GUVI Radiance Calibration Update

- Last successful stellar cal observation:
  - Spectrograph mode, wide slit, motor step 58 from 2005-12-06, 11:15 UT to 11:30 UT, star HD52089
  - April 2006 revisit of HD143275 was unsuccessful (commanded pointing was slightly off, not an instrument problem).
  - December 2006 revisit of HD52089 was unsuccessful (communication problems, data loss)
- Stellar Calibration Observation Summary
  - 3 calibration stars have been observed.
  - Stellar cal observations span the period from early 2002 until April 2007.
  - The HD143275 (HR5953) spectra ***are not consistent*** with the other two stars.
    - HD143275 is more variable (Be star, prone to outbursts, plus multiple (?) components?)
- Lyman alpha is hardest to measure well (sharp absorption feature in stellar spectra + steep slope in responsivity).

GUVI Stellar Calibration Observations, 2002-2007

Date	Day of Year	UT	Orbit	HD #	HV #	Pixels Illuminated	Count Rate	Data?	Pixels Used
7-Apr-2002	2002-097		1789	143275	5953	4,5,6,7,8,9,10,11,12		yes	None (a)
7-Apr-2002	2002-097		1790	143275	5953	4,5,6,10,11,12		yes	None (a)
7-Apr-2002	2002-097		1791	143275	5953	3,4,5,11,12,13		yes	None (a)
7-Sep-2002	2002-250	17:45-17:57	4058	175191	7121	4,5,6,7,8,9,10,11,12	7500	yes	4-12
8-Dec-2002	2002-342	20:52-21:03	5423	52089	2618	4,5,6,7,8,9,10,11,12	17000	yes	4-12
30-Mar-2003	2003-089	10:02-10:12	7076	143275	5953	6,7,8,9,10,11	11000	yes	None (a)
30-Mar-2003	2003-089	11:40-11:48	7077	143275	5953	6,7,8,9,10	11000	yes	None (a)
7-Apr-2003	2003-097	16:45-17:00	7199	143275	5953	3,4,12,13	11000	yes	None (a)
7-Sep-2003	2003-250	15:44-16:04	9466	175191	7121	4,5,6,7,8,9,10,11,12	11000	yes	4-12
5-Apr-2004	2004-096	21:50-22:00	12598	143275	5953	6,7,8,9,10	11000	yes	None (a)
6-Apr-2004	2004-097	07:30-07:45	12604	143275	5953	3,4,12,13	11000	yes	None (a)
6-Apr-2004	2004-097	15:47-15:51	12609	143275	5953	2,3	10000	yes	None (a)
5-Sep-2004	2004-249	21:15-21:30	14866	175191	7121	2,3,13	10000	yes	2
6-Sep-2004	2004-250	18:16-18:28	14879	175191	7121	5,6,7,8,9,10,11	10000	yes	5-11
6-Dec-2004	2004-341	01:40-01:43	16218	52089	2618	1,2	16000	yes	1,2
6-Dec-2004	2004-341	19:17-19:29	16229	52089	2618	3,4,5,12,13	18000	yes	3,13
7-Dec-2004	2004-342	11:27-11:38	16239	52089	2618	4,5,6,7,8,9,10,11,12	18000	yes	4-12
5-Apr-2005	2005-095	11:43-11:55	18004	143275	5953	5,6,7,8,9,10,11	11000	yes	None (a)
5-Sep-2005	2005-248	13:38-13:53	20273	175191	7121	5,6,7,8,9,10,11	11000	yes	5-11
6-Dec-2005	2005-340	11:15-11:30	21637	52089	2618	4,5,6,7,8,9,10,11,12	18000	yes	4-12
5-Apr-2006	2006-095	10:47-11:07	23416	143275	5953	0	500	yes (b)	None (a)
5-Dec-2006	2006-339	18:12-18:27		52089	2618	4,5,6,7,8,9,10,11,12	18000	no (c)	None
3-Apr-2007	2007-093	17:45-18:05	28805	143275	5953	8	11000	yes	None (a)
3-Apr-2007	2007-093	22:38-22:58	28808	143275	5953	6,7,8,9,10	11000	yes	None (a)
4-Apr-2007	2007-094	01:52-02:12	28810	143275	5953	5,6,7,8,9,10,11	11000	yes	None (a)
4-Apr-2007	2007-094	05:05-05:25	28812	143275	5953	4,5,6,7,8,9,10,11,12	11000	yes	None (a)
4-Apr-2007	2007-094	09:57-10:17	28815	143275	5953	3,4,12,13	11000	yes	None (a)
4-Apr-2007	2007-094	13:10-13:30	28817	143275	5953	3,13	11000	yes	None (a)
4-Apr-2007	2007-094	16:24-16:44	28819	143275	5953	2,13	10000	yes	None (a)

