ESO VISTA Public Surveys — A Status Overview

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The ESO policies for public surveys include regular monitoring and reviews of the progress of the surveys to ensure their legacy value and scientific competitiveness. The review process is carried out on the basis of reports by the ESO survey team and the survey PIs submitted to the relevant Public Survey Panel (PSP) — the VISTA PSP in this case. A summary of the time allocation to VISTA surveys, the service mode observations and the current progress after two years of telescope operation is provided. Furthermore the content of the data products delivery by the survey teams to the ESO Science Archive Facility is described.

Phase 1 — time allocation to surveys

Scheduling of the VISTA Public Surveys (PS) is done in line with the VISTA PSP recommendation that every effort should be made to complete the surveys within five years. Realistic expectations on what can be executed in the next semester are also taken into account, based on experience gained from the previous semester(s) of VISTA operation. The time allocation to surveys is based on the updated observing request by the PS principal investigators (PIs) and takes into account the carryover time needed to complete the observations submitted in the previous period. Figure 1 provides an overview of the time allocation to the six VISTA PSs from the extended period 85 to period 89 (P85–P89).

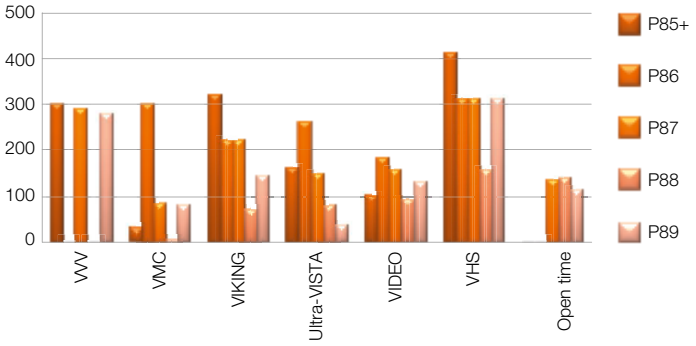


Figure 1. Overview of the VISTA time allocation in hours. P85+ included dry runs which were executed before the official start of VISTA operations.

The implementation of the PSP recommendation on time to survey completion implied a revision of the standard VLT model of scheduling observing time in service mode because the VISTA public survey programmes are all essentially at the highest priority of execution. As an added complexity, normal programmes were scheduled alongside public surveys and Chilean programmes from P87. Because the former have top priority and essentially cover all observing conditions, normal (open time) programmes must also be assigned a similar priority if they are to be executed at the telescope. Starting from P88, normal programme observations are not carried over regardless of their ranking, to avoid extra carryovers hindering the progress of the surveys. To limit the impact of open programmes on the progress of the VISTA PS the following policy has been implemented since P89: open time proposals can access restricted right ascension ranges, but should carefully justify the scientific goals and why these scientific goals are not achievable through the scheduled PS.

Phase 2 — service mode observations for public surveys

VISTA public surveys are ambitious programmes which entail very large allocations of time, of order of 1800 to 3400 hours, with consistent observing conditions. For a summary of the scientific goals of the VISTA public surveys, their area coverage and photometric characteristics, see Arnaboldi et al. (2007). An overview of VISTA and of its wide-field imager VIRCAM is provided by Emerson et al. (2006). Observation preparation and submission for public surveys is done on a half-yearly basis, following the standard ESO service mode procedures. The PIs of VISTA public surveys and their teams submit Observation Blocks (OBs) — the standard basic observing units. The deeper surveys (Ultra-VISTA, VIDEO, VIKING and VMC) have typically ~ 1-hour-long OBs, while the wide surveys (VHS and VVV) have OBs lasting between 5 and 30 minutes. The survey with the largest number of submitted OBs is VVV: because of the multi-epoch observations the total number of OBs prepared and executed will be of order 30 000. Figure 2 shows the number of hours of execution of OBs each month for all VISTA surveys. The time charged for each OB execution is only counted for successfully completed observations and Figure 2 shows the completed OB hours that are computed by the observation preparation software (P2PP3). While in the first year of the operations there was still some fine-tuning of the operational procedures and overheads, now the overheads computed by version 3 of the Phase 2 Proposal Preparation system (P2PP3) are very similar to the actual time needed to execute the observations.

The histogram in Figure 2 shows the effect of technical interventions on the speed of execution of the public survey OBs, with the main impact falling in the period 3 April 2011 to 4 May 2011, which coincided with the recoating of the primary (M1) and secondary (M2) mirrors with aluminium due to fast degradation of the original silver coating, and an extended recovery and maintenance of M1.

