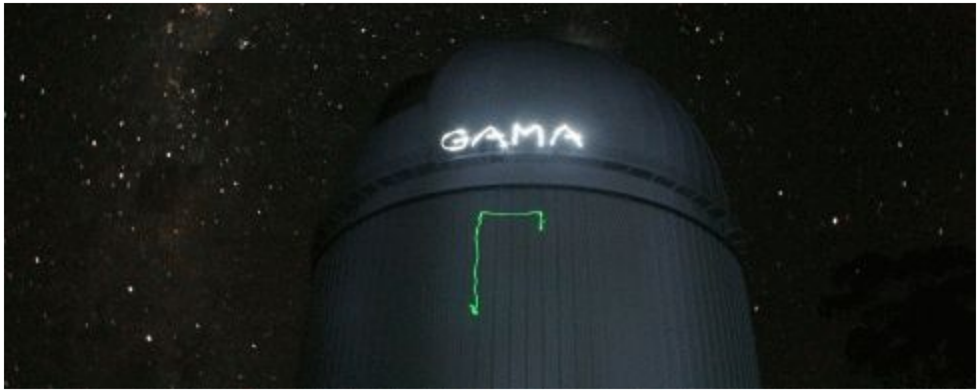
# Central velocity dispersions of the GAMA spectroscopic database and synergies with KiDS

***G. D'Ago - INAF-OACN***

*In collaboration with: N.R. Napolitano, C. Tortora, C. Spiniello, F. La Barbera*

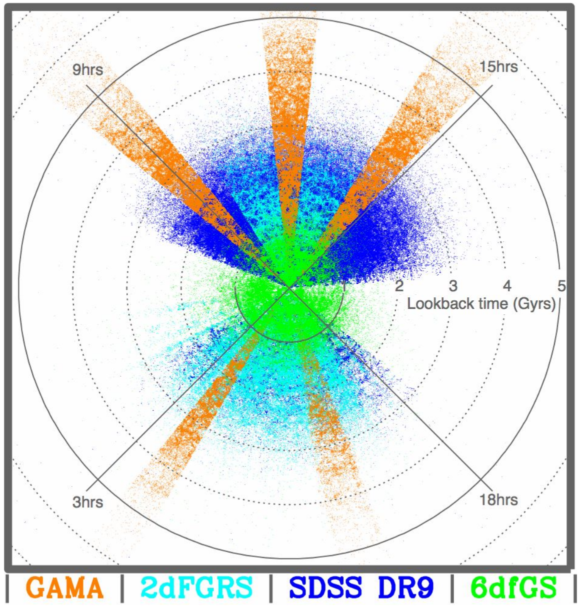
GAMA




- 270k spectra for galaxies < 19.8mag collected at the Anglo-Australian Telescope (AAT)

- 345k with SDSS,2dFGRS,MGC
- 286 deg2 covered

- Spectra have been taken with the AAOmega MOS (580V + 385R)
- Averaged resolution: R ~ **1300**
- $\lambda$ range: **3727.49 Å - 8857.49 Å**
- Averaged SNR: ~ **8/pixel**




| Region | RA range | Dec range | Main survey limit |
|---|---|---|---|
| G02 | 30.2 - 38.8 | −10.25 - −3.72 | r < 19.8 |
| G09 | 129.0 - 141.0 | −2 - +3 | r < 19.8 |
| G12 | 174.0 - 186.0 | −3 - +2 | r < 19.8 |
| G15 | 211.5 - 223.5 | −2 - +3 | r < 19.8 |
| G23 | 339.0 - 351.0 | −35 - −30 | i < 19.2 |

**KiDS!**

Unrivaled combination of:

**PROs**

- Covered area
- Spectroscopic depth
- Spatial resolution
- Wavelength coverage (21-band)

Large-scale structure and galaxy evolution:

**GOALS**

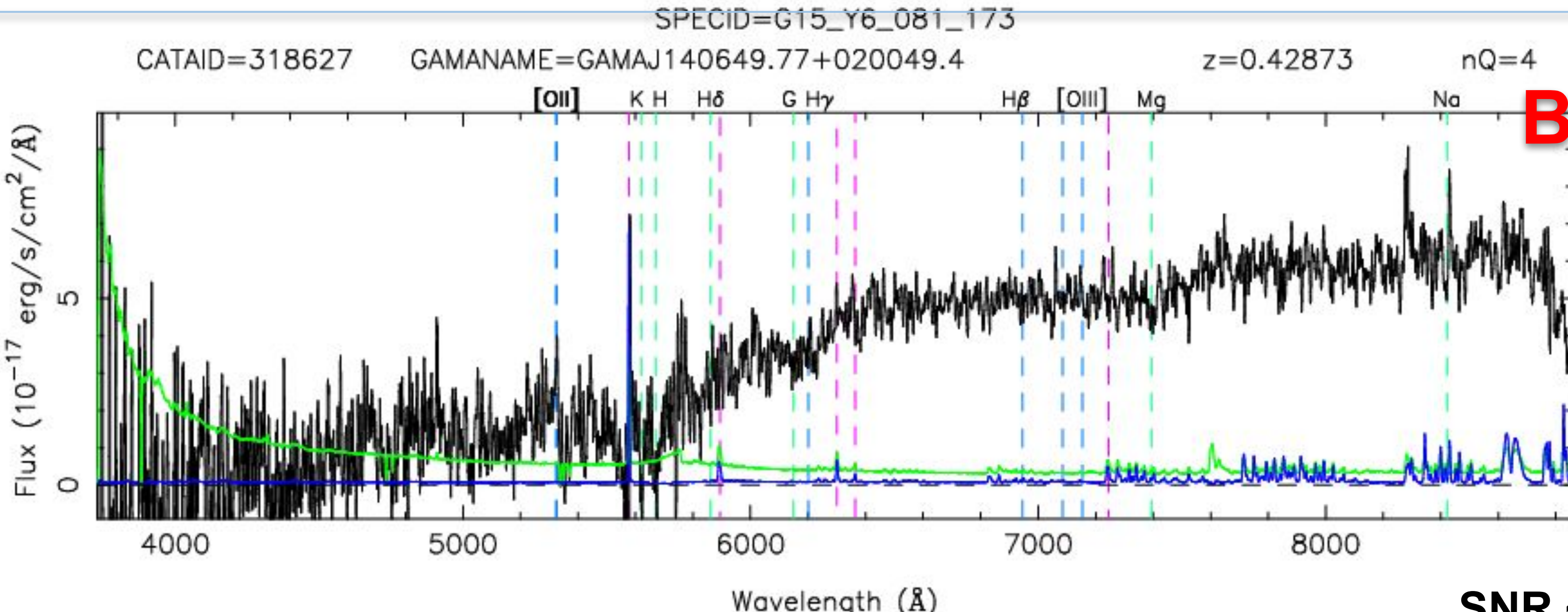
- growth rate of structure
- halo mass function
- star formation efficiency in groups
- stellar masses
- measure the recent galaxy merger rate …

We already have redshifts for the whole database. **Velocity dispersion measurements are still missing!**

- **key role in understanding the evolution of galaxies**
- **scaling relations**
- **dark matter fraction ...**

*PPXF (Cappellari, 2017) is the state-of-the-art for measuring the internal kinematics of galaxies*

- *good selection of templates*
- *good quality spectra (in terms of SNR and features)*
- *good choice of the initial guess*
- *optimal pixel-masking*
- *SNR > 8? (Hopkins et al. 2013)*




**BAD**

**SNR ~ 3**

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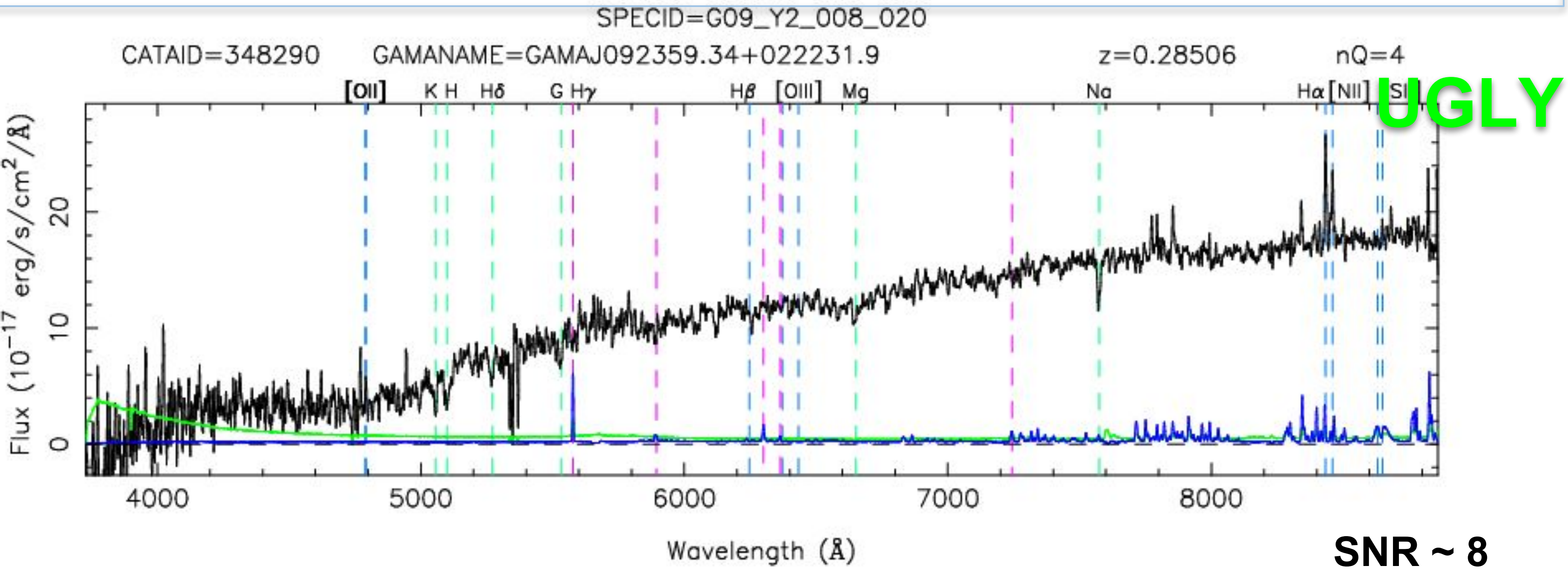


