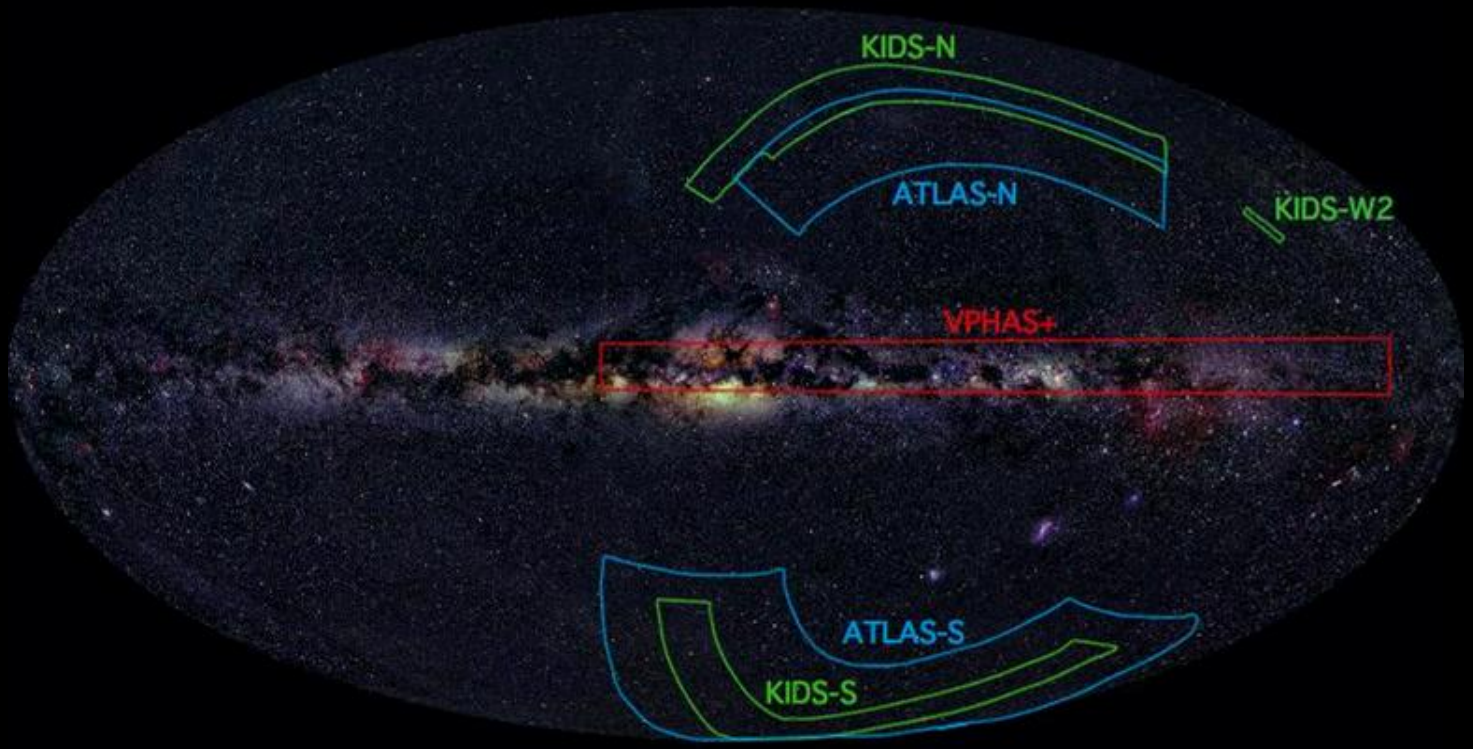
Extragalactic imaging surveys with VST and VISTA

