Strategies for Initial Pointing Calibration Observations

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Outline

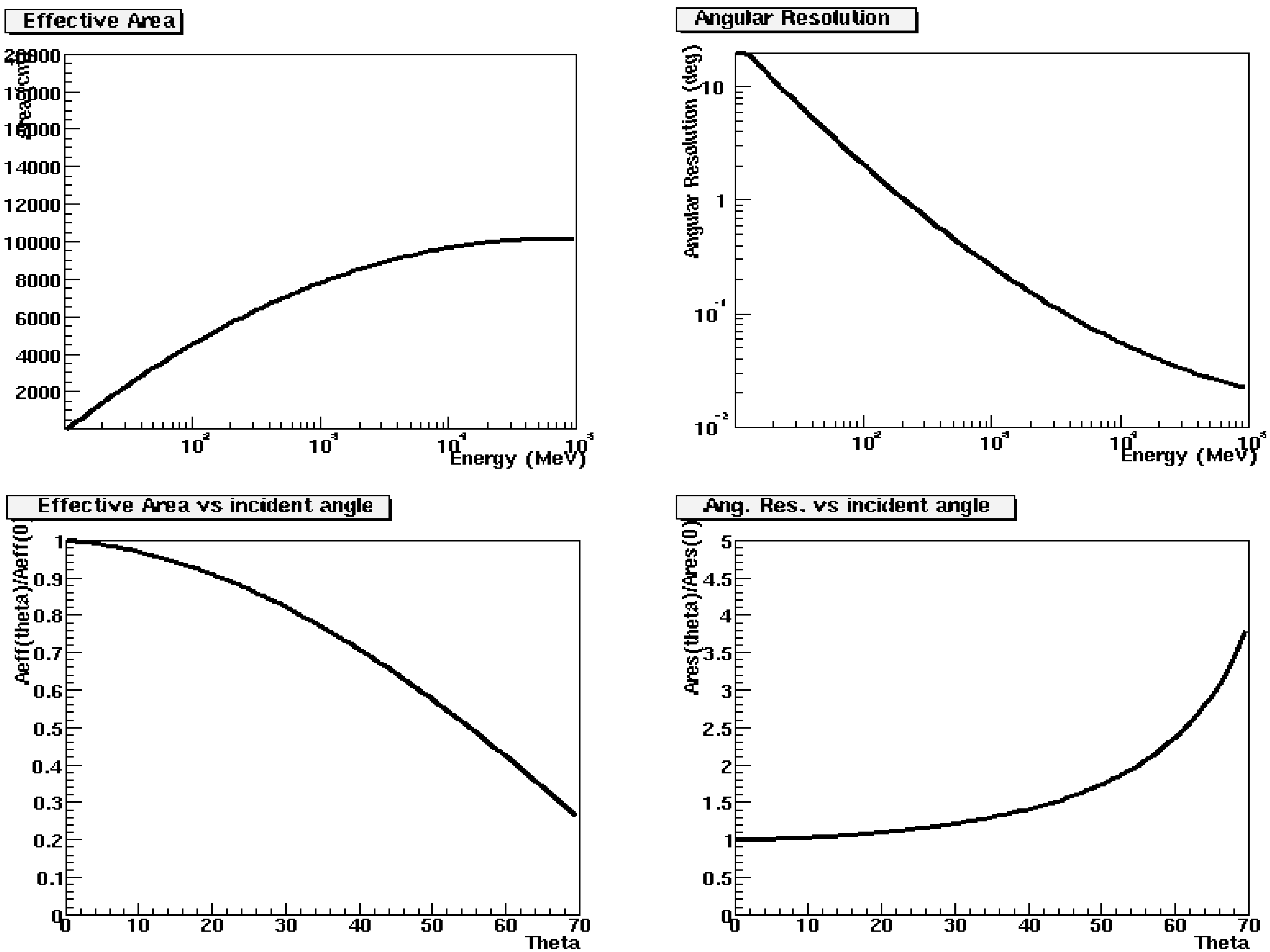
Check that the LAT is pointing where we think it is, allow for the possibility of a translation and/or rotation of the FOV.

