

1st FUSE (GI) Data Analysis Workshop

Detector Flat Fields

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1. Flat Field Features

- Sources of fixed-pattern noise

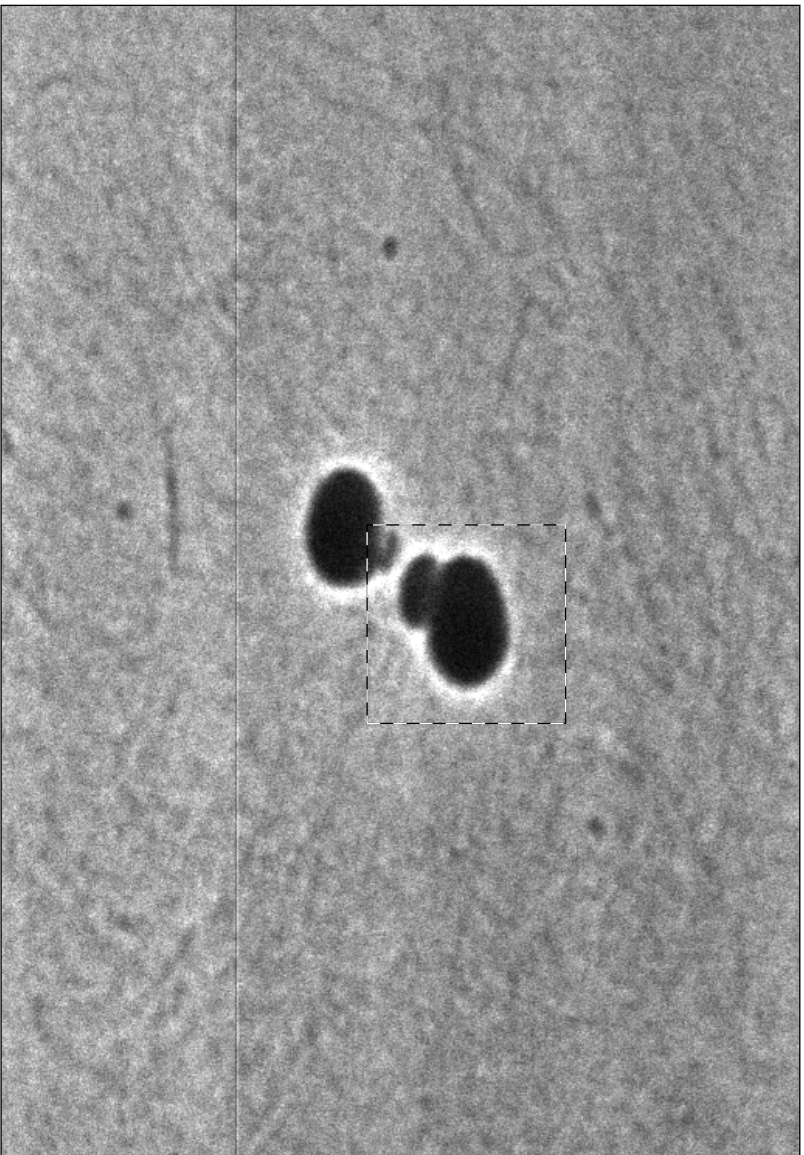
2. Baseline Flat Field Strategy

- Deep pre-flight stim lamp exposures

3. Alternate Approaches

- Dithering in LWRS aperture
- FP-SPLITS in MDRS aperture (HIST data)
- Derive 1D flat field from FUV bright sources

