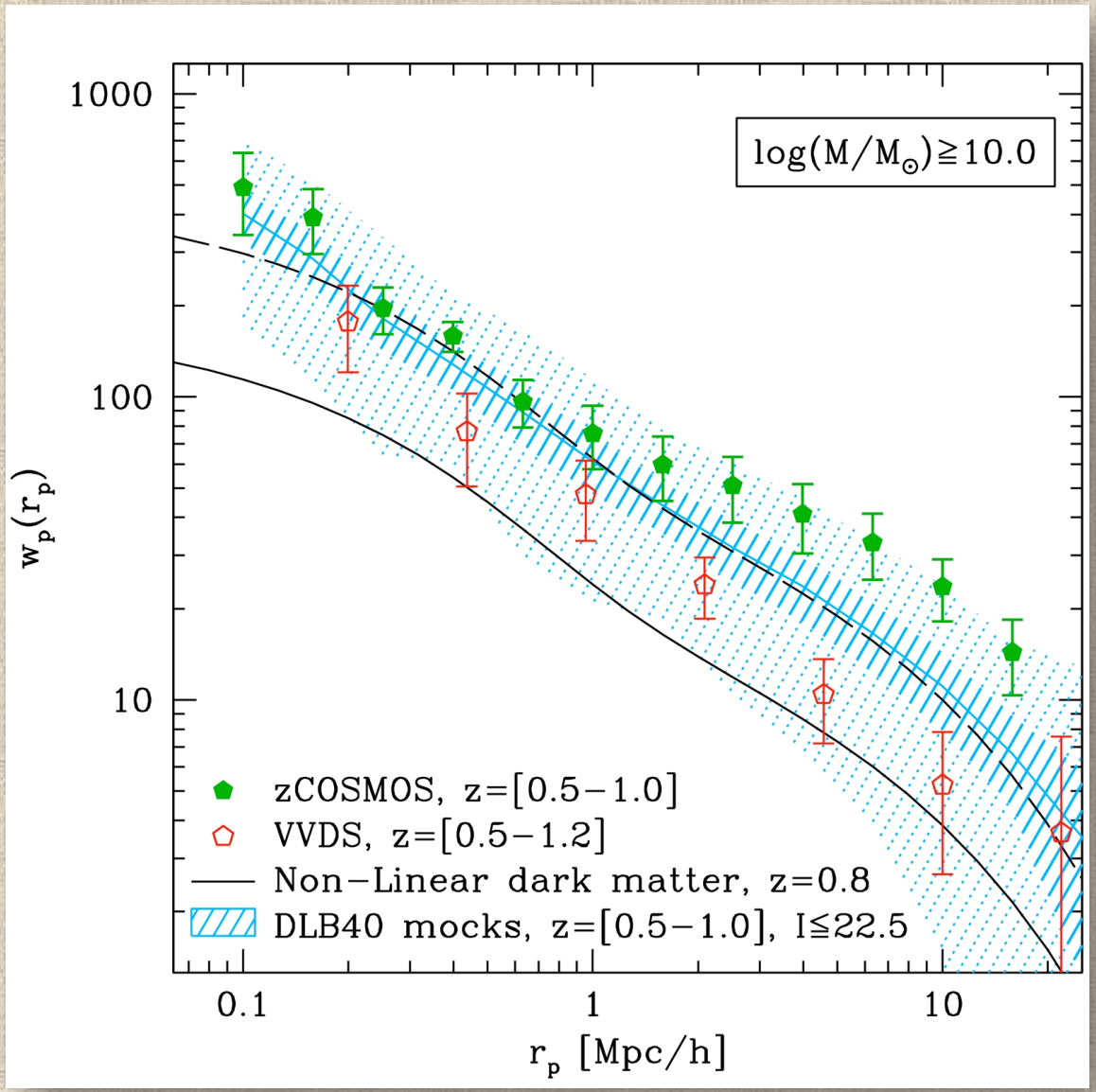
MILANO OAB: L. Guzzo, S. de la Torre, , E. Majerotto, U. Abbas (Turin), A. Iovino; MILANO IASF (data reduction center): B. Garilli, M. Scodeggio, D. Bottini, P. Franzetti, P. Memeo, M. Polletta, L. Tasca; BOLOGNA: M. Bolzonella, L. Moscardini, E. Branchini (Rome), A. Cappi, F. Marulli, D. Vergani, G. Zamorani, A. Zanichelli; EDINBURGH: J. Peacock; GARCHING MPE/LMU: B. Meneux, S. Phleps, H. Schlagenhaufer; JHU: A. Szalay; LYON: J. Blaizot; MARSEILLE: O. Ilbert, O. Le Fevre, V. Le Brun, C. Adami, O. Cucciati, C. Marinoni; PARIS: H. McCracken, J. Coupon, Y. Mellier; PORTSMOUTH: W. Percival, R. Nichol, R. Tojeiro, A. Raccanelli; TRIESTE: G. de Lucia; WARSAW: A. Pollo, J. Krywult, K. Malek

Survey motivations

- Clustering measurements from existing z~1 samples (VVDS, ZCOSMOS) are cosmic-variance limited
- Look for best compromise between largest possible volume (reduce cosmic variance) and good sampling (reduce Poissonian noise in field reconstructions)
- Exploit VIMOS high multiplexing on moderately large field of view: focus on LSS and clustering, completing and extending the original VVDS-Wide concept
- To do this, introduce new techniques to maximize volume and sampling in redshift range of interest
- The next step of large-scale structure studies at z~1: in practice, a 2dFGRS at z~1 (but with 5-band photometry)

Cosmic variance in z~1 clustering measurements

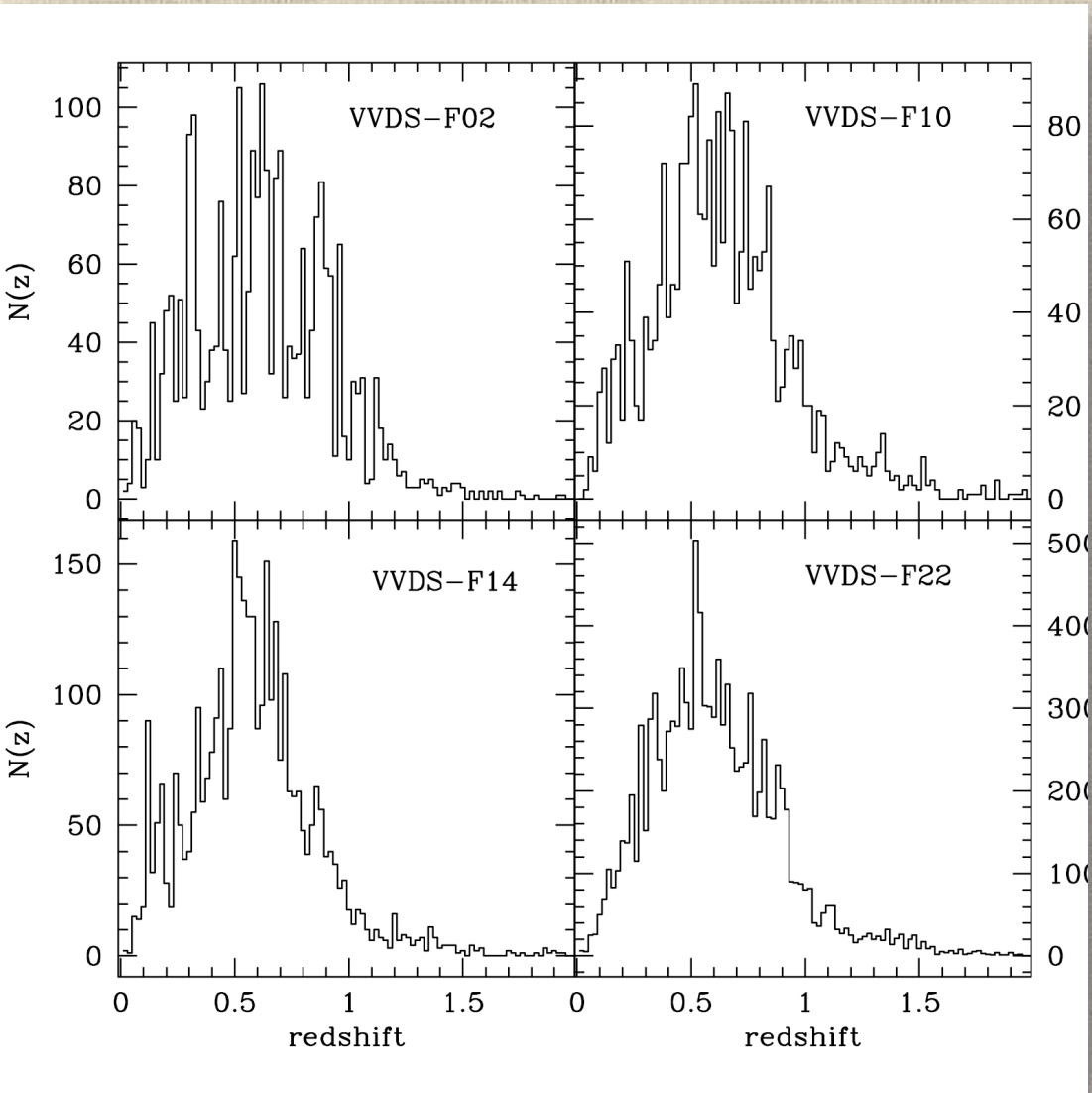


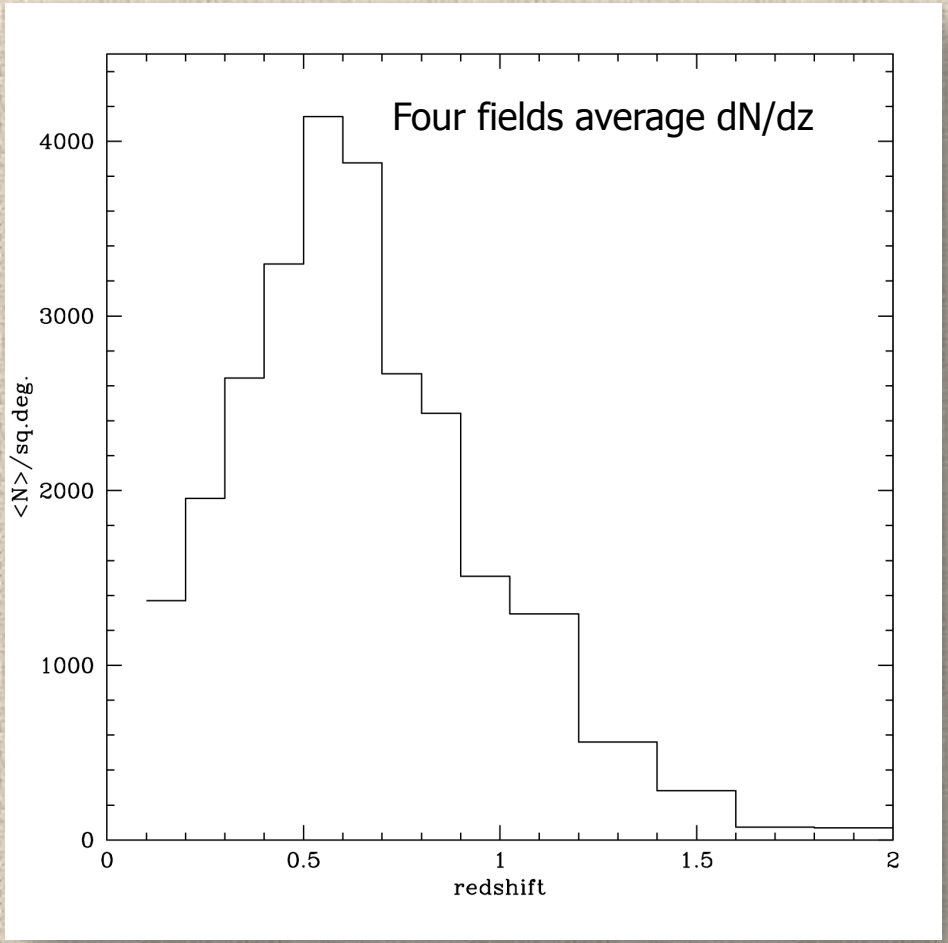
Meneux & ZCOSMOS Collaboration, 2009, in preparation

