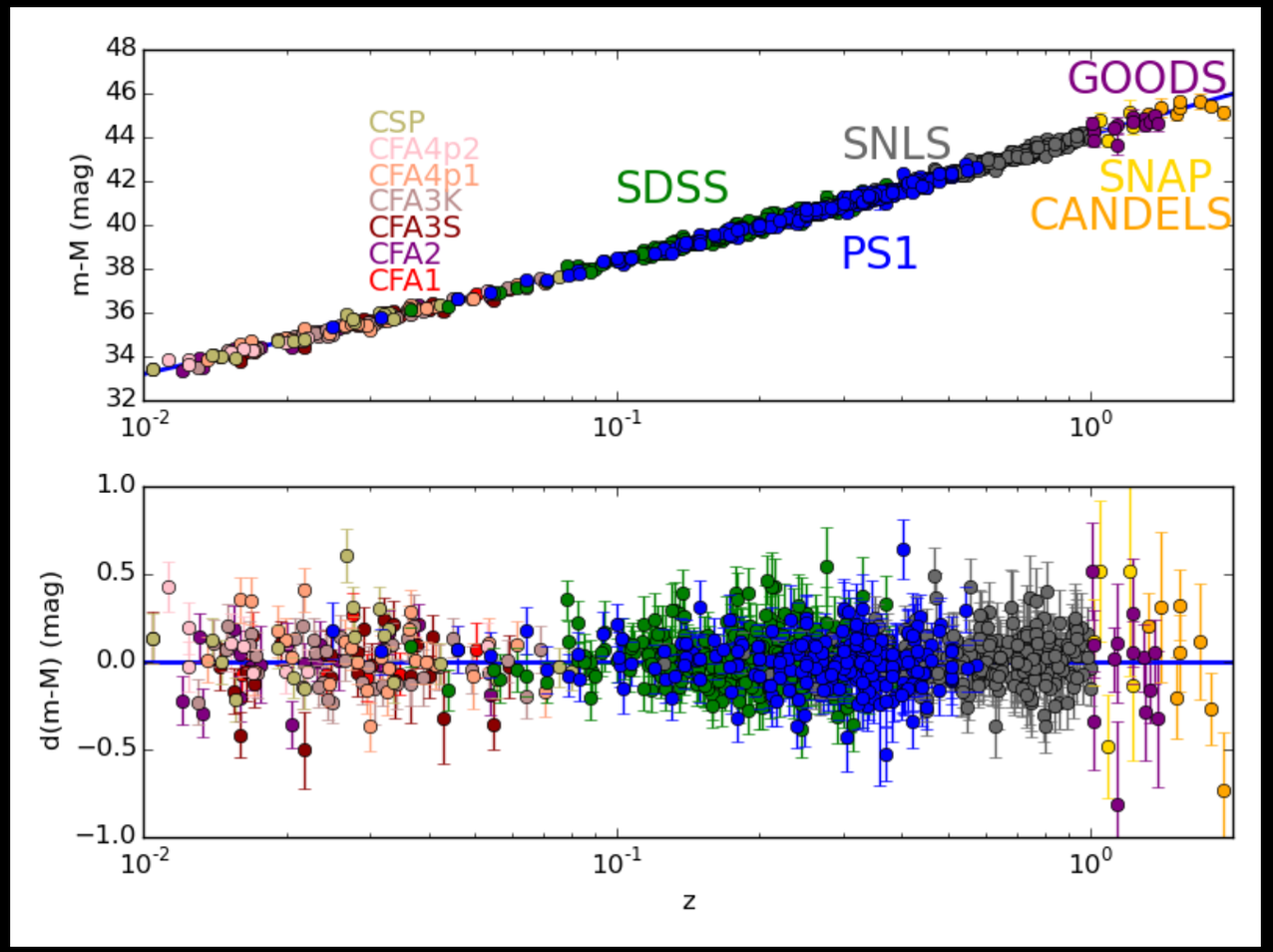
