VISTA Science Verification Report I

Summary of VISTA status following the Science Verification run: 15-30 October 2009

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Date: 02 November 2009

1 Introduction

The VISTA Science Verification (SV) run was scheduled from 15-30 October 2009. This run provided a very important check of the entire operational procedures, test of many different observation strategies, test of science templates including very large variety of input parameters, and last but not least it provided a first comprehensive scientific dataset obtained with VISTA. It allowed to find errors in some of the templates and to collect the necessary data for the check of the Exposure Time Calculator (ETC). The full report of the data taken during the SV run and the cross-check with the matrix of Survey Management Plans is presented in a separate document.
Overall the telescope and instrument performance was good and the operations run quite smoothly. However, there is still a need to fine-tune and optimize the telescope, instrument, operational procedures and other tools, to prepare them for the start of efficient survey operations.
Here I report on the issues found during the SV run. Most of the below listed problems were reported via Paranal Problem Reporting System (PPRS) and are either assigned for follow-up or should be followed-up after the telescope handover. Some of the problems were found new during the SV, but some were already known and reported earlier. I do not make distinction between these here.

Science operations during the SV run were supported by:

Telescope Operator:
15-27 October: Carlos La Fuente
27-30 October: Nestor Jimenez

Support Astronomer:
15-21 October: Thomas Szeifert and Marina Rejkuba
21-25 October: Marina Rejkuba
25-29 October: M. Rejkuba and V. Ivanov
29-30 October: M. Rejkuba, T. Szeifert, V. Ivanov, M. Hilker

VISTA telescope manager:
15-20 October: Serge Guniat
20-26 October: Stephan Sandrock
26-30 October: Serge Guniat

In addition, during this period the following people were also present:

- L. De Bilbao (SDD, Pipeline responsible): 14-19 October
- M. Petr-Gotzens (USD, SV PI): 15-27 October
- M. Arnaboldi (EDP, SV PI): 24-30 October
- S. Mieske (PSO): 16-26 October – however from 18-26 October working full time as UT3 support astronomer and therefore having only very limited time for VISTA

All the operations were run from the VLT control building. This worked very well and is very important for inclusion of VISTA in the Science Operations flow on Paranal.

2 Telescope and Instrument open problems

Here I list the open issues and problems found during the SV run related with the telescope and instrument. Next to each of them I provide a remark necessary/critical/minor issue as I think is appropriate (but please note that this is personal assessment, and may not be most accurate due to lack of background information about the whole system). Also if there is an open PPRS I provide the number. Please note that due to problems to access PPRS-es via web from Garching this list may be incomplete.
Currently none of these problems is a show-stopper for the start of operations. Some of them may have larger impact making the operations less efficient, but my (personal) estimate is that they could be solved within the time expected for the start of official operations in February 2010.

1. **Pointing Model** - PPRS-033232 - (critical)

   This problem was known before, but was seen also during the Science Verification. In the beginning of the night using HOCS observation the pointing zero point is corrected and set. After that pointing in the similar region of the sky is very good, but as soon as one moves the telescope by more than ~ 40 degrees there are problems to find guide stars in an automatic way. The OB usually crashes and the guide star needs to be find by hand. More critical are situations where the guide star is not found, but the OB does not crash, and rather goes on with observation without guiding and without AO correction. In this case it is possible to have slightly wrong coordinates, and to have sub-optimal image quality.

   The new pointing model was installed on October 26, but it did not improve the situation significantly. This is a critical problem, because according to what I learned on Paranal ESO does not have tools in place currently to independently measure and compute the full pointing model for VISTA - we still rely on the computation from D. Turret from VPO. This should be clarified for the operations.

2. **Readout noise in channel #14 of detector 6** - PPRS-033088 - (critical)

   Additional strong readout noise was affecting some data during the science verification run. The problem was reported in PPRS-033088 on October 16 (but was also known before) and the PPRS was updated regularly during the run.

