VIKING (VISTA Kilo-degree Infrared Galaxy Survey): Imaging and Catalogue Data Release 2 (VIKING/batch_2) Release date (15th August 2014)

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Abstract: The VIKING survey with VISTA (ESO programme ID 179.A-2004) is a wide area (eventually ∼1500 sq.degrees), intermediate-depth (5-sigma detection limit J∼21 on Vega system) near-infrared imaging survey, in the five broadband filters Z, Y, J, H, K_s.

The planned sky coverage is at high galactic latitudes, and includes two main stripes $\sim 70 \times 10^\circ$ each: one in the South Galactic cap near Dec$\sim -30^\circ$, and one near Dec$\sim 0^\circ$ in the North galactic cap; in addition, there are two smaller outrigger patches called GAMA09 and CFHLS-W1.

Science goals include z >6.5 quasars, extreme brown dwarfs, and multiwavelength coverage and identifications for a range of other imaging surveys, notably VST-KiDS and Herschel-ATLAS.

This second public data release of VIKING data covers all of the highest quality data taken between the start of the survey (12th of November 2009) and the end of Period 92 (30th September 2013). This release supercedes the first release (VIKING and VIKING_CAT published 28.06.2013 and 16.12.2013 respectively) as it includes improved CASU processing (V1.3) that gives better tile grouting and zero point corrections.

This release contains 396 tiles with coverage in all five VIKING filters, 379 of which have a deep co-add in J, and an additional 81 with at least two filters where the second OB has not been executed yet or one filter in an OB was poor quality. These 477 fields cover a total of ∼690 square degrees and the resulting catalogues include a total of 46,270,162 sources (including low-reliability single-band detections). The imaging and catalogues (both single-band and band-merged) total 839.3GB. The coverage in each of the five sub-areas is not completely contiguous but any inter-tile gaps are relatively small.

Overview/layout of observations

The basic unit of observations is the VISTA tile, made from combining six offset "pawprints" to fill in gaps between the individual detectors. All VIKING tiles are observed in the default (zero) rotator-sky angle; thus each tile covers a rectangle approximately 1.5 degrees in RA by 1.0 deg in Dec to full exposure.

This data release 2 consists of a total of 477 tiles (∼690 sq.deg): this is subdivided into 219 tiles in the Northern Galactic Equatorial Strip (NGP) that covers the GAMA09/12/14 regions, 253 tiles in the Southern Galactic Pole Strip (SGP), and 5 tiles in the CFHLS-W1 region. These comprise most of the data observed up to the end of September 2013, and have overlap with VST-KiDS, the GAMA redshift survey in GAMA09/12/14, the Herschel-ATLAS submm survey (in both GAMA09/12/14 and SGP), and medium-deep CFHT Legacy Survey visible data in W1.

The current coverage is summarised in Figure 1 that plots the distribution of fields in the five filters.

Region	RA range	Dec range	Tiles
CFHTLS-W1	02h 16m to 02h 28m	-6.7 to -2.7 deg	5
SGP	22h 05m to 03h 32m	-34.0 to -28.0 deg	253
NGP	08h 34m to 14h 58m	-2.0 to +3.0 deg	219

Table 1: Approximate boundaries of sky coverage for the current release.

Release content

Exposure times per passband are as given in the following table; note that exposure times per source are the median values (and correspond to pixels with value 100 in the associated confidence-maps); pixels in detector overlap regions receive more exposure, while pixels near the top and bottom in detector x-coordinate (North/South) receive half the median exposure.

Filter	Integration/ tile	Integration/ source	Njitter	NDIT x DIT (sec)	Mag.lim (median)
Z	1440 sec	480 sec	4	1×60s	21.4
Y	1200 sec	400 sec	4	2×25s	20.6
J	2×600 sec	2×200 sec	2×2	2×25s	20.1
H	900 sec	300 sec	3	5×10s	19.0
K_s	1440 sec	480 sec	4	6×10s	18.6

Table 2: Integration times per tile, per source (median), number of jitter positions (per pawprint) and individual exposure lengths. Also shows median 10-sigma (Vega) magnitude limit for each passband.

Note that each tile was observed in two separate observing blocks (OBs) of approximately 70 minutes duration each: one for J, Y, Z filters, and the other for J, K_s, H; these are taken in either order, with the J exposure time divided between the two OBs. The time-span between the two blocks may be months or (sometimes) years; thus, the split J-band is intended to flag objects which may have moved or varied between the two blocks. Observations for band pairs Y/Z and K_s/H are in one OB, separated by a time-lag typically 25 minutes. The two J-band exposures are coadded to provide a deeper J pawprint. These intermediate pawprints are provided for these deeper co-adds in this release for completeness so accurate variability studies can be performed by comparison with the single epoch tiles in J. In 379 of the 396 cases where two J-band images exist the image quality were well matched so this coaddition was made.

The depth reached is not identical over all fields but none are more than 0.3mag shallower than the medians given in Table 2 as this was our quality threshold for depth. Likewise no field has a seeing worse than 1.2″ as this was the threshold set for image quality.

We have deprecated all fields with an ESO grade of C, R or X that are assigned to incomplete or poor quality OBs by the telescope operator after execution.

The observations in terms of field and filter listed in Table 3 are ones which which were released previously but are now deprecated due to falling below the same quality thresholds or having the wrong ESO grade.

Release Notes

Previous Releases: This release is superceeds that made in the first VIKING imaging and catalog (VIKING and VIKING_CAT) releases of October and December 2013 as it uses improved tile grouting and zero point corrections that the latest version of the CASU pipeline (V1.3) provides.

The data reduction follows the standard CASU infrared imaging pipeline from each individual tile image.

In brief, the reduction steps are as follows:

Reset correction: This occurs in the data acquisition system, i.e. a VISTA data frame is a difference of two non-destructive detector readouts separated by DIT seconds. Then, NDIT of these frames are co-added within the data acquisition system, before saving to hard disk.

Dark subtraction: using exposures with the dark filter inserted, matching the DIT values of the given science exposure.

Linearity correction: the VIRCAM detectors show non-linearity, typically a few percent at 10,000 ADUs. A correction polynomial (one per detector) is derived from a fit to observations of the dome screen with varying exposure times, and applied to the counts.

De-striping: this step removes a low-level horizontal striping intrinsic to the VIRCAM detector readout electronics, which is correlated across blocks of 4 detectors.

Flat-field correction: the frame is divided by a flat-field frame, derived from a set of twilight sky flats in the matching filter band.