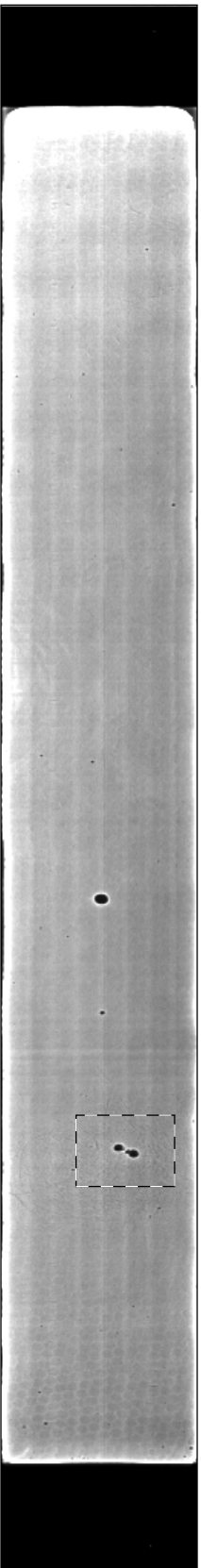
flat1a001.fit



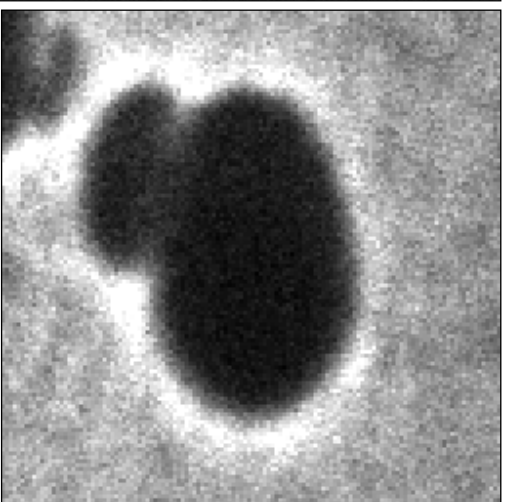
11586:12330 392:906

0.00000 1.50000

Linear Display

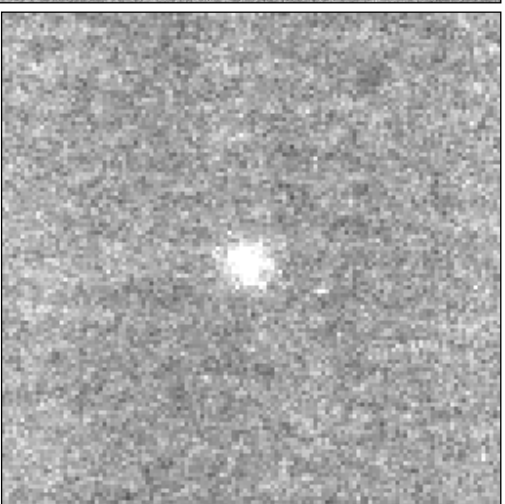
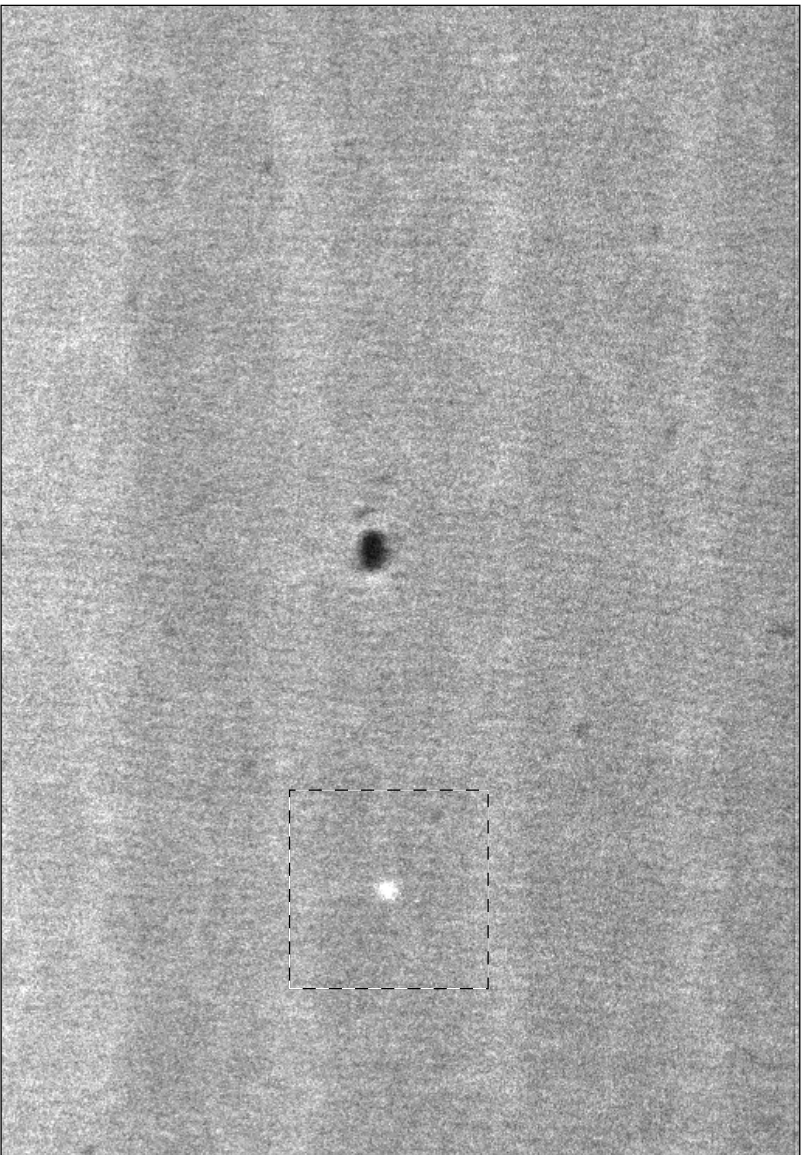


