

VST science verification

Issues common to wide field imaging surveys data processing

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&

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A0 - Raw data standards

Are the information provided in the FITS headers of the raw data and in opslogs adequate for the pipeline processing of the survey data?

- YES

-It would be useful to have in the header info about night photometric quality

A1 - BIAS

Is the bias constant and to which level?

Difference between the two bias

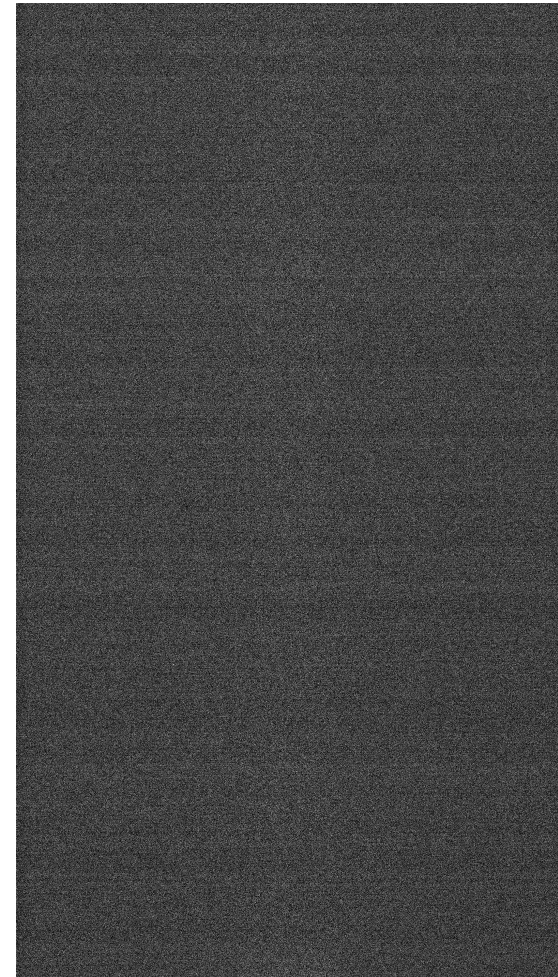
OMEGA.2011-10-25T09:00:15.847

and

OMEGA.2011-12-18T09:37:48.360

for ccd68 (the one with the structure inside).

The only difference is in the mean level (-3.96 ADU).



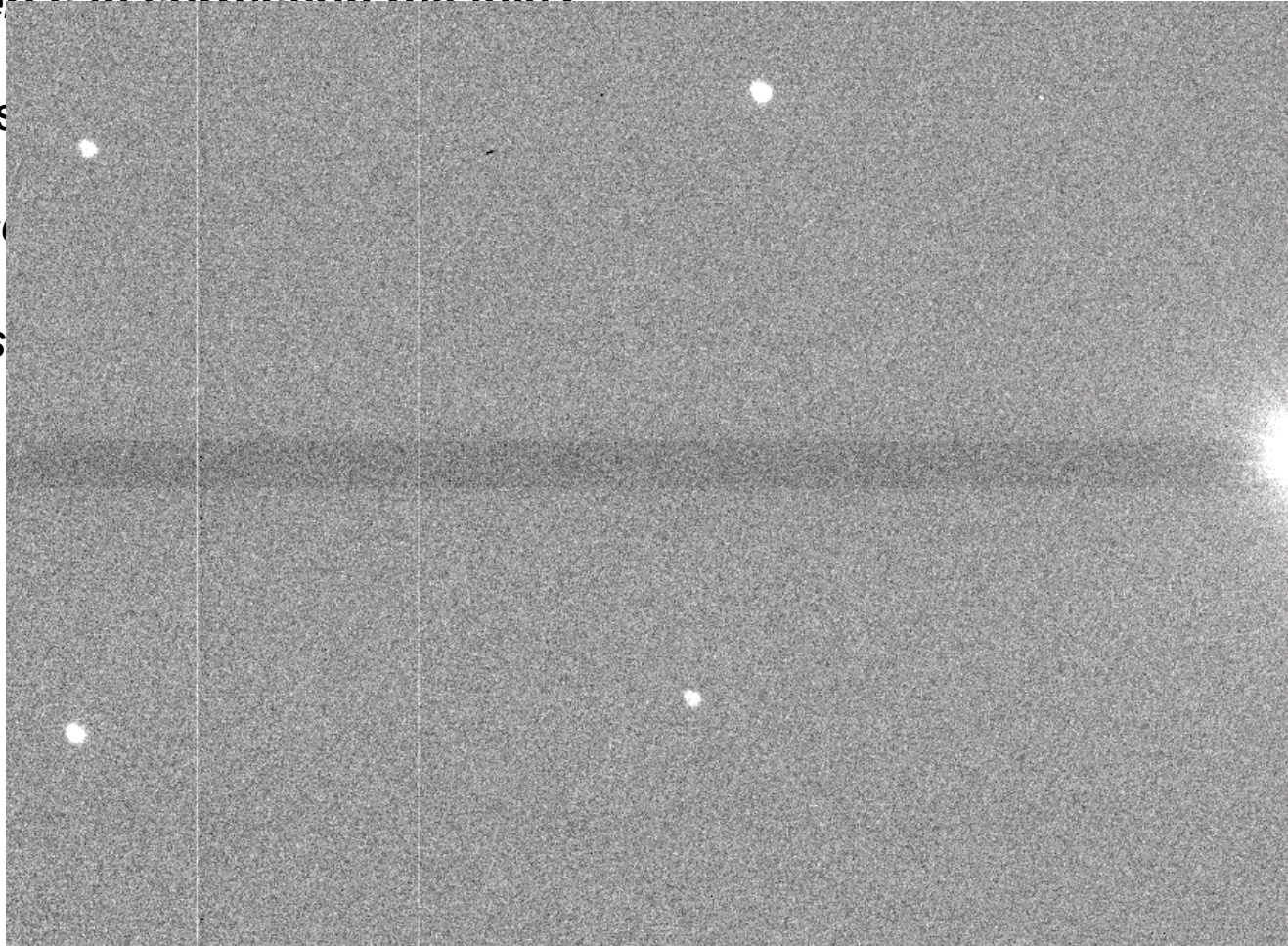
A1 - OverSCAN

Is the overscan correction reliable?

If a bright s

Possible s

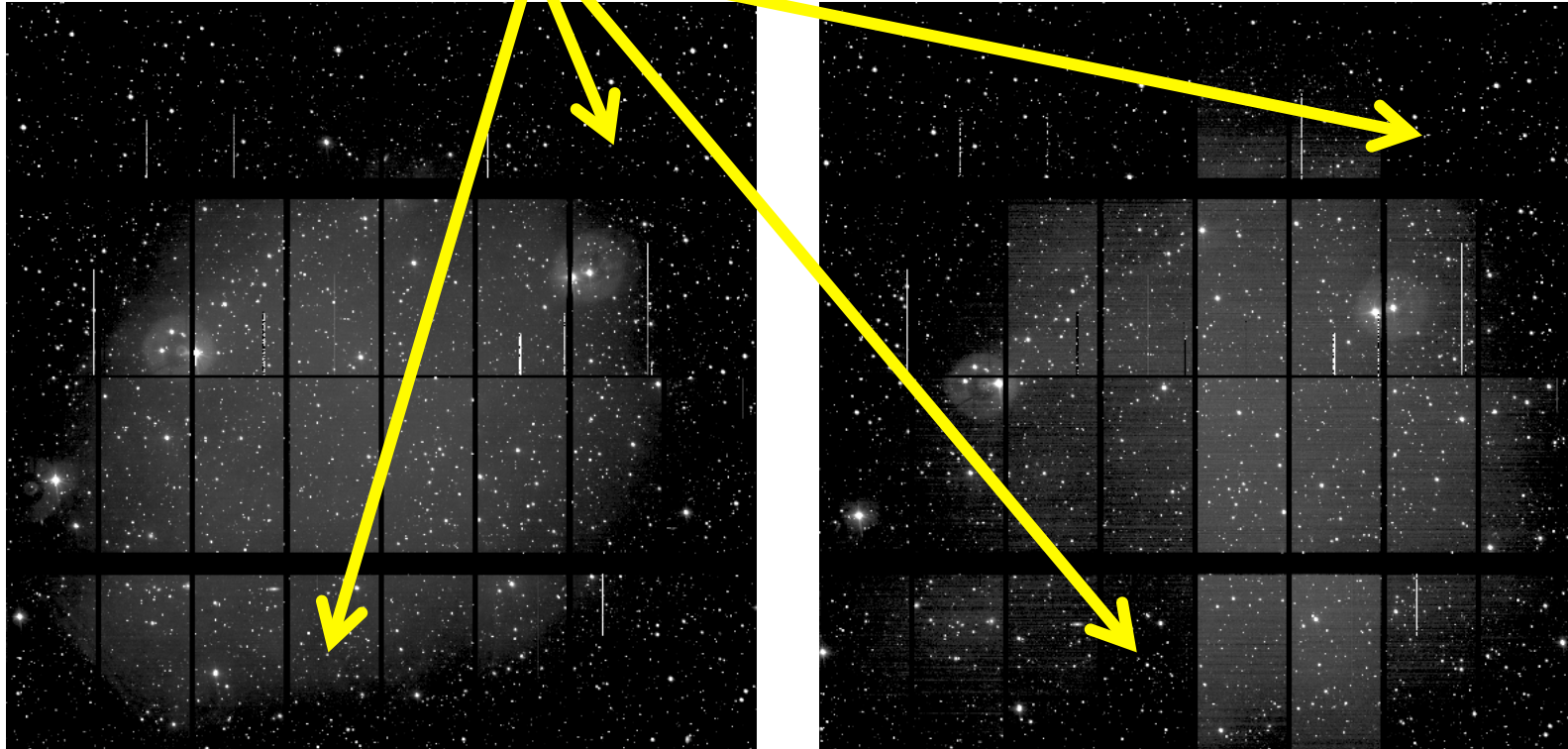
Method us



)

A1 - Overscan

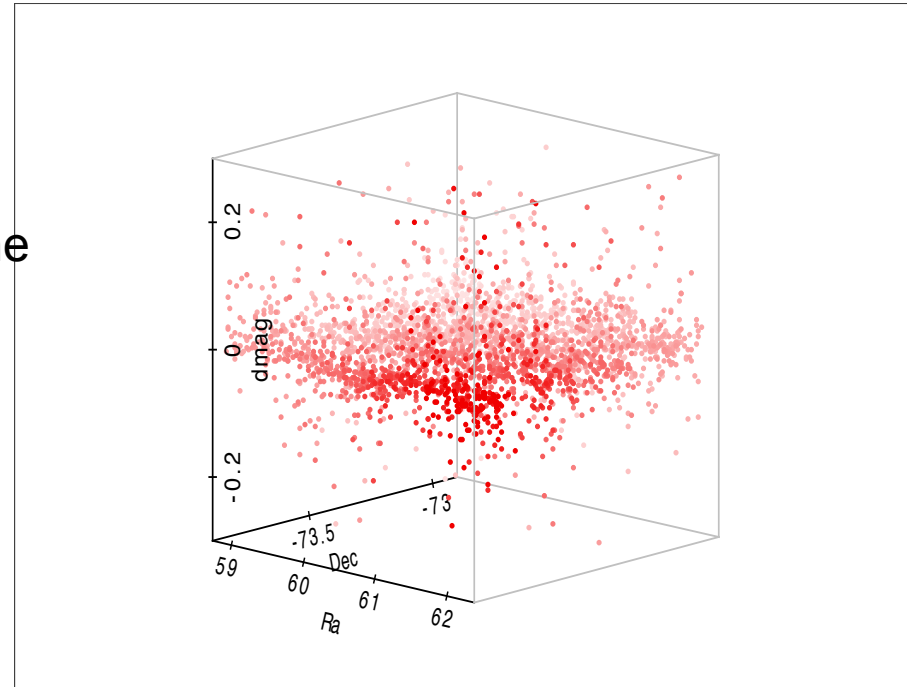
Jump in background level



The two images were reduced using the same calibration files. The CCDs gain harmonization was calculated on the longer exposures. To test for gain variations a photometric comparison was performed between the two images.

