Calibration of the SNLS

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Outline

- The SNLS Dataset
- The Megacam “Natural” magnitude system
- Calibration Procedure
- Uniformity of the Camera
- Conclusion

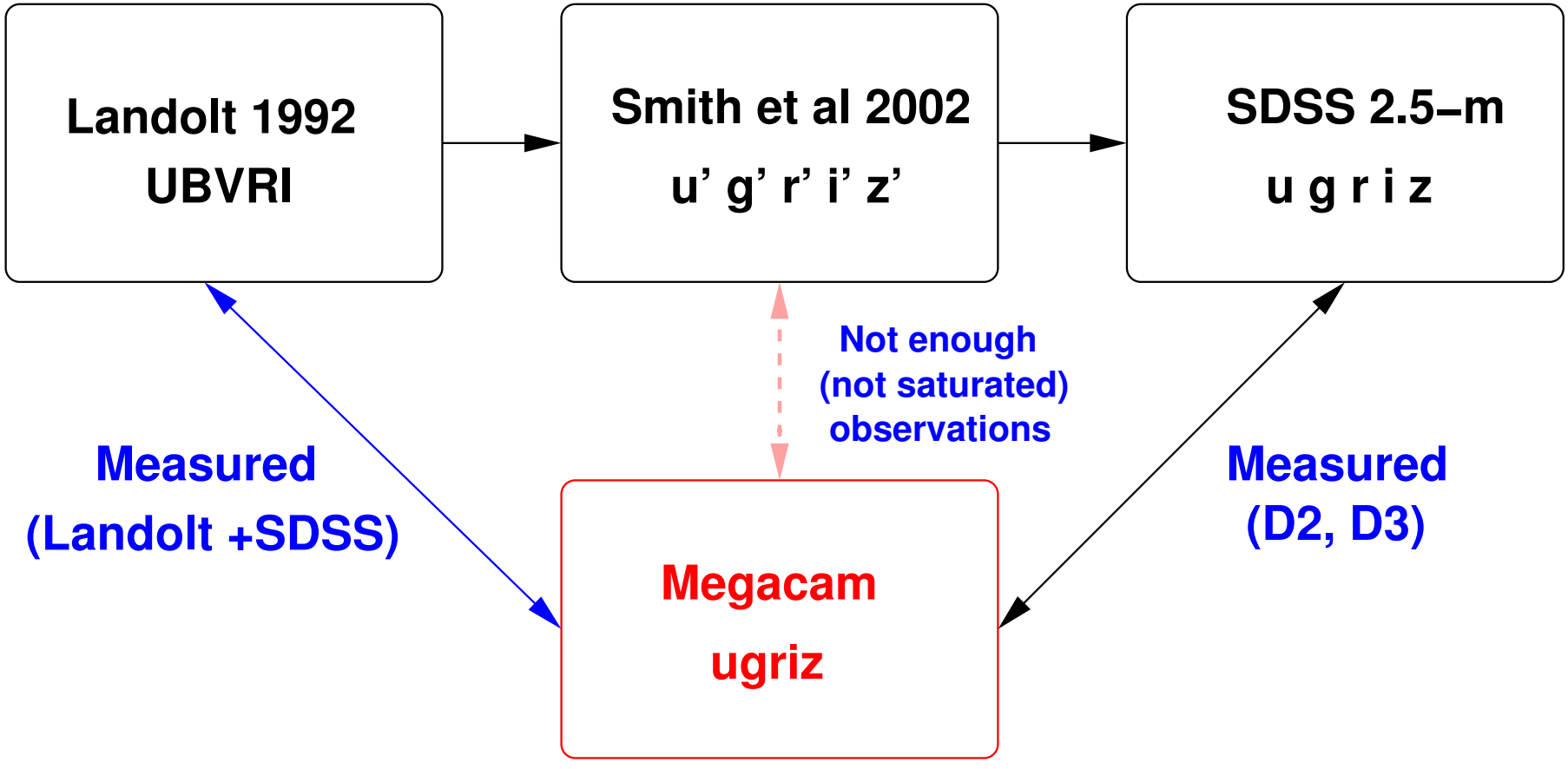
Calibration of the SNLS DATA

- 4 fields
  - D1 02:26:00 -04:30:00
  - D2 10:00:29 02:12:21
  - D3 14:17:54 +52:30:31
  - D4 22:15:31 -17:44:05
- 4 Megacam filters
  - g_M, r_M, i_M, z_M
- 2 Calibration sources
  - Landolt
    - $UBVRI$ (Johnson-Cousins)
  - Smith *et al.*
    - $u'g'r'i'z'$
  - SDSS catalog
    - SDSS 2.5-m $ugriz$

- Goal: g_M, r_M, i_M, z_M mags for the field stars.
- Determine mag transformations $\rightarrow$ other systems.
- Have a good determination of our filters.
  - be able to compare SN Megacam magnitudes and the nearby SN $BVRI$ magnitudes...

