CASU processing for VISTA

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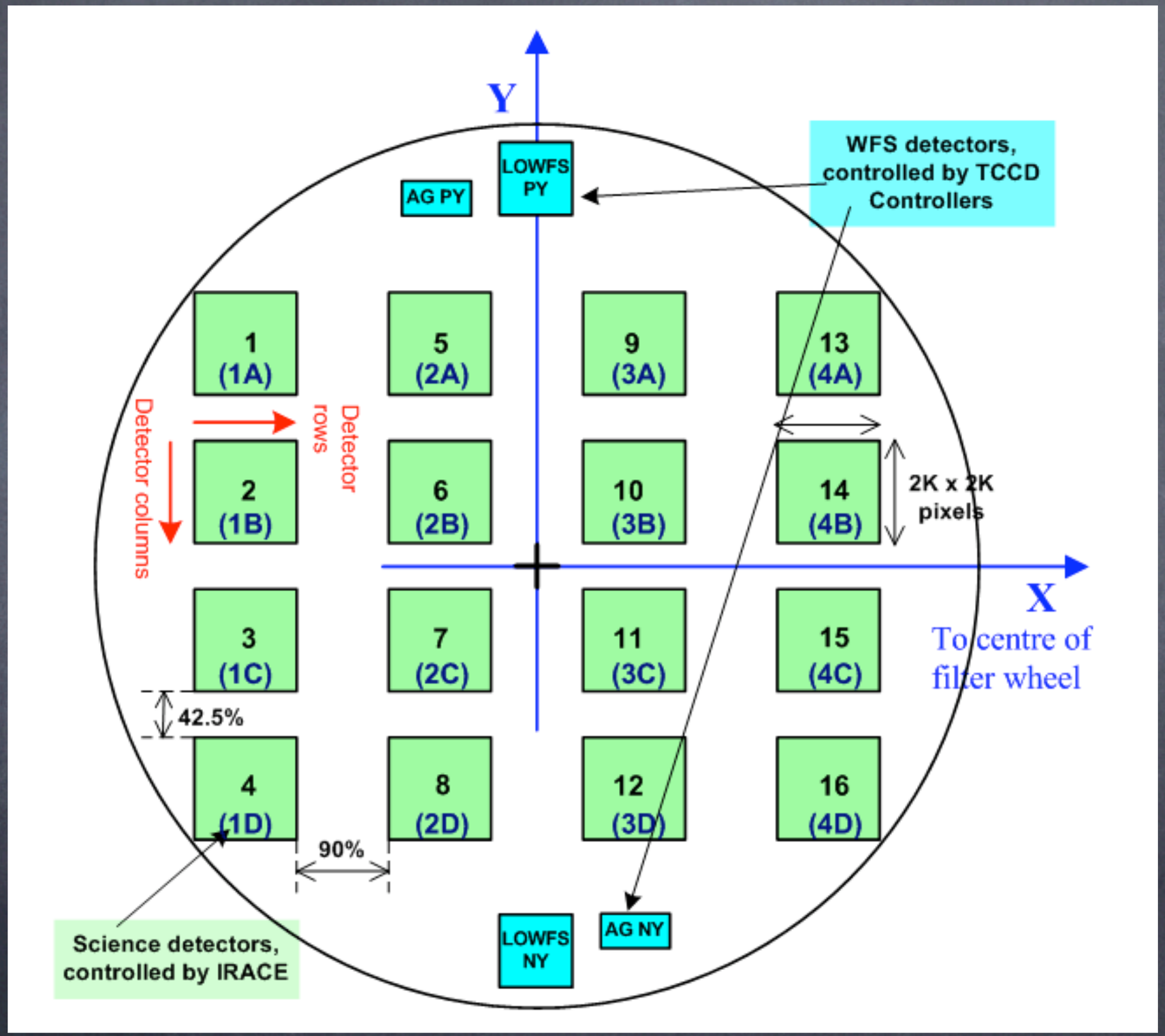
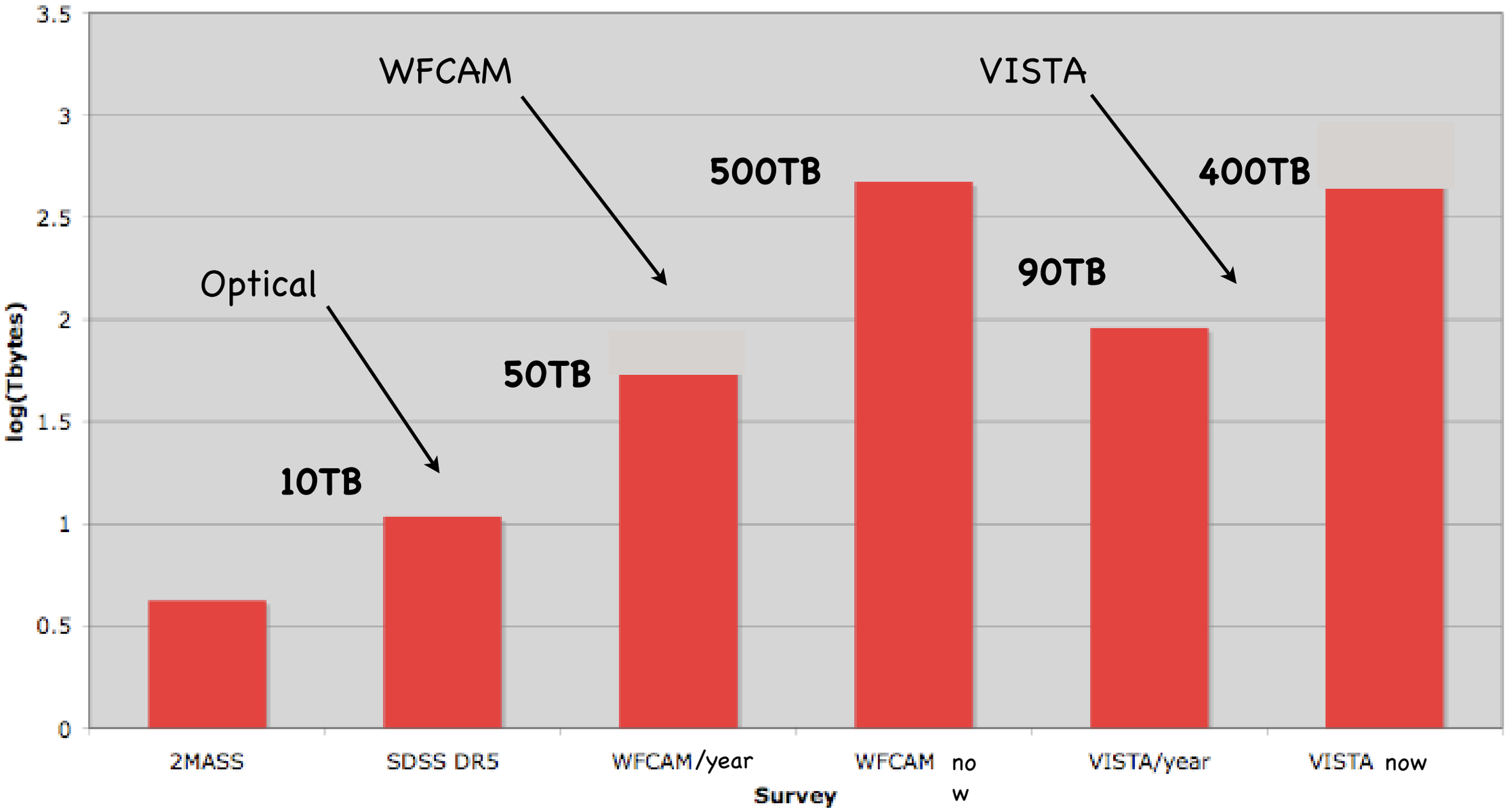
- CASU responsible for all NIR processing for VISTA and WFCAM as part of the VDFS
- VISTA pipelines: Paranal; Garching; Cambridge