A1 - Overscan

Aperture magnitude differences
between the two exposures over the
whole field of view
The rms is below 0.05 mag



Median_dmag_ccd94=1.6846 (282 sources)

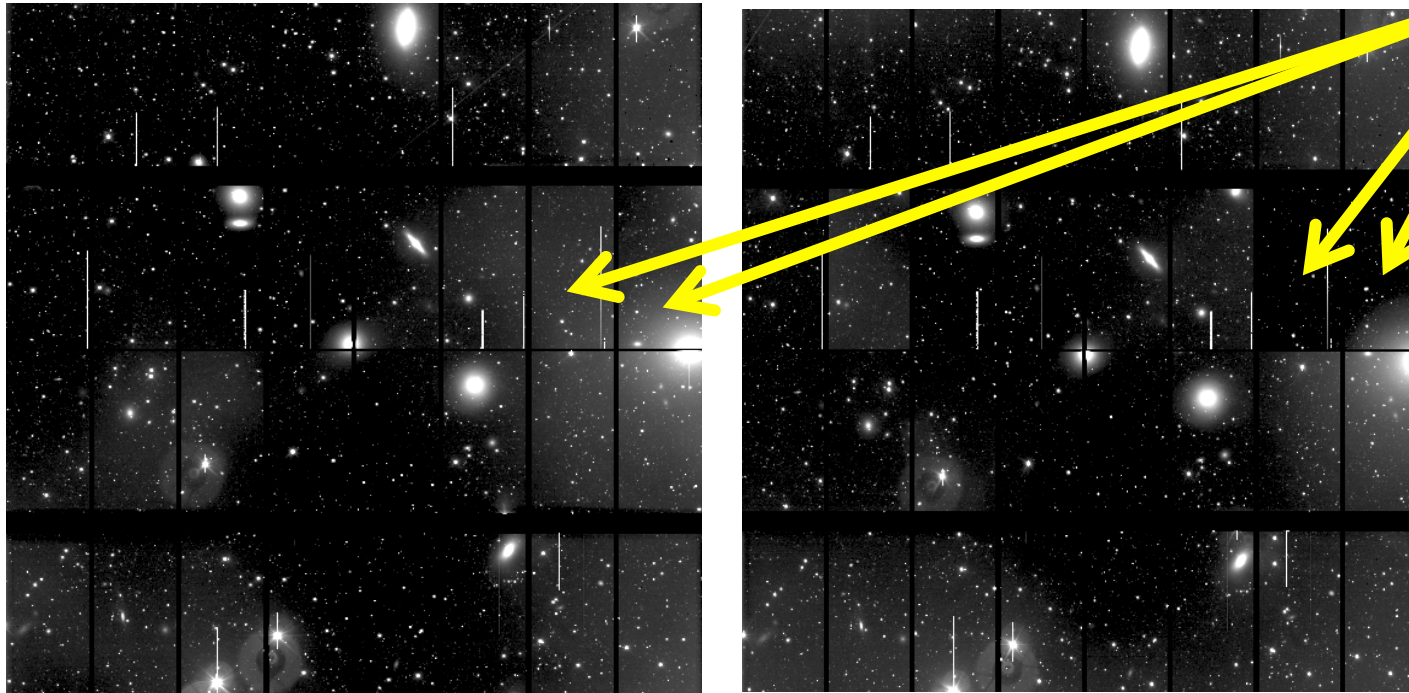
Median_dmag_ccd95=1.6753 (228 sources)

The magnitude differences between the two ccDs (94 and 95) is <0.01 mag

A1 - Overscan

Example: NGC1379

Bkg jumps



Going from one OB to the next (executed after one hour) there is a jump in the background level as much as 7 ADU (from 162 to 169 ADUs) for ccds 88 and 87.

The check for photometry gives:

$\text{Median}(\text{phot_aper_552_ccd86} - \text{phot_aper_559_ccd86}) = -0.0372$

$\text{Median}(\text{phot_aper_552_ccd87} - \text{phot_aper_559_ccd87}) = -0.0426$

Whith a difference of 0.0058 mags

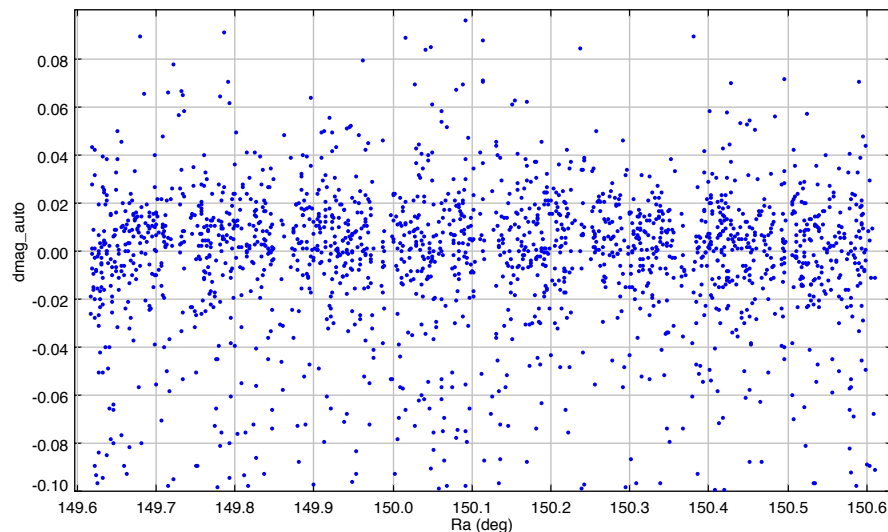
A2 – Flat-Fielding

What is the flat fielding accuracy in your pipeline?

Internal photometric (after illumination correction was applied) error vs Ra and Dec for two ditherings of the same pointing (COSMOS night 2012-01-17)

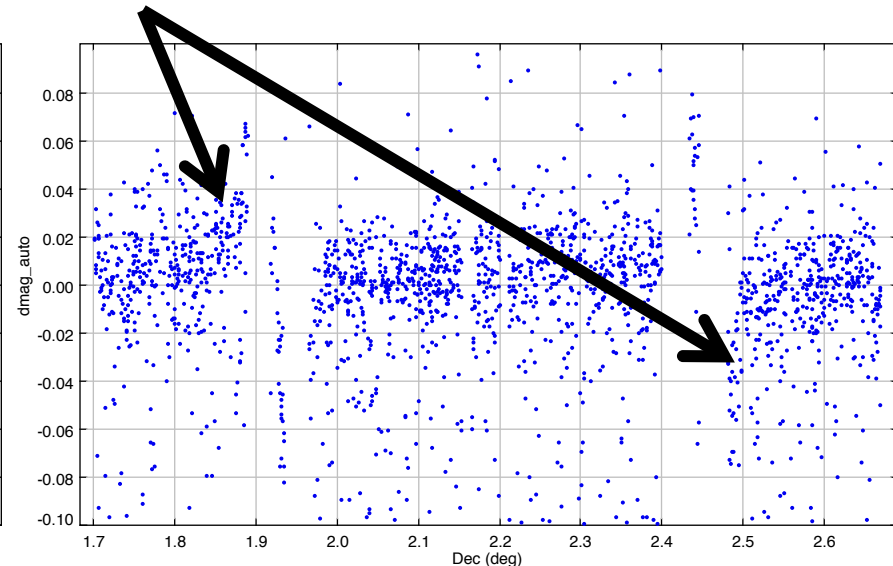
OMEGA.2012-01-18T04:40:15.889

OMEGA.2012-01-18T05:07:14.524



***$\sigma=0.03$ mag on the whole mosaic
high S/N***

ERROR in FLAT near big gaps



***$\sigma=0.03$ mag on the whole mosaic
high S/N***

A2 – Flat-Fielding

Are there any dependencies on filters?

We do not mix Flat fields for different filters. No tests performed

Are there any dependencies on the rotation angle!

Test done on early data (Omega Centauri) shows such effect

A2 – Flat-Fielding

Does your pipeline carry out checks on your master flats for possible remnants from stars? How is this done?

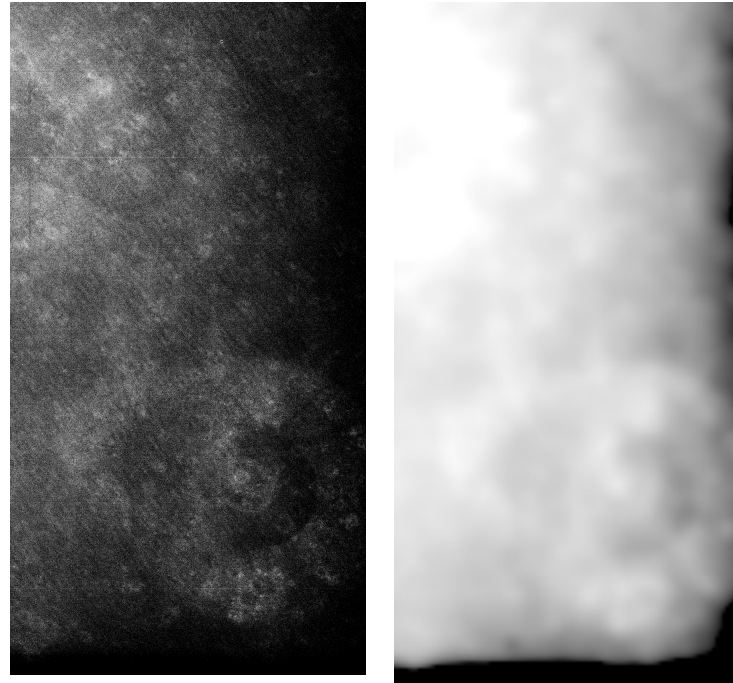
Two methods implemented in VST-Tube in master twilight flats and superflats production:

- 1) Sources are detected on each image, removed, the holes are filled with a background with the same average value and sigma as the surroundings. The images are combined and the result is fitted with a polynomial surface (problems with large structures like halos)
- 2) New method (tailored for VST): sources and halos are detected and flagged. The images are combined without taking into account the flagged pixels. Possible flagged pixels in the final image are interpolated. The the master image is low-pass filtered

A2 – Flat-Fielding

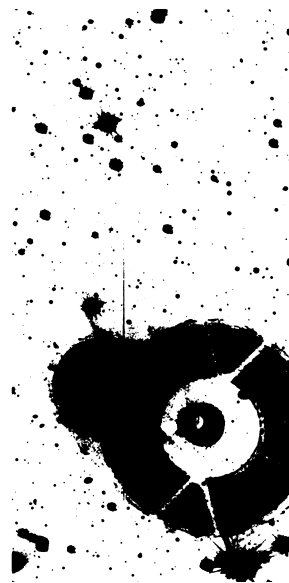
Does your pipeline carry out checks on your master flats for possible remnants from stars? How is this done?

Example of superflat



Left the sigmaclipped combination of 12 science images to create a superflat. On the right the low pass filtered (FFT). The sources residuals reach ~3%.

A2 – Flat-Fielding



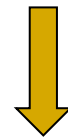
A mask for bright stars and ghost is created and applied to the science images before the combination. On the right the sigmaclipped (2-sigma) combination of masked images. The source residuals are below 0.5%.

A2 – Flat-Fielding

Does your pipeline deal with narrow band imaging? YES

What is the flat-fielding accuracy of the narrow band data?

$\sigma=0.09$ mag
On the whole
mosaic

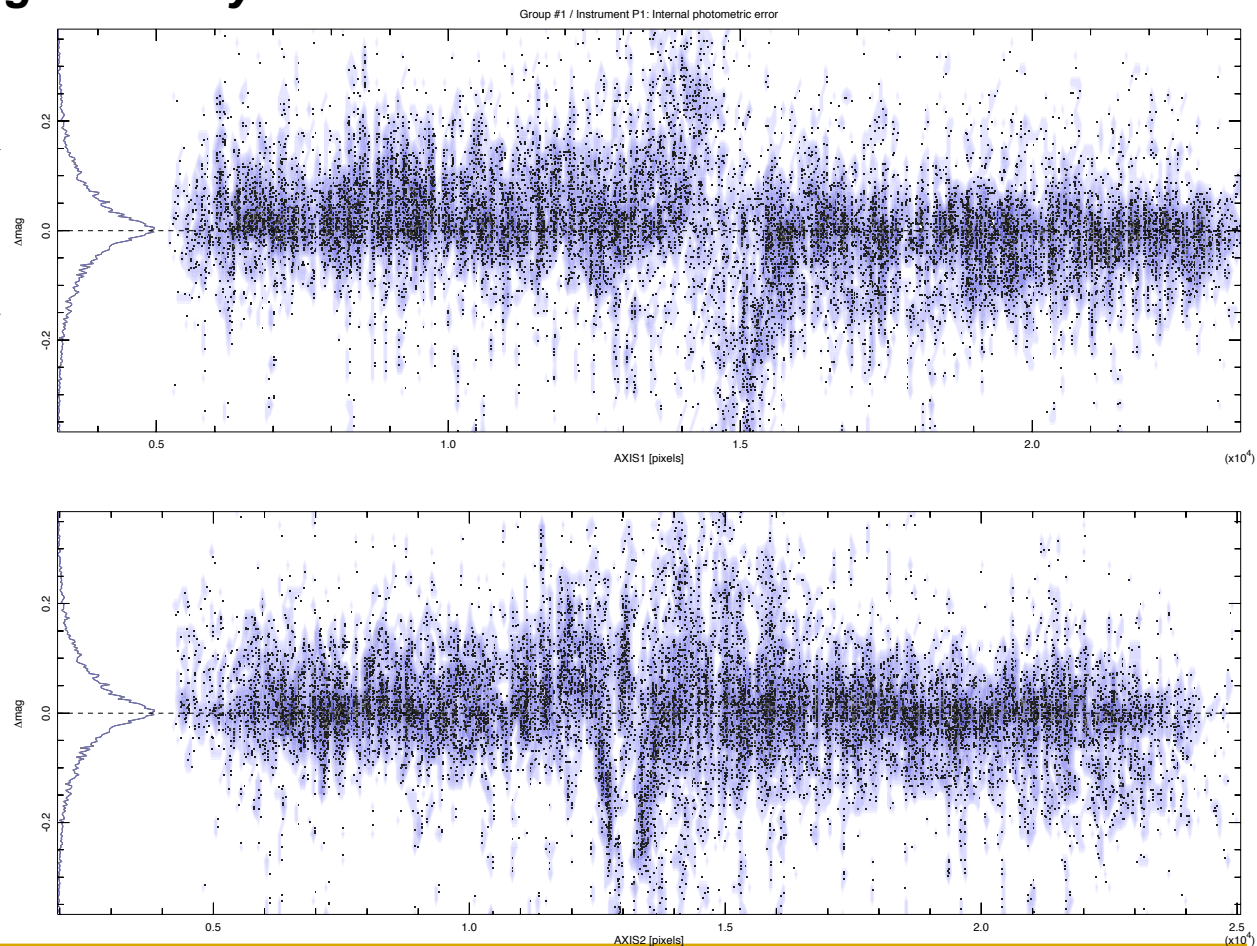


0.2

$\sigma=0.05$
removing
regions near
big gap



Internal photometric
errors for 13 NGC253
NB_659 exposures



A3 - Fringing, persistence, cross-talk

Have you detected any persistence in images taken after one strongly saturated image?

