

**ACS Flatfield Update
&
New L-flats for the SBC**

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Calibration Workshop - October 27, 2005

CCD Flatfield Summary

All P-flats taken in the lab, except earthflats (**green**).

L-flat corrections based on dithered observations of 47 Tuc (*ISR 02-08, Mack et al.*)

~1% accuracy for 47 Tuc L-flats (**red**)

~2% accuracy expected for interpolated L-flats (**black**)

Filter	WFC Lflats	HRC Lflats
F220W	--	None
F250W	--	None
F330W	--	Earth
F344N	--	Earth
F435W	47Tuc	47Tuc
F475W	Interpolated	47Tuc
F502N	Interpolated	Interpolated
F550M	Interpolated	Interpolated
F555W	47Tuc	47Tuc
F606W	47Tuc	47Tuc
F625W	Interpolated	47Tuc
F658N	Interpolated	Interpolated
F660N	Interpolated	Interpolated
F775W	47Tuc	47Tuc
F814W	47Tuc	47Tuc
F892N	Interpolated	Interpolated
F850LP	47Tuc	47Tuc

HRC Earthflat Observations

Bohlin, Mack, Hartig & Sirianni (ACS ISR 2005-12)

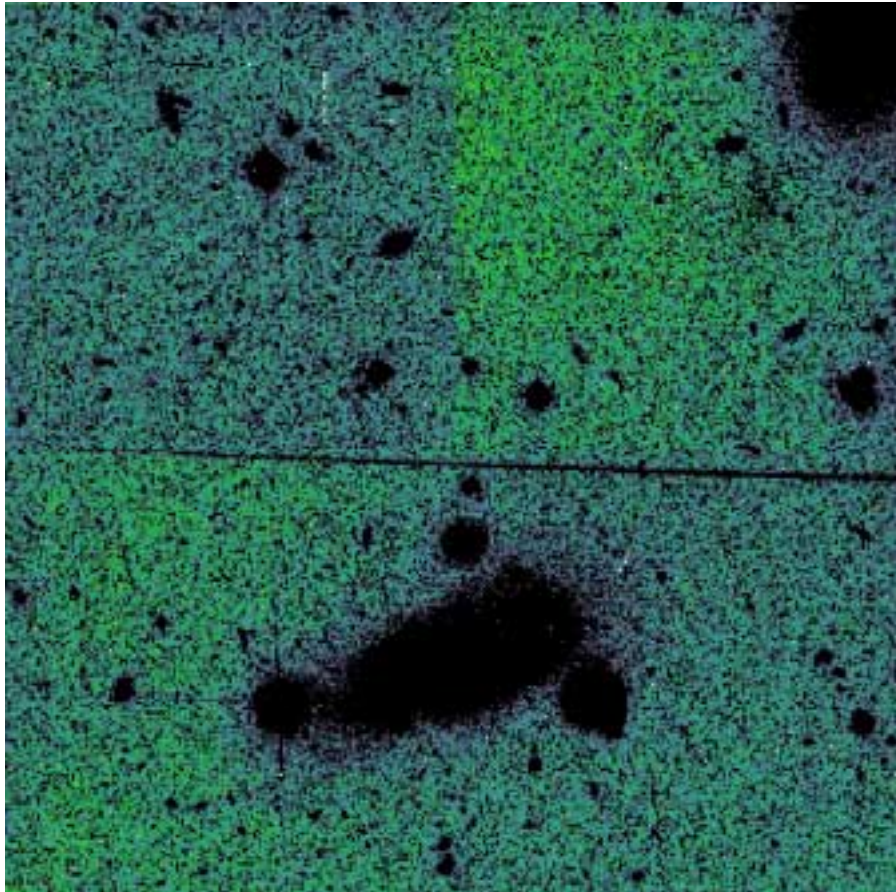
Filter	Nobs	% Deviation	Stellar L-flat Used?
F330W	20	0.4±0.7	No (earthflat)
F344N	34	0.1±0.9	No (earthflat)
F435W	10	0.9±0.9	Yes
F475W	6	0.7±0.8	Yes
F502N	6	1.3±0.4	No (interp)
F550M	4	2.4±1.3	No (interp)
F555W	4	1.8±1.6	Yes
F606W	3	1.1±1.1	Yes
F625W	6	1.4±0.8	Yes
F658N	6	1.2±0.7	No (interp)
F660N	3	0.9±1.0	No (interp)
F775W	2	2.6±0.5	Yes
F814W	3	4.0±1.9	Yes
F892N	6	6.5±1.5	No (interp)
F850LP	4	8.4±3.0	Yes

