2024 marks the 34th anniversary for the Hubble Space Telescope producing exemplary science. HST, a powerful observatory, probes the astrophysics of the cosmos from Solar System studies to the high-redshift universe. Many compelling investigations have benefitted from a long baseline of consistent observations over time, and now, new possibilities with Webb and Hubble combined studies.
Key Science Threads

- Properties of the huge variety of exo-planetary systems: compositions and inventories, compositions and characteristics of their planets
- Probing the stellar and galactic evolution across the universe: pushing closer to the beginning of galaxy formation and conducting coordinated observations with JWST
- Exploring traces of the nature of dark energy
- Probing the effect of dark matter on the evolution of galaxies
- Quantifying the types and astrophysics of black holes of over 7 orders of magnitude in size
- Tracing the distribution of chemicals of life in the universe
- Investigating phenomena and possible sites for robotic and human exploration within our Solar System
- Hubble’s UV sensitivity, nearly all-sky access, and response times make it an ideal facility to pursue a wide range of time-domain astrophysics

Besides the general observing opportunities provided by the annual call, mid-cycle call, and continuous Director’s Discretionary time, HST has several dedicated topical initiatives and also joint proposals with other facilities.

ACS Celebrating 21 years of operations, ACS offers wide field imaging from FUV to near-IR. Starting forward from HST Cycle 31, imaging (slitless) spectropolarimetry is offered as a new mode of operation for the Wide Field Channel. Calibration updates continue to be made to the Solar Blind Channel, offering unique FUV imaging capabilities not offered elsewhere.

WFC3 offers high resolution imaging in many bands ranging from 2000 to 17000 Angstroms, as well as spectroscopic capability in the near ultraviolet and infrared. Many different modes are available for high precision photometry, astrometry, spectroscopy, mapping and more.

COS Entering its fifteenth year of operation, COS continues to provide critical spectroscopic observations of the ultraviolet universe. Plans are in place to retain the full science capability of the far ultraviolet (FUV) detector out to 2030 and beyond, with Lifetime Position 6 having been introduced for Cycle 30.

STIS With over 26 years in space, STIS offers a wide variety of observing modes from the far ultraviolet through the near infrared. STIS is used primarily for its spectroscopic capabilities with efficient, broad wavelength coverage at low resolution and offering (in the UV) the highest spectral resolution of any of HST’s instruments. Imaging and coronagraphy modes are also available, and a recently available spatial scanning mode allows for extremely high signal-to-noise observations.
ULLYSES: UV Legacy Library of Young Stars as Essential Standards

What is ULLYSES? A 1000 orbit program with the Hubble Space Telescope to obtain a spectroscopic legacy library of young low mass stars in star-forming regions in the Milker Way and massive O and B stars in nearby low metallicity galaxies

Why ULLYSES? To build a library of UV spectra toward low mass stars sampling a range of accretion rates and stellar masses, understand accretion physics from UV diagnostics and the impact of UV radiation on planet-forming disks and planet habitability; To extend the library of UV spectra of O and B stars to low metallicity, understand how their powerful winds driving galaxy evolution change with metallicity, and enable population synthesis in low metallicity high redshift galaxies observed with JWST and the ELTs

When? Over cycles 27, 28, 29 (June 2020–July 2023)

All targets are being observed with COS and/or STIS medium-resolution modes, as detailed in Table 2.

