Inflation and dark energy from high redshift spectroscopy

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BERKELEY CENTER *for* COSMOLOGICAL PHYSICS

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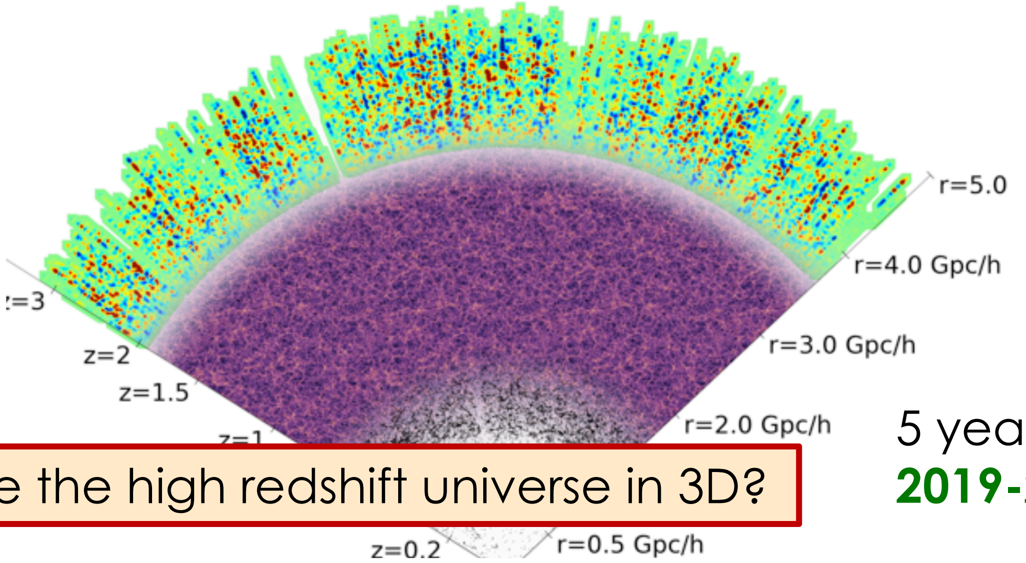
Present: DESI

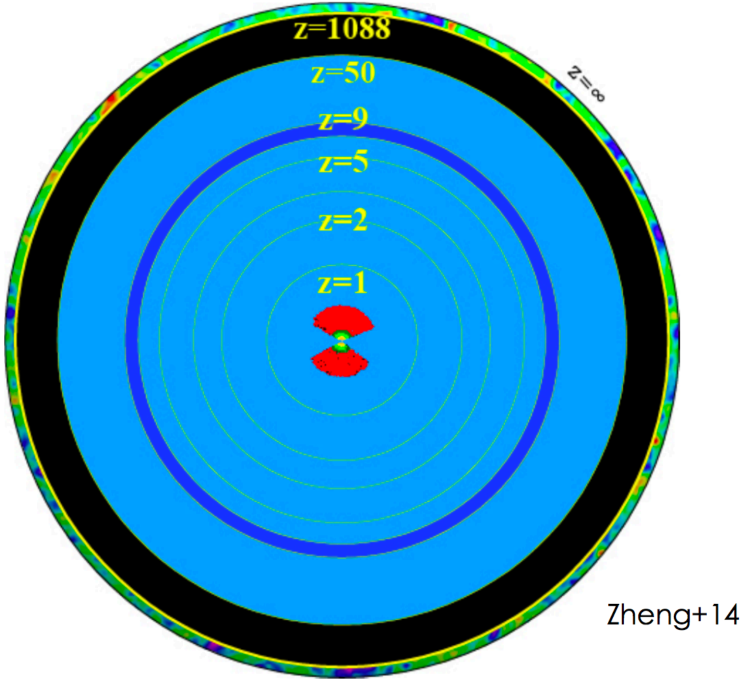
5000 fibers
- 6 Million **LRG** $0.1 < z < 1$
- 17 Million **ELG** $0.1 < z < 1.6$ ([OII] doublet)
- 2 Million **QSO** $z < 3.5$ + Ly-α forest
- +10M bright galaxies at low z (BGS)

