

- **You want me to talk about calibrating photo-zs using the observable with the worst possible redshift resolution??**
- Of course adding any two Fisher matrices generally reduces the errors on all parameters.
- One may hope that when cross-correlating a galaxy lensing survey with CMB lensing in the same area of sky there is some extra gain.
- I will do some ~pedagogical exploration of LSST x CMB lensing with emphasis on relevance of photo-z errors.

# How to think about photo-zs

- Things like number density and bias (shear bias?) are generally functions of both true and photo-z.
- I think it is useful to think about them that way and then understand what priors you are imposing.

$$b(z_t, z_p) \rightarrow b(z_t)$$

$$n(z_t, z_p) \rightarrow \exp\left(-\frac{(z_t - z_p - \Delta_z)^2}{2\sigma_z^2}\right)$$

- $\Delta_z$  and  $\sigma_z$  are free parameters in each of my z bins representing systematic error in mean and rms of photo-z estimation.  $b(z)$  is also free in each bin.

- Base of  $\sim$ LSST galaxies in  $dz=0.2$  (photo and true) bins with  $z<2$ .
  - Include all correlations of density and lensing.
  - $k<0.1$  h/Mpc for density,  $l<500$  for lensing.
  - fiducial  $\sigma_z = 0.05(1 + z)$
- My “CMB lensing” is an extra zero-noise source plane at CMB  $z$  (not “CMB-S4”, but very clear what is added).
- Always include no-lensing Planck Fisher and DESI BAO.

- Who cares actually about nuisance parameters — tell me cosmological parameter improvements (for a relevant set of experiments and parameter space).

base+	photo-z errors?	FoM
LSST	N	336
LSST + CMBL	N	562
LSST	Y	231
LSST + CMBL	Y	337

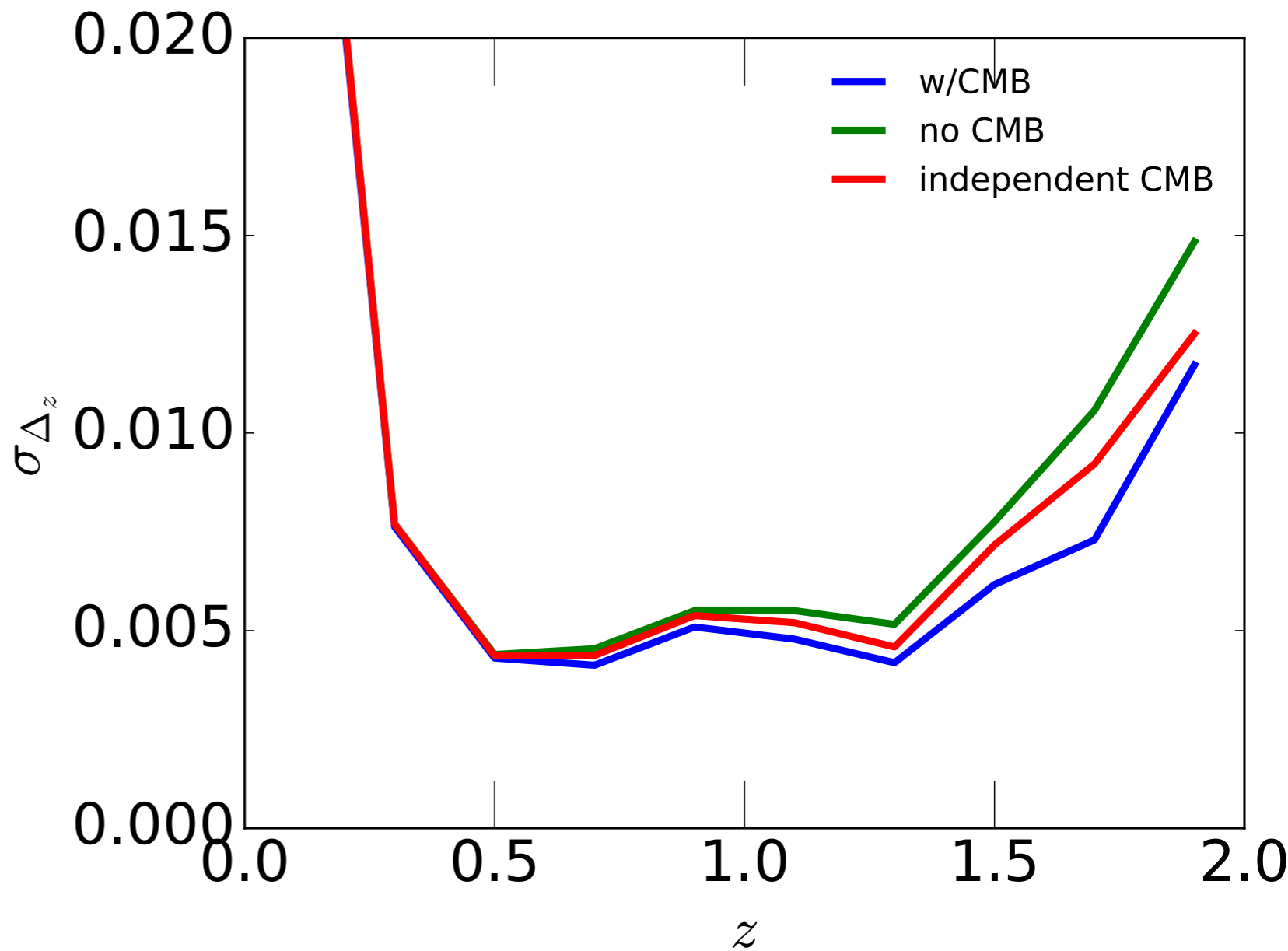
TABLE I. FoMs for different scenarios. All include Planck ( $\sigma_\tau = 0.009$ ) and DESI BAO. Standard DE FoM except marginalized over neutrino mass.

- Mostly photo-z errors are just bad, although maybe surprisingly un-fatal. If anything CMBL adds less when you have them.
- Almost entirely from mean shift (width harmless).

- Maybe you're more interested in neutrino mass...

base+	photo-z errors?	$\sigma_{m_\nu}$ [eV]
LSST	N	0.021
LSST+CMBL	N	0.020
LSST	Y	0.027
LSST+CMBL	Y	0.022

- Marginalized mean shift errors, FoM scenario.
- Neutrino mass case almost identical.



# Conclusions

- Photometric surveys and CMB lensing are complementary, sometimes more so with photo-z uncertainty.
- Not clear it is useful to think of this as CMBL calibrating photo-zs.
- This is a toy calculation, intended to stimulate thinking about more complete ones.
- Preliminary - I don't guarantee bug-free.