<table>
<thead>
<tr>
<th>Region</th>
<th>Instrumental modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMC and SMC</td>
<td>COS/G130M/1096 (brightest O stars)</td>
</tr>
<tr>
<td></td>
<td>COS/G130M/1291 + COS/G160M/1611 or STIS E140M</td>
</tr>
<tr>
<td></td>
<td>STIS/E230M/1978 (O9 I – B9 I only)</td>
</tr>
<tr>
<td></td>
<td>STIS/E230M/2707 or COS/G185M/1953 + 1986 (B5-9 I)</td>
</tr>
<tr>
<td>Sextans-A and NGC 3109</td>
<td>COS/G140L/800</td>
</tr>
<tr>
<td>Survey T Tauri stars</td>
<td>COS/G130M/1291 + COS/G160M/1589 + 1623 STIS/G230L + STIS/G430L + STIS/G750L</td>
</tr>
<tr>
<td>Monitoring T Tauri stars</td>
<td>COS/G160M/1589 + 1623 + COS/G230L/2635 + 2950</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
<th># ULLYSES targets</th>
<th># AR targets</th>
<th># ULLYSES orbits</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMC</td>
<td>98</td>
<td>55</td>
<td>225</td>
</tr>
<tr>
<td>SMC</td>
<td>65</td>
<td>65</td>
<td>220</td>
</tr>
<tr>
<td>Sextans-A</td>
<td>3</td>
<td>6</td>
<td>~37</td>
</tr>
<tr>
<td>NGC 3109</td>
<td>3</td>
<td>0</td>
<td>~15</td>
</tr>
<tr>
<td>Lupus</td>
<td>27</td>
<td>4</td>
<td>142</td>
</tr>
<tr>
<td>Cha I</td>
<td>12</td>
<td>3</td>
<td>98</td>
</tr>
<tr>
<td>η Cha</td>
<td>4</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>η Cha</td>
<td>4</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>Orion OB1</td>
<td>10</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Σ Ori</td>
<td>3</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>CrA</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Monitoring CTTS</td>
<td>4</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>TOTAL</td>
<td>233</td>
<td>137</td>
<td>981</td>
</tr>
</tbody>
</table>

FOR MORE INFORMATION, VISIT
https://ullyses.stsci.edu

DOWNLOAD DATA AT
https://mast.stsci.edu/search/ui/#/ullyses
**Massive Stars**

The massive star component of ULYSSES leverages on existing FUSE and HST archival data, to provide full UV coverage at medium-resolution for ~240 targets uniformly sampling spectral type and luminosity class.

The ULYSSES dataset for massive stars will enable transformative science in the field of stellar astrophysics, and enable a legacy of studies of the interstellar and circum-galactic media.

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**T Tauri Stars**

The 58 T Tauri stars to be surveyed in 8 Milky Way star-forming regions uniformly sample mass and disk accretion rate. The library of UV-optical-NIR spectra from ULYSSES will enable studies of the accretion and resulting UV radiation in those objects, which affects the evolution of proto-planetary disks and the chemical composition and atmospheric escape of young planets.
Wide Field Camera 3 (WFC3) offers high resolution imaging in bands ranging from 2000 to 17000 Angstroms, as well as spectroscopic capability in the near ultraviolet and infrared. A variety of modes are available for high precision photometry, astrometry, spectroscopy, mapping and more: https://www.stsci.edu/sites/www/home/hst/instrumentation/wfc3.html

Select filters shown. UVIS/IR channels feature 62/15 filters, respectively, with varying bandwidths for many spectral features

https://hst-docs.stsci.edu/wfc3ihb
**Direct Imaging**
High resolution, wide field imaging. Large complement of filters for various photometric bands/spectral features.

**Grim Spectroscopy**
Using grisms instead of imaging filters allows low resolution spectroscopy, while maintaining high spatial resolution.

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**Handbook:** [https://hst-docs.stsci.edu/display/WFC3IHB](https://hst-docs.stsci.edu/display/WFC3IHB)

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**Spatial Scanning**
Slewing during exposure (spatial scanning) places source flux on hundreds of pixels/avoids saturation, achieving extremely high SNR photometry.

