

Next generation wide and deep Spectroscopic redshift surveys with the ESO-VLT

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- Why spectroscopic redshift surveys ?
- Still major questions ahead
 - Galaxy formation and evolution: an unsolved puzzle
 - Cosmology: what is the content of the Universe ?
- Needs
 - Survey large volumes to large lookback times
 - Assemble large samples
 - Understand and minimize selection biases
- Pushing ahead with new surveys
 - Ultra-Wide
 - Ultra-Deep

Deep redshift surveys are a central tool to modern Astrophysics

Understand galaxy formation and evolution

Measure Cosmology parameters

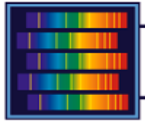
Understand LSS formation and evolution

- Deep redshift surveys ($z > 0.3$) have shaped our current understanding:
 - CFRS (1995)
 - LBG surveys (Steidel et al. 1996+)
 - DEEP/DEEP2 (2005+)
 - VVDS (2005+)
- Compare high redshift to low redshift spectroscopic surveys
- Knowledge of the sources: physical informations available
- Redshift information with $\sim 100\text{km/s}$ accuracy enables to look for 3D distribution
- A basis for robust selection for detailed follow-ups
- Important serendipitous capabilities

600z
↓
50000 z

Deep spectroscopic surveys at ESO

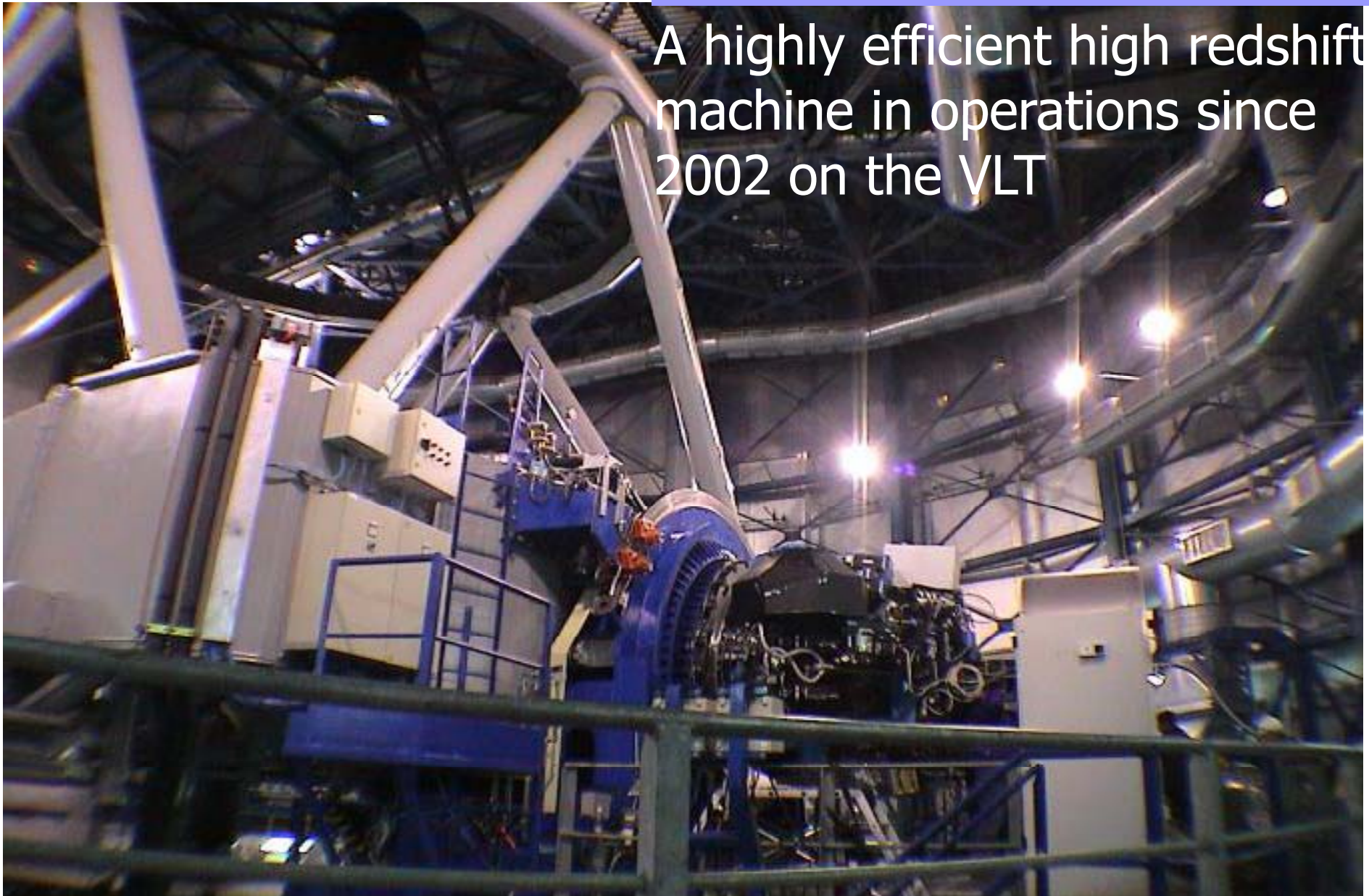
- 10 years ago: EFOSC, EMMI, OPTOPUS/MEFOS,
 - **ESP**, 3000z, $z \sim 0.3$
- Now at the VLT, several surveys covering up to $z \sim 6$
 - *VIMOS*: **VVDS** (50000z, up to $z=5$), **zCOSMOS** (25000z, up to $z=3$), **GOODS** (7000z), **UDF** (5000z)
 - *FORS2*: **GMASS**, **UDF**
 - *FLAMES/GIRAFFE*, *SINFONI*: follow-ups



