Swapped fibre analysis update

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18/11/2022

Method

- The method for detecting mislabelled (“swapped”) fibres is as follows -
  1. fit Gaussian/Moffat PSFs to bundle images of stars.
  2. Flag fibres exhibiting large (>3sigma) residuals to the fit.
  3. Swap each of the flagged fibres with their two neighbours and re-do the fit. If the reduced-chi2 of the fit improves significantly, then flag this fibre pair as a “swap candidate”.
  4. Swap candidates that are flagged in multiple dithers in which there is light in at least one of the affected fibres are likely to represent swapped fibres.
- I developed a 17-point dither pattern that illuminates all regions of the largest bundles sufficiently for this method to detect *all* possible swapped fibre pairs in simulated bundle images at typical S/N of observations from Hector commissioning runs, assuming a FWHM of 3.5” (corresponding to the maximum practical telescope defocus).
  - *Details on these simulations can be found in the DR document.*
- Caveats: this method assumes that only neighbouring fibres in the slitlet can be swapped.

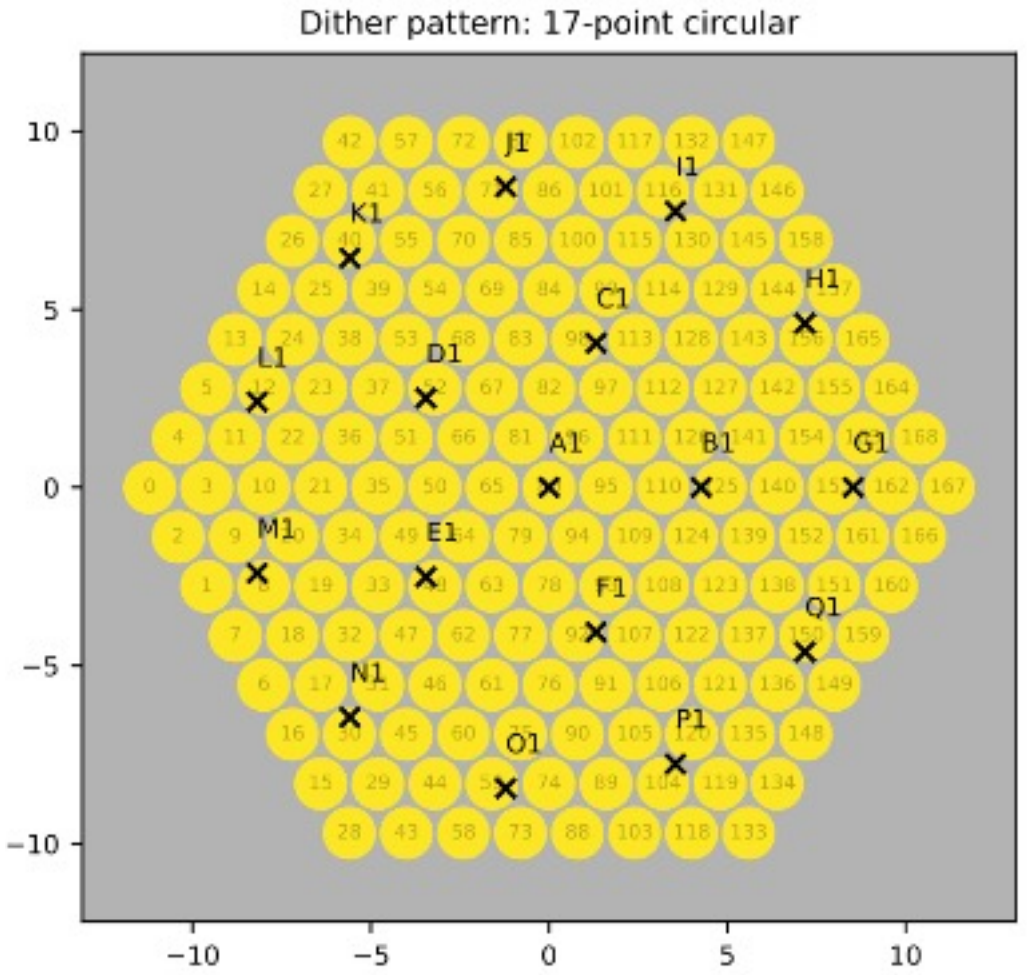

Figure 1: 17-point dither pattern for detecting "swapped" fibres.

