Program Title: Daily Monitoring of ACS CCDs **PI:David Golimowski**
Co-Is : Marco Sirianni

Purpose: This program comprises basic tests for measuring the read noise and dark current of the ACS CCDs and for tracking the growth of hot pixels. The recorded frames are used to create bias and dark reference images for science data reduction and calibration. This program will be executed four days per week (Mon, Wed, Fri, Sun) for the duration of Cycle 17 (January 2009 - March 2010). To facilitate scheduling, this program is split into two proposals each spanning 7 months.

Description: This program mimics the corresponding CCD daily monitoring program executed in Cycle 15 before the failure of ACS. A series of bias and dark frames are recorded on Monday, Wednesday, Friday, and Sunday of every week. Four 1000 sec WFC and HRC dark frames are obtained concurrently using the signal processing scheme (clamp-and-sample or dual-slope integration) adopted after SMOV and the default gain setting of 2.0 e-/DN. Four bias frames are obtained from each camera before and after the dark frame series. Two frames are recorded using the default gain of 2.0 e-/DN, while the other two frames are recorded using other gain setting(s) that may be supported after the SMOV tests of ACS-R.

Fraction GO/GTO Programs Supported: All GO/GTO programs involving the ACS CCDs. Science programs involving transient phenomena (e.g., supernovae, variable stars, etc.) will rely on the daily accounting of hot pixels derived from this program.

Resources Required: Observation: Sixteen internal ACS frames (8 x 1000 sec dark and 8 bias) are obtained every other day (i.e., four days per week), yielding a total of 64 frames each week. Each day's exposures will span 4 internal orbits. All frames can be obtained during approximately 20% of Earth occultation time. This program uses approximately 980 internal orbits, which are divided into two observing proposals of about 490 orbits.

Resources Required: Analysis: About 0.5 FTE is required to reduce and analyze the data and to produce and deliver the calibration reference files.

Products: The daily bias and dark frames will be combined to produce the biweekly superbias and superdark reference frames used in OTFR by OPUS. The daily darks will be used to monitor and inventory hot pixels before and after the monthly ACS anneal.

Accuracy Goals: Our chief goals are (1) to produce a clean daily dark (i.e., one free of the affects of cosmic rays) and a biweekly reference files, and (2) to monitor the number and intensities of hot pixels with a two-day sampling frequency.

Scheduling & Special Requirements: Avoid execution during SAA passages because the enhanced cosmic-ray flux compromises the discrimination of hot pixels from multiple cosmic-ray impacts and contaminates the bias frames with unwanted cosmic rays during readout. Note that SAA-impacted orbits are usable.

ACS External CTE Monitor **PI: M. Chiaberge**

Purpose. This program will obtain a direct calibration of photometric losses due to imperfect
CTE by imaging stars in 47 Tuc.

Description. Observations of 47 Tuc with half-FOV sized dithers, various filters, and exposure times are used to achieve different background levels to characterize impact of CTE on photometry. For each pointing we will obtain 2 CR-SPLITs to allow cosmic ray rejection and provide a set of "clean" stars for the analysis of CTE effects on photometry. More specifically, since the CTE also depends on the background level, we will obtain 4 different background levels for HRC and 5 for WFC, using the F502N and F606W filters and different exposure times, from 30s to 400s per exposure. In this way, we will obtain background levels ranging from ~0 to ~50 e-/pixel. Thus the total number of exposures for WFC is 5 (bkg levels) x2 (CR-SPLIT) x 3 (positions on the sky) = 30. Since it is crucial to obtain an almost constant sky level, we will request "low sky". Four to five images can be done each orbit so the total orbit calculation for WFC leads to 8 orbits (verified with APT). For HRC, we will keep the field fixed and perform readout using 3 different amplifiers. Therefore 4 (bkg levels) x 2 (CR-SPLIT) x 3 (amplifiers) = 24 HRC images can be obtained in 3 orbits. Therefore, the total number of requested orbits for this Cycle is 11.

Fraction GO/GTO Programs Supported. About one third to one half of all WFC programs, with an increasing fraction with time as the effect grows larger. Programs which endeavor to perform high precision photometry are particularly reliant on the up-to-date CTE calibration.