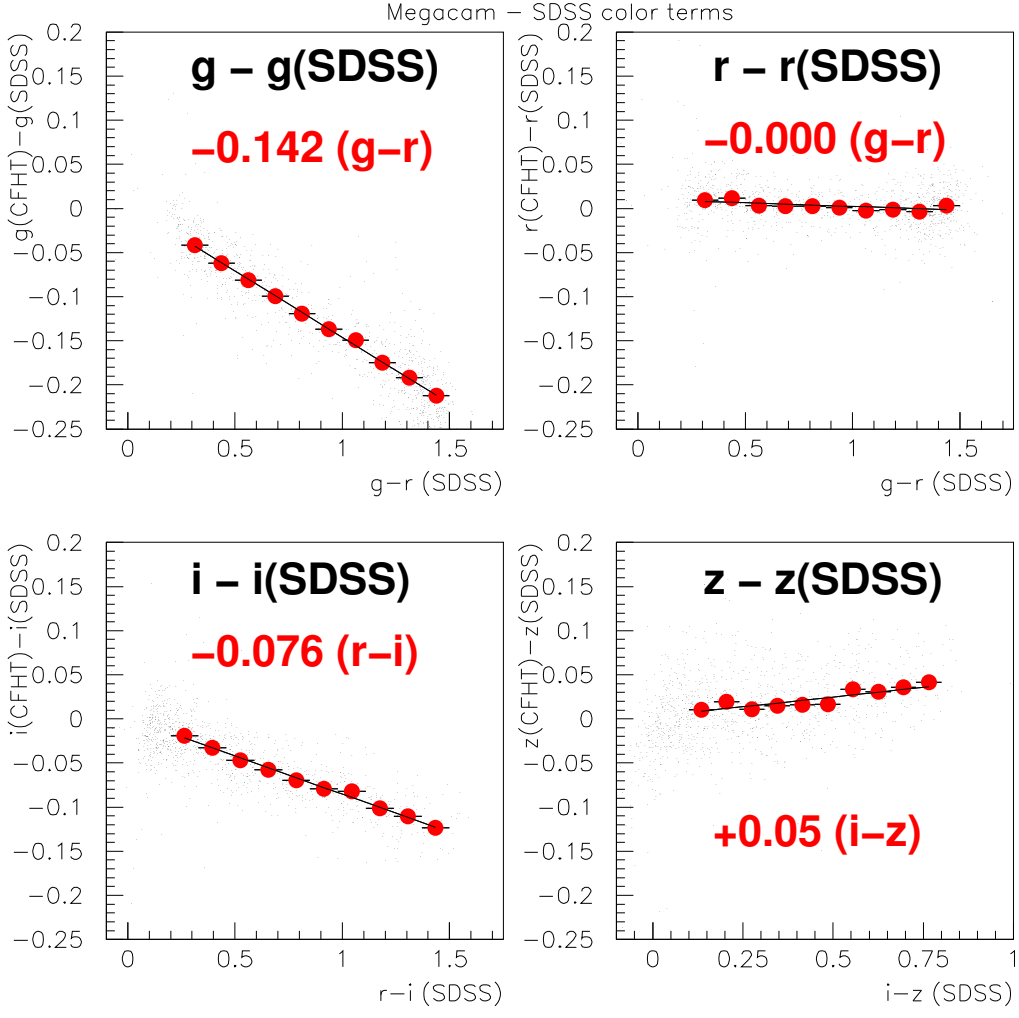
The Megacam "Natural" system

... and how it translates into the standard systems



SDSS to Megacam

- Redetermined using the D2, D3 to SDSS comparisons.



