SNLS: Status of the Survey and Photometric Calibration

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CFHT Legacy Survey Users' Meeting

Outline

Outline

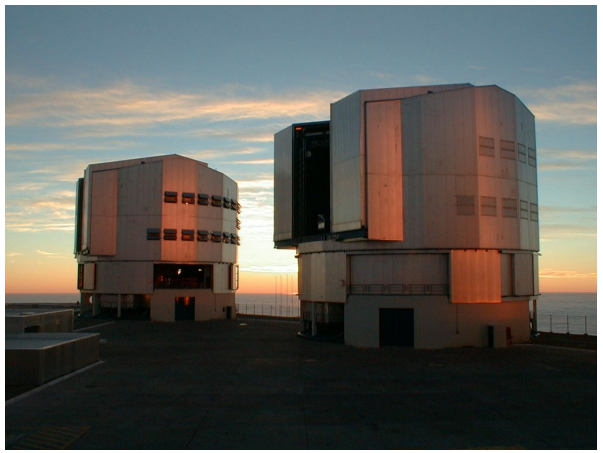
SNLS = CFHTLS-DEEP + Large Spectroscopic Survey

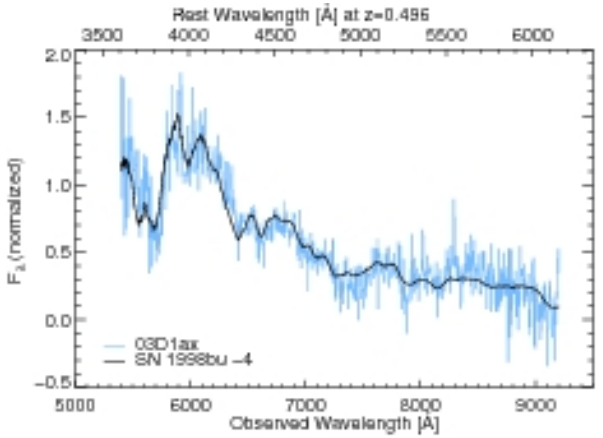
Goals

- spectral identification of SNe Ia ($z < 1$)
- redshift determination (host galaxy lines)
- complementary programs
  - detailed studies of SNe Ia

Telescopes

- VLT large program (80h / semester)
- Gemini (60h / semester)
- Keck (30h / semester, Spring Semester)





(Howell et al, 2005 – ApJ 634, 1190)

Statistics

Public list of candidates:
http://legacy.astro.utoronto.ca

Sept. 2006

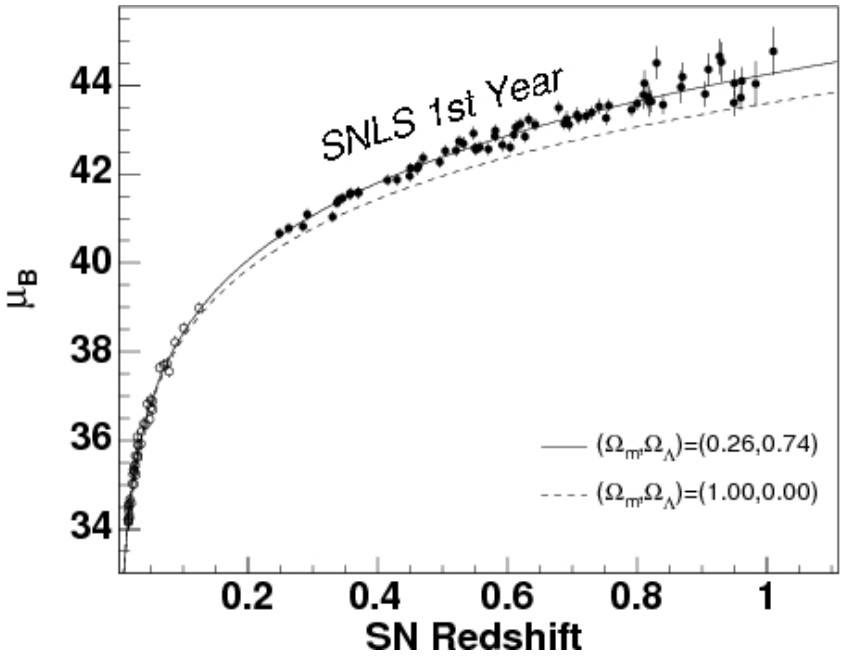
Telescope	SNIa (/?)	SNII (/?)	Total SN (/?)	Other	Total
Gemini	96	9	151	0	151
Keck	77	21	139	4	143
VLT	120	22	235	13	248
Total	293	52	525	17	542

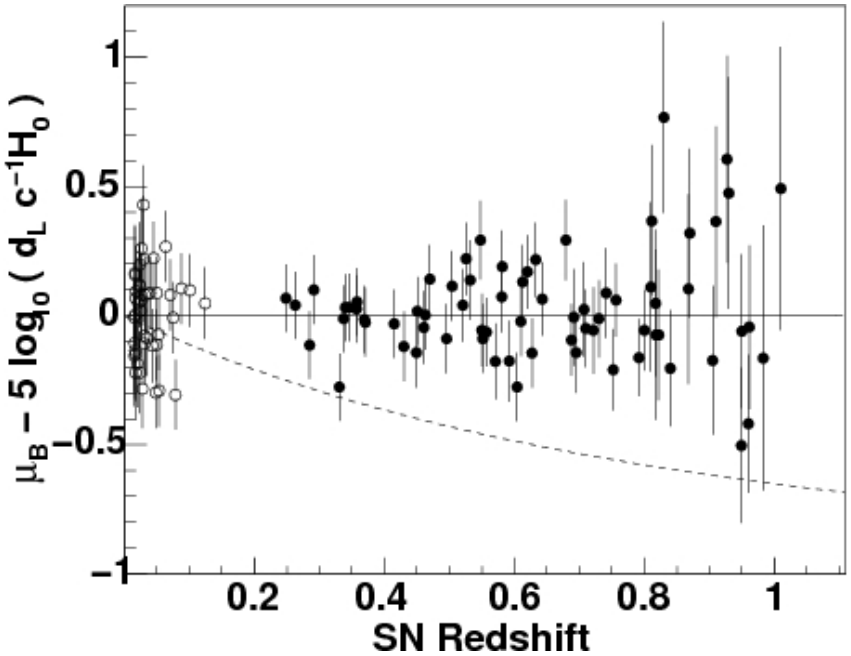
$\sim$ 300 Identified Type Ia Supernovae on disk

$\sim$ 500 Identified Type Ia Supernovae at the end of the Survey

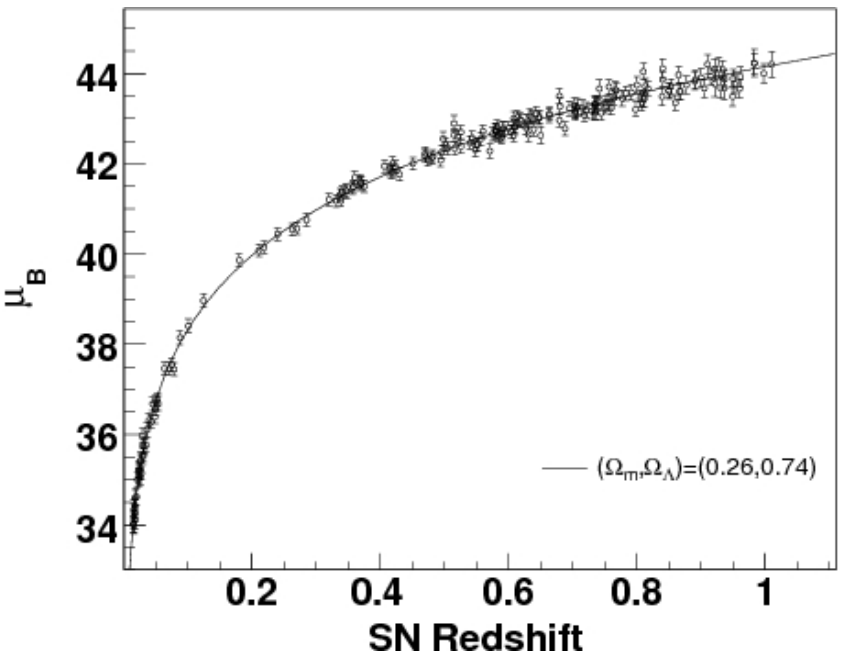
The 1.0 year Hubble Diagram (reminder)

