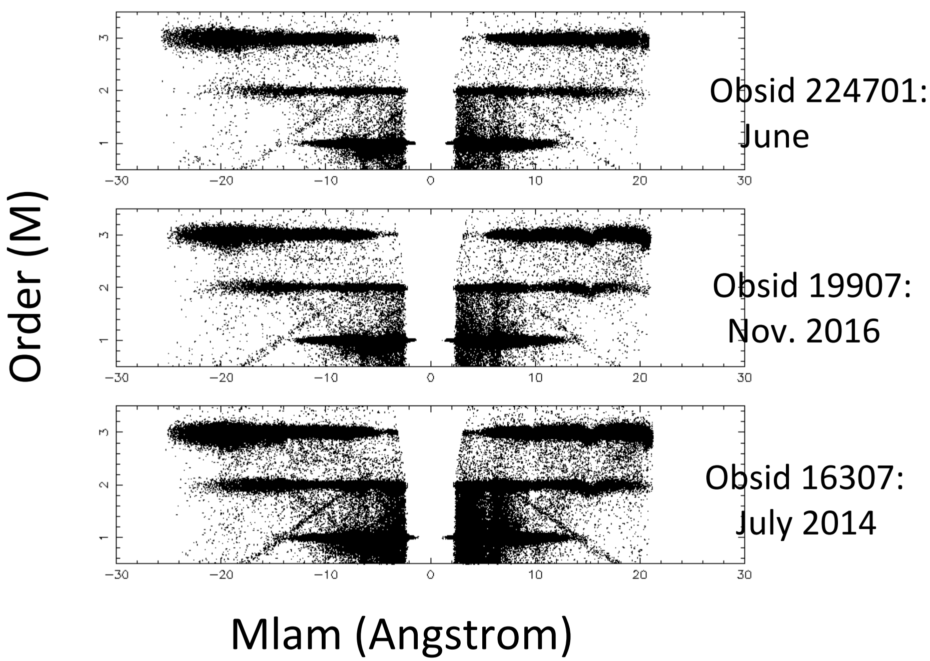
HETG Spectra at Focal Plane Temperature -105 C