Landolt to Megacam (I)

- Transformations determined using:
  - the Smith *et al.* stars in common with the Landolt catalog.
  - the $u'g'r'i'z' \rightarrow ugriz$ transformation given by the SDSS.
  - the 2.5-m SDSS $\rightarrow$ Megacam determined by ourselves.

$$g_M = V + 0.500 \times (B - V) - 0.097 \quad \text{if } (B - V) < 0.5 \tag{1}$$

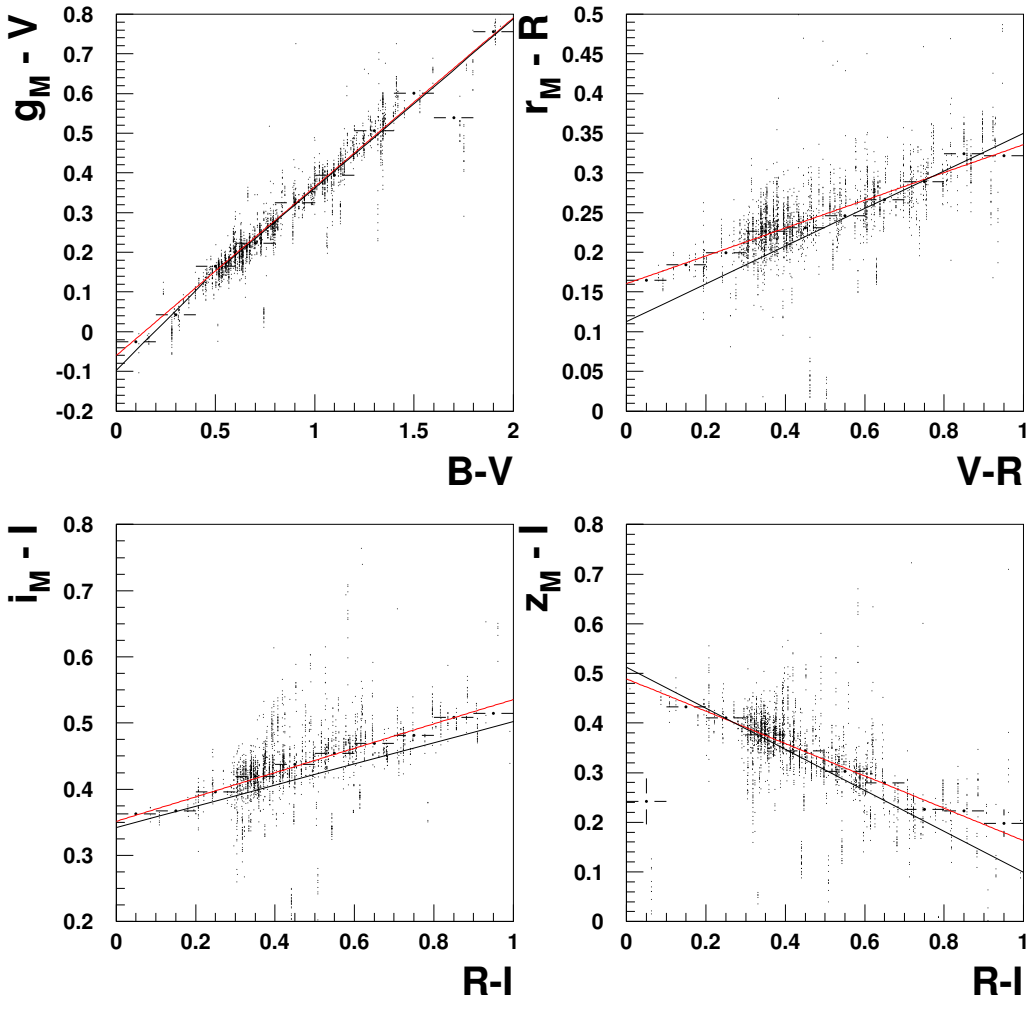
$$g_M = V + 0.425 \times (B - V) - 0.063 \quad \text{if } (B - V) > 0.5 \tag{2}$$

$$r_M = R + 0.237 \times (V - R) + 0.113 \quad \text{if } (V - R) < 1.0 \tag{3}$$

$$i_M = I + 0.160 \times (R - I) + 0.342 \quad \text{if } (R - I) < 1.0 \tag{4}$$

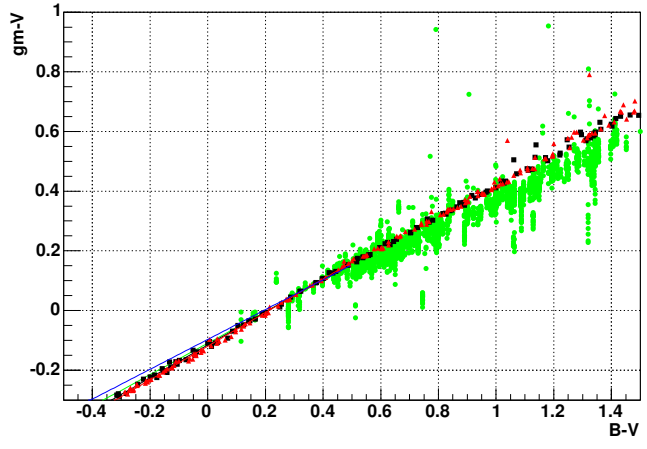
$$z_M = I - 0.413 \times (R - I) + 0.510 \quad \text{if } (R - I) < 1.0 \tag{5}$$