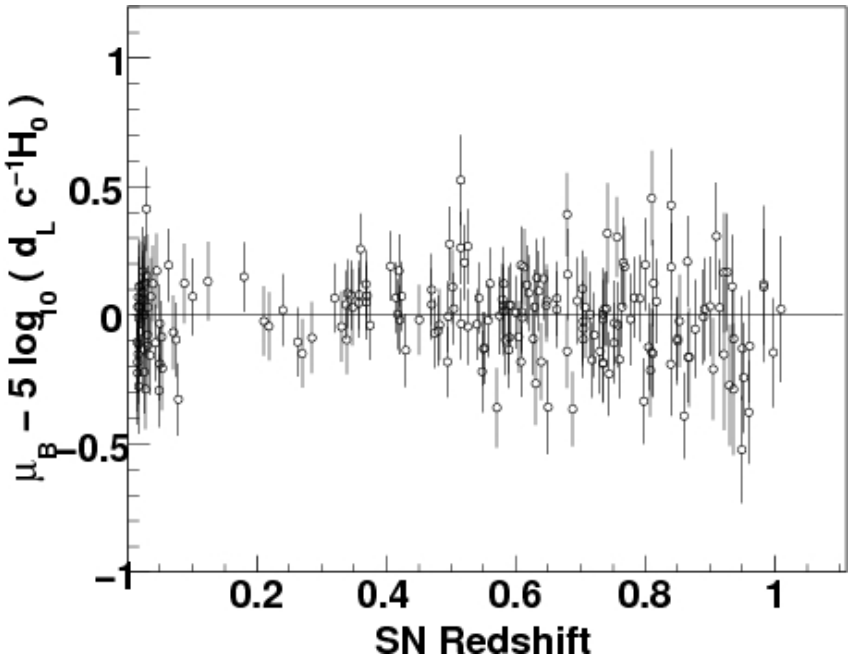
Astier et al, 2006





The 2.5 year Hubble Diagram





Identified Sources of Systematics

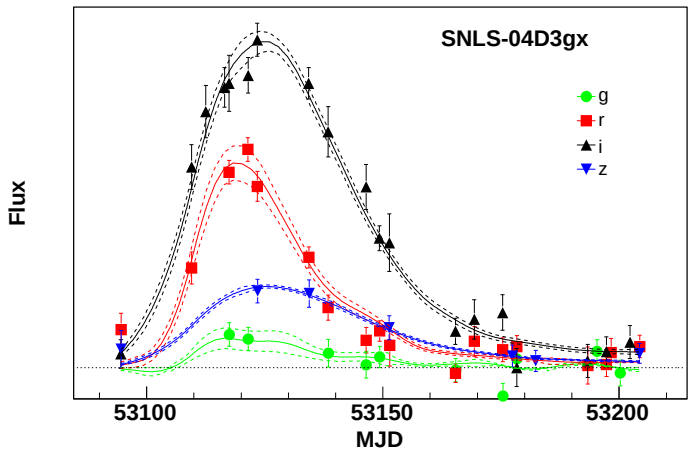
- Photometric calibration & modeling of the passbands
- Empirical modeling of lightcurves
  - restframe region used: $(B, V)) \rightarrow (U*, B)$ at large z
  - modeling of the SED in the far-UV is crucial for $z > 0.8$
- Detection biases
  - simulation of the detection pipeline
- Contamination
- Evolution effects
  - study of SN Ia properties as a function of Host Galaxy
  - comparison of nearby and distant SNe Ia
- Extinction by intergalactic dust
- Gravitational lensing

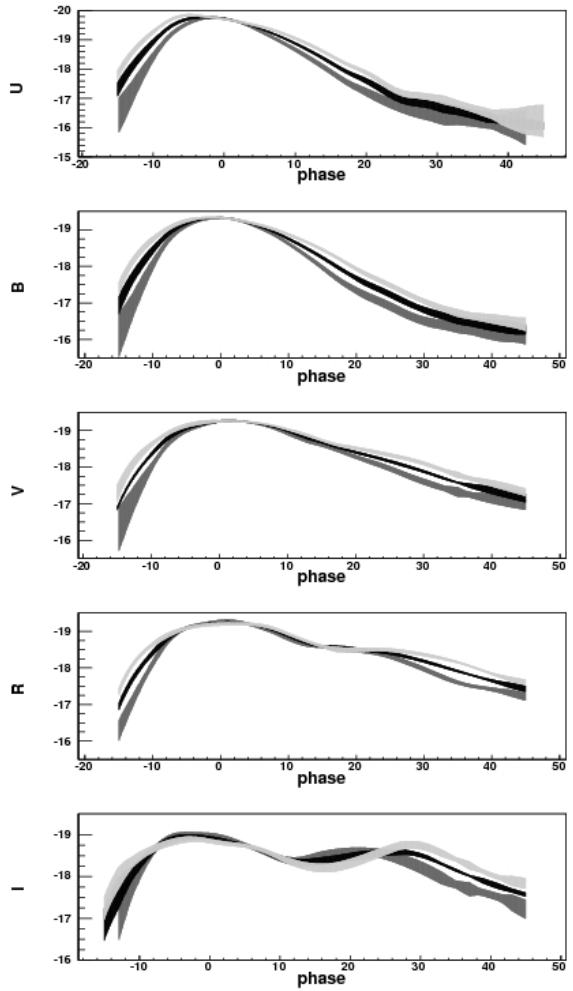
SALT2: modeling SN Ia SED in the far-UV

J. Guy et al, in prep

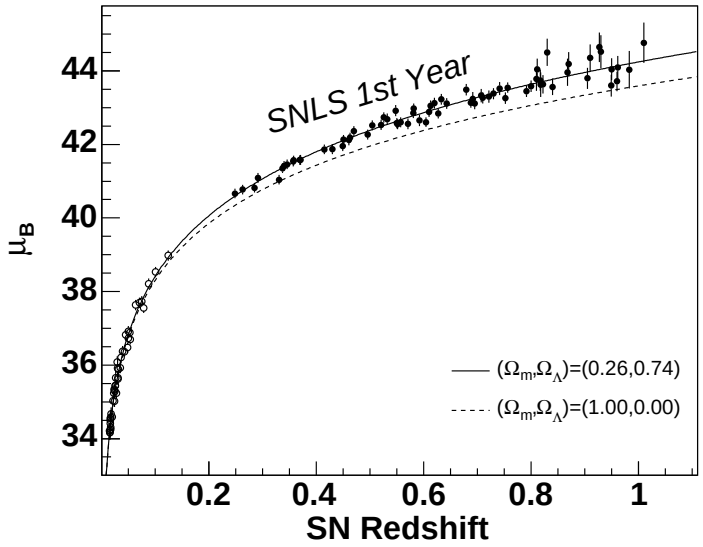
SALT2: J. Guy et al (in prep)

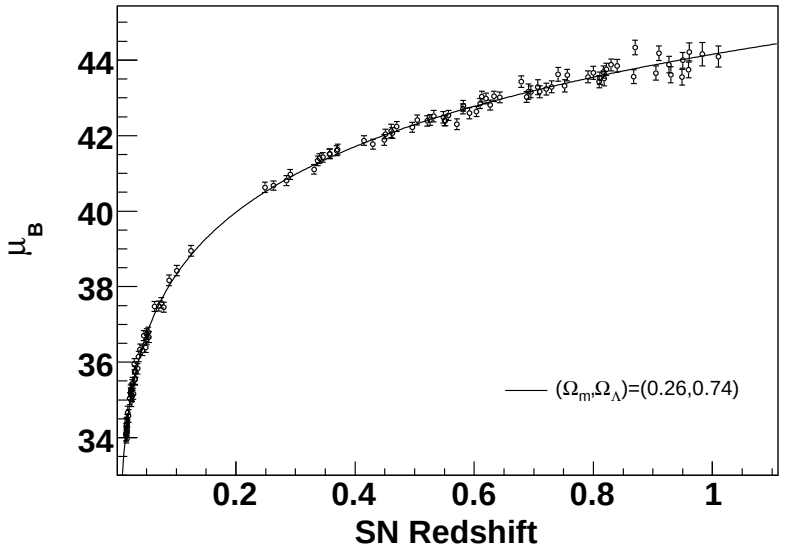
- Use photometric and spectroscopic data
- PCA to describe SN variability
- Derive model uncertainties
- Modeling of SN Ia SED in the far UV

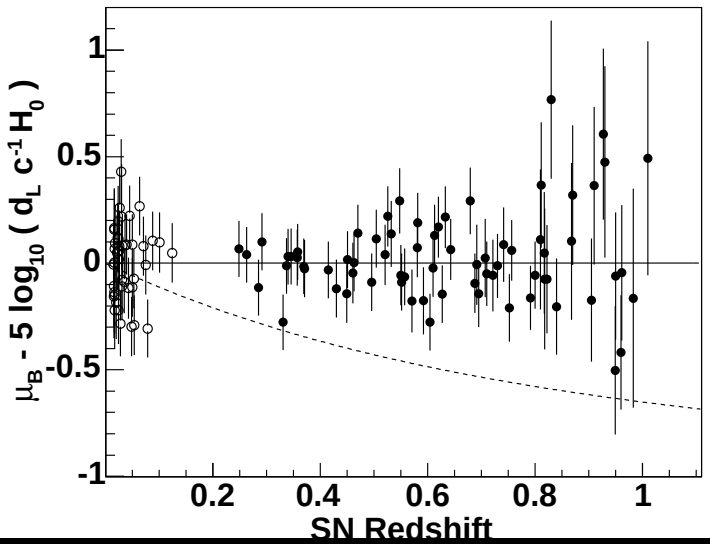


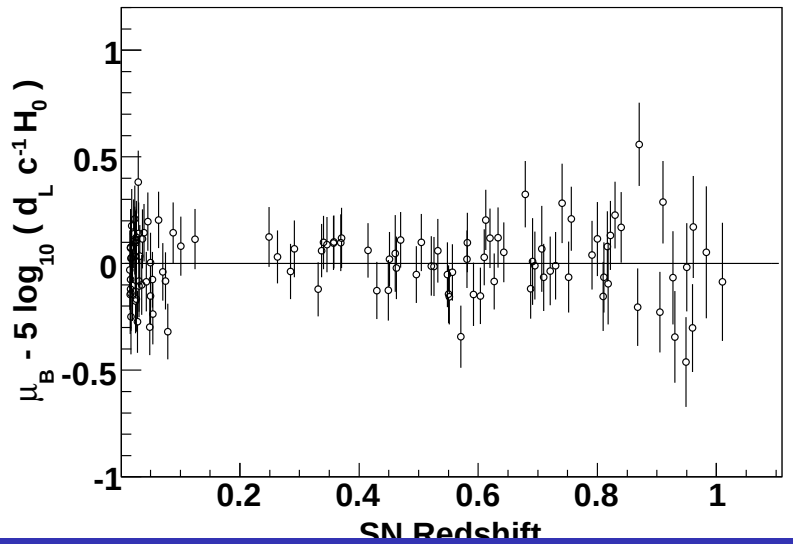


SALT2

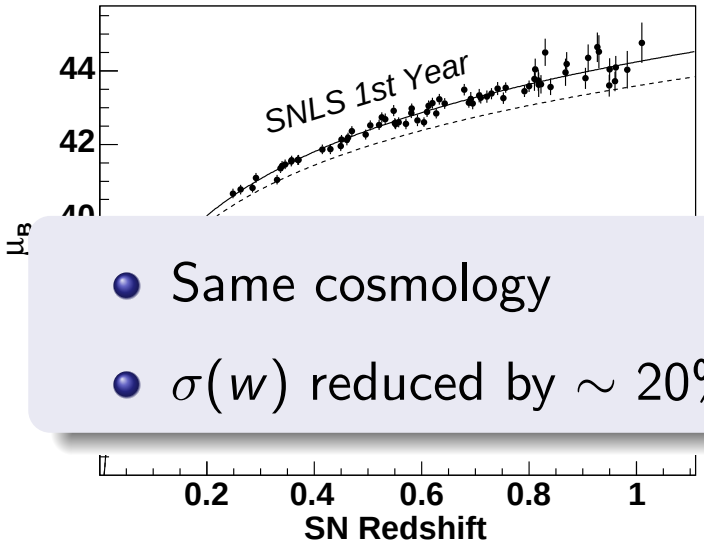

SNLS 1st Year
μ_B
SN Redshift
$(\Omega_m,\Omega_\Lambda)=(0.26,0.74)$
$(\Omega_m,\Omega_\Lambda)=(1.00,0.00)$

