



# The State of Rubin Calibration

Robert Lupton, Princeton University  
Rubin Pipeline/Calibration Scientist

2021-12-08



U.S. DEPARTMENT OF  
**ENERGY**

**SLAC**

CHARLES AND LISA SIMONYI FUND  
••• FOR ARTS AND SCIENCES •••



# Introduction

---

Calibration is where DM meets the camera, and so there are lots of people involved. From DM, Andrés Plazas, Merlin Fisher-Levine, Chris Waters, 0.48 Eli Rykoff.

# Introduction

---

Calibration is where DM meets the camera, and so there are lots of people involved. From DM, Andrés Plazas, Merlin Fisher-Levine, Chris Waters, 0.48 Eli Rykoff. but of course also a cast of many from The Camera, Harvard, DESC's PCWG, UC Davis, ...

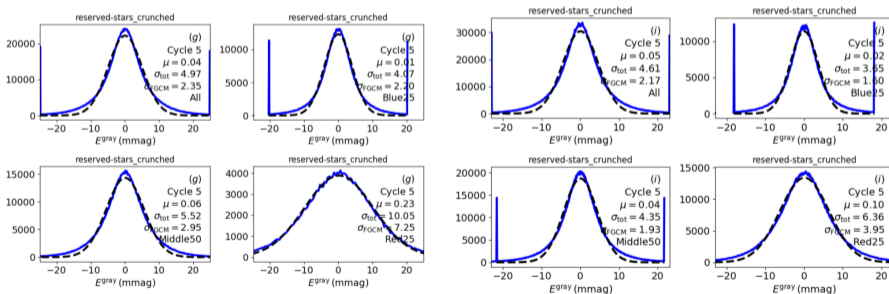
## FGCM

As Eli Rykoff showed at the last PST meeting, the Burke and Rykoff Forward Global Calibration Model approach works extremely well, and is integrated into the Rubin pipelines.

As Eli Rykoff showed at the last PST meeting, the Burke and Rykoff Forward Global Calibration Model approach works extremely well, and is integrated into the Rubin pipelines.

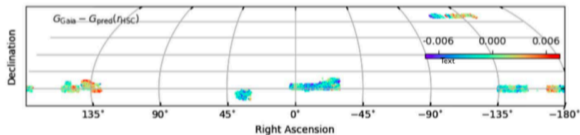
- 2-4 mmag repeatability for most bands / colors
- Worst for reddest stars in g-band (unmodeled chromatic corrections)

Eli Rykoff

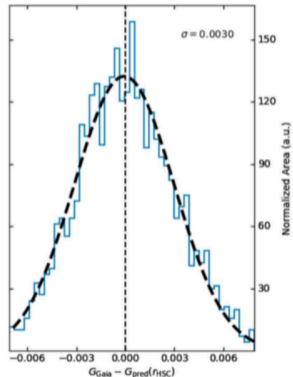


# FGCM

As Eli Rykoff showed at the last PST meeting, the Burke and Rykoff Forward Global Calibration Model approach works extremely well, and is integrated into the Rubin pipelines.



Eli Rykoff Alg Workshop P'ton



# The Rest of The Problem

---

## The Rest of The Problem

---

- We still need to carry out a reliable ISR



## The Rest of The Problem

---

- We still need to carry out a reliable ISR
- FGCM works well for stars with simple spectra (ABAFG stars?)

## The Rest of The Problem

---

- We still need to carry out a reliable ISR
- FGCM works well for stars with simple spectra (ABAFG stars?)
  - but we need exquisite photometry for all objects, including galaxies and SNe

## The Rest of The Problem

---

- We still need to carry out a reliable ISR
- FGCM works well for stars with simple spectra (ABAFG stars?)
  - but we need exquisite photometry for all objects, including galaxies and SNe
- DES and HSC didn't have a  $u$  filter

# Rubin ISR

---

The LSSTCam is a fully-featured camera.

## Rubin ISR

The LSSTCam is a fully-featured camera.

We are taking “afternoon calibrations” on LATISS and AuxTel using (Rubin-approved) ScriptQueue commands (thank you, Alysha). These are automatically reduced using the OCPS to generate master

- bias
- dark
- flat/PTC gains

## Rubin ISR

---

The LSSTCam is a fully-featured camera.

We are taking “afternoon calibrations” on LATISS and AuxTel using (Rubin-approved) ScriptQueue commands (thank you, Alysha). These are automatically reduced using the OCPS to generate master

- bias
- dark
- flat/PTC gains

This is followed by running `cp_verify` to check if the data is good.

## Rubin ISR

---

The LSSTCam is a fully-featured camera.

We are taking “afternoon calibrations” on LATISS and AuxTel using (Rubin-approved) ScriptQueue commands (thank you, Alysha). These are automatically reduced using the OCPS to generate master

- bias
- dark
- flat/PTC gains

This is followed by running `cp_verify` to check if the data is good.

This is taking longer than I would like, and we failed to detect the last two problems with cameras (a DAQ data corruption on ComCam and a failure to enable VBB on the LATISS REB).

The LSSTCam is a fully-featured camera.

We are taking “afternoon calibrations” on LATISS and AuxTel using (Rubin-approved) ScriptQueue commands (thank you, Alysha). These are automatically reduced using the OCPS to generate master

- bias
- dark
- flat/PTC gains

This is followed by running `cp_verify` to check if the data is good.

