

# Quality Control Support from the Beginning to Decommissioning of the VLT/ISAAC

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## INTRODUCTION

The Infrared Spectrometer And Array Camera (ISAAC) of the European Southern Observatory Very Large Telescope (ESO VLT) has been operated since 1999. It is one of the very first VLT instruments installed at Paranal. Originally it was mounted at the Nasmyth B focus of the Unit Telescope 1 (UT1) but it was moved to UT3 in August 2009. In December this year it will be decommissioned to make room for the new generation VLT instrument – SPHERE.

ISAAC has two arms, one equipped with a 1024 x 1024 Hawaii array used at short wavelengths (1–2.5 microns) (SW), and the other with 1024 x 1024 InSb Alladin array used in long wavelengths (3–5 microns) (LW) or for JHK imaging. Several observing modes are supported: imaging, spectroscopy in both SW and LW, and imaging polarimetry in SW.

ISAAC is also the first VLT instrument that was fully supported by the Quality Control Group at ESO Garching all the way from the beginning of the operations until upcoming decommissioning. The only instrument before – FORS1, was decommissioned in Apr. 2009 and was not covered with all the services.

## QUALITY CONTROL OF ISAAC

Data quality control is a process that has two major goals (Hanuschik 2006, 2008):

- to ensure that obtained science data have all necessary calibrations of verified quality
- to monitor status of the instruments and provide feedback to the observatory staff

Right from the beginning of ISAAC operations in the end of 1998 a dedicated QC scientist has been appointed to perform instrument's quality control checks (Hummel et al. 2002).

Once the raw ISAAC data are acquired at the telescope they are initially inspected by the daytime astronomer in the observatory. For detailed analysis they are transferred to ESO Garching. Originally it was done via ftp on a daily basis. Later, with more instruments at Paranal, the physical media were used, which was giving up to two weeks delay between generation of the data and their quality check. Since mid 2008 ISAAC data stream has been entirely transferred through the internet (Romaniello et al. 2010) and currently allows quick data analysis and feeding the QC information back to the mountain.

The ISAAC data arriving to Garching are first ingested into ESO Archive and then retrieved through automatic processes maintained by the QC group. The data are organized, classified, associated according to calibration plan and pipeline processed.

Specially designed QC parameters that carry information about performance of the instrument and quality of the data are calculated by the recipes, extracted from the headers of the products and stored in the database. Some of them are used for scoring in certifying master calibrations, and some are monitored in the ISAAC Health Check plots. Those plots are one of the main interfaces between the QC group and the observatory.

The science raw frames are further associated with the verified master calibrations according to the calibration plan. They used to be then pipeline processed and distributed to the users but this service was stopped in October 2011. Currently, the users can retrieve the raw science frames and associated calibrations directly from the ESO Archive.

The main Quality Control and Data Flow Operations web site can be found at <http://www.eso.org/qc>. It offers links to QC pages of all supported VLT instruments and, in particular, to the below ISAAC QC page.

We present currently supported main services of the ISAAC QC to the mountain and data users. All the below sites can be directly accessed from the main menu of the QC pages.

## Reference Frames

Detector	Hawaii	Alladin
Read-out mode	DCR, NDR, DCR-LB, DCR-HB, UCR	
Dark		
	1.5 Mh, 1.5 Mh, 2.0 Mh, 2.5 Mh, 2.7 Mh	
	hd, hd, hd, hd, hd	

Resolution	Wavelength	1.06	1.25	1.65	2.20
Lamp on					
		1.5 Mh	1.5 Mh	1.5 Mh	1.5 Mh

The ISAAC reference frames website was created in the first half of 2004. It contains examples of the imaging and spectroscopic calibrations in instrumental setups most frequently used. Both raw frames and pipeline products are displayed. This page is particularly useful for daytime astronomers on the mountain that may not be familiar with all ISAAC calibration frames. It is also used by observers wanting to compare their data.

