Incompleteness models

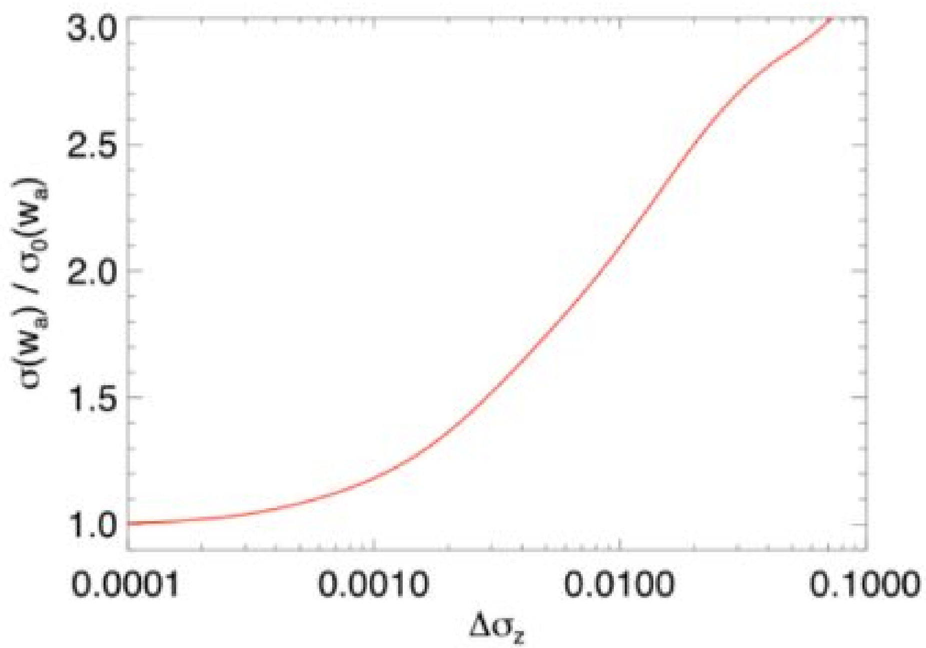
Will Hartley

Weak lensing and supernovae require highly accurate calibration on overall bias and errors (or redshift distributions)

Uncertainty in bias,
σ(δ z)= σ(<z p –z s >),

and uncertainty in scatter,
σ(σ z)= σ(RMS(z p –z s)),

must both be <~0.002(1+z) for Stage IV surveys.



Newman et al. 2013

Calibration of photo-z has always used spectroscopic redshifts in the past.

→ **Motivates clear requirements for spectroscopic survey**

- Sensitive spectroscopy of >~30,000 faint objects (to i=25.3)
    - Based on estimates from a variety of theory papers
    - Needs a combination of large aperture, long exposure times, and high multiplexing

- Coverage of full ground-based spectral window
    - Ideally, from below 4000 Å to ~1.3μm

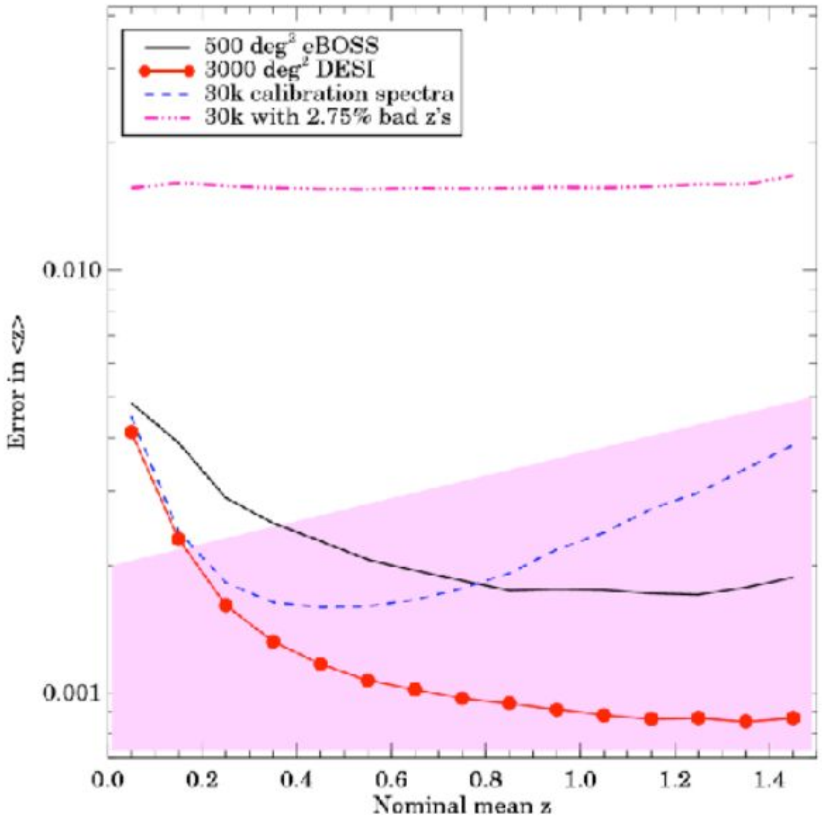
- Significant resolution ($R=\lambda/\Delta\lambda$>~4000) at red end
    - Allows secure redshifts from [OII] 3727 Å line at z>1