VIMOS

VIMOS -VLT-UT3

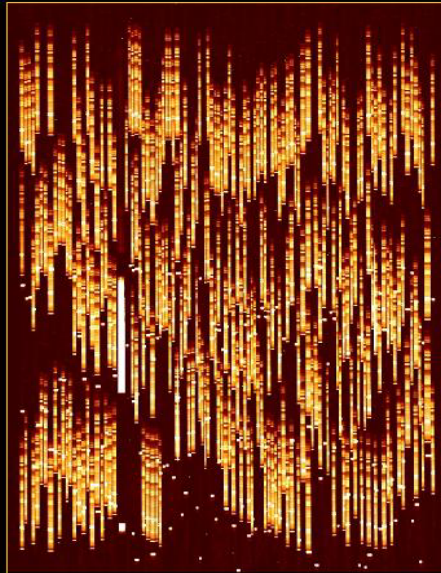
A highly efficient high redshift machine in operations since 2002 on the VLT



Multi-slit mode

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

VIMOS at the VLT observes **150 galaxies**
at once at high spectral resolution ($R \sim 4000$)

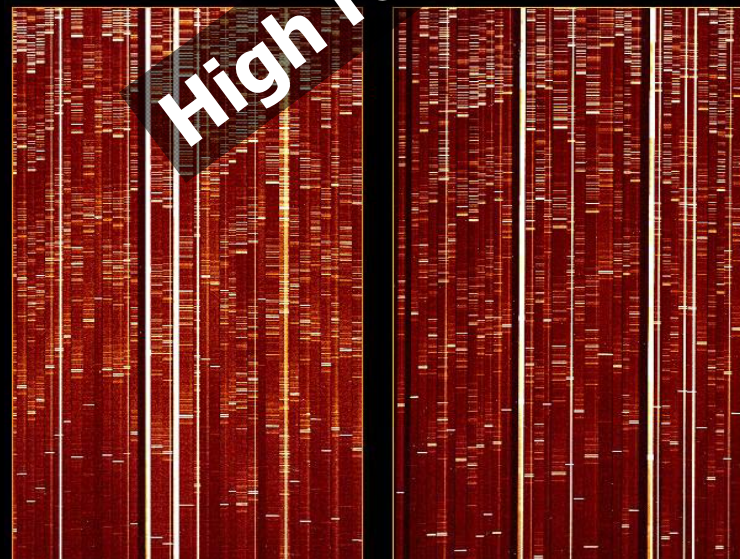
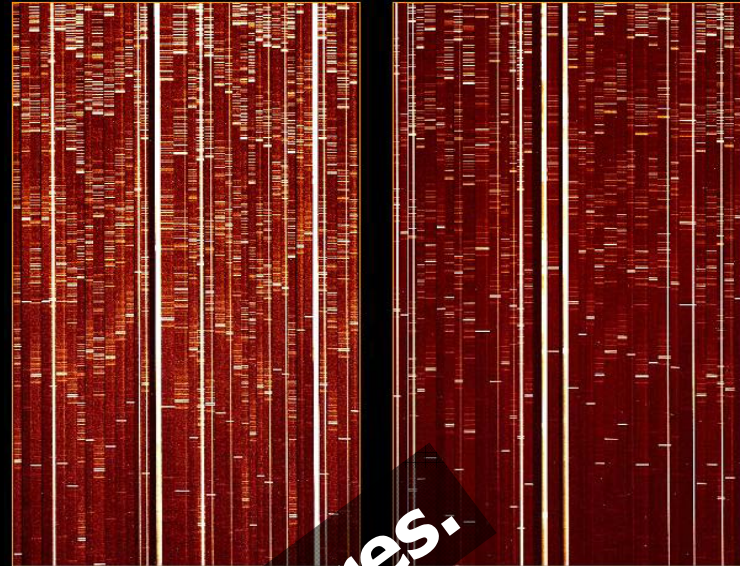


