Technical Evaluation Report
"Initial Results of the MCP Lifetime Test & the Implications for On-Orbit Flat Field Calibration of the COS/FUV Detector"

Date:	December 8, 1999
Document Number:	COS-11-0012
Revision:	Initial Release
Contract No.:	NAS5-98043
CDRL No.:	N/A

Prepared By: ______________________ ______
E. Wilkinson, COS Instrument Scientist, CU/CASA — Date

Reviewed By: ______________________ ______
J. Green, COS Principle Investigator, CU/CASA — Date

Reviewed By: ______________________ ______
J. Morse, COS Pr — Date

Approved By: ______________________ ______
J. Andrews, COS Experiment Manager, CU/C — Date

Approved By: ______________________ ______
D. Hood, Project Manag — Date

Approved By: ______________________ ______
K. Brownsberger, Detector Software Manager, CU/CASA — Date

Center for Astrophysics & Space Astronomy
University of Colorado
Campus Box 593
Boulder, Colorado 80309

REVISIONS					
Letter	ECO No.	Description	Check	Approved	Date
-		Initial Release			

Original Release Name	Date	
Drawn: E. Wilkinson	12/10/99	**THE UNIVERSITY OF COLORADO** At Boulder **The Center for Astrophysics and Space Astronomy**
Reviewed:		**Technical Evaluation Report** "Initial Results of the MCP Lifetime Test & the Implications for On-Orbit Flat Field Calibration of the COS/FUV Detector"
Approved:		

Size	Code Indent No.	Document No.	Rev
A		COS-11-0012	-
Scale: N/A			

TABLE OF CONTENTS

1. INTRODUCTION

The Statement of Requirements (COS-08-0003) states in section 3.14:

"The microchannel plates shall provide <1% decrease in the BOL DQE for every 0.5 coulombs/cm^2 extracted from the MCP material."

This requirement translates to a total fluence of 10^{11} photons/cm^2 through the detector microchannel plates. This specification was originally chosen for historical reasons with no basis in the expected usage of the COS instrument nor its calibration plan. There is now sufficient information regarding the observing plan for COS and the microchannel plate performance to reevaluate the lifetime specification and the calibration plan.

From the design reference mission document (STScI report # COS-ISR-99.010) there will be 2.22 X 10^9 photons observed from astrophysical targets during the 5 year lifetime of the COS instrument. Under the current plan twice each year the detector flat field for each grating would be characterized, thus 6 flat fields each year would be acquired. Each flat field would be accumulated over an 11-hour exposure at 25,000 counts/second over an area of 0.5mmX85mm (This information is derived from OP-01, Table 2-6 and the COS-ISR-99-01, section 3.6). For a single flat field the total fluence over the spectral region of a segment would extract about 7.5X10^{-3} coulombs/cm^2 from the MCPs. If 6 flat fields were acquired over a year then 0.045 coulombs/cm^2 would be extracted. Wavelength calibration would be done for each target visit with a total number of 1300 wavelength calibration per year taken at 1500 counts/second for 5 minutes each (This information is derived from OP-01, Table 2-3 and the COS-ISR-99-01, Table 10). This is exceedingly conservative as it assumes that all pixels are illuminated, which is clearly not the case.

Type of Observation	Total Counts Per Year	Charge Extracted
Astrophysical Target	2.78 X 10^8	0.00089 C/cm^2
Flat Fields (6)	1.40 X 10^{10}	0.045 C/cm^2
Wavelength Calibrations	5.85 X 10^8	0.00187 C/cm^2
Totals	1.49 X 10^{10}	0.0478 C/cm^2

Assuming the specification is achievable, the current understanding of the total fluence is an order of magnitude below the requirement, so a significant amount of lifetime margin seems to exist.

2. TEST RESULTS

New lifetime test results on sample MCPs which are representative of the flight plates have now been completed. A complete description of the test and results has been prepared by John Vallerga at UCB in document UCB-COS-006. The most easily measured metric to use for the MCP lifetime is the drop in modal gain per coulomb/cm^2 extracted from the plates, i.e. the slope of gain degradation with charge extraction. This specification relates directly to the conditioning of the plates and is a measurable quantity.

After a thorough burn-in of the MCPs the plates exhibited a 100%/(C/cm^2) slope in the modal gain versus charge extracted. For example, if 0.5 C/cm^2 were extracted from the plates the peak of the pulse height distribution would drop 50%. Even under the best circumstances a 50% drop in the gain would result in a significant loss of DQE.

3. IMPLICATIONS FOR ON ORBIT FLAT FIELDS

The issue now is how do the MCP lifetime test results and the planned observational scenarios fit together? The answer is that they don't. Under the current plan we can expect ~5% decrease in the modal gain per year from extracting 0.045 C/cm^2. This may decrease the DQE more than 1%, thus violating the current requirement, although at this point we cannot be more definitive. However, if the decrease in the modal gain can be brought under 1% then UCB and CO feel that the decrease in DQE will be under 1%. This means that the maximum amount of charge that can be extracted from the plates must be less than 0.01C/cm^2. The current plan flat field plan extracts a factor of 5 more charge than the MCPs can tolerate and still support the lifetime specification.

There are two steps that can be taken to mitigate this issue:

1. Only acquire 2 flat fields per year and use the same flat field for each grating. This should be acceptable as the flat field is independent of wavelength in the FUV regime (this will be verified during integration and test at a minimum). In addition, the flat field produces a true continuum for wavelength > ~1600Å, so a flat field acquired with the G160M grating may be preferable for flat fielding G130M and G140L spectra.
2. Acquire fewer photons. A S/N ~100 flat field (1x10 pixels) can be acquired in about 2 hours at 25,000 counts/second that would over sample a spectral resolution element by a factor of 4.

A combination of these two solutions could bring the total fluence below the 0.01 C/cm^2 threshold and thus ensure that the DQE will be stable to 1% over a years worth of observing.

4. CONCLUSIONS

Given the current understanding of the MCP lifetime it is clear that the strategy for monitoring the flat field of the COS/FUV detector must be reevaluated. The current plan for flat fielding the detector could potentially alter the performance of the MCPs. Either altering the amount of data taken for a flat field and/or minimizing the number of flat fields taken will ensure that adequate margin in the lifetime of the MCPs to support the scientific requirements.