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Curvature Corrections for 5.3.1

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The cosmic ray based alignment of the COT by Hays and Kotwal has been implemented for version 5 production and it profoundly changes curvature corrections. The earlier alignment required an overall offset and phi dependence that was essential to high pt measurements. The new alignment improves that greatly so the largest correction for typical W lepton ($p_T \sim 38$ GeV/c) is10%. On the other hand, more terms become relatively significant. Corrections are updated to the full bhel0d + bhel0e samples.

I have used electrons from the bhel sample to study curvature effects in COT tracking, both with silicon hits and COT beam constrained. An earlier version of this derived from 5.1 blpc0c for COT beam constrained tracks is very similar; bhel has better high pt statistics, errors cut in half due to prescale of 8 GeV electrons, and the changes are minor. Updating to the full bhel sample makes small changes. Also, 5.3.1 has some silicon alignment change from 5.1 so silicon tracks needed to be done with 5.3.1.

There is a clear dependence on cot(θ) as shown in Fig. 1b. Note that the corrections are determined by iteration rather than from the fit; iteration tends to magnify deviations by 50%. The smoothe flat after plot for cot is Fig 2..A quadratic seems to deal with cotangent well. I have no physical model for a quadratic term, the linear term could result from the two ends being twisted differently. If the center supports somehow gave a different twist to the middle, one could imagine two straight lines smeared out by the width of the vertex distribution, but selecting on the vertex for crossing or not crossing z=0 has no effect. The quadratic and cross terms are artifacts of the new alignment. Note that having a quadratic term makes the constant term less obvious to interpret. Orthogonal variables have advantages. I looked versus z0 but there was nothing significant left there.

The phi distribution is shown in Fig. 1a. Note that the three phi term is now as big as anything so we take it as well. Three phi may correspond to three angles of compression, at the two supports and at the top. There is some residual fine structure even after removing everything else; if you use the crappy chisquared to measure it, it corresponds to a residual false curvature rms from misalignment which corresponds to 6000 GeV/c p_T; this is shown a finer binned version is Fig.3 which hints at more structure. Note that the three phi term is particularly stable, does not care which data you use, which alignment.

Prodded by Ashutosh and Chris who were worried about the wire sag model built into their alignment, I looked for correlation of cotangent behavior with azimuth; this is seen in Fig. 4 which has charge asymmetry as a function of cotangent for quadrants of phi, centered north, up, south and down. Cross terms were iterated to flatten these.

The entire process was repeated using silicon tracks with at least two axial hits. As one might expect, the three phi and cross terms are consistent with COT beam constrained results.

So, bottom line, the correction for COT beam constrained tracks is

```
pinv=1/pt;
if(event<0) pinv=-pinv;
pinv=pinv-(.000026+.000072*cot-.00024*cot*cot-.00020*sin(phi+3.4));
pinv=pinv+.00022*sin(3*phi+.9);
pinv=pinv-.00020*cot*sin(phi-.9)-.00020*cot*cot*sin(phi-4.1);
pt=fabs(1/pinv);
```

where the sign of the track is carried by "event." The coefficient uncertainties are (in the last digit quoted) 26±5, 72±11, 24±1, 20±2, 22±2, 20±3 and 20±5. These include some estimate of systematics for example varying the range of cotangent in the fit. Angle are well determined as you can see in Fig. 1a. For silicon tracks use

```
pinv=1/pt;
if(event<0) pinv=-pinv;
pinv=pinv-(.000039+.000082*cot-.00023*cot*cot-.000195*sin(phi+3.73));
pinv=pinv+.00022*sin(3*phi+.9);
pinv=pinv-.00023*cot*sin(phi-.9)-.0002*cot*cot*sin(phi-4.1);
pt=fabs(1/pinv);
```

which is just different enough to remind us that silicon alignment is not trivial. The silicon plots are Figs. 5-8.

