



COS

Monthly Status Review



Center for
Astrophysics and
Space
Astronomy

Agenda

COS Science Overview	J. Green
Program Overview	J. Andrews
Progress Summary Since Last Monthly	J. Andrews
Tinsley/J-Y Status	J. Andrews
UCB FUV Detector Status	J. Andrews
Optics Test Status	S. Osterman
CU Software Activities Status	J. Andrews
Schedules	J. Andrews
Upcoming Events/Activities	J. Andrews
CU Issues & Resolution Plan	J. Andrews
STScI Presentation	STScI
BATC Presentation	D. Hood
Financial Splinter	GSFC/Ball/CU

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Hubble Space Telescope

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March 16, 2000

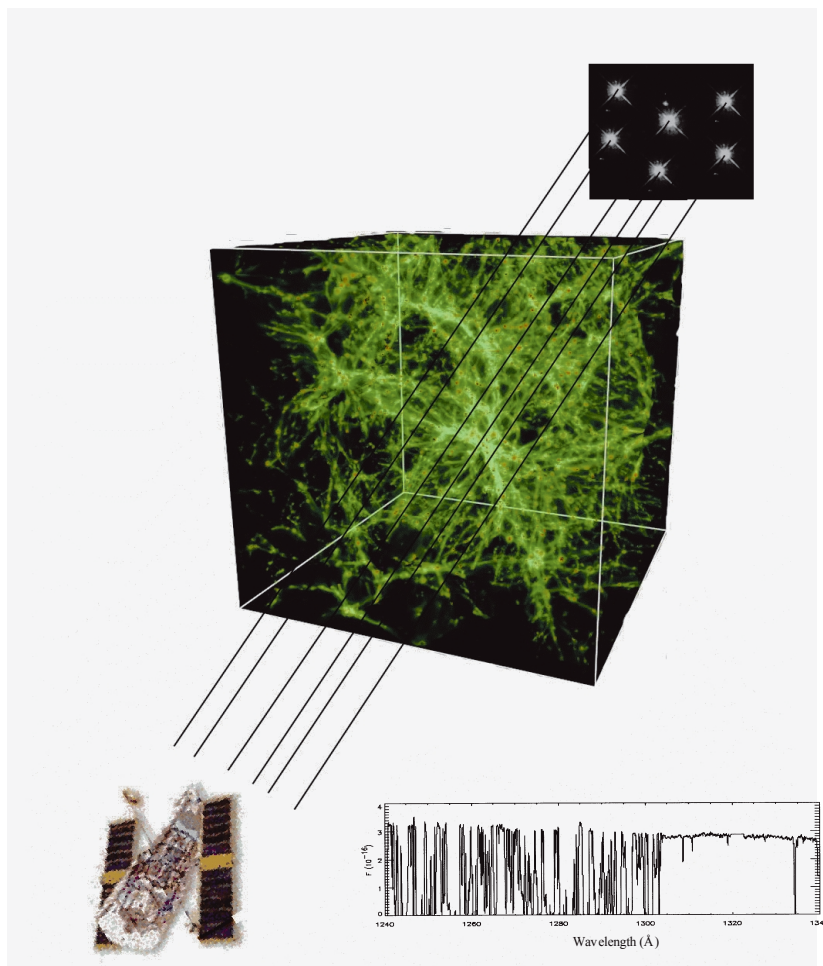


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Probing the IGM



- Perform absorption spectroscopy of the matter that makes up the universe: *see the missing mass*
- Must be able to sample many lines of sight to probe morphology and evolution

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Additional Science Drivers

- Study D/H along many extragalactic sightlines, observing its evolution with redshift and correlation with metallicity
- See into highly reddened regions where UV light is highly attenuated: *star forming/planet forming regions*



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Design Requirement



- Enable efficient *extragalactic* ultraviolet spectroscopic observations with large simultaneous wavelength coverage
- Requires increase in sensitivity of 10 X

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Design Requirements

- $R = 20,000$ for D/H, confusion avoidance, and accurate equivalent width determination
- $A_{\text{eff}} > 1000 \text{ cm}^2 @ 1300 \text{ \AA}$
- Largest possible simultaneous bandpass
- Sufficiently low noise for long observations of faint targets (and remain signal limited)



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Design Implementation

- FUV:
 - One bounce system
 - Open face MCP detector
 - Low scatter holographic gratings
 - Large format detectors giving 300 Å coverage
- NUV:
 - Large format detector not available: use spare STIS MAMA
 - Adjustable Czerny-Turner with multiple camera optics



