

CASU processing of VST data



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assessment and processing of VST science data

OmegaCAM

fov 1 deg x 1 deg

32 CCD mosaic
2k x 4k e2v 44-82
256 Mpixels

0.214 arcsec sampling

co-planar to +/-20um

r/o time 40s

r/o noise $6e^-$

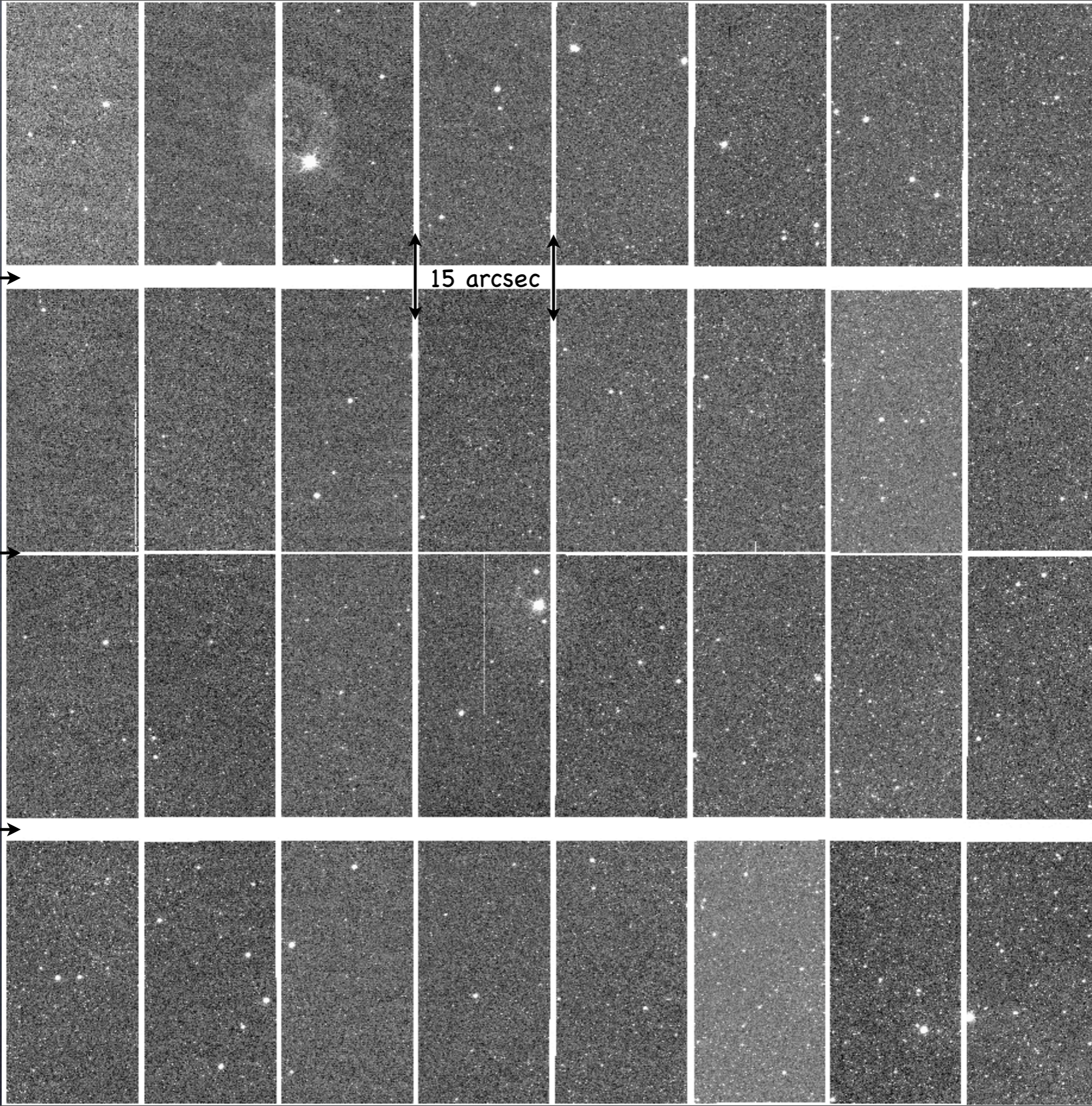
2 x 6 filter stack
changes 65s - 115s

gain $\sim 2.9e^-/ADU$

PA 0, 90, 180, 270



Array
gaps



80 arcsec

15 arcsec

10 arcsec

80 arcsec

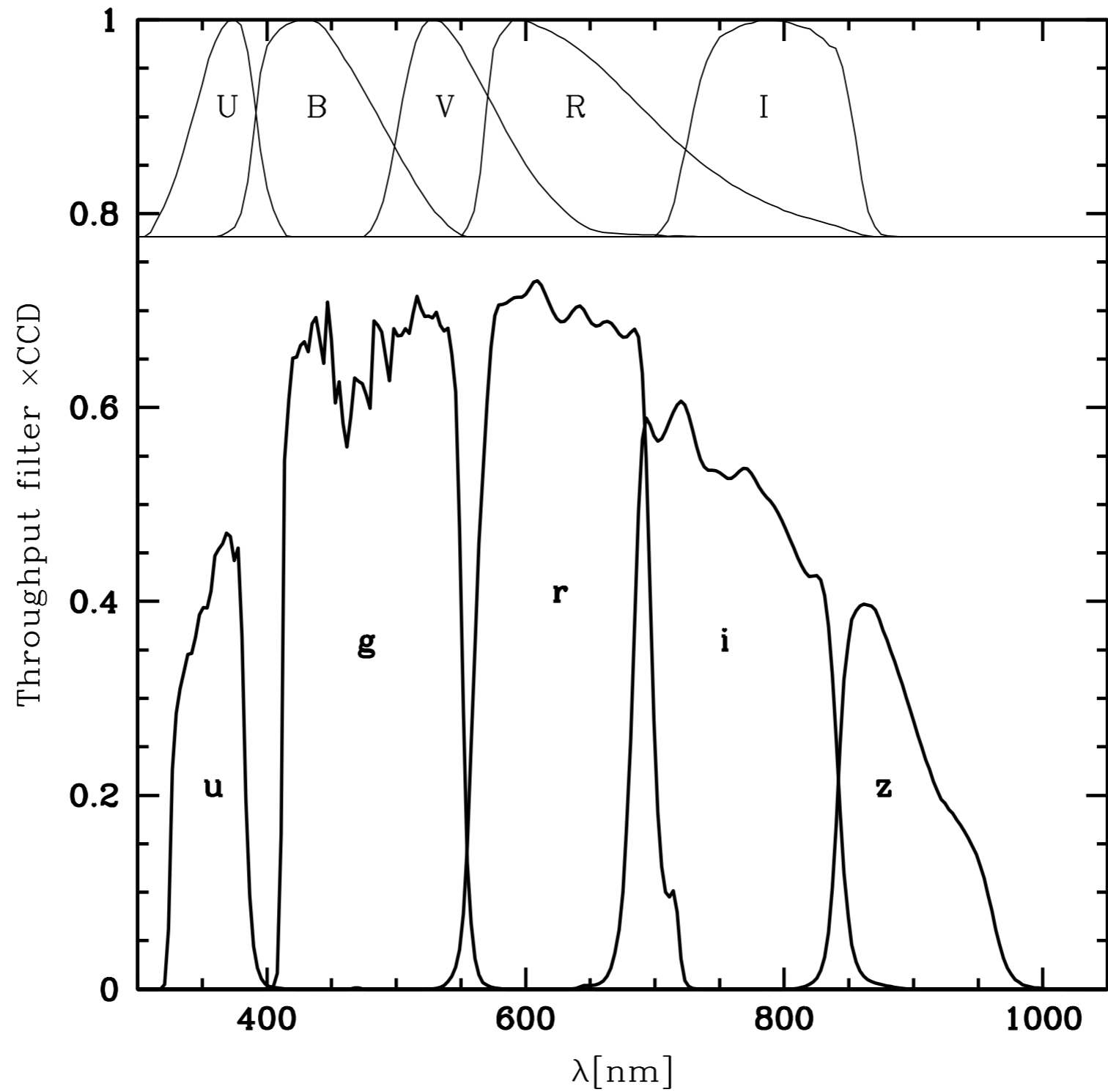


Figure 9: Throughput of the OmegaCAM Sloan filters, times the average quantum efficiency of the CCDs. For comparison the standard Johnson-Cousins UBVRI filters are also shown.

VST data flow

- raw data transfers via Internet
 - Rice-compressed MEFs 16-bit from ESO archive
 - ingest & verification → raw data archive
 - off-line tape backups
 - update calibration files as necessary
 - bias, fringe frames nightly, flatfields monthly
 - parallel nightly processing
 - astrometric & photometric calibration
 - band-merged science products
 - check derived QC info & sample of images
 - processing web page updates
 - ingest to post-processing database enables checks
 - FITS header contents, long-term trends
 - survey progress, data access
- <http://casu.ast.cam.ac.uk/surveys-projects/vst>

CASU mantra

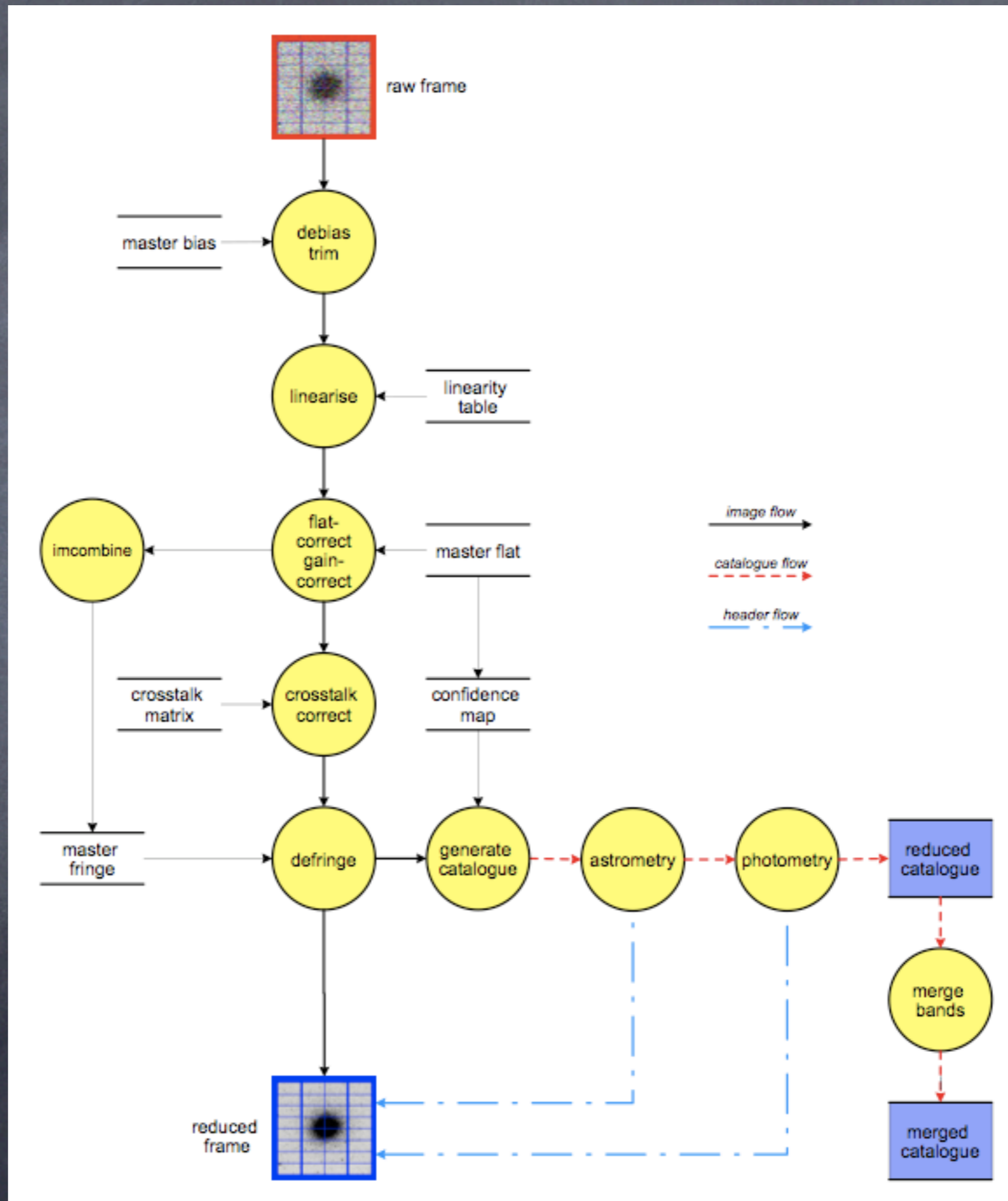
- MEFs as container -> simplifies bookkeeping
- use lossless Rice-compression -> (x 2-4 less space)
- FITS images and catalogue binary tables (CFITSIO)
- FITS headers record processing details
 - derived QC parameters
 - WCS astrometric calibration
 - photometric calibration
 - table/image fluxes in ADU, x,y positions
 - versioning and software details
- modular software -> C & perl/python scripts
- minimise external software dependencies

Data products

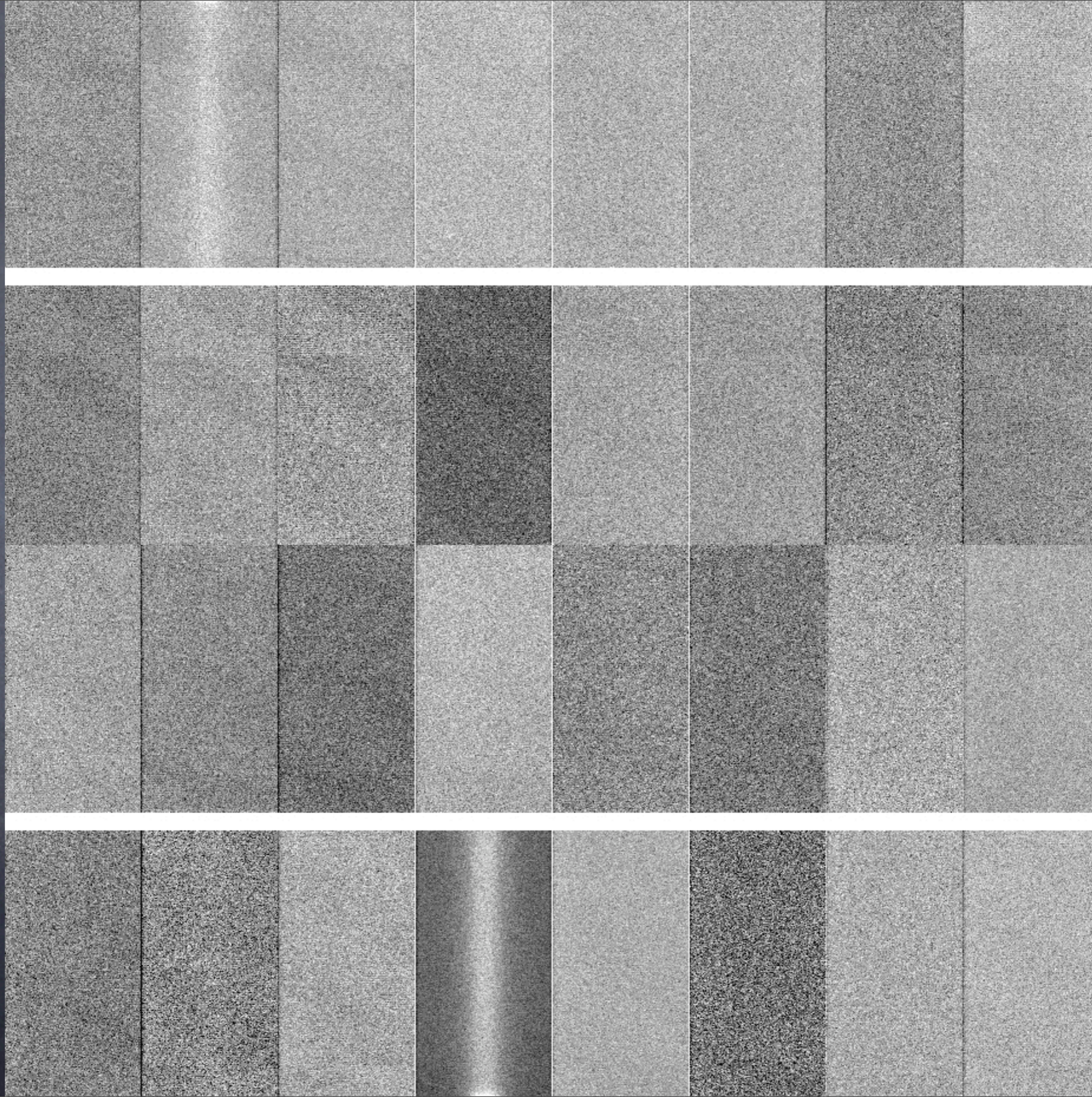
- calibrated images & catalogues for single exposures
- confidence maps (weight, exposure, bad pixels)
- QC information for each detector/exposure
- [deep stacked images, tiles and catalogues if needed]
- homogeneous band-merged catalogues
- federation with 2MASS PSC, WFCAM, VISTA
- database of all derived information, QC, logs
- assorted analysis assessment plots (CMDs), spatial distributions

VST processing schema

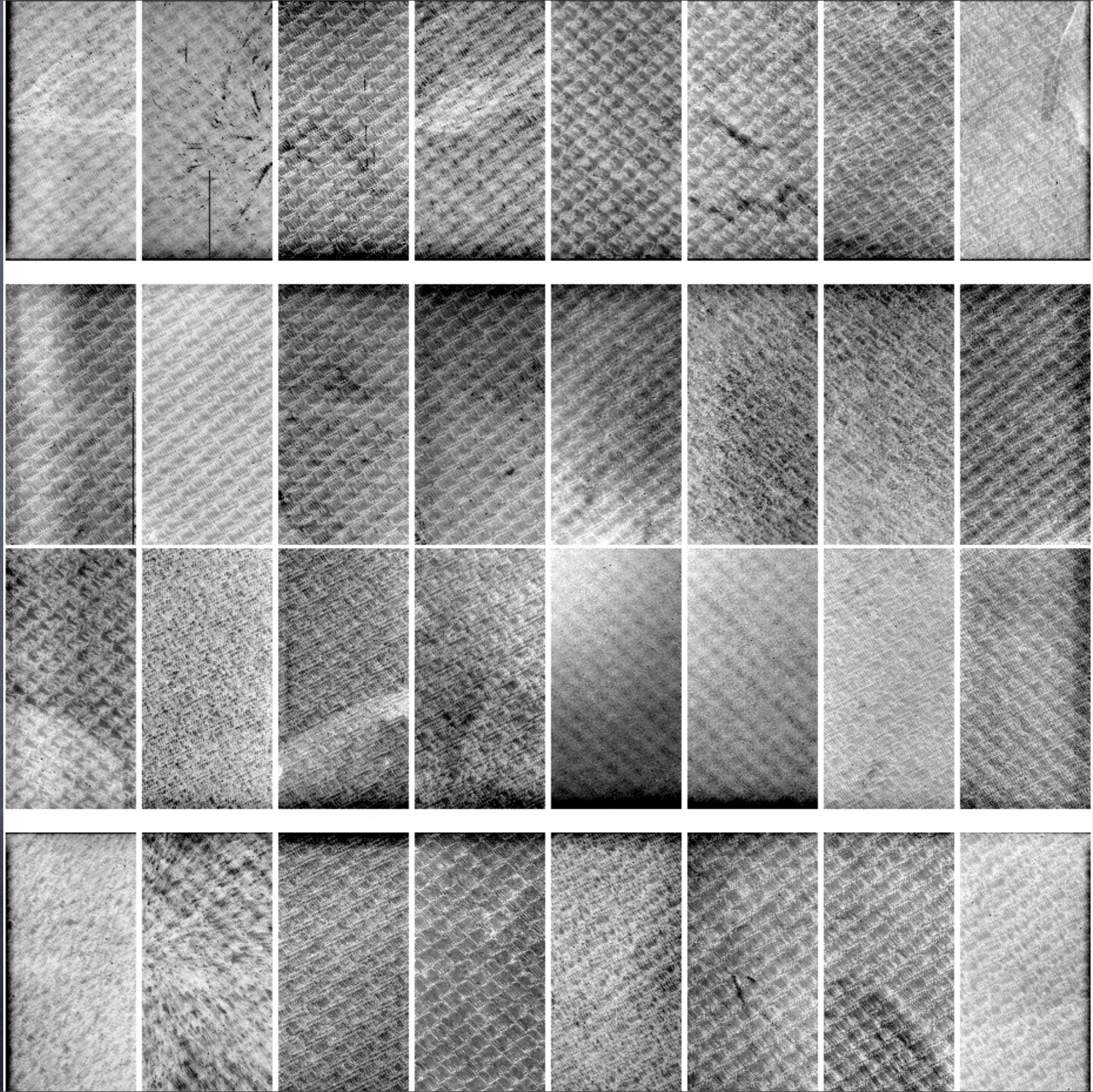
[pre-commissioning plan
based on processing
for other optical
mosaic cameras]



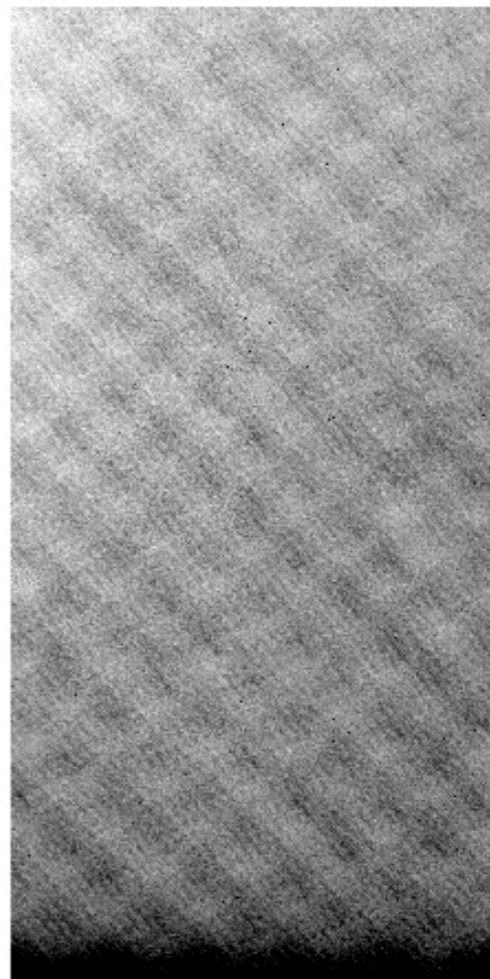
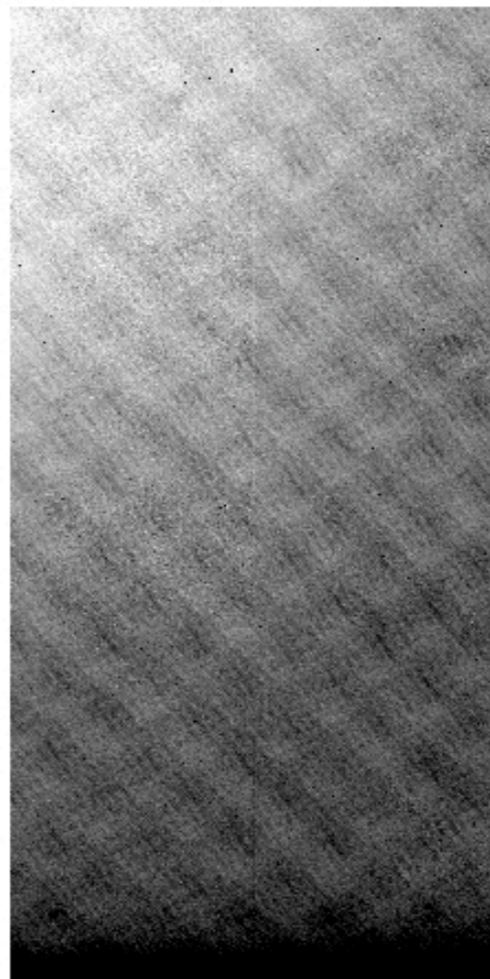
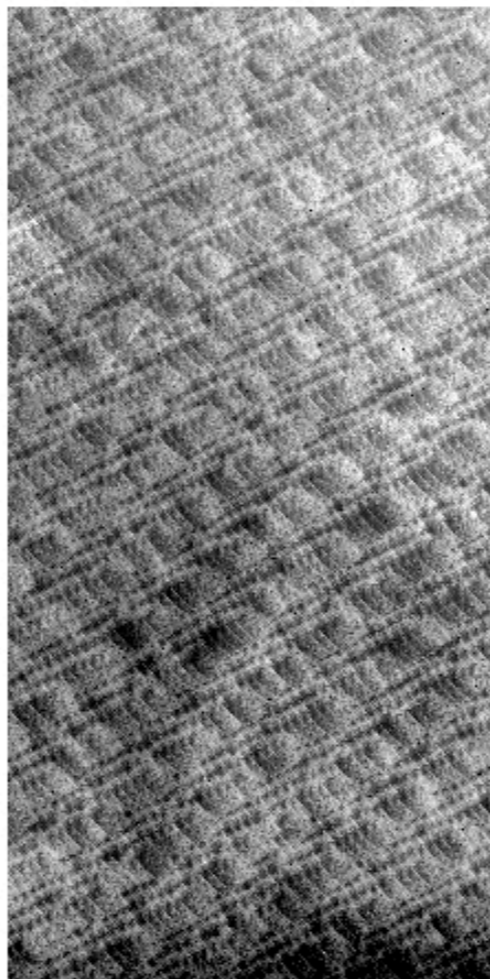
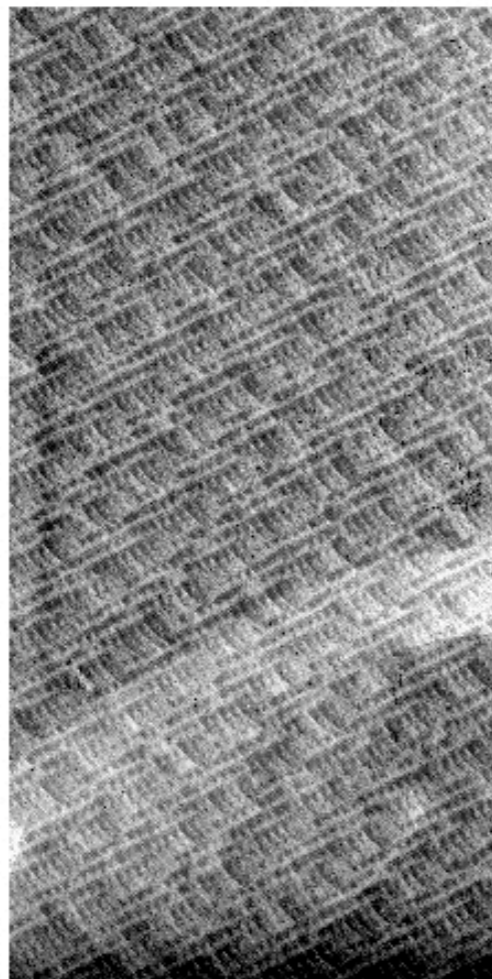
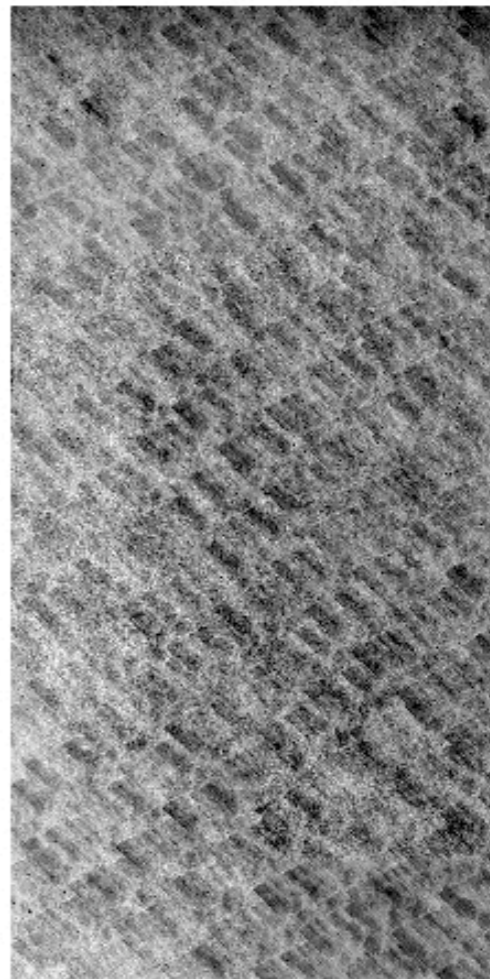
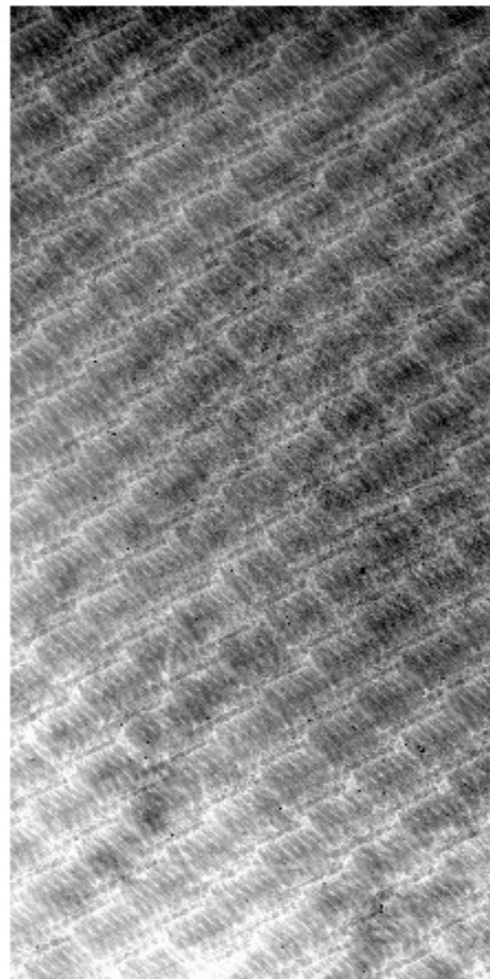
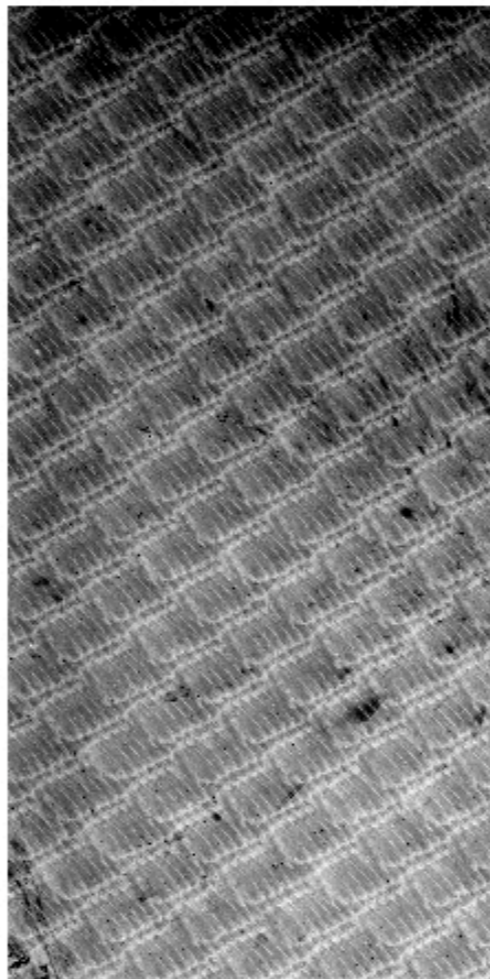
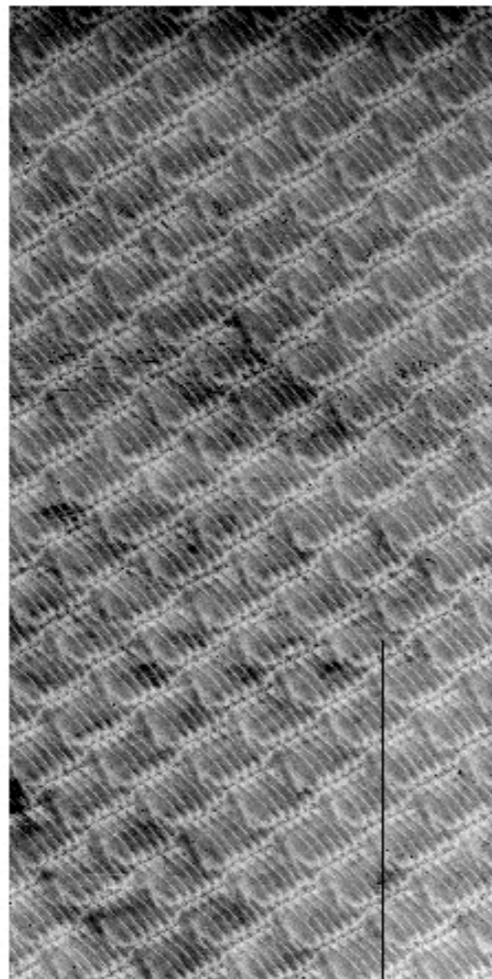
bias
frame



