1 VISIONS - VISTA Star Formation Atlas

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1.1 Abstract

The VISTA Star Formation Atlas (VISIONS) is a sub-arcsec near-infrared atlas of all nearby (d < 500 pc) star formation complexes accessible from the southern hemisphere. This atlas will become the community's reference star formation database, covering the mass spectrum down to a few Jupiter masses and spatial resolutions reaching 100-250 AU. The survey will cover a total of ∼550 deg^2 distributed over the six star forming complexes of Ophiuchus, Lupus, Corona Australis, Chamaeleon, Orion, and the Pipe Nebula and is planned to be finished three years after the observations commence. VISIONS is separated into three sub-surveys. A *wide* astrometric survey will perform large-scale H-band imaging of the target regions distributed over six epochs with an effective exposure time of 60s and a limiting magnitude of $H \approx 19$ mag. The immediate objective of the *wide* survey is to derive positions and proper motions of the embedded and dispersed young stellar population inaccessible to Gaia, as well as provide complementary photometry to the first generation VHS survey which fully covered all target regions in the J and K_S bands. The total requested time for the *wide* multi-epoch survey amounts 478h 41m 36s distributed over 2148 individual tiles. Complementary to the *wide* survey VISIONS includes a set of *deep* observations which will image the high-column density regions of the star-forming complexes. The *deep* survey features JHK_S observations of 57 tiles imaged in one epoch and 600s exposure times including sky offsets reaching limiting magnitudes of $J \approx 21.5$ mag, $H \approx 20.5$ mag, and $K_S \approx 19.5$ mag. The total requested time for the *deep* survey amounts 54h 36m 36s. For statistical comparison with the galactic field population VISIONS includes a set of six *control* fields (18 tiles) with the same limiting magnitudes and similar strategy as the *deep* observations. For the *control* sub-survey the requested observing time amounts 19h 19m 12s. In total the requested time for VISIONS amounts 552h 37m 24s for 2223 tiles where for the majority Thin observing conditions are required.

2 Survey Observing Strategy

VISIONS, the VISTA Star Formation Atlas, will allow the community to address in a complete and coherent way fundamental open questions in star formation and ISM research. The VISIONS public survey, optimized for astrometry, aims to observe all molecular cloud complexes within 500 pc accessible from the southern hemisphere. To achieve its goals, the following observing strategy, calling for three sub-surveys, was designed: we will observe 1) *wide* fields, covering the poorly known dispersed young population, 2) *deep* fields in the high-column density regions in these complexes ($A_V > 5$ magnitudes), where sensitivity and resolution are key to recover the embedded population of protostars, and 3) critical but often forgotten *control* fields.

A detailed view on both the *wide* and *deep* target regions is shown in Fig. 1 which also shows the coverage of other public VISTA surveys. An overview of the observing strategies and time requests for all sub-surveys is given in Tab. 1. The table lists - for each region and sub-survey the number of requested tiles, covered area, observing sequence, as well as individual and total OB execution times. For all sub-surveys in common a

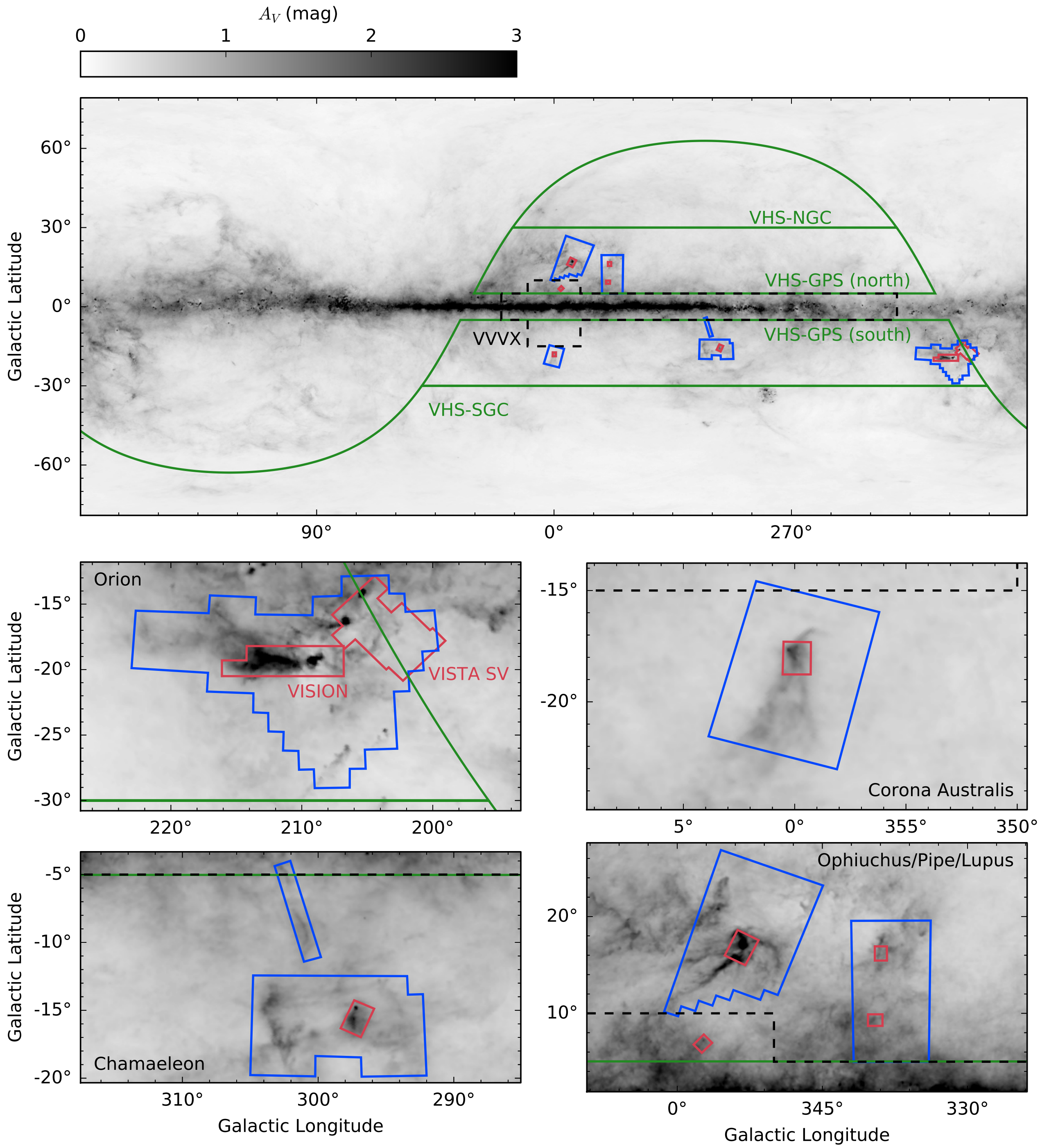

Figure 1: Overview of all *wide* (blue) and *deep* (red) target regions. The limits of the public VISTA surveys VVVX (black dashed lines) and VHS (green solid lines) are also displayed.

1 arcmin overlap for the doubly exposed area in a VISTA tile is included for adjacent tiles.

2.1 VISIONS sub-surveys

In the following subsections we will individually discuss the survey observing strategies in more detail for the three independent sub-surveys. In addition to the figures and tables presented in this document, we also offer an interactive display of the survey field definitions via the Aladin Sky Atlas (Bonnarel et al., 2000)[1]. Users can start the Aladin Sky Atlas and load the survey script by entering the following line into the command bar at the top of the software window (it is recommended to allow the software a few seconds to finish the script while the VISIONS coverage is drawn):

```
load https://www.univie.ac.at/alveslab/VISIONS/coverage.ajs
```

The resulting view shows all current field definitions on top of the Planck R2 HFI color composite (353-545-857 GHz). *Wide* tiles are shown with blue contours, *deep* tiles with red contours, and *control* tiles with green contours. For each tile the center position of all offsets are displayed, excluding jittered pointings. In addition also the VVVX, VISTA Science Verification, and the Meingast et al. (2016) Orion A VISTA observation contours are shown.

2.1.1 Wide sub-survey

The *wide* sub-survey features large-scale observations over six epochs of the nearby star forming regions Ophiuchus, Lupus, Corona Australis, Chamaeleon, and Orion. As agreed with the PSP, the *wide* field for the Pipe nebula was omitted since this region will be covered by the parallel ongoing public VVVX survey. The main goals of the *wide* observations are to provide complementary information on positions and proper motions for sources inaccessible to Gaia and deep near-infrared photometry on large scales. This includes both the embedded protostellar population of the star forming complexes, as well as the more evolved and dispersed young stars and brown dwarfs. The goals in choosing these wide fields were to cover as much as possible of the (a) high column-density parts of the cloud, (b) the very young embedded objects, as well as (c) the more dispersed young stellar population.

