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ABSTRACT

We report the implemented architecture for monitoring the health and the quality of the Son Of X-Shooter (SOXS) spectrograph for the New Technology Telescope in La Silla at the European Southern Observatory.

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Briefly, we report on the innovative no-SQL database approach used for storing time-series data that best suits for automatically triggering alarm, and report high-quality graphs on the dashboard to be used by the operation support team. The system is designed to constantly and actively monitor the Key Performance Indicators (KPI) metrics, as much automatically as possible, reducing the overhead on the support and operation teams. Moreover, we will also detail about the interface designed to inject quality checks metrics from the automated SOXS Pipeline (Young et al. 2022).

Keywords: SOXS, noSQL, Quality control, Quality Checks, Pipeline, Data Reduction, Spectroscopy, Imaging

1. INTRODUCTION

The Son-Of-X-shooter (SOXS) (Son Of X-Shooter) instrument is a new medium resolution spectrograph ($R \simeq 4500$) able to simultaneously observe 350-2000nm (U- to H-band) to a limiting magnitude of R $\sim$ 20 (3600sec, S/N $\sim$ 10). It shall be hosted at the Nasmyth focus of the New Technology Telescope (NTT) at La Silla Observatory, Chile (see[1] for an overview). This paper describes the design of the SOXS quality check and data-flow system. Details of each of the other SOXS subsystems can be found in a set of related papers , see.[1–28] A peculiarity of this instrument, as described in Asquini et al 2022 SPIE in press, the instrument will be operated in the ESO La Silla-Paranal Observatory operation environment without an astronomer on the mountain. From this stems the need to design and develop a suite of software that can autonomously organize and manage the night both in advance (for scientists to approve and scrutinize) and to monitor the health of the instrument. In this paper we focus on the Quality Check System architecture that has been implemented for SOXS.

2. THE SOXS PIPELINE - THE FIRST BLOCK FOR THE QUALITY CONTROL

As described in Young et al 2022 SPIE in press, the main purpose of the SOXS Data Reduction pipeline is to use SOXS calibration data to remove all instrument signatures and deliver Phase 3 compliant science data products. The pipeline also measures parameters on calibration product and intermediate product to assess both the quality of the data and the health of the instrument. The schema shown in Figure 1 reports how the SOXS pipeline interacts with Quality Check Systems by using FITS headers.

3. A NO-SQL APPROACH DATABASE

The Quality Check control for SOXS will store time-series data that will be presented to the user in order to produce both (a) a first glance table that summarises the status of instrument, by comparing measured values on the images with those expected by design (RON, dark,..), and (b) provide interactive plots that can be used to better understand trends, outliers, etc.

Since the structure of the database, the number of monitored Quality Checks and the data structure in general will be fluid both during the design of the instrument and during the operations we decided to adopt a MongoDB no SQL database to store our data points. The noSQL databases have the great advantage to be fast against certain queries and flexible with respect to the underlying data structure (no a-priori design of the data structure is needed). They basically store each datum as a JSON file in sets called collections. We exploit this to fact to design the overall architecture of our databases as reported in Figure 2.

Briefly, for each arm of the instrument we define in our MongoDB cluster a database that contain JSON documents that are organized in Collections as in the sample of Figure 3. For each group of Quality Checks that we intend to maintain under control (dark current, efficiencies, Signal-to-Noise ratio reached, etc.) we define a MongoDB Collection (which is no more than a set of document) to store a JSON document for each measured data-point which contain the measured value with proper unit and a set of metadata used to identify the data-point. Those metadata are the qcname (a mnemonic label that will be displayed on the Web Application) and the group name which the quality check belongs to. For example, as shown in Figure 3 in the Collection *format stability* we will measure a number wavelength calibration quality checks in the group called *wavecal_slit*. The quality check value *diffy_rms* which measures the rms on the wavelenght calibration belongs to the collection *Format Stability* in the group *wavecal_slit*.Finally, for keeping the data up-to-date a deamon, running on the pipeline machine, checks for new calibration, intermediate and final product on the filesystem. If new files are found, then the header is parsed and a JSON document is sent to the MongoDB database cluster in the proper collection for storage (see Figure 4).

