OVERVIEW OF THE VIMOS INSTRUMENT AND DATA REDUCTION SOFTWARE PACKAGES

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ABSTRACT. VIMOS is a spectrograph with imaging capabilities which will be mounted on the Nasmyth B focus of VLT UT3. The main characteristics of VIMOS are the multiplexing spectral capabilities (up to 800 spectra per exposure), and the presence of an Integral Field Unit (IFU), which allows spectrophotometry of 1 armin^2 field. To reach the goal of 800 spectra per field, VIMOS has been designed with a large field of view, divided into 4 quadrants, each quadrant being by all means a full spectrograph on its own. Spectra are obtained using masks with slits which are designed by the astronomer.

The ESO-VLT Project has devised a general Data Flow, within which all VLT instruments have to operate. During design and development of VIMOS instrument software, we had to deal with the VLT general concept, and adapt it to our needs.

1. THE INSTRUMENT SOFTWARE

Scope of the Instrument Software is to operate the instrument, to test and maintain it, to prepare observations and to reduce the obtained data. For each of these tasks, there is a dedicated software package. Each software package must have its own maintenance capabilities and testing mode, its own Graphical User's Interface and can be operated as a stand alone system.

Within the VLT Data Flow Concept, we have identified seven different software systems (see Figure 1) but, given VIMOS own characteristics, we had to introduce some changes with respect to the standard VLT Instrument Software Model.

OBSERVATION PREPARATION SOFTWARE : includes all tasks needed by the user to prepare observations. It includes the template signatures needed by P2PP package to build the Observation Blocks, template scripts and the Exposure Time Calculator (ETC).

MASK PREPARATION SOFTWARE (VIMOS specific): MPS is a completely new item within Instrument Software. We had to devise how to insert it in the normal VLT Data Flow and the concept of flexible scheduling, taking into account that, contrary to

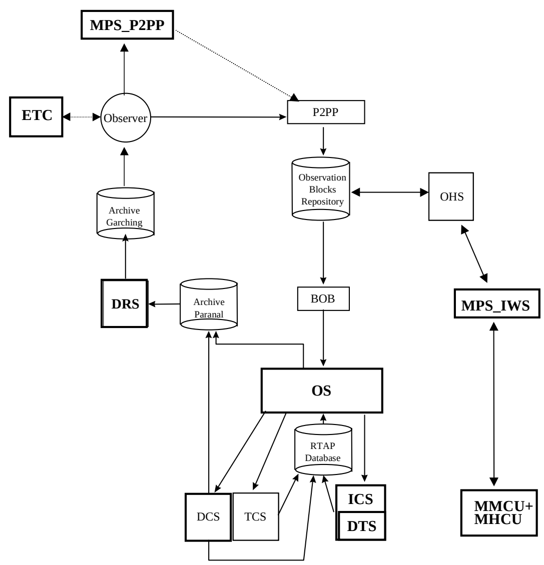

Fig. 1. Layout of VIMOS software : bold objects are VIMOS s/w subsystems. Continuos lines represent direct connections, dashed lines indirect connections between software subsystems

FORS, each mask can have such a high number of slits that an automatic procedure for choosing and placing slits had to be devised. Moreover, as no direct operation is allowed on the instrument during the night, masks have to be prepared in advance, and their handling be done within the Observation Blocks and Observations sequences characteristics of the VLT. See Garilli et al., these proceedings, for details.Mask Preparation Software will be developed for use both by VIMOS and NIRMOS instruments, with the only difference of the calibration tables to be used in the two cases.

OBSERVATION SOFTWARE : OS handles the single observations. Basically, it takes care of coordinating operations between ICS and DCS, and TCS. With respect to other instruments, VIMOS OS has to deal with 2 DCSs instead of one.

INSTRUMENT CONTROL SOFTWARE : ICS controls all hardware motions through the LCUs (Local Control Units). It has to deal with four separate beams. Although the four beams are always operated in the same way (same exposure time, same filter, etc.)

each of them must be driven separately. The total de-coupling of the beams allows a much higher level of flexibility in case of failure (e.g. if one of the filter wheels should get stuck, the instrument can be operated in "degraded" mode with only three beams active). On the other hand we have to assure the maximum degree of parallelism in setting up the different hardware components, to diminish instrument setup time (full setup in no more than 60 seconds). Given the high number of movable devices present in VIMOS, two Local Control Units are needed.

DEVICE TEST SOFTWARE : DTS has been developed for direct hardware control. It includes all the low level meta-libraries, eventually required by ICS to control motors. DTS is by all means the mechanical-dependent part of ICS.

DETECTOR CONTROL SOFTWARE : DCS is responsible for controlling the detector. ESO shall provide the DCS for the FIERA controller, which is capable of operating 2 detectors at a time. As in VIMOS there are four detectors, there will be two DCS, the coordination of which is a task for OS. No independent developing will be done by the VIRMOS consortium on DCS.