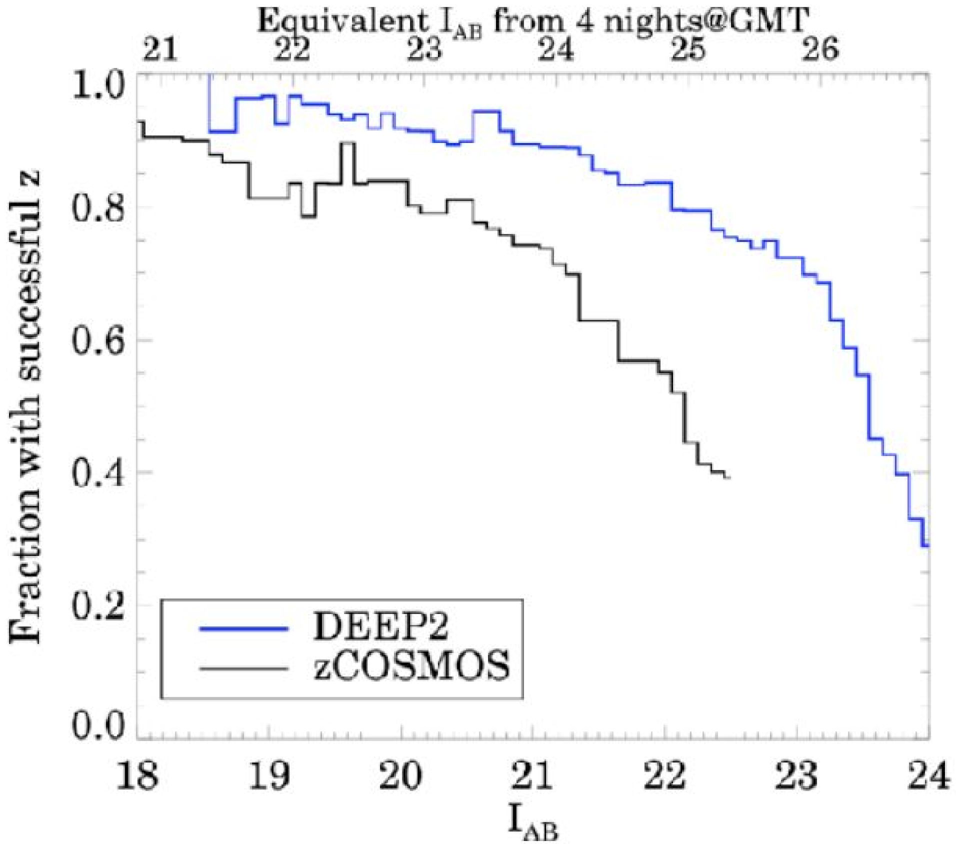
- Field diameters > ~20 arcmin
    - Need to span several correlation lengths for accurate clustering

- Many fields, >~15, to mitigate sample/cosmic variance
    - 15 0.1 deg 2 fields have ~same variance as six 1 deg 2 fields.

- If all of these are achieved, with highly-secure redshifts measured for >99% of targets, the training set can also calibrate LSST at the needed accuracy.

