# VLASS Technical Review Summary

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## Introduction

Members of the NRAO staff were asked to review technical aspects of the VLASS proposal – mainly the Technical Implementation Plan (TIP) document, but also the main proposal where it covered non-scientific issues. Specifically, reviews in the following areas were solicited:

- Scheduling
- Technical maturity and implementation plan
- Data Management and Software (DMS)
- Pipeline processing
- Imaging algorithms
- STEM/EPO
- Science support

Specific detailed reviews in all but one of these areas have been prepared and submitted to the director; this document is an attempt to collect these reports together into a summary.

Separate reviews were solicited from NRAO staff covering the proposed science of the VLASS. They have been summarized in a document similar to this authored by Chris Carilli. Note that it is impossible to define an exact separation between "technical" and "scientific" here, as the overlap between what might be considered technical and scientific is very significant. Because of that, there is some overlap between both the individual and summary technical and scientific reviews. Many of the individual science reviewers included material that is probably more properly considered technical in nature. What I consider technical for the purposes of this document is everything involved in preparing for, executing, calibrating, imaging, archiving, and making available the observations that comprise the VLASS. Specifically:

- SB preparation
- Scheduling
- Executing the observations
- Data storage (archiving)
- Data reduction and analysis, including:
    - Calibration
    - Imaging (including mosaicking)
    - Other data products
- Serving up raw data, images, and data products

While the focus in the following is on issues with the current proposal, it should be noted that a number of reviewers expressed excitement about the VLASS and the necessary developments. Many of these developments are things we have wanted for some time, and this particular project would give them the priority and focus needed to get done. This was notable especially in the areas of EPO and DMS.

### No Single Technical Showstopper

In all of the various individual reviews, there were no single technical showstoppers found and described. With enough time and effort, everything that needs to be done for the VLASS to happen can almost certainly be done. In fact most of the items described in the Test & Development Plan (T&DP) are low- to medium-risk. However, all of the reviews included several fairly major obstacles to be overcome for the VLASS to be technically feasible on the timescale proposed.

### Major Issues

There were a number of either more general, or specific items, which were brought up in multiple reviews, and are important enough to call into question the ability to execute the VLASS on the proposed timeline.

#### *High Cumulative Risk*

Although there are no single showstoppers, the amount of work to be done, taken as a whole, makes the T&DP high risk (i.e., the cumulative risk is high). This includes both development and operational aspects. Note that the bulk of this effort is in Scientific Support and DMS. The authors of the TIP should be commended on their long list of necessary test and development items, and the presentation of the T&DP to address them, but it demonstrates the magnitude of the tasks to be completed. We simply don't have sufficient resources to implement the T&DP on the proposed VLASS timeline, or to support the operational phase as described, unless we stop most other development. In this era of flat budgets and hence staffing, and at a time when we are both still commissioning VLA observing modes, and attempting to start to define what the Next Generation VLA will be, even if we do stop most other development this is risky. There were several reviewers that felt that the effort estimates in the TIP were optimistic, by varying factors. The TIP authors should attempt to work with the staff and managers to get a more realistic estimate of this effort.

#### *Severity of Impact on PI-led Projects*

This is an item that is clearly in that gray area between science and technical, but I include it here because of the scheduling aspect. Taken at face value in the proposal, the requested time for VLASS would basically exclude most PI-led projects in the A- and B-configurations. From discussions with the VLASS leaders, it is clear that the intent is that a month will be taken from each of the C- and D-configurations and that those months will be added to the A- and B-configurations. It is also clear that the VLA schedulers are assuming this, since they explicitly state that the extension is by 28 days in each of A- and B-configuration in their technical review. If

the proposers are assuming this will be true, it should be made clear in the proposal, so that all reviewers can review it in that light. I will assume that this is the case in the following analysis. There are three major impacts in general under this scheme.

**Impact 1:** Taking one month away from D-configuration is a serious impact. Looking at the TAC reports for the past three configurations (all of A-, B-, C-, and D-), I find median hours requested as:

- A-config: 3169
- B-config: 2480
- C-config: 2447
- D-config: 3186

D-configuration is our most proposed-for configuration, by total hours – it is highly sought after. Taking 25% of D-configuration time away has significant impact.

**Impact 2:** The assumption in the proposal is that only the lowest ranked science proposals in A- and B-configurations will be impacted. Specifically, that only 25% of currently scheduled projects will not get on the telescope. I think this is grossly wrong. Firstly, the oversubscription rate of the VLA means that anything that gets on the telescope is pretty good science. Secondly, the 25% number must have been calculated incorrectly.