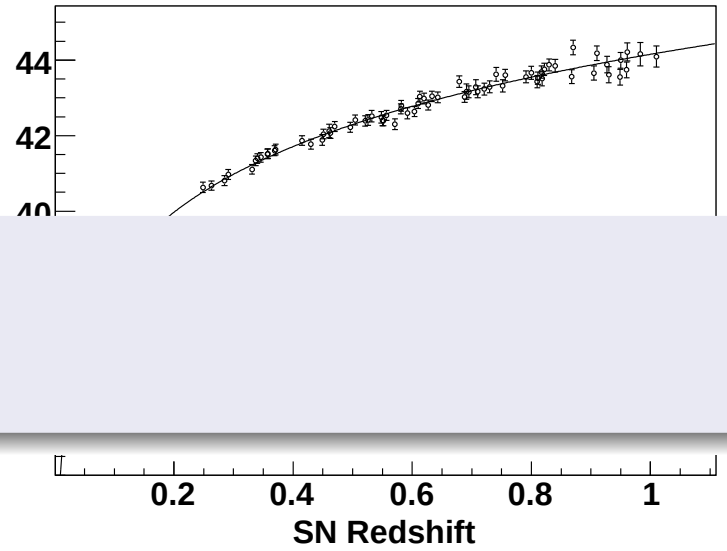

μ_B
SN Redshift
$(\Omega_m,\Omega_\Lambda)=(0.26,0.74)$


μ_B - 5 log$_{10}$ (d$_L$ c^{-1} H$_0$)
SN Redshift

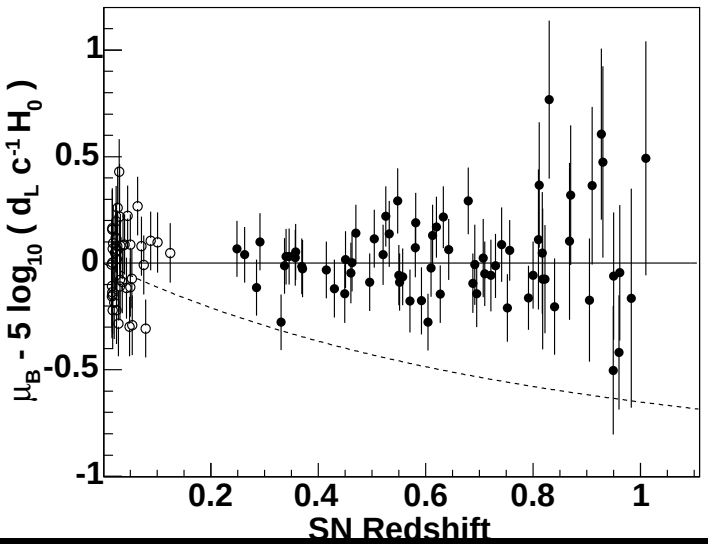

μ_B - 5 log$_{10}$ (d$_L$ c^{-1} H$_0$)
SN Redshift

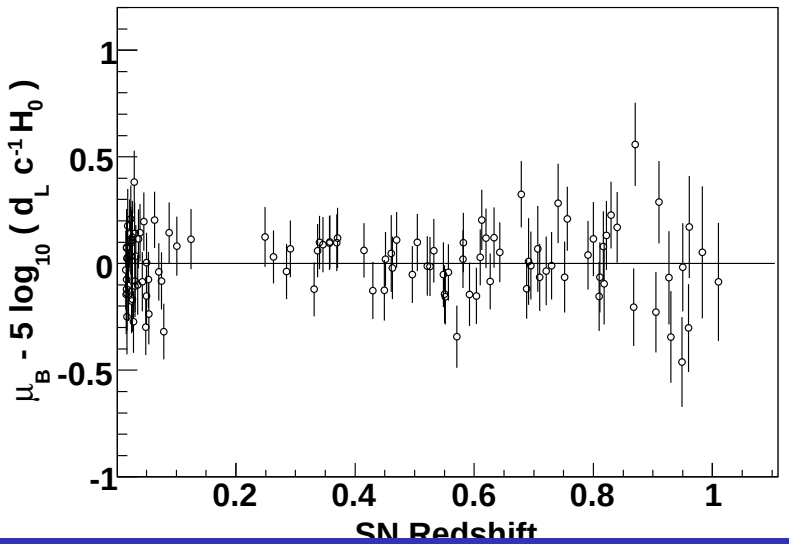
SALT2





- Same cosmology
- $\sigma(w)$ reduced by $\sim 20\%$



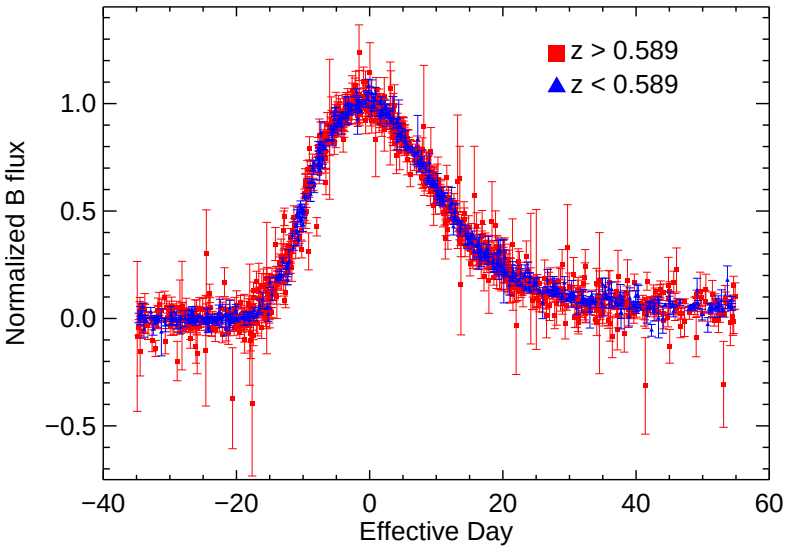


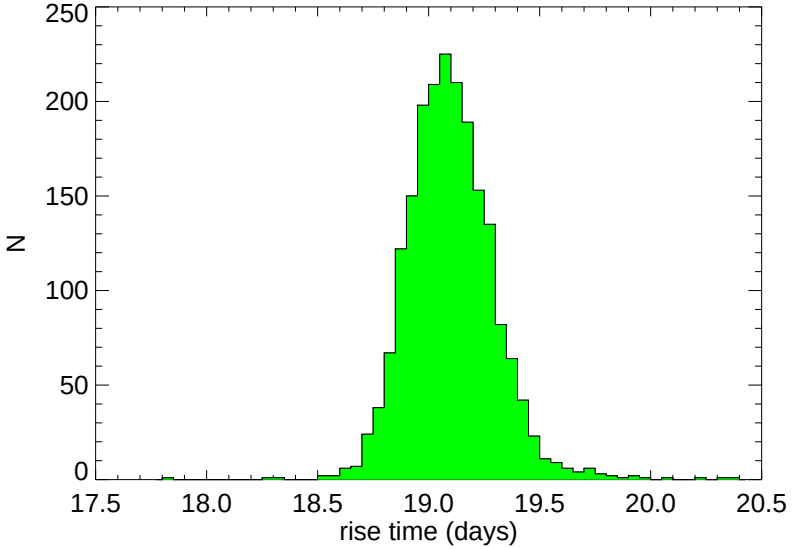
SN Ia Lightcurve Rise Time

Conley et al, 2006

SN Ia evolution check

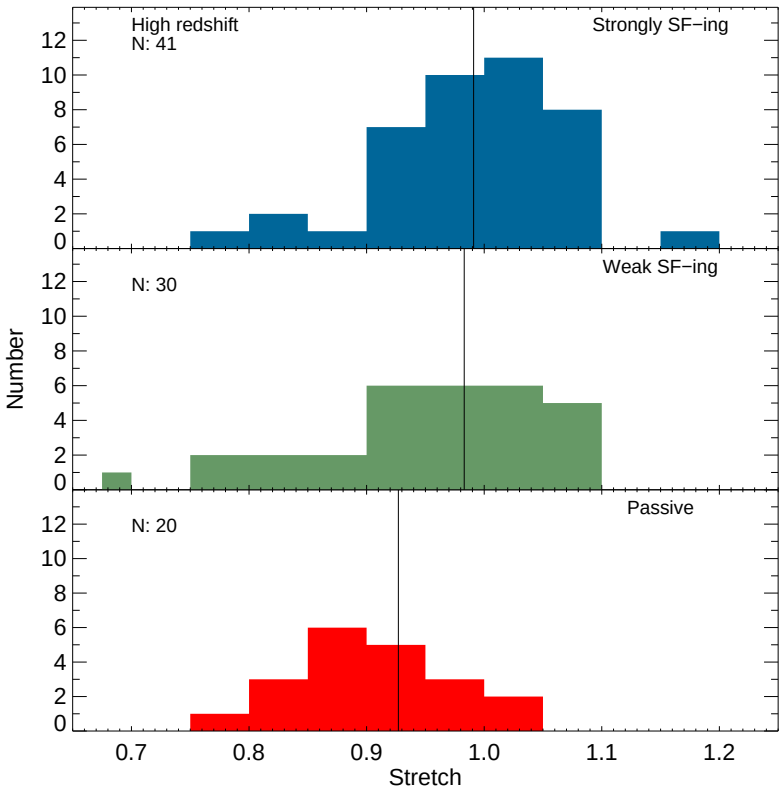
- Compare nearby and distant SN early lightcurve shape (B-band)
  - nearby: 19.58 ± 0.2
  - distant: $19.10 \pm 0.2(stat) \pm 0.2(sys)$





