer lever arm of MF1 does not help.

The situation is more dramatic in the gap between MS1 and MF1 around $|\eta| = 1.4$. Again the full measurement is not affected, but the stand alone measurement is significantly deteriorated. The lack of the muon station in the turnig point of the magnetic field does not allow to use the full $\int B \times dl$. At MF2 track is already partially "unbent". Moreover the extrapolation to the tracker goes through much larger amount of absorber increasing multiple scattering and energy loss fluctuations. As a result the precision is about 5 times worse than in the rest of the detector.

Without detailed pattern recognition studies both in the muon system and in the inner tracker it is difficult to say quantitatively what is the track matching efficiency. Nevertheless the strong nonuniformity of the detector performace around $|\eta| = 1.4$ strongly suggests to improve muon measurement in this region in spite of technical difficulties.

References

[1] CMS TN/93-124, V.Karimäki, "Study of the muon momentum resolution in the forward region".

[2] CERN/LHCC 93-48, "CMS Status Report and Milestones".

[3] CMS TN/94-151, V.Karimäki, "Overall muon momentum fit in the CMS detector".

[4] CMS TN/93-63, C.Charlot et al., "CMSIM–CMANA, CMS Simulation Facilities".

[5] V. Innocente, M. Maire and E. Nagy, "GEANE: Average Tracking and Error Propagation Package, CERN Program Library W5013-E (1991)".

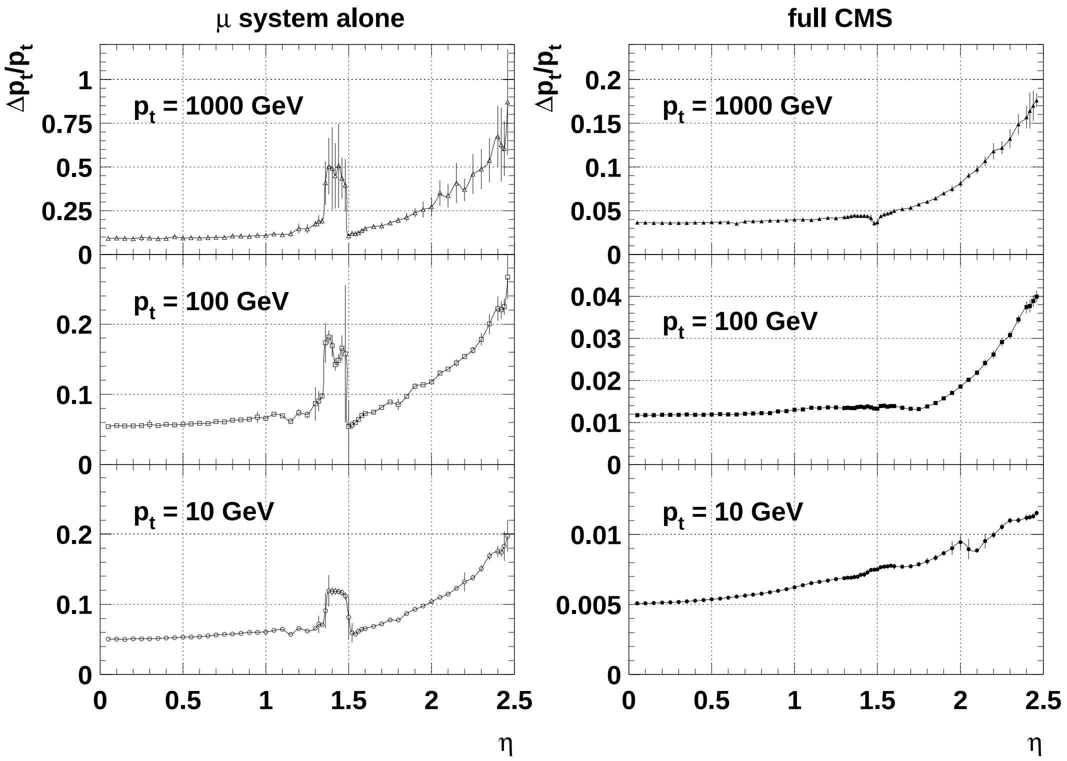

Figure 1: Muon transverse momentum resolution in CMS.

