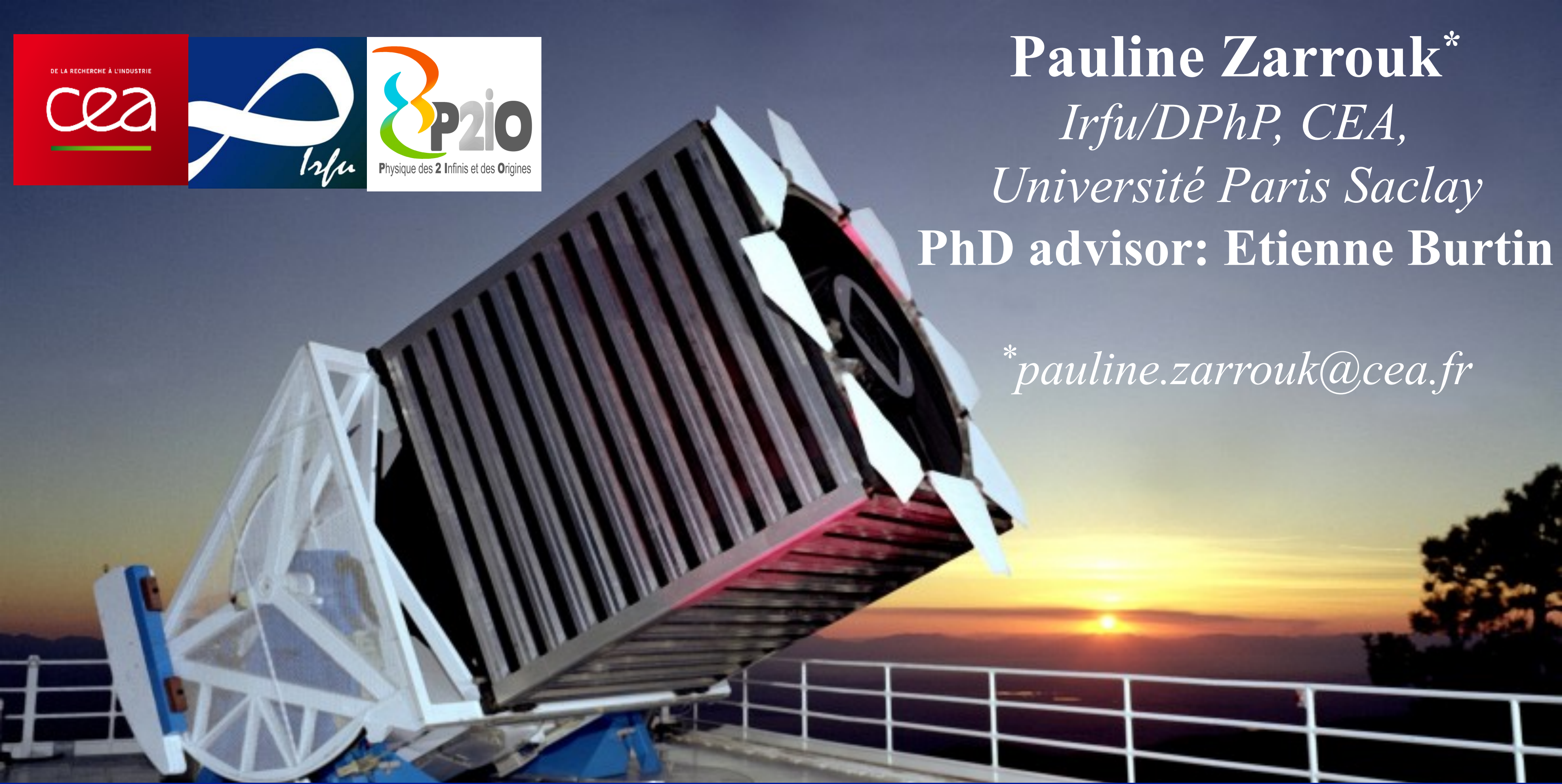

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Towards precision cosmology with quasar anisotropic clustering

