

Target Selection for future spectroscopic surveys (DESPEC)

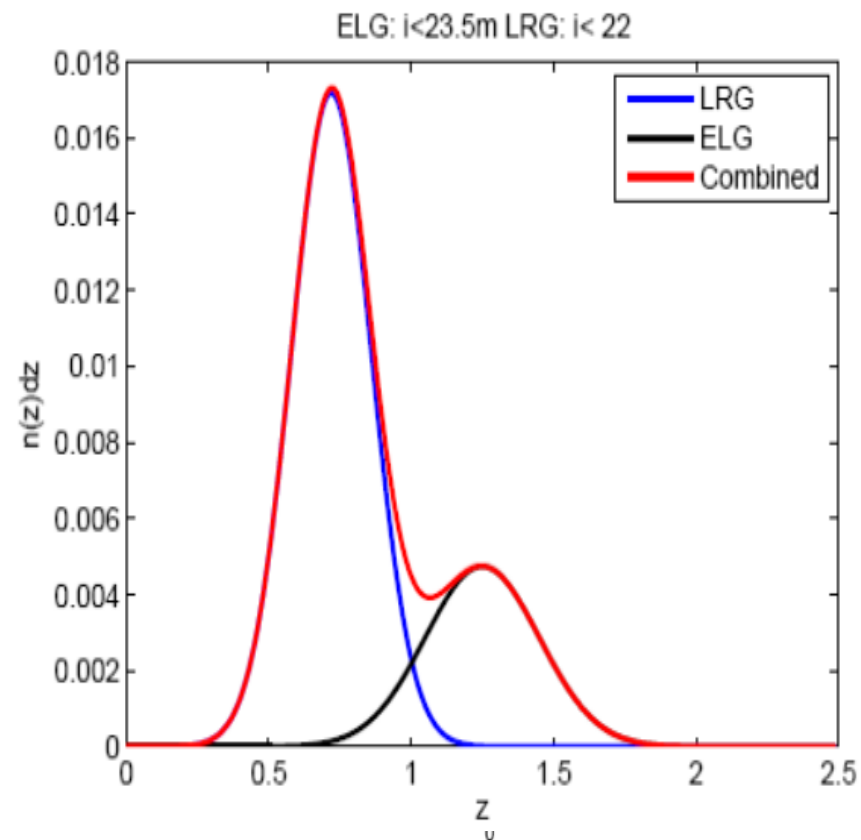
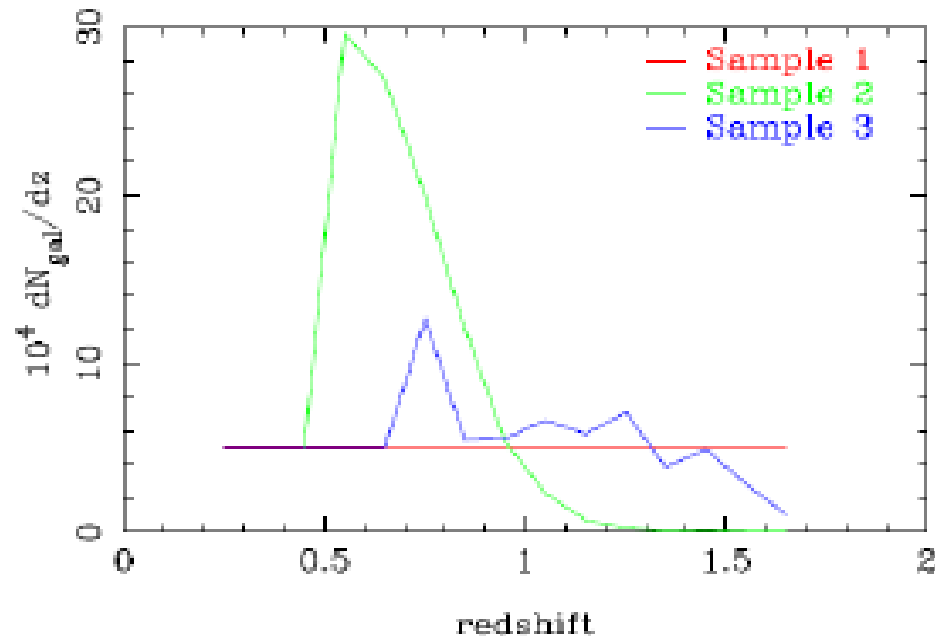
Stephanie Jouvel, Filipe Abdalla,
With DESPEC target selection team.

Outline:

- Scientific motivation (has an impact on how to select targets...) :
- Summary of target selections considered
- Mock galaxy catalogues
- Target selection results for the white paper.
- Other R&D studies left to be done.

FOM for dark energy studies. BAO + P(k) + RSD's...

- 1- Constant density $0.2 < z < 1.7$, 10^7 galaxies
- 2- Constant density $0.2 < z < 0.5$, plus $i < 22.5$ for $0.5 < z < 1.7$ @65% eff'y. Total 10^7 galaxies. Note redshift cut-off
- 3- Constant density $0.2 < z < 0.7$, plus emission line galaxies for $0.7 < z < 1.7$. Total 10^7 galaxies.



DES(WL) + DESpec(LSS)
Kirk, Lahav & Bridle, in prep

Motivation from Donacha's talk ->
Improved FOM for DE and modified gravity.
Link his talk to a realistic $n(z)$ and N targets.

Photo-z calibration: direct and cross correlation

$$C_\ell \equiv \langle \delta^{2D} \delta^{*2D} \rangle = 4\pi \int \Delta^2(k) W_i(k) W_j \frac{dk}{k}$$

A spectroscopic survey to further calibrate photo-z, given depth of DES, most likely a large fraction of DES galaxies will have been calibrated but not all -> small deep field

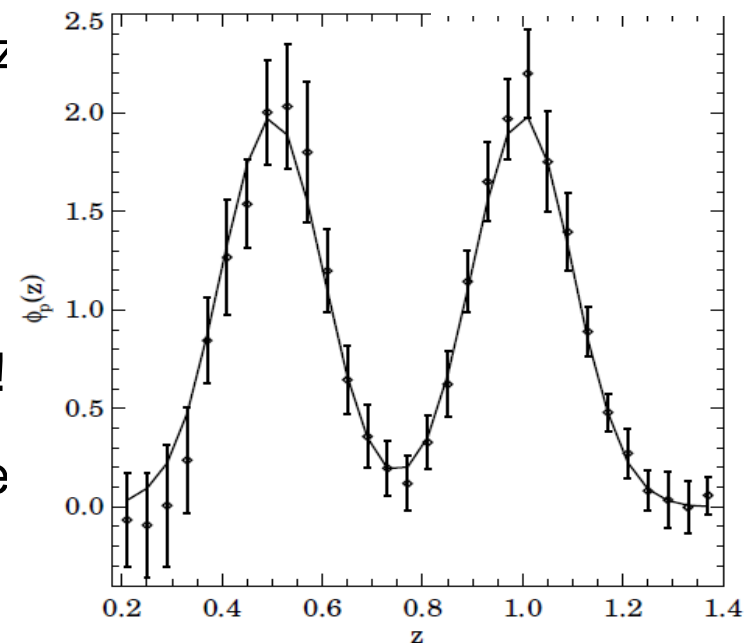
$$W_\ell(k) = \int f(z) j_\ell(kz) dz$$

$$f(z) = n(z) D(z) \frac{dz}{dx}$$

Would, possibly, calibrate deeper photo-z surveys with the x-correlation technique. See sims (Matthews and Davis 10).

Problem: degenerate with bias(z)

Technique not put to the test on data yet!
Would be nice to see it actually working. If so, DESpec could calibrate a large fraction of surveys such as LSST.



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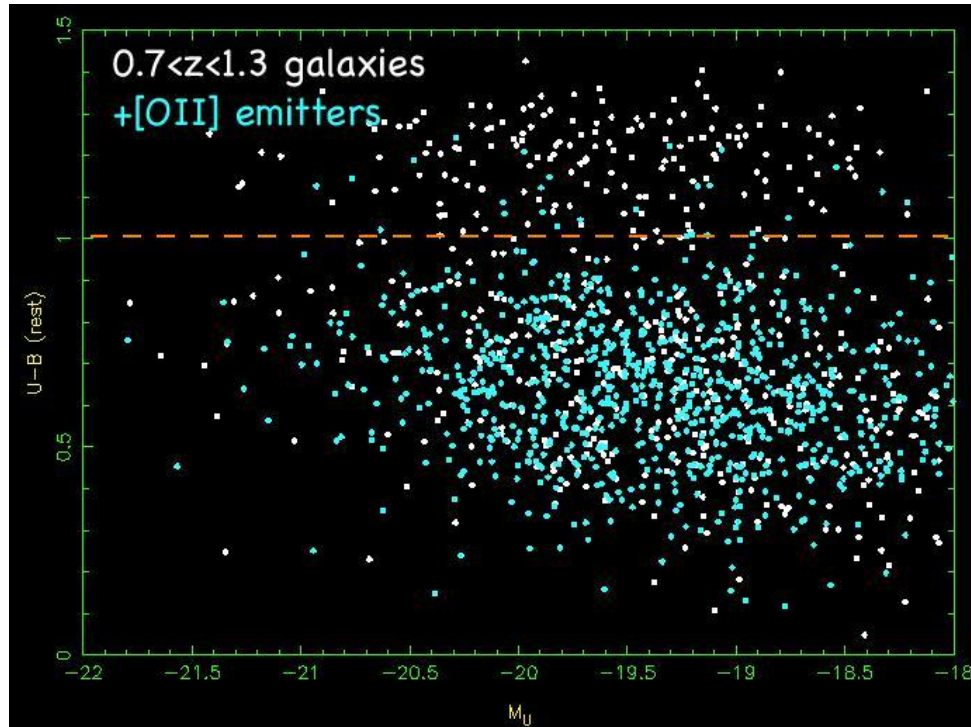
Target selection: success rate!

- Selection of the correct galaxies (enough bands)
- Selection of galaxies with enough signal to noise
=> Realistic photometric scatter
- Need proper simulation => Realistic noise
realisation of the spectrum
- Line in the correct spectral range for the
spectrograph.

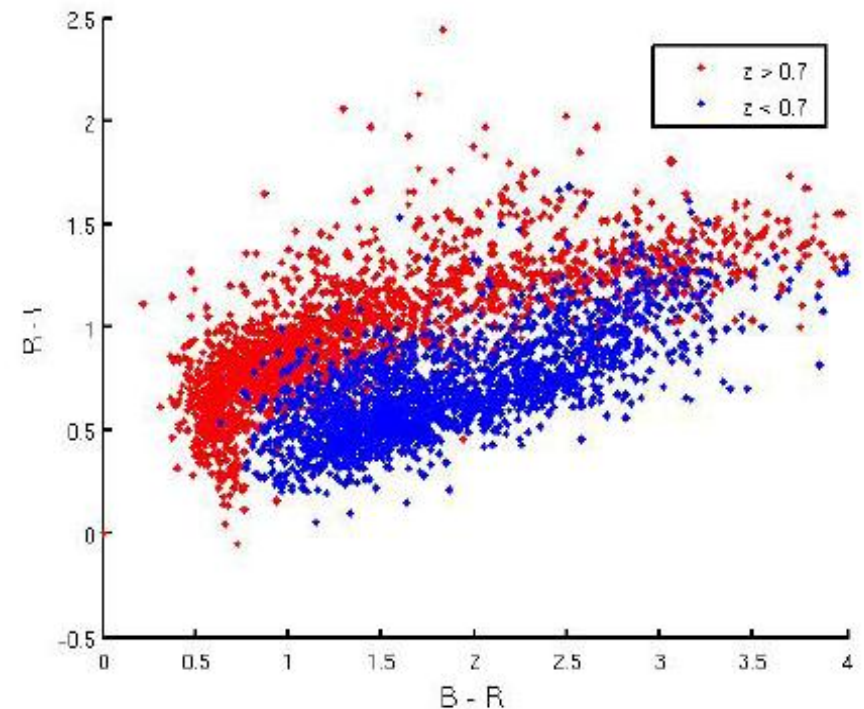
=> Mostly H α and OII for a 0.6-1.1 μ m spectrograph

Selection of ELG (WFMOS/KAOS)

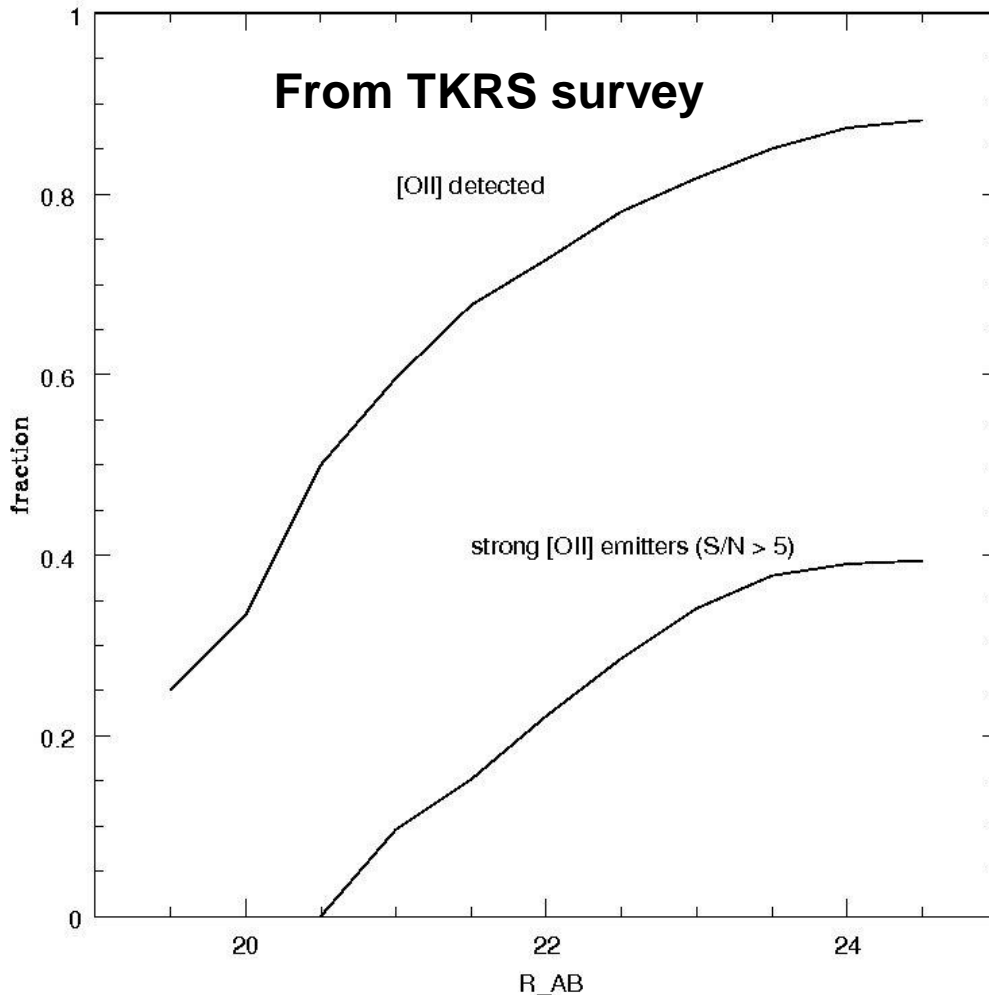
Original old strategy...



