VISTA PUBLIC SURVEY STATUS REPORT
(90th OPC MEETING)

This report has to be returned to the Observing Programmes Office of the European Southern Observatory (opo@eso.org).

PROPOSAL ESO No.: 177.A-3011
TITLE: The VST ATLAS
PRINCIPAL INVESTIGATOR: : Prof. T. Shanks

1. **Scientific Aims (brief description)** The main aim of the VST ATLAS is to make a survey of >4000deg^2 in the Southern Hemisphere in the ugriz bands to the depth of SDSS. The ATLAS will comprise ~2000deg^2 in the North Galactic Cap between 10h<RA<15h30 and ~2000deg^2 in the South Galactic Cap between 21h30<RA<04h00. The main motivation for the survey is for cosmology. For example, there is the possibility of using the VST ATLAS UV coverage as the base for spectroscopic QSO redshift surveys out to z=2.2 in order to investigate non-Gaussianity and the power-spectrum turnover via QSO clustering. Such a QSO survey could also deliver competitive Baryon Acoustic Oscillation measurements of the Dark Energy equation of state at z~1.5. Pilot survey observations based on ATLAS data have already been carried out on the AAT 2-degree Field (2dF) facility. ATLAS data can also be combined with the VISTA Hemisphere Survey to produce ugrizYJHK photo-z for galaxies out to z~1. Then cross-correlation of Luminous Red Galaxies with the Cosmic Microwave Background fluctuations will test the evidence for an accelerating Universe via the Integrated Sachs Wolfe effect. Many other non-cosmological projects are clearly also feasible including the search for high redshift z~7 QSOs via optical dropout, the search for stellar streams and the search for local large scale structure including the Great Attractor. Indeed, our aim is that ATLAS becomes the equivalent of a Southern Sloan with similar scientific impact.

2. Detailed progress report with respect to initial estimate from the Survey Management Plan (including preliminary results, whether published or not).

2.1. Progress report

The VST ATLAS now has covered ~1100 deg^2 in ugriz so far since mid-August, 2011 until mid-May, 2012 (see status maps at http://astro.dur.ac.uk/Cosmology/vstatlas/). Over these 9 months , this rate therefore corresponds to ~800deg^2 per 6-month Period. Since we are aiming to cover >4000deg^2, this means that we may need to extend the project into ESO Periods 92-93. CASU are pretty much up-to-date in their preliminary reduction (v0.9) of the ATLAS data as described below.

Progress report on VST activities from Cambridge Surveys Unit (CASU)

Pipeline processing

From February 29th, Internet transfers of VST data from Paranal to Garching have been using the EVALSO link and VST data is now available in the ESO archive

for CASU to transfer over the Internet some 24 hours later. CASU had previously already automated the transfer process from the ESO archive for available VST data and now routinely acquire VST data for checks and local ingest within a few days of the observations. The VST web pages at CASU for processing status (http://casu.ast.cam.ac.uk/vst/data-processing/) and survey progress and access(http://casu.ast.cam.ac.uk/vstsp/) have been upgraded to reflect the full status of what is happening.

An internal CASU review of the first-pass VST processing at the beginning of January showed up several obvious pipeline issues that needed fixing in addition to highlighting several genuine problems with VST data. The latest pipeline version (v0.9) addresses all of the main image processing issues and all the VST data has now been reprocessed with this version prior to release to PIs. Work is still ongoing to fully address the intrinisic VST-specific problems but with promising results.

After much trial and error we have concluded that ab-initio detection on U-band data is not good enough for the ATLAS requirements and have decided to complement the normal U-band catalogues with list-driven catalogues based on the g-band. These will be generated at the band-merging stage and will be included as an extra in addition to the original u-band catalogue. Whether or not to extend this, or some variant of the list-driven approach, to the other bands remains TBD.

Quality Control

In addition to the usual VDFS QC monitoring of average stellar seeing and ellipticity, and sky surface brightness and noise properties, CASU have also initiated a more detailed analysis of the image properties based on inter-detector comparisons.

