VISTA HEMISPHERE SURVEY
DATA RELEASE 1

Release date (will be set by ESO)

PROPOSAL ESO No.: 179.A-2010
PRINCIPAL INVESTIGATOR: Richard McMahon

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1. Abstract

The aim of the Vista Hemisphere Survey (VHS) is to carry out a near Infra-Red survey, which when combined with other VISTA Public Surveys will result in coverage of the whole southern celestial hemisphere (~20,000 deg^2) to a depth 30 times fainter than 2MASS/DENIS in at least two wavebands (J and K_s), with an exposure time of 60 seconds per waveband to produce median 5σ point source (Vega) limits of J = 20.2 and K_S = 18.1. In the South Galactic Cap, ~5000 deg^2 will be imaged deeper with an exposure time of 120 seconds and also including the H band producing median 5σ point limits of: J = 20.6; H = 19.8; K_s = 18.5. In this 5000deg^2 region of sky deep multi-band optical (grizY) imaging data will be provided by the Dark Energy Survey (DES). The remainder of the high galactic latitude (|b|>30°) sky will be imaged in YJHK for 60sec per band to be combined with ugriz waveband observations from the VST ATLAS survey.

The medium term scientific goals of VHS include:

- the discovery of the lowest-mass and nearest stars
- deciphering the merger history our own Galaxy via stellar galactic structure
- measurement of large-scale structure of the Universe out to z~1 and measuring the properties of Dark Energy
- discovery of the first quasars with z>7 for studies of the baryons in the intergalactic medium during the epoch of reionization

In addition the VHS survey will provide essential multi-wavelength support for the ESA Cornerstone missions; XMM-Newton, Planck, Herschel and GAIA.

2. Release content

The VHS survey data in this release consists of three survey components that have different OB structures.

- VHS DES: 120secs in J, H and K
- VHS ATLAS: 60secs in Y, J, H and K
- VHS GPS: 60secs in J and K

In Figure 1 we shows the RA, Dec distribution for observations up to the 30 Sep 2010.

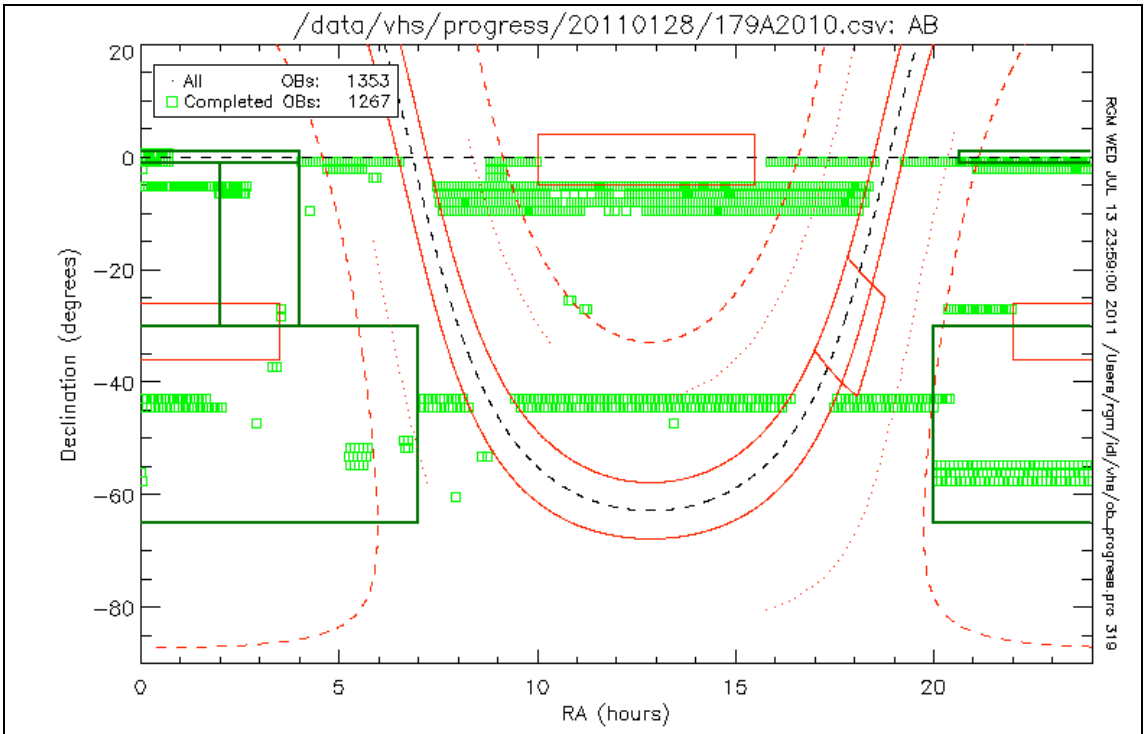

Figure 1: Sky coverage of the VHS survey in Data Release 1. The thick green lines show the Dark Energy Survey footprint. The solid rectangles show the nominal footprint of the VIKING survey which is avoided by VHS. The solid curved lines show the galactic latitude= -5,5 and the bulge region of the VVV survey.

Example colour-magnitude and colour-colour diagrams

Figures 2-4 show colour-magnitude and colour-colour diagrams for two typical fully reduced example high galactic latitude tiles. Some examples of problem tiles identified during VHS QC are shown in Figure 2. The blue points are objects classified as stars and the grey points are objects classified in K as non-stellar.

These QC diagrams demonstrate the precision of the photometry and star-galaxy separation. The J-K-v-K stellar locus clearly delineates the distinct disk dwarf and halo giant populations which show up as two separate populations with J-K<1.0. The non-stellar objects which are mainly external galaxies have J-K>1.0.

