Photometric Redshift, Stellar Mass and Star Formation Rate from MDS data

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With the help of:
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KP12-TW team

OUTLINE

- Photometric redshifts in MDS
- Physical parameters
- SFR - stellar mass relation

Photoz codes

- Importance of getting good photozs
- Two family of codes:
  – Template fitting (SED)
  – Algorithm training/Machine learning (Empirical)
    - Supervised (need a training set)
    - Unsupervised (don't need any training set)
- All methods requires good photometry
  – ZP corrections ("*fine tuning*" – see Ilbert et al. 2006)
- Good spectroscopic sample (large and representative)
  – For SED: template training ("*fine tuning*" - see Ilbert again)
  – For Supervised Empirical: training set!!
  – For all: performance tests
- More in the discussion part? (Jim Heasley, IfA)

Catalogs and photoz

- Stacks MIT, catalogs Sextracted
- Photoz computed with EAZY (Brammer et al. 2008)
- Prior on redshift distribution at given i-band mag. from SAM (Guo et al. 2011)
- ZP corrections applied (weak for *grizy*, large for *u*)
- Different set of templates: PEGASE13 (SSP), CFHTLS (empirical)
- Different seeing: *grizy* >1", *u* <0.9" (PSF matching?)
- Magnitude used: `ISO_MAG_i-AUTO_MAG_i=corr`
  - *grizy* : `MAG=AUTO_MAG+corr`
  - *u* : `MAG_AUTO`