Bad pixel rejection: Pixels showing substantial deviance from the linearity frames are masked as bad,

Field name	Filters
00h05-031d26/27	H, Ks, J_deep
00h13-032d25	Y, J_deep
00h19-032d25	Y, J_deep
00h21-033d23	Z, Y, J_deep
02h02-031d26/27	Z, Y, J_deep
02h09-031d26/27	Ks, J_deep
02h09-033d23	J_deep
02h14-030d28/29	Z, Y, J_deep
02h19-004d07	Y, J_deep
02h19-032d25	J_deep
02h25-003d08	Z, Y, J_deep
02h25-005d06/07	Z, Y, J_deep
02h26-032d25	J_deep
02h28-031d26/27	Z, Y, J, H, Ks, J_deep
02h29-033d23	Z, Y, J_deep
02h35-033d23	Z, Y, J_deep
02h46-032d24/25	Y, J_deep
02h47-031d26/27	H, Ks, J_deep
08h36+002d25	Z, Y, J_deep
08h42-000d28/29	J_deep
08h48+000d28/29	H
08h48+002d25	Y, J_deep
09h00+000d28/29	Y, J_deep
09h00+001d27	Ks, J_deep
09h00-000d28/29	Y, J_deep
09h06+000d28/29	Y, J_deep
09h06+001d27	Y, J_deep
09h11+000d28/29	Z, Y, J_deep
09h17+000d28/29	Ks, J_deep
09h17+001d26/27	J_deep
09h17+002d25	Z, Y, J_deep
09h17-000d28/29	Ks, J_deep
11h40-000d28/29	J_deep
11h59+001d26/27	Z, Y, J_deep
12h10+001d27	Y, J_deep
12h16+001d27	J_deep
14h21+000d28/29	Y, J_deep
14h27+000d29	H, Ks, J_deep
22h03-032d25	Z, Y, J, H, Ks, J_deep
22h03-033d23	Ks, J_deep
22h10-031d26/27	Ks, J_deep
22h10-033d23	Z, Y, J, H, Ks, J_deep
22h17-031d26/27	J_deep
22h23-031d26/27	Z, Y, J_deep
22h24-032d24/25	Ks, J_deep
22h37-031d26/27	Z, Y, J_deep
22h44-032d25	J_deep
23h19-032d24/25	Ks, J_deep
23h26-033d23	Y, J_deep
23h39-032d25	Z, Y, J_deep
23h46-032d25	Y, J_deep
23h58-031d26/27	Y, J_deep
23h59-032d25	Z, Y, J_deep

Table 3: Field and filter combinations that were in the First Release but have now falled below the quality and/or ESO grade cuts.

and assigned zero weight in subsequent combinations.

Sky background correction: this removes large-scale background variation.

Jitter stacking: the set of individual jittered frames for one pawprint-filter combination are combined into a pawprint image, with bad-pixel rejection. These individual pawprint images are available in the data release (see below).

Photometric and astrometric calibration: This is based on matching with 2MASS stars (see details below).

Tiling: The six individual pawprint images for one filter are combined into a full tile image.

Grouting: When combining images into a full tile, there are non-negligible PSF variations, due mainly to seeing variations between the six individual pawprints, and also slight variation in image quality with off-axis distance. Different pairs of pawprints contribute to different regions in the tile, thus the aperture correction varies with position. A specific correction for this (aka "grouting") is applied to the photometry in the catalogues and is significantly improved in the latest version of the CASU pipeline.

Astrometric Calibration

The main astrometric calibration is based on 2MASS stars; there are typically 50 unsaturated 2MASS stars per VIRCAM detector, and astrometric transformations from detector coordinates to RA, Dec are derived from these. The typical rms is 0.15 arcsec per star per coordinate, which is dominated by photon noise in the 2MASS data.

External comparisons with UKIDSS and SDSS (in the GAMA09 region) show that the astrometry is good, with typical rms per coordinate around 0.09 arcsec and mean offsets below 0.03 arcsec. Small correlated residuals (generally between pawprints) are seen at the level of approx 0.05 arcsec; these may be improved in a future data release.

Photometric Calibration

Photometric calibration is also derived from 2MASS stars. A set of colour equations is used to predict VISTA native magnitudes from the observed 2MASS J,H,K_s colours; these are given by slight modifications of those for UKIDSS (see Hodgkin S. et al., 2009, MNRAS, 394, 675). The adopted VIKING colour terms are:

$$Z_V = J_{2M} + 1.025(J_{2M} - H_{2M})$$
$$Y_V = J_{2M} + 0.610(J_{2M} - H_{2M})$$
$$J_V = J_{2M} - 0.077(J_{2M} - H_{2M})$$
$$H_V = H_{2M} + 0.032(J_{2M} - H_{2M})$$
$$K_{sV} = K_{2M} + 0.01(J_{2M} - K_{2M})$$

where in the above, subscript 2M denotes 2MASS and V denotes VIKING. The above equations give the predicted VISTA-system magnitudes of 2MASS stars, and comparing these to instrumental counts for these stars, a zeropoint is determined for each image.

The *internal* photometric zeropoint stability, as deduced from repeated measurements of stars in overlapping regions of adjacent tiles, are stable to $\sim$0.03 mag rms.

Externally, comparison against UKIDSS measurements in the GAMA09 region shows good consistency in the H, K_s bands: the per-tile mean offset is close to zero, and tile-to-tile dispersion in the mean is typically 0.03 mag rms. For bluer bands, there are non-negligible mean zero point offsets, approximately 0.05 mag in J-band and 0.09 mag in the Y-band, both in the sense that VIKING magnitudes are brighter than UKIDSS for the same object. This is probably caused by a combination of two factors: the stellar locus in Y-J, J-K_s is slightly non-linear, and almost all the matching 2MASS stars are substantially later than A0 spectral type, so the extrapolation of the stellar locus using the above colour terms does not quite pass through (0,0).

The Z band global zeropoint is slightly more uncertain, since the extrapolation from 2MASS is larger, and also the SDSS z-band has a significantly different response function shape (approximately triangular) from VIKING Z (approximately box-car). Preliminary comparisons suggest the current VIKING Z zeropoint may be too bright by approximately 0.10 mag.

Star-galaxy classification

A star-galaxy classification parameter (ClassStat) is provided in the list files; this is intended to be approximately Gaussian N(0,1) for stellar objects, and extends to large positive values for galaxies. Also an integer-based classification (Class); see description below. The band-merged catalogue file (_finalSourceCat_) contains also merged statistics based on a quasi-Bayesian combination of the single-band classifications.

