ESO Phase 3 Data Release Description

Data Collection	HAWK-I
Data Provider	James Lewis and Mark Neeser (data until September 2015) ESO, Science Data Quality group (data starting October 2015)
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Abstract

This data collection provides pipeline-reduced images obtained with HAWK-I, a near-infrared (0.85 – 2.5 μm) wide-field imager[1]. In 2016, the full HAWK-I archived dataset, comprising the observations from the beginning of regular operations (April 2008) until September 2015, was reduced by the Cambridge Astronomy Survey Unit (CASU) using newly developed calibration and science recipes. As of 2017, ESO took over to continue the processing of HAWK-I science data, starting with data taken in October 2015 and with further data being added at regular intervals.

This release description has two parts: the first describes the general methods applied along with details of the CASU processing. The second part describes differences in the ESO processing (applicable for observations measured post September 2015).

Part 1: General information and CASU processing

Overview of Observation

The data set contains all of the science observations done using the HAWK-I instrument. These are not part of a single self-contained project or survey. Rather, they contain observations from many different projects and surveys, using various filters and observing methods. The distribution of fields is obviously governed by the time of year in which the observations were taken.

Release Content

This part of the data collection contains all of the science observations done with HAWK-I starting from 2008, and contains data up to October 2015. The content is increased beyond this date with ESO taking over the science processing of HAWK-I images (see Part 2). The first data release (April 2008 – September 2015) consists of 40,552 frames with a total size of 3.2 Tb.

From both the CASU and the ESO processing, the following data products are available for science observations:

- Stacked jittered images of the individual exposures at the detector level
- Variance arrays for the stacks
- Confidence maps for the stacks
- Single-band source catalogues for the stacks
- Fully tiled images of all of the individual exposures
- Variance arrays for the tiles
- Confidence maps for the tiles
- Single-band source catalogues for the tiles.

[1] https://archive.eso.org/docurl?HAWKI

All reduction has always been done at the OB level and no attempt has been made to stack data between OBs. The following observations have been omitted:

- Observations done under any technical programme having an OBS.PROG.ID like "60" and "060" (including any standard star observations).
- Observations done in HAWK-I burst mode (DPR.CATG = "SCIENCE" and DPR.TECH = "IMAGE,HIT").

Release Notes

The data for this release was processed by the Cambridge Astronomy Survey Unit (CASU) using recently written science recipes that run within the ESO CPL environment. The main processing steps (applicable also to the ESO QC processing) are described in the following section.

Data Reduction and Calibration

For all observations the following data reduction steps are performed:

- Dark correction using a master dark frame of the correct DIT/NDIT combination. By and large dark observations are done after sunrise for the DIT/NDIT combinations that have been used during the previous night. Where this has not been the case or where there was some sort of failure in the dark observation, a similar master dark frame from another night has been substituted.
- Flat fielding using a master twilight flat field for the matching filter. Twilight flat fields are changed roughly every three months during the reduction. This is so that there will be three months of data that can be stacked together in order to work out the illumination correction.
- A gain correction is applied to each detector. This is done to compensate for slight gain variations between the detectors.
- A sky background estimate is obtained and subtracted from each individual exposure. Getting this correct is just about the hardest task in infrared imaging. Because the infrared sky varies rapidly both temporally and spatially the best way to do this is to use the science images themselves to form 2d sky background images. In the case where there are large extended source in the science images, then it is often the case that offset sky exposures will have been done.
- A source catalogue is extracted for each exposure and this is used to fit a world coordinate system (WCS). The ZPN projection is used in conjunction with known projection coefficients. In general the WCS is done relative to the WISE point-source catalogue. This, in general, has a higher source density than the 2MASS PSC, which can be important for HAWK-I as the field of view is small and the instrument is generally used in regions where there are few stars. However in regions with large amounts of nebulosity the random errors in the WISE coordinates become significantly worse than for 2MASS and in such cases, 2MASS is substituted. The WCS is fitted to all four HAWK-I detectors simultaneously using the known internal geometry of the focal plane.
- The individual exposures for a single OB and a given detector are stacked using the WCS solutions defined above. The stacks are formed using a bi-linear interpolation algorithm to resample the input pixels onto the output grid. This leads to an OB stack for each detector. Note that the image stacks and tiles are re-gridded to a TAN projection. However, if a stack or tile consists of only a single exposure, then this will retain the ZPN projection.
- A single-band source catalogue is extracted from the stacked images (one for each detector).
- The source catalogue is used to redefine the WCS for the stack and to do a photometric calibration against the 2MASS PSC (see page 8 for relation between HAWK-I and 2MASS filters).
- The individual exposures for a single OB for all detectors are tiled together to form a single mosaicked image.
- A source catalogue is extracted from the tiled image.

- The tile's WCS is redefined using the above source catalogue. Also the whole tile is photometrically calibrated.
- The spatial resolution quality keywords PSF_FWHM and PSF_FERR are computed using stellar sources in each image. If the data is a multi-extension stack and there are an insufficient number of stars in the field of view of any single detector, then the average value of the other detectors is used for this keyword. Otherwise, the Paranal seeing monitor (DIMM) is used by converting its value to the different telescope size, the different waveband, and an average over the duration of the exposure. The keyword comments describe the method used.

All image products are accompanied by a variance map that has been propagated through the complete reduction cycle. Stacks and tiles also have a confidence map. Source catalogues are generated at a threshold of 1.5 times the background noise, with a minimum area of 10 pixels. The reductions were done with version 1.1.0 of the pipeline suite.

Data Quality[2]

- The astrometric solutions are generally good to 250 milli-arcseconds, with no discernible systematic residuals, however, individual images can be slightly worse.
- There are projects that have used defocused images that give significantly worse solutions. These typically can have 500 milli-arcsecond residuals.

For all of the HAWK-I object catalogues a source-by-source match was made to the 2MASS catalogue to determine the overall astrometric and photometric quality of the images. This comparison was done using all of the 11 available HAWK-I filters (the broad band filters: Y, J, H, and Ks; as well as the narrow band filters: BrG, CH4, H2, NB0984, NB1060, NB1190, and NB2090). It was found that 82.4% of sources have magnitude differences of less than 0.1 magnitudes (92.3% have $|\Delta m| < 0.2$ magnitudes).

