

ZTF : SNeIa and Cosmology

Where we are today

Mat Smith, representing the ZTF SNIa Working Group

Come join the fun

the ZTF SN Ia Working Group

* *Flags by institute
not nationality*

** *My apologies if
you should be here*

*** *Join the fun; get
a flag...*

Benjamin Racine



Manu Gangler



Melissa Amenouche



Philippe Rosnet



Julian Bautista



Bastien Carreres



Maxime Deckers



Adam Miller



Joel Johansson



Kate Maguire



Valéry Brinnet



Estelle Robert



Jacco Terwel



Mattia Bulla



Kate Maguire



Valéry Brinnet



Fabrice Feinstein



Jakob Nordin



Luke Harvey



Leander Lacroix



Martin Briday



Young-Lo Kim



Rahul Biswas



Georgios Dimitriadis



Dominique Fouchez



Abigail Polin



Simeon Reusch



Suhail Dhawan



Maxime Cherry



Ariel Goobar



Nicolas Regnault



Jeremy Lezmy



Nora Nicolas



Mat Smith



Kélian Sommer



Mickael Rigault



Mark Magee



Simon Prentice



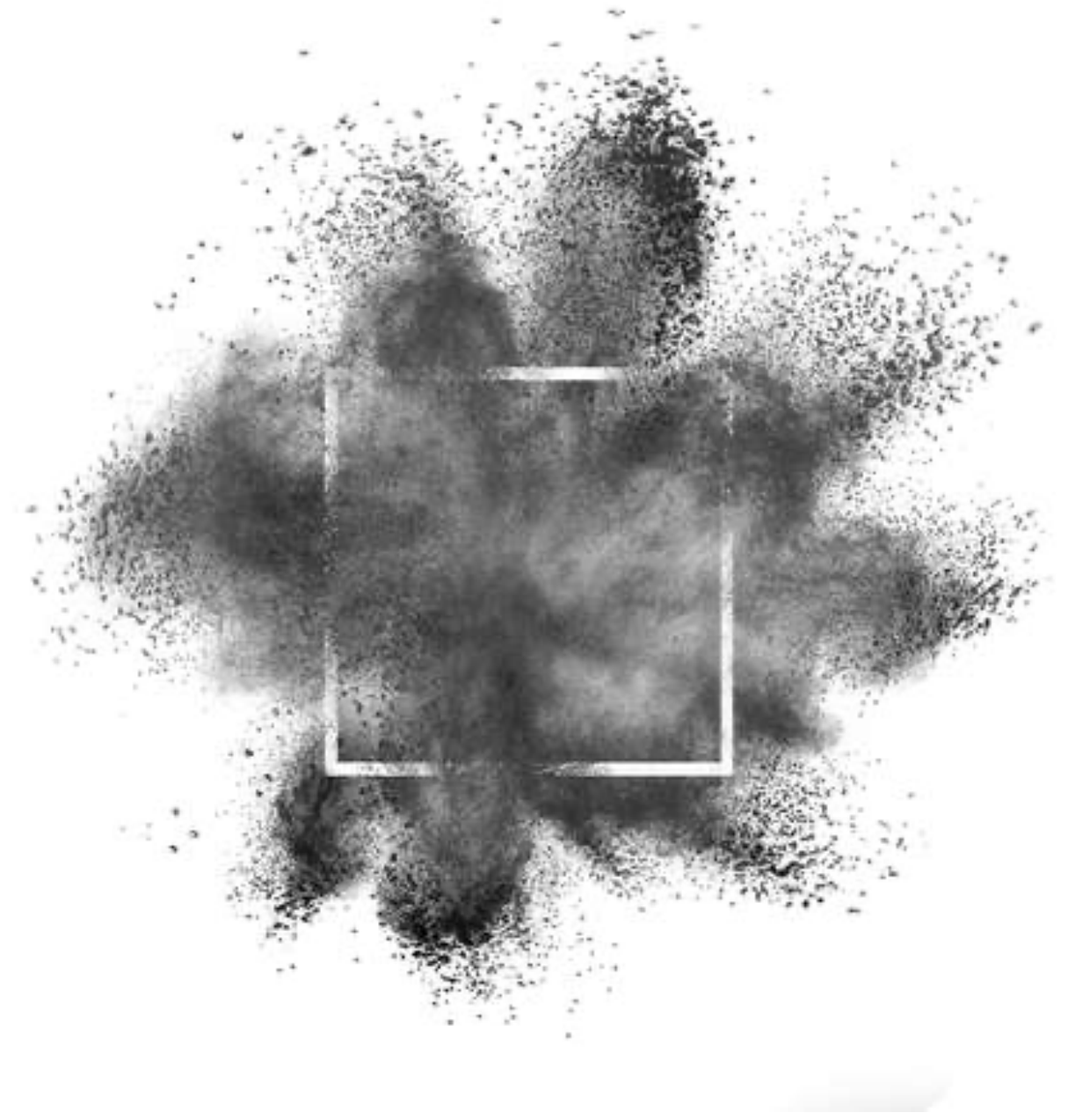
Alice Townsend



Ana Sagués Carracedo

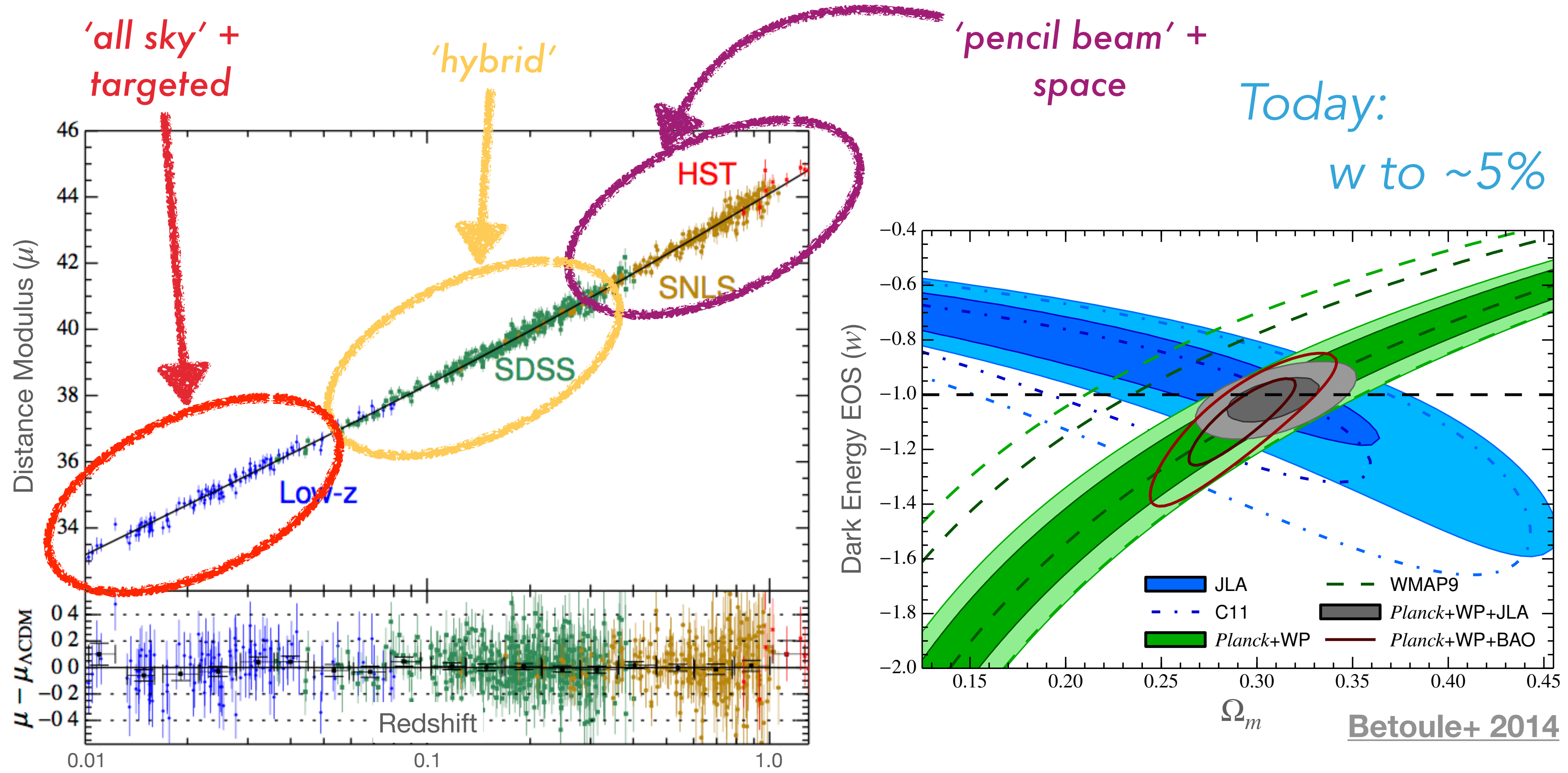


SNela*



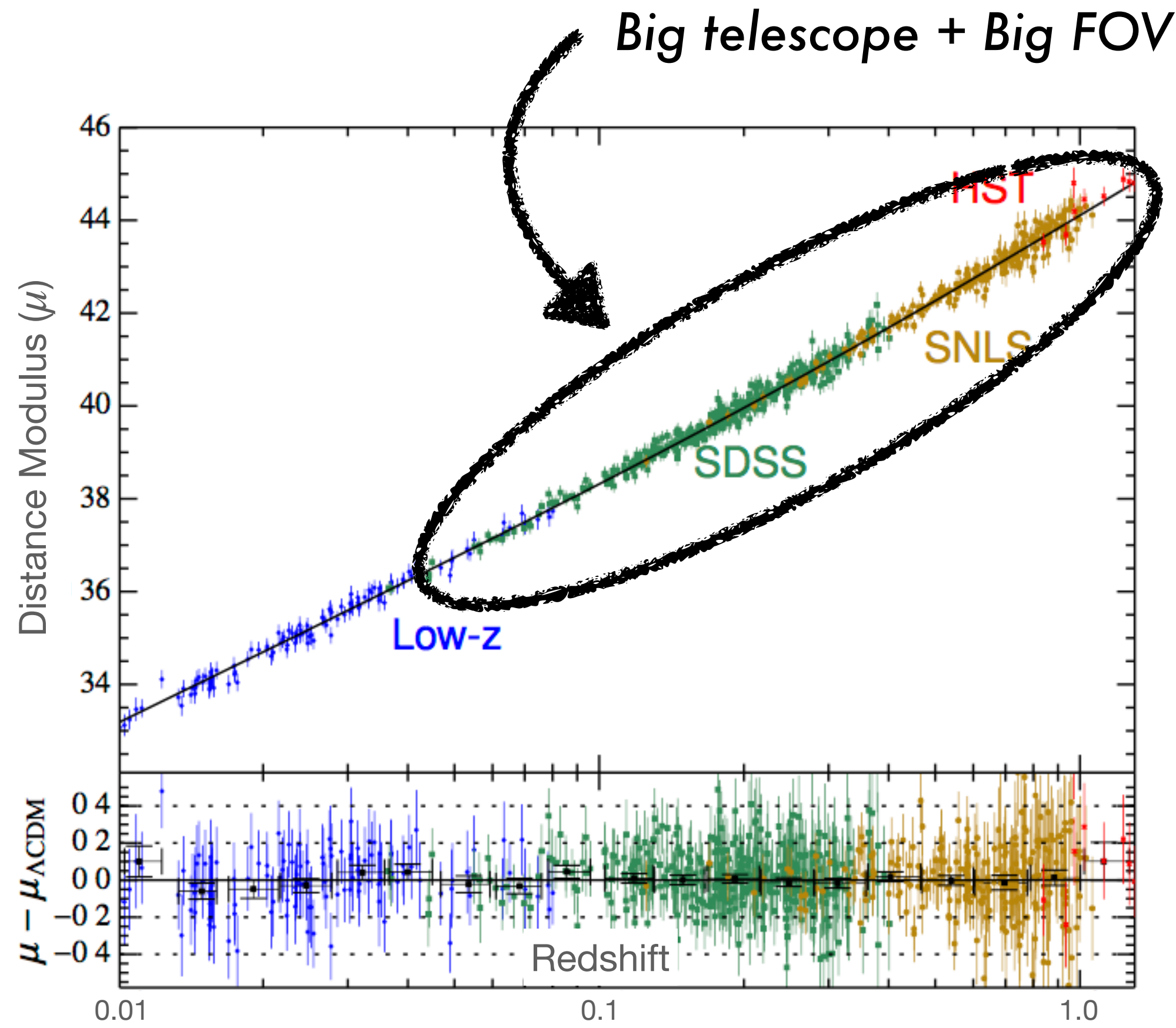
Luminous explosions of evolved stars
Uncertain origin; homogeneous
Central to 'what is the universe up to'

