GALAXY EVOLUTION FROM DEEP GALAXY FIELDS

From galaxies to cosmology with deep spectroscopic surveys
A tribute to Olivier Le Fèvre. 4-8 July 2022

REVIEW OF
OLIVIER'S
CONTRIBUTION

Laurence Tresse LAM

Chercheur la nuit !

Dirigeant le jour

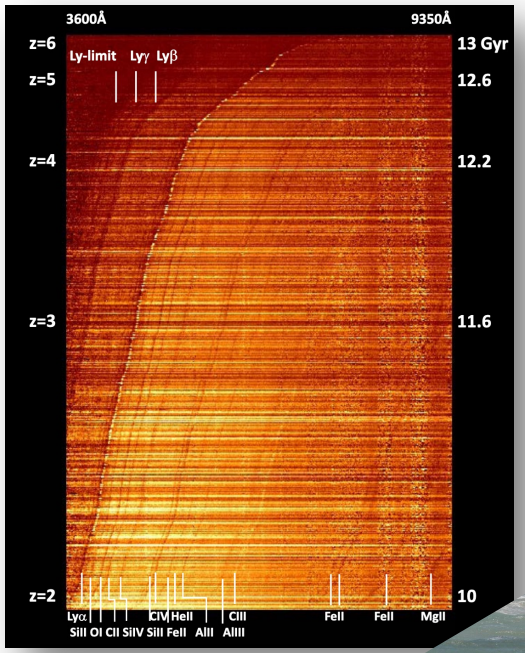
LAM
LABORATOIRE D'ASTROPHYSIQUE
DE MARSEILLE

Status of galaxy evolution – 2 major questions

 # Hunting for the sources of reionisation
 # Passive galaxies challenge our galaxy formation models

→ Nowadays galaxy demography at 0<z<2 is well constrained.

→ Results of decades to build deep z-surveys in which Olivier has played a major role.



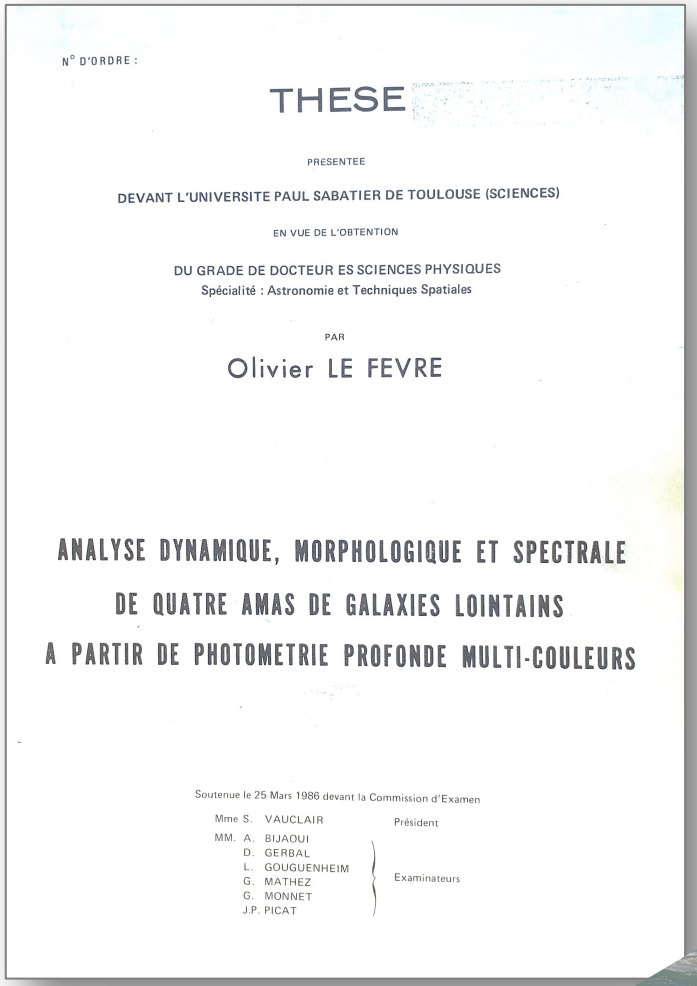
REVIEW of Olivier's early contributions in galaxy evolution

- 90's The CFRS / MOS-SIS @CFHT
- 00's The VVDS / VIMOS @VLT

His first-author paper was about the comet Hallet in 1984
His last ones about sources up to z=6 in 2020 (VUDS & ALPINE-ALMA [CII] survey)

Mid-80's – his first steps in faint galaxy fields and high-z galaxies

PhD in 1986 on high-z (0.2<z<0.6) galaxy clusters & three comparison **faint galaxy fields**



N° D'ORDRE :

THESE

PRESENTEE

DEVANT L'UNIVERSITE PAUL SABATIER DE TOULOUSE (SCIENCES)

EN VUE DE L'OBTENTION

DU GRADE DE DOCTEUR ES SCIENCES PHYSIQUES
Spécialité : Astronomie et Techniques Spatiales

PAR

Olivier LE FEVRE

ANALYSE DYNAMIQUE, MORPHOLOGIQUE ET SPECTRALE
DE QUATRE AMAS DE GALAXIES LOINTAINS
A PARTIR DE PHOTOMETRIE PROFONDE MULTI-COULEURS

Soutenue le 25 Mars 1986 devant la Commission d'Examen

Mme S. VAUCLAIR — Président

MM. A. BIJAOUI
D. GERBAL
L. GOUGUENHEIM
G. MATHEZ
G. MONNET
J.P. PICAT — Examinateurs

Imaging of 300 galaxies in clusters and 100 in fields

- Deep photometry with 3.6m CFHT (BV) and 2m Pic du Midi (RI)
- Automatic photometric treatment of **faint galaxy fields**

Studies of galaxies wrt. environment (Butcher & Oemler effect at z>0.1)

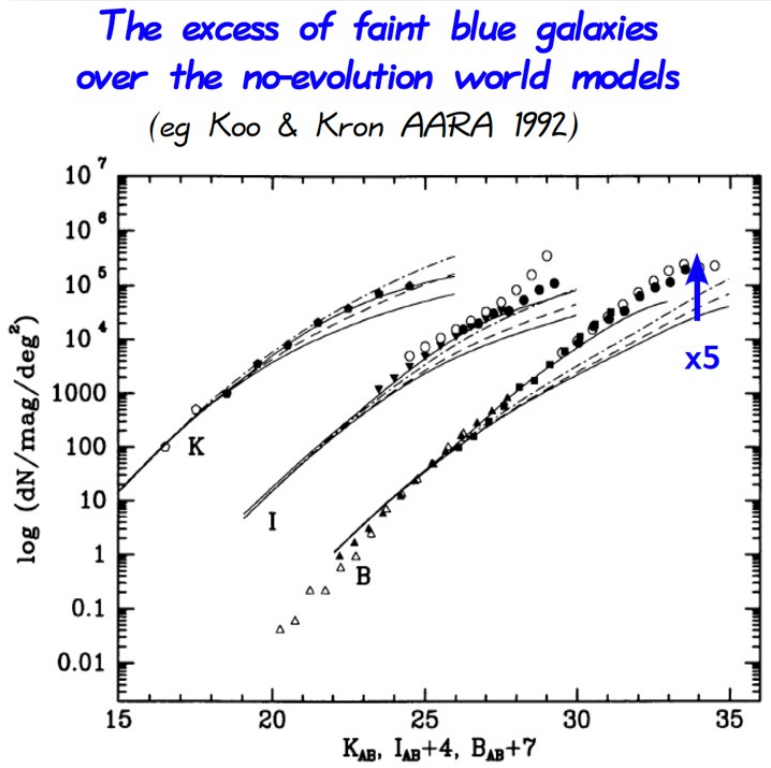
Toulouse Hawaii @CFHT

Late 80's he published several papers on CFHT **imaging** radio galaxies (3CR) to probe **the far universe at 1<z<2** (CNRS bronze medal in 1987)

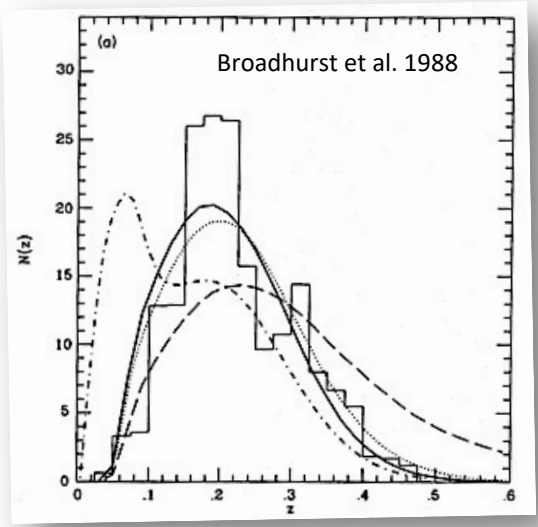
Mid 80's – the context about galaxy evolution

Galaxy Surveys as Cosmological Probe?

Hubble and Tolman 1935



Advent of the first CDDs



80's First B-selected redshift surveys

- N(m) dominated by luminosity and colour evolution
  Tinsley (1972), Bruzual (1983), etc.
- N(z) in agreement with no evolution models
  Broadhurst et al (1988)

Conclusions in mid '80s

Mild evolution of galaxies at low-z

Still N(B) et N(z) not fitted simultaneously

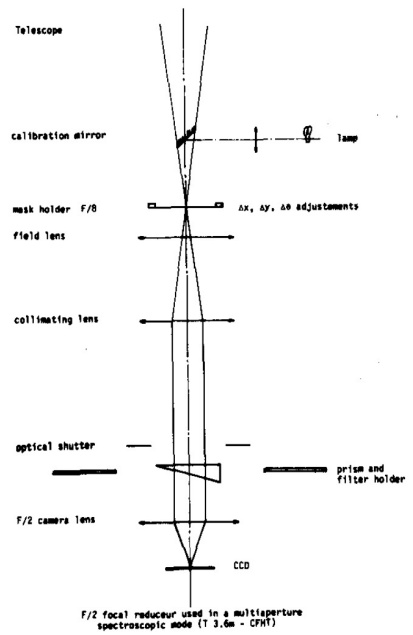
Mid-80's – the context about multislit spectrographs & galaxy surveys

Advent of the first multislit spectrographs at CFHT back to the mid-80's
the MARLIN spectrographs, a focal reducer installed at Cassegrain focus

C.F.H.T. FOCAL REDUCER : IMAGE AND MULTIAPERTURE SPECTROSCOPY

B. Fort[1], G. Lelièvre[2], J.P. Picat[1], Y. Rio[3], L. Vigroux[3]

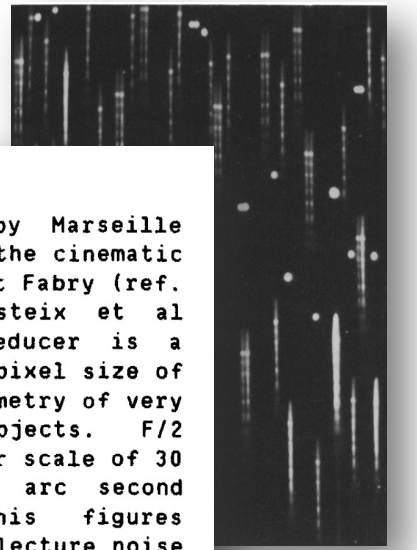
Focal Reducer



Designed (fig. 1) by Marseille Observatory to study the cinematic of galaxies with Perot Fabry (ref. Courtes, 1960, Boulesteix et al 83), this focal reducer is a perfect match for the pixel size of CCD cameras for photometry of very faint isolated objects. F/2 aperture gives a linear scale of 30 microns for the 0.8 arc second regular seeing. This figures minimize the surface lecture noise of CCD and provide a very fast instrument for deep imagery and multiaperture spectroscopy.

Fig. 1 (left) : Optical design of the focal reducer

1984



Proceedings of the IAU Colloquium No 79: "Very Large Telescopes, their Instrumentation and Programs" Garching, April 9–12, 1984.