**SNR ~ 8**

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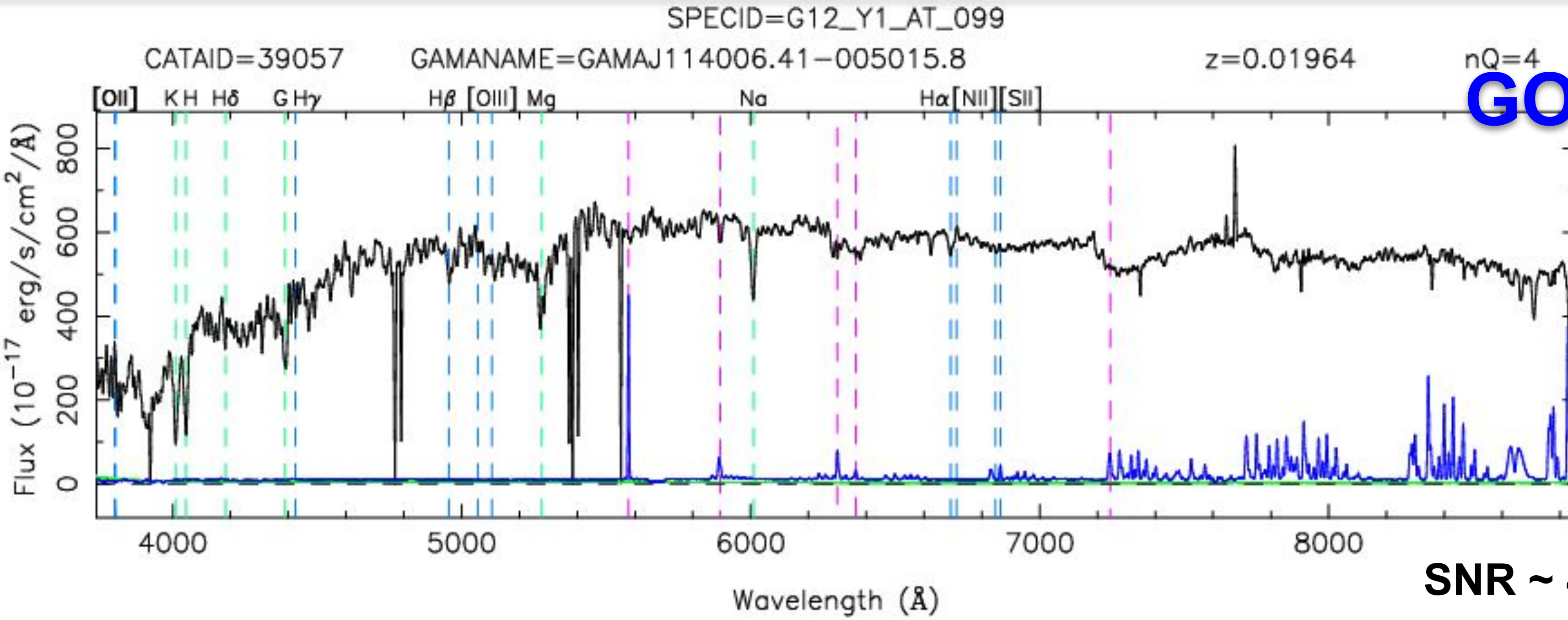


**GOOD**

**SNR ~ 40**

# THE SETUP:

- Selection of **45** MILES SSP (IMF: un $\Gamma$=1.3, met: -2.27 - 0.40, age: 0.03 - 14 Gyr)
- **$\Delta\lambda$_1**: 3850-6000 Å, **$\Delta\lambda$_2**: 4500-6800 Å
- ***CaII-K, CaII-H, Hdelta, G-band, Mg, Na***
- **0.003 < z < 0.9** (reliability redshift range)
- conservatively masking typical gaseous lines
- very low cut on SNR (let's try to exploit the most of the spectra, by selecting SNR>3)
- nQ>2
- COMMENTS_FLAG==0 (it means no bad spliced or fringed spectra)

***GAMA provides with reliable redshift estimates, making things really easy...***

***...we exploit a BOOTSTRAP pipeline in order to extract velocity dispersions!***

# Optimised Modelling of Early-type Galaxy Aperture Kinematics (OMEGA-K)

1. **Templates are loaded just once for the whole pipeline run**
2. A spectrum is selected, restframed, and logarithmically rebinned
3. Spectrum is trimmed according to redshift
4. Templates are logarithmically rebinned to the instrumental velocity scale, and are convolved with the instrumental FWHM -> building up the template matrix
5. Typical gaseous lines are conservatively masked
6. PPXF runs in sigma-clipping mode iteratively and every time the noise is adapted in order to find the optimal noise level and a pixel mask
7. BOOTSTRAP: 256 fitting conditions (moments and polynomial degrees) are randomly set and 256 simulated spectra are generated from the original one according to the noise -> 256 fits run in parallel mode
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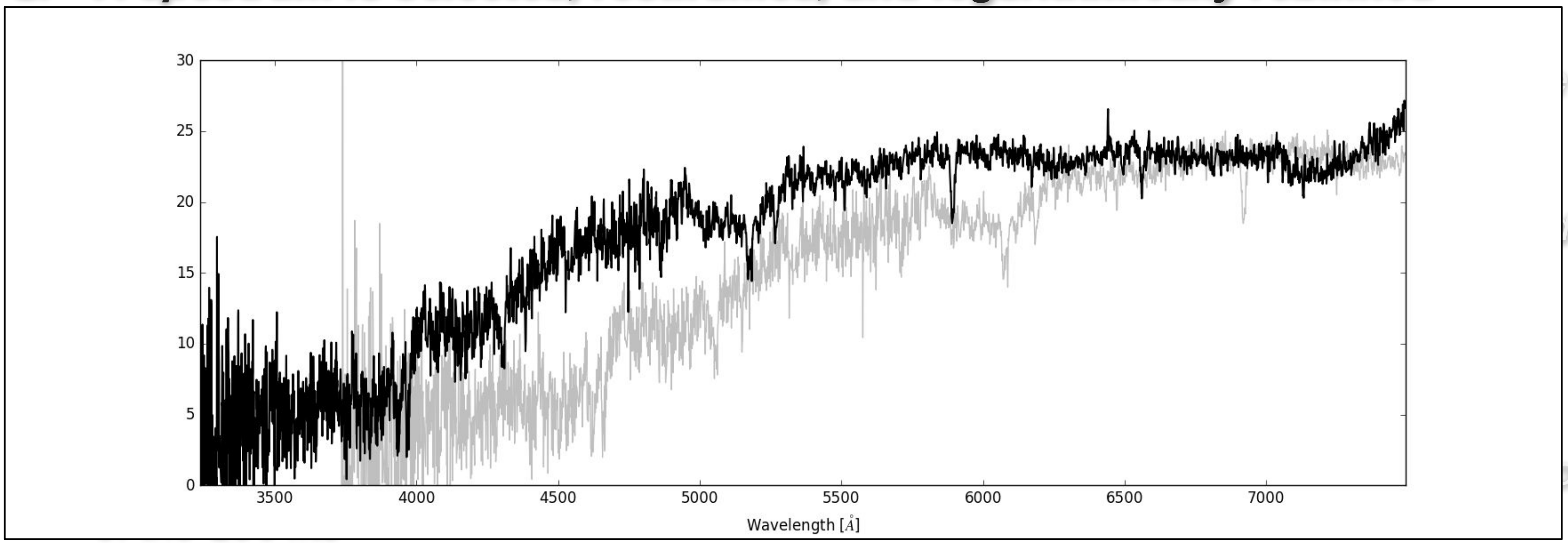

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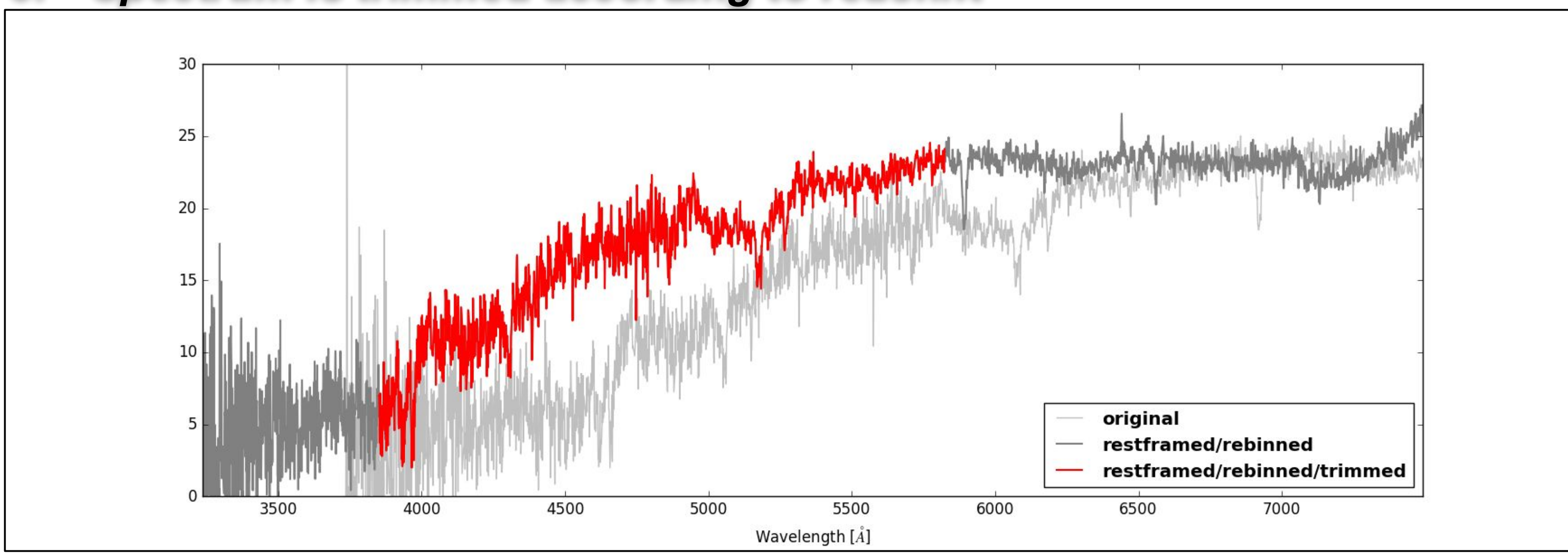

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7. BC … ra… ac…
8. Ou… …iation of…

```
[4 - 5/84626] Start fitting G09_Y2_004_377.fit at z=0.17459 and SNR_gama=16.21

Optimising noise and pixelmask...
chi2/DOF: 0.762
chi2/DOF: 0.839
chi2/DOF: 0.908
chi2/DOF: 0.963
chi2/DOF: 1.034
Fit0 sigma: 181.200712287 +/- 14.7083389759 km/s,   chi2=1.0344

Starting simulations... 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
```

