

# Type Ia Supernova Cosmology from DES to LSST and Roman

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*On behalf of the DES-SN team*

Duke University

Jan 14, 2025  
DES-DESC Splinter @ AAS

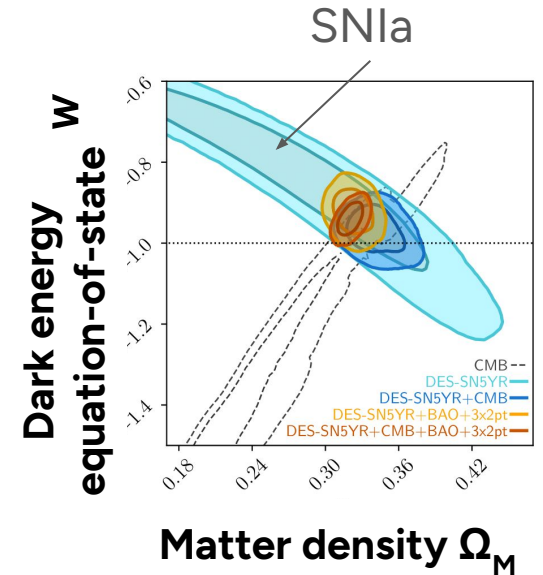
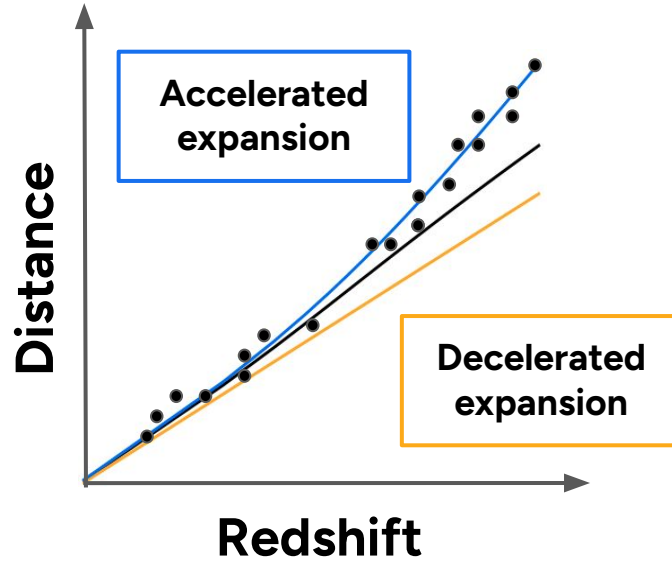
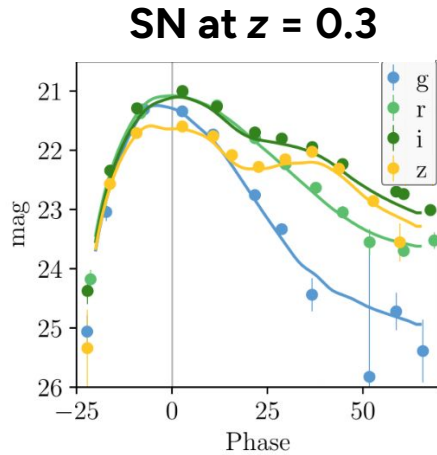
**Data and analysis products are all public:**

<https://github.com/des-science/DES-SN5YR>



The DES Supernova Working Group

# Using Type Ia Supernovae as "standardizable candles" to measure cosmic distances, we can probe the universe's expansion history