u-band
flat



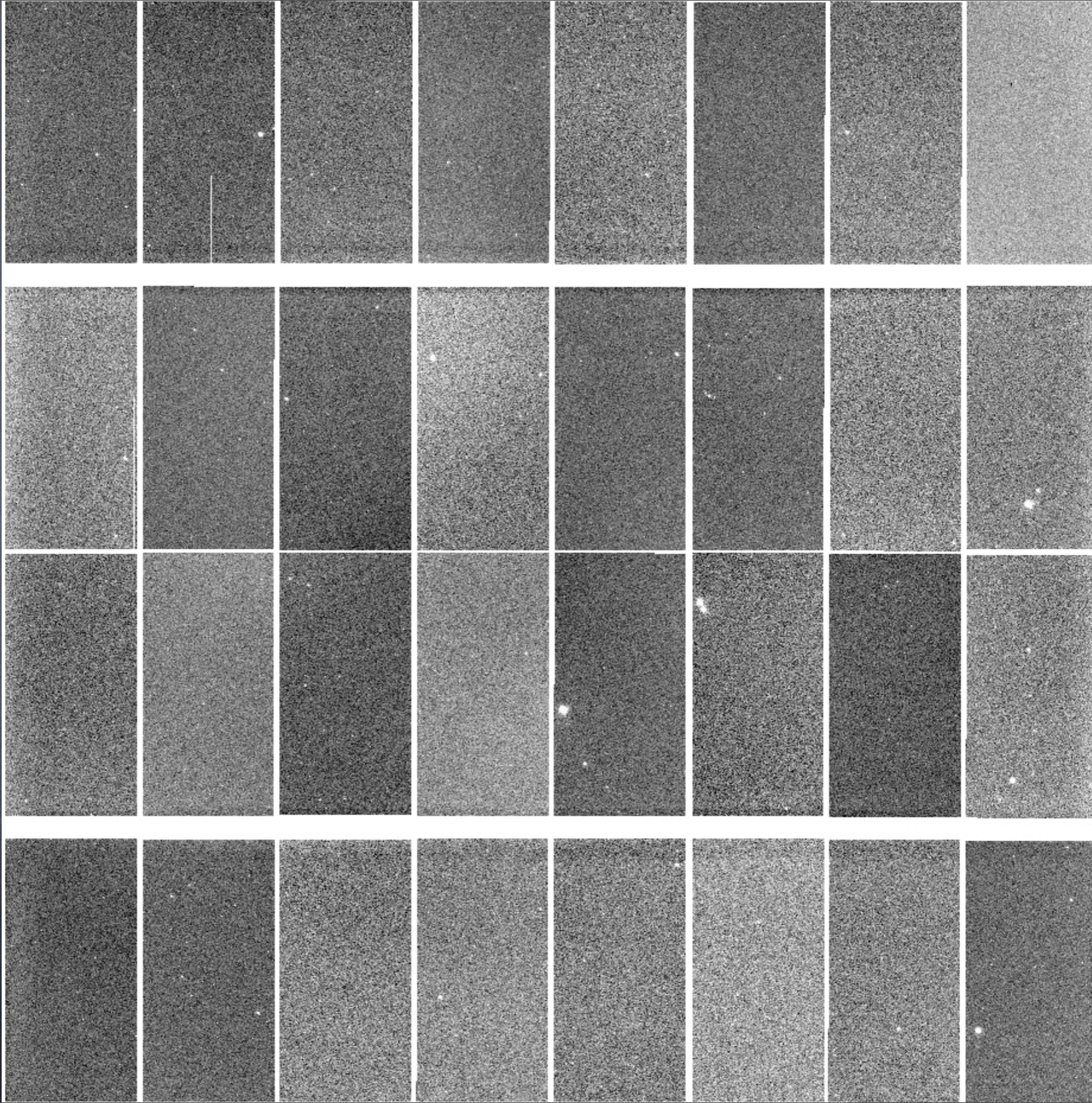
u-band
flat



u-band
processed
images

SA110

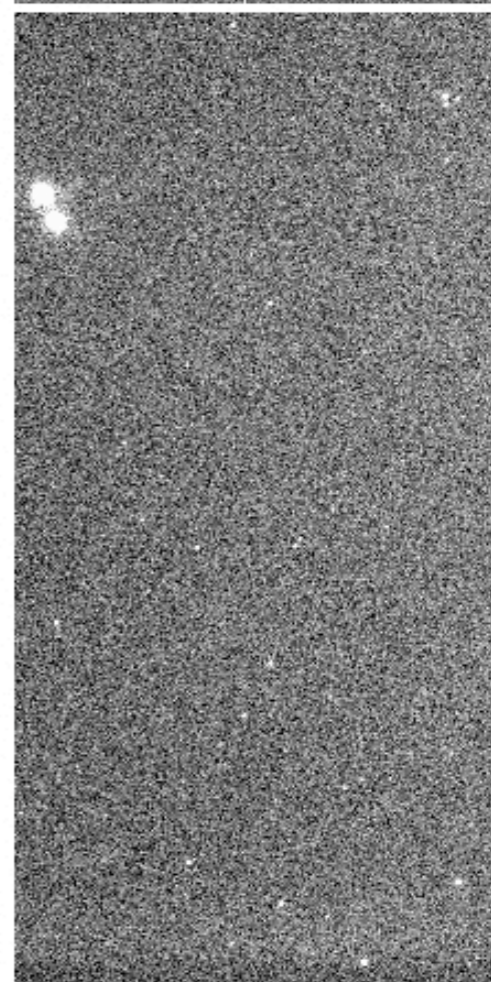
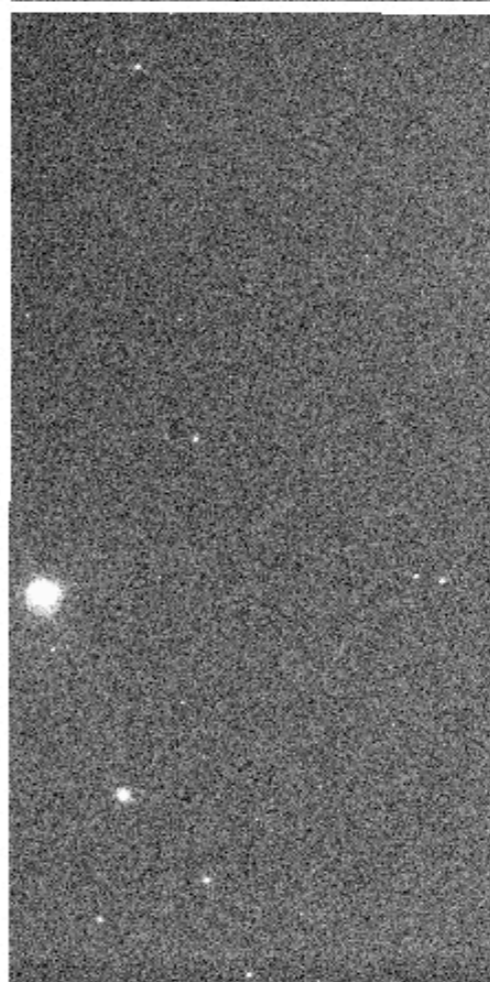
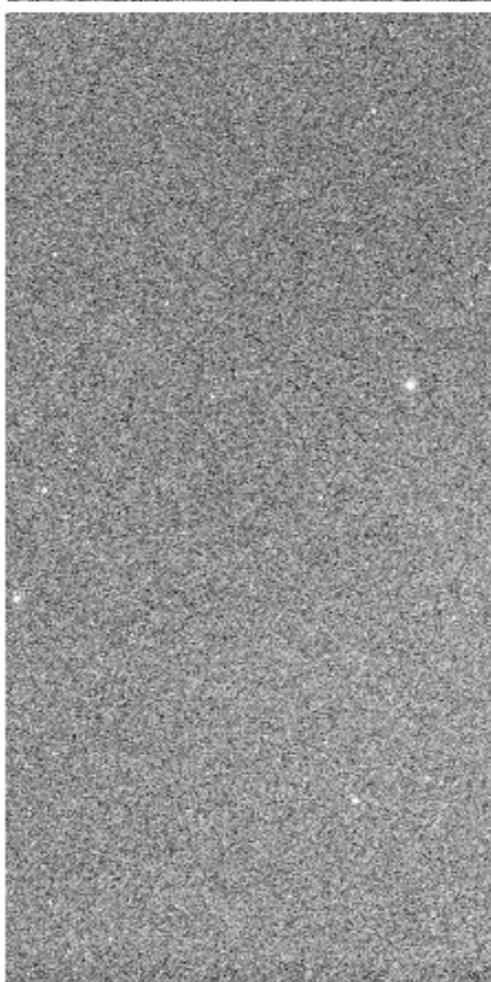
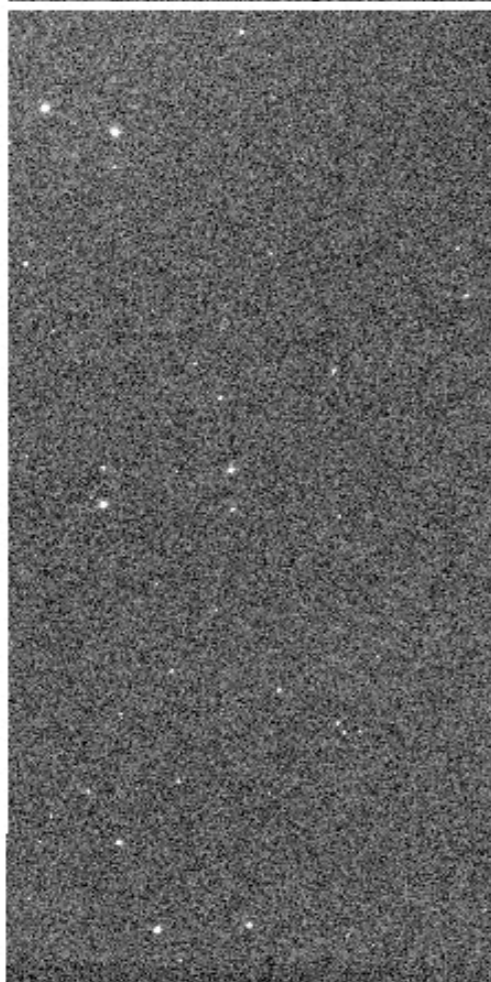
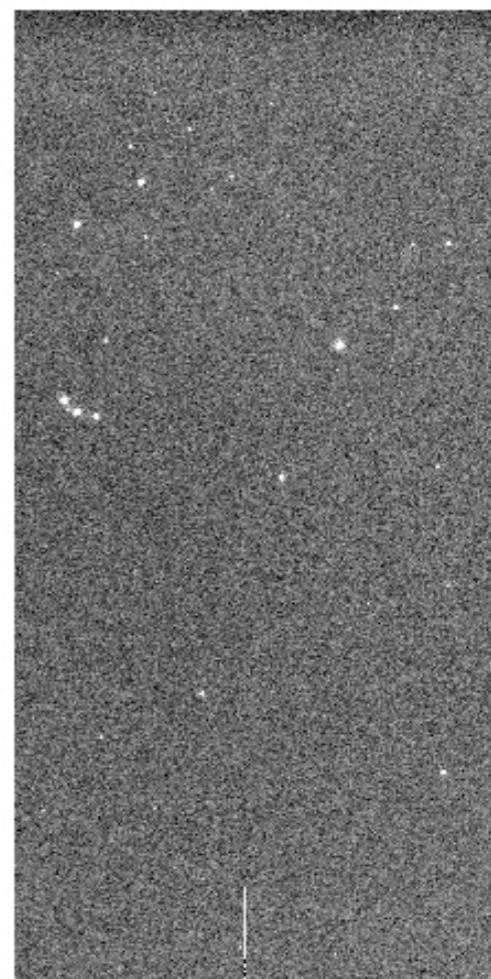
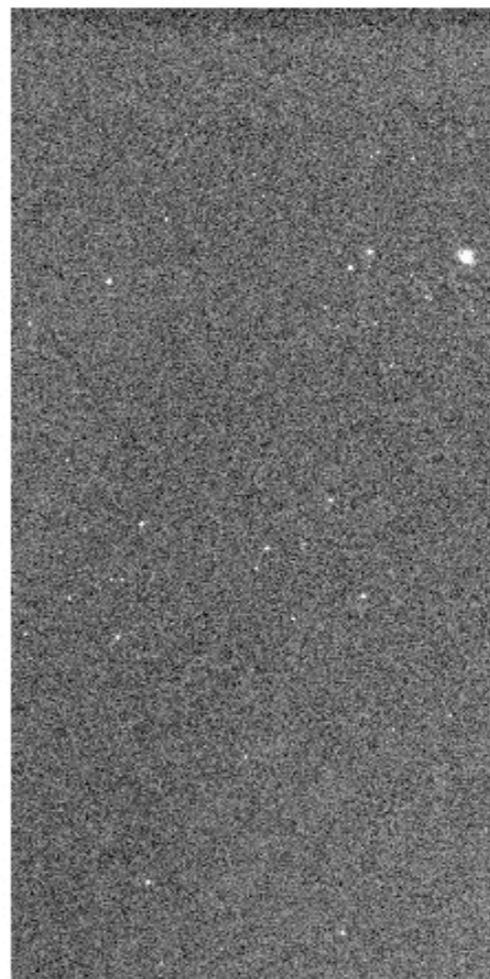
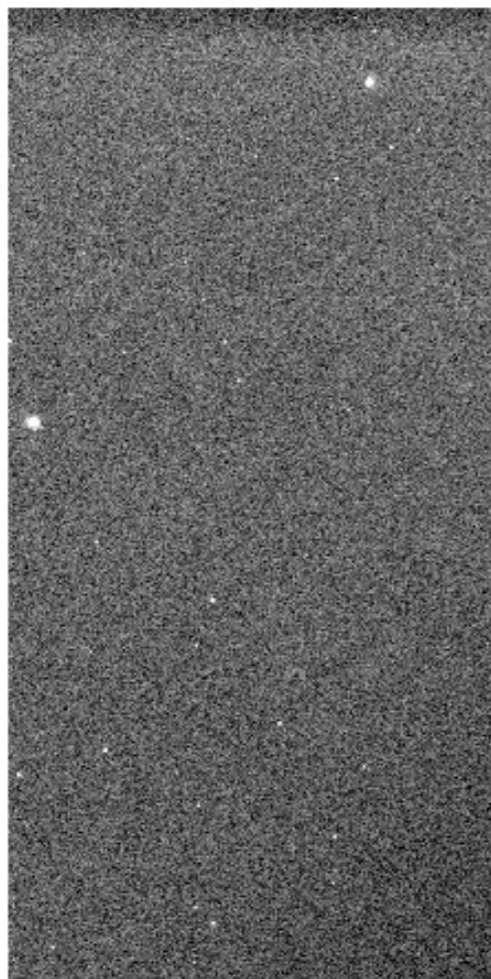
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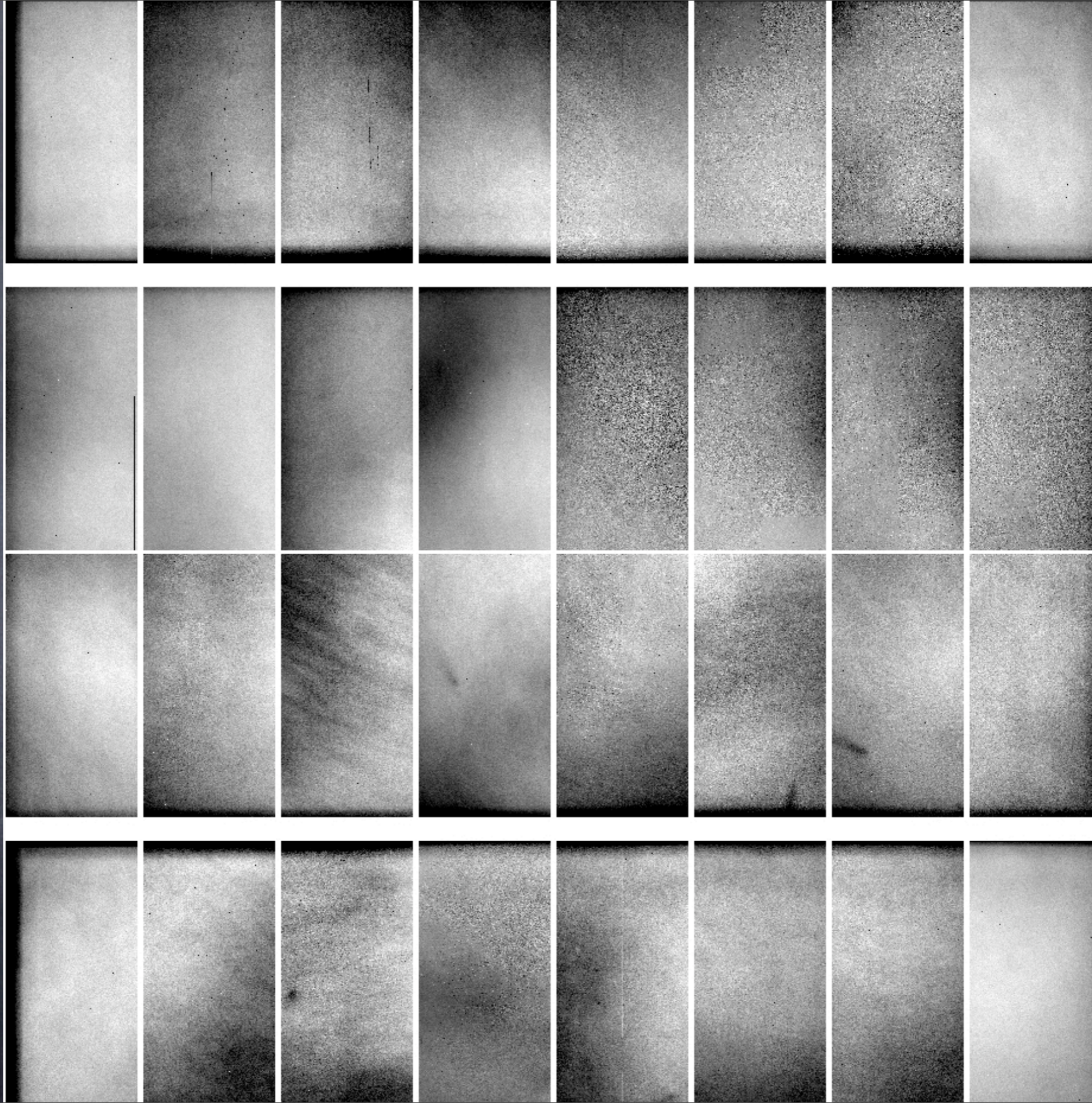
u-band
processed
images

SA110

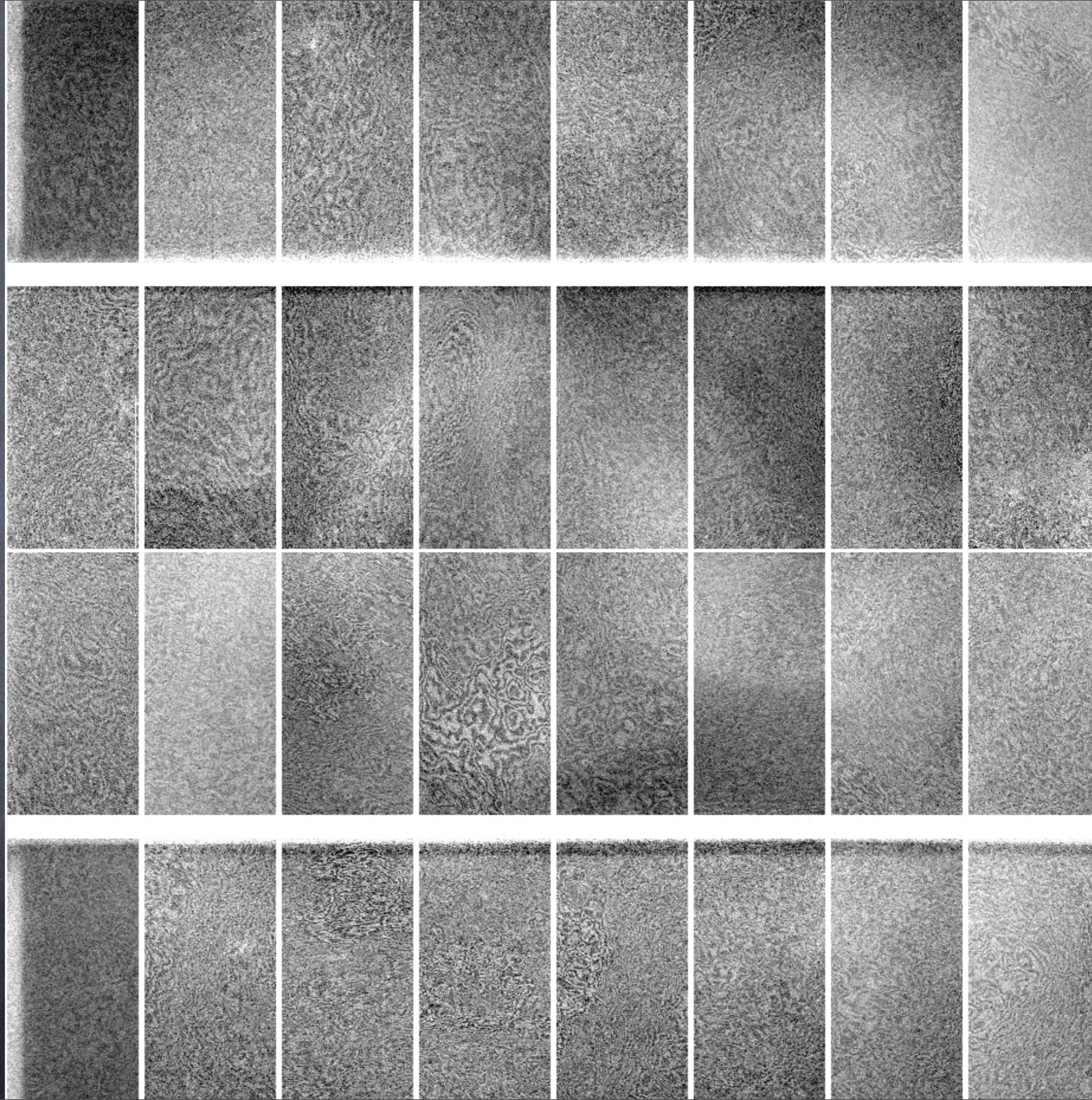
$t = 240s$



i_flat
&
i_fringe



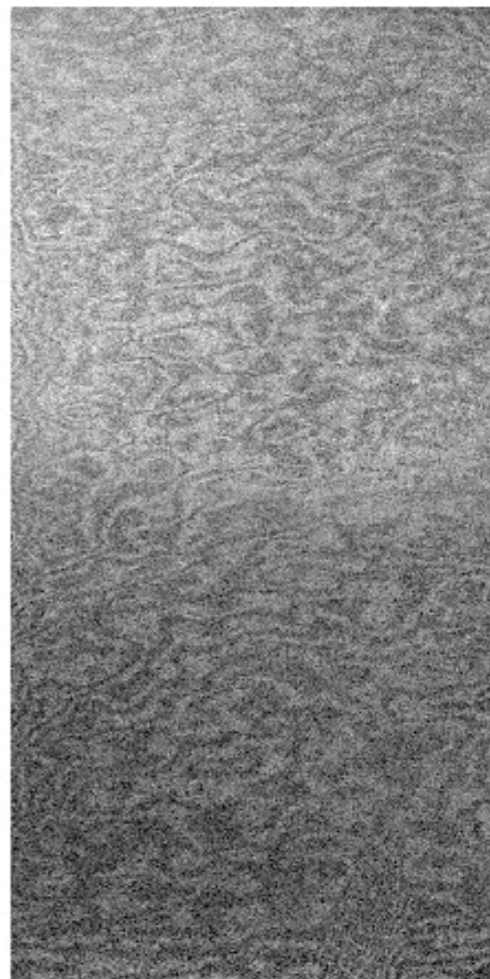
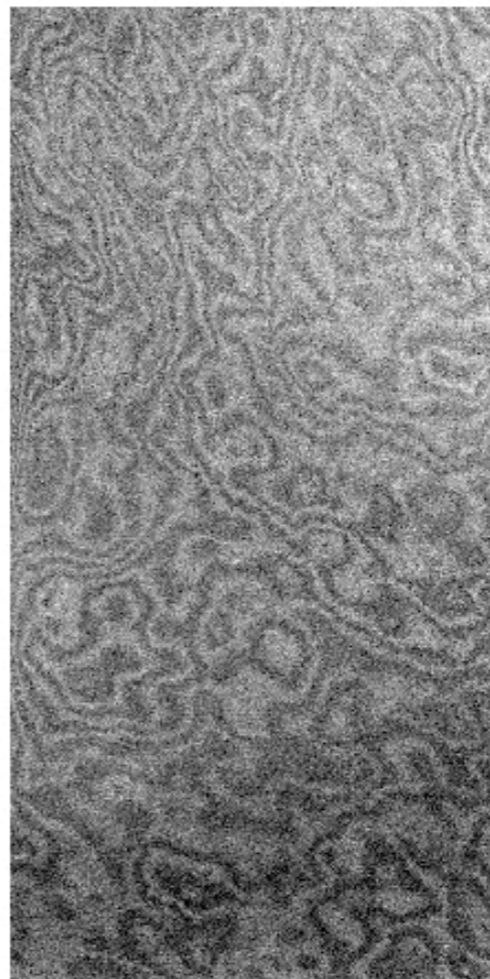
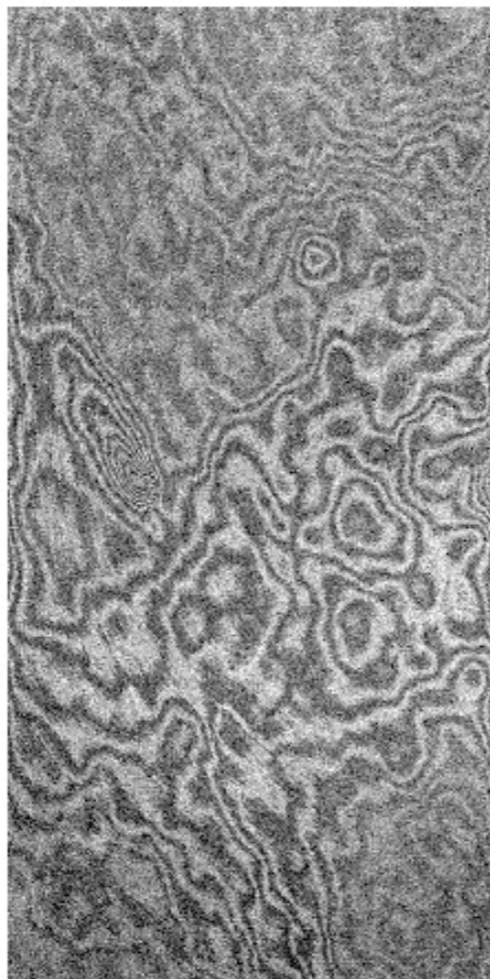
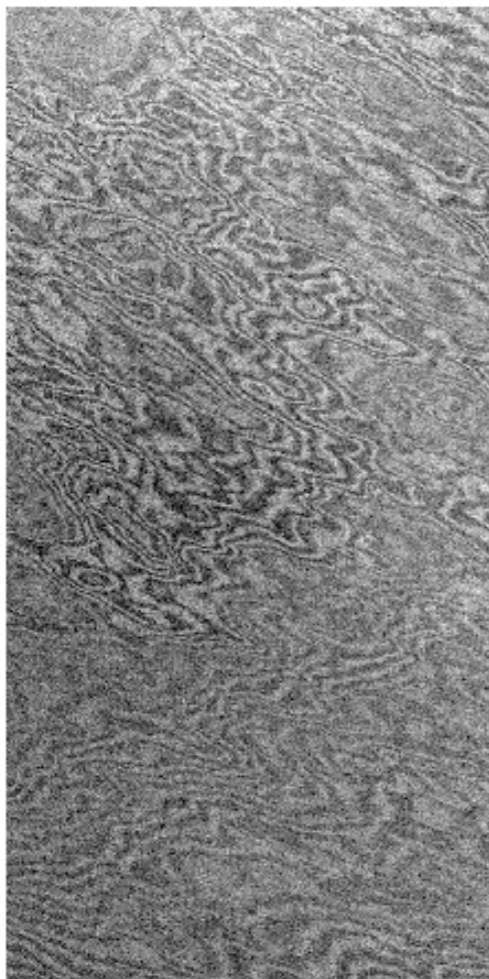
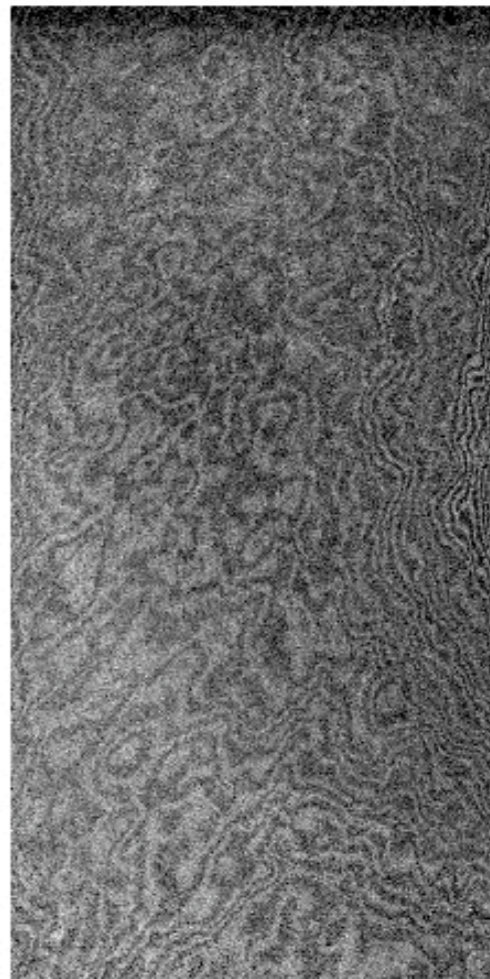
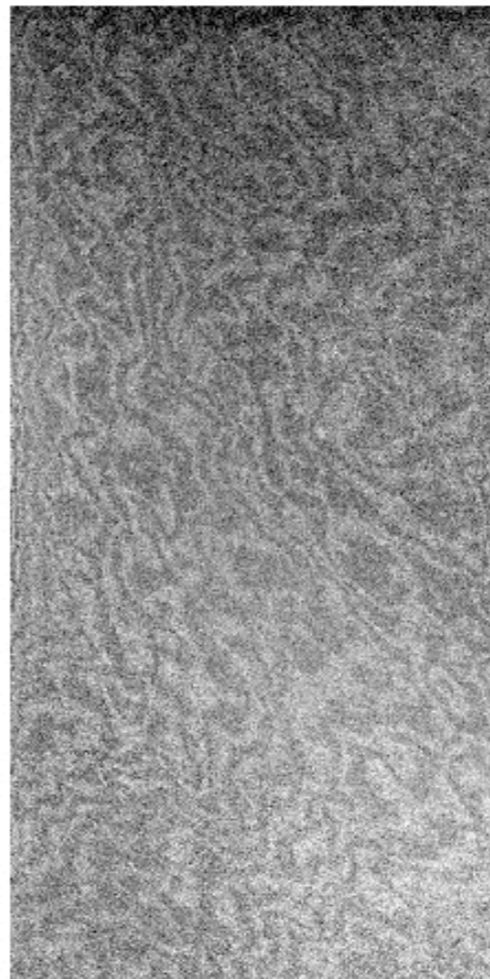
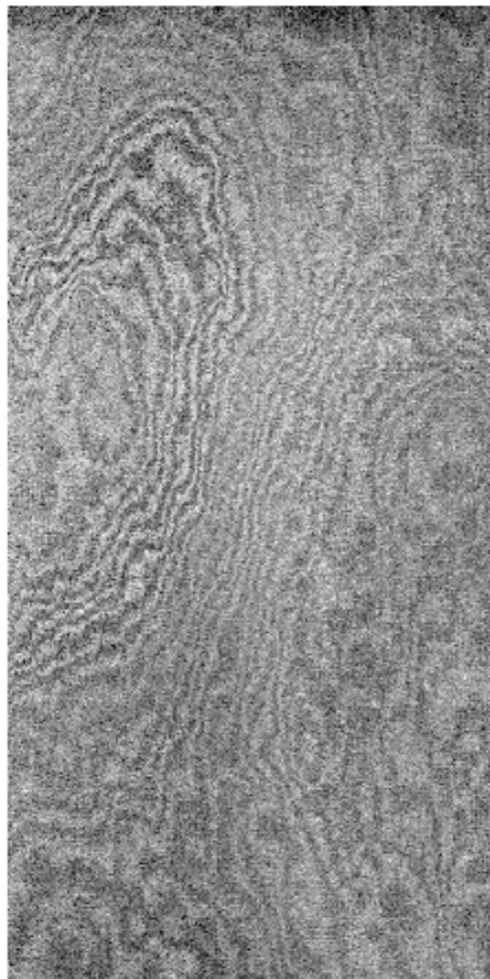
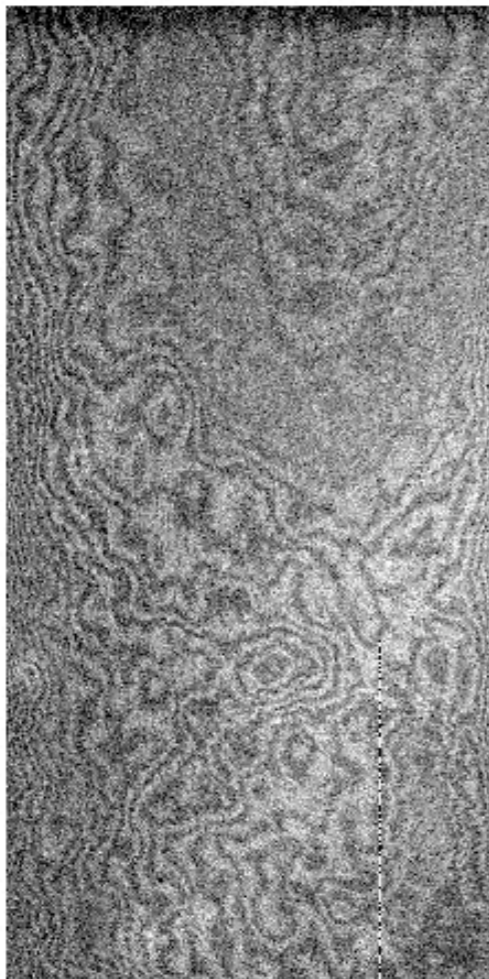
i_flat
&
i_fringe



i_flat

&

i_fringe

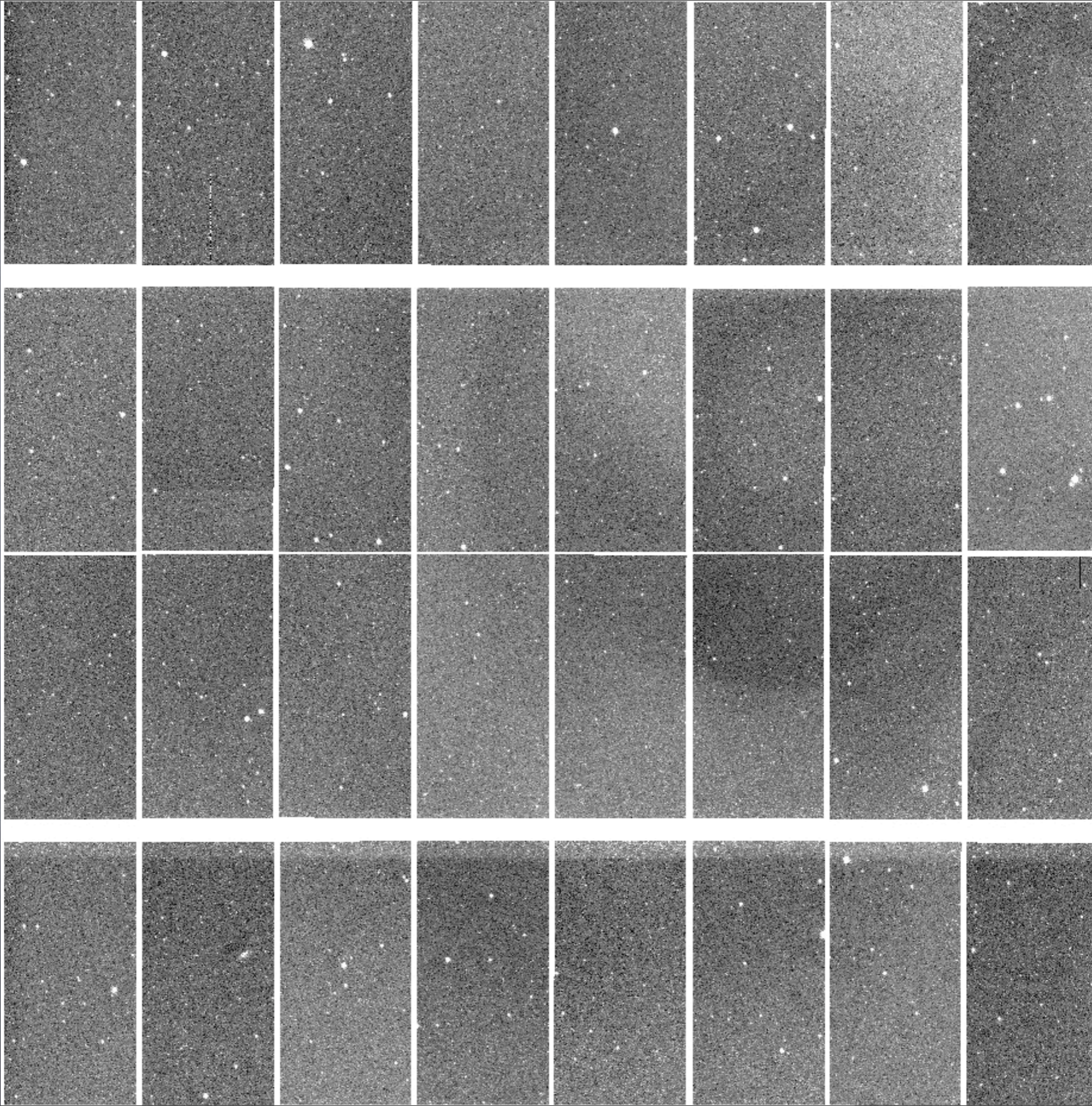


i_science

@

Dec = -89

t = 115s

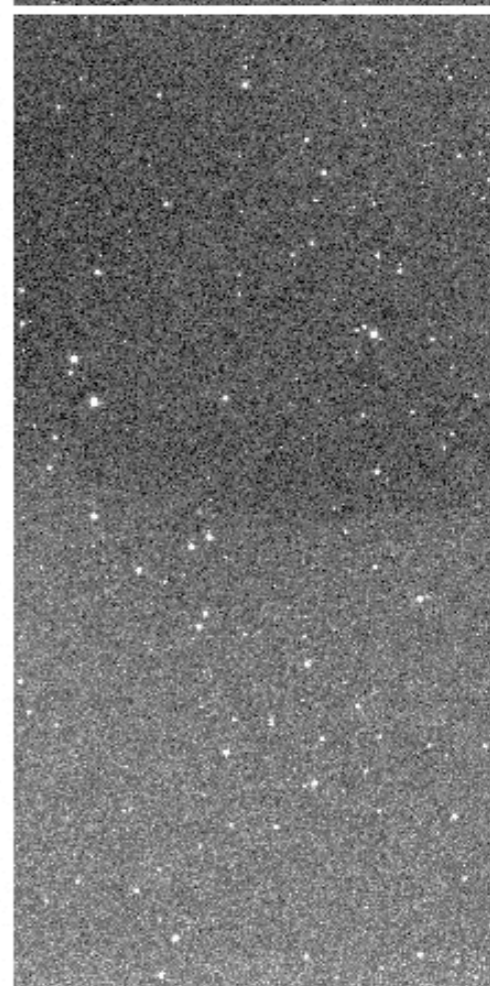
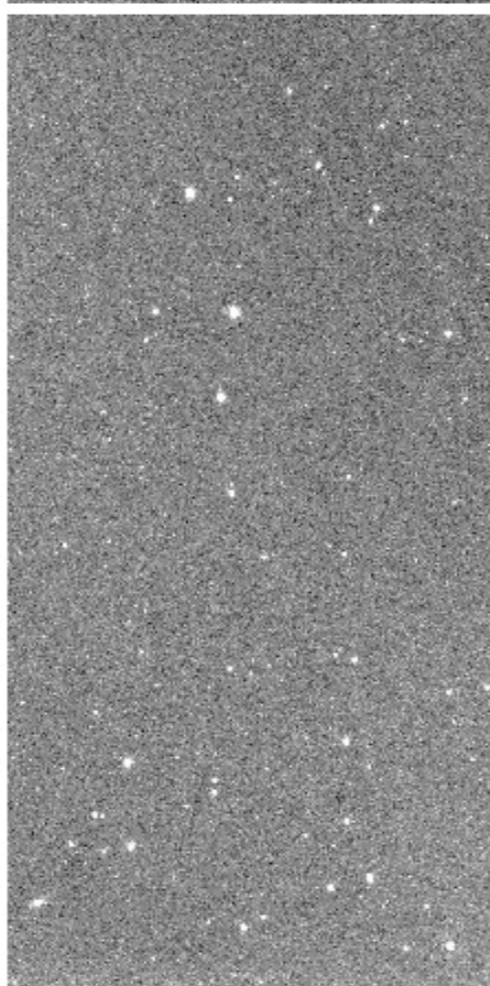
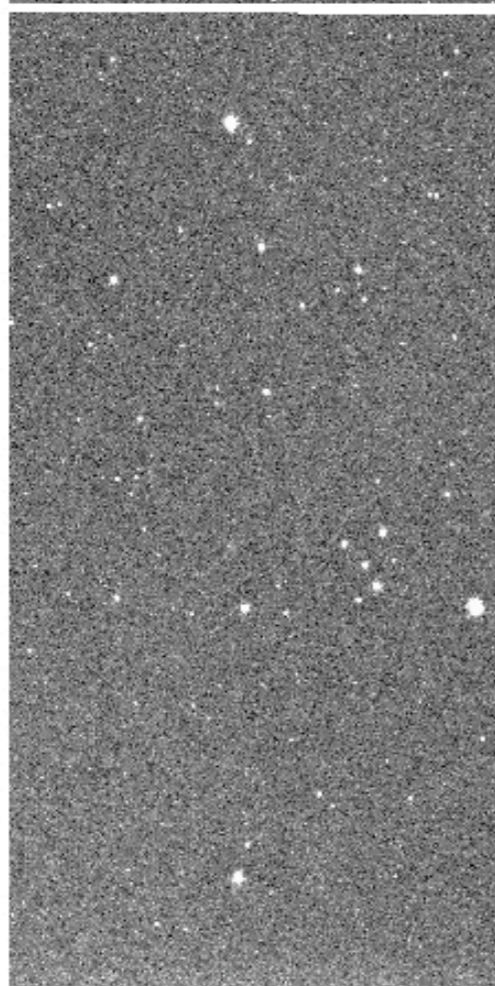
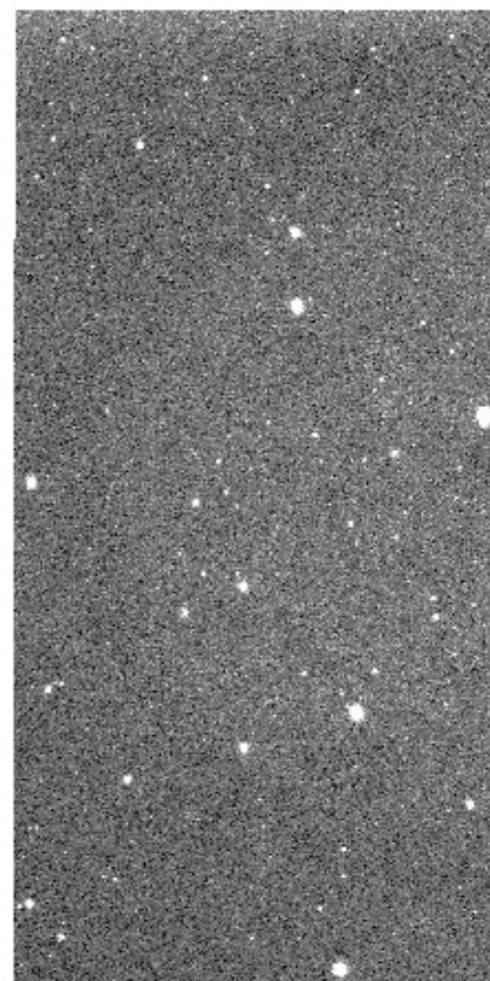
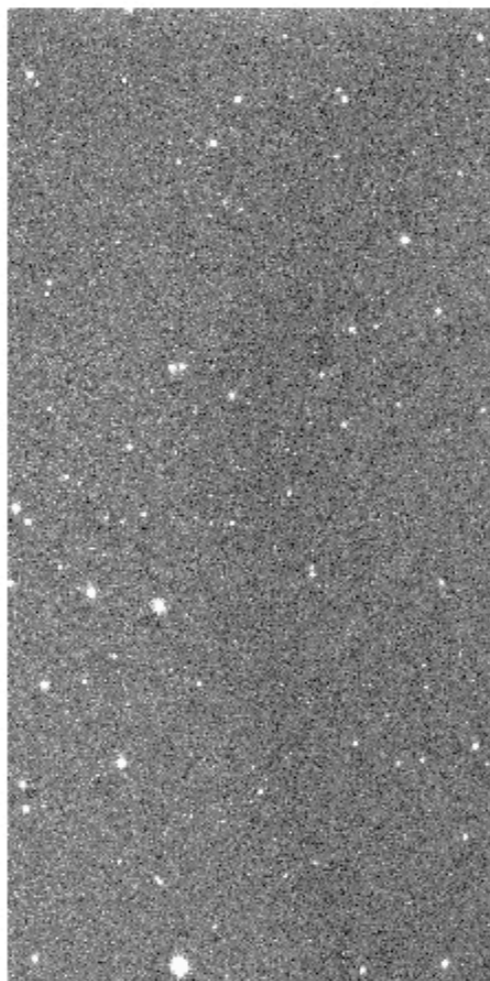


i_science

@

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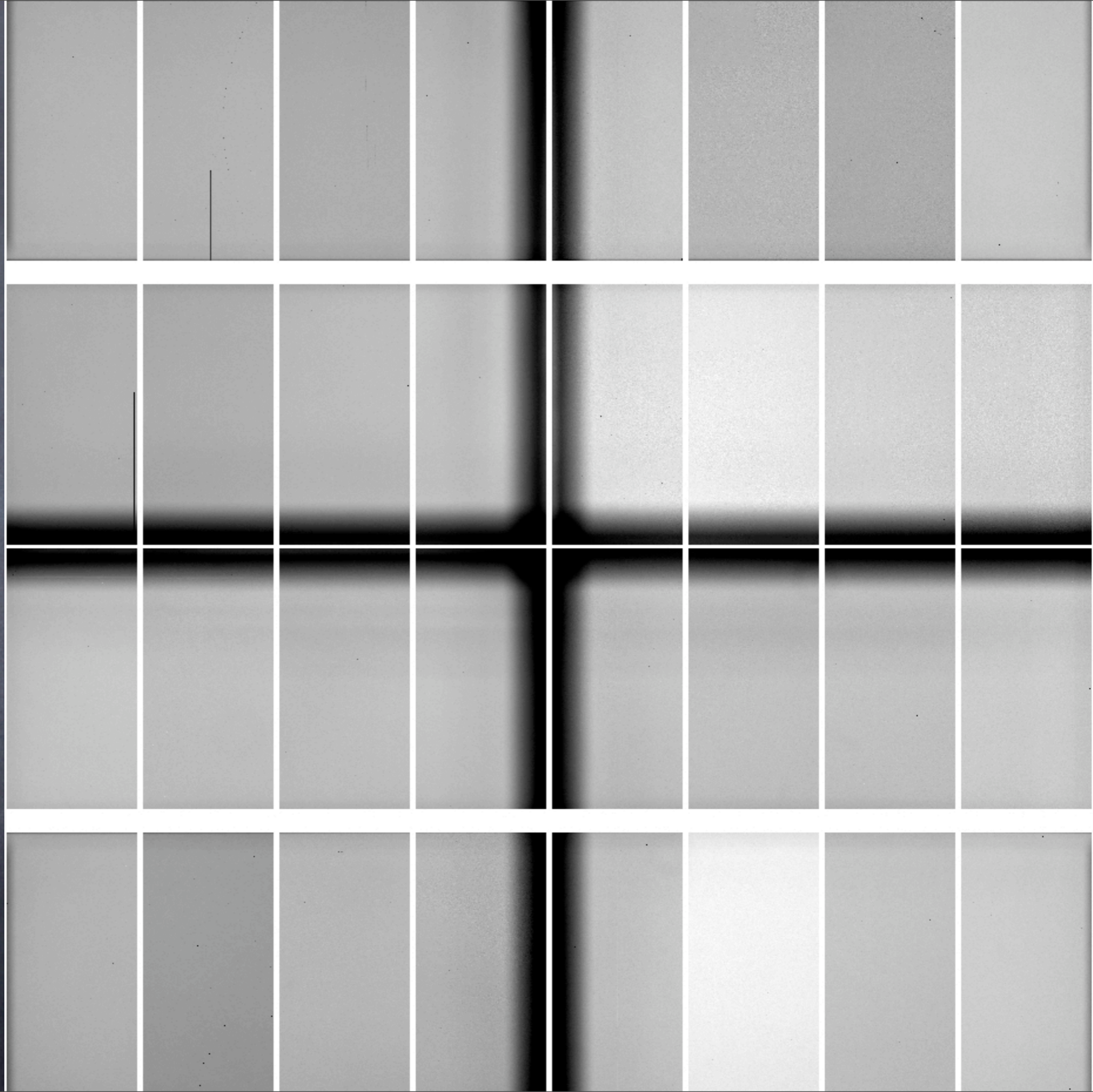
t = 115s