Status 06/27/23

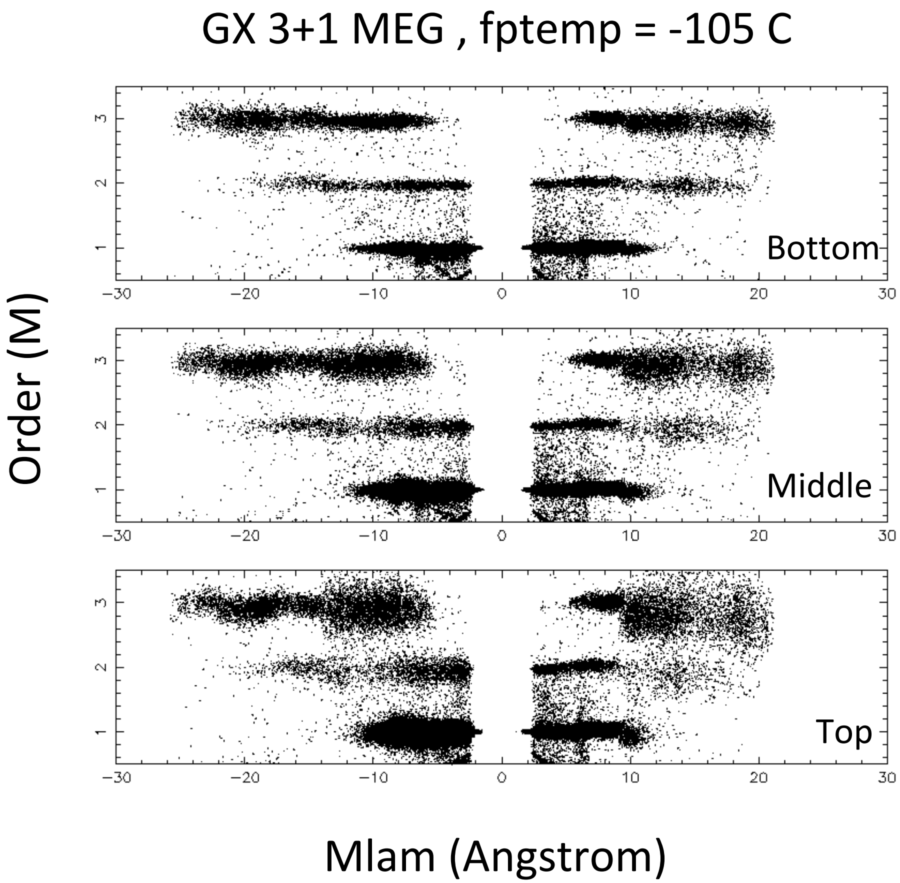
Final Report

GX 3+1 MEG , fptemp = -118 C



We observed the bright X-ray binary source GX 3+1 at a focal plane temperature of -105 C with the HETG at three Y locations of the ACIS array with a zeroth order placed near chipy=250 (ObsID 27271), 500 (ObsID 27272),and 750 (ObsID 27273) for an exposure of 10 ksec each. Dispersed spectra range about 160 pixels (CHIPY) above and below the zeroth order. Other ObsIDs at cold focal plane (-118C) we looked at were 24701, 19907, and 16307.

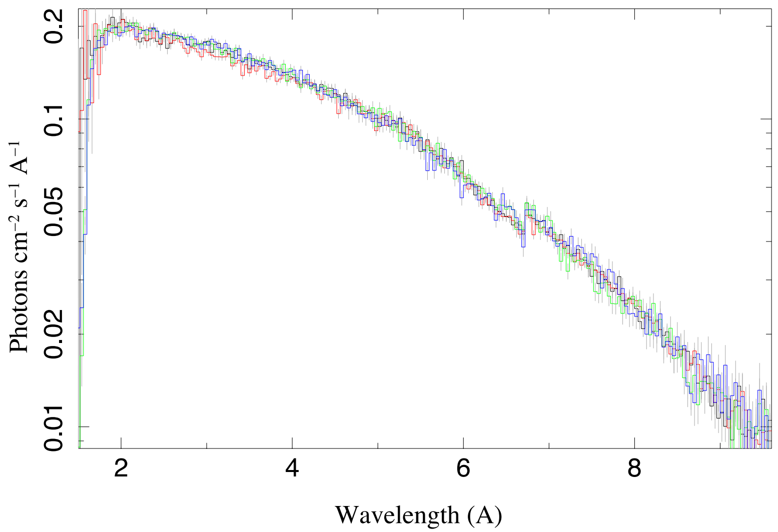
The flux calibration depends on factors such as order-sorting PHA windows, CCD QE, CCD CTI correction, and CCD grade migration.All spectral arms should yield the same flux.



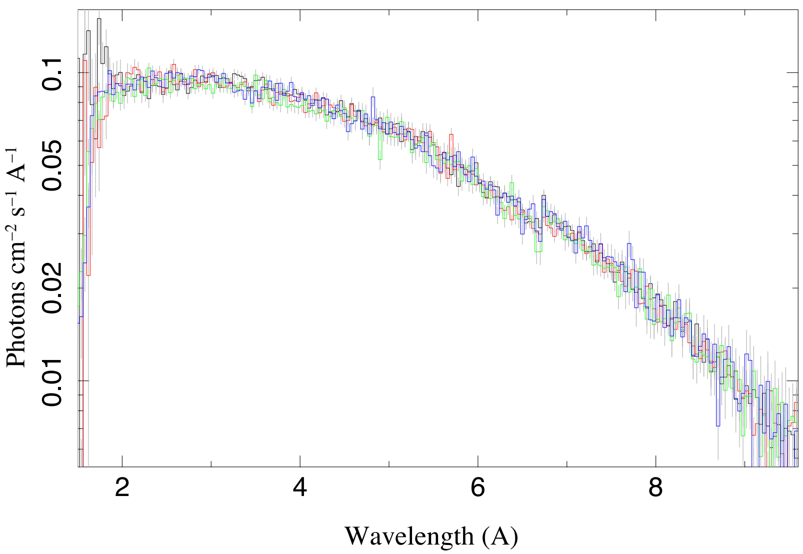
For all spectral arms, we examined the ratio of the ACIS CCD energy to the HETG dispersed energy to determine any shift from the standard order sorting selection windows (defined by the CALDB OSIP files). This ratio is a real-valued order; the OSIP file tabulates low and high energy bounds vs energy for first order, based on the ideal CCD response. We did not observe any significant clippings or exclusions.

Charge transfer inefficiency significantly degraded the response the observation on the top of the array (high CHIPY) in the -105 C focal plane case in an expected way. Source flux also was not affected.