SN light-curves

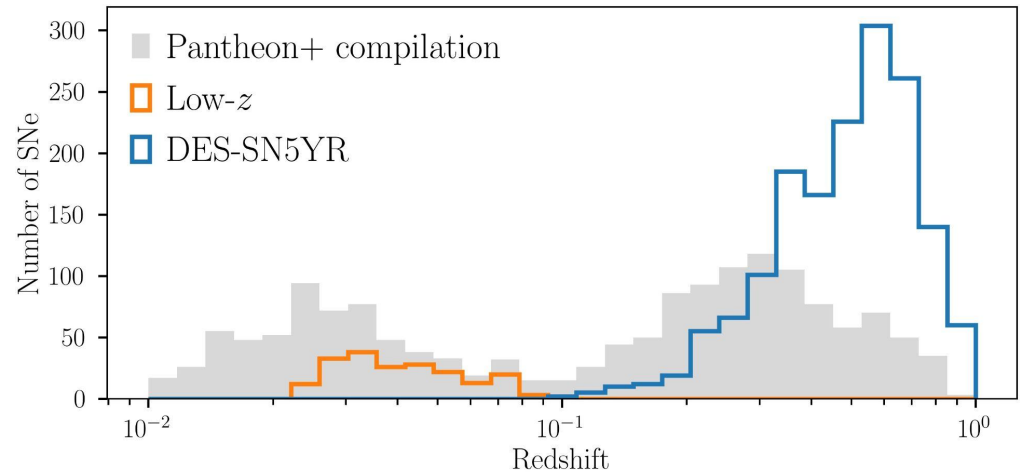


Hubble Diagram

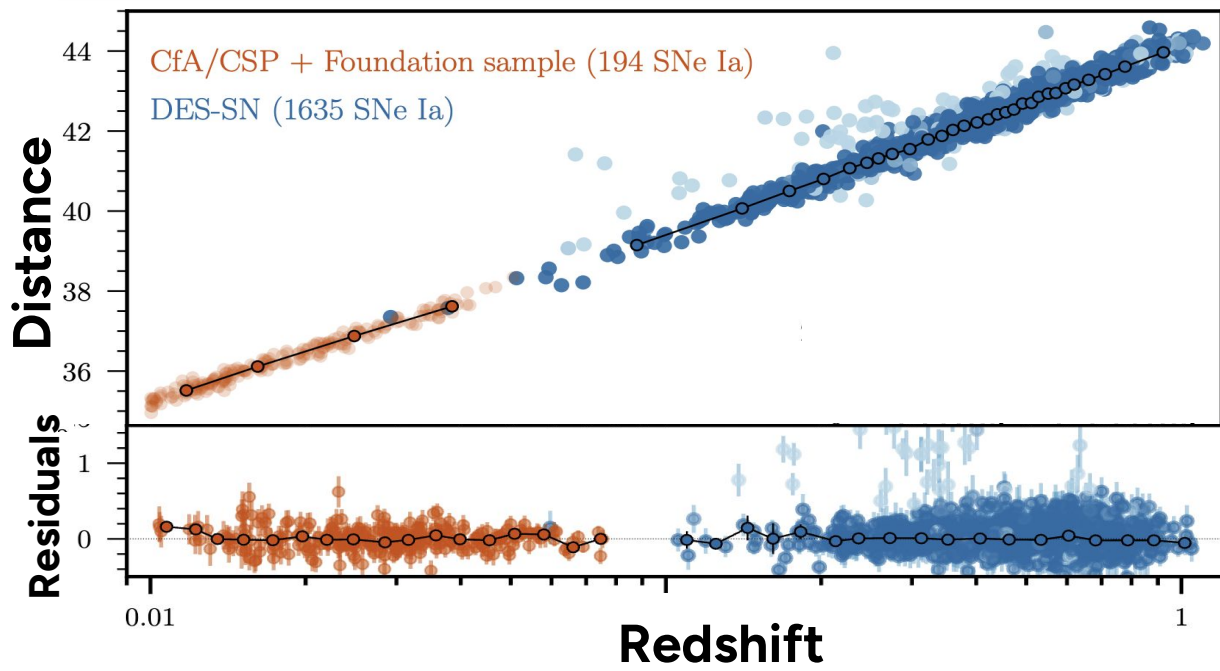


Cosmological constraints

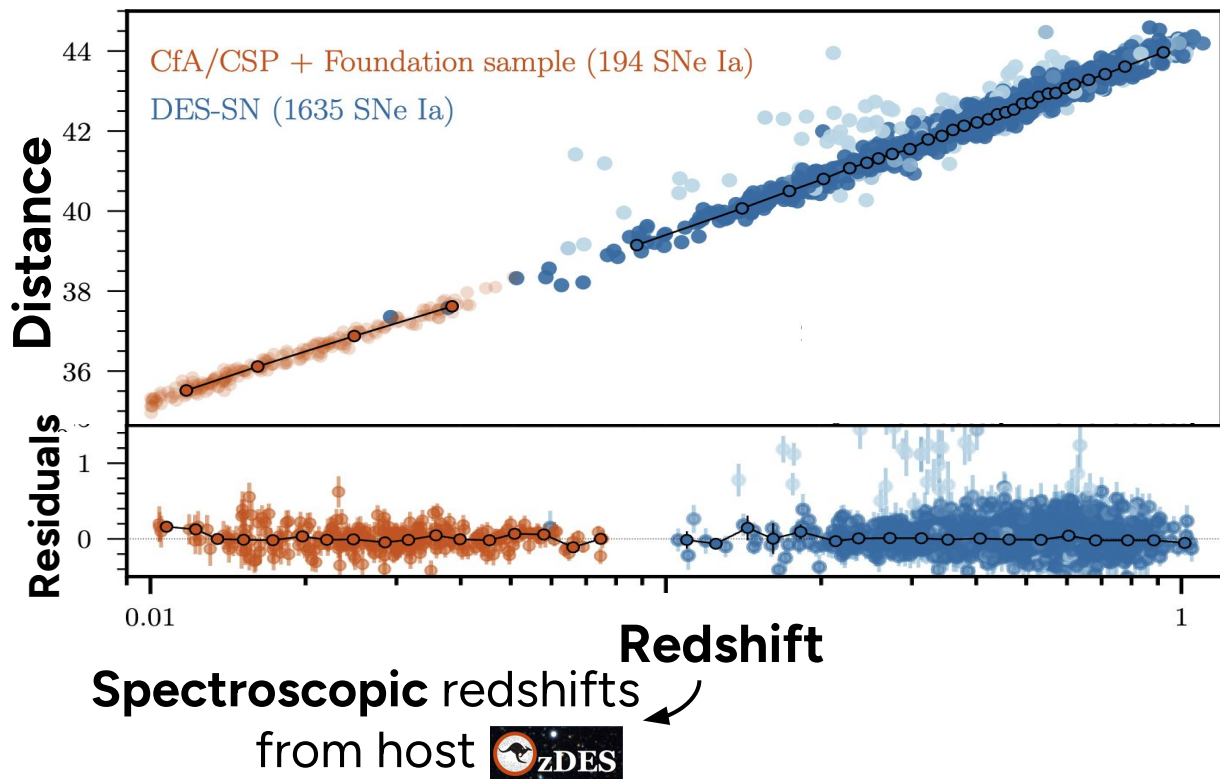
**The DES-SN5YR sample is the *largest* and *deepest* SN sample collected from a single telescope to date.**