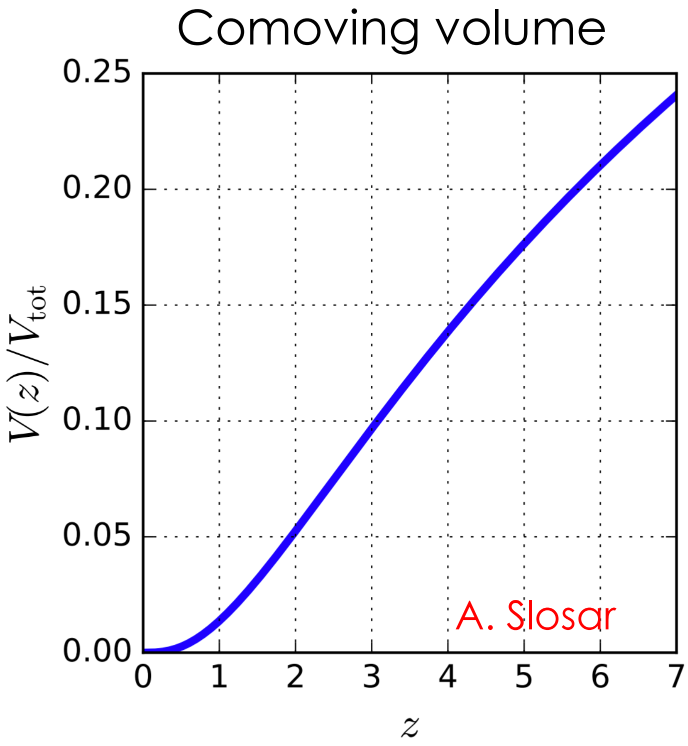


How to measure the high redshift universe in 3D?

5 years
2019-2024

Why high redshift?