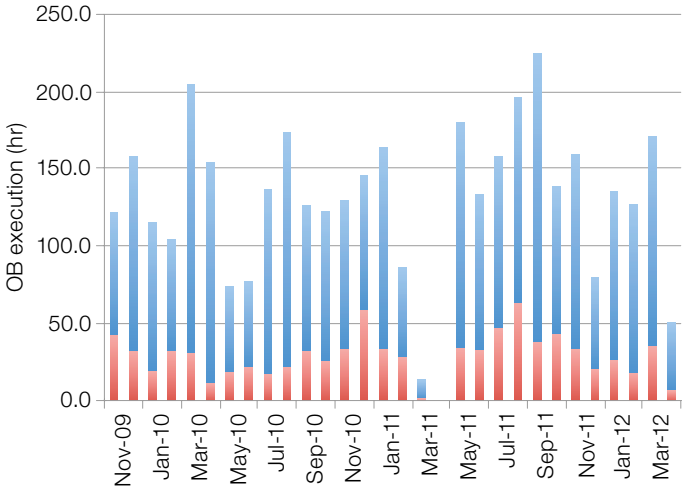


Figure 2. Histogram of the number of hours of execution of OBs each month for all VISTA surveys up to 1 April 2012. Quality control grade A is assigned to OBs completed fully within requested constraints (i.e. sky transparency, image quality, airmass, Moon illumination, etc.), while grade B is assigned to those OBs for which one of the constraints is violated up to ~ 10%.

In order to enable the survey teams to prepare large numbers of similar OBs and for ESO user support and science operations to verify and execute them in the most efficient manner, new tools have been developed (Arnaboldi et al., 2008). We list them briefly:

The Survey Area Definition Tool (SADT) was developed by the VISTA consortium (led by J. Emerson) and delivered as part of the United Kingdom in-kind contribution to joining ESO. The main role of the SADT is to efficiently mosaic the survey area and to identify the necessary active optics and guide stars for each tile. The SADT has been further improved following the experience gained during VISTA science verification, dry runs, and the first period of observations (P85+). The latest improvement was to introduce the 2MASS catalogue transformation to *I*-band magnitudes, which is now used for guiding and active optics on VISTA. This is important, as it was noticed that other catalogues suffered from low resolution, containing binary stars or galaxies, and some defects (e.g., containing spurious sources due to scratches on the plates from which these surveys were derived) which caused execution time losses due to the choice of unsuitable guide and/or active optics stars.

Phase 2 preparation tool for surveys (P2PP3) and Observing Tool (OT) for public survey support have resulted from the evolution of the main ESO observation preparation and execution tools. The PS teams prepare the observations using P2PP3 which takes as input the survey area definition file generated with SADT. In this way hundreds of similar OBs that adopt the same observing strategy and point to different areas in the sky are generated automatically, thus preventing typing errors and saving time. In addition to an interface with the SADT, this tool also allows the survey PIs to define the survey observing strategy via scheduling containers. These concepts can be easily encoded in an automatic ranking algorithm that suggests to the observers which OB is to be selected out of many thousands of similar survey OBs. The OT is used on Paranal for selecting the observations to be executed; it has the VISTA-specific ranking algorithm (Bierwirth et al., 2010) as well as reporting functionality.

Survey Monitoring and Visualisation Tool (SVMT) is a new tool developed to facilitate the Phase 2 review of thousands of survey OBs and to enable monitoring of the survey observations. The main functionalities are the display of the survey areas and the OB status for selected areas or survey runs, and the visualisation of the distribution on-sky for the submitted survey data products. Basic statistical functionalities have been implemented, such as calculation of the survey area and accumulated exposure times for which the observations have been completed or the data products submitted. This tool is used by the User Support Department and Archive Science Group, for the purpose of Phase 2 and Phase 3 reviews, respectively, and for overall survey progress monitoring by the ESO Survey Team (EST).

