CR workshop(s) de calibration LSST/DESC

N. Regnault, S. Bongard

Contexte

- Situation calibration -> printemps 2018
  - **DESC**
    - importance calibration pas tres claire
    - Calib est essentiellement l'affaire du projet
    - Focus sur DC2 (comment PCWG peut aider sur DC2 ?)
  - **Project**
    - Requirements de calib peu agressifs (~1%)
    - Pas / peu de collaboration avec DESC / PCWG
- Challenges
  - Convaincre DESC importance calib a ~ 0.1%
  - Faire accepter l'idee de requirements de calibration DESC
  - Trouver modalités de collaboration avec le Projet

Contexte (II)

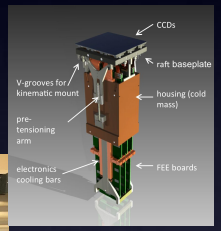
- Situation a évolué (positivement) courant 2018
  - **Requirements de calibration specifiques DESC**
    - Travail de F. Hazenberg (propagation calib ds analyse SN)
    - Travail Science Requirement Document (importance SNe -> stage 4 project)
  - **Workshops LSST / DESC**
    - 23-25 mai 2018
    - 2-5 octobre 2018
    - SLAC (?), Princeton (?)
    - Début d'une collaboration directe avec le projet, sur instru + analyse données (effort AuxTel).

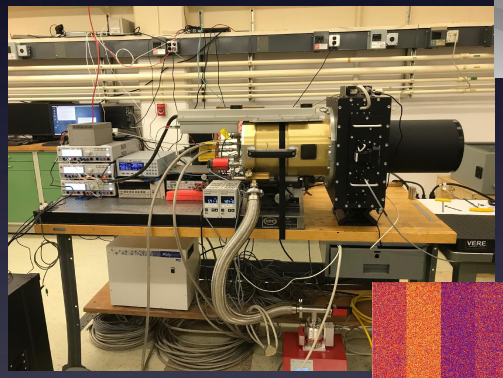
AuxTel commissioning: putting everything together

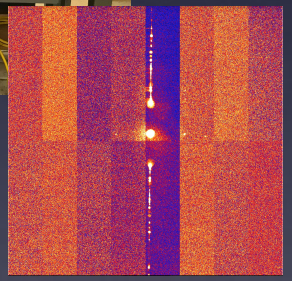
The People

The Analysis

The Hardware



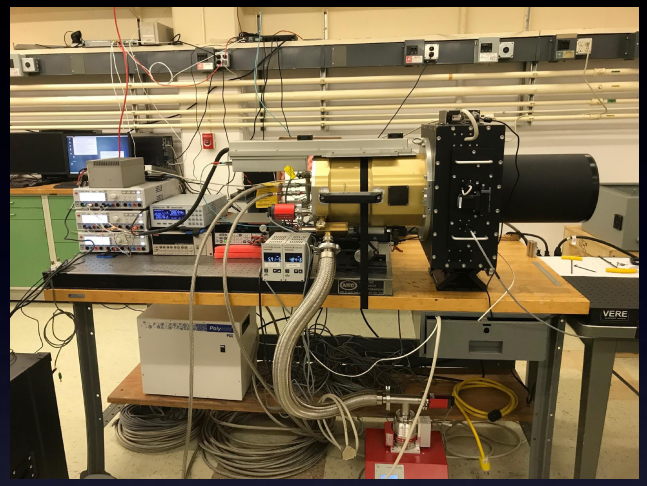


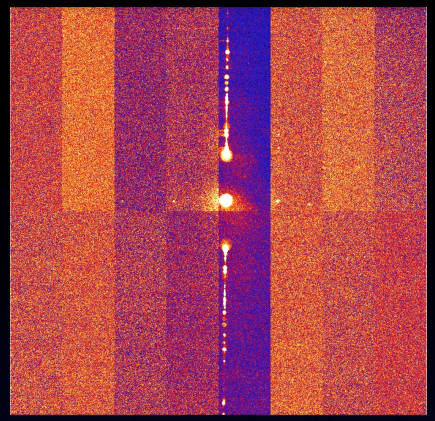


The Software

Bringing everything together for the FIRST TIME

AuxTel detector in Tucson:





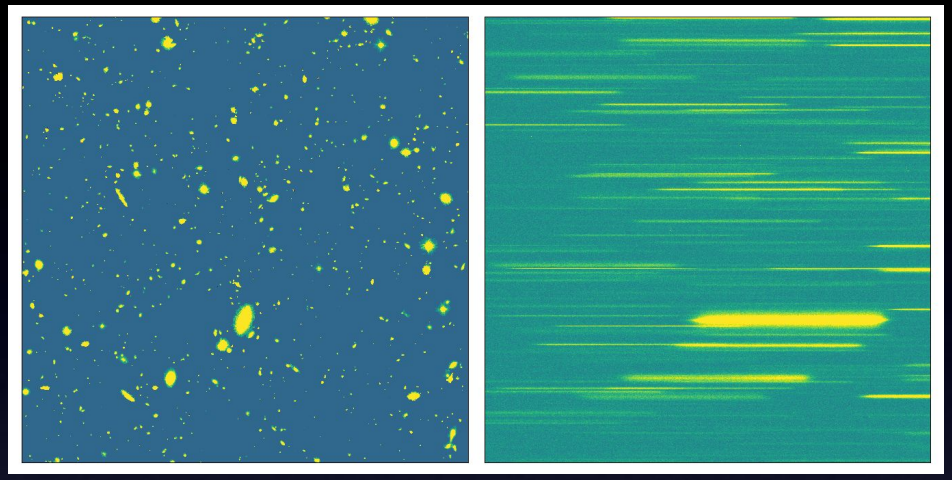
There is data being taken

Detector caracterization PCWG/SWAG

Interface between systems: STACK use “live”

Data sharing “live” : interface with NCSA

Spectrograph characterization



Jeremy Neveu leading/coordinating the DESC effort

Spectrograph qualification data definition

Forward model slitless spectra extraction with DM

Hologram caracterization

On site caracterization:

Spectrograph fully caracterized
at the lab this spring

On Site commissioning Summer 2019

On site caracterization operations:
Real life Ops for the first time !

- Perfect place for DESC expertise

There is potentially DESC funding for this

S.Bongard and C. Stubbs coordinating the effort
PCWG telecon is the place
where things happen

LSST / DESC Calibration Workshop

2-5 octobre 2018
LPNHE
Fuseau horaire Europe/Paris

- Vue d'ensemble
- Ordre du jour
- Liste des contributions
- Ma conférence
  - Mes contributions
- Inscription
- Liste des participants

The second LSST/DESC calibration workshop will be organized at LPNHE-(Paris) from Tuesday October 2nd - to Friday October 5th 2018.

The main goal of this workshop is to review together the status of the efforts that were initiated during the May workshop (AuxTel, cadence/ubercal, GAIA), and to work collaboratively on those projects. Special attention will be given to the ongoing AuxTel effort.

A schedule will be available shortly. We will make sure that time and space will be available for small hacks. If there are specific topics you would like to see discussed, please contact the organizers (Seb and Nicolas)

The workshop will take place at LPNHE on the Jussieu campus (Paris, 5th arrondissement). The main entrance of the campus is 4 place Jussieu (Jussieu Metro station). You can get there by Metro (line 7 or line 10) or by Bus (lines 67, 89). Here are instructions on how to get to LPNHE, when you arrive.

Meeting live notes.

Sessions broadcasted on the PCWG zoom channel.

27 attendees

- 7.49 Project
- 15.51 DESC
- 4 external

Commence le 2 oct. 2018 à 08:00
Se termine le 5 oct. 2018 à 17:30
Europe/Paris

LPNHE
Salle des seminaires
4 place Jussieu
75005 Paris

Aucun document.