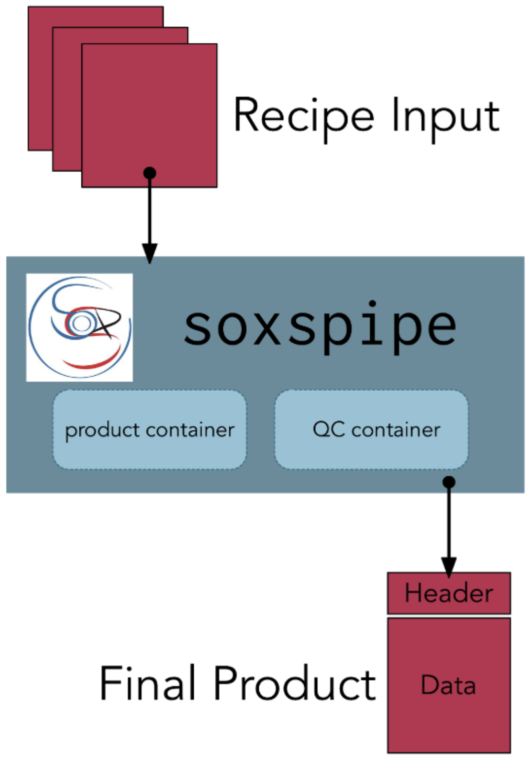

Figure 1: General flow from the soxspipe and the QC container. The QCs computed by the pipeline are stored in the proper fits header of each calibration, intermediate and final product. A daemon, running on the pipeline machine, will read the header and push documents into the no-SQL database collections.

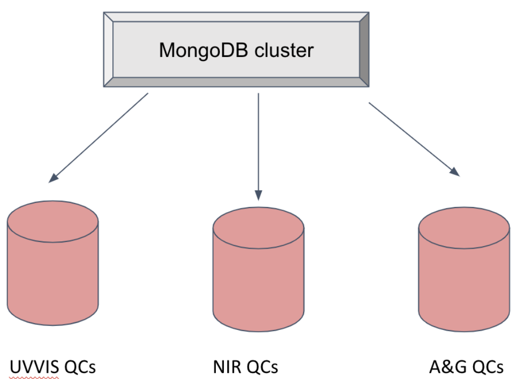

Figure 2: The SOXS quality check system database architecture.

4. THE WEB APPLICATION

In order to present data to the end-user and to the operation team, a proper Web Application with state-of-the art responsive tecnologies has been developed.

The application is in charge to present a Dashboard (see Figure 5) where the global health status of the instrument is presented. If the series of monitored quality check parameters is OK, a green tick is reported while a red mark is shown when parameters are 1-sigma out of the expected nominal value coming from design (or actual measurements during the Commissioning Phase in La Silla).