**Grim Scanning**
Combining scanning and grim spectroscopy allows for extremely high SNR spectra. Useful for transit observations.
## SPACE TELESCOPE IMAGING SPECTROGRAPH (STIS)

<table>
<thead>
<tr>
<th>Detectors</th>
<th>Wavelength Coverage</th>
<th>Imaging</th>
<th>Spectroscopy</th>
<th>Unique modes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FUV-MAMA</strong></td>
<td>λ.1150-1740 Å</td>
<td>25”x25” FOV 0.025” pixels</td>
<td>G140L: R ~ 1000</td>
<td><strong>TIME-TAG</strong>: 125 μs resolution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>G140M: R ~ 10,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E140M: R ~ 45,800</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E140H: R ~114,000</td>
<td></td>
</tr>
<tr>
<td><strong>NUV-MAMA</strong></td>
<td>λ.1650-3100 Å</td>
<td>25”x25” FOV 0.025” pixels</td>
<td>G230L: R ~ 500</td>
<td><strong>TIME-TAG</strong>: 125 μs resolution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>G230M: R ~ 10,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E230M: R ~ 30,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E230H: R ~114,000</td>
<td></td>
</tr>
<tr>
<td><strong>CCD</strong></td>
<td>λ.1650-11,000 Å</td>
<td>52”x52” FOV 0.051” pixels</td>
<td>G230LB/G430L/G750L R ~ 500 - 700</td>
<td><strong>Spatial scanning</strong>: high S/N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>G230MB/G430M/G750M R ~ 5,000 - 6,000</td>
<td><strong>Coronography</strong>: mask for imaging and occulting bars for spectroscopy</td>
</tr>
</tbody>
</table>

**Detectors**
- **FUV-MAMA**
- **NUV-MAMA**
- **CCD**

**Wavelength Coverage**
- FUV-MAMA: λ.1150-1740 Å
- NUV-MAMA: λ.1650-3100 Å
- CCD: λ.1650-11,000 Å

**Imaging**
- 25”x25” FOV
- 52”x52” FOV
- 0.025” pixels
- 0.051” pixels

**Spectroscopy**
- G140L: R ~ 1000
- G140M: R ~ 10,000
- E140M: R ~ 45,800
- E140H: R ~114,000
- G230L: R ~ 500
- G230M: R ~ 10,000
- E230M: R ~ 30,000
- E230H: R ~114,000
- G230LB/G430L/G750L R ~ 500 - 700
- G230MB/G430M/G750M R ~ 5,000 - 6,000

**Unique modes**
- **TIME-TAG**: 125 μs resolution
- **Echelle** gratings for high spectral resolution
- **Spatial scanning**: high S/N
- **Coronography**: mask for imaging and occulting bars for spectroscopy

Visit the STIS website for more information and links to our documentation
https://www.stsci.edu/hst/instrumentation/stis
In recent cycles, STIS has been used to explore a wide variety of phenomena, including:

- Solar System science (planets, satellites, comets)
- Stellar astrophysics (including heavy use in the ULLYSES program)
- Exoplanet characterization
- Debris disks
- Interstellar and intergalactic media
- Black holes and active galactic nuclei
- Supernovae
- Starbursting galaxies:

STIS observations of moving shadows in TW Hydra

Artist interpretation of TW Hydra’s tilted disks

STIS NEWS

On-going efforts to update the absolute flux calibration to the latest CALSPEC models.
https://www.stsci.edu/hst/instrumentation/stis/flux-recalibration

New repository of Jupyter “walk-through” notebooks for STIS:
https://spacetelescope.github.io/hst_notebooks/notebooks/STIS/README.html
Dust Pillars in Carina observed with the ACS/WFC. Uses filters F502N ([O III], blue) and F658N (Hα + [N II], red).

Gravitational lensing in Abell 370 observed with ACS/WFC. Uses filters F475W (blue), F625W (green), and F814W (red).