Inscription
Vous êtes inscrit(e) à cet événement
27
Voir les détails

LOC: Bongard, Regnault, Antilogus

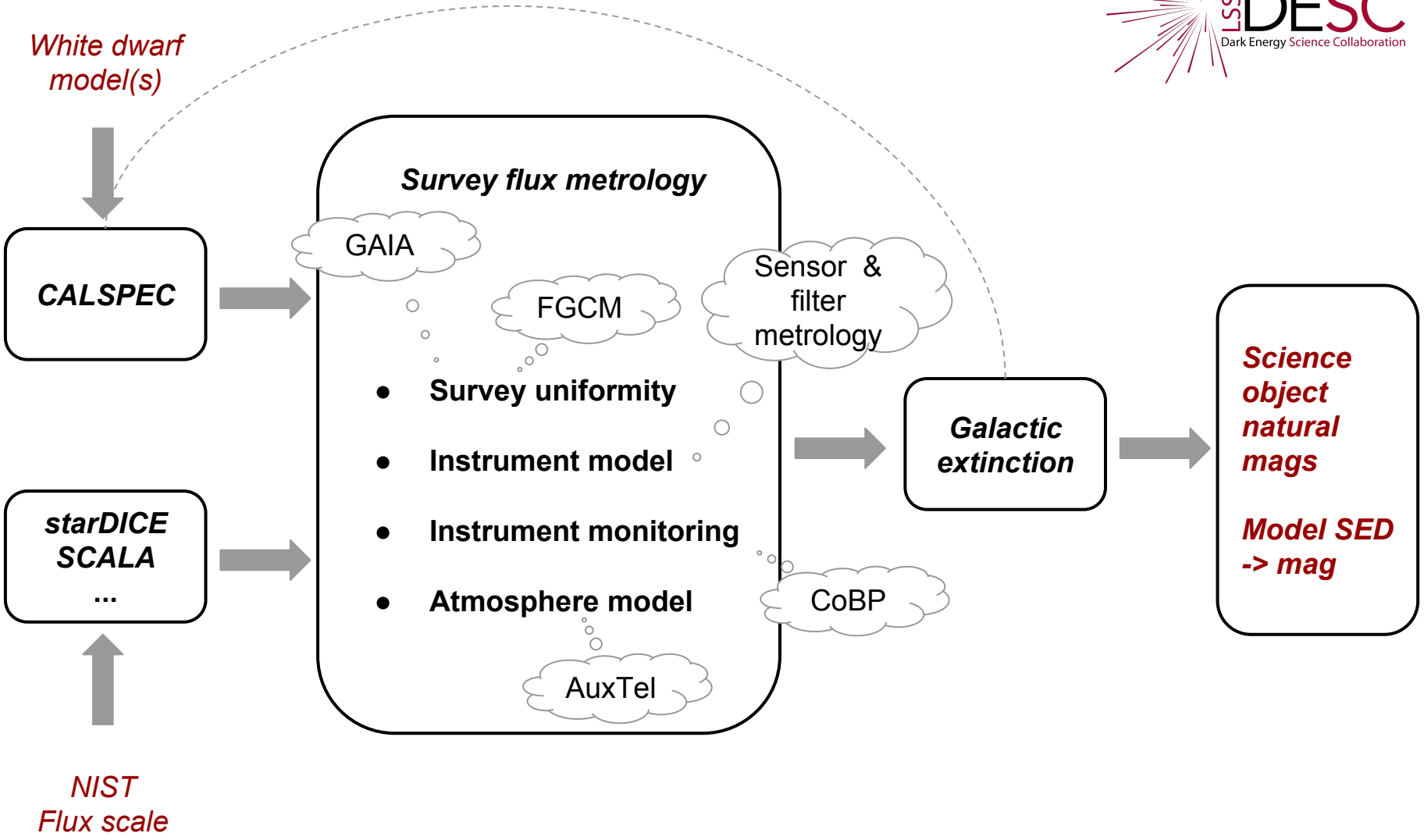
https://indico.in2p3.fr/event/17773/

Aide | Contact | Conditions générales

Workshop d'Octobre

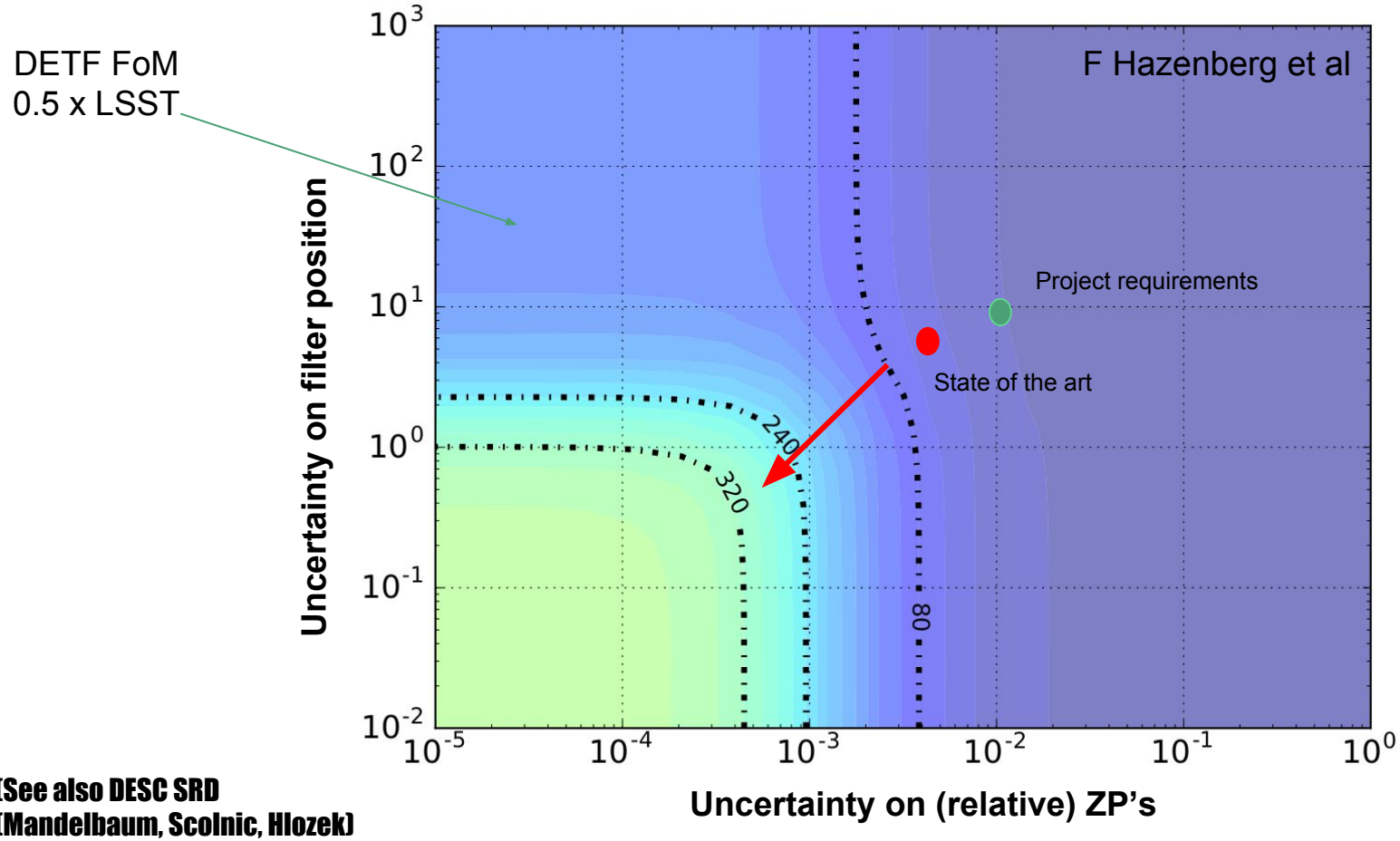
- Revue projets en cours
  - StarDICE (Betoule, Hazenberg)
  - Comparaison MODTRAN / libRadTran (Gilmore, Dagoret-Campagne)
  - Atmosphere data challenge (Dagoret-Campagne)
  - Uniformity (GAIA, cadence) (Rykoff, Feinstein, Regnault)
  - Aerosol monitoring (Mondrik)
  - PSF models (Leget)
- Focus sur l'effort AuxTel
  - Status AuxTel (Gilmore, Ingraham,)
  - Sensor studies (Gilmore, Astier, Antilogus, Juramy, Le Guillou)
  - Holographic disperser (Moniez, Dagoret-Campagne, Neveu…)
  - Spectrograph characterization (Ingraham,)
  - Collimated beam Projector (Mondrik,)
  - Priors from ancillary data (MERRA2,...) (Guyonnet)
  - Slitless spectrum extraction (Copin, Lupton, Neveu)
  - Data sharing, code interfaces (Lupton, Boutigny, Ingraham…)
  - Discussion sessions (Bongard)

Flux metrology chain



How much does this matter ?

- SRD & PCWG work have made clear that DESC has strong calibration requirements, beyond Project requirements



(See also DESC SRD (Mandelbaum, Scolnic, Hlozek)

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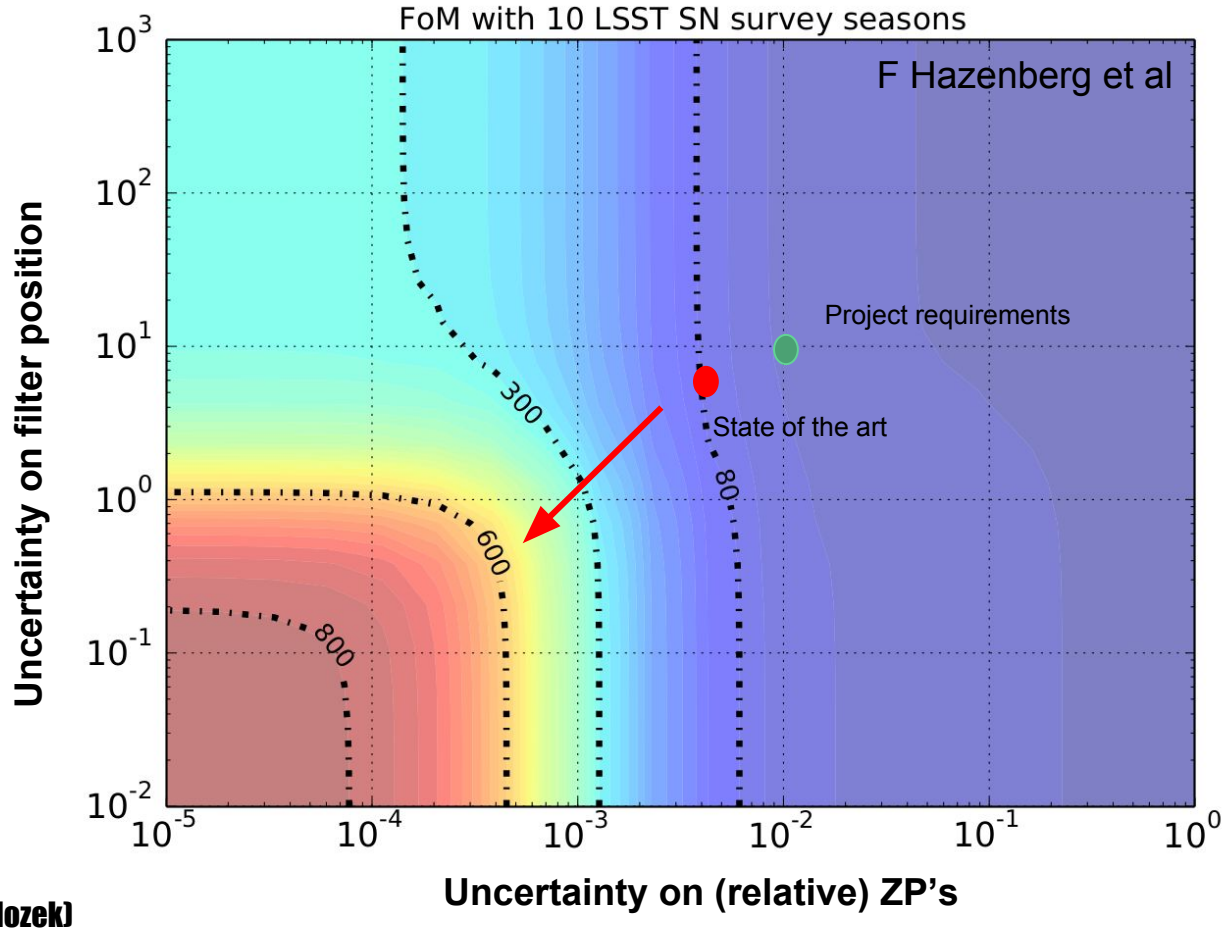


(See also DESC SRD (Mandelbaum, Scolnic, Hlozek)

Motivation

- DESC-specific calibration requirements driven by *SN cosmology*
- Ingredients for SNe distance estimates are *griz*-observations
- As of today,
  - no DESC-specific requirements for u and y bands
  - No other probe has issued DESC specific calibration requirements
  - It is possible / likely that additional DESC-specific calibration requirements will emerge
  - The sooner the better !

starDICE

- Goal : compare NIST and CALSPEC flux scales
  - from photometric measurements only
  - with a NIST-calibrated, stable, LED source
  - Small aperture / small focal distance telescope

