Spectroscopy performance simulations

BIANCA GARILLI

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Instrument design ⇔ science requirements

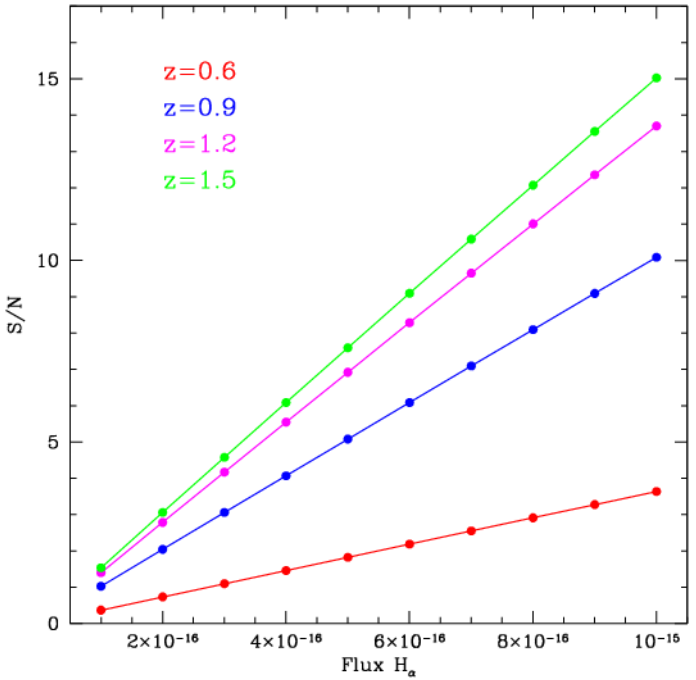
Standard ETC approach

- **instrumental parameters**
  - **Exp. Time, effective area, throughput, electronic dark current and ron,…**
- **source characteritics,**
  - **Flux, extension, spectral type**
- **Background**
  - **Sky emissivity**

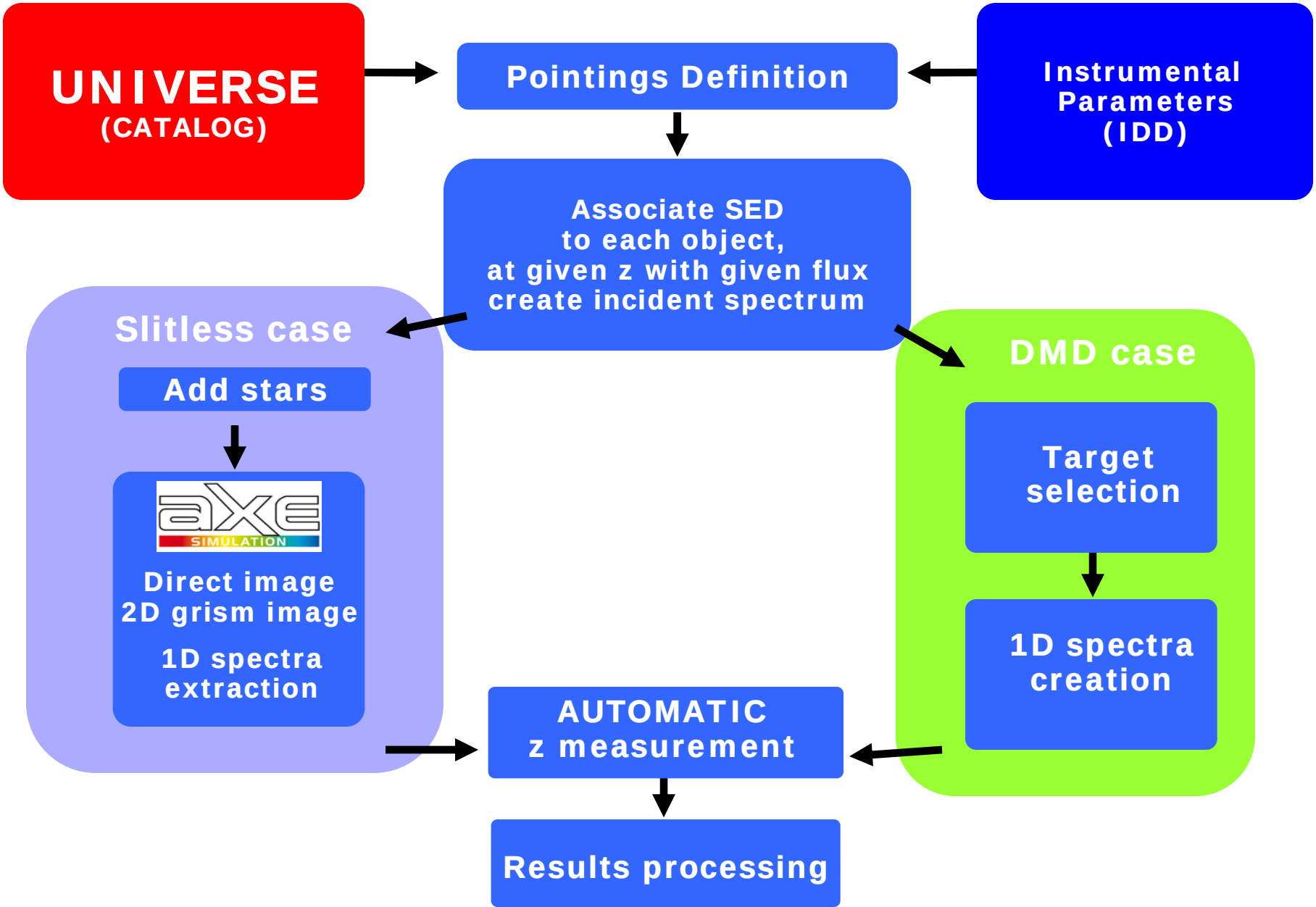
$$S/N = \frac{S}{\sqrt{Var(S) + \left(1 + \frac{1}{n_B}\right)(Var(B) + Var(D))}}$$

- ASSUME s/n>x => redshift measured
- convolution with galaxy counts and redshift distribution to get to total survey yield,
- SLITLESS: does not take into account confusion

Full End to End approach: from mock catalogs to redshift measure, via simulation of spectra and redshift measurement

