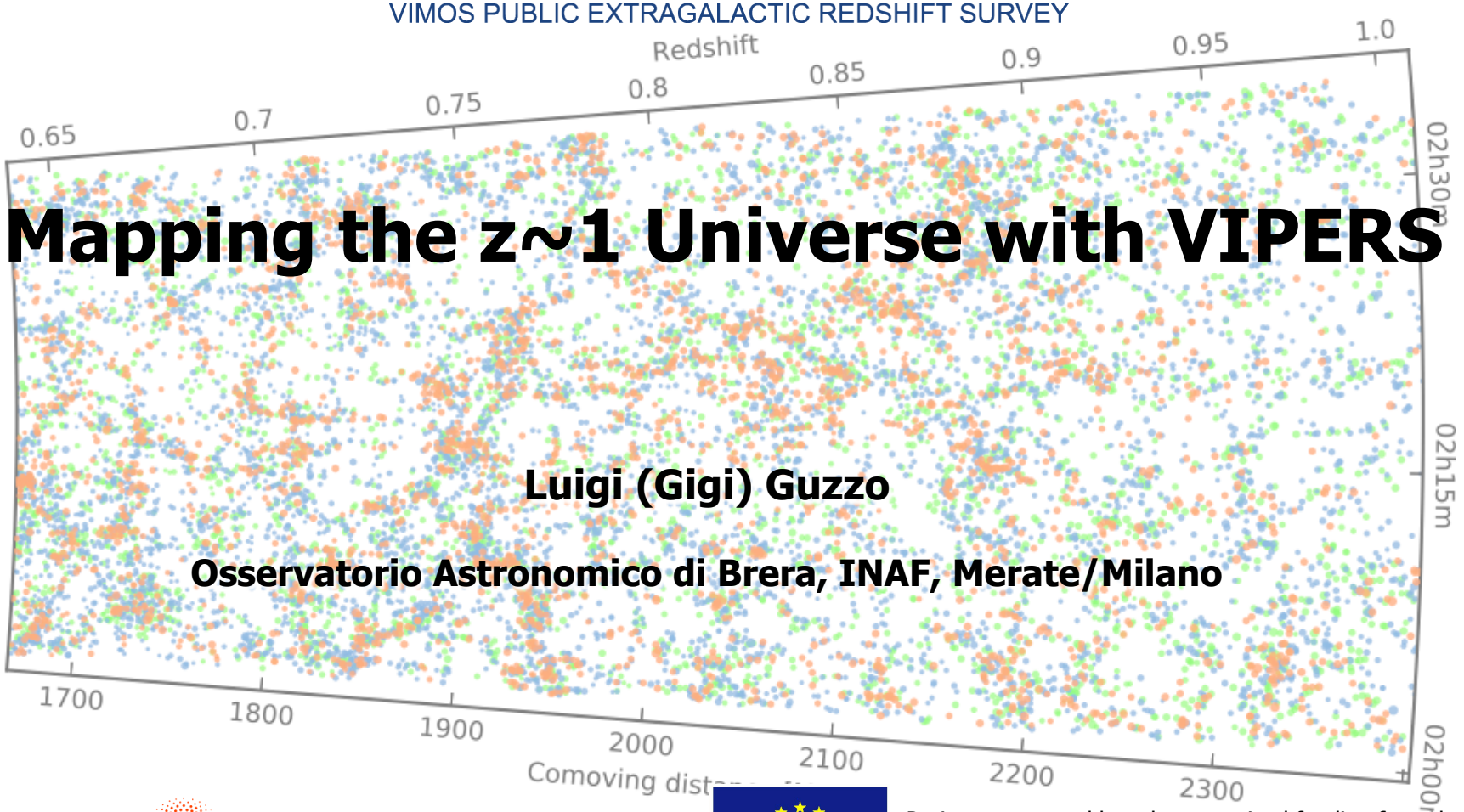
VIMOS PUBLIC EXTRAGALACTIC REDSHIFT SURVEY

Mapping the z~1 Universe with VIPERS



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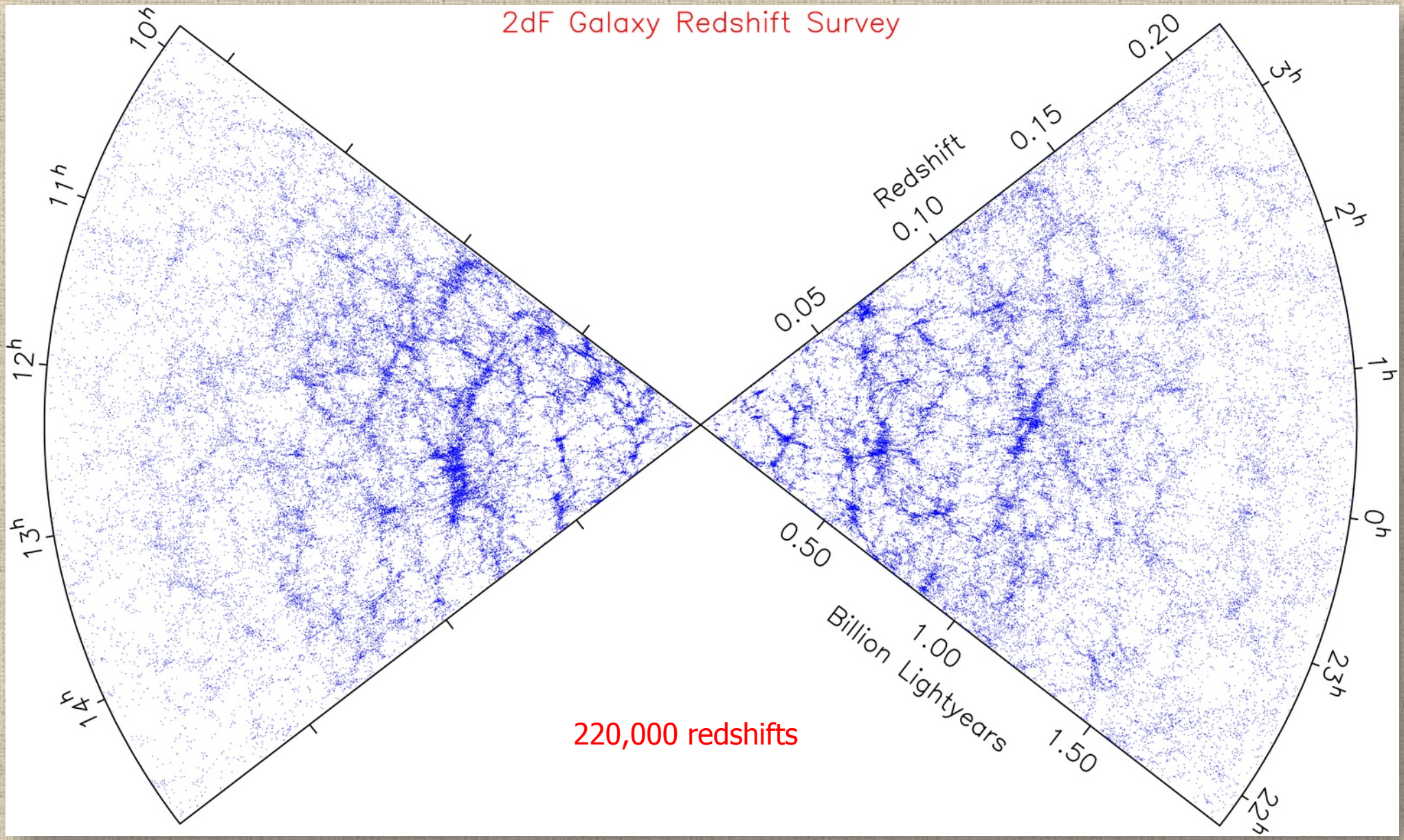
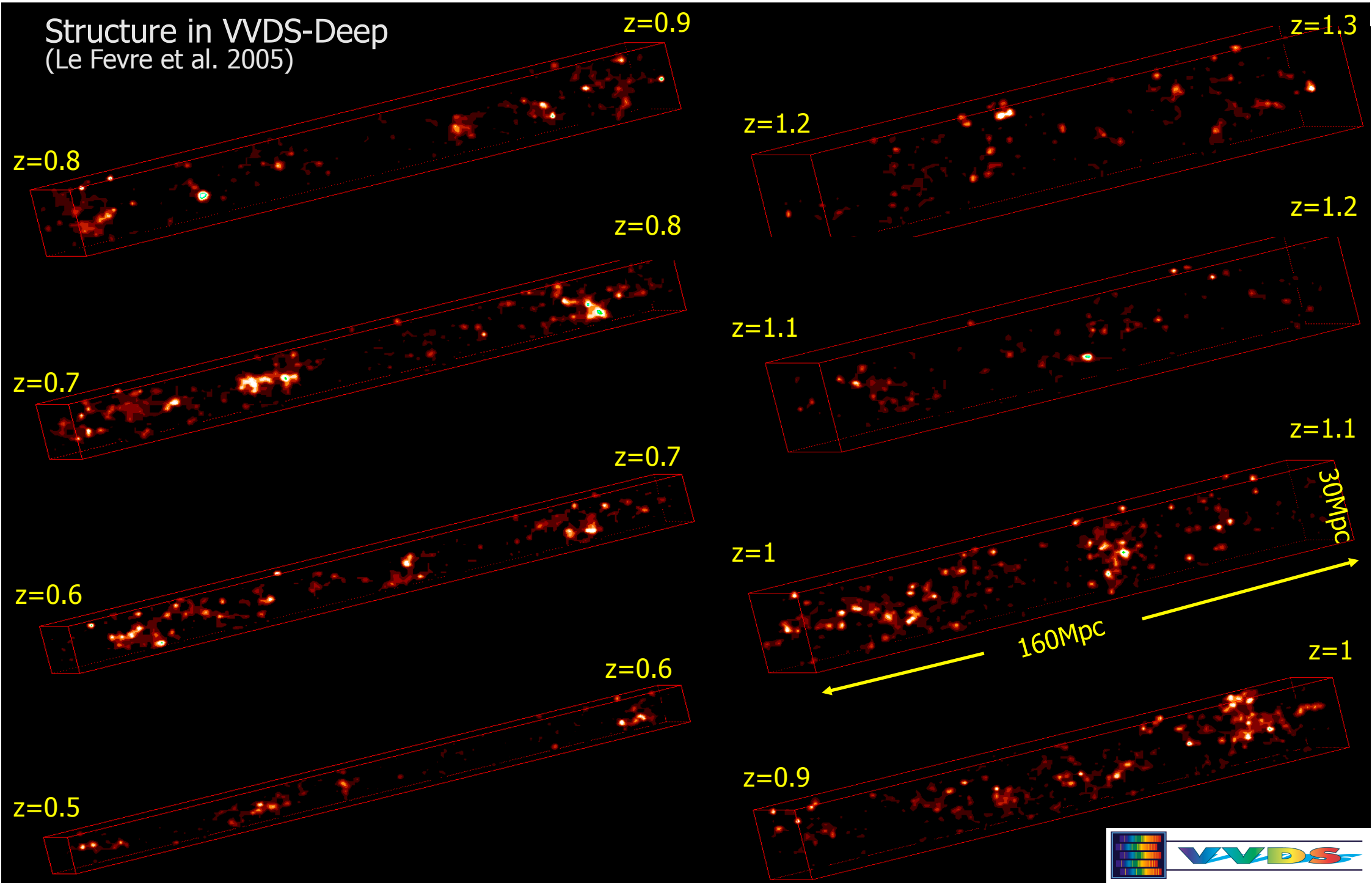
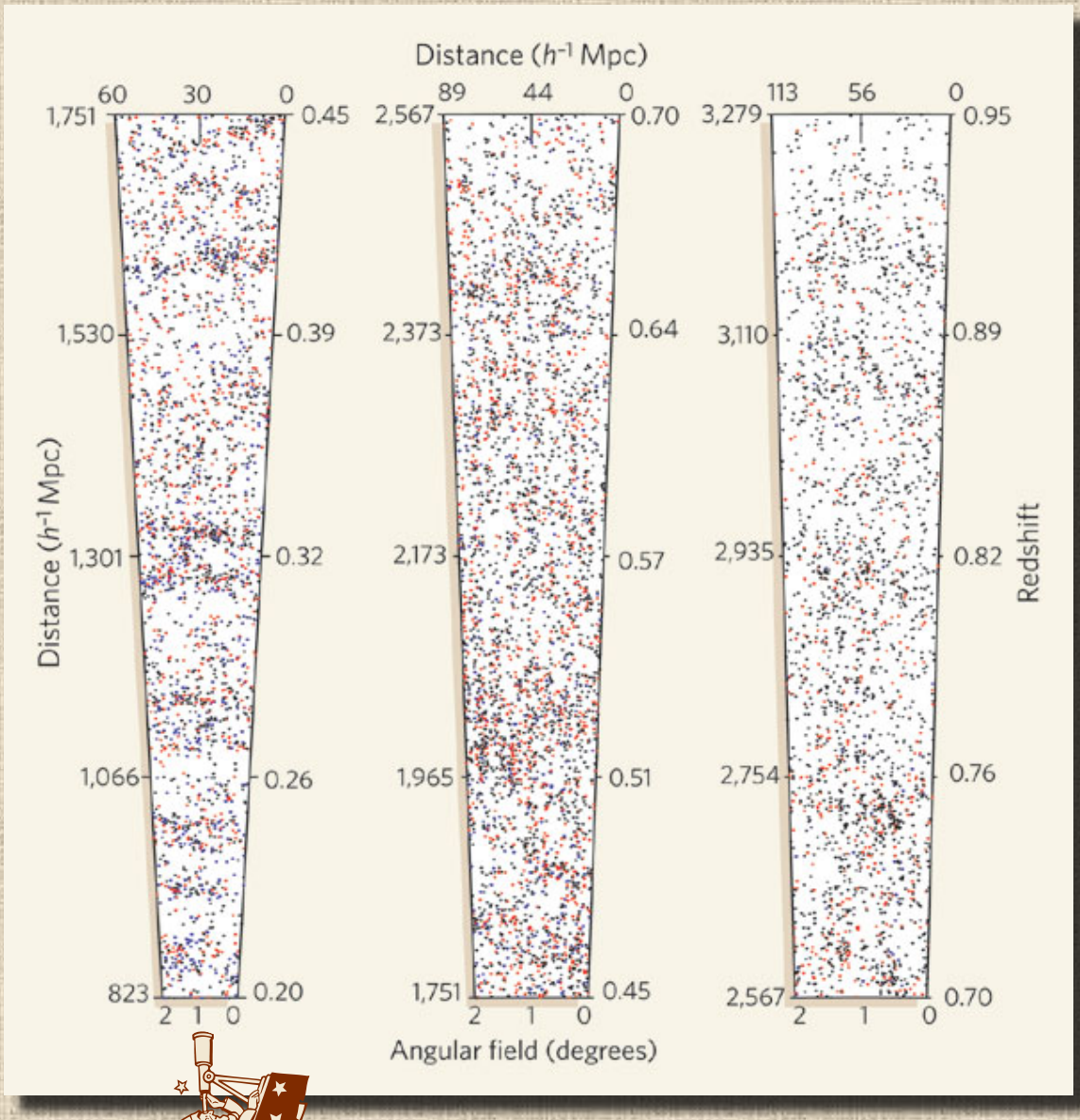
Projects presented here have received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration, under grant agreement no 291521

