
OSIRIS

Optical, Spectroscopic, and Infrared Remote Imaging System

OSIRIS camera linearity and saturation level

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1 General aspects

1.1 Scope

This document describes the methods and results of the OSIRIS camera linearity analysis. The examination was carried out on the OSIRIS flight model Narrow Angle and Wide Angle Cameras to provide the following data for the calibration pipeline:

- saturation level of the CCD in DN units
- non-linearity level of the CCD in DN units
- general linearity performance of the camera system
- default shutter correction value for 0 ms exposure

The analysis is based on Vega and internal calibration lamp images.

1.2 Applicable Documents

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

1.3 Reference Documents

no.	document name	document number, Iss./Rev.
RD1	OSIRIS user manual	RO-RIS-MPAE-UM-004, D/s
RD2	OSIRIS Calibration Report	RO-RIS-MPAE-RP-147, 1/b
RD3	OSIRIS calibration pipeline OsiCalliope	RO-RIS-MPAE-MA-007, 1/-



2 Camera response linearity

The linearity analysis is based on the linearity observation sequences of the NAC and WAC systems, during the CG comet approach and escort phases of the Rosetta spacecraft. These sequences provided images of standard calibration stars (such as Vega) with several different commanded exposure times, from low exposure to full saturation.

The OSIRIS cameras utilize high quality CCDs, with full well capacity around 120000 electrons. The readout electronics are adjusted to saturate the CCD, at A/D converter readouts well below the 65536 limit. This results in different saturation DN values for the NAC and the WAC system.

2.1 Evaluation method

The Vega images were processed by the following method:

- The image statistics were calculated for the full window area of each image: average, std.dev., median, 1_sigma_clip_avg (average after sigma clipping), sum_DN (full DN content), see Table 1.
- The background was estimated by the sigma clip average
- The maximum pixel DN value determined
- The sum_DN of an 11x11 pixel area around the star image was calculated after removing the background (Vega_DN).
- Linear fit was applied over the exposure times, and the Vega_DN. The deviation from the linear fit was calculated; see Figure 1. NAC linearity and Figure 2. WAC linearity.

2.2 Results

Based on the Vega images, the CCD saturation levels are:

$$\text{SAT_LEVEL_NAC} = 54000 \text{ DN}$$

$$\text{SAT_LEVEL_WAC} = 48000 \text{ DN}$$

Both cameras demonstrated excellent linearity (< 2%) over the full range

$$\text{NON_LIN_LEVEL_NAC} = 54000 \text{ DN}$$

$$\text{NON_LIN_LEVEL_WAC} = 48000 \text{ DN}$$

The values are in effect from 2014-01-01. The earlier IDL pipeline used the hard coded saturation value of 45000 DN and nonlinearity value of 40000 DN for both cameras.