   A concern is that until October 27, nobody from Paranal engineering started looking into this, and only discussing the pending problem with S. Sandrock (telescope manager) and after he sent a specific e-mail to G. Gillet asking that someone looks into it, the ticket was assigned. M. Cullum visited VISTA on October 23, and asked to have a copy of a snapshot that evidences the problem. He showed it to experts in Garching (G. Finger), who provided some suggestions on how to solve it. Additional suggestions came from A. Born and T. Szeifert who followed the updates of this ticket more or less daily. Finally, after the ticket was assigned to a Paranal engineer on October 27 to investigate, it became clear that solution to this will not be easy, because it is not possible to reproduce the occurrence of noise at will. It appears and disappears apparently completely randomly. Currently I have not yet seen a possible solution. This is probably the major pending problem affecting science observations as it may affect potentially large amount of data.

3. **Several problems with Enclosure** - PPRS 033208, 033239 (critical)

4. **Templates** - PPRS 033270, 033251, 033114 (necessary)

   - In case the OB starts with AO priority HIGH and there is a large change in pointing, the LOWFS AO correction is not always done before starting of the science exposure - this needs a better testing as the problem could be related to the pointing model problem. It is not clear if this is template problem or the problem with the AO setup.
   - PFJME nesting and AO correction abort signal - After each exposure there is an abort signal sent to the LOWFS and the AO computation is aborted, even if the telescope does not move - described in PPRS-033270.
   - The pair of tile patterns 3nx and 3px when taken in two OBs should cover the tile fully (and be therefore equivalent to tile 6 pattern). Currently this is not so. Problem is most probably in how SADT starts tiling, which produces a shift of 1/2 of the expected initial shift from the central position for Tile3px, as described in PPRS-033251.
   - Tile6 template with PFJME nesting and two identical filters in the list does not work as expected. This is described in detail in PPRS-033114.

5. **Frequent failures of Probe PY and Probe NY, and TCCDs** - PPRS 033182, 033104, 033162 (necessary)

   There are some recurrent problems with autoguider and technical AO CCDs. When it happens that the AG probe goes to standby, if the observer/operator notices the problem it is sometimes possible to put the system back online. However, if the telescope tries to offset while it is in standby the OB crashes causing loss of time and the need to sometimes repeat the whole OB (depending on nesting used in the template). In some cases it was necessary to re-boot the TCCD.

6. **Non-optimized AO / AG system** - (necessary)

   Some issues that are mentioned in PPRS-es, and some that became more obvious during the SV run:

   - there is no change of AG/AO exposure time based on the magnitude of AO/AG star. The AO and AG stars are sent from the PAF file for almost all science OBs and the magnitude is known. In all cases the currently running exposure time is simply assumed. This could be optimized by applying some correction factor to the exposure time based on the difference in magnitude between the current and the new star magnitude. In this way frequent manual corrections (or forgetting/overlooking them - which may lead to saturated guide star or too faint for good corrections) would be avoided.
   - there should be some (small) display of AO star fit result for each LOWFS detector available all the time. Currently the operator needs to open the panel manually (it is not automatically refreshed) - this is not practical in case of OBs with frequent pawprint offsets which select a new AO star about once per minute.

- There are no alarms/complaints from the system if AG/AO star is too faint or too saturated. Sometimes the system applied the corrections computed based on extremely noisy or too saturated stars without giving any warning. Only visual inspection of images showed the problem (apart from degraded image quality on the science RTD).
- there are no warnings provided in case the guide star is a binary or found in crowded fields. In some cases the AO correction is rejected, but sometimes it is accepted... this is similar to the previous point.
- In the beginning of the night one runs HOCS to compute the corrections to be applied to M1. Later, during the night LOCS runs in parallel with the observations. Currently only few people (T. Szeifert and probably C. La Fuente and A. Paraguez) have expertise and training sufficient to evaluate whether the computed coefficients are ok. Instrument scientist and other support astronomers and telescope operators do not have yet the necessary training for this. The solution to this is not clear - possibly more training... but with the foreseen operation model for VISTA it may end up depending on a core of very few people. In case of sickness or unavailability of these core people this may become a problem.

