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KiDS

Photometric redshifts in the Kilo-Degree Survey

Overview of Data Release 3

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On behalf of the KiDS collaboration

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The default photo-z solution in KiDS:
Bayesian Photometric Redshifts (BPZ)

- Bayesian template-fitting method employing priors (Benitez'2000, Coe+06)
- Gives best-fit redshifts on output, as well as their PDFs
- Adapted for KiDS following CFHTLenS methodology (Hildebrandt+12) e.g. by modifying the prior
- Re-calibrated template set by Capak'04
- BPZ photo-zs are calculated by the KiDS pipeline, using GAaP *ugri* mags, for all the objects, including those with upper limits or no measurements in some of the bands
- For details of KiDS implementation see e.g. Kuijken+15, de Jong+17

Machine-learning photo-z solutions in KiDS:

(1) MLPQNA + METAPHOR

- Multi-Layer Perceptron with a Quasi-Newtonian Algorithm (Cavuoti+12)
- Neural network model (MLP) implemented with a QNA as the learning rule
- MLPQNA photo-zs are derived using GAaP and two aperture *ugri* magnitudes, and related colours (21 photometric parameters in total)
- Training sets used for KiDS-DR3: GAMA DR2 and SDSS DR9
- Calculated for KiDS galaxies with several magnitude cuts e.g. $g<24.5$, $r<23.3$ & $i<23.0$ (8.6 million objects out of ~49M)
- Photo-z PDFs generated with the METAPHOR method (Cavuoti+17)
- Separate paper on the produced catalogue is in preparation (Amaro+)

Machine-learning photo-z solutions in KiDS:

(2) ANNz2

- ANNz2 (Sadeh+16): public photo-z software based on CERN ROOT, incorporating neural networks, boosted decision trees, etc.
- Allows for weighting of non-representative training sets using the k-nearest neighbours method
- These weights are propagated through training and evaluation
- Training set for KiDS-DR3 is a compilation of GAMA-II, SDSS-DR13, 2dFLenS, zCOSMOS, CDF-S/ACES, and DEEP2 (300,000 sources)
- Weighting applied in training to mimic the target photometric data

Machine-learning photo-z solutions in KiDS: (2) ANNz2

- ANNz2 photo-zs derived using GAaP *ugri* magnitudes for all sources having all four measurements (~39 million out of full 49M in DR3)
- A fiducial subset with “safe” photo-zs defined based on training data coverage: $u<25.4$, $g<25.6$, $r<24.7$ & $i<24.5$ (19 million sources)
- ANNz2 can output PDFs but these aren’t currently stored for KiDS
- Paper on the experiments and catalogue is in preparation (Bilicki+)

KiDS-DR3 photo-z performance

Summary statistics from GAMA and zCOSMOS spec-z comparison

Set	Sources	$\overline{\delta z}$	σ	NMAD	Outl.
KiDS vs. GAMA					
BPZ, DR3	53 282	0.020	0.044	0.028	0.8%
MLPQNA	53 008	0.002	0.042	0.023	0.6%
ANNz2	53 233	0.003	0.043	0.030	0.7%
KiDS vs. zCOSMOS					
BPZ, DR3	11 304	−0.027	0.124	0.057	10.0%
BPZ, KiDS-450	9 150	−0.040	0.099	0.059	10.0%
MLPQNA	7 560	0.062	0.266	0.111	29.5%
ANNz2	10 907	0.033	0.172	0.065	10.6%

de Jong+17

KiDS-450 is a subset of DR3 processed with lens*fit (e.g. Fenech Conti+16) which in particular removes all the* r*<20 sources from the sample*