Konrad Kuijken

Leiden Observatory

ESO's VST public surveys

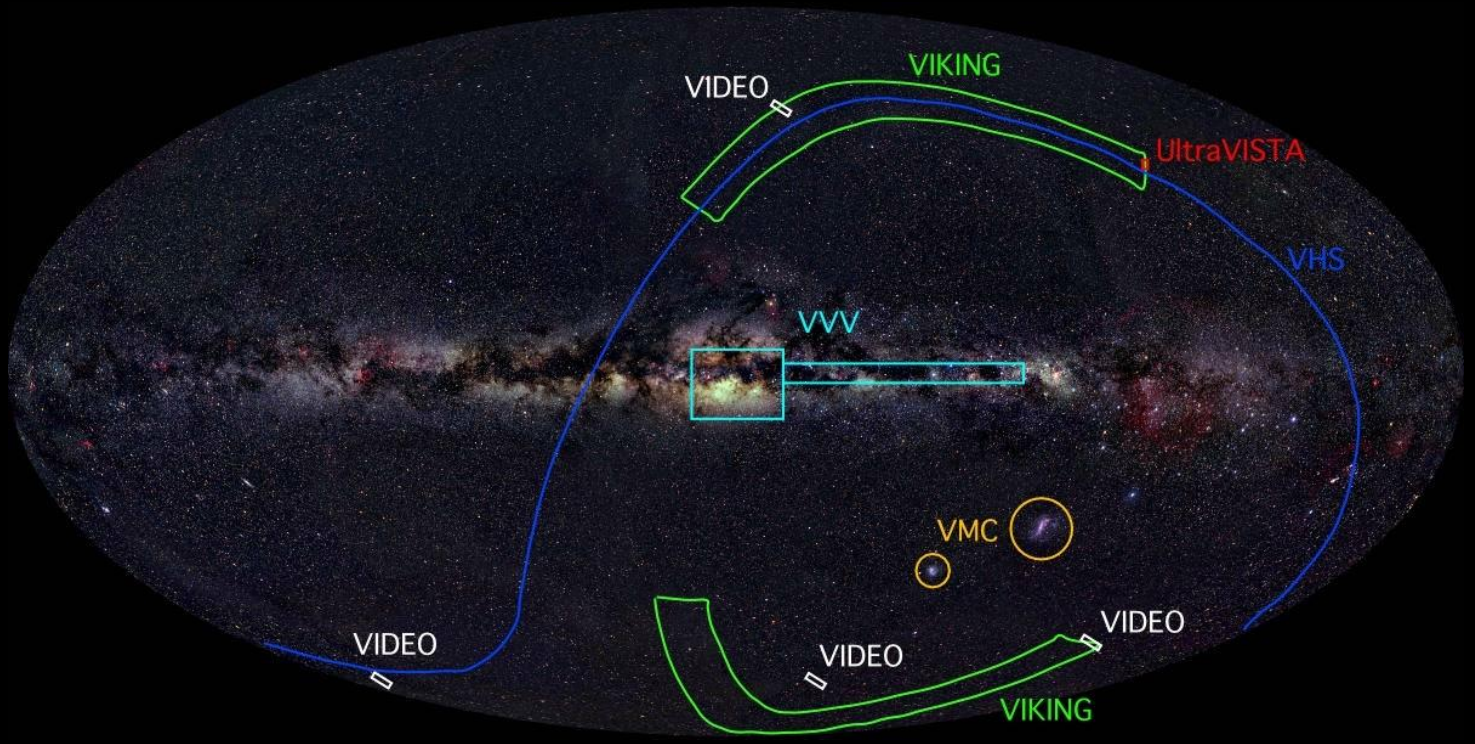


VPHAS+: galactic plane Uvx, Hα

ATLAS: Southern Sloan

KiDS: Deep/wide lensing survey

ESO's VISTA public surveys



UltraVISTA: very deep COSMOS field

VVV: Milky Way bulge/disk

VIDEO: SWIRE fields

VHS: shallow hemisphere map

VMC: Clouds

VIKING: KiDS-IR

KiDS

LEIDEN GRONINGEN MUNCHEN PARIS NAPLES BONN EDINBURGH CAMBRIDGE IMPERIAL

- Big astronomical survey, starts in 2009;
  - 1500 square degrees map (= area of South America on Earth globe)
  - Many applications incl. studying dark matter and dark energy

- Will use millions of ordinary galaxies as `lenses'
  - Average signal $\rightarrow$ high accuracy
  - Determine redshifts from colours measured with 9 filters
- Measure ripples from galaxy distribution on sky

- Cf. Sloan Survey:
  - Images 2 x sharper (equiv to map of Earth at 6m resolution!)
  - Will include sources 6 x fainter

- Data volume: 15 terabyte pixel data, +++
  - Astro-WISE data archiving / processing system (with EU funding)
  - Large team!

PARANAL OBSERVATORY

250 nights

440 nights

VISTA

4m telescope

0.6 sq.deg. InfraRed camera

16 2kx2k detectors

0.35” pixels

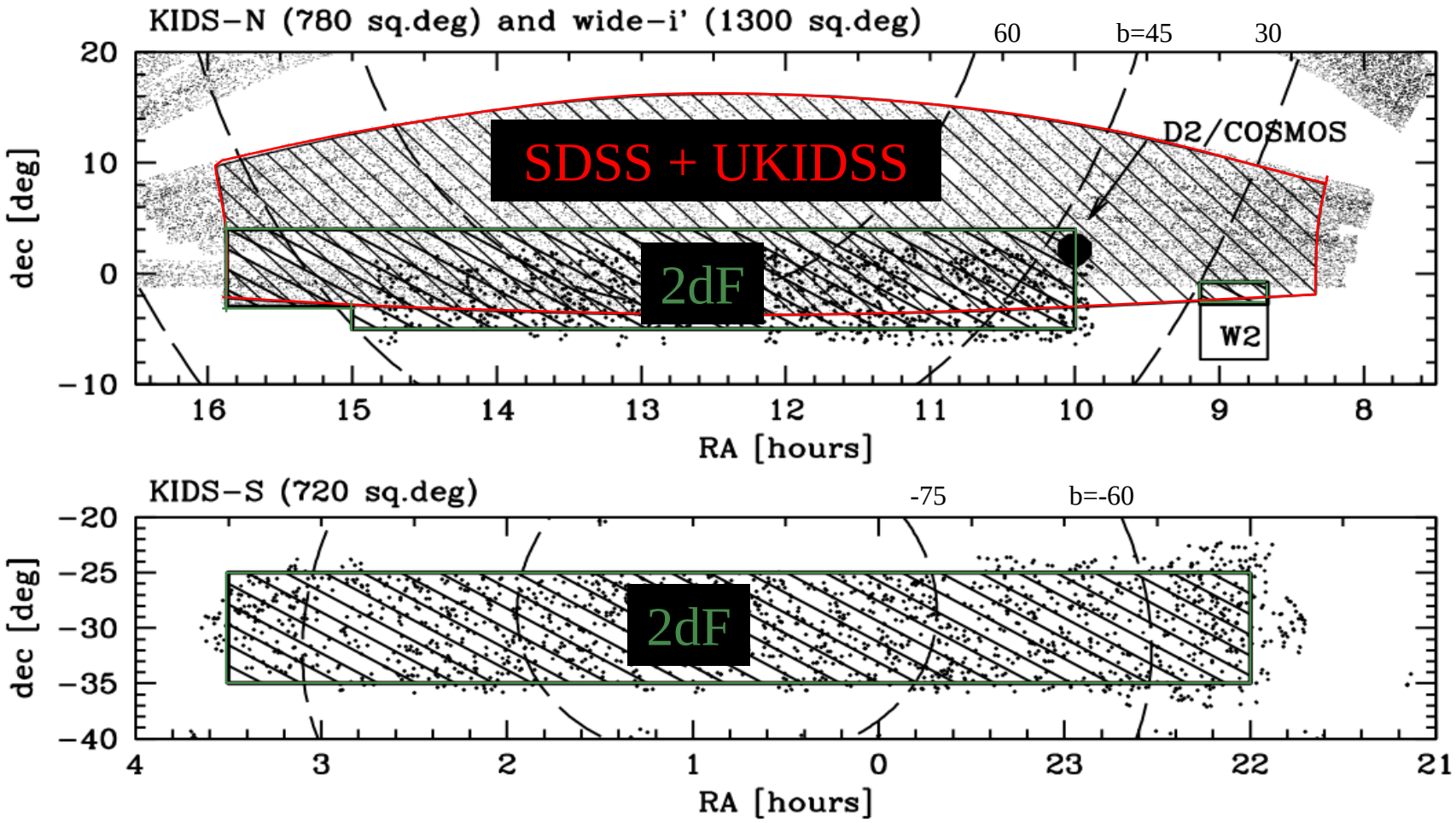
VST

2.6m telescope

1 sq.deg. optical camera (OmegaCAM)

