

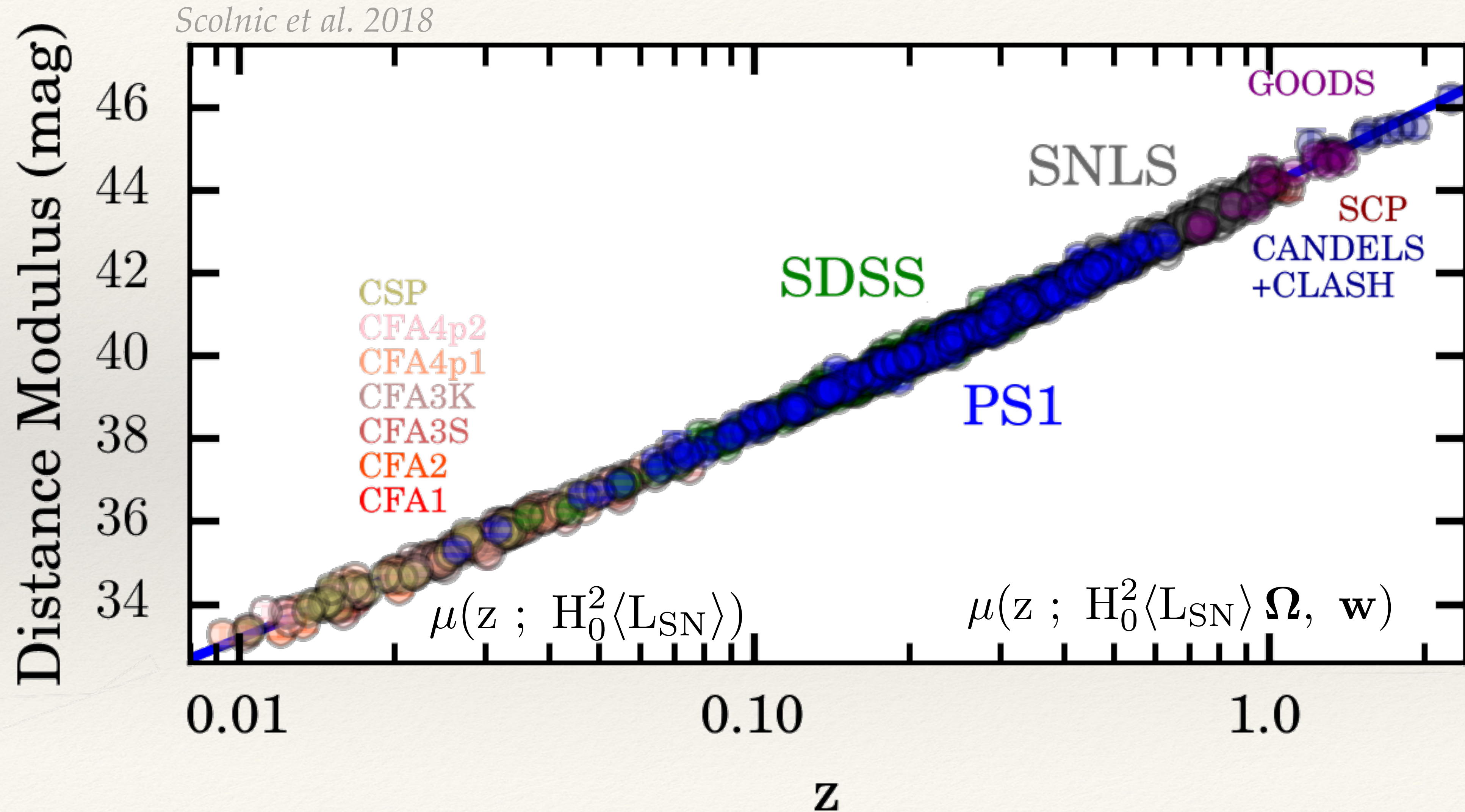
The Zwicky Transient Facility

SNIa Cosmology in 2022

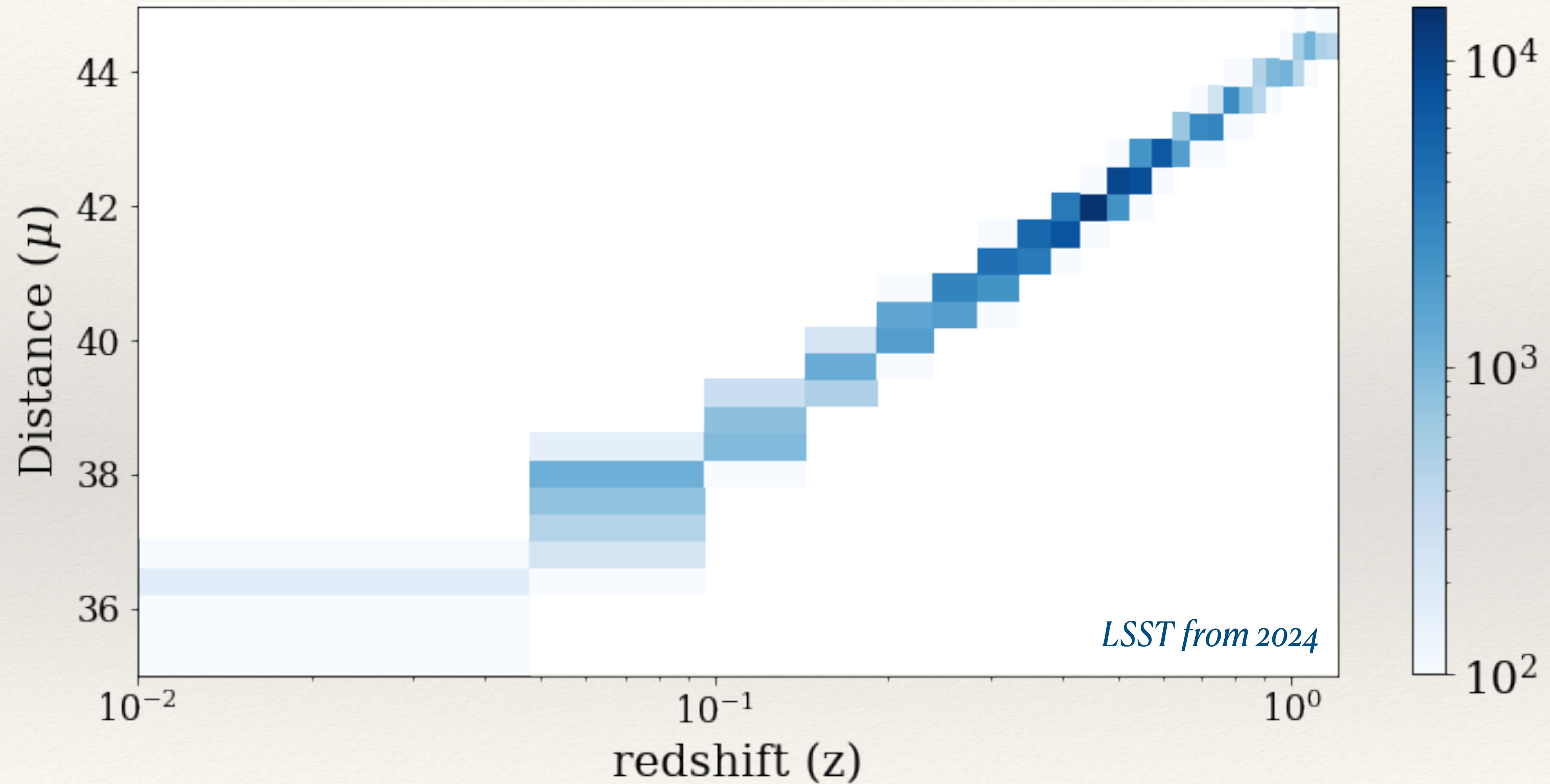
Mathew Smith (IP2I, Lyon) on behalf of the ZTF SNIa WG