In addition to the above, colour-based classification using near-infrared colours (especially including K_s band) can also provide an effective discriminant between stars and galaxies. For the current dataset, using the Z-J, J-K_s two-colour diagram appears to be the best choice (especially at faint magnitudes where the morphological classification becomes indecisive). This two-colour diagram shows a well-defined boomerang-shaped stellar locus, flattening off near J - K_s $\sim$0.80, and a large cloud of galaxies at redder J-K_s values, typically $1 < \text{J-K}_s < 2$. (This behaviour is caused by a combination of several factors: late giant stars have redder J-K_s colours than dwarfs; galaxies can have internal extinction, while stars have minimal extinction in these high-latitude fields; and especially the 1.6 micron bump feature in the SED of late-type stars. Redshifting of the 1.6 micron bump towards the K_s filter causes galaxy J-K_s colours to shift redwards from z$\sim$0 to z$\sim$0.4, then flatten off above this).

In future, when visible band (u, g, r, i) data is available from the KIDS survey, even better colour-based classification is likely to be deliverable using for example the (g-i, J-K_s) two-colour diagram, as shown by Baldry et al (2010, MNRAS 404, 86).

Inspection of samples of "discrepant" objects, defined as those where the morphological and ZJK_s two-colour classifications disagree, shows the following general trends:

• The majority of "discrepant" objects arise from blending issues, e.g. close pairs of objects where the dominant component is a star, or objects affected by halos around bright stars.

• There are a small fraction of genuine blue galaxies close to the stellar colour locus, mostly bright low-z late-type galaxies.

• There are some quasars/AGNs appearing as stellar objects in the red cloud.

Merging of source catalogues

The released band-merged catalogues are created from the merger of single band catalogues also included in this release. This merging process is outlined in more detail in the VSA documentation but involves the creation of a `vikingSource` table from the individual `vikingDetection` tables. The matching iterates through the catalogues for each band in turn (bluer to redder) and matches can include any combination of filters (one to five) depending on how many filters it is detected in.

These tables are linked via reference ID numbers. The matching is done within a default radius of 2.0 arcsec and the selection between multiple potential matches can be made using the `priOrSec` (primary or secondary) flag. The `PRIMARY_SOURCE` flag has been added to provide an indication which one of the duplicates created in overlap regions between frames should be used. The user is advised to consult with the VSA documentation for more detail about these flags and the merging process.

Data files and conventions

The imaging data files have the following naming convention:

`viking_er2_HHhMM-DDDdMM_[tile/offN]_F_[type]_NNNNN.ext`

where `HHhMM-DDDdMM` labels RA/Dec of the pointing centre in hours/minutes of RA, and degrees/arcmins of Dec, `tile/offN` specifies if the image is of a full "tile" or one of the constituent 'pawprints' `off0 - off5`, the filter `F` is one of `z, y, j, h or ks`, `type` is whether the file is a FITS image (`image`), confidence map (`conf`) or quicklook jpeg of each of these images (`jpeg`) and the final integer is a unique identifier assigned by the VSA to each image. Catalogue and jpeg files have numbers NNNNNN matching the parent FITS image, while confidence maps have integer increased by 1 from the matching image. The extension `.ext` denotes file format, and is one of: .fits.fz (Rice-compressed FITS file).fits (uncompressed FITS file), or .jpg (JPEG image file).

The single band catalogue files in this data release have the following naming conventions:

File names follow the general convention:

`viking_er2_HHhMM-DDDdMM_tile_F_cat_NNNNNNNNNNNN`

Meanings are as follows:

• HHhMM-DDDdMM labels RA/Dec of the pointing centre in hours/minutes of RA, and degrees/arcmins of Dec.

• F gives the filter observed for that observation.

• The twelve-digit integer `NNNNNNNNNNNN` is a unique identifier assigned by the VSA to each field.

The band-merged catalogue files in this data release have the following naming conventions:

File names follow the general convention:

`viking_er2_HHhMM-DDDdMM_zyjhks_finalSourceCat_NNNNNNNNNNNN`

Meanings are as follows:

• HHhMM-DDDdMM labels RA/Dec of the pointing centre in hours/minutes of RA, and degrees/arcmins of Dec.

• The twelve-digit integer `NNNNNNNNNNNN` is a unique identifier assigned by the VSA to each field.

Entries band-merged catalogues

The contents of the passband-merged catalogues are given by the **vikingSource** schema of the VSA database (`http://horus.roe.ac.uk/vsa/www/VIKINGDR2/VIKINGDR2_TABLE_vikingSourceSchema.html`).

A summary of the most relevant parameters in the band-merged catalogue files is given below:

`ra, dec`:	RA, Dec in J2000 decimal degrees.
`l, b`:	Galactic coordinates, decimal degrees.
`zXi, zEta, yXi, yEta, etc`:	Source offsets from master position in each of the five bands Z, Y, Y, H, K_s; in arcsec East and North respectively.
`priOrSec`:	Integer flag for "primary" or "secondary" source. Objects with priOrSec = 0 are unique to this tile. Objects with priOrSec = frameSetID are "primary" objects on this tile, with a secondary detection on another tile. Objects with priOrSec>0 and priOrSec != framesetID are "secondary" objects with a "primary" detection on a different tile.
`zSeqNum, ySeqNum, etc`:	Sequence number, enabling matching this entry to the corresponding single-band detecti
`zmyPnt, ymjPnt, jmhPnt, hmksPnt`:	Respectively colours Z-Y, Y-J, J-H, H-K_s assuming a point source, from the corresponding AperMag3 values.
`zmyExt, ymjExt, jmhExt, hmksExt`:	Respectively colours Z-Y, Y-J, J-H, H-K_s assuming an extended source (using 2 arcsec aperture with no aperture correction).

`zAperMag3, zAperMag4, zAperMag6,`
`zAperMagNoAperCorr3, zPetroMag,`
`zSerMag, zPsfMag, etc`:
	A subset of the various magnitude measures for all the single passbands,
	beginning with one of z,y,j,h,ks denoting passband. Here,
	a subset is given to reduce line length: of the many AperMagN values, only
	AperMag3,4,6 are given here, and the corresponding versions without aperture correctio

`zClass, zClassStat, etc`:	Respectively integer and real classification flag for each of the single bands.
`mergedClass, mergedClassStat`:	Band-merged integer and real classification, based on a quasi-Bayesian combination of the individual passbands.
`pStar, pGalaxy`:	Probability that the object is stellar/galaxy, respectively.
`pNoise, pSaturated`:	Probability that the object is noise/saturated, respectively.
`zppErrBits, yppErrBits, etc`:	Integer error bits code for each of Z, Y, J, H, K_s bands. Value Zero = no warnings, 1-255 indicates "Warning" level, and any `ppErrBits` value >256 indicates potentially more serious problems.
`PRIMARY_SOURCE`	Integer flag to select between multiple entries in the catalogue. If the value is 1 then this is the 'primary' entry for the source, i.e. priOrSec=0 or priOrSec=frameSetID. If the value is 0 then that entry is a duplicated source, usually a source in an overlap region between fields or tiles.