All regions are to be observed in H-band to provide complementary data to the first generation public VHS survey which imaged all our target regions in the J and K_S bands. In addition, the VHS survey will allow to extend the time-baseline for derived proper motions. For 60s per pixel effective exposure time on the assembled tiles we chose a combination of DIT= 3s, NDIT= 2, NJITTER= 5 resulting in a single OB execution time of 14m 12s. While this setup will saturate stars brighter than $H \approx 11.7$ mag, we expect to reach a completeness of around $H \approx 19$ mag. Since the low order wave-front sensor imposes a minimum of 45s between individual jittered exposures, the observations must necessarily be taken in open-AO mode with AO corrections only between exposures. Given these short integration times we will switch the priority of the active optics corrections to "low" if necessary to retain the same OB execution times. As recommended by the EST we will additionally set AG=T for the first pawprint of the sequence to minimize ellipticity due to the short integration times.

Based on our experience with the Meingast et al. (2016) data we chose a number of five jittered positions to ensure adequate bad pixel rejection for accurate positional measurements. In order to optimize the survey efficiency 4 adjacent tiles will be merged into a concatenation. After the first OB execution in a concatenation, subsequent executions will take only 12m 32s. Thus, for 4 concatenated OBs, the average OB time amounts 12m 57s, the total time 51m 48s. To optimize the positional measurements over the duration of the survey and distribute the different epochs, we will define absolute time intervals for the different sets of concatenated OBs (see Sect. 2.2.1 for details).

The total area covered in the *wide* survey is 537.4 deg^2 distributed over 358 individual tiles. For the planned six epochs there are then a total of 2148 tiles to be observed. 2/3 of the OBs (1440) will be put into concatenation

[1] Available for download via `http://aladin.u-strasbg.fr`

containers, while we leave one third (708) as single OBs to be efficiently scheduled between observations or at the end of the night. The *wide* sub-survey will take up the largest fraction of the requested observing time with a total of 478h 41m 36s.

2.1.2 Deep sub-survey

Deep field observations in addition to the *wide* astrometric survey will image the high-column density parts of nearby star-forming regions in the J, H, and K_S bands. The largest clouds (Orion A and B) have already been observed with VISTA (Science Verification, Spezzi et al., 2015; VISION, Meingast et al., 2016). Thus the *deep* observations constitute a relatively small portion of the entire survey. The remaining target regions are the central parts of Ophiuchus and Corona Australis, Lupus I and Lupus III, the Chamaeleon I star forming complex and B59 in the Pipe Nebula (as agreed with the PSP).

We planned the observations for the *deep* fields based on the experience with the previously published data. Since we expect large regions of extended emission, we include sky offsets for all *deep* fields except the Pipe Nebula which is characterized by less extended emission compared to the other regions. In addition, to ensure sufficient overlap in dynamic range for photometric calibration with 2MASS (Skrutskie et al., 2006) we favoured a relatively large number of detector integrations (NDIT) and jittered positions over longer individual integration times. For a total of 600s exposure time per pixel we chose DIT= 5s, NDIT= 10, NJITTER= 6 in J, and DIT= 2s, NDIT= 25, NJITTER= 6 for H and K_S. However, for the fields with sky offsets, the execution time of such OBs approaches almost two hours. For easier scheduling we therefore split the *deep* fields with sky offsets into two separate OBs, each observing NJITTER= 3. In the case of the Pipe nebula (which does not require separate sky observations), all jittered positions will be acquired in a single continuous OB. For all OBs with a duration slightly longer than the standard maximum one hour execution time we will submit waivers.

With these setups saturation issues will occur for stars brighter than $J \approx 12.1$ mag, $H \approx 11.3$, and $K_S \approx 10.6$ mag. The limiting magnitudes for the stacked observations will be around $J \approx 21.5$ mag, $H \approx 20.5$, and $K_S \approx 19.5$ mag. The total duration for the *deep* observations of 54h 36m 36s for all regions and bands will be distributed over 10 unique pointings including a total of 57 OB tiles.

2.1.3 Control sub-survey

Control field observations for statistical comparisons (e.g. estimating intrinsic colors and discriminating stellar populations) for each observed cloud will be located in regions of low column-density at similar galactic latitudes to the science targets. The observing strategy (DIT= 5s, NDIT= 10, NJITTER= 6 in J, and DIT= 2s, NDIT= 25, NJITTER= 6 for H and K_S) for the *control* fields follows the *deep* fields and does not include sky offsets due to the lack of extended emission in the target regions. The *control* fields are aligned with the *deep* fields in such a way that the galactic stellar population can be sampled in a field with as little extinction as possible. Since the exact pointing of the *deep* fields depends on guide star availability, the exact coordinates of the *control* fields will be determined once the *deep* OBs are finalized.

For Orion Meingast et al. (2016) already observed a *control* field. Lupus, on the other hand, requires two such fields since the *deep* fields cover two embedded regions at different galactic latitudes (separated by $\Delta b \sim 10°$). There are six control fields (18 individual tiles for a complete JHK_S set) to be observed (Ophiuchus, 2× Lupus, Corona Australis, Chameleon, and Pipe) for a total duration of 19h 19m 12s for all regions and bands.

2.2 Scheduling requirements

The scheduling for all VISIONS observations is summarized in Tab. 3. The total OB execution time for VISIONS is 552h 37m 24s which splits into 478h 41m 36s for the *wide* part, 54h 36m 36s for the *deep* part, and 19h 19m 12s for the *control* sub-survey. The multi-epoch *wide* survey will therefore take up the majority of the requested time (87%). 10% of the total time will be spent on *deep* observations and 3% on the *control* sub-survey. Below the scheduling requirements for the individual sub-surveys are discussed separately.

Table 1: Overview of the observation setup itemized for all regions in the *wide*, *deep*, and *control* sub-surveys.

Region	Band	Tiles (#)	Area[2] (deg^2)	DIT/NDIT/NJITTER	Exptime (s)	OB time[1] (hh:mm:ss)	Total time (hh:mm:ss)
				Wide			
Ophiuchus	H	93	139.6	3/2/5	60	-	20:43:56
Lupus	H	70	105.1	3/2/5	60	-	15:35:40
Corona Australis	H	25	37.5	3/2/5	60	-	05:35:00
Chamaeleon	H	56	84.1	3/2/5	60	-	12:28:32
Orion	H	114	171.1	3/2/5	60	-	25:23:48
Subtotal		358	537.4	-	-	-	79:46:56
Subtotal (6 epochs)		2148	537.4	-	-	-	478:41:36
				Deep			
Ophiuchus	J	8	6	5/10/3	300	00:51:06	06:48:48
	H	8	6	2/25/3	300	01:00:06	08:00:48
	K_S	8	6	2/25/3	300	01:00:06	08:00:48
Lupus	J	4	3	5/10/3	300	00:51:06	03:24:24
	H	4	3	2/25/3	300	01:00:06	04:00:24
	K_S	4	3	2/25/3	300	01:00:06	04:00:24
Corona Australis	J	2	1.5	5/10/3	300	00:51:06	01:42:12
	H	2	1.5	2/25/3	300	01:00:06	02:00:12
	K_S	2	1.5	2/25/3	300	01:00:06	02:00:12
Chamaeleon	J	4	3	5/10/3	300	00:51:06	03:24:24
	H	4	3	2/25/3	300	01:00:06	04:00:24
	K_S	4	3	2/25/3	300	01:00:06	04:00:24
Pipe	J	1	1.5	5/10/6	600	00:52:24	00:52:24
	H	1	1.5	2/25/6	600	01:10:24	01:10:24
	K_S	1	1.5	2/25/6	600	01:10:24	01:10:24
Subtotal	-	57	15	-	-	-	54:36:36
				Control			
Ophiuchus	J	1	1.5	5/10/6	600	00:52:24	00:52:24
	H	1	1.5	2/25/6	600	01:10:24	01:10:24
	K_S	1	1.5	2/25/6	600	01:10:24	01:10:24
Lupus	J	2	3	5/10/6	600	00:52:24	01:44:48
	H	2	3	2/25/6	600	01:10:24	02:20:48
	K_S	2	3	2/25/6	600	01:10:24	02:20:48
Corona Australis	J	1	1.5	5/10/6	600	00:52:24	00:52:24
	H	1	1.5	2/25/6	600	01:10:24	01:10:24
	K_S	1	1.5	2/25/6	600	01:10:24	01:10:24
Chamaeleon	J	1	1.5	5/10/6	600	00:52:24	00:52:24
	H	1	1.5	2/25/6	600	01:10:24	01:10:24
	K_S	1	1.5	2/25/6	600	01:10:24	01:10:24
Pipe	J	1	1.5	5/10/6	600	00:52:24	00:52:24
	H	1	1.5	2/25/6	600	01:10:24	01:10:24
	K_S	1	1.5	2/25/6	600	01:10:24	01:10:24
Subtotal	-	18	9	-	-	-	19:19:12
Total	-	2223	561.4	-	-	-	**552:37:24**

[1] This table does not include single OB durations for the *wide* survey since these are mixed with concatenations. See Sect. 2.1.1 for individual OB durations. For OBs longer than one hour appropriate waivers will be submitted.
[2] The total area is calculated for unique pointings and not as the sum of all tiles.

