The World Space Observatory Project

WSO/UV http://wso.vilspa.esa.es/

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Background

- The World Space Observatory (WSO) concept was discussed for the first time in the conclusions and recommendations of the 8th UN/ESA Workshop for Basic Space Science in the Developing Countries.
- An ESA internal study was proposed in order to assess the mission feasibility and to provide the conceptual design of the WSO/UV space/ground system. The study was financed under the ESA General Studies Programme, under the responsibility of W. Wamsteker (ESA):
- **ESA-CDF assessment study ESA/CDF-05(A)**
  http://wso.vilspa.esa.es/docs/WCC/DOC/Attachments/GENTN-0002-1-0.pdf (May 2000)

This was followed by

- A **JPL/NASA assessment study ADP Report: CL#01-1168**
  http://wso.vilspa.esa.es/docs/WCC/DOC/Attachments/GENTN-0001-Draft-0.pdf (Gen 2001)

WSO/UV facts

WSO/UV is an International Collaboration to build a UV (103-310 nm) dedicated telescope (1.7m) capable of:

- ✓ high resolution spectroscopy
- ✓ long slit low resolution spectroscopy
- ✓ deep UV imaging
- ✓ free of visibility constraints (L2)
- ✓ "real time" operations
- ✓ investigate all possible time-scales

WSO/UV principia

- Use application innovation, but avoid technical innovation
- Use heritage as much as possible;
- Apply new engineering methods (*concurrent design*);
- Keep the mission simple;
- Science Operations Centers at National level.

Performances

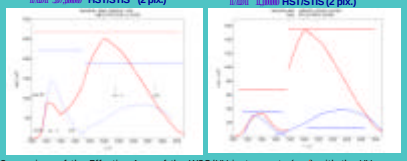
- ✓**Spectral resolution**: WSO/UV-HIRDES ≈ HST-STIS
  WSO/UV-HIRDES > HST-COS
- ✓**Sensitivity**: WSO/UV-HIRDES ≈ 5-10 × HST-STIS
  WSO/UV-HIRDES ≈ HST-COS
- ✓WSO/UV is a **dedicated UV** telescope
- ✓WSO/UV has a **high efficiency** of observations **at L2**

WSO/UV will provide a net increase in UV productivity of a factor ~40-50 compared to HST/STIS.

WSO/UV-HIRDES vs. HST-STIS

High Resolution
WSO/UV (3 pix.)
HST/STIS (2 pix.)

Low Resolution
WSO/UV (3 pix.)
HST/STIS (2 pix.)



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

Science

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**.

✓ Carry out large scale, **high resolution spectroscopic surveys** of galactic sources.

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.

Main WSO/UV Science Interests of the Italian UV community

- **Hot stars and mass loss phenomena, Supernovae (STScI, CT)**
- **Hot horizontal branch stars (PI)**
- **Interacting Binaries (PD, RM)**
- **Novae (TS, PI)**
- **Cool Stars, Atmospheric Structure, Magnetic Activity (CT, TS)**
- **UV-bright stars, Young Stars in Globular Clusters (PI, RM, CT)**
- **Stellar populations in Galaxies (NA)**
- **Active Galactic Nuclei (MI)**
- **Cataclysmic Variables (NA, RM)**
- **Low Mass X-ray Binaries (NA, PI)**
- **Interstellar medium (PI)**

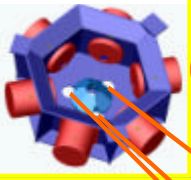
Telescope and Payloads

Lavochkin Association

The telescope is heritage of the Spectrum-UV Project.
To be used by WSO/UV it was necessary to have optical modifications, mass reduction, cost reduction.

D	170 cm
F	1700 cm
F/10	
FoV	30 arcmin (150 mm)
scale	12.05 arcsec/mm
Imaging	
D_{80} @	0.35 arcsec @ 633 nm
D_{80} @	0.07 arcsec @ 122 nm

The **Imaging Camera** design is based on the Tauvex mission.



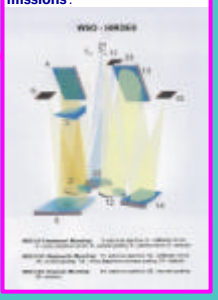
A **Central Field Camera** will sample the diffraction limited resolution. Additional imagers can be allocated by using 90° single reflections:

- 2 high resolution UV cameras
- 2 high sensitivity UV cameras
- 2 optical imagers.

A study for a polarimeter unit is in progress.

- Each of the three spectrometers has its own entrance slit
- The three optical trains are used 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**.

HIRDES: the High Resolution Double Echelle Spectrograph is heritage of the German Orpheus missions.