## QC1 Database

Instrument	table	interface	description
ISAAC	isaac_checkflat	isaac_plot	TEC daily check flat
	isaac_slit	isaac_plot	TEC grating and slit
	isaac_dark	isaac_plot	DET darks
	isaac_line	isaac_plot	DET detector linearity
	isaac_zp	isaac_plot	IMG photometric zeropoints
	isaac_tflat	isaac_plot	IMG twilight sky flat
	isaac_tflat_oe	isaac_plot	IMG odd even column effect (SW)
	isaac_illu	isaac_plot	IMG illumination
	isaac_imgobs	isaac_plot	IMG science imaging
	isaac_arc	isaac_plot	SPE arcs

The QC1 database was established very early in the ISAAC operations. It collects values of the quality control parameters describing the data and status of the instrument (qc1) rather than ambient conditions during observing (qc0). Different tables correspond to different types of ISAAC calibrations like e.g. darks or standard stars. The qc parameters from the QC1 database are further used for e.g. scoring quality of master calibrations or for trending.

## Health Check Monitor

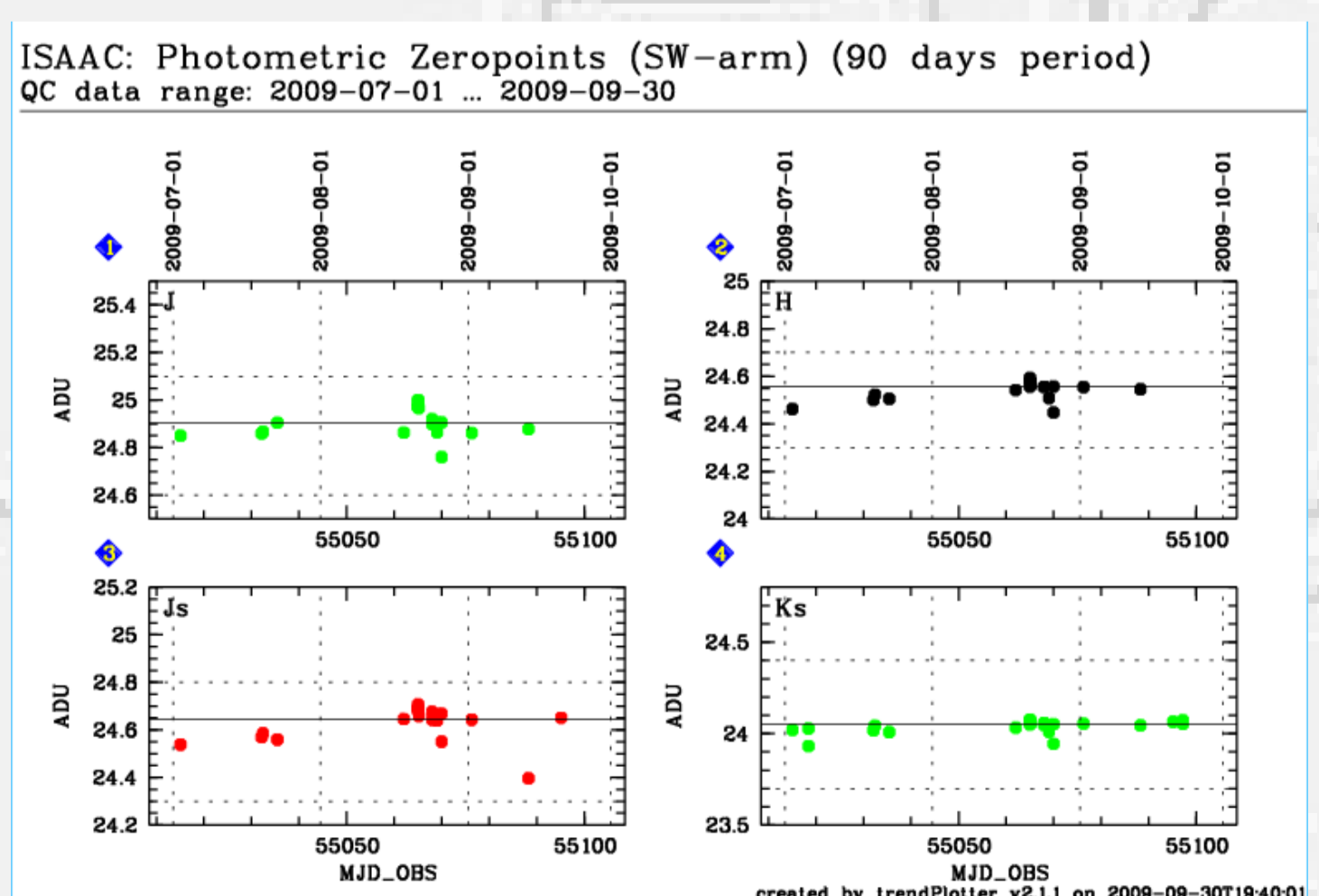
The ISAAC Health Check (HC) plots are displayed within the general HC monitor supported from early on by the QC Group. Their main purpose is to feed the information about the status of the instrument and about the data back to the observatory. The format of the plots and frequency of the updates were changing over time. Currently, the new data points inferred from pipeline processed calibrations are included in the plot in no more than an hour from their acquisition. This allows quick response in case of problems.

