More than 28 years since launch, the Hubble Space Telescope continues its role at the forefront of astronomy, ranging from our own Solar System to the high-redshift universe.

Through the middle of the next decade, HST will remain the only space-based telescope providing spectroscopy and high-resolution imaging at UV, optical, and near-infrared wavelengths. With the launch of JWST in the near future, the bold science questions pursued with HST will be bolstered by the complementary capabilities of the two observatories.
Highlights

ACS Cycle 25 (CALACS) broadly updated for pixel-level corrections: “Putting the electrons back where they belong”
http://www.stsci.edu/hst/acs/performance/calacs_cte/calacs_cte.html

WFC3 New calibrations for UVIS PSFs, Grism and Exoplanet noise simulators. Also “Aligning HST Images to Gaia: A Faster Mosaicking Workflow”

COS A new initiative, COS 2025 aims to retain full science capability of COS/FUV out to 2025: “Preserving the COS FUV instrument: a new strategy”
http://www.stsci.edu/hst/cos/cos2025

STIS Updates for CALSTIS include geometric distortion, time sensitivity and blaze shift.
See stisblazefix, a tool for blaze fixing:
https://github.com/spacetelescope/stisblazefix

Key Science Threads

• Properties of the huge variety of exo-planetary systems: compositions and characteristics of the parent stars and their planets

• Probing the stellar and galactic evolution across the universe: pushing closer to the beginning of galaxy formation and preparing for JWST deep observations

• Exploring traces 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

Observing opportunities include preparation for JWST observations, the UV initiative, and mid-cycle observing proposals.
Wide Field Camera 3 (WFC3)

WFC3 In Brief:

**Ultraviolet-Visible Channel (UVIS)**
- 162'' x 162'' field of view
- 62 filters: 200 - 1000 nm coverage
- 1 grism: 200-400 nm
- 0.039''/pixel

**Infrared Channel (IR)**
- 123'' x 136'' field of view
- 15 filters: 800 - 1700 nm coverage
- 2 grisms: 800 - 1150 nm, 1075-1700 nm
- 0.13''/pixel

Basic Modes:

**Direct Imaging**
- high resolution imaging over the full optical and infrared wavelength range
- wide field of view in both channels
- range of broad, medium and narrow filters

**Spatial Scan Imaging**
- measure changes in source position to a precision of 20-40 μas
- enables parallax distance measurements up to 5 kpc.

**Dash Observing Strategy**
- Enables multiple pointings per orbit in gyro guiding without re-acquiring the guide stars

**Grism Spectroscopy**
- low resolution slitless spectroscopy in UV & IR
- zJ & JH continuous coverage in IR
- high multiplexing
- spatially-resolved emission lines
- 10x increase in redshift accuracy over photometry

**Spatial Scan Spectroscopy**
- best suited for stellar spectra
- high precision spectrophotometry
- spectrum perpendicular to the dispersion direction, = more photon collection
- longer exposures saturation free
- transit spectroscopy
- McCullough & MacKenty 2012, ISR WFC3 2012-08

For further information about WFC3, visit our website: [www.stsci.edu/hst/wfc3](http://www.stsci.edu/hst/wfc3)
For more information about STScI: [help@stsci.edu](mailto:help@stsci.edu)
Wide Field Camera 3 (WFC3) continued

What's new?

UVIS PSF Database
- Database of high S/N isolate stars
- More than 22 million sources
- Extended to all UVIS filters
https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html

Photometric repeatability with spatial scan
- Designed to observe very bright stars'
- Spatial scan allows collect millions of photons without saturating the detector
- Considerably reduces sources of noise and flat-fielding errors
- The photometric repeatability for UVIS scanned observations is at the 0.1% level
- Shanahan et al. ISR WFC3 2017-16

New Grism Calibration and Software
- New trace and wavelength calibrations of the UVIS G280 +1/-1 Orders (Pirzkal et al. WFC3 ISR 2017-20)
- Release of the Grism multi-orientation reconstruction code LINEAR
https://bitbucket.org/Russell_Ryan/linear-reconstruction

WFC3 transiting exoplanet noise simulator PANDEXO
- Optimizes WFC3’s NSAMP and SAMP-SEQ parameters
- Predicts scan rate, # of orbits per visit, transmission/emission spectrum uncertainties
- Determines the observation start window (for APT)
- Supports G102 & G141, 256x256 & 512x512 subarrays, spatial scanning

Comparison between the observed (red) and expected (blue) counts for the spectrum of WASP 43b
Advanced Camera for Surveys (ACS)

