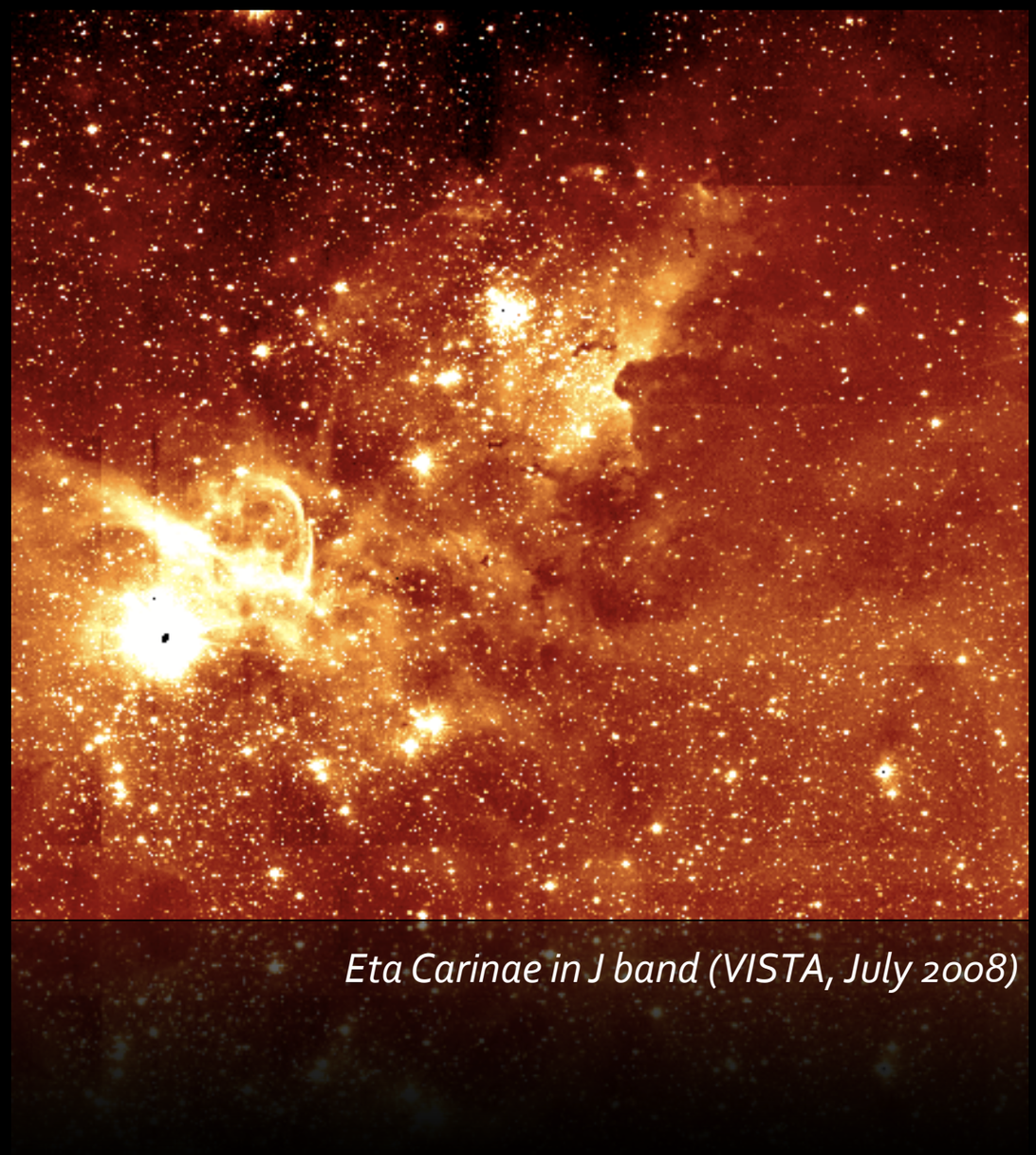
VISTA & VST Pipeline status

E. A. Gonzalez-Solares (CASU)



Eta Carinae in J band (VISTA, July 2008)

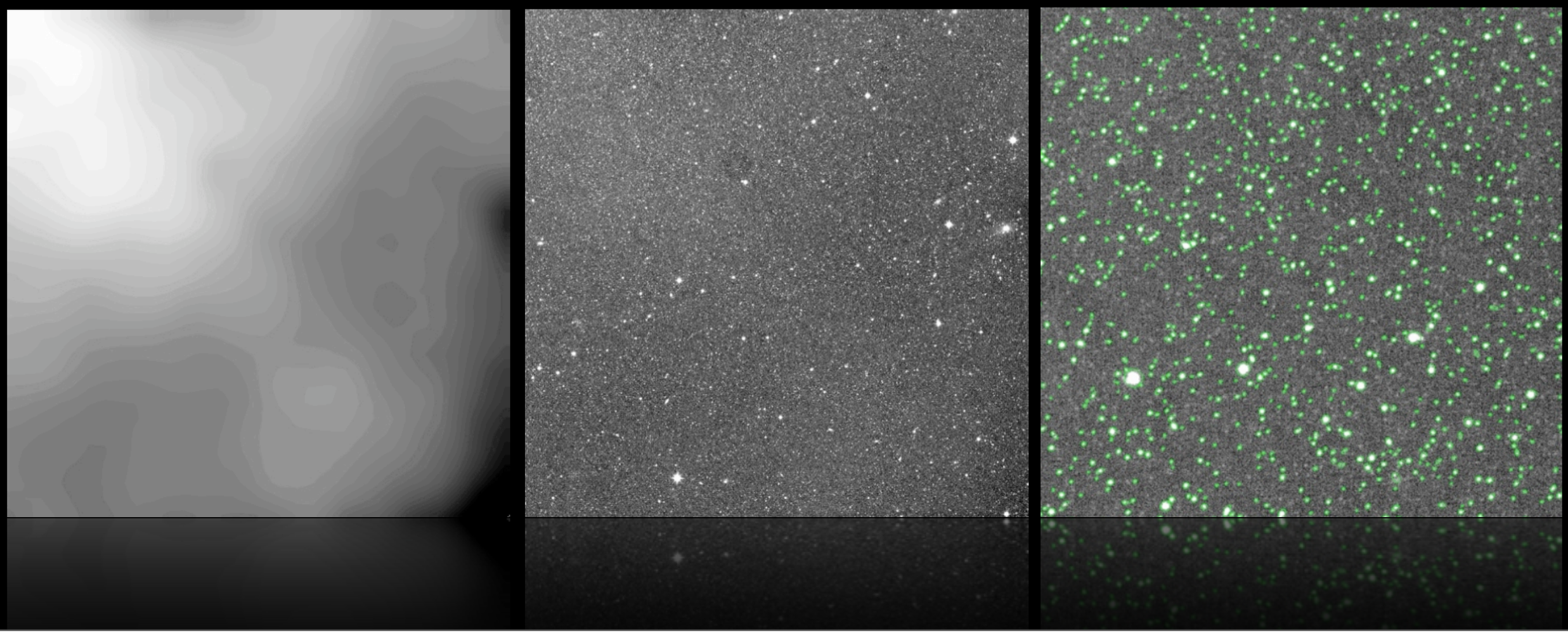
ESO Public Surveys Phase 2 Workshop - ESO Sep 15th-17th, 2008

The image on the right illustrates one of the first images from VISTA. This is Eta Carinae observed during 5 minutes in J band in July.

Outline

- Data processing at CASU
- Data processing steps
- Properties overview of first VIRCAM data
- Data processing issues
- VISTA / VST data processing timescales
- User tools (QC, processing status, survey progress)

Data Processing at CASU



CASU optical processing

- APM Photographic Sky Survey Catalogue
- WFC @ INT (4 2k x 4k)
- Mosaic1 @ KPNO, Mosaic2 @ CTIO (8 2k x 4k)
- MegaCam @ CFHT (36 2k x 4.5k)
- SuprimeCam @ Subaru (10 2k x 4k)
- WFI @ 2.2m ESO (8 2k x 4k)
- OmegaCam @ VST (32 2k x 4k)

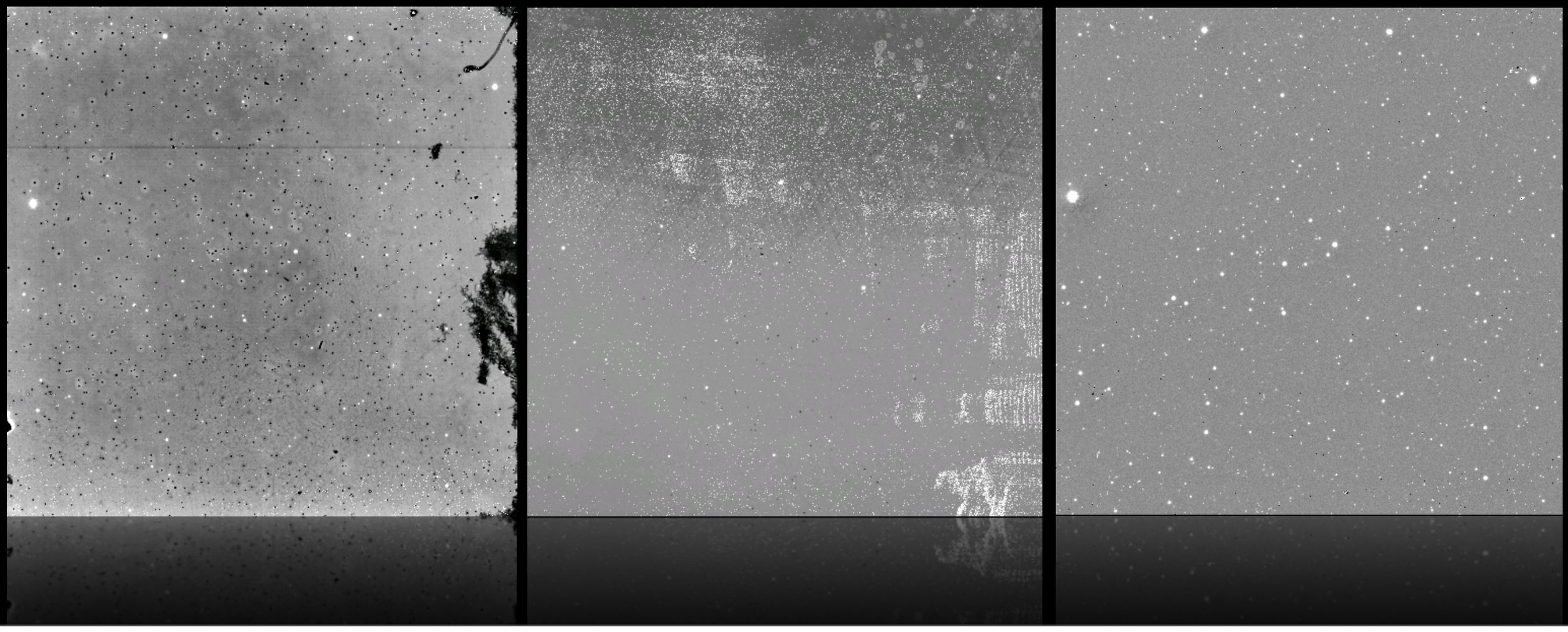
Along the years we have been involved in many wide field surveys and processing of the data coming from so called panoramic cameras. From the start extracting a catalogue out of the Palomar photographic plates using APM, our pipeline has been successfully used to process data coming from many camera/telescopes combinations. The WFC at the INT, the Mosaic cameras at KPNO and CTIO, Megacam at CFHT, SuprimeCam at Subaru, the Wide Field Imager at the 2.2at ESO. And in the near future we will process the data from the VST surveys VPHAS and VST-Atlas.

CASU near-IR processing

- CIRSI @ INT (4 1k x 1k)
- WFCAM @ UKIRT (4 2k x 2k)
- HAWK-I @ VLT (4 2k x 2k)
- VIRCAM @ VISTA (16 2k x 2k)

That was in the optical, but we also have some experience processing some near-IR data. We are now processing data from WFCAM at UKIRT totaling about 150TB of processed data, 3M images. We have also processed some data from HAWK-I and of course in the near future VIRCAM.

VISTA Pipeline Processing



WFCAM Data Flow

- Raw data travels from Hawaii to Cambridge by FTP (100-200 GB/night)
- Pipeline processing at CASU
- Raw data transfered to ESO for archiving by FTP
- Processed data transfered to WSA for ingestion also by FTP

This slides shows the data transfer flow for WFCAM data, which will be similar to VISTA. In case of WFCAM the data is transfered from Hawaii to Cambridge by FTP. The amount of data is about 100 to 200 GB/night similar to the expected data volume for VISTA. Once the data arrives it passes some verification checks to ensure that we can start with the processing and we process the data. Meanwhile the raw data is transfered to ESO by FTP for archiving and when we finish with the processing the data is transfered to WSA for ingestion. Note that we choose to do all data transfers by FTP since that speeds up the whole process and also is less prune to e.g. tape errors.

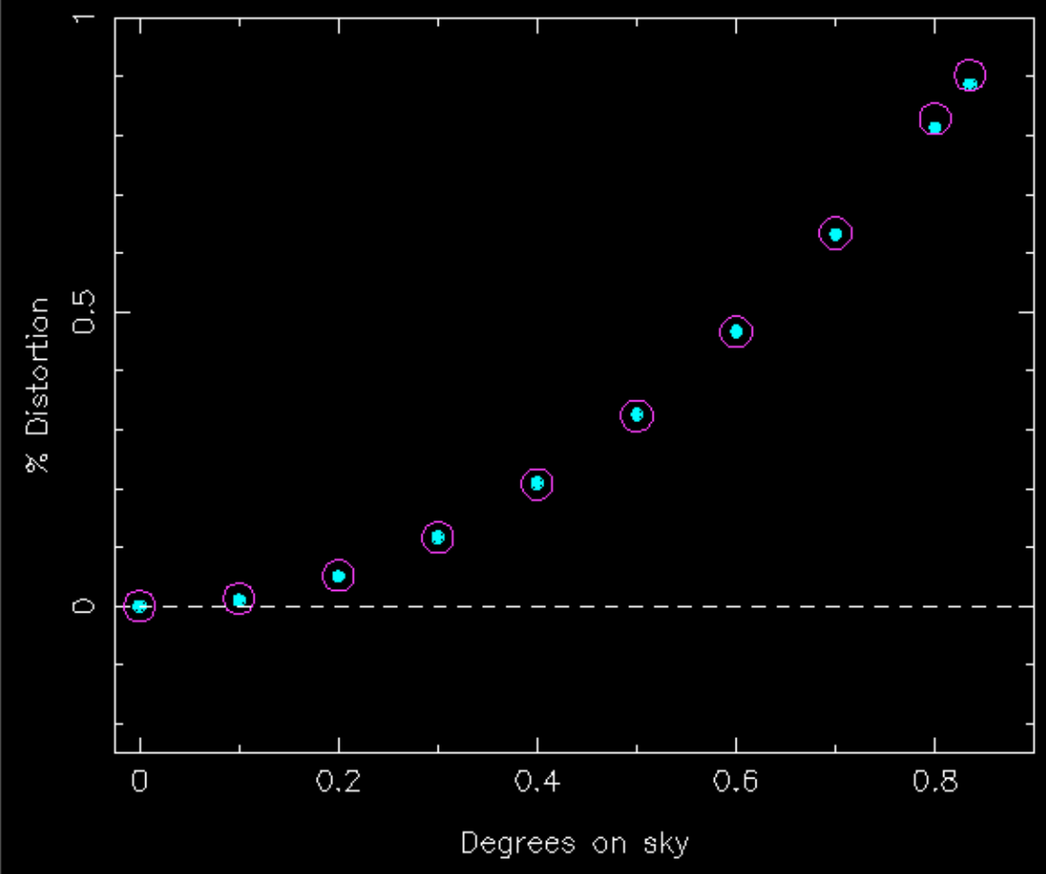
Data transfered to ESO is calibrations and UKIDSS.

