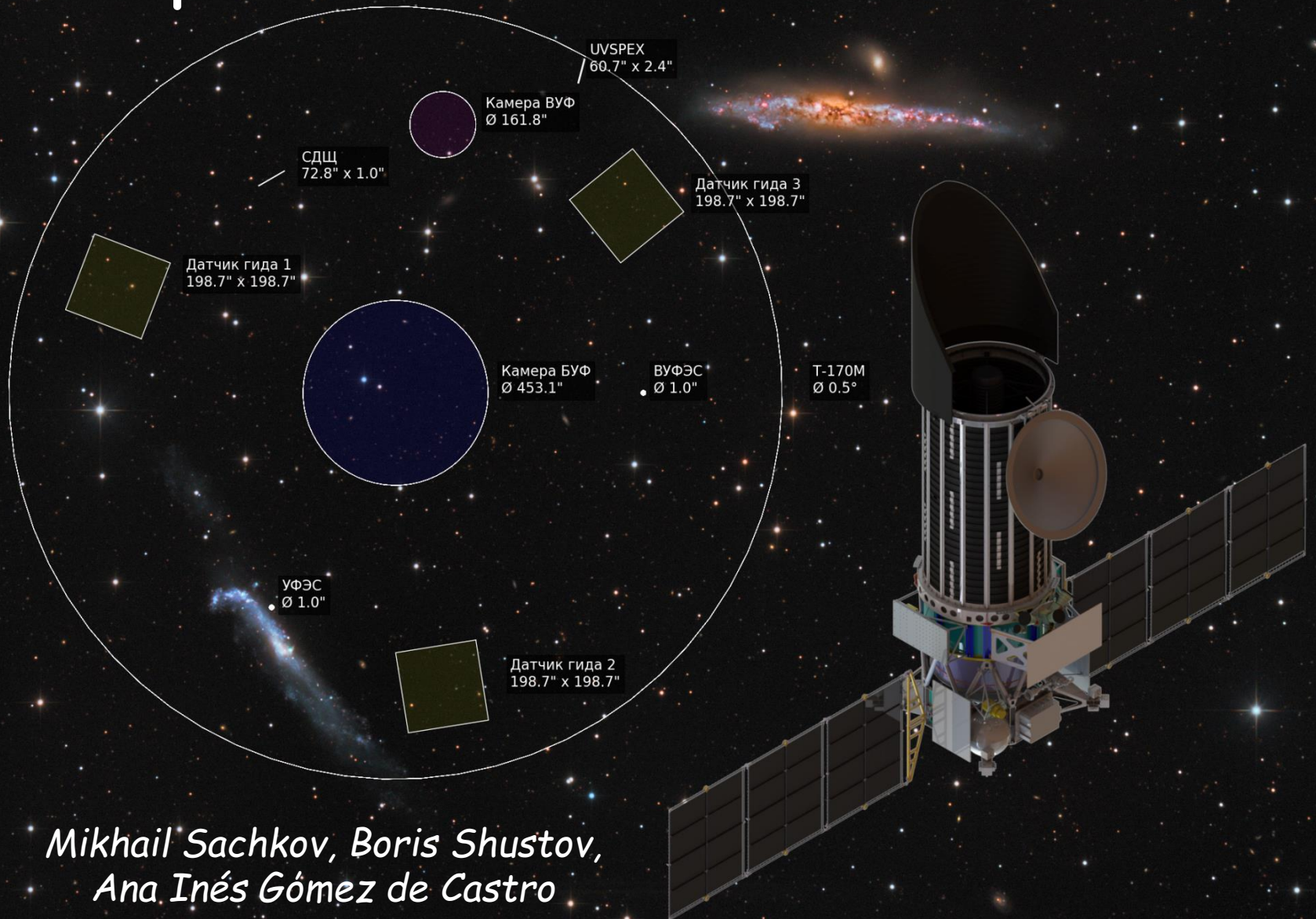


ULTRAVIOLET ASTRONOMY IN THE XXI CENTURY



e-Workshop 2020 – October 27-29

Spektr-UF / WSO-UV status 2020



*Mikhail Sachkov, Boris Shustov,
Ana Inés Gómez de Castro*



Russian-Spanish WSO-UV team

Institute of Astronomy RAS (Russia)

University Complutense de Madrid (Spain)

In collaboration with:

Rikkyo University (Japan)

*National Institute of Optics, Astronomy and Engineering
(Mexico)*

"Spektr" SERIE in the Russian Federal Space Program



SPECTR - R (RADIOASTRON)

Was working successfully
2011 - 2019



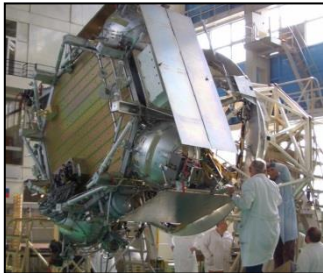
SPECTR - RG (WITH E-ROSITA)

