ULTRAVISTA-TERAPIX "TV-01" data release

H. J. McCracken, P. Hudelot, Y. Goronova, Y . Mellier,
F. Magnard, M. Monnerville, (TERAPIX/ Institut d'Astrophysique de Paris)
J. Dunlop, O. Le Fèvre, M. Franx, J. Fynbo,
B. Milvang-Jensen, J. Holt, K. Caputi (Ultravista core team)

June 10, 2011

1 Scope

This document describes the first ULTRAVISTA-TERAPIX data release, hereafter referred to as TV-01. This data release differs from the CASU processed images in the following aspects:

- Stacks are created from sky-subtracted individual images, and not from *.st* images provided by CASU; the CASU sky-subtractions are not used.
- A different running sky image is created *for each image* based on the temporal image sequence and subtracted from the images before stacking (after the CASU-subtracted sky frames are added back in);
- Astrometric solutions are computed using the COSMOS CFHT $i-$band reference catalogue and are used to warp all sky-subtracted images onto a final stacked image at a pixel scale of $0.15''$/pixel on the COSMOS tangent point, facilitating construction of multi-band catalogues. The CASU astrometric solutions are not used.

The data products described here are available from the TERAPIX ftp server at the following address: `ftp://ftpix.iap.fr/`, username `uvista-consortium`. These images and catalogues will be made available through the ESO archive system starting in July-August 2011.

2 Image selection

The images in this release were taken between 5th December 2009 and the 19th of April 2010. This does not consist of the complete number of images taken for the UltraVISTA program in the 2009-2010 observing season; subsequently, around $10\% - 20\%$ additional images were made available by CASU using a different pipeline processing, after we had already graded the first batch of images. In order to maintain as a homogenous as possible data set, we restrict in this current release ourselves to this initial batch.

The images considered here were all processed used v0.8 of the CASU release. In total, we consider 7031 individual images (each of which is a single multi-extension fits image containing 16 image extensions for each of the VISTA detectors). We do not use the confidence maps provided by CASU, but create our own weight-maps from the supplied flat-fields and bad pixel maps.

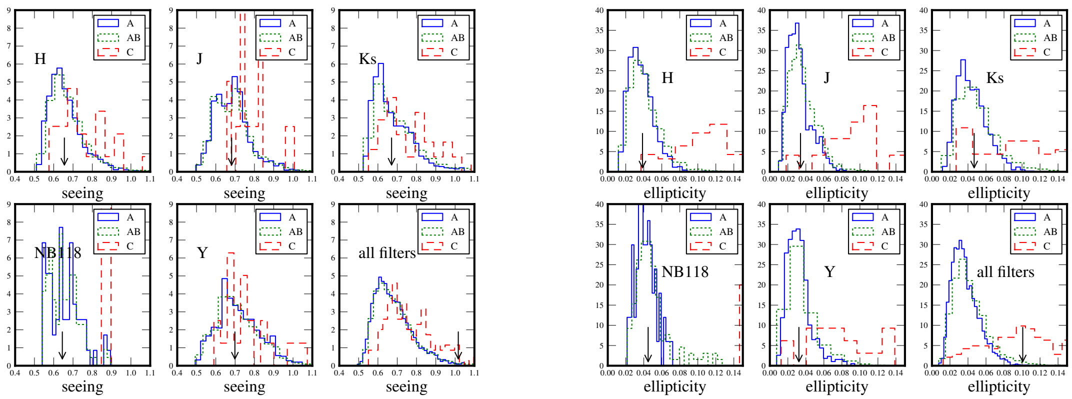

Figure 1 Seeing (left) and ellipticity (right) distributions for all UltraVISTA images considered here. Note that the different distributions have been re-normalised.

These images were inspected and graded in the YOUPI[1] environment at TERAPIX. Images were assigned a grade of A, B (usable for science), C, D (rejected). The left and right panels of 1 shows the seeing and ellipticity distributions for all images. Based on these distributions we decided to keep all images which have stellar FWHM $1.0''$ and ellipticity < 0.1 and which were classified A, B based on visual inspection. The visual inspection process in general finds images which have bad PSFs or other optical defects which would have not been found by a typical seeing or ellipticity cut (for example, tracking problems which produce double-lobed PSFs. In total we reject 426 images or around 6% of the total.

