Calculating Zeropoints

Bob Armstrong
NCSA, University of Illinois

Calculating Zeropoints

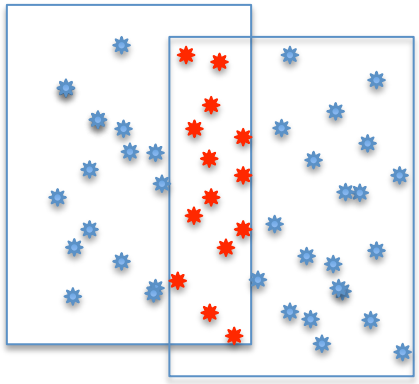
- Each ccd (or image) is cataloged independently to a zeropoint of 25.
  - This allows for magnitude adjustment afterward.
- Photometricity is based on observer logs and weather monitors.
- For those nights blessed as “photometric”, the PSM module is run. The PSM module compares each ccd/band to a standard star catalog and derives the zeropoint and rms.

- We took data last November, under questionable weather, that led us to reexamine the process of how we calculate the zeropoints.
- We also had never really evaluated how good our photometry was on real data, to know if we were doing well. It never looked really good, but we were unsure where the problem was.

Coadd Calczp

- We use three different constraints that are fed into a least squares solver

1. Calculate the mean and rms for all possible ccd combinations that contain matching objects.



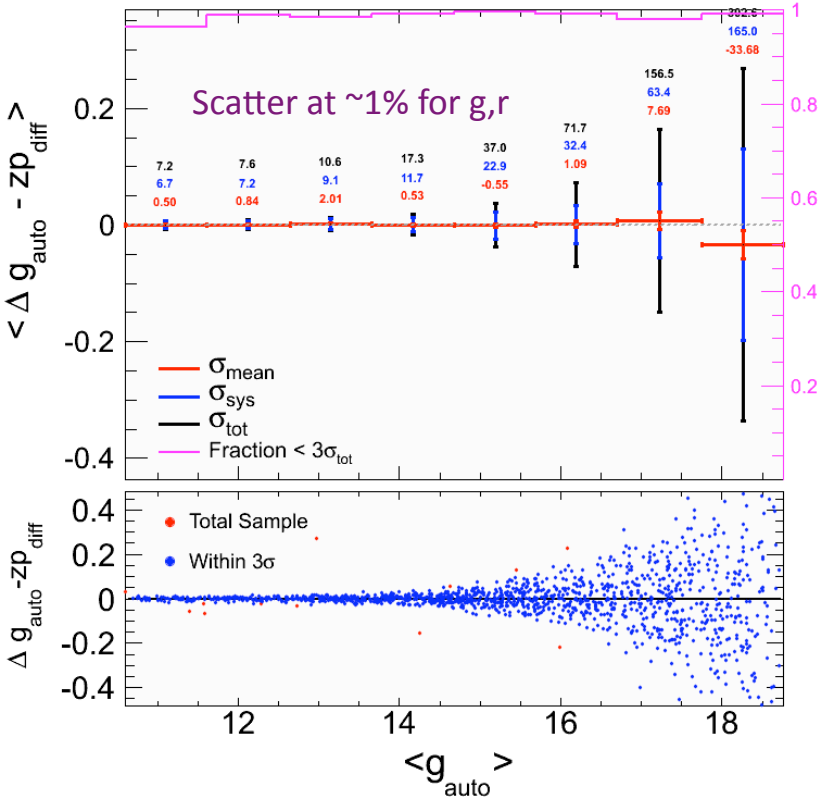
2. Add constraints from the PSM module for images whose nights are “blessed” as photometric.
3. For each photometric night, calculate the mean and rms of the sky brightness for each ccd-to-ccd combination.