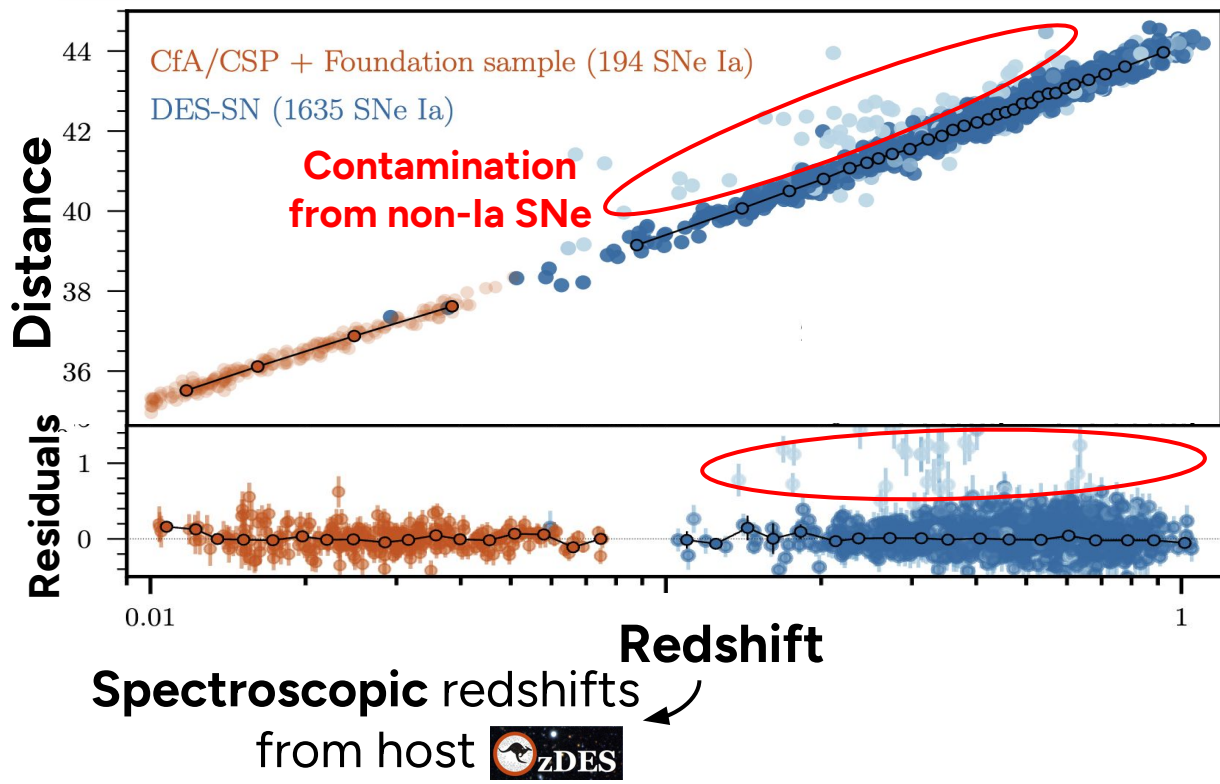
# DES-SN5YR: ~1600 *photometrically-classified* SNe