Large-scale structure at z<0.2

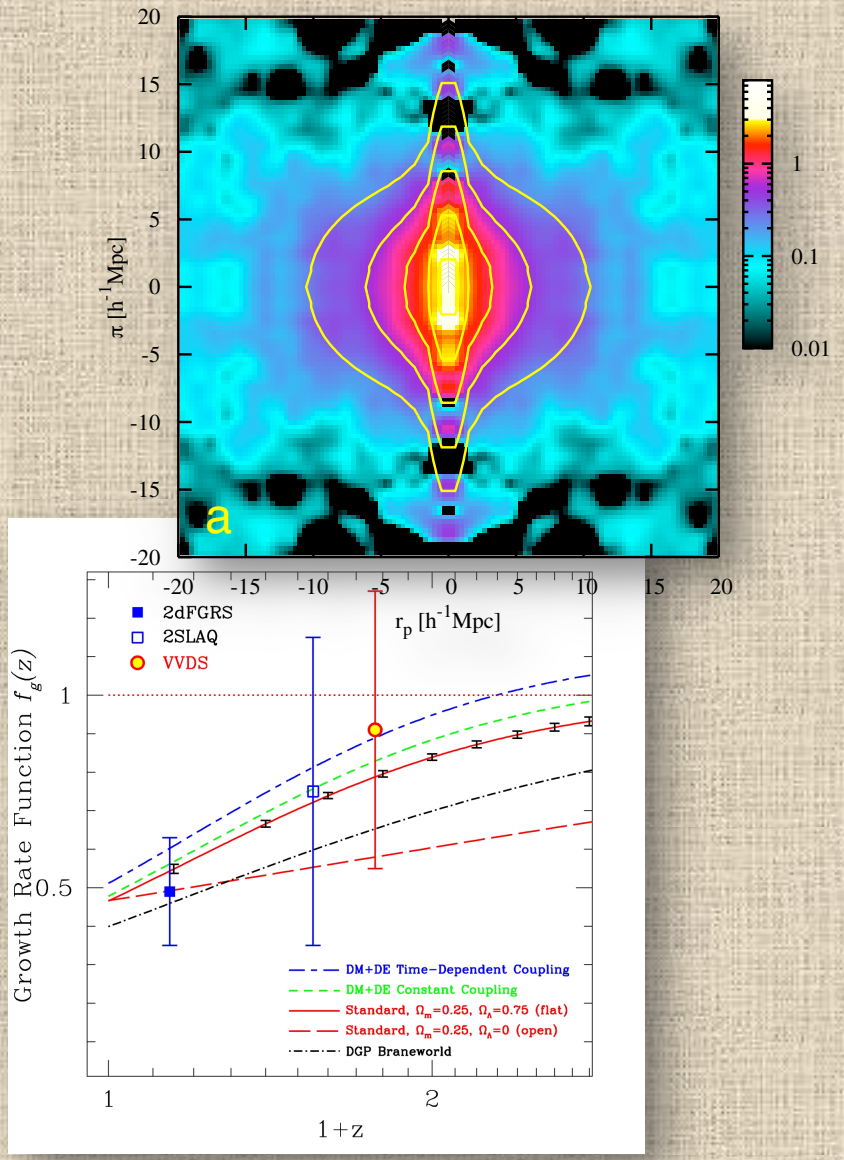



Structure in VVDS-Deep
(Le Fevre et al. 2005)
z=0.9
z=0.8
z=0.8
z=0.7
z=0.7
z=0.6
z=0.6
z=0.5
z=1.3
z=1.2
z=1.2
z=1.1
z=1.1
z=1
30Mpc
160Mpc
z=1
z=0.9
VVDS

VVDS-Wide F22 field: 4 deg^2, 10,000 redshifts to z~1.2

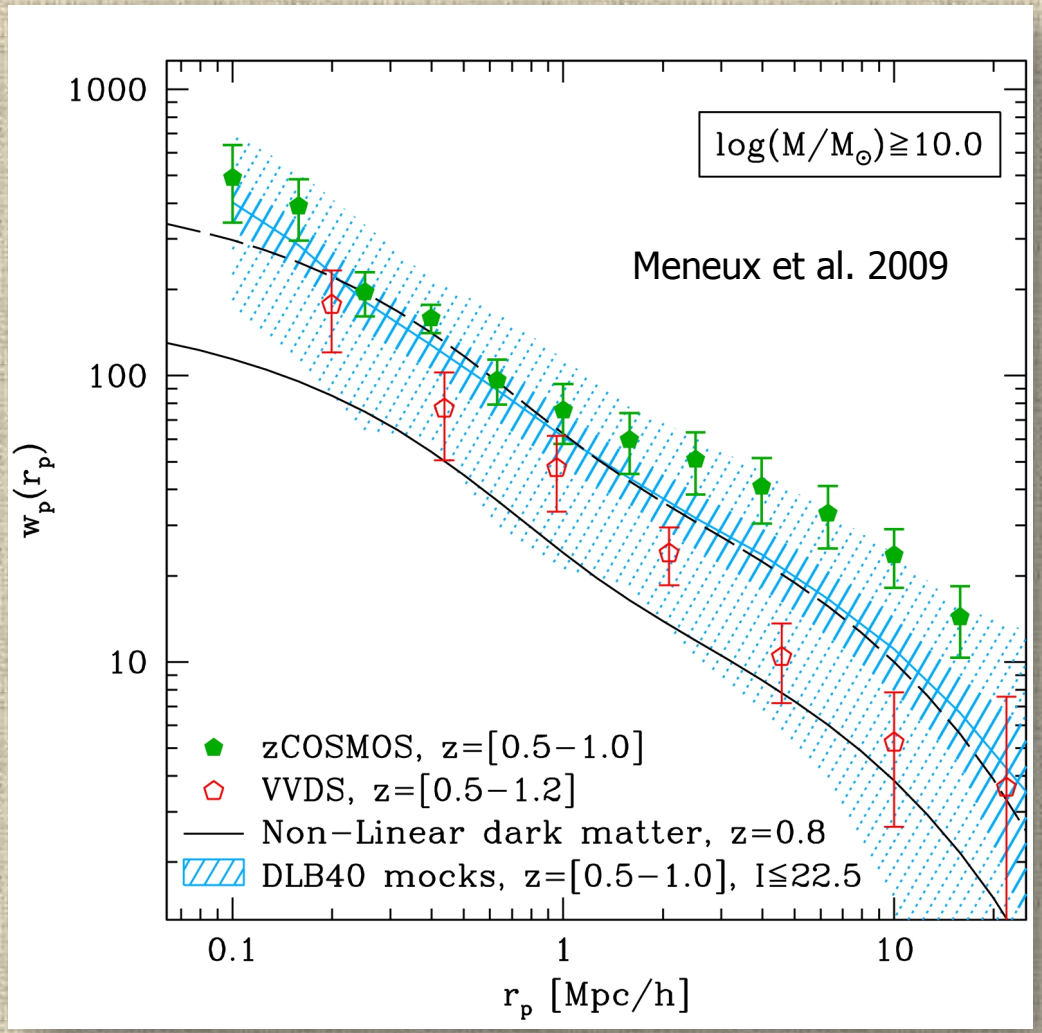


(Garilli et al. 2008, A&A 486, 683)



(Guzzo et al. 2008, Nature 451, 541)

Still small volumes: strong sample variance



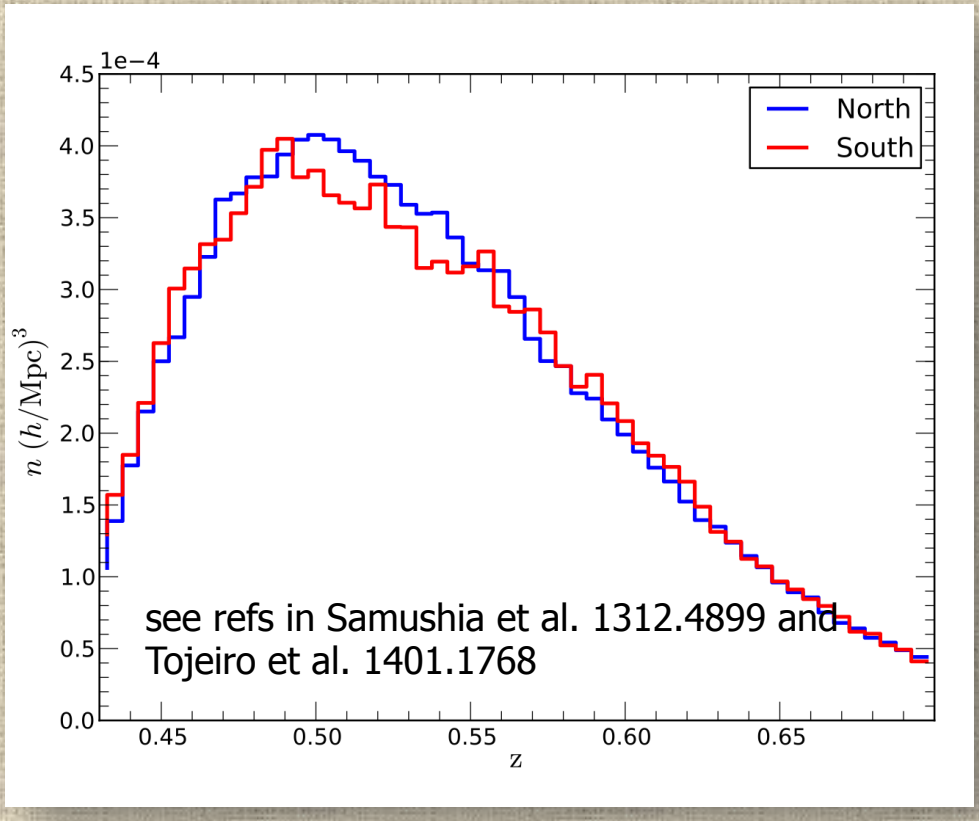
→ 2-point clustering: zCOSMOS vs VVDS-Wide F22 @<z>~0.8

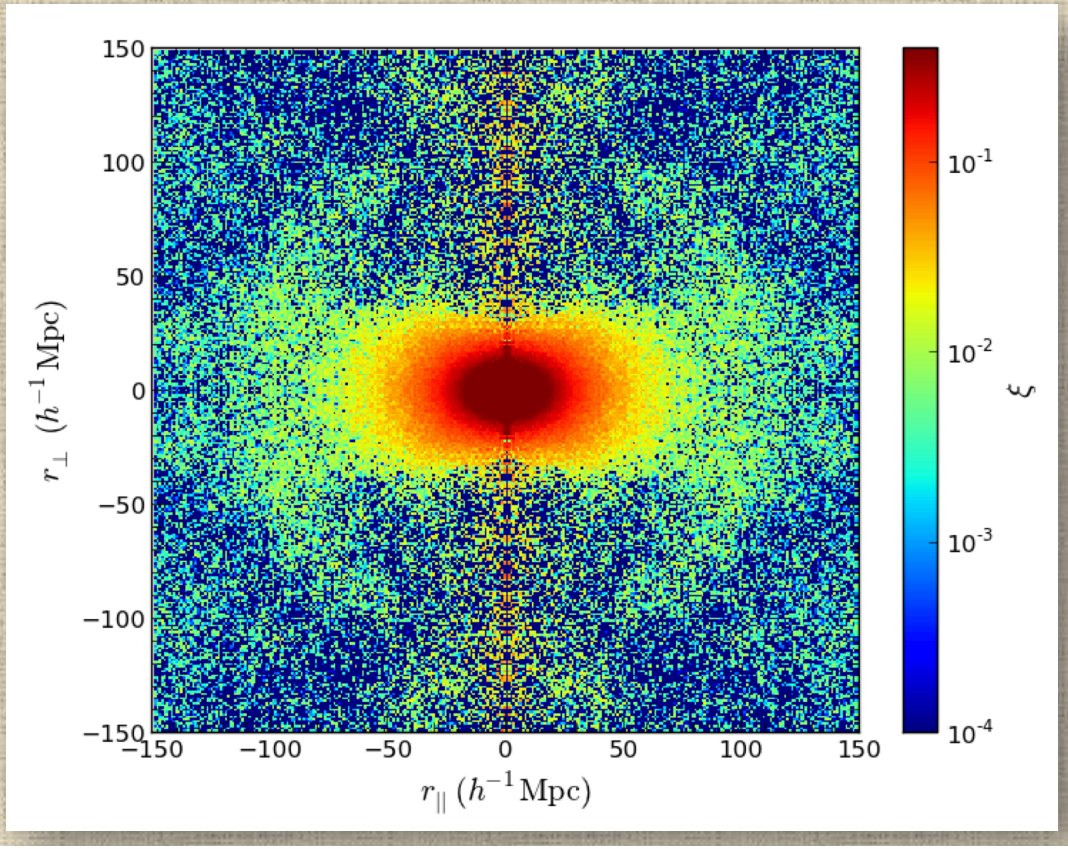
→ Expected in a hierarchical scenario if density PDF not representative (here due to excess of high-density regions in zCOSMOS at these redshifts)

De la Torre, LG & zCOSMOS Collaboration, 2010, MNRAS, 409, 867

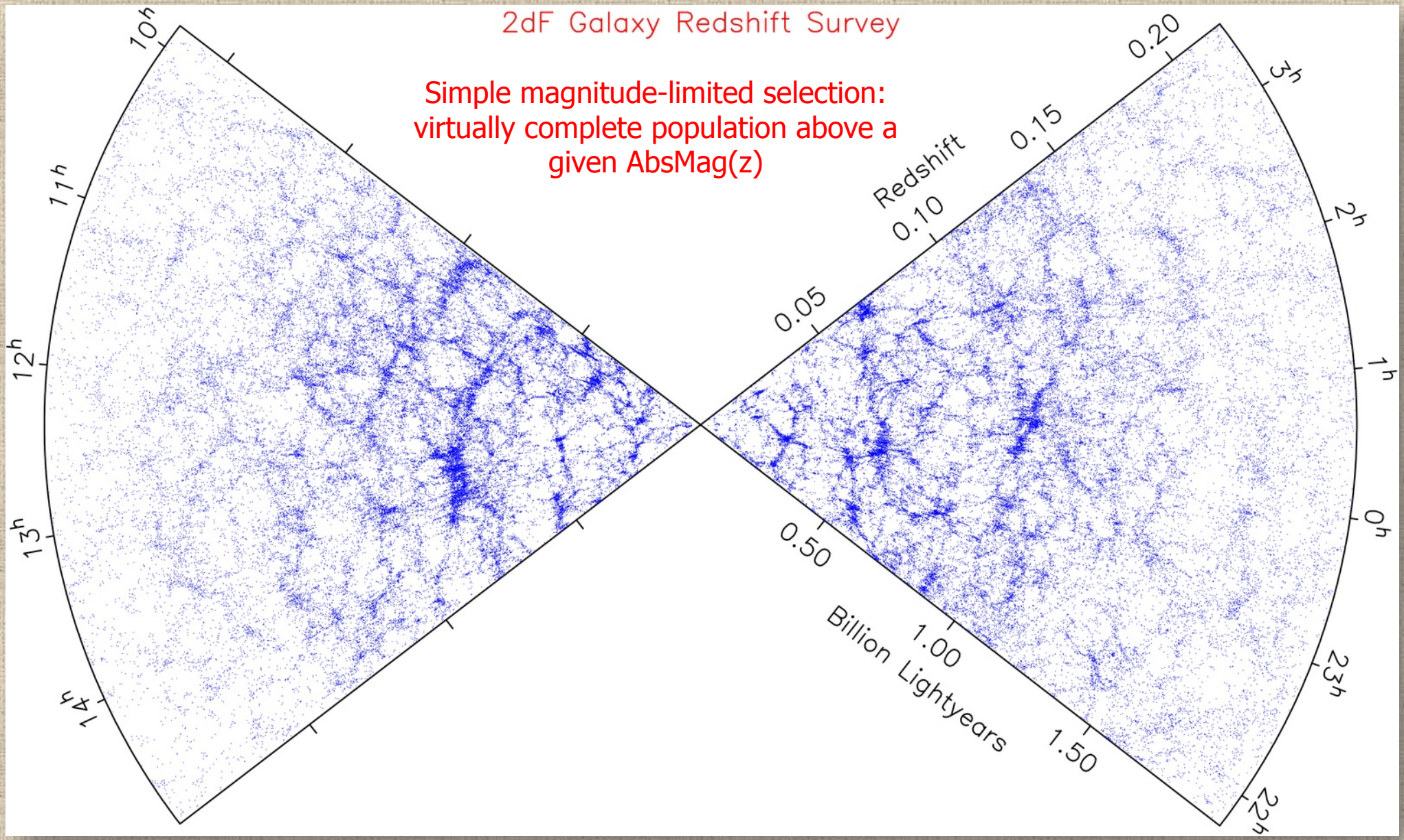
Pushing to z~0.7 with sparse "special" populations: e.g. **BOSS**