3. Release notes

Quality Control

The data processing of the science products released in this data release come for version 1.1 of the VISTA Data Flow System(VDFS) pipeline running at the Cambridge Astronomical Survey Unit(CASU). Quality control consists of visual inspection of a subset of image and visual inspection of colour magnitude diagrams

from all data. In addition the distribution of astrometric and photometric parameters are inspected. A independent check on the astrometry has been carried out via comparison with 2MASS using the VISTA Science Archive for a subset of the data. An independent check on the photometry has been carried by comparing the VHS Y, J, H and K photometry with the Y, J, H and K photometry from the UKIDSS survey.

Robust, objective and quantitative quality control processes for VHS are still under development and we are working closely with the VDFS pipeline team at CASU in Cambridge to develop routine automated machine learning based techniques such as decision tree based QC techniques.

Colour-magnitude and colour-colour plots as shown in Figure 2-4 are being produced for all paw-print and tile bandmerged catalogues. Figure 2 shows examples of version 1.0 VDFS data products that failed our QC. Figure 3 shows the VDFS version 1.1 data products for the same raw data and shows that the version 1.1 products now pass our image classification and photometric QC. Figure 4 shows data from the final VHS OB for Period 85 and Period 86 respectively.

Image quality

Figure 5 shows the distributions of the image quality in all wavebands for all VHS observations obtained in Period 86. This plots contain repeat OBs and hence although the median value will be robust, poor quality data will be over represented. Figure 5 shows the measured seeing (FWHM) for stellar objects and Figure 6 shows the image ellipticity distribution. Visual inspection of the images with ellipticity > 0.15 is carried out. Some have double images whereas some may still be useable. In Period 86 the ellipticity distribution has improved compared with Period 85.

The medians of the seeing distributions show a wavelength dependence increasing from 1.03 arc seconds in K_S to 1.11 arc seconds in J. The ratio of 1.08 is consistent with a Kolmogorov $\lambda^{-1/5}$ wavelength dependence assuming a effective wavelengths of 2.149μm for K_S and 1.254μm for J. The Y band images have median seeing of 1.07 arc seconds. Overall the median measured seeing is similar to the values obtained in Period 85.

The seeing distributions in J has a significant tail to value that exceed out seeing limit of 1.4". In Period 85, Y band also had a large tail but in period 86 this is reduced.

Astrometry

Figure 8 shows the distribution of the World Cooordinate System (WCS) rms astrometric errors derived from 2MASS. The J and K bands have a tail to smaller values compared to Y and H, since there are J and K observations in regions of higher stellar density at lower galactic latitude.

Zero-points and atmospheric transparency

Figure 10 shows the measured zero-point on tiles for all Period 86 VHS observations based on photometric calibration using 2MASS. There is a tail to bright magnitudes amd ~10% have relative attenuation >0.2 magnitudes which is outside the ESO THIN constraint. Some of this may be due to the known degradation in the VISTA system

throughput due to the degradation of the primary mirror reflectivity since the primary mirror was coated in September 2009.

Limiting magnitudes
Figure 11(a,b,c) shows the computed 5sigma point source limiting magnitudes for the 3 VHS survey components. Note the VHS DES component has exposure times of 120 seconds per band compared to 60 seconds for the other two components (GPS and ATLAS).

4. Data format

This data release consists of pawprint and tiles images and catalogues derived from both the pawprint and tile images. Further details about these data products can be obtained from the CASU website at

http://casu.ast.cam.ac.uk/surveys-projects/vista/technical

5. Acknowledgements

The acknowledgments to be included when using this data is McMahon et al in preparation.

"This paper uses data from the VISTA Hemisphere Survey ESO programme: 179.A-2010 (PI. McMahon)"

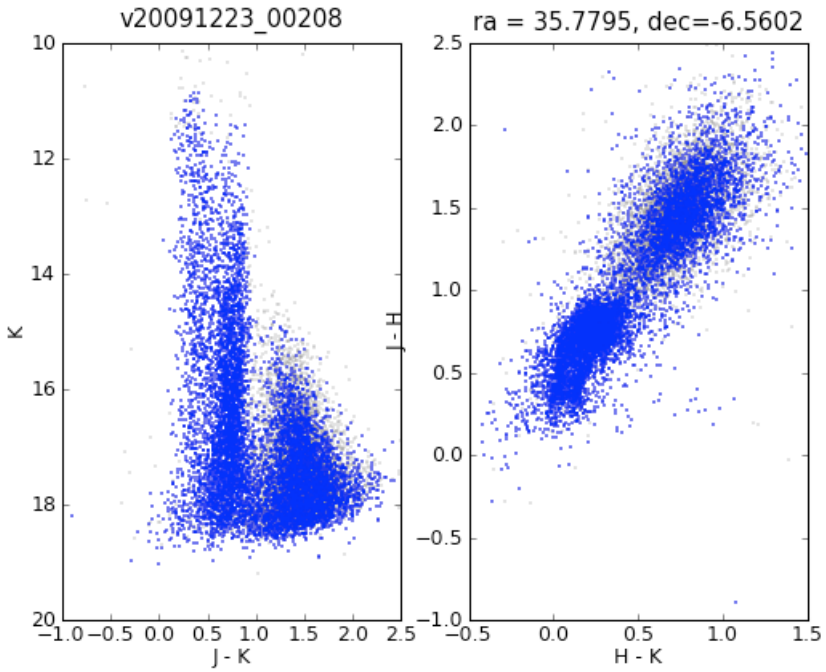

Figure 2(a): Version 1.0 data products showing QC problem with star-galaxy separation. Blue points are starlike objects; Grey points are non-stellar objects