Resources Required: Observation. This program requires 11 external orbits each time it executes. The next execution should be planned in February 2009.

Resources Required: Analysis. About 0.5 FTE will be required to plan, reduce and analyze the data.

Products. Monitoring the validity of the time dependent photometry correction formulae. Accuracy Goals. ~10 of the size of the correction, roughly 1 – 2% in absolute photometry precision.

Scheduling and Special Requirements. This program is done once in the Cycle, possibly at the beginning of it. Note that in case post-SM4 CTE shows substantial differences with respect to the published formulae, we will need to repeat the program one more time during the Cycle (possibly between August and September 2009) and derive new coefficients for the time-dependent correction formulae.

ACS internal CTE monitor **PI: Max Mutchler**

Purpose. This program will measure the internal charge transfer efficiency (CTE) of the HRC and WFC detectors once per year, to track the accumulating CCD damage due to on-orbit radiation exposure. The internal CTE data can be much more easily related to ground testing for fostering engineering understanding, than the external CTE observations aimed at obtaining an empirical correction for science data.

Description. EPER (extended pixel edge response) and FPR (first pixel response) data will be collected over a range of signal levels, but skewed towards the low levels where CTE losses are most significant (although we have begun including more of the higher signal levels recently). The internal tungsten calibration lamps will be used, with default amps and gains. Both parallel and serial CTE measurements can be made with the data.

Fraction GO/GTO Programs Supported. Not directly used for calibration corrections, in an indirect sense supports all CCD observations.

Resources Required: Observation. About 35 internal orbits of CTE data at a wide range of signal levels will be obtained annually. A one-orbit monthly check at the Fe55-like signal level (1620e) for WFC is also obtained by the anneal program, and will be included in this analysis. The total request is 35 internal orbits.

Resources Required: Analysis. About 0.2 FTE will be required to reduce and analyze the data, and publish results. IDL scripts initially created pre-flight by Mike Jones (and later modified for inflight data by Marco Sirianni) will be used to reduce the EPER and FPR data. New IDL programs by Pey-Lian Lim will also be used. If the bias level measurement problem persists, this program may require more manual effort to yield good results, since CTE results are very sensitive to the bias level correction.

Products. An ISR describing the CTE trend / forecast was published in April 2005, including a comparison against predictions based on similar pre-flight data, so further results will be continually added to the plots on the CTE webpage. Due to the switch to the side 2 electronics (in particular the lower CCD operating temperature) and the unknown effects of ACS being offline for many months prior to SM4, we will likely document any significant findings in another ISR.

Accuracy Goals. A fractional precision of at least 10e-7 (six 9s) for the measurements will be needed to track the effect, although higher precision is typical.

Scheduling and Special Requirements. This program should be executed during Earth occultations, but not during SAA passages. Specially designed timing patterns (invoked via the CTE optional parameter) produce extra (75) overscan pixels for EPER data, and create the electronic knife-edge for FPR data. Short dark pseudo-bias frames are also obtained with the same CTE clocking pattern for bias correction. We would nominally execute this program in April 2009, but earlier would be better.

Program Title: ACS CCD Hot Pixel Annealing **PI: Colin Cox**

Purpose: To anneal out hot CCD pixels caused by radiation damage.

Description: Every four weeks the CCD TECs are turned off and heaters activated to bring the detector temperatures to about +20 degrees C. This state will be held for 12 hours after which the CCDs are returned to normal operating conditions. To assess the effectiveness of this procedure and to provide longitudinal data for hot pixel monitoring a bias and four dark images will be taken before and after for both WFC and HRC in parallel. This will replace the daily dark program for that day. The charge transfer efficiency (CTE) of the ACS CCD detectors declines as damage due to on-orbit radiation exposure accumulates. This degradation has been closely monitored at regular intervals, because it is likely to determine the useful lifetime of the CCDs. We now combine the annealing activity with the charge transfer efficiency monitoring and also merge into the routine dark image collection. To this end, the monthly (but not those at a large number of signal levels executed yearly in the Internal CTE Monitor) CTE EPER and FPR exposures have been moved into this proposal.