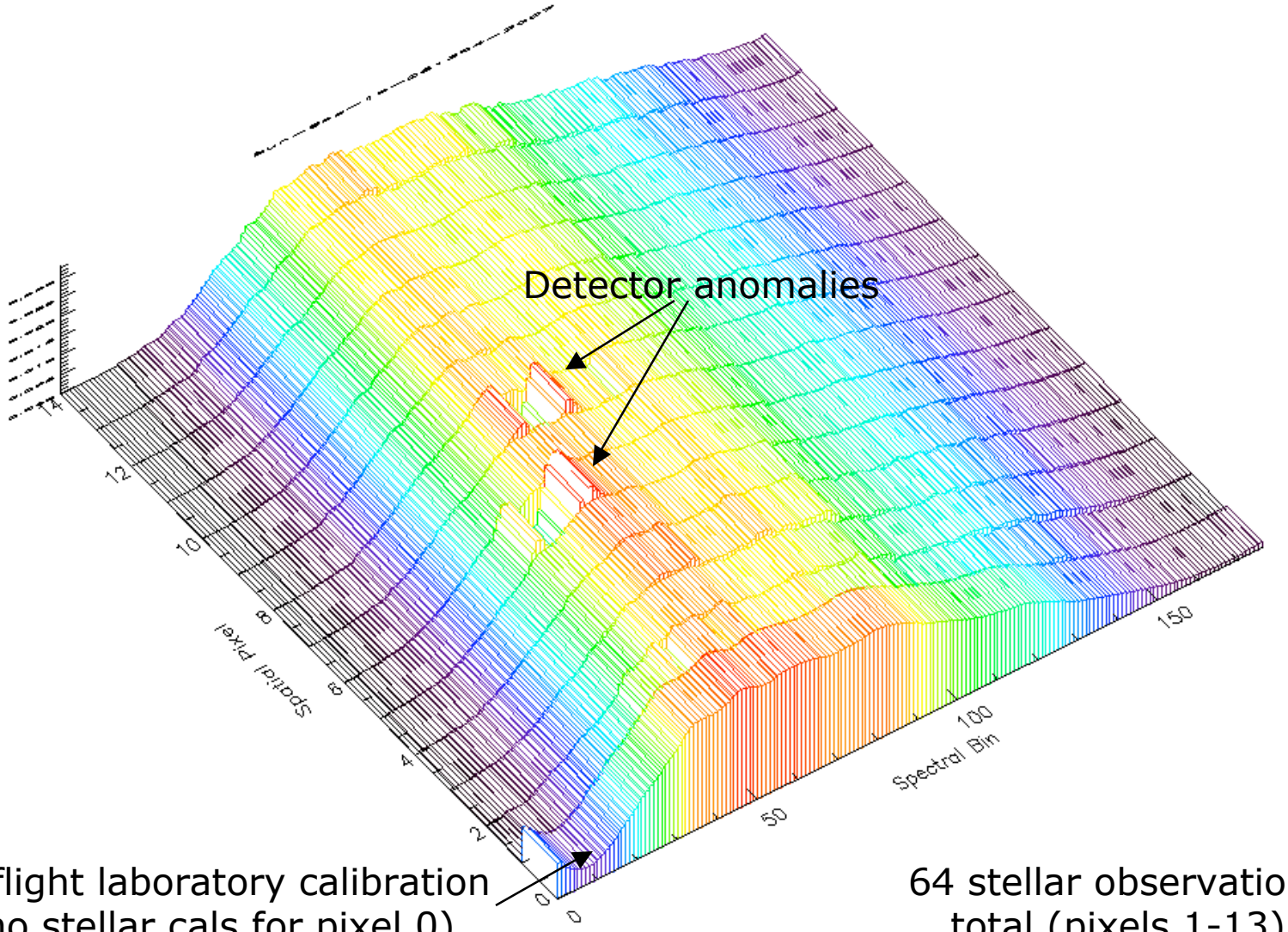
Count rates are summed for one integration period over spectral bins 60-120. **Pixels used** refers to those supplied as inputs for creation of a calibration file. To date, 64 acceptable observations have been processed.

a) HD143275 (HV5953) appears to have a large variation in its light curve, measurements are not to be trusted.

b) Pointing slightly off, only caught corner of one pixel

c) Communication problems (60-ft. dish out, used USNO?), huge solar flare, data corrupted?

