FLAMES: a Multiobject Fibre Facility for the VLT

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ABSTRACT

FLAMES is a fibre facility to be installed on the A platform of the VLT Kueyen telescope, which can feed up to three spectrographs with fibres positioned over a corrected 25 arcminutes Field of View. The initial configuration will include connections to the GIRAFFE and to the red arm of the UVES spectrographs, the latter, located on the Nasmyth B platform of the same telescope, is already in operation as a long slit stand alone instrument.[1] The 8 fibres to UVES will give R∼45000 and a large spectral coverage (200 nm), while GIRAFFE will be fed by 132 single fibres (MEDUSA), or by 15 deployable integral field units (IFUs) or by one central large integral unit (ARGUS). GIRAFFE will be equipped with two gratings, giving R=5000-9000 and R=15000-25000 respectively. It will be possible to obtain GIRAFFE and UVES observations simultaneously. Special attention is paid to optimizing night operations and to providing appropriate data reduction.

The instrument is rather complex and it is now in the construction phase; in addition to ESO, its realization has required the collaboration of several institutes grouped in 4 consortia.

Keywords: Optical Fibres, Wide Field Multi Object Spectroscopy, Intermediate and High Resolution Spectroscopy

1. INTRODUCTION

There is a need for wide field, multi object spectroscopy in most applications of modern astrophysics; by coupling wide field, multi object capabilities to state of the art spectrographs and 8 m class telescopes, it is really possible to tackle fundamental problems which could not otherwise be addressed (see e.g.[2]).

FLAMES (Fibre Large Array Multi Element Spectrograph) is a facility which is intended, through the coupling of fibres to several spectrographs, to provide fundamental data for a variety of open topics, ranging from the chemical composition and dynamics of clusters and galactic structures, to the dynamics of intermediate redshift galaxies, to the study of intermediate redshift clusters of galaxies.

In order to achieve such an ambitious project, it has been necessary to develop a rather complex facility, composed of several stand-alone instruments.

In this contribution we describe the whole FLAMES facility, whereas most of its components are presented separately at this conference[1345] . All the components are now in the manufacturing phase and commissioning is expected to begin in the middle of 2001.

Figure 1 shows a picture of Kueyen, which summarizes some of the FLAMES components and characteristics.

The light is sent to the Nasmyth A focus, where a 90 cm *Field Corrector* provides an excellent image quality and concentric exit pupil to a slightly curved focal plane.

Then a four plates *Fibre Positioner* places the magnetic buttons attached at the end of the fibres on the plates. The *Fibre System* connects two of the plates to the *GIRAFFE* and to the red arm of the *UVES* spectrographs. Provision is made for feeding a *Third Spectrograph*, still to be defined by using the two positioner plates still available. Obviously such a complex system needs a rather sophisticated central control, capable of interacting with the VLT environment and software and of coordinating all activities. This is the *FLAMES Observing Software (OS).*

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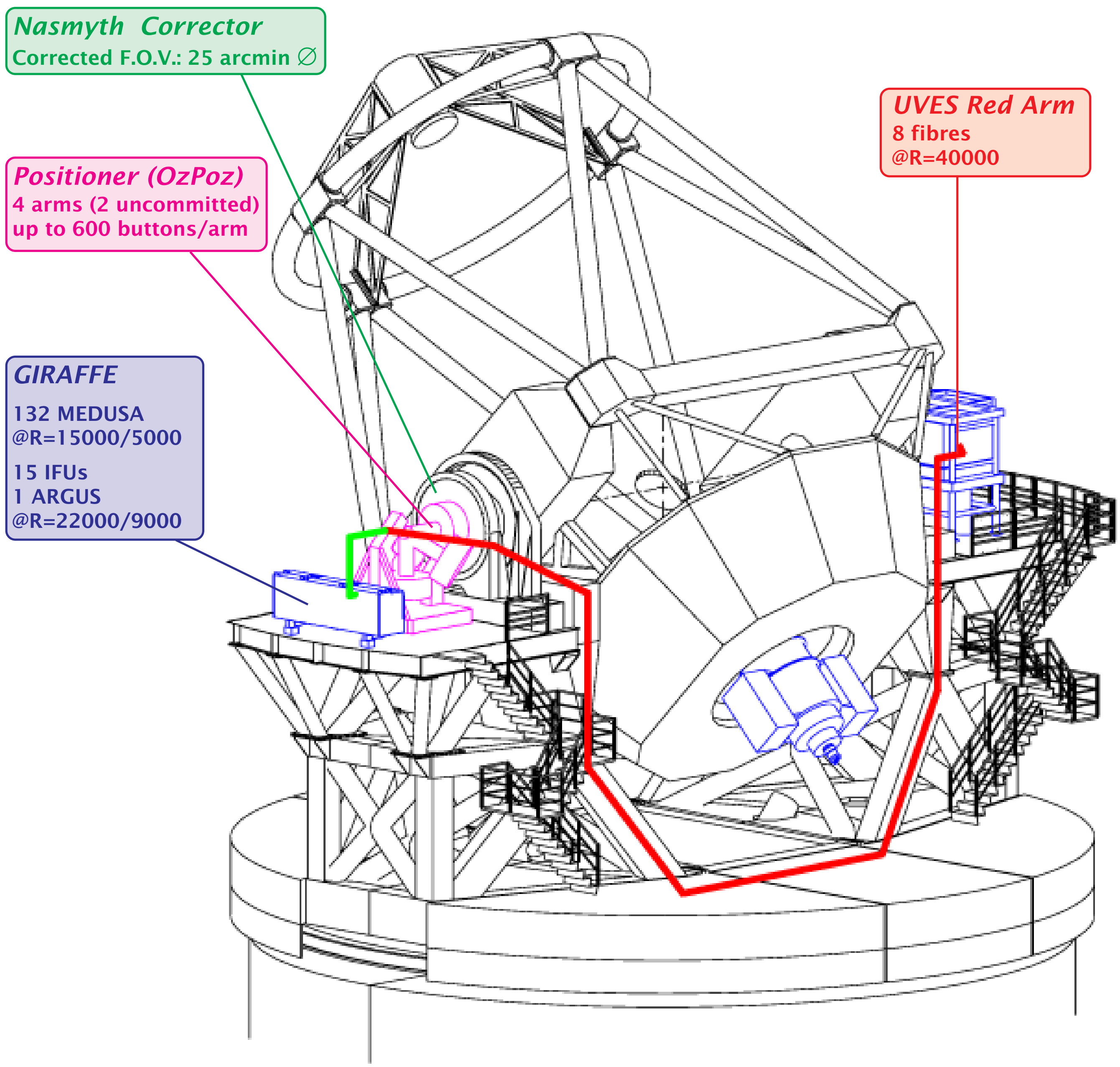

