Using Subaru PFS to support DESI+LSST+CMB S4

- Based on an off-comment buried somewhere in CVDE document
- All numbers are approximate (and obtained by a theorist)

- Uros Seljak UCB/LBNL (with help from Rachel Mandelbaum, CMU)

PFS Subaru survey

- Subaru PFS BAO survey: 1400 square degrees of HSC imaging, 2 exposures per field, 1.3 degree FOV, 2400 fibers, 100 clear nights
- Estimated half of the targets will be DESI targets: can PFS BAO be done with 1 visit per field? Would they be interested in this option? Would/could DESI frontload HSC area?
- Near IR is unique advantage of PFS: $650\text{nm}<\lambda<1260\text{nm}$

Extending PFS survey

- Subaru time may be for sale at 100k$/night
- There is 4000 square degrees overlap between DESI and LSST (and 5000 between Subaru and LSST)
- Assuming 30 degrees per clear night and 4000-1400=2600 square degree area we get 85 nights to cover with a single exposure. This becomes of order 115 nights with weather losses. So of order 10M$ investment.
- If PFS team can be convinced of doing their survey the same way then one would do 4000 square degrees on PFS with a single visit with 177 nights total (133 clear nights), of which 133 presumably already guaranteed by PFS: additional investment of 40-50 nights, 5M$ investment
- Targets beyond HSC 1400 sq. degrees would be drawn from LSST with $z>1.3$ to complement DESI targets (mostly $z<1.3$): timing should work

Science: spectroscopy

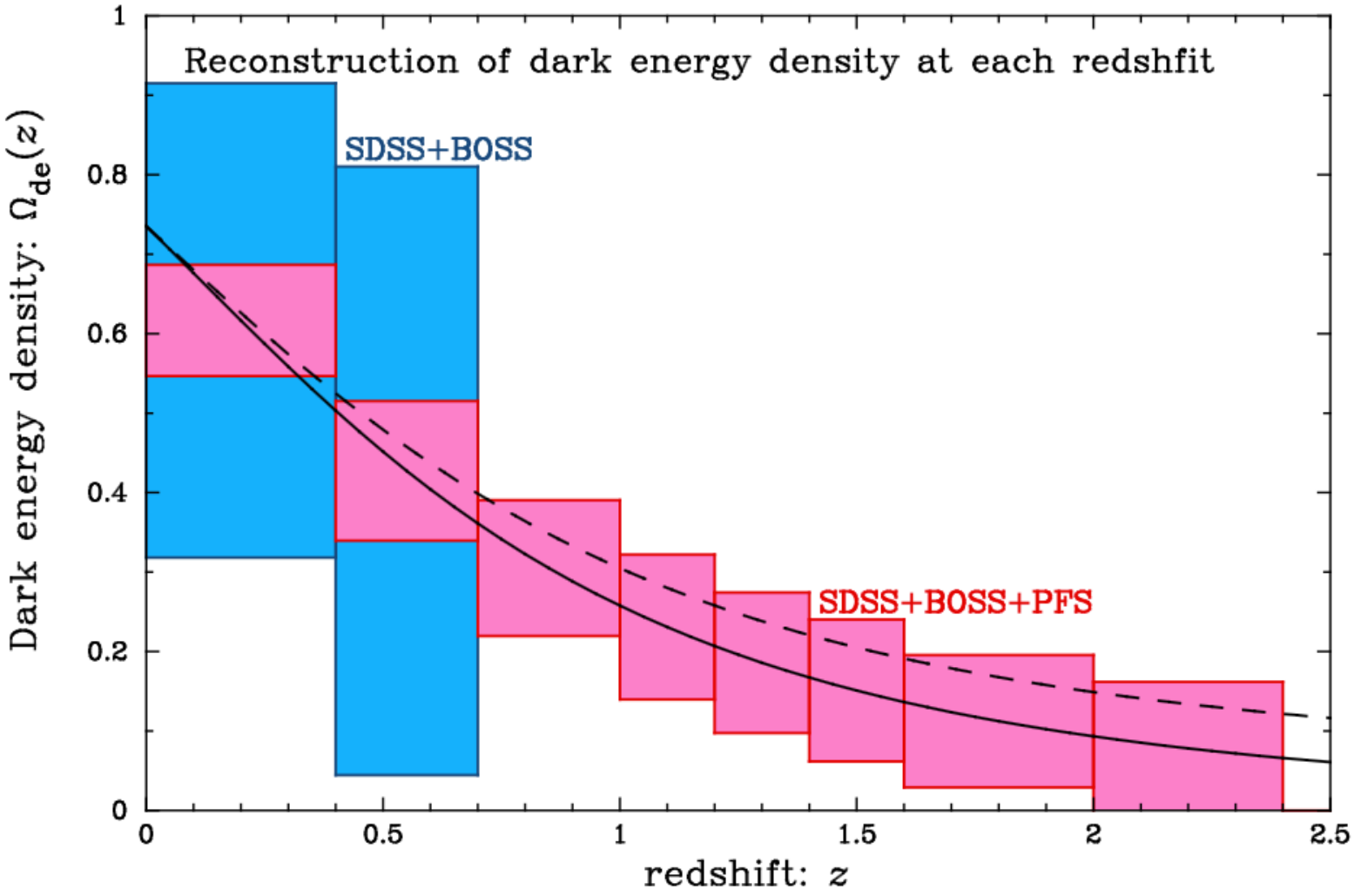
- Effective volume is 20(Gpc/h)^3 = (1.19+2.58+2.71)*3
- Number of targets: 4000*1600=6.4M
- at z=2 nP=1 at k=0.1h/Mpc
- For comparison: DESI 14k z<1.3 30(Gpc/h)^2
- Complementary to DESI, combined volume of 50(Gpc/h)^3
- Takada etal 2013

