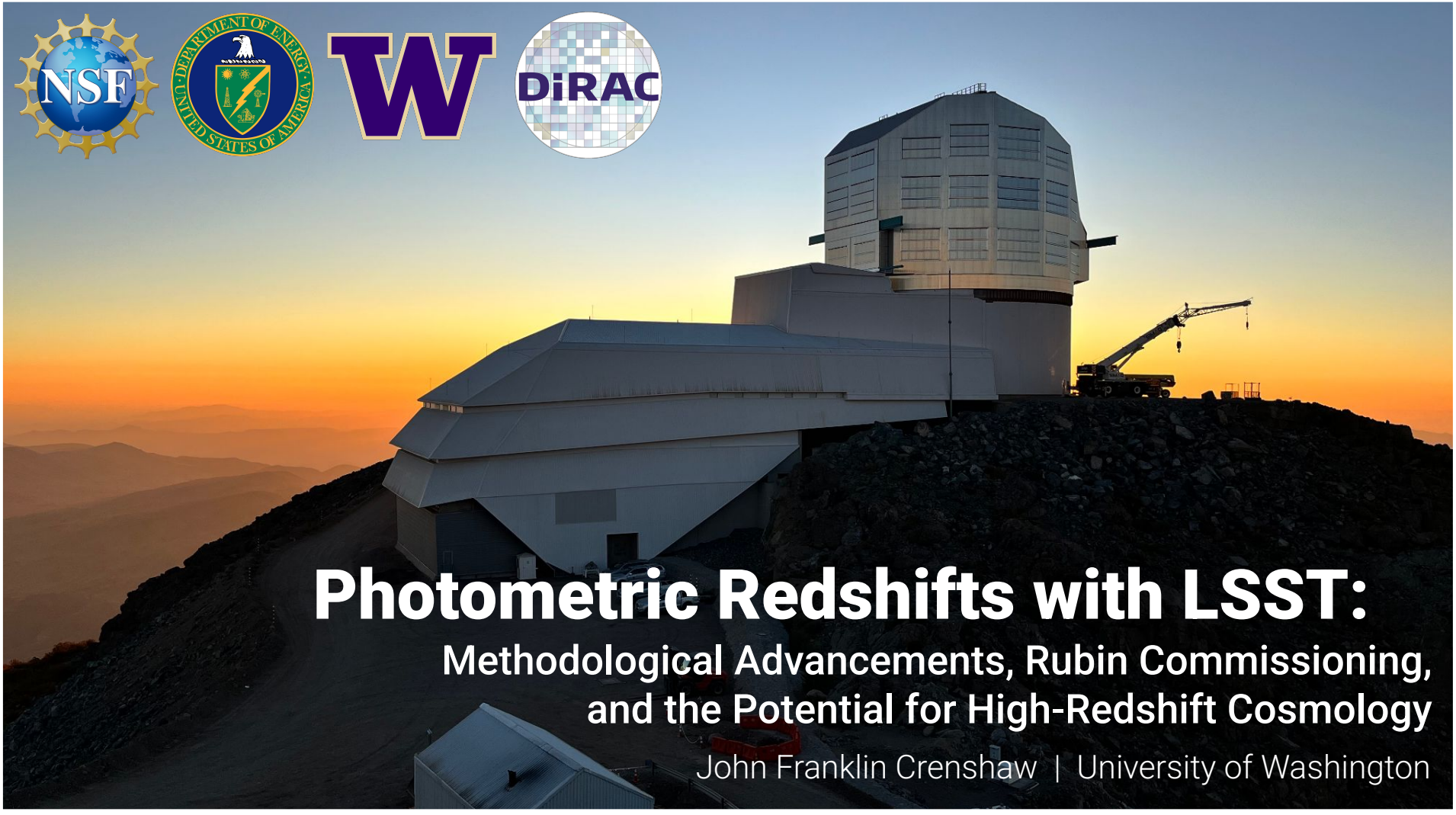


Photometric Redshifts with LSST:

Methodological Advancements, Rubin Commissioning, and the Potential for High-Redshift Cosmology

John Franklin Crenshaw | University of Washington

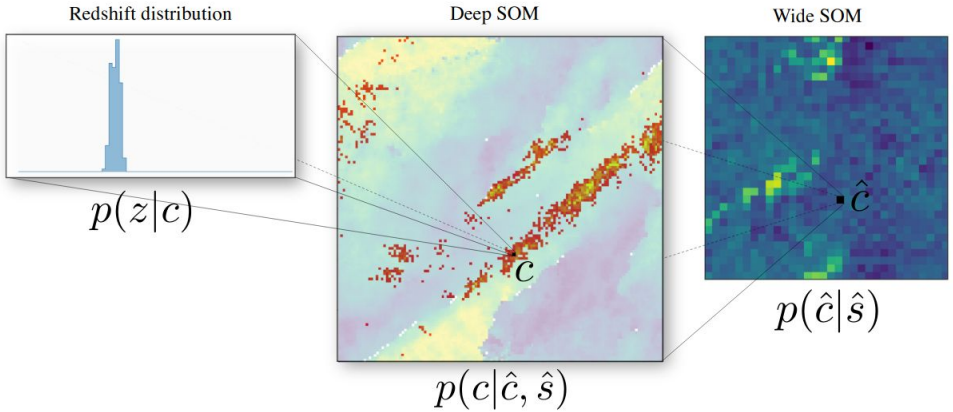
DES as a starting point

Lots of continuity of DES, including many DES members directly contributing to DESC photo-z efforts

DES 2-tiered SOM likely to feature prominently in (early) DESC cosmology

Exploring improvements, e.g.