VISTA public survey completion rates

Here we present the current fraction of completeness for each VISTA PS and the expected time to completion, based on the current efficiency of execution. The absolute completion rate is based on theoretical OB execution times as computed by the P2PP execution time module and the time requested by the PI of each survey for the total duration of the project, as described in the Survey Management Plan (SMP). The absolute completeness fraction is given by the ratio of the completed OB time divided by the time requested in the SMPs. The completion rates are calculated for the observations up to the end of Period 88 (end of March 2012), hence they cover the first four periods of VISTA operations. In these four periods, the effective telescope time is about 1.75 years, as there were three months of technical downtime (mirror coating, M1 intervention and technical downtime to correct the focal plane tilt). These technical interventions affected mostly the VVV and Ultra-VISTA projects, as they took place in those months when either the Milky Way Bulge or the COSMOS fields are visible.

The absolute completion rates of the surveys at the end of P88 are listed in Table 1. These can be used to extrapolate the time necessary to complete the VISTA public surveys, assuming that the observations continue at a similar pace. From these assumptions, the VHS survey can be completed in about five years, while VVV, Ultra-VISTA, VIDEO and VMC are all expected to take more than seven years. These numbers are lower limits as the requested observing time in the SMPs was computed using overhead values that later proved to be underestimates. As the survey projects progress, and once one of the approved surveys is completed, the speed of completion is expected to increase for the other surveys. The VIKING survey was set to the lowest priority in P89 (October 2011–March 2012), as this survey currently fails to comply with the Phase 3 policies of data products submission for the ESO public surveys. Additional time allocation for the public surveys is pending the completed delivery of the agreed data products.

Table 1. Overview of the absolute completeness of the VISTA public surveys after 1.75 years of VISTA observing time (effective).

Period	VVV	VMC	VIKING	Ultra-VISTA	VIDEO	VHS
01.04.2010–30.03.2012	24 %	22 %	32 %	29 %	25 %	38 %

VISTA science operations

The VISTA telescope and its near-infrared camera VIRCAM are in normal operation: science data are being taken, and delivered to the users. Currently, the typical technical downtime is 2–3 %, to be compared with 10–12 % of weather downtime. During the commissioning of VISTA and VIRCAM, the overheads for telescope pointing, guiding and camera setup turned out to be ~ 30 % larger than the overheads estimated by the VISTA consortium. Several actions were then implemented to reduce the various sources of overhead. Furthermore, the telescope efficiency is about 10 % lower than expected because the original silver mirror coating was replaced with aluminium in April 2011, due to the fast degradation of the earlier coating. In Table 2 we provide the zero-point measurements in early operations with silver coating (dating from October 2009), the last measurements for silver (from March 2010) and the zero point with the new aluminium coating (measurements from July 2011).

Table 2. Photometric zero-point measurements (Vega magnitudes) in early operations (October 2009) with silver coating, last silver coating values (taken March 2010) and with the new aluminium coating (July 2011).

Filter	October 2009	March 2010	July 2011
Ks	23.03	22.88	22.96
H	23.87	23.61	23.76
J	23.78	23.43	23.66
Y	23.45	22.97	23.33
Z	23.82	23.22	23.58

During current standard operations, typical VIRCAM/VISTA technical downtime is due either to the M2 unit or active optics (AO) and autoguiding (AG) related problems. The AO and AG problems are partially caused by the incompleteness of the catalogues used by SADT to select guiding stars. The catalogue issue was improved by replacing the Guide Star Catalogue 2 (GSC2) optical catalogue with the 2MASS near-infrared catalogue, and by extending the latter catalogue to include synthetic optical magnitudes. The high elongation of the measured point spread function (PSF) detected during early telescope operations is now mostly under control and resolved. Occasionally elliptical images are recorded, typically due to azimuth axis oscillations that appear at seldom and irregular intervals.

Several optimisation steps were introduced into the instrument and telescope operation to increase the efficiency of observations: relaxing the declination tolerance of the AO correction and parallelising the instrument and telescope setups to decrease the overheads. Finally, the calibration plan was further revised, giving an extra 40 minutes per night for survey OB execution. Further hardware improvements are not realistic; software developments and further improvement of operations procedures may effectively improve progress speed, but only by a few percent.

The ESO policies for public surveys entail that raw data become public as soon as they are ingested in the ESO Science Archive Facility (SAF). Following the Memorandum of Understanding for VISTA, the Cambridge Survey Unit (CASU) receives a copy of all the raw data collected by VISTA for public surveys and normal programmes. PIs of VISTA public surveys do not automatically receive a copy of the raw data, but can access the pipeline data products either from CASU or the Wide Field Astronomy Unit (WFAU) archive in Edinburgh. Raw data are delivered regularly upon request to the Ultra-VISTA team.