Wide Field Channel (WFC)

- Optical imaging, slitless spectroscopy and spectropolarimetry (3,500–11,000 Å)
- Highest throughput on HST in visible light
- 202'' x 202'' field of view, largest on HST
- 13 wide, medium, and narrowband filters
- 15 tunable wavelength filters
- Grism (5,500–10,500 Å); R ~ 100 at 8,000 Å
- Near-UV / visible linear polarization filters

Solar Blind Channel (SBC)

- FUV imaging and slitless spectroscopy (1,150–1,700 Å)
- High throughput, best for FUV imaging
- 35'' x 31'' field of view
- 5 longpass filters, 1 Lyman α filter
- Two prisms; R ~ 79 and 96 at 1,500 Å

Please see the ACS Instrument Handbook for more detailed information on ACS capabilities. https://hst-docs.stsci.edu/display/ACSIHB/
Crab nebula polarization with the ACS/WFC.
Filters: F550M (*red*) and F606W plus a visible linear polarization filter (*blue*).

Detection limits for WFC and SBC (flat spectrum in frequency)

<table>
<thead>
<tr>
<th>Camera</th>
<th>Filter</th>
<th>V-band AB limit (S/N=5 in 1 hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFC</td>
<td>F606W</td>
<td>28.2 mag</td>
</tr>
<tr>
<td>WFC</td>
<td>F814W</td>
<td>27.7 mag</td>
</tr>
<tr>
<td>SBC</td>
<td>F125LP</td>
<td>26.0 mag</td>
</tr>
</tbody>
</table>

1. ACS/WFC has the largest field of view and highest throughput in visible light of any HST instrument
2. The ACS/WFC grism provides slitless spectroscopy and spectropolarimetry of visible to near-IR light
3. ACS is the only active space-based, high spatial resolution polarimeter, providing synergy with JWST dust studies
4. The ACS/SBC is especially optimized for FUV imaging, but also supports slitless spectroscopy

For a complete list of ACS instrument science reports, please visit: https://www.stsci.edu/hst/instrumentation/acs/documentation/instrument-science-reports-isrs
COSMIC ORIGINS SPECTROGRAPH (COS)

**COS Overview**

**Far Ultraviolet (FUV)**
- Medium Resolution mode:
  \[ R \approx 15,000-21,000 \]
  \[ \lambda \approx 900-1800 \text{ Å} \]
- Low Resolution mode:
  \[ R \approx 1,500-4,000 \]
  \[ \lambda \approx 800-2050 \text{ Å} \]
- Effective area \( \approx 1800-3000 \text{ cm}^2 \)
- Three gratings:
  G130M, G160M, G140L
- Pixel format: 16384 x 1024

**Near Ultraviolet (NUV)**
- Medium Resolution mode:
  \[ R \approx 15,000-24,000 \]
  \[ \lambda \approx 1700-3200 \text{ Å} \]
- Low Resolution mode:
  \[ R \approx 2,100-2,900 \]
  \[ \lambda \approx 1650-3200 \text{ Å} \]
- Effective area \( \approx 600-750 \text{ cm}^2 \)
- Four gratings:
  G185M, G225M, G230L, G285M (available but unsupported)
- Pixel format: 1024 x 1024

SEE OUR HANDBOOK AT
https://hst-docs.stsci.edu/display/COSIHB/

COS spectra through April 2017
the Hubble Spectroscopic Legacy Archive (HSLA):
https://archive.stsci.edu/hst/spectral_legacy/

COS Walkthrough Jupyter Notebooks
https://spacetelescope.github.io/COS-Notebooks/
STScI’s COS 2025 policy places restrictions on G130M cenwaves allowed at Lifetime Position 4 and 5 to reduce gain sag from geocoronal Ly-alpha with the goal of retaining full science capability of COS/FUV to 2030 and beyond. Lifetime Positions 5 (G130M) and 6 (G160M) were introduced in Cycles 29 and 30 to facilitate this goal.

**FUV Lifetime Positions** – FUV spectra continue to be obtained at LP2, LP3, LP4, LP5, or LP6, depending on cenwave. LP6, the default location for G160M spectroscopy, has increased wavelength calibration overheads. Please see the COS Instrument Handbook for more details.