Halpha
flats &
images

SA110

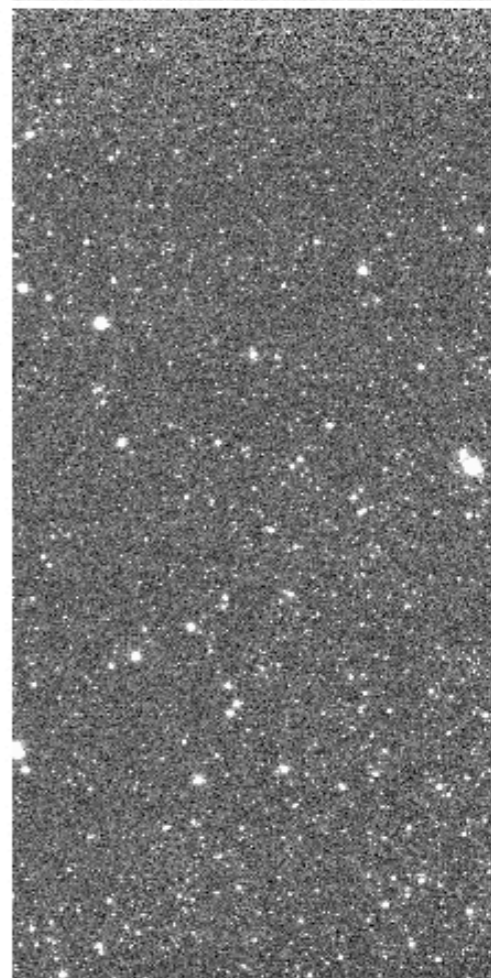
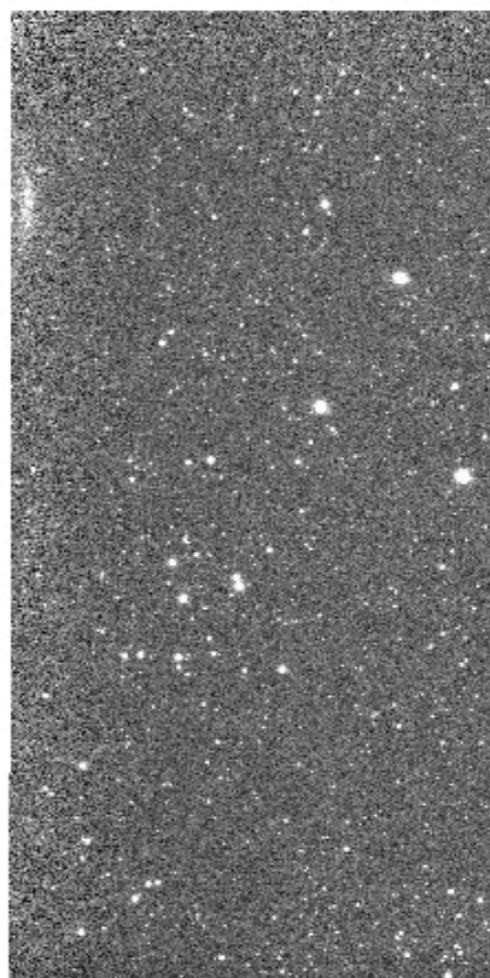
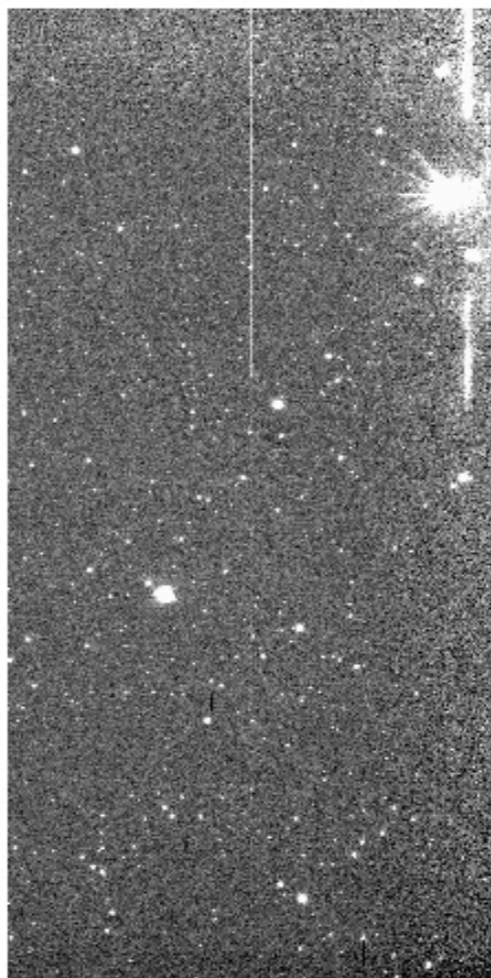
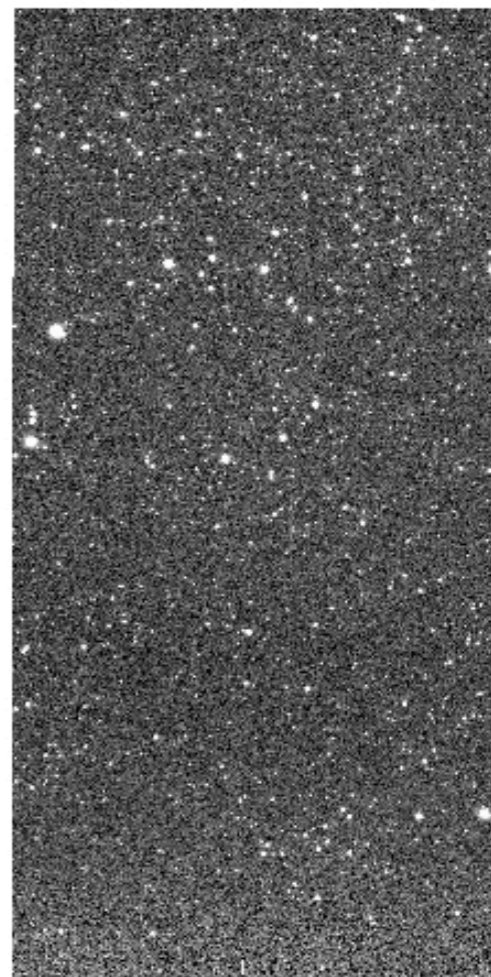
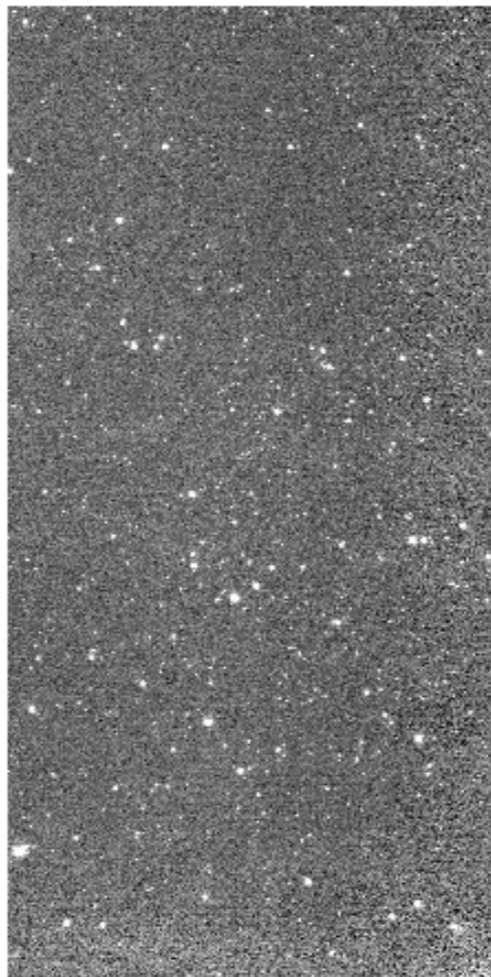
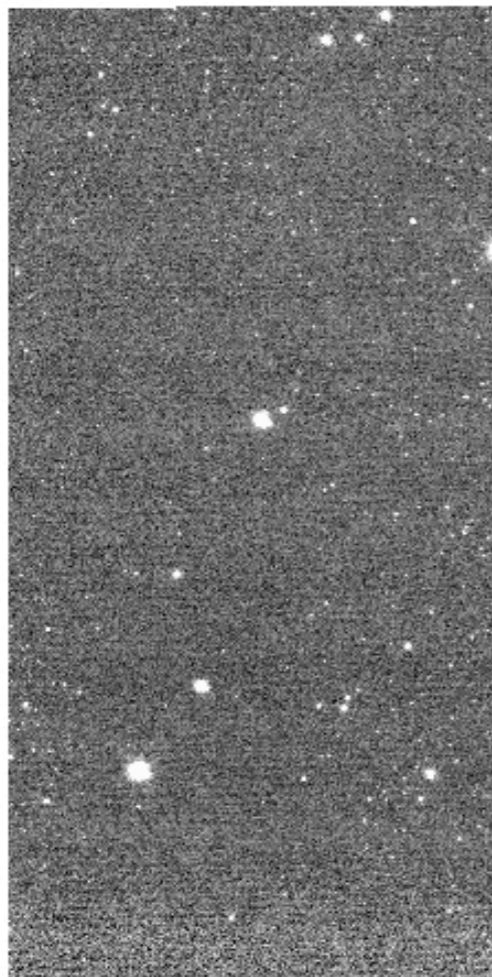
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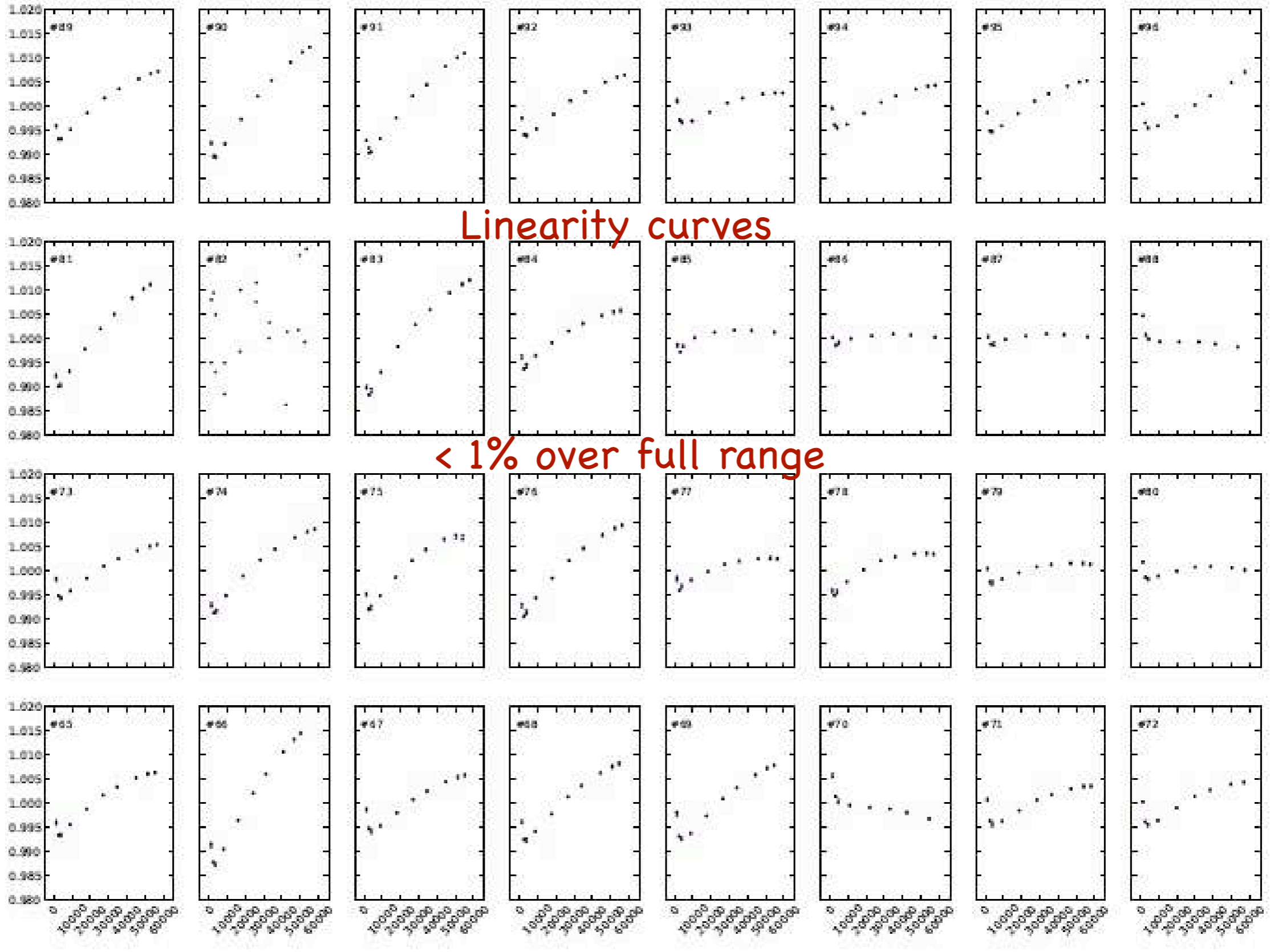


Halpha
flats &
images

SA110

$t = 240s$

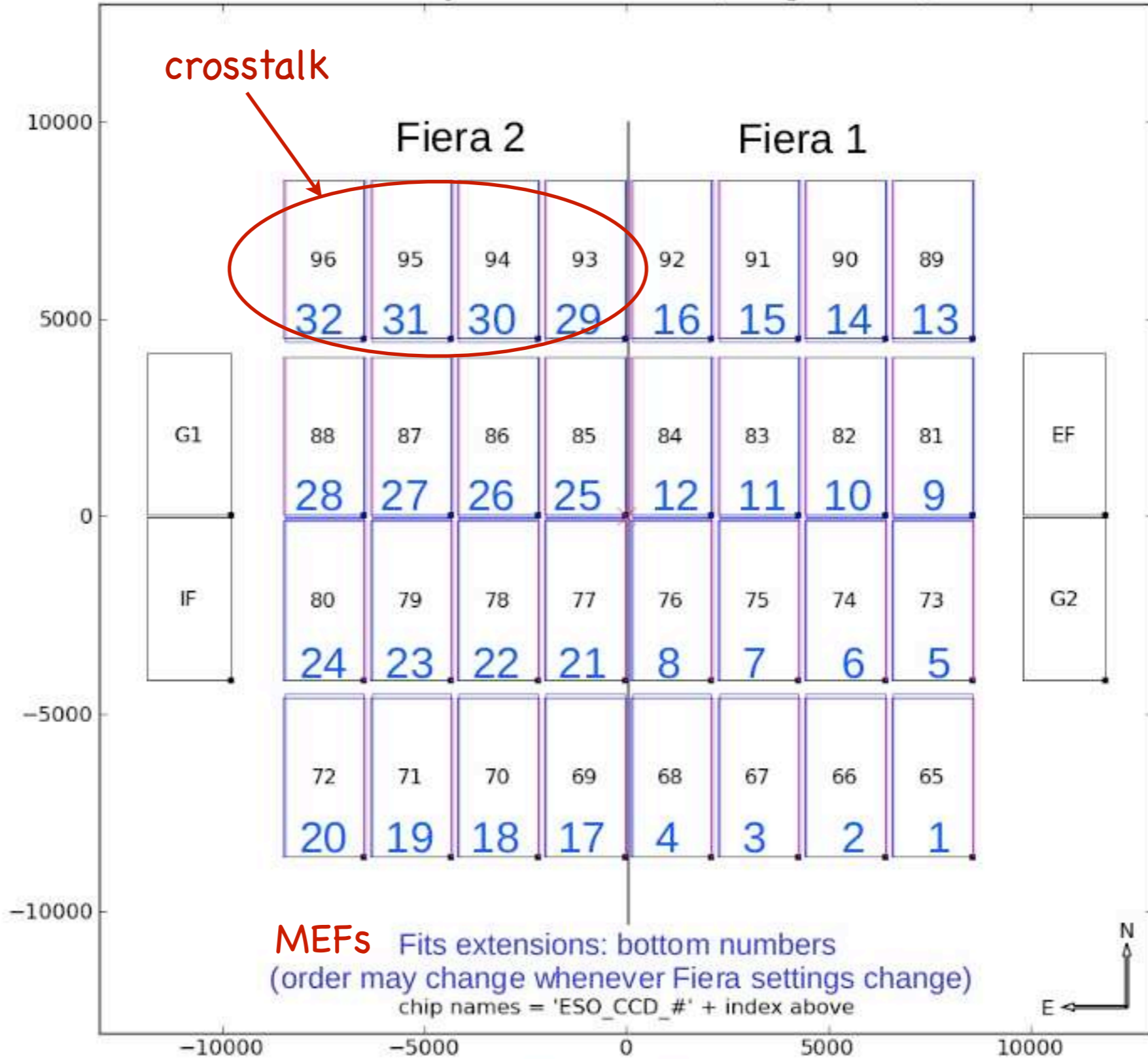




Linearity curves

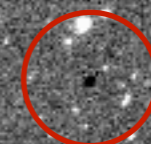
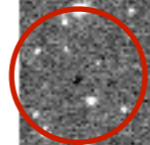
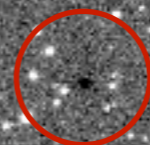
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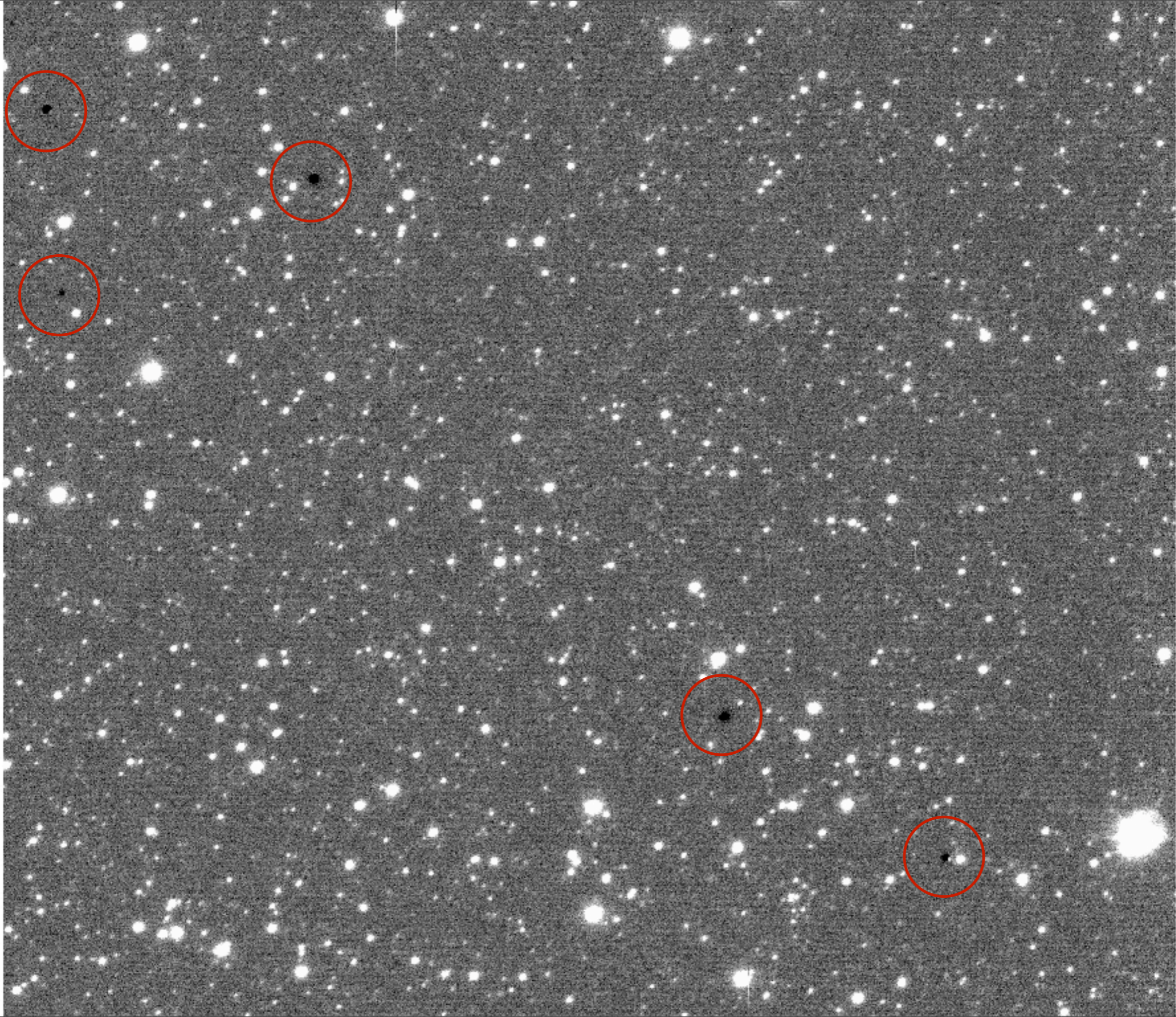
Mosaic Layout for OMEGACAM (configuration: 0)



#96

#95





Monitoring survey progress
and parameter trends



Cambridge Astronomy Survey Unit

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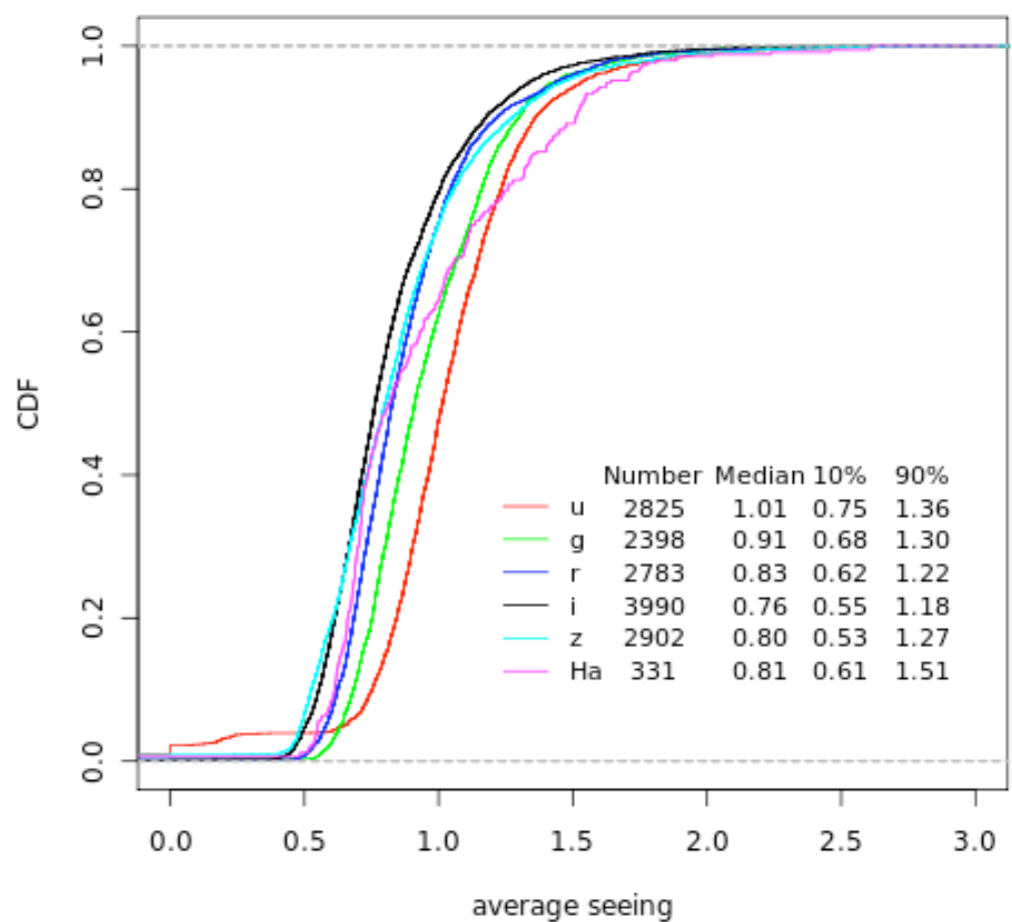
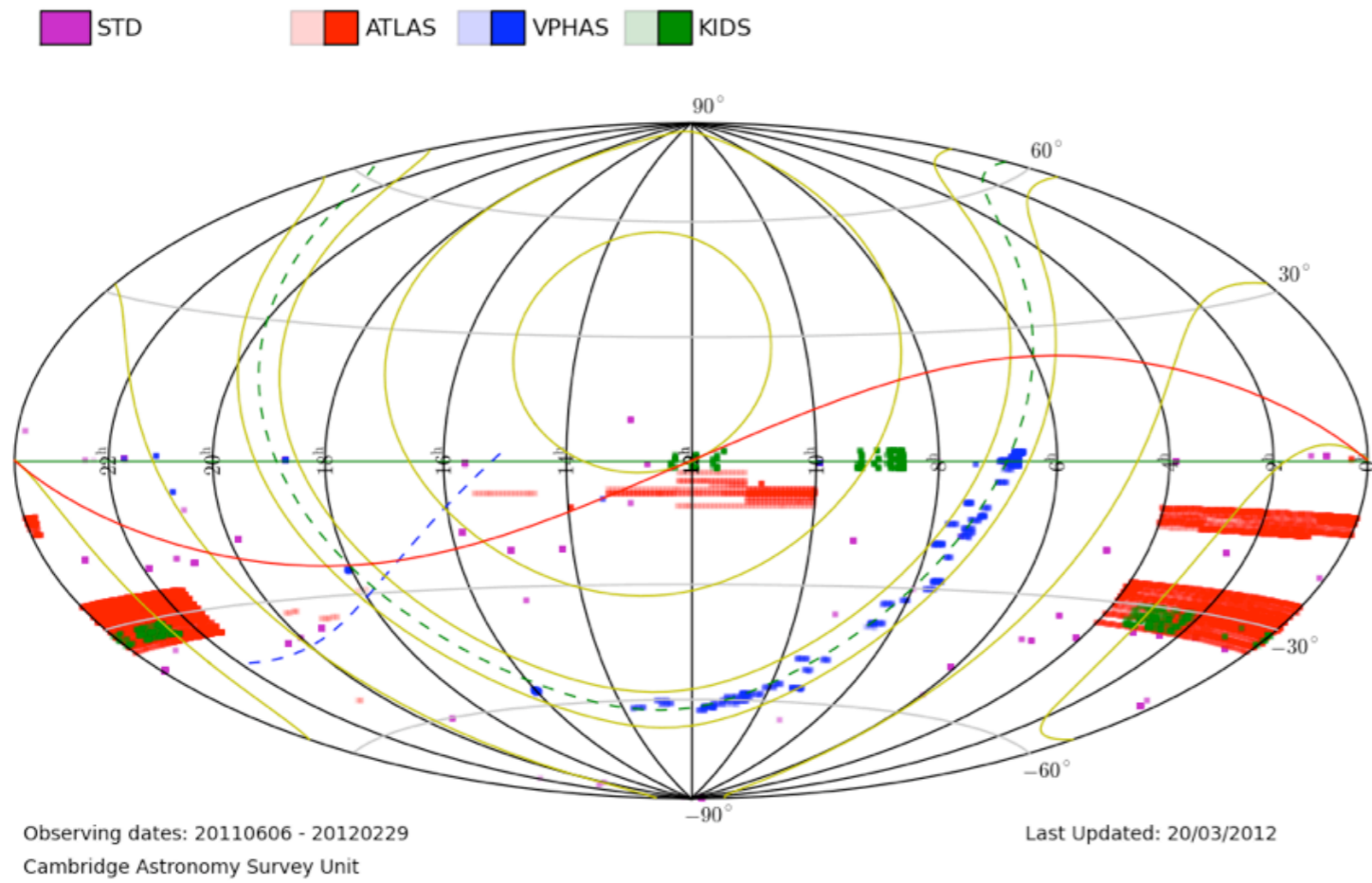
you are here: [home](#) → [surveys & projects](#) → [vst](#) → data processing

VST Data Reduction Progress: Comissioning

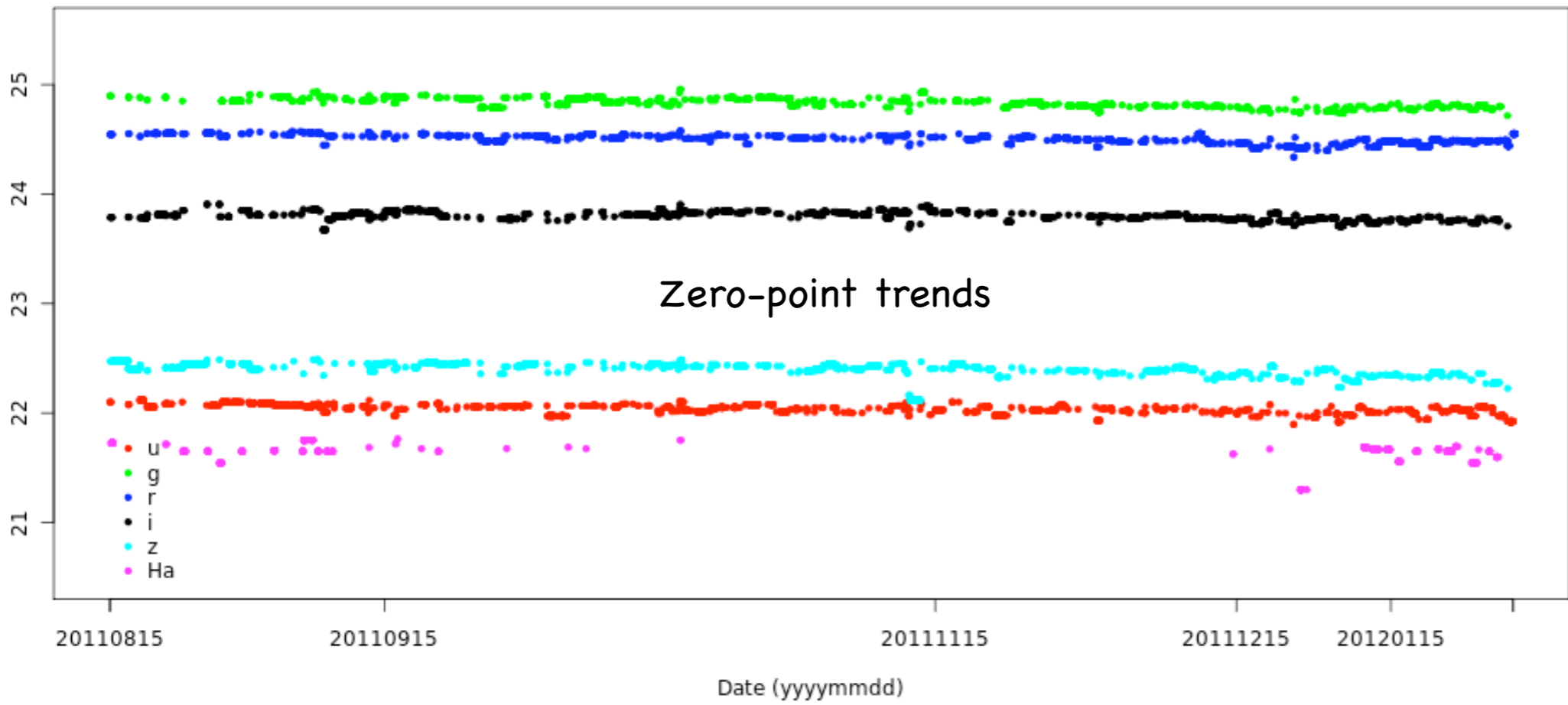
16 Aug 2011 to 14 Oct 2011

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

Night	Status	N _{raw}	Version	Released	Summary Plots	Photometry Plots	Summary Info	Observation Log	Paranal ambient conditions	Size raw [GB]	Full Size red [GB]
20110816	REDUCED	300	0.5		GIF1 GIF2	GIF	summary	index	nightmon	67.97	364.65
20110817	REDUCED	248	0.5		GIF1 GIF2	GIF	summary	index	nightmon	60.84	257.43
20110818	UNPROCESSED	22	0.5					index	nightmon	6.60	
20110819	REDUCED	181	0.5		GIF1 GIF2	GIF	summary	index	nightmon	45.00	158.87
20110820	REDUCED	284	0.5		GIF1 GIF2	GIF	summary	index	nightmon	60.96	368.37
20110821	REDUCED	292	0.5		GIF1 GIF2	GIF	summary	index	nightmon	63.36	348.86
20110822	REDUCED	373	0.5		GIF1 GIF2	GIF	summary	index	nightmon	82.86	485.39
20110823	REDUCED	161	0.5		GIF1 GIF2	GIF	summary	index	nightmon	28.41	268.84
20110824	REDUCED	137	0.5		GIF1 GIF2	GIF	summary	index	nightmon	21.28	204.61
20110825	REDUCED	132	0.5		GIF1 GIF2	GIF	summary	index	nightmon	26.18	160.01
20110826	REDUCED	119	0.5		GIF1 GIF2	GIF	summary	index	nightmon	22.60	174.92
20110827	REDUCED	280	0.5		GIF1 GIF2	GIF	summary	index	nightmon	43.69	481.75
20110828	REDUCED	246	0.5		GIF1 GIF2	GIF	summary	index	nightmon	45.38	354.09
20110829	REDUCED	192	0.5		GIF1 GIF2	GIF	summary	index	nightmon	38.82	207.06
20110830	REDUCED	124	0.5		GIF1 GIF2	GIF	summary	index	nightmon	21.06	163.80
20110831	REDUCED	183	0.5		GIF1 GIF2	GIF	summary	index	nightmon	47.43	135.63
20110901	REDUCED	131	0.5		GIF1 GIF2	GIF	summary	index	nightmon	34.73	82.76
20110902	REDUCED	92	0.5		GIF1 GIF2	GIF	summary	index	nightmon	26.73	63.92
20110903	REDUCED	192	0.5		GIF1 GIF2	GIF	summary	index	nightmon	53.59	81.37
20110904	UNPROCESSED	27	0.5					index	nightmon	4.67	
20110905	UNPROCESSED	127	0.5					index	nightmon	36.60	
20110906	NODATA								nightmon		
20110907	UNPROCESSED	13	0.5					index	nightmon	1.93	
20110908	NODATA								nightmon		
20110909	NODATA								nightmon		
20110910	UNPROCESSED	51	0.5					index	nightmon	14.03	
20110911	UNPROCESSED	53	0.5					index	nightmon	11.70	
20110912	UNPROCESSED	74	0.5					index	nightmon	19.35	
20110913	REDUCED	133	0.5		GIF1 GIF2	GIF	summary	index	nightmon	36.23	88.26
20110914	REDUCED	228	0.5		GIF1 GIF2	GIF	summary	index	nightmon	56.87	226.41
20110915	REDUCED	153	0.5		GIF1 GIF2	GIF	summary	index	nightmon	41.37	98.65
20110916	UNPROCESSED	10	0.5					index	nightmon	2.43	

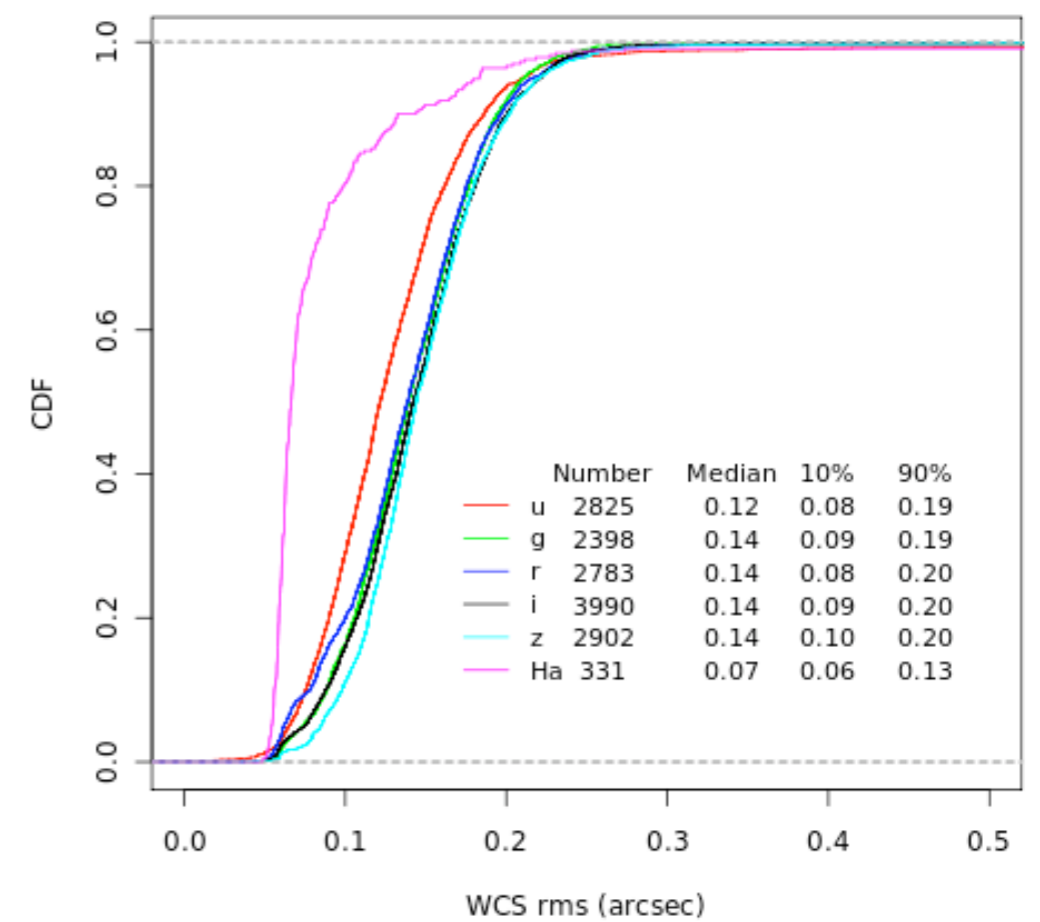
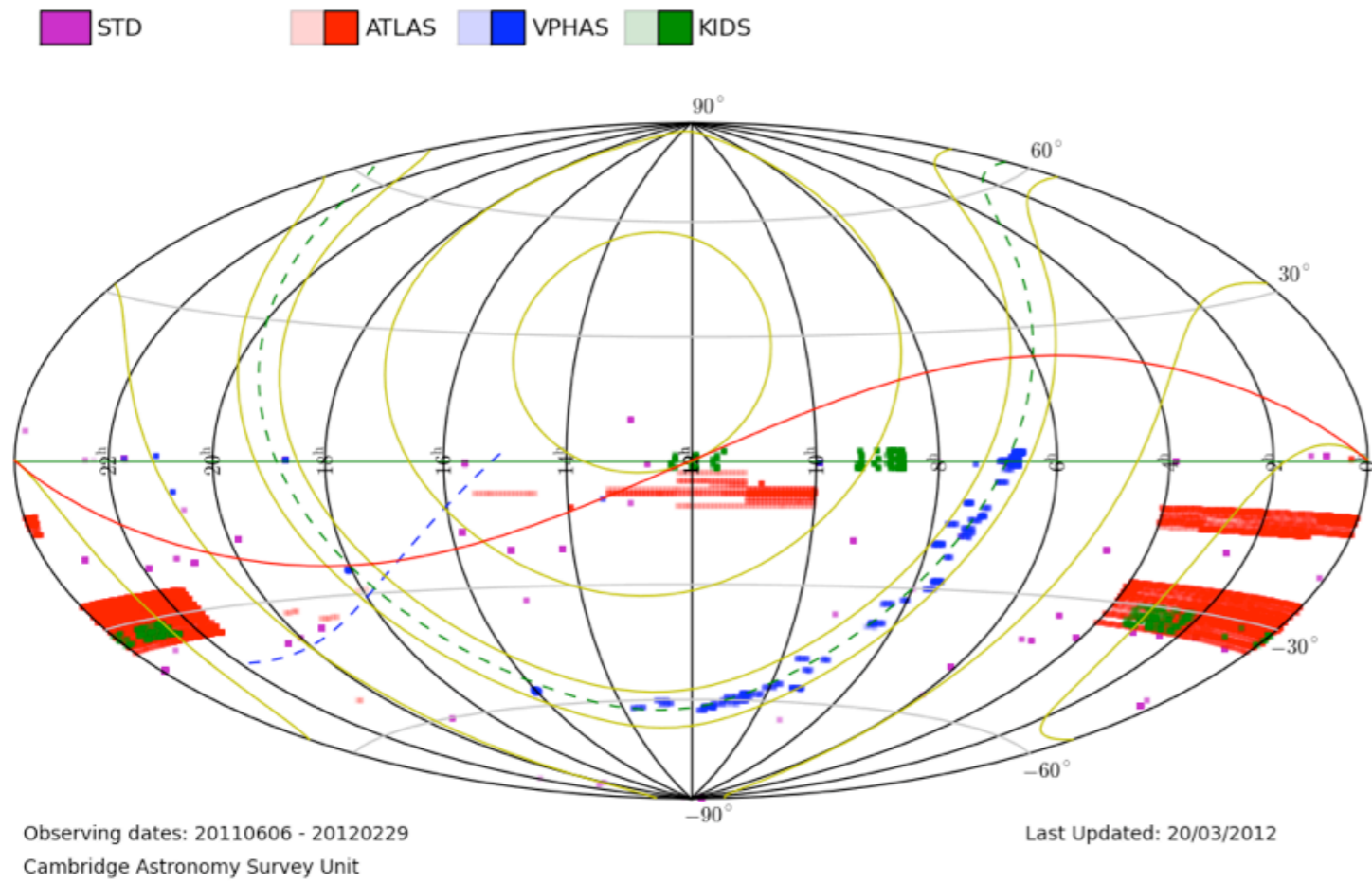