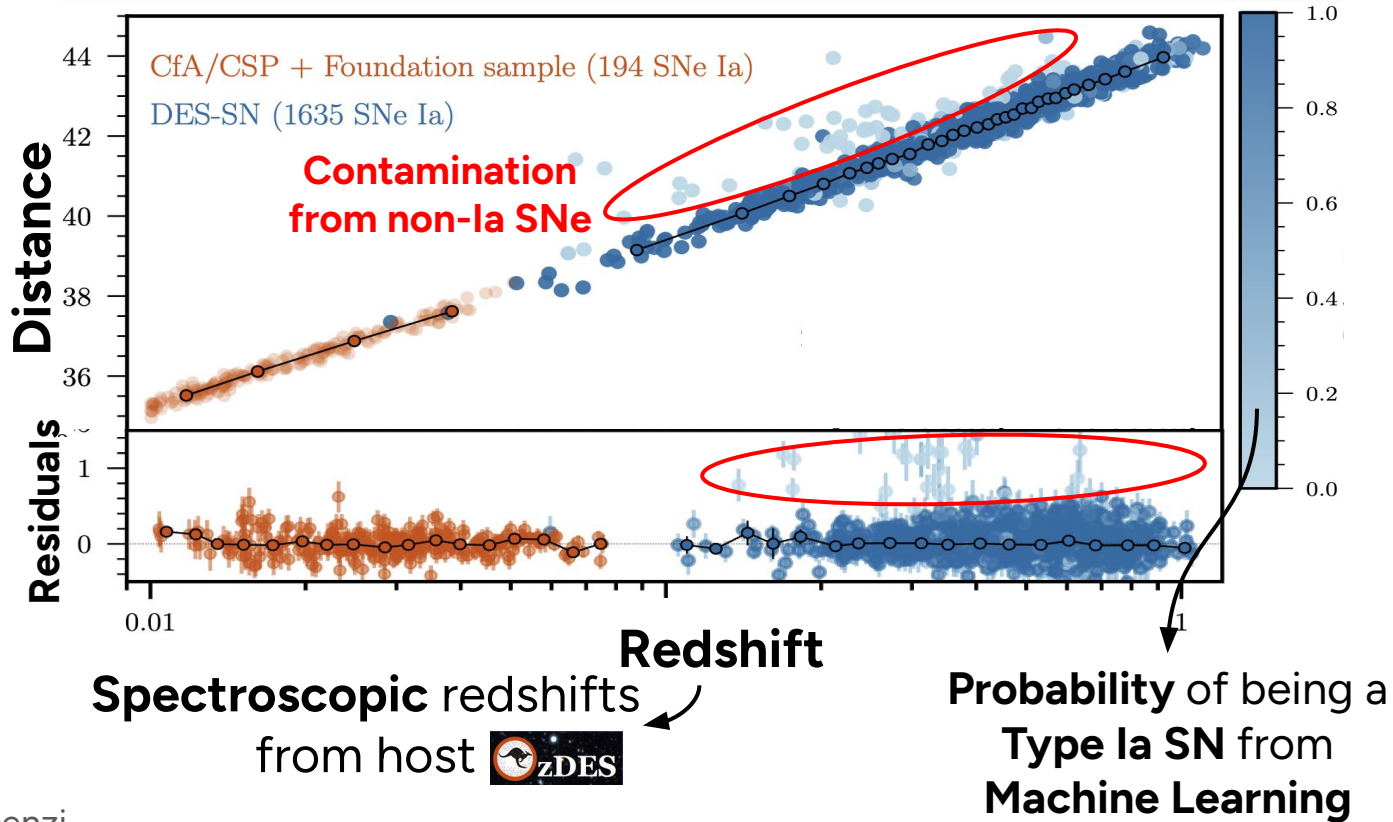
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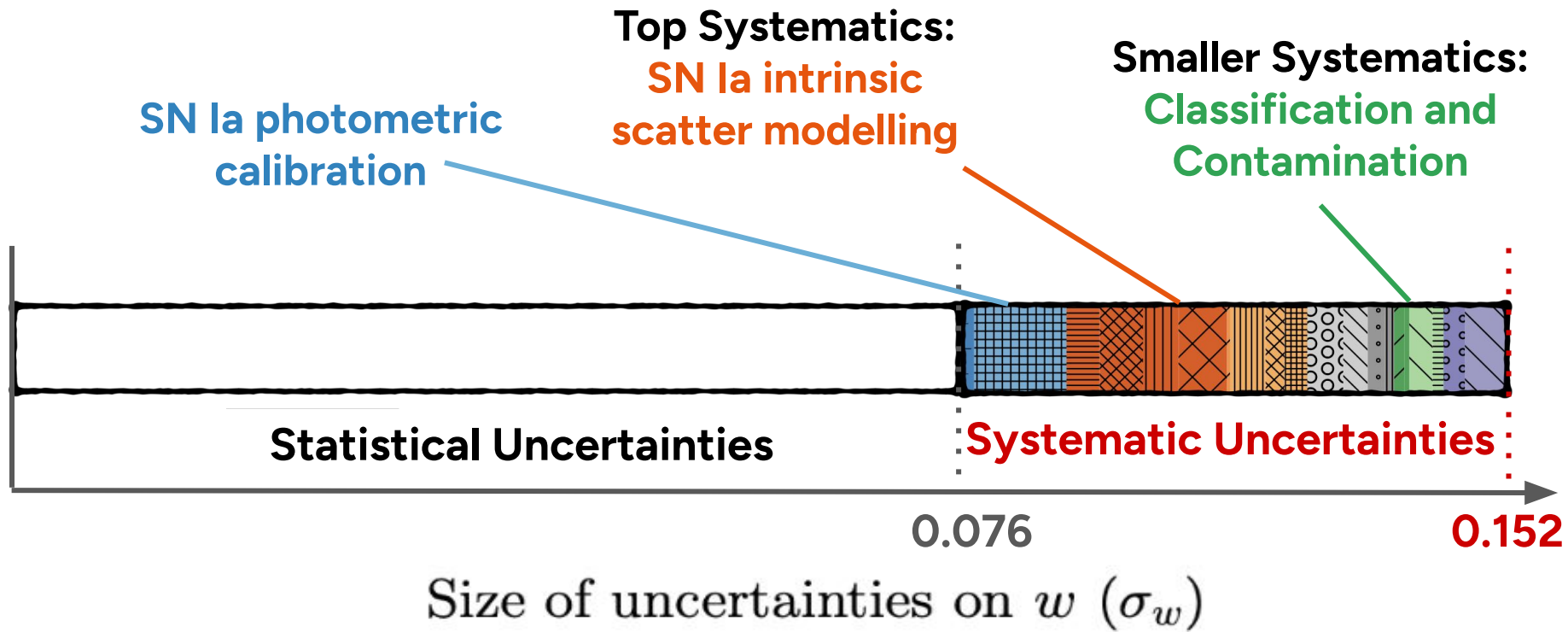
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# DES-SN5YR: ~1600 photometrically-classified SNe