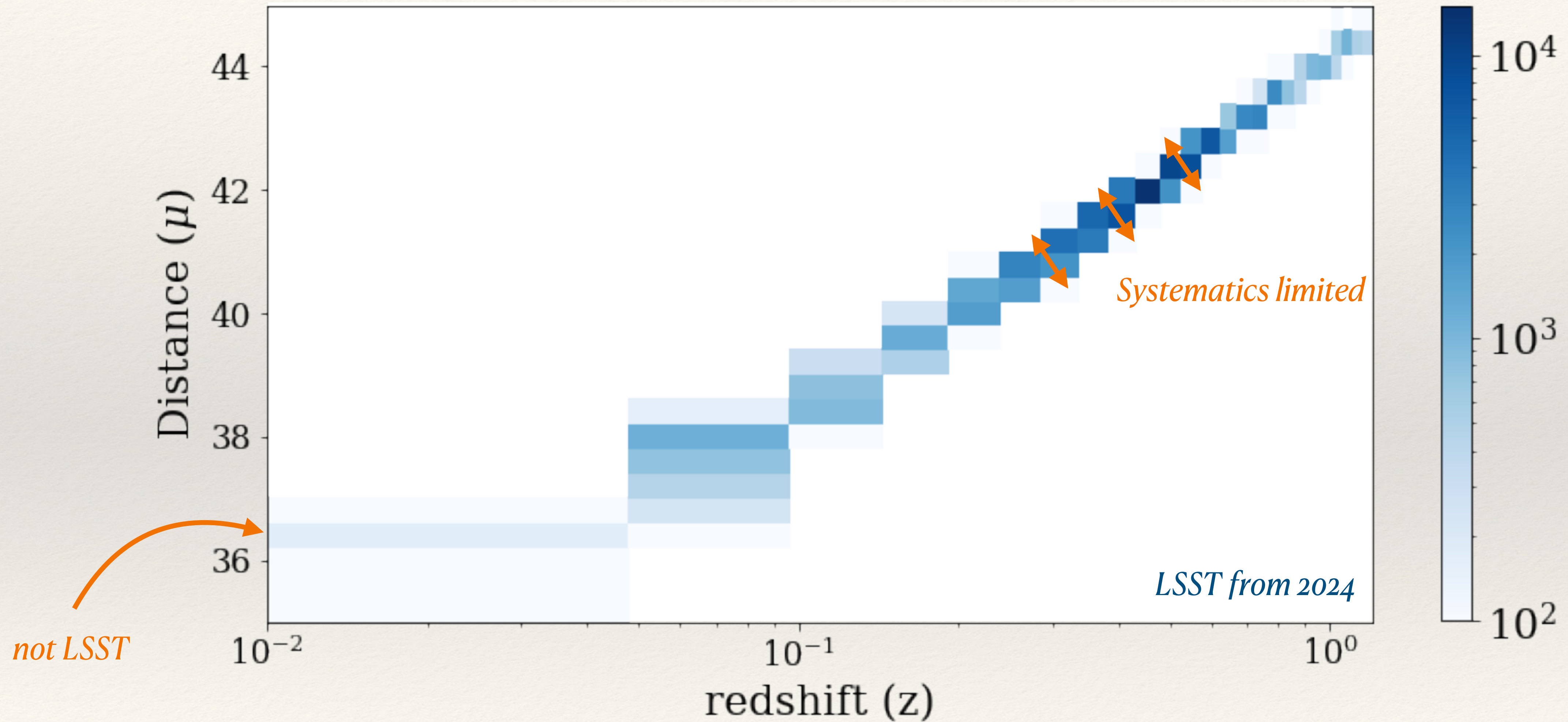
SNIa Cosmology: Today



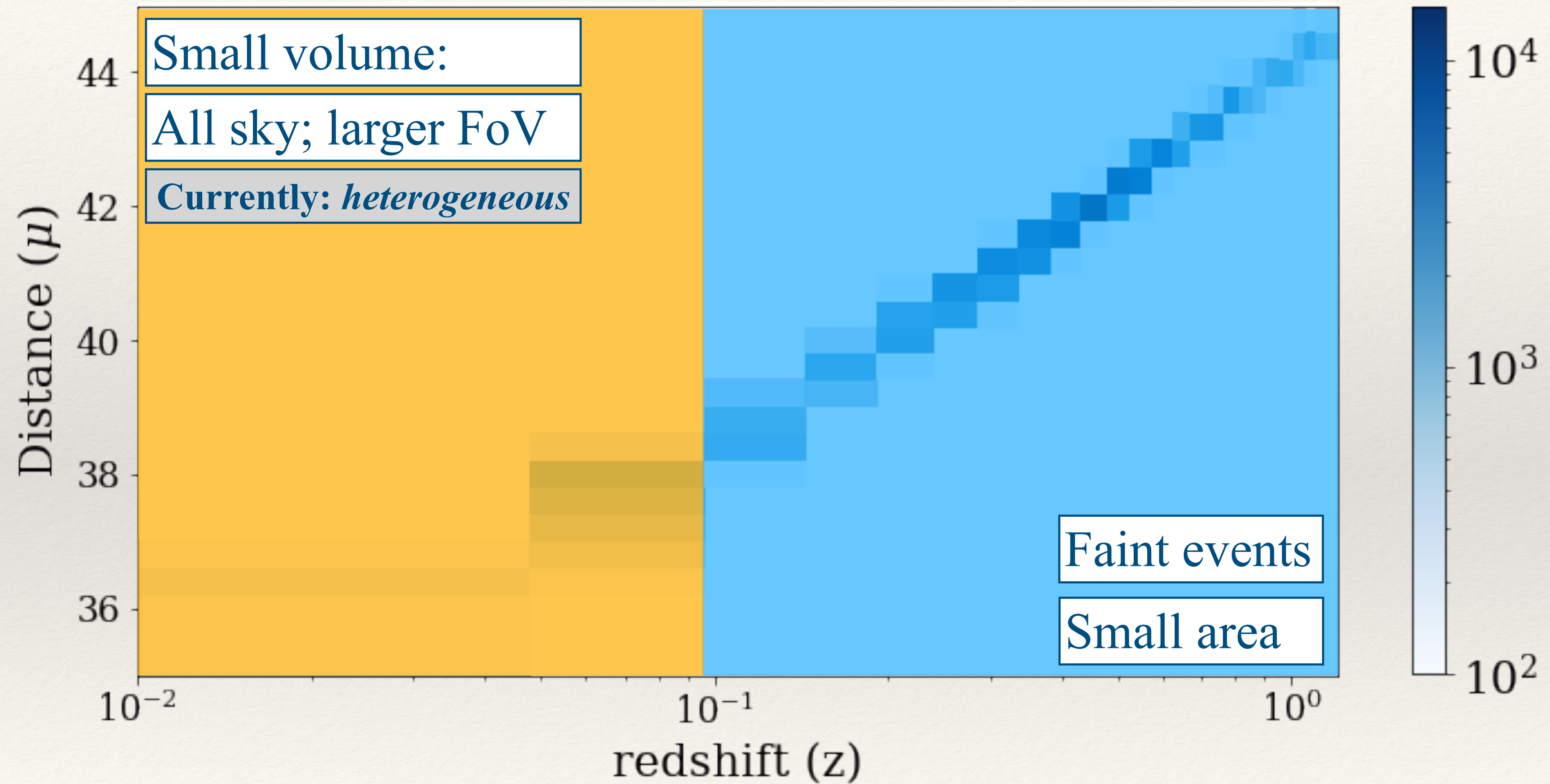
SNIa Cosmology: 2028



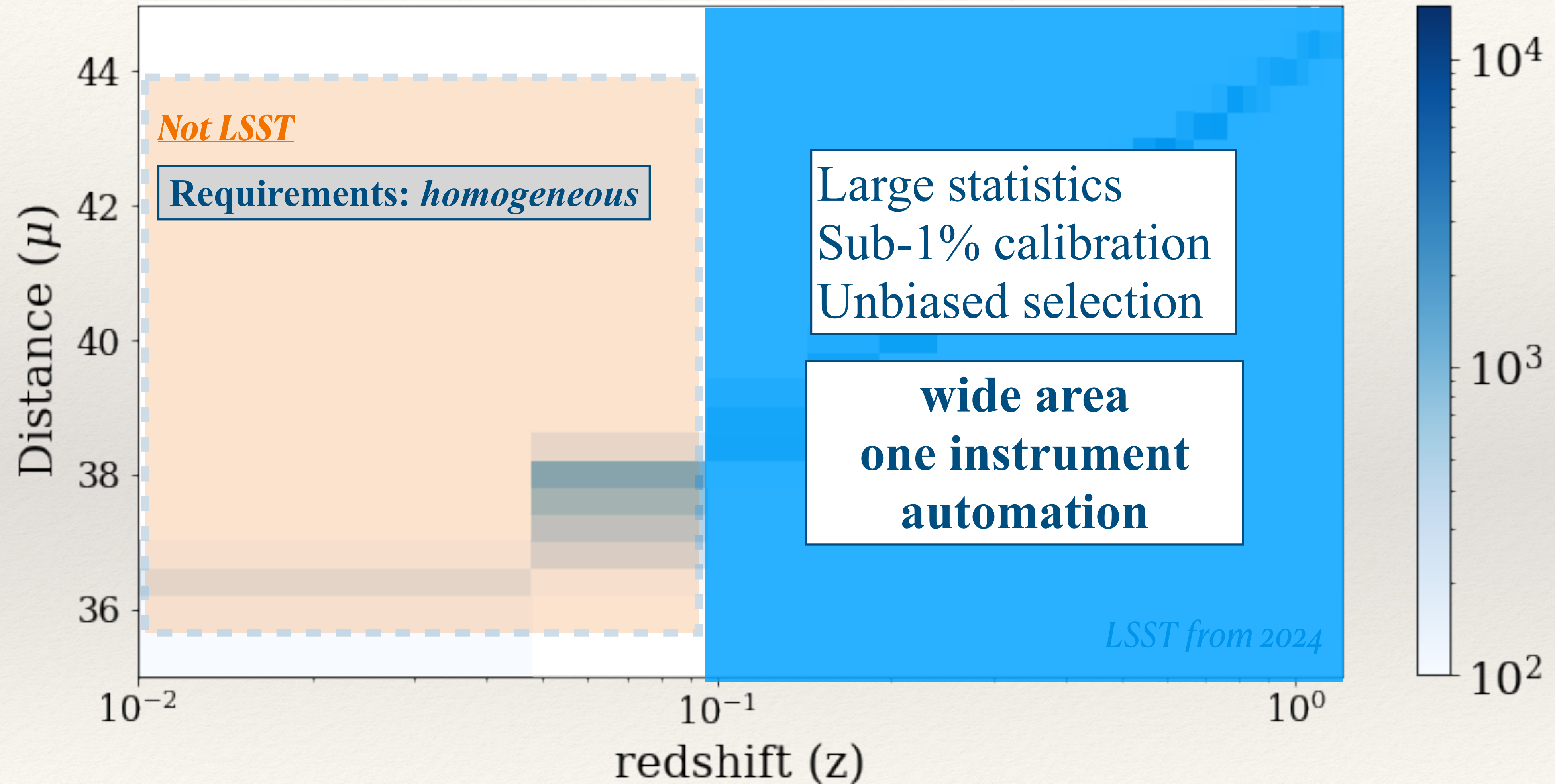
SNIa Cosmology: 2028



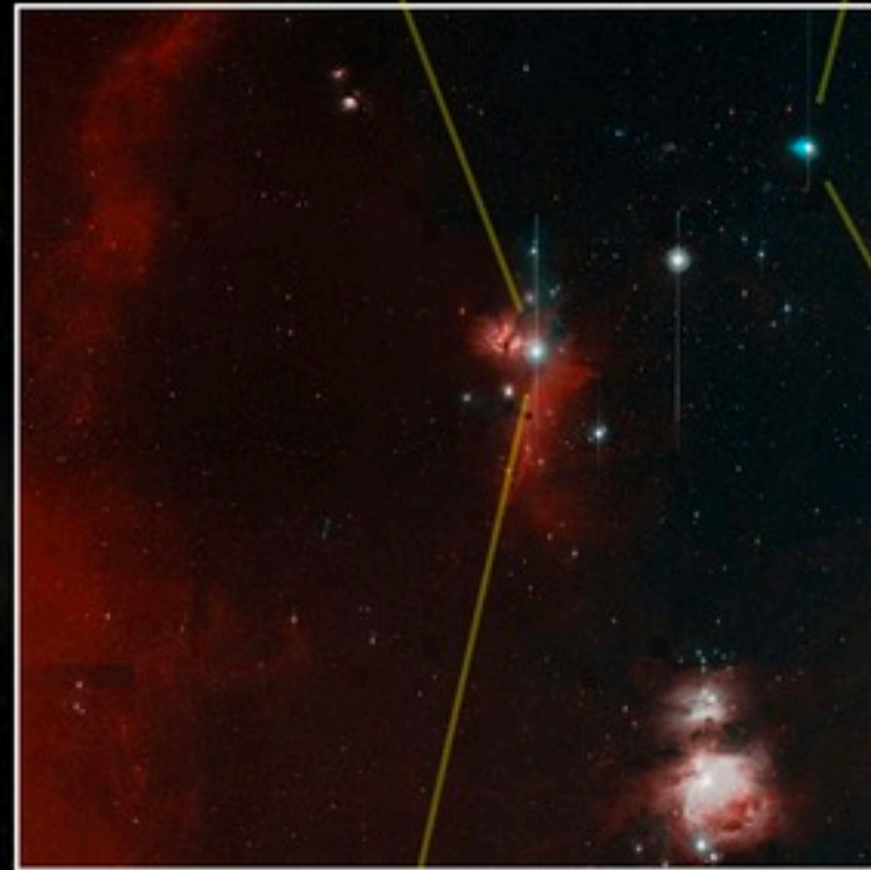
SNIa Cosmology: 2028



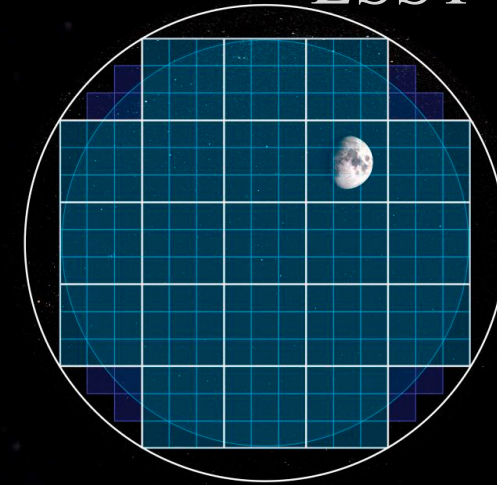
SNIa Cosmology: 2028



ZTF



LSST



Zwicky Transient Facility (ZTF)

3 filters (g, r, i)