32 2kx4k detectors

0.21” pixels



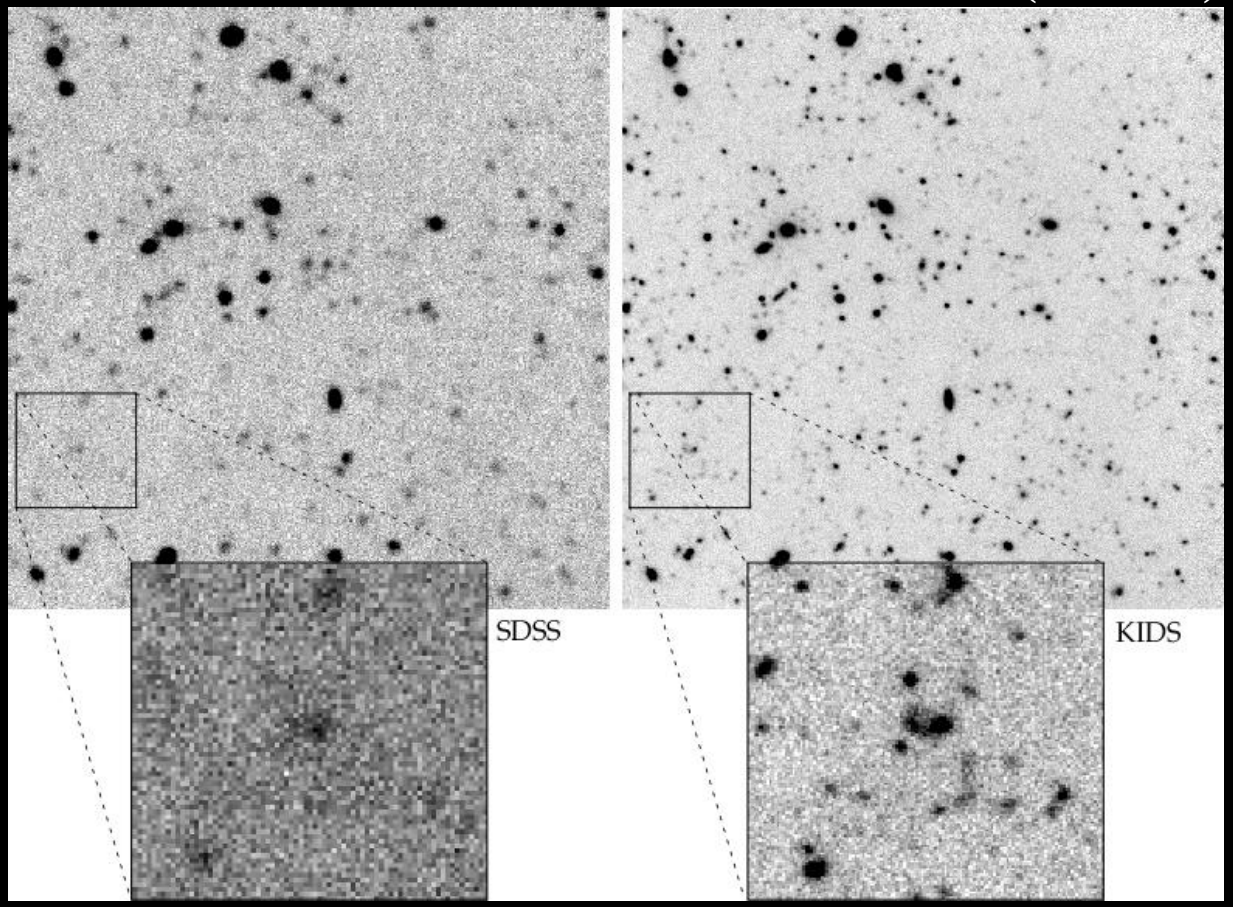
1500 sq.deg. in ugriZYJHK

+2000 sq.deg. in i (+UKIDSS YJHK)

KIDS vs. SDSS, CFHTLS

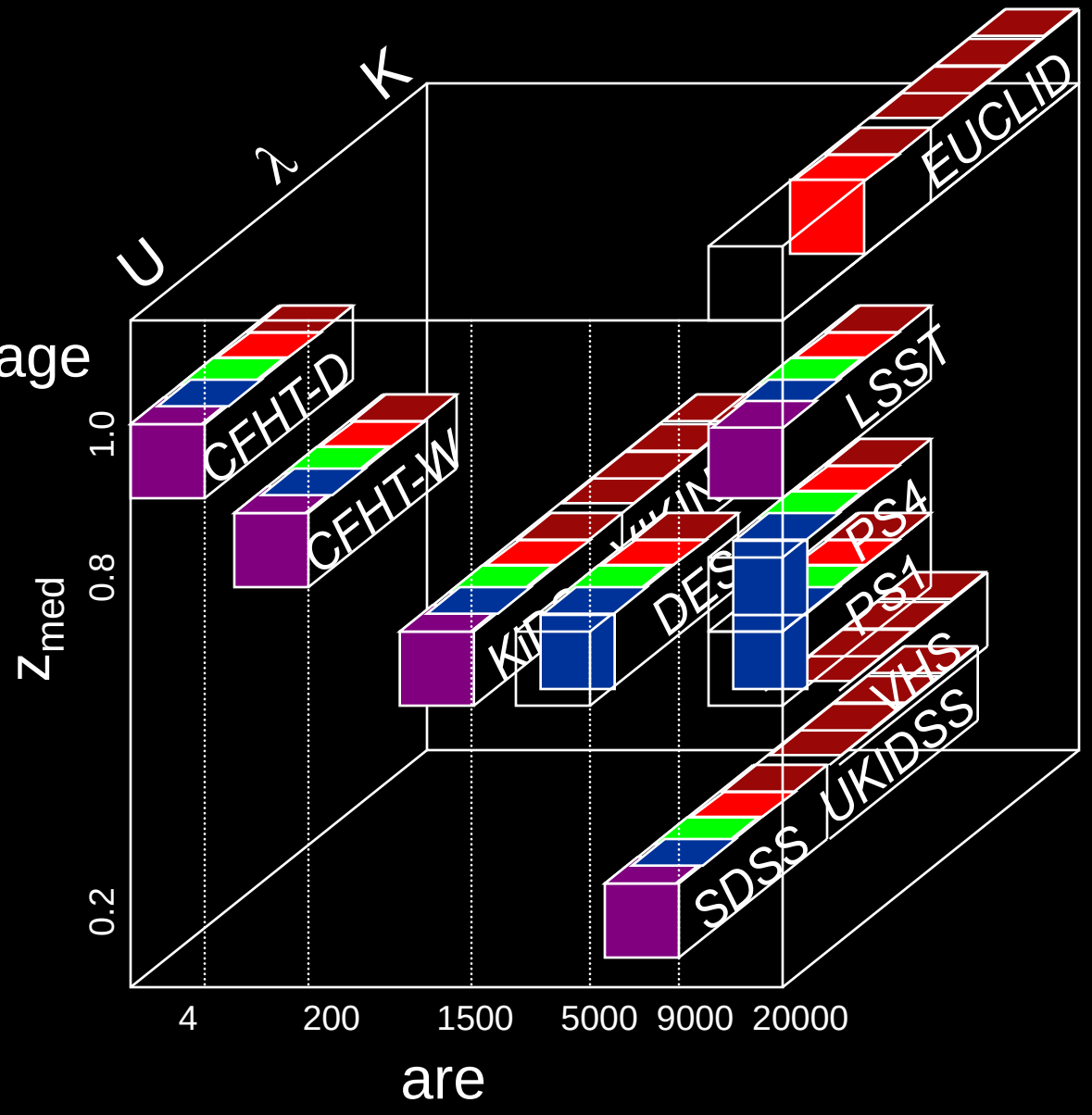
SDSS	CFHTLS
6 x area	1/9th area
2 mag shallower	1 mag deeper
2x worse seeing	~same