- A method to estimate how well the LAT can localize sources.

- Look for likely sources.

- Possible strategies.

Glast Response



Source Localization

For a set of points with weights $1/s_i$, the error in the weighted mean is:

$s^2 = (\Sigma(1/s_i^2))^{-1}$

If these points are gamma-rays, with locations weighted by angular resolution, then for a differential photon spectrum f(E), effective area Aeff(E), and angular resolution Ares(E), the uncertainty in the weighted position is:

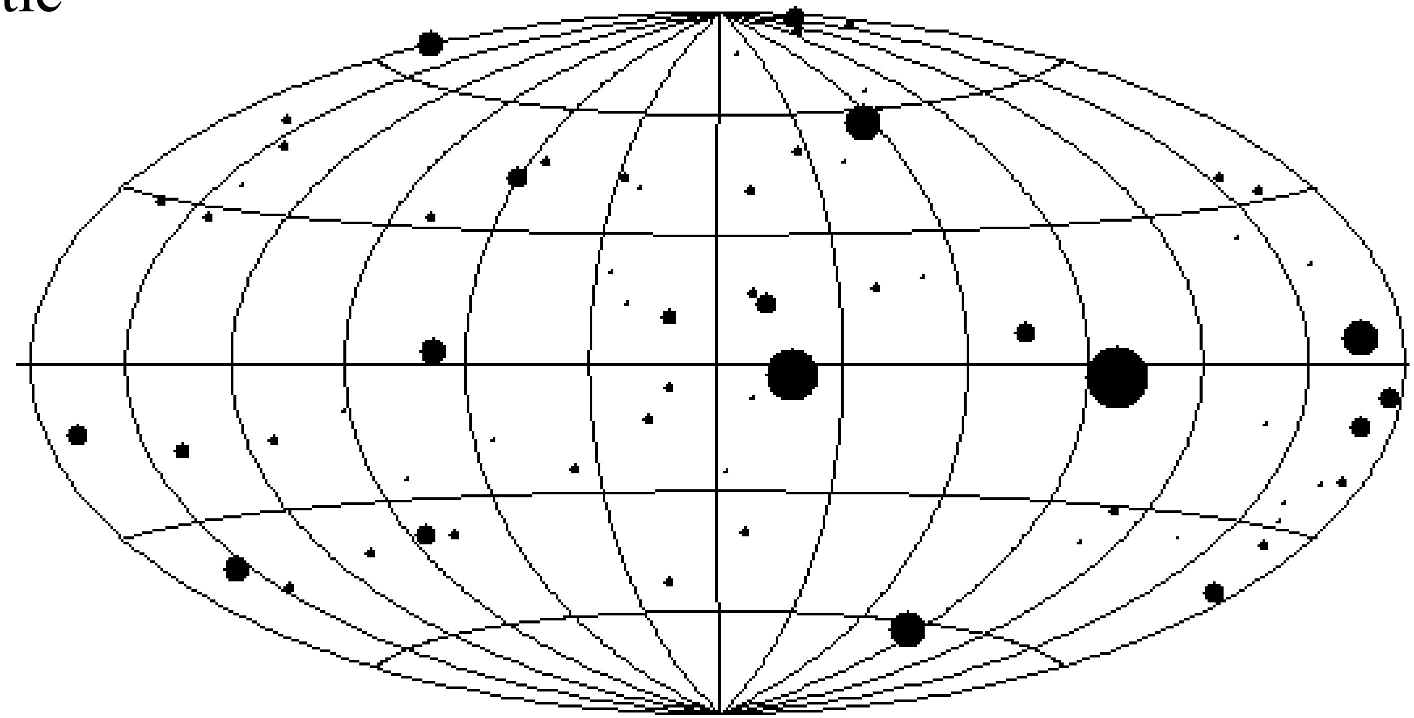
$$s^2 = \left(\int \frac{(f(E) * Aeff(E))}{(Ares(E))^2} \right)^{-1}$$,on axis

Integrate from 300 MeV.