See talks by Francois & Sylvie (this session)

starDICE talks
F. Hazenberg
M. Betoule

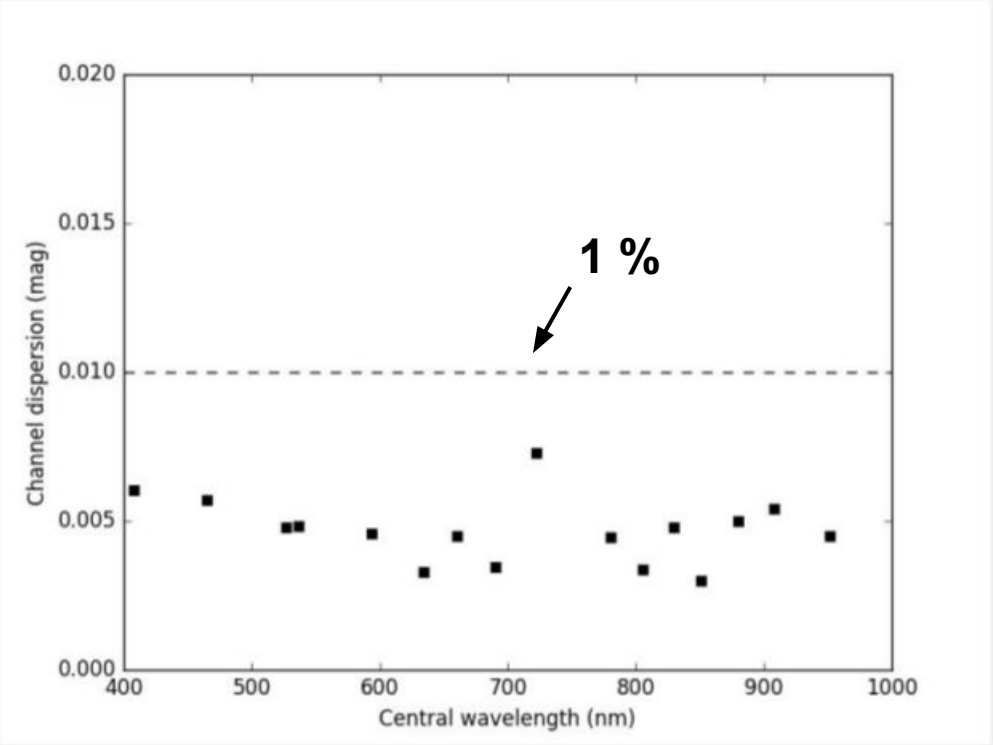
Results

Dispersion of the residuals of the fit in each channel in 3 months.

All channels below the % level.

Errors includes:

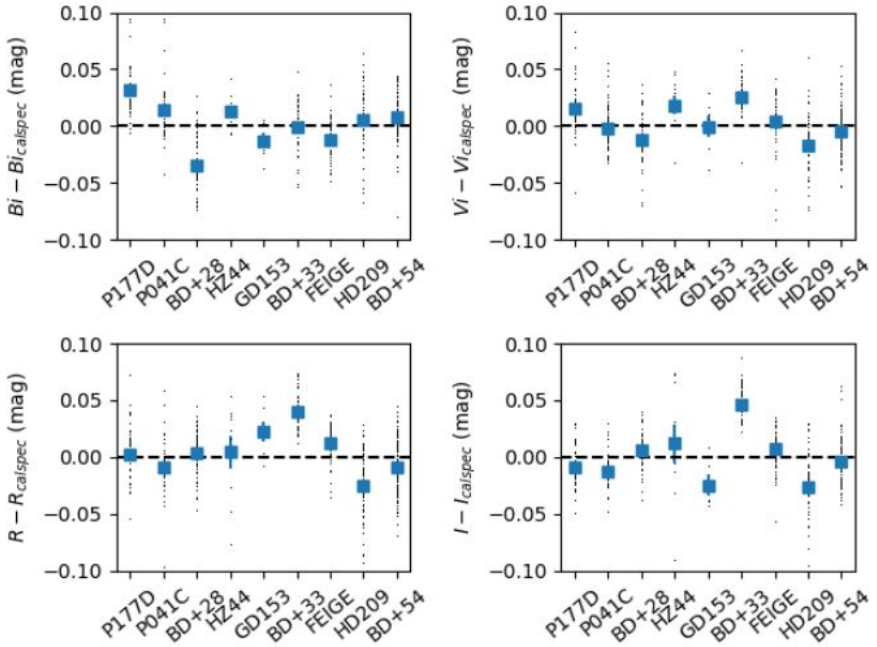
- LEDs variability
- Setup variability in a night



F. Hazenberg

Toward a first CALSPEC/NIST comparison

- 9 CALSPECS/7 nights
- Dispersion of individual measurements ~3 %
- Dispersion of stars < 2 % in all channels
- Should be able to go below 1 % averaging all data
- Detailed analysis ongoing



Future work

- Clear path towards NIST / CALSPEC comparison paper
  - At the level of ~ 1%
- Main topics are
  - (re-)characterization of the source on bench (ongoing)
  - Atmospheric transmission model
    - LED source -> telescope
    - stars -> telescope
- Planned upgrades for 2nd phase
  - Fainter light source with enhanced LED temperature monitoring
  - New telescope, with better detector + faster mount

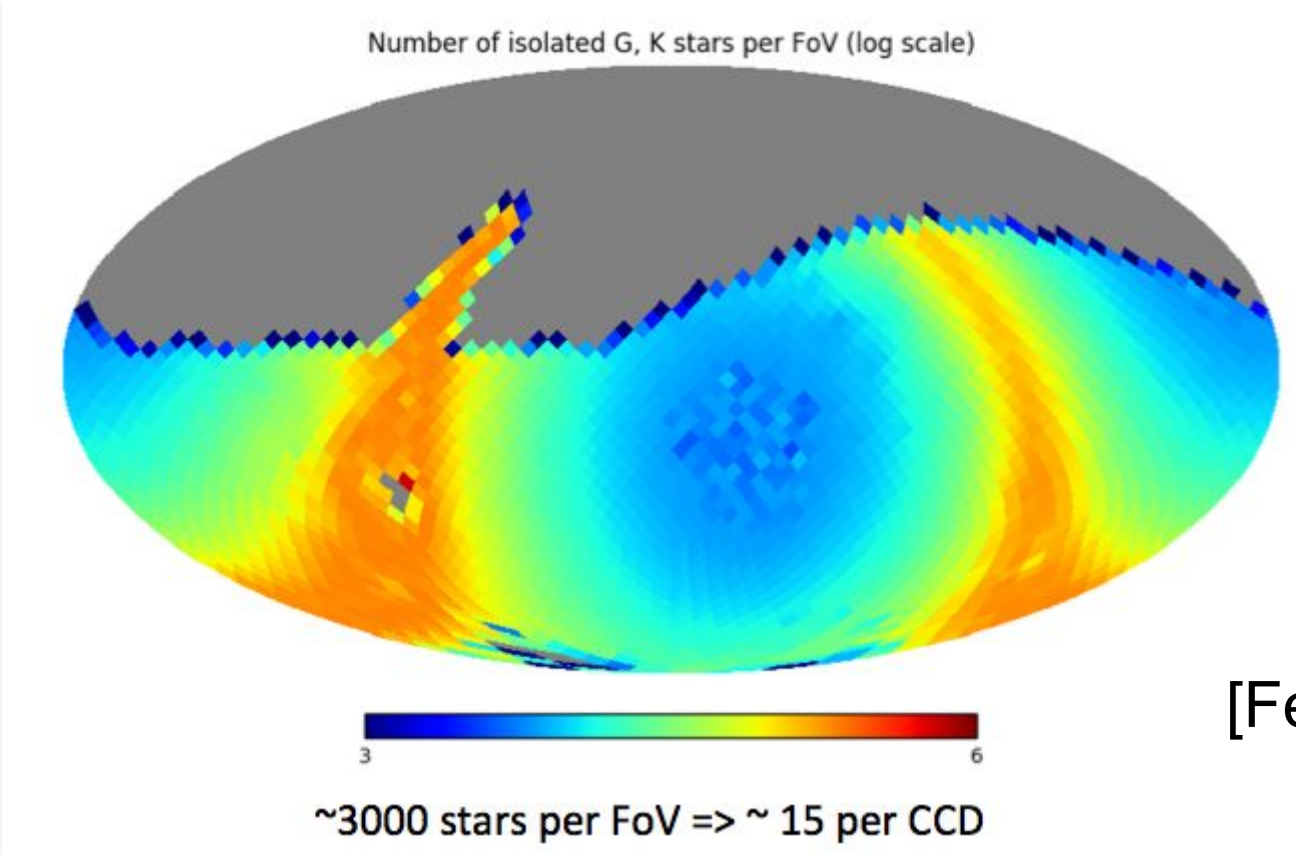
(summarized from M. Betoule slides)

Uniformity: Why Do We Care?

- To first order, variations in calibration over the footprint should average down with a large SN survey
  - Can create problems at specific scales
  - Can introduce systematic anisotropies
- Primarily a problem in transferring absolute calibration (as above)
- In the limit of one primary flux calibrator, transfer of that to survey requires precise knowledge of the throughput at that position

Uniformity: Gaia as a Reference

Gaia will have spectrophotometry for many well-measured stars



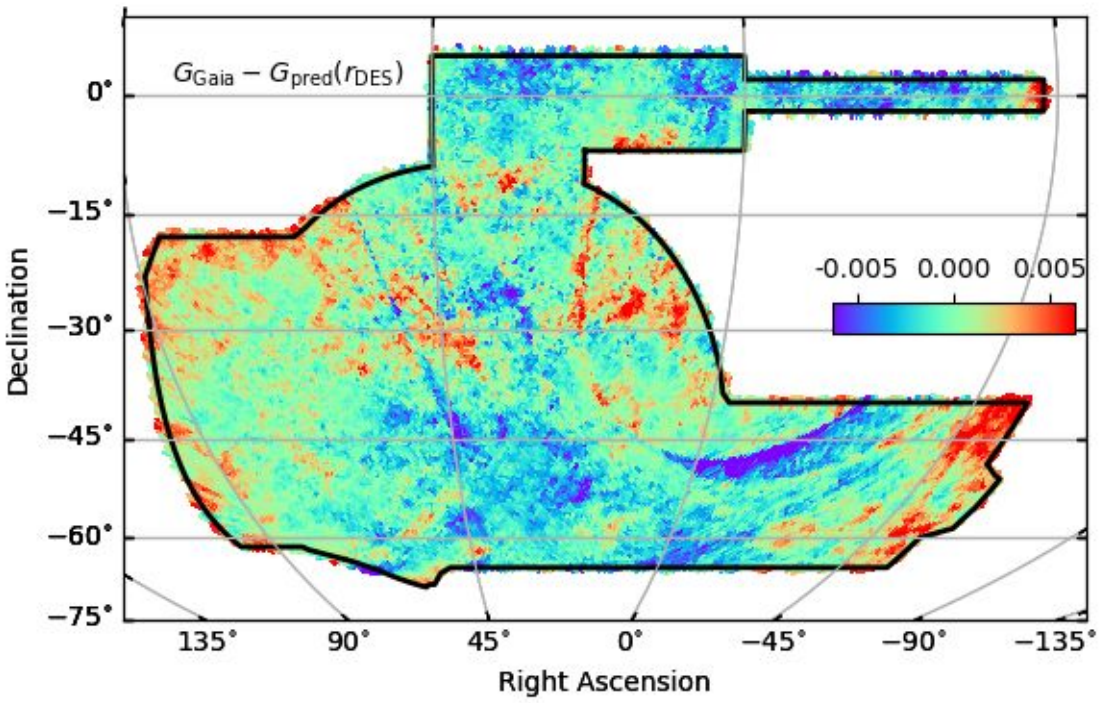
[Feinstein]