VISTA focal plane



Data products volume



optical

optical

NIR

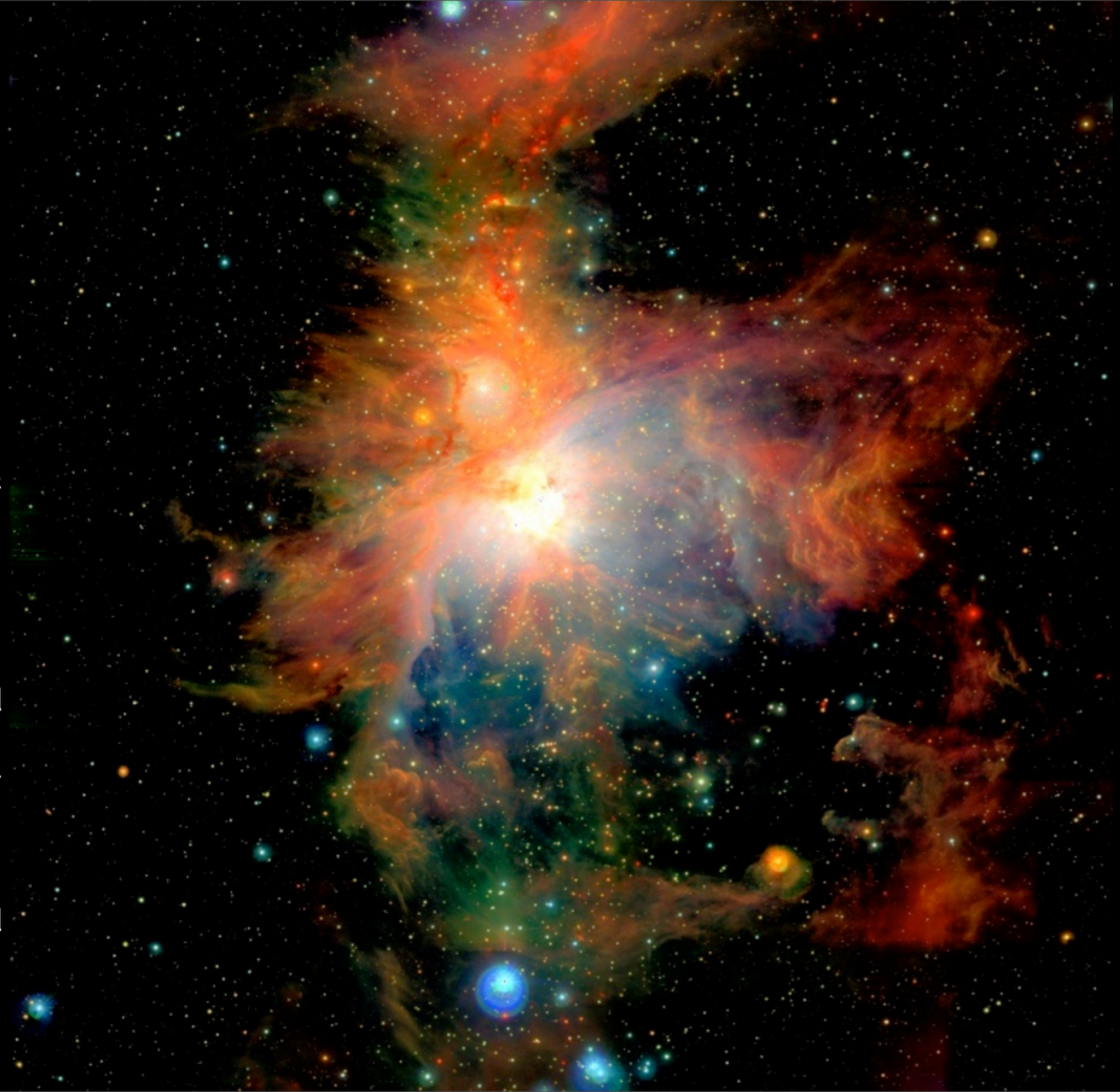
Orion

M42
region

colour
composite
J,H,Ks

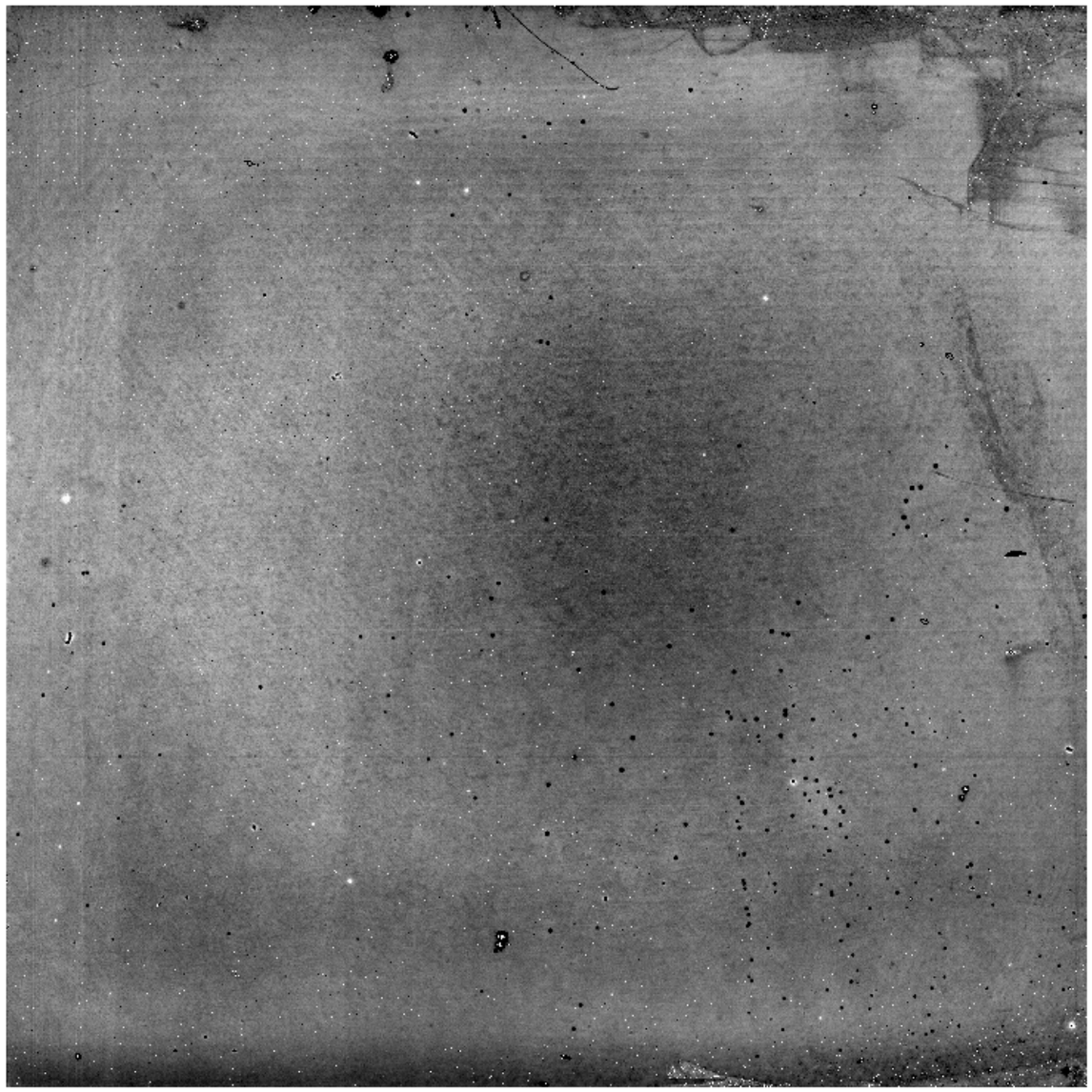
16kx13k
pixels/
waveband

mosaic of
96 2kx2k
images/
waveband

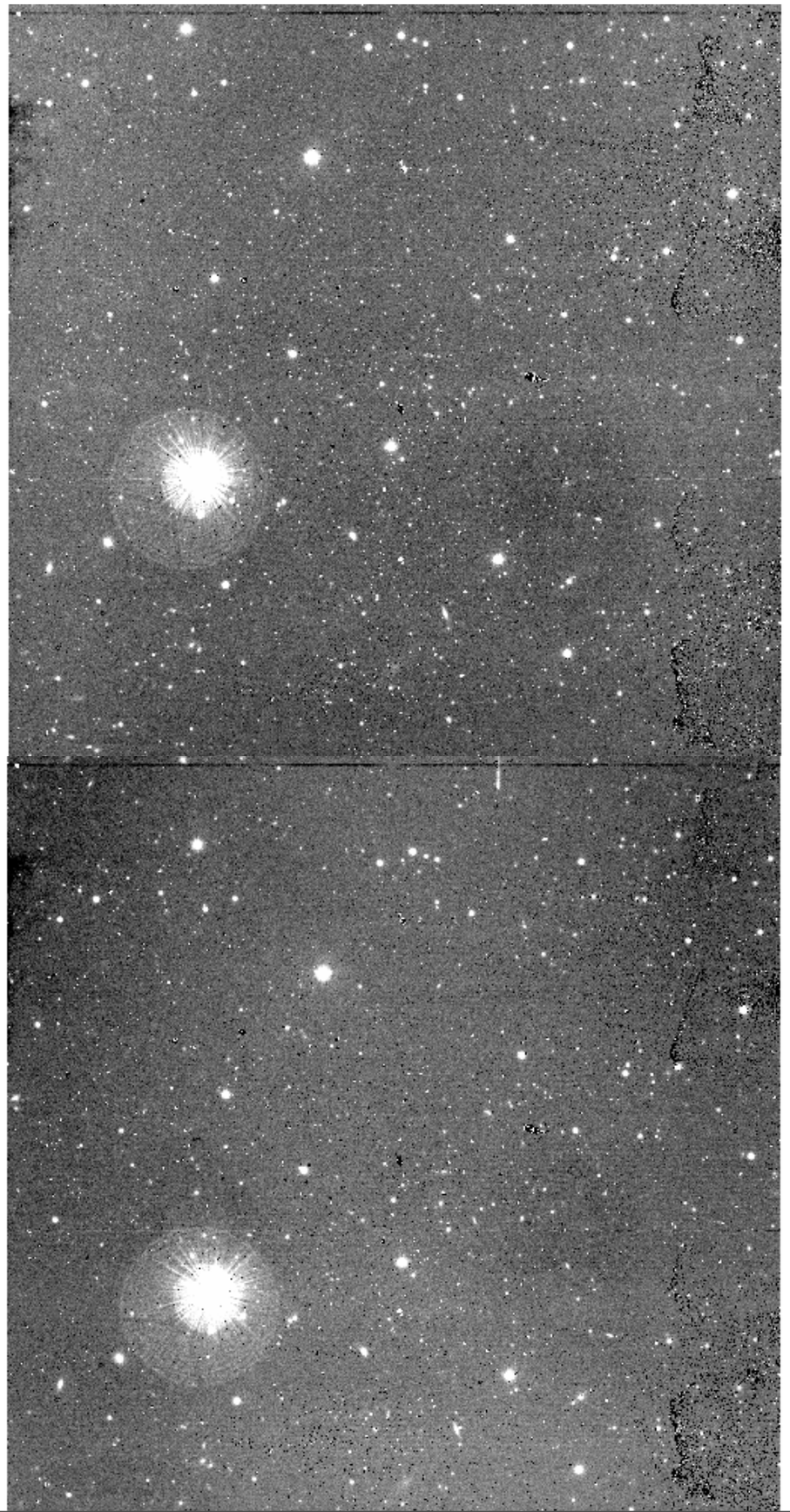


IR Data Reduction Issues

- IR detectors are inherently more unstable than optical CCDS
  - some odd electronic effects
  - not as good cosmetically as CCDs
- Sky background >100x brighter than most objects of interest
- Sky background is variable temporally and spatially
- Exposure times are short, so nightly data rates are very high (~250-500GB)



Time Variable Sky



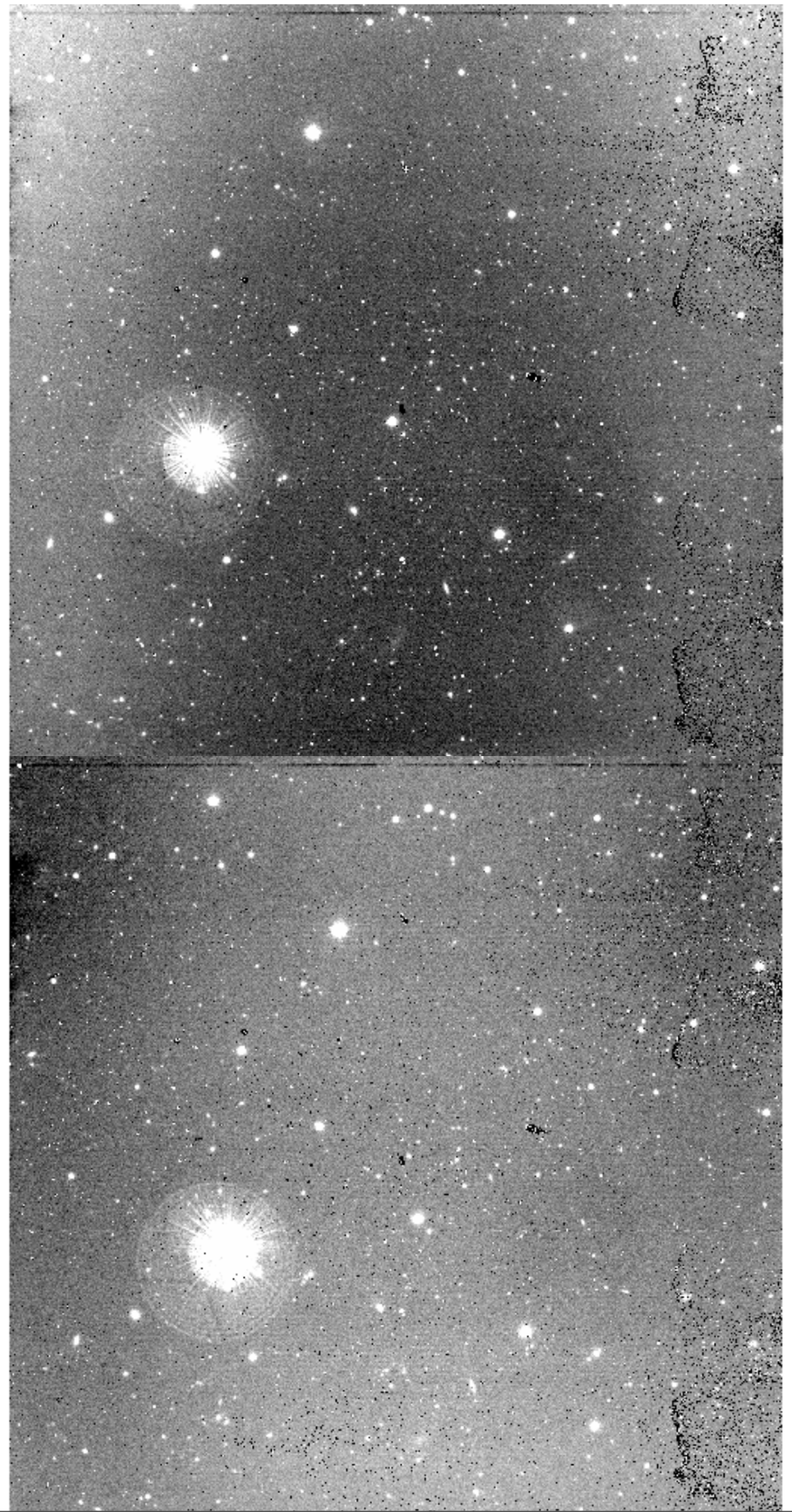
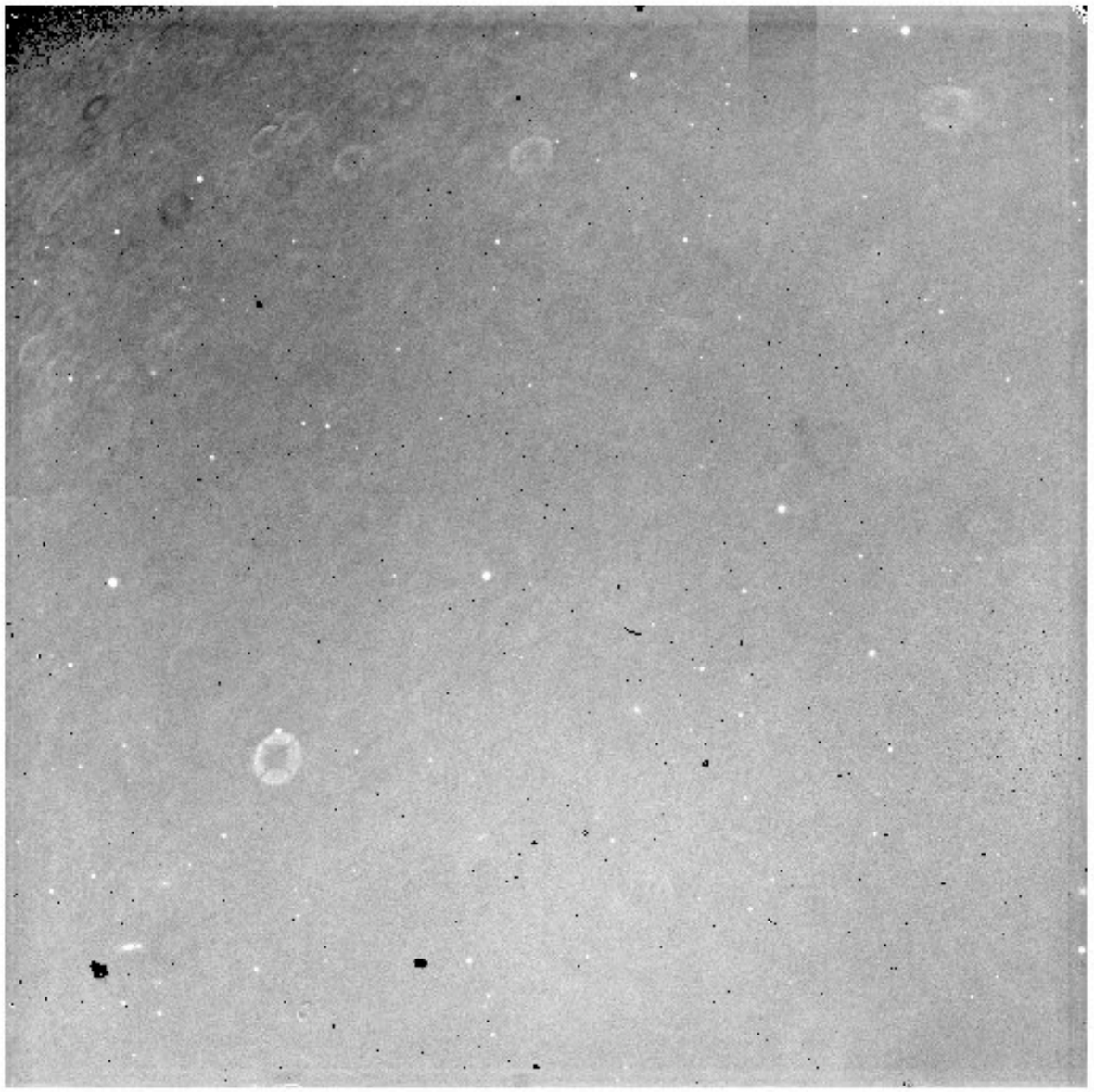
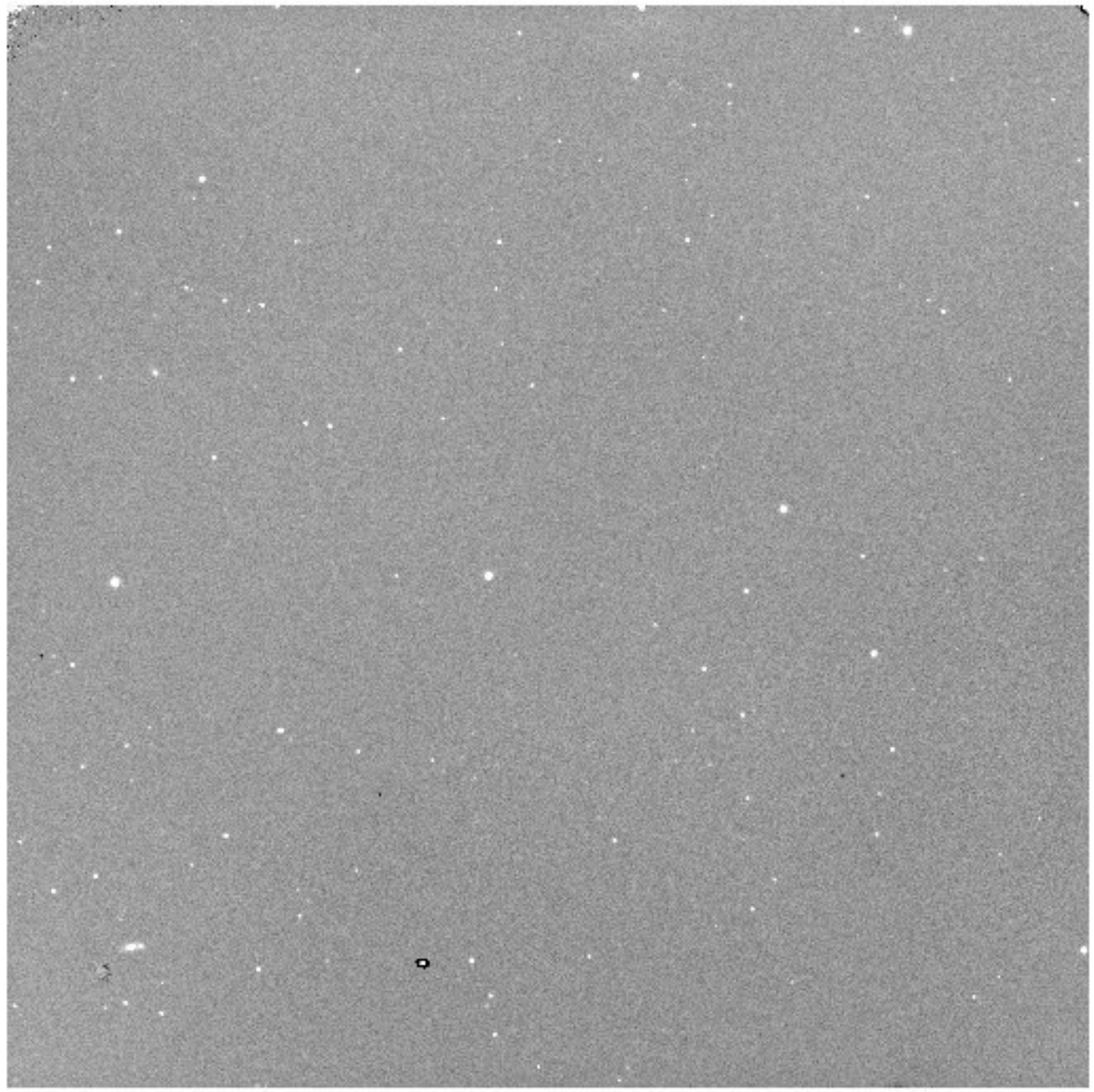


