Parallactic angle and optimum ALFA rotation for drift scanning

Robert Minchin

17 November 2004

For drift scanning, the ALFA rotation angle is optimised when the separation of the beams in declination is as even as possible, giving an equally-spaced comb across the sky as it drifts past. The optimum angle is given by the equation:

$$R = -P + O(P) \tag{1}$$

where R is the optimum rotation angle, P is the parallactic angle, and $O(P)$ is the offset angle to obtain the optimum rotation. If the array were projected onto a circle on the sky, then $O(P)$ would be a constant, approximately equal to 19. However, as ALFA is projected onto an ellipse on the sky, $O(P)$ changes with parallactic angle as the ellipse rotates.

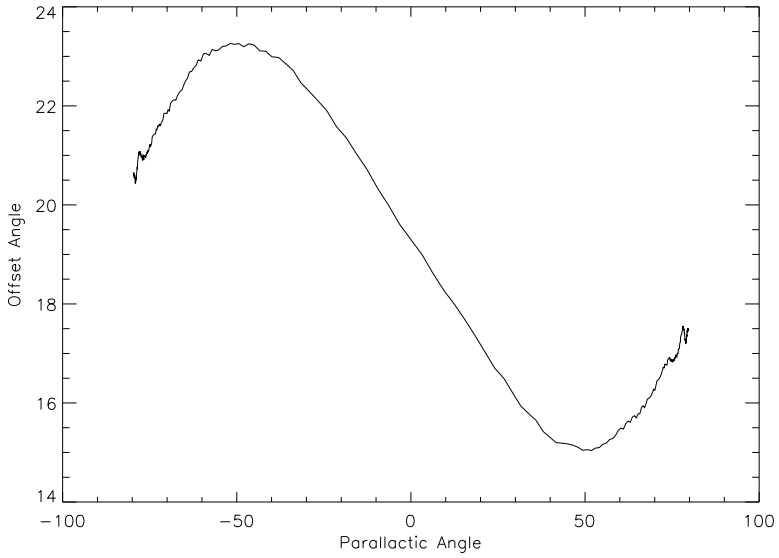

Figure 1: Offset angle as a function of parallactic angle, from numerical simulations for the source NGC 628.

By numerically finding the optimum rotation angle,R, $O(P)$ can be found as a function of P. This is plotted in Fig. 1 for the source NGC 628, but does not change for other sources. The wiggles seen on the plot are due to quantisation noise as the numerical routine only solves to the nearest 0.1 degree; $O(P)$ is a smoothly-varying function of P.

It can be seen that the $O(P)$ is indeed very close to 19° at a parallactic angle of zero, e.g. when the source crosses the meridian. It reaches a maximum or minimum of around 23° or 15° at a parallactic angle of about ±45° when

the asymmetry in the beam pattern on the sky is highest and then comes back towards 19° as the parallactic angle approaches ±90°. However, the higher order terms appear to have a dependence on the declination of the source (or possibly its elevation) as well as the paralactic angle as the exact position of the peaks changes for sources in different parts of the sky even when they have the same P, as shown in Fig. 2. Thus it is probably best to use a numerical routine to solve for the best rotation angle.

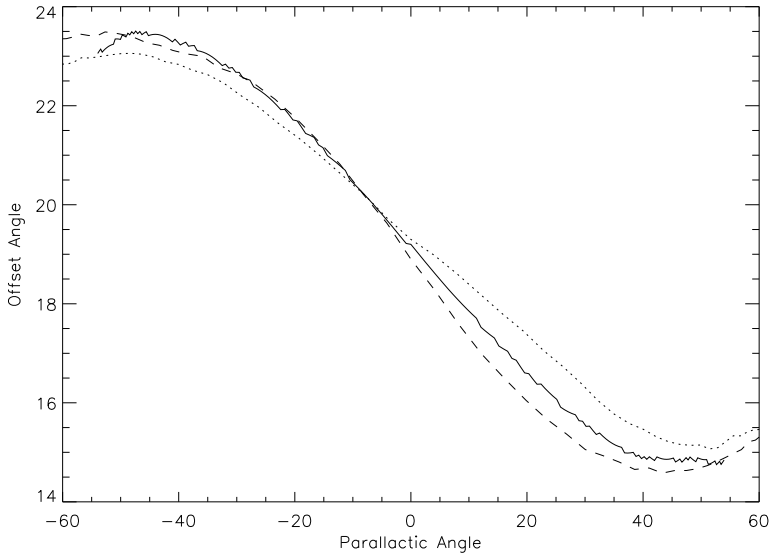

Figure 2: Offset angle as a function of parallactic angle fir souces at declinations of 08:21:13.7 (solid line), 16:21:13.7 (dotted line) and 20:21:13.7 (dashed line).

See also:

Martha & Riccardo's memo on array rotation and beam spacing for off-meridian E-ALFA drift observations:
http://www.astro.cornell.edu/ galaxy/rotbeams.htm

Phill's multibeam rotation page:
http://www.astro.cornell.edu/ galaxy/rotbeams.htm

Wolfram's documentation on Drift & Chase Observations:
http://www.naic.edu/ auds/doc/driftchasemap.html

German's memo on feed rotation:
http://alfa.naic.edi/memos/02-07.pdf

Ghigo's GBT memo on parallactic angles:
http://www.gb.nrao.edu/GBT/memos/memo52.ps

Documentation on the software used to calculate optimum rotation angles:
http?//www.naic.edu/ ages/alfa_ang.html