SN Ia Properties and Host Galaxies

Sullivan, LeBorgne et al, 2006



SNe exploding in a high SFR environment

- display a larger stretch (and are brighter)

$\Rightarrow$ younger progenitors produce brighter SNe Ia ?

no impact on the distance measurement for the 1 year sample

Outline

Motivations

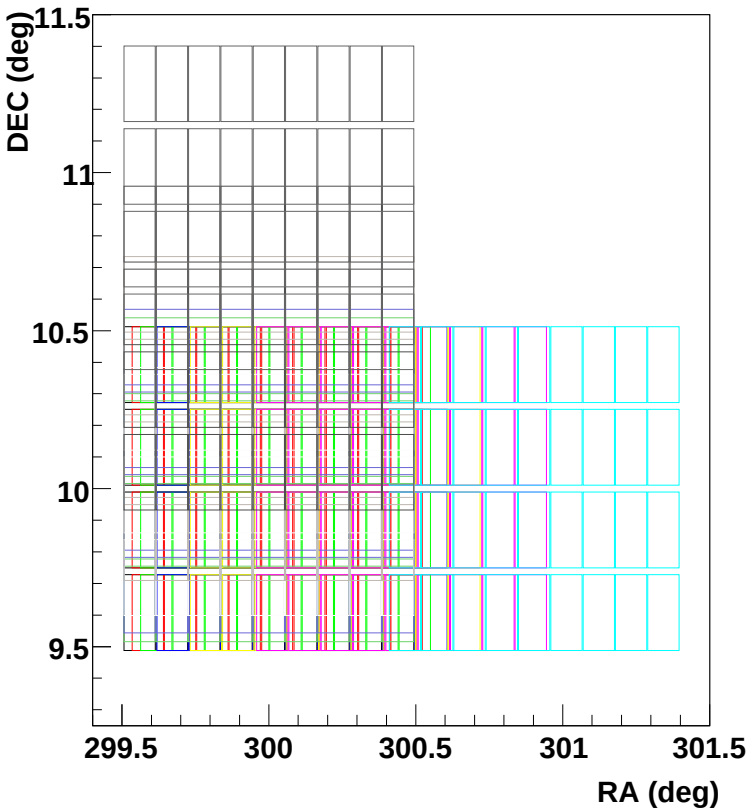
Source	$\sigma(\Omega_m)$ (flat)	$\sigma(\Omega_{tot})$	$\sigma(w)$	$\sigma(\Omega_m)$ (with BAO)	$\sigma(w)$ (with BAO)
Zero-points	0.024	0.51	0.05	0.004	0.040
Vega spectrum	0.012	0.02	0.03	0.003	0.024
Filter bandpasses	0.007	0.01	0.02	0.002	0.013
Malmquist bias	0.016	0.22	0.03	0.004	0.025
Sum (sys)	0.032	0.55	0.07	0.007	0.054
Sum (stat)	0.042	0.53	0.10	0.021	0.090

(From Astier et al, 2006)

Ongoing Work on Calibration

- Internal Calibration
  - linearity
  - stability
  - uniformity
- Passband models
  - Megacam passbands
  - Landolt and SDSS effective passbands
- Calibration path
  - flux calibration (intercalibration of Megacam passbands)
  - investigate how the Landolt system is tied to Vega
  - ultimately rely on HST (CALSPEC) spectrophotometric standards, instead of Vega

The Photometric Grid



- Modeling the non-uniformities of the photometric response
  - Plate scale variations
  - scattered light
- Dense stellar fields (`RA=20:00:00`, `DEC=10:00:00`)
- 13 dithered exposures variable steps: $\sim$ 100 pixels $\longrightarrow$ half a camera
- Reobserved after each significant modification of the optics
- No control observations

- grid corrections applied to the pixels by the `Elixir` pipeline (*scatter flats* or *photometric flats*)

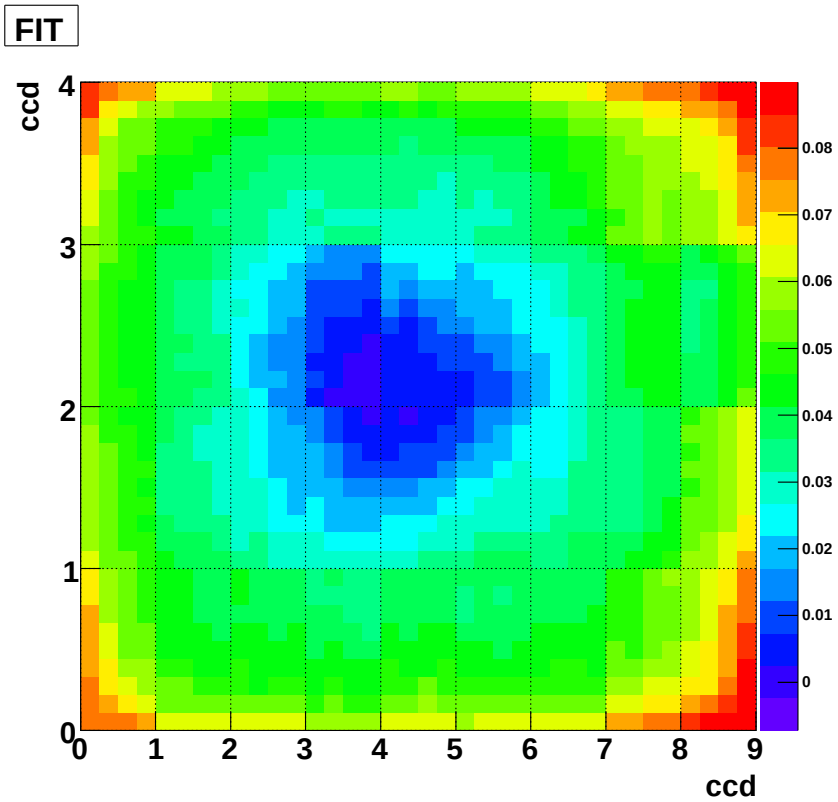
Analysis of the Photometric Grid

- Each CCD is divided into 4×9 cells
- $\sim 50,000 - 100,000$, isolated, well measured stars, each observed on $\sim$6 (3 – 12) cells
- We use the star flux measurements to measure:
  - an intercalibration coefficient w.r.t. the reference cell, δzp_{cell}
  - a possible color term drift w.r.t the reference cell, δk_{cell}
- Model

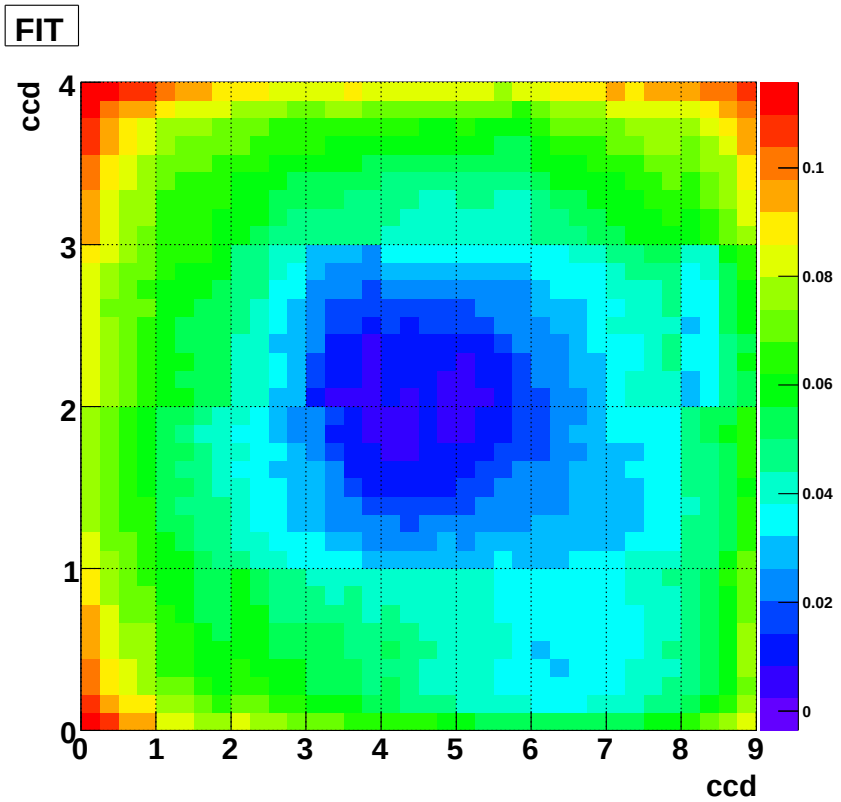
$$m(\mathrm{star}, \mathrm{cell}) = m(\mathrm{star}) + \delta zp(\mathrm{cell}) \quad [+\delta k(\mathrm{cell}) \times col(\mathrm{star})]$$

- Large fit !
  - 1295 (δzp) – 2590 ($\delta zp + \delta k$) calibration parameters
  - $\sim 100,000$ star fluxes (known only on the reference cell)