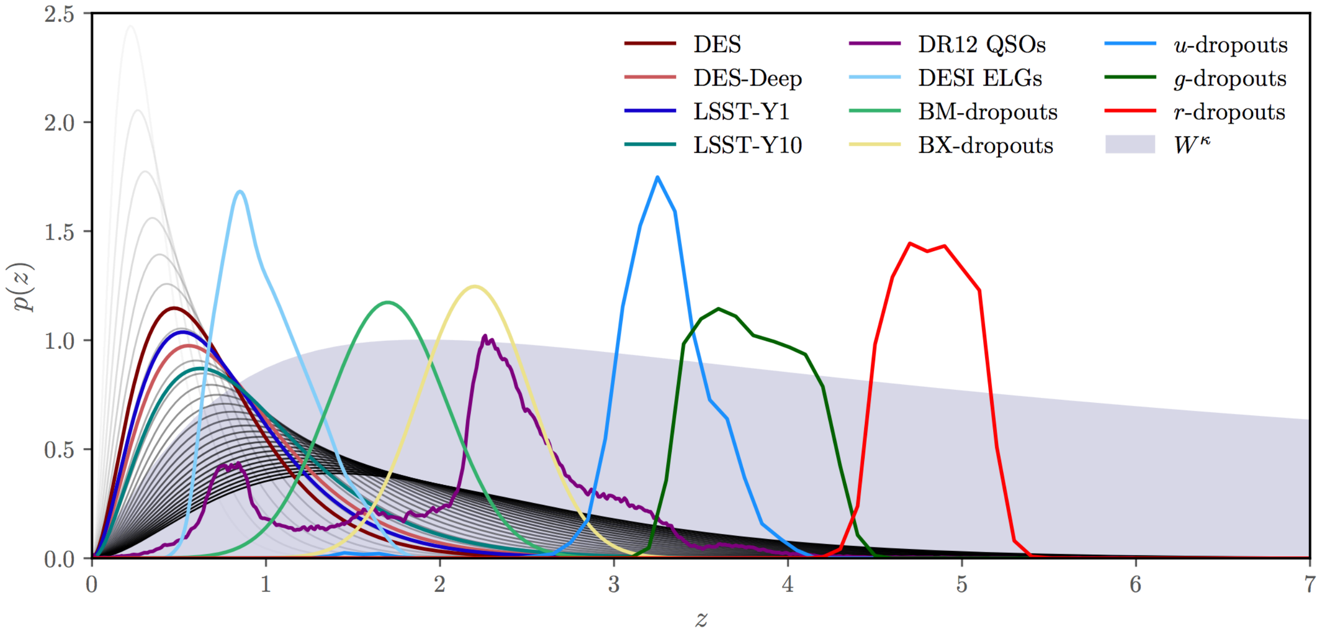




<u>Number of modes ~ Volume</u>

Can more than quadruple the available volume by observing to z ~ 5.5

Galaxies at high redshift from LSST

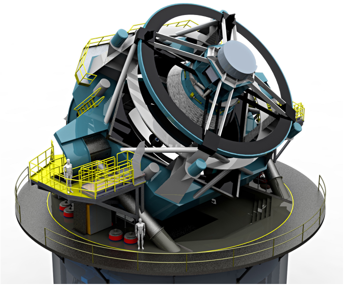


Cosmology with dropout selection: Straw-man surveys & CMB lensing

M. J. Wilson[a,b] and Martin White[a,b,c]

M. J. Wilson & M. White (2019)

Number densities from LSST imaging



Dropout selected galaxies (target sample, m_{UV} = 24.5)

z	$n(z)$ [$10^{-4}\,h^3\,\mathrm{Mpc}^{-3}$]	$b(z)$		z	$n(z)$ [$10^{-4}\,h^3\,\mathrm{Mpc}^{-3}$]	$b(z)$
2.0	25	2.5		4.0	1.5	5.8
2.5	12	3.3		4.5	0.8	6.6
3.0	6.0	4.1		5.0	0.4	7.4
3.5	3.0	4.9				

Successful redshifts with DESI spectrograph (360-980nm) on a 6.5m telescope

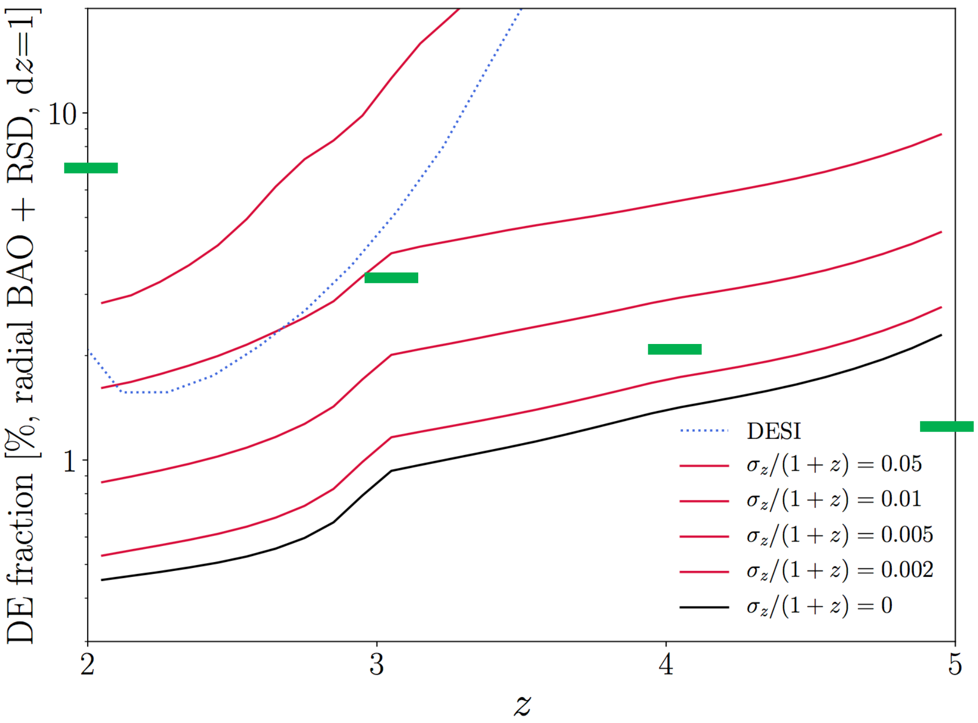
z	$n(z)$ [$10^{-4}\,h^3\,\mathrm{Mpc}^{-3}$]	$b(z)$		z	$n(z)$ [$10^{-4}\,h^3\,\mathrm{Mpc}^{-3}$]	$b(z)$
2.0	9.8	2.5		4.0	1.0	3.5
3.0	1.2	4.0		5.0	0.4	5.5