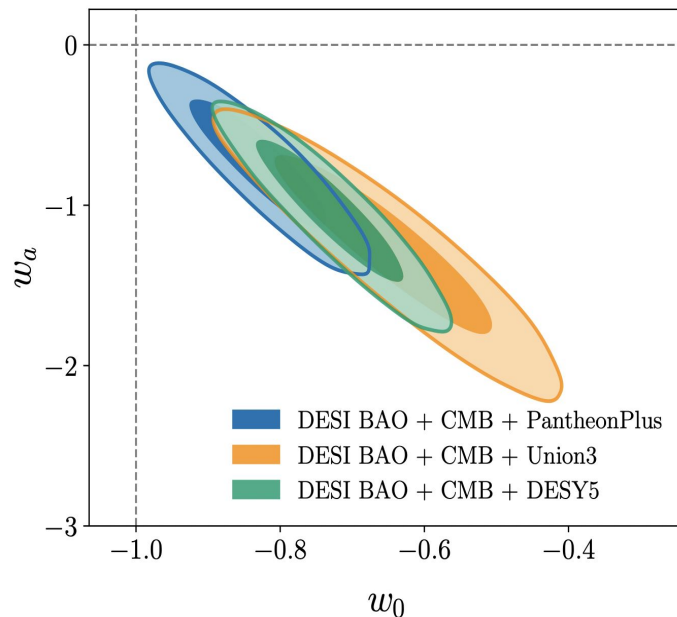
# In combination with DESI, hints of evolving dark energy?

	Spectroscopic SN Ia sample	Photometric SN Ia sample
Simulation-based methods	<b>Pantheon+</b>	<b>DES-5YR</b>
Bayesian Hierarchical method ("UNITY")	<b>Union3</b>	

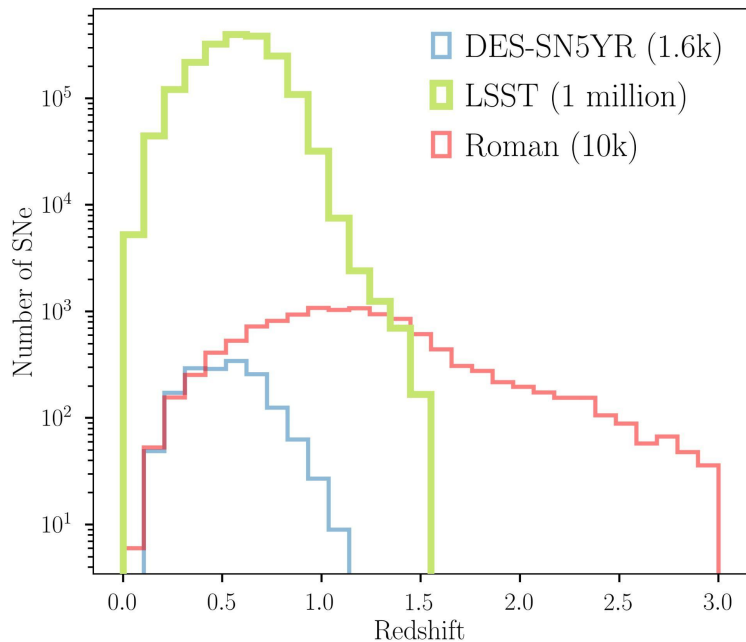


**Vincenzi+25 on arXiv today:**  
Response to Efstathiou 24

Explains discrepancies between DES and Pantheon+, thorough investigation shows analysis is robust