δzp, i-band, uncorrected data

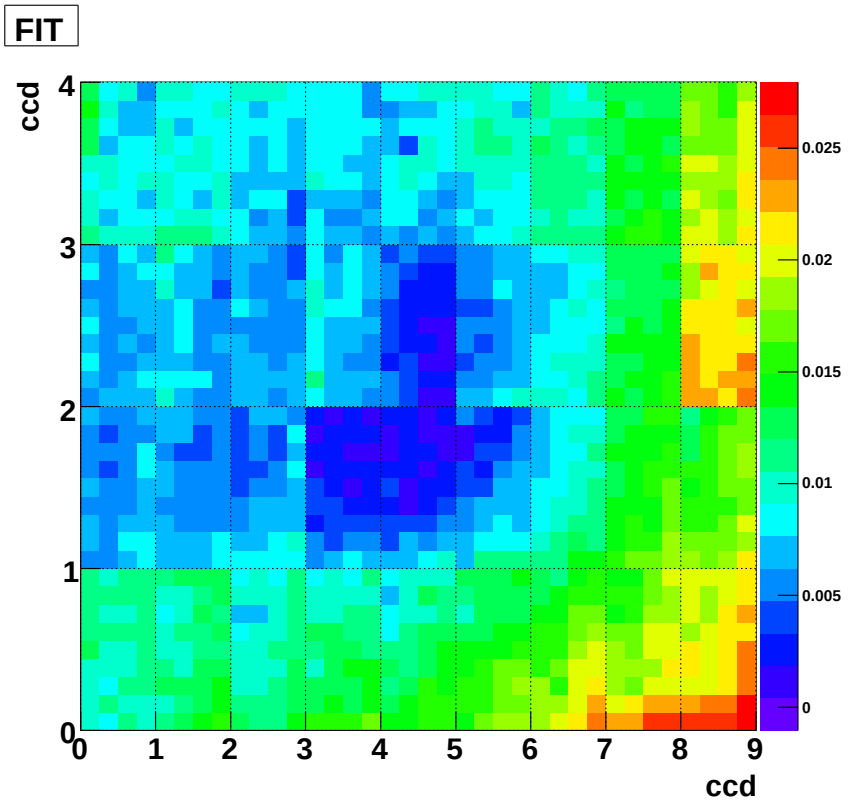


2003B

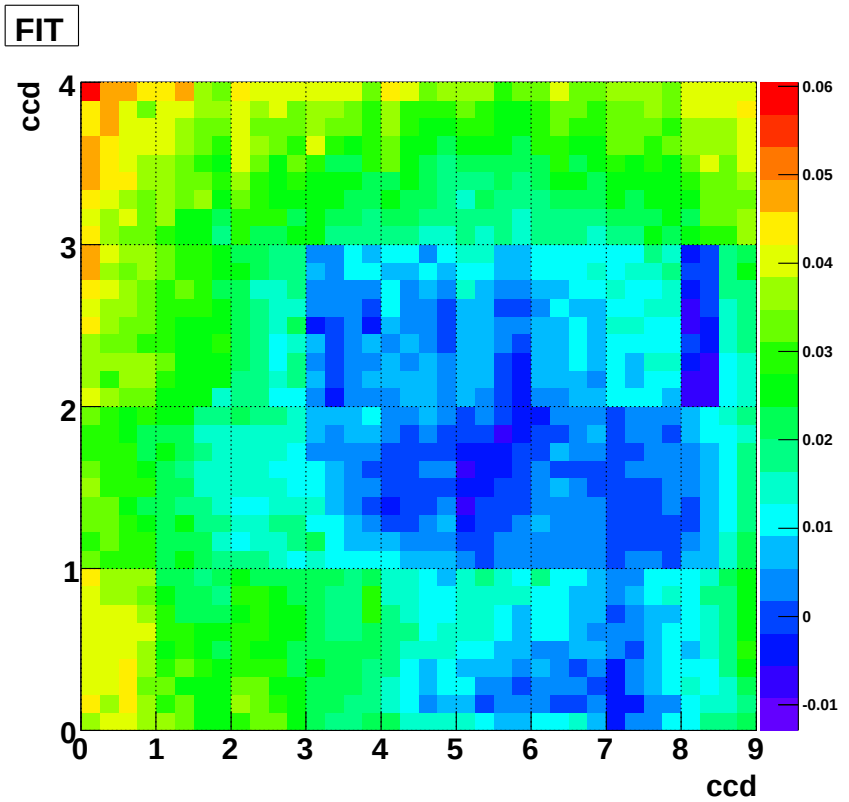


2005B

δzp, i-band, elixir corrected data

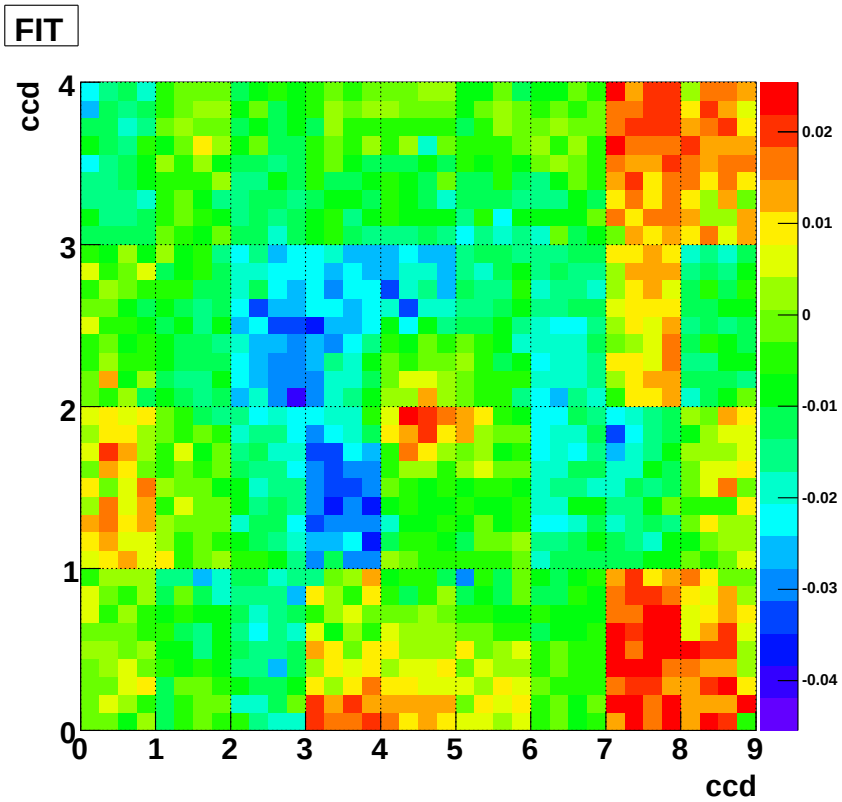


2003B

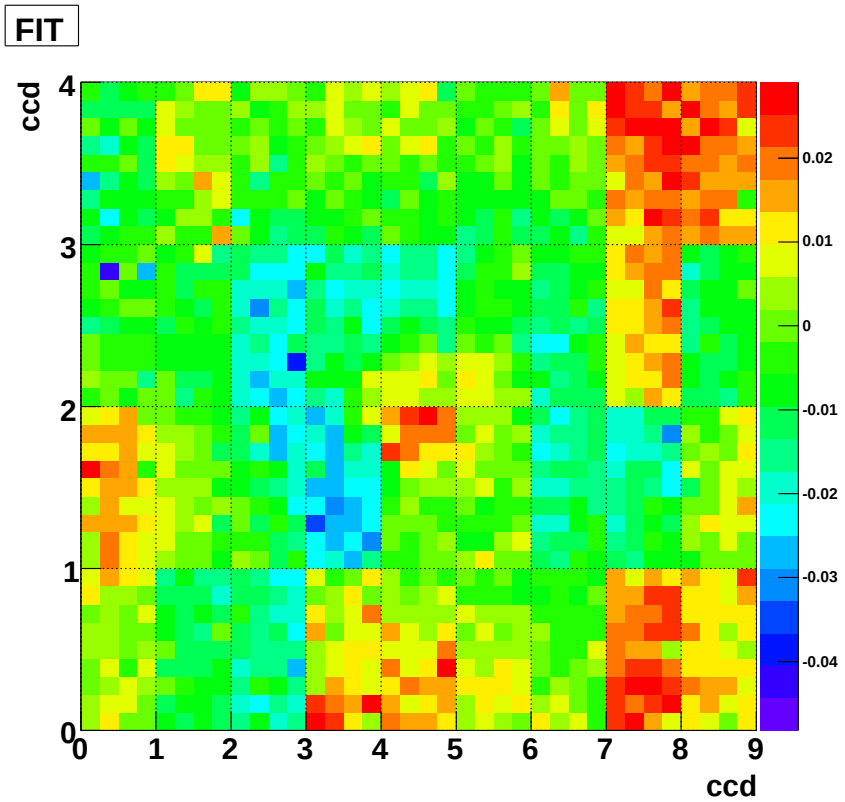


2005B

δk, u-band

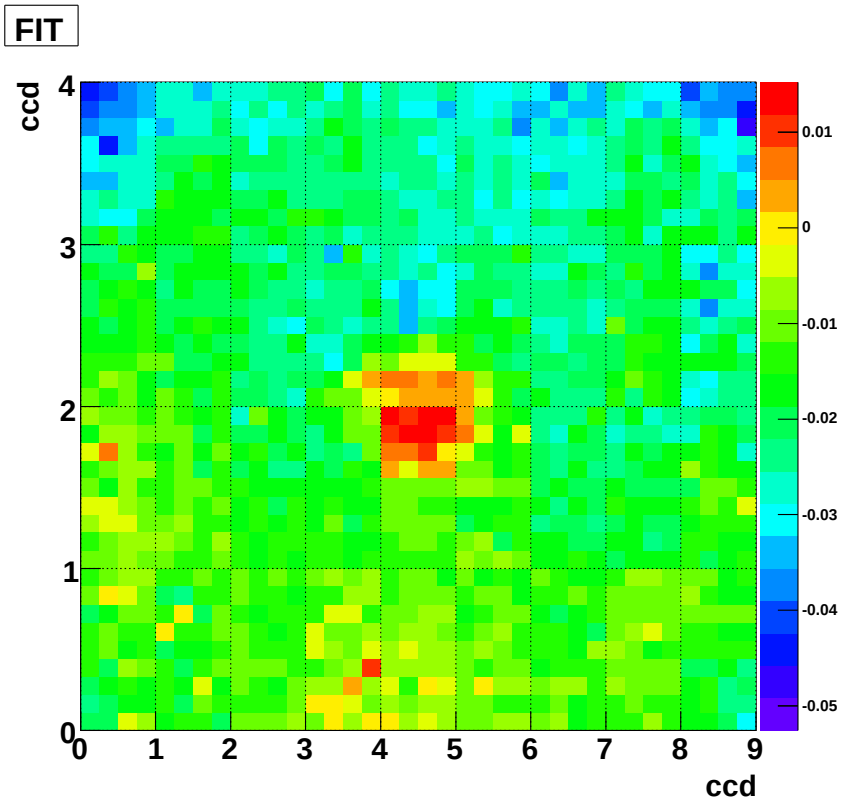