Success rate ~ 1/3 to 1/2

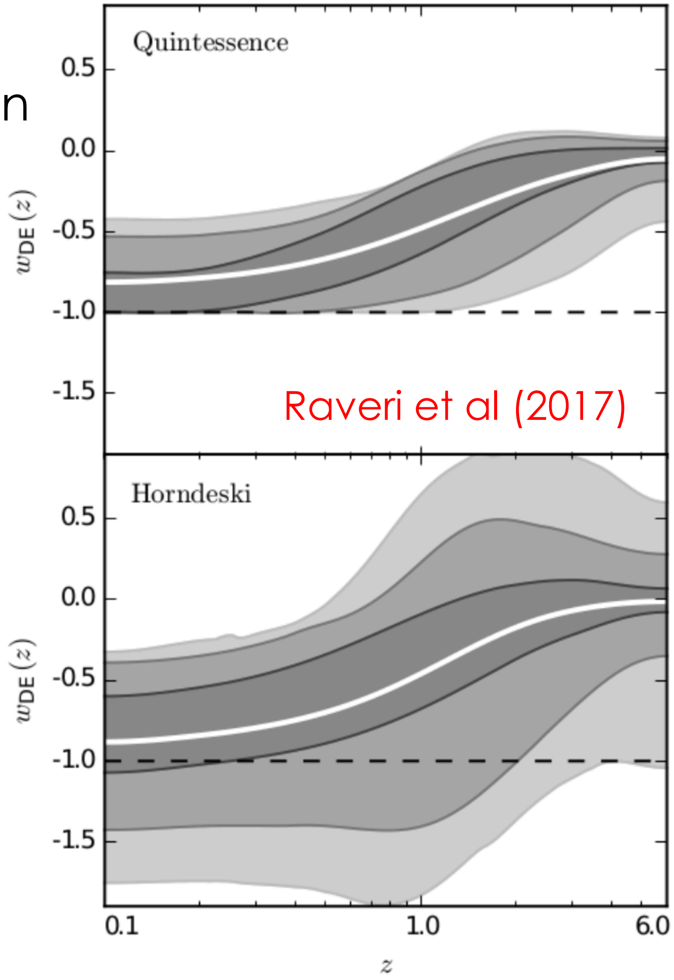
S.F., M. J. Wilson et al (2019)
M. J. Wilson & M. White (2019)

Dark Energy

= LCDM prediction



S.F., Mike Wilson et al (2019)