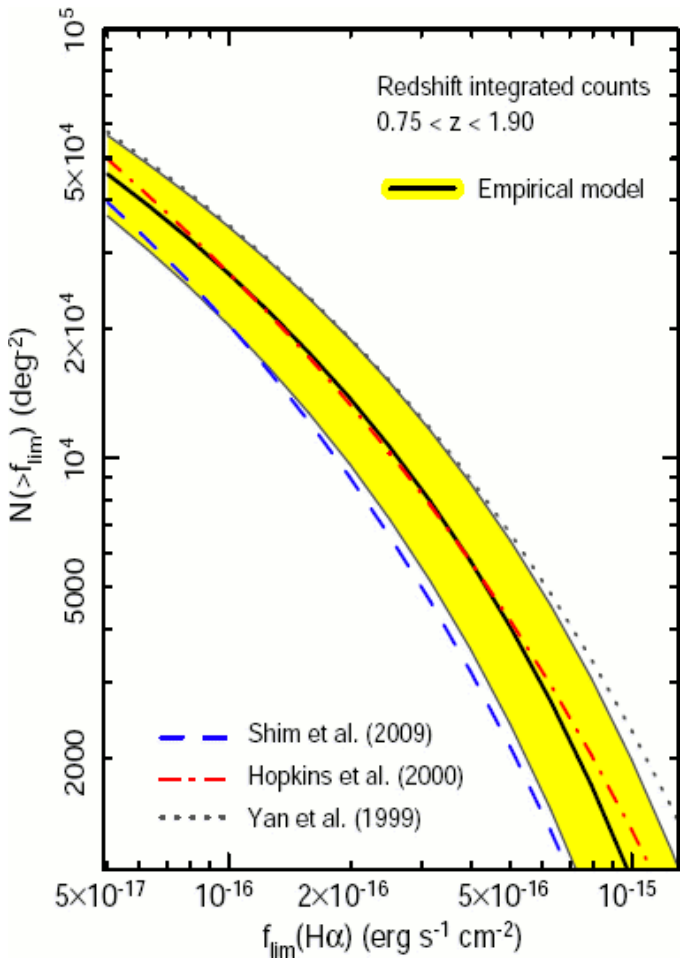


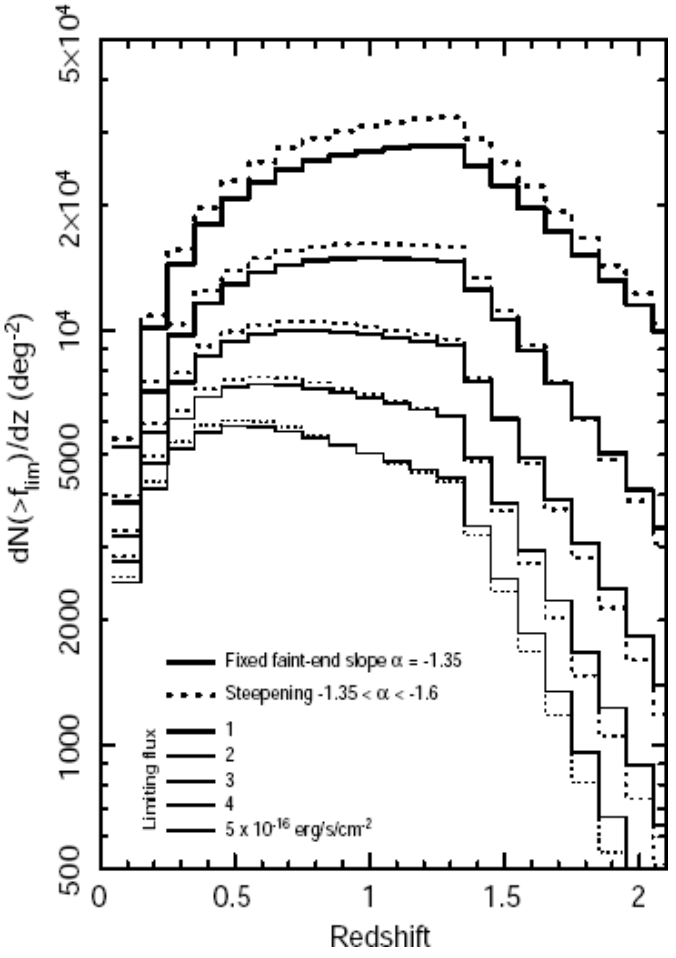
Full end to end simulations



Input counts and dN/dz of Hα emitters

- Geach et al. 2009, MNRAS accepeted : Latest empirical data to model an evolution LF of Hα emitters to z~2
- Reproduce slitless (Nicmos) + narrow-band NIR surveys results (Yan 99, Hopkins 00, Shim 09, Geach 08)
- Best current estimates of N(>$F_{Hα}$) and dN/dz , <u>but still suffers from ~25% uncertainty</u>..