Not a deep survey was carried out. It seems no persistence occurs

A3 - Fringing, persistence, cross-talk

Do you detect any cross-talk? At which level?

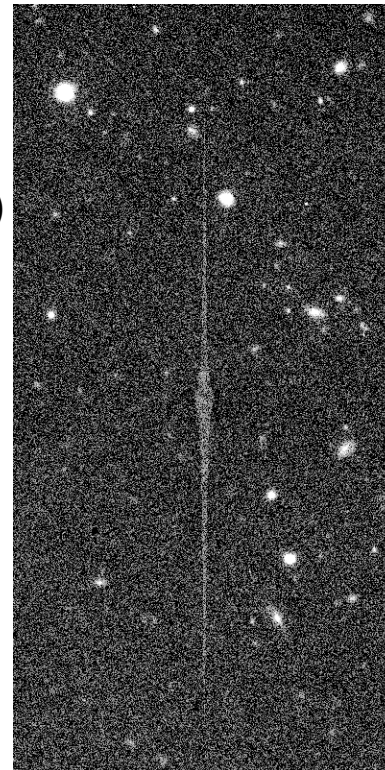
The CCDs ccd96-95-94 exhibit crosstalk. We detect a crosstalk also in the ccd87 with the difference that in this ccd the ghost is positive

Left image is a section of the image OMEGA.2011-11-01T05:28:02.552_ccd87 (10 ADU above the bkg which is 450 ADU) on the right a section (the same region of the image on the left) of OMEGA.

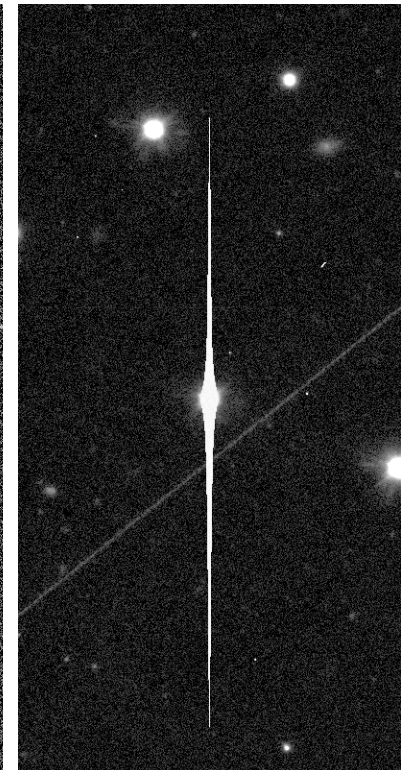
2011-11-01T05:28:02.552_ccd95 where is visible the bright star who caused the crosstalk.

On 8 out of 16 images appears the cross-talk.

In 4 of the 8 appear EMC (?) problems



ccd87



ccd95

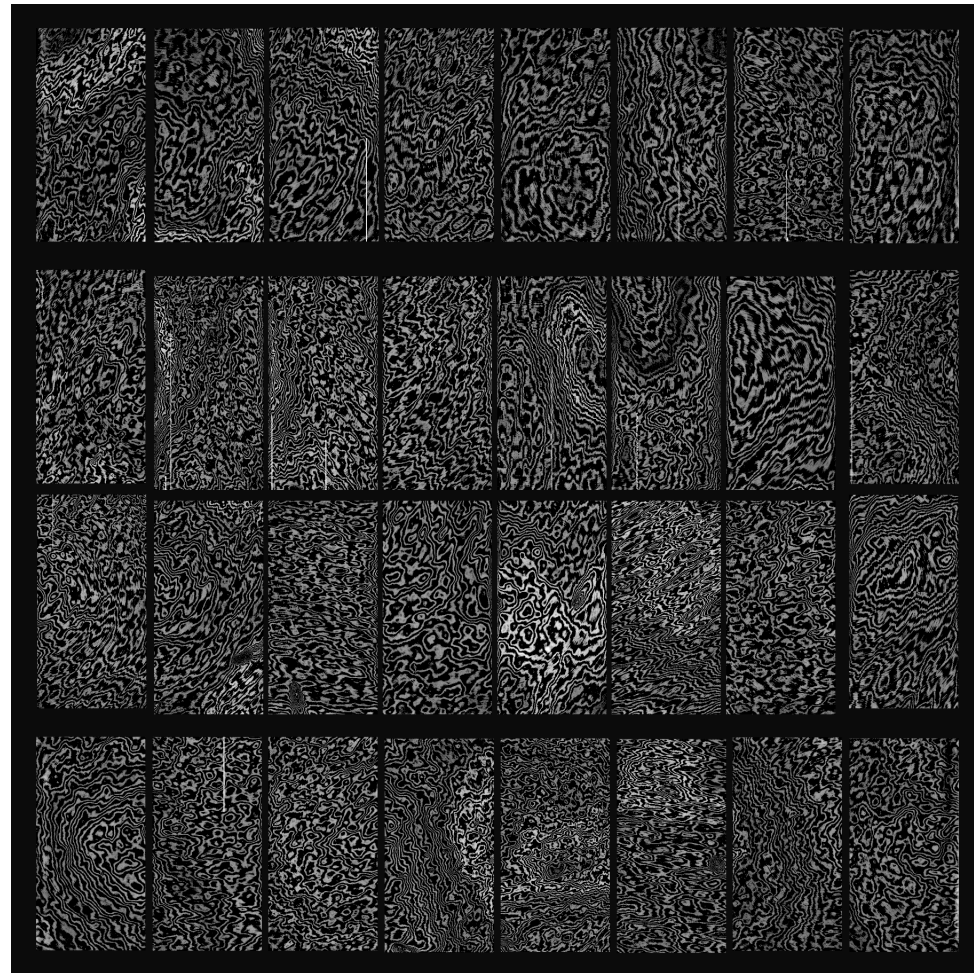
A3 - Fringing, persistence, cross-talk

How much is the fringing in the i' - z' band?

*Fringe map for NGC253 in
 i_{sdss} band*

~ 3%

*No z' band images were
reduced up to now*



A3 - Fringing, persistence, cross-talk

Do you detect any fringing in other bands?

How is it characterized and correct for it?

$$frP = \frac{SuperFlat}{SkyFlat} - Imsurfit \left(\frac{SuperFlat}{SkyFlat} \right)$$

The scaling factor applied to the fringe map is chosen in the way to minimize the background RMS in specific image regions

A3 - Satellite trails and stellar spikes

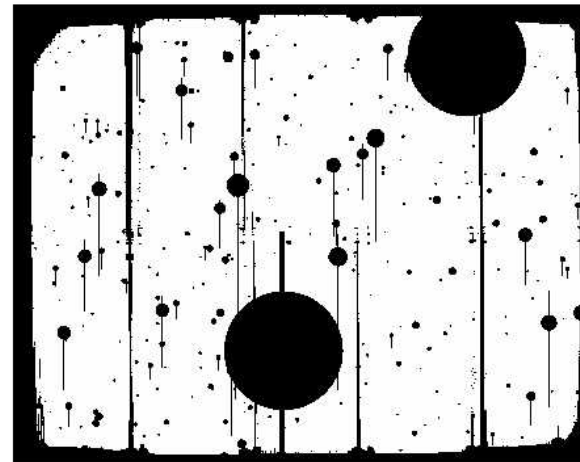
How well are satellite trails and stellar spikes corrected for?

We do not detect and correct for satellite trails (it is planned)

We do spikes detection we do not correct them but we can create an automatic mask (tool developed by Zhuoyi Huang)



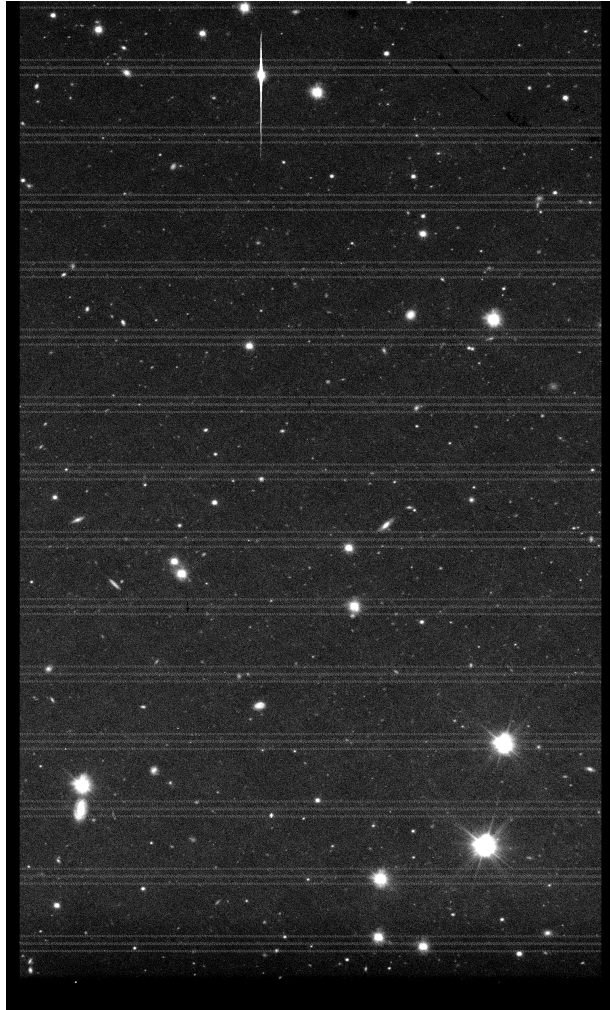
Section of VST mask



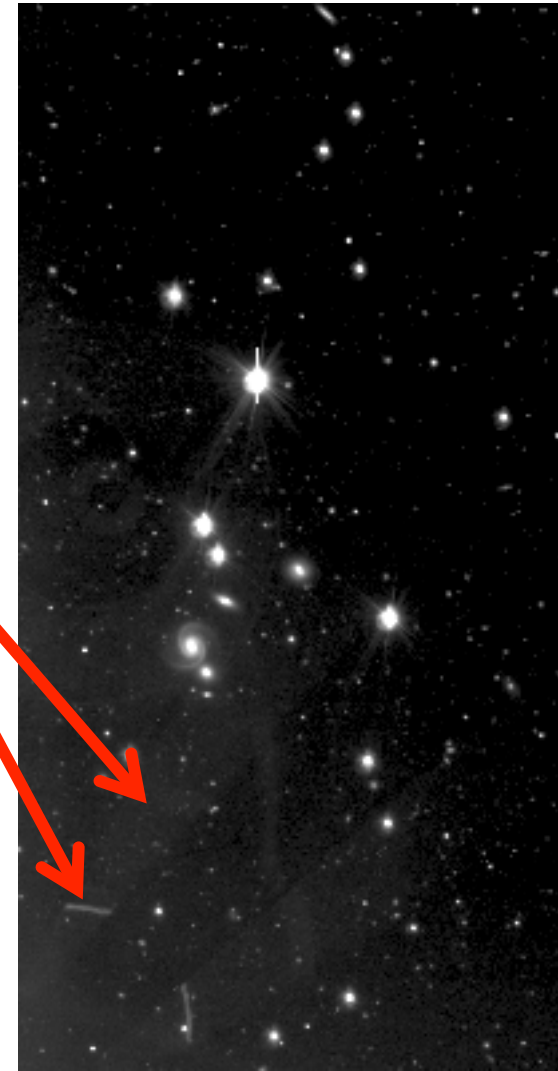
Suprime mask

Other issues

EMC problems?