Applying to observations

- The swapped fibre detection method was applied to all observations of star fields from the July to the September runs. These include defocused star field images especially taken during the September commissioning run to detect swapped fibres, covering some of the dithers in the pattern shown in Fig. 1, but also in-focus observations taken to test the standard Hector dithering pattern, which places the stars near the centres of bundles.
- As of October, not all regions of the largest bundles have been illuminated, as shown in Fig. 3, which shows the co-added bundle images from all star field observations from the July through September runs: the outer regions of bundles A-F are blue in colour, demonstrating that these bundles have not been illuminated sufficiently to detect swapped fibres in these regions.
- I have not yet re-run the swapped fibre detection pipeline on data from the October run. It also needs to be re-run to include frames in which standard stars were placed within specific bundles.

- **Results:**
  - In bundle J, fibres 15 and 16 appear to be swapped – this is obvious when comparing the 29jul14 and 29jul22 exposures in Fig. 2.
  - A small number of other fibre pairs were flagged as potential swap candidates, but further observations covering the outer regions of the dither pattern are required to confirm these (see Fig. 3).

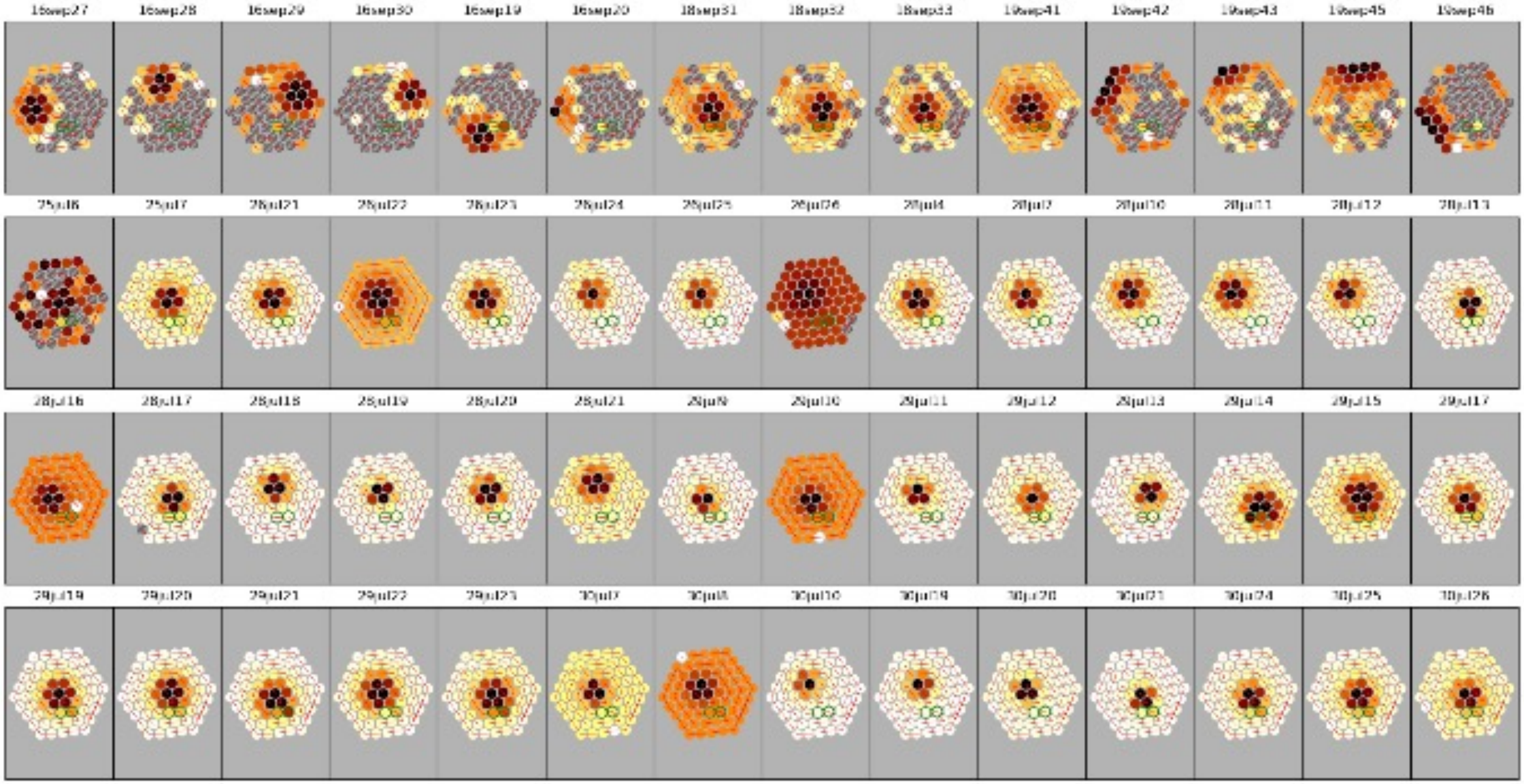

Figure 2: bundle images of stars from bundle J where the counts in each fibre have been log-scaled to bring out the faint wings in the PSF. The date and observation number are shown above each panel. The red line in each panel shows the ordering of the fibres along the slitlet. Fibres 15 and 16 are indicated in green, and appear to be swapped.