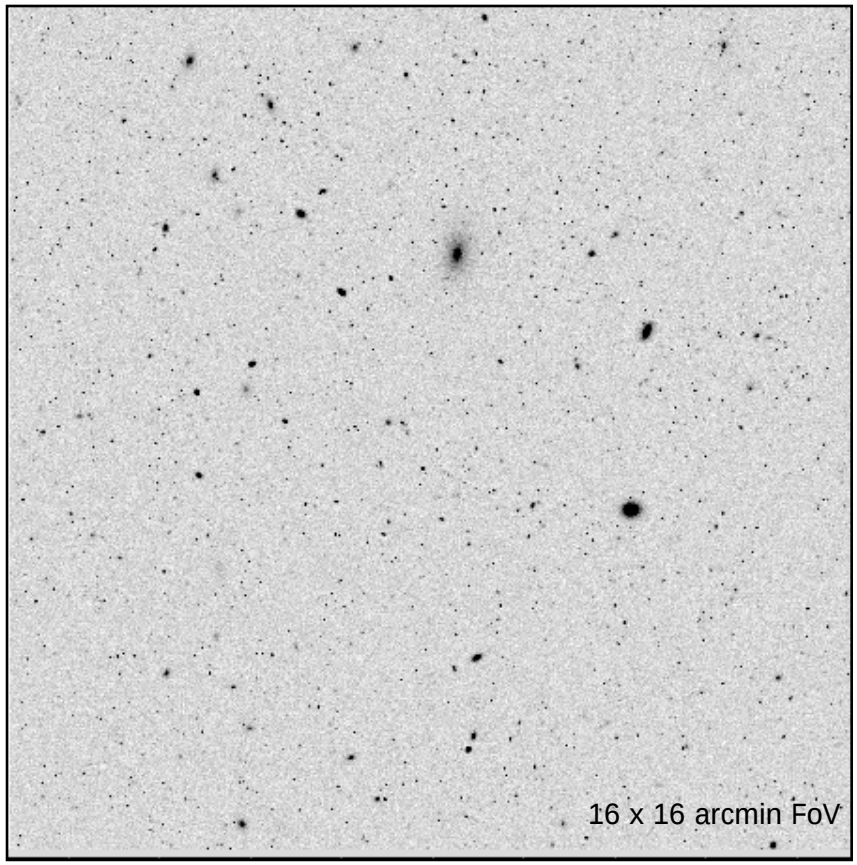




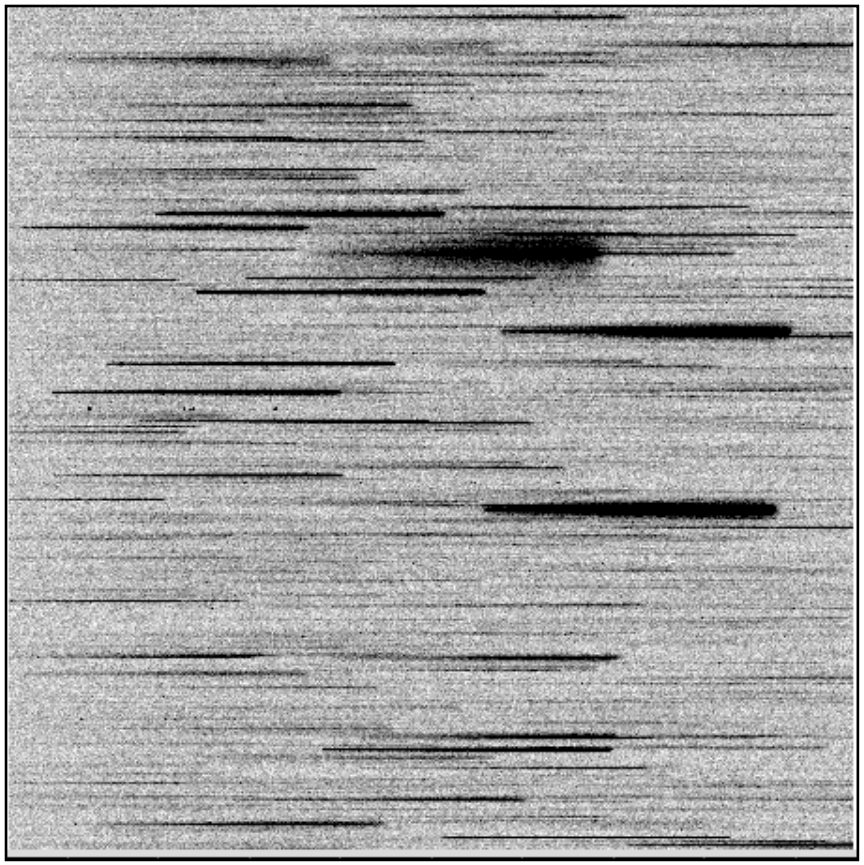
End-to-end Sky Simulations

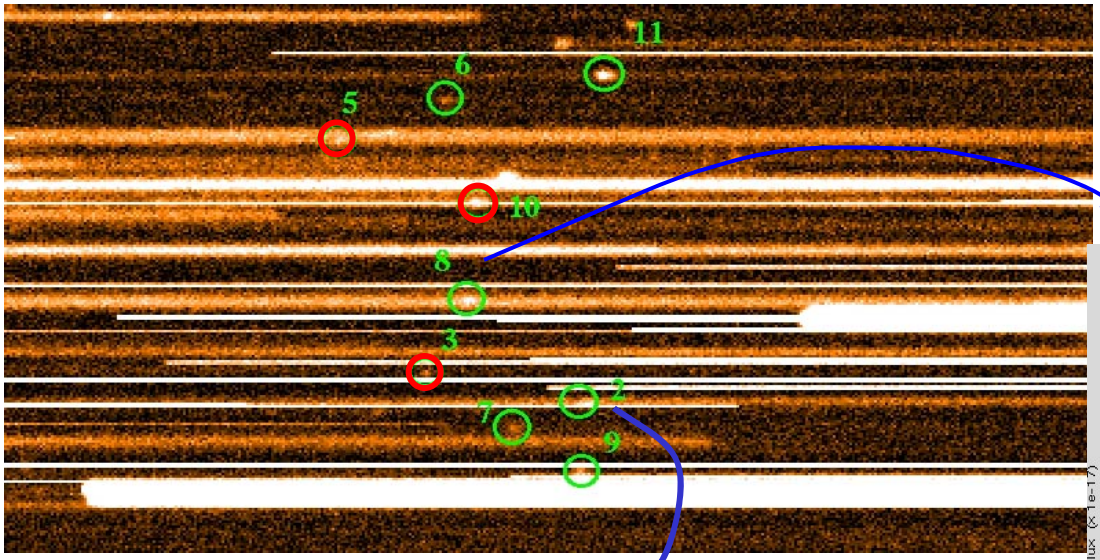
aXeSim simulations

Direct Image

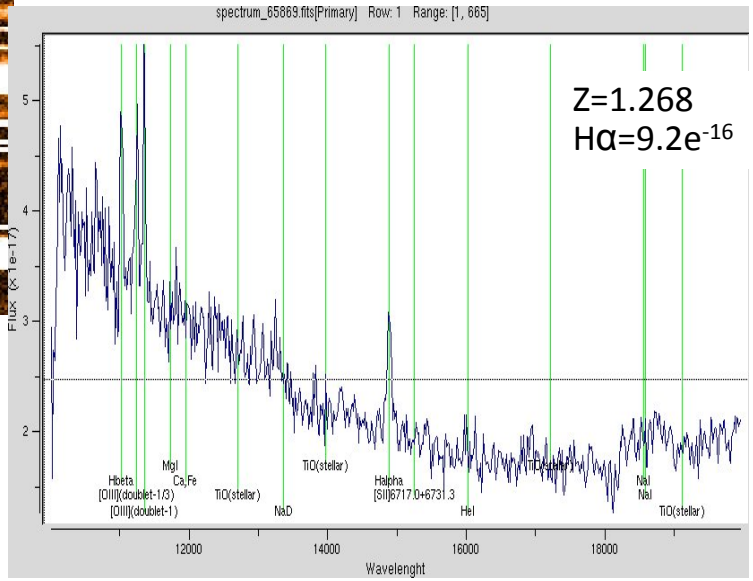


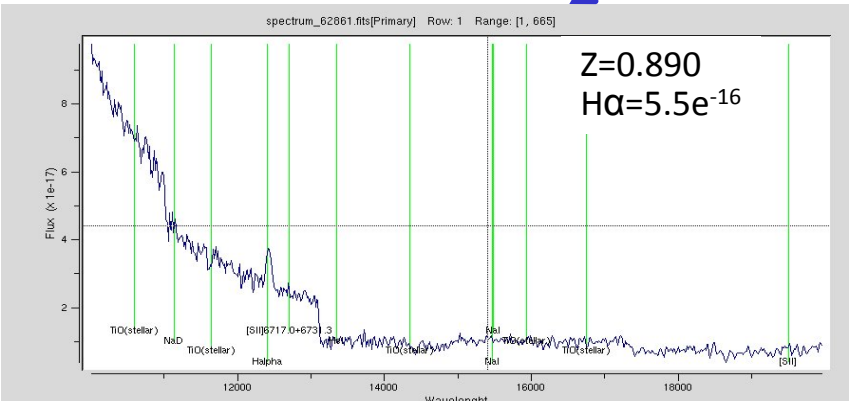
Slitless Image



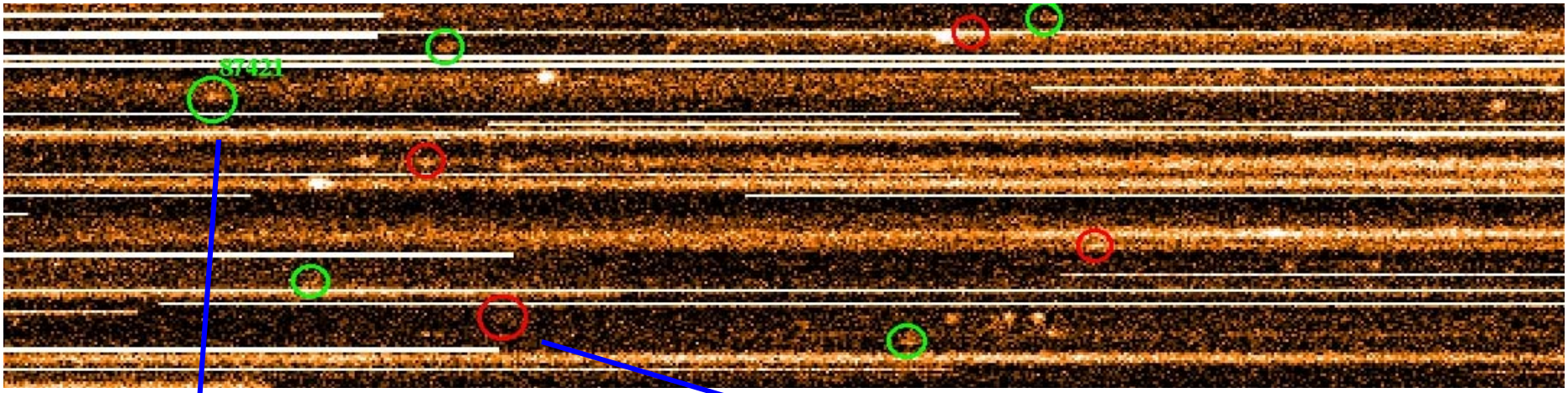

11
6
5
10
8
3
2
7
9

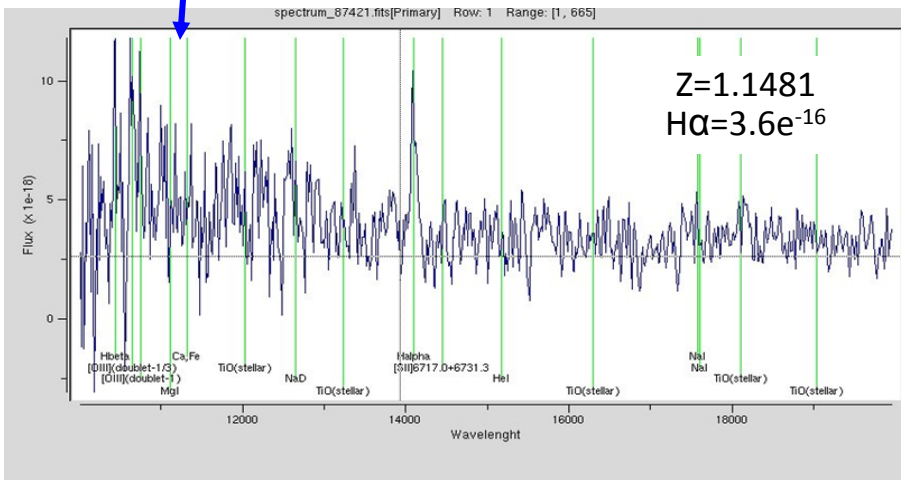
5-10 x10^{-16}

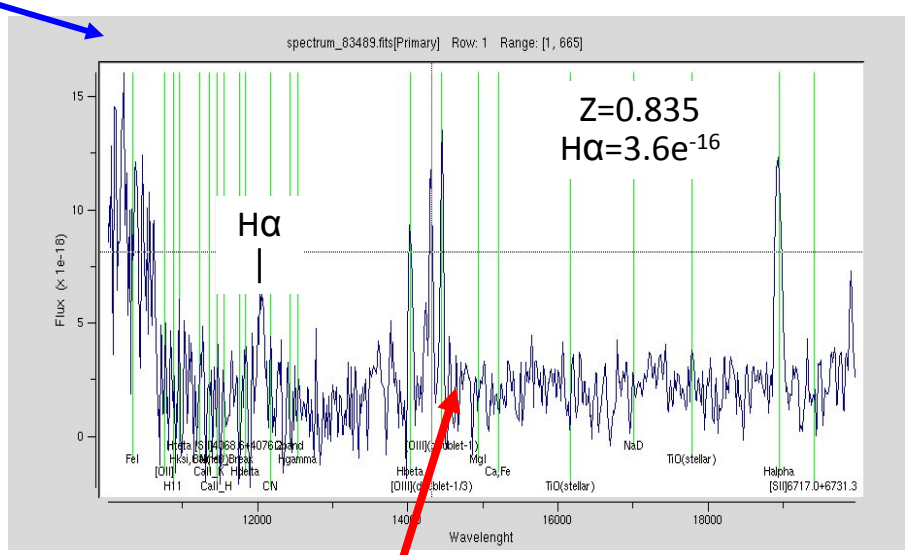

spectrum_65869.fits[Primary] Row: 1 Range: [1, 665]
Z=1.268
Hα=9.2e-16
Flux (x 1e-17)
Wavelenght