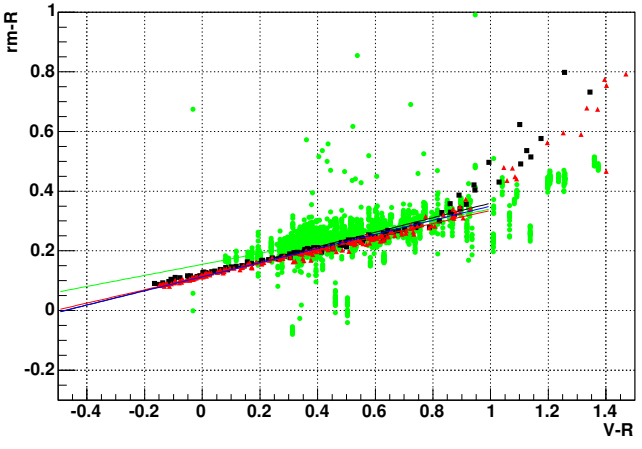
Landolt to Megacam (II)

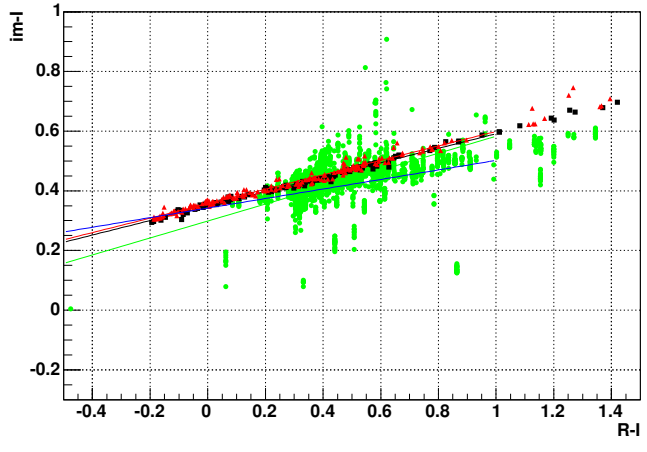


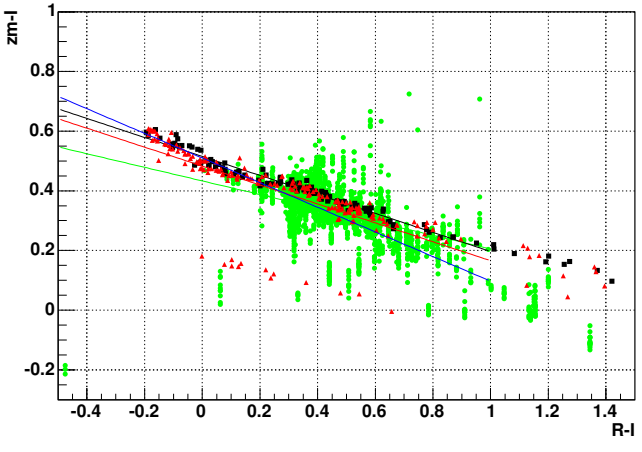
Synthetic Filters

- Spectrophotometric standards
- Filter transmissions (from Fukugita *et al* and ref. therein)
- Megacam transmissions









Calibration Procedure

- Field star photometry
  - w/ adaptative aperture
- Field star selection (shape)
- Night/Band flux averages