While real electrons are charge symmetric, since π^+A is not the same as π^-A, fakes are not and the W (and Z) are polarized, some background can bias these results overall and in cotangent; the current numbers use E_T and missing E_T above 25 (marked up from 22) which is sufficient to stabilize the results. It is amusing to turn this around and attempt to purify the blpc0e sample as fakes. Selecting $E_T<22$ and missing $E_T<6$ almost cleans out the W electrons as can be seen in Fig. 9 which uses post bad COT blpc0e data; the agreement with the W derived curvature corrections improves as you lower the missing E_T cut.

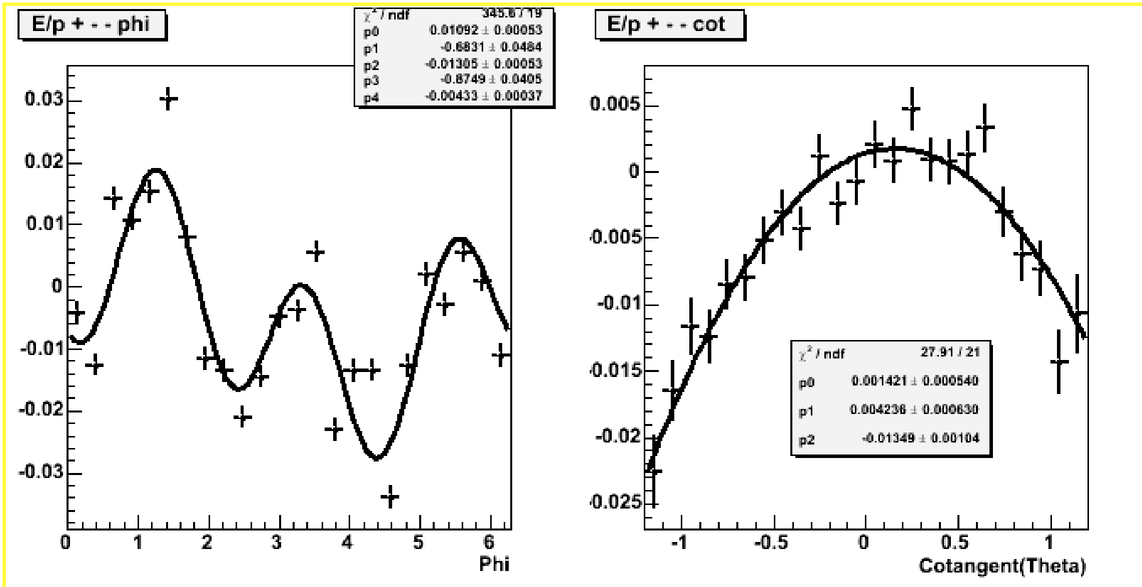

Figure 1. Charge asymmetry as a function of a) ϕ fit to p0*sin(ϕ-p1) + p2*sin(3ϕ-p3) + p4, and b) cotangent fit to a quadratic for COT beam constrained tracks.

