The Effect of the CDC/FDC Gap on Charged Particle Resolution in GlueX

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Abstract

This note presents a study of the effect on resolution of varying the spacing between the central drift chamber and the forward drift chamber in the GlueX detector.

1 Introduction

There is a well-known feature in the resolution function for charged particles momentum in the GlueX detector where, for a given particle total momentum, there is a increase in the transverse momentum resolution in the range of 15 to 20 degrees in polar angle in the lab. At these angles tracks of high momentum can leave the CDC through the endplate without traversing all CDC layers, and also have a small number of hits in the FDC, if any.

Fig. 1 shows a close up of a section of the elevation view drawing of the detector. The outer downstream "corner" of the CDC is at 29.0° and the outer upstream "corner" of the FDC is at 24.3°, and the outer downstream "corner" of the FDC is at 11.0°.

2 Estimating the Effect

I have used the program `REZEST`[1] to estimate the resolution in the problem angular region. Figs. 2, 3, 4, and 5 show the resolution in transverse momentum as a function of polar angle and of the gap size between the FDC and CDC for a 1.0 GeV/c pion. The four plots are different views of the same data. The various values of the gap are shown as a difference from the nominal gap size of 23 cm (*i. e.*, zero on this scale represents the nominal gap) and are plotted for a range from -20 to +20 cm. Gaps larger than nominal are not something we would consider, but are shown to give a feeling for the variation of the effect in both directions.

The plots show that the resolution can be improved by about 20% in the region of the "hump" if the gap could be reduced by 20 cm to 3 cm. This is likely more than can be achieved due to mechanical considerations.

Figs. 6 and 7 show transverse momentum resolution as a function of polar angle and total momentum for the nominal gap size of 23 cm and a reduced gap of 3 cm respectively. As has been shown before, the effect is worse at high momentum. However, the data shows that reducing the gap helps ameliorate the problem over a wide range of momenta.

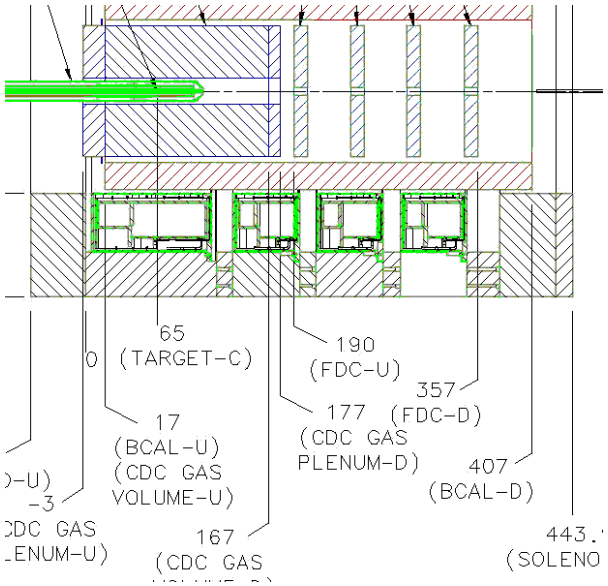

Figure 1: Close up of the elevation view of the GlueX detector. Focus is on the tracking detectors, the CDC and the FDC.

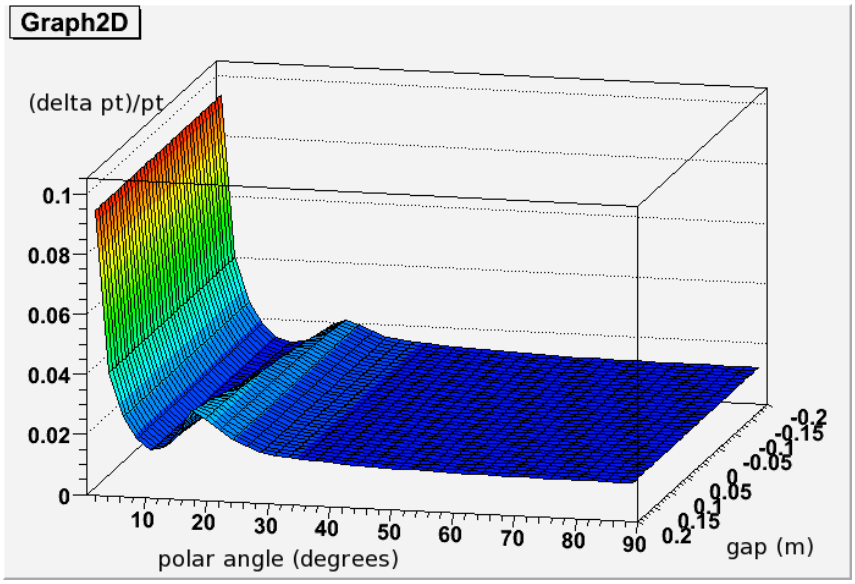

Figure 2: Resolution in p_t as a function of polar angle and the size of the gap between the CDC and FDC for 1 GeV/c pions.