VVDS: Meneux et al. 2008

Mock samples: Millennium simulation + semi-analytic (Blaizot & De Lucia 2006)

Cosmic variance in VVDS-Wide I_{AB}<22.5 fields





Garilli et al. 2008

European Organisation for Astronomical Research in the Southern Hemisphere

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

VISITING ASTRONOMERS DEPARTMENT • Karl-Schwarzschild-Straße 2 • D-85748 Garching bei München • e-mail: visas@eso.org • Tel. : +49-89-32 00 64 73

APPLICATION FOR OBSERVING TIME LARGE PROGRAMME PERIOD: **82A**

Important Notice:

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of CoIs and the agreement to act according to the ESO policy and regulations, should observing time be granted

1. Title Category: **A–3**

The large-scale structure and growth rate of the Universe at $z \sim 1$ from a survey of 100,000 galaxy redshifts

2. Abstract / Total Time Requested

Total Amount of Time: 0 nights VM, 423.0 hours SM Total Number of Semesters: 4

We propose to use VIMOS to realize the first concrete step towards a public ESO redshift survey of the $z \sim 1$ Universe, observing more than 100,000 galaxies with $I_{AB} < 22.5$ over a total area of 24 deg^2. This represents a ten-fold increase over current samples at comparable redshifts and exploits the still unsurpassed multi-plexing capabilities of VIMOS. Such an unprecedented data set will allow us to address a broad range of open problems in large-scale structure and galaxy evolution, with a *legacy* value comparable to that of the 2dFGRS at low redshifts. We shall accurately measure galaxy clustering and redshift-space distortions, quantifying the evolution of the growth rate of structure $f(z)$ between $z = 0.5$ and $z = 1.2$. Through a robust and carefully tested pre-selection of galaxies with $z > 0.5$, we reach an effective sampling rate of $\sim 40\%$ with only one VIMOS shot. Together with the large volume (5×10^7 h^{-3} Mpc^3), such high sampling brings the error on the global growth function in this range below $\sim 8\%$, nearly a factor of five increase with respect to current measurements. This will provide a direct test of the nature of cosmic acceleration, distinguishing dark energy models from modifications of the gravity theory. The measured redshifts will also provide a unique calibration set for next-generation photometric redshift surveys. To maximize its broader impact, the survey areas coincide with the two key fields of the CFHTLS and UKIDSS surveys, where accurate multi-band photometry is available.

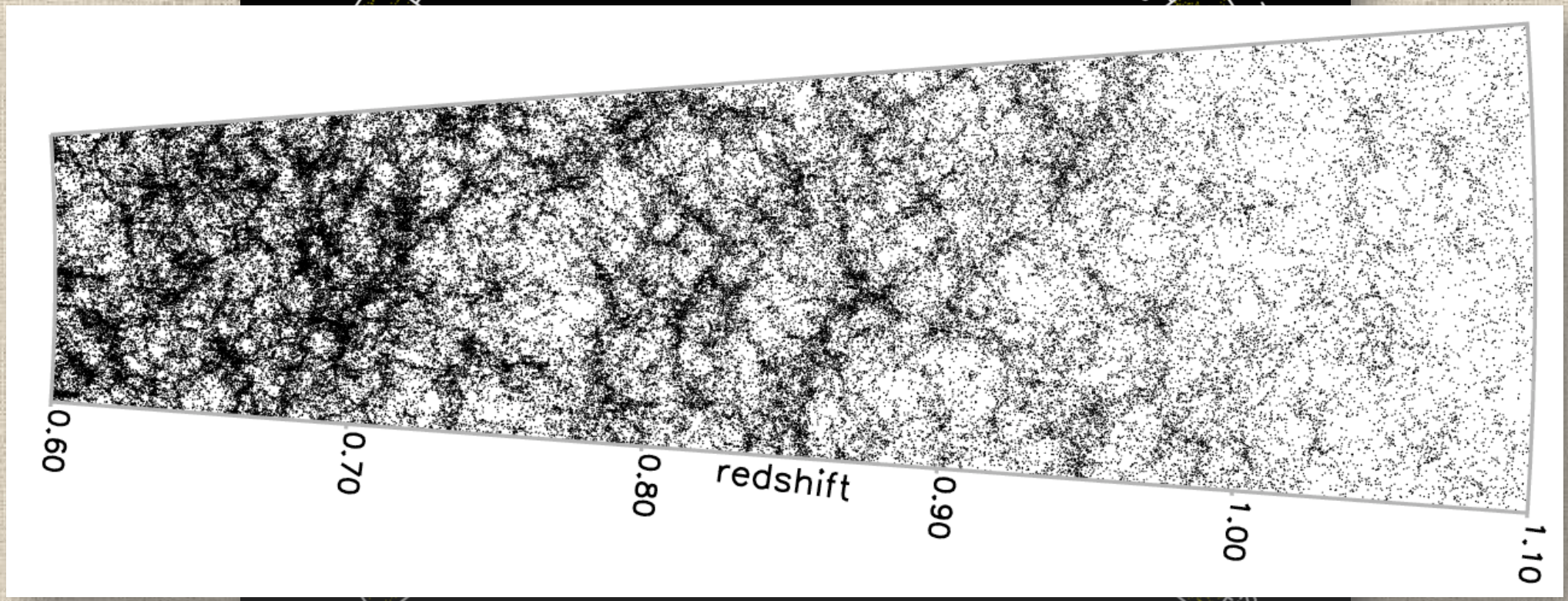
The project in a nut-shell

- 423 VLT hours (+17.5)
- ~24 deg^2 in the CFHTLS wide fields:
  - ~2x8 deg^2 slice in W1
  - ~2x4 deg^2 slice in W4
- I_{AB}<22.5, LR Red grism, 45 min exp.
- 288 VIMOS pointings
- z>0.5 color-color pre-selection
- PSF + SED –based star-galaxy separation (AGN color recovery)
- >50% sampling
- >100,000 redshifts

A	82	18.5h	oct	IMA
B	82	13h	oct	MOS
C	82	43h	nov	MOS
D	82	45h	dec	MOS
E	83	12.5h	jul	IMA
F	83	23h	aug	IMA
G	83	39h	aug	MOS
H	83	33.5h	sep	MOS
I	84	33h	oct	MOS
J	84	33.5h	nov	MOS
K	84	45h	dec	MOS
L	85	8.5h	jul	IMA
M	85	6h	aug	IMA
N	85	39h	aug	MOS
O	85	30.5h	sep	MOS

VIPERS: a 2dFGRS at 0.5<z<1.2

VIPERS 2x8 deg2 slice in CFHTLS W1 field (mock sample by J. Blaizot & G. De Lucia)



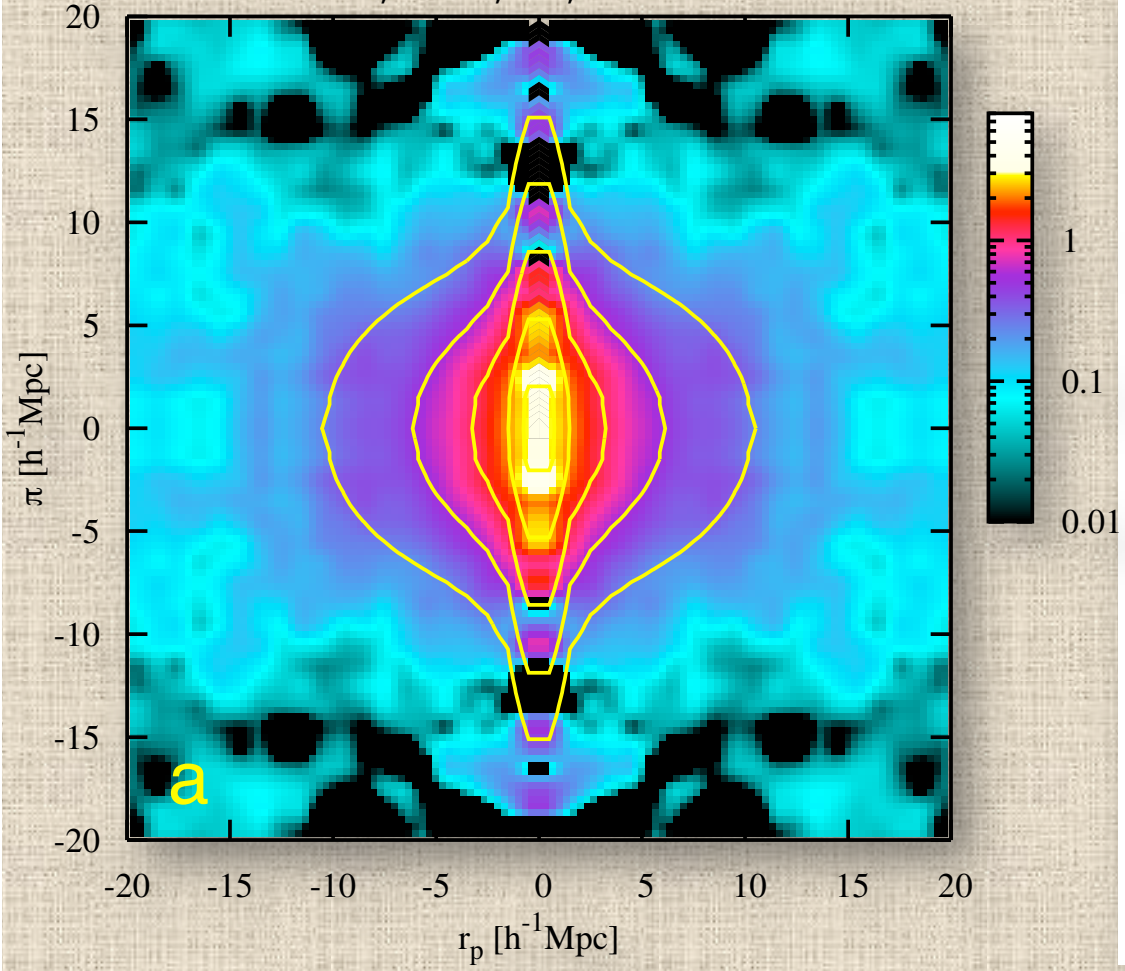
+2x4 deg2 slice in CFHTLS W4 field (VVDS F22)