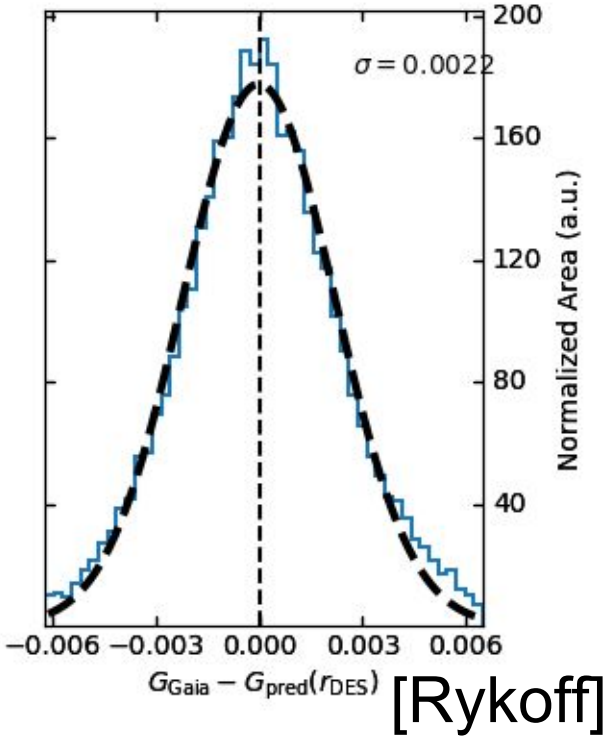
Uniformity: Self-Calibration

- Forward Global Calibration Method (FGCM) [Rykoff]
  - Solve the global calibration problem with a physical model of the atmosphere + instrument
  - Picking up on Stubbs and Tonry (2006)
  - See Burke, Rykoff ++ (2018) for application to DES
- Given a set of atmospheric parameters at any given time (under photometric conditions) we can predict the atmospheric extinction as a function of wavelength
- Always leads to physical solutions, includes chromatic corrections

Uniformity: DES and Gaia DR2

- Test uniformity of DES r-band with Gaia DR2 G-band
- 2.2 mmag uniformity at low Galactic latitude
  - MW Galaxy contamination because Gaia G-band is very broad, making comparison strongly dependent on SED

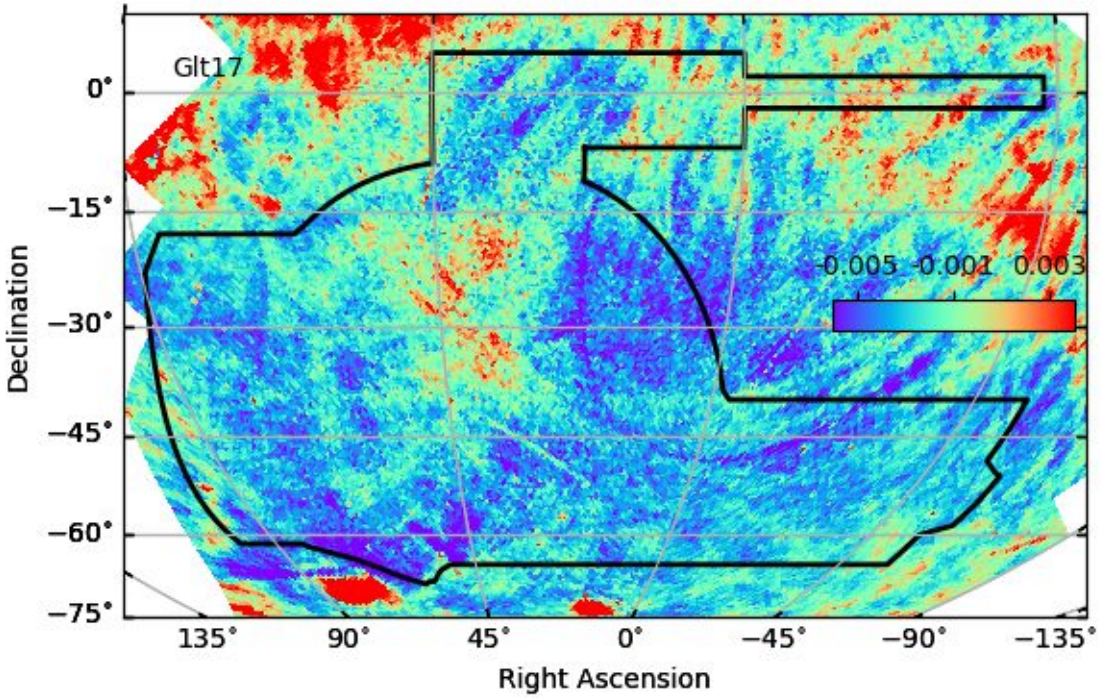


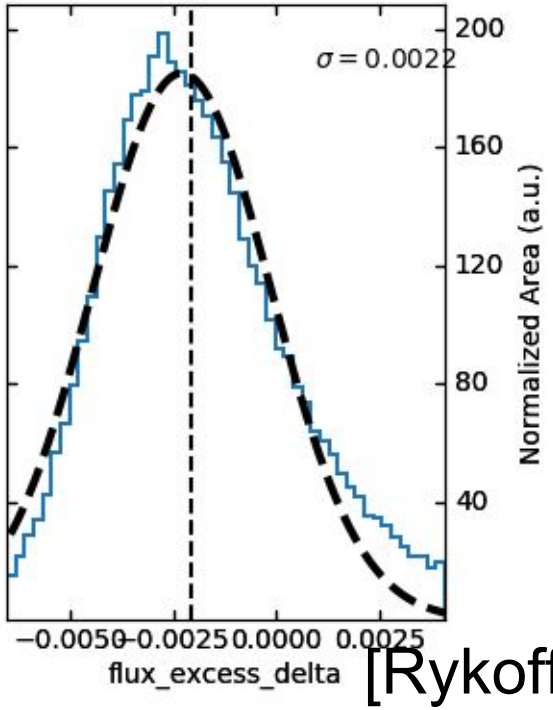


[Rykoff]

Uniformity: Gaia as a Reference

- Testing internal Gaia uniformity (Blue channel "BP"; red channel "RP"; broad "G" band)
- Map Gaia "flux excess" == (f_BP + f_RP) / f_G
- To be able to use Gaia for mmag precision will require more work
- Additional challenge of using spectrophotometry

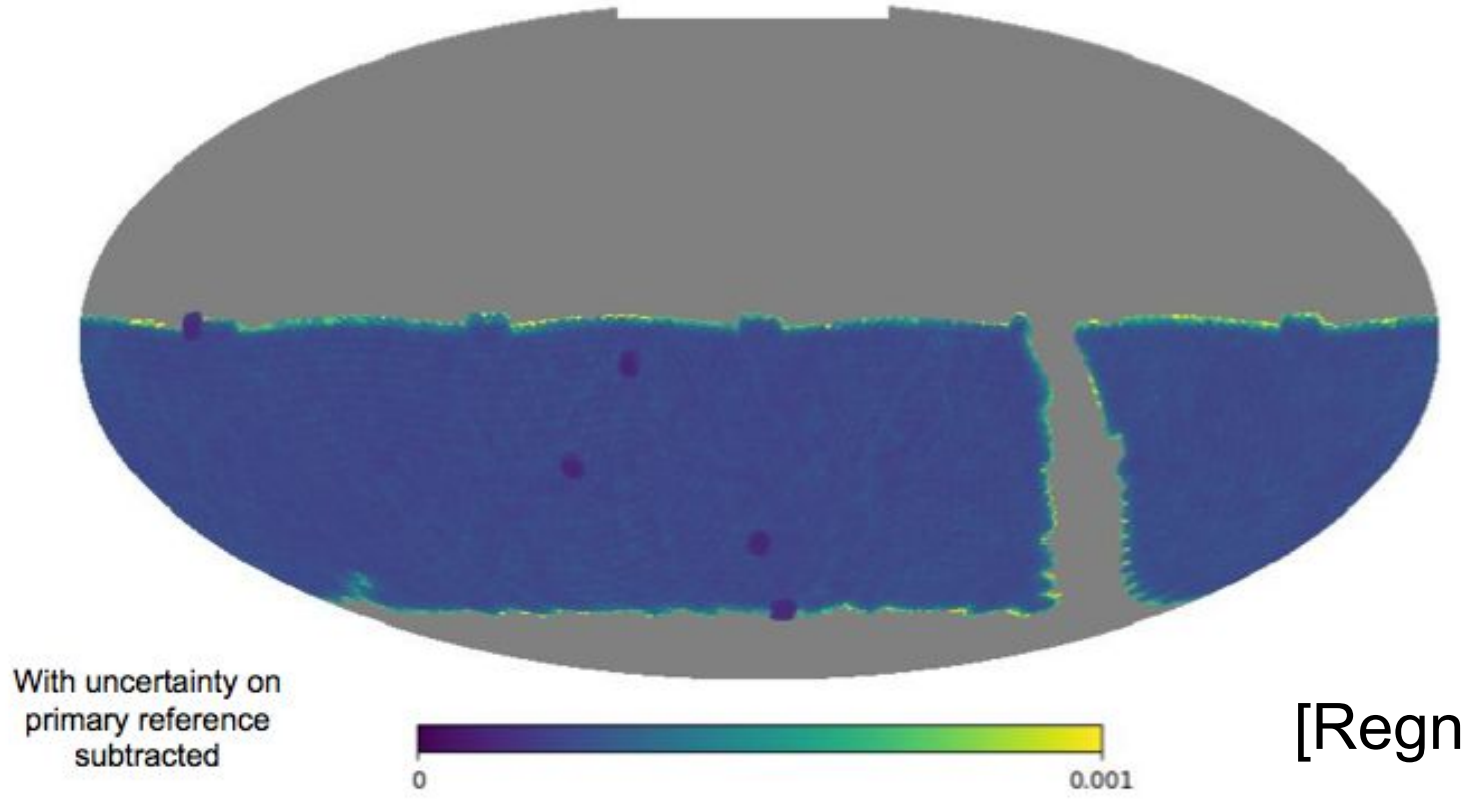




[Rykoff]