SCLSS – Oxford – April 20th 2018

eBOSS quasars : DR14 analysis and forecasts for DR16

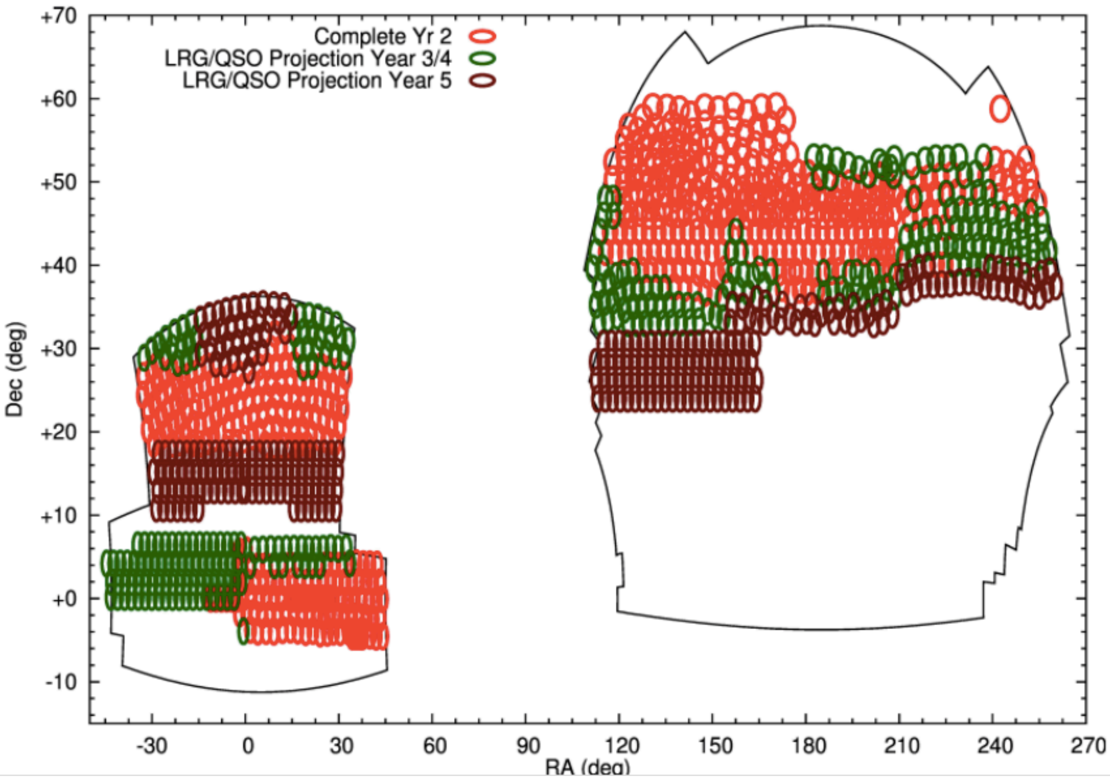
3 standard RSD clustering analysis using the eBOSS DR14 quasar sample

Gil-Marin et al. 2018, MNRAS, doi:10.1093/mnras/sty453

Hou et al. 2018 (submitted to MNRAS)

Zarrouk et al. 2018, MNRAS, doi:10.1093/mnras/sty506

→ 18% on $f\sigma_8$ 7.5% on H and 5.5% on D_A



Sample	Area	$\sigma_{f\sigma 8}$	σ_{α_par}	σ_{α_perp}
DR14	~2110	0.070	0.070	0.050
DR16	~5000	0.047	0.047	0.033

Requirements: **Systematics under control if account for less than 20% of the statistical precision**

→ Requirements on the shift on cosmological parameters induced by systematics for eBOSS quasar final sample: **$\Delta f\sigma_8$, $\Delta\alpha_{par}$, $\Delta\alpha_{perp}$ < 0.01**

→ Current DR14 analysis: $\Delta f\sigma_8$, $\Delta\alpha_{par} \geq 0.03$

Study of potential systematics for DR14 quasars

Statistical precision
$f\sigma_8$: 0.070
α_{par}: 0.070
α_{perp}: 0.050

- **Modelling systematics**
  - Bias models
  - Redshift uncertainties

→ **$\Delta f\sigma_8$= 0.033**
$\Delta\alpha_{par}$= 0.038
$\Delta\alpha_{perp}$= 0.006