# LSST and Roman will increase our SN sample sizes by *multiple orders of magnitude*



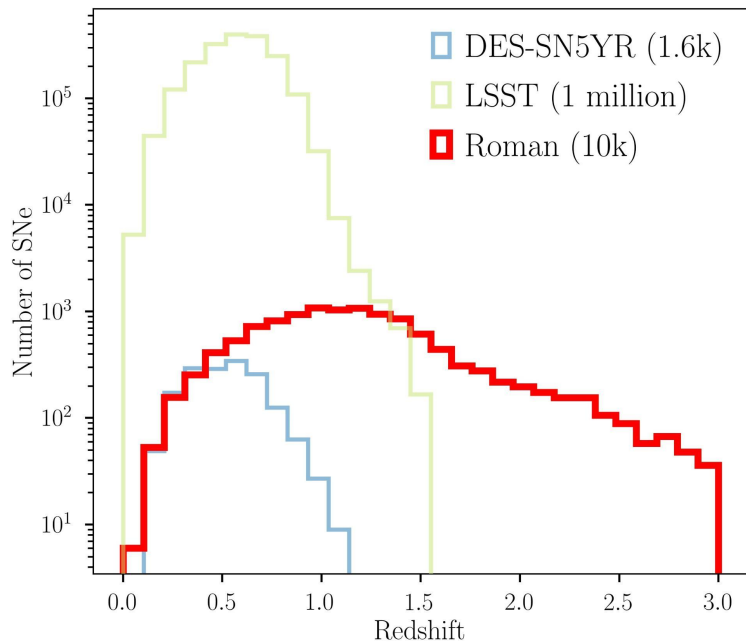
## Rubin LSST (ground-based, optical)

- Survey start 2025
- Unprecedented survey area with sufficient cadence for transients

## Roman Space Telescope (space-based, NIR)

- Launching in 2026
- Unprecedented number of high redshift supernovae

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# Challenges for DESC SN cosmology: Spectroscopic follow-up resources cannot keep pace with 1 million SNe

TiDES on 4MOST will obtain ~30k SN spectra and ~100k host spec-z

*Frohmaier,  
Vincenzi+ in prep.*

Classification: spectroscopic → photometric 

*Vincenzi+21, 23, 24,  
Moller+19, Qu+19*

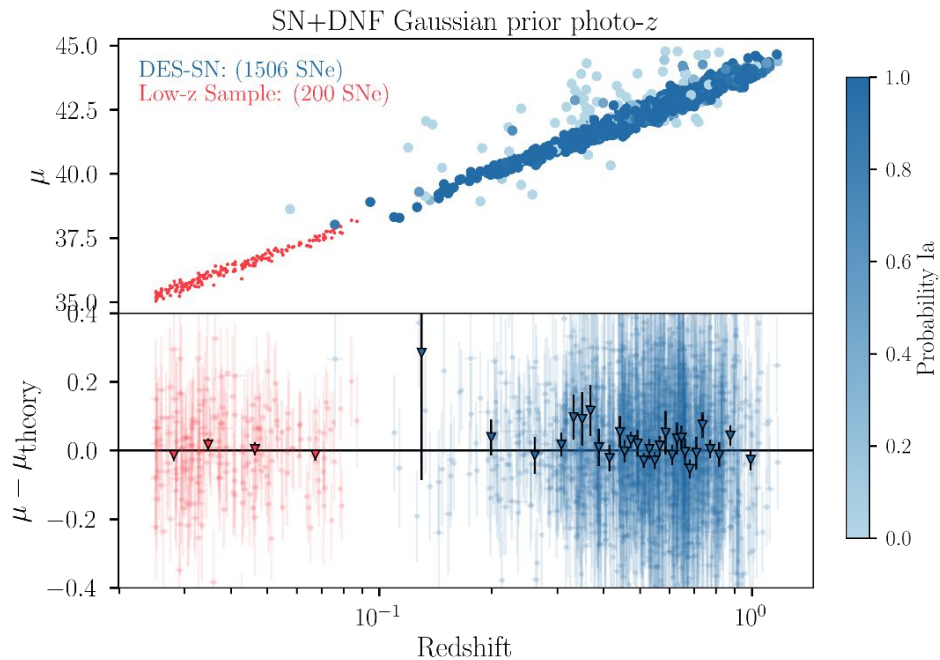
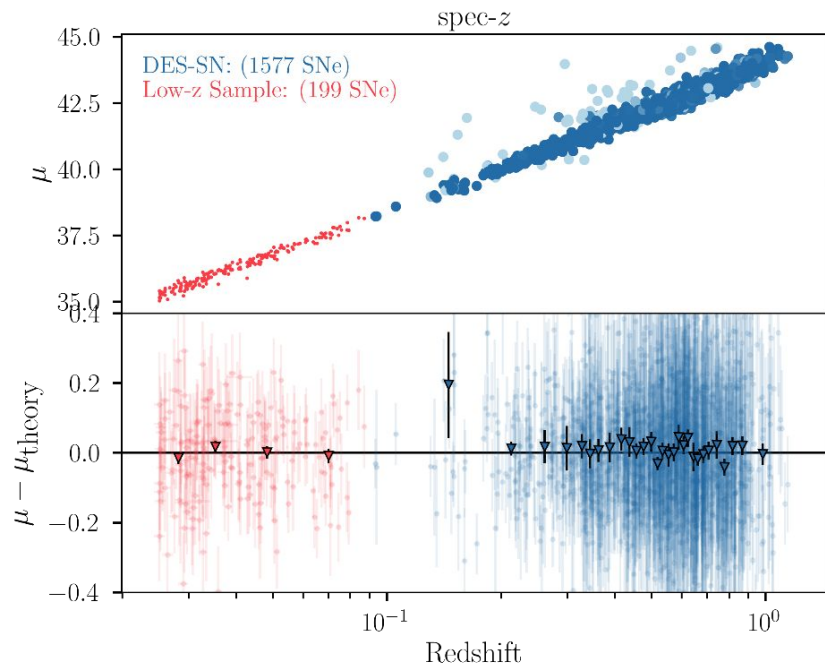
- DES analysis is robust against choices in algorithm, templates