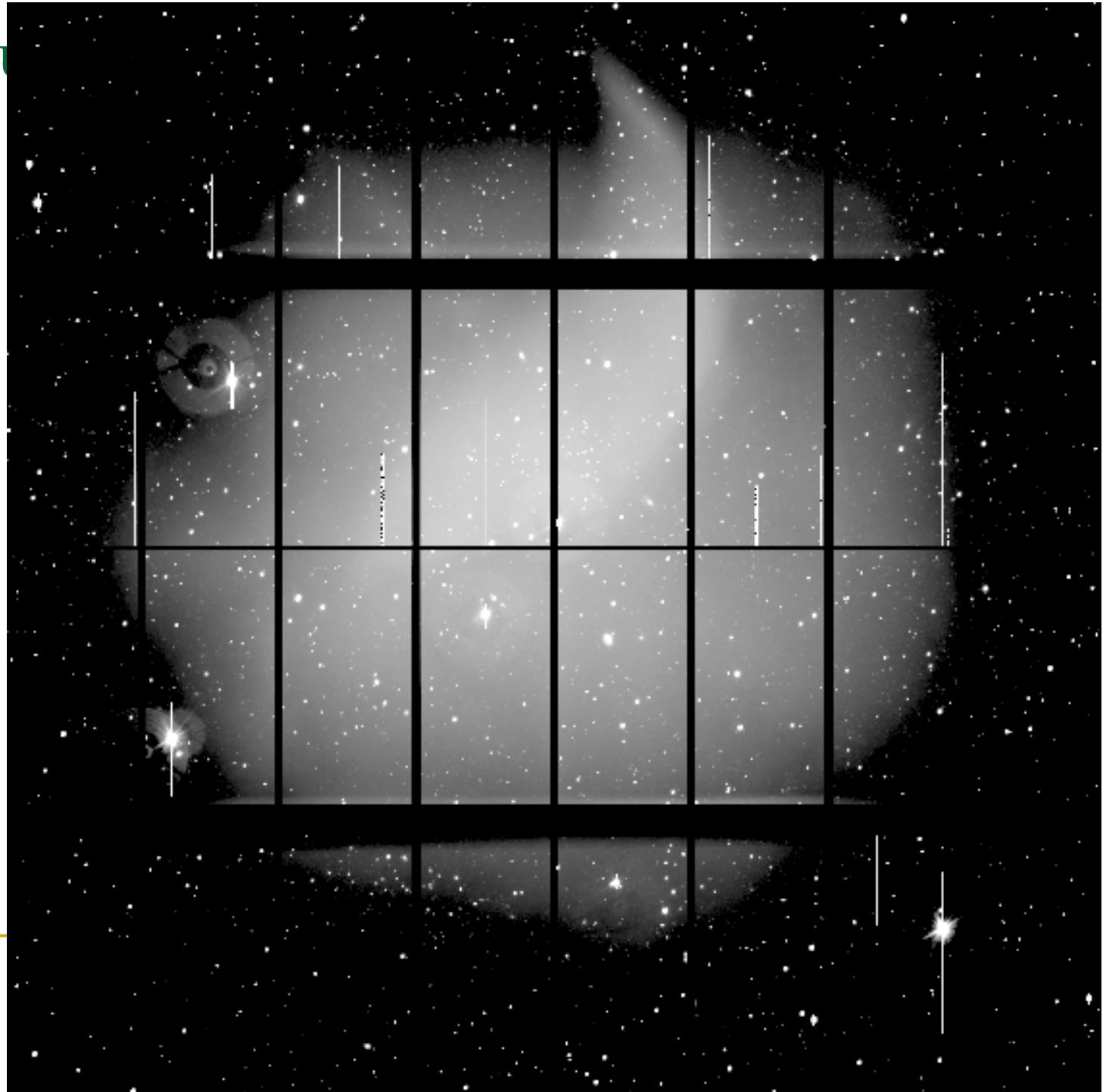


Light reflections
CCD65



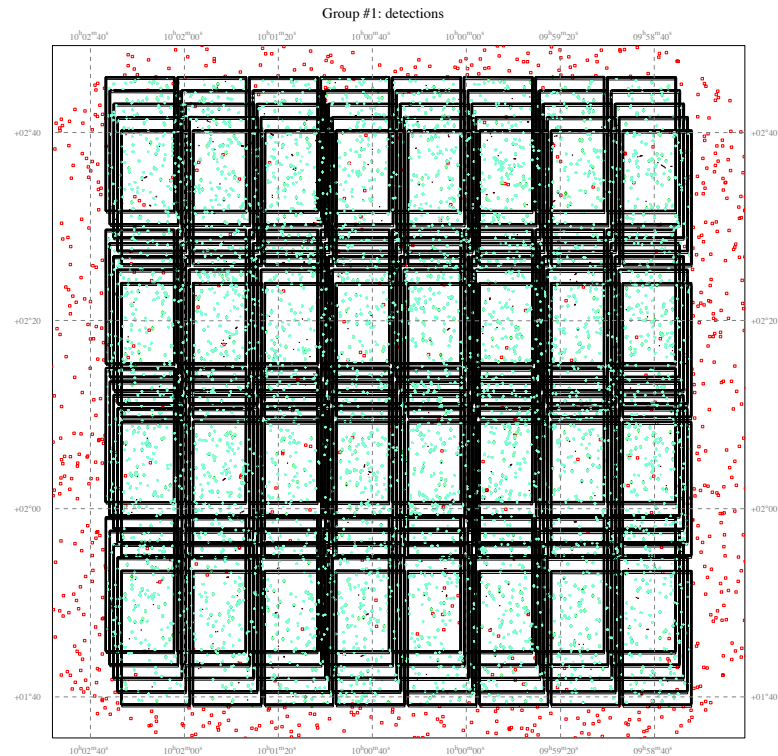
Other issues

Light reflections



A4 – Astrometric Calibration

As test bad we show COSMOS (Chilean GTO) calibration (16 nights
5x360s ditherings/Obs on the same pointing (total 96 exposures))



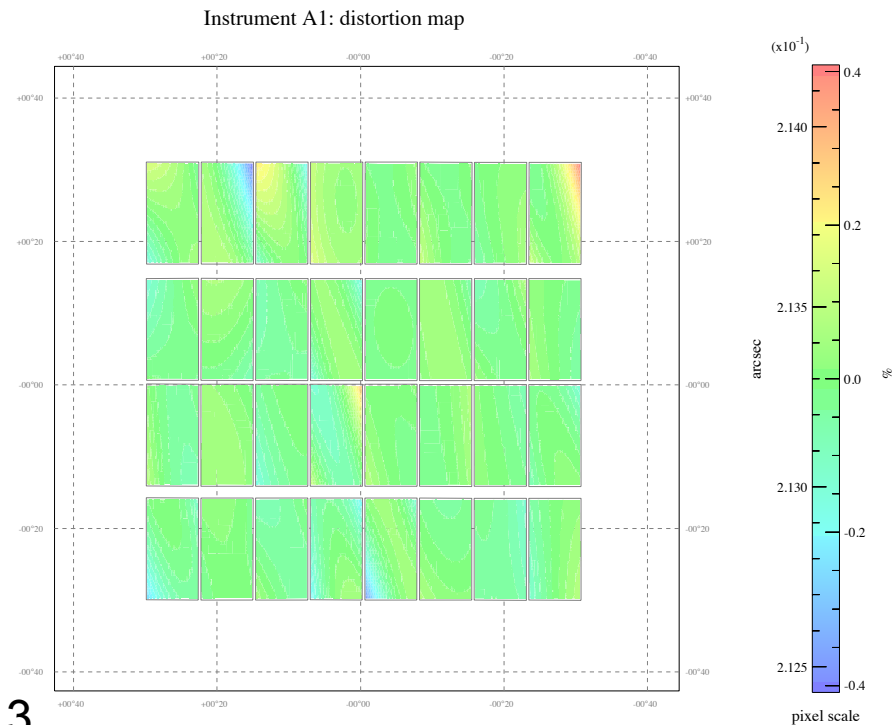
A4 – Astrometric Calibration

***How is the geometrical distortion treated in your pipeline?
Which model is applied and how large are the residuals?***

In VST-Tube two tools are available:

- 1) Scamp (E. Bertin)
- 2) AstromC (M. Radovic)

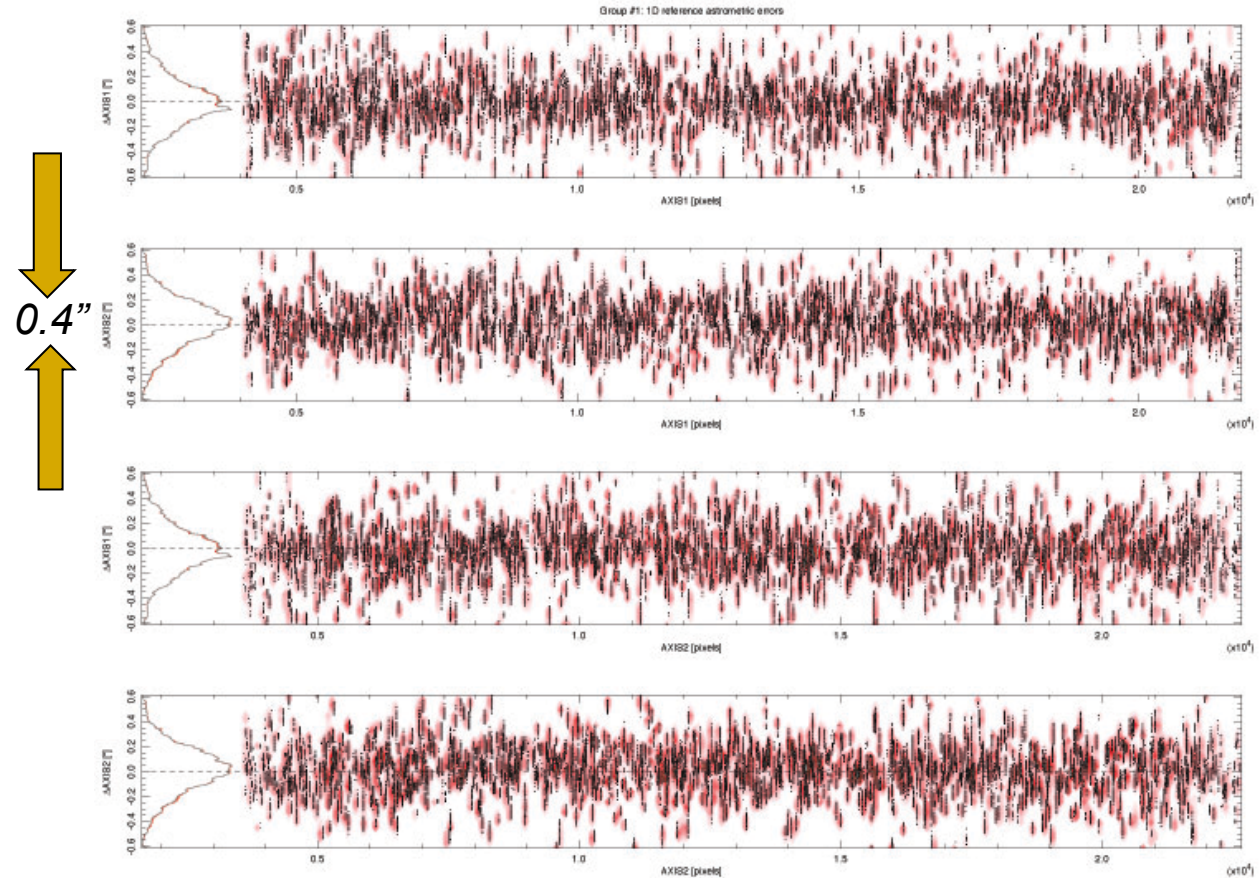
The distortion position dependency is modeled as a polynomial function (order 3 is enough)