The *Importance* of ZTF

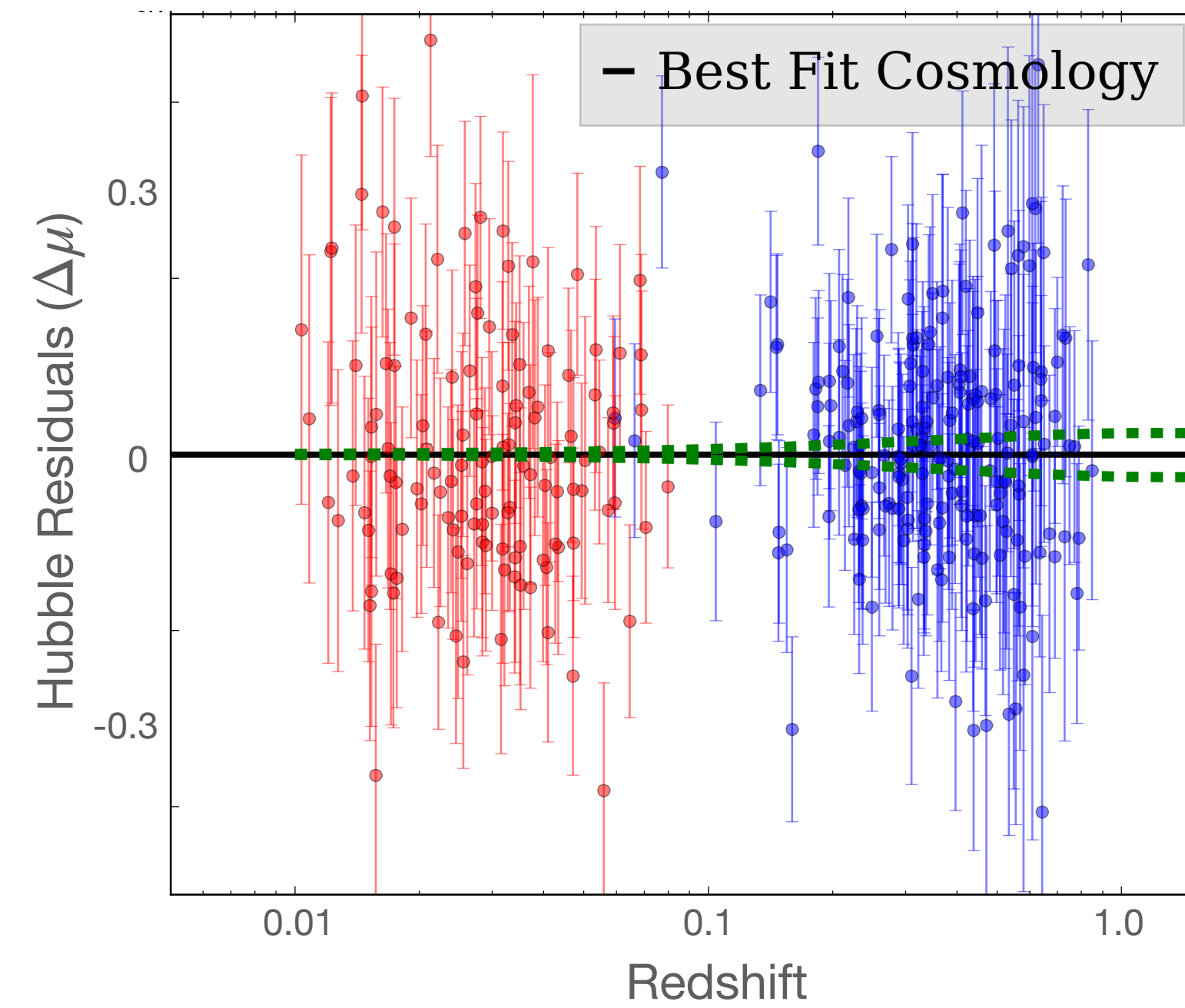


*Different strategies;
filters; instruments; cadence; selection...*

The *Importance* of ZTF



Tomorrow:
wCDM to ~5%

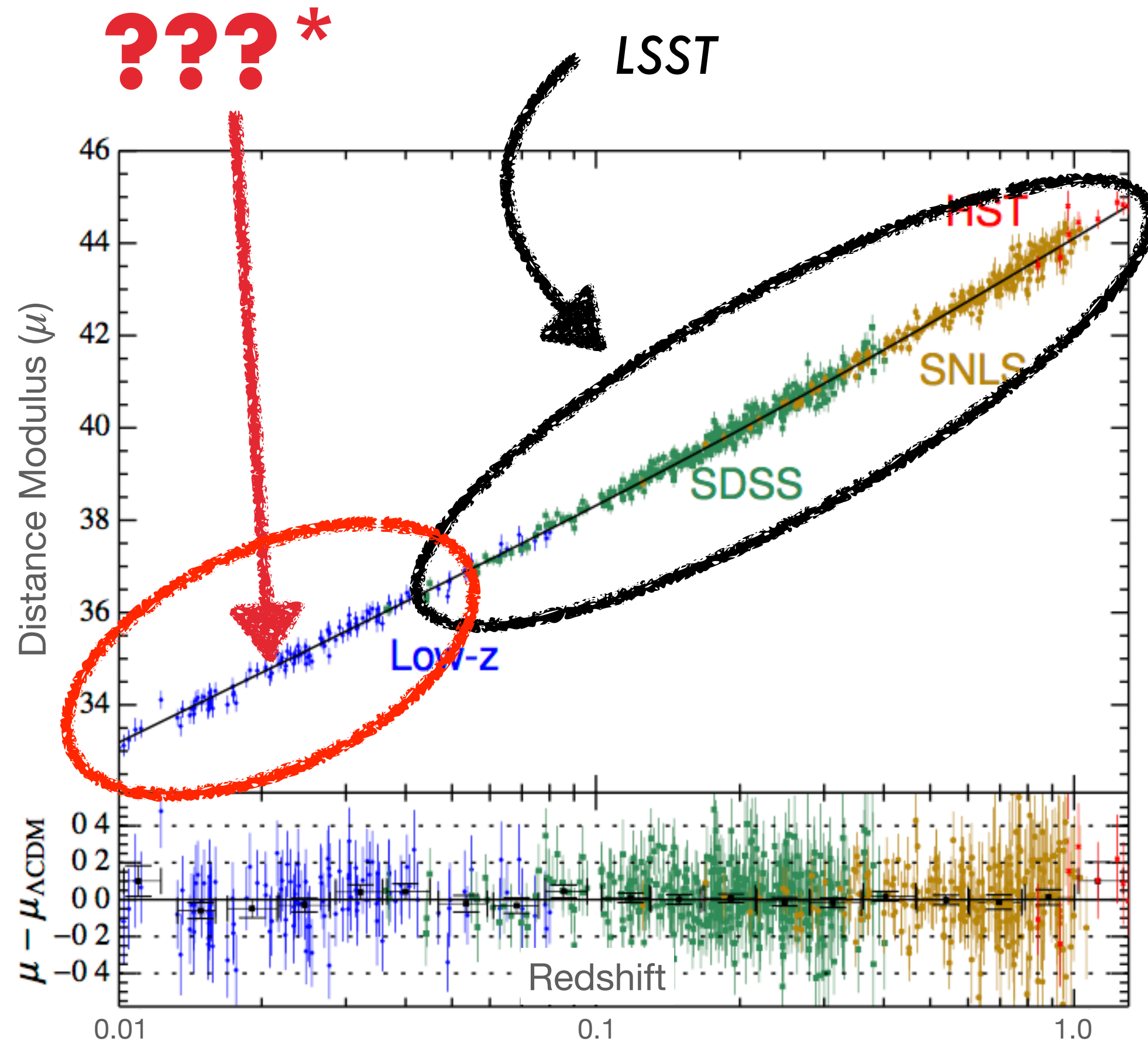


Brout+ 2019

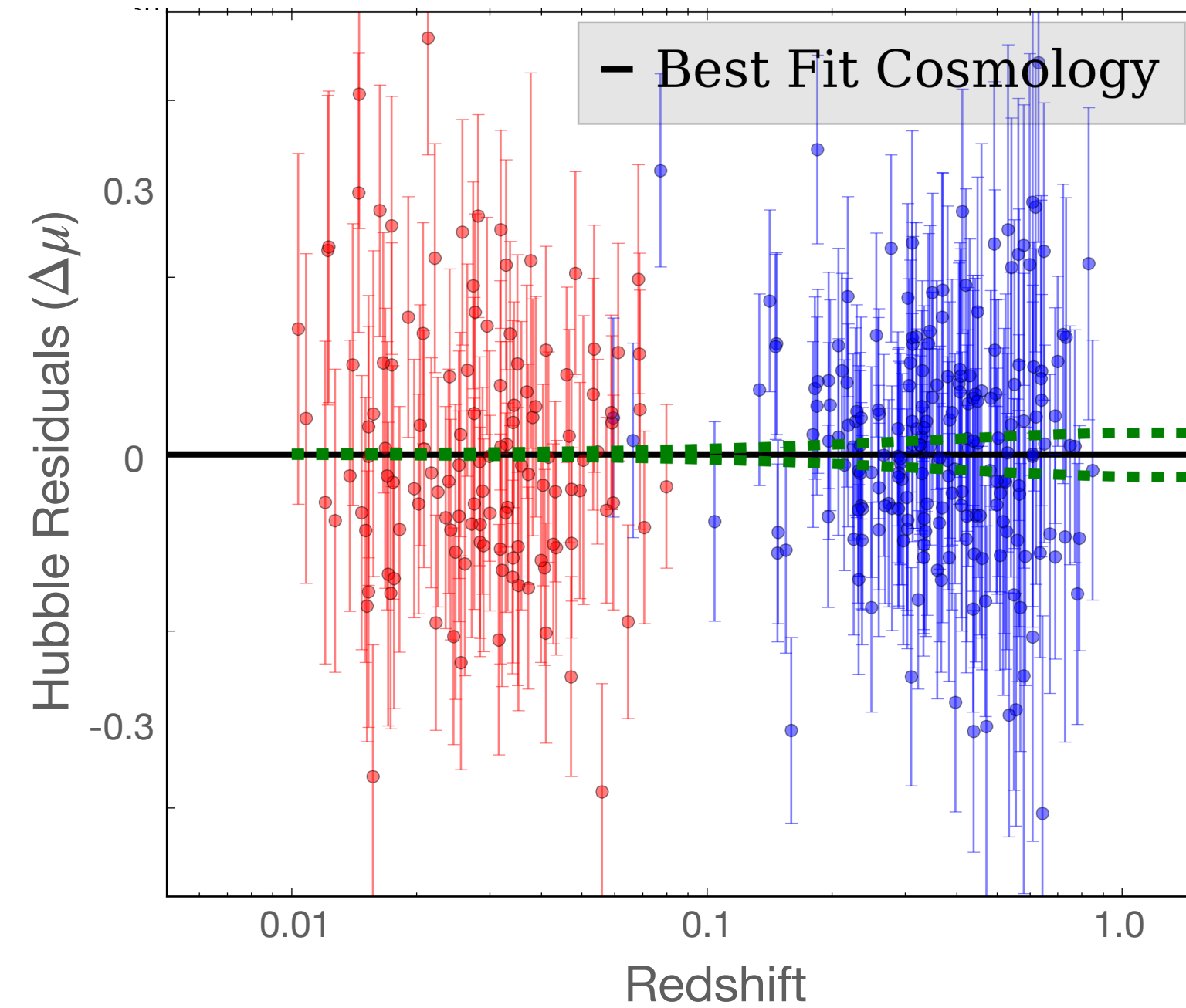
One survey; one strategy

LSST

The *Importance* of ZTF



Tomorrow:
 $w\text{CDM}$ to $\sim 5\%$

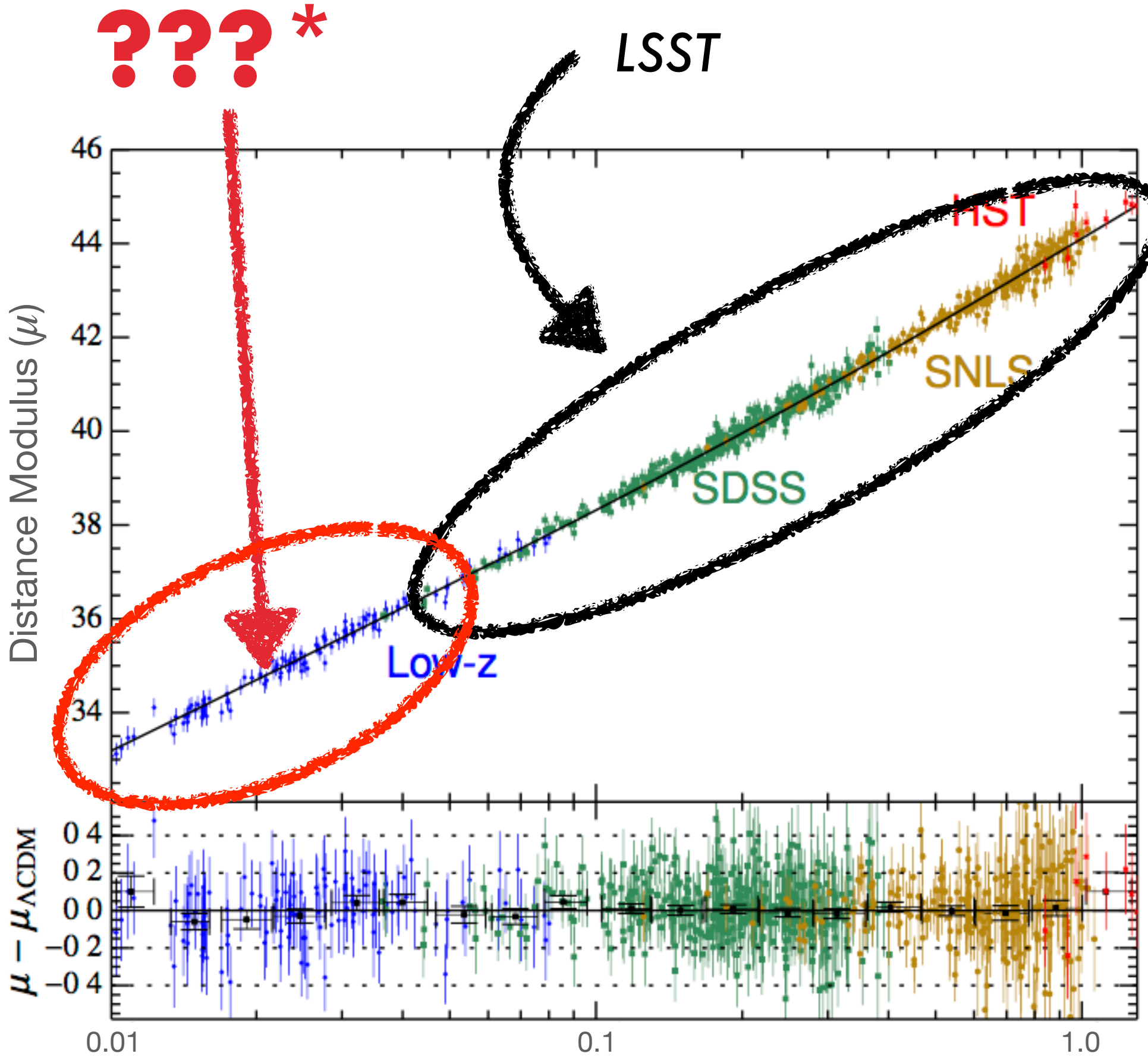


Brout+ 2019

*too bright;
 too quick;
 too rare
 (For LSST)

~~One survey; one strategy~~
LSST

The Importance of ZTF



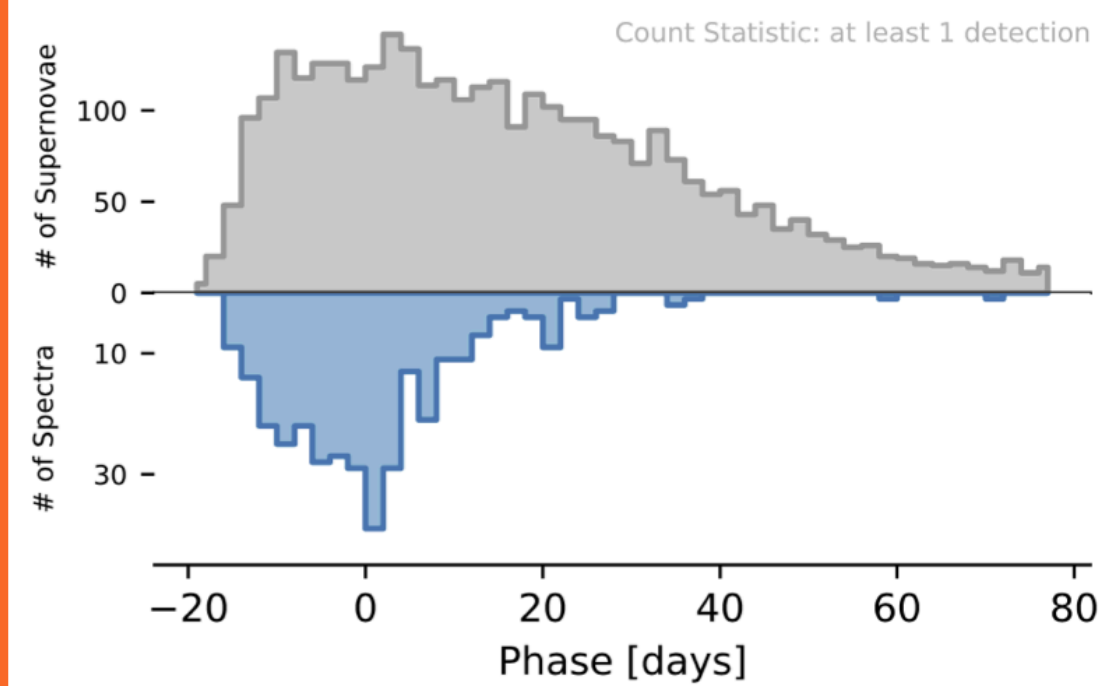
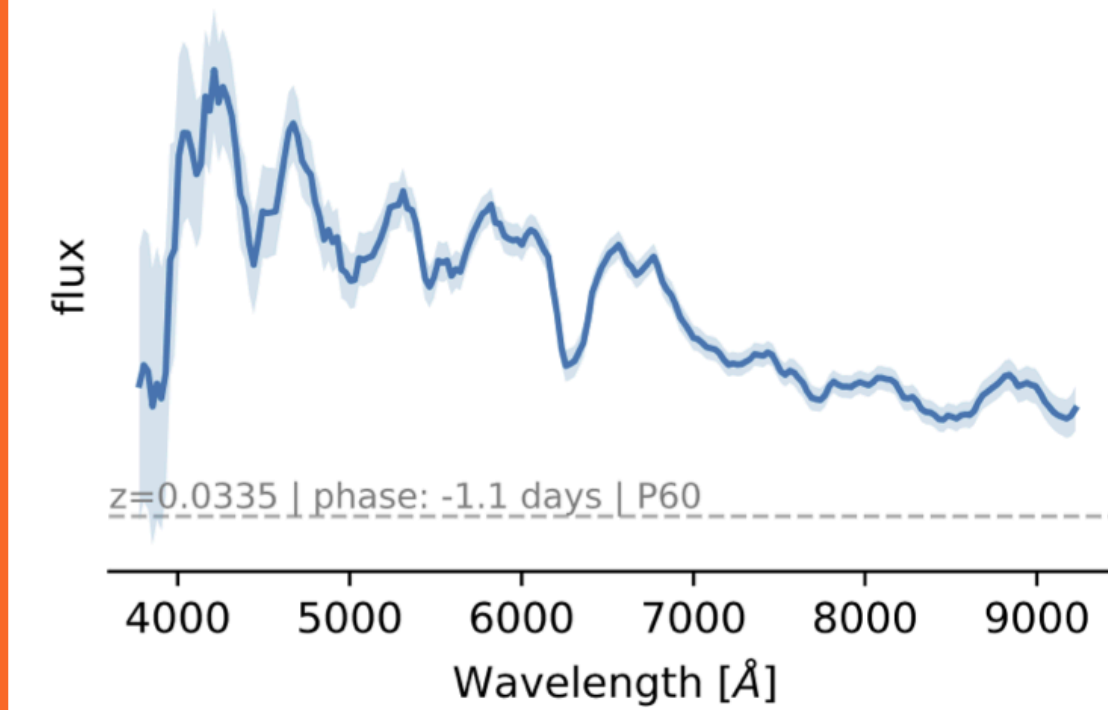
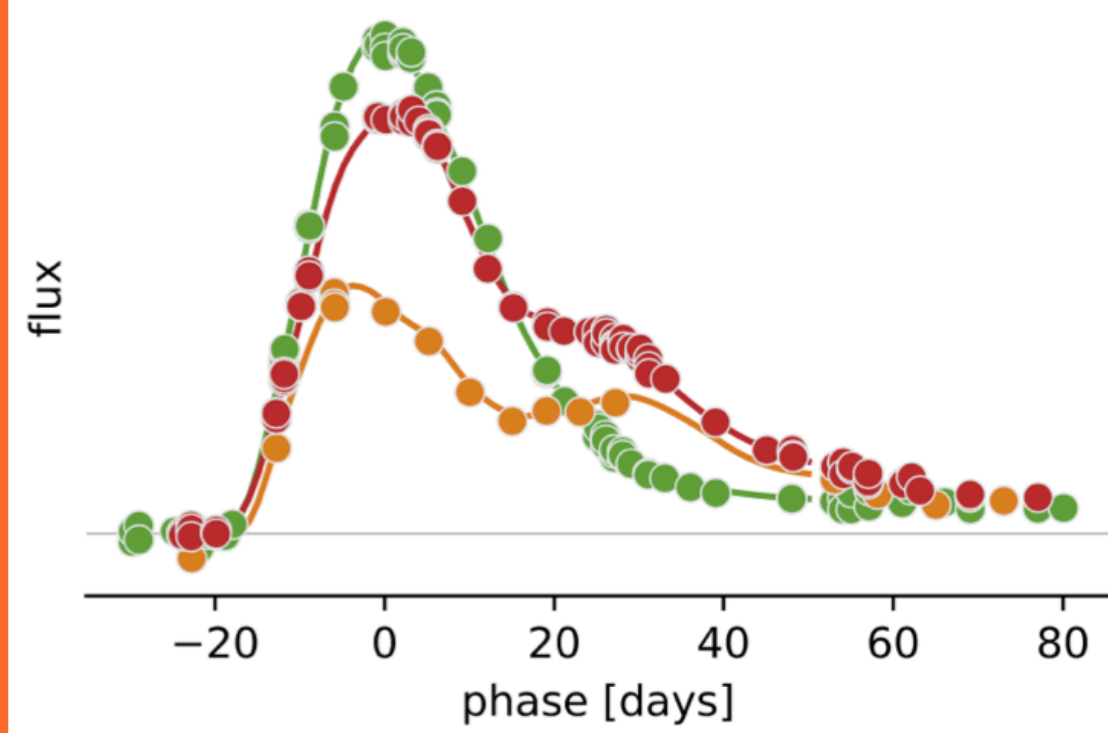
Description ^b	σ'_w	$\sigma'_w / \sigma_w^{\text{stat}}$	w shift
[Photometry and Calibration]	[0.021]	[0.50]	[-0.005]
Low- z	0.014	0.33	-0.003
DES	0.010	0.33	0.001
[μ -Bias Corrections: Survey]	[0.023]	[0.55]	[-0.001]
^e Low- z 3σ Cut	0.016	0.38	0.005
Low- z Volume Limited	0.010	0.24	0.009
Spectroscopic Efficiency	0.007	0.17	0.001
[μ -Bias Corrections: Astrophysical]	[0.026]	[0.62]	[-0.003]
Intrinsic Scatter Model	0.014	0.33	-0.001
c, x_1 Parent Population	0.014	0.33	0.000
^e Two σ_{int}	0.014	0.33	-0.005
MW Extinction	0.005	0.12	-0.001
^e w, Ω_M for bias corr	0.006	0.14	0.001
[Redshift]	[0.012]	[0.29]	[0.003]
^e $z + 0.00004$	0.006	0.14	-0.001
Peculiar Velocity	0.007	0.17	0.004
Total Stat (σ_w^{stat})	0.042	1.00	0.000
Total Syst ^c ($\sigma_w^{\text{total syst}}$)	0.042	1.00	-0.006

* too bright;
too quick;
too rare
(For LSST)

~~One survey; 0~~

LSST

"Find it; follow it"



Introducing ZTF



"Two surveys in one"



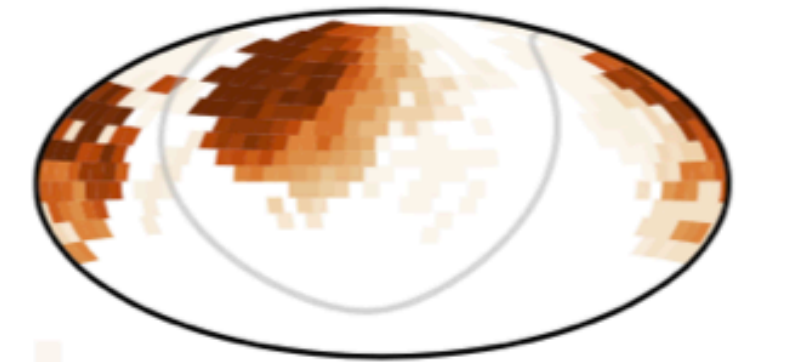
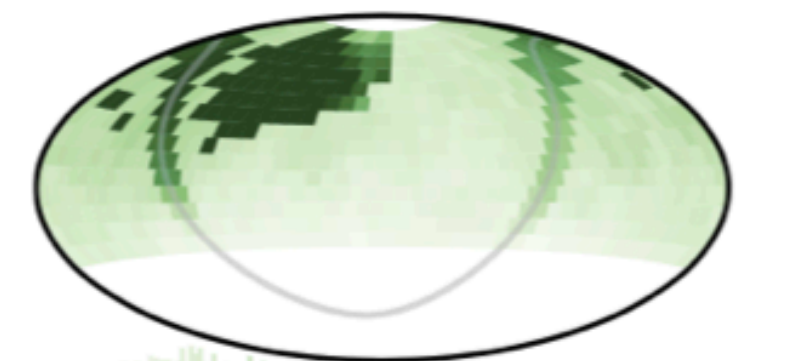
P48: Discovery



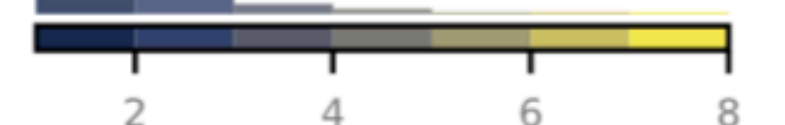
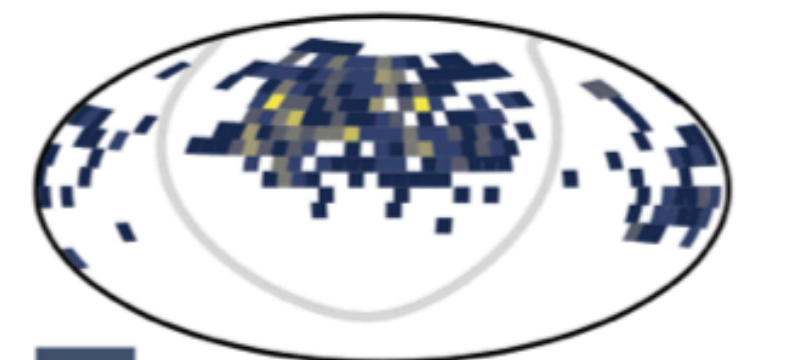
P60: Followup

P200: Classification

"The local LSST"



Number of observations [2018]