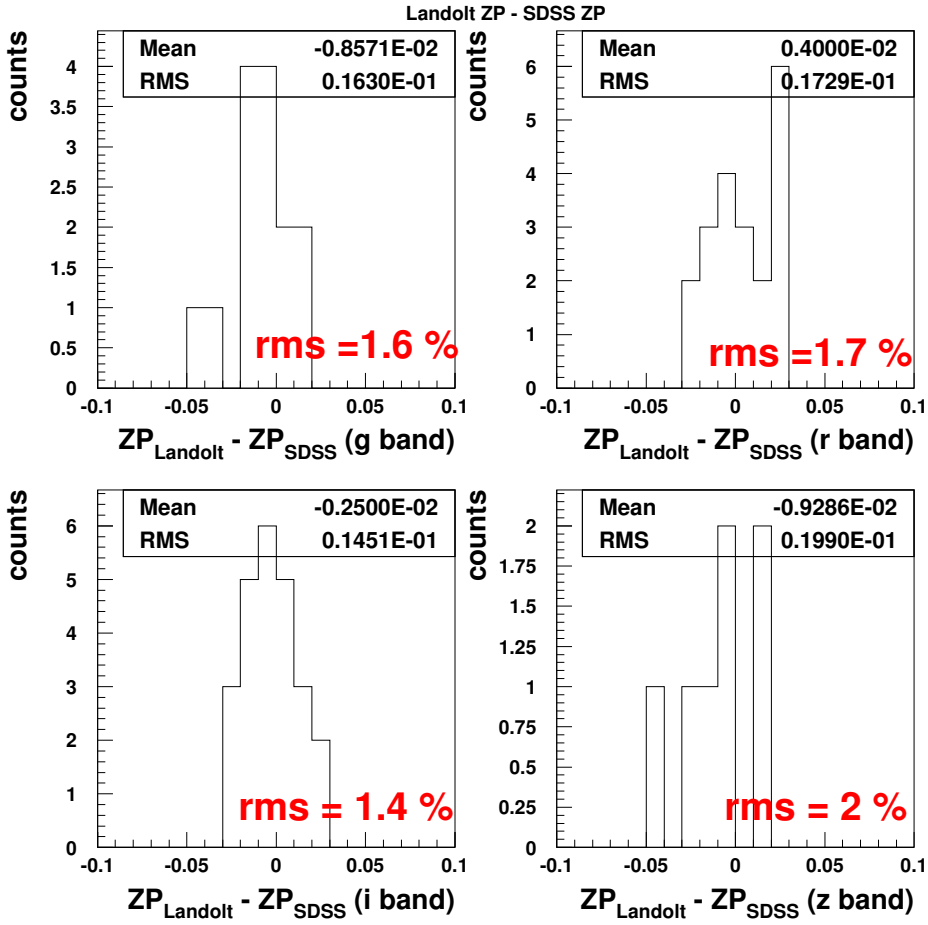
- Standard star photometry
- Landolt star selection (> 5 measurements)

- photometric night selection (skyprobe)
- zero points / nights (w/ Landolt or SDSS)
- apply zero points to the field star measurements
- average the calibrated field star measurements

$\Rightarrow g_M, r_M, i_M, z_M$ secondary standard catalogs.

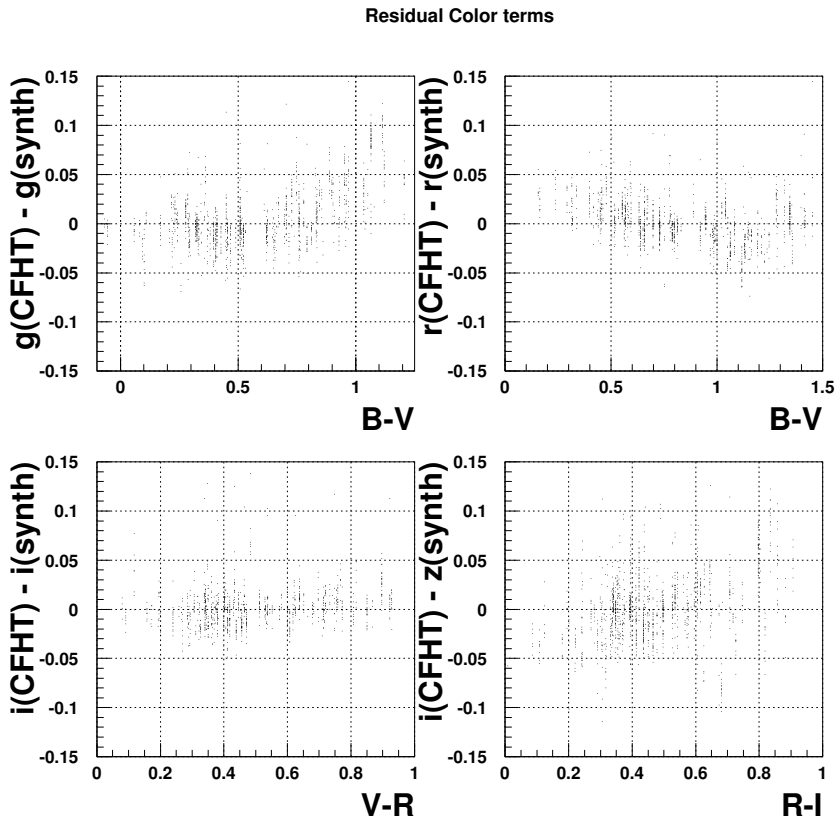
Landolt vs. SDSS Zero Points

- Zero Points determined for nights w/ Landolt + D2 or D3 obs.
- Excellent agreement $< 0.5\%$.