For both the astrometric and photometric quality it is apparent that these results are slightly worse than the internal errors of the 2MASS catalogue. The slightly larger mean internal rms can be explained by the fact that the bright catalogue stars are invariably saturated in the HAWK-I images and, therefore, only the fainter, less reliable, catalogue stars are available for calibration. A slightly better photometric result can be achieved by limiting the matching to the core broad-band HAWK-I filters.

For the entire reprocessing release, these results are summarised in Table 1 and Figures 1 & 2.

Astrometric and Photometric Accuracies	
median $\Delta\alpha * \cos(\delta)$	0.0 +/- 0.2 arcsec
median $\Delta\delta$	0.0 +/- 0.2 arcsec
median Δmag	0.0 +/- 0.2 magnitudes

Table 1: a summary of the results that match the HAWK-I tile source lists with the 2MASS catalogue.

[2] Based on investigations done with the CASU processing results for observations from April 2008 to September 2015

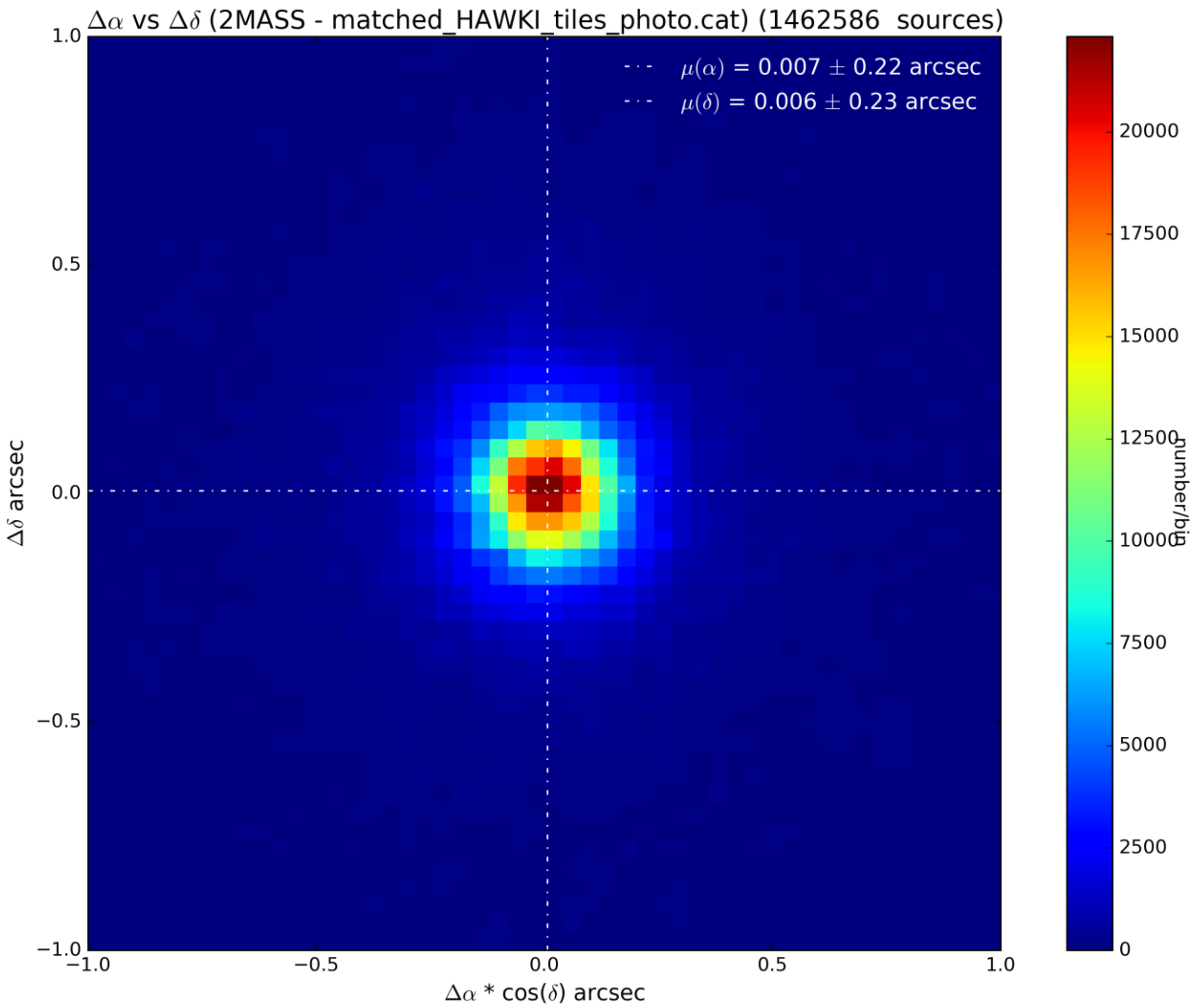

Figure 1: the astrometric quality of the HAWK-I reprocessed tiles as measured by comparing the HAWK-I source lists with the 2MASS catalogue. The standard deviation of the Δα*cos(δ) and Δδ distribution is 0.2 arcsec. This is close to the accuracies of the 2MASS point source catalogue.