FoV: 47 deg²

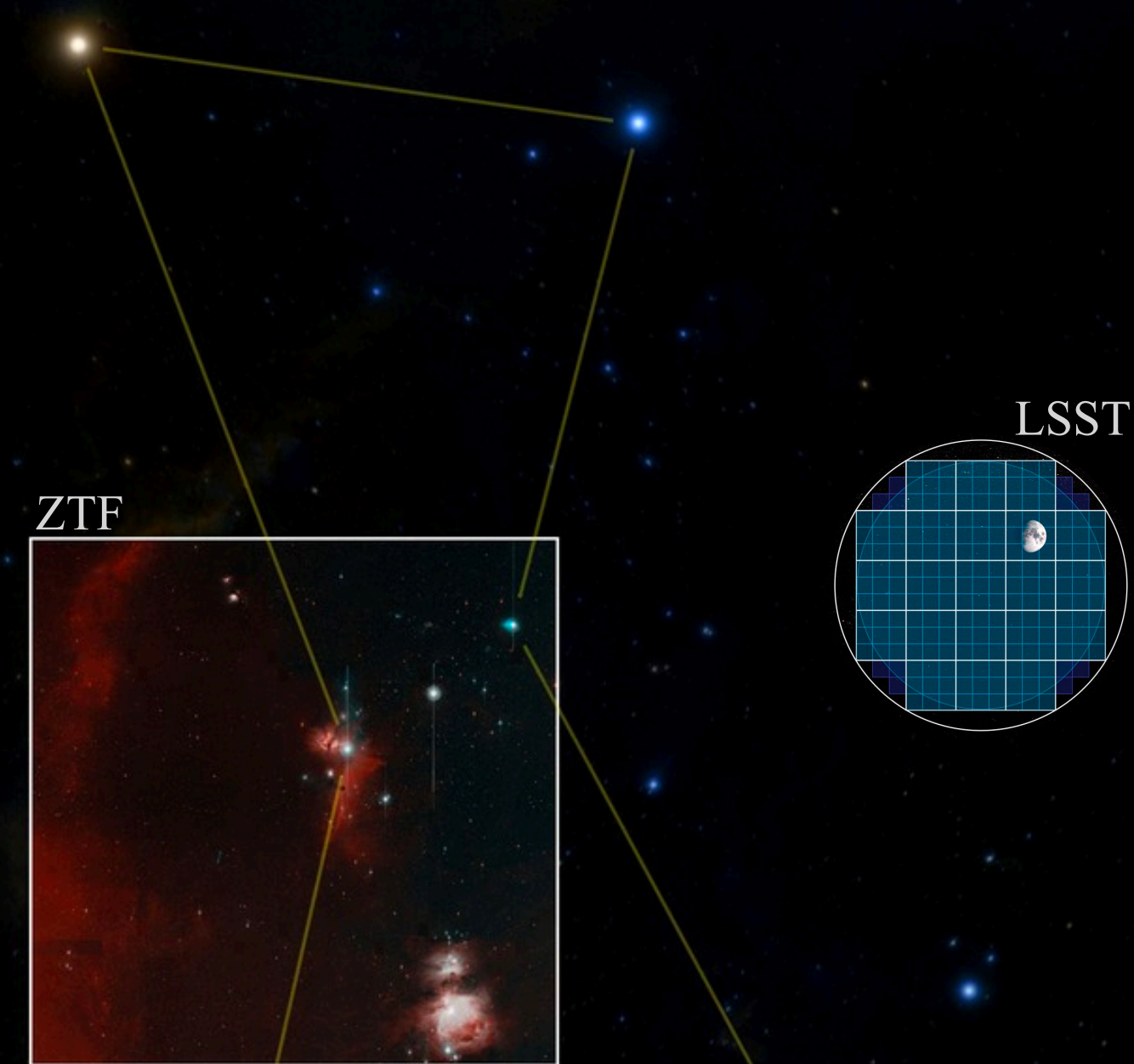
5 σ depth: 20.5 mag

CCD: 1pixel = 1arcsec

footprint: 15,000 deg

dedicated spectroscopy

ZTF 1: 2018->2020 3 day (g+r) + some i
ZTF 2: 2021->2023 2 day (g+r) + 5 day i



Caltech



IN2P3



ipac



Automated spectroscopy



'ZTF'
P48: Discovery



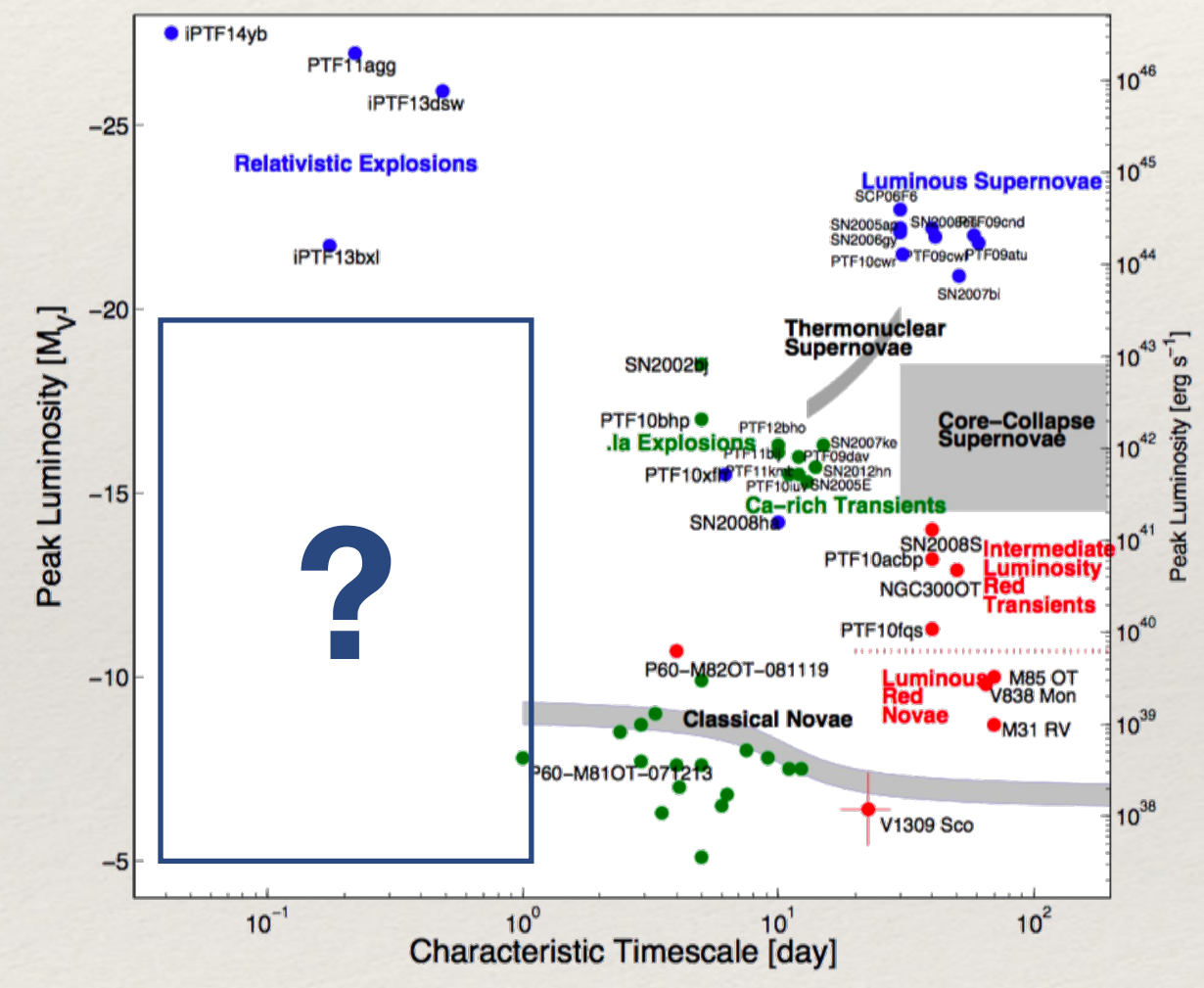
SEDm
P60: Followup
fully automated



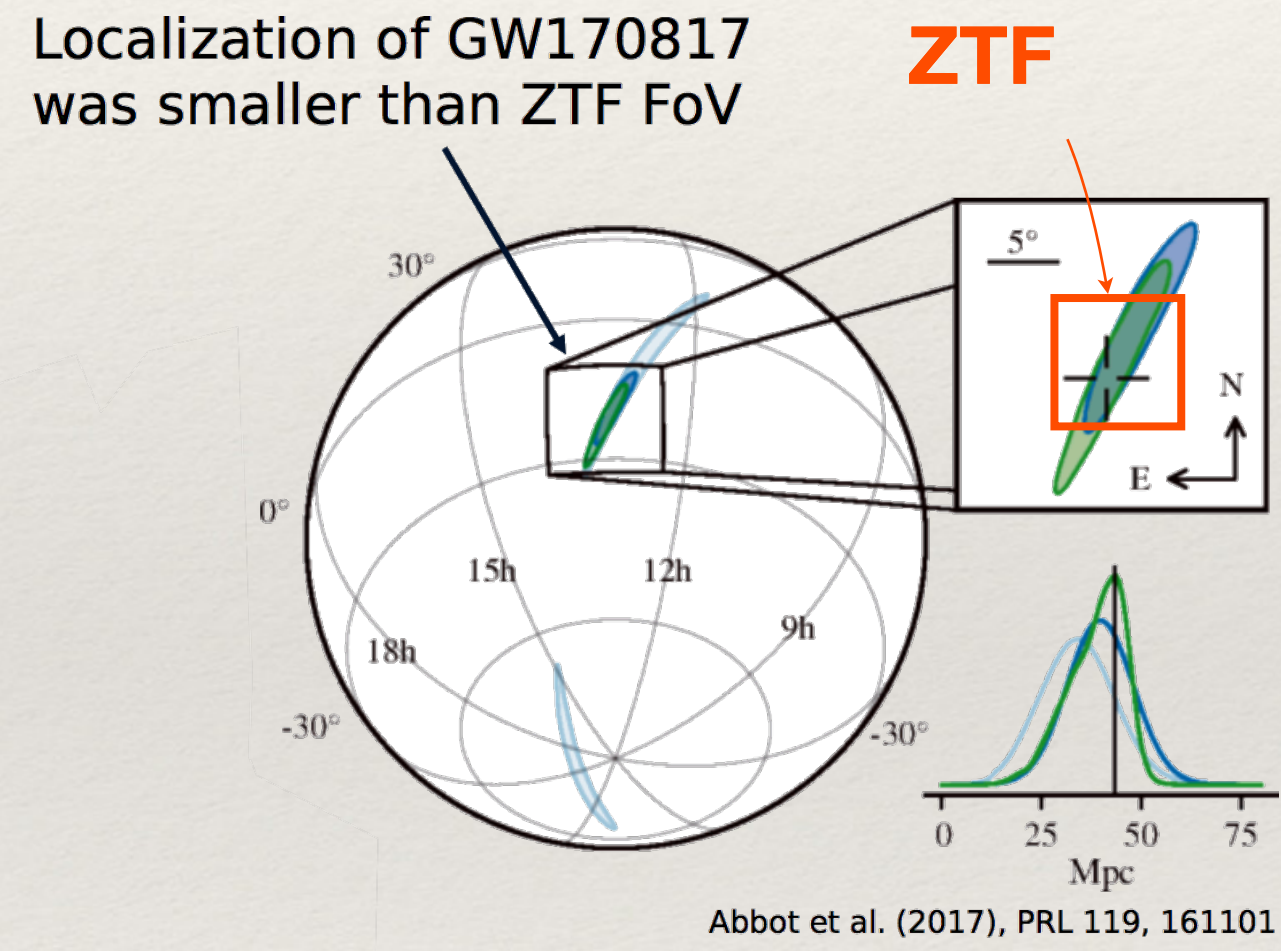
P200: Classification
'Just a 5m'

Some ZTF Science Cases

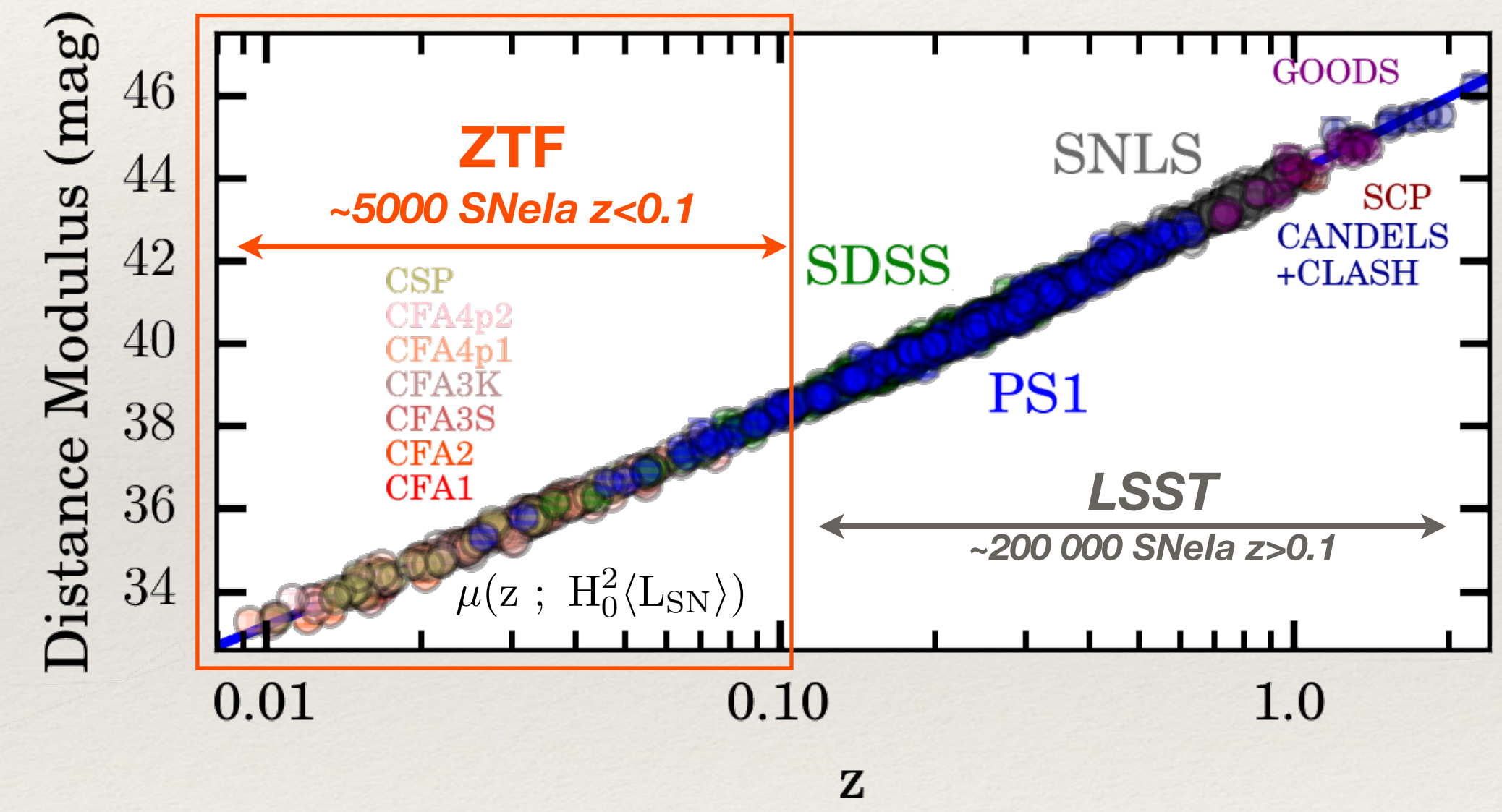
Transient Astro. Flash Spectroscopy



Multi-Messenger GW & Neutrinos



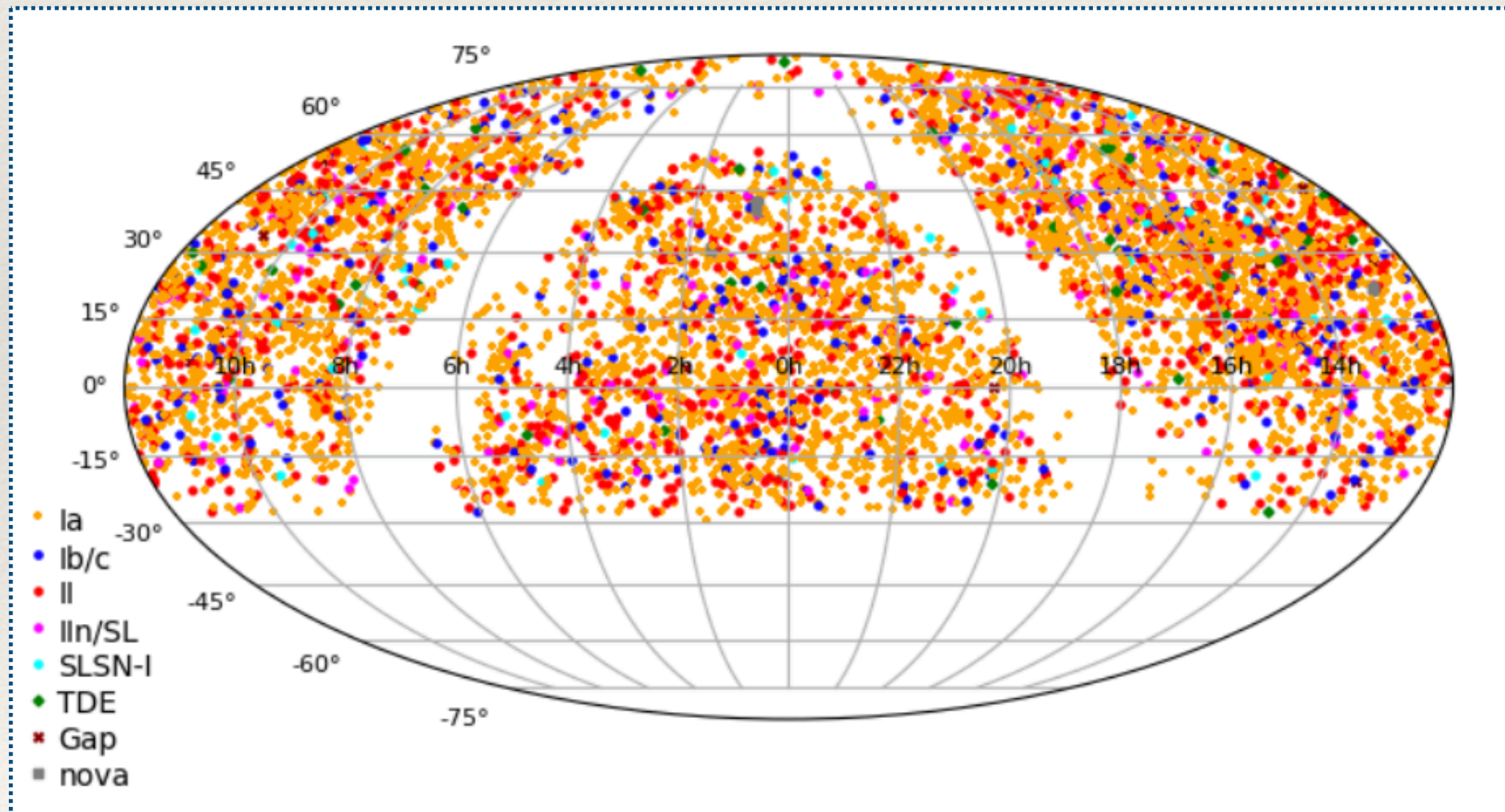
Supernova Cosmology Incl. w , H_0 , σ_8



Tidal Disruption Events | Stellar Astrophysics | Solar System Bodies | ...

ZTF: *In reality*

ZTF Today



Raw numbers

>1 million images

>2 million alerts

likely 200,000 SNe

Supernovae

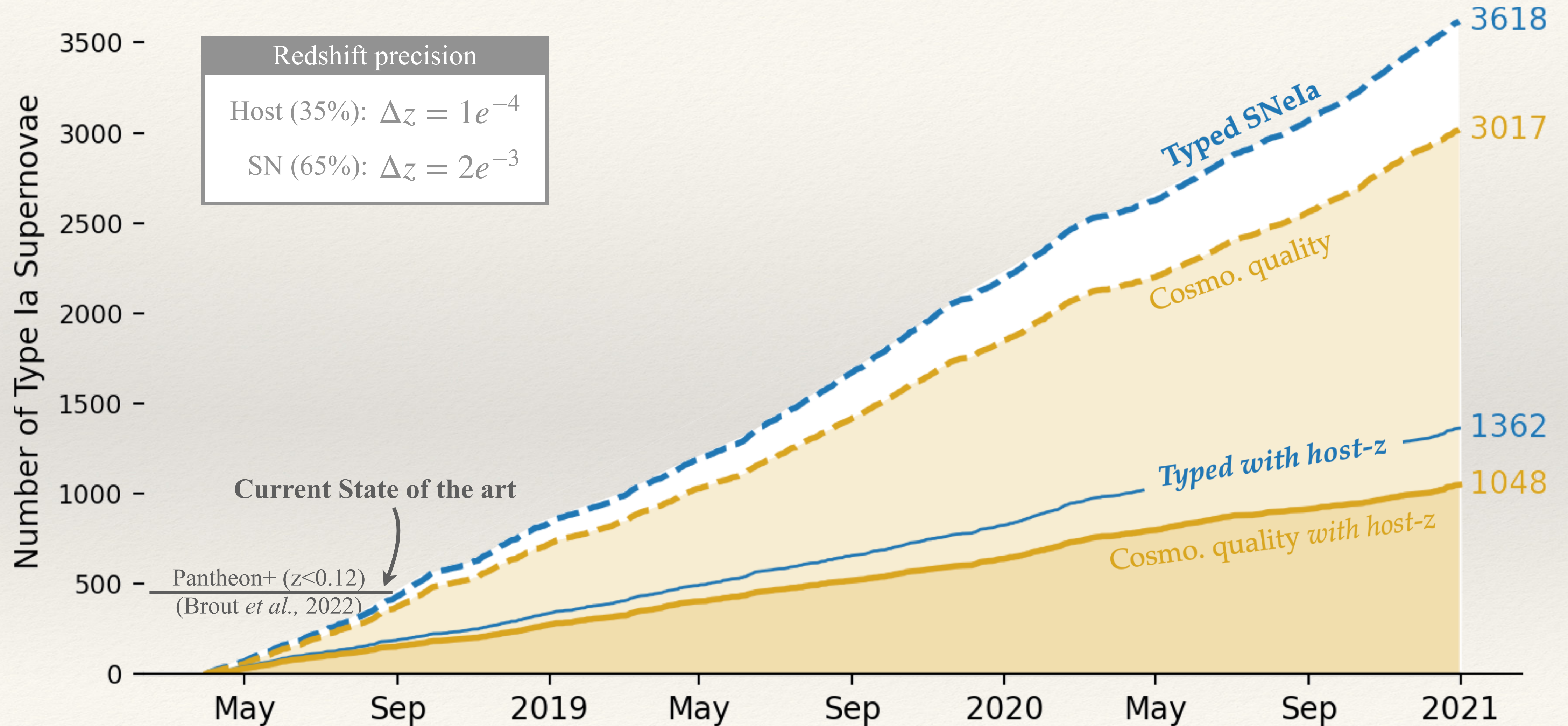
12,000 discoveries
($r < 19$)