We recommend that users should restrict their analysis to objects with `zppErrBits, yppErrBits, etc`<255 at all times and `zppErrBits`=0 if they require the most reliable subset of the sources. Values of `zppErrBits`=16 indicate that the source was deblended, `zppErrBits`=64 that at least one bad pixel was within the default aperture and `zppErrBits`=128 that the source was low confidence within the default aperture.

Known problems

As noted in more detail above, there are likely to be modest zero-point offsets ($\approx$0.06 mag at J, $\approx$0.09 mag at Y-band) in the sense that VIKING magnitudes may be too bright. These appear relatively stable across tiles.

In the current release, the most common source of spurious images is associated with diffraction halos and filter-reflection ghosts around bright stars; these are localised around the parent star, and are easily recognised in the parent images. There are also occasional single-band linear features from artificial satellite trails, meteors or aircraft, which can cause a chain of spurious images. Most such spurious images do not match-up between passbands, therefore multi-band matched detections are generally reliable (especially with 3 or more bands), but we emphasise that **all single-band detections should be treated as unreliable,** unless verified by inspection of images.

There are also "bad patches" on certain detectors, namely a large region on Detector#16 (South-East corner) which does not flat-field well, and a strip along an edge of detector#12 which likewise does not correct well and leads to occasional horizontal lines of spurious images.

Cross-talk between detector channels is essentially negligible.

Image persistence (latent images after a bright star lands on a pixel) is generally small, but not quite negligible: since VIRCAM has no shutter, very bright stars can occasionally cause curved "streaks" of persistence as they move in non-straight paths during telescope offsets.

There are a small number (<100) sources in the single band and band-merged catalogs that have very large (>100mag) errors due to them being close to the detection limit. These sources should be flagged manually and will be excluded in future releases. However, given they are so rare (<0.0006% of the band-merged sources) they should not be a major contaminant in any VIKING study.

Queries Questions concerning this data release should be addressed initially to alastair.edge@durham.ac.uk.

Acknowledgements Please use the following statement in any publication using these data: "This publication has made use of data from the VIKING survey from VISTA at the ESO Paranal Observatory, programme ID 179.A-2004. Data processing has been contributed by the VISTA Data Flow System at CASU, Cambridge and WFAU, Edinburgh".

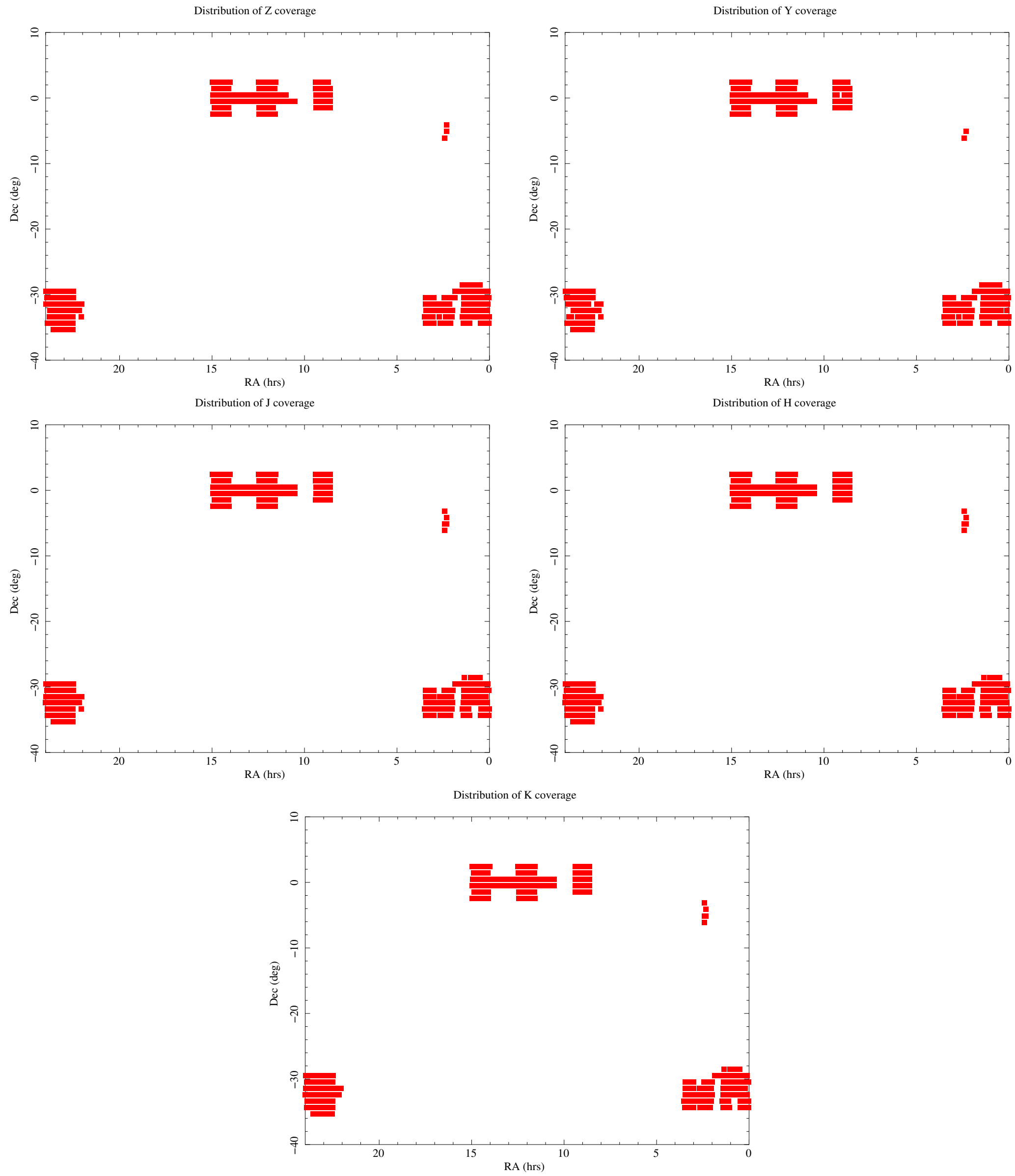

Figure 1: Sky coverage of the fields in this release in terms of filter in order of wavelength (Z, Y, J, H and K).