Image processing Steps

- Raw data transfer, ingest and organisation
- Monthly calibration updates (flats, linearity, masks)
- Nightly processing:
  - reset correction (debias - inline)
  - dark correction
  - linearity correction
  - flat field correction
  - sky background correction *****
  - destripe - controller level pickup
- Crosstalk, persistence, fringing corrections unnecessary

Before And After Background Correction



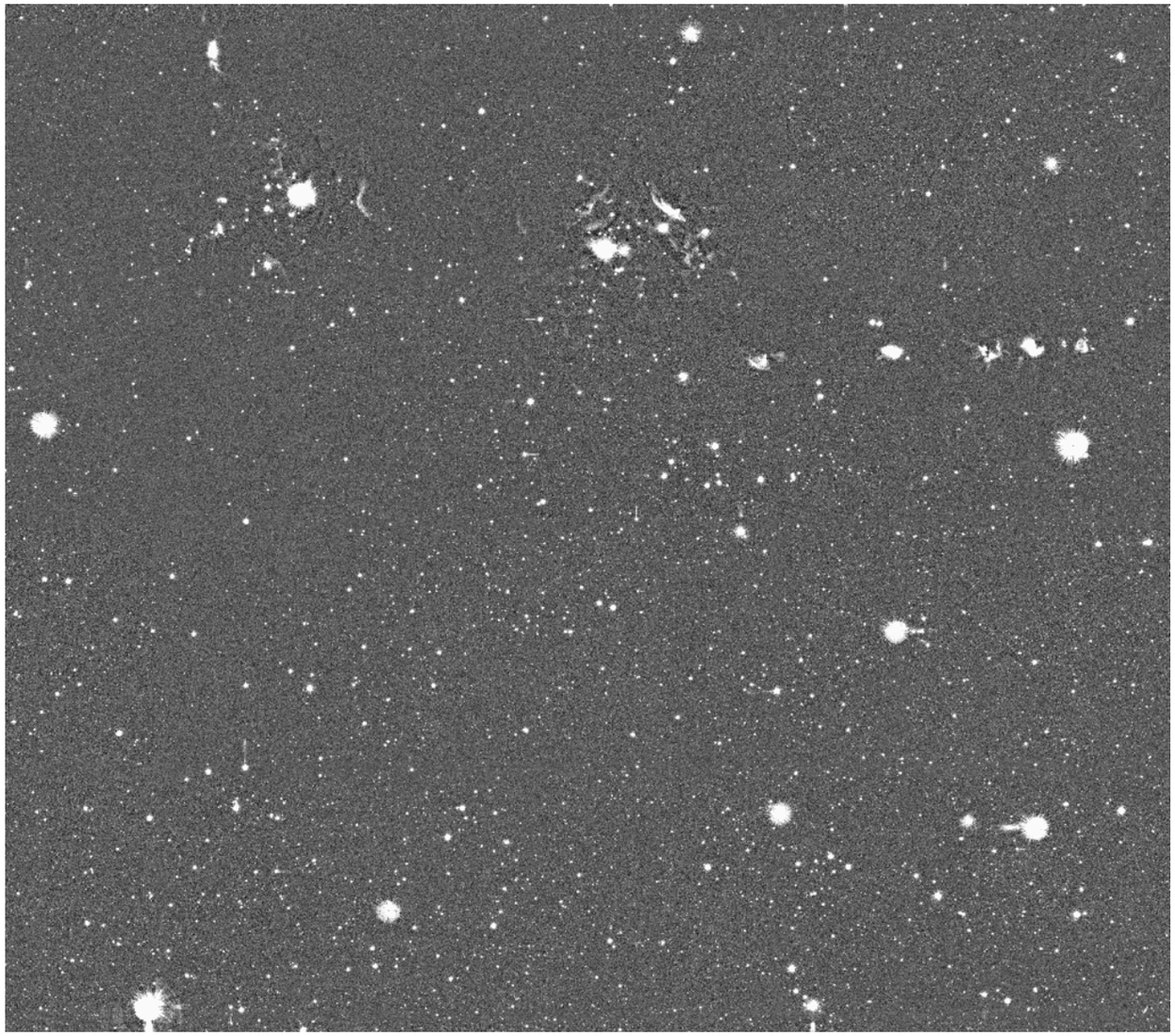


'Group' Processing Steps

- combining dithers -> stacked pawprints
- catalogue generation
  - morphological classification
  - astrometric calibration (< 100 mas)
  - photometric zeropoint calibration (< 2%)
- nebulising pawprint images
- tiling/mosaicing of pawprints
- tile catalogue generation + calibration
- retiling original stacked pawprints

Nebulised pawprints and tiles

Nebulosity filter applied to stacks before mosaicing



Post-Processing Steps

- monthly zeropoint updates
  - stack 2MASS photometric residuals
  - compute detector-level ZP offsets
  - and residual spatial illumination correction
- tile grouting
  - fix catalogues for variable PSFs
  - and for varying pawprint-level ZPs
  - and for individual detector-level ZPs
- reclassify and update tile catalogue calibration

Data Products - recap

- products consist of:
  - calibrated single exposure images
  - shifted "average" stack frames (pawprints) + conf maps
  - calibrated stacked pawprint catalogues
  - filled area tile images + confidence maps
  - calibrated tile object catalogues
  - sky background images, flats, darks, bad pixel mask
- science products are MEF files (images Rice-compressed)
- all QC parameters are stored in MEF headers
- headers contain provenance information
- processing web page updates
  - http://casu.ast.cam.ac.uk/surveys-projects/vista

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VISTA DATA REDUCTION PROGRESS: COMMISSIONING

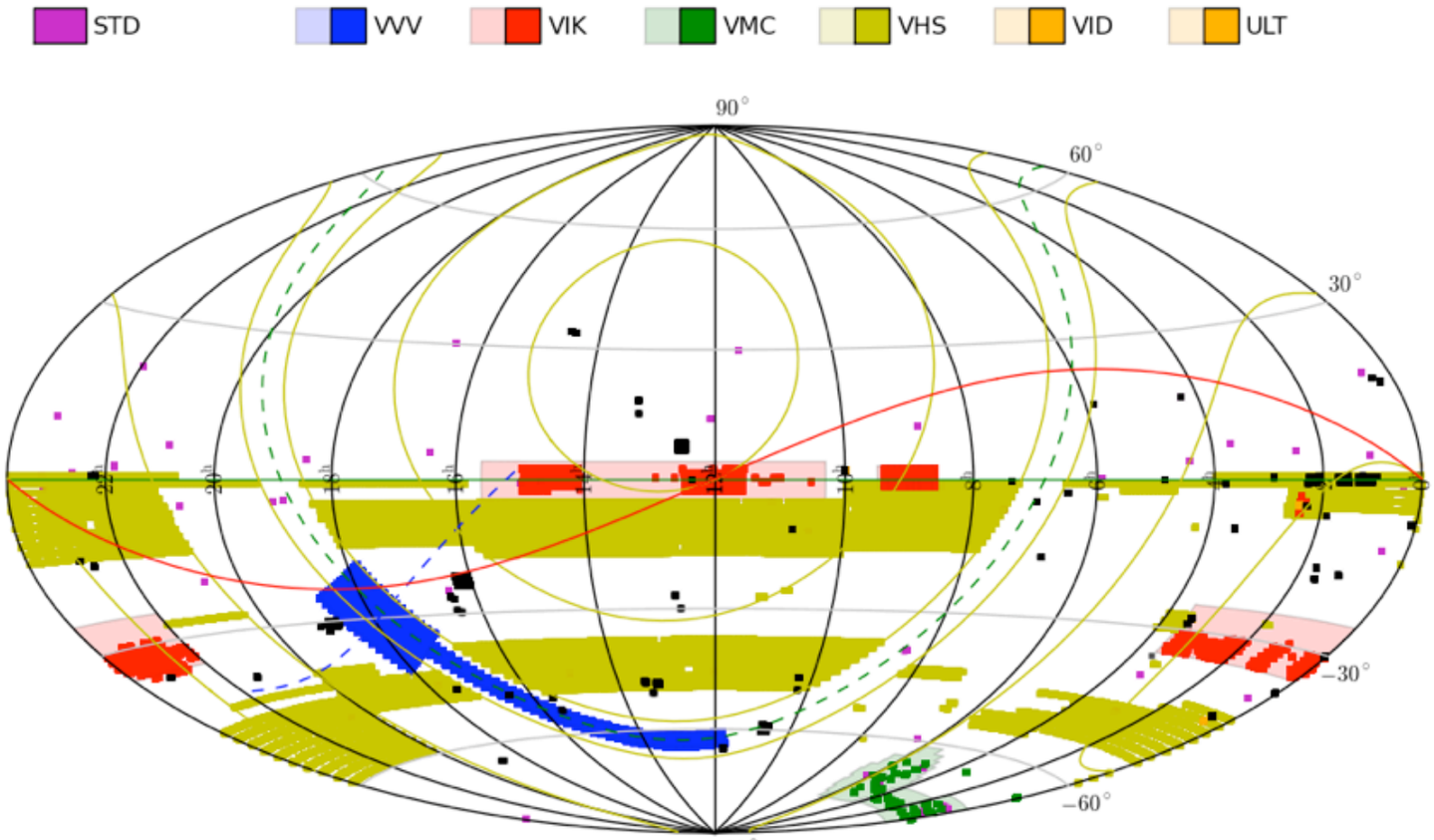
This page displays the reduction progress of VISTA data. Information is automatically updated hourly.

Night	Status	N_{raw}	Version	Summary Plots	Photometry Plots	Summary Info	Observation Log	Paranal ambient conditions	Size raw [Gb]	Size red [Gb]
2009/10/15	REDUCED	363		GIF1 GIF2	GIF	summary	obs_log	nightmon	23.86	43.78
2009/10/16	REDUCED	341		GIF1 GIF2	GIF	summary	obs_log	nightmon	25.53	137.65
2009/10/17	REDUCED	470		GIF1 GIF2	GIF	summary	obs_log	nightmon	33.61	183.47
2009/10/18	REDUCED	398		GIF1 GIF2	GIF	summary	obs_log	nightmon	29.51	154.95
2009/10/19	REDUCED	505		GIF1 GIF2	GIF	summary	obs_log	nightmon	35.24	184.86
2009/10/20	REDUCED	401		GIF1 GIF2	GIF	summary	obs_log	nightmon	29.76	192.84
2009/10/21	Reduction status	448		GIF1 GIF2	GIF	summary	obs_log	nightmon	32.11	179.83
2009/10/22	REDUCED	476		GIF1 GIF2	GIF	summary	obs_log	nightmon	36.66	204.01
2009/10/23	REDUCED	589		GIF1 GIF2	GIF	summary	obs_log	nightmon	42.97	266.31
2009/10/24	REDUCED	434		GIF1 GIF2	GIF	summary	obs_log	nightmon	30.17	131.61
2009/10/25	REDUCED	454		GIF1 GIF2	GIF	summary	obs_log	nightmon	34.09	191.42
2009/10/26	REDUCED	454		GIF1 GIF2	GIF	summary	obs_log	nightmon	33.89	192.52
2009/10/27	REDUCED	492		GIF1 GIF2	GIF	summary	obs_log	nightmon	35.20	198.65
2009/10/28	UNPROCESSED	15					obs_log	nightmon	0.92	
2009/10/29	REDUCED	435		GIF1 GIF2	GIF	summary	obs_log	nightmon	33.04	191.13
2009/10/30	UNPROCESSED	46					obs_log	nightmon	2.64	
2009/10/31	UNPROCESSED	100					obs_log	nightmon	4.91	
2009/11/01	UNPROCESSED	15					obs_log	nightmon	0.85	
2009/11/02	REDUCED	340		GIF1 GIF2	GIF	summary	obs_log	nightmon	25.31	102.82
2009/11/03	REDUCED	599		GIF1 GIF2	GIF	summary	obs_log	nightmon	47.72	249.12
2009/11/04	REDUCED	656		GIF1 GIF2	GIF	summary	obs_log	nightmon	53.90	205.86

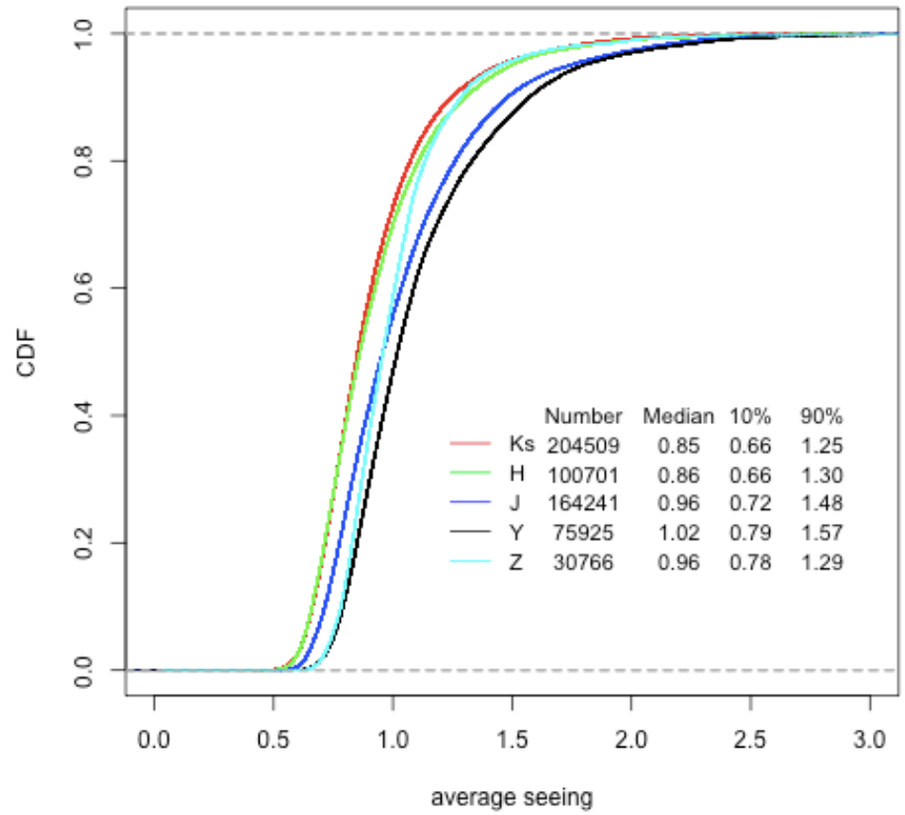
Table description :