Again, assuming an additional 28 days in one of the extended A- or B-configurations, each would last about 128 days. We observe with about 70% efficiency (of total wall clock time) for science, meaning there would be about 2150 hours for science in a given extended A- or B-configuration. If, as is proposed in the B-configuration baseline plan, 1180 of these hours are used for VLASS, this leaves 970 hours for PI-led science observing. This is only 57% of what is available in a current A- or B-configuration (70% of 100 days, or 1680 hours) – meaning that the VLASS will prevent as much as 40% of currently PI-led hours from being observed on the VLA. The practical effect will be that projects currently assigned a "C" scheduling priority will likely be given an "N" (don't observe); and most "B" priorities will be shifted to "C," while about half of those currently given an "A" priority will be given "B." These kinds of effects should be made explicit in the proposal so that such impacts can be weighed against the potential benefit of the VLASS.

**Impact 3:** Particular LSTs will be much more heavily affected than the general case considered in the other two impacts. In the worst case, for ECDFS (part of the DEEP survey), the survey occupies the entire LST range completely, and cannot even be completed on the baseline timeline (it will take an additional two configuration cycles to complete). But this is true to some degree for all of the DEEP survey fields, and partly true as well for the GALACTIC survey. For sources in the affected LST ranges, PI-led projects will be much tougher to get approved.

### *Focus on a Single Survey*

Again, this is in the area between scientific and technical, but there is a clear technical aspect. Given the amount of work in the T&DP (note the first item above), it would benefit the VLASS greatly to be able to focus on a single one of the surveys. This would help limit the risk, and allow focus to be placed on what needed to be

done for that one survey. The risk would still be high, but less than if all four are attempted.

### *Wide-Field Snapshot OTFM Polarimetry*

While wide-field polarimetry has been demonstrated in at least one case (Rudnick & Owen 2014), but this is in a full synthesis and does not involve either snapshots or the complexities of OTFM. This is the one single technical issue that is as close as a single showstopper as exists in the VLASS. This is an open area of research, and an area in which progress has been slow in the past. The assumption that the needed research can be completed on the required timescale is ambitious at best, especially since it is reliant on key people with limited availability and other commitments.

### *Automated Production of Pipeline Images (Including Processing On Demand – POD)*

We have ample experience with the VLA calibration pipeline, but have not included pipeline imaging of any sort in our regular pipeline reduction. There are several individual pipelines that have been constructed by observers, but none of these fit in the framework of the current scripted calibration pipeline. And we are just on the verge of trying to move over to the CASA-based pipeline. Adding polarization calibration into the mix (which is not included in the current pipeline), makes it difficult to imagine that all of this can be done on the necessary timeline. The mention of POD is exciting in some ways, as it is a capability we have talked about for many years, but it is equally far away from reality. One of the major hurdles to all of this working together in an integrated system is that the Science Data Model as currently defined is insufficient to record all of the linkages between the observations and the final mosaics (note also the separate item below about shared calibrations for which this is an issue).

## Other Issues

There are several other issues that might be as serious as those above, but were only brought up by one or two reviewers.

### *EPO Needs More Complete Integration*

The EPO plan needs input from NRAO's EPO department, as it seems to be decoupled from what is going on, and possibilities that could be capitalized on. With a more complete integration from the beginning the possible benefits for EPO would be much more easily realized. Note that a full EPO plan will need resources – one full-time Scientist reporting to EPO; potentially some time from other post-docs, interns, and REU students; and money for travel and event filming.

### *"Shared Calibration"*

The idea of shared calibrations across SBs is wonderful conceptually, but significant work and is far from having been demonstrated. There is infrastructure work to be done in SDM definitions, pipeline, scheduling, and other areas. We have been discussing the prospects of doing this kind of calibration (for flux density scale,

bandpass, and polarization, at least) for years, and are no closer to demonstrating that it can work.

### *Integrated Pipeline Development*

The possibility of developing the reduction pipeline in AIPS-Lite or as a standalone pipeline (the baseline plan) is presented in the proposal. From the perspective of DMS, the pipeline must be part of the normal CASA-based VLA pipeline, and in fact while staff scientists and other community members would be involved in development of heuristics, the actual coding would be done by members of the CASA group.

### *Observing Time Contingency*

We know that about 5% of observing time on the VLA is lost to failed observing, for any of a number of reasons. This contingency for failed observing should be built in to the overall time for the VLASS.

### *Image Quality*

The focus in the proposal is on image sensitivity only. There are many regions of the sky where images will not be dominated by sensitivity but rather by dynamic range – notably parts of the GALACTIC survey. Some discussion of what potential impact would be for such regions should be included.

### Minor Issues

There are a number of other more minor issues in the proposal, from true small technical details to grammar and spelling errors. The individual technical and scientific reviews should be consulted for these.