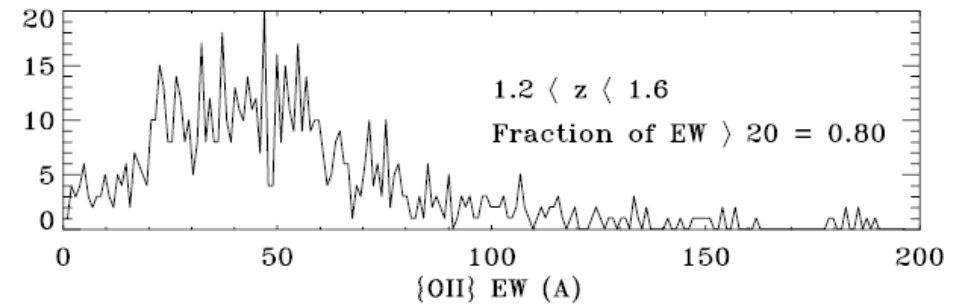
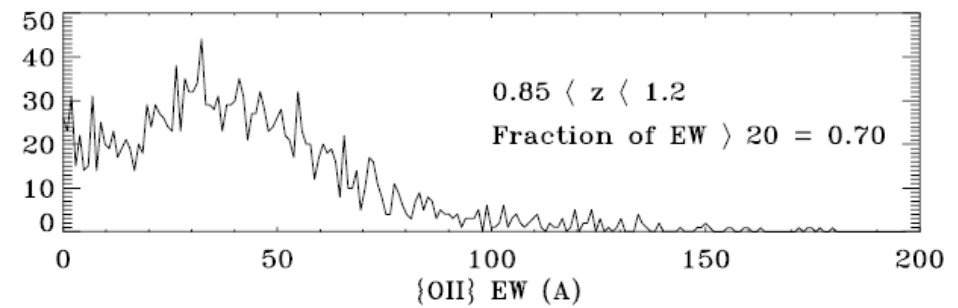
From K. Glazebrook old KAOS talk



Oil emitters in TKRS



From Laerte Sodre./ WFMOS proposal



R_{AB}^{lim}	z	galaxies deg ⁻²	$f([OII])_{S/N>3}$	$f([OII])_{S/N>5}$
22.5	0.5 - 0.7	2385.	0.55	0.30
22.5	0.7 - 0.9	608.	0.59	0.44
22.5	0.9 - 1.1	202.	0.67	0.44
22.5	1.1 - 1.3	45.	1.00	0.50
23.0	0.5 - 0.7	3712.	0.59	0.36
23.0	0.7 - 0.9	1710.	0.64	0.47
23.0	0.9 - 1.1	922.	0.76	0.51
23.0	1.1 - 1.3	68.	1.00	0.67
23.5	0.9 - 1.1	2295.	0.76	0.56
23.5	1.1 - 1.3	518.	0.87	0.65
24.0	0.9 - 1.1	3960.	0.73	0.56
24.0	1.1 - 1.3	1192.	0.89	0.62
24.4	0.9 - 1.1	5198.	0.74	0.58
24.4	1.1 - 1.3	1845.	0.88	0.61

PTF + PS target selection (ELG's):

Panstarrs + PTF

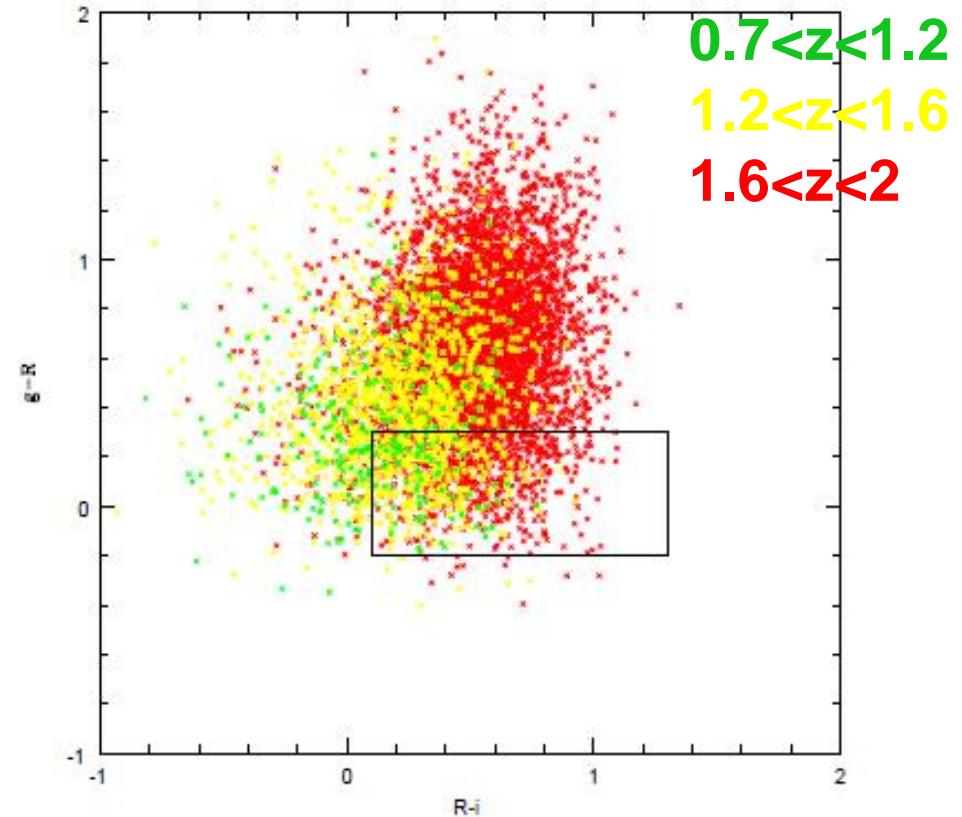
R, g and i bands.(~23 mag)

Colours are different redshift ranges.

Compared $n(z)$ with other selection.

Target selection aspect -> depends on the photometry only

Spec success rate depends on the instrument.



Color-color selection of ELG galaxies. The x-axis shows $R-i$ of panSTARRS i band and PTF R band as a function of $g-R$ of panSTARRS g band and PTF R band. The black box represent the color-color cut we apply to select bright ELG galaxies at $0.7 < z < 2$.

LRG IR selection:

WISE:

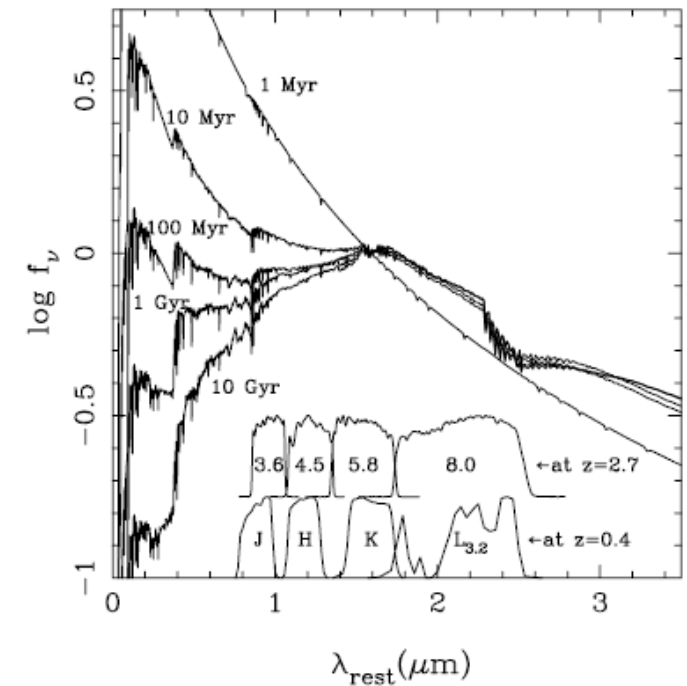
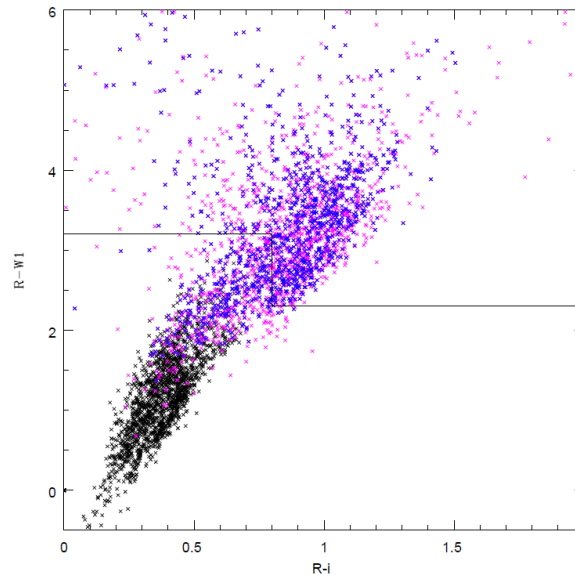
$3.4\mu\text{m}$ AB ~ 19

$4.6\mu\text{m}$ AB ~ 19

$12\mu\text{m}$ AB ~ 17

$22\mu\text{m}$ AB ~ 14

Selecting LRG's



Higher z LRG's have the break moving out of the I band, hence z bands or IR bands are needed.

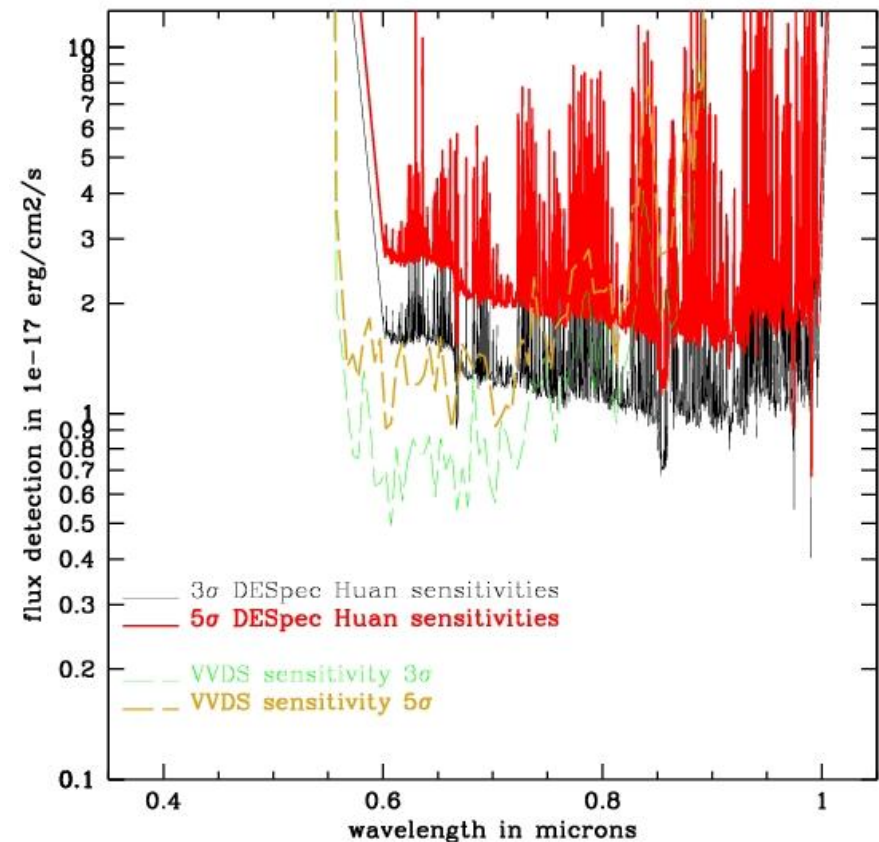
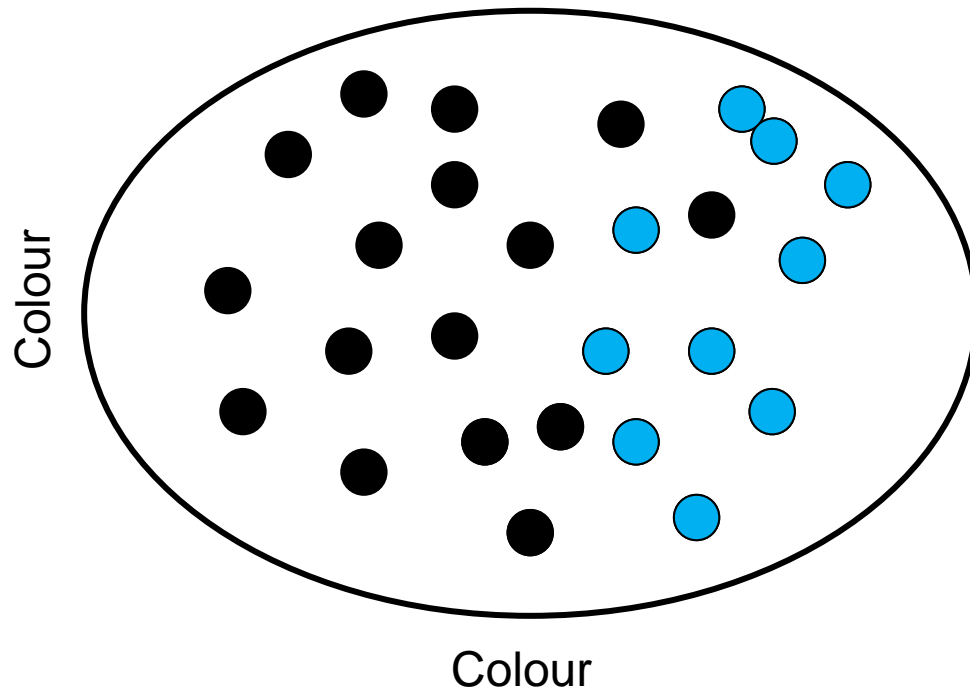
One way of getting higher redshift LRG's \rightarrow use far IR space data.
Use the H minus 1.6 micron bump. (see figure from Sawicki 02)

BigBoss will probably be able to select these very well.

Obtaining a flat $n(z)=\text{cst}$ will require photo-zs with near-IR data.

Multidimensional method based on NN selection

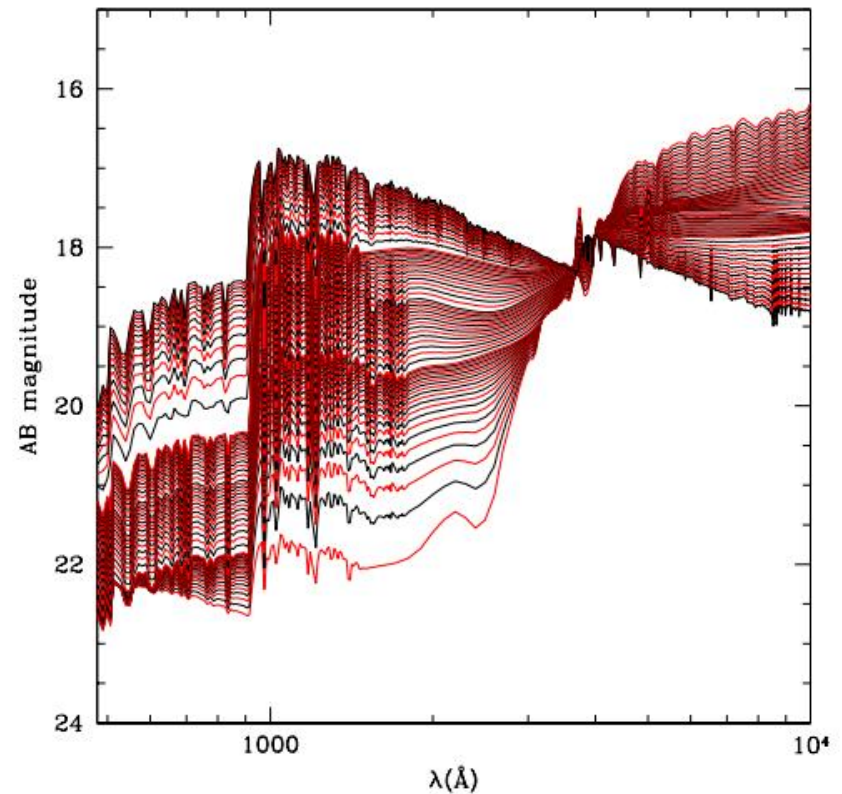
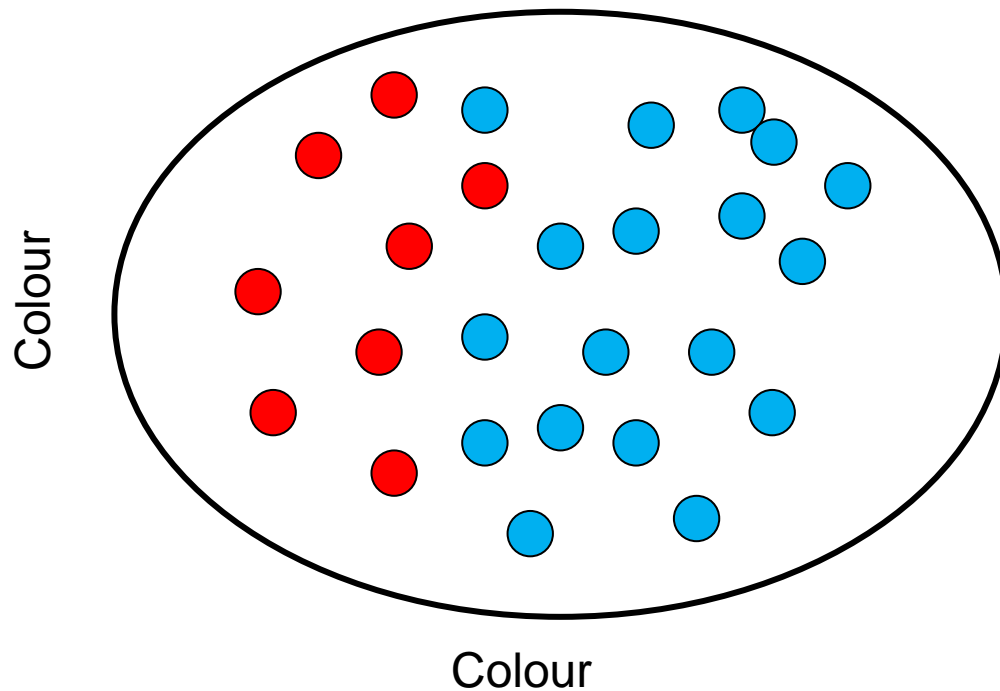
Find LRG/ELG using DES photometry in NN ?



- Blue galaxies have successful redshifts from the sensitivities.
- Black galaxies do not!
- If we change the exposure time the picture changes.

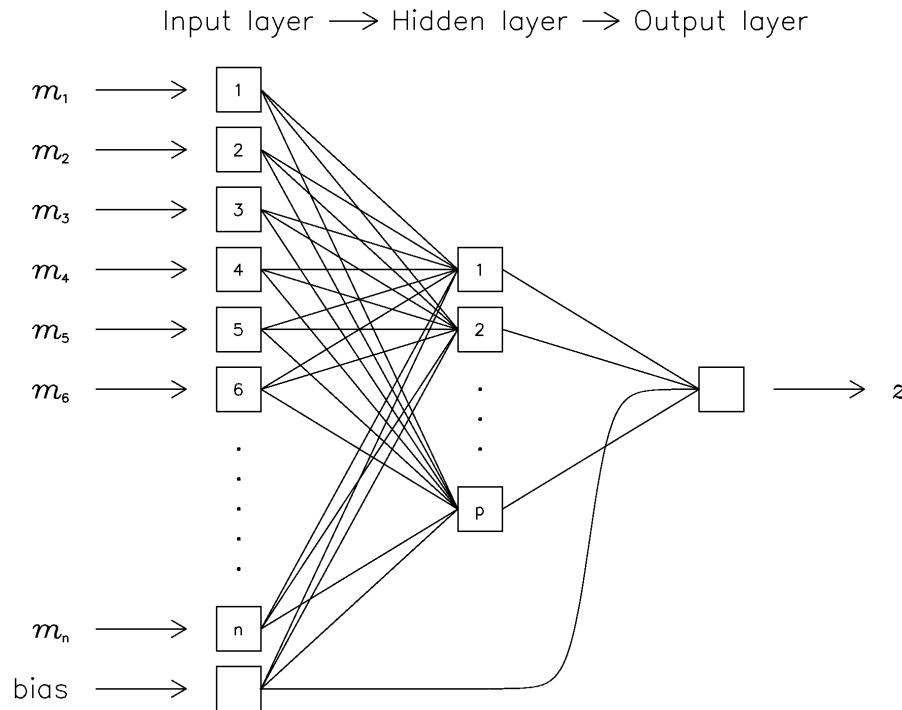
Multidimensional method based on NN selection

Find LRG/ELG using DES photometry in NN ?