Fraction GO/GTO Programs Supported: Supports all CCD measurements which is about 90% of ACS observations.

Resources Required - Observation: 192 internal orbits. (16 repetitions of 12 orbits)

Resources Required - Analysis: About 0.25 FTE will be required to analyze the data.

Products: Hot pixel counts as a function of time. CTE trend and forecast.

Accuracy Goals: N/A

Scheduling and Special Requirements: All observations are internal and so should be scheduled during Earth occultations but not during SAA passages. Specially designed timing patterns (invoked via the CTE optional parameter) produce extra (75) overscan pixels for EPER data, and create the electronic knife-edge for FPR data. Short dark "pseudo-bias" frames are also obtained with the same CTE clocking pattern for bias correction.

ACS UV Contamination Monitor **PI: L.J. Smith**

Purpose: To monitor possible variation of UV throughput with time.

Description: The observations consist of imaging with SBC and HRC of the cluster NGC 6681 which is the standard target we have used in the past for this calibration program.

HRC observations will be made at one epoch with the F220W, F250W, F330W filters and PR200L. The SBC observations will be through all six filters (F115LP, F122M, F125LP, F140LP, F150LP, F165LP) and the prisms PR110L and PR130L. These observations will be taken twice during the cycle. Data for the SBC prisms will only be taken once because this mode has not been requested for cycle 17. Two SBC dark frames will follow the SBC orbits.

Fraction GO/GTO Programs Supported: All programs with UV observations - 3-4%.

Resources Required: Observation:
HRC - 1 orbit, SBC - 2*2 orbits for a total of 5 orbits.

Resources Required: Analysis: The reduction and analysis of the data, as well as the delivery of relevant products and all documentation from this program will require approximately 0.2 FTE.

Products: Updates to UV photometric calibration zero points, dark reference files, and ISR.

Accuracy Goals: Goal is 1% for the UV photometry, and <10% for the relative SBC dark current (which is a very small absolute quantity).

Scheduling & Special Requirements: None.

Program Title: CCD Stability Monitor **PI: Jennifer Mack**
Co-I : Luigi Bedin, Ralph Bohlin

Purpose: This program will verify that the low frequency flat fielding, the photometry, and the geometric distortion are stable in time and across the field of view of the CCD arrays.

Description: A moderately crowded stellar field in the cluster 47 Tuc is observed every five months with the HRC (at the cluster core) and WFC (6 arcmin West of the cluster core) using the full suite of broad and narrow band imaging filters. The positions and magnitudes of objects will be used to monitor local and large scale variations in the plate scale and the sensitivity of the detectors and to derive an independent measure of the detector CTE. The UV sensitivity for the SBC and HRC will be addressed in the UV contamination monitor program (PI= L. Smith).
One additional orbit is required to verify the CCD gain ratios for WFC using gain 2.0, 1.4, 1.0, 0.5 and for HRC using gain 4.0 and 2.0.
One subarray exposure with the WFC will allow us to verify that photometry obtained in full-frame and in sub-array modes are repeatable to better than 1%. This test is important for the ACS Photometric Cross-Calibration program which uses sub-array exposures.

Fraction GO/GTO Programs Supported: 100% of CCD programs

Resources Required: Observation: Total = 10 orbits for the 15 month period from Jan 2009 - Mar 2010. The cluster will be observed three times during the cycle (~every 5 months), in May 2009, Oct 2009, and Mar 2010. One orbit is required to cycle through the 13 HRC optical filters (with 1-2 exposures each). Two orbits are required to cycle through all 12 WFC filters (with 1 exposure each). Three visits at three orbits each give a total of nine orbits, plus one additional orbit to evaluate the relative gain ratio for each of the detectors.

Resources Required: Analysis: Approximately 0.6 FTE.

Products: Updates to the relative sensitivity as a function of position on the detector will be provided via updated flat field reference files. Any changes in absolute sensitivity of the detectors as a function of time will be used to update the CCD QE curves used by the pipeline. Variations of the geometric distortion will be parameterized for use in the pipeline as appropriate.