Figure 1. Scheme of FLAMES on Kueyen: all FLAMES components are indicated

When planning such a facility, which is intended to produce thousands of spectra every night, considerable efforts has to be taken in optimizing its *Operations* and in providing the users with a robust *Data Reduction Software* and *Pipeline*.

For its complexity, such a project has no precedent within the VLT instrumentation, and in order to complete it, ESO has developed a number of collaborations with consortia all over the world. The project is also not trivial in terms of *Interfaces*.

The breakdown of the different institutes participating in the FLAMES project can be summarized according to the following scheme:

FLAMES System Engineering and Interfaces: ESO

Field Corrector : ESO

Fibre Positioner: Australis Consortium (AAO and Mount Stromlo)

FLAMES OS and Operations: ESO

GIRAFFE Spectrograph: ESO, Observatoire de Paris-Meudon

Fibre System (including Fibres to UVES): Observatoire de Paris-Meudon

Link to UVES: ESO

UVES OS and DRS: FLAMES-ITAL Consortium (Bologna, Cagliari, Palermo, Trieste)

GIRAFFE DRS: OGL Consortium (Genève and Lausanne)

Figure 2 shows a top view of the Nasmyth A platform disposition: the large VLT platform is filled by the Positioner, GIRAFFE and their Control Electronic Racks. The possible third spectrograph could be hosted either below the A platform, or in the Coudé platform.

2. FIELD CORRECTOR

The field corrector will allow the exploitation of the full 25 arcminutes diameter field of view of the Nasmyth focus of the VLT. It is formed by two large lenses, the first with a flat surface, the second with the surfaces having the same radius, in order to make the manufacturing acceptable and to limit the costs. The lens material selected is equivalent to BK7, and the present baseline foresees a single layer MgF_2 coating, guaranteeing a very good transmission over the whole 370-1400 nm range.

As mentioned above, the corrector has three main purposes: to improve the field aberrations, to reduce the field curvature and to provide a concentric exit pupil to the field curvature. The actual design fulfills very well these requirements, providing an image quality of better than 0.15 arcecsonds (80 % geometric energy) over the whole field of view on a radius of curvature of 4000 mm, and providing a lateral shift of the pupil of less than 3% of the pupil diameter except for the most Blue wavelengths (370 nm), where it reaches up to 6.5% at the edge of the field.

The corrector is mounted on a mechanical structure which will serve both to attach it to the Nasmyth adapter and to support the positioner plate during observations; the corrector, with its mechanical mounting is shown in Figure 4. Provision has also been made in the mechanical structure to allow easy access to the interior of the Nasmyth adapter. The VLT Guide arm will be placed in front of the corrector, and the corrector design has been optimized to allow the proper focusing and guiding on the guide arm.

The contract for the manufacturing of the corrector optics has been placed and the construction of the mechanical supports is at the stage of the final manufacturing drawings. The corrector is expected to be available at the end of 2000 and it will be commissioned separately from the rest of the facility at the beginning of 2001.