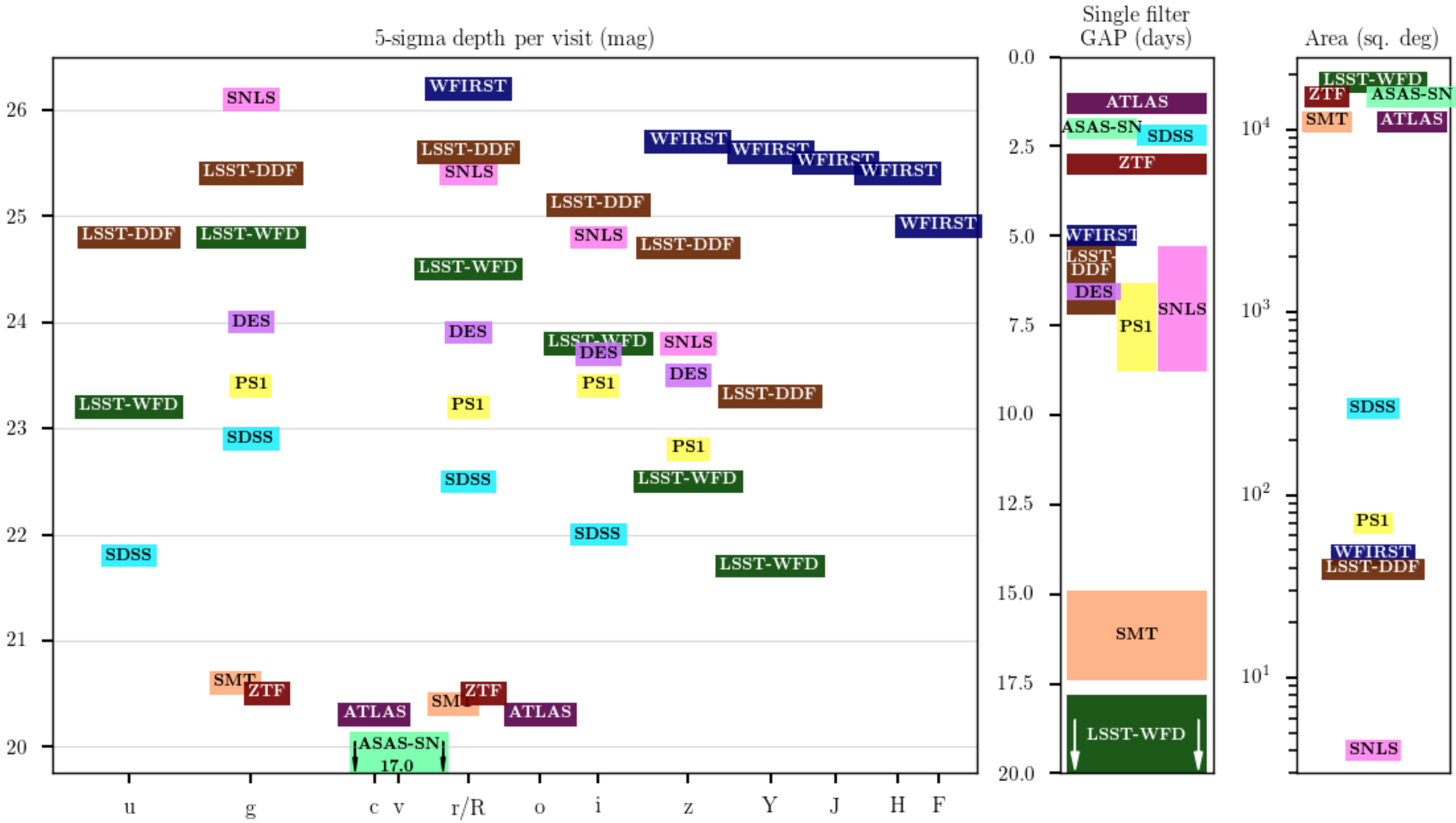
# WFIRST+LSST SN Synergy