Hbeta
[OIII](doublet-1/3)
[OIII](doublet-1)
MgI
Ca Fe
TiO(stellar)
NaD
TiO(stellar)
Halpha
[SII]6717.0+6731.3
HeI
NaI
NaI
TiO(stellar)


spectrum_62861.fits[Primary] Row: 1 Range: [1, 665]
Z=0.890
Hα=5.5e-16
Flux (x 1e-17)
TiO(stellar)
NaD
TiO(stellar)
Halpha
[SII]6717.0+6731.3
NaI
NaI
[SII]

2-4 x10-16





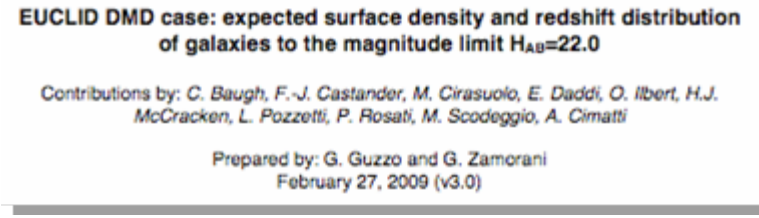


Contaminated, wrong redshift

DMD case

- no contamination,
  - no need to simulate 2D image
- need to take into account target sampling
  - SPOC (Bottini et al. 2005), adapted to E-NIS

