Table of WFCAM Catalog Parameters

Document Number: VDF-SPE-IOA-00009-0001 Version 2

APM/SuperCOSMOS/INT WFC/CIRSI analysis produced 32 4-byte parameters per detected object. This has been enhanced to an 80 4-byte parameter set to include extra parameters for flux estimation and error estimates. The following table covers the WFCAM standard and further processing pipeline output.

The main changes from the previous version of this document are: a slightly refined set of radii for the larger aperture sizes (the previous ones extended to an optimistically large final aperture which was similar size to the the background following algorithm ie. too big); a hopefully clearer definition of the aperture radii used; and renaming and redefinition of the radius of the FWHM total flux estimator to avoid confusion with the aperture 3 flux.

No.	Name	Description
1	Seq. no.	running number for ease of reference, in strict order of image detections
2	Isophotal flux	standard definition of summed flux within detection isophote, apart from detection filter is used to define pixel connectivity and hence which pixels to include. This helps to reduce edge effects for all isophotally derived parameters.
3	X coord	intensity–weighted isophotal centre–of–gravity in X
4	Error in X	estimate of centroid error
5	Y coord	intensity–weighted isophotal centre–of–gravity in Y
6	Error in Y	estimate of centroid error
7	Gaussian sigma	these are derived from the three general intensity–weighted second moments
8	Ellipticity	the equivalence between them and a generalised elliptical Gaussian
9	Position angle	distribution is used to derive Gaussian sigma = $(\sigma_a^2 + \sigma_b^2)^{1/2}$ ellipticity = $1.0 - \sigma_a/\sigma_b$ position angle = angle of ellipse major axis wrt x axis
10	Areal profile 1	number of pixels above a series of threshold levels relative to local sky.
11	Areal profile 2	levels are set at T, 2T, 4T, 8T . . . 128T where T is the threshold. These
12	Areal profile 3	can be thought of as a sort of poor man's radial profile. Note that for now
13	Areal profile 4	deblended, *i.e.* overlapping images, only the first areal profile is computed
14	Areal profile 5	and the rest are set to –1 flagging the difficulty of computing accurate
15	Areal profile 6	profiles.
16	Areal profile 7	
17	Areal profile 8	for blended images this parameter is used to flag the start of the sequence of the deblended components by setting the first in the sequence to 0
18	Peak height	in counts relative to local value of sky - also zeroth order aperture flux
19	Error in pkht	
20	Aperture flux 1	These are a series of different radii soft-edged apertures designed to

		adequately sample the curve-of-growth of the majority of images and to provide fixed-sized aperture fluxes for all images. The scale size for these apertures is selected by defining a scale radius ≈<FWHM> for site+instrument. In the case of WFCAM this "core" radius (rcore) has been fixed at 1.0 arcsec for convenience in inter-comparison with other datasets. A 1.0 arcsec radius is equivalent to 2.5 pixels for non-interleaved data, 5.0 pixels for 2x2 interleaved data, and 7.5 pixels for 3x3 interleaved data. In ≈1 arcsec seeing an rcore-radius aperture contains roughly 2/3 of the total flux of stellar images. [In general the rcore parameter is user specifiable and hence is recorded in the output catalogue FITS header.]
		The aperture fluxes are sky-corrected integrals (summations) with a soft-edge (ie. pro-rata flux division for boundary pixels). However, for overlapping images they are more subtle than this since they are in practice simultaneously fitted top-hat functions, to minimise the effects of crowding. Images external to the blend are also flagged and not included in the large radius summations.
21	Error in flux	
22	Aperture flux 2	
23	Error in flux	
24	Aperture flux 3	Recommended if a single number is required to represent the flux for ALL
25	Error in flux	images - this aperture has a radius of rcore.
26	Aperture flux 4	
27	Error in flux	Starting with parameter 20 the radii are: $1/2\times$ rcore, $1/\sqrt{2}\times$ rcore, rcore, $\sqrt{2}\times$ rcore, $2\times$ rcore, $2\sqrt{2}\times$ rcore, $4\times$ rcore, $5\times$ rcore, $6\times$ rcore, $7\times$ rcore,
28	Aperture flux 5	$8\times$ rcore, $10\times$ rcore, $12\times$ rcore
29	Error in flux	
30	Aperture flux 6	Note $4\times$ rcore, ensures $\sim$ 99% of PSF flux
31	Error in flux	
32	Aperture flux 7	extras for generalised galaxy photometry further spaced
33	Error in flux	
34	Aperture flux 8	in radius to ensure reasonable sampling further out.
35	Error in flux	
36	Aperture flux 9	
37	Error in flux	
38	Aperture flux 10	Note these are all corrected for pixels from overlapping neighbouring images
39	Error in flux	
40	Aperture flux 11	
41	Error in flux	
42	Aperture flux 12	
43	Error in flux	
44	Aperture flux 13	The biggest with radius $12\times$ rcore ie. ≈24 arcsec diameter
45	Error in flux	The aperture fluxes can be combined with later-derived aperture corrections for general purpose photometry and together with parameter 18 (the peak flux) give a simple curve–of–growth measurement which forms