- **Area=8500 deg^2 , Volume~6 h^{-3} Gpc, Ngal = 690,000**
- **"CMASS" LRG-like col-col selection, "loosely selecting constant mass galaxies"**
- **Low-density tracers**
- **Optimized for BAO, not for P(k) shape information (selection function)**
- **Excellent (a posteriori) for Redshift Space Distortions thanks to huge volume**

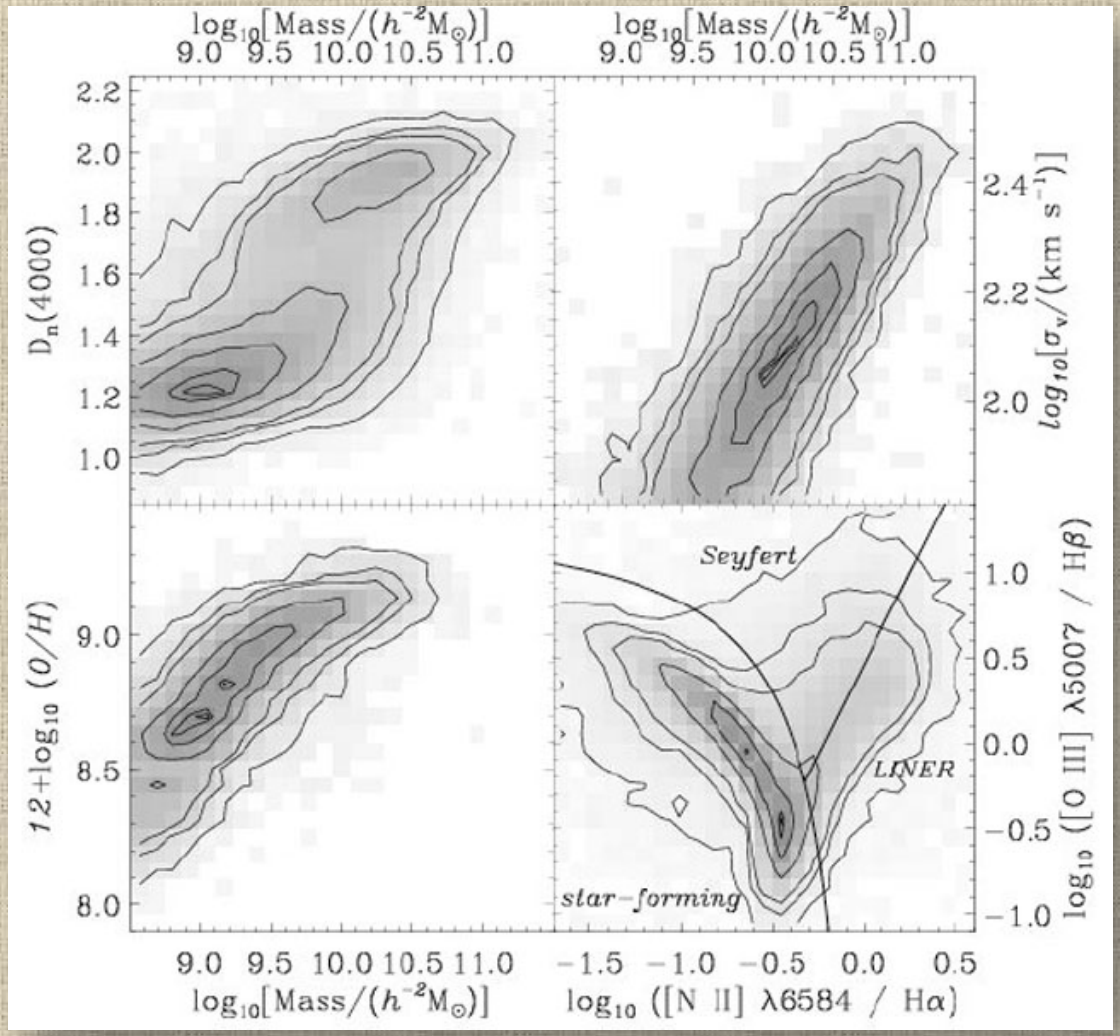




These surveys are fairly different from what 2dF and SDSS did at z<0.2

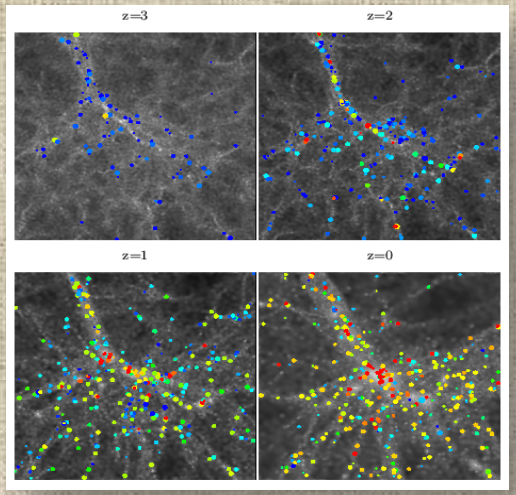


These also boosted our understanding the galaxy population…

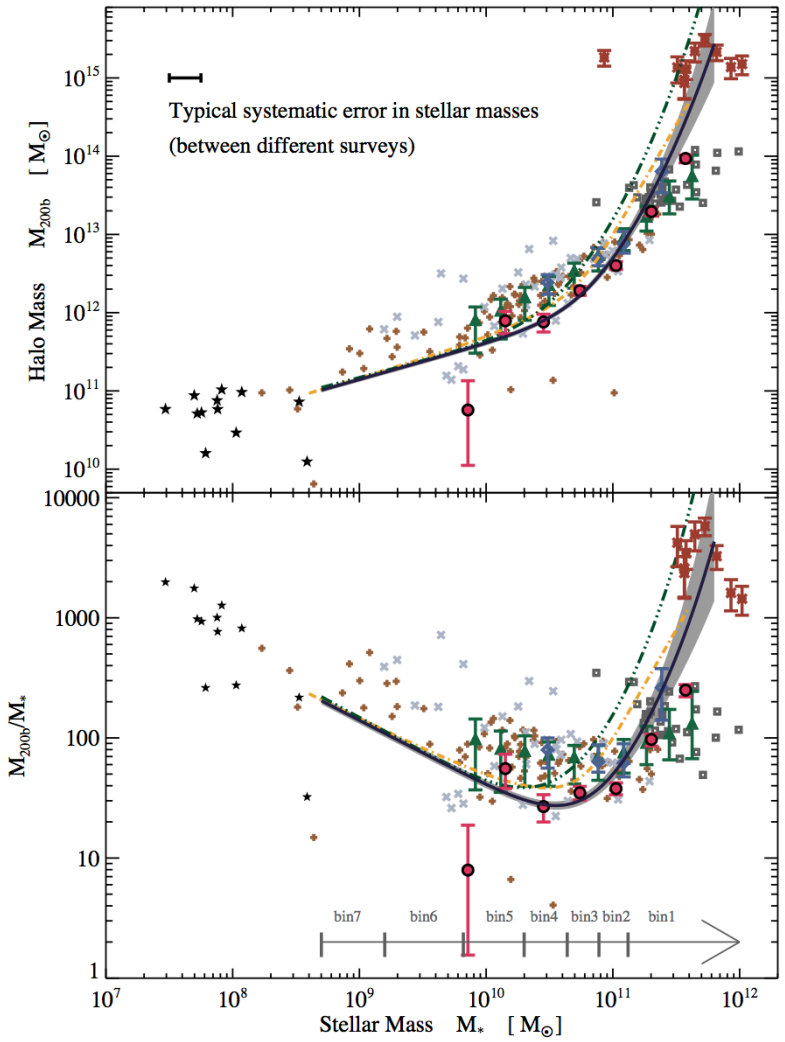


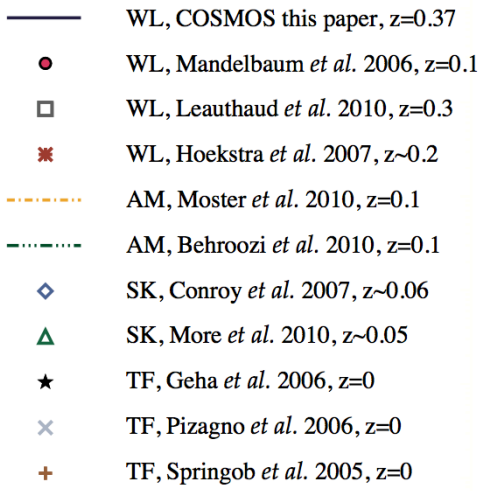
- SDSS: statistical distribution of galaxy properties for ~10^6 galaxies

We need to understand galaxies, to do cosmology...

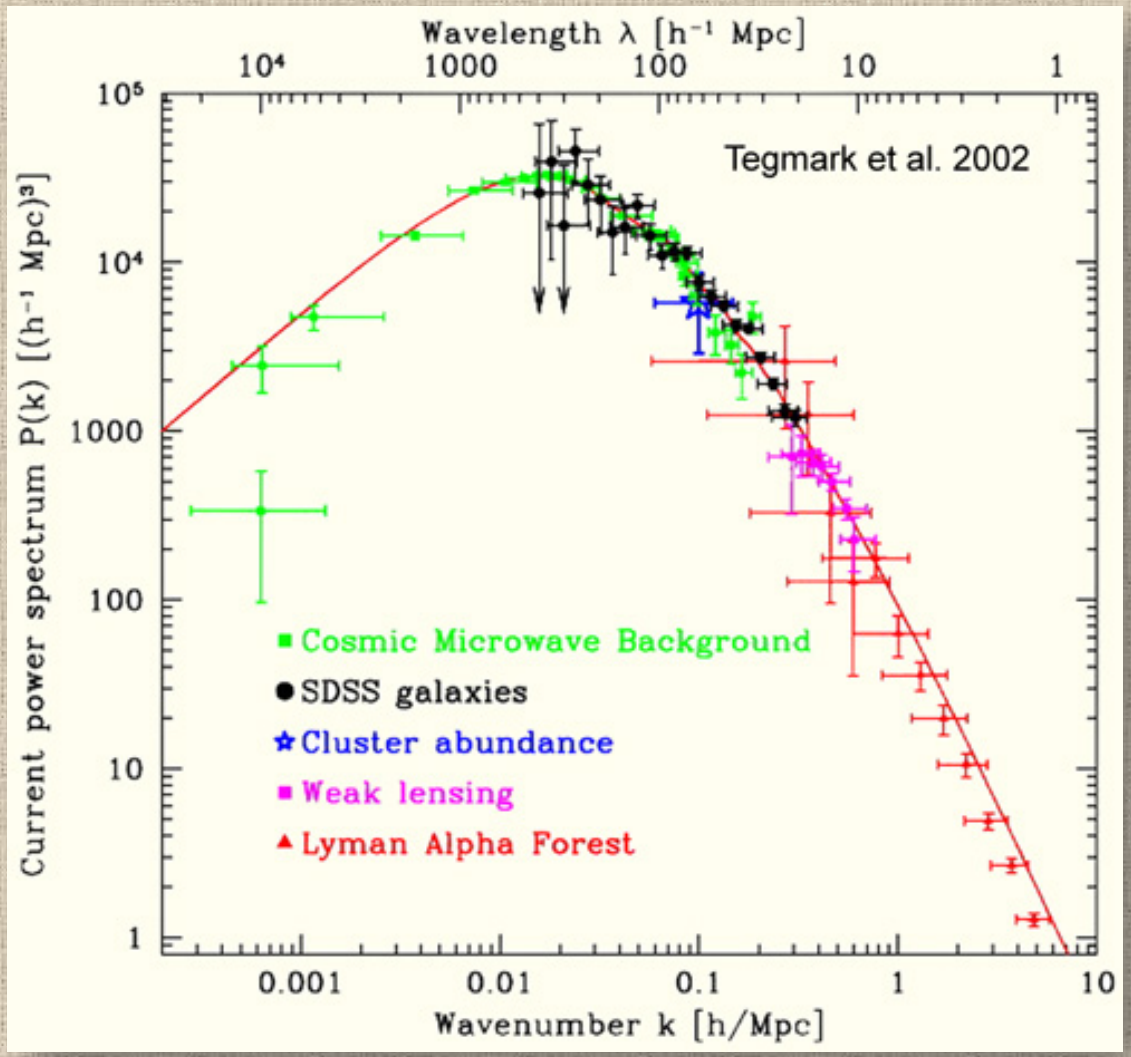


Kauffman & Diaferio 1998





The **clustering power spectrum**: a probe of the underlying cosmology (if we understand what we are using to trace structure! → bias!)