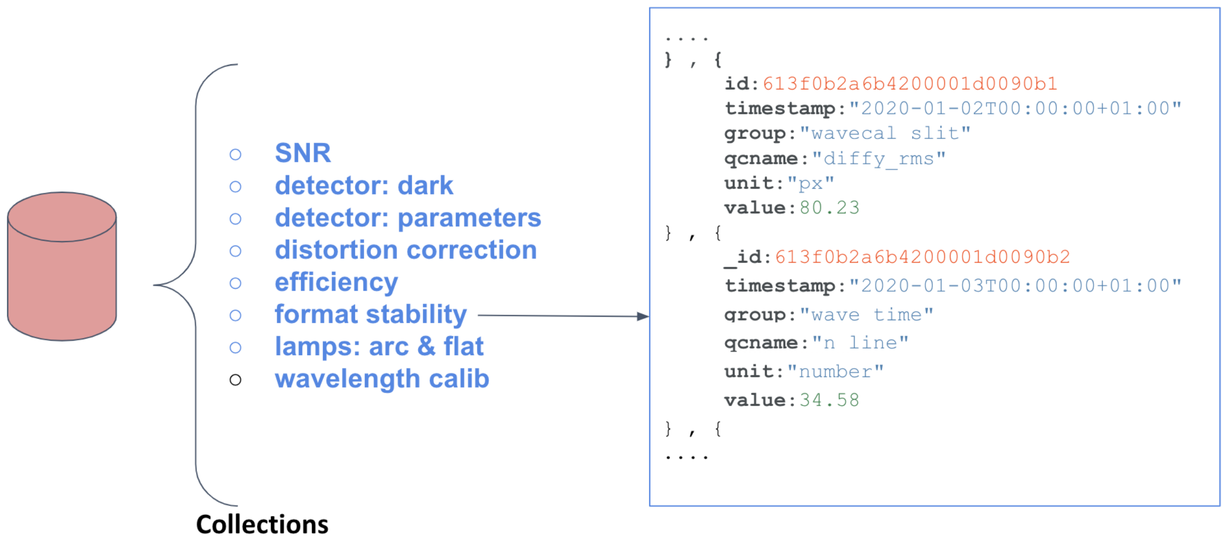

Figure 3: MongoDB collection and document organisation. See Section 2 in the text for details

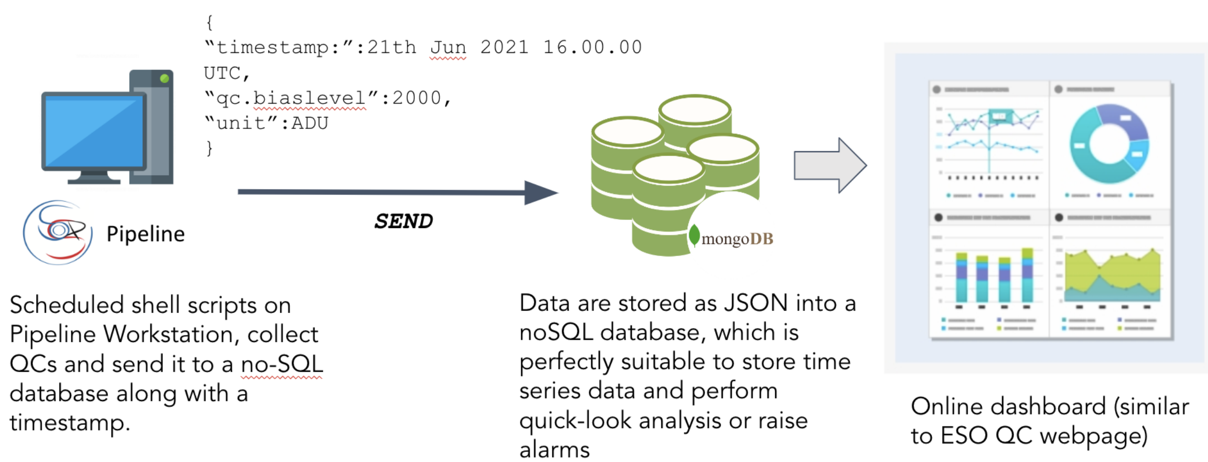

Figure 4: Injection of the data in the MongoDB database. A deamon, running on the pipeline machine, checks for new calibration, intermediate and final product on the filesystem. If new files are found, then the header is parsed and a JSON document is sent to the MongoDB database cluster in the proper collection for storage.

The Web application is also capable to show, for each monitored quality check, a detailed and interactive graph that could be used by the operation team to debug problems on the instrument or to monitor trends on relevant parameters of the detector (such as the dark current, the fixed pattern noise, etc.). Figure 6 and Figure 7 report a detailed view of the graph available for each quality check. The user, by moving the cursor on the plot line, could read the values and their goodness indicated by green or red marks.

The application allows also to download the data, selecting date range and relevant quality checks, in CSV or TXT format for offline analyses with other third-party tools if needed.

