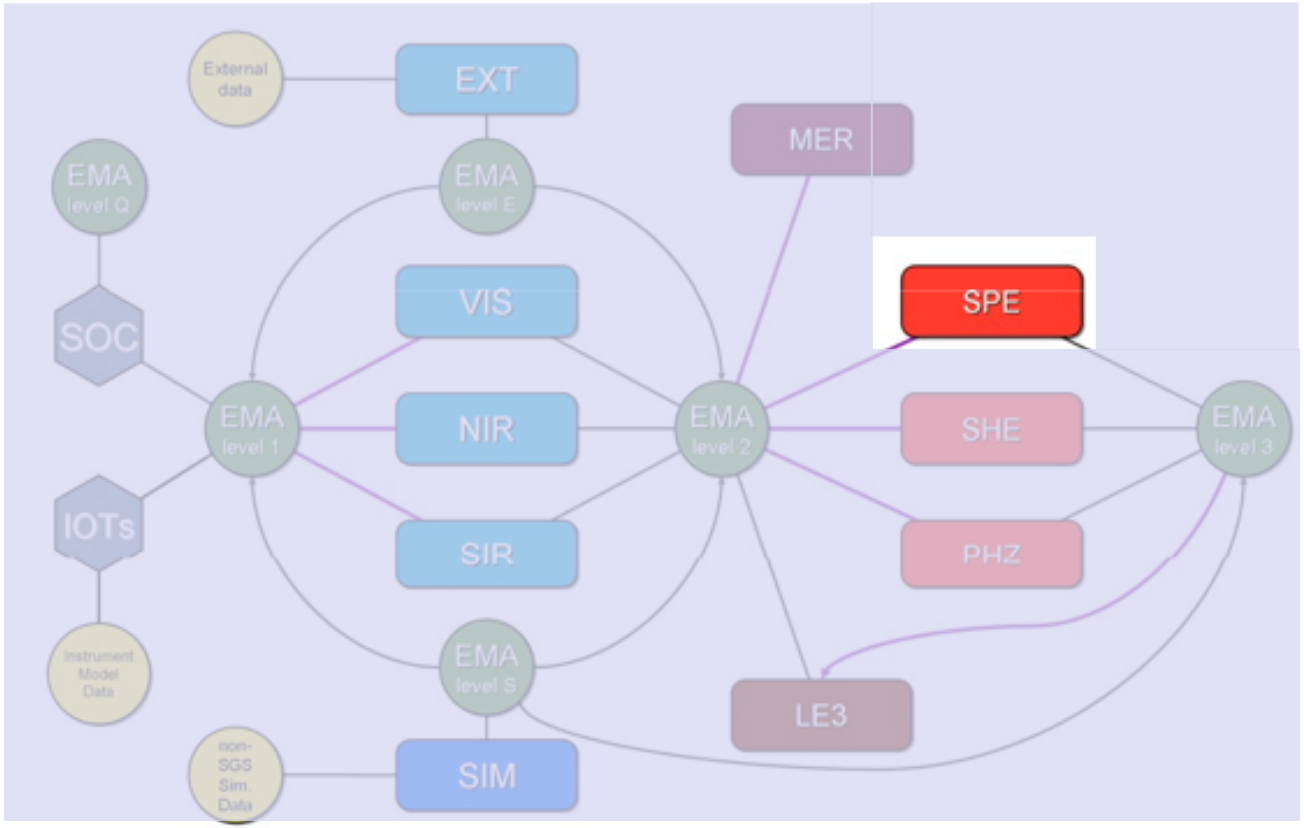
Processing Function SPE

OU–SPE (O. Le Fèvre/C. Surace)
SDC-FR (M. Poncet)
Calibration (B. Epinat)

Calibration Work Shop

Organisation



Interfaces :

- PF interfaces :
  - SIM
  - SIR
  - PHZ
- SWG interfaces :
  - GC
- Calibration
- SDC dev :
  - SDC-FR
  - SDC-IT

Goals

Goal of the PF-SPE :

- PF-SPE should deliver redshift and spectrophotometric information for each spectrum available, observed with NISP
- PF-SPE should provide
  - Best redshift for each galaxy, and list of redshifts with quality flags
  - PDF for redshift measurement
  - Measurements of spectral features (Emission Lines, Absorption lines, spectral breaks, continuum)
  - Spectral classification of each object
- INPUTS : 1D Spectra and associated 1D Noise from PF-SIR.
  - 1D decontaminated combined spectra
  - Single 1D decontaminated spectra for each single roll observation.
  - 1D Covariance matrix