Accuracy Goals: Variations with respect to previous observations will allow us to create flats which are accurate to 1% over the detector field of view. No absolute photometric calibration is provided by this program, although drifts in time of the sensitivity are tracked to ~0.1% per year. Geometric distortion is tracked to level of ~0.02 pixels across the detector.

Scheduling & Special Requirements: None

ACS Internal Flat Fields **PI: Aparna Maybhate**
Co-Is: Ralph Bohlin, Ronald Gilliland, Jennifer Mack

Purpose: The stability of the CCD flat fields will be monitored using the calibration lamps and a sub-sample of the filter set.

Description: Internal flats will be obtained for the HRC and WFC detectors using the tungsten lamp and a subset of filters (F435W, F625W, F814W, and F850LP). High signal observations will be used to assess the stability of the pixel-to-pixel flat field structure (similar to that done previously) and to monitor the position of the dust motes. Any changes in time of L-flats will also be tracked. One set of internal flats will also be obtained for each filter other than the ones mentioned above. This will establish a baseline that will be useful in case of possible instrument changes in the future.

Fraction GO/GTO Programs Supported: 90%

Resources Required: Observation: The CCD flats will be monitored six times per year, using HRC =1 orbit, WFC = 4 orbits for a total of 5 orbits/visit. Seven epochs for this 15-month Cycle 17 requires 35 orbits. The one-time creation of internal flat baseline for all non-monitor filters requires 1 orbit per each of 12 WFC filters and 1 orbit for each set of 3 HRC filters requiring 5 orbits for a total of 13 HRC filters and hence a total of 17 orbits for the non-monitor filters. The total number of internal orbits required is 52.

Resources Required: Analysis: Approximately 0.25 FTE.

Products: Results from this program will impact the standard flat field calibration files included in the pipeline, and an ISR will document the results.

Accuracy Goals The accuracy of the flat field calibration is expected to be better than 1%.

Scheduling and Special Requirements: None

Program Title: Earth Flats **PI: C. Cox**

Purpose: Sky flats will be obtained by observing the bright Earth with the HRC. Weekly coronagraphic monitoring is required to assess the changing position of the spots.

Description: This program will obtain sequences of flat field images by observing the bright Earth. Coronagraphic observations will be taken in combination with the F330W filter at the beginning and the end of each orbit to assure sufficient illumination.

Fraction GO/GTO Programs Supported: About 5%.

Resources Required - Observation: A single orbit is required each week for a total of 64 orbits in the 15 month cycle, all of which take place during Earth occultation.

Resources Required - Analysis: Approximately 0.05 FTE.

Products: The coronagraphic spot positions will be used to update the spot position reference table.

Accuracy Goals. The Earth flats will be statistically accurate to 0.25% per pixel. The position of the coronagraphic spot will be determined at the level of 1 pixel or better.

Scheduling and Special Requirements: We require observations of the bright Earth during occultation.

ACS Photometric Cross-Calibration using Stellar Flux Standards PI: R. Bohlin
Co-Is: R. Gilliland, J. Mack

Purposes:
a) Verify the ACS HRC and WFC photometric calibrations with a repeat visit to one of the three primary WDs.
b) Measure the change in sensitivity with time for bright stars, (which would include any small CTE contributions.)
c) Continue to investigate the ~2% discrepancy between ACS flux calibration and that of STIS (ACS ISR 2007-06). The goal is to measure any filter bandpass shifts in ACS or rule out the possibility of shifts as the primary contributors to the ACS/STIS discrepancy for cool stars.

Description:
This program is a follow-on to original ACS calibration programs 10740 (Cycle 14) and 11054 (Cycle 15). Only one visit of 11054 executed successfully before the ACS failure on 07jan27. Because WFC is the more important science mode and the HRC suffers from a much worse red-halo problem for the long wavelength filters, only one visit to a primary WD is included for HRC; the main effort will be to characterize the most important WFC filters.

Duplicate Data:
The ACS observation of BD+17 4708, P330E, and VB8 are repeats but are required to provide additional measures of sensitivity changes, to add confidence to the repeatability of the small (~2%) discrepancies, and to improve the statistical precision of the sparse data already available. The repeat data sets also quantify any variability in the star, which is especially important for VB8, where variability at the shorter wavelengths is observed.