Telescope / Instrument	Total time(y), DES / 75% complete	Total time(y), LSST / 75% complete	Total time(y), DES / 90% complete	Total time(y), LSST / 90% complete
Keck / DEIMOS	0.51	10.2	3.2	64
VLT / MOONS	0.20	4.0	1.3	25
Subaru / PFS	0.05	1.1	0.34	6.9
Mayall 4m / DESI	0.26	5.1	1.6	32
WHT / WEAVE	0.45	9.0	2.8	56
VISTA / 4MOST	0.39	7.8	2.4	48
GMT/MANIFEST+GMACS	0.02 - 0.04	0.42 - 0.75	0.13 - 0.24	2.6 - 4.7
TMT / WFOS	0.09	1.8	0.56	11
E-ELT / MOSAIC	0.02 - 0.04	0.50 - 0.74	0.16 – 0.23	3.1 - 4.7
Keck / FOBOS	0.12	2.3	0.72	14
MSE	0.03	0.60	0.19	3.7
Magellan / MAPS	0.09	1.8	0.56	11

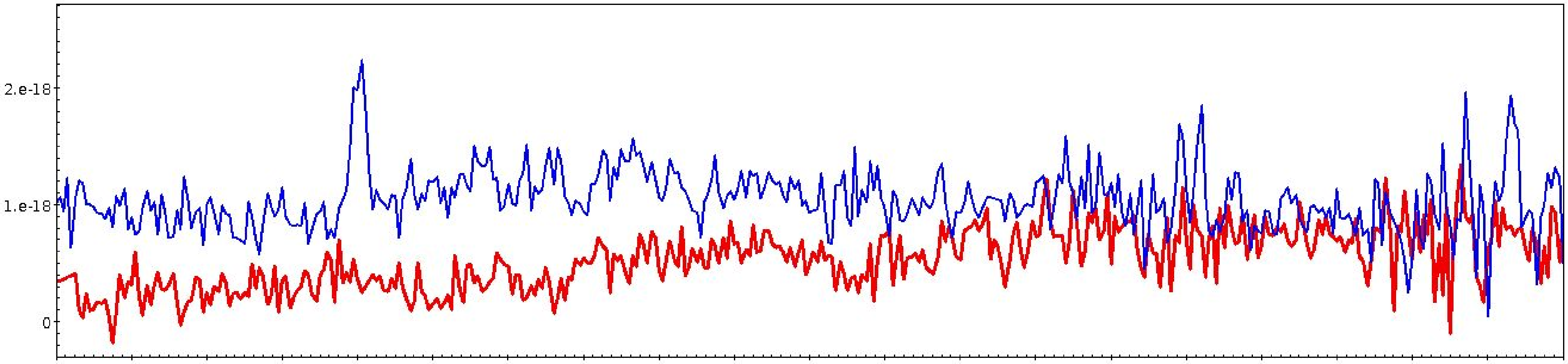




How badly does incompleteness affect our photo-z?

If we cannot obtain the ideal spectro survey, what can we achieve with more modest time allocations?

Why do we fail to obtain a secure redshift?



Features:

- e-line strengths
- break strengths
- stellar mass
- ....

→ confidence classification

Task is to obtain realistic spectral features

Simulation Data Challenges

Three data challenges with increasingly sophisticated and realistic data sets. ugrizy (+NIR) photometry for input to photo-z codes.

DC1: Idealized data (simple error model, no foregrounds, no blending). For DC1 tests we need perfect knowledge of templates/training sets, so we map SEDs to continuous version of Brown empirical spectra. Add emission lines with model based on Beck et al. (2016).
2nd Sim: Buzzard simulations with empirical SEDs from SDSS.

Given perfect knowledge, is there sufficient information in the LSST (+external) images to meet photo-z requirements?

Simulation Data Challenges

Large Synoptic Survey Telescope

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DC2: Add imperfections: systematic photometric errors, incompleteness in spectroscopic training sets (e.g. model failures based on emission lines, stellar mass, restframe color, sSFR), some foreground effects.

What imperfections will we need to address?
(e.g. spatially varying / redshift-dependent completeness in spec.; unknown base templates etc.)

How do we overcome them?