&

Selection of galaxies in red filters
FOCAM 2048x2048 camera @primefocus CFHT

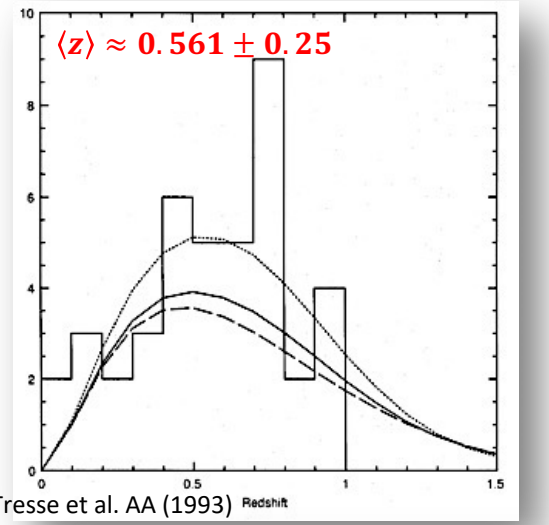
Two first multislit pilot surveys at $z \gg 0.3$
I-selection for sources at $0.05 \leq z \leq 1$

- ✓ 50ish sources in 3 fields (F03, F10, F14)
  FR Hammer, Le Fèvre, Proust, Tresse (1993)
- ✓ 50ish sources in 1 field (F22)
  CA Lilly (1993)

about 20 spectra simultaneously on faint sources

Early 90's – his initial steps in multislit spectroscopy

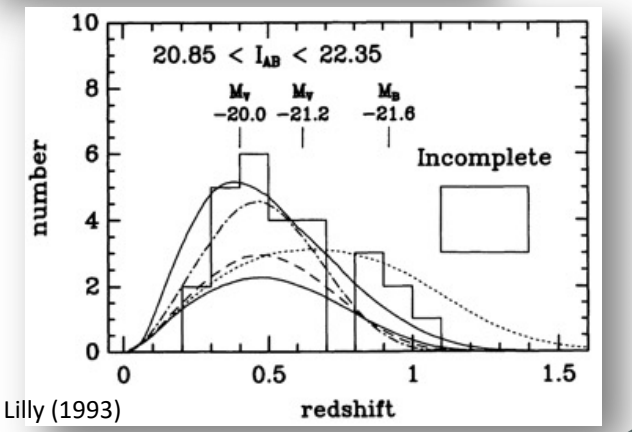
Degeneracy between mean galaxy population evolution and cosmology
Misunderstanding linked to unknown evolving properties of galaxy population



Tresse et al. AA (1993)

Deep redshift surveys built to understand **statistically** speaking the galaxy evolution & to trace a **coherent history** of the galaxy populations

I-band selected pilot surveys demonstrated that:
- ✓ the potential of such surveys to trace the galaxy population evolution up to $z \approx 1$
- ✓ faint galaxies at low-z are undergoing strong evolution
- ✓ <10 sources per Δz=0.25 is too small to establish fair statistical studies



Lilly (1993)

Conclusions early 90's
Evolution of galaxies at $z \gg 0.3$ cannot anymore be considered as a simple corrective factor

Start of large deep redshift surveys

Early-90's – his first steps in instrumental dev. of multislit spectrographs

Resident Astronomer

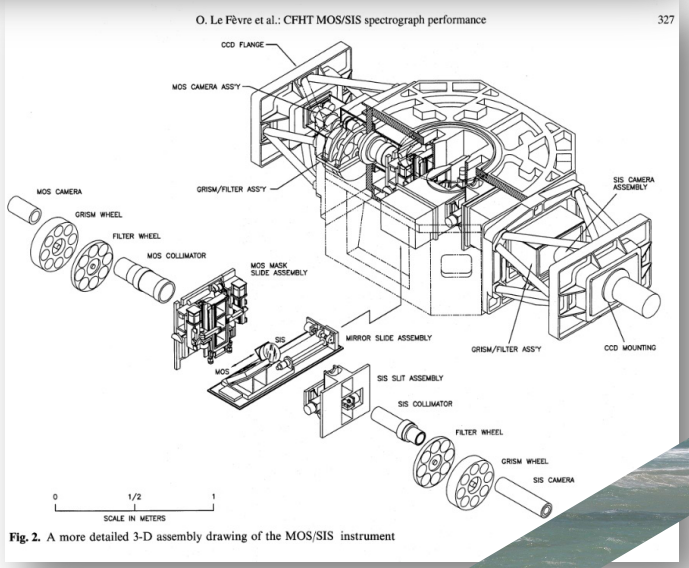


Fig. 2. A more detailed 3-D assembly drawing of the MOS/SIS instrument

MULTI-APERTURE and SUBARCSECOND IMAGING SPECTROGRAPH FOR CFHT

D. Crampton, W.A. Grundmann, B. Leckie and C.L. Morbey, DAO, Victoria, Canada
J.P. Lemonnier, P. Felenbok, M. Marteaud, P. Vola, Observatoire Paris-Meudon, Meudon, France
Y. Georgelin, Observatoire de Marseille, Marseille, France
O. Le Fèvre, B. Grundseth, G. Monnet, D. Salmon, CFHT, Kamuela, Hawaii, USA

1. Overall description

At a meeting in 1986, the CFHT user community identified a low spectral resolution multi-object spectrograph as one of the highest priorities for new instrumentation at CFHT. This followed first hand experience gained with the Toulouse group PUMA machine working with the CFHT focal reducer (Fort et al., 1987). The desire to observe many faint objects simultaneously with the mean image quality at CFHT of 0.75 arcsec led to the design of the ''MOS/SIS'' spectrograph, a dual Multi-Object and Subarcsecond Imaging Spectrograph. It is composed of essentially two focal reducer type spectrographs, one optimized for multi-object observations over a 10x10 arcmin field, the other for high spatial resolution spectroscopy in a 3x3 arcmin field, incorporating rapid tip/tilt image stabilization similar to that very successfully used in the CFHT/DAO high resolution camera HRCam (McClure et al., 1989).

The MOS/SIS spectrograph was jointly designed and built by teams from the Dominion Astrophysical Observatory (DAO) in Victoria, the Observatoire de Paris-Meudon (OPM), the Observatoire de Marseille (OM) and CFHT. Work began on the designs in May, 1988 and resulted in an instrument which can be described as a folded cassegrain spectrograph in which 45° mirrors feed two opposed, in-line ways, both of which are

CFHT MOS/SIS spectrograph: 10'x10' field, 2048x2048 15µm pixel CCD, 365-1000 nm, spatial sampling of 0.8". Best compromise between field size and spatial resolution.

about 60 slits simultaneously on faint sources

Early-90's – his deployment of a semi-automatic tool for mos data

Support Astronomer

CFHT MOS/SIS spectrograph performance

O. Le Fèvre [1], D. Crampton [2], P. Felenbok [3], and G. Monnet [1]

[1] CFHT, Kamuela, Hawaii, USA
[3] Dominion Astrophysical Observatory, 5071 West Saanich Road, Victoria, BC, Canada V8X 4M6
[3] Observatoire de Paris-Meudon, Section de Meudon, F-92195 Meudon Principal Cedex, France

Received April 16, accepted May 4, 1993

CFH Canada-France-Hawaii Telescope

A User's Manual for the CFHT's dual Multiple Object and Subarcsecond Imaging Spectrograph: MOS/SIS

Olivier Lefevre - 1993, Version 2

CFH Canada-France-Hawaii Telescope

A User's Manual for the CFHT Visible Imager: FOCAM

Olivier Lefevre, Robin Arsenault - August 1994, Version 3

He developped the first semi-automatic MOS reduction tool (with IRAF)

The MULTIRED package

The MULTIRED package has been written under IRAF by O. Le Fèvre to process MOS/OSIS multi-slit data following the above steps. The package can be obtained as a gzipped, tar file: multired.tgz

To unpack and recreate the files, type the command:

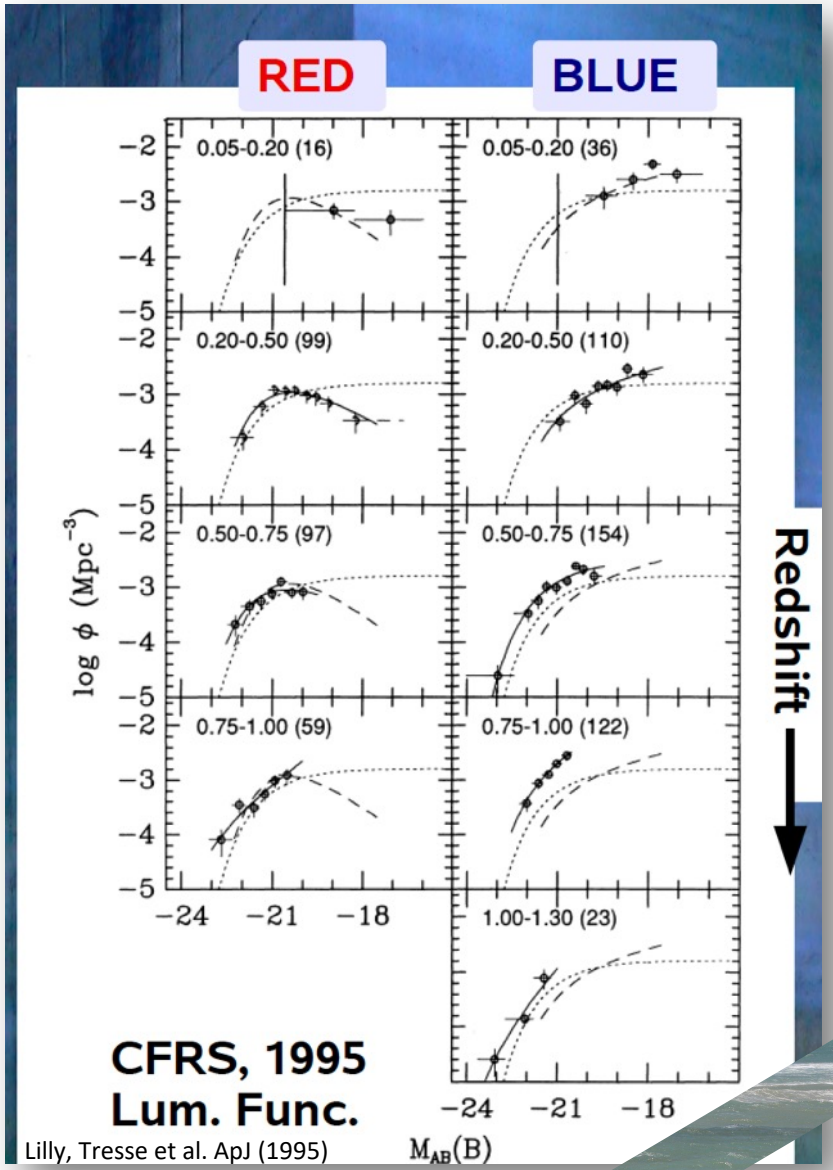
```
gunzip -c multired.tar | tar xvf -
```

Proceed with the installation of the package in IRAF, by following the steps described in the file RE

MULTIRED is a very efficient package which helps you keep track of slit numbers, works … images per mask, and performs the dataprocessing steps in a painless sequence to produce flat/sky corrected 2D spectra, as well as wavelength and flux calibrated 1D spectra. On line help is available for each MULTIRED task.

→ VIPGI/VIMOS (before ESO asked reduction pipelines to be included in projects)

The Canada-France redshift survey – one major result



Deep redshift surveys build to probe the galaxy evolution through cosmic times

- **The Canada-France Redshift Survey**

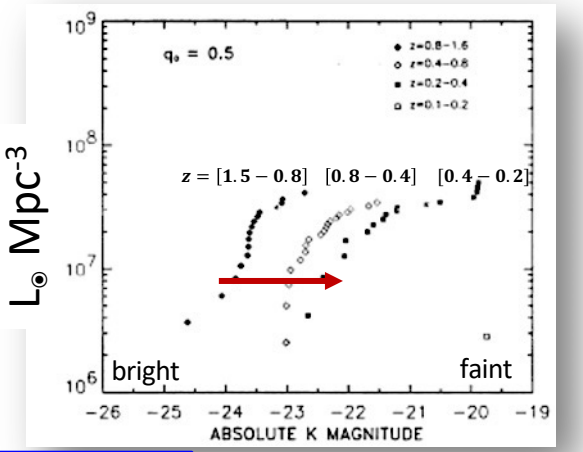
I_{AB}=22.5, five FOVs totalizing 112 arcmin², 1000 sources at $0.05 \leq z \leq 1$
Team: Crampton, Hammer, Le Fèvre, Lilly & Tresse 1995
The first large high-z survey (z=1 was high-z in the '90s)

Definitive answer about the galaxy evolution up to $z \approx 1$:

✓ The **RED** population is in place at $z \approx 1.3$, evolve passively
✓ The **BLUE** population evolves strongly
in luminosity (+1 mag) or in density (x3)

- **The Hawaii Fields**

$K \leq 20$, Cowie, Songaila, Hu & Cohen 1996
Galaxy formation took place in downsizing
(i.e. more massive galaxies at high-z)



Conclusions mid 95's

Evolution of galaxies is very differentiated through time, strongly linked to color-type

The Canada-France redshift survey products

A series of 15 publications (>3000 citations) 1995-1997

1995ApJ...455...50L 1995/12 cited: 291
The Canada-France Redshift Survey. I. Introduction to the Survey, Photometric Catalogs, and Surface Brightness Selection Effects
Lilly, S. J.; Le Fevre, O.; Crampton, David; Hammer, F.; Tresse, L. *show less*

1995ApJ...455...60L 1995/12 cited: 120
The Canada-France Redshift Survey. II. Spectroscopic Program: Data for the 0000-00 and 1000+25 Fields
Le Fevre, Olivier; Crampton, David; Lilly, Simon J.; Hammer, Francois; Tresse, Laurence *show less*

1995ApJ...455...75L 1995/12 cited: 85
The Canada-France Redshift Survey. III. ``Single Emission-Line'' Objects, Analysis of Repeat Observations, and Spectroscopic Identifications in the 1415+52 and 2215+00 Fields
Lilly, S. J.; Hammer, F.; Le Fevre, O.; Crampton, David *show less*

1995ApJ...455...88H 1995/12 cited: 52
The Canada-France Redshift Survey. IV. Spectroscopic Selection Effects and 0300+00 Field Spectroscopic Data
Hammer, Francois; Crampton, David; Le Fevre, Olivier; Lilly, Simon J. *show less*

1995ApJ...455...96C 1995/12 cited: 82
The Canada-France Redshift Survey. V. Global Properties of the Sample
Crampton, David; Le Fevre, O.; Lilly, S. J.; Hammer, F. *show less*

