

Data Flow Operations and Quality Control of SINFONI

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SINFONI as an integral field spectroscopy using slicers combines near-IR IF spectroscopy and adaptive optics. The instrument is mounted at UT4 of the ESO-VLT and is offered since April 2005. The calibration cascade and the pipeline recipes of slicer IFS instruments like SINFONI differ with respect to fiber-fed IFS instruments.

1. Introduction

SINFONI consist of an integral field spectrograph (SPIFFI, [3]), fed by an adaptive optics module [2]. It provides intermediate resolution ($R=2000 \dots 5000$) spectroscopy in the near infrared (J, H and K bands), covering a field of view between 0.8×0.8 arcsec and 8×8 arcsec. Two image slicers chop the FOV into 32 slices each of 64 pixel that are projected on a single long slit.

SINFONI, as all other ESO-VLT instruments, is operationally embedded in the VLT data flow [6], a complex network (Fig. 1) that links the observatory, the ESO science archive, Quality Control and the users.

2. Data organization

Science raw data and calibration frames have to be organized in several steps before being processed and distributed. Classification identifies each frame of a given data pool (e.g. all frames of an observing night including the follow-up day-time calibrations) belonging to a raw file type, like **DARK** or **DISTORTION**. The second step is grouping, meaning the set of files of a given raw type is chopped to build meaningful groups, called association blocks (AB) within the data flow terminology. In most cases raw frames listed in ABs are synchronous in the relevant instrument parameters. In the third step the calibration cascade is generated by associating the required calibrations using match rules (Fig. 2).

Calibrations and science raw frames are processed in a sequential or if appropriate in a parallel manner. The set of raw frames and the required master calibrations are submitted to the corresponding pipeline recipes and the products are made available for the next step of the processing cascade.

For practical reasons, the last step in the cascade, the processing of science raw frames is performed only after all master calibrations have been certified.

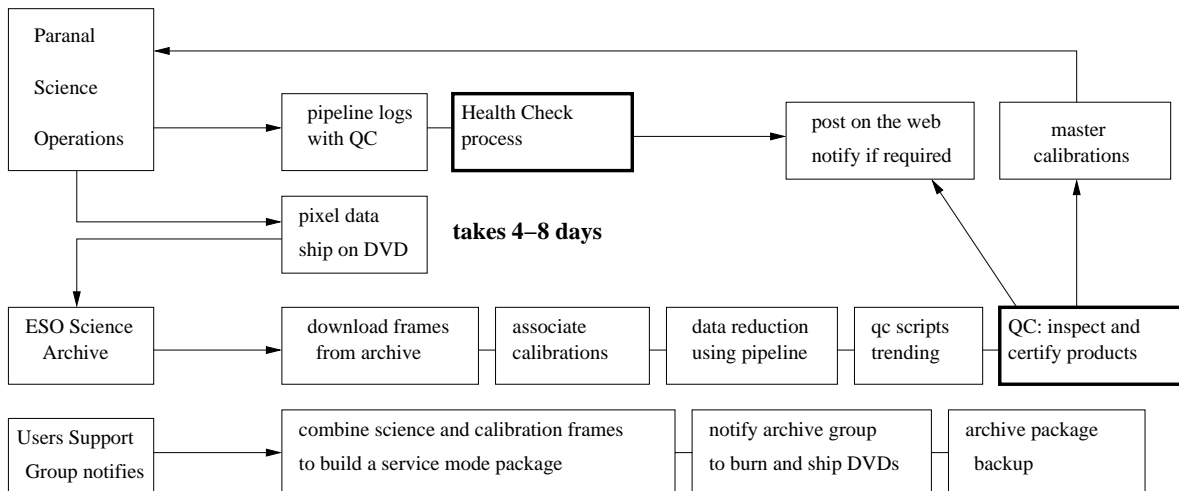


Figure 1. Post observation data flow of ESO-VLT instruments.

3. Pipeline

The SINFONI pipeline was developed by the consortium [1] using the eclipse library. It is currently being converted to CPL and adopted for the new science detector [5], that was installed only a few weeks before begin of operations. More than thirty QC parameters have been designed and implemented to monitor the overall performance of the instrument. Comments from the commissioning team, science verification team and observatory staff were meaningful to improve the performance and robustness of the pipeline. Each recipe generates a number of products of which some are used as master calibrations in follow up steps of the cascade, other products are for QC purpose only, and are not necessarily archived. The calibration recipes of the pipeline are robust (since version 1.0.6), all calibrations from begin of operations can be reduced. E.g. the `si_rec_wavecal` recipe finds the dispersion solution for wavelength offsets up to 200 pixels, while the real grating offsets are considerably lower (Fig. 4). The science recipe provides reduced (flat-fielded, wavelength calibrated, distortion corrected, sky subtracted and cube-reconstructed) OBJECT cubes and in addition a co-added cube product. The science recipe offers several sky subtraction strategies under configuration control.

The telluric standard star recipe and point spread function calibration star recipe provide the same functionality but differ from the science recipe by the different QC performed.