30,000 galaxy/sq.degree
simulations over 1 square degree
sampling=35%

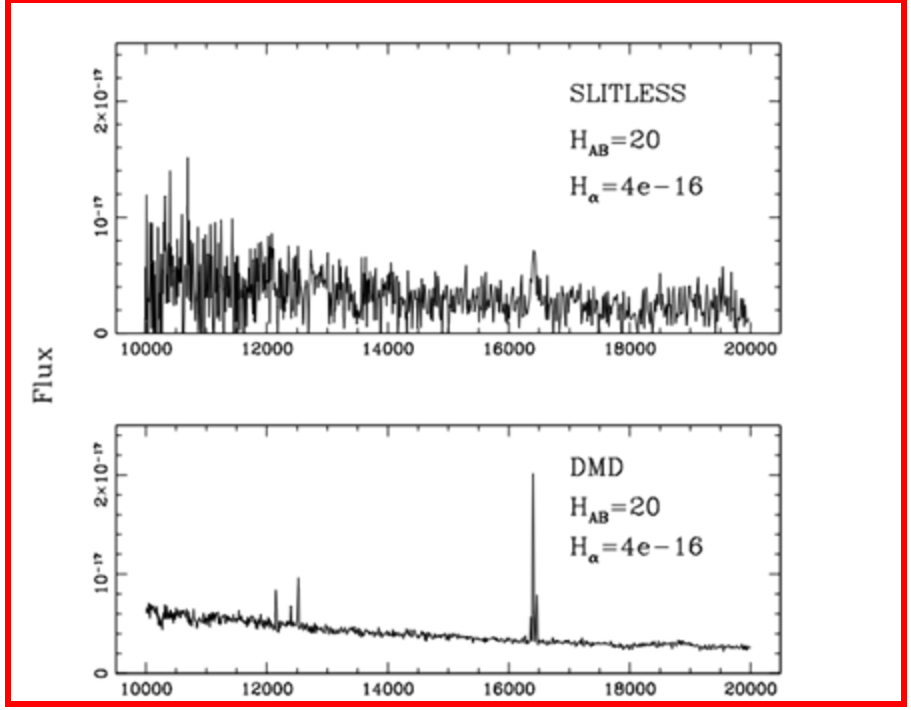

EUCLID DMD case: expected surface density and redshift distribution of galaxies to the magnitude limit H_{AB}=22.0

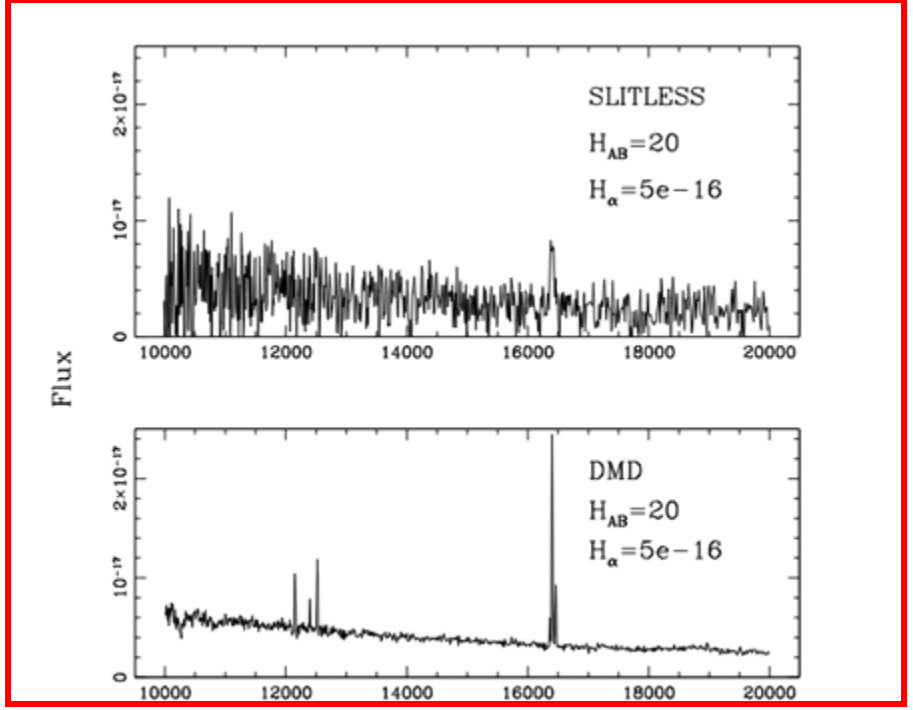
Contributions by: *C. Baugh, F.-J. Castander, M. Cirasuolo, E. Daddi, O. Ilbert, H.J. McCracken, L. Pozzetti, P. Rosati, M. Scodeggio, A. Cimatti*

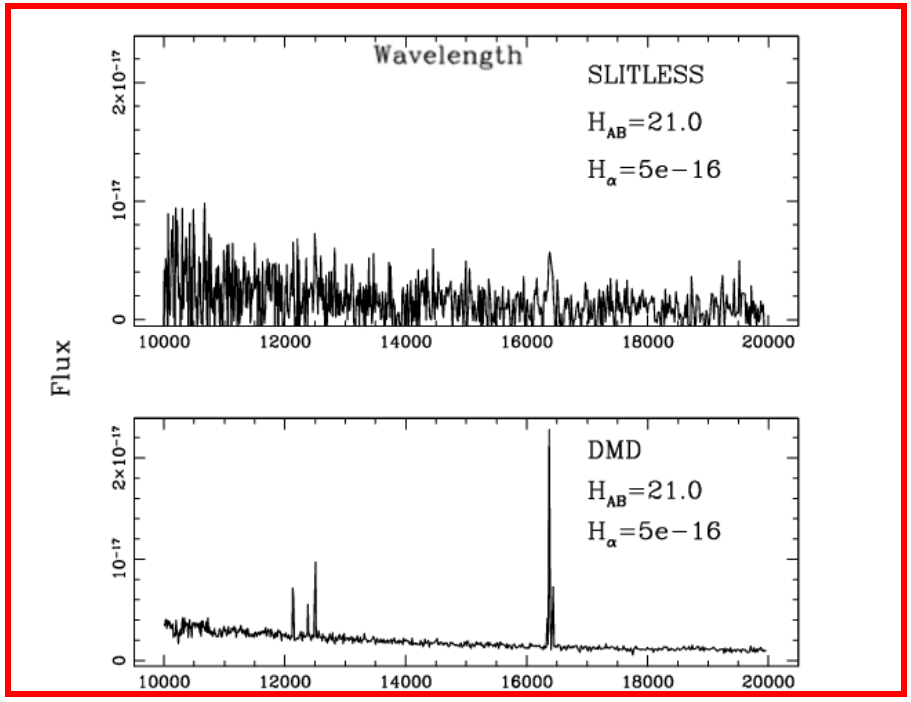
Prepared by: G. Guzzo and G. Zamorani
February 27, 2009 (v3.0)

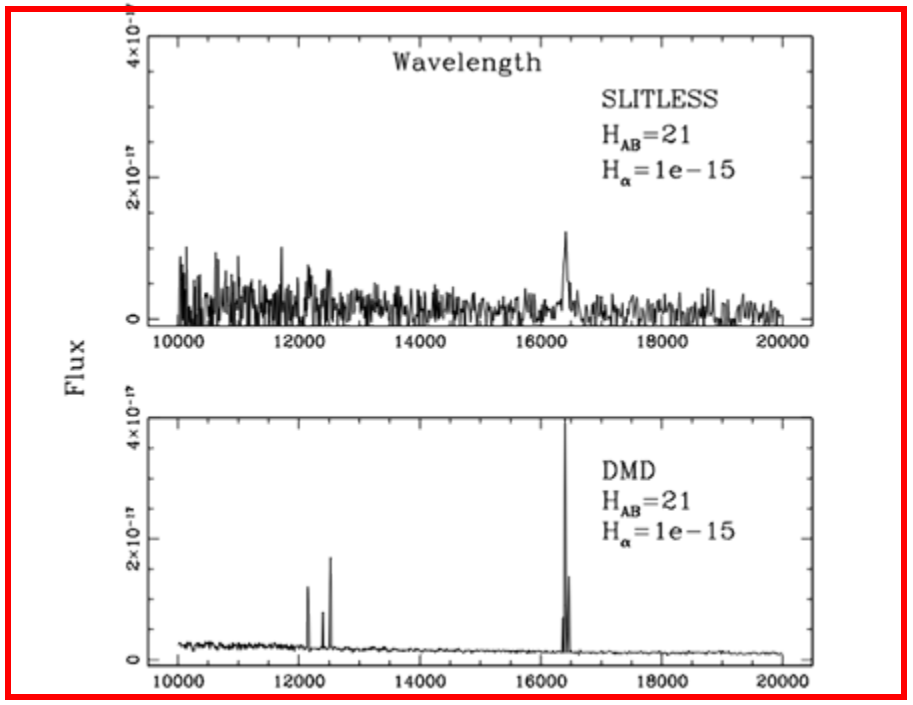
Empirical number counts and dN/dz to H=22 based on a combination of COSMOS, GOODS, UKIDSS-UDS