- N_{raw}: total number of raw images for the given night (this includes darks, flats, focus runs etc.)

http://casu.ast.cam.ac.uk/vistasp/



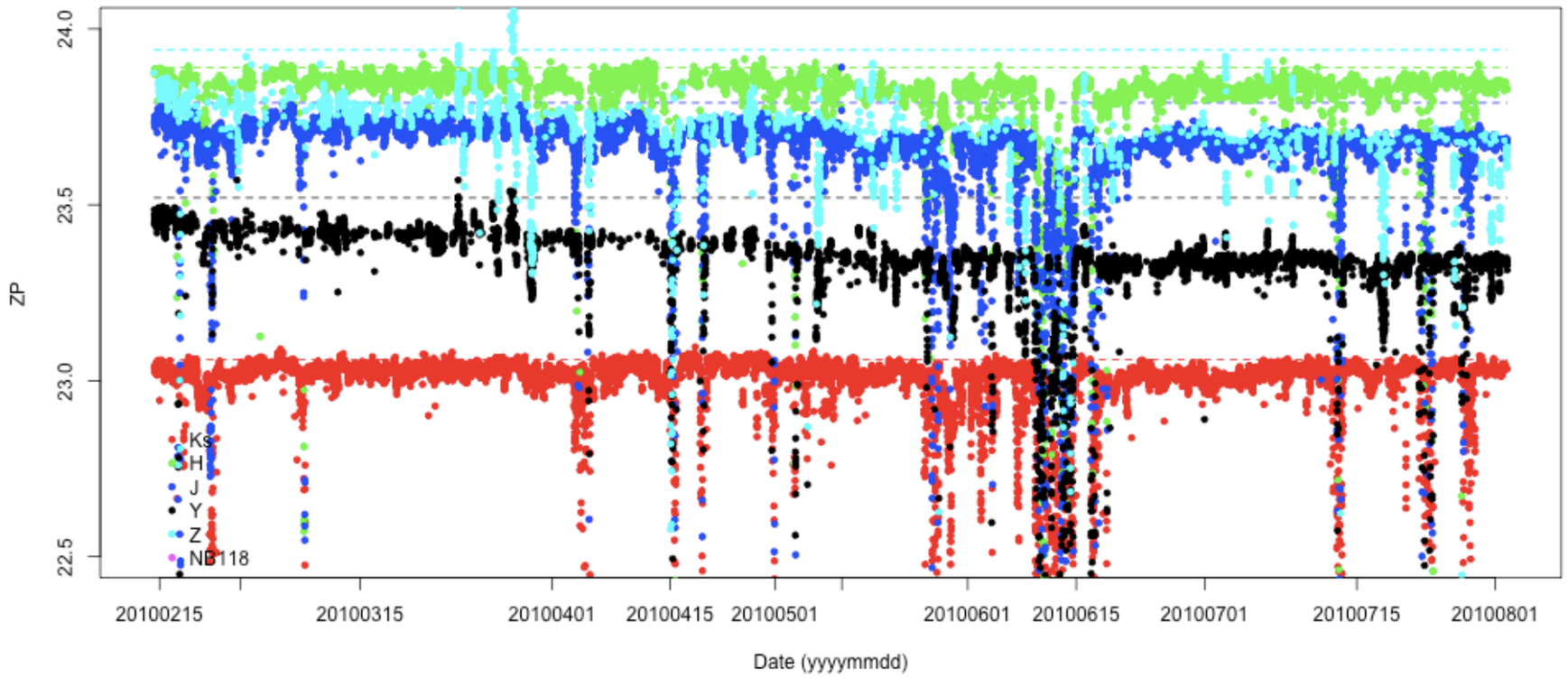
Survey progress overview



QC plots/tables summarise:

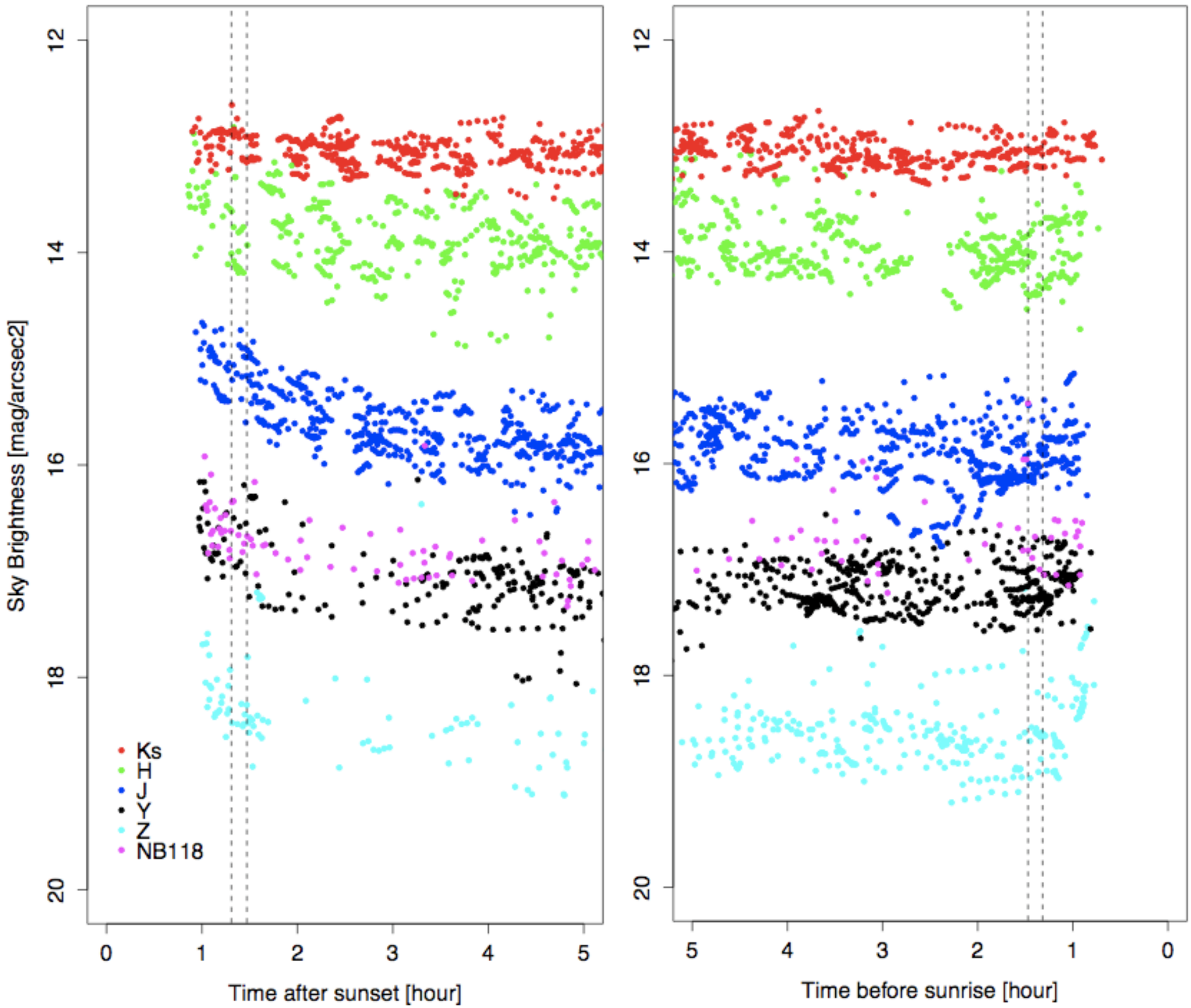
astrometry; seeing; stellar ellipticity; sky brightness; magnitude zero-point trends