VIPERS broad scientific goals

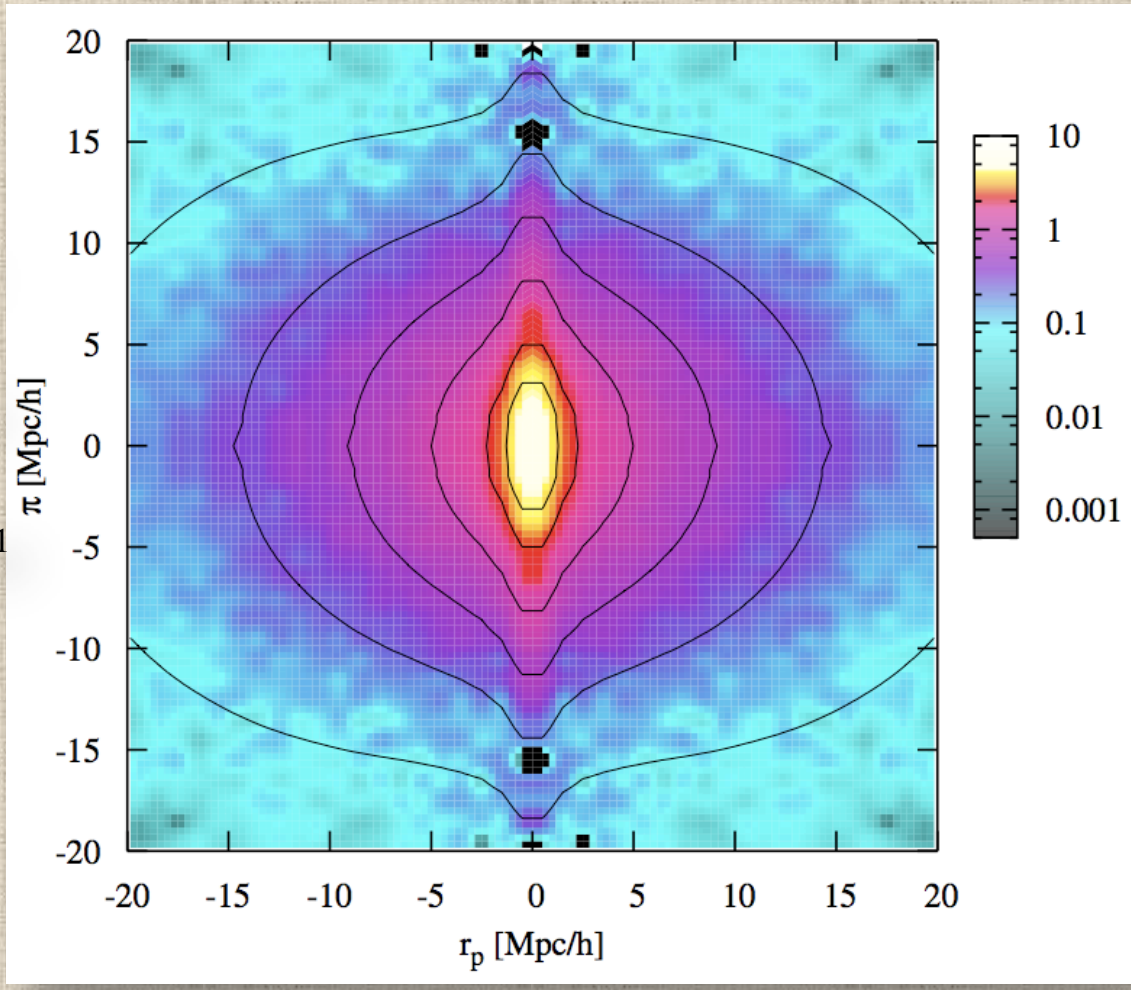
- Growth rate from redshift-space distortions
- Galaxy clustering at z~1:
  - Evolution of $\xi(r)$ and P(k)
  - Dependence of clustering on galaxy properties
  - HOD modeling
- Galaxy bias
- Massive clusters and super-clusters of galaxies
- Evolution of galaxy colors and dependence on local density
- Bright/massive/rare galaxies and the galaxy luminosity and stellar mass functions
- Evolution of AGN's
- Weak-lensing (photo-z calibration!)
- Multi-wavelength investigations (SWIRE, XMM, UDS)

Growth rate from redshift-space distortions

Guzzo et al 2008, Nature, 451, 541



VVDS F22 (~6000 gals)

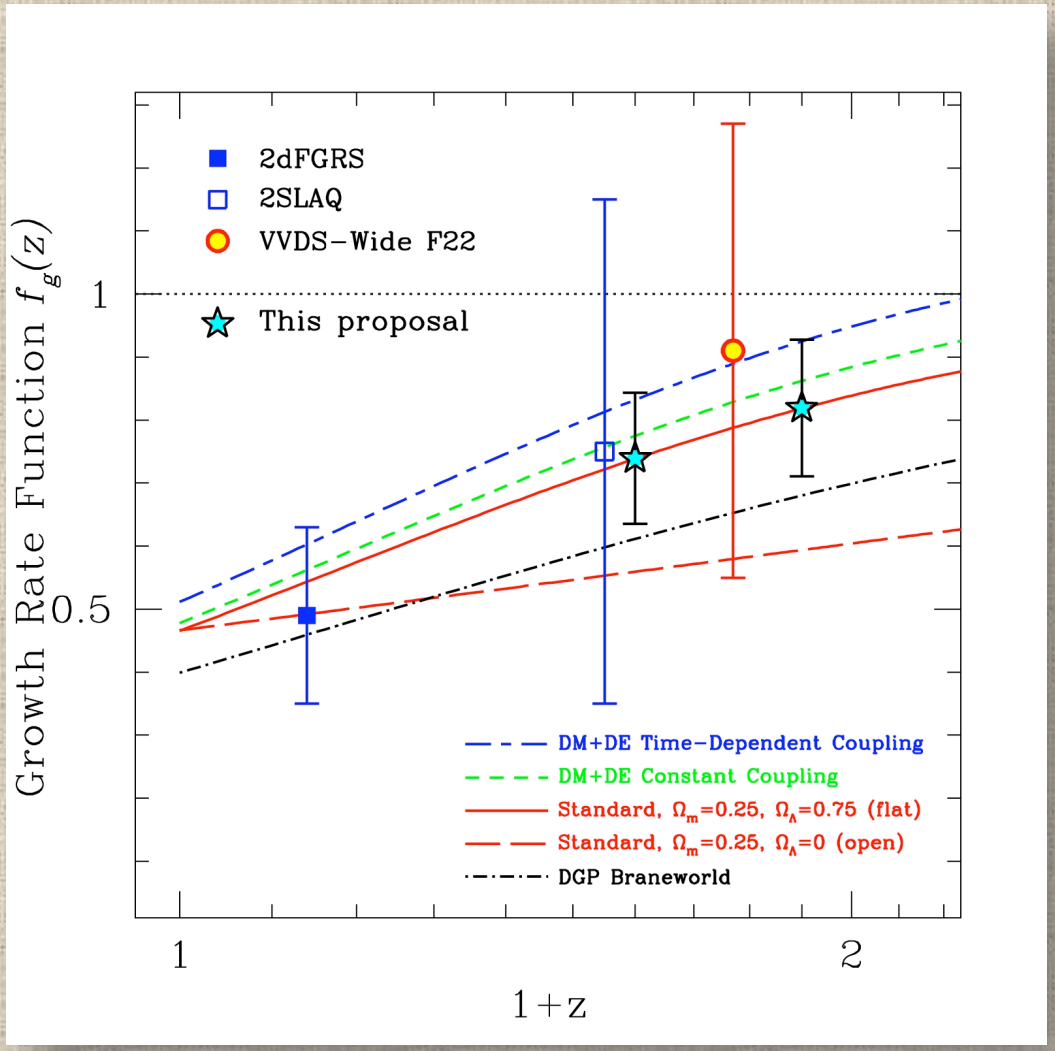


VIPERS (~100,000 gals)

(Conservative) forecast on f(z) in two bins from VIPERS

→ Measure f with better than ~10% uncertainty within two redshift bins: rule out class of modified gravity models (e.g. DGP)

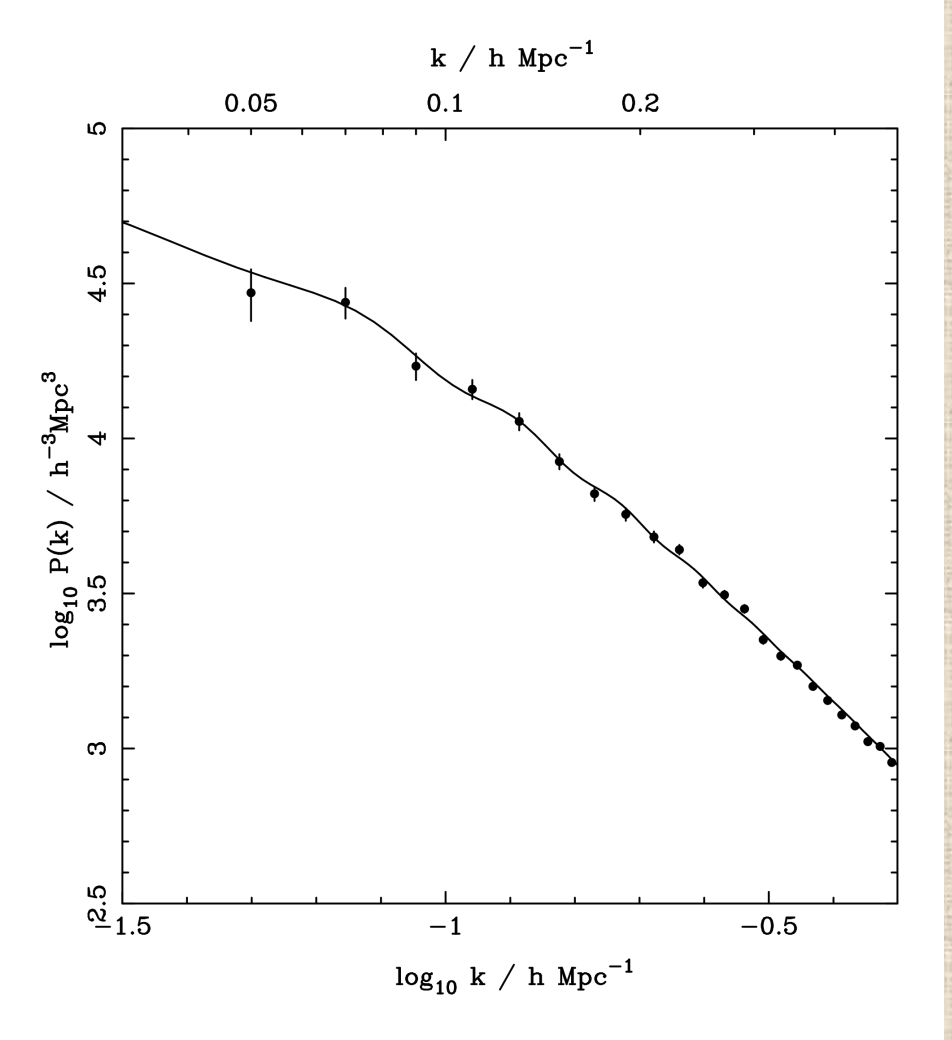
$$\sigma_\beta \approx \frac{A}{V^{0.5}\langle n \rangle^{0.44}}$$



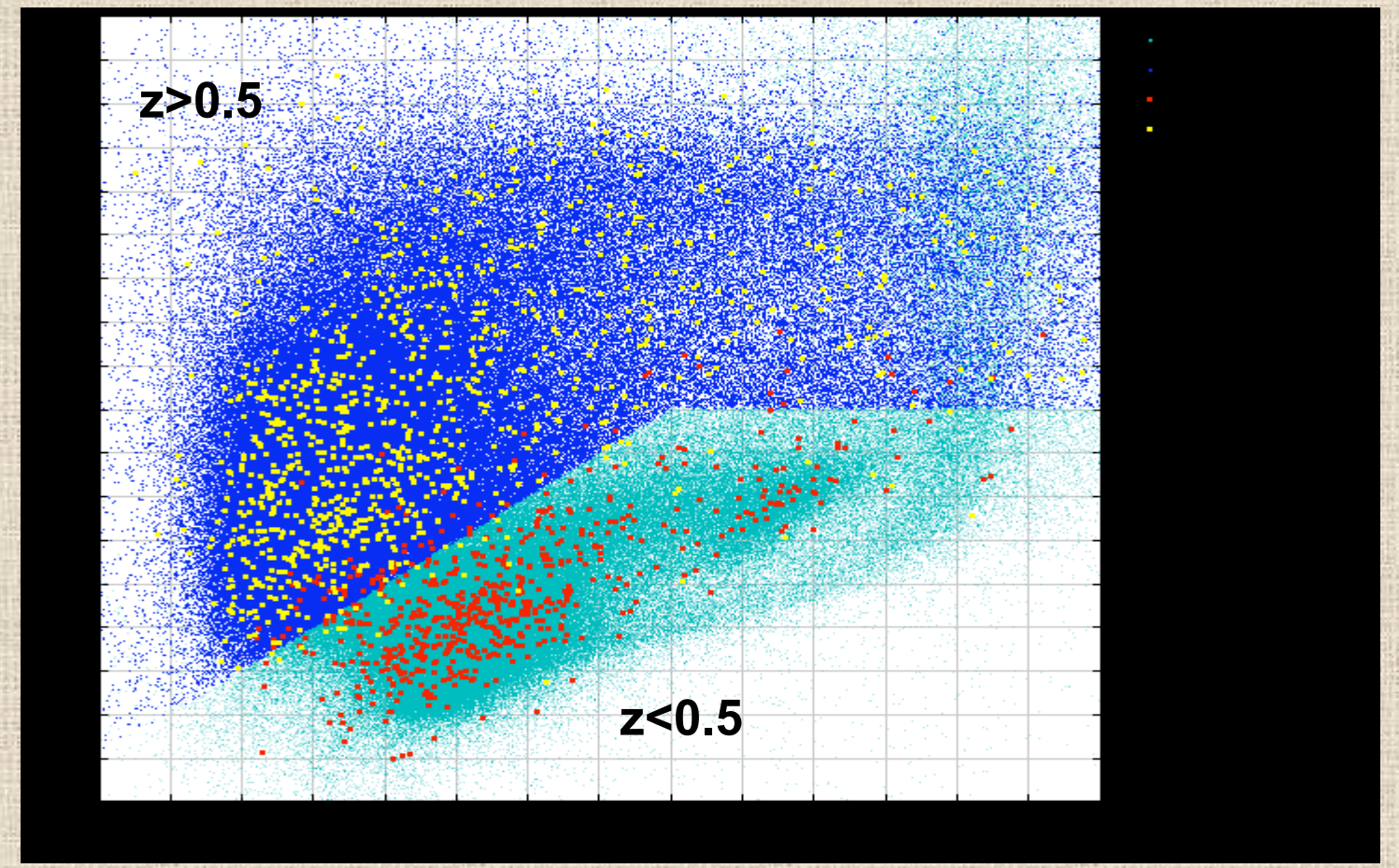
Expected P(k) at <z>~0.8 from VIPERS

(from W. Percival)