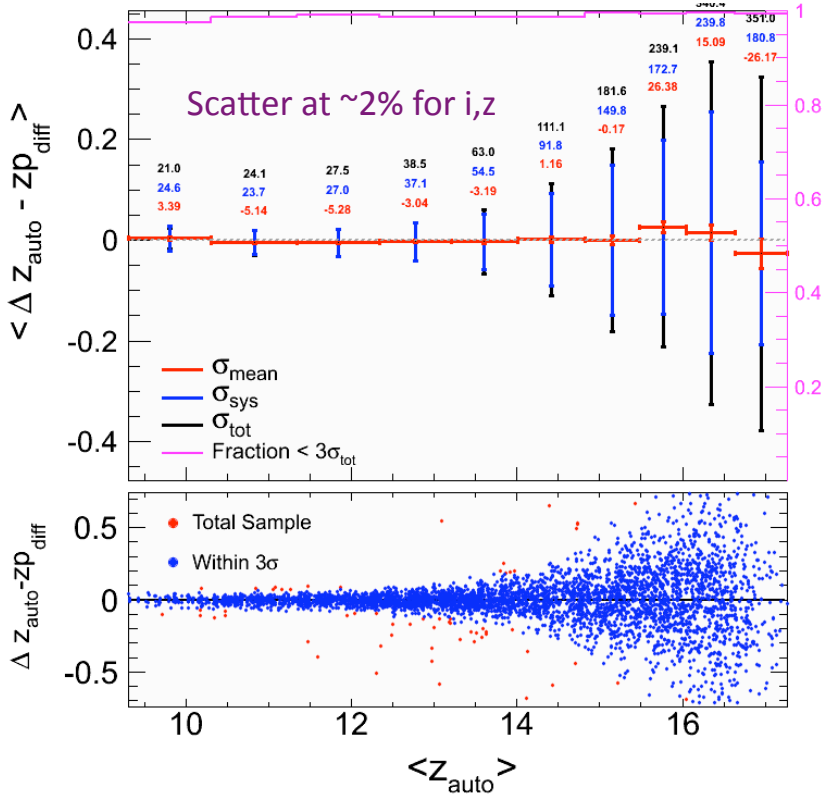
- This process seemed to work great on simulated data, but was always questionable when we used real data.

Where is the problem?

- Was the problem in detrending? Or does it happen after?
- One can compare instrumental magnitudes for pairs of objects
  - Need to remove the effect of different zeropoint differences for different images.

$$mag_{image1} - mag_{image2} - \left\langle mag_{image1} - mag_{image2} \right\rangle_{\substack{\text{all pairs from} \\ \text{image1 and image2}}}$$