3 Sky-subtraction, processing and stacking

We adopted the same set of processing steps for the each of the four filters, detailed below. Note that in this release we do not deliver the NB110 data; these will be made available in a subsequent release. After image selection, we processed the CASU sky-subtracted images (by which we mean astrometric solution, weight map generation, and stacking) to make a “first-pass” stack to derive the object mask for each image. For these images we used the tool `QualityFITS` to create weight-maps (from the corresponding flat-fields supplied in the release) and image catalogues. Using `scamp` we computed astrometric and photometric solutions using as reference catalogue the COSMOS $i-$band astrometric reference catalogue.

To create our sky-subtracted images, we use a set of tools developed at TERAPIX and which run under distributed processing environment “condor”. (These processing steps are described fully in Bielby et al 2011, in prepraration). To summarise, we start by “adding back” to each image the sky background frames subtracted by CASU, supplied as part of the original data release. Based on the first pass-stack and astrometric solutions, we compute object masks for each individual image. Next, we use these object masks (appropriately warped to match the images to compute and subtract a running sky for each individual image, based on a median

[1] `http://youpi.terapix.fr/`

of images taken during a 20 minute timescale. After the subtraction of the running sky, we re-"destripe" the images and remove large-scale background gradients using `sextractor`. In the final step, the `QualityFITS` tool is run once more to calculate weight maps and catalogues for each image. Saturated objects, based on an examination of the stellar locii, are flagged in the input catalogues. These catalogues are used to compute the final astrometric and photometric solutions. Note that we use the photometric solutions supplied by CASU for their *.st* stacks to as initial approximate photometric solutions for our individual images. All images are marked as "photometric" , although re-scalings are allowed based on overlapping images.

In the last step, the images are coadded using a modified version of the `swarp` software which permits combination of images based on a clipped sigma estimator; we use a clipping threshold of 2.8σ. Bad regions on individual detectors, such half of detector 16, are also masked, which explains the irregular appearance in the corner of the stacked images.

Given the dense sampling for the astrometric reference catalogue, and the large amount of overlap between exposures, our astrometric accuracy is very high, with r.m.s values much smaller than one pixel, typically $\sim 0.1''$ compared to the external catalogue and $\sim 0.05''$ internally.

4 Stacked data products

In this first release, we are making available four stacked images and their corresponding weight maps for Y,K_s, H and J data taken during the first year of public survey operations of the UltraVISTA survey.

These images have a zero point of 30.0 AB magnitudes and a pixel scale of $0.15''$/pixel. The images all have a common tangent point, in decimal RA,DEC of (150.116,2.2000), corresponding to the tangent point of the publicly available IRSA/COSMOS images. Each image (uncompressed) is $\sim$ 9Gb in size.

5 Data quality assessment

We have carried out a number of data quality tests on the final stacks which we will now present.

5.1 Completeness measurements

For each image, we estimate the completeness as a function of magnitude by adding simulated stellar sources with a FWHM of $0.8''$ to the images and determining how many objects are recovered as a function of magnitude. These curves are shown in Figure 2. The 95% and completeness limits and mean seeing are summarised in Table **??**.

