Drift Chamber Intrinsic Efficiency With Field On

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The drift chamber intrinsic efficiency is calculated for the field on case. Comparisons are made between real and Monte Carlo data. Tests are performed to attempt to untangle "observed inefficiencies" due to the *actual intrinsic inefficiency* of the DC from "apparent inefficiencies" due to the helix fit quality combined with other effects (physics or calibrations) that may result in hits appearing to be inconsistent with a specific track.

1 Introduction

The efficiency is calculated for each plane in the drift chamber with the magnetic field on. The code used is the same as in computing the efficiency with the field off; only the subroutine where the extrapolation from plane to plane is done has been modified. For the field off case, this subroutine uses the straight line parameters from the Kalman filter to do the extrapolation; for the field on case the χ^2 helix fit parameters are used. The extensive code testing done on the efficiency code with straight tracks, therefore, provides confidence in the efficiency calculations with field on as well.

The DC efficiency for the field on case may differ from that with the field off since the presence of the magnetic field inside the cell modifies the forces on the electron and changes its drift path to the wire. Furthermore, the efficiency for the field off case was calculated for pions, whereas the intrinsic efficiency relevant to our experiment is that resulting from Michel spectrum positrons. In the calculations below (for real data) the DC intrinsic efficiency is calculated for such a spectrum.

2 Monte Carlo Tests

The efficiency was first calculated from Monte Carlo runs for code testing purposes, with the MC efficiency set to 100 %. Positrons were generated at the target with a total momentum of 30 MeV/c and tracked in the downstream half of the DC stack. Figure 1 shows the results when MC events are generated with a) no energy loss (EL) or multiple scattering (MS); b) EL but no MS; c) EL and MS. In all three cases Jim's pattern recognition code was used. Figure 2 is the same as 1 except that Konstantin's pattern

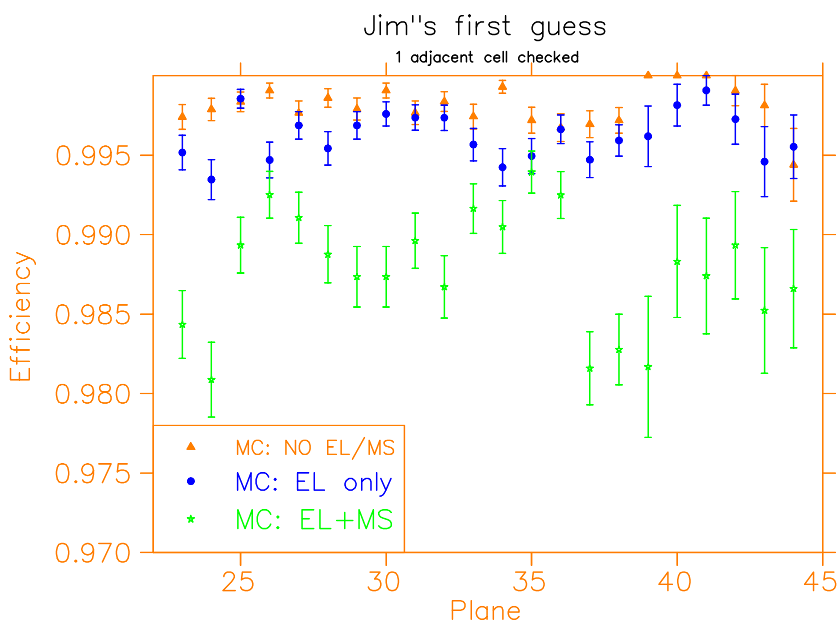

Figure 1: DC plane efficiency calculated from MC generated data with: a) no EL or MS; b) EL only; and c) EL and MS. Jim's first guess code is used and 1 adjacent cell is checked when no hit is found.

recognition code was used. In these two figures, if a hit was not found in the cell expected to display a hit the adjacent cell is checked and the efficiency counters are incremented if a hit is found. Since all planes in the MC are assumed to be 100% efficient, a reduced efficiency reflects the quality of the pattern recognition and tracking fits. As one would expect, when MS is not turned on, one obtains a better efficiency, however, the efficiency can still be as low as 99.5%. No significant differences are noticed between Jim's and Konstantin's pattern recognition codes. Figures 3 and 4 are the same as figures 1 and 2, respectively, except that 2 adjacent cells are checked if the hit is not found in the cell where it is to be expected. Only a slight increase in the efficiency is noticed.

