

Supernova Cosmology with LSST

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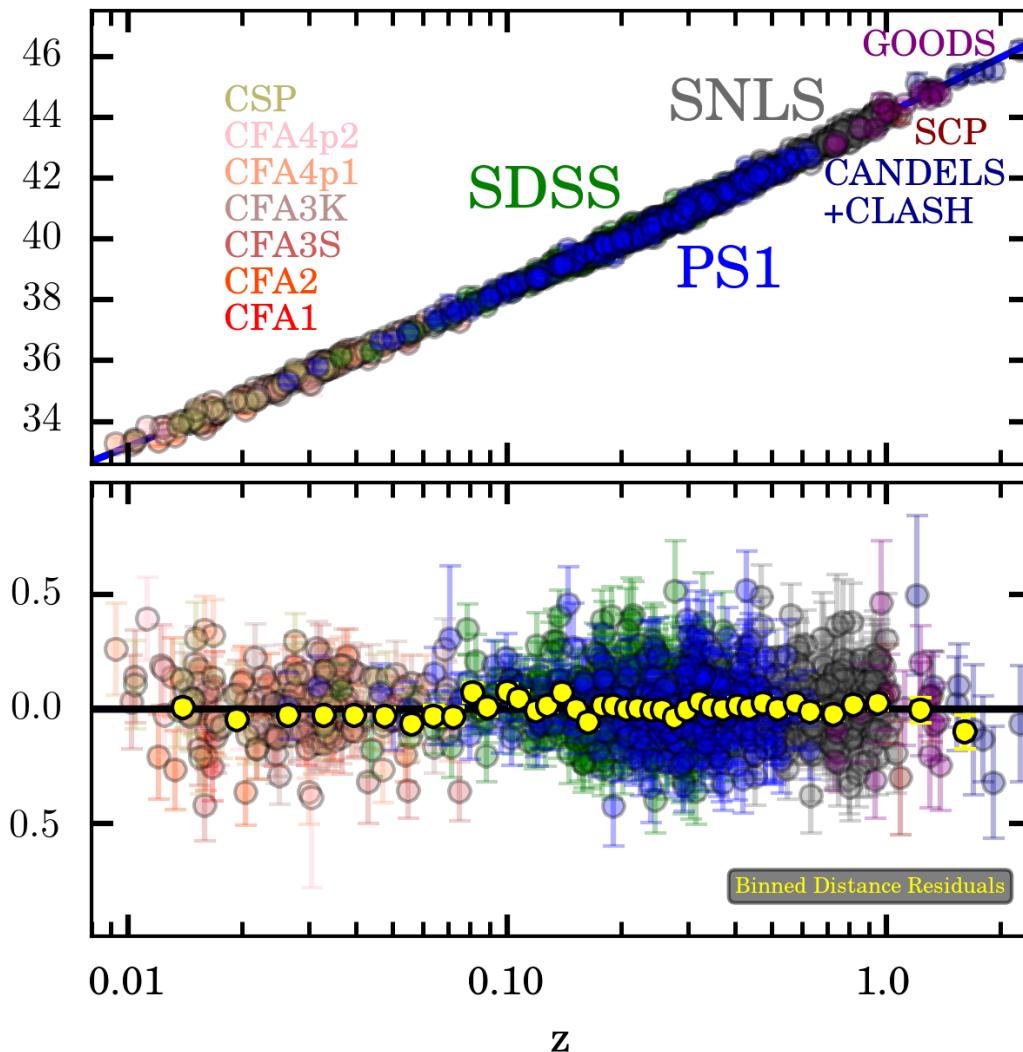