peak to peak distortion amounts to 0.8% of the pixel scale

A4 – Astrometric Calibration

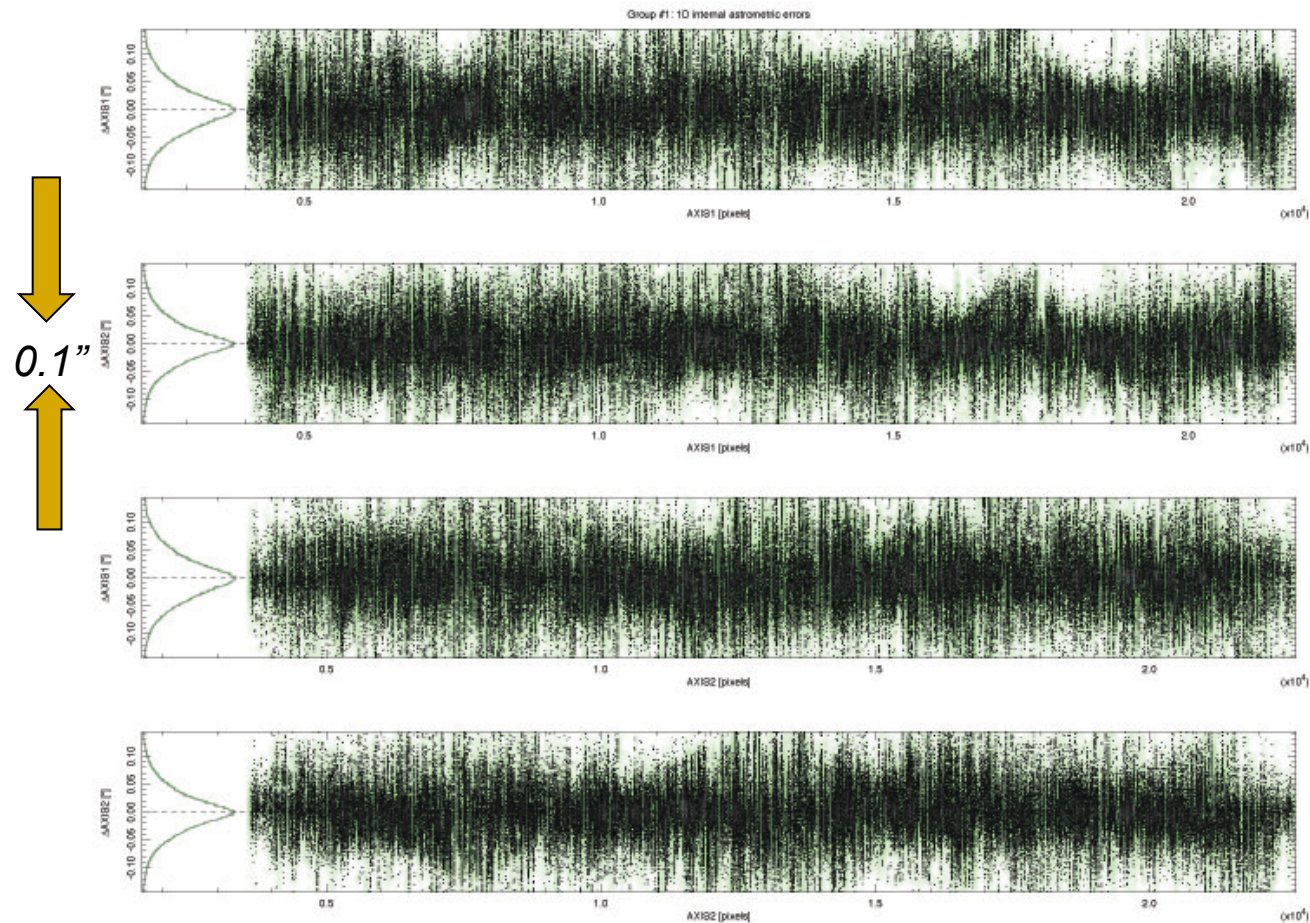
How good is your absolute astrometry? Which catalogue(s) do you use?



2MASS reference catalogue

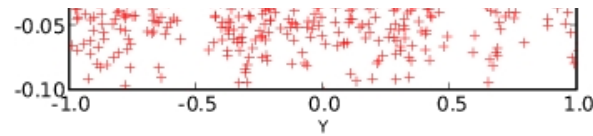
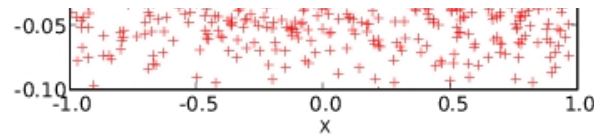
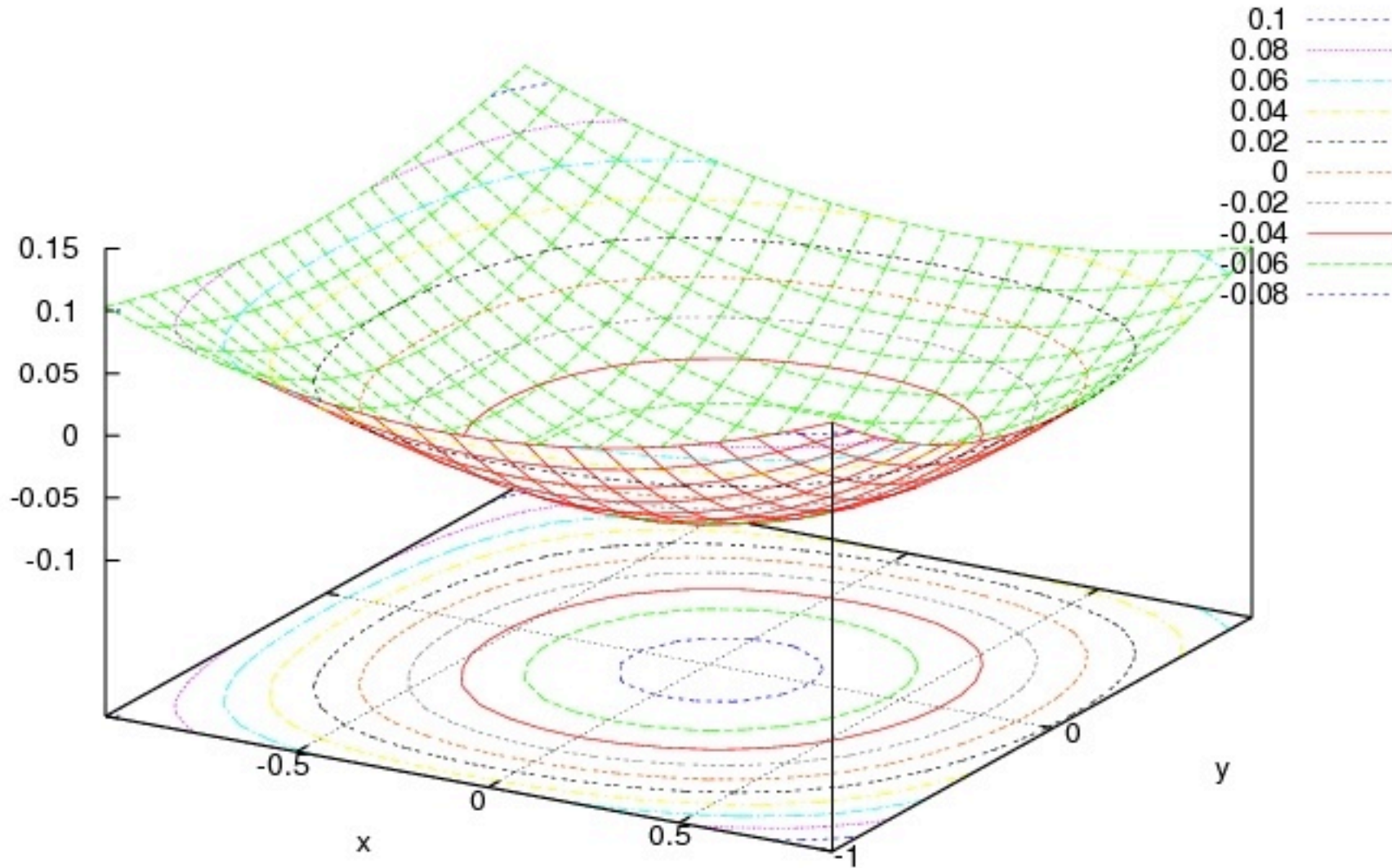
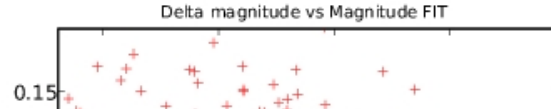
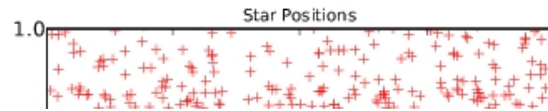
1-dimensional differences between detection coordinates and coordinates of the associated astrometric reference stars as a function of the position along each re-projected axis

A4 – Astrometric Calibration



1-dimensional pairwise differences between coordinates of overlapping detections as a function of position along each re-projected axis

A5



A5 – Photometric calibration

Can there be a color variation across the field?

OmegaCam consortia reports on a filter response dependency on the position. We did not search for such effect up to now.

Which correction for seeing variations (field-to-field and across different bands) is applied in order to obtain consistent (point) source fluxes?

Presently no PSF homogenization is implemented in the pipeline. A threshold can be defined to remove from the final mosaic all the exposure with FWHM greater than a user defined value.

A5 – Photometry calibration

How is the photometric calibration across the whole mosaiced area planned to be guaranteed?

In VST-Tube two procedures are available both use the background:

1) evaluate median background on the image

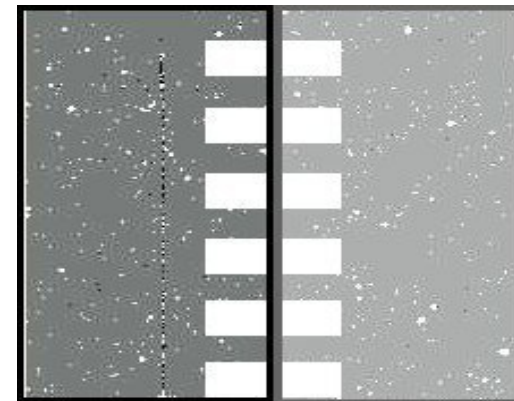
$$Imsurfit \left(\frac{SuperFlat}{SkyFlat} \right)$$

(not suitable in case of background gradient);

2) De-trended science frame are used to calculate gain coefficient which give the same level background in two adjacent CCDs.

Gap between the CCD and background gradient are taken into account.

The procedure is called gain ZIP



A5 – Photometry calibration

If you combine dithered observations, do you provide confidence maps?

An inverse variance map is provided which include: bad pixels mask (cold/hot), cosmics, number of pixels used, weight from flat field.

Optionally the weight map can contain a full noise propagation map using EFITS (an in house developed FITS library).

The weight map associated to the detrended image I_d (de-biased and de-flatted) is:

NGC4697
Weight map section

$$\frac{MF^4 * W_I * W_{MB} * W_{MF}}{W_{MF} * (W_{MB} + W_I) + (I - MB)^2 * W_I * W_{MB}}$$

Labels and arrows pointing to the formula:

- Flat → MF^4
- Weight Science → W_I
- Weight MasterBias → W_{MB}
- Weight MasterFlat → W_{MF}
- Raw Science → W_I in the denominator
- MasterBias → MB in the denominator

A5 – Photometry calibration

How is the PSF characterized?

QualityFITS (kindly provided by Terapix is included into VST-Tube)

We just add PSFex

Processing summary on 2012-03-09 at 18:18:14 – SeaMonkey (on vstun2.cluster1.na.astro.it)

file:///emc/sata02/VSTSV/psfex.xml

Aromatic.net Processing summary

PSFex 3.9.1 started on 2012-03-09 at 18:18:14 with 8 threads (run time: 9 s)
by user agrado from beo3.cluster2.na.astro.it in /emc/sata02/VSTSV

PSF stats per Input File ↓

Filename	Identifier	N _{ext}	N _{loaded}	N _{accepted}	Half-light diam.	Sampling	χ ² /d.o.f.	FWHM	FWHM pixel free	Ellipticity	Moffat β	Moffat R pixel free	Residuals	Residuals pixel free	Asymmetry ↓
bridge-i_sdss_10-Jan-2012-16h23m43s_sc11.ldac	bridge	1	1519.0	1261.0	3.90	1.00	1.35	2.94	2.81	0.04	0.04	2.84	2.63	0.03	0.03
			1519 - 1519	1261 - 1261	3.90 - 3.90	1.00 - 1.00	1.35 - 1.35	2.84 - 3.53	2.70 - 3.44	0.01 - 0.21	0.01 - 0.21	2.78 - 4.98	2.59 - 4.68	0.03 - 0.08	0.03 - 0.08

PSF stats per Extension ↓

Ext.	N _{loaded}	N _{accepted}	Half-light diam.	Sampling	χ ² /d.o.f.	FWHM	FWHM pixel free	Ellipticity	Ellipticity pixel free	Moffat β	Moffat R pixel free	Residuals	Residuals pixel free	Asymmetry
1	1519.0	1261.0	3.90	1.00	1.35	2.94	2.81	0.04	0.04	2.84	2.63	0.03	0.03	0.03
	1519 - 1519	1261 - 1261	3.90 - 3.90	1.00 - 1.00	1.35 - 1.35	2.84 - 3.53	2.70 - 3.44	0.01 - 0.21	0.01 - 0.21	2.78 - 4.98	2.59 - 4.68	0.03 - 0.08	0.03 - 0.08	0.02 - 0.07

Configuration File: psfex.conf ↓

Command Line ↓

```
psfex bridge-i_sdss_10-Jan-2012-16h23m43s_sc11.ldac -c psfex.conf
```