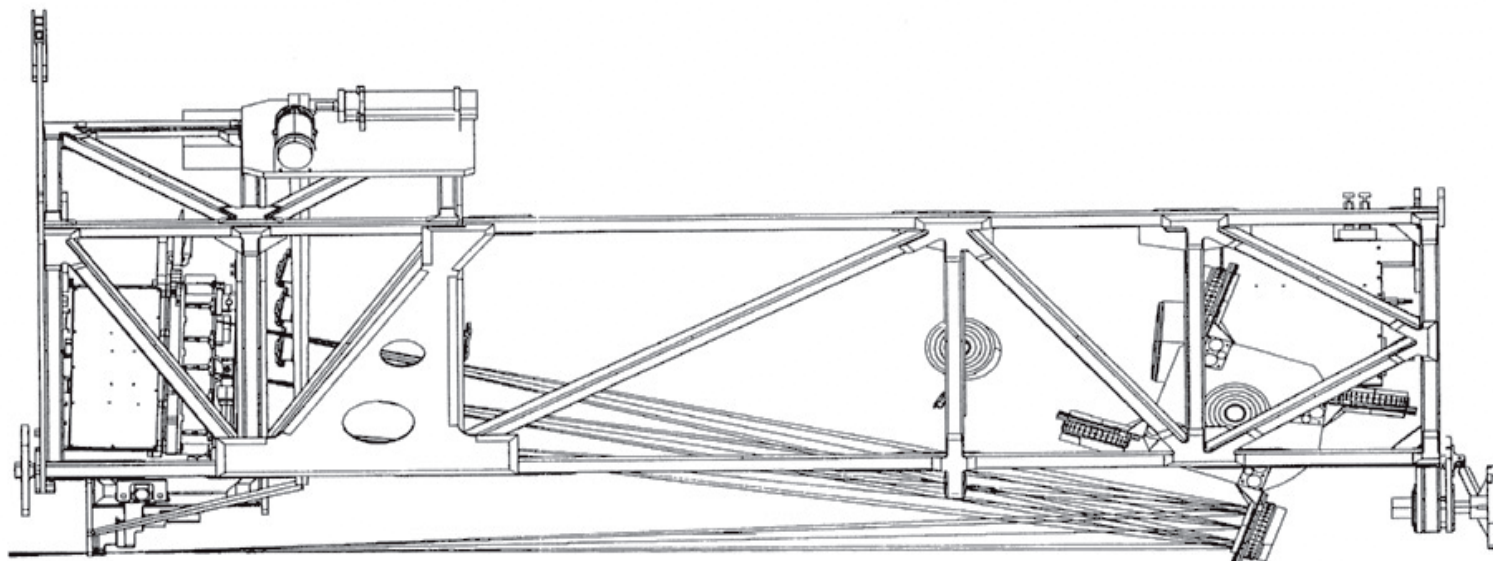
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FUV Design

FUV Channel Optical Path



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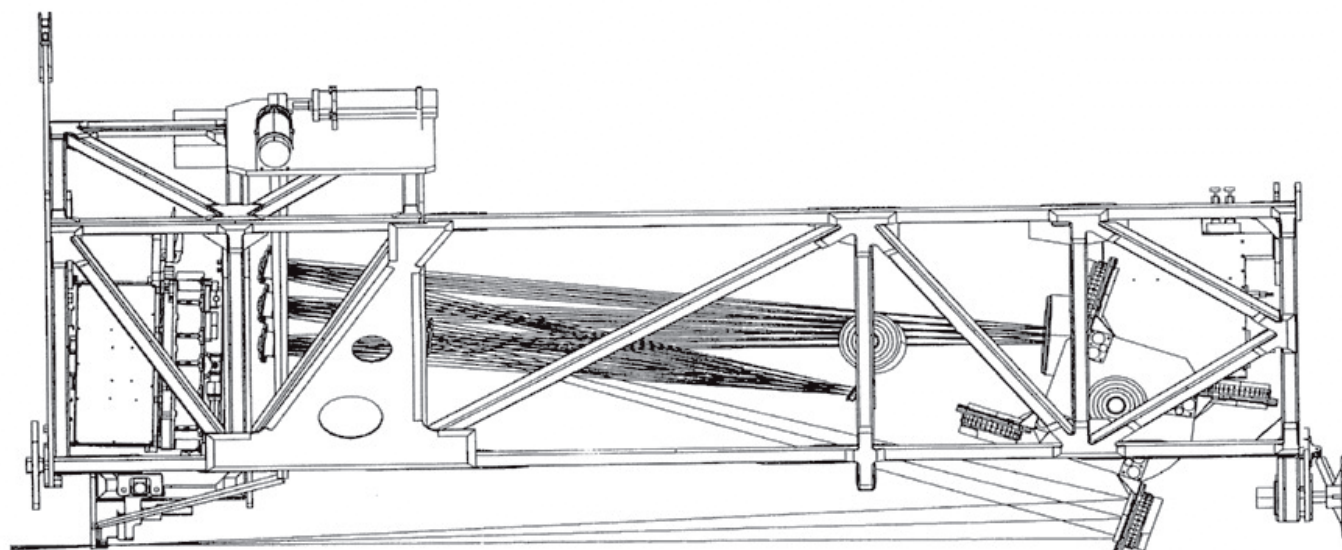
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NUV Design

