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WSO–UV: the space telescope for ultraviolet astronomy in 2014–2024

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Abstract

The World Space Observatory UltraViolet (WSO–UV) project is a multipurpose international space observatory. The 170 cm aperture of the telescope, the efficiency of the instruments and the geosynchronous orbit makes of the WSO–UV a versatile instrument for UV astronomy in the post-Hubble Space Telescope era. WSO–UV will provide observations that are of exceptional importance for the study of the intergalactic medium, star formation at all scales, the physics of astronomical engines and the magnetospheres of extrasolar giant planets. WSO–UV is implemented in the framework of a collaboration between Russia (chair), Spain, Germany and Ukraine. This article is an updated accounting of the status of the project and its implementation in Spain.

1 Introduction

The World Space Observatory-Ultraviolet (WSO–UV) Project is grown out the needs of the Astronomical community to have access to the Ultraviolet (UV) range of the spectrum in the post Hubble Space Telescope (HST) era. WSO–UV comes timely after the completion of the first (nearly) all-sky ultraviolet (UV) survey being carried out by the Galaxy Evolution Explorer (GALEX). GALEX was launched in 2003 and the baseline All Sky Survey was completed in 2007. GALEX AIS covers 26 000 deg^2 ($\sim$ 63% of the sky) and provides broadband imaging to magnitude $m_{\rm AB} = 20.5$ mag in two UV bands: 1350–1780 Å and 1770–2730 Å (excluding the Galactic plane and some strong UV sources in the galactic halo and nearby galaxies). WSO–UV will allow detailed spectroscopic and imaging follow-up studies.

The WSO–UV consists of an UV telescope in orbit, incorporating a primary mirror of 1.7 m diameter feeding a set of UV low and high spectral resolution spectrographs and UV–optical imagers. With a telescope with just half the collecting area of HST, but taking advantage of the modern technology for astronomical instrumentation, and of a high altitude, high observational efficiency orbit, WSO–UV will provide UV–optical astronomical data quantitatively and qualitatively comparable to the exceptional data base collected by HST. In addition to the newly observed targets, with the synergy of the HST archive, WSO–UV will allow long term photometric, spectroscopic, and astrometric monitoring of a variety of astronomical objects.

This contribution updates the previous report to the Spanish Astronomical Society presented during the 8th Scientific Meeting in 2008 [1]. Special emphasis is made on the recent developments of the Imaging and Slitless Spectroscopy Instrument for Surveys (ISSIS), the Spanish instrument in the WSO–UV. A detailed accounting on the current status on the Russian-Spanish ground segment, also part of the Spanish contribution to the project, can be found in [3].

2 Technical overview

The T-170M telescope is a Ritchey-Chretien on reflection optics with a focal length of 17 m. The primary mirror diameter is 1.7 m. The telescope provides a corrected field of view is 0.5 degrees on the telescope focal surface. WSO–UV uses the NAVIGATOR platform that has been designed in the Lavochkin Science & Technology Association (Russia) as a unified unit for several missions. The orbit is geosynchronous with an inclination of $51.^{o}8$. Launch Vehicle is a Zenit–2SB. The project is managed by a consortium led by the Federal Space Agency, Roscosmos, Russia, which provides the telescope, the platform, the launcher, the integration facilities and it is the main responsible of science and mission operations.

WSO/UV is equipped with multipurpose instrumentation to carry out:

- High resolution spectroscopy ($R \sim 55000$) of point sources in the range 1020–3200 Å by means of two high resolution echelle set-ups: the HIgh Resolution Double Echelle Spectrograph (HIRDES) . The sensitivity of this instrument is about ten times better that of the Space Telescope Imaging Spectrograph (STIS) on a similar configuration.
- Long-slit low resolution ($R \sim 1500-2500$) spectroscopy in the 1020–3200 Å range with the Long Slit Spectrograph (LSS).
- High sensitivity imaging and slit-less spectroscopy ($R \sim 500$) in the 1150–1750 Å range with spatial resolution 0.05 arcsec and field of view 2.1 arcmin for weak UV sources.
- Simultaneous imaging in the 1150−8500 Å range with a field of view (> 2.1 arcmin) for surveys, with spatial resolution 0.05 arcsec. Slit-less spectroscopy will also be available in this range with resolution 300 or 500 depending on the wavelength range.