8,000 classifications

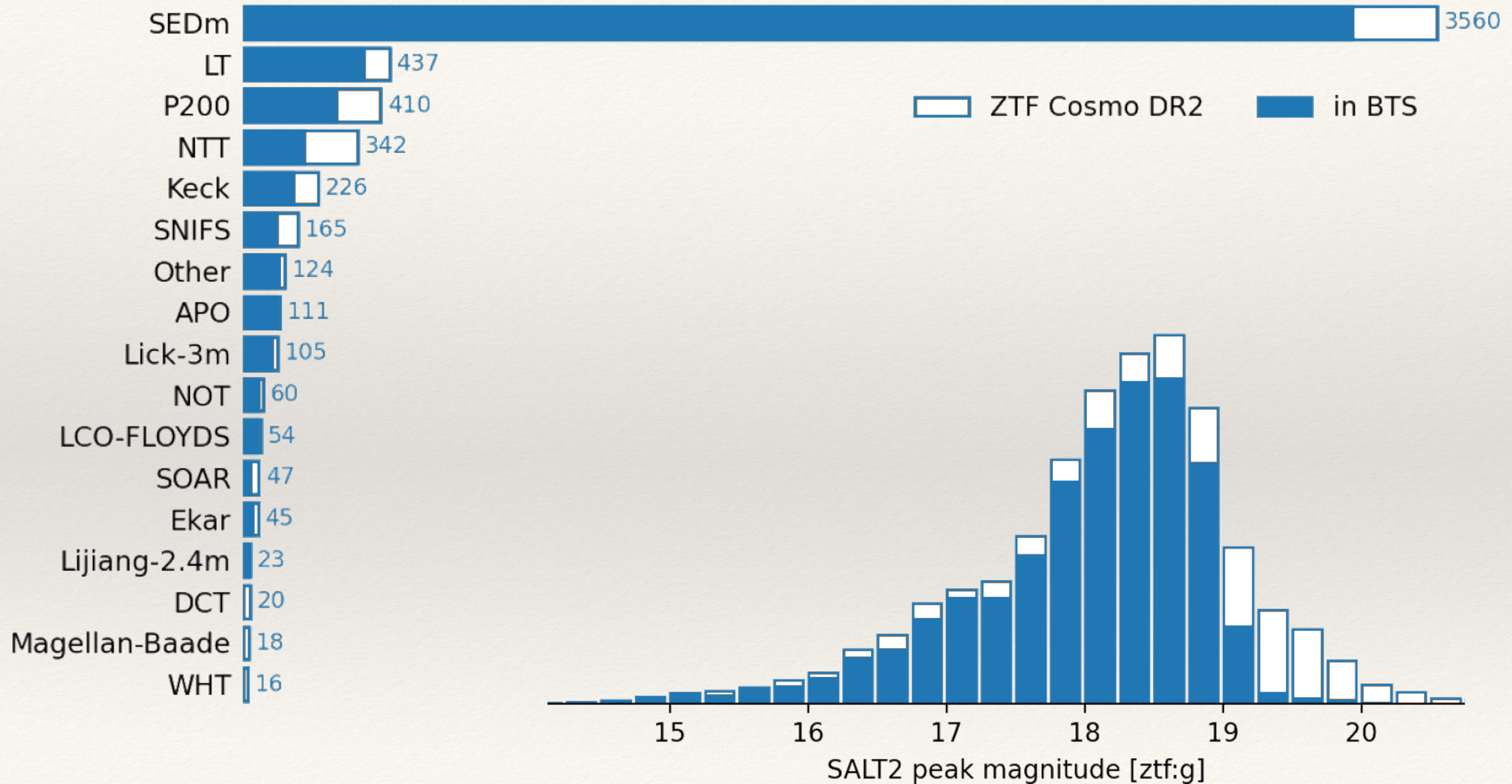
5,000 SNeIa

Towards Cosmology: Introducing ZTF-DR2

ZTF | Changing the scale of SN Cosmology

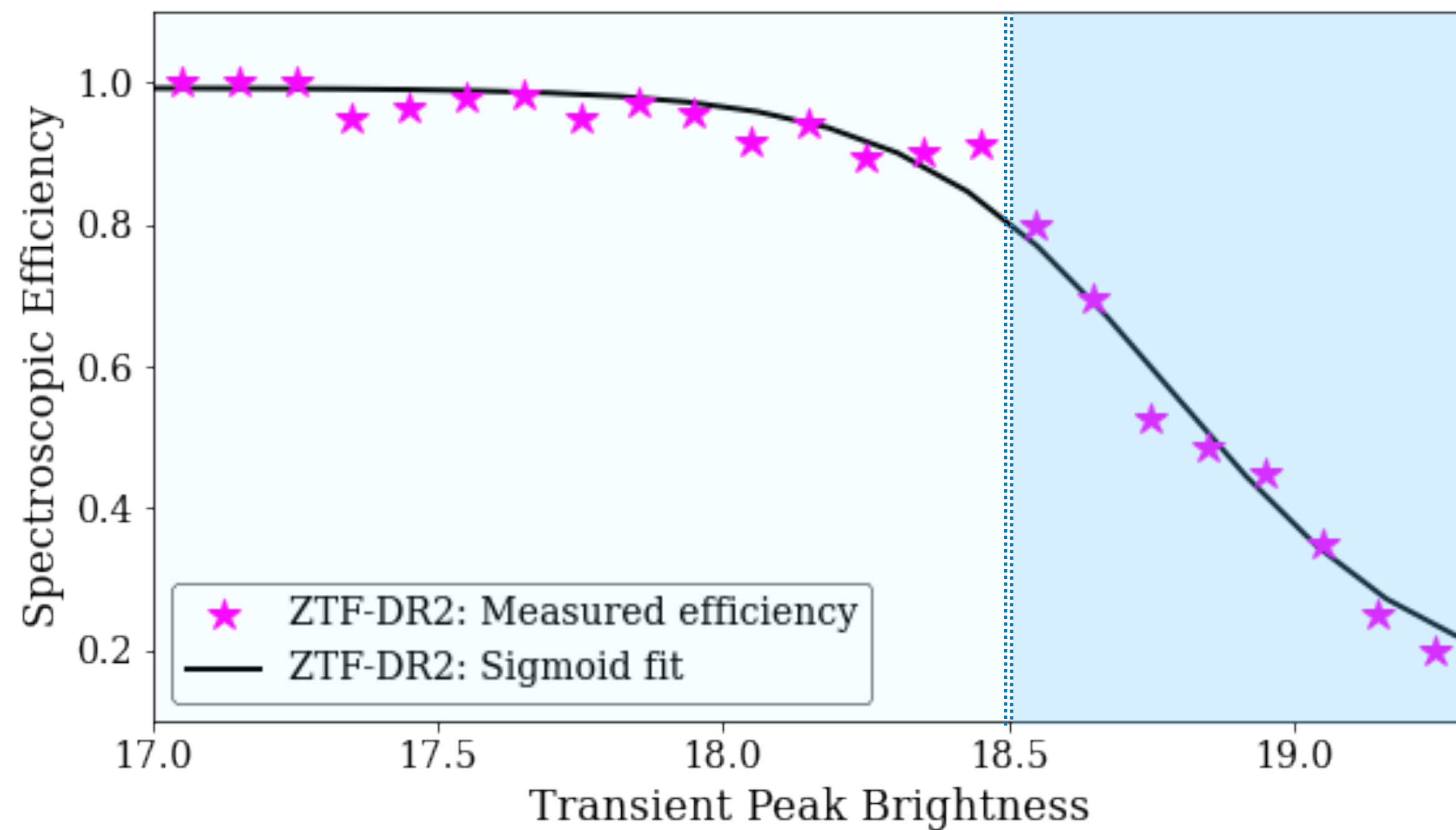


Spectroscopic Follow-up

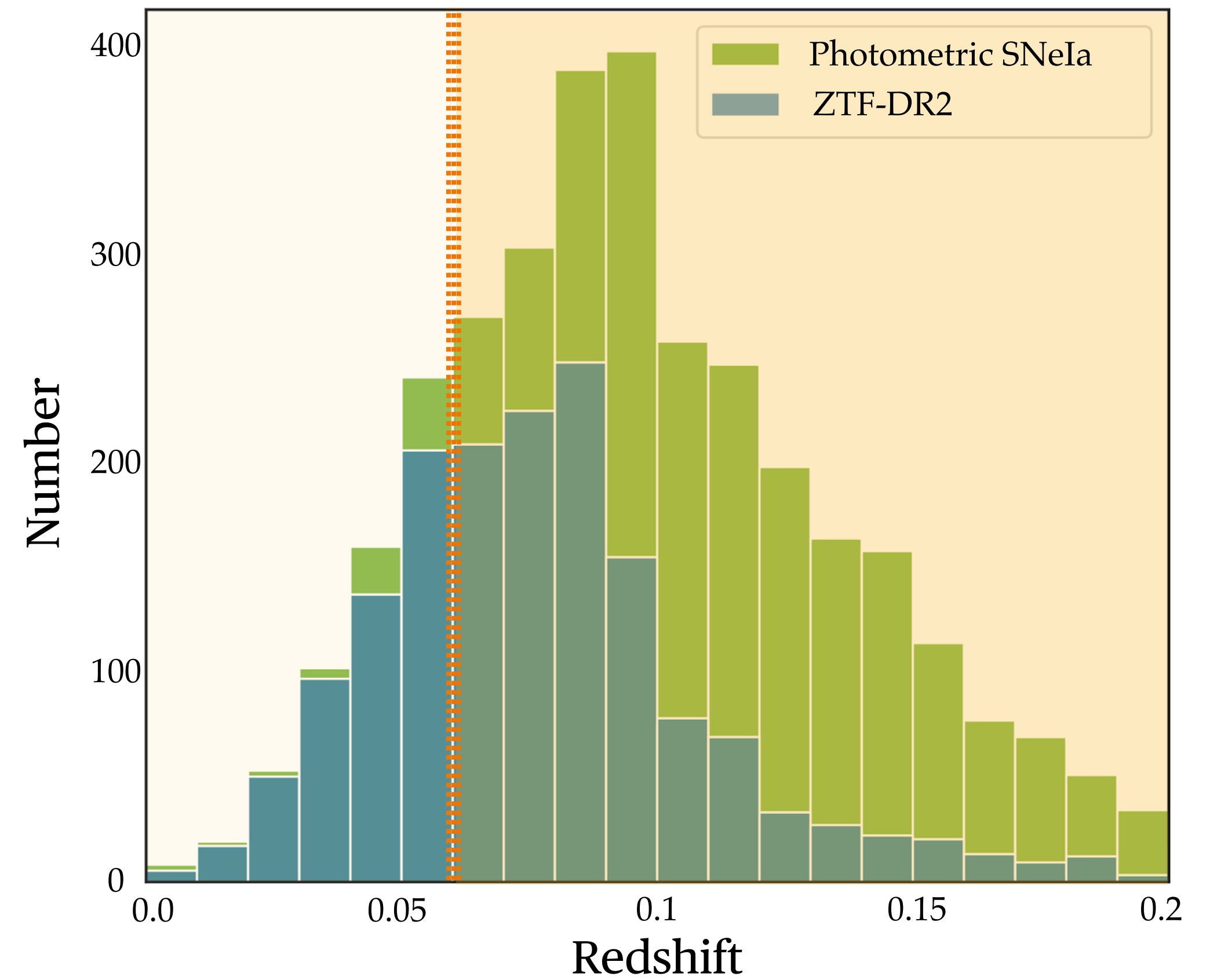