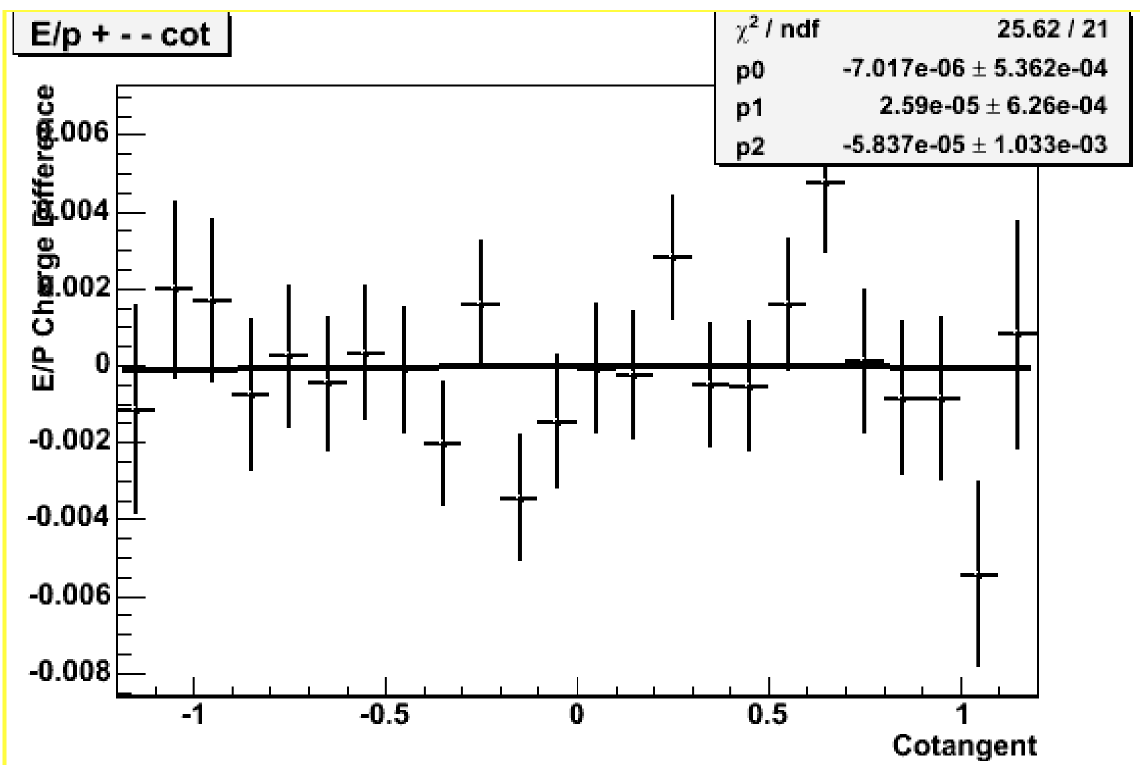

Figure 2. Phi fit of charge asymmetry; note that the three phi term is as big as anything.