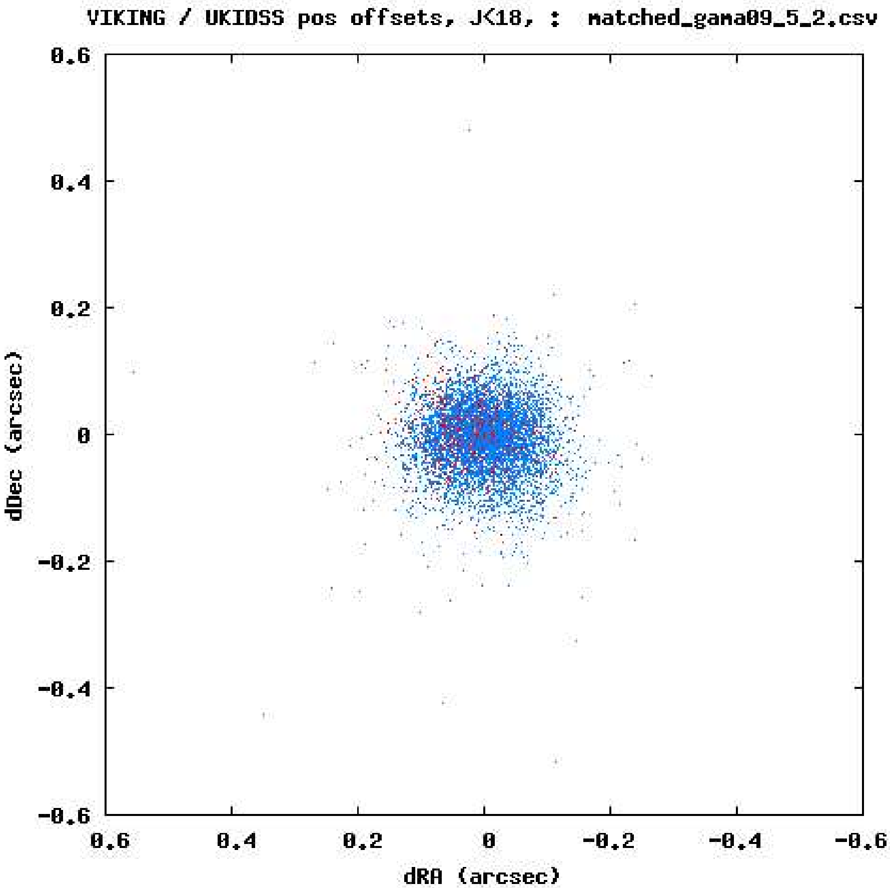

Figure 2: Position offsets in RA, Dec (VIKING-UKIDSS) for one tile, for objects with J<18; stellar objects are blue, extended objects in red.

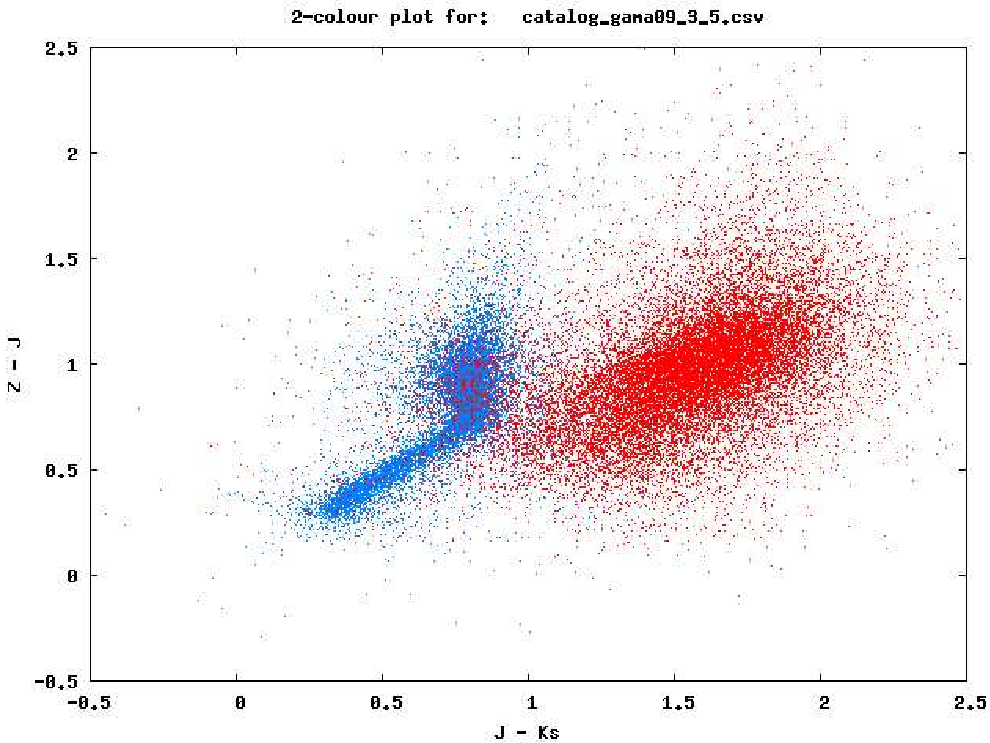

Figure 3: Two-colour diagram, Z-J vs J-K_s, for one tile, selecting objects with J<20. Stellar objects are blue points, extended objects are red points.