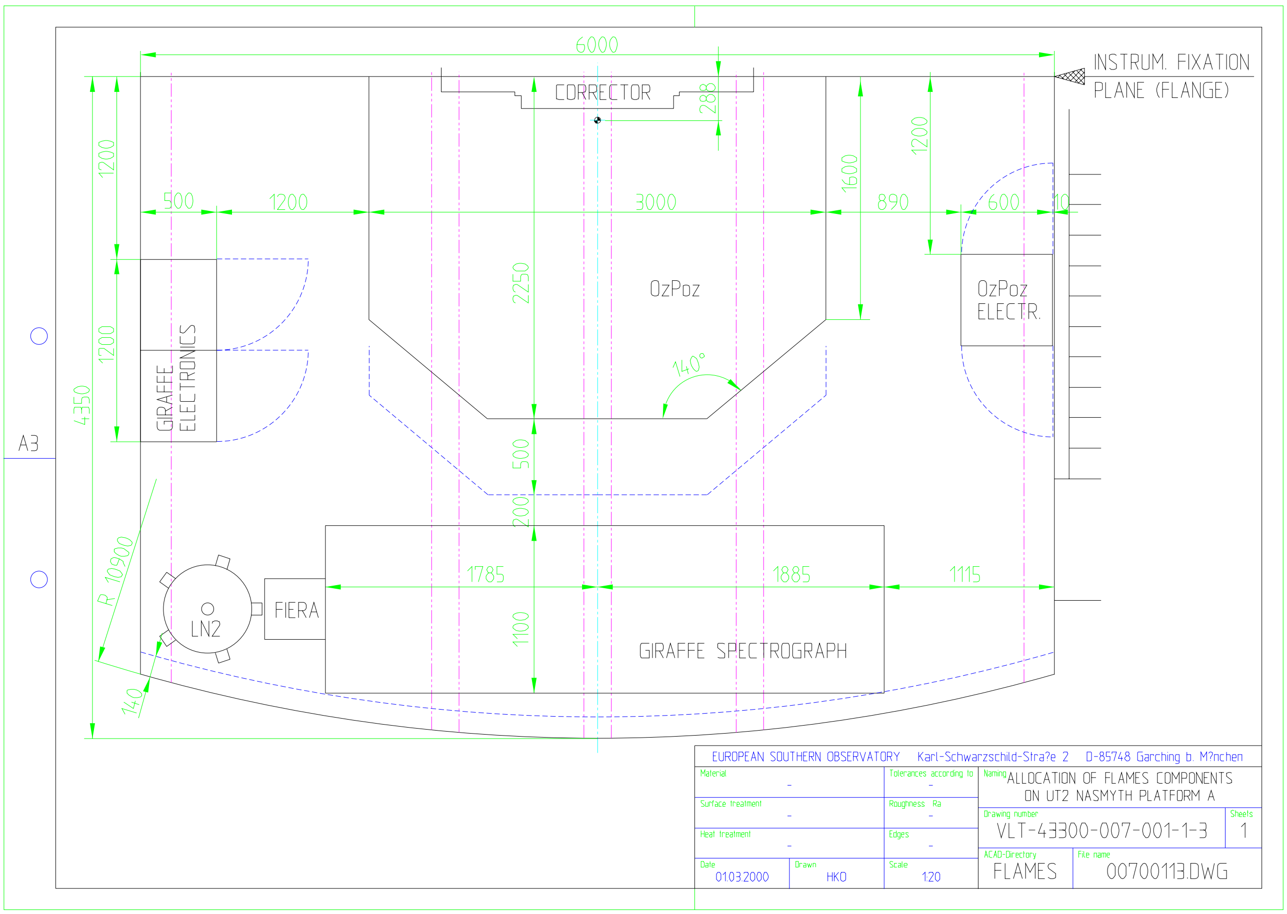

Figure 2. Space allocation on the Nasmyth platform A of Kueyen: provision is made to retract the positioner and its enclosure by 50 cm to facilitate maintenance operations

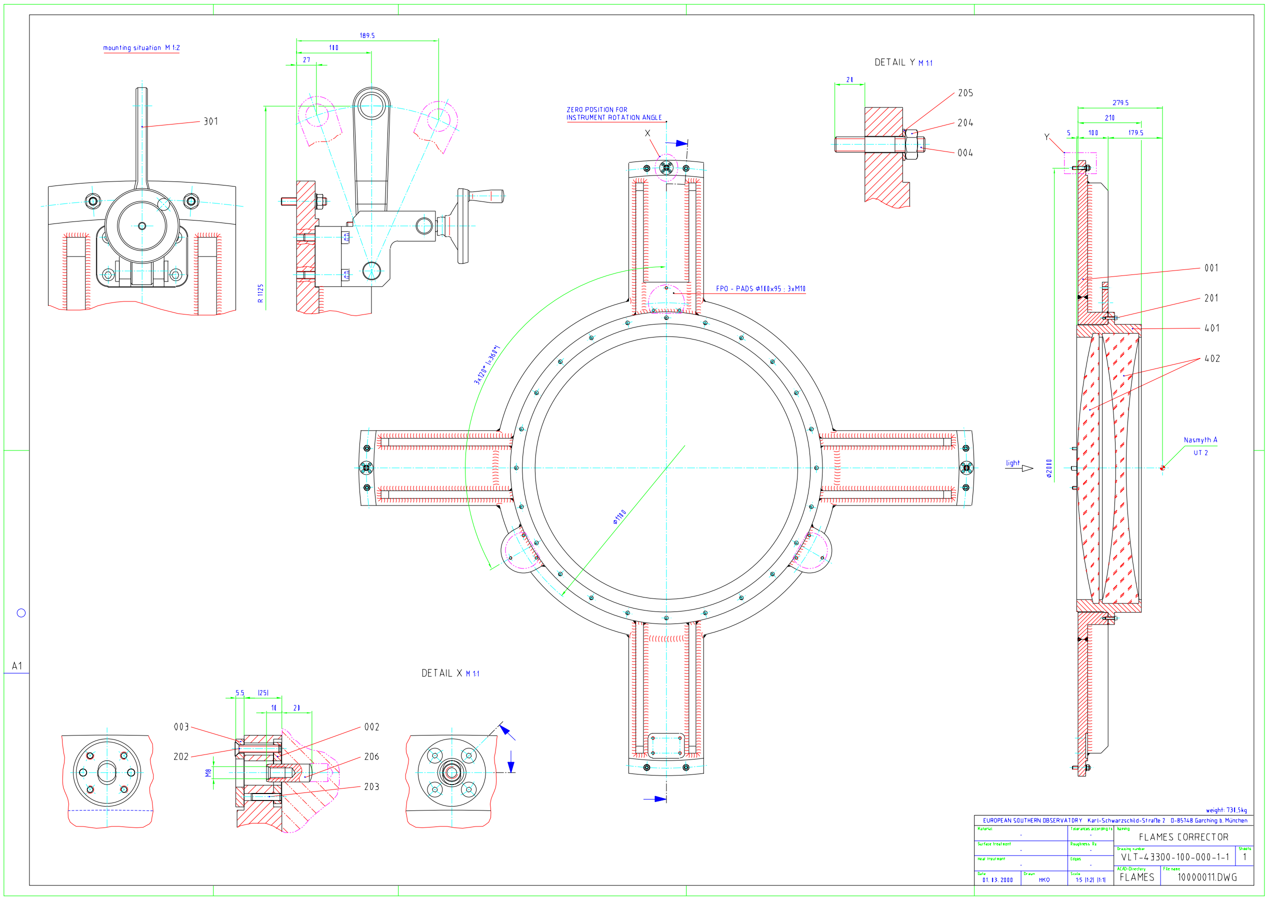

Figure 3. Mechanical support of the FLAMES corrector

3. POSITIONER (OZ POZ)

The positioner (dubbed Oz Poz) is fully described in a separate contribution to this conference,[3] therefore here only the relevant characteristics are summarized.