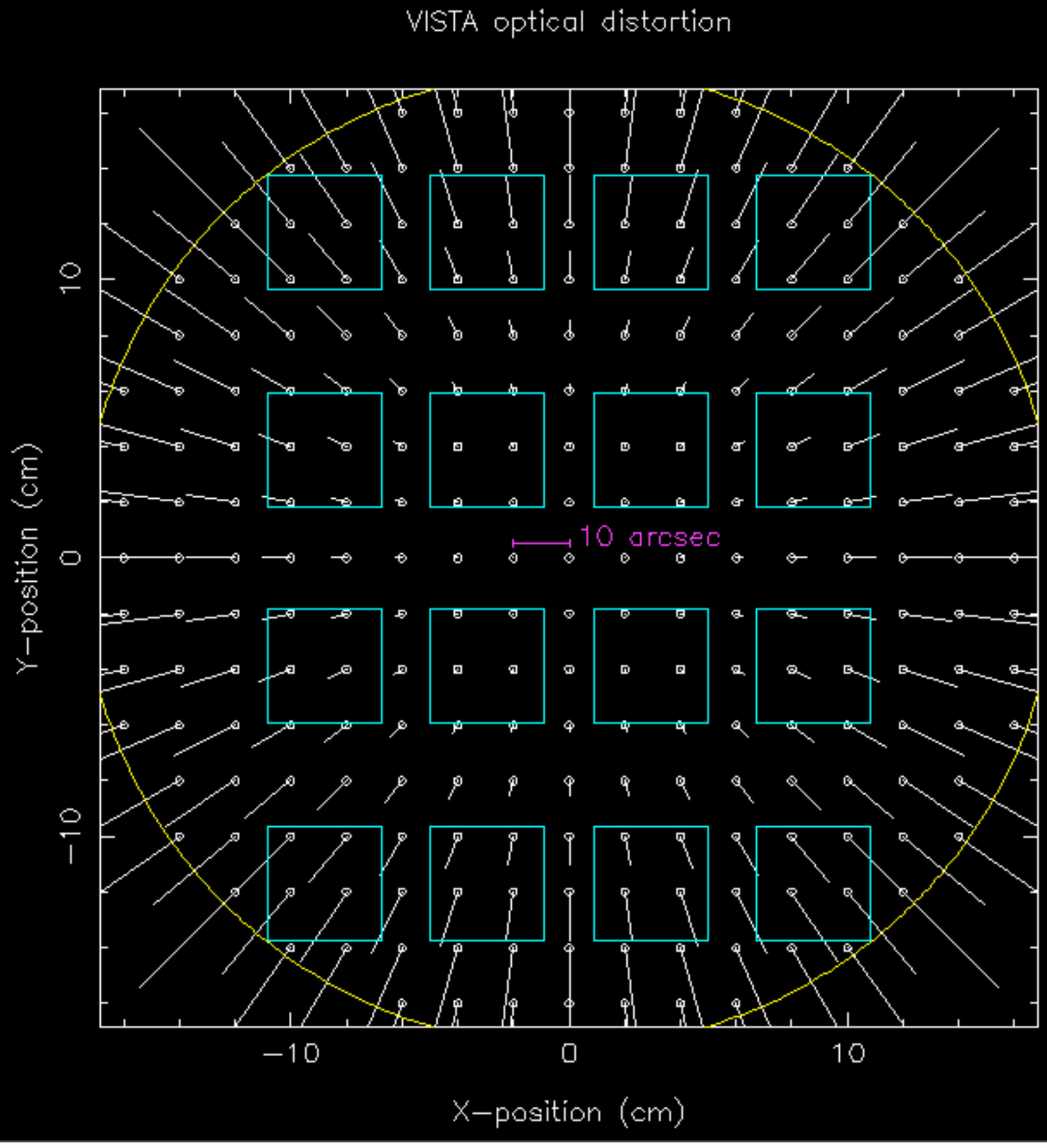
Pipeline Process

- Reset correction (DAS) ✔
- Linearity correction ✔
- Dark and reset anomaly ✔
- Flat field ✔
- Destripe ✔
- Cross talk removal ✖
- Persistence ✖
- Background sky subtraction ✔
- Interleaving ✔
- Dithering / Jittering ✔
- Catalogue generation ✔
- Astrometric calibration ✔
- Photometric calibration ✔
- Stacking & Tiling ✔

This slide shows the different processes involved in getting a scientific image from the input raw images. The reset correction is done at the DAS and we perform the correction for linearity, not needed for WFCAM but needed for VISTA. Then dark and reset anomaly correction, flat fielding and gain correction, destripe. I will talk about this later but the following steps are not needed in VISTA, crosstalk and persistence correction. After all this is done the subtraction of the sky background leaves the images basically reduced, i.e. the signature of the detector and telescope combination has been removed. Then it comes to stacking the different offsets according to the different dither and jitter strategies. One that is done catalogues are extracted from the images, and using 2MASS as reference we calculate the astrometric solution and we also do the photometric calibration. All this is done in a chip by chip basis for each OB so the last remaining step is stacking and tiling.

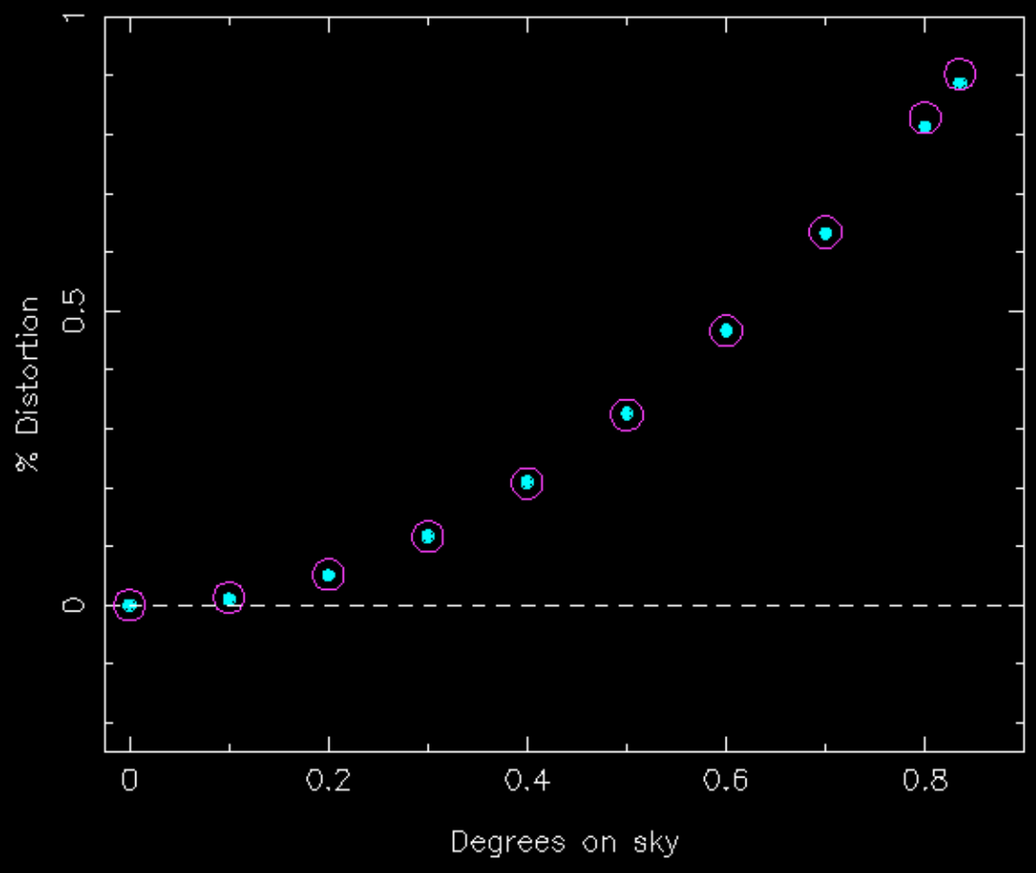
The final products are multiextension FITS files containing fully calibrated images with a wide range of QC parameters and processing history in the headers and confidence maps and FITS catalogues containing the usual image derived parameters for detected objects: position, magnitudes measured in different apertures, morphology information and several flags.

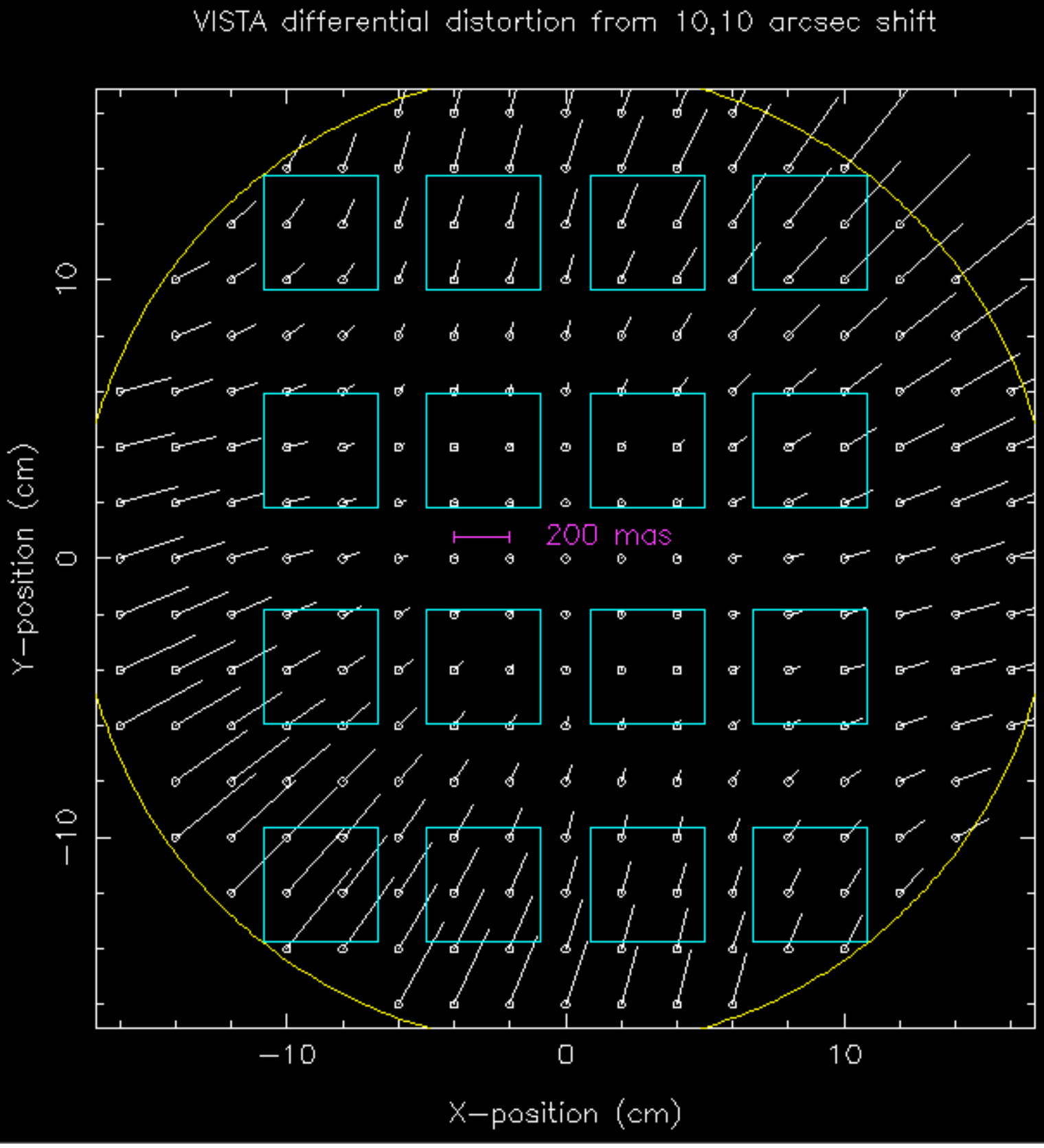




Optical systems do not have a uniform plate scale over the whole field of view and generally have a radial distortion term. This figure demonstrates the level of optical distortion over the field of view for VISTA which can be well fitted by a r-cube polynomial. This distortion is significant larger for VISTA than for WFCAM.

This type of distortion presents no problems for calibration of individual pointings but leads to complications when dealing with dither sequences. This is caused by the differential non-linear distortions across individual detectors being comparable to the pixel size of the detector. In these cases stacking involves resampling and interpolation of some form.





stacking needs resampling / interpolation

This figure shows an example of the differential non-linear distortion on sky arising from a shift along a diagonal of 10,10 arcsec.
As we move away from the center the effects of the differential distortion, so that a 10 arcsec shift in the centre corresponds to a 10.4 shift at the outer corners of the arrays. Bottomline is that all stacking needs pixel resampling and we offer three interpolation schemes: nearest-neighbour, “dribble” a variant of drizzle and one based on cubic splines.

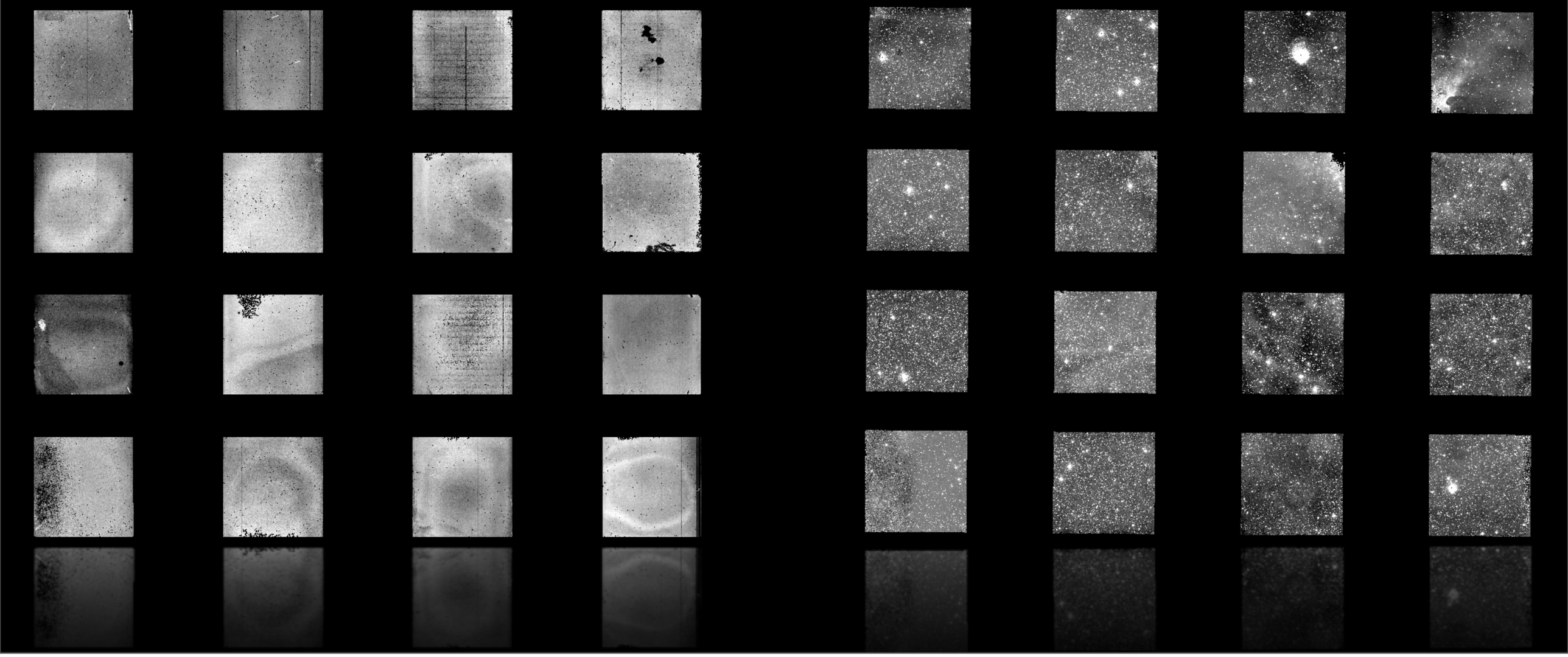
Photometric calibration

- Colour eqs to convert to instrumental system
- 2MASS S/N>10 in JHK and 0<J-K<1
- ~100-1000 “standards” per pointing
- required to be stellar and unsaturated
- monitor long term ZP behaviour, average detector ZP offsets, illumination corrections

Photometric calib is done using 2MASS stars with colour equations to convert the fluxes to instrumental. Only bright 2MASS sources are used S/N>10 in all JHK bands and with “normal” stellar colours. There are 100-1000 such standards per pointing and only those stellar in our images and unsaturated are selected.

Also used to monitor ZP evolution, ZP offsets between detectors and derive illumination corrections for each detector (i.e. offset between the “local” 2MASS ZP and the detector ZP).

VIRCAM First Data Properties



VIRCAM First Data

- Summary:
  - Detectors functioning well
  - Given right type of calibration good scientific results can be extracted

The bottom line is that the data from VIRCAM we have received so far indicate that the detectors are functioning well and that given the right type of calibration good scientific results can be extracted from them.

VIRCAM First Data

- Crosstalk - Absent, even from very bright objects
- Persistence - Minimal
- Non-linearity - Between 2-4% at 10000 ADU. Detector #13 is ~9%.

With the data we have to hand we can say that there is no obvious crosstalk, even from very bright objects. Our current expectation is that correcting for crosstalk will be unnecessary.

Observations in J of a very bright star J=0.4mag were done with 1s and 10s and after these a series of dark frames were obtained. In the case of the 1s exposure the dark frame showed some persistence but barely discernible. In the case of the 10s second exposure there was some small persistence which was gone by the 5th dark. Such a small persistence for this bright star is good news. Data from more normal observations e.g. Eta Carina do not show any persistence. Also results from linearity sequence....

All detectors are non-linear so a correction needs to be applied.