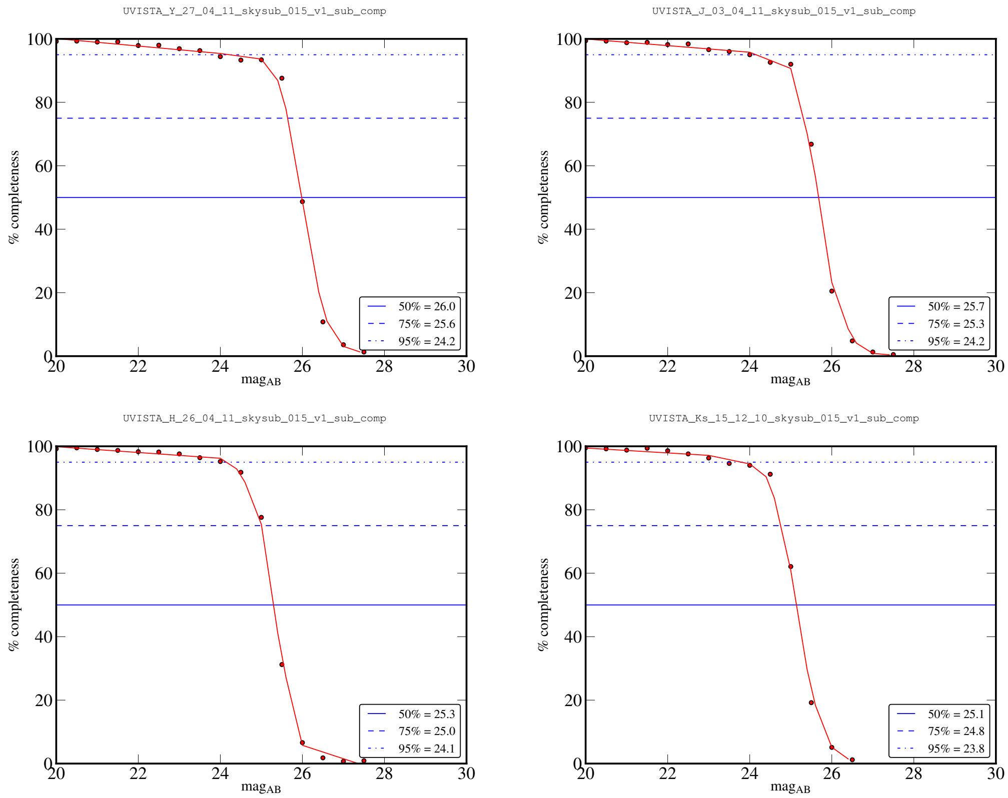

Figure 2 Completeness measurements for stellar sources for the centre of the mosaic in Y,J,H,Ks bands respectively (clockwise from top left).

5.2 Optical-infrared colour-colour diagrams

By complementing our data with publicly-available B and z photometry from $IRSA$[2] we are able to construct colour-colour diagrams which in which galaxies are cleanly separated from stars. We use this stellar catalogue to carry out a number of diagnostic tests. This diagram is shown in Figure **??**. Red points show faint stellar sources; blue, lighter points show brighter ones. We note that the position of the stellar locus is the same for bright and faint $K_{\rm s}$ magnitudes, indicating the absence of colour terms which depend on $K_{\rm s}$ magnitude or other systematic effects.

5.3 Image quality assessment

We use `sextractor`'s `FWHM_WORLD` to estimate the seeing of each stack. This parameter is calculated for stellar sources isolated using the optical near-infrared colour-colour diagram described in the previous section and binned up in the final stack. The results are show in Figure **??**. Note that there are structures visible in the H, Ks stacks, although the amplitude of these features are small ($0.1'' - 0.15''$ peak-to-peak). These "bars" are due to seeing variations present in the individual paws comprising the final stacks. We are currently preparing PSF-homogenised

[2] http://irsa.ipac.caltech.edu

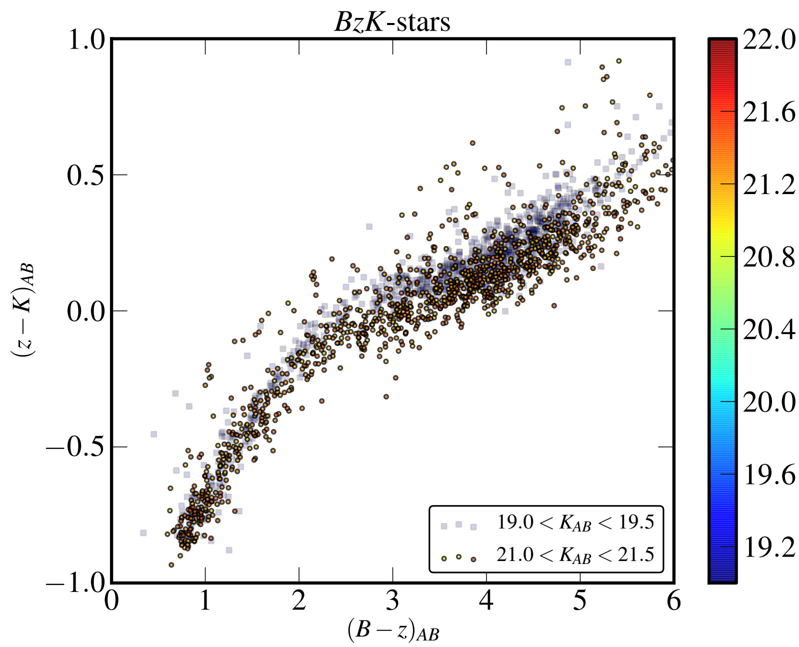

Figure 3 BzK diagram for faint and bright stellar sources (light and dark symbols respectively) selected using the UltraVISTA K_{s} data.