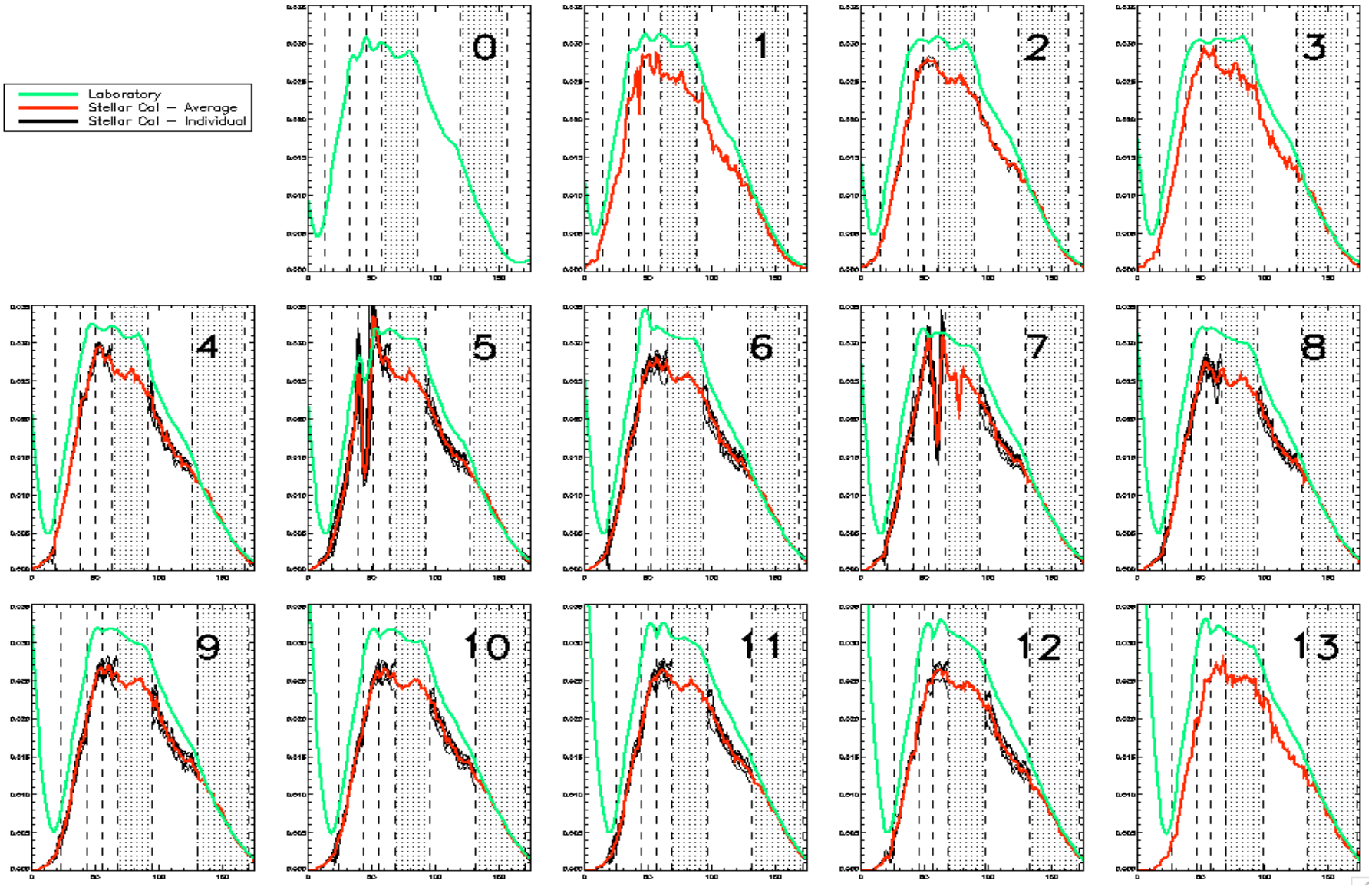
GUVI Primary Detector Point Source Responsivity



Preflight laboratory calibration
(no stellar cals for pixel 0)

64 stellar observations
total (pixels 1-13)

GUVI Point Source Responsivity Changes Relative to Lab Calibration



GUVI Primary Detector: Point Source Responsivity Changes Relative to Lab Calibration

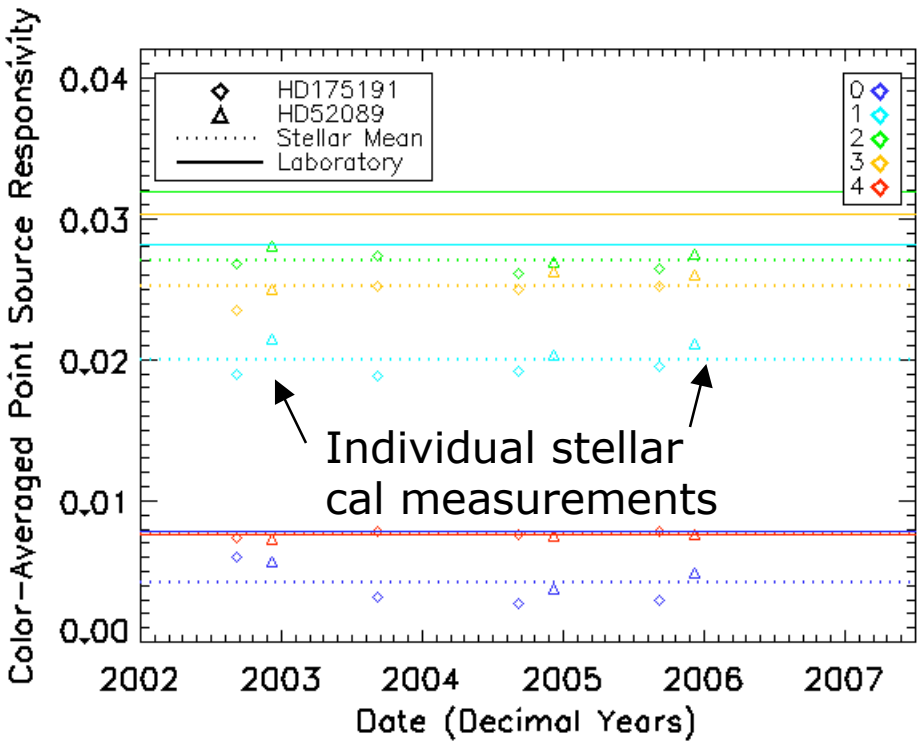
Pixel 6 – HD 143275 excluded

Year	Color	Stellar Cal	Laboratory Cal	Responsivity Ratio (Star/Lab)	Radiance Ratio (Star/Lab)
2006	1216	0.0045	0.0078	0.5711	1.7509
2007		0.0042	0.0078	0.5350	1.8692
2006	1304	0.0199	0.0282	0.7078	1.4127
2007		0.0199	0.0281	0.7080	1.4125
2006	1356	0.0271	0.0318	0.8519	1.1738
2007		0.0270	0.0320	0.8448	1.1837
2006	LBHS	0.0249	0.0302	0.8241	1.2135
2007		0.0251	0.0303	0.8294	1.2057
2006	LBHL	0.0076	0.0076	0.9930	1.0070
2007		0.0076	0.0076	0.9990	1.0010