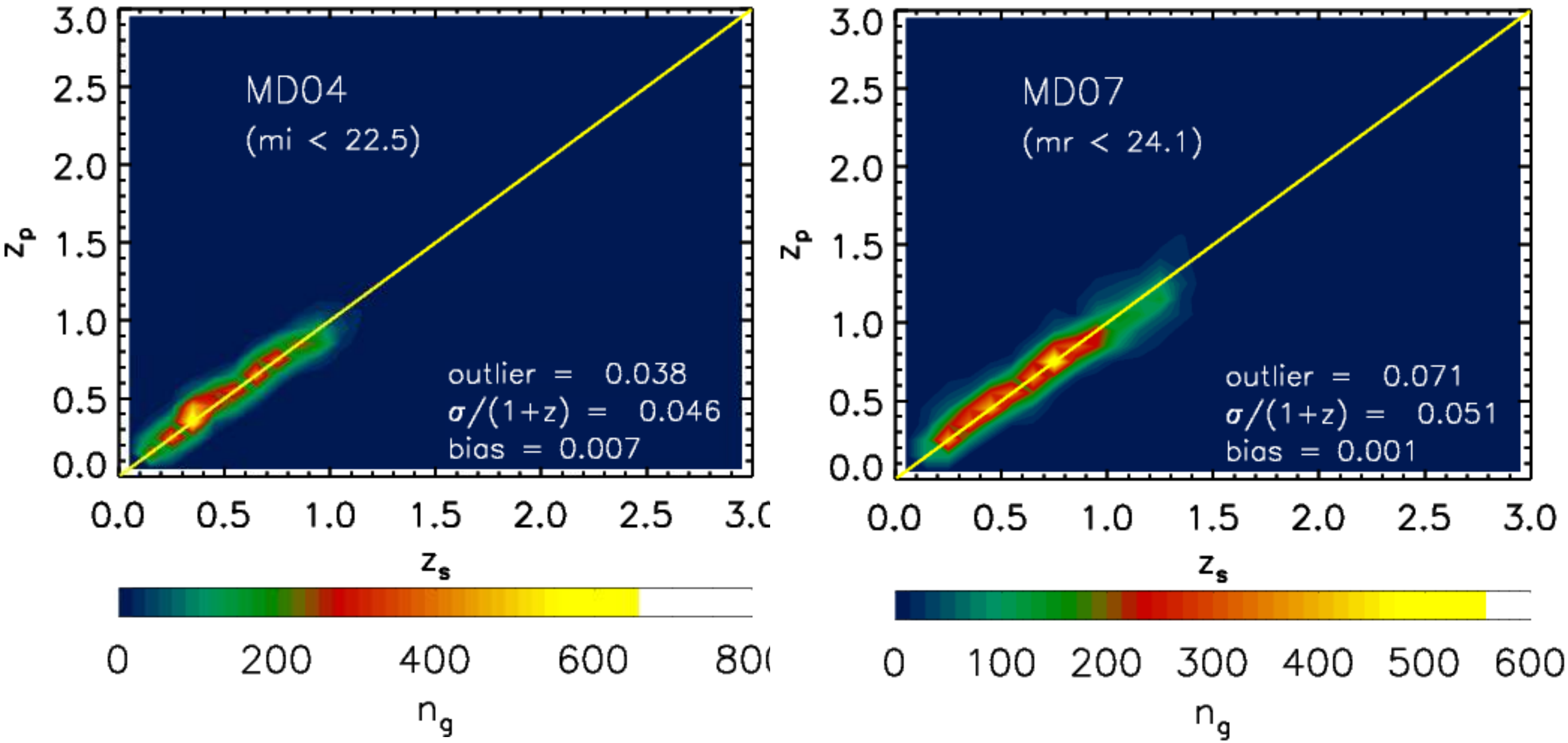
Depths of MD stacks

	g	r	i	z	y	u_{CFHT}
MD03$_{IPP_GR}$ (exptime/s)	25.060±0.141 (14376)	24.919±0.116 (15097)	24.735±0.154 (27840)	24.186±0.132 (27480)	22.844±0.209 (25200)	N/A
MD03$_{Seb_pre}$ (exptime/s)	24.704±0.087 ()	24.719±0.079 ()	24.644±0.067 ()	24.148±0.096 ()	22.642±0.132 ()	On Going
MD04$_{IPP_pre}$ (exptime/s)	25.035±0.197 (15944)	24.808±0.173 (15113)	24.649±0.142 (25920)	24.178±0.148 (25440)	22.749±0.190 (16140)	N/A
MD04$_{IPP_GR}$ (exptime/s)	25.069±0.239 (16719)	24.944±0.145 (17144)	24.684±0.165 (22080)	24.346±0.123 (26160)	22.759±0.237 (19920)	N/A
MD04$_{Seb_pre}$ (exptime/s)	24.875±0.067 (18080)	24.743±0.080 (17741)	24.611±0.068 (28800)	24.045±0.086 (25440)	22.205±0.110 (7680)	26.091±0.544 (191597)
MD05$_{IPP_GR}$ (exptime/s)	25.045±0.168 (18297)	24.870±0.147 (14381)	24.706±0.173 (25920)	24.143±0.181 (26400)	22.842±0.194 (25320)	N/A
MD05$_{Seb_pre}$ (exptime/s)	24.603±0.090 (11752)	24.554±0.085 (11752)	24.425±0.080 (21120)	23.694±0.093 (11520)	22.346±0.110 (13440)	On Going
MD06$_{IPP_GR}$ (exptime/s)	25.081±0.190 (14383)	24.870±0.147 (14381)	24.706±0.173 (25920)	24.143±0.181 (26400)	22.842±0.194 (25320)	N/A
MD06$_{Seb_pre}$ (exptime/s)	24.698±0.117 (13447)	24.736±0.073 (14351)	24.753±0.101 (42000)	24.095±0.074 (25200)	22.926±0.114 (27840)	On Going
MD07$_{IPP_GR}$ (exptime/s)	25.014±0.259 (18700)	24.853±0.208 (16610)	24.710±0.209 (30240)	24.193±0.159 (30240)	22.797±0.196 (27300)	N/A
MD07$_{Seb_pre}$ (exptime/s)	24.982±0.166 (20792)	24.846±0.098 (19888)	24.812±0.099 (48000)	24.308±0.077 (45360)	23.103±0.126 (36480)	25.595±0.299 (142527) 25.678±0.273 (131064)