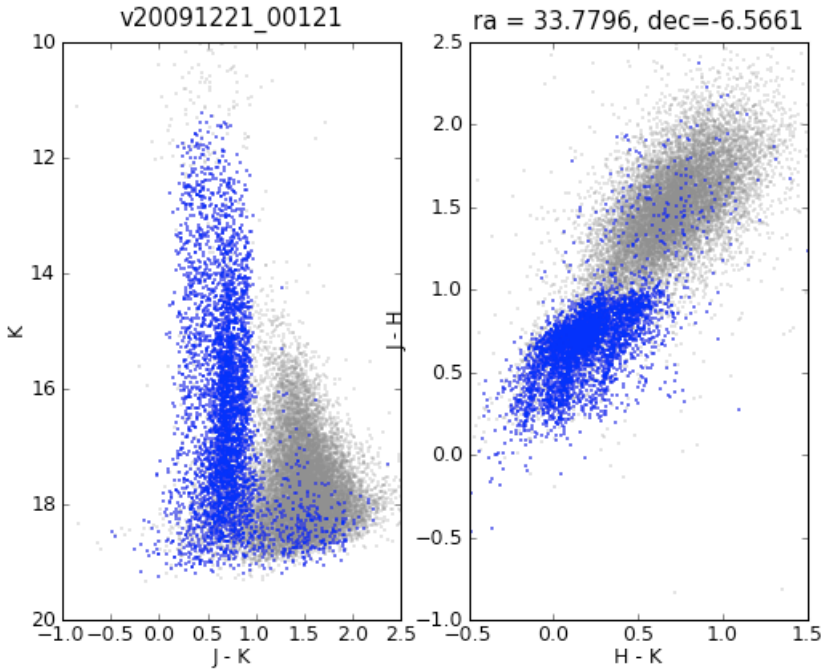

Figure 2(b): Version 1.0 data products showing QC problem with multiple offset stellar loci due to variable seeing causing spatially dependent aperture corrections in different pawprints.

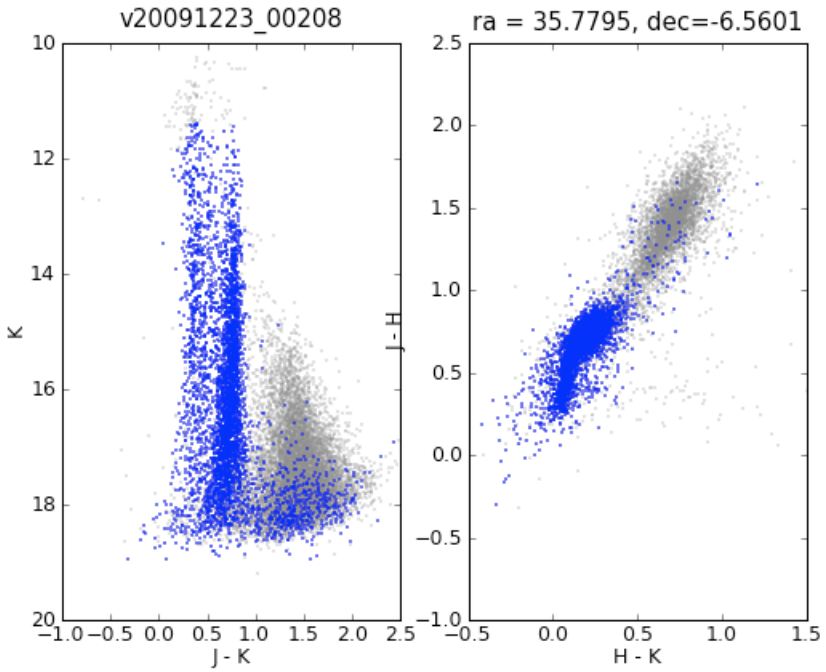

Figure 3(a): Version 1.1 data products for same observations as Figure 2(a) showing the improvement in star-galaxy separation for this OB. Blue points are starlike objects; Grey points are non-stellar objects

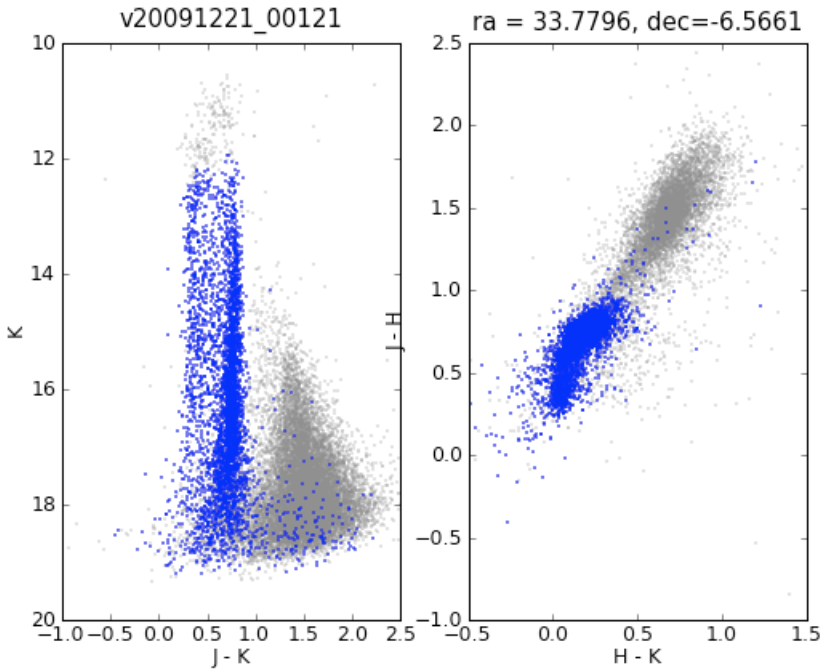

Figure 3(b): QC problem showing multiple offset stellar loci due to variable seeing causing spatially dependent aperture corrections in different pawprints.