- Red galaxies are LRGs on the mock.
- Blue galaxies are not.

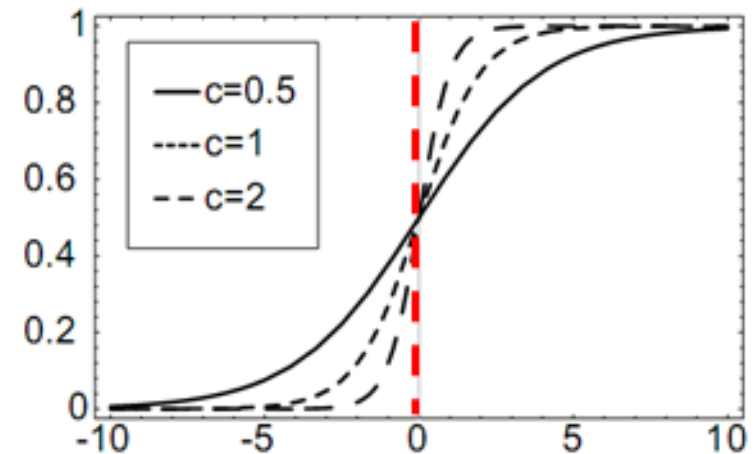
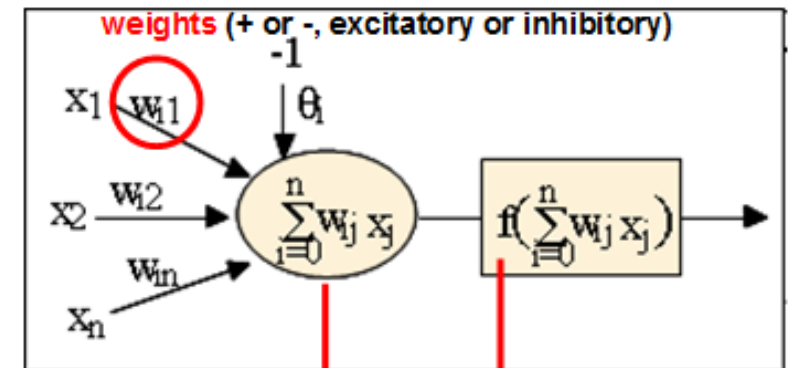
Photo-z's, target selection and Neural networks:



Collister & Lahav 2004

<http://www.star.ucl.ac.uk/~lahav/annz.html>

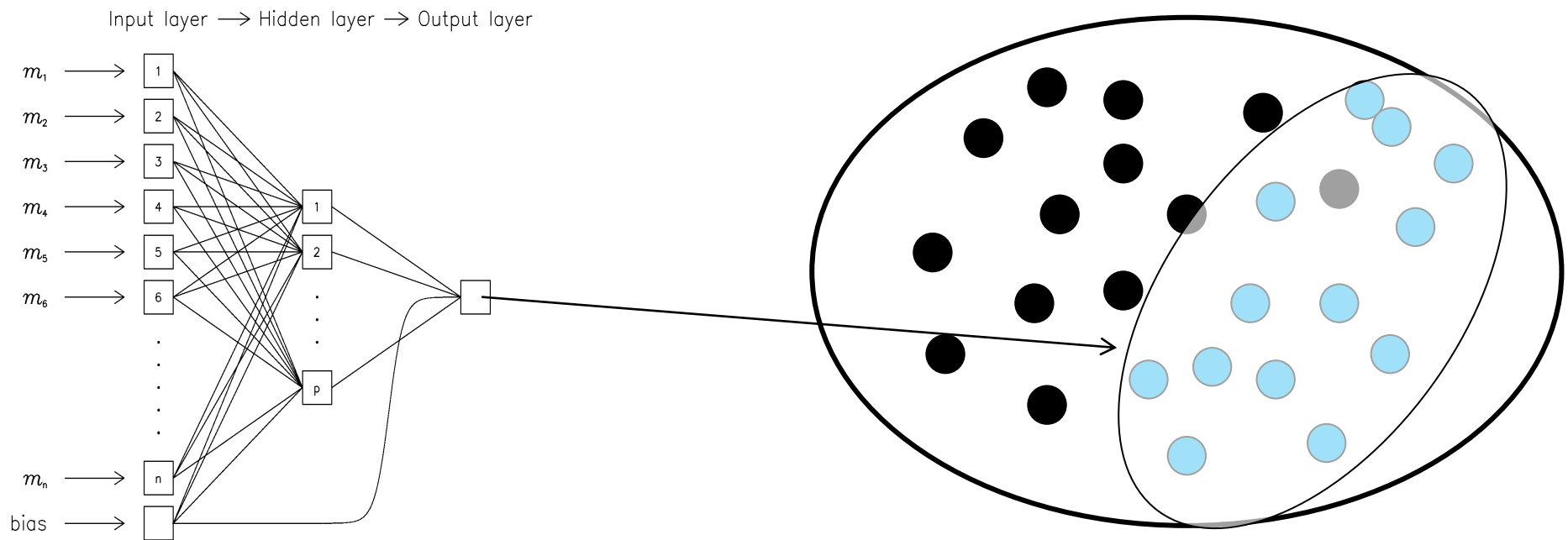
Has an architecture: defined by a number of inputs/ outputs and nodes in hidden layers



Internally values range from 0 to 1 roughly

Multidimensional method based on NN selection

Find LRG/ELG using DES photometry in NN ?

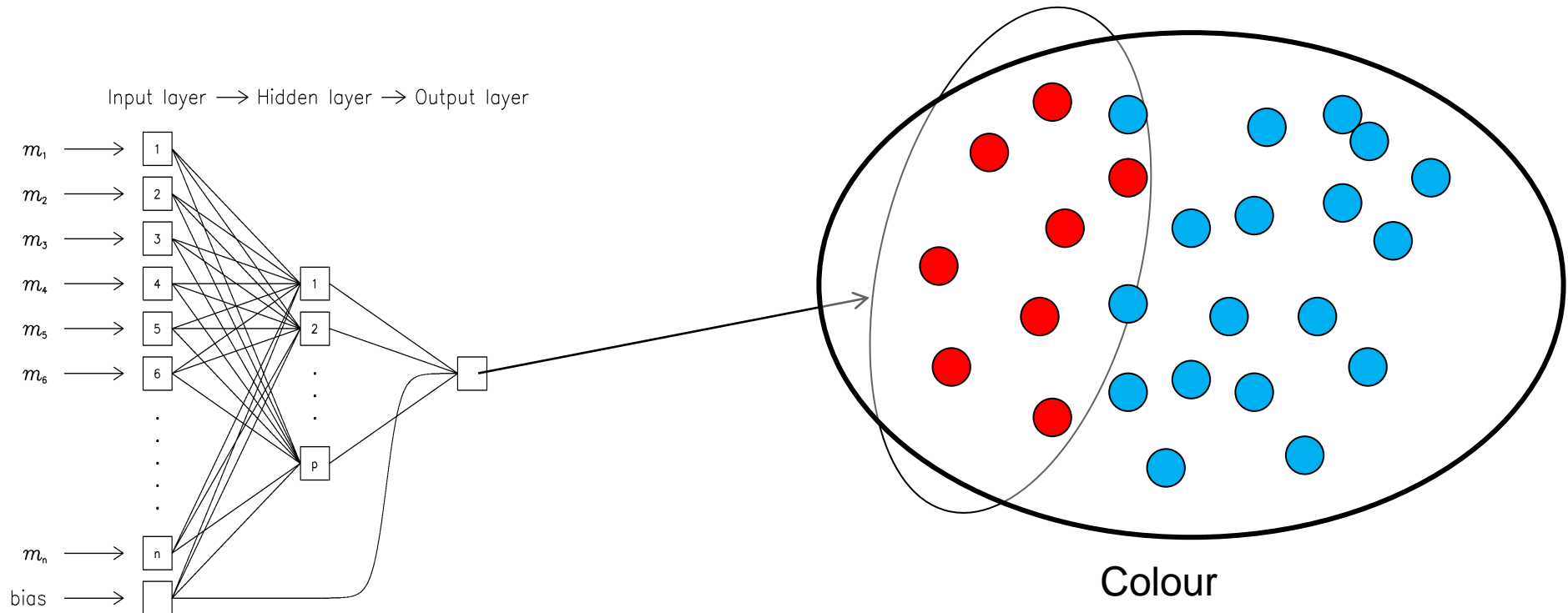


Collister & Lahav 2004

<http://www.star.ucl.ac.uk/~lahav/annz.html>

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Galaxy Properties from Deep Surveys

the COSMOS survey

Koekemoer et al. 2007

- 2deg² (representative)
- 30 photometric bands from UV to IR with HST, Galex, Spitzer, Subaru, VLA, NOAO
- HST/ACS I band observation: galaxy sizes & shapes
- zCosmos spectroscopic survey

the VVDS “Deep” survey

Le fèvre et al. 2005

- VIMOS/VLT deep spectroscopic survey on ~0.5 sq.deg
- ~9000 spectra from $0 < z < 5$ down to $I_{AB} \sim 24$ (magnitude selected)

Building Mock Catalogues

Use this catalogue

GOODS Luminosity Function catalogue

Simulated Catalogue
based on GOODS LF(z,type)

GOODS LF from
Dahlen et al. 2005

COSMOS size distribution,
emission lines

Jouvel et al. 2009

COSMOS Mock catalogue

COSMOS catalogue
(**position, size**, photometry)
1 million galaxies

Photoz, SED, **emission lines**

COSMOS photoz from
Ilbert et al. 2009

Photometry in DE mission filter sets
+ Photometric errors

Jouvel et al 2010

DE Forecast

- Realistic redshift distribution,
- Realistic size distribution,
- Emission line fluxes catalogue

COSMOS Mock Catalog (CMC) Photometry-validation

Construction using the properties of the COSMOS-ACS WL catalog :

- *realistic photometric redshift distribution*

30 photometric bands

calibrated with spectroscopic redshift :

- > zCOSMOS bright (I~22 AB) faint (I~25 AB)

- > MIPS-spectro-z sample

=> Impact DE FoM

- *best-fit template* from this photoz distribution

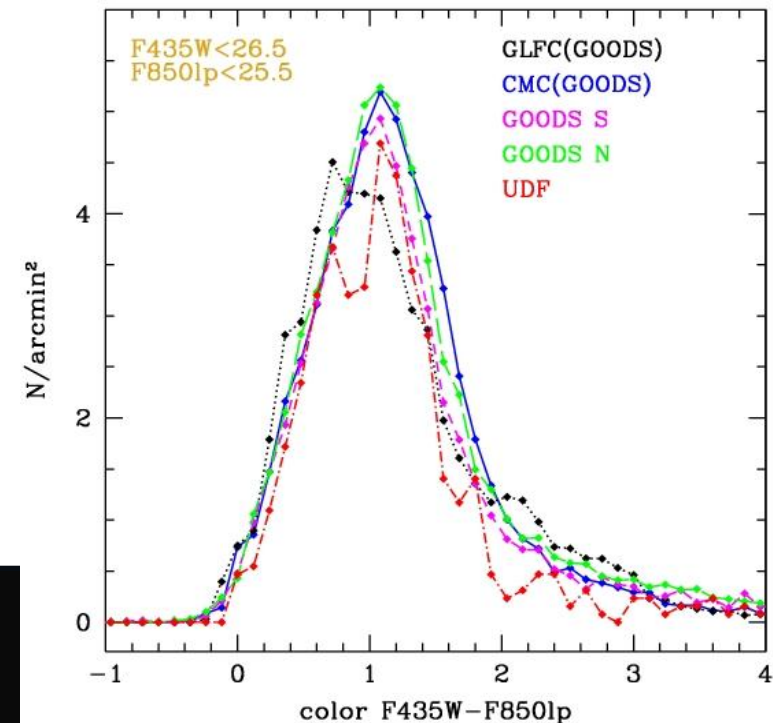
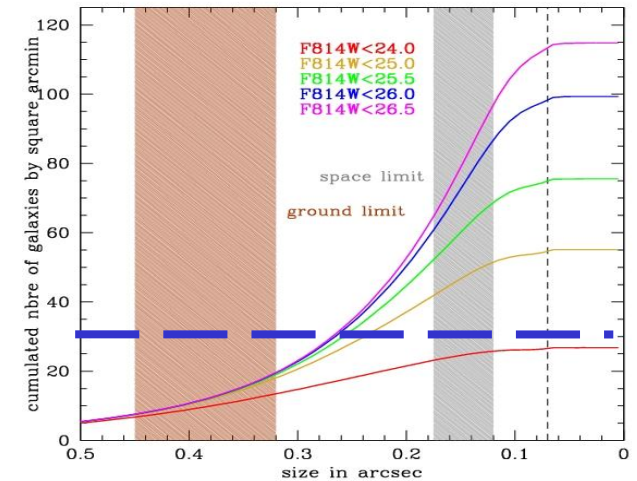
- *galaxy size* measured by SExtractor

(Leauthaud et al 2007)

=> Realistic noise distribution

Validation of the CMC using :

- GOODS N&S *visible*
- UDF *visible + jh band*
- VVDS *Ks band + spectro-z*
- GOODS-MUSIC *Ks band*



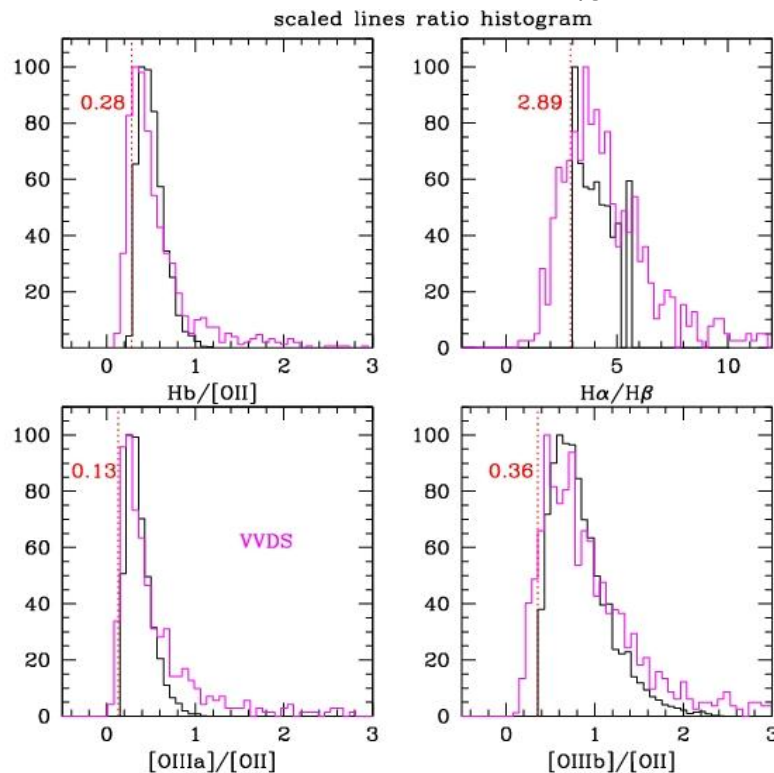
COSMOS Mock Catalog (CMC) : Spectro-validation

Emission line prediction :

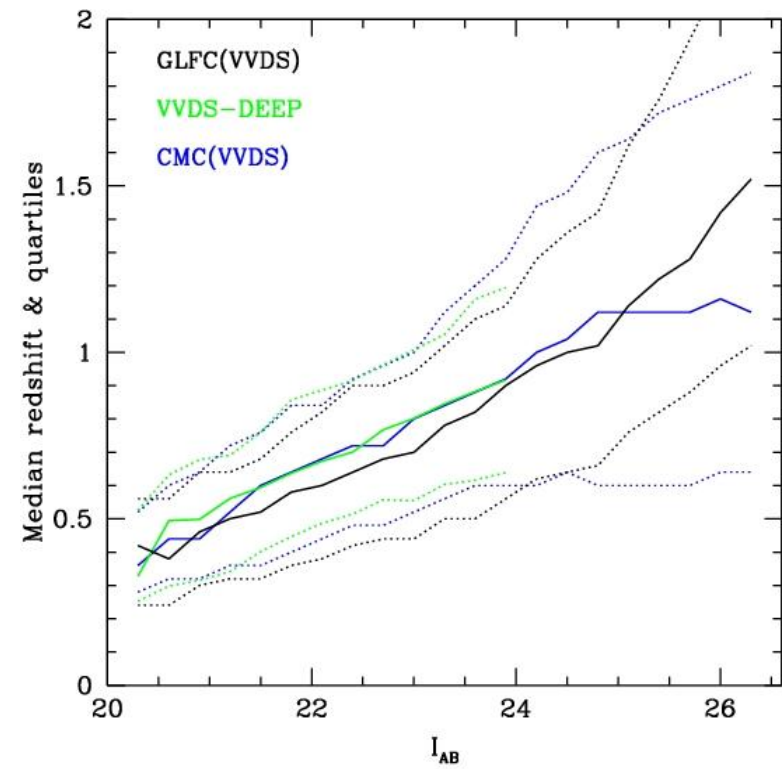
Kennicutt et al. 1998 :

