A Quick Comparison of Zenith_Align Methods Using the Crab and Mrk 421

Elizabeth Hays

September 4, 2003

1 Intro and Methods

At the July meeting there was some interest expressed in the differences between zenith_align and zenith_align2 pointing correction methods. I don't think we have documented any comparison beyond the initial tests of zenith_align vs. no zenith_align. My method of comparison is not optimal, but it does show that the two methods are consistent with each other.

The methods use a slightly different philosophy of repointing the shower direction due to a suspected overall tilt in the timing pedestal calibrations. The first, zenith_align uses data to adjust the distribution of x and y coordinates of the shower direction such that the distributions peak at zenith (see Andy's memo 1-29-03.) This correction assumes that the pond is effectively tilted and rotates the normal of the plane by the amount determined by the shifts in x and y distributions determined from data for each calibration epoch of the detector.

The second method, zenith_align2, is simply an update of the first assuming that the tilt is in the timing pedestals as opposed to a direct connection to the geometry of the pond. This means that there is a theta dependance that should be taken into account for the correction.

2 Data Sets and Results

In the pursuit of AGN limits I have analyzed REC data starting with MJD 1893 using both corrections. The initial zenith_align data set ended at MJD 2682. The zenith_align2 data set is truncated at the same date for this comparison. The data included in the analyses still differ slightly due to corrections made to the skymap binning and the exclusion of short maps in the more recent analysis which uses zenith_align2. In both analyses the

Crab nebula and Mrk 421 appear at > 4 sigma and can be used to make a rough comparison of the pointing corrections through the effect on a signal.

There is no noticeable difference and certainly none that is significant for a 4 sigma measurement in slightly different data sets with slightly different analyses. In that sense this is not a particularly good test since it is only sensitive to large changes, but it does show that zenith_align2 is not changing source sensitivity.

The results for the Crab and Mrk 421 in the source bin for both methods are in Tables 1 and 2. Significance plots are included for both methods made on the same scale to look at the effect on signal position and shape. Both sources show a very slight increase in significance for the data set using zenith_align2. However, I don't consider this a significant difference and can not rule it out as an effect of the other changes. The significance plots are quite similar in both cases.

A more useful way to make a comparison of the methods may be to use the moon data which has a much stronger signal and covers a broader range in theta.

Table 1: Results for the Crab nebula in the source bin for zenith_align and zenith_align2 methods.

	On	Off	Excess	Significance
zenith_align	1866574	1860198.00	6376.00	4.87 σ
zenith_align2	1885147	1878644.75	6502.25	4.94 σ

Table 2: Results for the Mrk 421 in the source bin for zenith_align and zenith_align2 methods.

	On	Off	Excess	Significance
zenith_align	2679491	2674259.50	4961.50	4.18 σ
zenith_align2	2691408	2686178.75	5229.25	4.34 σ

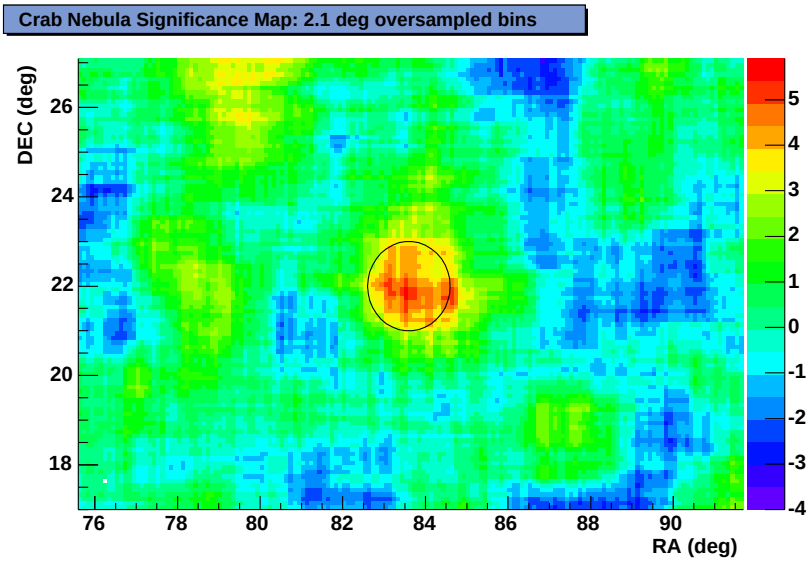

Figure 1: Crab Nebula for data from MJD 1893-2682 (Dec 15, 2000 through February 12, 2003.) Standard analysis with *zenith_align applied.*