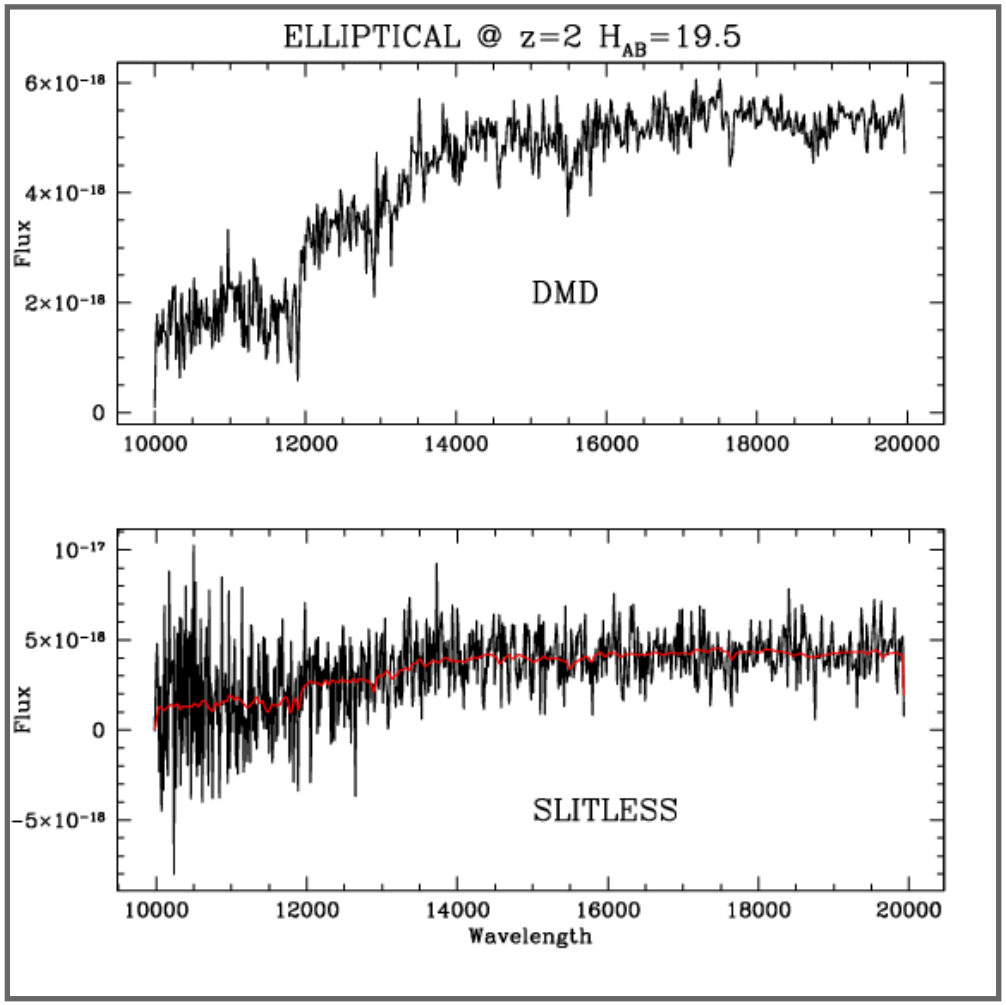
- Require catalog with ALL sources (E included), down to a given magnitude
  - Cosmos Mock Catalog, Jouvel et al. 2009


SLITLESS
H_{AB}=20
H_α=4e−16
DMD
H_{AB}=20
H_α=4e−16
Flux
10000
12000
14000
16000
18000
20000


SLITLESS
H_{AB}=20
H_α=5e−16
DMD
H_{AB}=20
H_α=5e−16
Flux
10000
12000
14000
16000
18000
20000


Wavelength
SLITLESS
H_{AB}=21.0
H_α=5e−16
DMD
H_{AB}=21.0
H_α=5e−16
Flux
10000
12000
14000
16000
18000
20000


Wavelength
SLITLESS
H_{AB}=21
H_α=1e−15
DMD
H_{AB}=21
H_α=1e−15
Flux
10000
12000
14000
16000
18000
20000