NUV Channel Optical Path



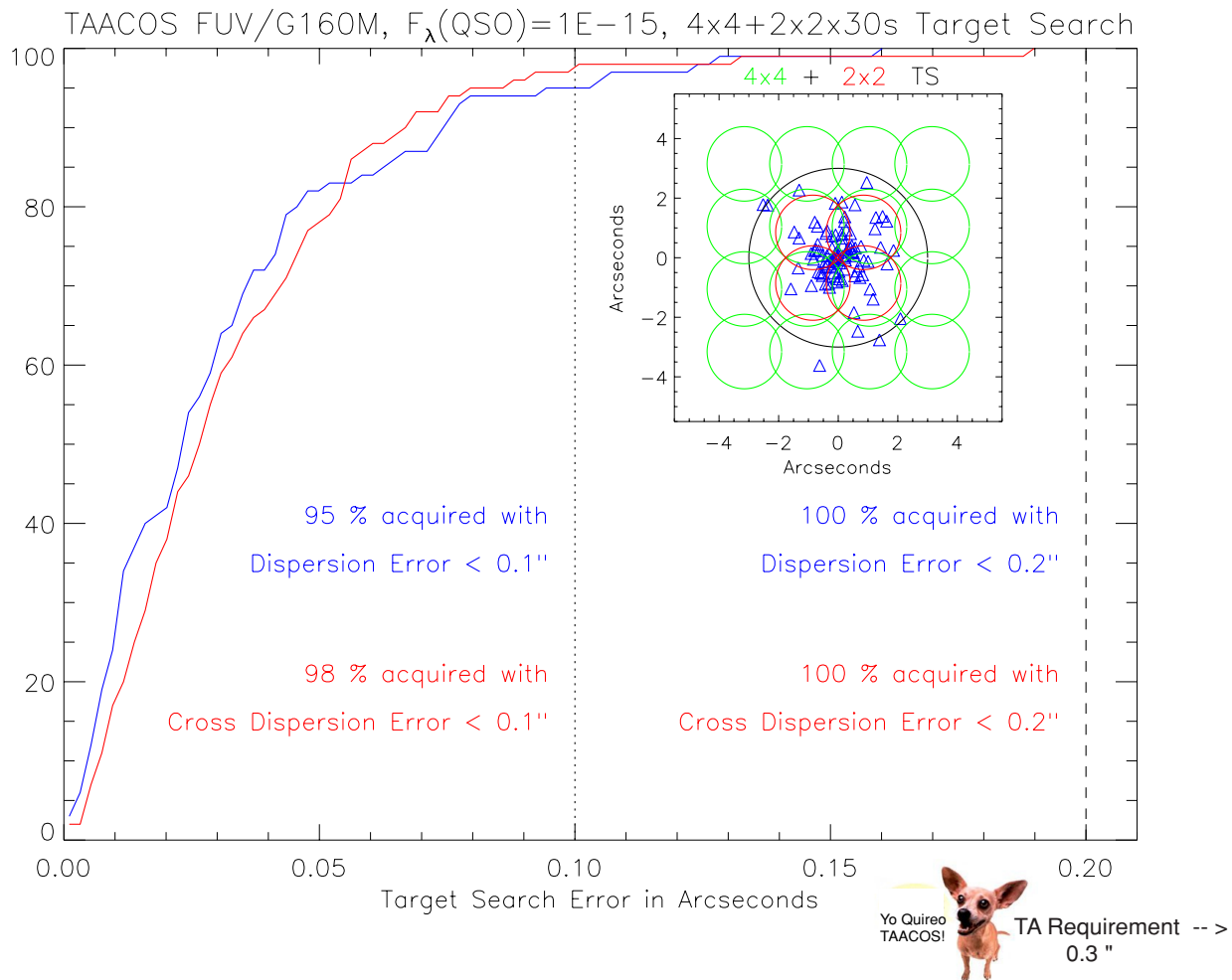
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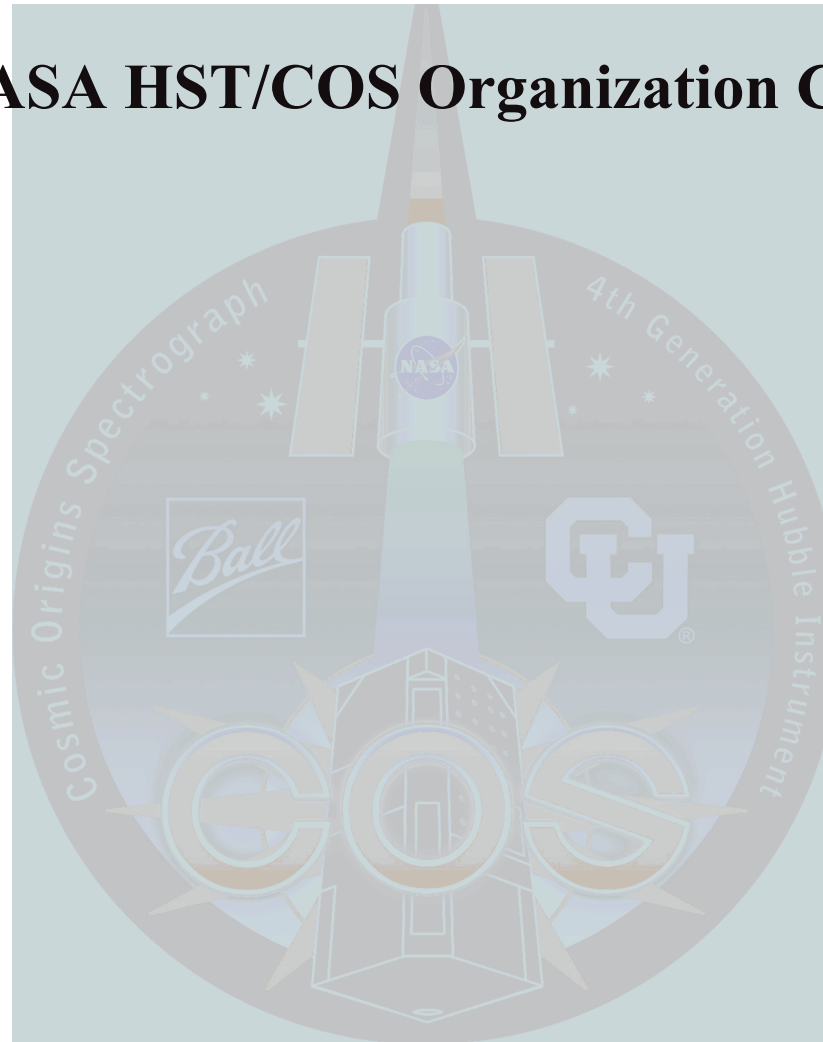


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CU/CASA HST/COS Organization Chart



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Progress Summary Since Last Monthly

- Completed G130M-c optical testing.
- Hosted DCE FSW delta-Design Review at CASA on 2/18/00.
- CU continued simulation work on COS target acquisition.
- Addressed and worked to resolve resource problems at UCB.
- UCB received DCE-A, B, C assemblies.
- UCB continued anode batch #2 processing.
- UCB continued anode batch #1 testing with good results.
- UCB commenced FSW code and test on commercial part DCE.