- Measure $\Omega_m h$ from shape of power spectrum
- BAO (baryon fraction, standard ruler?)
- z-space distortions
- neutrino mass?
- large-scale bias vs galaxy properties

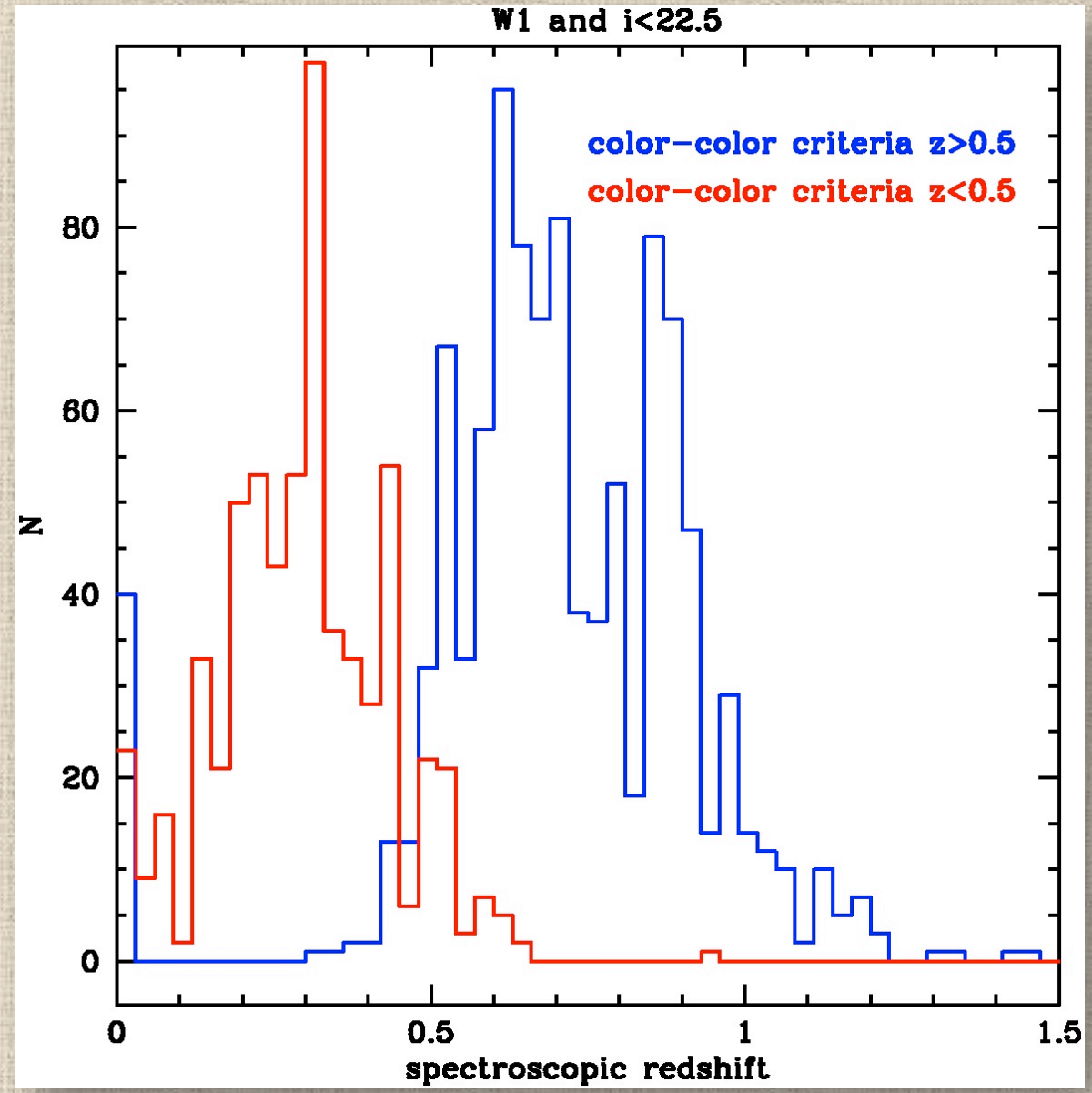


VIPERS COLOR-COLOR SELECTION: ISOLATING z>0.5 GALAXIES



VIPERS catalog and VVDS check sample

Completeness/contamination of color-color selection



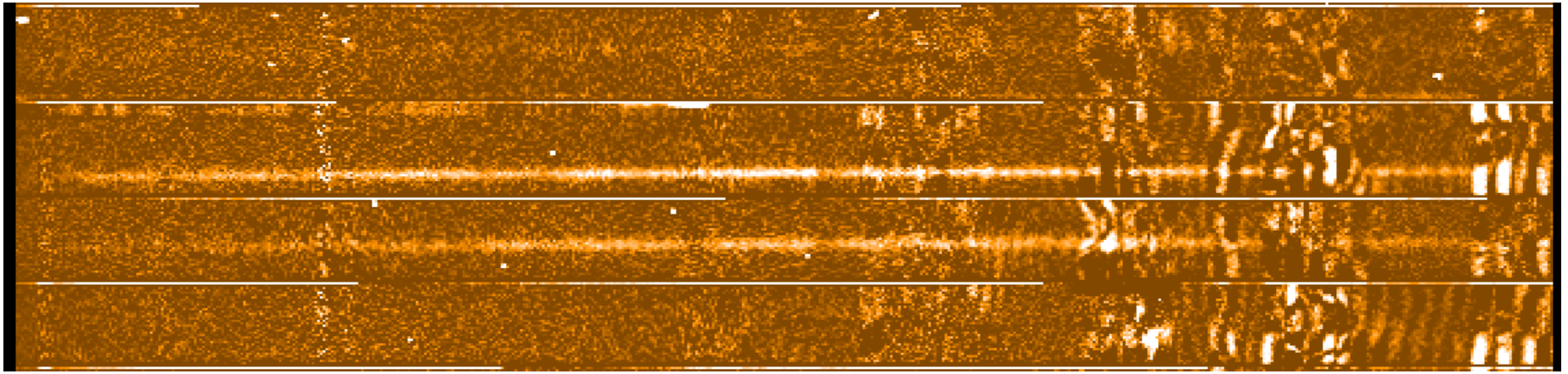
2nd improvement. New short-slit observing strategy: ~double packing of spectra within VIMOS FoV

- **Traditional method to correct fringing: jittered sequence, long slits**:
  - sky subtraction within each exposure, based on local (same slit) sky estimate, row by row
  - fringing residual subtraction based on median combination of jittered exposures

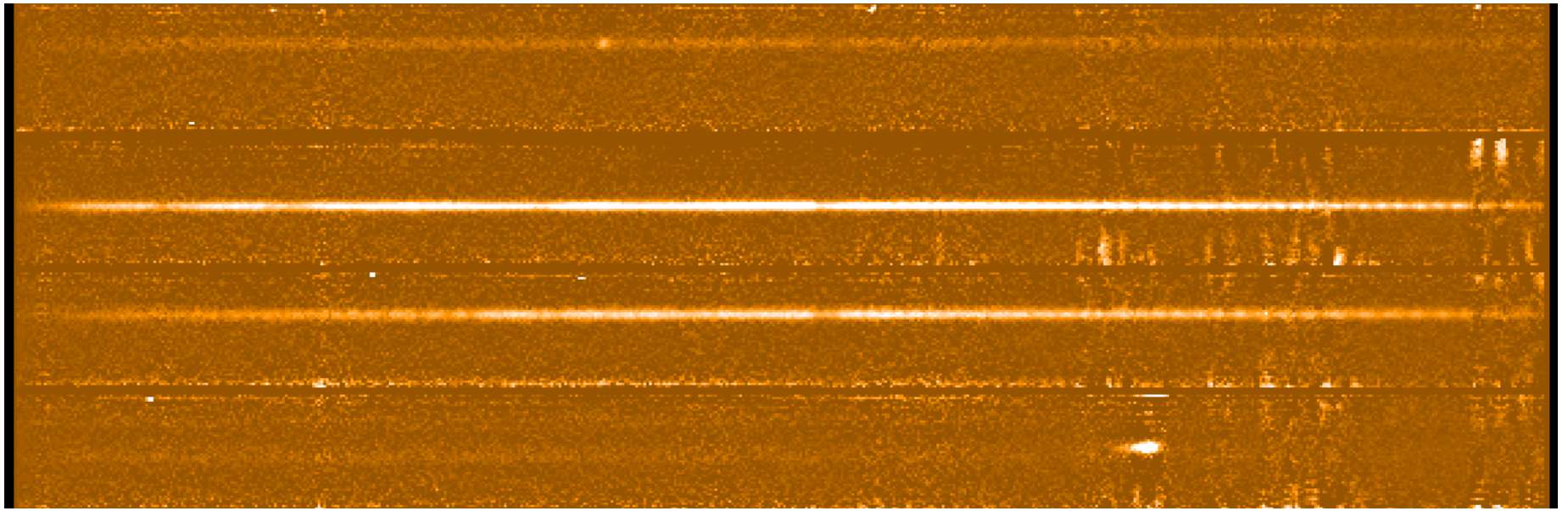
- **New method, stare sequence, short slits**:
  - sky level determination within each exposure, based on local (same slit) estimate, row by row
  - identification of flat-field row best matching the science exposure fringing pattern, allowing for flexures to shift the pattern around
  - subtraction of the best matching flat-field row, normalized to the sky level intensity

- → **Please see Marco Scodeggio for details** (see also Scodeggio et al., The Messenger)