- replacing Balrog SSI with Deep Field bootstrapping
- seperate SOM for each tomographic bin for all samples



Buchs et al. 2019

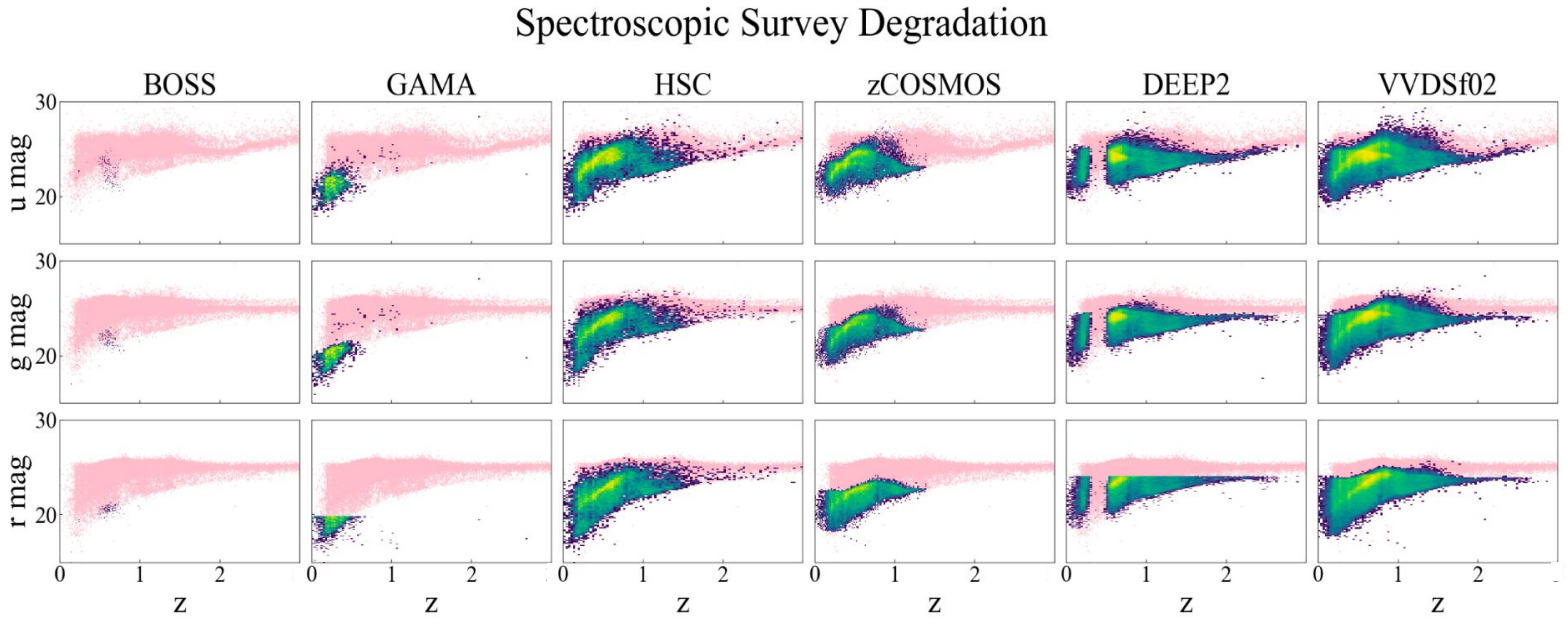
Building Beyond DES with RAIL

- Exploring and testing methods beyond DES. Especially worried about confirmation bias of DES results
- **RAIL**: framework for photo-z estimation, forward modeling, & pipelining
  - Flexibility to swap lots of photo-z algorithms into pipelines for comparison
  - Forward modeling with normalizing flows that provide *true photo-z posteriors* to enable evaluation at the per-posterior level (***PZFlow***, ***Crenshaw 2024***)
  - Also built-in SPS modeling
  - Modeling and testing systematic errors & quantifying impact on cosmology

Created by Alex Malz,
currently led by Ellen Hang and TQ Zhang,
supported by LINCC Frameworks