+ access for image search, preview and download



Zeropoint variation

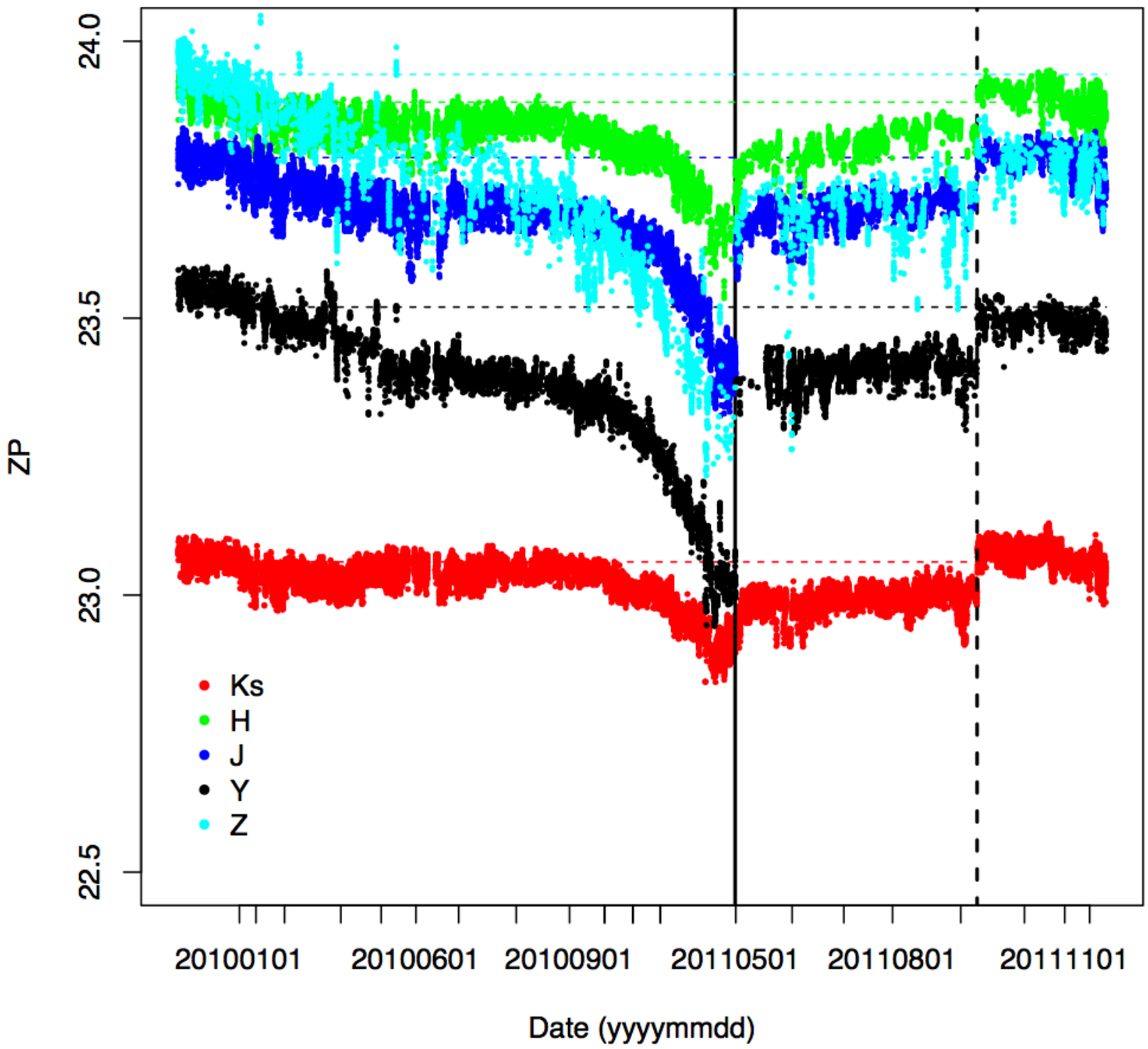
Monitoring sky surface brightness



An example of QC trend analysis

Variable zero-point (and hence survey depth) with time

- silvered mirror degradation
- aluminised mirror
- a bit of window cleaning



Astrometric & Photometric Calibration from 2MASS

WCS - ZPN projection $\quad r' = r + k_3 r^3 + k_5 r^5 \ldots$

NB. tiles are TAN projection

Linear solution
per detector

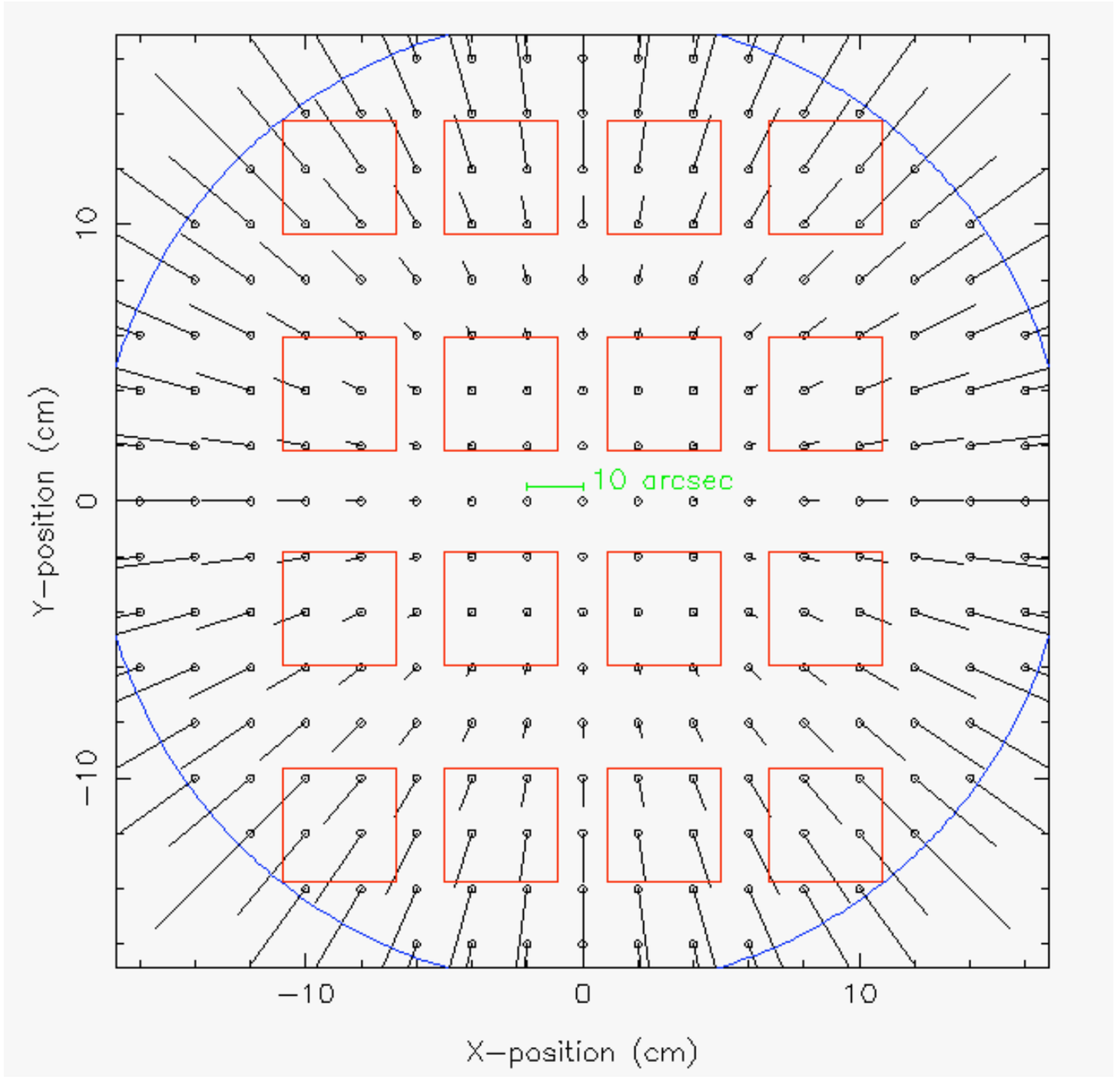
$$\xi' = ax' + by' + c$$

$$\eta' = dx' + ey' + f$$

⟶ rms < 100 mas

Tabulated
systematics
from stacked
residuals

⟶ sys < 25 mas



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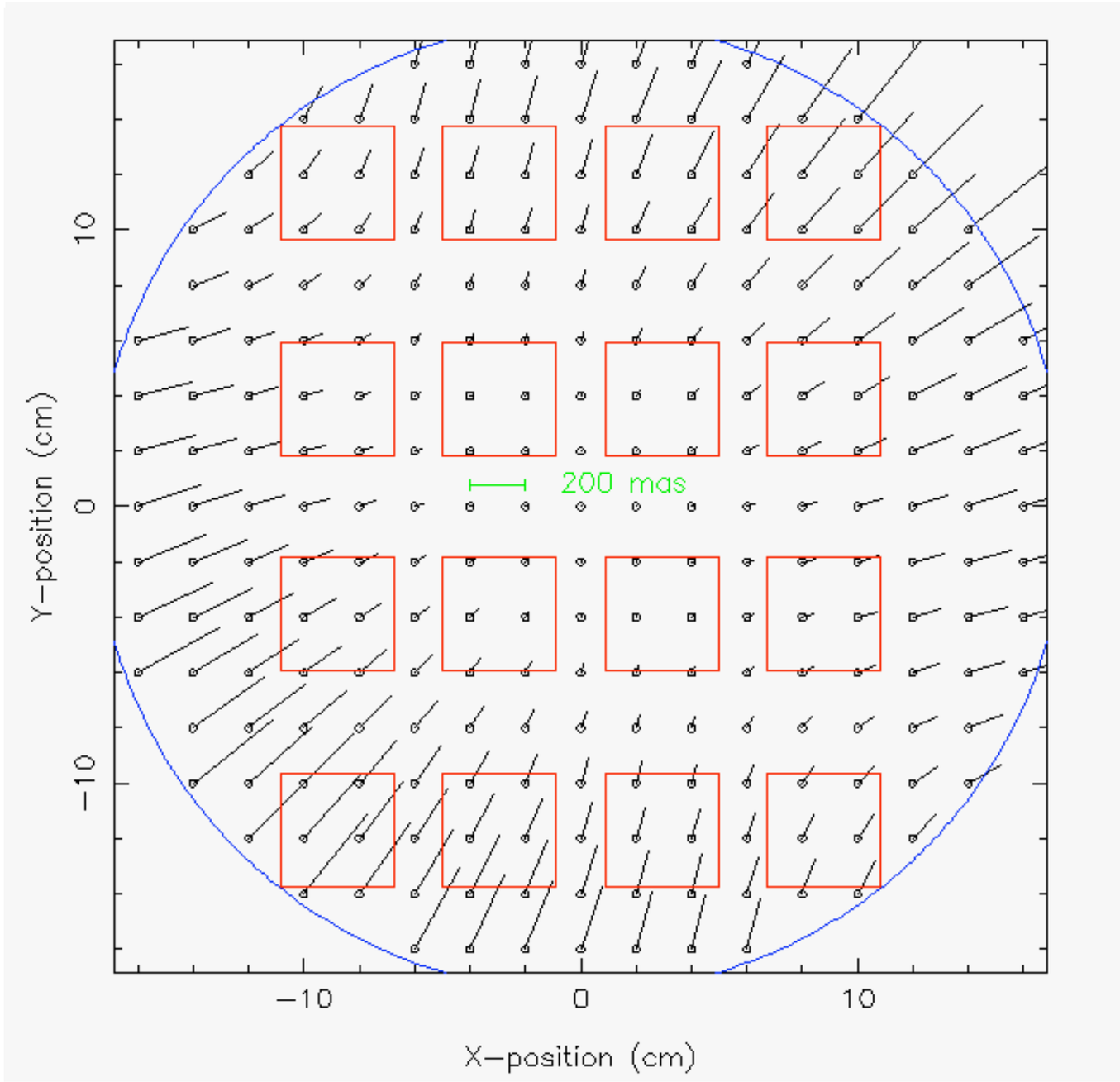
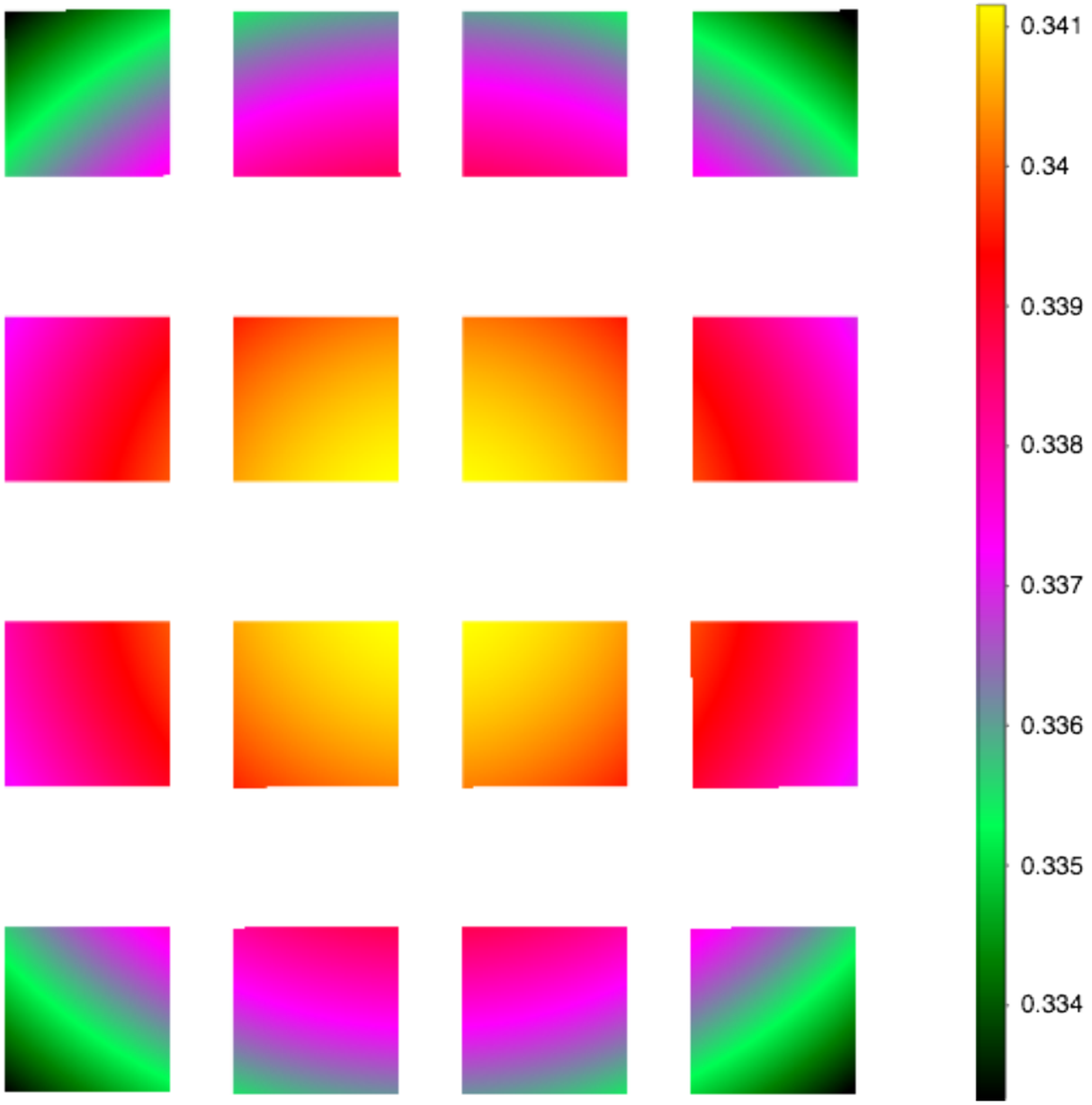
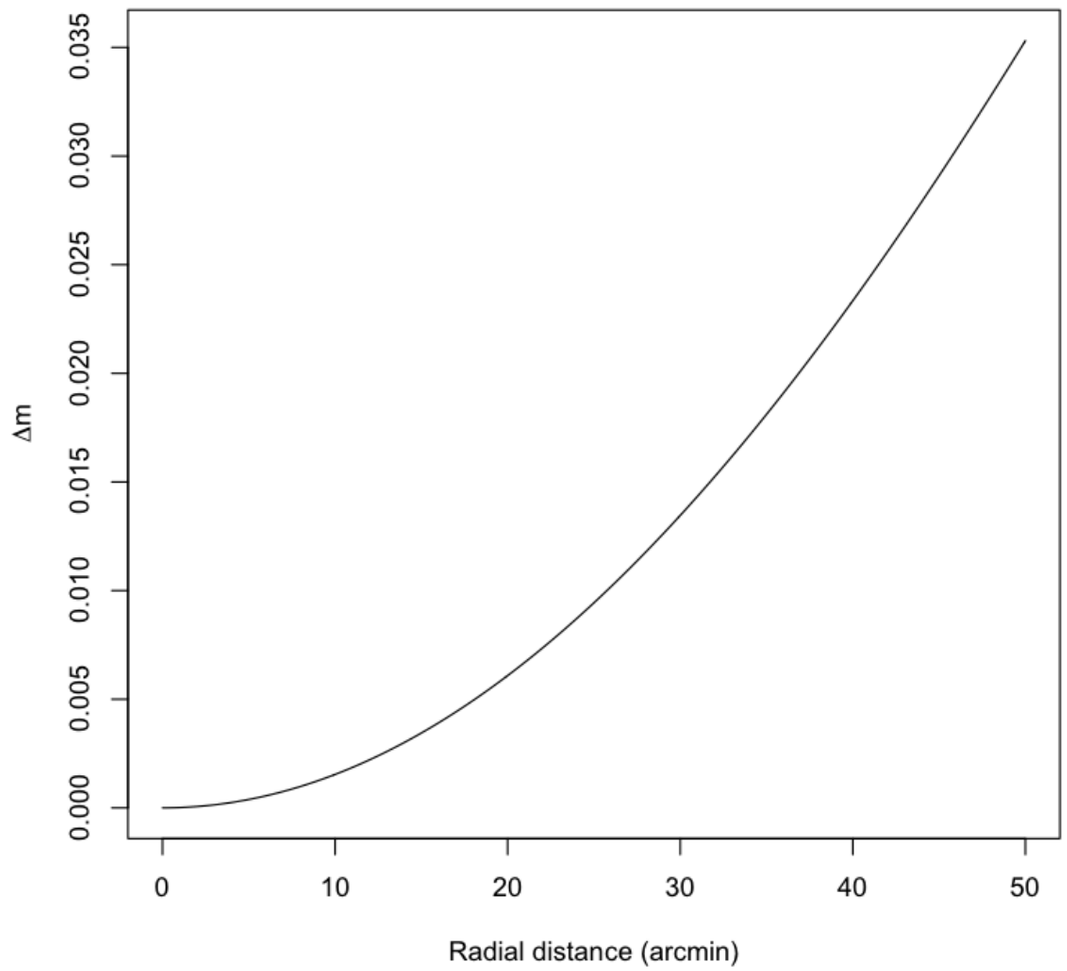