2003B



2005B

δk, g-band



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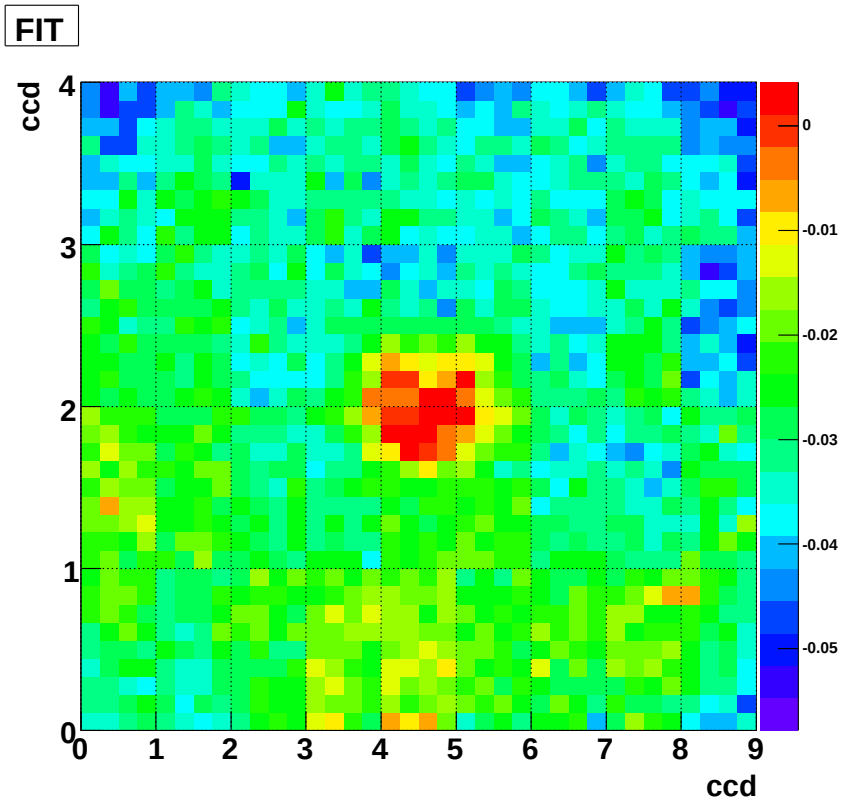
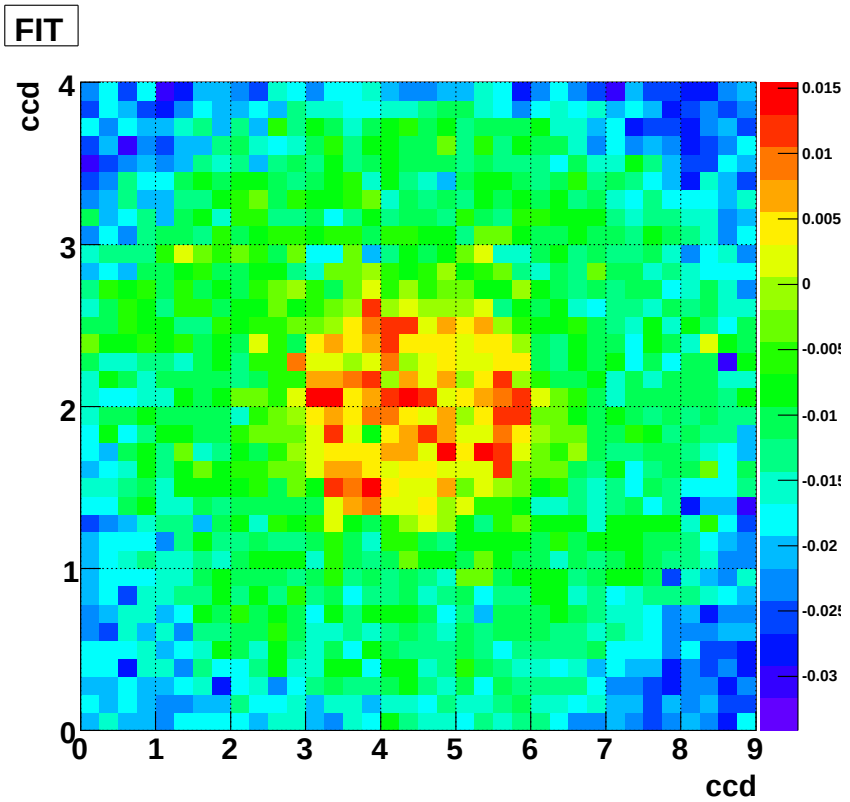


2005B

δk, r-band



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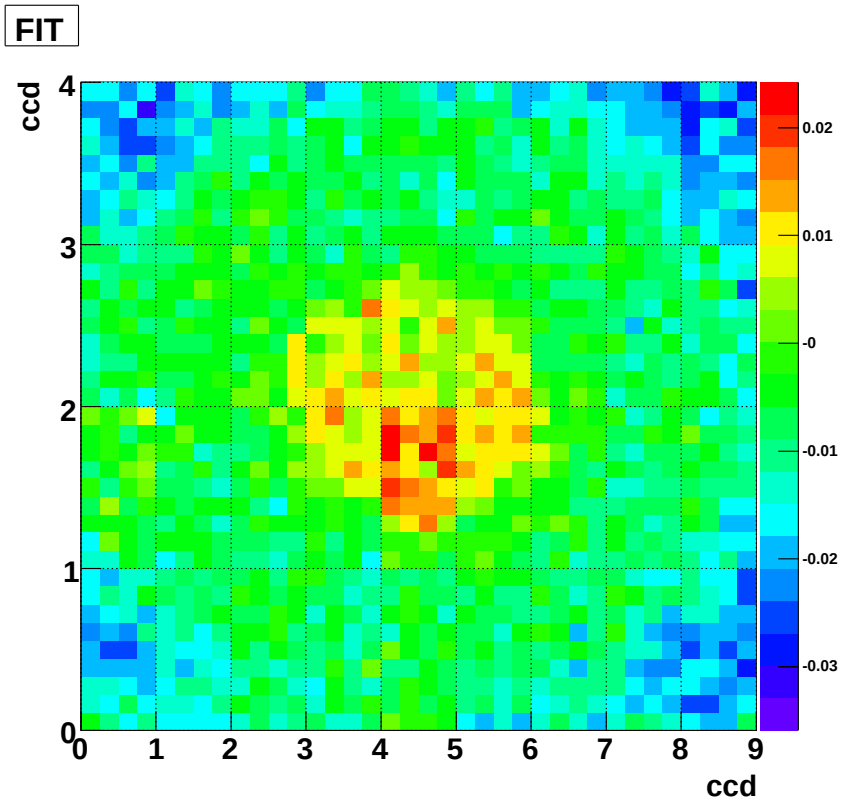
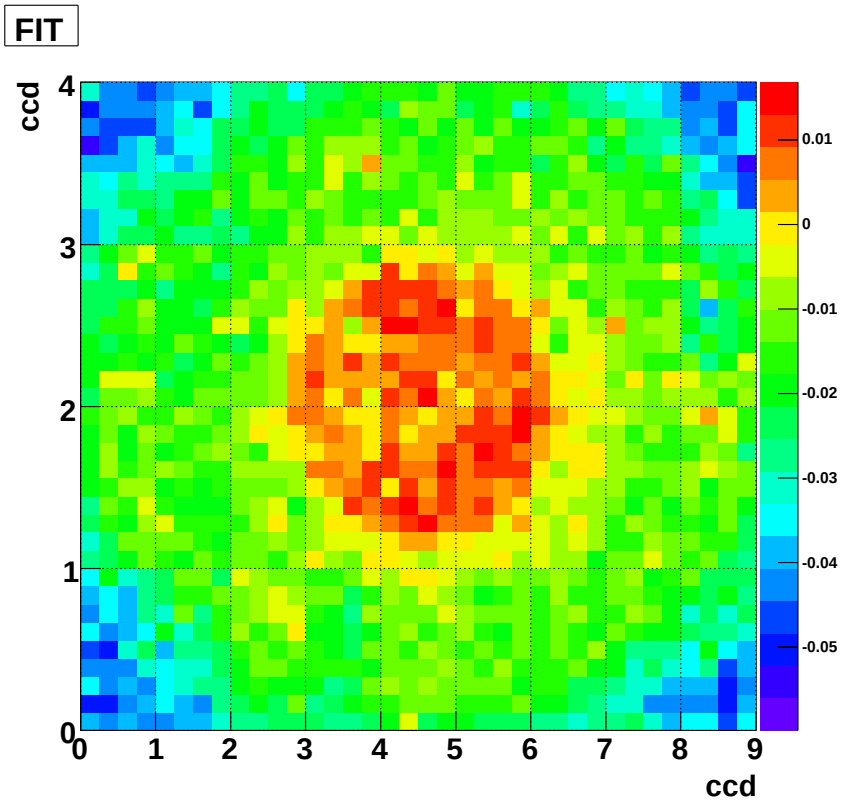


