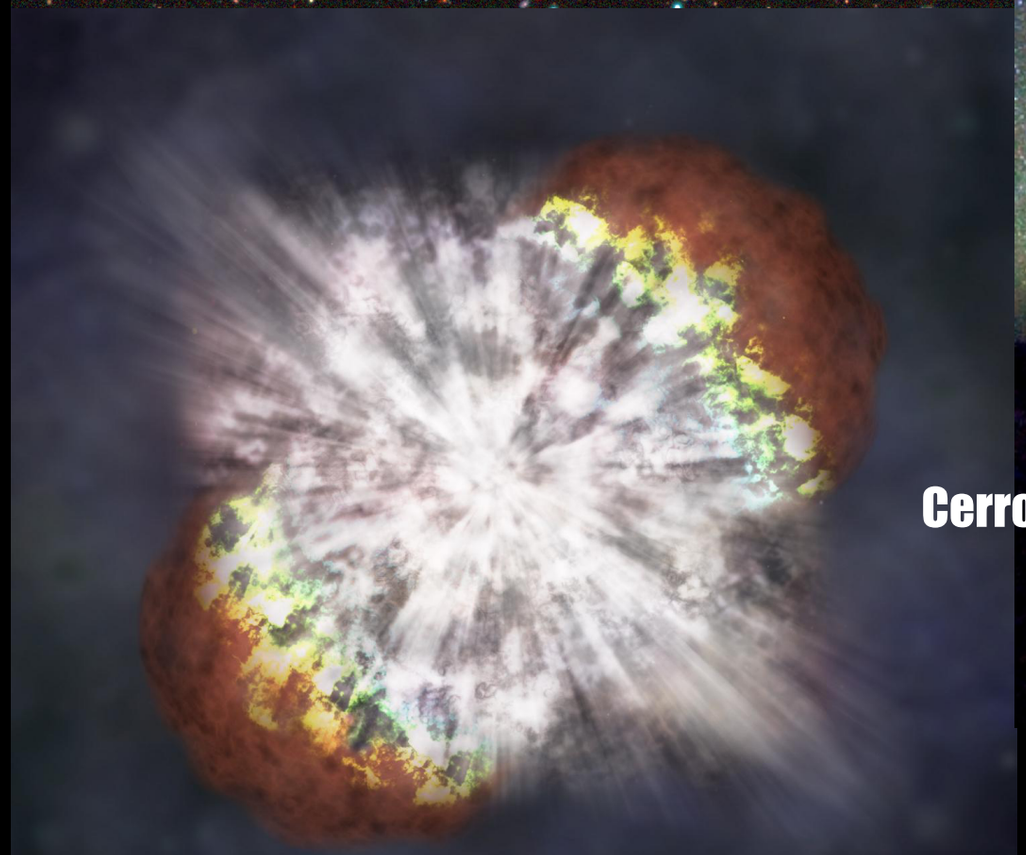
The UltraVISTA Explosive Survey:

a time-domain near-IR survey



Regis Cartier

Cerro Tololo Inter-American Observatory

19-09-19 Garching, Germany

C. Contreras (LCO), E. Diaz, P. Lira, M. Hamuy (U. de Chile), P. Sanchez-Saez [PUC],
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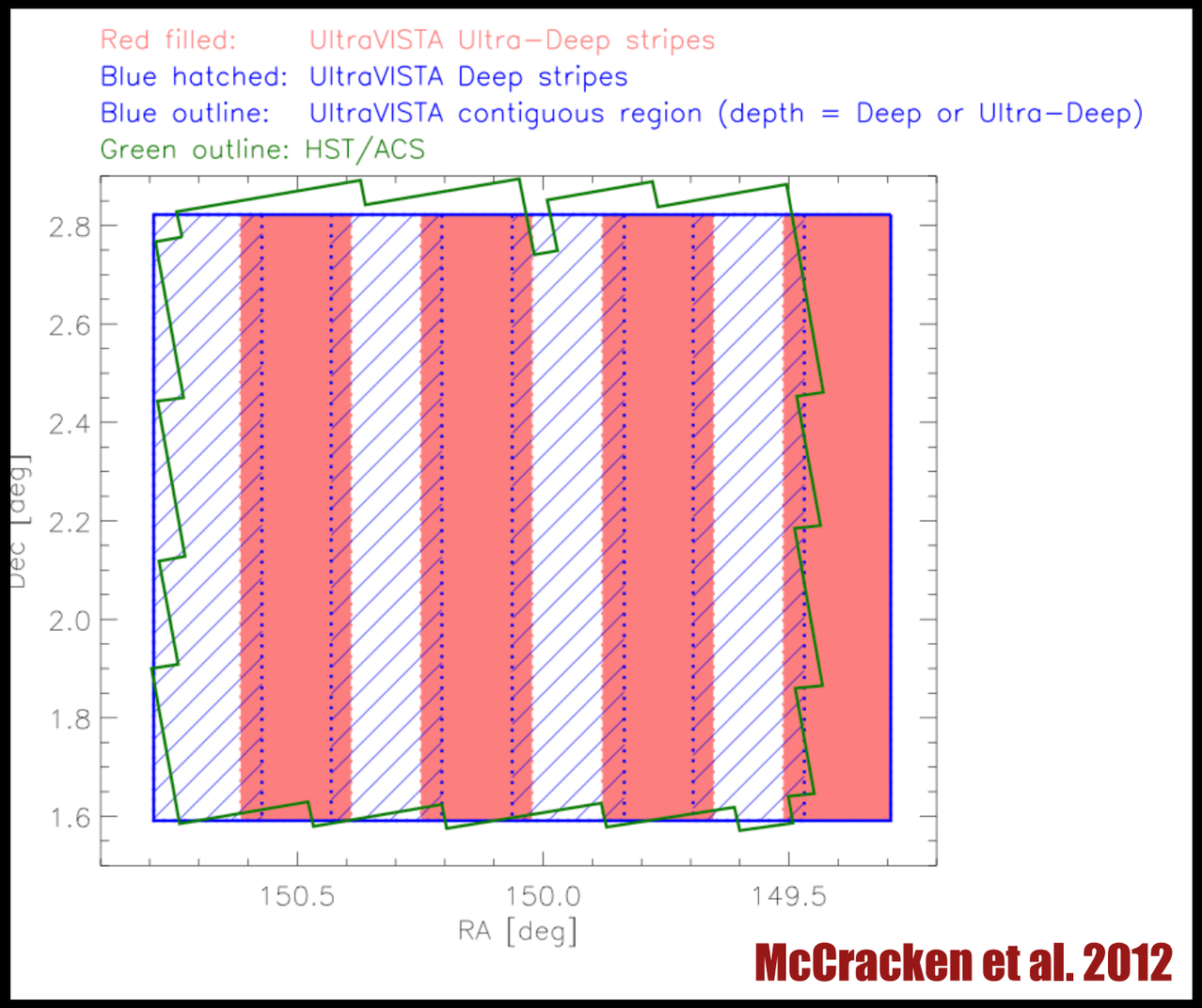
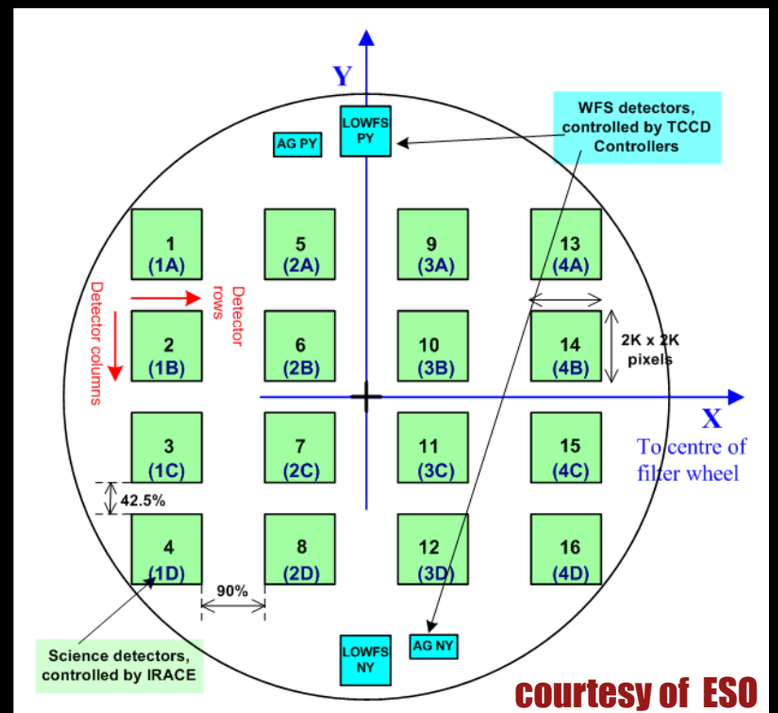
The UltraVISTA Survey

UltraVISTA is an ultra deep near-IR (JHKs) survey to study galaxy assembly and evolution in the COSMOS field. The survey comprises a deep (~1.5 sq. deg) and a ultra deep (~0.75 sq. deg) part.