LSST@Europe3



Supernova Cosmology (spectroscopic): State of the Art

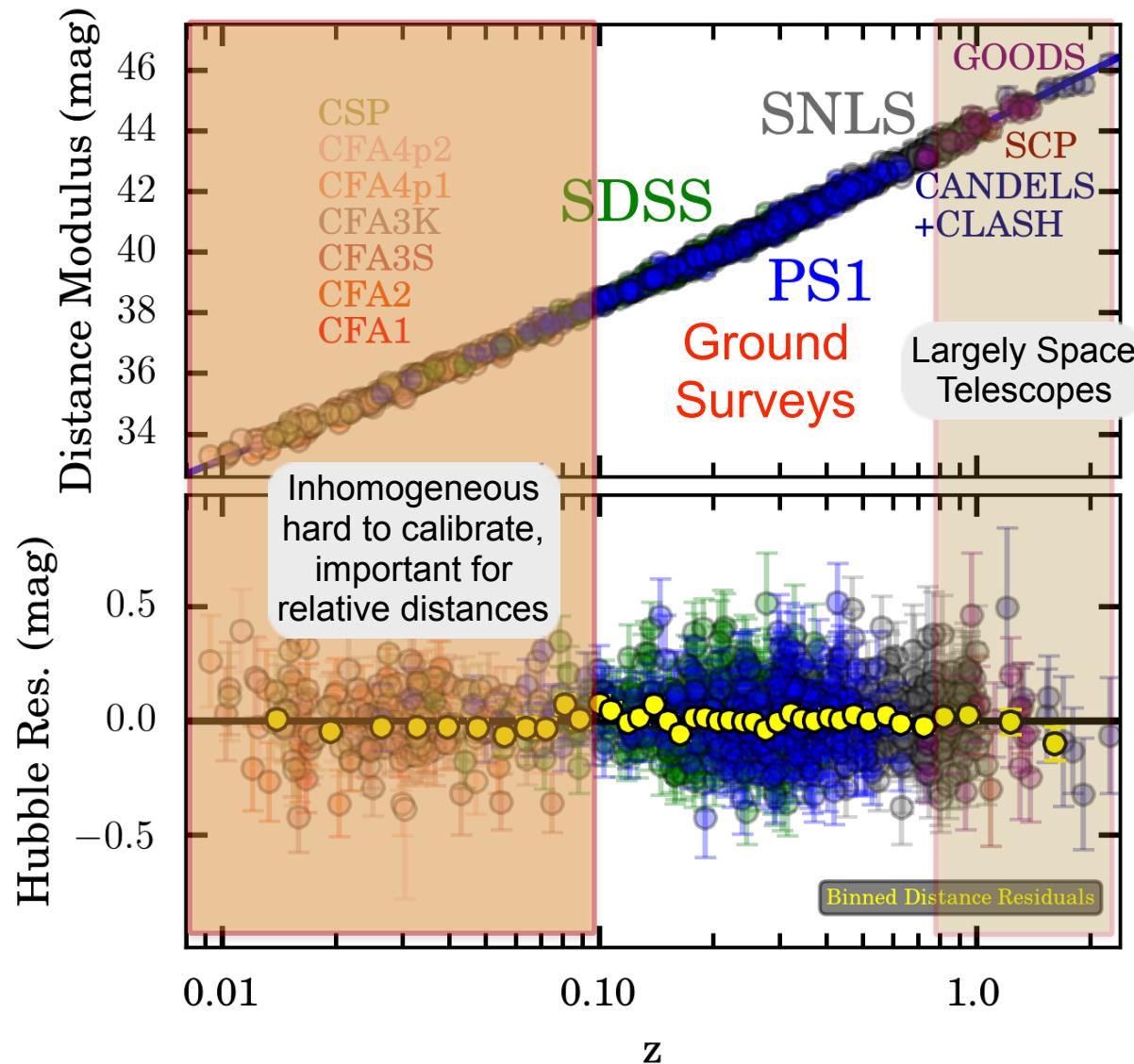
Scolnic et al, 2018 (Pantheon)



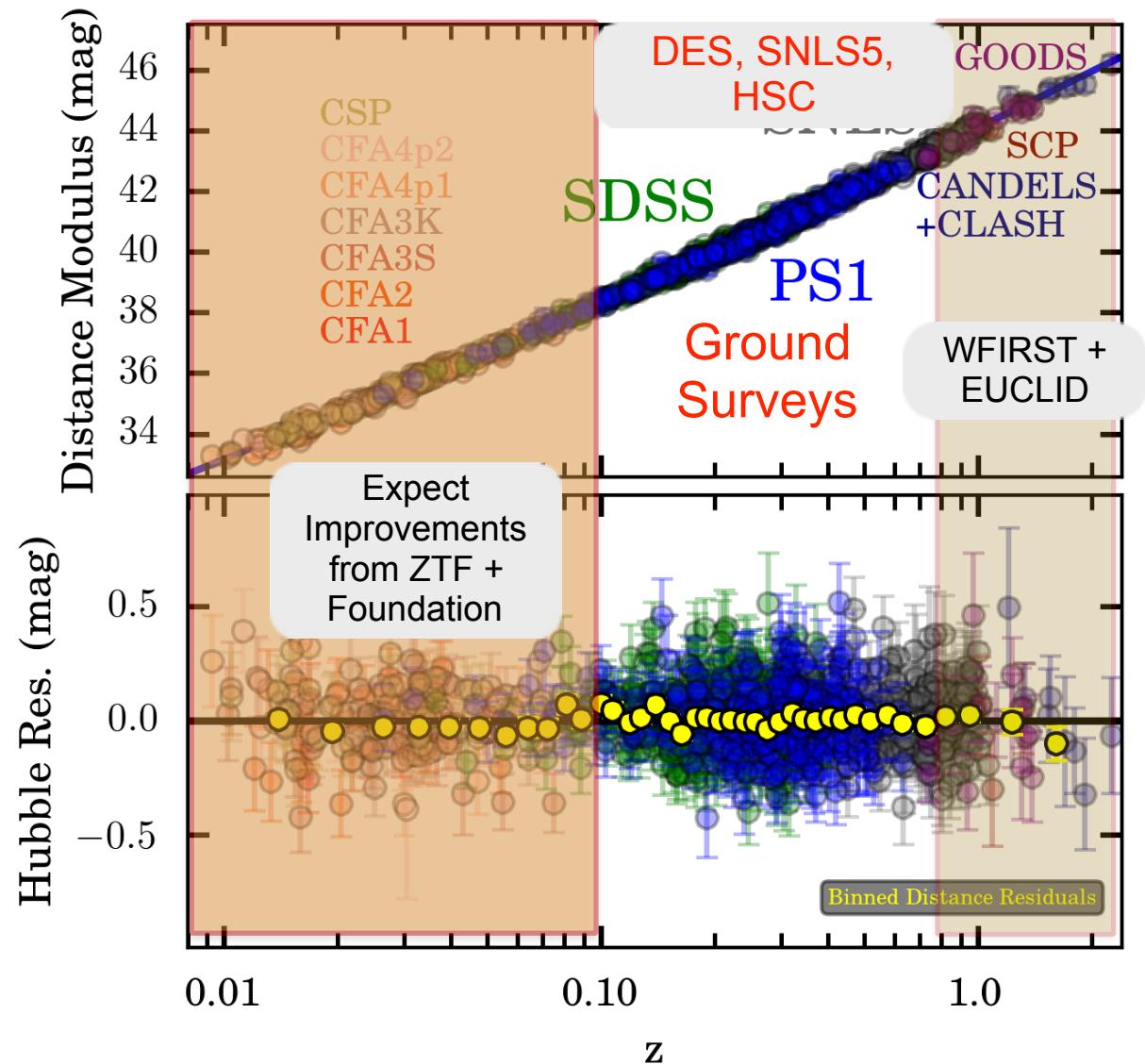
Probing expansion history
of the universe

