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The Spanish in-kind contribution to ESO — Pipelines

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Abstract

Ever since entering ESO in 2006, Spain has made an in-kind contribution in various fields. In the Pipeline Systems Department (PSD), this contribution has been made to a number of projects, in particular to the CPL (Common Pipeline Library), to the pipelines of the instruments ISAAC, SofI and FORS, and to the integration of the pipeline for the new VISTA telescope into the DFS (Data Flow System) at Paranal. Some of these projects started with the VLT a decade ago, and have experienced an evolution since, as a consequence of standardization processes, of the search of elements in common and, especially in the last couple of years, of the efforts to provide the astronomy community with 'science-ready' data products. At the same time, the PSD faces new challenges today, as the dramatic increase in the data volume of the Paranal Observatory since the start of operations of VISTA, or the needs of the pipelines of the future instruments of the E-ELT. In the latter, more concretely, the current status of the CPL is being analyzed, with the goal of establishing the necessary changes to meet those future needs. In this article we introduce briefly these projects and detail the Spanish in-kind contribution to them.

1 Introduction

The Spanish in-kind contribution to ESO is part of the accession agreement to the organisation. It includes the allocation of a certain amount of observing time at the GTC and the funding of several positions at two departments of ESO for several years. The latter amounts to a total of 13 FTEs[1], nine of which correspond to the VO[2] department, and four to the

[1]Full Time Equivalent.
[2]Virtual Observatory.

PSD.

This paper details in the following sections the work done within the PSD. In particular, we will explain the contribution to the development of several projects: the Detector Monitoring Project in Section 2, the new FORS pipeline in Section 3, the integration of the VISTA pipeline in Section 4, and the contribution to the CPL in Section 5. There has also been work in other minor projects, involving mainly support and maintenance to existing pipelines, like ISAAC[3], SofI[4] and WFI[5].

The works done in the VO department have already been described in several papers [9, 4, 10].

2 The detector monitoring project

The ESO Paranal observatory operates a rather heterogeneous set of science detectors. The maintenance and quality control of science detectors is an important routine task to retain the technical and science performance of the instrumentation. In 2006 a detector monitoring working group was built devoted with the following tasks: inventory of the currently existing detector calibration plans and monitored quality characteristics, completion and homogenization of the detector calibrations plans, design and implementation of cross-instrument applicable templates and data reduction pipeline recipes and monitoring tools. The detector monitoring project scope is limited to the science detectors only. Technical detectors used e.g. for guide probes and wavefront sensing are not covered. The science detectors of the VLT fall in two main groups: optical CCDs and near and mid infrared arrays.

The Spanish in-kind contribution was responsible of the software development required for this project. Several recipes were developed with the specific task of computing the different detector characteristics, mainly dark current, non-linearity, saturation and gain. Taking into account that these recipes were to be include into all the existing VLT instrument pipelines (meaning a variety of detectors, in size and other particularities), they had to be very flexible and capable of processing data coming from many instruments.

The corresponding recipes were put into operations at the beginning of 2008 and are in use ever since. They have become an extremely valuable tool for the QC department at ESO [6].

3 The new FORS pipeline

FORS stands for the visual and near UV FOcal Reducer and low dispersion Spectrograph at the VLT. It is a multi-mode (imaging, polarimetry, long slit and multi-object spectroscopy) optical instrument placed at the UT1 Cassegrain focus of the VLT. It was developed by the Landessternwarte Heidelberg, the University Observatory of Göttingen, and the University

[3]Infrared Spectrometer And Array Camera: one of the first instruments at the Paranal Observatory.
[4]Son of ISAAC: very similar instrument installed at La Silla.
[5]Wide Field Imager: also at La Silla.

Observatory of Munich. Two twin FORS instruments have been in operations for more than a decade (FORS1 was decommisioned in 2009).

Over the years, the original data reduction pipeline proved to be conceptually inadequate for science-grade data reduction for several reasons [8]. The effort of rewriting the FORS pipeline anew was estimated to be less than the one required for fixing, maintaining and further developing the old one. Other technical considerations also supported the rewriting option.

The new pipeline consists of very few (4 imaging, 2 spectroscopic, 2 spectro-polarimetric) recipes and its high quality results have been satisfactorily compared with other independent and even interactive data reduction procedures. The correctness of the error propagation has been confirmed by Montecarlo simulations.

The Spanish in-kind contribution's efforts have been concentrated on the development of the spectro-polarimetric part of the pipeline. It was commissioned in February, 2009 and is in operations since April 1, 2009. The newly implemented software (spectro-polarimetry was not supported by the old pipeline) is backwards compatible and has been successfully tested also with all past instrument settings. The development of the corresponding calibration and science recipes is based on [1]. Imaging polarimetry is currently not supported but, being by far less used that the spectro-polarimetry mode, its implementation is currently a rather low priority task.

4 The integration of the VISTA pipeline

VISTA[6] is a 4 m class specialized wide field survey telescope for the southern hemisphere, equipped with a near infrared camera VIRCAM[7] with 1.65 degree diameter field of view. This telescope has been constructed by the UK as their in-kind contribution to ESO. As such, the data reduction software has been developed by the UK, too [5].

The work of the in-kind contribution regarding VISTA has been the supervision of the pipeline development, the evaluation of its performance according to the initial requirements, its standardisation to adapt it to the Data Flow environment of ESO at Paranal and some of its user support after the start of operations [7], involving travel to Paranal in a couple of occasions, as for the Science Verification run in October 2009.

VISTA presents a serious challenge for the DFS, as its average nightly data production, close to 200 GB, is alone several times what all existing instruments of the VLT produce together. As such a new parallelisation strategy has been devised [3].

5 The CPL

The Common Pipeline Library [2] provides a comprehensive, efficient and robust software toolkit which forms the basis for the creation of automated astronomical data-reduction

[6]Visible and Infrared Survey Telescope for Astronomy.
[7]VISTA InfraRed CAMera.

tasks, the pipelines. It was developed to standardise the way VLT instrument pipelines are built, to shorten their development cycle and to ease their maintenance. However, it may be more generally applied to any similar application, and the details of the CPL code have been engineered in a way to make the library portable and flexible, as well as minimising external dependencies.

The Spanish in-kind contribution's efforts have been oriented to the performance improvement, maintenance and further development of several modules of the library, among others, the image object module, where complex types and FFTs based on the FFTW library have been introduced.

Recently a significant effort has also been done towards the evaluation of the readiness of the CPL in view of the requirements of the future E-ELT, its instruments and their expected data volume, complexity and processing requirements. As a consequence of this evaluation, thread-safety enforcement on the library has been set as a top priority. Different alternatives and scenarios have been analysed (see [3]).

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