Technical Evaluation Report
"Recommended Detector Lifetime Adjustments"

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We report the total predicted counts to be observed on the COS FUV and NUV detectors, based on the COS Design Reference Mission, and suggest baseline plans for making COS detector lifetime adjustments on both the FUV and NUV channels.

Detector lifetime adjustments: In this memo, we suggest that the planned detector lifetime adjustments for both the FUV and NUV detectors in COS, currently baselined at ~6 – 12 month intervals, may be more frequent than necessary, and that reducing the number and range of planned lifetime adjustments will simplify instrument operations.

1. The specification on the FUV detector is that there be only a 1% loss in QE after $10^9/mm^2$ events are recorded. Such a loss would not compromise COS's ability to achieve its science goals, and yet the COS Design Reference Mission (DRM) indicates that only a few $\times 10^9$ events will be observed *over the entire COS (~7 yr) mission through each channel*. Including events received for flat-field and flux calibration, we may conservatively estimate 10^{10} events observed through each channel during the COS mission. On the FUV detector, there are ~2400 independent spectral resolution elements (resels) per segment (R = 20,000 modes), with each resel occupying ~40×200 microns (≈ 7×10 pixels ≈ 0.008 mm^2/resel). Therefore each resel would suffer a 1% QE loss after 8×10^6 events. Spreading the 10^{10} events uniformly among the ~4800 total FUV resels results in each resel observing $\sim 2\times 10^6$ events. Even if some regions (e.g., rest Ly _) receive 10 times more events, only a few fresh detector regions are necessary to maintain the COS FUV performance. The actual frequency of detector lifetime adjustments needed will depend on the quality of the flight micro-channel plates for the FUV detector, and will be evaluated in detail at a later time.

2. The image at the NUV MAMA quickly degrades as a function of radius from the position of best focus. Hence, no detector lifetime adjustments are possible that will retain the full spectral resolution. However, spectra received from each grating will shift position on the MAMA as the gratings are scanned in wavelength. In addition each grating is expected to be slightly mis-aligned with the other gratings and will use its own detector rows in the dispersion direction.

3. Thus it appears that the planned annual adjustments may be more frequent than necessary to maintain the performance of COS. Lifetime adjustments for the NUV detector are not viewed as necessary, though STIS is currently moving its first-order spectra to new locations on its MAMA detectors monthly. Pending review of the benefits to STIS, the potential benefits of observing on "fresh territory" may be vastly outweighed by the burden of re-calibrating new detector regions frequently. By limiting the number of detector lifetime adjustments, we limit the number of times we need to re-calibrate new detector regions (in terms of flat-fielding and flux calibration), resulting in a substantial savings in calibration orbits over the mission

duration. Indeed, calibration – using bright external sources and internal lamps – may be one of the principal causes of detector performance degradation.

Recommendations: (1) Limit the planned FUV detector lifetime adjustments to ± 0.4 mm, making up to 5 different detector locations available during the mission. (2) Make the FUV detector lifetime adjustments as necessary (when noticeable QE loss or gain drop has occurred, as observed in periodic gain maps), perhaps at 2-year intervals rather than the 1-year intervals currently baselined. (3) Do not make NUV detector lifetime adjustments since small offsets from the best focus position do not preserve spectral resolution.