UV-OII relation

$$\log[\text{OII}] = -0.4M_{UV} + 10.57 \frac{DM(z)}{2.5}$$

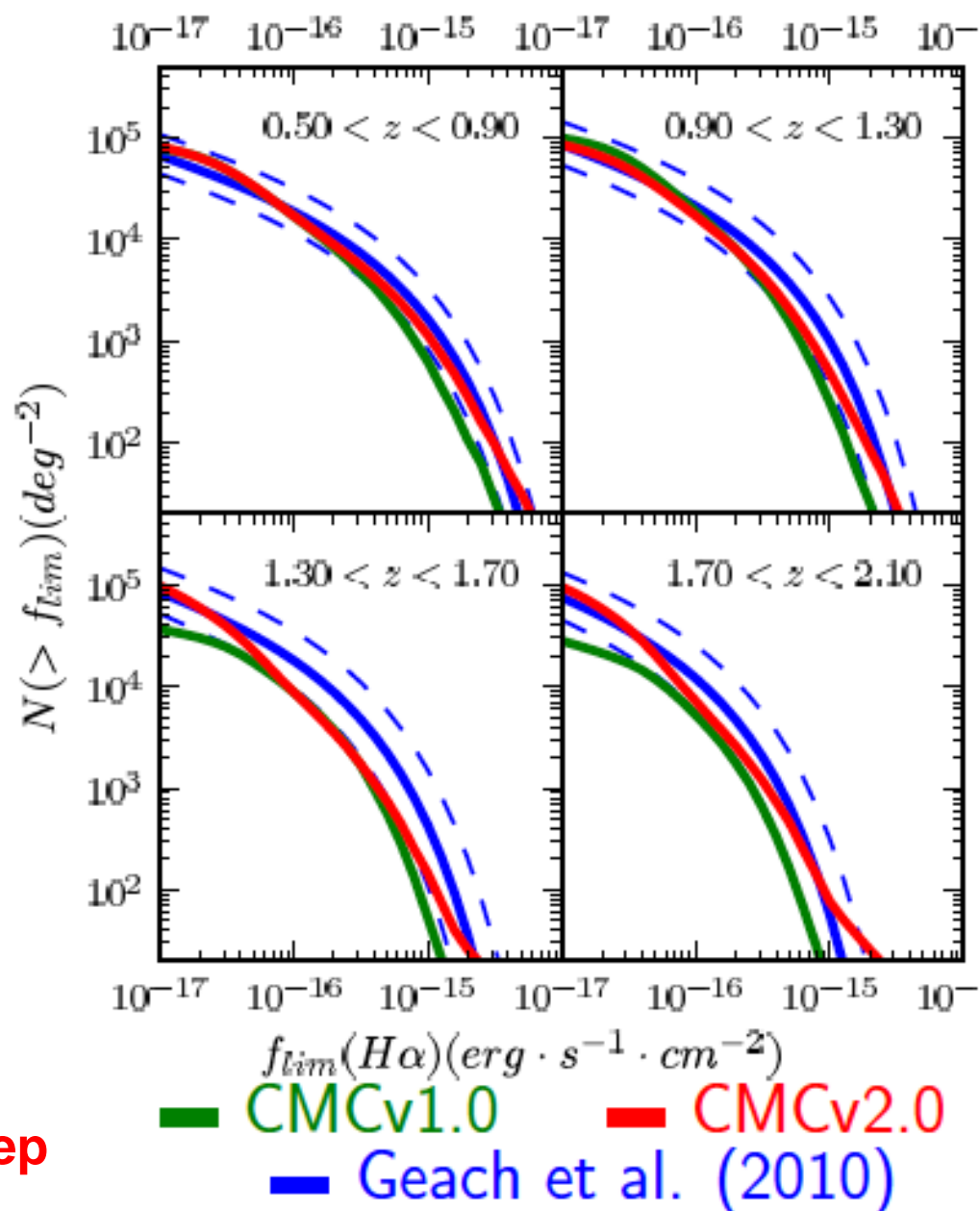
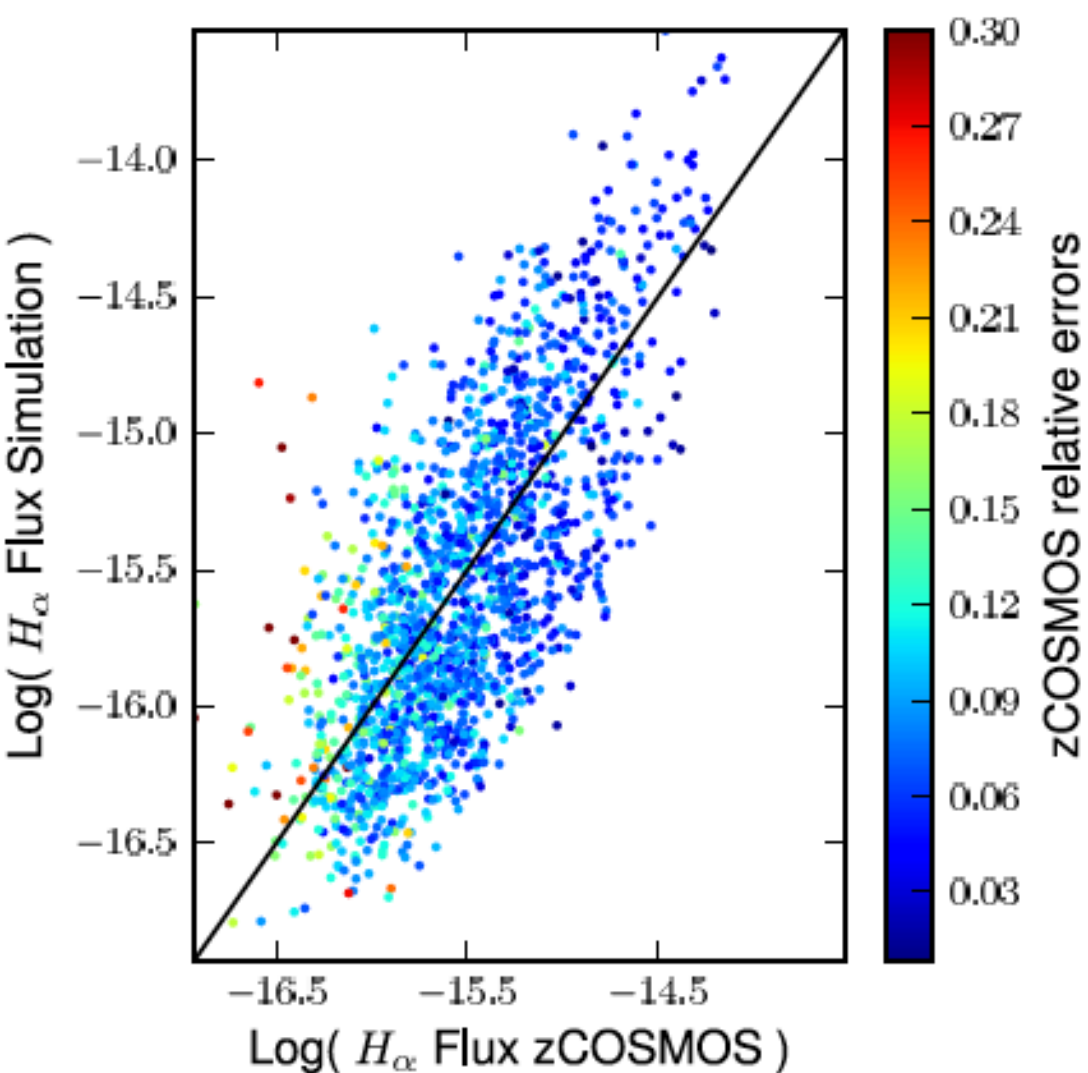


Validation of the redshift distribution and emission line fluxes using the VVDS-DEEP I~24 AB (Lamareille et al 2008)



Jouvel et al. 2009

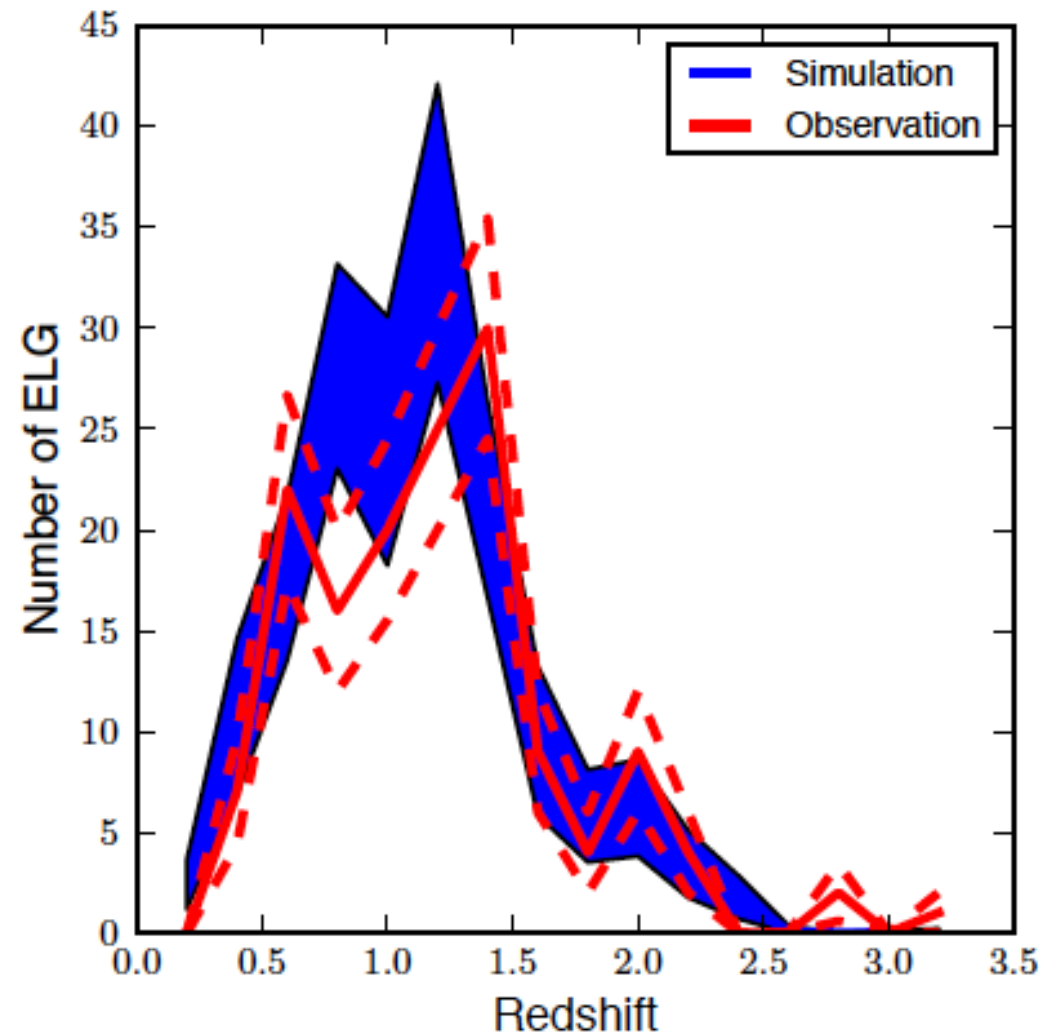
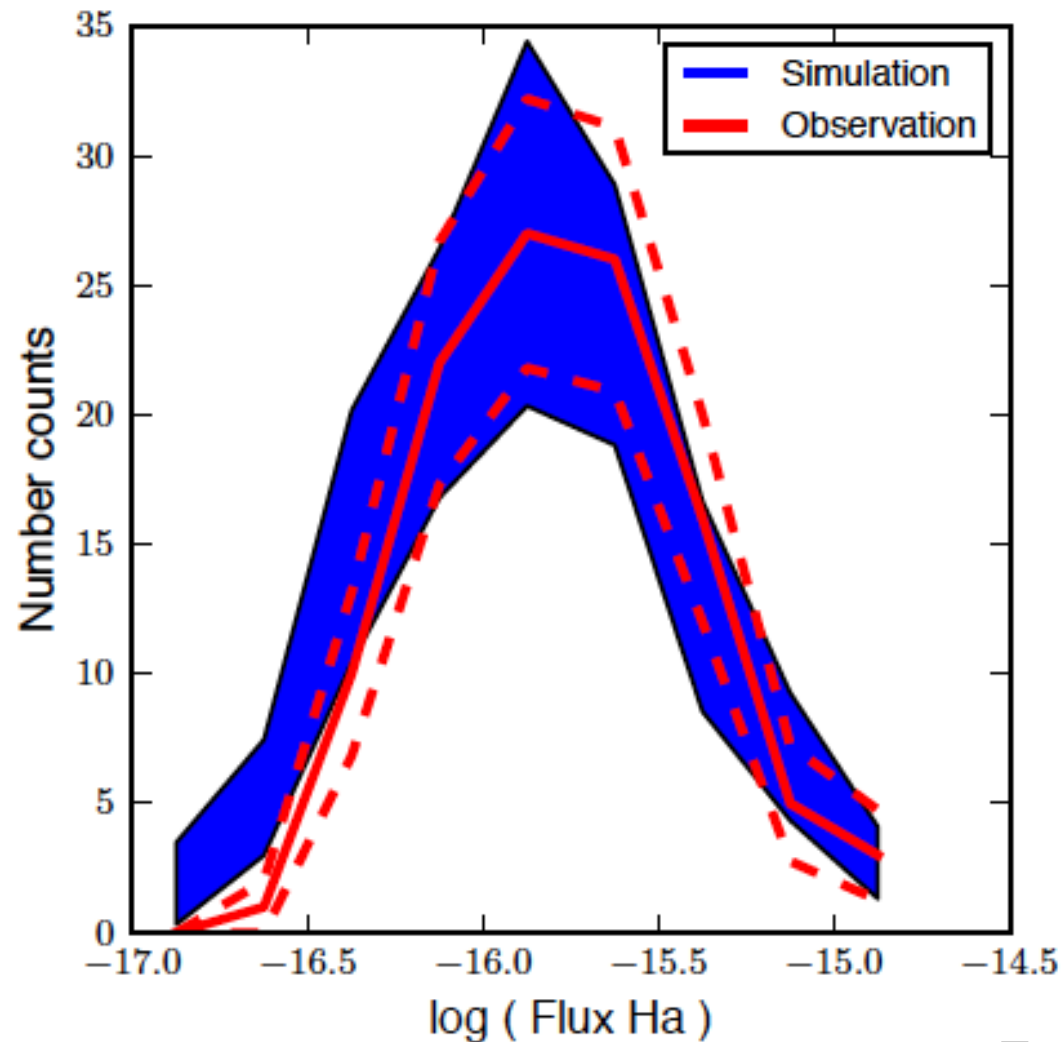
Calibration result for H_α lines



Zoubian, Jouvel, Kneib et al 2012 in prep

COSMOS Mock Catalog (CMC) : Validation

WISP Simulation Results



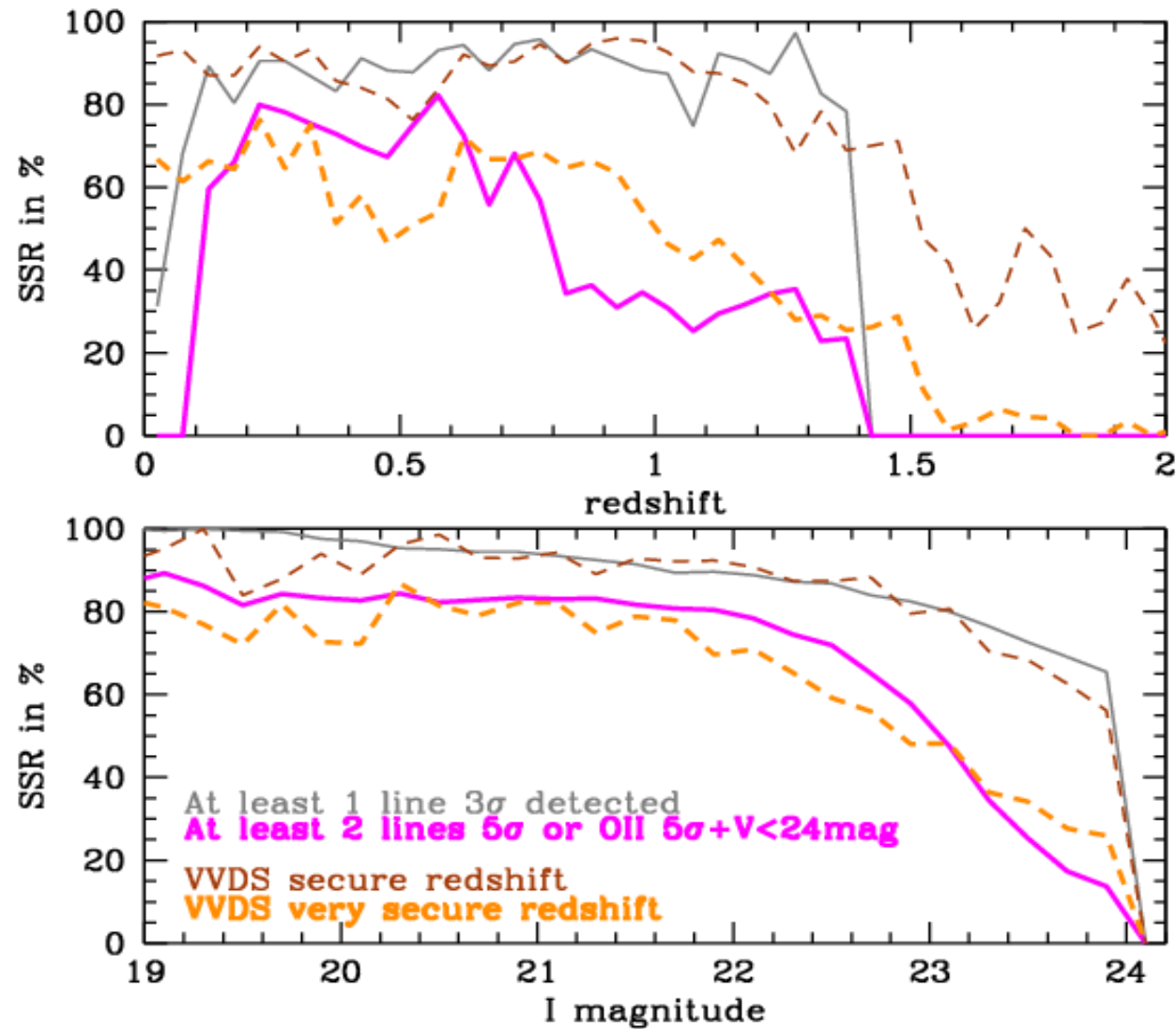
Zoubian, Jouvel, Kneib et al 2012 in prep