STANDARD FRINGING SOLUTION: JITTERING

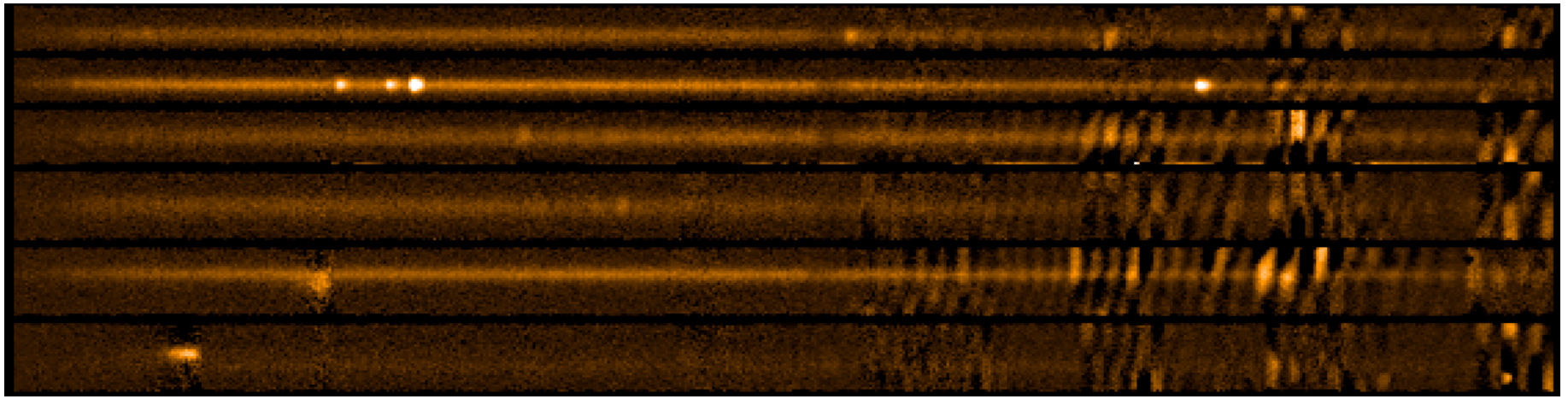


VVDS F02
single exp.
no fringing
correction

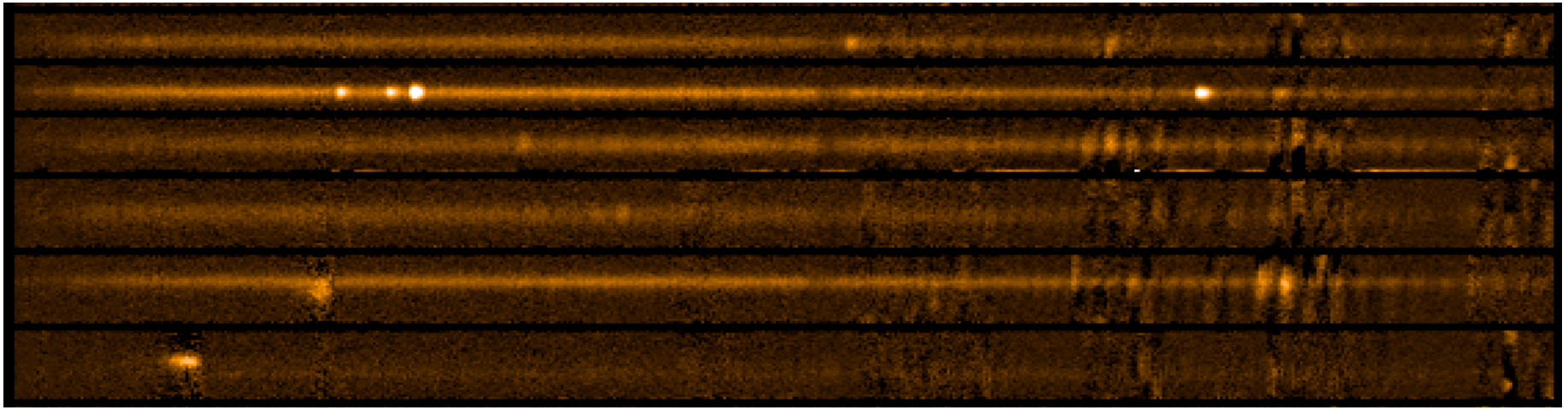


VVDS F02
combined
jittered exp.
with
fringing
correction

FRINGING: THE NEW SOLUTION



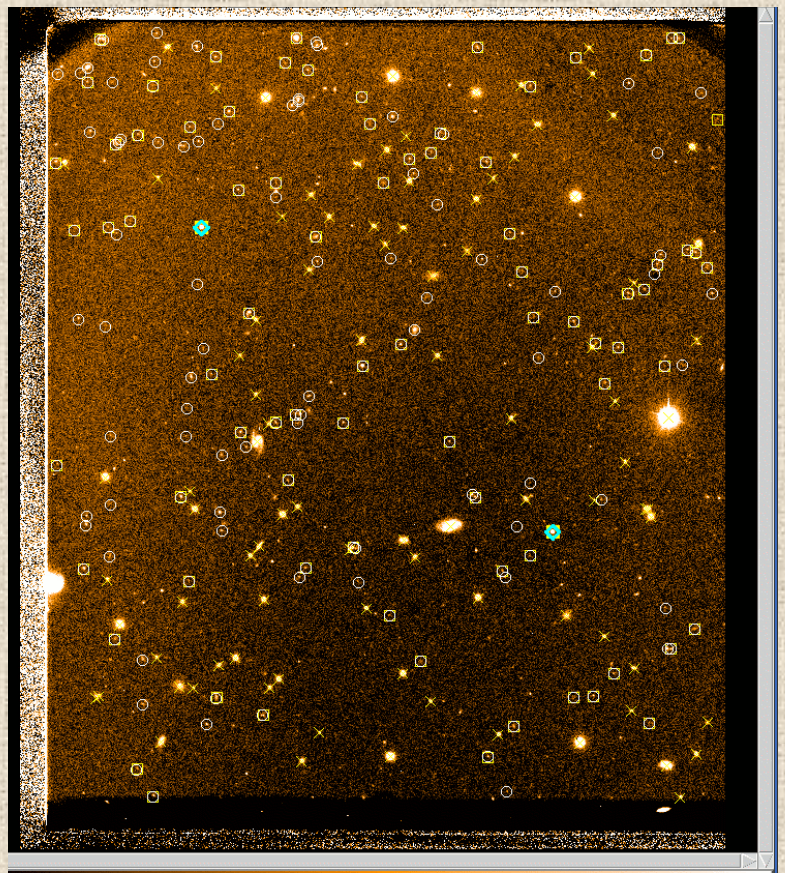
VIPERS short-slit observation, no fringing correction

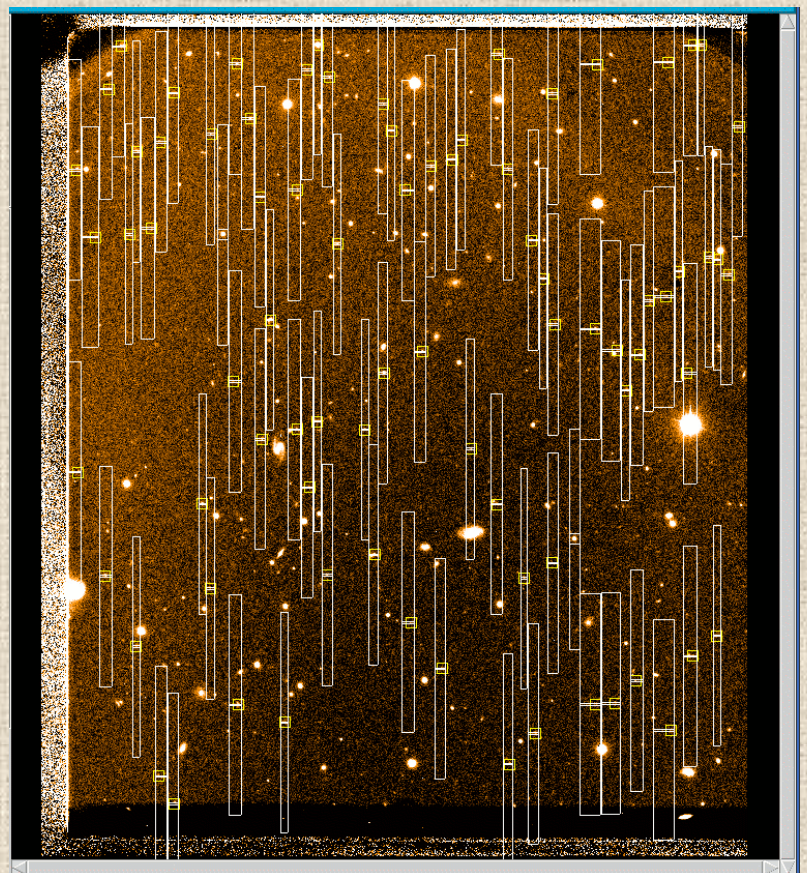


VIPERS short-slit observations, with fringing correction

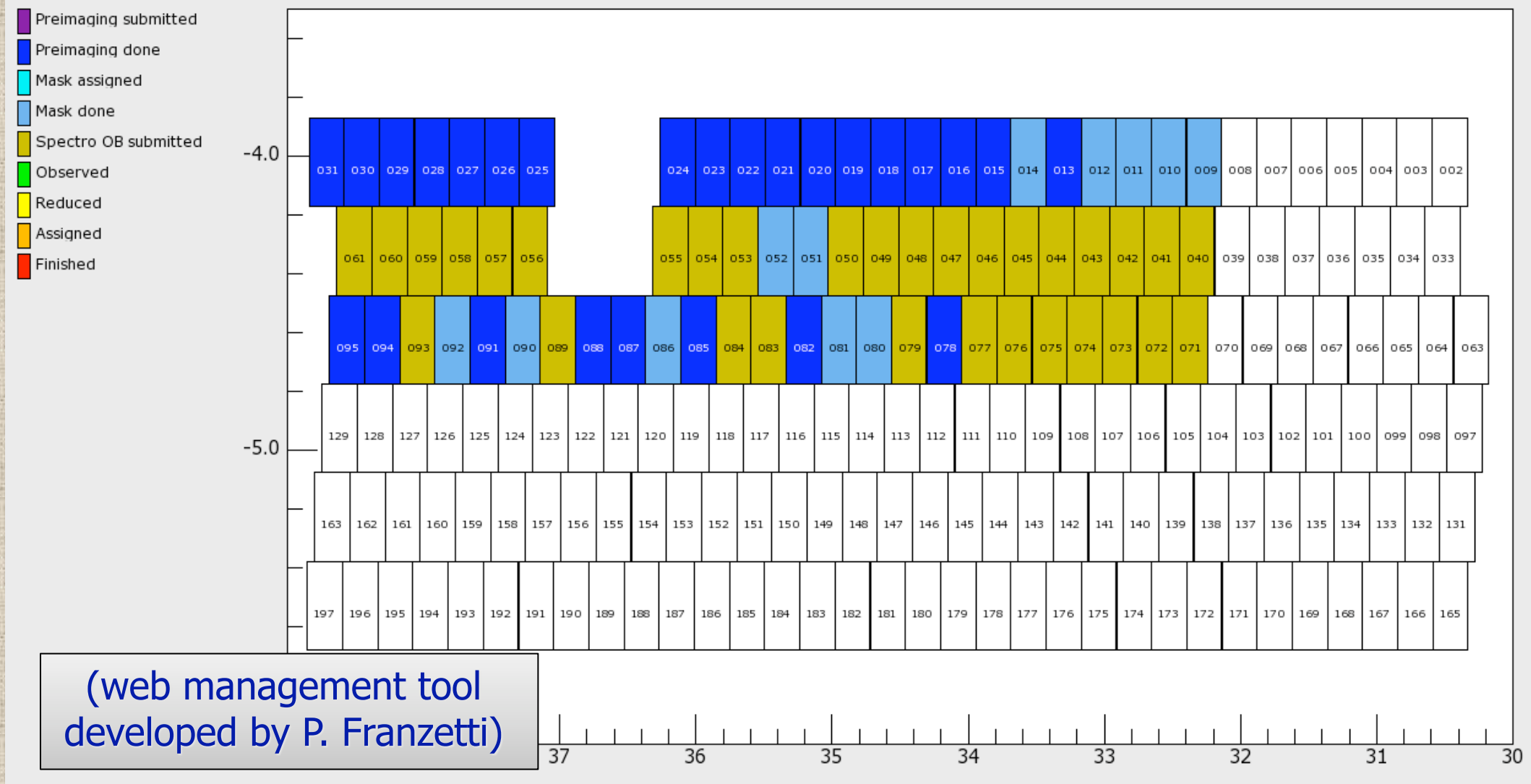
Net effect of VIPERS new selection strategy

- Sampling >50% of all I_{AB}<22.5 galaxies between z=0.5 and 1.2 in only one VIMOS pass:
  1. Get high density of tracers where you really need it
  2. Avoid multiple passes, thus maximize area for given telescope allocation