1 spectrum
of 1001

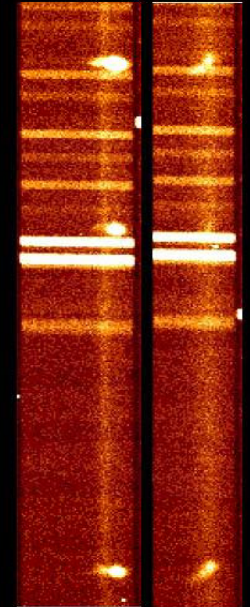
9500Å



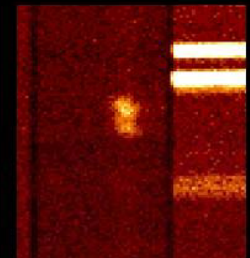
5500Å



Hydrogen+Oxygen
 $H\beta + [OIII]$
 $z=0.19$



Oxygen
[OII] doublet
 $z=0.71$



VIMOS VLT Deep Survey



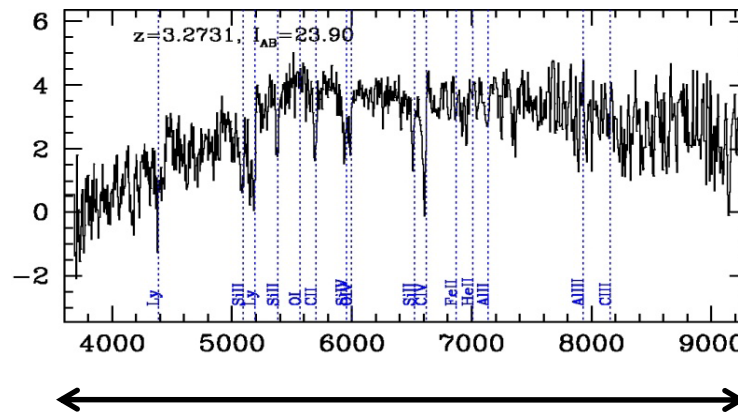
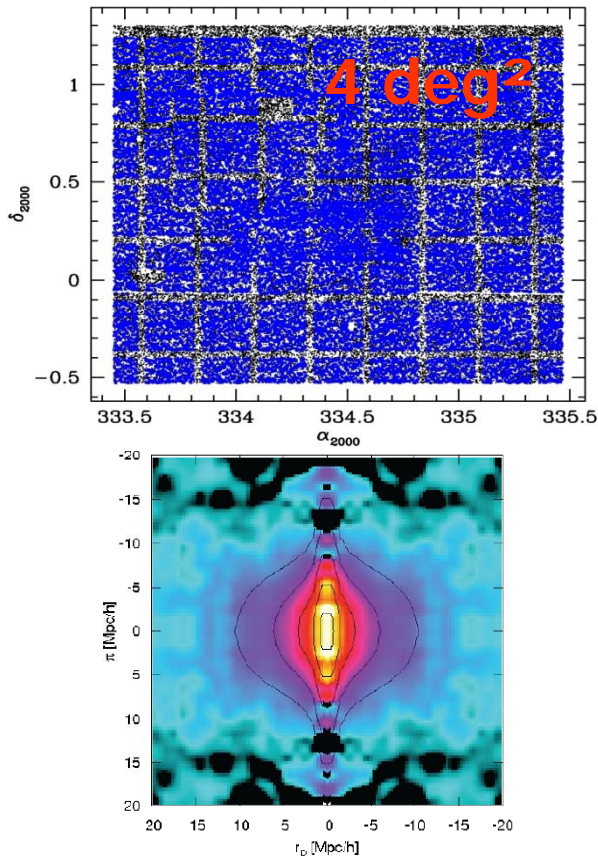
Field	$I_{AB} < 22.5$ WIDE 16+ deg ²	$I_{AB} < 24$ DEEP 1deg ²	$I_{AB} < 24.75$ Ultra-Deep 600 arcmin ²
0226-04		~14000 <i>Public</i>	1000 <i>(on-going)</i>
1000+03	~5000		
1400+05	~11000		
2217+00	~15000 <i>Public</i>		
CDFS		~1600 <i>Public</i>	
Total	~31000	~15500	~1000