Red filters - Large discrepancies at edges, Similar pattern (show fig of good/bad corr)
Long wave, QE drops, photons penetrate silicon layers of CCD and scatter back
Earthflats should be used for sources that fully illuminate detector

Artifacts which affect 'flatness' of calibrated observations:

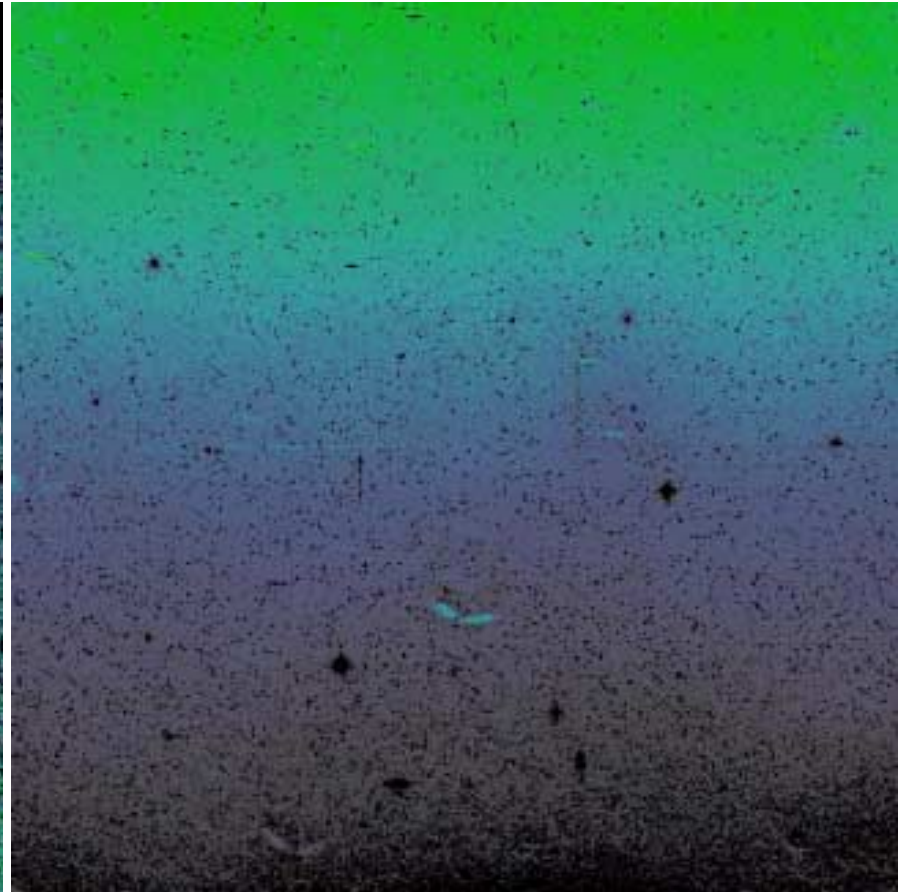
Bias Offset

Will cause flatfield 'footprint' on images'
WFC F814W 1260sec, binned 8x8
Total offset ~few DN



Scattered Earth Light

May be misinterpreted as poor flatfielding
WFC F606W, 350sec, binned 8x8
Earth limb angle=14 degrees, Gradient=15%



SBC (Imaging) Flatfields

- Original P-flats taken in the lab for all SBC filters
 - P-flats independent of wavelength to better than 1%
 - Summed super-flat used in pipeline until May 2005
- New P-flats were taken on-orbit using internal lamp
 - Single filter F125LP (since flats independent of wave, limited lamp lifetime)
 - 2 years of combined data... new P-flat with S/N~100
 - New P-flat in pipeline May 2005 (*ISR 2005-09, Bohlin & Mack*)
- Neither P-flat gives an accurate OTA illumination
- UV-bright stellar observations are required to correct variations in low-freq response