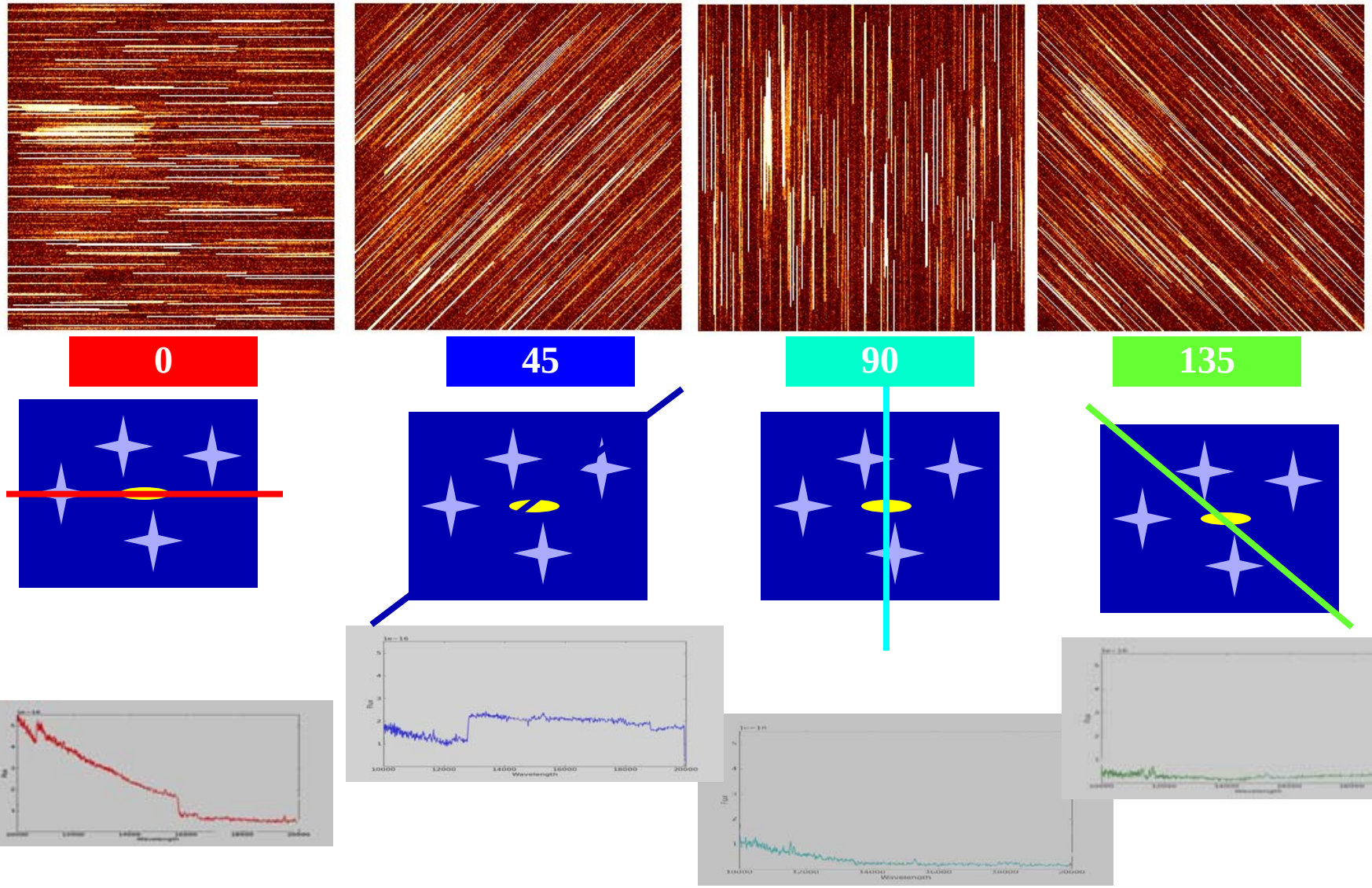

ELLIPTICAL @ z=2 H_{AB}=19.5
6×10⁻¹⁸
4×10⁻¹⁸
2×10⁻¹⁸
0
Flux
DMD
10000
12000
14000
16000
18000
20000
10⁻¹⁷
5×10⁻¹⁸
0
−5×10⁻¹⁸
Flux
SLITLESS
10000
12000
14000
16000
18000
20000
Wavelength

Accuracy and reliability

- Redshift automatically measured with EZ (used for VVDS and zCosmos)
- Not only redshift, but “accurate” and reliable
- Reliability computed on the basis of
  - **Line S/N**
  - **Presence of other “expected” lines**
  - **Continuum (DMD only)**
  - **Considered “successful” only redshifts with highest reliability**

σ_z	Slitless	DMD
Accuracy (R=500) $\sigma_z/(1+z)$	10^{-3}	$<10^{-3}$
Reliability	85%	90%

The problem of contamination: Multiple roll angle approach

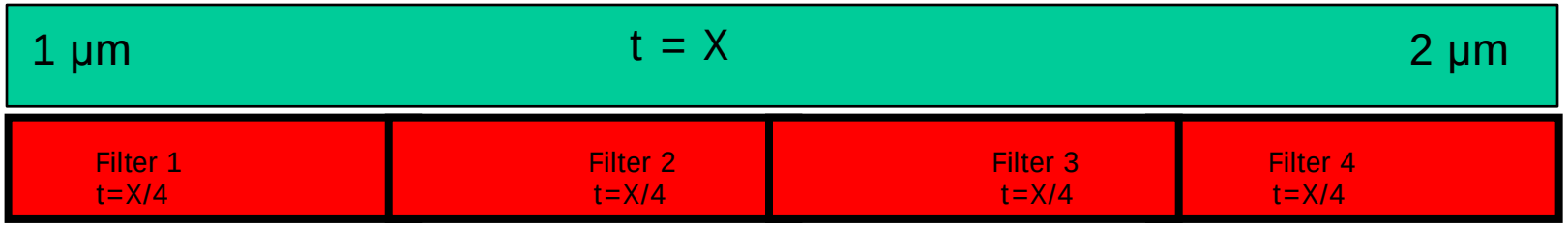


4 exposures at different orientations on sky

Not exciting results, due to high galaxy density

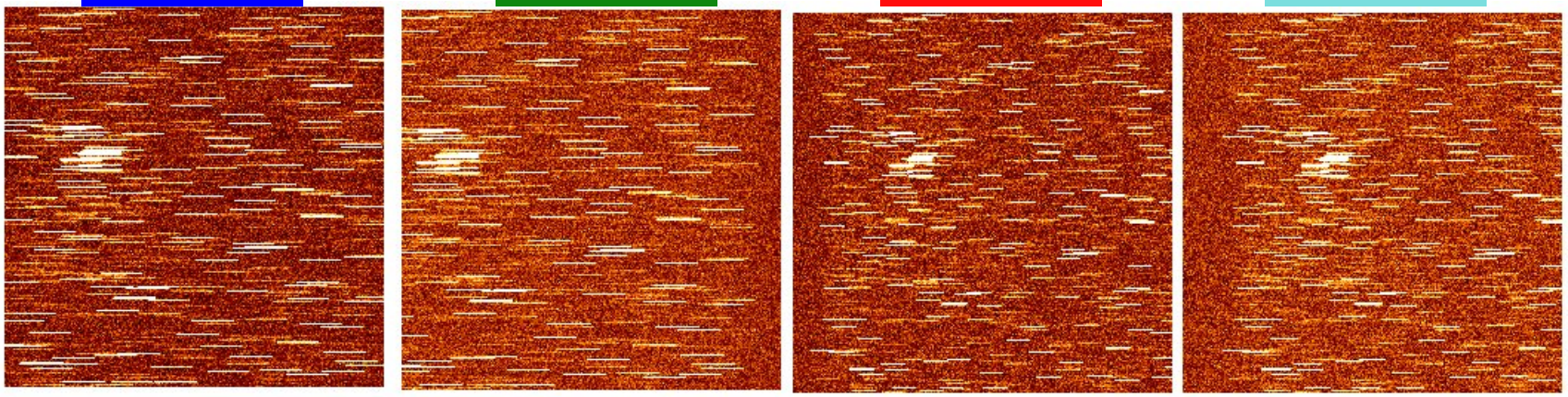
Requires further investigation on best combining strategy

