

WEAVE AN OVERVIEW AND STATUS UPDATE

P. Bonifacio¹, G. Dalton^{2,3}, S. Trager⁴, A. L. Aguerri⁵, E. Carrasco⁶, A. Vallenari⁷, D. C. Abrams⁸, K. Middleton², F. Say de¹ and the WEAVE Instrument Consortium

Abstract. The WHT Enhanced Area Velocity Explorer is a high multiplex, multi-object spectrograph that will equip the prime focus of the WHT 4.2m telescope. The instrument is currently in the construction phase and several components have already been procured. I will give a short overview of the instrument and of the project and its status. The French participation is done through CNRS - Institut National des Sciences de l'Univers and the technical activity is carried out, at this stage, at GEPI, Observatoire de Paris.

Keywords: Instrumentation: spectrographs, Surveys

1 Introduction

The need for a high multiplex spectrograph on a 4m class telescope has been clearly identified in the European strategic Astronet documents (Kauffmann 2005; Drew et al. 2008). The urgency of such a development was driven by the upcoming Gaia mission (Gaia Collaboration 2016), when it became obvious that, as a consequence of budget-driven descoping the Radial Velocity Spectrograph on-board of Gaia (Katz et al. 2004) would have magnitude limits brighter than expected Katz (2009). This of course, notwithstanding the expressed needs of such an instrument also for extragalactic science. The French community was very reactive in looking for a solution and launched on a fast track the study for GYES, a multi-object spectrograph for the prime-focus of the Canada-France-Hawaii Telescope (Bonifacio et al. 2010; Mignot et al. 2010; Bonifacio et al. 2011) that was completed in only ten months. In spite of a very positive report on the phase A study the instrument was not retained for phase B mainly based on what was felt the community interest*. The GYES project allowed to develop to a considerable degree the science case and some technical solutions, like a two-arm spectrograph with Volume Phase Holographic gratings as dispersing media, and a pick-and-place positioner based essentially on off-the-shelf components. This was also the occasion when the teams of GEPI and Oxford began to collaborate. The idea of a multi-object spectrograph for the WHT was presented at the SPIE meeting in San Diego (Balcells et al. 2010), with a strong support from the British, Dutch and Spanish communities. From the French perspective it was thus natural, once the GYES project was stopped, to divert the forces to join the WEAVE project. For the French community it has been very important that we were immediately welcomed in the project, even though France is not a member of the Isaac Newton Group (ING). This same open policy was the basis on which the project was opened to the Italian and Mexican contributions. In the following I will give a technical overview of the instrument and provide an update of its status. I will also provide an update of the French support to the project.

¹ GEPI, Observatoire de Paris, PSL Research University, CNRS, Univ. Paris Diderot, Sorbonne Paris Cit , Place Jules Janssen, 92195 Meudon, France

² RALSpace, STFC Rutherford Appleton Laboratory, OX11 0QX, UK

³ Dept. of Physics, University of Oxford, Keble Road, Oxford, OX1 3RH, UK

⁴ Kapteyn Institut, Rijksuniversiteit Groningen, Postbus 800, NL-9700 AV Groningen, Netherlands

⁵ Instituto de Astrof sica de Canarias, 38200 La Laguna, TF, Spain

⁶ INAOE, Luis Enrique Erro 1, Tonantzintla, Puebla, Mexico

⁷ Osservatorio Astronomico di Padova, INAF, Vicolo Osservatorio 5, 35122, Padova, Italy.