Variation of pixel scale



effect on magnitudes



VISTA pawprints

x6

dither stacked

+ confidence map
+ catalogue

mosaic tile

96 chips

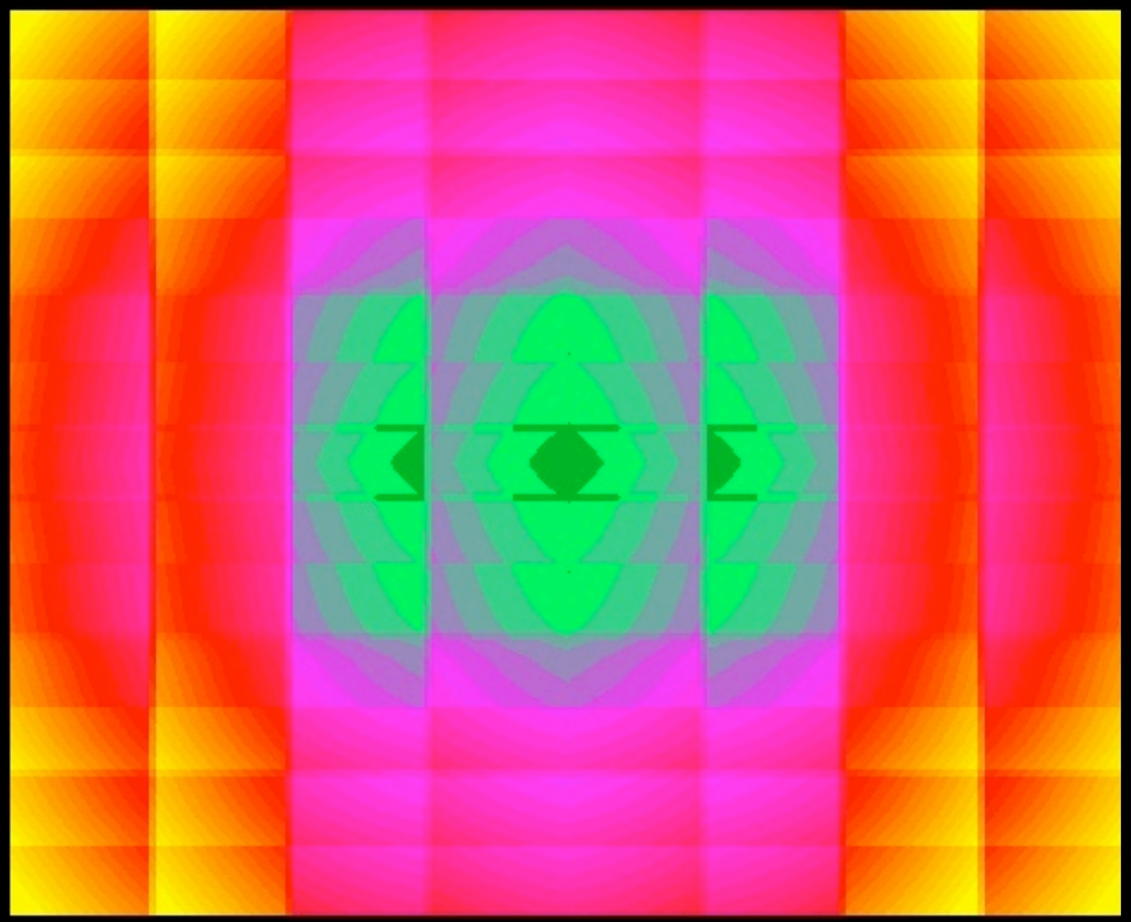
+ confidence map
+ catalogue

Challenges when dealing with tiles

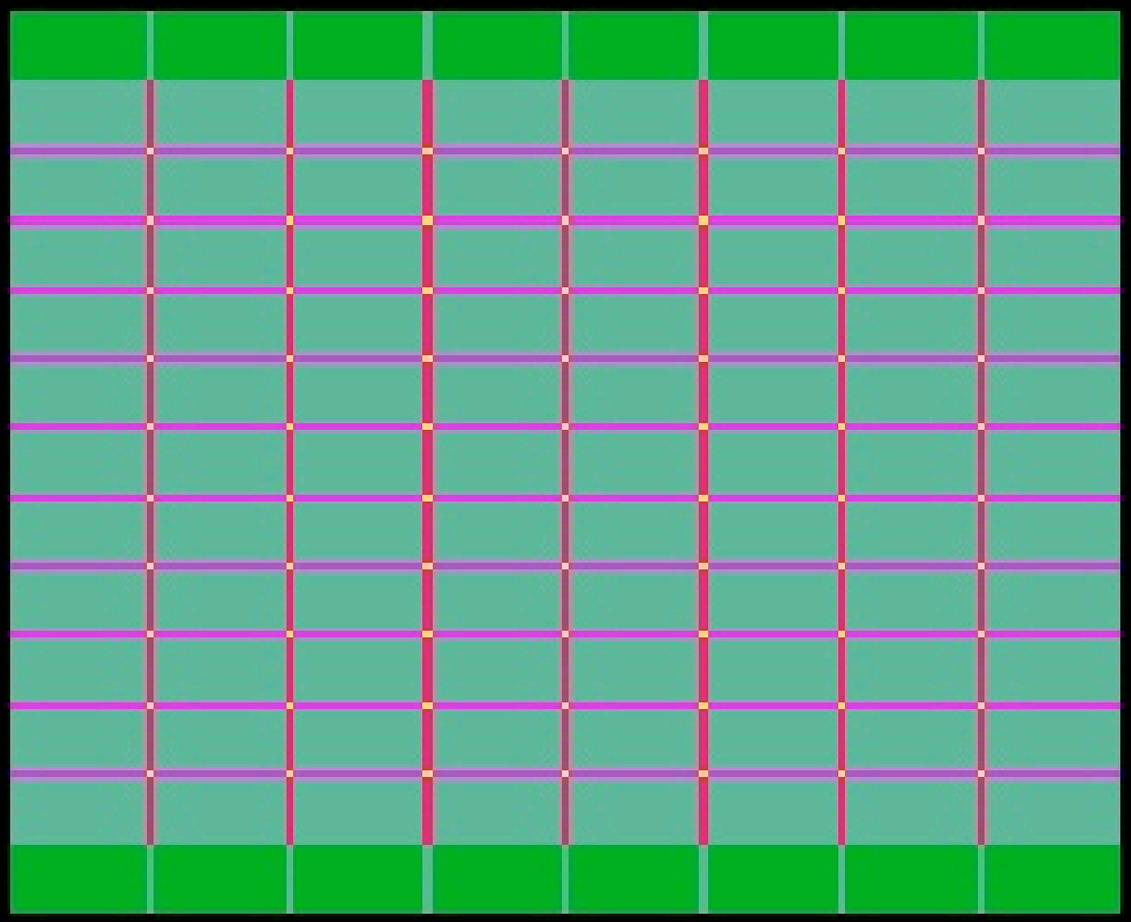
- imperfect sky subtraction pawprint matching + artefacts
- variable PSF across pawprint detectors
- variable seeing conditions for entire pawprint
- variable saturation levels of each detector
- variable extinction (ZP) during tile observations
- astrometric distortion = photometric distortion
- interpolation = varying correlated noise patterns
- "interesting" Modified Julian Date pattern