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Tinsley & Coastal Status

- Tinsley:
 - CU visited Tinsley on 2/14/00 to assess status.
 - Tinsley on track to deliver:
 - NUV flight units 5/15/00 (NCM1, NCM2, NCM3a, b, c)
 - NUV spares 7/15/00
- Coastal:
 - Coastal was contracted to provide TA-1 flat mirrors.
 - QA problems at Coastal have delayed final delivery.
 - TA-1 mirrors that meet all COS performance requirements are finished and in final inspection at Coastal now.



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J-Y Status

- Late December storms in France flooded JY's production facilities.
 - No COS gratings or substrates were damaged.
- JY's recovery seems to be slower than anticipated in January - deliveries of all gratings have slipped 1 to 2 months.
- Further compounding problems is error discovered in G160M fabrication documentation:
 - This is a CU error, which was discovered in January.
 - Fortunately, G160M ion etching had not been started and substrates can be reprocessed.
 - JY will re-record holography but not until 9/00.
- CU will visit JY on 4/3/00.
- We are currently assessing schedule impacts of delayed grating deliveries.



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FUV Detector Subsystem



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UCB FUV Detector Status - General

- It's important to note that UCB has overcome significant technical challenges that compromised the FUSE development (MCPs, detector bodies, progress on anodes, etc.) – this is the good news.
- Unfortunately, over the past few months UCB has suffered significant schedule erosion in many areas of the project for primarily programmatic (not technical) reasons. CU is very concerned with UCB's schedule performance.
- Further compounding UCB's schedule problems is the loss of their EE staff and the uncertainties associated with the earthquake retrofit of the old SSL building.



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UCB FUV Detector Status - Personnel Issues

- Problem - Both of UCB's EEs have quit.
 - As reported at January's MSR, UCB's Analog EE quit (left UCB in late January).
 - The EE left "completed" designs but un-tested hardware.
 - Shortly after the January MSR, UCB's Digital EE quit (left UCB in early March).
 - This EE left completed designs and was able to complete initial checkouts of the flight DCE-A, B, C boards.



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UCB FUV Detector Status - Personnel Issues (cont.)

- Solution(s) – At present, a patchwork of solutions is in progress:
 - UCB is in the process of advertising now to find a long-term replacement.
 - CU, GSFC, and D_N met at UCB in February to address the resource problem.
 - Present solutions include:
 - BAJA Technologies: an independent contractor with 2 full-time EEs located at UCB to oversee DEB development.
 - Rick Rifanti: the original TDC designer is working two days per week to test and troubleshoot the COS TDCs. This has been very beneficial.
 - Design_Net: CU's support subcontractor is picking up FPGA design work and providing additional support at UCB for power systems test and documentation support.
 - J&T: with GSFC's encouragement, J&T is locating personnel to UCB to assist in the test and qualification of the DCE.



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UCB FUV Detector Status - Facilities

- As mentioned at the December MSR, UCB was successful in getting funds from Explorers to augment/enhance their facilities in the new building.
- The second calibration facility's vacuum systems are online and work is progressing on the control rack and detector manipulation system.
- Modifications to the old building are presently not planned to start any earlier than 6/00. This start date has been slipping approximately one month per month.



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UCB FUV Detector Status - Detector Vacuum Assembly

- MCPs:
 - This activity is on schedule.
 - COS MCPs have been installed in the two good COS detector bodies and exposed to high-voltage. Uniformity and gain maps of the MCPs look good in both segments of both bodies.
- XDL Anodes:
 - Reworked anode from batch #1 has been tested for resolution with COS amp and its performance now meets COS resolution requirement.
 - Anode batch #2 is proceeding on schedule and should be ready for initial testing at UCB approximately 3/24/00.



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UCB FUV Detector Status - Detector Vacuum Assembly

- Detector Bodies:
 - 2 of 3 bodies have been tested with MCPs and yielded good results.
 - Body #3 demonstrated arcing with high-voltage application and a micro-crack in the ceramic was discovered. No. 3 is now scrapped.
 - UCB is investigating micro-crack cause; likely it occurred during brazing and was 1st detected with anomalous hi-pot test.
 - A good, FUSE spare body was found and will be used for future COS testing.
- Amplifiers:
 - Flight amplifier design has been tested and several improvements have been implemented and tested.
 - Part changes to flight units is scheduled for next week.
 - Post-modifications, the flight units will start burn-in, performance, and thermal soak tests.
- Harnessing:
 - On-going activity at UCB.



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UCB FUV Detector Status - Detector Vacuum Assembly

- QE Enhancement Grid:
 - In fabrication now.
- Detector Backplates:
 - 4 new backplates received at UCB this week.
 - All 4 pass inspection (including correct material) and 3 are out for feedthrough installation now.
 - 3 units to be shipped to K. Redman at GSFC in early April for optical calibration.
- Detector Door:
 - Door parts cleaned, and ready for assembly to vacuum housing.
 - Door assembly and test to occur in early April.



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UCB FUV Detector Status - Electronics

- Power Systems:
 - High voltage filter modules at UCB and in functional testing now.
 - HVPS undergoing final inspection this week.
 - LVPS at B.E. in final testing. Expected at UCB mid-April.
- Digitizers (TDC-X, TDC-Y):
 - Commercial part TDCs (CTDC) are being debugged by Rick Rifanti and BAJA Technologies at UCB.
 - After 4 weeks of evaluation and review, the TDC team has uncovered ~10 significant design problems in flight schematics and layout. ECO has been prepared.
 - Complete testing of CTDC is scheduled to take ~2 more weeks.
 - Rifanti/BAJA are recommending a re-layout of the boards and UCB has started this effort.
 - Board stuffing at J&T will be postponed several weeks.