Warnings (limited to the last 1000) ↓

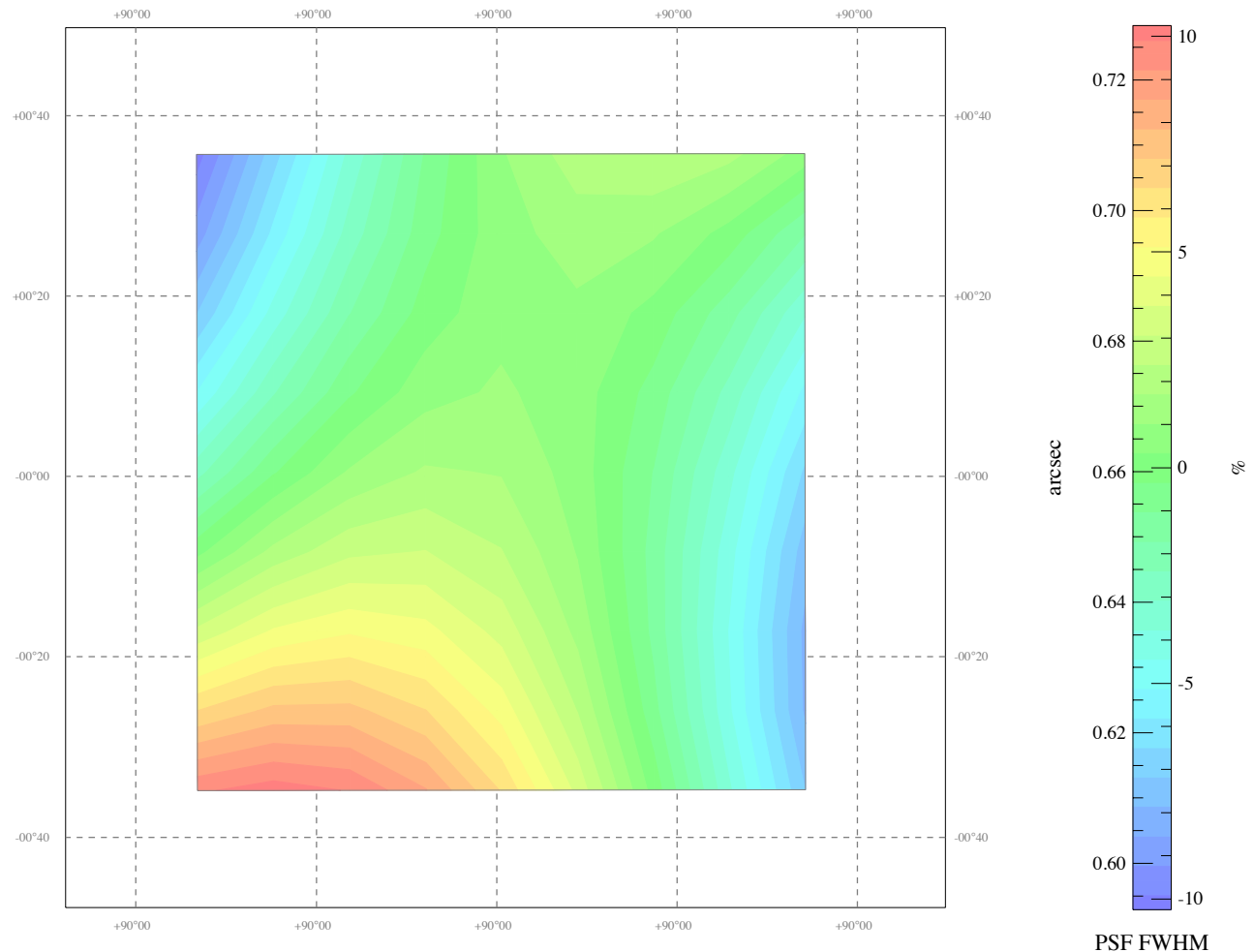
Date	Time	Message
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A5 – Photometry calibration

Field bridge-i_sdss_10-Jan-2012-16h23m43s_sci1: FWHM map

How is the PSF characterized?

PSF FWHM analysis
on single exposure
mosaic



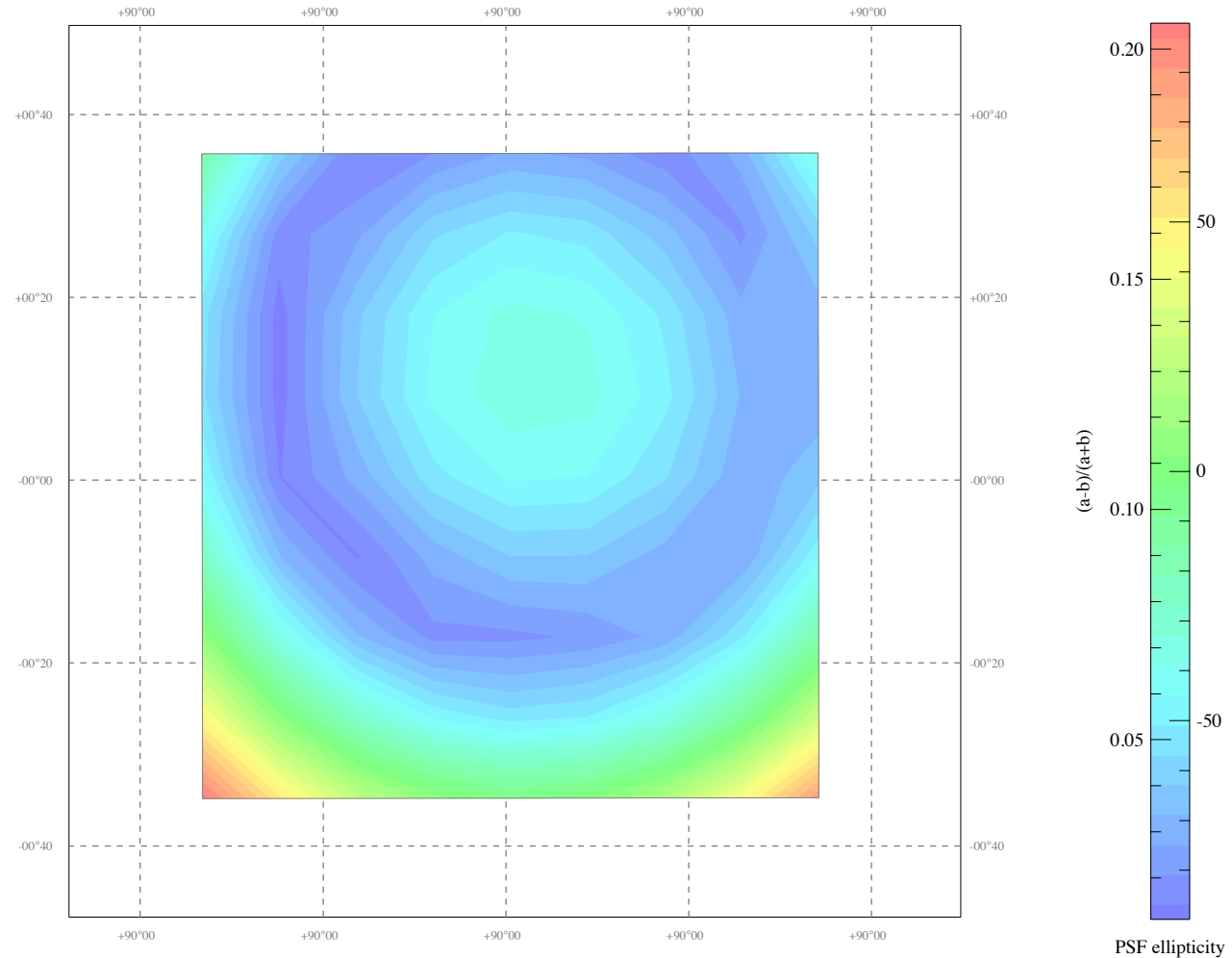
PSF FWHM 10% variation on the whole field

A5 – Photometry calibration

Field bridge-i_sdss_10-Jan-2012-16h23m43s_sci1: ellipticity map

How is the PSF characterized?

PSF ellipticity analysis on single exposure

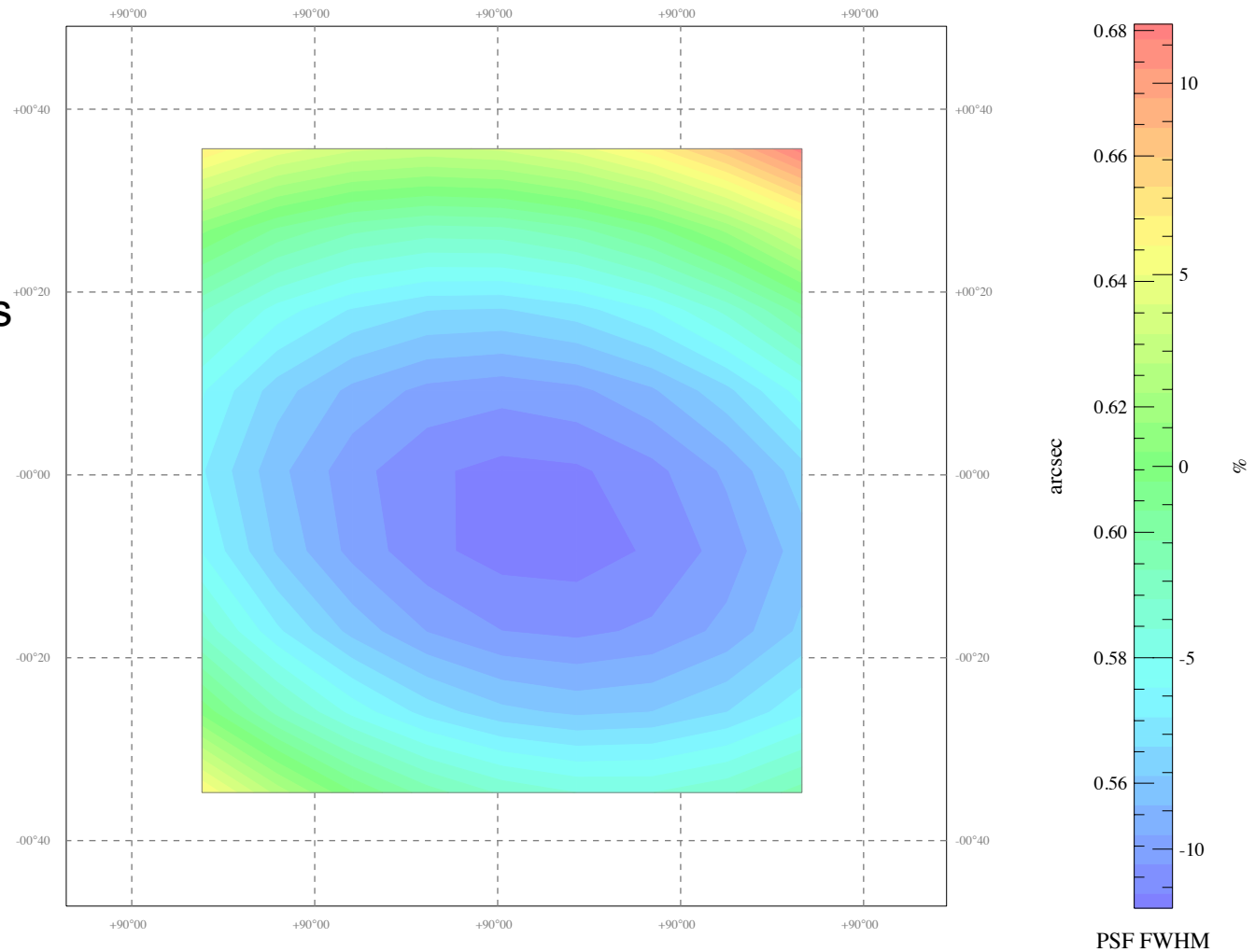


A5 – Photometry calibration

Field OMEGA.2011-12-18T07:03:15.998_12-Mar-2012-15h41m03s.mosaic: FWHM map

How is the PSF characterized?

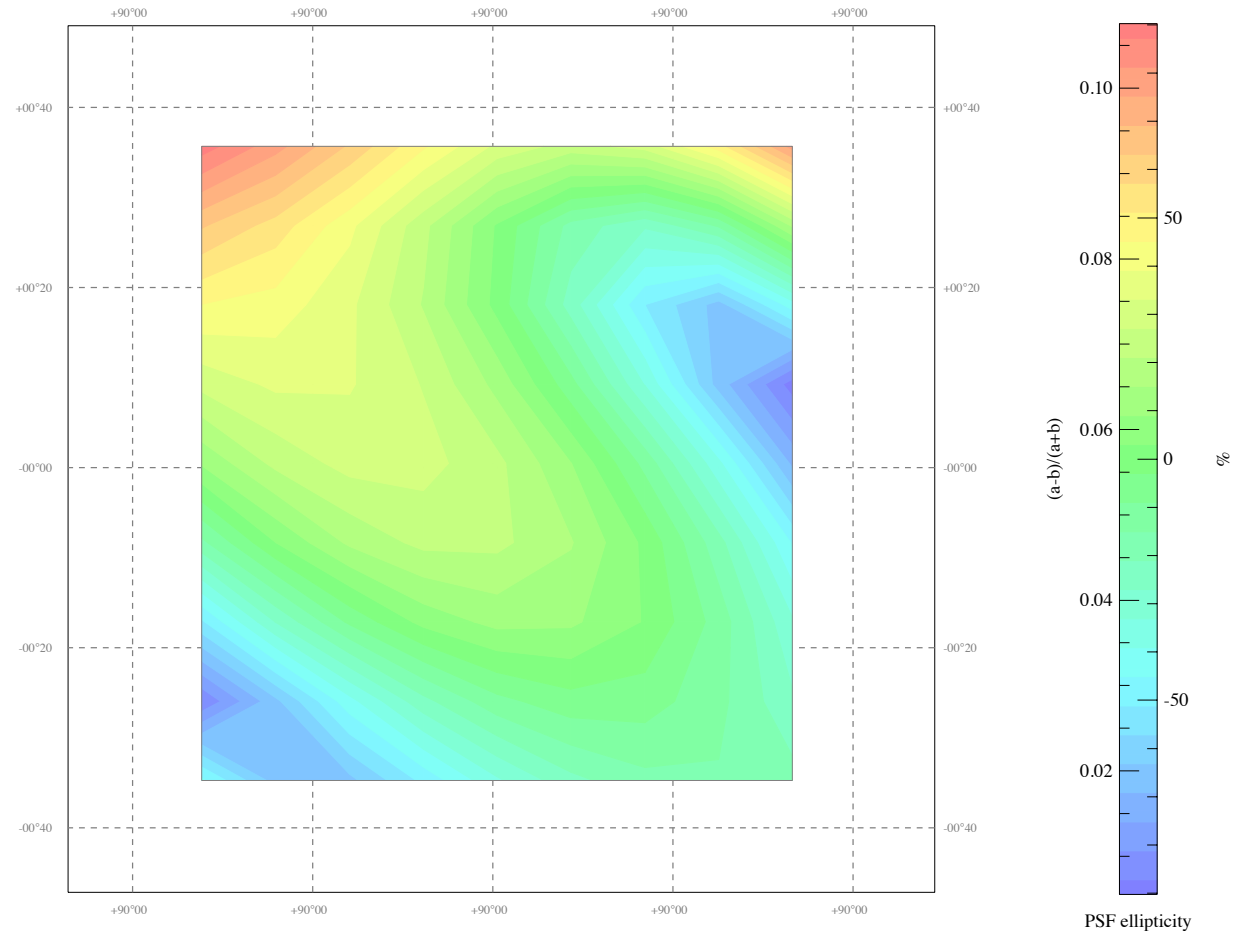
PSF FWHM analysis on single exposure mosaic (COSMOS r band)



