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The VIMOS-VLT deep survey

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The VIMOS-VLT Deep Survey

Olivier Le Fèvre, LAM, Marseille

Evolution of galaxies, LSS, AGNs from z~5 to present

Instrumentation: VLT-VIMOS

Spectroscopy Survey: first results

What's next ?

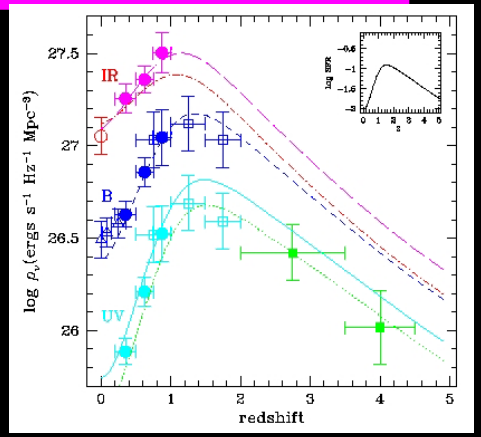
VVDS survey team

French-Italian team:

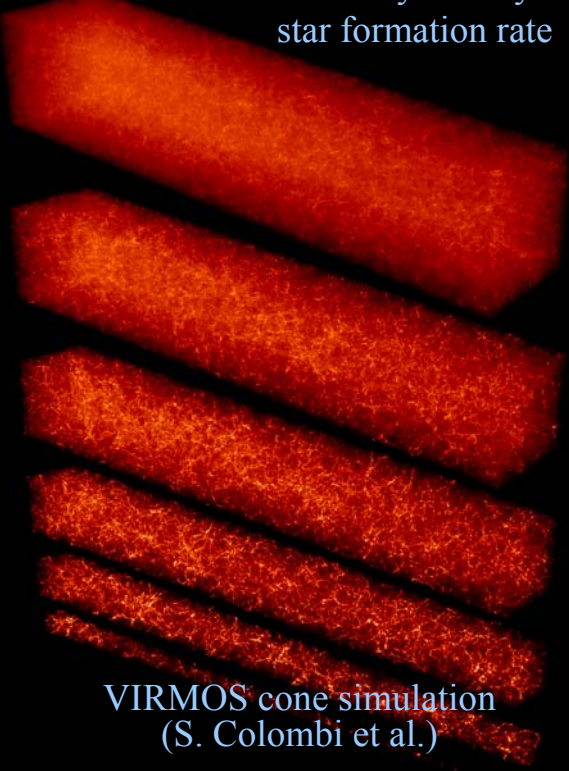
- Laboratoire d 'Astrophysique (Marseille) : *Adami, Ilbert, Le Brun, Le Fèvre, Marinoni, Mazure, Meneux, Tresse*
- OABo, IRA-CNR (Bologna): *Bardelli, Bondi, Cappi, Marano, Scaramella (Rome), Vettolani, Zamorani, Zanichelli, Zucca, et al.*
- IAP (Paris): *Bertin, Charlot (MPA), Colombi, McCracken, Mellier*
- IFCTR-CNROABr (Milan): *Bottini, Foucaud, Garilli, Maccagni, Scodeggio, et al.*
- OABr (Milan): *Guzzo, Iovino, Pollo, Chincarini, Rizzo*
- OAC (Naples): *Arnaboldi, Busarello, Merluzzi, Radovich, Ripepi*
- OMP (Toulouse): *Contini, Mathez, Pello, Picat*

VVDS: VIMOS-VLT Deep redshift Survey

- Trace galaxies and AGNs evolution across long time base
- What are the timescales associated to physical phenomena at work ?
- Quantify
  - LF, SFR evolution
  - ξ(r) evolution
  - Merging rate evolution
  - AGN contribution to evolution
  - link between galaxy evolution & LSS
- Measure evolution in a consistant way
  - Inside a single survey, large z baseline
  - Well defined selection function
- Compare to model predictions
  - Constraints on cosmological parameters



Evolution of the luminosity density / star formation rate



VIRMOS cone simulation (S. Colombi et al.)

VVDS strategy

- **5 fields**, 2x2 deg² each, ~100Mpc @z~1
  - 0226-04, 1003+02, 1400+00, 2217+00, CDFS
- **Purely magnitude selected sample**
- **Combined visible light / weak lensing studies**
- **Multi-wavelength analysis: VLA, XMM, Chandra, GALEX, SIRTF, HST**
- **150000 redshifts 0<z<5+**

VVDS strategy

Imaging Survey: 5 fields 2x2deg²

Build VLT-VIMOS

Imaging Catalog
UBVRIK
3millions objects

guaranteed VLT nights

Redshift Survey

VIRMOS Wide z<1.3
100000 z - I_{AB}<22.5
+B&K selected

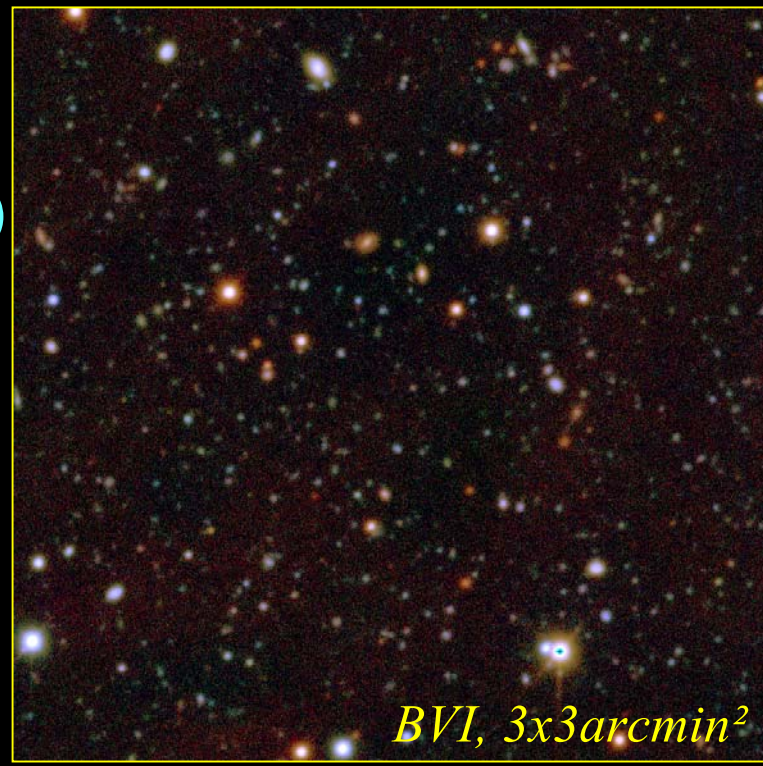
VIRMOS Deep z<5+
50000 z - I_{AB}<24
+B&K selected

VIRMOS Ultra-deep
a few 1000 z - I_{AB}<25

Coordination w/ other surveys (XMM-VLA-HST)
HST-COSMOS-ACS: 640 orbits

VIRMOS-CFH12K deep imaging survey

- 16 deg² in 4 fields 2×2deg²
  - ~100h^{-1} Mpc at z~1
- I_{AB}~25.3, B_{AB}~28 (3σ, ϕ3arcsec)
  - Depth: **no bias propagated to spectroscopic survey**
- Instruments
  - CFHT12K (30x40 arcmin²): BVRI
  - ESO-MPI 2.2m WFI: U
  - ESO-NTT: (J) K ’
- Data processing 5 Tb processed :
  - Terapix (IAP, Mellier)



BVI, 3x3arcmin²

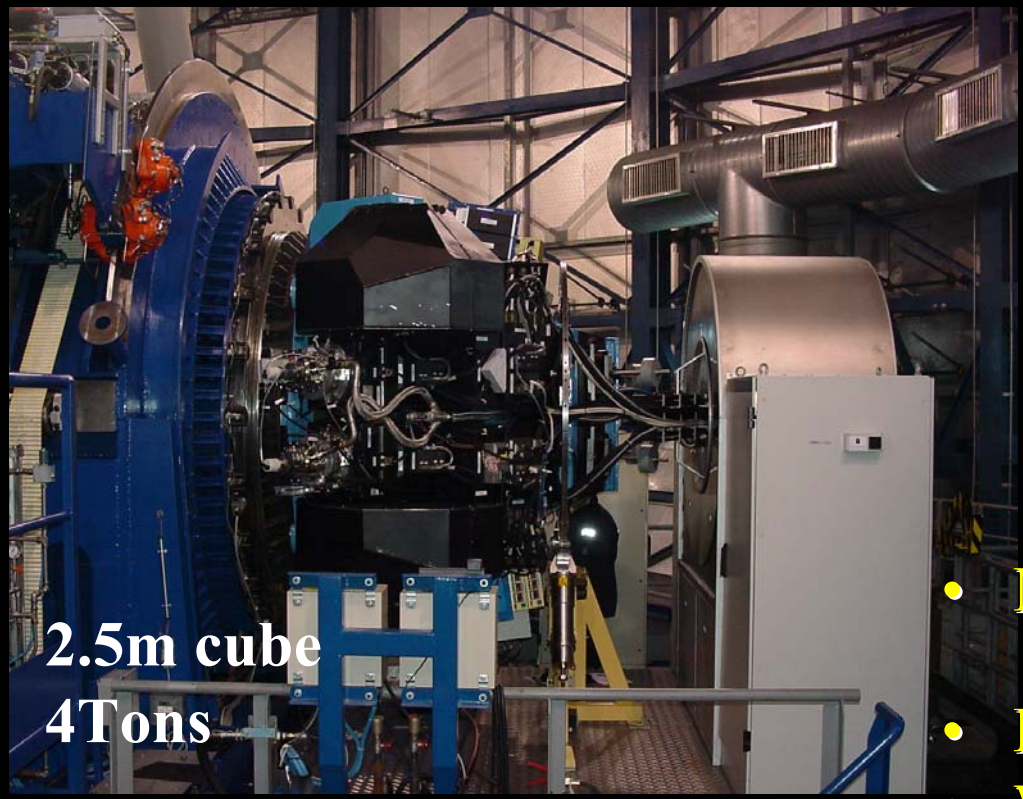
~1/6000th of full survey !