**Table 1 Image statistics**

File	N pix	Avg	S_Dev	Median	Avg_1S	N pix	Sum	Max_pix	T_exp	NAC Vega_Dn	Linear_DN	delta%
NAC_2014-12-22T13.44.00.133Z_ID10_1397549000_F82	65536	2.38E+02	2.75E+01	237	2.37E+02	121	4.68470E+04	3714	0.100	18142.53	18350.9135	-1.15
NAC_2014-12-22T13.44.09.573Z_ID10_1397549100_F82	65536	2.38E+02	4.02E+01	237	2.38E+02	121	5.70270E+04	5397	0.150	28285.99	27915.8638	1.31
NAC_2014-12-22T13.44.18.583Z_ID10_1397549200_F82	65536	2.38E+02	5.27E+01	237	2.38E+02	121	6.62440E+04	8166	0.200	37497.67	37480.814	0.04
NAC_2014-12-22T13.44.29.543Z_ID10_1397549300_F82	65536	2.38E+02	8.12E+01	237	2.37E+02	121	8.54550E+04	13708	0.300	56717.62	56610.7145	0.19
NAC_2014-12-22T13.44.38.593Z_ID10_1397549400_F82	65536	2.39E+02	1.10E+02	237	2.38E+02	121	1.04013E+05	22352	0.400	75259.41	75740.615	-0.64
NAC_2014-12-22T13.44.49.573Z_ID10_1397549500_F82	65536	2.39E+02	1.63E+02	237	2.38E+02	121	1.43162E+05	31068	0.600	114406.11	114000.416	0.35
NAC_2014-12-22T13.44.58.604Z_ID10_1397549600_F82	65536	2.40E+02	2.13E+02	237	2.38E+02	121	1.80577E+05	35928	0.800	151815.54	152260.217	-0.29
NAC_2014-12-22T13.45.09.589Z_ID10_1397549700_F82	65536	2.41E+02	2.66E+02	237	2.38E+02	121	2.19521E+05	46348	1.000	190754.70	190520.018	0.12
NAC_2014-12-22T13.45.18.609Z_ID10_1397549800_F82	65536	2.42E+02	3.67E+02	238	2.38E+02	121	3.02985E+05	56664	1.500	274199.10	286169.521	-4.37
NAC_2014-12-22T13.45.29.569Z_ID10_1397549900_F82	65536	2.43E+02	4.22E+02	238	2.38E+02	121	3.69626E+05	56532	2.000	340839.37	381819.023	-12.02
NAC_2014-12-22T13.45.38.579Z_ID10_1397549000_F82	65536	2.46E+02	4.96E+02	238	2.39E+02	121	4.62951E+05	56680	3.000	434023.41	573118.028	-32.05
NAC_2014-12-22T13.45.49.560Z_ID10_1397549100_F82	65536	2.47E+02	6.31E+02	237	2.38E+02	121	6.70050E+05	56724	6.000	641284.31	1147015.04	-78.86
NAC_2014-12-22T13.45.58.760Z_ID10_1397549200_F82	65536	2.53E+02	7.54E+02	238	2.40E+02	121	9.14814E+05	56988	12.000	88583.123	2294809.07	-159.06
File	N pix	Avg	S_Dev	Median	Avg_1S	N pix	Sum	Max_pix	T_exp	WAC Vega_Dn		delta%
WAC_2014-12-22T13.46.18.433Z_ID10_1397549400_F12	16384	2.44E+02	2.65E+02	238	2.39E+02	121	1.17677E+05	20404	0.080	88791.88	88949.0934	-0.17706
WAC_2014-12-22T13.46.28.446Z_ID10_1397549500_F12	16384	2.46E+02	3.31E+02	240	2.40E+02	121	1.41365E+05	21996	0.100	112338.07	112181.714	0.139181
WAC_2014-12-22T13.46.37.548Z_ID10_1397549600_F12	16384	2.51E+02	5.00E+02	240	2.41E+02	121	1.99451E+05	33076	0.150	170327.87	170263.266	0.037931
WAC_2014-12-22T13.46.48.485Z_ID10_1397549700_F12	16384	2.55E+02	6.74E+02	241	2.41E+02	121	2.57501E+05	48048	0.200	228281.07	228344.819	-0.02792
WAC_2014-12-22T13.46.57.688Z_ID10_1397549800_F12	16384	2.60E+02	7.75E+02	242	2.43E+02	121	3.15100E+05	49968	0.300	285703.78	344507.923	-20.5822
WAC_2014-12-22T13.47.08.460Z_ID10_1397549900_F12	16384	2.70E+02	8.94E+02	246	2.47E+02	121	4.29722E+05	49968	0.600	399860.29	692997.236	-73.3098
WAC_2014-12-22T13.47.17.508Z_ID10_1397549000_F12	16384	2.86E+02	1.05E+03	252	2.54E+02	121	5.59771E+05	49984	1.000	528978.68	1157649.65	-118.846
WAC_2014-12-22T13.47.28.471Z_ID10_1397549100_F12	16384	3.16E+02	1.36E+03	267	2.71E+02	121	7.98686E+05	5016	2.000	765862.21	2319280.7	-202.833