**New Reference Files** – Users should be aware that new time dependent sensitivity files were delivered on August 15, 2023. Additionally, by Spring 2024 there will be updated FUV geometric distortion correction and walk correction reference file updates that improve spectra at all lifetime positions, as well as high voltage sensitivity dependence corrections.

**Hubble Advanced Spectral Products** – In Winter 2024 MAST will release new automated spectral coadds of COS and STIS observations at the visit and program level, providing new and easier access to the rich spectroscopic archive of Hubble. Concurrent with the release is the ability to create custom coadditions through Python scripts and example Jupyter notebooks.

More information is available at: https://www.stsci.edu/hst/instrumentation/cos/proposing/cos2025-policies
Hubble Observing and Science Policies

Hubble science policies are coordinated by the STScI Science Mission Office.

**SMO outerspace:** https://outerspace.stsci.edu/display/SBOI/SMO+General+Information

**Call for Proposals**

The Cycle 32 Call for Proposals was released in mid December. Deadline Tuesday March 26, 2024 at 8pm EDT. We are now soliciting Multi-Cycle Treasury Proposals. These are a special class of Treasury GO proposals, requesting at least 350 orbits, that are intended to address high-impact scientific questions that require very large time requests that cannot be accommodated through the standard GO programs. An additional 1500 orbits will be available over Cycles 32-34 to enable these programs. These programs will not be offered annually. A future call may be possible, depending on the response from this call, and the future health of HST, but they will not be offered on a regular basis.

**Proposal Opportunities and Science Policies:** https://hst-docs.stsci.edu/hsp

**MCT page:** https://outerspace.stsci.edu/display/HPR/Multi-Cycle+Treasury+Programs

**Telescope Allocation Committee (TAC)**

The TAC reviews the submitted HST proposals and recommends a science program to the STScI Director. Community participation is a key part of the TAC process, and there are opportunities for both synchronous and asynchronous review. Proposal review will run through April and May with meetings in late May and early June. If you’re interested in serving on the TAC, you can volunteer!

**Volunteer Page:** https://outerspace.stsci.edu/display/SBOI/HST+Review+Volunteer+Form

**Space Telescope Users Committee (STUC)**

The STUC is the primary connection between STScI and HST Project at GSFC and the HST user community, and is charged with providing advice on all aspects of observatory operations. The STUC meets twice a year with STScI and GSFC to hear updates about Hubble operations and provide feedback from the user community. You can contact the STUC with your concerns, volunteer to serve as a STUC member, or review past reports.

**STUC page:** https://www.stsci.edu/hst/about/space-telescope-users-committee
**EXOPLANETS**

Discovery, confirmation, cloud structures

H₂O

Powerful winds, 4x expected water

Comprehensive spectrum of WASP-39b

---

Transits, direct imaging, spectroscopy, IR and near IR WFC3, detection of water, chemistry, clouds

K13B

K13Ab

TiO

---

**Very hot Jupiter, 5000 F, tidally locked**

Titanium cools with altitude on dayside, High wind transport TiO to cold side, precipitation.

Parent star is triple, with third member orange dwarf star Kepler-13C

---

**Slightly larger than Earth, density of two planets in the K138 system indicates water in a very hot thick envelope**

Earth

Kepler-138 d

Metals and rocks

Metals and rocks

High-pressure water

Water vapour

H₂O

---

**Escaping hot Jupiter 4,600 F atmosphere Upper atmosphere heating, tidally football shaped**

Wasp-121b

Mg + Fe

---

**Two mini Neptunes losing their atmospheres, transitioning to super Earths**

One in the HD 63433 system, and the other in the HD 73583 system

The second one is loosing the atmosphere towards its parent star
Time domain HST observations

LENSED SUPERNOVA IN ABELL 370

Cloud features plotted against solar UV radiation

LINK BETWEEN NEPTUNE CLOUD PATTERNS AND SOLAR CYCLE