Obviously to actually realise this, we would have to do some sort of weighted analysis.

Sources

Galactic



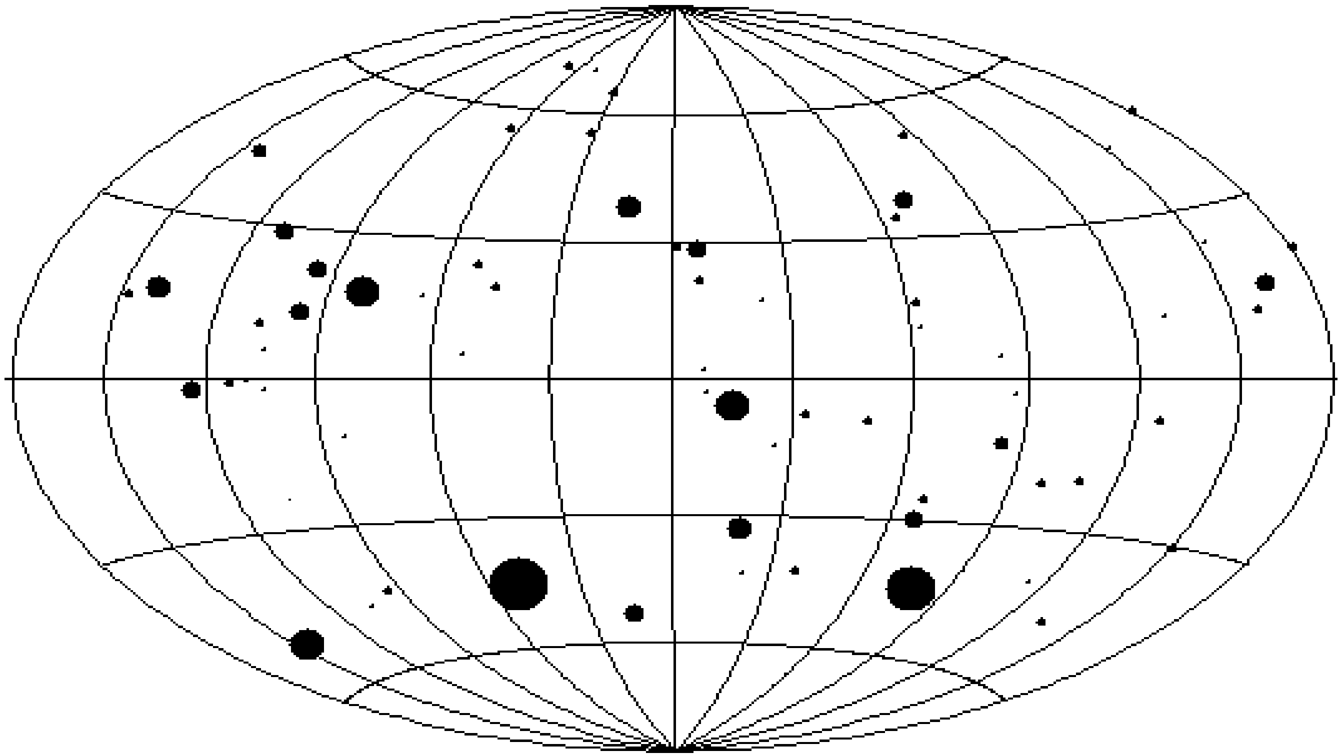
Size of each point is proportional to 1/s (bigger is better).

AGN from the EGRET 3rd catalog, used flux and spectrum from p1234 with a hard cutoff at 30 GeV.

Pulsars are modeled with a broken power-law + hard cutoff, normalized so that $F(E>100\text{MeV})$ = value from the 3rd Catalog.