Survey progress overview

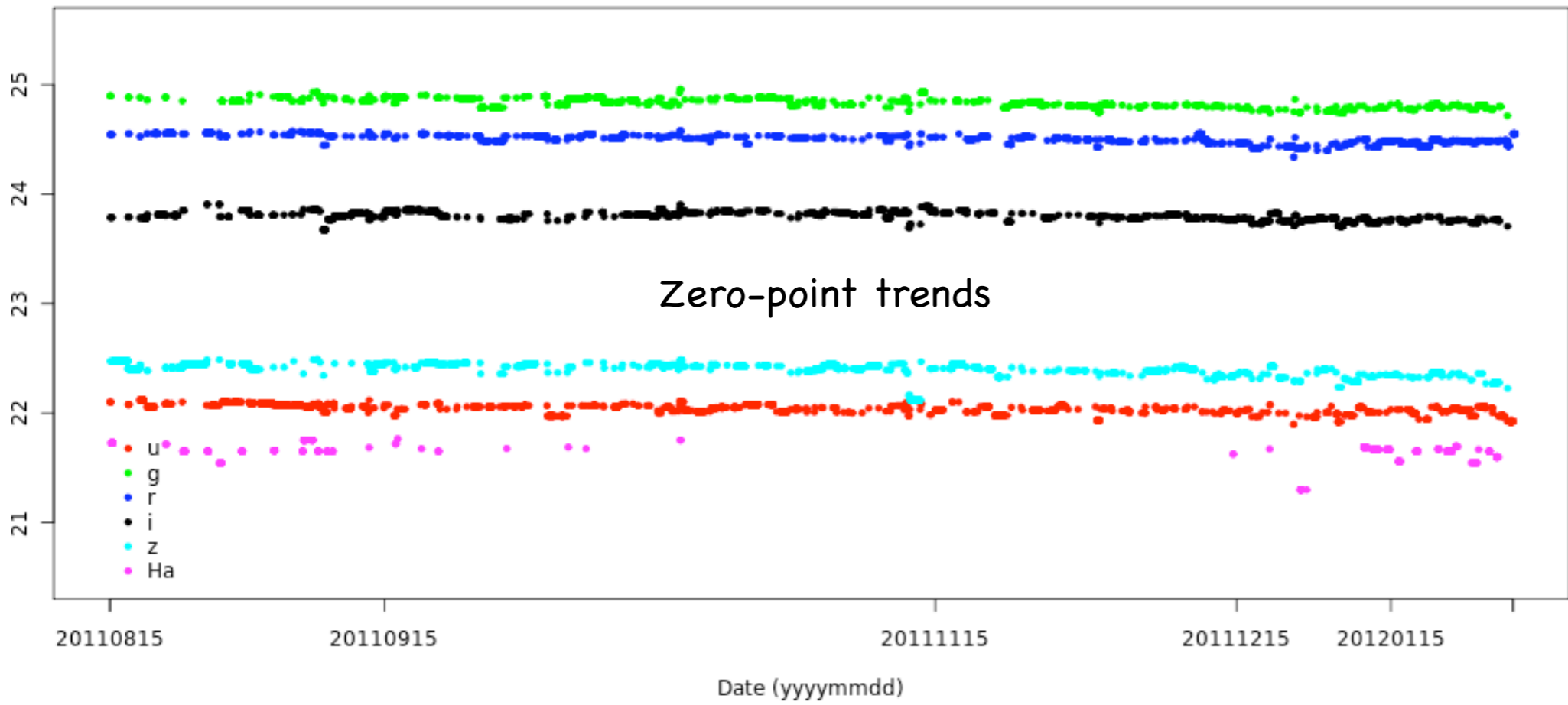


Zero-point trends

QC plots summarise:
astrometry; seeing;
stellar ellipticity; sky
brightness; magnitude
zero-point trends



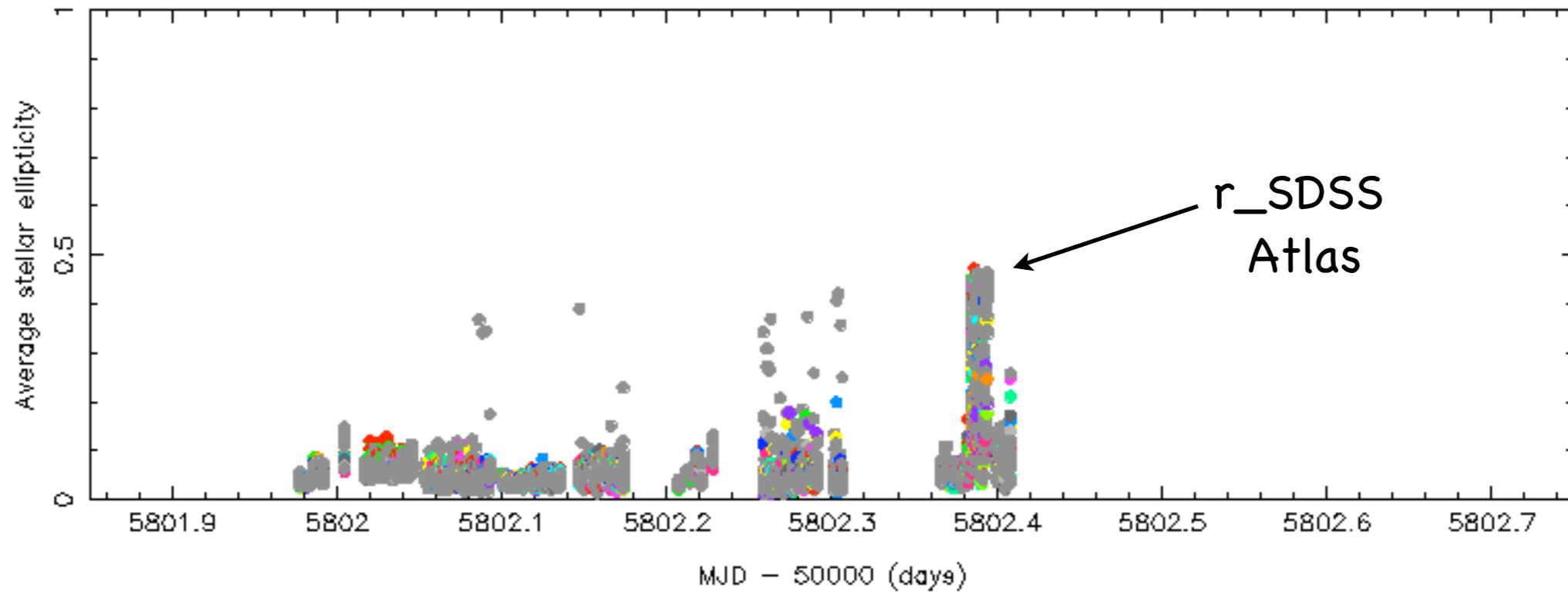
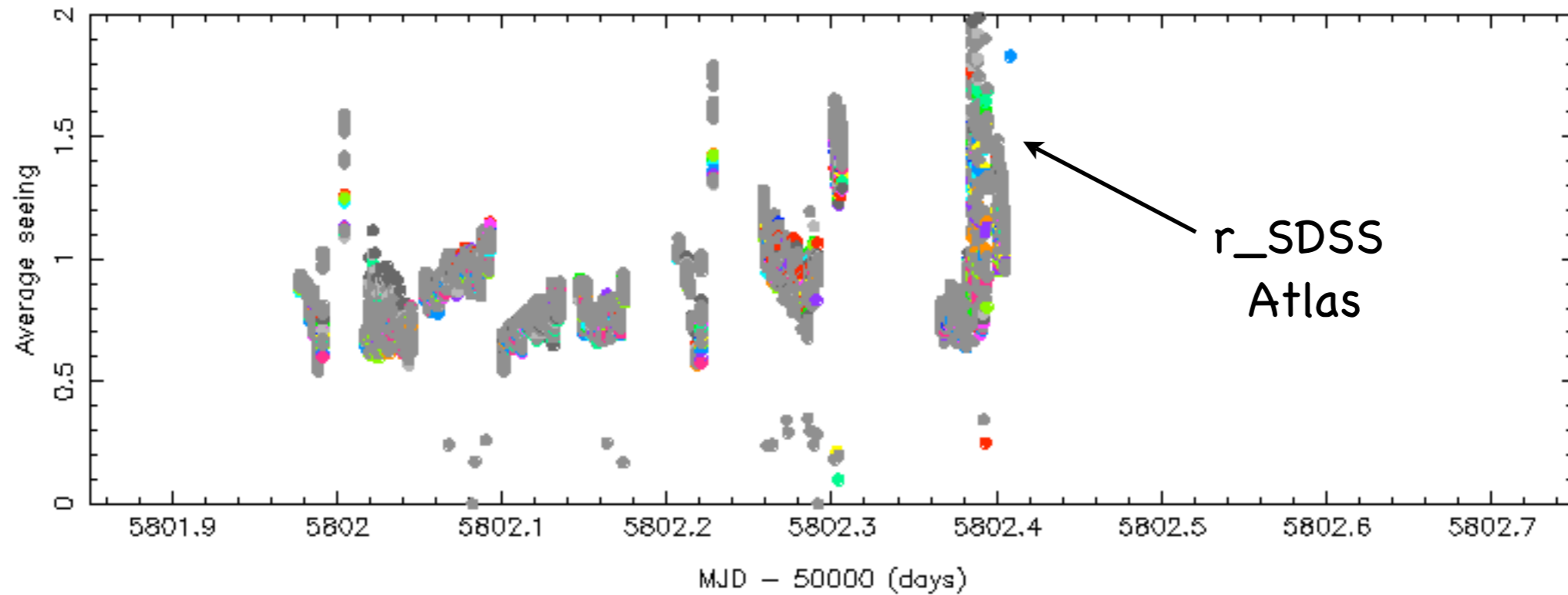
Survey progress overview



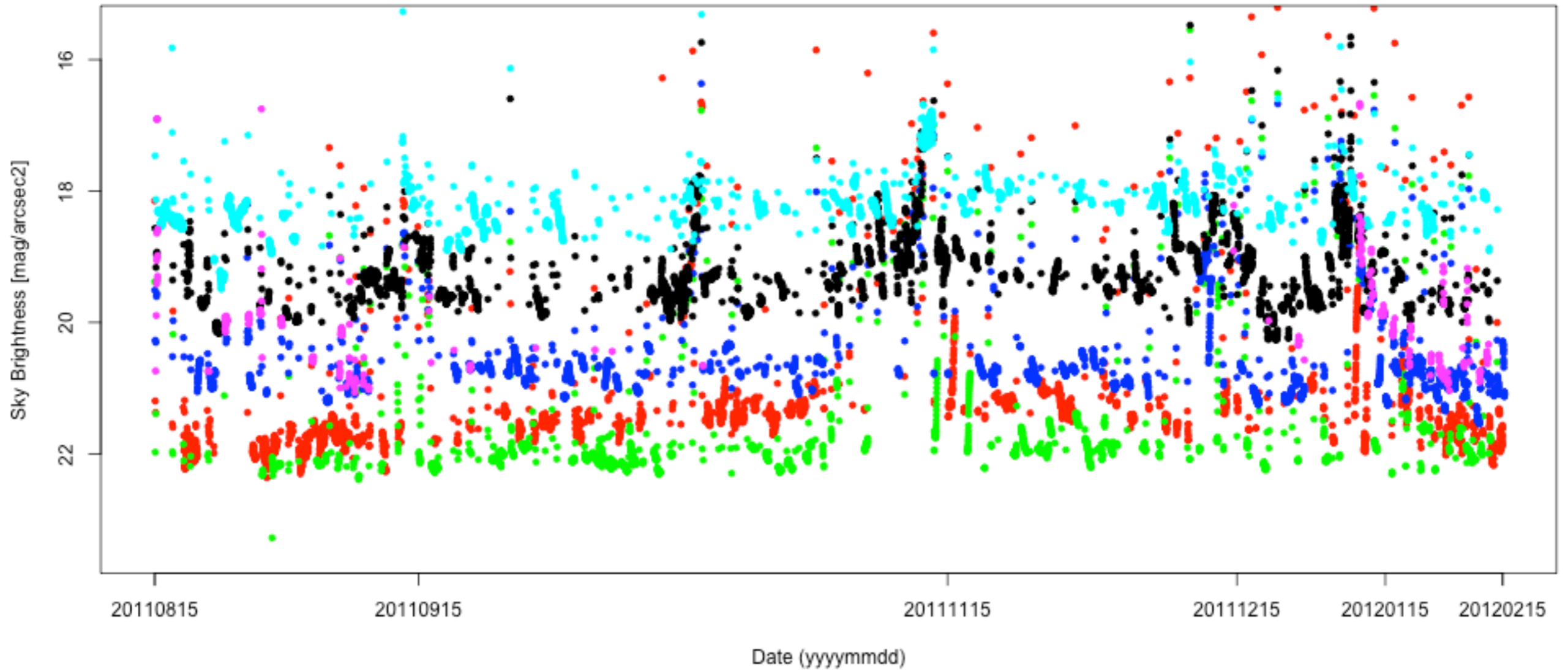
Zero-point trends

QC plots summarise:
 astrometry; seeing;
 stellar ellipticity; sky
 brightness; magnitude
 zero-point trends

Nightly QC seeing and ellipticity diagnostics



Monitoring sky surface brightness



Monitoring sky surface brightness

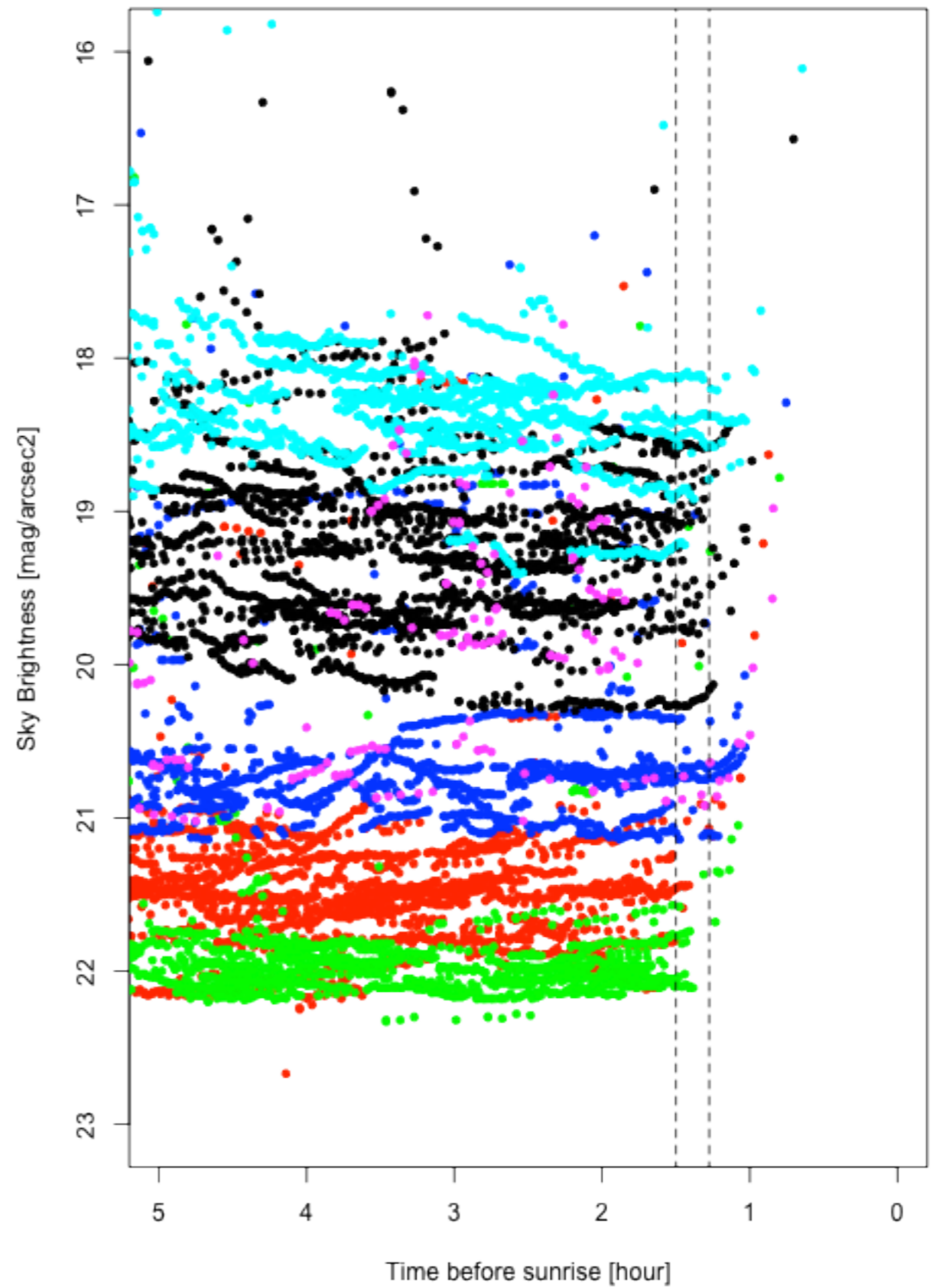
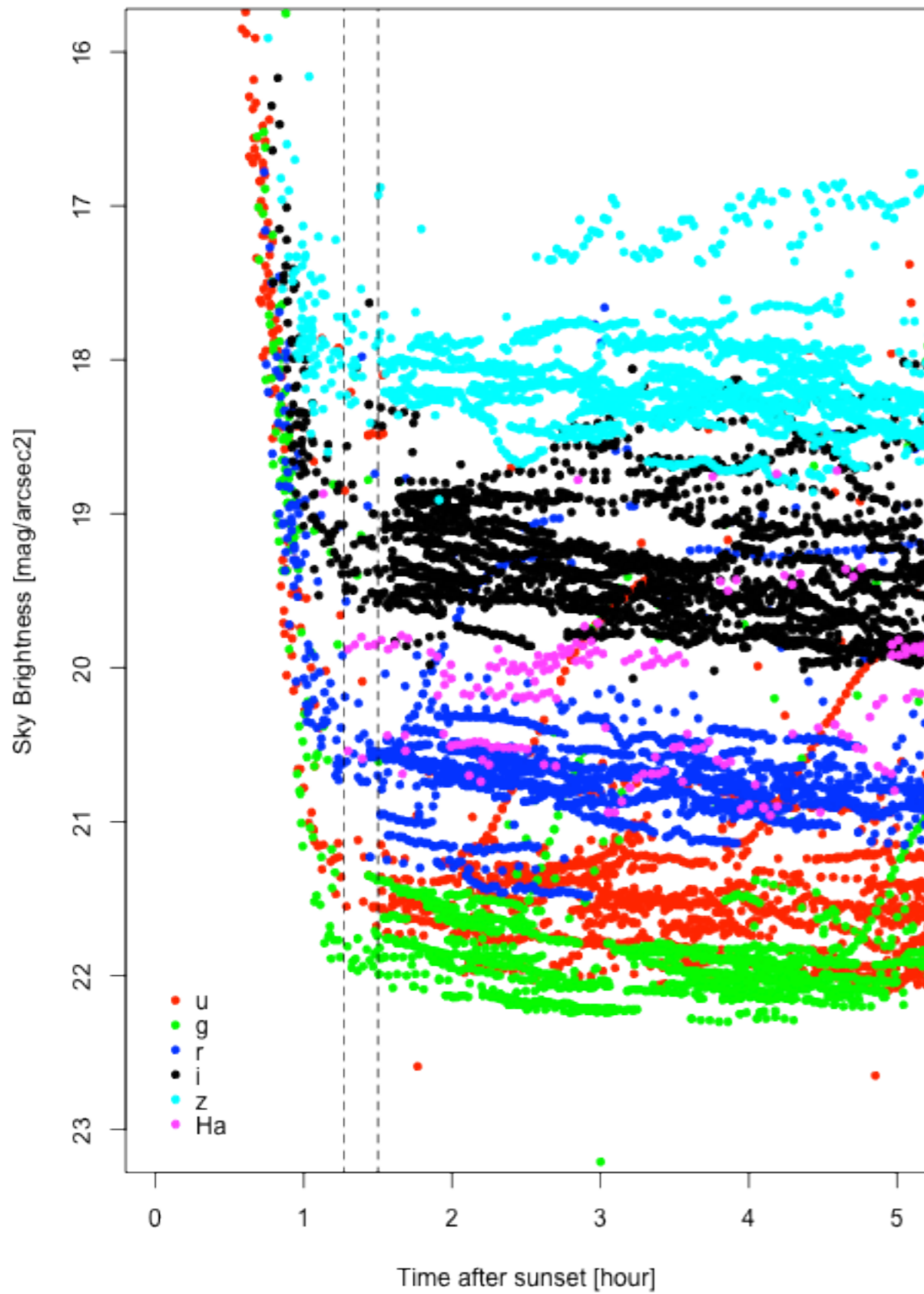


Image search, preview & download



VST Archive At CASU

login

Search on coordinates 00:00:00 -30:00:00 with radius 0.5 deg

Query ID: 1000001000 [?]

Filename	Object	Coords	Filter	UTC	Airmass	ExpTime	FWHM	Ellipticity	ZP	Mag Lim	APcor	WCSrms	Programme	Survey
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H α20110819_00054 [S]	ATLAS survey	00:00:27.09-29:34:19.8	u_SDSS	03:38:15	1.36	60.0	1.00 1.14	0.02 0.16	22.12	20.68	0.40 0.54	0.07 0.22	177.A-3011	ATLAS
H α20110819_00055	ATLAS survey	00:00:27.93-29:32:54.9	u_SDSS	03:39:58	1.35	60.0	0.24 1.19	0.02 0.35	22.12	20.35	0.42 0.60	0.06 0.21	177.A-3011	ATLAS
H α20110821_00076 [S]	ATLAS survey	00:00:27.08-29:34:19.9	r_SDSS	03:42:27	1.31	45.0	1.67 1.96	0.02 0.07	24.55	21.81	0.89 1.02	0.10 0.20	177.A-3011	ATLAS
H α20110821_00076	ATLAS survey	00:00:27.08-29:34:19.9	r_SDSS	03:42:27	1.31	45.0	1.60 1.88	0.02 0.06	24.55	21.58	0.85 0.96	0.09 0.21	177.A-3011	ATLAS
H α20110821_00077	ATLAS survey	00:00:27.92-29:32:54.9	r_SDSS	03:43:51	1.30	45.0	1.74 2.04	0.02 0.07	24.55	21.47	0.94 1.08	0.08 0.22	177.A-3011	ATLAS
H α20110924_00059 [S]	ATLAS survey	00:00:26.84-29:34:20.2	g_SDSS	01:19:48	1.35	50.0	1.13 1.25	0.08 0.20	24.79	22.80	0.49 0.60	0.08 0.21	177.A-3011	ATLAS
H α20110924_00059	ATLAS survey	00:00:26.84-29:34:20.2	g_SDSS	01:19:48	1.35	50.0	1.14 1.32	0.08 0.21	24.79	22.50	0.51 0.62	0.07 0.24	177.A-3011	ATLAS
H α20110924_00060	ATLAS survey	00:00:27.69-29:32:55.2	g_SDSS	01:21:22	1.34	50.0	1.10 1.21	0.08 0.21	24.79	22.54	0.47 0.59	0.08 0.27	177.A-3011	ATLAS
H α20110924_00197 [S]	ATLAS survey	00:00:26.84-29:34:20.2	r_SDSS	05:59:53	1.07	45.0	0.57 0.70	0.04 0.19	24.48	22.49	0.28 0.31	0.10 0.21	177.A-3011	ATLAS
H α20110924_00197	ATLAS survey	00:00:26.84-29:34:20.2	r_SDSS	05:59:53	1.07	45.0	0.54 0.65	0.04 0.22	24.48	22.21	0.27 0.30	0.09 0.22	177.A-3011	ATLAS
H α20110924_00198	ATLAS survey	00:00:27.69-29:32:55.2	r_SDSS	06:01:18	1.07	45.0	0.57 0.72	0.04 0.23	24.48	22.21	0.28 0.31	0.09 0.21	177.A-3011	ATLAS
H α20111124_00079	ATLAS survey	00:00:27.22-29:34:04.4	z_SDSS	02:45:40	1.17	45.0	0.76 0.91	0.03 0.07	22.39	19.86	0.30 0.36	0.08 0.21	177.A-3011	ATLAS
H α20111124_00079 [S]	ATLAS survey	00:00:27.22-29:34:04.4	z_SDSS	02:45:40	1.17	45.0	0.75 0.89	0.03 0.06	22.39	20.13	0.32 0.35	0.10 0.23	177.A-3011	ATLAS
H α20111124_00080	ATLAS survey	00:00:29.13-29:32:39.4	z_SDSS	02:47:05	1.17	45.0	0.72 0.87	0.04 0.08	22.39	19.87	0.30 0.34	0.05 0.22	177.A-3011	ATLAS
H α20111203_00055 [S]	ATLAS survey	00:00:27.22-29:34:04.4	i_SDSS	02:08:44	1.16	45.0	0.57 0.70	0.03 0.07	23.81	21.38	0.23 0.27	0.10 0.22	177.A-3011	ATLAS
H α20111203_00055	ATLAS survey	00:00:27.22-29:34:04.4	i_SDSS	02:08:44	1.16	45.0	0.54 0.69	0.04 0.10	23.81	21.10	0.22 0.26	0.10 0.23	177.A-3011	ATLAS



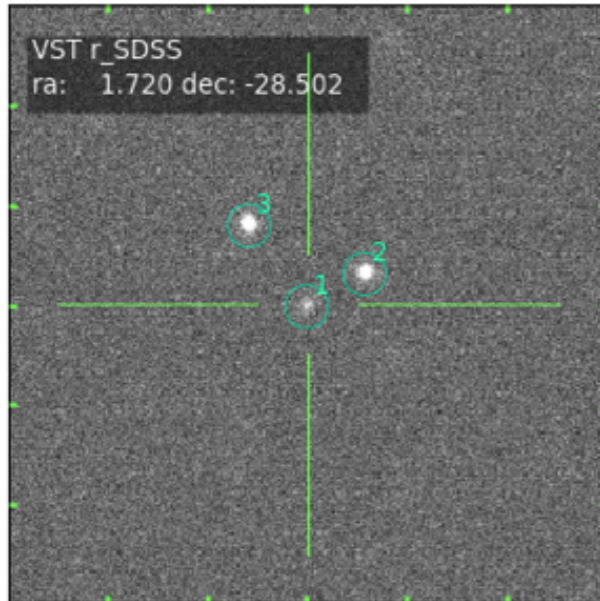
VST Archive At CASU

[Example manager] logout

- Home
- Manager
- My requests
- Search
- Data processing
- Technical Information
- QC Tables
- Help

A search by position returns images that contain that position and allows preview of postage stamps, catalogue sources and postage stamps of provenance images.

o20110926_00214_st.fit[11] - r_SDSS



Obs date 2011-09-27 07:00:52
 Airmass 1.211
 Exposure Time [sec] 45.0
 Average seeing [arcsec] 1.37
 WCS fit rms 0.09
 Ellipticity 0.04
 Magnitude limit [Vega] 22.56
 Programme 177.A-3011 (ATLAS)

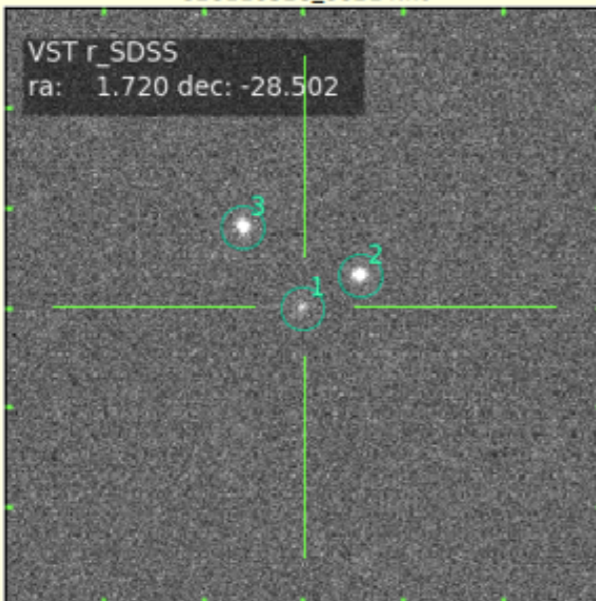
Current cutout size 60 arcsec

- 30 arcsec
- 60 arcsec
- 90 arcsec
- 120 arcsec

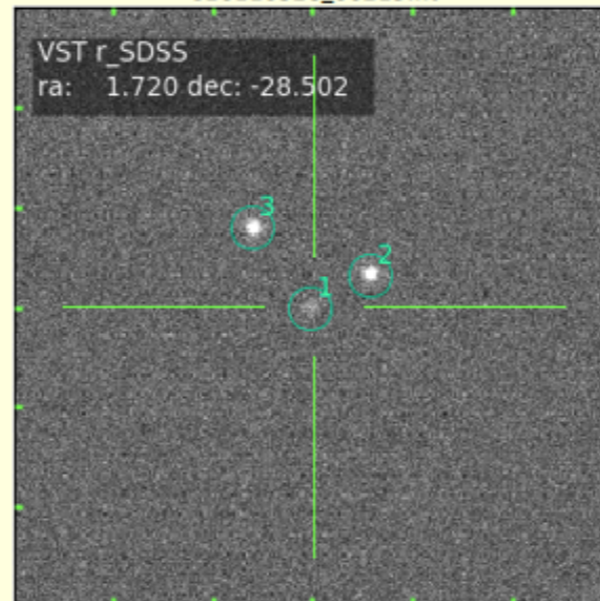
ID	Coords (J2000)	Apermag3	Class	Ellipt	Pos Ang	X	Y	AvConf	ErrBit
1	00:06:52.766 -28:30:07.622	21.168 (0.062)	extended	0.11	-11.95	356.714	1180.97	100.606	0.0
2	00:06:52.325 -28:30:04.273	19.982 (0.025)	pointlike	0.09	79.33	329.41	1196.59	100.618	0.0
3	00:06:53.211 -28:29:59.505	19.650 (0.020)	pointlike	0.10	25.62	384.081	1219.12	100.582	0.0
4	00:06:53.409 -28:29:33.547	22.443 (0.182)	pointlike	0.09	50.23	395.974	1340.87	100.817	0.0
5	00:06:53.223 -28:30:56.738	22.085 (0.135)	extended	0.50	6.14	385.536	950.749	100.76	0.0

Individual Images

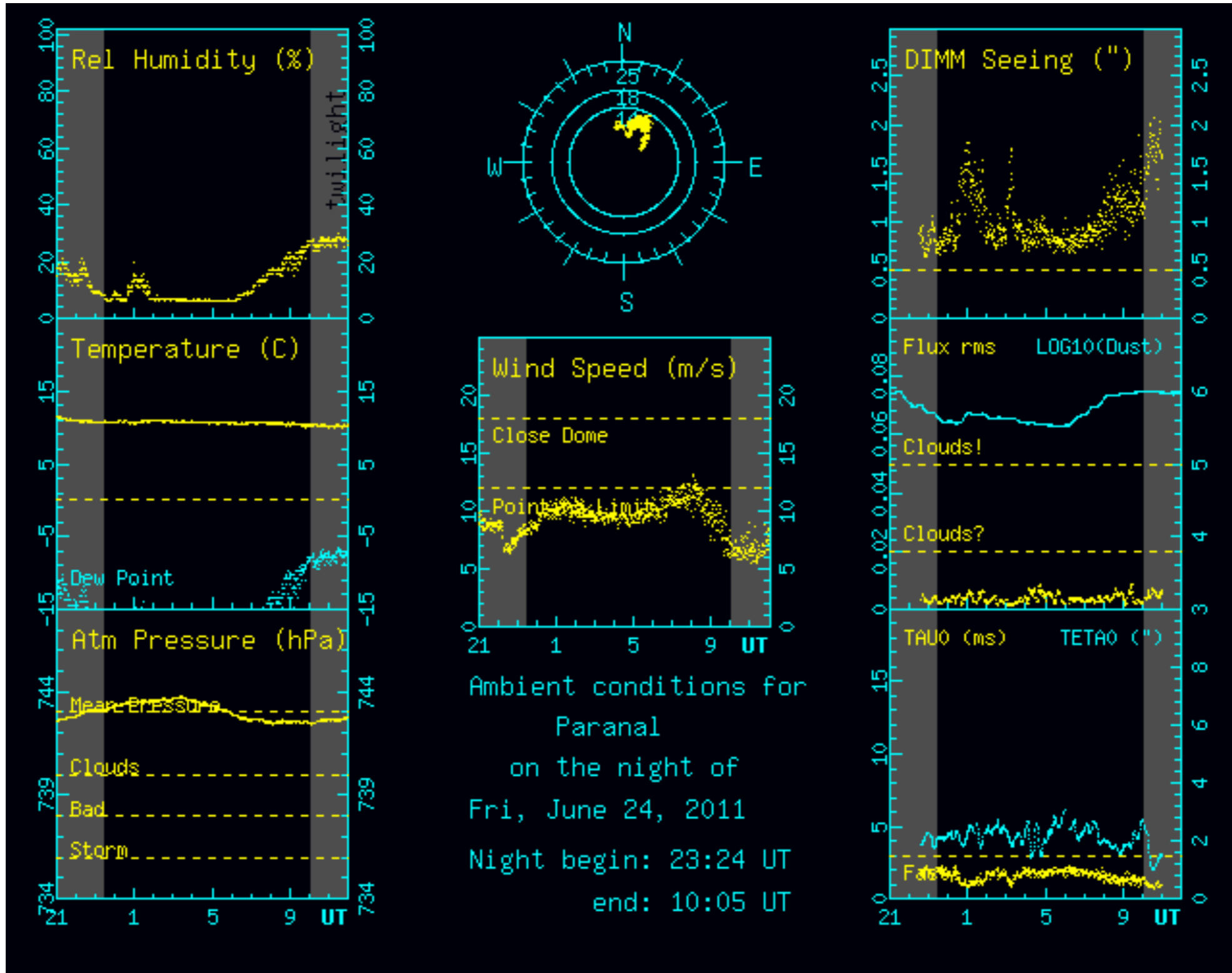
o20110926_00214.fit



o20110926_00215.fit



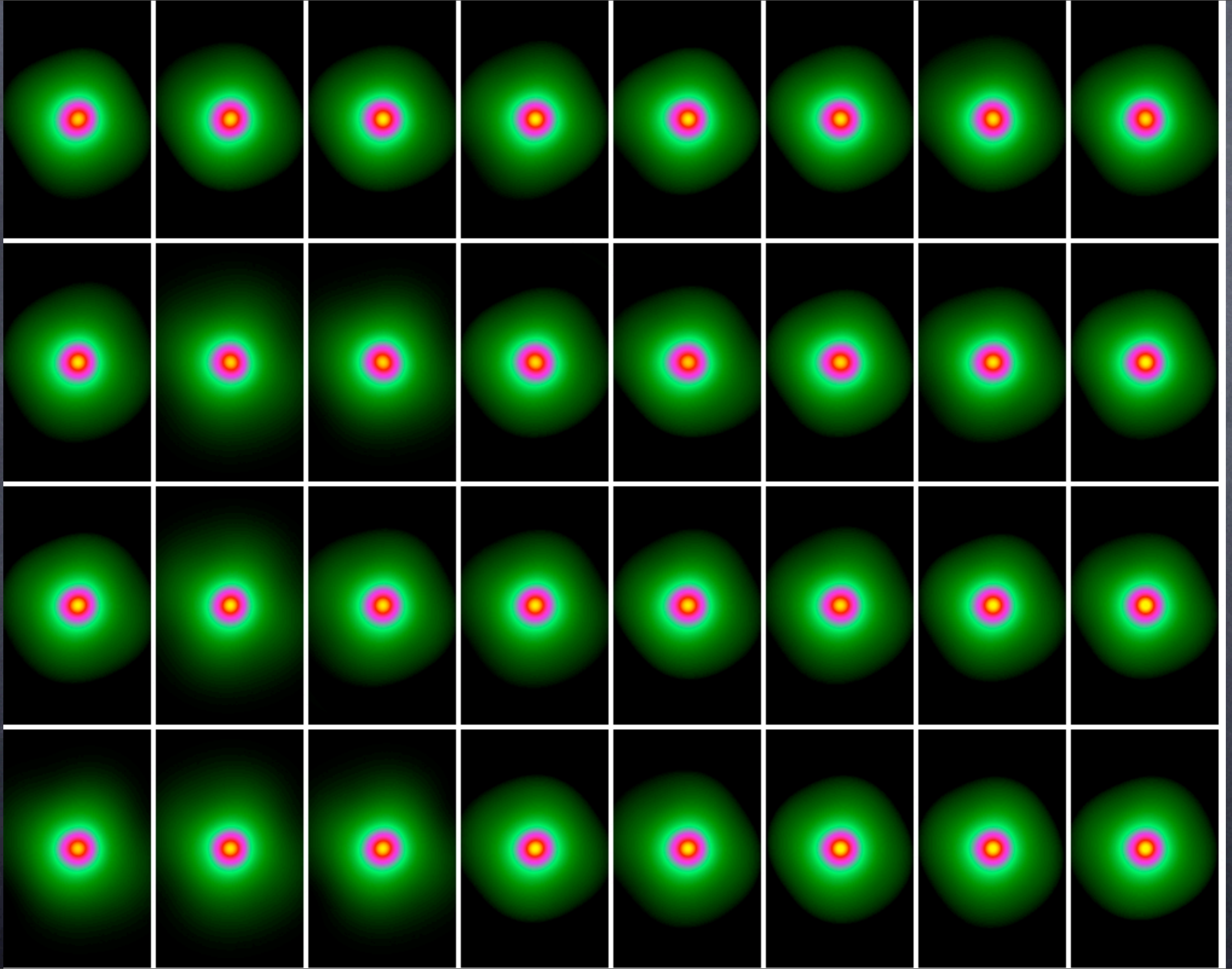
ESO monitoring of ambient conditions

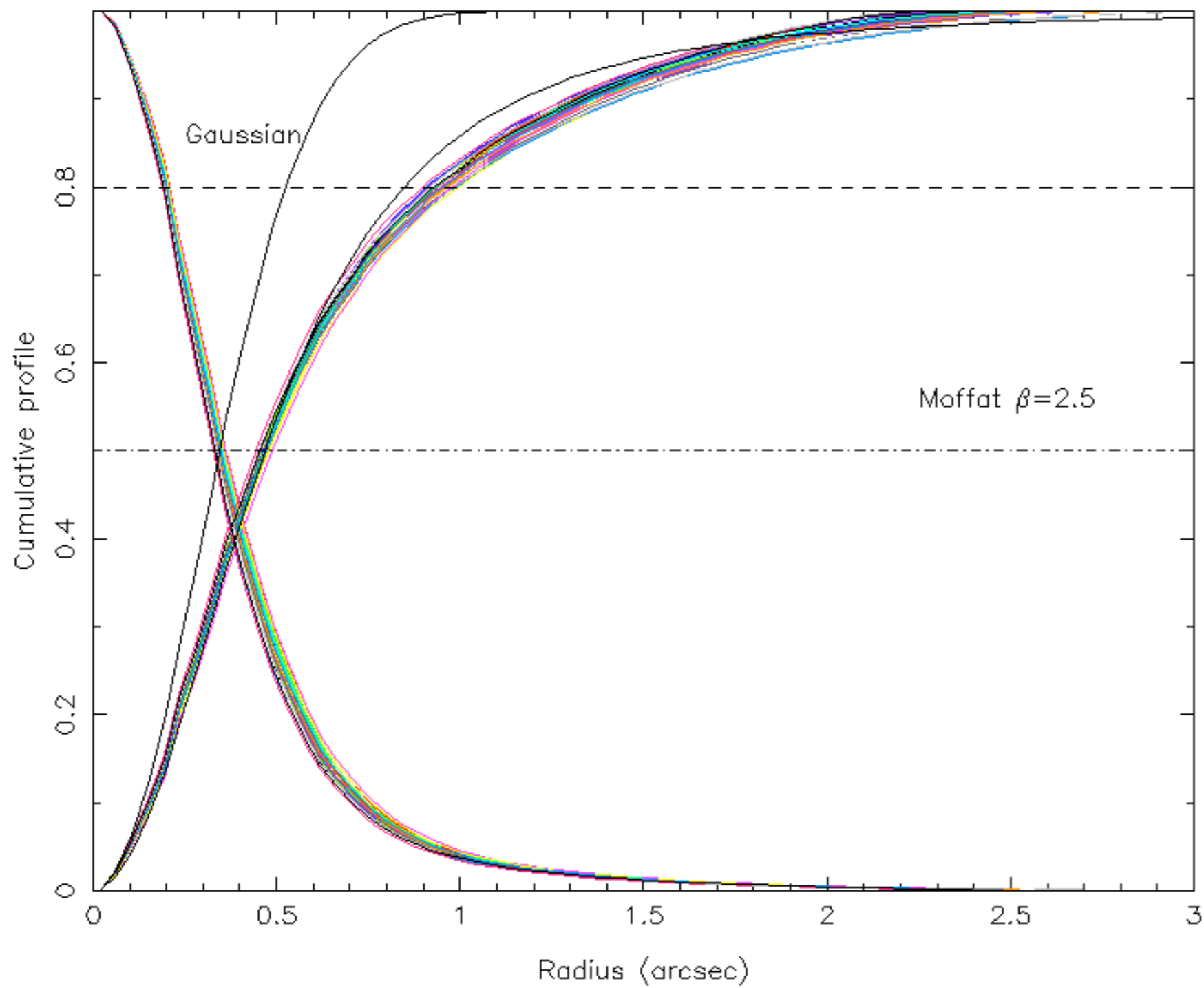


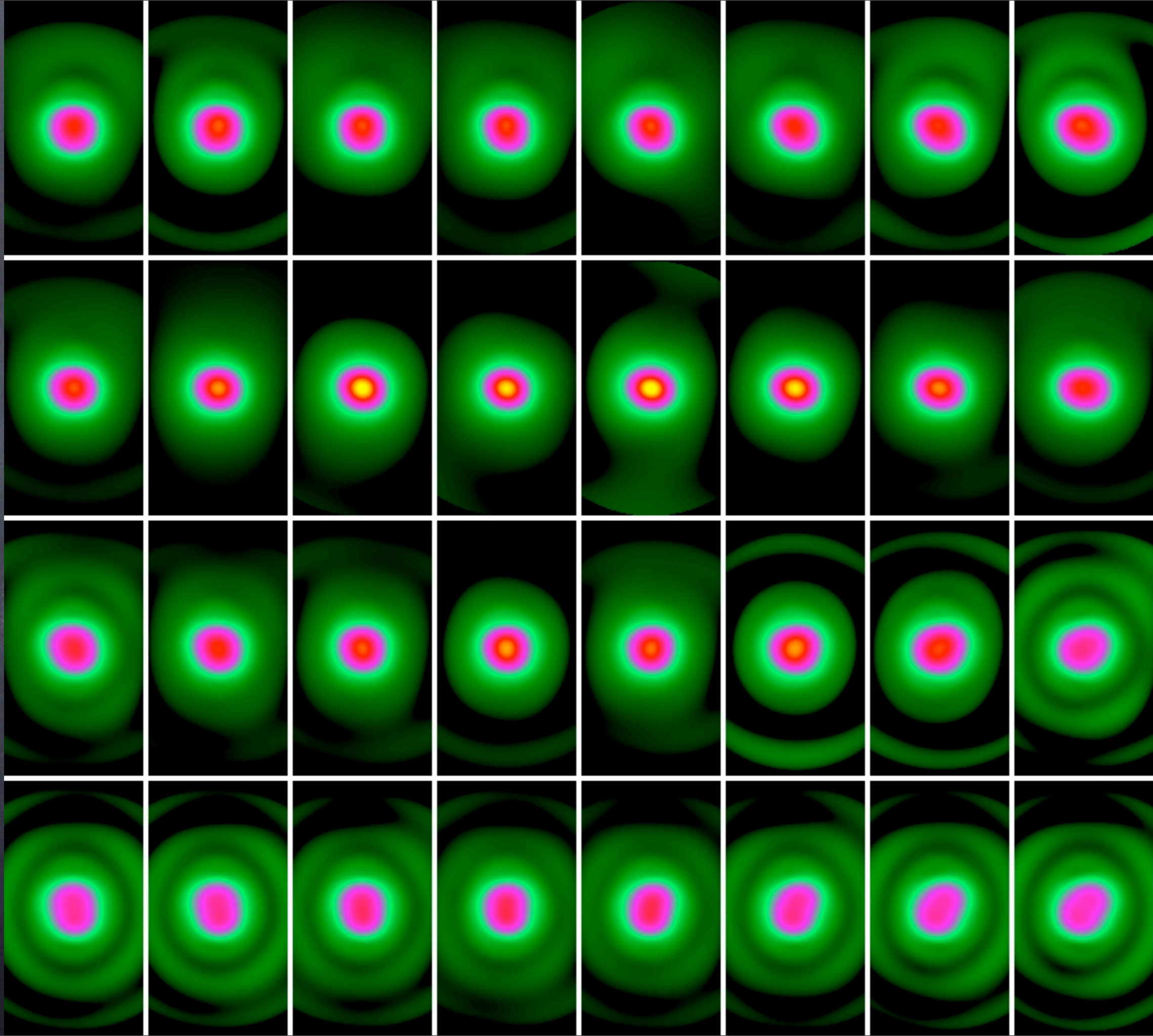
Issues/features

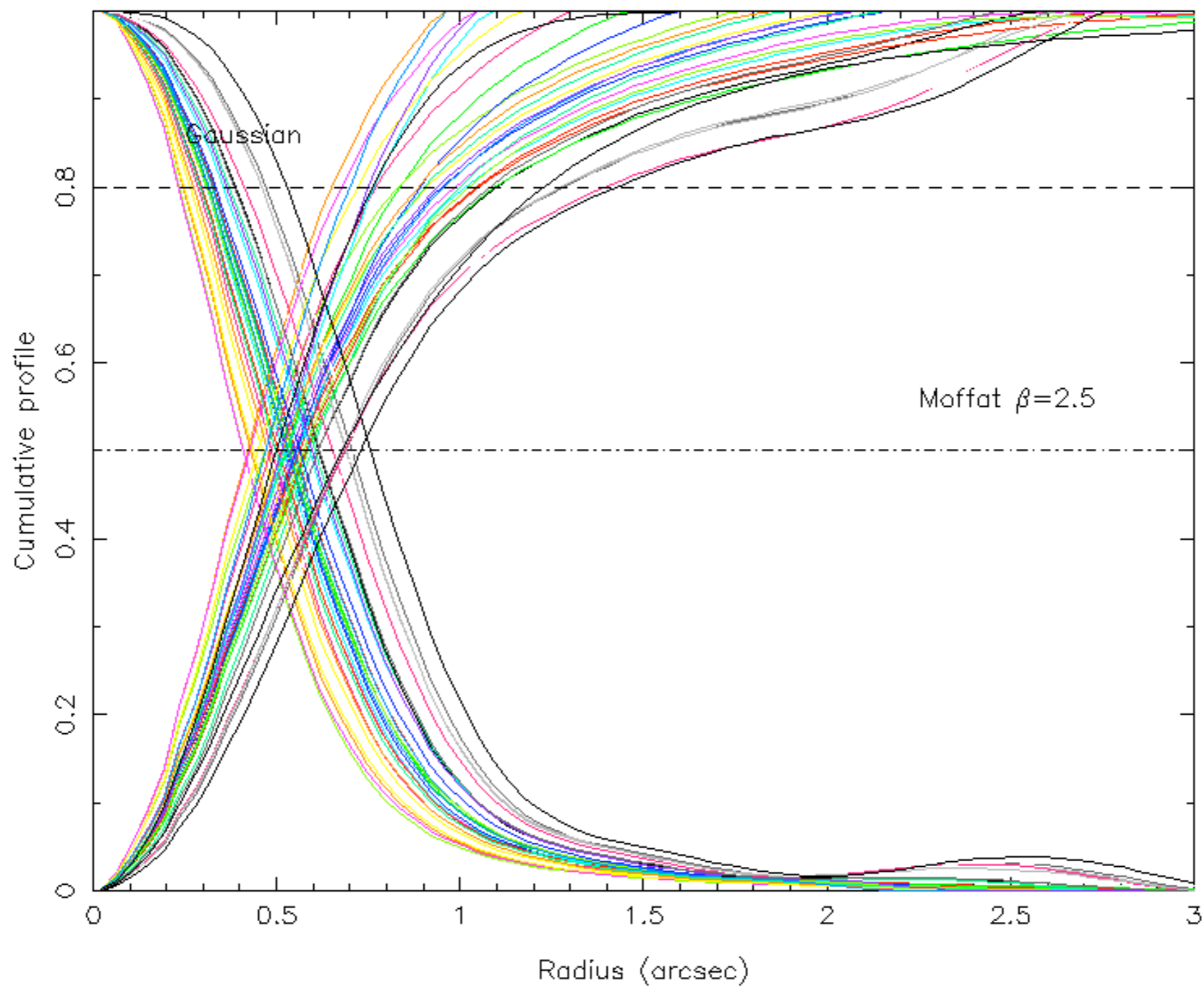
- efficiently acquiring raw VST data from ESO
- dealing with fringing in i,z bands
- crosstalk stability #93-96 [#29-32]
- scattered light problem → illumination correction
1 sq deg calibration regions ?
- uniform survey photometric calibration → howto
- astrometric calibration → TAN plane projection
- master calibration images - update frequency →
stability of "gains" of detectors
- stability of focus and hence PSF variations
- repeatability of filter positioning