2.2.1 *Wide* scheduling

The *wide* sub-survey monitors large regions covering nearby star-forming complexes in a six-epoch survey over the course of 3 years. In order to optimize proper motion measurements, this sub-survey requires optimal spacing of the individual epochs. Chamaeleon, Ophiuchus, and Lupus are visible during parts of both observing semesters in a year. Orion is only observable during the Chilean Summer, Corona Australis mostly only during the Chilean Winter. For the *wide* survey we therefore plan the following schedule:

– P99/101/103 (April - September): 2/6 epochs CrA, 1/6 epoch for Chamaeleon, Ophiuchus, and Lupus
– P100/102/104 (Oct - March): 2/6 epochs Orion, 1/6 epoch for Chamaeleon, Ophiuchus, and Lupus

To guarantee optimal spacing between the individual epochs, we will create OBs with absolute time intervals for each epoch for all *wide* observations. For instance, Lupus can be well observed from February to August. In this case the absolute time interval will ensure that an observation in March is not immediately followed by another epoch in April. In general we will schedule 6-8 week windows for one epoch, with a minimum break of two to three months to the start of the next epoch of the same field. This is especially critical for Corona Australis and Orion which are planned to be observed twice per semester (for each scheduled semester). In these cases we will have a 6 week window to observe the first epoch within the current semester, while the absolute time interval for the second epoch will be set to the last two months of the period. If necessary, for Coronal Australis, the second epoch can also be scheduled within the first few weeks of the following semester. All observations of the *wide* survey are independent of the moon phase and require seeing better than or comparable to $\sim 1''$. Compared to the initial request of Clear conditions in the VISIONS proposal, we relaxed the observing condition criterion to Thin.

2.2.2 *Deep* scheduling

The *deep* sub-survey will image the high-column density regions of the nearby star-forming regions. For the largest molecular cloud complexes - Orion A and Orion B - *deep* data already exists (Meingast et al., 2016 and VISTA Science Verification) and the survey strategy has been adapted and optimized based on the experience with these prior VISTA surveys. In contrast to the requirement of seeing conditions of $\sim 1''$ or better in the initial proposal we introduced the stricter seeing criterion of $\sim 0.8''$ to meet the VISIONS scientific goals (e.g. wide binaries). To allow for efficient scheduling with these strict observing criteria the *deep* observations are distributed over the entire duration of the survey. All requested regions are best visible during the Chilean summer and are therefore scheduled in blocks for odd semesters. Ophiuchus is scheduled for P99, Lupus and Corona Australis for P101, and Chamaeleon and the Pipe Nebula for P103. The survey team is aware that for Chamaeleon (airmass $\lesssim 1.7$, visible in parts of both semesters) an image quality of $0.8''$ may be difficult to achieve. In case the observing criteria are not met within the scheduled semester, the region can be observed in P104 with relaxed constraints. Since the sources in the *deep* fields may be (unpredictably) variable on timescales from hours to days or even months no constraints on scheduling (including group priorities) within each semester will be set for any of these fields.

For OBs including sky offsets (all *deep* fields except the Pipe Nebula), the execution times for a total 600s exposure per pixel approach impractical values. Therefore each of these tiles (and each filter) will be observed with two separate OBs to allow for more efficient scheduling. For all *deep* observations the AO priority will be set to "high" for optimal quality. The OB runtimes for the *deep* fields range from ~51m to ~1h 10m.

2.2.3 *Control* scheduling

The *control* survey closely follows the strategy of the *deep* fields (same total exposure time per pixel). Since these regions are selected to be extinction-free (therefore no feedback from star formation, no bright extended HII regions), no sky offsets are necessary and also a seeing of $1.0''$ is acceptable. The observing strategy is therefore the same as for the *deep* Pipe Nebula field. *Control* fields are scheduled to be observed in the same semester

Table 2: Distribution of survey areas (itemized by region) in RA and total execution times.

Region	RA (hh:mm)	time *wide* (hh:mm:ss)	time *deep* (hh:mm:ss)	time *control* (hh:mm:ss)	Total (hh:mm:ss)
Ophiuchus	16:30	124:23:36	22:50:24	3:13:12	150:27:12
Lupus	16:00	93:34:00	11:25:12	6:26:24	111:25:36
Corona	19:00	33:30:00	5:42:36	3:13:12	42:25:48
Chamaeleon	11:30	74:51:12	11:25:12	3:13:12	89:29:36
Pipe	17:00	-	3:13:12	3:13:12	6:26:24
Orion	5:30	152:22:48	-	-	152:22:48
Total	-	478:41:36	54:36:36	19:19:12	552:37:24

as their associated science field and are therefore planned for odd periods. One *control* field will be observed in P99 (Ophiuchus), three in P101 (2× Lupus, Corona Australis), and the last two in P103 (Chamaeleon, Pipe).

2.3 Observing requirements

The distribution of observing time in Right Ascension (separated by region) is listed in Tab. 2. About half of the requested time is allocated to regions between RA $\approx$ 15h − 17h (Ophiuchus, Pipe, Lupus) and about 27% are distributed towards the galactic anticenter (Orion, RA $\approx$ 5h − 6h).

The instrument setups, total exposure and execution times, requested observing conditions, and scheduling for all semesters are itemized in Tab. 3 for all regions. The observing conditions for the *wide* sub-survey have been relaxed to Thin, the seeing constraints tightened to $\sim 0.8''$ or better for the *deep* fields with respect to the VISIONS proposal. While Thin conditions are sufficient for positional measurements, the *deep* fields require better image quality to reach the scientific goals of the survey.

3 Survey data calibration needs

The VISIONS survey requires three different sets of calibration units:

- **Instrumental signature** removal. Necessary calibration frames are dark frames (dark current and reset anomaly), dome-flats (linearity, bad pixel masking), and twilight-flats (first-order gain harmonization) and combinations therefore to measure the detector gain and readout noise. The VISTA calibration plan offers all necessary data to remove the instrumental signature from VIRCAM data. No special calibration data are required.

- **Photometric** calibration can be performed indirectly using external photometric standard star fields or directly by comparing the measured flux with know field sources. Since VISIONS will observe only in the J, H, and K_S bands, the photometric calibration is based exclusively on the latter technique and will directly use 2MASS field sources to calibrate the zero-point and illumination corrections.

- **Astrometric** calibration for VISIONS will be based on the 2MASS point source catalog, fine-tuned by future Gaia data releases. Previous tests on VISTA VHS data (a survey which was not optimized for astrometry; i.e. few jittered exposures) demonstrated a precision of $\sim$20 mas in positional measurements only relying on 2MASS data (see Fig. 4, right panel). Therefore VISIONS will not require special astrometric calibration fields since the method relies only on external references and the data themselves (see Bouy et al., 2013 for an in-depth discussion on automated astrometry done with ground-based observations).

Table 3: Scheduling plan and observing requirements itemized for all regions separately.