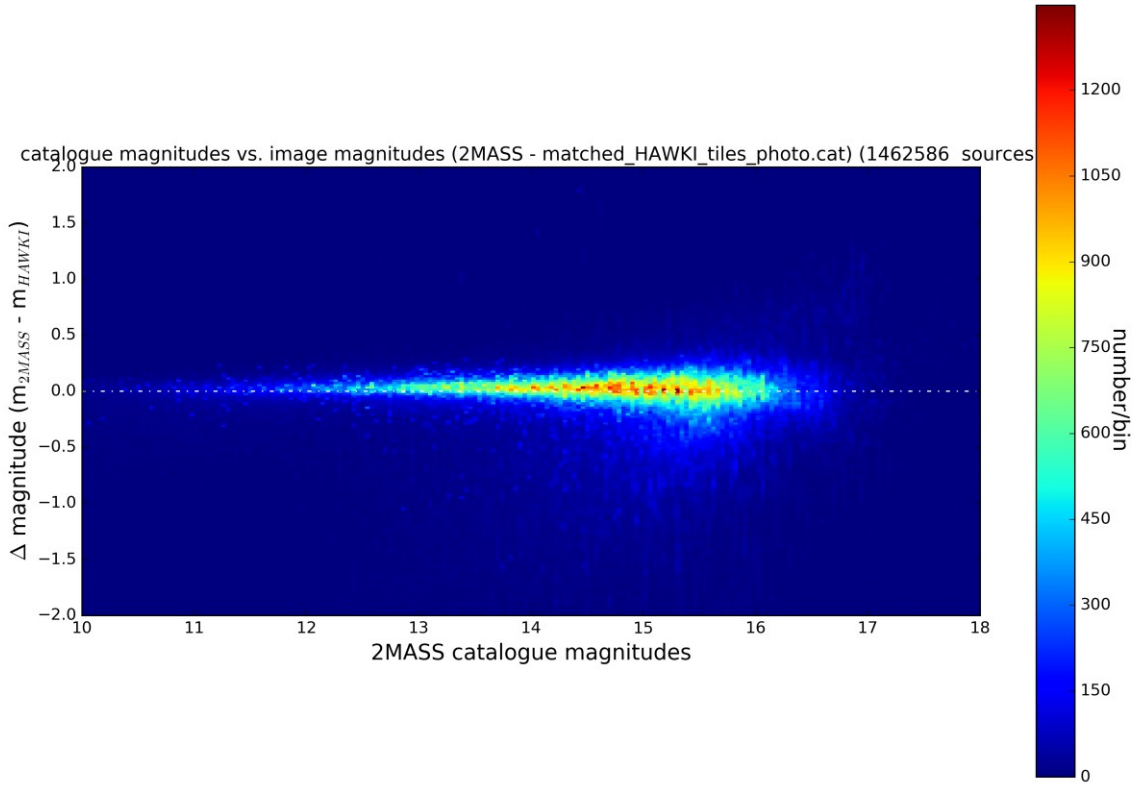

Figure 2: A magnitude – Δmagnitude density plot showing the photometric quality of the HAWK-I source catalogues. The data is derived from sources in all 11 filters from reprocessed HAWK-I tiles matched with 2MASS catalogue stars. The standard deviation of the magnitude difference distribution is 0.2 magnitudes, with 80.8% of sources having $|\Delta m| < 0.1$ magnitudes and 92.0% of sources having $|\Delta m| < 0.2$ magnitudes.

Known issues

None known

Previous Releases

None

Data Format

Files Types

In case of the CASU processing for data obtained until September 2015, the files are generally named after the raw files they are derived from. In the case of stacks or tiles, the name is derived from the first raw file included in the combined file. Below are examples of the file names that may be created from a given OB. The first raw file in this OB was called HAWKI.2013-08-02T03:17:00.146.fits:

- HAWKI.2013-08-02T03:17:00.146_st.fits – the stacked exposures from the whole OB (one stack per detector).
- HAWKI.2013-08-02T03:17:00.146_st_var.fits – the variance map for the stack
- HAWKI.2013-08-02T03:17:00.146_st_conf.fits – the confidence map for the stack
- HAWKI.2013-08-02T03:17:00.146_st_cat.fits – the source catalogue for the stack
- HAWKI.2013-08-02T03:17:00.146_ex_tl.fits – the full tile for the OB with all detector images combined onto a single output grid
- HAWKI.2013-08-02T03:17:00.146_ex_tl_var.fits – the variance map for the full tile
- HAWKI.2013-08-02T03:17:00.146_ex_tl_conf.fits – the confidence map for the full tile
- HAWKI.2013-08-02T03:17:00.146_ex_tl_cat.fits – the source catalogue for the full tile

For a description of the nomenclature of files from the ESO QC processing please see page 15.

With the exception of the tile products all of these are delivered as a single multi-extension FITS files with each detector being represented as an image or binary table extension. The ordering of the extensions is as it is in the raw files with the detectors represented in the order 1,2,4,3. The primary header unit has just header information that is relevant to the exposure or the stack as a whole. Tile image products are represented as a simple FITS file, whereas the tile catalogue is represented as a single binary FITS table extension.

Catalogue Columns

Table 2. Catalogue columns (CASU and ESO QC products)

Col #	Name	Description
1	Sequence_number	Running number for ease of reference, in strict order of image detections
2	Isophotal_flux	Standard definition of summed flux within detection isophote.
3	X_coordinate	The x, y coordinates and errors with (1, 1) defined to be the centre of the first active pixel in the image array.
4	X_coordinate_err	
5	Y_coordinate	
6	Y_coordinate_err	
7	Gaussian_sigma	Second moment parameters
8	Ellipticity	
9	Position_angle	
10	Areal_1_profile	The number of pixels above a series of threshold levels, relative to local sky. The levels are set at T, 2T, 4T, 8T, 16T, 32T, 64T and 128T where T is the analysis threshold
11	Areal_2_profile	
12	Areal_3_profile	
13	Areal_4_profile	
14	Areal_5_profile	
15	Areal_6_profile	
16	Areal_7_profile	
17	Areal_8_profile	
18	Peak_height	Peak intensity and its error in ADU relative to local value of sky
19	Peak_height_err	
20	Aper_flux_1	Flux and error within a specified radius aperture, typically set so that $R_{aperture} = \langle FWHM \rangle$ where the quantity in angle brackets is the mean FWHM of all stellar images. This is also known as the "core radius". The apertures here correspond to (0.5,1/$\sqrt{2}$, 1, $\sqrt{2}$, 2, 2$\sqrt{2}$, 4, 5, 6, 7, 8, 10, and 12) times the core radius.
21	Aper_flux_1_err	
22	Aper_flux_2	
23	Aper_flux_2_err	
24	Aper_flux_3	
25	Aper_flux_3_err	
26	Aper_flux_4	
27	Aper_flux_4_err	
28	Aper_flux_5	
29	Aper_flux_5_err	
30	Aper_flux_6	
31	Aper_flux_6_err	
32	Aper_flux_7	
33	Aper_flux_7_err	
34	Aper_flux_8	
35	Aper_flux_8_err	
36	Aper_flux_9	
37	Aper_flux_9_err	
38	Aper_flux_10	
39	Aper_flux_10_err	

