The Track Matching Resolution in MRS

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April 30, 2001

Abstract

The correlation between angular track resolution from TPC's and the resultion matching resolutions are investigated. The Note could also have been called Why Dana is wrong!

Recently we have been investigating the momentum resolution in the mid-rapidity spectrometer and in the forward spectrometer in connection with the p-bar - p paper. One of the puzzles have been: why does the apperent angular resolution deduced from the local tracking not match the resolution of the angular matching condition? In this brief note I demonstrate that value indeed are consistent, despite an apparent contradiction. I thank Peter and Dana for valuable input to the discussion.

The matching in the spectrometer are done assuming the effective edge approximation. The schematic layout is given in the figure.

The equation for determining the macthing condition is

$$\alpha_1 = \alpha_2$$

where α_1 and α_2 are defined as angle from the tracks relative to the link vector connecting the point $\vec{P_1}$ and $\vec{P_2}$ at the entrance and exit respectively. Let us assume that the tracks are determined in the front and back TPC by a position and a direction $\vec{P_B}$ and $\vec{a}_B$ and $\vec{P_F}$ and $\vec{a}_F$. Assume that the disctance from the center of TPC is L_F and L_b respectively. The one easily gets the equations in the bend plane,

$$\theta_{link} = (X_B - a_B * L_B - X_F + a_F * L_F))/L_{Magnet}$$

and thus that the matching condition

$$\alpha_1 - \alpha_2 = a_B - a_F + 2((X_B - X_F) + (a_B L_B - a_F L_F)/L_{Magnet}$$

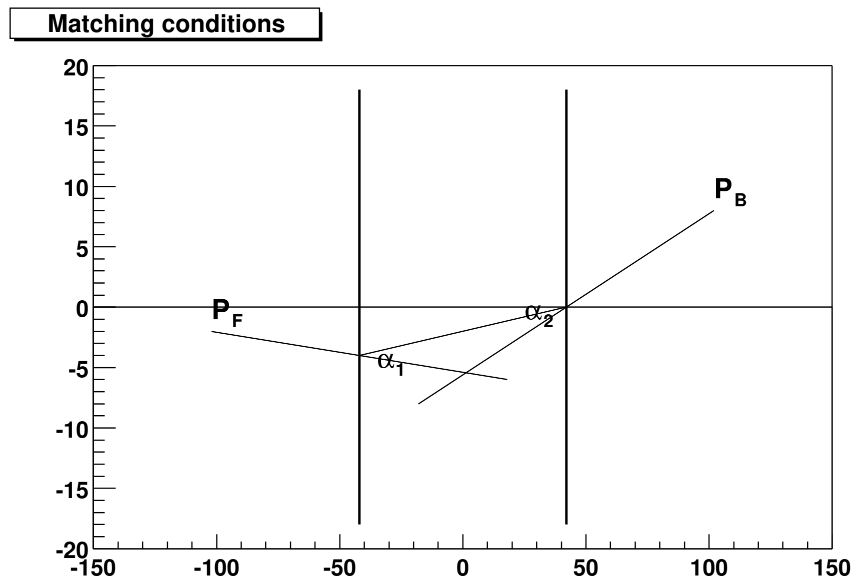

Figure 1: Scematic view of effective edge matching conditions

The error analysis thus easily shows , ignoring the contribution from error in X_F that

$$\sigma^2_{\alpha_1-\alpha_2} = \sigma^2_{a_1} + \sigma^2_{a_2} + (\sigma_{a_1} 2L_B/L_{Magnet})^2 + (\sigma_{a_2} 2L_F/L_{Magnet})^2$$

giving

$$\approx (\sigma^2_{a_1} + \sigma^2_{a_2})(1.0 + 2L_F/L_{Magnet})^2$$

assuming the length and angular resultion are similar. while the error on the sum which determines the momentum resolution is given by

$$\approx (\sigma^2_{a_1} + \sigma^2_{a_2})$$

Thus we find that the variance on the angular difference do not directly reflect the momentum resolution but is modified by the relative lenght of the tracking detector to the effectgive edge over the effective magnet length. For MRS $L_B = 54$ cm , $L_{magnet} = 84$ cm, while for FS $L_B = 74$ cm , $L_{magnet} = 168$ cm,This factor is about 2.6 for MRS and 1.88 for FS, thus explaining the difference seen in the two spectrometers, as well as the rather large variance for the angle difference variance.