Is on orbit
2019 - 2025



SPEKTR - UF WSO-UV

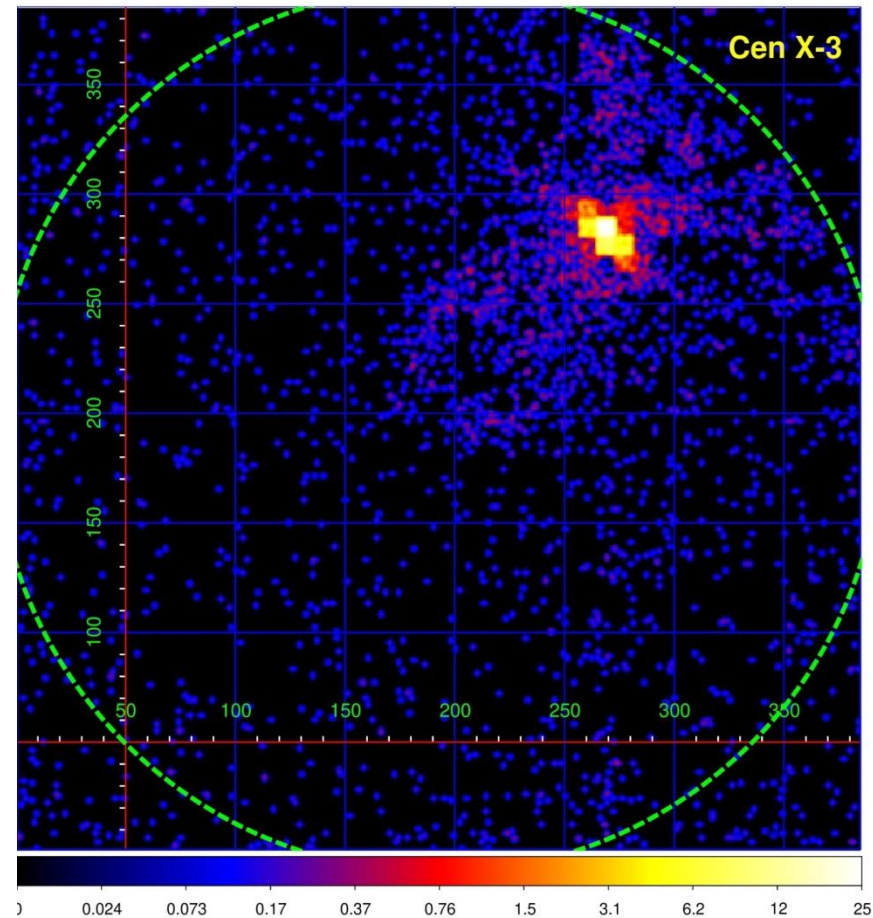
Should be launched
in 2025



The Unified space platform NAVIGATOR
for the "Spektr" SERIE

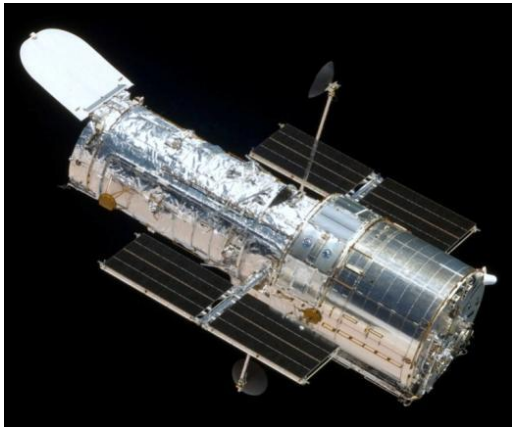


SPECTR - RG first light

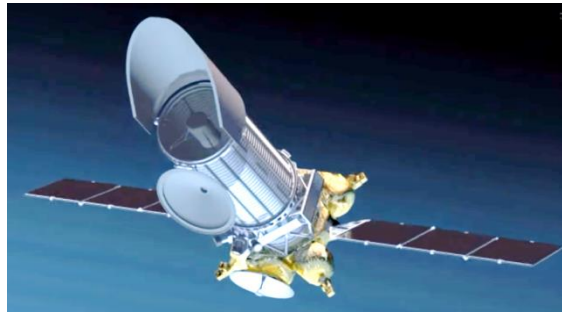


The first all-sky survey is finished

NO "dark UV epoch"

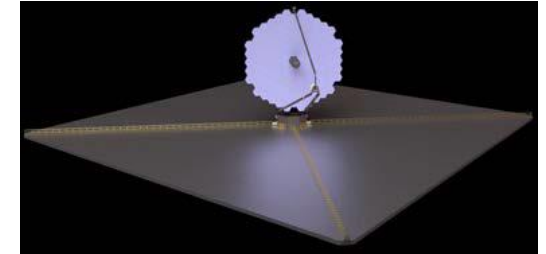


Hubble Space Telescope
1990 - 2025 (?)



**World Space Observatory
-Ultraviolet**

2025 - 2035 гг.



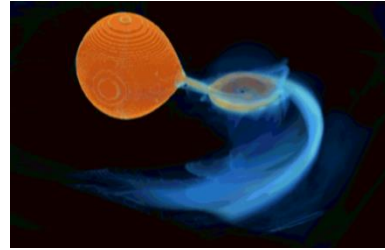
LUVOIR

2030-.....