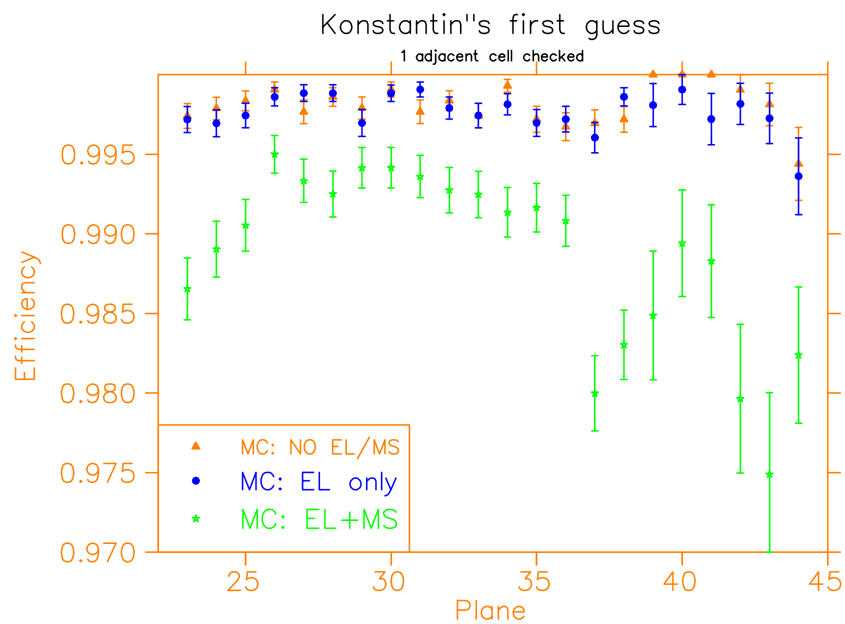

Figure 2: DC plane efficiency calculated from MC generated data with: a) no EL or MS; b) EL only; and c) EL and MS. Konstantin's first guess code is used and 1 adjacent cell is checked when no hit is found.

3 Comparisons to Real Data

The efficiency was also calculated from real data and compared to MC data. A skimmed data file containing only clean events was used. Figure 5 shows the results. No significant differences between MC and real data are observed in the planes close to the target, but away from the target differences of about 1% are observed. If one assumes that the MC perfectly simulates the experiment, this observed difference would be attributed to chamber inefficiency. Since this is not the case, the observed difference sets an upper limit on the inefficiency, and the fact that the efficiency is in the neighborhood of 99% suggests that the probability of throwing away a track due to the lack of a sufficient number of hits (which would otherwise bias this conclusion) is negligible.

For all the calculations thus far (figures 1-5) a cut at 1.0 was imposed on the helix χ^2 per degree of freedom. The χ^2 distribution for the real data is shown in Figure 6.