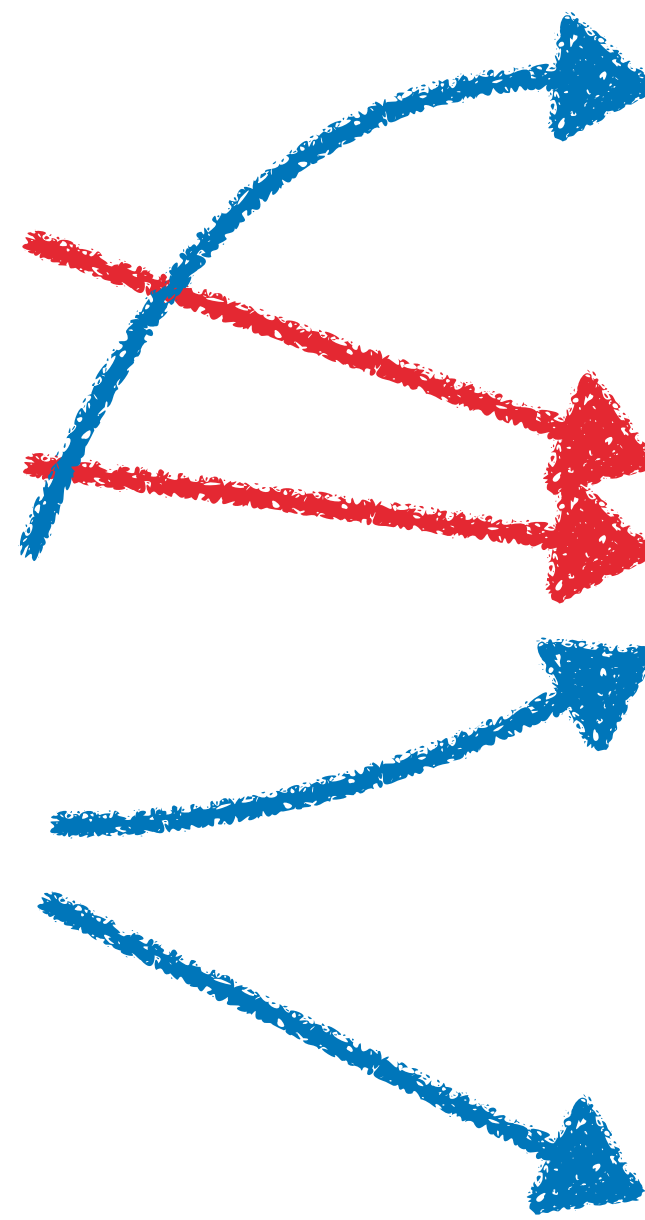


Number of Supernovae

The *Importance* of ZTF

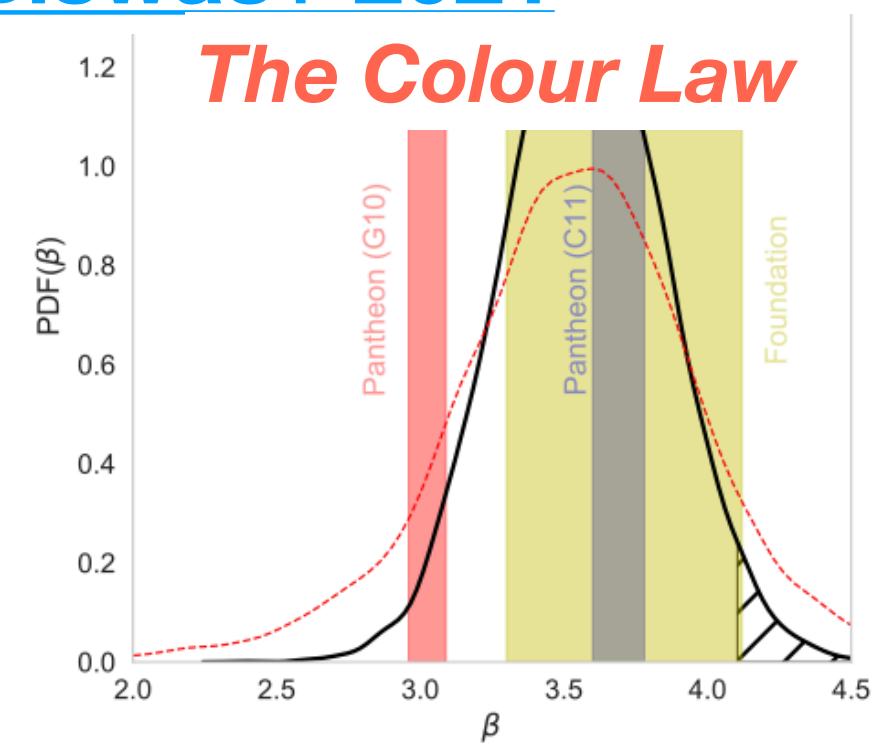
Measurable today

Not accessible to LSST



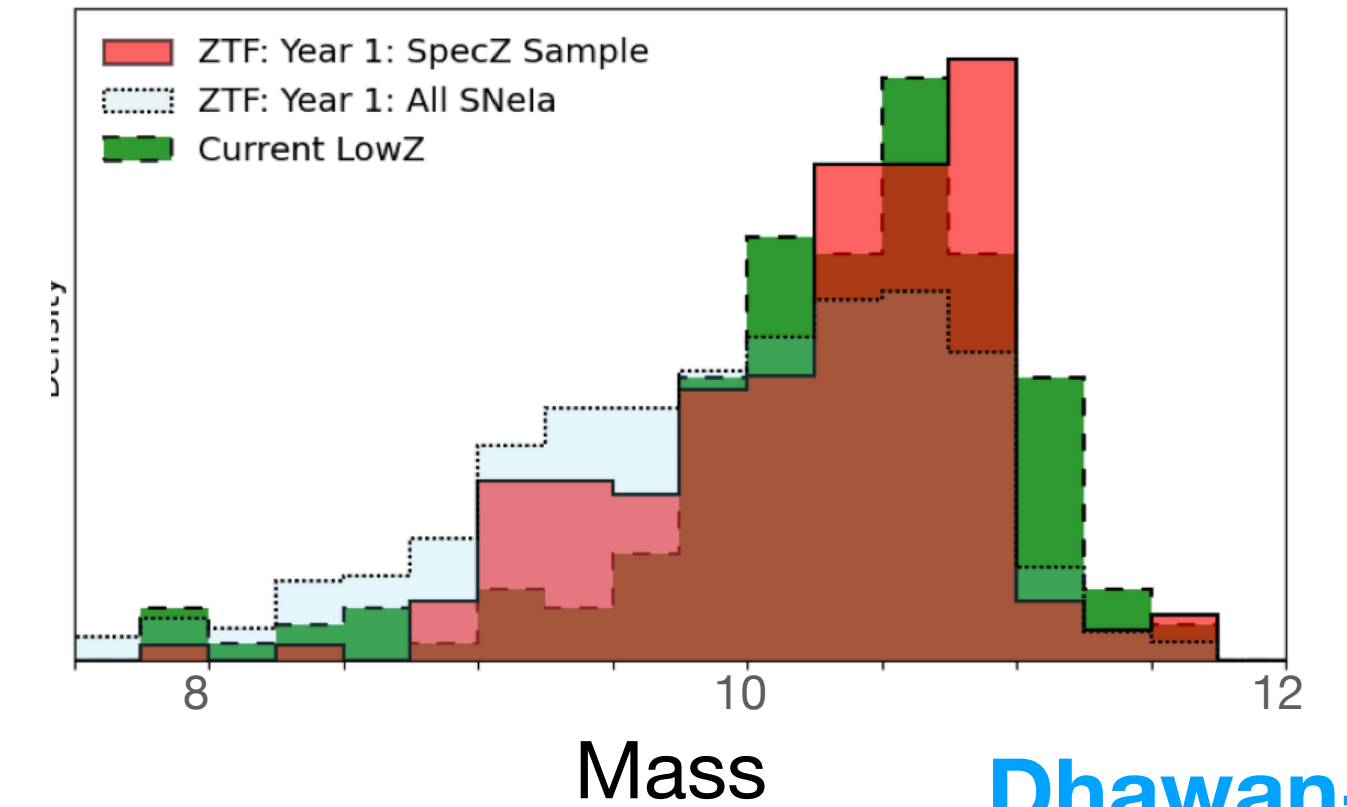
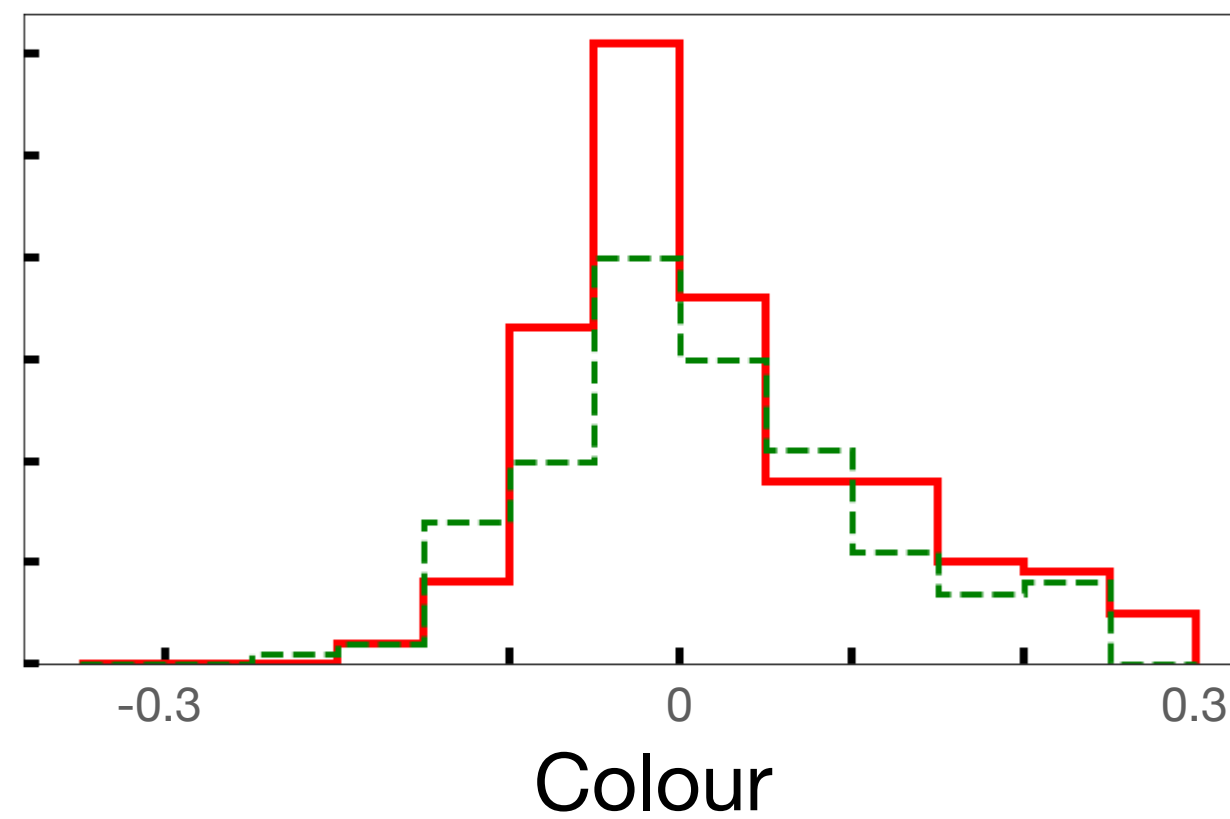
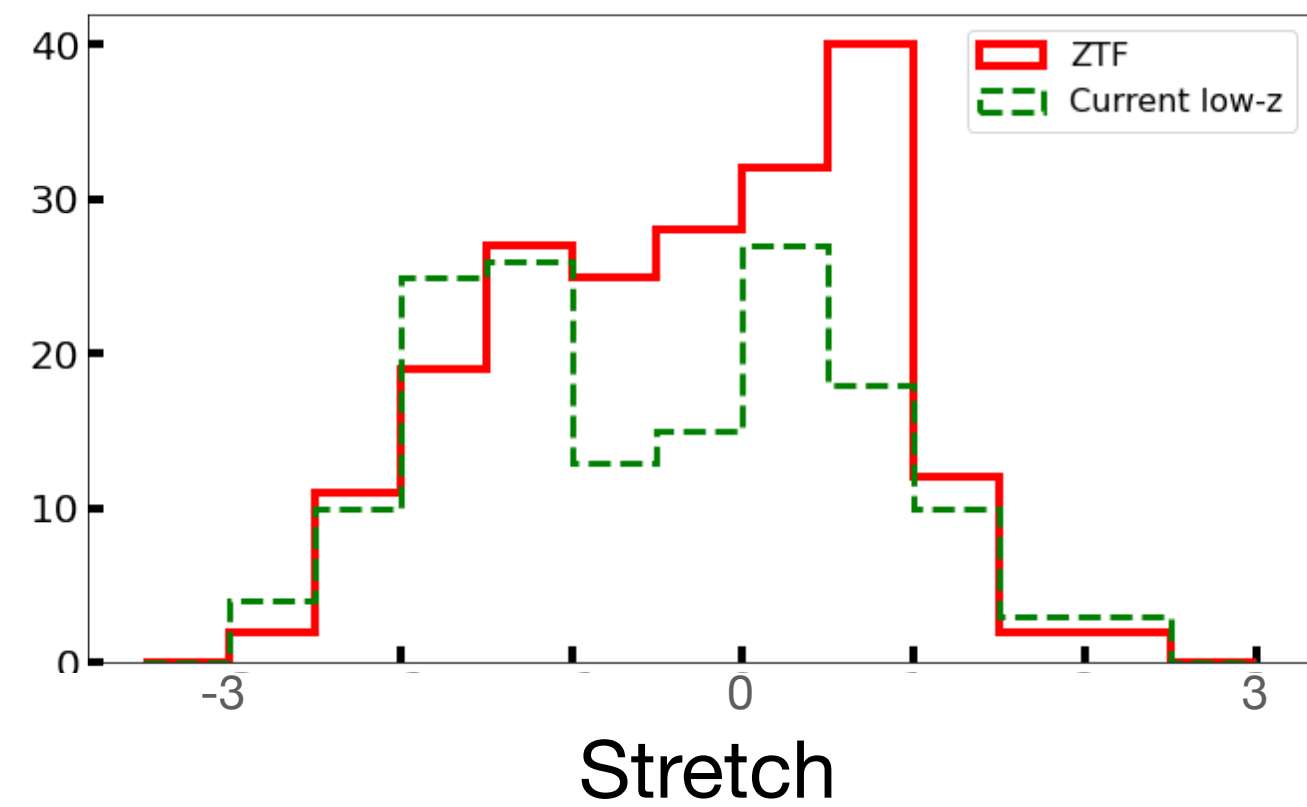
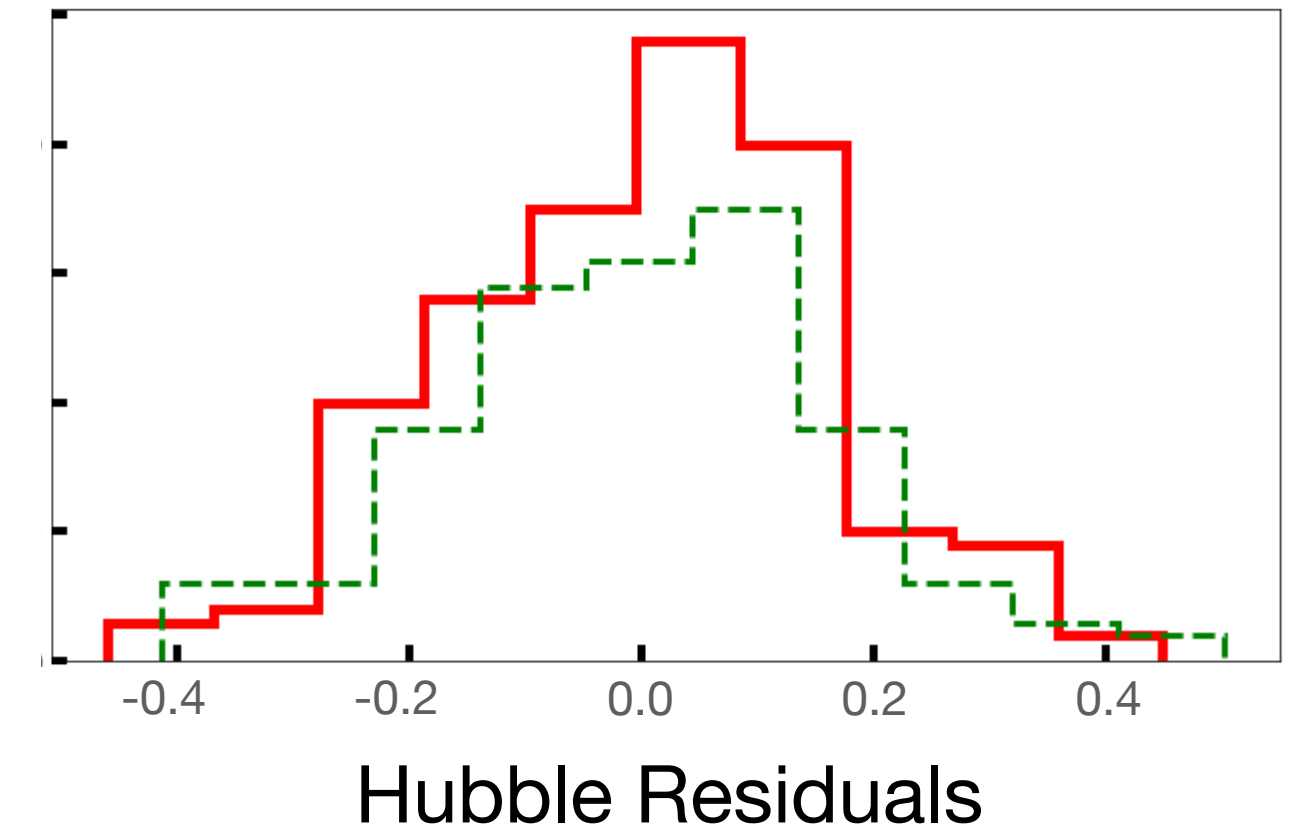
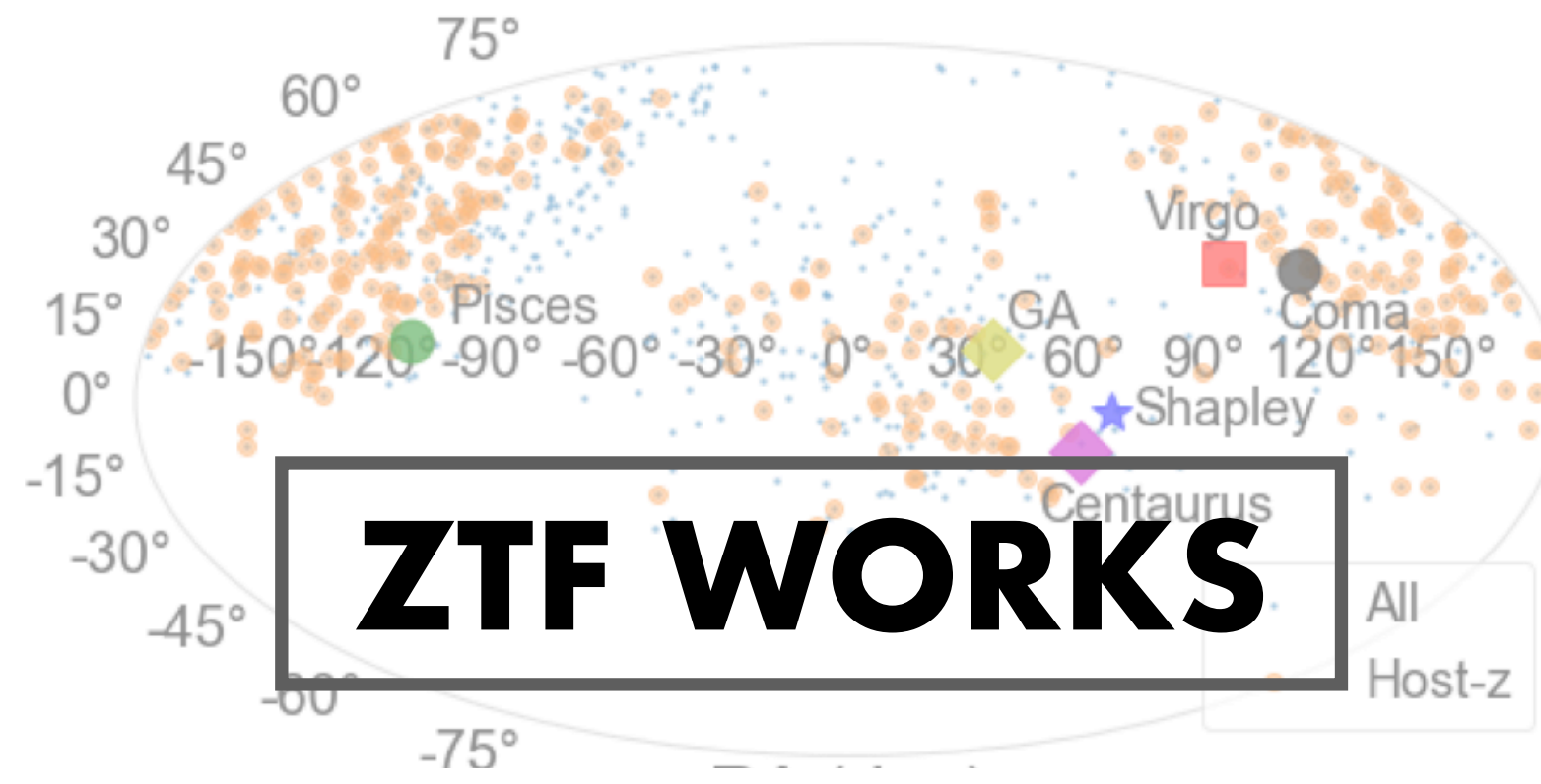
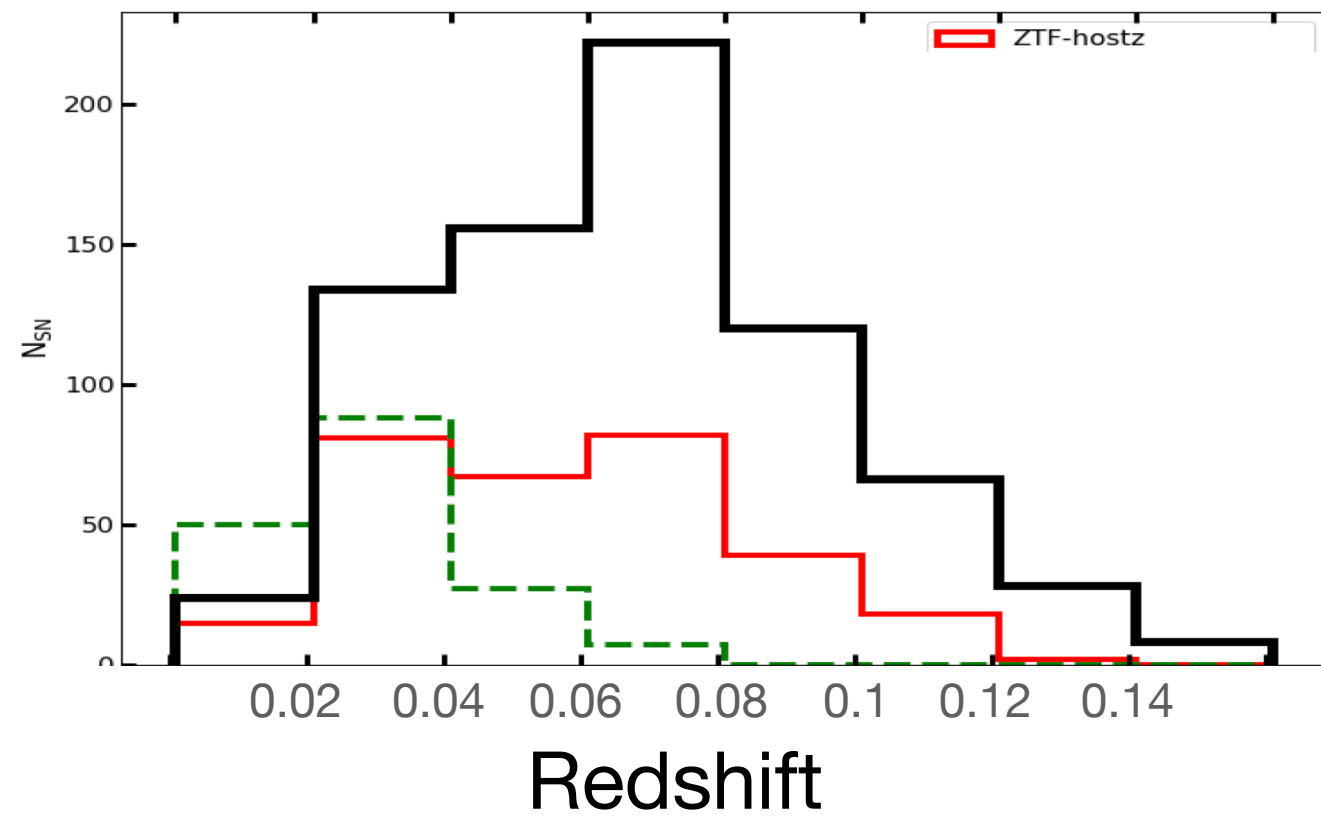
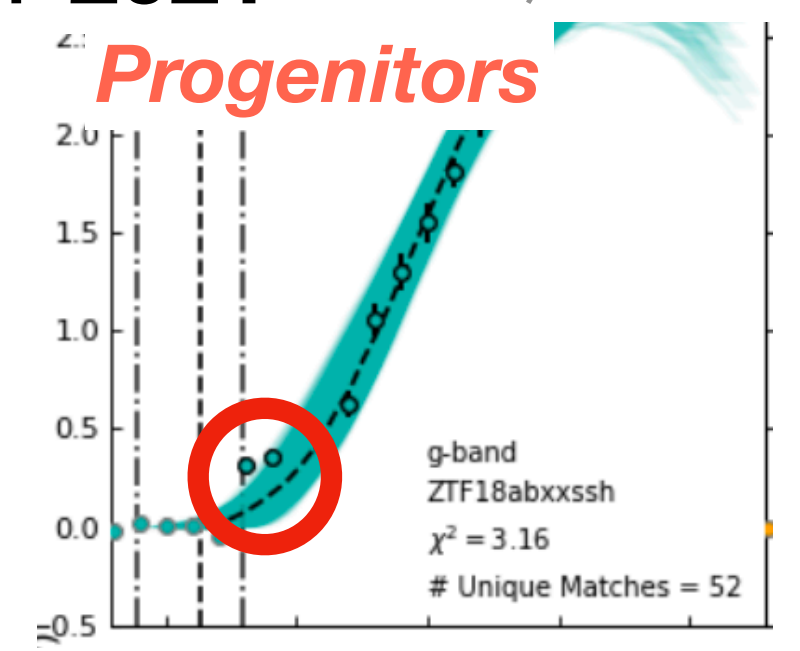
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Recent *Published* Highlights