KiDS-DR3 photo-z performance

Low redshift vs. high redshift

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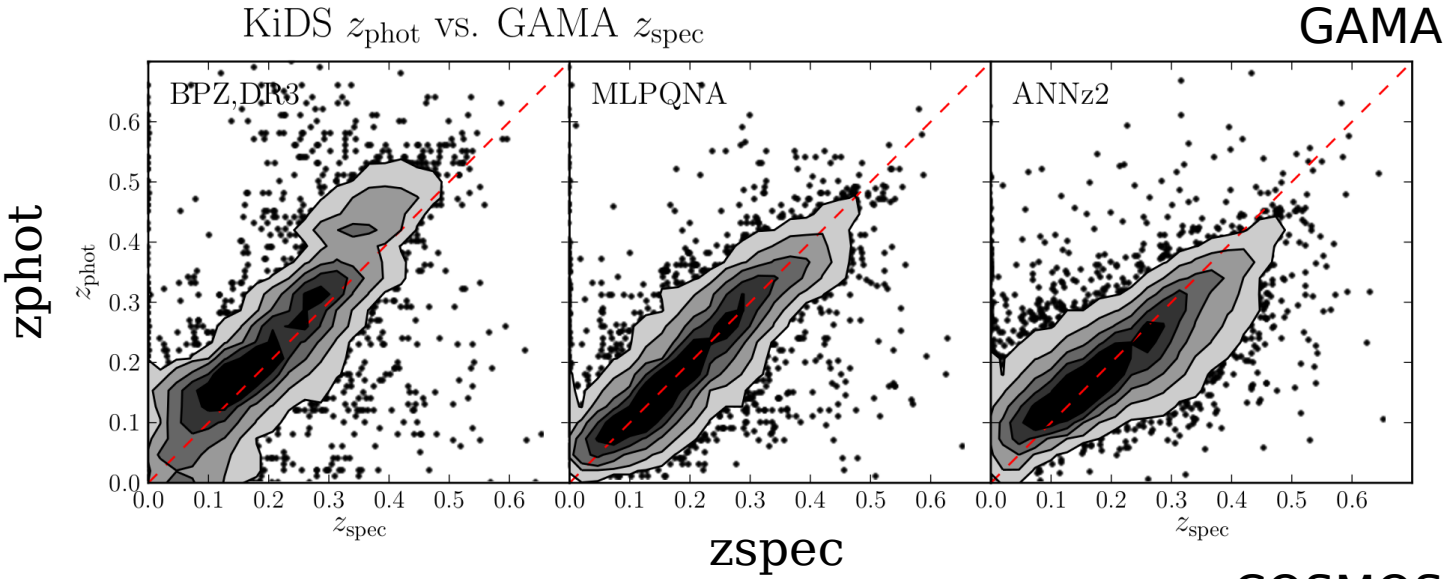
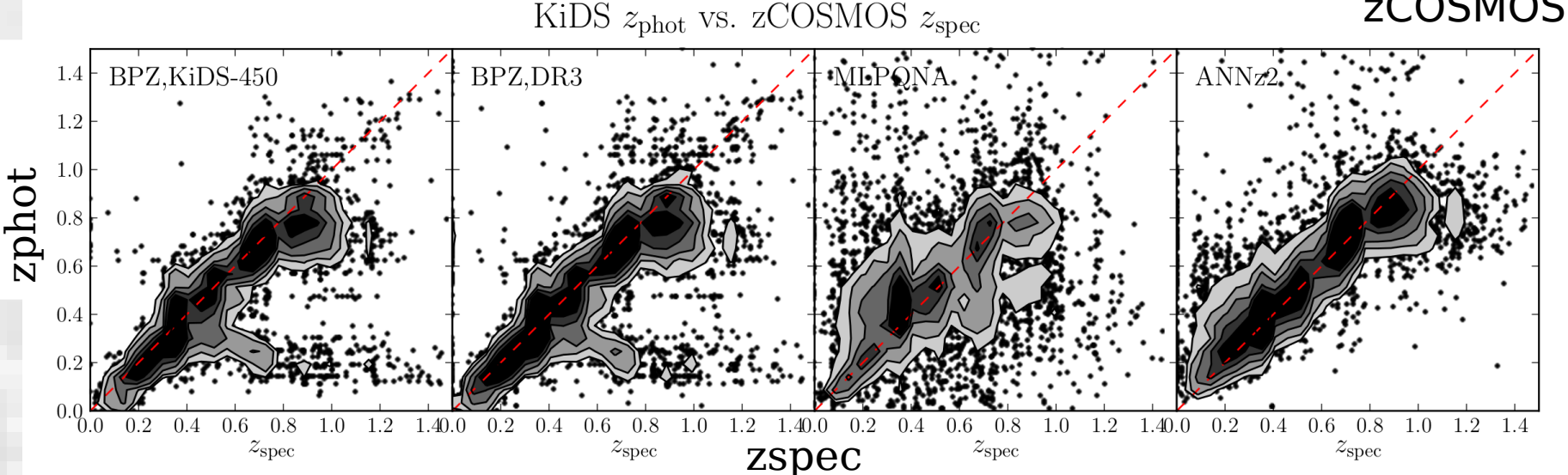
GAMA