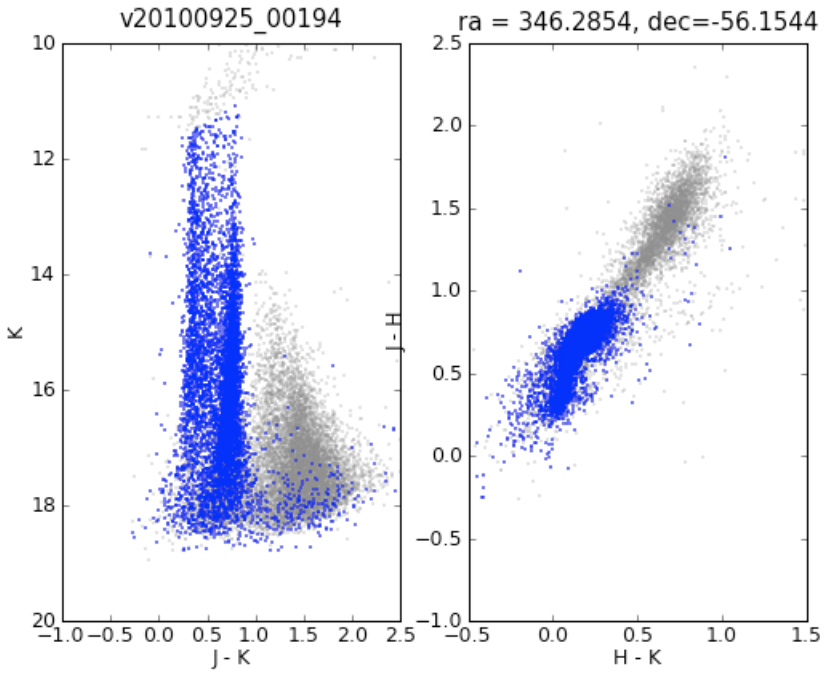

Figure 4(a): Version 1.1 data products for VHS final Period 85 OB acquired on 2010 Sep, 25th. Blue points are starlike objects; Grey points are non-stellar objects

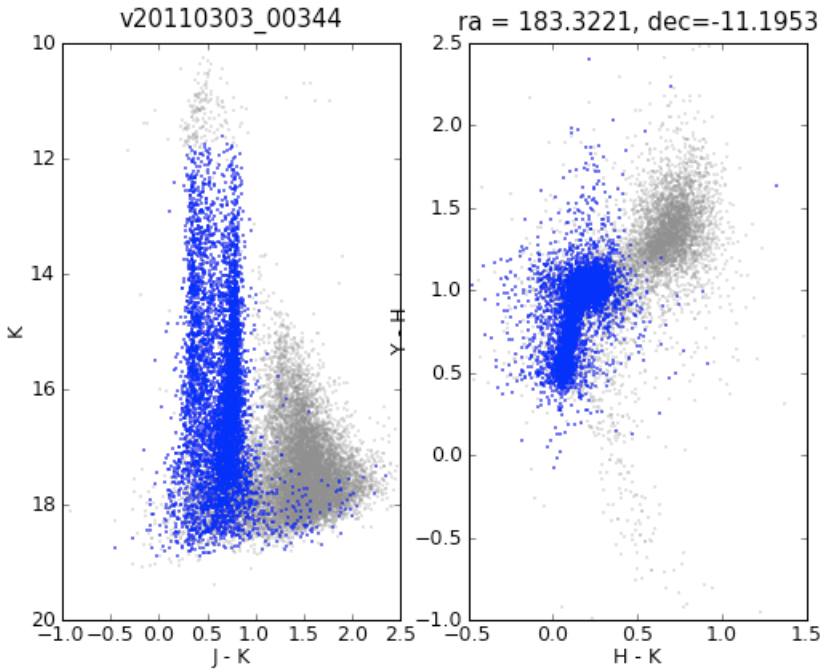

Figure 4(b): Version 1.1 data products for final VHS Period 86 OB acquired on 2011 March, 3rd; Note the right plot is H-K v Y-H whereas in other plots it is H-K v J-H