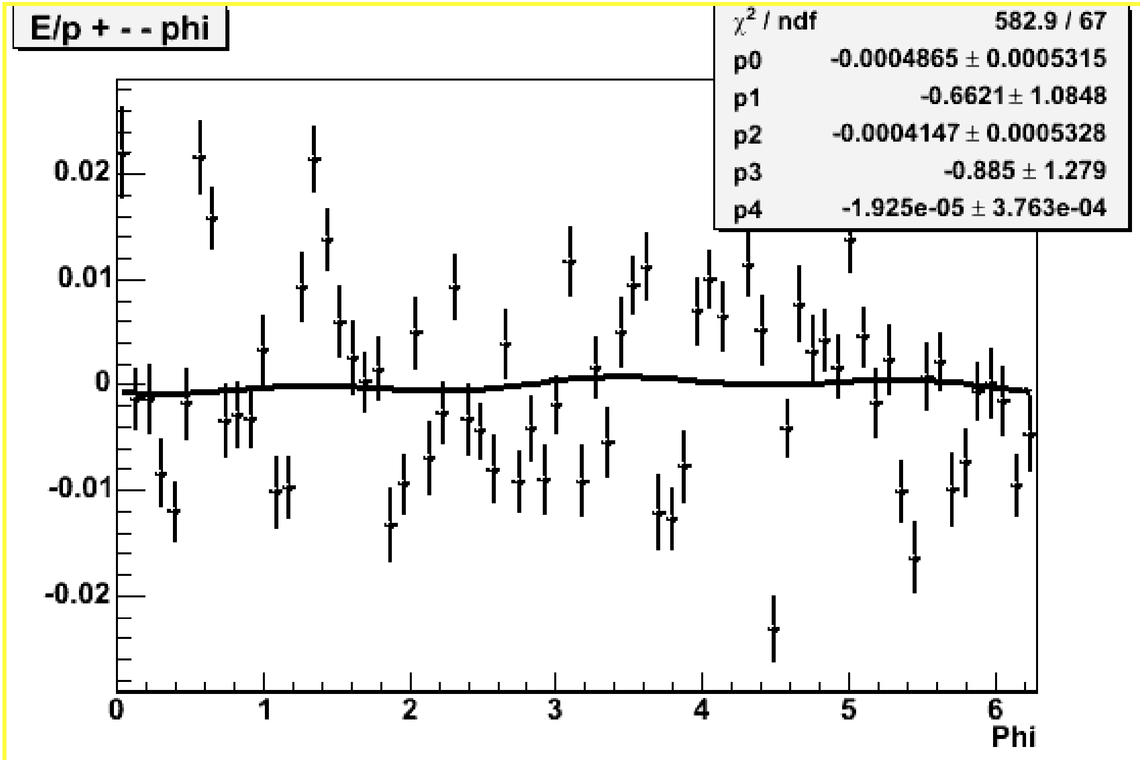

Figure 3. Phi after fixes. The errors and bad chisquared give an estimate of residual misalignment curvature error rms of 1/6000 GeV/c. Binning was made threee times finer after flattening to look for organized structure.

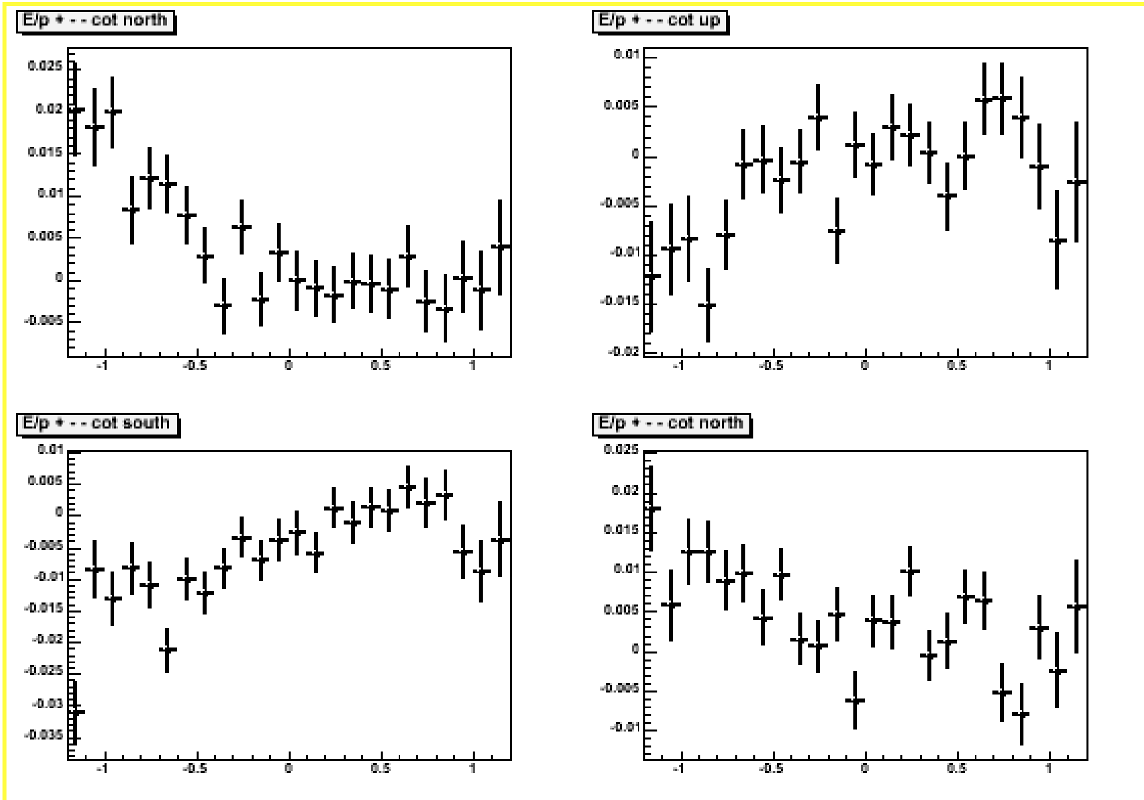

Figure 4. Cotangent behavior in four quadrants of azimuth. The cross term is an artifact of implementation of wire sag corrections. Note that the last north is really down. Global cotangent corrections are already in.