Completeness

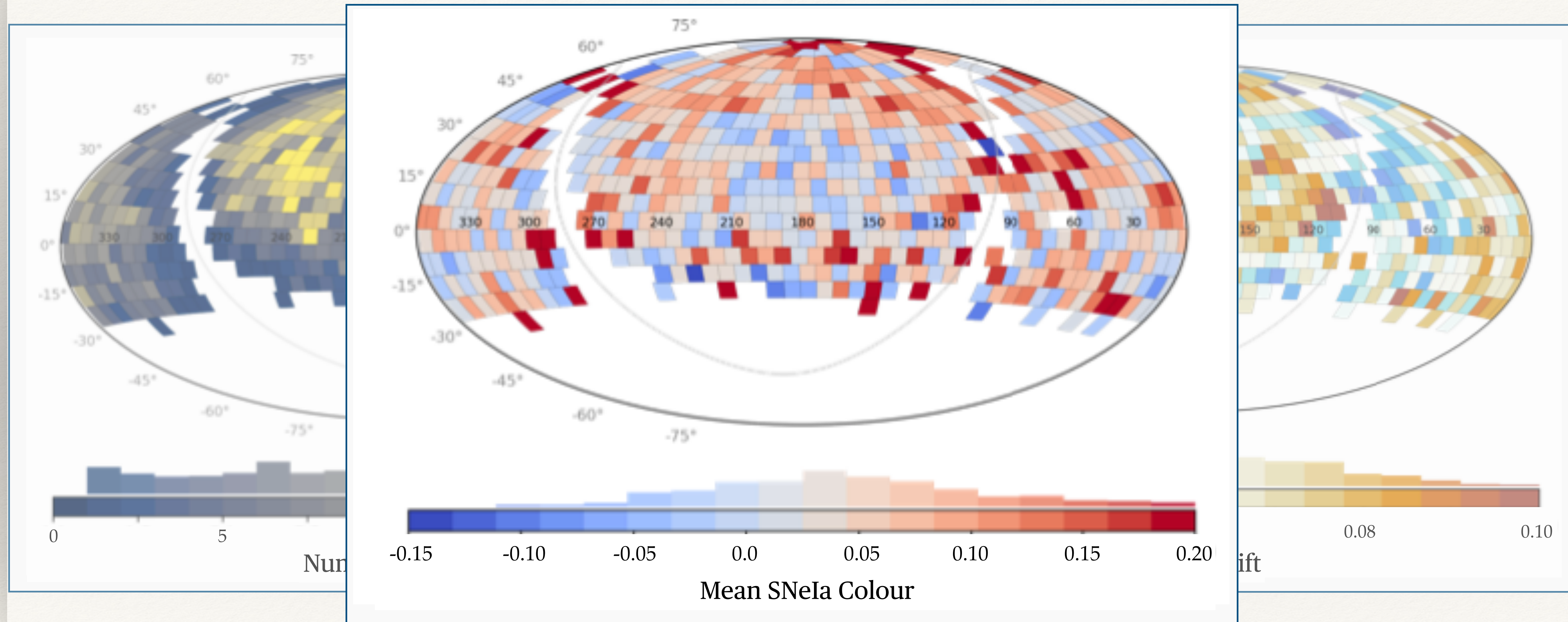
Complete and unbiased to $m=18.5$

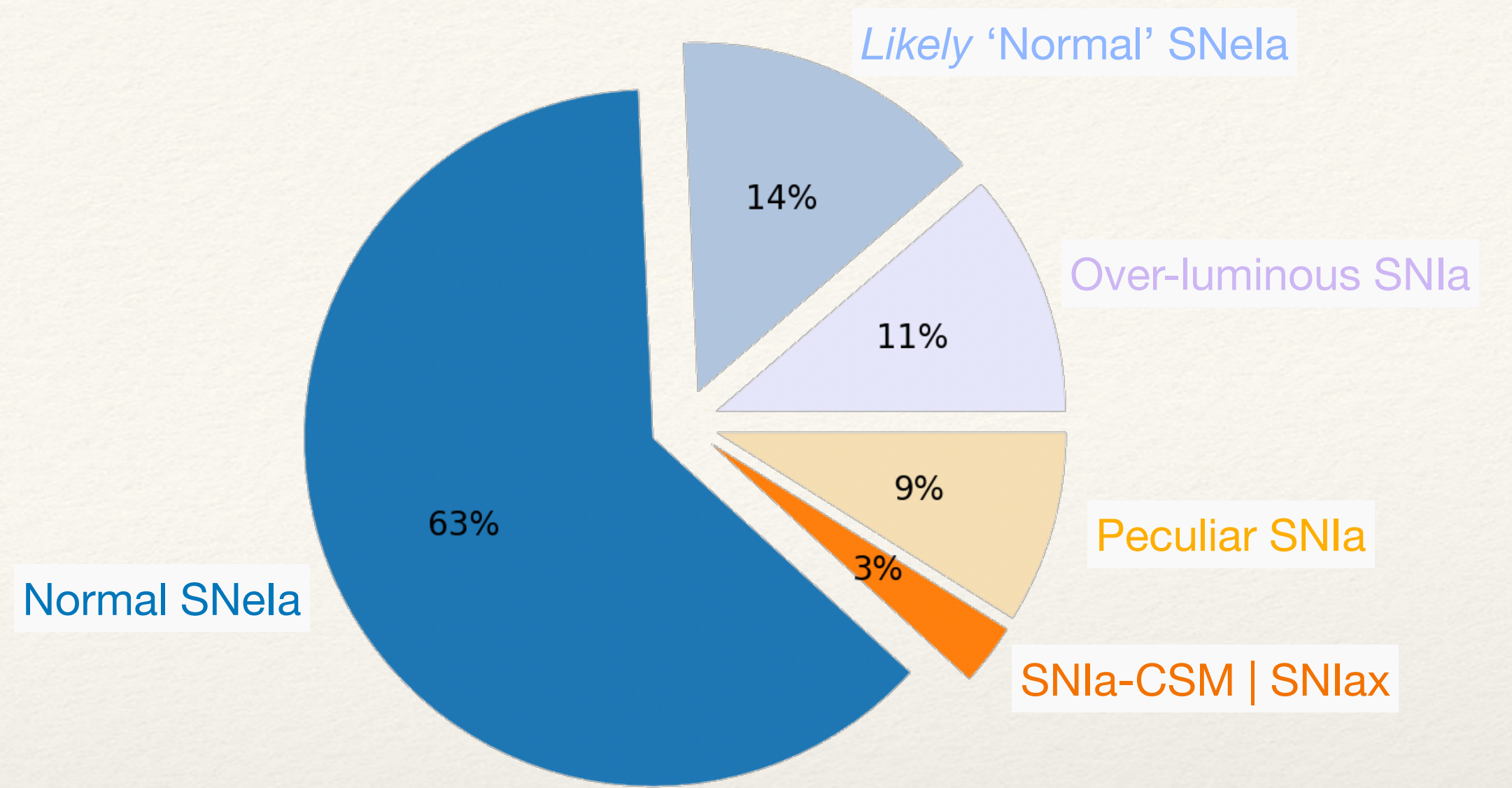
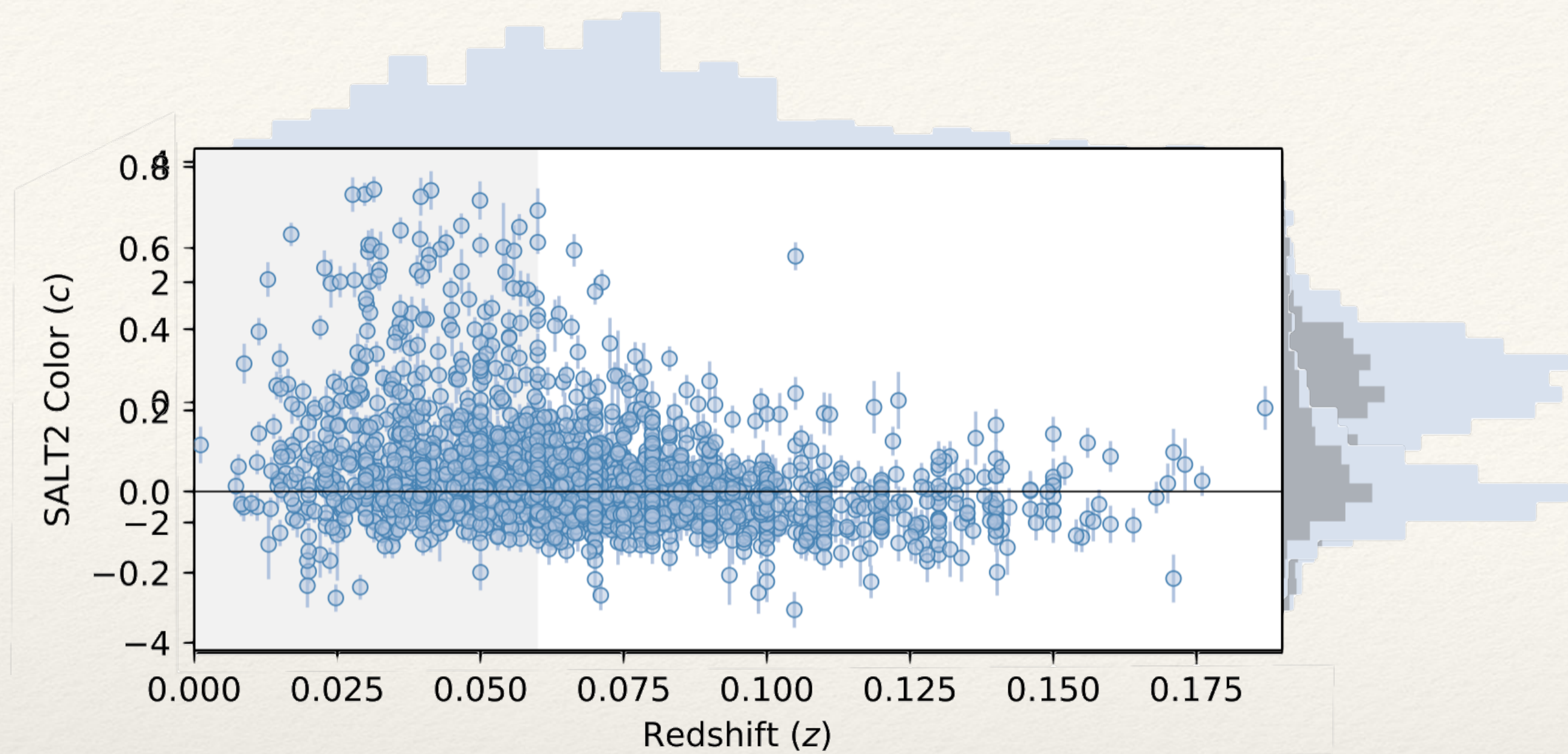


Unbiased to $z=0.06$

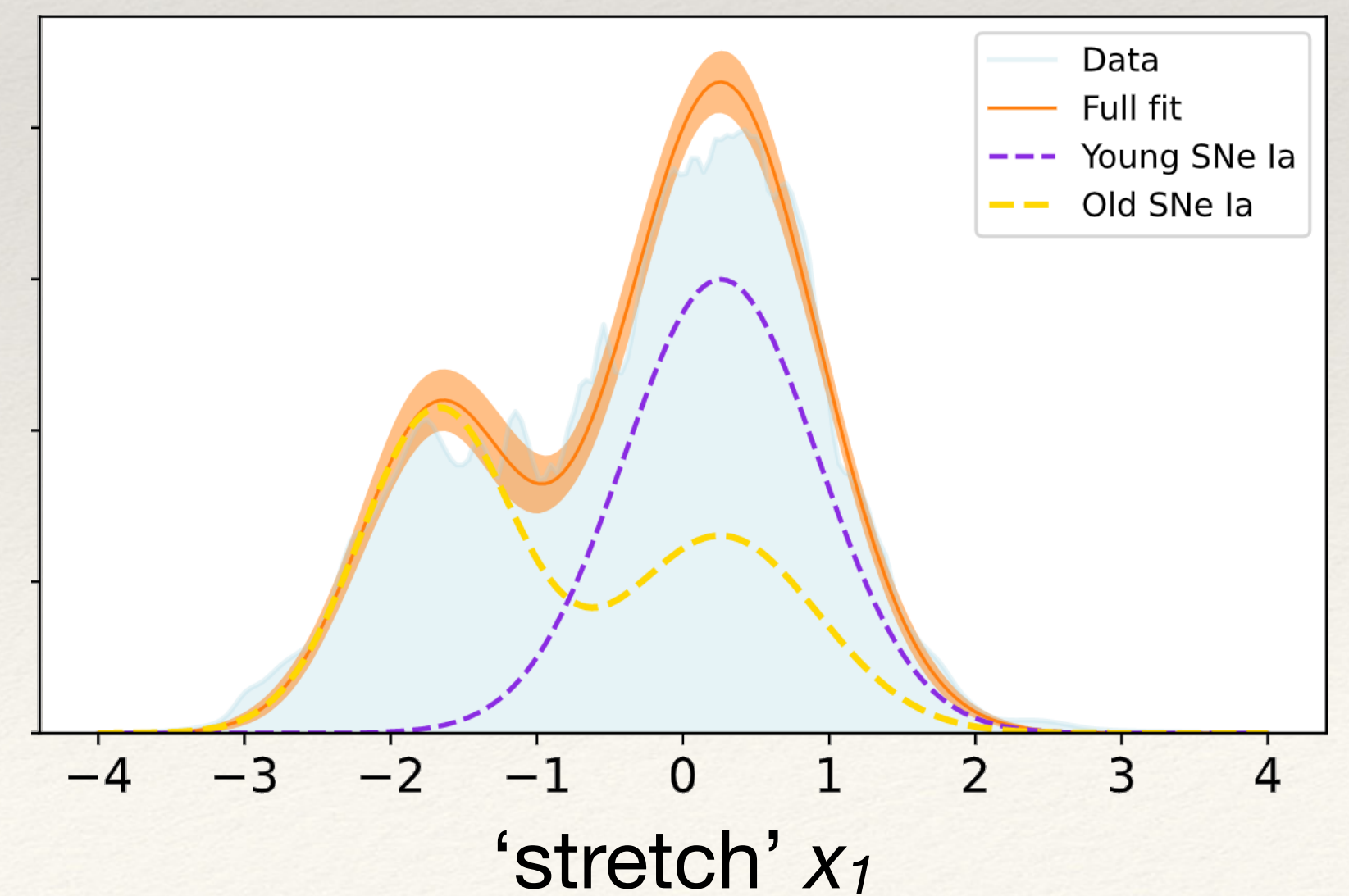
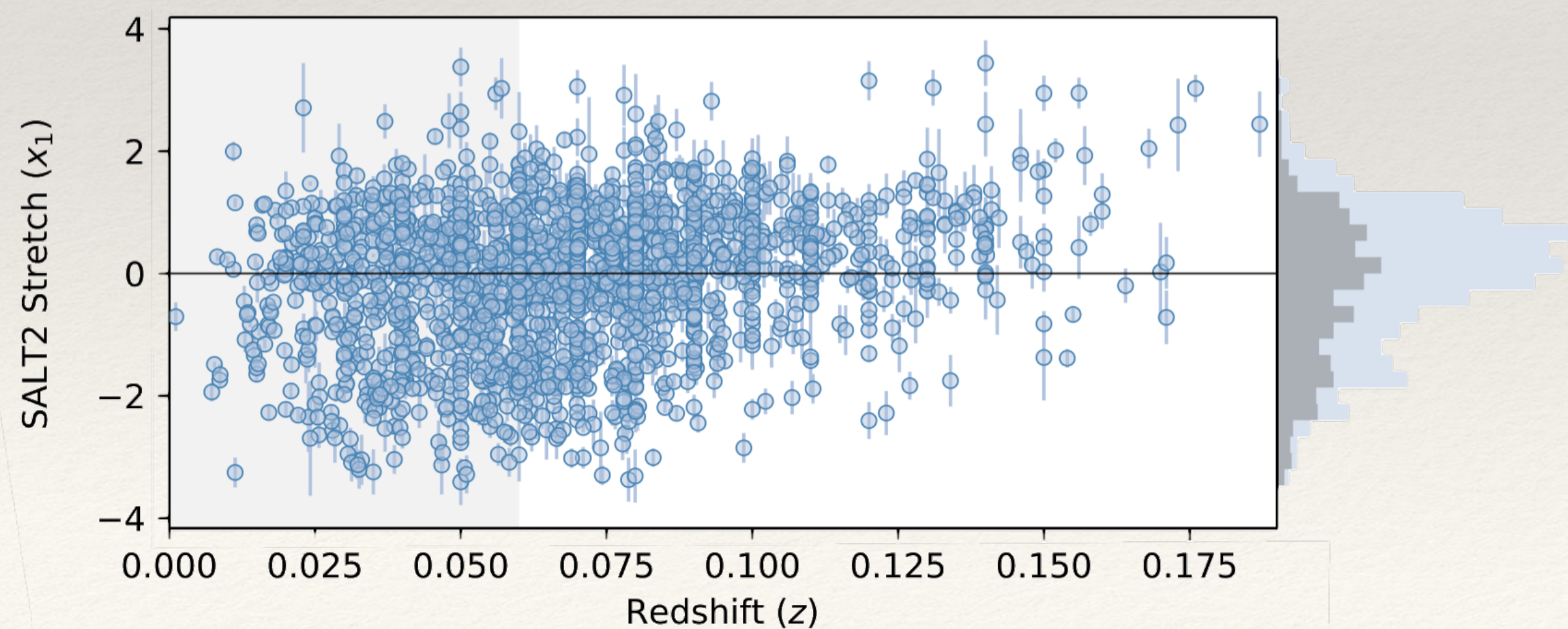


