How I Learned to Stop Worrying and Love ZenithAlign()

- The origin of Zenith Align()
- Magnetic Deflection
- DAW's large angle correction – ZenithAlign2()
- Connection to the data – ZenithAlign3()
- Is “up” up on an oblate spheroid?
Significance map of the crab for data collected online for calendar year 2002. Standard cuts: NF$\geq$20, $x^2>2.5$, 2.1 deg bin
Fit peak of “x” and “y” distributions

\[ x = \sin \cos \]
\[ y = \sin \sin \]

The hypothesis is that zenith will have the highest event rate.

Fit regions from -0.25 to 0.25 to a Gaussian. Fitted mean should be 0 if pointing is correct.

Fitted mean was found to be non-zero for nearly all the data collected online for the lifetime of Milagro.
Measured values for x and y depend greatly on the NFIT cut. For events with small NFIT, the x,y distribution is substantially shifted compared to the large NFIT data.

This effect is interpreted as due to the preferential direction of the magnetic field of the earth. The magnitude and direction of the correction are consistent with this interpretation. This was shown at the NYU meeting in 2002.

For large NFIT (>50), the x and y distributions flatten out. So, x and y with a strong NFIT cut is interpreted as a good measure of the detector pointing.

For the correction applied to the data, an NFIT>100 cut is applied.
ZenithAlign's effect on Mrk 421

Data: Online reconstruction from Dec 20, 2000 to Apr 23, 2001

Runs 2700-2887, JD 1900-2024
Alignment: x = -6.2 mr   y = -6.1 mr

Nfit>20, x2>2.5, 2.1 deg bin:

No ZA: 4.2 s
With ZA: 4.4 s

See maps...
Without Zenith Alignment

With Zenith Alignment
“zenith_align2()”: Theta Dependence

\[ = c \frac{t}{x} \]
\[
\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, \text{ set } a=1, \ b=\frac{3900}{3913}
\]
\[
y = b\sqrt{1 - x^2}
\]
\[
tangent = y' = \frac{-bx}{\sqrt{1-x^2}}
\]

at \(\sim 35^\circ\), \(x = \cos 35^\circ = 0.819152\)
\[
y = \frac{3900}{3913}\sqrt{1-0.819152^2} = 0.571671
\]

Overhead declination = \(\tan^{-1} \frac{y}{x} = 34.91^\circ\)

Surface Normal = \(\tan^{-1} \frac{3900}{3913\sqrt{1-x^2}} + 90^\circ = 35.09^\circ\)

Direction of Zenith is 0.18° North of actual declination.