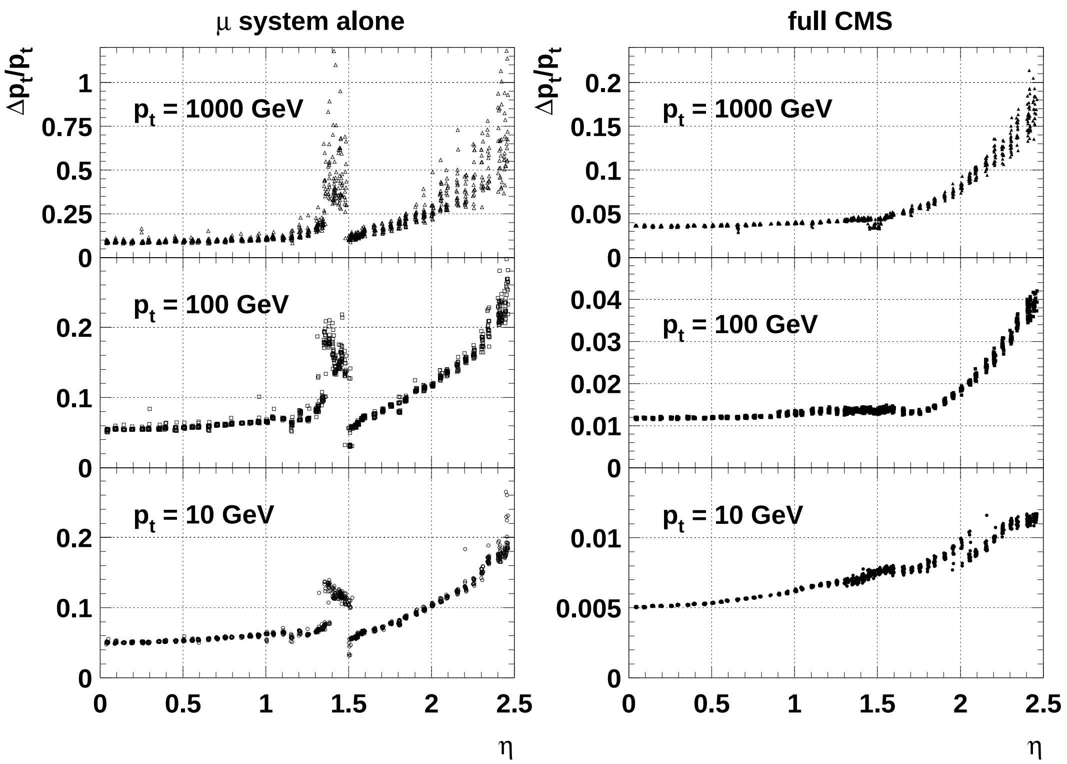

Figure 2: Spread of momentum resolution estimated in several trials.