Dan Scolnic, KICP/Hubble Fellow - University of Chicago

Cosmic Visions

# WFIRST and LSST are both unlike any SN survey we have seen before




Scolnic et al. 2017b

Where we are now

CSP
CFA4p2
CFA4p1
CFA3K
CFA3S
CFA2
CFA1
SDSS
SNLS
PS1
GOODS
SNAP
CANDELS

Scolnic et al. 2017a PS1+ Spec
Analysis: 1050 SNIa

Luminosity Distance (mag)

Foundation+SNFactory 800 SNe

PS1-Phot (Jones et al.) +DES: 5000 SNe

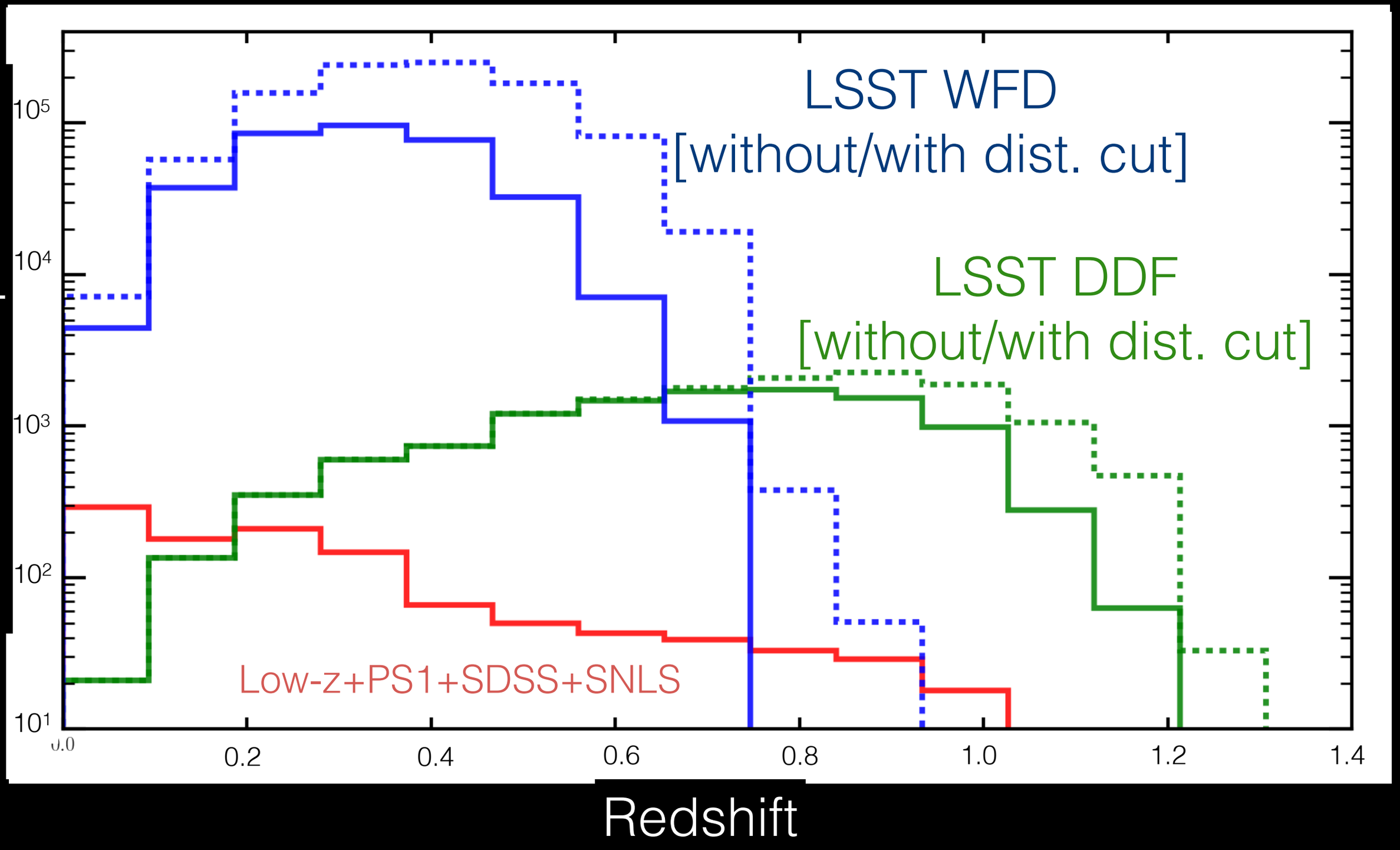
Where we will be soon

Distance Residuals to LCDM Model (mag)

