Effect of systematic shifts in ax and ay

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Stefan pointe out in his memo that ax and ay distributions of reconstructed data indicate systematic shifts in these variables. How do these systematic shifts alter celestial coordinates RA and DEC?

This memo is a study of shifts that would occur in the RA and DEC of a source in its traversal in the sky overhead, for systematic shifts in ax and ay. For this purpose parabolic fits were made to Stefan's plots for ax and ay as a function of θ. A single transit of a source was considered. JD 2447050.5 was chosen, time was incremented by a second and source location was chosen to be 340° which assured a full range of overhead traversal. Dec of the source was assigned three values : 10.8, 30.8 and 50.8 degrees. For each time, local angles, θ and ϕ where calculated. Using these new ax and ay were generated. These were then shifted according to Stefan's graphs and a new value of ax = $\sqrt{(1 - ax^2 - ay^2)}$ was also calculated. These were then used to compute shifted theta and phi: $\theta_1 and \phi_1$. Now using these new values, $\theta_1 and \phi_1$ and the time I recalculated new values for RA and DEC : Ra_1 and Dec_1. Finally the deviations of these new values from the original values of RA and DEC were calculated.

For this study one traversal of a source located at RA = 340 and three different values of Dec were considered. A $\cos(\theta)^4$ distribution is assumed for the event distribution and a traversal with $\theta < 60°$ is considered. For such traversal, Figures 1 and 2 show the event rate as a funtion of θ and ϕ, respectively.

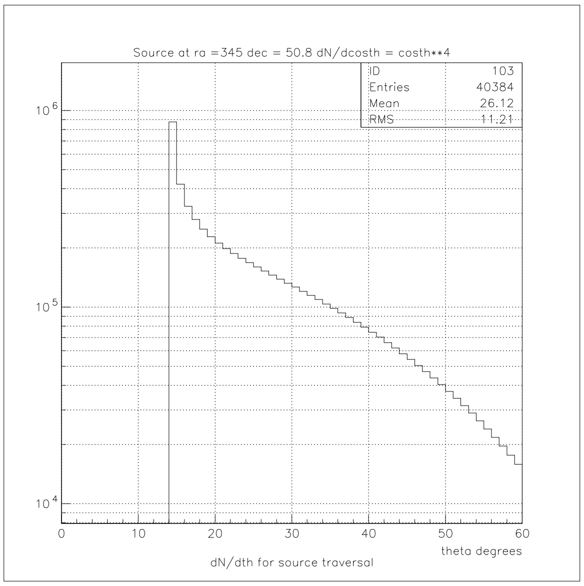

Figure 1: dN/dθ vs θ

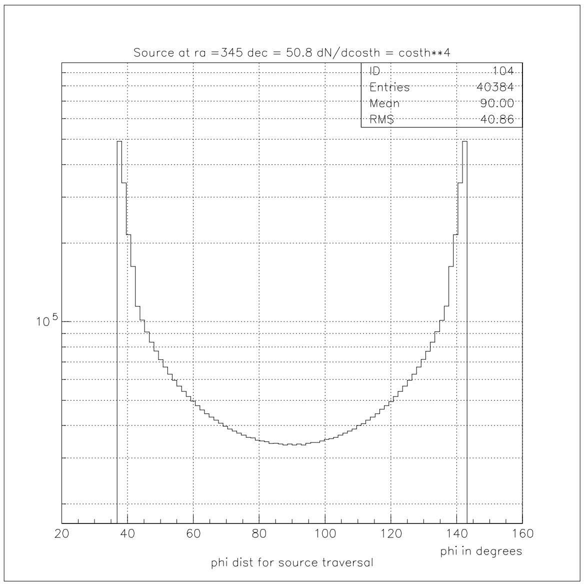

Figure 2: dN/dϕ vs ϕ

One observes that the event rate peaks for the smallest approach in θ and for values of ϕ corresponding to rising and setting of the source.