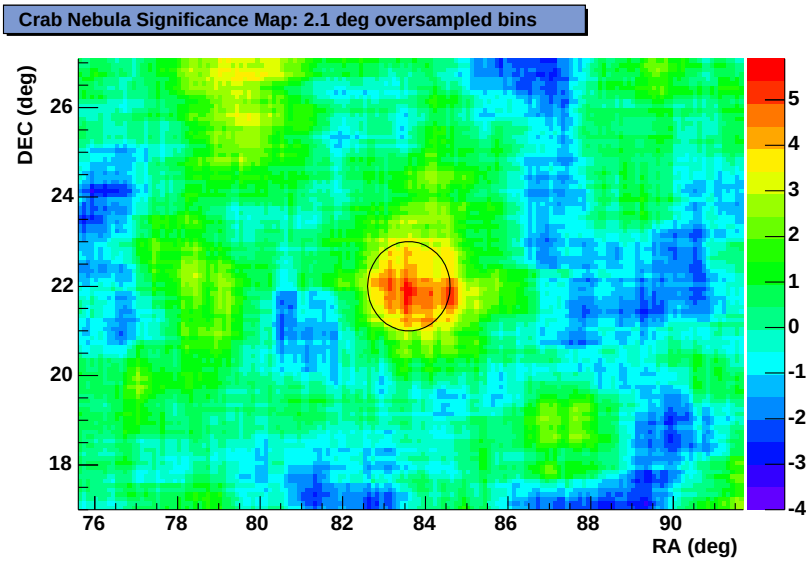

Figure 2: Crab Nebula for data from MJD 1893-2682 (Dec 15, 2000 through February 12, 2003.) Standard analysis with *zenith_align2 applied.*

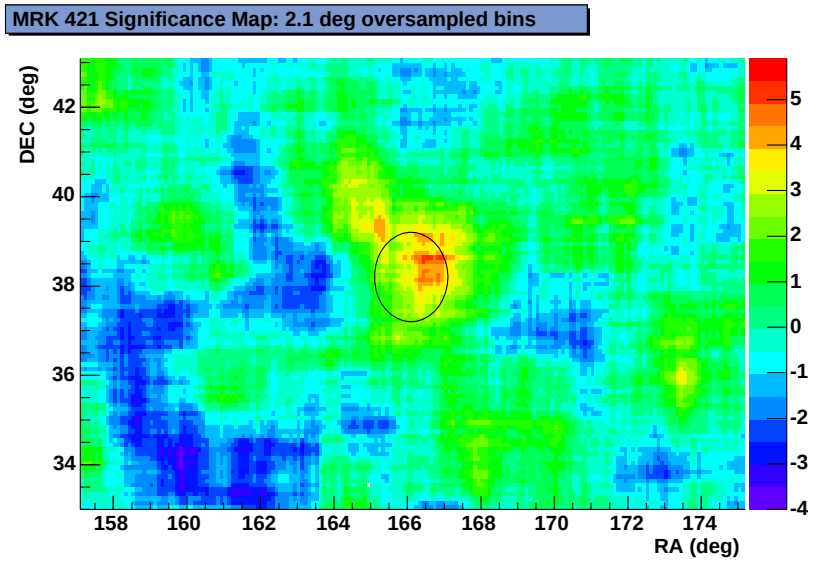

Figure 3: Mrk 421 for data from MJD 1893-2682 (Dec 15, 2000 through February 12, 2003.) Standard analysis with *zenith_align applied.*

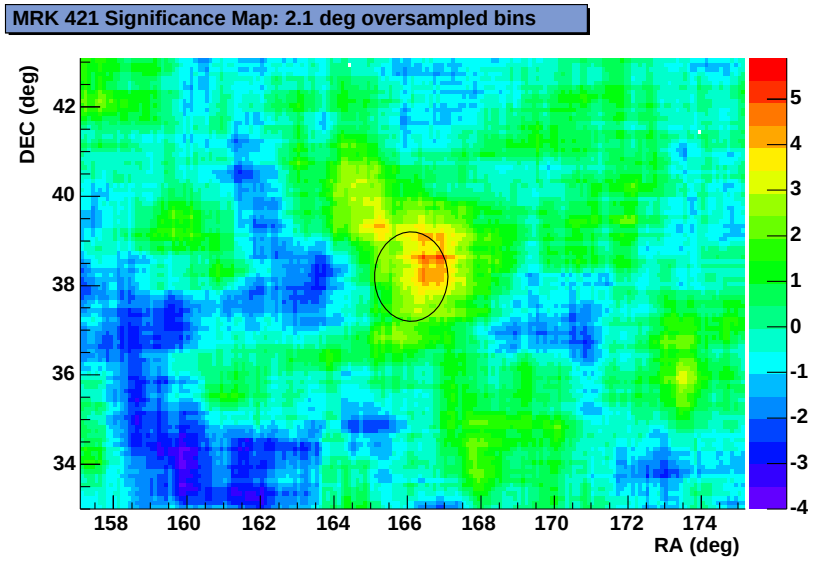

Figure 4: Mrk 421 for data from MJD 1893-2682 (Dec 15, 2000 through February 12, 2003.) Standard analysis with *zenith_align2 applied.*