Spectroscopic Success Rate (SSR) : Validation using VVDS

SSR : galaxy rate
for which we will be
able to measure a
redshift

Validation :
reproducing
the VVDS SSR

Jouvel et al. 2009

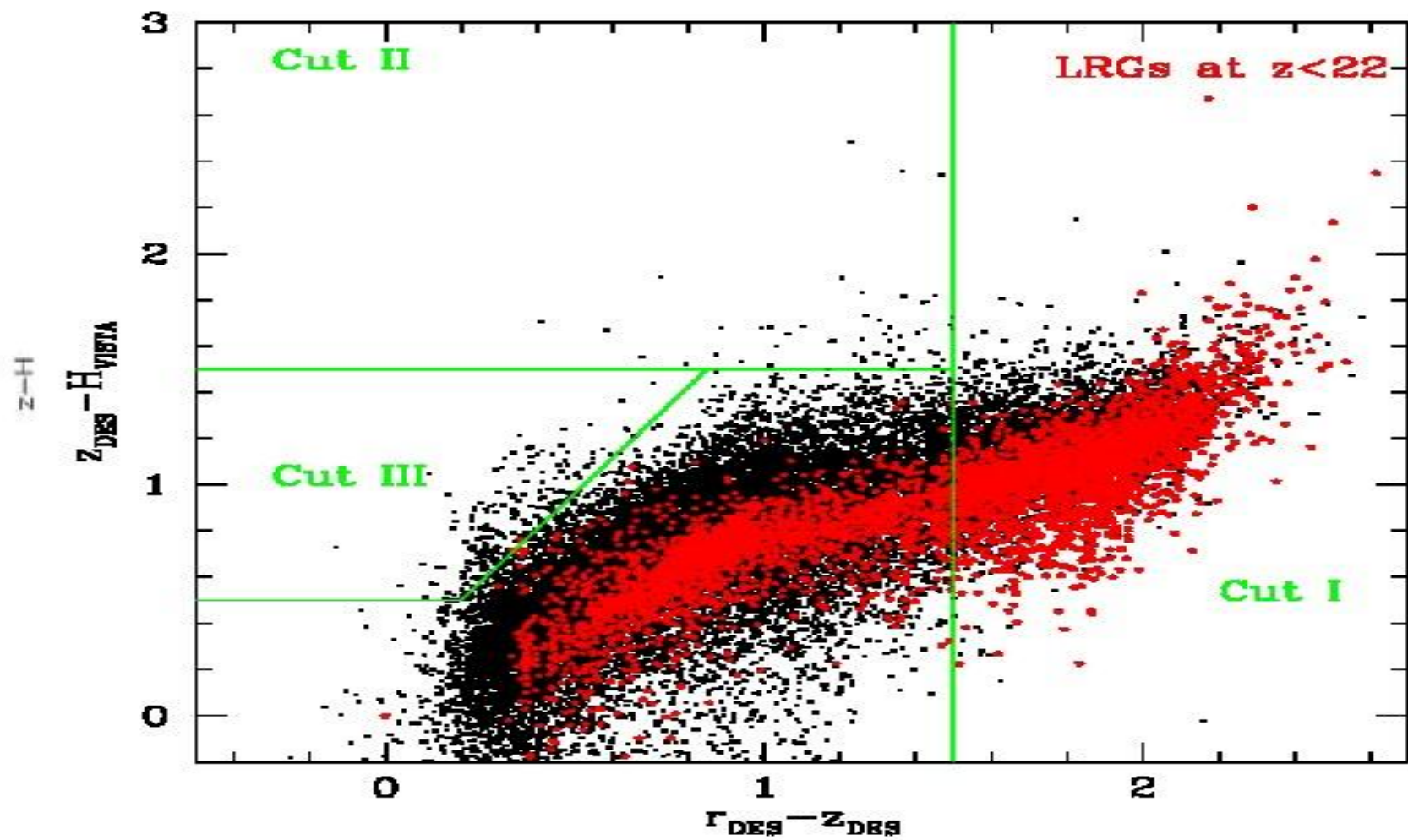


Outline:

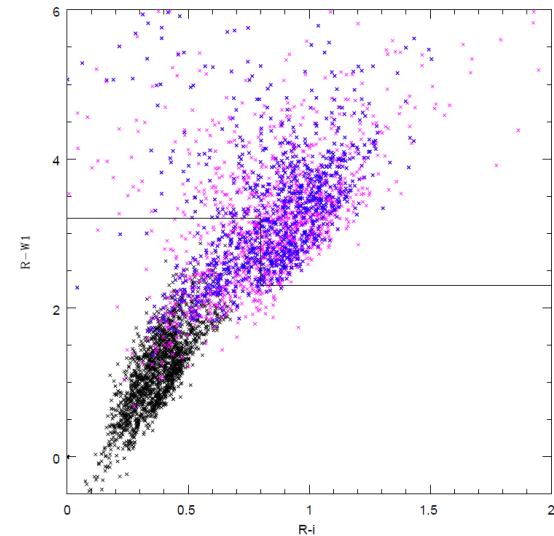
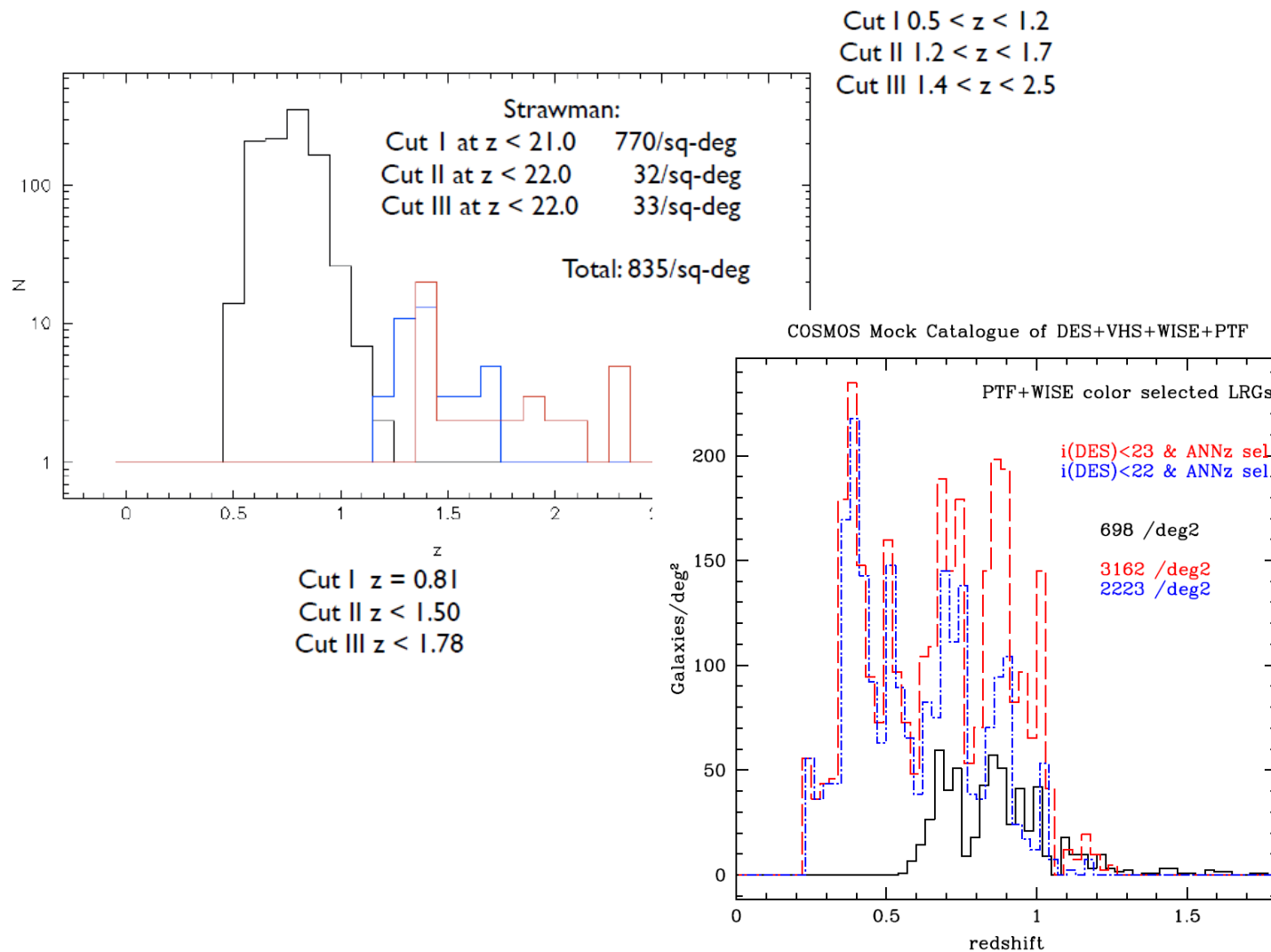
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LRGs target selection

LRG target selection

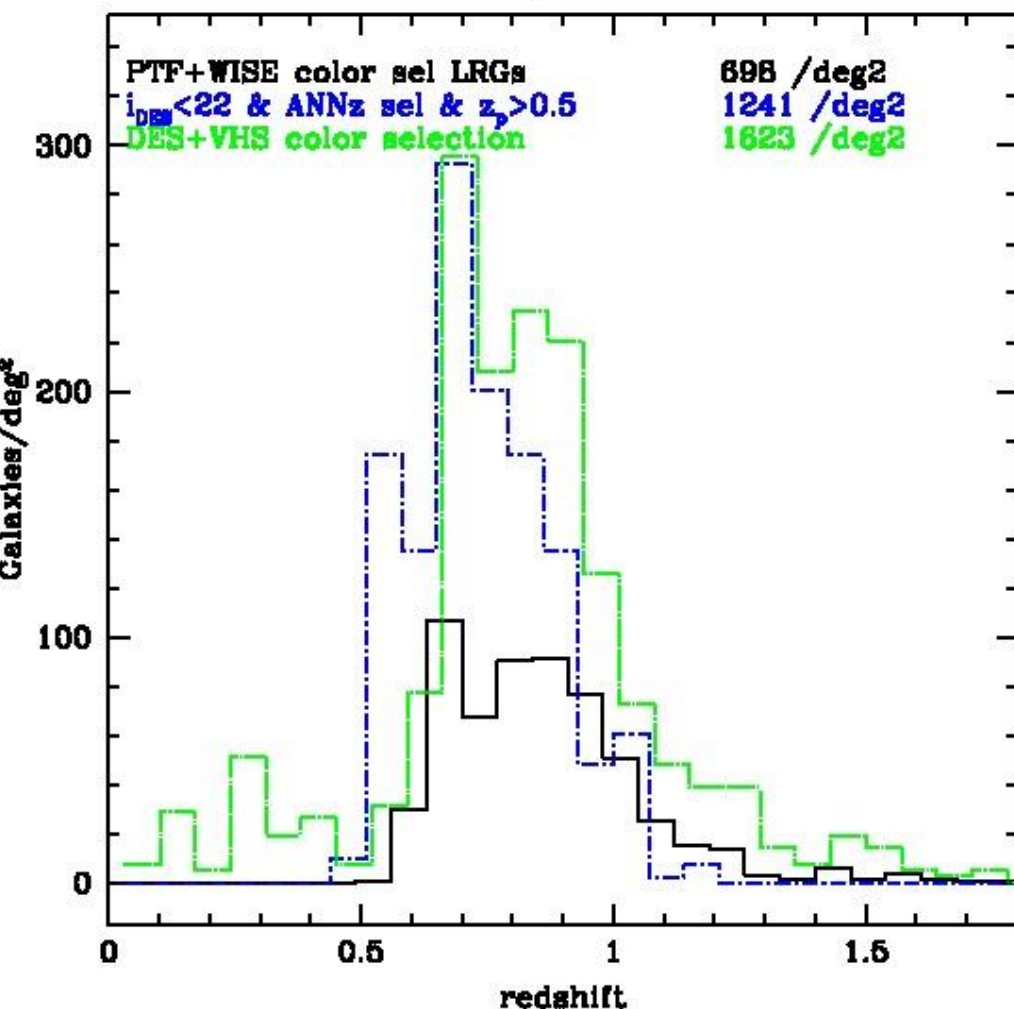


Strawman LRG target selection vs WISE vs full ANN selection.