- $R \sim 230$, 5500-9300Å
- ~50000 spectra

40+ papers published so far

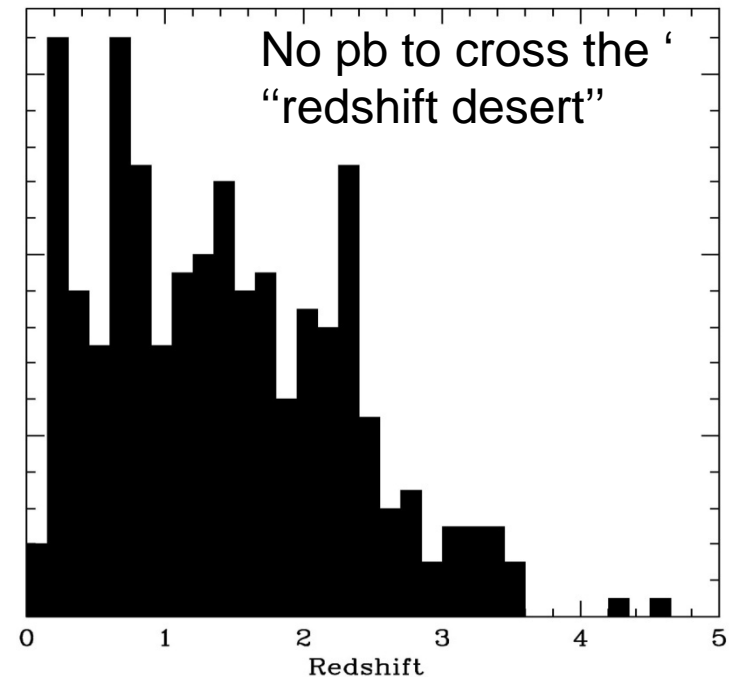
VVDS-Wide 35000 redshifts

- Measuring the growth rate, using $\xi(rp, \pi)$ at $z=0.8$
 - $\beta=0.7 \pm 0.24$
- From 8 deg² (Guzzo et al., 2008, Nature)