Uniformity: Impact of Cadence

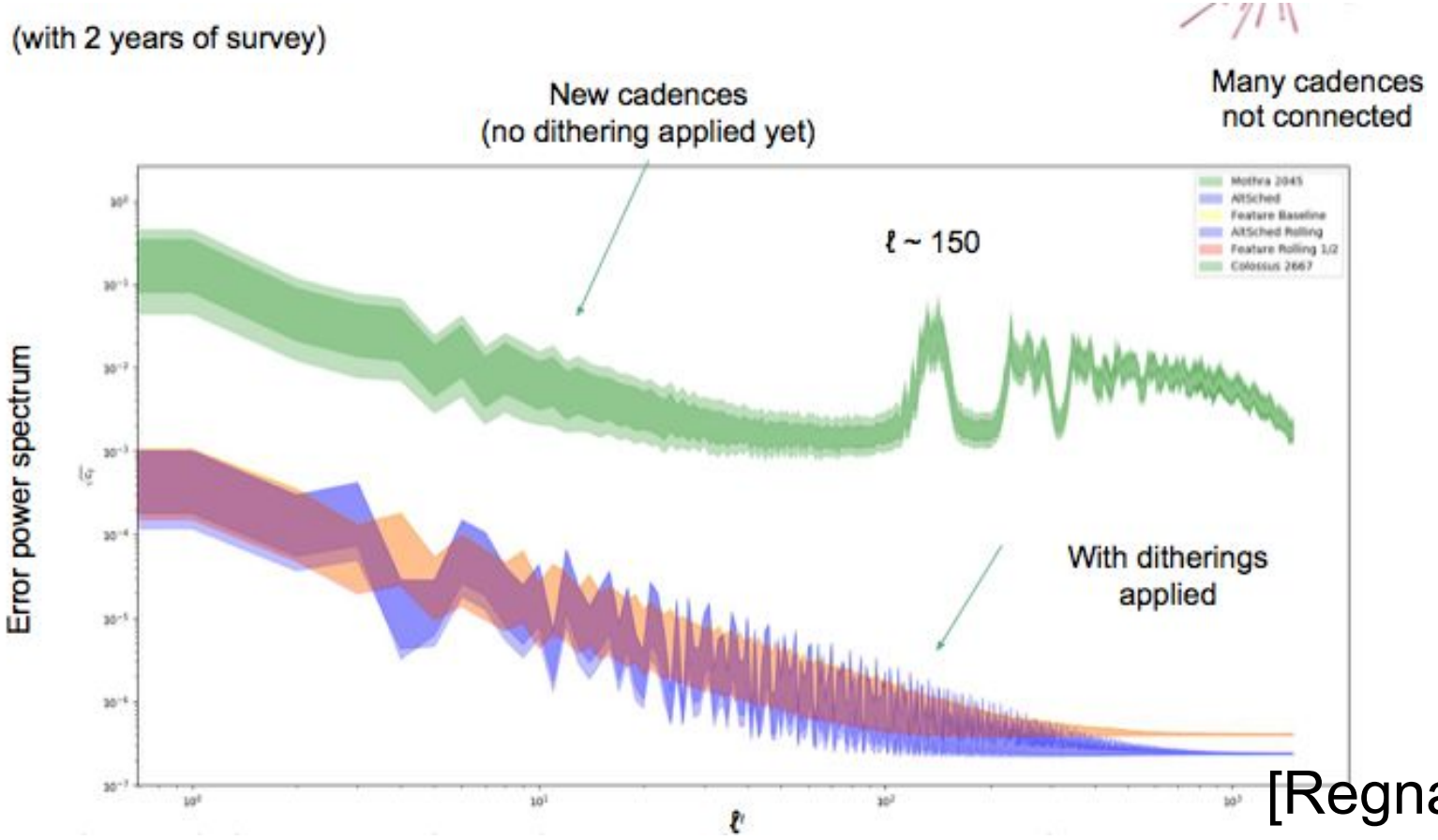
Large number of LSST observations allows a rigid ubercal-like solution (with some simplifying assumptions)...



[Regnault]

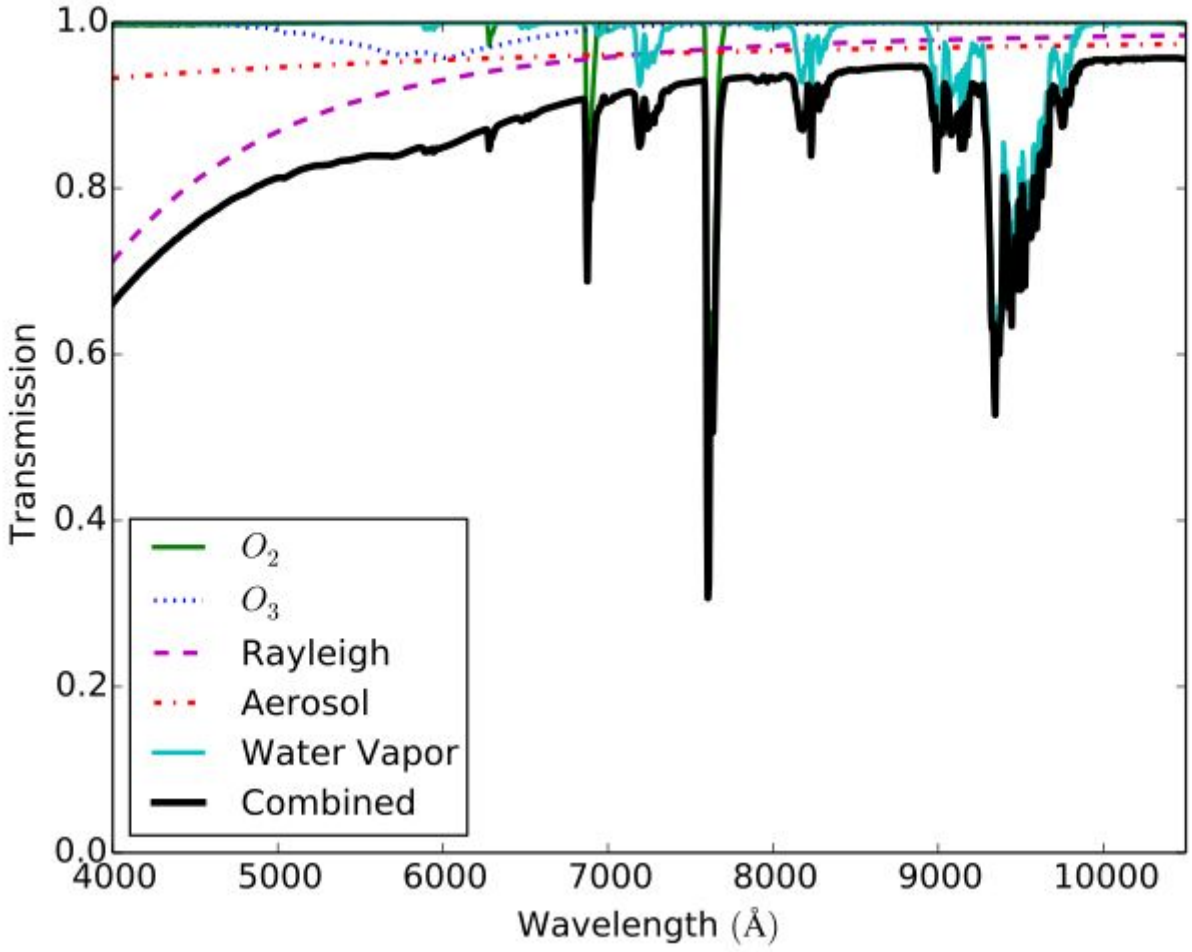
Uniformity: Impact of Cadence

...provided we have good dithering



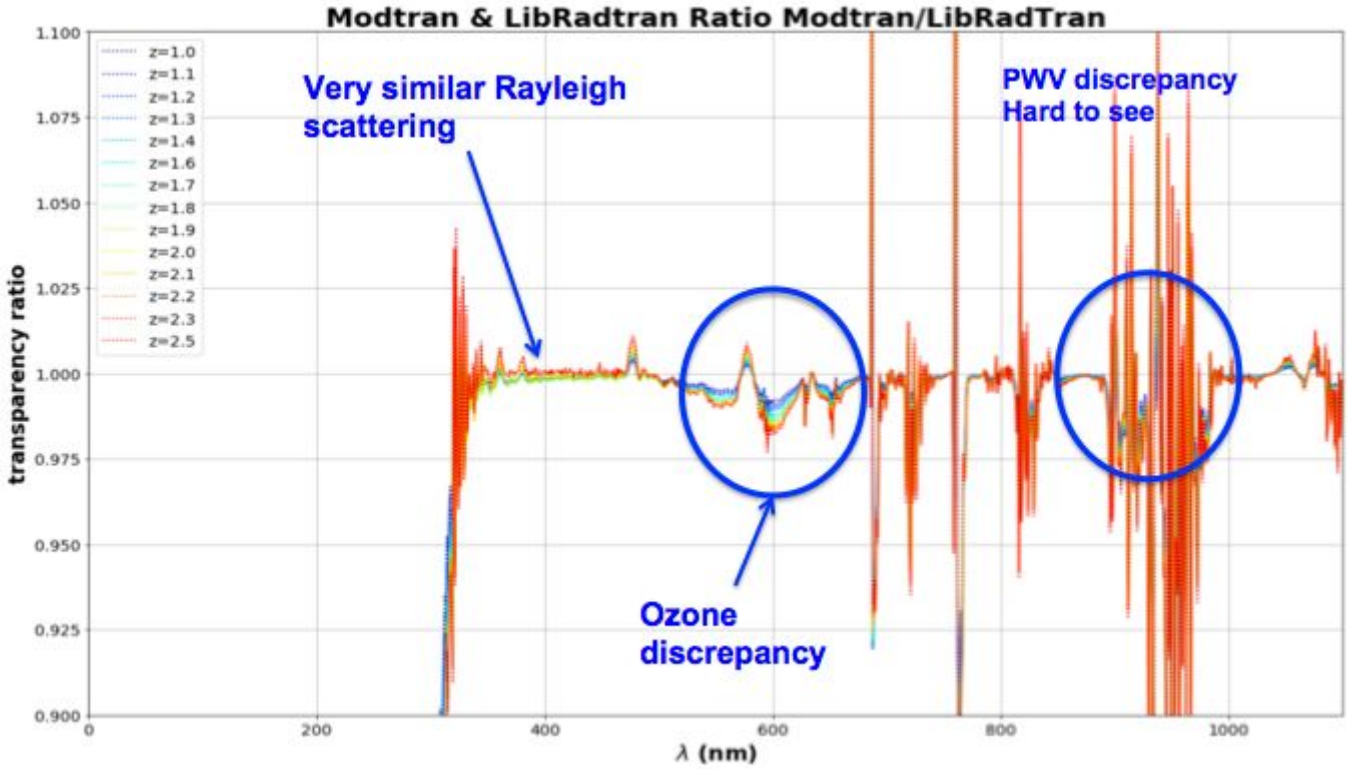
[Regnault]