Organisation

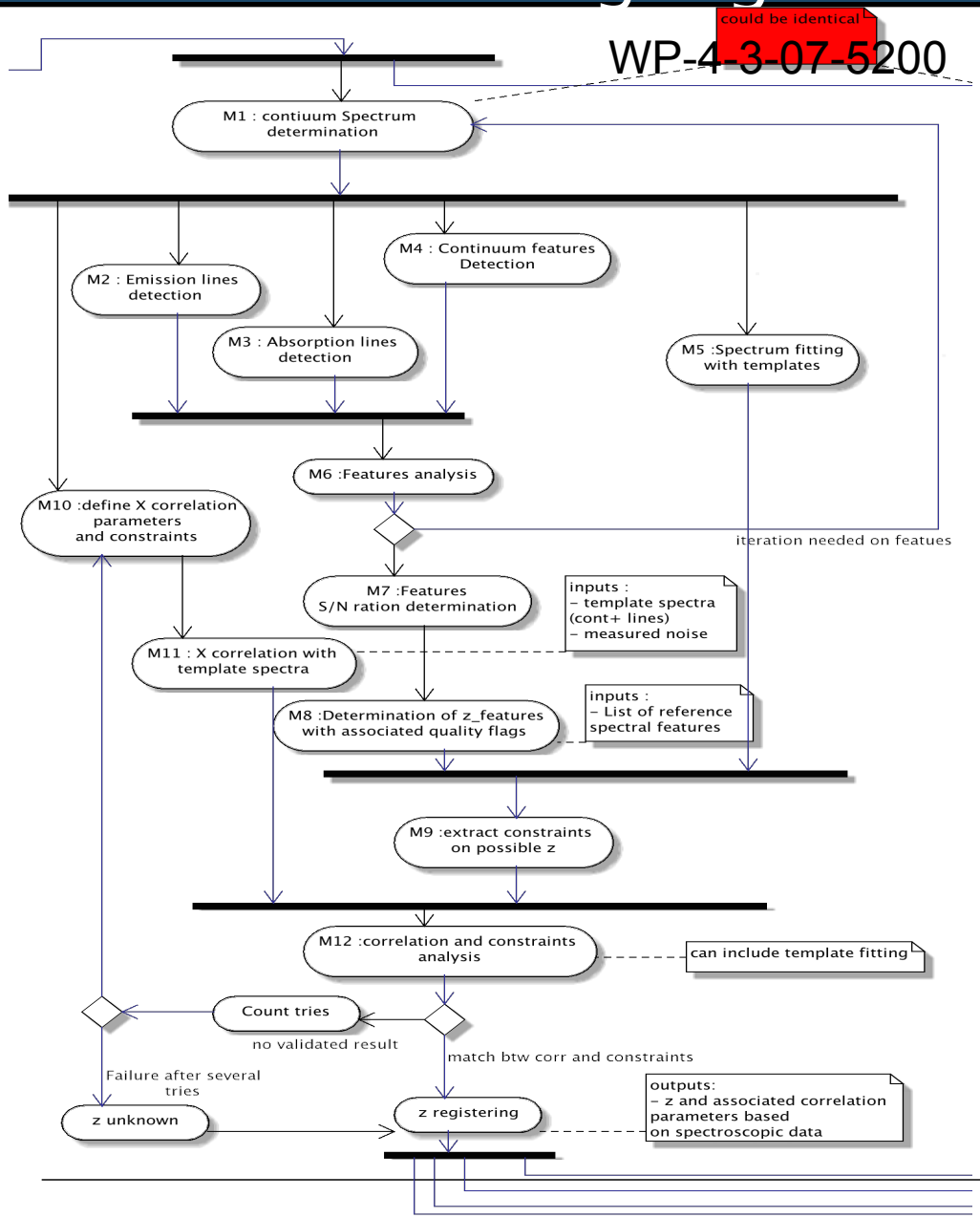
Wp number	Name	Leader	SDC-DEV
WP-4-3-07-1000	SPE Management	O. Le Fèvre	
WP-4-3-07-2100	SDC Interfaces	P.Y. Chabaud	
WP-4-3-07-2200	Interfaces - OUs	C. Surace	
WP-4-3-07-3000	Requirements and V&V	V. Le Brun	FR
WP-4-3-07-4100	Data Model	J.C. Meunier	FR
WP-4-3-07-4200	Data Calibration	B. Epinat	FR
WP-4-3-07-4300	Quality Mask	C. Surace	FR
WP-4-3-07-5200	Lines id. and z measurement	V. Le Brun	FR
WP-4-3-07-5300	Spectral features Measurement	M. Moresco	IT
WP-4-3-07-5400	Z Quality	O. Le Fevre	FR
WP-4-3-07-5500	Rest Frame Parameters	L. Tasca	FR
WP-4-3-07-5600	Spectro photo classification	O. Ilbert	FR
WP-4-3-07-6000	Infrastructure	T. Fenouillet	FR
WP-4-4-03-2207	SDC-FR DEV SPE PF implementation	P.Y. Chabaud	FR
WP-4-4-03-2307	SDC-FR DEV Support to SPE PF V&V	T Fenouillet	FR

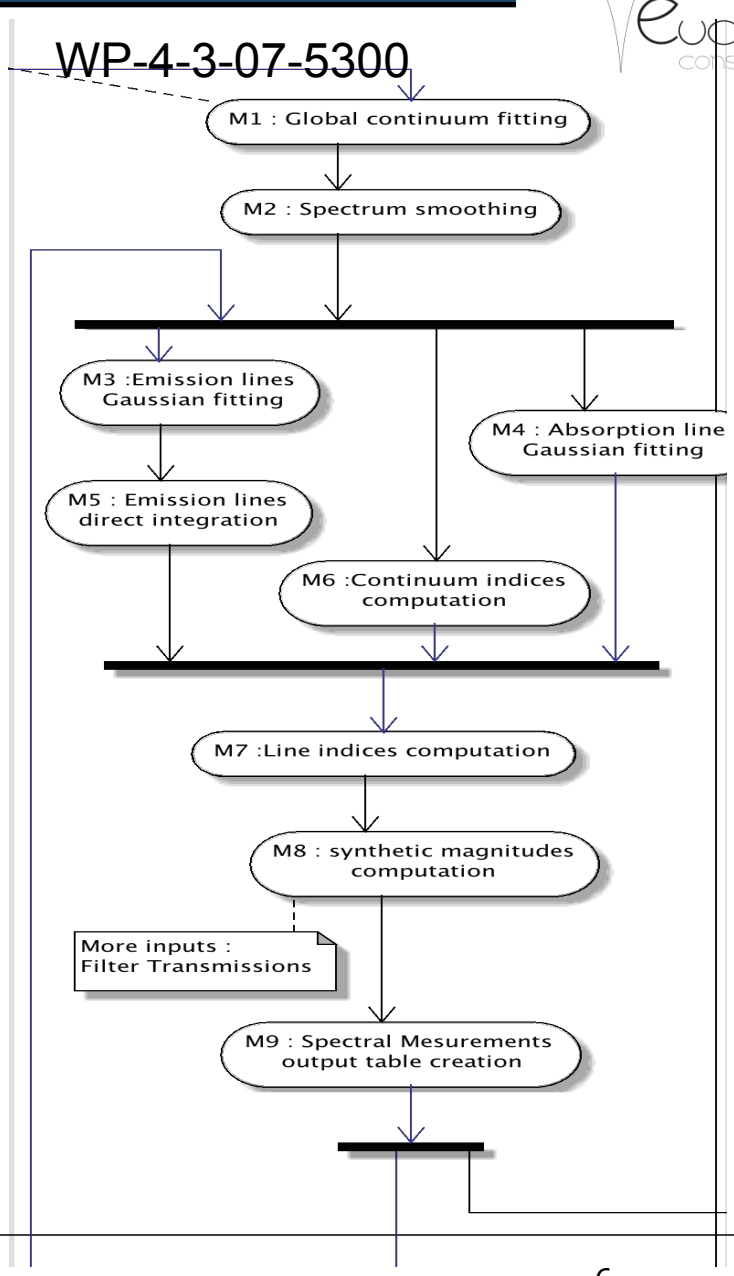
PF-SPE Implementation

- The PF has been split in Processing Elements. Each PE has been split into Modules.(links are descriptions of the PE in the EUCLID SGS redmine site)