The positioner is based on the successful concept developed for 2dF at AAO: while one plate is observing the other is positioning the fibres for the subsequent observations. The dead time between one observation and the next will be therefore limited to less than 5 minutes, guaranteeing a very good night duty cycle.

Oz Poz is able to host up to four plates, of which only two are used in the present FLAMES configuration. Each of the two plates will feed the GIRAFFE and the red arm of the UVES spectrographs. Another new feature will be that the two spectrographs can also be used simultaneously.

Plate one will therefore host 132 GIRAFFE MEDUSA buttons, 30 (15 sky plus 15 objects) Giraffe IFU buttons and 8 UVES buttons. Plate two will host the same buttons plus a central GIRAFFE Argus facility and 15 Argus-sky buttons. To these, several buttons for centering and maintenance purposes will be added.

The minimum object separation will be of 10.5 arcseconds, limited entirely by the size of the magnetic buttons.

Oz Poz will be able to position the fibres with an accuracy of better than 0.1 arcseconds; it will be provided with its own Observing Software and control electronics, as well as the necessary observations preparation tools, to allow the preparation of the observations by the astronomers in the Phase 2 Proposal Preparation.

In addition Oz Poz will be equipped with its own calibration system. Very accurate calibrations will be obtained by rastering the fibre buttons with an R-θ arm, and repeating this procedure many times. The calibrations so obtained are the only ones planned on a regular (daily) basis.

4. FIBRE SYSTEM

The FLAMES fibre system is also extensively explained in a separate contribution.[4]

The fibre system includes the magnetic buttons, with the coupling optics, the fibres, and the slit units.

Each plate is equipped with 132 MEDUSA fibres: each fibre has a microlens with an aperture of 1.2 arcseconds on the sky which convert the f/15 Nasmyth beam to the F/5 GIRAFFE aperture; then the light is diverted to the fibre and finally the fibres are arranged on the exit slit. MEDUSA mode is intended for point-like objects, making maximum use of the multiplexing of the facility. A schematic representation of the MEDUSA link for GIRAFFE is given in Figure4. As GIRAFFE is equipped with a single 2X4 K detector, a compromise has been necessary in order to maintain a high multiplex while still keeping negligible fibre-to-fibre contamination: a separation of 2.3 fibre cores on the detector has been adopted, which should ensure a cross contamination of less than 0.5% among adjacent fibres.

A similar system is implemented for the 8 fibres feeding the UVES red arm, with the difference that the microlenses will convert the telescope beam at F/3 instead of f/5 and that the aperture on the sky will only be of 1 arcsecond.

For several applications, however, more extended apertures are required, still keeping some spatial resolution and a high spectral resolving power. For this purpose, the GIRAFFE fibre system includes 15 deployable Integral Field Units (IFUs). These units have at the entrance an array of 20 square microlenses disposed on a rectangular grid. Each microlens has an aperture of 0.52 arcseconds on the side for a total sky coverage of 2x3 arcseconds per IFU. In addition 15 Sky IFUs will be available: they will be similar to the object IFUs, with the difference that only the central fibre will be present. In order to arrange the 315 spectra on the detector, a smaller separation (1.43 fibre core) has been planned. This separation will indeed produce a contamination of several percent between the fibres, but for the IFUs such a contamination is considered acceptable, since contamination will be already present at the fibre entrance.

Finally, a big central unit (GIRAFFE Argus) will also be present. Argus will be fixed at the center of the positioner plate, and it will host an array of 14 by 22 microlenses, identical to those used for the IFUs. With two possible magnification factors, an aperture of 11.5×7.3 or 6.6×4.2 arcseconds can be obtained, and an atmospheric dispersion corrector will maintain the spatial correspondence with the microlenses. The slit geometry will be the same as for the IFUs.

It is worth noting a few points which make the fibre system of FLAMES rather unique:

1. Simultaneous calibration: 5 GIRAFFE fibres in each GIRAFFE mode do not come from the positioner, but they are fed by a separate calibration unit. These 5 simultaneous fibres are used in every exposure. These fibres will allow two important improvements: they will allow to monitor all shifts and to check the quality of the observations, as well as to have very accurate wavelength calibrations, as recorded during the observations. Coupled with a proper disposition of these fibres along the slit, given the high resolving power of GIRAFFE and given the high instrument stability, the use of the five simultaneous calibration fibres will greatly facilitate the sky correction, and will allow rather accurate radial velocity measurements (150 m/sec).

   Note that also when UVES is used in fibre mode an additional fibre is available, to be devoted to simultaneous calibration, if required.

2. Fibre stability: in order to have a proper sky subtraction and to limit the number of calibrations, the requirements on the photometric stability of the FLAMES fibre system are rather high; the tests performed so far confirm very good performances, with variations below 2% (peak to peak) when moving the fibres and the buttons.

3. Spatial filters: in the whole design spatial filters have been minimized, and, in particular, no slits or microlenses are present at the fibre exit: the GIRAFFE fibres do not have any re-imaging system. The same is true for the UVES fibres, where the F/11 UVES beam is matched by using a focal enlarger, a system which has proven very effective in the case of the similar FEROS design.[10]

