



# Wide Field Camera 3

John W. MacKenty

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# WFC3 Summary



- **WFC3 is operating nominally**
- New Features for Observers in development:
  - UVIS 2.0 Pipeline changes
  - IR Spatial Scan Pipeline Changes
  - IR SPARS5 Sample Sequence
- Completed Studies and Enhancements:
  - CSM tracking and usage control
  - Snowballs history
  - Convenience Apertures
  - Improved tracking of Bad/Worst/Sensitive Actors
- Ongoing Activities:
  - IR Backgrounds
  - Improved Astrometry
  - PSF Library and GRISM Software



## UVIS 2.0



- New version of UVIS portions of the CALWF3 pipeline under development
  - Two chip photometric solution
  - CTE correction within the OPUS pipeline
  - Improvements to dark reference files
- Plan to release in Fall 2015 as a single major change
  - Awaiting major infrastructure changes to OPUS
  - Components and reference files currently available to users via [www](#) download



## Two-chip solution



- Original photometry approach (copied ACS)
  - Zeropoints based on averages over the two chips
  - Flat fields constructed from Omega Cen dithered over two chips
  - Pipeline flats for both chips normalized to area on amp A
- However, different WFC3 chip QE's create problems
  - Zeropoints require fudge factors in synphot tables
  - Astrodrizzle results are not optimal: requires flat image, single ZP
- New approach
  - Determine separate zeropoints for each chip
  - Determine and normalize flat field separately for each chip
  - Finally: scale chip 2 to chip 1 in calwf3 so zeropoints match
  - Fully backwards compatible (i.e. full set of keywords retained)
- Made available to community via www Dec 2014
  - Full set of reference files (including all Flat Fields)
  - [http://www.stsci.edu/hst/wfc3/analysis/uvis\\_2\\_chip](http://www.stsci.edu/hst/wfc3/analysis/uvis_2_chip)



# CTE correction in pipeline



- Current situation
  - Correction available since mid-2013 as standalone FORTRAN script  
[http://www.stsci.edu/hst/wfc3/tools/cte\\_tools](http://www.stsci.edu/hst/wfc3/tools/cte_tools)
  - Supports full-frames and majority of subarrays
  - Model and software stable
- Development starting for incorporation into OPUS/calwf3
  - Pipeline to branch into two paths (same conventions as ACS/WFC)
    - 1) Standard processing as done today, results in raw, flt, drz files
    - 2) New branch to correct for CTE then perform usual image calibrations (dark, flat, etc). Results in rac, flc, drc files.
  - All products, with and without CTE correction, produced and archived
  - Script transitioned to SSB for conversion to C



# Improved UVIS superdarks



- Current situation
  - Superdarks generated from non-overlapping 4-day intervals of dark frames, i.e.,  $\sim 2$  superdarks per week
  - Hot pixels identified as those above predefined threshold and set to value determined from the 4-day stack, flagged in DQF
  - Good pixels set to median of all good pixels across the chip
- Improved approach
  - Darks generated daily from sliding 4-day intervals, i.e.,  $\sim 7$  superdarks per week, providing more finely-tuned hot pixel correction for science images
  - Hot pixels identified and set as before
  - Good pixels set individually, using median value for each pixel based on  $\sim 1$  month of dark frames
  - Update software to use amp-dependent gain values ( $\sim 0.5$  to  $1.5\%$  change, depending upon amp)



## New IR Features



- OPUS pipeline to be modified to better handle spatial scans
  - Currently ramp fitting creates messy FLT files (will be disabled)
  - Relevant header keywords to be duplicated in FLT from SPT
- A new SAMPLE SEQUENCE is being added for Cycle 23
  - SPARS5 will provide a cadence between RAPID and SPARS10
  - Motivation was orbit packing efficiency for exo-planet transits