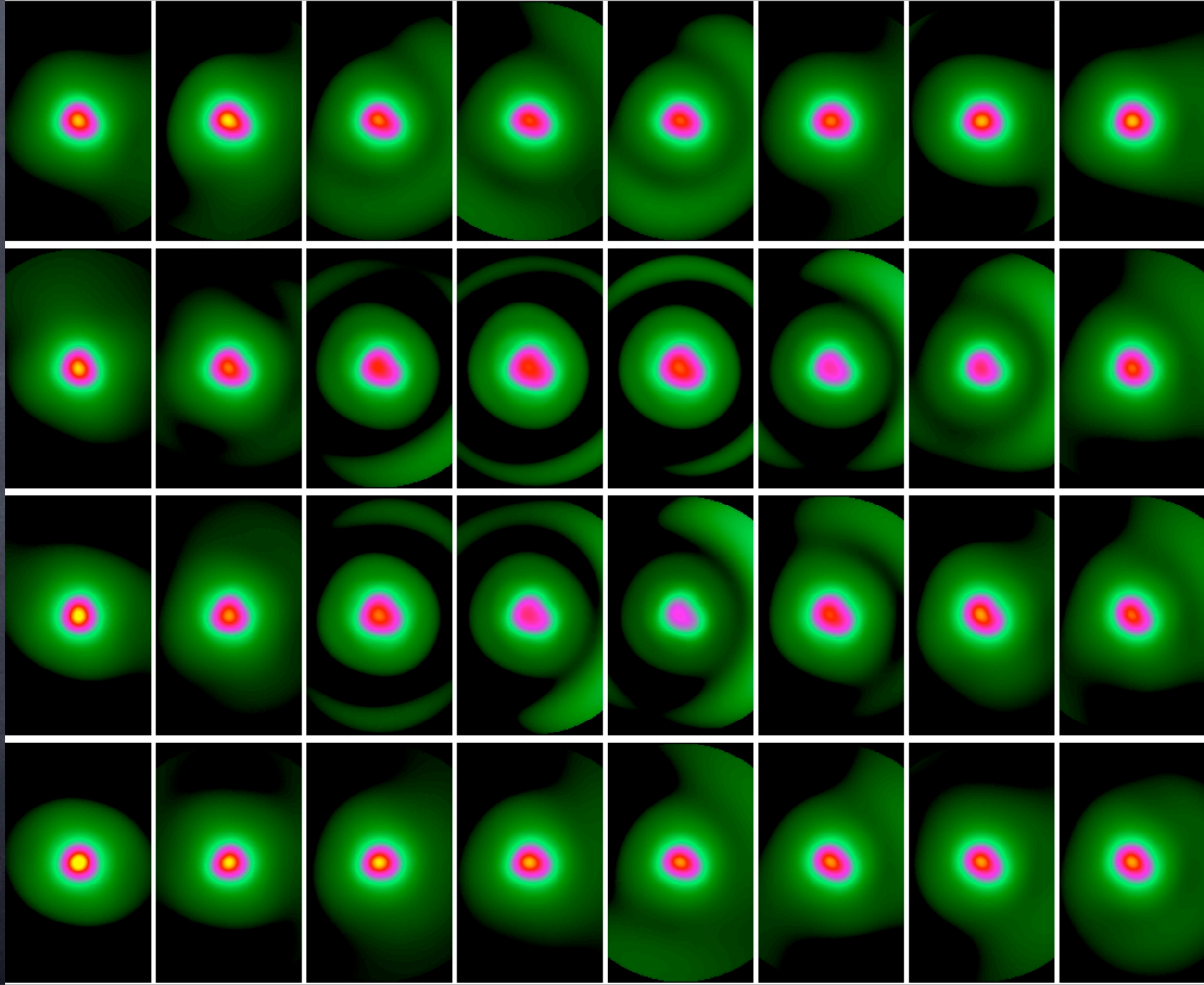
PSF variations











Astrometric and photometric calibration

Astrometric Calibration 2MASS - VST

WCS - TAN projection

$$r' = \tan(r)$$

Linear solution
per detector

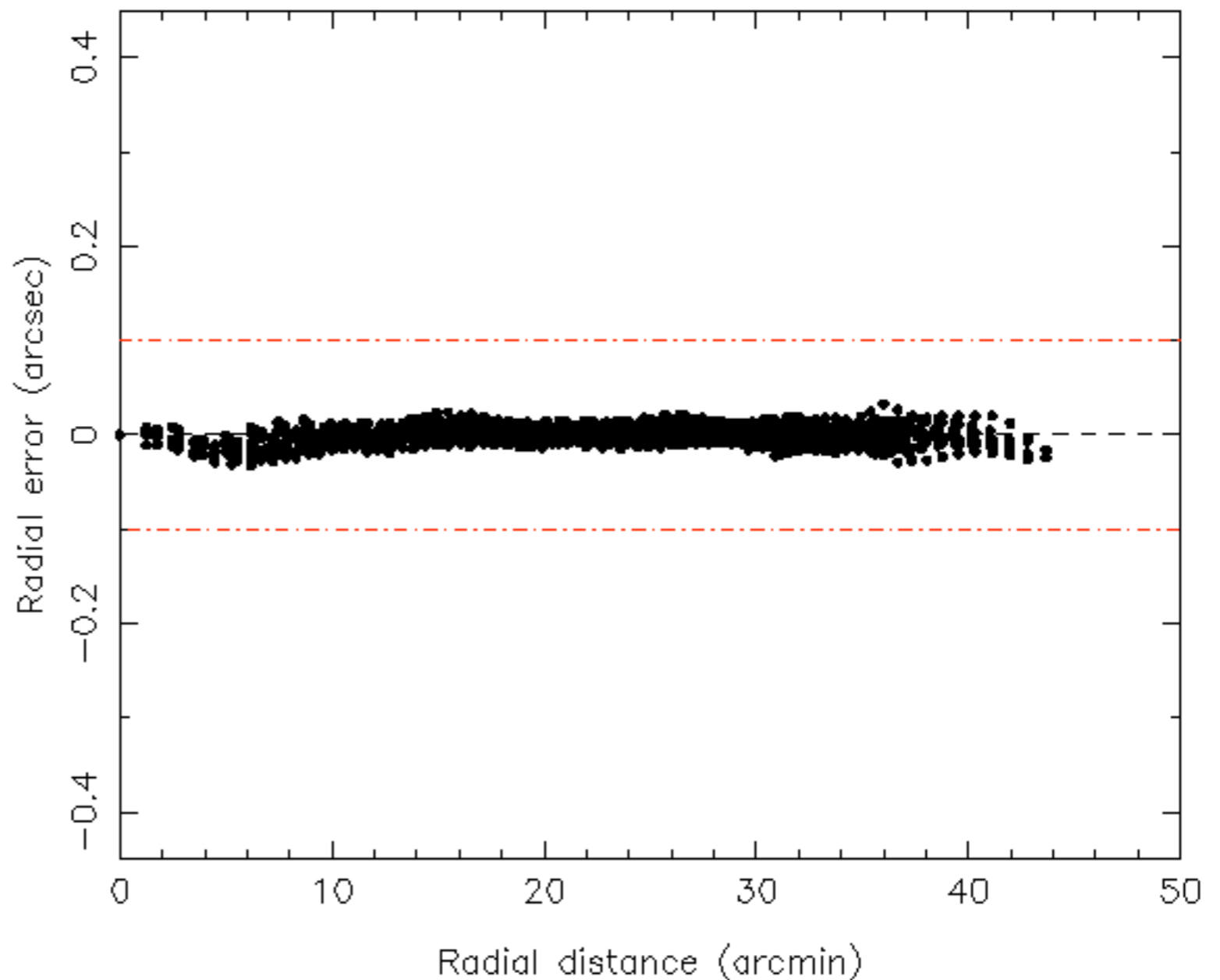
$$\xi' = ax' + by' + c$$

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

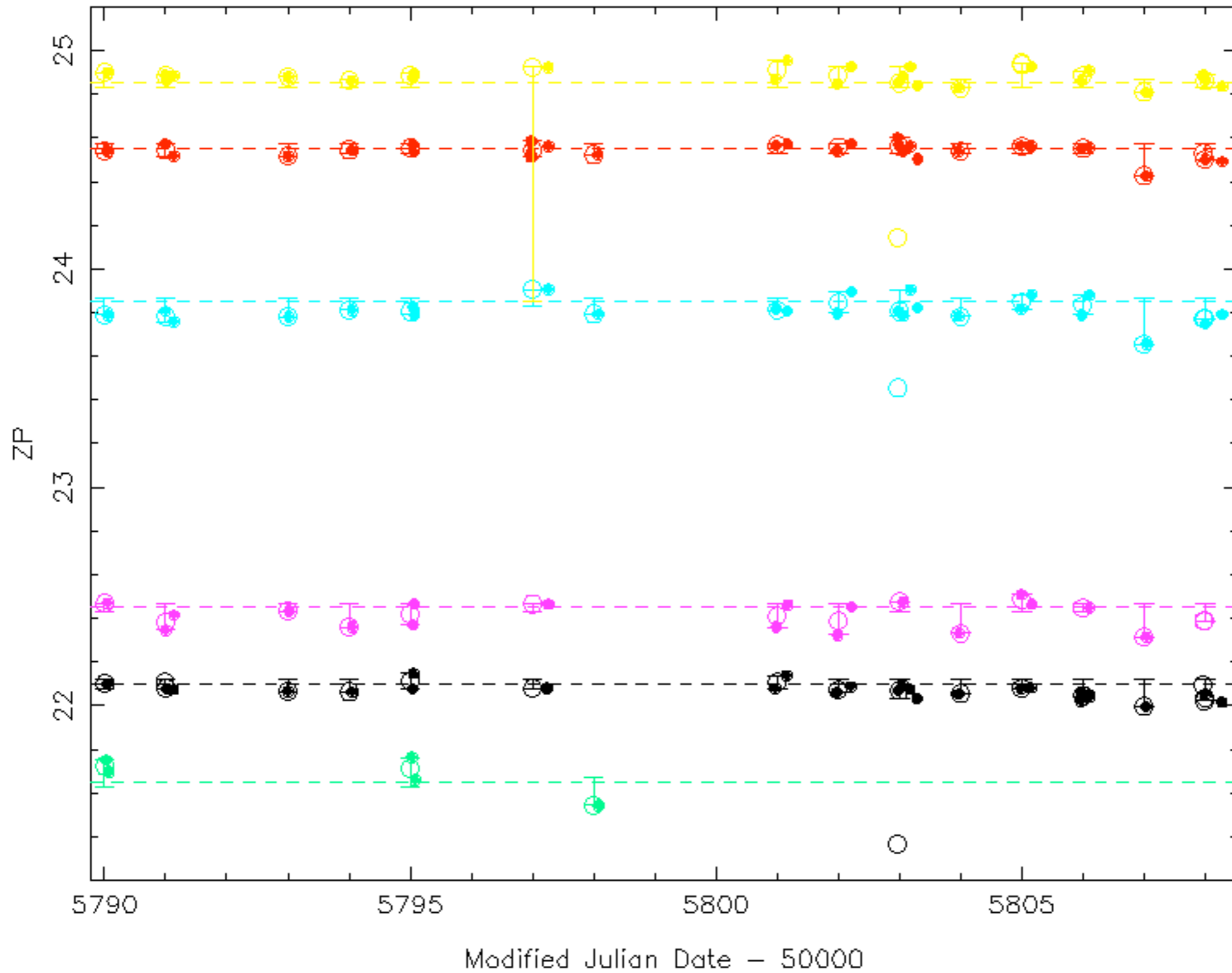
→ rms 100 mas

Tabulated
systematics
from stacked
residuals

→ sys < 20 mas



Photometric Calibration SA's



g

r

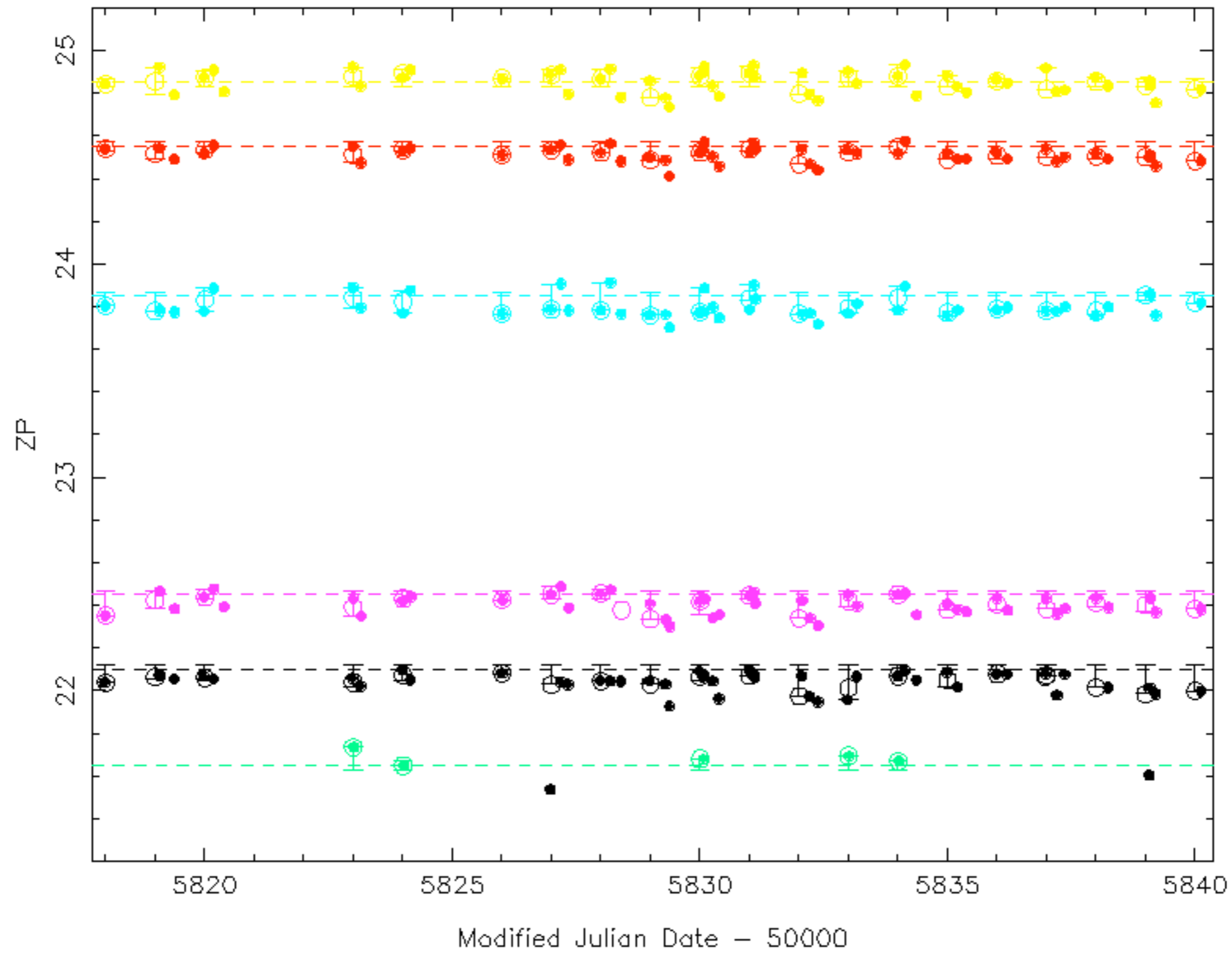
i

z

u

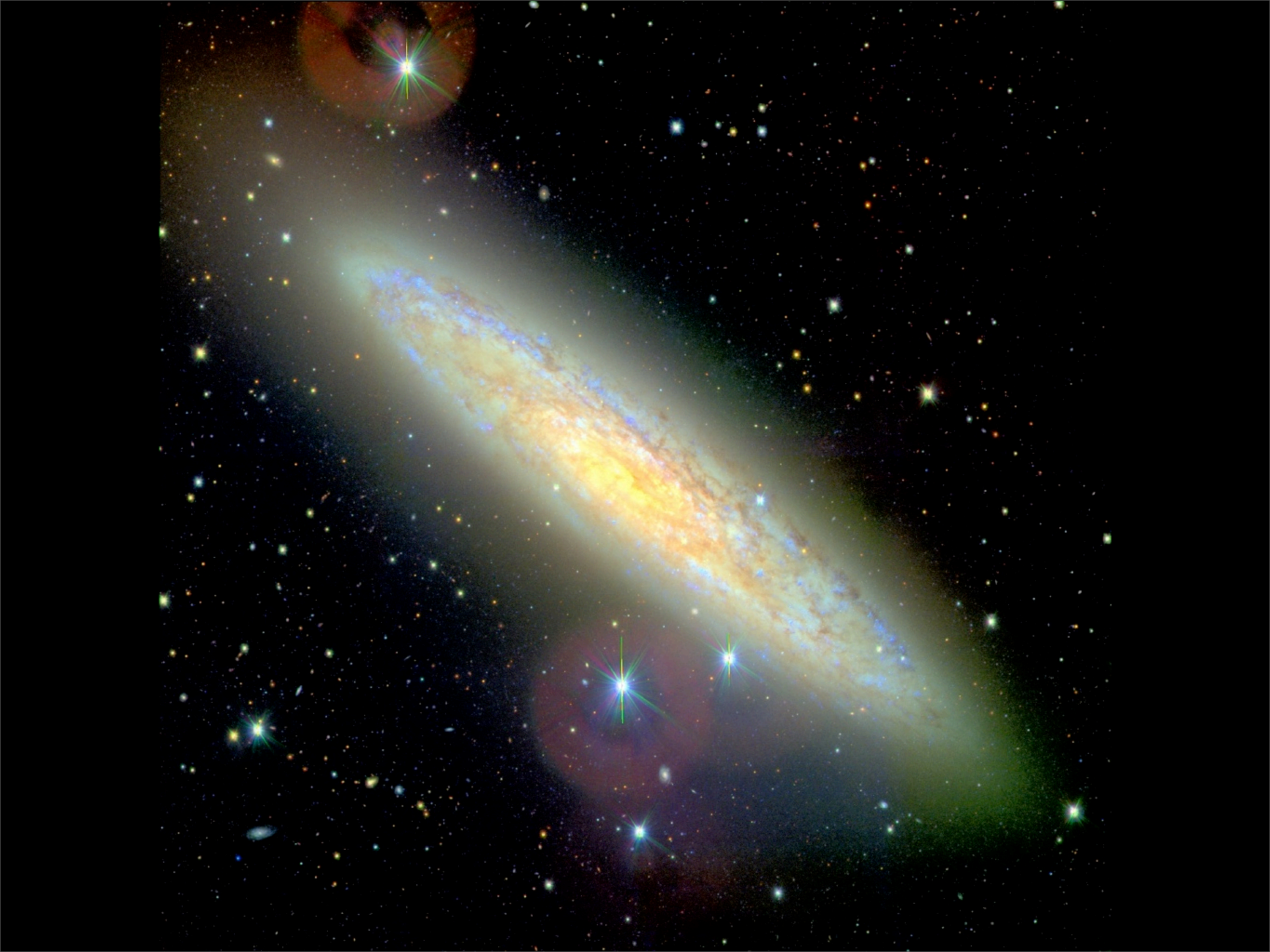
Ha

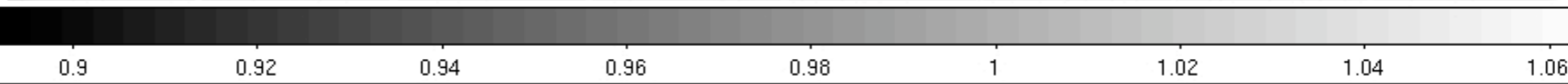
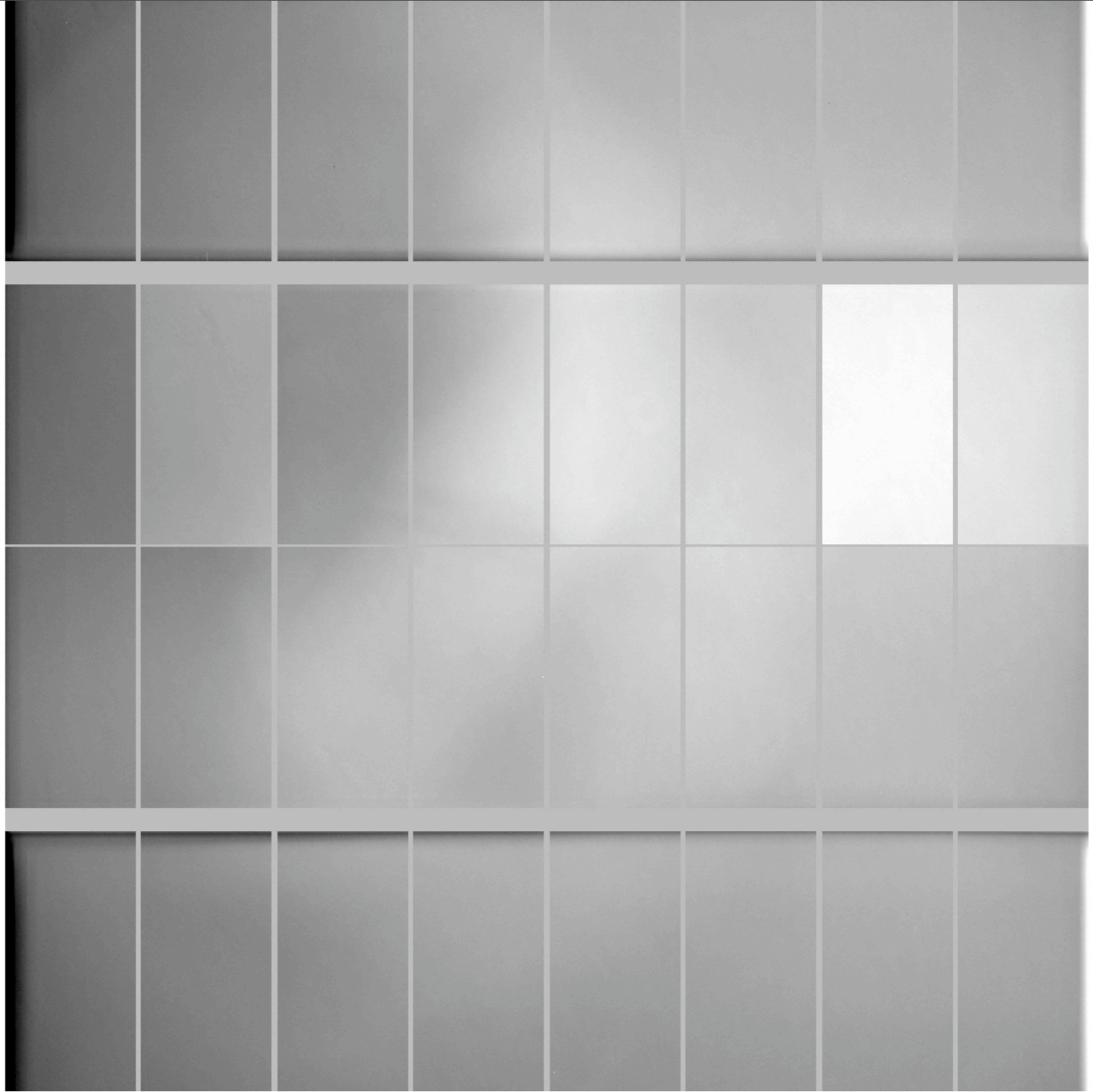
Photometric Calibration SA's



g
r
i
z
u
Ha

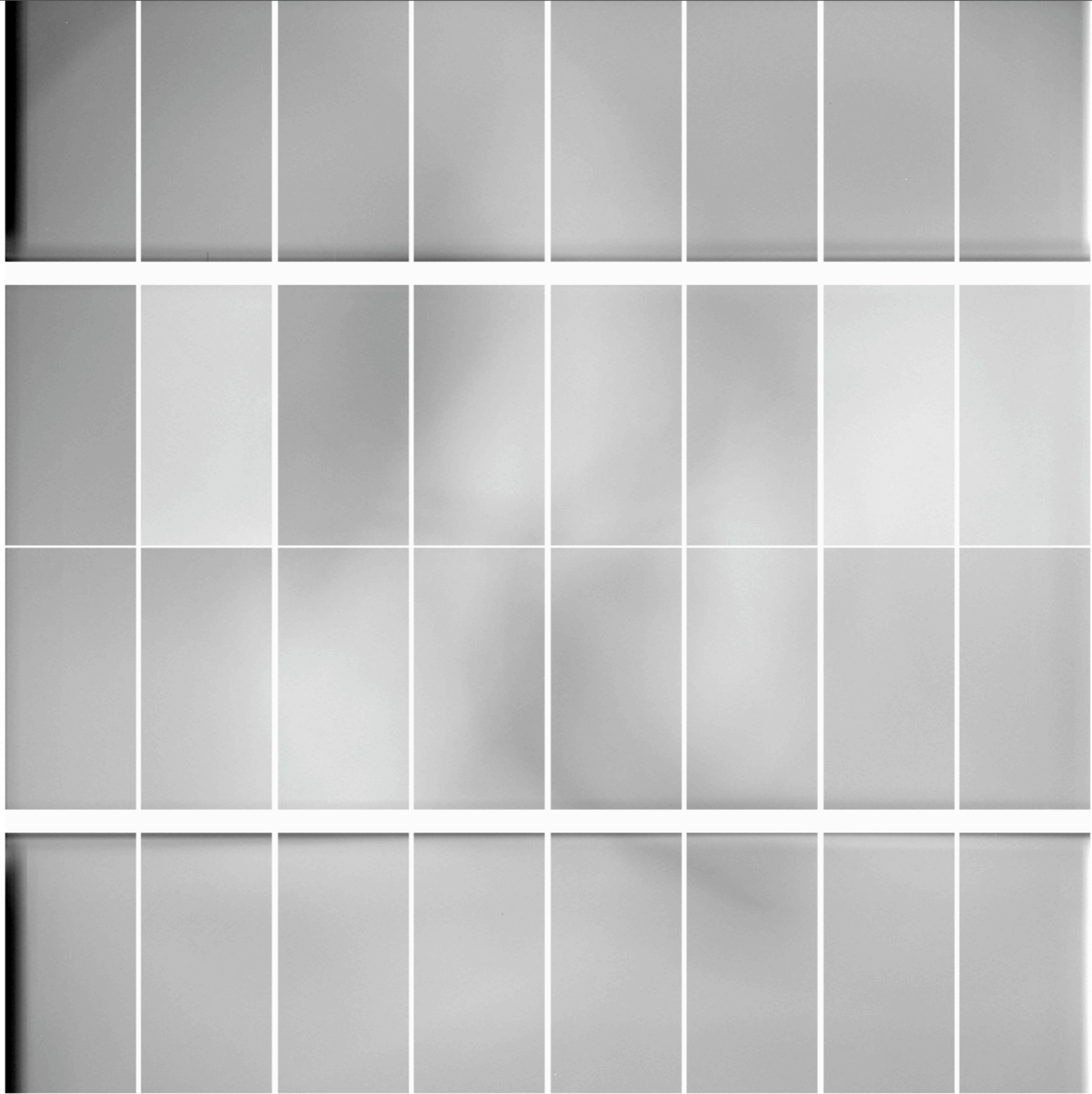
Filter positioning
detector "gain" variations
scattered light