40	Aper_flux_11	
41	Aper_flux_11_err	
42	Aper_flux_12	
43	Aper_flux_12_err	
44	Aper_flux_13	
45	Aper_flux_13_err	
46	Petr_radius	Petrosian radius, r_p in pixels as defined in Yasuda, et al. 2001, AJ, 112, 1104.
47	Kron_radius	Kron radius, r_k in pixels as defined by Bertin and Arnouts 1996, A & A Supp, 117, 393.
48	Hall_radius	Hall radius, r_h in pixels as defined by Hall and Mackay 1984, MNRAS, 210, 979.
49	Petr_flux	Petrosian flux and error to $2r_p$
50	Petr_flux_err	
51	Kron_flux	Kron flux and error to $2r_k$
52	Kron_flux_err	
53	Hall_flux	Hall flux and error to $5r_h$. Alternative total flux
54	Hall_flux_err	
55	Error_bit_flag	Bit pattern listing various processing error flags. Currently this is the number of bad pixels included in the aperture flux (Aper_flux_3)
56	Sky_level	Local interpolated sky level from background tracker
57	Sky_rms	Local estimate of variation in sky level around images
58	Parent_or_child	Flag for parent or part of de-blended deconstruct
59	RA	RA and Dec of each object in degrees
60	Dec	
61	Classification	simple flag indicating most probable classification for object: **-2:** Object is compact (maybe stellar) **-1:** Object is stellar **0:** Object is noise **1:** Object is non-stellar
62	Statistic	an equivalent N(0,1) measure of how stellar-like an image is. It is used in deriving the classification in a "necessary but not sufficient" sense. This statistic is computed from a discrete curve-of-growth analysis from the peak and aperture fluxes and also factors in ellipticity information. The stellar locus is used to define the "mean" and "sigma" as a function of magnitude such that the "statistic" can be normalised to an approximate N(0,1) distribution.
63-80	blank	

Converting the source catalogue fluxes (here, using any of the 13 aperture flux values: *Aper_flux_1* to *Aper_flux_13*) to magnitudes can be done with the following relation:

magnitude = PHOTZP - 2.5*$\log_{10}$(Aper_flux_i) - APCORi **(for i = 1 . . . 13)**

where uppercase parameters indicate header keywords:

PHOTZP = the photometric zeropoint [magnitude]

APCORi = the stellar aperture correction for i^{th} aperture flux [magnitude]

Colour transformation

HAWK-I and 2MASS filters relate as follows:

$$Y_{HAWKI} = 1.52 * J_{2MASS} - 0.52 * H_{2MASS}$$
$$J_{HAWKI} = 0.85 * J_{2MASS} + 0.15 * H_{2MASS}$$
$$H_{HAWKI} = 0.06 * J_{2MASS} + 0.94 * H_{2MASS}$$
$$Ks_{HAWKI} = 0.03 * J_{2MASS} + 0.97 * K_{2MASS}$$
$$CH4_{HAWKI} = 0.06 * J_{2MASS} + 0.94 * H_{2MASS}$$
$$H2_{HAWKI} = 0.03 * J_{2MASS} + 0.97 * K_{2MASS}$$
$$BrG_{HAWKI} = 0.03 * J_{2MASS} + 0.97 * K_{2MASS}$$
$$NB1060_{HAWKI} = 1.50 * J_{2MASS} - 0.50 * H_{2MASS}$$
$$NB1190_{HAWKI} = 0.85 * J_{2MASS} + 0.15 * H_{2MASS}$$
$$NB0984_{HAWKI} = 1.62 * J_{2MASS} - 0.62 * H_{2MASS}$$
$$NB2090_{HAWKI} = 0.03 * J_{2MASS} + 0.97 * K_{2MASS}$$

Part 2: ESO processing

Differences in data processing to CASU

This part describes differences in the ESO processing, applicable to observations measured in October 2015 and later.

Data selection

The processing is carried out for input data sets with at least four files because the background estimation is usually rather poor in such cases and resulting stacked images show significant artefacts.

Data reduction

Master calibrations. Master calibration products are regularly created from all measured calibrations. They are quality-reviewed and certified. The closest-in-time certified calibrations are taken for the science reduction. Master darks (matching the DIT/NDIT combination of the science data) are typically measured within 24 hours from the science observation. A suitable twilight flat field (matching the filter) is usually available within ±21 days.

Source catalogue. For fitting world coordinate systems (WCS), preference was given to 2MASS vs. WISE because the intrinsic accuracy is higher and the risk for ambiguity during source detection in crowded fields is much lower. In very few cases, source detection and therefore data reduction is impaired because the lower density of sources in 2MASS leads to an insufficient number of detections within a certain field. These observations have been processed again, this time using the WISE catalogue. If this is the case, a comment has been added in the QC_COMM<n> header keywords in the products.

Photometric calibration. Photometric calibration is always done using 2MASS (as for CASU). In a few rare cases, neither photometric standard stars could be identified nor a default photometric calibration could be applied. The corresponding data have not been included in the collection.

Online vs. offline catalogues. Data with observation dates before January 2026 have been processed with the offline catalogues for astrometry and photometry as available with the pipeline distribution. For later observations, the online catalogues as provided by CDS Strasbourg[3] have been queried. It has been noted that there are small differences of typically less than 0.1 magnitudes in the derived zero points. The differences are well within the errors.

Pipeline version. The initial data processed by ESO was created with pipeline version 2.1.1. The actual version can be found in the headers of the product FITS files in the keyword “PROCSOFT”.

Added information

Products

The same pipeline products as for CASU are delivered. Stacked and tiled images have some header keywords added with information related to the OB and to the Quality Control (QC) process (see Table 3). For observations taken from January 2026 onwards, the object catalogue (OBJECT_CATALOGUE_JITTERED) for the jittered image is not provided any more and the jittered image (JITTERED_IMAGE_SCIENCE, with 4 extensions) is delivered as an ancillary product to the main product (TILED_IMAGE).