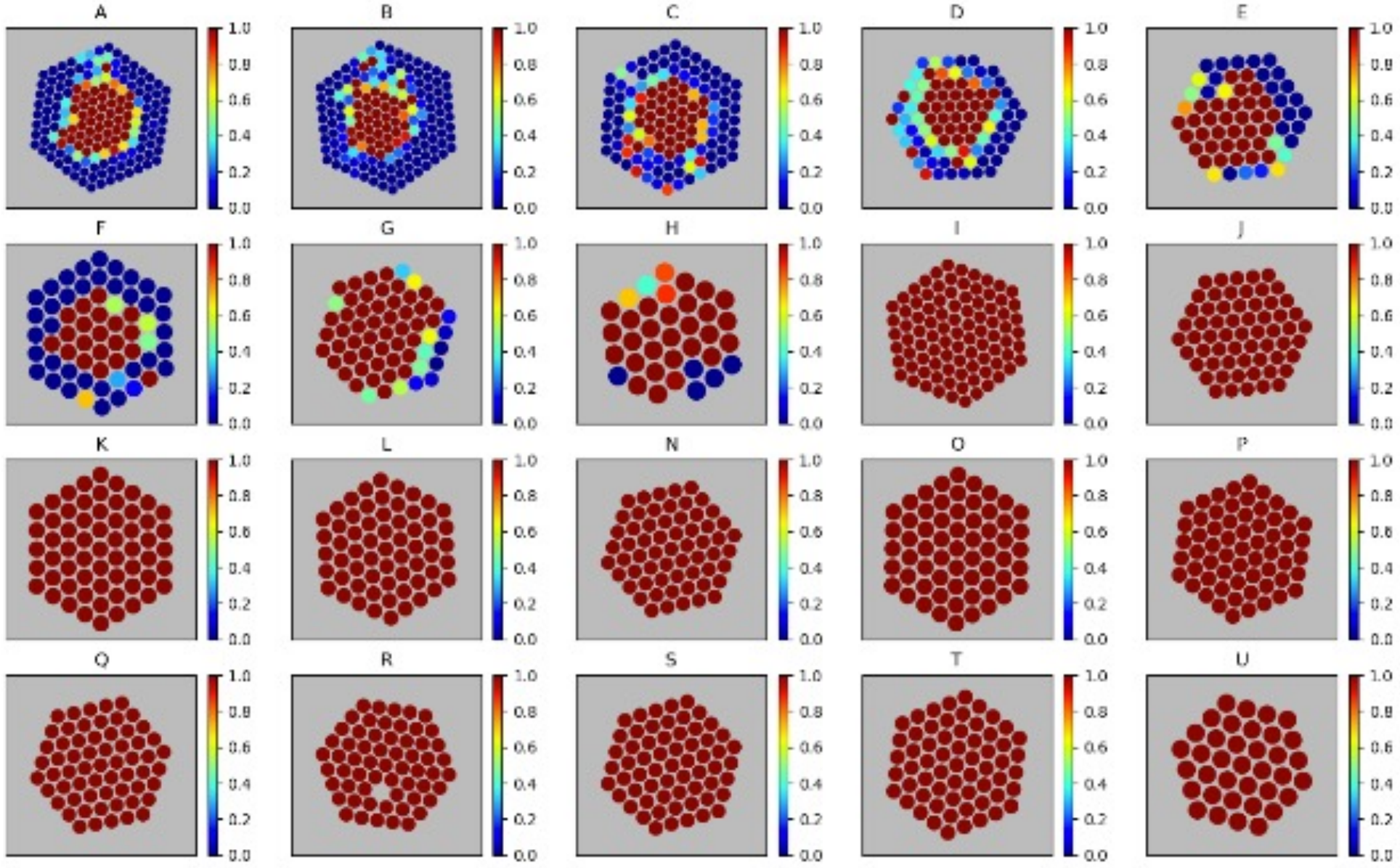

Figure 3: co-added bundle images from all star field exposures from the July to September runs. Fibres that are red have been illuminated in at least one exposure, whereas those that are blue have not.

Strange features in bundles I and T

- In the process of running the swapped fibre detection pipeline, it was discovered that bundles I and T show some odd patterns in the star images in some dithers, which are most notable when there is no object in the FoV of the bundle (see Figs. 4 and 5). As such, I could not reliably detect whether there are any swapped fibres in these bundles.