ratio
monthly
master
twilight flats

r-band
i-band

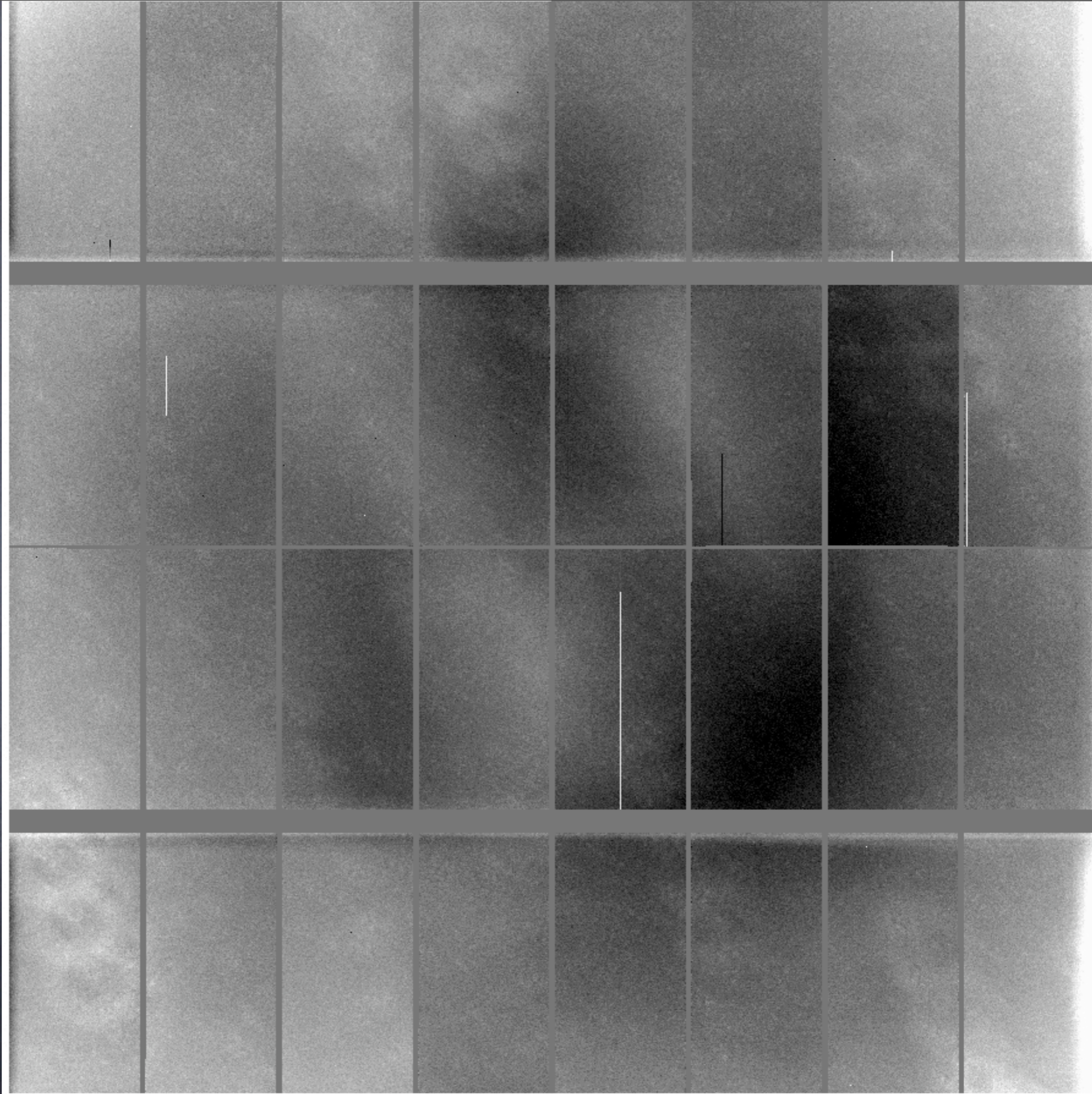


0.88 0.9 0.92 0.94 0.96 0.98 1 1.02 1.04

ratio
monthly
master
twilight flats

r-band
i-band

r-band
darksky
stacks



5

220

225

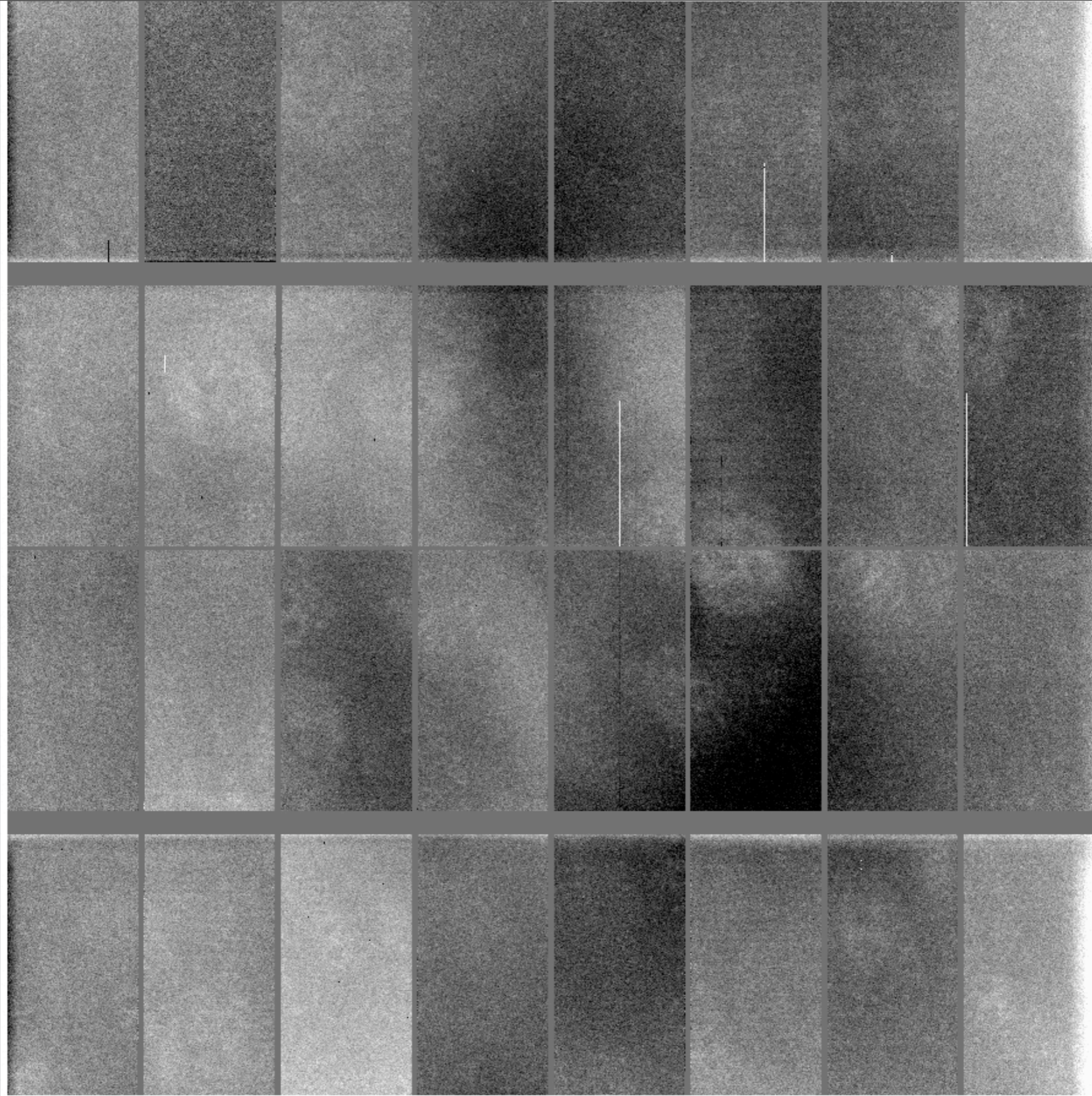
230

235

240

24

r-band
darksky
stacks



8

59

60

61

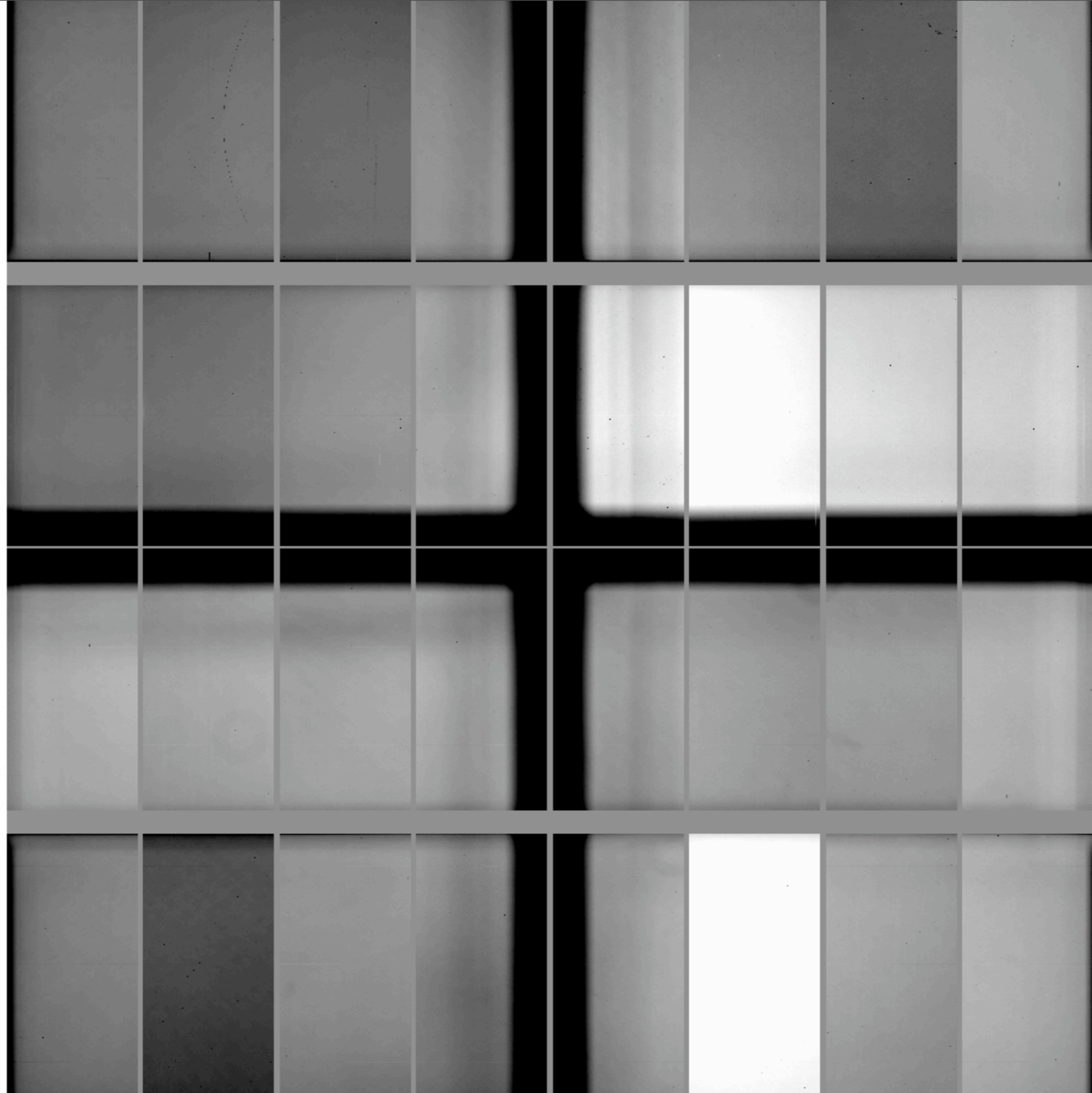
62

63

64

65

Halpha
monthly
flats &
ratio



0.85

0.9

0.95

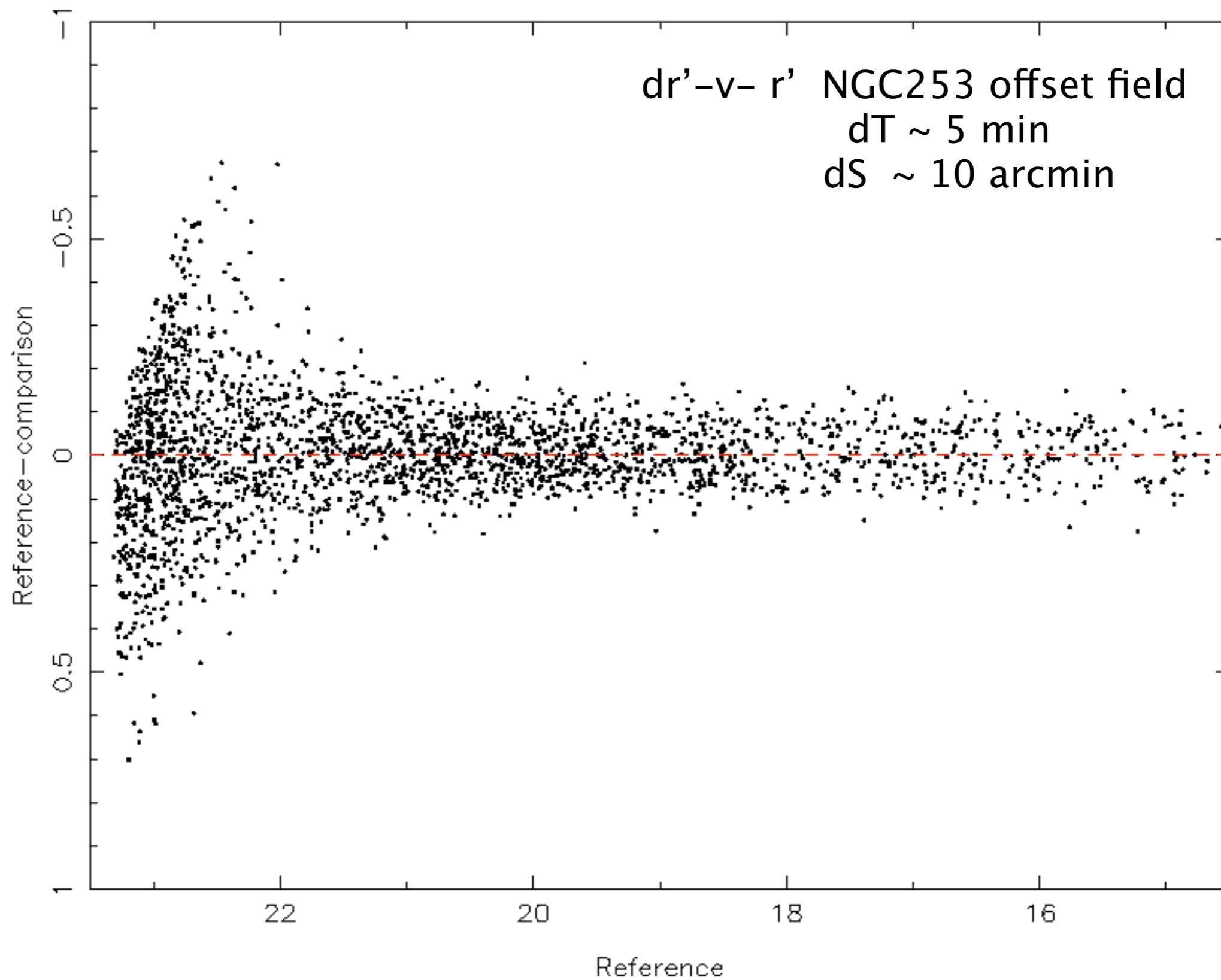
1

1.05

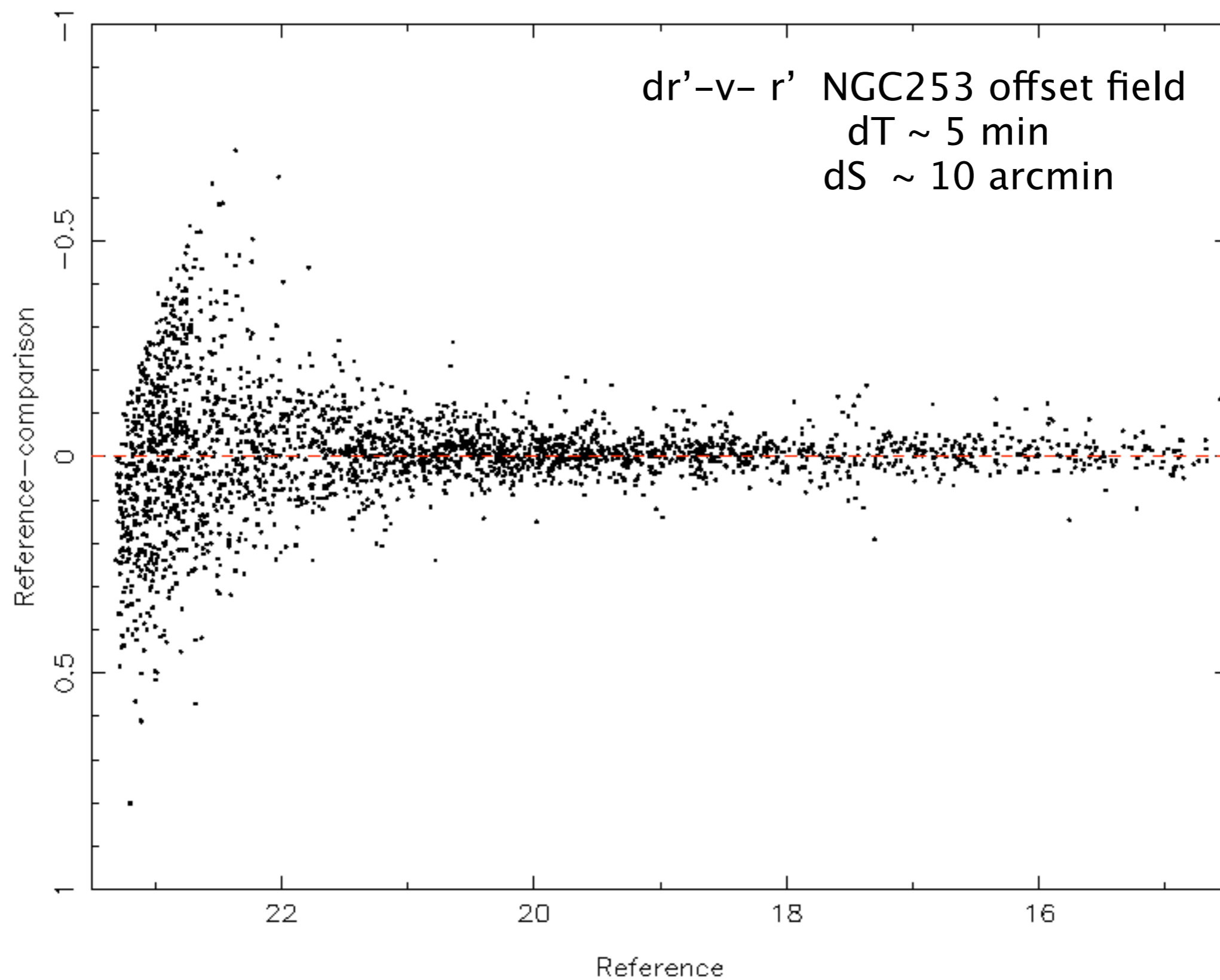
1.1

1.15

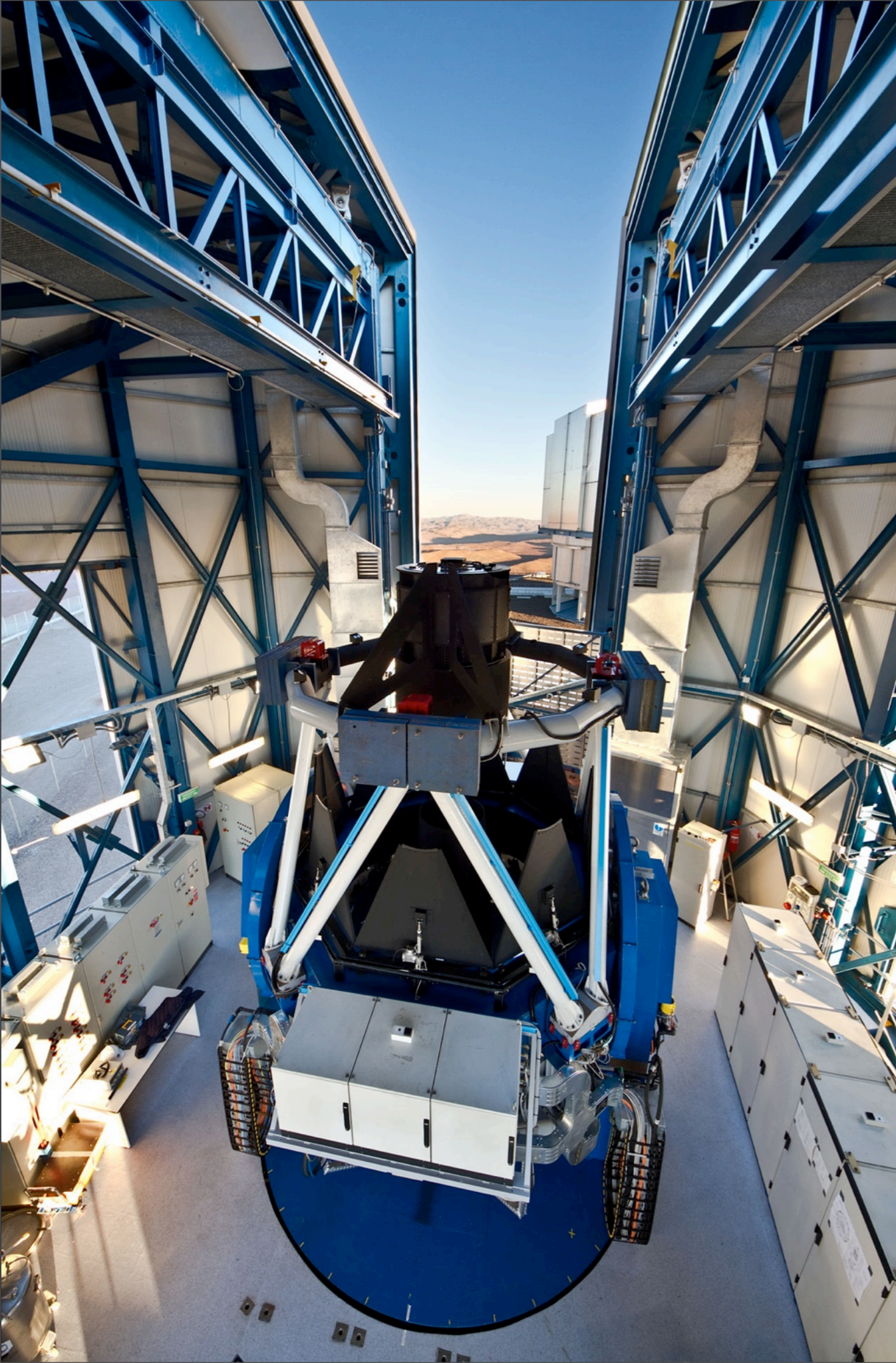
Magnitudes of matched objects



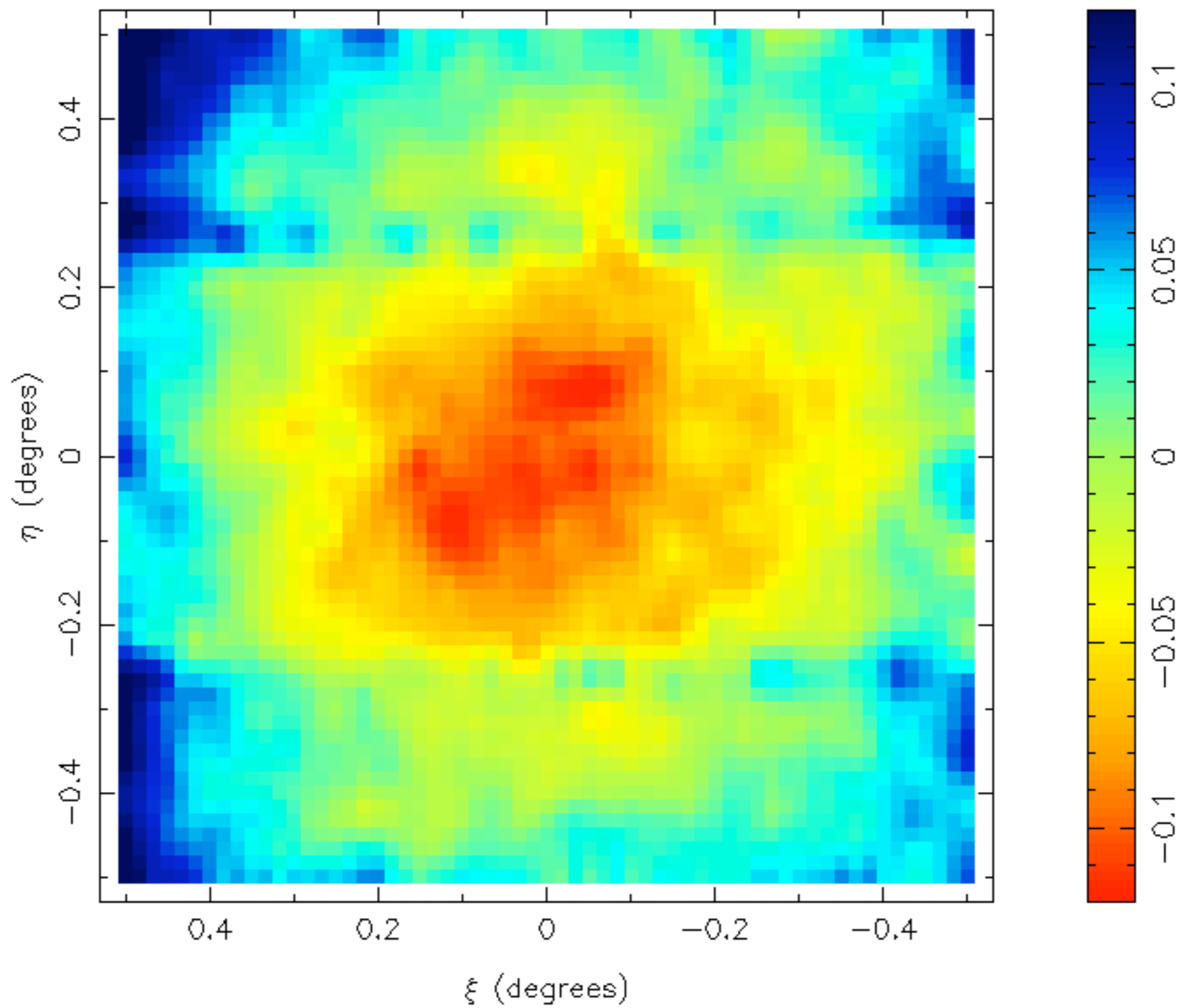
Magnitudes of matched objects



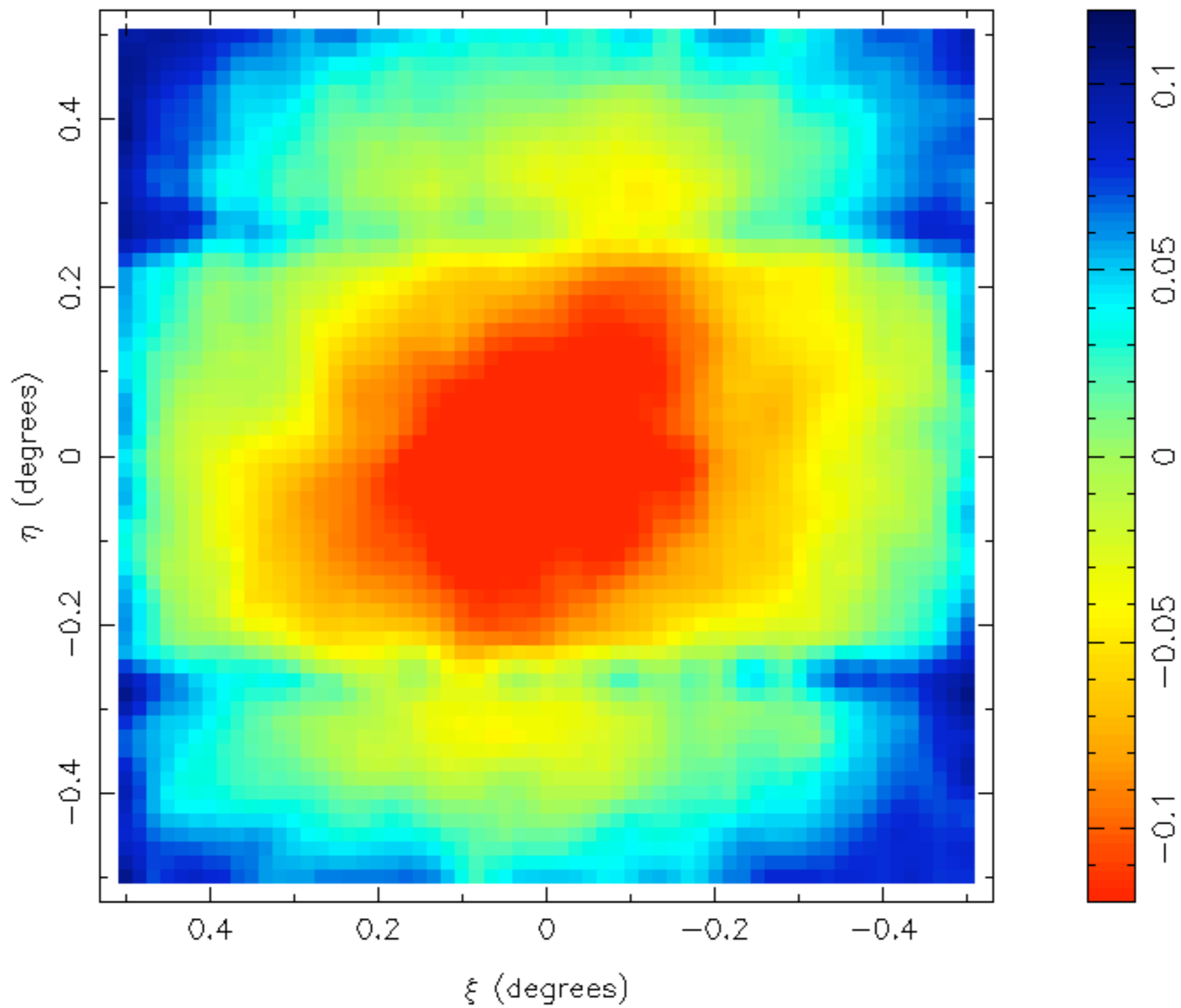




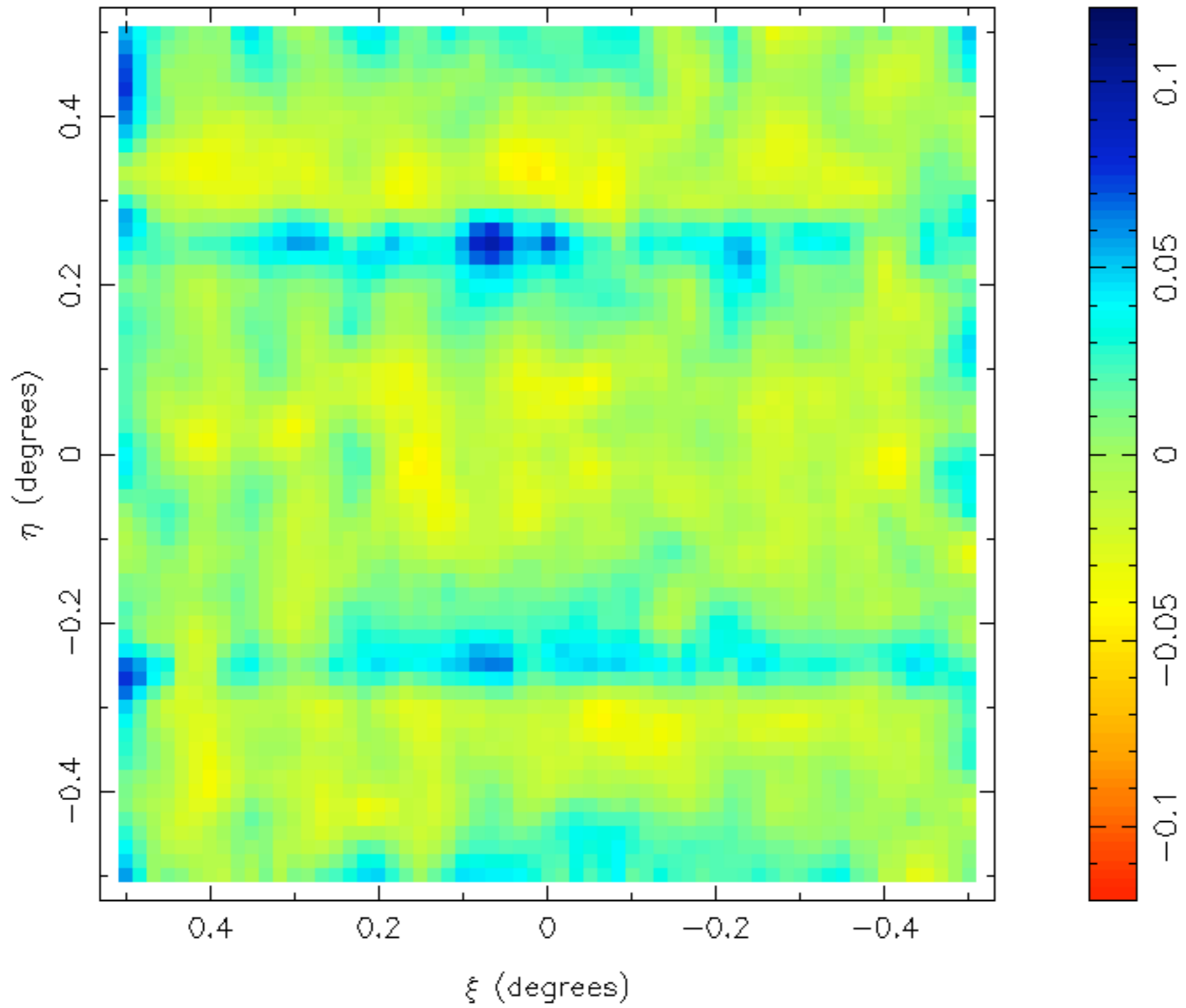
Illumination corrections i,z-band – derived from 2MASS



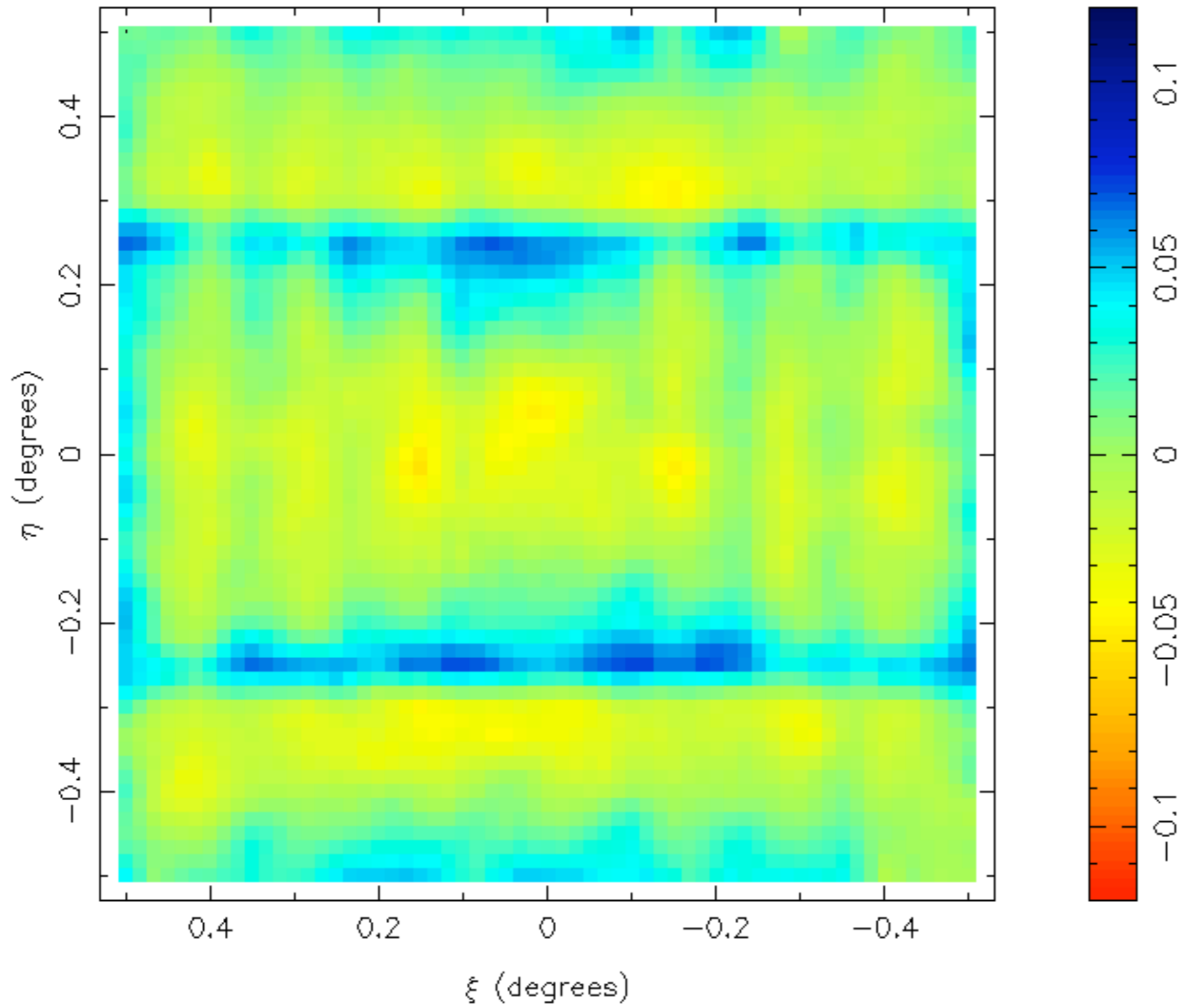
Illumination corrections i,z-band – derived from 2MASS



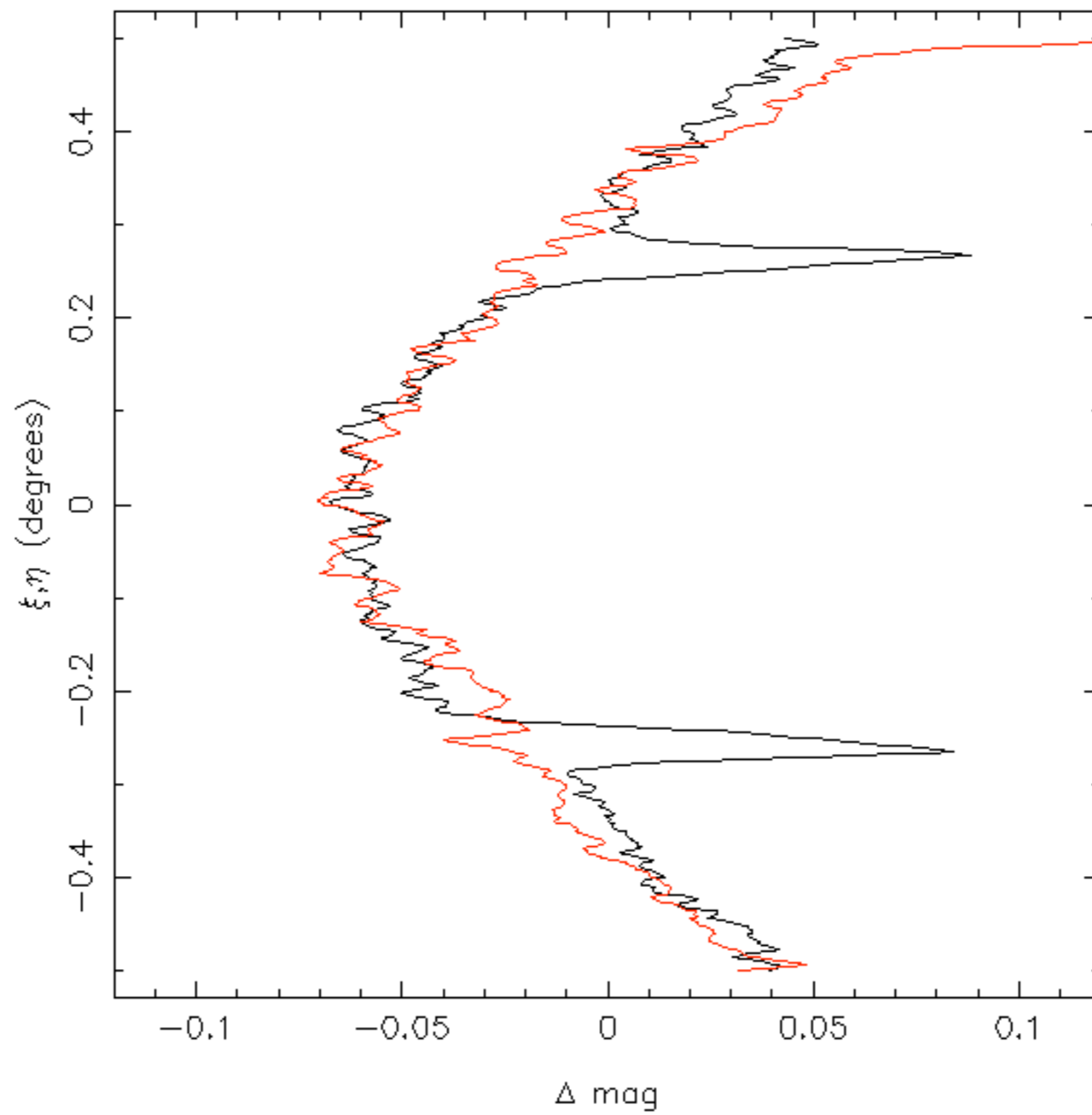
Illumination corrections i,z-band (detector-level fix)

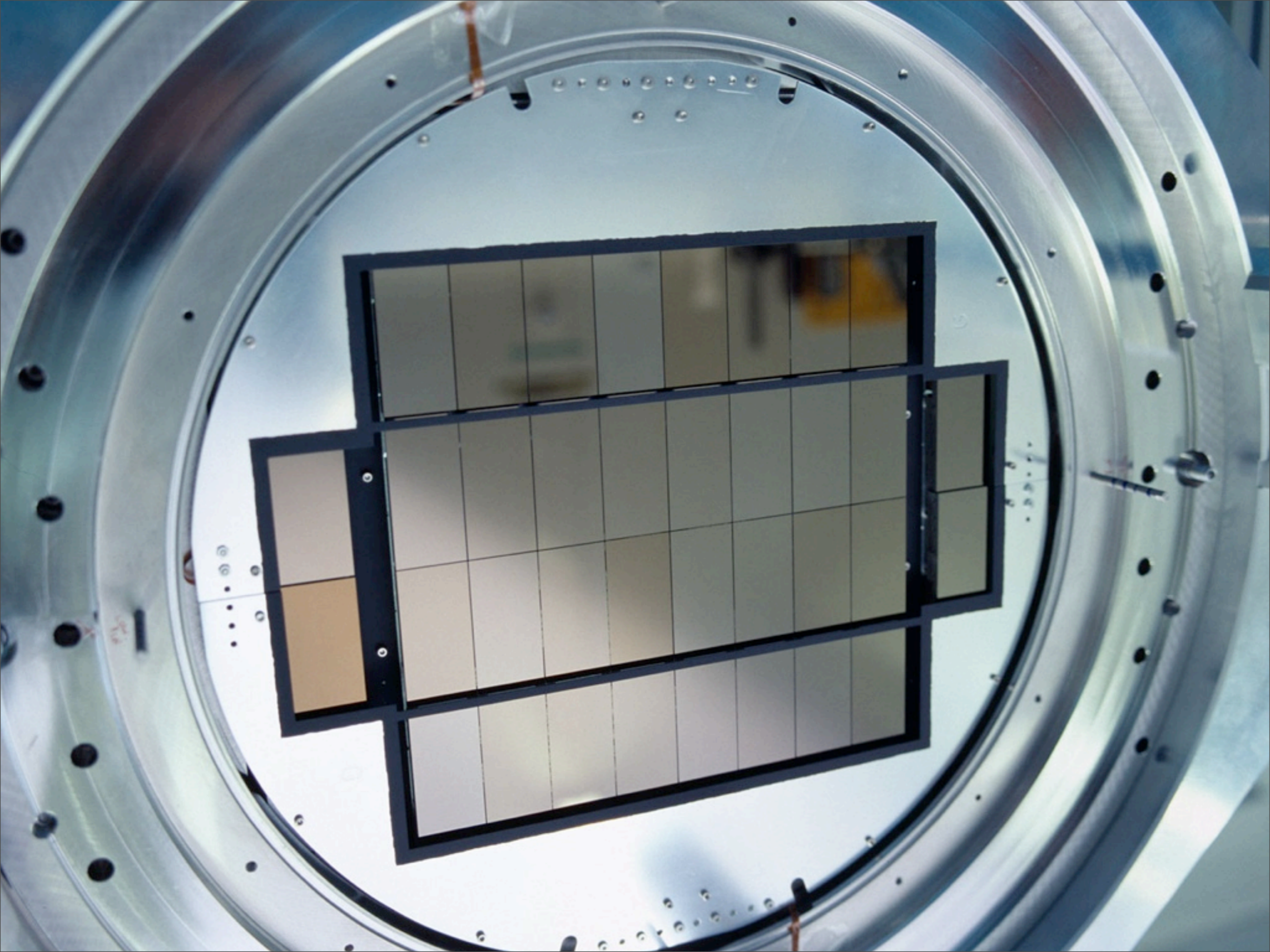


Illumination corrections i,z-band (detector-level fix)

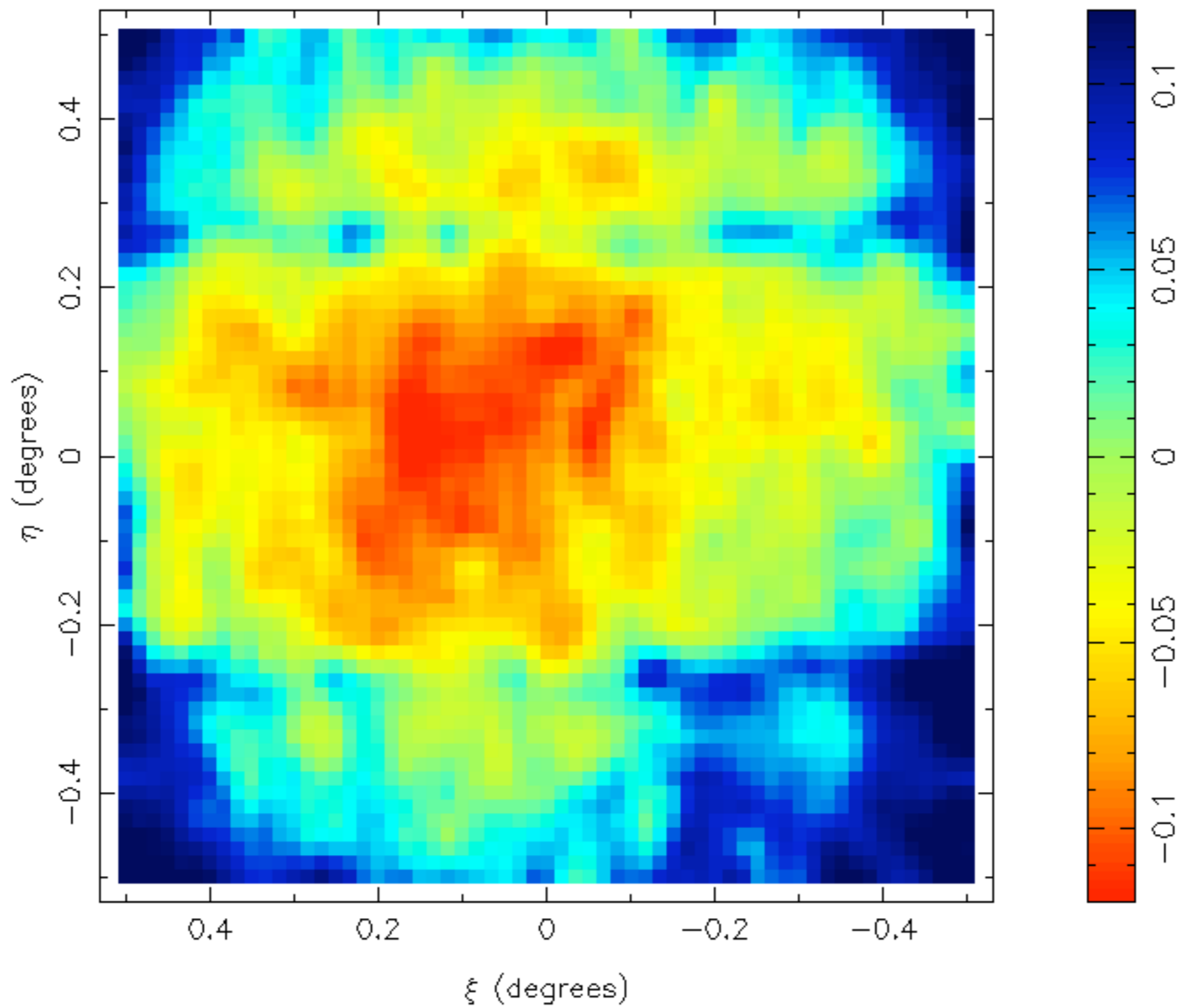


Illumination corrections i-band (marginal sums)