DATA REDUCTION SOFTWARE : DRS allows the user to take out instrument signature from his/her data and to extract astronomically meaningful information from the data. It will consist of on-line pipelines to be carried out at Paranal, and off-line calibration and observation pipelines, to be carried out in Garching. Given the high amount of data coming from one observation (80 Mby only for the raw image), VIMOS DRS has to be time effective and highly reliable. We have developed new, automatic and reliable routines to ease up the different reduction tasks. Basic data reduction (from bias subtraction to wavelength and flux calibration) can be performed in a fully automated way, and the results of the automatic reduction pipeline are fully reliable for supported observations modes.

During normal observing, each subsystem will receive commands from the immediately above subsystem. Ultimately, OS will receive inputs from BOB, and the astronomer will not directly operate the instrument but shall define observations via P2PP and prepare masks using MPS.

2. HARDWARE AND SOFTWARE ENVIRONMENT

VIMOS Instrument Software is based on an Instrument Workstation, 2 Local Control Units , two Detector Control Units. Such Units will be connected through a LAN, based on Ethernet standard for the part connecting IWS and LCUs and on ATM standard for the part connecting IWS and DCU.

VIMOS low-level software subsystems (OS, ICS, DTS) are based on the ESO- VLT software. DRS is partly based on MIDAS (all routines concerning image reduction) and partly on in house developed programs. OPS has been developed making use of ESO libraries.

3. OBSERVING MODES AND DATA FLOW

VIMOS foresees three main Observing Modes: Direct Imaging, Spectroscopy (Low and High Resolution) and Integral Field Spectroscopy. For each of these observing Modes,

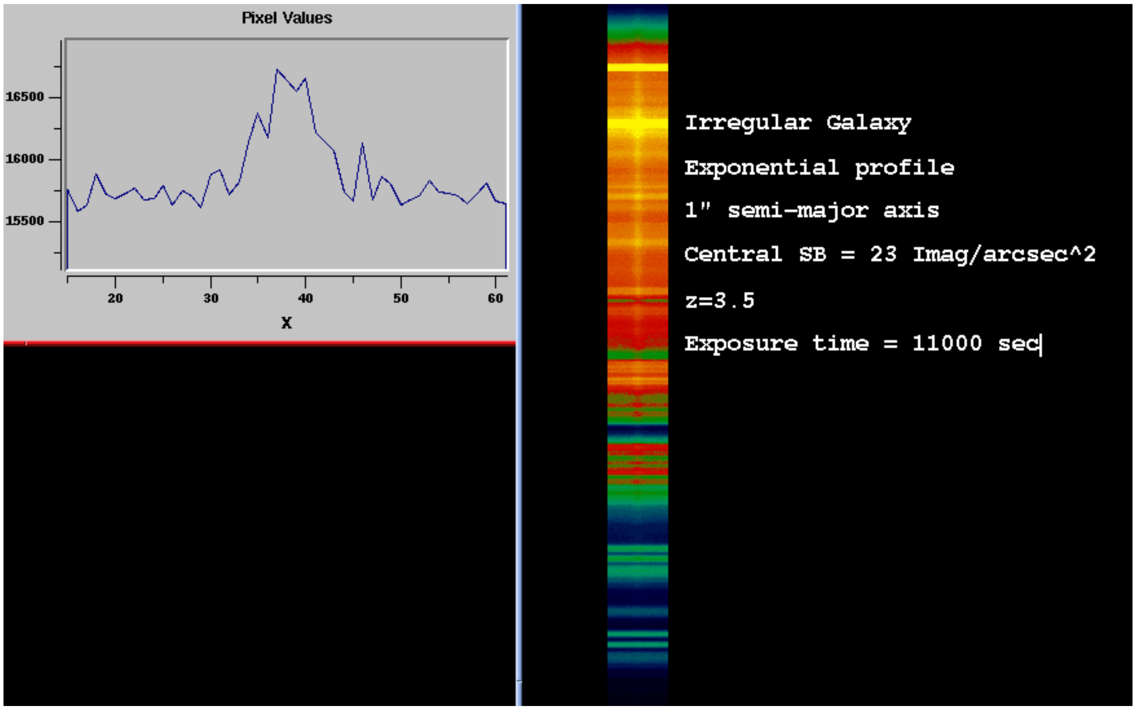

Fig. 2. A simulated spectrum produced with VIMOS ETC

the "shift and stare" technique is foreseen. Observation templates and Data reduction recipes will be provided for all these modes.

This is an example of the steps needed to carry out a MOS observation:

1. Observations are proposed by the PI, making use of ETC (see Fig. 2). The current version of VIMOS ETC includes also image simulation for both pointlike and extended sources, as shown in the example. Each MOS observation requires an Imaging exposure to be carried out before the spectroscopic one.

