The GTC/OSIRIS Data Reduction System

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Abstract

I present the online and the offline data reduction system for OSIRIS, the optical multi-mode instrument for GranTeCan. The software is written in Python and invokes PyRAF tasks which have been optimized for the instrument. I review the characteristics of the intrument and of the software. I will also present the improvements which are foreseen for both the instrument and the software. The flexibility of the software makes it easy to be adapted to other telescopes/instruments.

Gran Telescopio Canarias (GTC)

Located in the Observatorio de Roque de los Muchachos, in the Island of La Palma (Canary Islands, Spain), GTC is an alt-azimuthal telescope. Its primary mirror is made of 36 hexagonal segments (of a diameter of 1.9m each) building up a 11.3m quasi-hexagonal primary mirror (equivalent to a circular aperture of 10.4m).

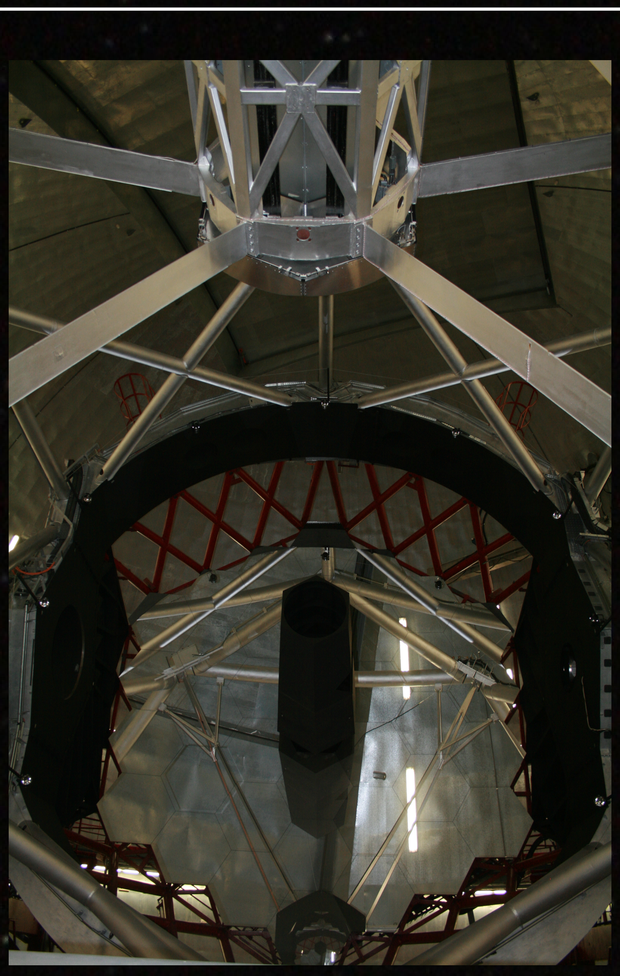

Figure 1 *The primary mirror of GTC. M2 can be seen reflected in M1 while M3 is in the buffer emerging from M1. The four "folded Cassegrain" focal stations are all located in the upper half of the black ring surrounding M1. The "Nasmyth B" focus, where OSIRIS is located, is on the right side of this picture.*

The `OOPS`: OSIRIS Offline Pipeline Software.

The `OOPS` has been designed to fully support all the observing modes of OSIRIS (although `v1.0` only supports broad–band imaging, tunable filter imaging and long–slit spectroscopy). It is fully customisable and the user can do all the reduction step-by-step.

The `OOPS` is a Python script executing `PyRAF` tasks. All `PyRAF` tasks can be tuned and the parameters are stored in a file for future use or to be used in the `OQuLTo` software.

The User must define the directories where the raw data is stored, where the reduced data is stored and where the "intermediate" data (i.e. the frames at intermediate steps of the reduction process) is stored. Whenever a task is called, the `OOPS` checks that the required calibration data exists and that the execution of such a task does not overwrite an already existing file. The `OOPS` also checks that a user does not combine images which have been taken with different modes of the CCD or different optical elements in the optical path (if applicable).