NGC 6681 Observations

Calibration Program	Program ID	SBC Imaging Filters Used
** SBC Flatfield Uniformity **	9024	F125LP, F150LP
SBC Geometric Distortion Calibration	9027	F125LP
SMOV Image Quality Verification	9023	F125LP, F150LP, F122M*
ACS Sensitivity Monitor	9020, 9563	F115LP, F125LP, F140LP, F150LP, F165LP
UV Contamination Monitor	9010, 9565, 9655, 10047, 10373	F115LP, F125LP, F140LP, F150LP, F165LP

*Insufficient data for F122M

F125LP Mosaic
SBC FOV= (26 x 26")



Filter	Number of Observations	Total Exposure (sec)
F115LP	33	3,960
F125LP	56	13,250
F140LP	33	5,190
F150LP	47	11,660
F165LP	33	8,525

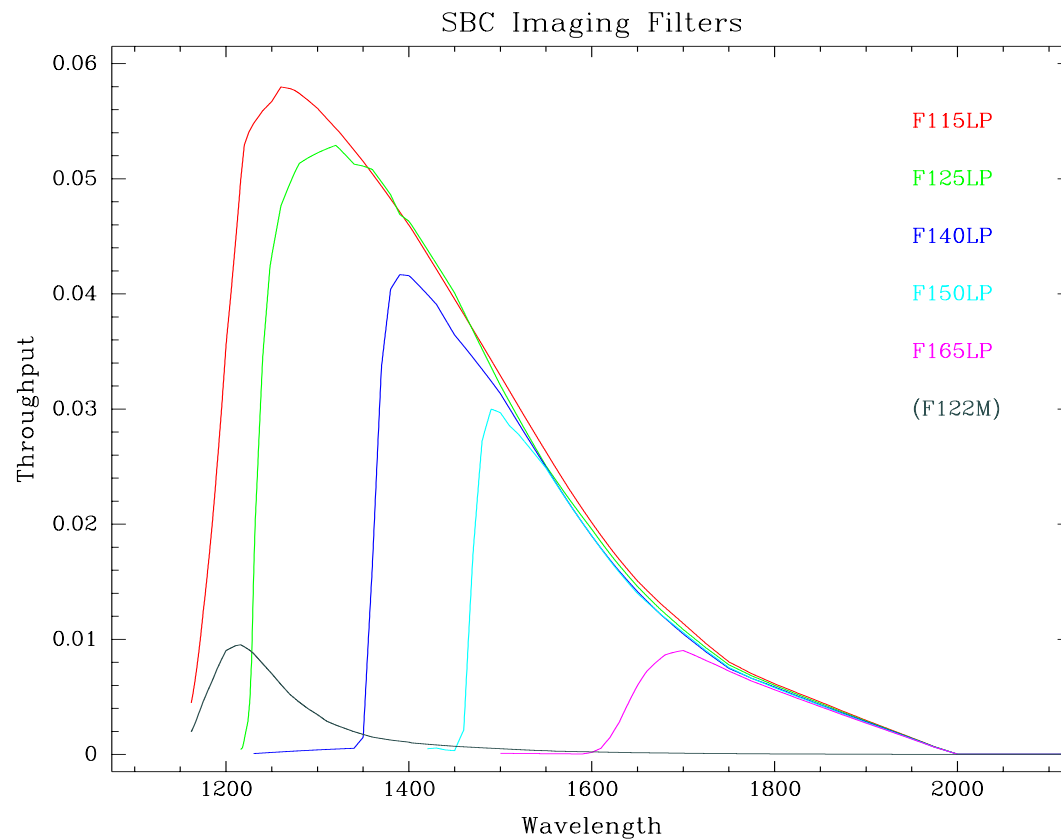
Photometry

- Aperture photometry on (~50) brightest objects in DRZ images
- Tested various apertures: $r=5, 7, 9$
sky annulus: $r=9-13$

$r=5$; affected by variations in PSF due to breathing, focus, etc.
 $r=9$; larger uncertainty in background subtraction due to neighbors

- No CR's or CTE corrections required for SBC

SBC Filter
Response



L-Flat Algorithm

(originally developed for WFC & HRC L-flats)

R. van der Marel (*ISR 2003-10*)

- * The basis functions can be polynomials or any other functional form.
- * The L-flat measures the residual structure with respect to the pipeline flat.