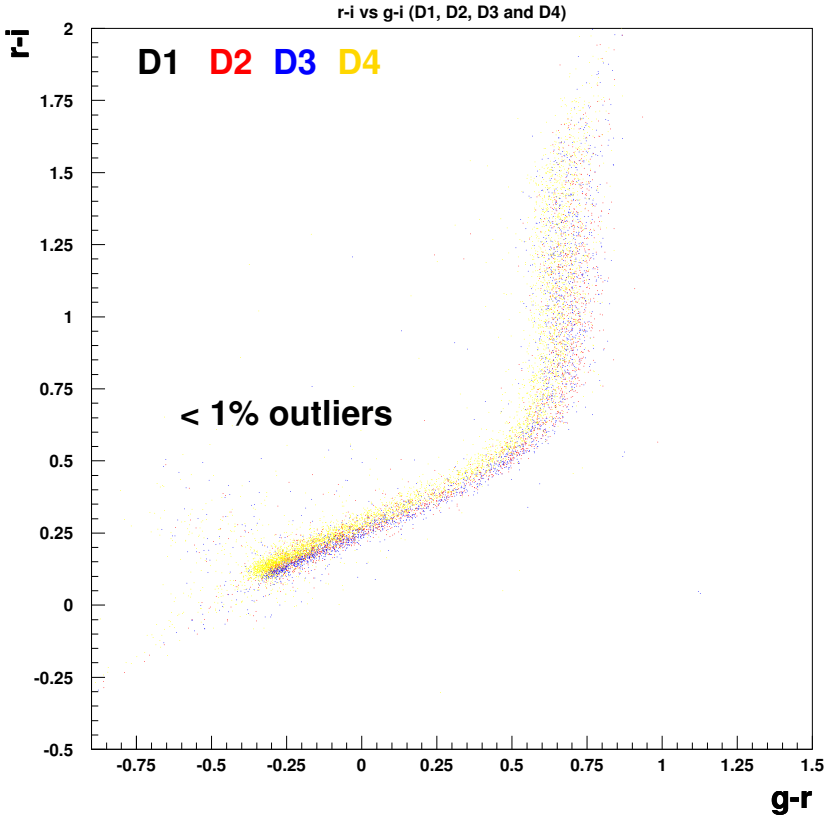


Landolt Calibration Residual CTerms

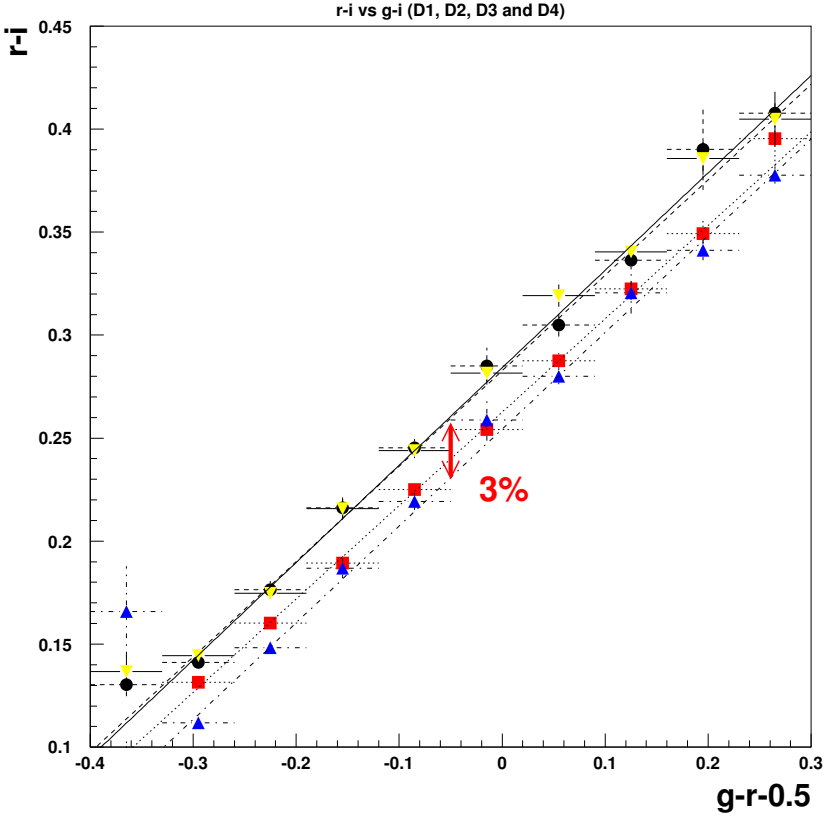
- Megacam Landolt star observations versus the Landolt stars $griz$ predicted magnitudes.
- Residual color terms (<0.05) & non linearities.