⁸ Isaac Newton Group, 38700 Santa Cruz de La Palma, Spain

*http://www.cfht.hawaii.edu/en/science/SAC/reports/SAC_report_Nov_2010.php

2 Overview of the instrument

The final design of the instrument can be found in Dalton et al. (2016), this supersedes previous designs (Dalton et al. 2012, 2014). The capabilities of the instrument are summarized in Table 1 of Dalton et al. (2016). WEAVE can deploy up to 960 single fibres over a field-of-view of 2° diameter, each fibre has an on-sky aperture of $1.3''$. Alternatively 20 integral-field units of $11'' \times 12''$, with $1.3''$ spaxels can be deployed on the same field. Finally a large integral-field unit with a field of view of $1.3' \times 1.5'$ and $2.6''$ spaxels can be used to study extended objects. Through a slit-exchange mechanism each fibre system can feed the WEAVE spectrograph. To accommodate the large number of fibres we have a single spectrograph with two arms, red and blue, and the light is split by a dichroic at 590 nm. The dispersing elements are Volume Phase Holographic gratings. A pair of gratings provides the low-resolution mode, with a mean resolving power $R \sim 5750$ and a full spectral coverage between 366 nm and 959 nm. The resolving power is not constant over each arm, but ranges between 3000 and 7500, the highest resolving power being attained at the red end of each arm. For stellar studies this is convenient since two very important spectral features, the Mgi b triplet at 518 nm and the CaII at 850 nm will be observed at the red end of the blue and red arms respectively at a resolving power around 7000. The high-resolution mode of WEAVE is obtained by inserting another pair of gratings in the optical path that provide a resolving power of ~ 21000 over two non-contiguous spectral ranges in the red and blue arms. In the blue arm one has a choice between a blue range (404 nm – 465 nm) and a green range (473 nm – 545 nm). In the red arm the range is 595 nm – 685 nm.

The positioner relies on two robots that cooperate to pick-and-place the fibres in such a way that a full plate configuration can be prepared a little less than one hour. Like similar positioners, 2dF (Taylor et al. 1997; Lewis et al. 1998) and OzPoz (Gillingham et al. 2000), WEAVE has two plates, while one is being configured by the robot, the other is observing. The plates are exchanged by tumbling the positioner around an axis orthogonal to the optical axis of the telescope. This optimizes the observation time, however it also fixes the minimum integration time on a given plate, if a full plate configuration is requested on the next plate. WEAVE has been conceived as an instrument for deep surveys so that a 1h total integration on each plate configuration is appropriate. Of course the total integration may be split into several shorter integrations. As long as each integration attains a signal from the targets well above the read-out noise, this strategy is beneficial since it will allow for cosmic-ray removal and avoid saturation of bright targets.

3 Current status

At the time of writing most of the WEAVE subsystems are in the stage of procurement and building. All the large blanks necessary for the prime focus corrector have been acquired. The largest lens, 1.1 m in diameter is fused silica and was created from a blank delivered by Corning to Kiwistar Optics that has started its polishing. Lens 4 has been polished and is now being tested. Lens 3 is close to completion on one surface. The prime focus translation system has been delivered and tested at IAC in June 2016 and will be shipped to La Palma later this year. A very important step has been made in mid-July when the top-end ring of WHT was removed and replaced successfully. This manoeuvre will become routine when WEAVE is to be replaced by another instrument. The fibres for the single objects and small IFUs ($1.3''$) on the sky have been delivered to France and are ready to be integrated into fibre bundles (24 fibres/bundles). The project appears to be on-schedule for a first-light in the first half of 2018.

4 French participation to WEAVE

From the technical point of view the French participation has been carried out at the GEPI and Lagrange laboratories. The scientific participation is much wider and involves most of the INSU laboratories. Lagrange did most of the design of the prime focus corrector in phase A, GEPI is responsible for design and procurement of the fibre systems, in collaboration with the University of Gröningen for the IFUs. The total French effort to the fibre system amounts to 8.3 Full Time Equivalents throughout the project. From the scientific point of view the French community is strongly involved in the Galactic Archeology Survey (Survey Leader V. Hill) and in the QSO survey (Survey leader M. Pieri), and a small involvement exists also in the LOFAR Survey.

From the institutional point of view it is very important that INSU has labelled two national observation services (Actions Nationales pour l'Observation, ANO) related to WEAVE. One for the WEAVE construction (WEAVE-ANO2, responsible P. Bonifacio) and one for the WEAVE survey (WEAVE-ANO4, responsible V.

Hill). This is very important, because, firstly, it allows astronomers of the Conseil National des Astronomes et Physiciens (CNAP) to work on either of the WEAVE aspects having their work recognised as observation service, secondly it opens up the opportunity of recruiting CNAP astronomers to work on WEAVE.

From the funding point of view, at this stage, CNRS and Observatoire de Paris are providing all of the FTEs necessary for the fibre system. The equipment costs are mostly covered by two generous allocations of Région Île de France that funded WEAVE through the 'Domaine d'Intrt Majeur Astrophysique et Conditions pour l'Apparition de la Vie' (DIM-ACAV[†]), for a total of 756 500 euro. A very important contribution has also come from the Région Franche Comté and the remaining from CNRS and Observatoire de Paris. Funding requests to the two latter organisms for 2017 are pending, upon successful outcome of these requests the hardware cost of the fibre systems should be covered.