The well-aligned coplanar detector array coupled with the curved focal surface is extremely sensitive to imperfections in focus which are relatively easy to detect using the detector-level average seeing measurement variation available for each of the 32 detectors. Likewise the variation in average stellar ellipticity from each detector over the field is used to monitor rotator angle tracking problems.

CASU are still waiting for a practical method of transferring the OB grades from ESO so that they can be incorporated in the data product files and also the progress database.

Calibration issues

After some experimentation, and verification, CASU are using the APASS all-sky photometric (http://www.aavso.org/apass) g,r,i catalogues to monitor both overall throughput and provide a working solution to the severe illumination correction problem inherent in VST data.

A solution has been developed over the last few months to correct the ~0.25 magnitude systematic variation in sensitivity over the array due to scattering from within the camera and from the telescope and dome structures. The scattered light corrupts the flatfields, both dome and twilight, with the detail varying with external conditions. In turn this leads to spatially-dependent magnitude offsets made up of several inter-related components with different spatial scales and symmetries. Tests so far indicate that a correction to the level of +/-1% is achievable for the broadband u,g,r,i,z filters.

As the fix is so complicated this involves producing a "fixed" version of all the relevant catalogues whereby all the internal flux values per detected object are corrected. After recalibrating these will form the basis for the standard user end products. The original catalogues will also be available, mainly to simplify implementing future improvements to the scattered light correction.

A further severe and unexpected issue are the gain variations in several detectors. These occur randomly in but most noticeably in detector #82 which shows excursions of up to 1/2 magnitude. A possible software solution to this is to attempt a fix at the catalogue band-merging stage.

Despite the illumination correction problem, even using only the ~3 Standard Areas observed each night from the primary calibration plan, CASU are finding virtually all nights yield a very steady ZP measurement. ZP variations per pointing are generally already well within 5%. After fixing the illumination correction, by additionally taking advantage of the all-sky APASS catalogues, achieving a uniform global calibration at the 2% level looks feasible.

2.2. Publications

The problems with the unexpectedly large illumination correction have held up the photometry calibration paper based on the William Herschel Deep Field, Chandra Deep Field South and SDSS overlap data but this will now be prepared when the recalibrated data is available from CASU in the next month or so.

3. Quality Control and Phase 3. The Phase 3 submission plan should be described here.

3.1 The PI should comment on the quality control and the science validation of the acquired data.

Quality control is ongoing at Durham. Generally data quality looks excellent. The most important way to validate the data is by using it for science projects and we have now carried out some pilot observations for a proposed AAT 2dF survey called the 2dF QSO Dark Energy Survey (2QDES). VST ATLAS provided the imaging data base for these pilot observations on a director's night on 20 December 2011 and then 3 nights between 28-30 April 2012. We prepared about 50 sq deg of ATLAS imaging data using u-g:g-r and g-r:r-i colour-colour diagrams to select QSO candidates which were then observed ~330 at a time using 2dF. The observations realized about 3000 QSO redshifts. 2dF fibre observations are clearly quite demanding, even more so since we were pushing to a limit of g~22 for QSO identifications. The success of the observations confirm that the positions for faint stellar objects are good enough for them to be observed in 2.1 arcsecond diameter fibres over a 3 sq deg field simultaneously. It also confirms that the CASU photometry reaches the equivalent of g~22 in the u-band. The best rates we have achieved from ATLAS are QSO sky densities of $60deg^{-2}$ or about 180 per 2dF field. This is even before the start of the approved Chilean u band extension which will double the u band exposure to 240s.

We have also been investigating the effect of using ATLAS data with and without the illumination correction for galaxy clustering projects. For the most demanding angular correlation function projects, the required rms in magnitudes is about 0.03mag. Without the illumination correction there would be a difference of ~0.15mag in zeropoint from the centre to the edge of the field. With the illumination correction, that reduces to ~0.01mag. Therefore the illumination correction is seen to be vital in allowing us to achieve our science goals in terms of studies of faint galaxy clustering.