Sources

Equatorial



3 best localized sources are:	68% containment radius
Vela	24.2”
PSR 1706-44	29.6”
Geminga	39.2”

For an 86400 second on-axis observation

Pulsar Spectra

	α	β	E_b	E_c	Δr
Crab	2.19	-	-	2000	66”
Geminga	1.5	-	-	1500	39.2”
Vela	1.69	-	-	2000	24.2”
PSR 1055-52	1.94	-	-	20000	67.8”
PSR 1951+32	1.74	-	-	30000	59.2”
PSR 1706-44	1.27	2.25	1000	30000	29.6”

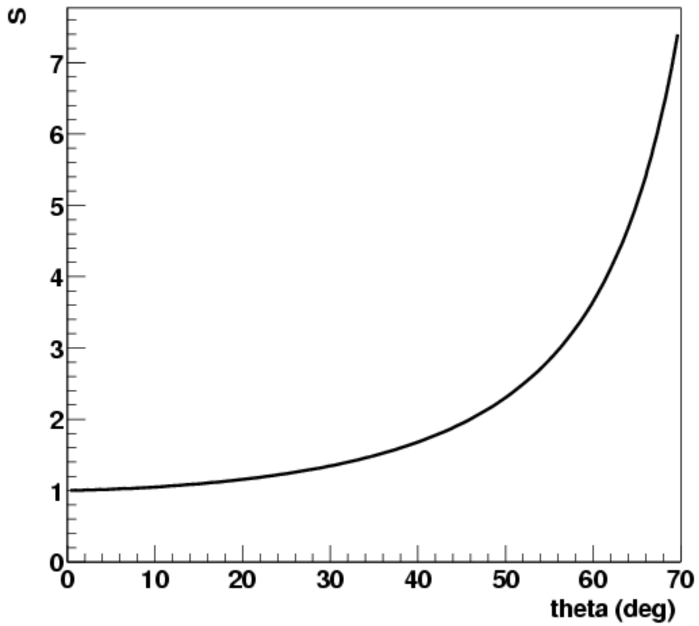
For Vela, α=1.62, β=2.7, E_b=1 GeV and E_c=30000 is also consistent with the data from EGRET. In this case Δr = 17.2”.

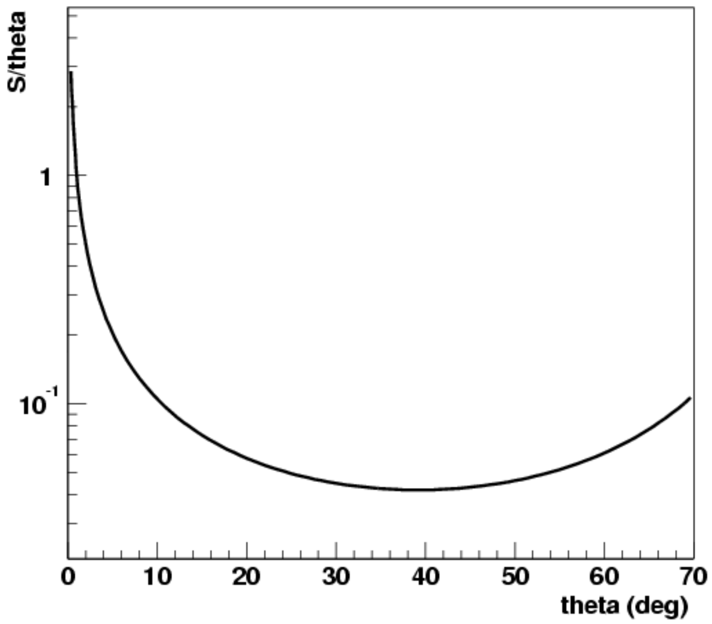
Using the response functions from the proposal, for Vela with α = 1.69 and E_c=2000, Δr = 36”