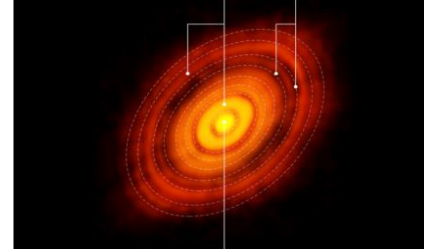
WSO-UV core program



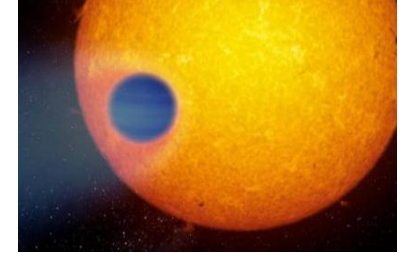
Chemical evolution of the Universe



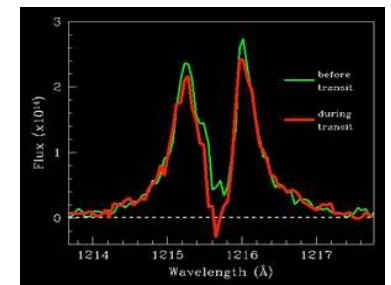
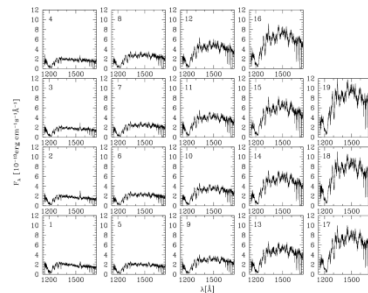
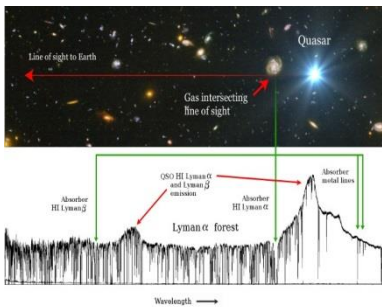
Accretion processes and stellar physics



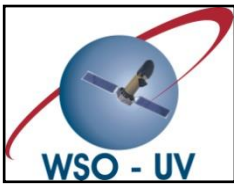
Star and planetary system formation



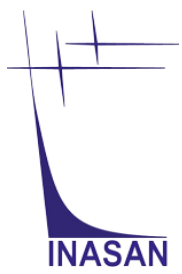
(exo) planetary atmospheres



The first Core Program Call TAC meeting: April 08, 2019



Institution	Proposal title
Centro de Astrobiología (INTA-CSIC)	Magnetospheric accretion or boundary layer? Understanding the formation of intermediate-mass Herbig Ae/Be stars from UV-spectra with the World Space Observatory
Institute of astronomy of the Russian Academy of Sciences	Accretion processes in magnetic cataclysmic variables
Institute of astronomy of the Russian Academy of Sciences	The WSO-UV survey of exoplanet atmospheres
Institute of astronomy of the Russian Academy of Sciences	UV spectroscopy of star-grazing comets
Institute of astronomy of the Russian Academy of Sciences	Studies of stellar activity of Sun-like stars and the stellar age-activity relation
Institute of astronomy of the Russian Academy of Sciences	UV spectroscopy of fast and ultra-fast late type rotators
Institute of astronomy of the Russian Academy of Sciences	Interstellar elemental depletions VS atypical extinction curves
Special Astrophysical Observatory	Relations between interstellar lines observed in UV and diffuse bands
Universidad Complutense de Madrid	Ultraviolet spectroscopy survey of T Tauri stars to understand planet formation
Universidad Complutense de Madrid	Observation of the Lyman-alpha variability in high velocity cool stars
Universidad Complutense de Madrid	Determination of the distribution of diffuse gas in the solar neighborhood
Universidad Complutense de Madrid	The UV counterpart to strong X-ray flares in the solar neighborhood
Universidad Complutense de Madrid	Detection of comet swarms around young stars
Universidad Complutense de Madrid	Pre-main sequence close binaries and its role in young planetary disk evolution



JCUVA

Joint Center of UltraViolet Astronomy



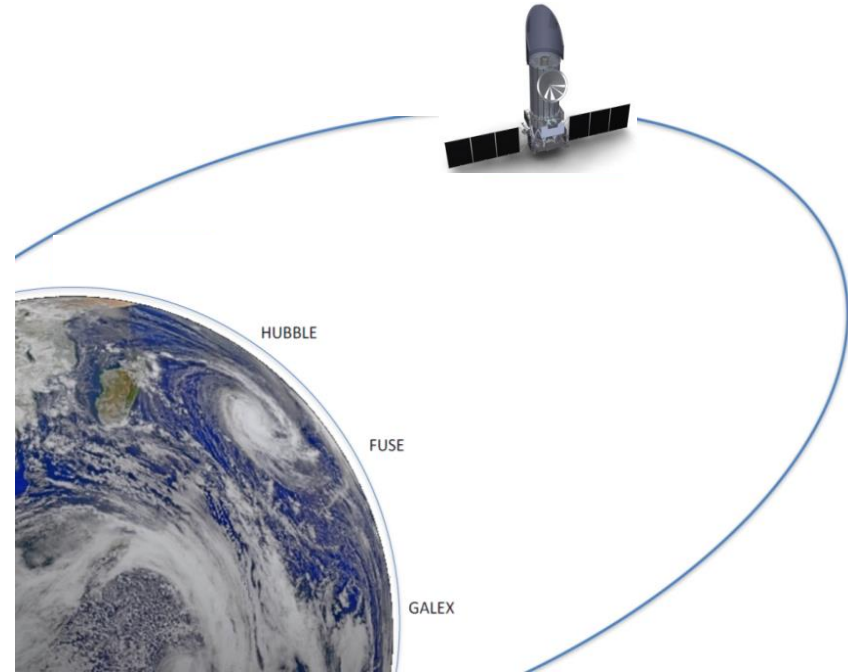
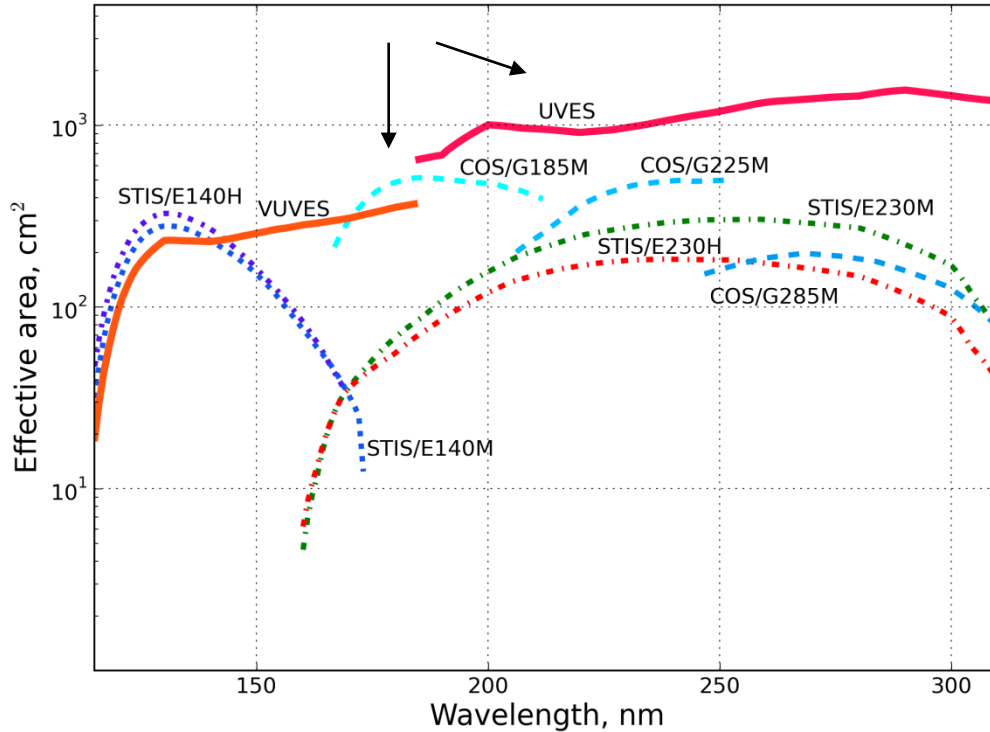
UNIVERSIDAD
COMPLUTENSE
MADRID