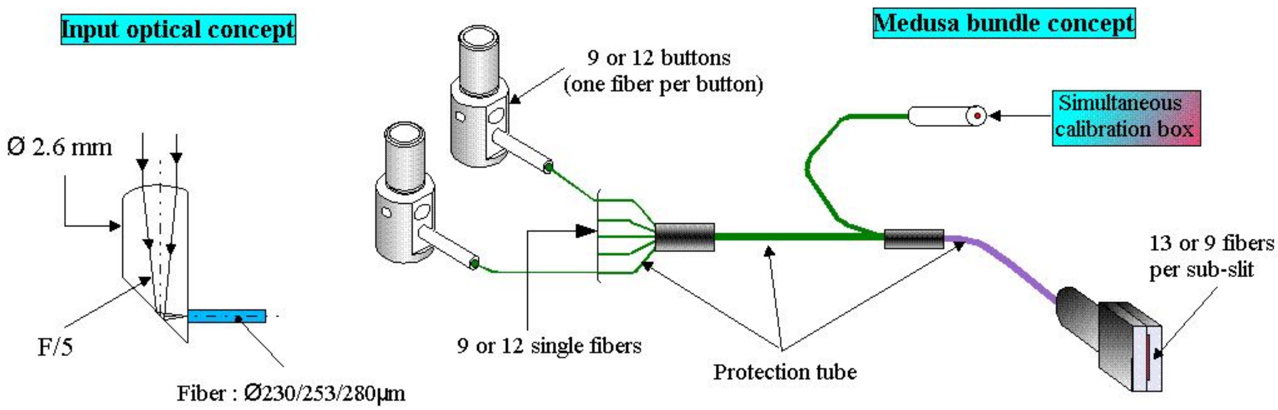

Figure 4. Schematic representation of the GIRAFFE fibre system

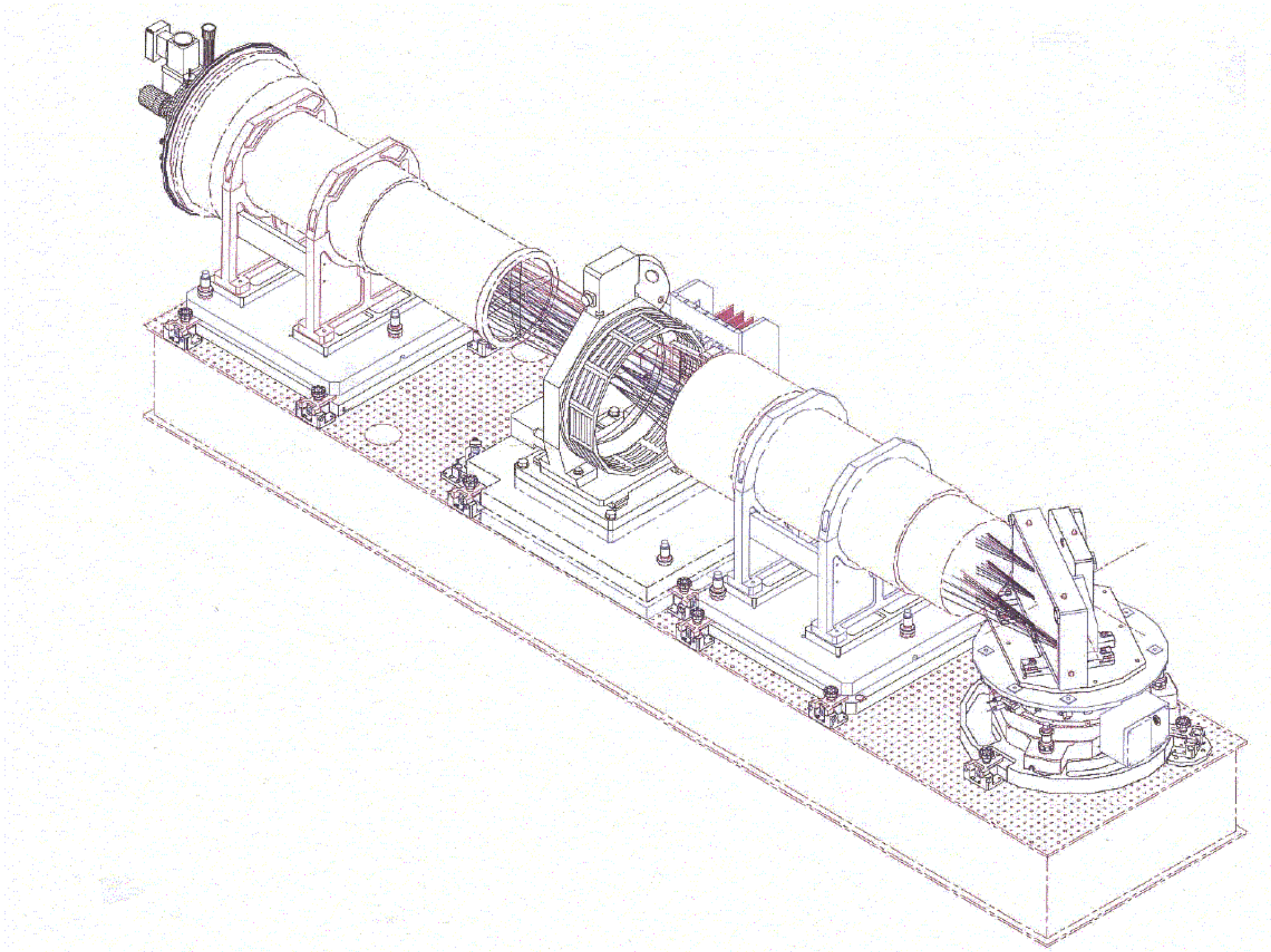

Figure 5. Optomechanical drawing of the GIRAFFE spectrograph

5. GIRAFFE

While the UVES spectrograph is a stand alone instrument which can be retrofitted with fibres,[1] the GIRAFFE spectrograph has been designed for its use with FLAMES and GIRAFFE will likely be the workhorse of FLAMES.

GIRAFFE (the name comes from the first design, where the spectrograph was supposed to stay vertical on the platform) is a medium-high resolution spectrograph, equipped with two gratings which uses filters to select the required spectral range. Each object can be only observed in a (fraction of) an order at once.

One drawing of the spectrograph with its mechanical mounting is given in Figure 5.

The light coming from one of the 6 available slits (2 MEDUSA slits (1 per positioner plate), 2 IFU slits, 1 Argus slit and 1 Long Slit for maintenance purposes) passes through the order sorting filter, is reflected into a double pass collimator, goes to the grating and, after an intermediate spectrum is formed, it is finally re-imaged on the 2K×4K 15 micron pixel detector. The spectrograph aperture is F/5 and the beam is 18 cm. 1.2 arcecsonds on the sky will correspond to 6 detector pixels, and different wavelengths are obtained by scanning the grating along its rotation axis.