A5 – Photometry calibration

Field OMEGA.2011-12-18T07:03:15.998_12-Mar-2012-15h41m03s.mosaic: ellipticity map

PSF ellipticity
analysis on single
exposure mosaic
(COSMOS r band)



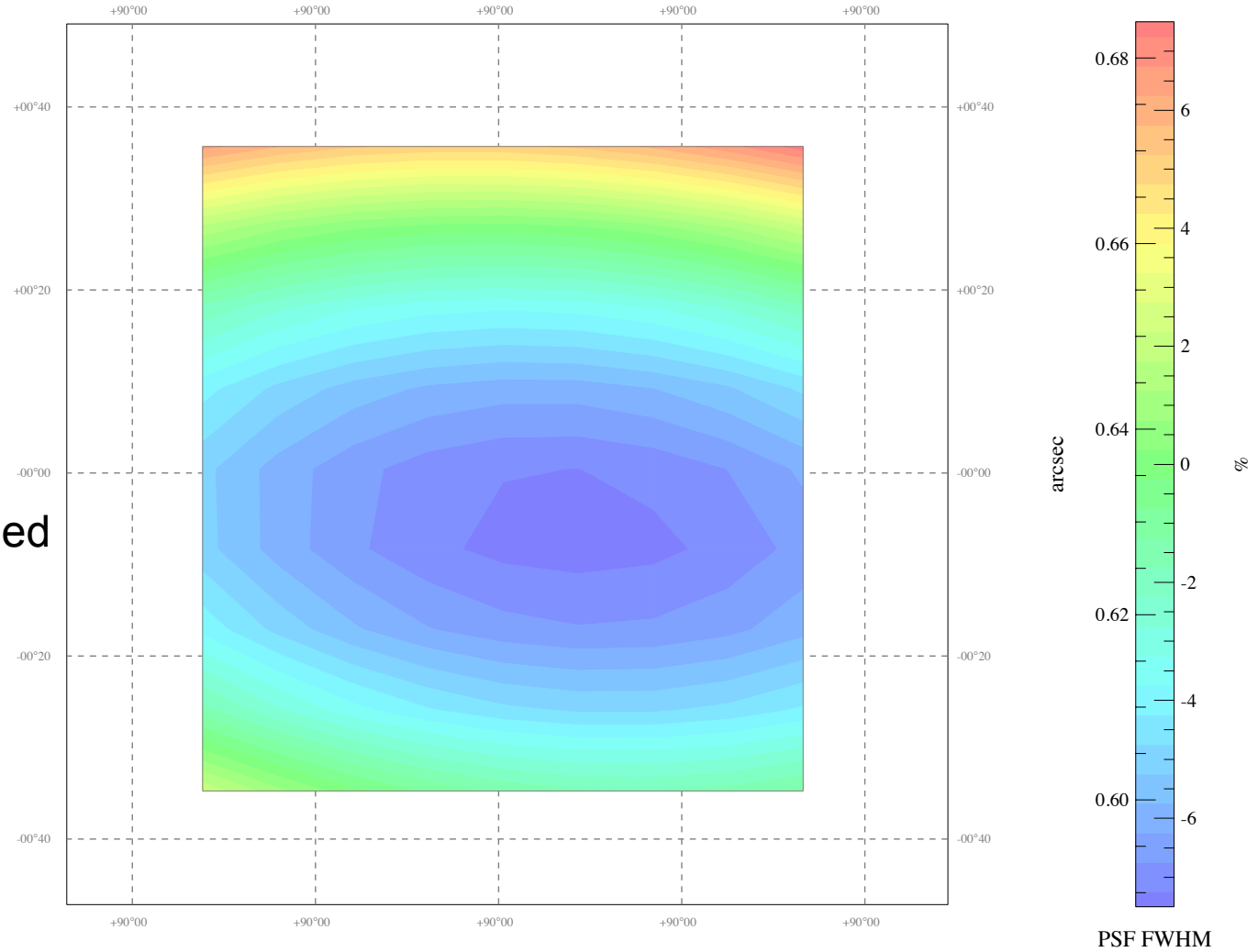
If it varies, do you have measurements of this variability? No trend analysis was done

PSF

How is the PSF characterized?

Field cosmos-r_sdss_12-Mar-2012-15h41m03s_all: FWHM map

PSF ellipticity
analysis on coadded
mosaic

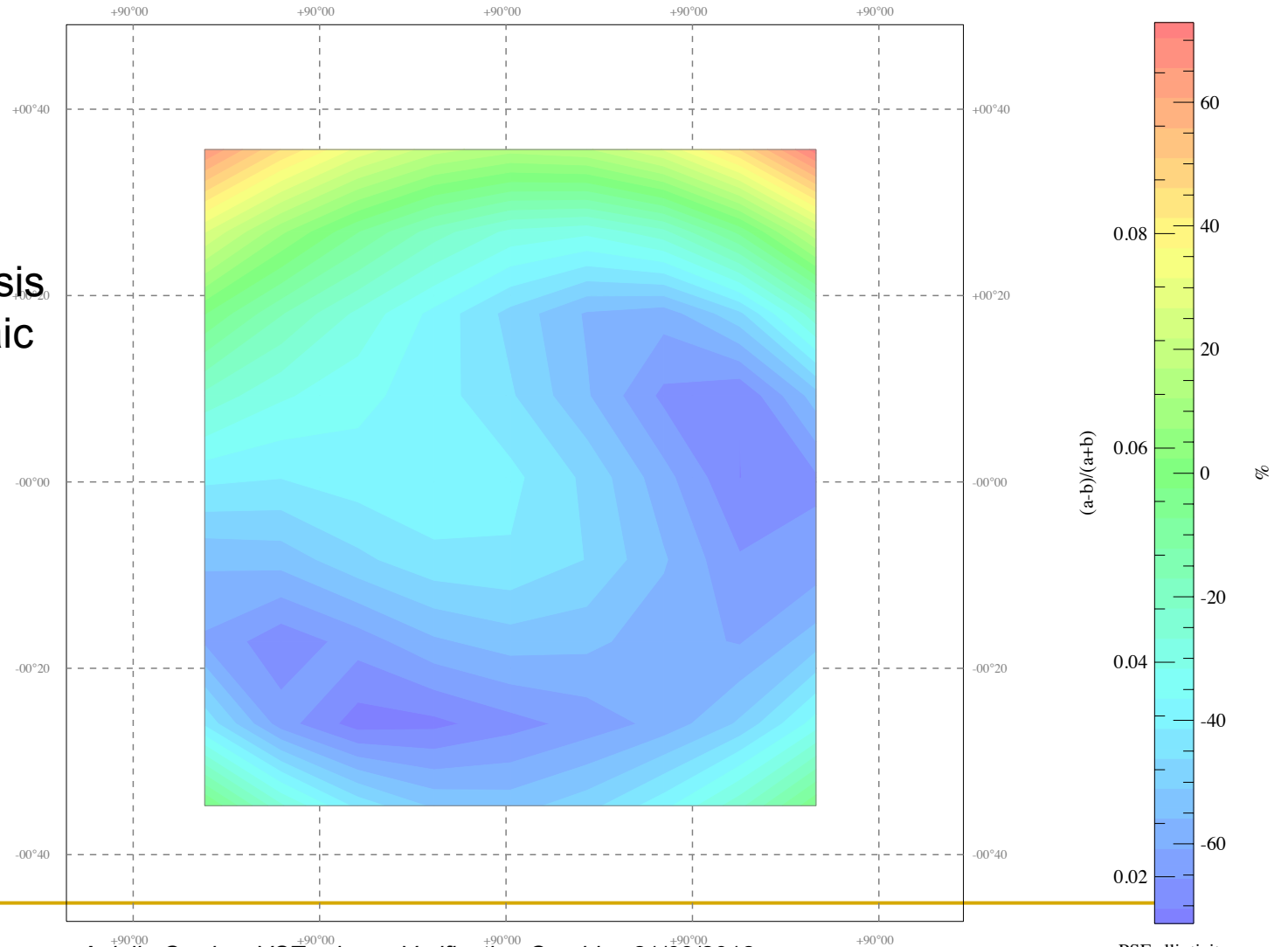


PSF

How is the PSF characterized?

Field cosmos-r_sdss_12-Mar-2012-15h41m03s_all: ellipticity map

PSF FWHM analysis
on coadded mosaic



A5 – Photometry calibration

What is the accuracy in the sky background estimate and its impact for surface photometry?

See next talk

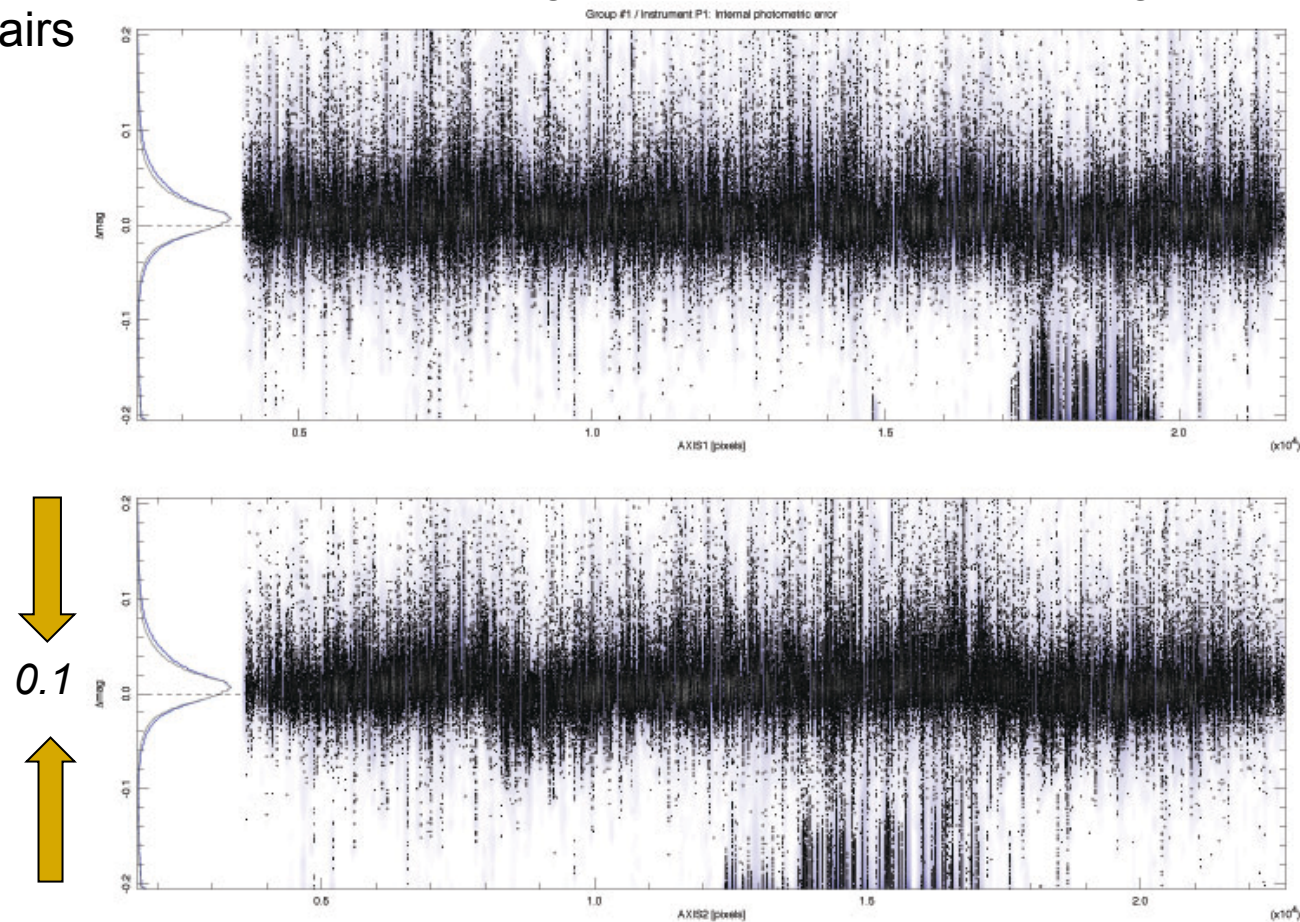
A5 – Photometry calibration

How is the sky background correction implemented for crowded areas?