Secondary Star Catalogs



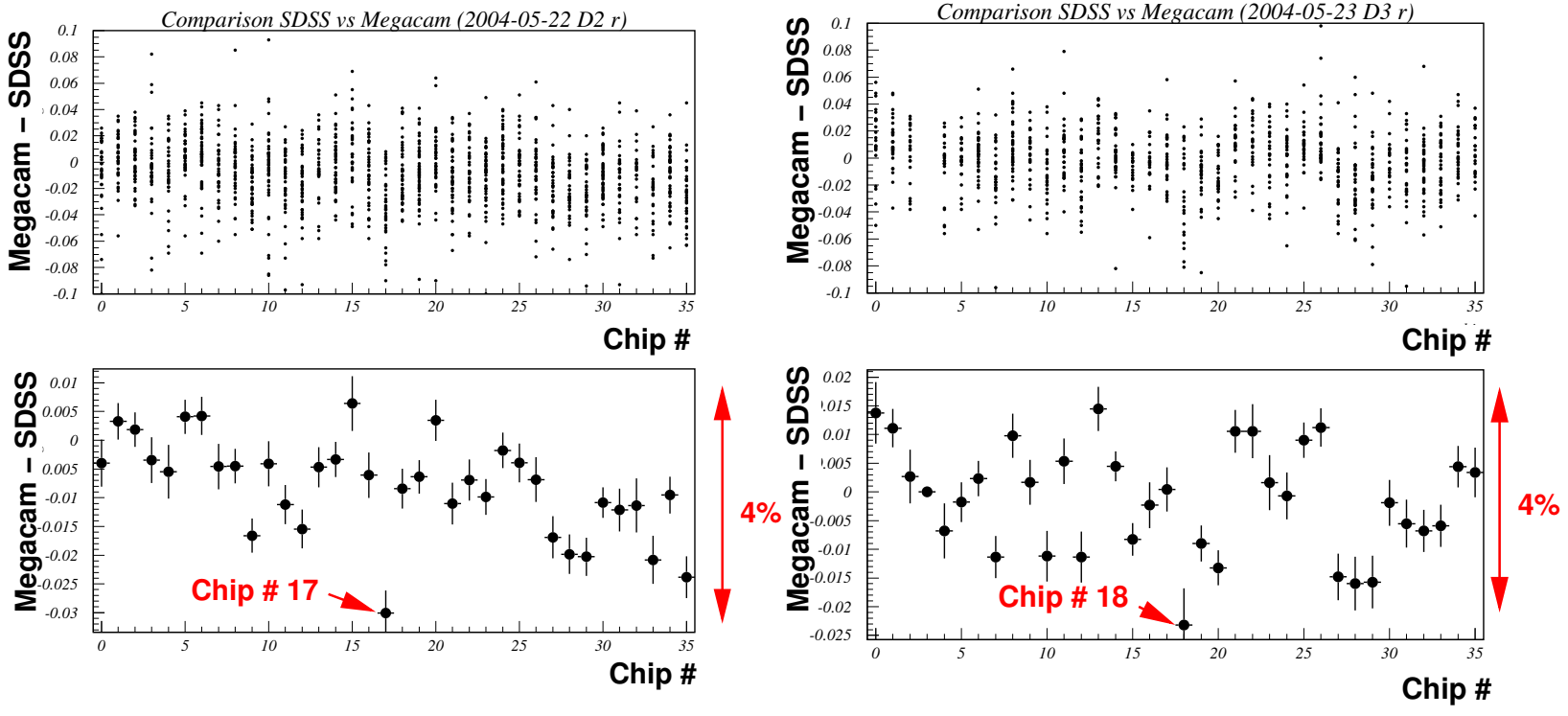
- color-color diagram



- Zoom on the bluer branch

Uniformity of the Camera (I)