- Properties of Dark Energy ($z \lesssim 1.7$)
- Local expansion history of the universe ($z \lesssim 0.1$)

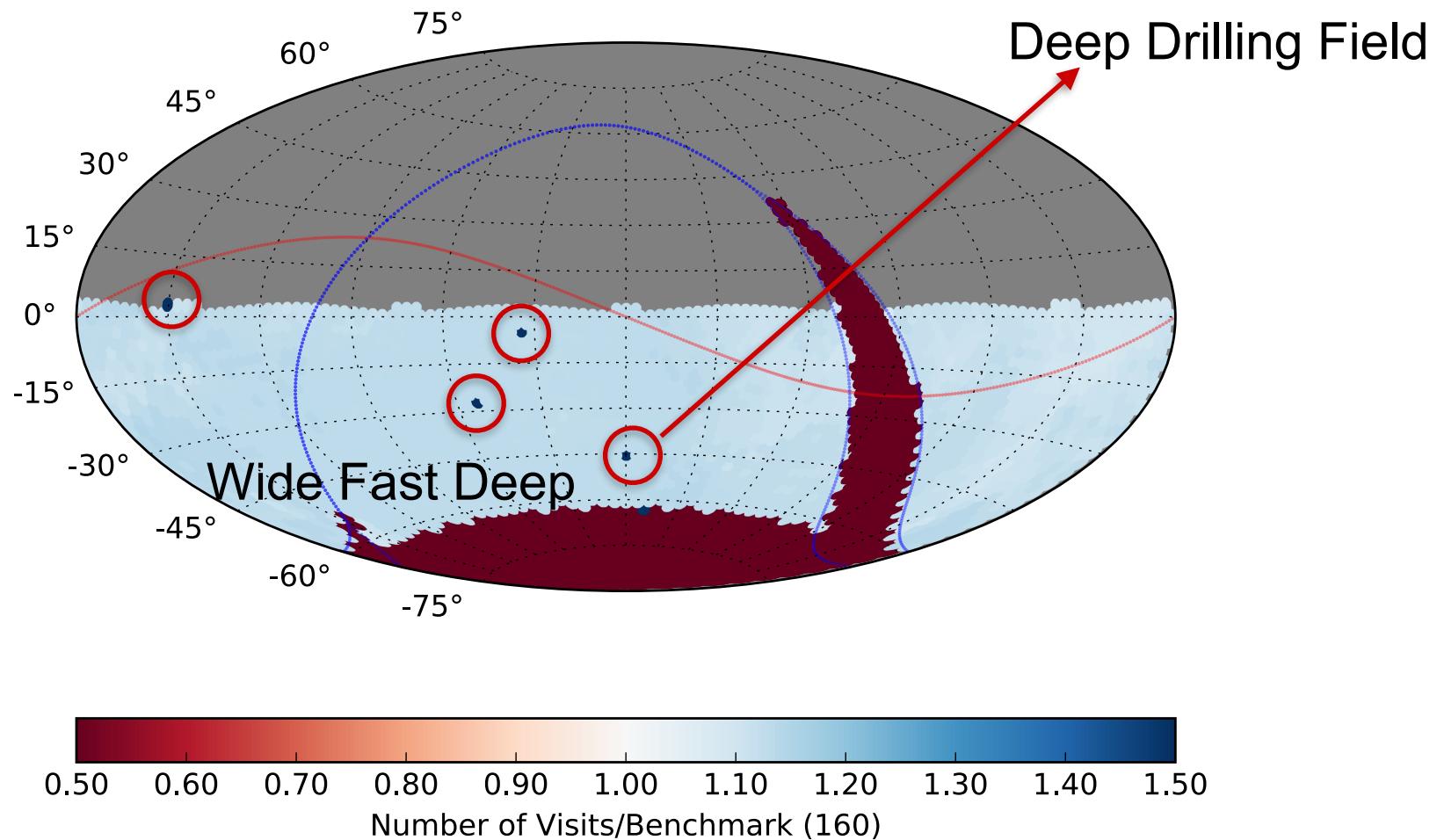
Future Challenges