McCracken et al. 2012

UltraVISTA observed from 2009 to 2016 using the VIRCAM at the 4.1 m ESO VISTA telescope.



courtesy of ESO

VIRCAM is a wide-field near-IR camera consisting of 16 2048 × 2048 arrays. The FoV diameter is 1.65 degrees and the mean pixel scale is 0.34″ pixel^{-1}

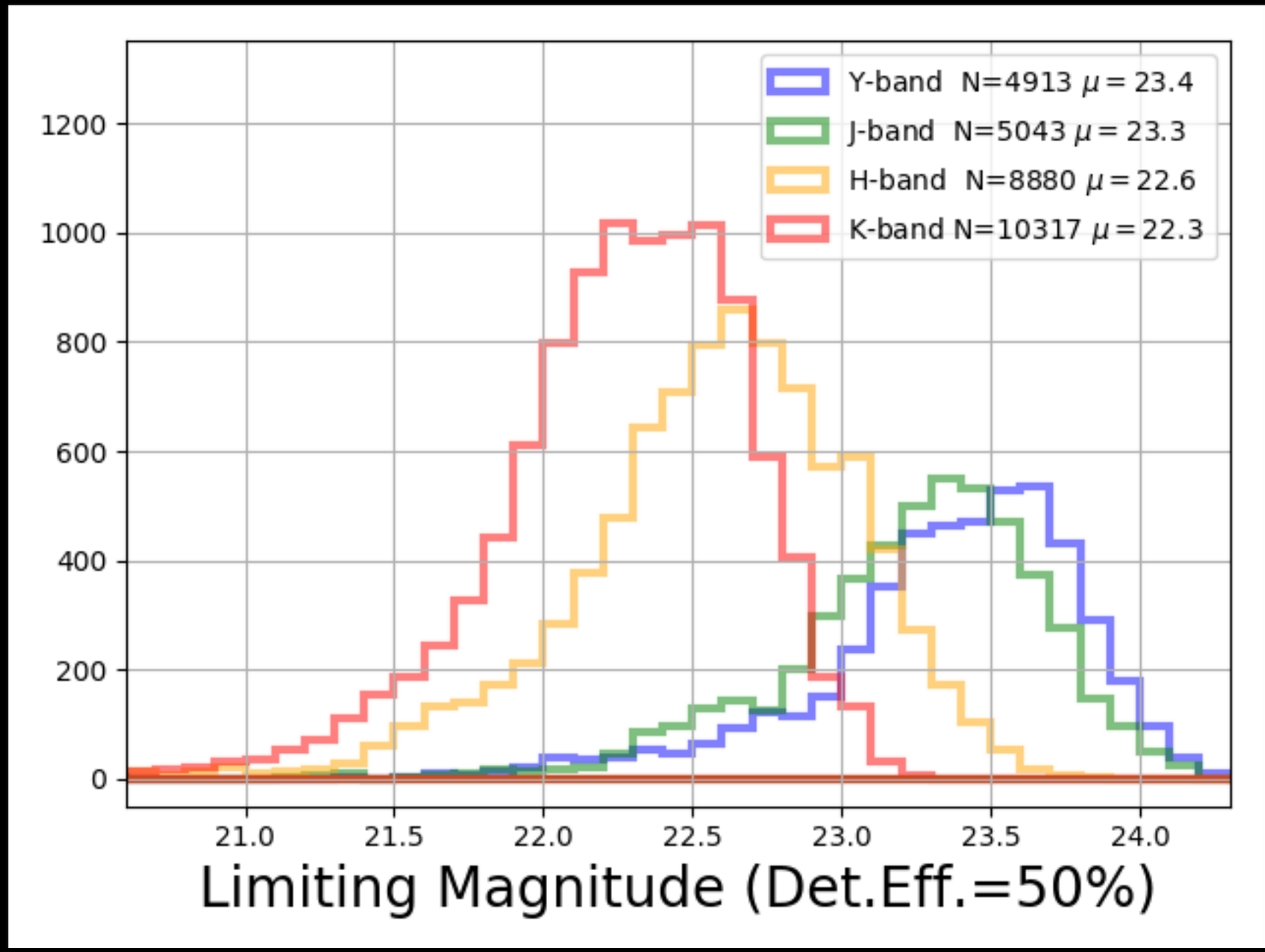
See Sanchez et al. 2017 for AGN variability with UltraVISTA.

The UltraVISTA Explosive Survey

- Typical exposure times are; 1 hr in Y and J bands and 0.5 hrs in H and Ks.

- Daily cadence in all bands combined, and every 3 d cadence in Y and J bands.

- We measured the 50% detection efficiency by input fake stars on the subtracted images.



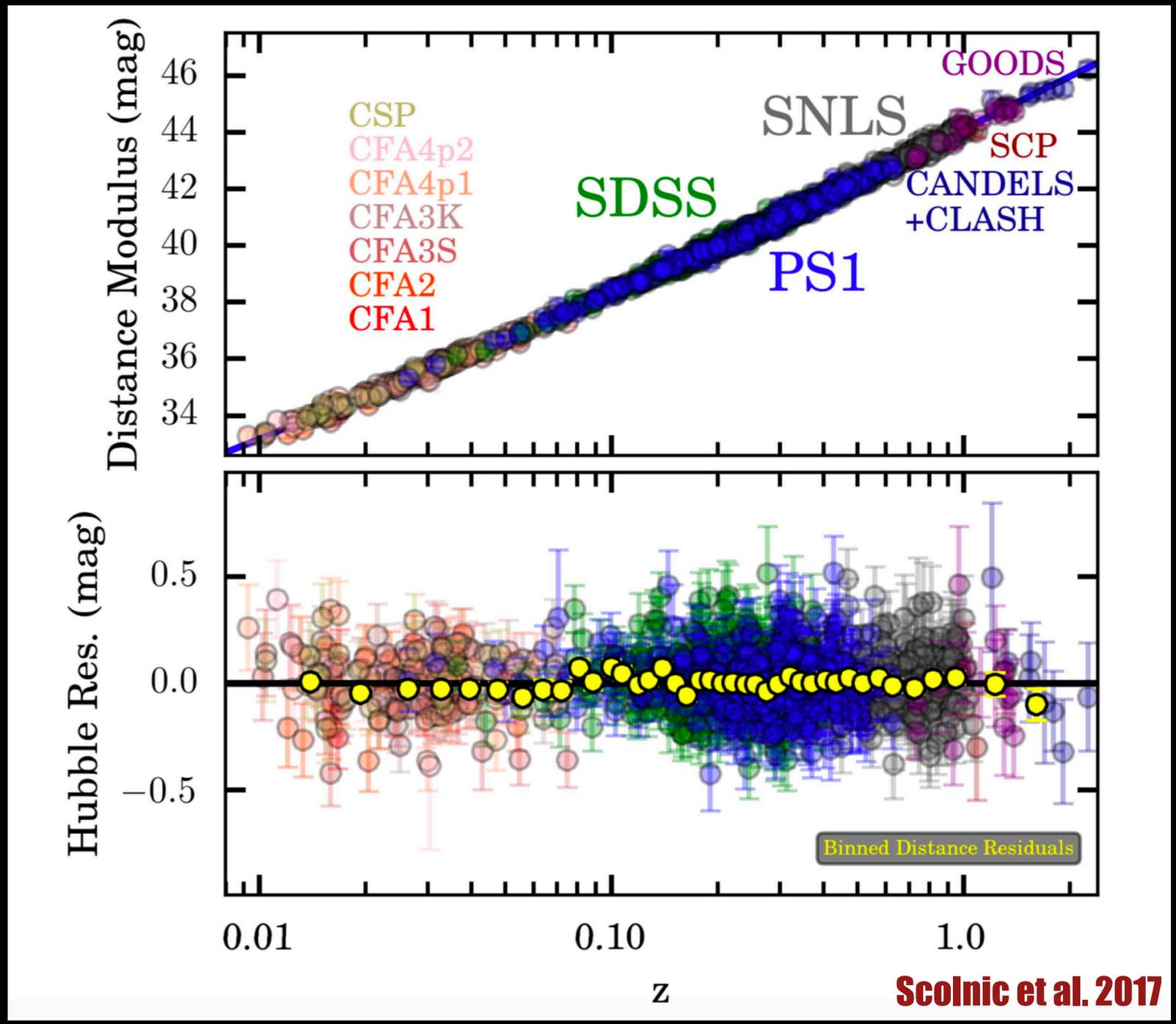
Contreras et al. 2019 in prep

Cosmology with SNe Ia

SNe Ia are standardizable candles in the optical, that can deliver distances with precisions of 7%.

The use of SNe Ia as distance indicators led to the discovery of the accelerated expansion of the universe. SNe Ia cosmology is a key science driver for LSST, WFIRST, EUCLID and JWST.