VIRCAM First Data

- Fringing - Need many more observations in all broad band filters but not evidence yet.
- Twilight flats - need better observations (correct dark frames and jitter exposures)

Fringing – If any it will be taken out during the sky subtraction.

Stress the importance of dark exposures that match the exposure parameters of the flats. Important since it is not possible to use old darks with similar exposure parameters. And also need jittering...

VIRCAM First Data

- Geometry - no evidence of non-coplanarity so far but need more data
- Astrometry - WCS as predicted. Astrometric residuals ~0.050" over the whole array
- Photometry - provisional estimates suggest throughput of 0.5 mag better than WFCAM in J

... see vircam_report.txt

Pending Issues

- How are we going to get the data? - Desirable FTP transfer from ESO, Garching (AAO, ING and JAC already do)
- SV programs - how / when are we going to get the data?
- SV programs are of extended objects. Need to obtain good calibration and sky offsets policy.

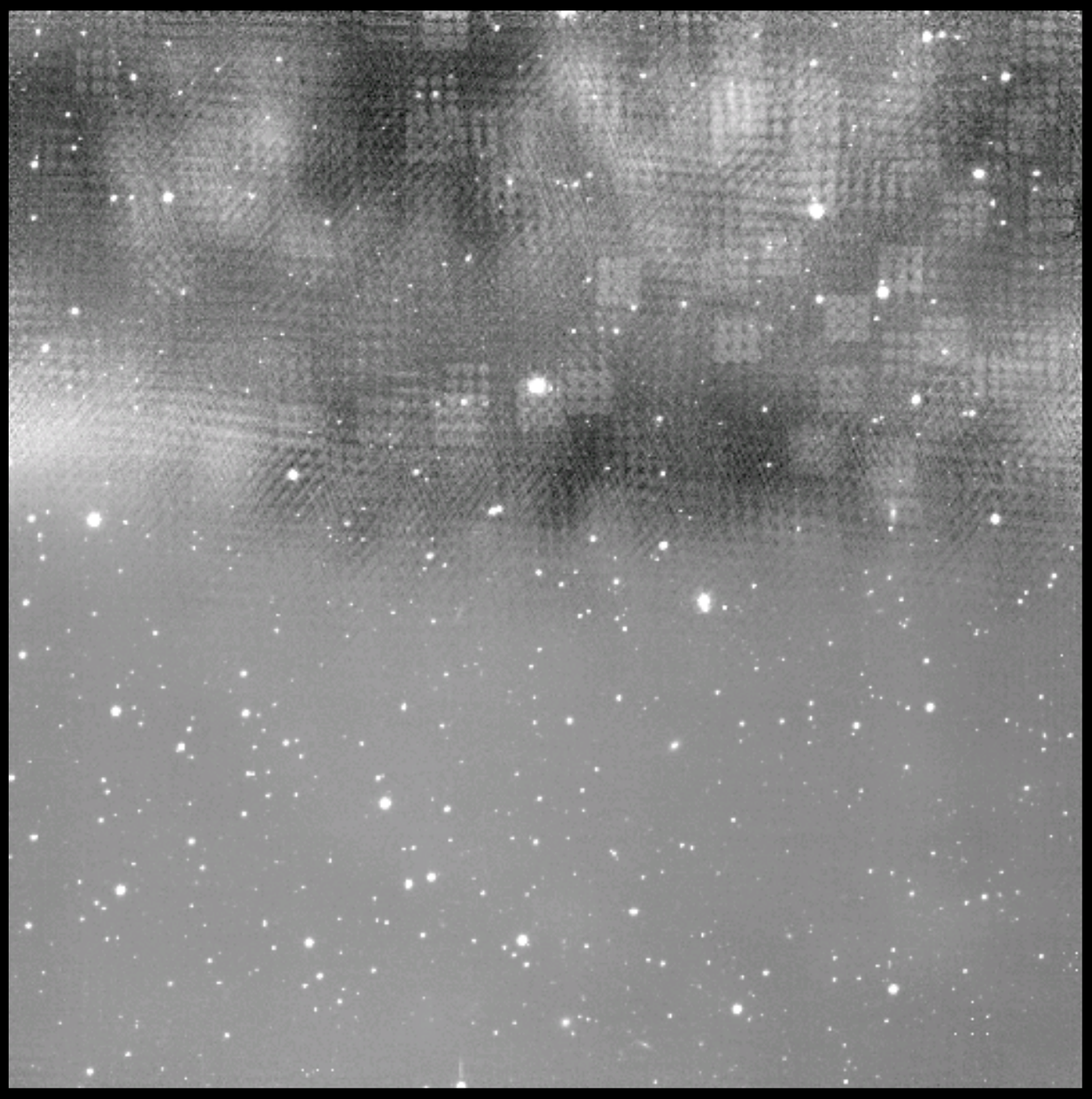
Data is transfered to CASU from ING and JAC basically in real time.

We favor also the use of FTP for transferring VISTA and VST data. Simple FTP seems to achieve ~5MB/s which is fast enough for the transfer (250GB night, rice compress to 60GB which would take about 3.5h to transfer).

Sky subtraction
vs
no sky subtraction

Here there are two images of the same chip processed one without a suitable sky and another one processed with a suitable sky. So if you are doing extended objects and you want your image to look like the one on the left you can forget about sky offsets. Otherwise please include offset sky in your observations.

Sky subtraction
vs
no sky subtraction



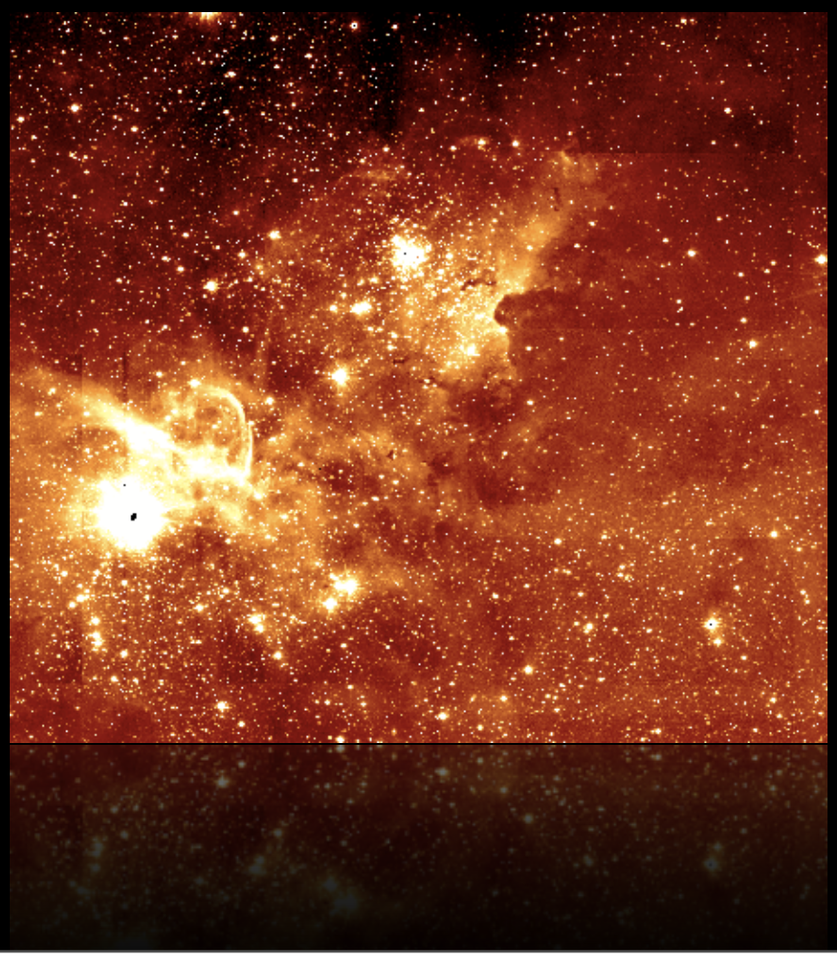
Here there are two images of the same chip processed one without a suitable sky and another one processed with a suitable sky. So if you are doing extended objects and you want your image to look like the one on the left you can forget about sky offsets. Otherwise please include offset sky in your observations.

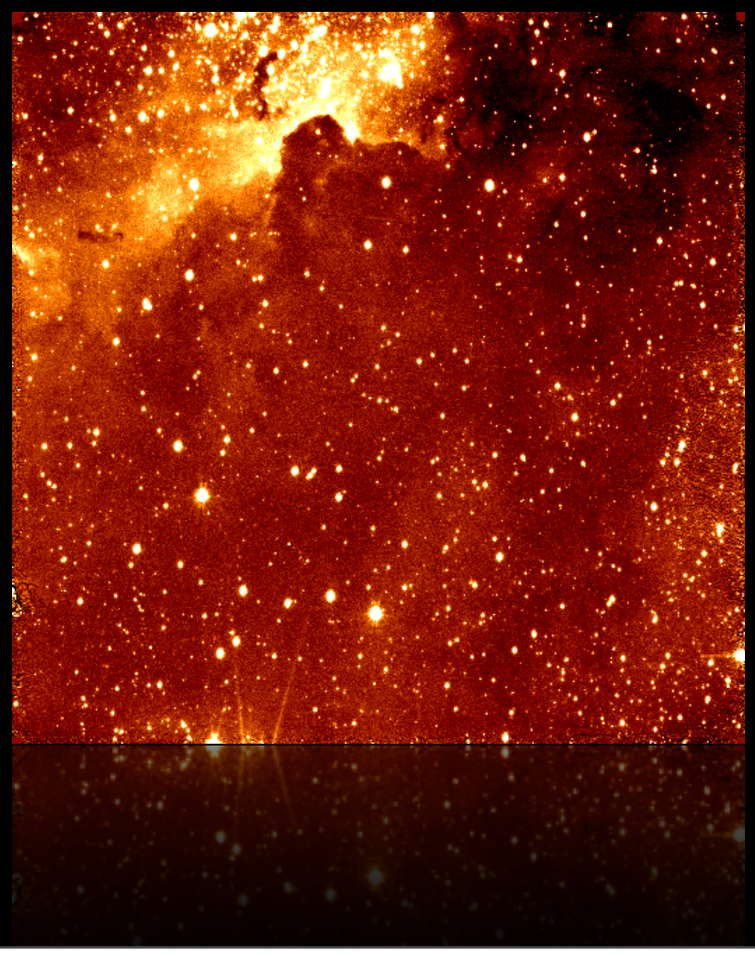
Processing Timescales

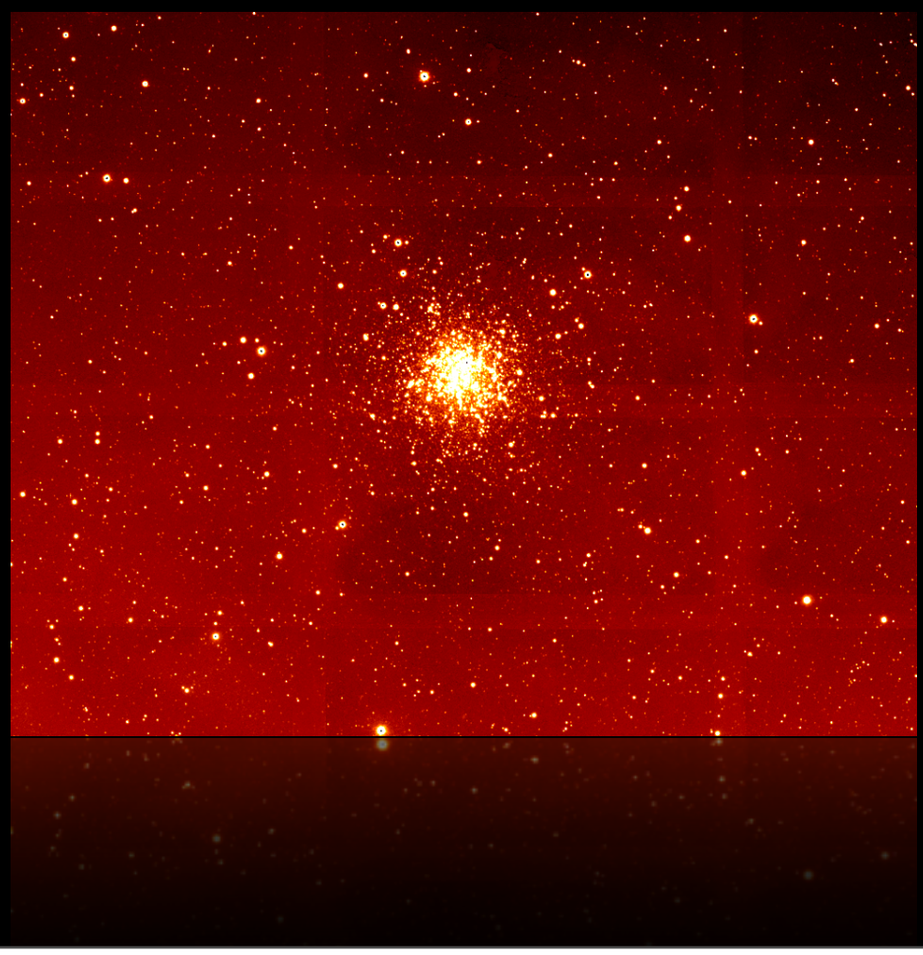
- SV & Initial Survey Data - iterative process but shouldn’t take longer than a month
- Steady state - within a month

A month from ingestion and verification of data received at CASU to final calibrated flat FITS files with images and catalogues. Does not include time from observing to us receiving the data.