Redshift

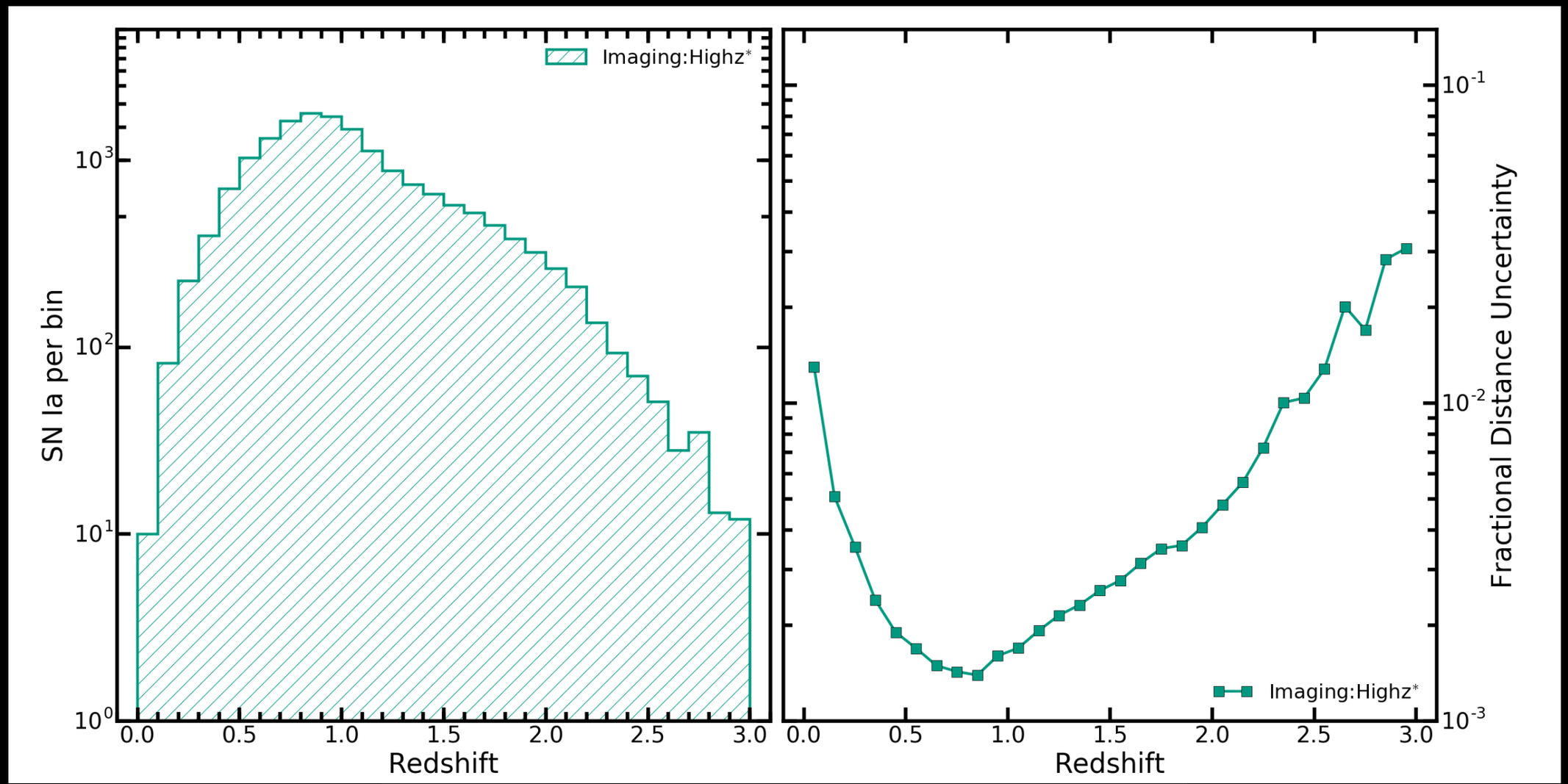
Showing 10-year total for LSST, with typical quality cuts on peak constraints, shape constraints