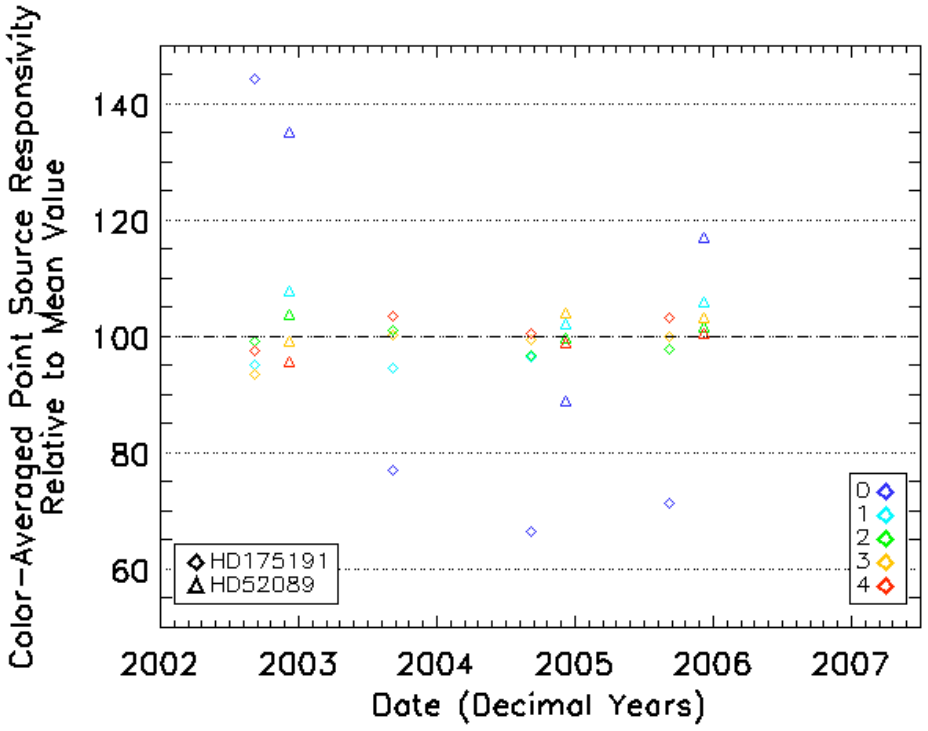
- I.E., the corrected GUVI radiance for 1216/Color 0 (based on update 2007 stellar calibration results), should be 87% larger than the current value (based on preflight laboratory measurements) for pixel 6.
- Changes in the "Laboratory Cal" value reflect different values calculated with different versions of the cal software. The underlying laboratory measurements did not change.

GUVI Responsivity Trends (excluding HD 143275)

Comparison of the mean value derived from stellar calibration (dotted lines) with the lab cal value (solid lines).



Variation about the mean value derived from stellar calibration (no lab data).