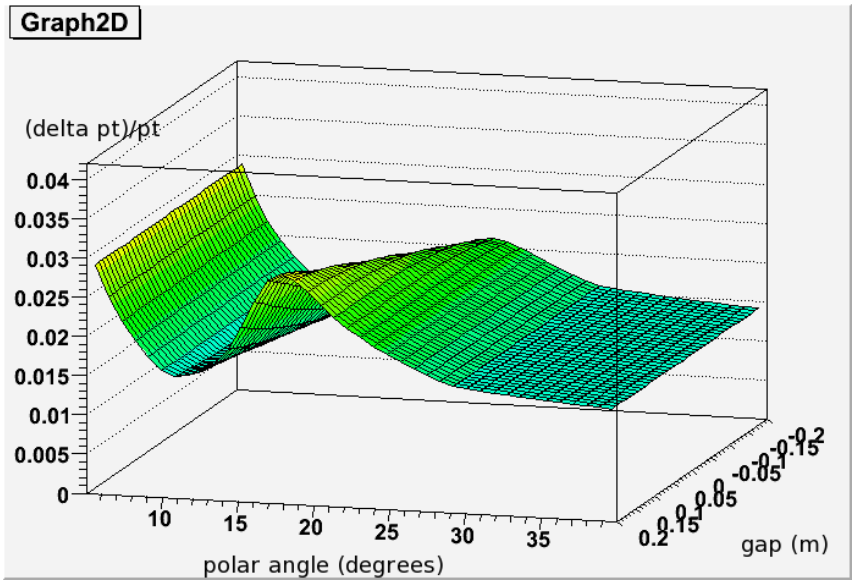

Figure 3: Resolution in p_t as a function of polar angle and the size of the gap between the CDC and FDC for 1 GeV/c pions, zoomed in.

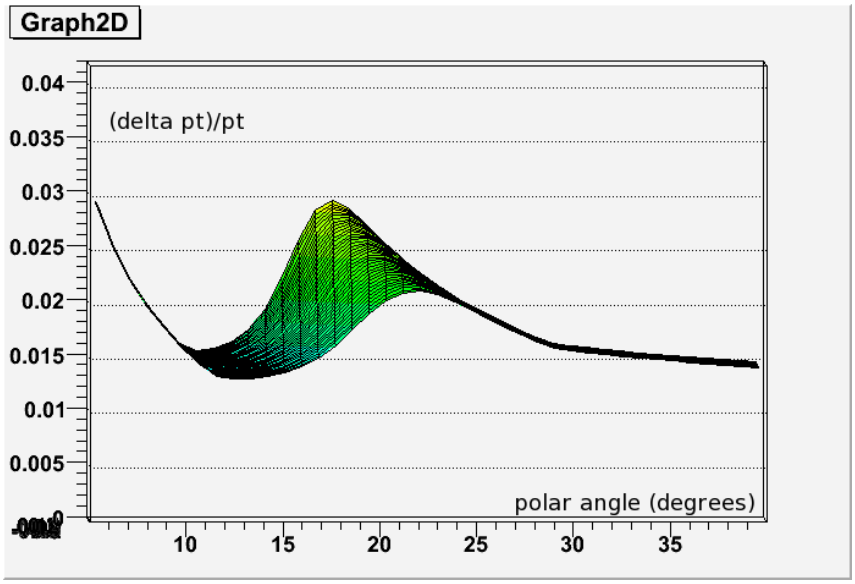

Figure 4: Resolution in p_t as a function of polar angle and the size of the gap between the CDC and FDC for 1 GeV/c pions, for various gap sizes (a projection of the data in Fig. 3). The upper curve is for a gap of 43 cm (nominal + 20 cm) and the lower curve is for a 3 cm gap (nominal − 20 cm).