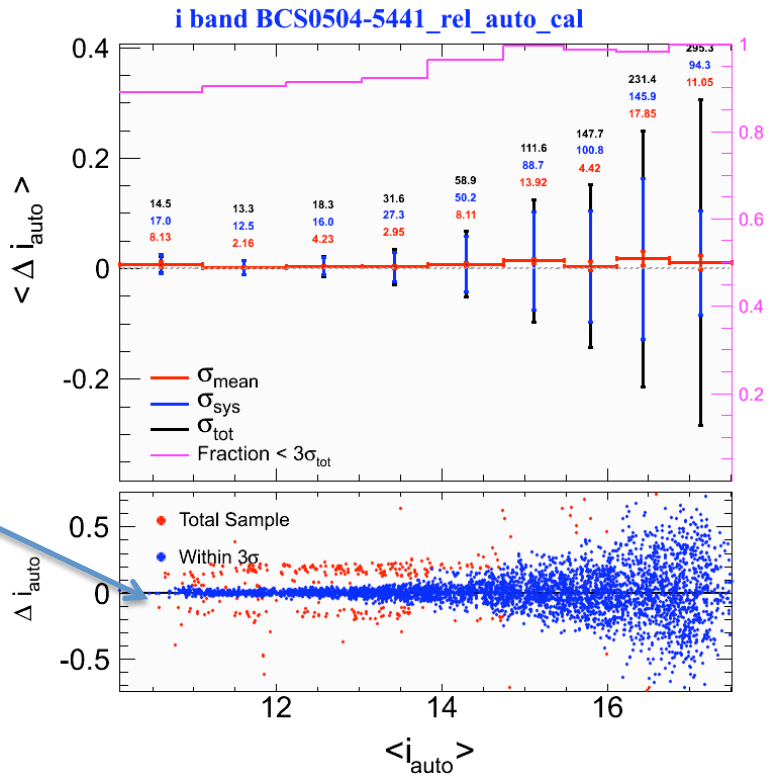


- These tests gave us confidence that our codes up to the zeropoint stage were good.

Relative Calibration

- The single epoch photometry after the zeropoints have been calculated always showed increased scatter and bands of bad data with bad zeropoints.

- Also saw that some photometric nights had been mislabeled. Removal of those nights showed improved photometry for those BCS tiles.

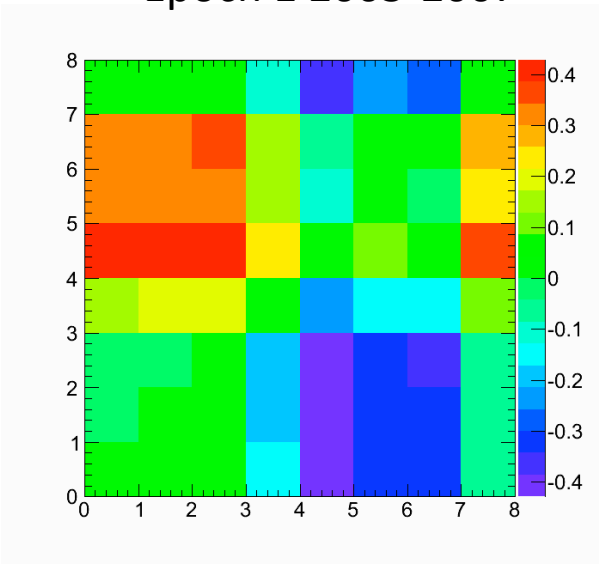


- To avoid potentially non-photometric data causing errors divide the calibration process into two steps.
  - First, do a relative calibration based on overlapping stars
  - Second, use information from the PSM or stellar locus to derive one number.

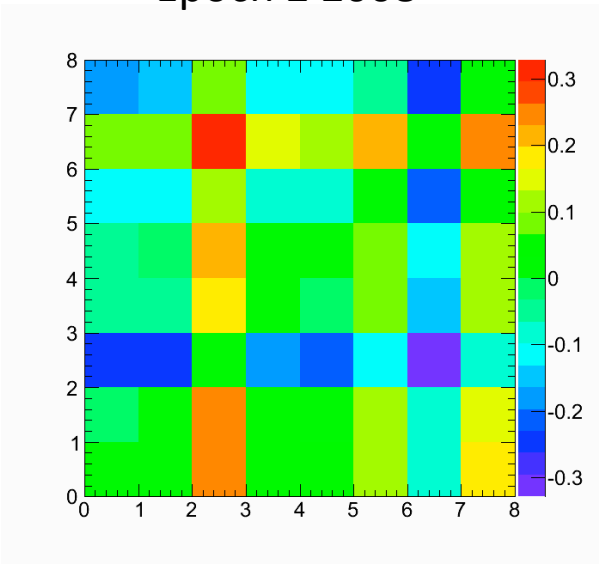
Seasonal Zeropoint Differences

- Instead of using nightly sky brightness, I looked at how consistent the nightly averages were over a longer period of time
  - I found the Mosiac data can be split up into three epochs (at least). There probably significant changes to the camera/electronics between these periods.
- What is the best way to use this information? If image is obscured by clouds adding these into the constraint equation will introduce additional scatter.
- Can be used to catch any images with no overlaps, but otherwise I'm unsure how well we can rely on these values. According to Douglas, there can be deviations of ~10% on non-photometric nights.