Maximum likelihood fit for the unknown quantities \vec{x} is one that minimizes the relation:

$$\chi^2 = \|\mathbf{A}\vec{x} - \vec{b}\| \quad (\text{Euclidean norm})$$

The vector \vec{x} which minimizes this relation is the least squares solution
(Obtained through singular value decomposition).

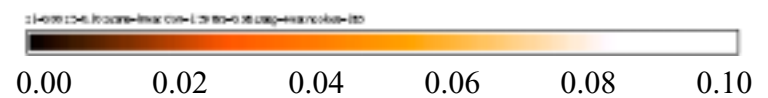
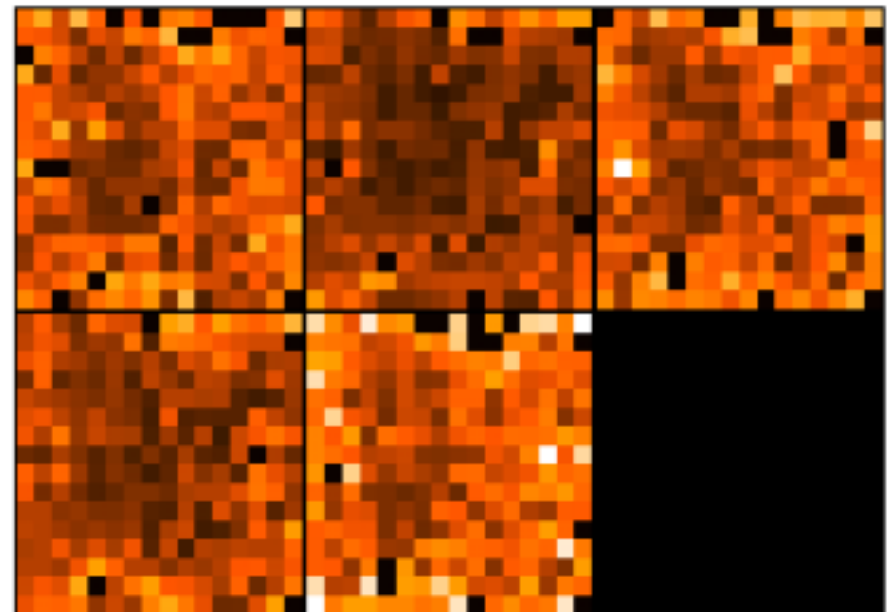
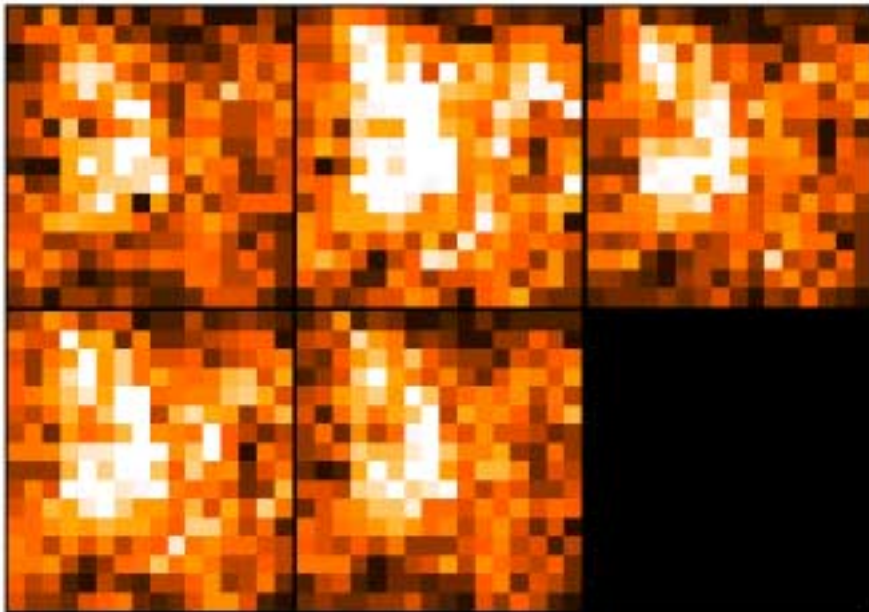
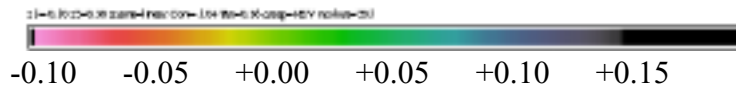
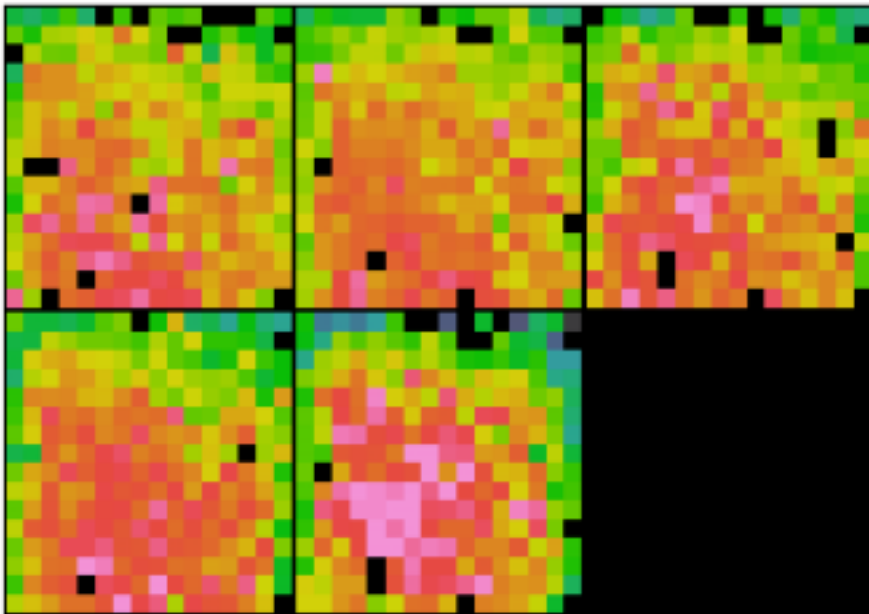
Matrix Solution