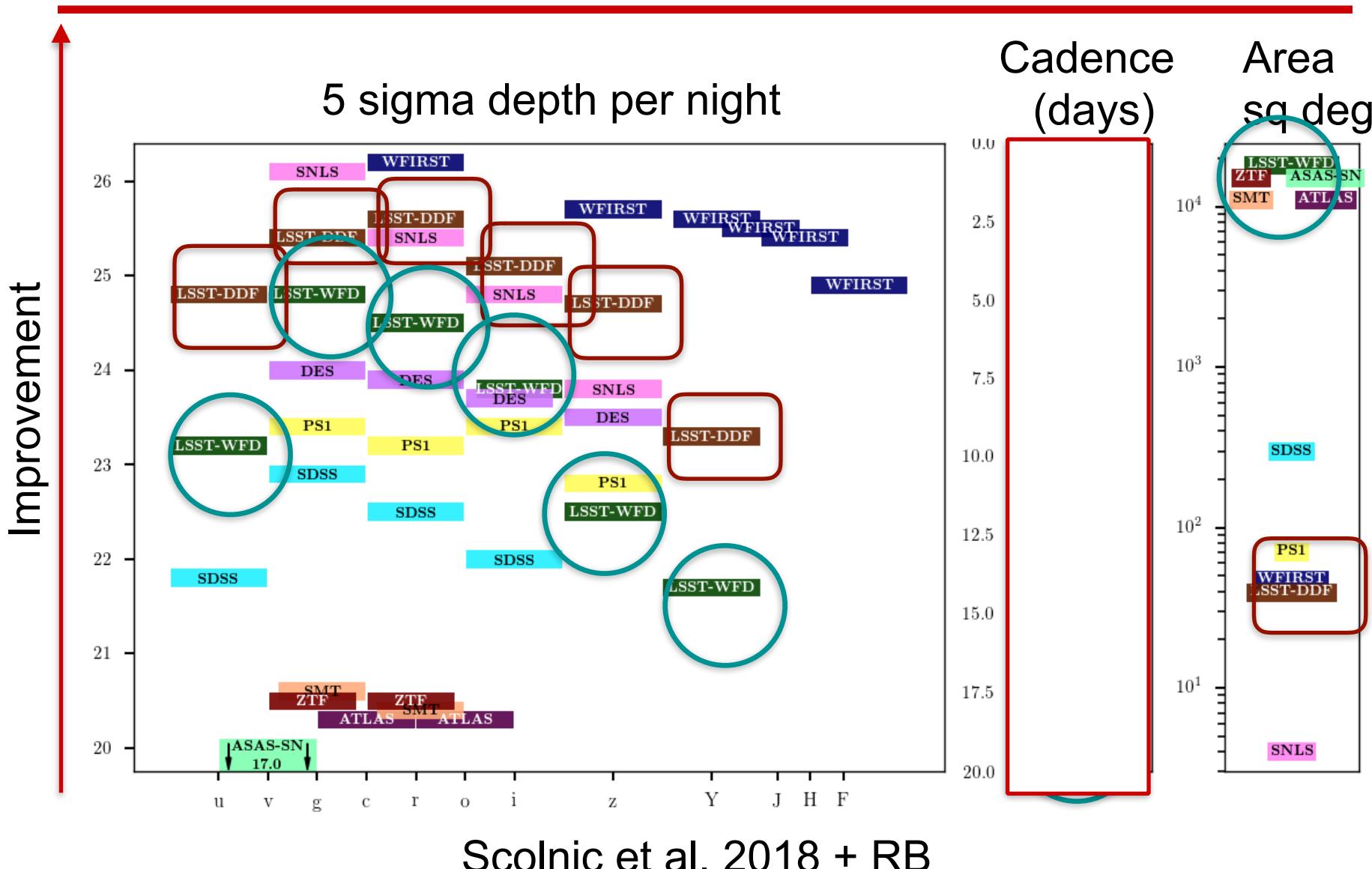
Supernova Survey Landscape



LSST SN Surveys



LSST in the context of SN Surveys



What can LSST do for SN Cosmology ?

