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EALFA Memo 040803:
Spacing of E-ALFA drifts for maximal sensitivity and resolution
mph, glh & rg– 03 Aug 2004

Issue: A careful design of the drift mapping strategy from the beginning is needed in order to maximize angular resolution and sensitivity and to minimize the "scallopping effect" caused by the unequal ALFA beam gains. Specification of a complete strategy now will optimize coverage for eventual multiple drift combination and homogeneity in map construction. We propose the following:

- As discussed in E-ALFA memo 040729, we have proposed to divide the Arecibo sky ($0^\circ < Dec. < +36^\circ$) into 648 **tiles** of 20^{min} in R.A. by 4° in Dec. **Bands** of tiles will be "filled" in a single pass mode by combining $\sim$17 successive drift scans offset from one another by $\sim 14.7'$ in Dec.

- Drift scan surveys with E-ALFA (except those near zenith) will be conducted with the azimuth in the N-S (transit) position and the array rotated by the appropriate angle to produce equally-spaced beams on the sky. The spacing of the beams in this configuration is estimated to be $\sim 2.1'$ ($\sim 126''$), which is slightly larger than the Nyquist sampling interval for ALFA. An example of the coverage of a single pass of a sample tile is shown in the upper panel of Figure 1.

- In order to minimize duplication and maximize homogeneity, the Beam 0 declinations for the entire set of drifts should be specified and prioritized in advance of survey start. We propose to do so.

- As discussed in E-ALFA memo 040702, a two pass strategy has several advantages in terms of rfi rejection and signal detection strategy and in enhancing opportunities for commensal transient searches. If the 2nd pass is offset from the first by half a beam spacing ($1.05'$), or some multiple thereof (see next), an angular resolution and position-centroiding advantage can also be gained.

- The central ALFA beam has a considerably higher gain than the outer beams. This fact will necessarily produce an uneven sensitivity within the maps. Offsetting the drift spacings for different passes can allow some smoothing of this scallopping gain effect.

- Additional passes may also be desirable to increase the integration time in areas of scientific interest. The strategy adopted in the beginning should allow a strategy to maximize the efficiency of future multiple passes both in terms of gain and angular resolution by combining separate drift passes to "build-up" sensitivity. The basic prescription for doing so should be to "fill-in" the map, spacing the center beam along the center of previous drifts and offsetting appropriately to maintain even spacings. In general, homogeneity is maximized for maps constructed from 1, 2, 4, 8, etc drifts.

- Prespecification of the location and order of multiple passes will optimize final products constructed from multiple drift passes. The proposed strategy for a 2-pass survey is illustrated in the lower panel of Figure 1, showing the central beam for the 2nd pass offset by $+7.35'$ ($7 \times 1.05'$) from the first pass. A strategy for multiple passes, through N=8, is illustrated in Figure 2. Once the ALFA beam spacing parameters are measured, we will generate a lookup table giving the center beam declination specifications for each pass of each drift.

- To allow for the optimal incorporation of wide area survey data into deeper maps of selected regions, all observations with ALFA in limited azimuth drift mode would follow the same convention as that adopted here.