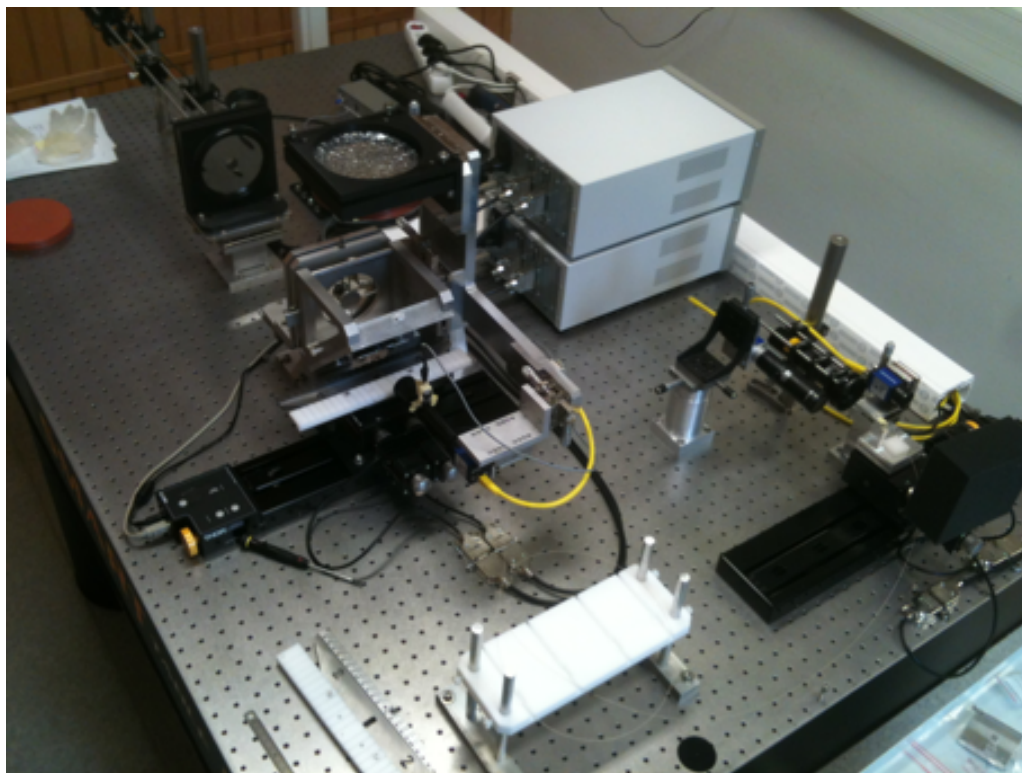


Fig. 1. The optical bench for testing the WEAVE fibres at GEPI.

5 Conclusions

WEAVE is an important opportunity for the French community, it will provide access to observational capabilities that are not otherwise available. It is quite remarkable that the bulk of the funding of the hardware does not come from traditional sources, but rather from regional funds. This is a virtuous example on how regions can boost their scientific potential through moderate, but well aimed, investment in science. In this respect a system like that of the DIMs introduced by Région Île de France appears to be extremely effective. It would certainly be positive if other French Regions would put in place similar structures.

The WEAVE project is proceeding as planned, all the subsystems are making considerable project. There are very exciting times ahead of us!

The French participation to WEAVE is coordinated by CNRS Institut National de Sciences de l'Univers (INSU) with the support of the Programme National de Cosmologie et Galaxies. We acknowledge funding from Région Île de France, through DIM-ACAV, Région Franche Comté through the institute UTINAM, INSU, and Observatoire de Paris.