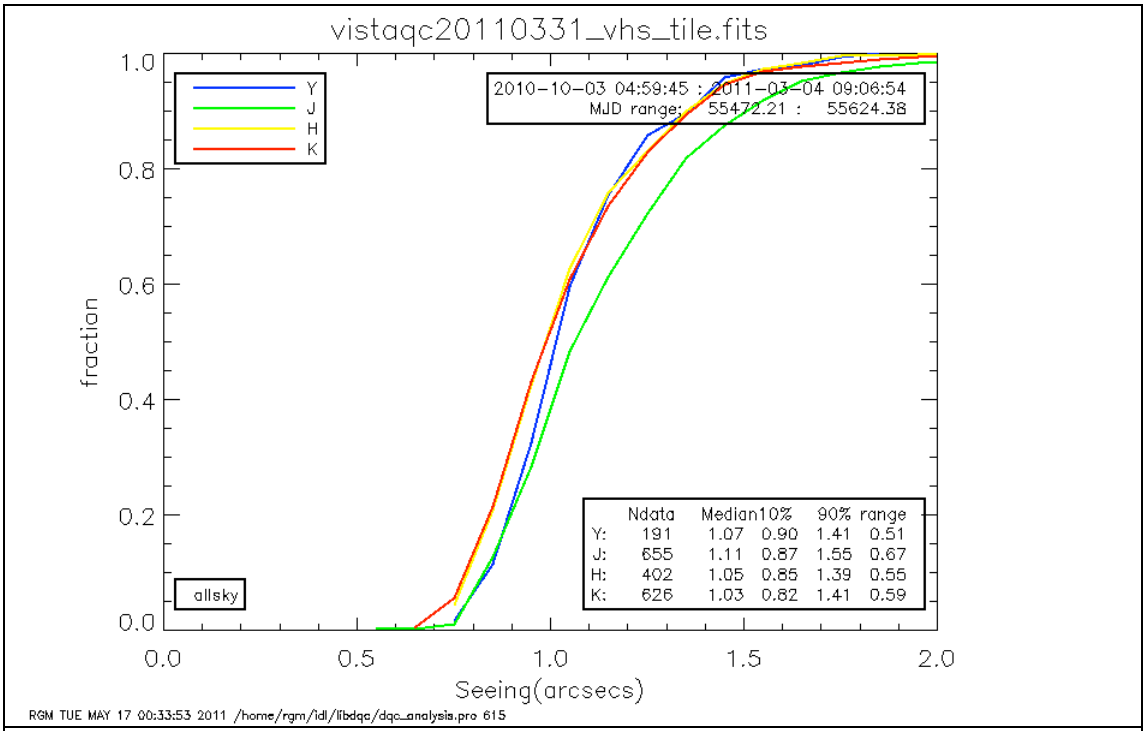

Figure 5: Measured image seeing (stellar FWHM) on tiles for all Period 86 VHS observations including rejected and repeated OBs.

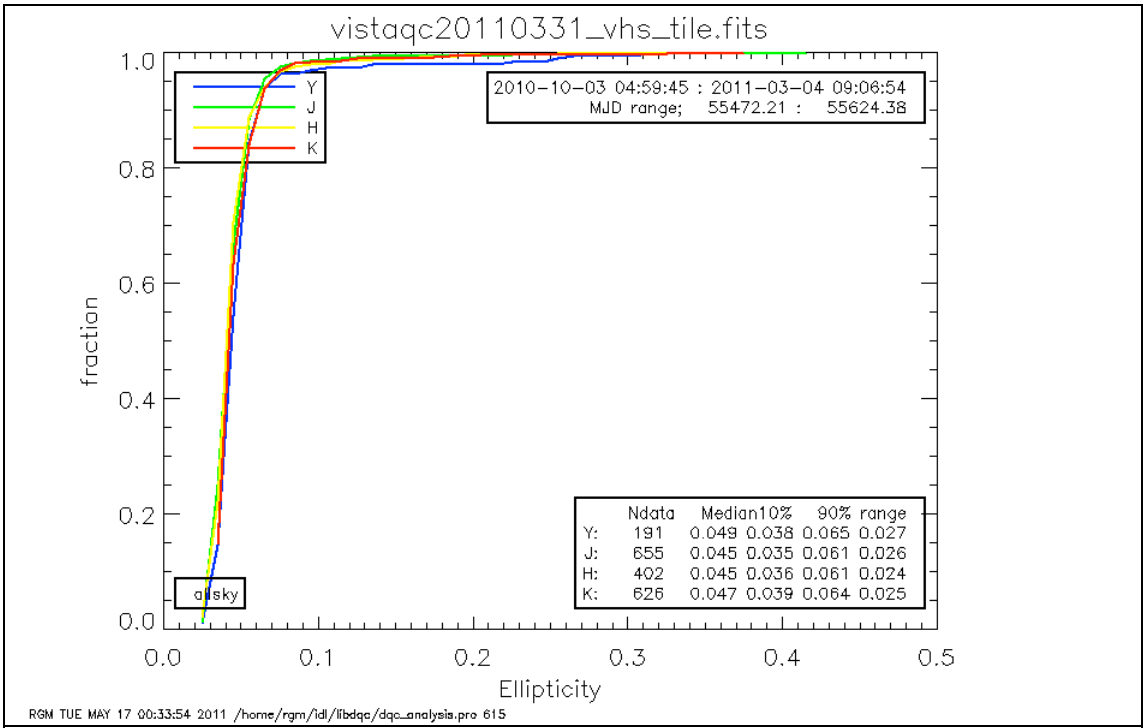

Figure 6: Measured image ellipticity on all tiles for Period 86 VHS observations including rejected and repeated OBs

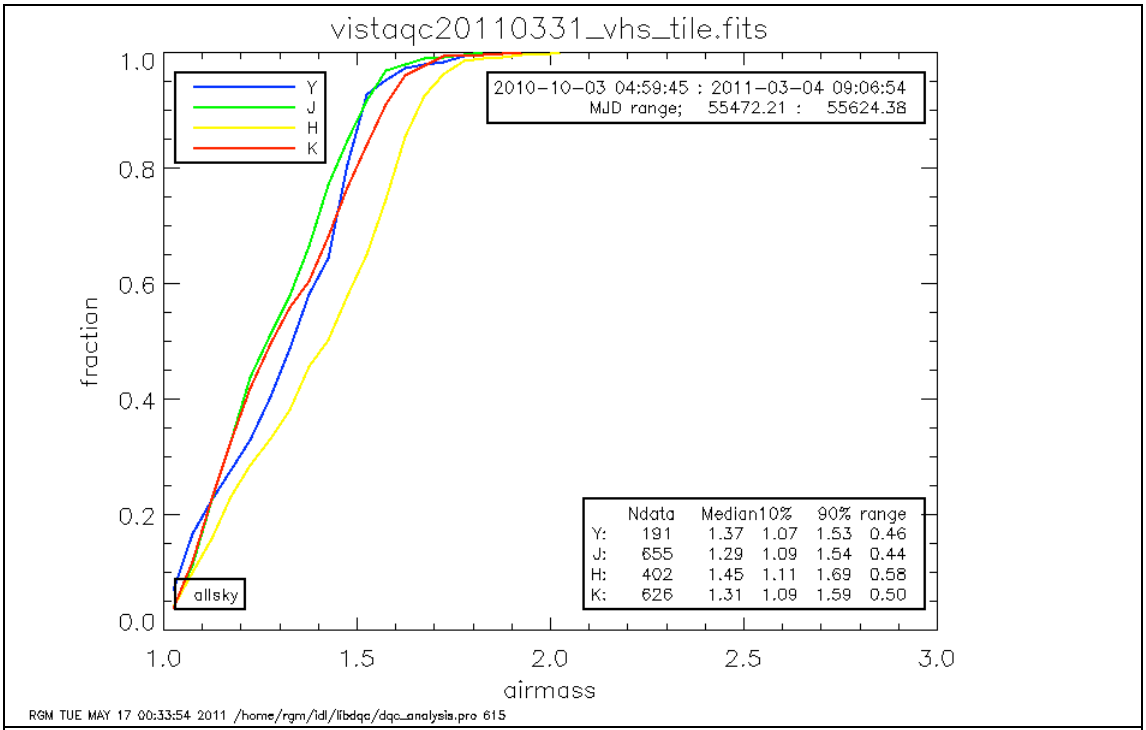

Figure 7: Airmass distribution for all Period 86 VHS observations i.e. includes rejected and repeated OBs.