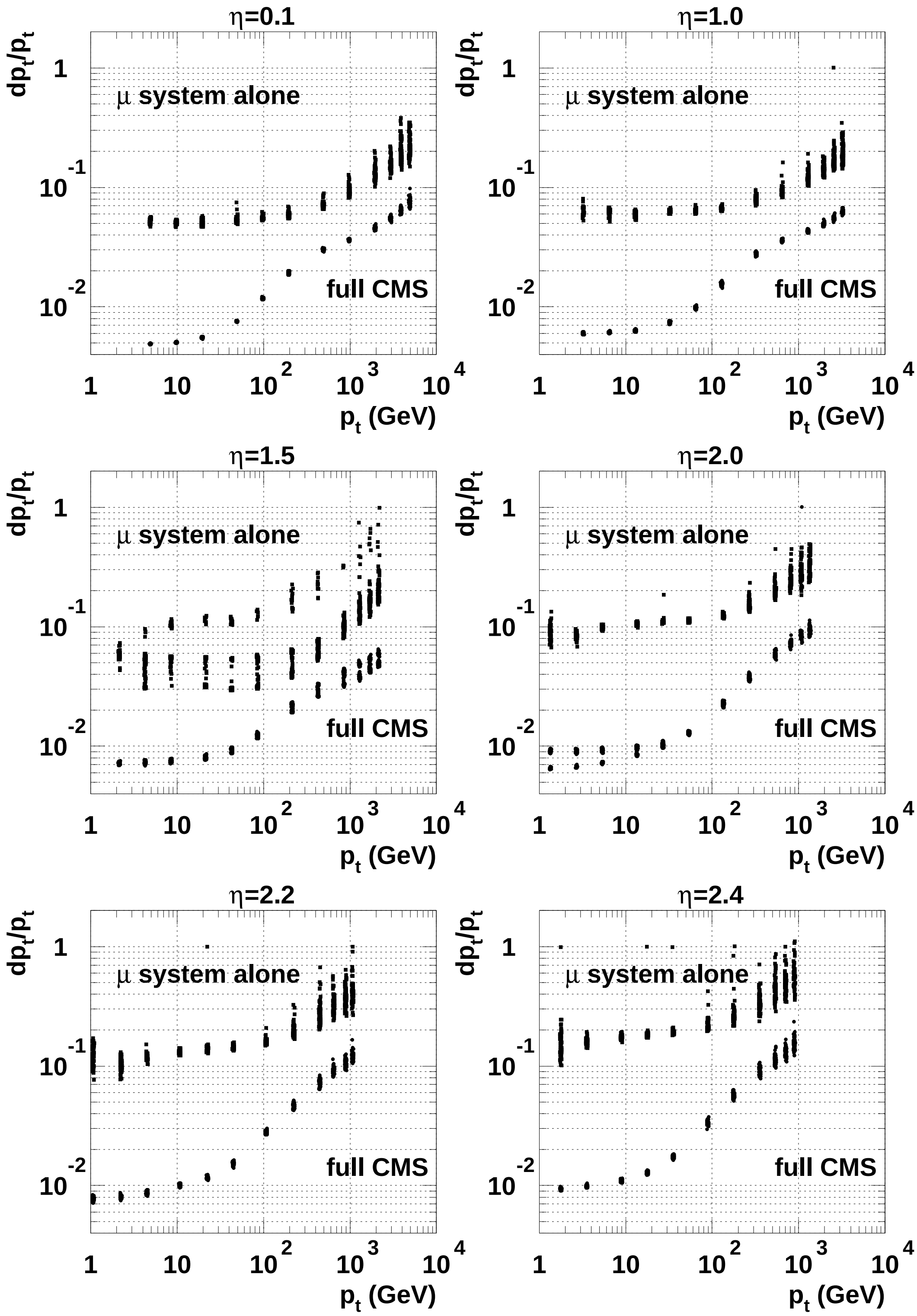

Figure 3: Spread of momentum resolution estimated in several trials. Note large ambiguities for stand alone measurement at $\eta = 1.5$