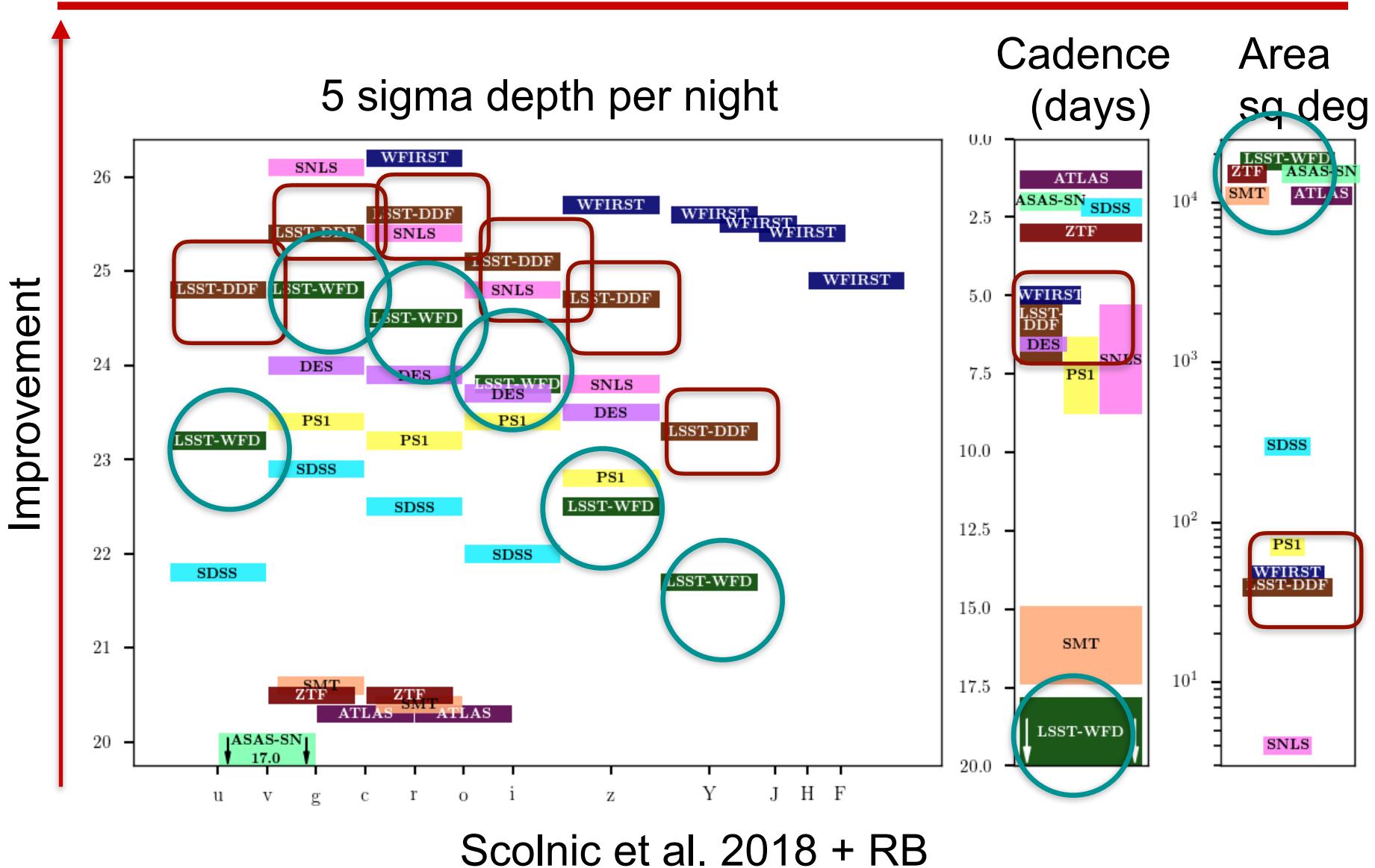
Cosmic expansion constraints significantly improved by combining both DDF and WFD surveys :

- DDF: large high-z SNe sample
- WFD: low-z sample with same calibration
- WFD: probes SN diversity & correlations with host properties.

Novel Science cases :

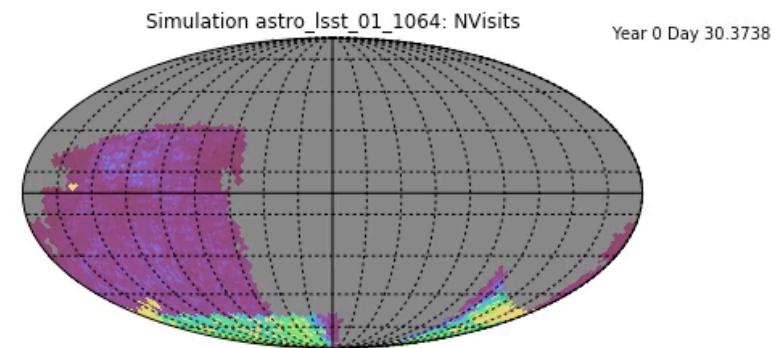
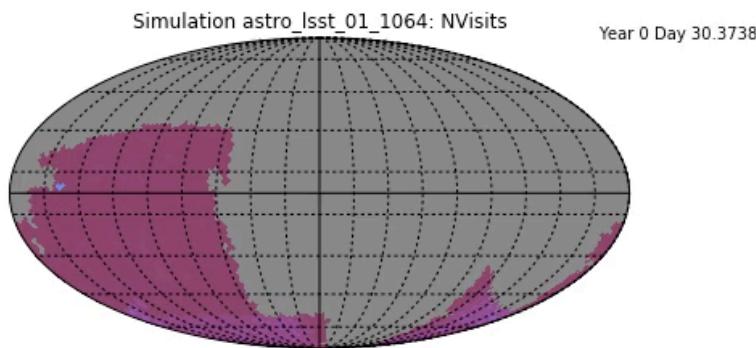
- WFD SNe Ia probe large scale structure with additional distance measure (eg. peculiar velocities, isotropy etc.)
- Strong and Weak lensing of SN constraining σ_8 and H_0 (see talks by Sherry Suyu / Simon Huber earlier and later)