  The system computes the Zernicke coefficients and asks the operator/astronomer to confirm the result. However, there is no reference with respect to which this should be compared and unless one has a really deep knowledge of the system errors are possible...
- In some cases OBs were executed where the guide star was not found on the patch for a subset (four out of 6) pawprint offsets. This is most probably due to problematic stars being selected by SADT. However, the OB could run without problems and without significant image quality loss, because the previous observations was on the same target, and therefore AO was ok. Also the tracking without guiding worked very well due to relatively short exposures. Therefore the operations without guide and without ao stars should be possible (as is indeed the case now), but some sort of warning would need to be issued to report such cases - currently they might go on unnoticed. Example of such an OB: OBID 431262 within run ID 60.A-9285(A).
- During the SV run, especially in the second part of the night, we had excellent seeing conditions. This allowed to collect images with IQ measured on the images of ~ 0.55 arcsec. In case of excellent seeing, it was noted that sometimes the deferred tilt correction for M2 can be large, resulting in the quite large differences between the image quality in the center and in the corners. One such example was noticed on the night of 25 October and then again the night after that.

  When the problem was found the second time it appeared to be caused by a double star selected by SADT as AO star. This produced wrong corrections, but no warning was issued.

```
-----------------------------------
OB-id:           431509
-----------------------------------
OB name:         KsJZlong_OB_FPJME_Orion_SV_tile6zz_gen_3_2_1
targ_coord:       52235.616   5329.400
ob  started:     UT  7:17:25
-----------------------------------
template:        VIRCAM_img_obs_tile6
data product:    SCIENCE/OBJECT/IMAGE,JITTER
airmass:         1.12
tpl started:     UT  7:17:59
-----------------------------------
UT  7:18: 8,      Ks,   2.0s,12, 2  DIMM=0.76"  VCAM.2009-10-25T07:18:07.905.fits
UT  7:29:33, AO  7:29:26, AG= ON, last file:    VCAM.2009-10-25T07:28:44.572.fits
UT  7:30:14,       J,   4.0s, 8, 2  DIMM=0.83"  VCAM.2009-10-25T07:30:13.997.fits
UT  7:41:38, AO  7:41:30, AG= ON, last file:    VCAM.2009-10-25T07:40:48.795.fits
UT  7:42:24,       Z,  30.0s, 5, 3  DIMM=0.69"  VCAM.2009-10-25T07:42:24.118.fits
UT  8:32:43, AO  8:32:29, AG= ON, last file:    VCAM.2009-10-25T08:30:01.090.fits

                  det 1        det4        det11       det13       det16
-------------------------------------------------------------------------------
'Ks'    IQ,EL=  0.65",0.05  0.61",0.08  0.54",0.05  0.76",0.05  0.64",0.09      'No
'Ks'    IQ,EL=  0.68",0.06  0.64",0.07  0.56",0.08  0.74",0.07  0.66",0.06      'No
'Ks'    IQ,EL=  0.68",0.09  0.64",0.06  0.55",0.07  0.67",0.07  0.64",0.08      'No
'Ks'    IQ,EL=  0.64",0.06  0.65",0.11  0.55",0.06  0.73",0.08  0.67",0.09      'No
'Ks'    IQ,EL=  0.67",0.05  0.63",0.08  0.56",0.07  0.74",0.05  0.63",0.06      'No
'Ks'    IQ,EL=  0.64",0.06  0.59",0.07  0.54",0.06  0.75",0.06  0.60",0.08      'No

'J'     IQ,EL=  0.63",0.07  0.63",0.07  0.61",0.07  0.75",0.05  0.64",0.07      'No
'J'     IQ,EL=  0.70",0.06  0.75",0.06  0.73",0.06  0.81",0.06  0.77",0.07      'No
'J'     IQ,EL=  0.72",0.06  0.76",0.08  0.71",0.10  0.85",0.06  0.73",0.08      'No
'J'     IQ,EL=  0.72",0.06  0.67",0.07  0.64",0.07  0.81",0.08  0.65",0.07      'No
'J'     IQ,EL=  0.64",0.08  0.66",0.07  0.63",0.07  0.68",0.06  0.64",0.06      'No
'J'     IQ,EL=  0.68",0.06  0.68",0.08  0.65",0.07  0.79",0.06  0.68",0.06      'No
```