Off-Axis Sources

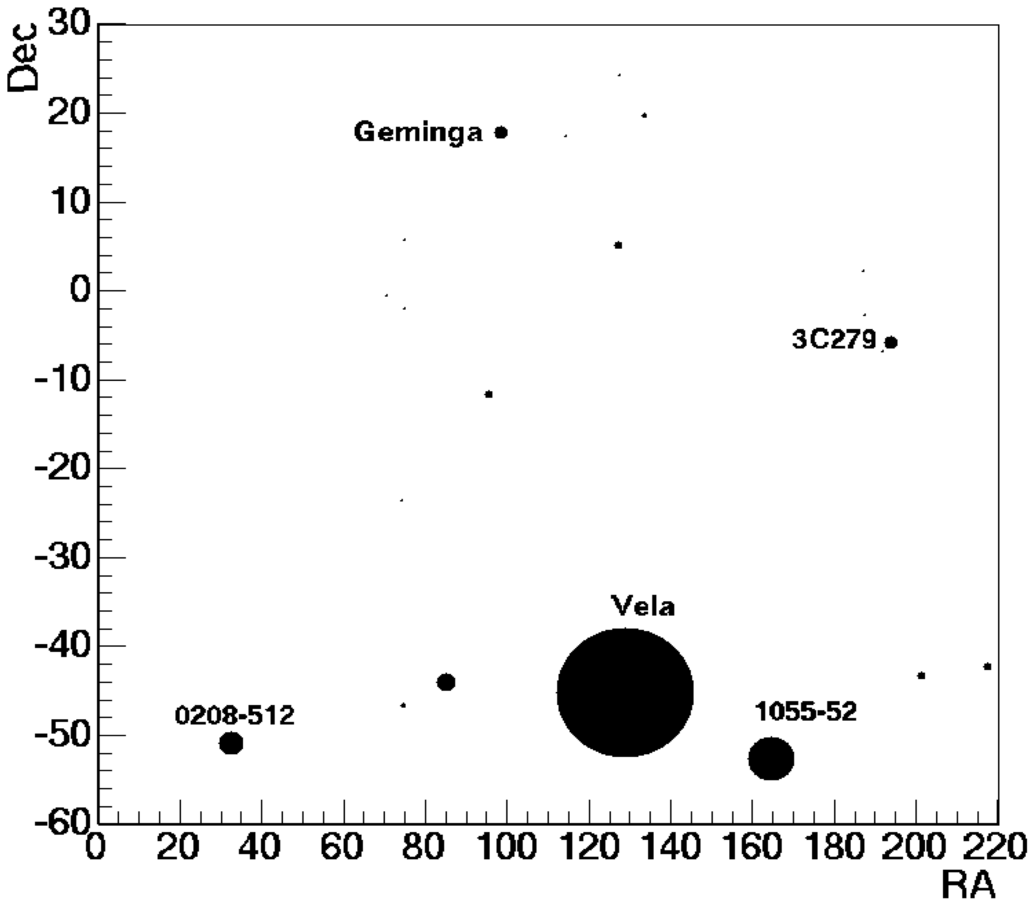
Assuming that the changes in angular resolution and effective area with inclination angle are independent of energy, then