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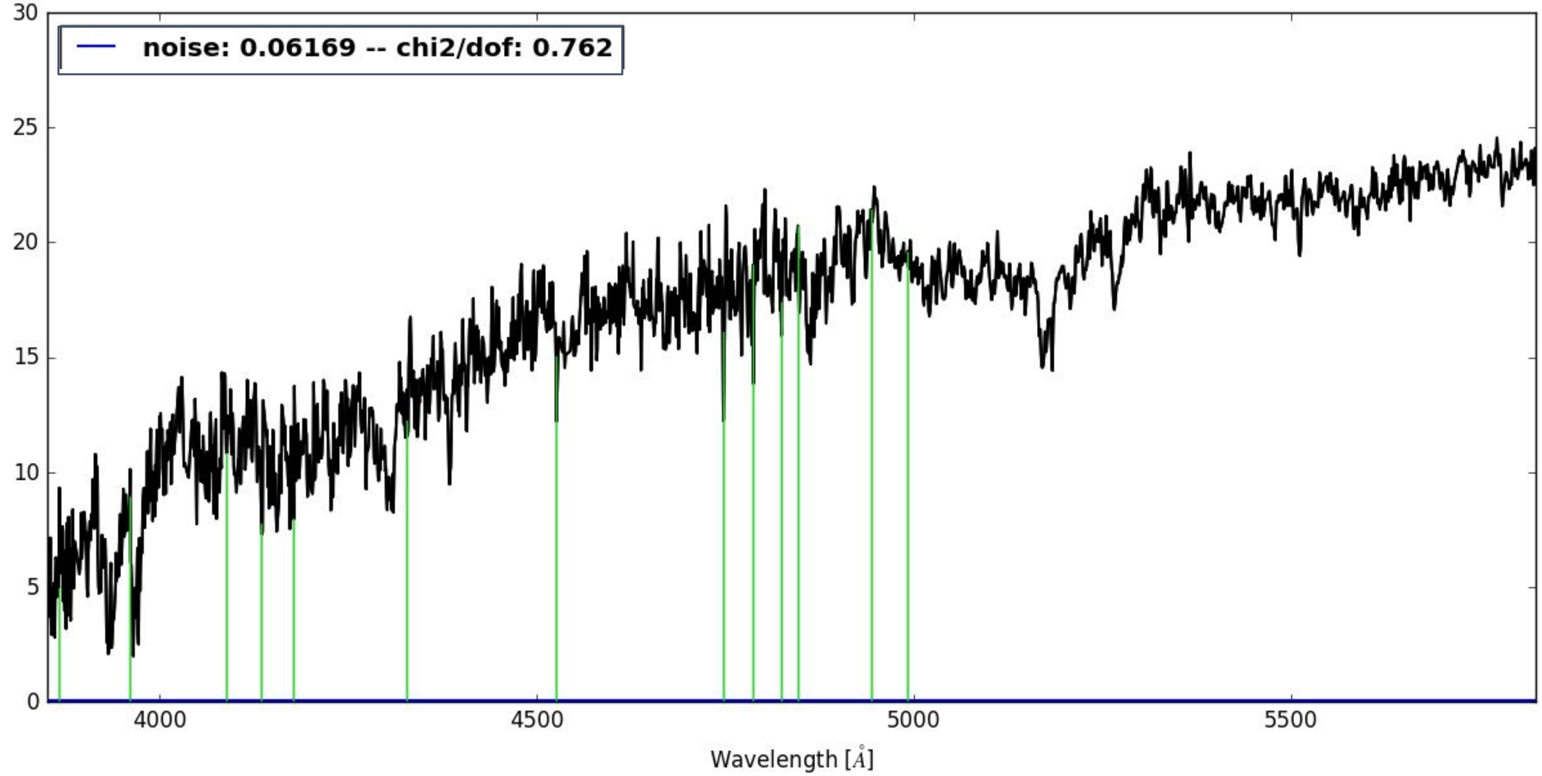

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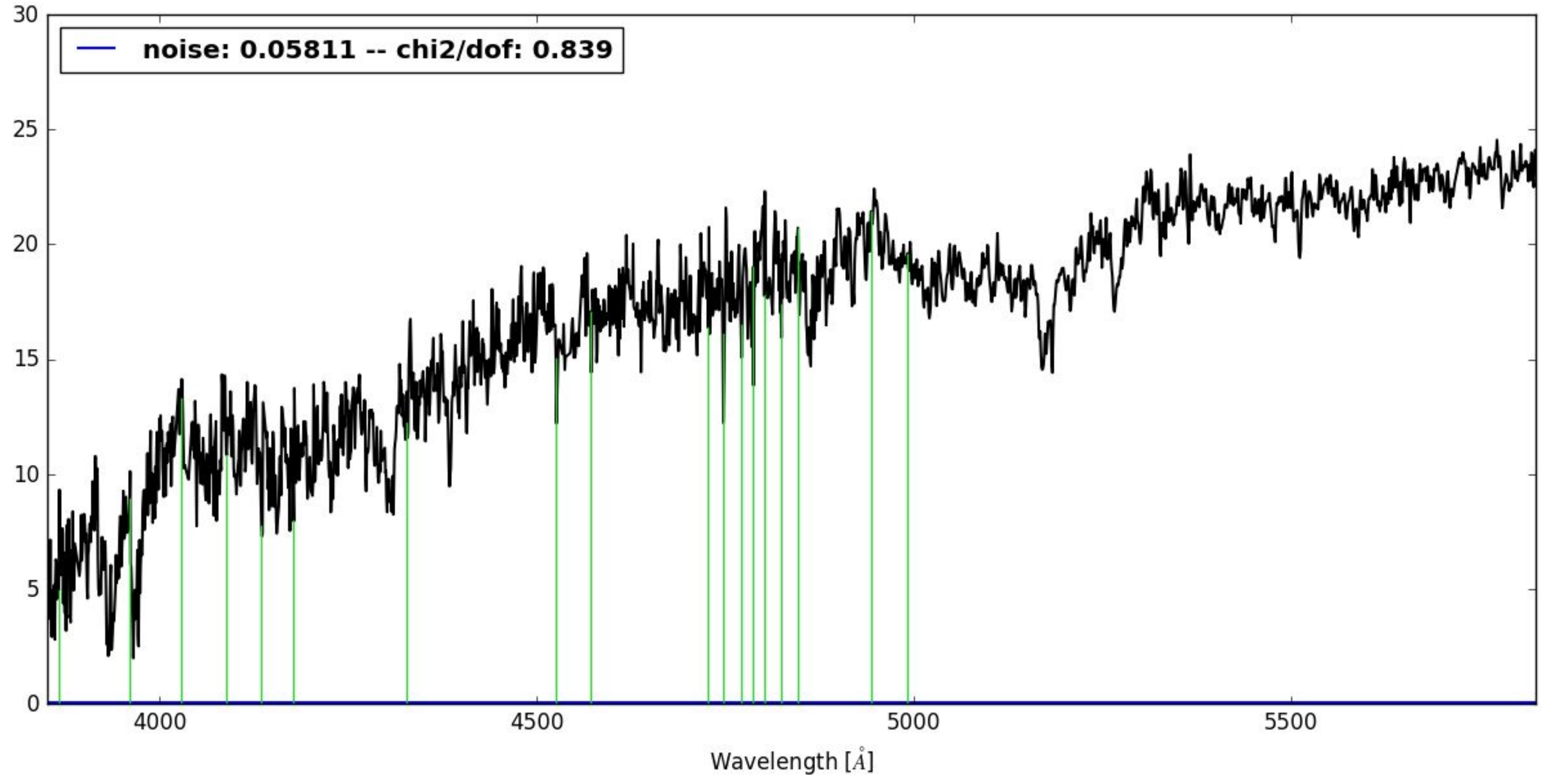

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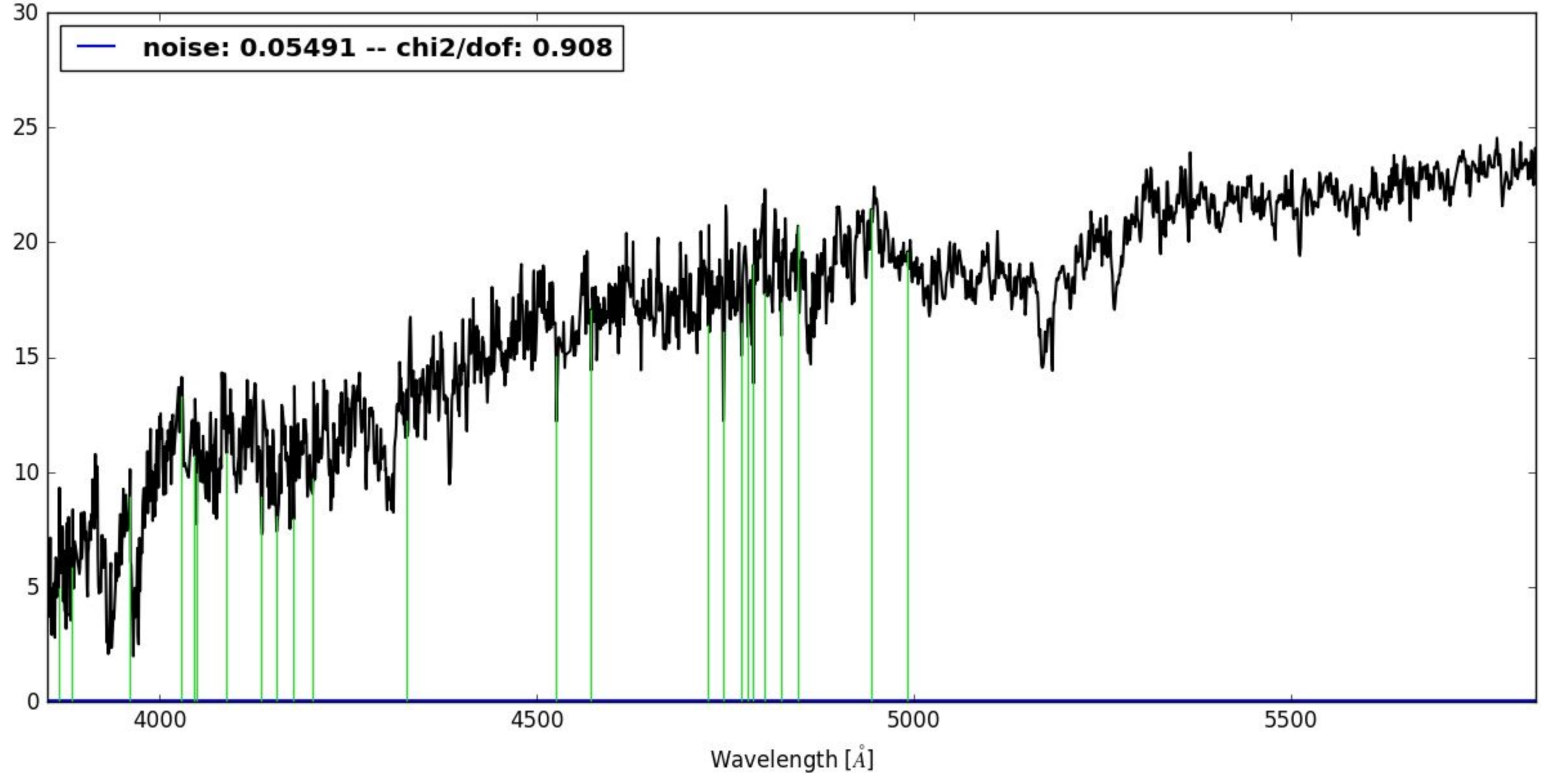