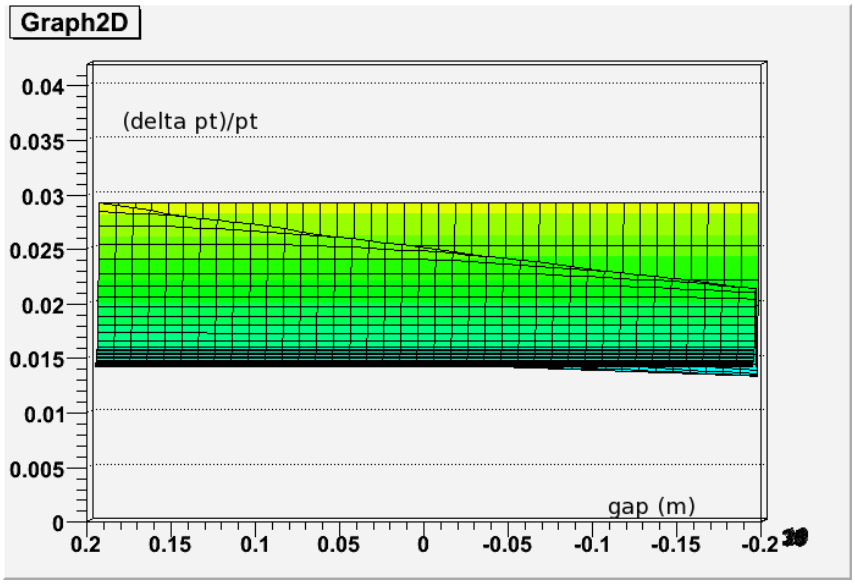

Figure 5: Resolution in p_t as a function of the size of the gap between the CDC and FDC for 1 GeV/c pions, for various polar angles (a projection of the data in Fig. 3). The diagonal line shows the height of the resolution "ridge" at 15 to 20 degrees in polar angle as the gap is varied.

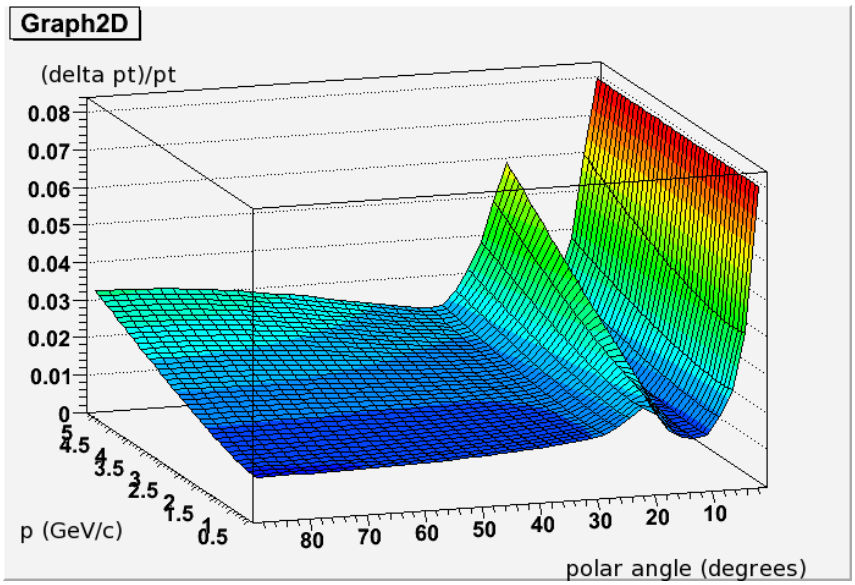

Figure 6: Resolution in p_t as a function of polar angle and total momentum for the nominal gap size of 23 cm.

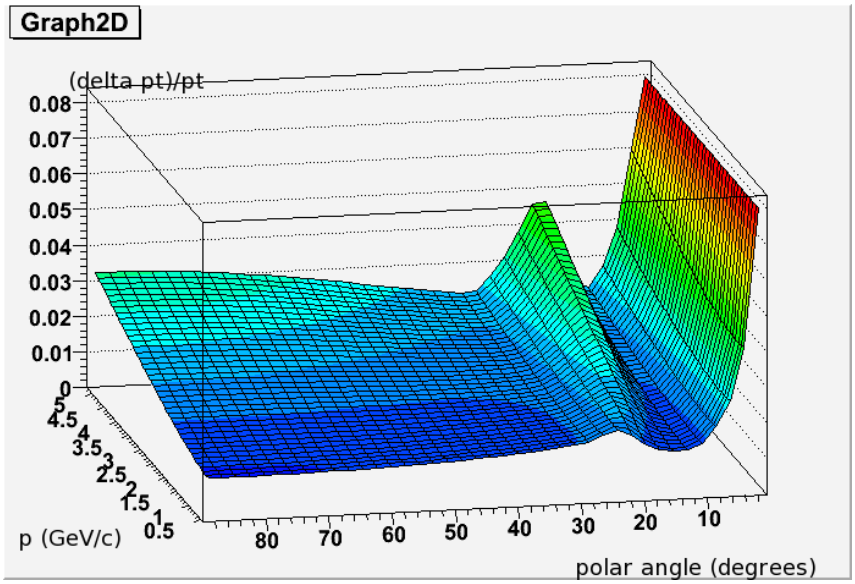

Figure 7: Resolution in p_t as a function of polar angle and total momentum for a reduced gap size of 3 cm.

3 Conclusions

The lack of active tracking measurements in the gap between the CDC and FDC cause a degradation of momentum resolution for tracks which leave the tracking volume in the gap region. Reducing the size of this gap reduces the size of the feature. Gains of up to 20% in transverse momentum resolution are possible in this angular region. The design should be modified to make this gap as small as possible.

References

[1] Mark M. Ito. Estimating resolution for charge particles in gluex. GlueX Note 1046, 2008.