TABLE 2
PFS COSMOLOGY SURVEY PARAMETERS

redshift	$V_{\rm survey}$ [Gpc/h]^3	N_g per field	$\bar{n}_g$ [$10^{-4}(h/{\rm Mpc})^3$]	bias b_g	$\bar{n}_g P_g(k)$ $k = 0.1h/{\rm Mpc}$	$\bar{n}_g P_g(k)$ $k = 0.2h/{\rm Mpc}$
$0.6 < z < 0.8$	0.59	85	1.9	1.18	0.74	0.25
$0.8 < z < 1.0$	0.79	358	6.0	1.26	2.23	0.74
$1.0 < z < 1.2$	0.96	420	5.8	1.34	2.10	0.68
$1.2 < z < 1.4$	1.09	640	7.8	1.42	2.64	0.87
$1.4 < z < 1.6$	1.19	491	5.5	1.50	1.78	0.59
$1.6 < z < 2.0$	2.58	598	3.1	1.62	0.95	0.31
$2.0 < z < 2.4$	2.71	539	2.7	1.78	0.76	0.25

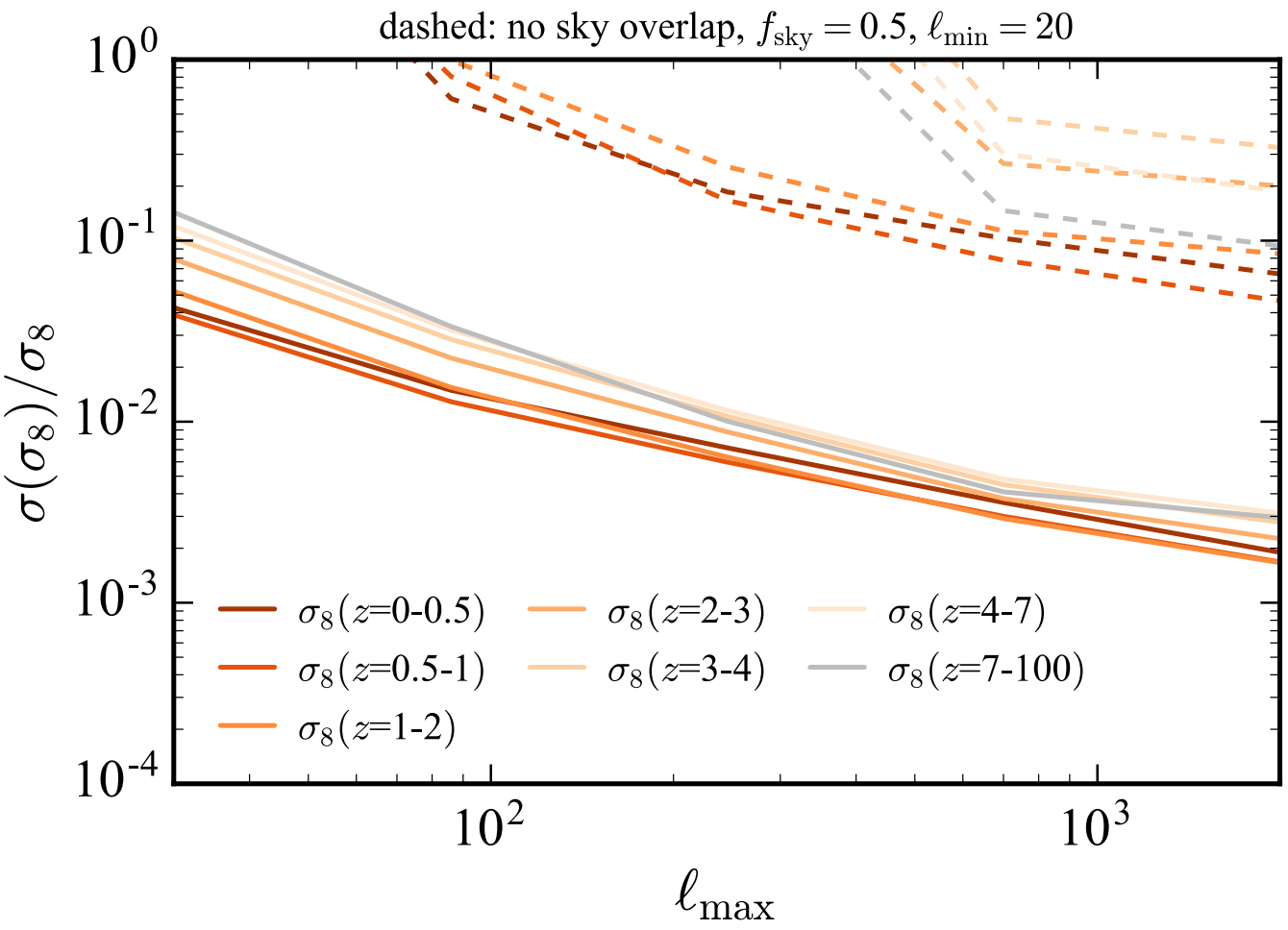
Dark energy at z>1.3

- Reduce the error by $3^{1/2}$



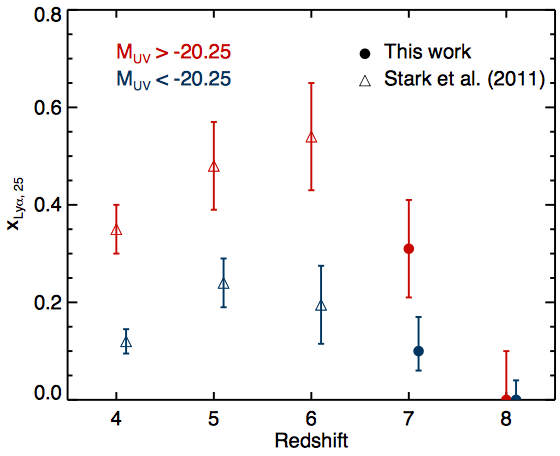
Calibration of LSST photozs

- **LSST+CMB S4 lensing can measure $\sigma_8(z)$ to sub-percent**
  (Schmittfull & US 2017)



Photoz calibration with clustering

- clustering cross-correlation analysis, we do not need high precision on z, just a reliable dn/dz
- we may not need high significance spectroscopy, probabilistic spectroscopic redshifts may suffice for cross-correlations
- Target selection strategies may differ from DE goals: more uniform redshift distribution, even if lower number density?
- Targets may include Lya emitters using u and g dropouts: at the faint end the fraction of dropouts with Lya emission increases
- Schenker etal 2014



Summary

- This small scale project will enhance DE knowledge at z>1.3
- It complements DESI, LSST and CMB S4. It exploits synergies between all these surveys so that the sum is more than each part
- Cost estimate: 5M$ if done jointly with PFS team, 10M$ otherwise
- Timeline: when PFS comes online and LSST produces targets
- Technical obstacles: PFS ETC (estimated time calculator) needs to be checked. Optimal target strategy TBD. International agreement of data sharing and purchase of 50 nights if jointly with PFS survey, otherwise agreement of purchase of 100-120 nights.