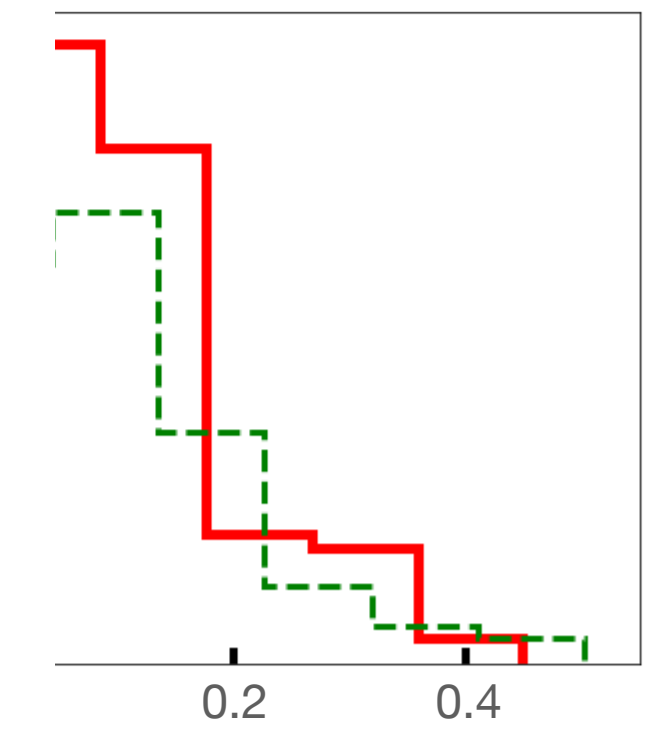
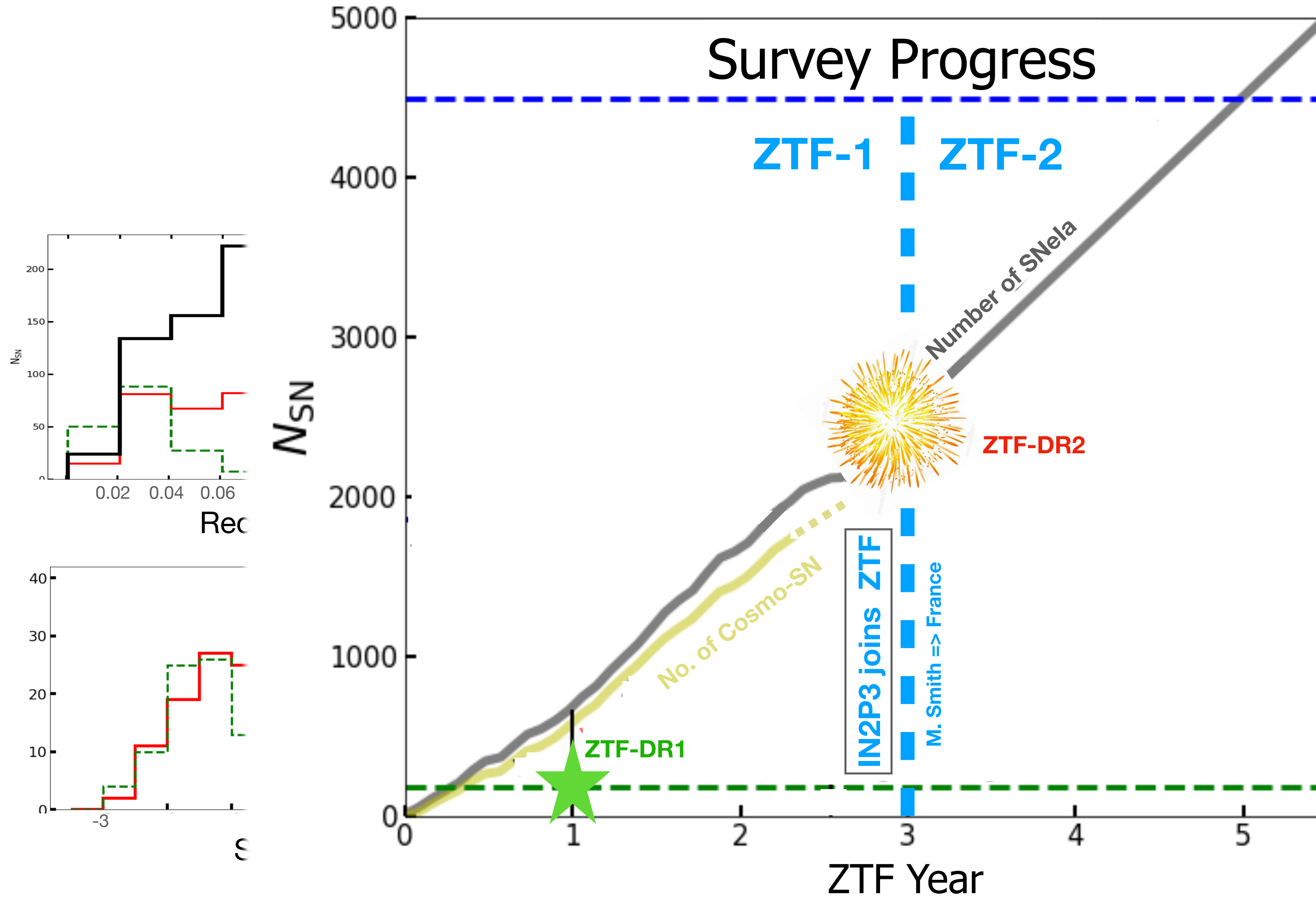
The first sample **DR1**

760 SN => 300 with spec_z => 200 for cosmology:

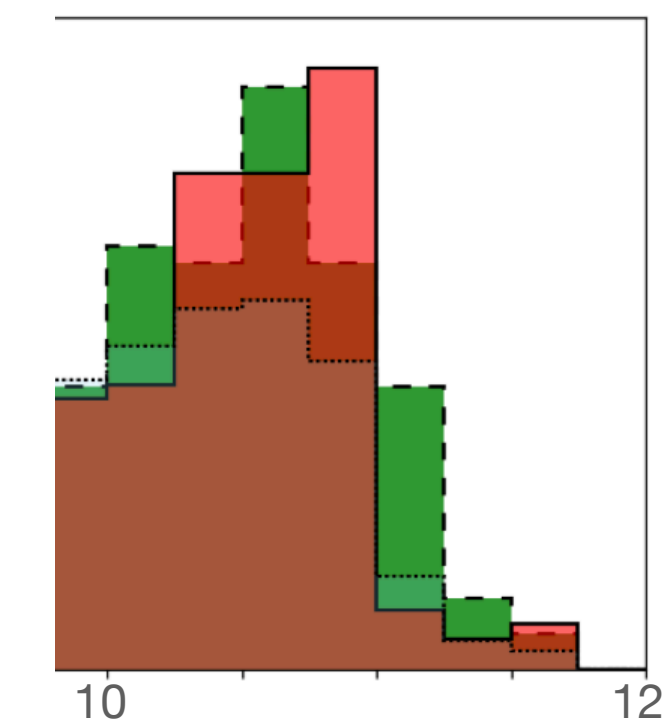


Recent Highlights

DR1 -> DR2



residuals

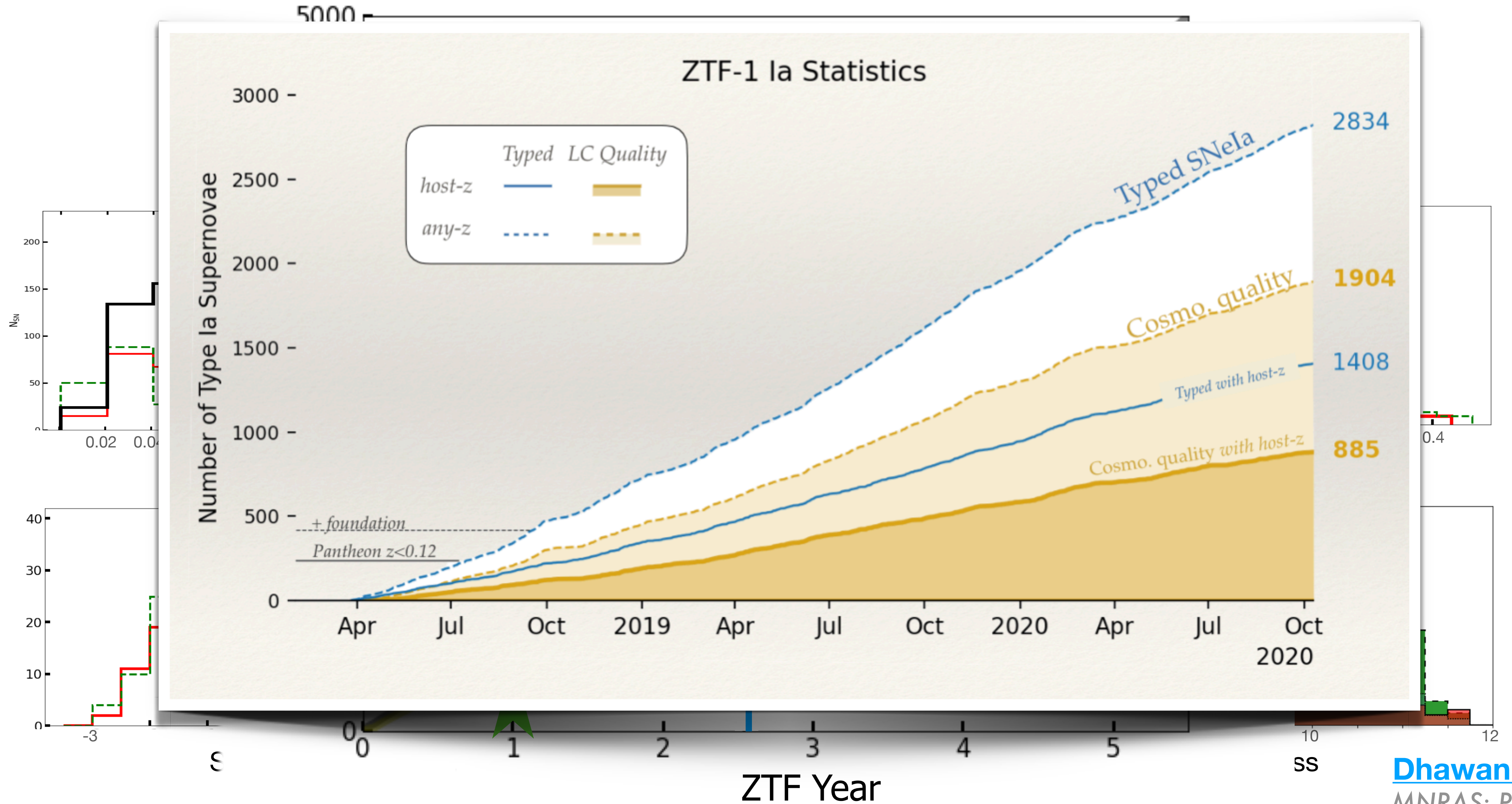


SS

[Dhawan+ 2021](#)
MNRAS; Published

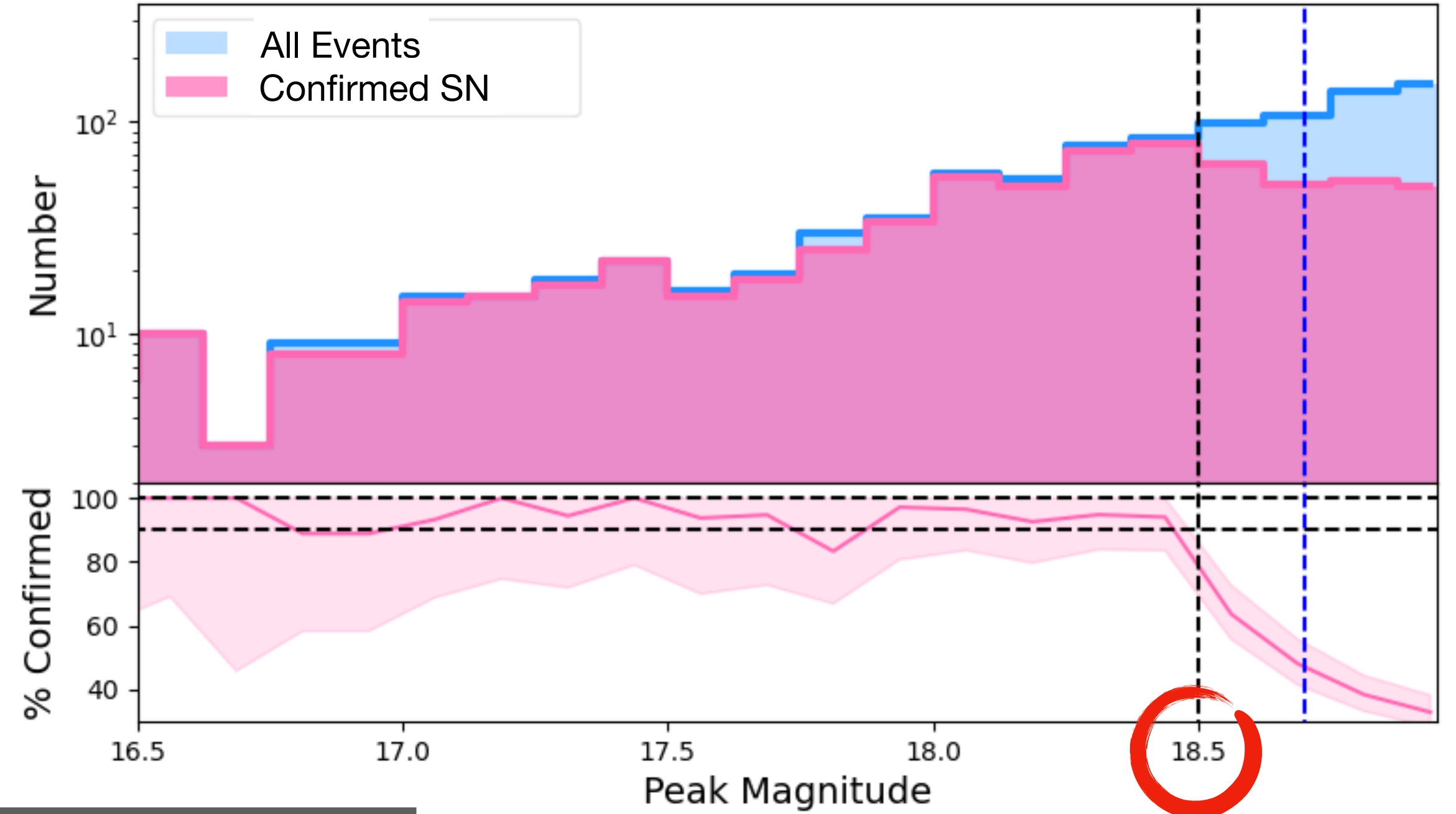
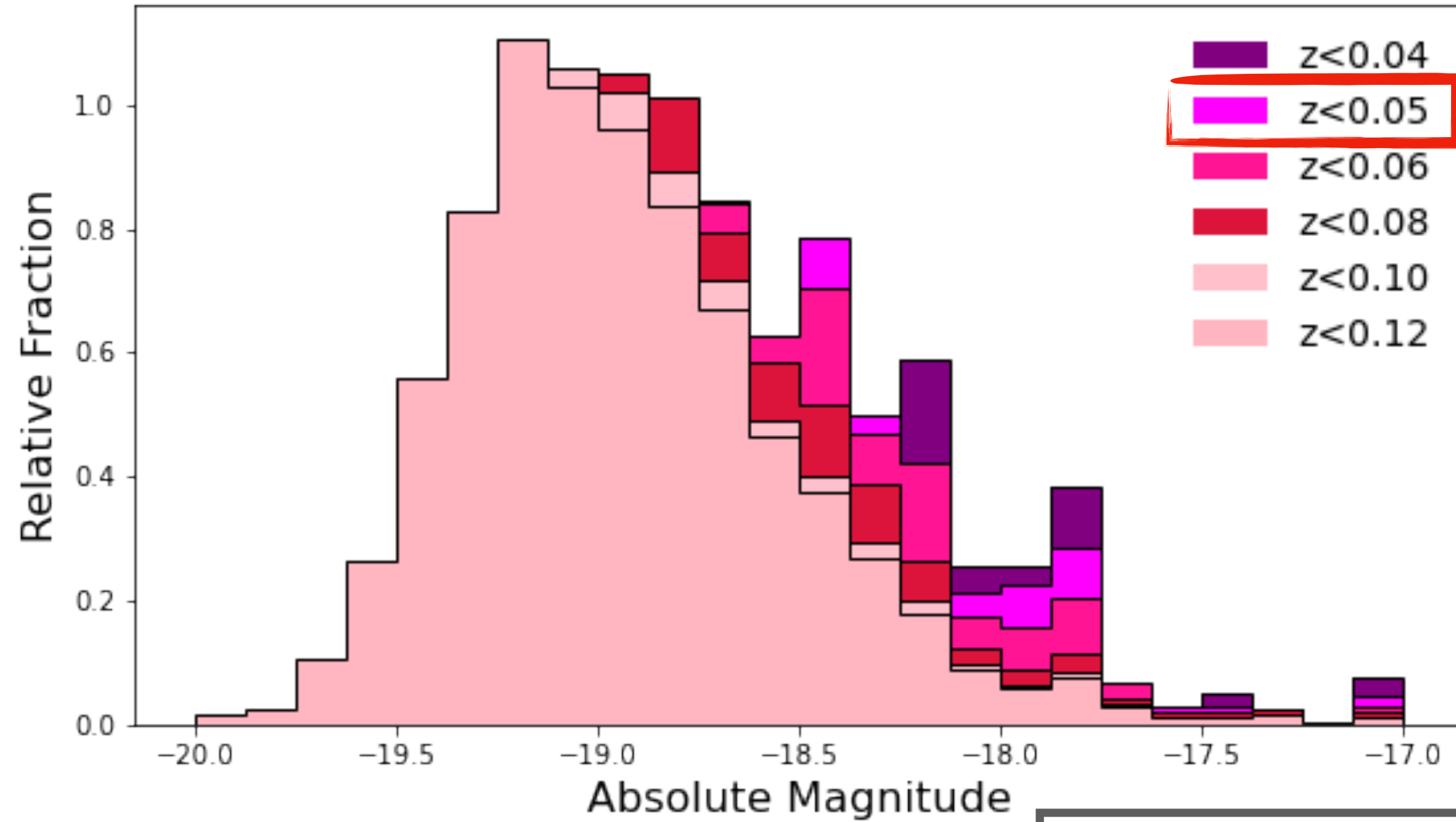
Ongoing Highlights

DR2



Completeness

DR2



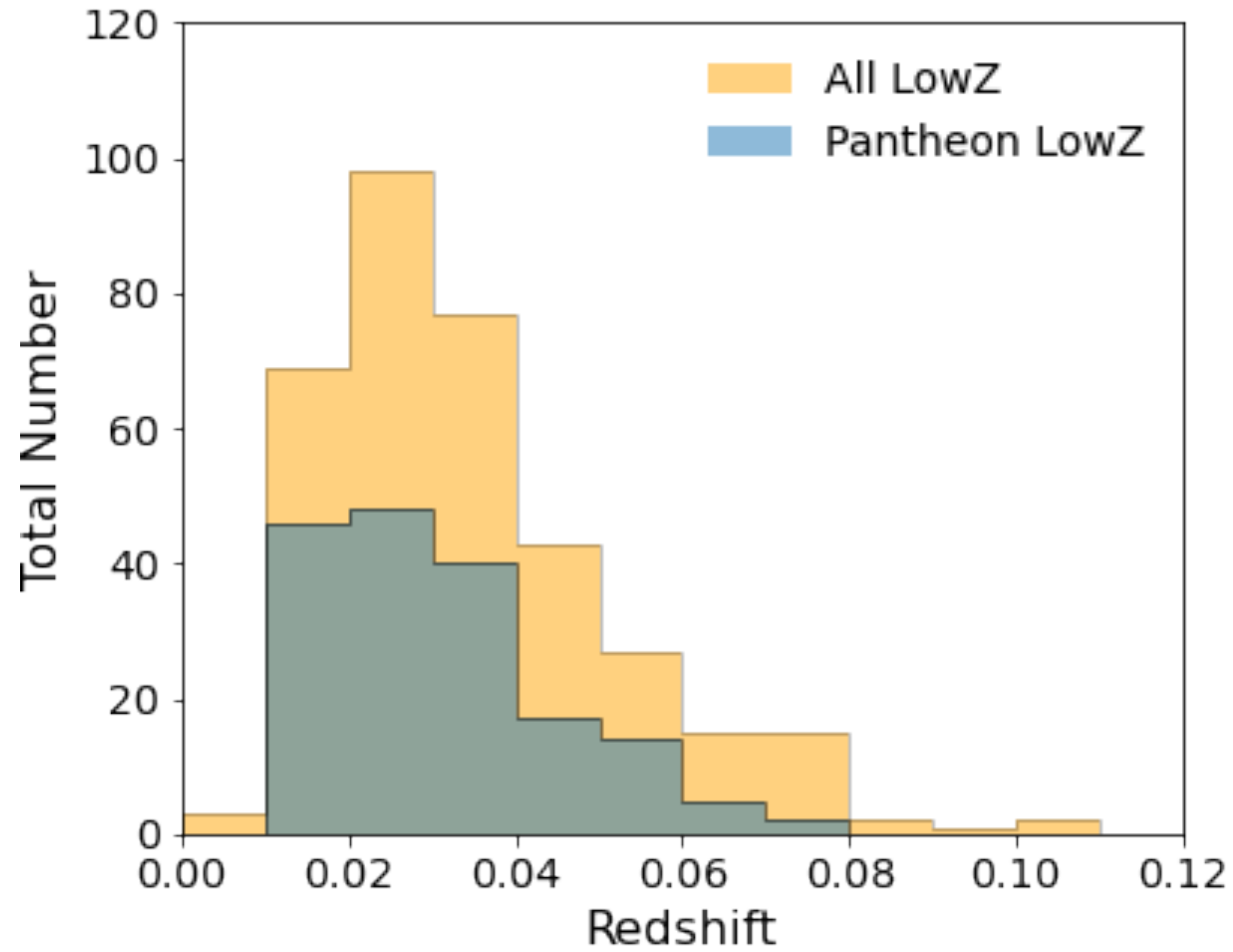
*ZTF1: Complete to $m=18.5$
 $\Rightarrow z \sim 0.05$*