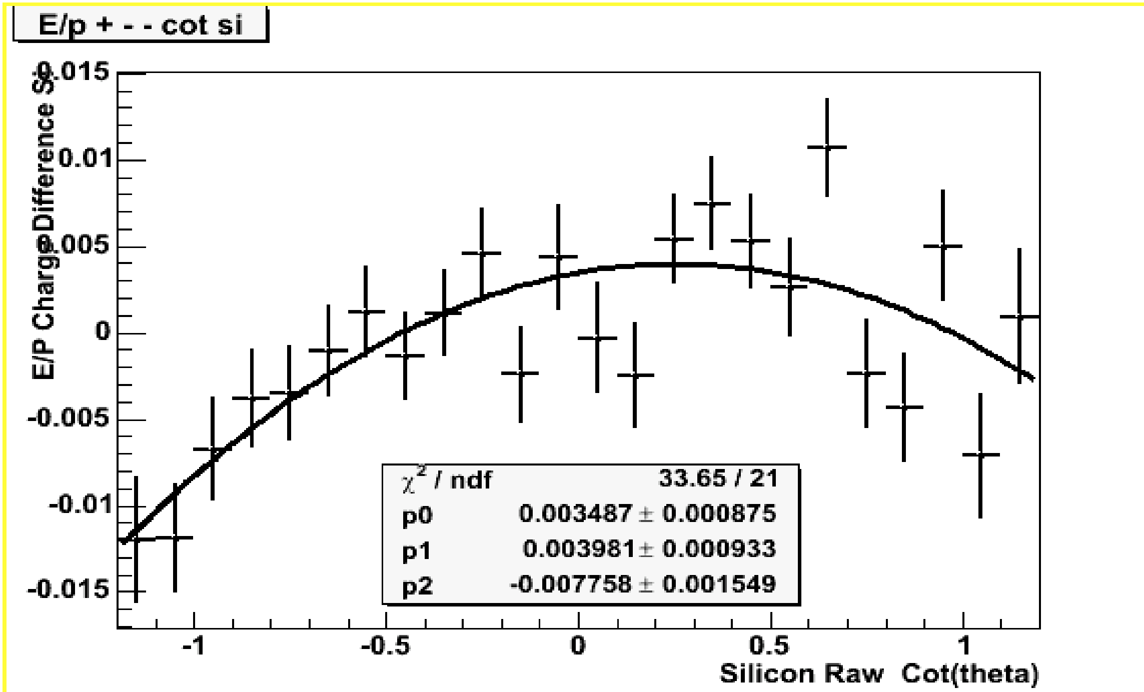

Figure 5. Cotangent for silicon tracks; this is bhel0d only.