1995ApJ...455..108L 1995/12 cited: 586
The Canada-France Redshift Survey. VI. Evolution of the Galaxy Luminosity Function to Z approximately 1
Lilly, S. J.; Tresse, L.; Hammer, F.; Crampton, David; Le Fevre, O. *show less*

1995MNRAS.276.1085H 1995/10 cited: 64
The Canada-France Redshift Survey - VII. Optical counterparts of microjansky radio sources
Hammer, F.; Crampton, David; Lilly, Simon J.; Le Fevre, O.; Kenet, T. *show less*

1996ApJ...461..534L 1996/04 cited: 155
The Canada-France Redshift Survey. VIII. Evolution of the Clustering of Galaxies from Z approximately 1
Le Fevre, O.; Hudon, D.; Lilly, S. J.; Crampton, David; Hammer, F.; Tresse, L. *show less*

1996ApJ...460L...1L 1996/03 cited: 1190
The Canada-France Redshift Survey: The Luminosity Density and Star Formation History of the Universe to Z approximately 1
Lilly, S. J.; Le Fevre, O.; Hammer, F.; Crampton, David *show less*

1996MNRAS.278...95S 1996/01 cited: 16
Canada-France Redshift Survey - X. The quasar sample
Schade, David; Crampton, David; Hammer, F.; Le Fevre, O.; Lilly, S. J. *show less*

1996ApJ...464...79S 1996/06 cited: 89
Canada-France Redshift Survey. XI. Morphology of High-Redshift Field Galaxies from High-Resolution Ground-based Imaging
Schade, David; Lilly, S. J.; Le Fevre, O.; Hammer, F.; Crampton, D. *show less*

1996MNRAS.281..847T 1996/08 cited: 108
The Canada-France Redshift Survey - XII. Nature of emission-line field galaxy population up to z=0.3
Tresse, L.; Rola, C.; Hammer, F.; Stasińska, G.; Le Fevre, O.; Lilly, S. J.; Crampton, D. *show less*

1997ApJ...481...49H 1997/05 cited: 191
Canada-France Redshift Survey. XIV. Spectral Properties of Field Galaxies up to z = 1
Hammer, F.; Flores, H.; Lilly, S. J.; Crampton, David; Le Fèvre, O.; Rola, C.; Mallen-Ornelas, G.; Schade, D.; Tresse, L. *show less*

CFRS 30 nights
A team of 5 persons
Le Fèvre, Lilly, Hammer, Crampton & Tresse
4 young astronomers ♂ & 1 PhD student ♀

Old times…when students were sometimes barely included or even quoted.

- At that time, Olivier Le Fèvre was already inclusive, as demonstrated through all his career, with a strong team spirit.
- After the CFRS he has set co-author policy rules in team works.

+ several follow-ups with XMM, HST, VLT, etc.

Meanwhile...Olivier resting?

Common room @CFHT 1993

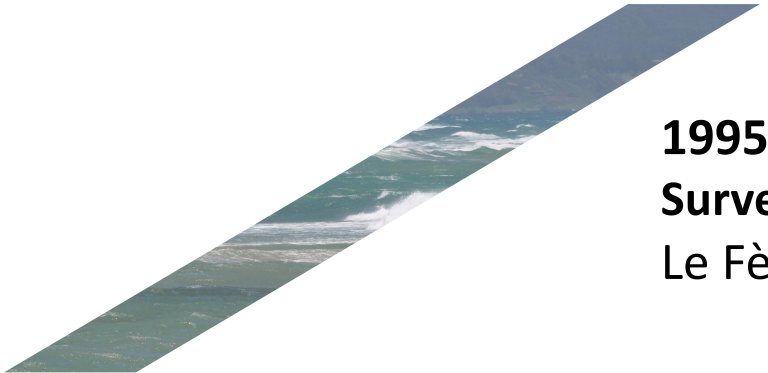
1994 *Future VLT instruments: scientific drivers and concept definitions*

NIRMOS: a wide field near-IR multislit imaging-spectrograph for the VLT
Le Fèvre, O. ; Felenbok, P. ; Hammer, F. ; Tresse, L. ; Delabre, B. ; Vettolani, P. ; Mellier, Y. ; Picat, J. P. ; Lilly, S. J.

WFIS: a Wide Field visual multislit Imaging-Spectrograph for the VLT
Vettolani, G. ; Delabre, F. ; Le Fèvre, O. ; Hammer, F. ; Zamorani, G.

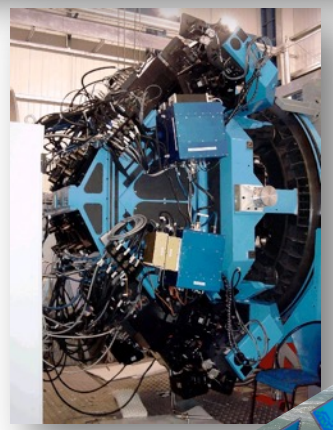
Hawaii @CFHT France

Feasability study with FR and IT institutes in 9 months 1995-1996 commissionned by ESO



1995 *Proceedings of the 30th Rencontres de Moriond*
Survey Spectrographs for Cosmology at the ESO-VLT
Le Fèvre, O. ; Vettolani, P.

Acquiring deep imaging while constructing VIRMOS (1997-2001)



PAE@OHP

- **October 1996 – ESO-STC selected VIRMOS**
- **July 1997 – Contract signed (ESO, FR, IT)**
- **Preliminary Acceptance Europe @OHP (11-13/09/2001)**

An ESO fast tract instrument…but first generation of big instruments...VIMOS/VLT too heavy, DEIMOS/Keck too large

VIRMOS = VIMOS [MOS+IFU] **+ NIRMOS + MMU** *(MMU also for FORS2)*

1997, 1998 The VLT-VIRMOS Deep Survey
Le Fèvre, Olivier; Vettolani, Paolo et al.

Meanwhile on-going deep imaging for the VVDS

- VIS (BVRI) The CFH12K Deep Survey *Le Fèvre, O.; Mellier, Y.; McCracken, H. J. 2004*
- U-band ESO/WFI *Radovich et al. 2004*
- NIR ESO/SOFI *Iovino et al 2005*

but also, always looking ahead…
Deep Redshift Surveys with the VLT-VIRMOS and the NGST
Le Fèvre et al. 2000

VIMOS Commissioning on VLT-Melipal

O. LE FÈVRE[1], D. MANCINI[2], M. SAÏSSE[1], S. BRAU-NOGUÉ[3], O. CAPUTI[2], L. CASTINEL[1], S. D'ODORICO[4], B. GARILLI[5], M. KISSLER[4], C. LUCUIX[3], G. MANCINI[2], A. PAUGET[1], G. SCIARRETTA[2], M. SCODEGGIO[5], L. TRESSE[1], D. MACCAGNI[5], J.-P. PICAT[3], G. VETTOLANI[6]

Messenger2002

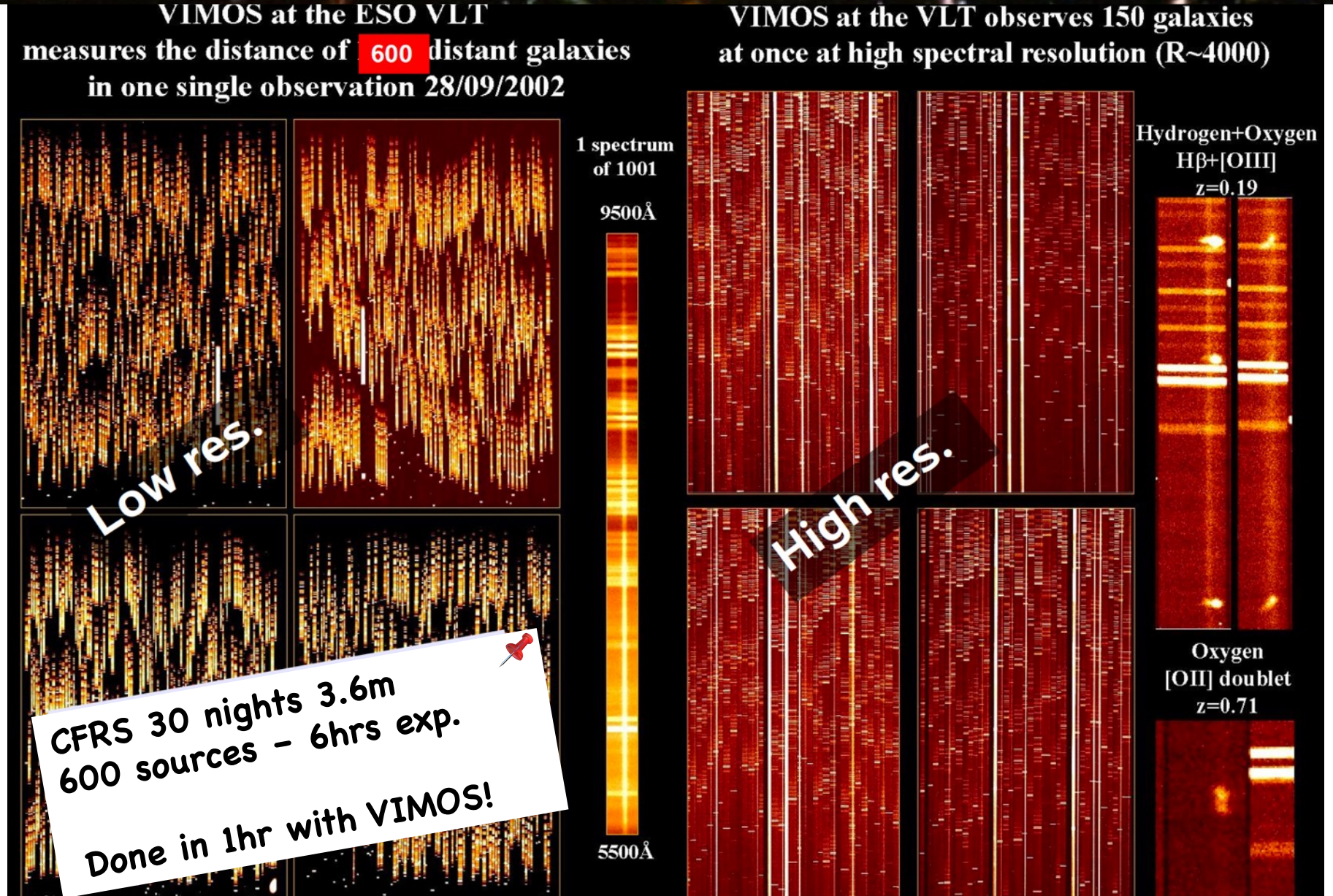
[1]Laboratoire d'Astrophysique de Marseille, France; [2]Osservatorio Astronomico di Capodimonte, Naples, Italy; [3]Observatoire Midi-Pyrénées, Tarbes, France; [4]European Southern Observatory, Garching, Germany; [5]Istituto di Fisica Cosmica e Tecnologie Relative, Milan, Italy; [6]Istituto di Radio Astronomia, Bologna, Italy

VIMOS

- First light: 26 Feb. 2002
- 3 commissionning periods Feb.-Oct. 2002

Commissioning and performances of the VLT-VIMOS instrument
Le Fèvre, O. et al. 2003, SPIE 4841, 1670

VIMOS 26 FEBRUARY 2002 - 24 MARCH 2018 : 16 YEARS OF REDSHIFT SURVEYS



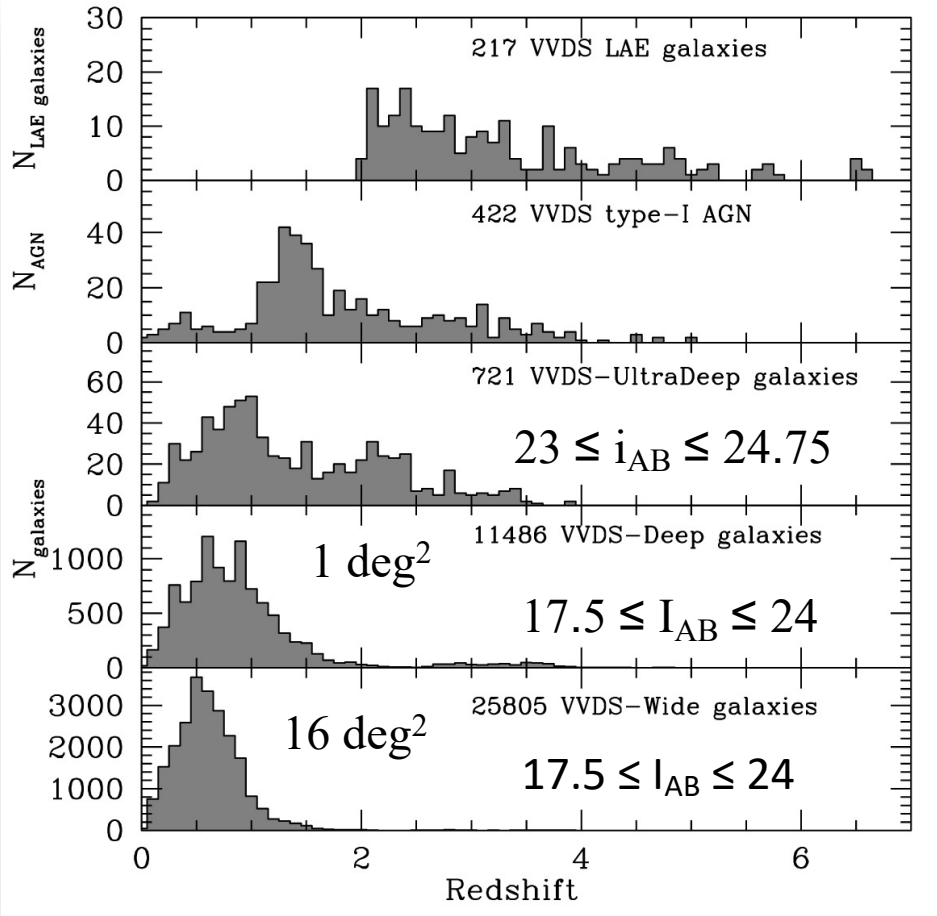
VIMOS

FOV: 4 x 7’ x 8’