		the basis of the morphological classification scheme
46	Petrosian radius	r_p as defined in Yasuda et al. 2001 AJ 112 1104
47	Kron radius	r_k as defined in Bertin and Arnouts 1996 A&A Supp 117 393
48	Hall radius	r_h image scale radius eg. Hall & Mackay 1984 MNRAS 210 979
49	Petrosian flux	flux within circular aperture to $k \times r_p$; $k = 2$
50	Error in flux	
51	Kron flux	flux within circular aperture to $k \times r_k$; $k = 2$
52	Error in flux	
53	Hall flux	flux within circular aperture to $k \times r_h$; $k = 5$; alternative total flux
54	Error in flux	
55	Error bit flag	bit pattern listing various processing error flags
56	Sky level	local interpolated sky level from background tracker
57	Sky rms	local estimate of variation in sky level around image
58	Child/parent	flag for parent or part of deblended deconstruct (redundant since only deblended images are kept)

The following are accreted directly after standard catalog generation

59	RA	RA and Dec explicitly put in columns for overlay programs that cannot,
60	Dec	in general, understand astrometric solution coefficients – note r*4 storage precision accurate only to $\approx$ 50mas. Astrometry can be derived more precisely from WCS in header and XY in parameters 5 & 6
61	Classification	Flag indicating most probable morphological classification: eg. –1 stellar, +1 non–stellar, 0 noise, –2 borderline stellar, –9 saturated
62	Statistic	An equivalent N(0,1) measure of how stellar–like an image is, used in deriving parameter 61 in a 'necessary but not sufficient' sense. Derived mainly from the curve-of-growth of flux using the well-defined stellar locus as a function of magnitude as a benchmark (see Irwin et al. 1994 SPIE 5493 411 for more details).

From the further processing pipeline after deriving a suitable PSF

63	PSF flux	fitted flux from PSF
64	Error in flux	
65	X coord	updated PSF-fitted X centre
66	Error in X coord	
67	Y coord	updated PSF-fitted Y centre
68	Error in Y coord	

69	PSF fit χ^2	standard normalised variance of fit
70	ν_{PSF}	no. of degrees of freedom for PSF fit
71	1D Sersic flux	fitted flux for Sersic profile
72	Scale length	scale factor of fit
73	Power index	power law index of fit
74	Error in fit	standard normalised variance of fit
75	ν_{S1}	no. of degrees of freedom for 1D Sersic fit
76	2D Sersic flux	fitted flux for PSF-deconvolved 2D Sersic fit
77	Scale length	scale factor of fit
78	Power index	power law index of fit
79	Error in fit	standard normalised variance of fit
80	ν_{S2}	no. of degrees of freedom for 1D Sersic fit

[For numerical stability the Sersic fits will use the previously derived x-y coordinates]

Note:- a more formal mathematical definition of many of these parameters, together with a corresponding definition of the image processing steps is given in the VDFS Data Reduction Library Design document VIS-SPE-IOA-20000-0010, and references therein, available on http://www.ast.cam.ac.uk/vdfs/docs/. Although this particular document is specific to VISTA, the formalism is generally applicable and the processing steps and catalog parameters are expected to be almost identical.