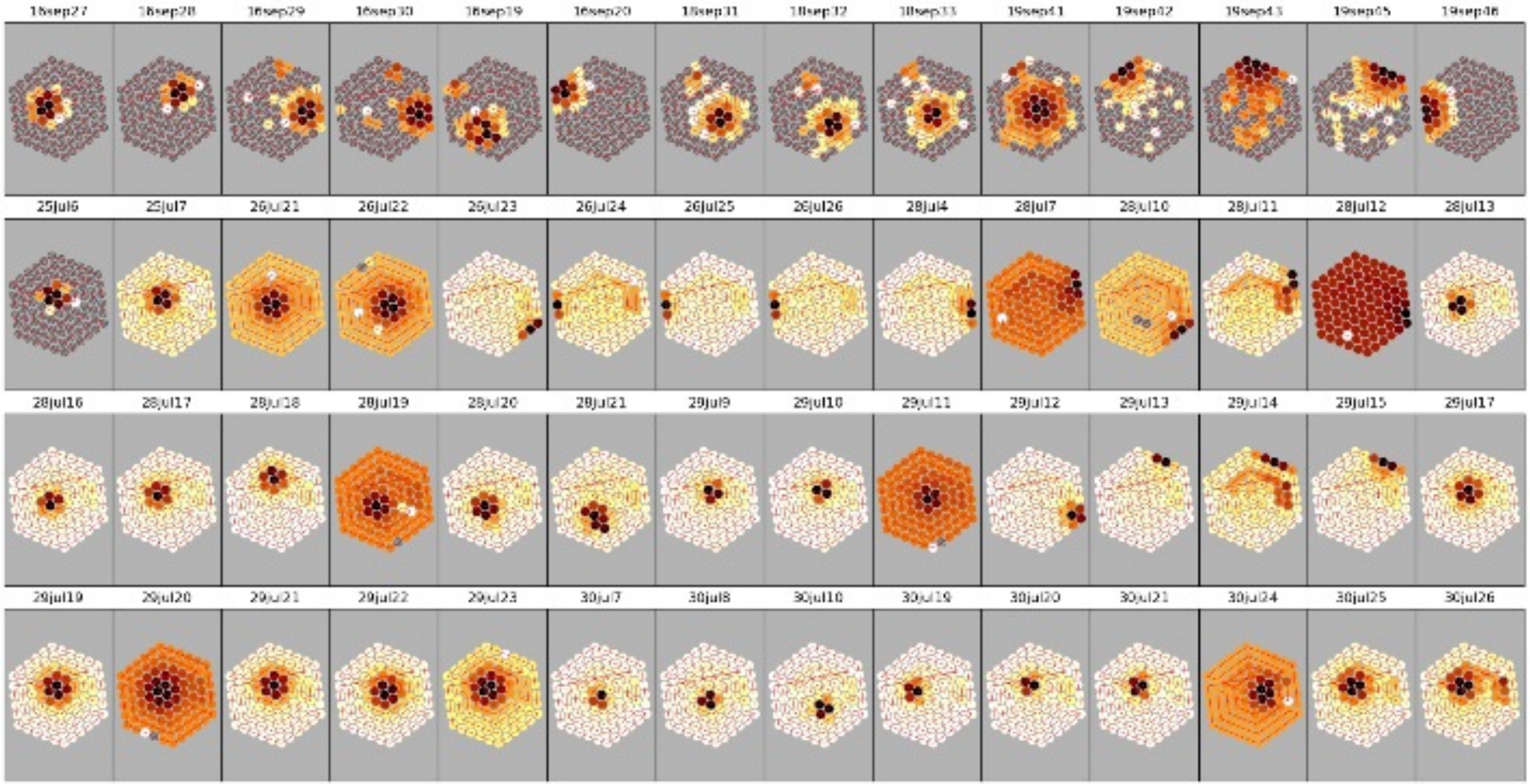

Figure 4: bundle images of stars from bundle I where the counts in each fibre have been log-scaled to bring out the faint wings in the PSF. The date and observation number are shown above each panel. The red line in each panel shows the ordering of the fibres along the slitlet.