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UCB FUV Detector Status - Electronics

- Detector Control Electronics (DCE-A, B, C):
 - DCE wire-wrap boards and DCE FSW were brought to Ball in February for successful hardware interface testing. Several actions were taken and UCB is to implement modest changes.
 - Flight assemblies now at UCB and have been through initial inspection and check-out by original design engineer before his departure.
 - FPGA designs for DCE are in review at D_N now.
 - CDCE is now up and running and is being used for DCE FSW development and flight DCE test procedure development.
 - Completion of the DCE development (performance verification, qualification, burn-in) is now being tasked to J&T with support from UCB and BAJA Technologies.



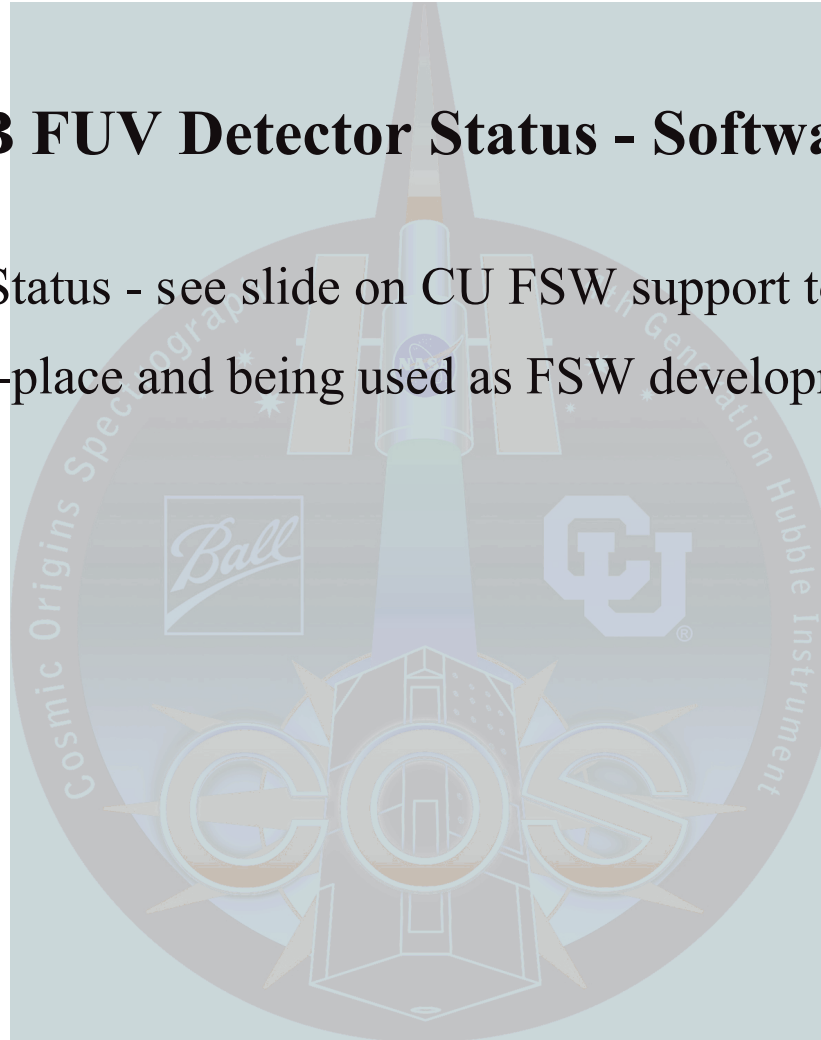
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UCB FUV Detector Status - Software

- Documentation Status - see slide on CU FSW support to UCB.
- CDCE is now in-place and being used as FSW development bench.





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UCB FUV Detector Status - Development Flow



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UCB FUV Detector Status - Systems

- Document Status:
 - CM Plan - released.
 - QA Plan - approved by GSFC with 2 small comments.
 - Performance Verification Plan - released, pending GSFC approval.
 - ICD Rev. A - in final review at CU, Ball, UCB, GSFC.
 - Environmental Verification Plan - in pre-release review now.
 - EEE Parts Stress Analysis - released.
 - FMECA - released.
 - DVA Backplate Stress and Fracture Assessment - internal review now.
- Details of the FUV Subsystem I&T plan are now being worked.
- Some systems work has fallen behind because UCB's Systems Engineer has been "plugging holes" left by departing EEs.



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UCB FUV Detector Status - Summary & Issues

- DVA related activities at UCB are making good progress.
- Key area of concern is the EE resource problem at UCB and the effective coordination of the various teams participating in helping UCB.
 - As mentioned at January MSR, CU (for multiple reasons) is increasing its presence at UCB to assist in the planning and coordination of activities and work.
- Plans for resources and electronics development are becoming clearer and final details should be in place by end of week.
- Present indications are that the COS FUV detector will have excellent performance. Focus now is to assure a thorough test program, and quality and reliability of hardware.



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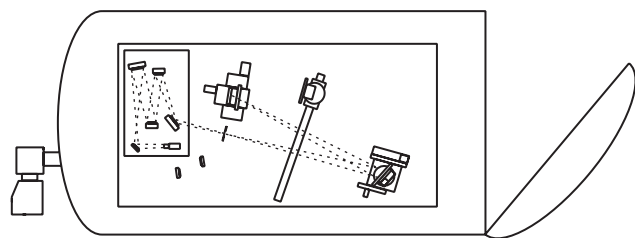