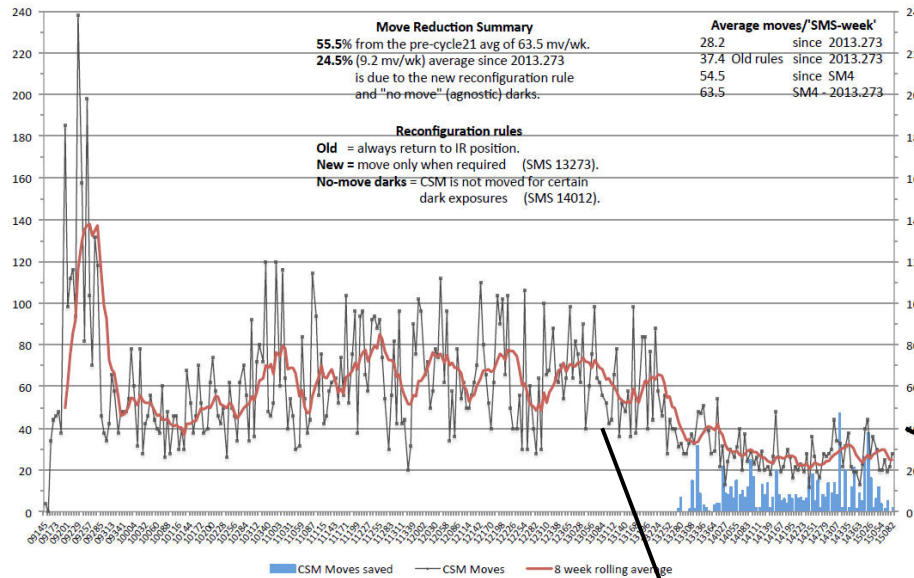


# CSM moves

Apr 6, 2015

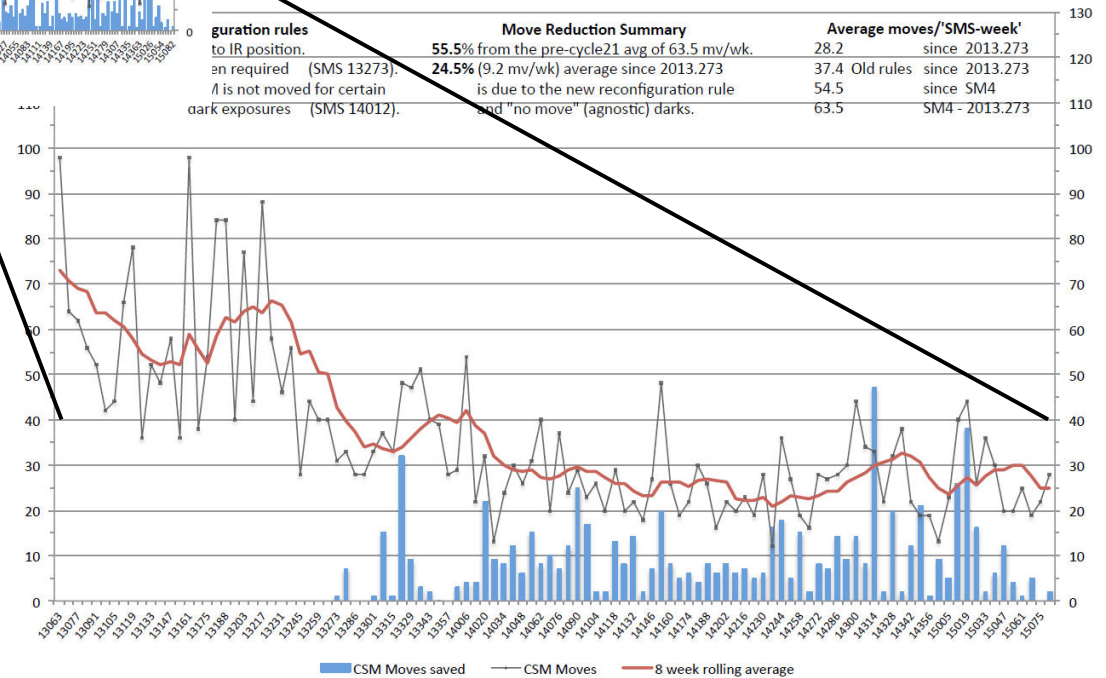


## WFC3 Channel Select Mechanism (CSM) Moves

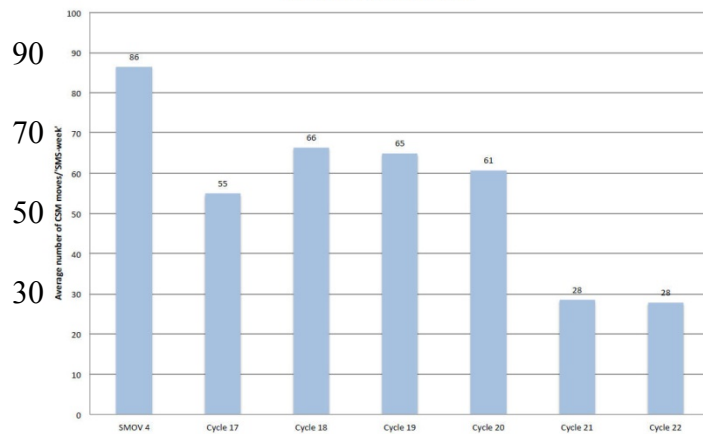


CSM moves staying at ~30/week or below.