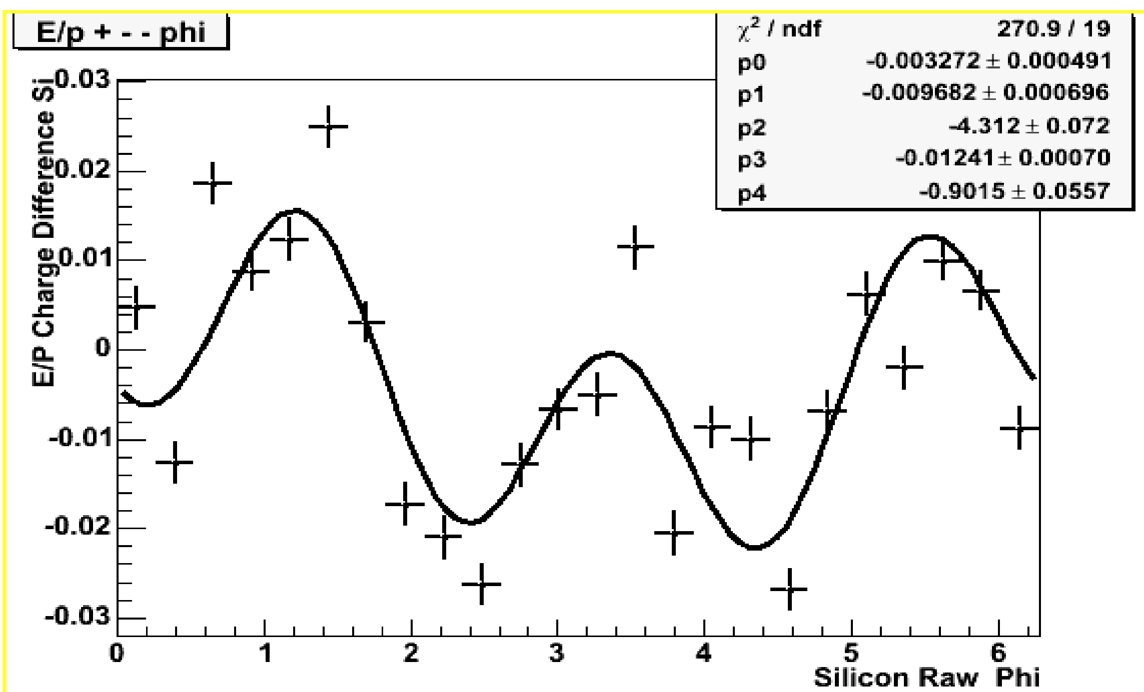

Figure 6. Phi for silicon tracks; note this is bhel0d only. Note the fit parameter order has the constant first.