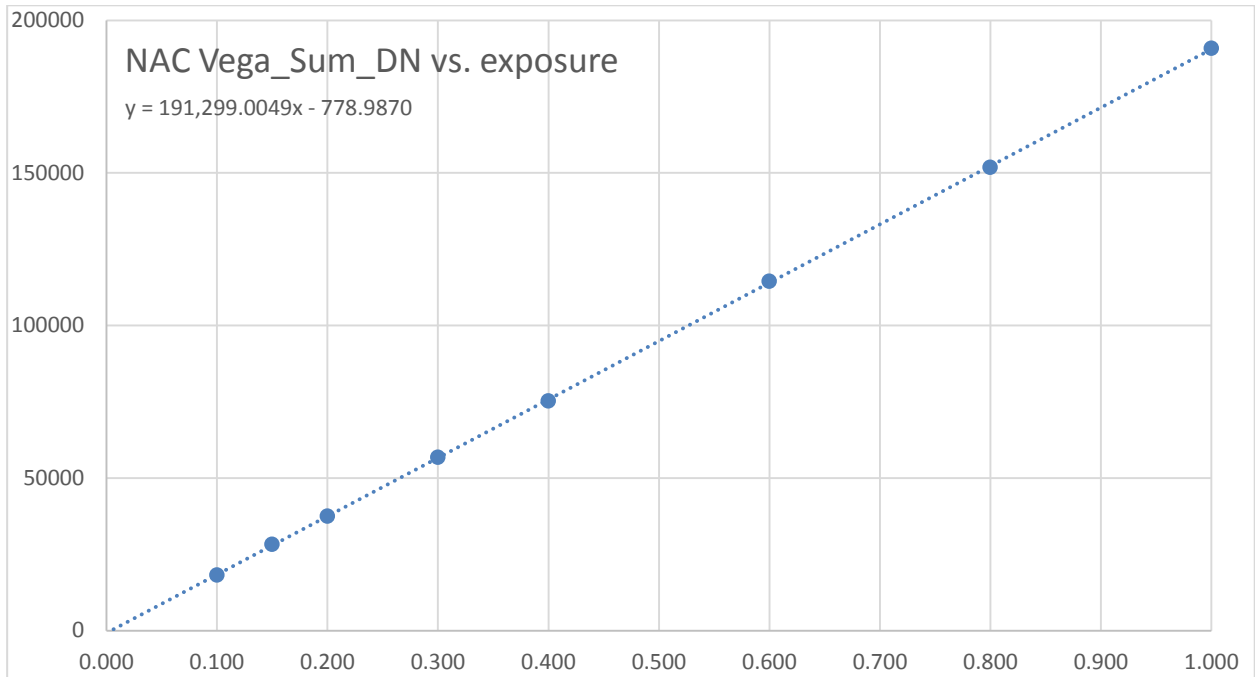


Figure 1. NAC linearity. The chart shows the Vega DN numbers as a function of the exposure time in seconds for the NAC.

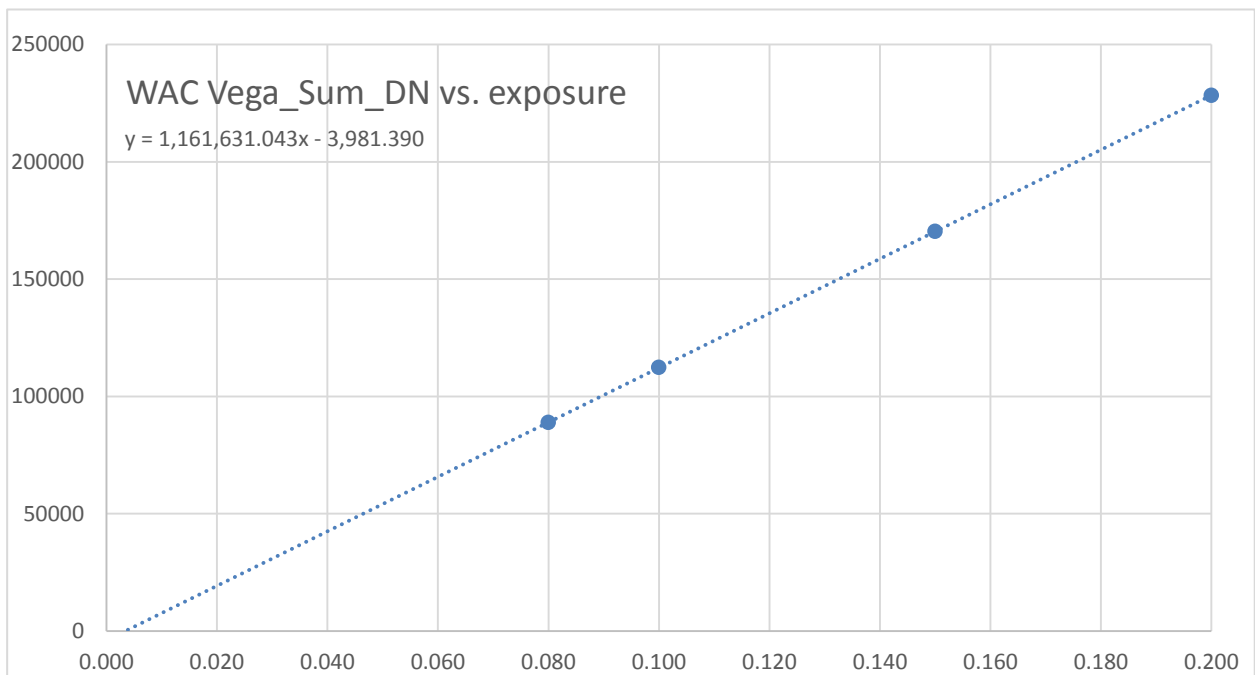


Figure 2. WAC linearity. The chart shows the Vega DN values as a function of the exposure time in seconds for the WAC.



3 Calibration files used by OsiCalliope

The saturation and non-linearity levels are stored in:

- OSICALLIOPE_V01.TXT

Previous versions:

- OsiCalliope.LBL (obsolete, same values as OSICALLIOPE_V01.TXT)