E.g. Modeling Spectroscopic Incompleteness

Spectra only obtained for biased subset of photometric sample

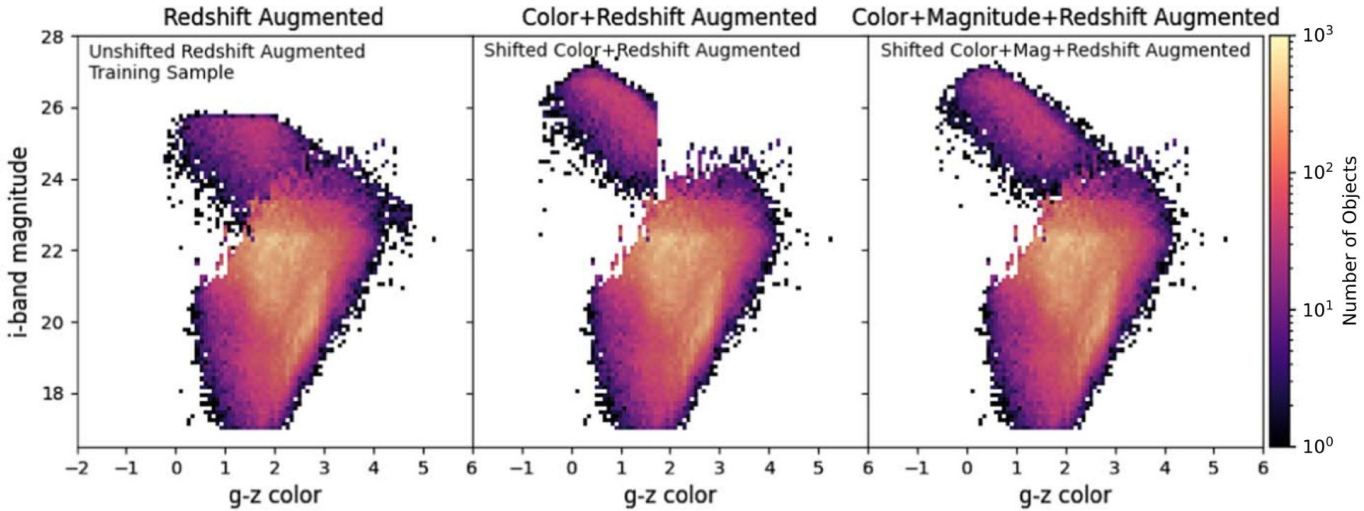


Alice Crafford (incl. Crenshaw) *paper in review*

Simulated Training Set Augmentation

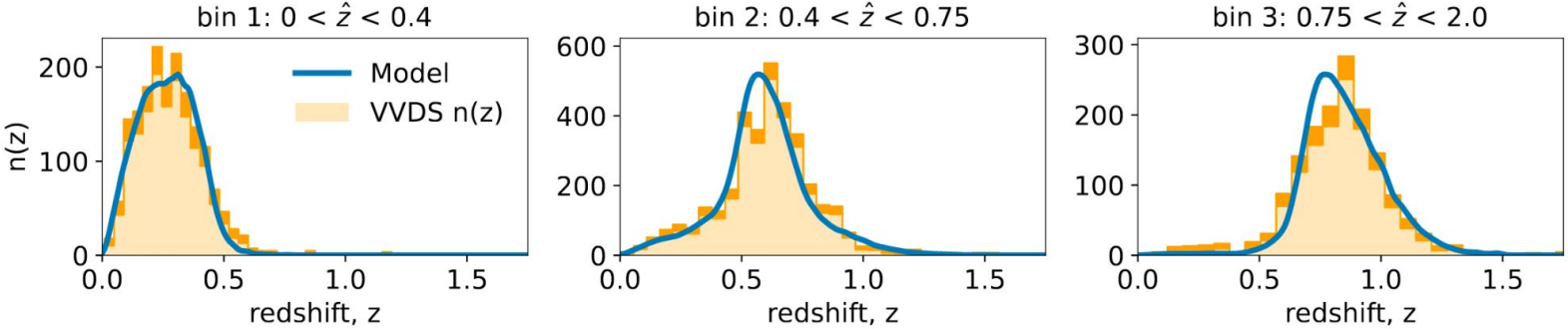
See Irene's poster
@ 5:30pm today!

Can you augment spectroscopic sets with simulated data?
Moskowitz 2024 (*incl. Crenshaw*) shows yes; can reduce bias by 50%!



SPS-driven Photo-z Estimation

- Lots of work to accelerate inference with Stellar Population Synthesis (SPS) models
- So far successfully applied to ~10^5 galaxies; more acceleration possible!
- Test using SPS to estimate photo-z's (and galaxy properties!) for DESC cosmology



Alsing et al. 2022

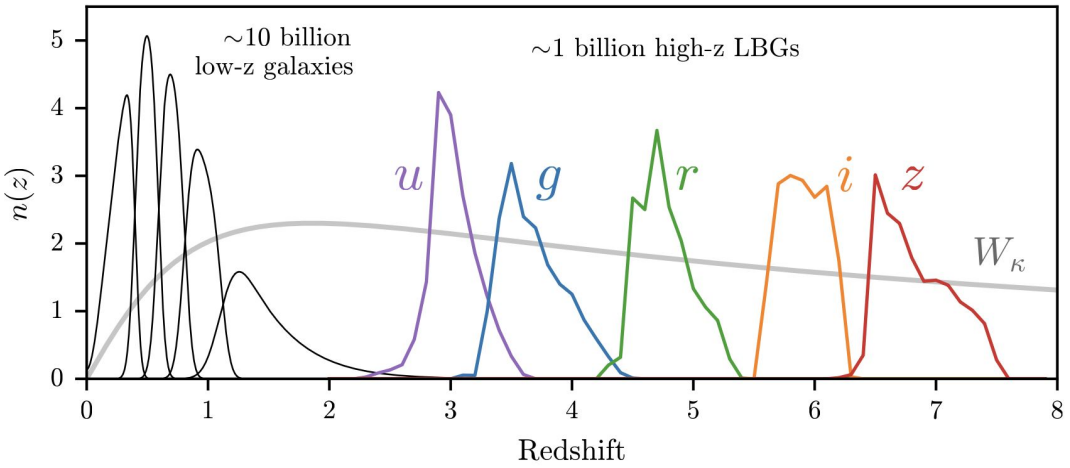
Pushing to Higher Redshifts

LSST depth and width will provide hundreds-of-millions Lyman-break Galaxies (LBGs) across the whole southern sky

Euclid and **Roman** will provide IR photometry that will enable secure photo-z calibration

DESI-II will provide high-z spectroscopy

Lots of synergies for high-z cosmology emerging this decade!