???????

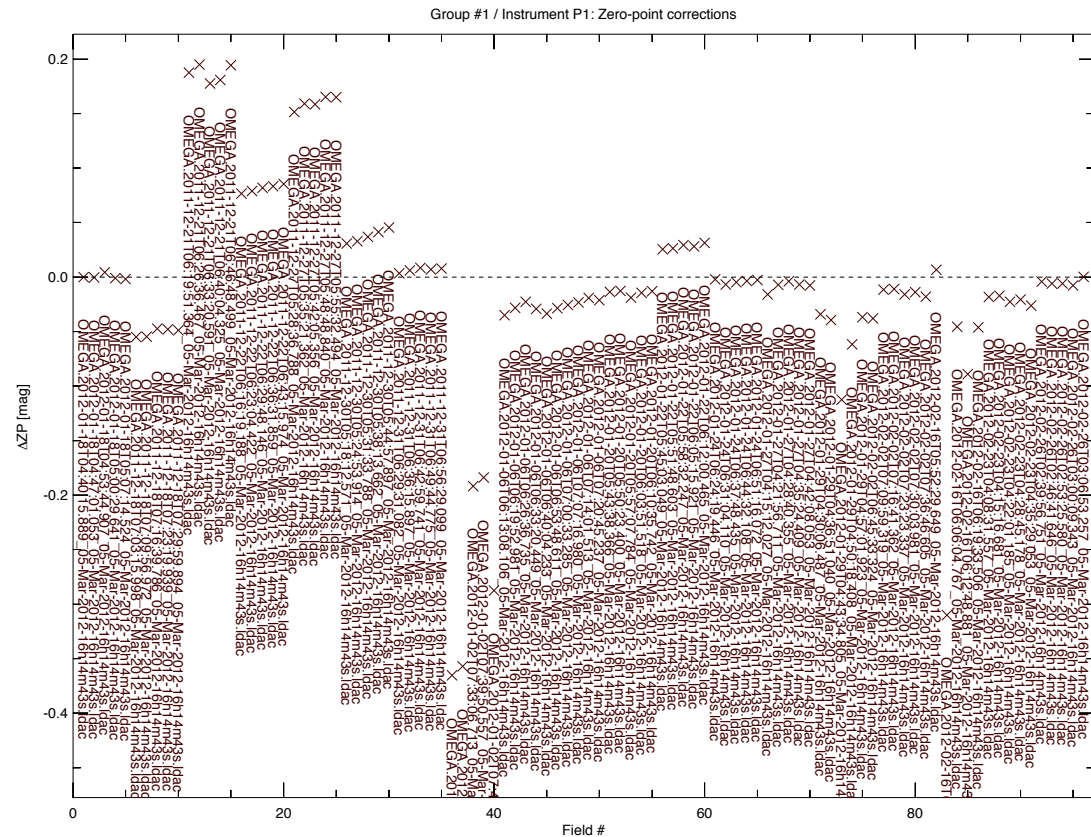
A5 – Photometry calibration

The internal photometric solution is the result of a χ^2 minimization. The adopted χ^2 is the quadratic sum of differences in magnitude between overlapping detections from pairs



A5 – Photometry calibration

Zp correction among exposures respect to the reference night (2012-01-17)



A5 – Photometry calibration

How do you determine zeropoints for narrow-band data?

Four spectro-photometric standards were observed

$$Z_p = -2.5 \log_{10}(F^0(\nu)) - 48.574 - \text{mag_instr} + c_ext * X$$

Where $F^0(\nu)$ is the average flux at the filter central wavelength ($\text{erg/s/cm}^2/\text{Hz}$)

File	night	Name	Mag_auto	airmass	zp
.825	2011-08-31	LTT1020	-13.034	1.033	21.97723
.733	2011-08-30	LTT1020	-13.023	1.129	21.97959
.975	2011-08-29	EG21	-12.425	1.398	21.99461
.039	2011-08-29	LTT1020	-12.014	1.104	20.96598

Adopted extinction coeff. (Patat et al. A&A 527, A91 (2011)) $C_ext=0.09$

Average zp =21.98

A5 – Photometry calibration

Do you monitor the stability of your results with time, temperature, moon, etc?

Not done

A6 – Support from operation

In general, what quality control parameters are monitored during the data processing, and which of these are most variable/critical for OmegaCAM?

- median values on raw images must be in defined intervals
- Visual checks on de-trended images
- check on background jump among CCDs
- Check on the absolute photometric calibration (residuals vs position)
- Astrometric calibration plots (see before)
- Internal photometric errors (see before)
- Limits on maximum sigma for astrometric and photometric calibration
- Plots on PSF
- Checks on median PSF FWHM

A6 – Support from operation

A small number of executed survey OB's have been re-graded due to quality issues (tracking and PSF anisotropy). Are there any issues with the current calibration plan and quality control that can be improved?

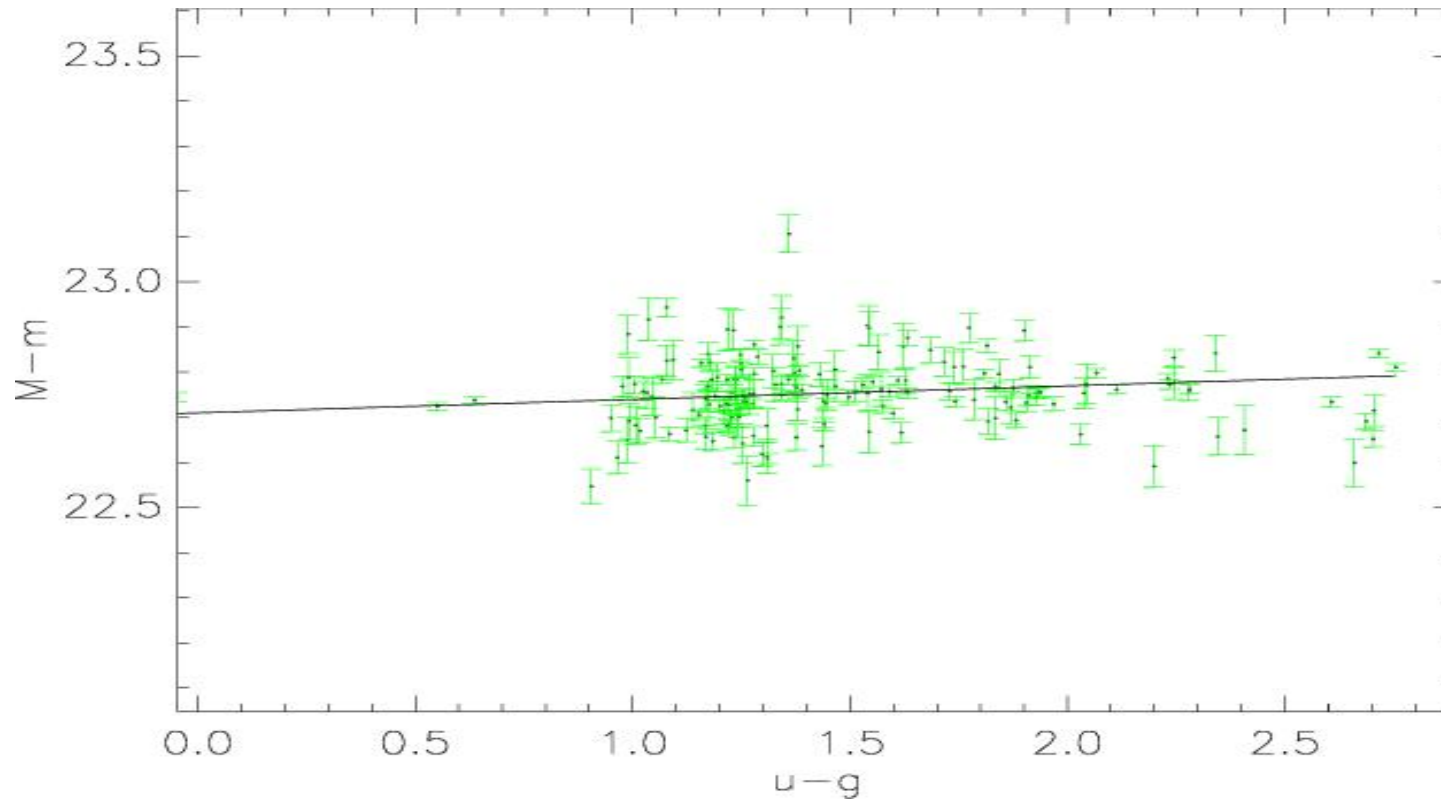
Photometric standard equatorial fields observations in a wide range of airmass

How large is the color range of your standard stars and how does it compare to the color range of objects in your data?

We use the SDSS DR8 catalogs on equatorial standard fields for the absolute photometric calibration.

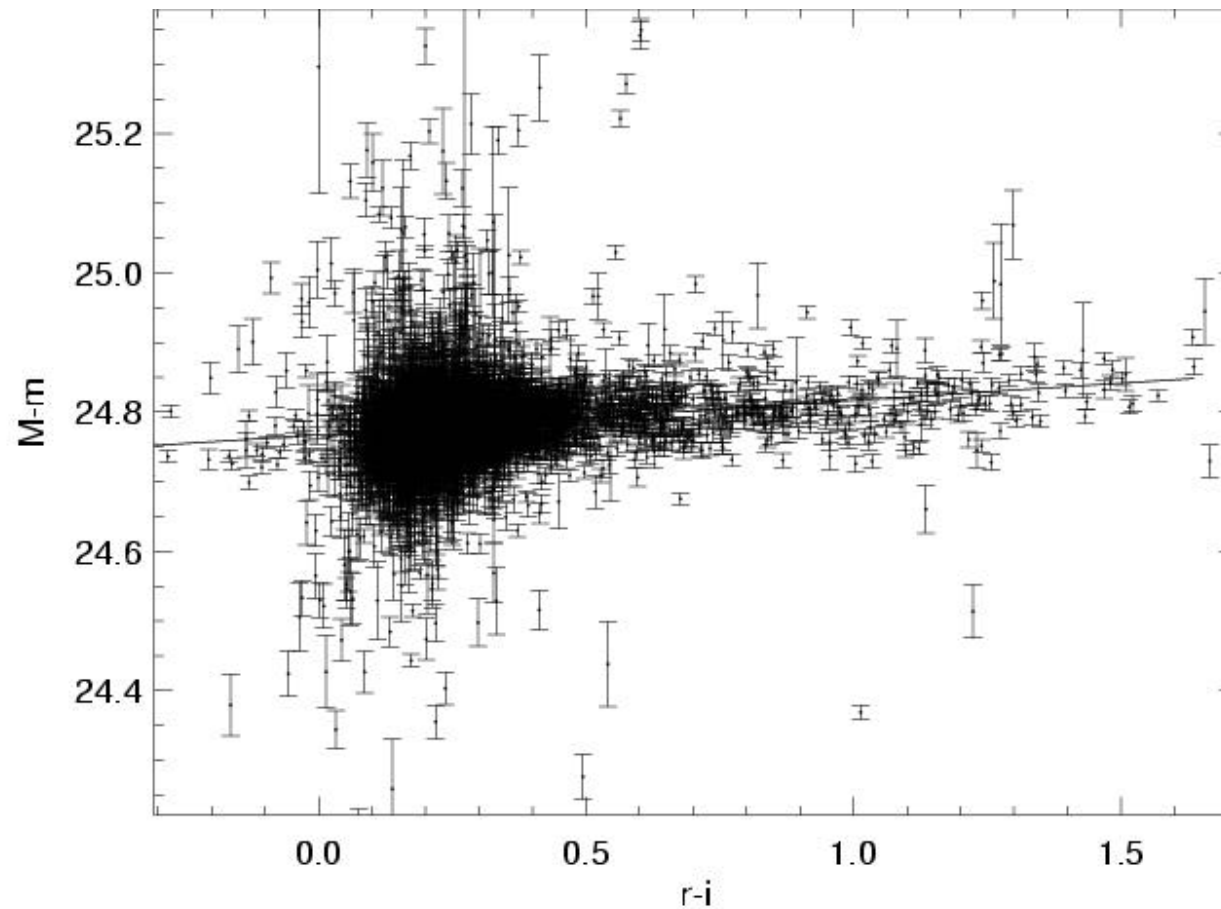
The software used is Photcal (by M. Radovich). If data allow can be fitted all together z_p , $color_term$ and extinction coefficient.

A6 – Support from operation



Absolute photometric calibration for NGC253 u' band (Stetson stars observed in SDSS DR8)

A6 – Support from operation



Absolute photometric calibration for NGC253 r' band (SDSS DR8)



Thanks