## WFC3 Channel Select Mechanism (CSM) Moves (2 year view)



## WFC3 CSM Moves by Cycle



Plots from G. Chapman

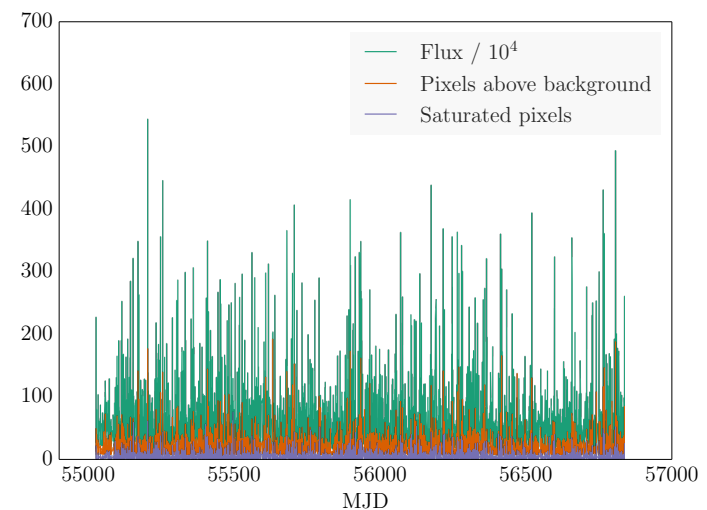
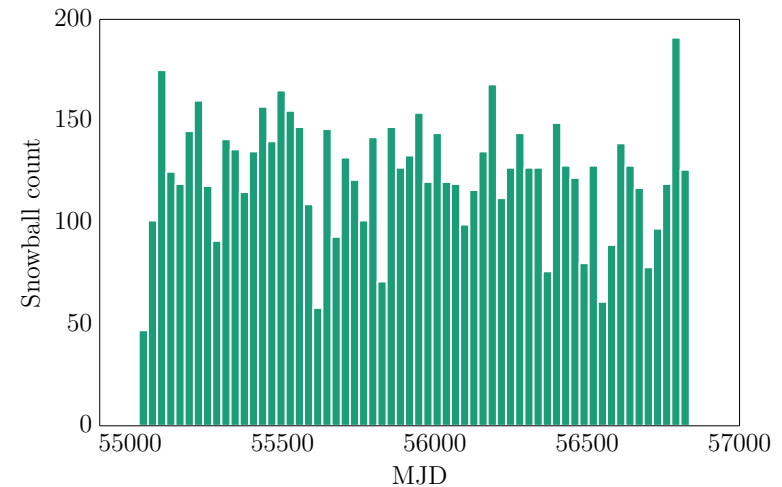
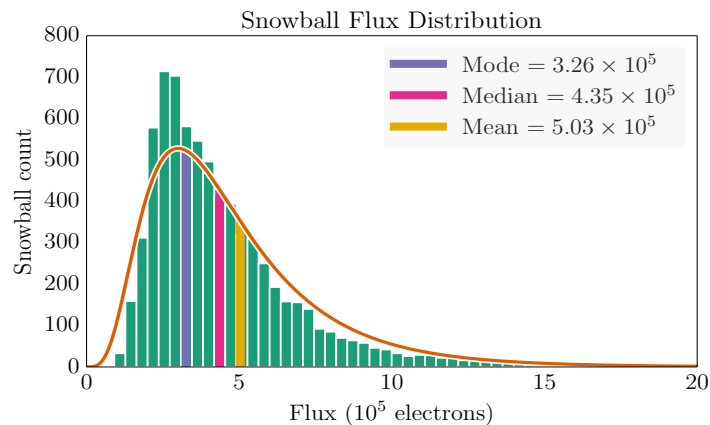
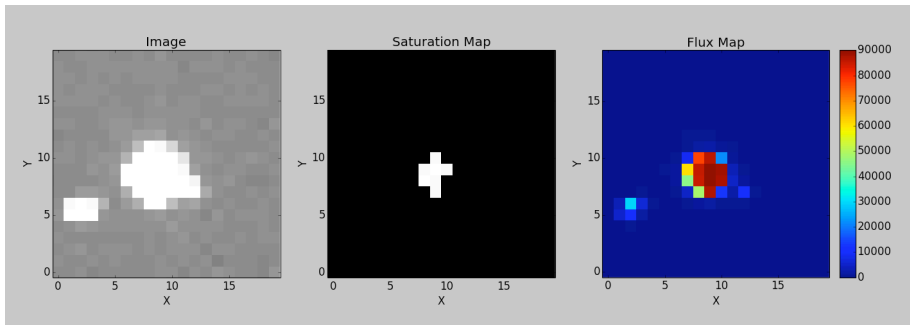