MD10$_{IPP_GR}$ (exptime/s)	24.872±0.096 (8948)	24.636±0.138 (8588)	24.563±0.159 (18000)	23.938±0.092 (17280)	22.603±0.162 (15120)	N/A
MD10$_{Seb_pre}$ (exptime/s)	24.612±0.092 ()	24.590±0.096 ()	24.667±0.095 ()	24.076 ±0.071 ()	22.483±0.101 ()	25.496±0.132 ()

Seeing of MD stacks

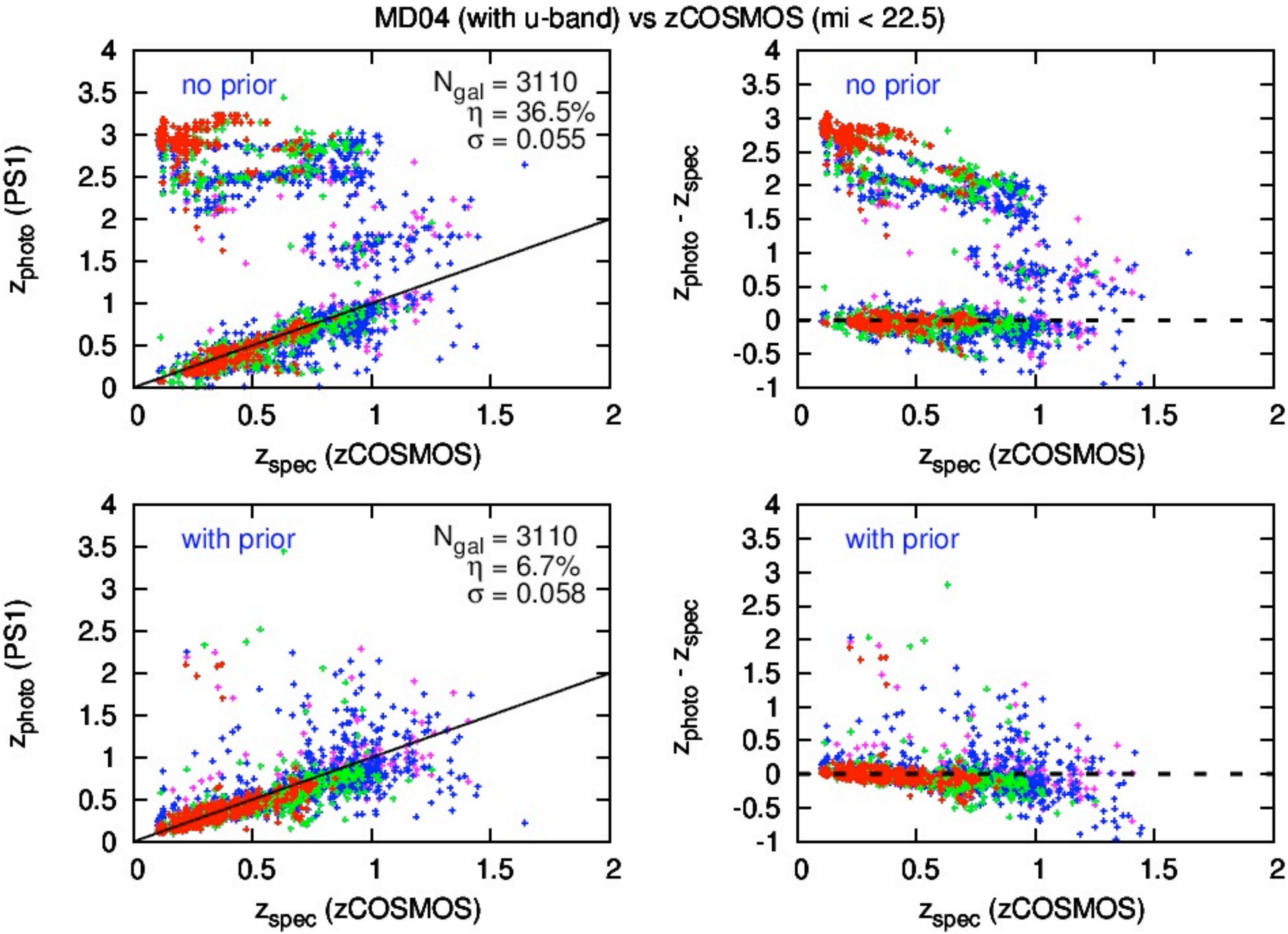
	g	r	i	z	y	uCFHT
$MD03_{IPP\_GR}$ (b/a)	1.02±0.04 (0.94±0.01)	0.95±0.04	0.91±0.03	0.84±0.03	0.90 ±0.04	N/A
$MD03_{Seb\_pre}$ (b/a)	1.19±0.04 (0.96±0.01)	1.03±0.04	1.02±0.04	0.92±0.04	1.09 ±0.04	On Going
$MD04_{IPP\_pre}$ (b/a)	1.10±0.06 (0.95±0.01)	1.03±0.04	1.01±0.07	0.95±0.04	0.90 ±0.07	N/A
$MD04_{IPP\_GR}$ (b/a)	1.06±0.04 (0.95±0.01)	0.98±0.04	0.92±0.04	0.92±0.04	0.93 ±0.04	N/A
$MD04_{Seb\_pre}$ (b/a)	1.20±0.04 (0.97±0.01)	1.08±0.04	1.02±0.06	1.01±0.03	1.08 ±0.06	0.85 ±0.04
$MD05_{IPP\_GR}$ (b/a)	1.10±0.06 (0.96±0.01)	1.03±0.04	0.93±0.03	0.87±0.03	0.90 ±0.04	N/A
$MD05_{Seb\_pre}$ (b/a)	1.20±0.04 (0.96±0.01)	1.07±0.04	1.08±0.04	0.91±0.04	1.21 ±0.07	On Going
$MD06_{IPP\_GR}$ (b/a)	1.07±0.04 (0.96±0.01)	0.98±0.04	0.90±0.04	0.87±0.04	0.85 ±0.04	N/A
$MD06_{Seb\_pre}$ (b/a)	1.18±0.09 (0.96±0.01)	1.05±0.06	1.03±0.03	0.95±0.04	1.02 ±0.04	On Going
$MD07_{IPP\_GR}$ (b/a)	1.07±0.04 (0.95±0.01)	0.97±0.04	0.93±0.04	0.90±0.06	0.82 ±0.07	N/A
$MD07_{Seb\_pre}$ (b/a)	1.13±0.04 (0.96±0.01)	1.01±0.06	1.08±0.04	1.02±0.03	0.95 ±0.04	0.88 ±0.10 0.86 ±0.10
$MD10_{IPP\_GR}$ (b/a)	1.09±0.06 (0.96±0.01)	1.01±0.04	0.89±0.03	0.88±0.03	0.84 ±0.04	N/A
$MD10_{Seb\_pre}$ (b/a)	1.21±0.06 (0.96±0.01)	1.06±0.04	1.04±0.06	1.05±0.04	0.84 ±0.06	0.78 ±0.06