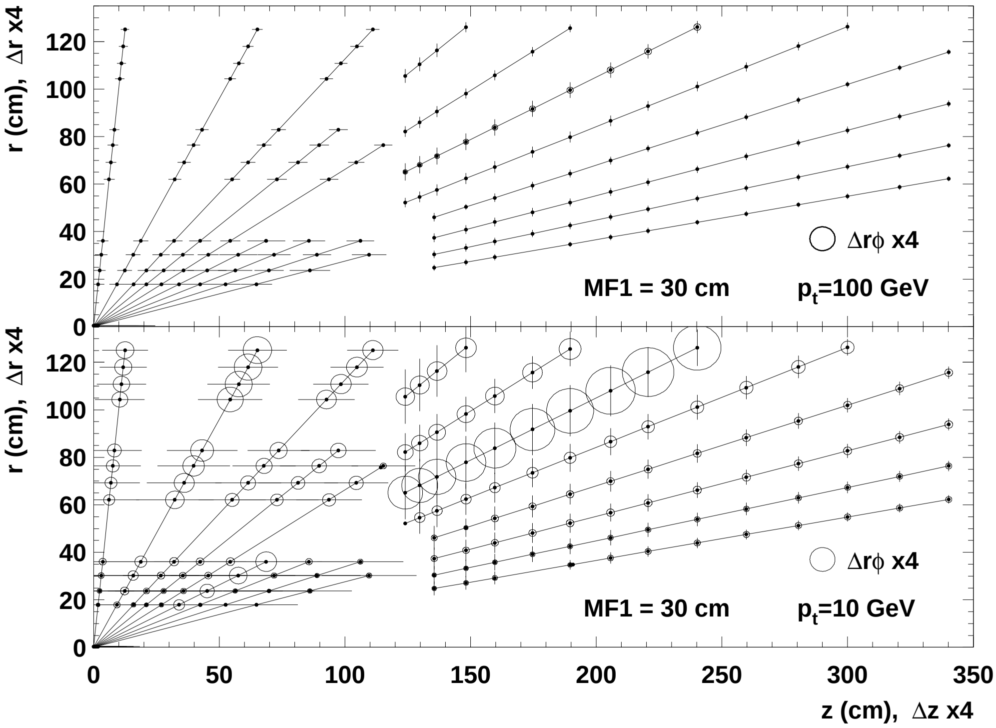

Figure 4: Accuracy of extrapolation to the tracker. Bars represents errors on r and z, circles – on $r\varphi$. All the errors are multiplied by 4 to be better visible.

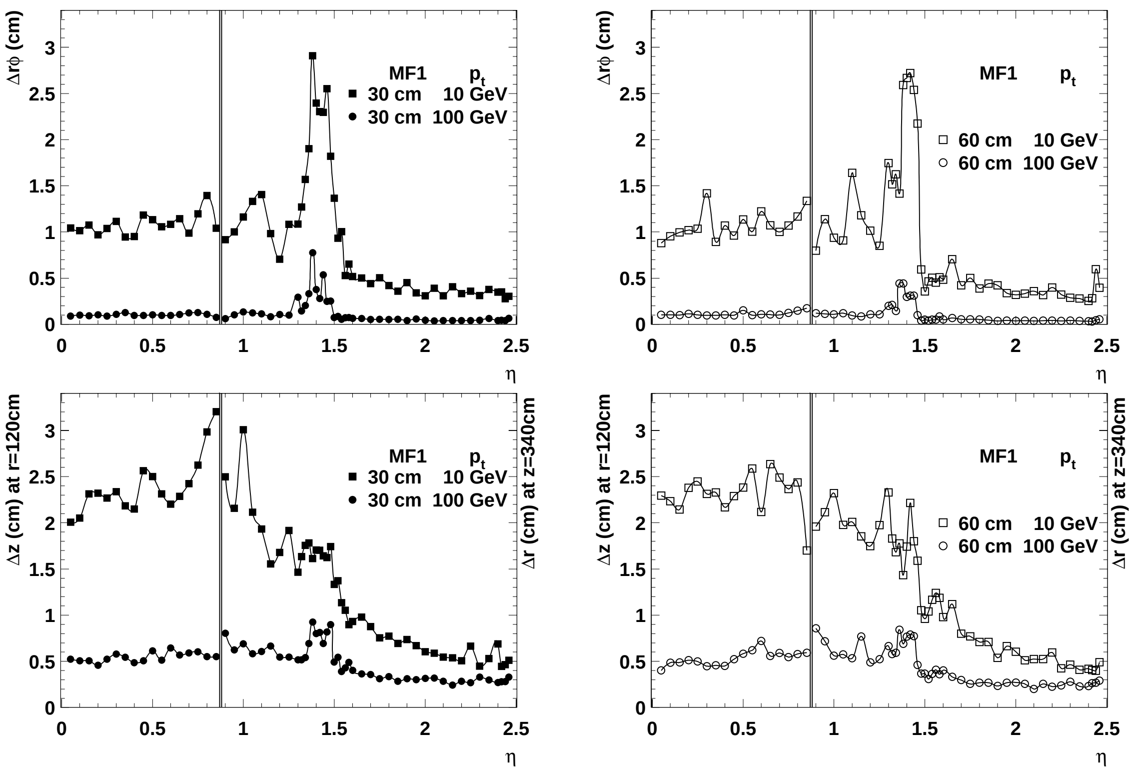

Figure 5: Accuracy of extrapolation to the tracker for standard (30 cm) and double (60 cm) MF1.