Images

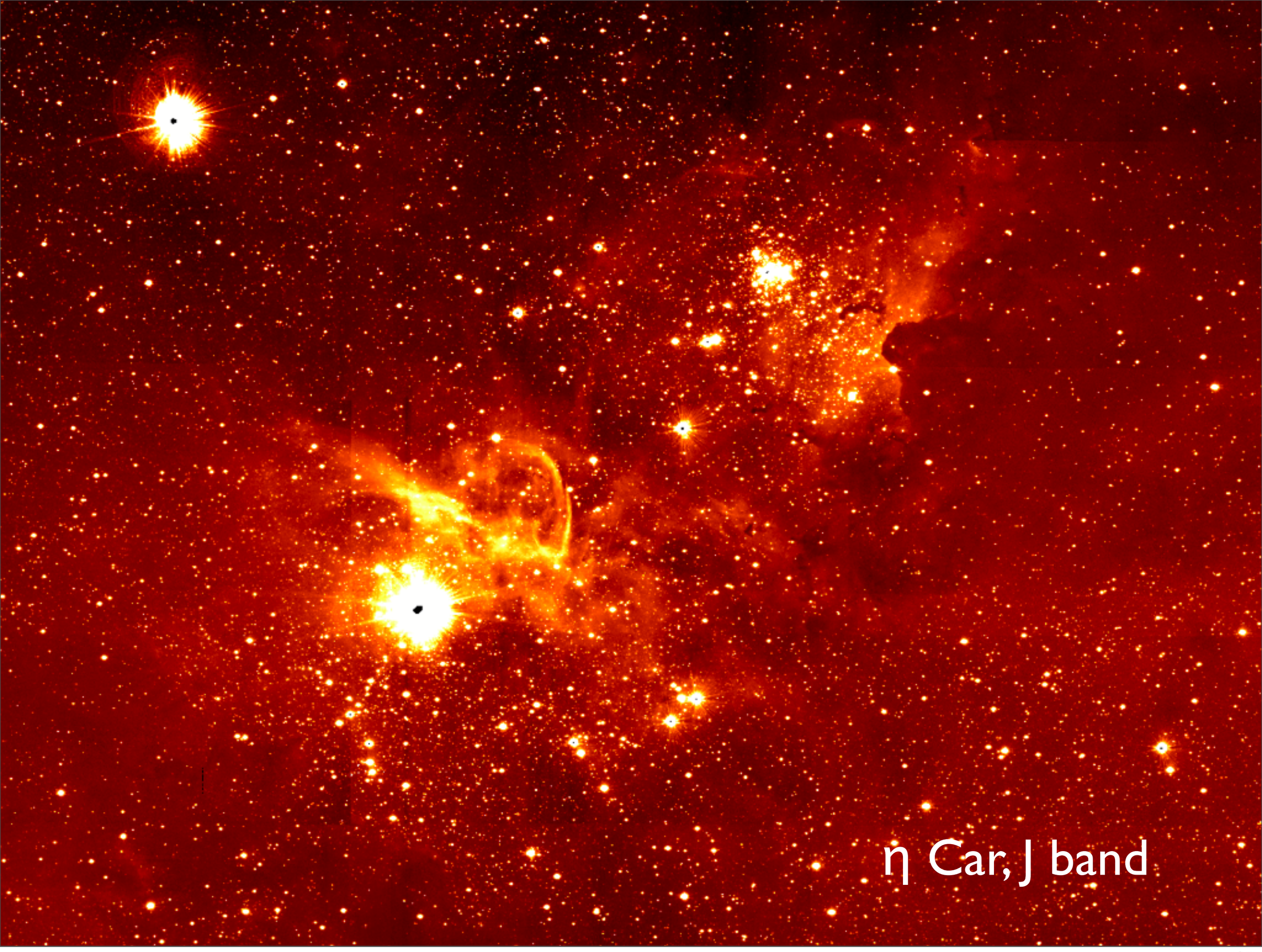


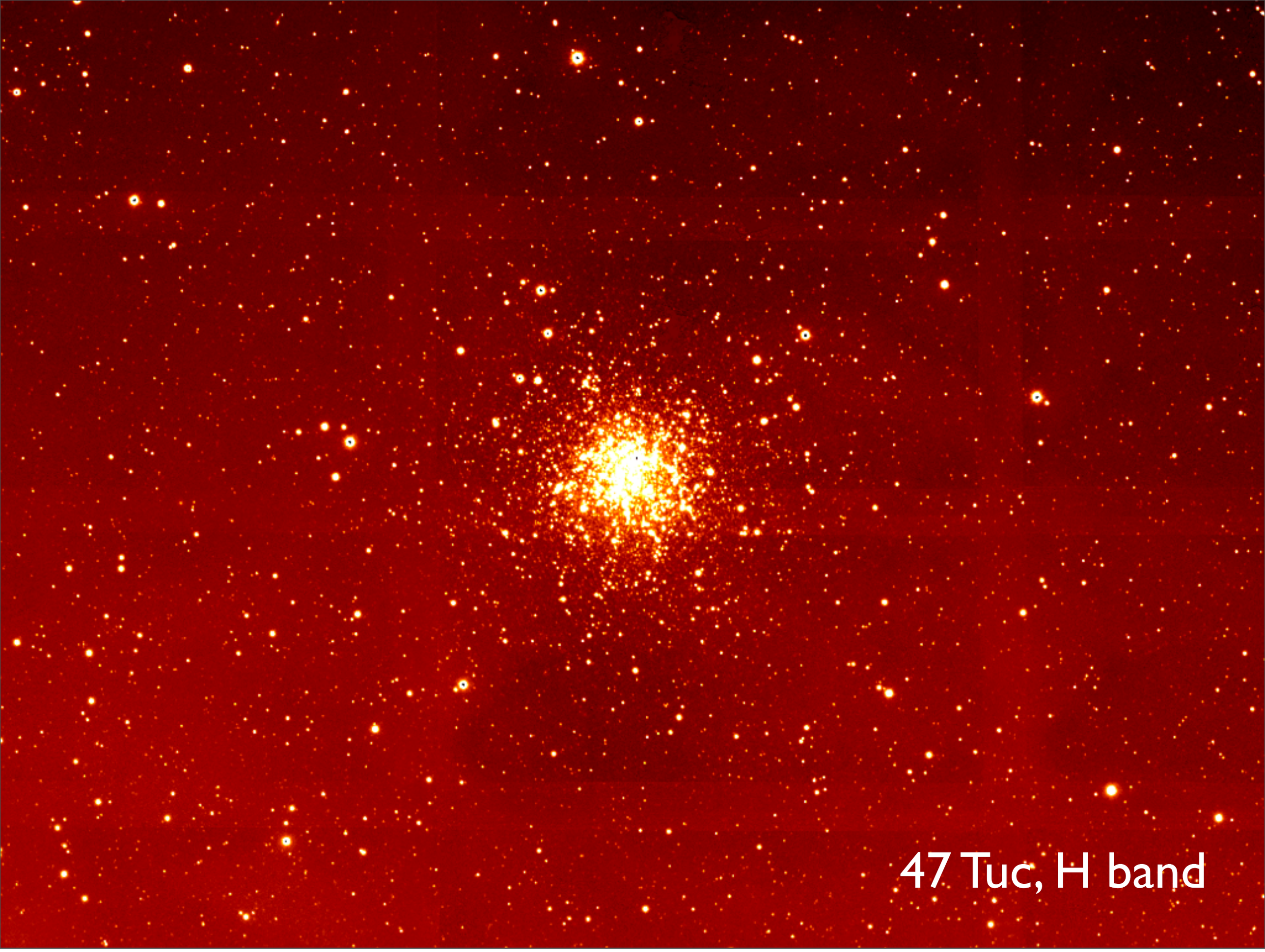




Full tile 1.5 deg x 1 deg.

Select an area of ~ 30’x20’

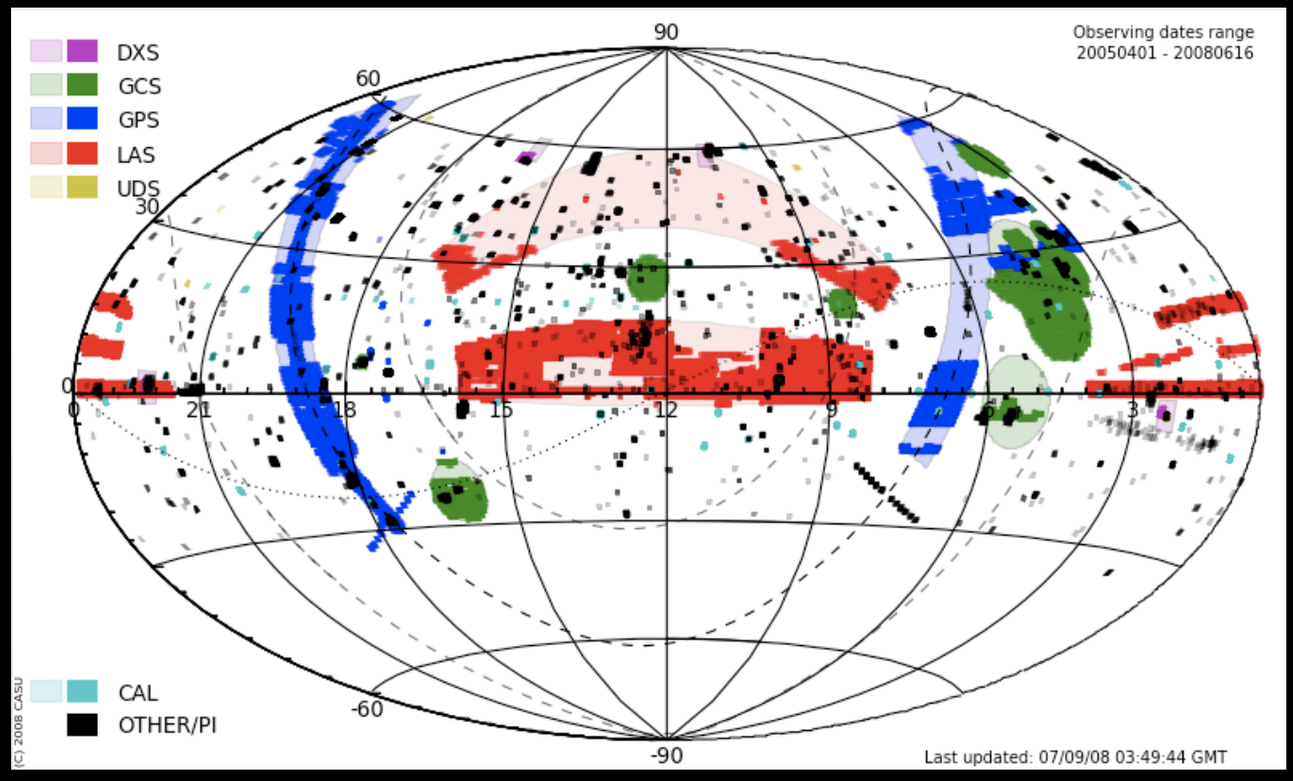

η Car, J band



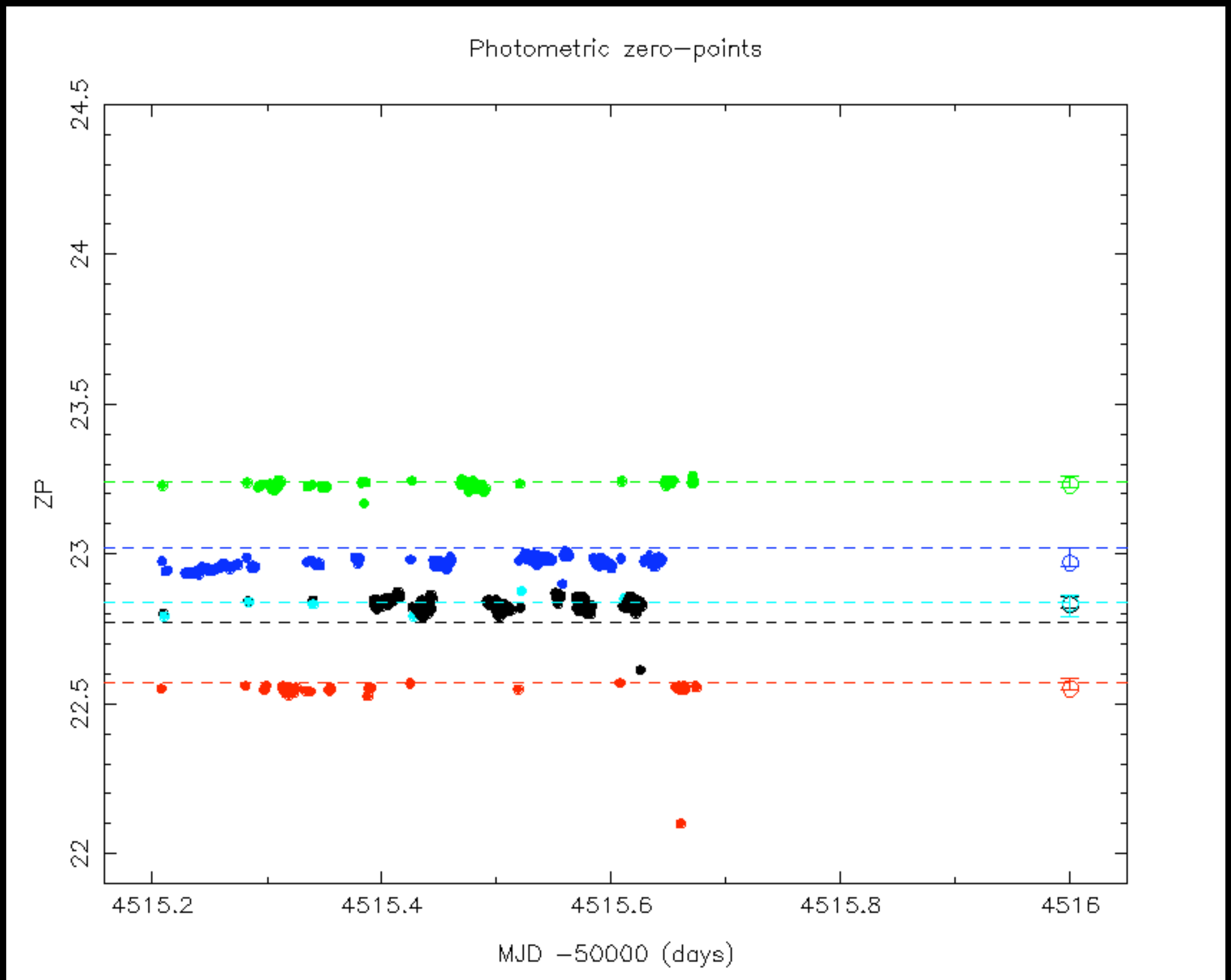
Globular cluster in 47 Tucana.

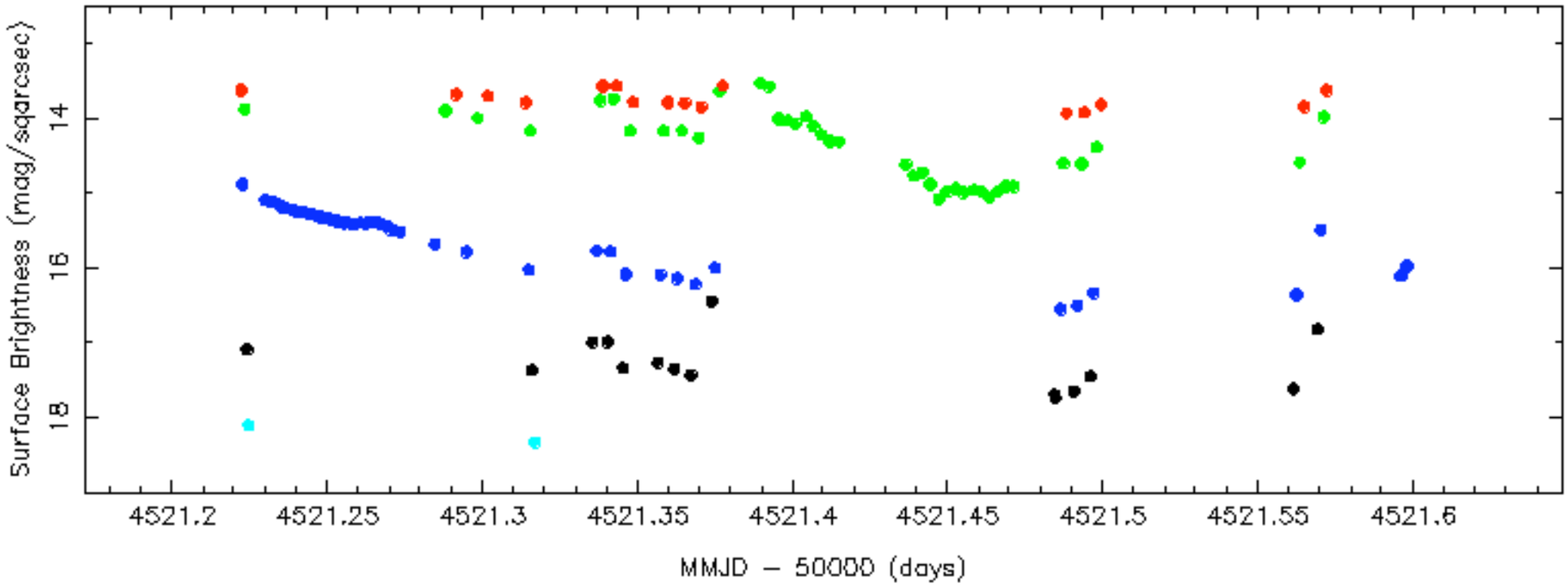
Additional Tools

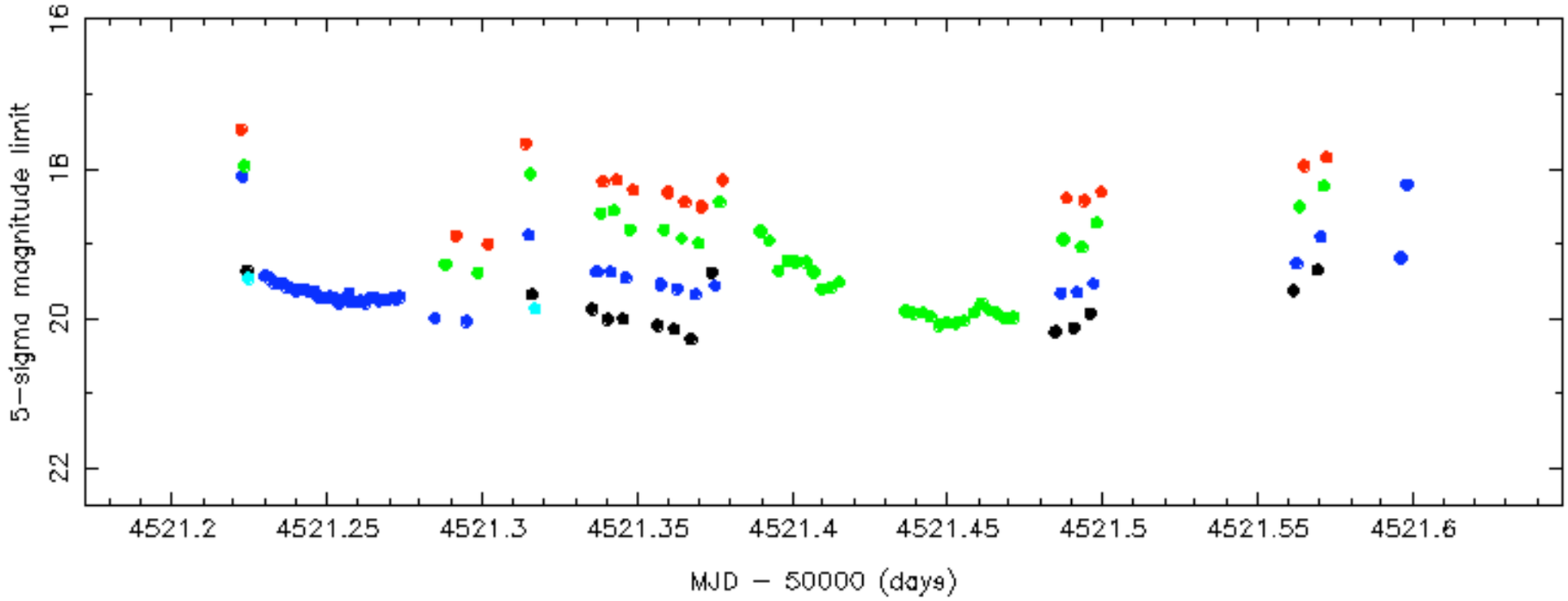
2008/02/14	reduced	1022	303	27 Apr 2008	30 Apr 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/15	reduced	1110	131	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/16	reduced	2236	1862	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/17	reduced	2383	2343	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/18	reduced	2506	1908	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/19	reduced	2433	2108	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/20	reduced	2394	1760	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/21	reduced	2334	2317	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/22	reduced	2613	2013	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/23	reduced	2360	1699	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/24	reduced	2722	2698	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/25	reduced	1270	133	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/26	reduced	1258	1225	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/27	reduced	2980	642	27 Apr 2008	02 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/28	reduced	1350	112	27 Apr 2008	02 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/02/29	reduced	1289	87	27 Apr 2008	02 May 2008	27 Apr 2008	1	GIF1 GIF2
2008/03/01	reduced	2569	1613	09 May 2008	19 May 2008	09 May 2008	1	GIF1 GIF2
2008/03/02	reduced	1877	827	27 May 2008	28 May 2008	27 May 2008	1	GIF1 GIF2
2008/03/03	reduced	1487	505	09 May 2008	19 May 2008	09 May 2008	1	GIF1 GIF2
2008/03/04	reduced	1421	735	09 May 2008	19 May 2008	09 May 2008	1	GIF1 GIF2
2008/03/05	reduced	1591	818	09 May 2008	19 May 2008	09 May 2008	1	GIF1 GIF2
2008/03/06	reduced	1323	334	09 May 2008	19 May 2008	09 May 2008	1	GIF1 GIF2



Too many slides here...


