Which spectroscopy for DE in the future?

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The specifications for DE probes

- SN and spectroscopy
  - Follow up SN + Host galaxy ,for typing and subclassification

  Spectro specifications= deep survey with optical and NIR imaging and spectroscopy with low/mid resolution, spectro photometry and extended source

  = > 3D/IFU

- WL and clusters
  - wide imaging surveys with precise PSF
  - Precise photometric redshift

  Spectro Specification = photo z calibration , good completeness in z and magnitude

  => MOS/ IFU

- BAO
  - Multi objects spectroscopy on a wide survey with large FOV

  Specifications= accurate redshifts

Photometric redshift specifications

Photo Z calibration and spectroscopy

Big degeneracies if not all information is used (in particular no NIR)
Precision can be degraded by 'simplist' hypothesis in dust …
=>spectroscopy for z calibration = 10^6 spectro z for 10^8 photo z representative in redshift and magnitude

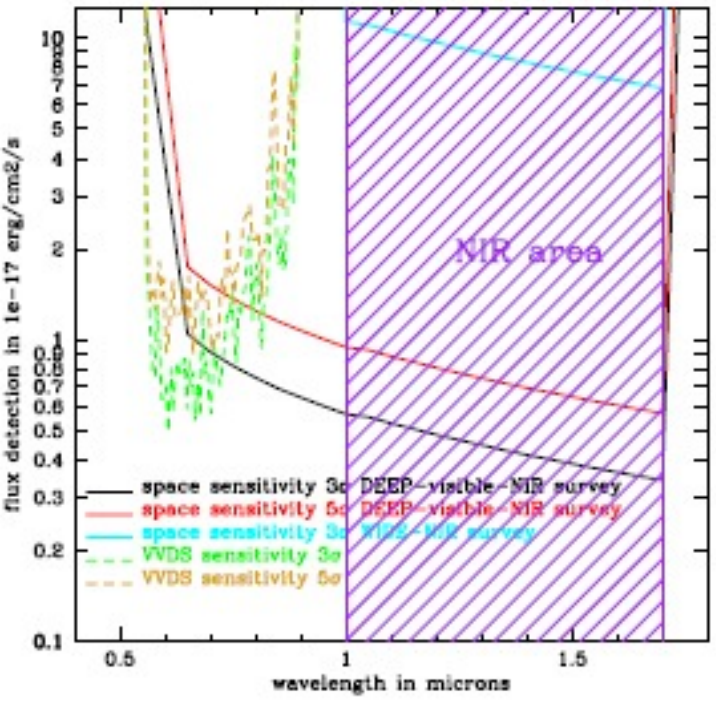
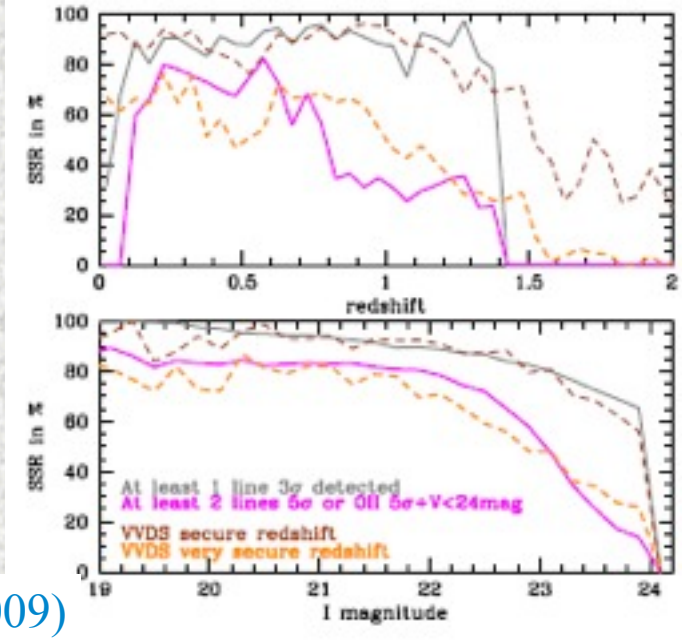


Fig. 14. Flux sensitivities for the VVDS-DEEP survey as a function of wavelength compared to forecast of future space WIDE and DEEP NIR [purple and shaded area] surveys with or without visible coverage.