…push to higher redshift, but aiming at a **volume and density** comparable to 2dFGRS and SDSS, with similarly broad selection function

VIMOS @ VLT fills unique niche in density-area space

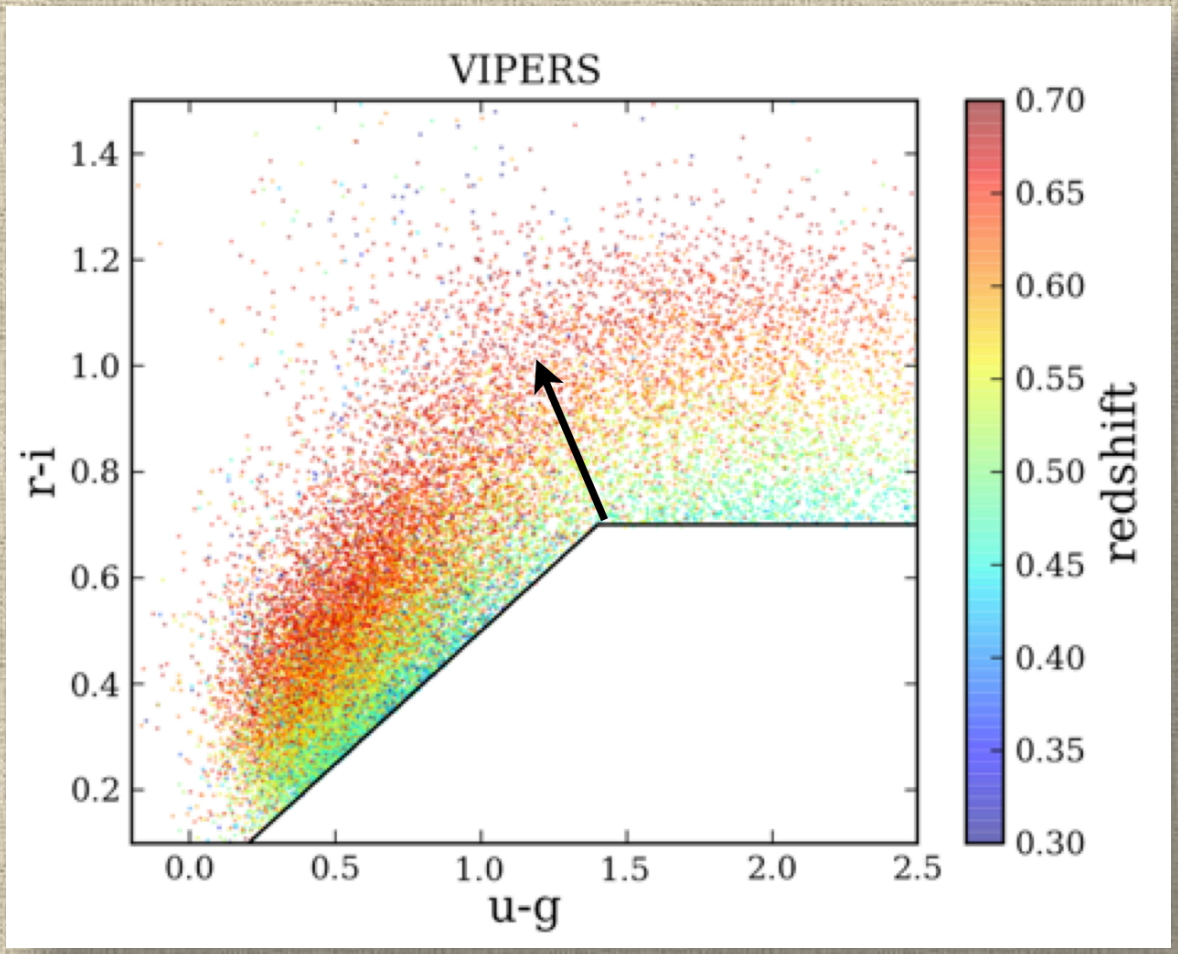
VIMOS @ VLT fills unique niche in density-area space

At VIPERS depth: ~100 gal/quadrant →
400/224 gal/arcmin^2 ~ **6500 gal/deg^2**

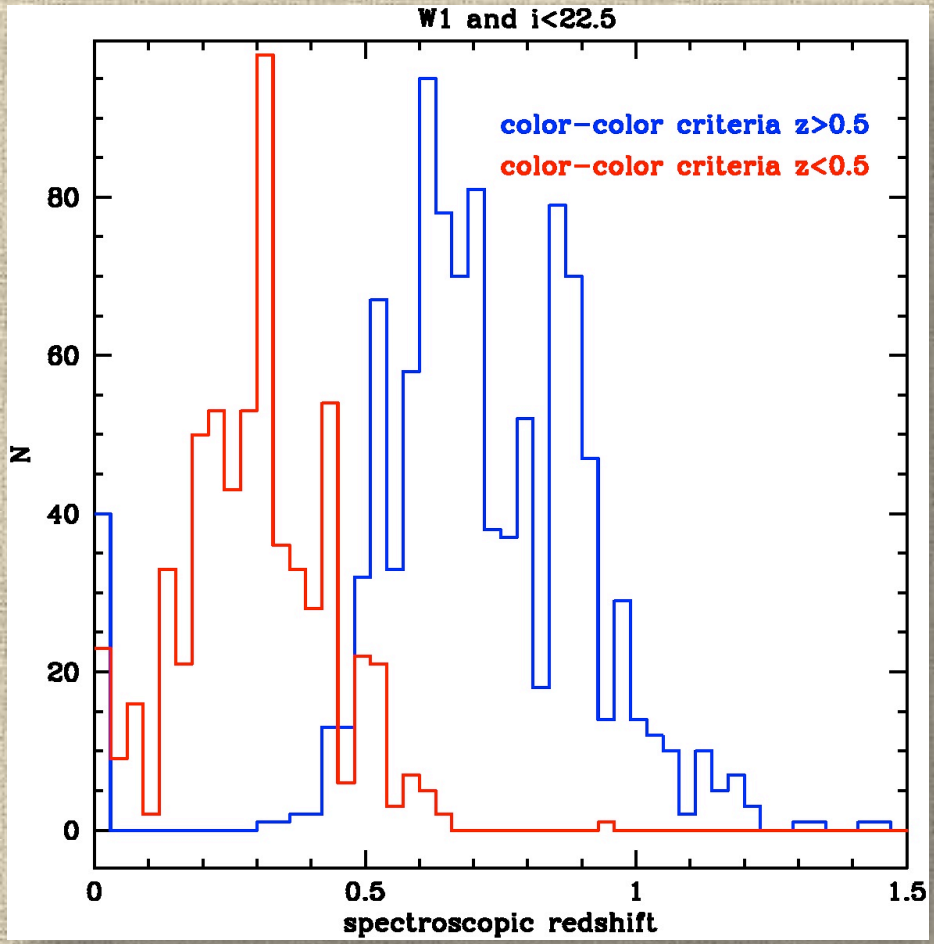
VIPERS Team

(see http://vipers.inaf.it)

VIPERS Colour-Colour selection: measure galaxies only where we need them, i.e. z>0.5 (calibrated using VVDS)



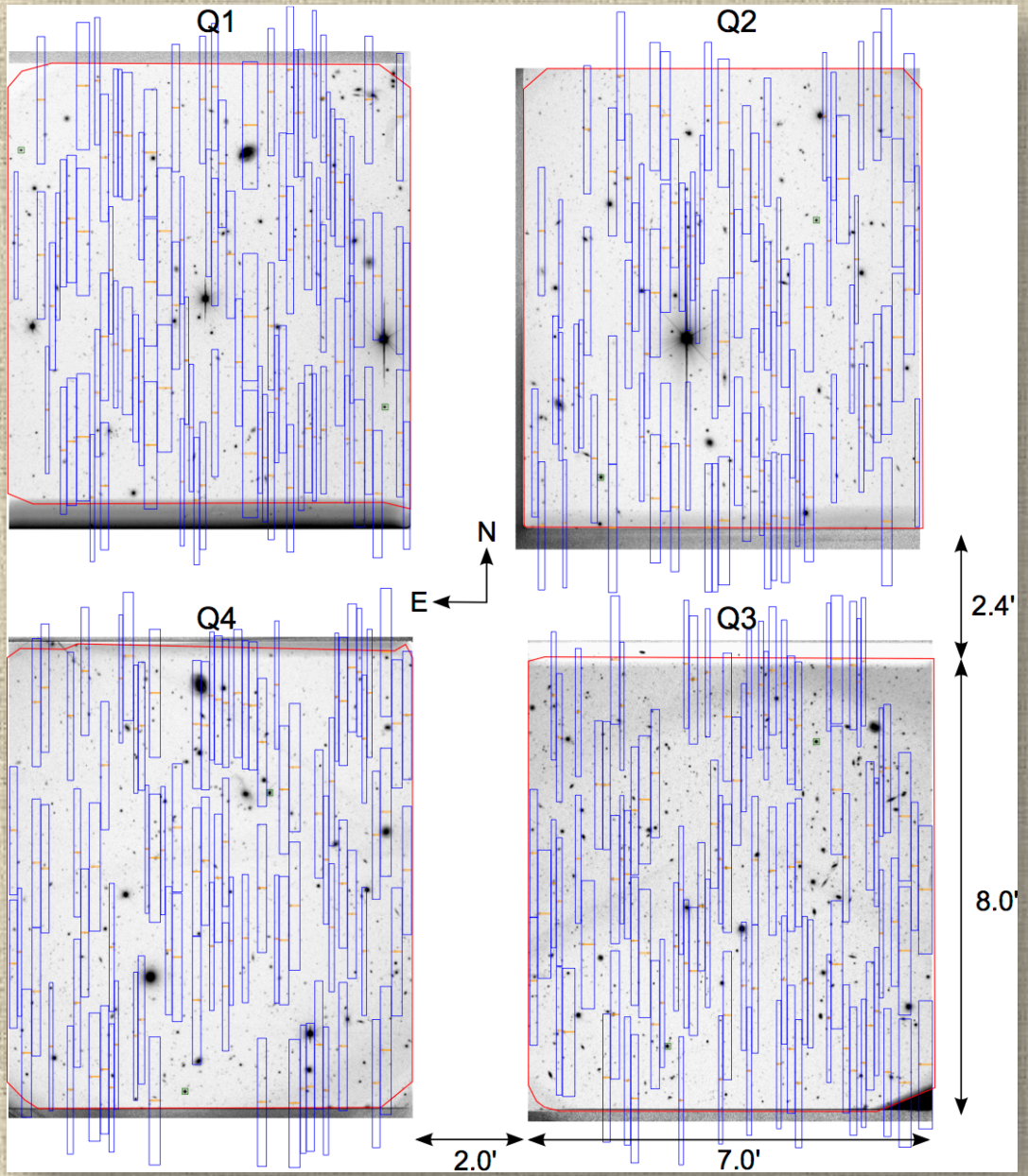
DEEP-2 like, but using 4 photometric bands



VIPERS single-shot footprint on the sky

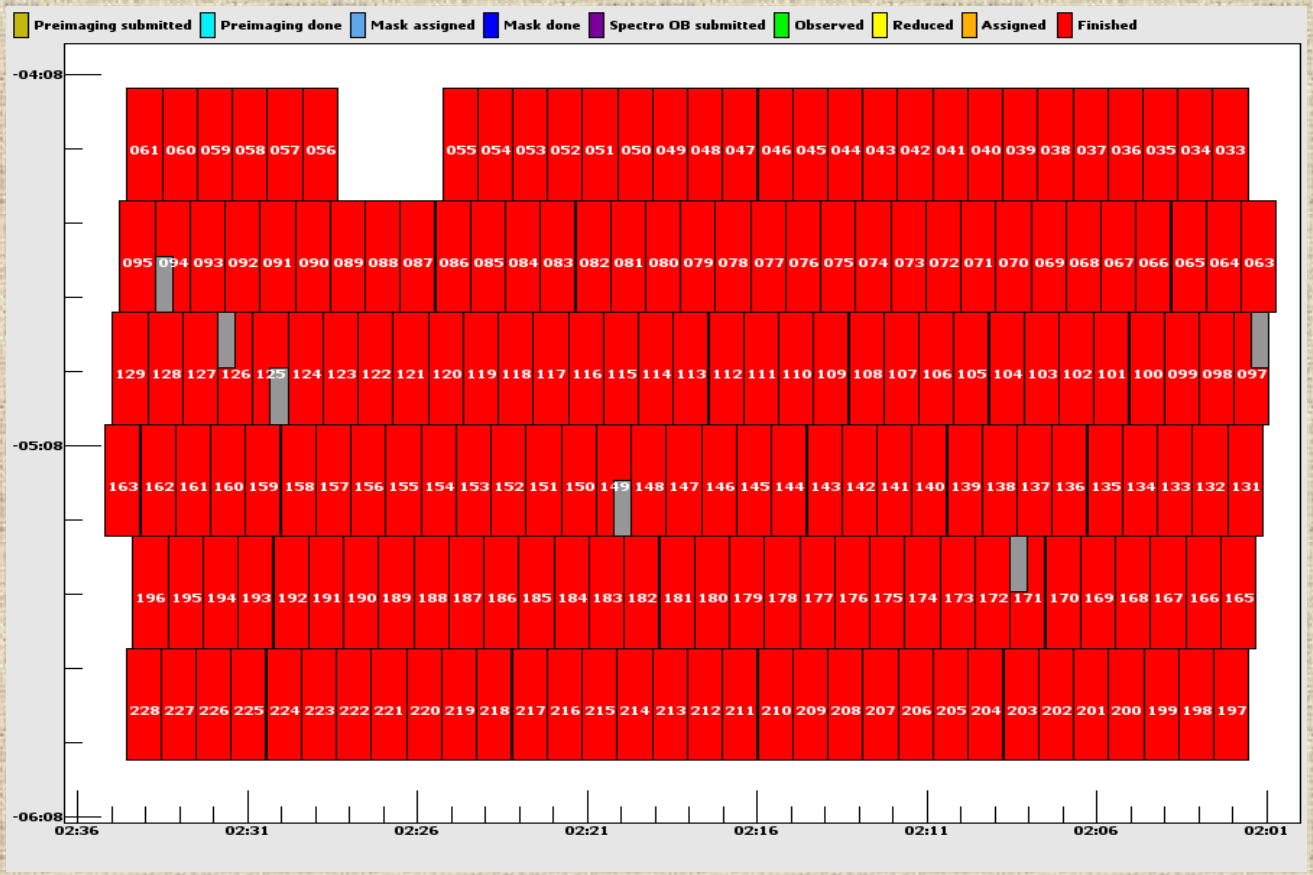
- **On average, 360 spectra observed per VIMOS pointing, given VIPERS target sample surface density and clustering**

- **VIPERS strategy yields mean spatial density $\langle n \rangle \sim 10^{-2}\ h^3\ Mpc^{-3}$ within the range of interest**

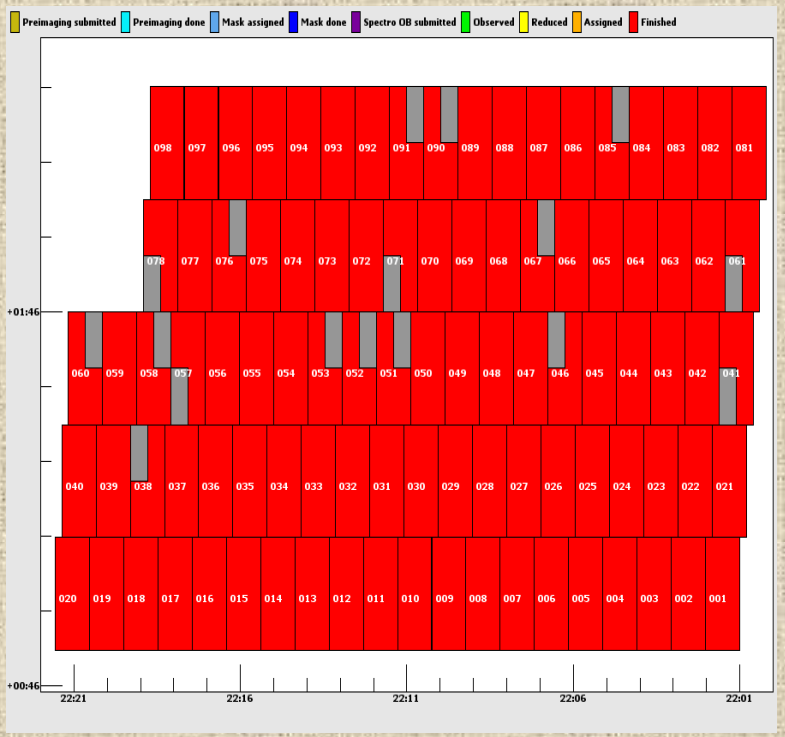


Sky coverage today: VIPERS is finished!