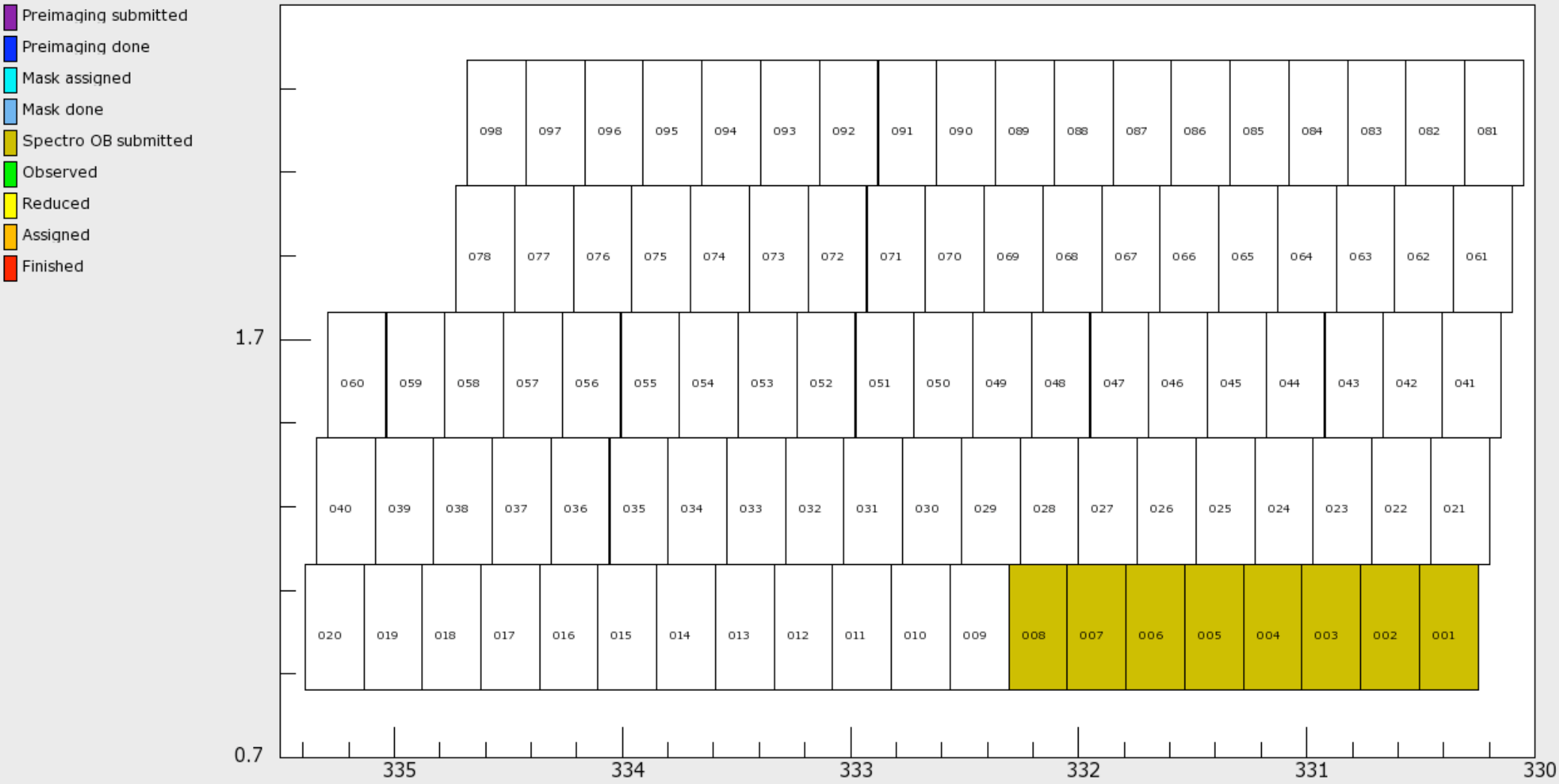


Status: W1, only 3 fields observed in P82



(web management tool developed by P. Franzetti)

Status: W4, no observations yet



Summary

- VIPERS finally exploits VIMOS capabilities, filling a specific niche for cosmological surveys at z~0.5-1
- Best compromise between large volume (like 2dFGRS, ~6 x 10^7 h^{-3} Mpc^3) and very good sampling
- Main goal is clustering at 0.5<z<1 over a fair volume of the Universe (similar to 2dFGRS at z~0), complementing the smaller-area VVDS-Deep, DEEP2 and ZCOSMOS (more focused on galaxy evolution):
  - Accurate estimate of small/intermediate-scale clustering vs galaxy properties (correlation function and power spectrum vs luminosity and stellar mass)
  - Redshift distortions and growth rate using multiple populations (to improve errors)
  - Bias reconstruction from large-scale density field
  - Clusters
- Data load: new (semi) automatic reduction pipeline in place
- Public survey: raw data public immediately, redshifts will be released in regular tranches

VIPERS scientific goals

- Growth rate from redshift-space distortions
- Galaxy clustering at z~1:
  - Evolution of $\xi(r)$ and P(k)
  - Dependence of clustering on galaxy properties
  - HOD modeling
- Galaxy bias
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- Bright/massive/rare galaxies and the galaxy luminosity and stellar mass functions
- Evolution of AGN's
- Weak-lensing (photo-z calibration!)
- Multi-wavelength investigations (SWIRE, XMM, UDS)

VIPERS Team

- MILANO OAB (PI): L. Guzzo, S. de la Torre, A. Iovino, U. Abbas (Turin), (E. Majerotto)
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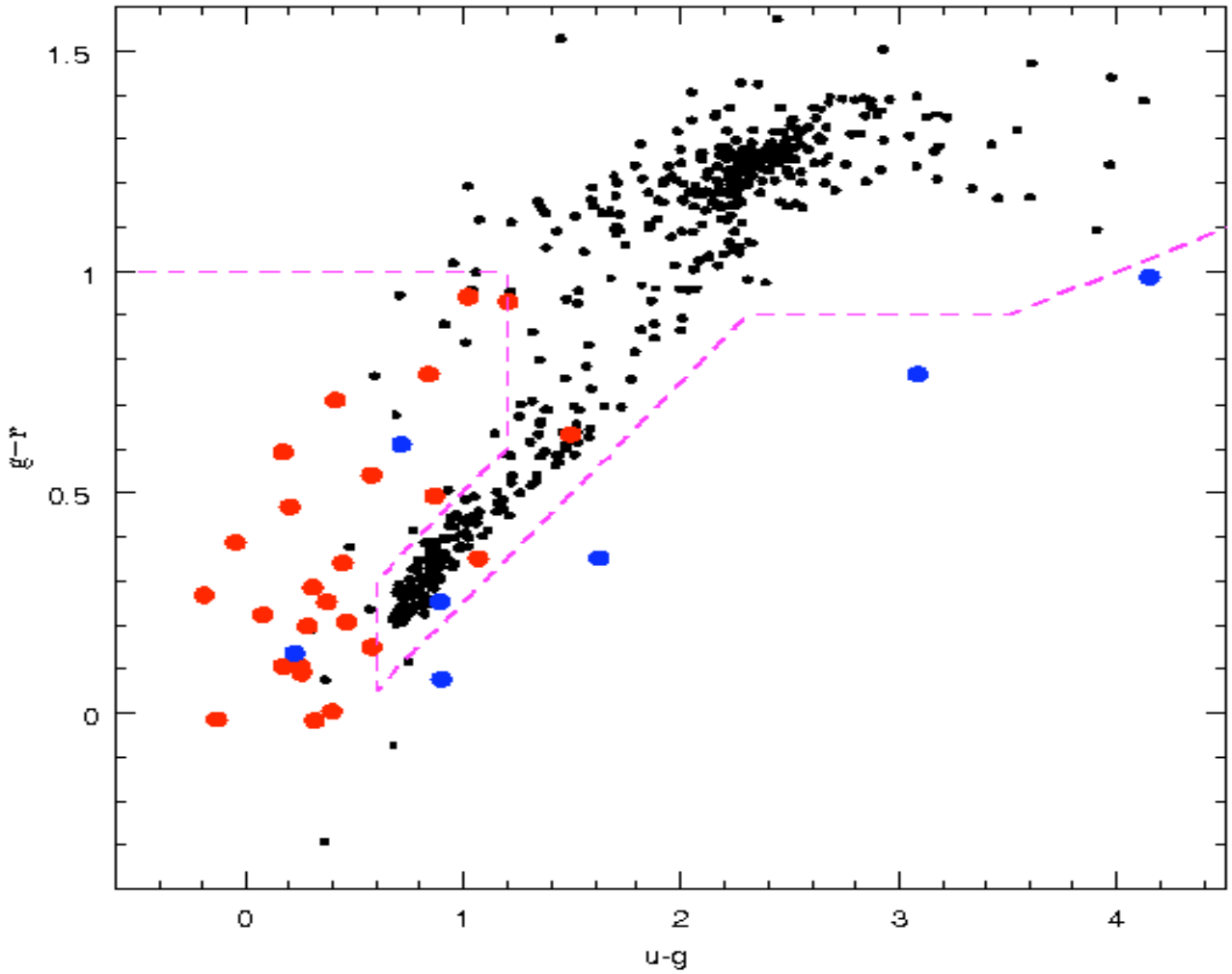
- WARSAW: A. Pollo, J. Krywult, K. Malek