(M.Neeser)



Survey parameters

- Area covered
- Median redshift
- Image quality
- Wavelength coverage



KIDS + VIKING

- VST/OmegaCAM: 1 sq deg, 2.6m telescope
- VISTA/VISTACAM: 0.6 sqdeg, 4m telescope
- 1500 sq.deg. of ugri (~400n VST)
  + ZYJHK (~200n VISTA)
- Deeper in r, with good seeing
- VST 2m deeper than SDSS
  (1m shallower than CFHTLS)
- VISTA 1.5m deeper than UKIDSS

filter	Exp (s)	5-σ 2" AB	cf. UKIDSS
Z	500	23.1	-
Y	400	22.4	+1.6
J	400	22.2	+1.8
H	300	21.6	+1.6
K	500	21.3	+1.3

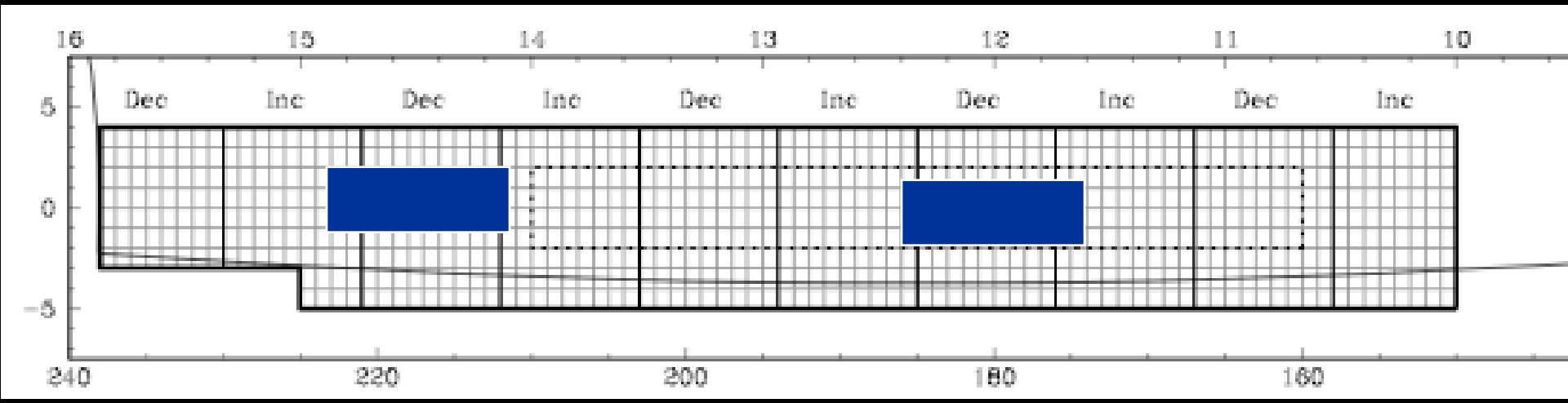
	<0.7" (40%)	0.7-0.85" (20%)	0.85-1.1" (20%)
Dark (50%)	**r'**	**g'**	**u'**
Grey (15%)	**-**	**-**	**-**
Bright (35%)	**i'**	**i'**	**i'**

filter	Exp time (s)	Medn seeing (")	5-σ 2" AB
u'	900	1.0	24.8
g'	900	0.75	25.4
r'	1800	0.6	25.2
i'	1080	0.75	24.2

GAMA Galaxy And Mass Assembly

- Redshift survey to r=19.8
  - 2,000 gals/sq.deg.
  - 140 sq.deg. Total
  - AAΩ 2008-2010
- Add to 2dF and SDSS spectra in hand !

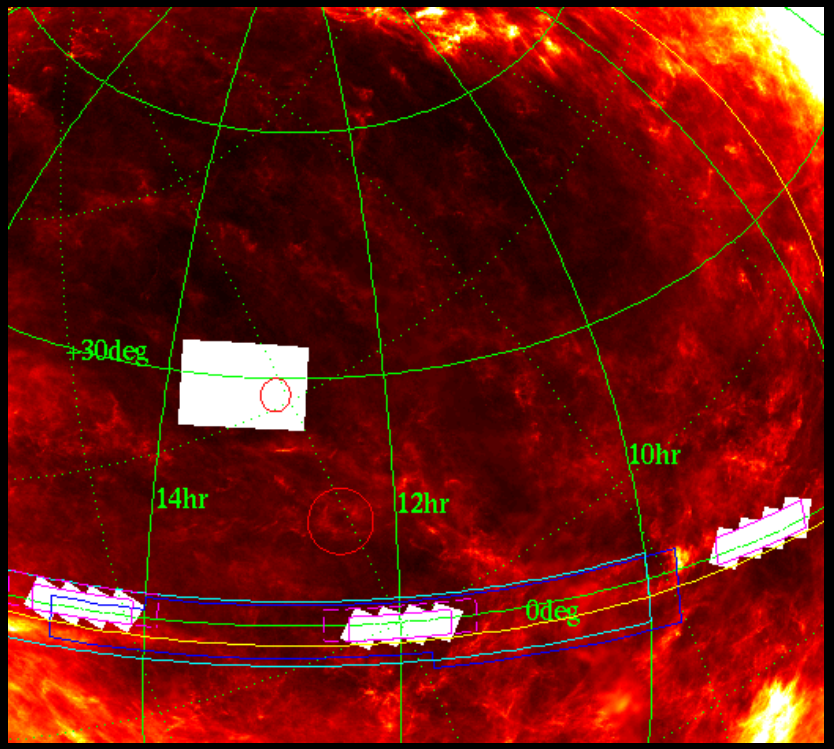
March: 15 nights,
35000 redshifts!