2. If the proposal is approved, the P2PP will allow the PI to plan the imaging observations.

3. The Imaging Observation must be performed not earlier than 4 weeks and not later than few days before spectroscopy.

4. When an observation is scheduled, BOB receives from the Observation Blocks Repository the appropriate Observations Block, breaks it down into the constituent templates.

5. OS uses the templates to issue setup parameters to ICS, TCS and DCS. When

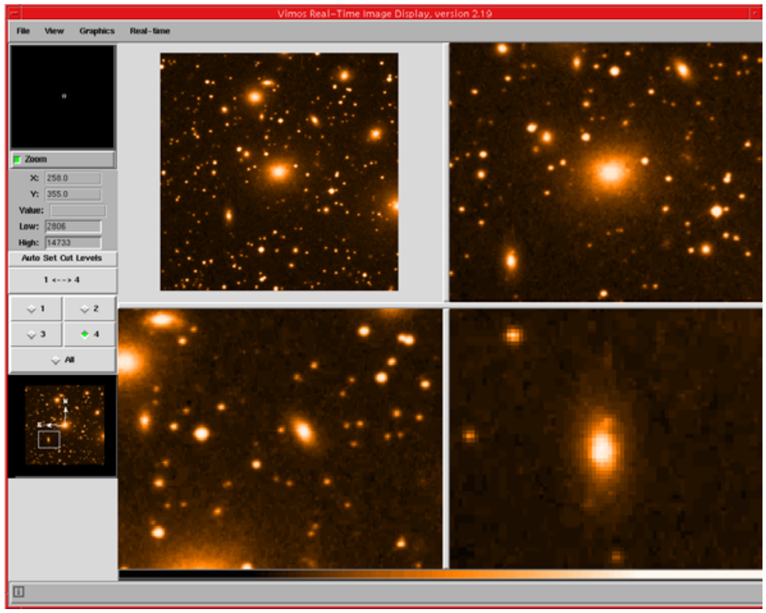

Fig. 3. Example of the four VIMOS quadrants displayed with the Real Time Display

OS receives acknowledge from them, it starts the observation.

6. When integration has finished, DCS will write data onto IWS hard disk. OS will complete FITS header with its own parameters and parameters received by TCS and ICS, and the image will be archived in the On Line Archive System (OLAS)

7. On-line data quality assessment is performed by DRS (on line pipelines). The Real Time display allows to get also a visual impression of the Data (Figure 3)

8. Off line data reduction is performed by DRS (off-line pipelines)

9. The user retrieves the reduced image from the archive, together with all data products

10. MPS-P2PP helps the astronomer to choose the objects of which to obtain the spectrum

11. P2PP is run again to prepare the spectroscopic Observation Blocks. The ADF (result of MPS-P2PP) is attached to the appropriate Observation Block by a dedicated function in the P2PP

12. ESO Observation Handling System (OHS) informs MPS-IWS of the necessity of producing a particular mask (2-3 days before observation)

13. MPS-IWS receives the ADFs from DFS, transforms them into a file understand-

able by the MMU and sends the files to the MMCU. When the mask has been manufactured and stored, MHCU informs MPS-IWS. This one passes the information to the Data Flow System, for storage in the Observation Blocks Repository

14. When the Observation Handling System (OHS) prepares the list of observations to be performed, passes this list also to MPS-IWS. This is in charge of communicating to MHCU which masks are to be put into the Instrument Cabinets. OHS also passes to MPS-IWS the list of OBs successfully carried out, so that the corresponding masks can be discarded. When the Instrument Cabinet has been filled, MHCU passes back to MPS-IWS the Instrument Cabinet slot number where a mask is. MPS-IWS passes this information to OHS for storage into the Observation Block Descriptor. MPS-IWS also informs OHS on masks which have been discarded. OHS will take care of flagging the relative OBs.

16. see step 4, 5, 6, 7, 8

4. DEVELOPMENT STATUS

VIMOS is known as a "fast track project", i.e. its design and development span over only 3 years. This has required a considerable effort in terms of manpower and skillness. For what software is concerned, VIMOS software is developed in 4 different institutes of the consortium. Each of these institutes is responsible for a well defined software package (see Table 1) and has developed it in an autonomous way. This approach, required by the short time we had, has forced us to devote some time in interface definitions, in order to avoid unpleasant surprises when the different packages are integrated with each other. As soon as a software module is completed and tested, it is integrated in the package and such package tested with other packages (in simulation mode). Such integration and testing is currently on going, and up to now we have encountered no major problems of interfaces between packages. Final integration and testing together with hardware will be done next summer

Table 1 - List of Institutes

IS subsystem	Institute	Town
MPS	IFCTR	Milan
OPS	IFCTR	Milan
DRS	IFCTR-OABo	Milan-Bologna
OS	IRA	Bologna
ICS	OMP	Toulouse
DTS	OAC	Naples

The final commissioning of VIMOS is foreseen for April 2000, and the instrument should be offered to the astronomical community early summer of year 2000.