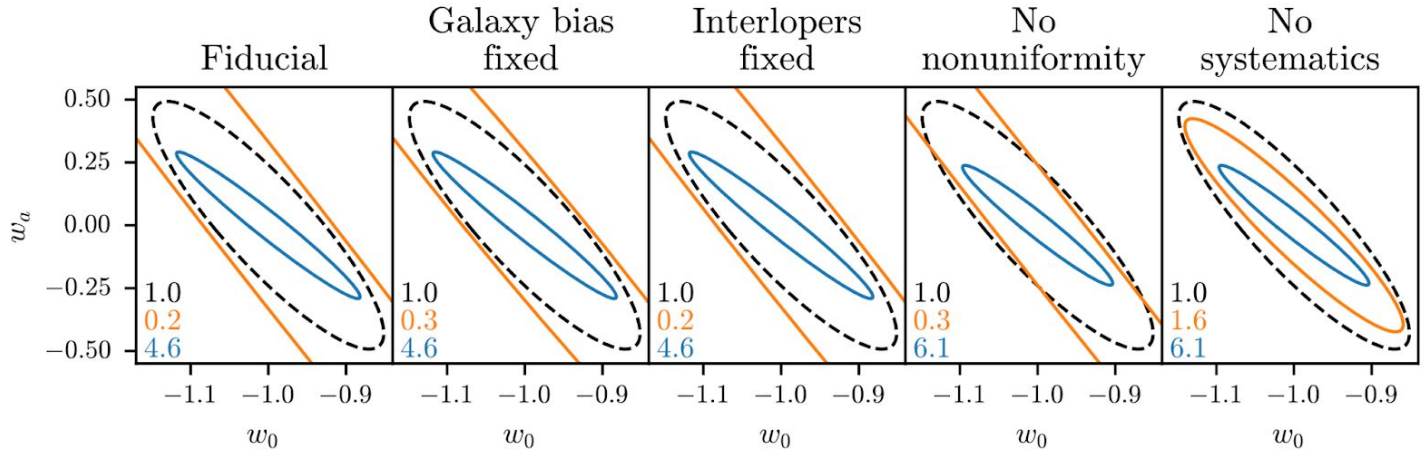


Crenshaw *in prep.*

Constraints on High-Redshift Cosmology

Clustering and cross-correlation with CMB lensing will provide powerful cosmological constraints

- Evolution of σ_8
- Evolution of DE
- Sum of neutrino masses (independent of tau)
- f_{NL}



Crenshaw *in prep.*

LBG Cosmology Topical Team

JFC

Tanveer Karim

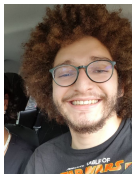
Lots of ongoing work:

- Optimizing survey strategy (w/ Boris Leistedt)

- Ramping up to measure UV LF using Rubin Commissioning Data

- Calibrating high-redshift cosmology simulations (w/ Gillian Mohrmann and Andrew Hearin)
- Cosmology forecasts (w/ Niko Šarčević)

- Exploring more flexible DE parameterizations (w/ João Victor Silva Rebouças and Diogo Henrique Francis De Souza)



- Inverse Galaxy-Galaxy Lensing (w/ Dane Cross and Carles Sánchez)

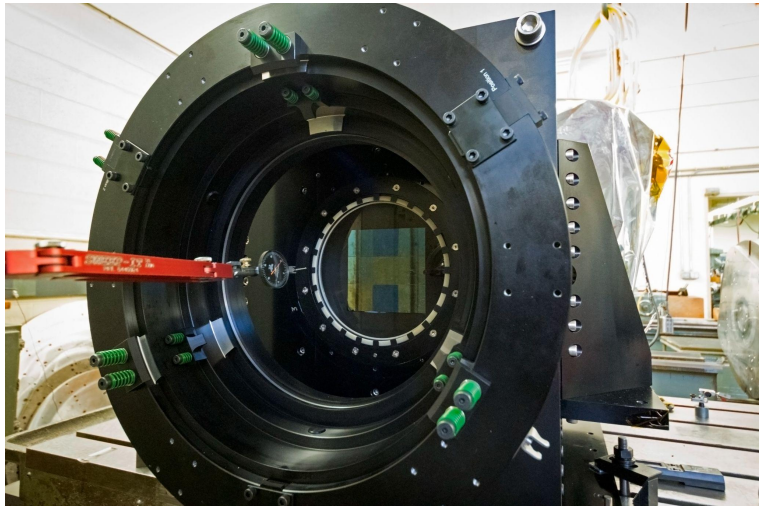
LBG Cosmology Workshop

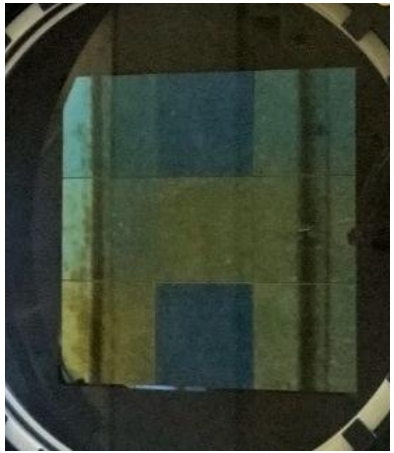
Dunlap Institute, Toronto

May 7 - 9

Rubin ComCam Commissioning

- Rubin on-sky from October - December 2024
- Same telescope, mirrors, etc. but only single raft (FoV ~ 0.5 deg^2)
- A lot of time dedicated to Active Optics and other engineering activities