LSST in the context of SN Surveys



Single Visit Depth/Area vs Cadence Optimization

Ideas collected in Science Driven Optimization of LSST Observing Strategy : LSST Science Collaborations: Phil Marshall et al. 2017



DESC Observing Strategy Task Force : *communicating DESC-wide science needs to the Project*

- led by **Dan Scolnic & Michelle Lochner**
- Many SN members involved, SN lead : **Philippe Gris** (see [talk by Gris in previous session](#))

LSST SN Cosmology : Other Challenges

Instrumental and astrophysical systematics :

- Calibration : DESC Photometric Calibration WG (**Regnault, Rykoff**) (See [Fabrice Feinstein's presentation](#))
- standardization of SNIa (**Leget + Gangler + Mondon, Kim, Saunders, Dai + Jha**), Eg. details @ **Rigault 4 pm.**

Photometric Classification of SNIa : (next slide)

Complementary external data : (spectroscopic) follow-up of SN and host sub-sample

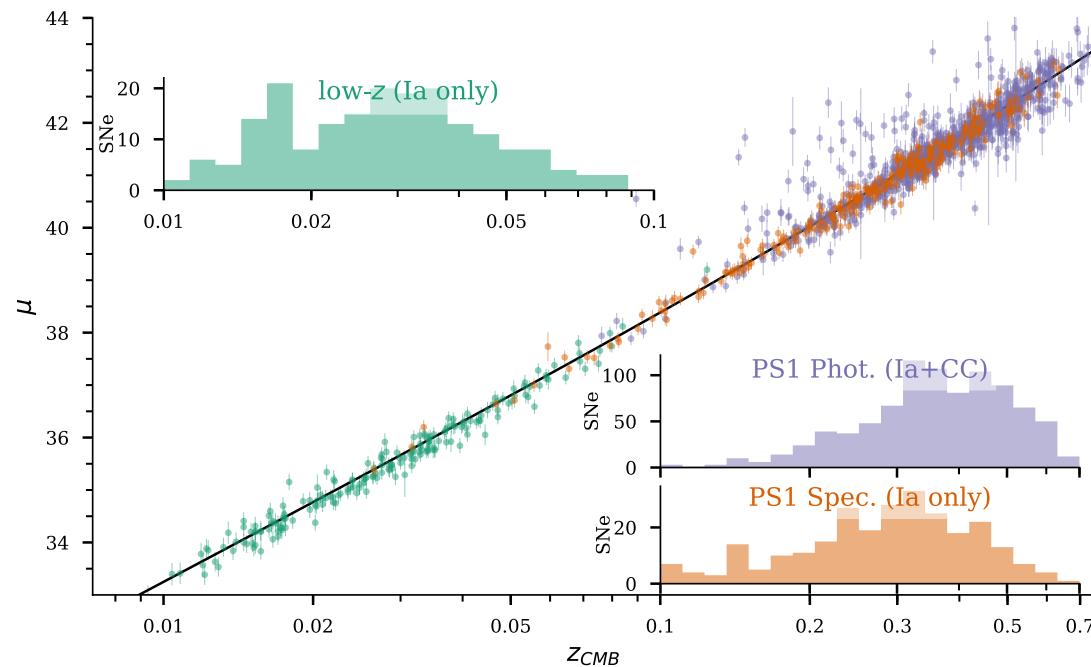
- 4MOST/TiDES (**Swann, Regnault, Antilogus, UK++**), DESI, Magellan

Analyses Methods Investigations:

- Improving analyses combining classification + distances (**Malz, Peters, Hložek, Ponder, Galbany ++**)

Photometric Classification

State of Art : ([PANSTARRS](#)) [Jones et al. 2018](#) host specz + classification + Bayesian analysis



experience of members in prior classification ([SDSS/SNLS](#)/
[PANSTARRS/+DES](#)) + codes used [PSNID](#) /[BEAMS](#)

will be even more important for LSST...