3.2 The PI should describe the current status of the Phase 3 submission. Any feedback or requested modifications of data products or timeline for survey releases should be described here. PIs should also include any relevant information for the scientific validation of the data products.

The Phase 3 submission plan remains the one described in Section 5 of the Revised ATLAS SMP. In detail: Our team anticipate two main product releases resulting from the survey, timed at survey start plus 1.5 yr and survey start plus 2.5 yr. These will be the DR1 and DR2 catalogue releases and will, finally, incorporate globally calibrated ugriz photometry on all catalogued sources. DR1 would only be flux calibrated at the individual pointing level, whereas the aim for DR2 would be to place the entire survey on a uniform photometric scale.

In addition to the DR1 and DR2 catalogue release indicated above, the ATLAS team will ensure delivery of the following core data products to the ESO SAF:

- astrometrically and photometrically calibrated images, along with their respective weight maps, in all of the project-relevant filters will be provided on a per pointing basis.
- source catalogues based on individual bands. Associated source catalogues linking the parameters of individual objects across all of the observed filter bands will be provided on a pointing by pointing basis.
- these survey products will be supported and characterized by additional "meta" information providing a full description sufficient for their full scientific exploitation.

In his talk at the 21/3/12 ATLAS Data Products meeting at ESO, J Retlaff suggested that ATLAS DR1 be released in November 2012 based on the first 6 months of data from October 2011 and including the pre-survey phase from August 2011. But our reading of our commitment in the revised SMP was that we would release the first year of ATLAS data from August 2012 in March 2013 ie all data up to end of P89 would be released in a DR1 at end of P90. Also taking into account that the illumination correction issue had held things up, this seems a timetable more likely to lead to a useful ATLAS data release. Therefore, although we can provide a data release in November of this year if required, we suggest that DR1 would be more usefully made in March 2013 on the basis of over a year of ATLAS data.

4. Are any changes proposed with respect to the Survey Management Plan in P90 (e.g., in strategy, field coordinates, exposure time and/or other settings)? If yes, please provide a clear and detailed justification.

We shall be generally continuing to follow the Revised SMP in terms of field coords, exposure times etc. The only potential change is to move back to 1hr OBs with ~1degree offsets from the shorter concatenated OBs currently used to save on overheads but this could only be done if ESO can confirm that the previous problem with offsets that "decay" as the 1hr OB proceeds, have been solved.

5. Observing Plan for Period 90.
Specify which part of the Survey Management Plan (SMP) the survey will focus on in P90 in the 1st column and provide the corresponding details in the table below. In particular please highlight any changes with respect to the SMP for P90, and provide a full justification for these changes in Section 4 above.

There are no changes with respect to the revised SMP for Period 90. Reiterating Table 4 of revised SMP:

SMP Period	Field name/ mean RA	Filter	Time (h)	Seeing	Moon	Transparency	Comments / strategy (e.g., no. of epochs)
P90 Oct-Dec	SGC RA~23h	ugr	115	<1.4	dark	clear + some phot.	As in revised SMP
P90 Oct-Dec	SGC RA~23h	iz	72	<1.4	gray/ bright	clear +some phot.	As in revised SMP
P90 Oct-Dec	SGC RA~02h	ugr	115	<1.4	dark	clear + some phot.	As in revised SMP
P90 Oct-Dec	SGC RA~02h	iz	72	<1.4	gray/ bright	clear +some phot.	As in revised SMP

For Period 91, we further request PSP approval to take the full Survey to 4711 deg^2 as designated in Table 4 of the revised SMP. At the previous PSP meeting on 28/9/10 the correct RA and Dec ranges were approved but the associated area was mistakenly underestimated at 4072deg^2. In the revised ATLAS SMP, the area within the same RA and Dec ranges was correctly calculated as 4711deg^2 and we now request that this anomaly regarding ATLAS survey size be clarified in advance of the P91 submission.