➡ **multi-color catalog: ~3x10^6 objets**

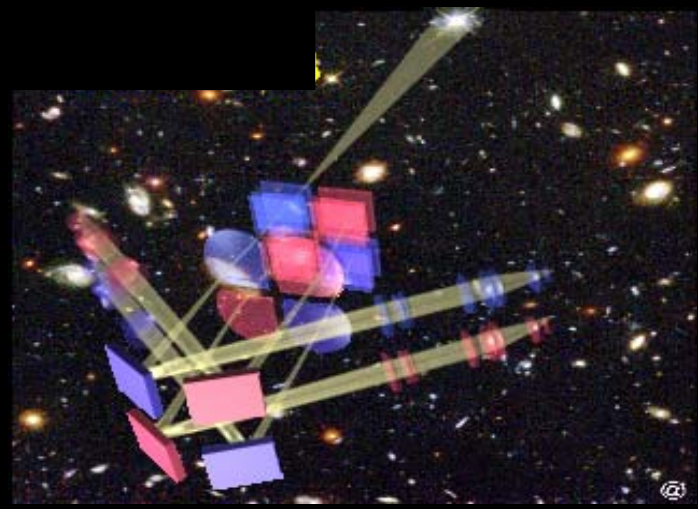
See astro-ph/: Le Fèvre et al., McCracken et al.

Used for the VIRMOS-DESCART Lensing survey (Mellier et al.)

VIMOS on VLT-UT3



VIMOS on VLT-UT3



- Multi-Slit Imaging-Spectrograph
  - 0.37-1 microns
- Designed for large surveys
- Wide Field: 4x7x8 armin^2
- Spectral R~200-5000
- High Multiplex: >800 Slits
- Wide Field IFU: 54x54 arcsec^2 (6400 lenses-fibers)

Multi-Slit mode

VIMOS at the ESO VLT
measures the distance of 1001 distant galaxies
in one single observation 28/09/2002

Low res.:
50x FORS1
20x FORS2
6x Keck-DEIMOS

1 spectrum
of 1001

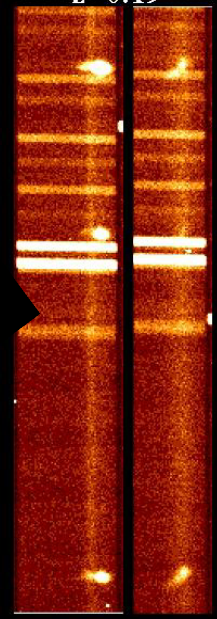
9500Å

5500Å

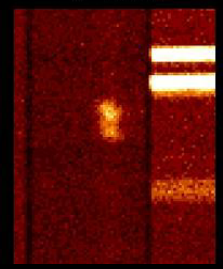
VIMOS at the VLT observes 150 galaxies
at once at high spectral resolution (R~4000)

High res.:
= Keck-DEIMOS

Hydrogen+Oxygen
Hβ+[OIII]
z=0.19



Oxygen
[OII] doublet
z=0.71



VVDS current observations status

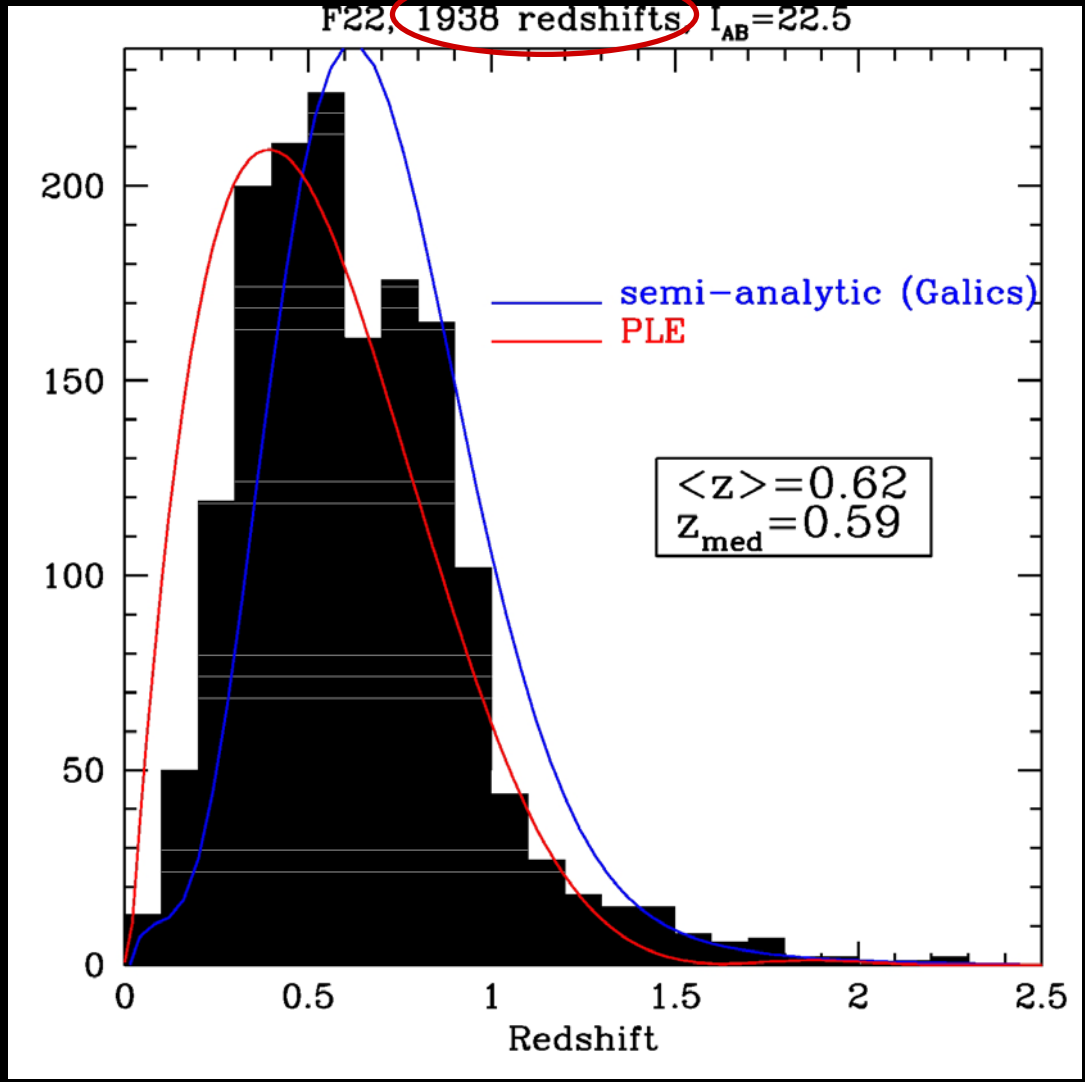
Total number of spectra acquired in 18 nights, fall 2002
(clear, out of 29 allocated)

Field	$I_{AB}<22.5$	$I_{AB}<24$
0226-04		9188
1000+03	2595	
2217+00	6849	
CDFS		2109
Total end 2002	9444	11297

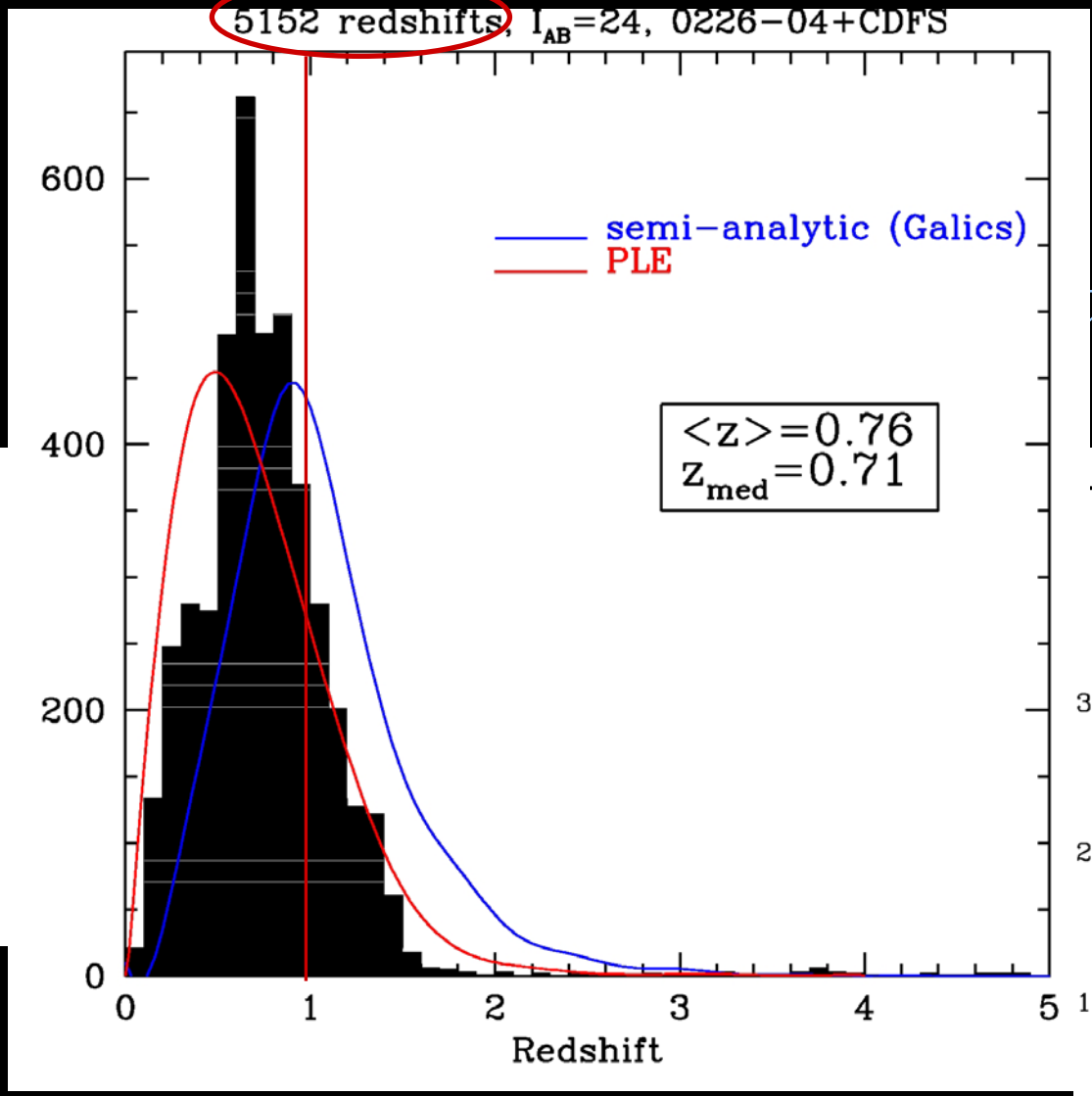
~14000 galaxy redshifts
After stars removal and incompletness:
10% of survey goal

current completness:
~85%

N(z), $I_{AB} \leq 22.5$

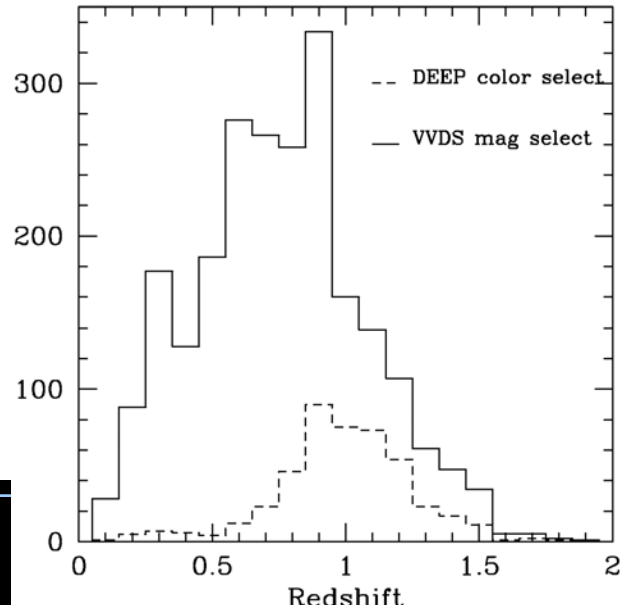


N(z), $I_{AB} \leq 24$



20% galaxies with z>1 (~3000 galaxies, 1.5<z<3 from existing observations)

