PUBLIC SURVEY STATUS REPORT
(93rd OPC MEETING)

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

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

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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 via QSO clustering primordial non-Gaussianity, the power-spectrum turnover and Baryon Acoustic Oscillation measurements of the Dark Energy equation of state at z~1.5. 17 nights of pilot survey observations based on ATLAS data have already been carried out on the AAT 2-degree Field (2dF) facility and future AGN surveys from e-BOSS and e-Rosita will greatly benefit from these data. This quasar redshift survey has further demonstrated the power of combining ATLAS with WISE satellite data in the L(3.4micron) and M(4.6 micron) bands to increase the quasar selection density. In this way, ATLAS has already uncovered a new population of dust-reddened quasars. ATLAS data can also be further combined with the VISTA Hemisphere Survey to produce *ugrizYJHKLM* 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. ATLAS Data Release 1 (DR1) covering the period from 1/8/2011 to 30/9/2012 is available from the ESO archive.

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

2.1. Scientific Progress and Outlook

The VST ATLAS now has covered the equivalent of ~2600 deg^2 in *ugriz* so far between mid-August, 2011 and October, 2013 in Periods 87,88,89, 90, 91 and 92 (see status maps at http://astro.dur.ac.uk/Cosmology/vstatlas/). Over these ~24 months, this rate therefore corresponds to ~650deg^2 per 6-month Period. Since we are aiming to cover >4000deg^2, this means that we shall need to extend the project

to ESO Period P94 (slightly earlier to complete *iz* and later for *ugr*). CASU are also pretty much up-to-date in their reduction (v1.0) of the ATLAS data.

The total number of tiles to cover the targeted ATLAS area is 5078 (x5 bands). Table 1 shows how many of these have been completed by passband. It can be seen that *i* and *z* which are done in gray time have the highest completeness followed by *r* then *g* then *u*. Most of the scheduled areas in *ugriz* are complete in the SGC. In the NGC *i* and *z* is more complete in the scheduled areas than *u* and *g*. The 389 *u* tiles in the past 6 months is reduced from the 496 in the previous 6 months. *r* is similarly reduced from 539 to 462 while *g* is up from 490 to 656. *i* and *z* have shown slight increases.

Band	Complete	Failed	Scheduled	Unscheduled
u	2169 (389)	100	1571	1238
g	2677 (656)	48	1115	1238
r	2760 (462)	65	1015	1238
i	3285 (650)	277	503	1013
z	3296 (645)	334	452	996

Table 1. Total number of VST ATLAS pointings so far completed up to October 2013. Scheduled means OB submitted and Unscheduled means OB to be submitted. Number in brackets shows tiles completed in last 6 months.

Table 2 shows that all OBs submitted for P87 have now been completed. 100% of *i* and *z* tiles have been completed for P88 with 90% of *u* and *g* tiles completed. For P89 about 70% of *i* and *z* have been completed whereas only 40% of *g* and 25% of *u* have been completed. The much smaller number of tiles scheduled for P90 and P91 reflects ESO desire to catch up with the backlog but significant amounts of *i* and *z* data have been taken for the P91 runs. P92 also shows a reduced number of tiles requested and this Period has only just begun. Note that the *ugr* backlog is more than in *riz*. There has also been a slowing down of the rate at which *u* tiles are being observed. This is unwelcome given the emphasis of the science case for ATLAS on the bluer bands.

Band	P87 (A,B)			P88 (C)			P89 (D)			P90 (E)		
	√	X	?	√	X	?	√	X	?	√	X	?
u	425	17	0	1268	17	151	277	63	817	12	13	48
g	425	17	0	1351	34	51	482	0	675	42	14	17
r	425	17	0	1402	0	34	579	51	528	59	14	0
i	425	1	0	1368	68	0	732	51	374	73	0	0
z	425	17	0	1385	51	0	715	119	323	73	0	0
Band	**P91 (F,G)**			**P92 (H)**								
	√	X	?	√	X	?						
u	136	0	45	34	7	483						
g	151	0	30	209	0	315						
r	181	0	0	97	0	427						
i	687	158	85	0	0	102						
z	698	164	68	0	0	102						

Table 2. VST ATLAS pointings by Period and bandpass. √ means completed, X means failed/rescheduled and ? means OB submitted but not completed.