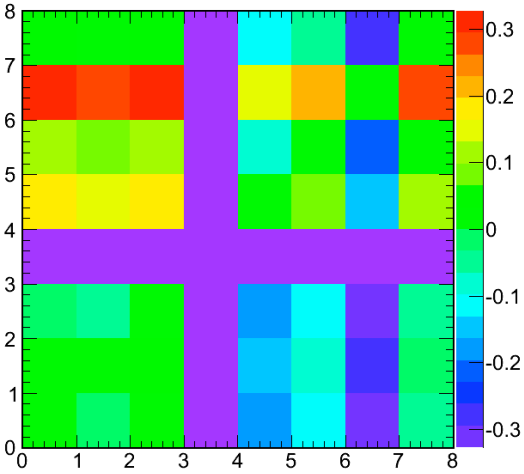
Epoch 1 2005-2007



Epoch 2 2008



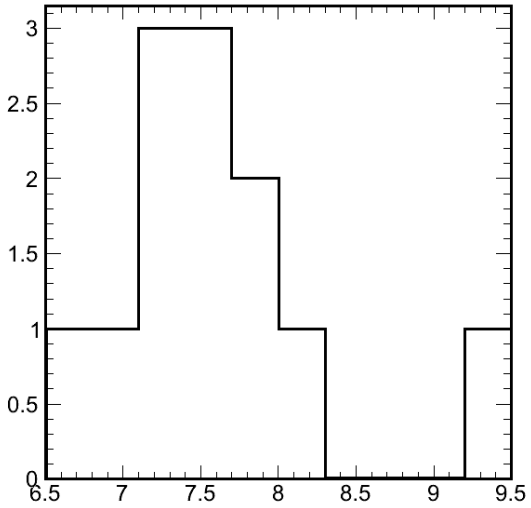
Epoch 3 2009



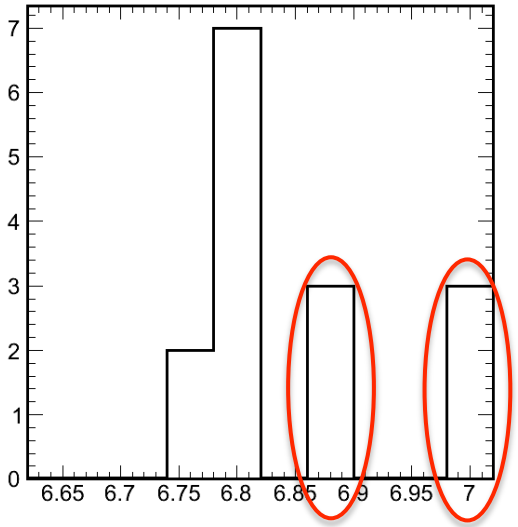
Absolute Calibration - PSM

- Once the relative zeropoints have been calculated, the PSM can then be used for each band to get one overall number to scale the data.