In the instrument compartment, see Fig. 1, the optical bench (OB), used as reference plane for all the onboard instrumentation, is aligned and maintained in the correct position

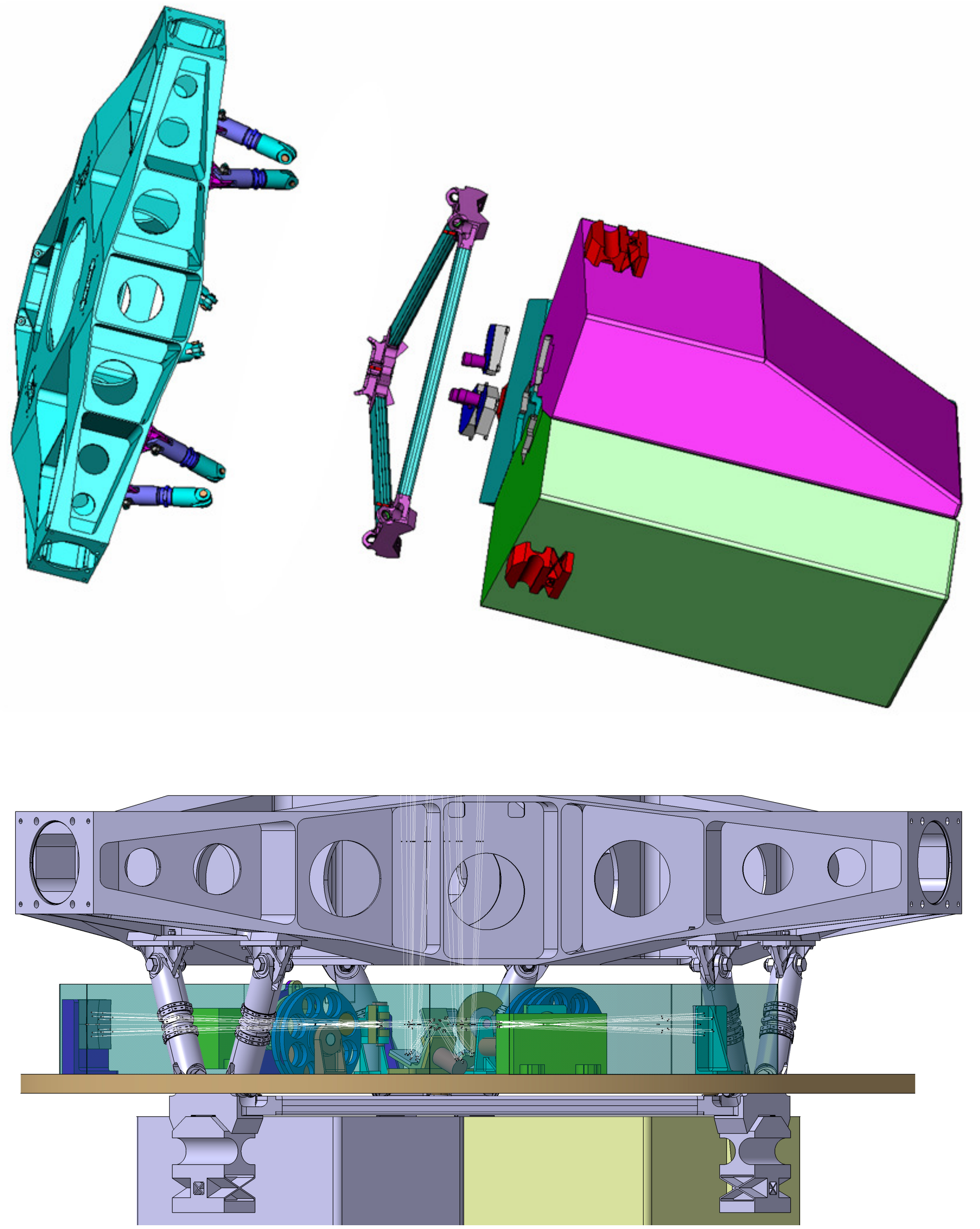

Figure 1: *Top*: Mounting of HIRDES and LSS on the optical bench. *Bottom*: Mounting of ISSIS on the OB.

with respect to the primary mirror unit (PMU) using a three rods system. The Imaging and Slit less Spectroscopy Instrument for Surveys (ISSIS) is mounted on the upper basis of the optical bench, in the space available between the PMU and the OB itself, while the two spectrographs HIRDES and LSS are mounted to the OB bottom basis. The Fine Guidance System, that uses three sensors placed in the focalplane close to the spectrograph entrance slits, ensures a pointing stability better than 0.1 arcsec (3σ); in the galactic plane, with bright guide stars, the guiding performance is expected to be as good as 0.05 arcsec.

3 WSO–UV instruments

3.1 WSO–UV spectrographs: WUVES

WSO–UV is equipped with a HIgh Resolution Double Echelle Spectrograph (HIRDES) and a Long Slit Spectrograph (LSS) that are being developed through a Russian-Germain collaboration.

HIRDES consist of two channels, VUVES (1020–1760 Å), and UVES (1740–3100 Å) able to deliver high resolution spectra ($R \sim 55\,000$). Each channel is accommodated in a separate bay in the instruments compartment.