In terms of estimating the time taken to complete the survey, *i* and *z* are going at a rate of about 140 tiles in each band a month and so should take 13 months from the time of writing to complete. The full ~4500deg^2 (of which 4200deg^2 has been approved by the PSP) *iz* survey should therefore be completed by the end of P93. The *ugr* survey is going at a rate of ~105 per band per month and so will take another 24 months to complete. At that rate the survey will be completed by the end of P95.

2.2. Refereed Publications (accepted or in press)

As indicated in the ESO Messenger article below there are many science papers in preparation based on VST ATLAS data including the basic VST ATLAS description, (Shanks et al) , 2QDES redshift survey of 10000 quasars (Chehade et al), Survey of high-z quasars (Findlay et al), A UV bright quasar survey (Worseck et al), Luminous Red Galaxy surveys out to z~1 (Chehade et al), GAMA (Norberg et al), SAMI Galaxy survey (Croom et al), Galactic Archaeology (Irwin et al), Galaxy Groups and Clusters (Murphy et al). Now that the illumination corrected and photometrically calibrated data is available these papers should now proceed quite quickly to submission in refereed journals.

2.3. Other Publications (e.g. conference proceedings)

VST ATLAS First Science Results, T Shanks, V Belokurov, B Chehade, SM Croom, JR Findlay, E Gonzalez-Solares, MJ Irwin, S Koposov, RG Mann, N Metcalfe, D Murphy, PR Norberg, MA Read, E Sutorius, G. Worseck, *ESO Messenger*, December 2013.

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 17 nights of pilot observations for a proposed AAT 2dF quasar redshift survey called the 2dF QSO Dark Energy Survey (2QDES). VST ATLAS provided the imaging data base for these pilot observations between December 2011 and July 2013. We prepared ~200 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 ~10000 QSO redshifts. 2dF fibre observations are clearly quite demanding, even more so since we were pushing to a limit of g~22.5 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*~22.5 in the *u*-band. The best rates we have achieved from ATLAS are QSO sky densities of 95deg^{-2} or about 300 per 2dF field. This is even before the inclusion of the ongoing Chilean *u* band extension (PI L. Infante) which will double the *u* band exposure to 240s.

CASU have implemented an illumination correction that reduces centre to edge photometric offsets from ~0.25mag to ~0.01mag. This is now within the range needed for projected galaxy and quasar clustering analyses.

We also note that the median seeing in the *riz* bands is sub-arcsecond with modes at 0.7arcsec. In *u* and *g* the median seeing is 1.0 arcsec FWHM. These distributions are well within our <1.4arcsec specification and are significantly better than the SDSS equivalents. Full details of these and other survey characteristics are given in our DR1 release description that accompanies the data on the ESO SAF (or see `http://astro.dur.ac.uk/Cosmology/vstatlas`).

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. ATLAS Data Release 1 was rolled out in October 2013 based on the first year of data taken to 1/10/12. The DR2 data release will occur in a year's time and data releases will continue at yearly intervals till the survey ends. DR1 is only flux calibrated at the individual pointing level, whereas the aim for the final release 6 months after the survey ends in P95 is to place the entire survey on a uniform photometric scale.

In addition to the DR1, DR2 etc catalogue release indicated above, the ATLAS team also delivers 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 are 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 are provided on a pointing by pointing basis.
- these survey products are supported and characterized by additional "meta" information providing a full description sufficient for their full scientific exploitation.

4. Are any changes proposed with respect to the Survey Management Plan in P93 (e.g., in strategy, field coordinates, exposure time and/or other settings)? If yes, please provide a clear and detailed justification.

The ATLAS survey was supposed to finish in P91. As described above, we need to extend the observations to P93 to finish the survey in *i*, *z* and to P95 in *u, g, r*. Remembering that the PSP recommended that ATLAS be accelerated and completed by the end of P91 because of competition from DES, we therefore urge the OPC to make a full allocation for time requested for ATLAS in P93.

