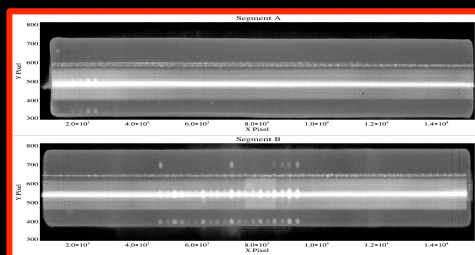


To forestall possible loss in recorded flux due to charge depletion in the microchannel plates (or "gain sag"), the location of spectra obtained with the far ultraviolet (FUV) detector of the Cosmic Origins Spectrograph (COS) on HST will be moved to a different position on the detector, i.e., a new lifetime position, in the summer of 2012. In order to maximize science quality over the next five years, a study of the impact of a new lifetime position on the performance of the COS FUV detector and optics was carried out. Recommendations derived from this study for the location of the next lifetime position are presented here.

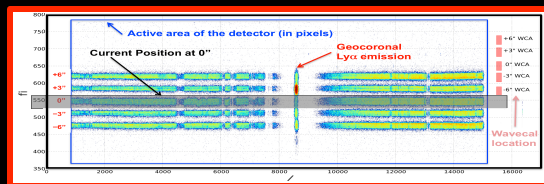
FUV Detector Gain Sag

The FUV detector of COS is an open face microchannel plate (MCP) detector with a cross-delay line (XDL) anode. Incoming photons strike the front surface of the MCP and release photoelectrons which are then accelerated and multiplied as they travel down the MCP pores. Each input photon produces an electron cloud with ~ 10 million electrons (referred to as "gain") which are then collected by the XDL, which uses timing measurements to identify the (x,y) position and total charge in the cloud, or pulse height.

The number of electrons, or total charge, in the cloud decreases with usage - the so-called gain sag effect - and eventually becomes too small to be detected by the electronics, leading to an effective loss in flux. (For strategies to mitigate gain sag see Poster 136.05). A map of the COS/FUV detector, representing all events that have been collected until March 2012 is presented in **Figure 1**:



When gain sag effects can no longer be overcome by either raising the high voltage of the detector or by using the FP-split technique (FP-POS), the only solution is to move the spectra to a pristine region of the detector, i.e. to a new lifetime position - illustrated in **Figure 2**:



Modeling Gain Sag Effects

Using data acquired during the 2+ years of on-orbit operations models were constructed to predict the evolution of gain sag at the current position as a function of time and position on the detector. While the information lost due to gain sag holes (gain sag in regions illuminated by Ly α airglow) can in principle be recovered by the use of multiple FP-POS positions, the same is not true when broad pieces of the continuum start being affected by gain sag. **The models predict that by September 2012 a non-negligible portion of the detector will suffer from gain sag effects, forcing us to move to a new lifetime position by this time. In order to add a safety margin to this time estimate the move to a new lifetime position was planned to occur in early July 2012.**

Maximizing Science Quality

To maximize science quality over the next five years, a study of the impact of a new lifetime position on the performance of the detector and optics was carried out. The parameters considered are: resolution, projected lifetime and overall flat-field characteristics at each position, the effect of the next lifetime position on subsequent positions, the ability to use the wavelength calibration lamp, the ability to perform dispersed light target acquisitions, and the impact of a new lifetime position on the aperture mechanism.

ABSTRACT

Resolution

Observations of an external source (SK191) were carried out at positions offset in the cross-dispersion direction by $\pm 3''$ and $\pm 6''$ from the current position (program 12678) in order to characterize how the resolution varies with offset (external data cannot be obtained beyond $\pm 6''$ due to cross-dispersion constraints on the aperture mechanism). Data obtained at the current position ($0''$) were convolved with several LSF with different FWHM until a best match was obtained between the convolved data and the spectra observed at different offset positions. **Figure 3** shows how the resolution, as measured by the FWHM of a gaussian, changes as a function of offset position (POSTARG), with respect to the resolution at the current position:

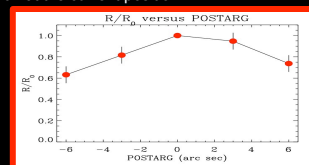
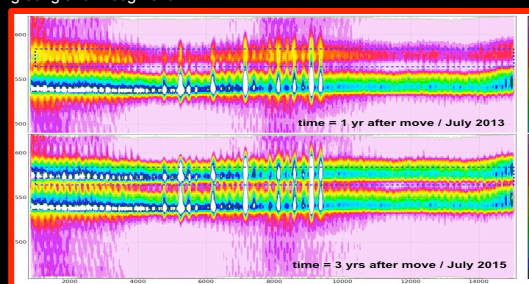


Figure 3 shows that moves in the negative cross-dispersion direction lead to a ~20% higher resolution degradation than similar moves in the positive direction. This behavior is expected from ray-trace models which predict that the peak of the resolution occurs between $0''$ (current position) and $+3''$.

Projected Lifetime at Each Position

The lifetime at a new position, i.e. the amount of time when data can be acquired without suffering from gain sag effects, is a function of the initial gain map at the specific location, the detector usage, and how close the new position is to the previous position. Simulations of the evolution of the gain map with time and position in the detector were carried out for several combinations of dispersion and cross-dispersion offsets. **Figure 4** shows a simulation for a cross-dispersion offset of $3.5''$, for data obtained with the G160M grating and B segment:



For each simulation, the % of pixels with modal gain less than or equal to 3 (corresponding to a flux loss of ~5%) was computed.

These simulations indicate that positions with positive cross-dispersion offsets allow us to mitigate gain sag effects for a longer period of time than similar positions with negative offsets, while offsets in the dispersion direction (to interlace Ly α holes) do not prolong the overall lifetime of the new position.

Other Parameters Affecting Choice of Lifetime Position

Although not as critical as the resolution and lifetime at each position, other parameters were also considered in the selection of the new lifetime position. The constraints from all the parameters are represented in **Figure 5**:

Y Positions (")	-6	-5	-4	-3.5	-3	-2	-1	0	1	2	3	3.5	4	5	6
Resolution															
Projected Lifetime															
Flat Field															
Subsequent Positions															
Wavecal															
Target Acquisitions															
Aperture Mechanism															

Next Lifetime Position

When all the parameters in **Figure 5** above are considered, taking into account that the resolution and lifetime at each position are the most critical in selecting a new lifetime position, it becomes clear that the next COS lifetime position should have an offset of $\sim +3.5''$ in cross-dispersion ($+41$ pixels in Y). The new lifetime position at $+3.5''$ should allow us to operate COS/FUV for at least another 3 years, assuming similar usage. In addition, strategies to increase the lifetime of the new position are being considered - these range from starting operations in the new position at a low high voltage level and incrementally increase it to overcome gain sag effects, to using a weighted extraction algorithm to extract 1-d spectra.

Move to the New Lifetime Position

Before the planned move to the new lifetime position in early July 2012 several programs were carried out in order to enable science at this position. These programs include a HV sweep to select the initial operating voltage at the new position, a focus sweep, and programs related to verifying the aperture and spectrum placement at the new lifetime position as well as updates to FUV dispersed light target acquisition parameters (as FUV target acquisition will be moved to the new lifetime position).

Once the move to the new lifetime position occurs, calibration programs will be executed in parallel with science observations. These programs will check the wavelength scales and resolution and will obtain data for flat-fielding and flux calibration.

The resolution of the new lifetime position is expected to be within ~10% of the resolution at the original position. Small changes to the wings of the line spread function are predicted; new LSF models have been computed and will be made available to users once they are validated by calibration observations at the new lifetime position. The flux and wavelength calibrations of the new lifetime position are expected to be very similar to those at the original position. All the calibration observations will be executed shortly after moving to the new lifetime position and updates to calibration reference files, if needed, will be promptly made.

The move to the new lifetime position will be transparent to users preparing their Phase II with APT. No changes will be made to the location of the COS NUV science or target acquisitions.

Move to New Lifetime Position Delayed due to COS Suspend

The move to the new lifetime position has been delayed due to COS suspending operations on Apr 30 2012, because of a count rate violation observed in the FUV detector. The NUV detector was returned to science operations on May 14. The ongoing process to recover the FUV detector takes a very cautious approach and is similar to the process used to turn on the FUV detector after COS was installed in HST. This process will be completed by June 12. Return to science operations is expected to occur around June 15. The move to the new lifetime position is expected to occur around middle to late July.