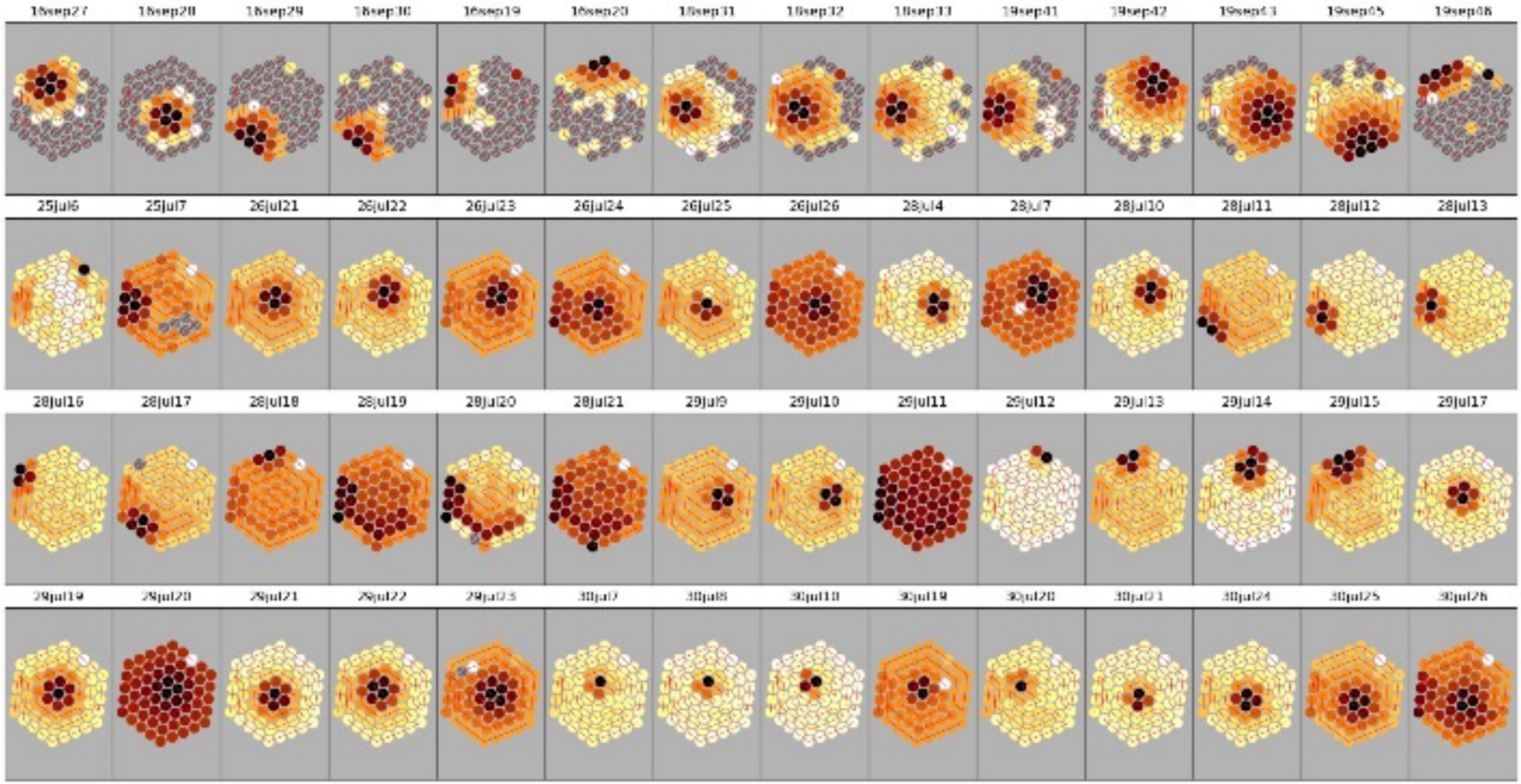

Figure 5: bundle images of stars from bundle T where the counts in each fibre have been log-scaled to bring out the faint wings in the PSF. The date and observation number are shown above each panel. The red line in each panel shows the ordering of the fibres along the slitlet.

Strange features in bundles I and T

- It was determined that this feature is due to large residuals in the red in Spector in one or two columns of pixels roughly halfway along in wavelength space (around ~2000 pixels). The feature is curved after the detector images have been re-gridded to a common pixel-to-wavelength scale, which indicates a detector fault rather than an arc line.
- It is present in most, if not all, fibres, but was easiest to see in bundles I and T due to the way the images were being calculated (they were produced using Madusha's quick-look tool, which sums the counts in a wavelength range centred at 2048 pixels, which meant that this feature was dominating the counts in some fibres in those bundles).
- The feature is only present in observations up until the October run (see Figs. 6-9)