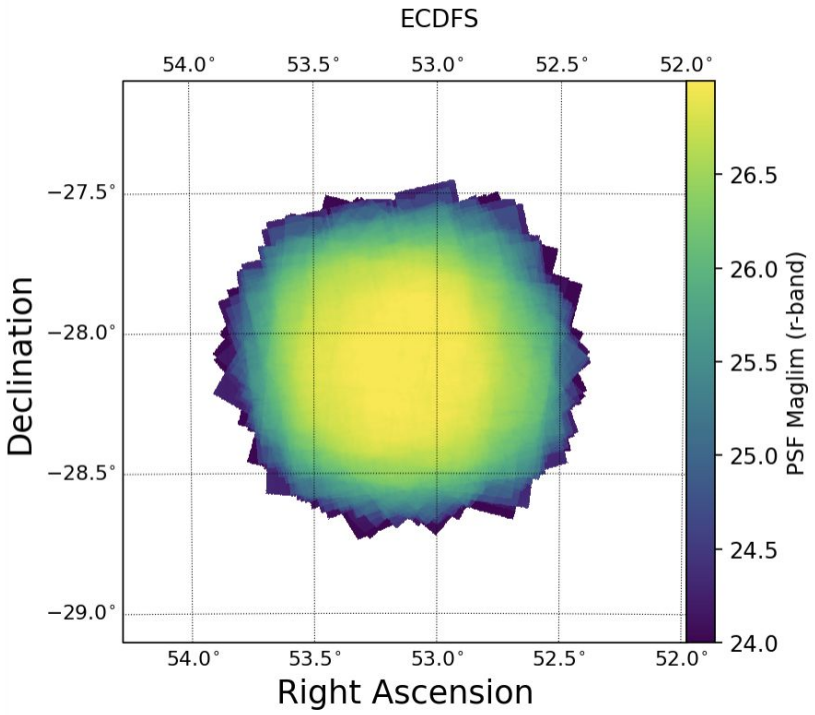
ComCam Commissioning Surveys

- 10 year *griz*, 2 years *uy* in ECDFS
- 2 year *ugrizy* in EDFS

Rubin Photo-z Commissioning Team beginning to process this data, test photo-z estimation, exercise our pipelines, etc.

I am preparing to begin testing LBG selection, UV LF measurements, etc.

Public release expected June – July 2025



Summary

- DESC photo-z analysis for early cosmology likely to look a lot like DES
- RAIL provides a flexible photo-z estimation framework, with which we are testing many different algorithms and calibrating systematic errors
- LBG cosmology will extend DESC cosmology to higher redshifts than seen in Stage III surveys
- The Rubin ComCam Commissioning Campaign provided deep imaging in Rubin Deep Drilling Fields. We are beginning to analyze this data, providing a first glimpse at the potential of LSST