Deep survey efficiency
x100 in 10 yrs

VVDS GTO 60 nights
50ish persons

Releases of the VVDS datasets – 10 years



- **The VIMOS VLT Deep Survey. Public release of 1599 redshifts to $I_{AB} \leq 24$ across the Chandra Deep Field South**

Le Fèvre et al. 2004

- **The VIMOS VLT deep survey. First epoch VVDS-deep survey: 11 564 spectra with $17.5 \leq I_{AB} \leq 24$, and the redshift distribution over $0 \leq z \leq 5$**

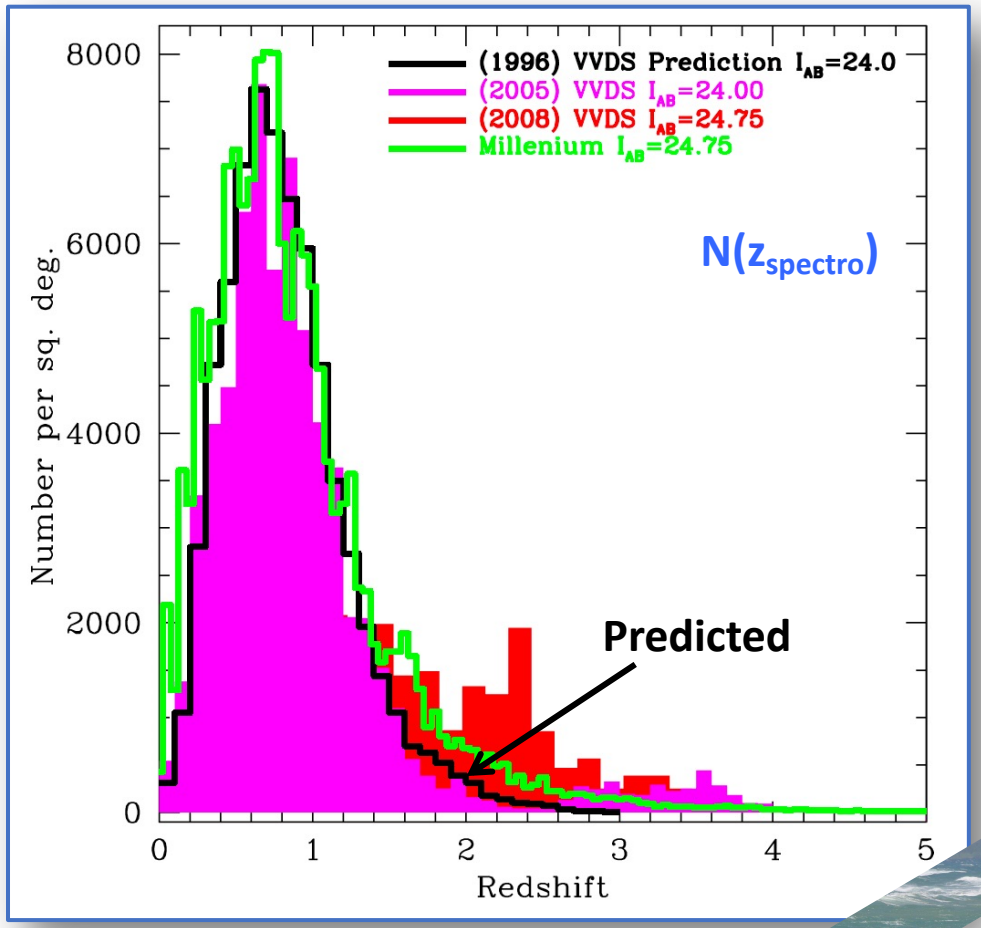
Le Fèvre et al. 2005

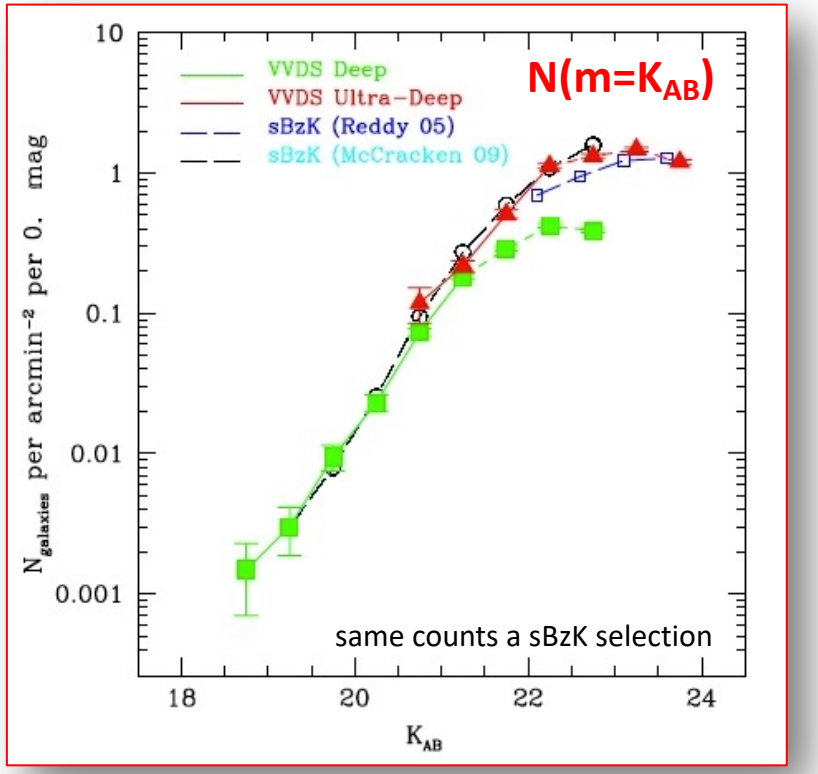
- **The VIMOS VLT Deep Survey final data release: a spectroscopic sample of 35 016 galaxies and AGN out to z ~ 6.7 selected with $17.5 \leq i_{AB} \leq 24.75$**

Le Fèvre et al. 2013

Olivier's credo: data must speak first

The VVDS Final Counts



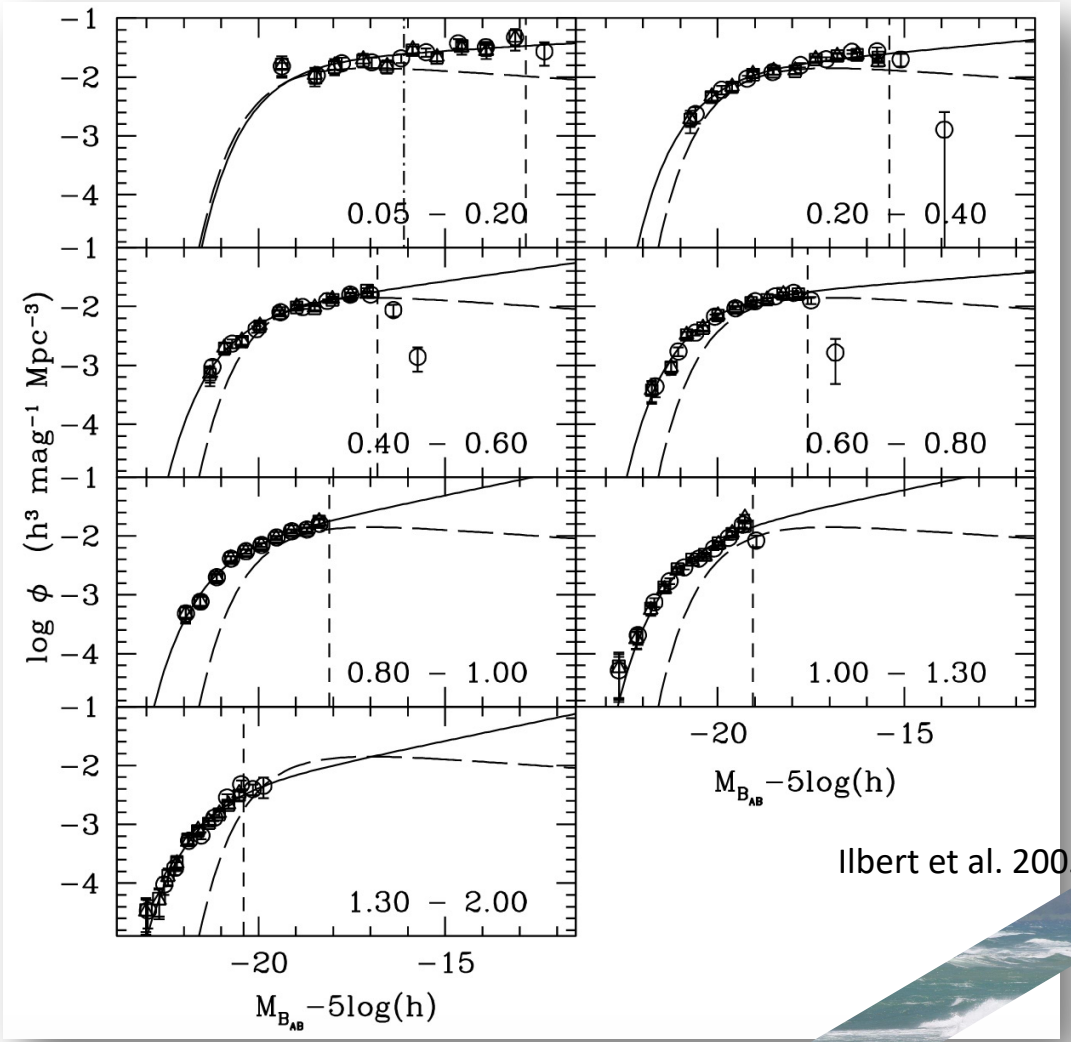


VVDS-Deep has been completed with the Ultra-Deep Survey
LR-Blue 18hrs +LR-Red 18hrs: 337<λ<2310 nm
To fill the redshift desert

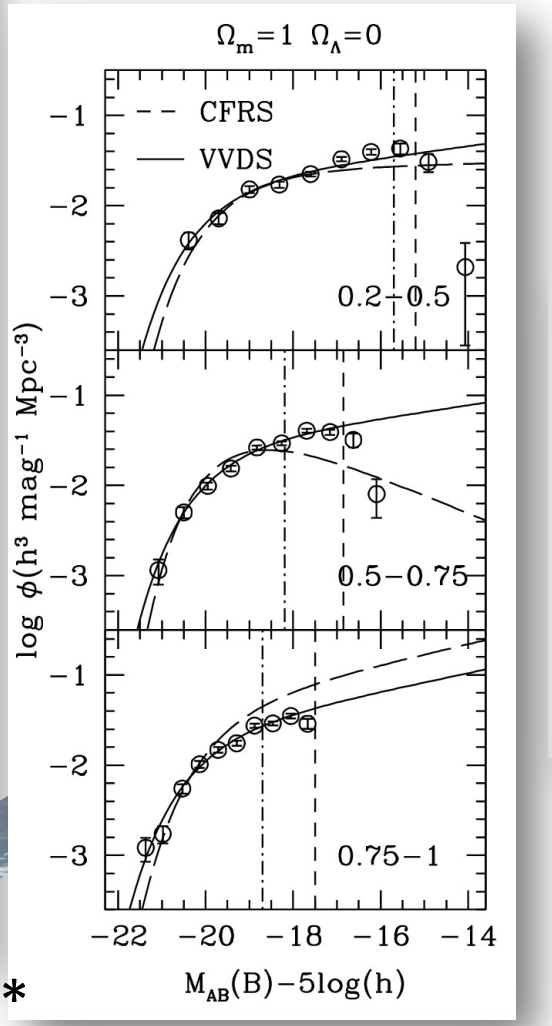
Later on, he said: *"la parole est aux données d'observation en évitant soigneusement tout biais observationnel, tout a priori fondé à tort où à raison sur les prévisions théoriques ou les modèles numériques."* Olivier

"the priority is given to observational data, carefully avoiding any observational bias, any a priori based rightly or wrongly on theoretical predictions or numerical models" Olivier