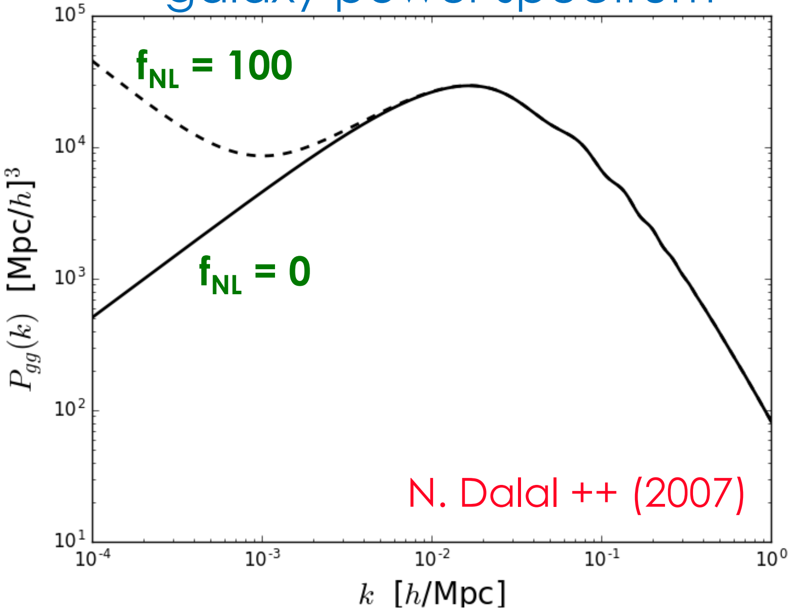
(local) Primordial non-Gaussianity

INFLATION
- **single field** → Gaussian fluctuations $f_{NL} \ll 1$
- **multi-field** → Non-Gaussian fluctuations $f_{NL} \gtrsim 1$

Generates *scale dependent* bias:

$$\delta_g = \overbrace{\left(b_g + \alpha \frac{f_{NL}}{k^2} \right)}^{\textbf{bias}(k)} \delta_m$$

galaxy power spectrum



Primordial non-Gaussianity

$\sigma(f_{NL}) \propto V^{-2/3}$ from the power spectrum

$\sigma(f_{NL})$ Fiducial / Idealised	P	$+B$	+ External	Current (Planck)	Photo-z degradation
Local	$\boxed{0.75 / 0.63}$	0.11 / 0.073	0.11 / 0.073	5	$\times 3$
Equilateral	–	43 / 23	23 / 18	43	$\times 4$
Orthogonal	50 / 33	8.8 / 5.0	7.5 / 4.7	21	$\times 3$

Warning: Large-scale systematics very challenging!
Cross-correlations can help

S.F., Mike Wilson et al (2019)