3 Operations

1. **Pipeline machine wvcpl and offline wvcoff disk space** - PPRS 032961 (critical)

   Currently available disk space on wvcpl is $\sim$ 800GB, while on the offline machine (wvcoff) there are 2TB of disk (partition /disb) that receive data via dataSubscriber and in addition 2TB (/diskc) that can be used for independent data reduction on the offline machine and for storing some results. The offline machine does not have redundancy. It is not clear if pipeline machine wvcpl has it. For the operations it is not so important to have redundancy on the wvcoff, but wvcpl should have it (to be confirmed by PSO VISTA Astronomers).

   The critical point is that within one night of full operations the pipeline machine can become full. During the science verification run it was necessary to clean wvcpl

during each night manually - it was not possible to keep more than current night + the previous night of data. During the SV run typically 120-150GB of raw images were recorded per night. It is expected that during the full operations, when VVV and VHS surveys will be observed the data flow of raw data may reach $\sim 300 - 350$GB. Therefore it is possible that the current wvcpl disk space is not sufficient even for only one night of data.

An additional minor point for the offline machine is that the user astro does not have permission to delete "date" directories under /data/reduced. It is however possible to remove the data in these directories.

2. **Insufficient time on VISTA schedule for SciOps** - (major concern)

   So far VISTA operation depends mainly on T. Szeifert. The VIRCAM Instrument Scientist was not scheduled on pure VISTA turno until the end of October. Later, until the end of the year SciOps astronomers do not appear scheduled on VISTA. The commissioning work, paranalization and preparation for the official start of surveys is supposed to be done as "extra work" on top of regular VLT Shift working at the same time as shift coordinator or day time astronomer or night support astronomer. This is rather inefficient and it is not clear if all the necessary preparation work can be done this way. During the VISTA SV the USD astronomer got more experience observing with VISTA than the Instrument Scientist. Once the survey operations start, there should be several trained astronomers and TIOs.

   Telescope operators training also needs to include training on observing tools. Until now this was not possible due to lack of tools and time for "science-like" observations. This should be implemented during the dry runs.

3. **Quality control of science observations** - (concern)

   Quality control of VISTA observations is done on Paranal assigning the grade to the collected data, similarly as for the VLT observations. The pipeline has been modified to include the reductions of all 6 pawprints observed within an OB. It was found that the newest pipeline release is fast enough to do that.

   However, in the operations model foreseen for VISTA, check of the quality of all 16 detectors pipeline reduced data is a major investment of time and it is not clear how this can be done. Proposal would be to do some (frequent) spot checks on the science data in Garching to ensure the quality of observations. The pipeline is fast enough now that this should not be a problem. This may need to be discussed at the IOT.

   Currently there is no check for the existence of necessary calibration frames (darks) for calibration observations (for flats and for standard star observations). This should be included in the calibration completeness checks on QC pages.

4. **Night report and problem reporting from the Paranal Night Log tool pending** - (necessary)

   The implementation of the night report within PANL is pending. It should be solved for the start of operations. Currently there are several scripts written by T. Szeifert that have to be run and results are then copied and pasted within emacs. While

this works ok, it is not practical for VISTA operations if they are to be run within Sciops 2.0 scheme.

5. **Instrument workstation** - (minor issues)

   The startup scripts and the overall setting of the instrument workstation was good. CalobBuild works well. Only minor changes are necessary as described in PPRS-033198 in order to align the setup with that of the other telescopes.