[3] https://cdsarc.cds.unistra.fr/viz-bin/cat/II/246

Table 3. Added Fits keywords

Keyword	Values	Description
OB related information:		
VM_SM	'VM' or 'SM'	Data taken in Service Mode of Visitor Mode. VM data are less constrained in terms of OB properties, they have no user constraints defined and therefore no OB grades
OB_GRADE	'A', 'B', 'C', 'D', or 'X'	Immediate grade[4] given by the night astronomer, considering ambient conditions checked against user constraints
OB_COMM<n>	Free text	Any optional comments added by the night astronomer, together with the approximate UT hh:mm (truncated after 200 characters)
QC related information:		
QCFLAG	e.g. '0000000'	QC flag composed of seven bits, see Table 4. Only available for data taken before January 2026
QC_COMM<n>	Free text	Optional comments added during the review of the pipeline products

QC flag

Only available for data taken before January 2026. The header key "QCFLAG" in the HAWK-I image products describes automatically assigned quality flags. It is comprised of seven bits (see Table 4). For each bit, the value "0" means "no concern", i.e. a value of "0000000" for the QC flag indicates that no potential issues have been found.

Flags #1 and #2 assess the quality of the data processing. Flag #1 is set when less exposures than originally intended have been executed (TPL EXPNO < TPL NEXP for the last input raw file). This means that the observation is not as deep as planned. Also, additional executions of the same OB may exist in order to compensate for this. Note that such cases are processed separately; there has been no attempt to stack exposures from different executions of the same OB.

Flag #2 is set when the time difference to the applied master twilight flat is larger than 21 days, the frequency according to the calibration plan. A minor violation is usually not an issue because flats are reasonably stable but large time differences may, nevertheless, indicate a potential problem with flat fielding during the reduction.

Flags #3 to #7 are related to the quality of the product. The HAWK-I detector pixels become non-linear if they are exposed beyond 25000 ADUs. Due to detector defects, some pixels are always classified as "bad"; in a typical exposure, the total number of these "bad" pixels is below 10000. If this is not the case then flag #3 is set. This could indicate that there are over-exposed sources in the observation.

In almost all exposures, some standard stars for the photometric calibration could be found within the 2MASS catalogue. If this is not the case then flag #4 is set.

The typical accuracy of the astrometric calibration is better than about 0.3 arcsecs. This is similar to the intrinsic accuracies of the 2MASS stars. Higher errors are indicated by flag #5.

The pipeline reports the image quality as the average FWHM of star-like sources. While large values can be due to poor weather conditions, very low values for non-AO observations could indicate that (detector) artefacts have been falsely identified as sources. Flag #6 is, therefore, set when the reported average image quality is below 0.3 arcsec. This can occur when there are very few stars in the field and the detections are dominated by detector defects.

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[4] 'A': fully within constraints. 'B': some constrains up to 10% violated. 'C': out of constraints. 'D': out of constraints, do not repeat. VM data are formally graded 'X' meaning 'unknown'

Finally, bit #7 is related to the optical quality of the observation and flags measurements where the average ellipticity is above 0.25.

Table 4. QC flags

Bit	**Content** (if YES value is 0, otherwise 1)	**Motivation**	**Header keys**[5] (HIERARCH ESO …)
#1 – template complete	Template completely executed?	If not, intended depth of the observation may not be reached; further exposures may exist to compensate	TPL EXPNO, TPL NEXP
#2 – Δt to twilight flat	Time difference to applied twilight flat < 21 days?	If not then this means a potential issue with flat-fielding	None
#3 – non-linear pixels	Number of pixels having more than 25000 ADU in first raw file below 10000?	High numbers of non-linear pixels indicate saturated sources	None
#4 – number of photometric standards	Standard stars for zeropoint calculation found in FOV?	If not then a default zeropoint is written to the product headers	QC MAGNZPT
#5 – error on WCS	Error on WCS < 0.3 arcsec?	A higher error may indicate an issue with the WCS fit	DRS STDCRMS
#6 – image quality	Image quality > 0.3 arcsec?	For non-AO data, a small value indicates that artefacts have been falsely identified as astronomical sources	QC IMAGE_SIZE
#7 – ellipticity	Ellipticity of stellar sources < 0.25?	High ellipticity could indicate a problem with the instrument focus or guiding	QC ELLIPTICITY

Previews

The preview plots are delivered as ancillary files along with the main products. There is one preview associated to a tiled image (combining all four quadrants, see Fig. 3 and 4) and four plots for a jittered product (one plot per quadrant, see Fig. 5 and 6).

[5] In the image and catalogue product files. The keywords "QC IMAGE_SIZE" and "QC ELLIPTICITY" are only written to the catalogues