The HIRDES design uses the heritage of the ORFEUS (Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer) missions successfully flown on the Space Shuttle in 1993 and 1996. The entrance slits of the two spectrographs lie in the focal plane, on a circle with diameter 100 mm which also hosts the LSS slits. The position of the target in the slit is monitored by an (optical) sensor of an Internal Fine Guidance System, which is part of every spectrograph. The VUVES and UVES detectors are photon counting devices based on Microchannel Plates, read out by means of a Wedge&Strip Anode based on the ORFEUS detector design. Technical details of the high resolution spectrographs are given in Table 1.

The Long Slit Spectrograph will provide low resolution ($R \sim 1500$–2500) spectra in the 1020–3200 Å spectral range with a design that emphasizes sensitivity for observing faint objects. This instrument has also two channels 1020–1600 Å (FUV) and 1600–3200 Å (NUV) ranges, respectively that are accommodated in the same bay with a single entrance slit of $1'\,75''$.

The spatial resolution is not worse than 1 arcsec (0.4 arcsec at best). Both channels use microchannel plates working in photon-counting modes as detectors. A slit-viewer similar to that used in HIRDES is under study.

3.2 Imaging and slitless spectroscopy instrument for surveys: ISSIS

ISSIS has evolved from is previous Phase A design to a two channels configuration due to the power, space and weight constraints imposed by the platform (see [2] for details). Design drivers to this configuration have been:

- To provide a high sensitivity instrument for the characterization of the far UV Universe. The spatial resolution has been set to the optimal guiding performance (0.05 arcsec).

Table 1: Properties of the HIRDES high resolution spectrographs

		UVES	VUVES
Spectral range		1745–3100 Å	1028–1756 Å
Dispersion		50 000	55 000
Properties at the minimum echelle order	Wavelength	3100 Å	1756 Å
	Order number	148	165
	Bandwidth/pixel	2.07 pm	1.07 pm
	Spectral range	20.9 Å	10.6 Å
	Order separation	180 μm	565 μm
Properties at the maximum echelle order	Wavelength	1745 Å	1028 Å
	Order number	263	282
	Bandwidth/pixel	1.16 pm	0.63 pm
	Spectral range	6.6 Å	3.6 Å
	Order separation	600 μm	200 μm

Given the low throughput of narrow band filters in the far UV, slit less spectroscopy ($R \sim 500$) is foreseen as the most used mode. However some step filters based on the cut-off windows of quartz, CaF_2, BaF_2 or dynasil (alike the available in the Solar Blind Channel of the Advanced Camera System on HST) will be available to allow direct imaging. The detector will be a photoncouting device alike the used for HIRDES and LSS. The wavelength coverage is 1150–1750 Å.

- To provide an instrument for UV observation of bright UV sources that allows completing the GALEX mapping of the galactic plane and nearby star forming regions. This instrument is also expected to operate in parallel mode while performing long exposures with the spectroscopic instrumentation on broad the WSO–UV: HIRDES or LSS. Broad wavelength coverage has been demanded by the Spanish WSO Science Working Group to allow follow-up studies in connection with photometric and astrometric ongoing research programs carried out with the HST. Up to 24 filters have been proposed for this channel from the UV to the I Johnson band. Slitless spectroscopy will also be available. The detector will be a CCD.

A summary of the instrument main characteristics is in Table 2.

4 Science: core program and scientific policy

The project observing time is planned to be distributed as: a) Core Program; b) Funding Bodies Programs; c) Open Time for the International Community. The Core Programme will be designed by a Core Programme Team, including scientists of the participating countries and other international scientists appointed by the WSO–UV consortium, and should be

Table 2: Characteristics of the ISSIS imaging and slitless spectroscopy instrument

	High Sensitivity Channel	Channel for Surveys
Spectral range	1150–1750 Å	1150–8500 Å
Spatial resolution	$0.''05$	$0.''05$
Spatial sampling	0.03 arcsec	0.03 arcsec
Field of view	> 2.1 arcmin	> 2.1 arcmin
Temporal resolution	40 ms	60 s
Detector type	CsI MCP	Full-frame CCD
Detector format	$> 2048 \times 2048$ pix	4096×4096 pix
Spectral filters	6	24
Slitless spectroscopy	$R \sim 500$	$R = 300$–500
Coronagraphy	TBC	Yes

carried out during the first 2 years of the project. The time for Funding Bodies Programs is allocated by a national panel for each of the WSO–UV funding countries. The observing time granted for each country will be proportional to its contribution to the project (see [4] for more details).

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References

[1] Gómez de Castro, A. I., et al. 2010, in *Highlights of Spanish Astrophysics V*, eds. J. M. Diego et al., Springer-Verlag, p. 219

[2] Gómez de Castro, A. I., et al. 2011, ApSS, in press

[3] Lozano, J. M., et al. 2011, these proceedings

[4] Malkov et al. 2011, ApSS, in press