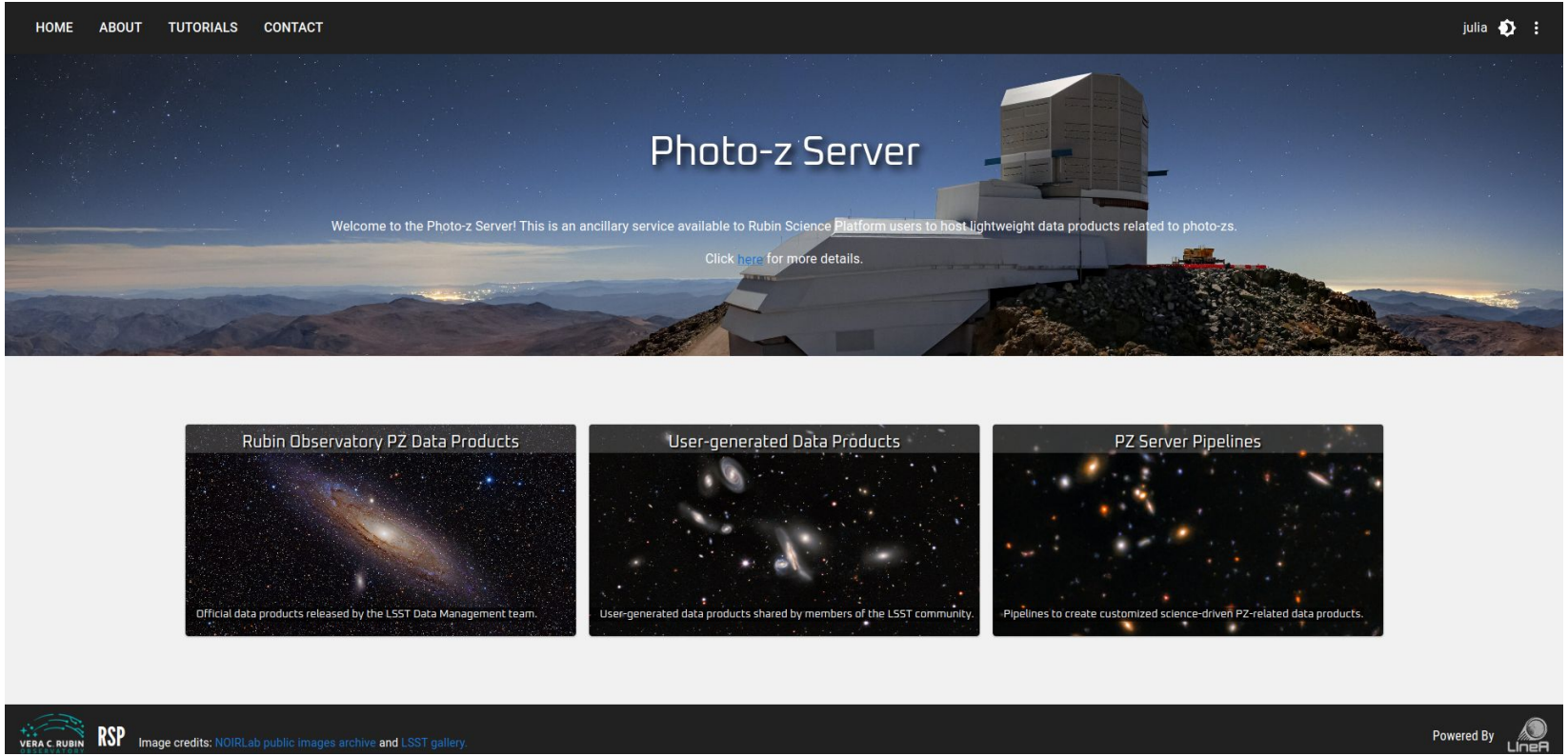
Backup Slides

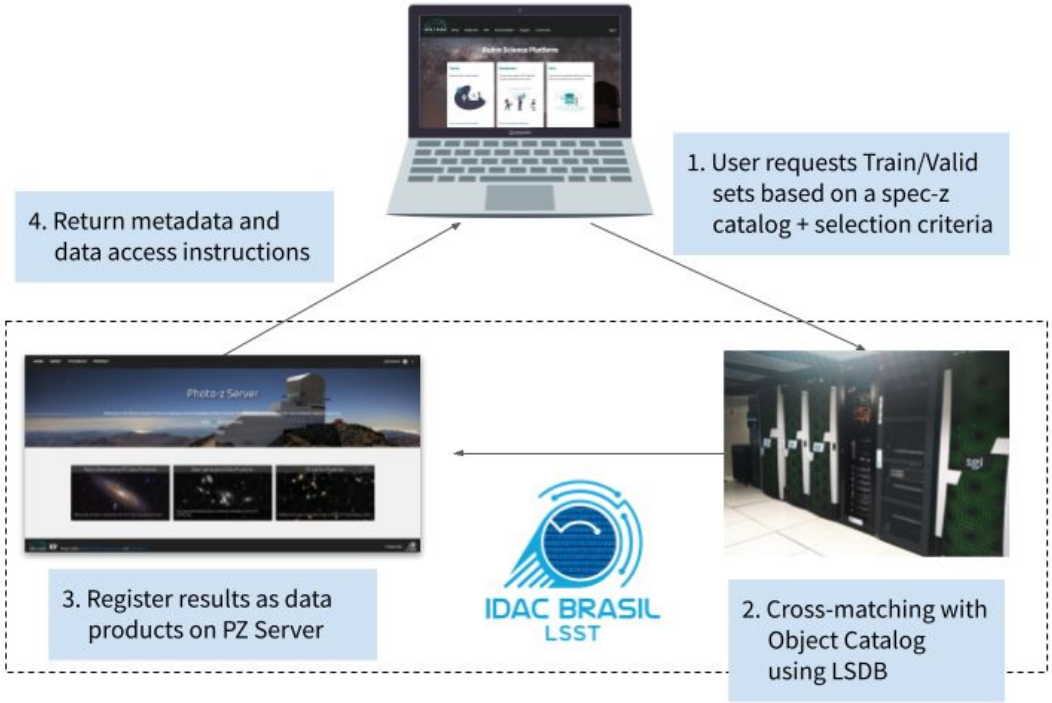
What does “photo-z” mean to DESC

There are a wide variety of uses and types of “photo-z” in DESC

- n(z) distributions for 3x2pt cosmology
- n(z) from cross-correlation with spectroscopic catalogs
- p(z) for individual galaxies
- p(z) for galaxy clusters

We will likely end up with multiple photo-z pipelines and resulting photo-z products, tailored to the needs of each science case


HOME
ABOUT
TUTORIALS
CONTACT
julia
Photo-z Server
Welcome to the Photo-z Server! This is an ancillary service available to Rubin Science Platform users to host lightweight data products related to photo-zs.
Click here for more details.
Rubin Observatory PZ Data Products
Official data products released by the LSST Data Management team.
User-generated Data Products
User-generated data products shared by members of the LSST community.
PZ Server Pipelines
Pipelines to create customized science-driven PZ-related data products.
RSP
Image credits: NOIRLab public images archive and LSST gallery.
Powered By