11921:12048 628:755 zoom = 2



Targname = 0
0 0
Detector = 1A
Aperture = 0

flat1b001.fit



5852:5979 218:345 zoom = 2

Targname = 0
0 0
Detector = 1B
Aperture = 0

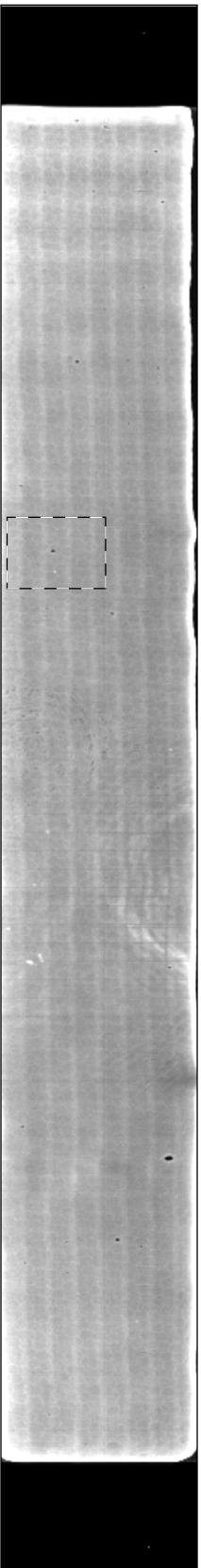
5346:6090 32:546

Linear Display

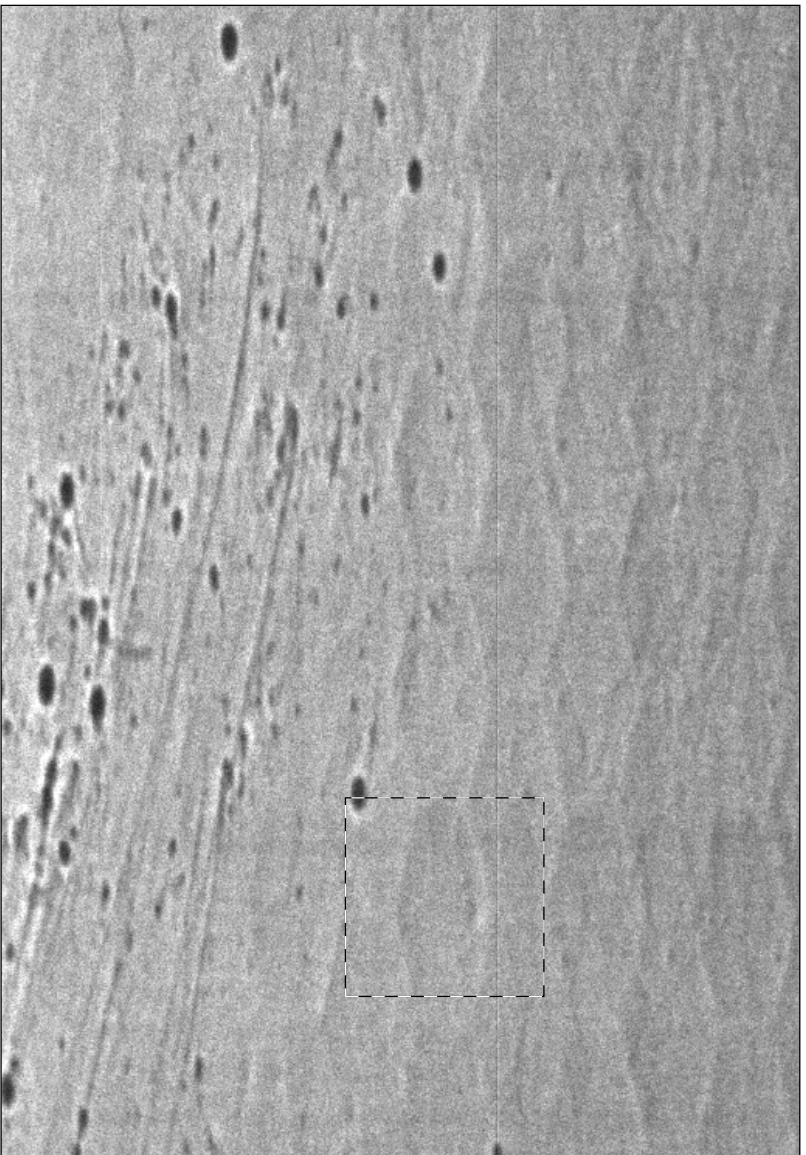
0.00000



1.50000



flat2a001.fit



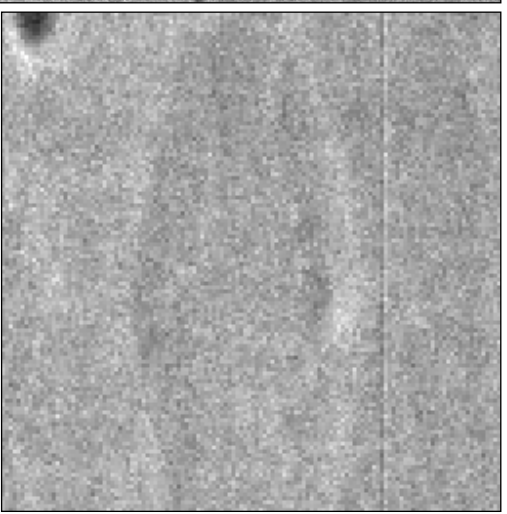