Appendix 1: summary of all columns in the band-merged VIKING catalogue

Column Name	Type	Length (byte)	Unit	Description	Default Value	Unified Content Descriptor
sourceID	bigint	8		UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm		ID_MAIN
cuEventID	int	4		UID of curation event giving rise to this record		REFER_CODE
frameSetID	bigint	8		UID of the set of frames that this merged source comes from		REFER_CODE
ra	float	8	Degrees	Celestial Right Ascension		POS_EQ_RA_MAIN
dec	float	8	Degrees	Celestial Declination		POS_EQ_DEC_MAIN
cx	float	8		unit vector of spherical co-ordinates		POS_EQ_X
cy	float	8		unit vector of spherical co-ordinates		POS_EQ_Y
cz	float	8		unit vector of spherical co-ordinates		POS_EQ_Z
htmID	bigint	8		Hierarchical Triangular Mesh (HTM) index, 20 deep, for equatorial co-ordinates		POS_GENERAL
l	float	8	Degrees	Galactic longitude		POS_GAL_LON
b	float	8	Degrees	Galactic latitude		POS_GAL_LAT
lambda	float	8	Degrees	SDSS system spherical co-ordinate 1		POS
eta	float	8	Degrees	SDSS system spherical co-ordinate 2		POS
priOrSec	bigint	8		Seam code for a unique (=0) or duplicated (!=0) source (eg. flags overlap duplicates).	-99999999	CODE_MISC
zmyPnt	real	4	mag	Point source colour Z-Y (using aperMag3)	-0.9999995e9	PHOT_COLOR
zmyPntErr	real	4	mag	Error on point source colour Z-Y	-0.9999995e9	ERROR
ymjPnt	real	4	mag	Point source colour Y-J (using aperMag3)	-0.9999995e9	PHOT_COLOR
ymjPntErr	real	4	mag	Error on point source colour Y-J	-0.9999995e9	ERROR
jmhPnt	real	4	mag	Point source colour J-H (using aperMag3)	-0.9999995e9	PHOT_COLOR
jmhPntErr	real	4	mag	Error on point source colour J-H	-0.9999995e9	ERROR
hmksPnt	real	4	mag	Point source colour H-K_s (using aperMag3)	-0.9999995e9	PHOT_COLOR
hmksPntErr	real	4	mag	Error on point source colour H-K_s	-0.9999995e9	ERROR
zmyExt	real	4	mag	Extended source colour Z-Y (using aperMagNoAperCorr3)	-0.9999995e9	PHOT_COLOR
zmyExtErr	real	4	mag	Error on extended source colour Z-Y	-0.9999995e9	ERROR
ymjExt	real	4	mag	Extended source colour Y-J (using aperMagNoAperCorr3)	-0.9999995e9	PHOT_COLOR
ymjExtErr	real	4	mag	Error on extended source colour Y-J	-0.9999995e9	ERROR
jmhExt	real	4	mag	Extended source colour J-H (using aperMagNoAperCorr3)	-0.9999995e9	PHOT_COLOR
jmhExtErr	real	4	mag	Error on extended source colour J-H	-0.9999995e9	ERROR
hmksExt	real	4	mag	Extended source colour H-K_s (using aperMagNoAperCorr3)	-0.9999995e9	PHOT_COLOR
hmksExtErr	real	4	mag	Error on extended source colour H-K_s	-0.9999995e9	ERROR
mergedClassStat	real	4		Merged N(0,1) stellarness-of-profile statistic	-0.9999995e9	STAT_PROP
mergedClass	smallint	2		Class flag from available measurements	1=galaxy 0=noise -1=stellar -2=probableStar -3=probableGalaxy -9=saturated	CODE_MISC

pStar	real	4		Probability that the source is a star		STAT_PROP
pGalaxy	real	4		Probability that the source is a galaxy		STAT_PROP
pNoise	real	4		Probability that the source is noise		STAT_PROP
pSaturated	real	4		Probability that the source is saturated		STAT_PROP
eBV	real	4		The galactic dust extinction value measured from the Schlegel, Finkbeiner & Davis (1998) maps. This uses the correction given in Bonifacio, Monai & Beers (2000). This correction reduces the extinction value in regions of high extinction (E(B-V)>0.1)	-0.9999995e9	
aZ	real	4	mag	The galactic extinction correction in the Z band for extragalactic objects	-0.9999995e9	
aY	real	4	mag	The galactic extinction correction in the Y band for extragalactic objects	-0.9999995e9	
aJ	real	4	mag	The galactic extinction correction in the J band for extragalactic objects	-0.9999995e9	
aH	real	4	mag	The galactic extinction correction in the H band for extragalactic objects	-0.9999995e9	
aKs	real	4	mag	The galactic extinction correction in the K_s band for extragalactic objects	-0.9999995e9	
zPetroMag	real	4	mag	Extended source Z mag (Petrosian)	-0.9999995e9	PHOT_MAG
zPetroMagErr	real	4	mag	Error in extended source Z mag (Petrosian)	-0.9999995e9	ERROR
zPsfMag	real	4	mag	Point source profile-fitted Z mag	-0.9999995e9	PHOT_MAG
zPsfMagErr	real	4	mag	Error in point source profile-fitted Z mag	-0.9999995e9	ERROR
zSerMag2D	real	4	mag	Extended source Z mag (profile-fitted)	-0.9999995e9	PHOT_MAG
zSerMag2DErr	real	4	mag	Error in extended source Z mag (profile-fitted)	-0.9999995e9	ERROR
zAperMag3	real	4	mag	Default point source Z aperture corrected mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
zAperMag3Err	real	4	mag	Error in default point/extended source Z mag (2.0 arcsec aperture diameter)	-0.9999995e9	ERROR
zAperMag4	real	4	mag	Point source Z aperture corrected mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
zAperMag4Err	real	4	mag	Error in point/extended source Z mag (2.8 arcsec aperture diameter)	-0.9999995e9	ERROR
zAperMag6	real	4	mag	Point source Z aperture corrected mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
zAperMag6Err	real	4	mag	Error in point/extended source Z mag (5.7 arcsec aperture diameter)	-0.9999995e9	ERROR
zAperMagNoAperCorr3	real	4	mag	Default extended source Z aperture mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
zAperMagNoAperCorr4	real	4	mag	Extended source Z aperture mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
zAperMagNoAperCorr6	real	4	mag	Extended source Z aperture mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG

zHlCorSMjRadAs	real	4	arcsec	Seeing corrected half-light, semi-major axis in Z band	-0.9999995e9	EXTENSION_RAD
zGausig	real	4	pixels	RMS of axes of ellipse fit in Z	-0.9999995e9	MORPH_PARAM
zEll	real	4		1-b/a, where a/b=semi-major/minor axes in Z	-0.9999995e9	PHYS_ELLIPTICITY
zPA	real	4	Degrees	ellipse fit celestial orientation in Z	-0.9999995e9	POS_POS-ANG
zErrBits	int	4		processing warning/error bitwise flags in Z	-99999999	CODE_MISC
zAverageConf	real	4		average confidence in 2 arcsec diameter default aperture Z	-99999999	CODE_MISC
zClass	smallint	2		discrete image classification flag in Z	-9999	CLASS_MISC
zClassStat	real	4		N(0,1) stellarness-of-profile statistic in Z	-0.9999995e9	STAT_PROP
zppErrBits	int	4		additional WFAU post-processing error bits in Z	0	CODE_MISC
zSeqNum	int	4		the running number of the Z detection -99999999		ID_NUMBER
zXi	real	4	arcsec	Offset of Z detection from master position (+east/-west)	-0.9999995e9	POS_EQ_RA_OFF
zEta	real	4	arcsec	Offset of Z detection from master position (+north/-south)	-0.9999995e9	POS_EQ_DEC_OFF
yPetroMag	real	4	mag	Extended source Y mag (Petrosian)	-0.9999995e9	PHOT_MAG
yPetroMagErr	real	4	mag	Error in extended source Y mag (Petrosian)	-0.9999995e9	ERROR
yPsfMag	real	4	mag	Point source profile-fitted Y mag	-0.9999995e9	PHOT_MAG
yPsfMagErr	real	4	mag	Error in point source profile-fitted Y mag	-0.9999995e9	ERROR
ySerMag2D	real	4	mag	Extended source Y mag (profile-fitted)	-0.9999995e9	PHOT_MAG
ySerMag2DErr	real	4	mag	Error in extended source Y mag (profile-fitted)	-0.9999995e9	ERROR
yAperMag3	real	4	mag	Default point source Y aperture corrected mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
yAperMag3Err	real	4	mag	Error in default point/extended source Y mag (2.0 arcsec aperture diameter)	-0.9999995e9	ERROR
yAperMag4	real	4	mag	Point source Y aperture corrected mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
yAperMag4Err	real	4	mag	Error in point/extended source Y mag (2.8 arcsec aperture diameter)	-0.9999995e9	ERROR
yAperMag6	real	4	mag	Point source Y aperture corrected mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
yAperMag6Err	real	4	mag	Error in point/extended source Y mag (5.7 arcsec aperture diameter)	-0.9999995e9	ERROR
yAperMagNoAperCorr3	real	4	mag	Default extended source Y aperture mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
yAperMagNoAperCorr4	real	4	mag	Extended source Y aperture mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
yAperMagNoAperCorr6	real	4	mag	Extended source Y aperture mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
yHlCorSMjRadAs	real	4	arcsec	Seeing corrected half-light, semi-major axis in Y band	-0.9999995e9	EXTENSION_RAD
yGausig	real	4	pixels	RMS of axes of ellipse fit in Y	-0.9999995e9	MORPH_PARAM
yEll	real	4		1-b/a, where a/b=semi-major/minor axes in Y	-0.9999995e9	PHYS_ELLIPTICITY
yPA	real	4	Degrees	ellipse fit celestial orientation in Y	-0.9999995e9	POS_POS-ANG
yErrBits	int	4		processing warning/error bitwise flags in Y	-99999999	CODE_MISC
yAverageConf	real	4		average confidence in 2 arcsec diameter default aperture Y	-99999999	CODE_MISC
yClass	smallint	2		discrete image classification flag in Y	-9999	CLASS_MISC
yClassStat	real	4		N(0,1) stellarness-of-profile statistic in Y	-0.9999995e9	STAT_PROP
yppErrBits	int	4		additional WFAU post-processing error bits in Y	0	CODE_MISC

ySeqNum	int	4		the running number of the Y detection	-99999999	ID_NUMBER
yXi	real	4	arcsec	Offset of Y detection from master position (+east/-west)	-0.9999995e9	POS_EQ_RA_OFF
yEta	real	4	arcsec	Offset of Y detection from master position (+north/-south)	-0.9999995e9	POS_EQ_DEC_OFF
jPetroMag	real	4	mag	Extended source J mag (Petrosian)	-0.9999995e9	PHOT_MAG
jPetroMagErr	real	4	mag	Error in extended source J mag (Petrosian)	-0.9999995e9	ERROR
jPsfMag	real	4	mag	Point source profile-fitted J mag	-0.9999995e9	PHOT_MAG
jPsfMagErr	real	4	mag	Error in point source profile-fitted J mag	-0.9999995e9	ERROR
jSerMag2D	real	4	mag	Extended source J mag (profile-fitted)	-0.9999995e9	PHOT_MAG
jSerMag2DErr	real	4	mag	Error in extended source J mag (profile-fitted)	-0.9999995e9	ERROR
jAperMag3	real	4	mag	Default point source J aperture corrected mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
jAperMag3Err	real	4	mag	Error in default point/extended source J mag (2.0 arcsec aperture diameter)	-0.9999995e9	ERROR
jAperMag4	real	4	mag	Point source J aperture corrected mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
jAperMag4Err	real	4	mag	Error in point/extended source J mag (2.8 arcsec aperture diameter)	-0.9999995e9	ERROR
jAperMag6	real	4	mag	Point source J aperture corrected mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
jAperMag6Err	real	4	mag	Error in point/extended source J mag (5.7 arcsec aperture diameter)	-0.9999995e9	ERROR
jAperMagNoAperCorr3	real	4	mag	Default extended source J aperture mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
jAperMagNoAperCorr4	real	4	mag	Extended source J aperture mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
jAperMagNoAperCorr6	real	4	mag	Extended source J aperture mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
jHlCorSMjRadAs	real	4	arcsec	Seeing corrected half-light, semi-major axis in J band	-0.9999995e9	EXTENSION_RAD
jGausig	real	4	pixels	RMS of axes of ellipse fit in J	-0.9999995e9	MORPH_PARAM
jEll	real	4		1-b/a, where a/b=semi-major/minor axes in J	-0.9999995e9	PHYS_ELLIPTICITY
jPA	real	4	Degrees	ellipse fit celestial orientation in J	-0.9999995e9	POS_POS-ANG
jErrBits	int	4		processing warning/error bitwise flags in J	-99999999	CODE_MISC
jAverageConf	real	4		average confidence in 2 arcsec diameter default aperture J	-99999999	CODE_MISC
jClass	smallint	2		discrete image classification flag in J	-9999	CLASS_MISC
jClassStat	real	4		N(0,1) stellarness-of-profile statistic in J	-0.9999995e9	STAT_PROP
jppErrBits	int	4		additional WFAU post-processing error bits in J	0	CODE_MISC
jSeqNum	int	4		the running number of the J detection	-99999999	ID_NUMBER
jXi	real	4	arcsec	Offset of J detection from master position (+east/-west)	-0.9999995e9	POS_EQ_RA_OFF
jEta	real	4	arcsec	Offset of J detection from master position (+north/-south)	-0.9999995e9	POS_EQ_DEC_OFF

