16. VLA Observing Strategies

ALAN H. BRIDLE

1. INTRODUCTION

This Lecture discusses the choice of parameters for VLA continuum observing based on a mixture of astronomical and instrumental criteria. It suggests an orderly way in which to use the material of Lectures 2, 4, 5, 6, 7, 8, and 9 to choose critical parameters when planning and executing VLA observations. It also suggests strategies for avoiding some of the pathological image defects that were emphasized in previous lectures. Unlike most of the other lectures in this series, this one is explicitly oriented toward specifics of VLA continuum observing, though the general principles apply to observations made with other synthesis arrays.

Figure 16–1 shows a decision tree for preparing VLA continuum observations; Sections 2 to 6 of this Lecture detail the various levels of this tree. Note that some system parameters (e.g., sensitivities) that affect these decisions will improve with time as a result of hardware upgrades, etc. NRAO publishes a *VLA Observational Status Report* that summarizes relevant system parameters at least once per year. You should check the most recent copy of this *Report* when planning a VLA proposal.

Sections 7 to 9 of this Lecture discuss calibration strategy, on-line observing strategy, and the observing proposal itself.

2. CHOICE OF ARRAY CONFIGURATION AND OBSERVING FREQUENCY

2.1. Resolution $\theta_{\rm HPBW}$—How much is enough?

An image made from untapered uniformly-weighted ≥ 4 hour tracks in a standard VLA configuration at positive declinations where foreshortening of the array is unimportant has a synthesized beam B with a half-power beamwidth given approximately by

$$\theta_{\rm HPBW} = 1\overset{\prime\prime}{.}25 \times \frac{1480}{\nu_0} \times 3.285^{n-1}\,, \tag{16–1}$$

where ν_0 is the observing frequency in MHz and $n = 1, 2, 3$, or 4 for the **A**, **B**, **C**, or **D** configurations respectively.

The *minimum* resolution (i.e., maximum value of $\theta_{\rm HPBW}$) appropriate for the observations will be determined by the need to separate or resolve important features of the structure in the region to be imaged. For observations of extended emission, the *maximum* resolution (minimum $\theta_{\rm HPBW}$) that is appropriate should also be considered, by estimating the total integration time $t_{\rm int}$ needed to achieve the required brightness sensitivity. There is no point observing extended emission using such a small beamwidth $\theta_{\rm HPBW}$ that the interesting features of the source are close to or below the r.m.s. noise ΔI_m on the final images. To make sure that this does not happen, you must consider the *apparent brightness* (flux density per synthesized beam area) that you expect such features to have at the resolution you will use for your final images.

Recall from Lecture 6 that a *point* source with flux density S Jy images with an apparent brightness of S Jy per synthesized beam area regardless of the area Ω_s of the

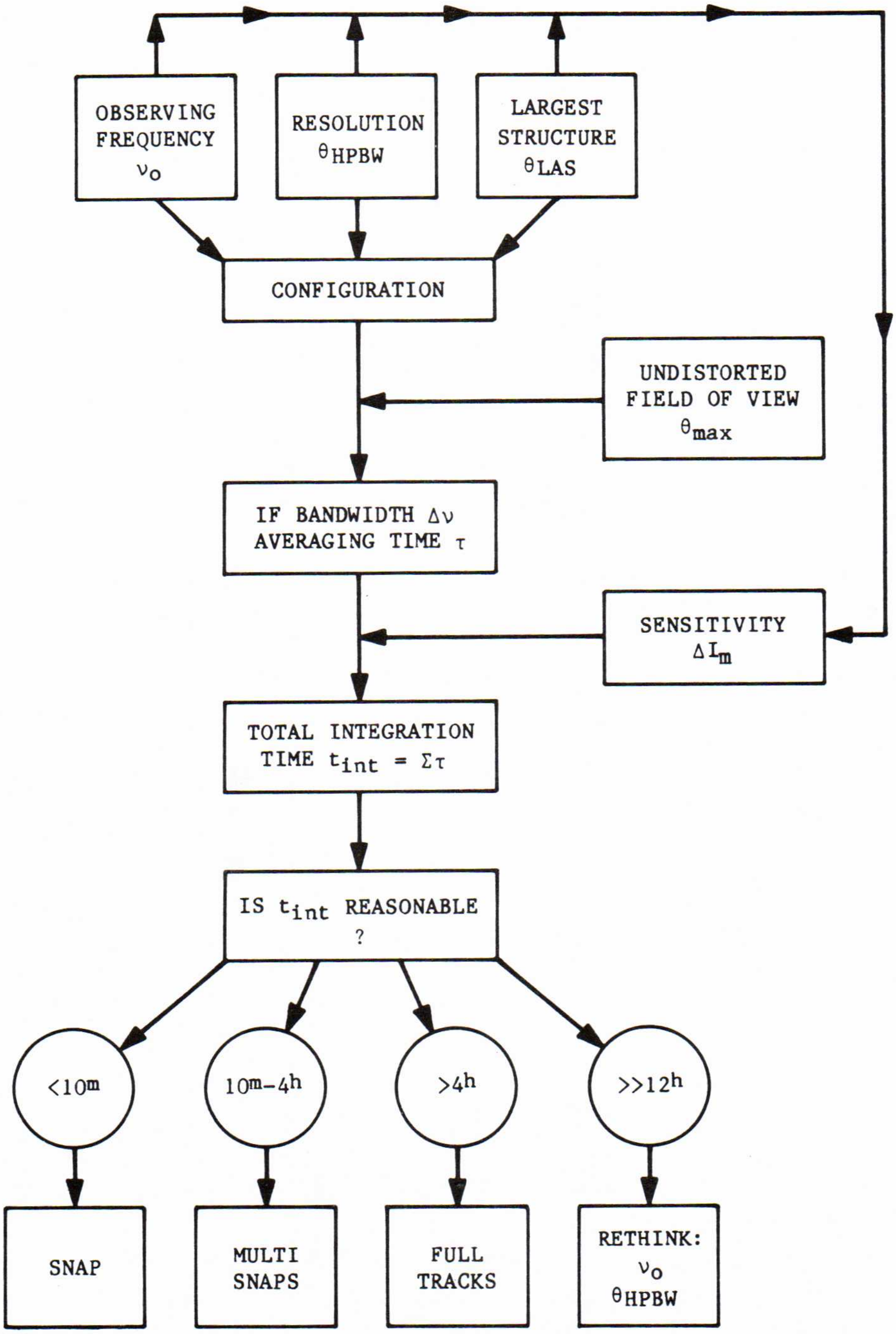

Figure 16–1. Factors Entering Into VLA Observing Strategy—A Suggested Decision Tree.

synthesized beam. It follows that, at a given frequency, all VLA configurations are equally sensitive to a given point source (apart from the effects of confusion and phase stability). In contrast, as described in Lecture 6, the apparent brightness of an *extended* emission region in a synthesized image depends on the region's detailed structure, on how well the visibility function $V(u, v)$ is sampled by the observations, and on the weighting and tapering functions D_k and T_k applied to the data at the imaging stage (Lecture 5, Section 2.2; and Lecture