8082:8826 192:706

Linear Display

0.00000

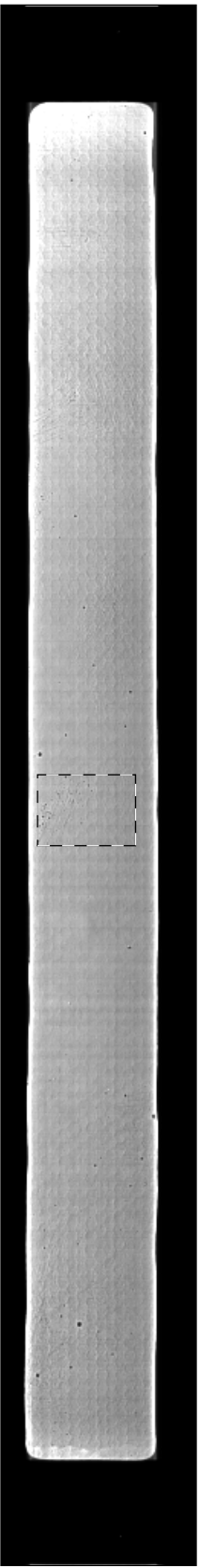


1.50000

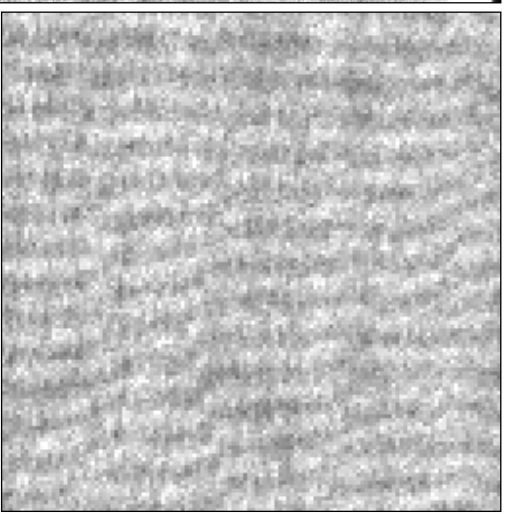
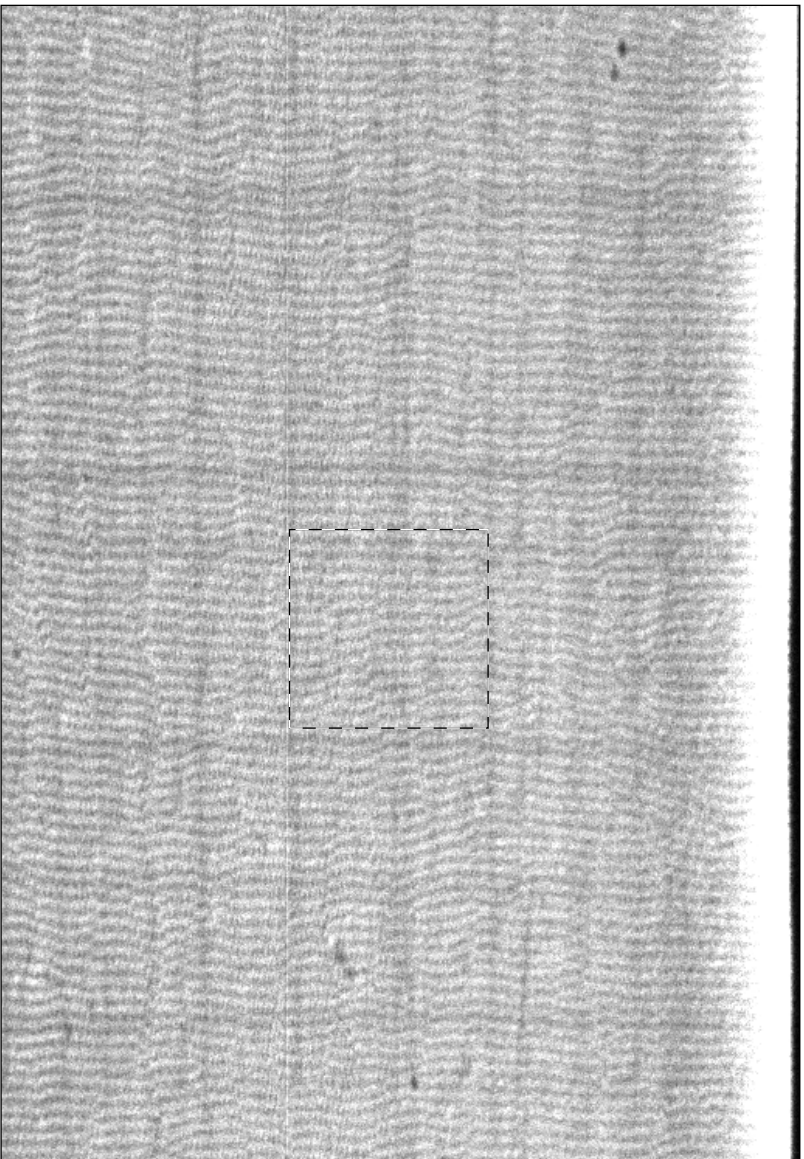