Atmosphere Constituents



Modeling the Atmosphere

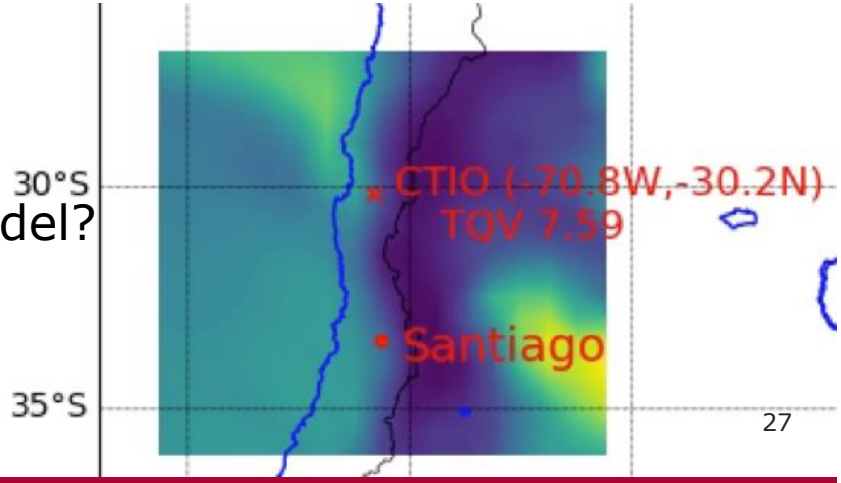
- Atmosphere modeling codes: MODTRAN and libRadTran
  - Does it make a difference? (Dagoret-Campagne and Gilmore)
  - DESC Note draft in progress



[Gilmore & Dagoret-Campagne]

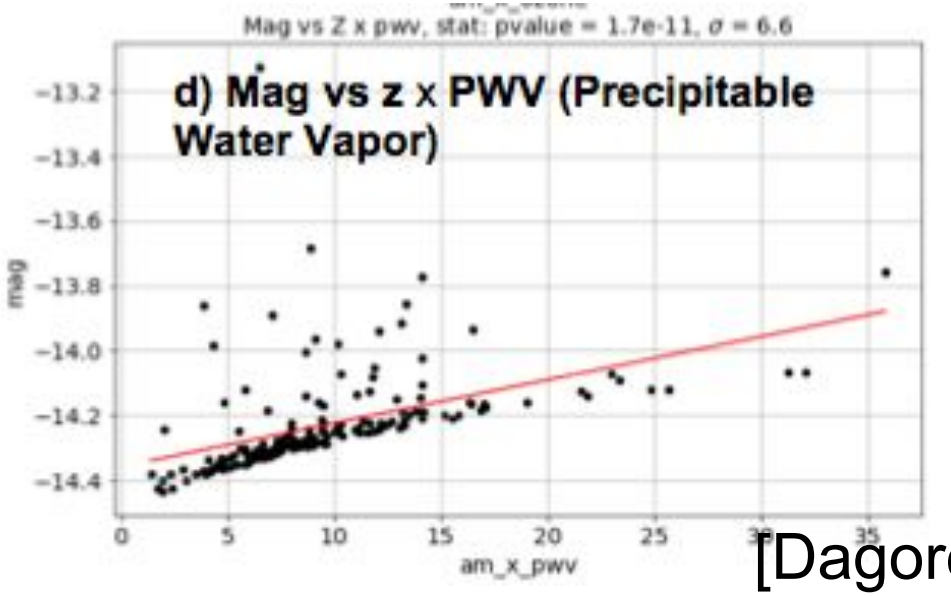
Constraining the Atmosphere

- Self-calibration from broadband data (e.g. FGCM) [Rykoff]
- Satellite Data [Guyonnet]
  - Satellite data summarized in MERRA-2 global modeling system
  - Ozone (Ozone Monitoring Instrument) (good precision)
  - Aerosols (okay precision, bad localization, uneven ground)
  - Precipitable Water Vapor (okay precision, bad localization)
- GPS Water Vapor measurements [Perrifort]
  - Cannot rely on Suominet service for GPS analysis
- Solar/Lunar aerosol measurements [Mondrick]
  - Not high enough precision;
    maybe useful as prior
- Which of these methods can get us
  to mmag precision in atmosphere model?



Atmosphere Mini-Challenge

- Dagoret-Campagne and Moniez
- Simulate broadband observations (via integration)
- Include non-photometric nights
- Can we recover the input atmospheric parameters, given 10000 stars with a range of SEDs and repeated observations?



[Dagoret-Campagne]

Fitting the Atmosphere

Measure moderate resolution spectra of bright stars with a dedicated telescope:

The Auxiliary Telescope (“AuxTel”)

AuxTel

- Goals
  - Monitor the atmospheric transmission along the light of sight
  - low-resolution spectra of (bright) stars in the current field
  - of spectrophotometric standard stars

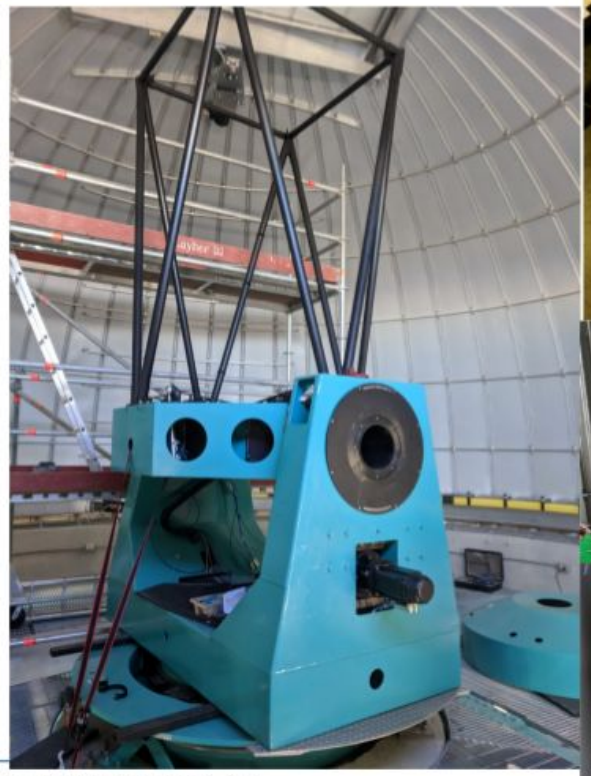
  => constraints on $T_{atm}(\lambda$; PWV, Ozone, Aerosols, Pressure)

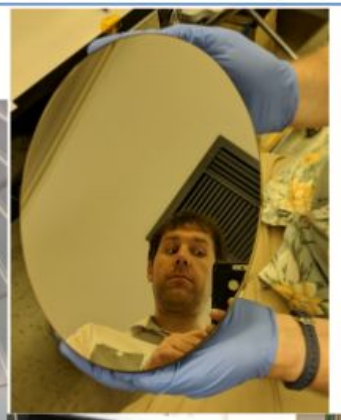
- Challenges
  - Telescope (AuxTel) and spectrograph (LATISS) integration
  - Sensor characterization (second LSST sensor on the sky !)
  - From spectra to atmospheric transmission

- Talks by P. Ingraham, K. Gilmore, R. Lupton, N. Mondrik, P. Astier, P. Antilogus, C. Juramy, Y. Copin, A. Guyonnet….

Auxiliary Telescope Status

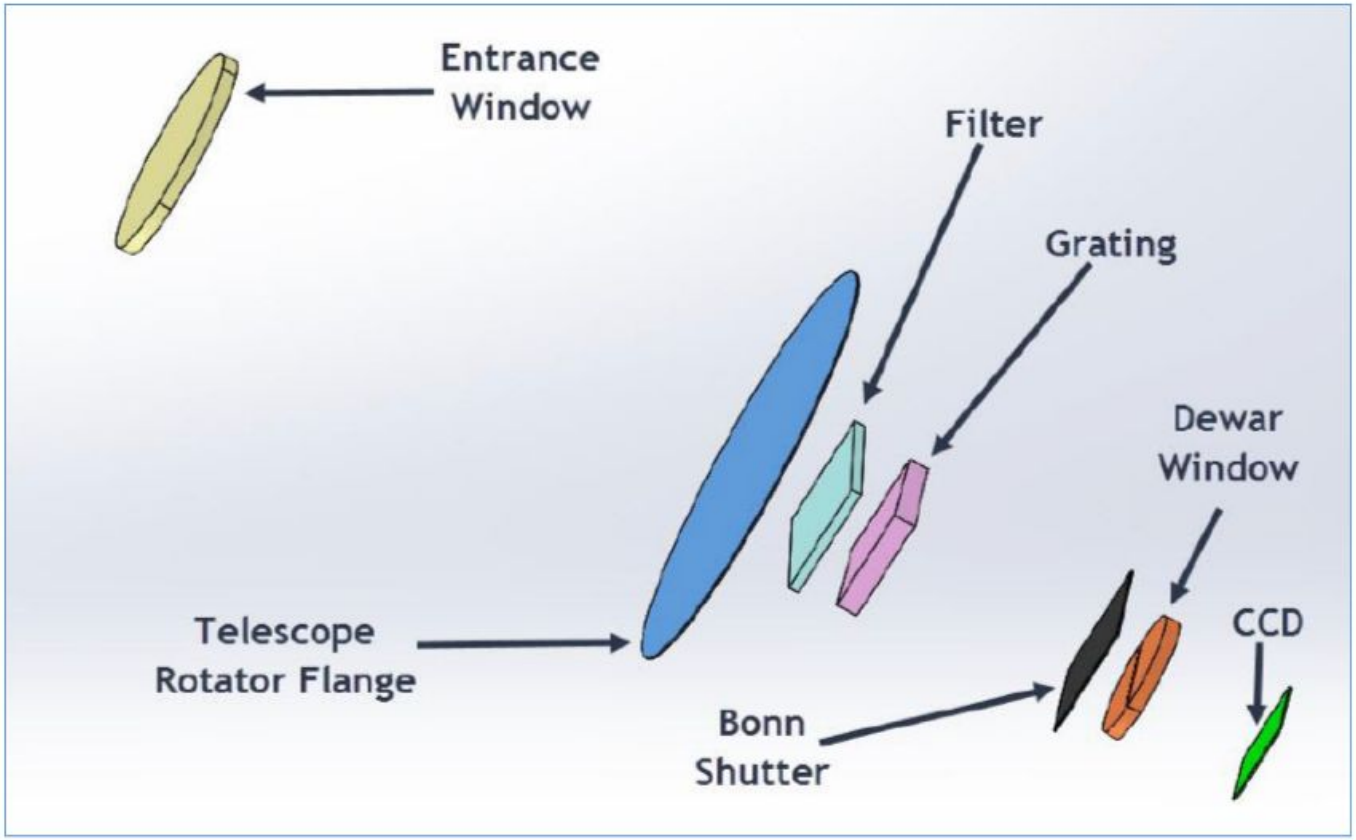
- Telescope currently in the hands of the CTIO controls group now developing the mount control system (ATMCS)
- Dome functions but has slipring issues that have yet to be resolved
- Pointing component (T-point) being developed by Observatory Sciences
- Expecting first light in February
  - Development of Pointing model
  - Collimation of telescope
  - Verification of telescope image quality with Zwo “high speed” camera and filter wheel
  - Verification of telescope requirements
    - Slew & settle speeds, pointing accuracy etc