Jouvel et al (2009)

Fig. 12. Comparison of the Spectroscopic Success Rate (SSR) of the VVDS survey with the simulated VVDS SSR using the CMC emission lines.

Future surveys specifications

- Large FOV for wide surveys and objects discovery and follow up (BAO, WL, SN, QSO)
- Multi band Imagery + photometry (WL, SN, clusters
- Precise photometric redshifts (WL, cluster)

- Multi objects spectrocopy (BAO + photoz calibration)
- 3D spectroscopy (SN)

Spectroscopy state of art

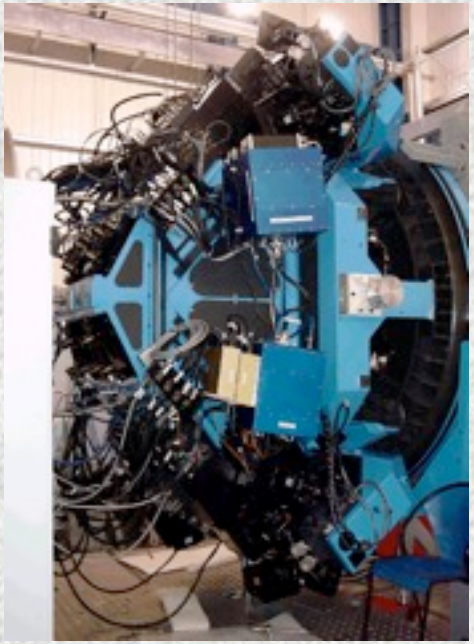
Spectro Type		advantage	Limitation	Techno S= space	Example of instrument
spectro	Long slit	Sensitivity	FOV	G/S	….lot.. HST/STIS
	3D IFU	3D info sensitivity spectro photometry	Limited FOV<~ 1 arcmin2	Slicer (G/S) Micro lenses (G)	SNIF (G) MUSE (G) MIRI (S)
Multiobjects (MOS)	slitless	simple, cheap	background	S	HST/nicmos galex (S)
	MOS	Large FOV (> 1 arcmin2) Multiplex sensitivity	complexity	Fibers (G) Microshutters(S) DMD(S) Mask (G)	BOSS/LAMOS NIRSPEC(S) EUCLID(S) VIMOS,DEIMO

3D/IFU on ground

A lot of IFU (lenses+fibers) and MOS(masks) facilities on large telescopes (VLT, Keck, Gemini)

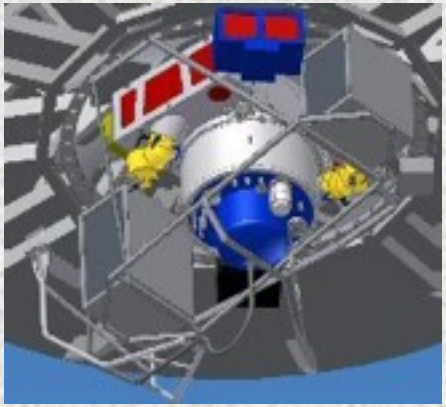
VLT = VIMOS (vis)
Gemini = GMOS
KECK = OSIRIS

Caveat =
FOV is small
Often different instrument for vis and IR
IR very limited (OH sky line)



VIMOS/IFU
6400 Fibers packed in 80 modules

VLT next generation IFU



X shooter
3 spectro of 3 slices, covering UV to IR (H band)