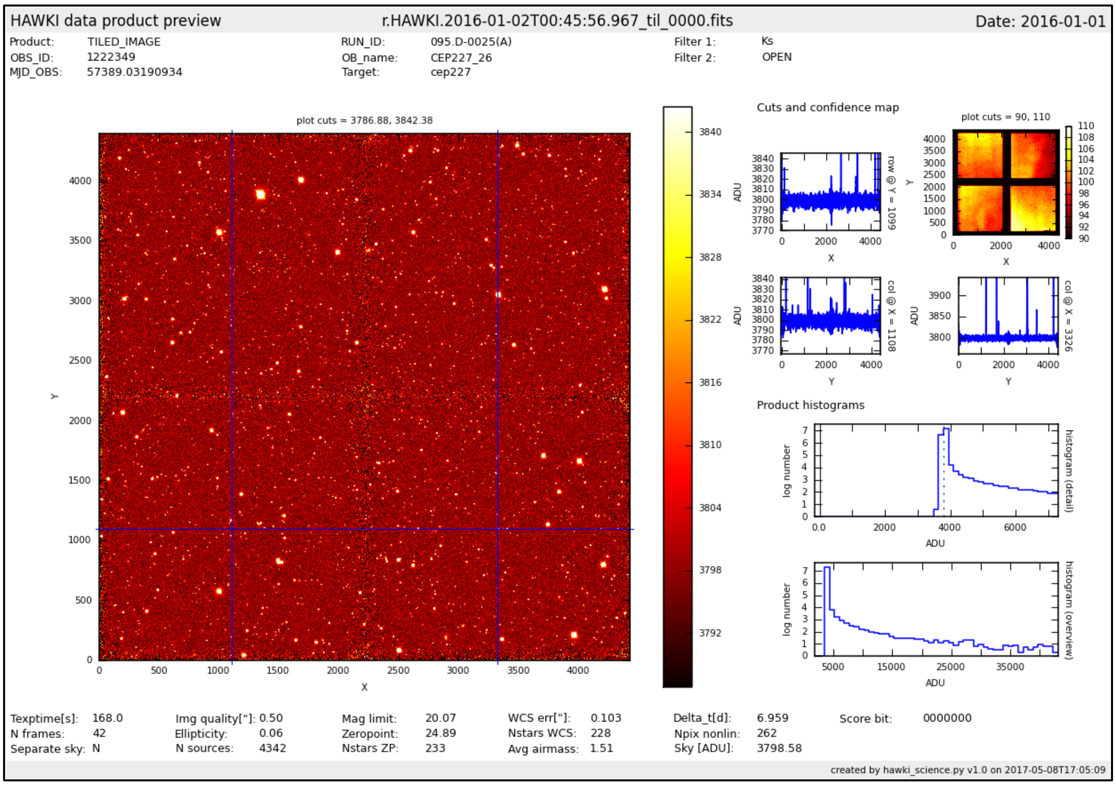

Figure 3. Preview plot associated to a tiled product (before January 2026). It has an overview of the complete image, the confidence map associated to this image (upper right), three cuts through the image (which are also indicated as blue lines in the overview image), and two product histograms (one around the residual background level and one for the overall distribution). At bottom, a set of QC parameters applicable to the product are printed: Texptime (total exposure time of the stack, from header keyword "EXPTIME"), N frames (number of input raw frames, from header keyword "PRO DATANCOM"), Separate sky ('Y' if a separate sky exposure exists), Img Quality (average FWHM of star-like sources, from "QC IMAGE_SIZE"), Ellipticity (average ellipticity of star-like sources, from "QC ELLIPTICITY"), N sources (total number of identified sources), Mag limit (limiting magnitude, from "QC LIMITING_MAG"), Zeropoint (photometric zeropoint for this observation, from "QC MAGZPT"), Nstars ZP (number of standard stars used for zeropoint calculation, from "QC MAGNZPT"), WCS err (error of the world coordinate system, from "DRS STDCRMS"), Nstars WCS (number of stars used for fitting the WCS, from "DRS NUMBRMS"), Avg airmass (average airmasse during observation of the stack), Delta_t (time difference to applied twilight flat), Npix nonlin (number of non-linear pixels), Sky (average sky value, from "QC MEAN_SKY"), and the score bit. On top, some keyword values extracted from the product header are printed

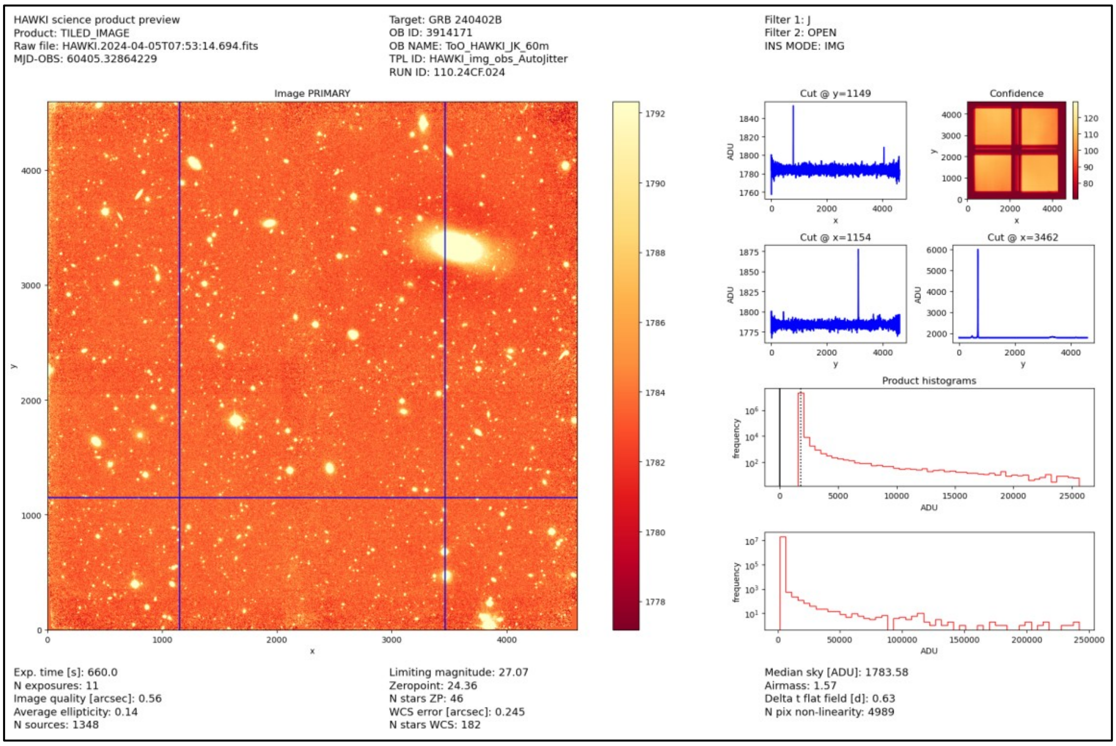

Figure 4. Preview plot associated to a tiled product (from January 2026 onwards). It has an overview of the complete image, the confidence map associated to this image (upper right), three cuts through the image (which are also indicated as blue lines in the overview image), and two product histograms (one around the residual background level and one for the overall distribution). At bottom, a set of QC parameters applicable to the product are printed: Exp. time (total exposure time of the stack, from header keyword "TEXPTIME"), N exposures (number of input raw frames, from header keyword "NCOMBINE"), Image Quality (average FWHM of star-like sources, from "QC IMAGE_SIZE"), Average ellipticity (average ellipticity of star-like sources, from "QC ELLIPTICITY"), N sources (total number of identified sources), Limiting magnitude (from "QC LIMITING_MAG"), Zeropoint (photometric zeropoint for this observation, from "QC MAGZPT"), N stars ZP (number of standard stars used for zeropoint calculation, from "QC MAGNZPT"), WCS error (error of the world coordinate system, from "DRS STDCRMS"), N stars WCS (number of stars used for fitting the WCS, from "DRS NUMBRMS"), Median sky (average sky value, from "QC MEAN_SKY"), Airmass (average airmass during observation of the stack, from "QC AIRM MEAN"), Delta_t flat field (time difference to applied twilight flat, from "QC DELTA TIME TWFLAT"), and N pix non-linearity (number of non-linear pixels, from "QC SAT NB"). On top, some keyword values extracted from the product header are printed