- PE5200 : Lines id. and redshift measurement
  - http://euclid.roe.ac.uk/projects/ou-spe/wiki/5200_v01_Describe_modules_in_prototype
- PE5300 : Spectral features Measurement
  - http://euclid.roe.ac.uk/projects/spe_pf/wiki/PE5300
- PE5400 : Redshift Quality
  - http://euclid.roe.ac.uk/projects/ou-spe/wiki/5400_v01_Describe_modules_in_prototype
- PE5500 : Rest Frame Parameters
  - http://euclid.roe.ac.uk/projects/ou-spe/wiki/5500_v01_Describe_modules_in_prototype
- PE5600 : Spectro photometric classification
  - http://euclid.roe.ac.uk/projects/ou-spe/wiki/Wp-4-3-07-5600-Description

Flow chart - Highlights

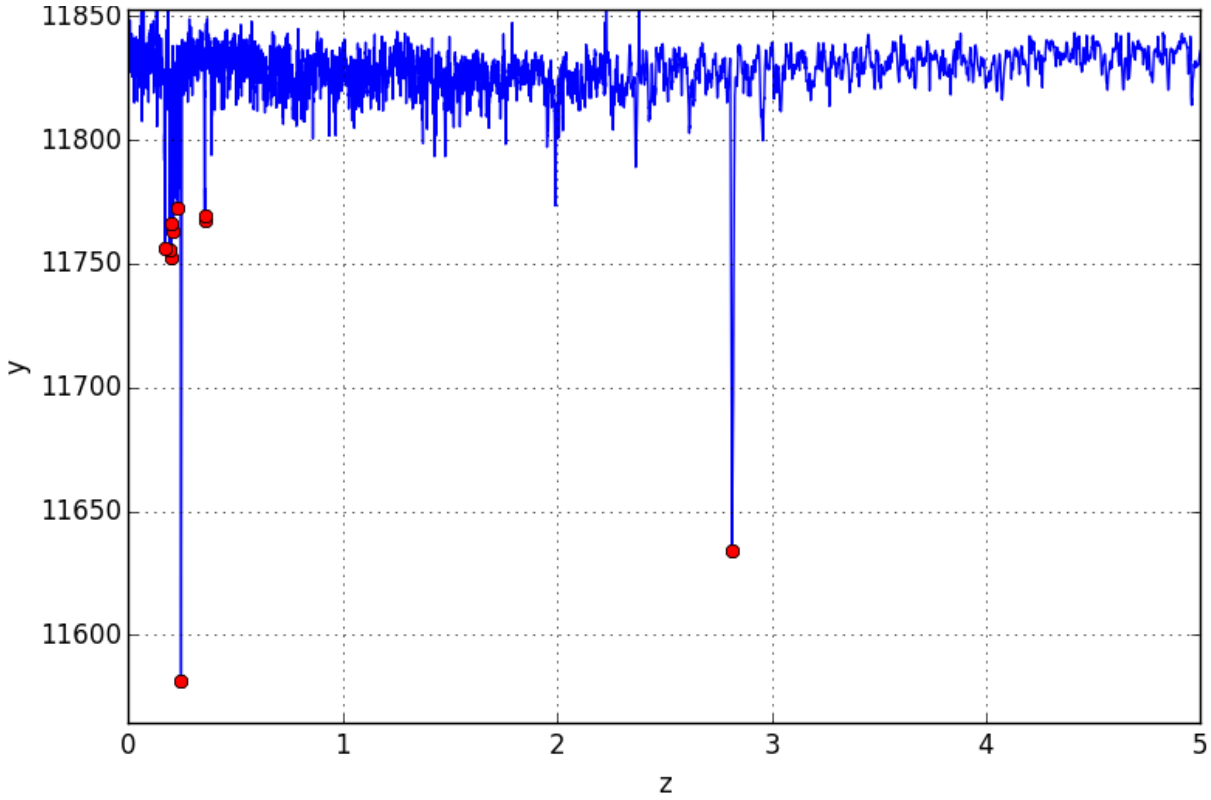




Algorithms: PE5200

Cross correlation with templates:

- Minimisation of the χ^2 function vs. redshift and maximisation of the likelihood

