The Advanced Camera for Surveys: Calibration Plan for Cycle 17

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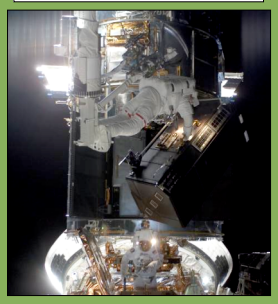
Abstract:

The Advanced Camera for Surveys (ACS) is scheduled for repair in October 2008 during HST's Servicing Mission 4. The repair will replace the CCD Electronics Box and Low Voltage Power Supply, restoring the two CCD cameras to full operation. Along with the Solar Blind Channel, which is currently still active, the ACS will have three fully functional detectors available for use in Cycle 17 science programs. In this poster, we present the Servicing Mission Orbital Verification Plan which will verify the basic characteristics of the instrument, allow for improvements as necessary, and which will establish improved calibrations.

ACS Installation During SM3B



Introduction:

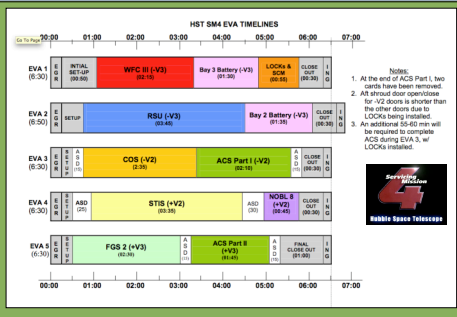
- Installed during SM3B in March 2002
- Powerful 3rd generation HST imager at UV/visible wavelengths (115-1050 nm)
- Three imaging channels:
  - **Wide Field Channel (WFC) :**
    HST's most sensitive, largest field-of-view (FOV) visible/near-infrared imager
    350-1050 nm; 202x202" FOV with 0.050" pixels
    13 broad and narrowband filters, plus polarizers and long-wavelength grism
  - **High Resolution Channel (HRC) :**
    HST's highest spatial resolution imager with NUV sensitivity
    200-1000 nm; 29x26" FOV with 0.027" pixels
    17 broad and narrowband filters, plus ramps, polarizers, and coronagraph
  - **Solar Blind Channel (SBC) :**
    HST's most sensitive ultraviolet photon-counting detector
    115-180 nm; 35x31" FOV with 0.031" pixels
    6 filters, 2 prisms (spectroscopic capability)

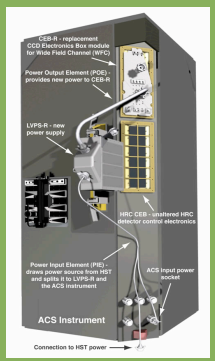
ACS Operational Status:

- ACS Side-1 failed on June 19, 2006. Operations with Side-2 resumed on July 4.
- ACS Side-2 failed on January 27, 2007 and is inaccessible for repair.
- ACS was configured for Side-1 operations using the SBC-only on Feb 15, 2007.

Hubble Servicing Plan (October 2008):

- WFC3 installed (in place of WFPC2)
- COS installed (in place of COSTAR)
- STIS repaired
- ACS repaired
- Fine Guidance Sensor #3 replaced
- All six gyros replaced (Rate Sensor Units)
- All six batteries replaced
- Over-voltage Protection kit installed
- Optical Control Electronics connected
- New Outer Blanket Layer installed on Bay 8
- Soft Capture Mechanism installed (for de-orbit)
- Re-boost
- Release on Flight Day 9

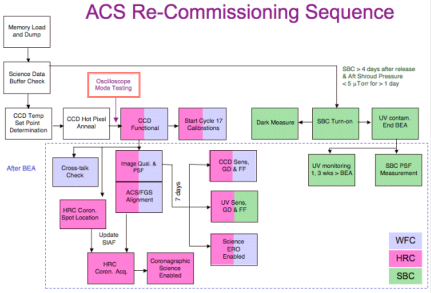




ACS Repair:

- Replaces the four boards within the WFC **CCD Electronics Box** (CEB) with a replacement module. The CEB-R accesses the WFC detector and the ACS command and data handling subsystem using the existing card edge connectors for the CEB.
- Attaches a new **Low Voltage Power Supply Replacement** (LVPS-R) box on the outside of the instrument at a handrail. This box provides power to the new CEB-R module for operating the WFC channel with the new CEB-R as well as for attempting the HRC restoration.
- Connects the LVPS-R to the ACS input power connector using a "splitter" cable called the Power Input Element (PIE).
- Connects the LVPS-R to the CEB-R using the Power Output Element (POE) cable.
- Operates the WFC CCDs using the new CEB-R electronics and LVPS-R power.
- Uses the existing power harnessing inside the instrument to convey LVPS-R power to the HRC. This power flows from the LVPS-R into the new (WFC) CEB-R and then into the card edge connectors at the WFC CEB to the existing power harnessing. Separate power supplies are used within the LVPS-R so that WFC and HRC operations are totally independent.

ACS Re-Commissioning Sequence



The Hubble Space Telescope In Orbit

ACS Servicing Mission Orbital Verification:

- **Engineering Requirements**
  Load and Dump On-Board Memory
  Science Data Buffer Check
  CCD Temperature Set Point Determination
  CCD Hot Pixel Annealing
  WFC Oscilloscope Test
  CCD Functional Test
  SBC Turn-on and Anomalous Recover Test
  SBC Dark Current Measurement
  SBC UV Contamination Check (Bright Earth Avoidance)
- **Target Acquisition Requirements**
  HRC Coronagraphic Spot Location
  HRC Coronagraphic Acquisition
- **Optical Alignment Requirements**
  SBC PSF Measurement
  CCD Image Quality, PSF measurement, ACS/FGS Align
  ACS Corrector Alignment, Coarse
  ACS Corrector Alignment, Fine
- **Calibration Requirements**
  CCD Cross Talk
  CCD External CTE Monitor
  CCD Sensitivity, Distortion, Flat Field (HRC/WFC)
  UV Sensitivity, Distortion, Flat Field (HRC/SBC)

**** Calibration and monitoring will continue in Cycle 17 ****

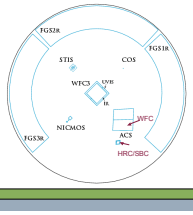
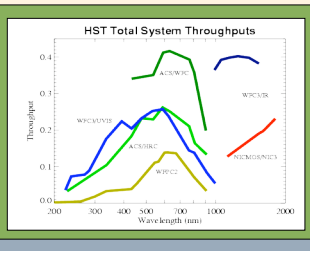
SMOV Optimization Plan:

- The hardware developed for the ACS Repair cannot be tested with the remaining on-orbit hardware or the on-orbit CCDs. This unusual situation requires tools usually available in the laboratory for fine tuning the CCD performance.
- For the first time, the functionality of an **oscilloscope** will be installed with the instrument to allow **on-orbit optimization** of the new control electronics.
- The optimization program will run in the **first 3 weeks** of SMOV.
- What can be optimized?
  1.) CCD bias voltages
  2.) CCD clock rail voltages
  3.) CCD readout timing pattern
  4.) Science Data Control Register - data transmission timing
- Normal frames (bias, EPER, darks) will be paired with oscilloscope frames for diagnostic purposes, in order to find the combination of parameters that will allow the best performance of the detectors in terms of:
  the final Read Noise (e-), Full Well,
  Linearity, and Charge Transfer Efficiency

ASSUMING October 8, 2008 LAUNCH DATE

HRC Science Enabled ~ Nov 15
WFC Science Enabled ~ Nov 22
SBC Science Enabled ~ Nov 22

The Future of ACS observing:

- ACS offers powerful, unique imaging capabilities, including:
  HST's largest field of view, highest spatial resolution, and highest sensitivity at UV/visible wavelengths
- Since its installation in 2002, ACS has been the dominant instrument on the observatory (in submitted proposals & approved orbits). In cycle 17, **ACS observations will comprise ~24% of allocated orbits** (both prime and parallel).
- The ACS-Repair restores unique capabilities not duplicated by WFC3.
- ACS will be extremely valuable when used for **parallel** observing, for example with:
  Large mosaics, with ACS covering the visible and WFC3 the near-UV or infrared
  Deep field observations, with ACS providing wide-field imaging and COS/STIS providing spectroscopic redshifts
- If WFC3 were to fail, a repaired ACS would be the only means of maintaining high-efficiency UV/visible imaging, a crucial capability of the observatory.

HST focal-plane following SM4