LSST Calibration Overview

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LSST Calibration Workshop
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Scope of LSST's Calibration Effort

We're ultimately interested in:

- Photometry
  - Consistent broad-band fluxes of identical stars over the entire focal plane
    - "identical stars" implies identical Galactic extinction
  - Consistent broad-band fluxes of identical stars over the entire sky/duration of survey
  - Precise knowledge of the relative system sensitivity as a function of λ
  - Good knowledge of the absolute system sensitivity
- Astrometry
  - Tied rigidly to the Gaia system

The SRD's Key Performance Metrics

Jira	ID	Description	Design value
DLP-316	PA1uzy	Photometric repeatability (u, z, y)	10 mmag
DLP-315	PA1gri	Photometric repeatability (g, r, i)	5 mmag
DLP-322	PA6	Absolute Photometry Accuracy	10 mmag
DLP-321	PA5u	Color Zero-point Accuracy (involving u)	10 mmag
DLP-320	PA5	Color Zero-point Accuracy (excluding u)	5 mmag
DLP-317	PA3u	Photometric Spatial Uniformity (u)	20 mmag
DLP-318	PA3grizy	Photometric Spatial Uniformity (grizy)	10 mmag
DLP-310	AM1	Relative Astrometry (5 amin scale)	10 mas
DLP-311	AM2	Relative Astrometry (20 amin scale)	10 mas
DLP-312	AM3	Relative Astrometry (200 amin scale)	15 mas
DLP-313	AB1	Astrometry Relative to r	10 mas
DLP-309	AA1	Absolute Astrometry (per coordinate)	50 mas

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  - Absorption/Scattering
    - O_3
    - Aerosols
    - O_2/N_2
    - OH
  - Correlated motions on scales of arcminutes

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- The Camera
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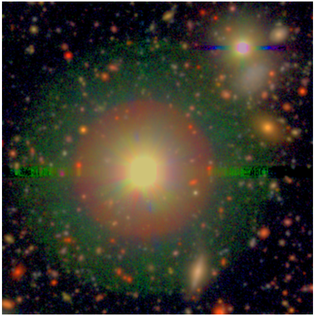

Note the chromatic ghosties and ghoulies. Ignore bleed trails.

The Scope of Calibration

- The Detectors
  - Bias and Dark structure
  - Flat fielding (as a function of λ)
  - Fringing (predominantly in y)
  - Static electric fields (tree-rings, bleed-stops, edges)
  - Brighter-fatter
  - Variable pixel size
  - Bad pixels (blocked or hot)
  - CT[EI] (parallel and serial)
  - RC times associated with the output FET
  - Other Bad Things

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- Use the discrepancies between the known and observed SED and other pertinent data (*e.g.* satellite ozone measurements) to characterise an atmospheric model.
    - model the atmosphere's spatial structure if necessary

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- Save enough information to the database to allow interested parties to redo this calculation with a user-provided SED

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- Standard calibrations
  - biases/darks
  - broadband and "monochromatic" (*c.* 1nm) flatfield images
- Calibrations derived from the sky
  - "PCA" fringe frames
  - dithered star fields
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- atmospheric data
  - $R \sim 80$ spectra with the Auxiliary Telescope ("AuxTel") spectrograph
  - water vapour monitoring (?)
  - 4-band all-sky images

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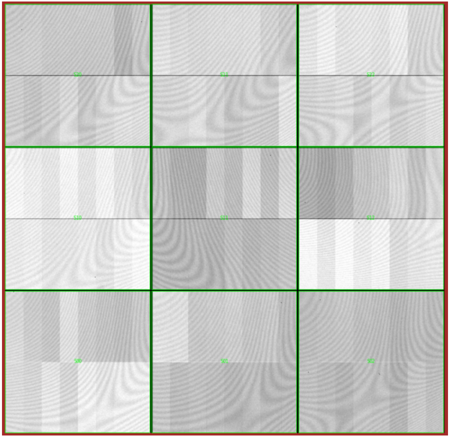

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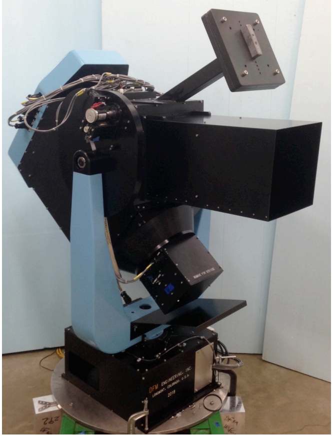

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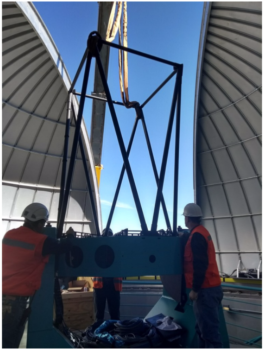

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- Ported DES’s "FGCM" calibration to LSST (testing with HSC)

Open Questions

We need to worry about:

- System Sensitivity
- Other detector effects
- The Atmosphere
- The AuxTel

System Sensitivity

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- Will the current scheme (CBP scans with/without filters + monochromatic dome flats) for flats work?
  - Will we be able to tie the spots together to model the ghost-free flats?
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- How will we get absolute fluxes? (calSpec? CalSpec *via* Gaia? Daughter-of-Stardice?)

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- Can we measure the colour of the sky well enough to use the proper flat fields?

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- How exactly will we measure the atmospheric transmission of calypso stars?
  - will the spectral extractions work?
  - what other inputs will we use (e.g. pressure, temperature, ozone), where will they come from, and how do they interact with the spectra?
  - which atmospheric model will we use? (MODTRANS? libRadTrans?)
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What happens when the AuxTel goes down?

- Are 8.4m operations affected (*e.g.* no *u* or *y*)?

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these questions apply across the (artificial) boundaries, and we need to concentrate on

- how will we handle and understand real data from an imperfect system

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LSST Needs You

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LSST Needs You

but I can say

LSST Can Use Your Work

(if you happen to guess what's needed to get our science out).