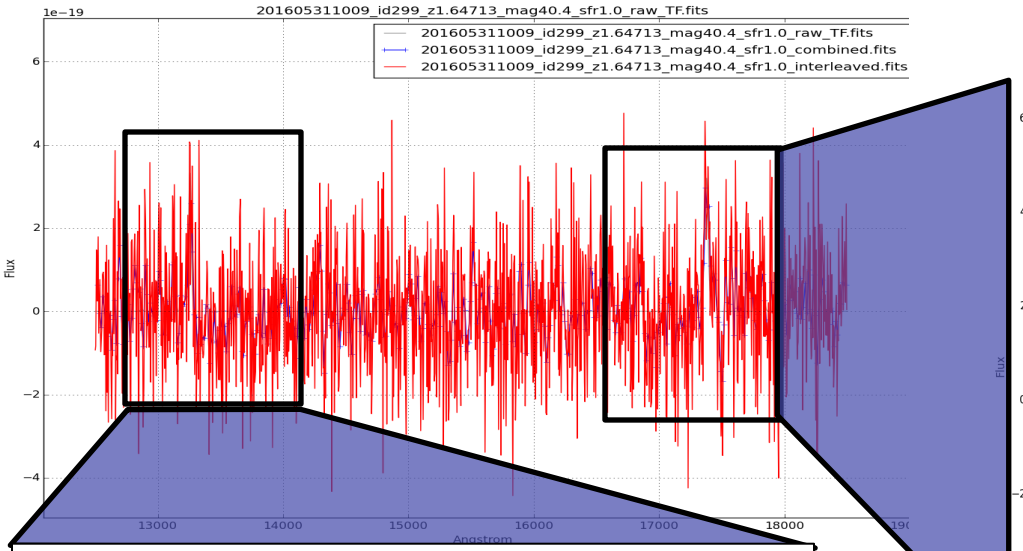


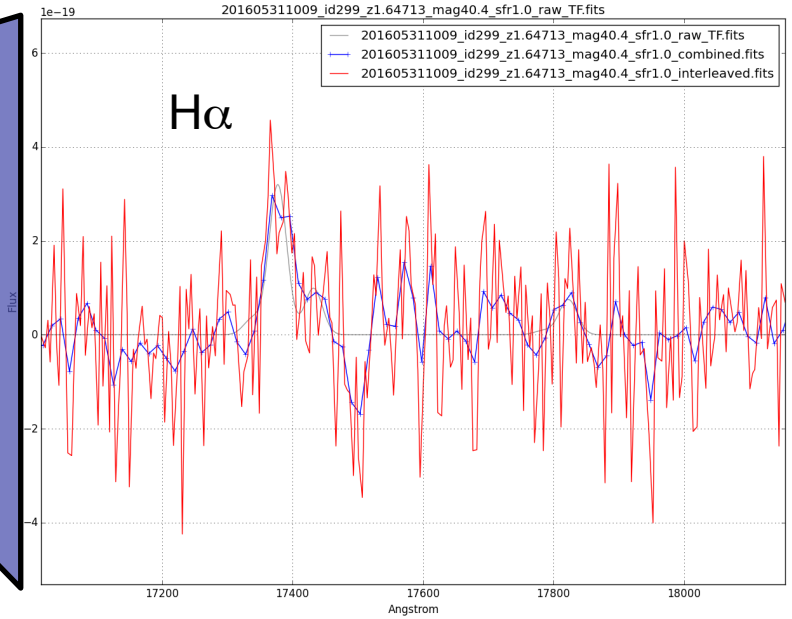
χ^2 function vs. Redshift

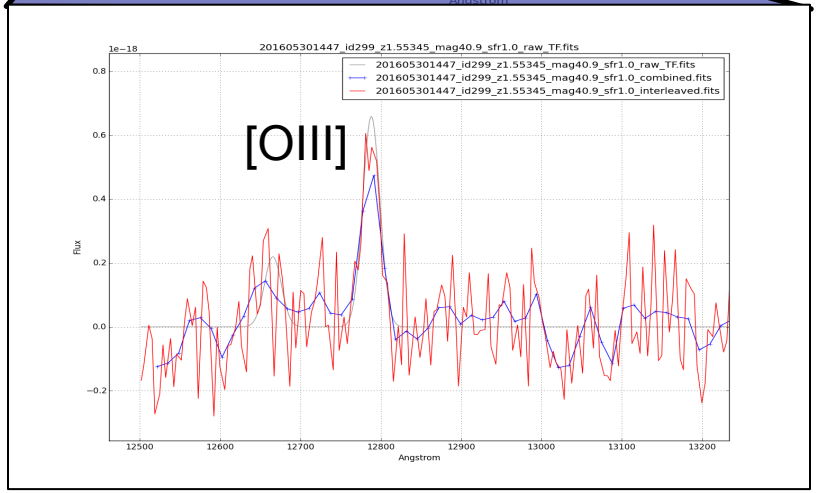
- The red points are the 10 best redshifts (peaks in χ^2
- Each redshift value has an associated quality (probability)

Test Status and Results: PE5200

Simulated spectra from internal data, with gaussian noise, no contamination noise. SIM simulated spectra will be next (beeing tested)