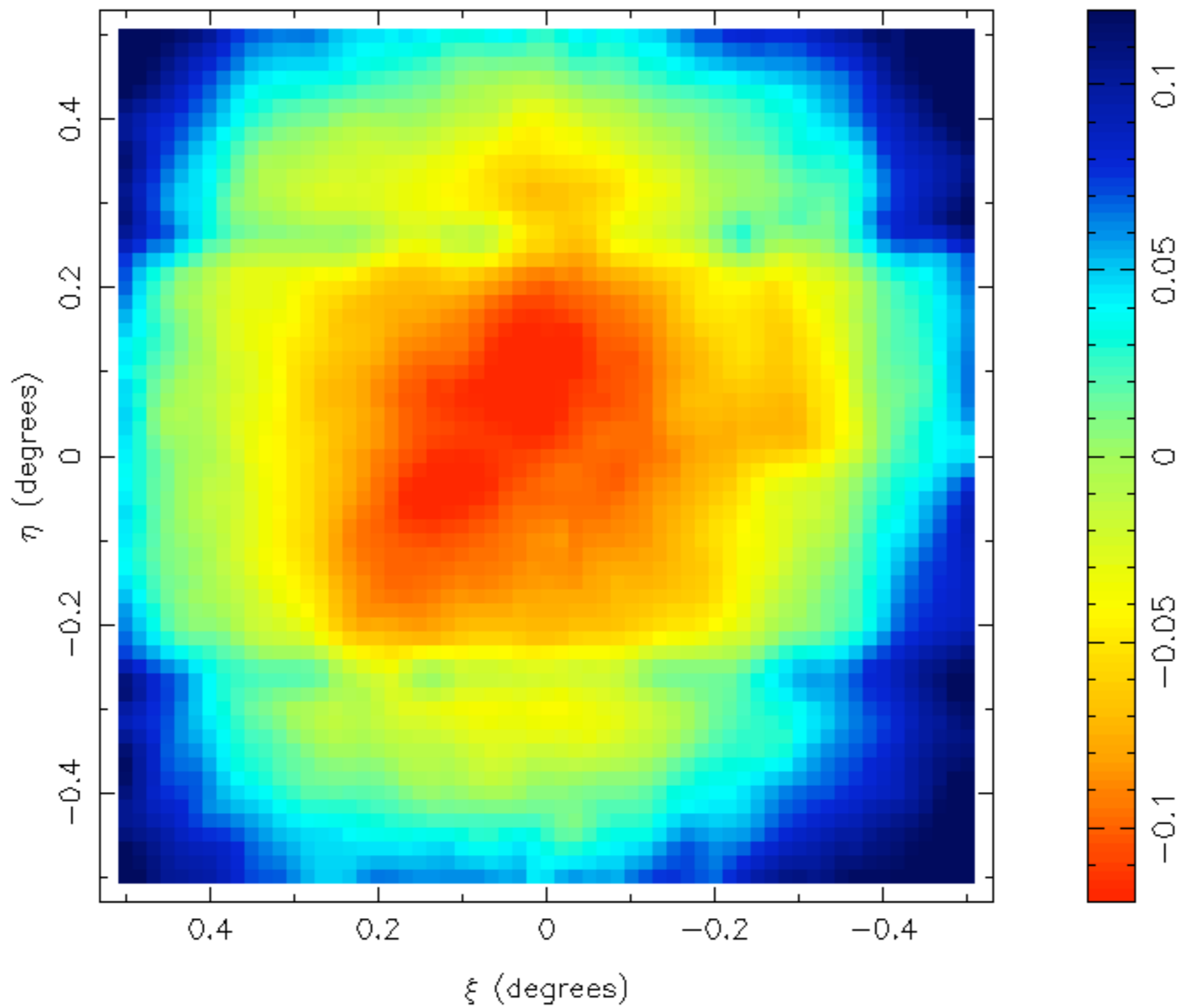




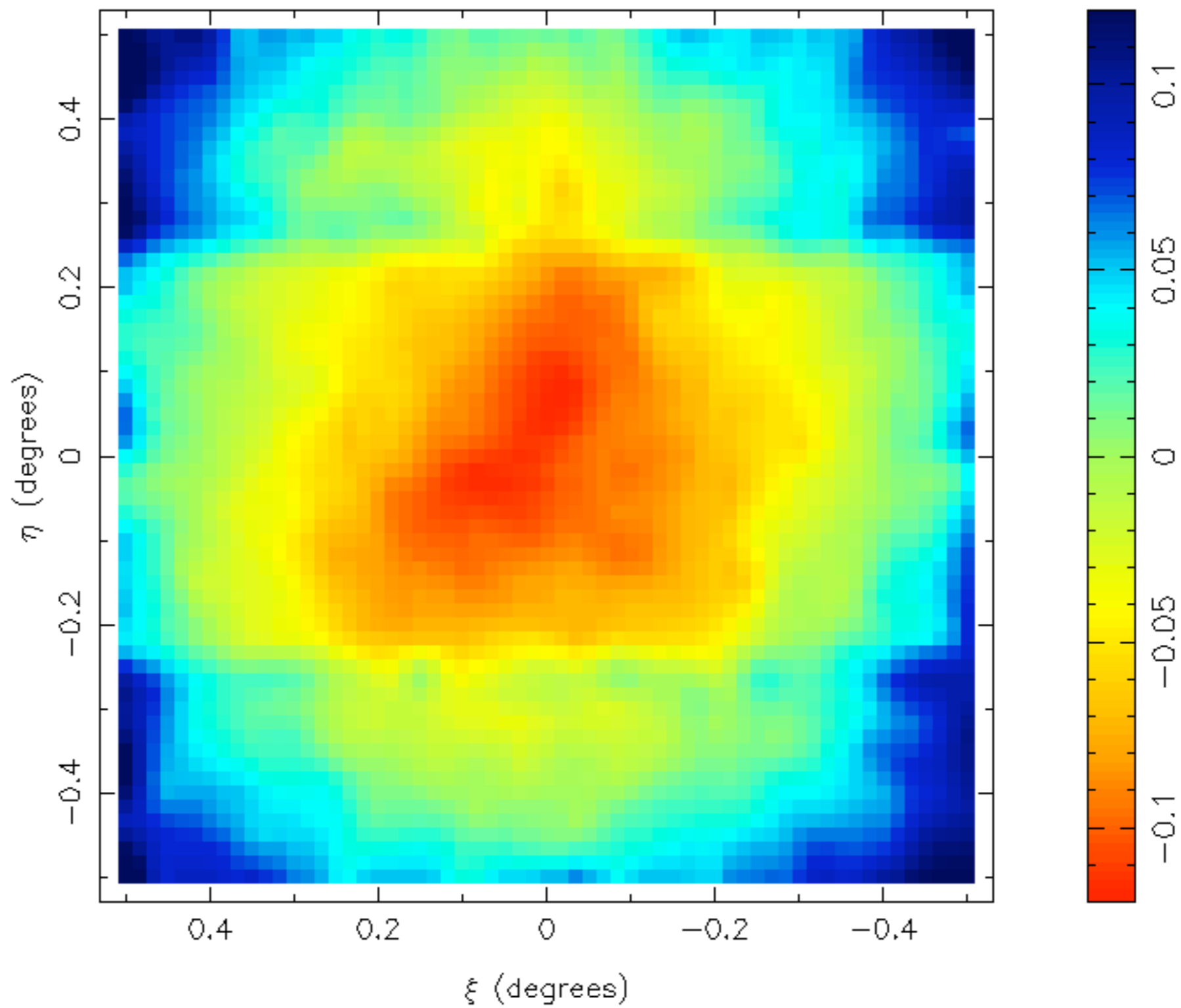
Illumination corrections u,g,r-band – derived from APASS



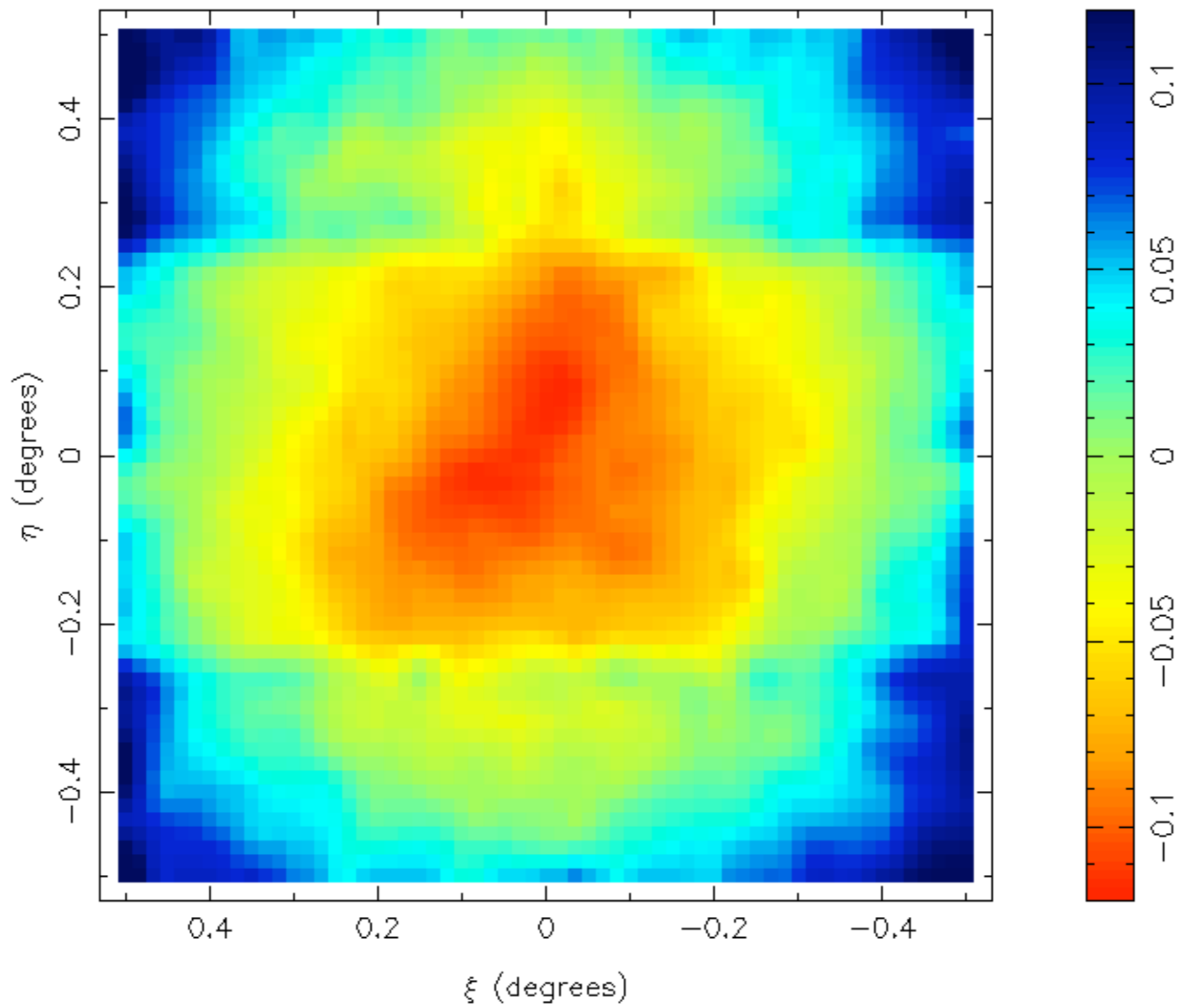
Illumination corrections u,g,r-band – derived from APASS



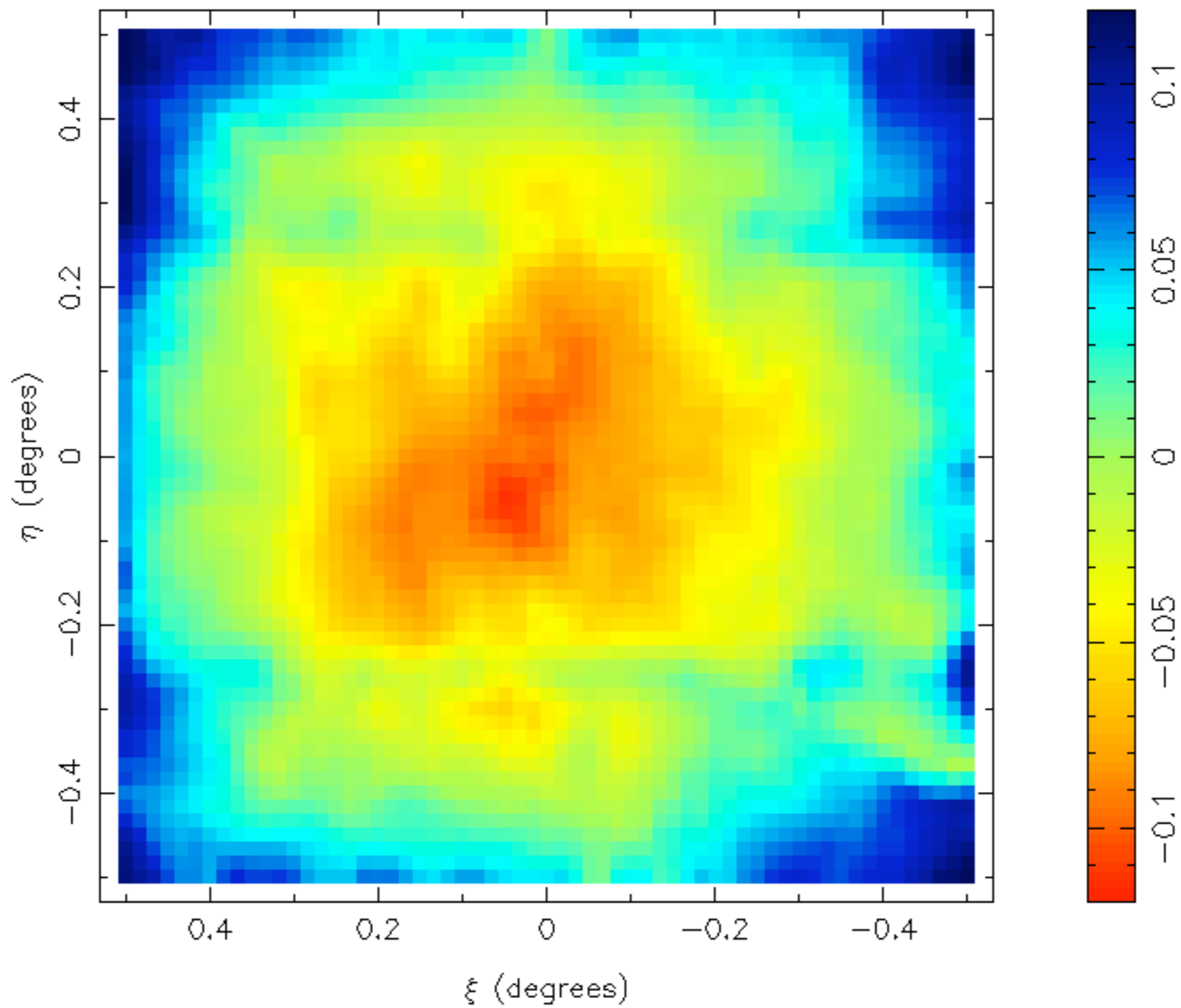
Illumination corrections u,g,r-band – derived from APASS



Illumination corrections r-band - APASS cf. SDSS



Illumination corrections r-band - APASS cf. SDSS



Photometric calibration

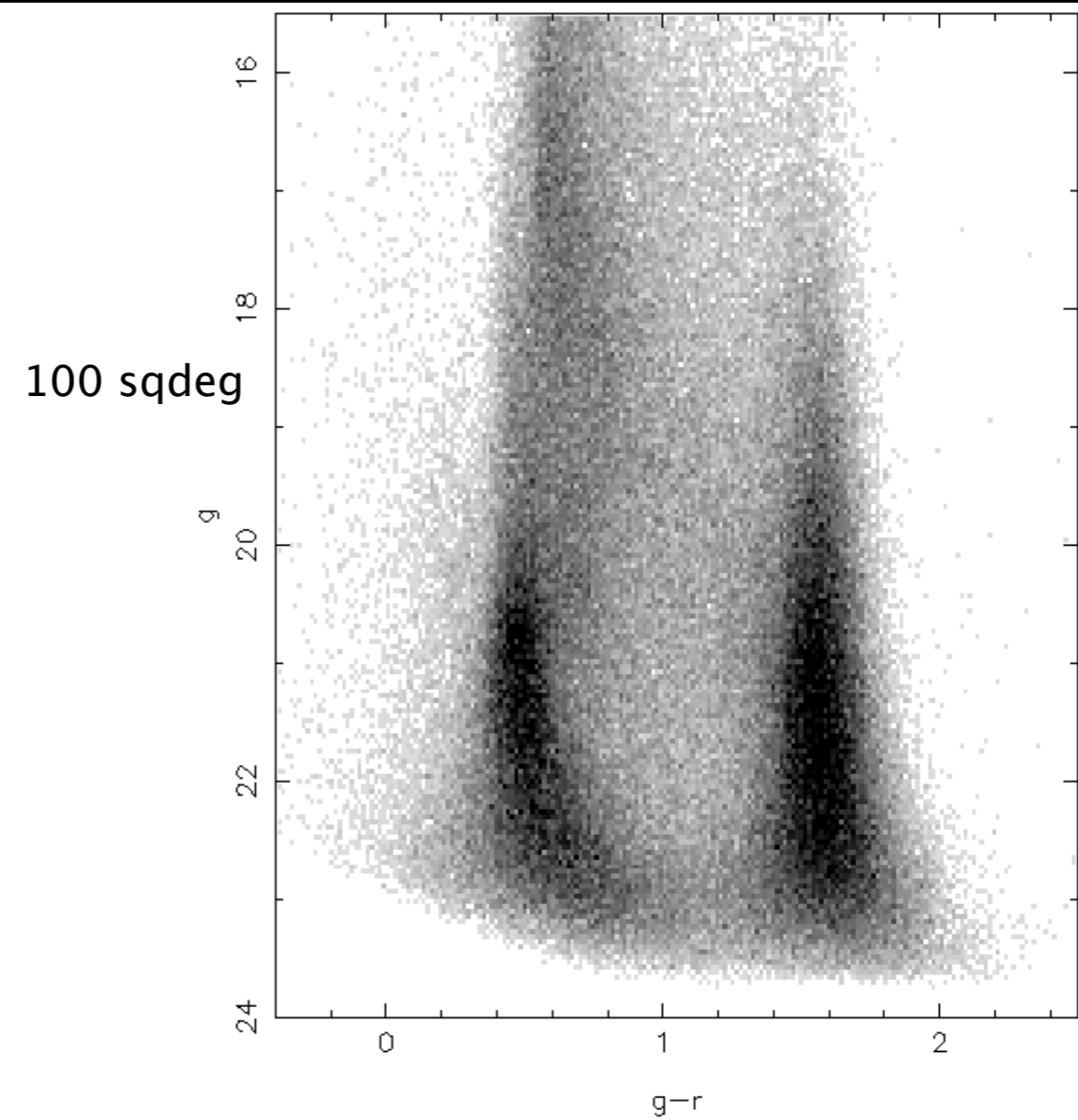
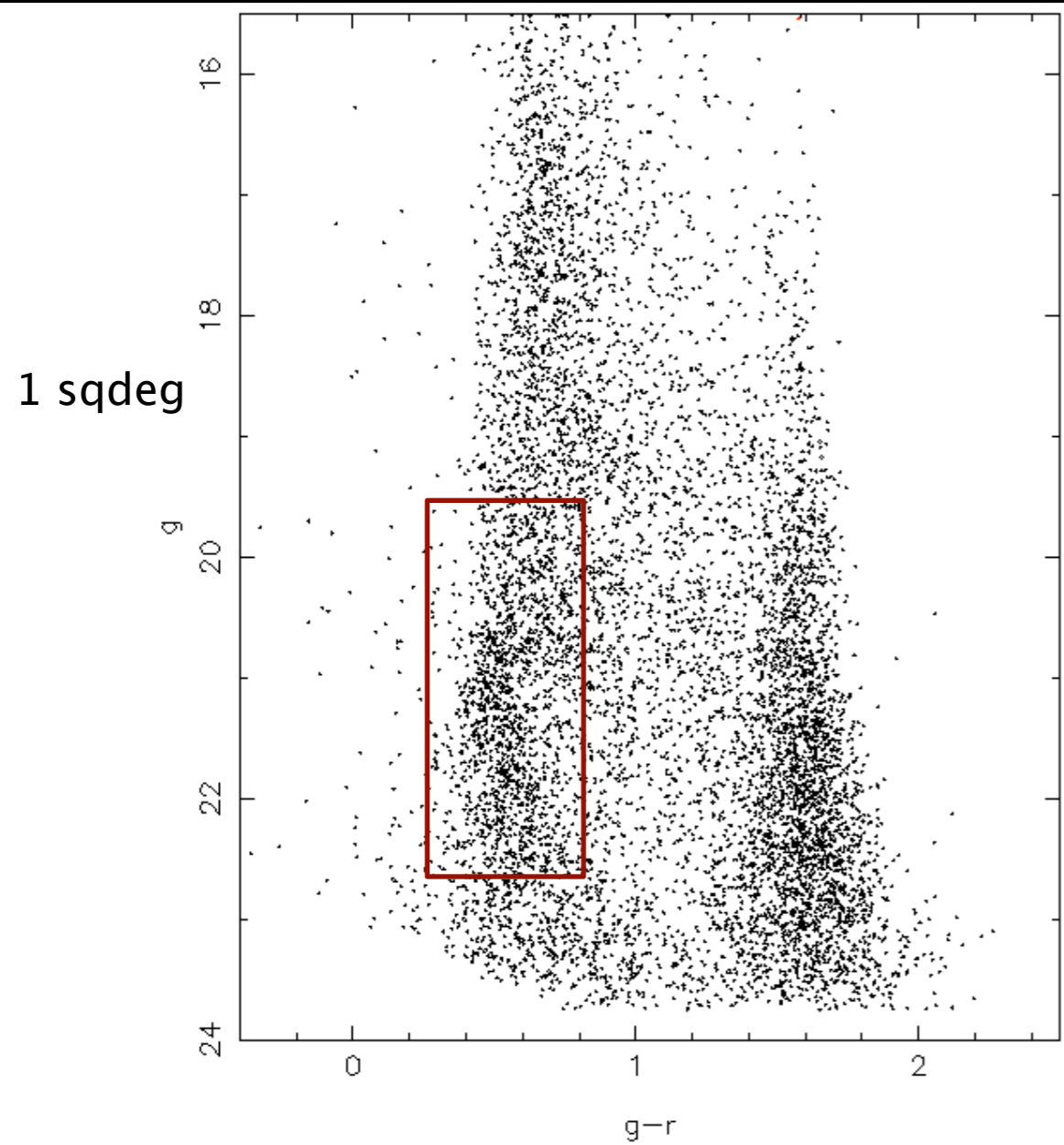
- internal gain calibration from twilight flats + dark skies
- STD field observations for 1st-pass calibration
incl. celestial pole at -89deg for extinction measures ??
- 2MASS to measure i- and z-band, APASS and SDSS SA
to measure u- g- and r-band illumination corrections
- SDSS overlap (ATLAS) to independently monitor/
measure illumination correction for u,g,r,i,z bands
- ce's variation with detector and/or radius
- overlap calibration from contiguous areas
- skymapper to provide uniform calibration eventually ?

Illumination correction issues

- radial concentration of scattered light in optics
- detector level zero-point differences
- non-uniform non-astronomical scattered light
- scattering off masking strips and edges
- PSF variations over calibration frames

- solutions -> 2MASS, APASS, SDSS, Skymapper ??
- achieving robust $\pm 1\%$ accuracy at a resolution of 1 arcmin is difficult