GX 3+1, fptemp = -118 C

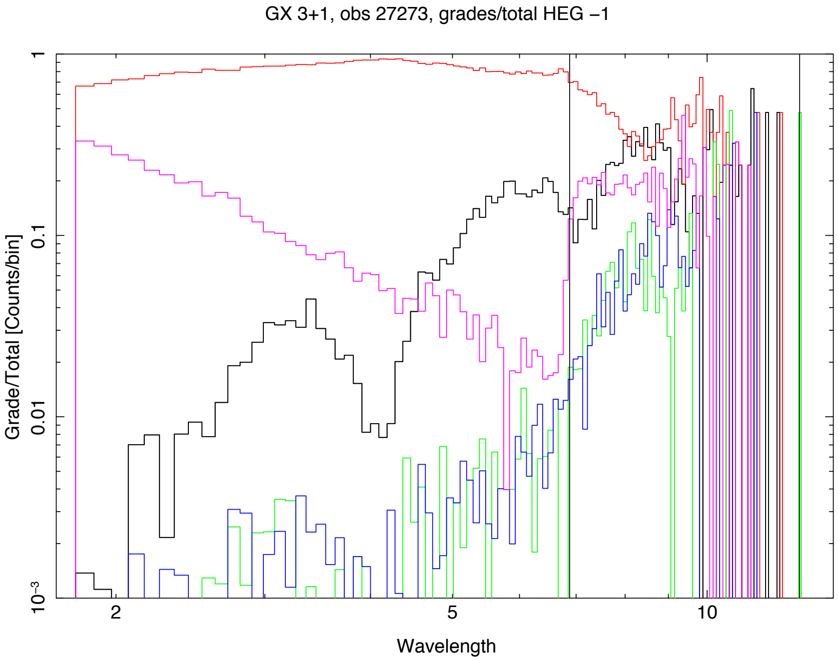


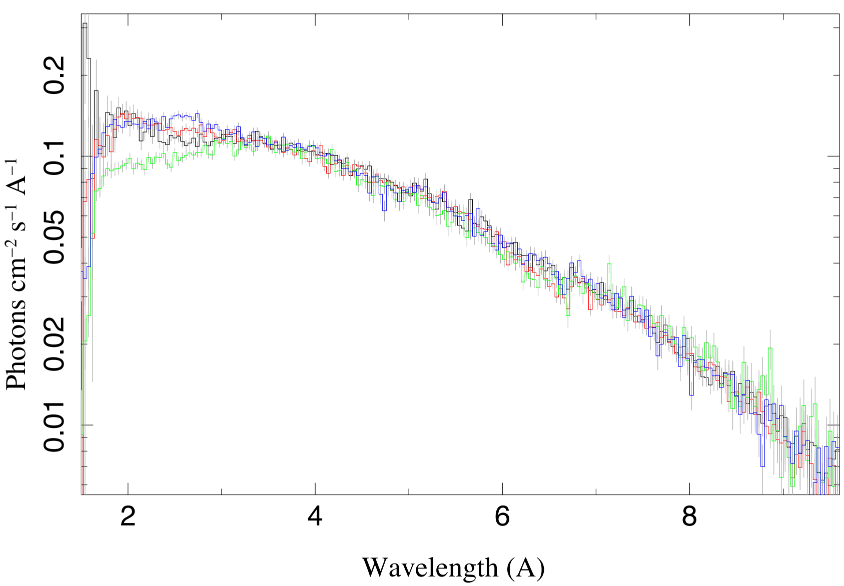
GX 3+1, fptemp = -105 C



We observed some minor variations in spectral shape and flux. These were all within expectation of X-ray source variations. The data in the order sorting did not show any indication of excessive charge transfer inefifciency variations that would cause clippings in the order sorting tables in any of the observations independent of any chip-y dependency.