Image name	Filter	95 % completeness	seeing ($''$)
`UVISTA_Y_27_04_11_skysub_015_v1.fits`	Y	24.2	0.82
`UVISTA_J_03_04_11_skysub_015_v1.fits`	J	24.2	0.79
`UVISTA_H_08_03_11_skysub_015_v1.fits`	H	24.1	0.76
`UVISTA_Ks_15_12_10_skysub_015_v1.fits`	Ks	23.8	0.75

Table 1 Characteristics of the image stacks

version of these stacks.

5.4 Comparison with existing COSMOS catalogues

Using the stellar catalogue introduced in Section 5.2 we compared with publicly-available COSMOS K_{s}, H, and J catalogues. Photometric measurements were made in $2''$ apertures and an approximate correction to total magnitudes were made by considering the difference between aperture and total magnitudes for our stellar reference catalogue.

The results of this comparison are show in Figure **??** for J, H bands and in Figure **??** for K_{s}. For the K_{s} comparison, we note that the photometric scatter is ~ 2 larger than the other bands, and that there is also some evidence of a position-dependent term. Initial tests suggests that the origin of this scatter lies with the COSMOS data, although further tests are in progress.

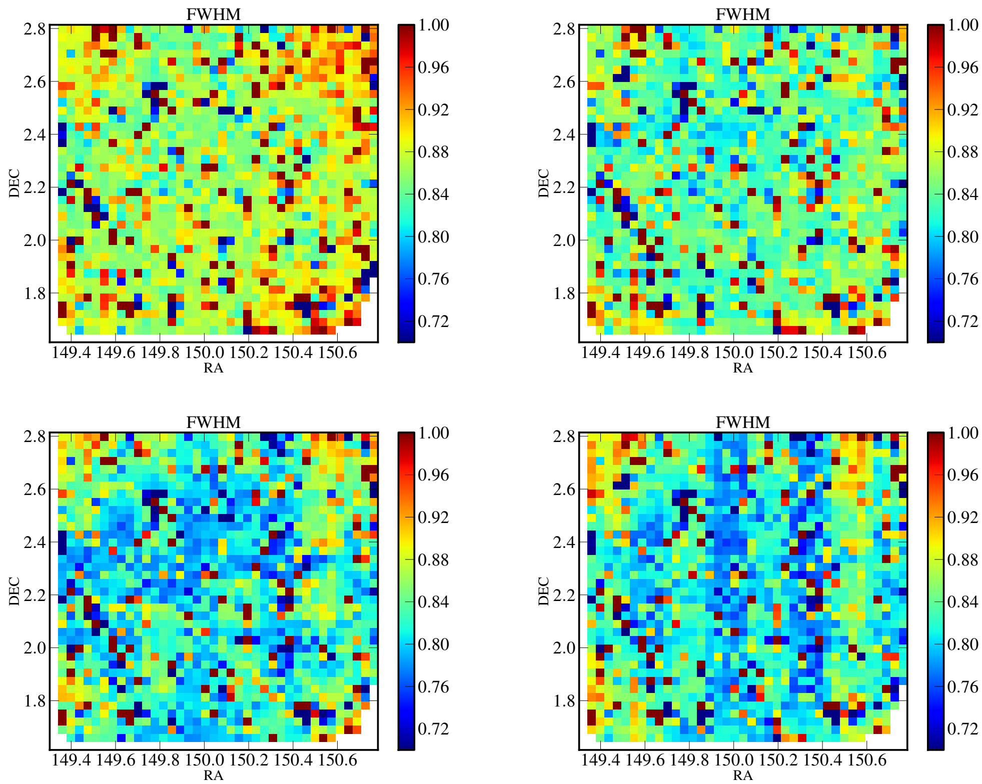

Figure 4 Average binned seeing in the final stacked mosaic for Y,J,H,Ks bands respectively (clockwise from top left).

