OSIRIS

Optical, Spectroscopic, and Infrared Remote Imaging System

Acquisition and processing of flat field images for OSIRIS calibration

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1 General aspects

1.1 Scope

This document describes how the flat fields to calibrate OSIRIS images have been obtained. The description is based on the OSIRIS calibration report RO-RIS-MPAE-RP-147/Dc.doc.

1.2 Applicable Documents

no.	document name	document number, Iss./Rev.
AD1		

1.3 Reference Documents

no.	document name	document number, Iss./Rev.

2 Flat fields determination

The OSIRIS flat fields were created using the integrating sphere with the calibrated halogen lamps (near-IR and visible) and xenon lamps (mostly UV), placed at a distance of 12mm and 50 mm. The configuration with the lamps at 12 mm is referred to as *lamps in bright position* and the one with the lamps at 50 mm as *lamps in dark position*. The intensity with the lamps in dark position is about 35 times lower than the one with the lamps in bright position.

The pre-flight flat fields are of special importance because no real flat field exposures can be obtained in flight. In fact, the internal calibration lamps do not provide homogeneous illumination (especially for the WAC) and the fields of view of the cameras are too large to obtain flat fields with celestial objects.

To create a flat field, 3-5 raw images of the integrating sphere obtained with the same filter combination were used. For the NAC, the flat fields have been obtained in the delta calibration on 19-20 July 2003 and for the WAC in December 2001. Flat fields obtained in other periods (i.e. October 2001 for the WAC and in 2001 for the NAC) should be discarded because the cameras were in a different configuration than the final one.

The selected images are full frame images (2048 x 2048 pixels) read out through amplifier B. Additionally all images contain 48 overclocked lines that are used to determine the bias level. All flat fields have been obtained with cold CCDs (~190 K).

Before creating the flat field, the raw images are processed: the coherent noise is removed, the bias is subtracted using the average intensity from the overclocked lines, and the overclocked lines are removed from the image. While the bad column on the WAC CCD is interpolated, dark pixels are not removed.

The flat field is created pixel by pixel. For each pixel, first the median value of the 3-5 input images is calculated. In case in one of the images the pixel value differs by more than 5σ from the median, this pixel value is rejected as being unreliable. The average of the remaining values is the value of the flat field at that pixel.

Finally, the flat fields are normalized to unity, dividing the image by the average value in the window [924:1123,924:1123]. In case of the WAC UV245 filter (F31), a pinhole is located in the center of the image. The additional intensity caused by the pinhole is corrected to calculate the normalization factor.

The flat fields used by the calibration pipeline to calibrate the OSIRIS images have been created with the Disrsoft routine makeflat.pro.

2.1 WAC flat fields

The flat fields for all WAC filter combinations are listed in Table 1. The original files (.uax) are stored in .\data\lab\FM\first_calibration\Analysis\flatfields\wac). The calibrated halogen lamps were used for the filters in the visible spectral range, while the xenon lamps were used for the UV-filters.

For filters in the visible wavelength range, the halogen lamps were operated in dark and bright position. The xenon lamp was operated only in bright position in order to produce flat fields of the UV filters. The differences between the flat fields obtained with the two lamp positions are small. For all filter except F12 we used the flat fields obtained in the bright lamp position. For the F12 filter, instead, flat fields obtained in the dark lamp position were used.

The flat fields currently used by the pipeline are listed in Table 3.

2.2 NAC flat fields

The flat fields for all NAC filter combinations are listed in Table 2. The original files (.uax) are stored in data\lab\FM\first_calibration\Analysis\flatfields\newnac.

Numerous filter combinations were observed with the Halogen lamps, both in bright and in dark position. Two filter combinations containing the blue filter (F83 and F84) and combinations containing the near-UV or far-UV filters were additionally flat-fielded with the Xenon lamps.

Contrary to the WAC, flat fields acquired with the lamps in bright position differ up to a few percent from flat fields obtained in dark position. It was decided to use the flat fields taken with the halogen lamps in bright position as default flat fields for all filter combinations that were flat-fielded in that configuration.