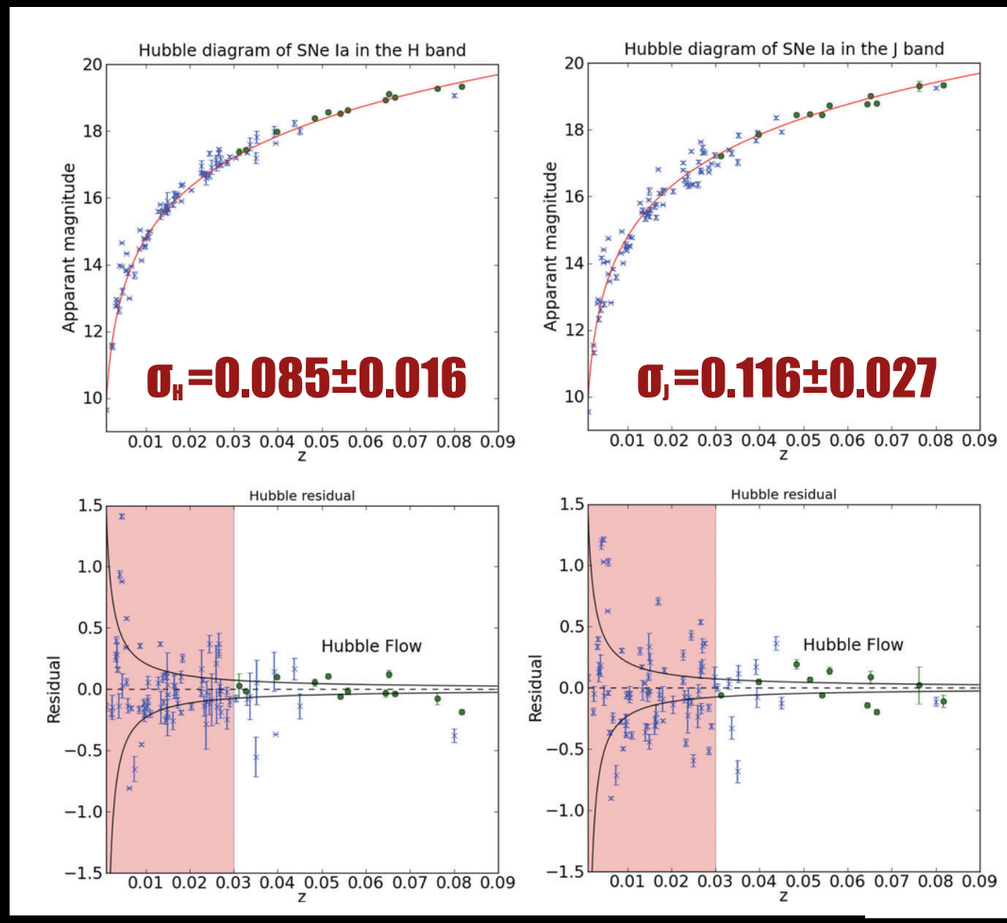
The Pantheon sample contains 1043 in the range of $0.01 < z < 2.3$



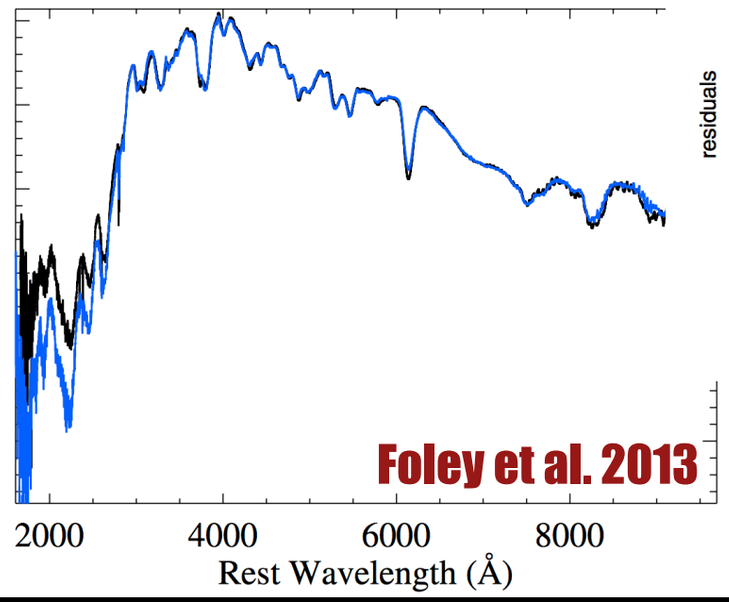
Scolnic et al. 2017

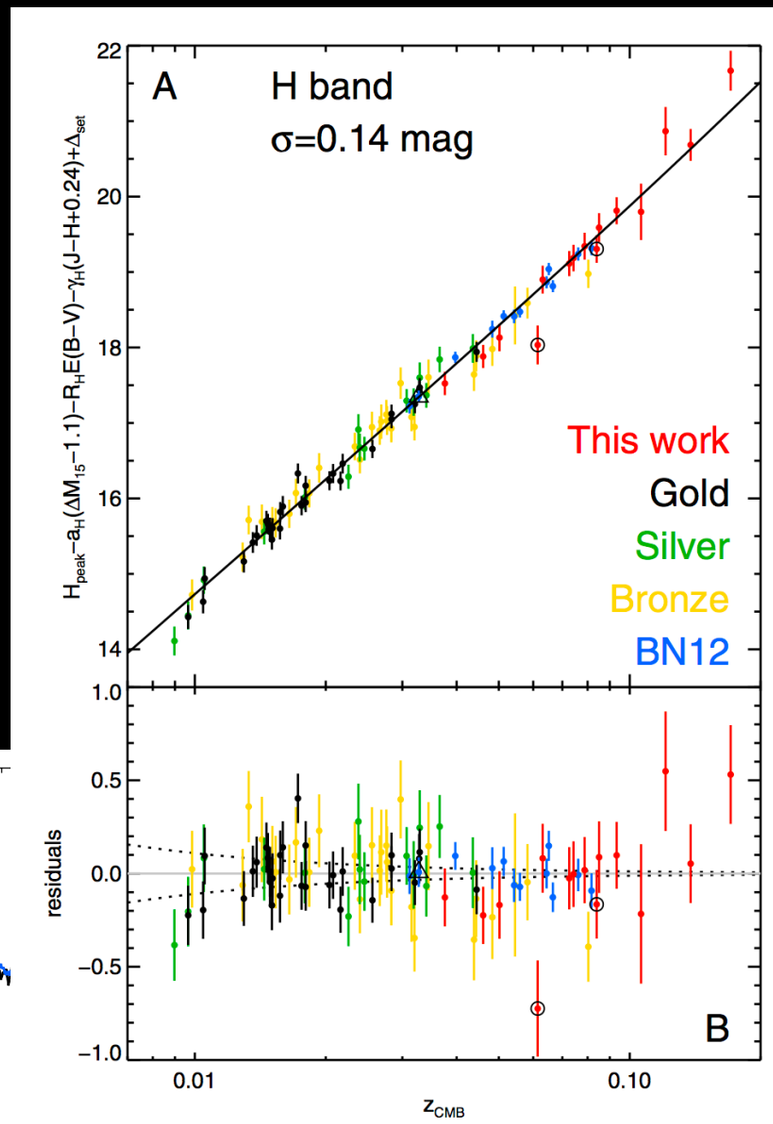
Cosmology with SNe Ia in the Near-IR

- SNe Ia are better standard candles in the near-IR.
- Less affected by dust extinction.
- Less affected by progenitor metallicity (Kasen 2006).
- Easy to identify based on photometry solely.