DEEP2 vs. VVDS selection



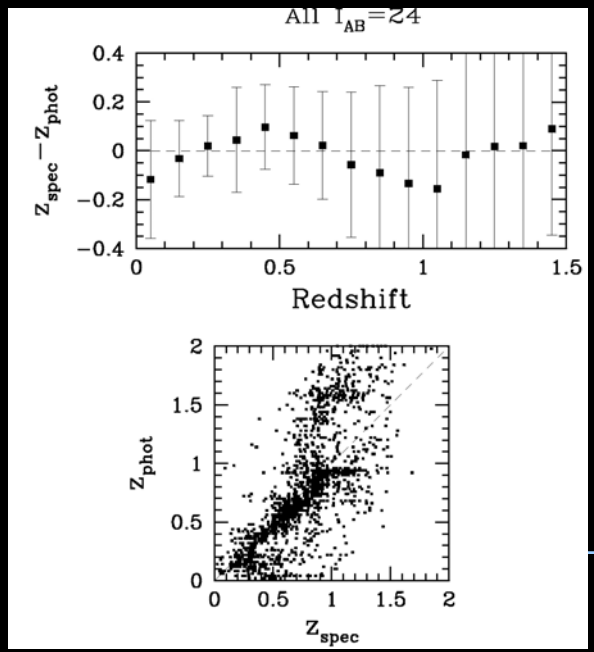
Incompletness, $I_{AB} \leq 24$

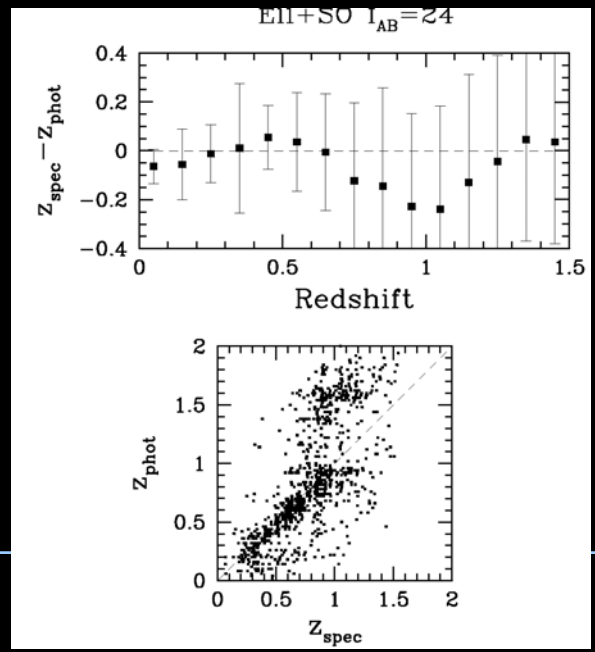
- **Tricky domain: 1.5<z<3**
- **Include good UV galaxy templates in z measuring machine**
  - **Use VVDS sample to build templates, self-trained**

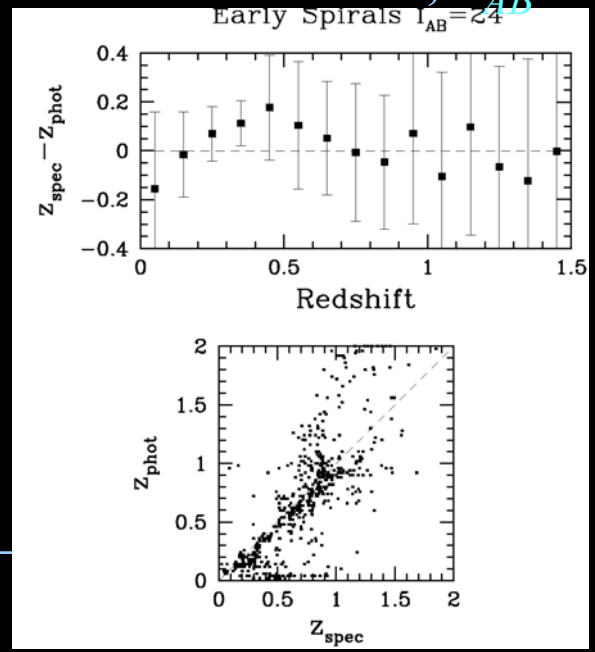
Photometric redshifts from (U)BVRI(zK)

- **Deeper than spectroscopic redshifts**
- **Use spectroscopic sample to validate**
- **Use photometric redshifts to quantify incompletness**