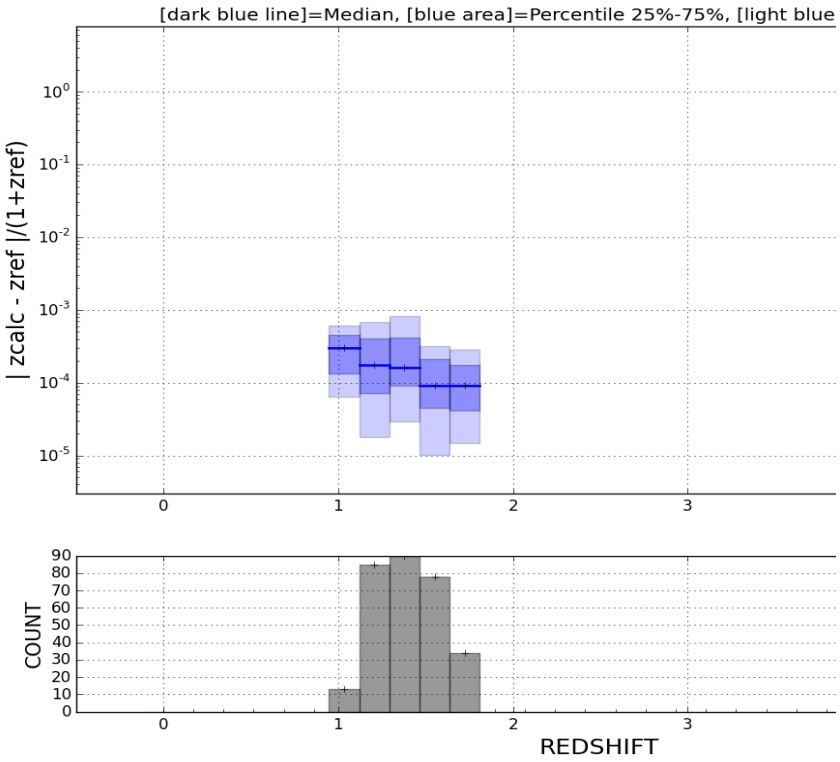


Simulated galaxy at z=1.647

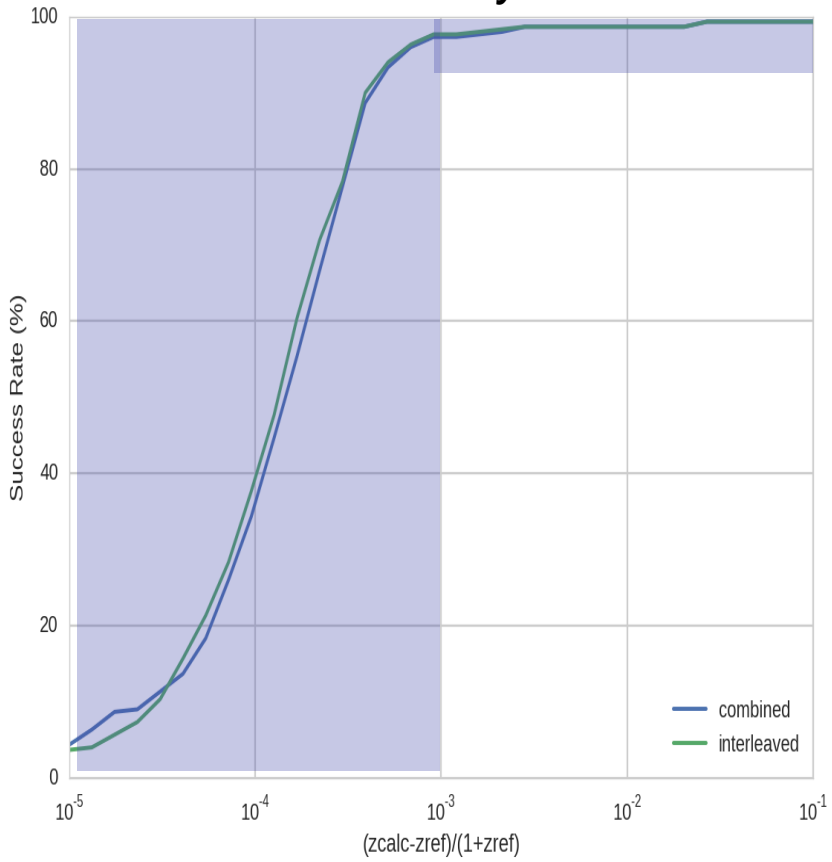
Test Status and Results: PE5200

Example of the analysis of simulated spectra using 4 roll angles spectra for the redshift extraction. With these data we reach the requirement of $\delta z < 10^{-3}$

Redshift accuracy



Success rate in redshift measurement vs. Redshift accuracy

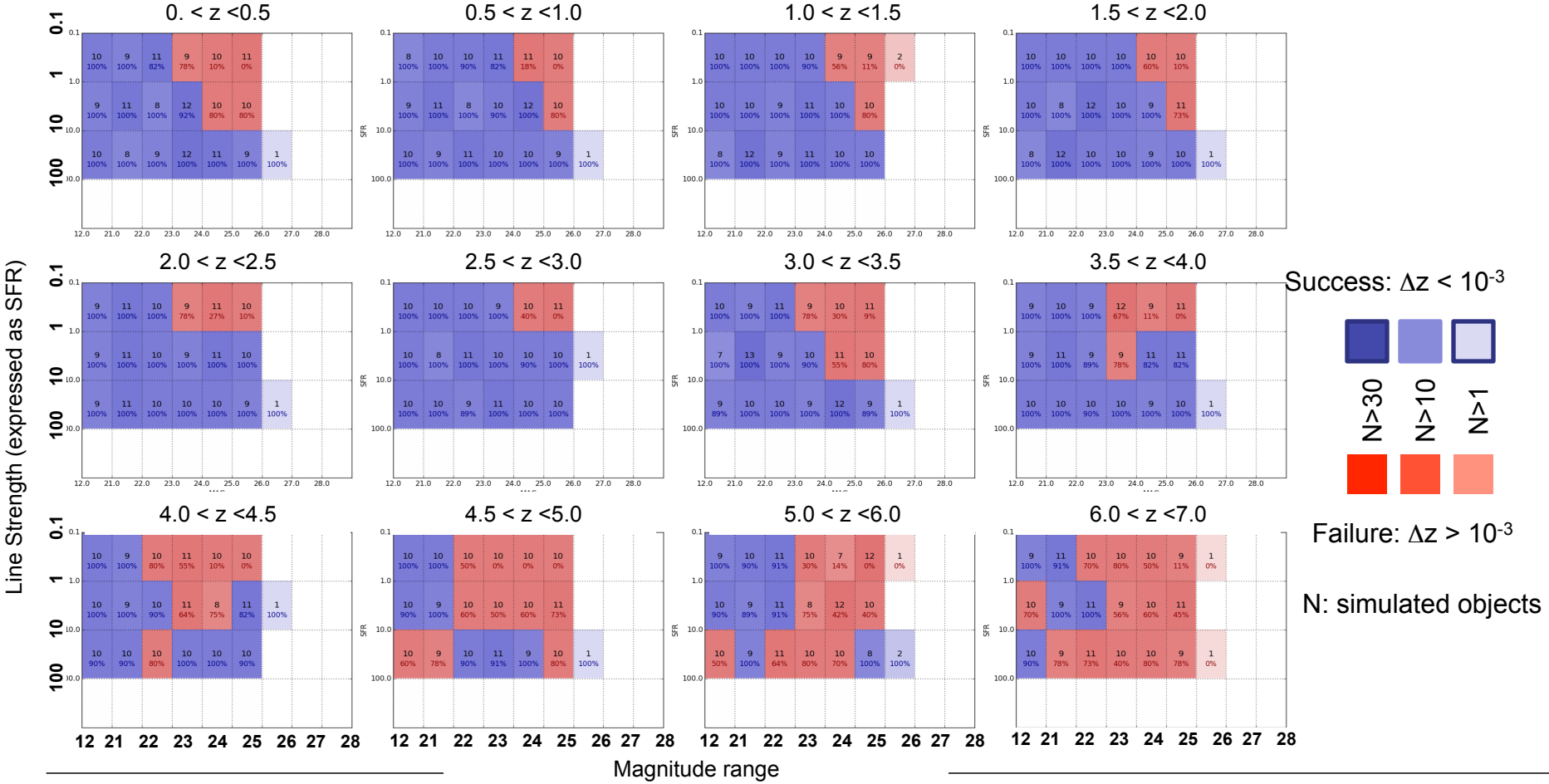


Test Status and Results: PE5200

Performance Tests to validate methods

A performance matrix is set up to identify limitations of the methods.