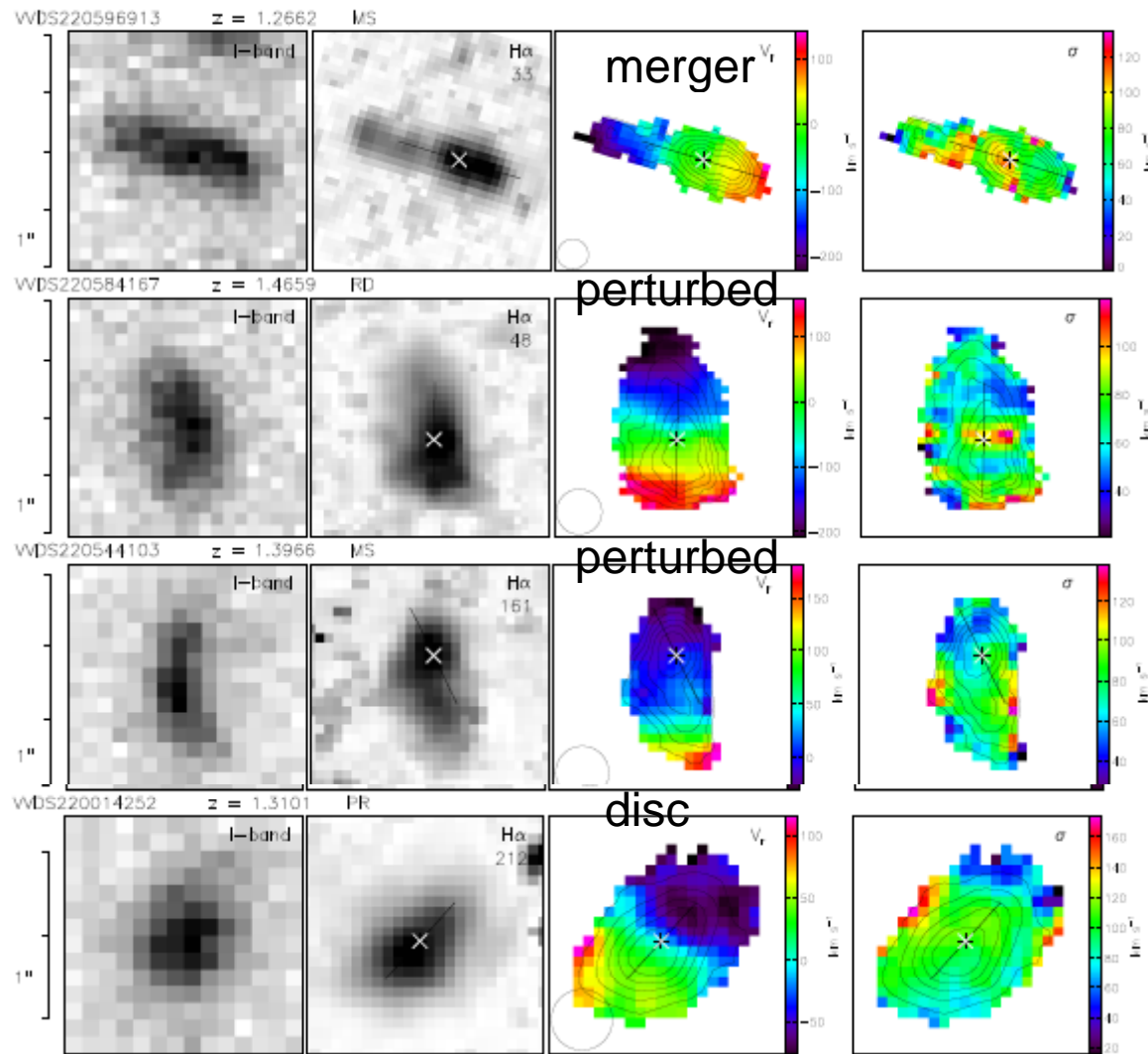


VVDS-UltraDeep 1000 redshifts

- Magnitude selected $I_{AB} \leq 24.75$
- 18h integration in blue + 18h in red
- Towards a complete census of star forming galaxies
- No a priori
- Serendipitous: 200 Ly α emitters



Deep spectroscopic surveys: enable follow-ups



- Select galaxies from a large and unbiased sample before to study the physics of galaxy assembly

SINFONI obs. of VVDS galaxies
 $1 < z < 2$
 Epinat et al., [arXiv:0903.1216](https://arxiv.org/abs/0903.1216)
 (today)

Deep spectroscopic surveys: serendipitous power



VVDS target

Slits: 1" x 5-20"

Serendipitous Ly α @ 1216Å

Target spectrum

Photometrically invisible Ly α emitter

- 1200 slits, 3.3 arcmin², 3500-9500Å, 65000s
- 8000 slits, 22.2 arcmin², 5500-9500 AA, 16000s


200 LAEs identified $2 < z < 6.5$
(Cassata et al., in prep.)

Next surveys at the VLT three realistic LEGACY surveys

1. VIMOS Ultra-Wide
2. VIMOS Ultra-Deep
3. VIMOS Extremely Deep

Capitalize on:

- New CCDs on VIMOS: 2x the QE at 9500Å (Urgent !)
- New sky subtraction techniques enable 2x smaller slits = 2x number of objects (Scodeggio et al., Messenger March 09)