Three examples from BCS tiles

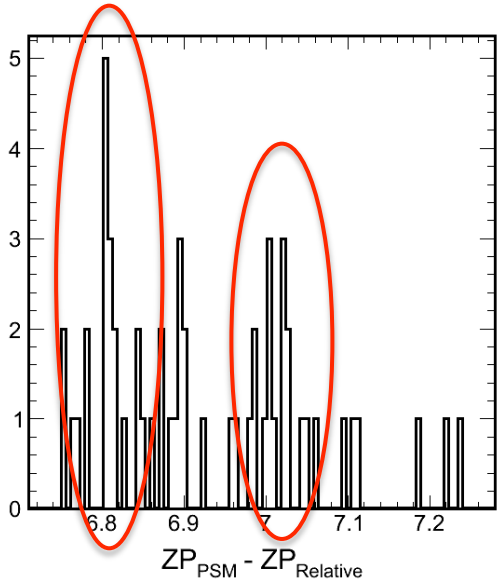


Large scatter in solution



From ccd 1

From ccd 4

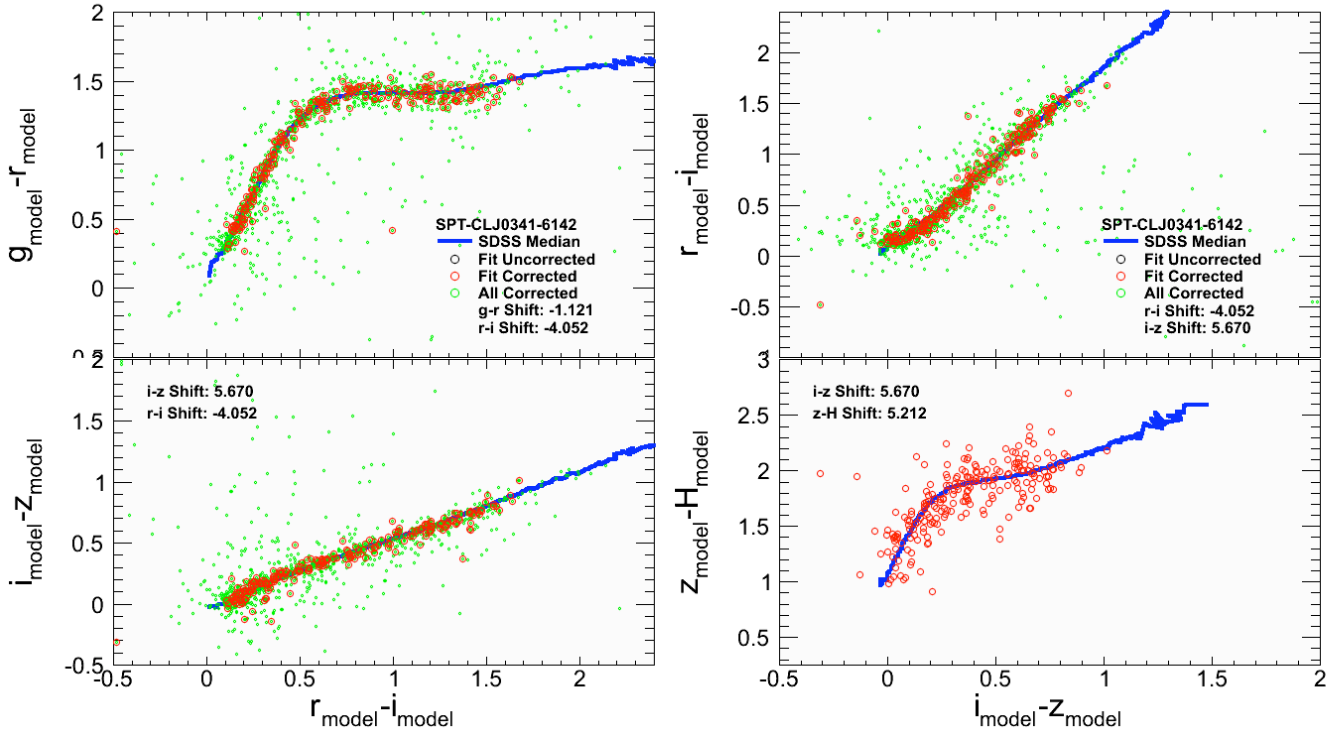


2 distinct exposures

- Can we use other information to know which solution to choose?

Absolute Calibration – Stellar Locus

- The final calibration step can also be done after the coadd is built by using the stellar locus and the SDSS-NOMAD data.