2005B

δk, i-band



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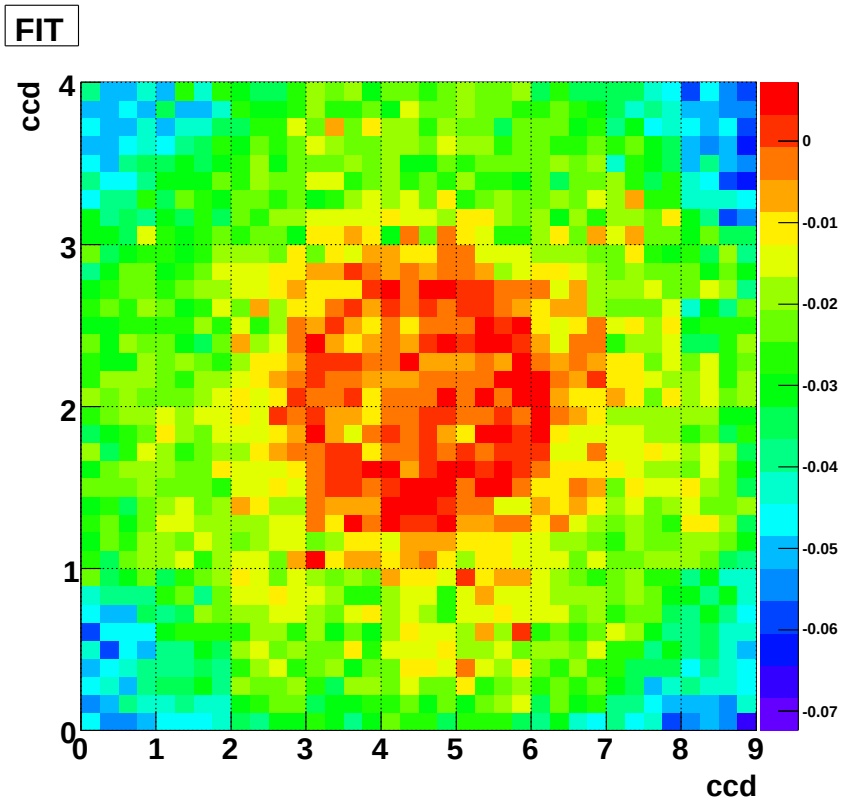
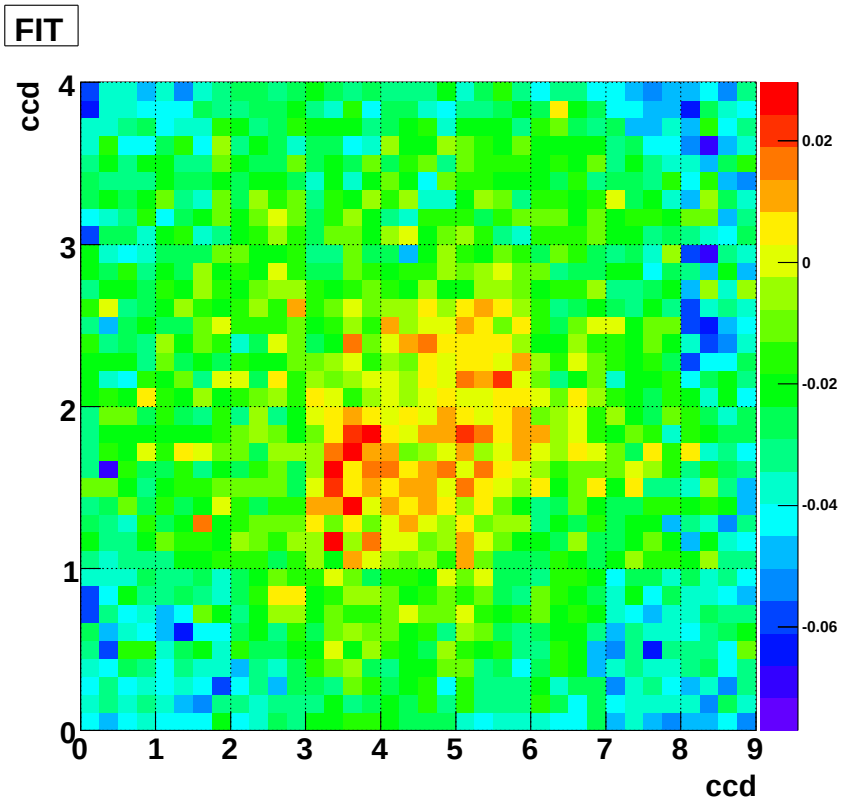


2005B

δk, z-band



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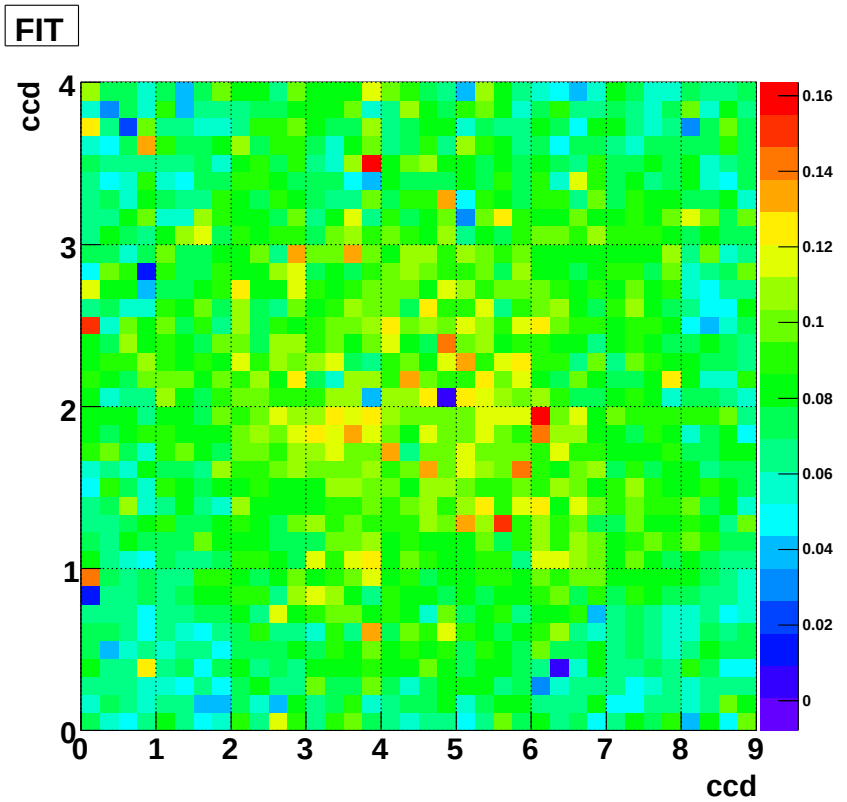
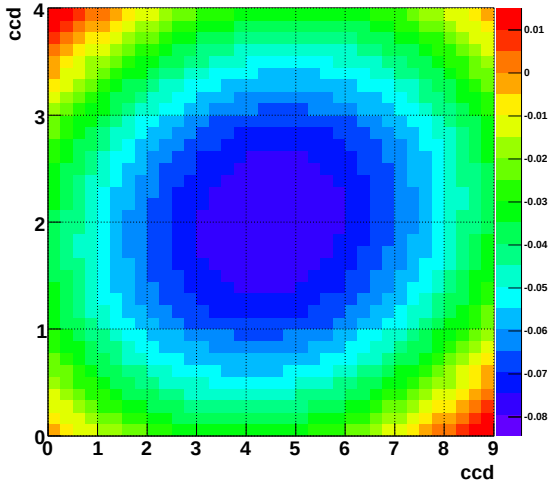