MUSE (vis)
24 spectrographs with slicer
24 detectors
No mechanism

Ground : Some MOS examples

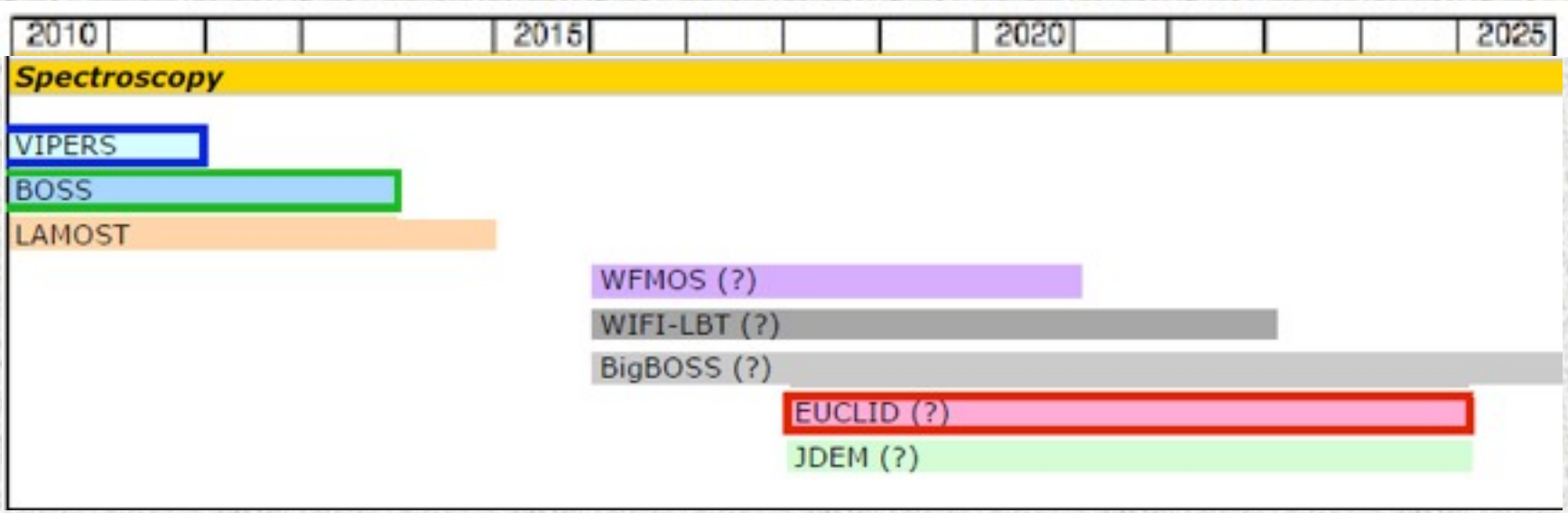
In general the same instrument have masks/slits

- VLT = VIMOS (600 slits)
- KECK = DEIMOS (130)
- Gemini = GMOS (40)

statistic is limited for large surveys as in general too small FOV (~ 10 arcmin2) and multiplex <1000

= > 10 time more spectra ($>10^6$) need a new generation of instruments (multiplex > 1000)

MOS future large surveys



Growing up on ground

- Use fibers to increase the multiplex advantage (typically 5000 instead of 500)
- but number of fibers increases complexity ..
  - BOSS (1000) , WFMOS (3000), LAMOST (4000), Big BOSS (5000)

- Space /Slitless (grism) / DMD(5000)

Spectroscopy for SN on ground

- Slit have been used for low and distant SN (z<1) on large facilities with large program (VLT, Keck, Gemini….)

caveat= coordination

precision du to observational condition

photometry

limitation of observational time (number of followed objects)

ground limitation (z<1) , IR access?

often no host spectrum

- Dedicated IFU used in Snfactory for nearby S
  - Good quality
  - Time series
  - Good spectro photometry
  - All information on the host galaxy

lesson learnt

-difficult to ensure all the needed information without a dedicated instrument

-Work in progress with low z

-High z?

Spectrocopy for SN issues for high z

Challenge is to increase statistic with good control (evolution) at low and high z

Spectrocopy beyond typing can be mandatory for evolution

=> have the same pass band for SN at all z with good precision=> Long exposure and IR follow up.