- Open research problem (eg. Pasquet, Fouchez, Ishida, Schuhmann, RB ++)
- Papers/Codes developed/improved within DESC :
 - Lochner, McEwen, Peiris, Lahav, Winter, 2016 : [snmachine](#)
 - Dai, Kuhlmann, Wang, Kovacs 2017
- PLAsTICC : *emulating the non-moving object classification problem in LSST*
 - Transient / Variables models collected and simulated with LSST baseline cadence to be made public after challenge.
 - Public classification challenge (Details: [Emille Ishida@4.00pm](#))

DESC SN Pipelines

Image Pipeline : *preparing the SN interface to LSST data*

- Pipeline Scientist : **Dominique Fouchez**
- use LSST software to create mock data release products and analysis code to for SN analysis to use these
- Effort starting out on DC2 images and precursor data

Catalog Pipeline : *synthesizing analyses methods for LSST*

- Pipeline Scientist : **Philippe Gris**
- Modular pipeline with different analyses with catalog inputs
- Enable comparison of analyses using simulations

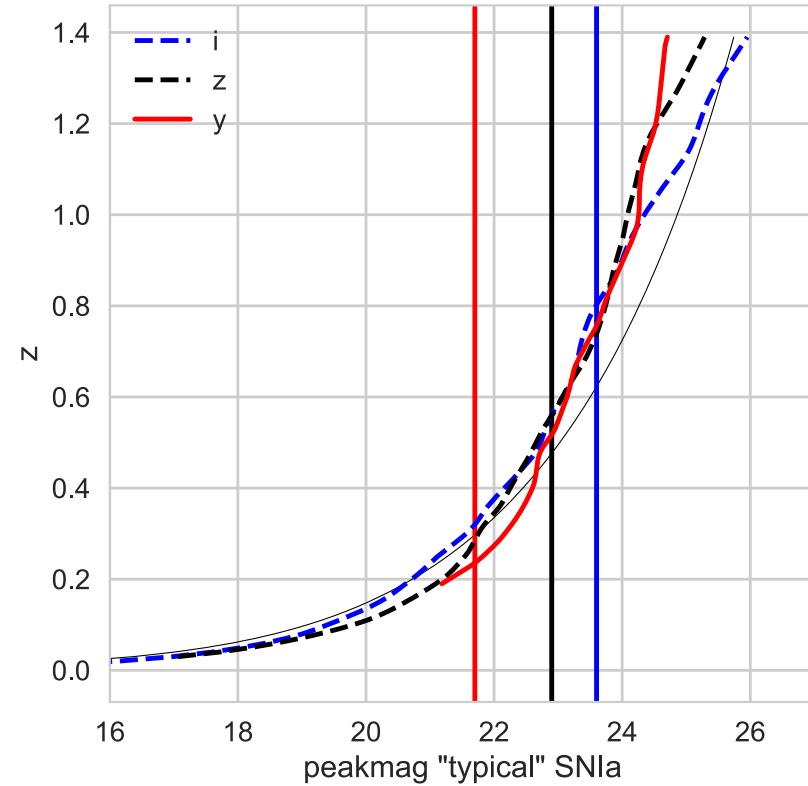
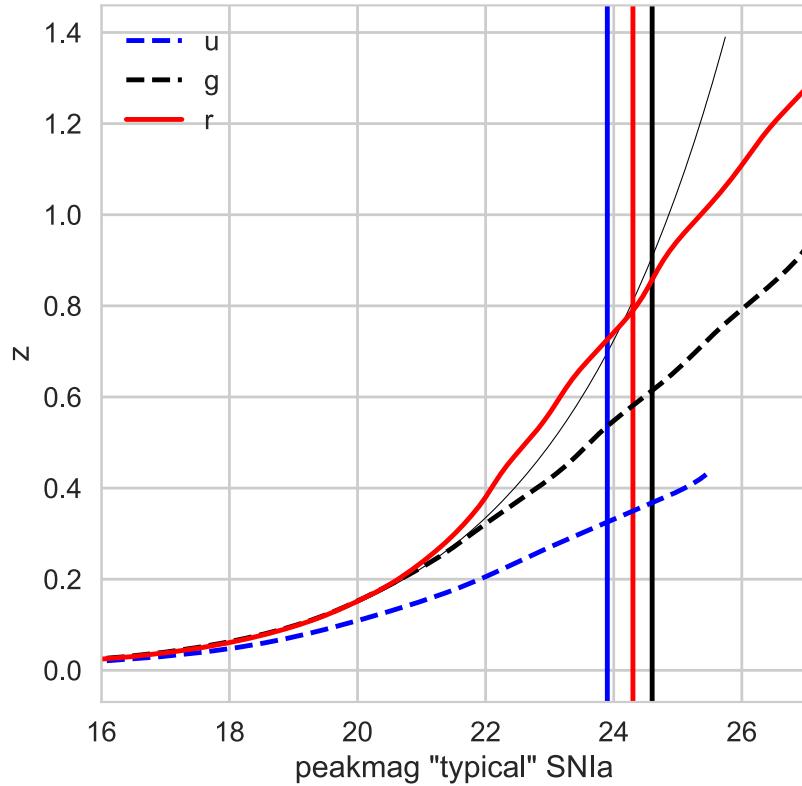
Prompt Pipeline : *interfacing prompt LSST products, Brokers and SN analyses*

- Not started yet. Documentation of needs (**A. Kim + RB**)
- Collect LSST prompt products, broker(s), previous data, trigger follow-up and manage results.