# IR Snowballs History



- Snowball: circular object  $\sim 2\text{-}5$  pix in radius that appear instantly between IR reads and saturates the detector –cause uncertain? Radioactivity?
- Good news: stable since SM4!



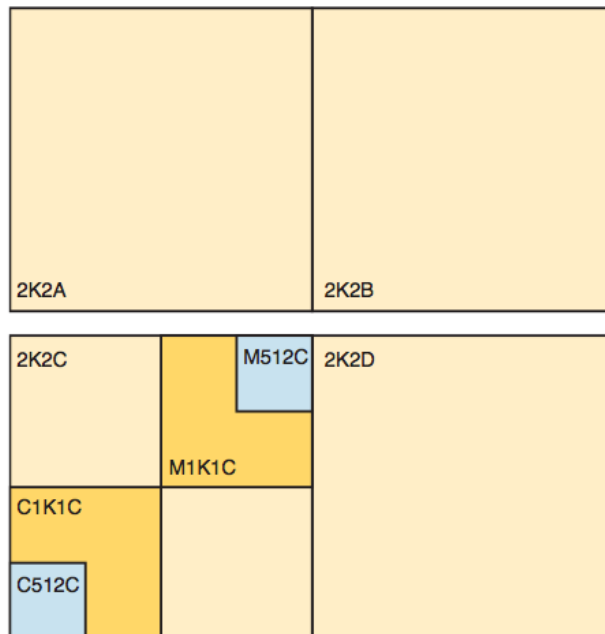


## Two New Full Array UVIS Aperture Definitions



Multiple UVIS subarray apertures were introduced in cycle 18 to eliminate the need for user-defined subarrays -- reduced errors and Phase 2 re-work.