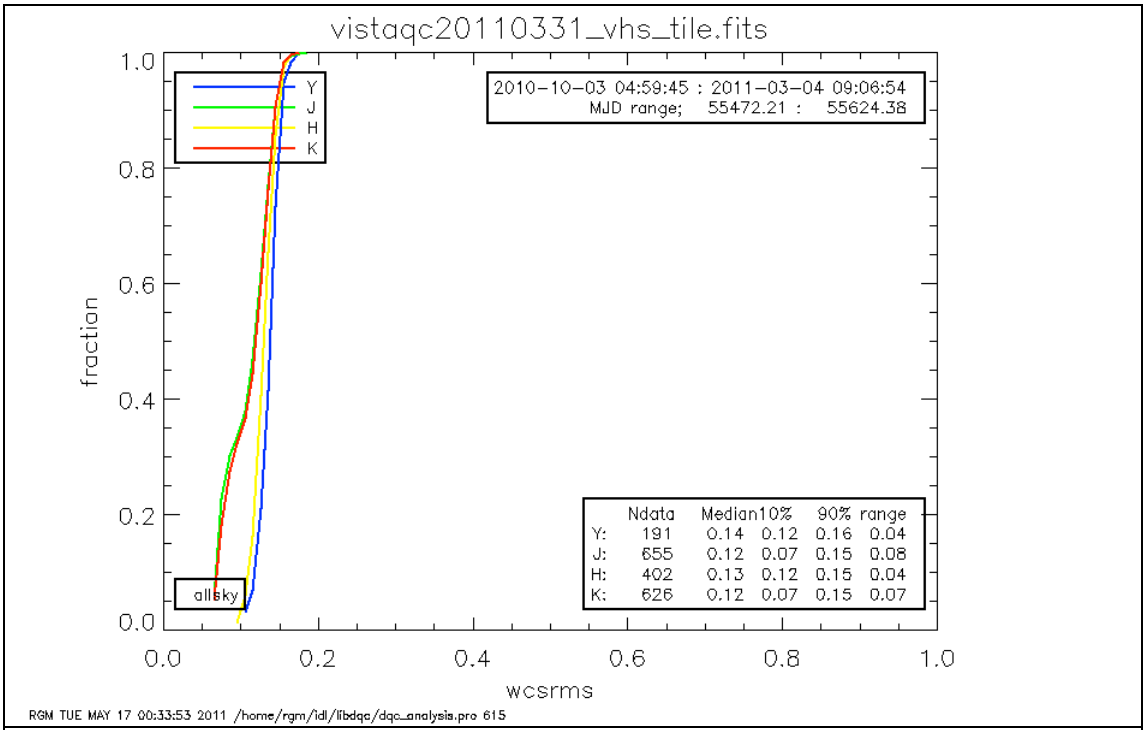

Figure 8: Distribution of the World Cooordinate System(WCS) rms astrometric errors for tiles. The J and K bands have a tail to smaller values compared to Y and H due to larger fraction of fields at low galactic latitude and hence more WCS 2MASS astrometric calibration stars.

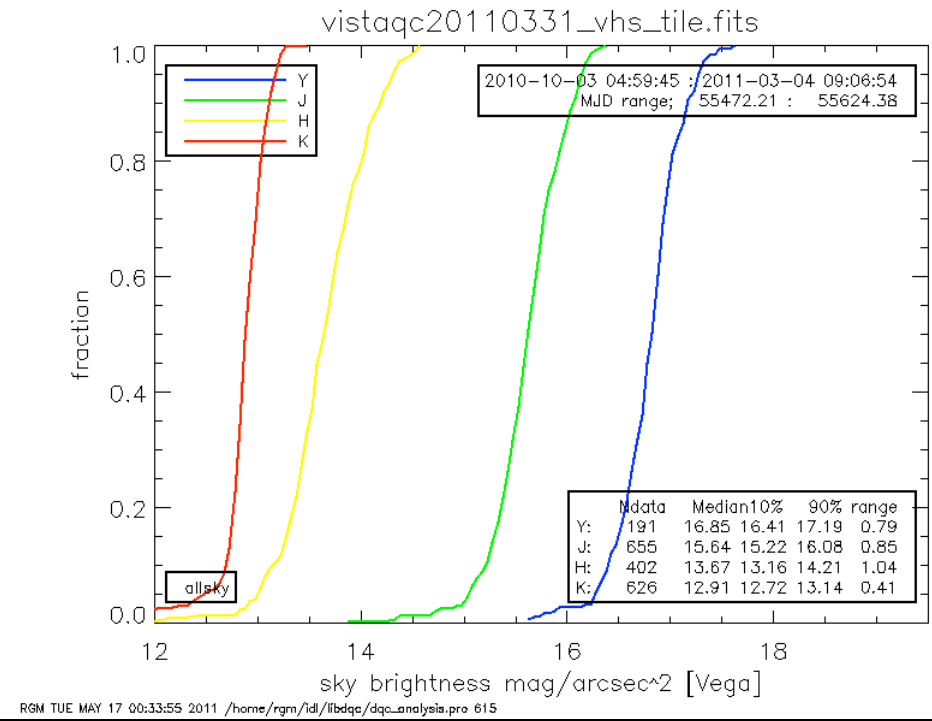

Figure 9: Measured sky brightness seeing on all VHS tiles for Period 86 observations. Note the tail to bright magnitudes that effects ~5% of observations.