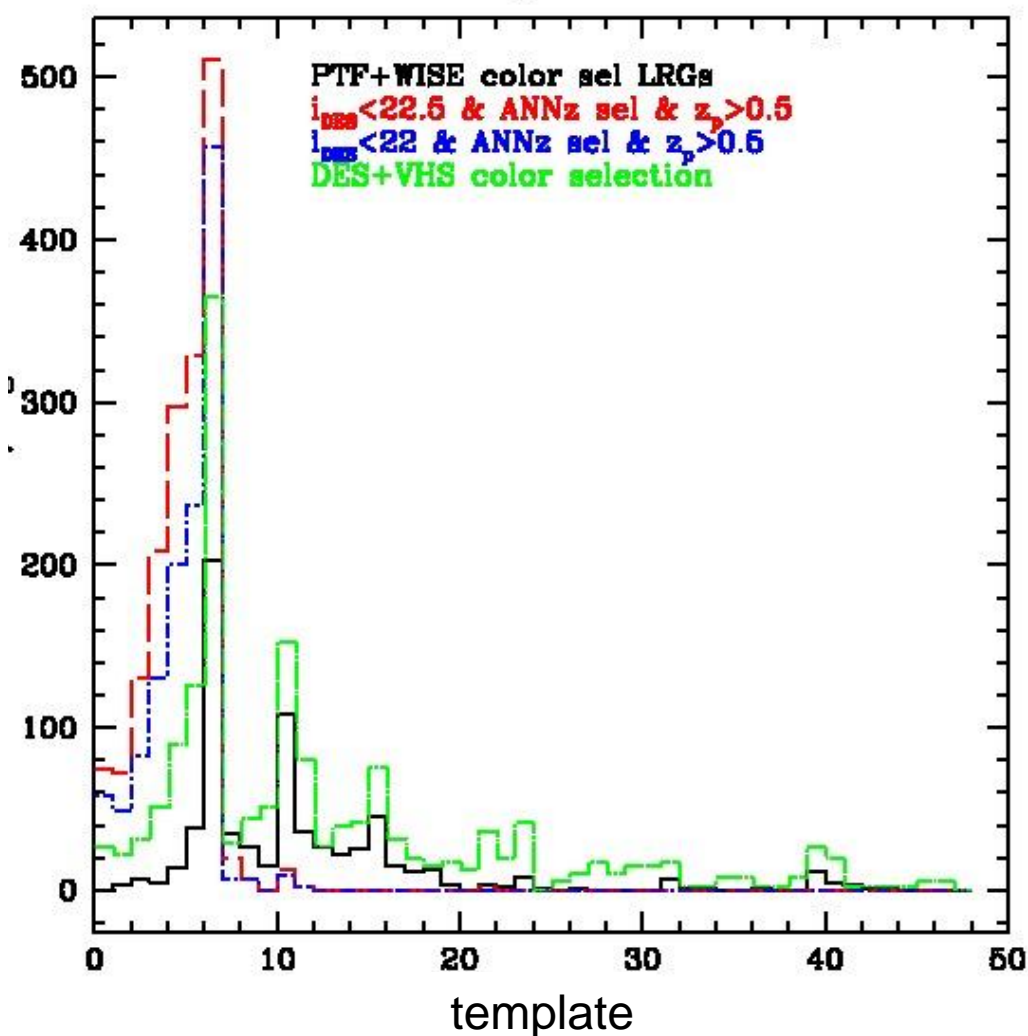


Use of NN to select LRGs : Color-color vs NN selection

COSMOS Mock Catalogue of DES+VHS+WISE+PTF



COSMOS Mock Catalogue of DES+VHS+WISE+PTF

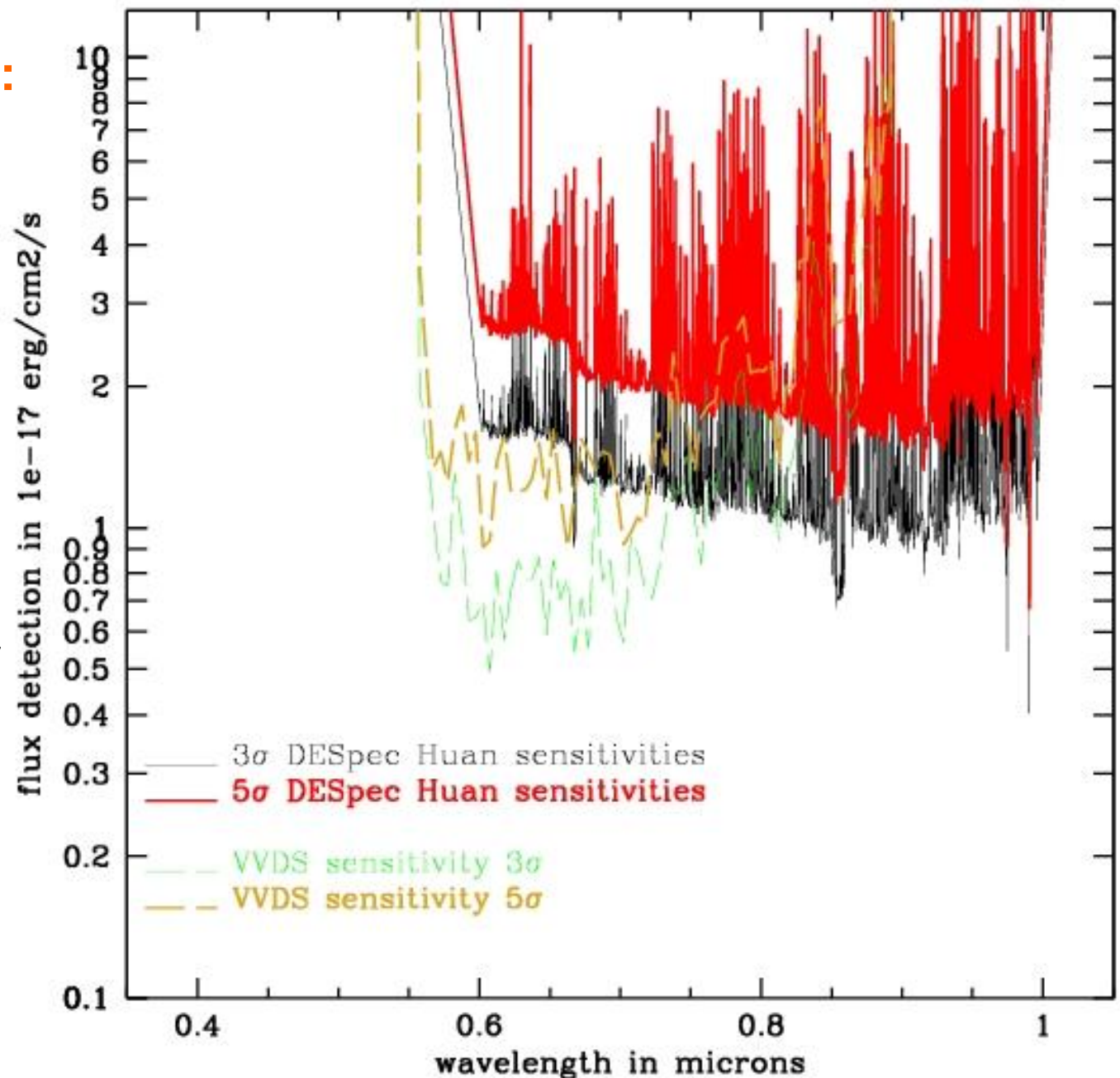


ELGs target selection

Sensitivities from 0.6-1 μ m (H. Lin)

How do we select ELG:

- 30 mins exposure time on 2 arcsec ϕ fibers (70% light fraction)
- Resolution $R=2500$ at 0.9 μ m.
- Calculation include DES throughput + sky noise and atmospheric lines from Hanuschik (2003)



Use of NN to select em line galaxies

We assign a value of :

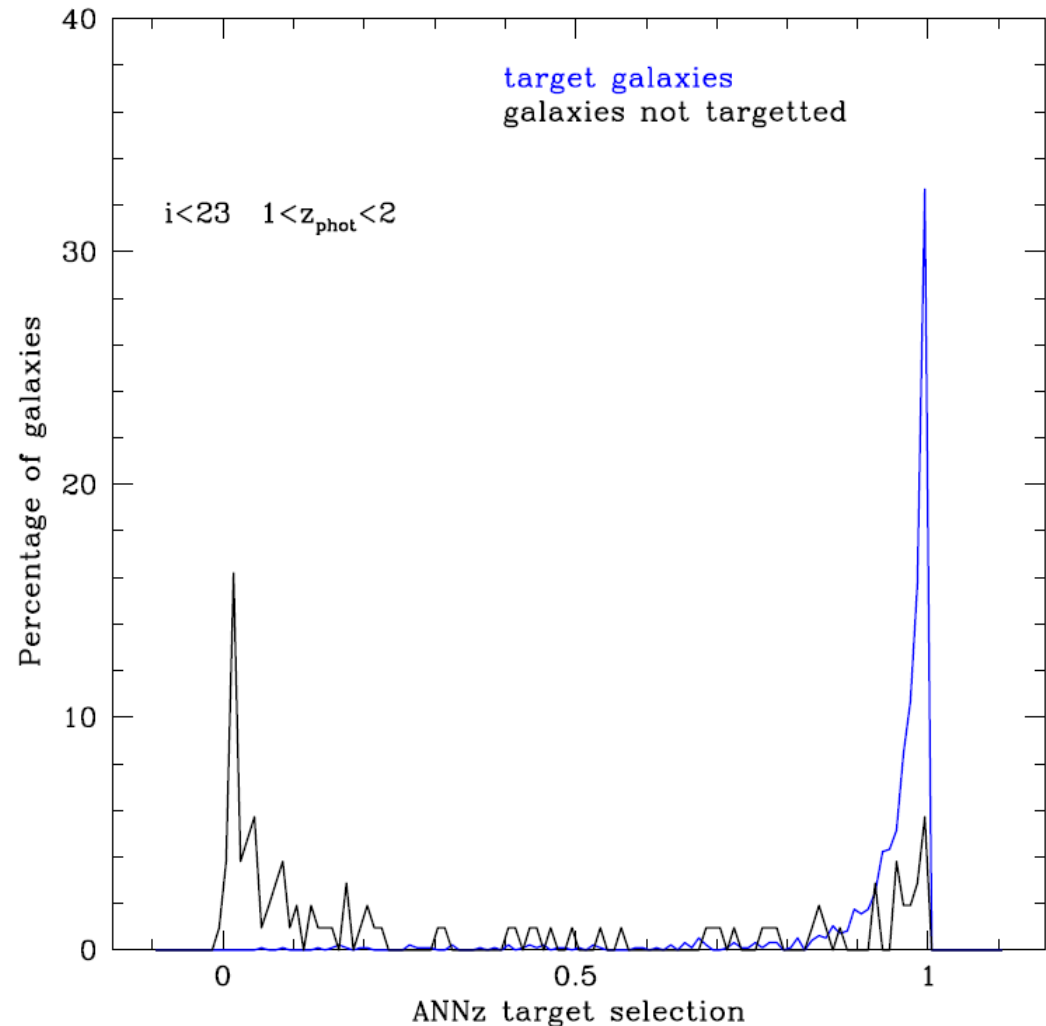
- 1 for targetted ELG
- 0 for non targetted galaxies

We then use ANNz and train a NN on a sample of 10000 galaxies from the CMC (DES+VISTA)

Results for $i(\text{DES}) < 23...$

Using Huan Lin sensitivities
cut between 0.6-1um

How well ANNz can select galaxies to target from photometry :



Which ANNz selection criterion ?

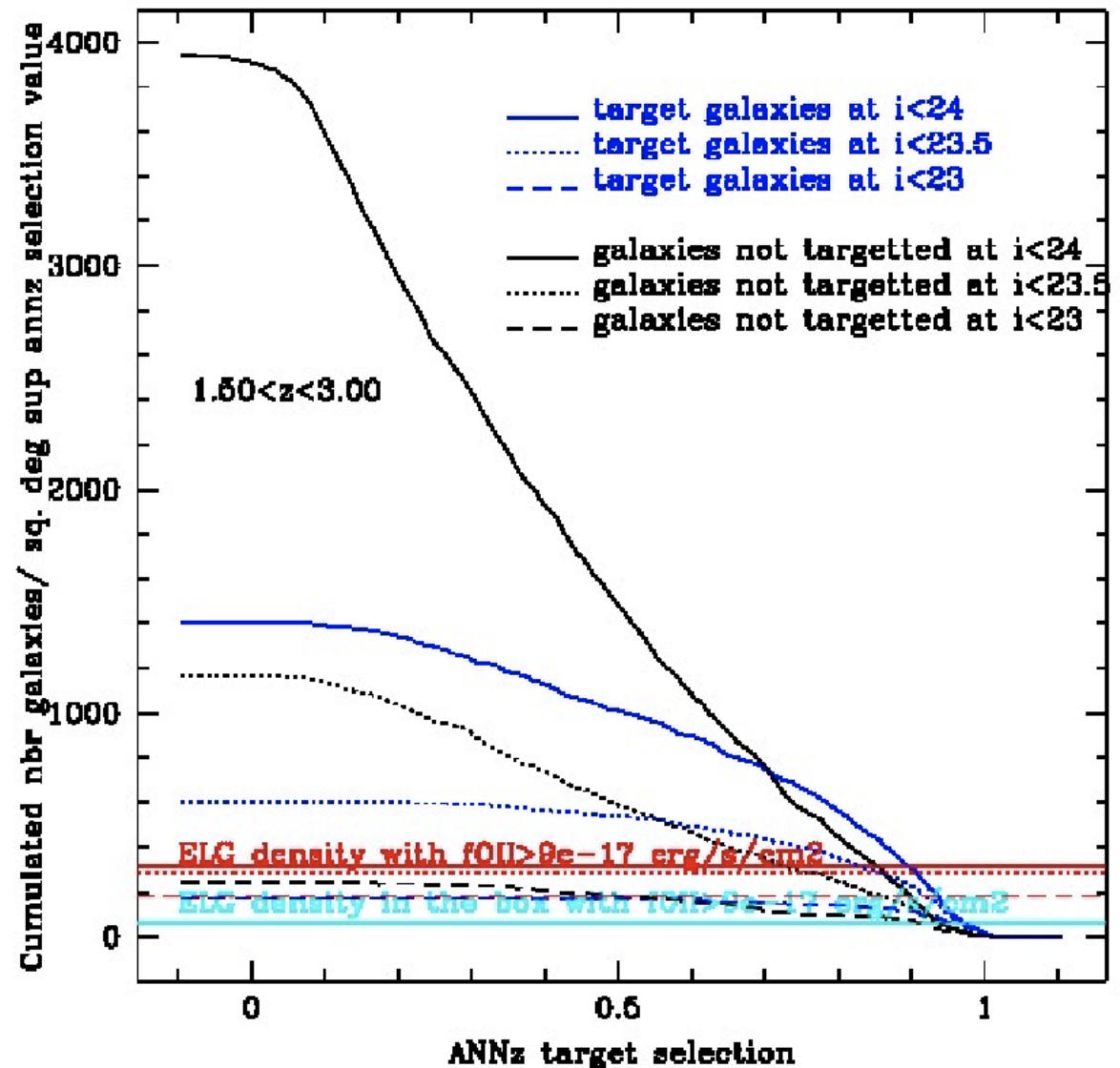
How well ANNz can select galaxies to target from photometry :

Fig : Cumulative nb galaxies/deg² fct ANNz target probability

$1.5 < \text{photoz} < 3$

ANNz sel > 0.8
allows to get most of the
high-redshift galaxies at
 $i < 23.5$

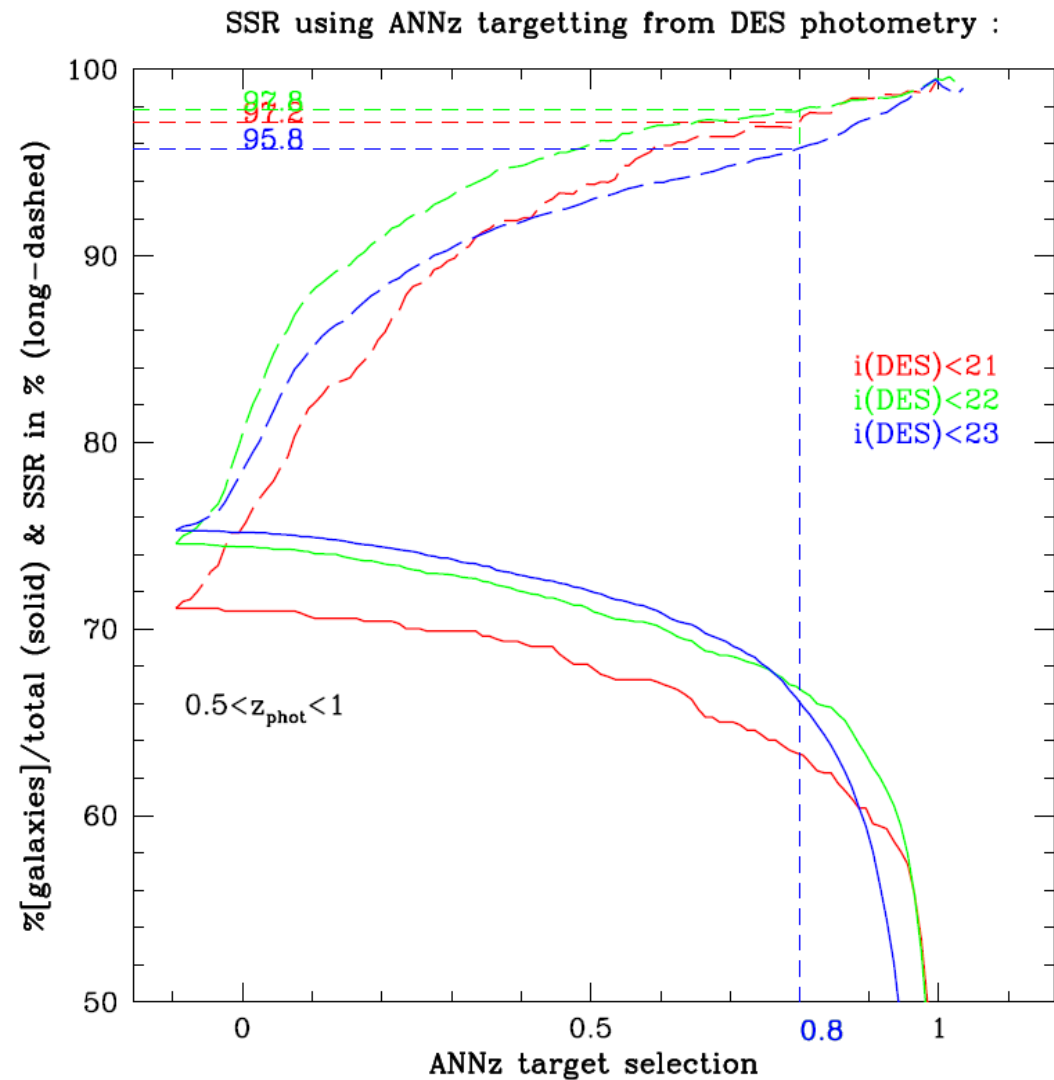
Using sensitivities cut
between 0.6-1 μm



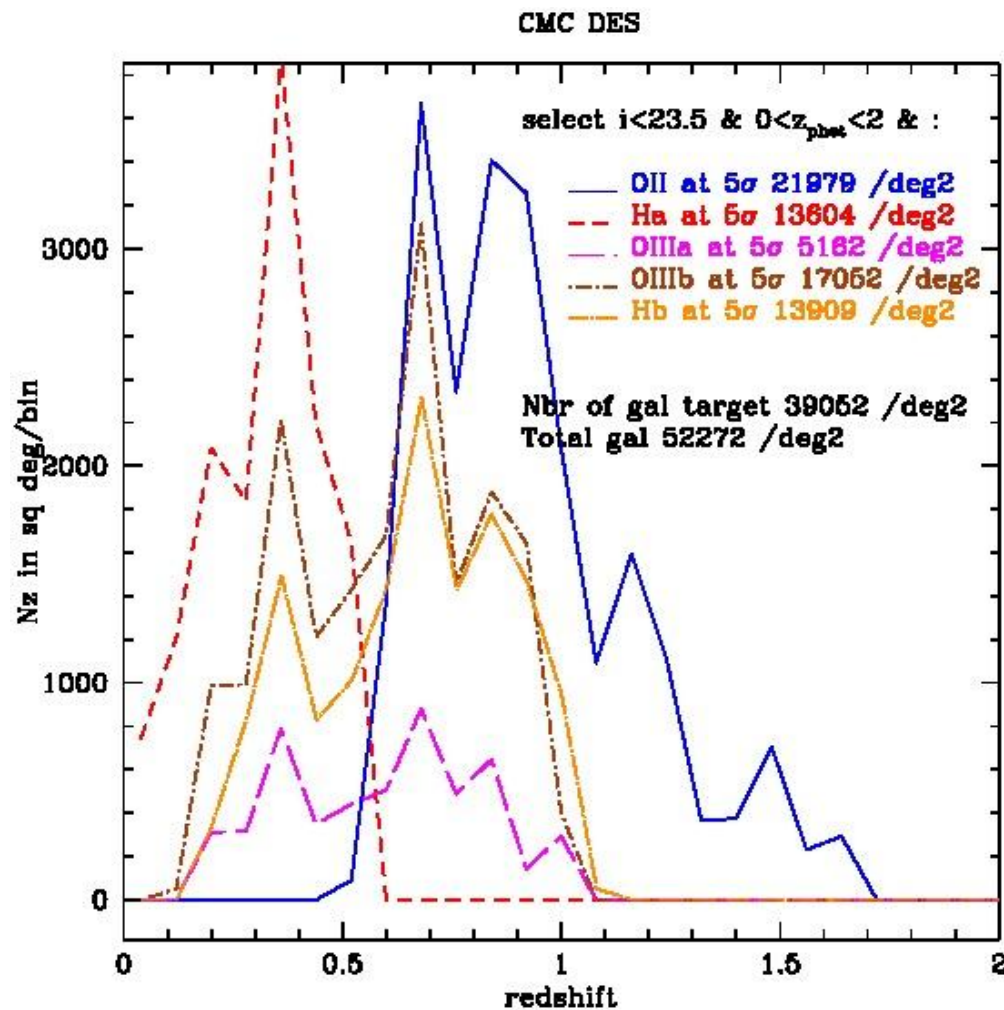
Which ANNz selection criterion ?