P. Ingraham

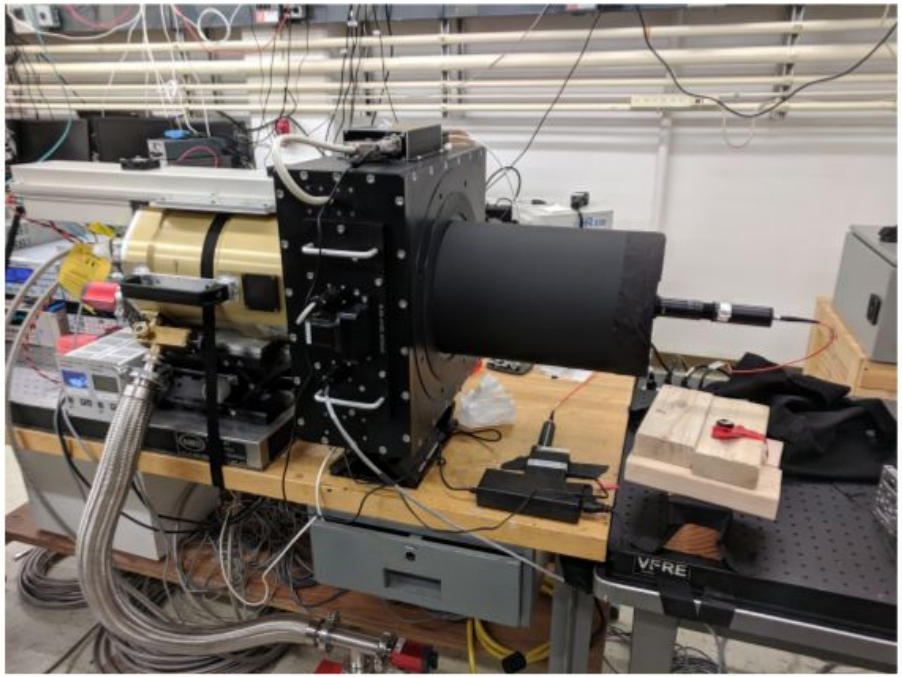
Spectrograph Optics



P. Ingraham

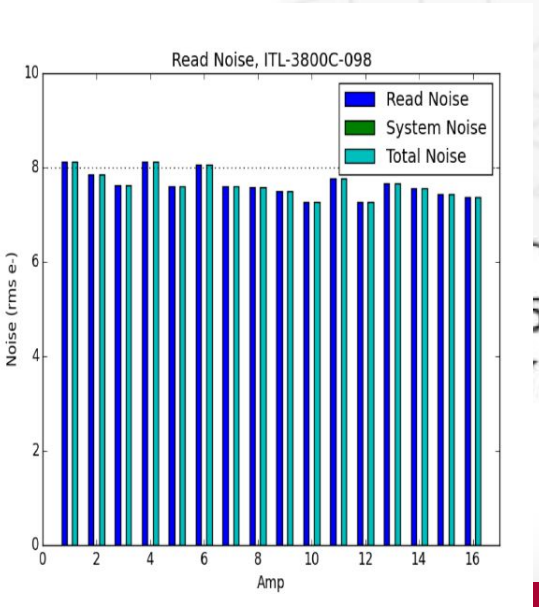
LATISS Status

- LSST Atmospheric Transmission Imager and Slitless Spectrograph
  - Grating + filter wheels each have 4 positions
  - Ronchi gratings were delivered, but were rejected because they were not wedged
    - Should be finished this week
  - Kirk to discuss detector characterization
- Have a few vendor software issues to resolve but not halting progress
- Telescope simulator allows (semi-realistic) spectra to be obtained
  - Optimized for 400-700 nm
  - Re-images fiber therefore creating odd "PSF"
  - Cannot tip/tilt/translate beam



P. Ingraham

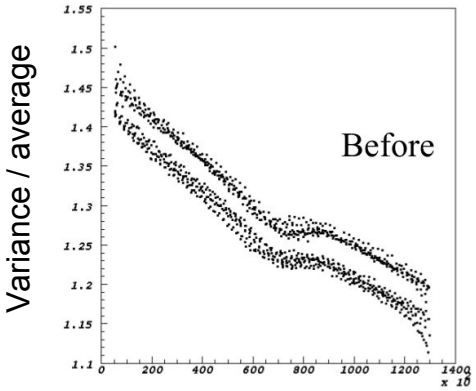
AuxTel / LATISS sensor

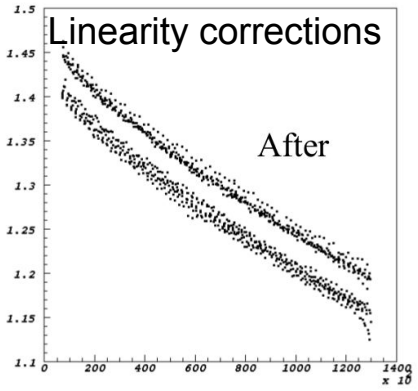


Spectrograph sensor studies

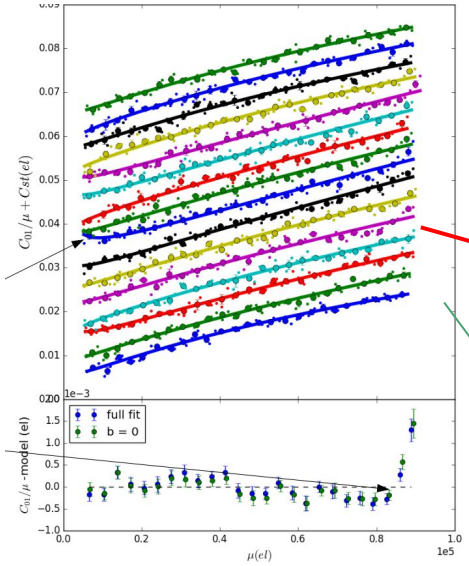
- Ongoing effort to optimize CCD clocking / readout sequences (K. Gilmore, C. Juramy, T. Johnson et al)
- Validation & characterization data being taken (K. Gilmore, T. Johnson)
  - Mostly flat field ramps (-> Photon Transfer Curves)
  - Data made available to DESC
  - Early feedback on data quality
  - Sensor characterization studies (P. Astier, P. Antilogus et al)
    - Readout noise
    - linearity
    - Correlations in flat field pairs -> brighter-fatter effect
- Proposals

Sensor characterization studies

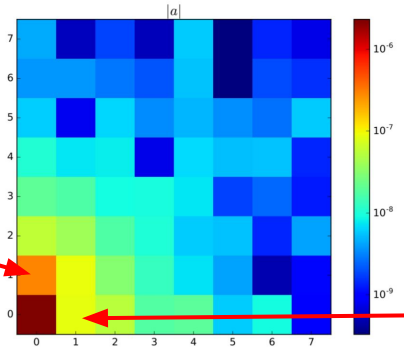




C01 correlations vs flux

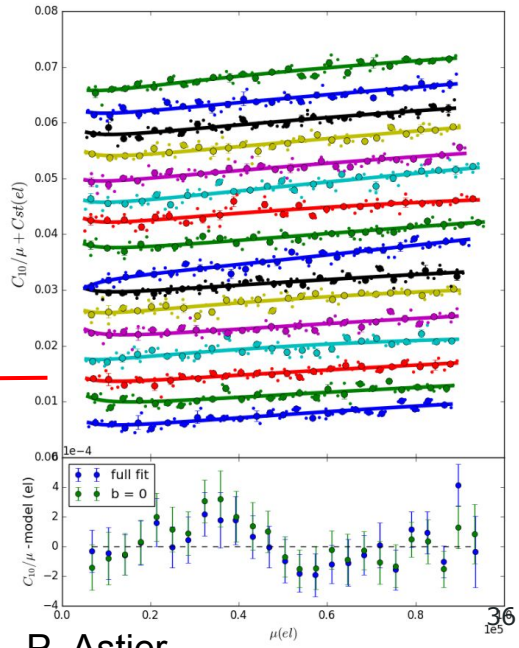


Constraints on BF model parameters



$$C_{ij}(\mu) = \frac{\mu}{g}\left[\delta_{i0}\delta_{j0} + a_{ij}\mu g + \frac{2}{3}[a\otimes a]_{ij}(\mu g)^2 + \frac{1}{3}[a\otimes a\otimes a]_{ij}(\mu g)^3 + \ldots\right]$$