VIPERS: WHY COLORS MATTER
PUTTING THE AGNs BACK IN THE CATALOG

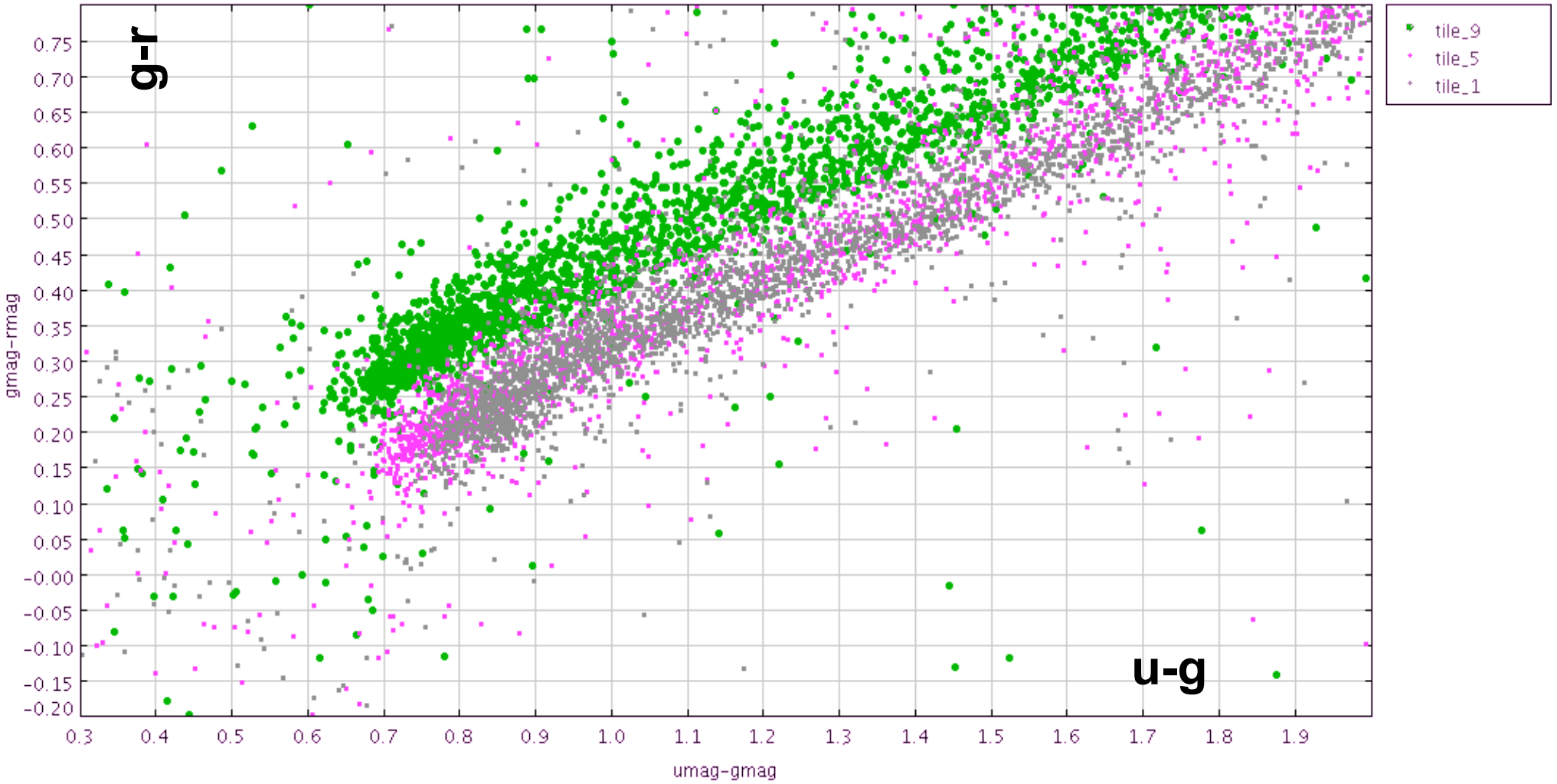


G. Zamorani

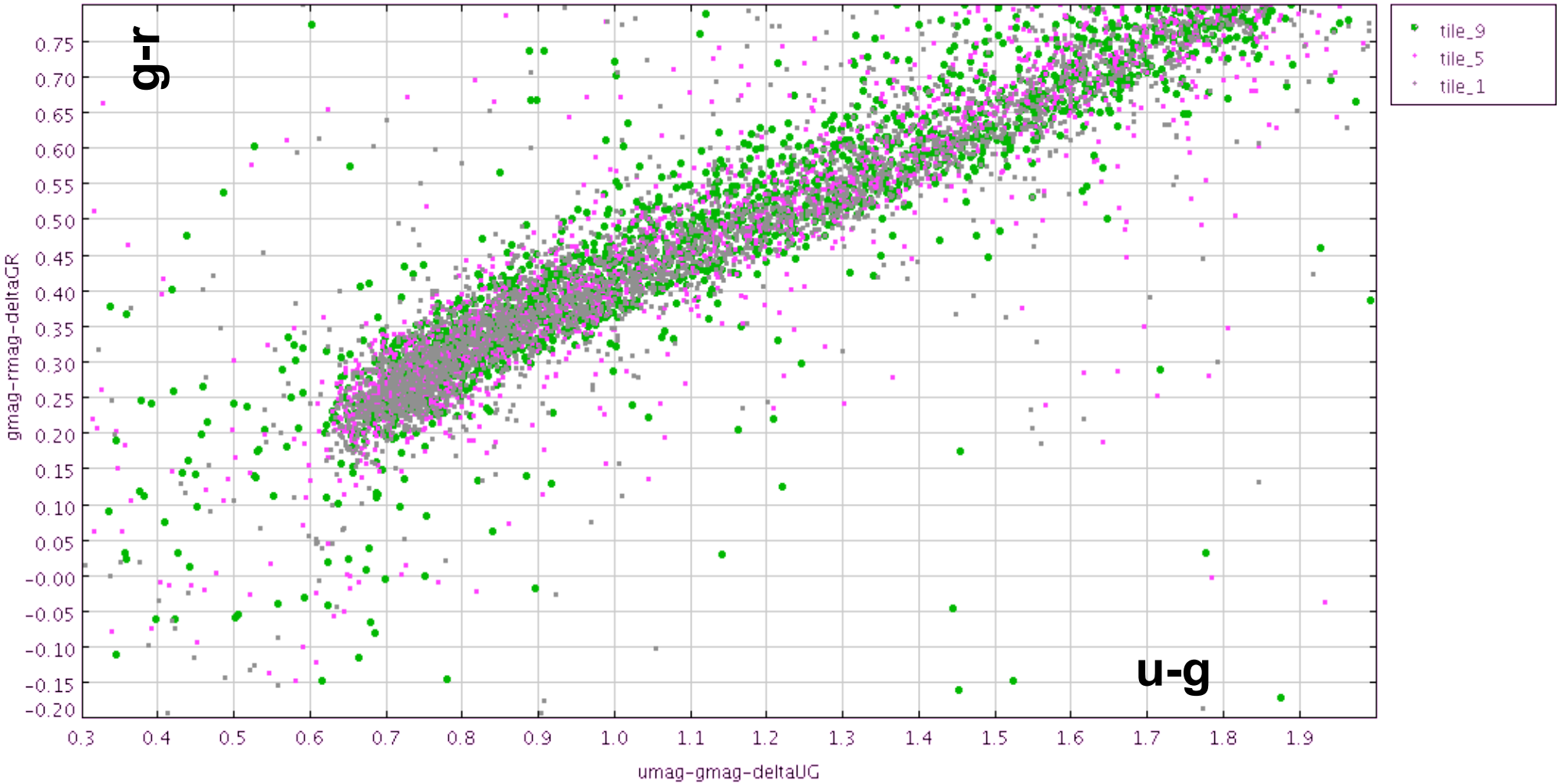
VVDS i<22.5

spectroscopically identified stars and AGN

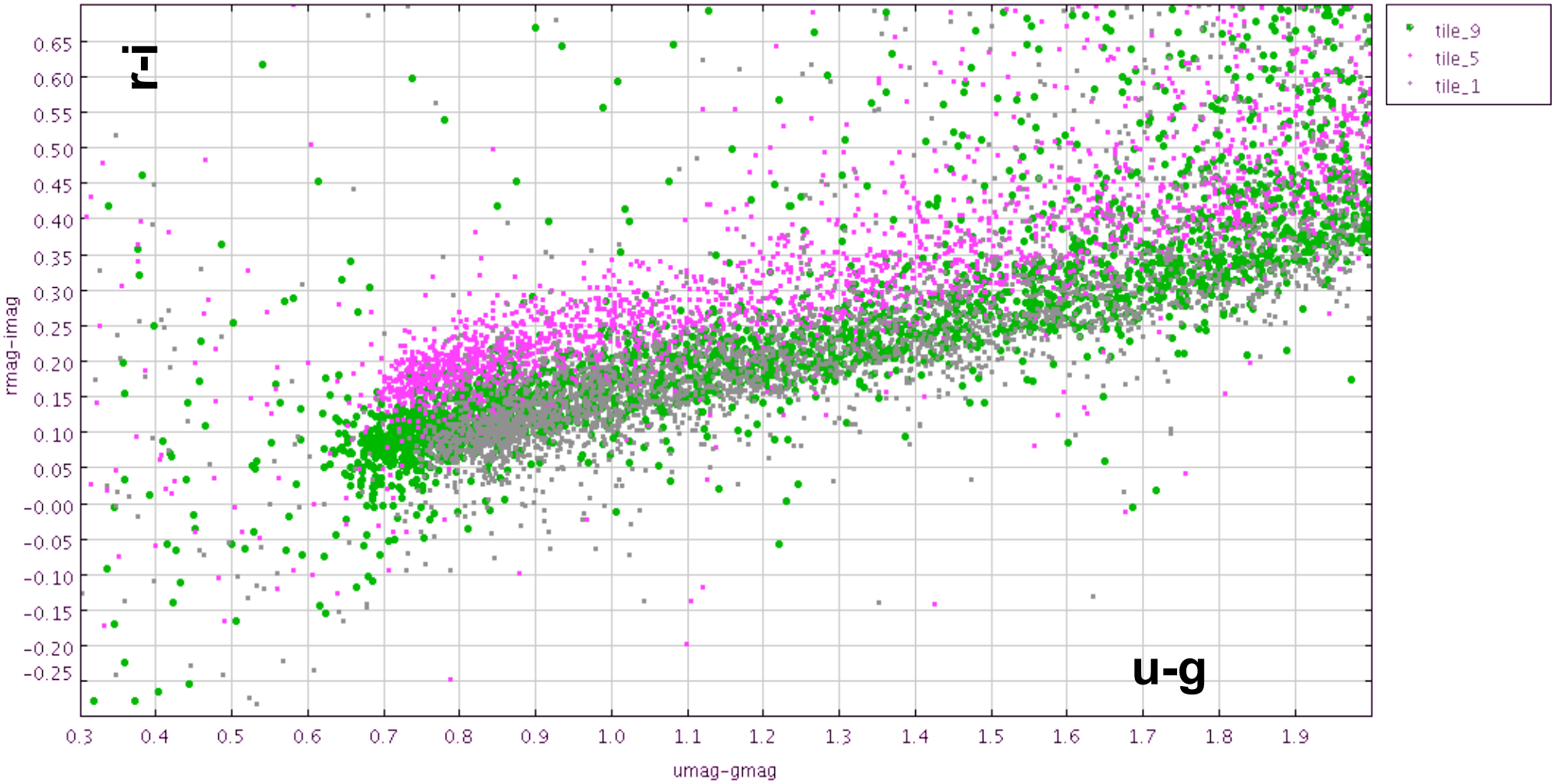
VIPERS/CFHTLS: ZERO POINT OFFSETS IN COLOR-COLOR SPACE



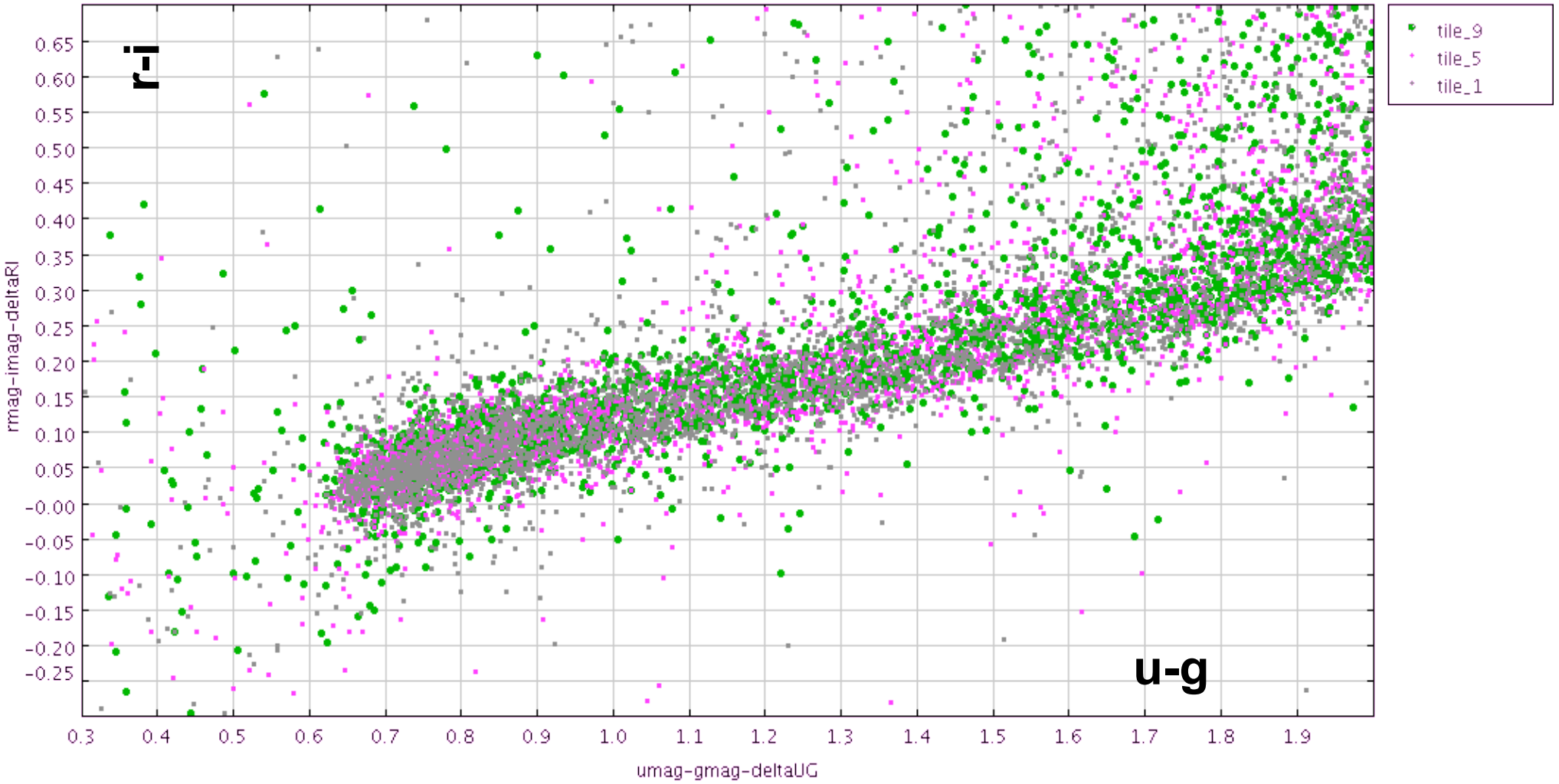
VIPERS/CFHTLS: ZERO POINT OFFSETS IN COLOR-COLOR SPACE



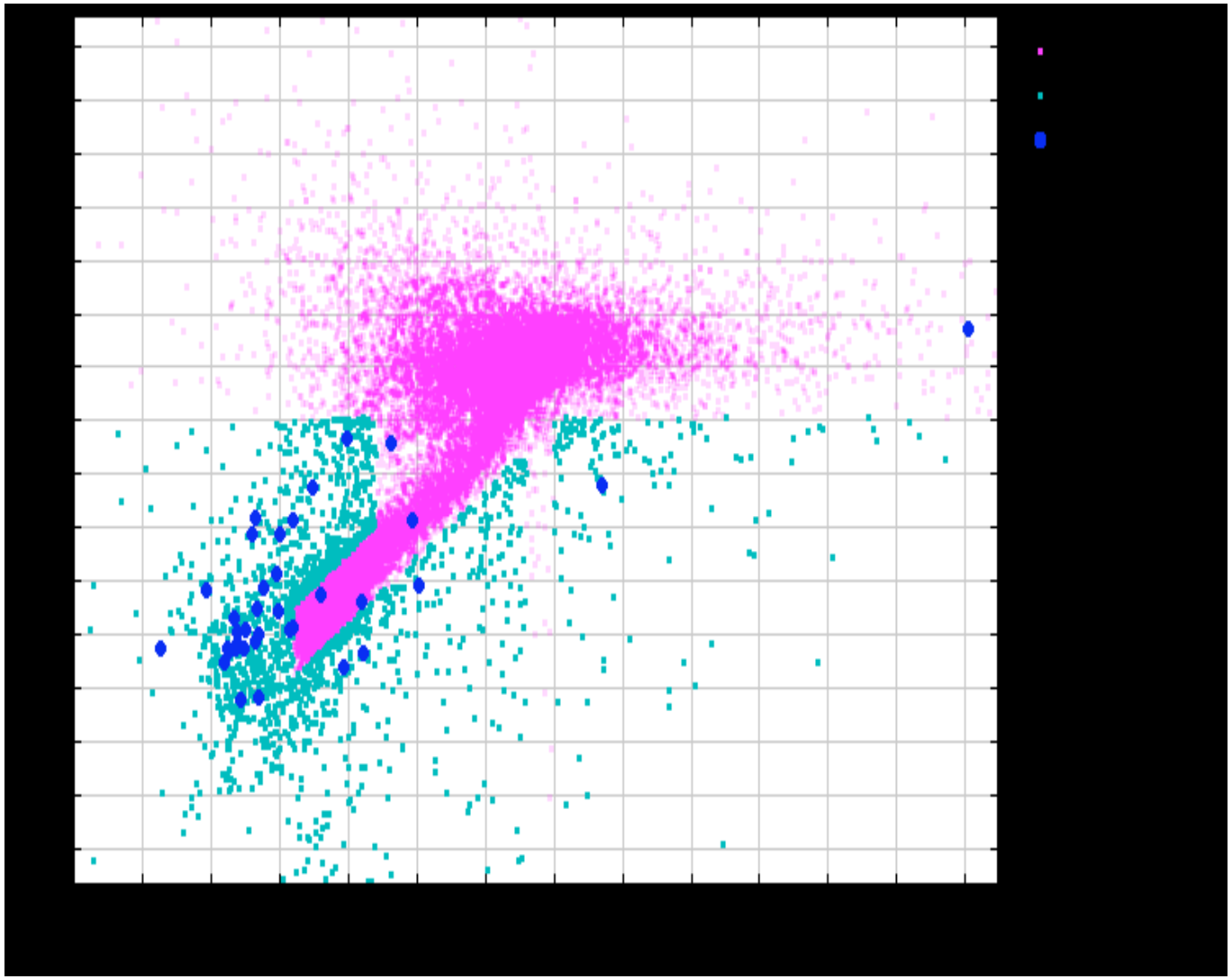
VIPERS/CFHTLS: ZERO POINT OFFSETS IN COLOR-COLOR SPACE



VIPERS/CFHTLS: ZERO POINT OFFSETS IN COLOR-COLOR SPACE



VIPERS: PUTTING THE AGNs BACK IN THE CATALOG



The VIPERS catalog:

4062 (W1) + 3923 (W4) candidate AGNs placed back in the catalog

VIPERS: THE XMM-LSS OBJECTS

- Starting catalog: XMM-LSS GTO+AO1+AO2+AO5 data