Photometric zero−points
ZP
24.5
24
23.5
23
22.5
22
4515.2
4515.4
4515.6
4515.8
4516
MJD −50000 (days)


Surface Brightness (mag/sqarcsec)
14
16
18
4521.2
4521.25
4521.3
4521.35
4521.4
4521.45
4521.5
4521.55
4521.6
MMJD − 50000 (days)


5−sigma magnitude limit
16
18
20
22
4521.2
4521.25
4521.3
4521.35
4521.4
4521.45
4521.5
4521.55
4521.6
MJD − 50000 (days)

WFCAM DATA REDUCTION PROGRESS: SEMESTER 08A

This page displays the reduction progress of WFCAM data. Information is automatically updated every hour (you need to reload the page).

Night	Status	N_{raw}	N_{ESO}	Checked	Transferred by WFAU	Last header update	Version	Summary Plots	Photometry Plots	Summary Info	Observation Log	SkyProbe (CFHT)
2008/02/06	nodata	0										skyprobe
2008/02/07	nodata	0										skyprobe
2008/02/08	nodata	0										skyprobe
2008/02/09	nodata	0										skyprobe
2008/02/10	nodata	0										skyprobe
2008/02/11	nodata	0										skyprobe
2008/02/12	nodata	0										skyprobe
2008/02/13	nodata	0										skyprobe
2008/02/14	reduced	1022	303	27 Apr 2008	30 Apr 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/15	reduced	1110	131	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/16	reduced	2236	1862	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/17	reduced	2383	2343	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/18	reduced	2506	1908	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/19	reduced	2433	2108	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/20	reduced	2394	1760	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/21	reduced	2334	2317	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/22	reduced	2613	2013	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/23	reduced	2360	1699	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/24	reduced	2722	2698	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/25	reduced	1270	133	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/26	reduced	1258	1225	27 Apr 2008	01 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/27	reduced	2980	642	27 Apr 2008	02 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/28	reduced	1350	112	27 Apr 2008	02 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe
2008/02/29	reduced	1289	87	27 Apr 2008	02 May 2008	27 Apr 2008	1	GIF1 GIF2	GIF	summary	obs_log	skyprobe

nightMonitor.html

http://casu.ast.cam.ac.uk/dqc/vista/nightMonitor/nightMonitor.html#app=777f&a571-selectedIndex=1

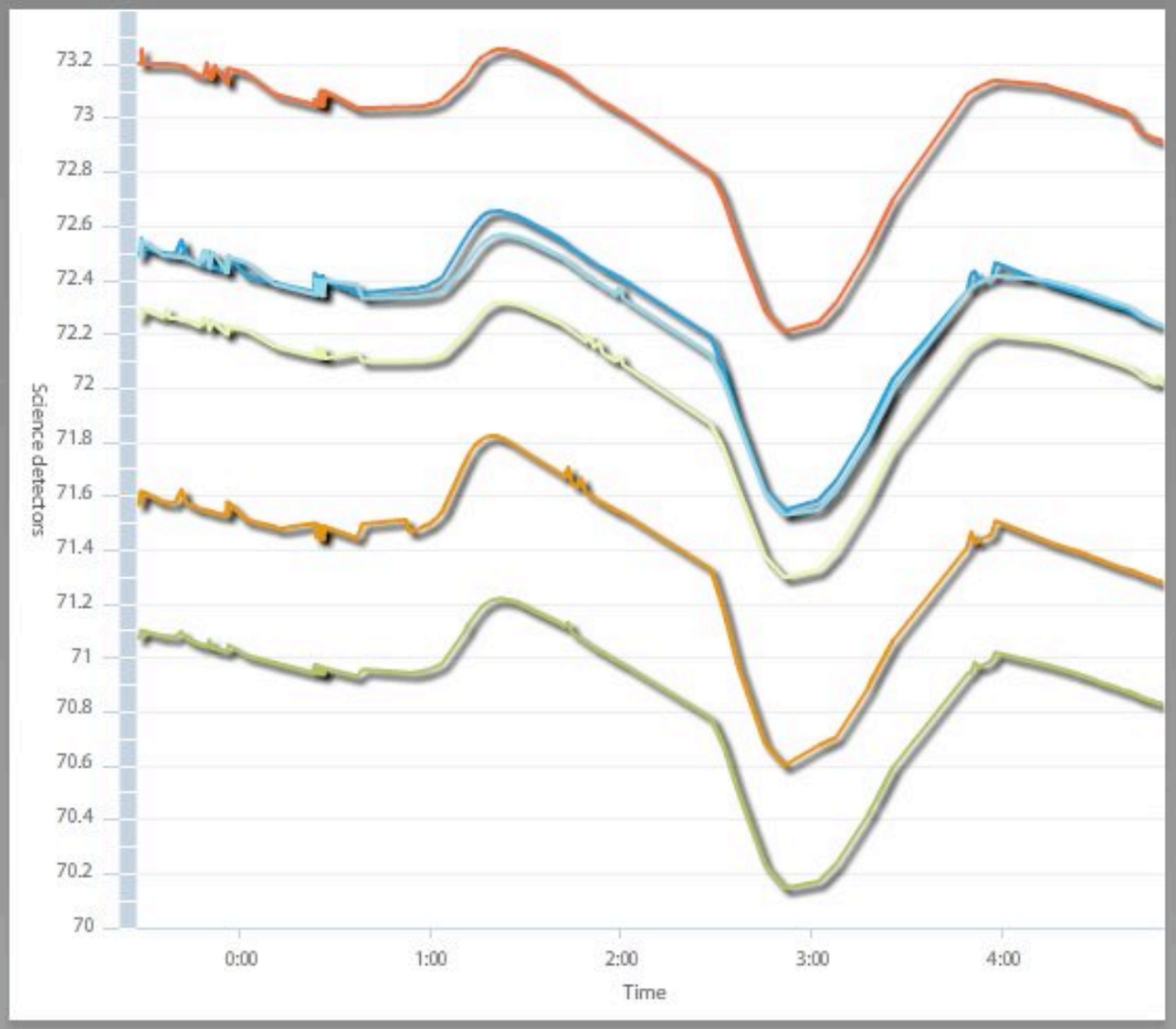
VISTA QC Night Monitor

Select night: 05/08/2008

Summary | Temperatures | Weather | Averages

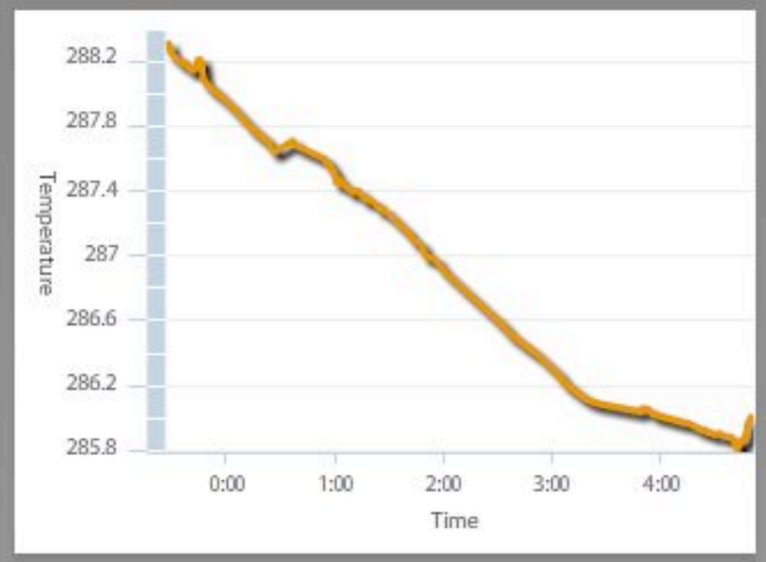
Instrument Temperatures [K]

[help]



Prev 5 Next

Ambient temperature [K]



PARAM	MEAN	MEDIAN
Science detector 3CD	73.056	73.089
Science detector 4BA	72.356	72.385
Science detector 2DC	71.986	72.022
Science detector 3AB	72.338	72.359
WFS plate	100.311	100.290
Science detector 4DC	72.122	72.147
FPA thermal plate	67.215	67.226
Cryostat tube	286.485	286.705
Cryostat window cell	287.391	287.580
Ambient temperature	287.156	287.385
Filter wheel shield	114.671	114.640

nightMonitor.html

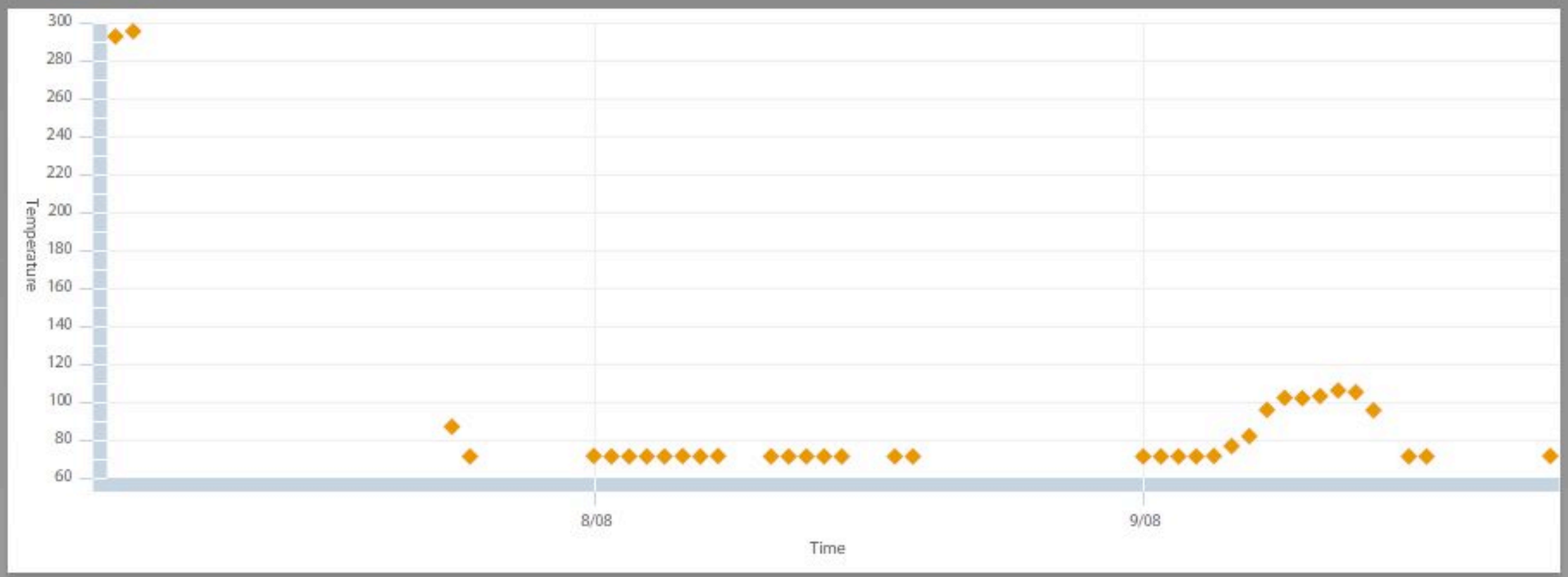
http://casu.ast.cam.ac.uk/dqc/vista/nightMonitor/nightMonitor.html#app=777f&a571-selectedIndex=3

VISTA QC Night Monitor

Select night: 05/08/2008

Summary | Temperatures | Weather | Averages

temp : Science detector 1AB | Mean



NIGHTOBS	MEAN	MEDIAN	MODE	STDEV	STERR	MINVAL	MAXVAL
20080605	293.010	293.010	291.860	1.626	1.150	291.860	294.160
20080606	295.720	295.720	295.720	0.000	0.000	295.720	295.720
20080624	86.991	87.095	74.676	11.851	0.958	73.348	129.440
20080625	71.400	71.394	71.347	0.042	0.003	71.333	71.490
20080701	71.483	71.457	71.448	0.153	0.015	70.875	71.671
20080702	71.293	71.296	71.321	0.021	0.002	71.249	71.326

WFCAM Survey Progress ...

http://casu.ast.cam.ac.uk/dqc/wfcam/#

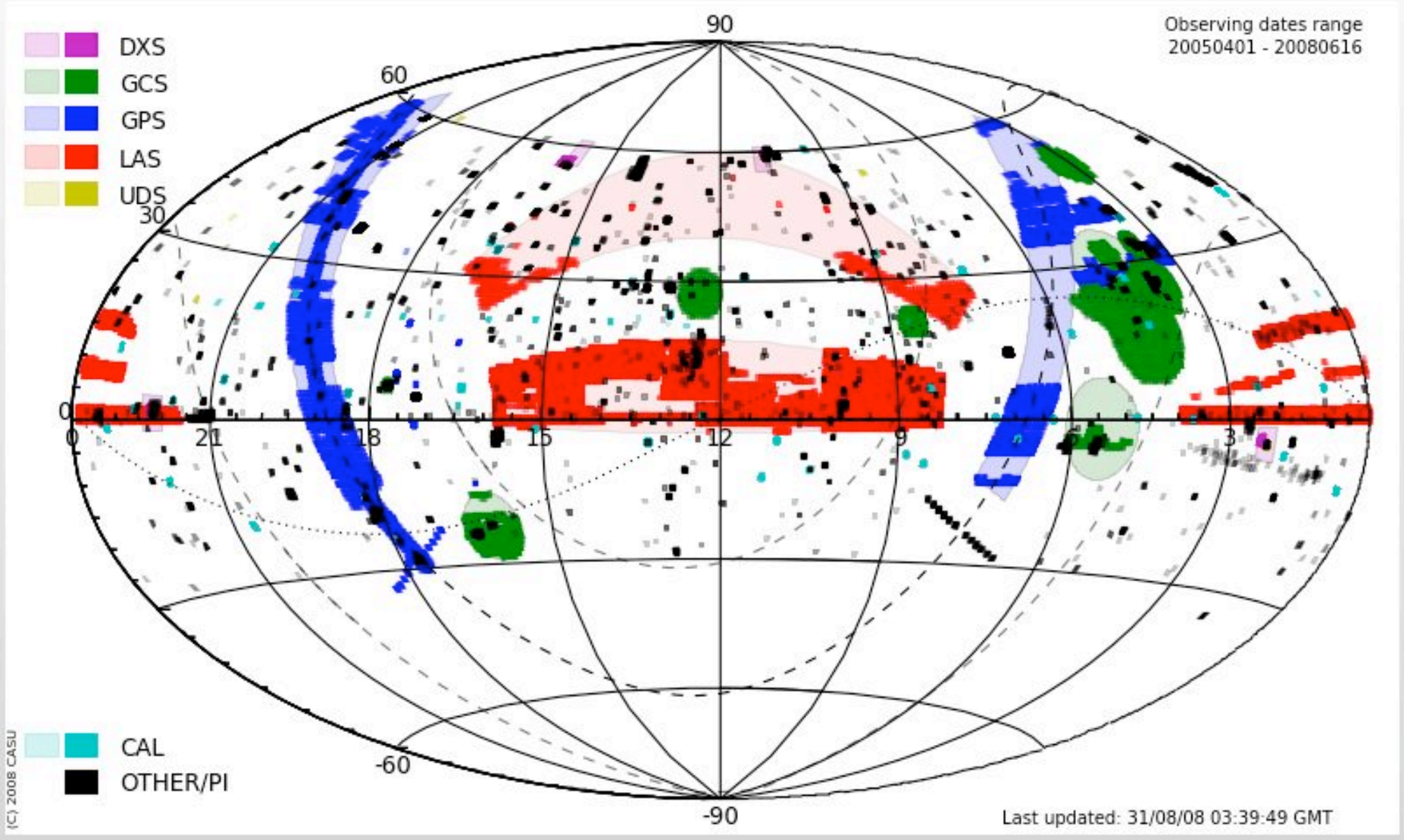
WFCAM SurveyProgress

Help

Full Sky | DXS | GCS | GPS | LAS | UDS

Options Snapshot

Coverage | Statistics



WFCAM Survey Progress ...