[†]<https://dimacav.obspm.fr/>

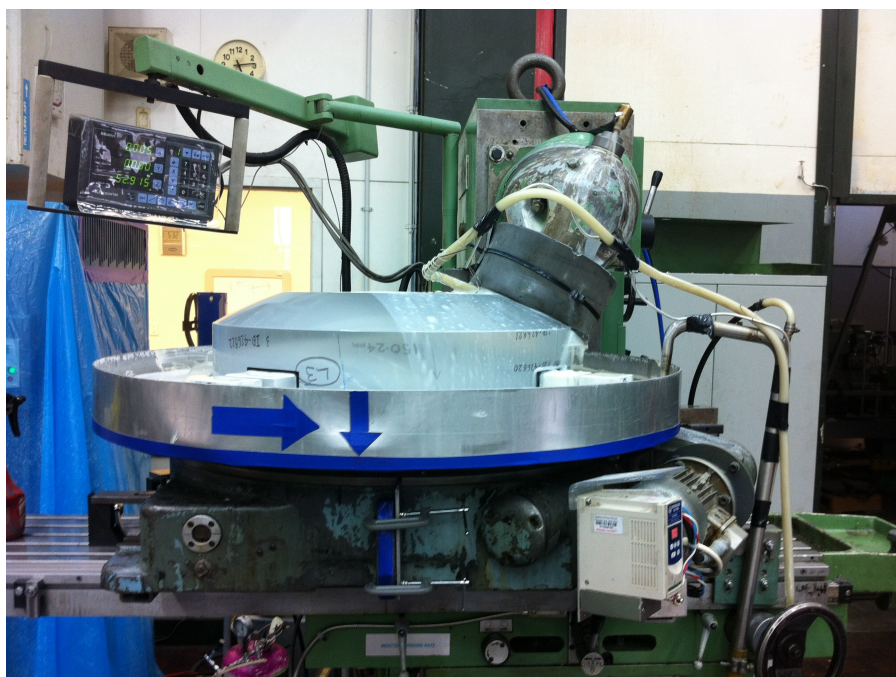


Fig. 2. Lens L3 of the prime focus corrector being polished at Kiwistar optics.

References

- Balcells, M., Benn, C. R., Carter, D., et al. 2010, in Proc. SPIE, Vol. 7735, Ground-based and Airborne Instrumentation for Astronomy III, 77357G
- Bonifacio, P., Arenou, F., Babusiaux, C., et al. 2010, in Proc. SPIE, Vol. 7735, Ground-based and Airborne Instrumentation for Astronomy III, 77350E–77350E–9
- Bonifacio, P., Mignot, S., Dournaux, J.-L., et al. 2011, in EAS Publications Series, Vol. 45, EAS Publications Series, 219–222
- Dalton, G., Trager, S., Abrams, D. C., et al. 2016, in Proc. SPIE, Vol. 9908, Ground-based and Airborne Instrumentation for Astronomy VI, 9908–53
- Dalton, G., Trager, S., Abrams, D. C., et al. 2014, in Proc. SPIE, Vol. 9147, Ground-based and Airborne Instrumentation for Astronomy V, 91470L
- Dalton, G., Trager, S. C., Abrams, D. C., et al. 2012, in Proc. SPIE, Vol. 8446, Ground-based and Airborne Instrumentation for Astronomy IV, 84460P
- Drew, J., Bergeron, J., Bouvier, J., et al. 2008, Report by the European Telescope Strategic Review Committee on Europe's 2-4m telescopes over the decade to 2020, Tech. rep., ASTRONET
- Gaia Collaboration. 2016, A& A in press, ArXiv e-prints
- Gillingham, P. R., Miziarski, S., & Klauser, U. 2000, in Proc. SPIE, Vol. 4008, Optical and IR Telescope Instrumentation and Detectors, ed. M. Iye & A. F. Moorwood, 914–921
- Katz, D. 2009, in SF2A-2009: Proceedings of the Annual meeting of the French Society of Astronomy and Astrophysics, ed. M. Heydari-Malayeri, C. Reyl'E, & R. Samadi, 57
- Katz, D., Munari, U., Cropper, M., et al. 2004, MNRAS, 354, 1223
- Kauffmann, G. 2005, Report on a wide field, highly multiplexed spectrograph, Tech. rep., ASTRONET
- Lewis, I. J., Glazebrook, K., & Taylor, K. 1998, in Proc. SPIE, Vol. 3355, Optical Astronomical Instrumentation, ed. S. D'Odorico, 828–833
- Mignot, S., Cohen, M., Dalton, G., et al. 2010, in Proc. SPIE, Vol. 7735, Ground-based and Airborne Instrumentation for Astronomy III, 77354H
- Taylor, K., Cannon, R. D., & Watson, F. G. 1997, in Proc. SPIE, Vol. 2871, Optical Telescopes of Today and Tomorrow, ed. A. L. Ardeberg, 145–149