Whole Sample:
2624 Cosmological SN;
923 with a spec_z

'Complete' Sample:
539 Cosmological SN;
306 with a spec_z

Data Size

DR2

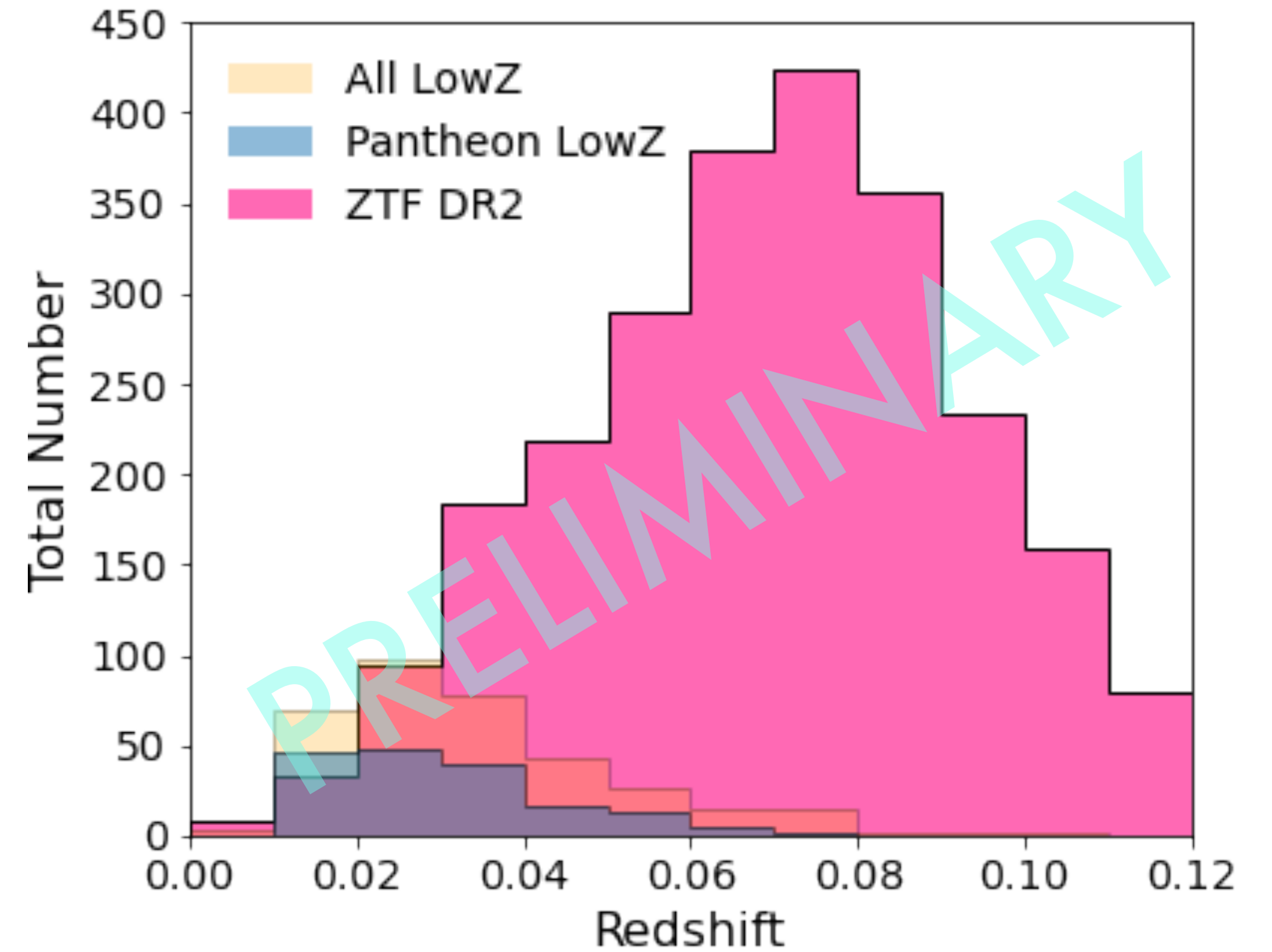
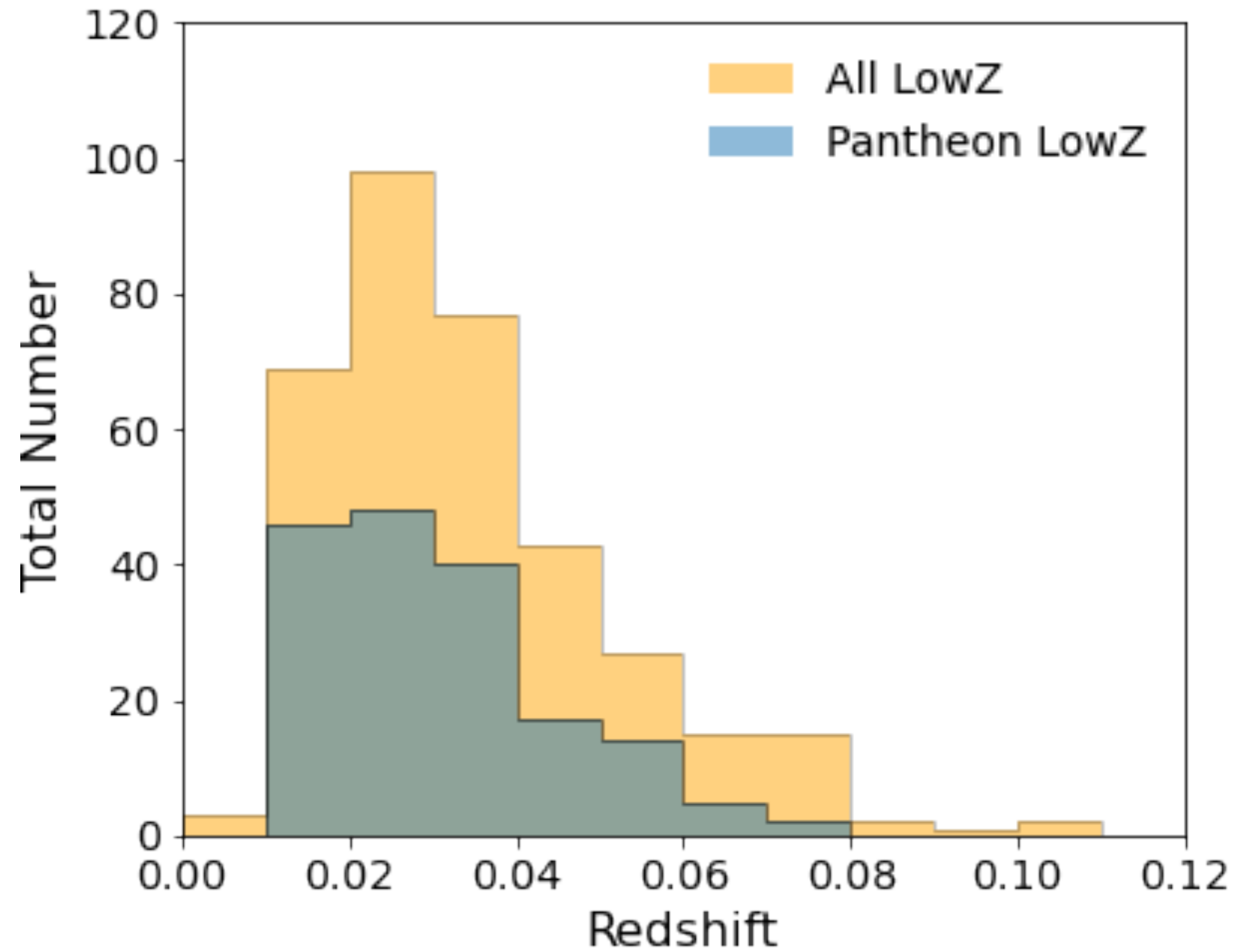


Pre-ZTF:
172 Cosmological SN;
352 over all datasets

(
'existing LowZ' 'Pantheon' 2018
'All LowZ' 'Foundation' 2019
'existing HighZ' 'Pantheon' 2018
)

Data Size

DR2



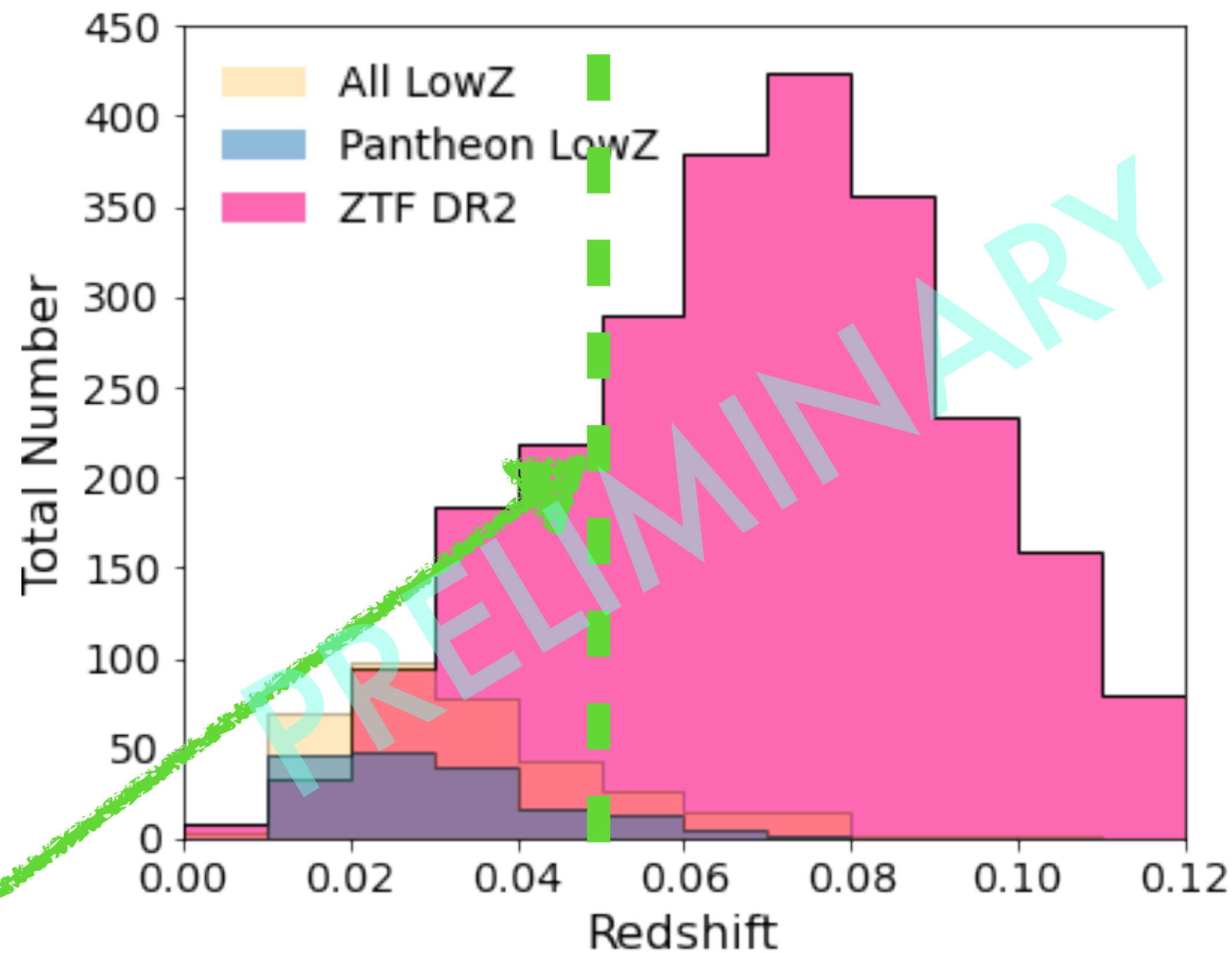
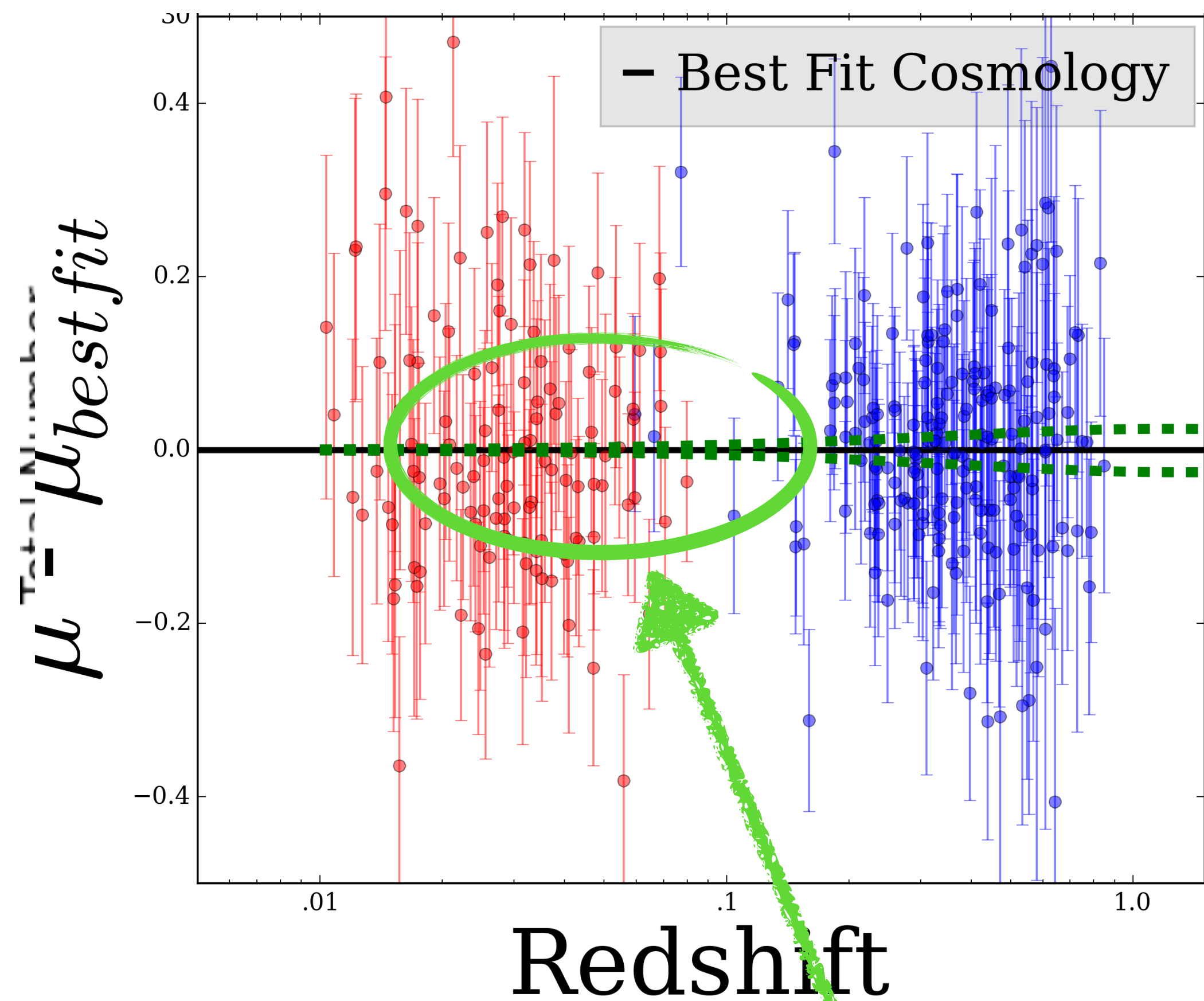
Pre-ZTF:
172 Cosmological SN;
352 over all datasets

ZTF DR2:
352 => 2624*;
172 => 923*

* today == end ZTF1

Data Size

DR2



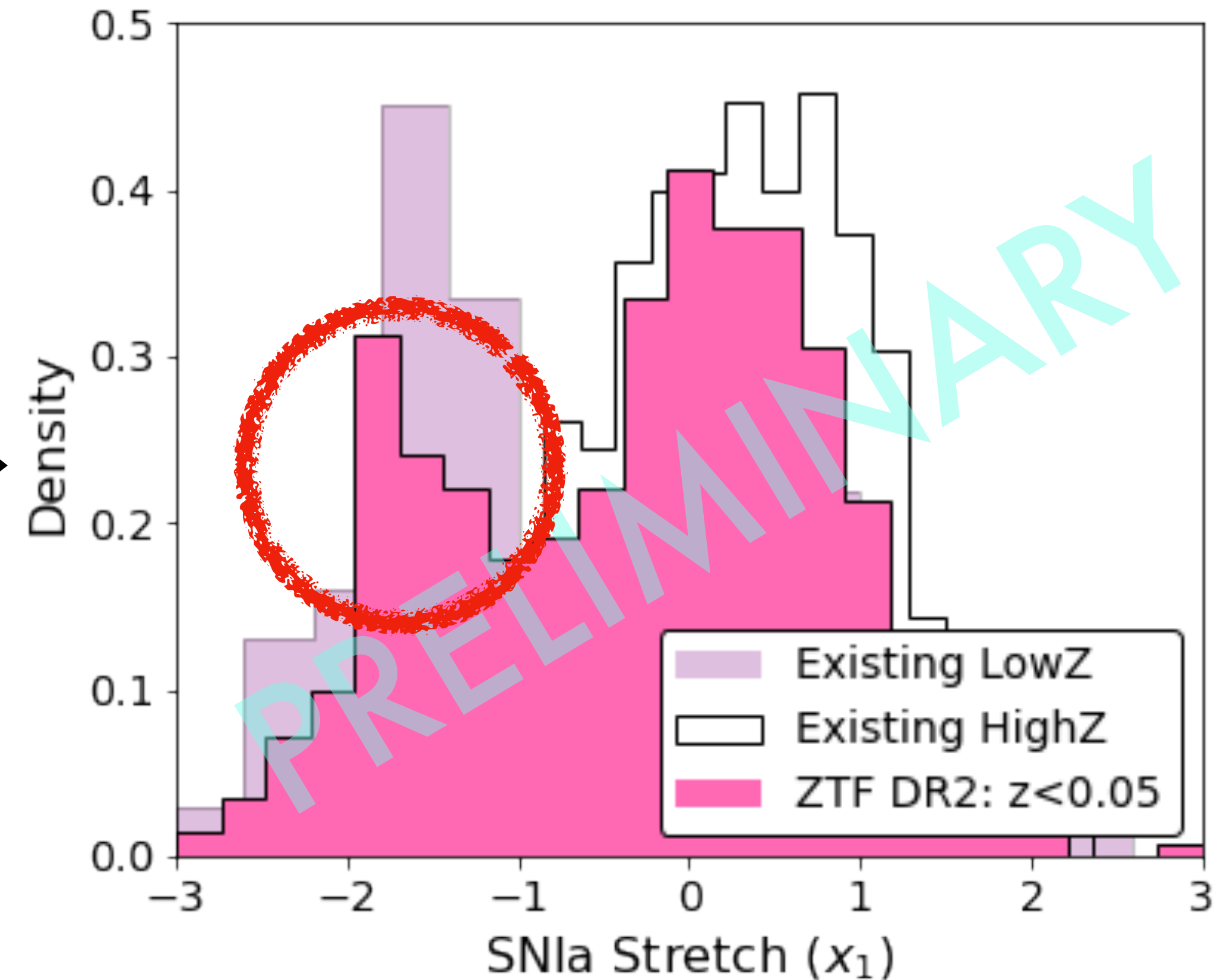
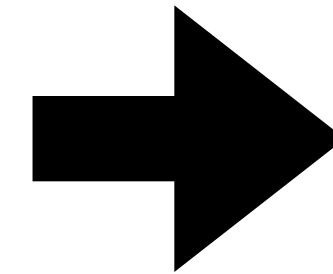
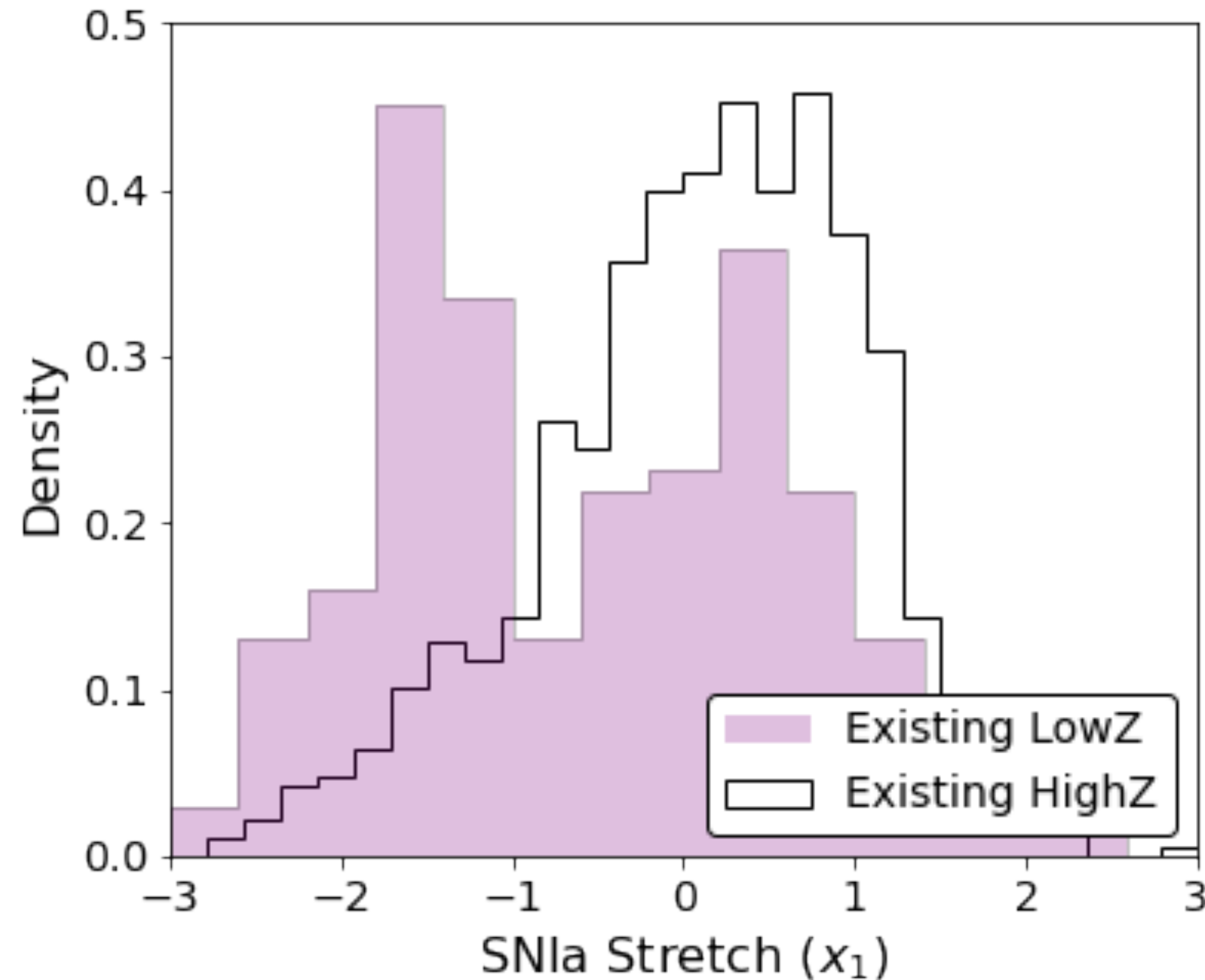
Maximum leverage for w