This is taking longer than I would like, and we failed to detect the last two problems with cameras (a DAQ data corruption on ComCam and a failure to enable VBB on the LATISS REB). As we find problems, we add tests (e.g. we’ll be checking muons when DM-32792 is Done)



The LSSTCam is a fully-featured camera.

We are taking “afternoon calibrations” on LATISS and AuxTel using (Rubin-approved) ScriptQueue commands (thank you, Alysha). These are automatically reduced using the OCPS to generate master

- bias
- dark
- flat/PTC gains

This is followed by running `cp_verify` to check if the data is good.

This is taking longer than I would like, and we failed to detect the last two problems with cameras (a DAQ data corruption on ComCam and a failure to enable VBB on the LATISS REB). As we find problems, we add tests (e.g. we’ll be checking muons when DM-32792 is Done) DM is working with the camera team (Jim Chiang, Eric Charles) to integrate camera “EOTest” code into `cp_verify`.

## Rubin ISR

---

In the longer term, we expect to generate monochromatic flats using the flatfield screen and tunable laser, corrected for ghosting using the CBP.

## Rubin ISR

---

In the longer term, we expect to generate monochromatic flats using the flatfield screen and tunable laser, corrected for ghosting using the CBP.

This is on hold until the hardware is delivered.

## Rubin ISR

---

In the longer term, we expect to generate monochromatic flats using the flatfield screen and tunable laser, corrected for ghosting using the CBP.

This is on hold until the hardware is delivered. And until we have human effort available to work on the algorithms.

## Rubin ISR

---

In the longer term, we expect to generate monochromatic flats using the flatfield screen and tunable laser, corrected for ghosting using the CBP.

This is on hold until the hardware is delivered. And until we have human effort available to work on the algorithms.

The intention is to match the flats to the sky colour, and to re-flatten all data to a flat  $\nu F_\nu$  SED after sky subtraction.

## Rubin ISR

---

In the longer term, we expect to generate monochromatic flats using the flatfield screen and tunable laser, corrected for ghosting using the CBP.

This is on hold until the hardware is delivered. And until we have human effort available to work on the algorithms.

The intention is to match the flats to the sky colour, and to re-flatten all data to a flat  $\nu F_\nu$  SED after sky subtraction. The pipeline infrastructure for this is not yet in place.

# The System Throughput

---

# The System Throughput

---

- FGCM works well for stars with simple spectra (ABAFG stars?)
  - but we need exquisite photometry for all objects, including galaxies and SNe



# The System Throughput

---

- FGCM works well for stars with simple spectra (ABAFG stars?)
  - but we need exquisite photometry for all objects, including galaxies and SNe

To do better than this, we need to understand the separate parts of the system

- The Camera (including filters)
- The Telescope
- The Atmosphere

## The CBP

---

The Collimated Beam Projector is designed to allow us to characterise the first two of these items.

## The CBP

---

The Collimated Beam Projector is designed to allow us to characterise the first two of these items.

It is currently in a lab in Tucson. It's hard to make much progress without real hardware on the mountain.

## The CBP

---

The Collimated Beam Projector is designed to allow us to characterise the first two of these items.

It is currently in a lab in Tucson. It's hard to make much progress without real hardware on the mountain. We could probably twist arms to generate simulated CBP data, but it's not clear how much this would tell us. The code to manipulate the CBP to work with the MT is written, but not validated.

## The CBP

---

The Collimated Beam Projector is designed to allow us to characterise the first two of these items.

It is currently in a lab in Tucson. It's hard to make much progress without real hardware on the mountain. We could probably twist arms to generate simulated CBP data, but it's not clear how much this would tell us. The code to manipulate the CBP to work with the MT is written, but not validated. Once again, no-one is available to work on this at present.

## The Atmosphere

---

AuxTel has taken some dispersed stellar spectra (using both Ronchi and holographic gratings). This data has been reduced through "spectractor" which is a gen3-capable package written by J r my Neveu and supported for Rubin by Merlin Fisher-Levine, and which is almost integrated into the core Rubin pipeline distribution (*i.e.* RFCs have passed).

## The Atmosphere

---

AuxTel has taken some dispersed stellar spectra (using both Ronchi and holographic gratings). This data has been reduced through "spectractor" which is a gen3-capable package written by J r my Neveu and supported for Rubin by Merlin Fisher-Levine, and which is almost integrated into the core Rubin pipeline distribution (*i.e.* RFCs have passed).

This work has not yet generated interesting constraints on *e.g.* the spatio-temporal variation of the aerosols over Cerro Pach n.

## Next Steps

---

- Continue to work with the camera team to take and verify calibrations in Chile
  - When appropriate, work with the camera team to handle LSSTCam's foibles in the Rubin ISR
- Process the spectroscopy that we have taken
  - Including atmospheric constraints
- Wait for the installation of the remaining calibration hardware



## Next Steps

---

- Continue to work with the camera team to take and verify calibrations in Chile
  - When appropriate, work with the camera team to handle LSSTCam's foibles in the Rubin ISR
- Process the spectroscopy that we have taken
  - Including atmospheric constraints
- Wait for the installation of the remaining calibration hardware

I am setting up a weekly meeting to understand problems with exploiting all the data being taken in Chile. I hope that this will move the calibration validation and atmospheric analysis along (it'll also support the imaging surveys being done using auxTel for more general commissioning purposes)

The End