What should be done with spectrocopy? Velocities, Line ratio?

- Strategy: one spectrum at peak or more epochs? redshift range ?
- Coverage: 3000-7000 A resframe ? NIR restframe observations?
- Resolution : is R= 100-300 enough ?
- Quality : SNR

The need of IR

- SN = IR is needed to follow Si line for z > 0.6
  - Vis + IR to ensure good homogeneity in indicator measurements on the redshift range
  - Good quality (drive the observation time)
- WL = For photo z calibration to ensure full coverage and good SSR
- BAO = needed to follow Hα for emission line galaxies

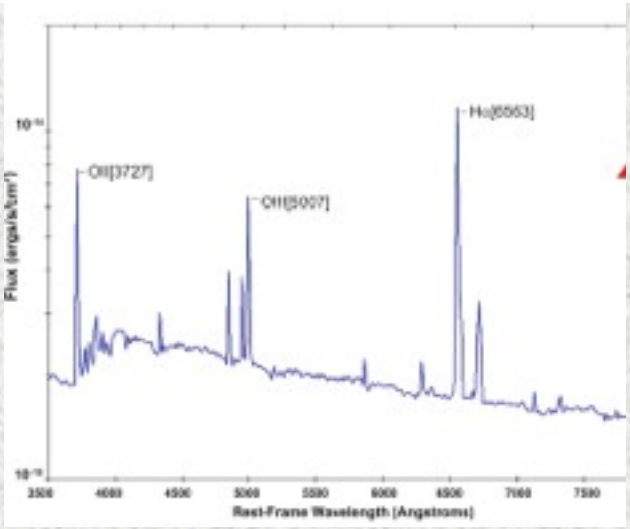


Photo z calibration

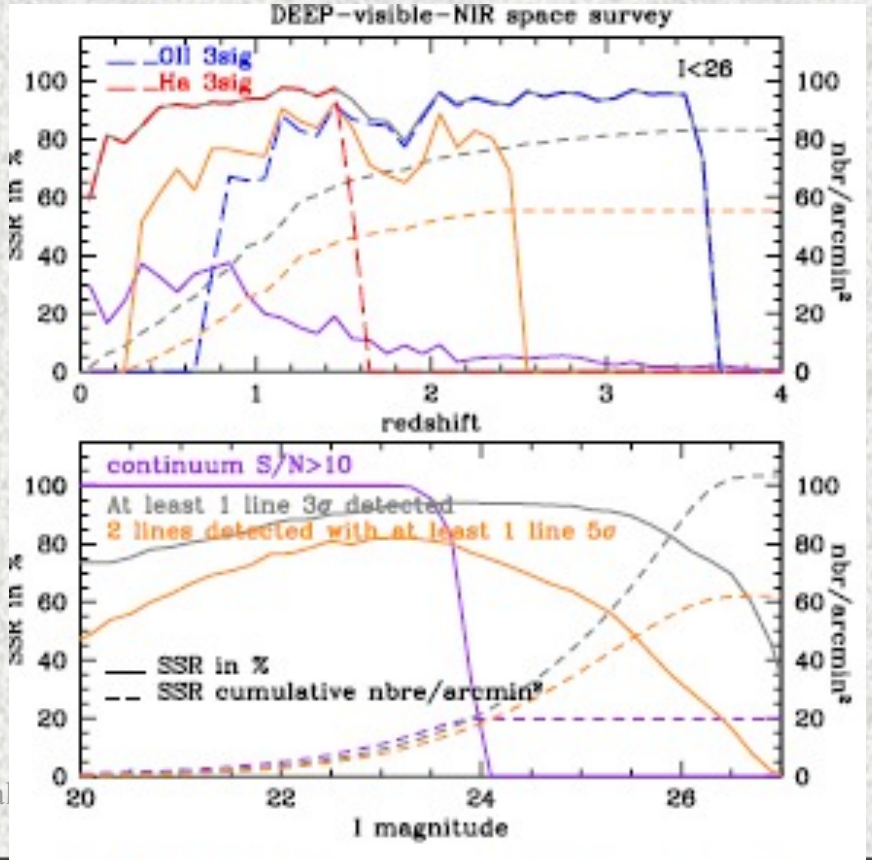
- 10^6 spectra needed to calibrate photoz

- Better SSR using visible and IR coverage

A deep survey ?