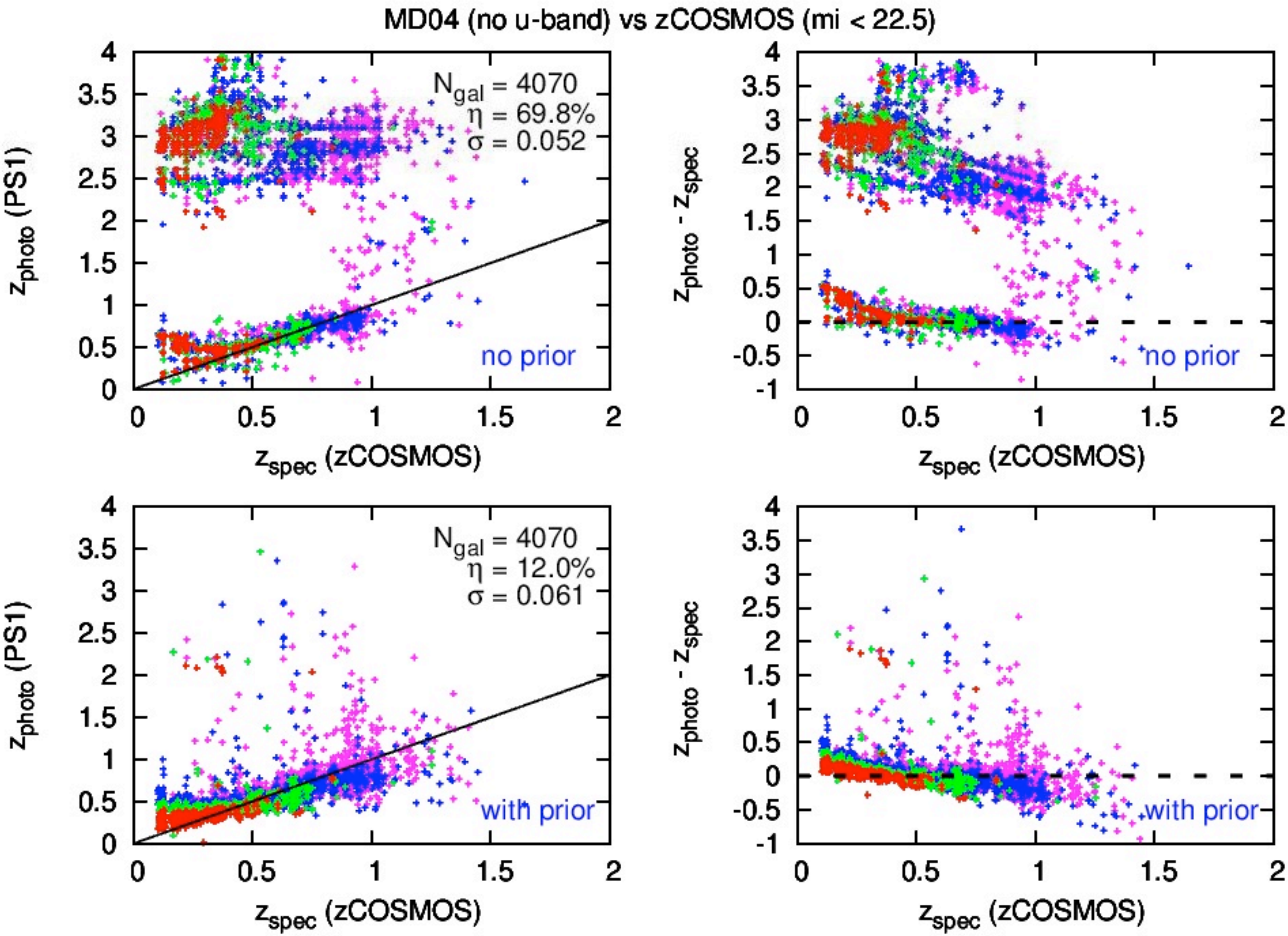
Photoz in MD04 and MD07



Depth:
26.2(u) 24.9(g) 24.9(r) 24.8(i) 24.2(z) 22.3(y)

Depth:
25.7(u) 25.0(g) 24.8(r) 24.8(i) 24.3(z) 23.1(y)


MD04 (with u-band) vs zCOSMOS (mi < 22.5)
no prior
N_gal = 3110
η = 36.5%
σ = 0.055
z_photo (PS1)
z_spec (zCOSMOS)
no prior
z_photo - z_spec
z_spec (zCOSMOS)
with prior
N_gal = 3110
η = 6.7%
σ = 0.058
z_photo (PS1)
z_spec (zCOSMOS)
with prior
z_photo - z_spec
z_spec (zCOSMOS)



MD04 (no u-band) vs zCOSMOS (mi < 22.5)
N_{gal} = 4070
η = 69.8%
σ = 0.052
no prior
z_{photo} (PS1)
z_{spec} (zCOSMOS)
$z_{photo} - z_{spec}$
no prior
N_{gal} = 4070
η = 12.0%
σ = 0.061
with prior
with prior

PSF matching and seeing improvement (MD04-g)

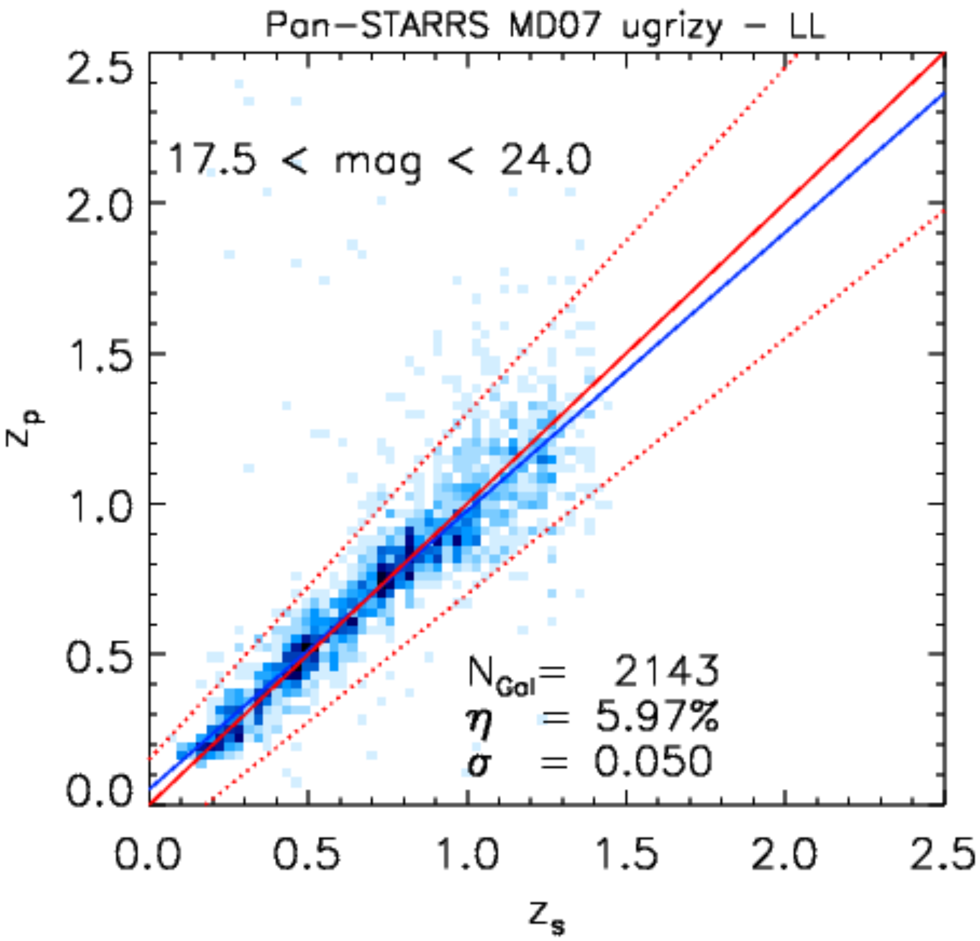
Skycell	Seeing cut	# frame	seeing	depth
065	None	20	1.27±0.11	24.99±0.03
	1.6”	15	1.15±0.07	24.92±0.04
	1.4”	10	1.13±0.09	24.67±0.05
066	None	20	1.24±0.08	24.93±0.05
	1.4”	15	1.18±0.10	24.84±0.06
	1.2”	11	1.12±0.06	24.57±0.04
077	None	20	1.26±0.07	24.93±0.03
	1.6”	14	1.19±0.09	24.84±0.04
	1.4”	11	1.15±0.06	24.56±0.02
078	None	20	1.19±0.04	24.94±0.02
	1.4”	15	1.12±0.06	24.71±0.02
	1.2”	10	1.06±0.07	24.57±0.03