4. Association map and Calibration plan

The calibration cascade of SINFONI differs in several aspects from that of fiber-fed IFS instruments [4]. One feature of the SINFONI calibration cascade is that the wavelength calibration recipe requires a master flat to account for the distinct flux levels in different slitlets. Another difference is: while the fiber arrangement is fixed via the bundle in

SINFONI Association Map

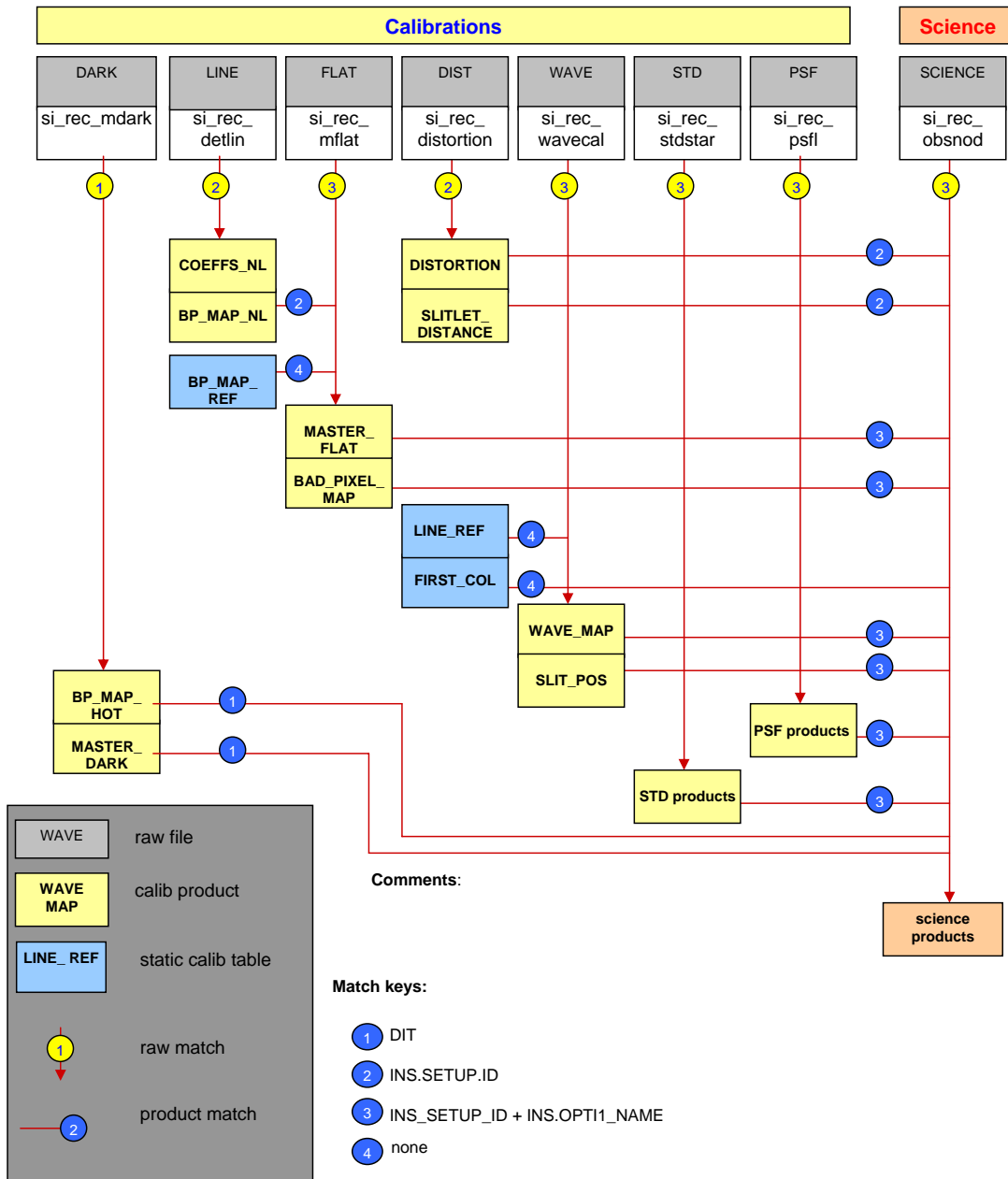


Figure 2. SINFONI association map. Example: A set of frames, classified as FLAT and grouped by rule (#3) are processed by the `si_rec_mflat` recipe using the static calibration `BP_MAP_REF` and the calibration product `BP_MAP_NL` coming from the `si_rec_detlin` recipe and generating a `MASTER_FLAT` and a `BAD_PIXEL_MAP` that is used in further steps of the cascade as master calibrations. Note that DARK, PSF and telluric standard star products complete the association cascade, but the science recipe of the pipeline does not make use of them. Linearity and distortion calibrations are acquired bi-monthly, while darks, flats and arcs are collected daily.