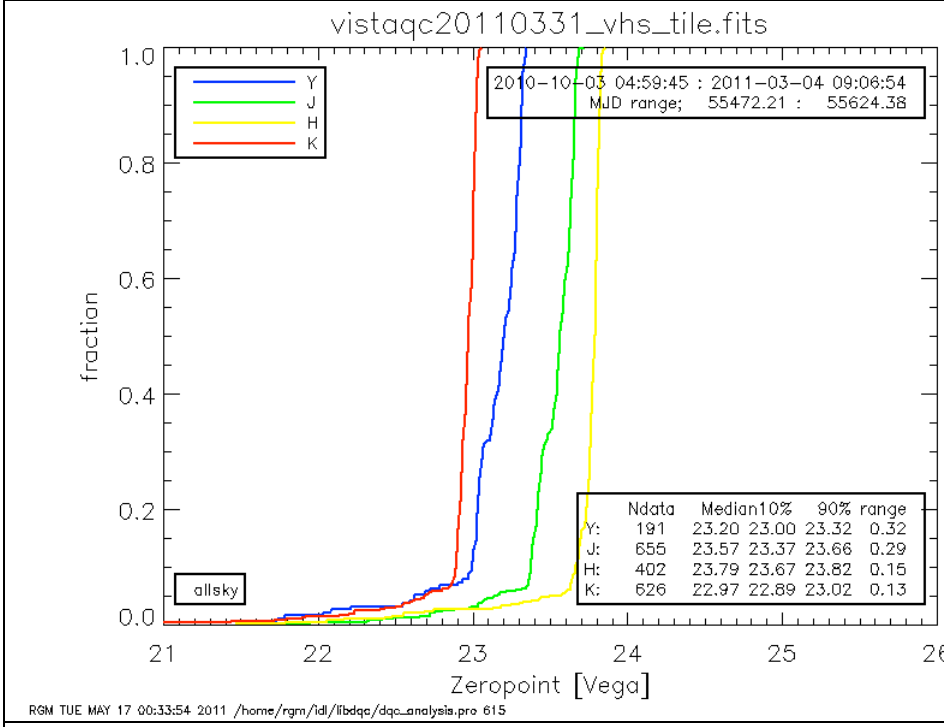

Figure 10: Measured zeropoint on tiles for all Period 86 VHS observations. Note the tail to bright magnitude. 5-10% have attenuation >0.2magnitudes.