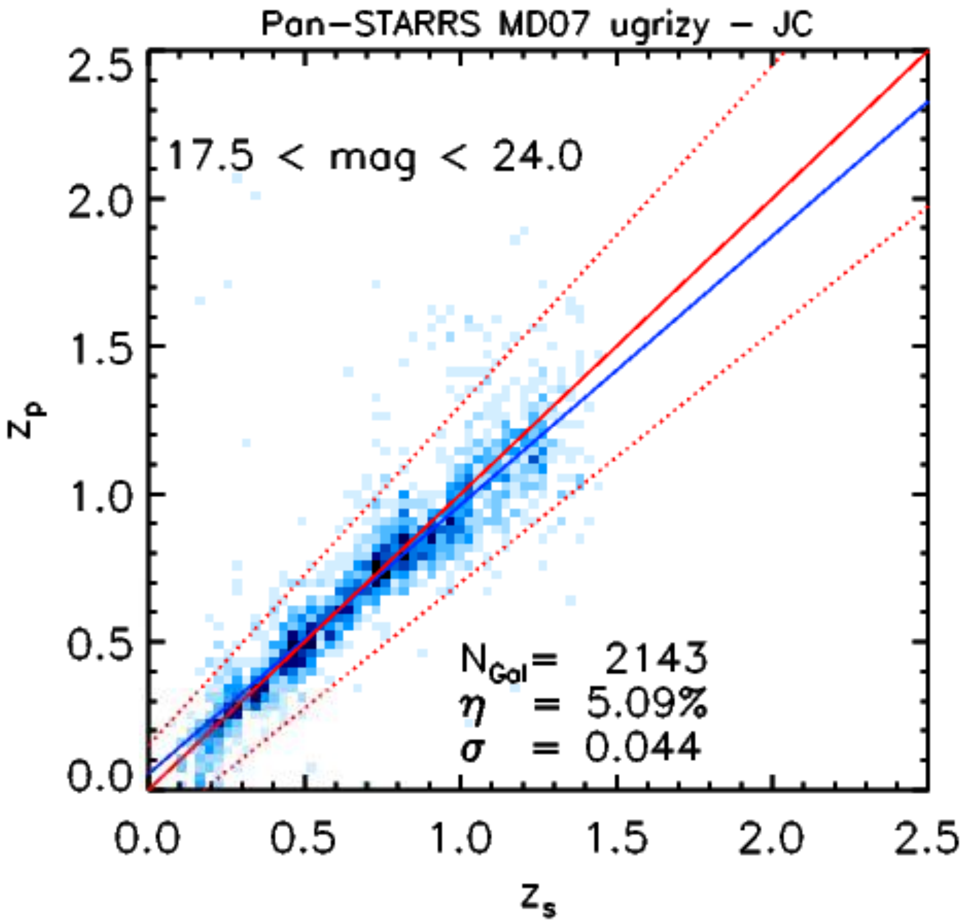
Photoz test in MD07 (mr < 24)

Template	Magnitude System	σ/(1+z)	Outlier
Pegase13	Auto mag	0.057	11.7%
Pegase13	Iso mag	0.055	8.9%
CFHTLS	Iso mag	0.051	7.2%
CFHTLS (PSF matched U-band)	Iso mag	0.051	6.1%

EAZY vs LePhare (with Jean Coupon's effort)

- Both utilizing CFHTLS templates (with minor differences)
- Different priors
- LePhare yields slightly better performance