- Generally used to enable parallel data dumps of short exposures (< 348 s)
- Some are also ideal for minimizing losses due to CTI
- HOWEVER: some uses want full array plus placing target new amplifier

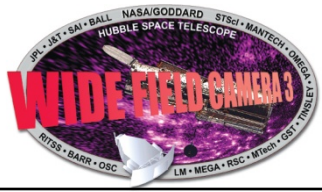


Target placement (x,y) near C amp:

aperture	x	y	size
UVIS2-C512C-SUB	257.0	257.0	513 x 512
UVIS2-C1K1C-SUB	512.0	512.0	1025 x 1024
UIVS2-2K2C-SUB	762.0	816.0	2047 x 2050
UVIS-QUAD-SUB (C)	762.0	816.0	2047 x 2050

Two new full array apertures with target placement that minimizes CTI losses and avoids the need to guess at POSTARGs

UVIS2-257XY-CTE	257.0	257.0	full array
UVIS2-512XY-CTE	512.0	512.0	full array

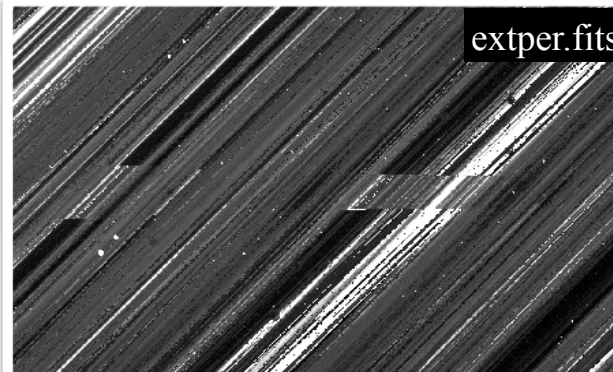
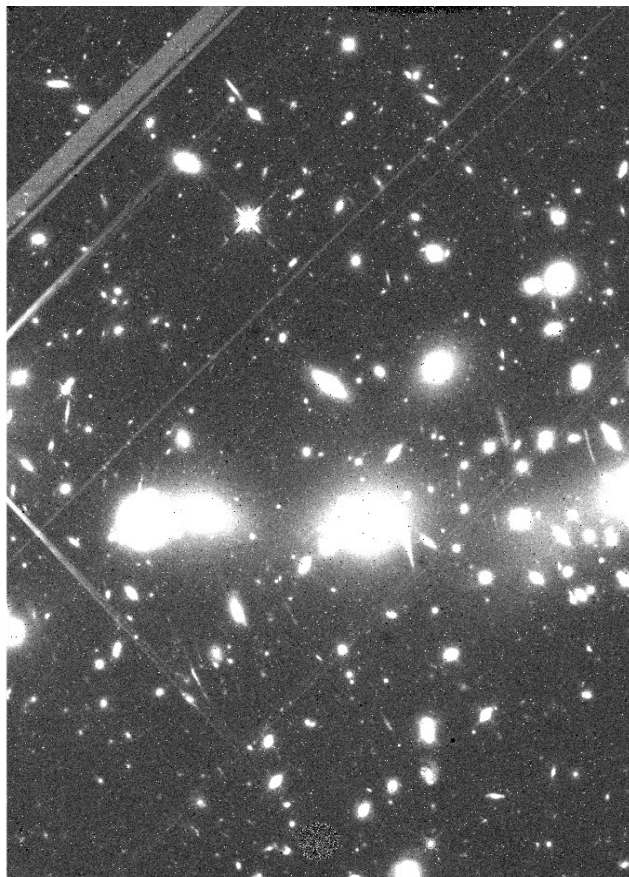


# IR Persistence



- Monitoring incoming data plus proposal reviews
  - Flag and schedule around: BAD (2 orbit) actors since Cycle 18
  - Now tracking WORST (10 orbit) and Sensitive (high impact) cases

*Macs0416 - F160W (PID#13496, Visit 94, exp. 01)*



Still not perfect:  
earth flat  
overflow a city



These aren't the  
scattered light  
artifacts you are  
looking for



# IR Backgrounds



- Prior STUC presentation on discovery of important of He 1.083 micron feature with HST is in daylight
  - Frontier Fields data scheduled successfully to avoid sunlight with impacted filters (i.e. F105W in night; F160W in day)
  - Multiple efforts to communicate this to observers
- Significant for most GRISM observations (lots of structure!)
  - Multi-component models with zodi + He I (+ earth limb) appear promising and are under development
  - Improved tools (pipeline?) for ramp fitting and data editing