Bundle I

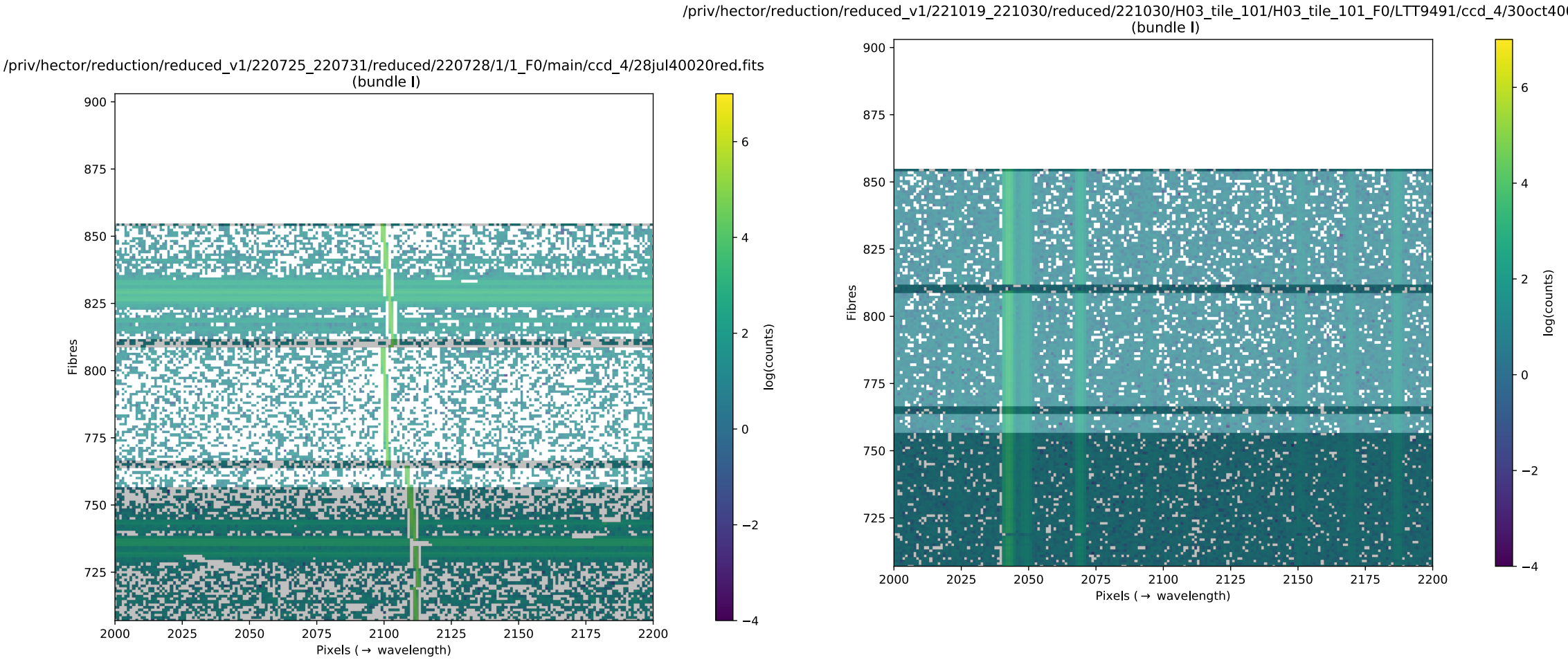

Figure 6-7: Fibre-extracted wavelength calibrated detector images, in which each row corresponds to a fibre, and each column corresponds to a wavelength. The unshaded areas