Follow-up observations (Noah Brosch + Wim van Driel + Peppo Gavazzi)

The E-ALFA surveys under consideration (including the all-AO sky shallow survey, the Virgo cluster survey, and the deep E-ALFA survey) represent unique astronomical resources whose expected yields have been described above. In order to generate maximal scientific results from these surveys, it is necessary to combine their results with those from existing surveys in other spectral bands, with other ALFA surveys that can yield relevant data, with specific targeted observations. Below we describe each separately, and with observations made subsequently in other spectral bands of selected objects.

Existing surveys relevant to E-ALFA surveys

The E-ALFA surveys are targeted to detect HI emission at redshifts from rest-frame (or slightly below, to account for objects in the Virgo region) to at least 30,000 km/sec. These are line observations that must be combined with other information to determine the nature of the detected objects. The surveys that will have relevant information available by the time the E-ALFA surveys will be executed are:

1. *Optical:* the SLOAN survey. A five-color imaging survey with the goals of mapping about 10,000 square degrees of the sky to ~22 mag at a few percent accuracy and provide spectroscopy of all galaxies down to 19 mag. This should be supplemented with X-DSS information, wherever SLOAN data are not available.

2. *Ultraviolet:* the GALEX all-sky survey, imaging and spectroscopy in two bands (Far UV and Near UV) to nearly the same depth as SLOAN, depending on the spectral energy distribution of an object. (The telescope was successfully launched on April 28, 2003).

3. *Near IR:* the 2MASS survey of the entire sky in three near-IR bands (J, H, and K_short). The sensitivity of this survey is rather shallow, 13-14 mag for extended sources, but it may be useful for specific sources.

4. *Far IR:* still the old and trusty IRAS, with supplements from ISO wherever observations exist. The ASTRO-F mission is scheduled for early 2004. This will provide an all-sky survey approximately one order of magnitude deeper than IRAS.

5. *Radio Continuum:* the VLA FIRST survey with the advantage of reasonable angular resolution but rather shallow depth. Might be supplemented with a (perhaps) deeper continuum survey derived from the off-channels of the E-ALFA surveys, or possibly from the P-ALFA survey.

6. *X-ray:* Nothing new after RASS (ROSAT All Sky Survey), unless the Germans resurrect ABRIXAS.

The requirement for efficient use of these surveys in the process of source identification and follow-up is the generation of positions with sufficiently high accuracy for the sources detected by E-ALFA. In this context, we urge the attempt

to generate this by super-resolution, or drizzling, as done for HST images, through the combination of different stepped scans and high-accuracy calibration of the telescope. The quality control (calibrator observations) should be done 'on-the-fly' to provide for corrections during the pipeline processing.

Given the large number of detections, the process of cross-correlating sources from different surveys, including E-ALFA, should be automated. In view that this is a problem generic to a number of surveys, it seems that this mechanism already exists (see for example the Hopkins Center, where these surveys are combined, or the various 'Virtual Observatory' projects). It is therefore necessary to produce the list of sources in a format compatible with ingestion into such a 'correlation machine'.

Relevance of other ALFA surveys to E-ALFA

It was already mentioned in the "synergies" chapter that G-ALFA would have significant synergy with E-ALFA because of the possibility of time-sharing. Above, we included P-ALFA as a possible source of high-sensitivity continuum information. This is because of their large bandwidth, in case the 300 MHz back end is adopted.

Future possible surveys relevant to E-ALFA

A basic datum that would not be available by the time E-ALFA is launched is narrow-band Há information about all sources and at all conceivable redshifts covered by E-ALFA. The value of such data would be that one could immediately relate the HI mass to the newly formed stars.

In traditional observations, narrow-band Há information is obtained by filter imaging and one needs a filter for every redshift range. For example, with 50Å filters one samples a redshift range of a bit more than 2000 km/sec. To cover the range of E-ALFA, observations with at least ~15 filters would be required, which would use prohibitively large amounts of (large) telescope time. It may be possible to design a specific survey for this purpose, maybe inventing new ways of doing tuned-filter observations (e.g., OSIRIS at GranTeCan, which should see first light in 2004). This is a TBD topic to be further investigated. In principle, it would be possible to select subsets of sources detected by E-ALFA and whose other observational parameters were downloaded from the other existing surveys, for follow-up Há observations.

Follow-up observations of E-ALFA sources

1. Observations in the HI line

For HI sources with only a tentative detection from the E-ALFA survey, subsequent deeper observations could be obtained at Arecibo.

Selected HI sources could be mapped in the HI line with radio synthesis telescopes, such as the ATCA, GMRT, VLA and WSRT.

For example, it is probable that E-ALFA would detect isolated HI clouds, or extended HI distributions around galaxies. A logical follow-up would be to map such distributions in detail at finer angular resolutions. The goal would be to understand how these distributions were created, by accretion of separate HI clouds or by tidal pulling off larger distributions.

2. Observations in other wavelength domains

Selected HI sources could be observed in other wavelength domains could be obtained, to complement the available survey data listed above. The international composition of the E-ALFA Consortium gives access to a great variety of ground-based telescopes in both hemispheres.

Obvious multi-frequency follow-up observations will include:

i) The mm and sub mm: pointed observations (both continuum and line) with existing instruments and future telescopes (e.g., ALMA, and the new Mexican 50m telescope).

ii) Near IR: especially the galactic plane survey will greatly benefit from follow-up observations in the Near IR to minimize obscuration from the Galaxy. 2MASS is indeed too shallow. The need for large field of view detectors at NIR is still a major concern.

iii) Optical: one square degree cameras are becoming a reality (e.g., KPNO 0.9m and MEGACAM at the CFHT).