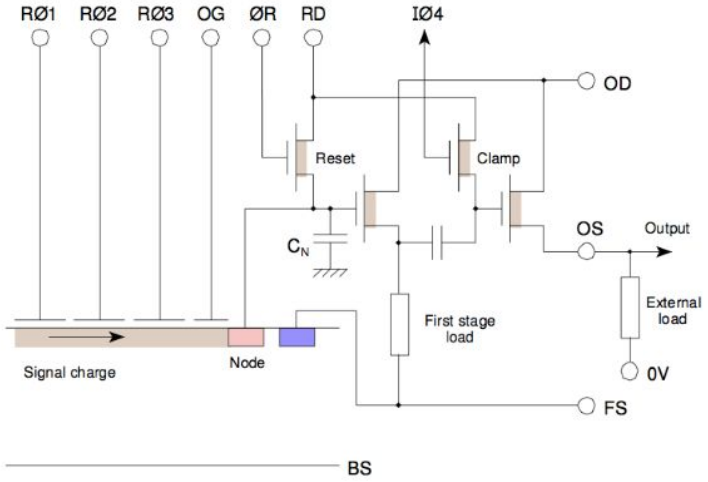
C10 correlations vs flux



P. Astier

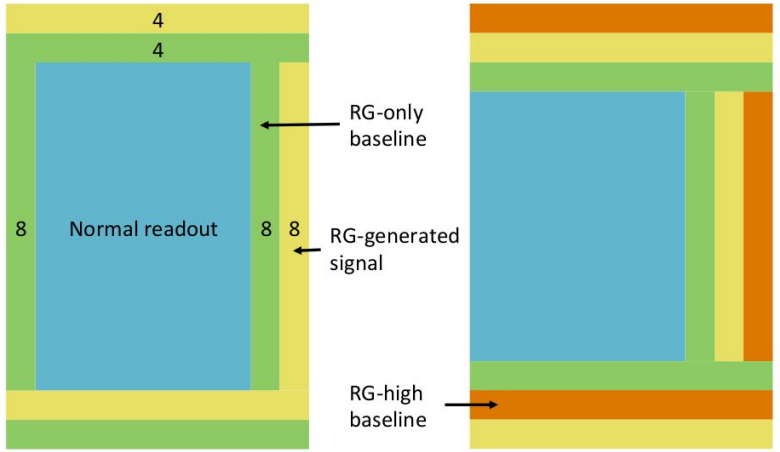
Injecting known signal -> readout chain

- Pixel content is transferred to the capacitive node. The voltage on the node is amplified through one (ITL) or 2 (E2V) transistors to reach the OS output of the channel.
- When the RG clock is high, the capacitive node is forced to the RD voltage instead.
- When RG is released, there is a downward jump in the output voltage, and it stabilizes at the 'post-reset level'



Frames with built-in calibration

- Adding calibration rows and columns + baseline



C. Juramy

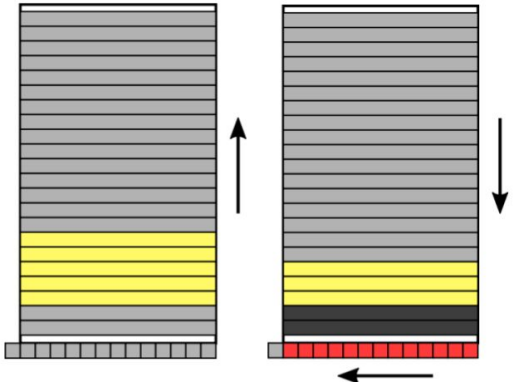
REB sequence programs -> test linearity

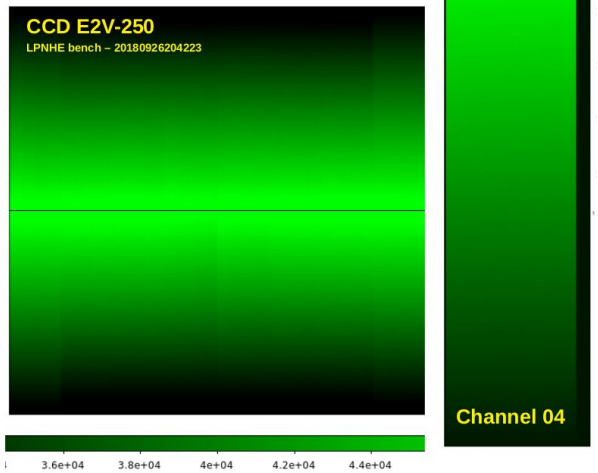
Motivation : study sensor & electronics linearity

- **At low flux** → may be important when stacking all LSST frames
- Non-linearity feature ~42000 el (PTC study, Pierre & Pierre & ...)

Procedure (tentative) **:**

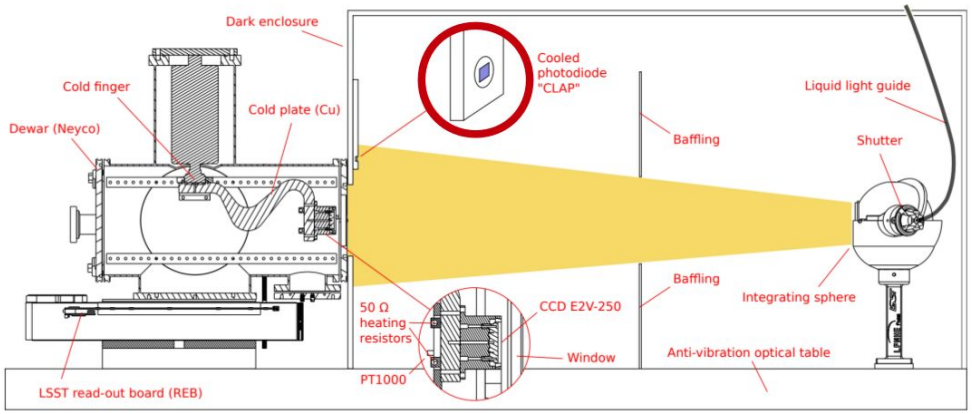
- Open the shutter
- Repeat with increasing Δt :
  - **Move several lines UP**
  - **Wait (increasing) Δt**
  - **Trash some lines DOWN**
  - **Read a few (10) lines**
  - Clear the remaining
  - **Shutter stay open all time**
  - Repeat to fill the frame

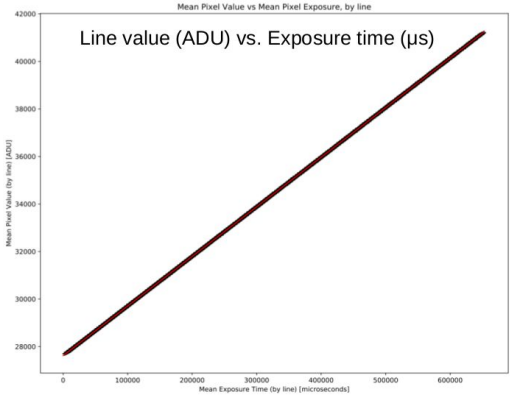




- **Monitoring the light flux during each exposure**

  → sampling at **31.25 kHz** with an home made photodiode electronics (CLAP)





Sensor studies

- Good model of a Project - DESC live integrated effort
  - Instrument integration
  - Data taking
  - Instrument validation
  - Analysis / sensor characterization
  - Early feedback

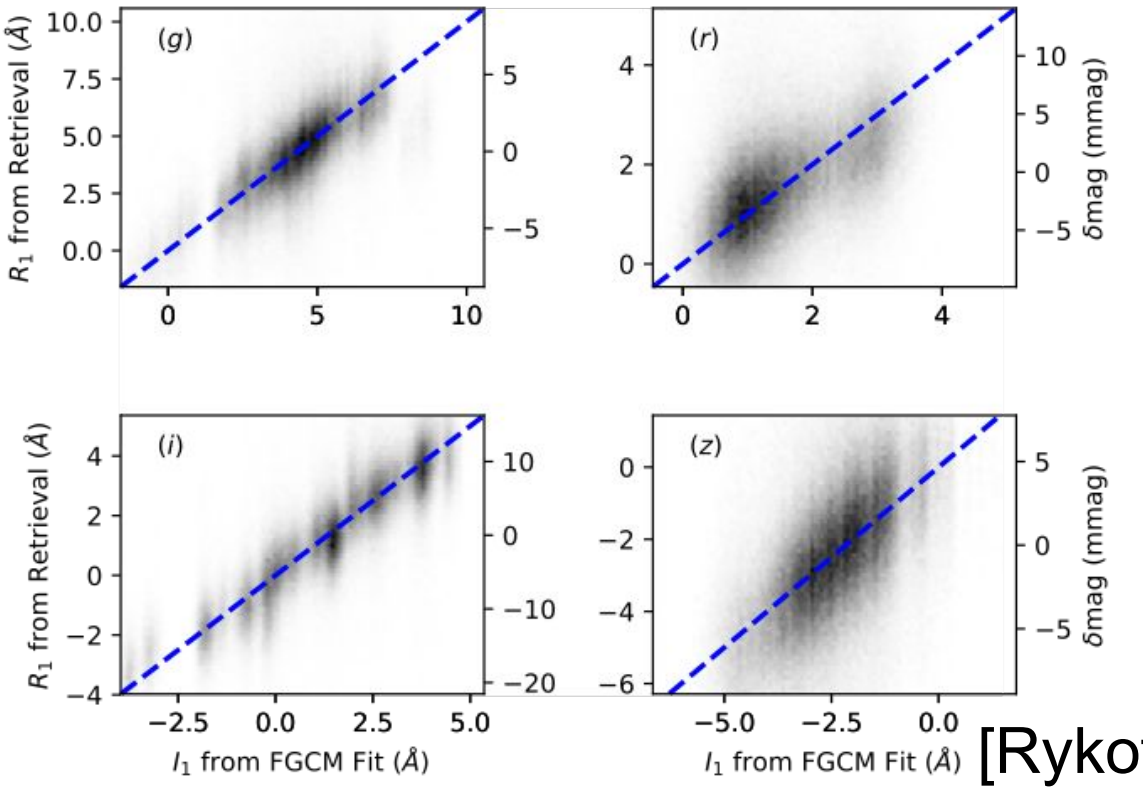
On Project

DESC contribution

- Discussed similar interactions for
  - Spectrograph characterization (in the Lab, and on sky)
  - Analysis of AuxTel data after first light (mid 2019)
    - with the goal of "closing the calibration loop"
    - i.e. determining atmospheric transmission from AuxTel measurements / verifying on AuxTel photometry that no chromatic residuals.
- First (ITL) LSST sensor on the sky !
- DESC support (e.g. pipeline scientist) would be very helpful

Instrumental Measurements are Key

In DES the instrumental variations matter much more for chromatic precision than atmosphere (except PWV in DES z-band)



[Rykoff]

Collimated Beam Projector

- A telescope in reverse!
- Mounted to edge of LSST dome
- Project monochromatic spots onto LSST focal plane
- Trace relative throughput, ghosting, Filter response, sensor QE
-

[Stubbs, Ingraham]