Period	Target name	RA	DEC	Filter setup	Tot. exp. time [hrs]	Tot. exec. time [hrs]	Seeing/FLI/ transparency
P99	Ophiuchus deep	16:30	-24	JHK	2.00	22.84	0.8″/bright/CLR
P99	Control 1[1]	-	-	JHK	0.50	3.22	1″/bright/CLR
P99	Ophiuchus epoch 1	15:45 – 17:10	-30 – -16	H	1.55	20.73	1″/bright/THN
P99	Lupus epoch 1	15:20 – 16:30	-46 – -30	H	1.17	15.59	1″/bright/THN
P99	Corona epoch 1	18:50 – 19:20	-40 – -34	H	0.42	5.58	1″/bright/THN
P99	Corona epoch 2	18:50 – 19:20	-40 – -34	H	0.42	5.58	1″/bright/THN
P99	Chamaeleon epoch 1	9:25 – 13:15	-82 – -67	H	0.93	12.48	1″/bright/THN
P100	Ophiuchus epoch 2	15:45 – 17:10	-30 – -16	H	1.55	20.73	1″/bright/THN
P100	Lupus epoch 2	15:20 – 16:30	-46 – -30	H	1.17	15.59	1″/bright/THN
P100	Chamaeleon epoch 2	9:25 – 13:15	-82 – -67	H	0.93	12.48	1″/bright/THN
P100	Orion epoch 1	5:00 – 6:10	-16 – 3	H	1.90	25.40	1″/bright/THN
P100	Orion epoch 2	5:00 – 6:10	-16 – 3	H	1.90	25.40	1″/bright/THN
P101	Lupus deep	15:45 – 16:10	-39 – -34	JHK	1.00	11.42	0.8″/bright/CLR
P101	Corona deep	19	-37	JHK	0.50	5.71	0.8″/bright/CLR
P101	Control 2[1]	-	-	JHK	0.50	3.22	1″/bright/CLR
P101	Control 3[1]	-	-	JHK	0.50	3.22	1″/bright/CLR
P101	Control 4[1]	-	-	JHK	0.50	3.22	1″/bright/CLR
P101	Ophiuchus epoch 3	15:45 – 17:10	-30 – -16	H	1.55	20.73	1″/bright/THN
P101	Lupus epoch 3	15:20 – 16:30	-46 – -30	H	1.17	15.59	1″/bright/THN
P101	Corona epoch 3	18:50 – 19:20	-40 – -34	H	0.42	5.58	1″/bright/THN
P101	Corona epoch 4	18:50 – 19:20	-40 – -34	H	0.42	5.58	1″/bright/THN
P101	Chamaeleon epoch 3	9:25 – 13:15	-82 – -67	H	0.93	12.48	1″/bright/THN
P102	Ophiuchus epoch 4	15:45 – 17:10	-30 – -16	H	1.55	20.73	1″/bright/THN
P102	Lupus epoch 4	15:20 – 16:30	-46 – -30	H	1.17	15.59	1″/bright/THN
P102	Chamaeleon epoch 4	9:25 – 13:15	-82 – -67	H	0.93	12.48	1″/bright/THN
P102	Orion epoch 3	5:00 – 6:10	-16 – 3	H	1.90	25.40	1″/bright/THN
P102	Orion epoch 4	5:00 – 6:10	-16 – 3	H	1.90	25.40	1″/bright/THN
P103	Chamaeleon deep	11	-77	JHK	1.00	11.42	0.8″/bright/CLR
P103	Pipe deep	17	-27	JHK	0.50	3.22	0.8″/bright/CLR
P103	Control 5[1]	-	-	JHK	0.50	3.22	1″/bright/CLR
P103	Control 6[1]	-	-	JHK	0.50	3.22	1″/bright/CLR
P103	Ophiuchus epoch 5	15:45 – 17:10	-30 – -16	H	1.55	20.73	1″/bright/THN
P103	Lupus epoch 5	15:20 – 16:30	-46 – -30	H	1.17	15.59	1″/bright/THN
P103	Corona epoch 5	18:50 – 19:20	-40 – -34	H	0.42	5.58	1″/bright/THN
P103	Corona epoch 6	18:50 – 19:20	-40 – -34	H	0.42	5.58	1″/bright/THN
P103	Chamaeleon epoch 5	9:25 – 13:15	-82 – -67	H	0.93	12.48	1″/bright/THN
P104	Ophiuchus epoch 6	15:45 – 17:10	-30 – -16	H	1.55	20.73	1″/bright/THN
P104	Lupus epoch 6	15:20 – 16:30	-46 – -30	H	1.17	15.59	1″/bright/THN
P104	Chamaeleon epoch 6	9:25 – 13:15	-82 – -67	H	0.93	12.48	1″/bright/THN
P104	Orion epoch 5	5:00 – 6:10	-16 – 3	H	1.90	25.40	1″/bright/THN
P104	Orion epoch 6	5:00 – 6:10	-16 – 3	H	1.90	25.40	1″/bright/THN

[1] The exact positions of the control fields will be defined at the stage of OB submission since they must be aligned with the corresponding *deep* fields. The position of the deep fields, however, will only be finalized upon OB creation when the Survey Area Definition Tool acquires guide stars.

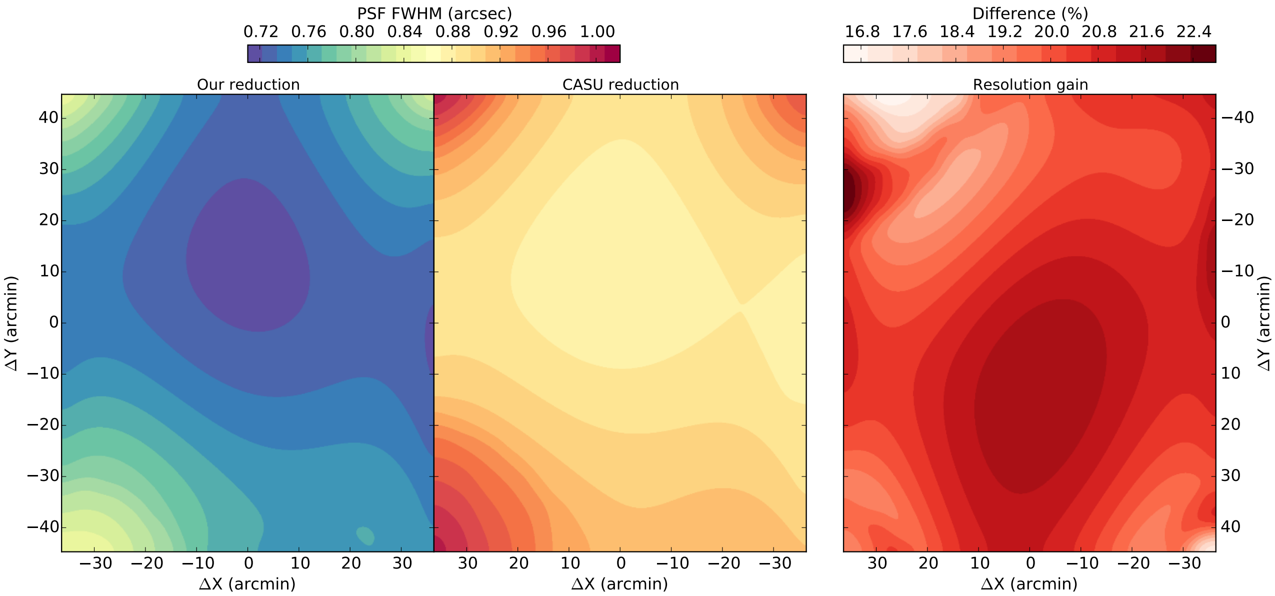

Figure 2: FWHM maps for both the Astropype reduction and the standard CASU pipeline of a tile in H band. Clearly a significant gain in image quality is achieved in our reduction. This figure was adopted from Meingast et al. (2016).

4 Data reduction process

The Meingast et al. (2016) VISTA survey of the Orion A molecular cloud demonstrated that the standard pipeline for VISTA data, operated by CASU, is not optimal for projects which aim for the highest image quality and unbiased photometry. Two major drawbacks in the CASU processing method make an independent data calibration necessary for the VISIONS project:

- To optimally co-add all reduced paw prints, each input image needs to be resampled onto a common reference frame. The CASU pipeline uses a radial distortion model together with fast bilinear interpolation to remap the images for the final tiling step. Bilinear interpolation, however, has several drawbacks. Apart from significant dispersions in the measured fluxes, it additionally "smudges" the images, leading to lower output resolution (see Bertin, 2010 for details and examples).
- For the zero-point calculation of each observed field the CASU pipeline applies a galactic extinction correction to all photometric measurements based on data from Schlegel et al. (1998) and Bonifacio et al. (2000). This will add systematic offsets with respect to photometric data for which no such correction was applied. For studies concerned with the intrinsic color of stars (e.g. extinction mapping), however, it is critical not to be biased in any way by such systematic offsets.

Meingast et al. (2016) implemented a completely independent data reduction environment, which (a) uses sophisticated high-order resampling kernels and (b) directly calibrates the photometry towards the 2MASS system without biasing the results with galactic extinction corrections. Figure 2 shows a FWHM map for on observed tile of the Orion A survey in H band for both the CASU and the improved reduction, as well as the corresponding gain in resolution.