One of the critical, non trivial tasks in Giraffe has been the optimization of the coupling between the gratings and the order sorting filters, also when considering that the fast track of the project does not leave much room for new grating ruling and when considering that in aiming at quantitative spectroscopy we imposed tight constraints on the contamination from 'unwanted' orders and on the global instrument efficiency.

Table 1. 316 lines/mm, 63.5 blaze grating. Pos is the setup number; θ the exit angle; Ord. the working echelle order; Wl1,3,5 the wavelengths at the edges and center of the CCD; Band is the covered spectral bandpass; R1 and R2 the resolving power obtained in IFU-Argus and MEDUSA mode respectively.

Pos	θ	Ord	Wl1	Wl3	Wl5	Band	R1	R2
1	61.1	15	370.	379.	386.7	16.7	29700	18000
2	58.2	14	385.4	395.8	404.9	19.5	25900	15800
3	63.	14	403.3	412.4	420.1	16.8	32700	19900
4	59.1	13	418.8	429.7	439.3	20.5	27000	16400
5	63.9	13	437.6	447.1	455.2	17.6	34300	20900
6	59.1	12	453.8	465.6	475.9	22.2	27000	16400
7	63.9	12	474.2	484.5	493.2	19.	34400	20900
8	58.5	11	491.7	504.8	516.3	24.6	26200	15900
9	63.2	11	514.3	525.8	535.6	21.2	33100	20200
10	57.3	10	533.9	548.8	561.9	28.	24800	15100
11	62.	10	559.7	572.8	621.8	24.3	31000	18900
12	55.6	9	582.1	599.3	614.6	32.6	23000	14000
13	60.3	9	612.	627.3	640.6	28.6	28500	17400
14	65.1	9	638.3	651.5	662.6	24.3	36700	22400
15	56.3	8	660.6	679.7	696.5	35.9	23800	14500
16	61.1	8	693.7	710.5	725.	31.4	29600	18000
17	65.9	8	722.5	737.	749.	26.5	38500	23400
18	55.4	7	746.9	769.1	788.9	42.	22900	13900
19	60.1	7	785.6	805.3	822.5	36.9	28300	17200
20	64.9	7	819.5	836.6	850.9	31.4	36400	22100
21	53.2	6	848.4	875.7	900.1	51.7	20900	12700

Table 2. 600 lines/mm, 34 blaze grating. For the column captions, see Table 1

Pos	θ	Ord	Wl1	Wl3	Wl5	Band	R1	R2
1	33.2	5	370.	393.5	415.7	45.7	9800	6000
2	29.1	4	411.6	442.1	471.2	59.7	8300	5100
3	33.5	4	465.9	495.1	522.8	56.9	9900	6000
4	27.2	3	517.7	559.	598.6	80.9	7700	4700
5	31.7	3	591.3	631.	668.8	77.5	9200	5600
6	36.1	3	661.8	699.7	735.3	73.5	10900	6600
7	25.4	2	728.7	791.6	852.	123.	7200	4400
8	29.8	2	840.9	901.6	959.4	118.	8600	5200

Finally, two gratings have been chosen: the high resolution one is a 316 lines/mm 63.5 degrees blaze (existing master) while for the low resolution one: 600 lines/mm, 34 degrees blaze a new ruling is required. With 29 setups it will be possible to cover the whole 370-900 nm range at high and low resolution. Tables 1 and 2 summarizes the available setups, and the resolving power obtained with the two gratings in MEDUSA and ARGUS-IFUs modes.

In order to minimize the spectrum contamination and to maintain a high efficiency, special filters with very steep edges (in particular for the blue setups), high rejection factors (better than 10^{-4}) and high transmission (70-80 %) have been ordered.

When considering all components (including telescope reflectivity, corrector, fibres and the whole GIRAFFE), the overall peak efficiency of the instrument is expected to range from 7% in B, to 9% in V and R, to 4.5% in the reddest orders. The drop in the red is almost entirely induced by the detector QE response.

Since FLAMES operations foresee that calibrations should be acquired either in the afternoon preceding the observations or in the following morning, the requirements on the GIRAFFE stability and repositioning are quite strict.

The control electronics is developed by ESO and it will make the maximum use of the components already developed for the UVES spectrograph[1] to streamline maintenance operations. The assembling of the electronics components has already started at ESO Garching.

6. FIBRE LINK TO UVES

UVES is the high resolution spectrograph of the VLT, located at the B Nasmyth platform of Kueyen; UVES has been designed for working in long slit mode but, thanks to a rather small modification it is possible to add a fibre mode on its red arm, which was not foreseen in the original design.[1]

Each positioner plate will therefore have 8 fibres connected to the Red arm of UVES. Each fibre will be 40 meters long.

With an aperture on the sky of 1 arcsecond, the fibres will project on 5 UVES pixels giving a resolving power of ~45000. Three standard UVES setups will be offered. It has been possible to insert this new function in UVES with small modifications: the fibres are injected just before the slit through a projector, which changes the F/3 fibre exit to the F/10 UVES aperture. All the 16 fibres coming from the two positioner plates are mounted on two parallel arrays in a single slit.

In addition to the 8 fibres per plate, an additional fibre will be available. This fibre is fed by a separate calibration unit and it is meant to be used for simultaneous calibration to obtain very accurate radial velocities with UVES with the method pioneered by the Geneva group ([7]). Due to the large, but still limited UVES interorder separation, when this simultaneous calibration fibre is used, only 7 fibres can be devoted to astronomical objects, i.e. the multiplex capabilities are reduced.

For faint objects one or more fibres can be devoted to recording the sky contribution. One of the most attractive aspects is that within FLAMES UVES can be simultaneously used with GIRAFFE, and the exposure times for the two spectrographs do not need to be the same. Given the higher resolution and the large spectral coverage (200 nm) provided by UVES, we expect that several programs will benefit from these combined observations.

