ALFA Memo 040902: Lessons Learned in the Precursor ALFA Drift Survey A1946

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02 September 2004

The ALFA Precursor observations for the Drift E-ALFA group started at Arecibo on August 19, 2004. As of the date of this document, about half of the time allocated to the proposal — about 45 hours — had been used. A number of tests were run to verify the ALFA system performance, data taking and analysis software, calibration schemes and overall survey optimization. We have learned a number of useful lessons. For what may be worth, we put in writing a summary of those, for the benefit of other members of our group and of E-ALFA that may use the array in similar circumstances.

1. **ALFA Hardware Isn't Perfect.** ALFA is a nice machine. However, an important "design feature" is that in order to reach the LNAs, the whole contraption needs to be disassembled. You may have heard that Pol A of Beam 0 (the central one) is currently malfunctioning because of a short somewhere. To fix it would require about six weeks (the whole array has to be brought down from the dome; it is big!; some 3000 screws need to be undone and put together again). As a result, it is highly unlikely that NAIC will decide to take ALFA down until at least 2 or 3 of the 14 channels fail, and you may be wise in assuming that, on average, ALFA may not operate at full capacity.

2. **AO Operates Powerful Transmitters,** and ALFA needs to be protected from high radiation flux. During operation of the S–band transmitter or the 430 MHz one in its dual beam mode, the ALFA feeds are shielded by a cover. The cover needs to be removed for normal ALFA operation. In the long run, it is expected that NAIC will devise a remotely operable cover system, but for the moment, the job requires that the telescope operator go up to the dome both to cover/uncover ALFA. If your run starts after a transmitter run, allow 30 to 40 minutes for removal of the cover, before your program can start. For distant solar system targets, the transmitter is turned off before the end of their alloted time while they wait for the return. See if someone can remove the cover as soon as the transmitter is turned off; that can save you precious observing time.

3. **Check the Rotation Motor of the Feed Array.** The motor that rotates the feed array does occasionally get stuck, notably after a power dip or failure. In order to get it back in action, it needs to be reset manually, via a button located in the Gregorian enclosure. Make sure that you check that the array rotates normally at the beginning of each observing session or, if possible, by strolling through the Control Room after a bad storm. Ask the telescope operator to select the video monitoring camera showing ALFA. Try rotating the thing; make sure you can see it move. It is expected that NAIC will soon devise a scheme to reset the motor remotely.

4. **AO Illuminated Area is Elliptical.** The regular hexagon at the corners of which the ALFA beams are located, in the telescope focal plane, maps into an irregular hexagon on the sky, due to the elliptical illumination of the Gregorian subreflectors. On the sky, the beams are located along an ellipse with major axis oriented along a constant Azimuth line. Rotation of the array 'moves' the beams along the ellipse but does not produce a rotation of the ellipse. This has important consequences for mapping schemes. For example, if you orient the array at an angle that equalizes the declination spacing of the feeds in drift mode, the feed separation will change depending on

the Gregorian azimuth, from a max of about 2.0′ to a min of about 1.7′. Keep also in mind that the beam shape is elliptical, and that the orientation of the major axis of the ellipse of each beam will change with Gregorian Azimuth, as will the sidelobe structure. For further discussion of the ALFA beam configurations and the need to track the parallactic angle, see the several relevant documents posted on the A1946 web site.

5. **Timing Issues.** Be alert to timing problems cropping up in your data. Mismatches between data and time stamp were found during the initial part of our precursor run. The Observatory staff is aware of them and they should get fixed soon. However, subtle variations of those problems may raise their ugly crest again and we should be alert to pointing them out, because they are unlikely to be caught by the necessarily brief maintenance tests carried out by the staff. Among the problems noted during A1946: - different polarizations of the same beam having different time stamps; - cal pulses appearing in different records in different beams (which is physically impossible since the cal is a single noise diode distributed to all beams simultaneously; we noted the problem occurring specifically with the beams recorded in Wapp 1, i.e. beams 0 and 1, occasionally timing themselves apart from the rest); - if you choose to fire the cal in the middle of a scan, note that the cal is "asynchronous", i.e. it doesn't get fired at the same tic as the beginning of a record and it doesn't have a precise duration, so that in order to make sure that at least a single record is fully "cal-ed", the cal needs to be fired for a duration equal to several record lengths. The problem should not appear if a separate cal scan is obtained. NAIC will implement a "synchronous" cal in the near future, so the cal problem should be resolved soon.

6. **Software Specialization.** In order to meet the specific needs of each survey team, the Observatory staff has designed a number of highly specialized observing modes (such as "fixed azimuth drift", "basket weave", etc.). Each of them has some unusual features hardwired in. Make sure that if you use any of those you fully understand their operation, possibly by interacting with a knowledgeable member of the survey team that designed the observing mode. While the Observatory provides some very handy real-time monitoring tools (accessible only on site because of high data rates), these do not allow for any quick data reduction or analysis. It is each team's responsibility to have adequate software up and running before your observing starts so that you can evaluate in near-real time the efficacy of your observing strategy and the quality of your data. You should not count on using data processing software developed for another survey effort, without some major changes. Unless of course you choose to take data in the exact mode for which the software was designed (documentation on how to use our "fixed azimuth drift" mode is posted on this website). Survey teams will develop software that maximizes efficiency for their specific purposes, at the expense of generality.

7. **Impact of Hardware Failure on Data Processing.** As mentioned earlier, ALFA may not always operate at 100% capacity, i.e. you may have to limp along with one and sometimes more 'bad' boards. When you process data, the presence of bad records (e.g. NaN, ∞, etc.) may have an impact on your software, especially as you are likely to process data 'by the array'. Make sure you code with enough elasticity so that the agility of the data processing is not affected.

8. **Precursor Runs: be on Site.** At this point in time, given the complexity of the instrument, the number of things that can — and will — go wrong during precursor runs is very large. That's what "shared-risk precursor" observing is all about. In order to have proper appraisal of problems and prompt attention to their cure, it is absolutely necessary that experienced team members be on site during the observations. Do not expect to be able to troubleshoot effectively - or to get any scientifically valuable data, while testing observing modes remotely. That will not work, and you will be wasting valuable telescope time.

9. **Manpower Limitations.** The Observatory staff is working very hard to support the commission of ALFA but is stretched out very thin by the ALFA precursor experiments, especially when several are running during the same period. They also need to attend to other tasks, there are important priorities and their response times may not always be to your best convenience. Make sure you document adequately your requests for action, and copy them to all members of the ALFA Commissioning Team.

10. **Data Size.** ALFA can produce data at very high rates. Estimate your data storage needs ahead of your run, and make a request to the Observatory to set aside for you sufficient disk capacity. You also need to plan for data transfer.