The optimized processing typically achieves 20% higher resolution compared to the standard CASU pipeline, i.e. a 20% smaller FWHM. In addition, one can observe a dependency of the resolution gain with observing conditions. While only a gain of 10-15% is reached for seeing conditions > 1 arcsec, up to almost 30% can be gained for excellent conditions (~ 0.6 arcsec). Moreover, the improved reduction recovers the image quality of the pawprint level for the combined tiles which is not the case for the CASU reduction.

4.1 Astropype Reduction Cascade

For VISIONS the Meingast et al. (2016) data reduction environment and all individual modules have been aggregated into the stand-alone software package Astropype. The software was developed at the University of Vienna and is entirely written in Python. Astropype features fully automatic data processing optimized for VISTA, but it's basic processing modules are in principle applicable to any other imaging data (Astropype was successfully tested with VST and HAWK-I data products). For photometric and astrometric calibration and PSF analysis the pipeline environment relies on external software packages for which Python wrappers were developed. Figure 3 shows a schematic overview of the principle data flow in the Astropype environment. Below we will only give a concise overview of the key features of the major data reduction steps. Details on each individual module are given in Meingast et al. (2016).

1. Completely self-contained master-calibration unit. All necessary calibration data are automatically generated based on the time stamps in the FITS headers. Astropype is specifically tuned to generate master calibration units from the data collection as defined in the VISTA calibration plan. This includes bad-pixel-masks, master-darks, master-flatfields, weight-maps (also referred to as confidence maps), and linearity tables. In addition Astropype generates astrometric and photometric reference catalogs, as well as sky-frames for background modeling.
2. The master-calibration units are subsequently used to process the raw science data to remove the basic instrumental signature and the sky background from the VIRCAM images.
3. External references (2MASS and Gaia catalogs) are then used to simultaneously perform photometric and astrometric calibration via Scamp (Bertin, 2006). Following the initial photometric calibration an illumination correction is calculated directly from the external reference data. This process generates modified external calibration headers which contain astrometric information, as well as the necessary flux-scaling parameters for gain-harmonization, illumination correction, and photometric standardization.
4. All processed data are subsequently scaled and resampled onto a common reference frame and zero-point with SWarp (Bertin, 2010) using high-order resampling kernels.
5. From these resampled frames Astropype constructs calibrated pawprints and tiles and generates several quality control and global calibration units (e.g. aperture corrections). These pawprints and tiles are part of the VISIONS data products.
6. The constructed pawprints and tiles are then processed with SExtractor (Bertin and Arnouts, 1996) and PSFEx (Bertin, 2011) to generate source catalogs.
7. These raw source catalogs are then subject to further processing where e.g. aperture corrections and machine-learning-based morphological classification schemes are applied (see Fig. 9 in Meingast et al., 2016). In addition sources are cross-correlated with various quality control parameters and calibration units (completeness, local image quality, total effective exposure time, etc.)

Once data calibration for VISIONS commences and the Astropype code has been frozen, the software will be made publicly available on Github.

4.2 Benchmark

To estimate the total time required to process a typical night, we downloaded and processed a random night (2015-01-16) from the ESO Public Archives. A total of 775 files, including calibrations, ESO QC and scientific

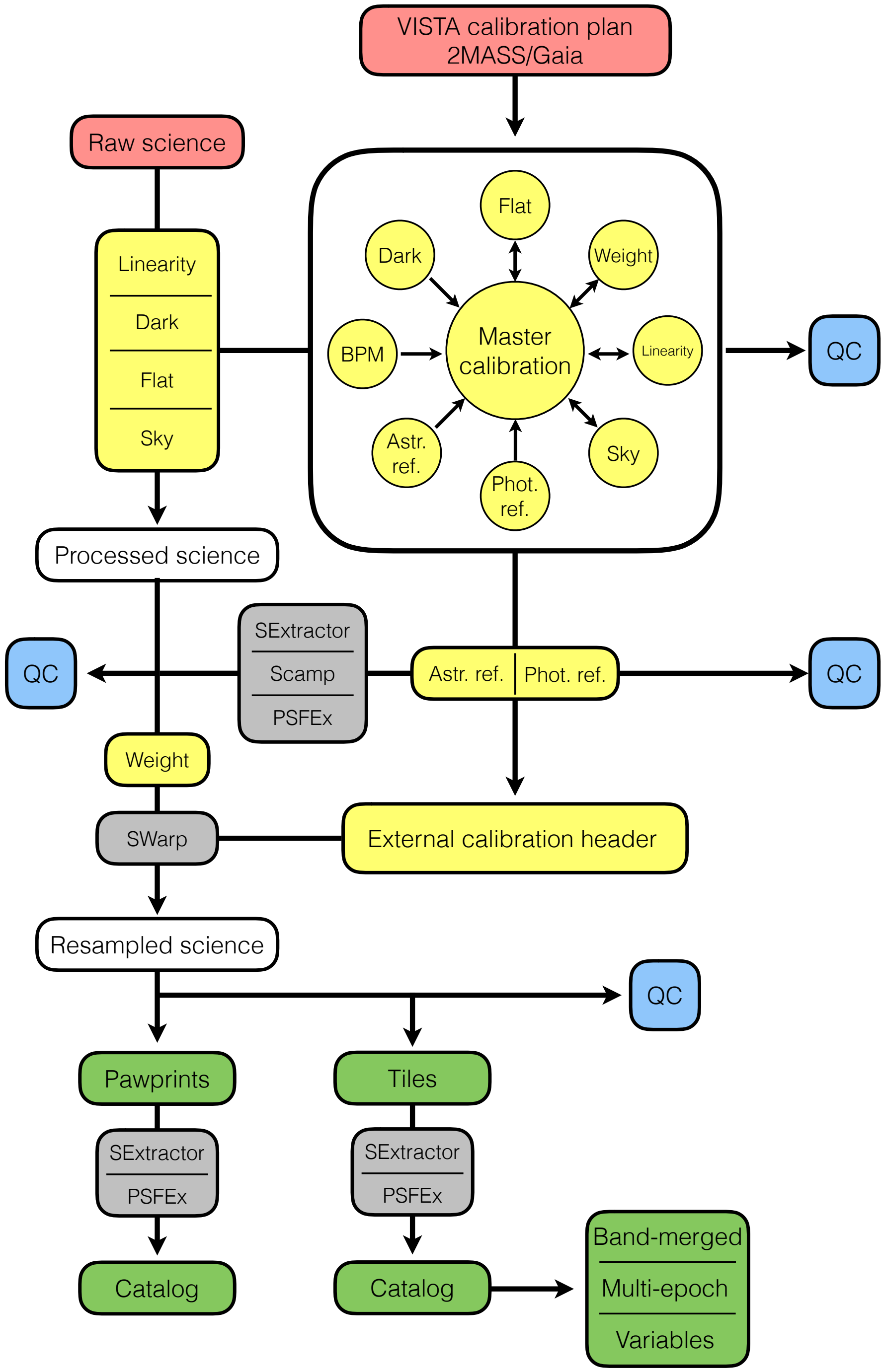

Figure 3: Schematic view of the basic Astropype processing steps. Input data is highlighted in red, calibration steps in yellow, quality control in blue, intermediate products in white, external software in gray, and deliverables in green.

images, were retrieved, totalizing 48GB of data. Table4 gives an overview of the execution times of the main reduction steps.

Table 4: Execution time for the various processing steps

Download from archive	45 min
Decompressing	20 min
Splitting MEF	60 min
Process Master Calibrations	1 min
Pre-Process Science Files	11 min
Astrometric + Photometric Solution	55 min
Co-addition	75 min
Final source extraction	10 min
Total:	4.5h

These benchmarks were obtained on a cluster made of 140 CPU with fast stripped hard drives and a 10GB/s network. This cluster will undergo a major upgrade in Nov. 2016 (see Section 5.1 below) and these data processing times should be greatly reduced. The above estimate should therefore be regarded as a conservative limit. It nevertheless demonstrates our capacity to download and process the observations on a nightly basis, which will be essential to provide a almost real-time feedback to the observatory.

5 Manpower and hardware capabilities devoted to data reduction and quality assessment

The VISIONS survey team will be structured into two major groups: the Survey Management Team (SMT) and the Survey Support Team (SST). While the former is responsible for the successful execution of the survey, the latter consists of multiple joint work groups which are specialized in specific tasks. The SMT will work continuously over the entire duration the survey, with monthly meetings, while the SST will work on particular time blocks on specific tasks.