ZTF DR2:
352 => 2624*;
172 => 923*

* today == end ZTF1

Answering Questions

DR2



Pre-ZTF:
LowZ: two populations*
HighZ: one population**

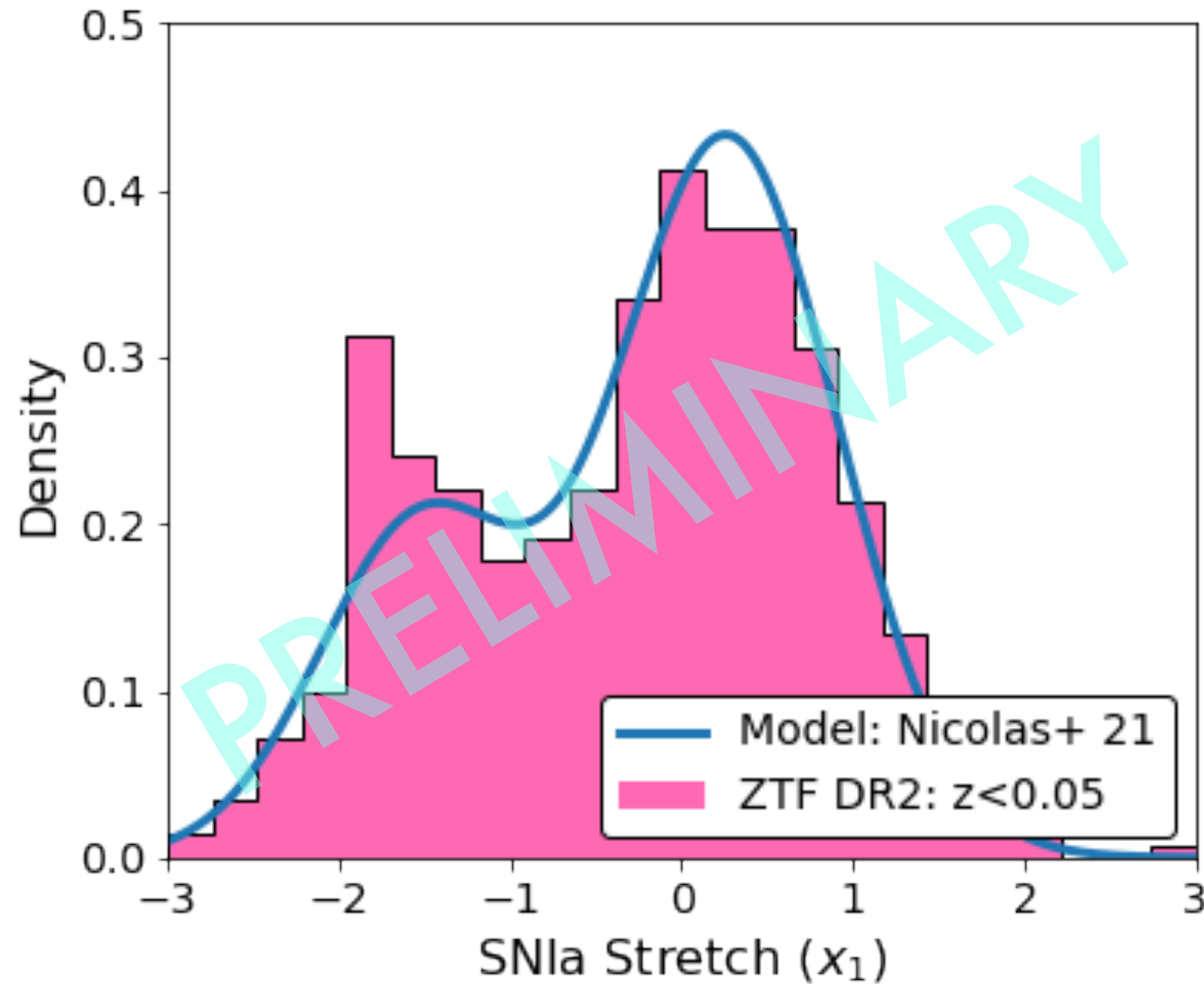
ZTF DR2:
LowZ: two populations
but one dominates

* Selection effects?

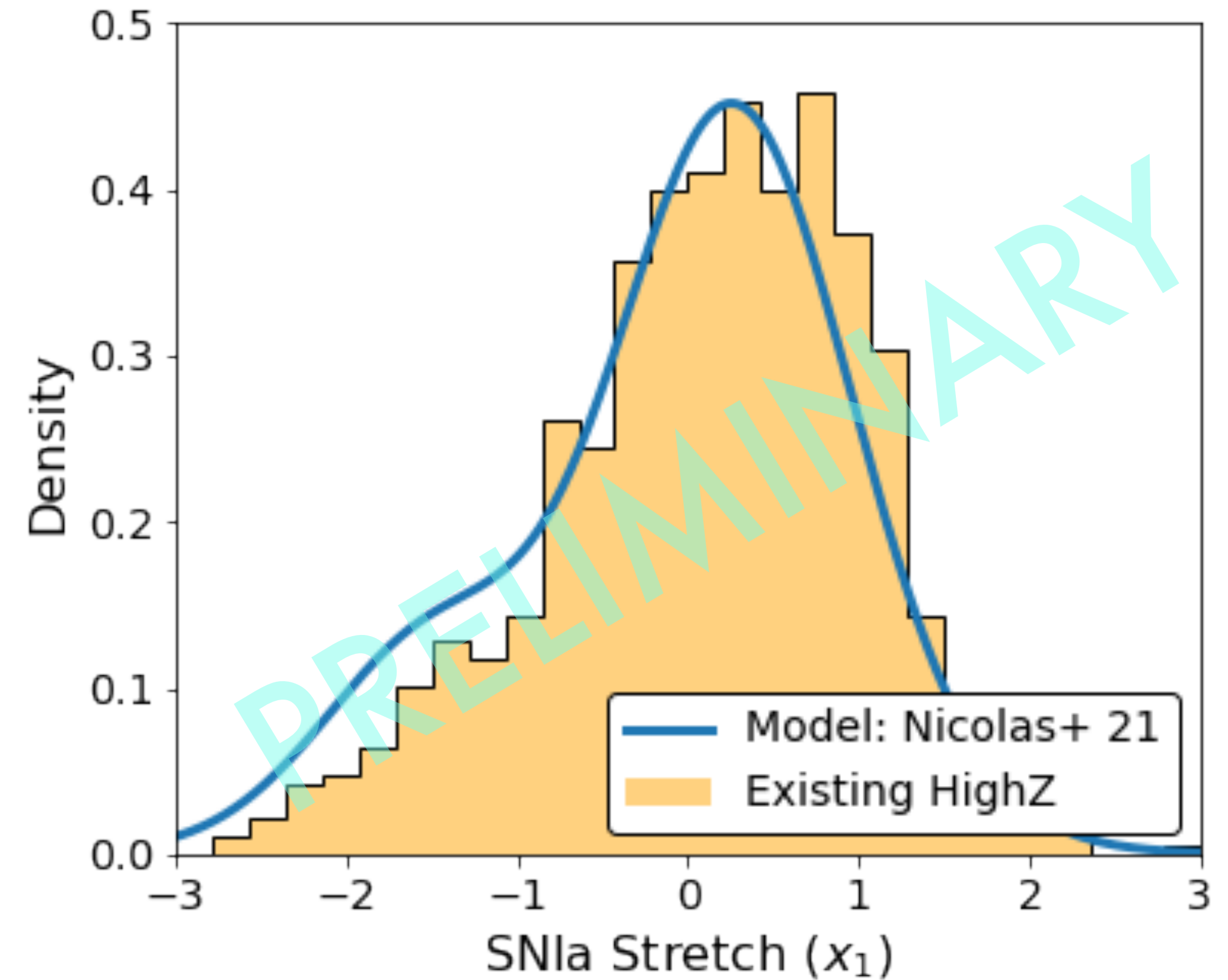
** Selection effects or evolution?

Testing Models

DR2



+



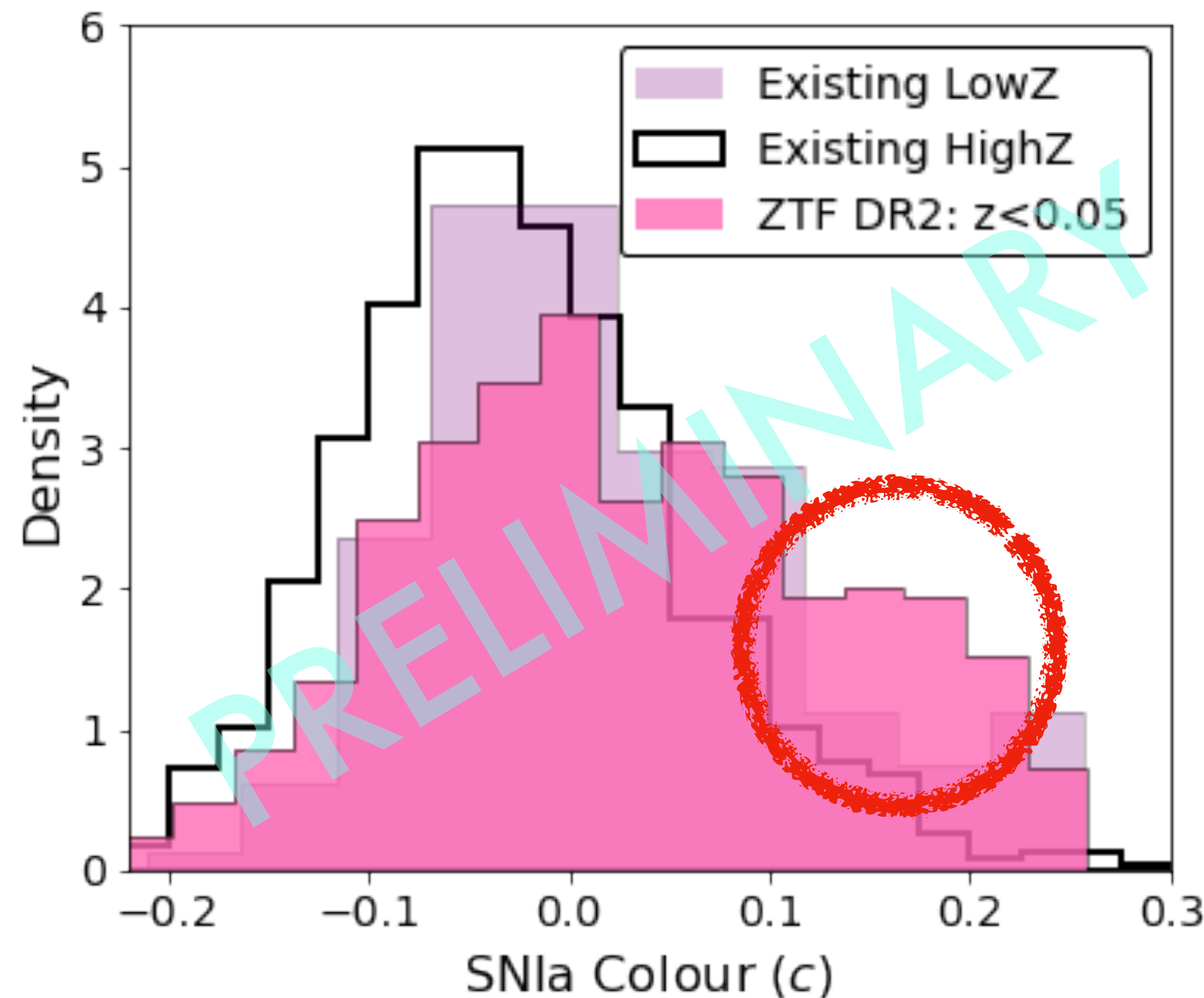
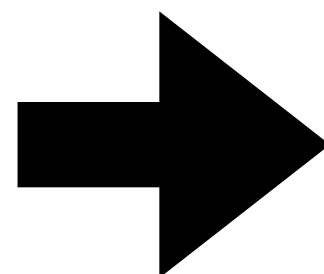
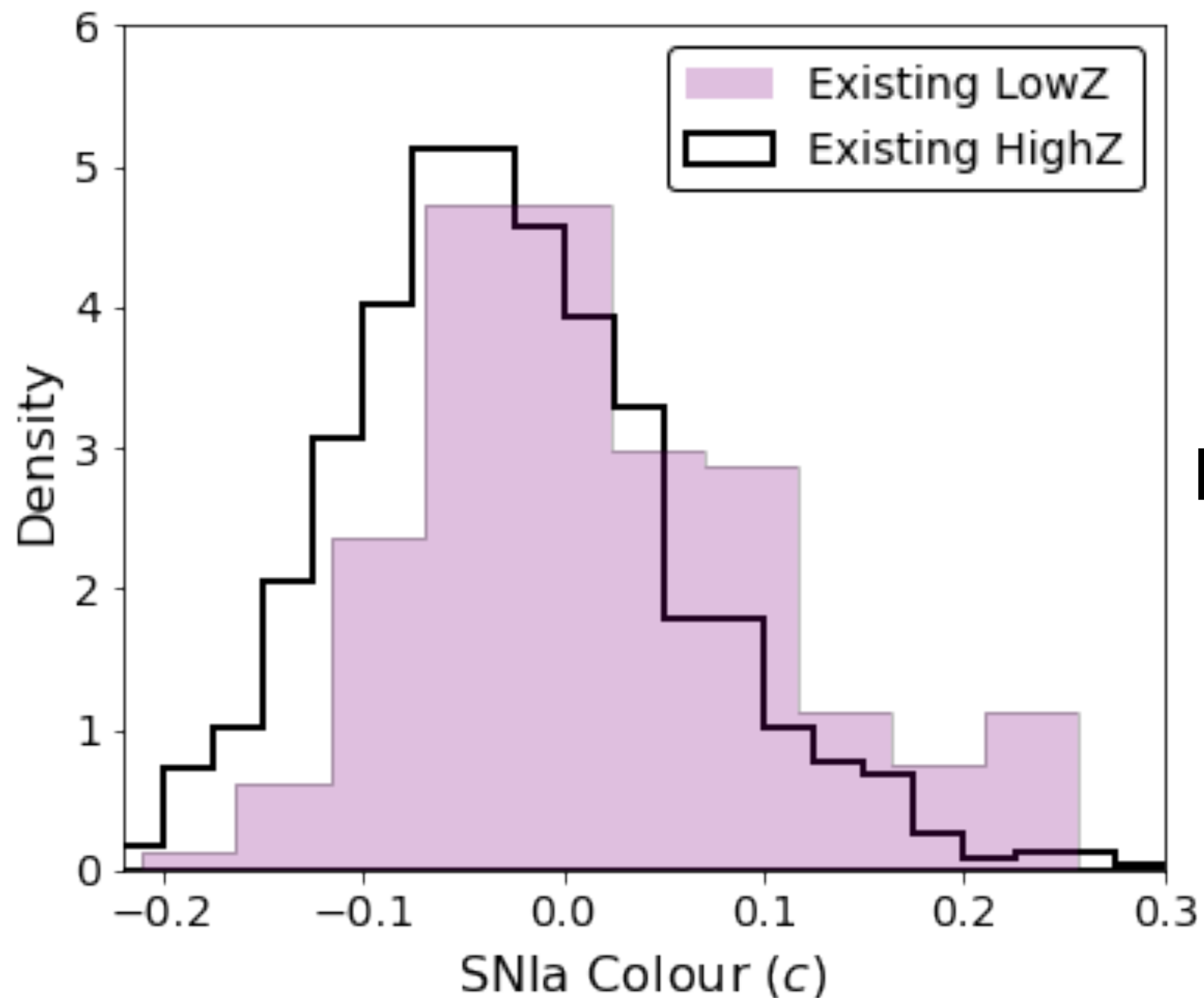
LowZ:
Two populations

evolves
into

HighZ:
One population

Concerning Colour

DR2



Pre-ZTF:
LowZ: excess of red SNe
*/**

ZTF DR2:
Colour excess is still seen ***

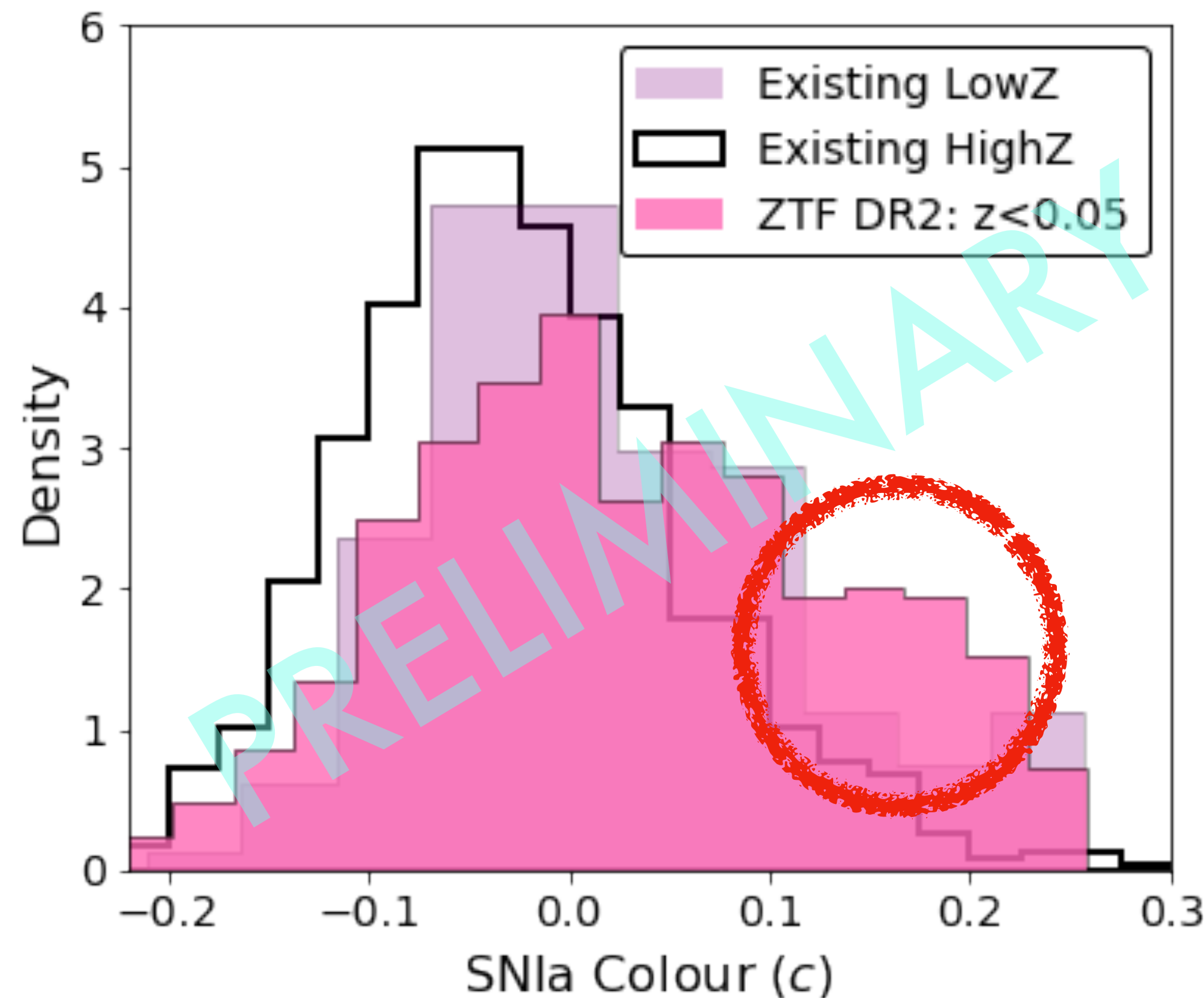
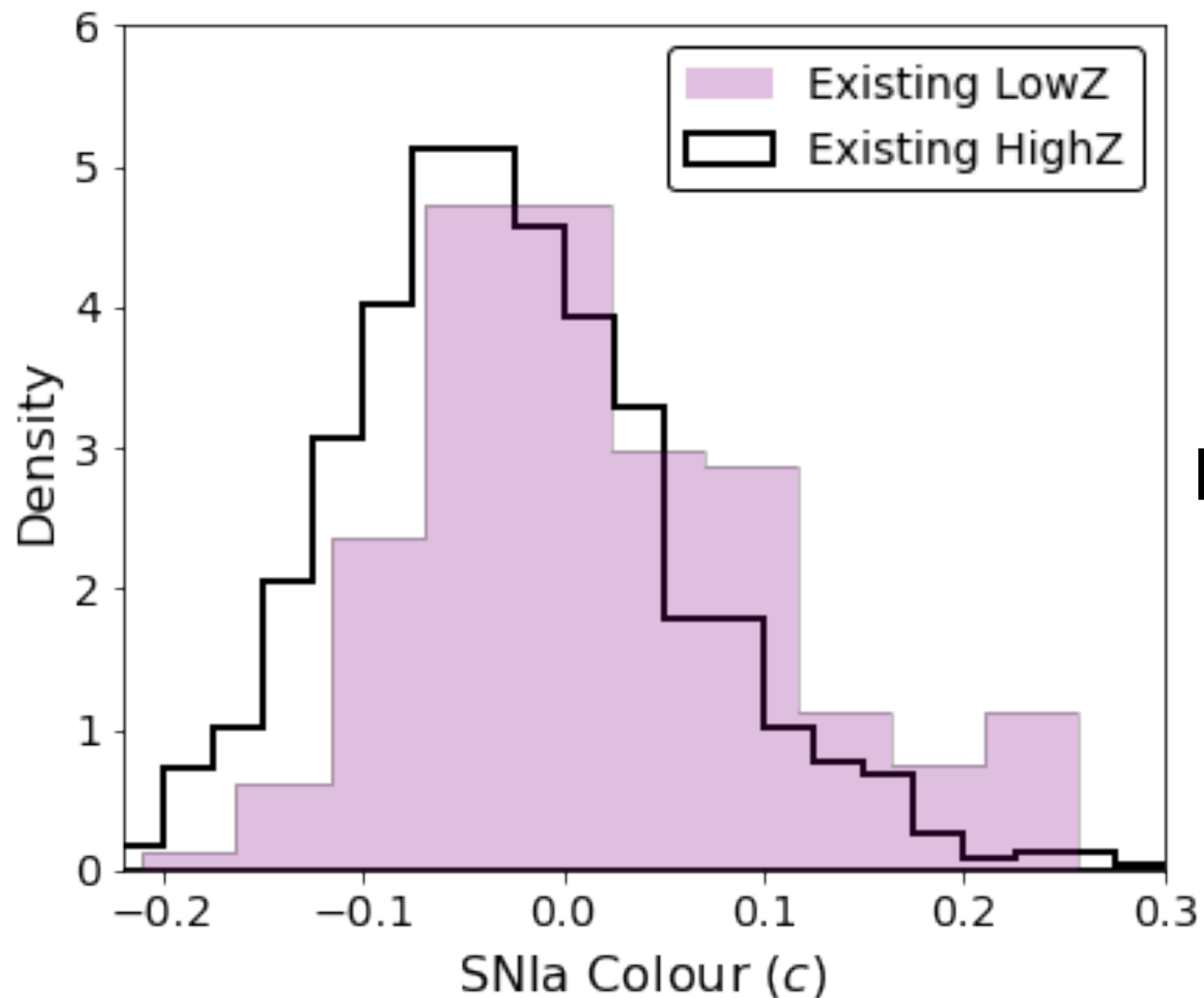
* Selection effects?