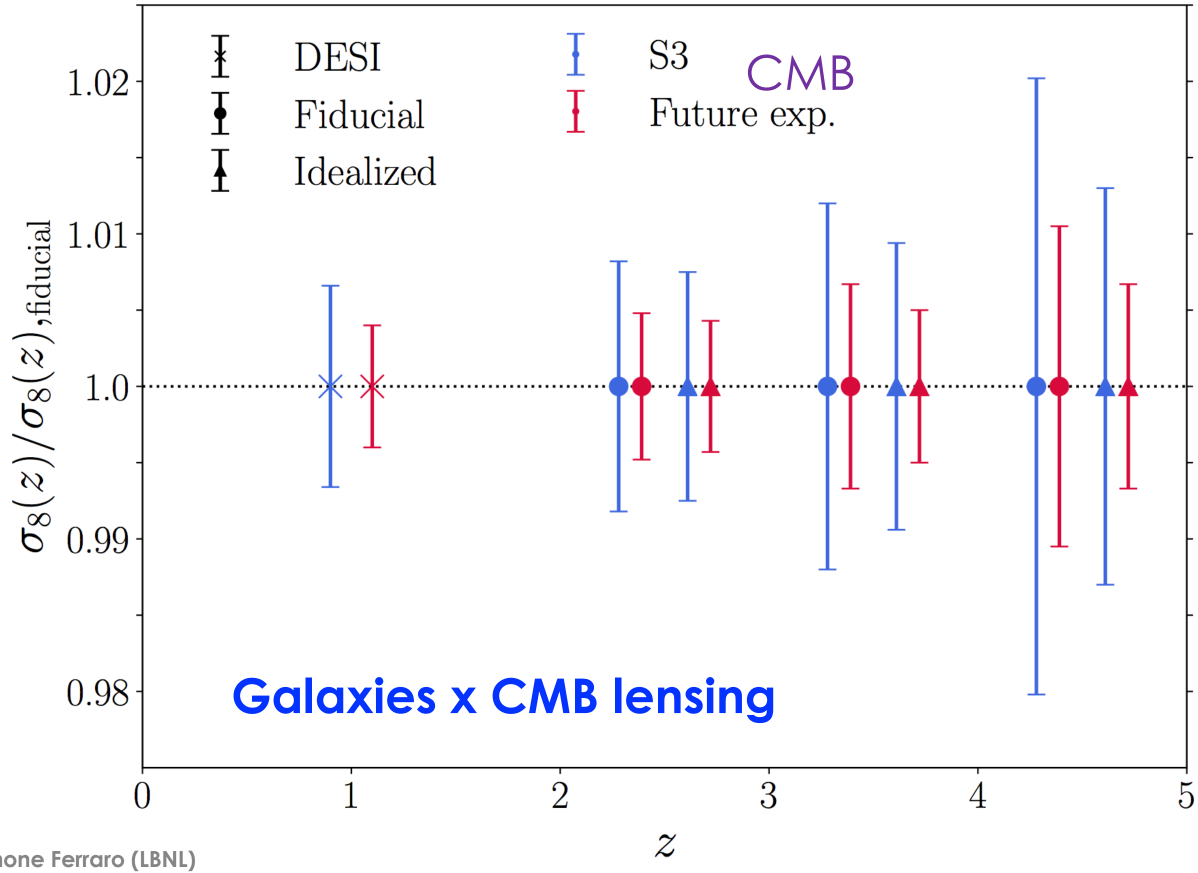
Cosmological parameters

Parameter	σ(parameter) Fid./Ideal.	DESI
Curvature $\Omega_K/10^{-4}$	6.6 / 5.2	12.0
Neutrinos $\sum m_\nu$	0.028 / 0.026	0.032
Spectral index n_s	0.0026 / 0.0026	0.0029
Running α_s	0.003 / 0.003	0.004
Rel. species N_{eff}	0.069 / 0.069	0.078
Gravitational slip	0.008 / 0.008	0.01
D.E. FoM	398 / 441	162

Can relax many restrictive assumptions about the model and initial power spectrum (see Eric Linder's talk)

S.F., Mike Wilson et al (2019)