W1



W4



VIPERS Status

- **Survey completed in January 2015; all data now reduced and validated: internal final (V6.0) catalogue available to team:**

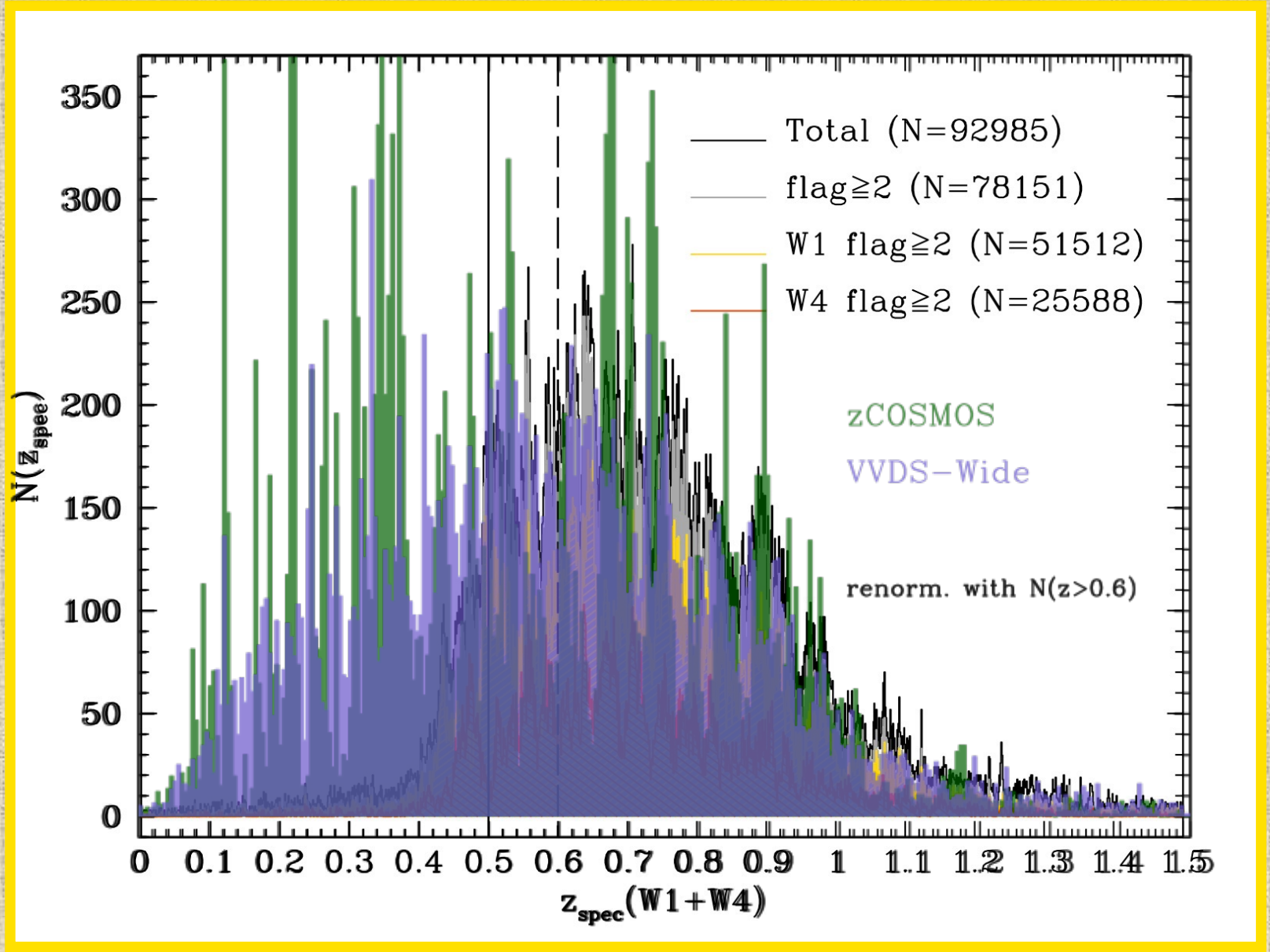
SURVEY STATUS AS OF 14/05/2015

EFFECTIVE TARGETS	MEASURED REDSHIFTS	STELLAR CONTAMINATION	COVERED AREA
93252	88901	2265 (2.5 %)	100.0 %

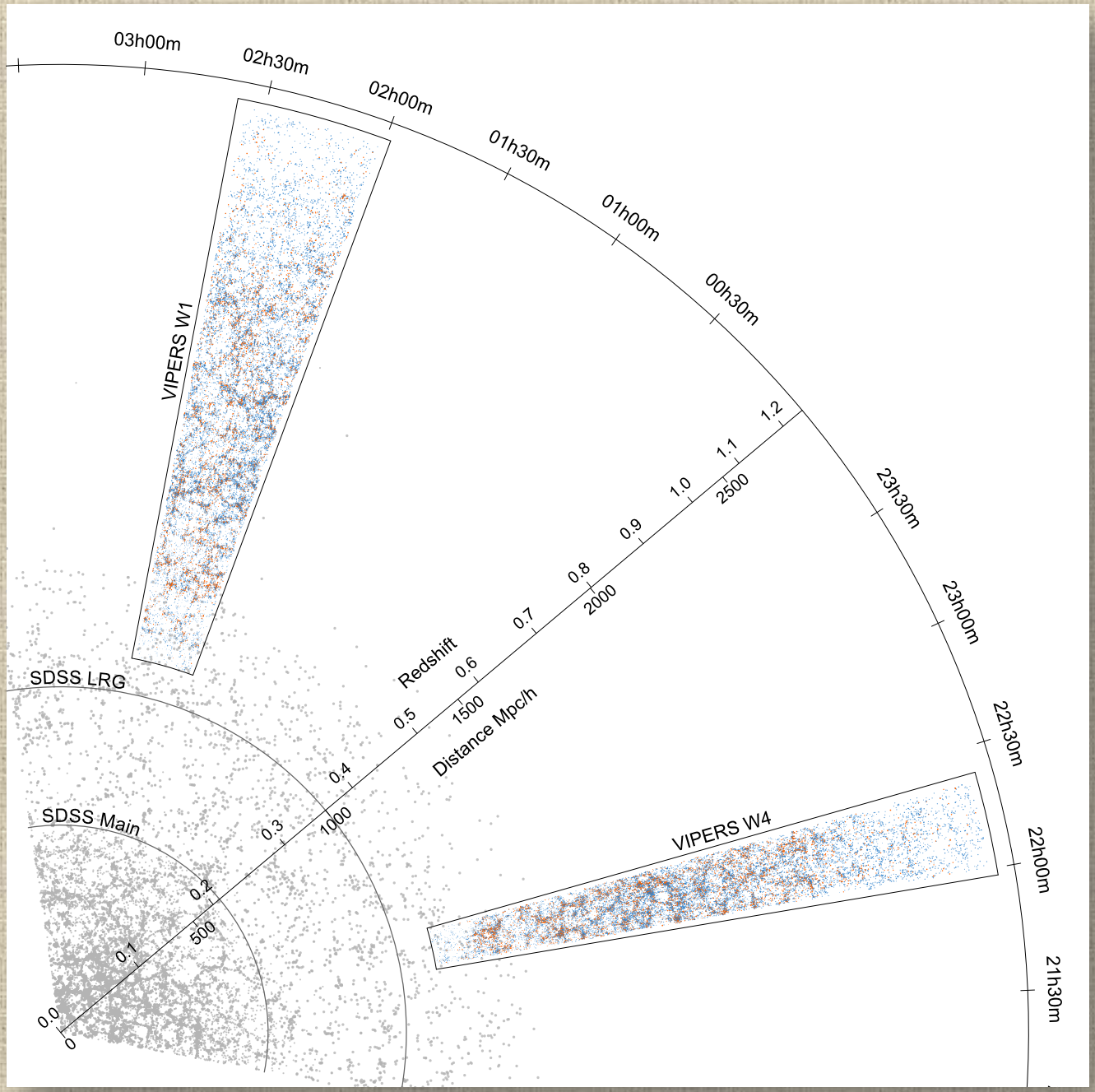
EFFECTIVE TARGETS (ET) are all the primary targeted objects with the exclusion of the ones flagged as -10 (undetected). MEASURED REDSHIFTS (MR) are the fraction of ET for which a redshift has been measured. STELLAR CONTAMINATION are the MR objects which have been identified as stars.

- **Summer 2016: public release of full data set**

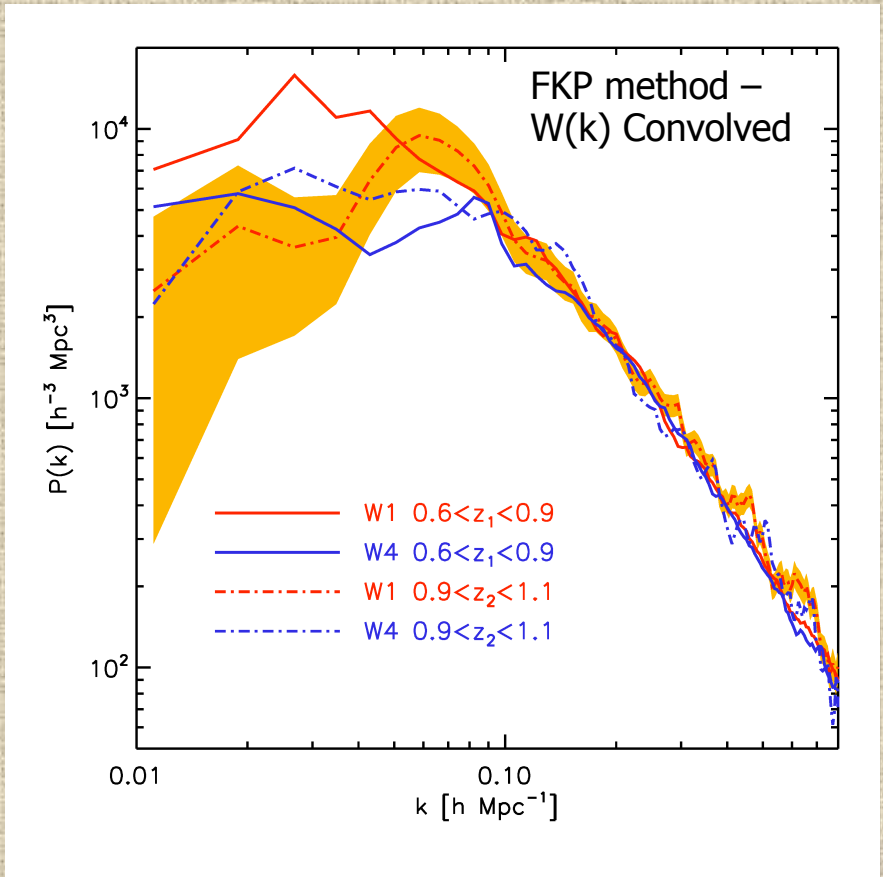
Final VIPERS vs previous smaller-area probes (all i_{AB}<22.5)

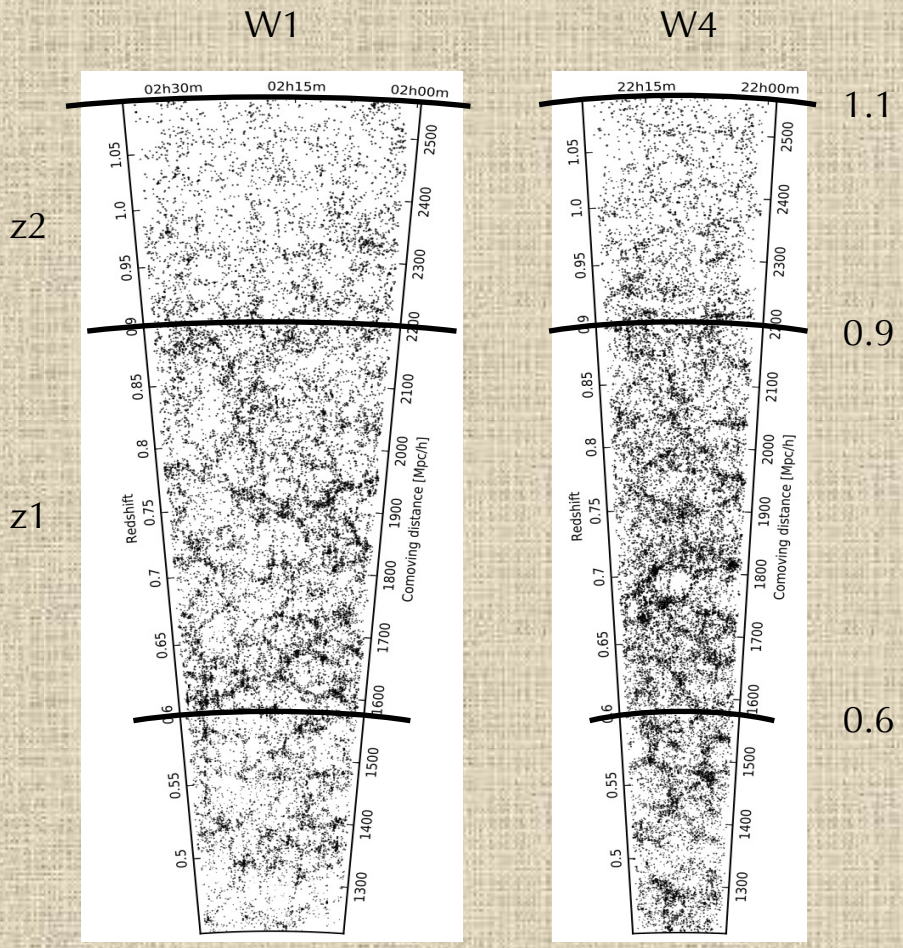


(Comparison by M. Bolzonella)


03h00m
02h30m
02h00m
01h30m
01h00m
00h30m
23h30m
23h00m
22h30m
22h00m
21h30m
VIPERS W1
VIPERS W4
SDSS LRG
SDSS Main
Redshift
Distance Mpc/h
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
0
500
1000
1500
2000
2500

The power spectrum of the galaxy distribution at z=0.5-1.1 from VIPERS (S. Rota PhD work)



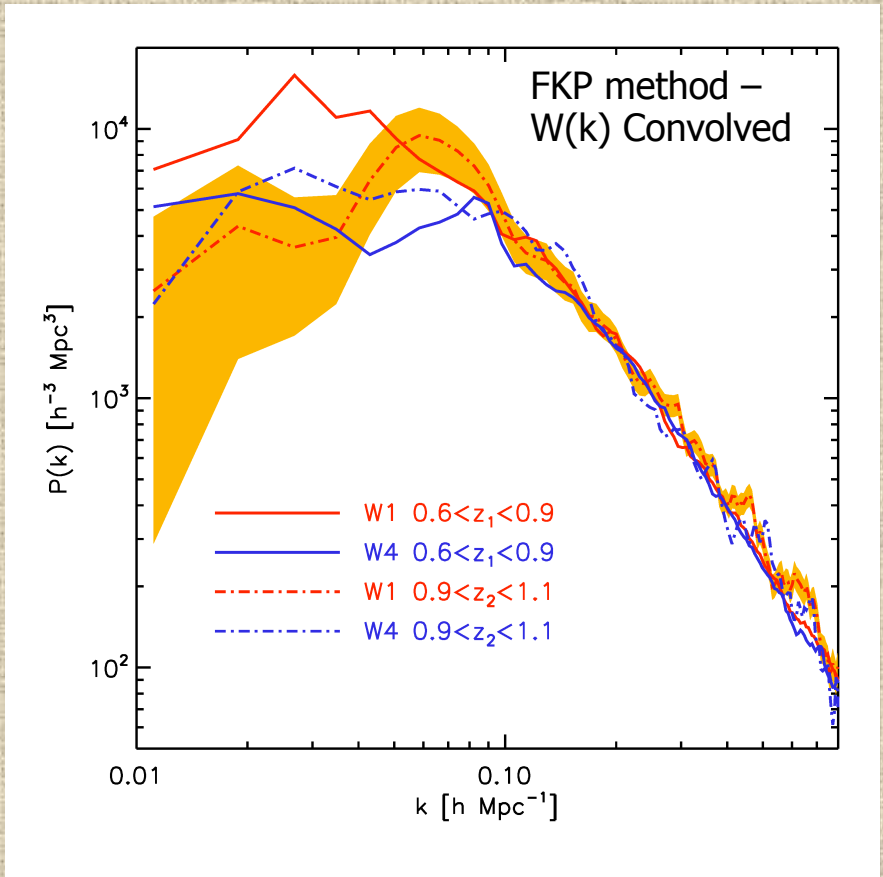


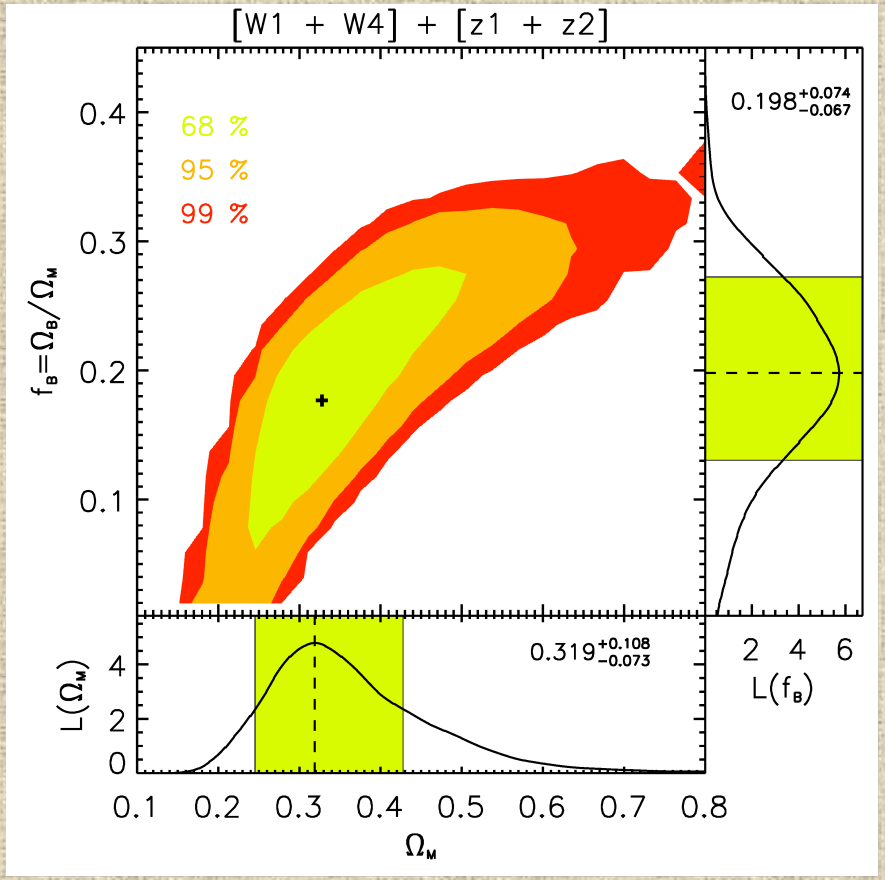
- Very careful treatment of window function