**Orion nebula**
(F435W + F555W + F658N + F775W + F850LP)

**Abell 370**
(Frontier Fields: F435W + F606W + F814W)

<table>
<thead>
<tr>
<th>Wide Field Channel (WFC) images shown above</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Optical imaging and spectroscopy (3,500–11,000 Å)</td>
</tr>
<tr>
<td>• 202″ x 202″ field of view, largest on HST</td>
</tr>
<tr>
<td>• Two 2,048 × 4,096 25 μm/pixel CCDs</td>
</tr>
<tr>
<td>• 0.05″ pixels; critically sampled at 8,000 Å</td>
</tr>
<tr>
<td>• 3 mirror design, overcoated silver on mirrors</td>
</tr>
<tr>
<td>• 13 wide, medium, and narrowband filters</td>
</tr>
<tr>
<td>• 15 ramp filters with selectable central wavelengths</td>
</tr>
<tr>
<td>• G800L grism (3,500–10,500 Å) R ~ 100 at 8,000Å</td>
</tr>
<tr>
<td>• Polarizers optimized for UV and visible wavelengths with relative position angles 0°, 60°, and 120°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solar Blind Channel (SBC)</th>
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<tbody>
<tr>
<td>• FUV imaging and spectroscopy (1150 –1700 Å)</td>
</tr>
<tr>
<td>• 35″ x 31″ field of view, 0.032″ pixels</td>
</tr>
<tr>
<td>• 1024 x 1024 CsI 25 μm/pixel MAMA</td>
</tr>
<tr>
<td>• 2 mirror design, MgF2 on Al</td>
</tr>
<tr>
<td>• 5 longpass filters, 1 Lyman α filter, 2 prisms</td>
</tr>
<tr>
<td>• PR110L, PR130L prisms R ~ 79, 96 at 1500 Å</td>
</tr>
</tbody>
</table>

*High Resolution Channel (HRC) inoperative*

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For more information about STScI: help@stsci.edu
For proposal information: http://www.stsci.edu/hst/proposing/documents/cp/cp_cover.html

More information on ACS can be found at http://www.stsci.edu/hst/acs
http://www.stsci.edu/hst/acs/analysis/throughputs
What's new?

17–01: Sink Pixels in ACS/WFC (Ryon & Grogin; figure at right)
17–02: Updated MDRIZTAB Parameters for ACS/WFC (Hoffmann & Avila)
17–03: New Subarray Readout Patterns for the ACS Wide Field Channel (Golimowski et al.)
17–04: Updated Measurements of ACS/SBC Dark Rates (Avila)
17–05: Pixel History for Advanced Camera for Surveys Wide Field Channel (Borncamp et al.; figure at bottom)
17–08: A Study of PSF Models for ACS/WFC (Hoffmann & Anderson)
17–12: The Hubble Space Telescope ‘Program of Last Resort’ (Bellini et al.)

ACS Calibration Pipeline (CALACS) broadly updated for Cycle 25: Improved WFC pixel-based correction for charge-transfer inefficiency; flagging of charge-sink pixel trails; de-flagging of stable warm- and hot-pixels

Recent ACS Instrument Science Reports (ISRs) http://www.stsci.edu/hst/acs/documents/isrs
Cosmic Origins Spectrograph (COS)

COS Overview

Far Ultraviolet (FUV):
- Medium Resolution mode:
  \[ R (\lambda / \Delta \lambda) \approx 15,000-21,000 \]
  \[ \lambda \approx 900-1800 \text{ Å} \]
  \[ \lambda \text{ per exposure} \approx 292-360 \text{ Å} \]
- Low Resolution mode:
  \[ R (\lambda / \Delta \lambda) \approx 1,500-4,000 \]
  \[ \lambda \approx 900-2050 \text{ Å} \]
  \[ \lambda \text{ per exposure} \approx >1150 \text{ Å} \]
- Effective area \( \approx 1800-3000 \text{ cm}^2 \)
- Background \( \approx 1.1 \times 10^{-4} \text{ cts s}^{-1} \text{ resel}^{-1} \)
- Blue modes:
  unique access to \( \lambda < 1150 \text{ Å} \), but lower resolution and throughput.

Near Ultraviolet (NUV):
- Medium Resolution mode:
  \[ R (\lambda / \Delta \lambda) \approx 15,000-24,000 \]
  \[ \lambda \approx 1700-3200 \text{ Å} \]
  \[ \lambda \text{ per exposure} \approx 3 \times 35-41 \text{ Å} \]
- Low Resolution mode:
  \[ R (\lambda / \Delta \lambda) \approx 2,100-2,900 \]
  \[ \lambda \approx 1650-3200 \text{ Å} \]
  \[ \lambda \text{ per exposure} \approx 2 \times 398 \text{ Å} \]
- Effective area \( \approx 600-750 \text{ cm}^2 \)
- Background \( \approx 7.4 \times 10^{-3} \text{ cts s}^{-1} \text{ resel}^{-1} \)
- NUV imaging mode:
  FOV area (arcsec²) \( \approx 4.9 \) (un-vignetted) or 12.5 (full)
  Pixel Scale (arcsec) \( \approx 0.024 \)
  Bandpass \( \approx 1700-3200 \text{ Å} \)

More information on COS can be found at http://www.stsci.edu/hst/cos
For more information about STScI: help@stsci.edu
For proposal information: http://www.stsci.edu/hst/proposing/documents/cp/cp_cover.html
COS/FUV resolution as function of wavelength for Cycle 25+

COS 2025: New strategy to extend the lifetime of COS

The goal of COS 2025 is to retain full science capability of COS/FUV out to 2025. It places restrictions on the G130M cenwaves allowed at Lifetime Position 4 to reduce gain sag from Ly-alpha. It is in place starting with cycle 25.