# WFD will have observed 380k[998k] good SNIa light curves
# DDF will have observed 11k[14k] good SNIa light curves



# What does WFIRST Add To The Picture?

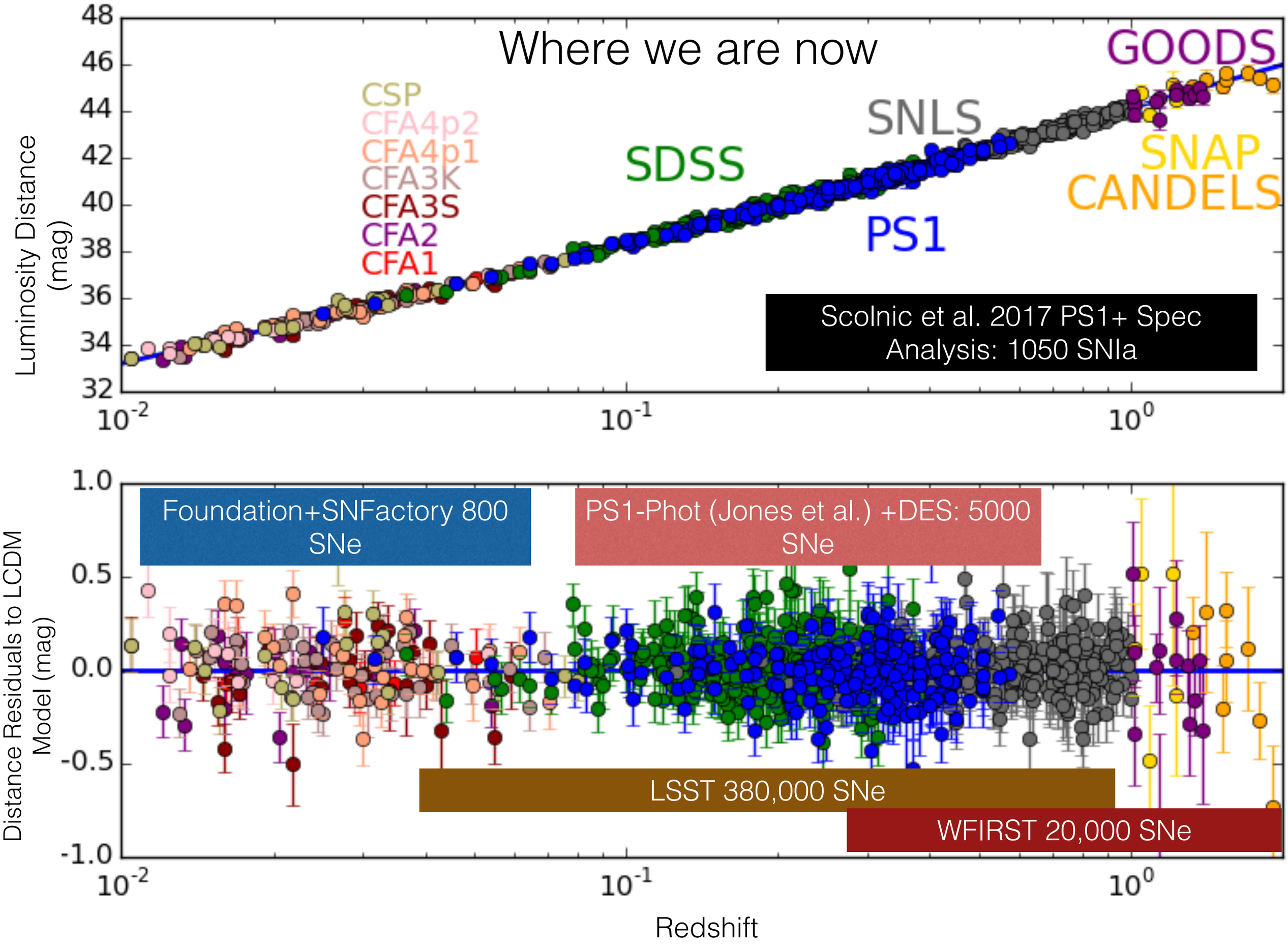
With Imaging Survey, 20k SNe out to z~3 for WFIRST SN survey, compared to the 10k (DDF) from LSST out to z~1.2 [No spectroscopic classification - photometric analysis selection criteria.]




| Tier | Filters | *Area ($deg^2$)* | *No SN IA* |
|---|---|---|---|
| Medium | RZYJ | 32 | 8000 |
| Deep | YJHF | 13 | 8900 |

From Hounsell. et al. 2016

# Where we are now



*100x increase in statistics!*
*That is 2 Dijkstra's laws!*

*And 10x increase in FoM.*

e we are now

GOODS
SNLS
SDSS
SNAP
CANDELS
PS1

Scolnic et al. 2017 PS1+ Spec
Analysis: 1050 SNIa

Luminosity Distance (mag)

48
46
44
42
40
38
36
34
32

$10^{-2}$ $10^{-1}$ $10^{0}$

Foundation+SNFactory 800 SNe

PS1-Phot (Jones et al.) +DES: 5000 SNe

LSST 380,000 SNe

WFIRST 20,000 SNe

Distance Residuals to LCDM Model (mag)

1.0
0.5
0.0
-0.5
-1.0

$10^{-2}$ $10^{-1}$ $10^{0}$

Redshift

But… there are two new problems:

-Redshifts

-Classifications

And one key lingering one:

-Calibration

But one particularly exciting feature:

-Multi-survey coordination

# How can we find synergy between LSST and WFIRST?

1. Saul talked about IFC follow-up of LSST discoveries

2. Overlapping imaging fields gives UV->NIR light-curves, never been done before.

3. The amount of coordination between surveys raises bar of difficulty, but no showstoppers.

Still, this relies on overlapping fields….