$$s_{theta} = s_0 * \text{fAres(theta)/sqrt(fArea(theta))}$$



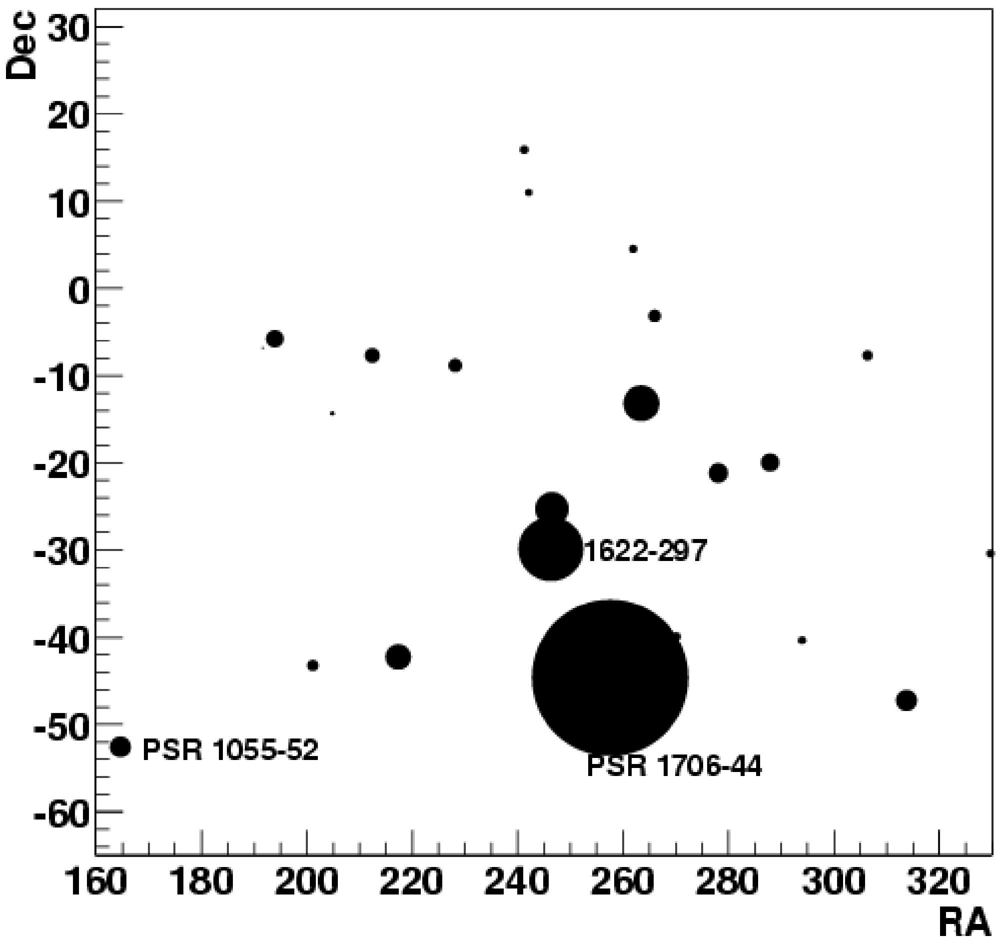


Staring at Vela



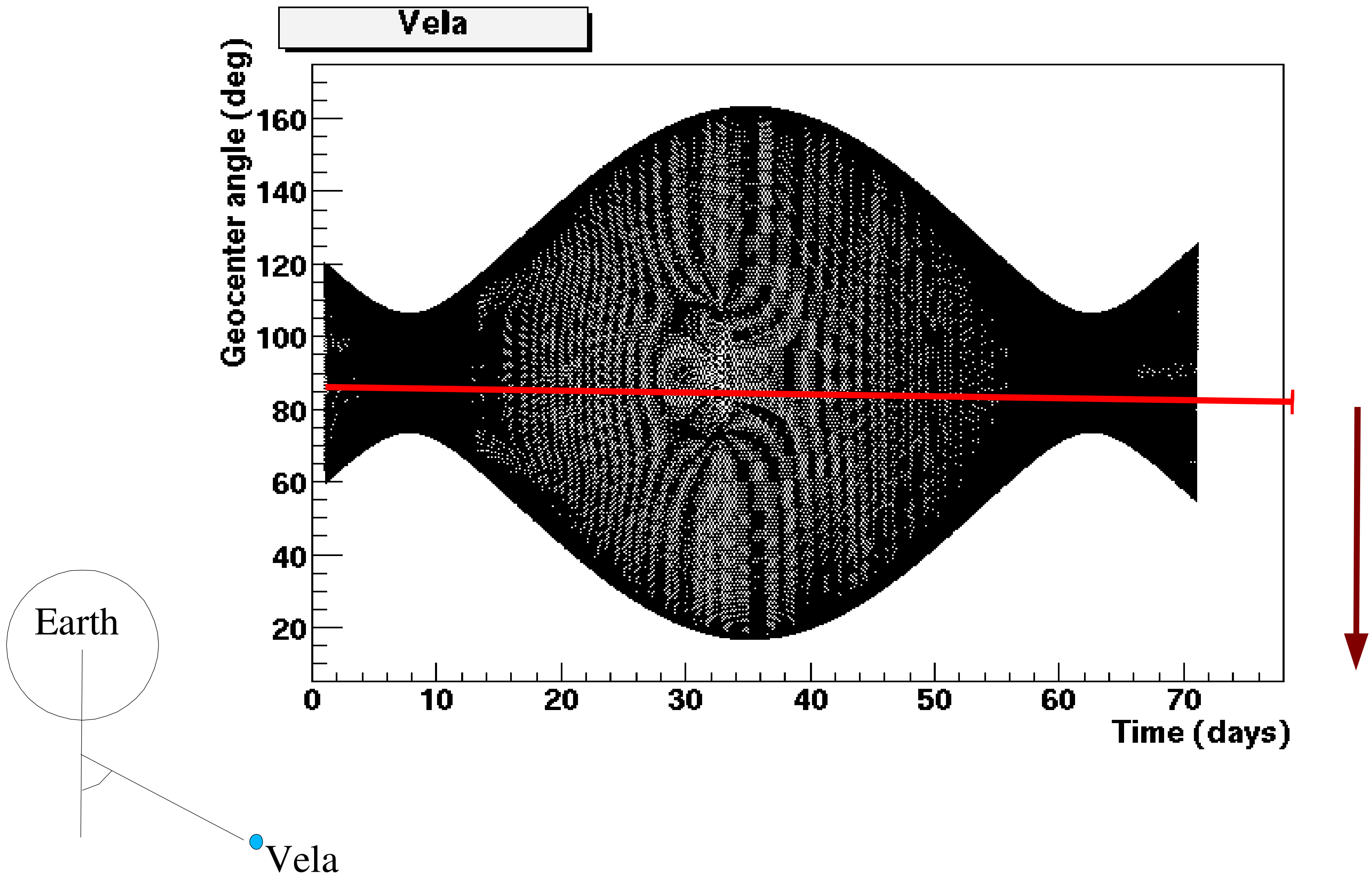
Source	Δr	θ	$\Delta r/\theta$
Vela	24.2	0	-
1055-52	83.1	24.4	3.2'
0208-512	153	59.9	2.4'
3C279	287	68.5	4'
Geminga	268	69	3.7'