One advantage of having a real instrument, UVES, already in operation is that we can move from the somewhat virtual world of simulations to that of field tests; to this purpose a fibre head prototype has been produced and the first fibre test frames have been obtained with UVES: a small portion of a UVES Red CCD frame, centered at 580 nm is shown in Figure 6. In this Figure, several orders are displayed: seven of the fibres were fed by the day sky spectrum, while the eight fibre is fed with a Th-A lamp. The preliminary analysis of the data so far confirms the simulation results: the crosstalk among the fibres will be limited to ~1% of the adjacent fibres flux.

7. OPERATIONS

Operations of FLAMES are by no means trivial. The basic philosophy, which has driven the design of some components of GIRAFFE and of the calibration unit of the Positioner, is that calibrations are acquired in the afternoon preceding or in the morning subsequent to the observations, therefore without losing precious observing time.

This approach, which is the only acceptable one at the VLT, has contributed to stringent requirements on GIRAFFE, such as those on shifts and repeatability of setups within a fraction of a pixel, and to the novel concept of the GIRAFFE simultaneous wavelength calibration with 5 fibres, but also to some restrictions on the possible use of the instrument. For instance, only the fixed GIRAFFE set ups of Table 1 and 2 are offered, without the possibility of customizing the spectral range for the specific observer purpose. Also, in order to have a sustainable calibration time, the number of possible setups used every night will likely be limited. On the other hand we plan to take the maximum advantage from having fixed setups: since we are dealing with 29 (GIRAFFE) and 3 UVES fixed setups, we intend to create a library of standard calibration templates, which has not to be defined by the user, but they are automatically selected depending on the observations (to be) executed. Obviously the best handling of operations will be optimized with experience. The starting philosophy is a rather strict approach, where the observations are defined at Phase 2 Proposal Preparation and not modified in the course of the following process. Such an approach, of course, relies on the reliability of the whole system, from the corrector to the detectors, including the complex fibre system. A full set of observing templates has been defined and will soon be implemented.

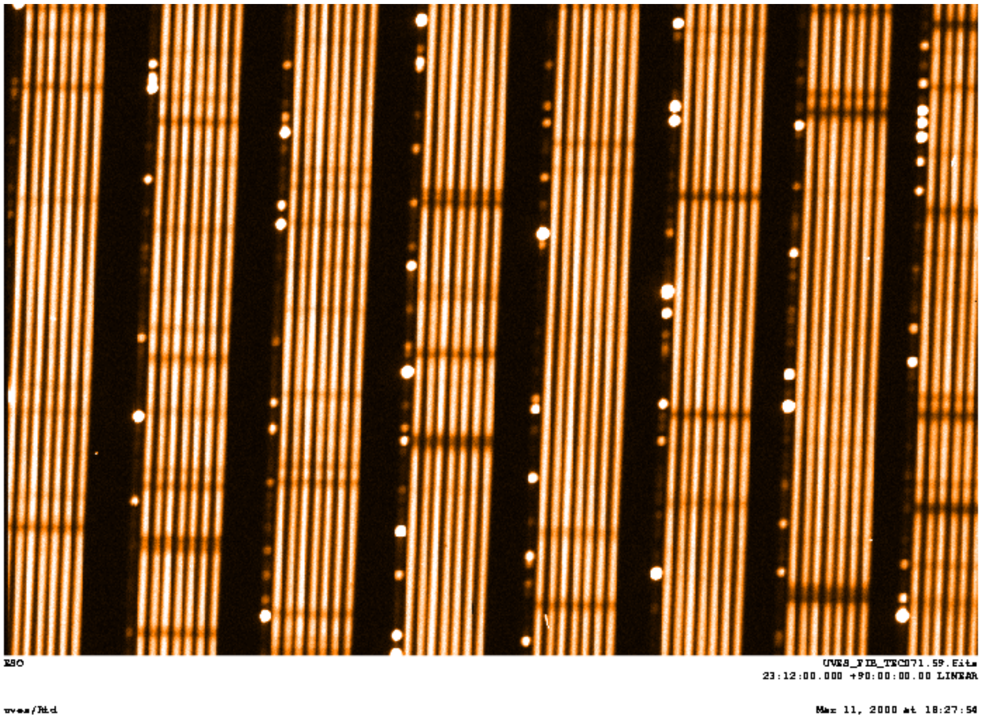

Figure 6. Spectrum of UVES in fibre mode taken with a test fibre set: 7 fibres are fed by day sky light and one by a Th-A lamp

8. INTERFACES

The managing of interfaces in FLAMES is a hard and complex task. Interfaces are present with the VLT telescope and environment, among the different FLAMES components, at the hardware, software and human level; in addition, the building consortia are split among 6 countries on 3 continents (without including sub-contractors!).

In this respect the presence of good communication tools and of well established standards are key issues, but perhaps the most important component has been the will to succeed of all participants.

By its own nature, FLAMES has posed some very specific challenges; for instance a vital operation requirement, like the possibility of configuring one positioner plate while observing with the other, has required a modification of the present VLT control software, in order to enable it to handle two Observing Blocks simultaneously.

Hardware interfaces include 'standard' interfaces as the splitting of the space and weight on the Nasmyth platform, the magnetic button design, and the whole fibre design and routing, but also more complex ones, like the management of the fibre 'back-illumination' system required by Oz Poz for precise positioning of the fibres.[3] This back-illumination is powered and controlled by Oz Poz, but it has to be on the other hand physically located on the spectrographs fibre exit.

9. ASTRONOMICAL PERFORMANCES

The three key aspects of FLAMES are multiplexing, spectral resolution and large field of view. Of course, in order to make use of the potential of the VLT telescope, efficiency is also a key word.