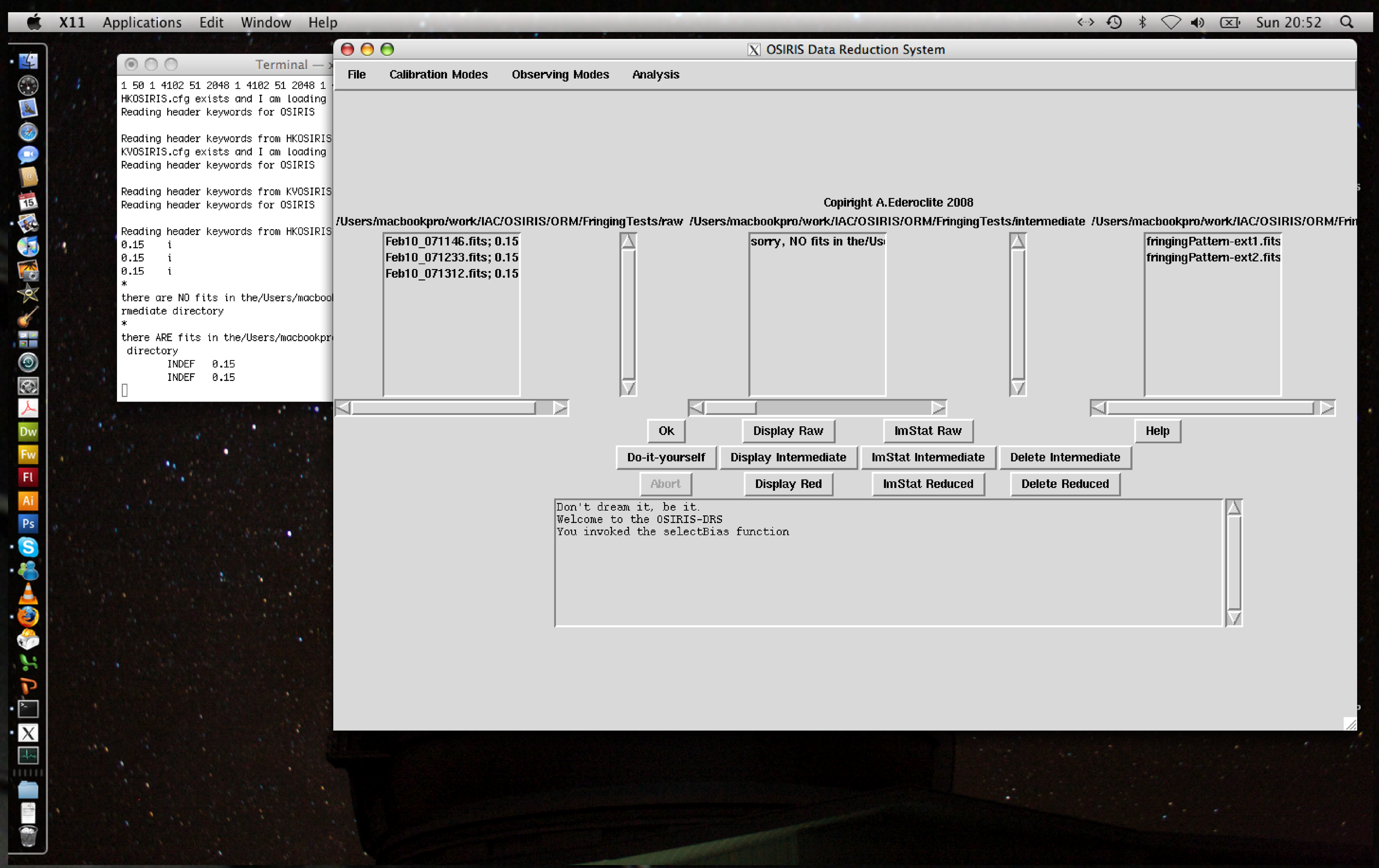

Figure 3 *The OOPS running.*

OQuLTo: OSIRIS Quick Look Tool

`OQuLTo` is the online software that can be used for real–time assessment of the quality of the data. `OQuLTo` is a set of scripts:

- `startOQuLTo.py` starts up the scheduler
- `onlinepipeline.py` is the scheduler: checks every 5 seconds if every file in the raw data directory has been reduced and, if needed, it starts the reduction, calling `IRAFpipeline.py`
- `IRAFpipeline.py` is the actual pipeline which reduces the images depending on their header keywords
- `stopOQuLTo.py` stops the scheduler and saves the log

`OQuLTo` only needs two configuration files: one with the IRAF parameters to be used (normally using a copy of the one used by `OOPS`) and one with the name of the directories where the raw data is placed and where the reduced data will be placed.

If a calibration frame does not exist, the software uses a temporary solution (informing the User about this). In case, for example, a proper bias for a science exposure does not exist, the software only uses the overscan region. In another, potentially common, case, if a flat field is not available, the software does a low–order fit to the image and uses it as a flat. At the end of the reduction process, `OQuLTo` re–builds the multi–extension fits file.

OQuLTo can also work "offline" reducing, in alphabetical order, all the data which is present in a directory.

Figure 2 *The instrument OSIRIS attached at the Nasmith focus of GTC and the first author of the poster during commissioning.*

OSIRIS

OSIRIS (Optical System for Imaging and low Resolution Integrated Spectroscopy) is the optical Day–One instrument for GTC. OSIRIS is equipped with a mosaic of two back-illuminated 2048×4096 CCDs. The field of view of OSIRIS is 8.53' × 8.53' in direct imaging and 8.0' ×5.0' in spectroscopy.

Its basic modes are:

- Imaging
  - Broad-band imaging; using Sloan filters
  - Tunable-filter imaging
    - Standard TF Imaging; using a red (600-1000nm) or a blue (375-675nm) TF which can be tuned to have a FWHM of ∼1.2 – 2.0nm (depending on wavelength)
    - Straddling line; combining TF with charge shuffling to observe a line and its blue and red continuum
    - N-shuffle; combining TF with charge shuffling to scan through a wavelength range
- Spectroscopy
  - Long-slit spectroscopy; standard long slit spectroscopy with resolution $(\lambda/\delta\lambda)$ between 300 and 2500
  - Multi-Object Spectroscopy (MOS)
    - Standard MOS
    - Nod-and-shuffle; shuffling the charge when moving the telescope to a blank field for improved background subtraction
    - micro-shuffle; shuffling the charge when moving the telescope to a blank field for improved background subtraction in a crowded field (uses a pinhole mask instead of the standard MOS-mask)
- Fast-modes
  - Fast photometry
    - Decentered slit; uses charge shuffling taking an image through a 3" slit at the top of the mosaic
    - Windowing with frame transfer; readout time of a small window can be as low as 0.2s
  - Fast spectroscopy
    - Decentered slit; uses charge shuffling taking spectra through a custom-made MOS mask with only one aperture at the top of the mosaic
    - Frame transfer; uses a customised MOS mask with a small slit centered at 1/4 of the detector edge. The spectrum is then transferred to the non-illuminated part of the detector and read out while a new spectrum is being observed.

Towards `OOPS` and `OQuLTo v2.0`

The planned improvements for the softwares are:

- Data analysis included in `OOPS`
- Support of MOS and fast modes
- Abort the execution of a task in `OOPS`
- GUI for `OQuLTo`

Tentatively a version 1.0 will be available on 1st Nov 2009 and a version 1.5 (supporting all modes) will be available on 1st Feb 2010. Version 2.0 (with a revised architecture of the software) will be released on 1st Sep 2010.

`OOPS` and `OQuLTo` will be extensively used during the OTELO survey (Cepa et al 2008).

The simplicity and the versatility of `OOPS` and `OQuLTo` make them ideal to be adapted to a similar instrument (i.e. any multi–mode instrument in the optical).

References:

Cepa, J. et al. 2008 A&A, 490, 1

Cepa, J. et al. 2009, A&A, *in prep.*

All the pictures in this poster belong to the author (A.Ederoclite, 2008)

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