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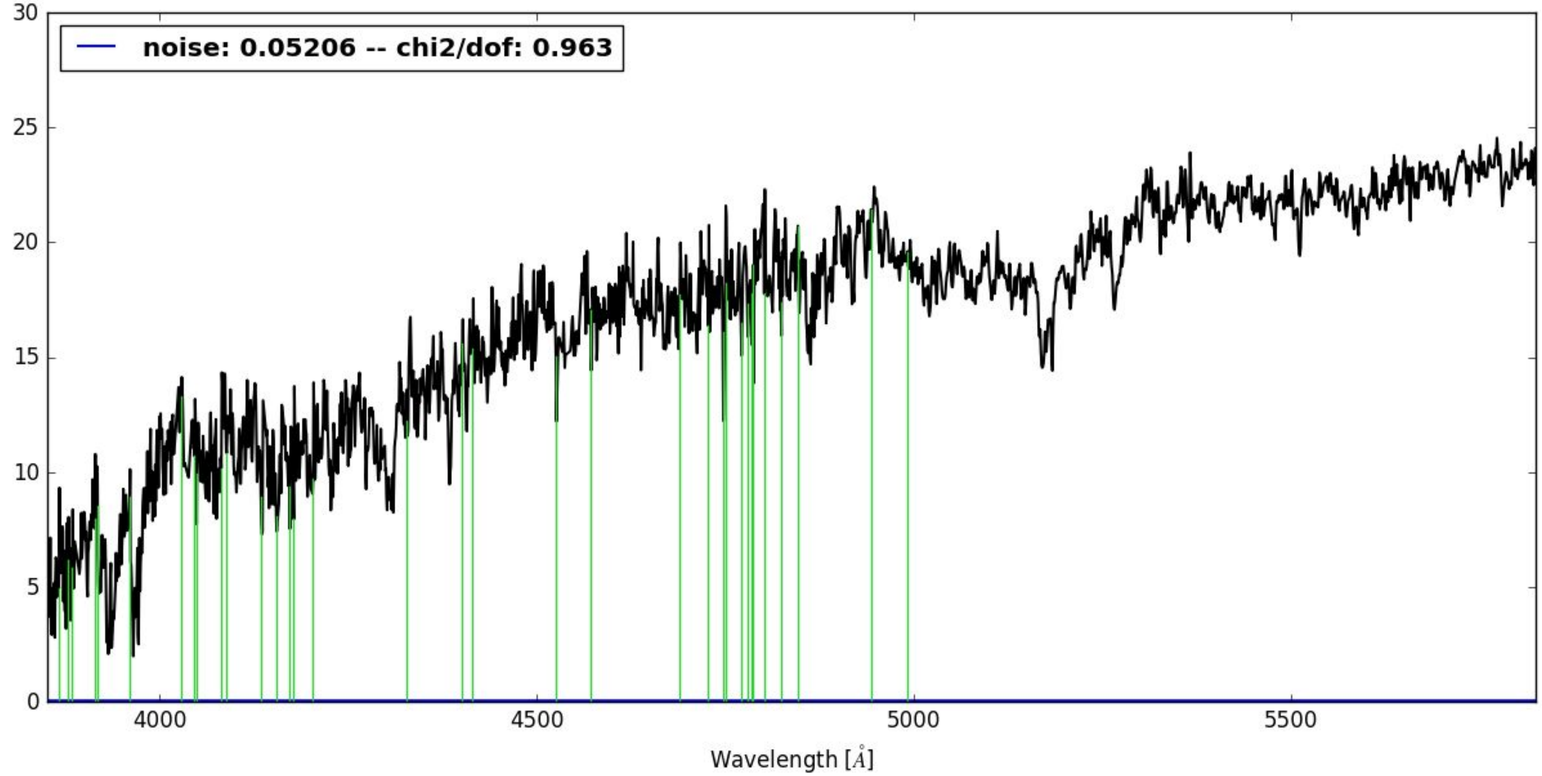

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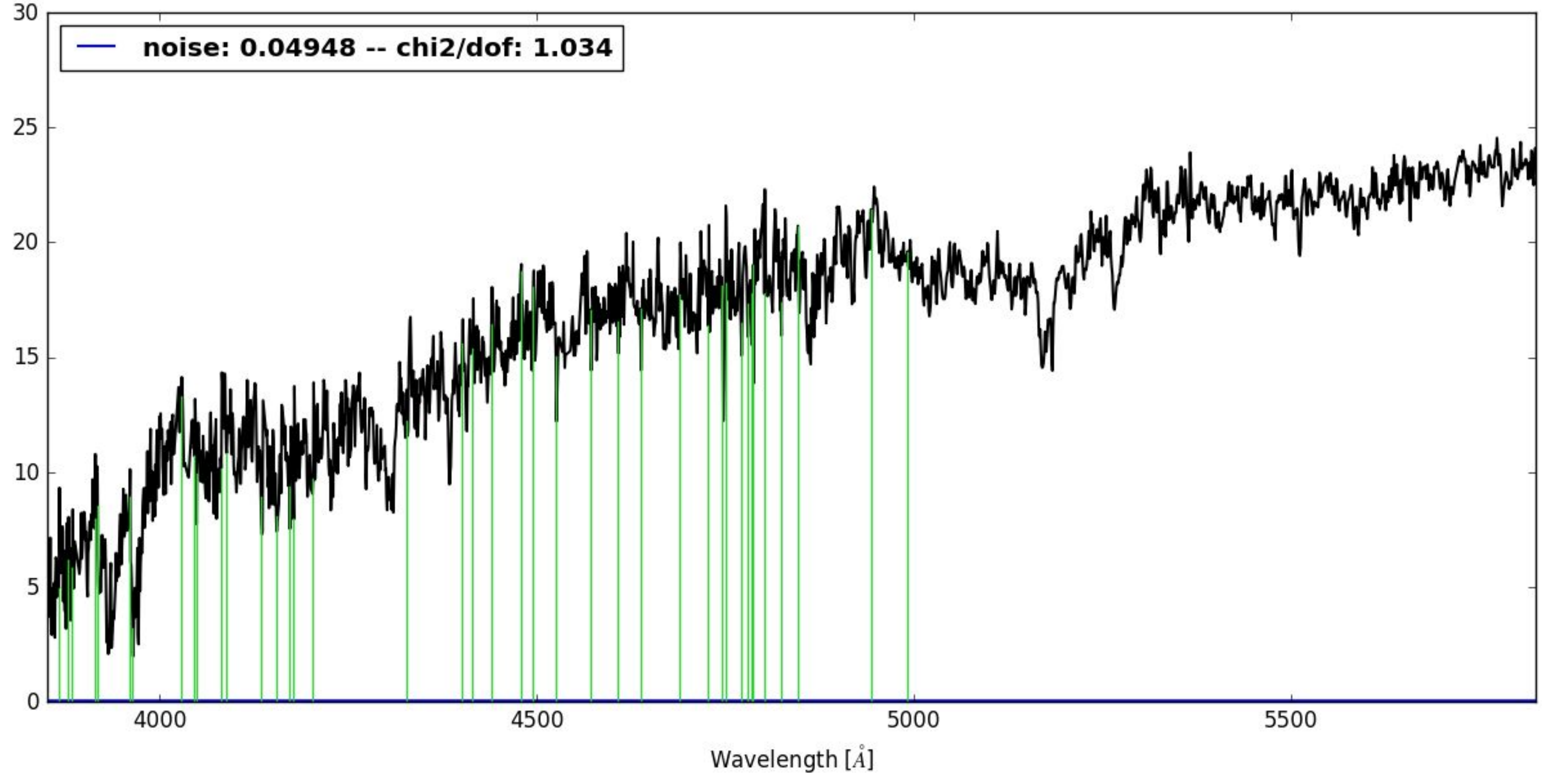

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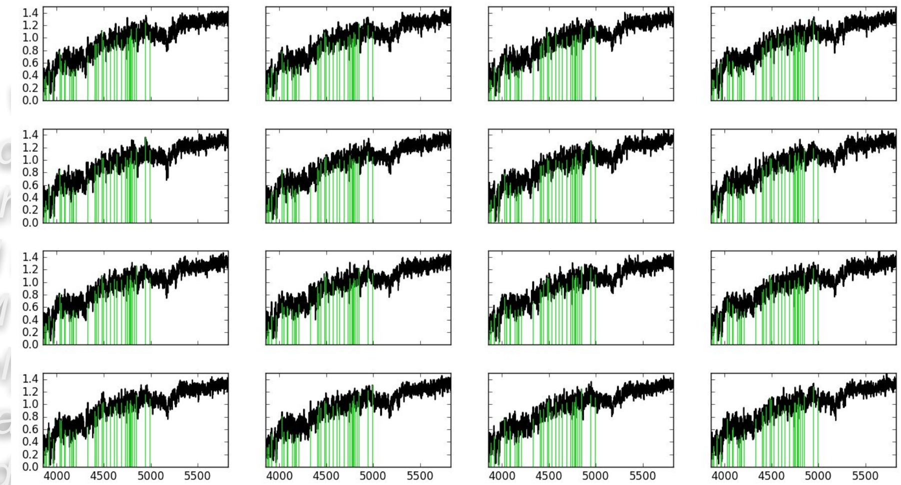


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3. Spectrum is trimmed according to redsh
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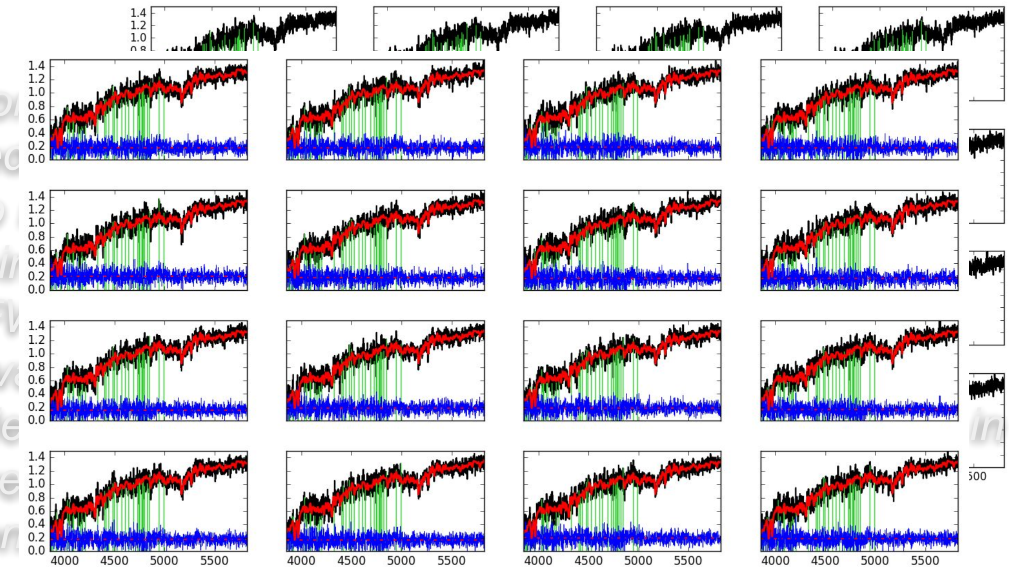
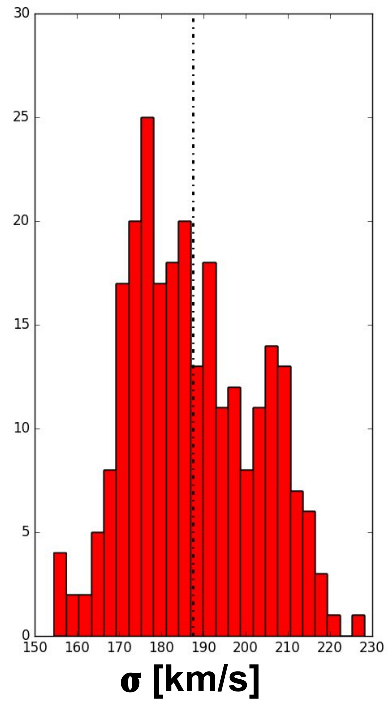
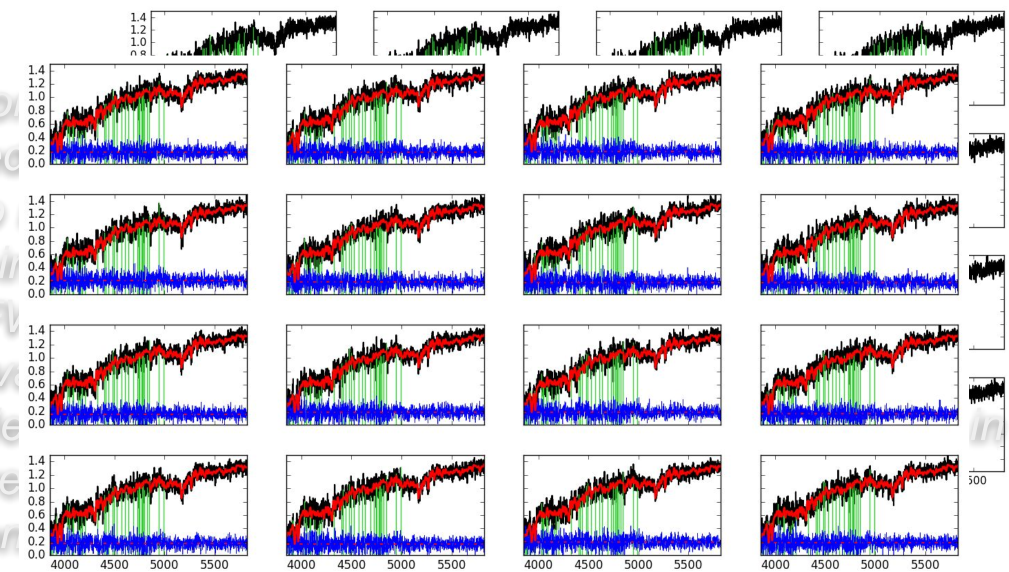