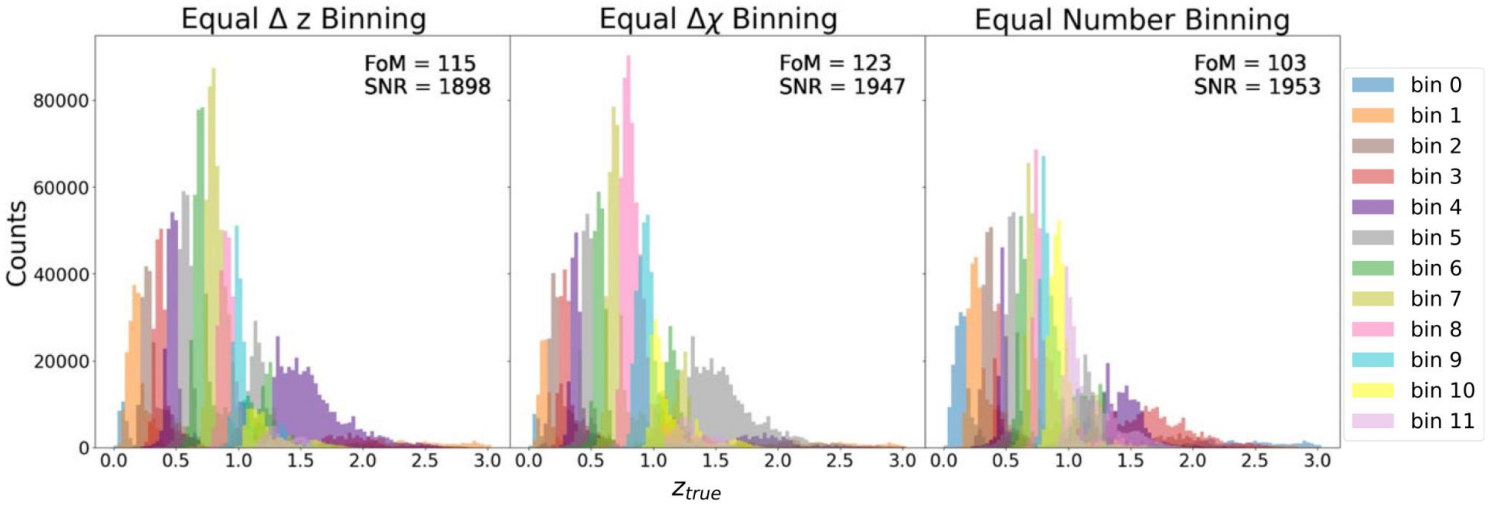

1. User requests Train/Valid sets based on a spec-z catalog + selection criteria
4. Return metadata and data access instructions
Photo-z Server
3. Register results as data products on PZ Server
IDAC BRASIL
LSST
2. Cross-matching with Object Catalog using LSDB

Optimizing definition of n(z) binning

See Irene's poster
@ 5:30pm today!

Exploring different schemes for determining bin edges to optimize DE figure of merit

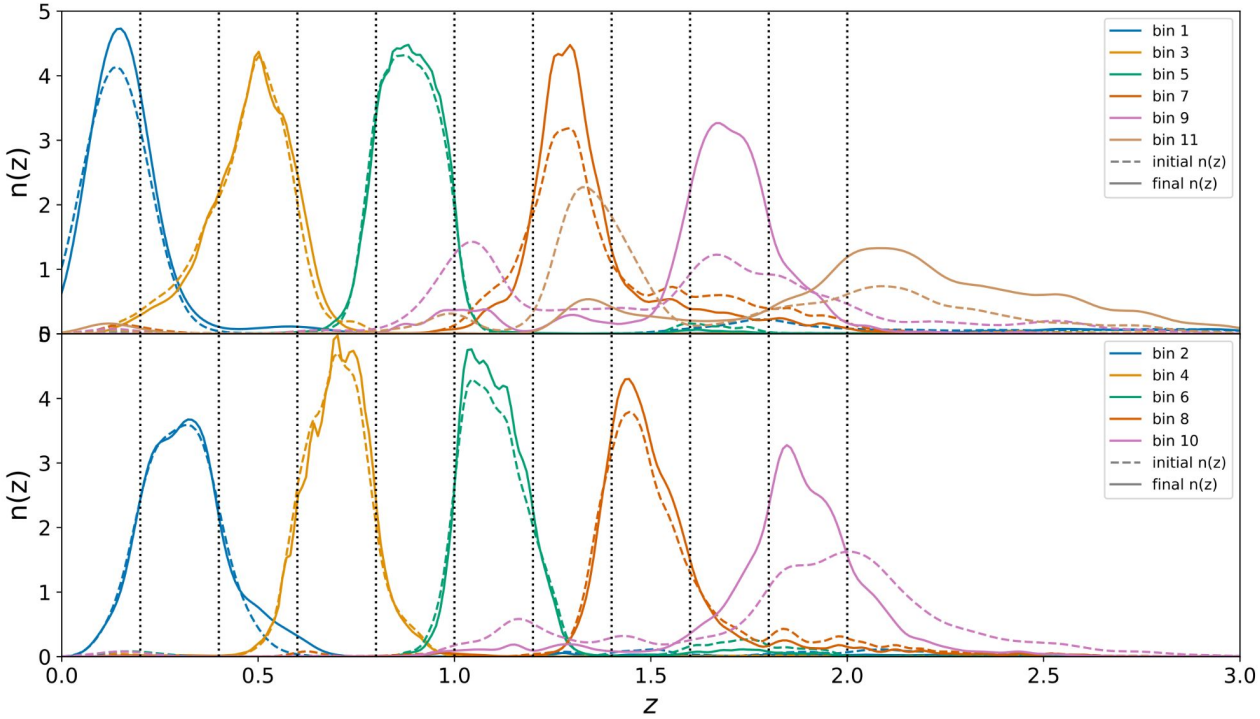
Moskowitz 2023 shows equal comoving distance is close to optimal (but depends on galaxy sample)