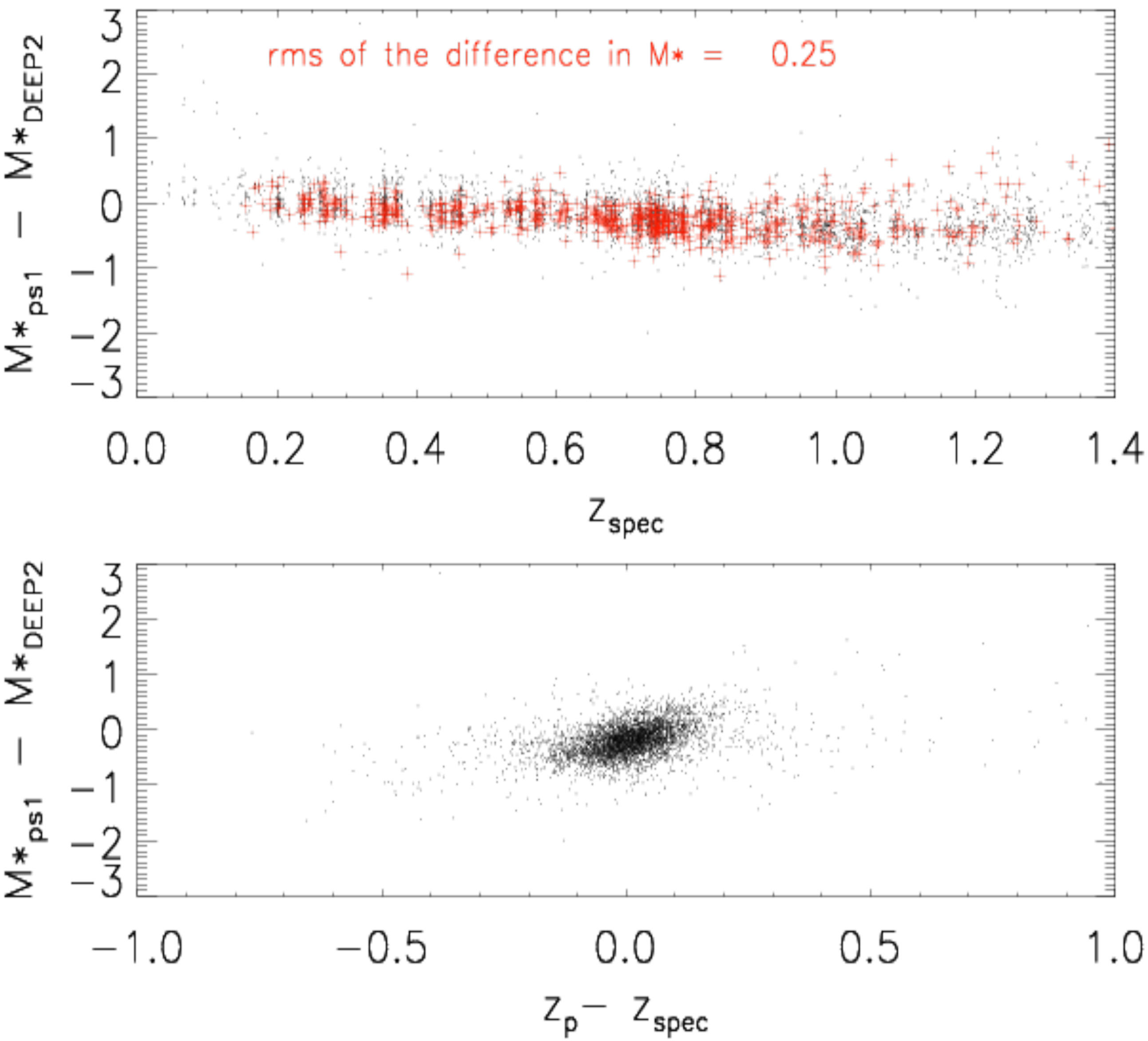


Catalogs and photoz

- bias≈0.001, σ_z≈0.06 and η≈7% (comparison with DEEP2)
- u-band help in reducing interlopers by a factor 2 and to get correct photozs at z<0.4
- Priors help reducing interlopers by a factor 5!

- Photometry corrections for ZP
- Correcting seeing effect: `ISO_MAG` corrections good enough, but PSF matching would be ideal!
- Template fine tuning play a small role as well
- Lots of fine tuning required!

Stellar mass measurement



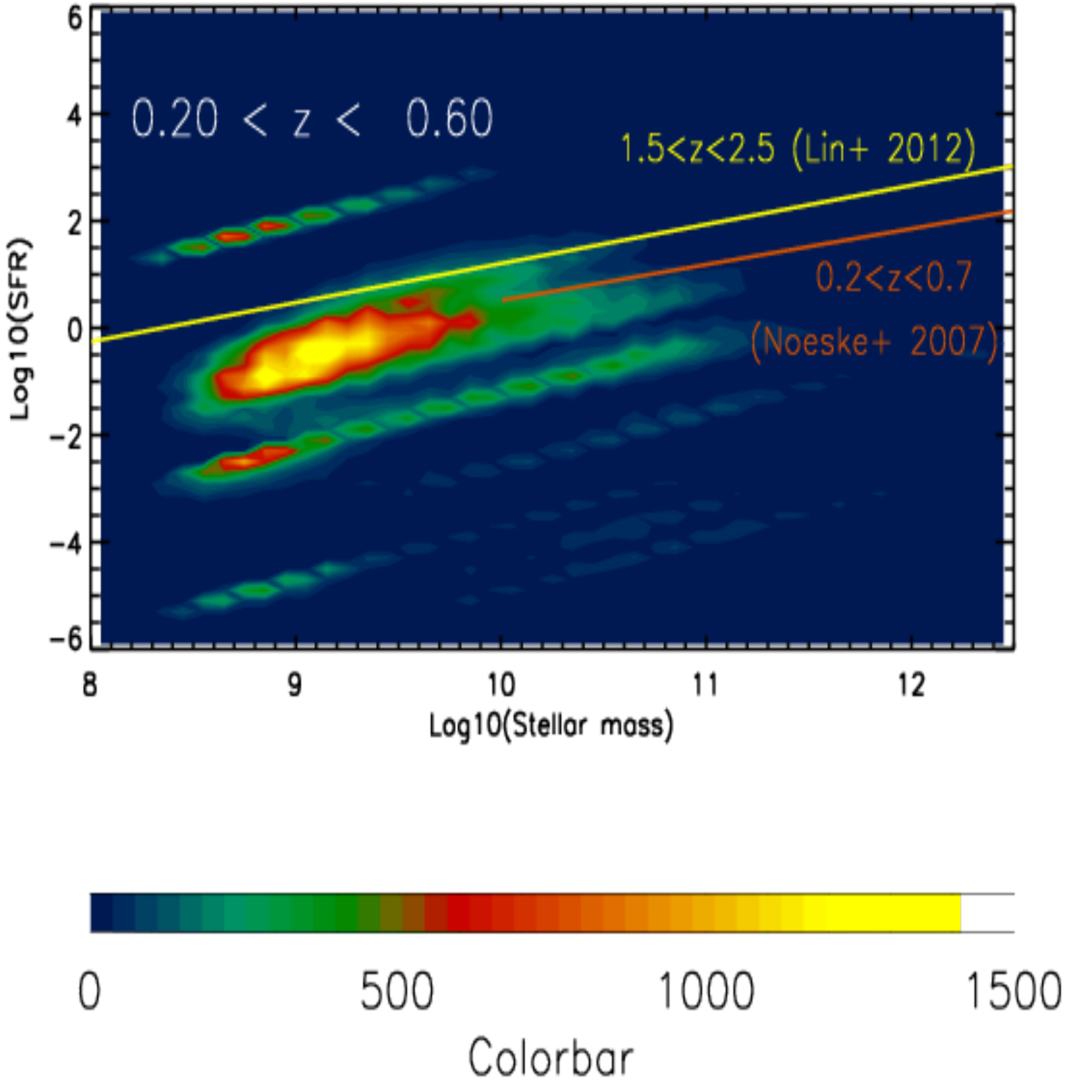
- Black: objects with spectroscopic redshift measurement
- Red: a subset of the black points—whose photoz agree with specz (<0.01)