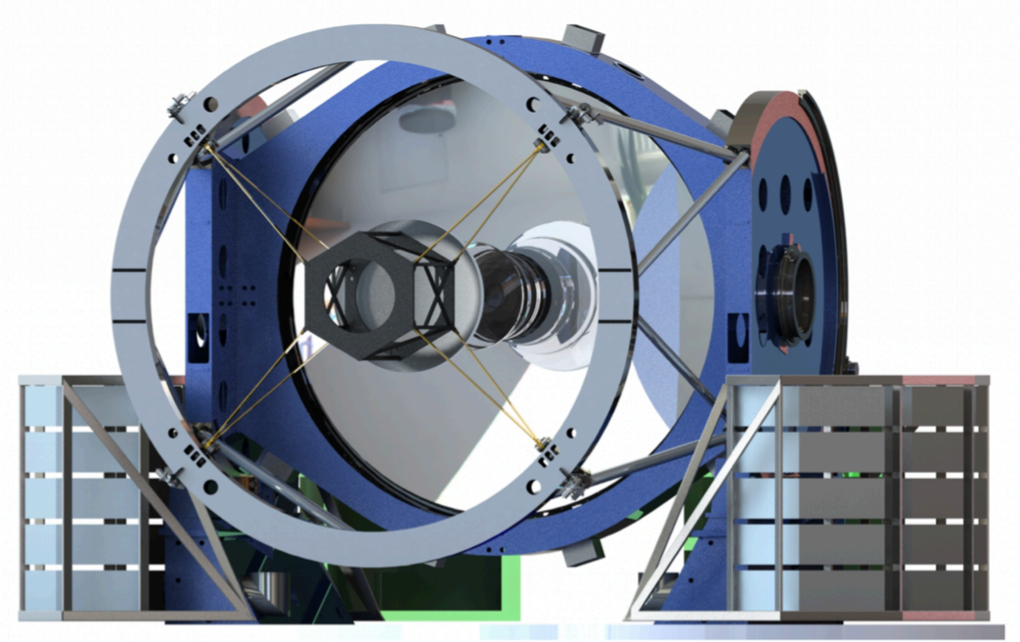
Mapping the growth of structure



- ~1% constraint on amplitude up to z ~5
- Neutrino mass without CMB optical depth

S.F., Mike Wilson et al (2019)
B. Yu et al (2018)

MegaMapper: a proposal

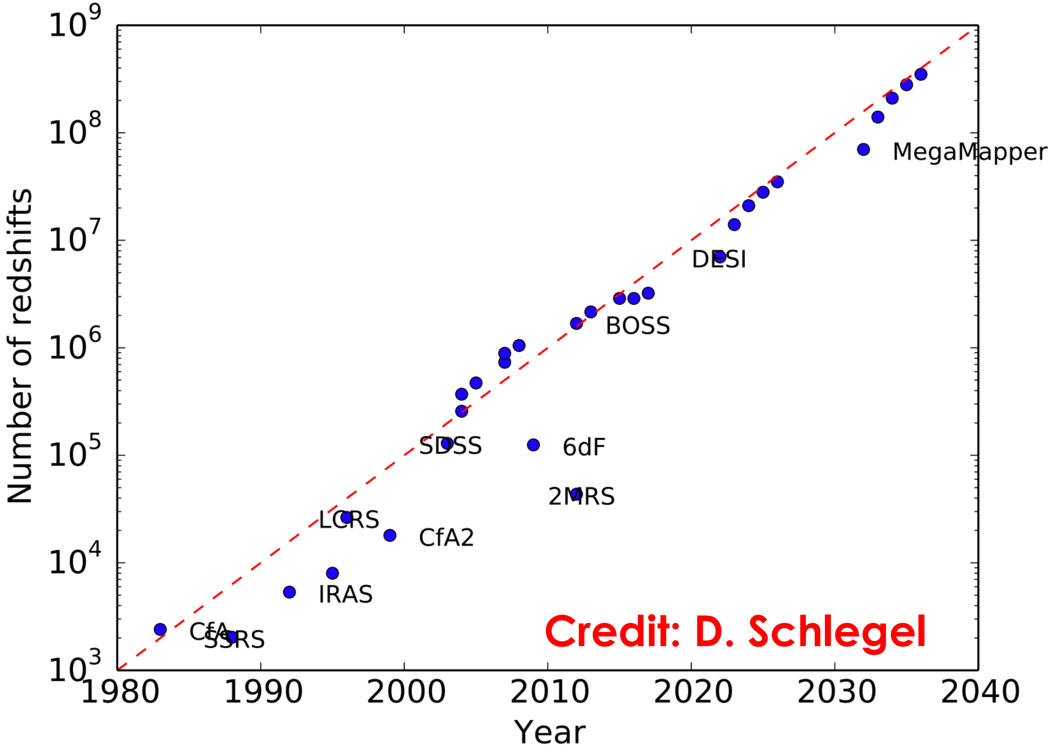


- Magellan-type telescope
- 6.5m primary mirror
- Wide FOV (> 3.5 sq deg)
- 20,000 fibers with robotic positioners
- 36 DESI-like spectrographs (16 already existing: DESI + SDSS-V). Range 360 – 980nm
- R = 2000 (blue) – 5500 (NIR)
- Las Campanas Observatory in Chile

Designed to be <u>cost effective & proven technology</u>

Schlegel, Kollmeier et al (2019)

Spectra Moore's law



Thanks !

Other designs: SpecTel, Keck/FOBOS, MSE, …. or 21cm intensity mapping (Puma, …)