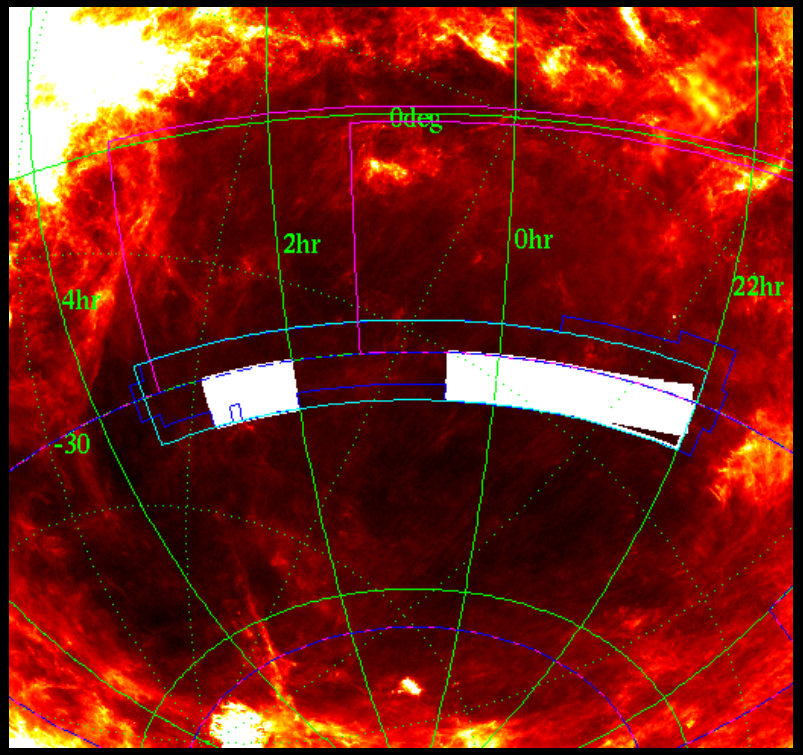


H1K

~~SLEWS: Spitzer postcryo~~
~~N: CFHTLS (150)~~
~~S: VIKING/H1K (150)~~

- Herschel Key programme
  - 550 sq.deg. awarded:
    250 in KiDS-S, 150 in KiDS-N

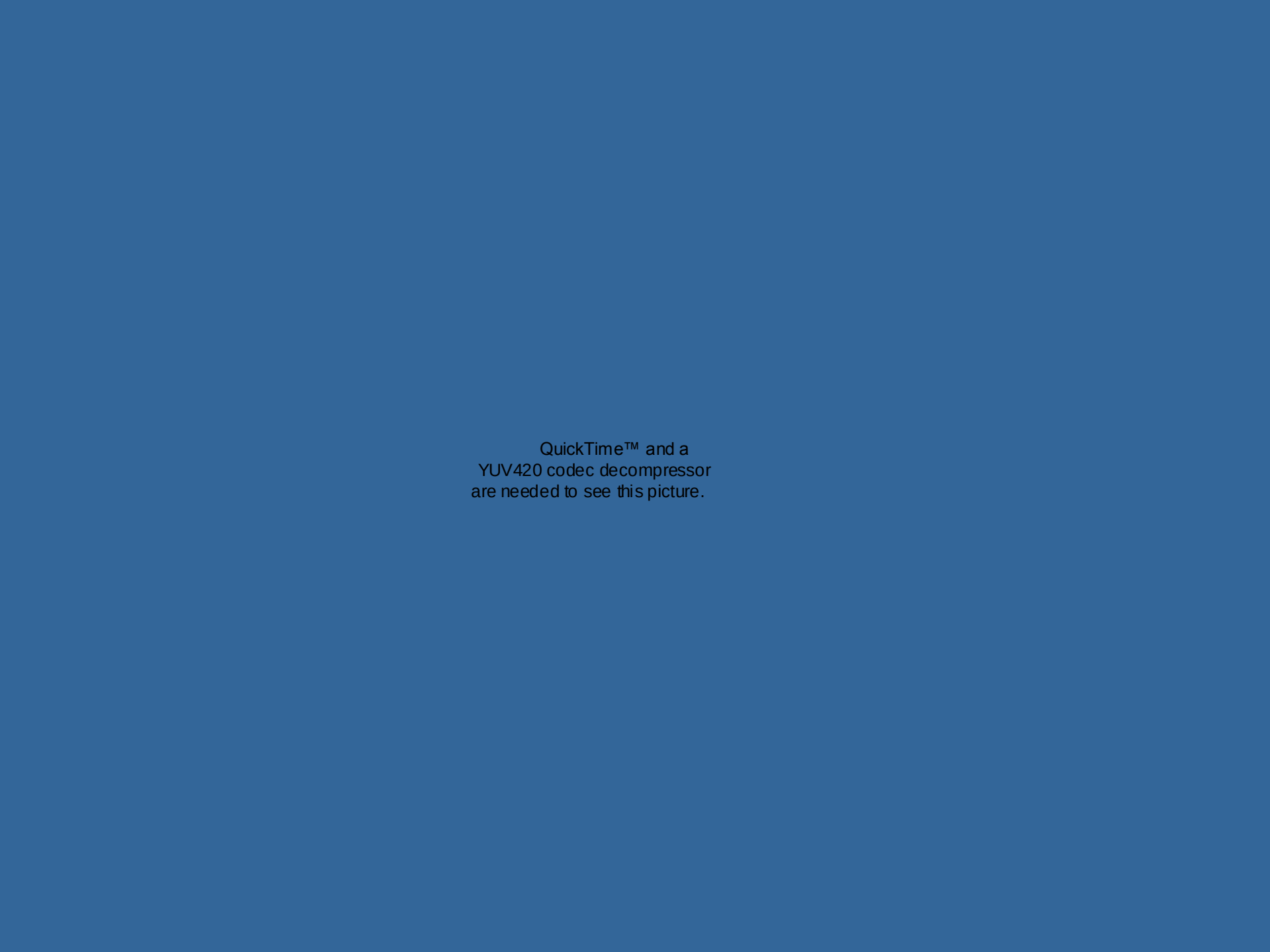




KiDS Science Objectives

- Dark matter distribution through weak lensing

- Collateral damage:
  - Galaxy evolution as related to environment
  - Cluster counts/samples
  - Stellar halo
  - Faint end of stellar Lum.Fn.
  - High-z qso’s


QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

Measuring weak lensing

Gravitational deflection by large-scale structure

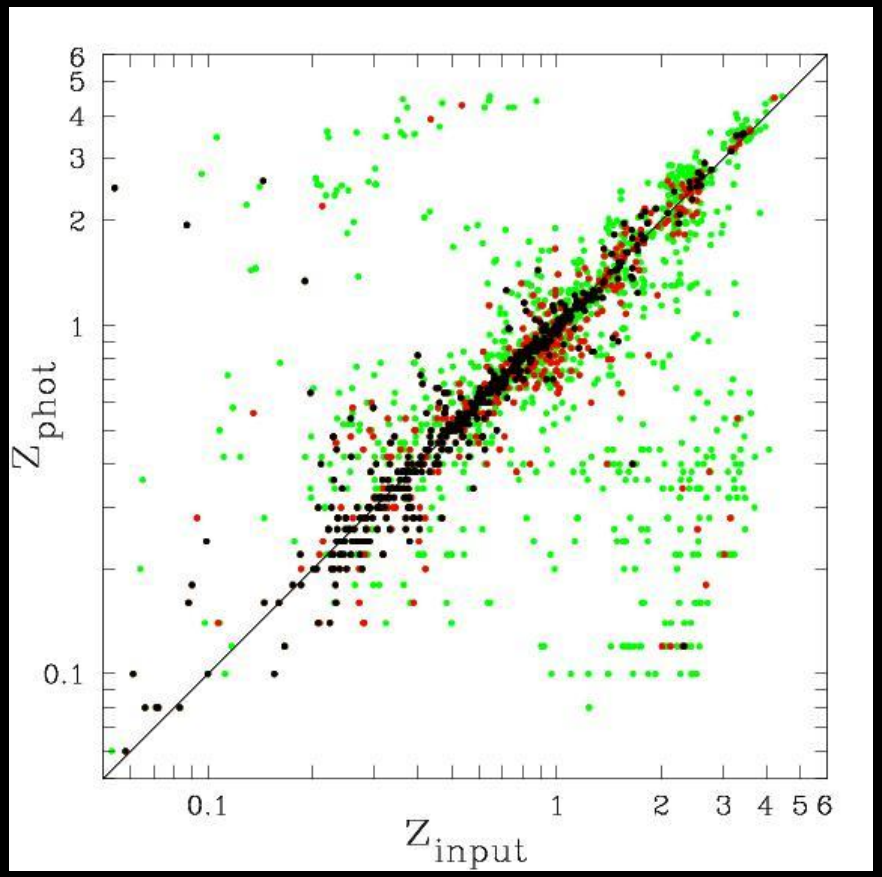
Systematic distortions / alignments of background galaxies

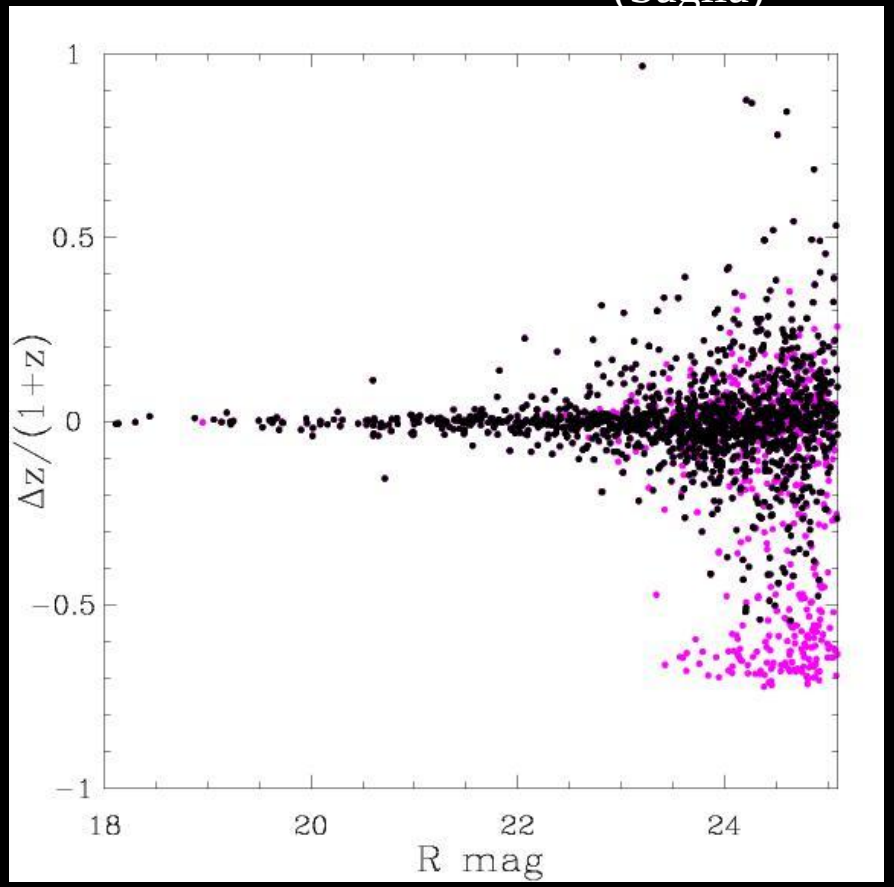
Statistical effect on top of `shape noise'

Measurement requires good seeing

Photo-z from KIDS/UKIDSS

(Saglia)