Using the N-body OuterRim simulation (Habib et al. 2016)

- **Observational systematics**
  - Inhomogeneities in the target selection → **Photometric weight w_{photo} for variations in target density**
  - Missing quasars due to fiber collision: close pairs
  - Unsecured redshift for quasars: redshift failures

$$W_{\mathrm{focal}-\mu} = w_{\mathrm{FKP}} \cdot w_{\mathrm{photo}} \cdot w_{\mathrm{cp}} \cdot w_{\mathrm{focal}}$$

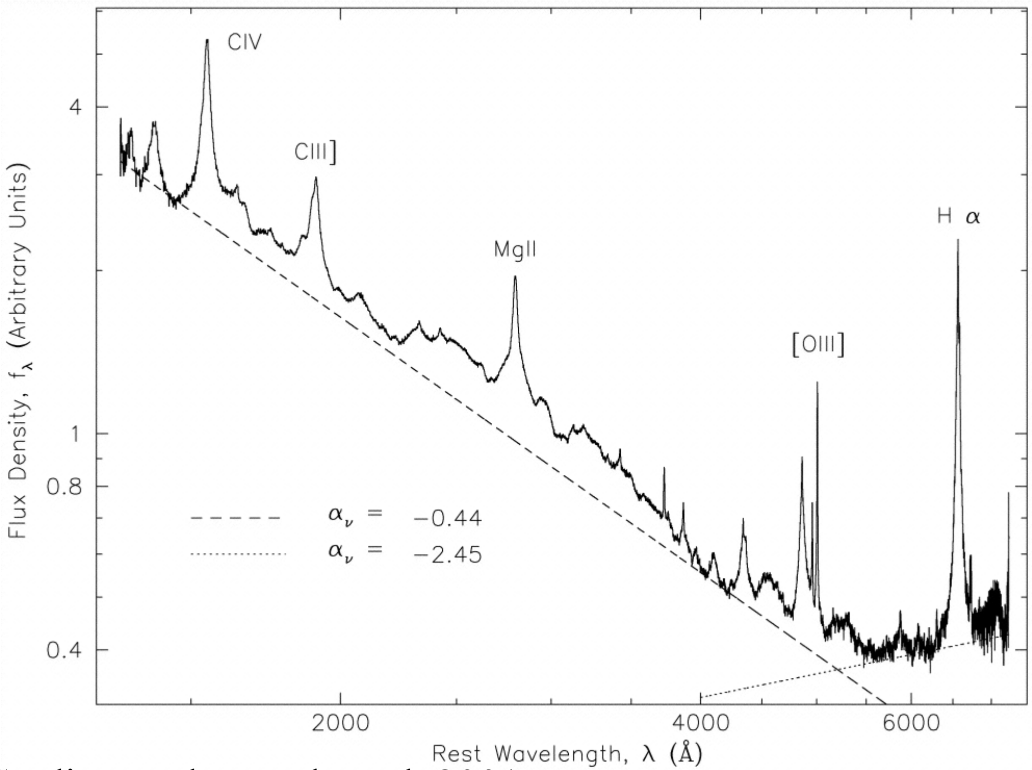
→ **Negligible observational systematics**

  - Redshift estimates
    - Catalogue based on **z**
    - Catalogue based on **z_{MgII}**
    - Catalogue based on **z_{PCA}**

→ **Compatible with mocks statistics**

Using 1,000 EZ mocks (Chuang et al. 2015**) with redshift failures and close-pairs**