- 4-sigma detections either in the 0.5-2 keV or in the 2-10 keV band
- good optical counterparts, with probability of chance association $p<0.01$
- in case of multiple good counterparts, the most likely one

Result: 450 compulsory targets; 173 of them among the star-like AGNs

CONCLUSIONS

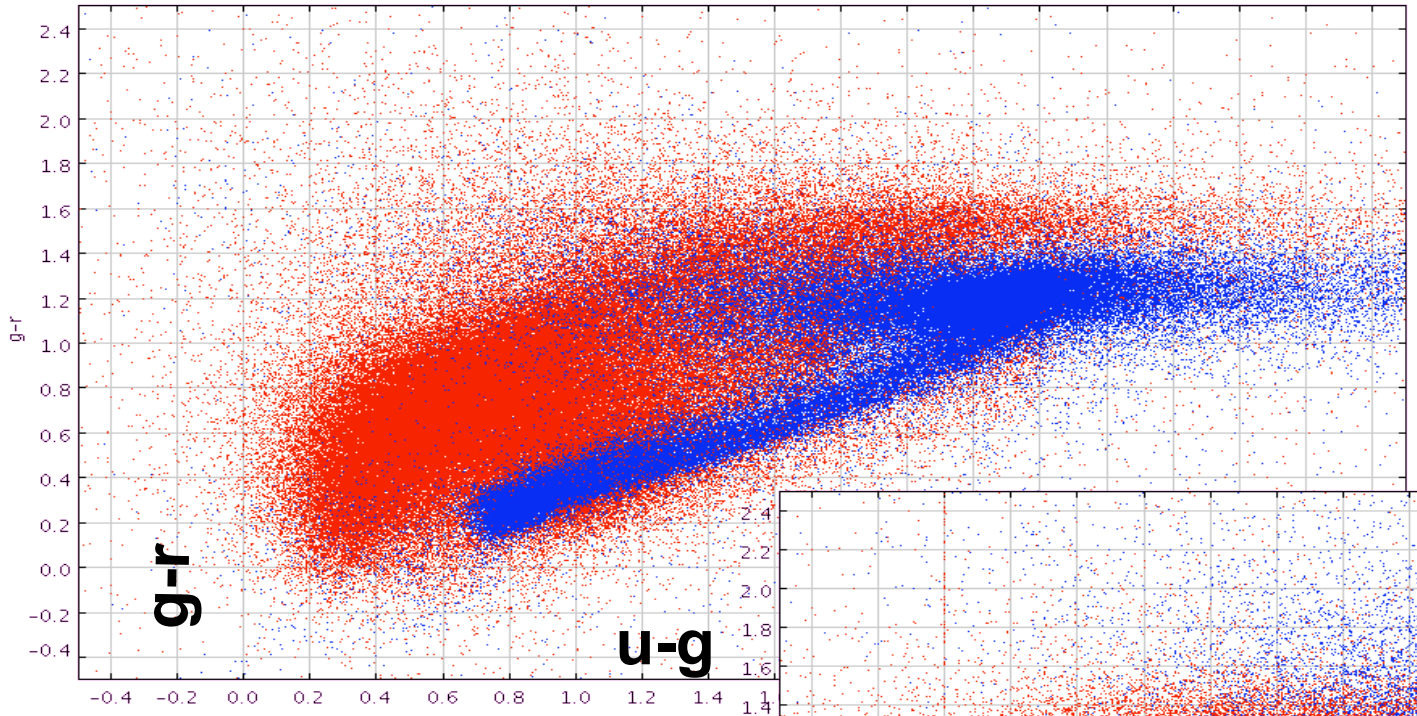
The final VIPERS input catalog contains:

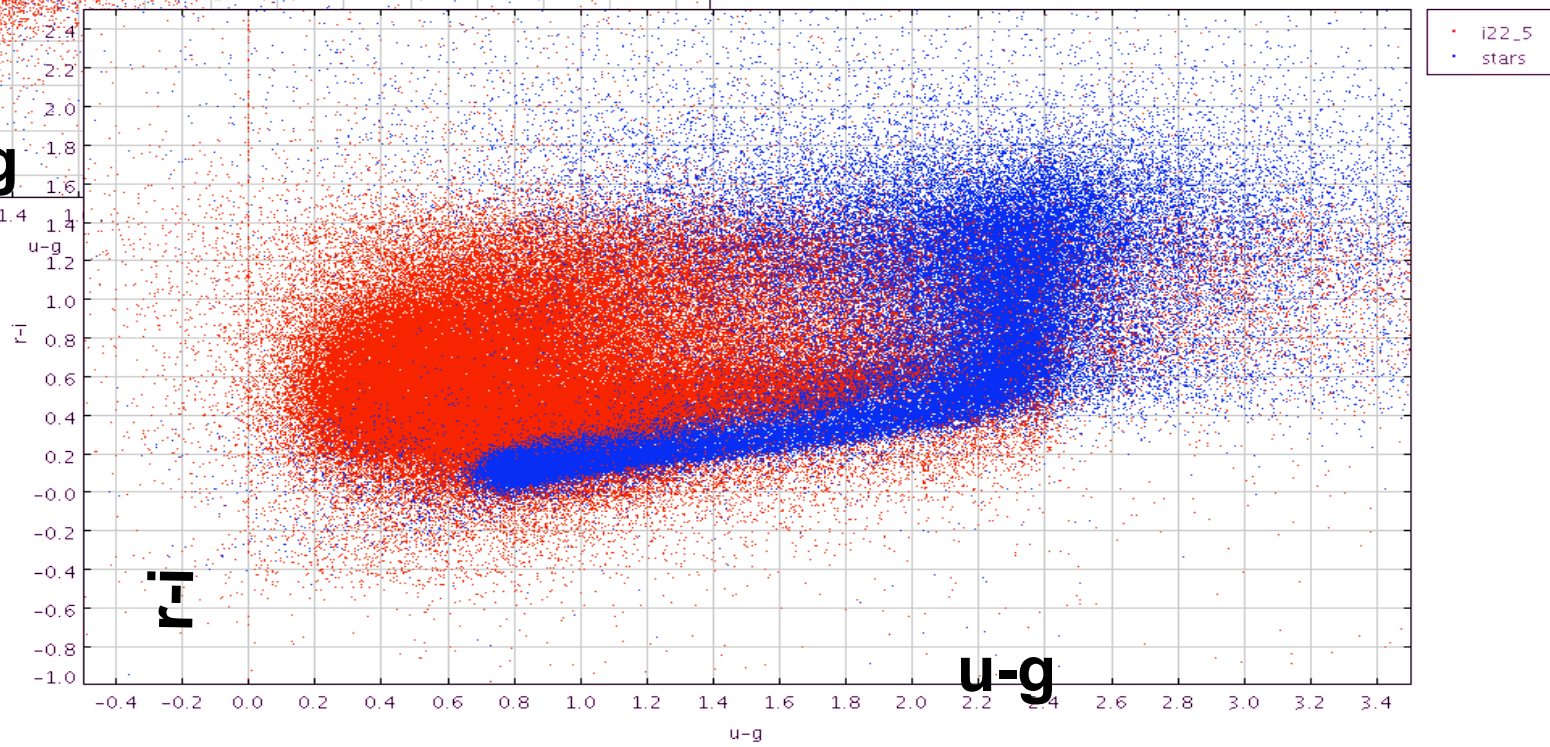
in the W1 area
162237 random targets and 450 compulsory targets
resulting from 158520 “galaxies with z>0.5” (172 compulsory)
and 4062 “stellar-like AGNs” (173 compulsory)

in the W4 area
115459 random targets, no compulsory
resulting from 111536 “galaxies with z>0.5”
and 3923 “stellar-like AGNs”

Expected spectroscopic sampling around 50%
(to be discussed this afternoon)

VIPERS/CFHTLS: THE COLOR-COLOR DISTRIBUTIONS





BAO for VIPERS