# There are 4 LSST DDF chosen: None make everyone happy.

| | ELAIS S1 | XMM-LSS | Extended Chandra Deep Field-South | COSMOS |
|---|---|---|---|---|
| **RA 2000** | 00 37 48 | 02 22 50 | 03 32 30 | 10 00 24 |
| **DEC 2000** | -44 00 00 | -04 45 00 | -28 06 00 | +02 10 55 |
| **Galactic l** | 311.30 | 171.20 | 224.07 | 236.83 |
| **Galactic b** | -72.90 | -58.77 | -54.47 | 42.09 |
| **Ecliptic l** | 345.97 | 31.04 | 40.29 | 150.70 |
| **Ecliptic b** | -43.18 | -17.90 | -45.47 | -9.39 |

No Subaru PFS

Far from CVZ, High Zodiacal Light

No Subaru PFS

Far from CVZ, High Zodiacal Light

How to proceed is a big decision that needs to be done soon

D.Rubin,WFIRST-DDF team

# What can we do about calibration?

1. Obviously an Uber Ubercal

2. Need to develop networks of standard stars for each survey to look at (like white dwarfs)

3. Need to push laboratory testing of system throughput to sub percent level, especially in NIR

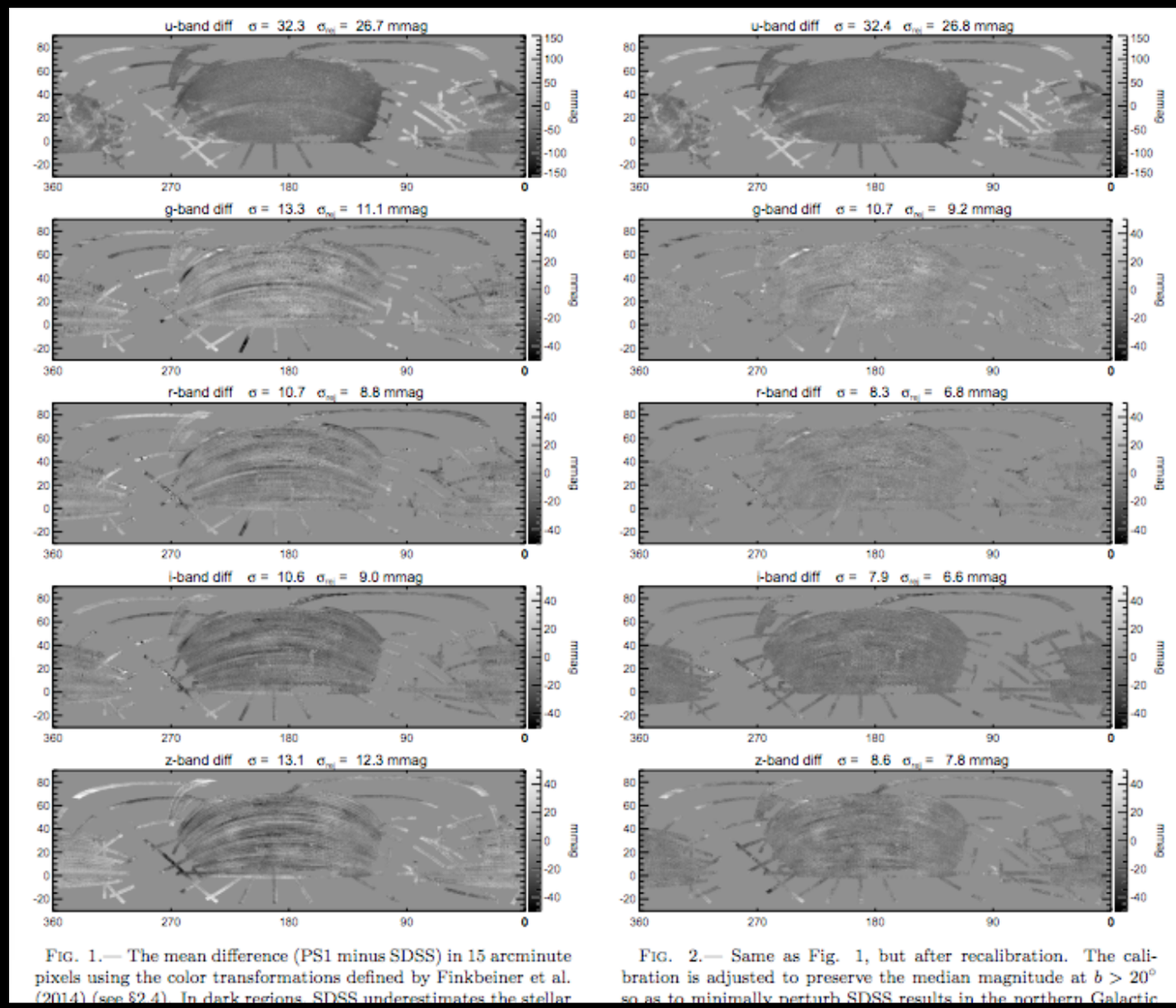



FIG. 1.— The mean difference (PS1 minus SDSS) in 15 arcminute pixels using the color transformations defined by Finkbeiner et al. (2014) (see §2.4). In dark regions, SDSS underestimates the stellar