However, for some filter combinations, the flat field used by the pipeline to calibrate the images is not the default one, as can be seen in Table 2. The first column contains the filenames of the flat fields called by OsiCalliope – that are the same that were used by the IDL pipeline. The default flat fields are the ones marked in bold.

In 2005 a new analysis of the flat fields was performed (by M. Küppers). The flat fields are stored in:

WAC:

Y:\data\lab\FM\first_calibration\Analysis\flatfields\20_09_2005\WAC\Xenon\Dec2001
Y:\data\lab\FM\first_calibration\Analysis\flatfields\20_09_2005\WAC\Halogen\Dec2001

NAC:

Y:\data\lab\FM\first_calibration\Analysis\flatfields\20_09_2005\NAC\Halogen
Y:\data\lab\FM\first_calibration\Analysis\flatfields\20_09_2005\NAC\Xenon

These flat fields are different from the ones currently used by the calibration pipeline.

2.3 Revised NAC flat fields

Color ratio images of the comet surface highlighted the known non uniformity of some of the NAC flat fields, in particular of the NAC F16 (Near-UV), F24 (Blue) and F84 (Blue) flat fields. Those filters are in the short wavelength part of the visible spectrum, with $\lambda_{cent} \leq 480$ nm. We will refer to the flat fields of those filters as “shorter wavelength flats” and to the flat fields of filters with $\lambda_{cent} \geq 535$ nm as “longer wavelength flats”.

In the GRM delta calibration performed in 2016, the non-uniform pattern of the shorter wavelength flat fields was reproduced and attributed to illumination artifacts of the integrating sphere at the time when the images used to generate the flat fields were acquired.

2.3.1 Flat field image acquisition and generation

Flat field images can be handled as a product of two separate images: a low spatial frequency and a high spatial frequency image.

- The high spatial frequency component shows the small scale, pixel to pixel variations. This is the effect of the CCD pixel non uniformities in size and sensitivity, and also the contamination effects on or close to the CCD surface.
- The low spatial frequency component contains the effect of the optical system, filter transmission non-uniformities, and the illumination artefacts of the target. These are large scale variations of the pixel sensitivities across the image surface.

Since the integrating sphere artifacts affect only the low special frequency flat fields, the correction should be applied only to this component, keeping the original high spatial frequency part unchanged.

The separation of the low and high spatial frequency components of the flat field image is done by the following procedure:

- Remove the hot and cold areas (gray level > 1.1 and gray level < 0.95) from the flat images by area patching, to avoid that they affect the averaging.
- Create the low spatial frequency image by applying a Gaussian blur filter with a size of 100 pixels.
- Normalize the low spatial frequency image to 1.00.
- Create the high spatial frequency image by dividing the original flat field by the low spatial frequency image.

The longer wavelength flats are relatively uniform, with a maximum deviation of only 2% from the average (Figure 1). The shorter wavelength flats, and especially F24, F84 and F16, show larger non-uniformity (about 5%) and a characteristic pattern near the corners (Figure 2).

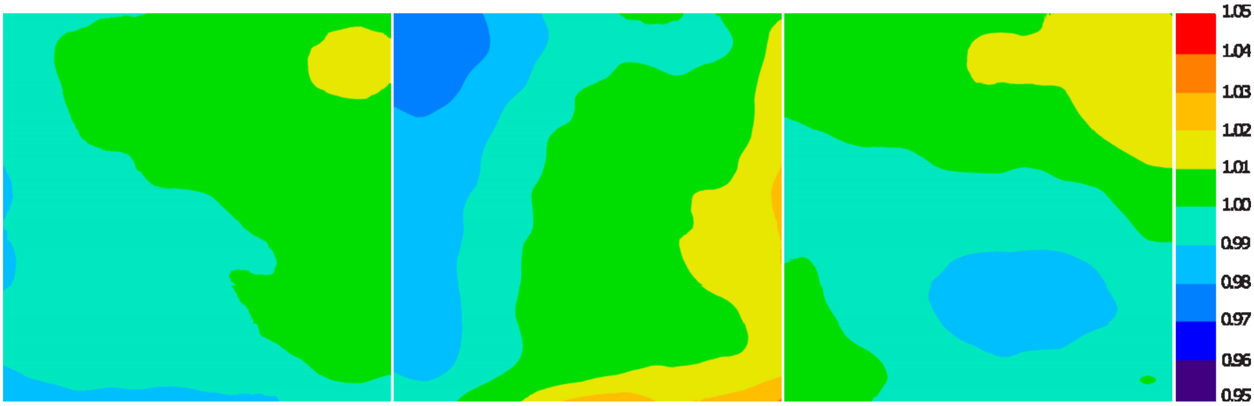

Figure 1 Original low spatial frequency flat fields for F22, F23, and F82.