The survey activities will be coordinated and overseen by the SMT (Alves, Bouy, Meingast). The SMT is also responsible for the survey preparation (e.g. OB submission) and the timely delivery of Phase 3 data products (contact point, Meingast). They will also manage and distribute tasks (e.g. quality control, pipeline upgrades) to specific panels of the SST. Each panel will be chaired by a responsible, supported by other team members. From experience, many issues only become apparent when working directly with the generated data. Each member of our team has a personal scientific interest in these data, which will guarantee quick real-life tests. The panels of the SST cover all major technical and scientific aspects of VISIONS: Survey execution and progress; pipeline/photometry/astrometry; data quality; stellar clusters; young stellar objects; positions and proper motions; dust properties. Each member is assigned to multiple support teams according to their specialization and scientific interests. A description of the detailed responsibilities of the members of the VISIONS survey team, their affiliation, and FTE commitment to the project is given in Tab. 5

5.1 Hardware

Processing and storing the large amount of data produced by VISIONS will require powerful high-performance computing facilities. We estimate that 500TB of disk space will be required to store and process the entire dataset produced over the duration of VISIONS. High throughput and parallelization will be essential for an efficient and timely processing of the continuous data flow, allowing a rapid quality check of the data and responsive feedback to the observatory.

We will have access to several computing facilities, all already funded:

Table 5: Allocation of resources within the VISIONS survey team.

Name	Function	Affiliation	Country	FTE
	Survey Management Team			
J. Alves	PI	U Vienna	A	0.2
H. Bouy	Co-PI	U Bordeaux	F	0.2
S. Meingast	Co-PI (contact point)	U Vienna	A	0.8
	Survey Support Team			
J. Ascenso	Young clusters, dust properties	FEUP	P	0.1
A. Bayo	SED modeling and APOGEE	U Valparaiso	RCH	0.1
E. Bertin	Pipeline and web interface	IAP	F	0.1
A. Brown	Interface with Gaia	Leiden U	NL	0.05
J. de Bruijne	Interface with Gaia	ESA	ESA	0.05
J. Forbrich	Radio astrometry, dust properties	U Vienna	A	0.1
J. Großchedl	Observation preparation, YSOs	U Vienna	A	0.1
A. Hacar	Cluster formation	Leiden U	NL	0.2
B. Hasenberger	Observation preparation, CMF/IMF	U Vienna	A	0.1
J. Kainulainen	Density mapping, structure analysis	MPIA	D	0.2
J. Kauffmann	Interface with SDSS	MPfR	D	0.1
R. Köhler	Binaries, jets proper motions	U Vienna	A	0.1
K. Kubiak	Observation preparation, dispersed population	U Vienna	A	0.1
K. Leschinski	Observation preparation, streams	U Vienna	A	0.1
M. Lombardi	Extinction mapping	U Milan	I	0.1
D. Mardones	Jets and outflows, obs. preparation	U Chile	RCH	0.1
A. Moitinho	Young optical population	U Lisboa	P	0.1
K. Peña Ramírez	Interface with VVV, IMF	U Cat. Chile	RCH	0.1
M. Petr-Gotzens	Observation preparation, binaries, IMF	ESO	ESO	0.1
T. Prusti	Interface with Gaia	ESA	ESA	0.05
R. Ramlau	PSF reconstruction, image quality	U Linz	A	0.1
T. Robitaille	Consultant (Hyperion, astropy)		UK	0.1
P. Teixeira	Observation preparation, binaries	U Vienna	A	0.1
E. Zari	Interface with Gaia	Leiden U	NL	0.1
W. Zeilinger	Observation preparation, galaxy clusters	U Vienna	A	0.15
	Planned positions			
Postdoc	Cloud structure analysis	MPIA	D	0.6
Postdoc	Data reduction	U Bordeaux	F	0.3
PhD student	3D modeling	U Vienna	A	0.8

- A HPC cluster located at the University of Bordeaux and owned entirely by H. Bouy. It will consist of 448 modern Intel CPU and 10 NVIDIA Pascal GPU, 1TB of RAM and will include 1.5PB of high-throughput enterprise-grade redundant (RAID) disk space, and a 40 Gigabyte/s Omnipath Network. This cluster is fully funded and is under design at DELL and will be delivered by the end of 2016.
- Dedicated high-performance workstations at the University of Vienna with high-throughput enterprise-grade redundant (RAID) disk space. A new set of workstations will be acquired in 2018 to complement the HPC cluster and small workstations and laptop.
- Personal computers for administration, reports, OB preparation, etc.

This hardware is offering a CPU and RAM overcapacity of at least 5 and a storage overcapacity of at least 3 for the VISIONS processing pipeline and expected dataflow. It therefore ensures that we will be able to deal with the data and eventual variations of data flow rates and reprocessing requirements on a nightly basis, as described in Section 4.2. All raw and processed files will be stored using lossless Rice tile compression to save a factor of 4 in storage requirements.

In addition to the computing facilities mentioned above, we will set up our own public cloud server and archive to share internally and externally all the raw and processed images and catalogues. A dedicated server will host a visualization interface based on the VisiOmatic software where users will be able to access, browse and explore the processed images and catalogues, enhancing and increasing the impact of ESO data. Finally, modern web-based collaborative tools, including a project management software, Wiki and WebRTC communication software, will give us full control of task and time management, team collaboration and reporting.

6 Data quality assessment process

The main resource for quality assessment for all data products will be dedicated quality control units generated by the pipeline infrastructure. These are produced at various stages in the data flow (compare Fig. 3). Examples of these units created by Astropype are shown in Fig. 2 (PSF FWHM map of a stacked VISTA tile), Fig. 4 (aperture correction and positional residuals during astrometric calibration), and Fig. 5 (detector non-linearity as measured from a VISTA dome-flat sequence). Other units generated by Astropype include, bad-pixel fraction, dark current, read-noise, gain variation, sky background variation, zero-point verification (fitting uncertainty, residual 1D and 2D variations after photometric flux scaling). The processed data will also include a suite of quality control parameters stored in the FITS headers including Phase 3 compliant information (e.g. limiting magnitude, saturation limit, spatial resolution, source ellipticity).

In addition to the survey team members responsible for quality assessment who will continuously monitor these quality control units, Astropype will also prompt warnings in case predefined upper and lower boundaries for the quality parameters are exceeded (e.g. bad pixel fraction, fitting uncertainties, etc.) upon which the survey team will investigate possible issues.

Since CASU already operates a stable pipeline environment for VISTA, the quality control parameters derived by Astropype and the general data products (e.g. processed pawprints) will also be compared to the standard VISTA pipeline reduction to identify potential systematic errors.

7 External Data products and Phase 3 compliance

The VISIONS data products will be delivered according to the ESO Phase 3 policies. All science products will initially be made available via the ESO Phase 3 ecosystem and will comply to the given standards (e.g. metadata FITS header QC keywords). Any subsequent publication via e.g. CDS will acknowledge ESO as data origin. The following data products will be made available:

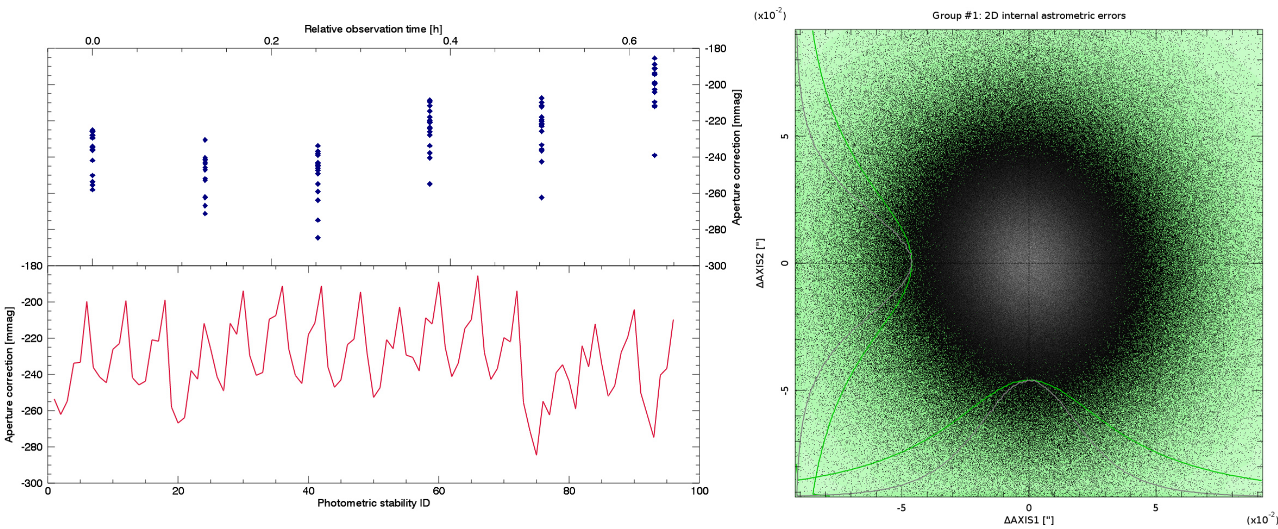

Figure 4: Left: Aperture correction quality control unit generated by Astropype for the K_S control field of Meingast et al. (2016). Right: 2D internal astrometric residuals obtained for a test-sample of 1600 K_S VHS VISTA images. The gray curve represents the integrated distribution for SNR$>$ 100 sources, and the green curve the integrated distribution for SNR=10. They have a 1-σ dispersion of $\sim$ 20mas.