## Calibration Completeness Monitor

The Calibrations Completeness Monitor was put in operation in 2008. It verifies if all ISAAC science data taken during the night have all required calibrations available and within the validity range. The checks are performed every 30 minutes and results are closely monitored in the observatory and by the QC Group in Garching. In case of an outdated or missing calibration a yellow or red flag appears to alert and, if necessary, trigger action. In some cases though calibration may not be required, so the analysis mechanism allows communication between the Paranal Science Operations and Garching.

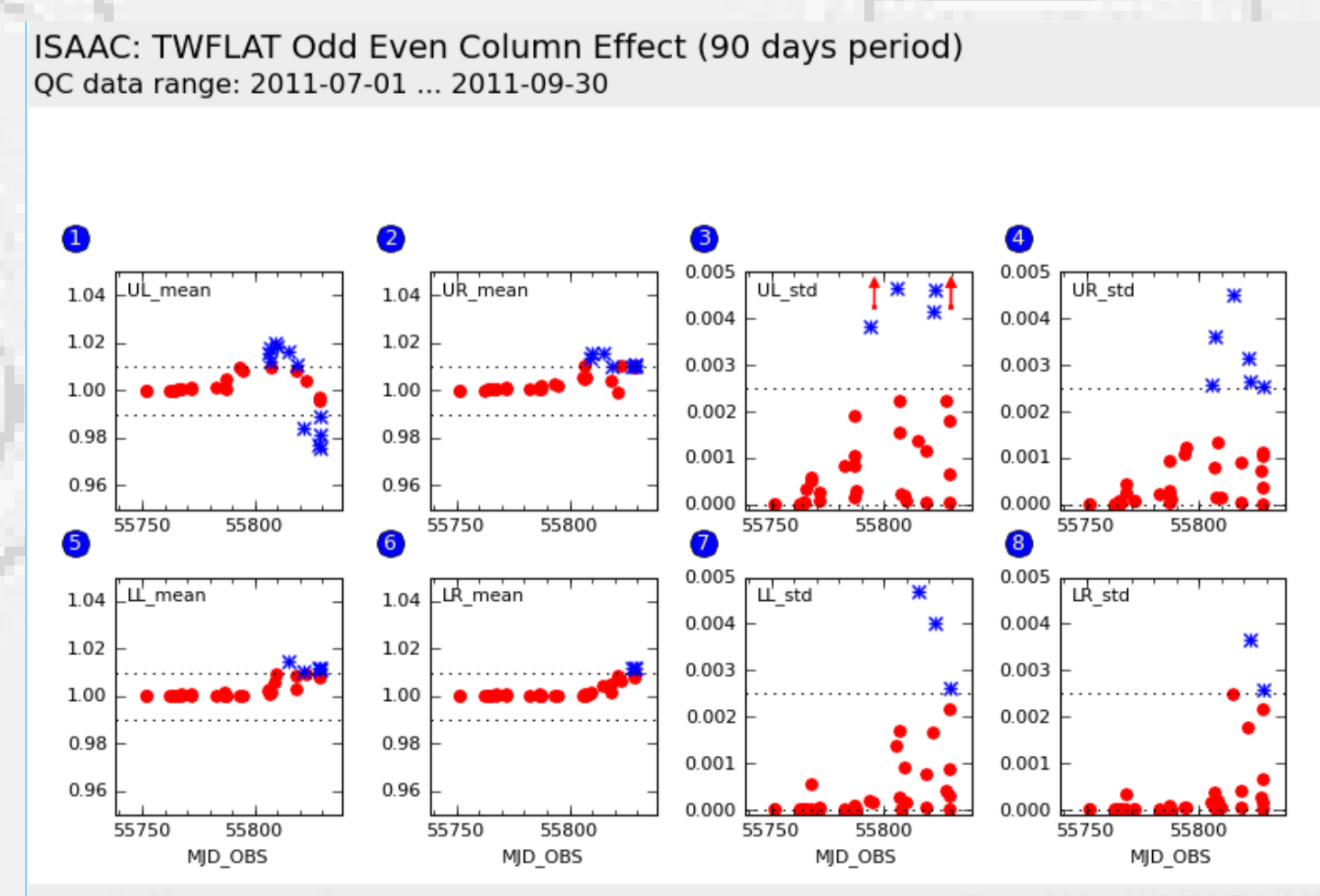
## Events from life of ISAAC

### Move of the instrument



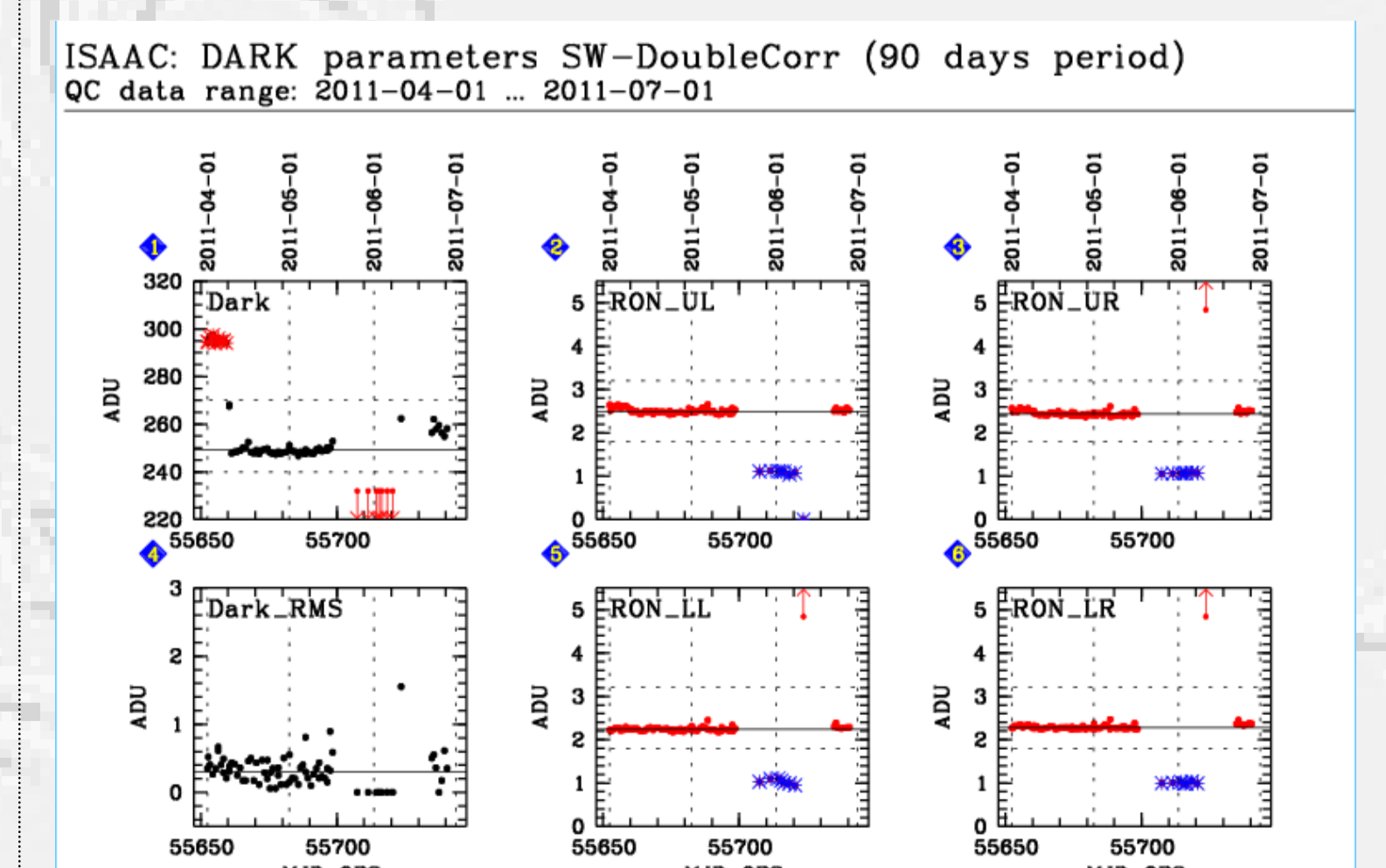
In August 2009 ISAAC instrument was moved from UT1 (Antu) to Nasmyth A focus of UT3 (Melipal). The above historical health check plot trending zero points as observed by ISAAC illustrates the process. The instrument was turned down on August 1, 