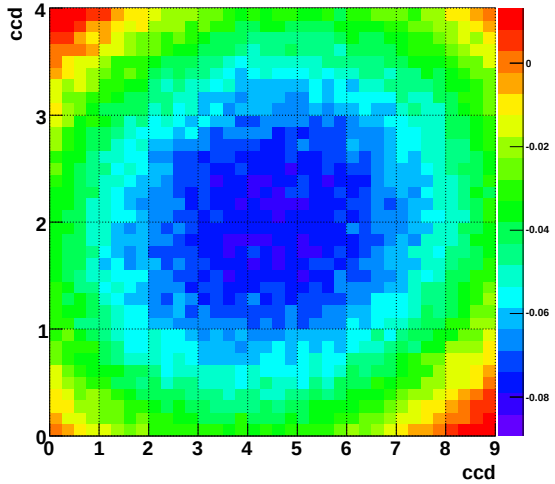
2005B

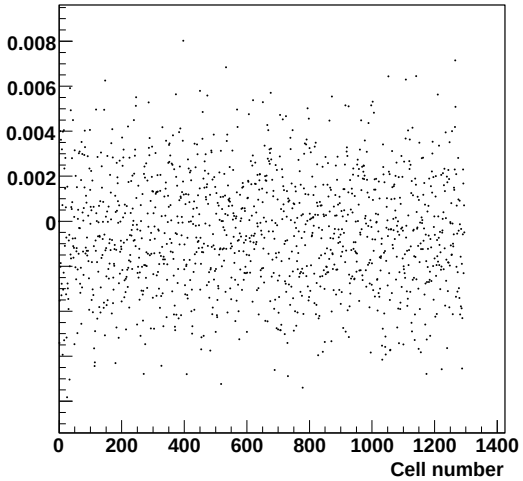
Simulation

Photometric Distorsion

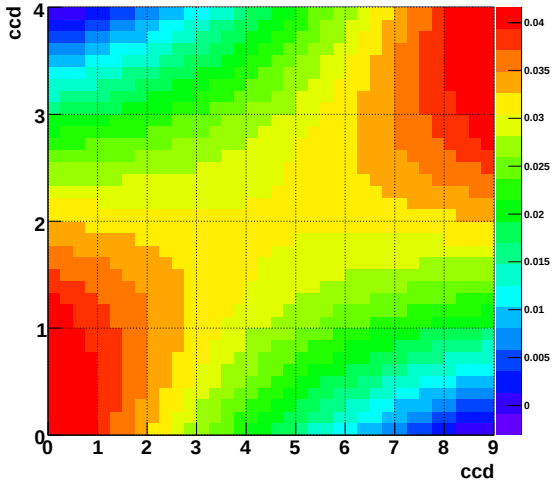


FIT

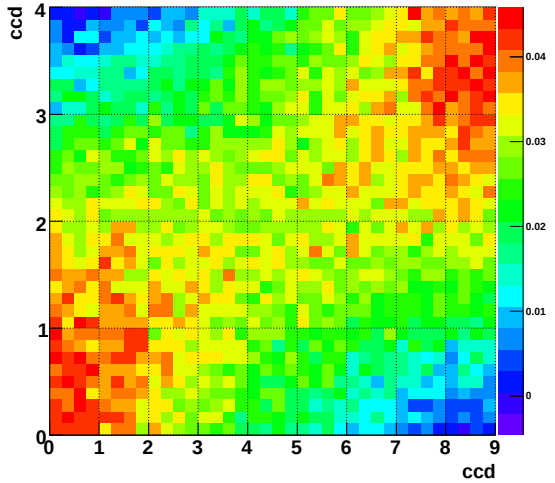


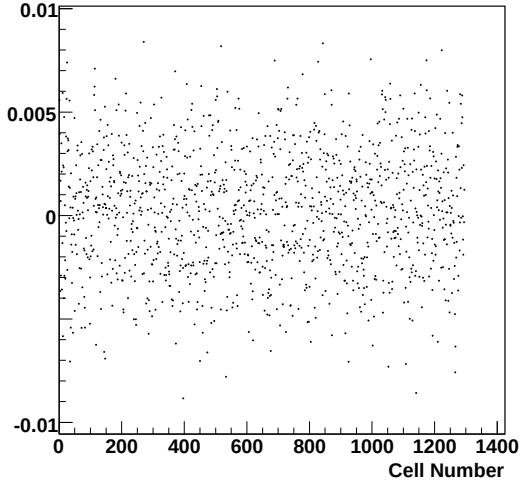


Color terms

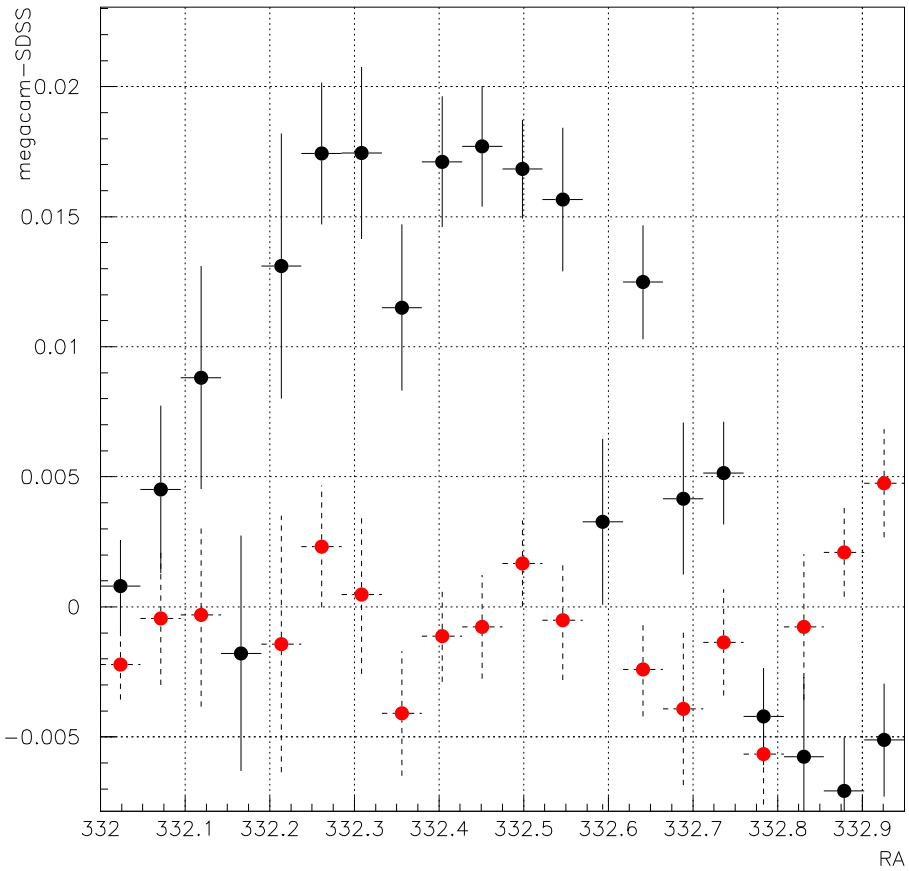


FIT





SDSS Southern Strip



Summary

The bad news

- Residual non-uniformities in the Elixir-corrected data, at the level of $\sim 2-3\%$
- Large (unexpected) non-uniformities of the passbands
  - seem to follow a radial pattern
  - 4 to 5% in all bands (4 to 5 nm)
  - cannot be corrected at the pixel level (!)

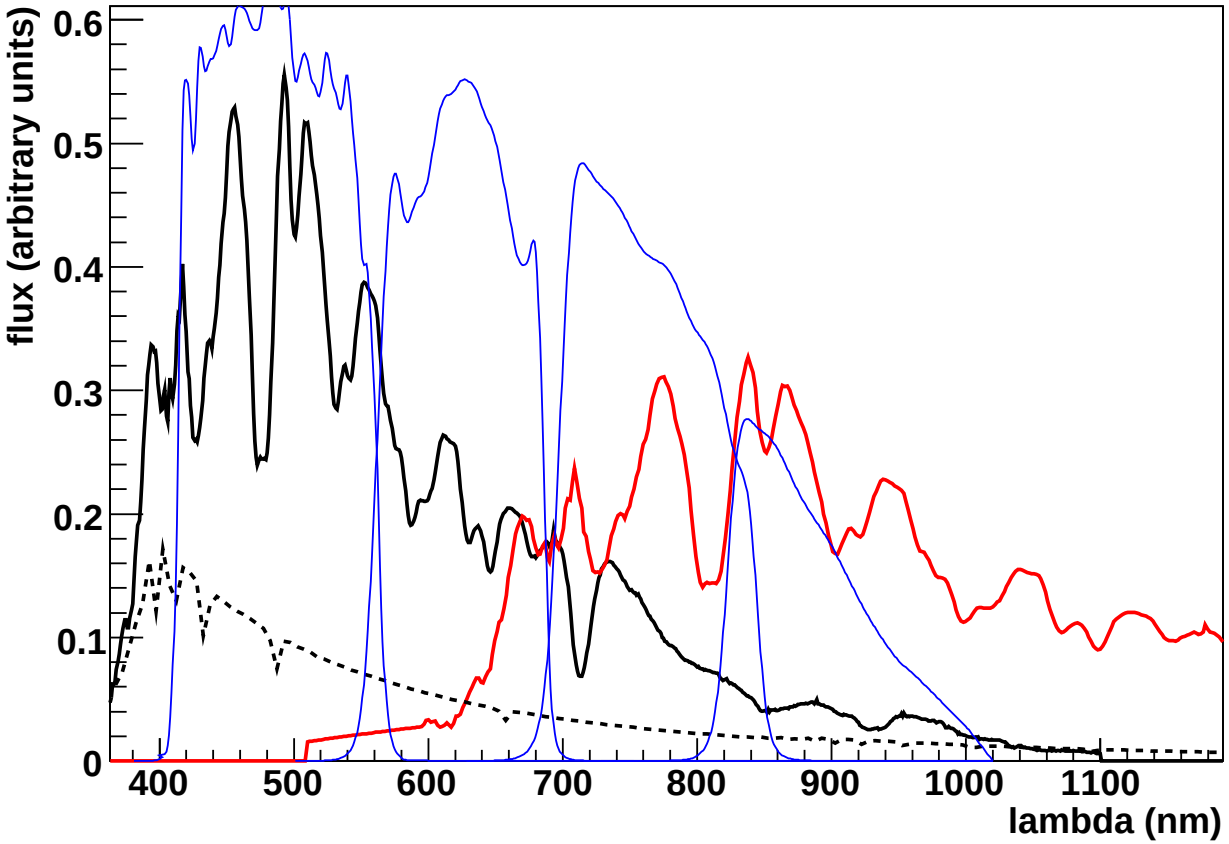
The good news

- we can target a uniformity of a few mmag
- should be checked using additional (dithered) observations (SDSS Southern Strip)

A big Thanks to Jean-Charles for his help !

Outline

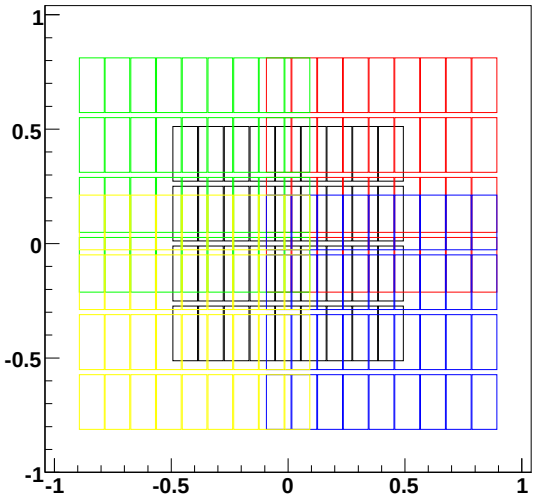
Absolute Colors Needed



The E98/E95 program

Goal: Secure a flux calibration of the Megacam survey

- Cosmology w/ SNe Ia
- Photometric redshifts and Galaxy SED modeling
- Stellar physics



E98 Observing Group: 2 band observations of

- A DEEP field
- A Landolt/Smith field
- SDSS Southern Strip
  w/ Very Large Dithering pattern
- 2+ HST spectrophotometric standards

The E98/E95 program

It will allow us to:

- check the imager uniformity
- secure a good intercalibration with the SDSS 2.5-m system
- compute the colors of Vega in the Landolt system (flux calibration of the Landolt system)
- define a natural, flux calibrated system for the survey

Test OGs

- taken on 2006-08-30: 1 OG $\sim$ 55mn
- *gr*, *ri*, *iz*, *ru* blocks scheduled for each of the DEEP fields
- SDSS Southern Strip observable until end of January (!)

Conclusion

SNLS is doing well

- $\sim$ 300 identified SNe Ia on disk
- $\sim$ 500 identified SNe Ia at the end of the survey (mid-2008)
  - impact of wheather on data taking (!)

Calibration studies under way

- Goals
  - precision $\leq$ 1% of the internal calibration
  - precision $\leq$ 1% of the calibration w.r.t. HST standards
  - investigate the colors of Vega in the Landolt system
- heavily rely on the E98/E95 program
- Instrumental calibration under study