Mem. S.A.It. Vol. 3, 327

Memorie della
Supplementi

The World Space Observatory Project WSO/UV *

I. Pagano[1], M. Rodonò[2], G. Bonanno[1], L. Buson[3], A. Cassatella[4], D. De Martino[5], W. Wamsteker[6], B. Shustov[7], M. Barstow[8], N. Brosch[9], Cheng Fu-Zhen[10], M. Dennefeld[11], A.I. Gomez de Castro[12], N. Kappelmann[13], J. Sahade[14], K. Van der Hucht[15], J.-E. Solheim[16], H. Haubold[17], A. Altamore[19], V. Andretta[5], M. Badiali[4], U. Becciani[1], I. Busà[1], E. Cappellaro[5], D. Cardini[4], S. Catalano[1], V. Castellani[27], ,M. Chiaberge[25], A. Chieffi[4], C. Chiuderi[20], R. Cosentino[1], G. Cremonese[3], G. Cutispoto[1], R. Falomo[3], F. Ferrini[27], M.G. Franchini[23], A. Frasca[1], F. Giovannelli[4], L. Gori[20], M.T. Gomez[5], M. Hack[24], A.F. Lanza[1], A. Lanzafame[2], M.L. Malagnini[24], E. Marilli[1], P. Marziani[3], F. Matteucci[24], C. Morossi[23], U. Munari[3], E. Pace[20], N. Panagia[26], L. Pasinetti[21], G. Piotto[3], F. Polcaro[4], M. Radovich[5], S. Ragaini[5], A. Rifatto[5], C. Rossi[18], S. Scuderi[1], P. Selvelli[4], R. Silvotti[5], L. Terranegra[5], M. Turatto[3], M. Uslenghi[22], R. Viotti[4]

[1] INAF-Ct [2]Univ. Ct [3]INAF-Pd [4]CNR/IASF-Roma [5]INAF-Na [6]ESA-Vilspa [7]INASAN, Russia [8]Univ. Leicester, UK [9]Wise Obs., Israel [10]USTC-CfA, China [11]IAP, France [12]UCM, Spain [13]Univ. Tübingen, Germany [14]CONAE, Argentina [15]Sron-HEA, Netherlands [16]Tromsoo Univ., Norway [17]UN-OOSA [18]Univ. Roma 1 [19]Univ. Roma 3 [20]Univ. Fi [21]Univ. Mi [22]CNR/IASF-Milano [23]INAF-Ts [24]Univ. Ts [25]CNR/IRA-Bo [26]ESA-STScI, USA [27]Univ. Pi

Abstract. The World Space Observatory Project is a new space mission concept, grown out the needs of the Astronomical community to have access to the part of the electromagnetic spectrum where all known physics can be studied on all possible time scales: the Ultraviolet range. The physical diagnostics in this domain supply a richness of new experimental data unmatched by any other wavelength range, for the studies of the Universe. As WSO/UV has been driven by the needs of scientists from many different countries, a new implementation model was needed to bring the World Space Observatory to reality. The WSO/UV consists of a single Ultraviolet Telescope in orbit, incorporating a primary mirror of 1.7 m diameter feeding a UV spectrograph and UV Imagers.

Key words. UV astronomy – space science – new instrumentation

1. Introduction

The World Space Observatory (WSO, http://wso.vilspa.esa.es/) concept was dis-

Send offprint requests to: I. Pagano, ipa@ct.astro.it

* Poster at http://sait.oat.ts.astro.it/MSAIS/3/POST/Pagano_poster.pdf

cussed for the first time in the conclusions and recommendations of the 8th UN/ESA Workshop for Basic Space Science in the Developing Countries (UN A/AC.105/723 1999).

Thereafter, the mission feasibility and the conceptual design of the WSO/UV space/ground system have been assessed by ESA (CDF-05(A) 2001) and JPL/NASA (ADP Report 2001).

The basic ideas under the WSO project are to use application innovation, but avoid technical innovation, use heritage as much as possible, apply new engineering methods (concurrent design), keep the mission simple, and allow science operations centers at national level. Following these ideas the WSO/UV project has been developed as an International Collaboration to build a UV (103-310 nm) dedicated telescope (1.7m) capable of high-resolution spectroscopy, long slit low-resolution spectroscopy, and deep UV imaging.

The telescope will orbit the Lagrangian point L2, therefore it will be almost free of visibility constraints and capable of real time observations.

2. WSO/UV Telescope and Payload

The WSO/UV telescope is a Ritchey-Chretien with 1.7 m aperture, eqivalent focal length of 17.0 m, FOV of 40 arcmin (Ø 200 mm), optical quality of the two mirrors of l/30 rms at 633 nm, capable of 12.05 arcsec/mm angular resolution on the focal plane. The telescope is a new version of the T-170 telescope designed in Russia by Lavochkin Association for Spectrum-UV mission.