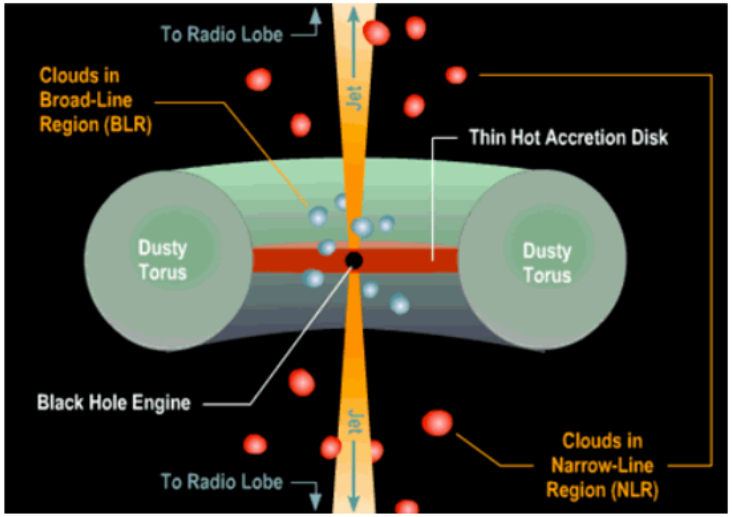
Investigate the effect of redshift uncertainties



Credit: Vanden Berk et al. 2001

Quasar physics

- Continuum
- Broad emission line: MgII, CIV
- Narrow emission line: [O III], [O II]

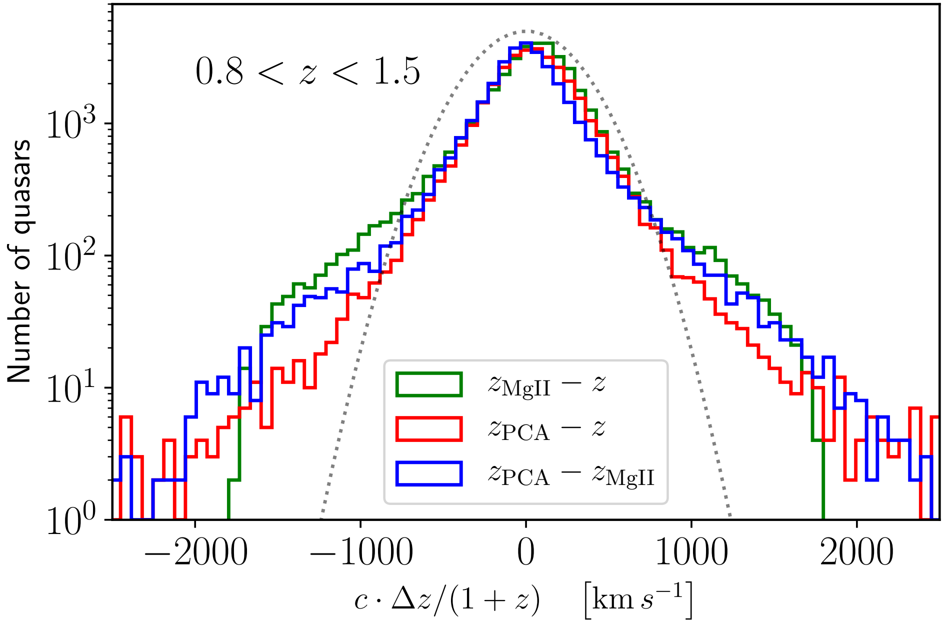


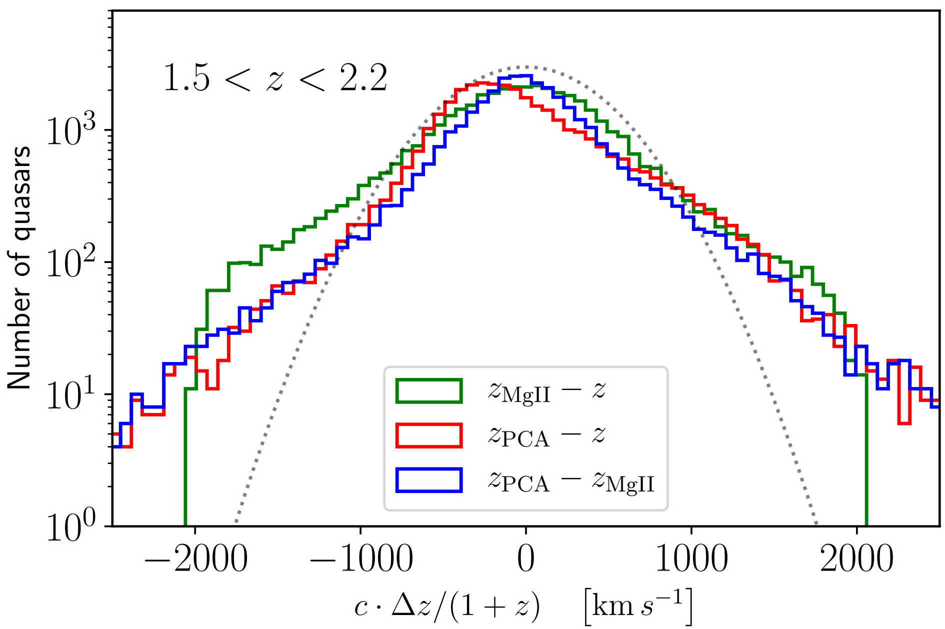
Redshift estimates in the DR14 quasar analysis

