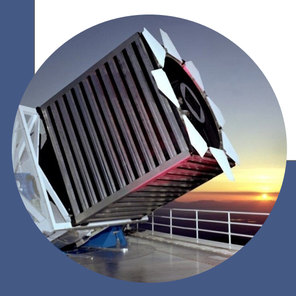
Volumetric Rates of Type Ia Supernovae in DES + SDSS and forecasts for Roman using solely photometric data

C. Meldorf, M. Sako, R. Kessler



Motivation & Aims

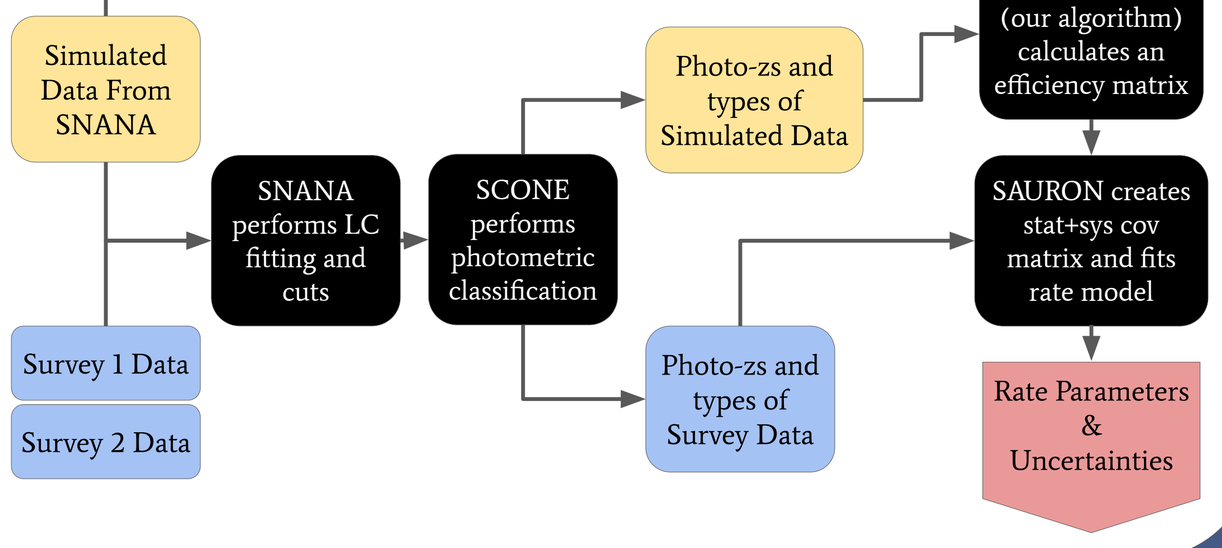
Knowledge of the Volumetric Rate of Type Ia Supernovae (VSNR) allows us to:

- Improve our simulations and survey design.
- Better understand the enrichment of the universe with iron and α-process elements.
- Study the nature of the Type Ia progenitor systems through the Delay Time Distribution, a current open question and possible systematic for cosmological measurements.

Key Questions:

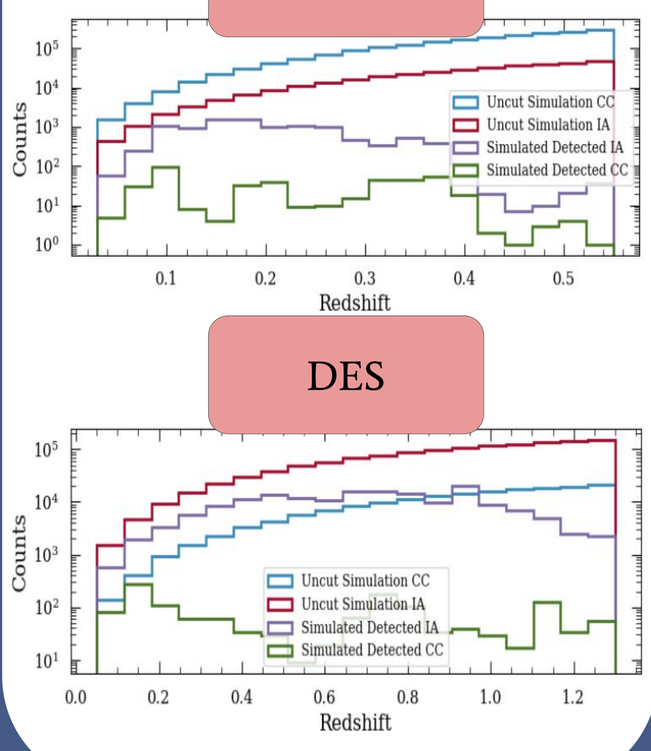
- Can we extract VSNR using only photometric data?
- Can we combine surveys to increase VSNR precision?
- How accurate do we expect our rate measurements to be using the Roman Space Telescope?
- What can these measurements tell us about the nature of the SNe Ia progenitor?