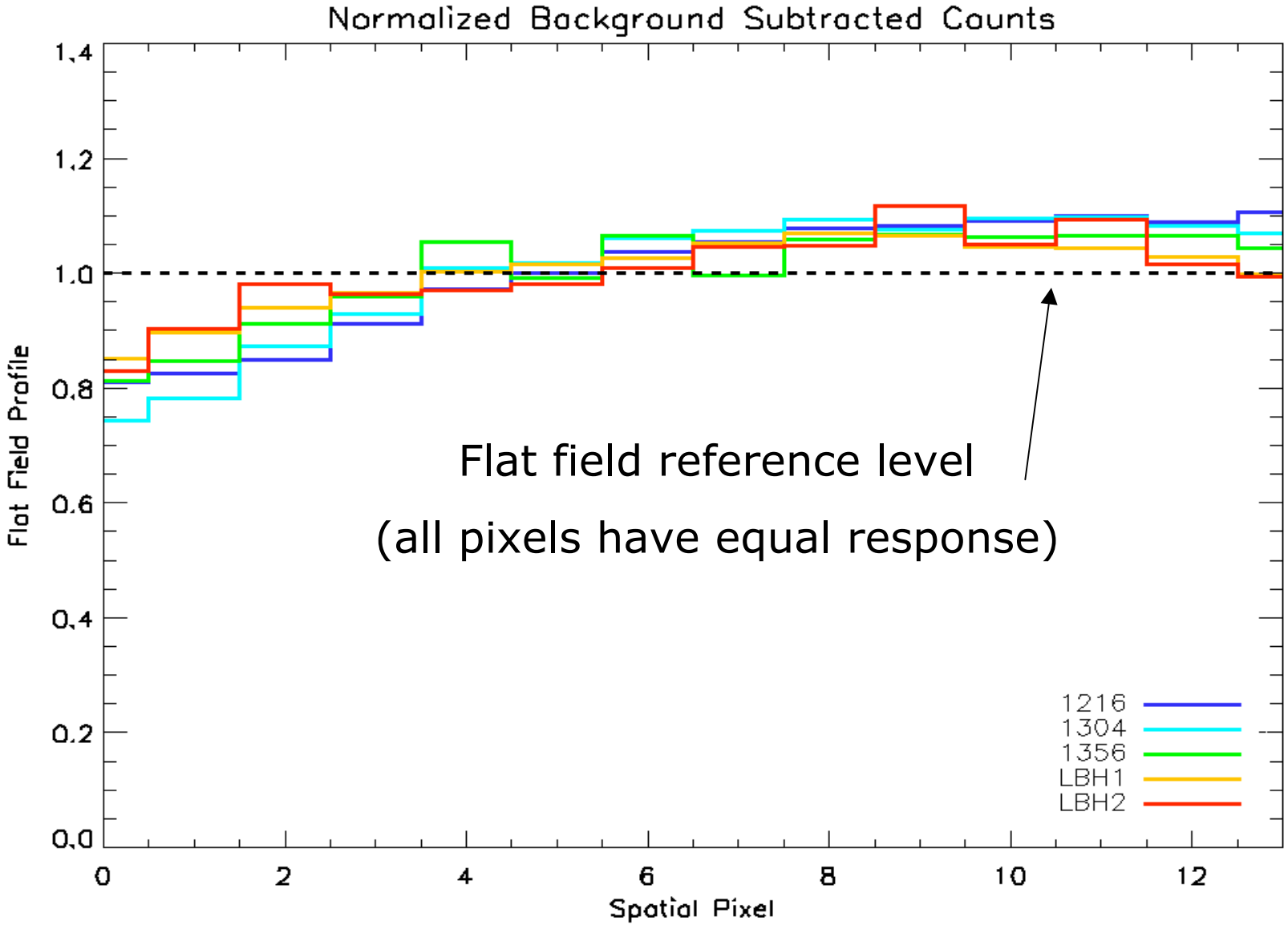
Radiance Calibration Process

- Determine point source responsivity (lab and/or stellar cal) as a function of spatial and spectral position on the detector.
- Measure slit functions (responsivity versus across-slit angle) in order to estimate filled slit responsivity (directly measured only in lab).
- Calculate line fraction = fraction of a spectral line that lies within the defined colortable boundaries for a given pixel and color.
  - The line profile is the convolution of the slit function for a given slit, color/wavelength, and spatial pixel with the point spread function of the instrument (essentially a 1-D line spread function for GUVI, as GUVI 'spots' are much smaller than spatial pixels).
  - The line profile is normalized to 1.0 in each spatial pixel. The line fraction is a number between 0 and 1. It is the total of the product of the line profile and the colortable (0=off,1=on) for a given pixel and color.
- The nominal responsivity value is the product of the filled slit responsivity, the line (or band) fraction, and the scan mirror reflectivity, divided by the integration period.

Radiance Calibration Process

- Flat fielding may be used to infer the values of pixels that were not sampled by stellar calibration (pixel 0), or those impacted by anomalies on the detector (e.g., pixels 5 and 7 of GUVI primary detector, color 1356).
- The along-slit count profiles (see next slide) are a function of the instrument characteristics, the color table boundary positions, and the background subtraction algorithms. They are independent of the responsivity tables! (Thus making them useful as a reference for adjusting those tables…)
- A weighting matrix (function of detector, color, and spatial pixel) is applied to the responsivity measurements and the observed along-slit count profiles in order to generate the final responsivity values.
  - This matrix places more emphasis on pixels that were measured often (multiple stellar cals), and is adjusted to reduce the weighting of a particular pixel/color/detector that is known to have issues.