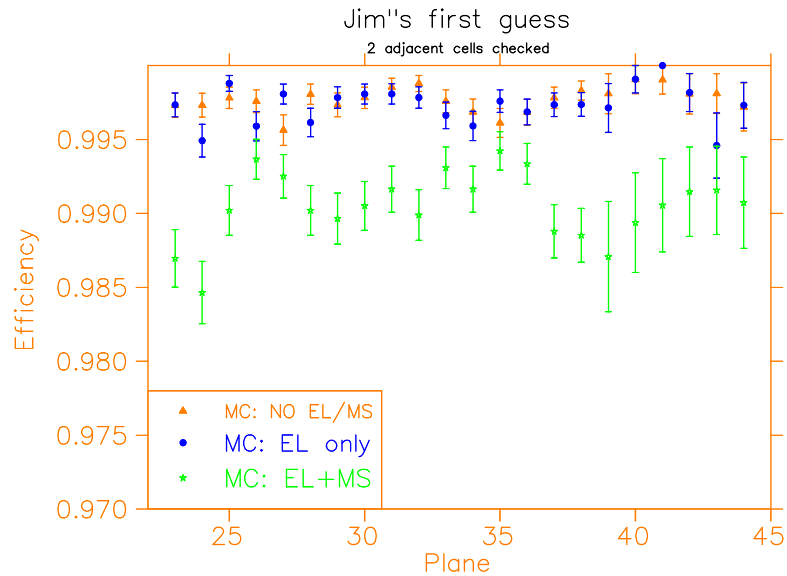

Figure 3: DC plane efficiency calculated from MC generated data with: a) no EL or MS; b) EL only; and c) EL and MS. Jim's first guess code is used and 2 adjacent cells are checked when no hit is found.

4 Verifying Hits Presence and Testing Sensitivity to χ^2

Further tests were done to confirm that hits are not found in (or around) the cell where they are expected due to the quality of the fit as well as hard scattering rather than a DC inefficiency. Figure 7 shows the efficiency when 10 adjacent cells (on each side) are checked. The result suggests that the hits are indeed present, but not found due to the quality of the fit and/or hard scattering. This calculation, however, maybe biased by the possible presence of noise. A better approach is to use a tighter χ^2 cut. Plotted on the same figure is the efficiency when only 2 adjacent cells are checked, but the cut on the χ^2 distribution (of figure 6) is set to 0.5. The efficiency obtained is above 99.8% for the 10 planes close to the target (note that the next 2 planes were not functioning), but goes down to about 99% for the remaining planes. While the presence of hard scattering might explain some of this reduction, the weights used in the fitting can also result in a contribution. In particular, if the progressive hit weight reduction in the direction away from the target to account for MS is exaggerated, one would expect the efficiency to be higher in the planes closer to the target.

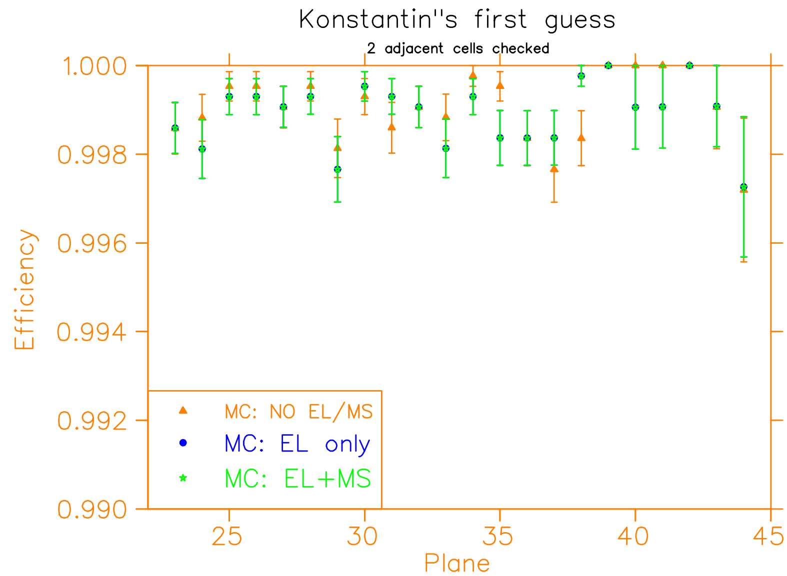

Figure 4: DC plane efficiency calculated from MC generated data with: a) no EL or MS; b) EL only; and c) EL and MS. Konstantin's first guess code is used and 2 adjacent cells are checked when no hit is found.

Figure 8 shows the efficiency from real data for all 44 DC planes with the χ^2 cut at 0.5. A similar pattern is observed in the upstream planes as in the downstream planes. The efficiency is over 99% for the planes close to the target, and gradually decreases as one moves away from the target. This is easily explained by the arguments made in the previous paragraph. The stronger deterioration in the efficiency in several of the last downstream planes as opposed to their counterparts in the usptream half, however, is significant. One possible explainantion is the presence of three dead planes in this reagion, as well as a plane with a dead wire. This may result in a reduced ability to pin down the track in this region, thereby resulting in a reduced "apparent efficiency".