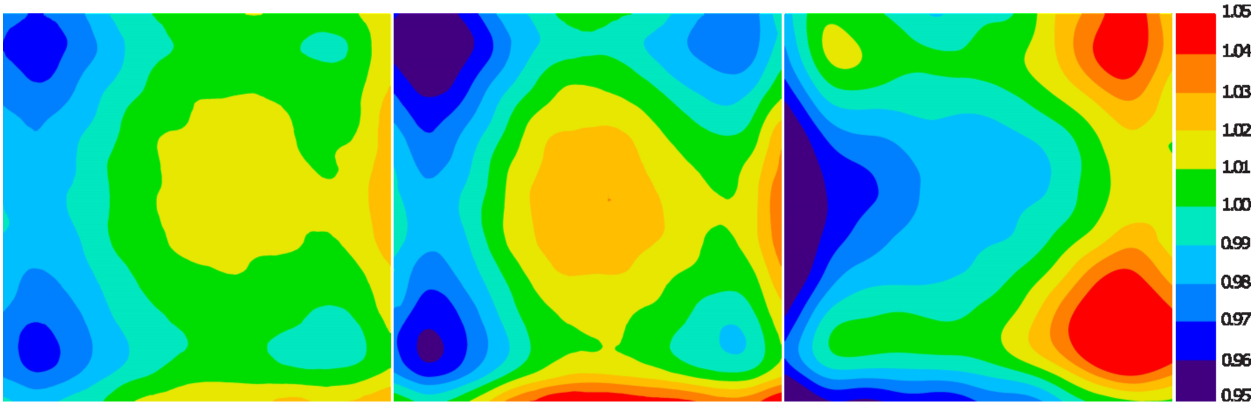

Figure 2 Original low spatial frequency flat fields for F24, F84, and F16.

Analyzing the in-flight internal calibration lamp images of the NAC, the characteristic large scale non-uniformities are not visible. This indicates that these artefacts are caused by the laboratory calibration optical setup.
Consequently, if we assume that the longer wavelength flat fields are correct, the correction of the shorter wavelength flat fields can be performed using in-flight calibration lamp images:

$$FLAT_{short\_corrected} = FLAT_{long\_ref} * FLAT_{short\_lamp} / FLAT_{long\_lamp}$$

where:

$FLAT_{short\_corrected}$	the corrected shorter wavelength flat field image
$FLAT_{short\_lamp}$	the in-flight shorter wavelength calibration lamp flat field image
$FLAT_{long\_lamp}$	the in-flight longer wavelength calibration lamp flat field image
$FLAT_{long\_ref}$	the original longer wavelength reference flat field image.

For the generation of the corrected shorter wavelength flat fields we have used the flat field of the orange filter (F22) as longer wavelength reference flat field.

The generation of the new flat images is done by the following procedure:

- Generate flat field images from the calibration lamp images, for the longer wavelength and the shorter wavelength filters.
- Separate the high- and low-spatial frequency component of the original flat images, and the calibration lamp flat images.
- Calculate the corrected low spatial frequency flat image based on the above formula, using only the low spatial frequency component of the original and the calibration lamp flats.
- Generate the new flat image by multiplying the new low spatial frequency component with the original high spatial frequency component.

Figure 3 shows the comparison between the original and the corrected flat fields for F16 (top row), F24 (center row) and F84 (bottom row), respectively.