Figure 3 shows the distribution of the shifts in RA and DEC that are calculated for this traversal in a two dimensional plot of the difference between the shifted positions and the true position of the source in right ascencion and declination. The three curves correspond to different values of DEC: 10.8, 30.8(overhead) and 50.8. These curves are strongly peaked at the cusp. The maximum value of the shift in declination are about -0.25 for 50.8, 0.0 for 30.8 and -0.5for 10.8 values for declination, respectively.

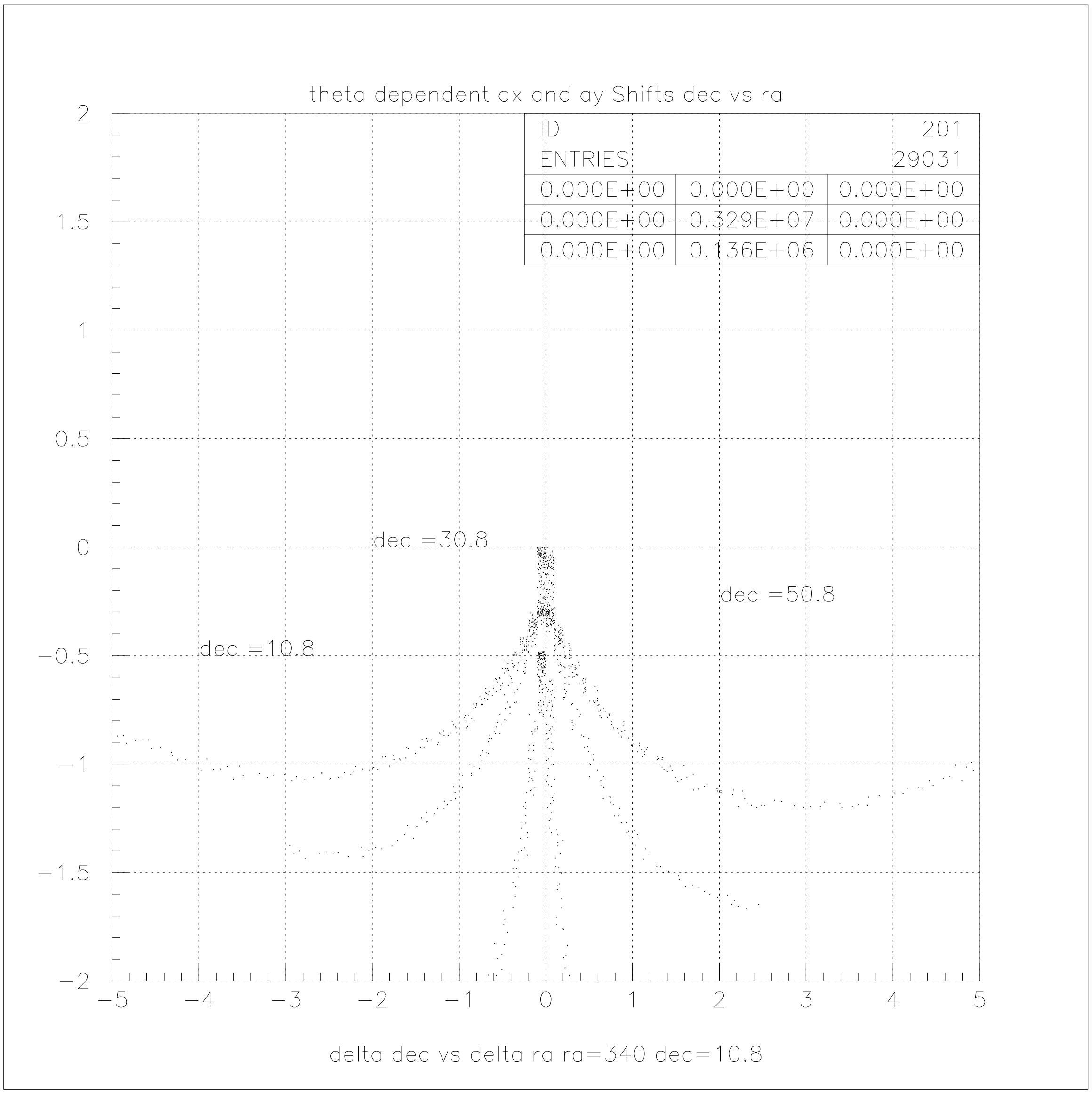

Figure 3:Δ(Dec) vs Δ(RA)