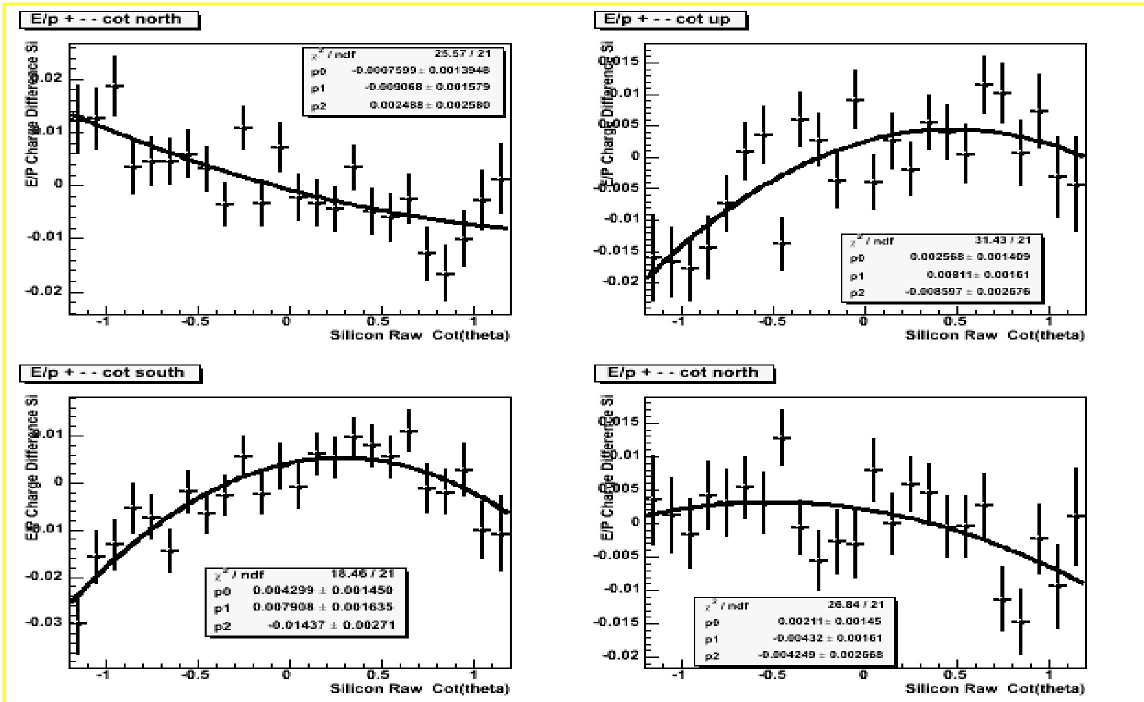

Figure 7. Cotangent in phi quadrants for silicon tracks; bhel0d only. And the last north is down.