The planes closest to the target are the ones that reflect most accurately the *intrinsic efficiency* of the DC planes. These planes show the intrinisic efficiency to be around 99.9% with the field on, thereby showing no deterioration of the DC efficiency in the presence of a magnetic field.

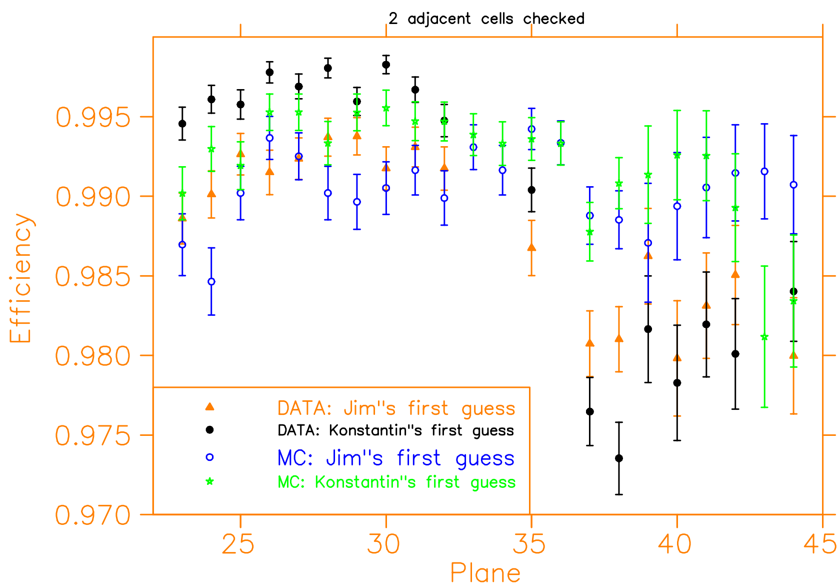

Figure 5: DC plane efficiency calculated from MC and real data.