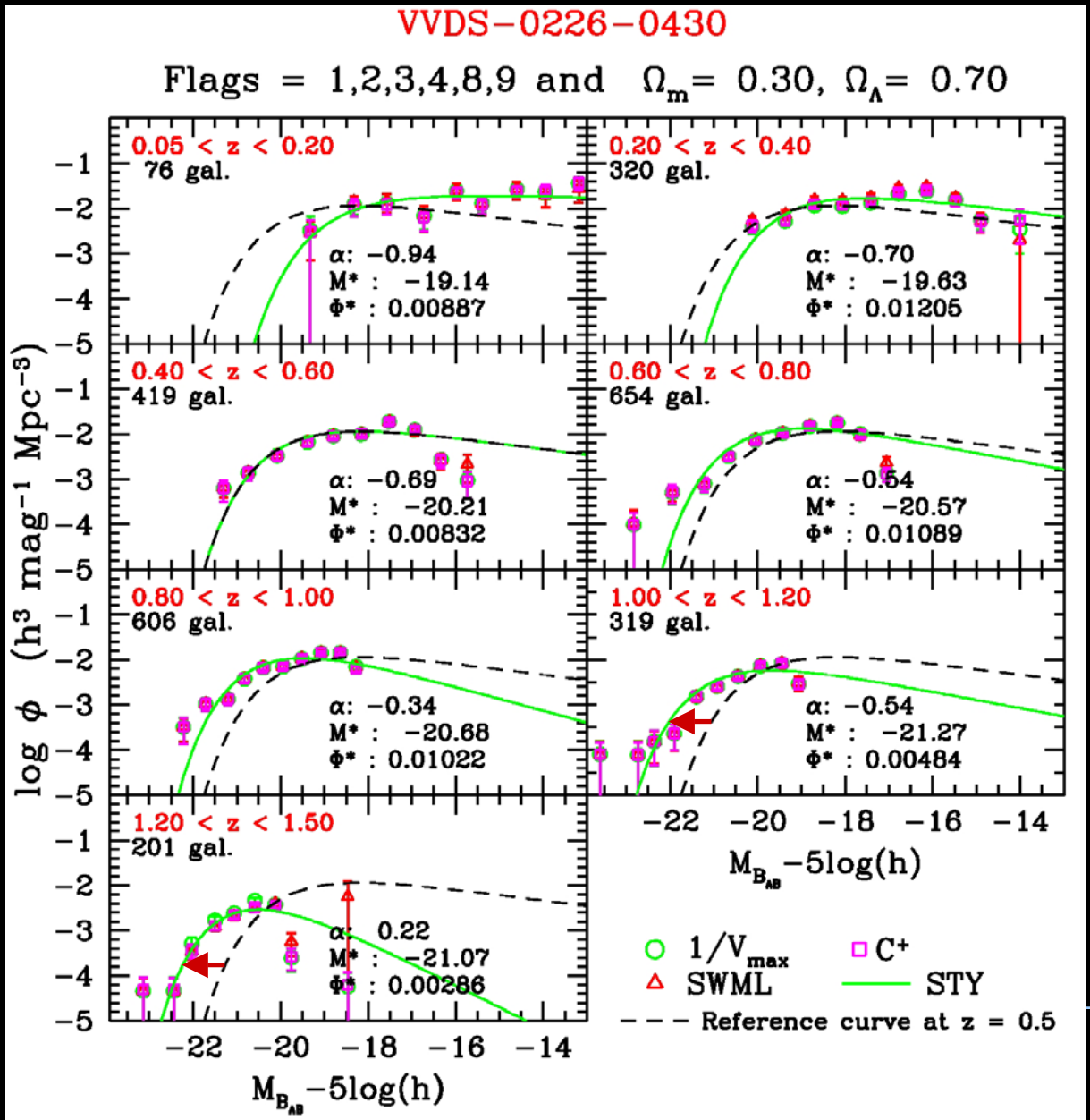
Phot-z from BVRI, $I_{AB} \leq 24$







Luminosity function to z=1.5



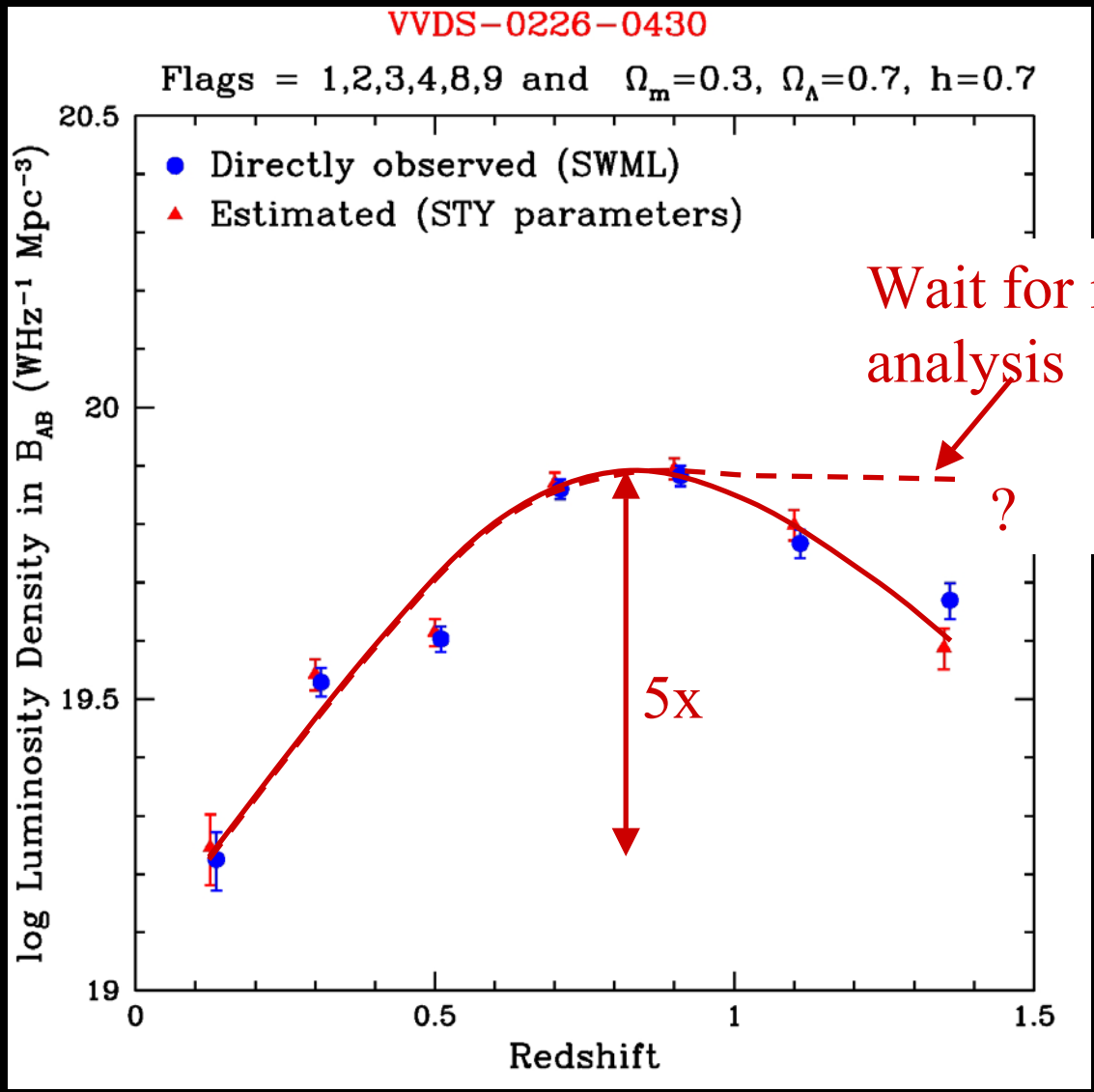
Preliminary !

2595 galaxies from IAB≤24 sample

>1 magnitude evolution at z~1

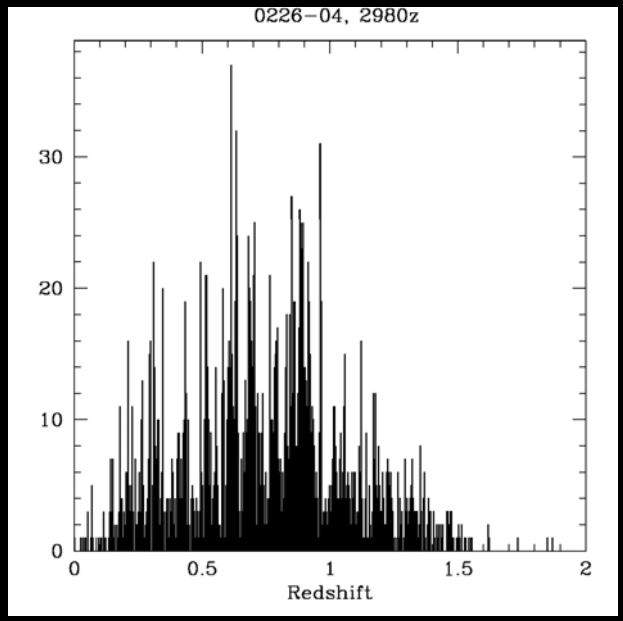
Ilbert, Zucca et al., in prep.

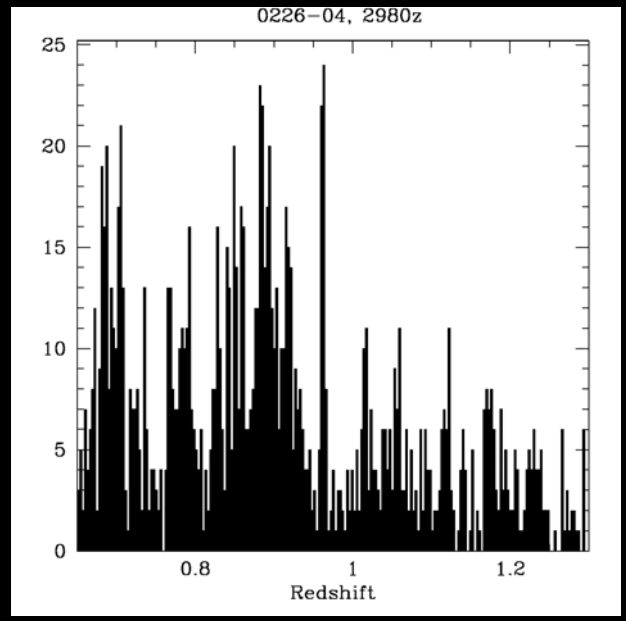
Luminosity density

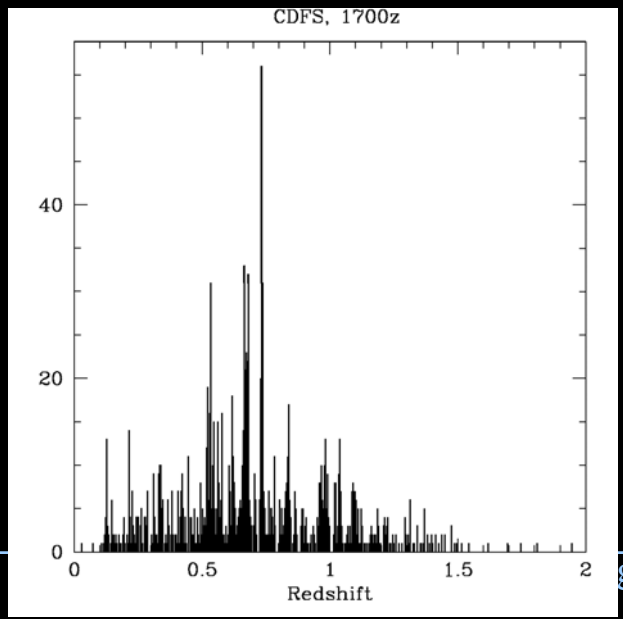


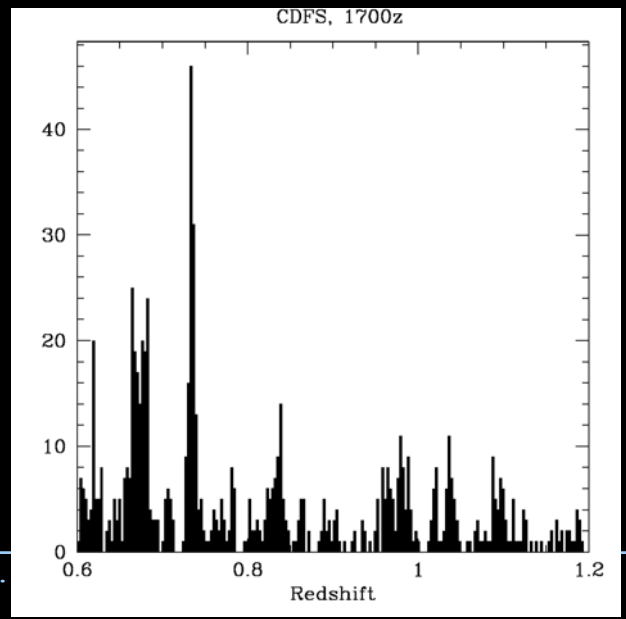
Tresse et al., in prep.