Solid : percentage of galaxies for which we will measure a redshift/total nbr gal & Dashed : SSR fct ANNz target probability

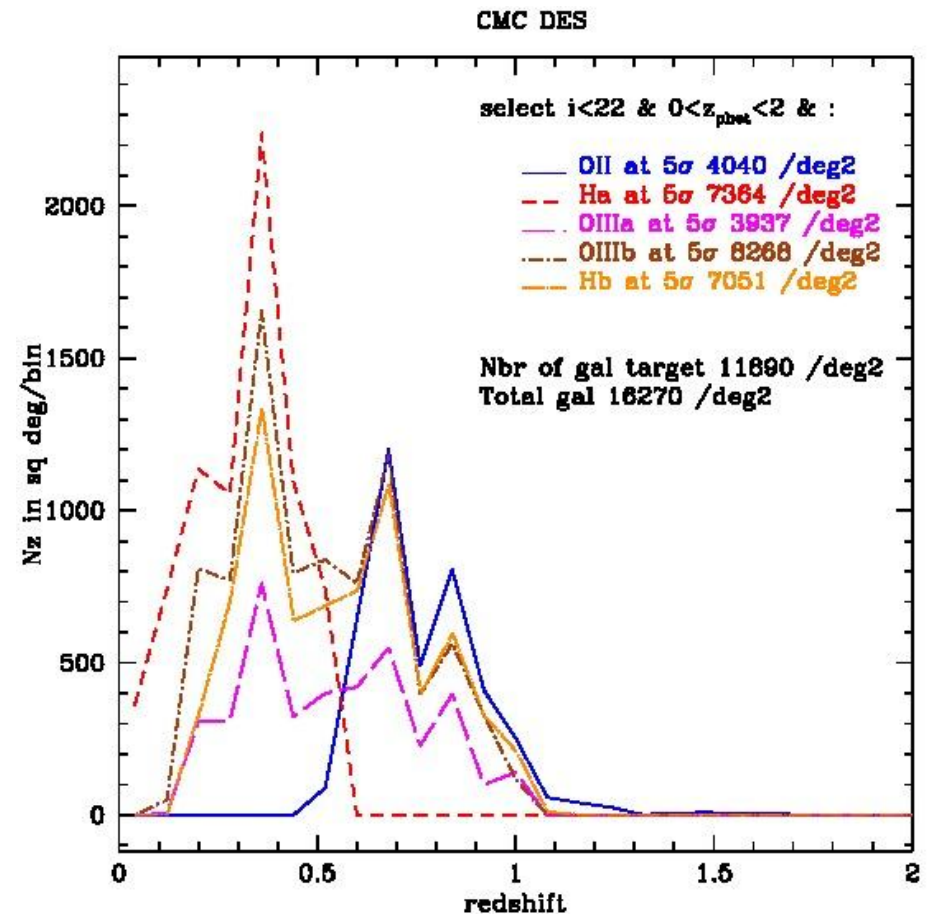
At ANNz sel>0.8 you will target about 66% of galaxies at $i<23$ in the photoz range for which you'll measure a redshift for 95.8% of the targets



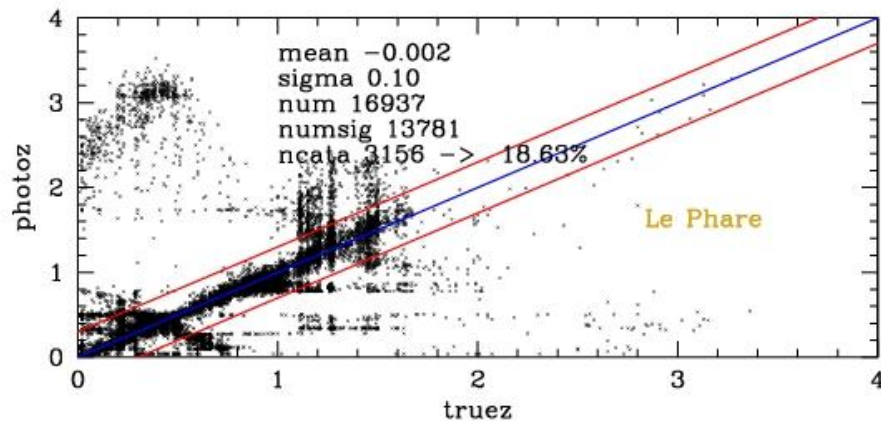
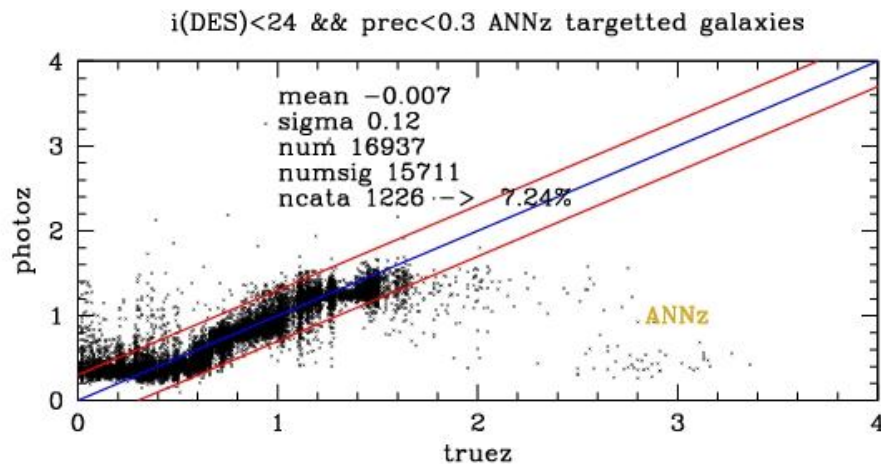
Redshift distribution / em lines gal



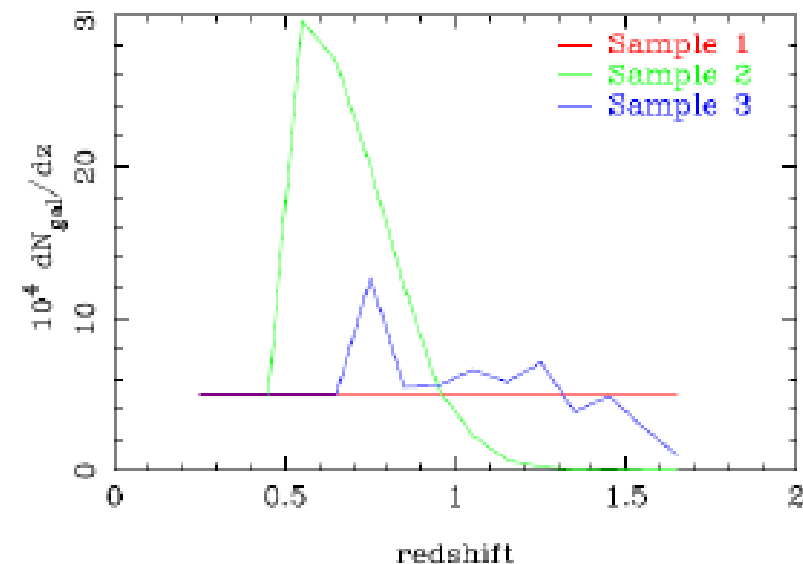
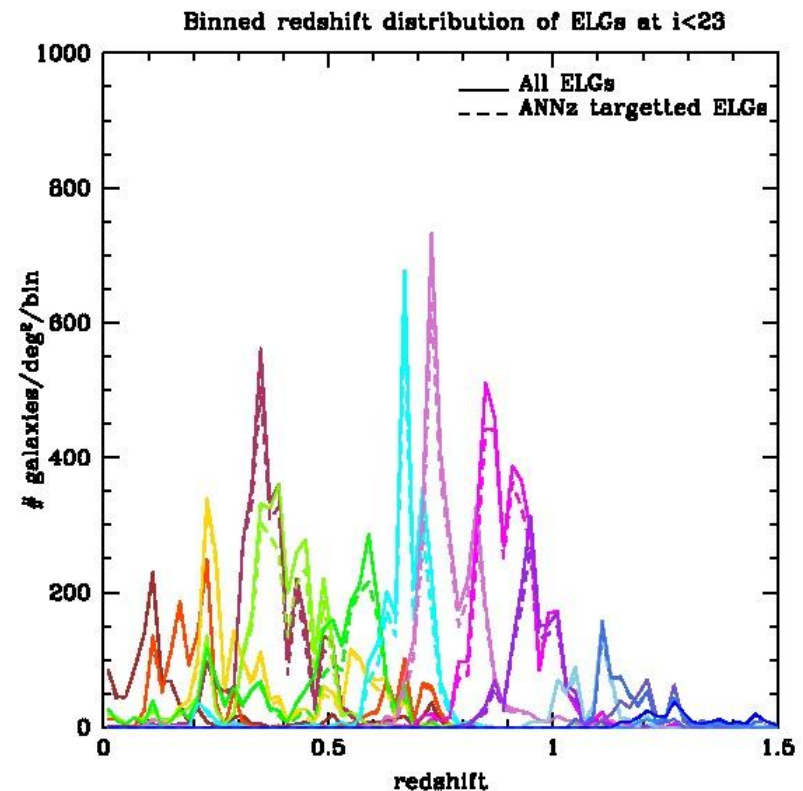
Redshift will be measured with OII mainly for a 0.6 to 1um spectrograph



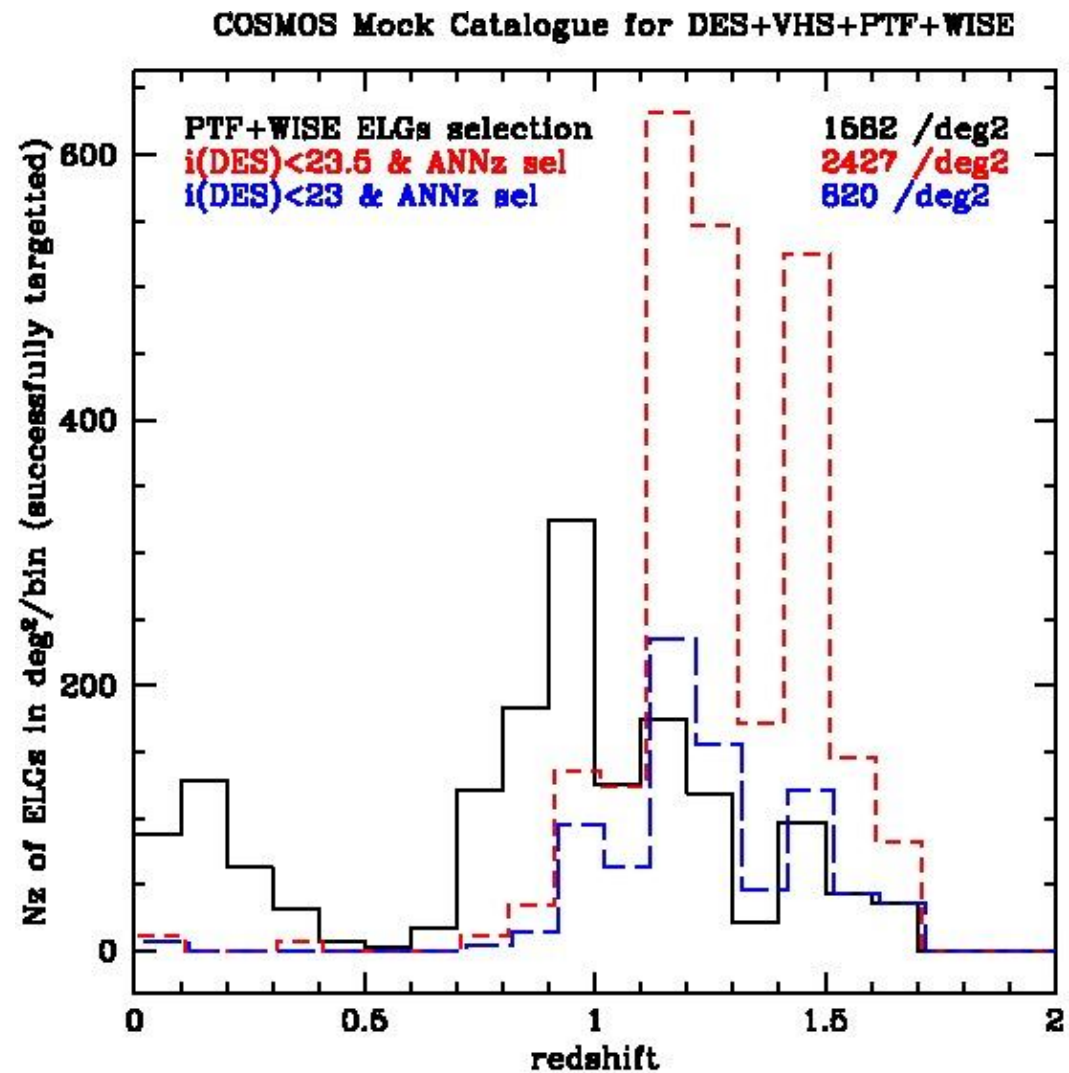
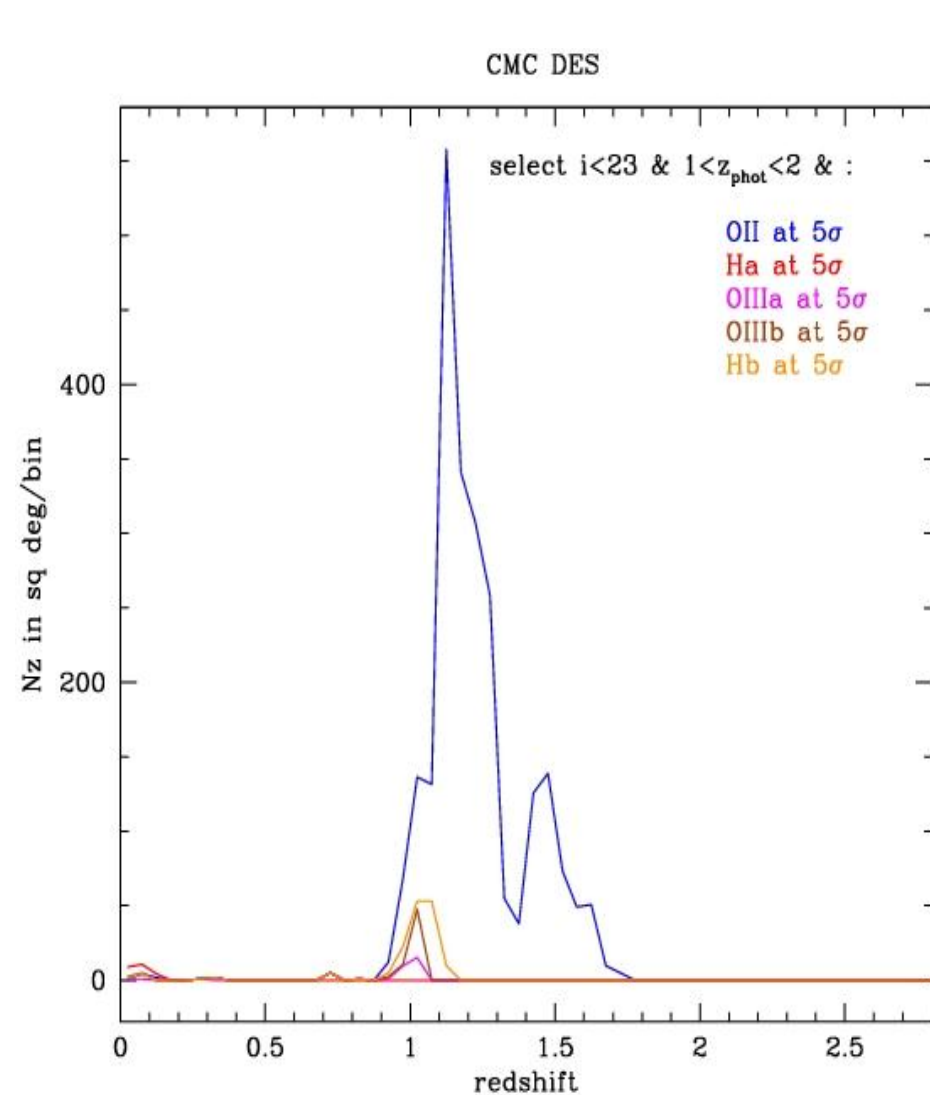
Target selection