** Selected out at high-z?

*** g+r only

Concerning Colour

DR2



<p><u>Pre-ZTF</u> LowZ: excess of */**</p>	<p>Can we measure c? See M. Amenouche on simulations</p>	<p><u>DR2:</u> excess is still **</p>
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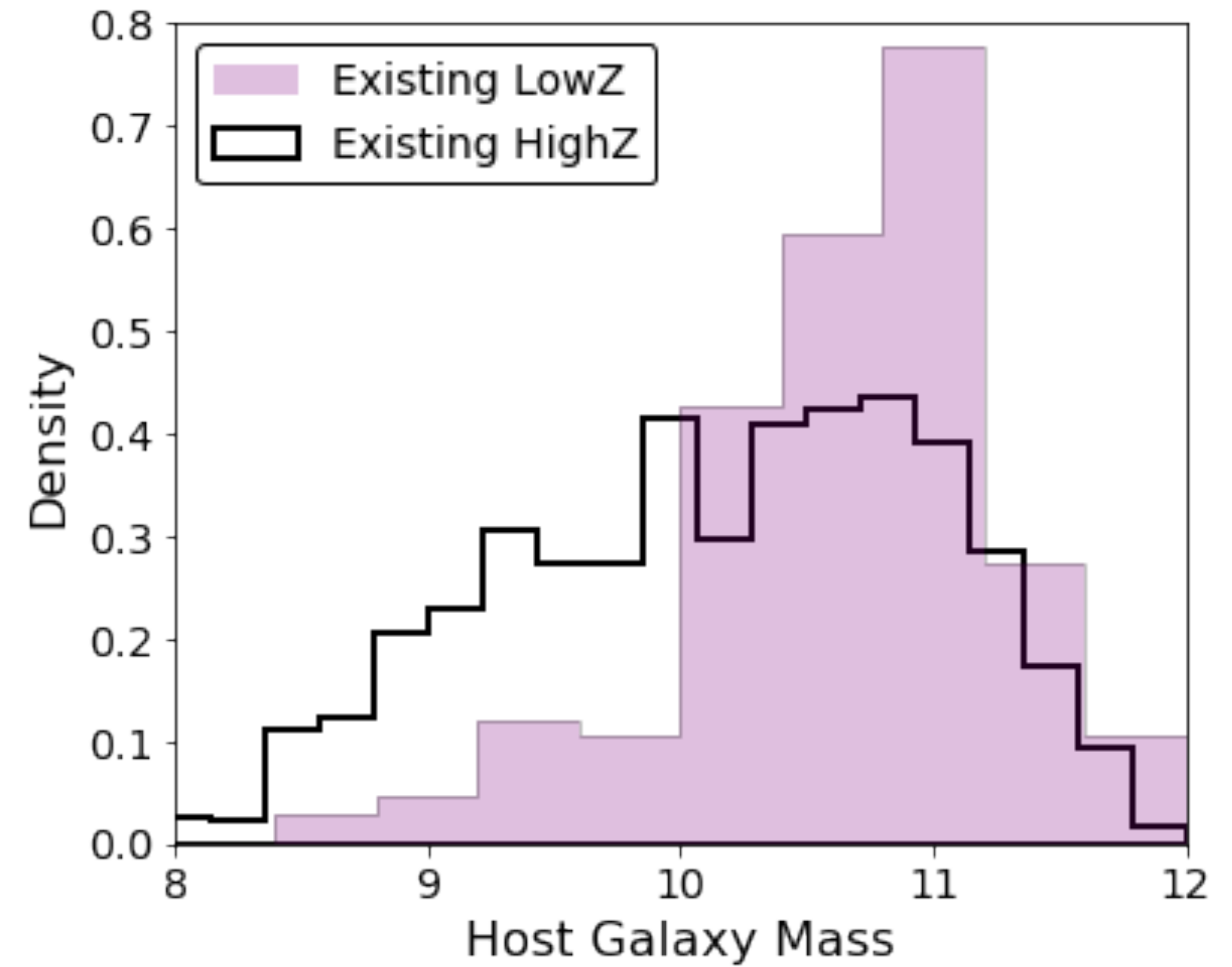
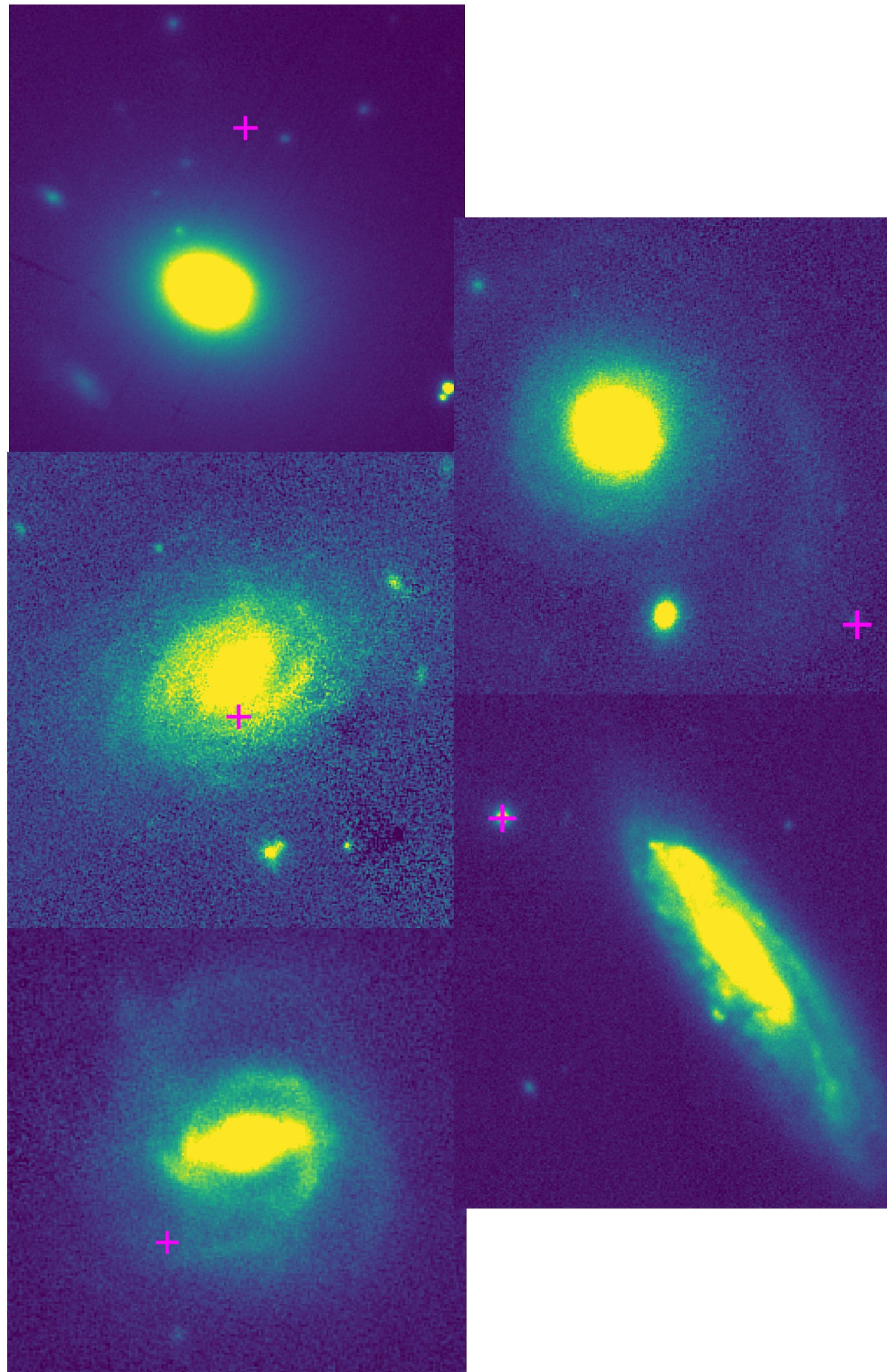
* Selection effects?

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Environmental Dependence

DR2

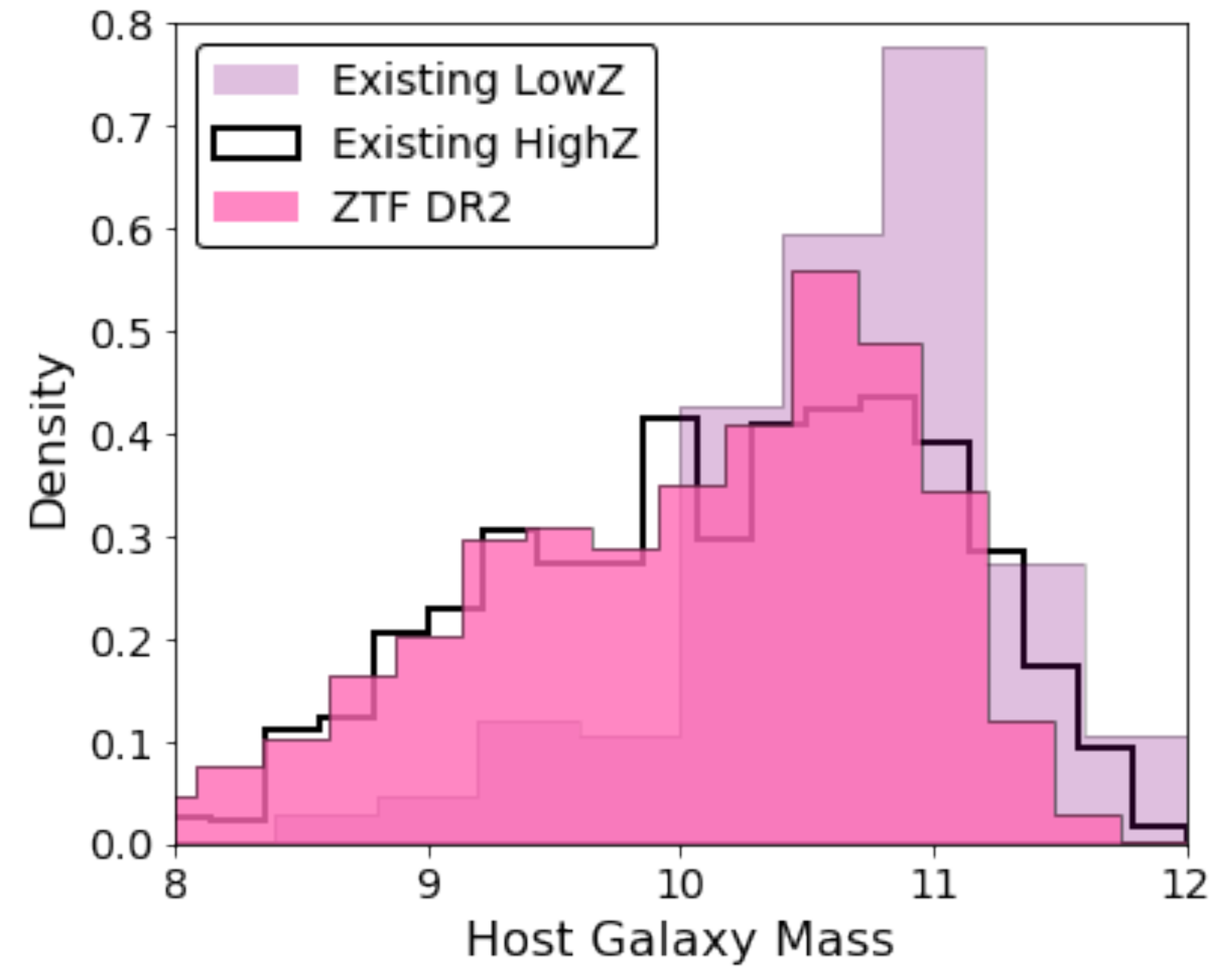
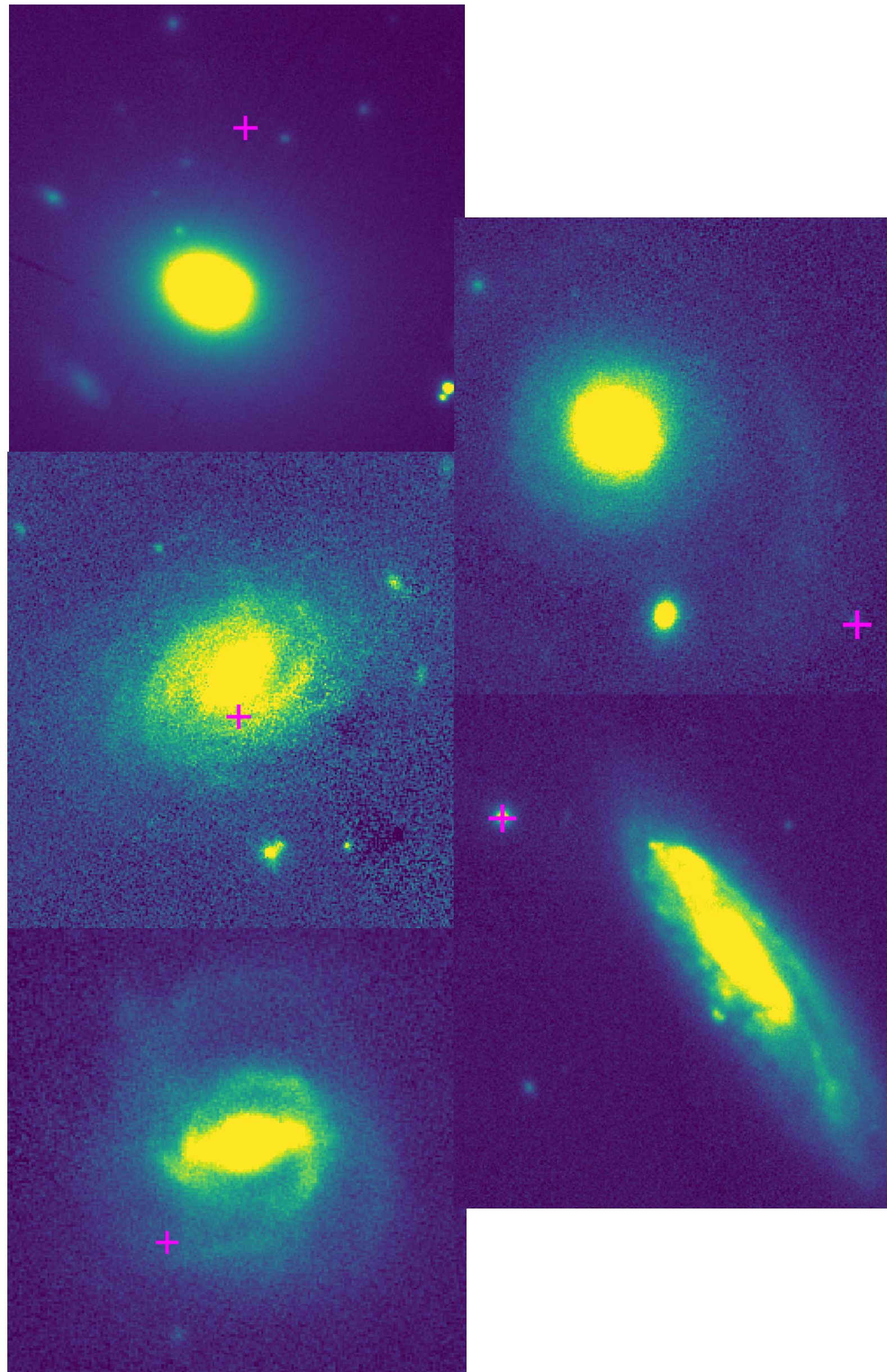


Pre-ZTF:
*LowZ: no SNeIa in small galaxies**

* Selection++++

Environmental Dependence

DR2

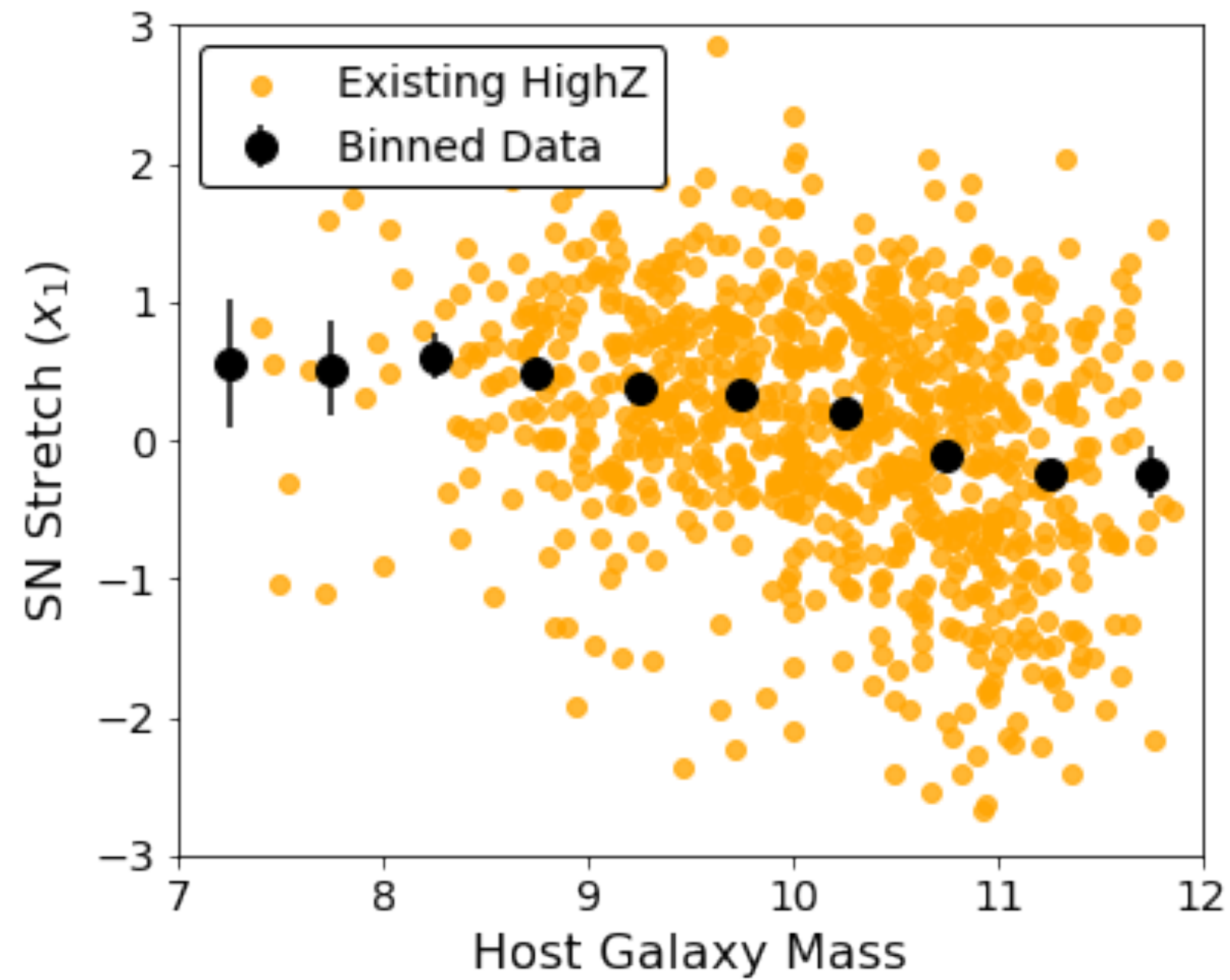


DR2:
 $LowZ == HighZ$
!

See also sSFR, local colour, ...