2009. It started taking data again at new location 20 days later. The move went smoothly. Note, that from the first night the new zero point magnitudes were consistent with those before and even improved a little.

### Odd-Even-Column effect episodes



ISAAC has been occasionally suffering from the Odd-Even-Column effect in the Hawaii array. It manifests itself as a difference in flux recorded on the odd and even columns. Although the cause is unknown, a strategy was developed to reduce it. The effect comes and goes, so it has been monitored through a dedicated plot based on parameters from the twilight flat data. The above is showing one of the episodes in September 2011, when over 2% discrepancy was observed.

### Problems with the Upper Left quadrant of the Hawaii Detector



On May 17, 2011 during daytime calibrations the upper-left quadrant of the Hawaii detector stopped responding. This health check plot of the parameters inferred from the daily dark frames shows sudden drop of the median dark level. Also, estimates of the read-out-noise in all quadrants appeared affected. After detector intervention, the Hawaii frame went back to normal in mid June.

## After Decommissioning

The ISAAC instrument is scheduled to be decommissioned in the first half of December 2013. Before then, a series of specially designed close-out calibrations will be taken to assure that there is a complete list of data available to calibrate all the instrument modes and setups.

The QC support will be significantly reduced but some services will continue. The activities having to do with daily operations will cease e.g. Calibration Completeness Monitor, processing of the calibration frames and harvesting new QC parameters, updates of the HC plots. However, access to the existing ISAAC QC pages will remain. The historical HC plots, QC1 database, reference frames, tutorials will still be accessible from the main website of the QC Group.

Also, there will be no longer a dedicated QC scientist overlooking quality control issues of ISAAC.