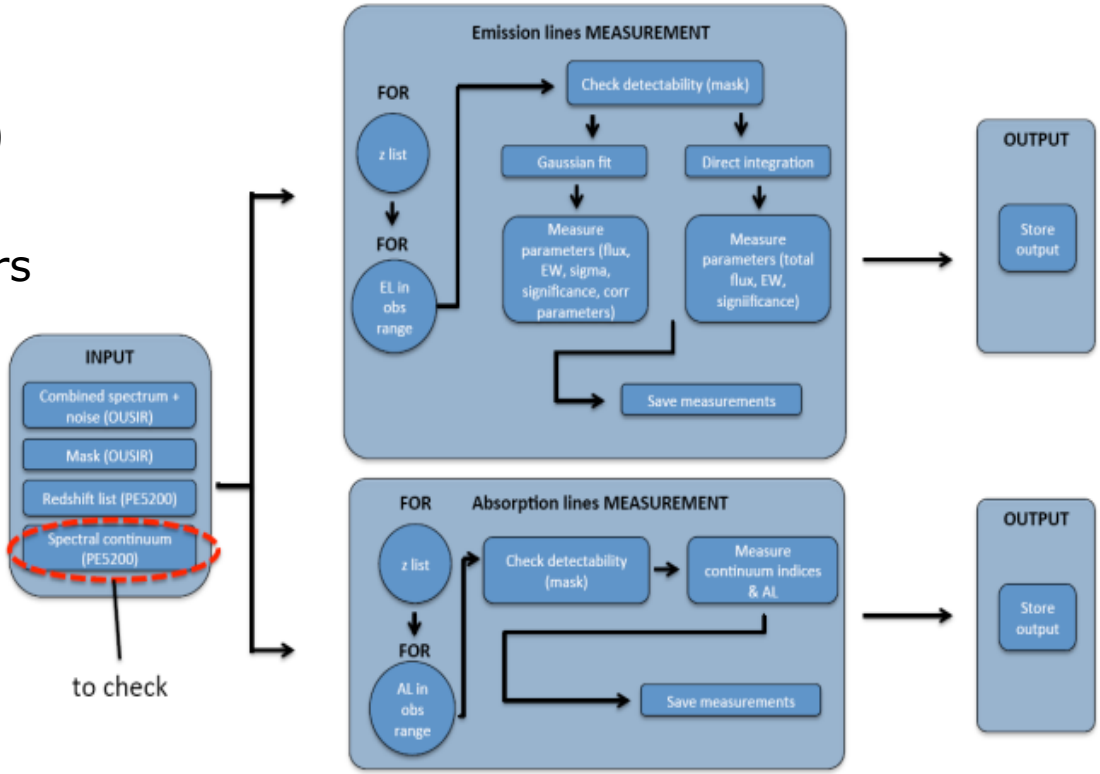
For each redshift bin (z=0 to 7.0 with 0.5 steps), simulations are produced on a grid of integrated line fluxes and objects magnitude. PF-SPE is run on the simulated spectra and the success rate in redshift measurement is computed for each bin.

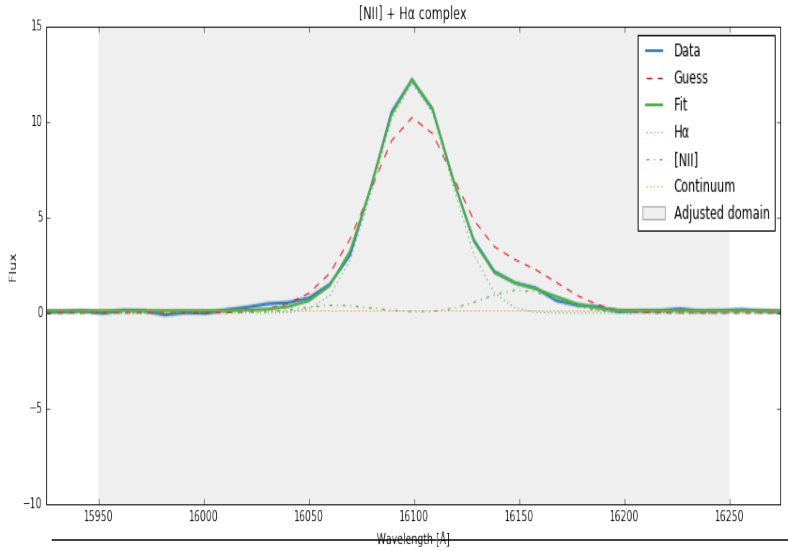


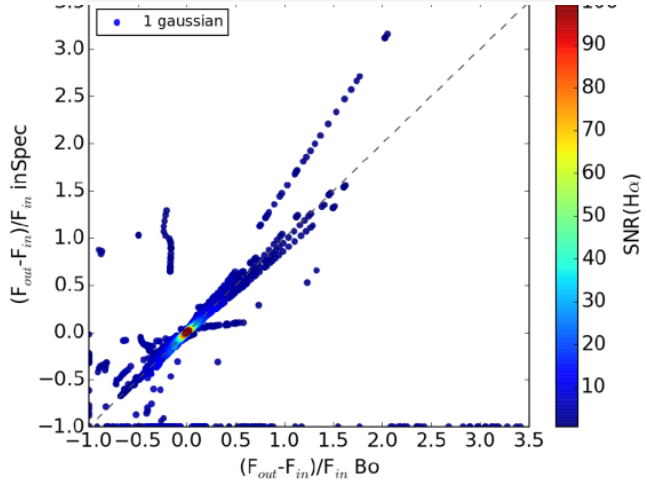
Algorithms: PE5300

PE5300: line measurement

- With the redshift list from PE5200 compute line fluxes, EW, FWHM
- Perform line fit and measure errors
- Provide measurement of the continuum and absorption indices (checks ongoing)







Algorithms: PE5400

Bayesian model

Posterior pdf : $p(\text{redshift } z, \text{model } M_t \mid \text{data } D, I) = \dfrac{\text{Likelihood } p(D \mid z, M_t, I) \quad \times \quad \text{Prior pdf } p(z, M_t \mid I)}{\text{Evidence } p(D \mid I)}$

MAP estimate : $z_{spec,\ estim} = \text{argmax}_z\left(p(z \mid D, I)\right) \quad with: \ p(z \mid D, I) = \int_{M_T} p(z, M_t \mid D, I)\, dM_t$

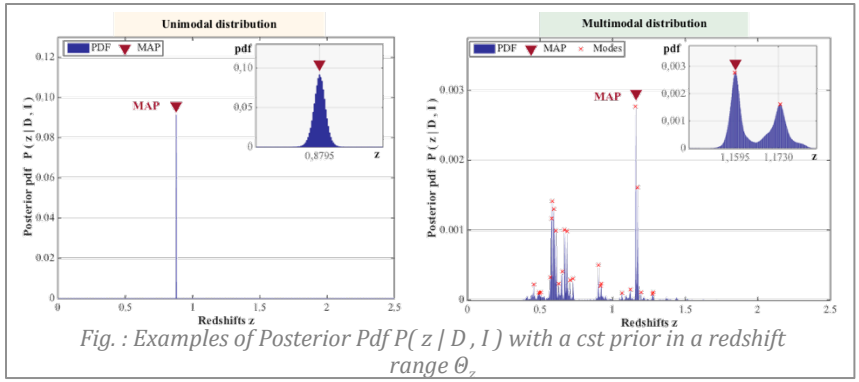


Fig. : Examples of Posterior Pdf P(z | D , I) with a cst prior in a redshift range Θ_z