Tile photometric distortion

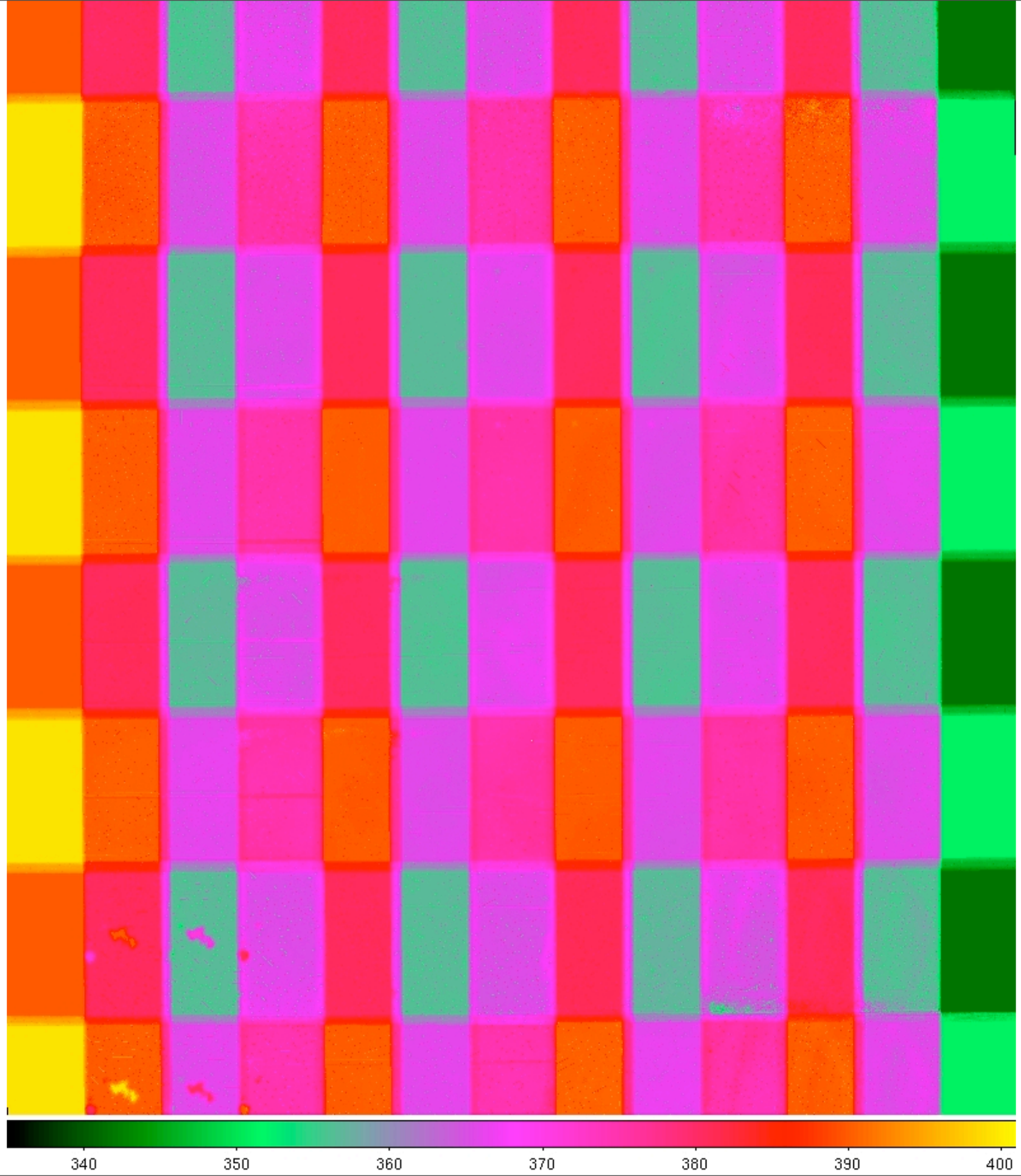
Inherent illumination correction



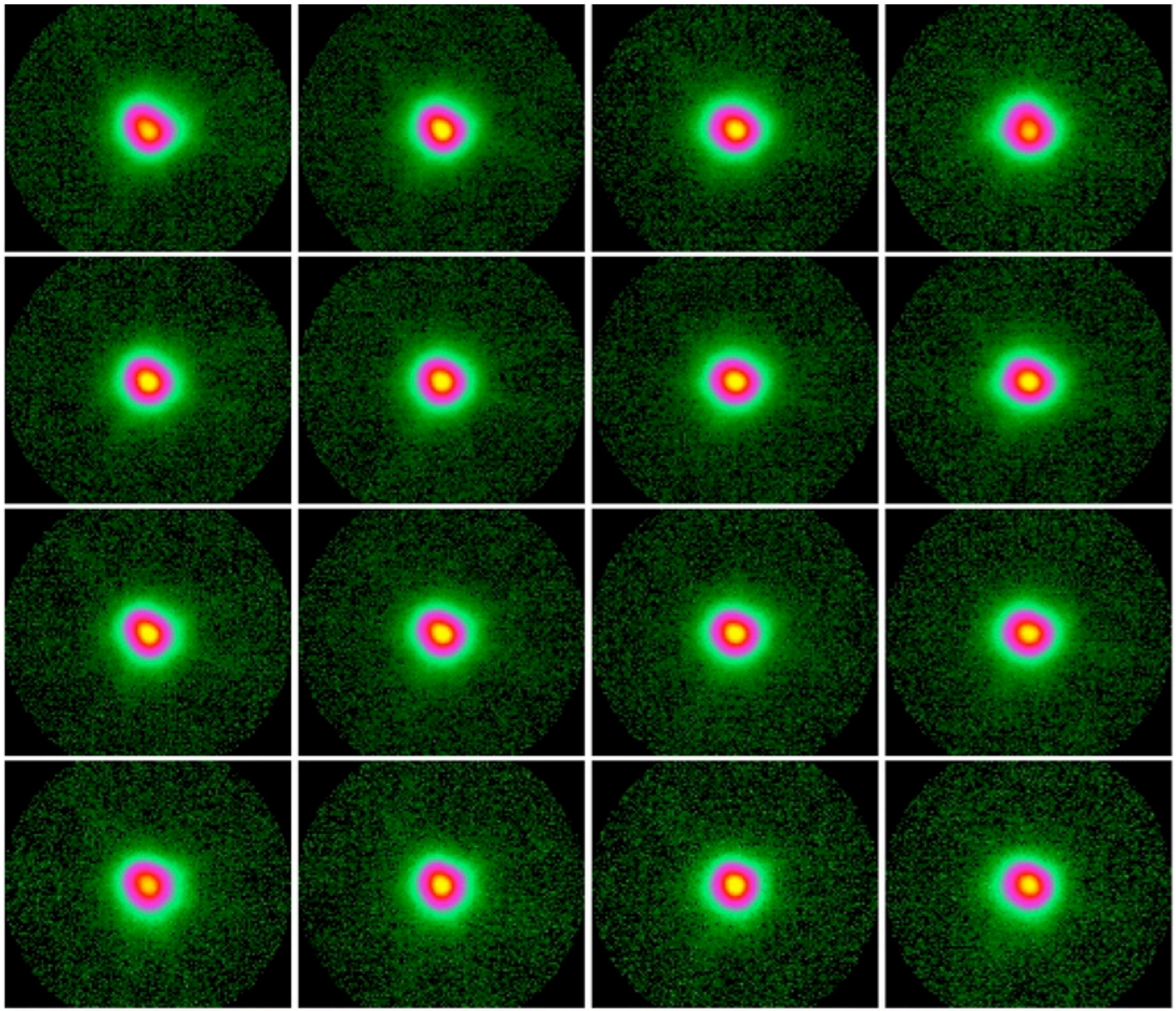
Tile exposure map



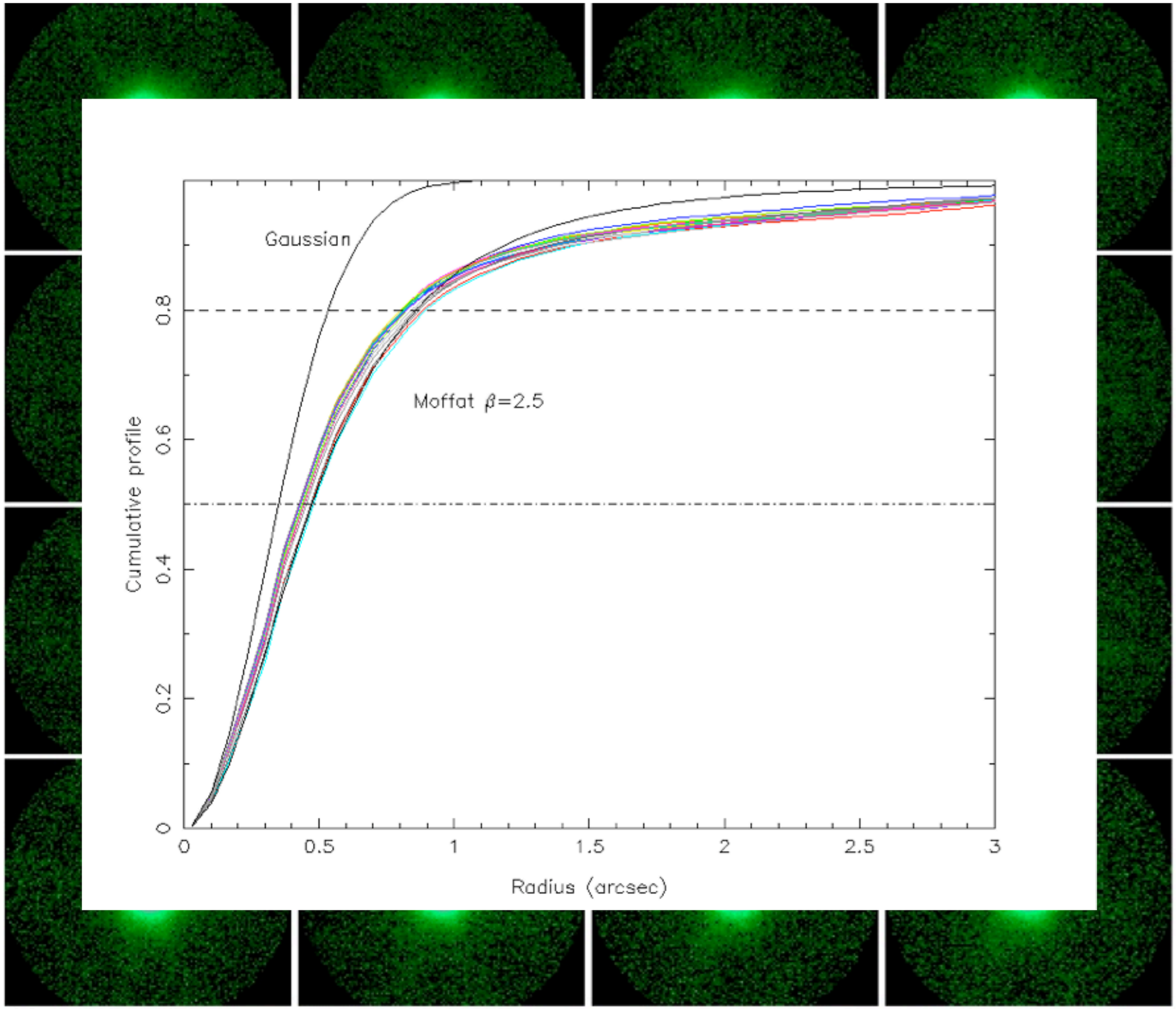
MJD variation across tiles



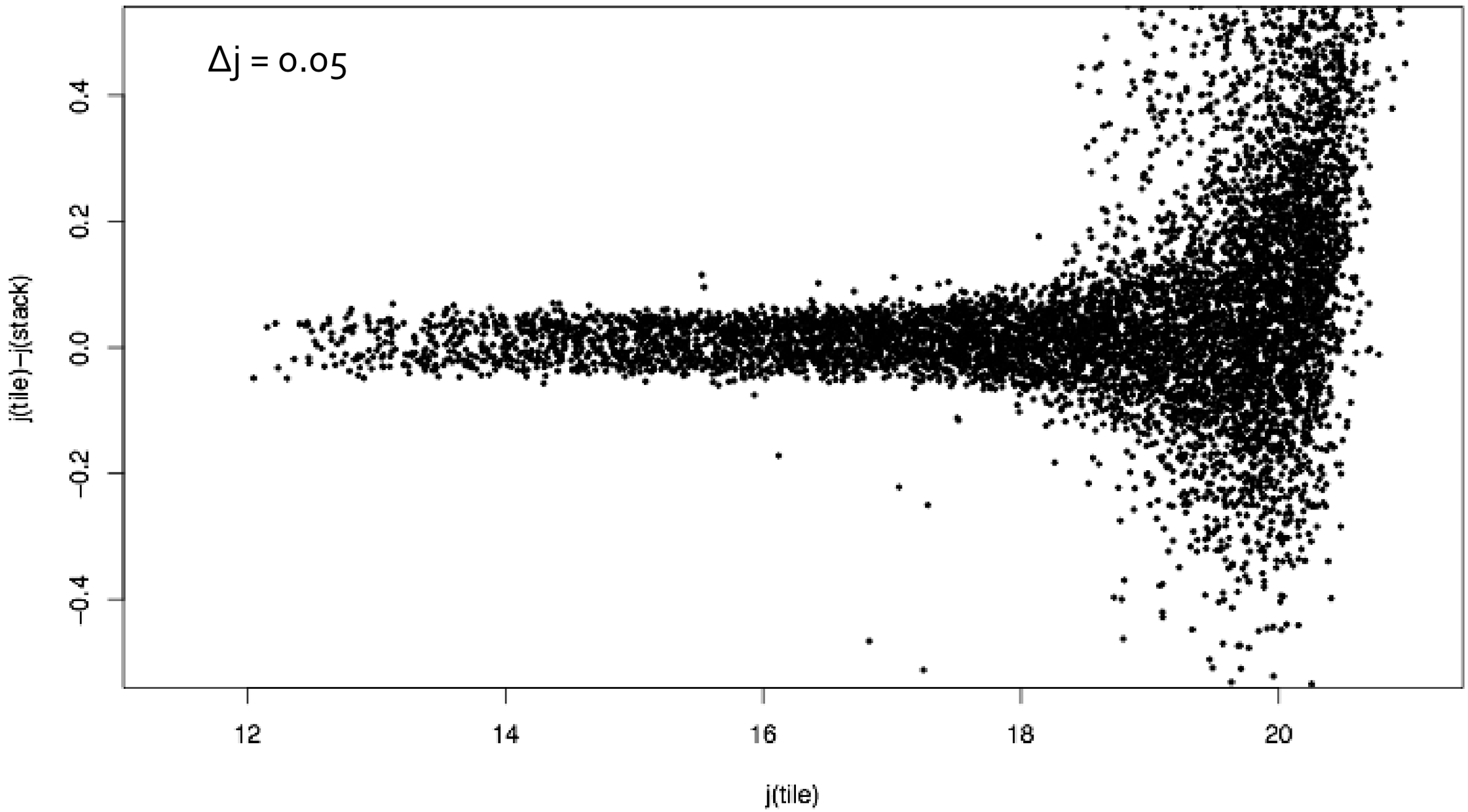
Detector PSF variations



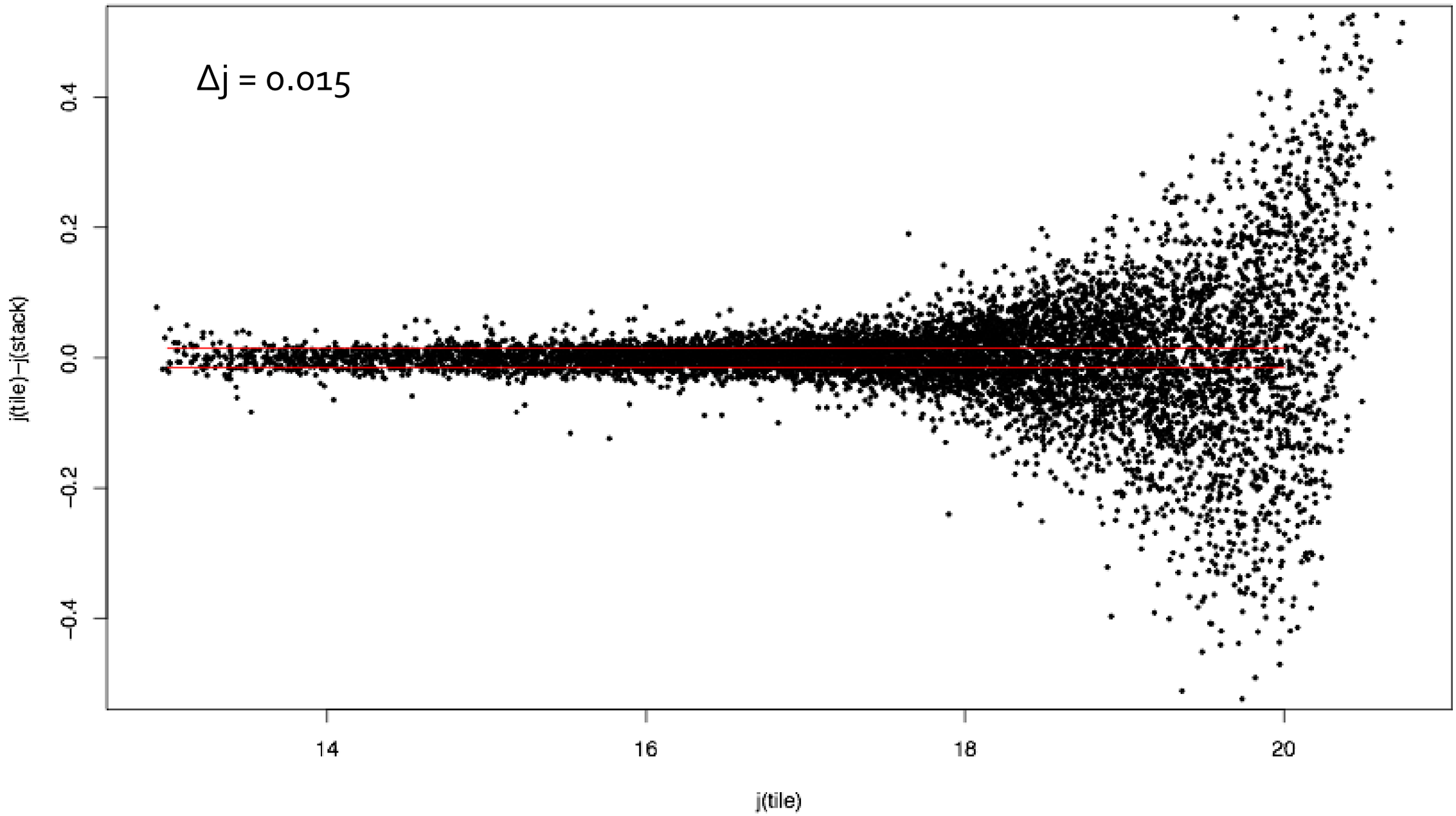
Detector PSF variations



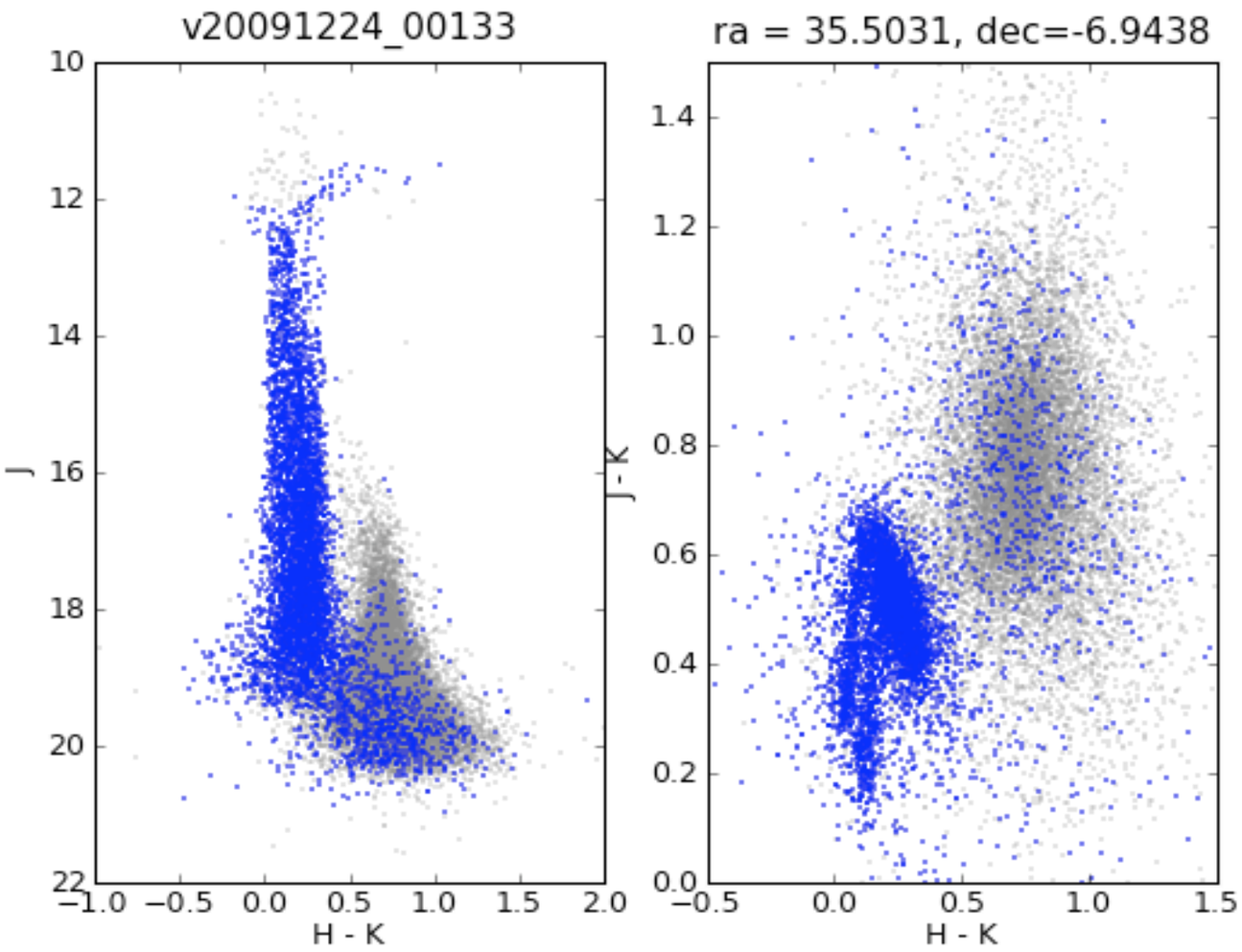
Tile vs Stack photometry (before grouting)



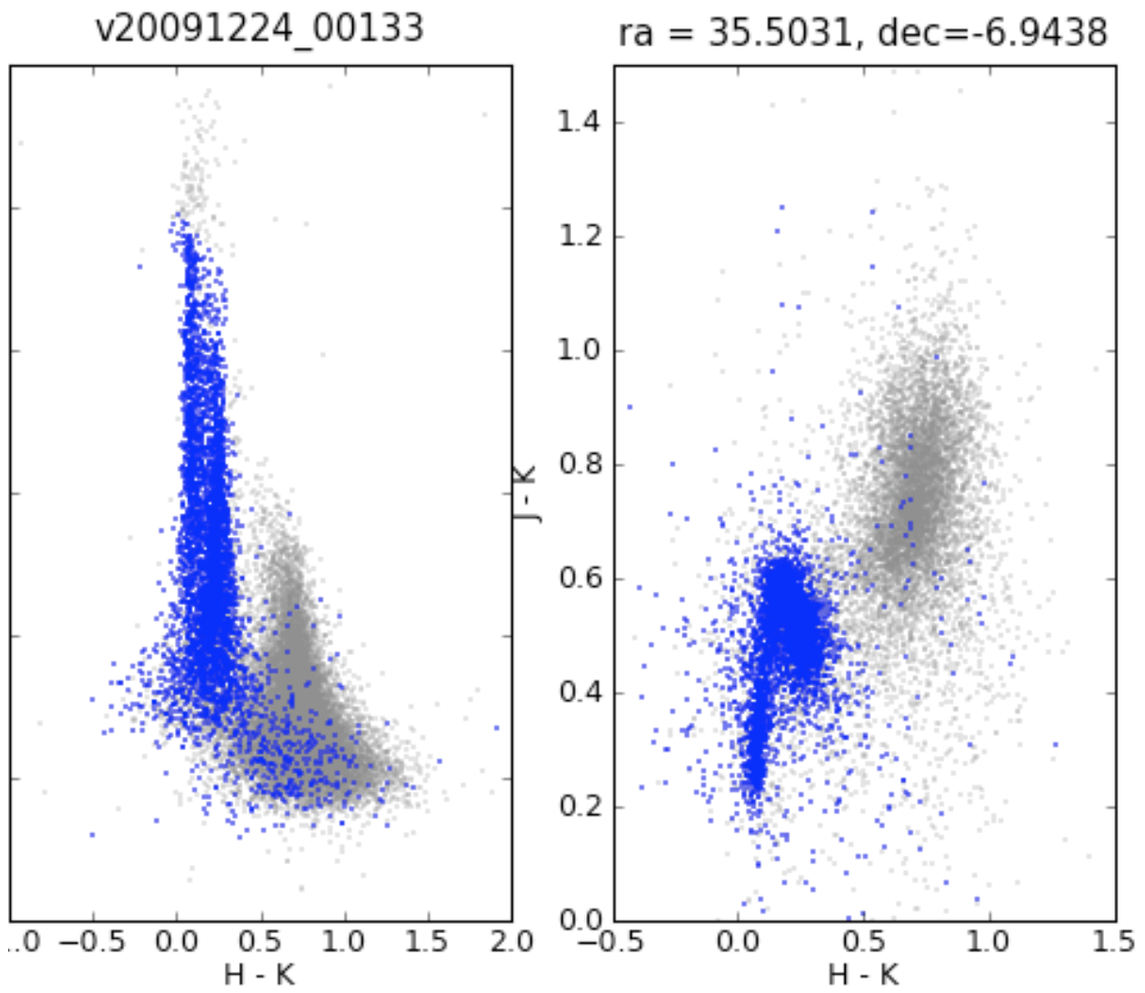
Tile vs Stack Photometry (after grouting)