Redshifts: spectroscopic → photometric 

- Analyses with DES data and LSST sims have shown we can recover unbiased cosmology
- Probabilistic framework SCIPPR under development

*Chen+22, 24  
Mitra+22, in prep.*

*Malz, Hlozek, Peters,  
Chen, Carreres*



**More on SN Cosmology with photo-z:**  
**Dissertation talk tomorrow, Cosmology III at 2:20 pm**

# Challenges for DESC SN cosmology: Increased control of systematics will be required

## SN Ia intrinsic scatter/astrophysics

- Improved SN intrinsic scatter modeling efforts (dust-based)
- Lack of consensus: intrinsic or extrinsic causes?

*Brout&Scolnic 21,  
Popovic+21ab,  
Kelsey+23,  
Wiseman+22*

## Photometric calibration and light-curve modeling

- SALT2 → SALT3
- DESC SN Ia light-curve modeling topical team
  - SALT3-UV: *Wang* - talk in Thurs SN IV session
  - LSST-Roman: *Anumba+ in prep.* - iPoster at 5:30 today!

*Kenworthy+21,  
Taylor+23*

## Summary

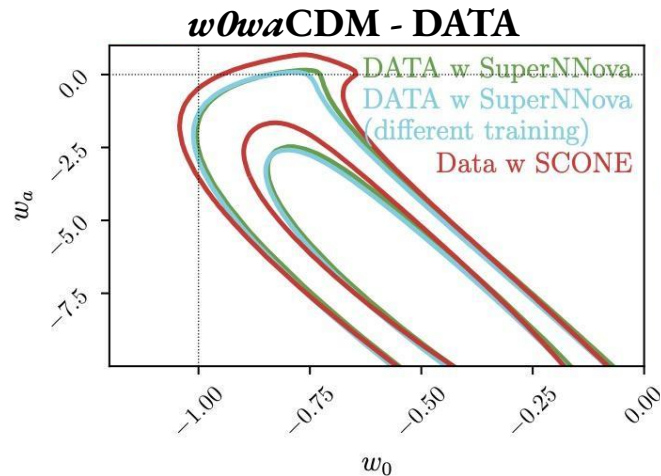
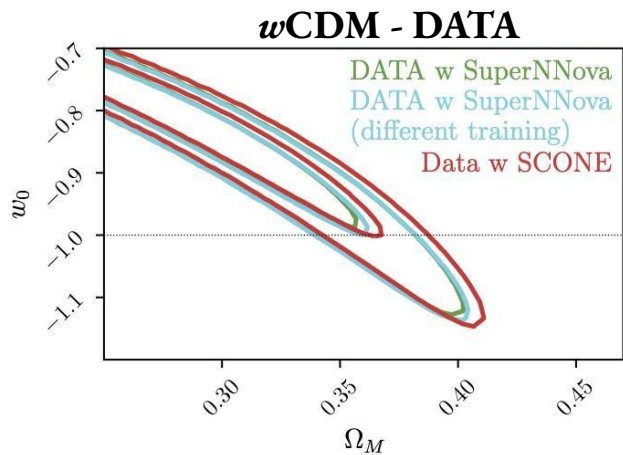
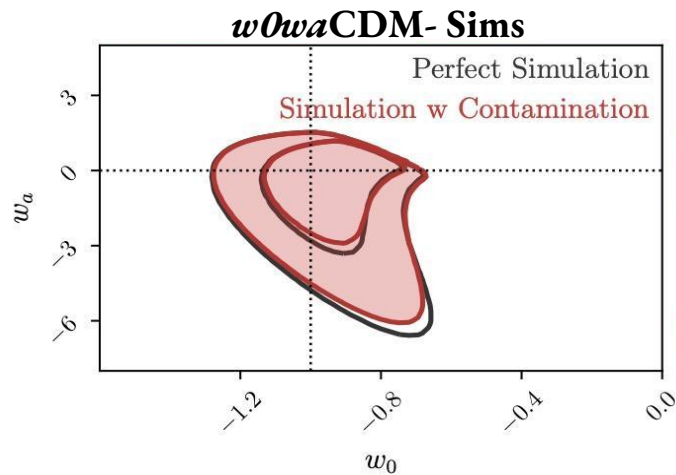
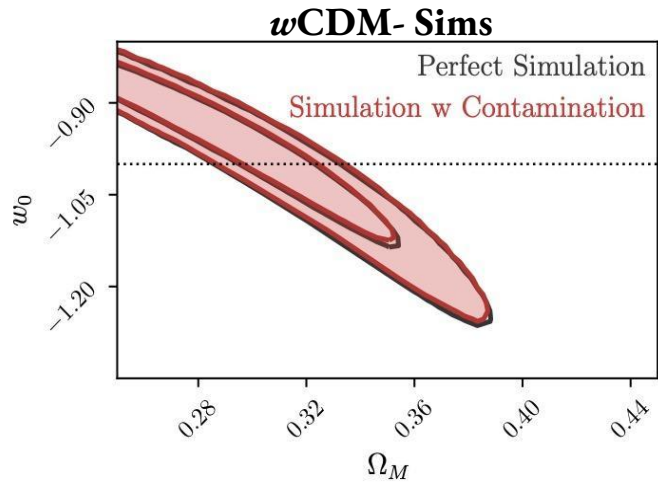
- The DES-SN5YR analysis has illustrated the power of a *photometrically-classified* SNIa sample
- Largest contribution to systematic uncertainties from open questions related to SNIa intrinsic scatter and astrophysics, photometric calibration+light-curve modeling