4 Phase 2 and other tools

1. **P2PP**

   P2PP for surveys works well. It was released to external users for OB preparation and so far no serious complaints were received. There are only minor pending issues. These are all documented in DFS tickets.

   Direct mode and engineering mode are not implemented in P2PP for surveys. Soon the P2PP3 will be discussed for implementation on the VLT instruments. There something will need to be implemented. It is important that Paranal is represented and present actively in these requirements re-discussions.

2. **OT for surveys**

   The OT for surveys is still in beta version, and the current version has a number of critical problems that should be solved urgently. The current schedule foresees that VISTA is operated mainly by TIOs and that an oversight of the queues is made by the Shift Coordinators in the afternoon and early evening. Therefore the tool needs to allow for smooth operations where one person runs the telescope, the instrument, reporting (night report and problem report), scheduling and quality control! These tasks are currently not yet at the level of automatization that would allow for one person job during "service" mode nights.

   The currently available version on Paranal is beta8, which is couple of versions behind that released to USD (beta10). A large number of issues were found, some of them critical for operations. These were all reported via e-mail to D. Dorigo and T. Bierwirth on October 19th. They are included here for completeness in Attachment A.

   In addition the following problems were identified (and will be reported via e-mail to T. Bierwirth and DFI):

   (a) After one exportx OBs from OT all information about the containers is lost. All time links information, group contribution information and all user priorities are lost. After importing OBs in P2PP it is not possible to re-create the links within OBs that were present in containers.

   (b) One other occurence of inconsistent OB states was found
   OBID 430081 was on +, and then set to "-" by mrejkuba on 25/10 and then was tried to check-out. Check-out did not work with the message

```
"Check-out unsuccessful

0 containers were checked-out.
0 OBs were checked out
1 Error(s) reported.
Error #1: Obs Block 430081 cannot be checked-out,
because the following OB(s) are queued to be observed
[430081]

0 Warning(s) reported."
```

However at this time OT was not running and there were no observations (was tried again in the afternoon with the same error).

Then I set (logged in the OT as mrejkuba with the USD role) this OB to "+" and then to "-" again. Now it was possible to check-out.

3. **SADT**

SADT acceptance is organized by M. Arnaboldi, and is scheduled for beginning of December. Until November 15 feedback should be collected and a report sent to J. Emerson. Michael Hilker (USD) has collected feedback on SADT based on preparation of the tool for phase 2 for dry runs. During the SV the problem with covering of the full tile with 2 Tile 3 templates was found (as already mentioned above when discussing templates):

The pair of tile patterns 3nx and 3px when taken in two OBs should cover the tile fully (and be therefore equivalent to tile 6 pattern). Currently this is not so. Problem is most probably in how SADT starts tiling, which produces a shift of 1/2 of the expected initial shift from the central position for Tile3px, as described in PPRS-033251.

Based on the experience gained through the SV and dry run OB review the following change in the XML schema for the SADT output is proposed here. The parameters that are currently present in the header of the XML file and that are directly written into OB template keywords should be duplicated as *comments* in the header of each PAF file:

(a) Survey - maxJitter

(b) Survey - tile overlap X and tile overlap Y

(c) Tile - DEC

(d) Tile - RA

(e) Tile - offangle

(f) Pawprint - offsetx and offsety

This is necessary in order to have access with the EVM script to check that target coordinates, rotator angle and tile pattern are not changed after the import of the SADT file in the OB.

SADT sometimes chooses double stars or galaxies for AG/AO stars. It is not clear if it is possible to check/prevent this based on current catalogues. Possibly a newer/better catalogue should be implemented.

4. **Pipeline**

   Offset skies templates are not yet available. Therefore to reduce data in the best possible way pipeline reduction needs to be setup manually, assigining to some frames "SKY_OFFSET" or "EXTENDED_OBJECT" tags. This is very time consuming and tedious.