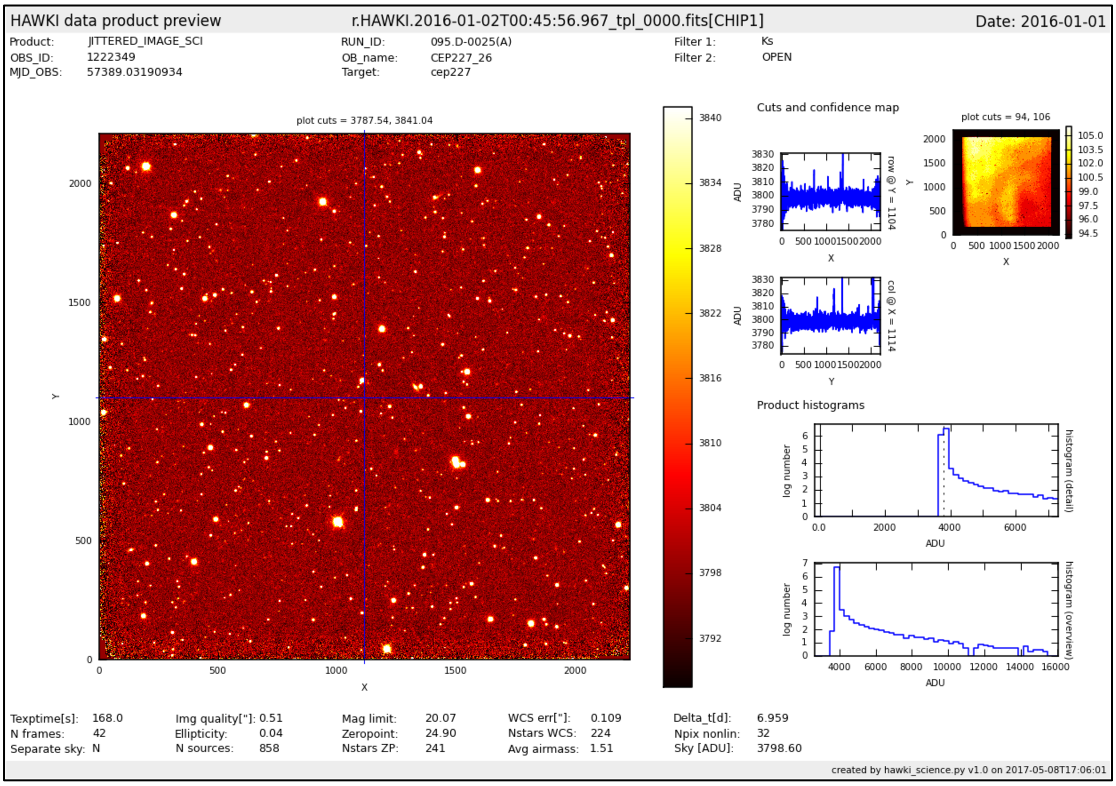

Figure 4. Preview plot associated to a jittered stack (before January 2026). It comes per quadrant. Content is basically the same as for the tile except that only two cuts are drawn. The score bit has been omitted since it is only applicable to the tile

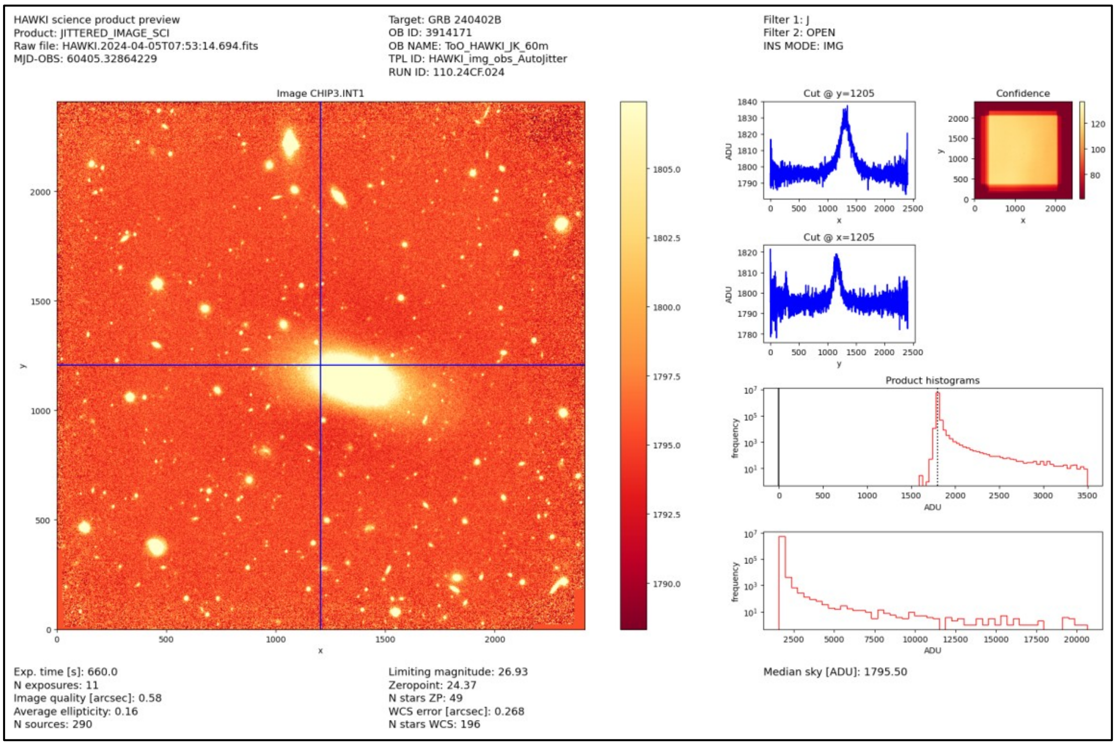

Figure 5. Preview plot associated to a jittered stack (from January 2026 onwards). It comes per quadrant. Content is basically the same for the tile except that only two cuts are drawn

Data Format

Files Types

There are four primary product files and four ancillary fits files for each data set. Table 5 gives an overview of them.