5. ALARMING

An important part of the monitor system of SOXS is the automatic alarm feature present on the system. In particular, by adopting Cloud Based services offered by Amazon Web Services (see e.g.[29]) the system is able to notify the operation team of a faulty monitored quality check by email or SMS. This methodology, coupled with

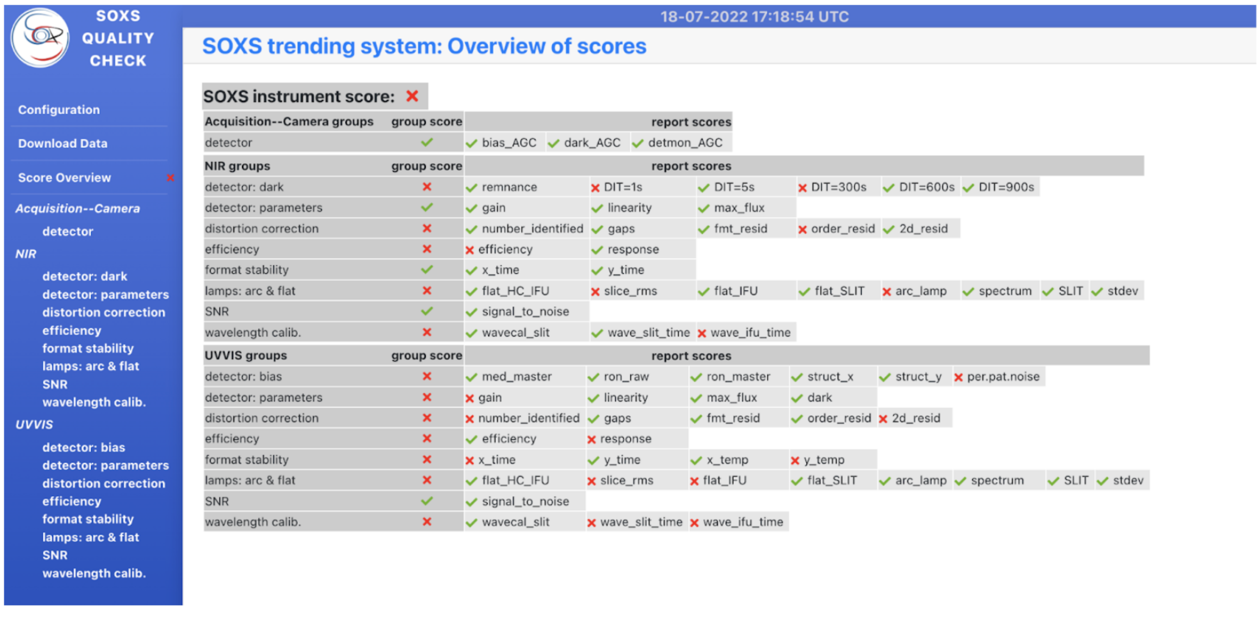

Figure 5: Dashboard of the Web Application for SOXS Quality Checks monitor. See text for details.