(Rota, Bel, Granett, LG & VIPERS Team, to be submitted)

- 4 independent estimates: 2 z bins in 2 independent fields (W1 and W4)

The power spectrum of the galaxy distribution at z=0.5-1.1 from VIPERS (S. Rota PhD work)





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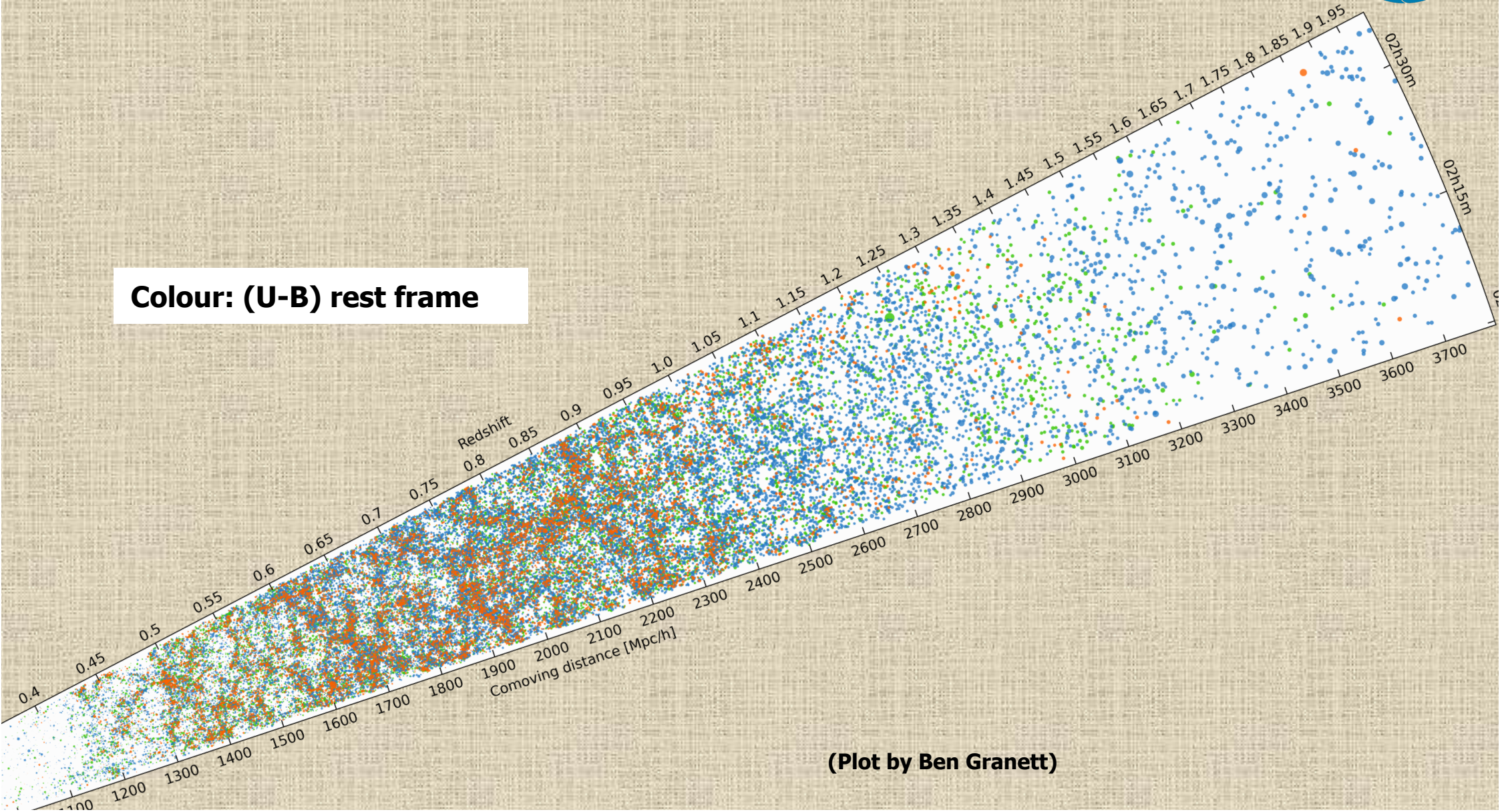
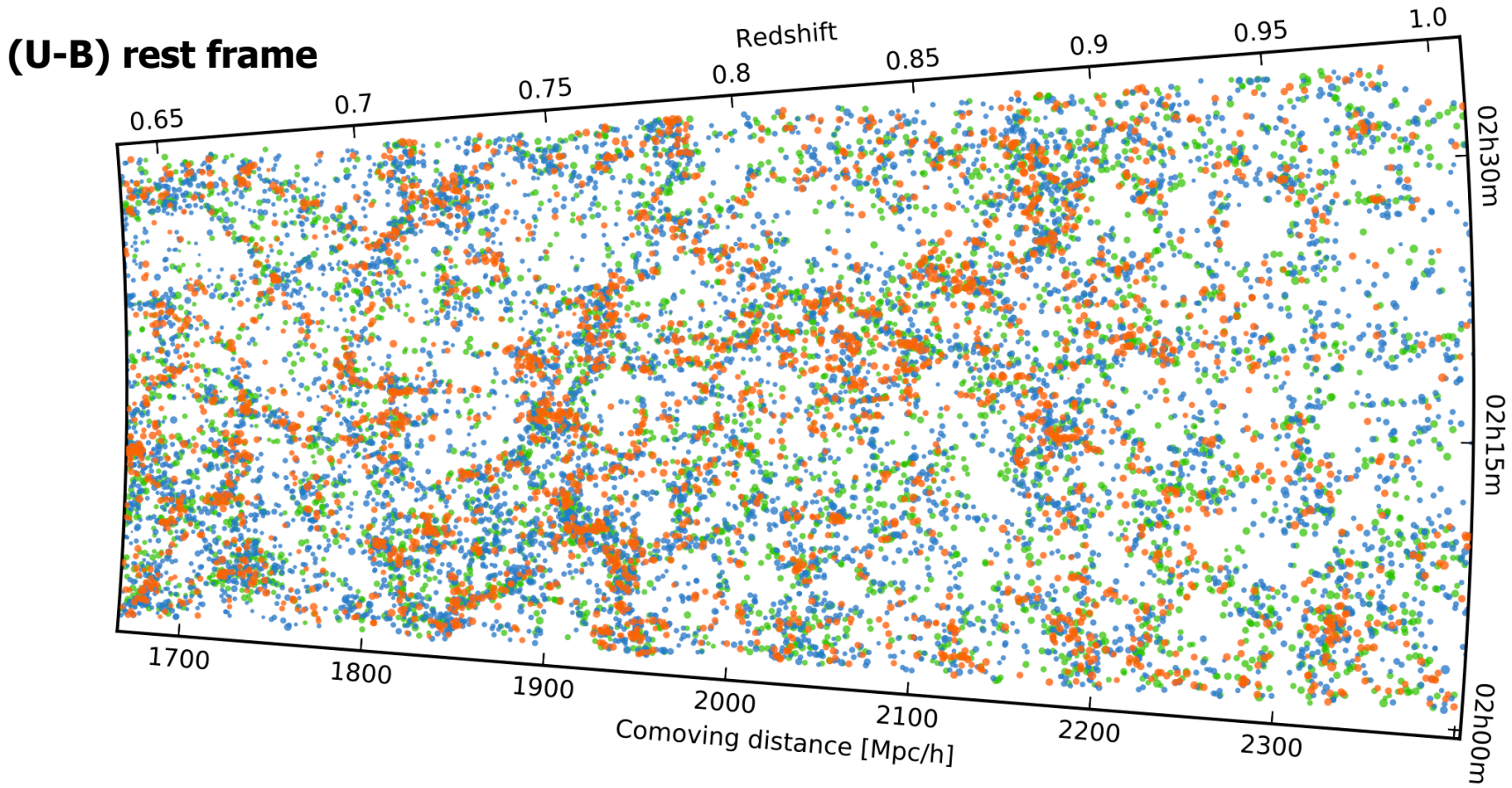
VIPERS provides detailed structure AND galaxy properties



(Plot by Ben Granett)

VIPERS provides detailed structure AND galaxy properties



Color-density relation is self-evident: see Cucciati's talk

Wiener-filter reconstruction of the density field

(slides courtesy of Ben Granett)

Bayesian technique

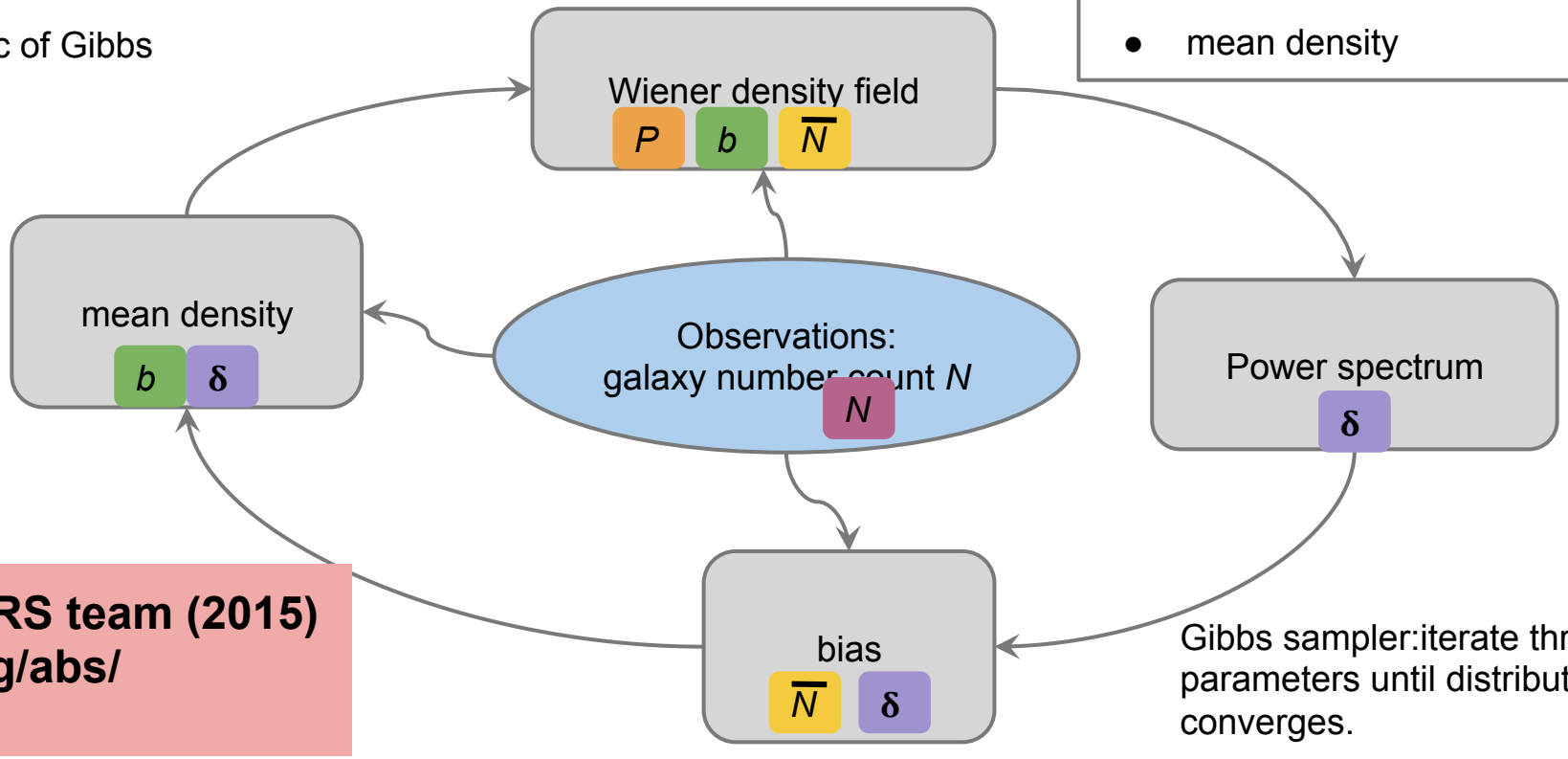
- Markov Chain random walk through the parameter space gives the joint posterior probability distribution of the density field and galaxy statistics.

Dependencies

- Wiener density field
- Power spectrum
- bias
- mean density

δ P b $\overline{N}$

Schematic of Gibbs sampler:



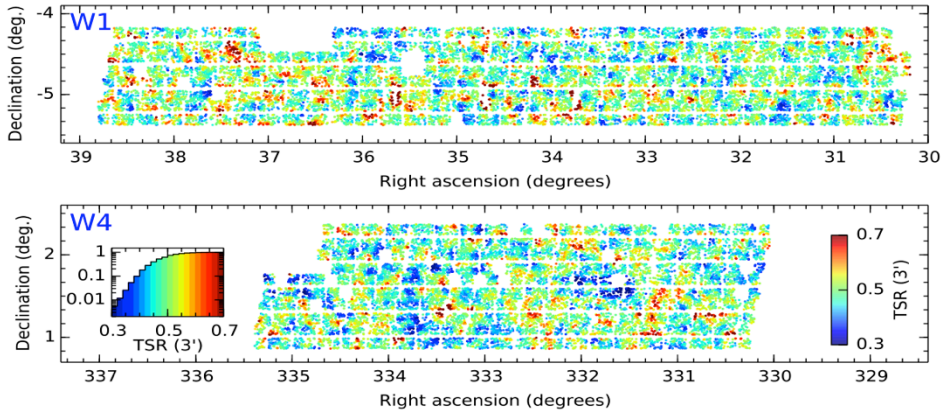
Gibbs sampler:iterate through parameters until distribution converges.