Reaching deep magnitudes to constraint the LF slope



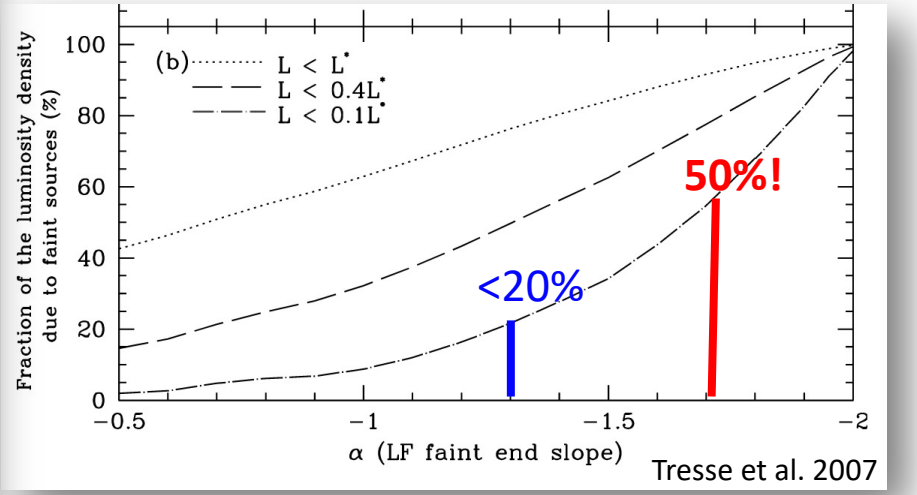
Ilbert et al. 2005



L>>L*

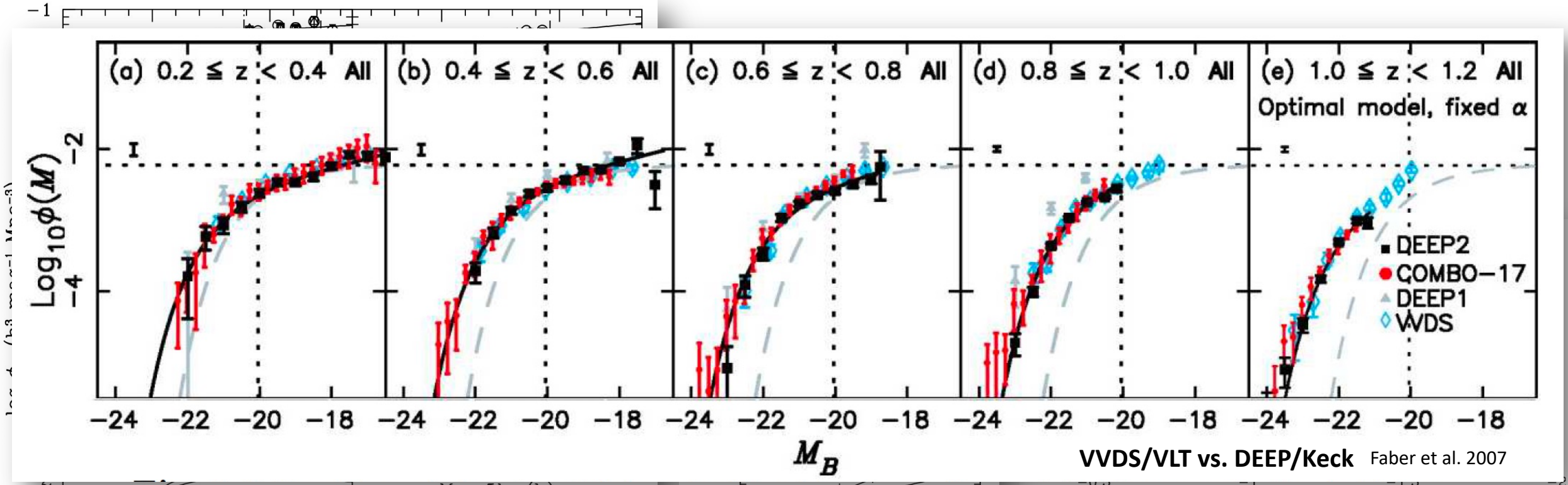
1.5 mag deeper – field x 10 larger

The steeper the slope, the more one needs to observe at low luminosities to avoid missing large % of LD

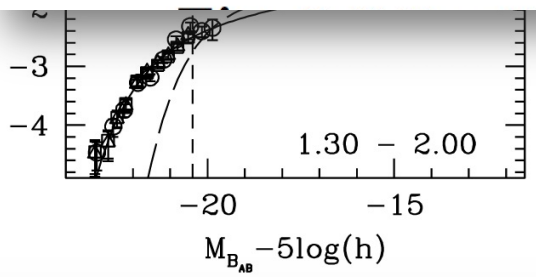


Tresse et al. 2007

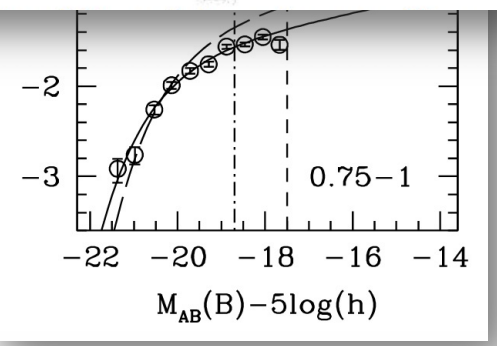
Reaching deep magnitudes to constraint the LF slope



VVDS/VLT vs. DEEP/Keck Faber et al. 2007



Ilbert et al. 2005



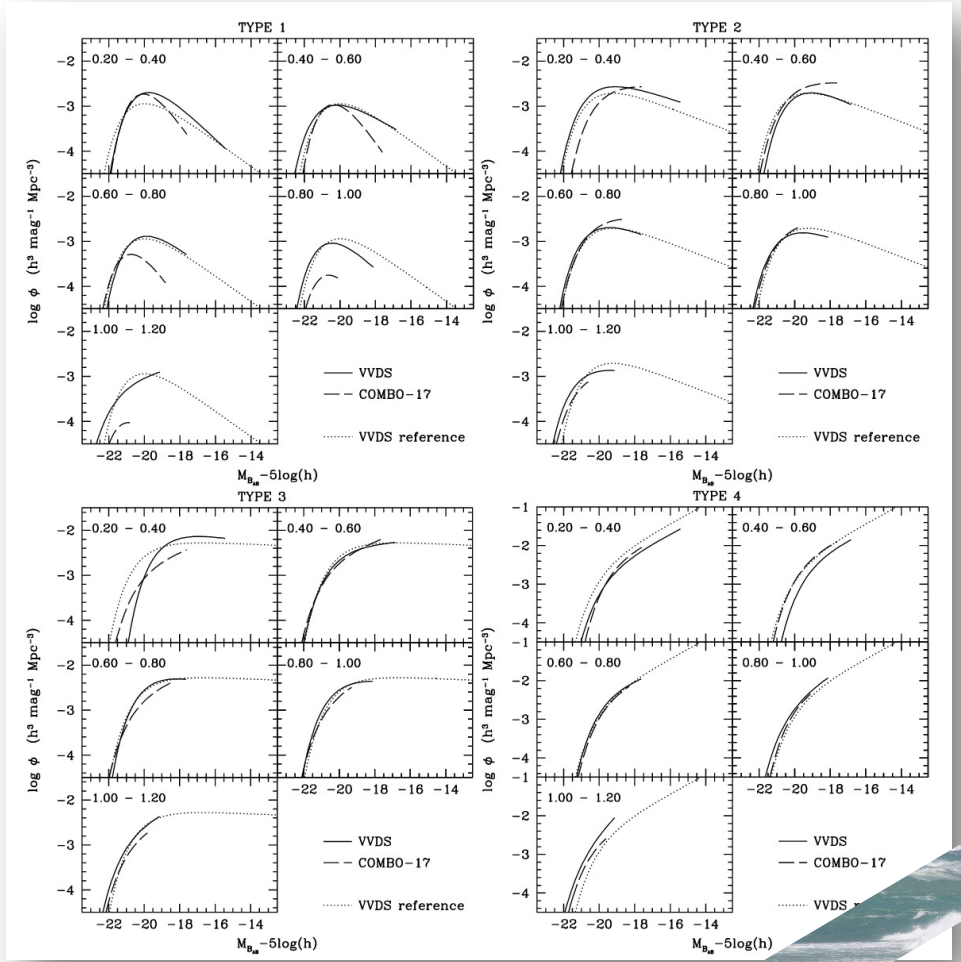
Tresse et al. 2007

L>>L*

1.5 mag deeper – field x 10 larger

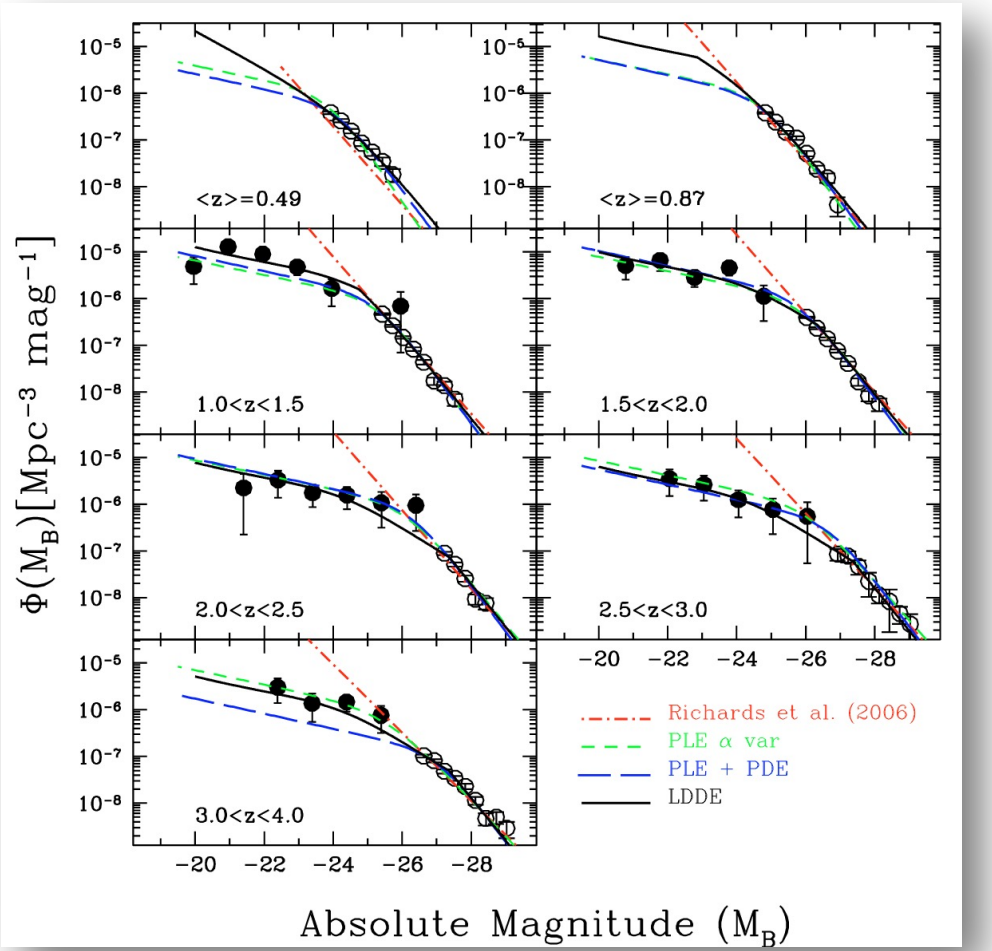
Enough galaxies to derive the LF per type

a strong type-dependent LF evolution, the latest spectral types being responsible for most of the evolution of the UV-optical LF out to z = 1.5



Zucca et al. 2006

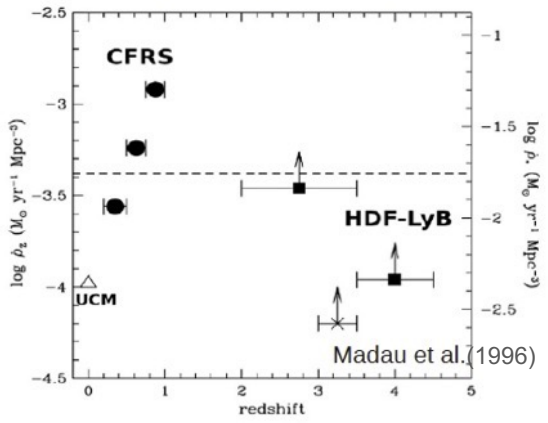
type-1 AGN sample consistent with a scenario of AGN cosmic downsizing



Bongiorno et al. 2007

Context of the cosmic SFR density in 2006

Compilation in 1996 CDM
No dust correction

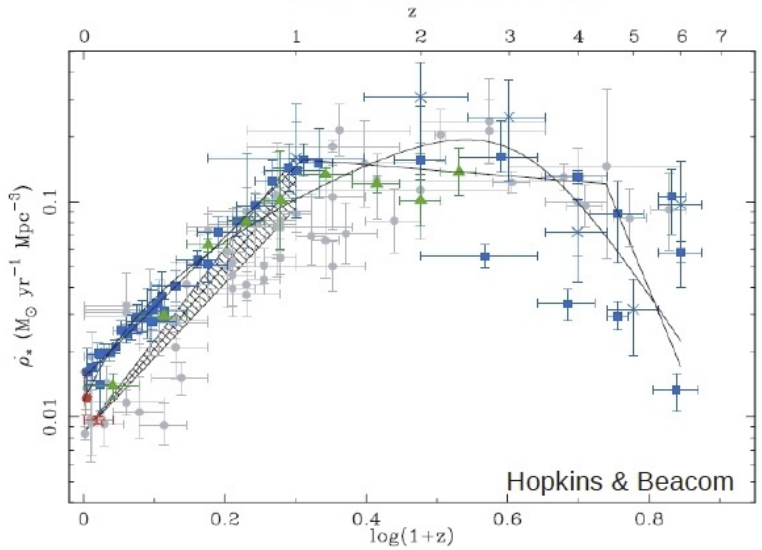


Three different **redshift** surveys
Hα/I-band/LBG selections

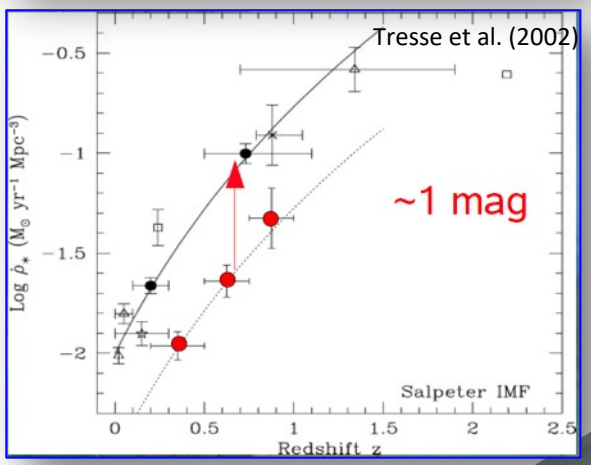
First big picture in 1996

10 yrs later…
a fully messy filled dust corrected CSFRD !