   In addition, for extended objects it is necessary to turn "destriping" option off, which leads to not the best results in case one is interested in faint targets. If destriping is on, then the area of the detector where the large extended object(s) is present will have wrong flux subtracted, resulting in wrong results. Apparently CASU has some more advanced recipes to deal with this (e-mail from J. Lewis from 20 October 2009).

   Here I just point this as a remark. ESO is currently not committing to reduce science data (beyond those of Science Verification). However, in the future we will probably offer VISTA for "normal programmes" - in that case it would be important to be able to offer science-grade quality pipeline.

5. **Keyword propagation from OBs and from TCS and OT to FITS headers**

   A short document describing the problem and listing the necessary keywords and use cases was sent to T. Szeifert and V. Ivanov on September 18, 2009. So far no comments were received. This needs to be urgently discussed and sent for approval to A. Dobrzicky.

A OT feedback - e-mail sent to DFI on 19/10/2009

Feedback on OT (report on bugs & undesired behaviour) based on SV run:

CRITICAL:

1. please do not remove from the execution sequence aborted OBs automatically - this is particularly critical for concatenations; after abort it is standard procedure to reset status of the OB and re-start it directly from BOB. After that however the subsequent OBs from the concatenation cannot any more be added to the execution sequence because the current OB has status "S"
2. communication between OT and BOB is not fully consistent - we observed on several occasions during the last nights that the status of the OB in the repository browser was "S" (and the OB was running in BOB), but in the execution sequence the status was "A" (previous/old status). It happened also that after an OB was aborted in BOB, since it was not present in the execution sequence, it remained in the Repository Browser on status "S". It is not easily reproducible, because more often the OB Report window opened even for OBs that were not in the execution sequence, and the status could be updated.
3. replication of OB status between Paranal and Garching is not fully consistent. Example: we tried to execute OBID 428180, but it aborted due to wrongly set rotator angle in the acquisition template. After it got status "A" and this was confirmed, I logged-in using ot on my laptop (and connecting to the Garching database (I thought)), and I changed OB status to "-". I asked the user to check-out and revise. However the user could not check-out OB, getting report that its status is "A". However, I still see in repository browser status "-"?! Another example: in the Report of executed OBs for dates between 2009-10-15 and 2009-10-19 none of the OBs belonging to the run 60.A-9285(B) is listed. However several were observed - their status in the Repository Browser visible from Garching is not changed however!
4. OB Report does not contain information on the requested constraints - please correct

NECESSARY:

1. container name is not available either in Repository Browser nor in Orang window - please add
2. in version beta8 used on Paranal the Run View window hangs if opened
3. Verify Night report does not seem to work?
4. in Repository Browser open Report (e.g. execution time report), and then close; instead of returning the view to the Repository Browser (the window from which the action was taken), the Orang window pops on top, and repository browser is below all other windows - this is anoying
5. too often it happens that when one wants to click on a field in a queue view (or some other window), other opened windows pop-up on top; it is then necessary to select the desired window and field again

6. OB report (PDF file) in version beta10 that I have installed on mac laptop pops-up window that asks to save or open file continuously. I had to kill OT to stop this loop. In addition it is overwriting each time the same stuff with the same name. In mac the way that the command for the reader should be issued is not clear...

DESIRABLE:

1. container ID should be displayed in Run View window (currently only OBID is there)
2. please remove "Type" column from the Repository Browser and from Orang window - it always has exactly the same value (O) and is therefore useless
3. in the Repository browser after changing status there is a window that shows progress of the action; after the action is finished it asks for confirmation - this could be skipped (useless to confirm OK, since nothing else can be done)
4. in the Repository Browser please change "User ID" to "Last Name" to have it identical to the OT+Repository Browser version 2.13
5. please add User Prority among the selectable fields in Orang
6. the behaviour between windows for ORANG and Repository Browser is not consistent. It is possible to close Repository browser window, but closing Orang shuts down the whole OT. I think it would be more consistent to have the same behaviour for both - should be possible to close the window. To close OT the main OT window should only have exit.