Granett+VIPERS team (2015)
http://arxiv.org/abs/1505.06337

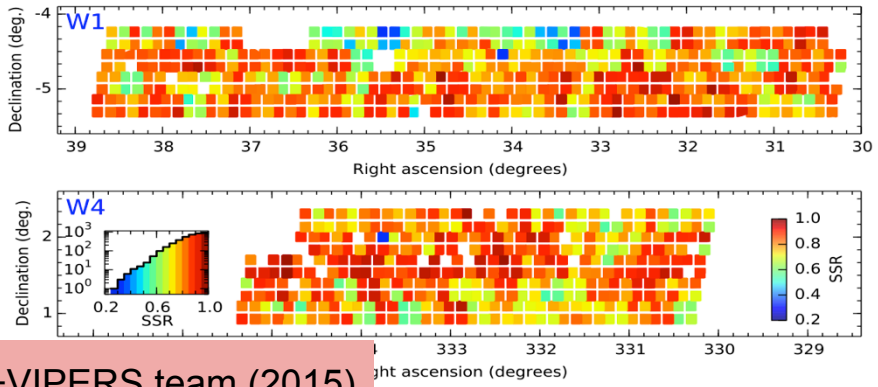
VIPERS data model 1

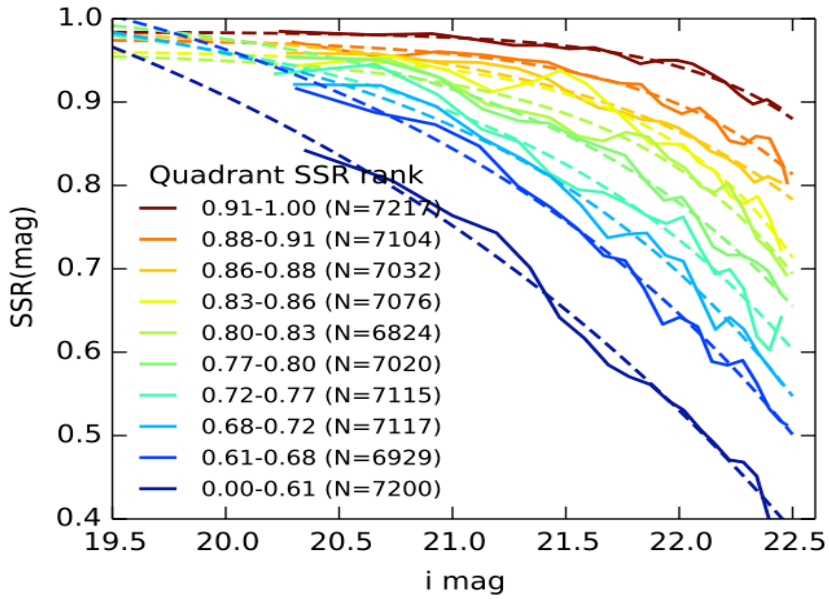
- VIPERS v5 sample
- Selection function includes local TSR (*3 arcmin scale*)
- Galaxies are up-weighted by *quadrant and i_AB* dependent SSR

TSR



SSR





Granett+VIPERS team (2015)
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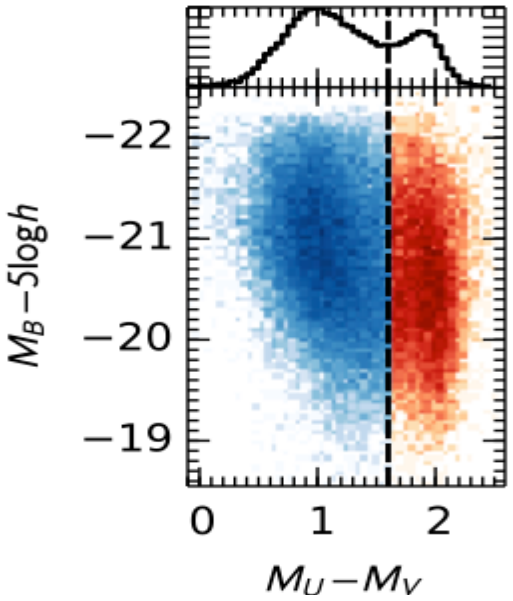
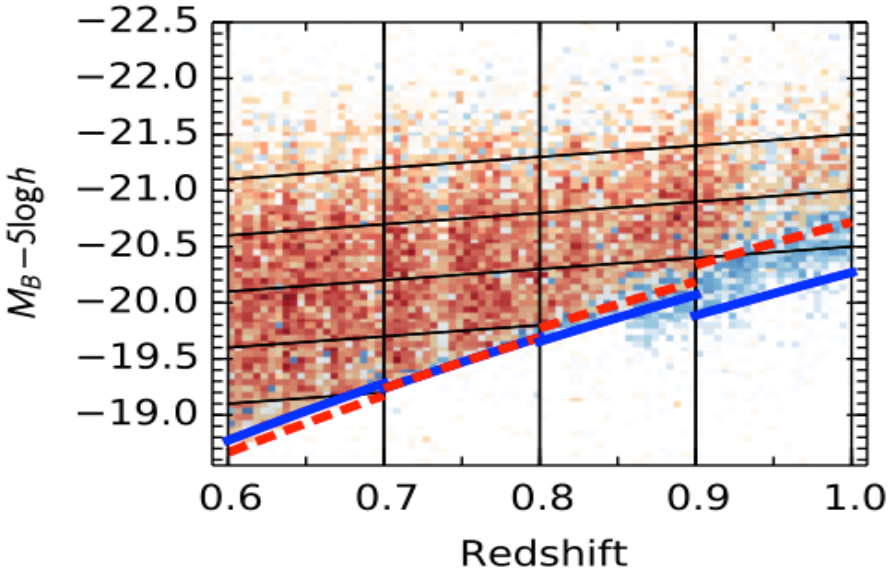
VIPERS data model 2

- The galaxy sample is partitioned into
  - Red/blue colour
  - Bins of abs magnitude M_B
  - 4 redshift bins between 0.6-1.0
- Colour separation U-V=1.6 (independent of redshift)
- Each sub-sample has a free bias parameter and mean density.
- N(z) of each subsample is constrained by flux limit and assumed k-correction





Granett+VIPERS team (2015)
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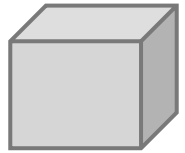
VIPERS data model 3

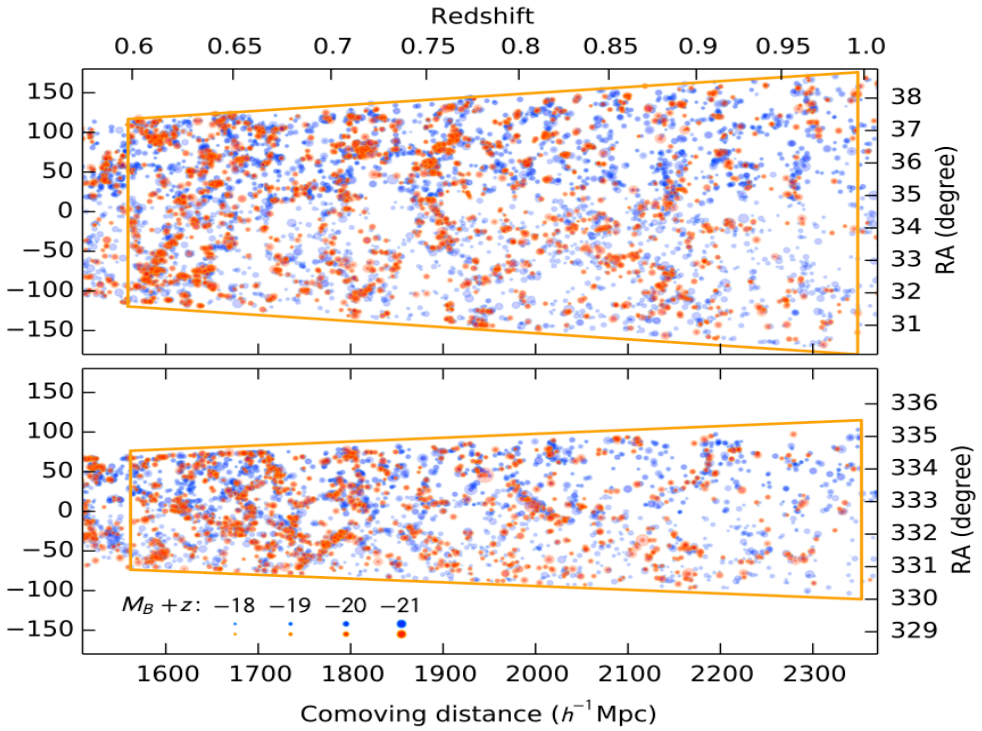


5 Mpc/h cells

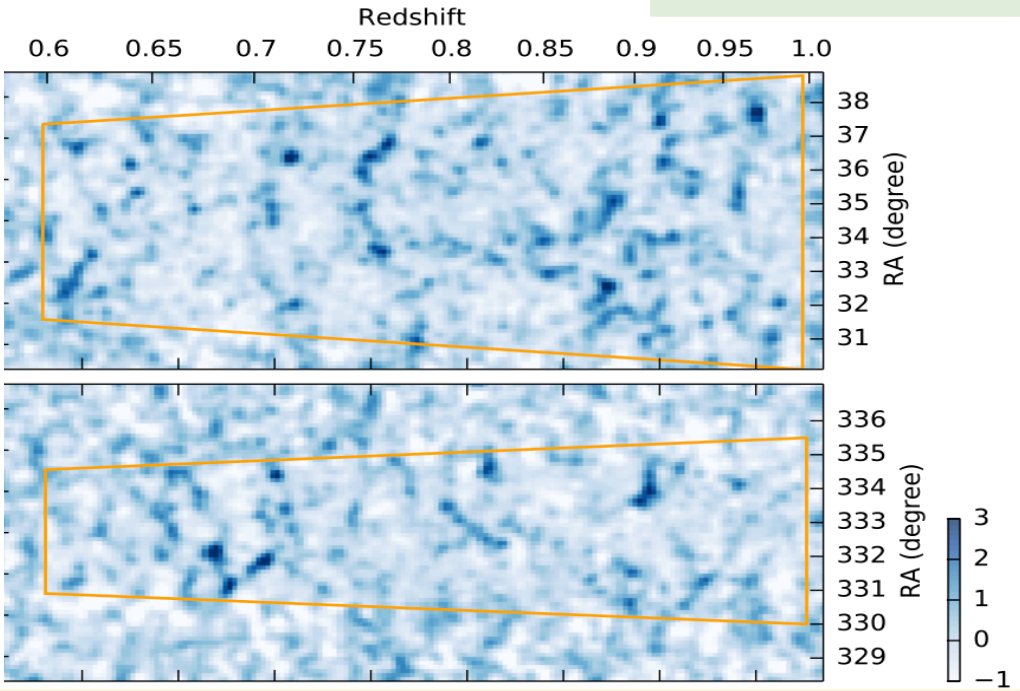
- Galaxies trace an underlying density field (*in redshift space)* with a linear bias
- The density field is characterised in Fourier space by a power spectrum.
- Take Gaussian prior on delta and Gaussian likelihood (Wiener filter)