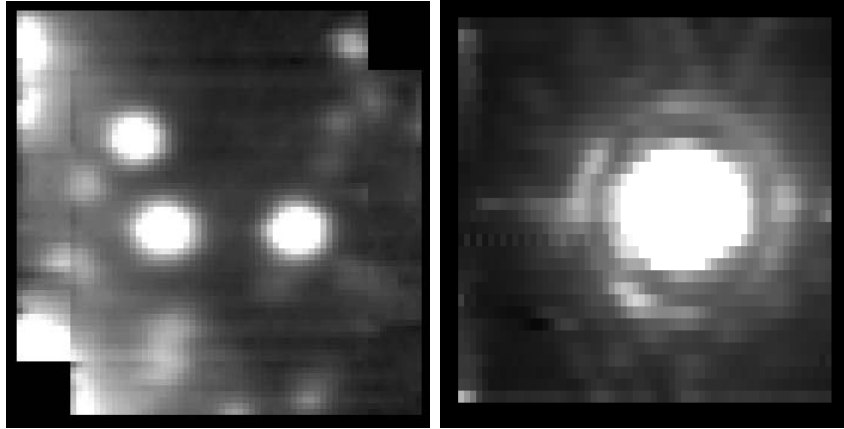


Figure 3. Left: SINFONI pipeline science product. The median of the co-added reconstructed cubes is shown (H band and 250mas/pixel camera). Right: Calibration product: Median collapsed cube view of a telluric standard star (K-band and 25mas/pixel camera). The AO loop is closed.

instruments like GIRAFEE and VIMOS, the begin and the end of each slitlet and the geometrical arrangement of the slitlets on the detector is identified by the pipeline using the discontinuities in the wavelength dispersion coefficients that occur at both sides of each slitlet. The wavelength calibration is therefore a pre-requisite of the cube reconstruction of the SINFONI pipeline.

Another feature of the calibration cascade is the geometrical distortion correction step. For reasons to keep the logical tree-like links of the calibration cascade (Fig. 2), the set of raw frames of this step contains calibration fiber frames at positions in the FOV and in addition a set of raw flat and raw arc frames. The distortion recipe processes the arcs and the flats to be used internally as master calibrations for the fiber frames. The recipe is hence kept independent from other master calibrations.

5. Quality Control Aspects

Quality Control of VLT instruments is a process shared between Paranal Science Operations and Quality Control Group in Garching. The main parts of this process are

QC parameters, that are well defined characteristics. These single numbers, extracted by the pipeline, measure a) performance of a single optical element (e.g. RON of the detector), b) performance of a set of optical items (e.g. Strehl ratio), an alignment (e.g. grating offset) or the quality of a pipeline processing step (e.g. a fit quality). QC parameters are archived and trended.

Daily Health Check, is a set of plots (Fig. 4) that show the current values of the most critical QC parameter values from the observatory together with the most recently in Garching processed values.

SINFONI Health Check Plot : Offset/Pixel K Measured-Minus-Nominal (+ Average)

Last QC date: 2005-06-30, last PSO date: 2005-07-22

last update: 2005-07-26T09:16:06

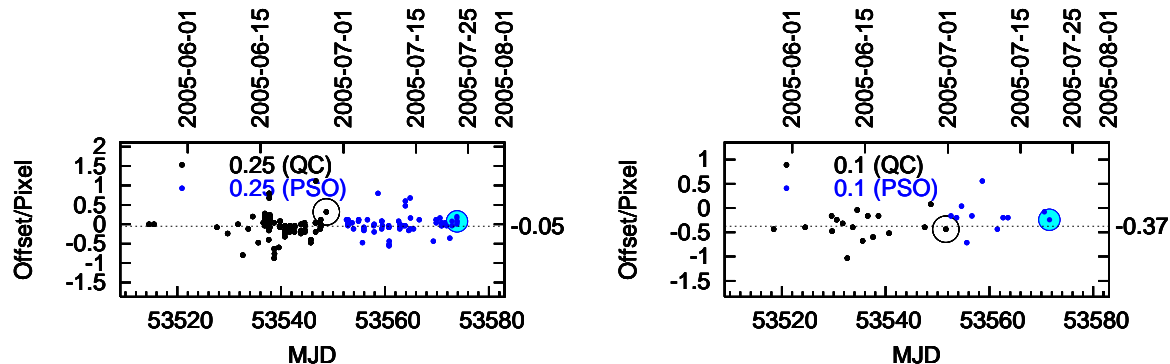


Figure 4. SINFONI Health Check plot showing the K-band grating offset of the central wavelength, as derived by the pipeline recipe. Two cameras (0.25, 0.1) are shown. See also <http://www.eso.org/qc> .

QC plots, per raw type show more detailed information, like cross-sections and histograms. In many cases the equivalent of a reference is plot as well.

In a first pass day-time calibration products and on-the-sky calibration products are assessed by the QC scientist according to the quality products. Only certified calibration products necessary for the cascade are archived and used to process science frames in a second pass. Master calibrations are made available for the on-line pipeline at the observatory.

SINFONI master calibration products and the QC1 parameters will become public within the next observing period.

REFERENCES

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