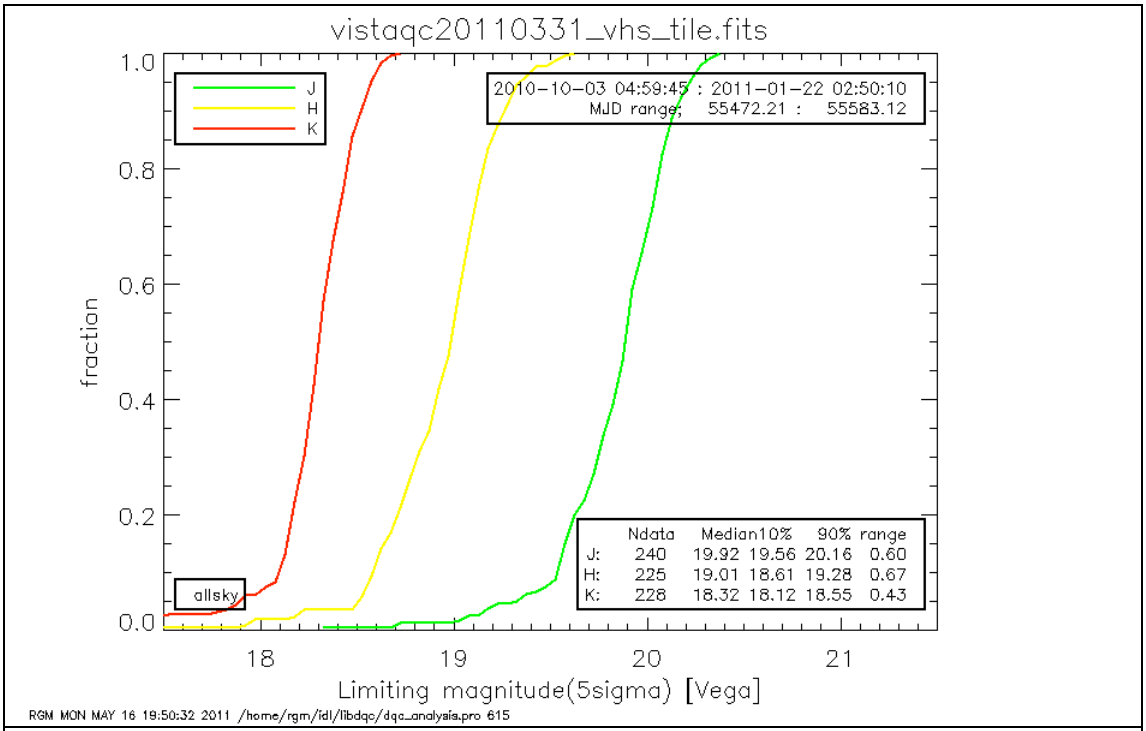

Figure 11(a): Limiting magnitudes for VHS DES component

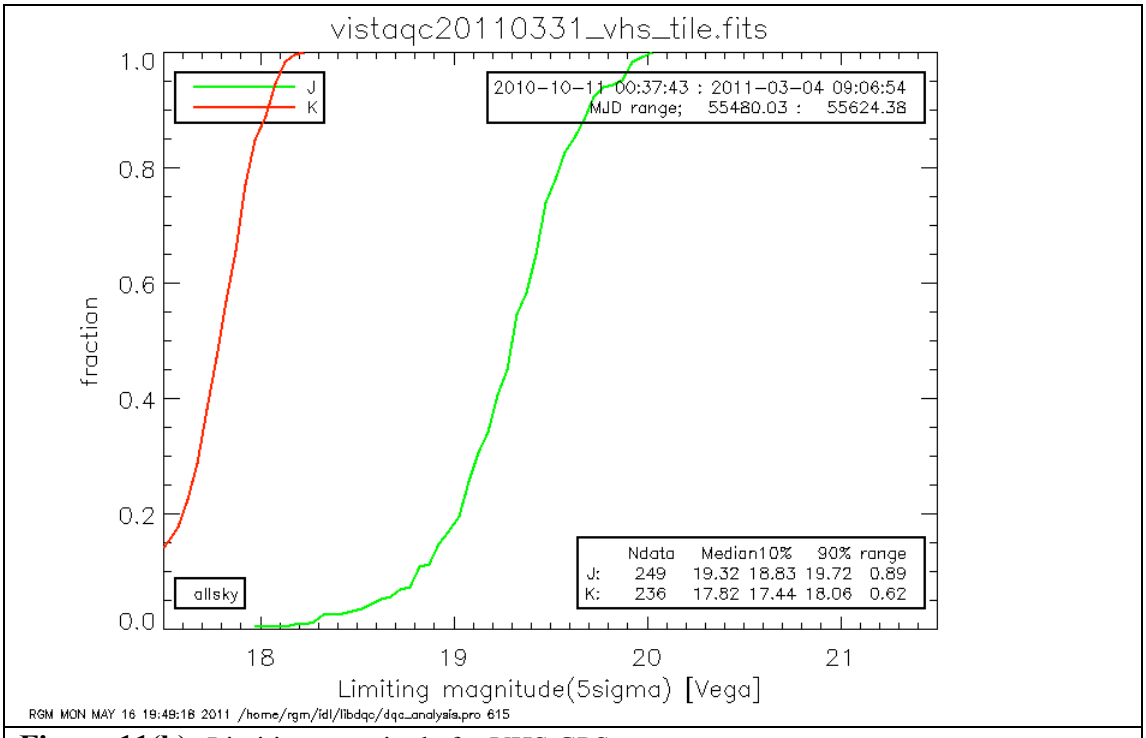

Figure 11(b): Limiting magnitude for VHS GPS component

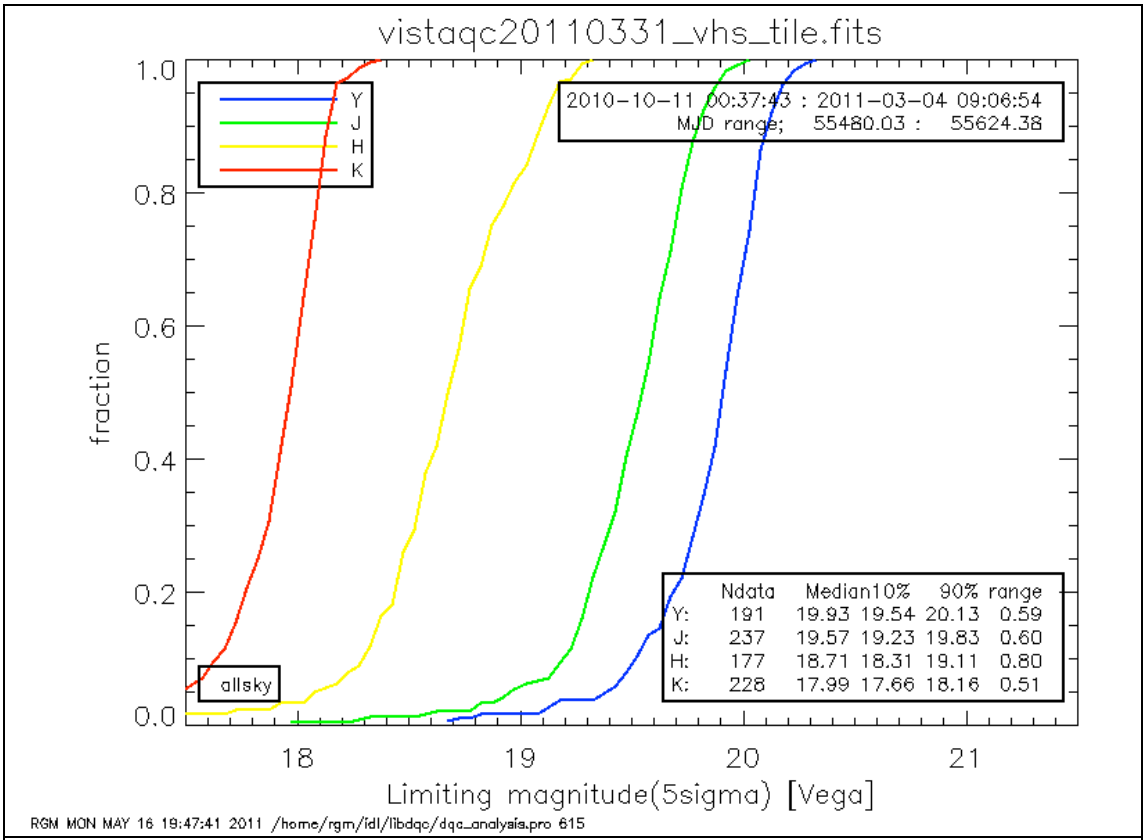

Figure 11(c): Limiting magnitude for VHS ATLAS component

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