Phase 3 – data products from public surveys

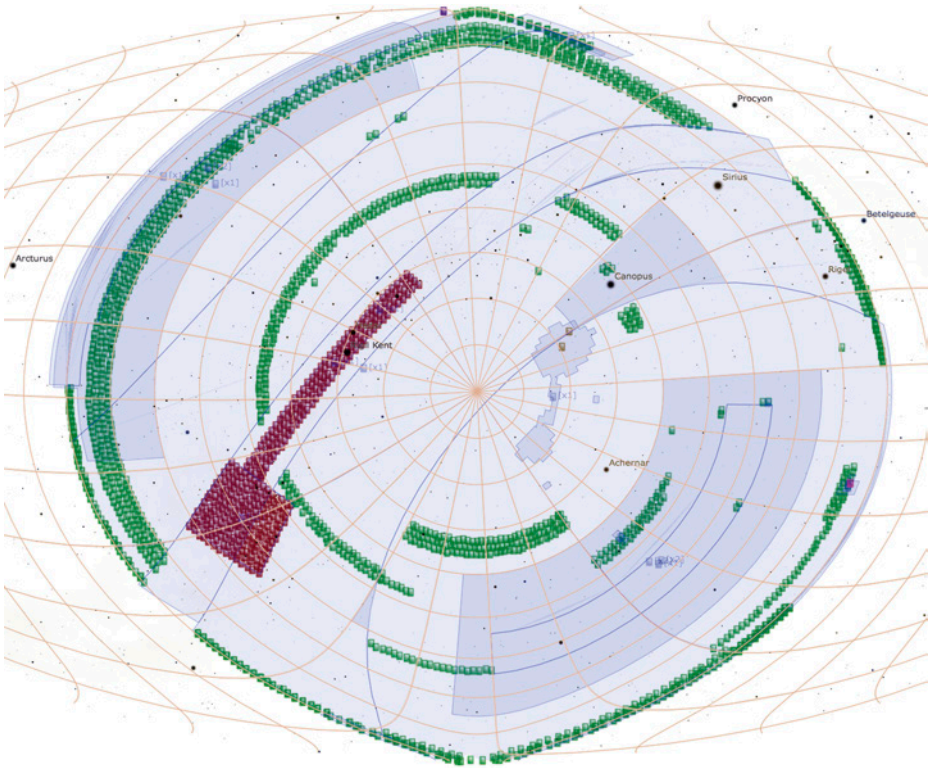
The raw data collected at the survey telescopes for the different projects amounts to about 1.5 TB per month, which, in turn, are condensed into a few terabytes of data products each year. Because of the legacy value of the public survey data products, ESO's policy is to ensure their long-term archival storage and public accessibility in order to promote their wide scientific use by the astronomical community at large, beyond those scientific goals initially identified by the survey teams. In order to bring this about, ESO has set in place a whole new process, called Phase 3, which represents the final step in the execution of ESO large programmes and public surveys.

The new Phase 3 infrastructure was deployed on 10 March 2011; it supports the reception, validation and publication of data products from the public survey projects and large programmes to the ESO Science Archive Facility; for a description of the Phase 3 tools and the infrastructure see Arnaboldi et al. (2011). Data products must be consistent with the data standards documented by the Archive Science Group at ESO. These data standards are required to characterise the level of data reduction and calibration, to track provenance, which allows ESO to monitor survey progress, and finally to support the query for specific data products via the ESO archive interfaces. In the context of the Phase 3 process, the data products returned by the survey teams are regularly monitored with respect to the actually executed observations. The timeline defining the requested delivery dates by type of data product is given by the Phase 3 policies.

For the VISTA data, a number of product types have been identified: images, weight maps and source lists. As high-level data products, the resulting source catalogues from the PS projects represent particularly important resources. The catalogues are different from the source lists, which are per-tile products and can be downloaded as entire FITS tables. The catalogue contents will be searchable via a dedicated query interface in the ESO SAF, which should become available in the second half of 2012. Basic functionalities will be supported to allow the archive user to carry out searches by position as well as by non-positional source parameters for sources in any area of the sky visible

Table 3. Overview of the ESO Phase 3 data releases resulting from the VISTA public surveys.