Fraction GO/GTO Programs Supported. 80%.

Resources Required: Observation. 9 Orbits.

Resources Required: Analysis. 0.3 FTE

Products. Better filter bandpasses, improved sensitivities, and more accurate flux standards.

Accuracy Goals. 1%

Scheduling and Special Requirements. None.

Program Title: ACS SBC MAMA recovery **PI: C. Cox**

Purpose: This proposal is designed for the initial turn-on of the ACS MAMA detector and to permit recovery after an anomalous shutdown.

Description: The Initial MAMA turn-on/recovery from anomalous shutdown consists of three tests: a signal processing electronics check, high voltage ramp-up to an intermediate voltage, and high voltage ramp-up to the full operating voltage. During each of the two high voltage ramp-ups, diagnostics are performed during a dark ACCUM. The turn-on is followed by a MAMA Fold Analysis.

Fraction GO/GTO Programs Supported: Supports all SBC measurements which is about 5% of ACS observations.

Resources Required: Observation. 4 internal orbits per occasion. Normally less than once per year.

Resources Required: Analysis. About 1 day (0.004 FTE) will be required to analyze the data.

Products: Addition to spreadsheet which contains historical record of analyses.

Accuracy Goals.

Scheduling and Special Requirements. It is a goal to schedule each visit when a TDRS is visible so that voltages and count rates can be monitored. Note that Visits containing MAMA high voltage activities must be scheduled outside of the SAAs.

Calibration of ACS/WFC Half-Speed Readout Mode **PI: Norman Grogin**
Co-Is : Marco Sirianni, Ron Gilliland, Kenneth Sembach

Purpose: Assessment and Calibration of the ACS/WFC Half-Speed Readout Mode

Description: Pursuant to TIR ACS 2008-01, we propose a suite of internal and external calibration exposures with ACS/WFC in half-speed readout mode ("SRM") at both GAIN=1 and GAIN=2, including biases, darks, lamp flats, and 47 Tucanae.

These exposures will characterize the ACS/WFC in-flight performance with SRM, including readnoise, gain and gain ratio, linearity, CTE, and crosstalk. If the half-speed readout mode results in a significantly reduced readnoise, it may be advantageous to operate ACS/WFC in this mode if the full-speed readout post-SMOV has risen above ~6.5 e-.

Fraction GO/GTO Programs Supported:
Depending on the post-SMOV ACS/WFC comparative readnoise at full-speed and half-speed, this may vary from ***all*** ACS/WFC programs, to only the subset that require the lowest readnoise.

Resources Required: Observation:

22 internal orbits:
(4 x bias; 4 x 1000sec darks; five pairs of flats) for GAIN=1 and GAIN=2
6 external orbits:
47 Tucanae, identical to SMOV CTE program 11510, except at half-speed readout

Resources Required: Analysis: Data will be processed with identical scripts for determining readnoise, gain, linearity, CTE, and crosstalk already developed for SMOV. 0.2 FTE will be required for data analysis.

Products: ISR documenting the ACS/WFC performance in half-speed readout mode and assessment for its general use.

Reference biases and darks for half-speed mode pipeline processing, if adopted for general use.

Accuracy Goals:

Scheduling & Special Requirements:

None; preference for 47 Tuc, to match SMOV CTE program, but can select an alternate target as scheduling allows

Program Title: ACS SBC Darks **PI: C. Cox**

Purpose: Monitor the SBC dark current as a function of time, and implicitly detector temperature during a multi-orbit visit.

Description: SBC darks will be run over a continuous 6-orbit period so that the effect of increasing temperature with turn-on time can be monitored

Resources Required: Observation. This program uses 6 internal orbits.

Resources Required: Analysis. Estimate 0.1 FTE to analyze data and update calibration files
Products. Revised SBC dark reference file.

Accuracy Goals. A relative accuracy of 10% is sought on the very small SBC dark current.

Scheduling and Special Requirements: Since the same program will be run as part of the SM4 SMOV it might not be necessary to repeat this during Cycle 17.
This program could remain on hold pending analysis of SM4 results.