N(z), $I_{AB} \leq 24$, 0226-04 & CDFS



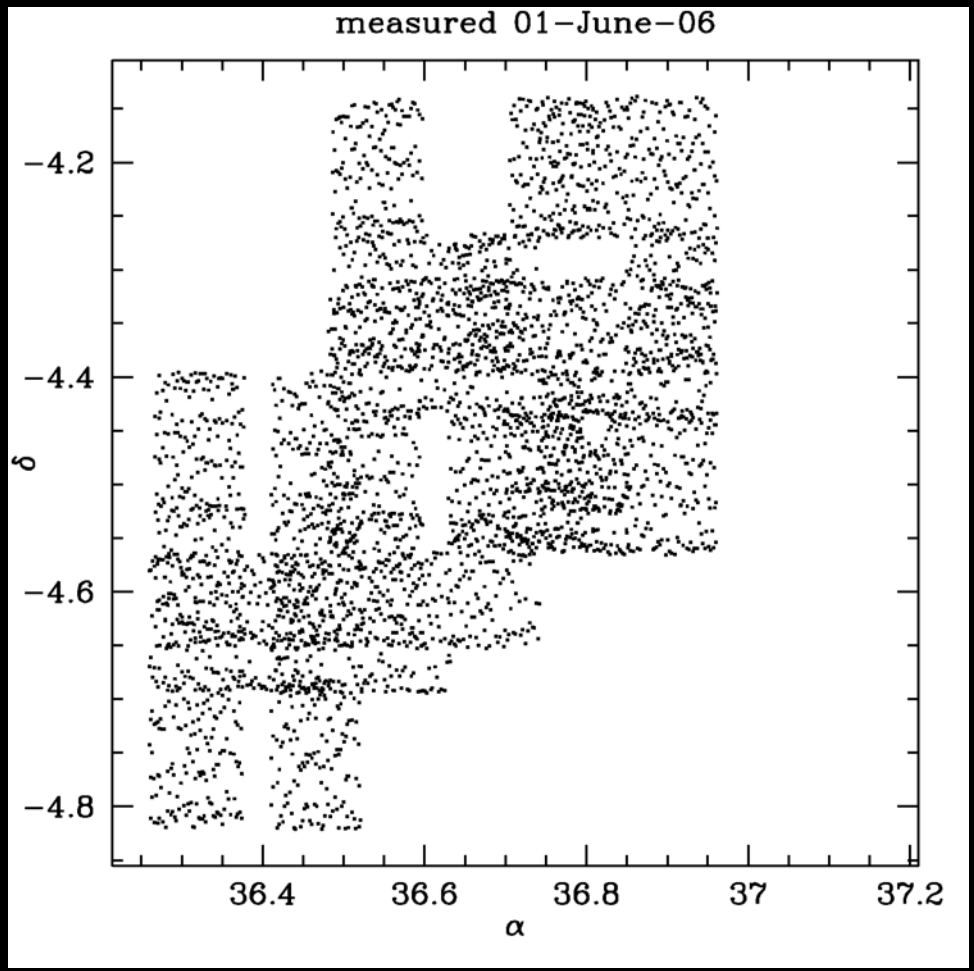




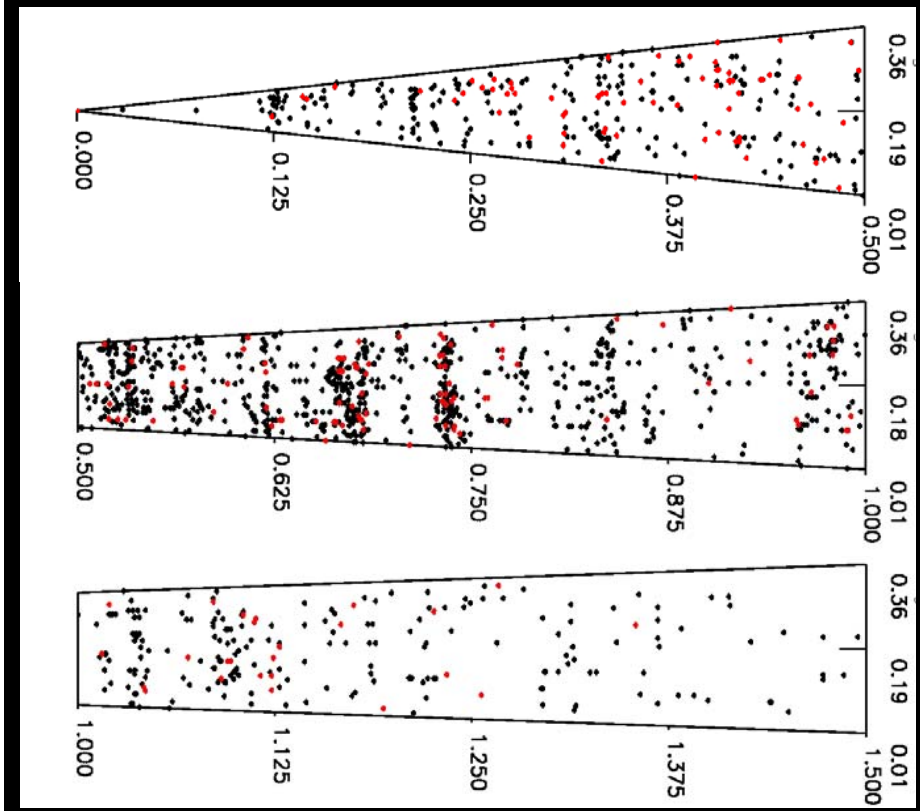


Distribution of galaxies

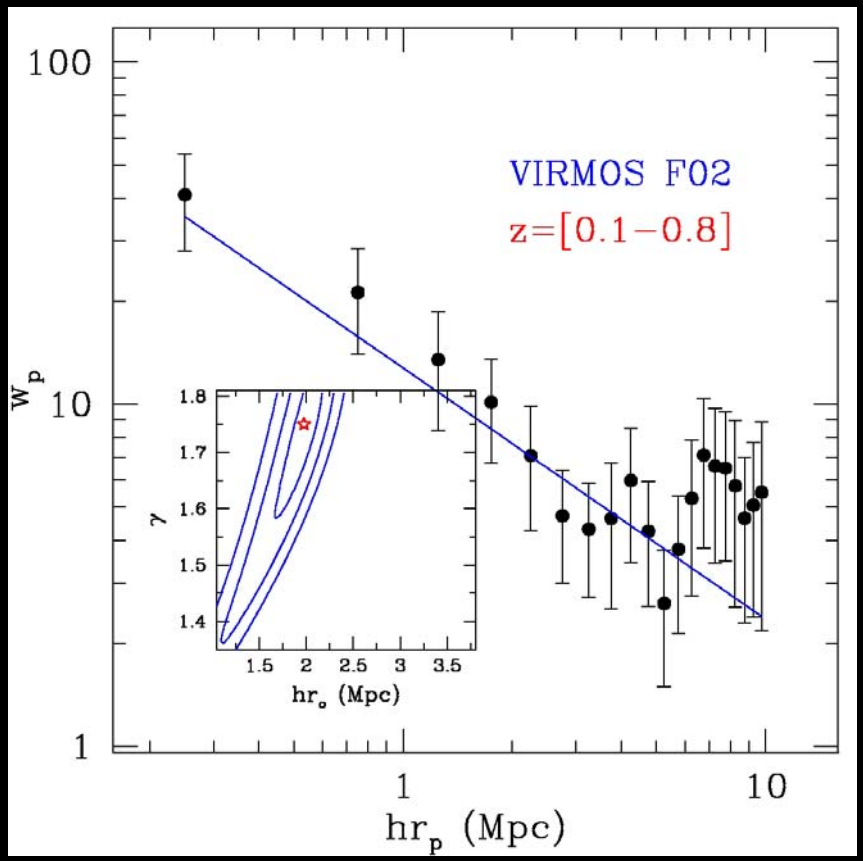
0226-04

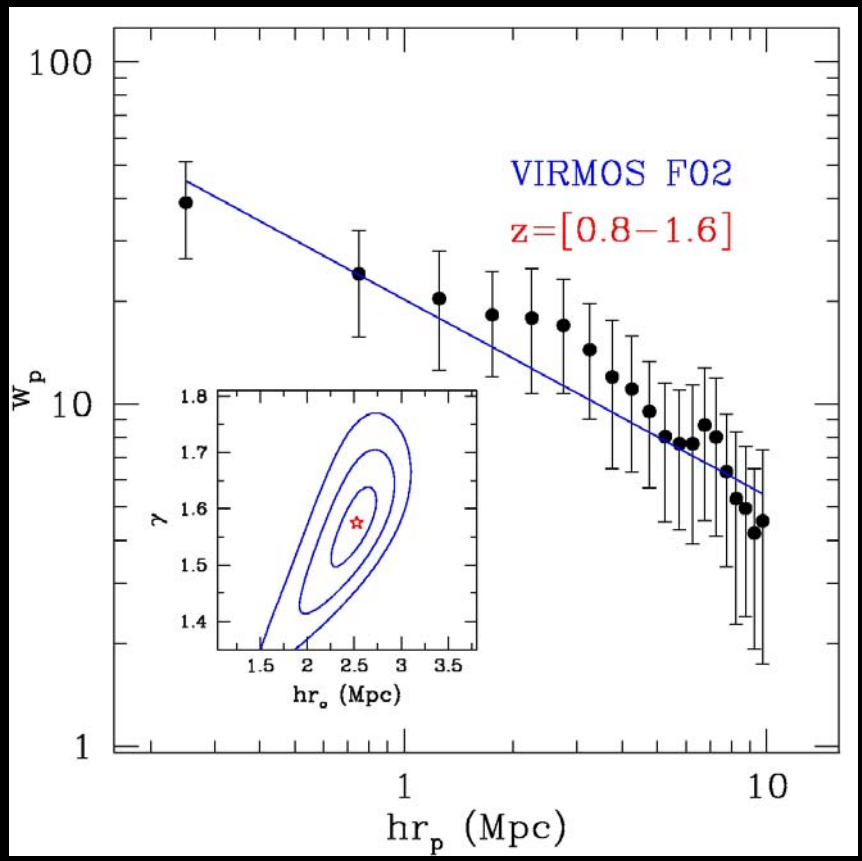


CDFS



Correlation function



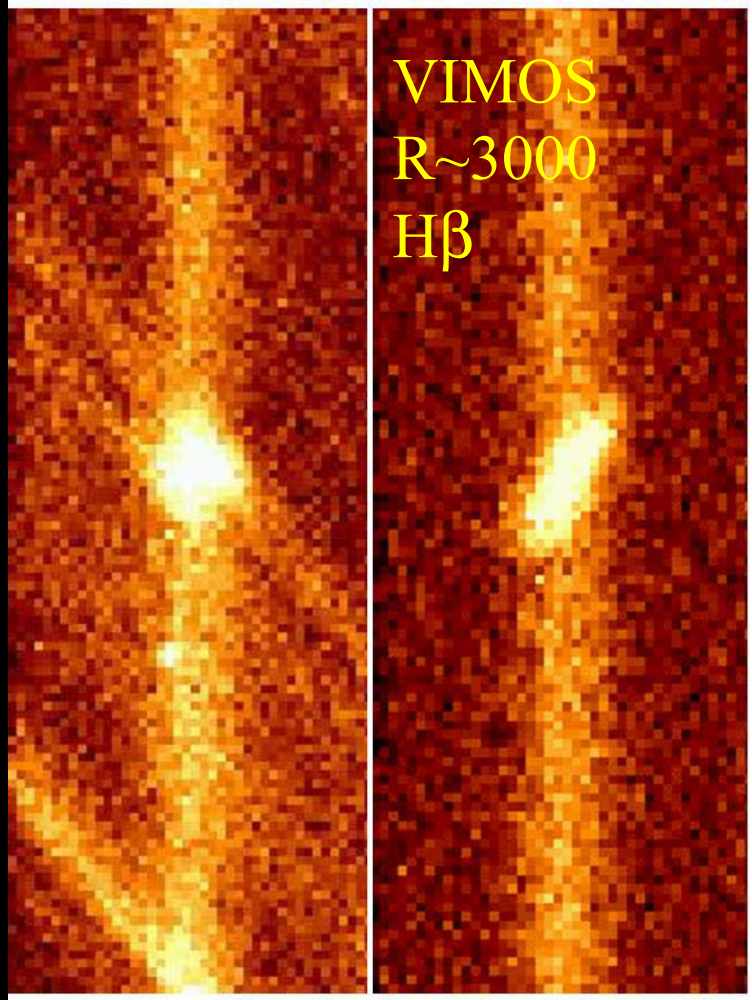


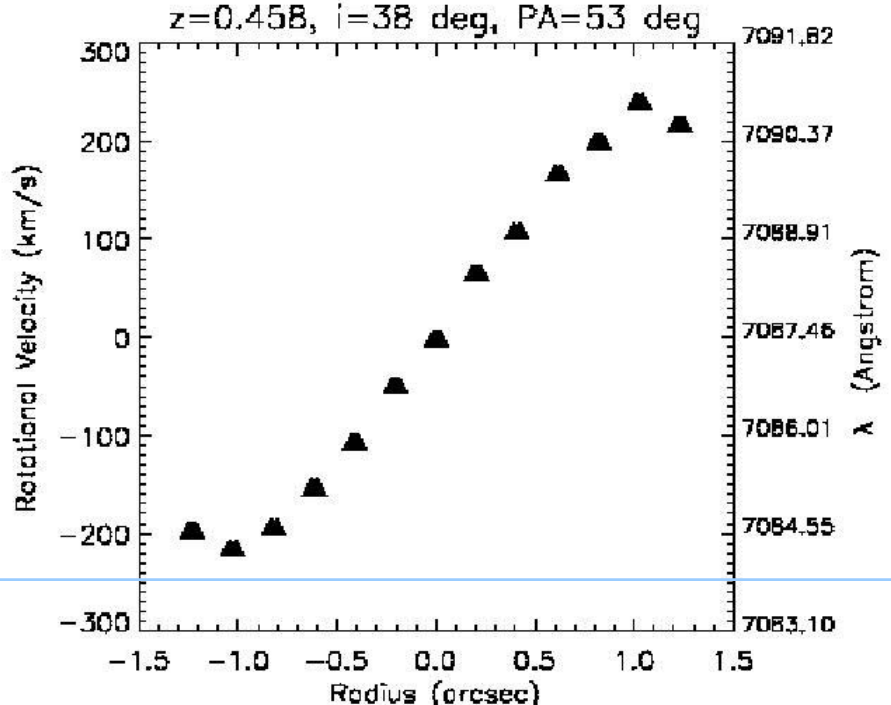
Low r_0~2-2.5Mpc over redshift range

but not the same population at low and high z

Guzzo, Meneux, Pollo, in prep.

Other VVDS products





Marinoni et al., in prep

What's next ?

- **Spectroscopic survey**
  - only 10 GTO nights scheduled on VLT in 2003 (ESO strategy ???)
  - Emphasis on 02hr and 10hr fields
- **Multi-wavelength datasets**
  - Combine redshift survey with radio (VLA), far-IR (SIRTF-SWIRE), near-IR, visible (CFHTLS), UV (Galex), X-rays (XMM-LSS)
- **High resolution imaging: HST-COSMOS Legacy**

HST-COSMOS
PI: N. Scoville (Caltech)

- **Image 2deg² of VVDS 1003+02 field**
  - I band first, possibly g band next period
- **Legacy program**
  - Will be immediately public
- **640 HST orbits with ACS**
- Depth I_{AB}=27 (10σ)
- 50x50Mpc² @ z=0.5, 170x170Mpc² @z=3
- >3000 HDFN !
- 70000 redshifts with VLT-VIMOS

Link galaxy evolution to LSS evolution

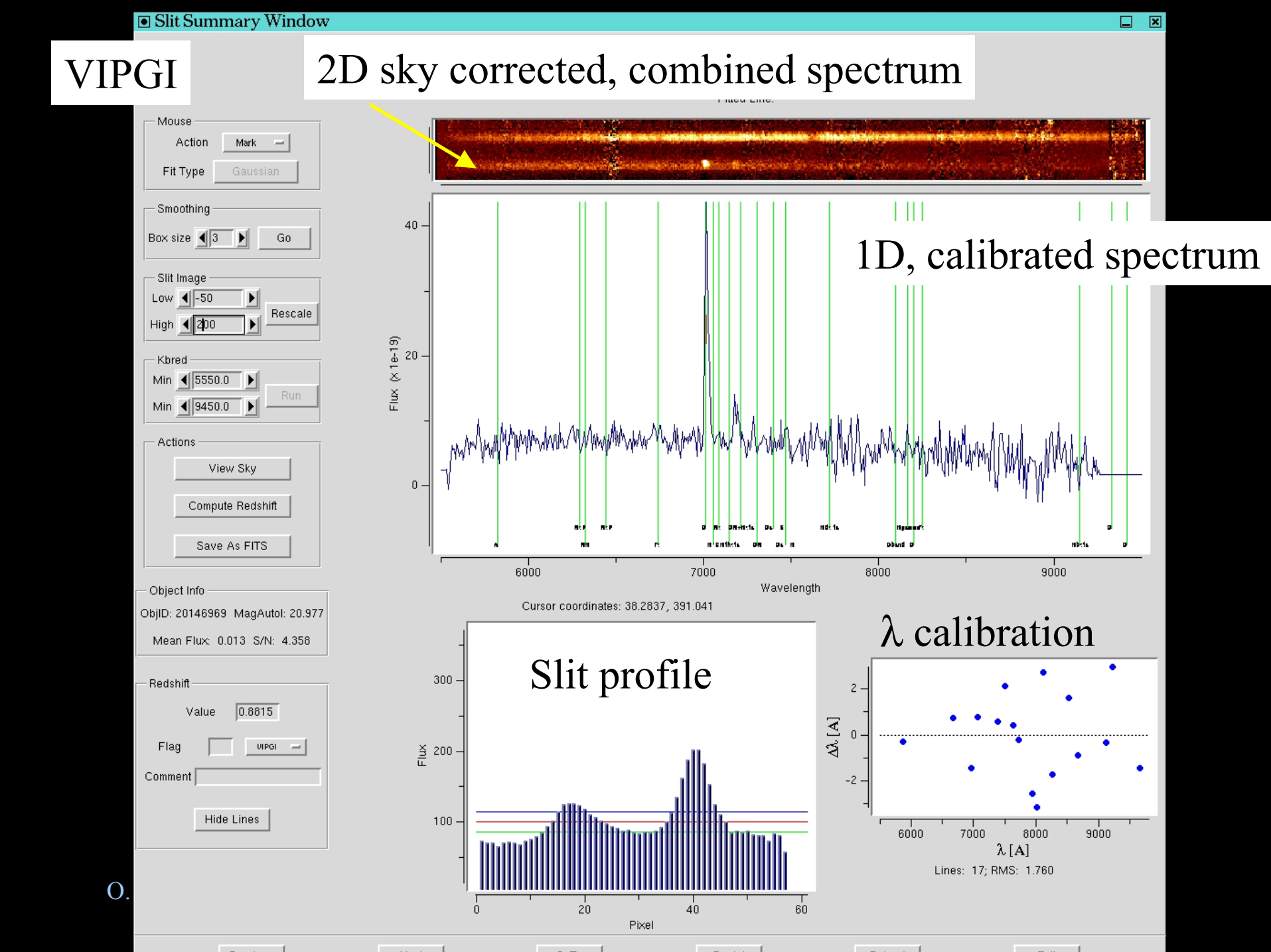
Summary

- VVDS: major on-going deep survey of $>10^5$ galaxies
  - 21000 spectra so far
