Technical Evaluation Report
"COS Thermal Sensitivity"

Date:	November 6, 1998
Document Number:	COS-11-0001
Revision:	Initial Release
Contract No.:	NAS5-98043
CDRL No.:	SE-05

Prepared By: ______________________________ ____________

E. Wilkinson, COS Instrument Scientist, CU/CASA Date

Approved By: ______________________________ ____________

D. Hood, Program Date

Approved By: ______________________________ ____________

J. Andrews, COS Experiment Manager, CU/CASA Date

Approved By: ______________________________ ____________

J. C. Green, COS Principa ASA 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	11-6-98	**THE UNIVERSITY OF COLORADO** At Boulder **The Center for Astrophysics and Space Astronomy**
Reviewed:		**Technical Evaluation Report** "COS Thermal Sensitivity"
Approved:		

Size	Code Indent No.	Document No.	Rev
A		COS-11-0001	-
Scale: N/A			

Table of Contents

1. INTRODUCTION

This TER addresses Ken Carpenter's request that the COS team describe the performance impacts of various thermal environments on the COS instrument. The goal is to identify the sensitivity to the instrument performance with temperature so that the impact of the aft shroud cooling system (ASCS) on the COS instruments can be evaluated and managed during the remaining life of the HST. Two thermal issues are discussed in this memo, absolute temperature and stability.

Effects on the COS instrument performance come about from two primary avenues, thermally induced mechanical distortion and thermally induced detector distortions. Both of these effects result in degraded resolution and thus decreased science performance.

2. CONFIGURATION OF THE COS THERMAL CONTROL HARDWARE

Three components within the COS instrument have heat pipes attached to them for thermal control; the FUV detector vacuum assembly (DVA), the FUV detector electronics box (DEB), and the NUV MAMA detector. The heat pipes are all attached to a common interface plate. Under normal operating conditions the interface plate temperature is controlled by the ASCS. If the ASCS were to fail the interface plate would dissipate it's thermal load through radiative dissipation into the HST aft shroud.

In the event of a failure of the ASCS, the thermal stability of the COS components would be controlled through active heating. This will result in elevated component temperatures. Only the charge amplifiers in the DVA are predicted to experience temperatures above operational limits. These scenarios are reflected in Table 1 at the end of this document.

3. ABSOLUTE TEMPERATURE

Fortunately for the COS instrument the performance of the instrument is only weakly dependent upon the absolute temperature of the instrument. The only consideration on instrument performance with temperature is that the operating temperature ranges not be exceeded. The FUV detector subsystem components are currently designed to operate from –10ºC to +40ºC, although the preferred operating range is between 20ºC and 30ºC as this is the typical temperature regime during ground testing.

4. TEMPERATURE STABILITY

The performance of the mechanical components of the COS instrument are still far too immature to accurately describe how they will function in a changing thermal environment. However, from a mechanical standpoint thermal stability is crucial to maintaining the optical alignment of the COS instrument.

We do have good data regarding the performance of the FUV detector with temperature stability. The primary limits on thermal stability of the COS instrument is derived from this data.

4.1 FUV DETECTOR THERMAL REQUIREMENTS

The FUV detector is an analog system and not a digitized detector, such as a CCD or MAMA detector, which has physical pixels. The FUV detector utilizes a time delay anode and associated circuitry to measure the x location of an incident photon. In this scheme the charge cloud from the microchannel plate stack lands onto the time delay anode. The charge cloud splits with approximately half of the charge moving to one side of the anode while the other half moves to the opposite side of the anode. The propagation speed of the charge is determined by the dielectric constant of the anode material. The x position of the photon is calculated by measuring the difference in the arrival time between the charge pulses at either end of the anode. Two temperature dependent effects have been identified which effect the imaging performance of the detector.

First, the dielectric constant of the anode material is temperature dependent. Therefore, the speed of the charge cloud and thus the “size” of the anode in *time* is also dependent upon temperature. The pixelization is, however, fixed by the ADC used in the electronics. Therefore, as the dielectric constant of the anode changes with temperature so does the number of pixels across the detector image. This effectively changes the plate scale (mm/pixel) of the detector image.

Second, the temperature dependence of a capacitor located in the time to digital converter (TDC) electronics also introduces a variation in the size of the image in time, but at a lower level.

The FUV detector sensitivity to these effects has been measured on the FUSE delay line detectors and is described in the UCB memo FUSE-UCB-014. An important point is that these sensitivities are to first order *LINEAR*. Therefore, there is no absolute temperature requirement, only a requirement on the stability of the temperature over a given time period. The relevant sensitivities are:

Anode temperature sensitivity	≤±2 pixels/ºC≈ ±0.3 resels/ºC
TDC temperature sensitivity	≤±0.75 pixels/ºC≈ ±0.1 resels/ºC

The sensitivities are quoted as ± since the effect is symmetric about the center of the image and varies linearly across the face of the detector. Therefore, the maximum shift introduced in an image occurs at the very edge of the detector and there is no measurable shift at the center of the image.

5. PREDICTED COS THERMAL ENVIRONMENT & SCIENTIFIC IMPACT

The predicted thermal environments for COS are presented below. If the ASCS is operating properly the FUV detector vacuum assembly (DVA) is held well within the required temperature limits and is held stable to ±1 °C/orbit as modeled by BATC. This environment will not degrade the scientific performance of the FUV detector.

However, if the ASCS were to fail the Hot Operational case is predicted to exceed the nominal operating temperature limits of the DVA. The good news is that the stability of the temperature is still ±1 °C/orbit.

In summary, at our current level of design and understanding of the COS thermal environment there is likely to be little degradation in the quality of the scientific data acquired by COS in the event that the ASCS were to fail. However, the higher operating temperatures of the detector components could result in a shorter lifetime.

Table 1

	With ASCS			Without ASCS		
	Cold Hold	Cold Op.	Hot Op.	Cold Hold	Cold Op.	Hot Op.
FUV Detector						
Backplate	30	30	30	30	30	33
Charge Amps	34	34	34	24	32	**42**
FUV Electronics						
Attach plate	24	24	24	23	26	31
TDC frame	33	33	33	39	39	**39**
MEB	0	22	36	0	22	38
Temperature Stability	≤±1°C	≤±1°C	≤±1°C	≤±1°C	≤±1°C	≤±1°C