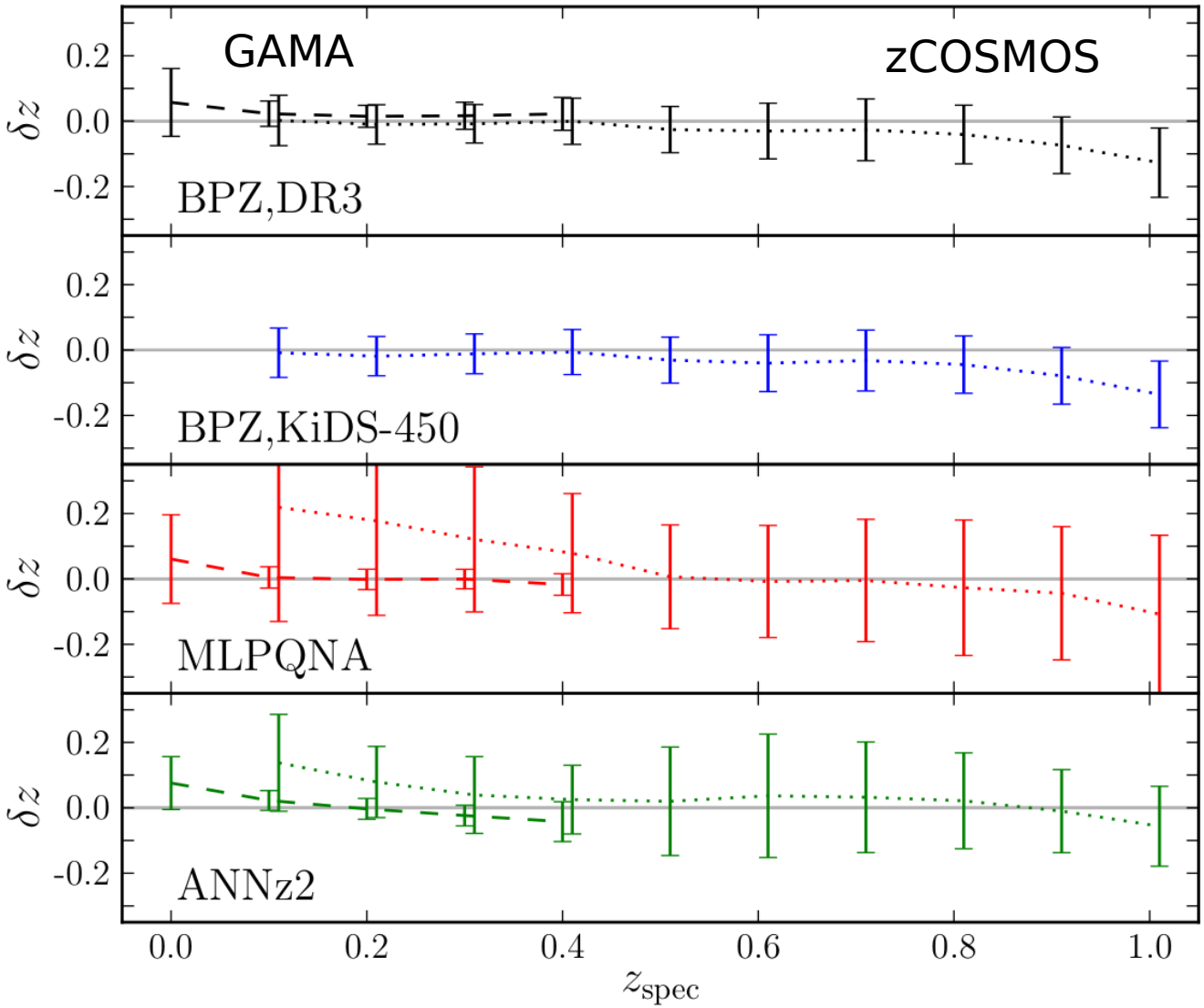


zCOSMOS



KiDS-DR3 photo-z performance

Low redshift vs. high redshift



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KiDS-DR3 photo-z performance