Compilation in 2006 ΛCDM
Dust accounted for



Yet, the drop at z < 1
& the rise at z < 5
are persistent

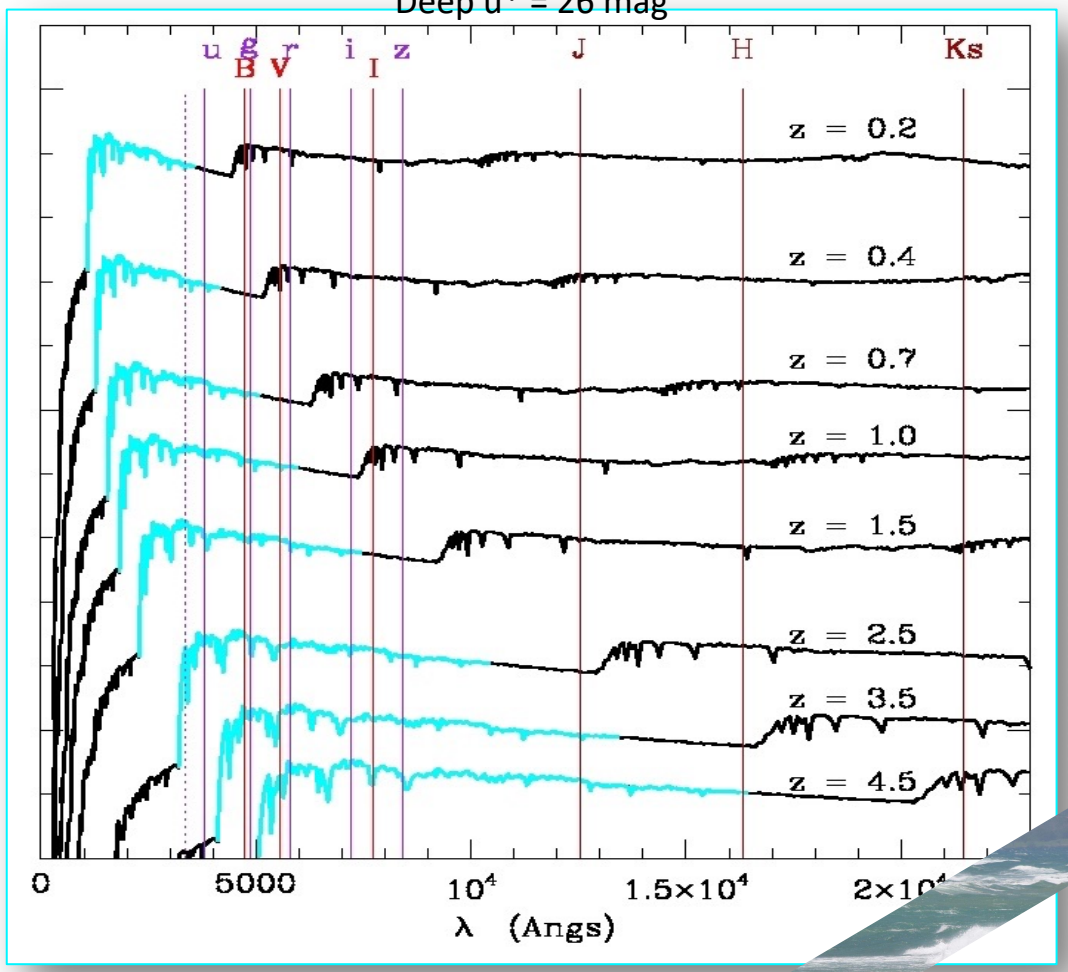


Many surveys or single points
Many assumptions on dust, on LF slope
Many underestimated errors
…blurring the picture

Surveys yield the global SFRD without being perturbed by individual stochastic evolution

The observed rest-frame UV window

The UV continuum [912-3000]-Å is directly spanned at z > 0.1
i.e. NUV-2500 at z > 0.2 & FUV-1500 at z > 0.9
Deep u* = 26 mag

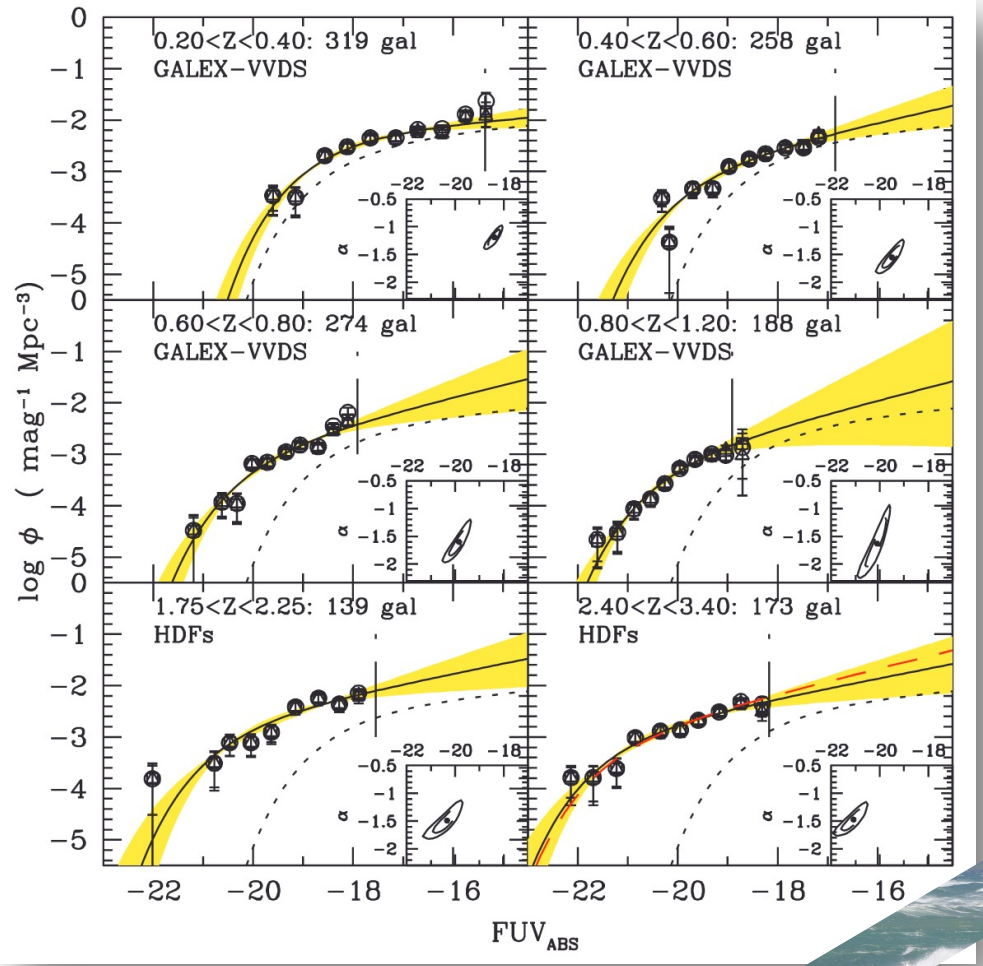


Aim = with the VVDS to trace the FUV-derived dust-corrected CSFRD over 12 Gyr
using a single methodology

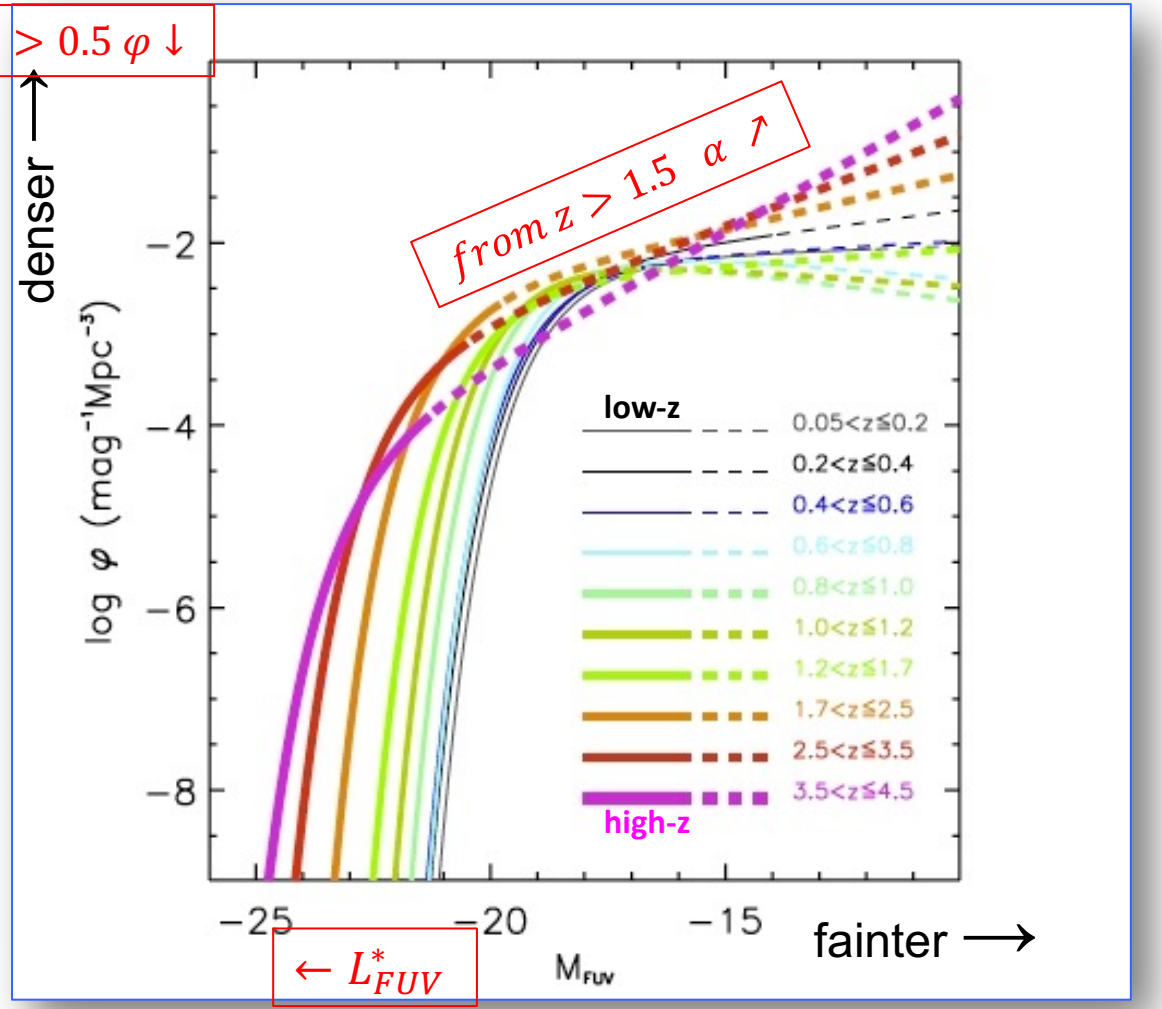
Multi-wavelength, very deep, optical + NIR photometry enable to detect very faint, normal, dusty galaxies