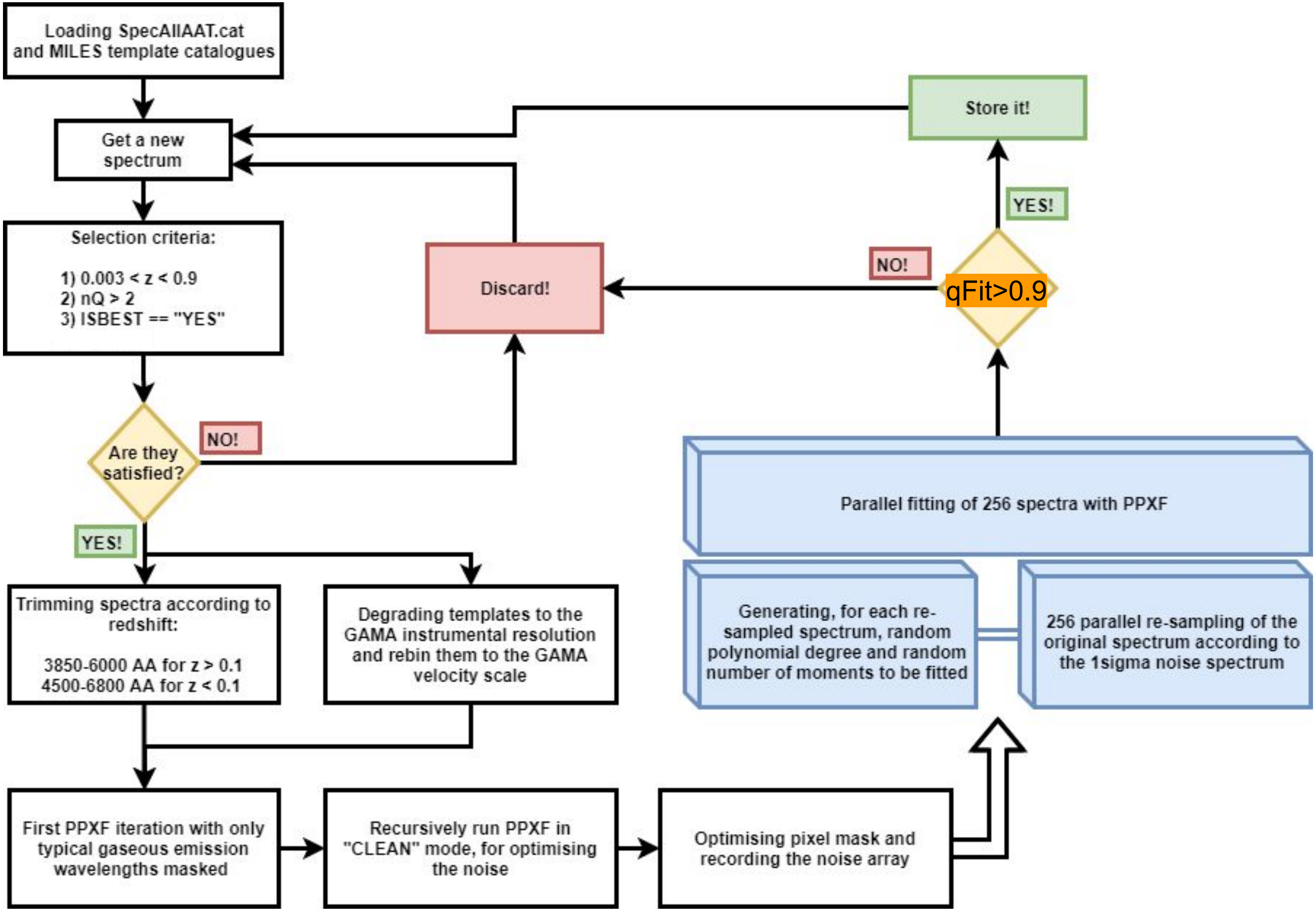

**256 fits run in parallel mode!**

# Optimised Modelling of Early-type Galaxy Aperture Kinematics (OMEGA-K)

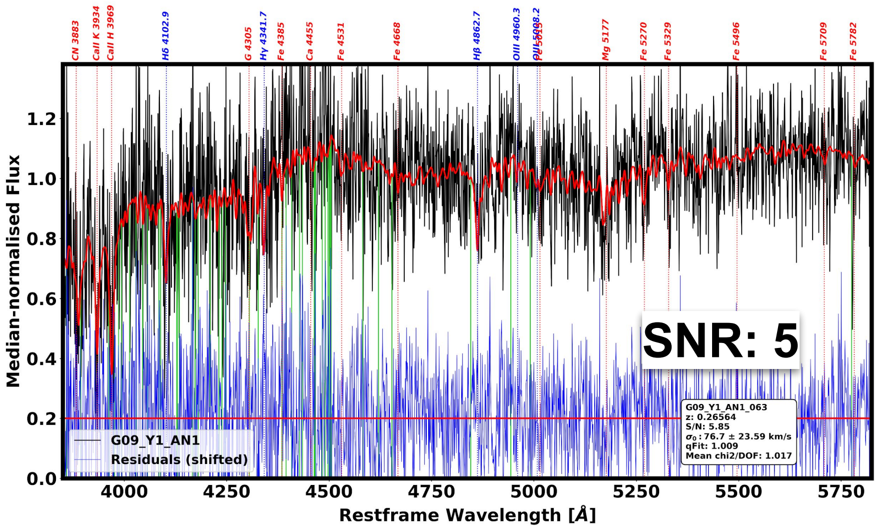


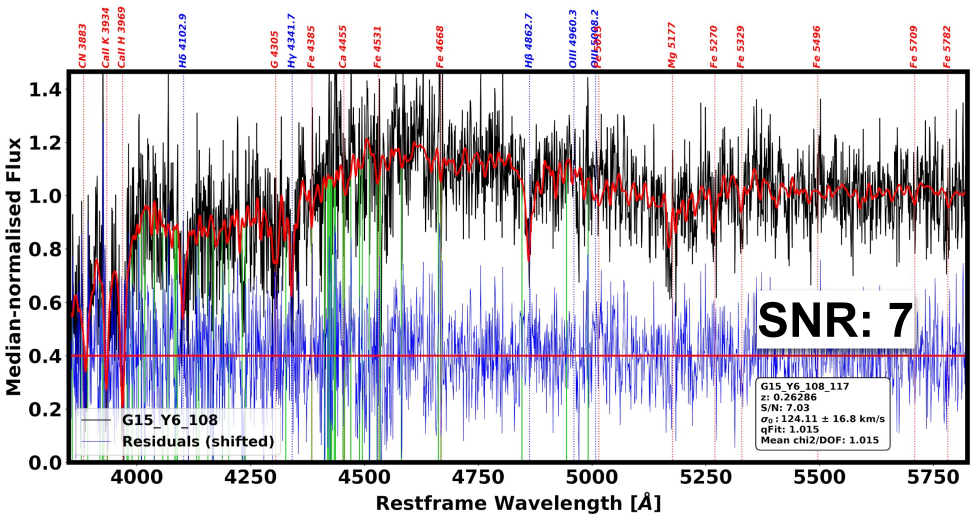



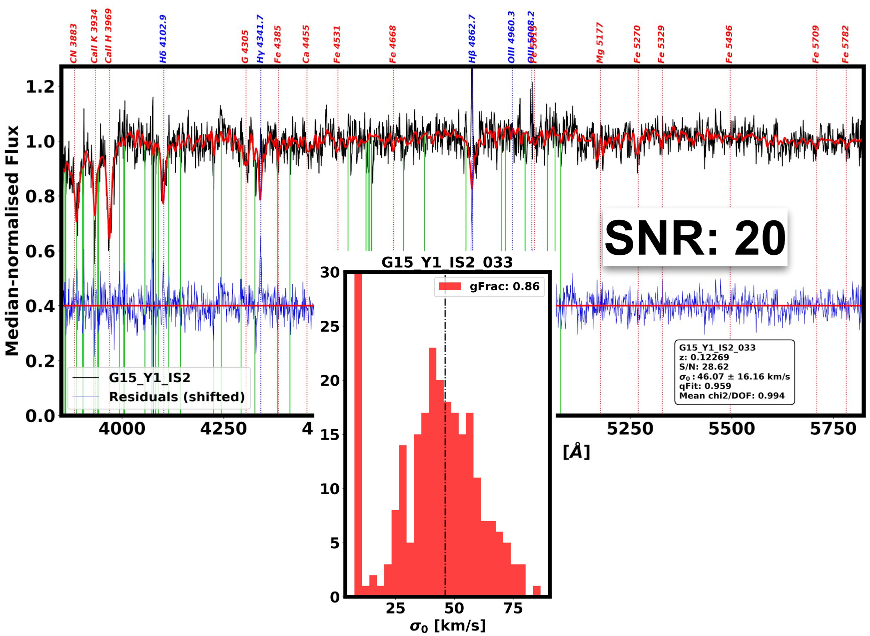

8. ***Our best velocity dispersion estimate is stored as the mean and standard deviation of the 256 bestfit velocity dispersions***