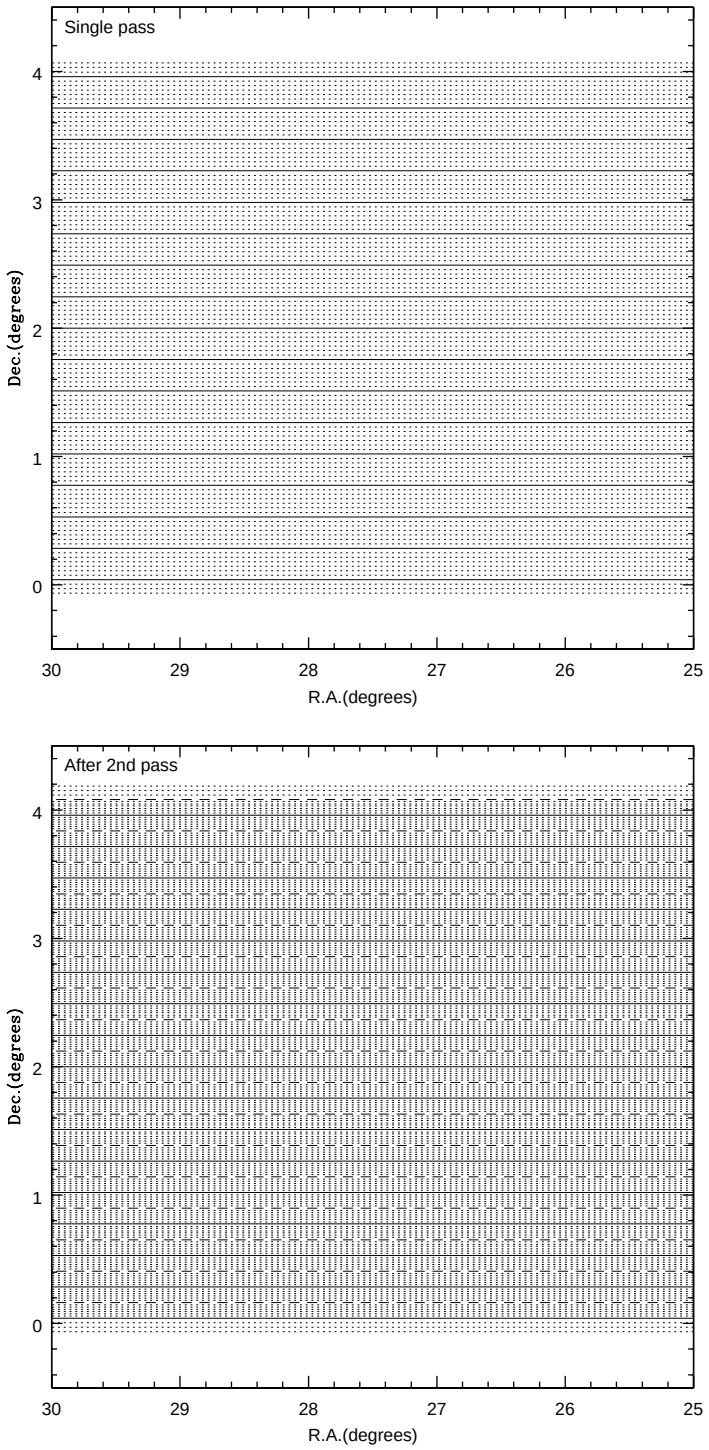
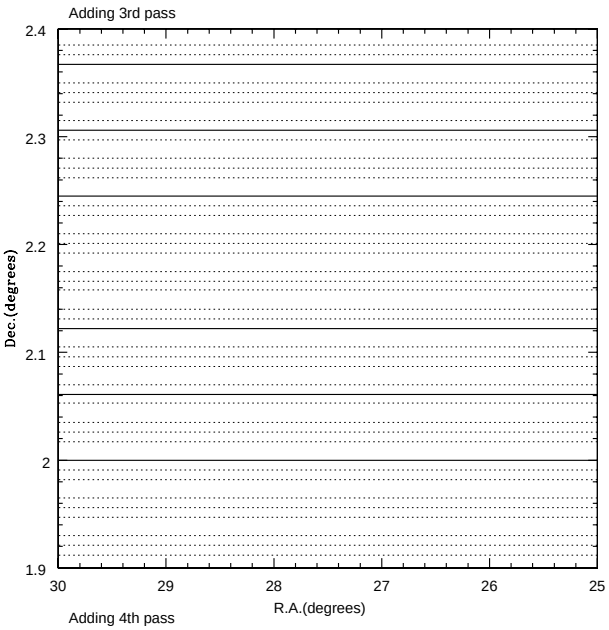
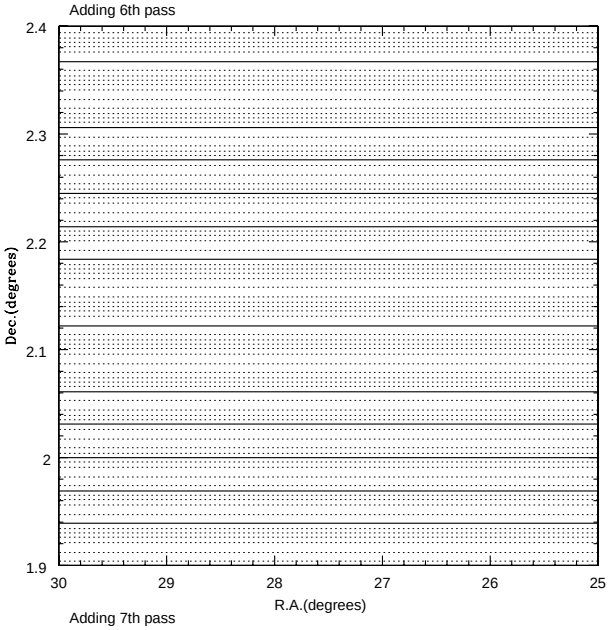


Figure 1: *Upper*: Drift spacing for a single pass over a complete tile. Central pixel strips are shown as the heavy solid lines, while dotted ones denote the outer ring beams. A fixed beam separation of $2.1'$ is assumed. *Lower panel*: Similar to the upper, except that a second pass, offset from the first by $7.35'$, is assumed. The heavy dashed lines show the strips of the central beams during the proposed second pass. Figure 2: (next page) Successive coverage afforded by the multiple pass strategy, adding additional drifts over a small area within a tile. Note that the aspect ratio in the declination direction is exaggerated for illustrative purposes (the RA axis is arbitrary anyway).