http://casu.ast.cam.ac.uk/dqc/wfcam/#app=5016&7ce3-selectedIndex=1

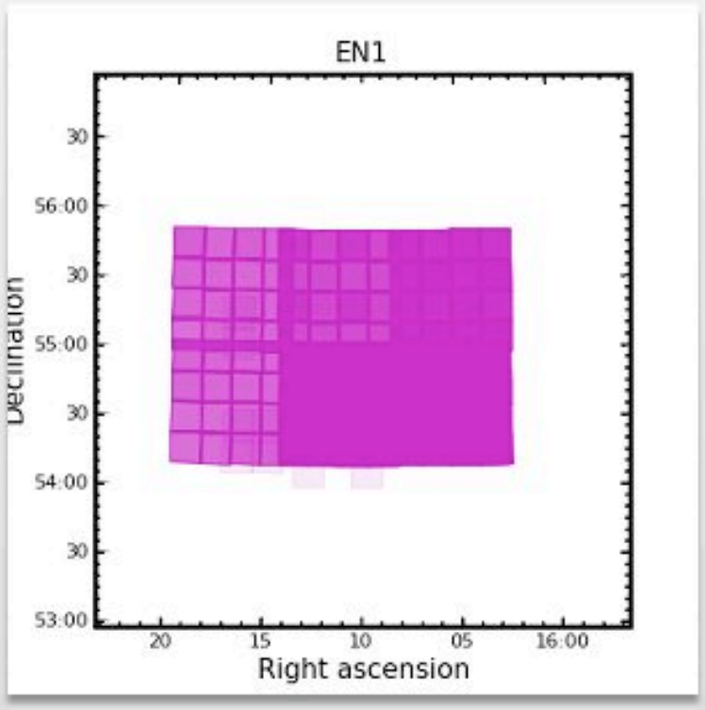
WFCAM SurveyProgress

Help

Full Sky | DXS | GCS | GPS | LAS | UDS

Options Snapshot

Coverage | Observed area | Observing time



WFCAM Survey Progress ...

http://casu.ast.cam.ac.uk/dqc/wfcam/#

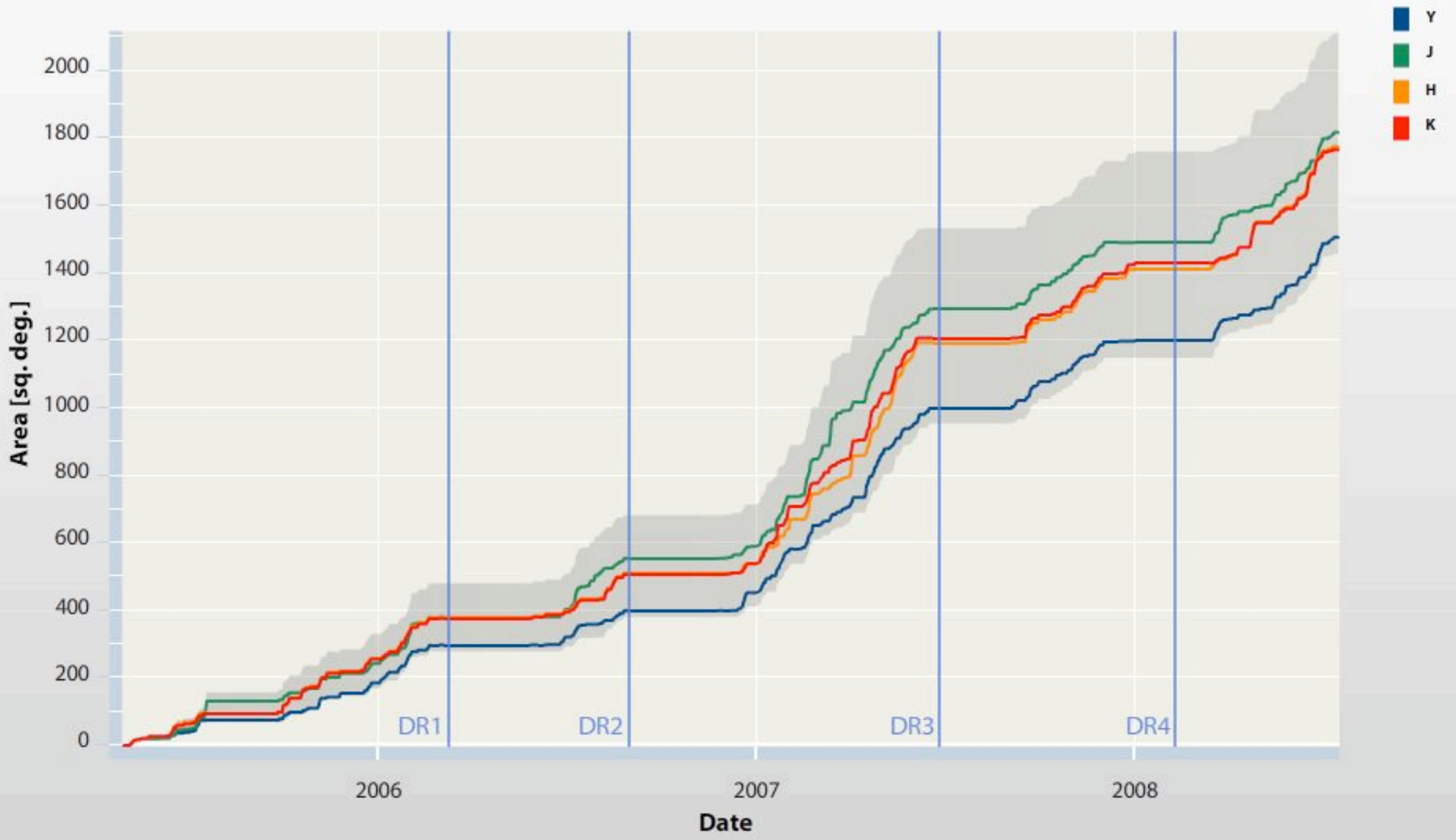
WFCAM SurveyProgress

Help

Full Sky | DXS | GCS | GPS | LAS | UDS

Options Snapshot

Coverage | Observed area | Observed area : LAS1 | Observed area : LAS2 | Observed area : LAS3 | Observing Time



WFCAM Survey Progress ...