COS FUV Grating Test Status 3/13/2000

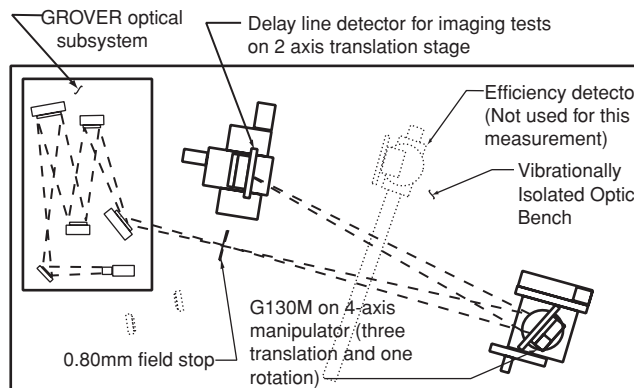
- G130M-C Testing:
 - Testing is completed
 - Data analysis completed
 - Draft calibration report is finished
- G130M-B Testing:
 - Grating has been installed in vacuum test facility
 - Testing is in progress



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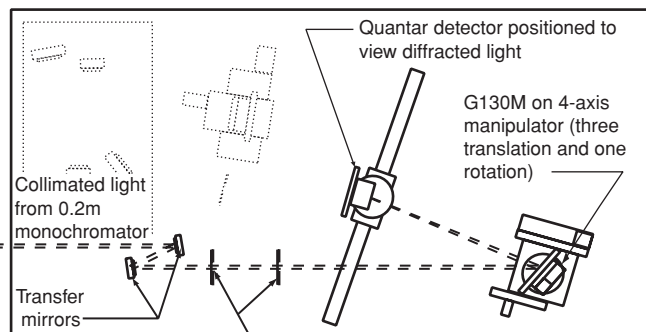


Vacuum Test Facility Layout

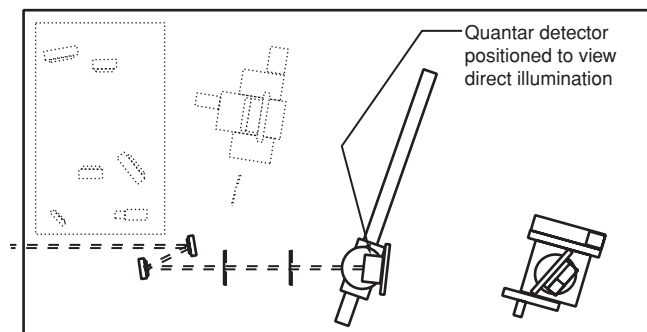


Grating Resolution Test Setup

FUV Grating Test Setup



Diffracted Beam Measurement



Incident Beam Measurement

Grating Efficiency Test Setups



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G130M-C Test Results

Wavelength	FWHM (mÅ)	Resolution $\lambda/\Delta\lambda$	Required Resolution
1219.49Å	54.18mÅ	22880	? 20000
1283.70Å	59.63mÅ	21825	? 20000
1382.05Å	62.28mÅ	22168	? 20000

Grating Resolution Results

Wavelength (Å) (Source)	Grating Efficiency (Grating Average)	Measurement Uncertainty	Required Efficiency
1164 (Kr-I)	0.375	0.006	? 0.27
1236 (Kr-I)	0.428	0.006	? 0.37
1304 (O-I)	0.438	0.006	? 0.36
1356 (O-I)	0.463	0.047	? 0.36
1411 (O-I)	0.484	0.007	? 0.36
1470 (Xe-I)	0.472	0.006	? 0.36

Grating Efficiency Results

Source Wavelength (Å)	Source Counts (background corrected)	Scatter Wavelength (Å)	Scatter Counts (background corrected)	Scatter/Å	Maximum Allowable Scatter/Å
1200 (N-I)	2,378,000	1209.6	80/0.057Å	$\leq 1.92 \times 10^{-5}$	2.0×10^{-5}

Grating Scatter Results

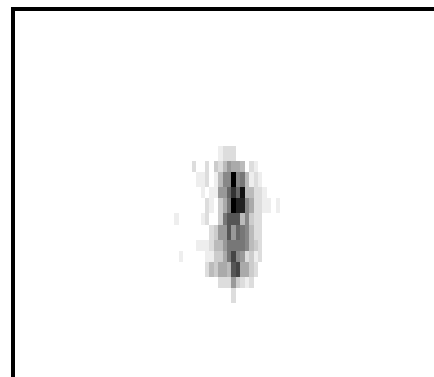
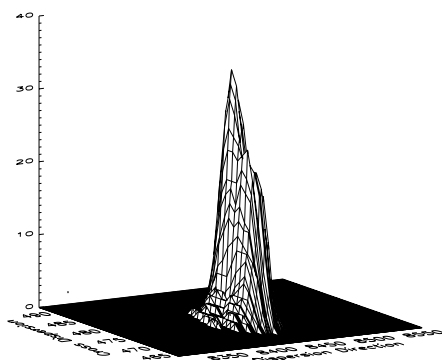
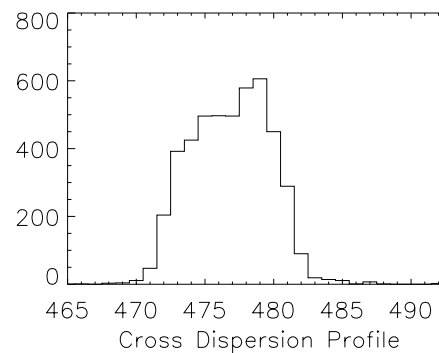
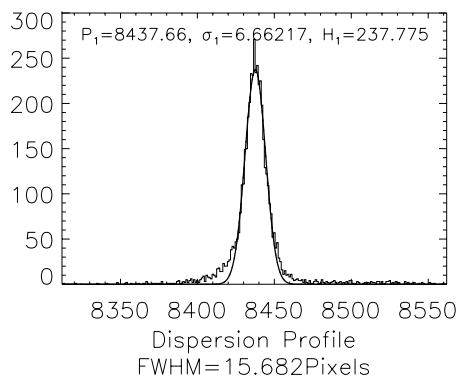