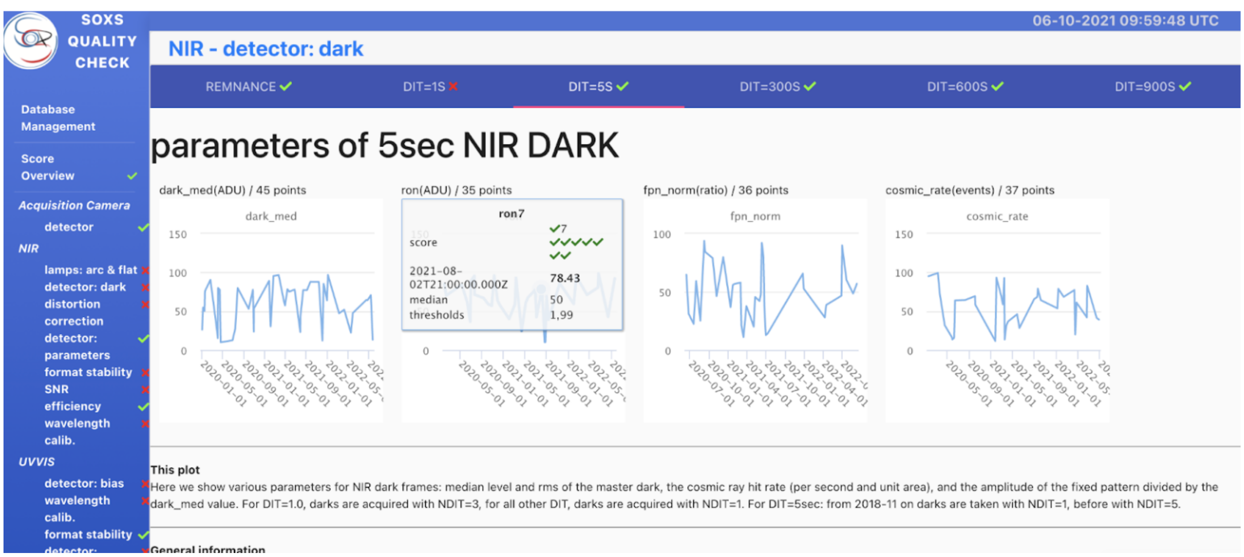

Figure 6: Graphs for the dark current quality checks monitored for SOXS.

the presented web-based dashboard, allows a very quick instrument monitoring by the operation team both in Europe and Chile and to discover as soon as possible drifting key parameters of SOXS in advance.

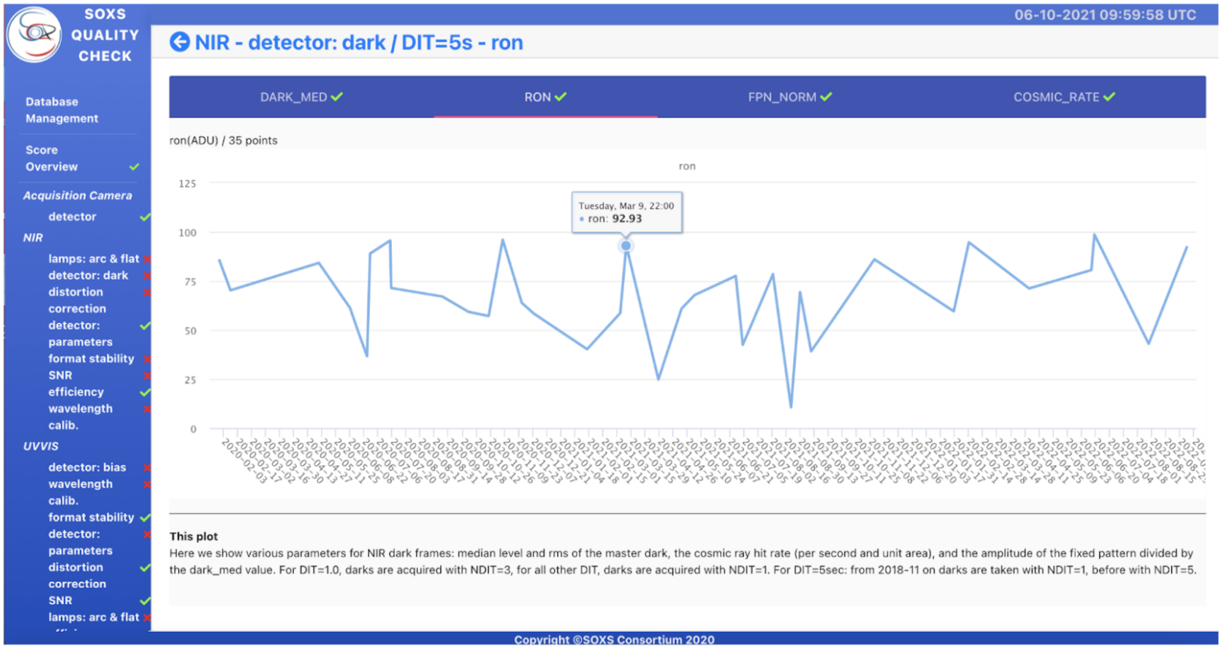

Figure 7: A zoomed view of a graph for a quality check. See text for details

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