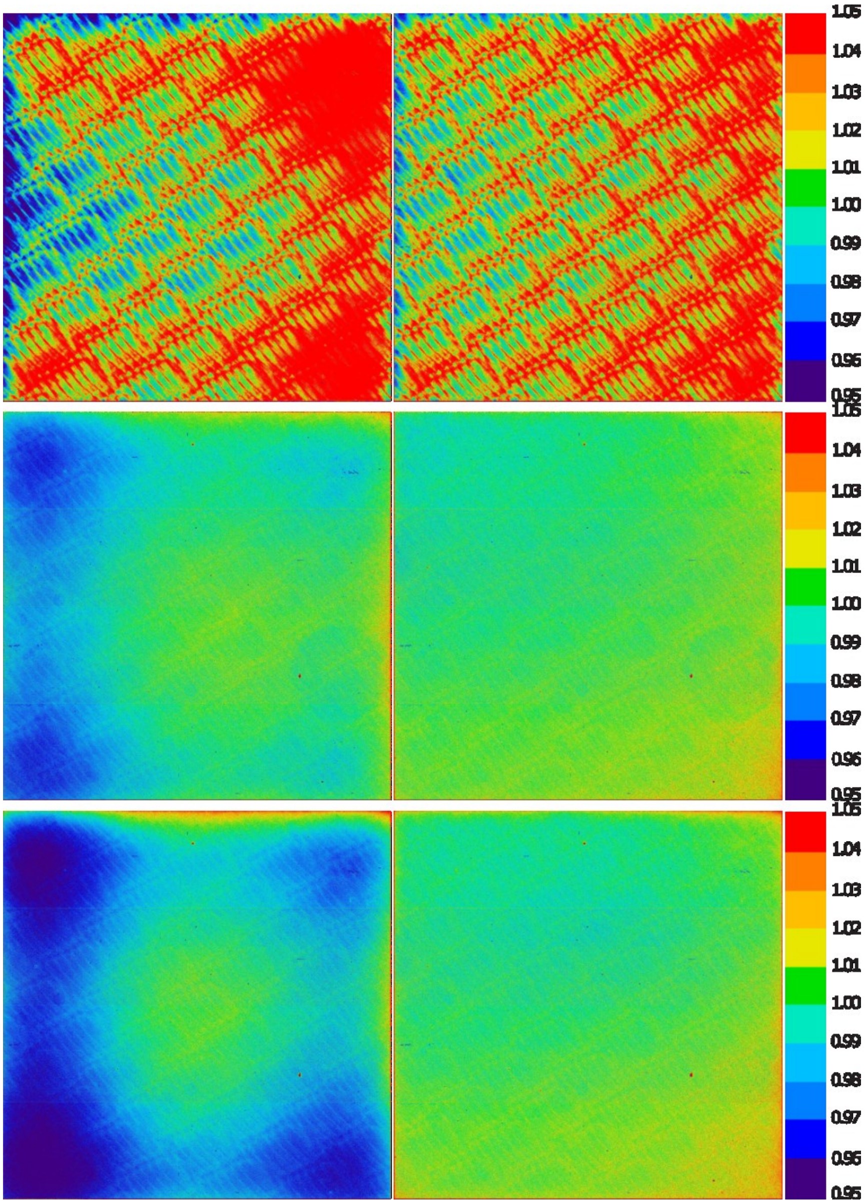

Figure 3 Original and corrected F16 (top row), F24 (center row) and F84 (bottom row) flat field images.

The flat fields currently used by the pipeline are listed Table 3.

2.4 WAC F11 flat field

The flat field of the WAC F11 filter has been synthetically generated as weighted average of existing visible wavelength flat fields. As weighting factor we have used the CCD quantum efficiency at the central wavelength of each filter.