FIG. 2.— Same as Fig. 1, but after recalibration. The calibration is adjusted to preserve the median magnitude at $b > 20°$ so as to minimally perturb SDSS results in the northern Galactic

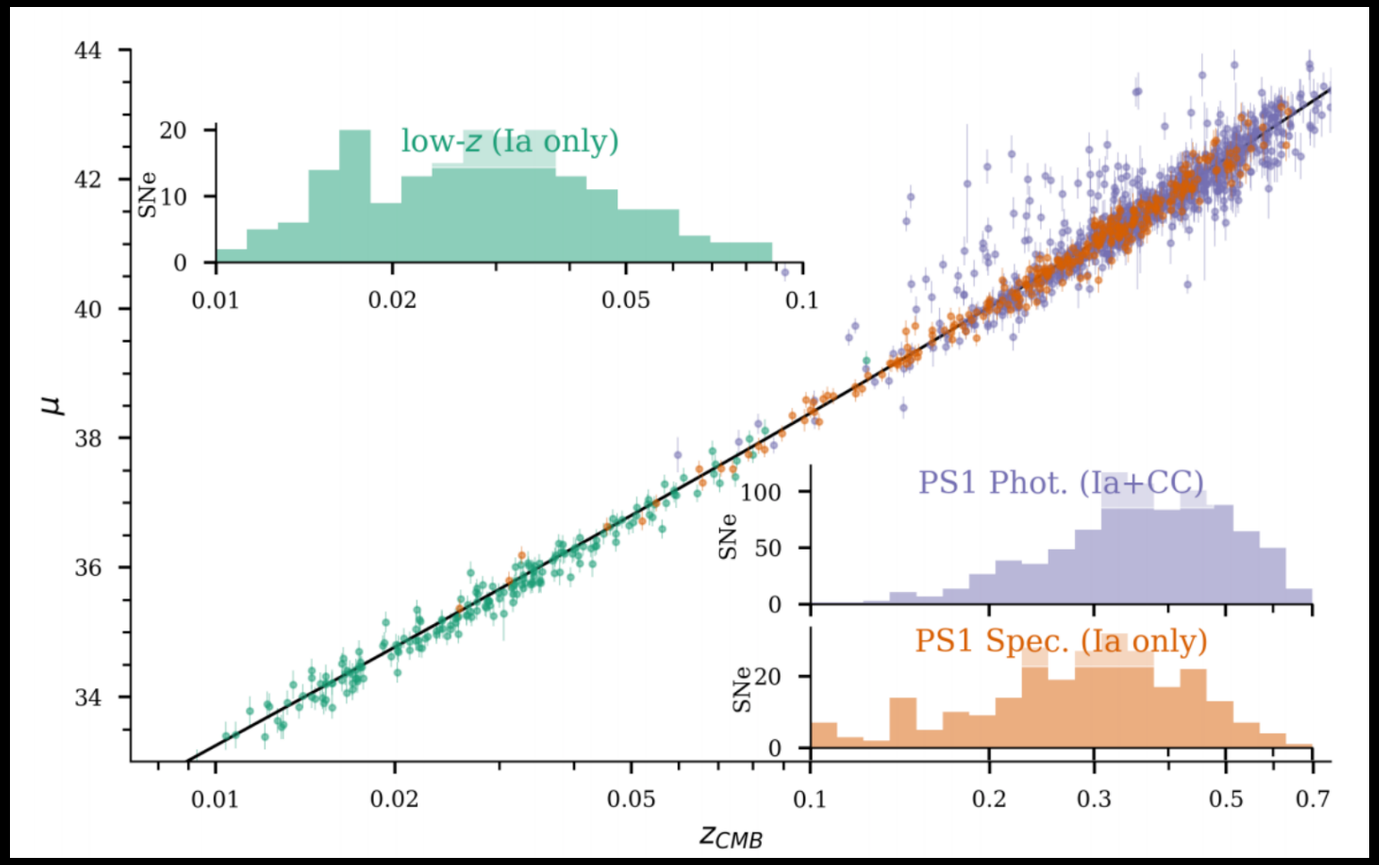
Schlafly et al. 2014

[These are small scale investments with huge payoffs!]