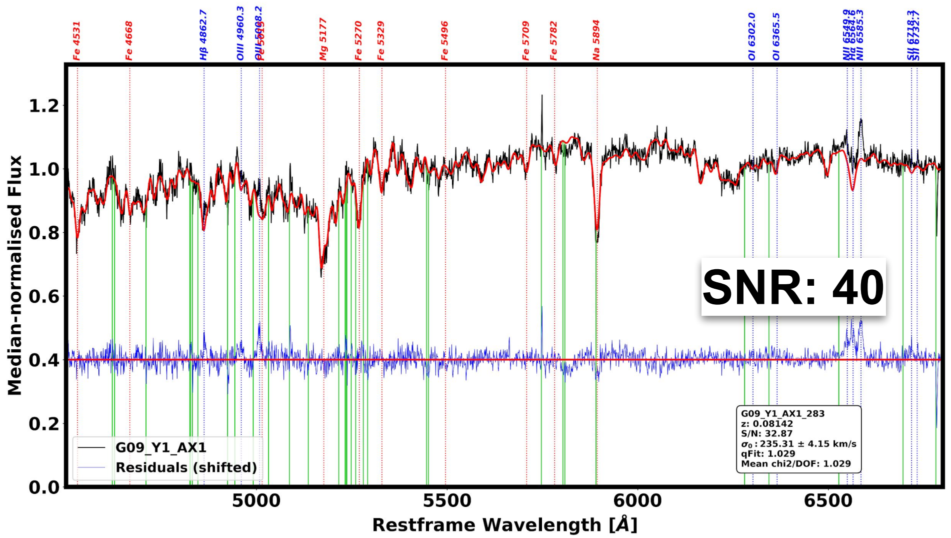

Loading SpecAllAAT.cat and MILES template catalogues
Get a new spectrum
Selection criteria:
1) 0.003 < z < 0.9
2) nQ > 2
3) ISBEST == "YES"
Are they satisfied?
NO!
Discard!
YES!
Trimming spectra according to redshift:
3850-6000 AA for z > 0.1
4500-6800 AA for z < 0.1
Degrading templates to the GAMA instrumental resolution and rebin them to the GAMA velocity scale
First PPXF iteration with only typical gaseous emission wavelengths masked
Recursively run PPXF in "CLEAN" mode, for optimising the noise
Optimising pixel mask and recording the noise array
Generating, for each re-sampled spectrum, random polynomial degree and random number of moments to be fitted
256 parallel re-sampling of the original spectrum according to the 1sigma noise spectrum
Parallel fitting of 256 spectra with PPXF
qFit>0.9
NO!
YES!
Store it!

# *Central velocity dispersions of the GAMA spectroscopic database*



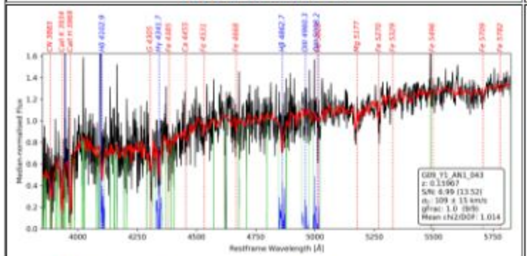
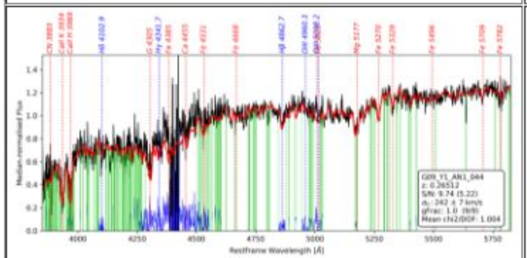
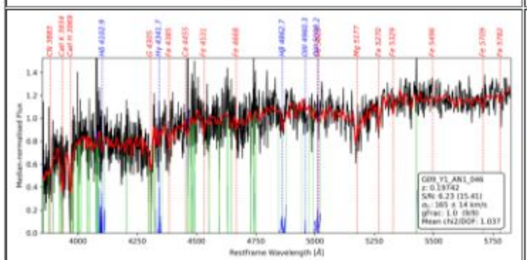



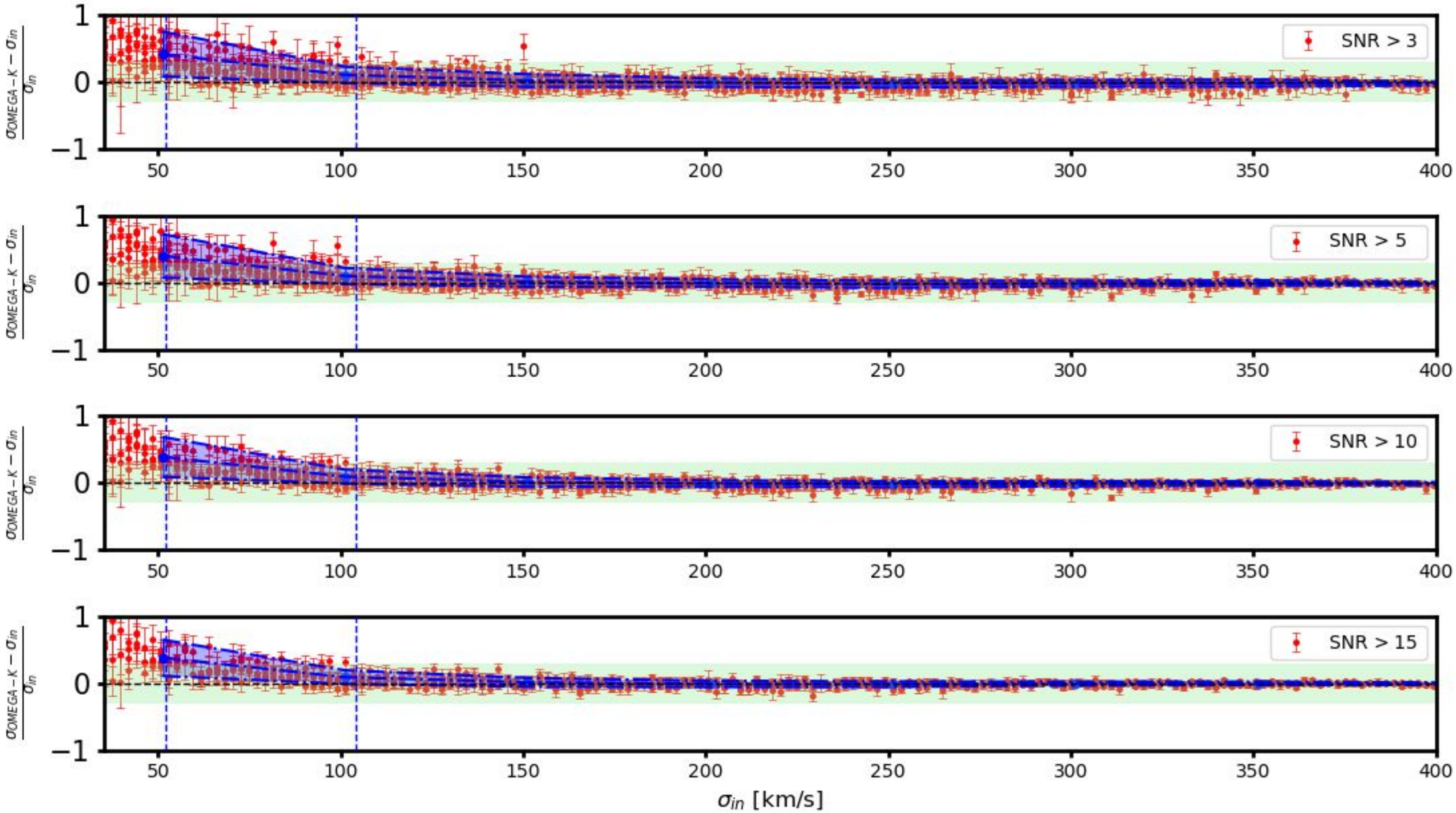
GAMA velocity dispersior

file:///C:/GAMAbootstrap/20182003_code/gama_html.html

# GAMA intDR velocity dispersion measurements with OMEGA-K

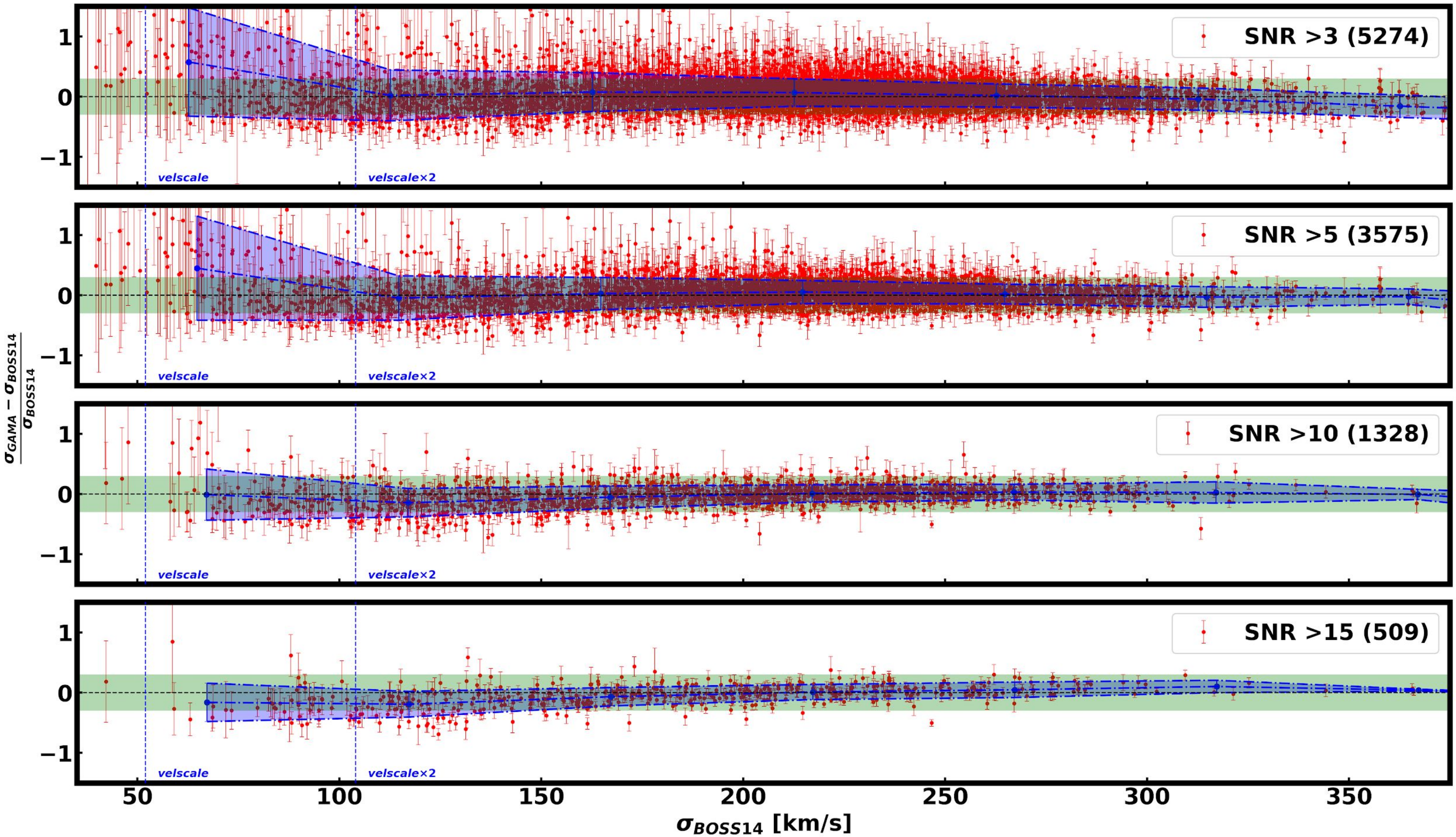
## (G. D'Ago, INAF-OACN)