hPetroMag	real	4	mag	Extended source H mag (Petrosian)	-0.9999995e9	PHOT_MAG
hPetroMagErr	real	4	mag	Error in extended source H mag (Petrosian)	-0.9999995e9	ERROR
hPsfMag	real	4	mag	Point source profile-fitted H mag	-0.9999995e9	PHOT_MAG
hPsfMagErr	real	4	mag	Error in point source profile-fitted H mag	-0.9999995e9	ERROR
hSerMag2D	real	4	mag	Extended source H mag (profile-fitted)	-0.9999995e9	PHOT_MAG
hSerMag2DErr	real	4	mag	Error in extended source H mag (profile-fitted)	-0.9999995e9	ERROR
hAperMag3	real	4	mag	Default point source H aperture corrected mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
hAperMag3Err	real	4	mag	Error in default point/extended source H mag (2.0 arcsec aperture diameter)	-0.9999995e9	ERROR
hAperMag4	real	4	mag	Point source H aperture corrected mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
hAperMag4Err	real	4	mag	Error in point/extended source H mag (2.8 arcsec aperture diameter)	-0.9999995e9	ERROR
hAperMag6	real	4	mag	Point source H aperture corrected mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
hAperMag6Err	real	4	mag	Error in point/extended source H mag (5.7 arcsec aperture diameter)	-0.9999995e9	ERROR
hAperMagNoAperCorr3	real	4	mag	Default extended source H aperture mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
hAperMagNoAperCorr4	real	4	mag	Extended source H aperture mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
hAperMagNoAperCorr6	real	4	mag	Extended source H aperture mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
hHlCorSMjRadAs	real	4	arcsec	Seeing corrected half-light, semi-major axis in H band	-0.9999995e9	EXTENSION_RAD
hGausig	real	4	pixels	RMS of axes of ellipse fit in H	-0.9999995e9	MORPH_PARAM
hEll	real	4		1-b/a, where a/b=semi-major/minor axes in H	-0.9999995e9	PHYS_ELLIPTICITY
hPA	real	4	Degrees	ellipse fit celestial orientation in H	-0.9999995e9	POS_POS-ANG
hErrBits	int	4		processing warning/error bitwise flags in H	-99999999	CODE_MISC
hAverageConf	real	4		average confidence in 2 arcsec diameter default aperture H	-99999999	CODE_MISC
hClass	smal	lint 2		discrete image classification flag in H	-9999	CLASS_MISC
hClassStat	real	4		N(0,1) stellarness-of-profile statistic in H	-0.9999995e9	STAT_PROP
hppErrBits	int	4		additional WFAU post-processing error bits in H	0	CODE_MISC
hSeqNum	int	4		the running number of the H detection	-99999999	ID_NUMBER
hXi	real	4	arcsec	Offset of H detection from master position (+east/-west)	-0.9999995e9	POS_EQ_RA_OFF
hEta	real	4	arcsec	Offset of H detection from master position (+north/-south)	-0.9999995e9	POS_EQ_DEC_OFF

ksPetroMag	real	4	mag	Extended source K_s mag (Petrosian)	-0.9999995e9	PHOT_MAG
ksPetroMagErr	real	4	mag	Error in extended source K_s mag (Petrosian)	-0.9999995e9	ERROR
ksPsfMag	real	4	mag	Point source profile-fitted K_s mag	-0.9999995e9	PHOT_MAG
ksPsfMagErr	real	4	mag	Error in point source profile-fitted K_s mag	-0.9999995e9	ERROR
ksSerMag2D	real	4	mag	Extended source K_s mag (profile-fitted)	-0.9999995e9	PHOT_MAG
ksSerMag2DErr	real	4	mag	Error in extended source K_s mag (profile-fitted)	-0.9999995e9	ERROR
ksAperMag3	real	4	mag	Default point source K_s aperture corrected mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
ksAperMag3Err	real	4	mag	Error in default point/extended source K_s mag (2.0 arcsec aperture diameter)	-0.9999995e9	ERROR
ksAperMag4	real	4	mag	Point source K_s aperture corrected mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
ksAperMag4Err	real	4	mag	Error in point/extended source K_s mag (2.8 arcsec aperture diameter)	-0.9999995e9	ERROR
ksAperMag6	real	4	mag	Point source K_s aperture corrected mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
ksAperMag6Err	real	4	mag	Error in point/extended source K_s mag (5.7 arcsec aperture diameter)	-0.9999995e9	ERROR
ksAperMagNoAperCorr3	real	4	mag	Default extended source K_s aperture mag (2.0 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
ksAperMagNoAperCorr4	real	4	mag	Extended source K_s aperture mag (2.8 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
ksAperMagNoAperCorr6	real	4	mag	Extended source K_s aperture mag (5.7 arcsec aperture diameter)	-0.9999995e9	PHOT_MAG
ksHlCorSMjRadAs	real	4	arcsec	Seeing corrected half-light, semi-major axis in K_s band	-0.9999995e9	EXTENSION_RAD
ksGausig	real	4	pixels	RMS of axes of ellipse fit in K_s	-0.9999995e9	MORPH_PARAM
ksEll	real	4		1-b/a, where a/b=semi-major/minor axes in K_s	-0.9999995e9	PHYS_ELLIPTICITY
ksPA	real	4	Degrees	ellipse fit celestial orientation in K_s	-0.9999995e9	POS_POS-ANG
ksErrBits	int	4		processing warning/error bitwise flags in K_s	-99999999	CODE_MISC
ksAverageConf	real	4		average confidence in 2 arcsec diameter default aperture K_s	-99999999	CODE_MISC
ksClass	smallint	2		discrete image classification flag in K_s	-9999	CLASS_MISC
ksClassStat	real	4		N(0,1) stellarness-of-profile statistic in K_s	-0.9999995e9	STAT_PROP
ksppErrBits	int	4		additional WFAU post-processing error bits in K_s	0	CODE_MISC
ksSeqNum	int	4		the running number of the K_s detection	-99999999	ID_NUMBER
ksXi	real	4	arcsec	Offset of K_s detection from master position (+east/-west)	-0.9999995e9	POS_EQ_RA_OFF
ksEta	real	4	arcsec	Offset of K_s detection from master position (+north/-south)	-0.9999995e9	POS_EQ_DEC_OFF
primary_source	smallint	2		to select between multiple entries in the catalogue	0	PRIMARY_SOURCE