Survey	Submission Date	Date of Observations	Release Content	Filter	Sky Coverage (sq.deg)	Type of Data Products	Total Volume	Total Number of Files	Publication Date
VVV	03.05.2011	Feb 2010–Sep 2010	Contiguous patch of Bulge and Disc region including multi-epoch data in *Ks*	*ZYJHKs*	~ 520 (348 tiles)	Tiles Single-band source lists	1.5 TB	7980	25.07.2011
VIDEO	03.05.2011	Nov 2009–Feb 2010	XMM-LSS field	*YJHKs*	1.5	Tiles Single-band source lists	24 GB	291	25.07.2011
VMC	08.09. 2011	Nov 2009–Nov 2010	Two tiles in the LMC: one overlapping 30 Doradus and the other the South Ecliptic Pole region	*YJKs*	3	Stacked tiles and pawprints Single-band and band-merged source lists	8.1 GB	1256	25.09.2011
VHS	15.09.2011	Nov 2009–Sep 2010	VHS DES – 120 s in *JHK* VHS ATLAS – 60 s in *YJHK* VHS GPS – 60 s in *JK*	*YJHKs*	~ 1910	Tiles Pawprints Single-band source lists	3.9 TB	96474	17.10.2011
Ultra-VISTA	06.10.2011–30.01.2012	Dec 2009–Apr 2010	Deep imaging of the COSMOS field	*YJHKs*, NB118	1.5	Stacked images, SExtractor catalogues including *w*-selected multi-band catalogue	87 GB	19	15.02.2012
VIKING	10.10.2011	*Phase 3 data submission to be closed by PI*			–	–	19 GB	6276	–



from the La Silla Paranal Observatory, for further scientific selection and investigation on the user's computer.

Table 3 provides an overview of the ESO Phase 3 data releases resulting from the VISTA public surveys and Figure 3 shows a map with the sky coverage. A detailed description of the data releases is available[1]. These release pages are based on the information provided by the PIs and give an overview of the observations, a description of the data reduction and calibration, additional release notes illustrating the scientific quality of the data and any additional useful information regarding the content of the release. The data products from each VISTA public survey are available via the query form[2] or by following the link at the bottom of each release description page.

Figure 3. The VISTA public survey data products released through the Phase 3 process in 2011/2012 cover almost 2500 square degrees of the southern hemisphere. Colour coding: VHS–green, VVV–red, VMC–yellow, VIDEO–pink, UltraVISTA–purple. Entire survey footprints are shown in light blue.

The first public data release from the VISTA public surveys took place in December 2011. Since then, more than five thousand files and 2.0 TB of VISTA data products have been downloaded from the ESO SAF by the community. The most requested and downloaded data product type is the source list (in FITS table format).

Conclusions

VISTA survey operations have now reached a steady state and nearly 80 % of the night-time on VISTA is used to successfully execute survey observations. The VISTA public survey teams are actively carrying out their observations and achieving their scientific goals: as documented by the nine ESO press releases based on VISTA data since January 2010 and the 23 refereed papers from ESO public surveys thus far. In order to increase community awareness of the scientific research opportunities from the VISTA public surveys, ESO is organising a workshop on 15–18 October 2012 entitled "Science from the next generation imaging and spectroscopic surveys"[3].The astronomical community is invited to access the opportunities provided by the large wealth of data products delivered by the public surveys and to use them to explore science goals beyond those originally identified by the VISTA PS teams.

References

Arnaboldi, M. et al. 2011, The Messenger, 144, 17
Arnaboldi, M. et al. 2008, The Messenger, 134, 42
Arnaboldi, M. et al. 2007, The Messenger, 127, 28
Bierwirth, T. et al. 2010, SPIE, 7737, 19
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Links

[1] Description of the Phase 3 data release: http://www.eso.org/sci/observing/phase3/data_releases.html
[2] Query form for data products from each VISTA public survey: http://archive.eso.org/wdb/wdb/adp/phase3_vircam/form
[3] Homepage of the workshop "Science from the next generation imaging and spectroscopic surveys": http://www.eso.org/sci/meetings/2012/surveys2012.html

ESO/INAF-VST

This large field colour image of the nearby edge-on spiral galaxy NGC 253 was composed from VLT Survey Telescope (VST) images in *g*-, *r*- and *i*-bands. NGC 253 is a member of the Sculptor group at a distance of about 3.5 Mpc and as the nearest starburst galaxy shows signs of disc disruption and outflowing ionised gas. The dust absorption, well seen in this image, obscures the central starburst and possibly an active galactic nucleus. More details are available in Release eso1152.