Box is filled with a Gaussian random field correlated with VIPERS structures

Galaxies

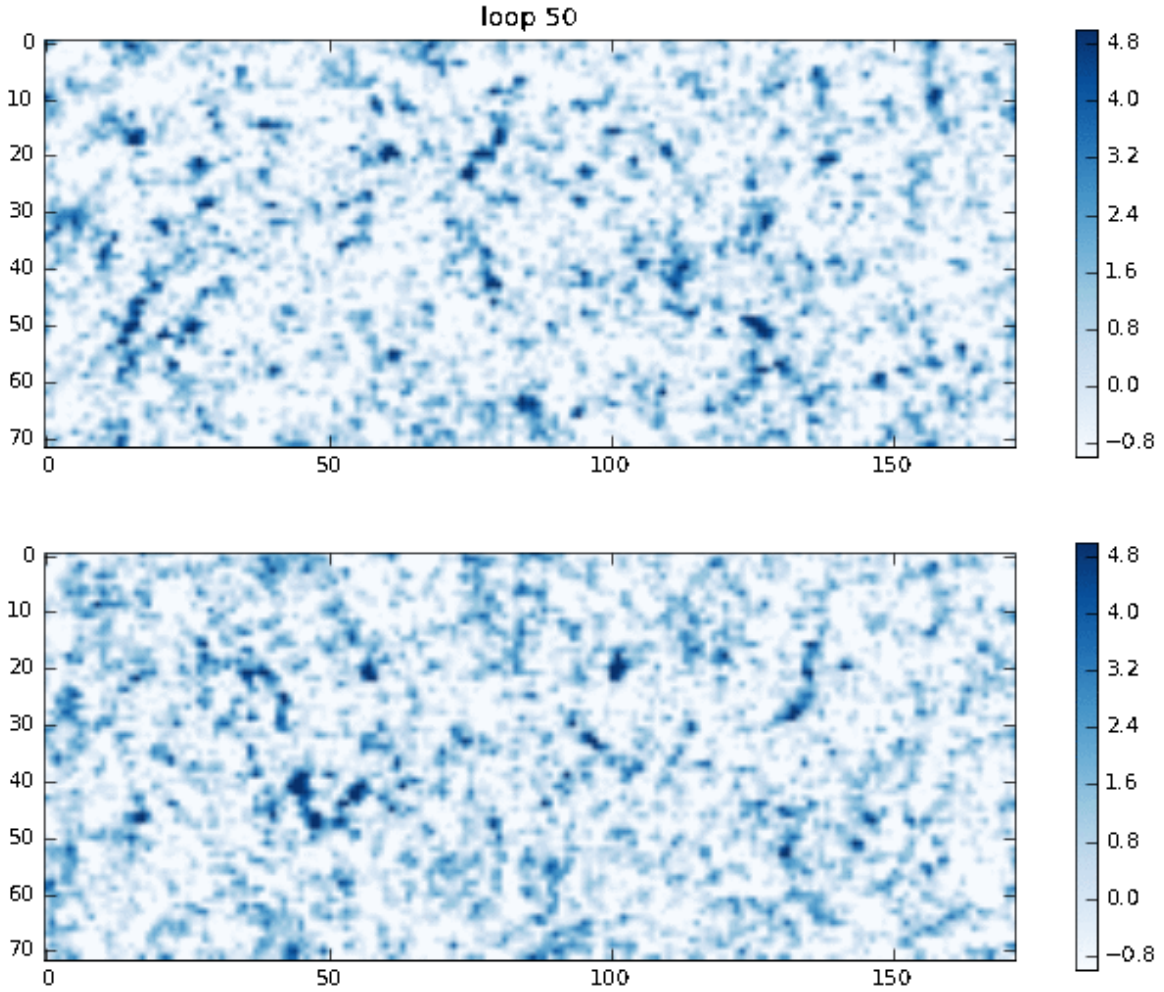


Wiener density field



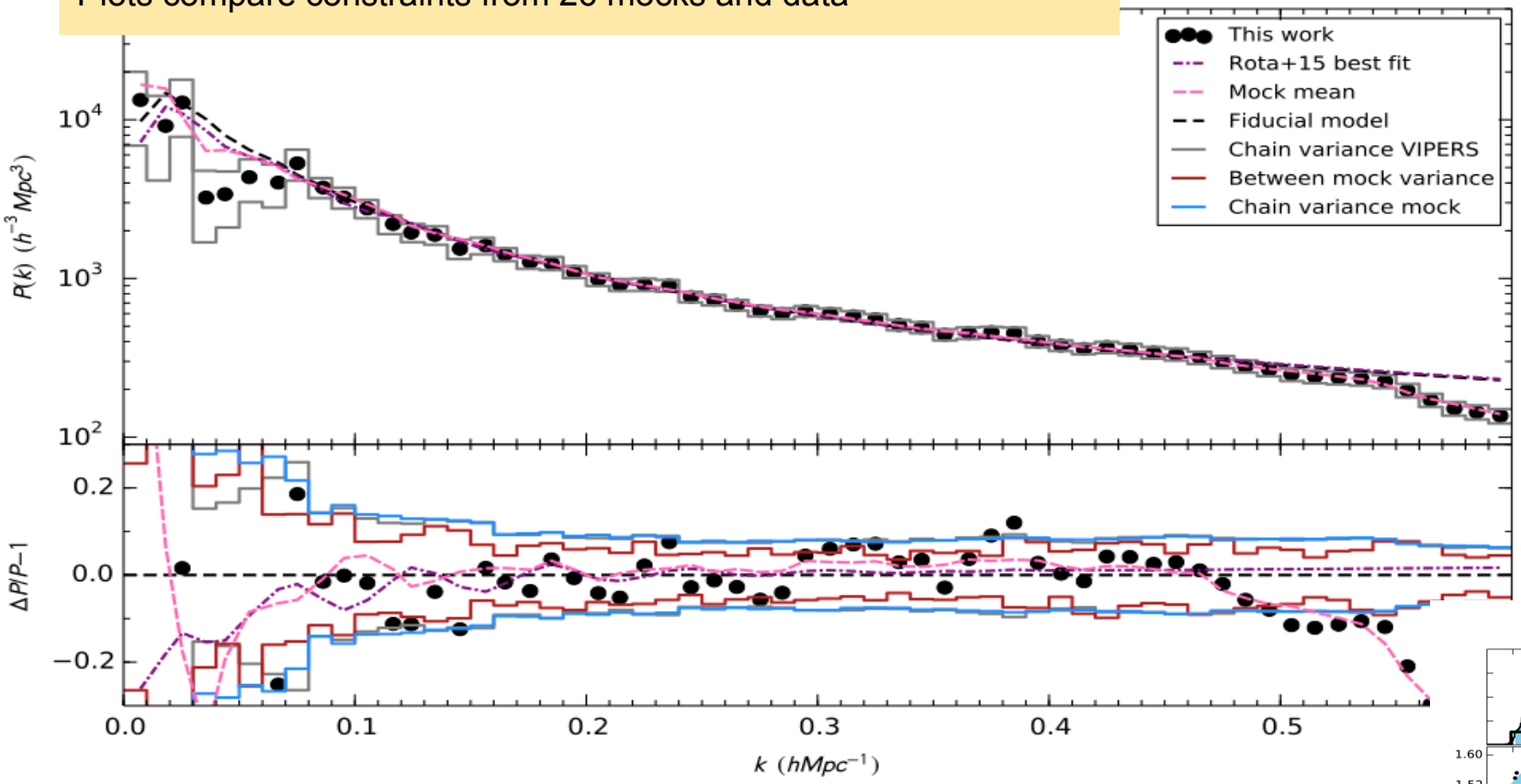
The Wiener density field estimator combines galaxy subsamples with bias weights (Cai+11)

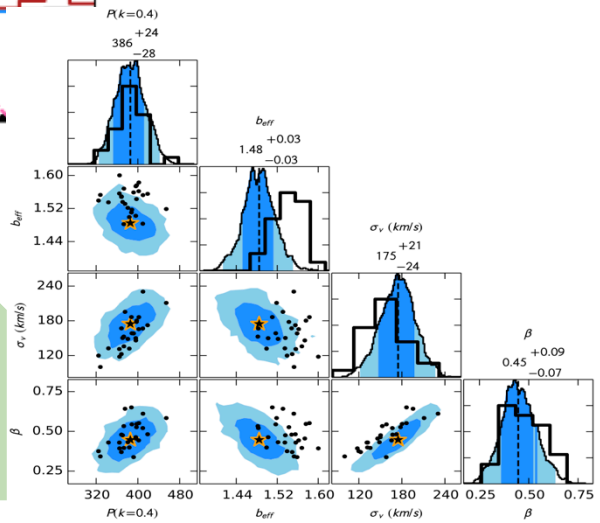
Wiener-filter reconstruction of the density field



Results: Power spectrum and RSD parameters

Plots compare constraints from 26 mocks and data



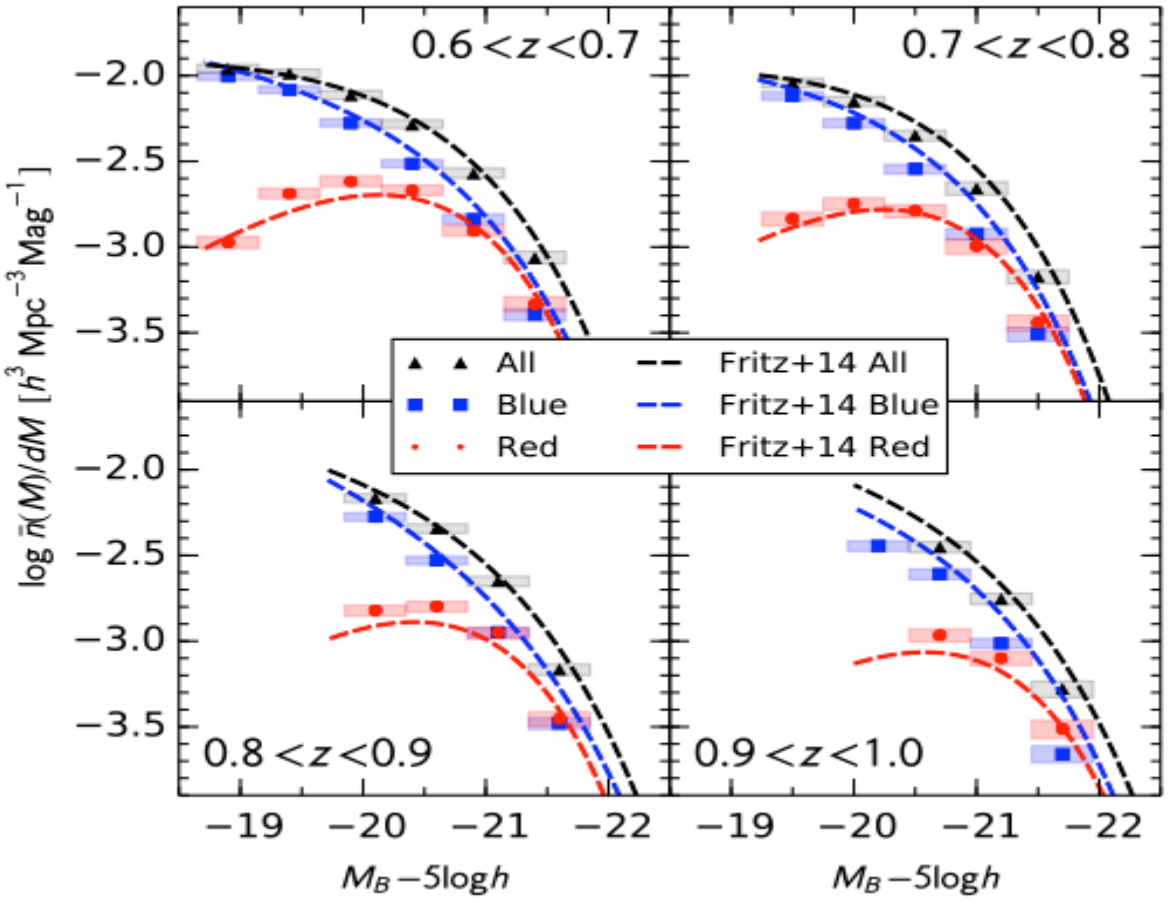


Granett+VIPERS team (2015)
http://arxiv.org/abs/1505.06337

Recovered value for beta and growth rate are consistent with previous VIPERS analyses

Results: number density and luminosity function

- Comparison of n(z,L) with Fritz et al
- Bayesian estimator accounts for correlations between galaxy bias and luminosity (a difference with STY estimator)



Granett+VIPERS team (2015)
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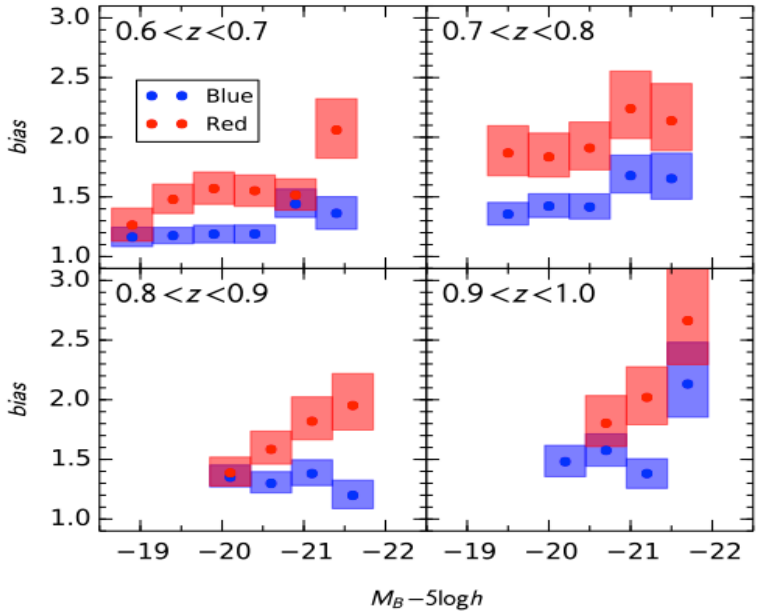
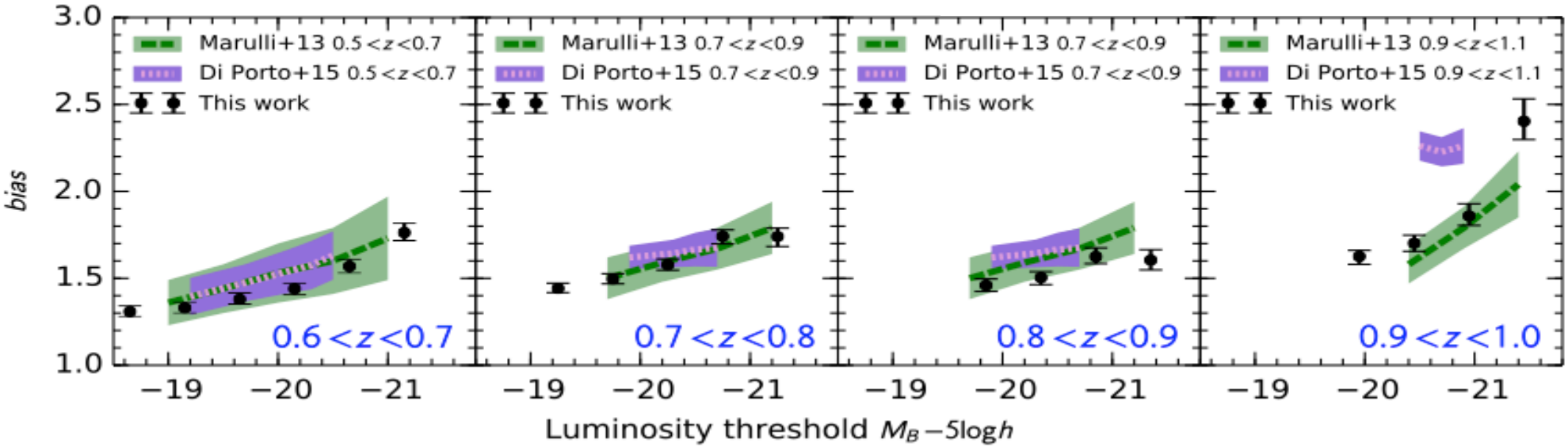
Results: galaxy bias

- ***Color dependence shows red/blue bimodality***
- ***Luminosity dependence in agreement with previous VIPERS analyses.***





Tracking shot of VIPERS

Density field
(Cucciati et al. 2014
Granett et al. 2015
Cucciati et al.)

edshift space distortions
(de la Torre et al. 2013)

Groups of galaxies
(Iovino et al.)

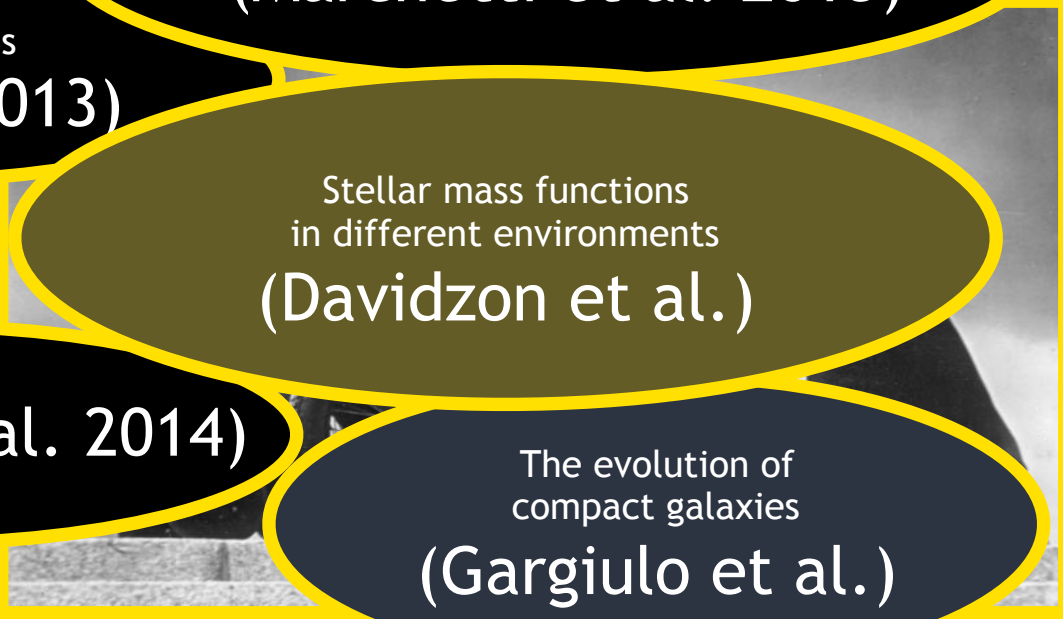
3pt correlation function
(Moresco, Marulli et al.)

Morphology
(Krywult et al.)

Stellar Mass functions
(Davidzon et al. 2013)

PCA galaxy classification
(Marchetti et al. 2013)

Correlation functions
(Marulli et al 2013)



Stellar mass functions
in different environments
(Davidzon et al.)

SFH of early type galaxies
(Siudek et al.)

Voids
(Micheletti et al. 2014)

The evolution of
compact galaxies
(Gargiulo et al.)

Colour bimodality
and luminosity function
(Fritz et al. 2014)

VIPERS: published papers so far

- Marchetti et al. 2013: *The VIMOS Public Extragalactic Redshift Survey (VIPERS): spectral classification through principal component analysis*
- Małek et al. 2013: *The VIMOS Public Extragalactic Redshift Survey (VIPERS). A support vector machine classification of galaxies, stars, and AGNs*
- Marulli et al. 2013: *The VIMOS Public Extragalactic Redshift Survey (VIPERS) . Luminosity and stellar mass dependence of galaxy clustering at 0.5 < z < 1.1*
- de la Torre et al. 2013: *The VIMOS Public Extragalactic Redshift Survey (VIPERS) . Galaxy clustering and redshift-space distortions at z ≃ 0.8 in the first data release*
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