3 List of flat fields files

Filename[a]	Original filename[b]	Old filename[c]	Image IDs[d]	T [s][e]	Filters[f]	Lamps[g]	Position[h]
WAC_FM_FLAT-16.img	flat_wac_empty1_na_h_12.uax	WAC_FM_FLAT-16_V1_28062005.img	10670-10674	0.20	F16	Halogen	bright
WAC_FM_FLAT-17.img	flat_wac_empty1_oi_h_12.uax	WAC_FM_FLAT-17_V1_28062005.img	10675-10679	0.25	F17	Halogen	bright
WAC_FM_FLAT-18.img	flat_wac_empty1_vis610_h_12.uax	WAC_FM_FLAT-18_V1_28062005.img	10681-10685	0.07	F18	Halogen	bright
WAC_FM_FLAT-15.img	flat_wac_empty1_nh2_h_12.uax	WAC_FM_FLAT-15_V1_28062005.img	10687,10688, 10690-10692	0.12	F15	Halogen	bright
WAC_FM_FLAT-21.img	flat_wac_green_empty2_h_12.uax	WAC_FM_FLAT-21_V1_28062005.img	10696-10700	0.03	F21	Halogen	bright
WAC_FM_FLAT-12.img	flat_wac_empty1_r_h_50.uax	WAC_FM_FLAT-12_V1_28062005.img	10738,10741-10743,10746	0.12	F12	Halogen	dark
WAC_FM_FLAT-31.img	flat_wac_uv245_empty2_x_12.uax	WAC_FM_FLAT-31_V1_28062005.img	10806-10810	6.00	F31	Xenon	bright
WAC_FM_FLAT-41.img	flat_wac_cs_empty2_x_12.uax	WAC_FM_FLAT-41_V1_28062005.img	10815-10819	12.00	F41	Xenon	bright
WAC_FM_FLAT-51.img	flat_wac_uv295_empty2_x_12.uax	WAC_FM_FLAT-51_V1_28062005.img	10825-10829	6.00	F51	Xenon	bright
WAC_FM_FLAT-61.img	flat_wac_oh308_empty2_x_12.uax	WAC_FM_FLAT-61_V1_28062005.img	10834-10838	6.00	F61	Xenon	bright
WAC_FM_FLAT-71.img	flat_wac_uv325_empty2_x_12.uax	WAC_FM_FLAT-71_V1_28062005.img	10842,10843, 10845-10847	1.00	F71	Xenon	bright
WAC_FM_FLAT-81.img	flat_wac_nh335_empty2_x_12.uax	WAC_FM_FLAT-81_V1_28062005.img	10852-10855	3.00	F81	Xenon	bright
WAC_FM_FLAT-13.img	flat_wac_empty1_uv375_x_12.uax	WAC_FM_FLAT-13_V1_28062005.img	10862-10866	0.45	F13	Xenon	bright
WAC_FM_FLAT-14.img	flat_wac_empty1_cn_x_12.uax	WAC_FM_FLAT-14_V1_28062005.img	10873-10877	0.50	F14	Xenon	bright

Table 1 List of WAC flat fields.

[a]: file name as in the OsiCalliope database. [b]: file name of the original flat field images in uax format. [c]: filename used to store the flat fields images in the IDL pipeline database. [d]: IDs of the images that were used to create the flat field (taken from the list obtained by the IDL procedure readfilelist). [e]: exposure time. [f]: the filter positions. [g] and [h]: lamps and their positions.