We will select galaxies based on their photoz and ANNz target selection



ELG target selection : Color-color vs NN selection

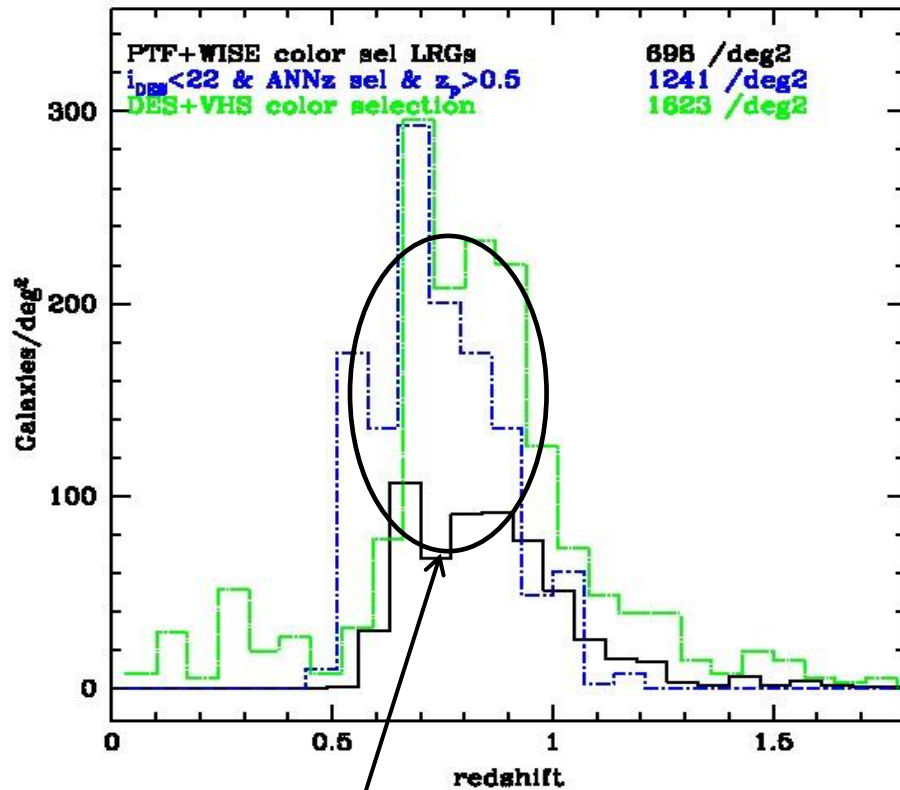


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Final target selection:

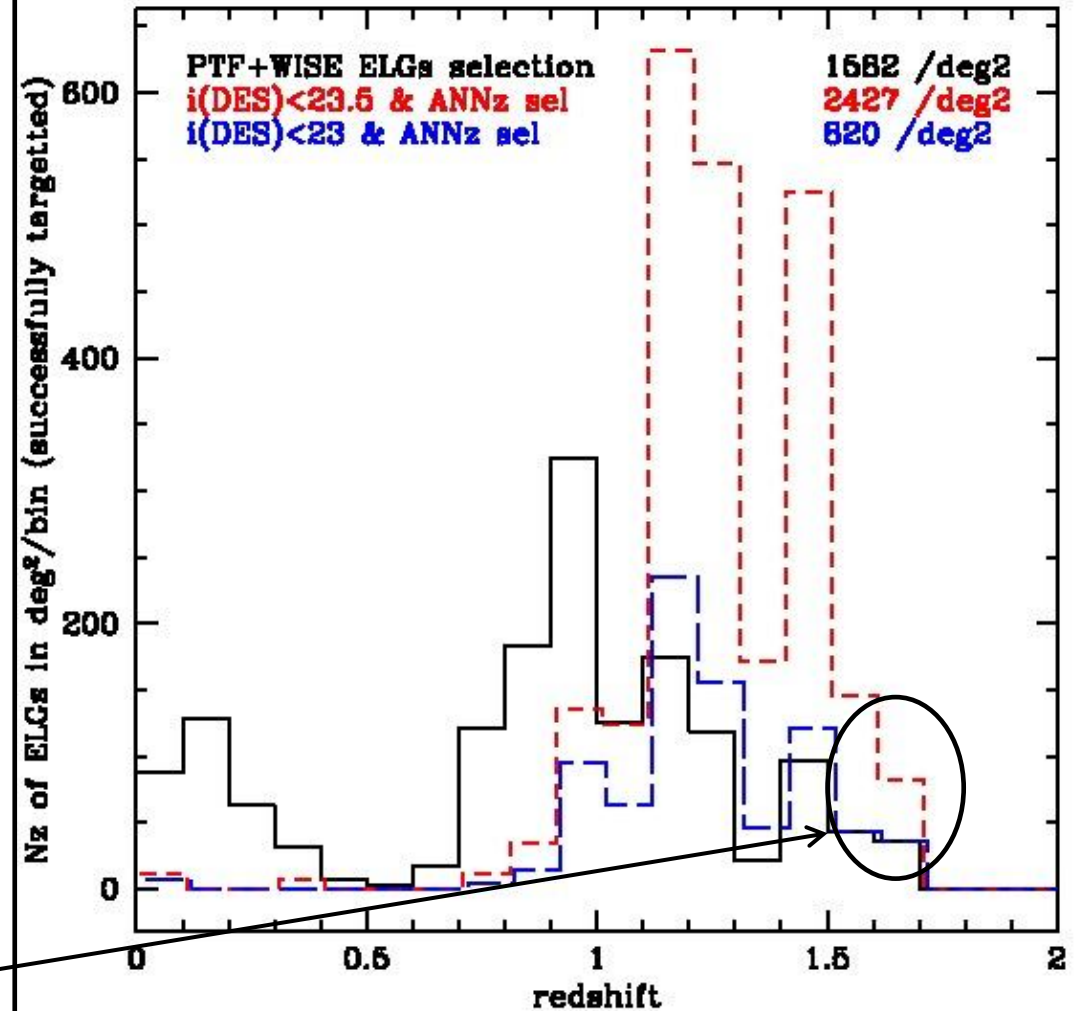
COSMOS Mock Catalogue of DES+VHS+WISE+PTF



High number density for bias cross-corr at $z \sim 0.7$

Number density to be shot noise limited is around 80 per sq deg in a 0.1 z bin

COSMOS Mock Catalogue for DES+VHS+PTF+WISE



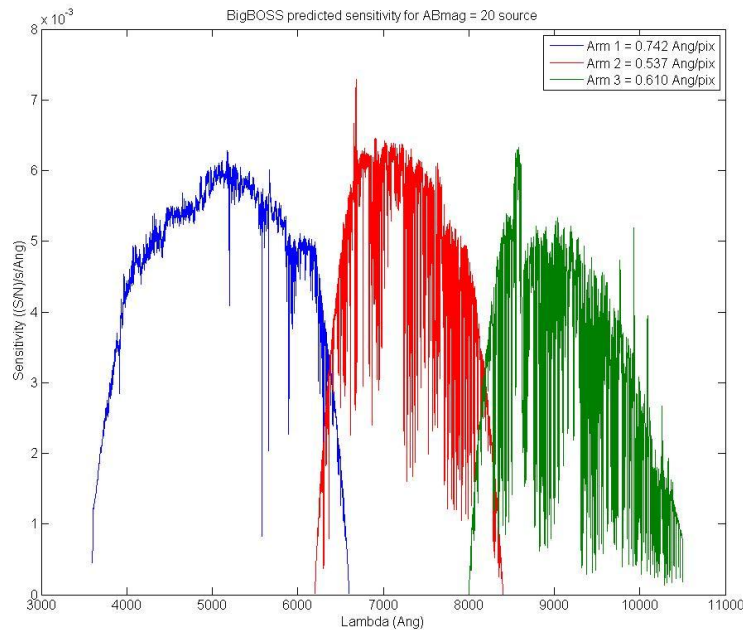
Mock surveys from Donnacha's talk:

- Assume ~300 nights, 4000 fibres over 3deg²
Scenario 1: 5000 deg², 33% LRG 67%ELG
Scenario 2: 7500 deg², 25% LRG 75%ELG
Scenario 3: 7500 deg², 50% LRG 50%ELG
Scenario 4: 15000 deg², 67% LRG 33%ELG
Scenario 5: 15000 deg², 33% LRG 67%ELG
- 300 nights at ~7 hours a night inc eff. ~30 mins exposure => ~4200 pointings * 4000 fibers = ~16.8M targetted galaxies. Times eff to get final no of gals.
- Scenario 1 requires target density of ~3000 per sqdeg.
- Scenarios 2 & 3 ~ 2000 per sq deg
- Scenarios 4 & 5 ~ 1000 per sq deg. ->
- We can do all, now optimise this...!

Target selection pipeline:

- Production of a mock catalogue:
 - Colours and spectra
- Production of sensitivity curves
- Production of redshift success rate from the spectrum for each simulated galaxy.
- Production of an algorithm for selection
 - Investigation of impact of this algorithm
- Allocation efficiency from fiber positioner
- Allocation efficiency from a real pointing strategy
- Link with FOM for the given $n(z)$

Realistic spectroscopic simulation: Done for BigBoss, tbd for DESspec (Oli Coles)

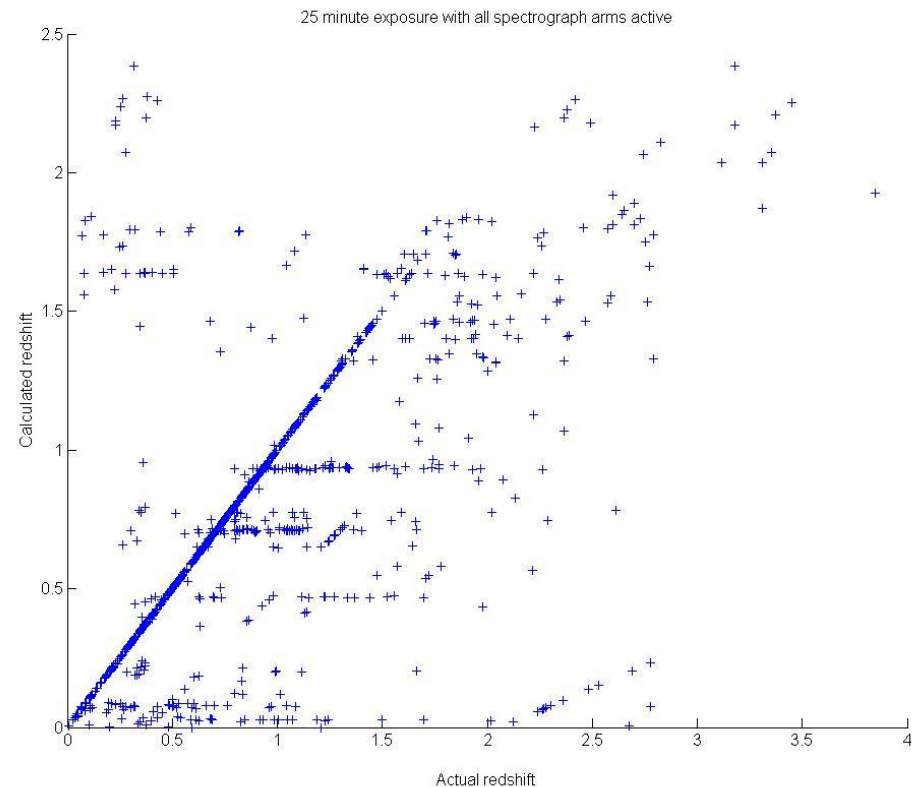


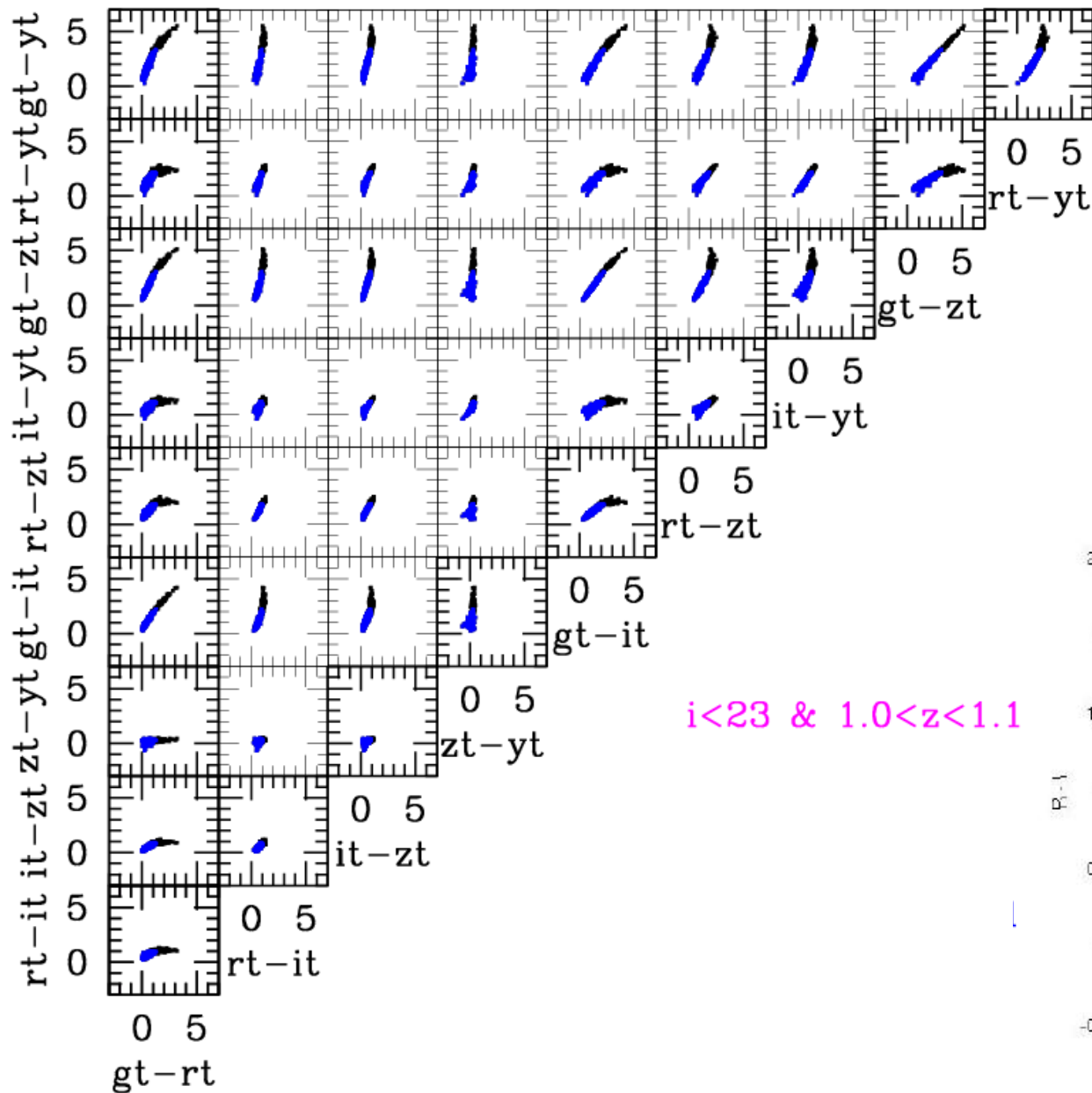
Simulation does with PCA cross correlation

Each point is one of the simulated galaxies
from the CMC

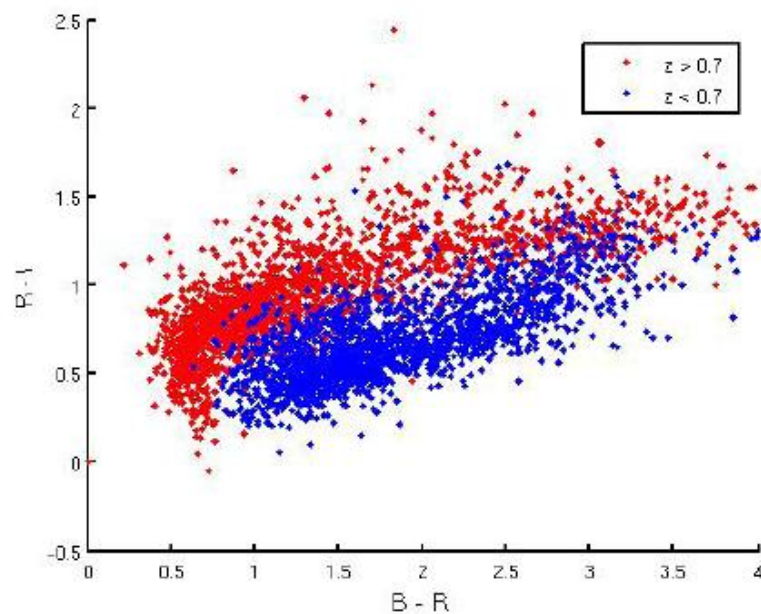
Outliers are misidentification of lines.

Could use a photo-z prior to improve.
 $p(z_0) = p(z_{\text{spec}}) * p(z_{\text{phot}}) * p(\text{EW})$





Colours and ANNz



Conclusion

Quick run through the science motivation -> how it might affect the target selection, i.e. RSD's BAO's $P(k)$.

Quick outline of the survey strategy taken by the many other WG looking into future spec surveys.

Outline of the work done for the white paper with some comparisons with the other original strategies.

mocks & instrument & strategy & etc...

Outline of the other needed steps.