8593:8720 414:541 zoom = 2

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Detector = 2A
Aperture = 0



flat2b001.fit



Targname = 0
0 0
Detector = 2B
Aperture = 0

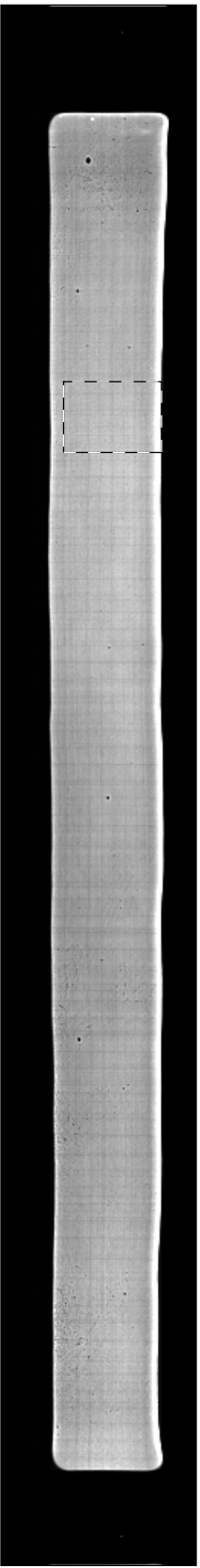
3954:4698 328:842

Linear Display

0.00000



1.50000



Baseline Flat Field Strategy

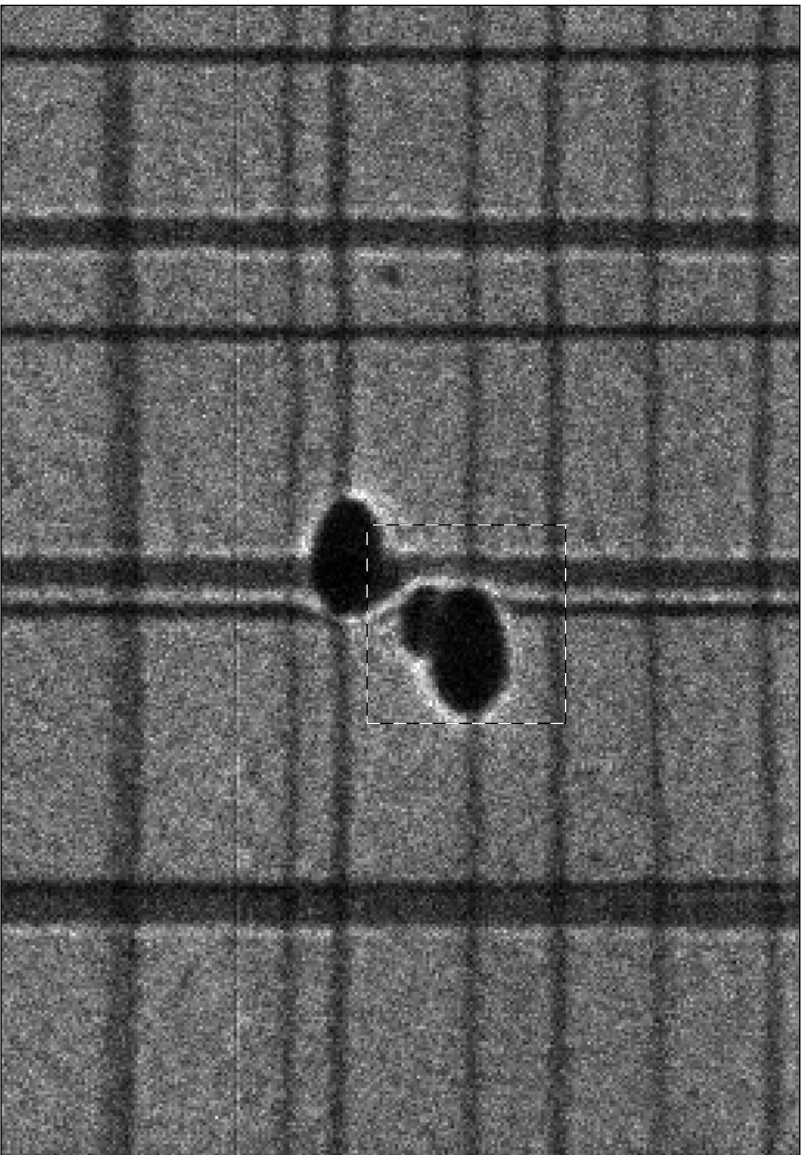
1. Ground flats based on deep stim-lamp exposures

- 7 exposures for each segment obtained during spectrograph I&T; each 5-10 ksec @ 9-20 kcounts/s
- have been aligned to ≤ 1 pixel rms in “baseline alignment reference frame” (BARF)
- typical counts per detector pixel in coadded images are:
(1A, 1B, 2A, 2B) = (64, 42, 103, 67)
 \Rightarrow S/N = (8.0, 6.5, 10.1, 8.2) per pixel
 \Rightarrow S/N = (25-60, 22-50, 28-70, 21-54) per y-collapsed “1D” pixel
 \Rightarrow S/N = (56-134, 50-112, 63-156, 47-120) per spectral resolution element, assuming $R_\lambda = 30,000$
 \Rightarrow these flat fields are adequate to support the nominal requirements
- preflight tests:
without flat-fielding: $S/N \approx (S/N)_{\text{ph}}/3 - (S/N)_{\text{ph}}/2$
with ground flats: $S/N \approx (S/N)_{\text{ph}}$ for $S/N \leq 80$
main issue: alignment. Stim pulses? Dead zones?
- use in calfuse pipeline:
 - normalized to unity in central region; variance array and quality flags
 - align (“shift & stretch”) flat with data frame; i.e., BARF \rightarrow data
 - divide: data = data / flat
 - propagate photon statistics; set quality flags to ignore dead zones