Bright end vs. faint end

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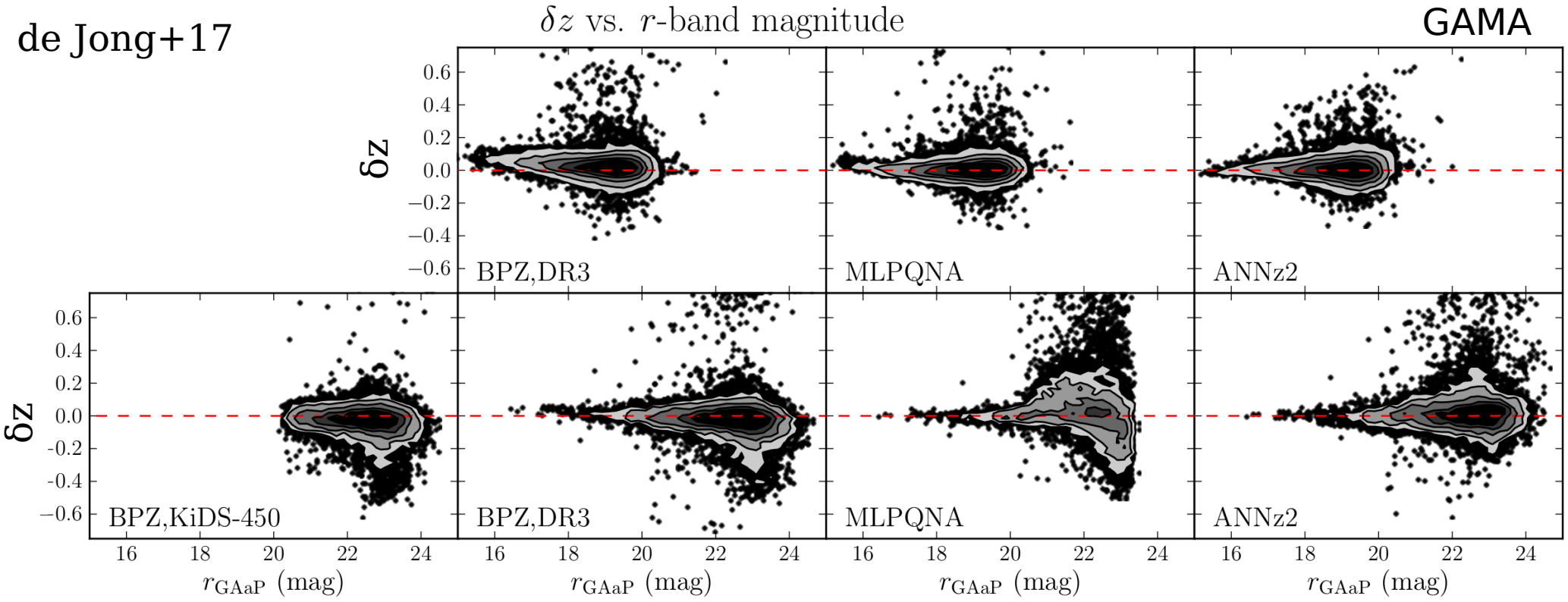