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G130M-C Resolution Test Image - 1283.7Å



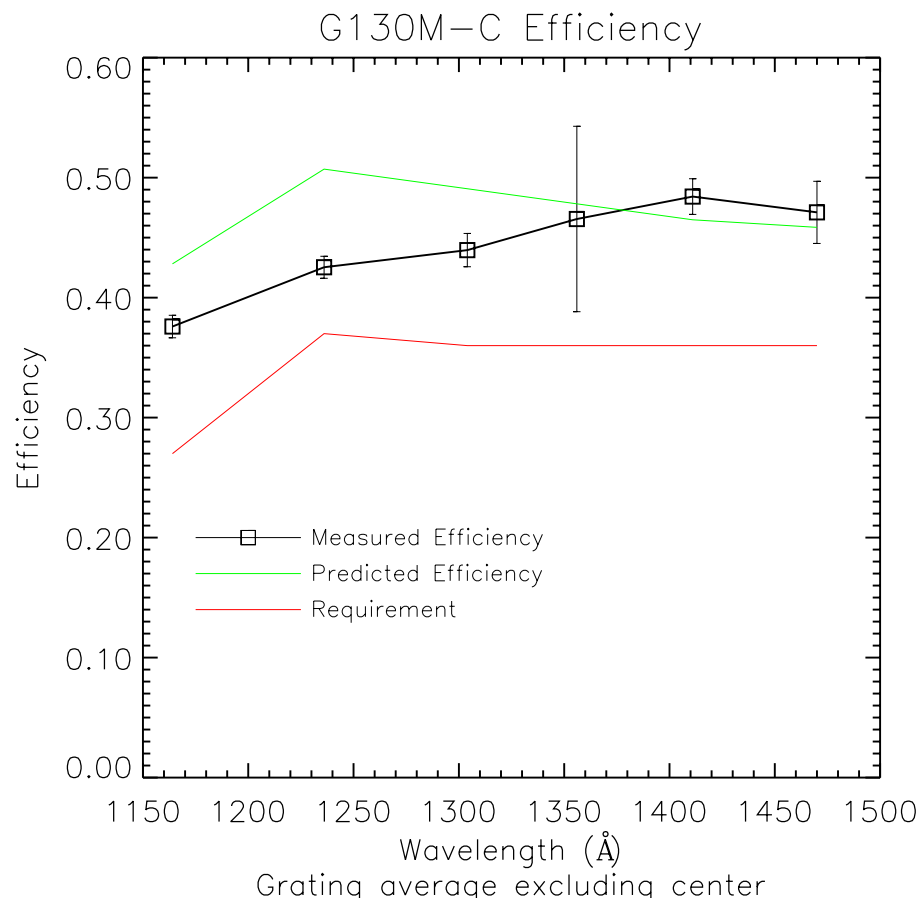


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Mean Grating Efficiency vs. Wavelength G130M-C



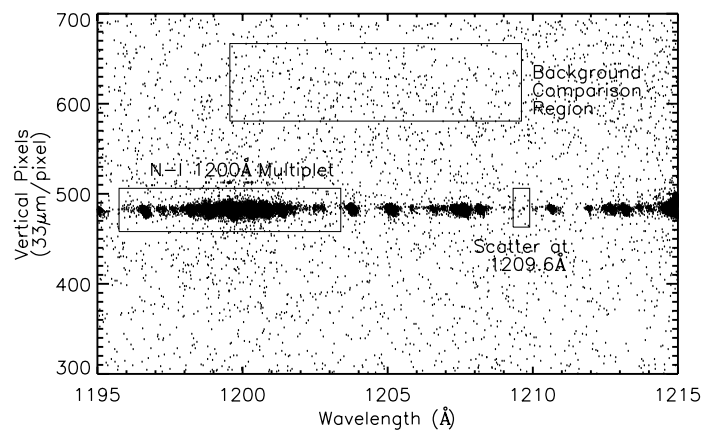
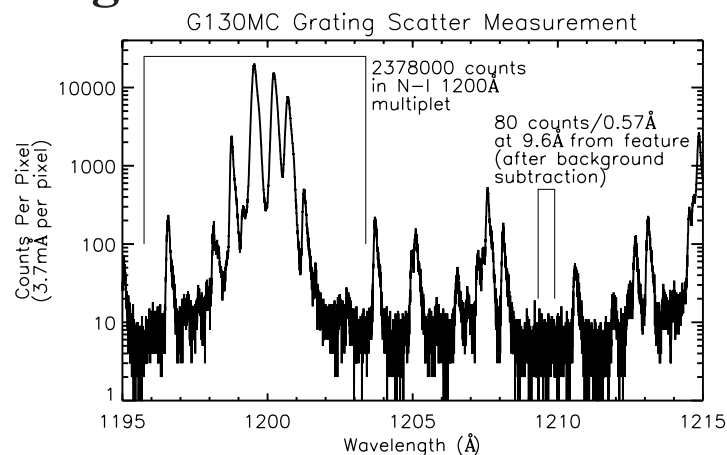


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Grating Scatter at 1200Å G130M-C





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Operations & Software Activities at CU

- GSE Software Development at CASA-ARL
 - COS Science Data Index and Analysis Software (CEDAR)
 - Website gives full details for CEDAR: <http://cos-arl.colorado.edu/CEDAR/>
 - At the request of BATC, CEDAR development schedule revised to allow for an early "spin-off" of code with functionality for Memory Dump and Diagnostic Data only (called Build II "beta").
 - Build II "beta", for Memory Dump/Diagnostic Data Only, demo held at BATC on 3/2/2000.
 - Build II "beta" modifications - based on BATC/GSFC user feedback - to be completed by 3/17/2000.
 - Build II "beta" to be used at BATC for early FSW Testing during 4/2000.
 - Build II schedule revised for release and test at BATC in 6/2000.
 - Build III (i.e., Maintenance) release of CEDAR tied to BATC FSW development schedule.
 - Build III usage at BATC expected in the 12/2000 timeframe.