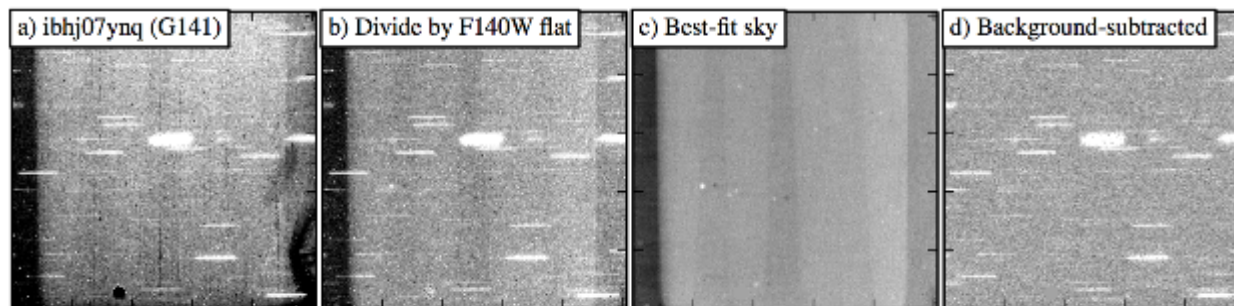
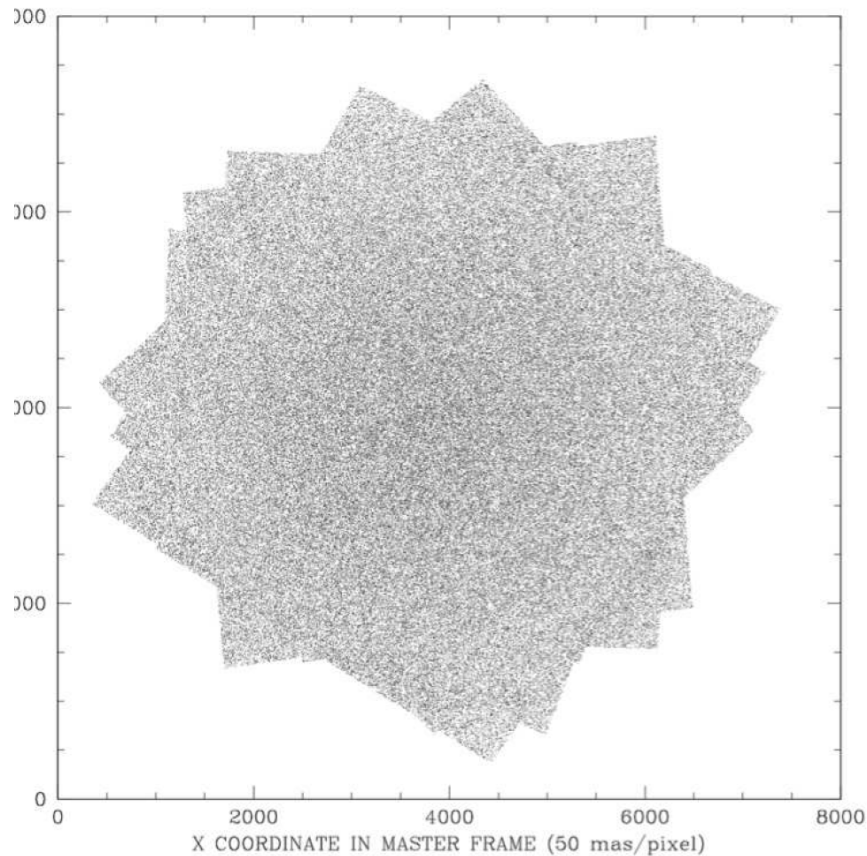


Figure X: Sky-subtraction of grism exposures with master sky images. Panel b) represents a trivial grey flat-field correction using the imaging flat-field reference file. The best-fit sky image in panel c) is a composite of zodiacal and He 1.083 $\mu$ m line components; the structure results from overlapping vignettted grism orders.