F115LP	F125LP	F140LP
F150LP	F165LP	

L-Flat Solution (mag)

Number of Stars

Formal Error (mag)

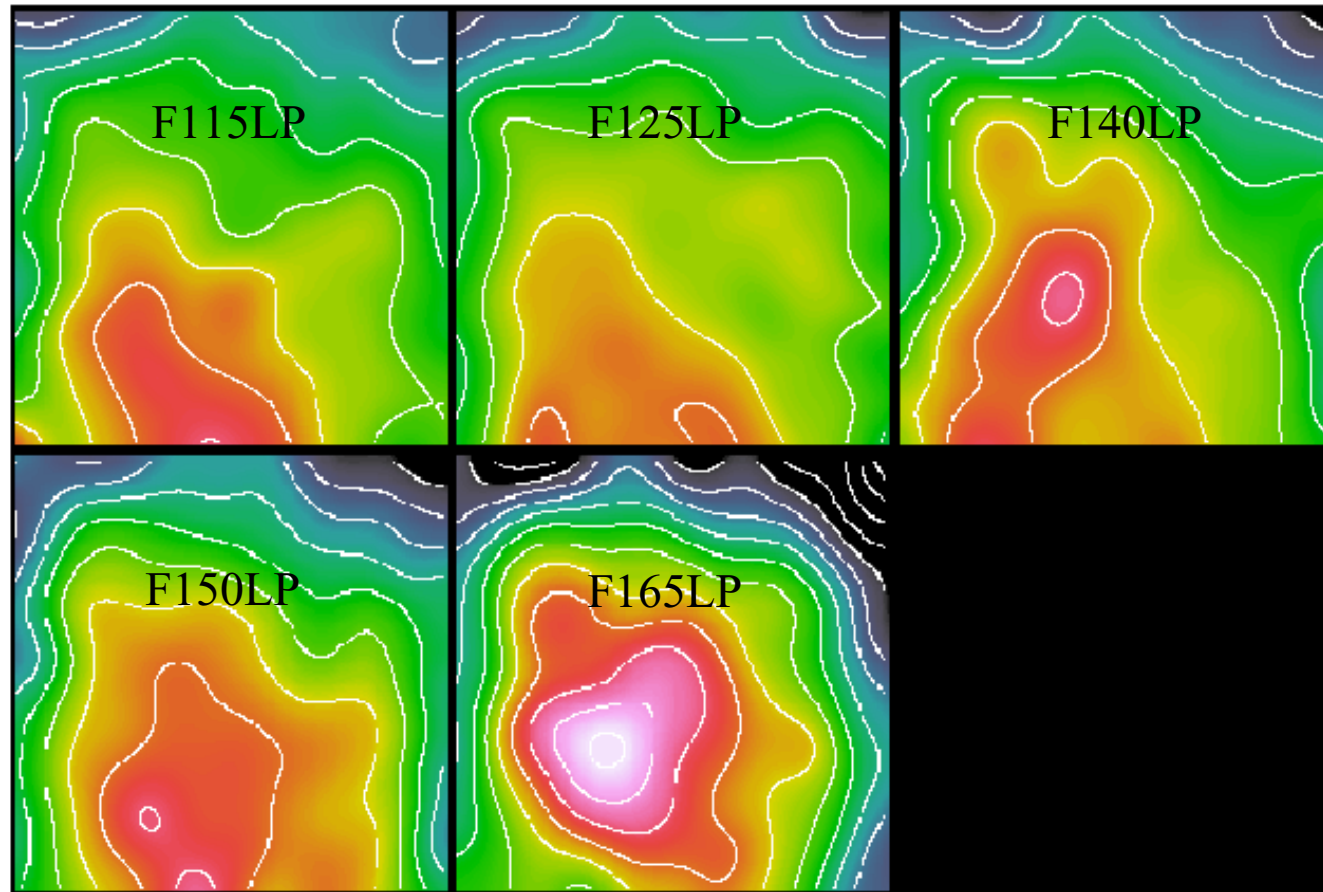


L-Flat (mag)

Grid smoothed with gaussian, sigma=1 box (64pix)

Contour interval = 0.02 mag

Differences with λ are significant compared to the errors



$z=0.10$ $z=0.15$ $z=0.20$ $z=0.25$ $z=0.30$ $z=0.35$ $z=0.40$ $z=0.45$ $z=0.50$ $z=0.55$ $z=0.60$ $z=0.65$ $z=0.70$ $z=0.75$ $z=0.80$ $z=0.85$ $z=0.90$ $z=0.95$ $z=1.00$