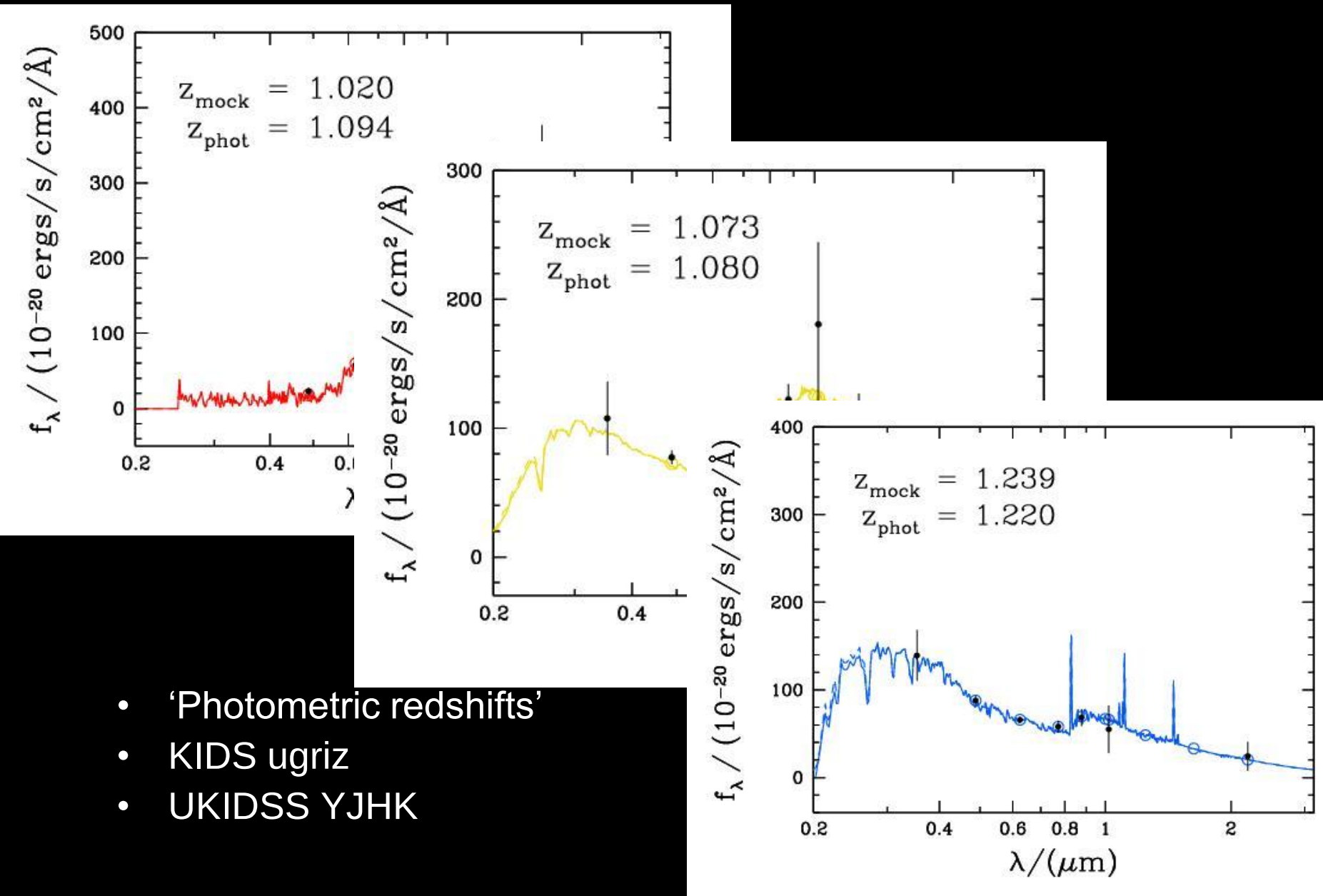




r<23.5 **r<24** **r<25** **0<z<6** **0<z<1.5**

Scatter further reduced with deeper IR data

Typical Spectra (r~24, redshift~1)



- ‘Photometric redshifts’
- KIDS ugriz
- UKIDSS YJHK

3% photo-z accuracy - waw?

Dark matter / weak lensing

- Mass concentrations along line of sight deflect light rays.
  Gradient $\rightarrow$ distortion $\rightarrow$ correlated ellipticities

- Probe of
  - Galaxy halos: mass, extent, shape
  - Large scale structure ***mass*** power spectrum

- As function of source redshift:
  - Growth history $\rightarrow$ H(z)
  - Angular-diameter / redshift relation $\rightarrow$ H(z)
  - Separate probes of dark energy physics `w'
  - Combination tests for consistency of General Relativity

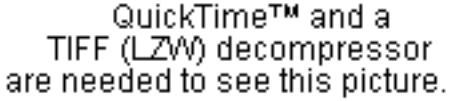
Galaxy-galaxy lensing

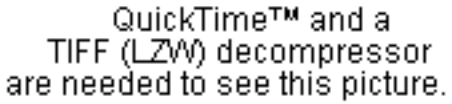
45 sq. deg from RCS survey (Hoekstra, Yee, Gladders 2004)

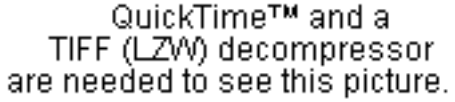
Galaxy-mass correlation

Halo radii

Halo shapes







KIDS:

6x smaller errors (#pairs)

Good photo-z's (b/g), spectroscopic z's (lenses)