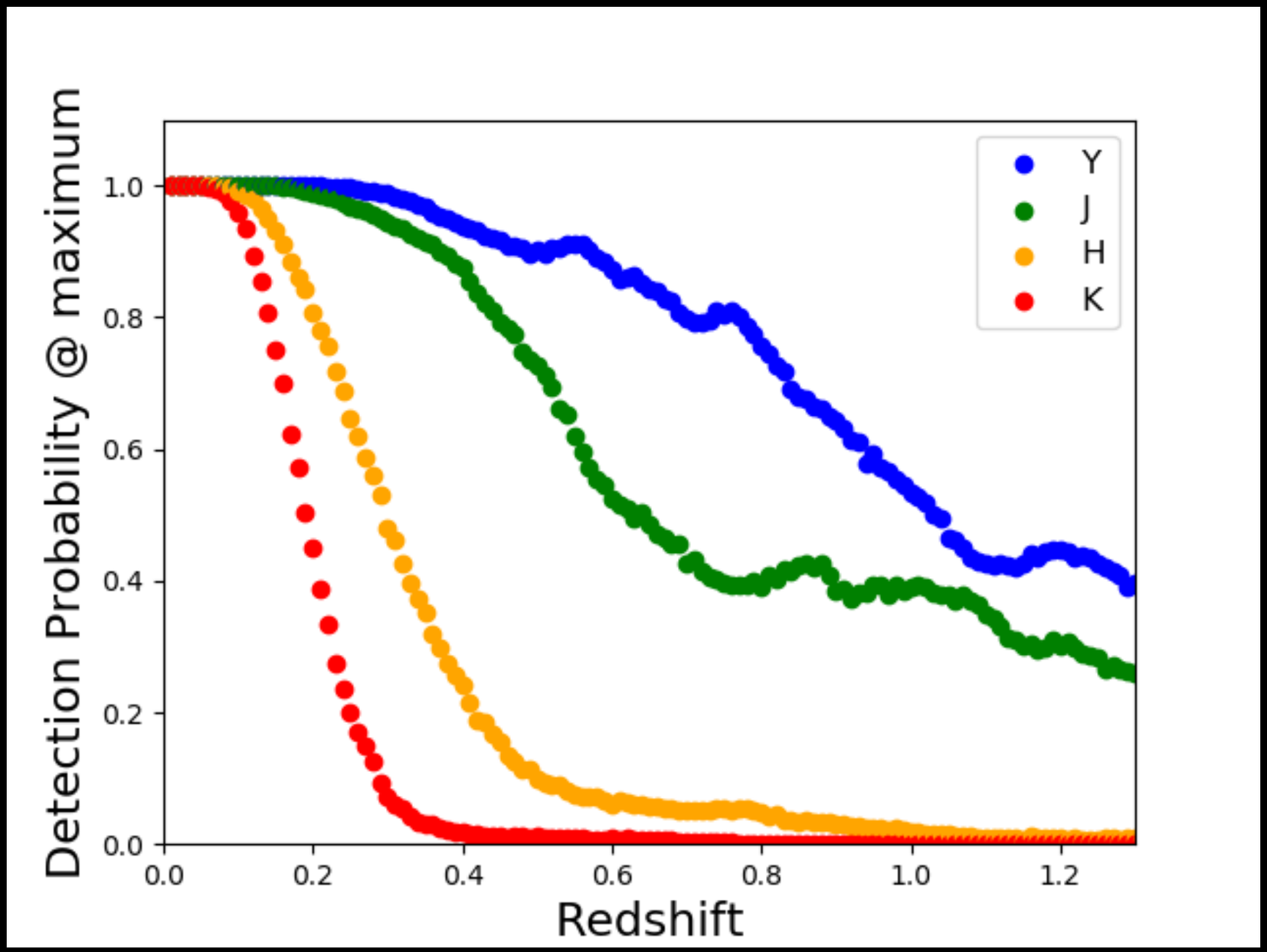
Barone-Nugent et al. 2012





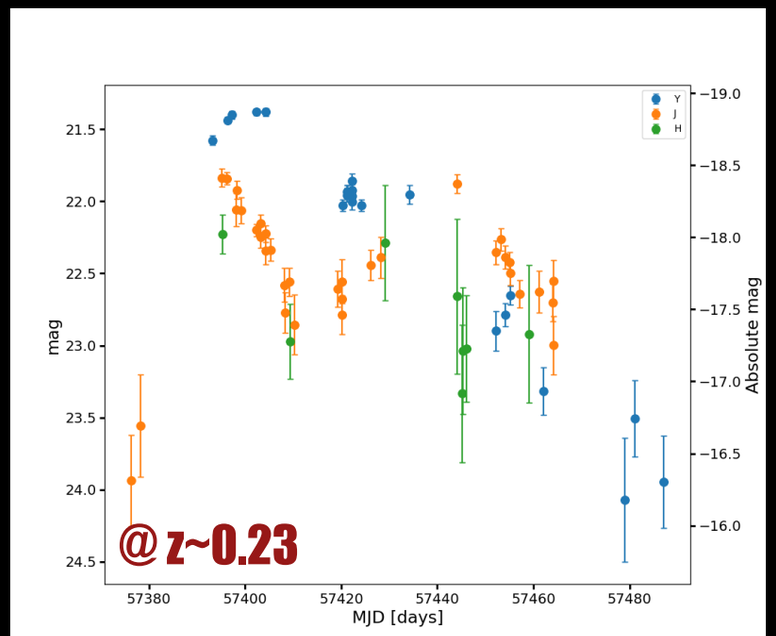
Stanishev et al. 2018

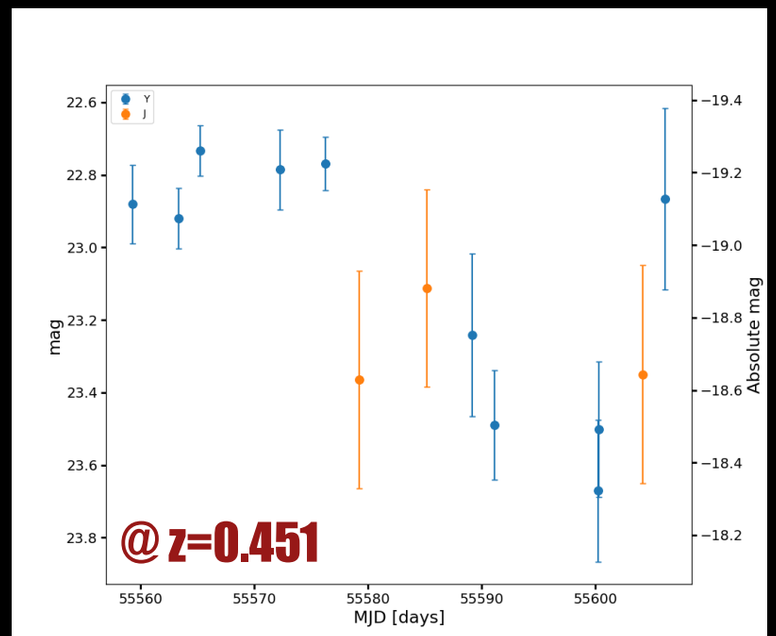
SNe Ia with UltraVISTA



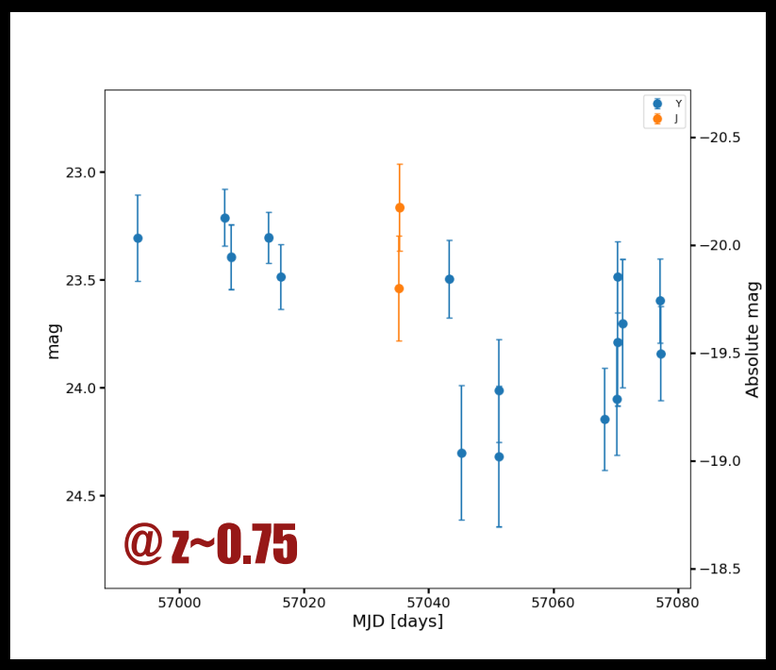
We can detect SN Ia to z~0.6 in J and to z~1.0 in Y.

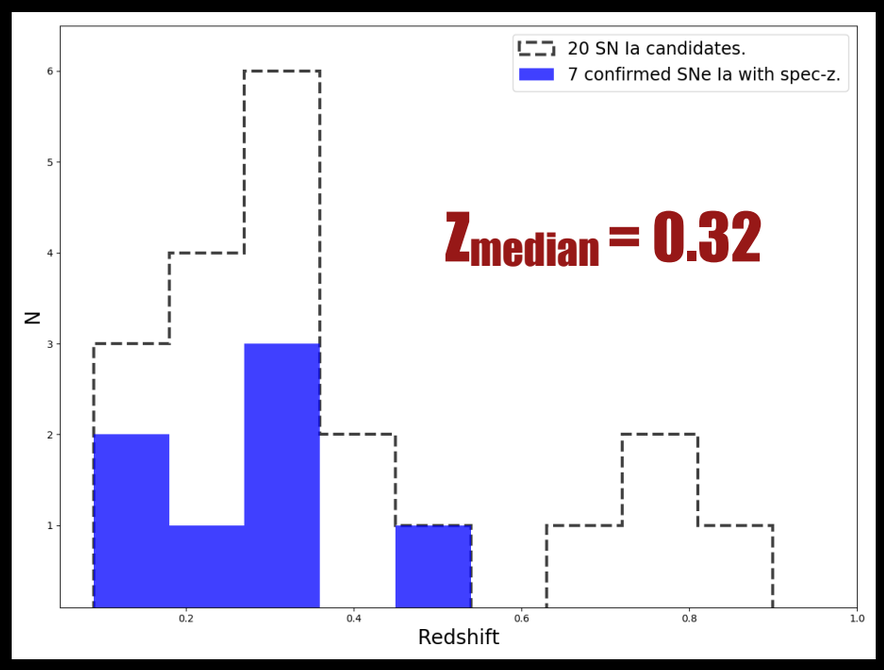
SNe Ia with UltraVISTA





- 111 SN candidates in total.
- 9 confirmed SNe Ia, 7 with spec-z.
- 41.2 hrs awarded at FORS2/VLT to obtain host galaxy redshifts for 40 SN candidates on faint hosts.