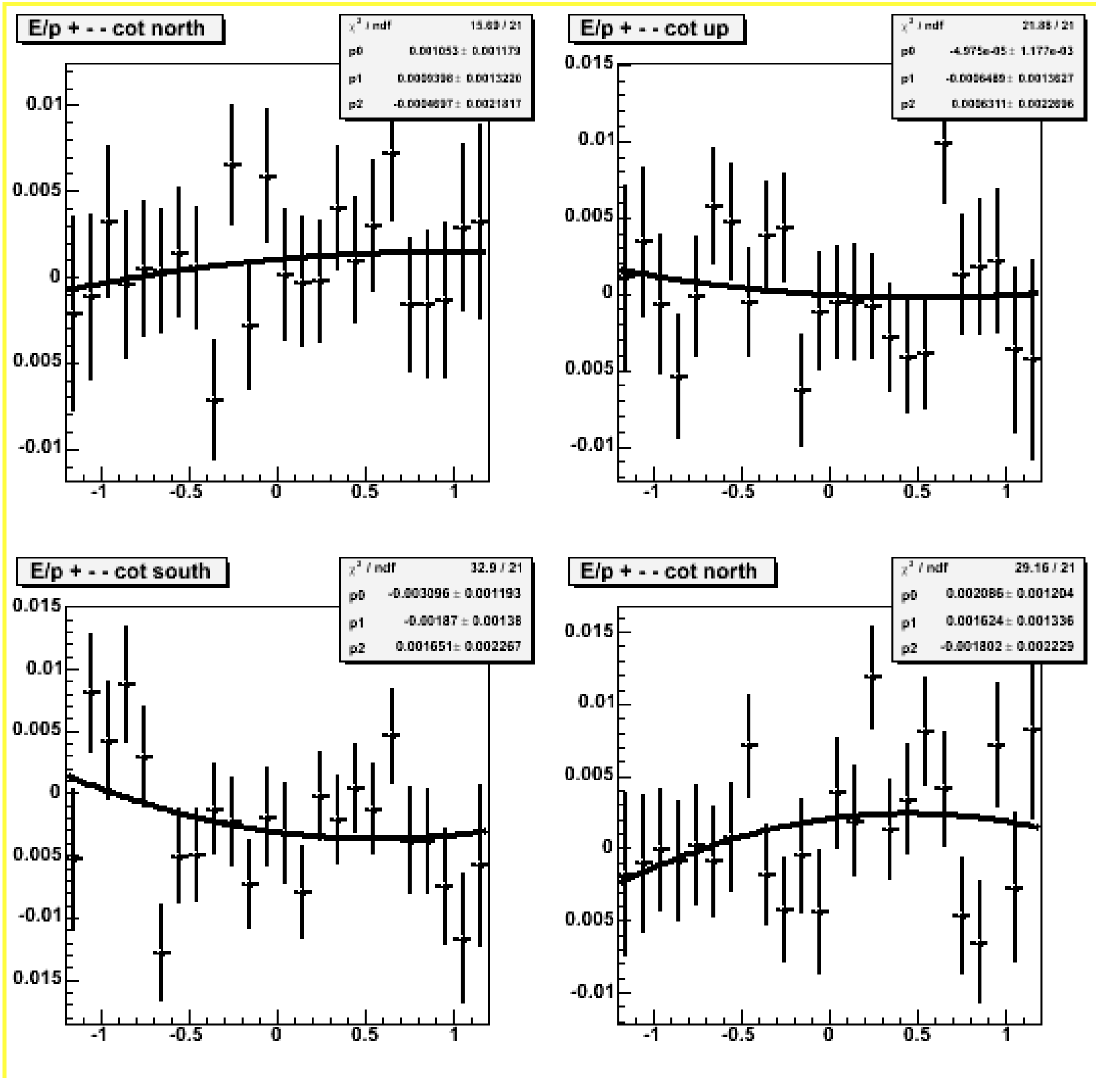

Figure 8. Cotangent by phi quadrant, silicon tracks with fix in, full data sample, and the last north is down.

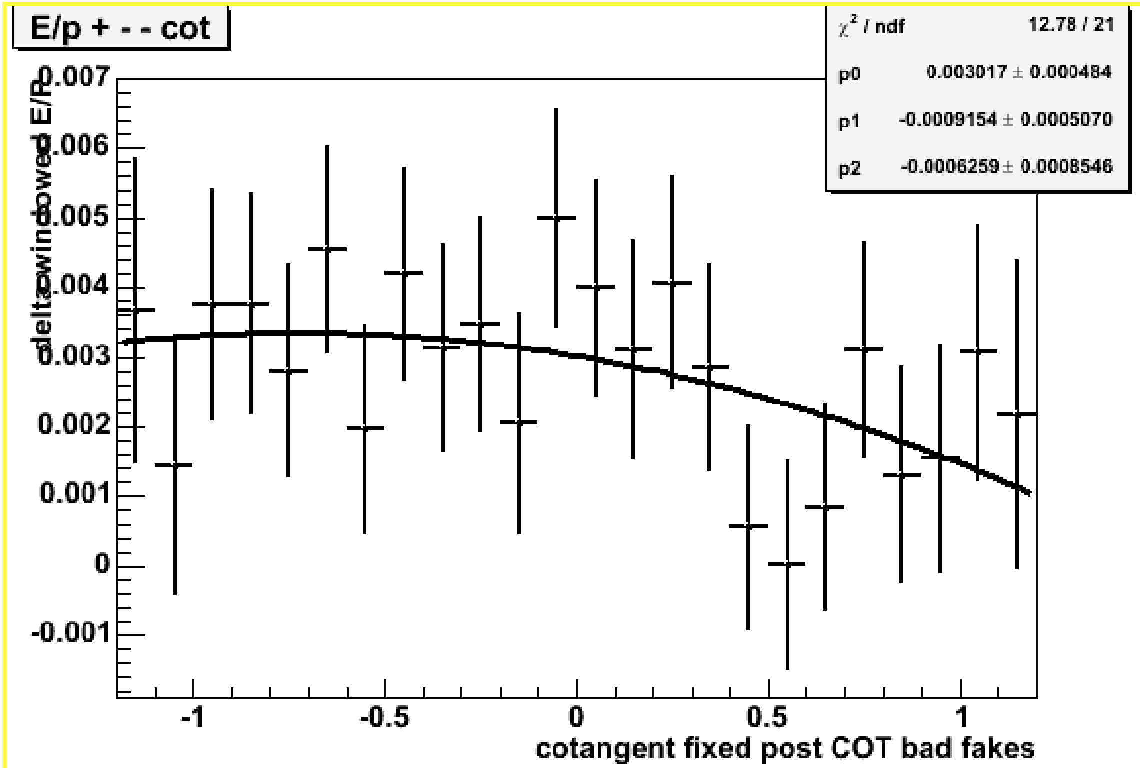

Figure 9. Corrected charge asymmetry for predominininantly fake electrons in the post bad COT blpc0e sample, as a function of cotangent. The linear slope grows more negative if you let in more Ws.