fptemp = -105 C. grades, top array

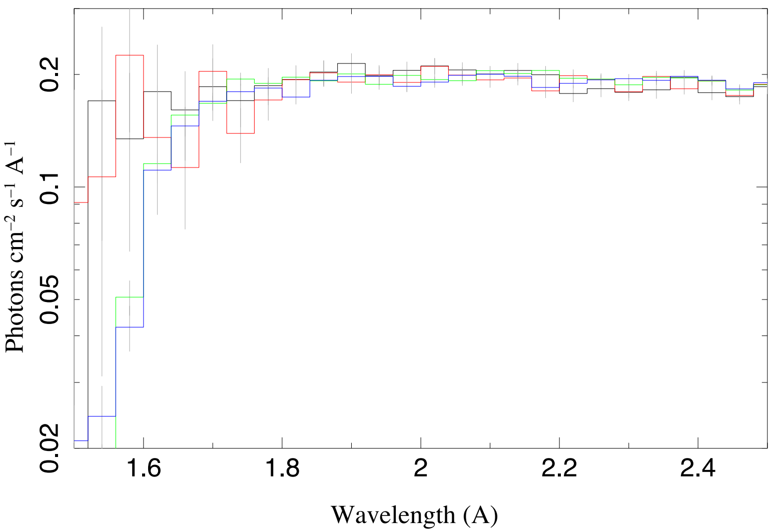




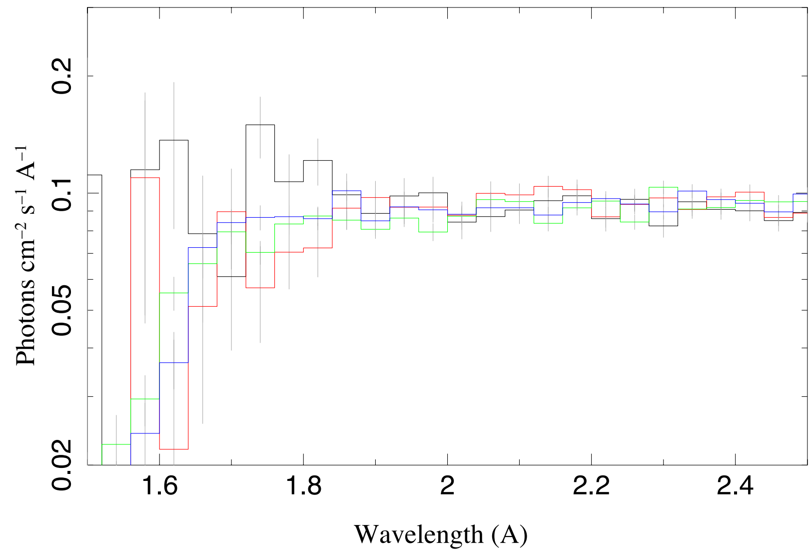
We observed some unusual grade ratio patterns and variations which appear confined to the S2 chip and not related to focal plane temperature. For most of the observations the HETG appeared to perform nominally at -105 C focal plane temperature and consistent with current (-120C) calibration products.

We did find a discrepancy in the HEG -1st order of the top (y=750) below 3 Angstrom. We traced this effect back to a grade migration where the 0, 3 and 4 good grades appeared to change unrecoverably into bad grades. The resultant effective area deficiency was between 5 to 10%. This effect was not observed in the spectra of the middle (y=500) and bottom (y=250) of the ACIS-S array.