Observed GUVI count profiles after background subtraction

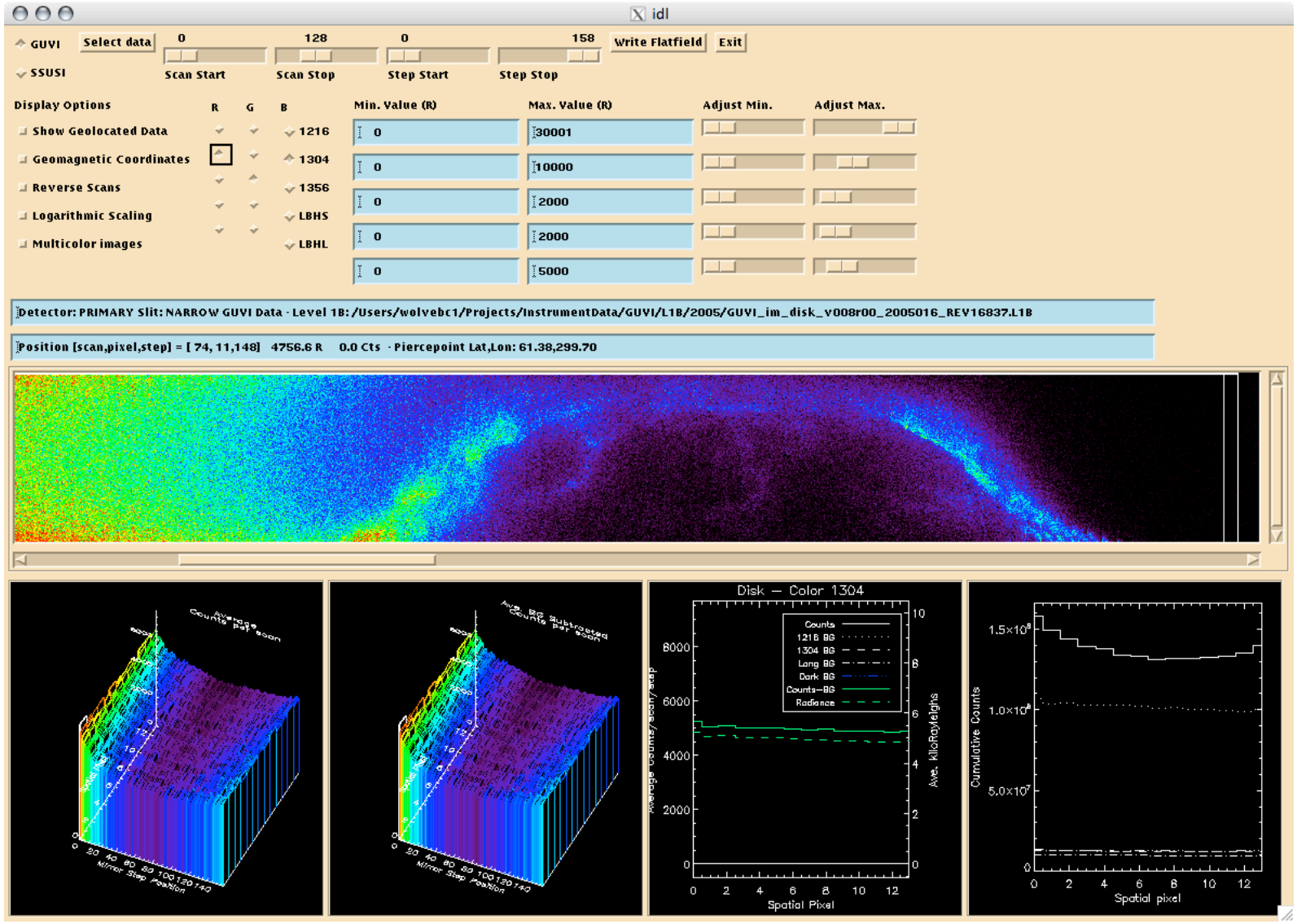


GUVI Primary Detector: Final Filled-slit Responsivity Values Relative to Previous Calibration

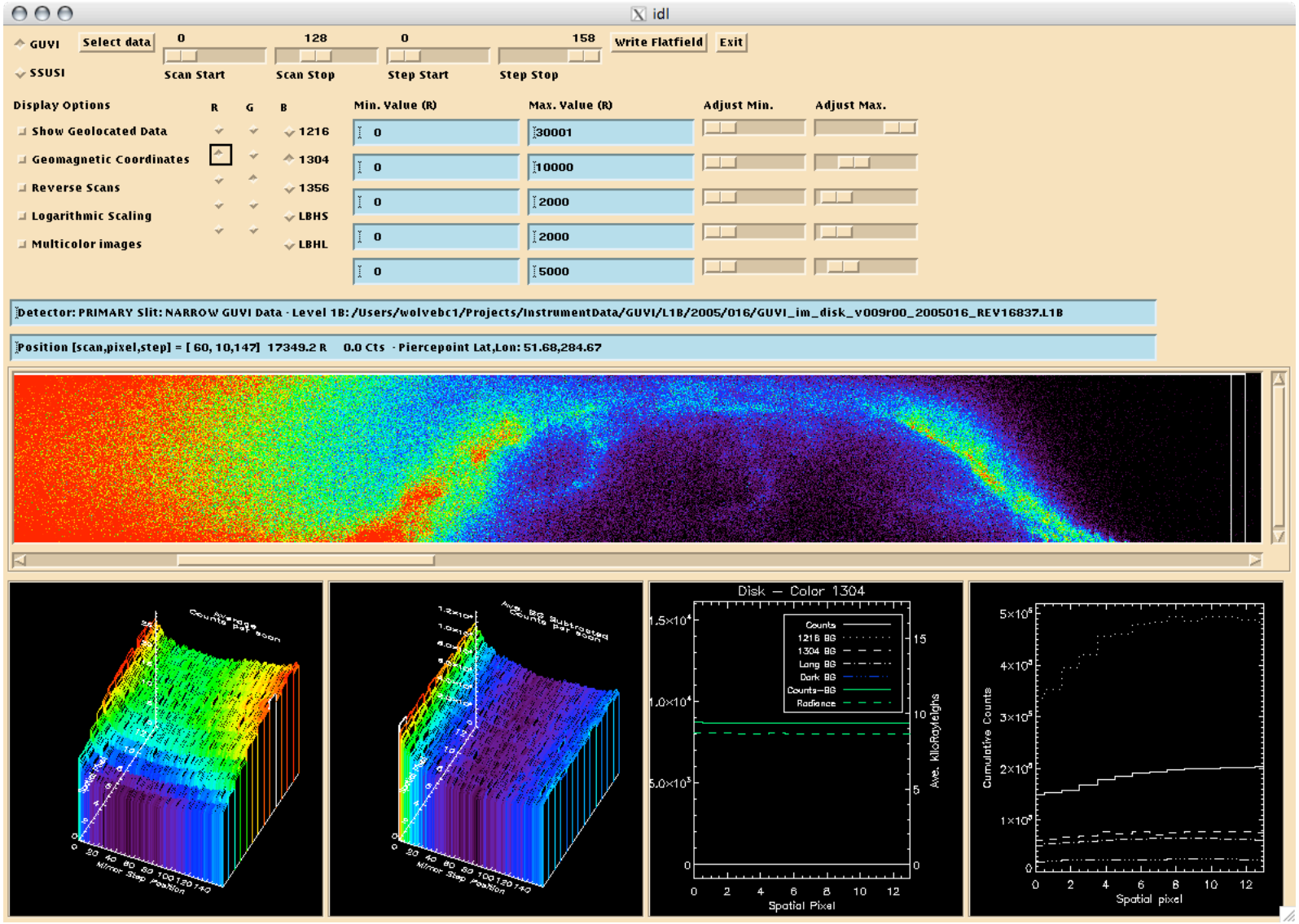
	1216	1304	1356	LBHS	LBHL
Old	0.023	0.076	0.096	0.101	0.025
New	0.009	0.052	0.085	0.079	0.025
Ratio	0.40	0.68	0.89	0.78	1.02
1/Ratio	2.51	1.46	1.12	1.28	0.98