UVES is an extremely efficient spectrograph, in particular when considering the resolving power attainable and the large telescope size. Its performances are given in[6] and will not be repeated here. With the FLAMES fibre system the global efficiency in the red arm will be slightly higher than 50% of the present value obtained in long slit mode, and therefore an increase of almost a factor 2 in the integration times computed for UVES in[1] and[6] must be accounted for. On the other hand the 8 fibres will allow an increase of multiplexing of almost 4 times, and perhaps

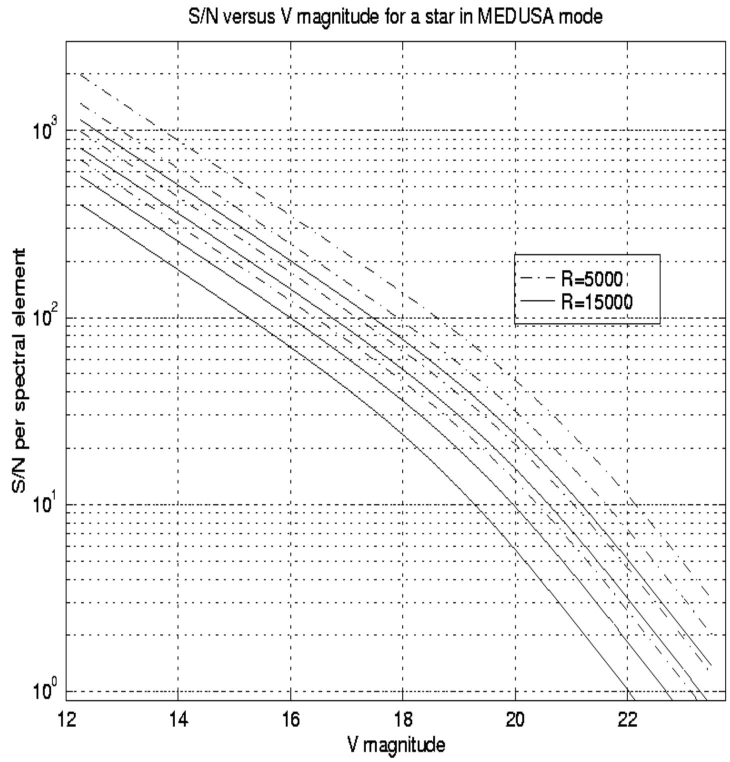

Figure 7. Signal to noise ratio attainable with FLAMES and GIRAFFE in MEDUSA mode. Continuous curves refers to the high resolution mode, dashed curves to the low resolution mode. The curves are for integration times of 15, 30, 60 and 120 minutes respectively

what is most important, this increase in multiplexing will allow to perform several programs which would otherwise not be feasible in practice, given the high competition level present at large telescopes and at the VLT in particular.

As far as GIRAFFE is concerned, when considering fibre entrance losses, instrument efficiency, a statistical Dec entering star to fibre of 0.2 arcseconds, a VLT seeing of 0.8 arcseconds and a systematic effect of 1% given by imperfect sky correction, the expected performances are given in Figure 7 for the MEDUSA case in high and low resolution modes. It can be seen that it will be possible to obtain a S/N ratio of 10 at V=20.5 in 1 hour exposure.

We would like to emphasize that we expect to have a very good control of the typical parameters affecting sky subtraction. The fibre stability in our configuration seems extremely good.[4] The spectrograph is very stable, and we can recover a very accurate wavelength solution for each observation and fibre. The resolving power is high enough to ensure, even in the GIRAFFE low resolution mode, a very good separation of the sky lines. Finally the possibility of posing the sky fibres in optimal positions on the field of view and their relatively high number, will ensure that the sky determination should not be affected by local fluctuations.

One relevant point which must always be stressed is that FLAMES will require special care in the observation preparation and in the data reduction by the users. Astrometry at better than 0.2 arcseconds on a relative scale is required in order to obtain the best instrument performances. In addition a careful selection of the objects several months in advance of the observations is also required. In order to facilitate this preparatory work, ESO has embarked on a photometric and astrometric survey with the ESO-MPI 2.2.m telescope and WFI[9] with the aim of producing not only the raw data, but also stellar catalogues in a large number of interesting stellar regions.

As far as post observations is concerned, that is the data reduction, this also is of some concern, since FLAMES is expected to produce up to 1 million high and intermediate resolution spectra in 10 years of planned lifetime. Of course an efficient tool for handling the data is necessary. For this purpose contracts have been awarded to the OGL consortium[5] and to the FLAMES-ITAL consortium to develop the Data Reduction Software for GIRAFFE and UVES in fibre mode. This SW is expected to be delivered at the beginning of 2001, and to be used in the laboratory tests and in commissioning. The Data Reduction Software (DRS) will be integrated into the ESO pipeline[8] but will also be delivered in form of a separate package for the data reduction at the visitor's home institution. The first simulations show that both DRS can be rather fast and can ensure in a few minutes the full reduction of one frame.

However, when dealing with quantitative high and intermediate resolution spectroscopy, data reduction is only the first step to be carried out, and the analysis of the data can be very time consuming. To further support the astronomers in the preliminary steps of their data analysis, the OGL Consortium is planning to deliver as well a Data Analysis Package for GIRAFFE, which will provide, among other things, shift of the spectra to zero wavelength, radial velocity determinations and spectra normalization.

10. STATUS

FLAMES components are at an advanced stage; all the hardware components have passed the Final Design Review and are in the manufacturing phase.

The contract for the corrector optics has been issued, and the mechanics will follow soon.

The positioner critical items are solved, the prototyping of the most critical parts completed and manufacturing has been started.

The whole fibre system is in the manufacturing phase, and the first fibre bundle will be produced by the middle of 2000.

GIRAFFE optics are in the polishing phase, assembly of the electronics has started and the mechanics is under construction. Critical items like gratings and filters have been ordered.

The manufacturing of the UVES link will start in April 2000, and tests were acquired with a prototype bundle.

As far as the software is concerned, the design phase of the whole software is at advanced stage and the Final Design Review is scheduled for July 2000.

The project in its status was approved by ESO governing bodies in April 1998, and commissioning will start in June 2001, i.e. in slightly more than 3 years after formal approval.

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