Adding 3rd pass
Dec.(degrees)
R.A.(degrees)
2.4
2.3
2.2
2.1
2
1.9
30
29
28
27
26
25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R.A.(degrees)
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2.2
2.1
2
1.9
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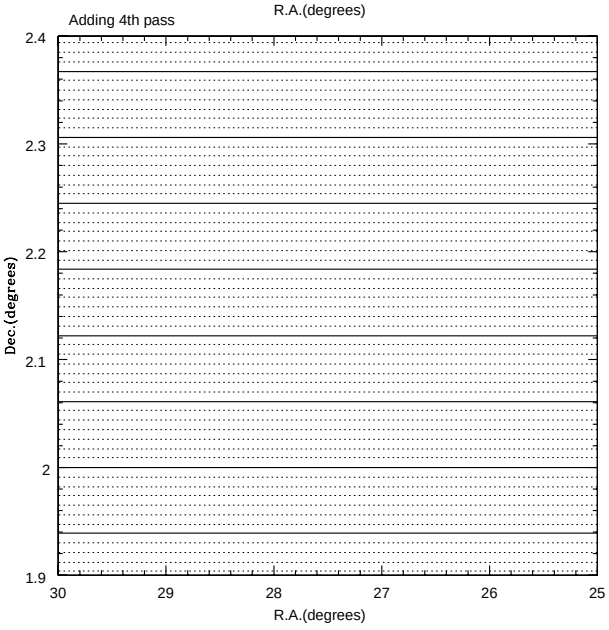
29
28
27
26
25


Adding 4th pass
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1.9
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26
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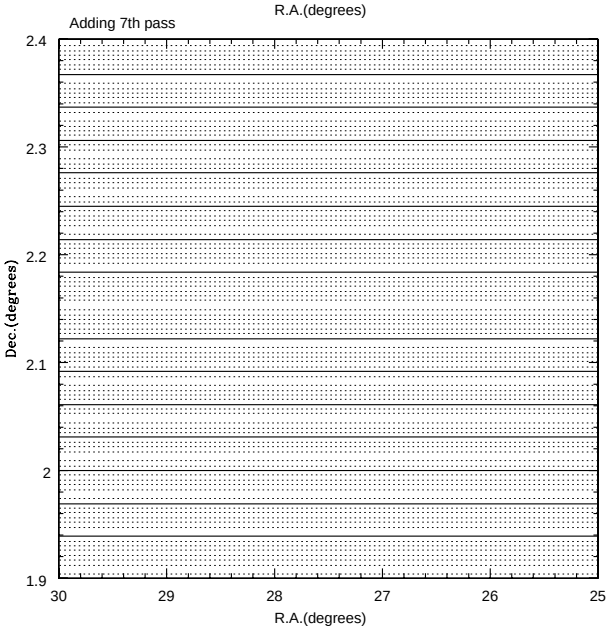
Adding 7th pass
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1.9
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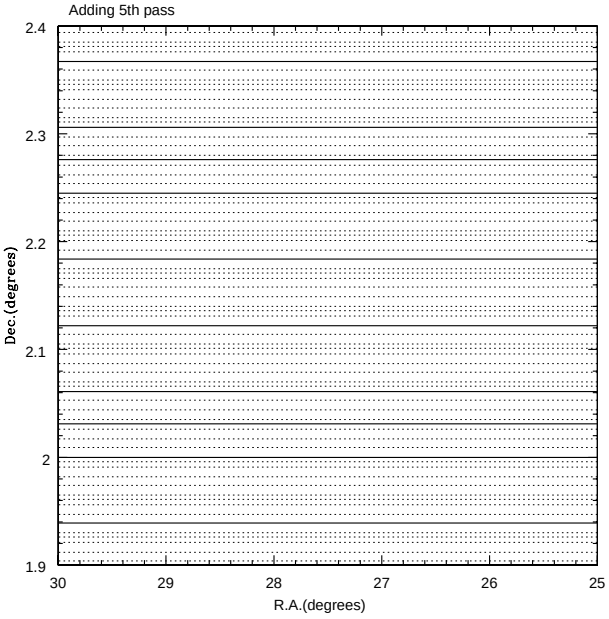
27
26
25


Adding 5th pass
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2
1.9
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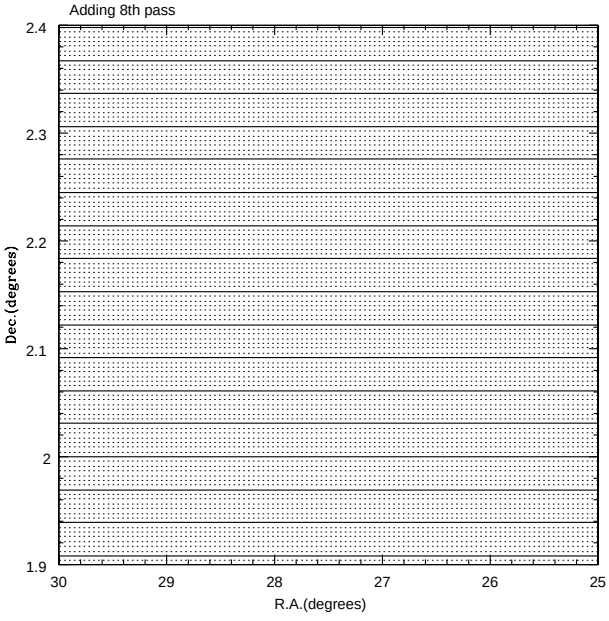
27
26
25


Adding 8th pass
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R.A.(degrees)
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2.1
2
1.9
30
29
28
27
26
25