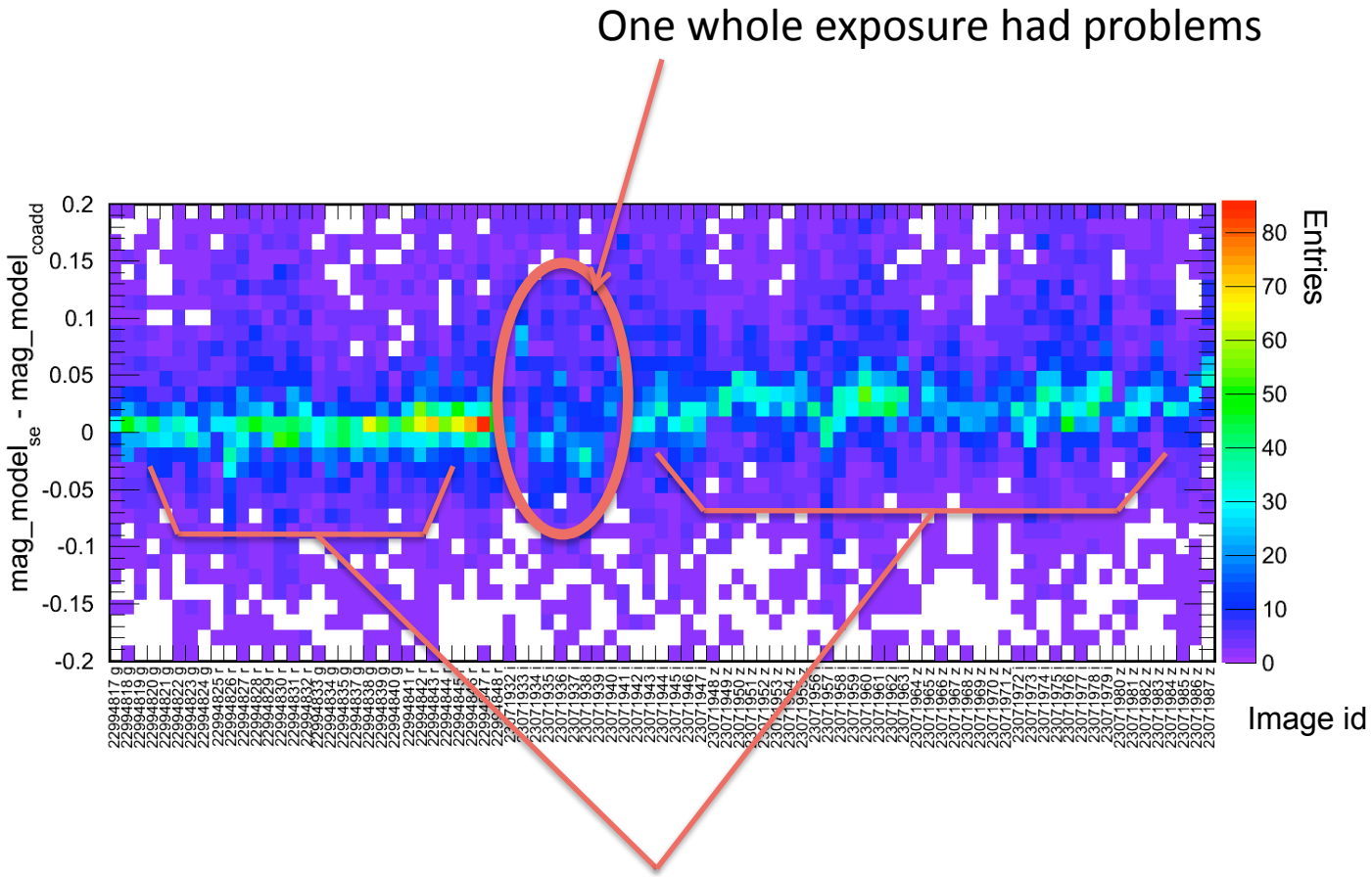


- How should this information be used? Must be done on all bands at once.

Summary

- Found a problem in the calculation of the zeropoints when processing real data.
- Now have some good diagnostics to evaluate the relative photometry of the single epoch data that go into the coadd.
- New method to calculate the zeropoints does not use photometric data until the last step.

Coadd vs. Single Epoch



Small shift between certain exposures.