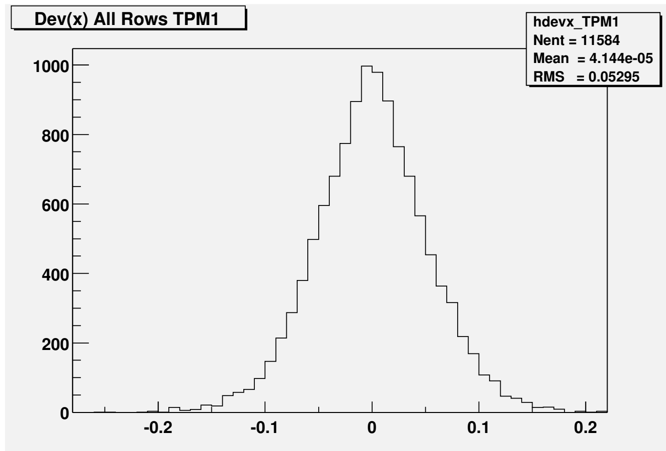

Figure 2: Track residuals for TPM1.

To see how consistent this is with the analysis code and simulation a simple simulation was performed sending pions at 1 GeV/c into the MRS at 90$\circ$. The four plots enclosed shows the track residual in TPM1, TPM2, the angle resolution and the momentum resolution. The numbers are pretty close to those observed in MRS at the 2KG field settings.

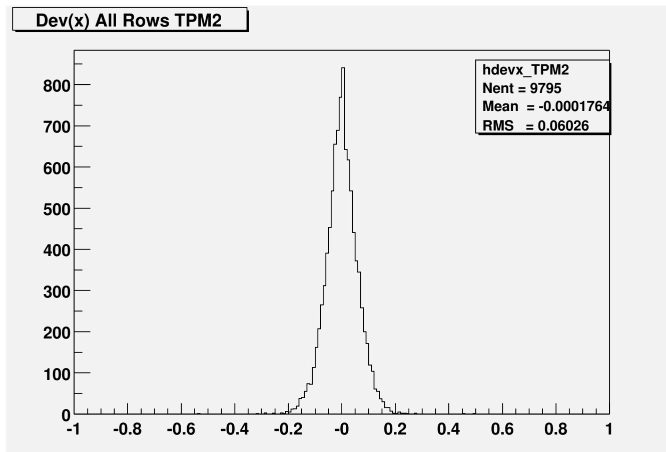

Figure 3: Track residuals for TPM2.

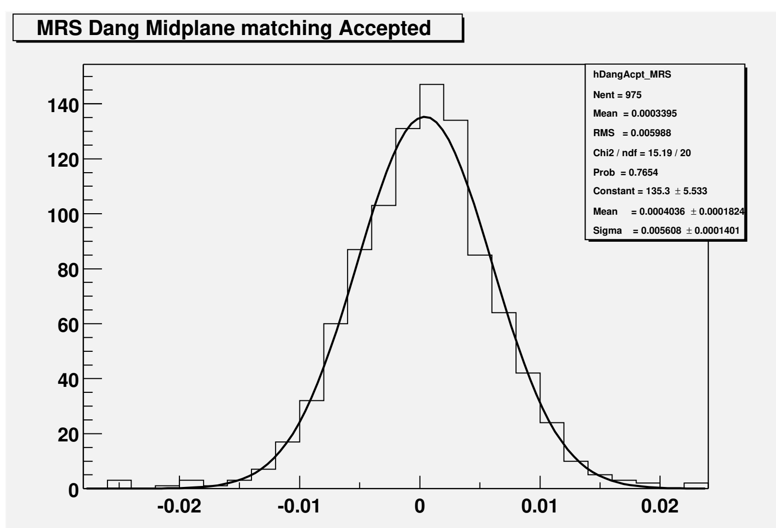

Figure 4: Angular resolution.

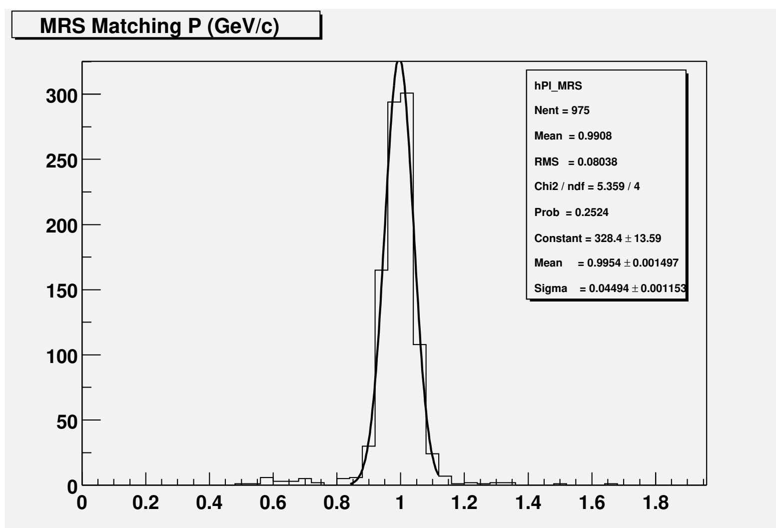

Figure 5: Momentum as reconstructed for 1 GeV/c pions at 90 deg.