| MEAN PLOTFIT | CATAID | SPECID | RA [deg] | DEC [deg] | z | SN | SN_m | SIGMEAN [km/s] | SIGERR [km/s] | gFRAC | Chi2/DOF |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 300522 | G09_Y1_AN1_043 | 129.94838 | 1.02466 | 0.15967 | 6.99 | 13.52 | 109 | 15 | 1. | 1.019 |
|  | 300518 | G09_Y1_AN1_044 | 129.91463 | 1.06686 | 0.26512 | 9.74 | 5.22 | 243 | 8 | 1. | 1.008 |
|  | 371124 | G09_Y1_AN1_046 | 130.14879 | 0.85127 | 0.19742 | 6.23 | 15.41 | 165 | 15 | 1. | 1.056 |
|  | | | | | | | | | | | |

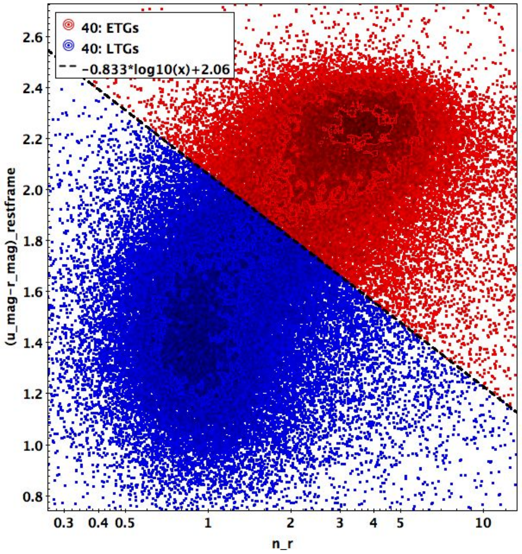



- 4000 GAMA-like simulated spectra (3 < SNR < 40)
- < 30% median scatter at 2*velscale
- < 10% median scatter at higher $\sigma$

# *Central velocity dispersions of the GAMA spectroscopic database*



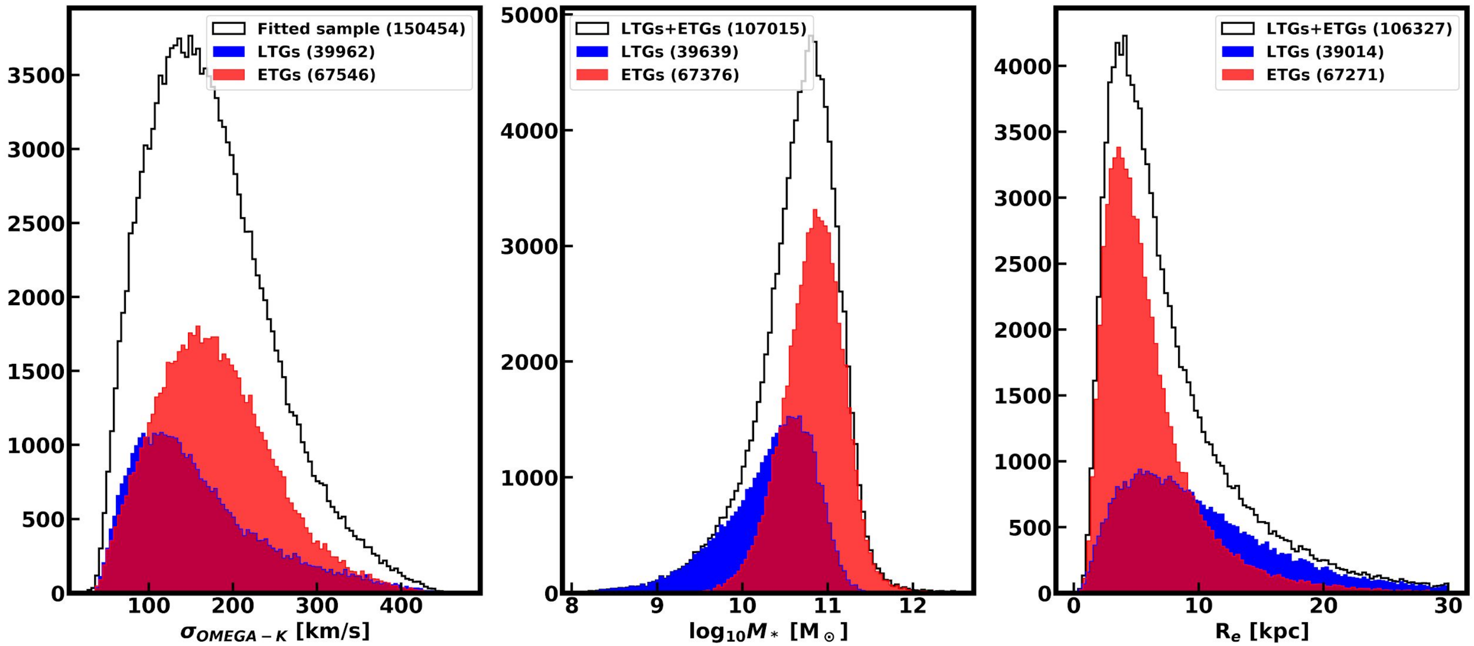

- **7000 matches with SDSS DR14**
- **< 30% median scatter at 2*velscale (SNR>5)**
- **few points at higher SNR show good agreement too**

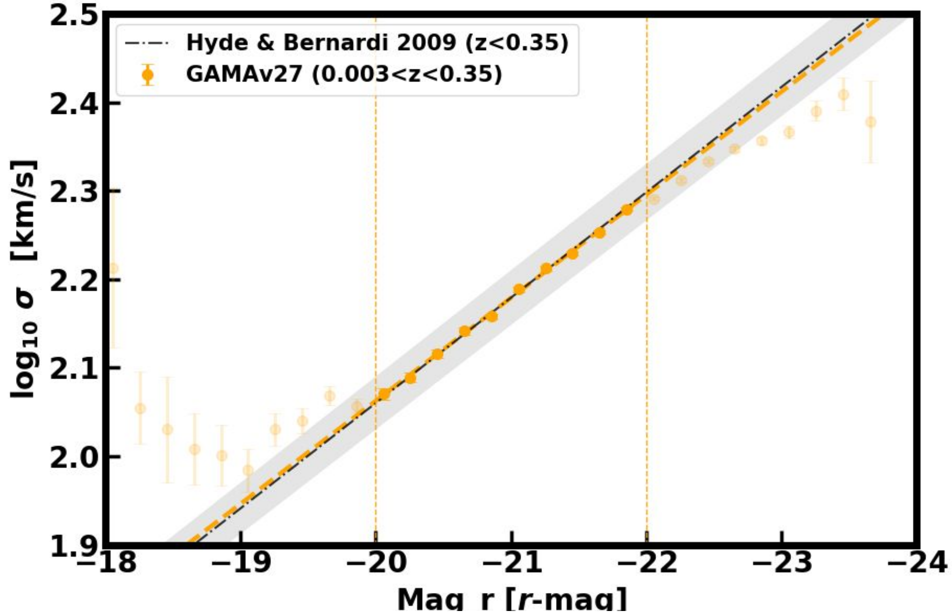


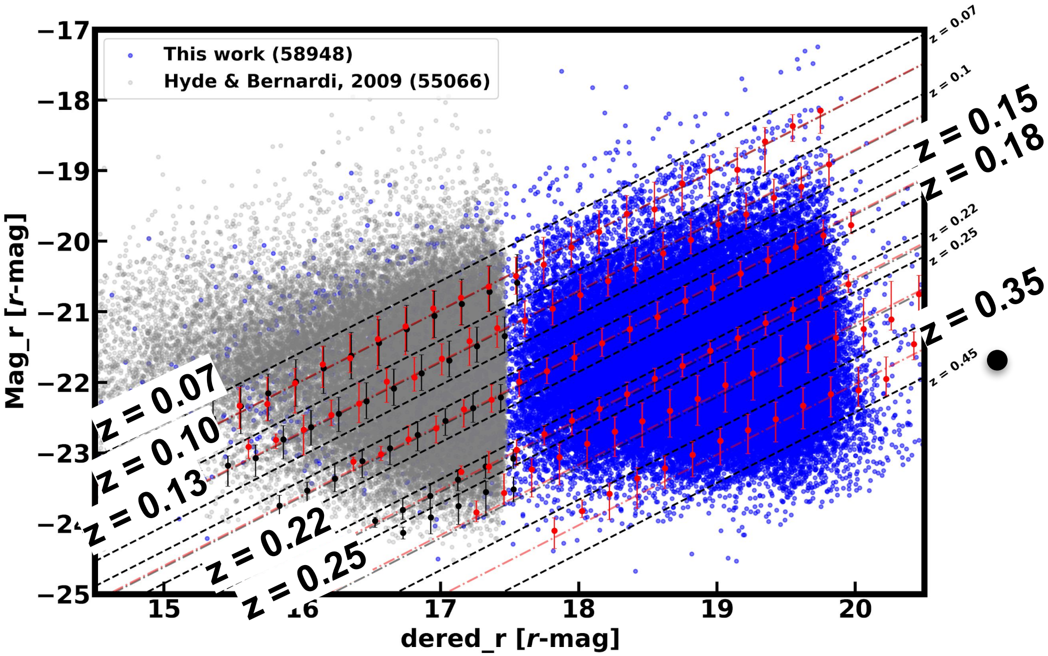

*from Kelvin, Lee S. et al. 2012:*

- *separation between disk-dominated (LTG) and spheroid-dominated (ETG) galaxies*
- ***u-r** vs $\boldsymbol{n_r}$*

- ***>150k galaxies***
- ***>100k galaxies with measured structural parameters by GAMA***






- ***Hyde and Bernardi investigated F-J relation in the 0.07 - 0.35 redshift range (fit to the median in 0.2 mag bins)***
- ***Our data are well compatible with the literature within magnitude range [-20 mag,-22 mag]***