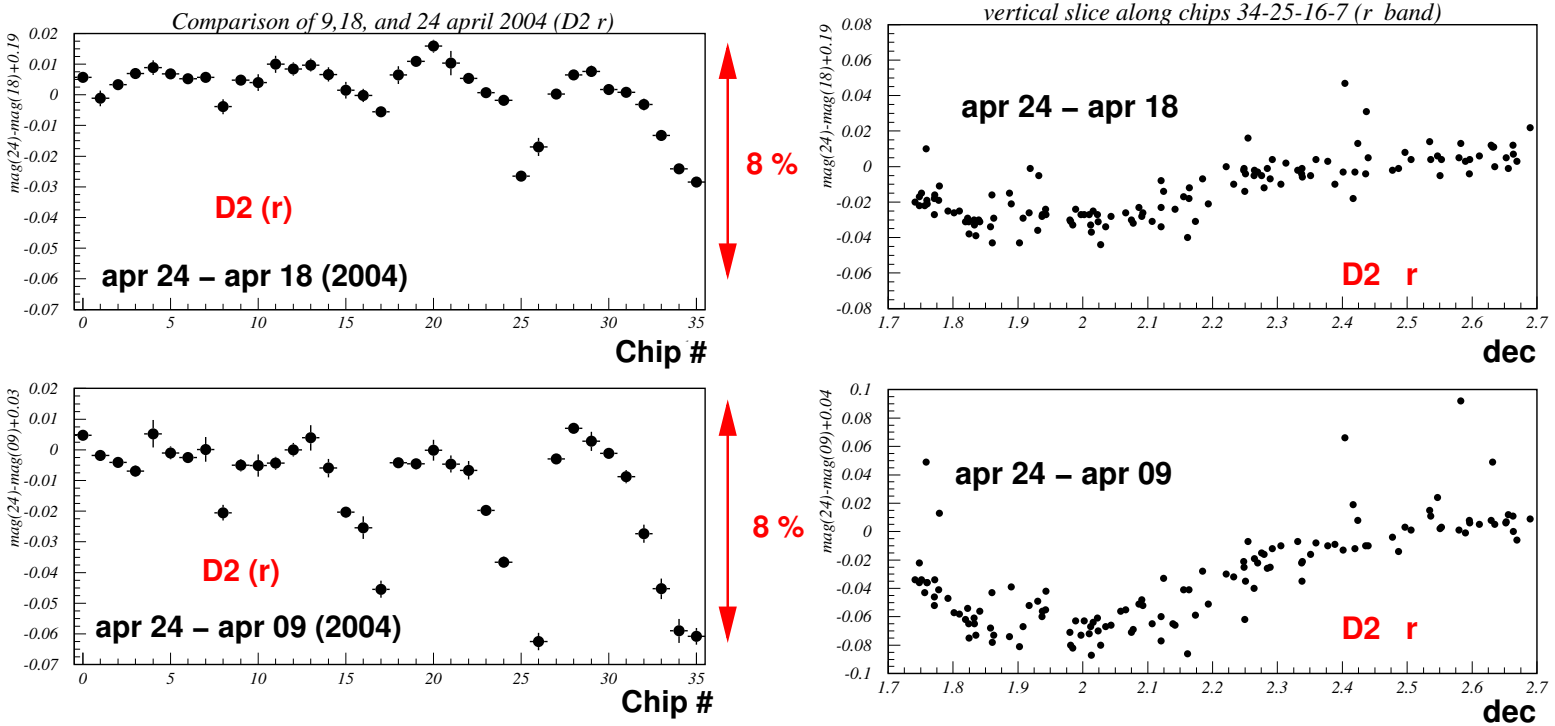
- Two different fields compared with the SDSS.
- Same Epoch Same Band (r) Same FLAT (**04Am05.flat.r.36.01.fits**)
- Different residual patterns across the camera.



- D2 r 2004-05-22
- D3 r 2004-05-23

Uniformity of the Camera (II)

- We compared Megacam observations together (D2 field, r band)
- Pathological nights in April 2004.
- Continuous pattern (not due to the electronics).
- Something (ice ?) on the dewar window (?)



Conclusion

- Secondary star catalogs (g_M, r_M, i_M, z_M)
  - produced for the 4 deep fields.
  - used to calibrate the SNLS lightcurves.
- Good understanding of the Megacam $\rightarrow$ other systems transformations.
- Typical Zero Point rms: $\sim 2\%$
- Camera Uniformity
  - Observed Internal dispersion in the camera of about 1% (rms).
  - Variable δZP between CCDs (do not seem to depend on the flat).
  - This is not a real issue for the SN studies.
- Published Nearby SNeIa fields should be re-observed.