Space Telescope Imaging Spectrograph (STIS)

Essentials of the Instrument:

<table>
<thead>
<tr>
<th>Installed on HST</th>
<th>Feb. 1997 (SM2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>High/medium/low resolution 2-D spectroscopy, imaging, coronagraphy</td>
</tr>
<tr>
<td>__ range</td>
<td>1150-10300 Å</td>
</tr>
<tr>
<td>Optical Elements</td>
<td>Gratings, filters, prism</td>
</tr>
<tr>
<td>Detectors</td>
<td>1024² MAMA (2), 1024² CCD</td>
</tr>
<tr>
<td>Field(s) of View</td>
<td>Wide variety of slit widths &amp; heights for 25² and 52² arcsec MAMA, CCD fields of view</td>
</tr>
<tr>
<td>Spectr. resolution</td>
<td>R=500-1.1E5</td>
</tr>
<tr>
<td>Enhancement factor over predecessor instrument (if any)</td>
<td>512x over GHRS, FOS due to spatial multiplexing</td>
</tr>
<tr>
<td>Cost</td>
<td>$162M (FY00$)</td>
</tr>
<tr>
<td>Current status/health</td>
<td>Operational, but no electrical redundancy</td>
</tr>
</tbody>
</table>

Capabilities of STIS

STIS is a highly efficient, all-purpose spectrograph with many available observing modes across nearly a decade of wavelength from the far-ultraviolet (FUV) to the far-red/near-infrared. In 1997 it introduced 2-D spectroscopy to HST and made programs previously infeasible (due to observing time limitations) achievable. STIS also contains limited imaging capability, as well as a coronagraphic mode. Tabulated below is a top-level listing of the instrument’s spectroscopic modes. All

<table>
<thead>
<tr>
<th>Grating</th>
<th>Sp. Range (Å)</th>
<th>Å Per tilt</th>
<th>Resolving power</th>
</tr>
</thead>
<tbody>
<tr>
<td>G750L</td>
<td>5240-10270</td>
<td>5030</td>
<td>530-1040</td>
</tr>
<tr>
<td>G750M</td>
<td>5450-10140</td>
<td>570</td>
<td>4870-9050</td>
</tr>
<tr>
<td>G430L</td>
<td>2900-5700</td>
<td>2800</td>
<td>530-1040</td>
</tr>
<tr>
<td>G430M</td>
<td>3020-5610</td>
<td>286</td>
<td>5390-10020</td>
</tr>
<tr>
<td>G230LB</td>
<td>1680-3060</td>
<td>1380</td>
<td>620-1130</td>
</tr>
<tr>
<td>G230MB</td>
<td>1640-3190</td>
<td>1155</td>
<td>5470-10630</td>
</tr>
<tr>
<td>G230L</td>
<td>1570-3180</td>
<td>1610</td>
<td>500-1010</td>
</tr>
<tr>
<td>G230M</td>
<td>1640-3100</td>
<td>90</td>
<td>9110-17220</td>
</tr>
<tr>
<td>G140L</td>
<td>1150-1730</td>
<td>610</td>
<td>960-1440</td>
</tr>
<tr>
<td>G140M</td>
<td>1140-1740</td>
<td>55</td>
<td>11400-17400</td>
</tr>
<tr>
<td>E230M</td>
<td>1570-3110</td>
<td>800</td>
<td>30000</td>
</tr>
<tr>
<td>E230H</td>
<td>1620-3150</td>
<td>267</td>
<td>114000</td>
</tr>
<tr>
<td>E140M</td>
<td>1150-1710</td>
<td>620</td>
<td>45800</td>
</tr>
<tr>
<td>E140H</td>
<td>1150-1700</td>
<td>210</td>
<td>114000</td>
</tr>
<tr>
<td>Prism</td>
<td>1150-3620</td>
<td>2470</td>
<td>2900-25</td>
</tr>
</tbody>
</table>
gratings down to G230MB utilize the CCD
detector, and those below feed either the
FUV MAMA detector (G140L,M,
E140M.H) or the NUV MAMA (G230L,M,
E230M.H, prism). The “per tilt” column
lists the wavelength coverage in a single
exposure; rotation of a mechanism brings
the next piece of spectrum onto the detector.

Several aspects of the detectors are
noteworthy. The MAMAs are high-
technology photon-counting devices
developed specifically for low-noise
FUV/NUV applications in the STIS science
program, and were later used as proven
heritage designs and spare hardware on ACS
and COS. The CCD was coated to have
sensitivity to as blue wavelengths as
possible (< ~2000Å) in addition to a near-IR
response, to provide alternative observing
modes in the NUV as well as backup
capabilities should the NUV MAMA fail.

Science Highlights

The ability of the STIS long-slit to provide
Doppler velocities simultaneously at
separate space points in a galaxy’s core has
been the key to the efficient detection and
characterization of supermassive black holes
(SBH) at the centers of galaxies using HST.
STIS revealed that the SBH mass is tightly
correlated with the mass of the stellar bulge
of the parent galaxy, i.e., the birth/growth of
SBHs is related to the properties of bulges.

STIS was the first instrument to measure the
composition of an extra-solar planet’s
atmosphere when it detected sodium, and
later an extended hydrogen exosphere, in the
atmosphere of the Jovian-size planet
revolving about the star HD209458.

STIS data have produced over 400 papers in
the refereed scientific literature.

STIS Status and Prospects

STIS is performing nominally at the current
time, and is carrying out the 23% of orbits
allocated to it during the Cycle 12 observing
program. Phosphorescence induced by
particle radiation on the NUV MAMA
detector window produces an undesired
background which has been present since
1997 and is slowly increasing as the
detectors warm along with other instruments
in the telescope’s aft shroud. The MAMA
detectors themselves are performing
nominally. The CCD detector is slowly
degrading as a result of radiation particle
hits over time. Specifically, the number of
unannealable “hot pixels” is substantial and
growing, and the pixel-to-pixel “charge
transfer efficiency” during CCD readouts
degraded from its initial state of ~0.99999
to ~ 0.9997 after the first 4.5 years on orbit.

The biggest threat to STIS lies not in its
detectors, but in its electronics. All HST
instruments are built with a fully redundant
electronics chain—“Side 2”—in addition to
the primary “Side 1.” On May 16, 2001,
STIS lost operations on Side 1, presumably
to a shorted tantalum capacitor in a low-
voltage power supply board. Operations
were successfully restored on Side 2, and
have continued uninterrupted ever since.
However, STIS is now an electrically no-
fault-tolerant instrument: there will be no
return to Side 1 should Side 2 develop problems. However, there is no known specific threat to Side 2.