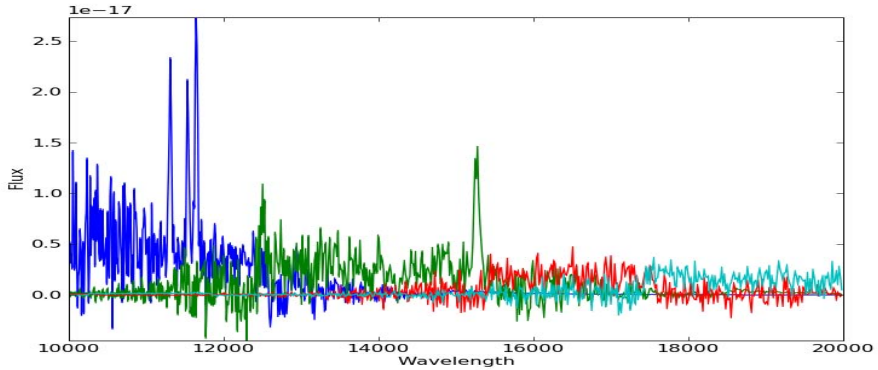
The multiple-filters approach

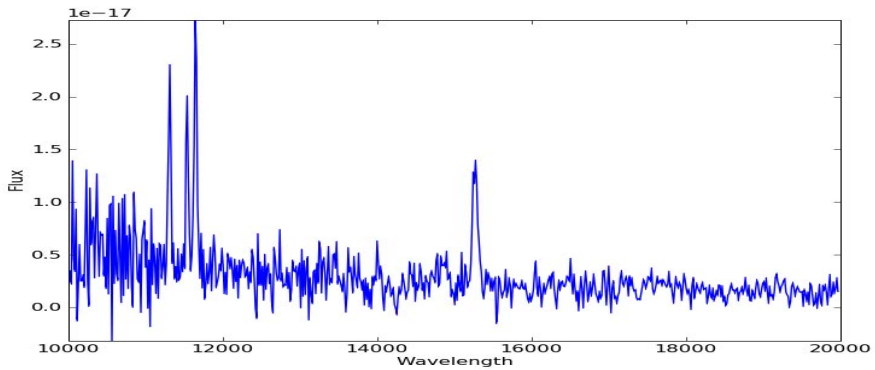


Strong decrease of the sky background
Similar S/N ratio for emission line
Spectra are “shorter” (170 pix vs 670 pix) **(less severe spectral confusion)**

10000-12500 **12500-15000** **15000-17500** **17500-20000**







1 sq. deg simulated per configuration

	4 roll	4 filters
Success rate increase	**+7%**	**+15%**

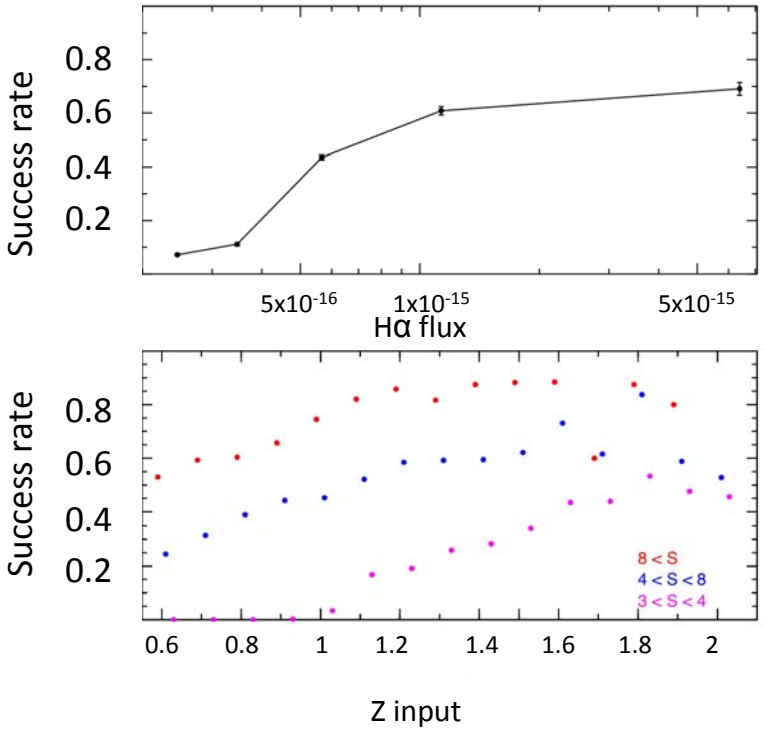
Multi grism approach gives better results
Multi roll approach requires deeper investigation

ON GOING

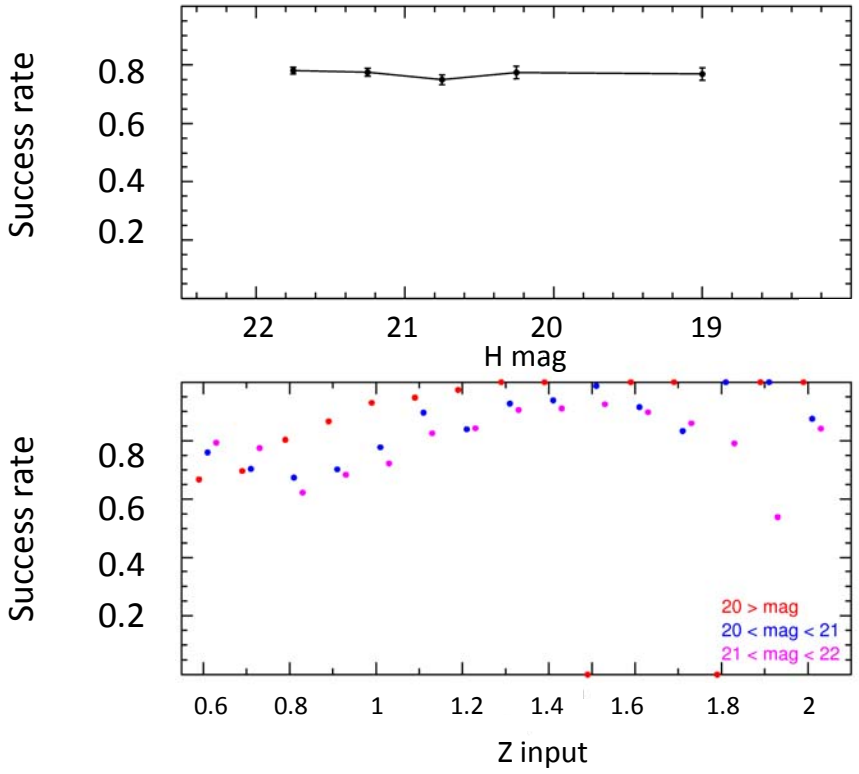
Success rate

ε(F,z)ε=reliable redshifts (>85%)/Total number of sources
2 sq. degrees~60000 galaxies

Slitless success rate



DMD success rate



	SLITLESS CASE (single exposure)	DMD case
Survey limit	3e-16 erg/cm2/sec/A	H=22
Explorable z range	0.5-2	0.-2
Target sampling rate	**100%**	**35%**
Z success rate	**30-60%**	**80%**
Z accuracy	1.e-3	5.e-4
Zyeld/sq deg	~2700	~8400
Mission yield (5 years)	**~6.5×10^7**	**~1.5×10^8**
	only star forming galaxies smaller survey volume	**all galaxy types larger survey volume FoM ~ 2-2.5 larger**

Additional Science Cases: all OK with DMD, only some with slitless

Summary

- end-to-end simulations important to make sound predictions on global survey yield, especially in Slitless mode
- Current simulations can (and will) be improved
- **Slitless allows to fulfill main science goal**
- DMD based survey more powerfull