We expect to extend the SNe Ia Hubble diagram to z~0.9 in the near-IR by including 50 new SNe Ia well observed in Y and J bands.

Photometric redshifts from Laigle et al. 2016

SLSNe from UltraVISTA

- SLSN are explosions of stars that reach peak luminosities a factor of 10 or more compared with standard supernovae.

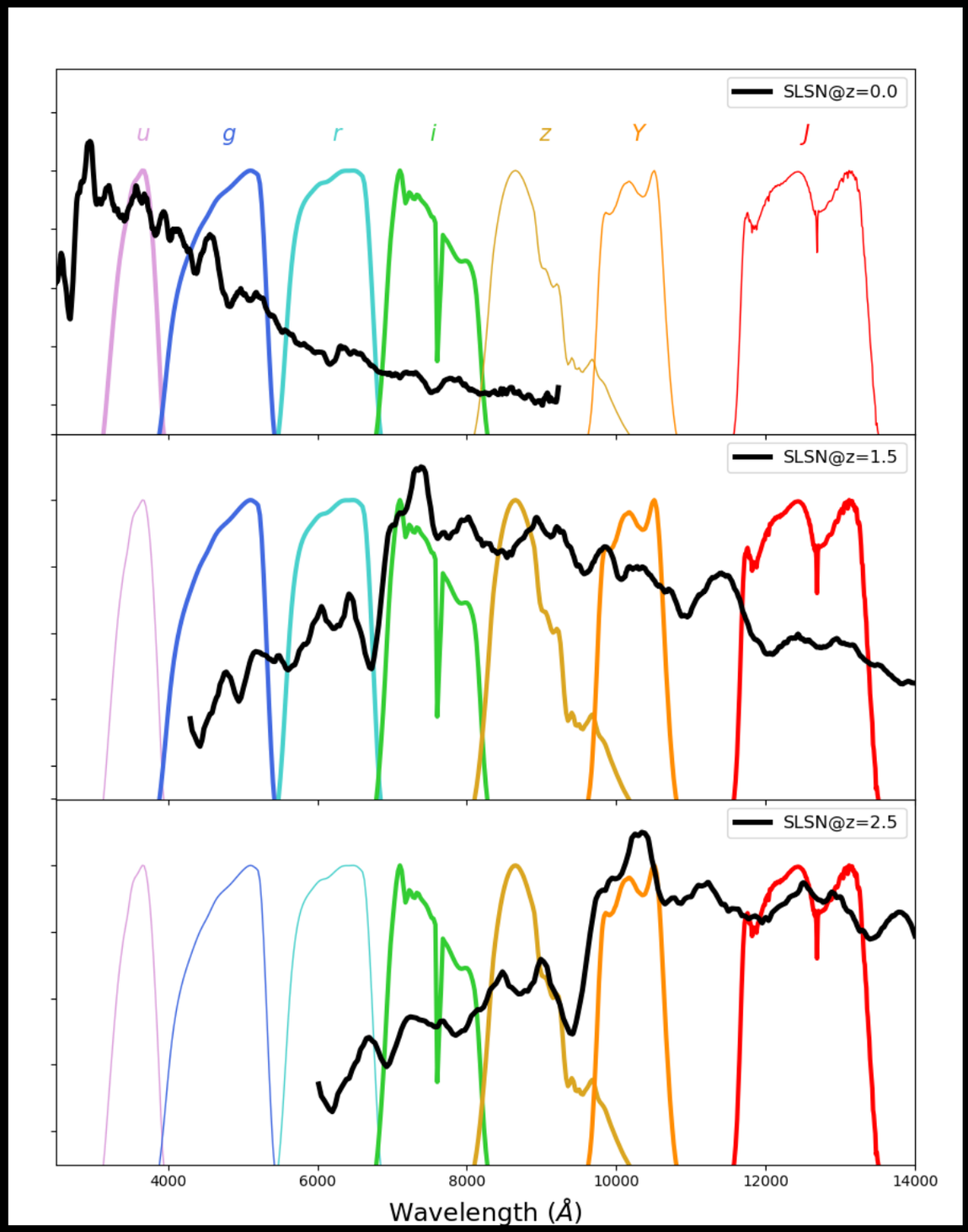
- They are powered by magnetars, ejecta-CSM interaction or are proposed to be the result of PISN.

- SLSNe are the best tools to trace SFR at the highest redshifts.

- Deep optical surveys are more efficient detecting SLSNe at z<2.0.

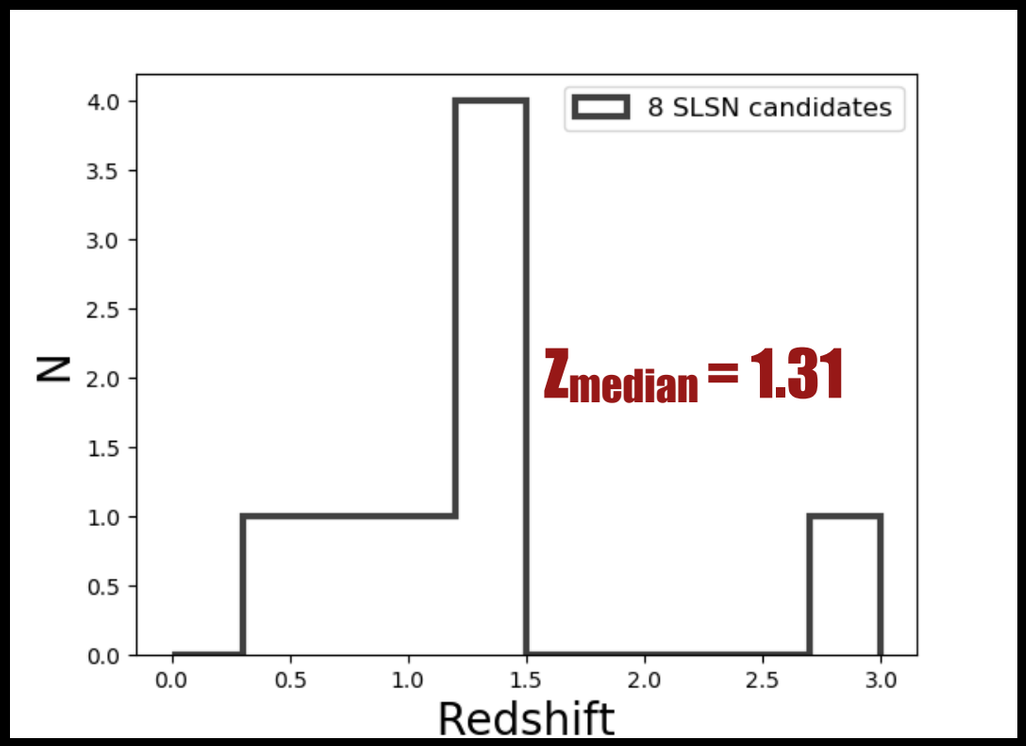
- Deep near-IR surveys are good detecting high-z SLSNe [Tanaka+12, Inserra+18, Regos & Vinko 2019).

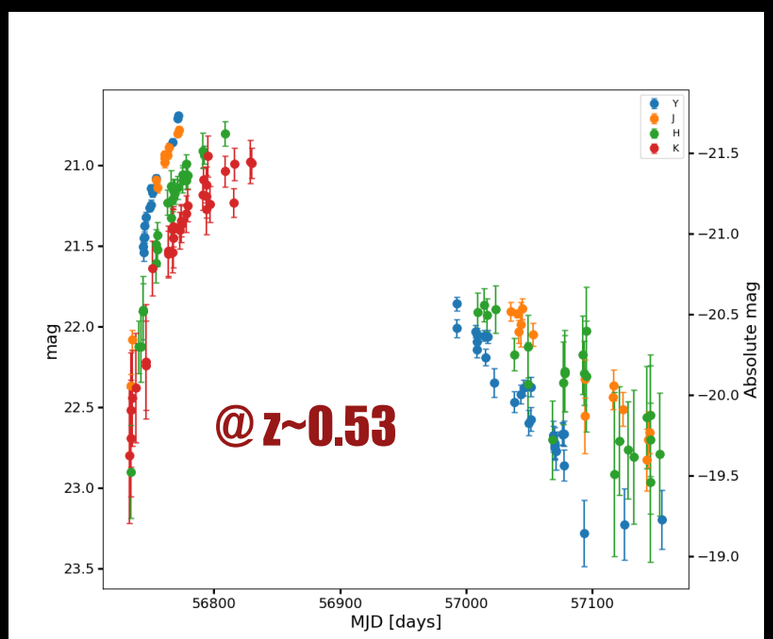
- Our survey is able to detect SLSNe to z~2.0-3.0.