- Processed pawprints with removed instrumental signature including photometric and astrometric (compliant with the WCS standard) calibration, with Phase 3 compatible FITS headers. All processing steps will also be documented in the headers.
- Stacked tiles constructed from the processed pawprints (also Phase 3 compliant with appropriate headers).
- Weight (confidence) maps for both the processed pawprints as well as the stacked tiles.
- Quality control database including maps tracing background noise, seeing, PSF shape, exposure time, frame coverage, effective observing time, and completeness estimates (see Meingast et al., 2016 for examples).
- Derived source catalogs for both pawprints and stacked tiles, including positions, multi-aperture photometry, and morphological classification.
- Homogeneous band-merged catalogues directly constructed from the VISIONS data (*deep* and *control* survey) or merged with VHS data (*wide* survey).

8 Delivery timeline of data products to the ESO archive

Simultaneously with the start of the VISIONS observations in P99 (April 2017), the team members in charge of data reduction and quality assessment will continuously monitor the survey progress. The survey team expects a test phase of 6 months for final pipeline implementation, initial data validation and quality assurance. As soon as a stable setup is achieved, data reduction will commence and will continue parallel to the observations.

The survey team plans in total three data releases:

- October 2018, DR1: 18 months after the start of the public survey operations in April 2017, the initial release of VISIONS will include all available data products of the *deep* and *control* observations that were

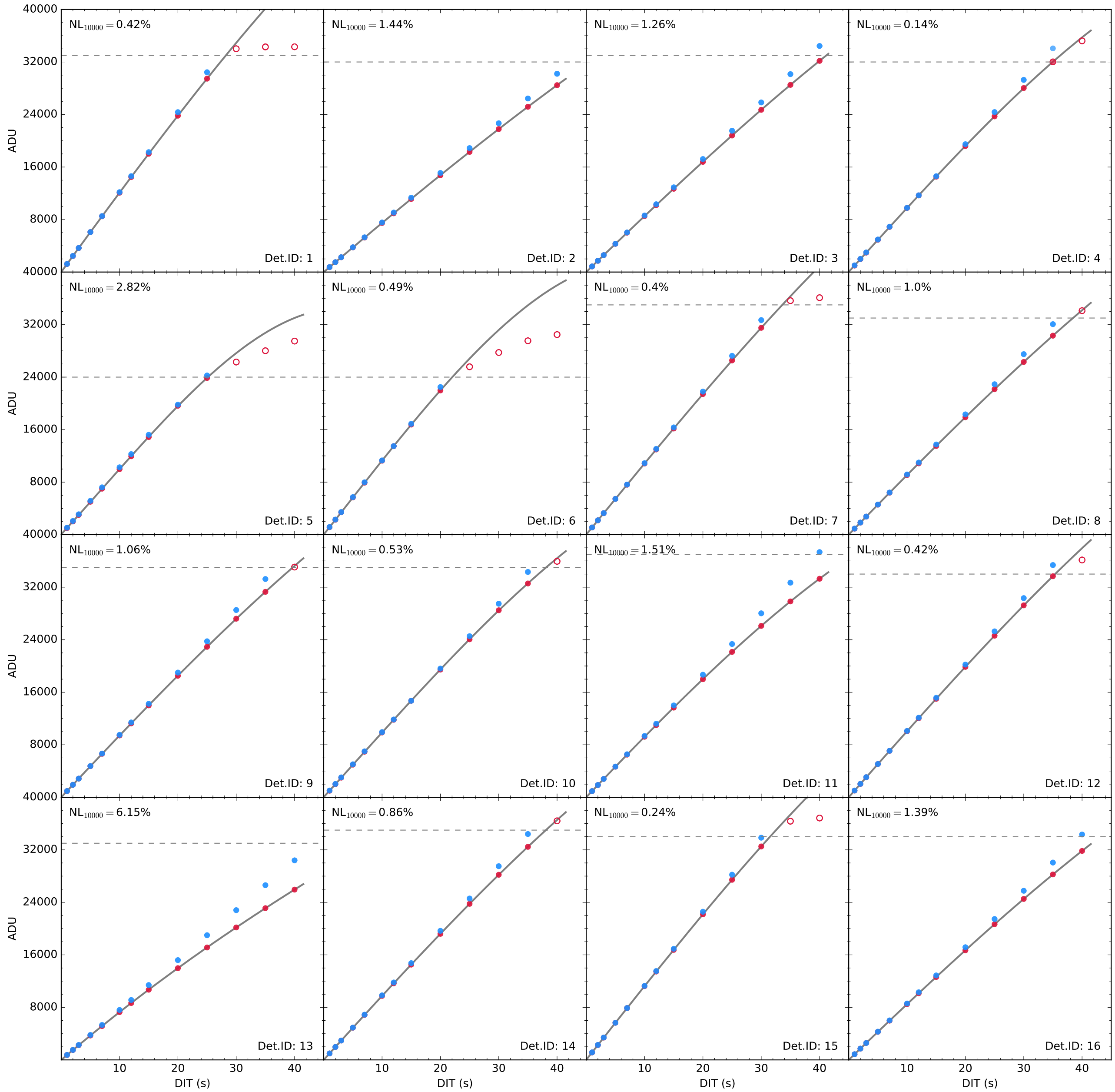

Figure 5: QC unit generated by Astropype to measure non-linearity of the VIRCAM detectors for a randomly selected dome-flat sequence from the VISTA calibration plan.

observed by April 2018. This includes all processed and calibrated pawprints and tiles, the complete band-merged source catalogs as well as various advanced quality control units.

- October 2019, DR2: Release of photometry for the *wide* survey. As in DR1 this release consists of calibrated pawprints, tiles, and source catalogs. DR2 will also be complemented by all additional *deep* and *control* fields which have been observed by April 2019.
- October 2020, DR3: Final release of the *wide* survey data products. Building on DR2, this release will include multi-epoch photometry (6 epoch *wide* survey) and positions of all detected sources. Also remaining *deep* and *control* sub-survey data products will also be made available. In addition we will provide the final mosaics via the VisiOmatic web interface (Bertin et al., 2015). A sample illustrating some of the numerous capabilities can be seen on the following webpage: http://visiomatic.iap.fr/pleiades/

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Appendix A: Response to EST/ASG/instrument scientist Report

1. Phase 1: the team is requesting 75 hrs with more stringent observing conditions with respect to the submitted proposal. The request of 0.8 for fields at airmass 1.6 -1.7 (Chamaeleon SFR) is particularly difficult to achieve. The team is asked to modify this request in the revised SMP by relaxing the observing constraints. For scheduling purposes, the more stringent conditions may be accepted for no more than 20 hrs per semester.

   The *deep* and *control* survey strategies have been revised to allow for more efficient scheduling. To this end we relaxed the observing constraints for the *control* fields to 1″ seeing (but keeping CLR conditions) and instead of scheduling all *deep* and *control* blocks in P99, each odd semester now includes a set of these observations. For P99 we schedule Ophiuchus (execution time: 22h 50m 24s) and one control field, for P101 Lupus (11h 25m 12s), Corona (5h 42m 36s), and three control fields, and for P103 we will observe Chamaeleon (11h 25m 12s), the Pipe (3h 13m 12s), and the remaining two control fields. In addition we adjusted the delivery timeline of the survey science products accordingly.

   The VISIONS team is also aware that 0.8″ for Chamaeleon are difficult to achieve. However, previous surveys have shown that such conditions can be met at similar altitudes (e.g. LMC/SMC). The Chamaeleon field is visible in both observing semesters where the *deep* field is currently scheduled for P103 and requires an execution time of 11.4h. If the criteria are not met within this time frame, it is possible to relax the constraints for subsequent observations in P104.

2. Phase 1: Please add in Sec. 2.1.2 the information that the OB strategy for the deep survey OBs includes sky offset fields, which leads to longer OB execution times than for the otherwise identical control field survey OBs.