Method



Simulations Used

SDSS

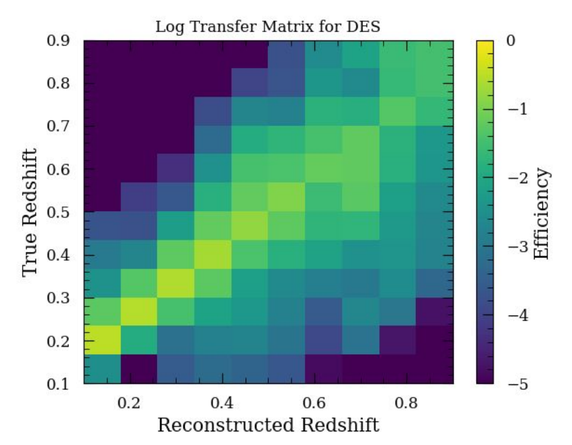


DES

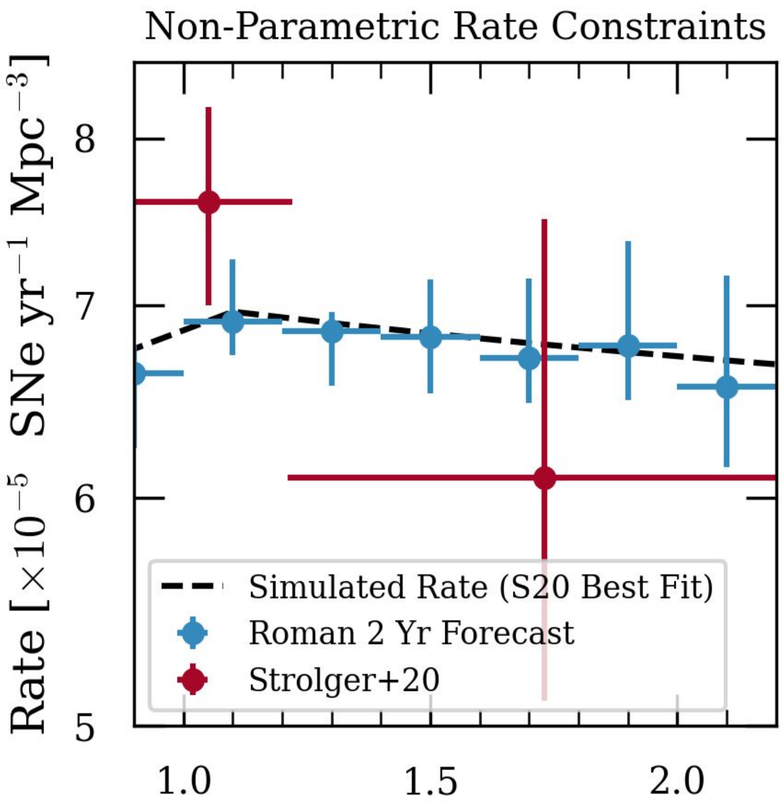
Efficiency Matrix

$$\epsilon_{ij} = \frac{n_{\mathrm{obs},i}}{n_{\mathrm{sim},j}}$$

Accounts for bias and scatter introduced by the photo-z inaccuracy.



Results: Roman 2YR Forecasts



Roman 2YR will offer ~3x better constraints with 5x finer binning than the combination of all currently existing VSNR data (compiled in Strogler 2020).

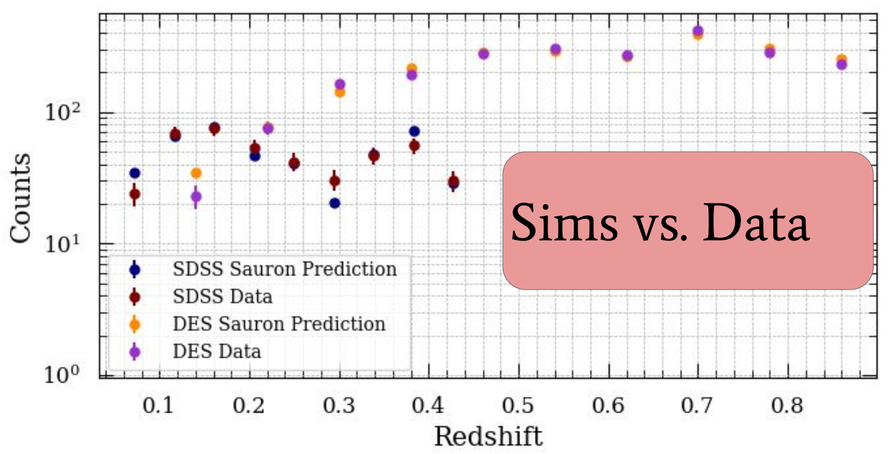
Results: DES + SDSS

$\alpha = (2.10 \pm 0.11) \times 10^{-5} \mathrm{SNe/Mpc^3/yr}$

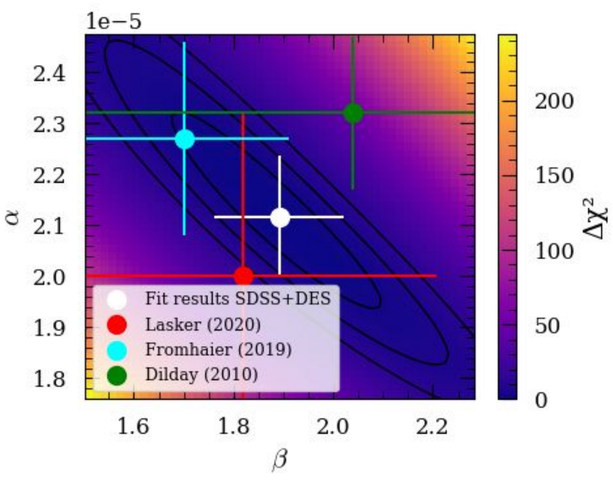
$\beta = 1.9 \pm 0.12$

Where $(r(z) = \alpha(1+z)^{\beta}$

C.f. other works



Sims vs. Data



Discussion and Conclusions

- Accurate rate measurements are possible with solely photometric data.
- Roman Space Telescope will put very tight constraints on the z > 1 volumetric rate, with important implications (reducing uncertainty on the prompt fraction of SNe Ia by a factor of ~3) for the nature of the Type Ia progenitor system(s).