http://casu.ast.cam.ac.uk/dqc/wfcam/#app=5016&7ce3-selectedIndex=1

WFCAM SurveyProgress

Help

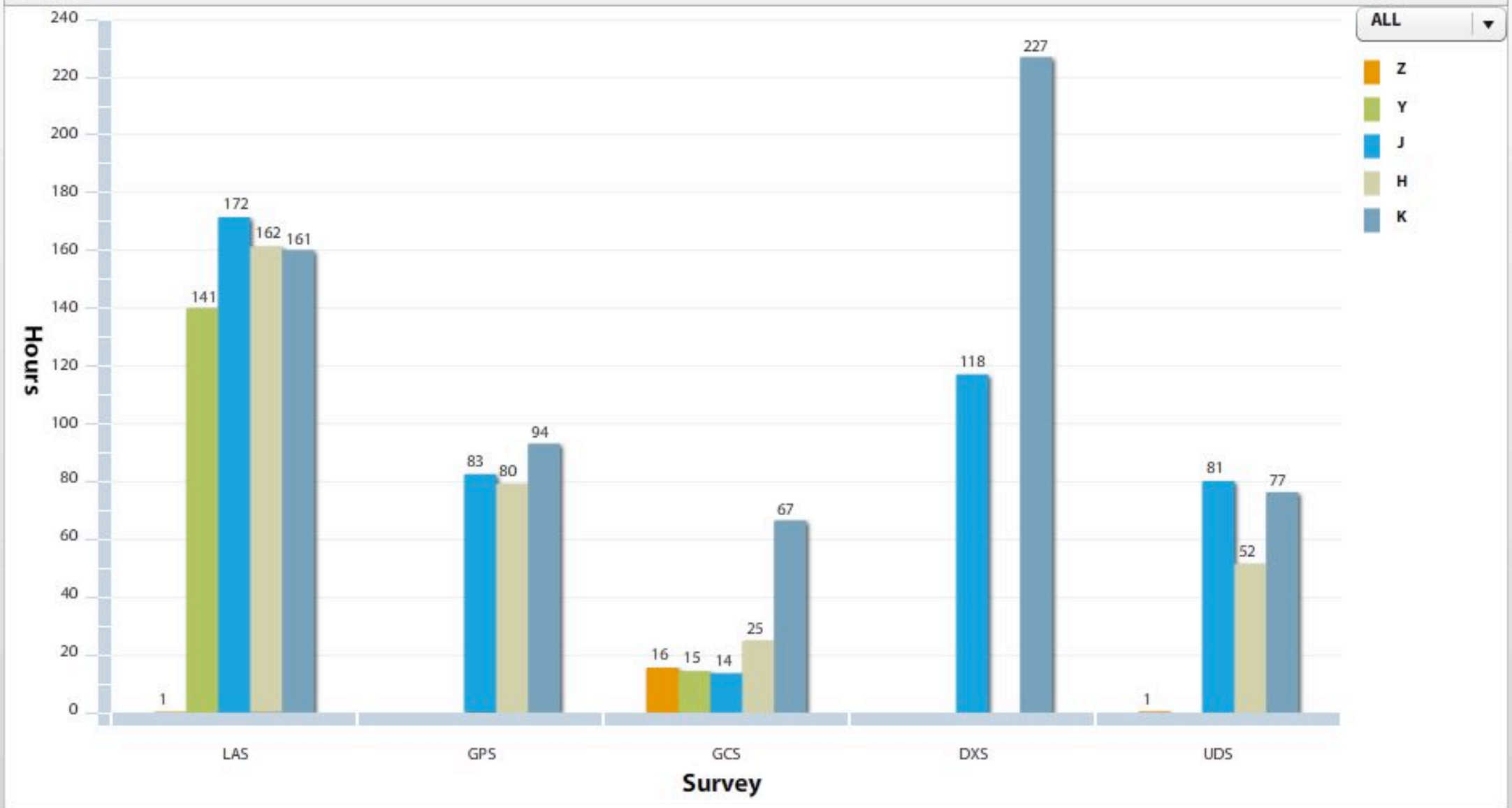
Full Sky | DXS | GCS | GPS | LAS | UDS

Options Snapshot

Coverage | Statistics

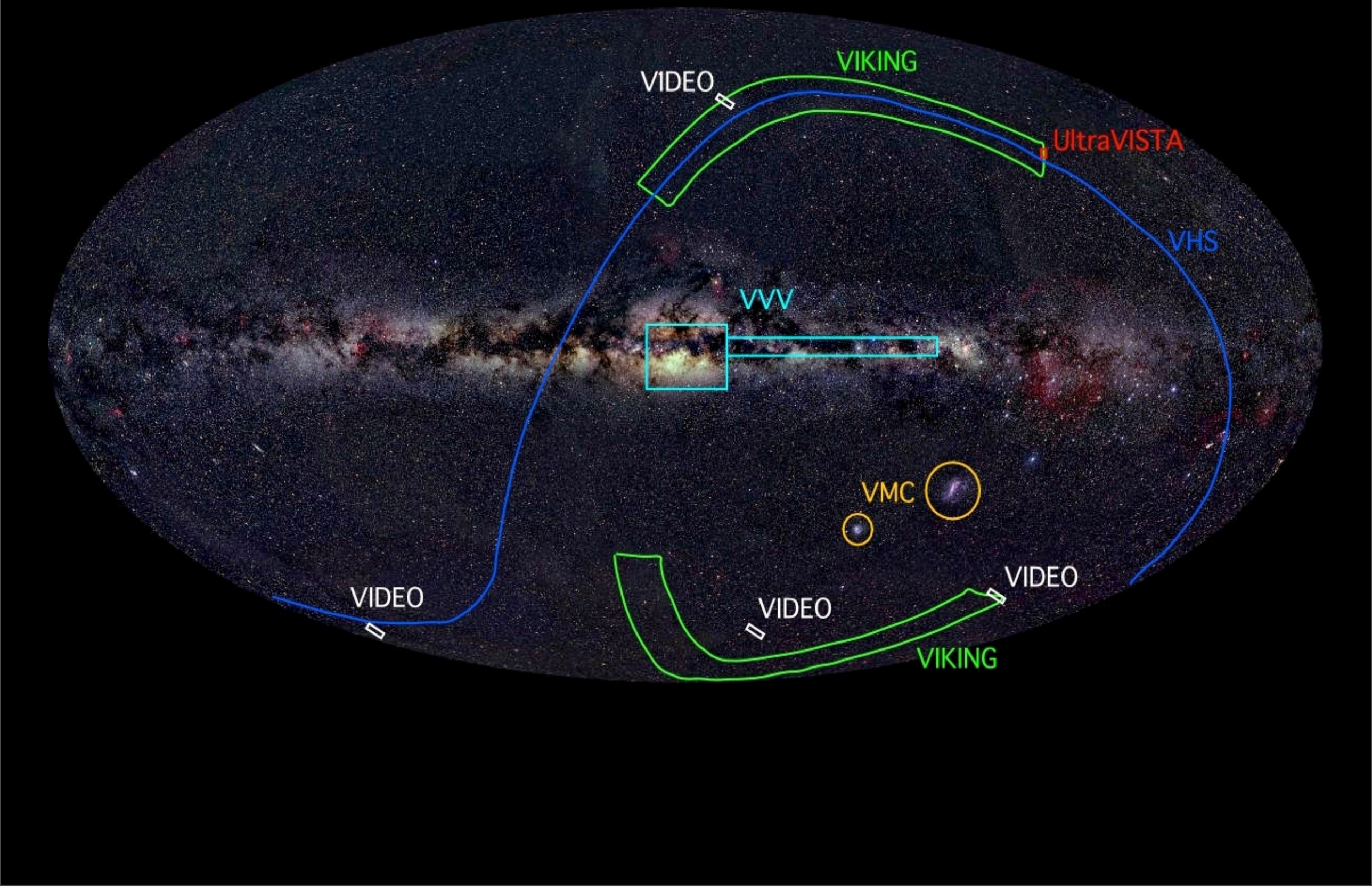
Number of completed MSBs

Observed Time



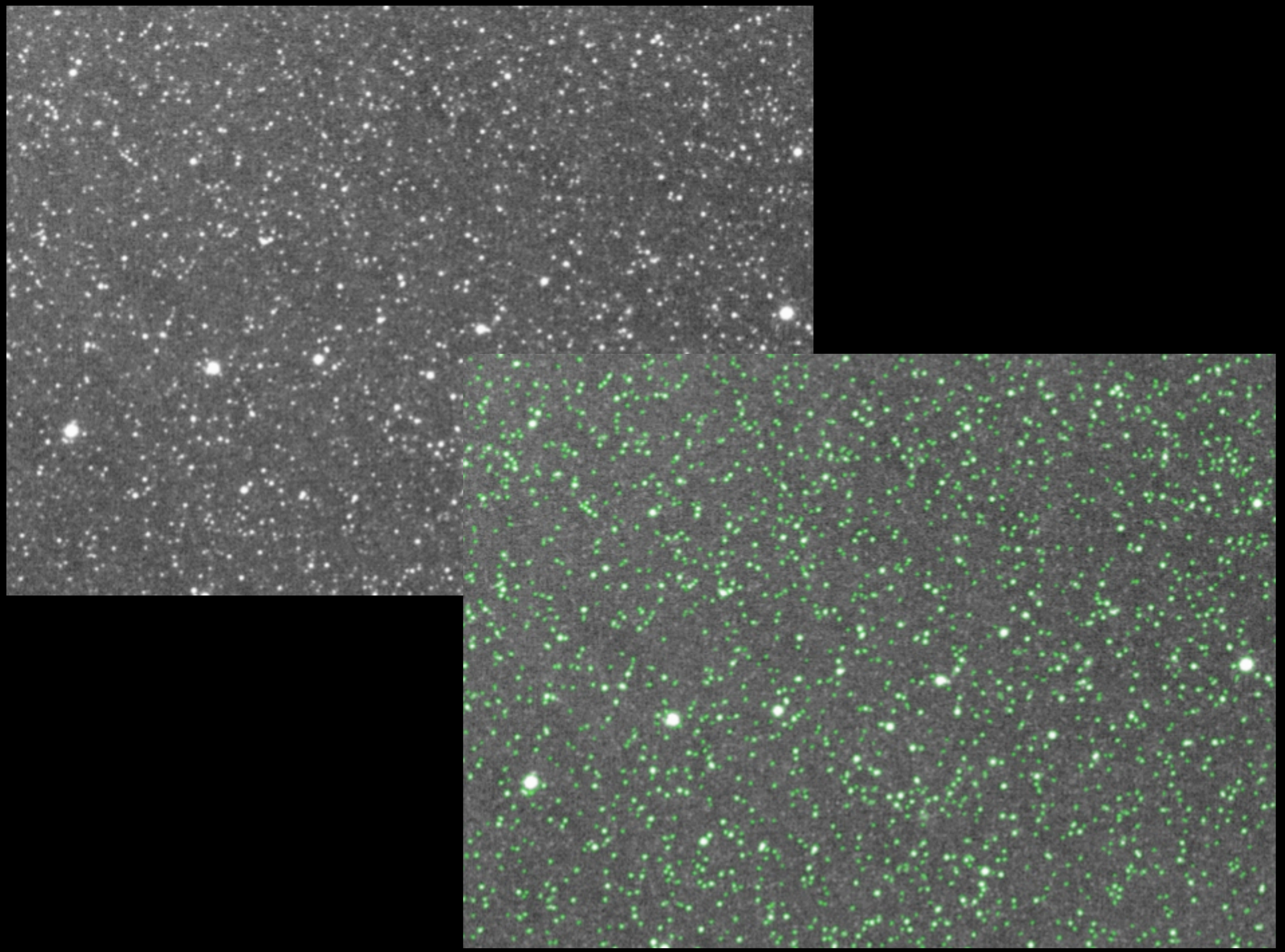
Observed Area

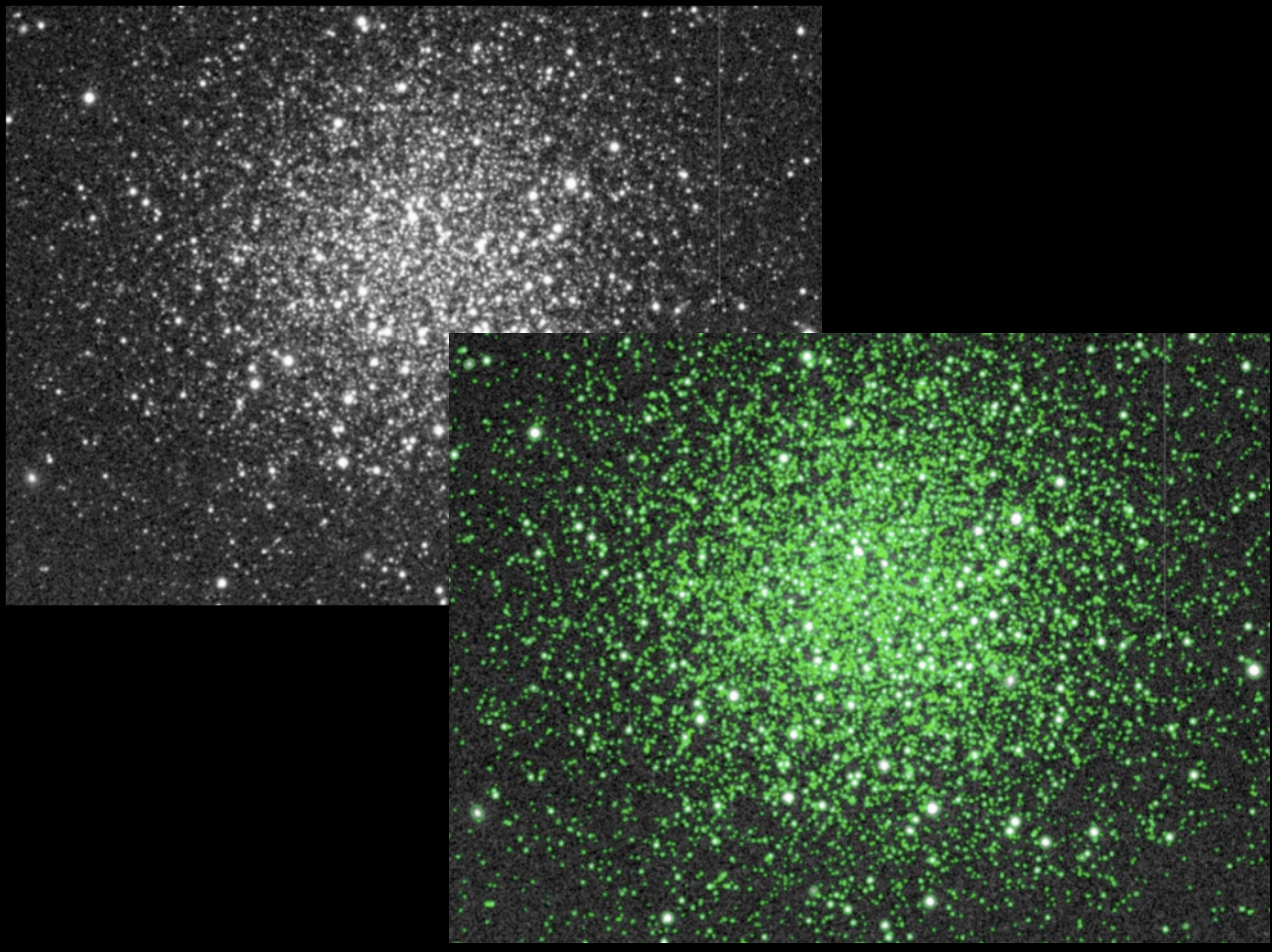
Fin

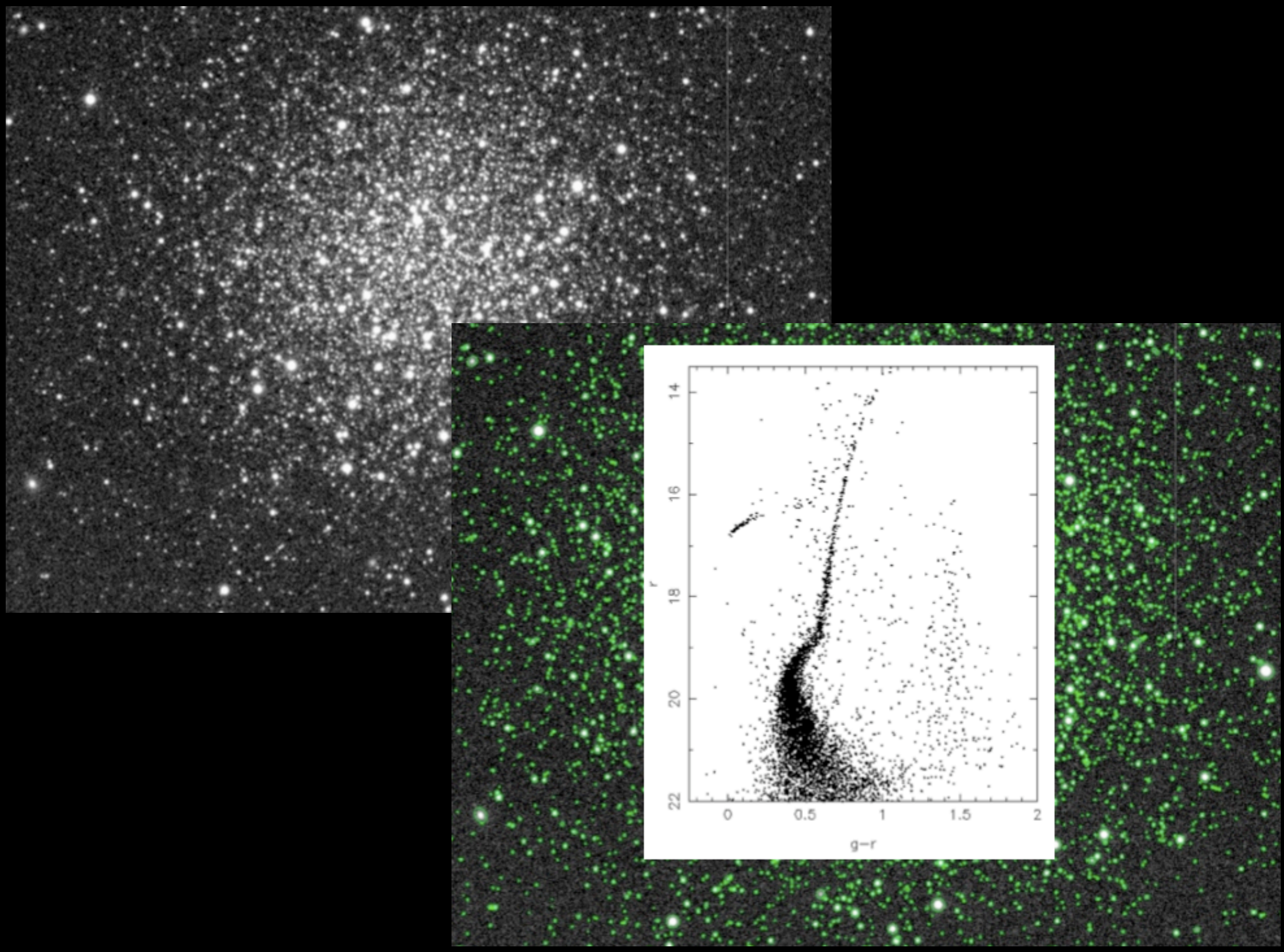

VIKING
VIDEO
UltraVISTA
VHS
VVV
VMC
VIDEO
VIDEO
VIDEO
VIKING

QC information from catalogues

- sky brightness + sky noise - estimate depth ?
- average FWHM of stellar images - seeing ?
- average ellipticity of stellar images - trailing? focus?
- aperture corrections - peculiar PSF ?
- astrometry - pointing? residuals?
- photometric calibration - extinction? throughput? problem images? nightly and longer term trends?