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Operations & Software Activities at CU

- GSE Software Development at CASA-ARL
 - COS Target Acquisition Simulation Software (TAACOS)
 - Website gives full details for TAACOS: <http://cos-arl.colorado.edu/TAACOS/>
 - Build I "early results" for FUV Channel are extremely promising - with all indications that TA will meet and exceed requirement of 0.3" (3 sigma) in Dispersion Axis, for isolated point sources with initial target uncertain of 1" (1 sigma) or less.
 - Build I "early results" suggest modest enhancement to existing TA FSW Design. (Enhancement involves moving FUV subarrays to maintain constant wavelength coverage.) BATC given advanced warning of this possible enhancement at the COS TA FSW Detailed Design Review on 2/17/2000.
 - Build I "official" simulation runs for FUV to begin 3/22/2000. (Will take ~300 CPU hours to complete, with available CPU resources, about 5 days.)
 - Build I Software for FUV channel on schedule for completion by 4/2000.
 - Build I Software for NUV channel on schedule for completion by 5/2000.
 - Build II Software - contingent upon results of Target Acquisition Simulations from Build I, but no earlier than 7/2000.



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Operations & Software Activities at CU

- Assistance with FSW Development Efforts at UCB
 - DCE FSW Documentation Efforts
 - Website gives full details of DCE Documentation efforts underway:
 - <http://cos-arl.colorado.edu/DCE/>
- Highlights:
 - DCE Software "Delta" Design Review - held on 2/18/2000 at CASA-ARL.
 - Redlines and Action Items from Review incorporated into DCE Software Design Document by 3/31/2000.
 - DCE Hardware/Software Interface Document - Feedback/Comments from recently departed UCB EE being incorporated into Document. Next revision to be released by 4/3/2000.
 - DCE Software Test Plan - to be released for formal review on 3/27/2000.
 - DCE Software Test Procedures - development to begin in 4/2000.



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COS Schedule for CU/UCB



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Upcoming Events/Activities

- Continue oversight and support of UCB efforts.
- COS CDR scheduled for 4/26-27/00 here at Ball.
- Start verification testing on G130M-B FUV grating at CU.
- Continue TAACOS development and test at CU.
- Host COS Science Team Meeting at CU on May 16.
- Visit JY on 4/3/00.
- Take delivery of two G140L (non-blazed) gratings ~5/1/00.
- UCB complete TDC debugging and start board stuffing at J&T.
- UCB complete flight anode processing and begin anode testing in COS bodies.
- UCB start DCE test and qualification at UCB.
- UCB Complete and submit FUV Subsystem Environmental Verification Plan.



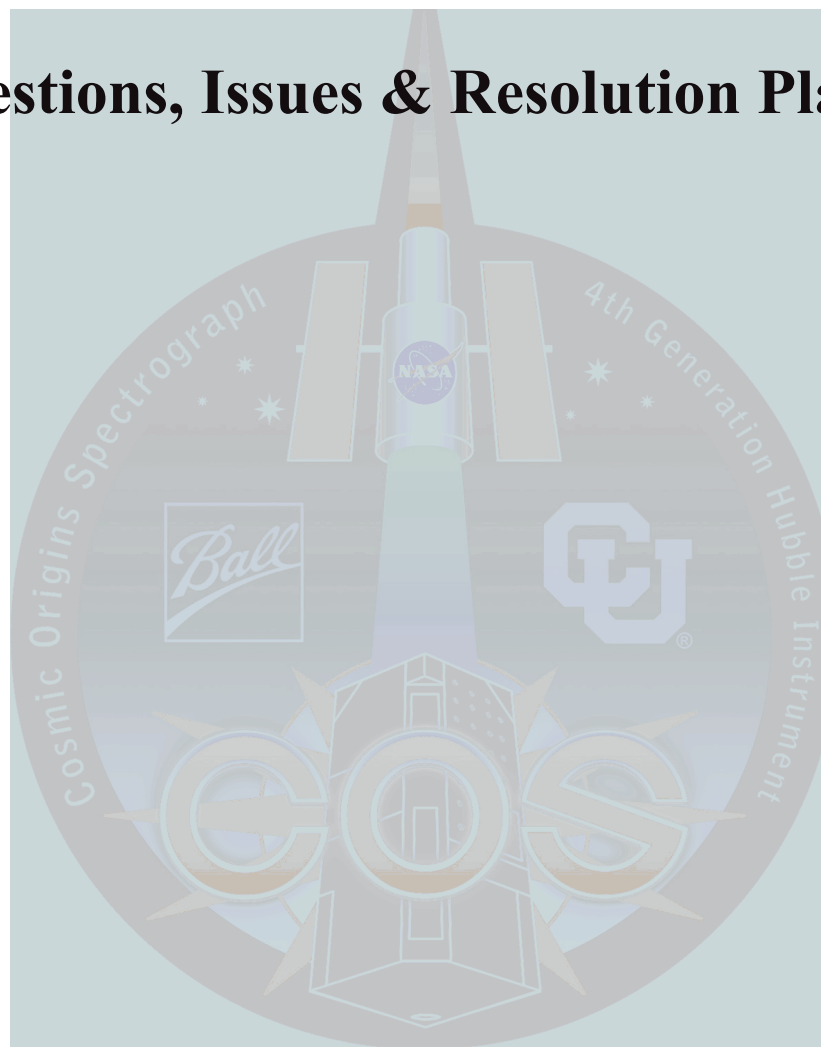
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Questions, Issues & Resolution Plan

- None



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