   Section 2.1.2 has been rewritten to consider all changes with respect to the *deep* survey and now also describes the sky offset strategy in detail.

3. Phase 2: OBs of 1hr:57 min are very long and the PI should be aware of the QC policy that if the conditions degrade after the first hour of execution, in violation of the constraints, the OB would be continued and will not be repeated. This means that such a long OB execution will not guarantee homogeneous image quality. A split into two OBs might result in more homogeneous quality and also ease the scheduling.

   The OBs for the *deep* fields including sky offsets have been split into two separate blocks, each including three (of the in total six) jittered positions. Instead of 1h 57m 42s runtimes (for H and K_S), the split OBs now are executed in one hour each. The J band *deep* OBs now take 2× 51m instead of 1h 39m 42s. Individual *deep* field regions are still scheduled to be observed in the same semester. The longest OB execution times now are 1h 10m 24s for the *control* and *deep* (Pipe) observations without sky offsets. Executing the two split OBs leads to a longer observing duration compared to using only one long OB. However, since we also removed the sky offsets for the Pipe Nebula the *deep* survey now requires less time (54h 36m 36s instead of 55h 51m in the previous survey plan). Due to the revised strategy the total requested time has changed to 552h 37m 24s.

4. Phase 2: time sequences of concatenation of OBs are NOT possible. Please revise the observing strategy whereby concatenation of OBs are defined with absolute time windows.

   We have adjusted the observing strategy for the *wide* fields in such a way that absolute time intervals will be defined for a set of four concatenated OBs. Time-link containers will therefore not be required for scheduling. All *wide* OBs will be given certain absolute time intervals in which they should be observed (6-8 weeks). The next epoch of the same field will then be defined so that there is minimum break of two months. This is especially important for *wide* fields which have two scheduled epochs in one semester (Corona Australis and Orion).

5. Phase 2: For OBs with short exposures (NDIT x DIT < 31 secs) one can get high ellipticity. It helps to set AG=T for the first pawprint.

   We acknowledge this very helpful hint, will follow the recommendations, and have added a statement to Sect. 2.1.1.

6. Quality control: QC parameters referring to science data products must be included in the FITS header of the respective file. Example: PSF_FWHM. The team may add its own parameters to complement the set of SDPS keywords. See P.12 below for Phase 3 standard validation.

   The survey team is aware of these requirements. All necessary QC parameters will be generated by our pipeline and will be added to the phase 3 products. A short statement has been added to Sect. 7.

7. FTE/resource allocation: it is worrisome that the PI allocated only 0.2 FTE yearly to the survey. Many allocations to team members at the level of 0.1 FTE, which is not effective.

   We understand the concern but we see the FTE contributions as mean contributions to the project. A typical 0.1 FTE contribution should not be seen as 4h per week but as a specific intense period of work for a particular task that, on average, over the duration of the survey, will take 0.1 FTE per year. In contrast, the 1.2 FTE for the SMT should be seen as a continuous contribution. We changed the contribution from a post-doc in Table 5 from 0.2 to 0.3 FTE. Although this might not alleviate all concerns, we are currently procuring funds for a PhD position for which we already have have part of the money. We plan to use 100% of this position to the project, although we do not list it yet on Table 5.

8. FTE/resource allocation: Table 4 should indicate the team member responsible for the OPC report and the assignee of the Phase3 survey manager role, i.e. who is responsible for data release planning, validation and documentation (data release description).

   The SMT as a whole (Alves, Bouy, Meingast) is the direct responsible for the OPC report and the assignee of the Phase 3 survey manager role, and will work tightly, via monthly telecons, to keep the survey obligations on time. If a single contact person is necessary for these tasks, this should be Co-PI Stefan Meingast.

9. FTE/resource allocation: it is noted that the hardware for data processing becomes available to the team at the end of 2017/2018, hence it is not available (installed, commissioned and tested in operation) at the start of the survey. This is a concern as it is likely to propagate in a backlog of data to be processed, and generate substantial delays for the data releases and science exploitation. The team is asked to describe the mitigating strategies to be set in place to secure an earlier the delivery of the hardware and carry out an efficient commissioning.

   It was a mistake. The HPC cluster is fully funded and is being designed at the moment with the DELL team. We expect a delivery by the end of 2016, 6 months before the start of observations. Its characteristics have been updated, and it represents a large overcapacity with respect to the expected requirements to process the survey.

10. FTE/resource allocation: the team is asked to provide an estimate of how long it takes to process one night of VIRCAM data, in order to assess the time required to process the entire backlog of raw data, caused by any delays in the delivery of the hardware or commissioning of the pipelines.

    A new section 4.2 has been added. We find that it takes about 4.5h to process an typical night with our current HPC cluster. This figure should drop by at least 30% with the new facility expected for the end of the year.

11. Phase 3: the team is asked to carry out a Phase 3 format and provenance verification of their products as to check the compliancy of the metadata information and data format with the phase 3 standard. Their already reduced and published data for VISION (Meingast et al. 2016) could be used as a test data set.

We also acknowledge this additional helpful advice and the survey team will carry out a Phase 3 verification with the VISION data before the start of the VISIONS operations in April 2017. We expect that this step will minimize the potential issues when preparing the new survey data for the subsequent Phase 3 release.

12. Phase 3: Master calibration frames are generated by ESO on a regular basis and made available to the community via the ESO archive. The scope of Phase 3 delivery are science data-products only (as defined in ESO/SDPS doc. and the published amendments)

    We have removed the master-calibration units (darks, flats, linearity) from the provided external data products in Phase 3 (see Sect. 7). However, the team still plans to provide advanced calibration units to the community including data from our quality control setup (image quality maps, completeness, etc.).

13. Phase 3: The science data products must be submitted via Phase 3, to be compliant with ESO PS policies, despite possible redistribution through other channels (pls. acknowledge ESO as data origin; and follow requirements for third parties distributing ESO data http://archive.eso.org/cms/eso-data-access-policy.html)

    The VISIONS team is aware of these policies and the initial release of all science data products will be made via the ESO phase 3 infrastructure. Subsequent publications (e.g. via CDS) will acknowledge ESO as data origin.

13a. One point still open: Not clear whether they deliver light curves from multi epoch observations: in Section 7 they state "Homogeneous band-merged catalogues directly constructed from the VISIONS data, but not clear statement about multi-epoch photometry data. These deliverables are then listed in Section 8 (to be included in DR3), but not included in the detailed list of products in Section 7. Please clarify in the revised SMP to be published on the ESO web site.

We will provide multi-epoch photometry for all wide fields in one final single catalog. Every object will have, when detected, six flux measurements. We removed the statement on variability flags from section 8.

Appendix B: Changelog

1. Following the request to modify the *deep* survey strategy, we now distribute the *deep* and *control* sub-surveys over multiple periods. This was preferred over relaxing the observing constraints to $1''$ seeing.

2. The changed schedule for the *deep* and *control* sub-surveys made it necessary to adapt the delivery timeline of VISIONS data products. Instead of releasing the *deep* and *control* data with DR1, these data are now also distributed over the three planned releases.

3. For easier scheduling, the observing conditions for the *control* fields have been relaxed to $1''$.

4. The long *deep* sub-survey OBs including sky offsets have been split into two separate OBs with the consequence that the total execution time for these *deep* OBs increased. However, we have removed the sky offset observations for the Pipe Nebula *deep* field since we do not expect large amounts of extended emission in this region. In total the duration of the *deep* survey decreased from 55h 51m to 54h 36m 36s.

5. As a consequence of the adjustment of the *deep* survey, the total requested time for VISIONS now amounts 552h 37m 24s (instead of 553h 51m 48s).

6. We have adjusted the observing strategy of the *wide* fields so that no time-links between concatenations are required (which is not possible). Instead we will create OBs with absolute time intervals for each wide sub-survey.

7. We have rephrased various statements concerning FTE contributions from the survey team. In particular we highlight, that the relatively small contributions (0.1 FTE) are considered specific tasks at particular stages of the survey (e.g. OB creation) and are not meant as a continuous contribution. In contrast, the Survey Management Team will work closely together over the entire duration of VISIONS.

8. We corrected errors in the description of the hardware deployment and added a section including a processing benchmark for a typical VISTA/VIRCAM night.

9. We removed master-calibration units (bad pixel masks, master-darks, master-flats, non-linearity tables) from the Phase 3 deliverables since these are also being made available by ESO via the ESO archive.

10. We acknowledge the very helpful tips of the ESO Survey Team, the VISTA/VIRCAM instrument scientists, and the Archive Science group and have taken their suggestions into account. This includes the setup of the active optics, the various suggestions related to Phase 3, and the notes on ESO public survey policies.