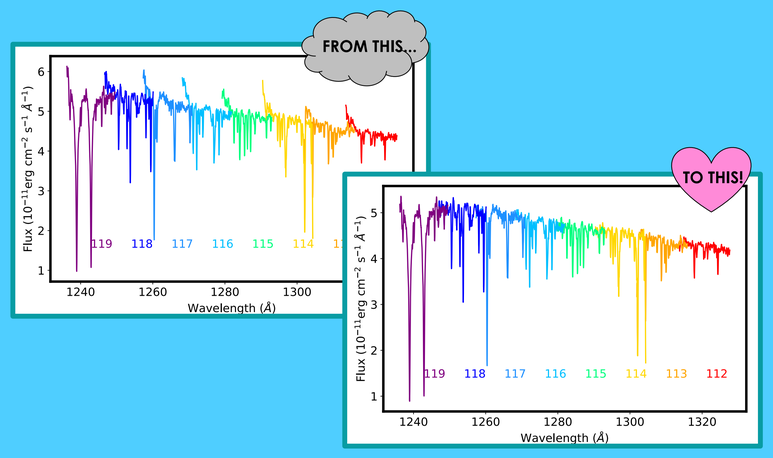


# Improved Flux Calibration of HST/STIS E140M via New Sensitivity Curves


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## E140M's Blaze Shape Change

- The **blaze function** (characteristic sensitivity of a spectral order) of all STIS echelle gratings shift in wavelength with slight variations in the angle of incidence of incoming light.
- Accounting for shifts is essential for accurate flux calibration, particularly at order edges.
- Recent E140M spectra cannot be corrected with simple shifts to the blaze functions, suggesting a shape change.

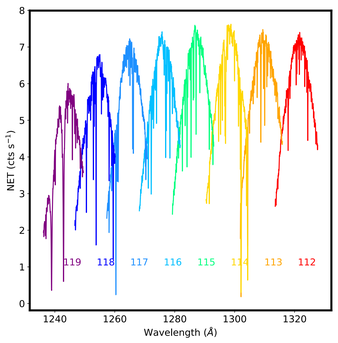


**Fig 1.** Net count rate in a typical E140M observation, illustrating the inverted U-shape of the blaze function of each spectral order. Eight of the 44 spectral orders are shown.

## Remeasuring Sensitivity

**Target:** G191-B2B, a $T_{eff}$ ~ 60,000 K, DA.8 white dwarf.
**Observation:** Dataset `odqw01010`, taken on 2018-02-19.

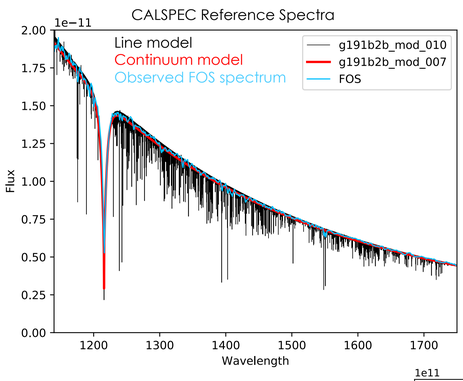


**Fig 2.** Comparison of available CALSPEC (Bohlin et al., 2014) flux references for G191-B2B. The **line model** (Rauch et al. 2013) is used to robustly identify continuum regions in the observed spectrum. The **continuum model** (metal-free) is used to set the absolute flux of the star. Note a small (~2%) difference in the absolute flux of the models.

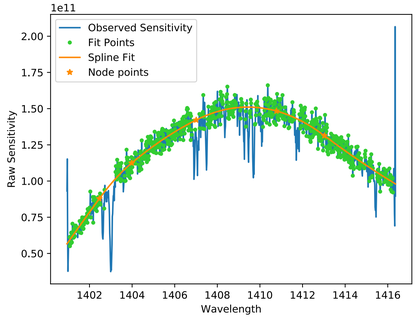


**Fig 3.** The observed net count rate is divided by the model flux to determine the raw sensitivity. A 5-node quadratic spline function is fit to the likely continuum points to determine a smooth sensitivity function. This analysis builds on the work of Bostroem et al. (2012).