Filename[a]	Original filename[b]	Old filename[c]	Image IDs[d]	T [s][e]	Filters[f]	Lamps[g]	Position[h]
NAC_FM_FLAT-82.img	flat_nac_neutral_orange_h_50.uax	NAC_FM_FLAT-82_V1_28062005.img	14677-14681	16.000	F82	Halogen	dark
	flat_nac_neutral_green_h_50.uax		14689-14693	50.000	F83	Halogen	dark
	flat_nac_neutral_blue_h_50.uax		14705-14709	75.000	F84	Halogen	dark
NAC_FM_FLAT-87.img	flat_nac_neutral_hydra_h_50.uax	NAC_FM_FLAT-87_V1_28062005.img	14719-14723	20.000	F87	Halogen	dark
NAC_FM_FLAT-88.img	flat_nac_neutral_red_h_50.uax	NAC_FM_FLAT-88_V1_28062005.img	14734-14738	8.000	F88	Halogen	dark
NAC_FM_FLAT-22.img	**flat_nac_ffp-vis_orange_h_50.uax**	**NAC_FM_FLAT-22_V1_28062005.img**	**14753-14757**	**0.800**	**F22**	**Halogen**	**dark**
NAC_FM_FLAT-23.img	flat_nac_ffp-vis_green_h_50.uax	NAC_FM_FLAT-23_V1_28062005.img	14764-14768	3.000	F23	Halogen	dark
NAC_FM_FLAT-24.img	flat_nac_ffp-vis_blue_h_50.uax	NAC_FM_FLAT-24_V1_28062005.img	14778-14782	5.000	F24	Halogen	dark
NAC_FM_FLAT-27.img	flat_nac_ffp-vis_hydra_h_50.uax	NAC_FM_FLAT-27_V1_28062005.img	14795-14799	1.000	F27	Halogen	dark
NAC_FM_FLAT-28.img	**flat_nac_ffp-vis_red_h_50.uax**	**NAC_FM_FLAT-28_V1_28062005.img**	**14809-14813**	**0.400**	**F28**	**Halogen**	**dark**
NAC_FM_FLAT-32.img	**flat_nac_nfp-vis_orange_h_50.uax**	**NAC_FM_FLAT-32_V1_28062005.img**	**14823-14827**	**0.800**	**F32**	**Halogen**	**dark**
NAC_FM_FLAT-33.img	flat_nac_nfp-vis_green_h_50.uax	NAC_FM_FLAT-33_V1_28062005.img	14843-14847	3.000	F33	Halogen	dark
NAC_FM_FLAT-34.img	flat_nac_nfp-vis_blue_h_50.uax	NAC_FM_FLAT-34_V1_28062005.img	14861-14865	5.000	F34	Halogen	dark
NAC_FM_FLAT-37.img	flat_nac_nfp-vis_hydra_h_50.uax	NAC_FM_FLAT-37_V1_28062005.img	14873-14877	1.000	F37	Halogen	dark
NAC_FM_FLAT-38.img	**flat_nac_nfp-vis_red_h_50.uax**	**NAC_FM_FLAT-38_V1_28062005.img**	**14894-14898**	**0.400**	**F38**	**Halogen**	**dark**
NAC_FM_FLAT-51.img	flat_nac_ortho_ffp-ir_h_50.uax	NAC_FM_FLAT-51_V1_28062005.img	14904-14908	2.000	F51	Halogen	dark
NAC_FM_FLAT-58.img	flat_nac_ortho_red_h_50.uax	NAC_FM_FLAT-58_V1_28062005.img	14918-14922	20.000	F58	Halogen	dark
NAC_FM_FLAT-41.img	flat_nac_nir_ffp-ir_h_50.uax	NAC_FM_FLAT-41_V1_28062005.img	14936-14940	1.500	F41	Halogen	dark
NAC_FM_FLAT-61.img	flat_nac_fe2o3_ffp-ir_h_50.uax	NAC_FM_FLAT-61_V1_28062005.img	14950-14954	3.000	F61	Halogen	dark
NAC_FM_FLAT-71.img	flat_nac_ir990_ffp-ir_h_50.uax	NAC_FM_FLAT-71_V1_28062005.img	14964-14968	6.000	F71	Halogen	dark
NAC_FM_FLAT-21.img	**flat_nac_ffp-vis_ffp-ir_h_50.uax**	**NAC_FM_FLAT-21_V1_28062005.img**	**14979-14983**	**0.100**	**F21**	**Halogen**	**dark**
	flat_nac_neutral_orange_h_12.uax		**15064-15068**	**0.800**	**F82**	**Halogen**	**bright**
NAC_FM_FLAT-83.img	**flat_nac_neutral_green_h_12.uax**	**NAC_FM_FLAT-83_V1_28062005.img**	**15071-15075**	**3.333**	**F83**	**Halogen**	**bright**
NAC_FM_FLAT-84.img	**flat_nac_neutral_blue_h_12.uax**	**NAC_FM_FLAT-84_V1_28062005.img**	**15078-15082**	**6.666**	**F84**	**Halogen**	**bright**
	flat_nac_neutral_hydra_h_12.uax		**15085-15089**	**1.666**	**F87**	**Halogen**	**bright**