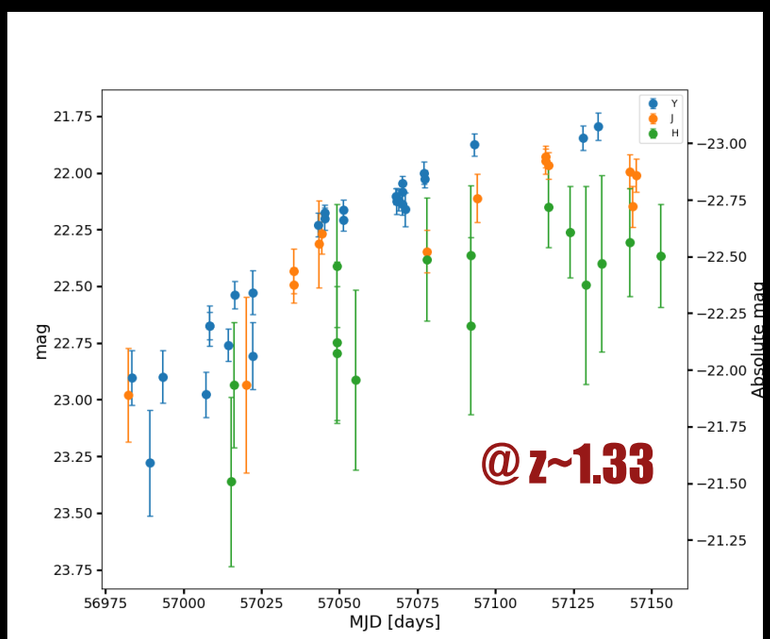


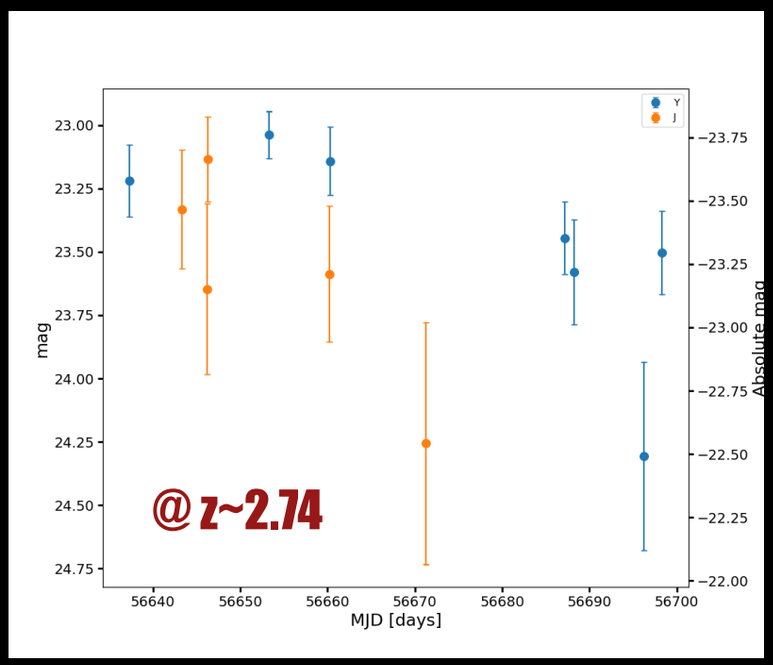
SLSNe from UltraVISTA

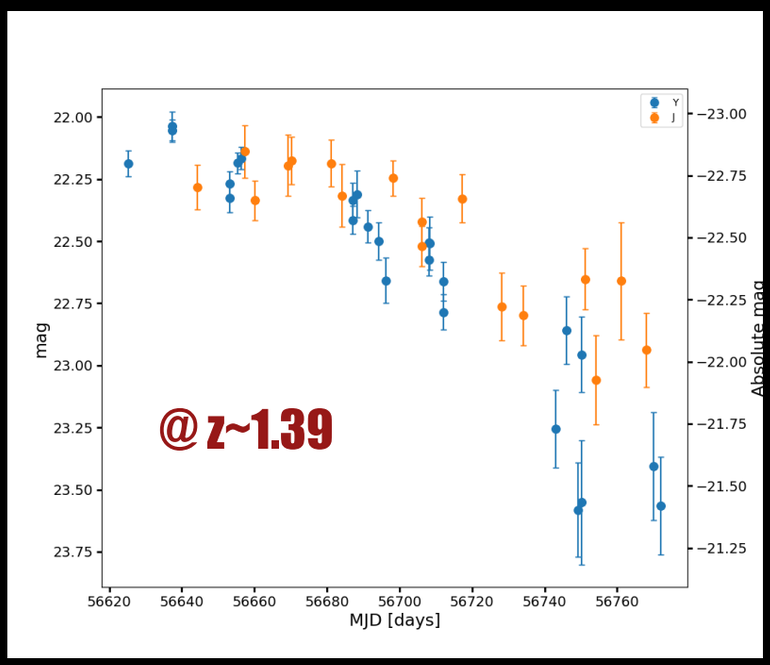
Photometric redshifts from Laigle et al. 2016