# Improving UVIS Astrometry



— X&Y positions of 184,890 well-measured stars in the master stars list. The X and Y coordinates are given in ACS/WFC pixel.

- Initial WFC3 requirement: 4 mas (0.1 pixels) for AstroDrizzle is sufficient for most image registration and stacking programs
- Potential to do much better
  - WFC3 very stable internally due to thermal control of optical bench
  - Inclusion of photolithographic mask offsets (2013) → 2 mas
  - Inclusion of filter induced mid-spatial frequencies → 1 mas
    - Done for ~10 UVIS filters with sufficient Omega Cen data
    - Expanding to remaining filters over Cycles 22-23
  - Omega Cen field now has Jay Anderson's proper motion catalog
- Questions:
  - How to best exploit GAIA?
  - Future applications of Spatial Scanning approach (<30  $\mu$ as – Riess et al.)



# PSF Library and GRISM tools



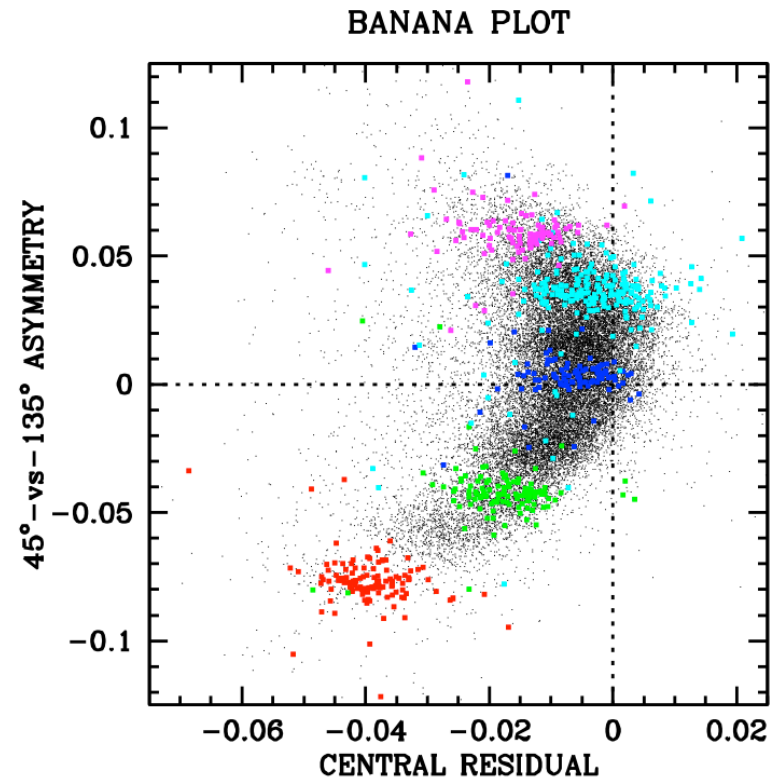
- PSF Library
  - $\sim 10^7$  stars “reasonably isolated” with “reasonable S/N” in F606W
  - Expanding to entire set of WFC3 observations
  - First application: improve focus monitoring from  $\sim 2 \mu\text{m}$  to  $< 1 \mu\text{m}$ 
    - Provides nearly continuous tracking (rather than monthly monitors with Phase retrieval) with comparable results
    - Outcomes: improved breathing model and (perhaps) more frequent focus adjustments for WFC3/UVIS
  - Exploring methods for making this usefully available –suggestions welcome!
- Advanced GRISM data reduction algorithms/software
  - Tool to handle observations at multiple roll angles
  - Forward Modeling methods to extract fainter sources and understand errors
  - Highly synergistic with JWST and WFIRST-AFTA needs



# A Study of Focus Variability of the WFC3/UVIS F606W PSF



Date	Focus Model
17 Mar 2014	3.75 (magenta)
27 Feb 2012	1.9 (cyan)
24 May 2013	-2.6 (blue)
8 Jun 2012	-4.1 (green)
6 Jun 2012	-7.4 (red)



The colored points represent a few exposures where stars from a given exposure occupy a similar location in the focus space.