WSO-UV as the HST "successor"



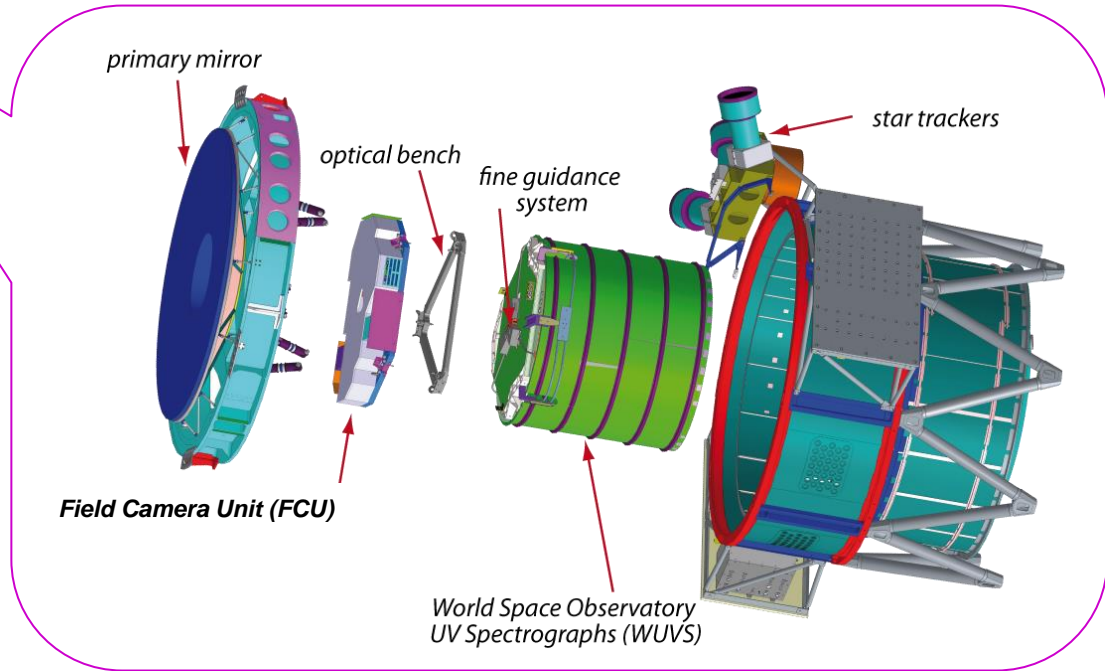
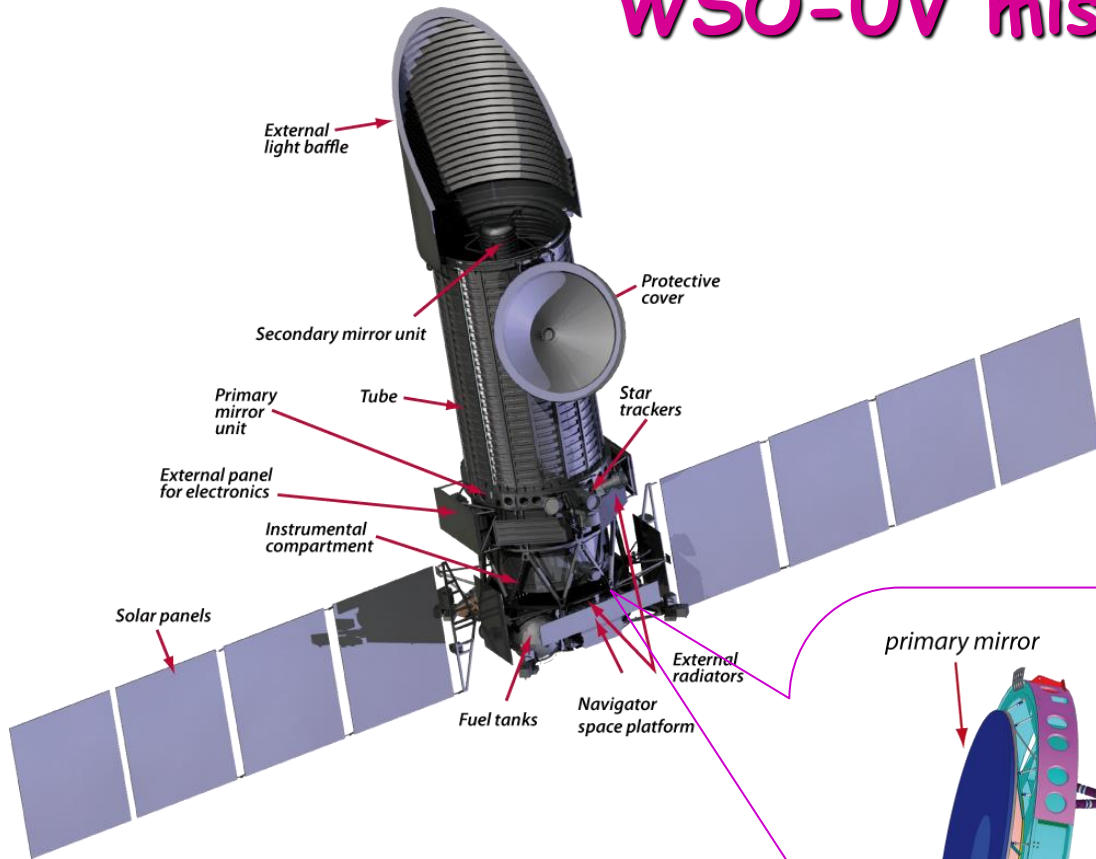
WUVS