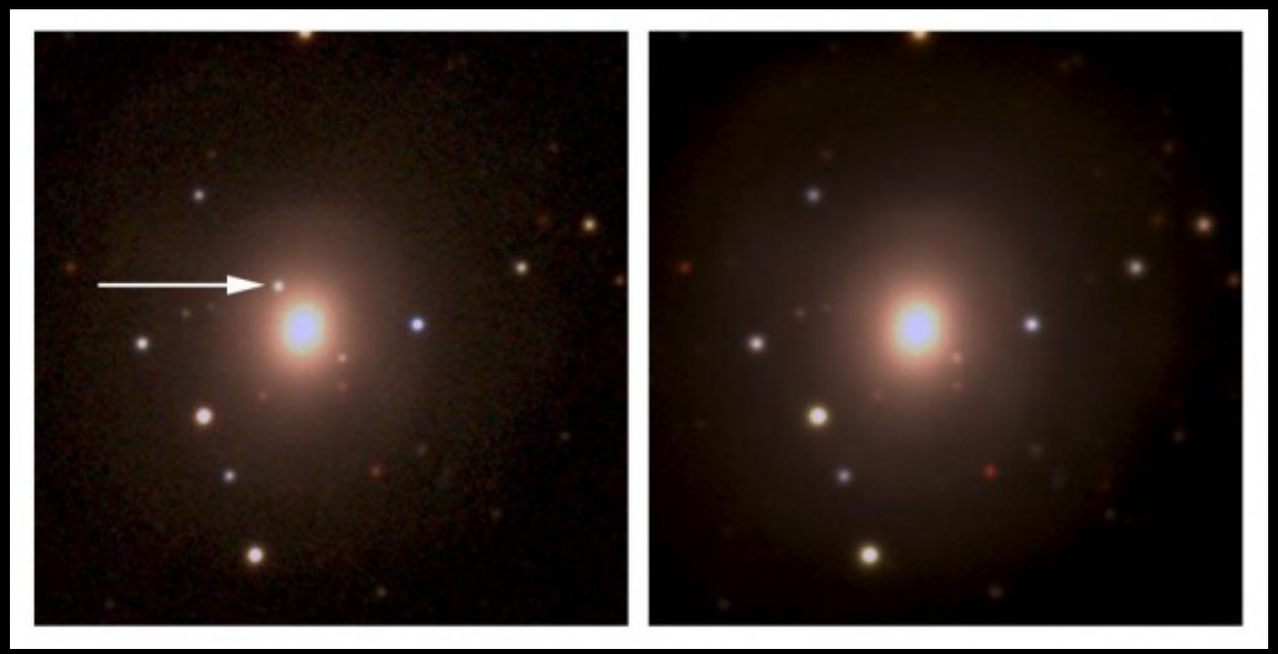




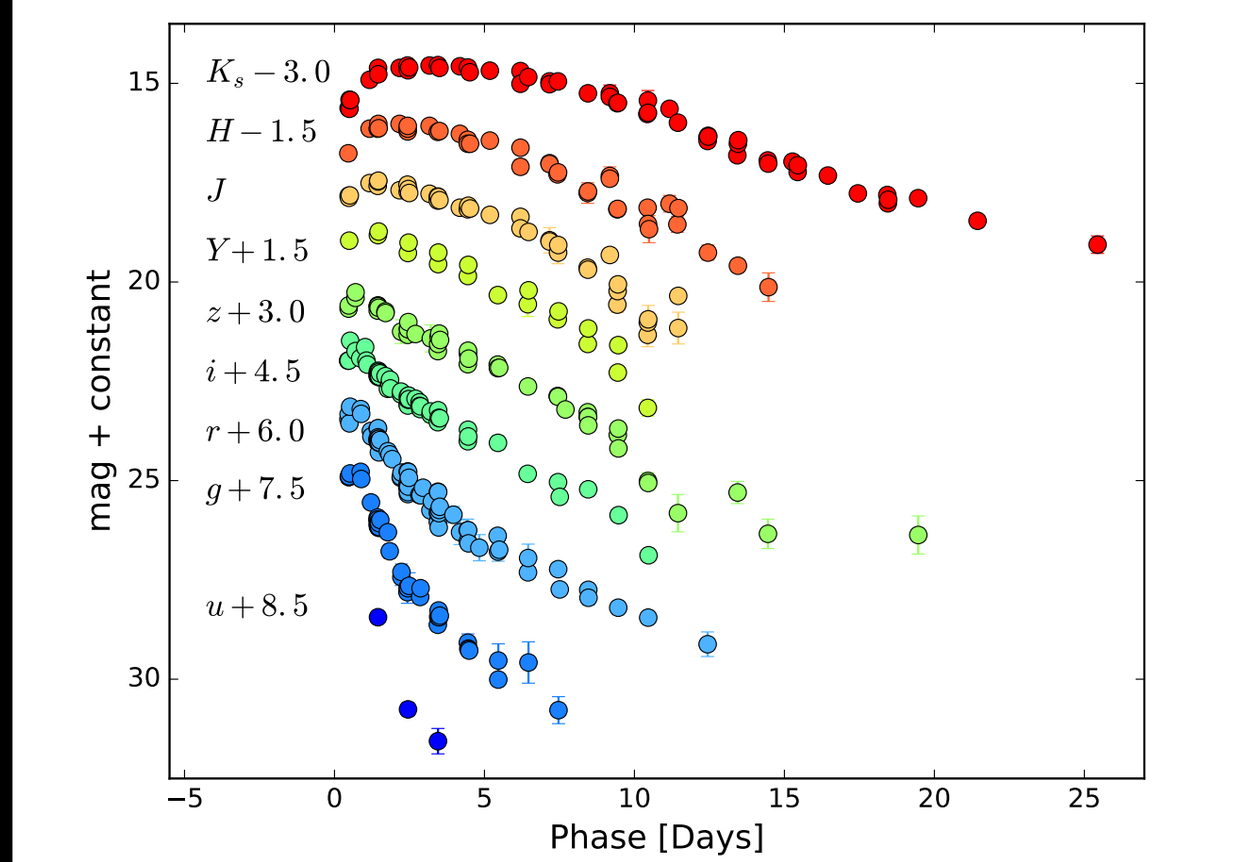




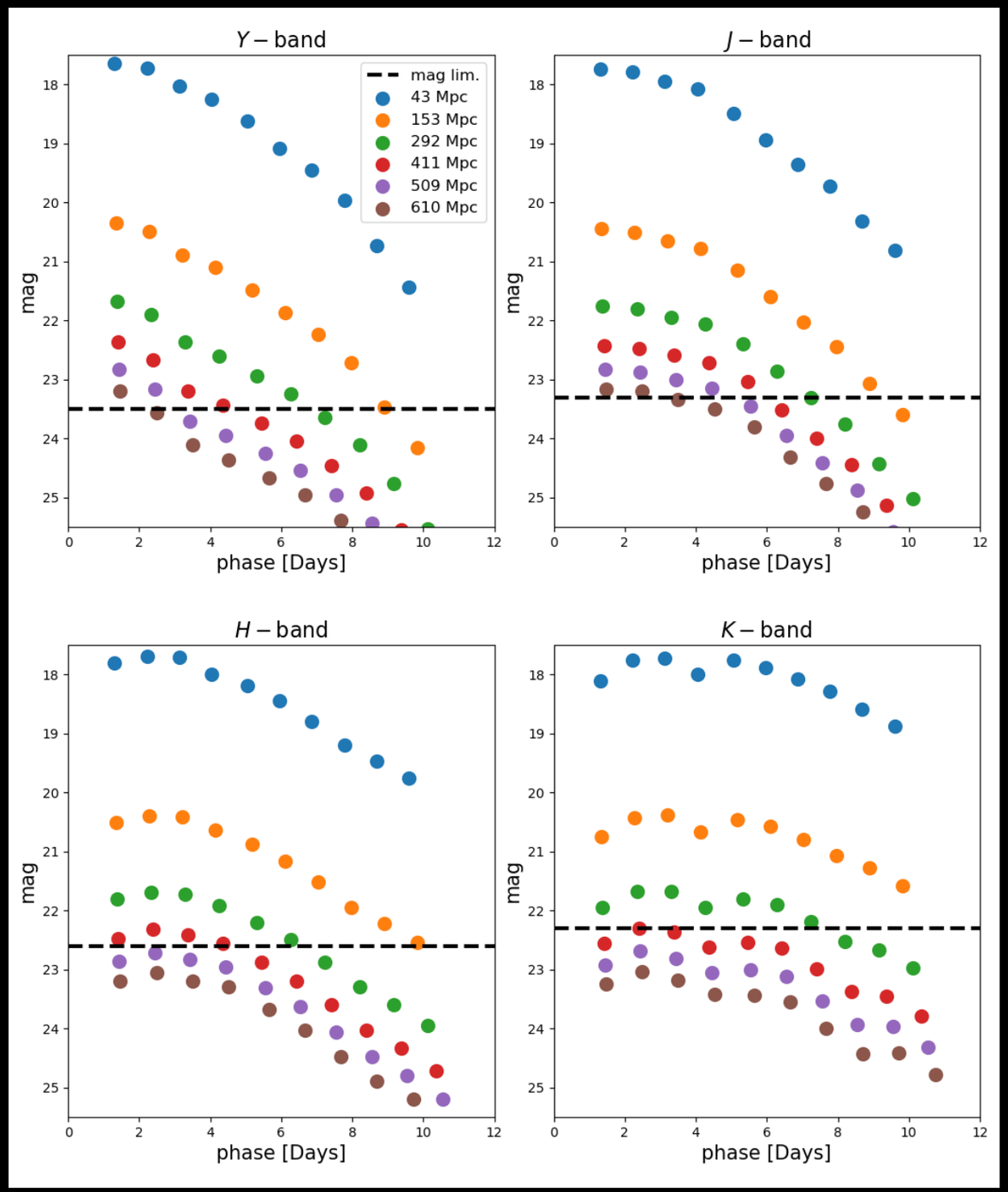
Kilonovae

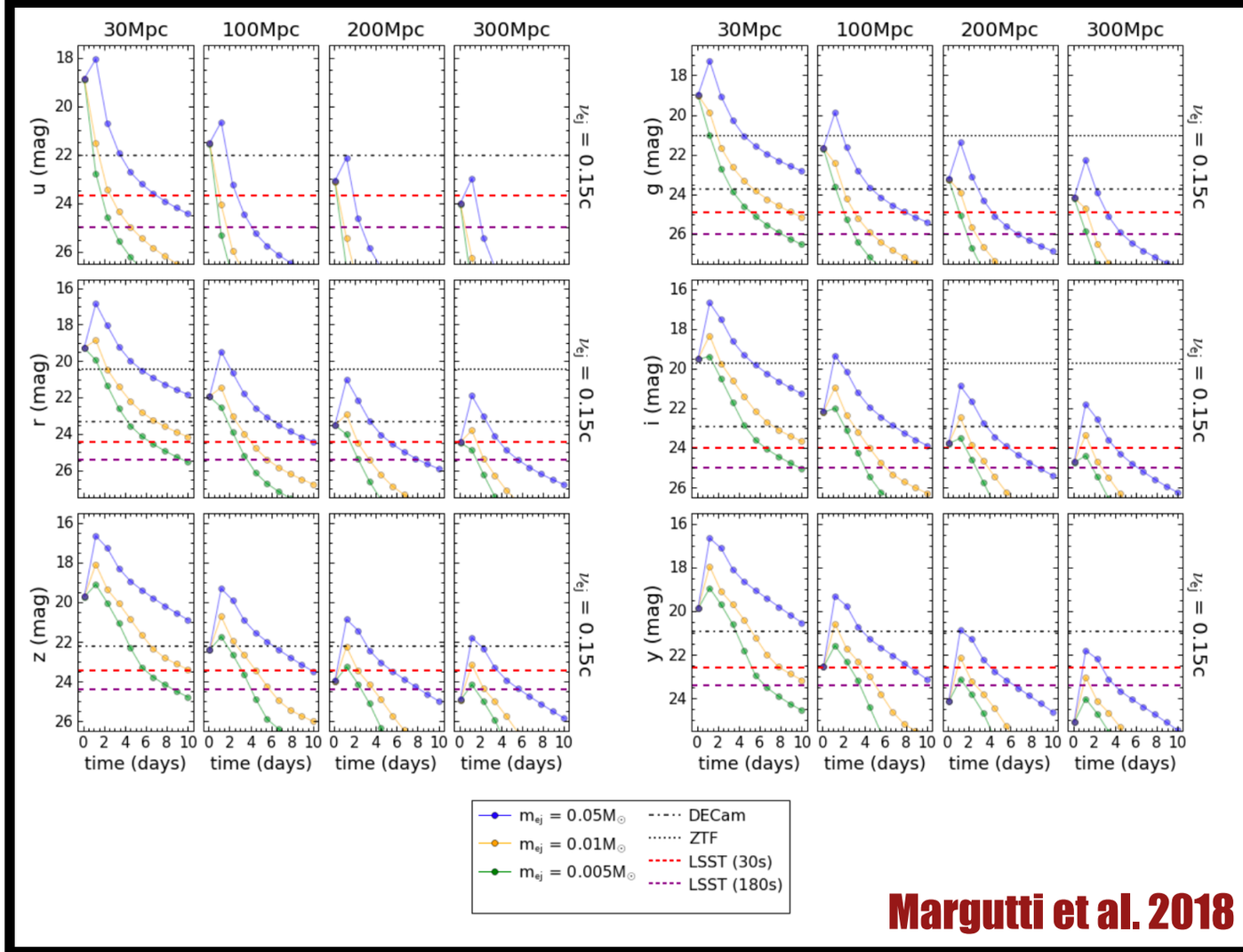


Located at a distance of 40 Mpc (z=0.0098)