Getting Engaged in DESC SNWG

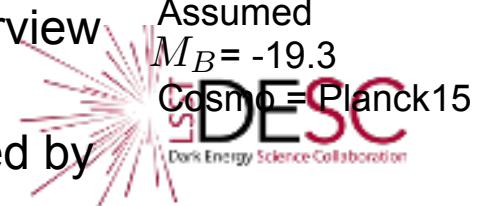
- join DESC !
 - contact DESC SNWG conveners: Renée Hložek / Rahul Biswas
-
- Group zoom telecons twice a month
 - slack channel #desc-sn for main SN related communication + topic
 - software mostly on DESC github organization

WFD area $\sim 18,000$ sq degrees

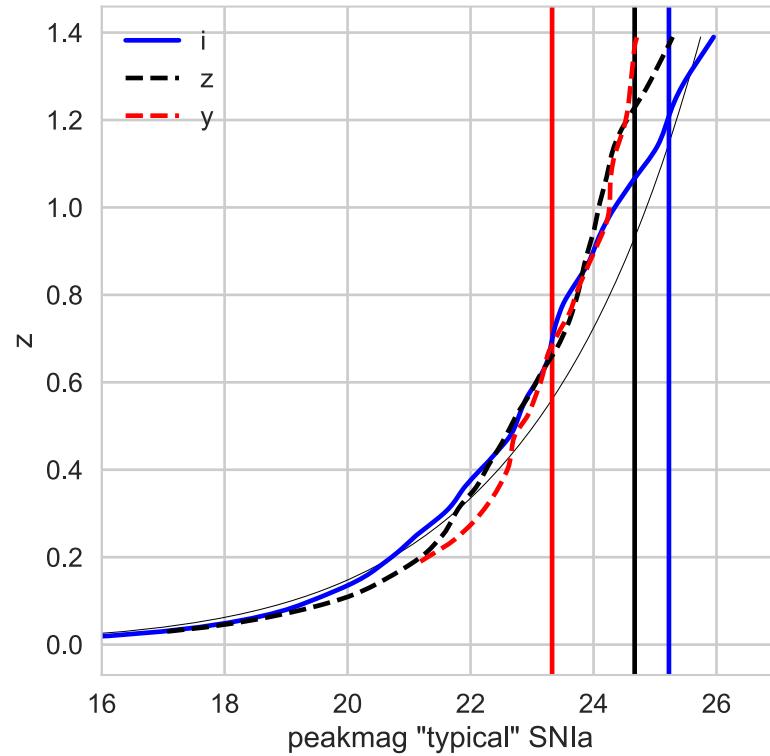
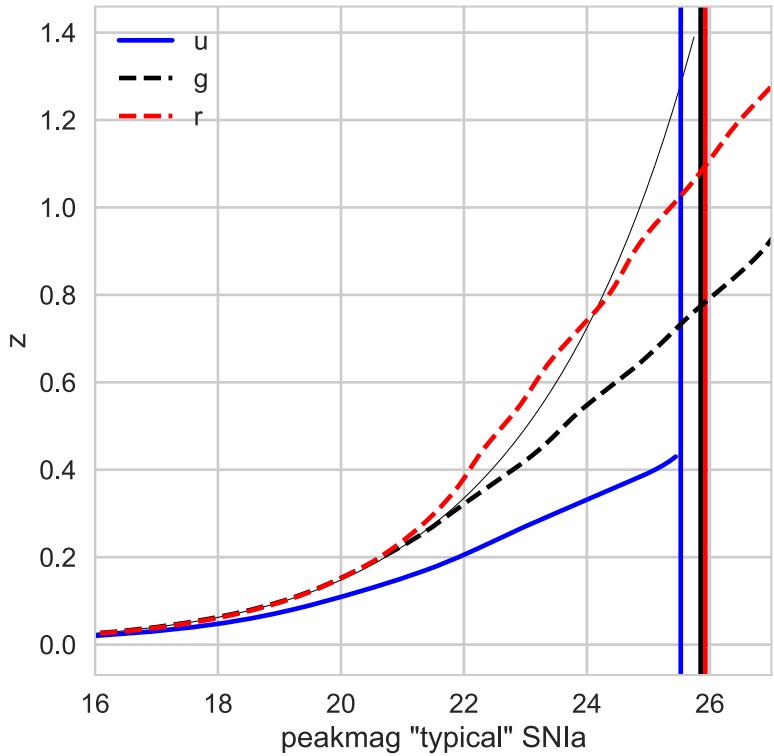


Vertical Lines denote single visit 5 sigma depths from LSST overview paper arxiv/0805.2366 (Table 1) in same bands

Caveat : Usefulness of the detected supernova is determined by Cadence / Observing Strategy (will revisit)



DDF area ~ 50 sq degrees



Vertical Lines denote nightly visit depths using the visit sequence +
 single visit depth in LSST overview paper Table 1. of arxiv/
 0805.2366

Caveat : Cadence / Observer Strategy (will revisit)