In Figure 1 the arrangement of instruments in the WSO/UV focal plane is shown.

The high resolution double echelle spectrograph (HIRDES), designed for WSO/UV using the heritage of the ORFEUS missions (Barnstedt et al. 1999, Richter et al. 1999), comprises three different single spectrometers. Two of these are echelle instruments, designed to deliver high spectral resolution, and the third is a low dispersion long slit instrument (LSS). At high dispersion, the 110 to 320nm waveband of the WSO will be divided into two, the UV (UVES, 178-320nm) and VUV (VUVES, 103-180nm). Each of the three spectrometers has its own entrance slit, lying in the focal plane of the T-170M telescope on a circle with diameter 100 mm. The three optical trains are not used for simultaneous observation, but in sequential mode. This is managed by satellite motion with a pointing stability requirement of 0.1 arcsec to be monitored by three Fine Guidance Sensors (FGS).

The imagers on WSO/UV are four UV cameras, two providing high spatial resolution (HRI) with FOV of 1 arcmin, and two providing high sensitivity (HSI) with 5 arcmin FOV. A selection of bandpasses will allow to get images in the range between 122nm and 320nm.

An optical camera is designed to deliver images betweeen 400 and 800 nm, in selected bands, useful also for outreach purposes.

In the focal plane three Fine Guidance Sensor (FGS) will be placed to get a pointing stability of 0.05 arcsec/24hours. The FGS design is one of the critical element of the project.

A comparison of the Effective Area of the WSO/UV instruments with the UV spectrographs STIS on HST at comparable resolution is given in Figure 2. The spectral resolution provided by HIRDES is similar to that provided by HST-STIS, but higher than that provided by HST-COS, the instrument which will replace STIS in the next future. As far as sensitivity is concerned WSO/UV-HIRDES is comparable to HST-COS and definitely better than HST-STIS. Accounting also for the fact that WSO/UV will be a dedictaed UV telescope and will have a high efficiency of observations at L2, WSO/UV will provide a net increase in UV productivity of a factor about 40-50 compared to HST/STIS at the same spectral resoltuion.

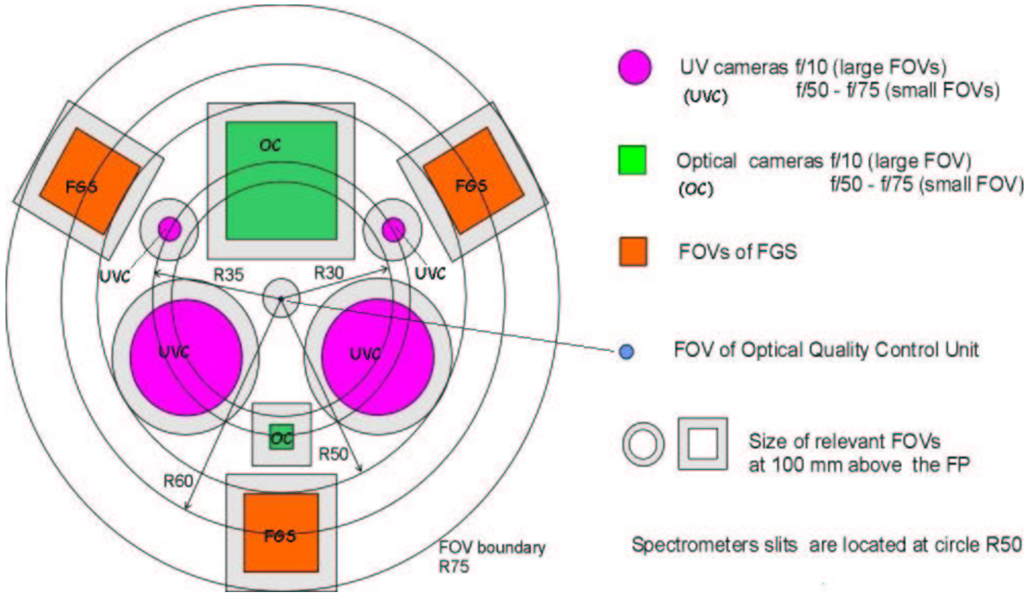

Fig. 1. Instruments allocation in focal plane of WSO/UV

3. Science Objectives

WSO/UV will allow us to observe objects 4-5 magnitudes fainter than possible with HST, providing completely new opportunities in extragalactic astronomy and cosmology. With a 2007/8 launch date, WSO is ideally placed to provide follow-up studies of the large number of UV sources expected from the GALEX sky survey. Here following the main scientific objectives of WSO/UV are listed:

- Gravitational lenses, Hubble parameter and galaxy masses;
- Gamma-ray bursts and the afterglow;
- Metal abundances in the intergalactic medium at redshift $z < 2$;
- Active Galactic Nuclei (AGN);
- Stellar Populations in Galaxies;
- Young globular clusters in irregular galaxies;
- Horizontal Branch (HB) stars in globular clusters;
- Supernovae;
- Classical novae;
- The classical nova – dwarf nova connection;
- Accreation phenomena;
- Magnetic fields in stellar structure and evolution.