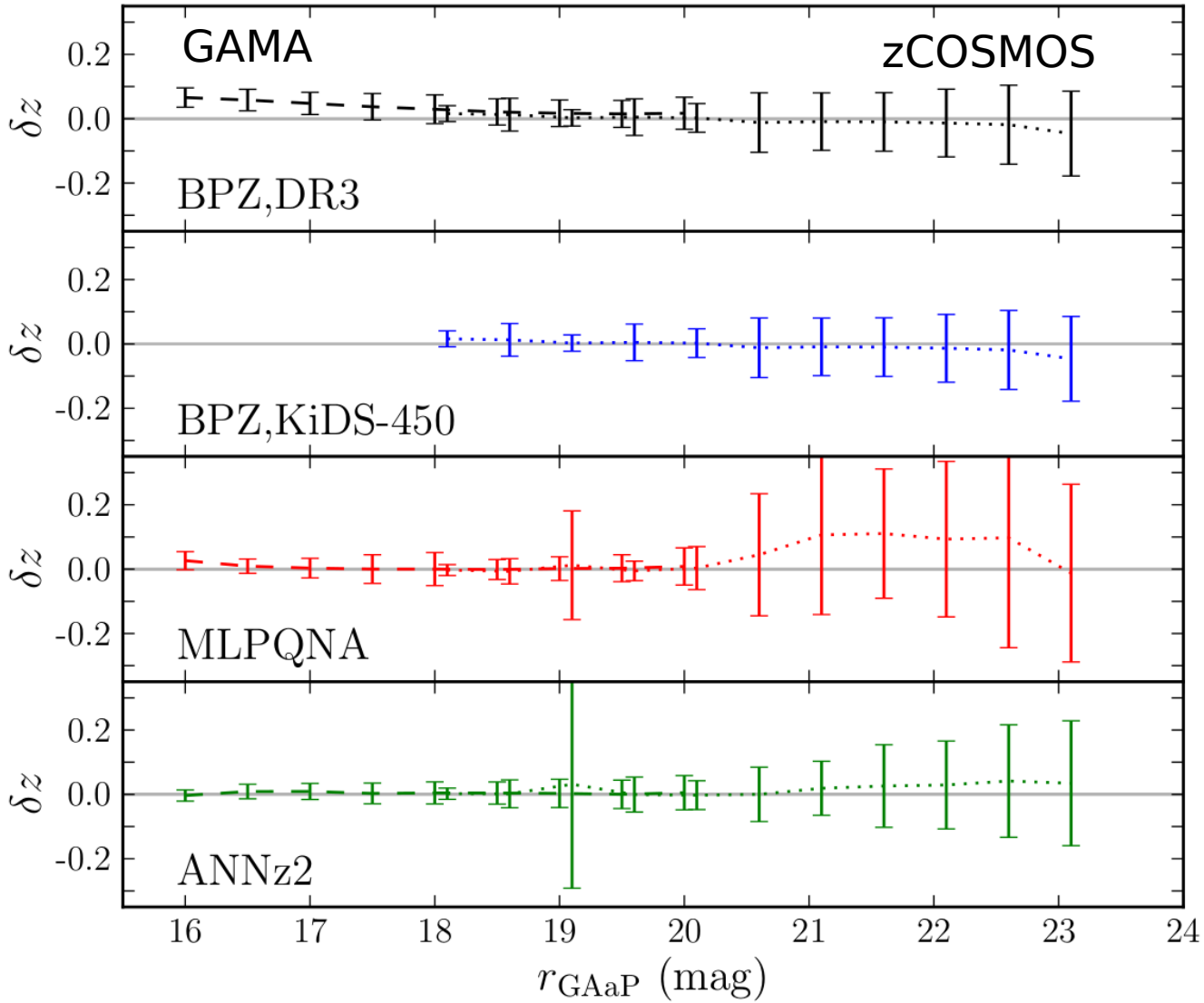
GAMA

r band mag

zCOSMOS

KiDS-DR3 photo-z performance

Bright end vs. faint end



de Jong+17

KiDS photo-z solutions for DR ≥4

Ongoing improvements

- More bands: +VIKING [all methods]; +WISE? [GAMA-depth]
- Extended training sets: +VVDS; +VIPERS [machine-learning]
- Extended parameter space? Sizes, surface brightness, ... [ML]
- Case of ANNz2:
  → Improved full-depth catalogue employing the above (for DR ≥4)
  → A GAMA-depth (r<20, $\langle z \rangle$~0.2) catalogue targeting galaxy-galaxy lensing and related studies; mean photo-z bias $\langle \delta z \rangle$~1e-4; scatter $\sigma_{\delta z} < 0.02$ (Bilicki+ in prep.)