Environmental Correlations

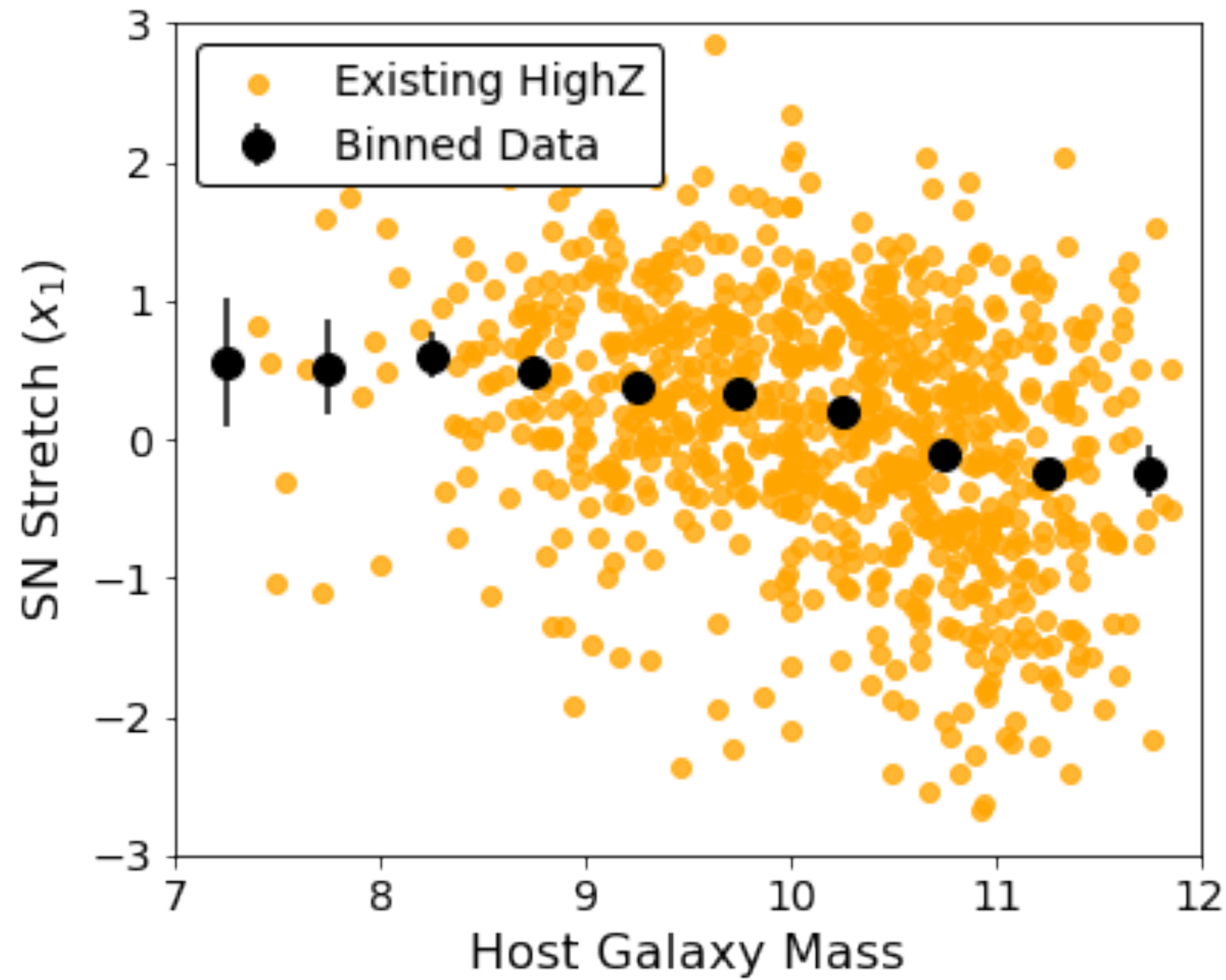
DR2



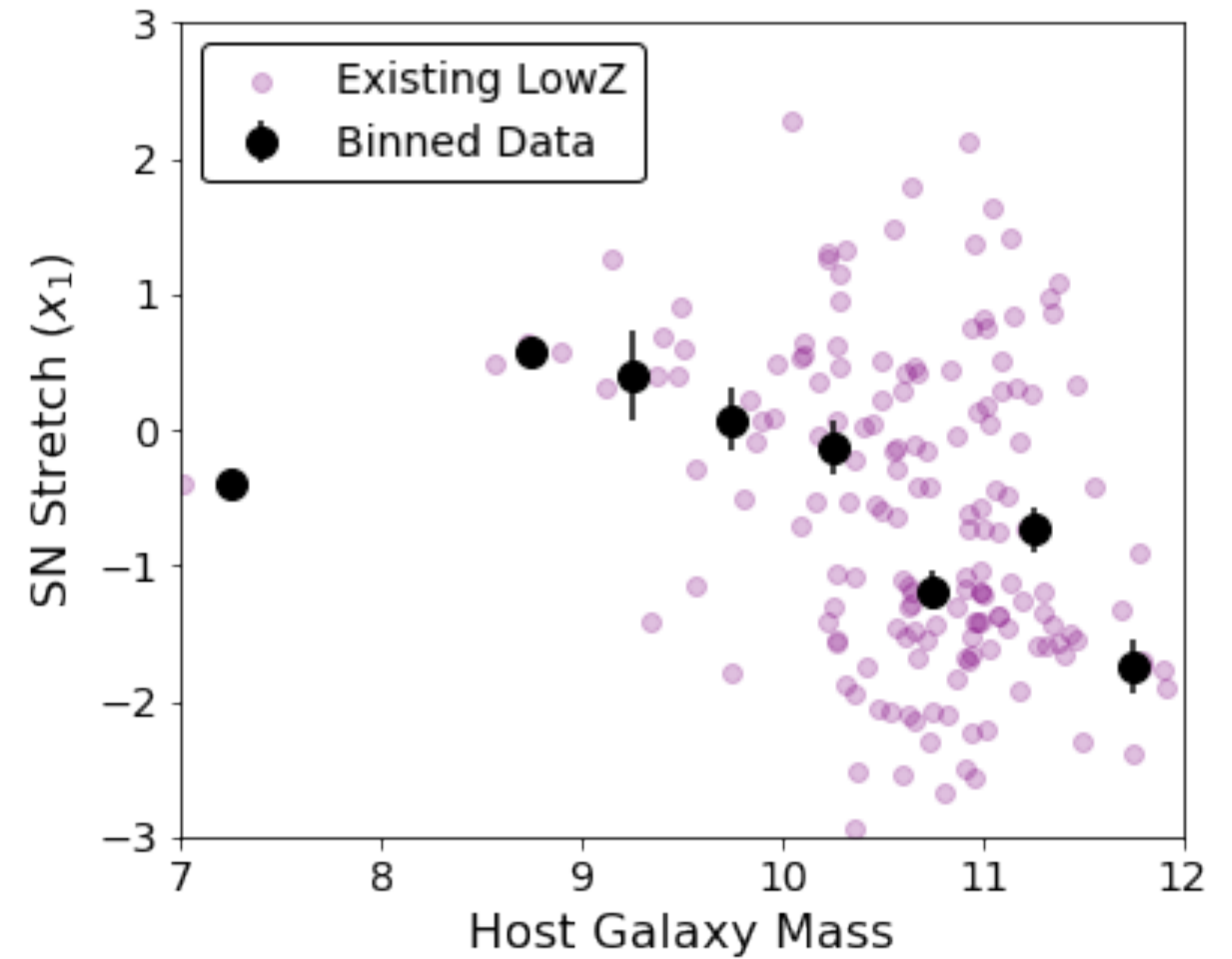
HighZ:
Mass \propto Stretch
Two Populations?

Environmental Correlations

DR2



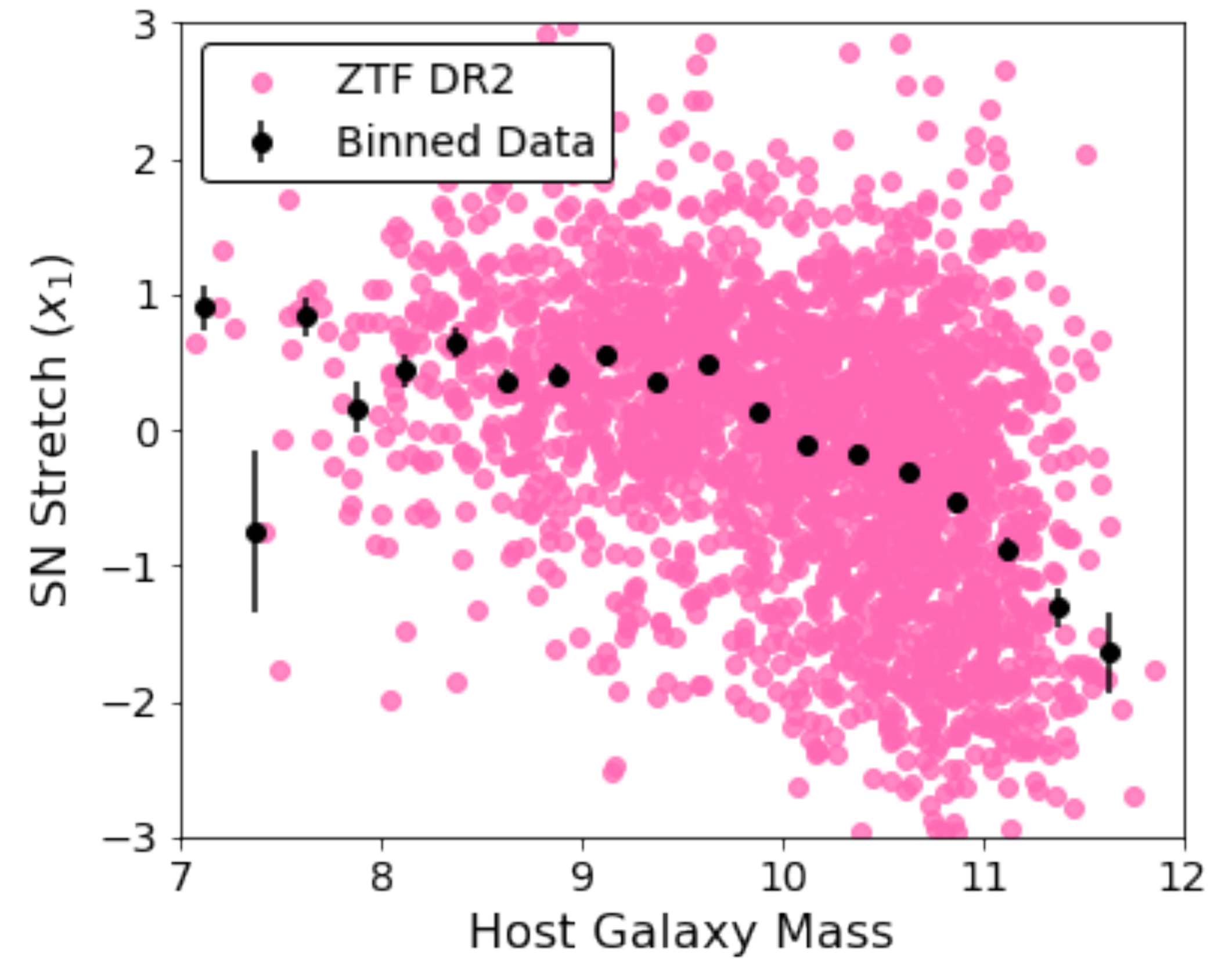
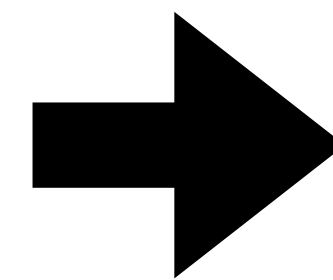
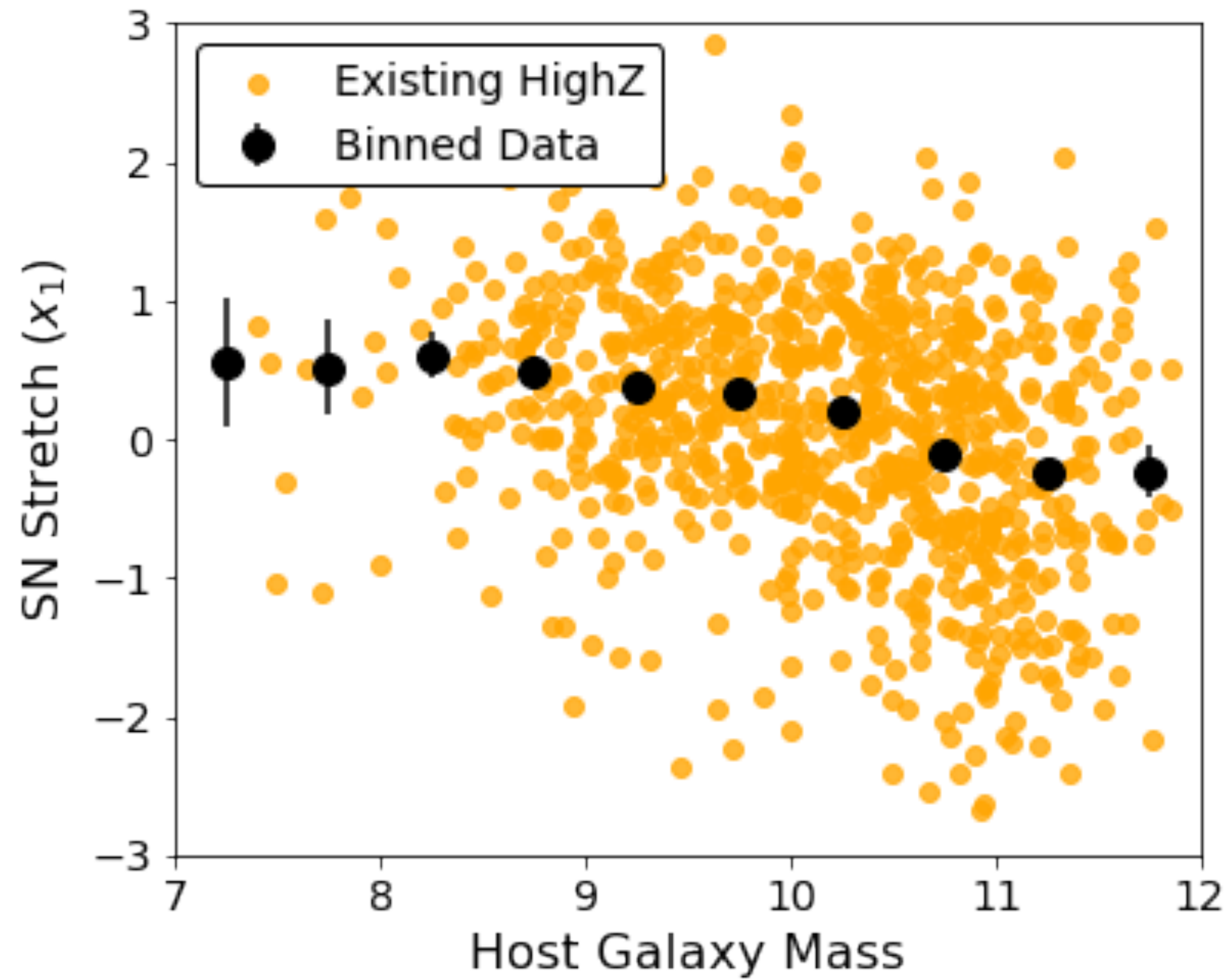
HighZ:
Mass \propto Stretch
Two Populations?



LowZ:
Biased....
Unclear

Environmental Correlations

DR2



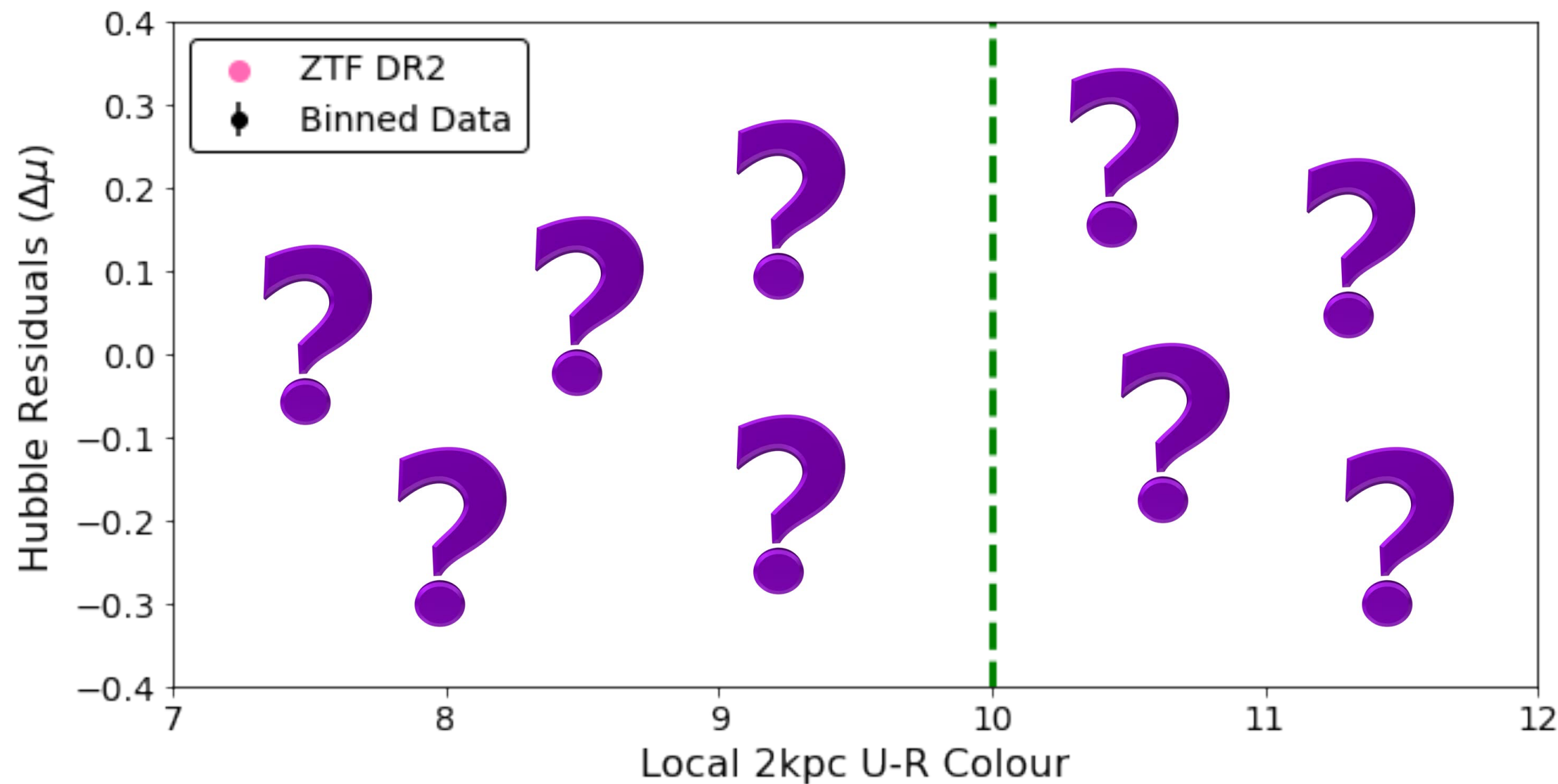
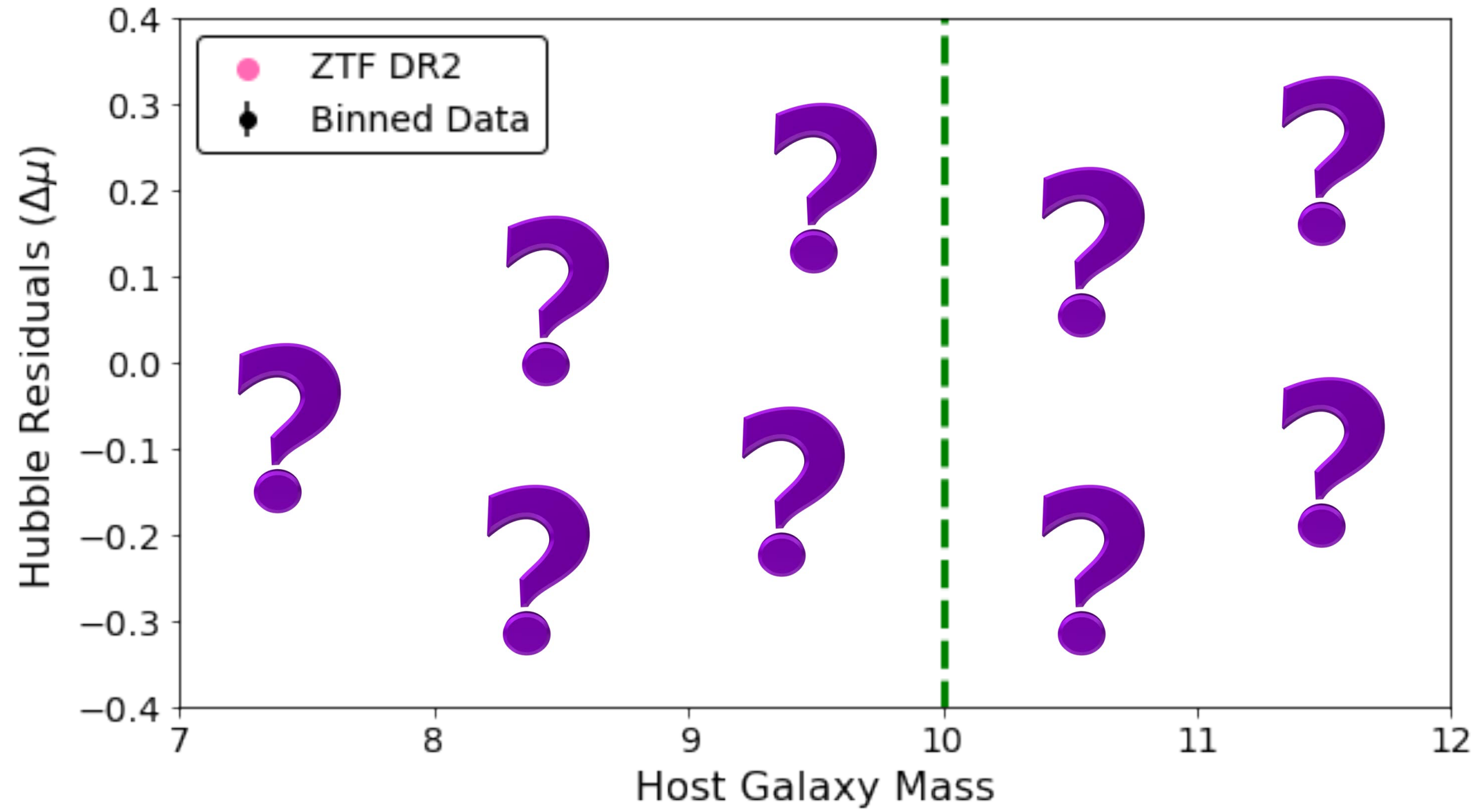
HighZ:
Mass \propto Stretch
Two Populations?

DR2:
Mass \propto Stretch
Two Populations

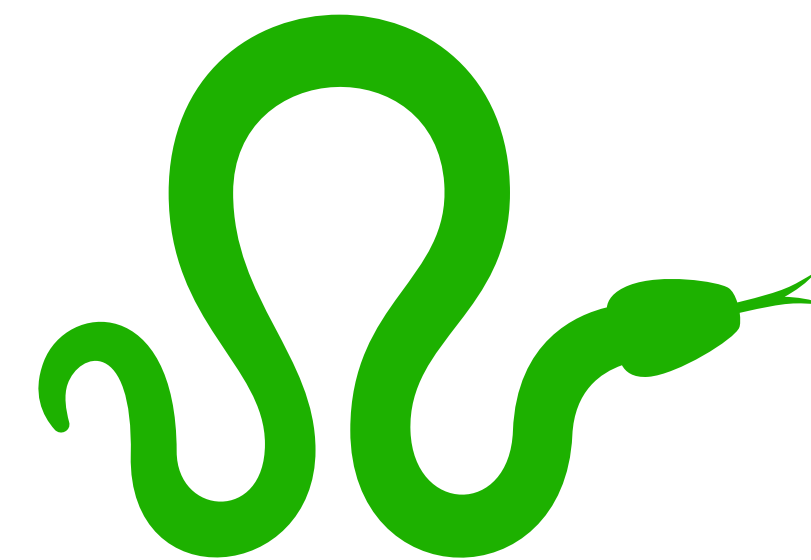
See also SN colour

The Next Step

DR2



Key Question:
SN Luminosity \propto Host Prop
?



*Dependent on:
selection, calibration,
completeness, model ...*

The Summary

ZTF-DR2

>1000 cosmological SN today

First unbiased sample at low-z

Ideal/necessary for LSST HD

Strong evidence of multiple populations

HIGHLIGHTS

SN \propto Environment

Coming Soon...

*underlying populations, luminosity
correlations, cosmology, etc...*

Merci / Gracias / Thank you :)

Also dankeschon, tack and go rabid maith agat ;)



Credit: Debbie Smyth