Study effect by galaxy type, scaling relations

LENS EFFECT DEPENDS ON DISTANCE TO THE SOURCE

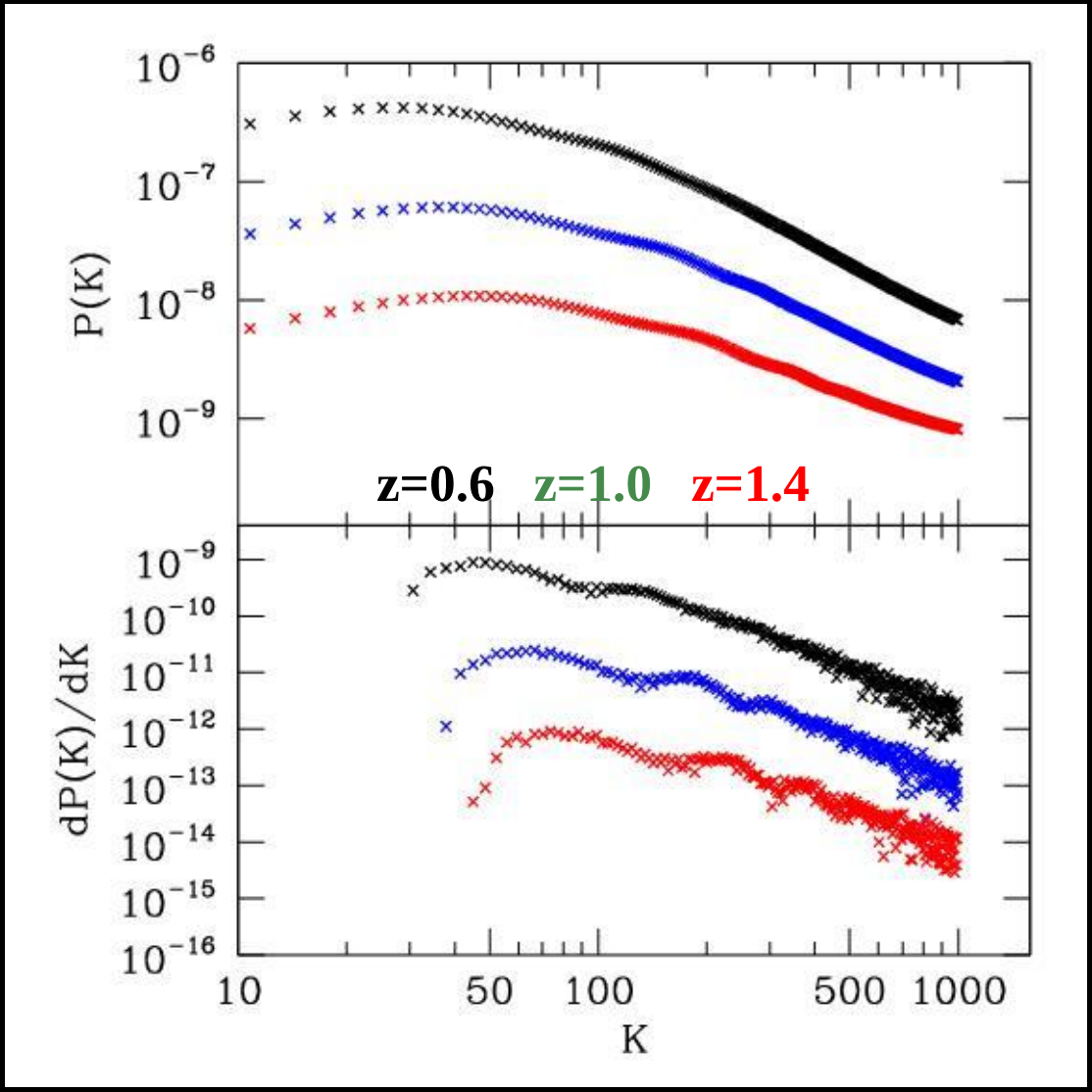
$$\theta-\beta=\alpha D_{ls}/D_s$$

LENS EFFECT DEPENDS ON MASS OF THE LENS

$$\theta-\beta=\alpha D_{ls}/D_s$$

Baryon Acoustic Oscillations

(P. Schuecker)



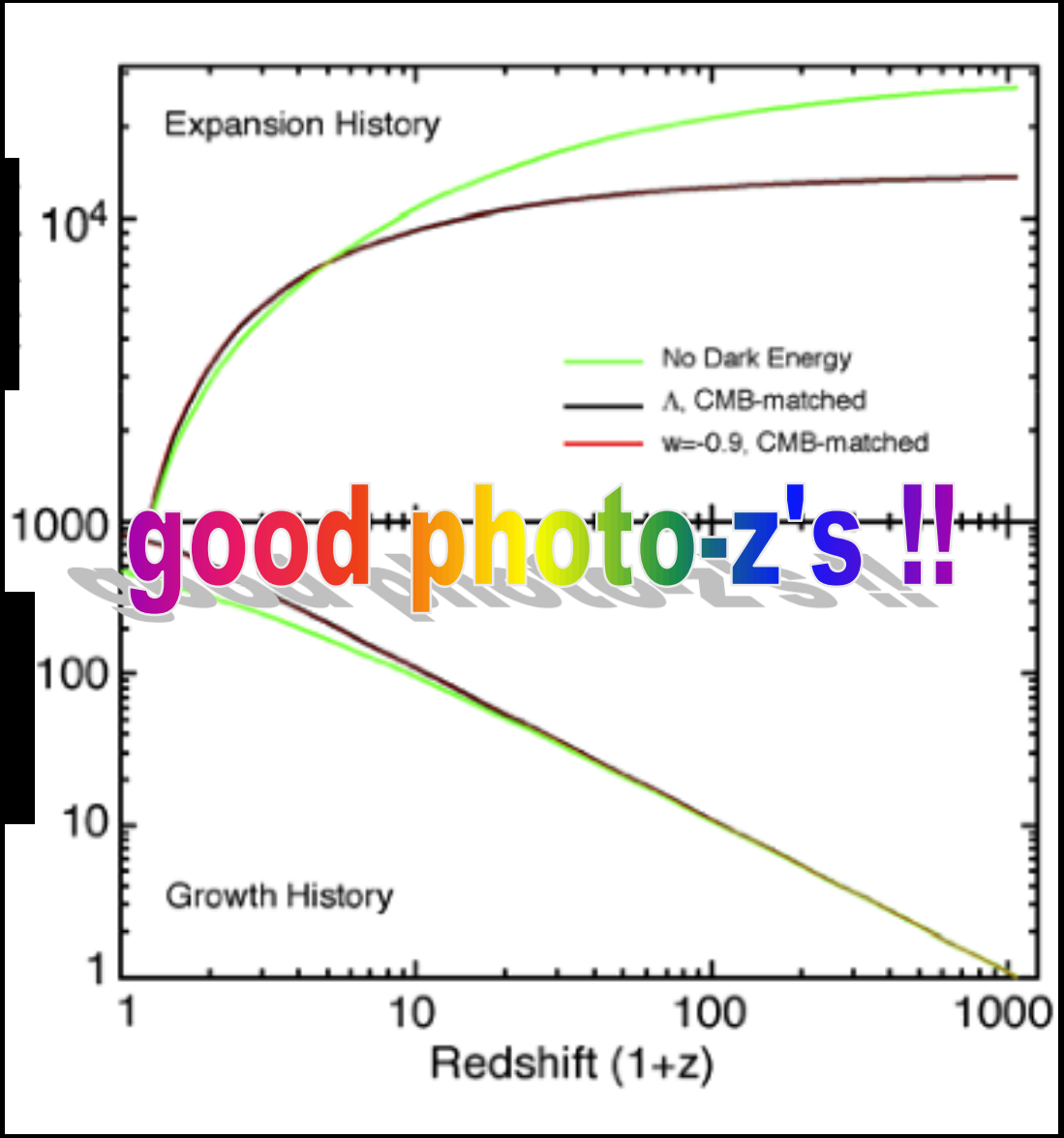
Angular corr.fn.

60 million gals
3% photo-z

Can trace baryon oscillations

3 handles on w from KiDS

- Cosmic shear:
  growth of structure
- Baryon oscillation bumps in angular corr. fn.
  (angular diameter-redshift relation)
- Galaxy-galaxy lensing: shear dependence on source redshift (angular diameter-redshift relation)



Conclusions

- Weak lensing + redshifts
  - Powerful probe of cosmology
- Photometric redshifts must be very well calibrated
  - Spectroscopy of large and representative sample