ATLAS data to 30th Sep
137 fields with ugriz



ATLAS U-band issues

U-band v0.9

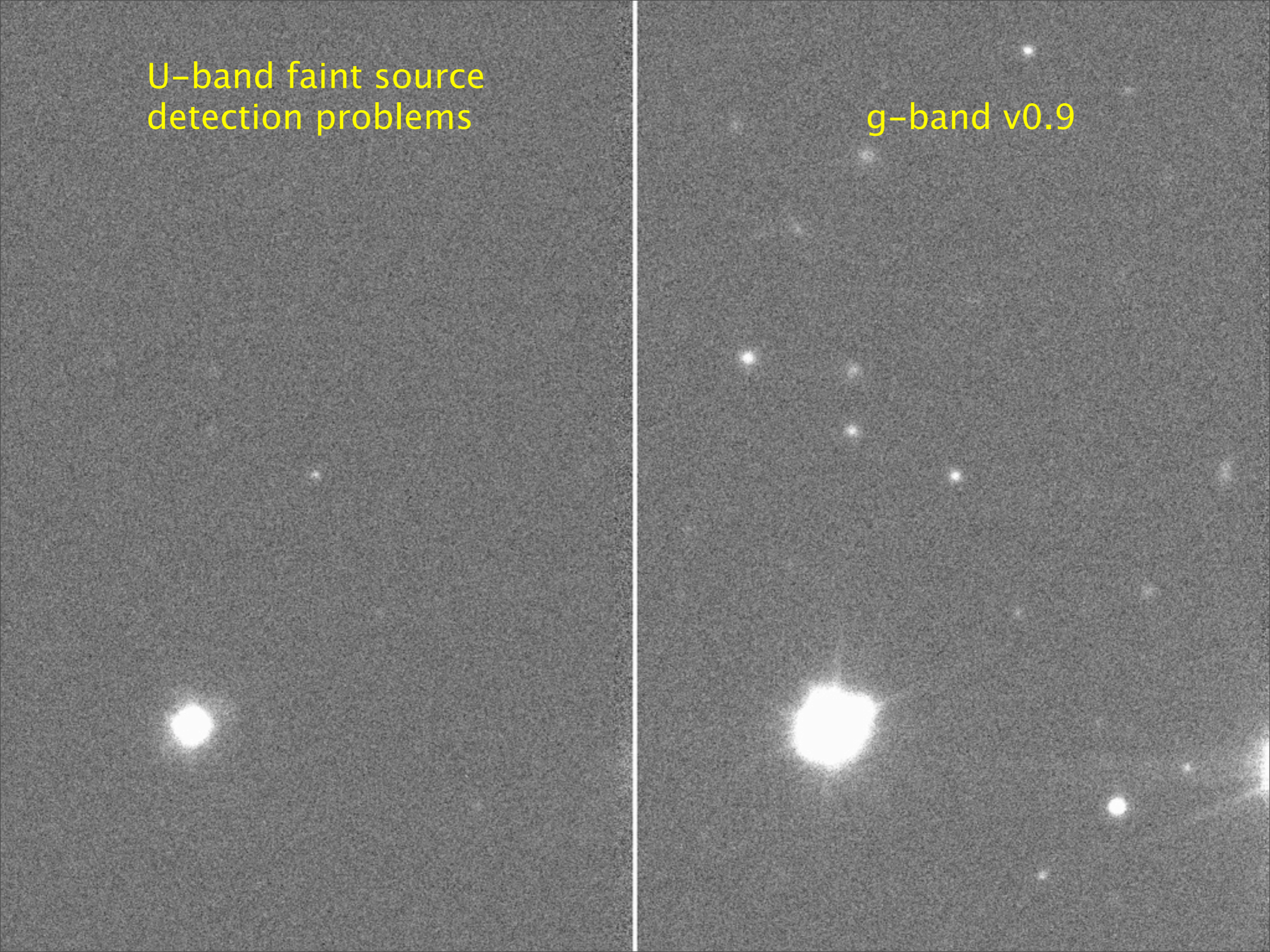


U-band v0.5

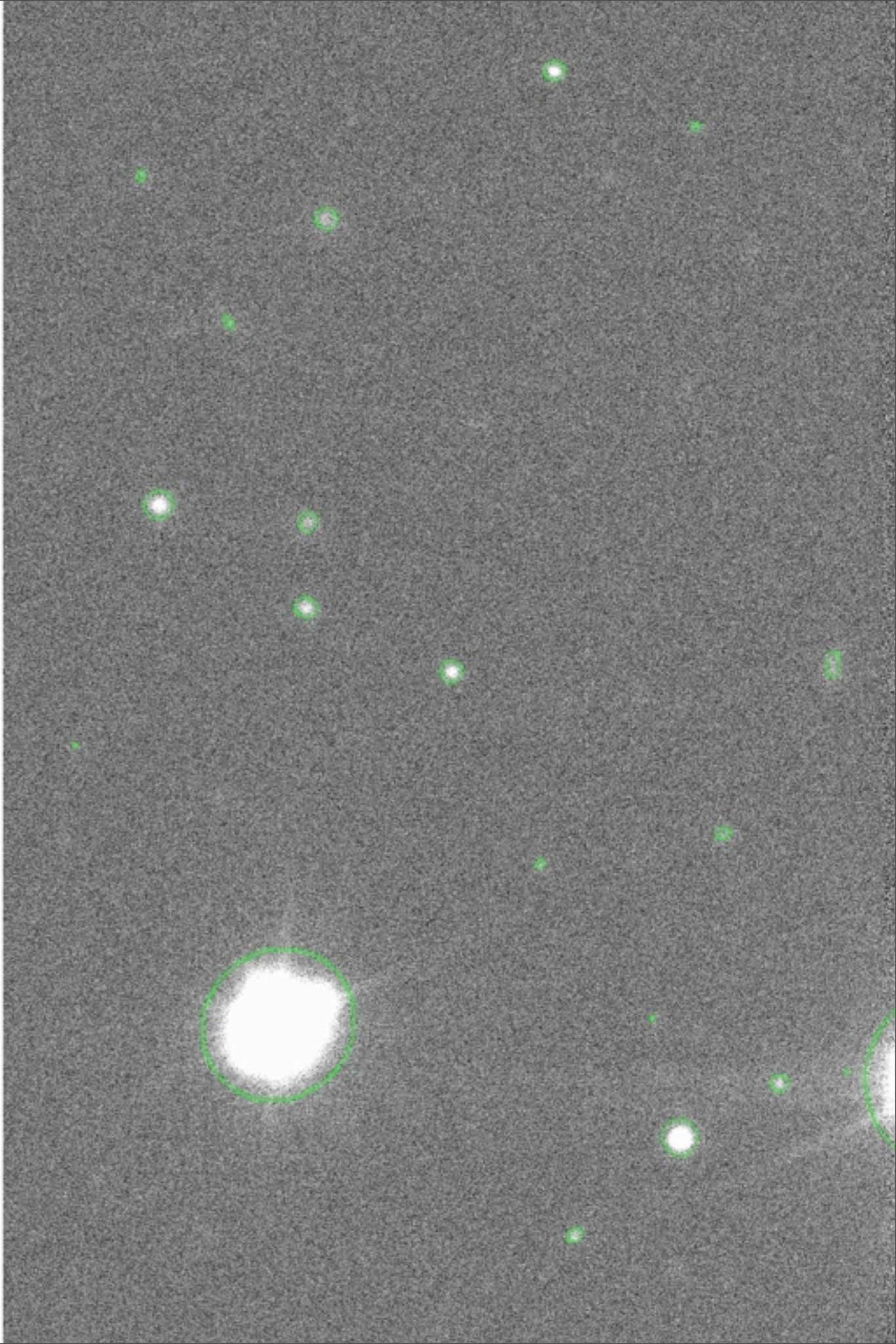


U-band faint source
detection problems

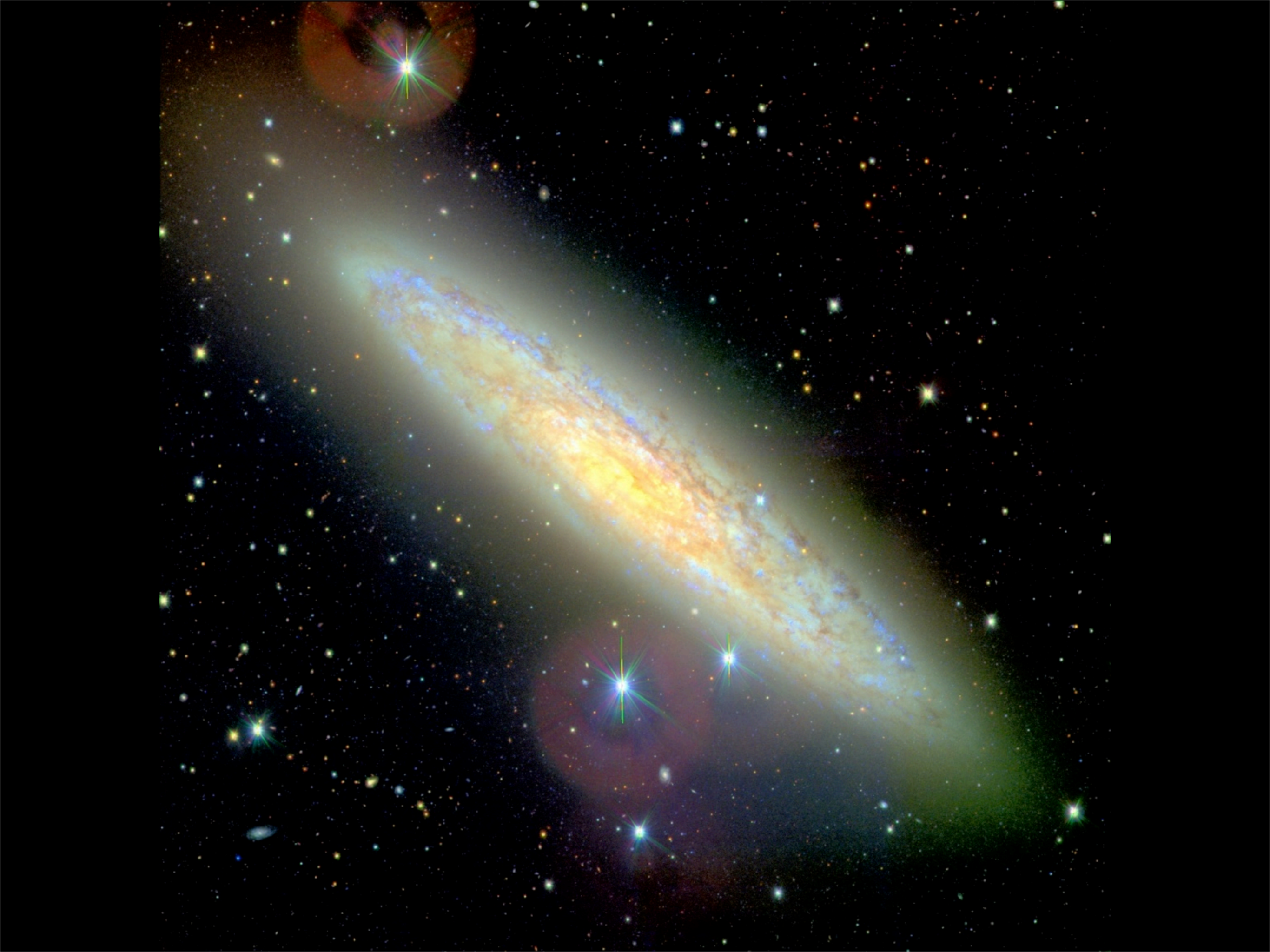
g-band v0.9



U-band faint source
detection problems



A quick-look at SV data



NGC253

u,g,r

u = 6216s

g = 1200s

r = 900s

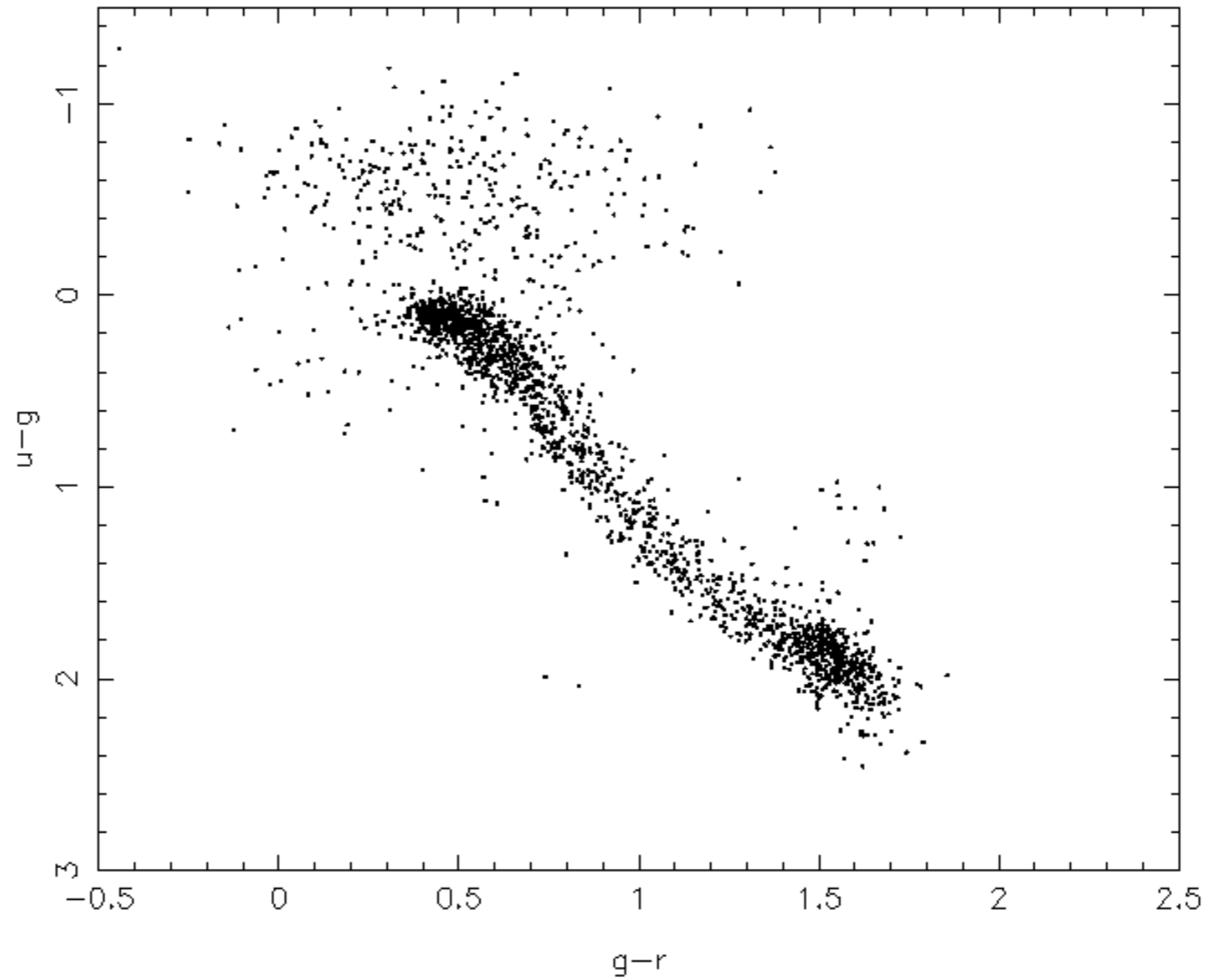
airmass 1.1

seeing 0.8

00h47-25d

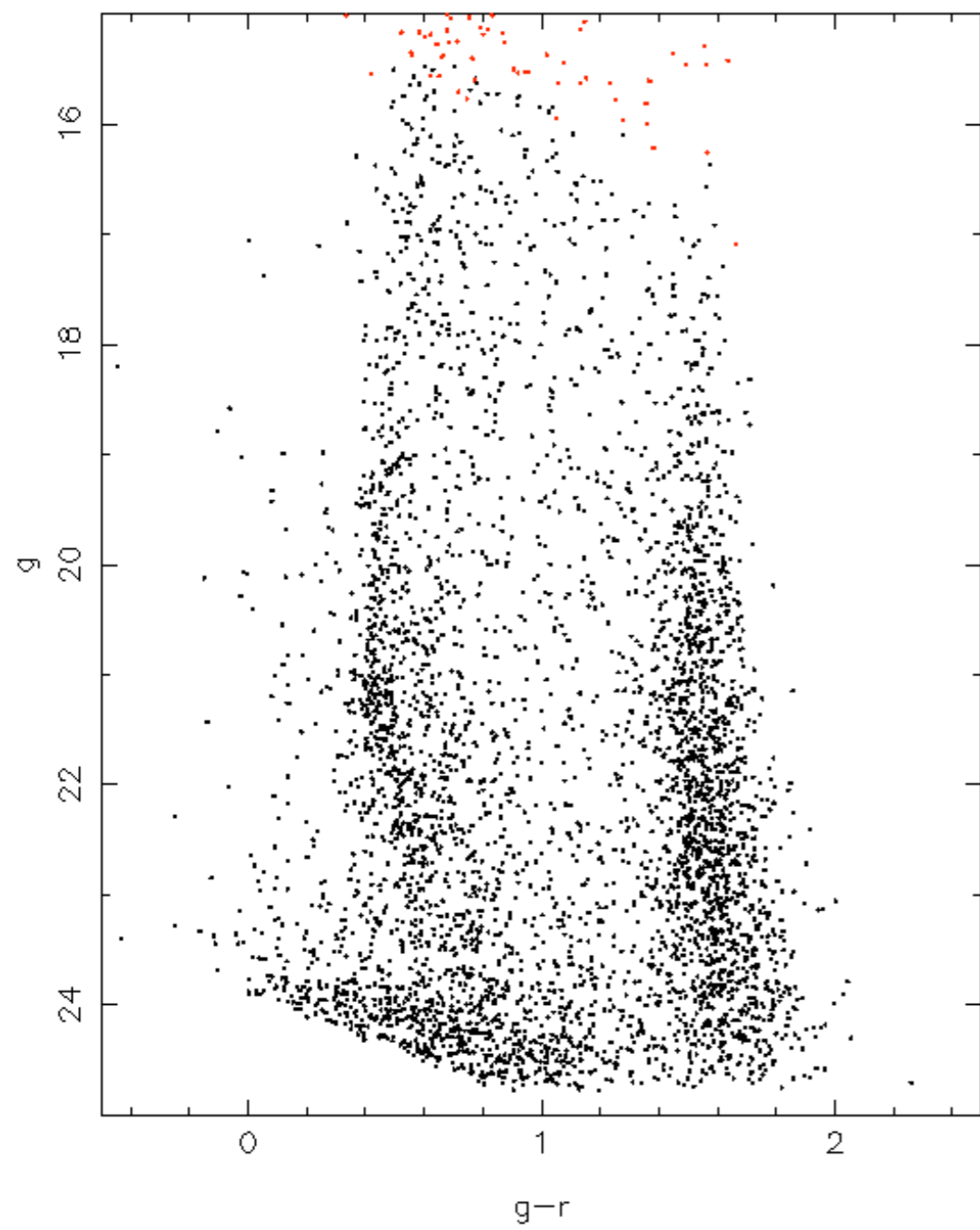
l,b=96.8,-88.0

$E(B-V)=0.02$

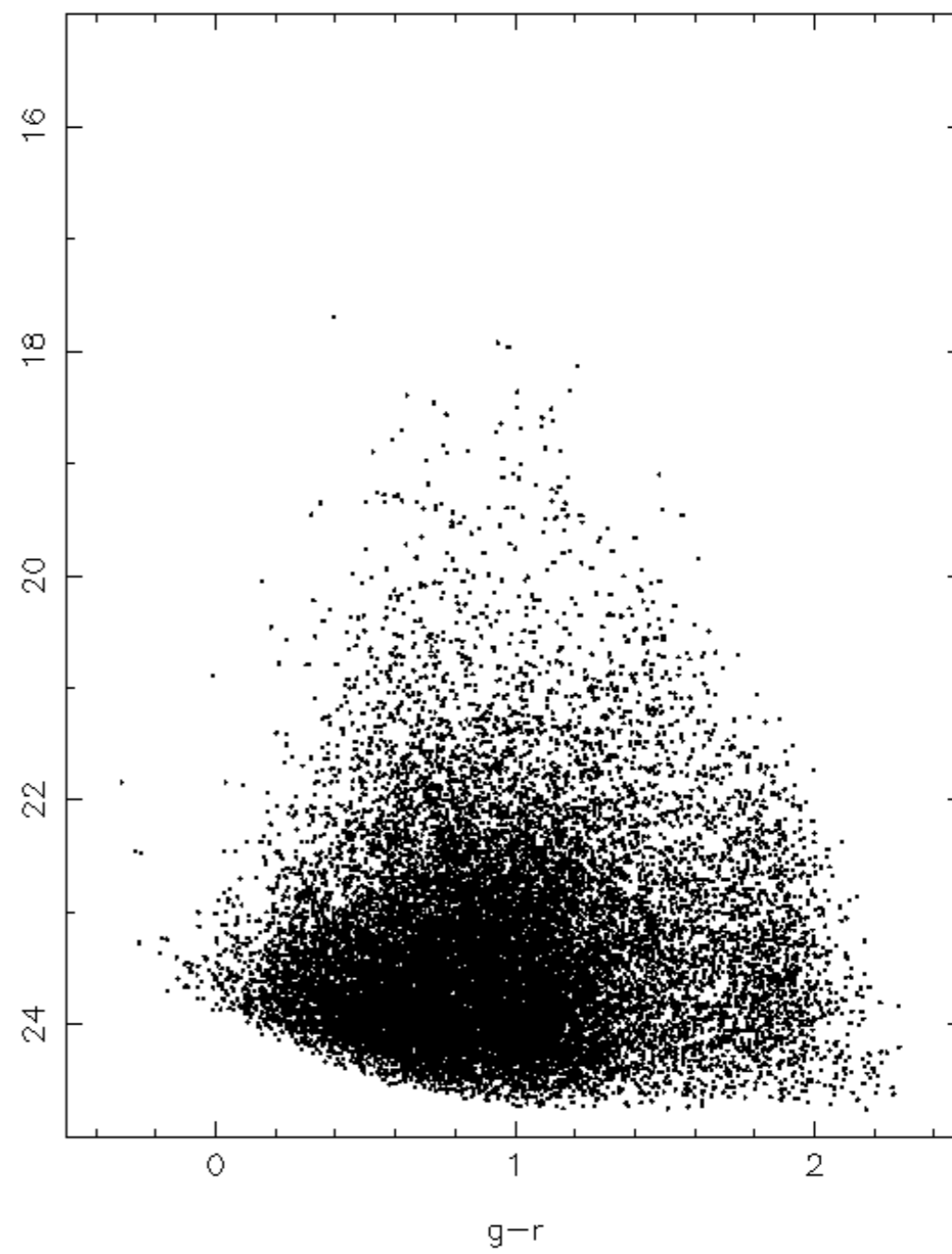


NGC253 SV field

Stellar

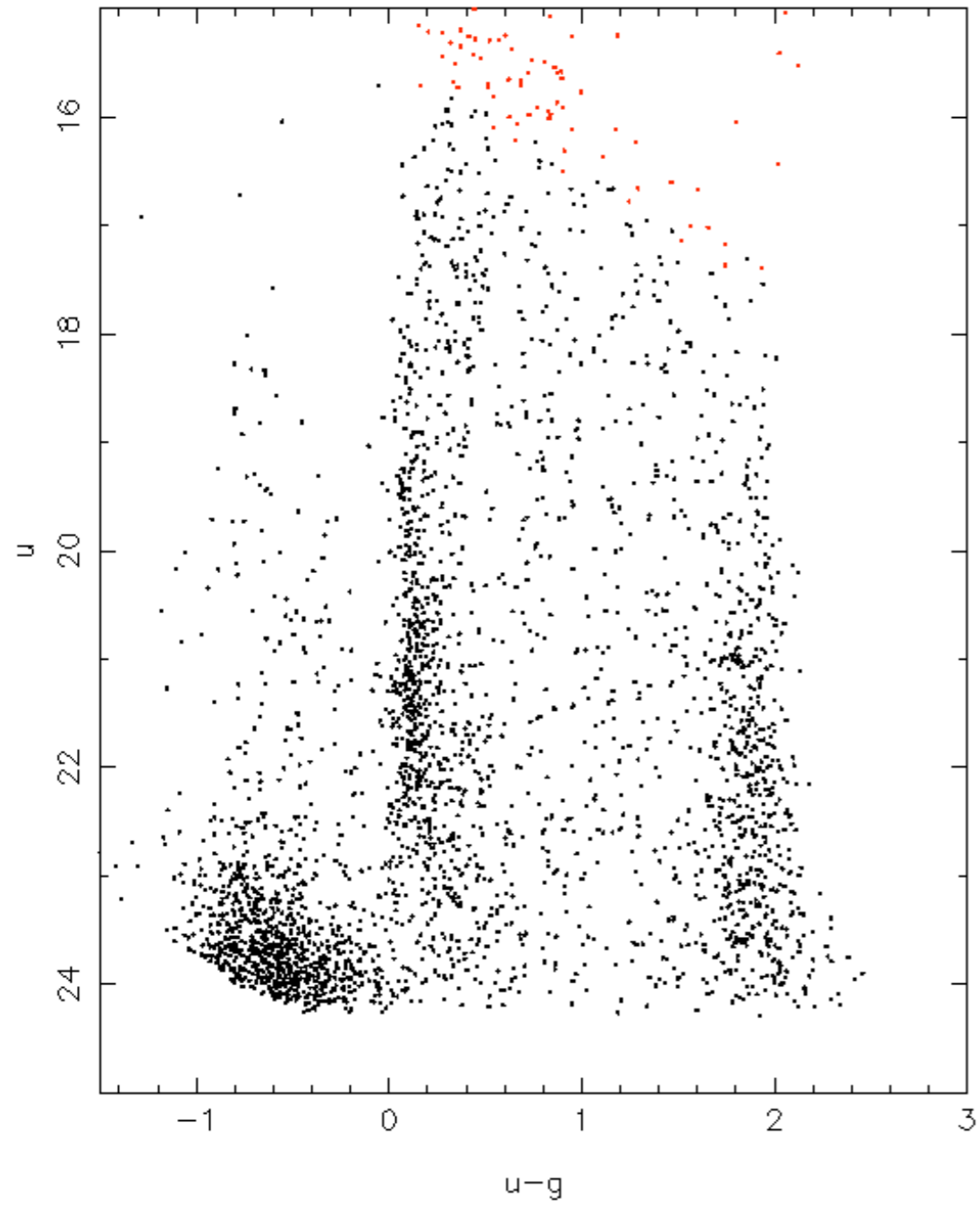


Non-stellar

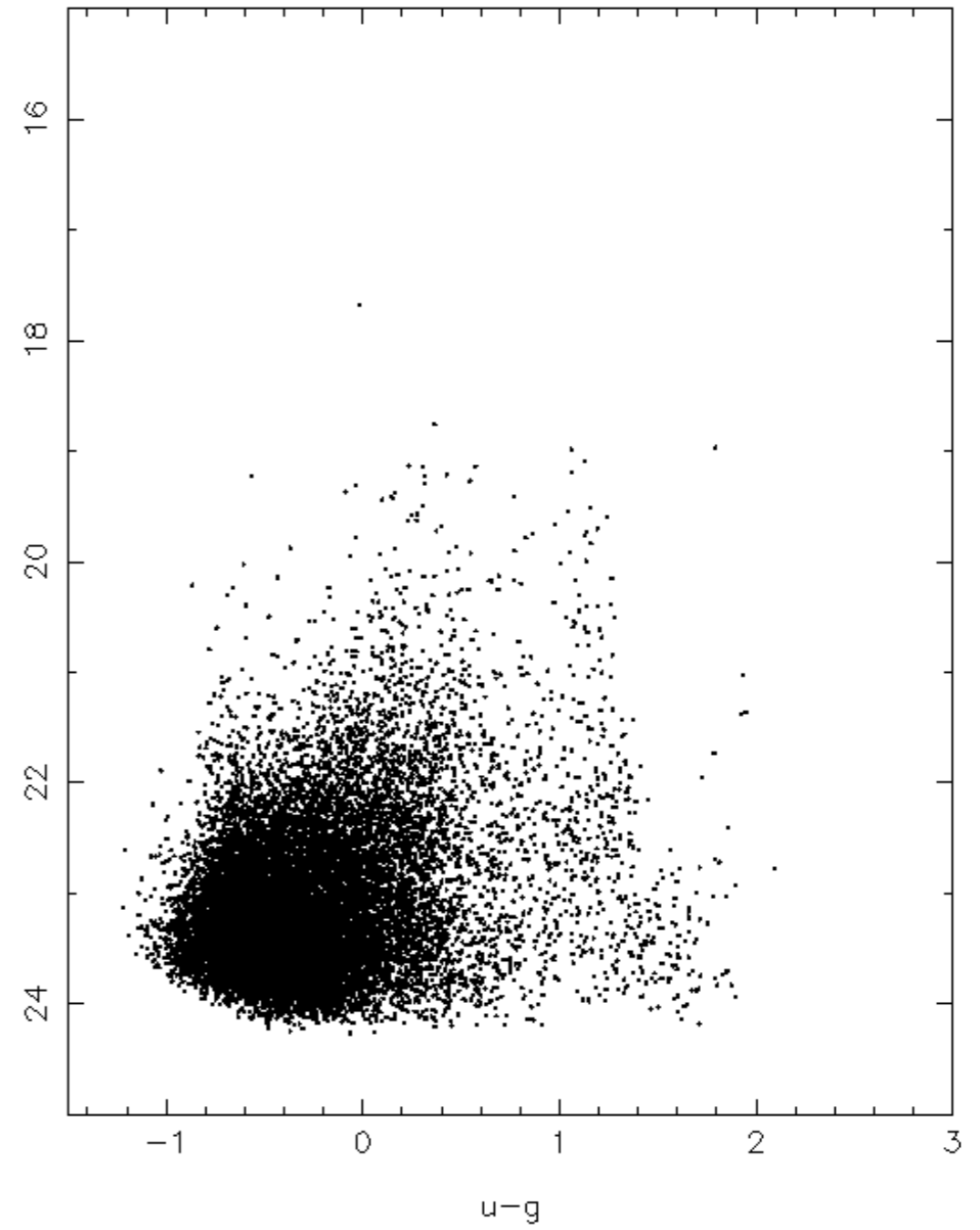


NGC253 SV field

Stellar



Non-stellar



CASU software tools

Innovative software solutions

- nebuliser
 - removes complex background variations
 - enhanced object detection & parameterisation
- despiker
 - removes diffraction spikes, charge bleeding artefacts, and saturated stellar cores
- mosaicer
 - CASU tiling software developed for VISTA
- psf'ers
 - automatically generates detector-level PSFs
 - and performs PSF photometry

Nebuliser -> M31 field 23 MegaCam



Nebuliser -> M31 field 23 MegaCam



Despiker -> Subaru Suprime-Cam HolmbergII



Despiker -> Subaru Suprime-Cam HolmbergII

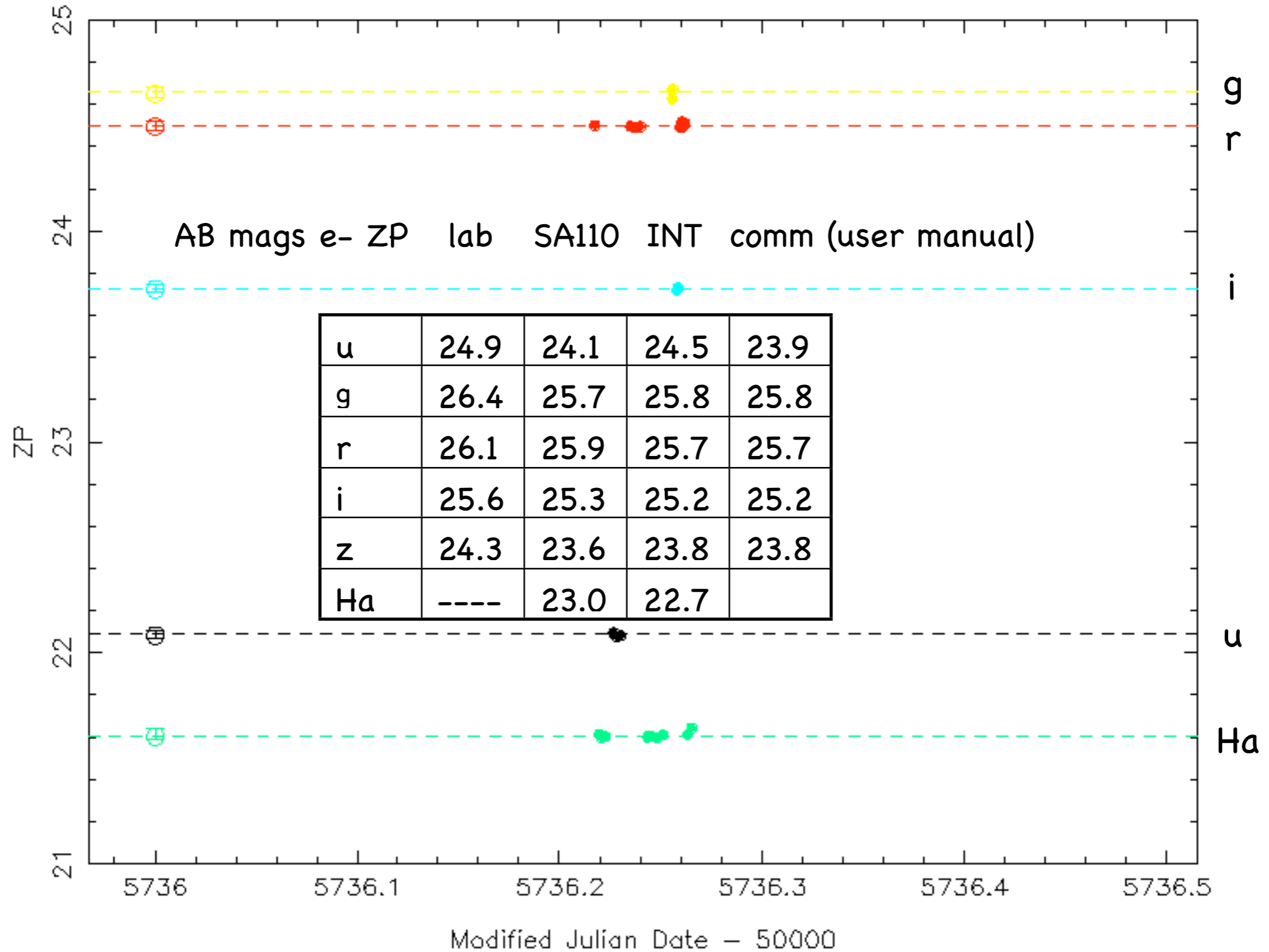


Despiker -> Subaru Suprime-Cam HolmbergII

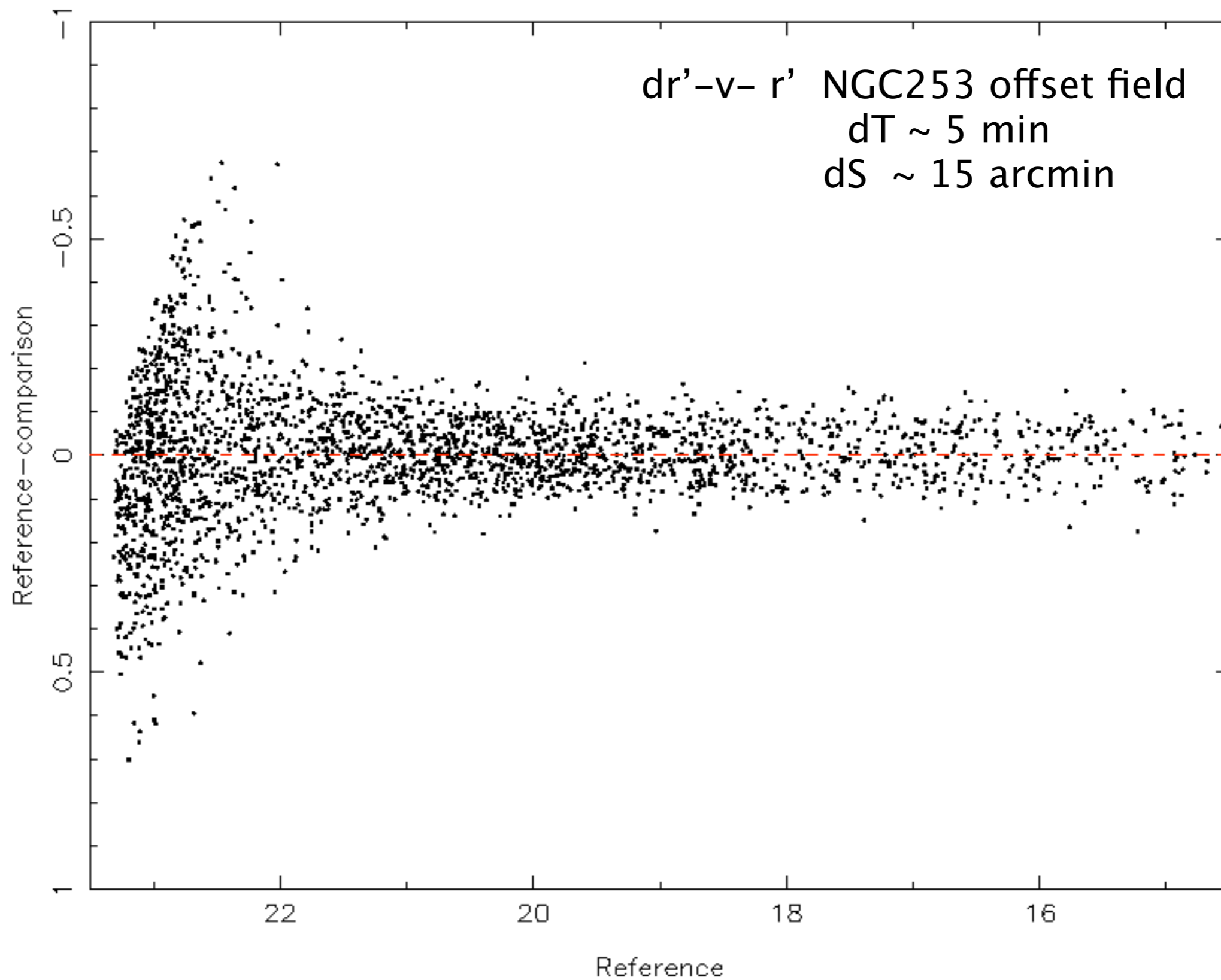


fin/ spare slides

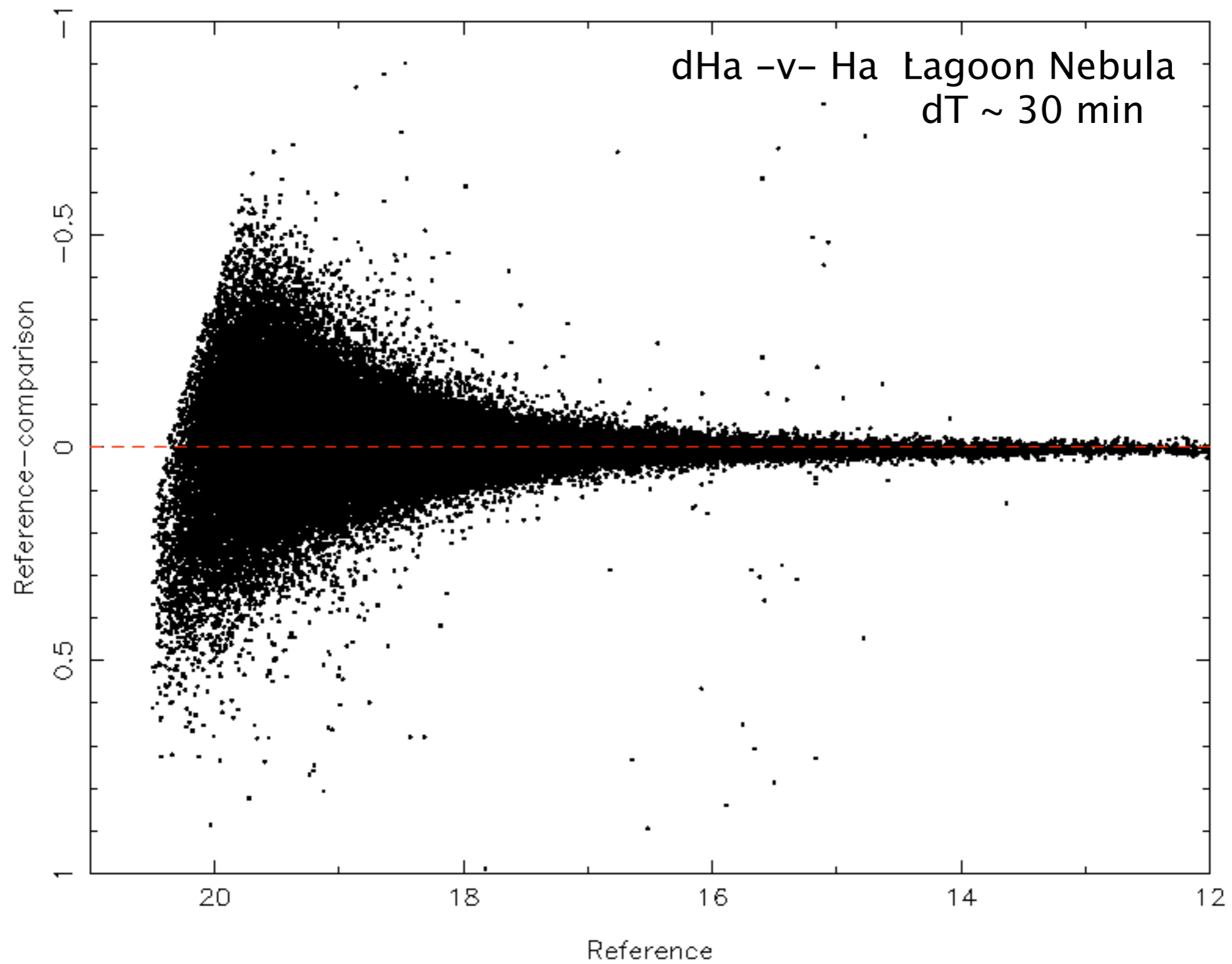
WFS Photometric zero-points



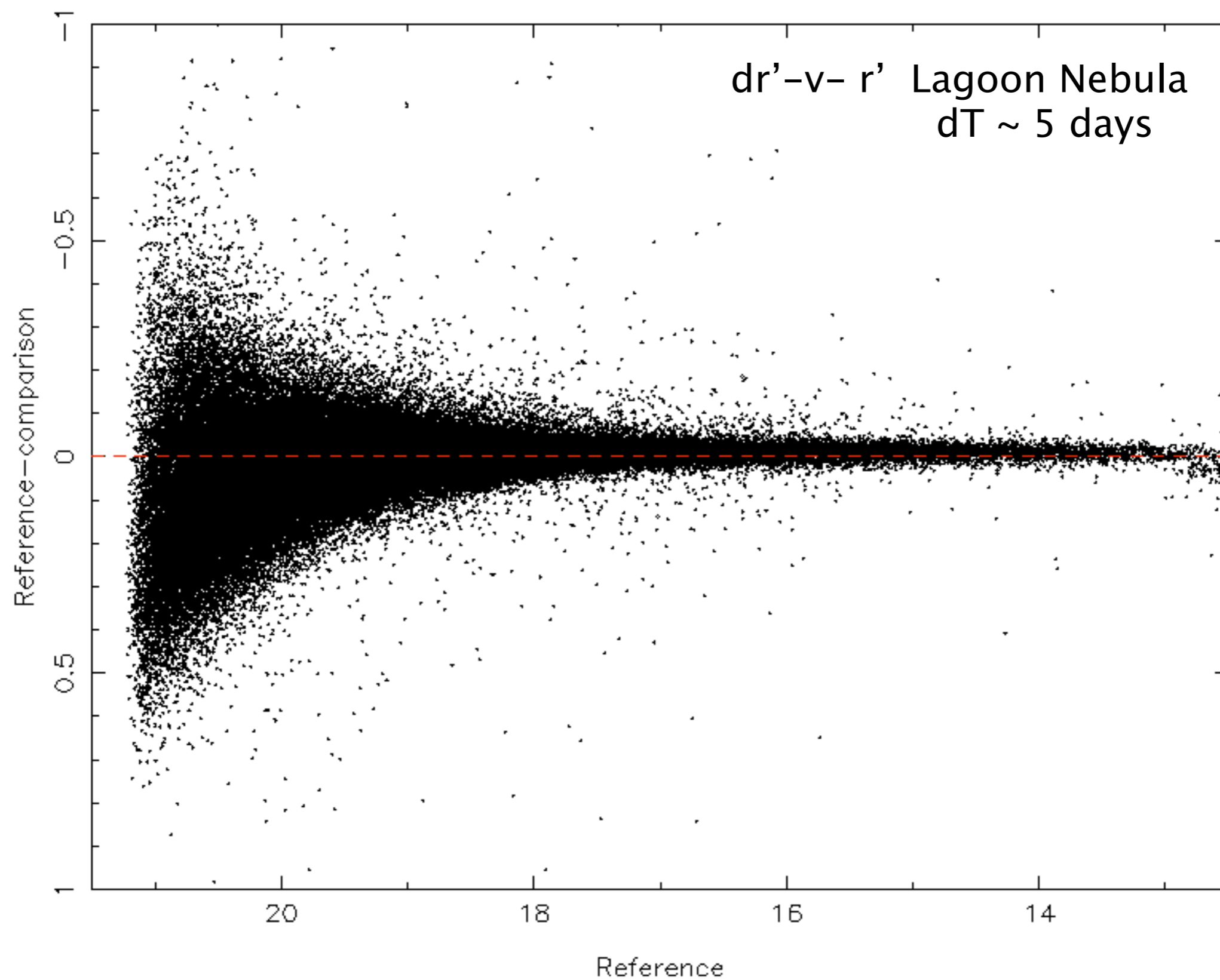
Magnitudes of matched objects



Magnitudes of matched objects



Magnitudes of matched objects



VPHAS field

SA110
ugriHa
CMDs

$u = 240s$

$g = 10s$

$r = 30s$

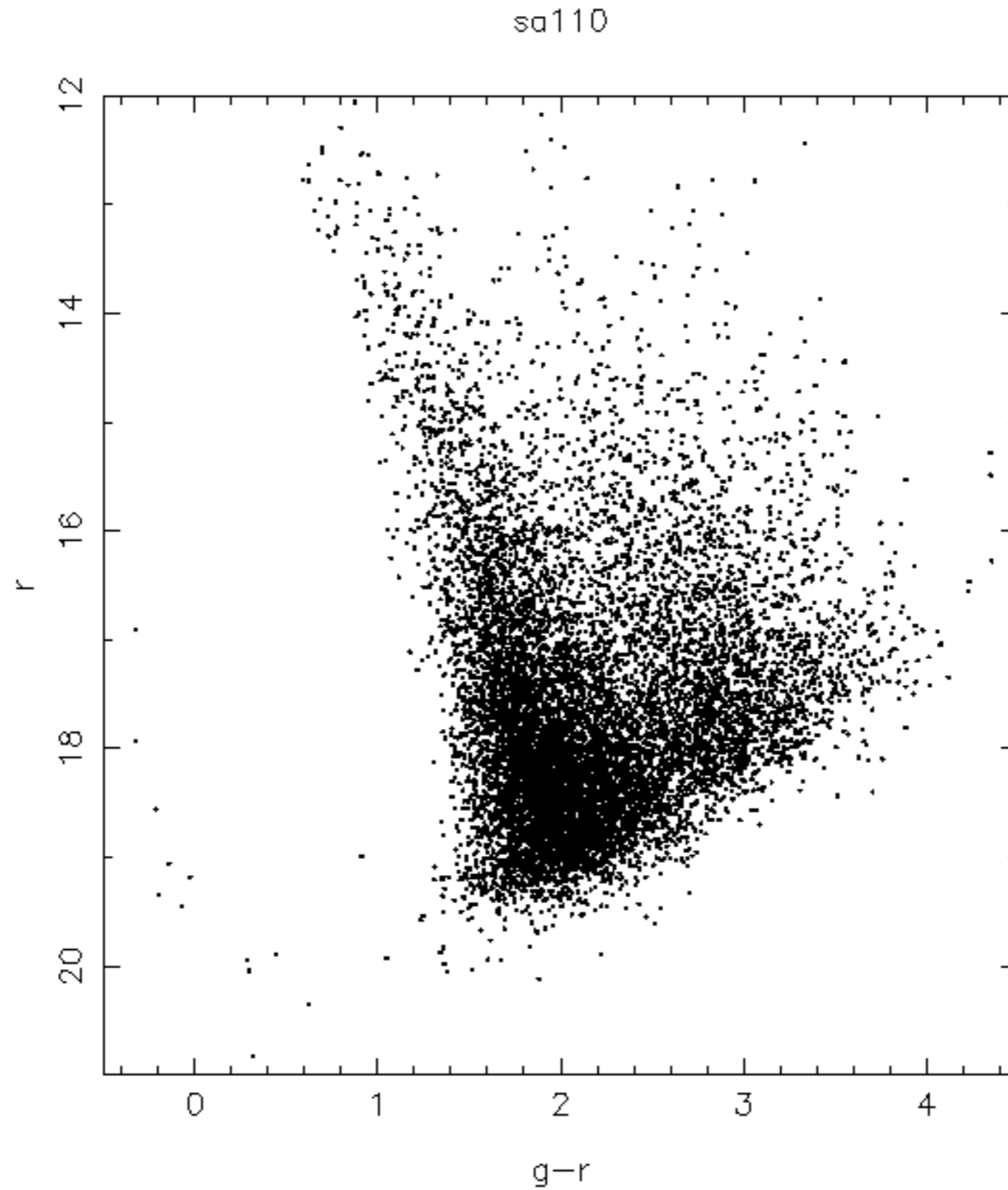
$i = 10s$

$H\alpha = 240s$

18h42+00d

$l, b = 32.1, 2.1$

$E(B-V) = 2.3$



VPHAS field

SA110

ugriHa

CMDs

$u = 240s$

$g = 10s$

$r = 30s$

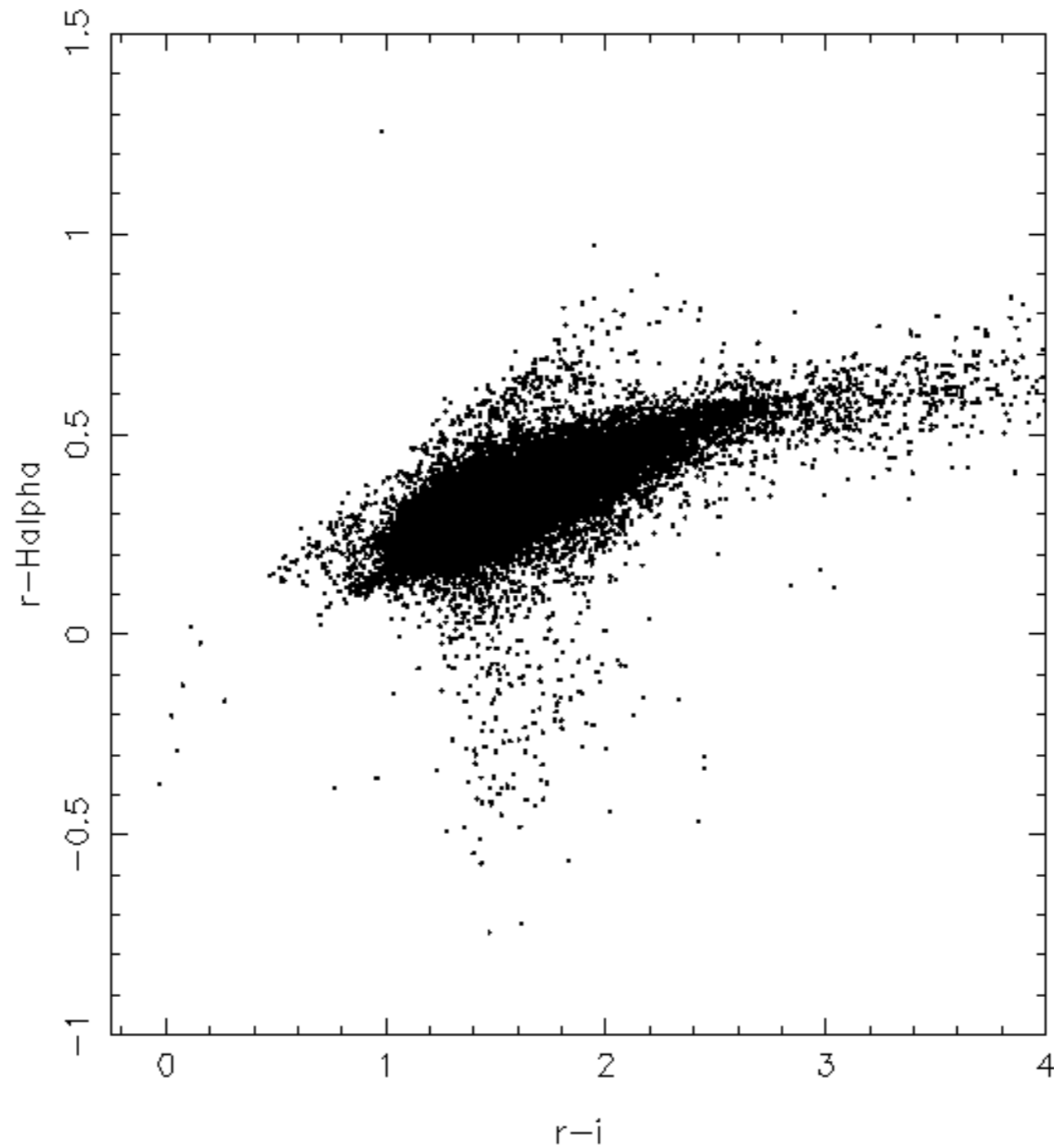
$i = 10s$

$H\alpha = 240s$

18h42+00d

$l, b = 32.1, 2.1$

$E(B-V) = 2.3$



VPHAS field

SA110
ugriHa
CMDs

$u = 240s$

$g = 10s$

$r = 30s$

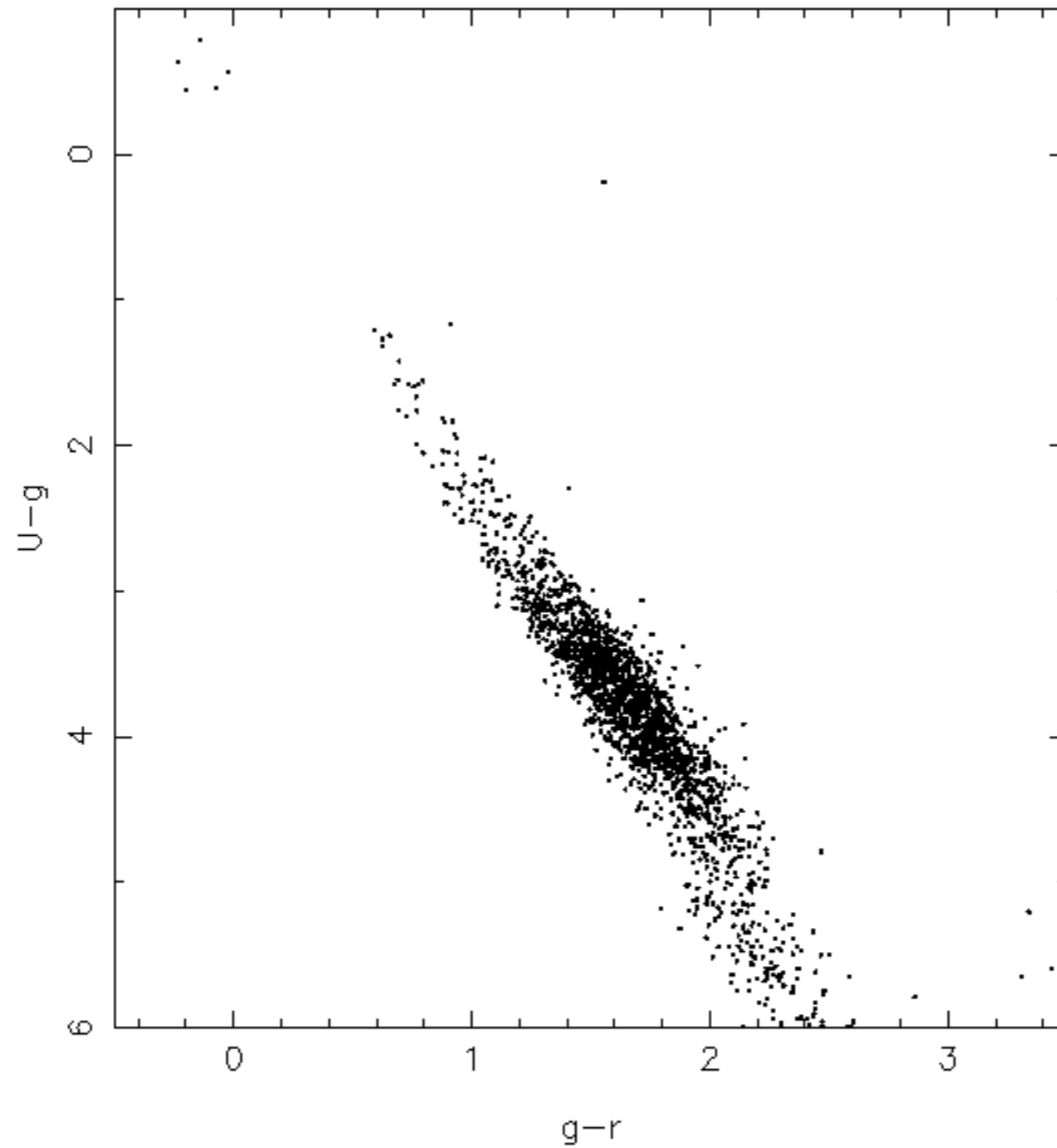
$i = 10s$

$H\alpha = 240s$

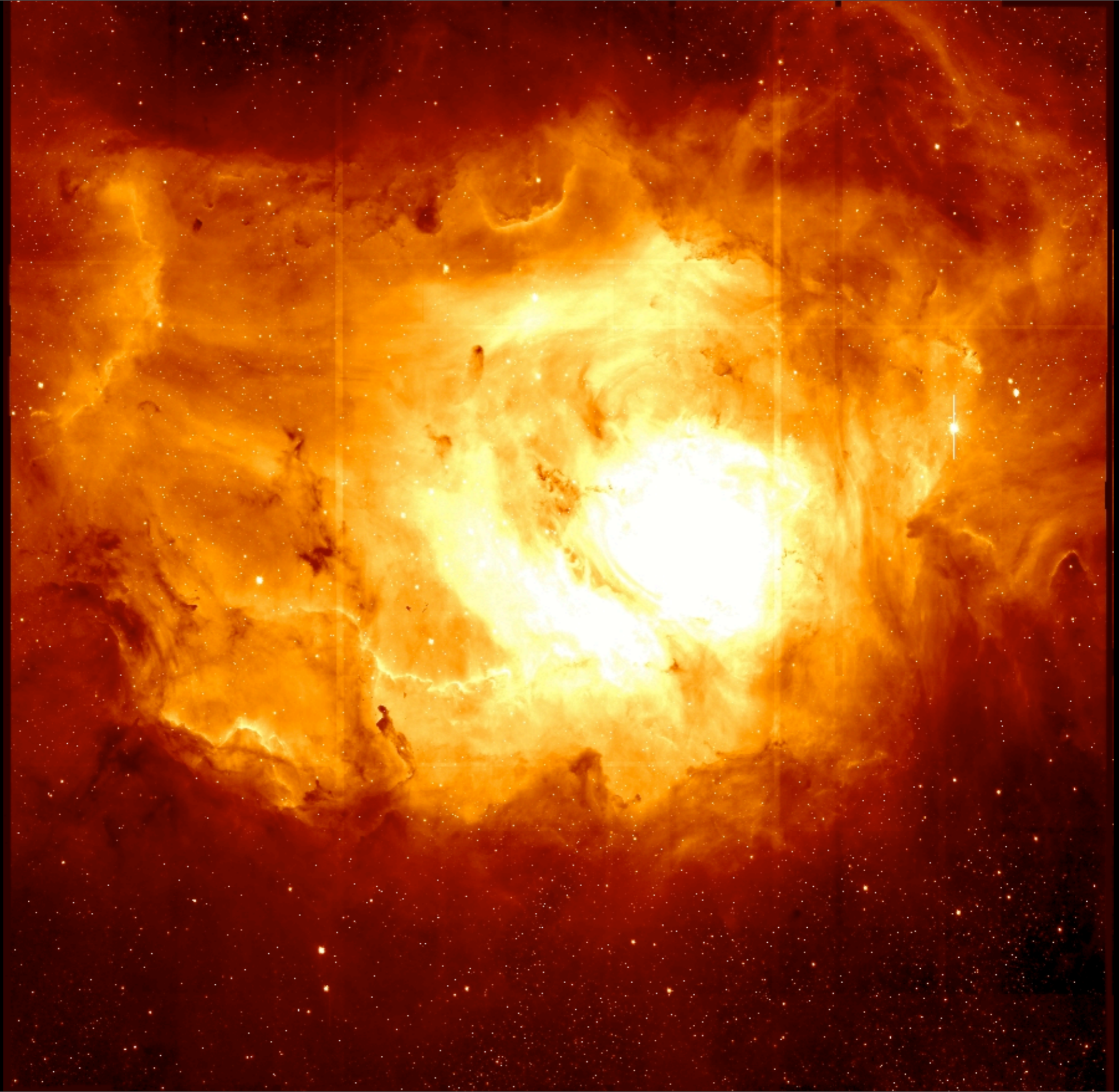
18h42+00d

$l, b = 32.1, 2.1$

$E(B-V) = 2.3$



Lagoon
nebula
H-alpha



Lagoon
nebula
H-alpha