	flat_nac_neutral_red_h_12.uax		15092-15096	0.500	F88	Halogen	bright
	flat_nac_ffp-vis_green_h_12.uax		15099-15103	0.100	F23	Halogen	bright
	flat_nac_ffp-vis_blue_h_12.uax		15106-15110	0.166	F24	Halogen	bright
	flat_nac_ffp-vis_hydra_h_12.uax		15113-15117	0.083	F27	Halogen	bright
	flat_nac_nfp-vis_green_h_12.uax		15120-15124	0.100	F33	Halogen	bright
	flat_nac_nfp-vis_blue_h_12.uax		15127-15131	0.166	F34	Halogen	bright
	flat_nac_nfp-vis_hydra_h_12.uax		15134-15138	0.066	F37	Halogen	bright
	flat_nac_ortho_ffp-ir_h_12.uax		15141-15145	0.066	F51	Halogen	bright
	flat_nac_ortho_red_h_12.uax		15148-15152	0.666	F58	Halogen	bright
	flat_nac_nir_ffp-ir_h_12.uax		15155-15159	0.050	F41	Halogen	bright
	flat_nac_fe2o3_ffp-ir_h_12.uax		15162-15166	0.100	F61	Halogen	bright
	flat_nac_ir990_ffp-ir_h_12.uax		15169-15173	0.200	F71	Halogen	bright
NAC_FM_FLAT-15.img	flat_nac_ffp-uv_fuv_x_12.uax	NAC_FM_FLAT-15_V1_28062005.img	15189-15193	3.500	F15	Xenon	bright
NAC_FM_FLAT-16.img	flat_nac_ffp-uv_nuv_x_12.uax	NAC_FM_FLAT-16_V1_28062005.img	15207-15211	0.100	F16	Xenon	bright
	flat_nac_neutral_blue_x_12.uax		15223-15227	0.500	F84	Xenon	bright
	flat_nac_neutral_green_x_12.uax		15240-15244	0.700	F83	Xenon	bright
NAC_FM_FLAT-26.img	flat_nac_ffp-vis_nuv_x_12.uax	NAC_FM_FLAT-26_V1_28062005.img	15257-15261	0.150	F26	Xenon	bright
NAC_FM_FLAT-36.img	flat_nac_nfp-vis_nuv_x_12.uax	NAC_FM_FLAT-36_V1_28062005.img	15275-15279	0.150	F36	Xenon	bright
NAC_FM_FLAT-35.img	flat_nac_nfp-vis_fuv_x_12.uax	NAC_FM_FLAT-35_V1_28062005.img	15292-15296	12.000	F35	Xenon	bright
NAC_FM_FLAT-86.img	flat_nac_neutral_nuv_h_12.uax	NAC_FM_FLAT-86_V1_28062005.img	15309-15313	30.000	F86	Xenon	bright

Table 2 List of NAC flat fields.

[a]: file name as in the OsiCalliope database. [b]: file name of the original flat field images in uax format. [c]: filename used to store the flat fields images in the IDL pipeline database. [d]: IDs of the images that were used to create the flat field (taken from the list obtained by the IDL procedure readfilelist). [e]: exposure time. [f]: the filter positions. [g] and [h]: lamps and their positions.

4 Calibration files used by OsiCalliope

The calibration files used by OsiCalliope to calibrate OSIRIS images are listed in Table 3.