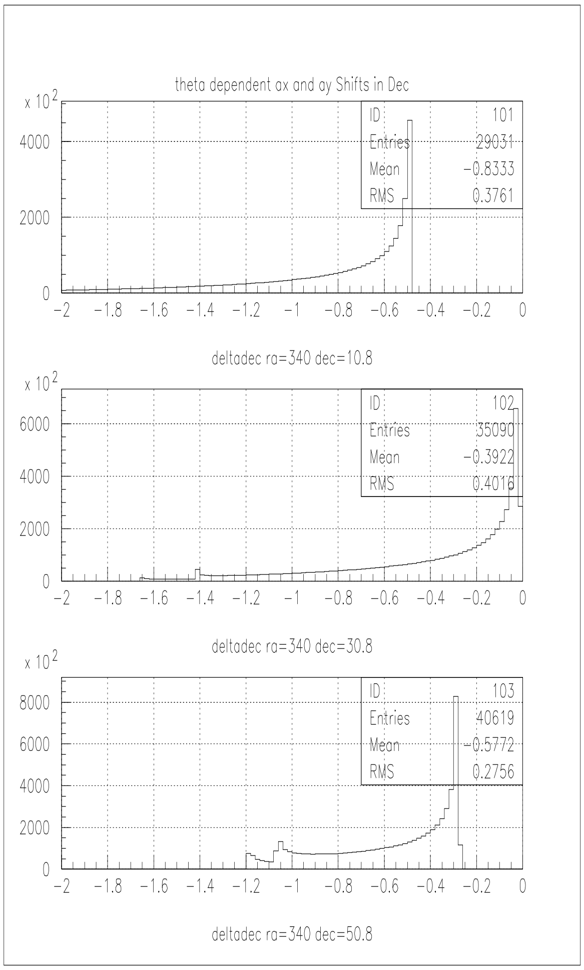

Figure 4: Dec projection θ

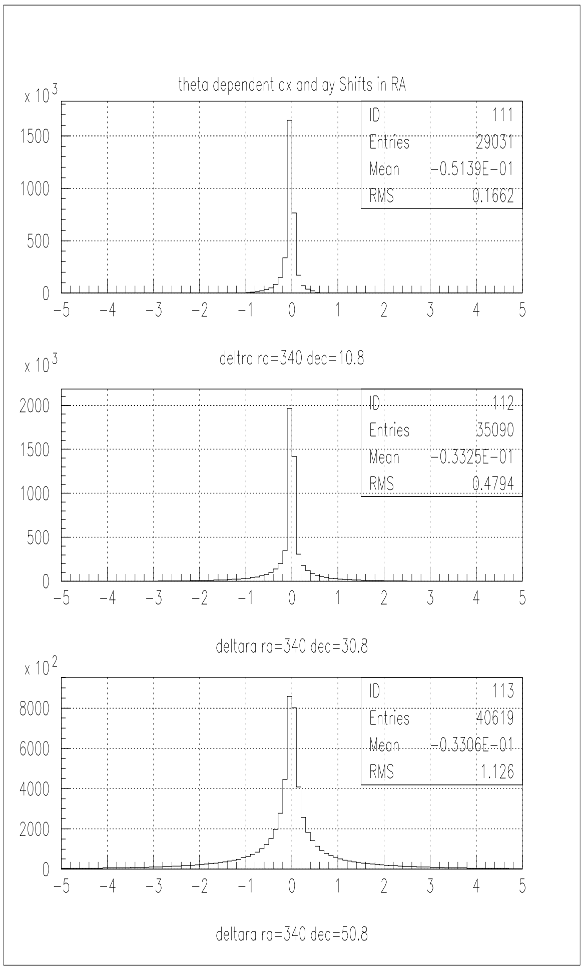

Figure 5: RA projection

Figures 4 and 5 show the projections of this diplot on the DEC and RA axes. Several conclusions can be drawn from these figures:

- Shift in RA is quite small and symmetric. The widths vary with DEC, increasing from 0.162 to 1.12 degrees as one goes from Dec = 10.8 to Dec = 50.8 degrees.
- Shift in DEC is larger and it depends on the declination of the source. The largest shift is obtained for declinations smaller than local lattitude. The shift in dec is always negative for the assumed shifts in ax and ay. The rms value of the width of the distributions are roughly the same for all three assumed DEC values.