- ‘z’: pipeline redshift (template-based) after correction for catastrophic redshifts
- ‘z_{MgII}’: redshift deduced from the fit of the location of the MgII peak
- ‘z_{PCA}’: another template-based redshift using MgII line as the reference

→ Scatter between ‘z_{MgII} - z’ gives us an estimate of the redshift resolution

Investigate the effect of redshift uncertainties





- Gaussian distribution according to SRD
- '$z_{\rm MgII} - z$' distribution rescaled so that the width matches the one of the SRD

→ Focus on the impact of exponential tails on cosmological measurements

→ DR14 analysis: Half of the modelling systematics came from redshift uncertainties

Zarrouk et al. 2018 [arXiv:1801.03062]

Towards a more robust estimation of modelling systematics

→ Even with SRD Gaussian distribution for redshift uncertainties:
$\Delta f\sigma_8, \Delta\alpha_{par}, \Delta\alpha_{perp} \geq 0.01$

- **Does $\Delta f\sigma_8, \Delta\alpha_{par}, \Delta\alpha_{perp} \geq 0.01$ depend on the bias models?**

HOD with 3 different satellite fractions (0%, 13%, 25%)
Bin in mass 12.5 ± 0.3
No mass selection, just a cut to have mocks with the same statistics

- **Does $\Delta f\sigma_8, \Delta\alpha_{par}, \Delta\alpha_{perp} \geq 0.01$ depend on the simulation?**

Simulation	Box length	# particles	mass resolution	halo finder
OuterRim	3 Gpc/h	$(10240)^3$	1.8 10^9 M_{sun}/h	particles only
BigMDPL	2.5 Gpc/h	$(3840)^3$	2.4 10^{10} M_{sun}/h	Rockstar

- **Does $\Delta f\sigma_8, \Delta\alpha_{par}, \Delta\alpha_{perp} \geq 0.01$ depend on the RSD model?**

CLPT-GS (Zarrouk et al. 2018), TNS (similar to Gil-Marin et al. 2018), CLEFT-GS

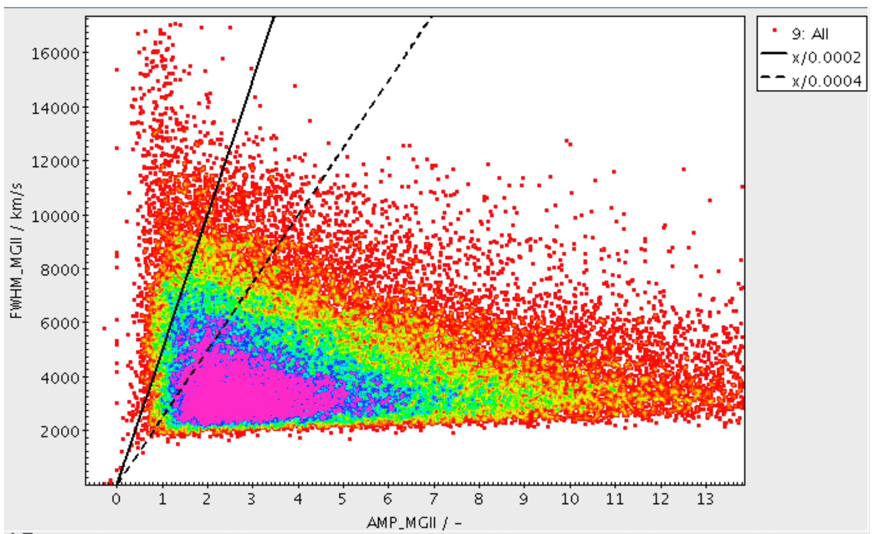
- **Toy model to investigate numerical issues and test the fitting procedure**