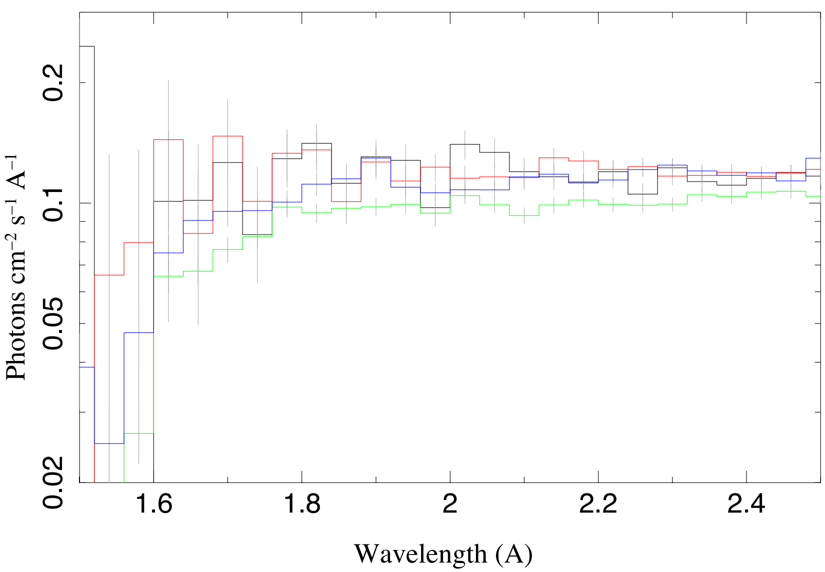
fptemp = -118 C. bottom array



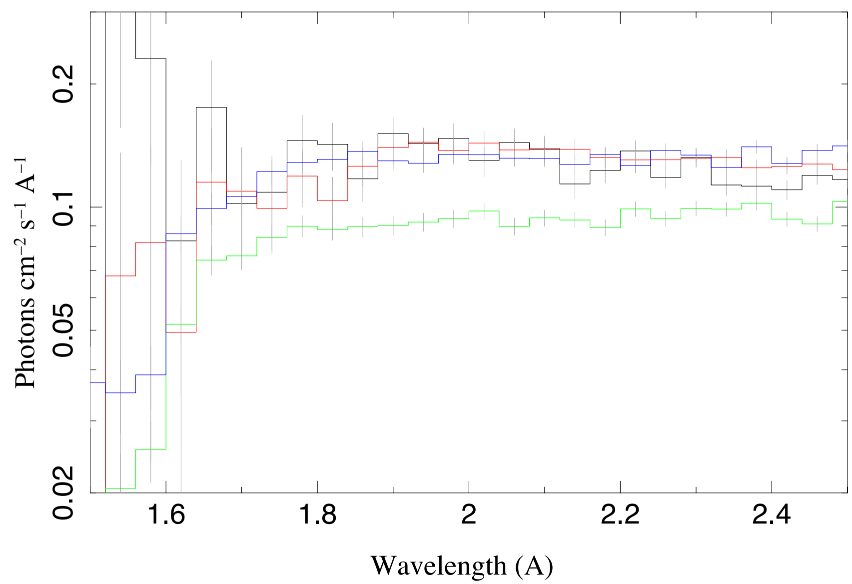
fptemp = -105 C. bottom array



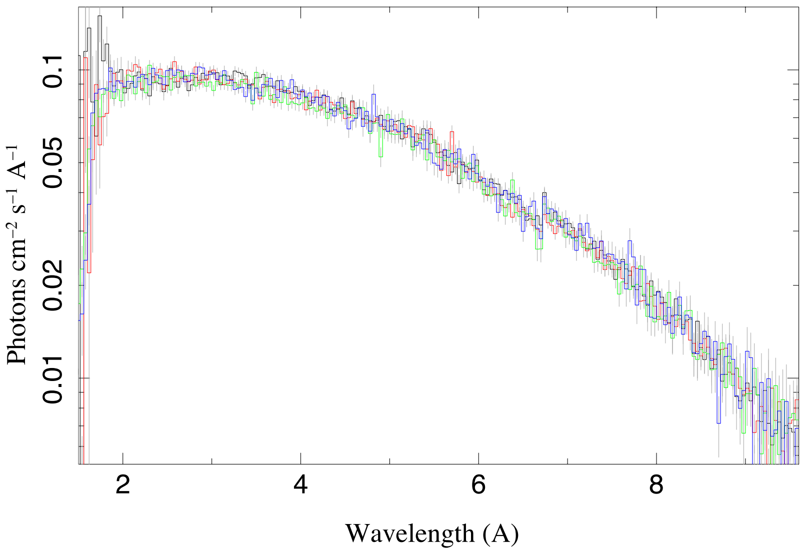
fptemp = -105 C, middle array

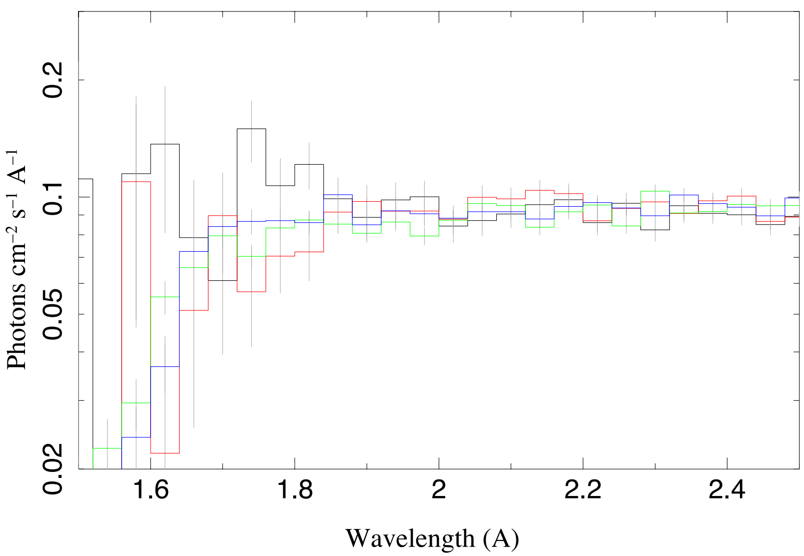


fptemp = -105 C. top array



fptemp = -105 C. bottom array





We therefore come to the following conclusion based on the results of the GX 3+1 warm focal plane observations:

- The HETG can be used at -105 C focal plane temperature only if the zero-order location is moved beyond 6 mm in -Sim Z direction, preferably associated with a sub-array.

- The observed grade migration effect is expected at higher focal plane temperatures, and we suspect this effect becomes worse at higher temperatures.

We will continue to study these warm observations and we may at some point conclude that the HETG cannot be used at higher focal plane temperatures without substantial re-calibrations.