Kilonovae

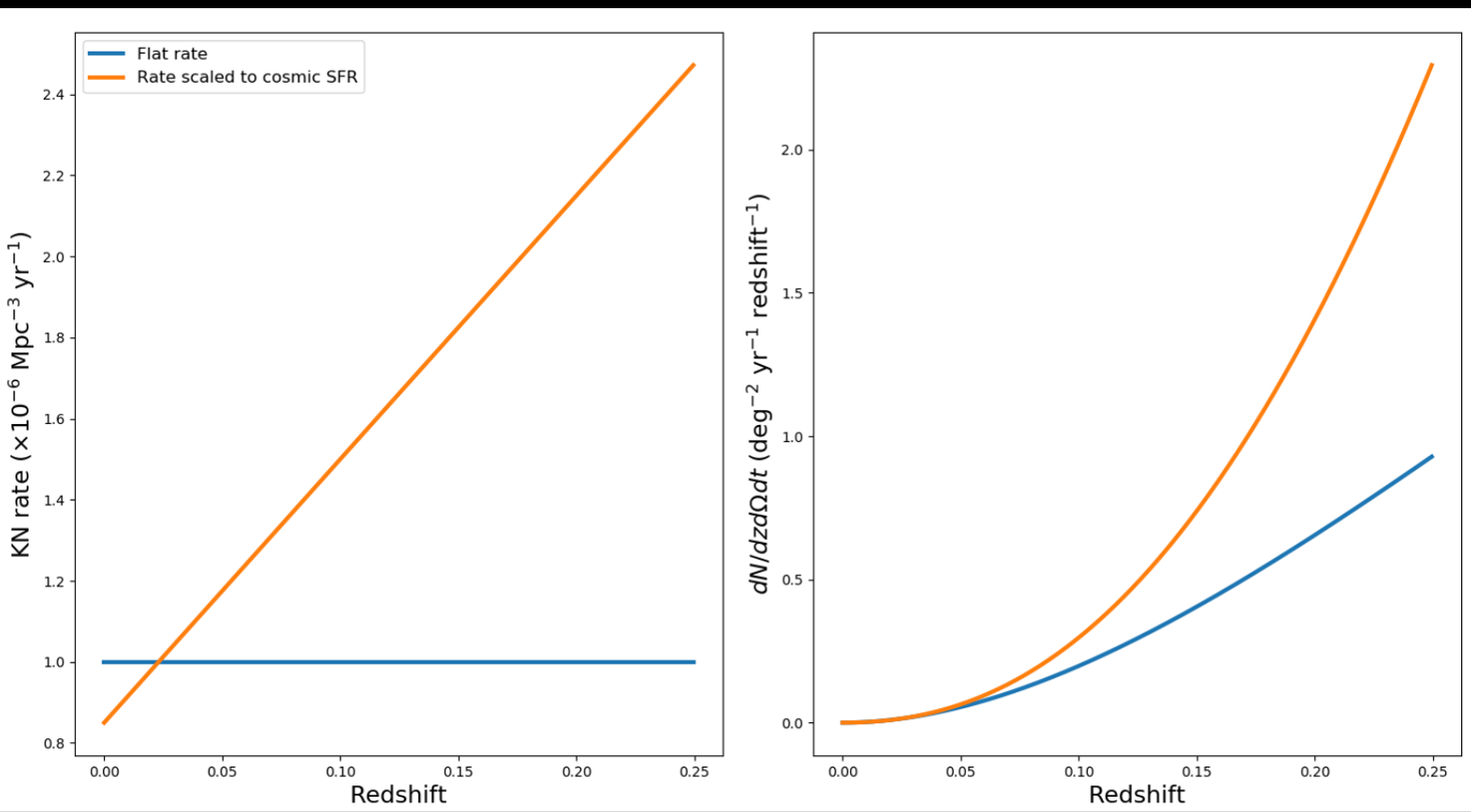




Margutti et al. 2018

- With the UltraVISTA data we could detect a AT2017gfo-like KN/GW170817 to 400-500 Mpc or z~0.10.
- We have estimated an upper limit on the kilonova rate using UltraVISTA (Contreras et al. 2019 in prep).

Kilonovae



Deep surveys such as WFIRST (24.8-26 mag) have the potential to constrain the rate of KN to z~ 0.15-0.20 or 700-1000 Mpc. But high cadence is required!

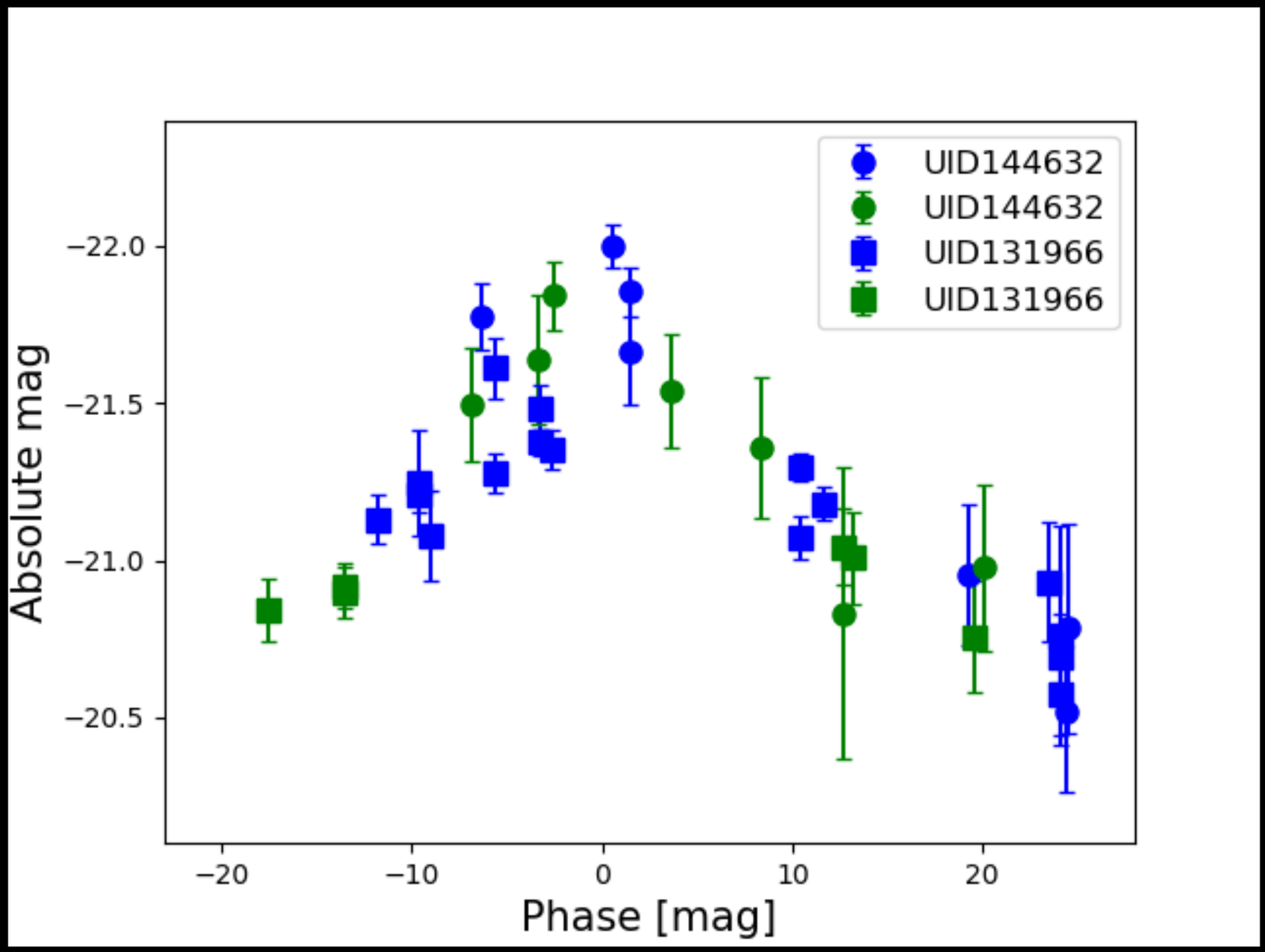
The best observational constrains on the rate of KN are from short GRB (see Fong+15).

Lessons learned

- Most candidates are detected in Y and J bands, we recommend to avoid Ks in future ground based time domain surveys.
- For well-observed NIR LC, photometric classification can be good as spectroscopic classification. Save spectroscopic time!
- Focus spectroscopic time in transients on faint hosts, otherwise could be impossible to get a redshift for them.
- There is a lot to learn from NIR LC at low-z, only SNe Ia have a large and well characterized sample.

Thank you!!!

Bright and Fast twins?



UID144632 z~1.3

UID131966 z~0.75