In the SGC in *iz* we have about 300deg^2 still requiring OBs to be submitted. We estimate this will need about 40 hrs of VST time to complete in P93. In the NGC in *iz* we have about 500deg^2 still requiring OBs to be submitted so we shall require about 60hrs to complete in P93 ie 100hrs of *iz* in the NGC+SGC in total. This is well within our usual allocation in *iz* of 126hrs between SGC and NGC as specified in the SMP and assuming good progress in the current P92 with the backlog, would complete the ATLAS survey in *iz* by the end of P93. This estimate of the end of the *iz* survey is only based on the rate envisaged in the revised SMP but is consistent with the more realistic estimate based on past survey speed from Section 2.1 and Table 1.

In the SGC in *ugr* we have about 500deg^2 still requiring OBs to be submitted. We estimate this will need about 90 hrs of VST time to complete for P93. In the NGC in *ugr* we have about 750deg^2 still requiring OBs to be submitted. We estimate this will need about 130 hrs of VST time to complete the NGC *ugr* survey. Again this *ugr* SGC+NGC total of 220hrs lies close to our usual SMP guideline total exposures for *ugr* in NGC and SGC of 205hrs. We emphasise that the *ugr* survey is still realistically likely to extend to P95 since the exposure time requests in Table 3 are based on what was envisaged in the revised SMP and not on the more realistic *ugr* survey speeds discussed in Section 2.1 based on Table 1. But at least all the OBs would then be in the ESO system so that the targets could not run out before survey completion, allowing the most efficient end to the survey.

5. Observing Plan for Period 93 – for VISTA & VST Public Surveys *only*. Please specify which part of the Survey Management Plan (SMP) the survey will focus on in P93 in the 1st column and provide the corresponding details in the table below. In particular, highlight any changes with respect to the SMP for P93, and provide a full justification for these changes in Section 4 above.

SMP Period	Field name/ mean RA	Filter	Time (h)	Seeing	Moon	Transparency	Comments / strategy (e.g., no. of epochs)
P93 Apr-Jun	NGC RA~14h	ugr	130	<1.4	dark	clear + some phot.	Nominal exposure in line with revised SMP
P93 Apr-Jun	NGC RA~14h	iz	60	<1.4	gray/ bright	clear +some phot.	Nominal exposure in line with revised SMP
P93 Jul-Sept	SGC RA~23h	ugr	90	<1.4	dark	clear + some phot.	Nominal exposure in line with revised SMP
P93 Jul-Sept	SGC RA~23h	iz	40	<1.4	gray/ bright	clear +some phot.	Nominal exposure in line with revised SMP

Table 3. Observing Plan for Period 93. The total number of hours requested is 320 hrs to complete the survey at least in terms of OB requests, slightly lower than the total of 331 hrs envisaged for each Period in the revised SMP.

6. For Public Surveys, VHS, VIKING, VVV, ATLAS, KIDS & VPHAS+: PIs of the above surveys are requested to review the observations that were assigned a Quality Control grade "D". Please report what fraction of the D-classified OBs must be repeated to attain their scientific goals and include an assessment of the time required to repeat these OBs.

We have assessed the D grade OBs observed since July (see Table 4) and all need to be re-done to satisfy our survey's scientific goals, usually because the seeing was outside specification. There are 13 of these and so we shall require a further 1 hr exposure to repeat these pointings. We request 2hrs in total to take into account increased overheads of observing single fields..

OB ID	Date	Time	Duration (s)	Run
795903	01 Sep 2013	08:16:26	185	177.A-3011(E)
684102	04 Jul 2013	07:53:24	177	177.A-3011(D)
684105	04 Jul 2013	07:56:24	177	177.A-3011(D)
684126	04 Jul 2013	08:19:14	177	177.A-3011(D)
685568	10 Aug 2013	06:16:51	186	177.A-3011(D)
859064	28 Sep 2013	06:08:48	615	177.A-3011(F)
859199	23 Sep 2013	06:14:06	392	177.A-3011(F)
861995	11 Sep 2013	08:39:03	176	177.A-3011(F)
933378	09 Aug 2013	08:32:36	170	177.A-3011(G)
933387	09 Aug 2013	08:41:25	178	177.A-3011(G)
933917	14 Aug 2013	03:11:20	177	177.A-3011(G)
934327	10 Aug 2013	06:42:02	378	177.A-3011(G)
934574	16 Aug 2013	07:03:41	176	177.A-3011(G)

Table 4. The 13 fields with ESO D grade that we wish to be repeated.