Spatial Uniformity



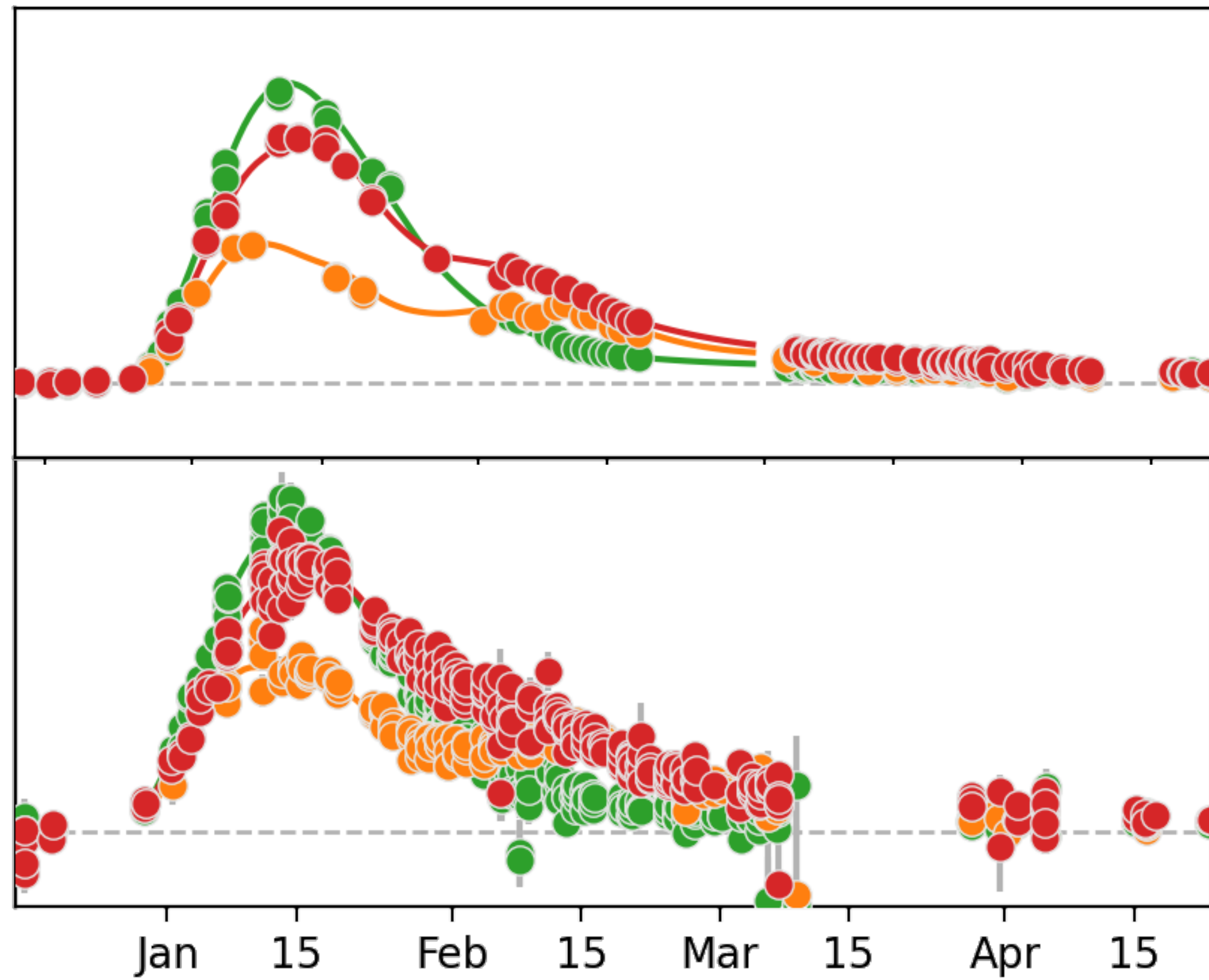


Defining SNeIa | *Madeline is next*

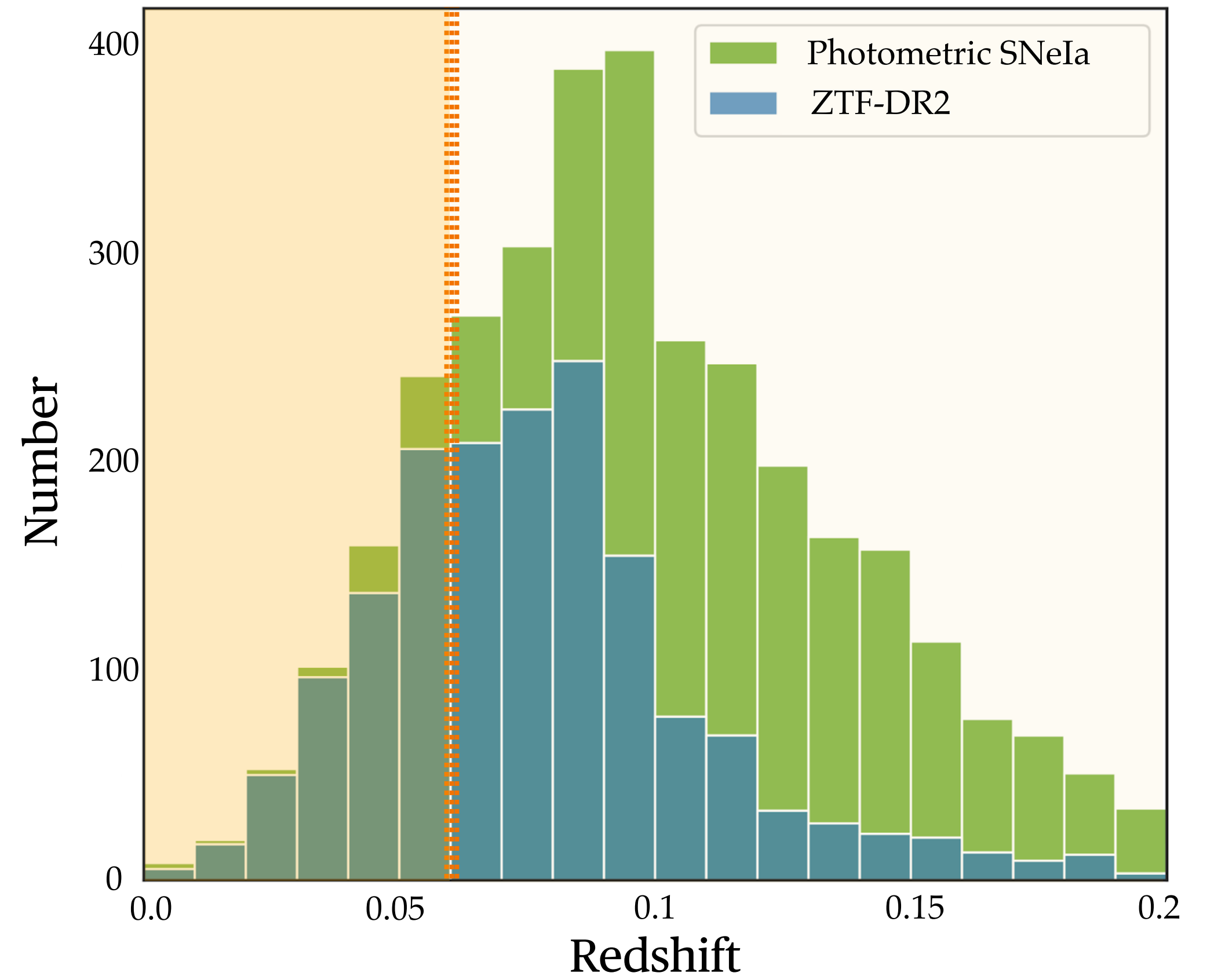


Two outstanding issues

Field-to-field calibration uncertainties



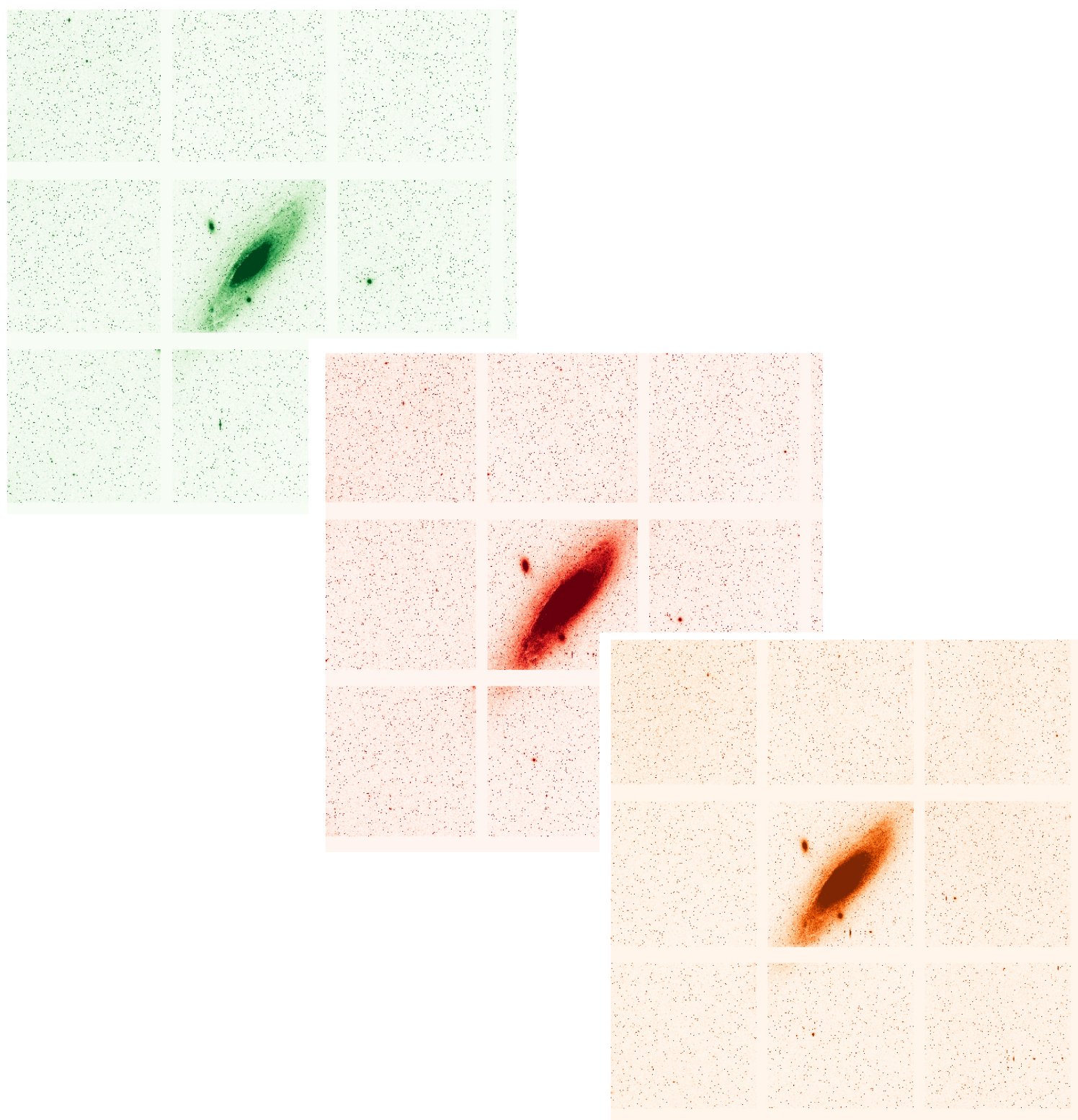
Quantifying biases



Photometry: ZTF-IN2P3 pipeline

Data uniformity

IN2P3 Pipeline : Consistent reduction of all images



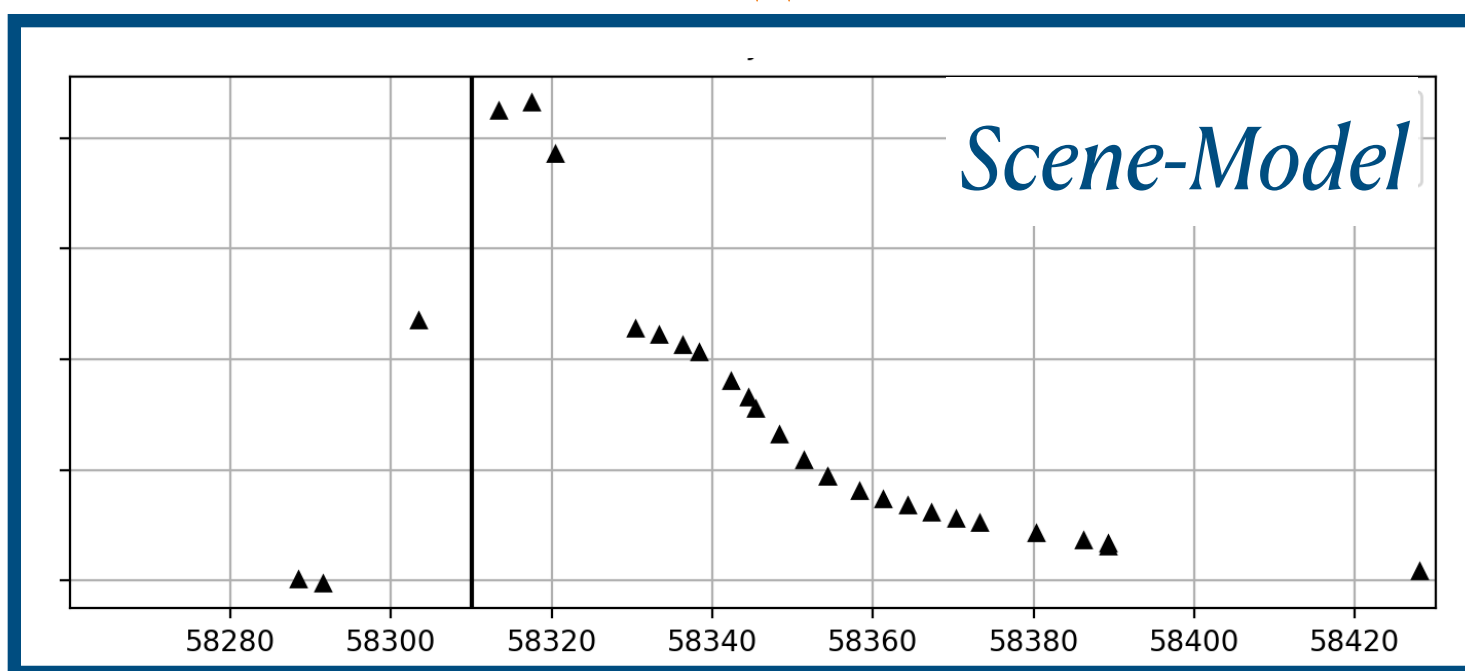
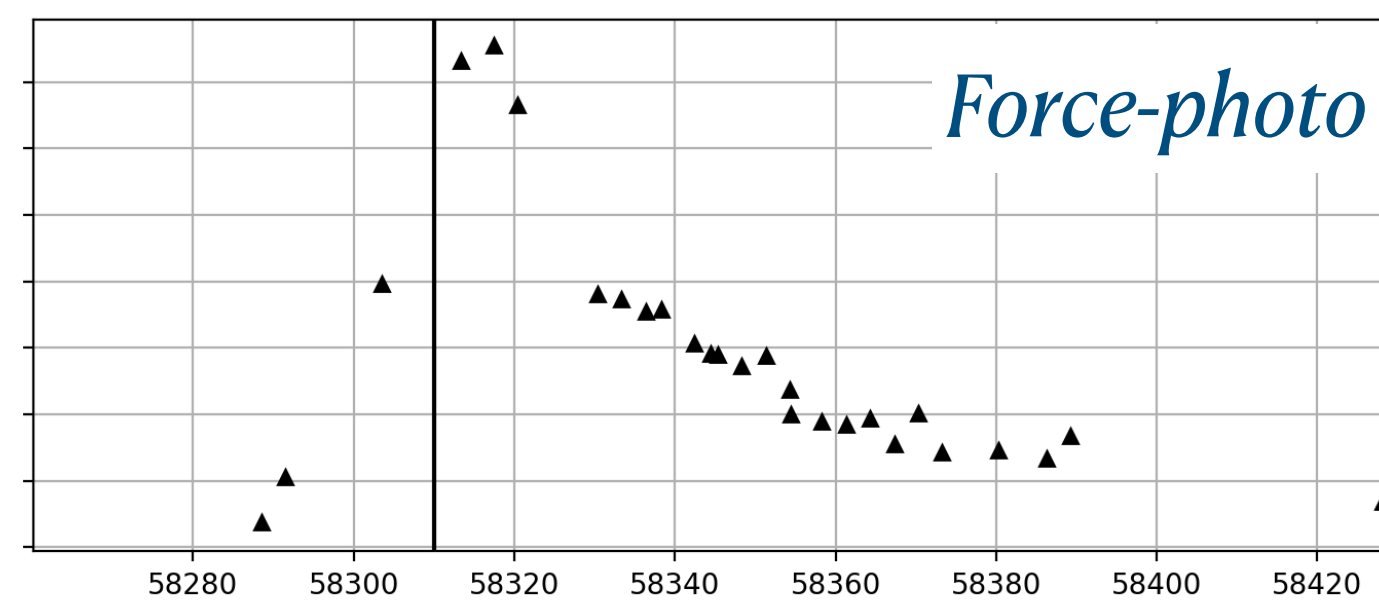
One integrated pipeline for all reduction steps

Rosnet et al. in prep

Flux uniformity

Scene modeling : Same flux estimator for stars & transient

Before:

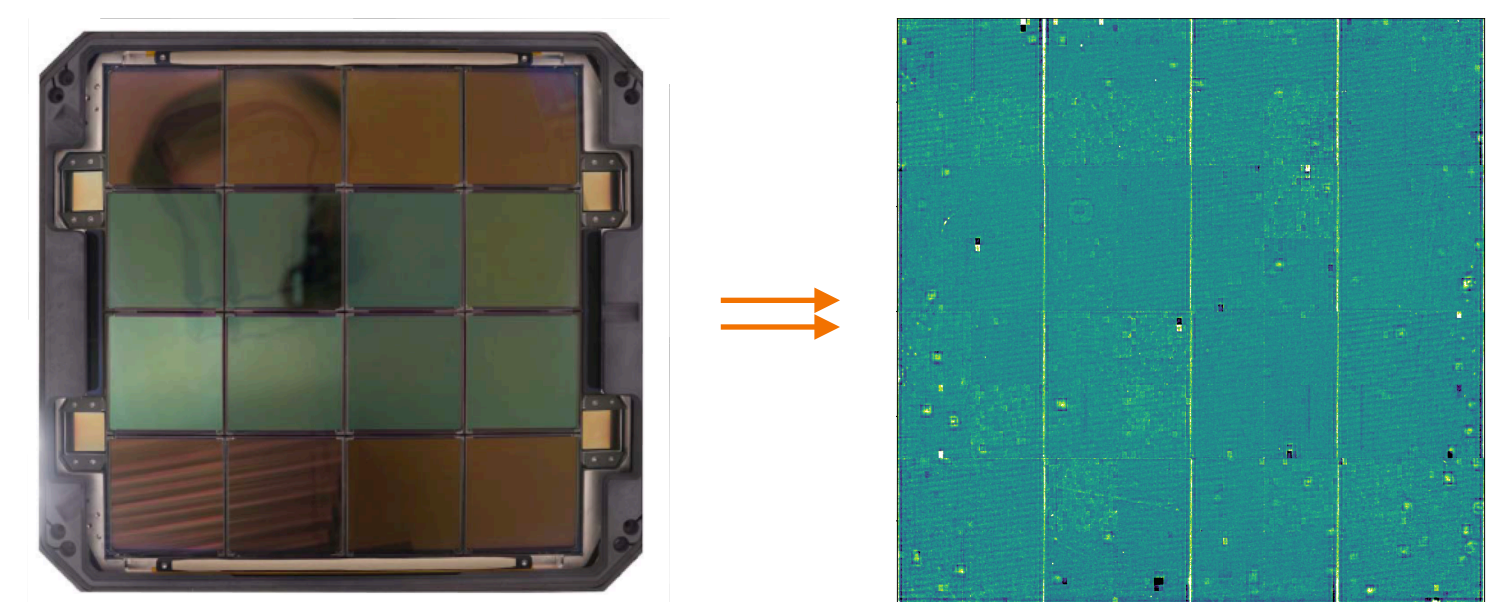


Photometric uncertainties at $< 1\%$

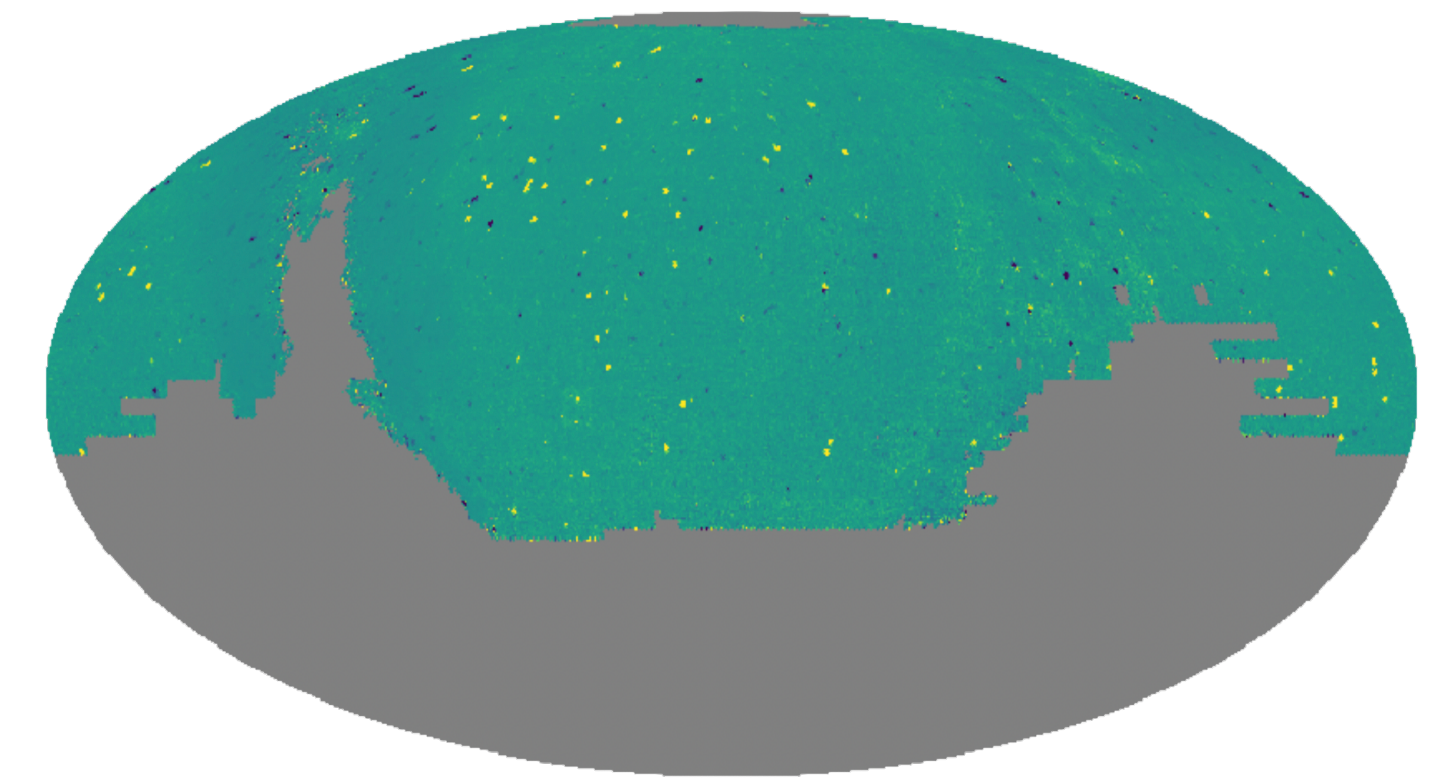
Lacroix et al. in prep

Survey uniformity (space & time)

Ubercal : anchored using multi-fields stars



Working towards:



self-consistent ZTF photometric system | no more PS1

Racine et al. in prep

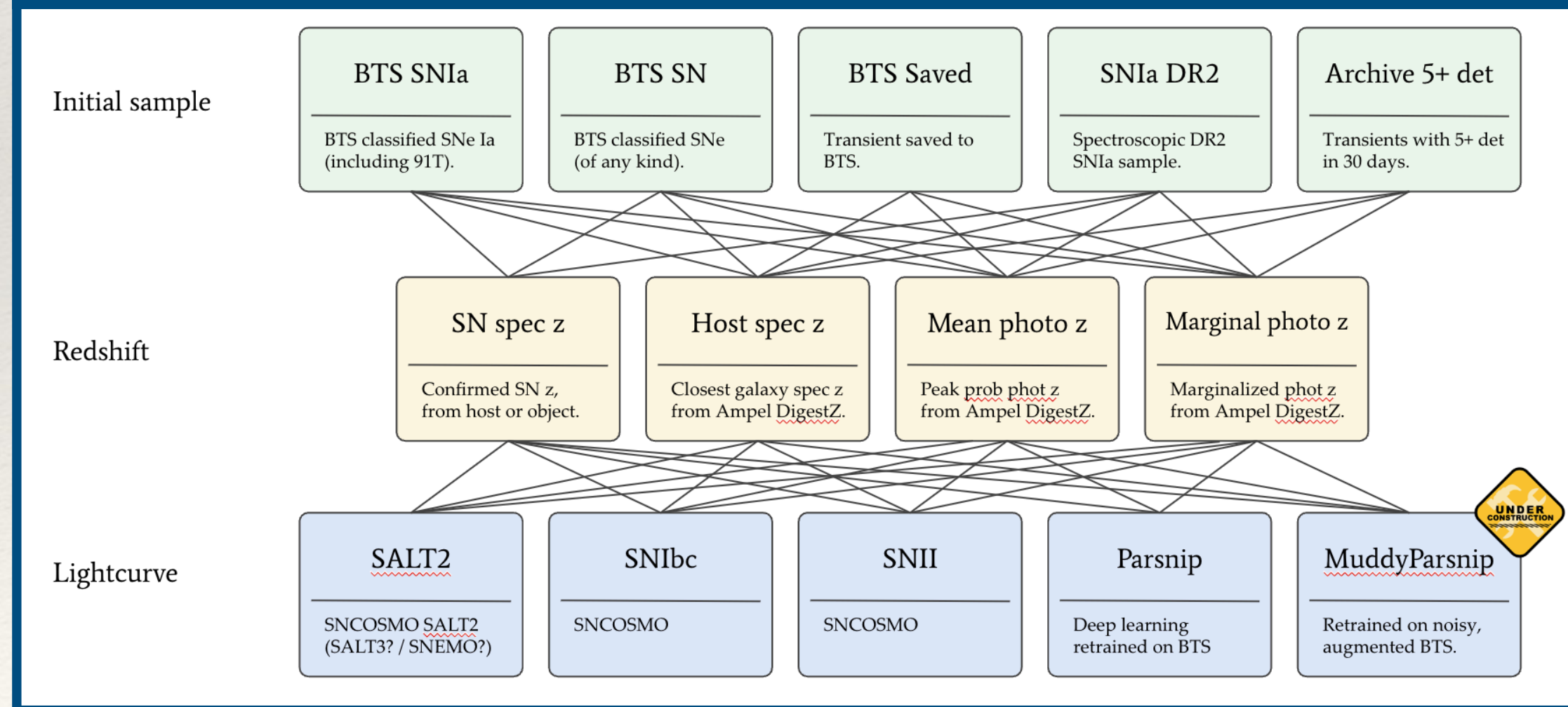
Quantifying Biases

Simulation | Forward modelling to quantify selection

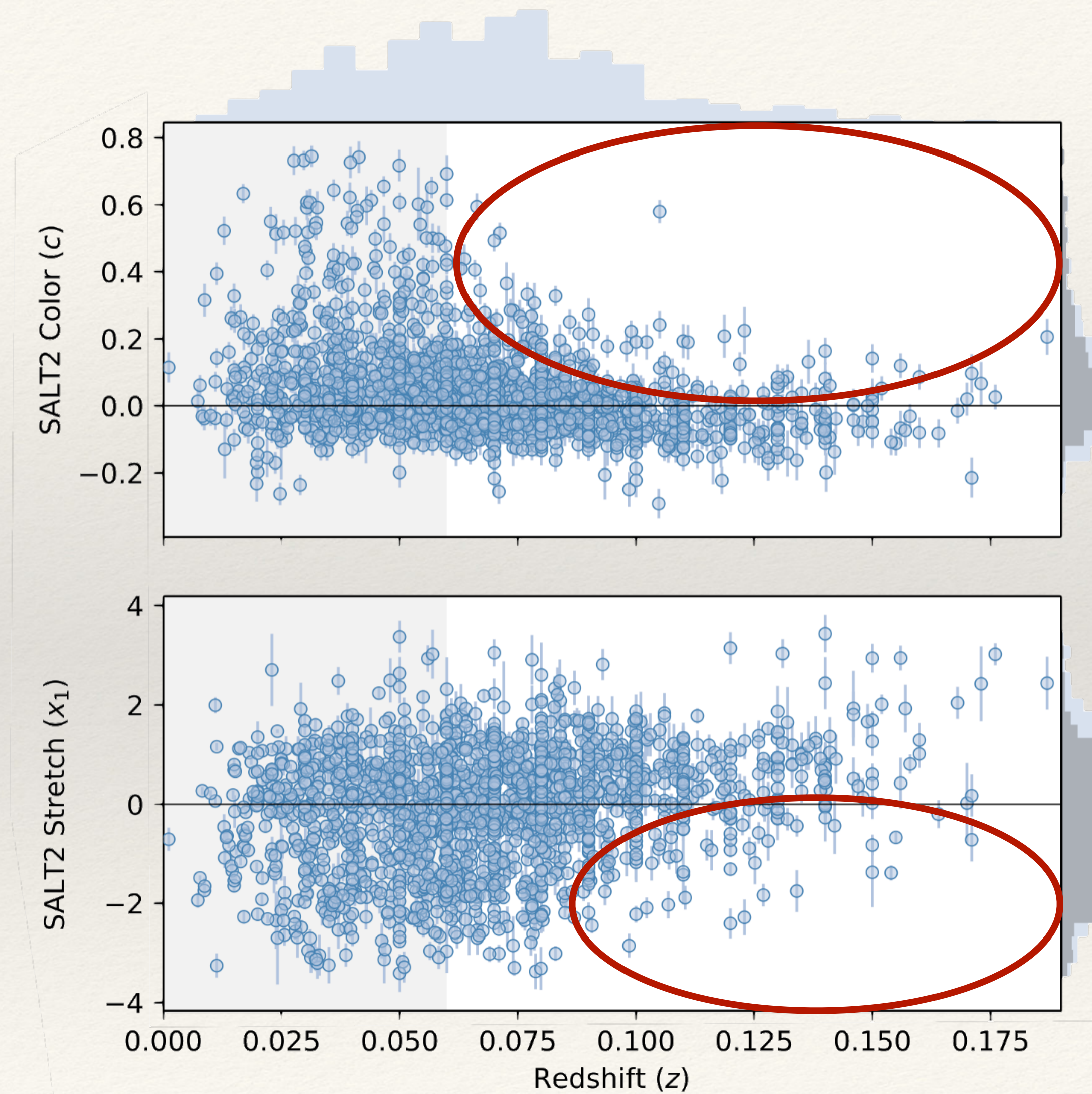
simsurvey | *Amenouche et al. in prep*

Selection function & cosmology | *Carreres et al. in prep*

Large ongoing effort starting in Berlin | *AMPEL-based*



AMPEL | *Townsend & Nordin et al. in prep*

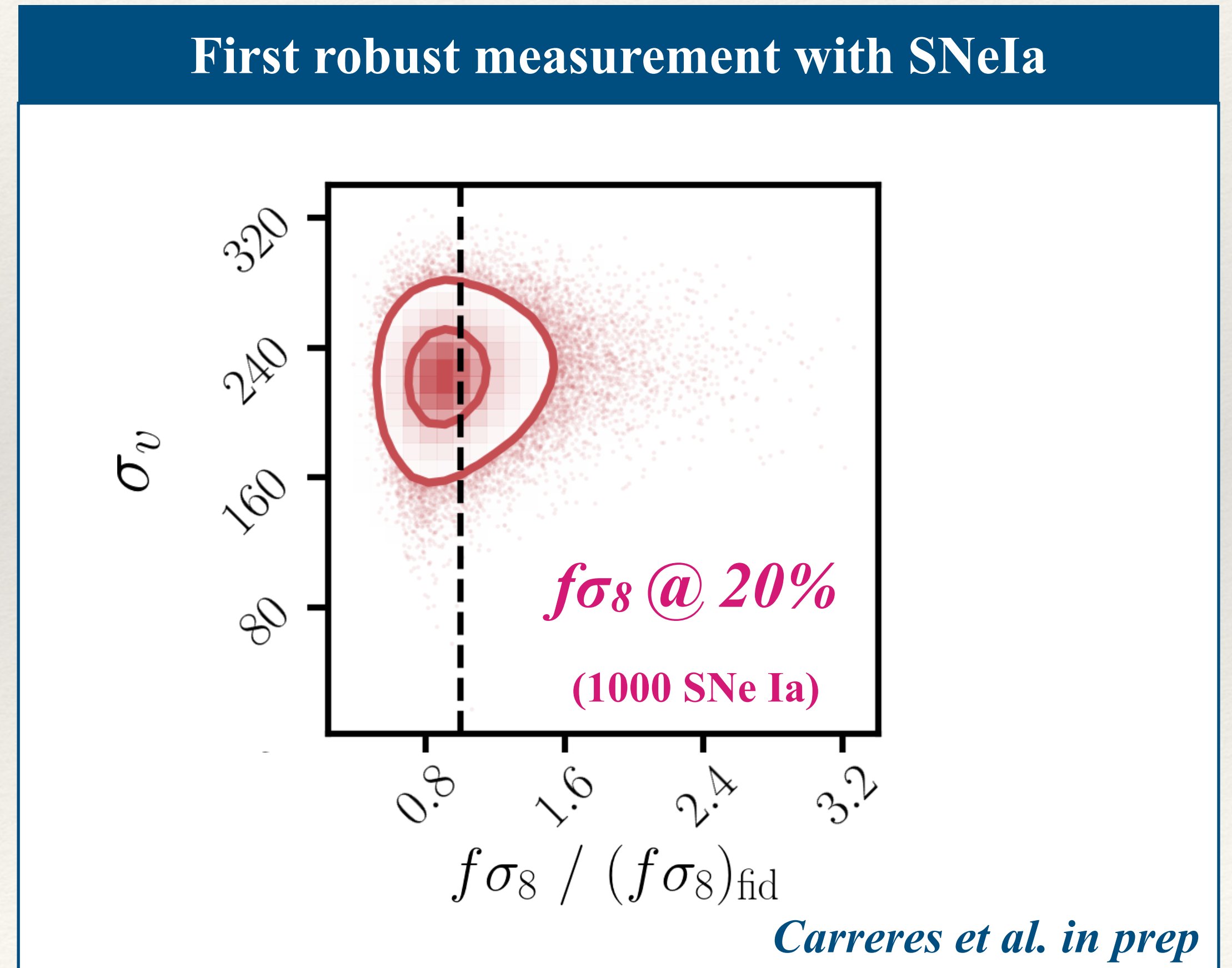
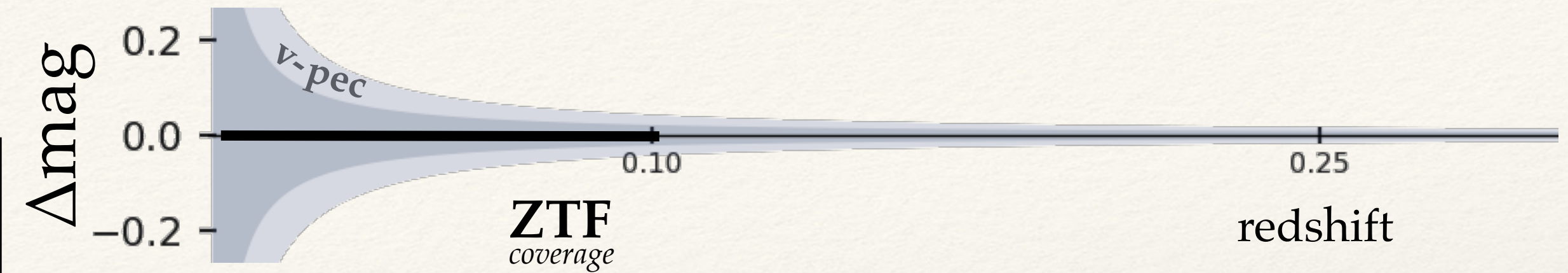
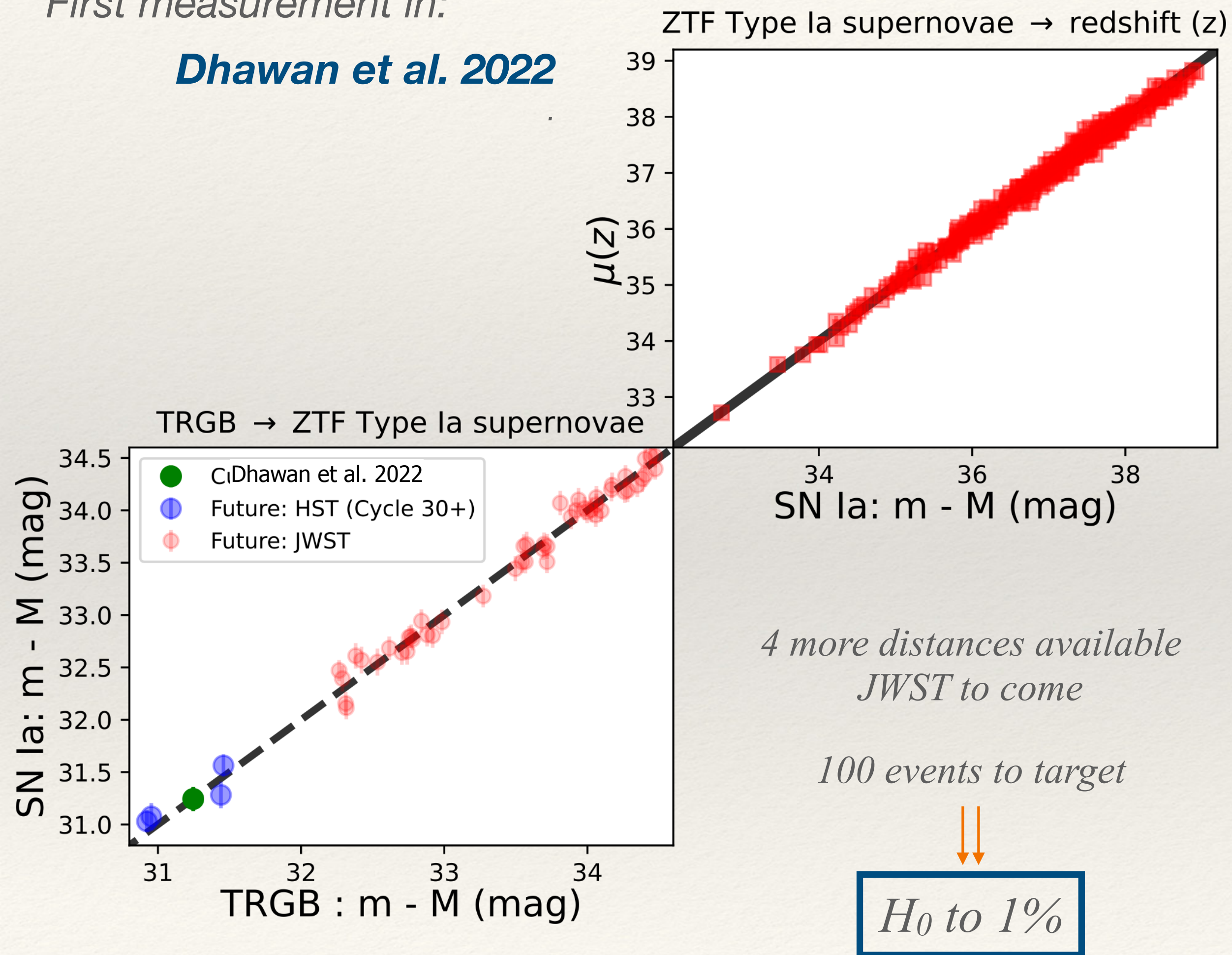


Towards Cosmology

Hubble Constant (H_0) | Growth rate (σ_8)

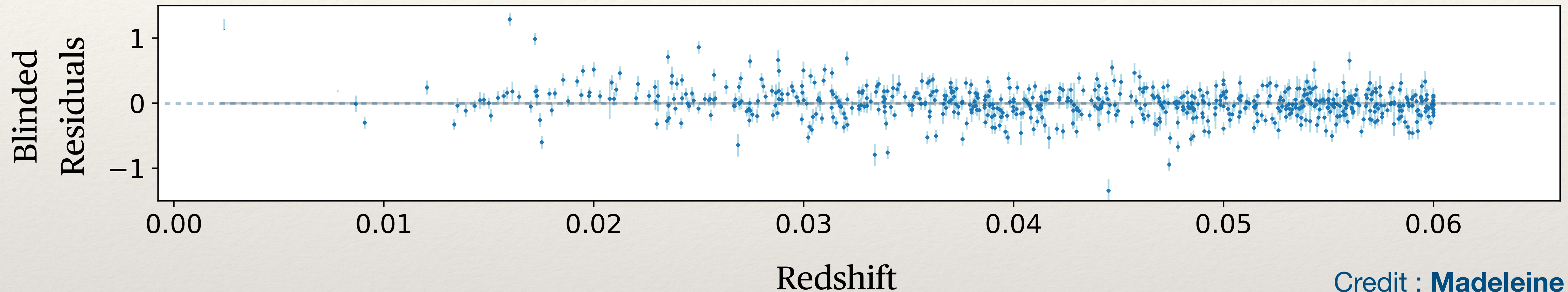
First measurement in:

Dhawan et al. 2022



Dark Energy

ZTF-DR2 volume limited sample : 1000 SNeIa



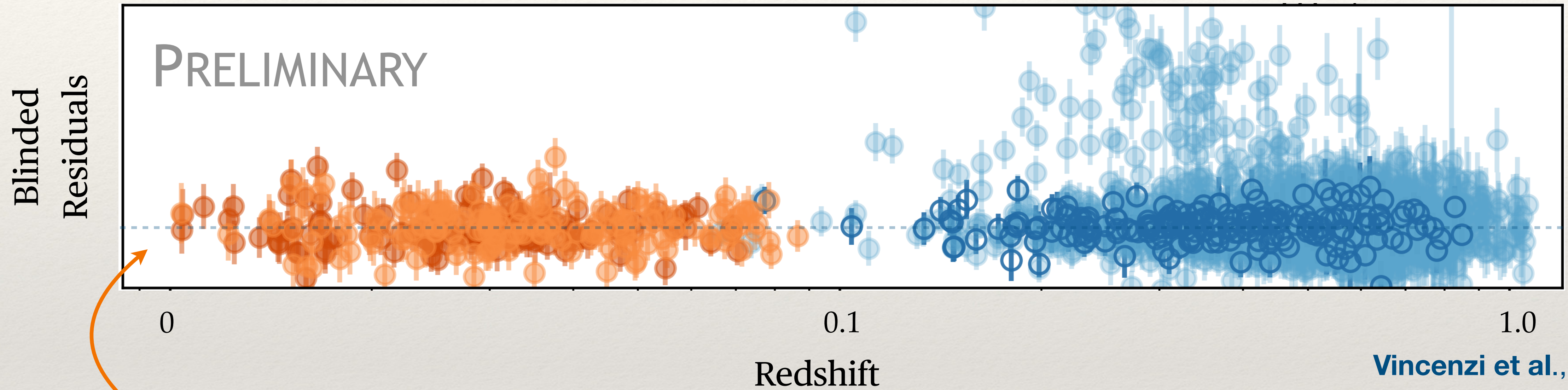
$$\sigma_{\text{scatter}} = 0.14$$



Force-photometry light-curves

Dark Energy : Elsewhere

DES5YR Sample : 1600 SNeIa



Compilation of 300 Low-Z SNeIa

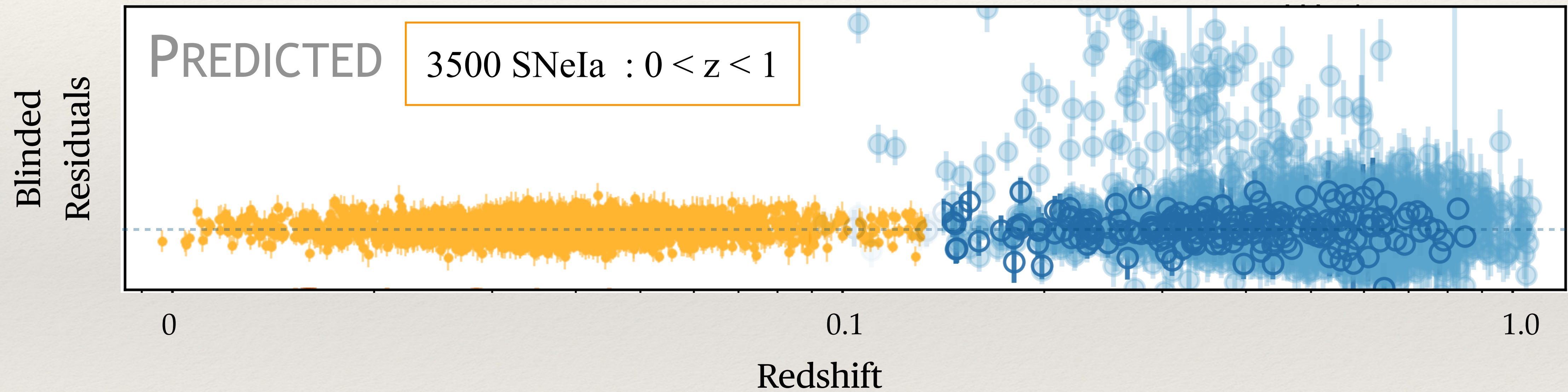
$$\sigma_{\text{scatter}} = 0.12$$

Release date: 2023

Dark Energy : Forthcoming

ZTF x DES Cosmology Taskforce formed in July 2022

PI: M. Smith | Data and Expertise Sharing



Early 2023 | Full cosmological forecast

Late 2023 | First estimates of w

LSST requirement | Dataset combination

ZTF Cosmo Data Release 2 | *20 ongoing papers*

SN In Clusters

$f\sigma_8$ from SNe Ia measurements

I-band second bump analysis

Impact of survey selection function on $f\sigma_8$

SNe Ia Subclasses statistical study

Progenitor physics in SN lightcurves

Minimal metallicity SNe Ia

Data Release

Hypergal

Host-less SNe Ia and Exotic Dark Matter

ZTF DR2 sample simulation

w-letter

Early and Late Lightcurve modelling

Search for Strongly lensed SNe Ia

Toward the 1 per mil calibration

SN Astrophysical bias

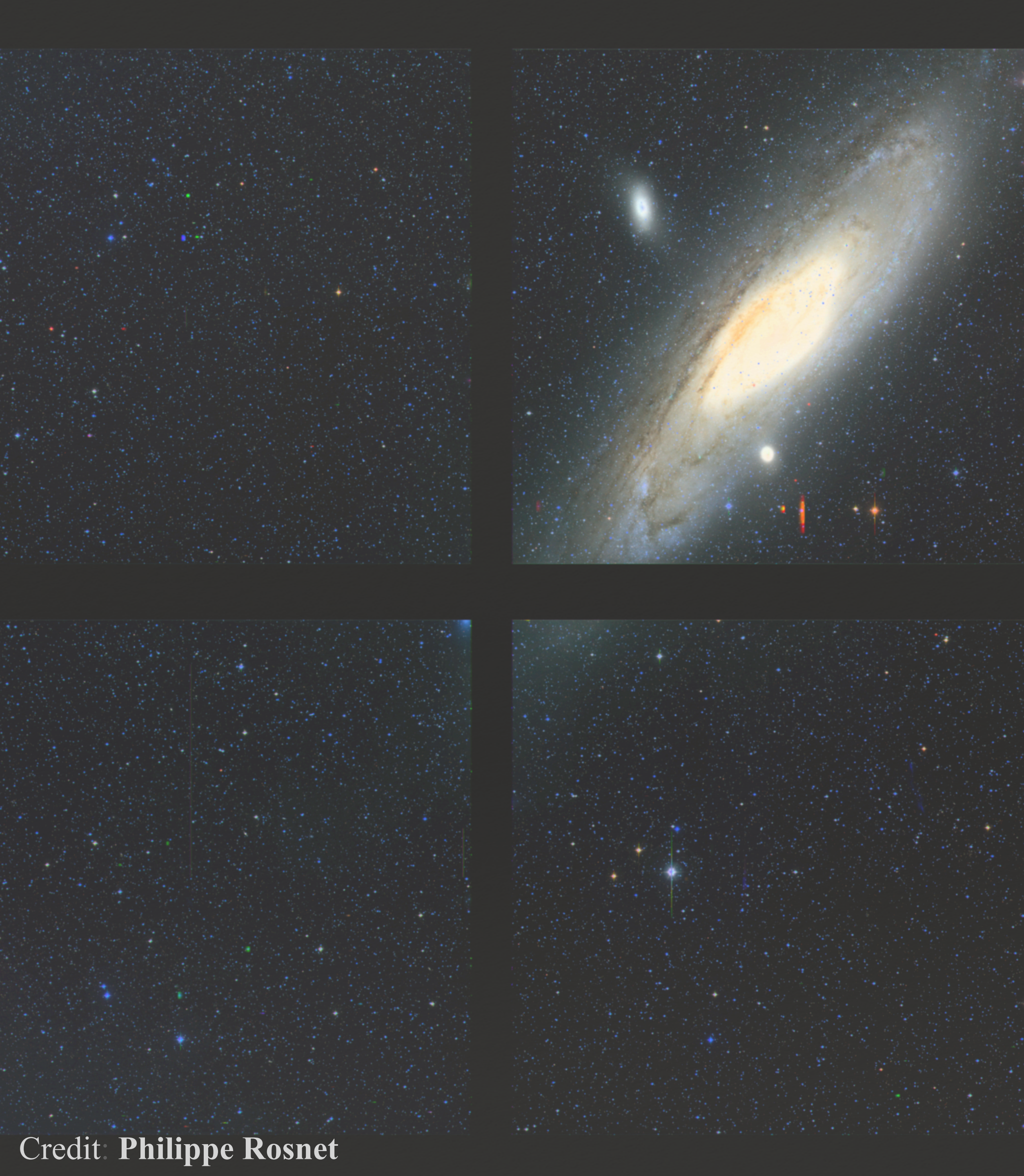
SNe Ia Spectral properties

Very reddened objects

two colour model and the mass step

SNe Ia Siblings

Release in early-2023



Merci

&

Thank you