The rest-frame FUV LFs to derive the SFRD

GALEX-VVDS dataset

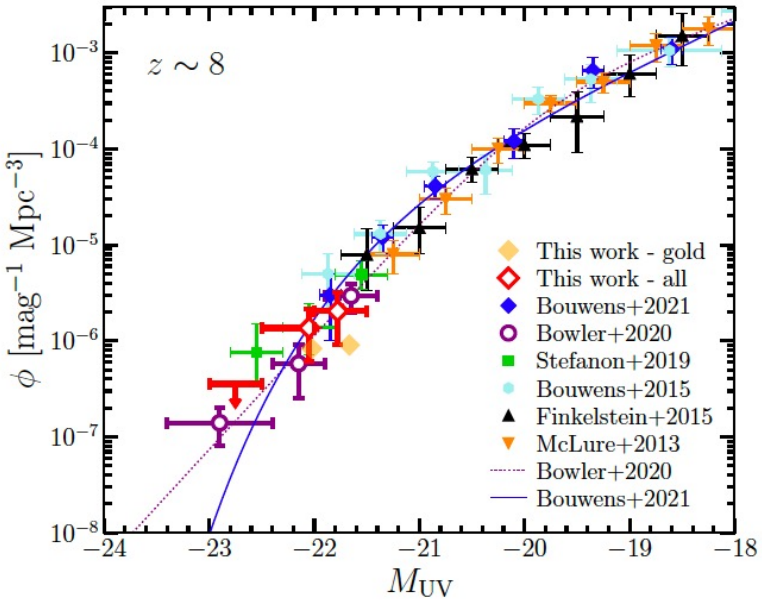


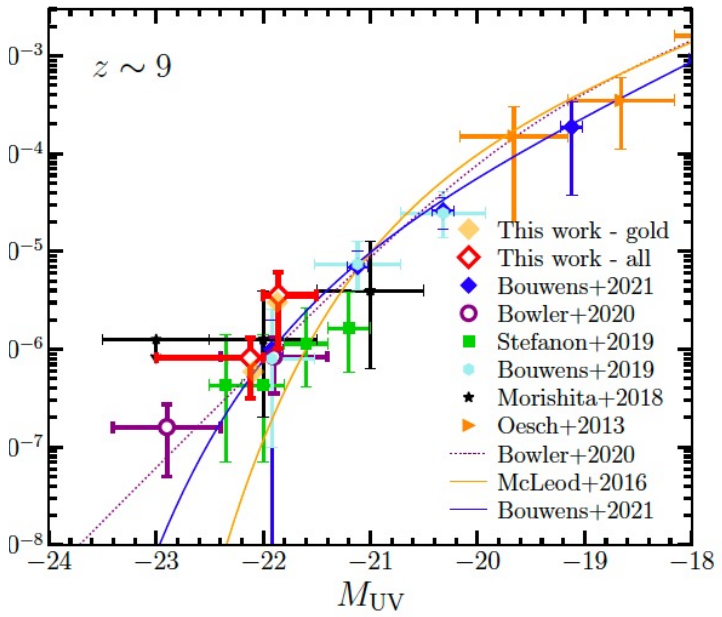
Arnouts et al. 2005

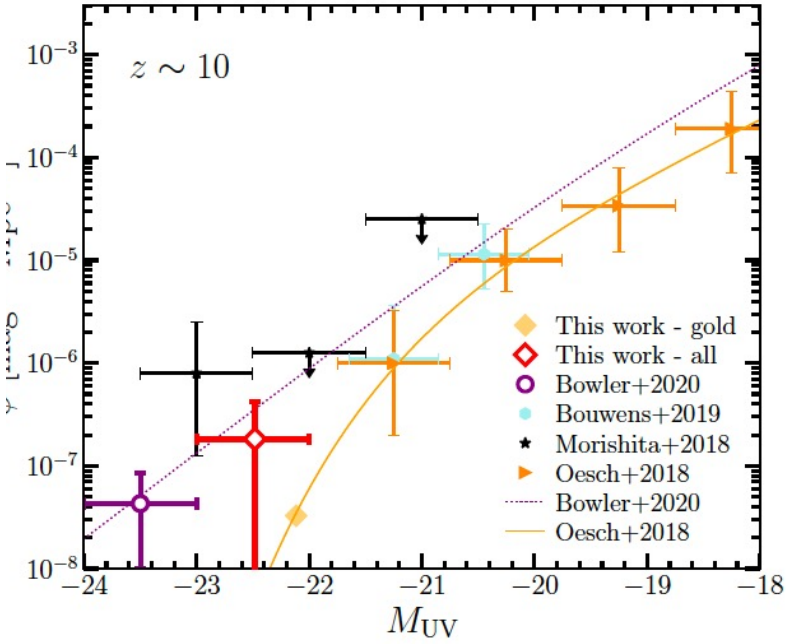


Cucciati et al. 2012

COSMOS2020: UV selected candidates at z > 7.5







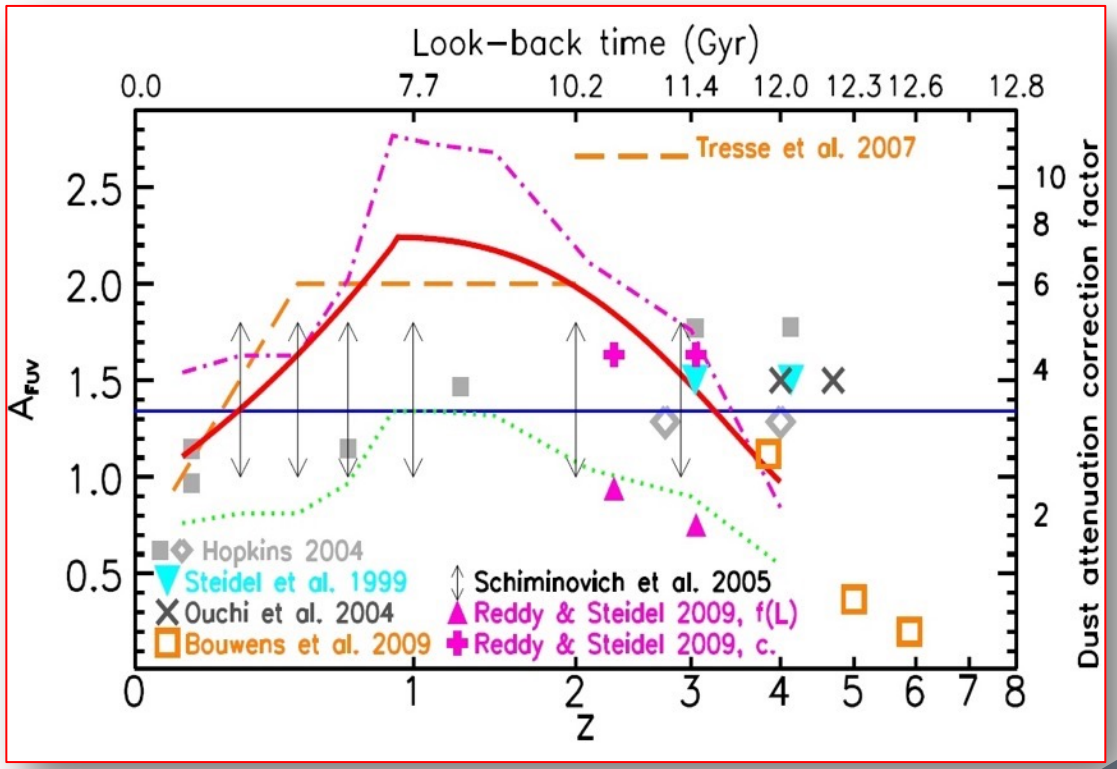
Kauffmann, O.B, Ilbert, O. et al. 2022, *submitted*

→ the confirmation of photometric redshifts is necessary to differentiate between a power law and a Schechter LF shape.

Olivier's last contribution towards the reionization epoch.

Evolution of the average dust attenuation in FUV

The FUV emissivity is the most absorbed at $0.8 < z < 2$



Cucciati et al. 2012

Average attenuation i.e. dominated by the typical state of visible galaxies at a given epoch

_____ **Calzetti (2000) law**

IRX-β relation Meurer (1999)
but β depends strongly on the galaxy type, cf. Treyer 2007, Wijesinghe 2011

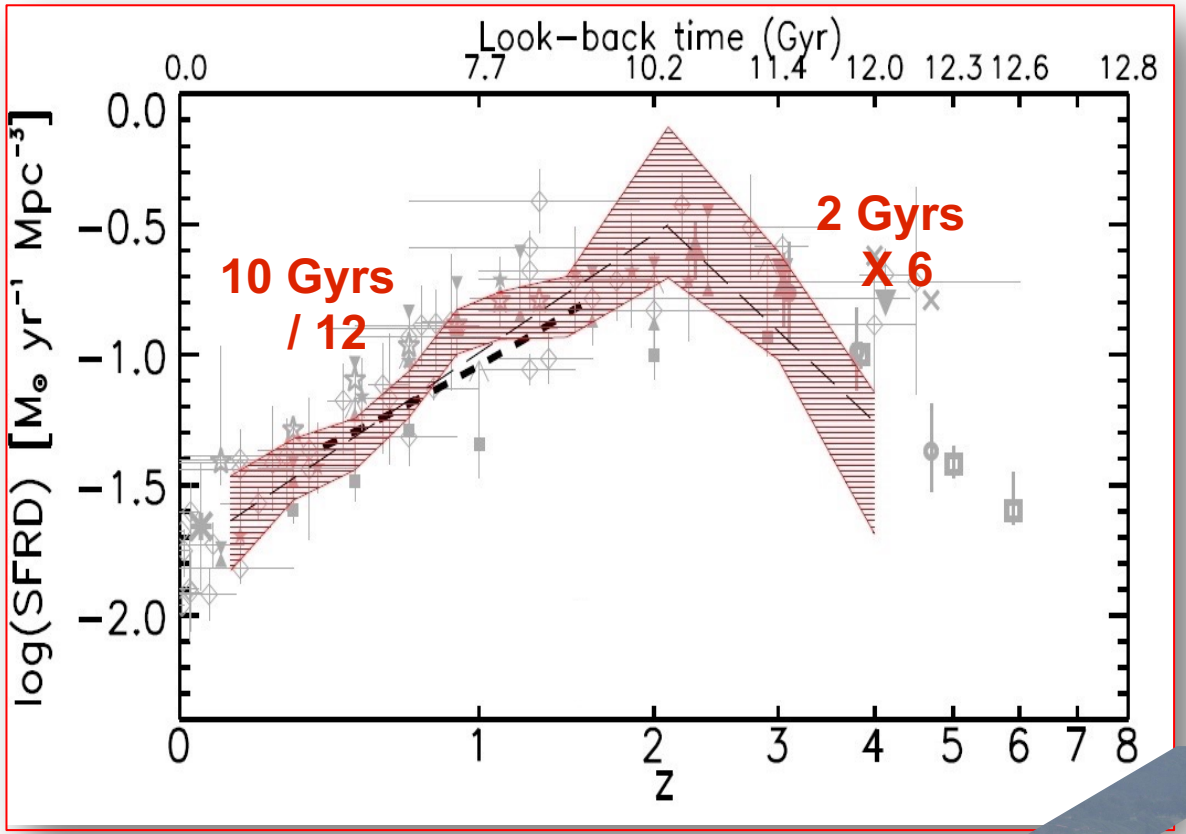
_____ β slope Kong et al. (2004)

_____ β slope Cortese et al. (2006)

Whatever the method to derive the dust attenuation,
the amount of dust in the global galaxy population increases from the earliest epochs to reach a plateau at $z \approx 1\text{-}1.5$

Evolution of the SFRD over 12 Gyrs

SFRD FUV-derived and dust corrected $SFRD(z) = 1.4\times10^{-28}\times \mathcal{L}_{FUV}(z) \times 10^{0.4\times A_{FUV}(z)}$



Cucciati et al. 2012

Full account of errors
(STY parameters, weights, Poisson, CV)
...often underestimated in the literature.