For more information visit: http://www.stsci.edu/hst/cos/cos2025

New COS FUV central wavelength settings:

Two new central wavelength settings are being offered this cycle for COS/FUV observations, named G140L/800 and G160M/1533. The G140L/800 setting allows for contiguous coverage of the entire spectral region from 800 to 1950 Angstroms on a single COS detector segment (FUVA) with a low spectral height below 1150 Angstroms, allowing higher S/N for background-limited observations. The G160M/1533 setting extends coverage at the short-wavelength end of G160M by 44 Angstroms to overlap with the longest wavelengths covered by the G130M/1222 setting, and is otherwise expected to be very similar to the existing G160M/1577 cenwave. This allows a broad range of FUV wavelengths to be covered by just two central wavelength settings (1222+1533). For full details, see the COS Instrument Handbook:

The Hubble Spectroscopic Legacy Archive

Solar System and Exoplanets

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Galaxies and Clusters

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Stars

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<td>Late Type Stars (N = 82)</td>
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<td>White Dwarfs (N = 169)</td>
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<td>T Tau Stars (N = 34)</td>
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<td>Post-AGB (N = 27)</td>
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<td>Low-Mass X-Ray Binaries (N = 7)</td>
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<td>Other (N = 41)</td>
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QSOs, AGN, and Seyferts

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<td>QSOs, AGN, and Seyferts (N = 628)</td>
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Supernovae and SNRs

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<td>Supernovae and SNRs (N = 11)</td>
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Searchable, and can be sorted by many attributes

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<th>DEC</th>
<th>Nexp</th>
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<th>AltClass</th>
<th>RedShift</th>
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<th>Median S/N</th>
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<td>796</td>
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<td>2.05241</td>
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<td>QSO</td>
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<td>GALAXYNUCLEUS;SEYFF</td>
<td>Mrk-509</td>
<td>G</td>
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<td>IC6230</td>
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<td>75.4871</td>
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</tbody>
</table>

Quicklook of co-added spectra: e.g. NGC-5548

- Archive contains science-grade combined spectra of COS data organized by target type and scientific purpose
- Download all the data associated with a target or type of target with a single click

https://archive.stsci.edu/hst/spectral_legacy/
Space Telescope Imaging Spectrograph (STIS)

FUV MAMA (Multi Anode Microchannel Array)
- 1024 x 1024 CsI detector, TIME-TAG available
- Imaging: 25'' x 25'' FOV, 0.025'' pixels, 9 filters
- Spectroscopy: 2 first order and 2 echelle gratings
  - $\lambda = 1150 – 1740\text{Å}$, $R \sim 1000 - 200,000$
  - ~30 cen. wave. configurations

NUV MAMA
- 1024 x 1024 Cs$_2$Te detector, TIME-TAG available
- Imaging: 25'' x 25'' FOV, 0.025'' pixels, 12 filters
- Spectroscopy: 2 first order and 2 echelle gratings
  - $\lambda = 1650 – 3100\text{Å}$, $R \sim 500 - 200,000$
  - ~55 cen. wave. configurations
- Prism spectroscopy
  - $\lambda = 1150 - 3620\text{Å}$, $R \sim 10 – 2500$

CCD
- 1024 x 1024 SITE CCD detector
- Imaging: 52'' x 52'' FOV, 0.051'' pixels, 9 filters
- Spectroscopy: 6 first order gratings
  - $\lambda = 1650 – 11,000\text{Å}$, $R \sim 500 - 10,000$
  - ~40 cen. wave. configurations
- Usable with coronagraphic mask and occulting bars
  - Broadband imaging (2000 - 10,300 Å)
  - Bar-occulted spectroscopy (2000 - 10,300 Å)

STIS offers visible and UV imaging and spectroscopy http://www.stsci.edu/hst/stis
For more information about STScI: help@stsci.edu
For proposal information: http://www.stsci.edu/hst/proposing/documents/cp/cp_cover.html

STIS

10^{-4} contrast at 0.2'' with BAR5
What’s new?

Reference File Updates for CALSTIS

**Geometric Distortion**
- Geometric distortion correction for FUV-MAMA imaging
- Astrometric precision reduced from ~30 to ~4 mas

**Time Dependent Sensitivity**
- Updated corrections to the time dependent sensitivity of all spectral modes
- Improved flux calibrations up to ~8%

**Blaze Shift**
- Updated blaze shift for FUV E140H
- Reduces “flux mismatch” in overlapping regions from 5-10% to < 5%

Blaze fix tool: stisblazefix
- Python tool for finding empirical correction to blaze shift
- Improves correction on individual spectra over CALSTIS results
More info: https://stisblazefix.readthedocs.io/

**New CCD Spatial Scanning**
- Overcome fringing limitations in the red to achieve high S/N (>500)
- Mode is currently “available but unsupported” — STIS team is investigating more support for Cycle 26
More info: goo.gl/p48U9S

Weak DIBs detected with STIS spatial scanning (Cordiner et al. 2017, ApJL, 843, L2)