Efficiency of WSO-UV Spectrographs

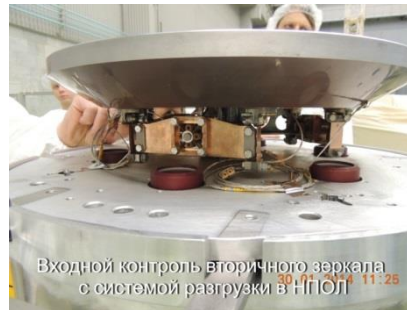
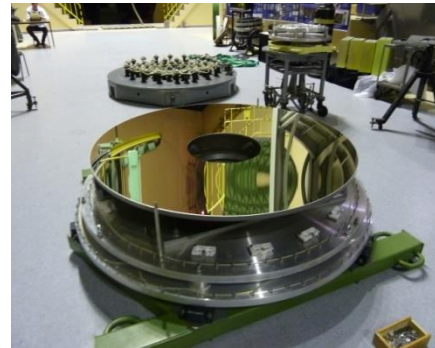
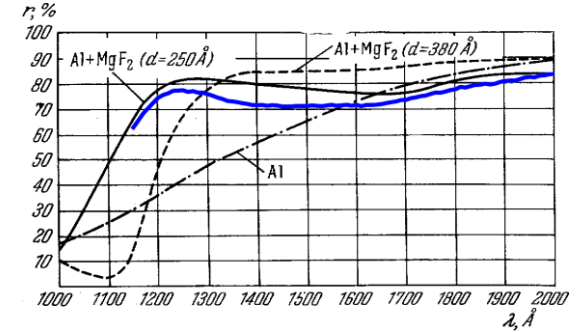
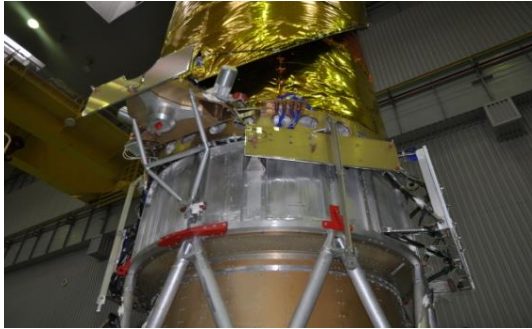
A geosynchronous orbit ("above" the geocorona)

WSO-UV mission concept

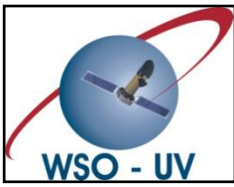


The T-170M Telescope

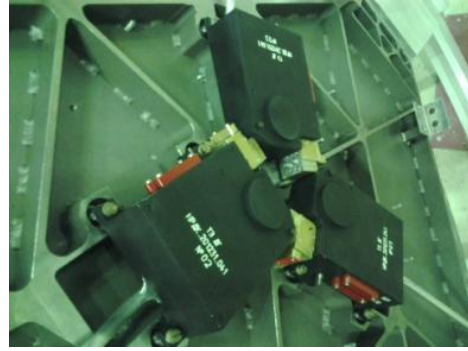
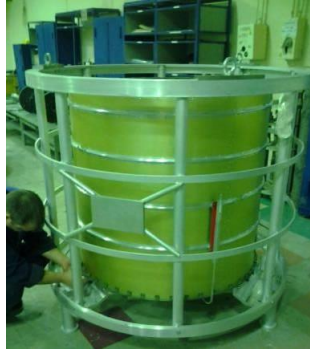
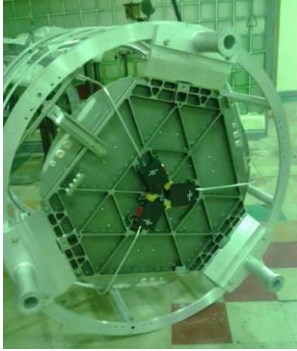
EQM construction was finished