Staring at PSR 1706-44

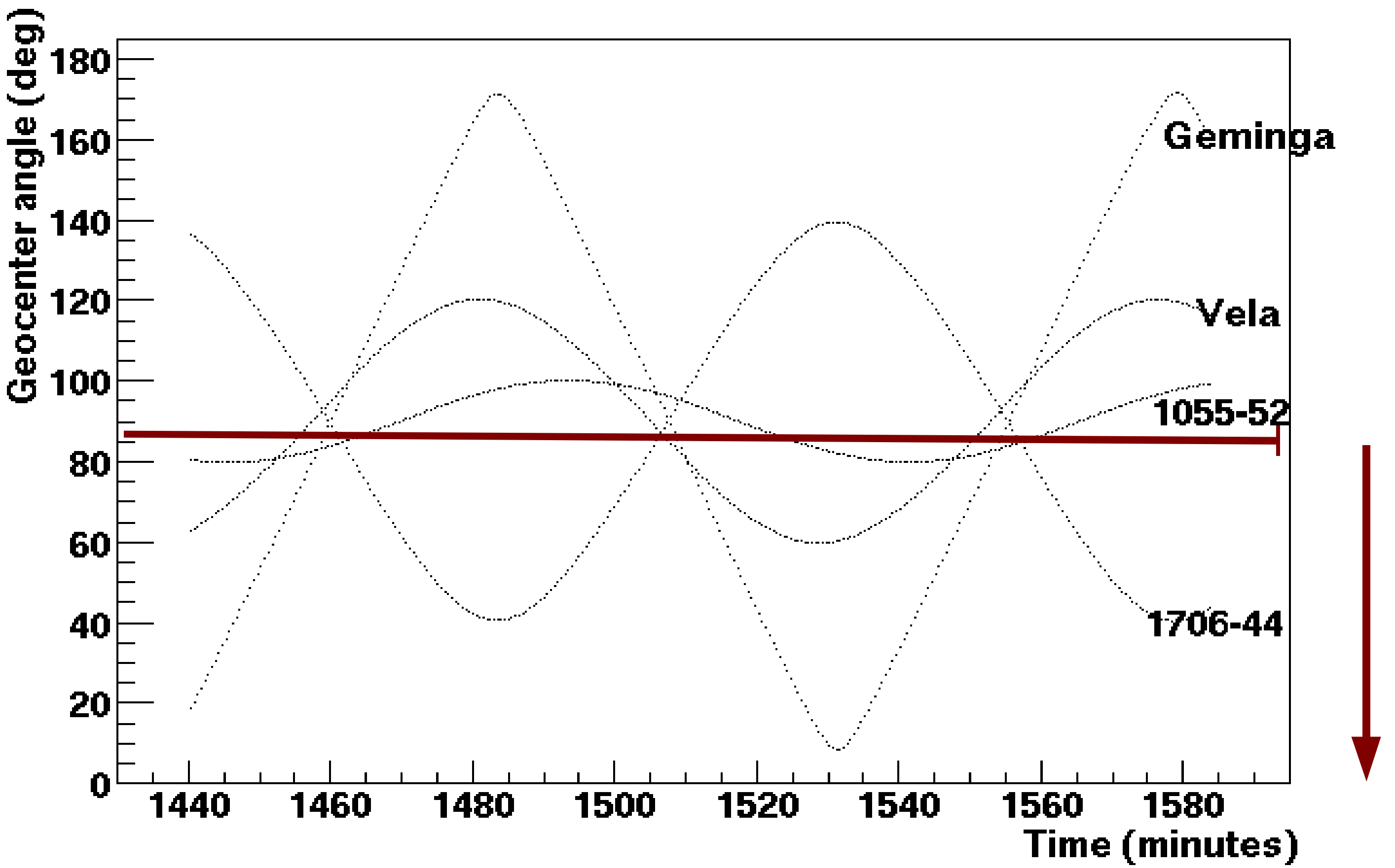


Object	Δr	θ	Δr/θ
PSR 1706-44	29.6”	0	-
1622-297	71.5”	17.2	3.9'
PSR 1055-52	216”	57.5	3.6'

Earth Occultation



Earth Occultation



Can stare at PSR 1706-44 when Vela is occulted by the Earth.

An Estimate

If we spent 40% of each orbit staring at Vela, 40% staring at PSR 1706-44 and 20% slewing from one location to the other then in one day:

Δr (68% containment) = 30.2”

Δphi ~ 5' (from Geminga while staring at Vela)

If we did this for two weeks then:

Δr/sqrt(14) = 8.1”

Δphi/sqrt(14) = 1.3'

Caveats

The effect of background is ignored, will make the numbers a little worse. Spatial structure in the background may cause the errors to be assymetrical.

Obviously we won't just use one or two sources. We will fit for a translation and rotation of the field using all known sources and find dx, dy and dphi.

Some Possibilities

Stare at Vela and PSR 1706-44 for two weeks

Stare at Vela and PSR 1706-44 for a shorter period (day, few days) then refine position uncertainties in scanning mode.

Check alignment while in scanning mode, don't bother with an initial stare observation.

Something else entirely?

Staring at Geminga