  - N(z)
  - strong LF, LD evolution from z~1.5
- Detailed census of galaxy population up to z~5
- Link between LSS and galaxy evolution
- Large reference database for population studies

➡ Mapping the luminous high redshift universe on large scales

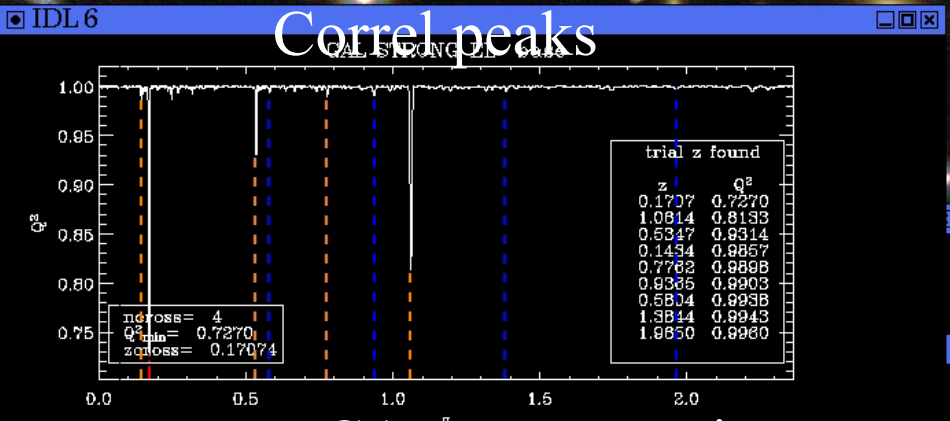
Measuring redshifts

- **Automated pipeline for 1D spectra extraction & calibration** (VIPGI, Scodeggio, Garilli, et al.)
  - 5 (wide) 10 (deep) exposures stack per pointing
  - One pointing of ~600 spectra processed in minutes
- **Measuring redshifts:**
  - large redshift range 0<z<5: difficult to train automated software
  - First blind pass with correlation / PCA tool (KBRED, Scaramella et al.)
  - Visual check of all spectra
  - 2/3 spectra treated “automatically”
  - 1/3 needs manual intervention

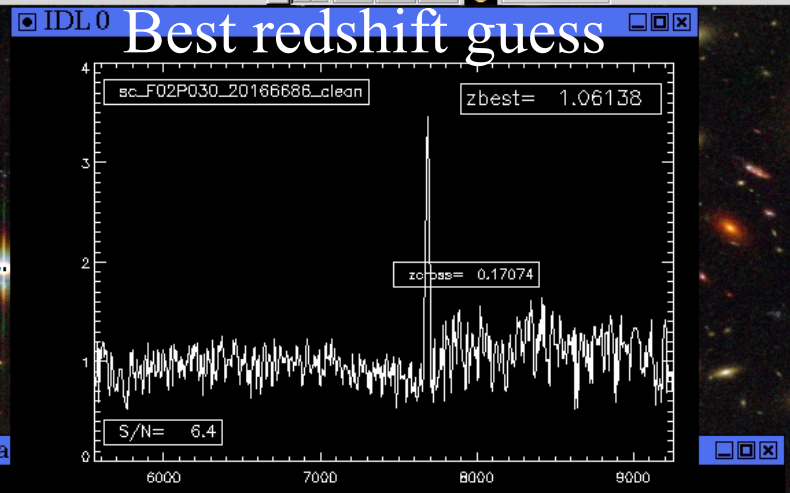

VIPGI
2D sky corrected, combined spectrum
Slit Summary Window
Mouse
Action
Mark
Fit Type
Gaussian
Smoothing
Box size
3
Go
Slit Image
Low
-50
High
200
Rescale
Kbred
Min
5550.0
Min
9450.0
Run
Actions
View Sky
Compute Redshift
Save As FITS
Object Info
ObjID: 20146969 MagAutol: 20.977
Mean Flux: 0.013 S/N: 4.358
Redshift
Value
0.8815
Flag
VIPGI
Comment
Hide Lines
1D, calibrated spectrum
Flux (X 1e-19)
Wavelength
Cursor coordinates: 38.2837, 391.041
Slit profile
Flux
Pixel
λ calibration
Δλ [A]
λ [A]
Lines: 17; RMS: 1.760