correspond to fibres in bundle I. The strong residual in the July exposure (left) is not apparent in the October exposure (right).

Bundle T

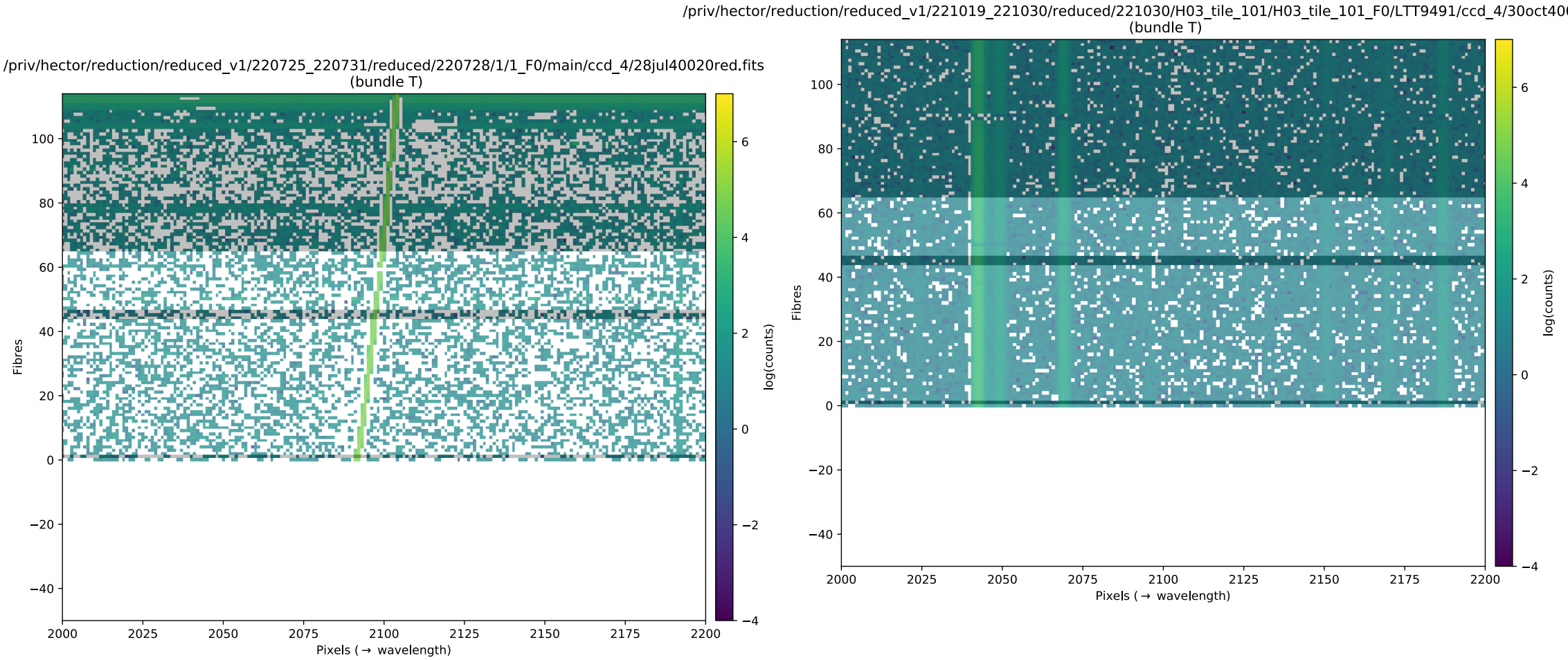

Figure 8-9: Same as Figs. 6-7 but for bundle T.