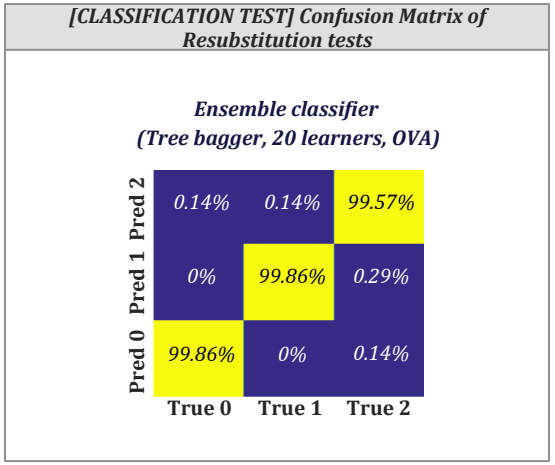
A unimodal pdf with a high probability leads to a '*certain*' estimation

A multimodal pdf with equiprobable modes leads to a '*unreliable*' z_{MAP}

Different types of the Posterior pdf p (z | D, I) ⇔ different level of trust in the estimation

Inference of the quality state of the global maxima z_{MAP} via:

- Machine learning (classification and/or clustering)
- Characteristics of the Posterior p (z | D, I)



- ***Preliminary tests [04/2016]***

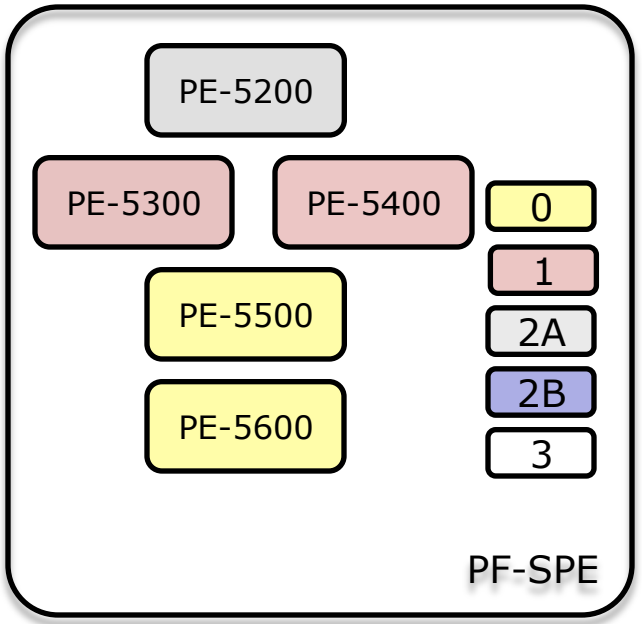
3 Levels the trust in the estimation zMAP

Unreliable	flag ' 0 '
Reliable	flag ' 1 '
Very reliable	flag ' 2 '

Status - Algorithms

Status of the Processing elements (PE)

- **PE-5200 : redshift measurement**
  - Line model implemented
  - Cross-correlation implemented
  - Spectral line detection implemented
  - Working within LODEEN
- **PE-5300 : Line measurements**
  - Fit of lines implemented
  - Extraction of Measurements / errors
- **PE-5400 : redshift quality determination**
  - Implementation of PDF
- **PE-5500 : Rest Frame parameters**
  - Algorithms defined
- **PE-5600 : Spectro photometric classification**
  - Identified algorithms and methods



Roadmap – planning Schedule

Release	Date	Delivery	SGS Obectives	SPE PF Objectives	Maturity Level
V0	Nov 2014	Technical note integration infrastructure	SRR – Science requ. Revue	Check and assessments of scientific requirements	0
V0.5	Nov2015	Prototype – including Data Model integration		Check integration within the LODEEN environment	1A -1B
V1	July 2016	Presentation of the software	TK1 – keypoint	Check advances in the development of the prototype	1A -1B
V1.2	October 2016	Prototype v1.2 - interfaces with infrastructure	Scientific challenge	Check integration within the CODEEN environment	2A
V2.1	October 2017	Prototype v2.1 - interfaces with infrastructure	DR	Requirements validation, testing in CODEEN environment	2A
V2.2	July 2018	Prototype v2.2 - interfaces with infrastructure	TK2 – keypoint	testing in CODEEN environment	2A-2B
V2.5	March 2019	Production PF v2.5	SGS scientific challenge #7	Full integration Fraction TBD of modules already coded and validated	2A-2 B– 3A
V2.9	April 2019	Production PF V2.9	IR	Full integration Fraction TBD of modules already coded and validated	2A-2 B– 3A
V3	May 2020	Production PF V3	RR	Full integration of modules already coded and validated	3B
V3.1	Sept. 2020	Production PF V3.1	ORR	Full integration of modules already coded and validated	3B
V3.5	July 2021	Production PF V3.5	DPRR	Full integration of modules already coded and validated	3B

Requirements

Main PF-SPE requirements :

- Process and deliver 150000 redshifts and associated data each week.
- *R-LRD-018/*R-GDP-DL3-222 : Provide central wavelength, identification, FWHM, equivalent width, flux and luminosity and errors associated
- *R-LRD-031* : Provide interpolated flux at a specified set of rest-frame wavelengths (1500Å, 2500Å, U,B, V, R, I, J, H, K) with associated errors.
- R-GDP-DL3-230 : Selection of sample (completeness level is > 45%) and purity (required survey purity level is > 80%) (The Hα line flux limit is 2×10^{-16} erg cm^{-2} s^{-1} at 1600 nm (at S/N > 3.5)) and meets the required density.

Demonstrated

OK by analysis/ or « perfect » data

In progress

To be done

Requirements

From Galaxy Clustering :

R-GC.1-3 : $\Delta z/z < 1*10^{-3}$ <(0.4 pix)

R-SPE-CAL-F-020 : Line intensity data processing error < 10% of the statistical error.

R-GC.1-4 : Measured redshifts should have a systematic offset <1/5 of the standard deviation given in R-GC.1-3, (exception of catastrophic redshift failures).