4. WSO/UV Organizational status

The implementation of the WSO/UV project is coordinated by a WSO/UV Implementation Committee (WIC) of which are member: Russia (chair), Argentina, China, France, Germany, Israel, Italy, Mexico, the Netherlands, Nordic Countries (Denmark Finland, Lithuania, Norway, Sweden), South Africa, Spain, United Kingdom, Ukraine, and two agencies: ESA, and UN. The total membership of the National WSO/UV Working Groups (NWWGs) comprise 130 scientists from ESA member states, 70 scientists in other states, and some 10 industries.

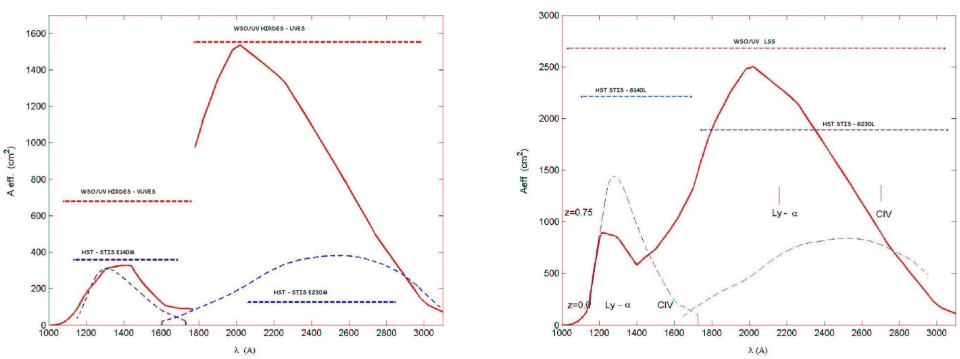

Fig. 2. A comparison of the Effective Area of the WSO/UV instruments (continous line) with the UV spectrographs STIS (dashed line) on HST at comparable resolution. The horizontal dashed lines give the Free Spectral Range (i.e. the range which can be observed in a single exposure) of the spectrographs. The wavelengths of the Lyman α and CIV lines at redshift of 0.75 are indicated in the right hand figure.

5. Italian contribution to the WSO/UV project

The areas in which the Italian community can give an important contribution to the WSO/UV project are:

Detectors: Photon Counter Intensified Active Pixel Sensors PC-IAPS have been developed in a collaboration between Catania Obervatory (INAF),and Milan IASF/CNR (Bonanno et al 2001, Uslenghi et al. 2001). These detectors, which are the natural evolution of MCP based detectors for UV astronomy, offer a wider dynamic range than other anologous ones. An assessment study will be conducted during the Phase A study to ascertain the feasibility and advantages to use this detectors for the UV imagers.

Instruments Control and Data Processing Units (ICU/DPU).

Fine Guidance System (FGS): The Italian aerospatial industries have all the required expertise in the field of high precision pointing instrumentation, as testified by the adoption of "made in Italy" units for several space missions developed in Europe (e.g. ISO, SOHO, INTEGRAL, XMM, SAX, Cassini, Mars Express).

Definition of WSO/UV main scientific objectives: Definition of filters for UV and optical cameras 2, and of strategies for pre/in flight calibration.

References

Barnstedt, J. et al. 1999, A&ASS 134, 561

Bonanno, G., et al. 2001 SPIE Vol. 4498, p. 185

ESA-CDF assessment study, ESA/CDF-05(A), 2000, http://wso.vilspa.esa.es-/docs/WCC/DOC/Attachments/GEN-TN-0002-1-0.pdf

JPL/NASA assessment study ADP Report: CL#01-1168 http://wso.vilspa.esa.es /docs/WCC/DOC/Attachments/GEN-TN-0001-Draft-0.pdf

Richter, P., et al. 1999, Nature, 402, 386

UN A/AC.105/723, 1999, Report on the VIIIth UN/ESA workshop on Basic Space Sciences, Section IV. http://www.seas.columbia.edu/ ah297/un-esa/wso.html

Uslenghi, M., et al. 2001 SPIE Vol. 4498, p. 173