- M^*_{ps1}: output from optical SED fitting

- M^*_{DEEP2}: derived from BRIK SED fitting

Agreement within 0.25 dex

SFR – Stellar mass Relation from PS1/MD



(Stellar mass, SFR) derived from SED fitting with broad band photometry

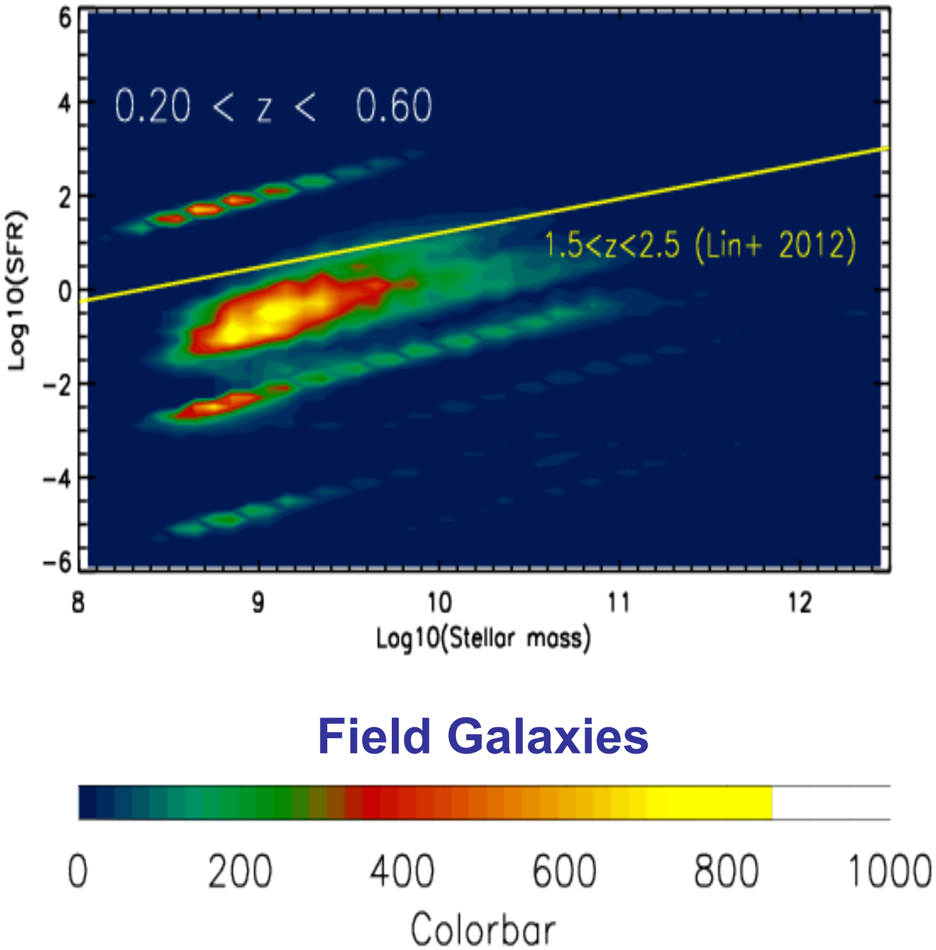
- Limited by model / parameter space sampling (tau, age)

- Alternatives:
  - UV flux scaling → sensitive to dust

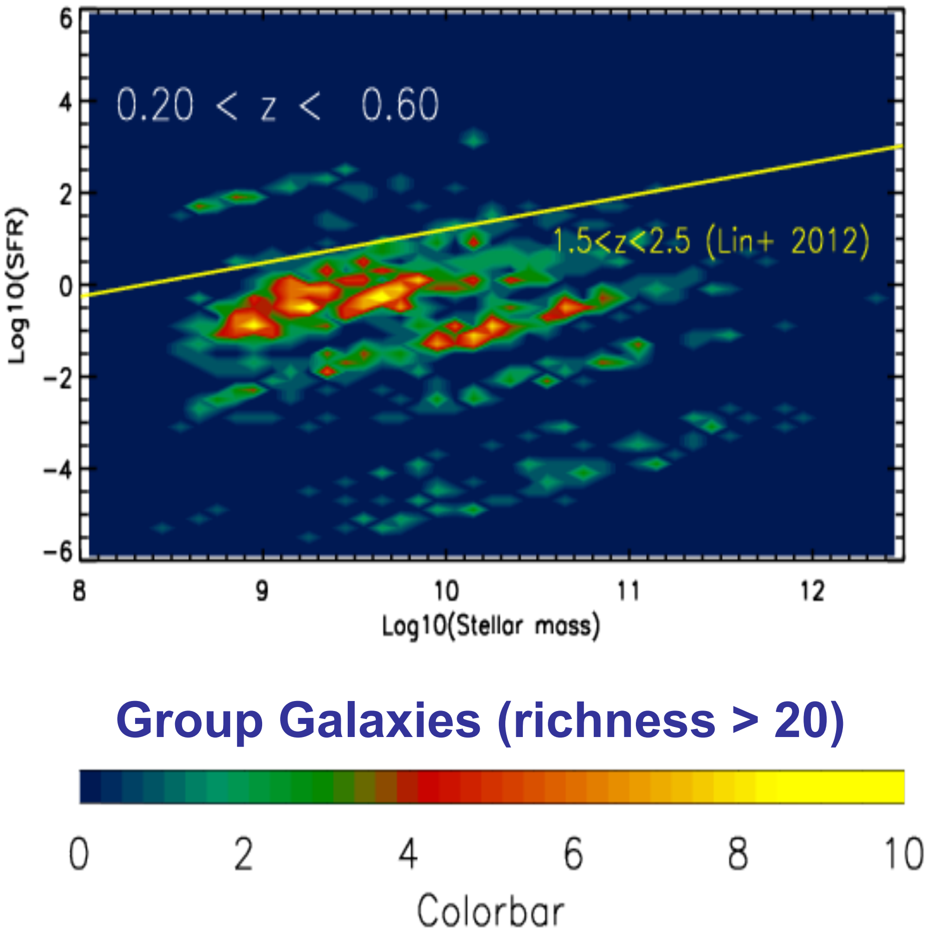
- From z~2 to z~0.5, SFR dropped by about 1 order of magnitude