The program was also run for moon transit for 28 days. The shifts in DEC and RA from the position of the moon is shown in Figure 6.

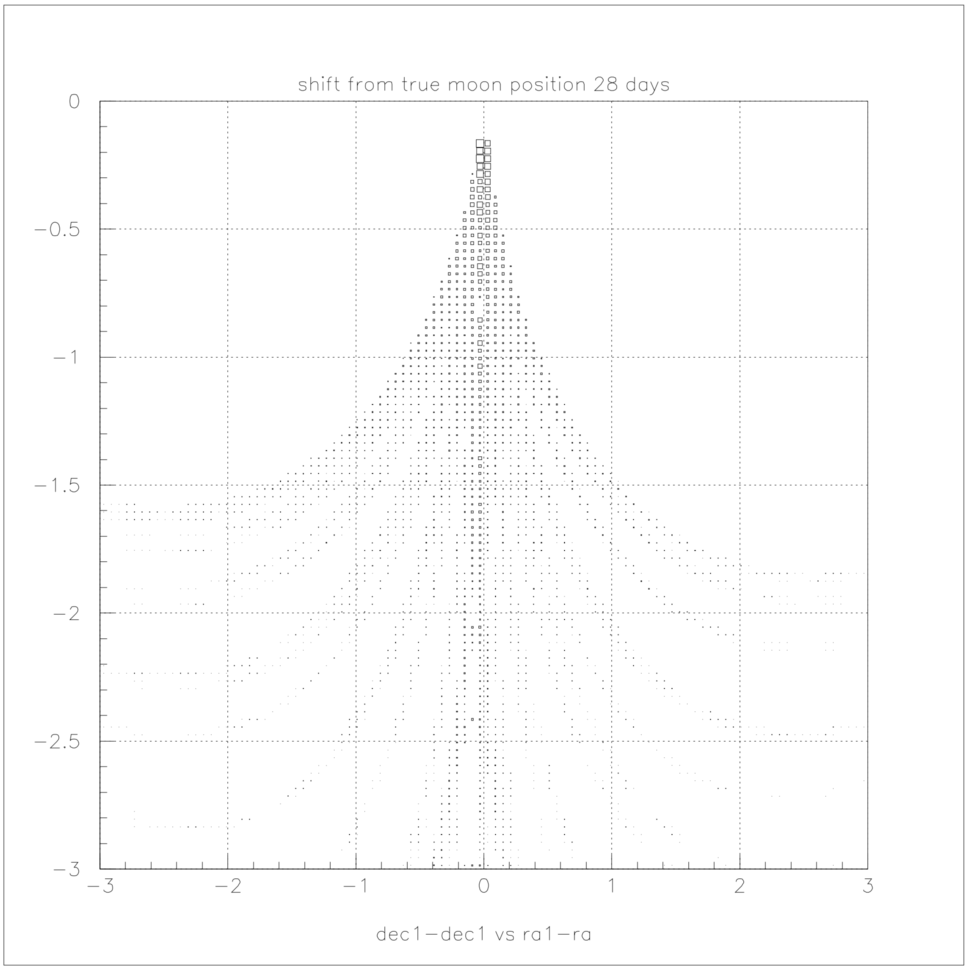

Figure 4: DEC-DECmoon vs RA-RAmoon

One sees a shift in DEC of about -0.5 and almost no shift in RA. The smalles shift in DEC occurs when the moon is highest and as the moon trajectory becomes further and further away from zenith the shift increases and there are tails in the RA differences which become large. It does not seem possible, from these calculations, to see a large DEC shift of the moon position due to the small ax and ay shifts.