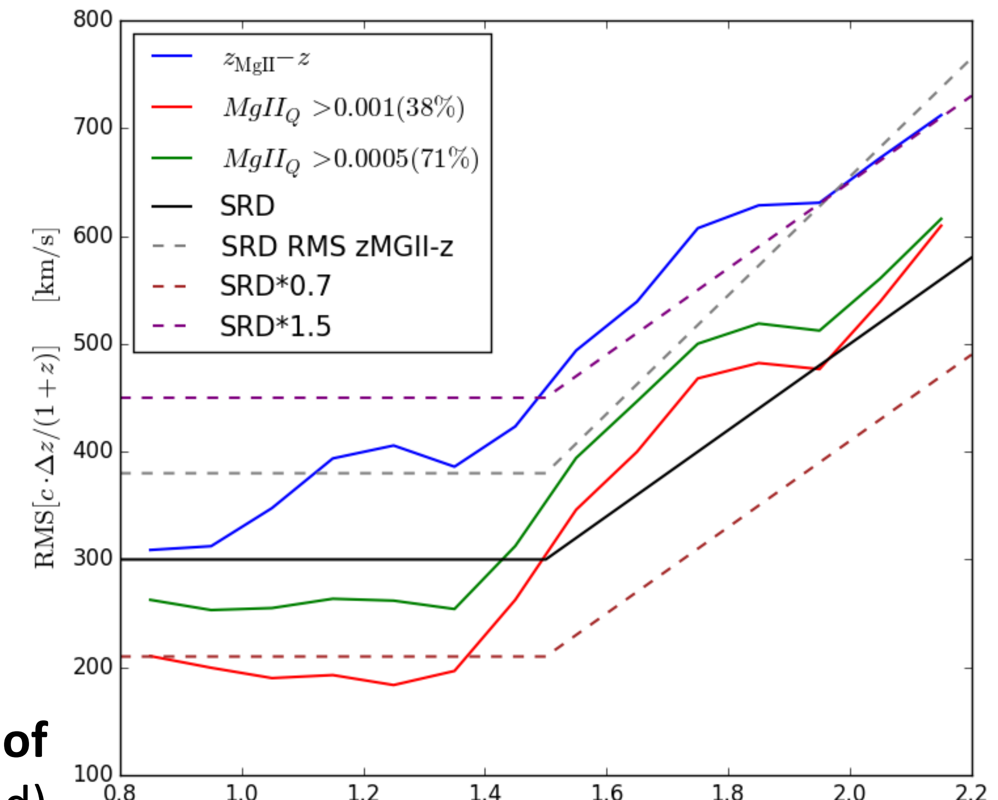
Towards a better understanding of eBOSS quasar redshift resolution

→ **Artificial scatter in $z - z_{MgII}$** due to statistical uncertainty in MgII-redshift because of line detectability given the eBOSS S/N and redshift range

- **MgII-line detectability** based on a criteria:

cutQ = AMP_MGII / FWHM_MGII





- When applying cutQ, **reduction of the scatter** (as expected)

Takeaway

- **Final eBOSS quasar sample (February 2019)**: need to **divide our systematic budget by a factor ~3** not to be systematics-dominated

- **Ongoing comparison in configuration space** between different N-body simulations, RSD models and bias models

- **Redshift uncertainties**: for clustering analysis, one would like to use a homogeneous redshift estimate across the redshift range

→ **Improve template-based redshifts (ongoing work)**
  - By developing new spectral templates
  - By testing their performance in terms of catastrophic redshifts (<1%) and spectroscopic resolution (comparison with MgII-based redshifts when MgII-line well detected)
  - By using repeated observations from the RM program to estimate the statistical uncertainty

→ **DESI will observe 1.7M quasars between 0.9-2.1**