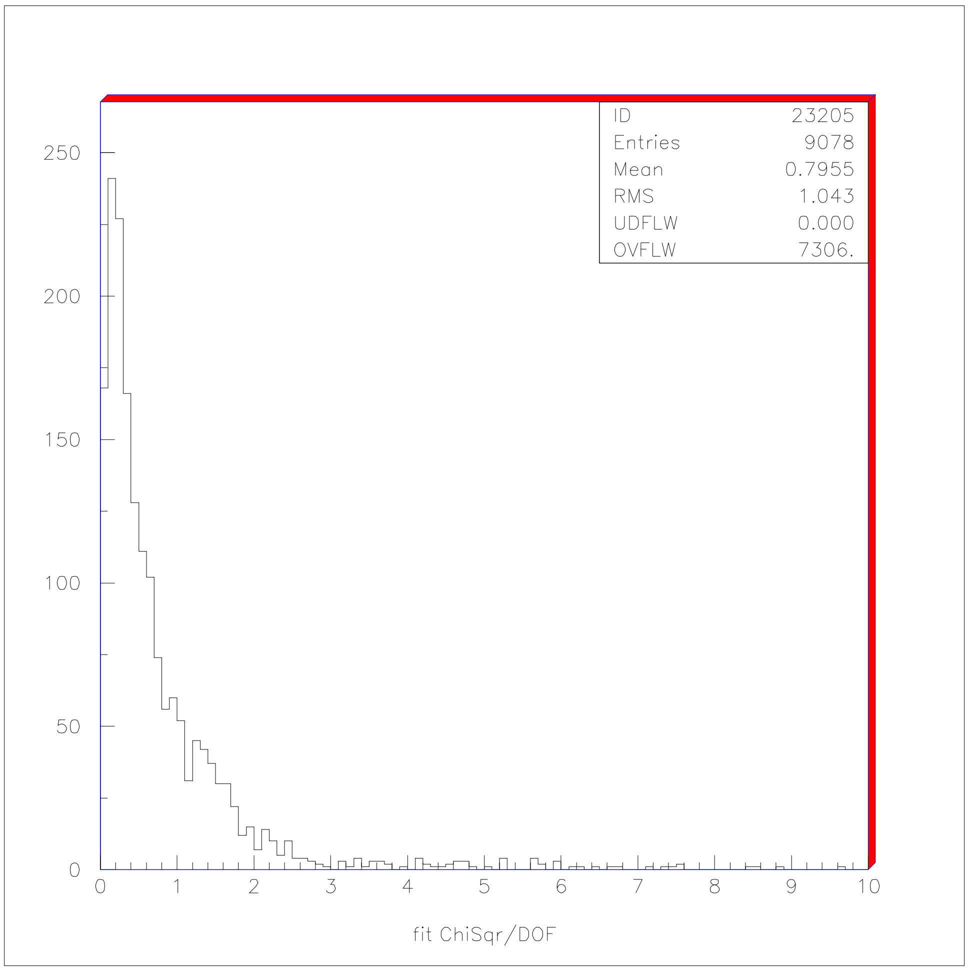

Figure 6: χ^2 distribution obtained from the helix fit for real data.

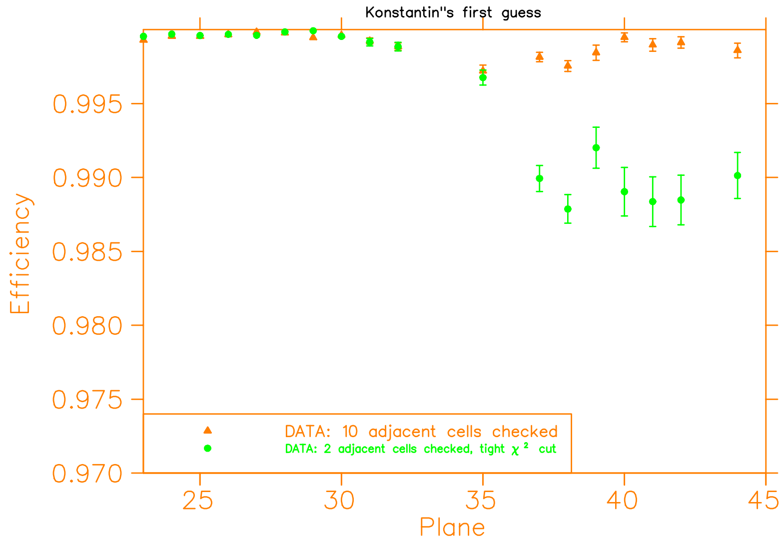

Figure 7: DC plane efficiency calculated from real data where: a) 10 adjacent cells are checked and the χ^2 is places at 1.0; and b) 2 ajacent cells are checked and the χ^2 cut is placed at 0.5.

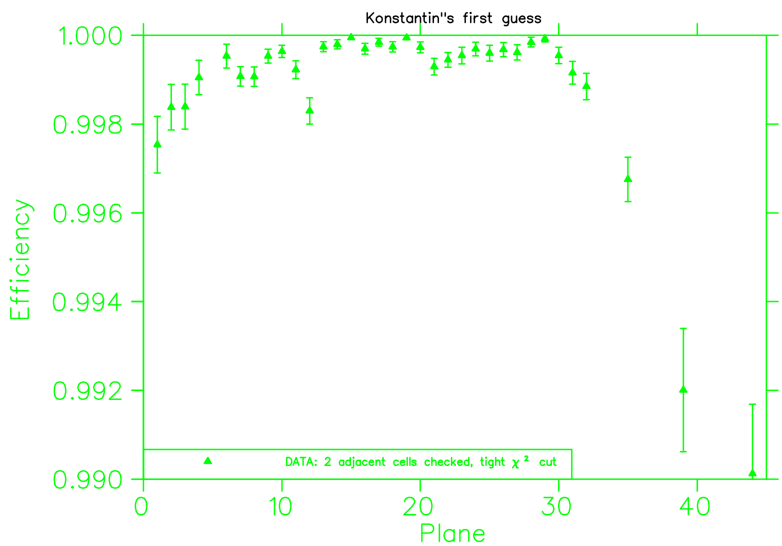

Figure 8: DC plane efficiency calculated from real data for all planes with the helix χ^2 cut at 0.5.