LETG Update

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Seven Minutes to Midnight

Worryingly, the metaphorical HRC "doomsday clock" now stands at 7 minutes to midnight.

The LETG prime detector, the High Resolution Camera Spectroscopy array (HRC-S), has had a well-documented secular loss of gain and quantum efficiency (QE) since it was launched. This has been described in detail in previous Newsletters. The gain loss itself is not a problem, until it gets so low that X-ray photon events are no longer recognized as such because the event pulse height—essentially the amount of charge generated—falls below a level at which it is ignored. That level is called the "event threshold". The event threshold is designed to easily veto events that have pulse heights inconsistent with X-rays to eliminate unwanted background and wasted telemetry. Unfortunately, X-ray events are now beginning to fall below the event threshold.

Until recently, the slow rate of QE loss, which remains unexplained in detail but is attributed loosely to space weathering of the microchannel plates, has been equally affecting all wavelengths of the LETGS. In the last two or three years, signs that this is no longer the case have been growing. We see this when we compare the flux vs wavelength in successive calibration observations of the hot white dwarf HZ43. Pete Ratzlaff, one of our talented computer specialists and data analysts, has been looking at these observations taken since launch and using them to devise corrections to apply to the detector QE to bring observed fluxes back into agreement with the reference model.

Figure 1 illustrates the wavelength-dependent correction factors derived by Pete from observations in 2018 and used for the long wavelength QE of the HRC-S. They are applied together with a constant that accounts for a steady grey QE decline, such that wavelength-dependent correction factors larger than 1 are possible in detector regions where the actual decline is lower than the mean grey rate. The region covering approximately 120–180 Å shows a decrement in QE amounting to 10% relative to the steady QE decline grey correction near 160 Å. This detector region also has significantly lower gain than other detector regions. We have verified that the QE loss here is due to photon events falling below the event discriminator.

All this sounds rather gloomy. The loss of QE would eventually render some wavelength regions with low gain effectively blind. Fortunately, there is a way to try to mitigate the gain loss: raise the high voltage across the microchannel plates. This procedure was carried out back in 2012 and did succeed in raising the gain. Slightly worryingly

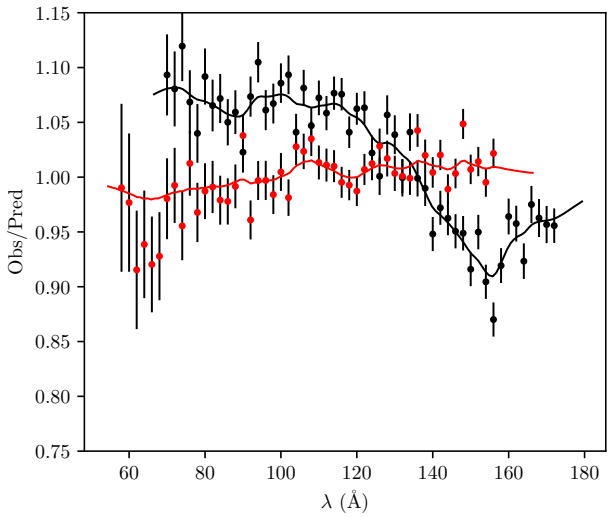

Figure 1: Quantum efficiency calibration corrections computed by Pete Ratzlaff as a function of wavelength from 2018 calibration observations of the hot white dwarf HZ43. These wavelength-dependent corrections are applied together with a constant grey correction factor to arrive at the final calibration. Black corresponds to positive first order and red to negative.

though, the gain decay in successive years was more rapid than before the voltage increase. The downside: a painful and lengthy re-calibration of the detector, which requires considerable calibration observations. There is also the, hopefully small, possibility that the detector does not like the higher voltage and ends up damaged.

So what time are we at with the HRC-S voltage increase clock? We still have a year or so to go before we feel it necessary to try and recoup the gain loss with another voltage increase.

I first learned of the Doomsday Clock metaphor through a terrific song "Seven Minutes to Midnight" by the British new wave band Wah! Heat that was inspired by the concept of the clock, with lyrics "...seven minutes to analyse, my instinct must be quick, seven minutes to midnight, I feel sick...". So the HRC-S clock is about 7 minutes to, I would think.

The author thanks the LETG team for their useful comments, information and discussion.