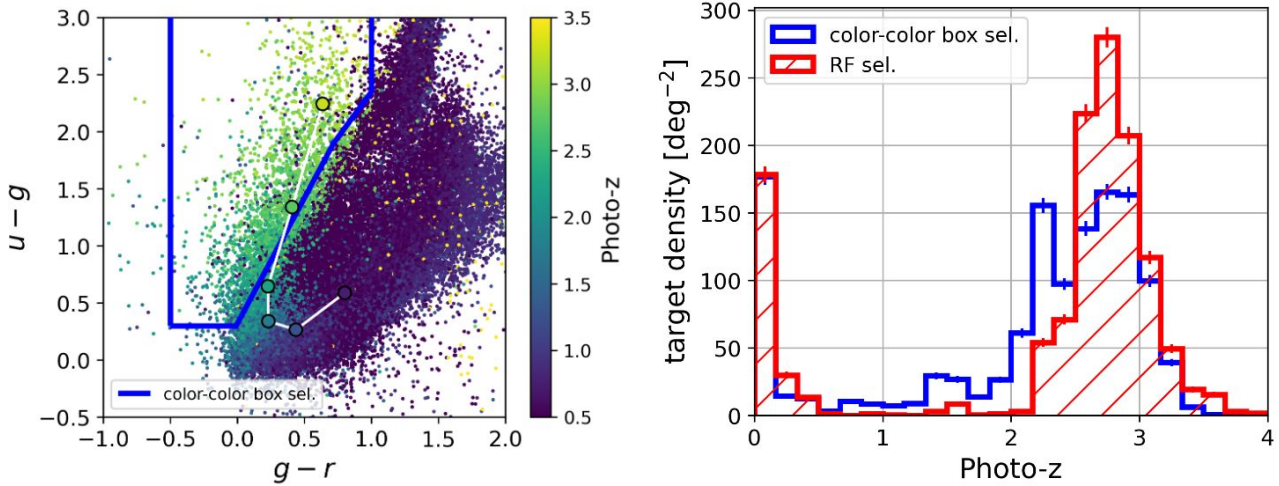
Optimizing Bin Assignment with Annealing

Stölzner 2022 developed method of using simulated annealing together with clustering signal to optimize tomographic bin assignment

(decreases outliers in highest-z bin from 57% to 16%)

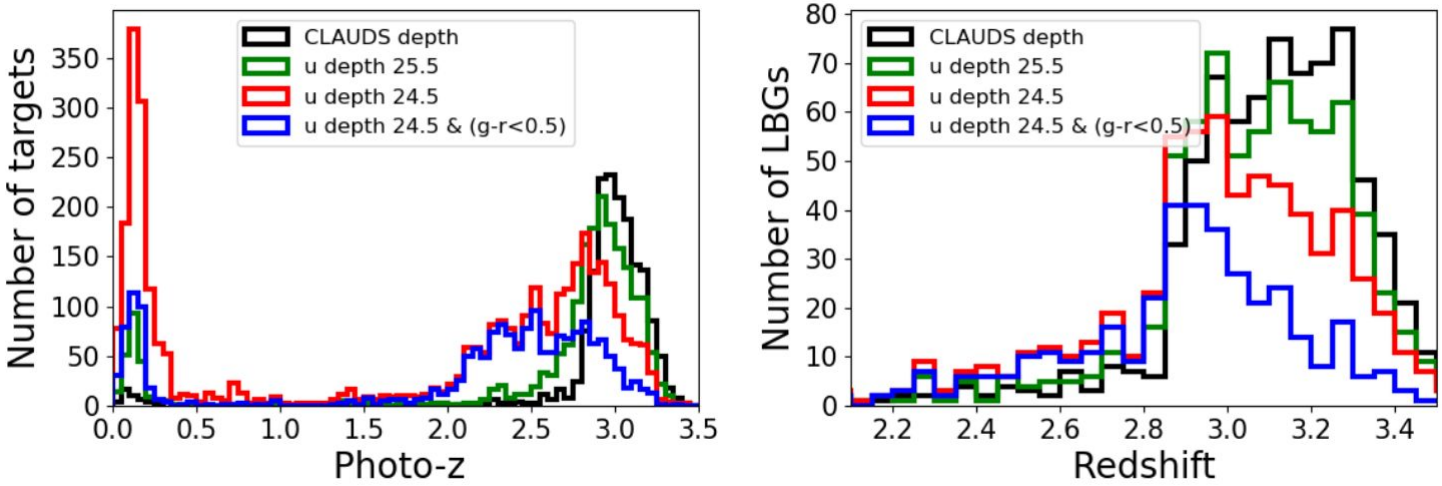


LBG selection: color-color vs random forest



Payerne 2024

LBG purity vs u-band depth



Ruhlmann-Kleider 2024