- Values are along-slit averages at nadir for each color, using the narrow slit.
- Units are counts/pixel/rayleigh/integration period

GUVI L1B Data Comparison: Old Calibration

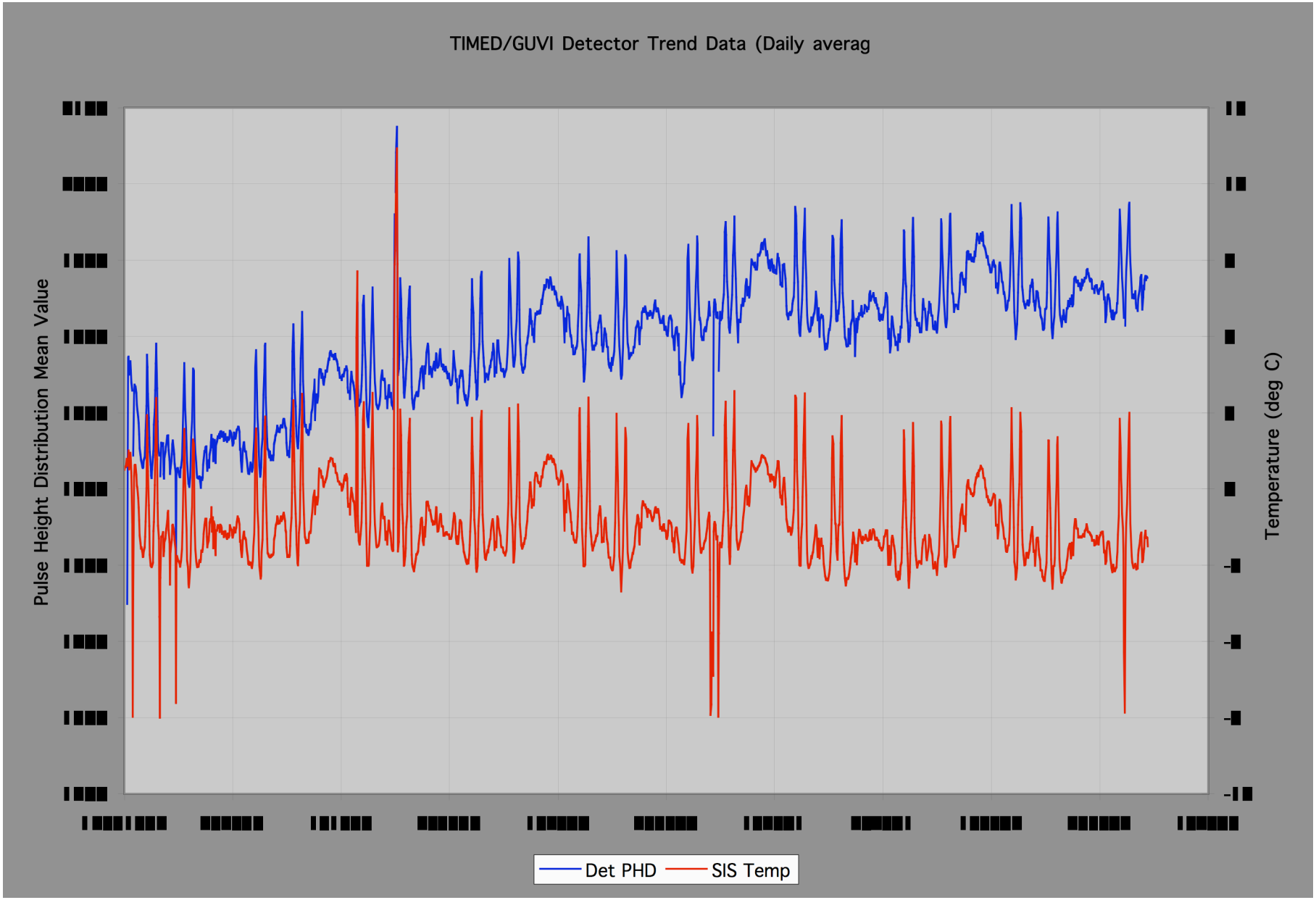


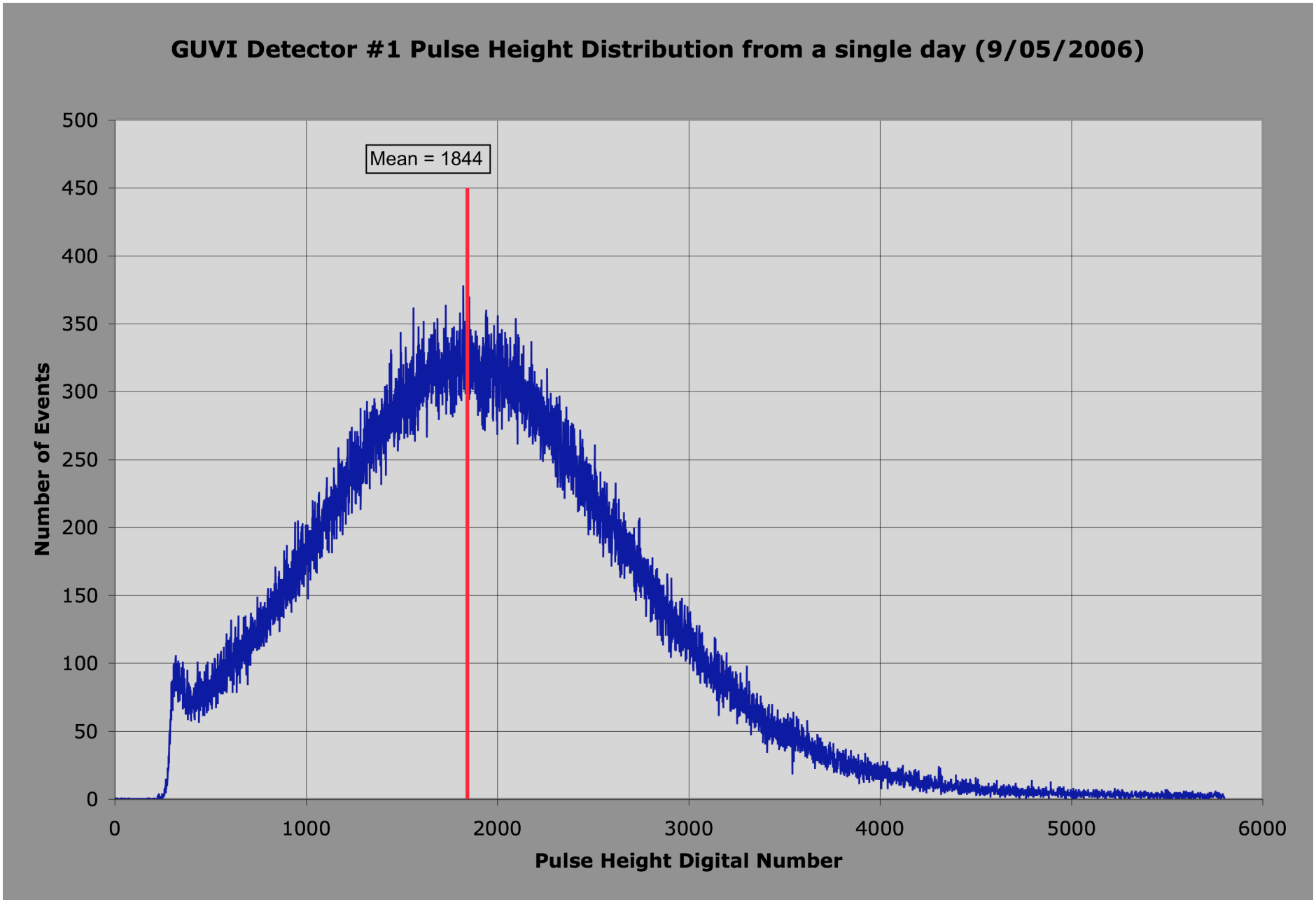
GUVI L1B Data Comparison: New Calibration



GUVI Detector Performance

- The GUVI detector has shown no measurable aging effects since the start of normal operations in January 2002.
- The detector microchannel plate gain is monitored daily from the pulse height events included in the imaging packets. The gain is the mean of the pulse height distribution of all events.
- The detector gain varies with the GUVI spectrograph temperature (see chart on slide 7). The gain variation is well within the event processing capability of the detector electronics. There has been no long term decrease in gain as would be expected from aging of the microchannel plates.
- There has actually been a slight increase in microchannel plate gain. The increase is probably due to aging of the zener diodes that provide the front and back bias voltages for the detector. A slight decrease in the zener diode voltage would apply more voltage across the microchannel plates and increase the gain.
- A typical pulse height distribution from a single day (9/5/06) is shown on slide 8.


TIMED/GUVI Detector Trend Data (Daily averag
Pulse Height Distribution Mean Value
Temperature (deg C)
Det PHD
SIS Temp


GUVI Detector #1 Pulse Height Distribution from a single day (9/05/2006)
Mean = 1844
Number of Events
0
50
100
150
200
250
300
350
400
450
500
0
1000
2000
3000
4000
5000
6000
Pulse Height Digital Number