2. Issues & Status: in order of increasing importance

- residual grid wire shadows
- on-orbit stability
- alignment with flight alignment reference frame (FARF)

Flat35-1A.fit



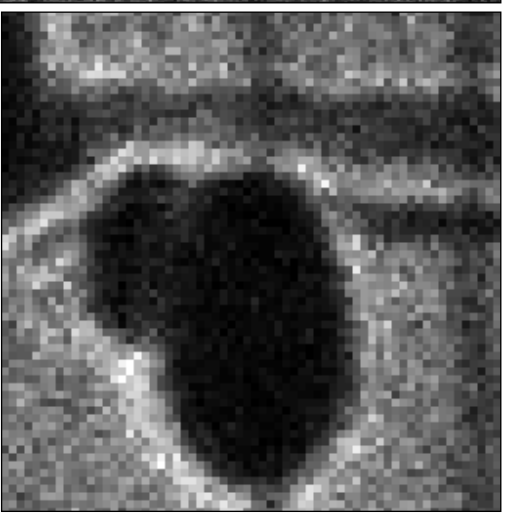
11586:12330 392:906

Linear Display

0.00000

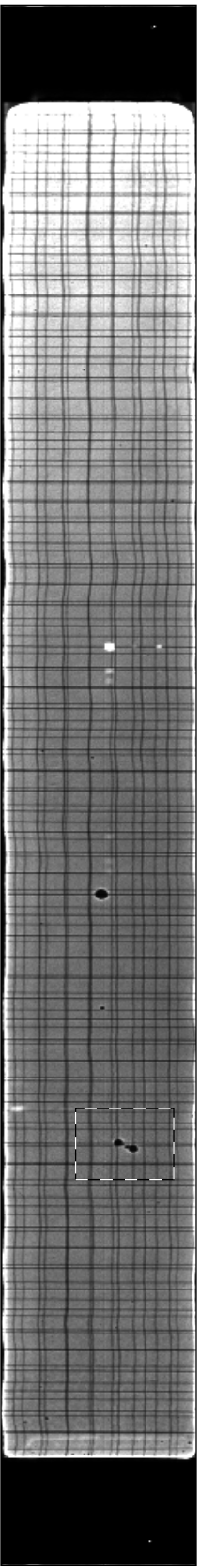


15.00000



11921:12048 628:755 zoom = 2

Targname = 0
0 0
Detector = 0
Aperture = 0



11586:12330 392:906

Alternate Approaches to Flat Fielding

1. Dithering in LWRS aperture

- Science Verification program S307 “S/N Ratio Capabilities” (Oegerle et al.)
- 27 HIST exposures of WD G191-B2B, each 483 seconds long
- dithered source in aperture by $4 \times 1.28''$ in the direction of dispersion;
mirror and grating motions added larger shifts
- use interstellar features to “shift + add” spectra in pixel space
- Results:

Channel	(S/N) _{raw}	(S/N) _{ph}	(S/N) _{s+a}
LiF1A	26	49	49
SiC1A	27	28	25
LiF2B	15	36	34
SiC2B	13	23	23

- residual features remain in some places

2. FP-SPLITS in MDRS/HIRS aperture (HIST data)

- FP-SPLIT in the sense of “shift + add” rather than “derive granularity vector from observation” due to S/N limitations
- efficacy will be tested during program S209 “Flat Fields Using Astronomical Sources” (Fullerton, Sembach et al.)

3. Derive a 1D flat field from FUV bright sources

- by-product of FP-SPLIT observations of bright FUV sources

4. Issues:

- How to incorporate these fundamental changes into `calfuse` ?