# What can we do about classification?

1. PS1 has showed won't be top systematic with Bayesian treatment

2. Need efforts to focus on building up training library. Starting to happen [e.g., PLASTICC Challenge <- small scale, community-wide benefit]




Jones et al. 2017

# What can we do about redshifts?

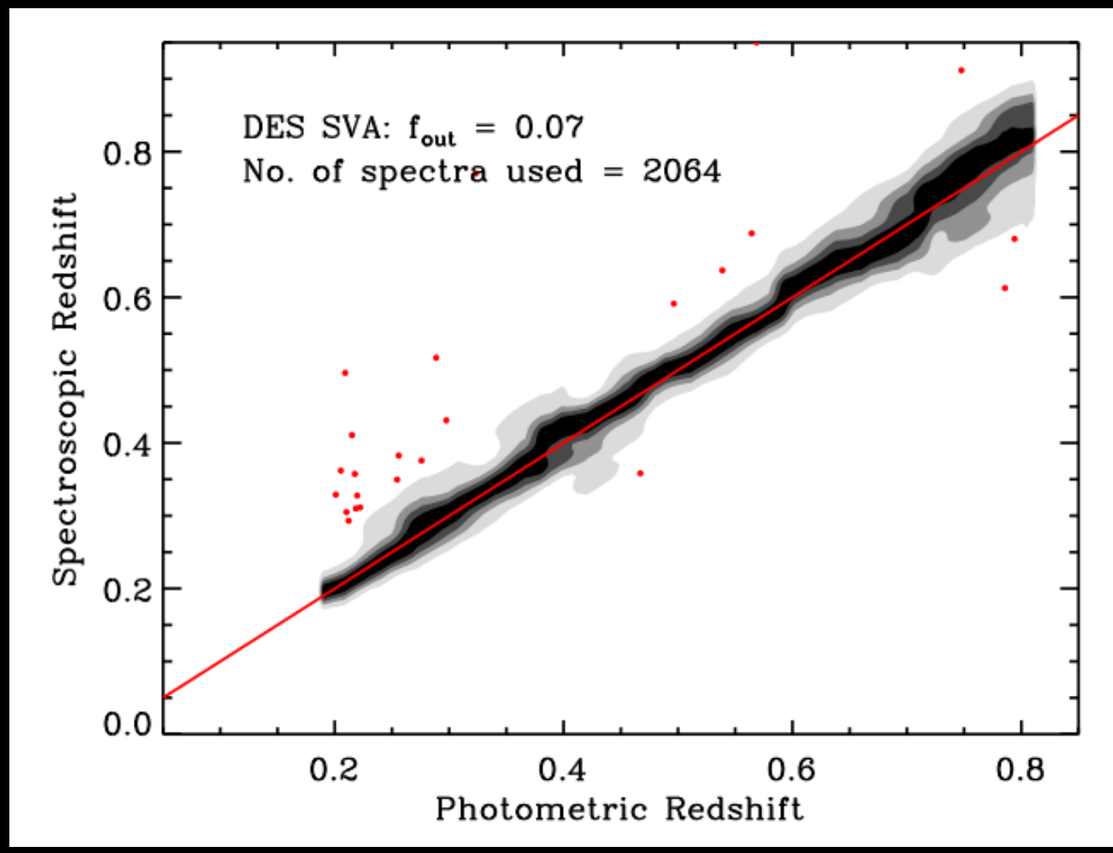
1. Everyone else has similar problem

2. Ours isn't so bad for WFIRST if have IFC

3. But still huge issue for LSST WFD

4. One solution is photo-z's for LRGs

5. But how else are we getting 400K Host Galaxy Redshifts over 20K deg out to z~1.2???




Rozo et al. 2015 using LRGs. See upcoming paper by E. Johnson et al.

- Are there small scale projects with big benefits? Absolutely.
  - ⋆ With new calibration instruments/methods [Timeline: Now. Cost: 500K]
  - ⋆ Building community-wide light-curve template libraries [Timeline: Now. Cost: 300K].
    - ⋆ Coordinating fields between LSST and WFIRST. [Timeline: Now. Cost: Free].
- Are there large scale projects with big benefits? Absolutely.
  - ⋆ Someone solving the whole 400K redshift problem.