Field vs Group

- Field galaxies:
  - More concentrated main sequence
  - Less massive members
- Group galaxies (identified with Hung-Yu's PFOF):
  - More massive members
  - More low SFR members
  - Less clear main sequence



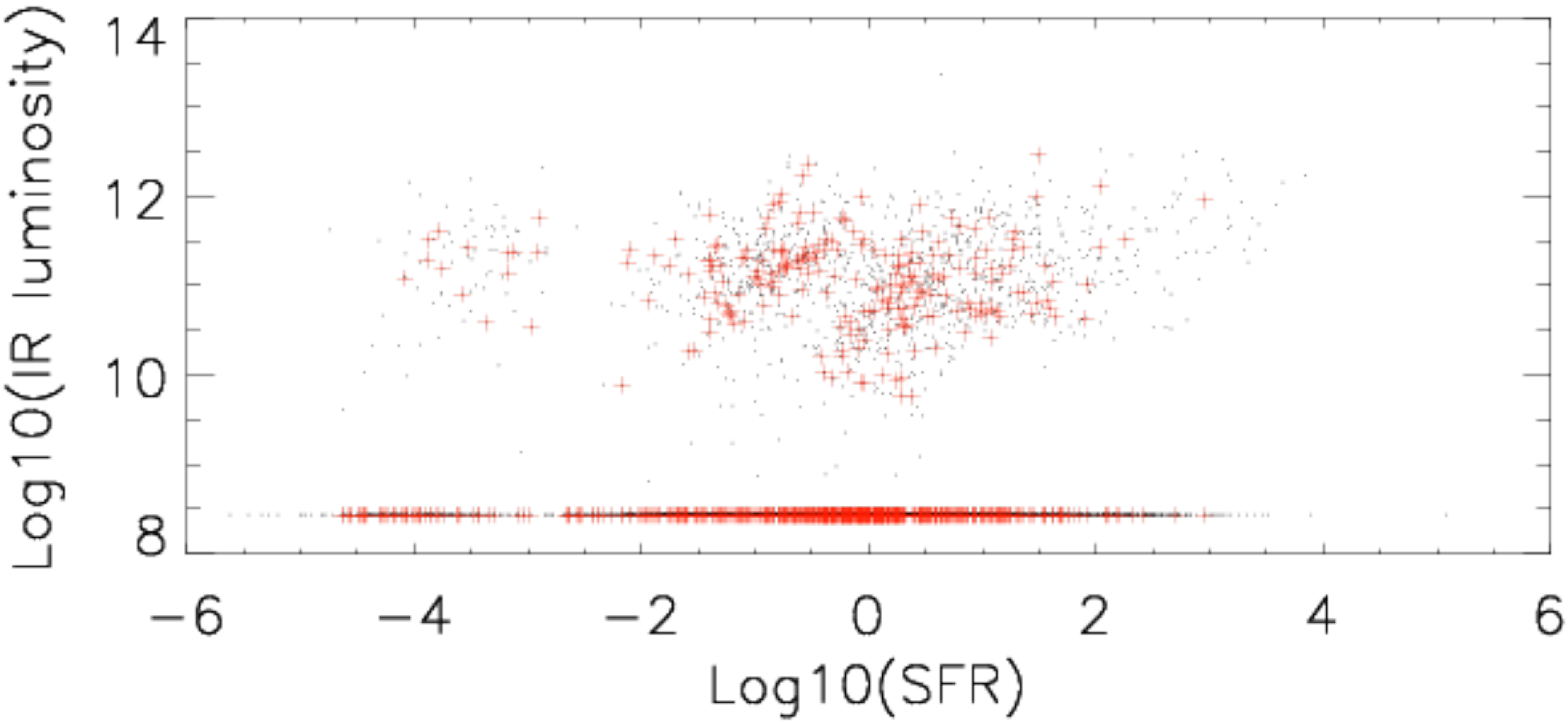
Field Galaxies



Group Galaxies (richness > 20)

SFR vs IR luminosity

SFR is underestimated for the dust-obscured population !



Conclusion

- With the addition of the u-band in the MD fields, the photoz accuracy is ~ 0.06 in $\sigma_z/(1+z)$ with 7% outliers at r<24.
- CFHTLS templates by far yield best results.
- The improvement from the PSF matched u-band is limited.
- The optical-based stellar mass agrees with the K-band stellar mass within 0.25 dex
- The SFR and stellar mass measurements from the SED fitting are limited by the grid resolution
- The field environment yields more concentrated star-forming main sequence than the group environment.

- More during the discussion…

CHEERS ….

Discussion: Added-Value catalog

Multiband photometry, Photometric Redshifts, Stellar Masses, Star Formation Rates, name it… and Database

Seb Foucaud (NTNU)

With the help of:

Peder Norberg (Durham), Roberto Saglia (MPE)

List of things to discuss

- Multiband photometry:
  - How to match?
  - Forced photometry
  - Where to store info?
- Spectroscopic sample (archives)
  - Matching and storage
- Star galaxy separation
  - Several methods
  - pdf?
- Photometric redshifts
  - Several codes
  - PanZ (PSPS); APZ (TWEA-DC); other codes somewhere else?
  - pdz
- …

List of things to discuss

- Other measurements from SED fitting (stellar masses, star-formation rates, ages etc.)
  - SED fitting
  - Centralized storage?
- Other information?
  - Galfit?

Some resolutions

- Photometric redshifts
  - Jim Heasly very keen in setting up a photoz WG, I agreed but I have not been very responsive lately (sorry!)
  - Using alternative methods
  - Matching them?
  - Probability distribution is the key!
  - related measurements (M*, SFR …)
  - I am planning to organize a “Photoz techniques workshop” in Summer 2013 in Taiwan, I let you know.

- Added value database
  - Not PSPS-bis!
  - Similar that the SDSS-NYU added value catalog!
  - Coordinating and merging efforts! Lots done by PCS, we should use this as well!
  - One database, potential mirrors? (TWEA-DC)

CHEERS ….