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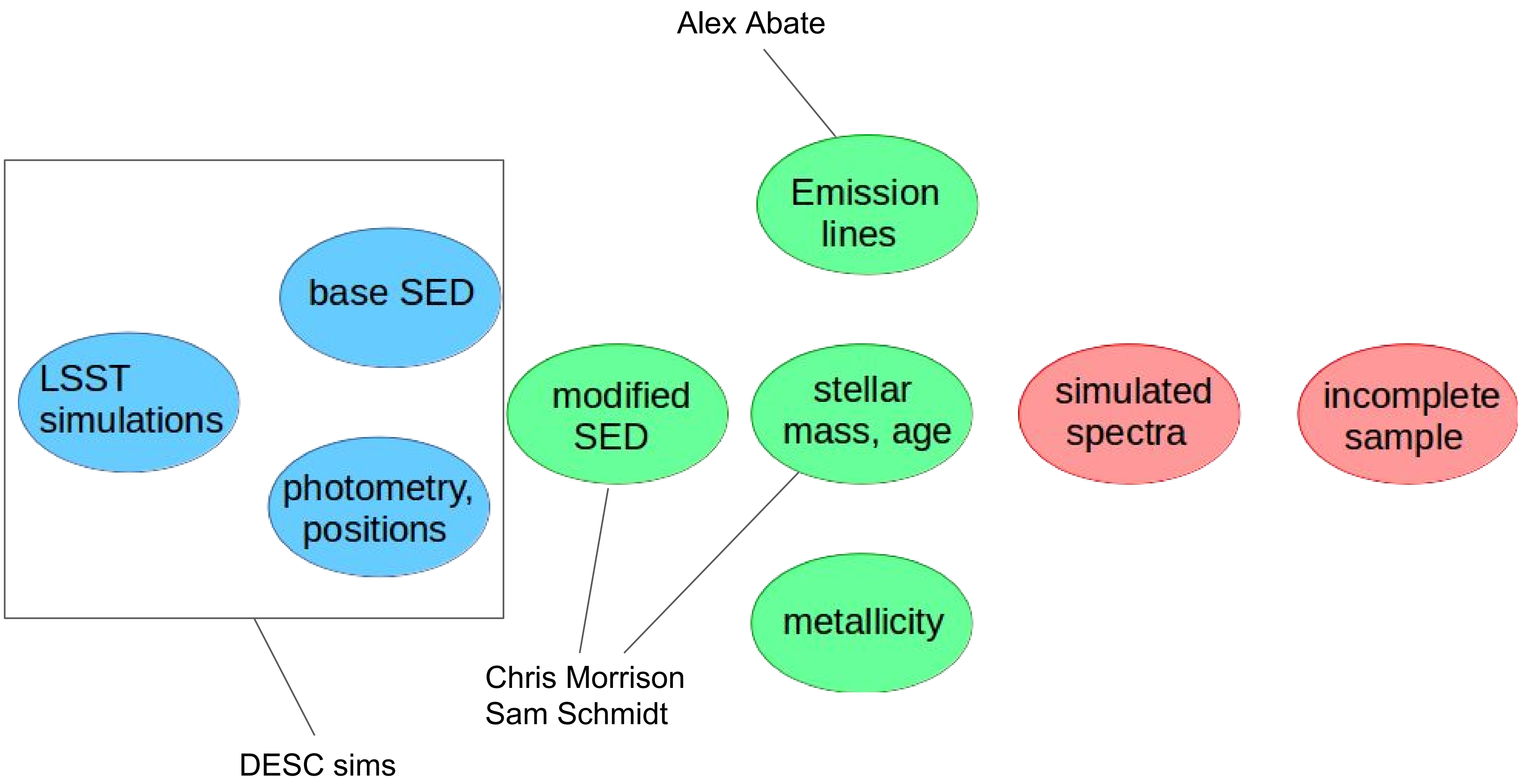
DC3: Full image based simulation, including blending, magnification, foregrounds, improved SEDs.

-> End-to-end pipeline for photo-z computation with improved algorithms (before data start being taken)



Alex Abate
Emission lines
base SED
LSST simulations
photometry, positions
modified SED
stellar mass, age
simulated spectra
incomplete sample
metallicity
Chris Morrison
Sam Schmidt
DESC sims

Un-completing spectroscopy

Large Synoptic Survey Telescope

Random in redshift:

Spatial dependence of success from, e.g. instrument flexure
Blended objects*
Degraded S/N (due to weather / badly inserted slit mask)

Non-random:

Feature stength
Spectral window
Instrumental weaknesses (e.g. VIMOS fringing)
Sky
Instrument resolution
(Nervous observers)