SFRD evolves as $(1+z)^a$

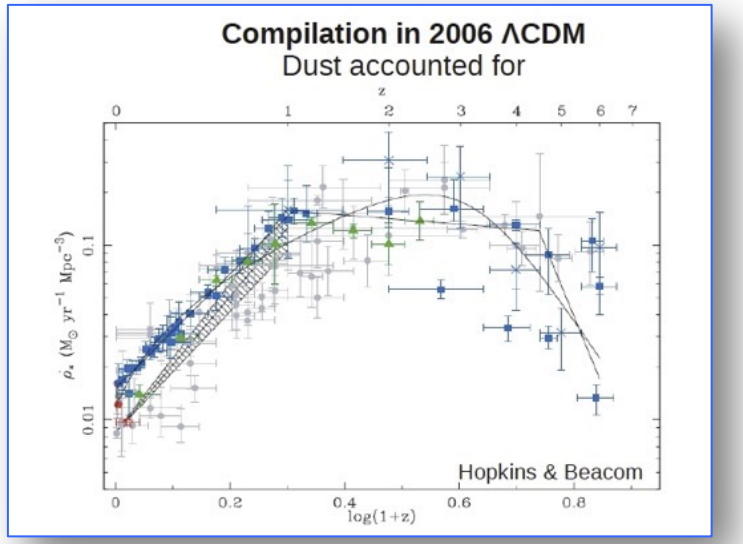
$z < 2 \quad a = 2.6 \pm 0.4$

$z > 2 \quad a = 3.6 \pm 1.9$

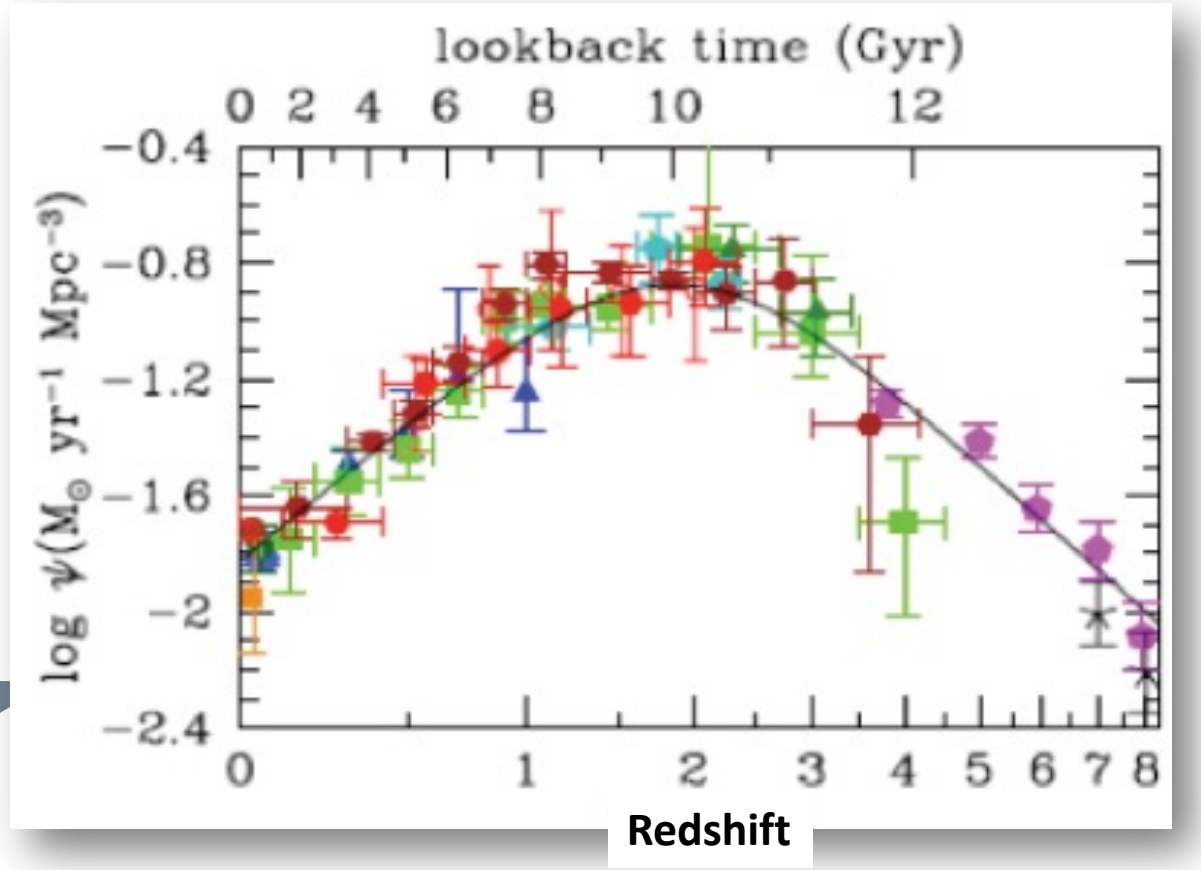
Using a single sample and a coherent method over 12 Gyrs
we can set a definitive clear SFRD maximum at z~2 (Cosmic Noon)

The CSFRD – overall picture in 2014

A very robust picture of the Cosmic Star-Formation History



10 yrs later…

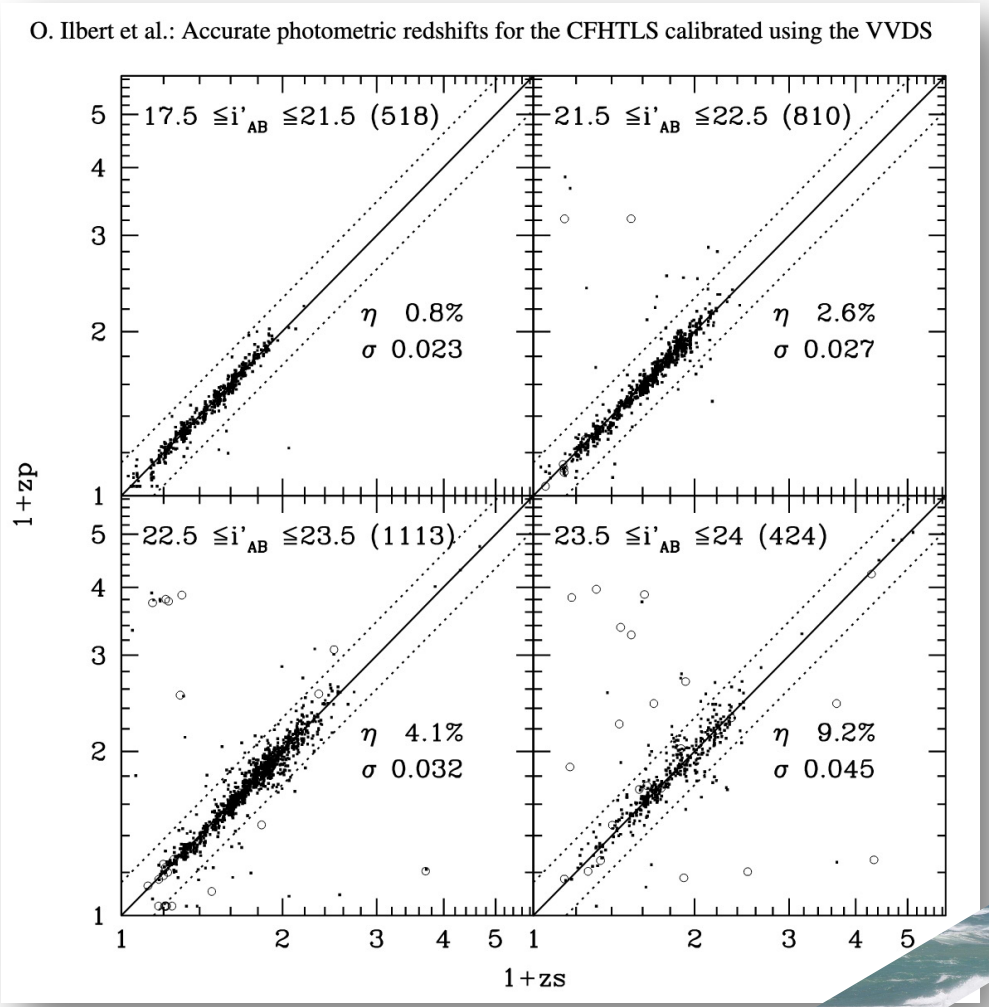


In less than 4 Gyr z=8 (EoR)→ z=2 (Cosmic Noon)

- ✓ the Universe reached its maximum SF activity
- ✓ ½ local stellar mass content is assembled

Madau & Dickinson 2014, ARA&A, 52, 415

VVDS enabled accurate zphots for the CFHTLS $I^*_{AB} \leq 25$ over 3.2 deg^2



Ilbert et al. 2006

Using the tool LePhare – Arnouts/Ilbert

Same expertise used for

→ Cosmos zphot with 30-Bands for 2-deg^2 Ilbert et al. 2009

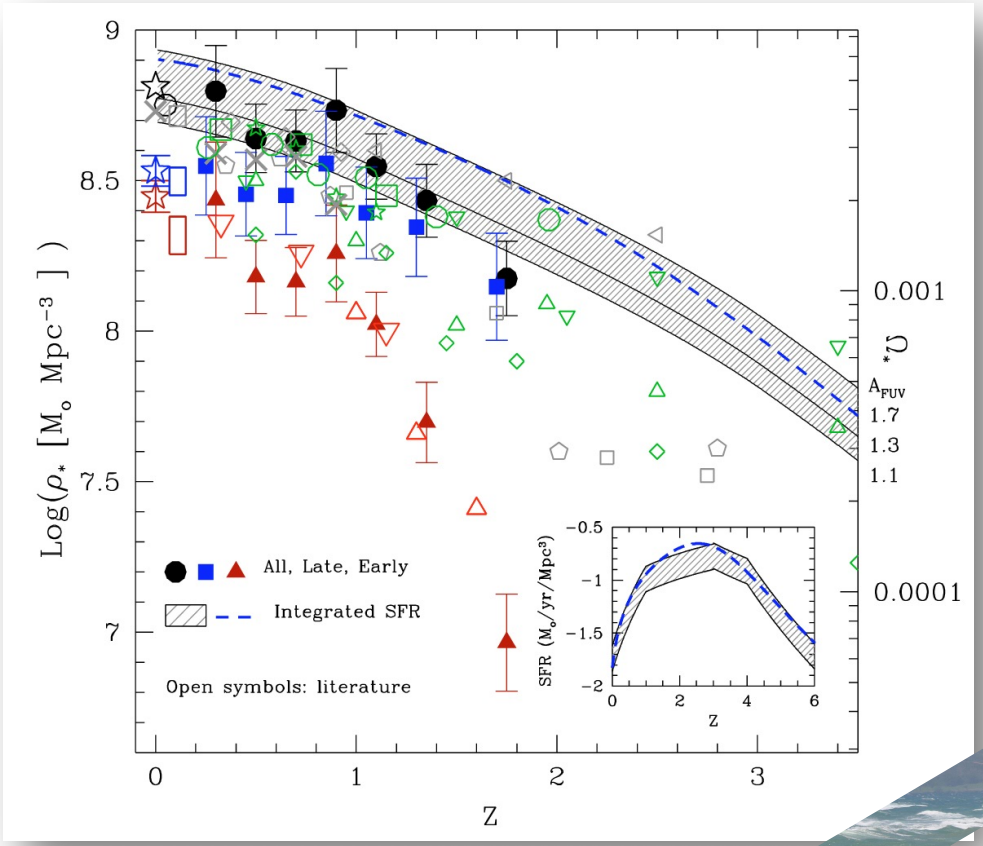
→ Cosmos2015 Laigle et al.

→ Cosmos2020 Weaver et al.

And the NIR LFs to derive the stellar mass assembly

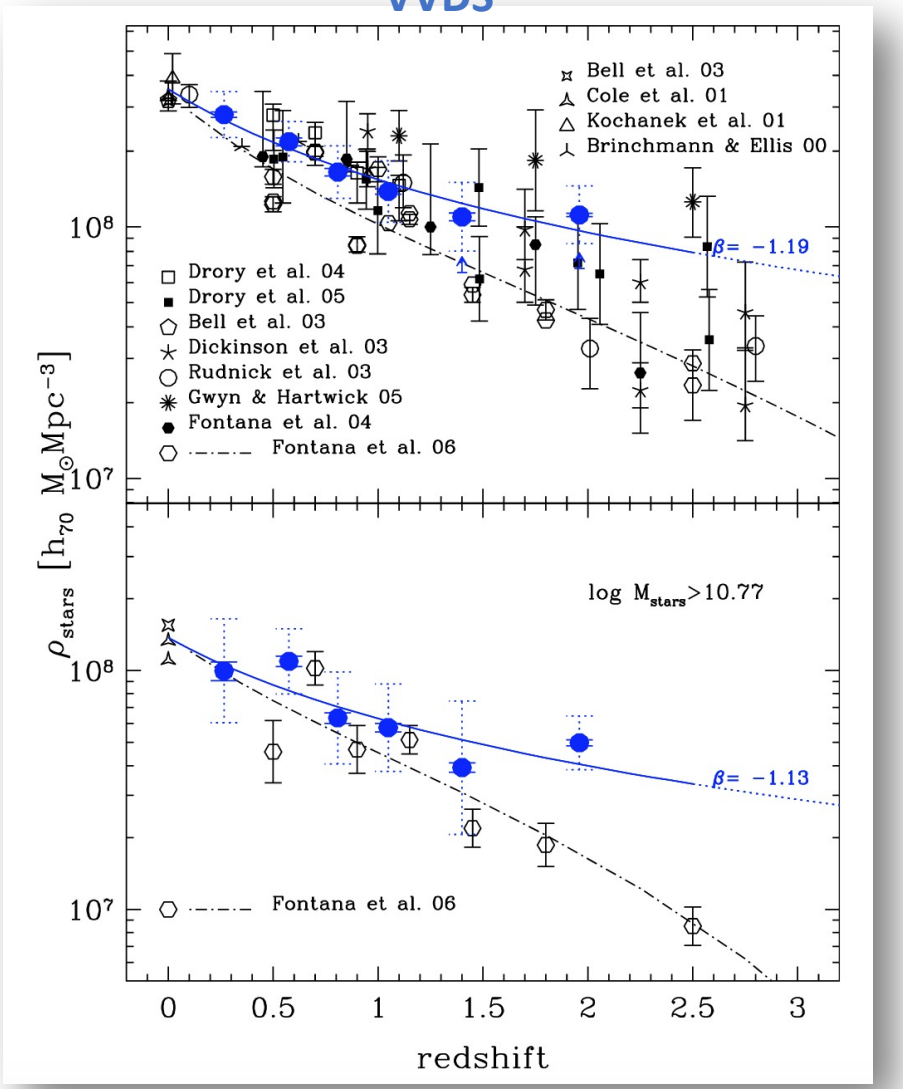
The **SWIRE-VVDS-CFHTLS** surveys

Evidence for a major build up of the red sequence between z = 2 and z = 1



Arnouts et al. 2007

VVDS



Pozzetti et al. 2007

TIRELESS' OLIVIER..

The CFRS and VVDS surveys have been the initial base to

several other z-surveys:
zCOSMOS, VUDS, VIPERS, …

several follows-up:
SINFONI/MASSIV, ALMA/ALPINE, HST/COSMOS, Chandra, XMM, CFHTLS, UltraVISTA, VLA, VIMOS-tilted slit, etc.

new instrumental MOS projects:
PFS/Subaru, Euclid/NISP, VLT/NIRMOS (2010), ELT/Optimos → DIORAMAS (2009-2010) → MOSAIC, Ng-CFHT/MSE, JWST/MIRI

" l'important c'est de couvrir l'espace des paramètres […] ça préserve l'espace de découverte. Dès qu'on utilise des pré-supposés sur les populations que l'on veut mesurer on a perdu une grande partie du pouvoir de découverte. " Olivier

" the important thing is to cover the parameter space [...] this preserves the discovery space. As soon as one uses pre-suppositions about the populations one wants to measure, one has lost a large part of the power of discovery. " Olivier

Always at the front of the instrumentation -

Thank you

From galaxies to cosmology with deep spectroscopic surveys
A tribute to Olivier Le Fèvre. 4-8 July 2022

Smell the sea, and feel the sky

Let your soul and spirit fly