NAC		WAC	
Filter	**Flat field filename**	**Filter**	**Flat field filename**
F15	NAC_FM_FLAT_15_V01.IMG	F11	WAC_FM_FLAT_11_V01.IMG
F16	NAC_FM_FLAT-16_v02.IMG	F12	WAC_FM_FLAT_12_V01.IMG
F22	NAC_FM_FLAT_22_V01.IMG	F13	WAC_FM_FLAT_13_V01.IMG
F23	NAC_FM_FLAT_23_V01.IMG	F14	WAC_FM_FLAT_14_V01.IMG
F24	NAC_FM_FLAT_24_v02.IMG	F15	WAC_FM_FLAT_15_V01.IMG
F27	NAC_FM_FLAT_27_V01.IMG	F16	WAC_FM_FLAT_16_V01.IMG
F28	NAC_FM_FLAT_28_V01.IMG	F17	WAC_FM_FLAT_17_V01.IMG
F32	NAC_FM_FLAT_32_V01.IMG	F18	WAC_FM_FLAT_18_V01.IMG
F33	NAC_FM_FLAT_33_V01.IMG	F21	WAC_FM_FLAT_21_V01.IMG
F34	NAC_FM_FLAT_34_V01.IMG	F31	WAC_FM_FLAT_31_V01.IMG
F37	NAC_FM_FLAT_37_V01.IMG	F41	WAC_FM_FLAT_41_V01.IMG
F38	NAC_FM_FLAT_38_V01.IMG	F51	WAC_FM_FLAT_51_V01.IMG
F82	NAC_FM_FLAT_82_V01.IMG	F61	WAC_FM_FLAT_61_V01.IMG
F83	NAC_FM_FLAT_83_V01.IMG	F71	WAC_FM_FLAT_71_V01.IMG
F84	NAC_FM_FLAT_84_v02.IMG	F81	WAC_FM_FLAT_81_V01.IMG
F87	NAC_FM_FLAT_87_V01.IMG		
F88	NAC_FM_FLAT_88_V01.IMG		
F41	NAC_FM_FLAT_41_V01.IMG		
F51	NAC_FM_FLAT_51_V01.IMG		
F61	NAC_FM_FLAT_61_V01.IMG		
F71	NAC_FM_FLAT_71_V01.IMG		
F58	NAC_FM_FLAT_58_V01.IMG		
F21	NAC_FM_FLAT_21_V01.IMG		
F26	NAC_FM_FLAT_26_V01.IMG		
F36	NAC_FM_FLAT_36_V01.IMG		
F35	NAC_FM_FLAT_35_V01.IMG		
F86	NAC_FM_FLAT_86_V01.IMG		

Table 3 List of the NAC and WAC flat fields used by OsiCalliope

Previous versions:

Table 4 lists previous versions of NAC and WAC flat fields. Those files are obsolete, but they are identical to the files listen in Table 3.

NAC		WAC	
Filter	**Flat field filename**	**Filter**	**Flat field filename**
F15	NAC_FM_FLAT-15.img	F11	WAC_FM_FLAT-11.img

F16	NAC_FM_FLAT-16_v02.img	F12	WAC_FM_FLAT-12.img
F22	NAC_FM_FLAT-22.img	F13	WAC_FM_FLAT-13.img
F23	NAC_FM_FLAT-23.img	F14	WAC_FM_FLAT-14.img
F24	NAC_FM_FLAT-24_v02.img	F15	WAC_FM_FLAT-15.img
F27	NAC_FM_FLAT-27.img	F16	WAC_FM_FLAT-16.img
F28	NAC_FM_FLAT-28.img	F17	WAC_FM_FLAT-17.img
F32	NAC_FM_FLAT-32.img	F18	WAC_FM_FLAT-18.img
F33	NAC_FM_FLAT-33.img	F21	WAC_FM_FLAT-21.img
F34	NAC_FM_FLAT-34.img	F31	WAC_FM_FLAT-31.img
F37	NAC_FM_FLAT-37.img	F41	WAC_FM_FLAT-41.img
F38	NAC_FM_FLAT-38.img	F51	WAC_FM_FLAT-51.img
F82	NAC_FM_FLAT-82.img	F61	WAC_FM_FLAT-61.img
F83	NAC_FM_FLAT-83.img	F71	WAC_FM_FLAT-71.img
F84	NAC_FM_FLAT-84_v02.img	F81	WAC_FM_FLAT-81.img
F87	NAC_FM_FLAT-87.img		
F88	NAC_FM_FLAT-88.img		
F41	NAC_FM_FLAT-41.img		
F51	NAC_FM_FLAT-51.img		
F61	NAC_FM_FLAT-61.img		
F71	NAC_FM_FLAT-71.img		
F58	NAC_FM_FLAT-58.img		
F21	NAC_FM_FLAT-21.img		
F26	NAC_FM_FLAT-26.img		
F36	NAC_FM_FLAT-36.img		
F35	NAC_FM_FLAT-35.img		
F86	NAC_FM_FLAT-86.img		

Table 4 List of the previous versions of NAC and WAC flat fields.