Telescope AIV facilities



WSO-UV Spectrographs



Three channels (spectrographs) of the WUVS :

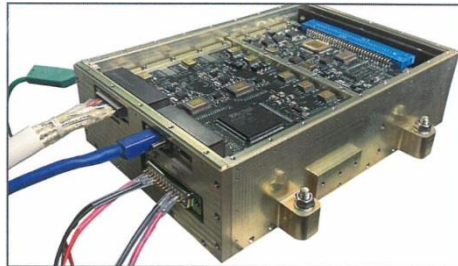
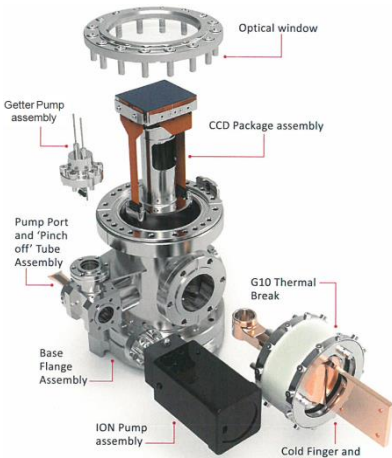
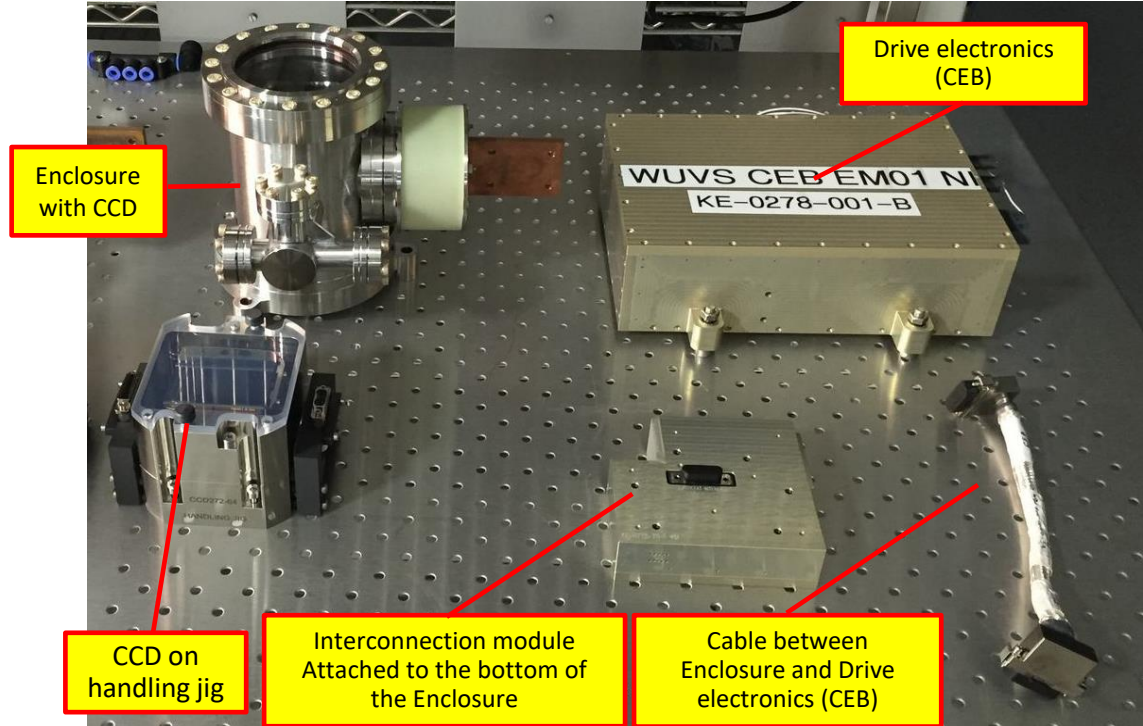
**Vacuum Ultraviolet Echelé Spectrograph
VUVES - 115-176 nm, $R \approx 50\ 000$**

**Ultraviolet Echelé Spectrograph
UVES - 174-310 nm, $R \approx 50\ 000$**

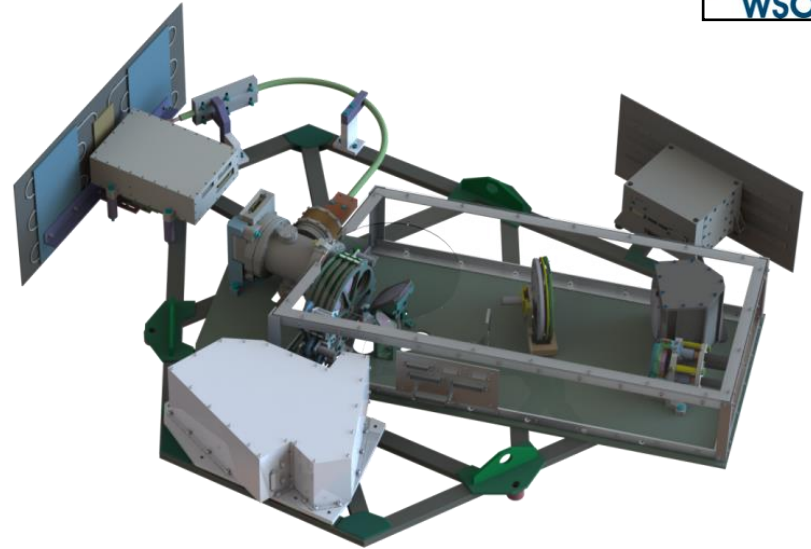
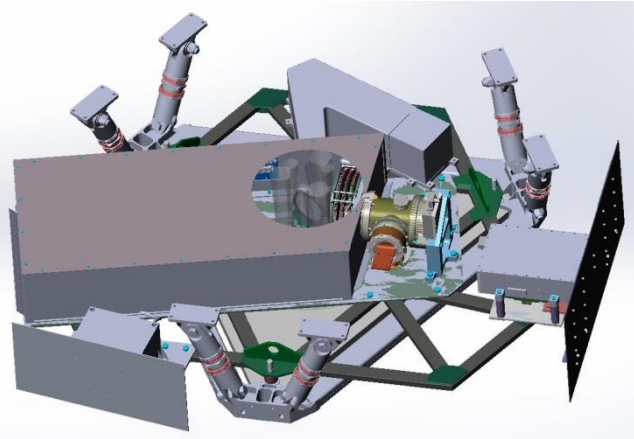
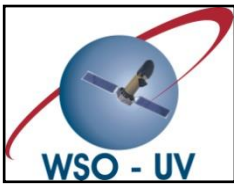
**Long Slit Spectrograph
LSS - 115-305 nm, $R=1000$**