***Hyde and Bernardi sample is more complete to lower redshift (see next slide)***

- ***We are more complete around z = 0.35***

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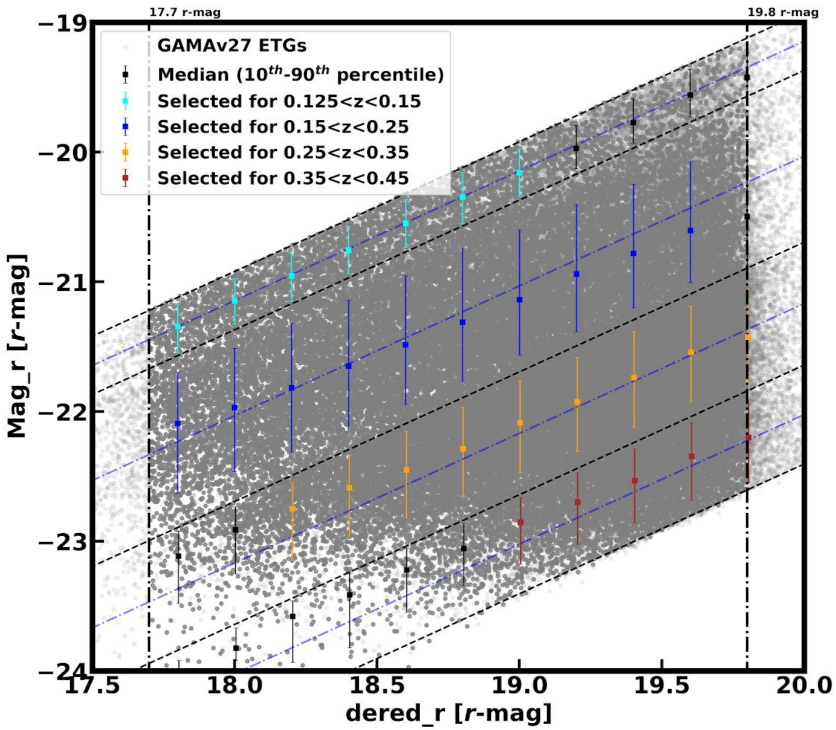
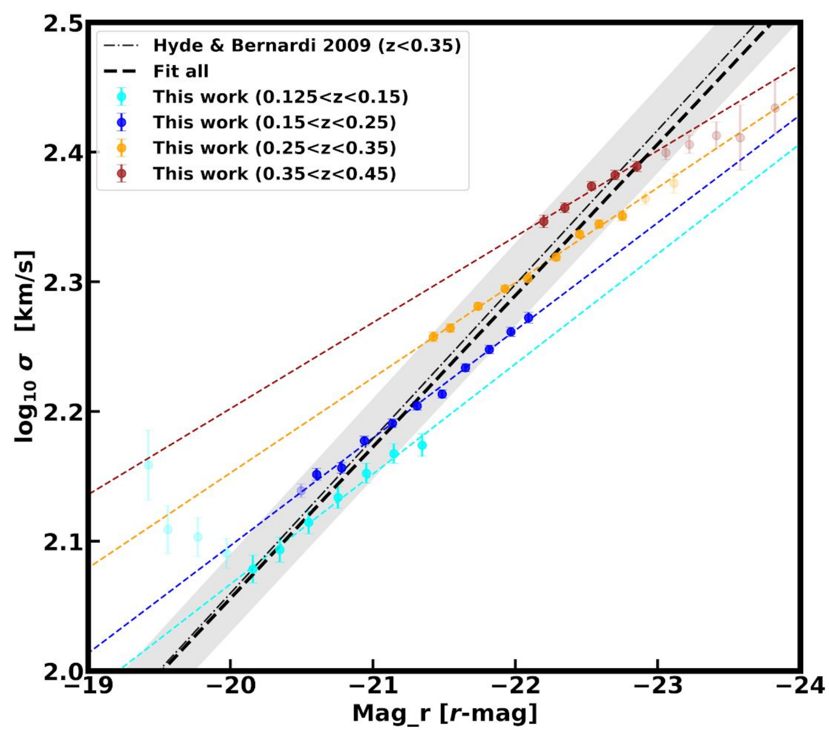
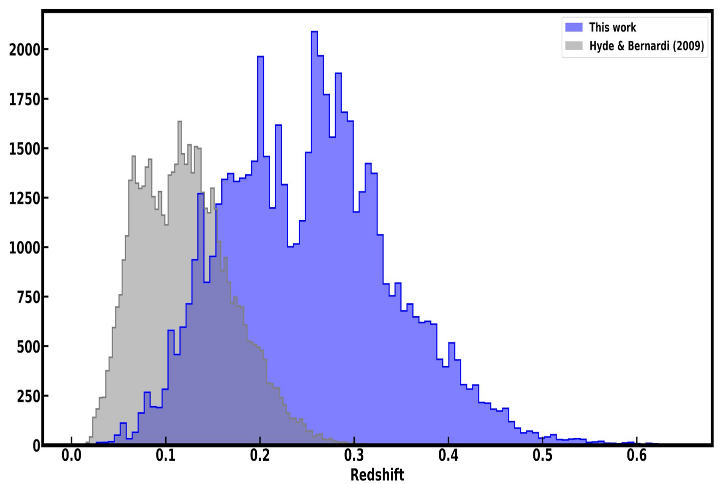
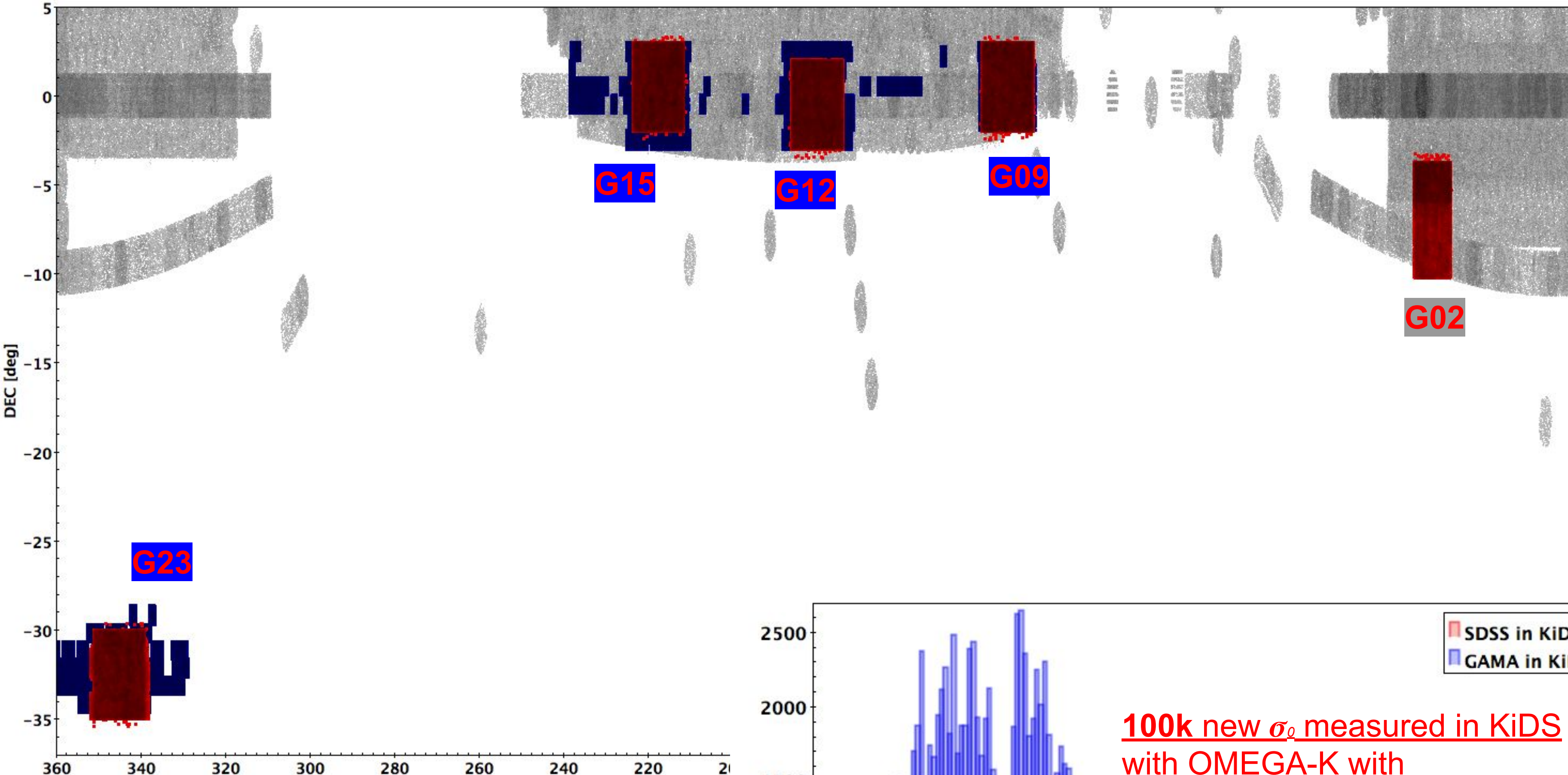


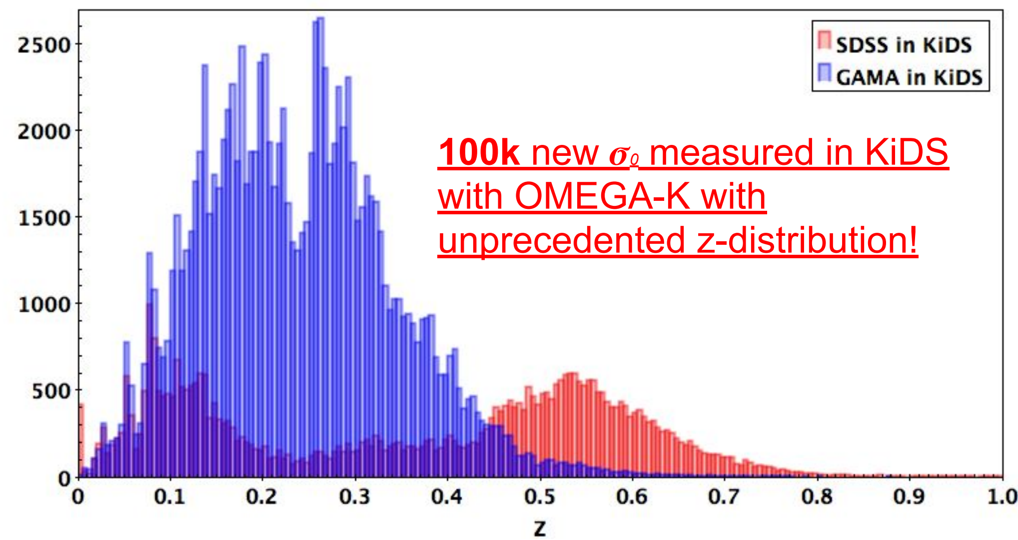




- ***The spectroscopic depth of our sample allows us to investigate different redshift bins suggesting a possible evolution of the F-J relation***
- ***The higher is the redshift, the less steep is the slope of the fit to the datapoints***

# *Central velocity dispersions of the GAMA spectroscopic database*




- ***150k galaxies match with KiDS database***
- ***40k galaxies match with SDSS DR14***
- ***5k galaxies in common KiDS/SDSS/GAMA***




**100k** new $\sigma_0$ measured in KiDS with OMEGA-K with unprecedented z-distribution!

***Thank you!***