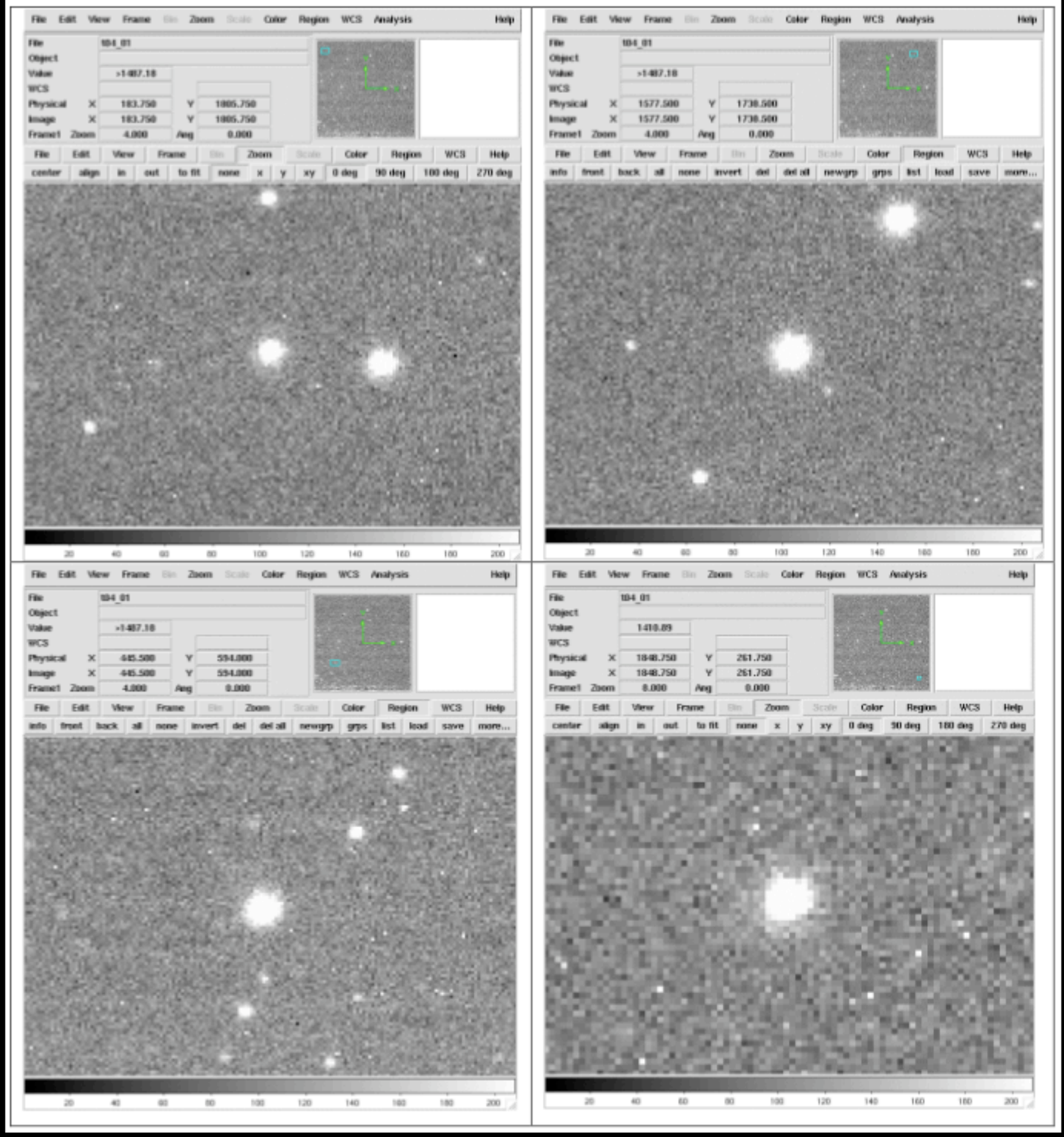


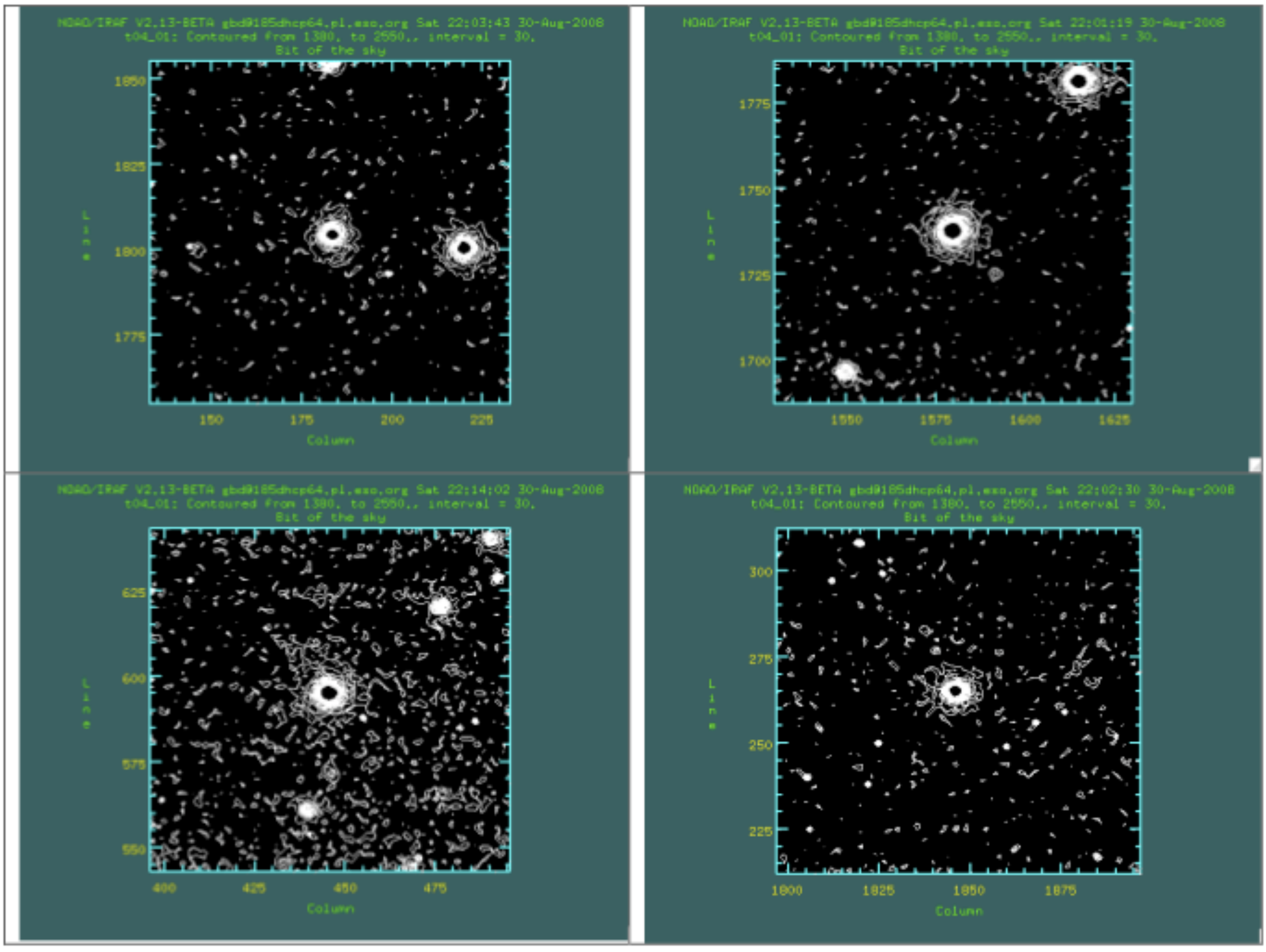


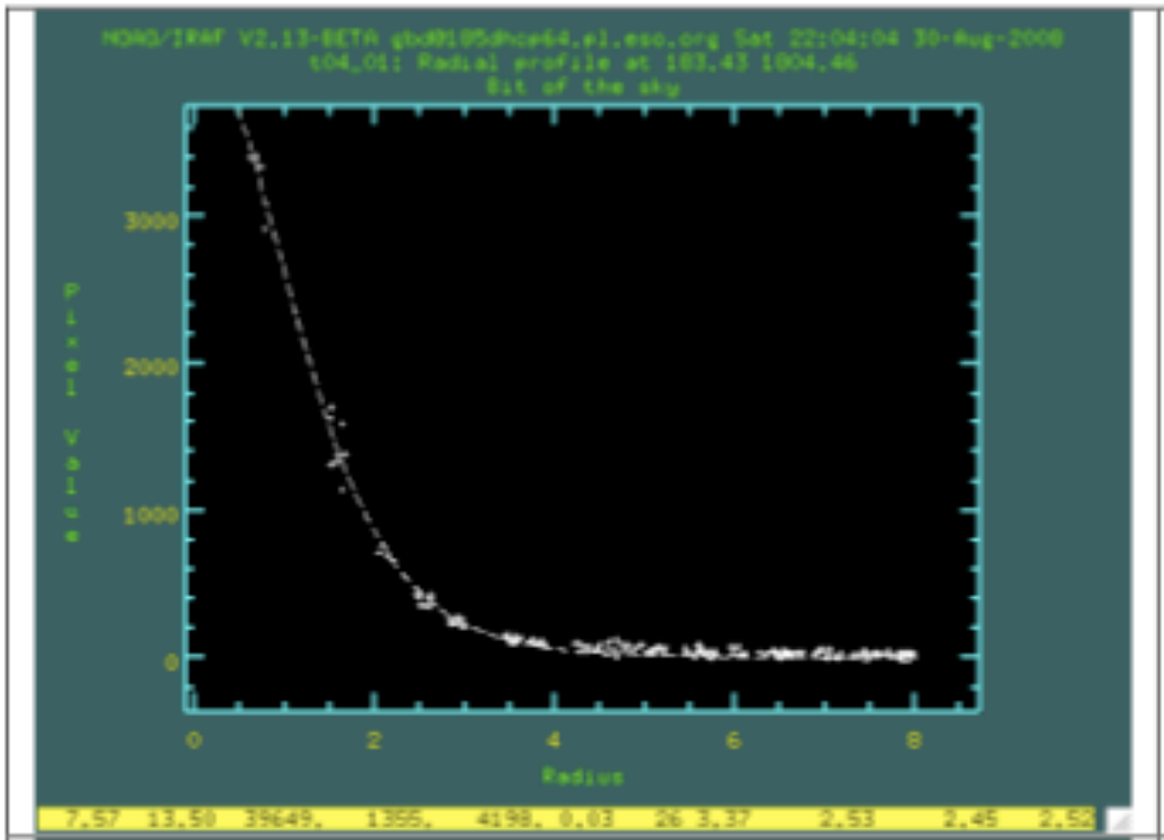

14
16
18
20
22
r
0
0.5
1
1.5
2
g−r

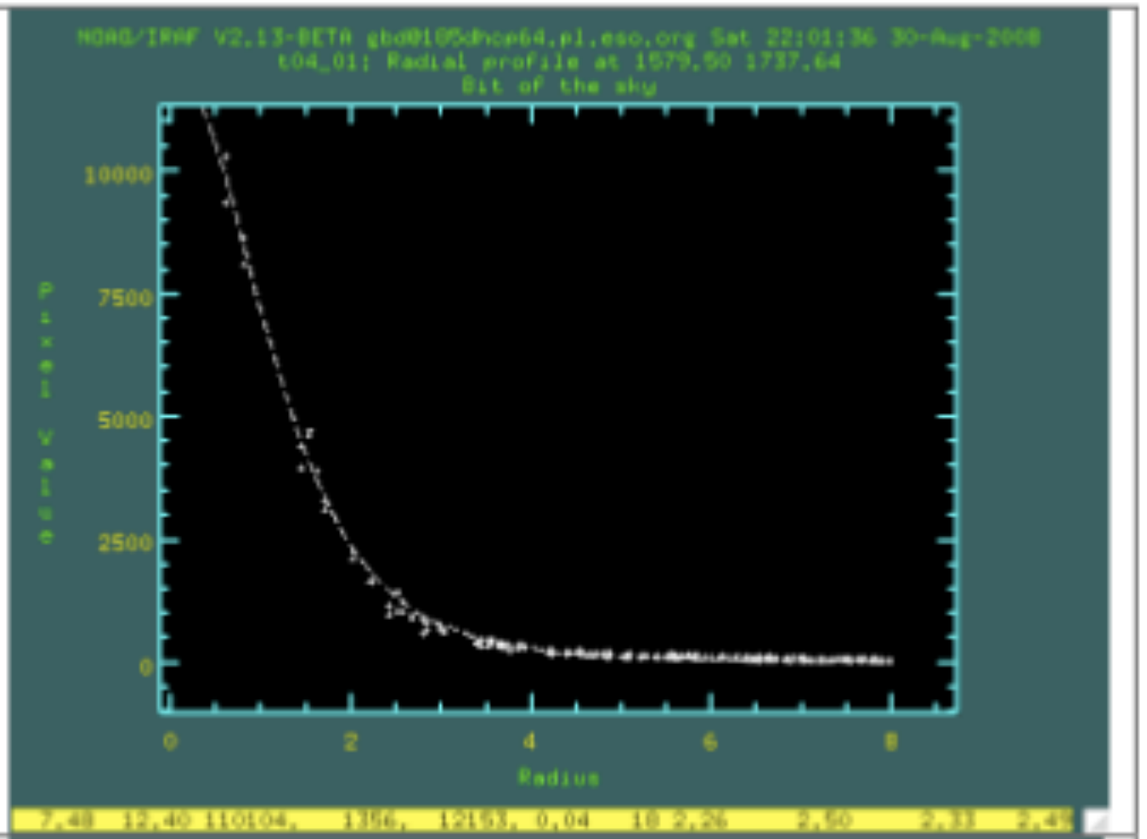
VIRCAM Pipelines

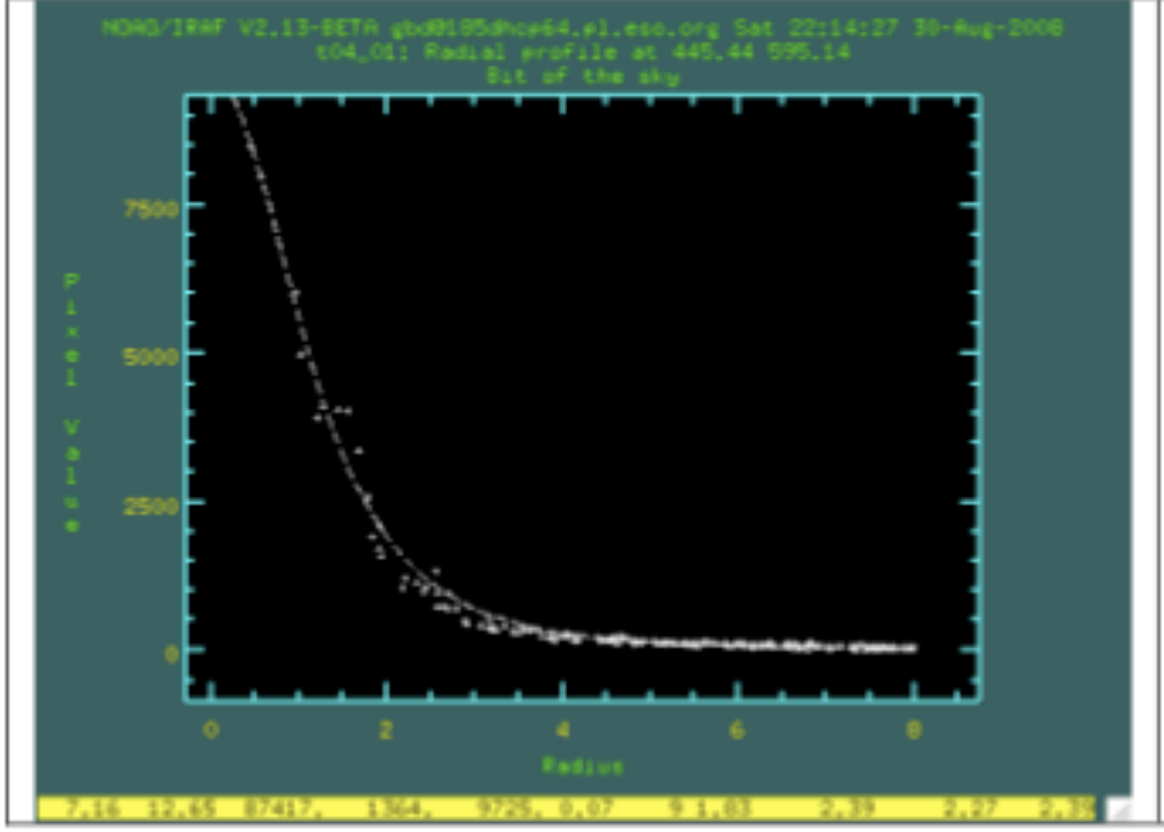
- QC-1 near-time pipeline at Paranal
- calibration and QC pipeline at ESO
  - process to pawprint level
  - includes deliverables to ESO
- UK science superset of above
  - process to full tile level
  - larger range of scientific products

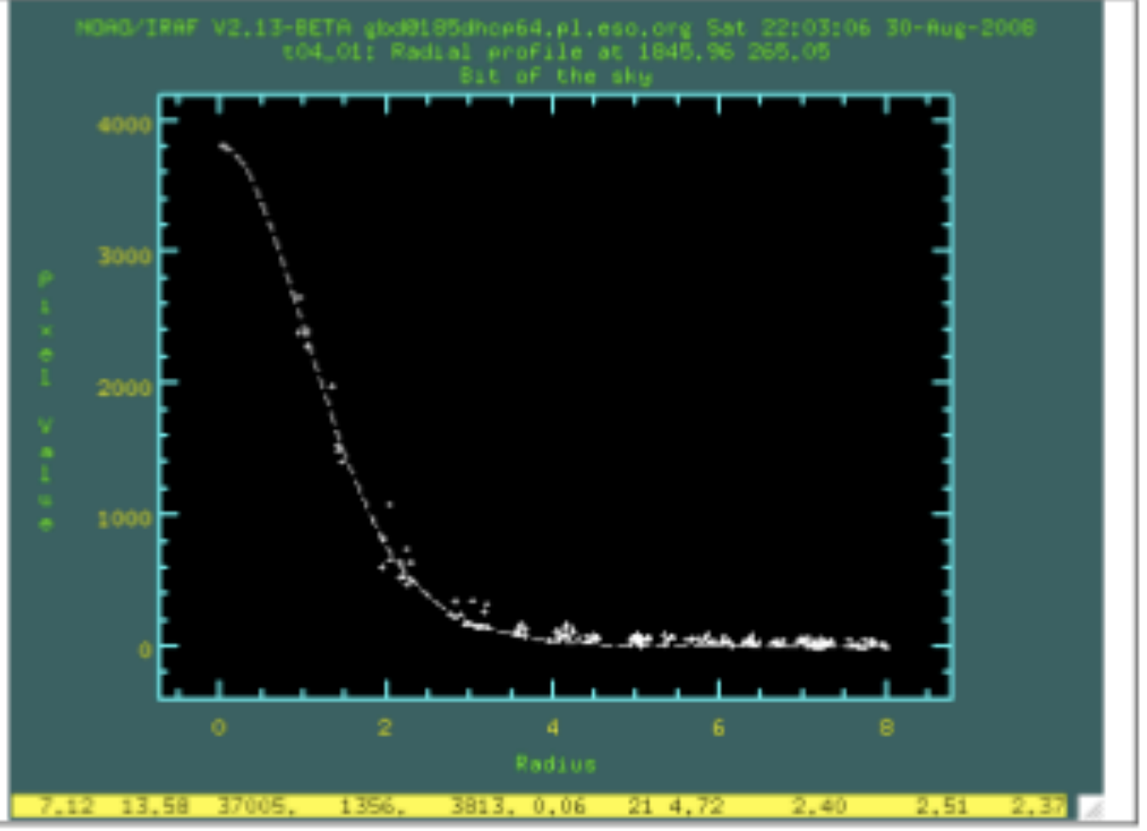

File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File 184_01
Object
Value >1487.18
WCS
Physical X 183.750 Y 1805.750
Image X 183.750 Y 1805.750
Frame1 Zoom 4.000 Avg 0.000
File Edit View Frame Bin Zoom Scale Color Region WCS Help
center align in out to fit none x y xy 0 deg 90 deg 180 deg 270 deg
20 40 60 80 100 120 140 160 180 200
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File 184_01
Object
Value >1487.18
WCS
Physical X 1577.500 Y 1730.500
Image X 1577.500 Y 1730.500
Frame1 Zoom 4.000 Avg 0.000
File Edit View Frame Bin Zoom Scale Color Region WCS Help
info front back all none invert del del all newgrp grps list load save more...
20 40 60 80 100 120 140 160 180 200
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File 184_01
Object
Value >1487.18
WCS
Physical X 485.500 Y 554.000
Image X 485.500 Y 554.000
Frame1 Zoom 4.000 Avg 0.000
File Edit View Frame Bin Zoom Scale Color Region WCS Help
info front back all none invert del del all newgrp grps list load save more...
20 40 60 80 100 120 140 160 180 200
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File 184_01
Object
Value 1410.89
WCS
Physical X 1848.750 Y 261.750
Image X 1848.750 Y 261.750
Frame1 Zoom 8.000 Avg 0.000
File Edit View Frame Bin Zoom Scale Color Region WCS Help
center align in out to fit none x y xy 0 deg 90 deg 180 deg 270 deg
20 40 60 80 100 120 140 160 180 200


NOAO/IRAF V2.13-BETA gbd@185dhcp64.pl.eso.org Sat 22:03:43 30-Aug-2008
t04_01: Contoured from 1380. to 2550., interval = 30.
Bit of the sky
Line
Column
NOAO/IRAF V2.13-BETA gbd@185dhcp64.pl.eso.org Sat 22:01:19 30-Aug-2008
t04_01: Contoured from 1380. to 2550., interval = 30.
Bit of the sky
Line
Column
NOAO/IRAF V2.13-BETA gbd@185dhcp64.pl.eso.org Sat 22:14:02 30-Aug-2008
t04_01: Contoured from 1380. to 2550., interval = 30.
Bit of the sky
Line
Column
NOAO/IRAF V2.13-BETA gbd@185dhcp64.pl.eso.org Sat 22:02:30 30-Aug-2008
t04_01: Contoured from 1380. to 2550., interval = 30.
Bit of the sky
Line
Column


NOAO/IRAF V2.13-BETA gbd0195dhcp64.pl.eso.org Sat 22:04:04 30-Aug-2008
t04_01: Radial profile at 183.43 1804.46
Bit of the sky
Pixel Value
Radius
0
1000
2000
3000
0
2
4
6
8


NOAO/IRAF V2.13-BETA gbd0195dhcp64.pl.eso.org Sat 22:01:36 30-Aug-2008
t04_01: Radial profile at 1579.50 1737.64
Bit of the sky
Pixel Value
Radius
0
2500
5000
7500
10000
0
2
4
6
8


NOAO/IRAF V2.13-BETA gbd0195dhcp64.pl.eso.org Sat 22:14:27 30-Aug-2008
t04_01: Radial profile at 445.44 595.14
Bit of the sky
Pixel Value
Radius
0
2500
5000
7500
0
2
4
6
8


NOAO/IRAF V2.13-BETA gbd0195dhcp64.pl.eso.org Sat 22:03:06 30-Aug-2008
t04_01: Radial profile at 1845.96 265.05
Bit of the sky
Pixel Value
Radius
0
1000
2000
3000
4000
0
2
4
6
8