Assuming that:
a) the telescope has 0.07" (80% Encircled Energy);
b) the MCP diameter is 25 mm;
c) the read-out anode has 2000x2000 pixel => pixel size = 12.5 microns

Camera	Aperture	velength Ran	SF Sampling	FOV	Photocatode	Number of mirrors
Central Field	F/10	120-190 nm	0.15"/pixel	5 arcmin	CsI	0
UV Imager HIS 1	F/10	120-290 nm	0.15"/pixel	5 arcmin	CsTe	1
UV Imager HIS 1	F/50	120-290 nm	0.03"/pixel	1 arcmin	CsTe	2
UV Imager HIS 2	F/50	120-290 nm	0.15"/pixel	5 arcmin	CsTe	1
UV Imager HIS 2	F/50	120-290 nm	0.03"/pixel	1 arcmin	CsTe	2
Optical Imager HIS	F/10	350-550 nm	0.15"/pixel	5 arcmin	BiaKali	1
Optical Imager HIS	F/50	350-550 nm	0.03"/pixel	1 arcmin	BiaKali	2

The reflection of Al + MgF_2 coating: 0,85 (120 - 290 nm); 0,9 (350 - 500 nm)

Fine Guidance System (FGS)

- In the WSO/UV design, the FGS units are part of the focal plane instruments.
- The FGS are required to maintain during science observation a pointing error < 0.03 arcsec (1 σ) over a period of 24 hours on all three axes
- To be able to support the tracking of objects moving up to 0.2 arcsec per second

FGS Requirements:

- Wavelength Range: 400nm .. 800nm (visible)
- Detector: 1024 x 1024 Pixel x16bit, CCD, pixel size 24um squared, overall active size 25mm x 25mm
- FOV: 55.2 arcsec square field extension
- IFOV = 0.054 arcsec
- 3 FGS arranged symmetrically around the optical axis with a distance of 20mm of each detector to the optical axis

Technical details of the UV Echelle Spectrograph UVES – 174.5-310.0 nm
Entrance aperture circular 80 im
Collimator mirror toroidal, R1 = 1608 mm, R2 = 1593 mm, circular 80 mm
Echelle grating 40 grooves/mm, 66.9° blaze, 90 mm x 190 mm
Cross dispersion prism 12° quartz, double pass, 100 mm x 110 mm
Camera mirror spherical, R=1600 mm, 110 mm x 130 mm
Detector: 30 mm (echelle dispersion), 30 im resolution(pixel-width)
40 mm (prism dispersion), 40 im resolution (pixel-height)
Resolving power R = 50000 (3 pixel criterion)

Technical details of the VUV Echelle Spectrograph - VUVES – 102.8-172.6 nm
Entrance aperture circular 80 im
Collimator mirror parabolic, R = 1600 mm, 6° off-axis, circular80 mm
Echelle grating 65 grooves/mm, 71° blaze, 90 mm x 270 mm
Wadsworth grating toroidal, 625 grooves/mm, R1 = 1698 mm, R2 = 1695 mm, 90 mm x 120 mm
Detector: 30 mm (echelle dispersion), 30 im resolution(pixel-width)
40 mm (Wadsworth dispersion), 40 im resolution(pixel-height)
Resolving power R = 55000 (3 pixel criterion)

Technical details of the Long Slit Spectrograph LSS – 102.8-310.0 nm
Entrance aperture rectangular, 80 im x 6 mm
Rowland grating aberration corrected concave grating, R 800 mm
Detector: 80 mm (grating dispersion), 15 im resolution (pixel-width)
Resolving power examples: R = 1000 (3 pixel criterion), 110 nm to 350 nm

WSO/UV Organizational status

The activities are coordinated by a WSO/UV Implementation Committee (WIC)

Non European Members: **Russia (chair), Argentina, Cina, Israele, Messico, Sud Africa, Ucraina**

European Members: Francia, Germania, Italia, Olanda, Paesi Nordici (Danimarca, Finlandia, Lituania, Norvegia, Svezia), Spagna, Regno Unito

Others: ESA, UN

14 NWWG's representing scientists form 17 countries.

The total membership of the NWWG's comprise **130** scientists from ESA member states; **70** scientists in non-member states; and some **10** industries.

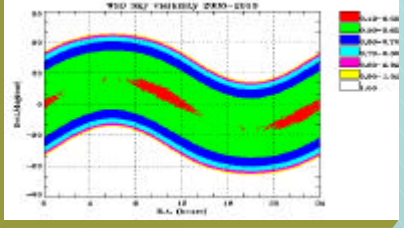
BUS

The bus developed for Herschel/Planck (and Eddington), by Alenia Spazio, has been selected by ESA as a working hypothesis for WSO/UV.

LAUNCHER

- **Middle class launcher Soyuz-2, or Zenith2E with booster Fregat are capable to put into L2 point vicinity the S/C up to 3.6 ton**
- **Chinese Long-March launcher is under consideration.**

L2 Lagragian orbit



Possible Italian Contribution to Phase A Study proposed to ASI

LABEN

- **Detectors** *(Photon Counter Intensified Active Pixel Sensors PC-IAPS)*
  Catania (INAF), Milano (CNR), Laben (elettronica)
- **Fine Guidance System**
  Galileo Avionica, Dip. Astronomia di Firenze XUVLab, Laben
- **Instruments Control & Data Processing Units (ICU/DPU)**
  Laben
- **Scientific Objectives Definition**
  Researchers at several Institutions
  1. Selection of filters for UV and optical camer as
  2. Definition of strategies for pre/in flight calibration
  3. Participation in the edition of the book "Science with WSO/UV" (ed. M. Barstow – Leicester Univ., UK)

Implementation Plan