WSO-UV Detectors. CCD. Teledyne-e2v/RAL (flight models delivered to Russia)



Field Camera Unit



two channels:

- **FUV channel with MCP detector, 115-176 nm**
 - Solar blind detector
 - Diffraction-limited imaging in FUV
 - High sensitivity in photon-counting mode
- **NUV channel with CCD detector, 174-310nm**
 - Low resolution field spectroscopy
 - Possibility for extended spectral range: 115-1000 nm

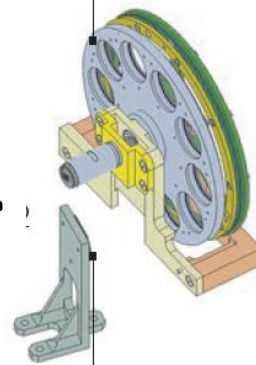
WSO-UV Detectors. MCP for FUV. SENER (Spain)

Flight models will be delivered in 2021

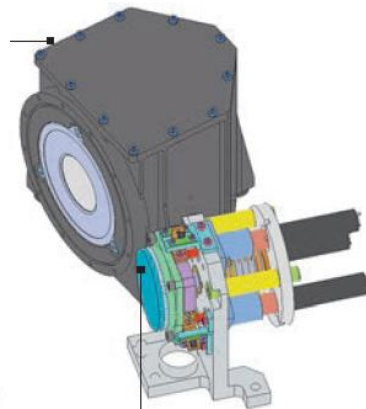


Filter wheels MCP

Flat mirror

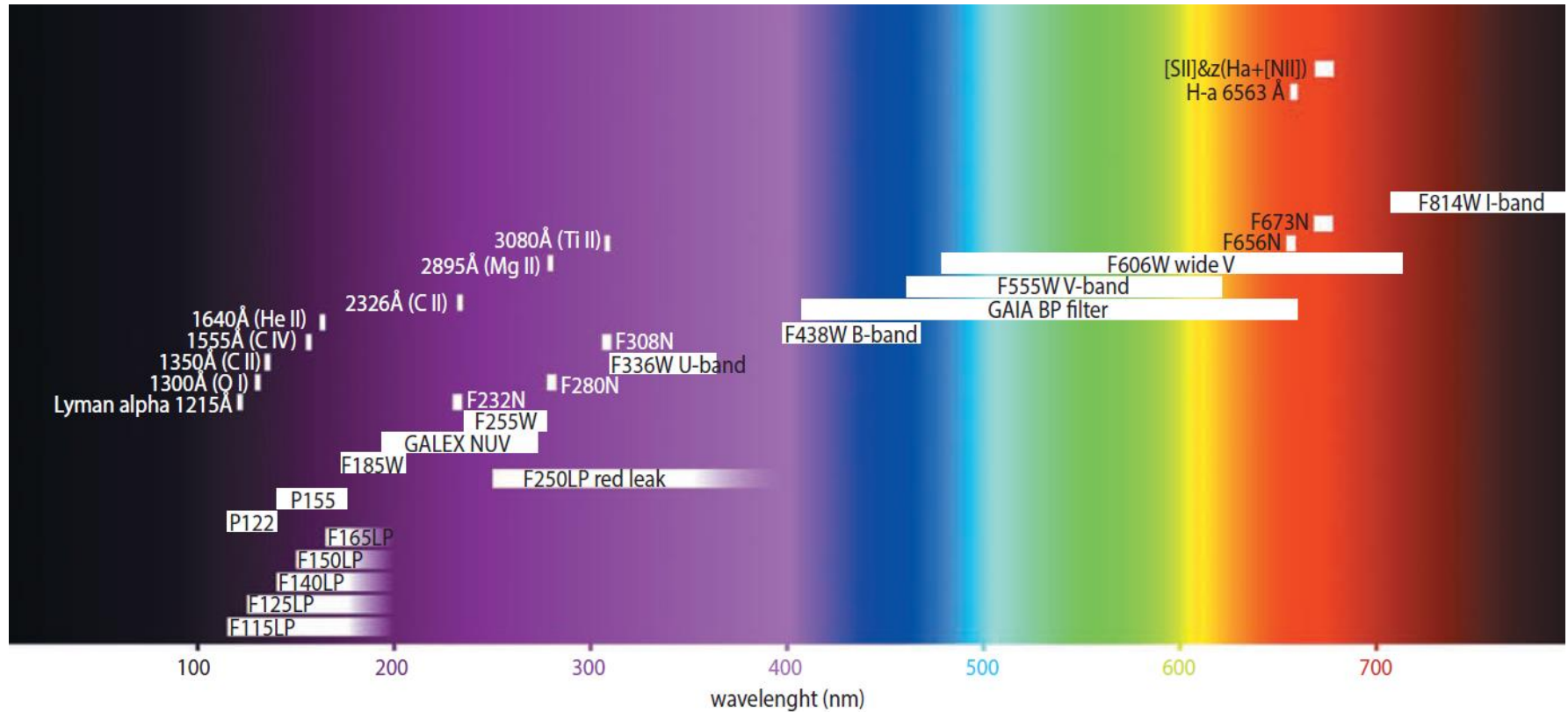


Aspheric mirror



Spherical mirror

Field Camera Unit Filters

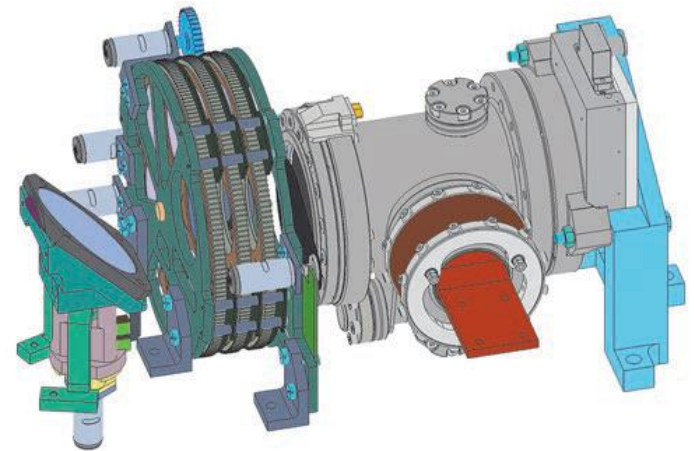


Field Camera Unit Filters (15 for NUV)



UV photometric bands proposed as standards (PROPOSAL FROM THE WORKING GROUP ON ULTRAVIOLET ASTRONOMY DIVISION B, Gomez de Castro et al.)

Band ID	Spectral Range	Objective
UV1	90-110 nm	FUSE window
UV2	120-140 nm	Far UV avoiding geocoronal Ly-alpha