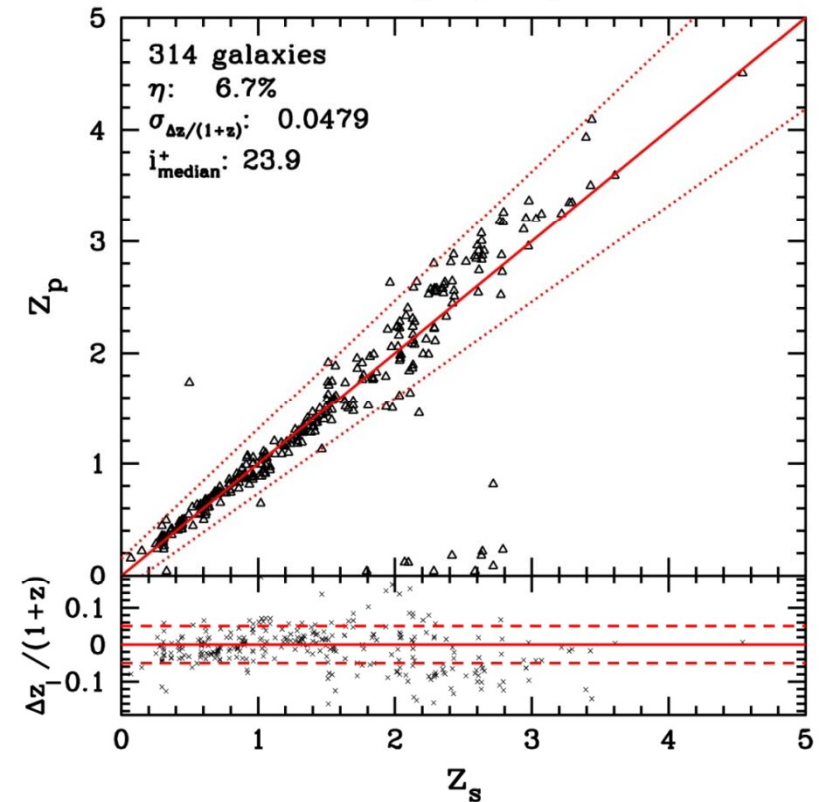
VIMOS Ultra Wide Survey

SDSS-like at $z \sim 1$

- Cosmology: probe the world model
 - 5-7y before space IDEM (JDEM+EUCLID, launch 2017 ?)
- BAO, growth rate, clusters
- $I_{AB} = 22.5$, 1000 gal/0.06 deg² in 30 min
- 300 deg² in 3000h (w/ overheads)
 - 5×10^6 galaxies
 - Scales > 500Mpc
- Need 300 nights = 5 years project @ 60n/y

VIMOS UltraDeep Survey VVDS-like at $z=3-6$

- A critical time in the galaxy assembly process
 - Contribution of mergers, accretion, feedback,...
- Current samples are <1000
- Smart pre-select
 - No color-color a priori
 - Limited use of photoz
- $AB \sim 25$, 15h blue + 15h red
 - 1000 galaxies / 0.06 deg^2 in 30h
- 100,000 galaxies, $\sim 6 \text{ deg}^2$ in 4000h (w/ overheads): need 400n
- Targets for follow-up: KMOS, JWST



*Photo-z are becoming reliable
(but be aware of caveats)
VVDS+WIRDS, 2009, in prep.*

VLT extremely-deep field ($\Rightarrow z \sim 10$)

- First bursts of star formation
- Requirements:
 - $H \sim 26$, select from UltraVista survey
 - ~ 1000 objects
- Combine VLT facilities
 - VIMOS
 - KMOS
- 100h integrations per setup
 - VIMOS 100h blue + 100h red for 1000 galaxies
 - KMOS do galaxies not identified by VIMOS ($z > 6.7$): 100h for 24 galaxies: \Rightarrow 2000h
- Prepare for JWST surveys

Summary

Next generation surveys with the VLT

- High science impact: dedicate VLT-VIMOS for very large redshift surveys

- $z \sim 1$, IAB ~ 22.5
- $z \sim 3-6$, AB ~ 25
- $z > 6$, AB ~ 26

- Dedicate follow-up

- KMOS

- Legacy, public

- Long term

- New instrument on 8m very wide field MOS with 10000 slits/fibers: complementary to a space facility and to 8m wide field imaging telescopes (LSST): new dedicated telescope or on existing UT ?
- z+J band multi-slit spectrograph on the VLT
- EELT wide field MOS

VLT Survey	Area / #z	Nights
UltraWide	$\sim 300 \text{ deg}^2 / 5 \times 10^6 z$	~ 300
UltraDeep	$\sim 10 \text{ deg}^2 / 10^5 z$	~ 400
ExtremelyDeep	$\sim 0.1 \text{ deg}^2 / 10^3 z$	~ 300
Total		~ 1000
~ 5 years of VLT UT3		