R-GC.1-10 : Catastrophic redshift failures < 0.2 (20%).

R-GC.2.1-2 : The completeness of the redshift measurements from NISP spectra shall be larger than 45%.

Interface and Data Definition

- Interface with Other PF/OUs
  - Interface with PF-SIR (1D spectra and noise, 1D covariance matrix, Masks)
  - Interface With SIM (SIM 1D by pass products)
  - Interface With PHZ(High quality redshift sample)
  - Interface with SWG (requirements)
  - **Interface with calibration (list of lines, templates)**
- Open points:

  List of products for interfaces TBD.
- Data Model
  - The definition of the 1D spectrum Data Model is still in progress (basic Spectrum DM)

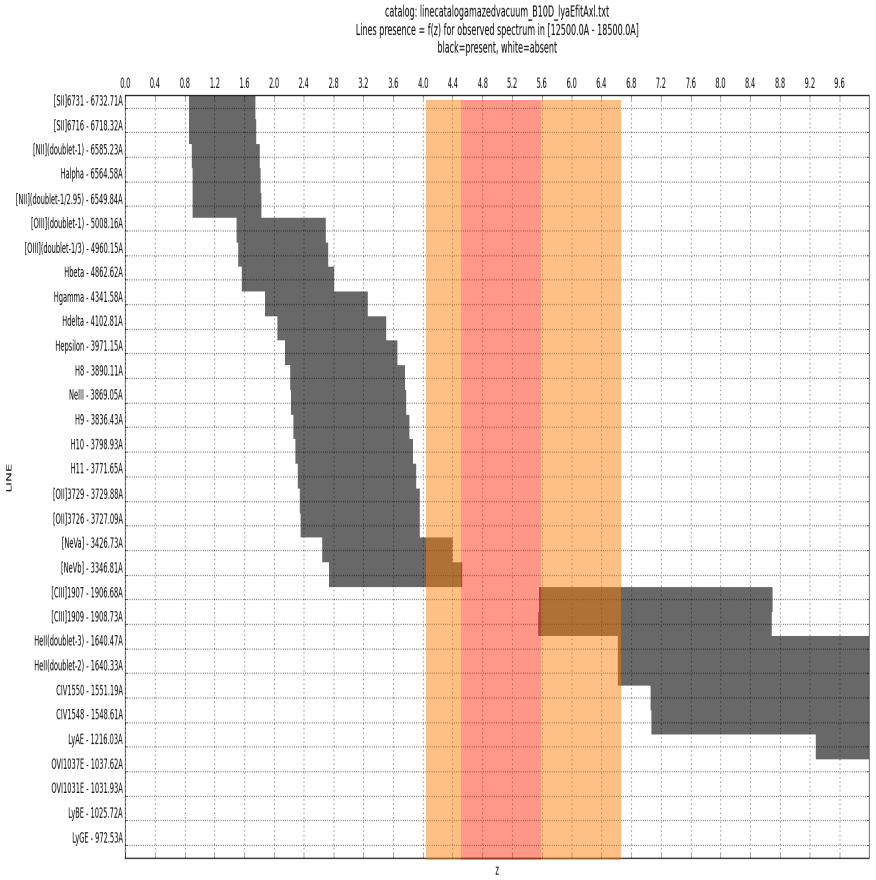
Open Issues II

- Validation tests with simulation spectra from SIM (working with by-pass)
  - SIM data are being tested, A test-bed will be provided before autumn
- Validation tests with output spectra from SIR
  - Date not yet defined, depending on SIR

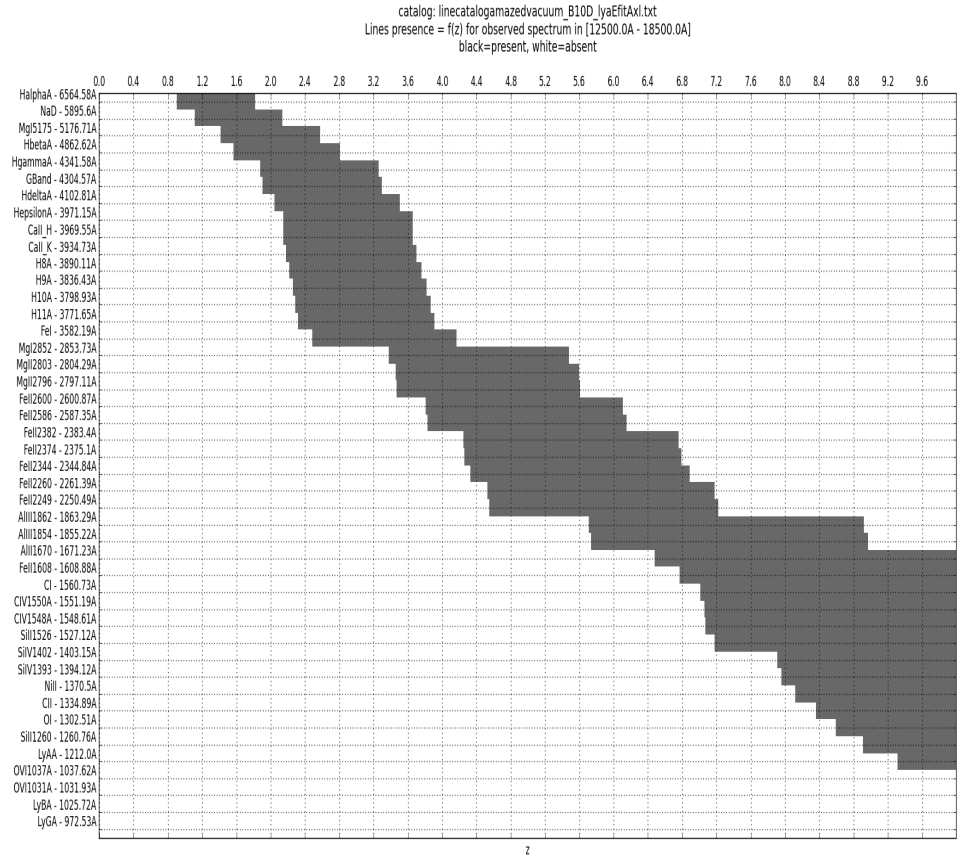
Extra slides

Algorithms

- Analysis of lines distribution wrt redshift



Emission Lines



Absorption Lines