UV3	140-180 nm	GALEX FUV
UV4	180-210 nm	Continuum shortward of the UV bump
UV5	210-230 nm	UV bump
UV6	230-280 nm	Near UV continuum, Fe bands
UV7	280-350 nm	Ozone cut-off window



- + **GALEX NUV**
- + **ASTROSAT-2 Filters**
- + **CASTOR Filters**

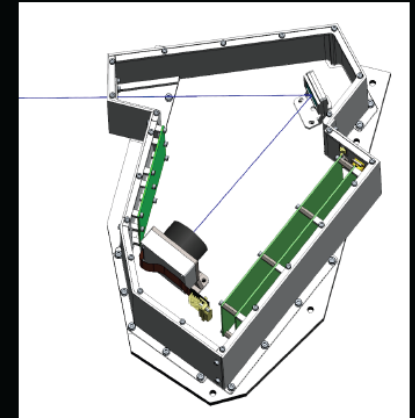
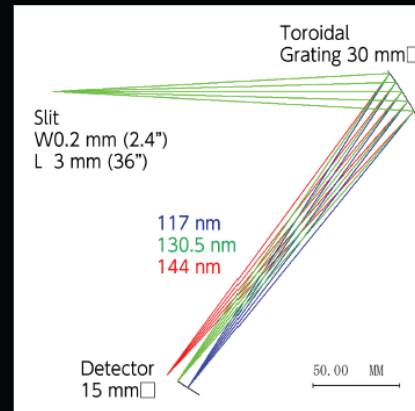
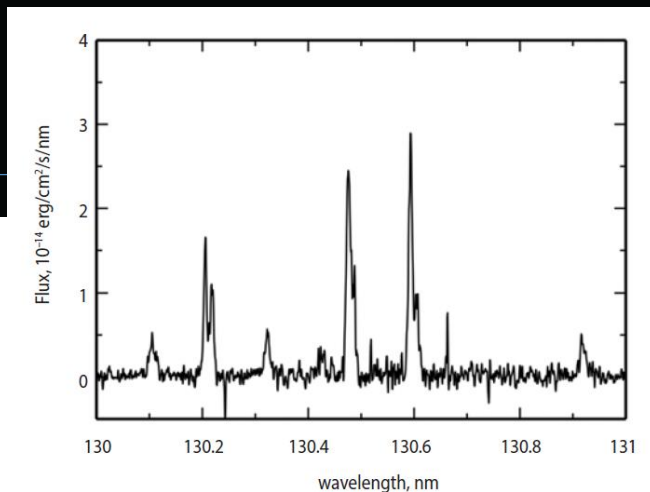
And your suggestions!!!

UVSPEX (see poster by Kameda et al.)

UV spectrograph for Exoplanets (UVSPEX)

- Slit + Concave (Toroidal) grating + Detector (MCP)
- Spectral range : 117-144 nm
- Spectral resolution : ~ 0.3 nm @130 nm
- Slit : 2.5" (= 200 μ m)
- Grating : Toroidal blazed grating, Al+MgF2 coating, ϕ 30 mm, 2400 gr/mm, $f = 250$ mm
- Detector : Image Intensifier (CsI photocathode + Funnel-type Microchannel Plate (MCP))

- 10-20 Earth-size exoplanets
Oxygen \leftrightarrow Ocean
- Earth-like TRAPPIST-1e can be detected in ~ 13 transits
- Model for upper atmosphere



Thank you!



WSO-UV Russian-Spanish team in Lavochkin Industries, 2019 г.