Slitless/fixed mask/IFU

Jouvel 2009



IR on ground

IR on ground difficult because of sky OH emission lines

- The general solution is to have high spectral resolution (R~5000)
  - Low efficiency, background limited
- OH suppression ?

Technology in progress (See Bland-Hawthorn, J., Buryak, A. & Kolossovski, K. 2008, JOSA, 25, 153 and Ellis, S.C. & Bland-Hawthorn, J. 2008, MNRAS, 386)

- Going to DOME A/C ???

Spectroscopy in space with IR

The space advantage = easy access to IR (zodiacal limited)

Current instrument HST (small FOV)

slit (STIS)

slitless (ACS/WFC3) 10-5 arcmin2

Future JWST (small FOV ~ 10 arcmin2)

NIRSPEC (1-5 μm) MOS microshutters (100) + IFU (slicer)(3x3")

MIRI (5- 27 μm)) IFU (slicer)

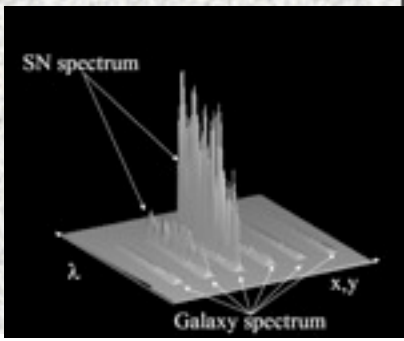
Spectroscopy in space for BAO JDEM/

Large FOV in the NIR (0.5 to 1 deg2)

- Slitless Hα survey (R~500) (with fixed masks ? (see JP Kneib))
  - Easy
  - limited in performance by the background
- DMD= multi-slit solution based on Digital Micromirror Devices (R~500, 5000 'slit')
  - studied in EUCLID as an option
  - more complicated
  - Allow to gain 2 magnitude in H and a factor 10 in number of galaxy =>

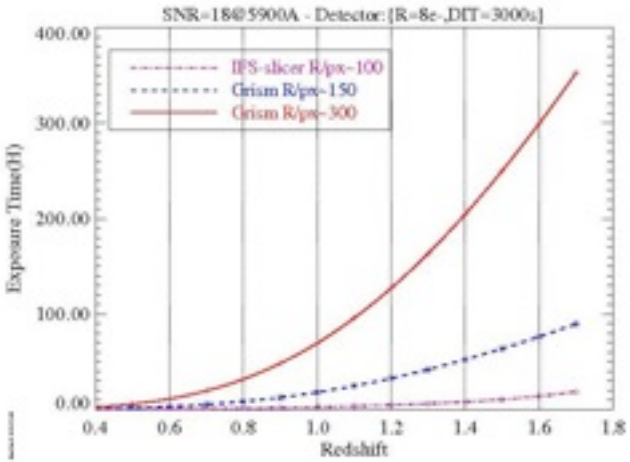
Spectroscopy in space

- slitless (baseline) in JDEM (R~100)
  - Feasibility proven using HST/ACS
  - Multiplex advantage, time series
  - Need a deep survey (dedicated?)
  - Photometry?
  - Limited by the background



- IFU/slicer proposed in JDEM/SNAP (dedicated with smaller FOV)

Very optimized, compact with good spectro photome



Conclusion

- Spectroscopy is needed for the 3 probes
- New generation of instruments is needed
  - To speed wide surveys need new MOS spectrograph (multiplex > 1000)
  - To increase the quality and band pass of followed SN particulary for high z (IFU , NIR)
- The IR specifications drive a space mission: spectroscopy/multi band optimisation for SN is one of the driver (wide/deep survey)