## Results

### NEW SENSITIVITY CURVES

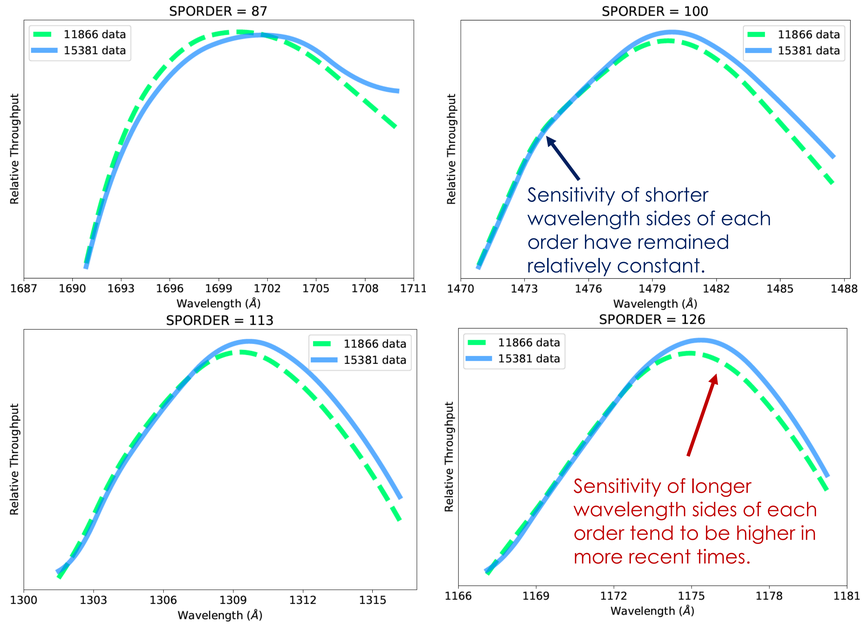


**Fig 4.** Comparison between sensitivity curves derived from data taken in 2009 from program 11866 (green dashed lines) and the data taken in 2018 for program 15381 (blue solid lines) for four representative spectral orders.

### IMPROVED FLUX CALIBRATION

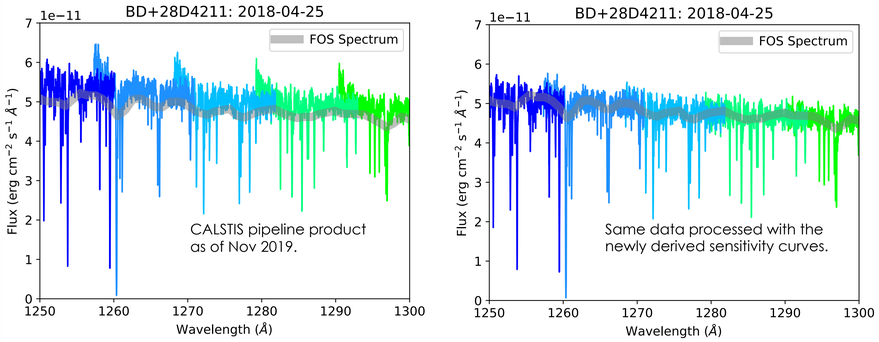


**Fig 5.** Flux calibrated spectrum of standard star BD+28D4211 (thin, colored lines) taken two months after the G191-B2B observations. The CALSPEC FOS spectrum (heavy, gray line) is shown for comparison. **Left**: The previous CALSTIS pipeline product showed flux mismatches in overlapping wavelength ranges of neighboring orders and, in this part of the spectrum, a systematic overestimate of the stellar flux. **Right:** The newly derived sensitivity file corrects both calibration errors.

## What to Expect in Your Data

- Two sets of PHOTTAB & RIPTAB reference files will be delivered to CALSTIS in Jan. 2020. All post-SM4 E140M datasets (2009-present) will be reprocessed.
- Spectral order 86 (~1712 – 1730 Å) is newly flux-calibrated in all post-SM4 data.

## A Second Shape Change?

- There is evidence of a new change in sensitivity on a larger wavelength scale, mostly affecting λ > 1600 Å.
- It is akin to either a shape change in the blaze of the cross-disperser or E140M's departure from the time-dependent sensitivity (TDS) of the FUV (see Fig. 5).
- The STIS team is monitoring this behavior to better understand its origin and possible evolution.
- The largest flux discrepancy (~6%) is still within STIS's specified flux accuracy (STIS IHB, Table 16.2).

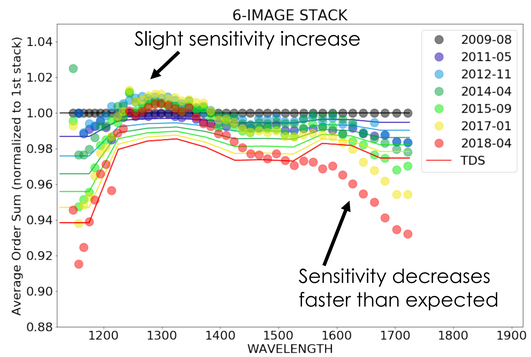


**Fig 5.** Net count rate in each spectral order in forty-two E140M observations of BD+28D4211, observed 4x/year for TDS monitoring. The total net count rate of 400 central pixels in each order are averaged over 6 consecutive images (spanning ~ 15 months). These average stacks are then normalized to the first image stack. The expected TDS relationships (derived from G140L data) for each image stack are shown with solid lines.

## References


- Bohlin et al. 2014, PASP,126,711
- Bostroem et al. 2012, STIS ISR 2012-02
- Rauch et al. 2013, A&A, 560, 106
- Riley, et al. 2019, "STIS Instrument Handbook," Ver. 18.0, (Baltimore: STScI.)



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