KBRED: cross correlation + PCA

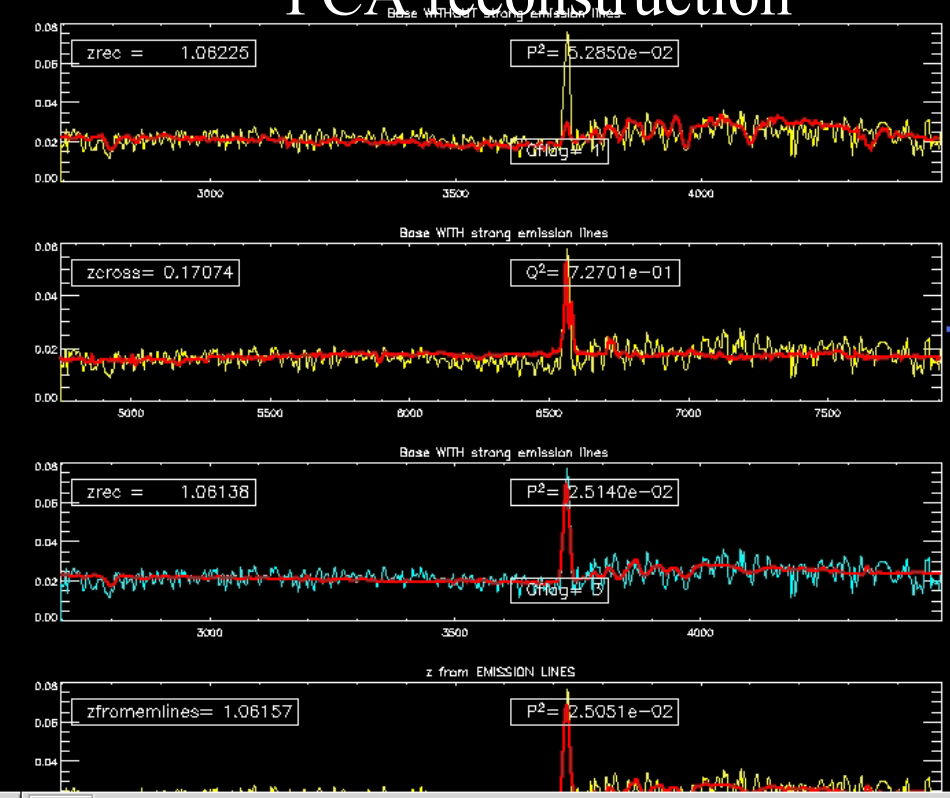
Correl peaks

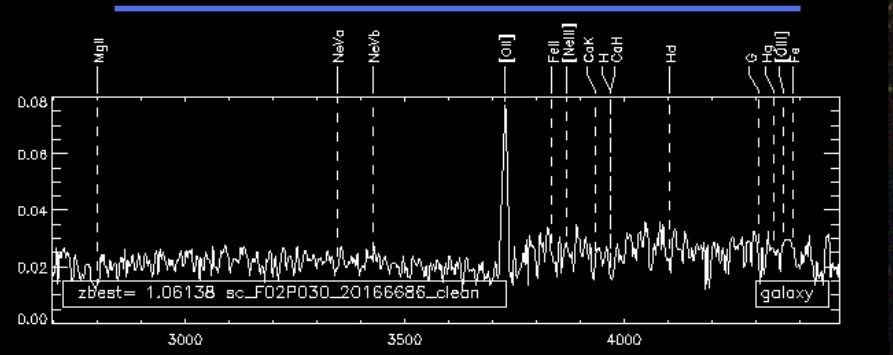


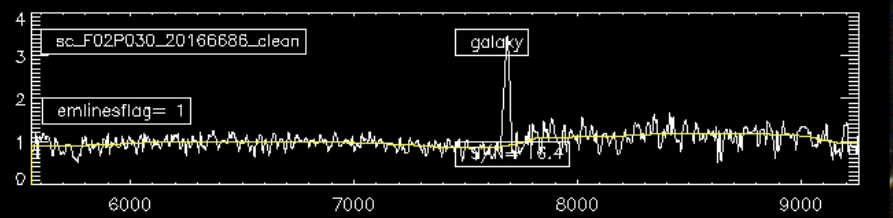
Best redshift guess

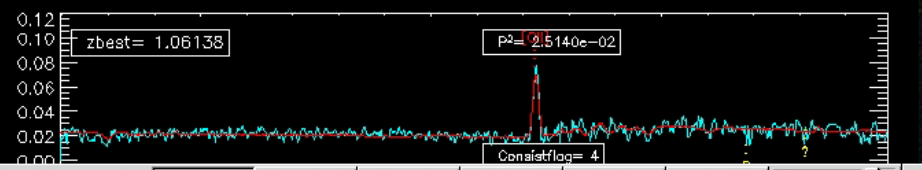


PCA reconstruction

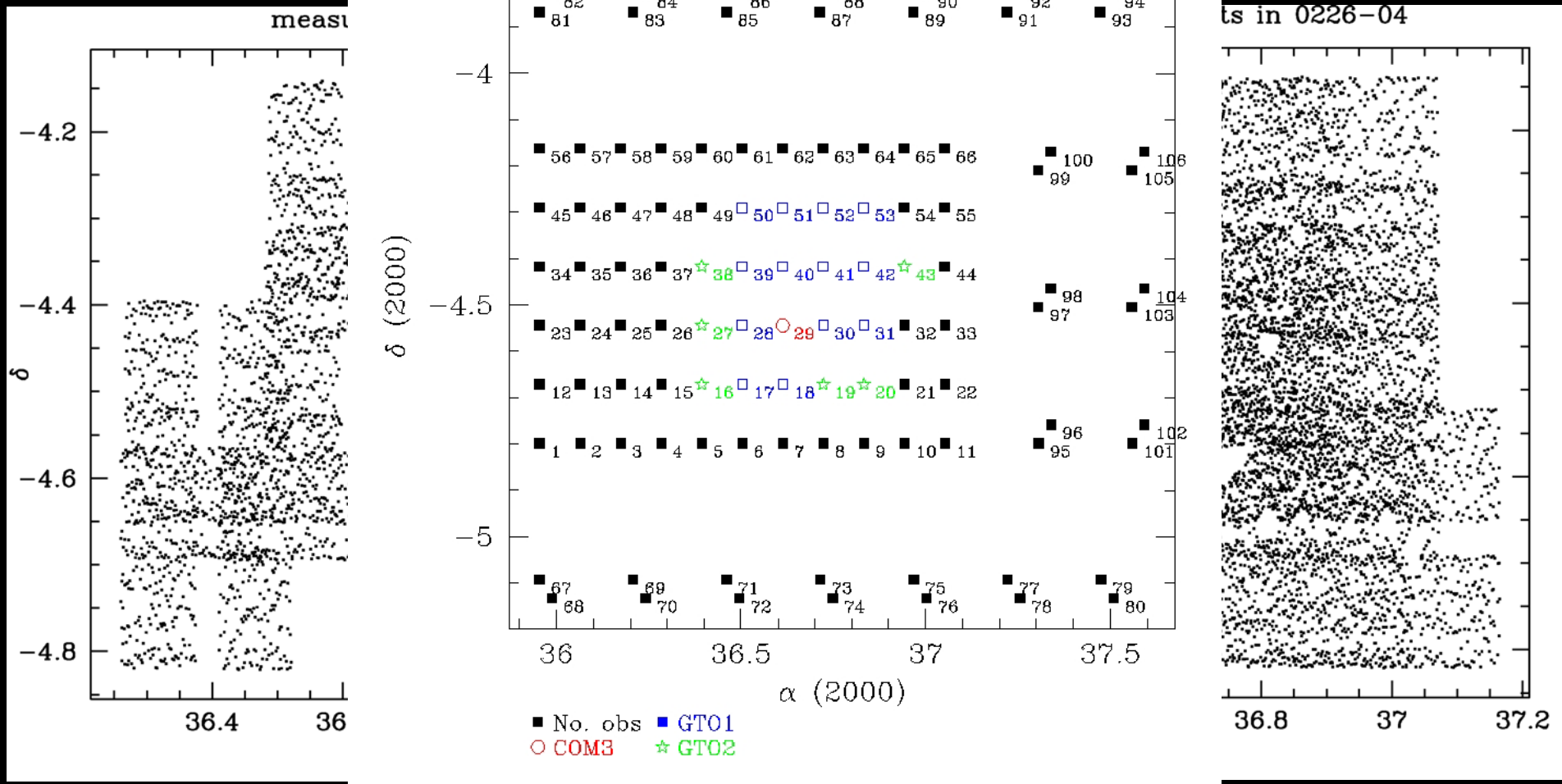




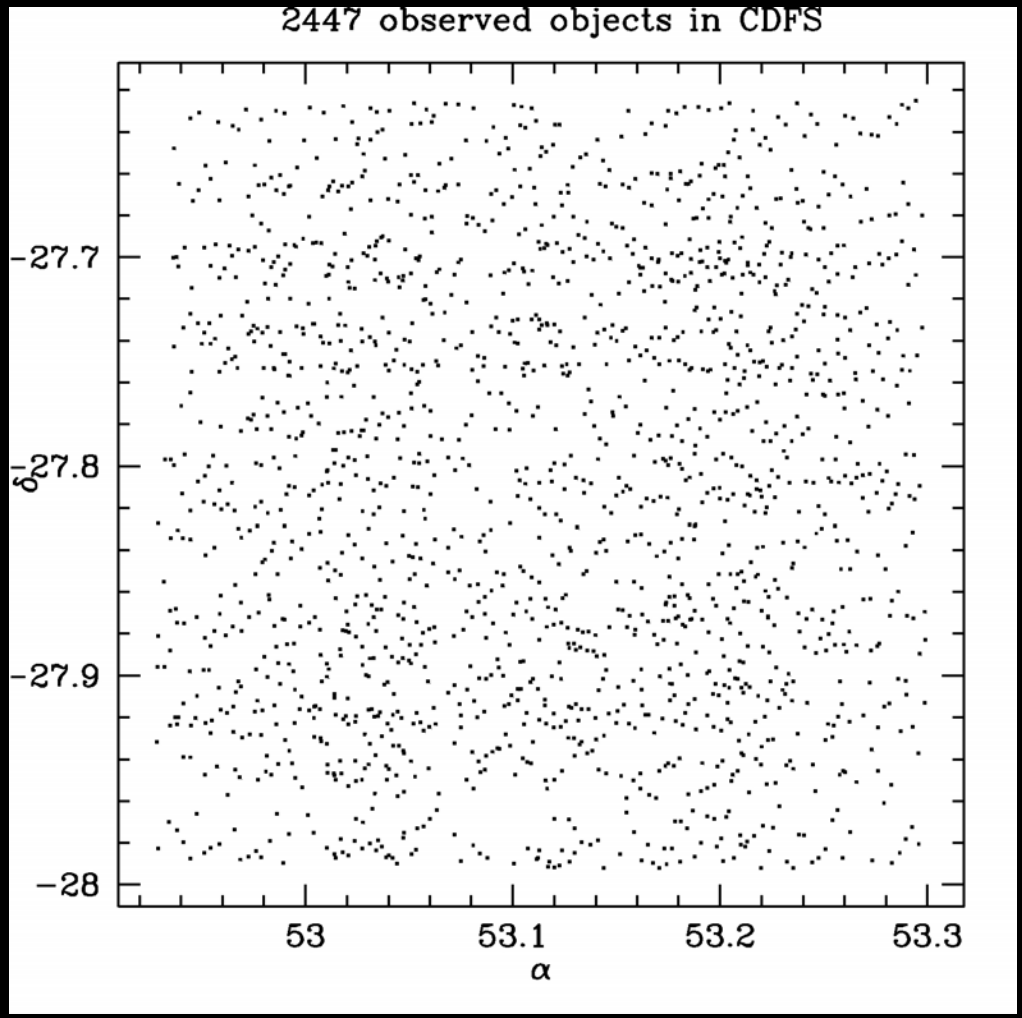