Naming convention before January 2026.

The following naming convention applies to the ORIGFILE product name for data taken before October 2025 Their ORIGFILE product names follow this naming convention[6]:

```
HI_<TYPE>_<OBS_ID>_<DP_ID>_f1<FILT1>_f2<FILT2>_AO|NOAO.fits
```

See Tables 5 and 6 for details. An example ORIGFILE name would be

```
HI_SOBJ_1864109_2018-01-06T07:47:23.427_f1Ks_f2OPEN_AO.fits
```

for a jittered image from OB 1864109, observation started at 07:47:23.427 UT on 6 January 2018 and was executed using the Ks filter and adaptive optics. The user may wish to read the ORIGFILE header key and rename the archive-delivered fits files accordingly.

Table 5. Primary and ancillary fits products before January 2026

Product category HIERACH ESO PRO CATG and PRODCATG	**Format**	**Primary or ancillary?**	**Description**
JITTERED_IMAGE_SCIENCE SCIENCE.MEFIMAGE	Image, 4 extensions	Primary	Stacked exposure
OBJECT_CATALOGUE_JITTERED SCIENCE.SRCTBL	Table, 4 extensions	Primary	Source catalogue for the stack
JITTERED_VAR_IMAGE ANCILLARY.VARMAP	Image, 4 extensions	Ancillary	Variance map for the stack
CONFIDENCE_MAP_JITTERED ANCILLARY.WEIGHTMAP	Image, 4 extensions	Ancillary	Confidence map for the stack
TILED_IMAGE SCIENCE.IMAGE	Image	Primary	Full tile with combined detectors
TILED_OBJECT_CATALOGUE SCIENCE.SRCTBL	Table	Primary	Source catalogue for the tile
TILED_VAR_MAP ANCILLARY.VARMAP	Image	Ancillary	Variance map for the tile
TILED_CONFIDENCE_MAP ANCILLARY.WEIGHTMAP	Image	Ancillary	Confidence map for the tile

Table 6. ORIGFILE naming convention

Component	**Description**
HI	HAWK-I product
<TYPE>	Products type; 'S' stands for science, 'J' and 'T' for jittered or tiled. HI_SIMJ: JITTERED_IMAGE_SCIENCE HI_SOBJ: OBJECT_CATALOGUE_JITTERED HI_SVAJ: JITTERED_VAR_IMAGE HI_SCFJ: CONFIDENCE_MAP_JITTERED HI_SIMT: TILED_IMAGE HI_SOBT: TILED_OBJECT_CATALOGUE HI_SVAT: TILED_VAR_MAP HI_SCFT: TILED_CONFIDENCE_MAP
<OBS_ID>	OB ID of the observation (header key HIERACH ESO OBS ID)

[6] In case of the ESO processing applicable for observations from October 2015 onwards. For a description of the nomenclature of files from the CASU processing please see page 5.

<DP_ID>	Time stamp in UT of the first exposure of the stack in the format <YEAR>-<MONTH>-<DAY>T<HOUR>:<MINUTE>:<SECOND>.<MILLISECOND>
<FILT1>	Name of filter in first filter wheel ('OPEN': no filter)
<FILT2>	Name of filter in second filter wheel ('OPEN': no filter)
AO|NOAO	Usage of adaptive optics (AO): 'AO' (AO was used during observation) or 'NOAO' (AO was not used). File names without the 'AO|NOAO' string come from observations without AO, which was always the case before January 2018

In addition to the fits products, also the preview plots are delivered as ancillary files. They come in the PNG image format and follow the naming convention

```
r.HAWKI.<DP_ID>_til_<NN>.png
```

where <DP_ID> is the time stamp of the first exposure and <NN> is a running number from 0 to 4: <NN>=0 is the preview for the tile while <NN>=1, 2, 3, and 4 are the previews for the respective extensions of the jittered product.

Naming convention from January 2026 onwards.
The ORIGFILE product name for observation from January 2026 onwards follow a naming convention which is

HAWKI_<PRO CATG>_<DATE-OBS>.fits

using the header keywords HIERACH ESO PRO CATG and DATE-OBS. The value of DATE-OBS can deviate by a millisecond from the time stamp given in the PROV1 header keyword. The preview files follow the same naming convention with the file type 'fits' replaced by 'png'.

Table 7. Primary and ancillary fits products from January 2026 onwards

Product category HIERACH ESO PRO CATG and PRODCATG	**Format**	**Primary or ancillary?**	**Description**
TILED_IMAGE SCIENCE.IMAGE	Image	Primary	Full tile with combined detectors
TILED_OBJECT_CATALOGUE SCIENCE.SRCTBL	Table	Primary	Source catalogue for the tile
TILED_VAR_MAP ANCILLARY.VARMAP	Image	Ancillary	Variance map for the tile
TILED_CONFIDENCE_MAP ANCILLARY.WEIGHTMAP	Image	Ancillary	Confidence map for the tile
JITTERED_IMAGE_SCIENCE ANCILLARY.MEFIMAGE	Image, 4 extensions	Ancillary	Stacked exposure
JITTERED_VAR_IMAGE ANCILLARY.VARMAP	Image, 4 extensions	Ancillary	Variance map for the stack
CONFIDENCE_MAP_JITTERED ANCILLARY.WEIGHTMAP	Image, 4 extensions	Ancillary	Confidence map for the stack

Acknowledgements
According to the Data Access Policy for ESO Data held in the ESO Science Archive Facility, all users are required to acknowledge the source of the data with an appropriate citation in their publications. Since processed data downloaded from the ESO Archive are assigned a Digital Object Identifier (DOI), the following statement must be included in any publications making use of them:
Based on data obtained from the ESO Science Archive Facility with DOI(s) : https://doi.eso.org/10.18727/archive/34.

For observation measured before October 2015 please also add:
Based on data products processed by the Cambridge Astronomy Survey Unit.