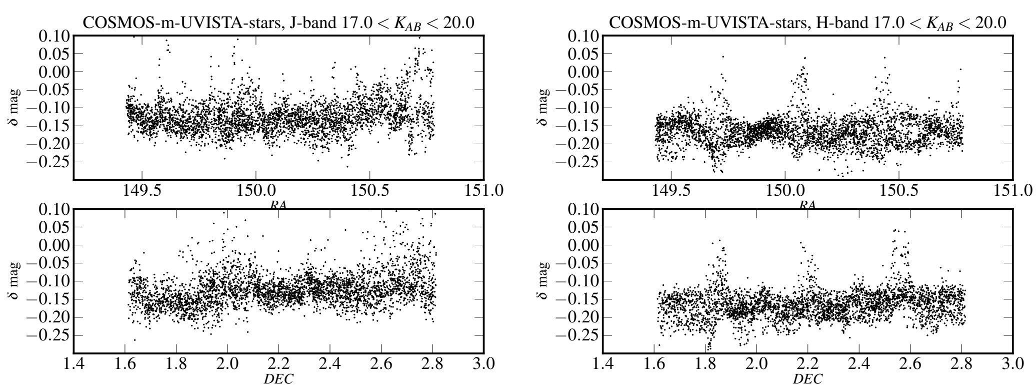

Figure 5 Aperture magnitudes in the COSMOS catalogues compared to UltraVISTA magnitudes as a function of right ascension and declination. The origin of the small constant offset between the two magitudes is under investigation.

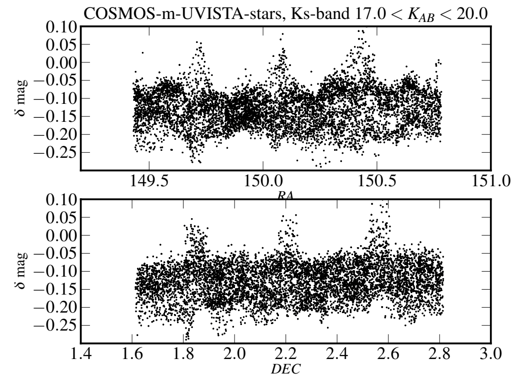

Figure 6 Aperture magnitude comparison between COSMOS and UltraVISTA K_s data.

6 Catalogues

We distribute two sets of catalogues: catalogues extracted on single images, and matched catalogues which use the K_s band image as a detection image. There are meant as *preliminary* catalogues, and have not yet been validated extensively. They should be used with caution. No masks have been applied to these catalogues, and the simply contain all detections. Aperture magnitudes reported in the catalogues are measured in $2'', 7''$ diameters respectively.

7 Complete list of distributed products

Table **??** lists products distributed in this release. In addition to the four stacked images, and their corresponding weight maps, we also distribute single band catalogues and matched catalogues.

8 Acknowlegements

We thank the staff of CASU, in particular Mike Irwin, Jim Lewis and Eduardo Gonzalez, for rapid delivery of the pre-processed images used here and answering our many queries concerning their data reduction process. Thanks as ever go to Emmanuel Bertin for his unfailing help with his software.

Filename	Description
UVISTA_Y_27_04_11_skysub_015_v1.fits	$Y-$band stack
UVISTA_Y_27_04_11_skysub_015_v1.weight.fits	$Y-$band weight
UVISTA_J_03_04_11_skysub_015_v1.fits	$J-$band stack
UVISTA_J_03_04_11_skysub_015_v1.weight.fits	$J-$band weight
UVISTA_H_08_03_11_skysub_015_v1.fits	$H-$band stack
UVISTA_H_08_03_11_skysub_015_v1.weight.fits	$H-$band weight
UVISTA_Ks_15_12_10_skysub_015_v1.fits	$K_{\rm s}$-band stack
UVISTA_Ks_15_12_10_skysub_015_v1.weight.fits	$K_{\rm s}$-band weight
UVISTA_YJK-cropped.tif	Composite three-colour image
UVISTA_Ks_15_12_10_skysub_015_v1_Y.cat.gz	$K-$selected Y catalogue
UVISTA_Ks_15_12_10_skysub_015_v1_J.cat.gz	$K-$selected J catalogue
UVISTA_Ks_15_12_10_skysub_015_v1_H.cat.gz	$K-$selected H catalogue
UVISTA_Ks_15_12_10_skysub_015_v1.cat	$K-$ catalogue
UVISTA_Y_27_04_11_skysub_015_v1.cat.gz	$Y-$ catalogue
UVISTA_J_03_04_11_skysub_015_v1.cat.gz	$J-$ catalogue
UVISTA_H_26_04_11_skysub_015_v1.cat.gz	$H-$ catalogue
release_v1.pdf	this document

Table 2 Summary of data products distributed in this release.