-0.10

-0.05

0.00

+0.05

+0.10

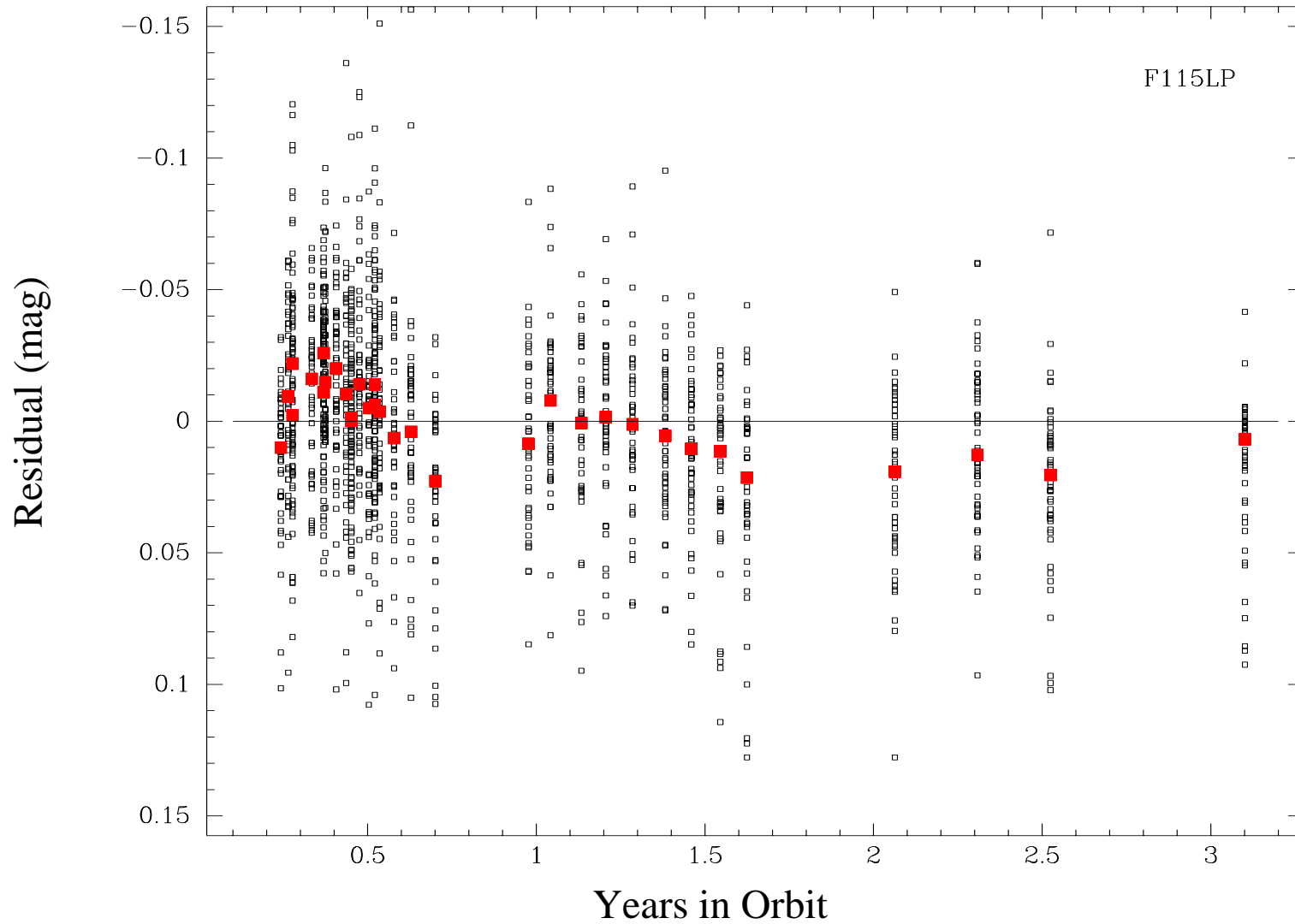
+0.15

L-flat Solution vs Date

Residual = observed magnitude - predicted magnitude

Median residual is overplotted in red

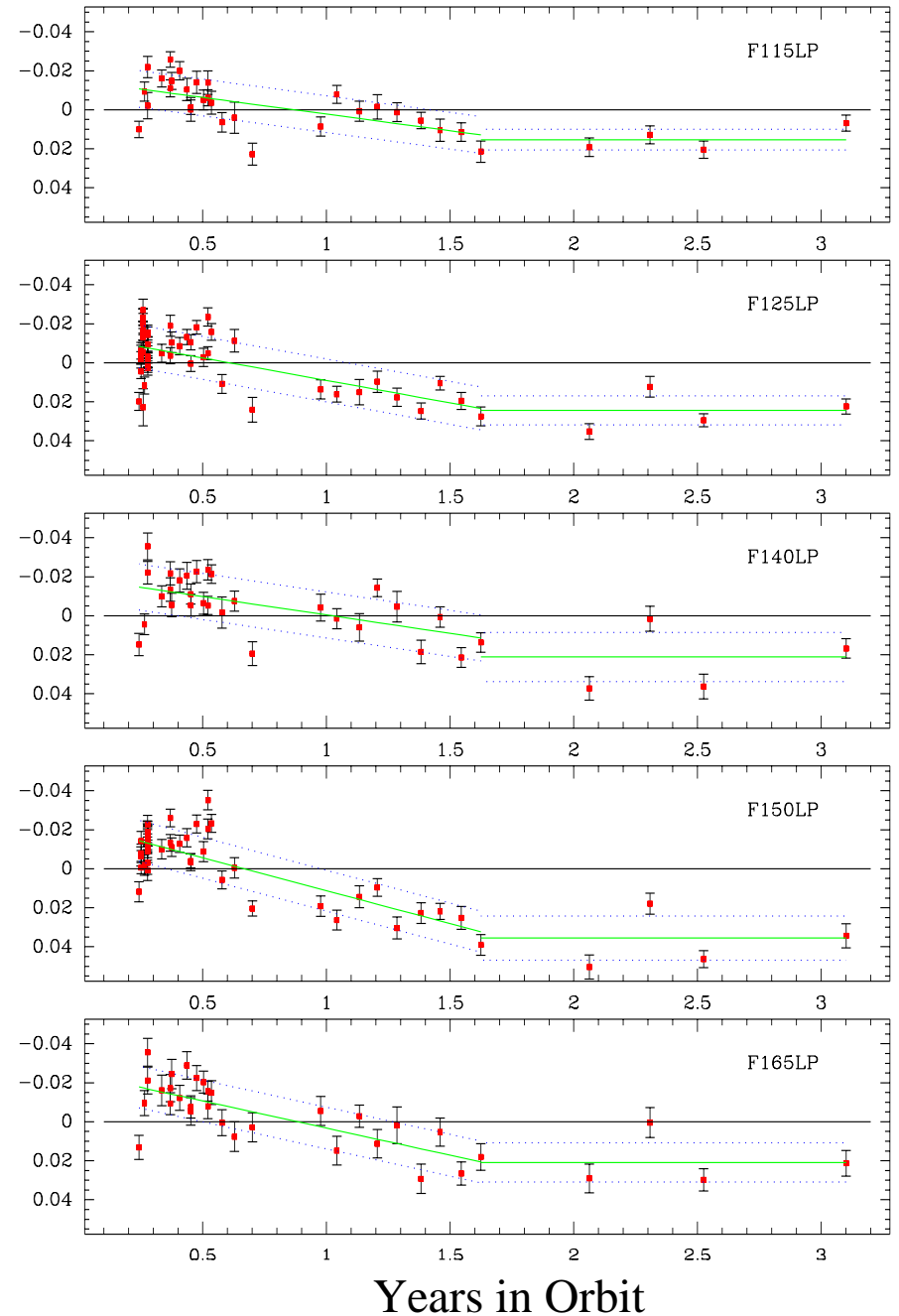
Any systematics?



Absolute Sensitivity vs Time

- UV Sensivity is declining
 - Not a simple linear trend
 - Following STIS example, fit slope with line segments
 - Increasing loss with wavelength
- (only show 1 plot)

Median Residual (mag)



UV Sensitivity Loss is consistent with STIS

**ACS/SBC Sensitivity Loss
(Percent/Year)**

**STIS FUV MAMA G140L Sensitivity Loss
(Percent/Year)**

SBC Filter	Pivot λ	Loss t=0.0-1.6 yrs	G140L Wavelength	Loss t=0.0-1.8 yrs	Loss t=1.8-5.0 yrs	Loss t=5.0-7.3 yrs
F115LP	1406	2.1 \pm 0.4	1400-1450	1.5 \pm 0.2	1.9 \pm 0.2	0.6 \pm 0.4
F125LP	1438	3.1 \pm 0.4				
F140LP	1527	2.7 \pm 0.5	1500-1550	2.8 \pm 0.2	2.3 \pm 0.2	1.3 \pm 0.5
F150LP	1611	3.9 \pm 0.4	1600-1650	2.9 \pm 0.3	2.9 \pm 0.2	1.1 \pm 0.5
F165LP	1758	3.3 \pm 0.5	1650-1700	1.1 \pm 0.3	3.3 \pm 0.2	0.9 \pm 0.5

* Sensitivity Monitor continued in Cycle 14 (2x per year) *

Work in progress.....

- Publish ISR
- Deliver new SBC reference files
 - Flatfields for 6 imaging filters
 - Time-dependent sensitivity line segments

Upcoming SBC calibrations....aperture corrections