Tile grouting



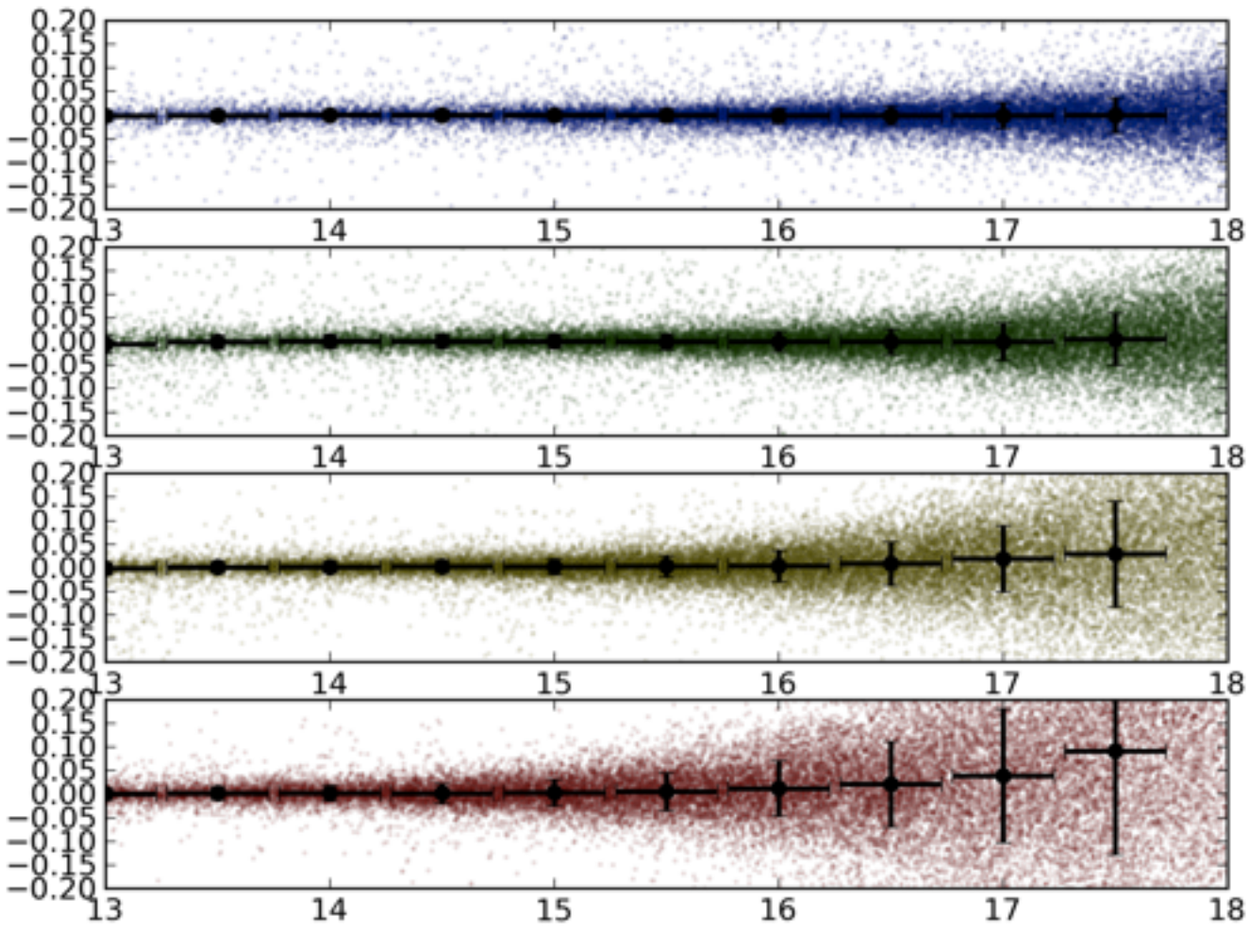
Before

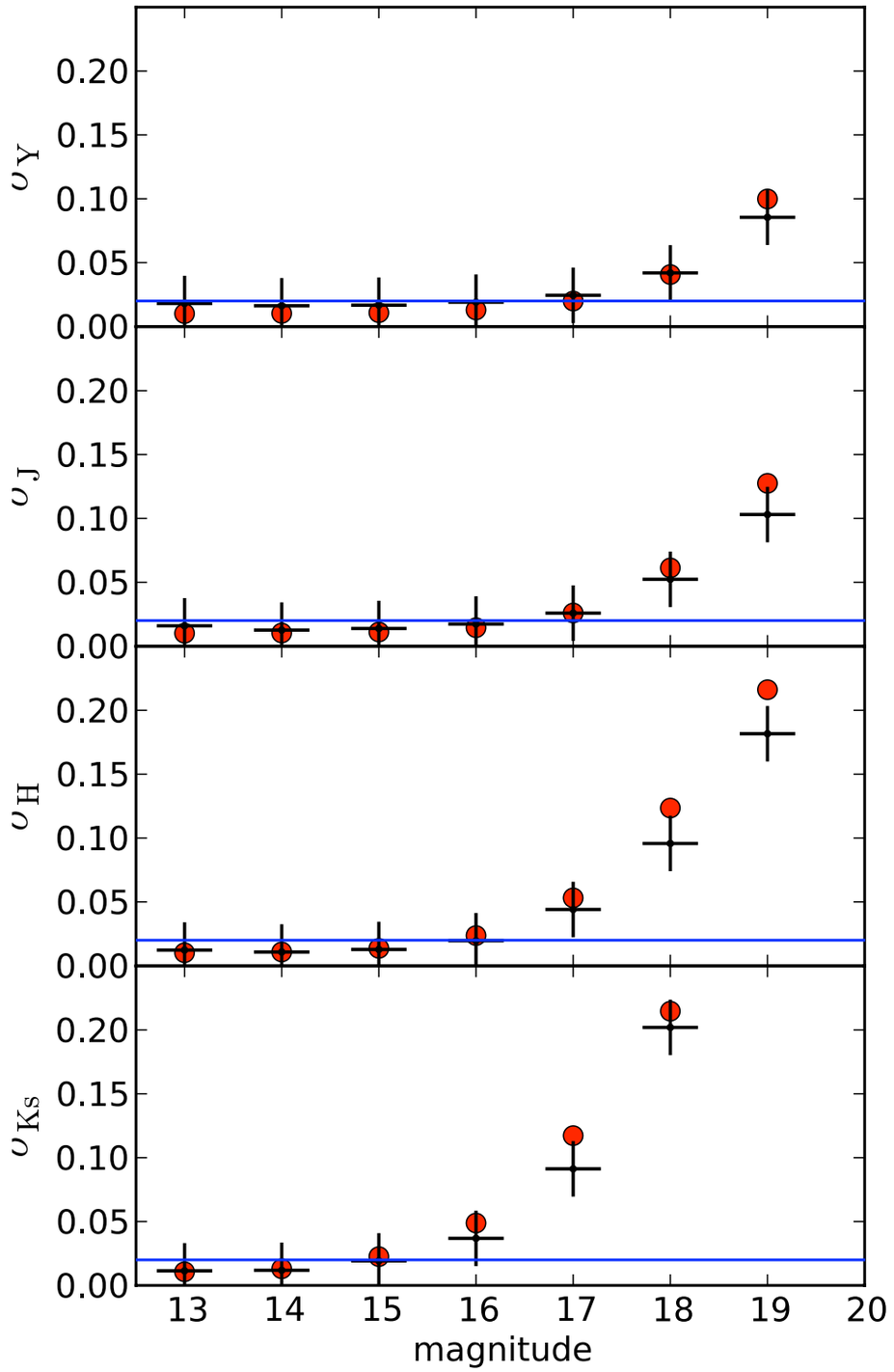


After

Verifying the magnitude calibration

(mainly using field overlaps)





VMC survey

SMC west

and 47Tuc

VMC survey

SMC west

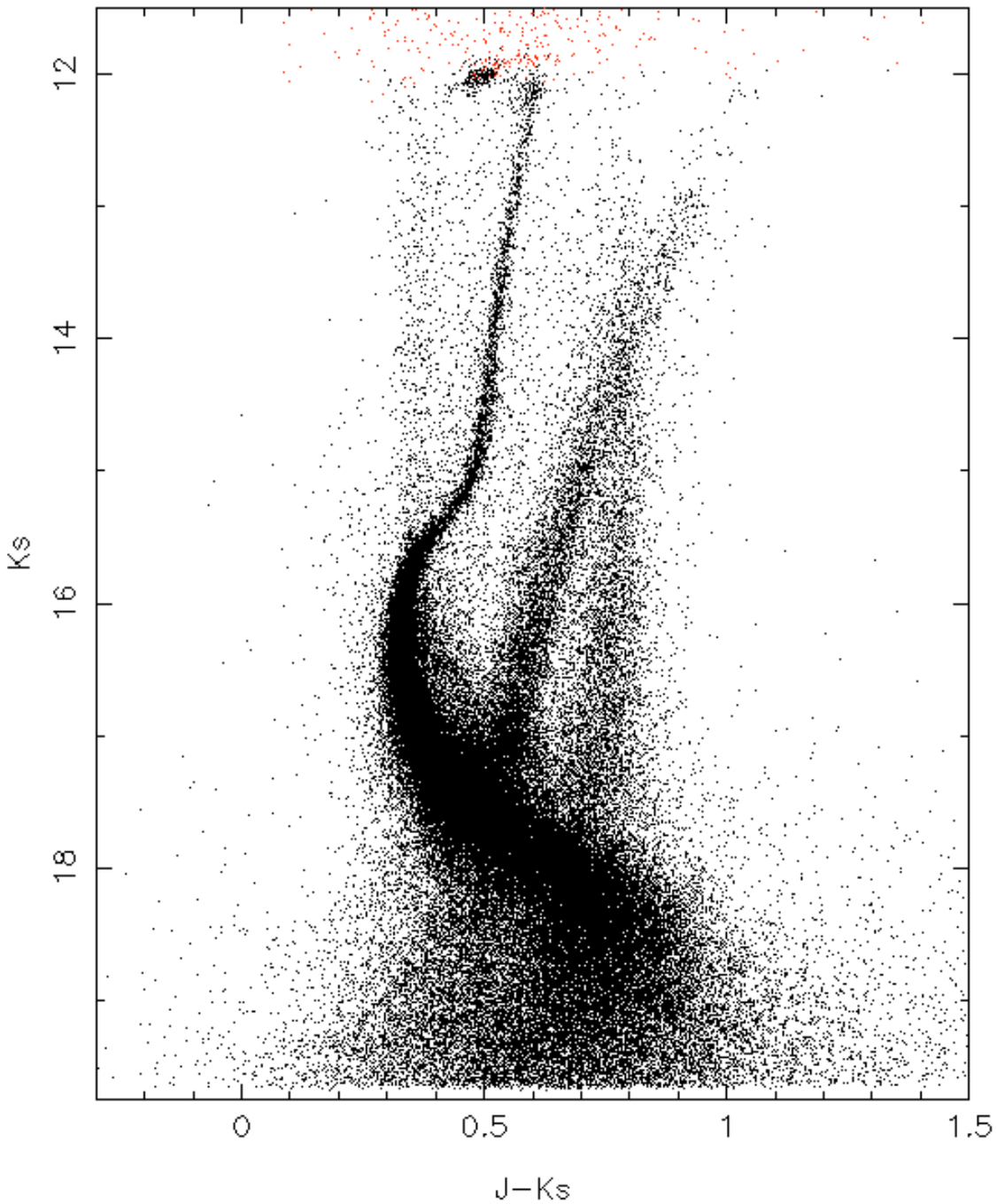
and 47Tuc

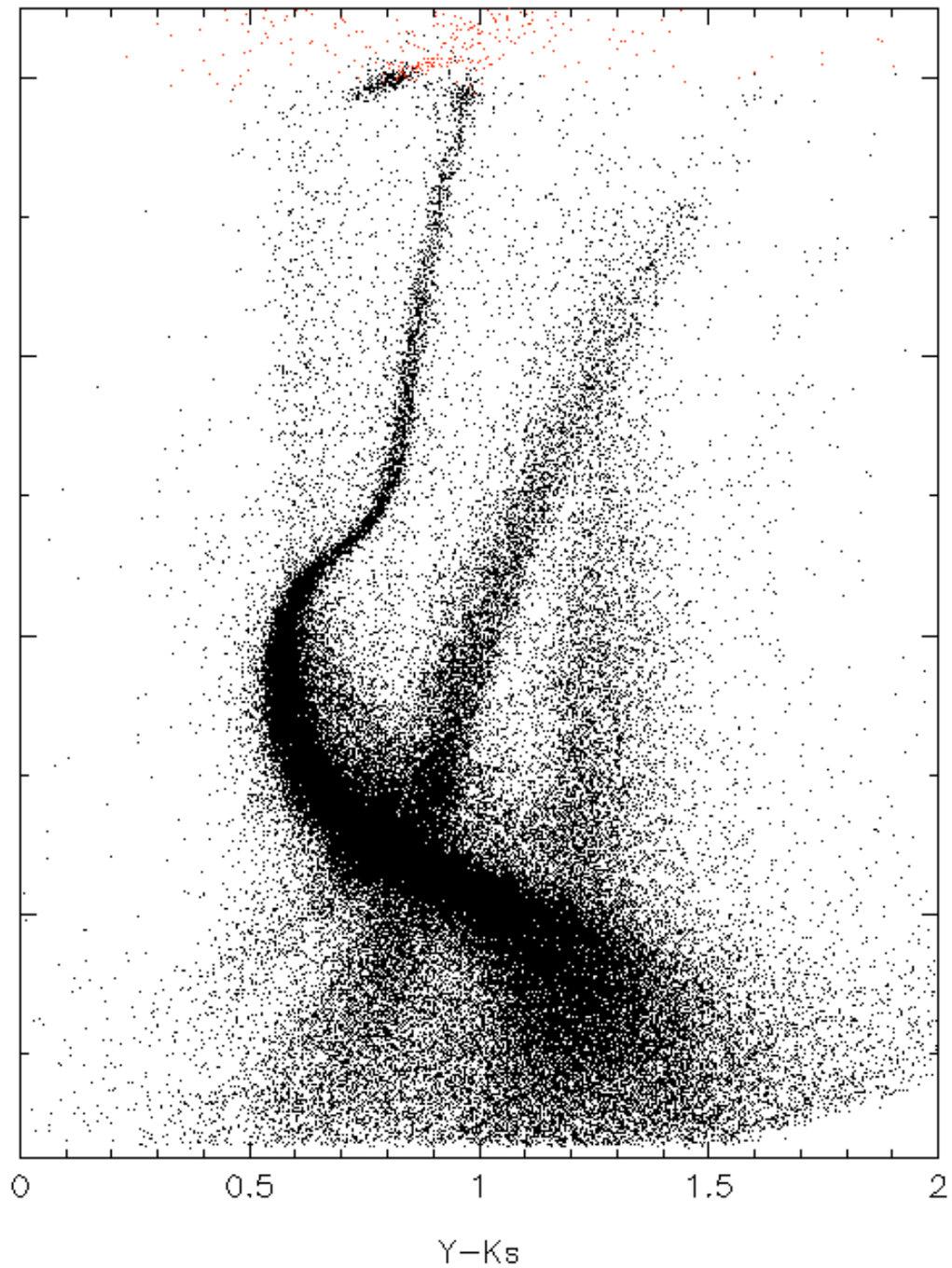
VMC survey

SMC west

and 47Tuc

VMC survey SMC west & 47Tuc -> pipeline CMD





VISTA data products