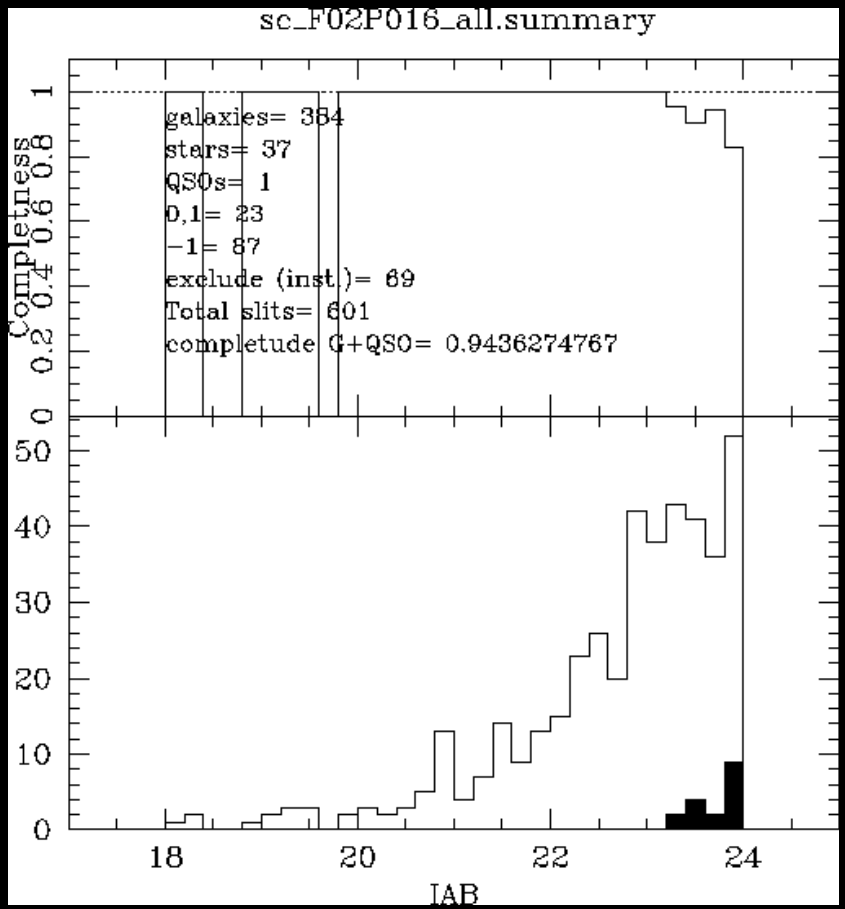
Observed galaxies: 0226-04

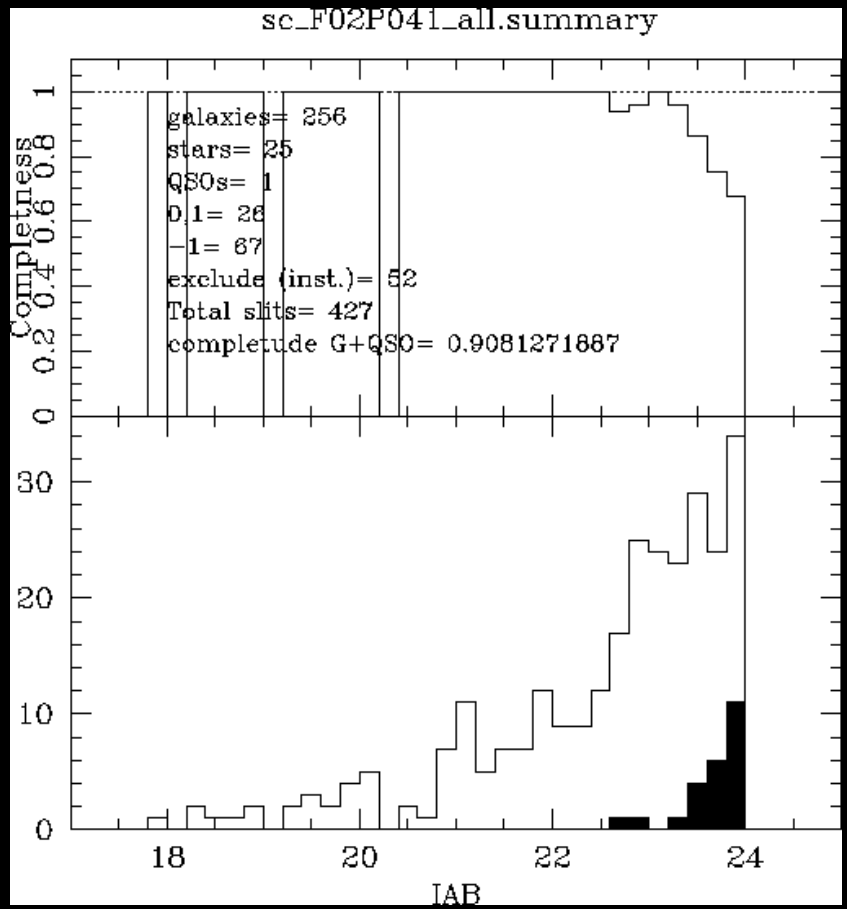


Observed galaxies: CDFS



Completness

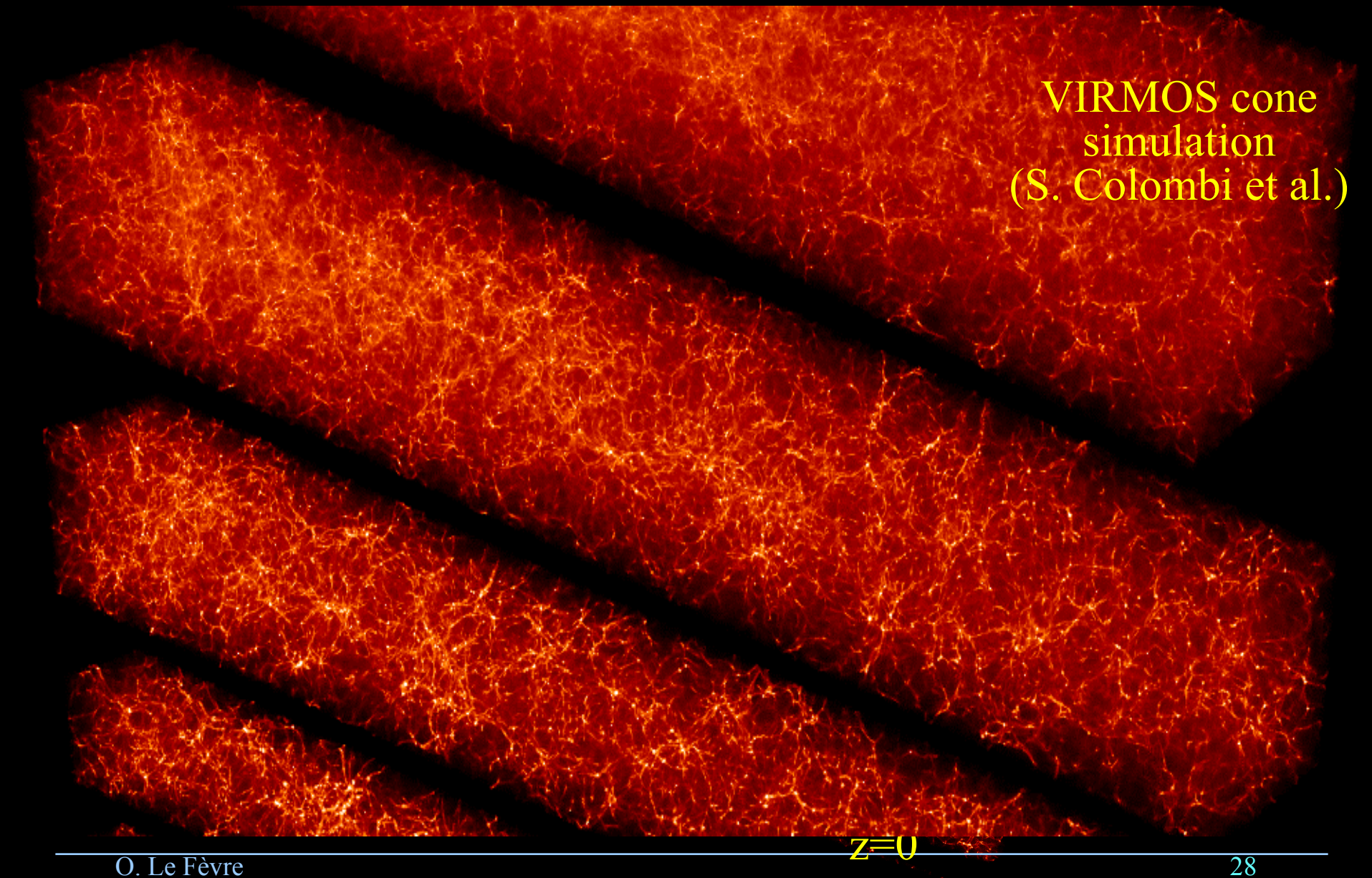




current is ~85%

known deficiency in 1.5<z<3: lack of templates in 1500<λ<2500Å, now fixed

What do we expect ?



What's next: HST-COSMOS