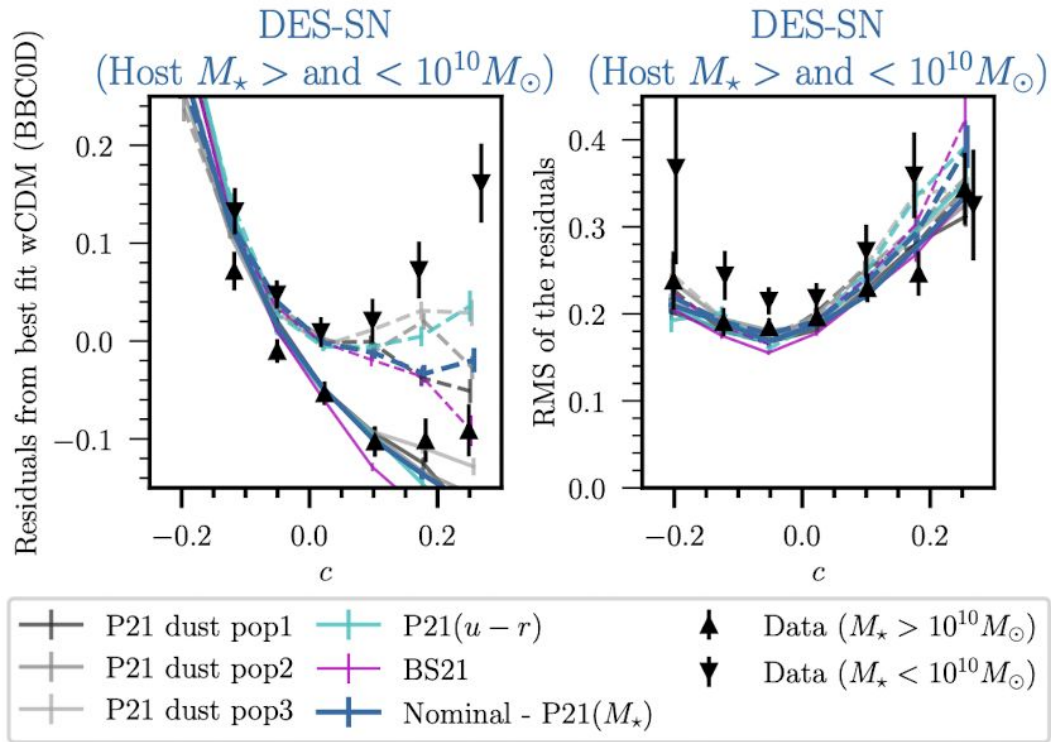
## Future Outlook

- Many analysis choices to be made soon for LSST early science
- Upcoming datasets will be revolutionary – the 🌟golden era🌟 of survey cosmology is ahead!



# Backup Slides





# The Dark Energy Survey dataset is an ideal testbed for photometric SNIa cosmology with upcoming Rubin LSST



Filters	SN Survey area	# SNe usable for cosmology	# spec-z
<i>griz</i>	30 deg <sup>2</sup> (Deep fields only)	~2200	~1600 (~75%)
<i>ugrizy</i>	18,000 deg <sup>2</sup> (Wide + deep fields)	~1000000	~100000 (~10%)



**DES-SN3YR**  
 ~200  
 spectroscopically  
 confirmed SNIa



**DES-SN5YR**  
 ~1600  
 photometrically  
 classified SNIa

