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Current status of PFS DRP development

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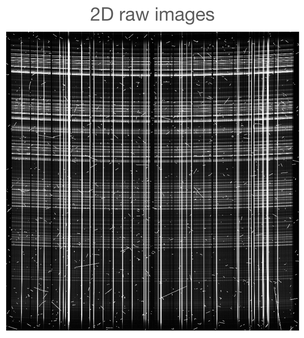
Abstract

PFS data reduction pipeline (DRP) processes raw 2D detector images of each spectrograph to extract calibrated 1D spectra and the physical quantities from the spectra. Quality assessment (QA) for the processed data evaluates the accuracy of various calibrations, spectral extraction, and sky subtraction, and so on. The development is on-going by utilizing on-sky data obtained in engineering observations, and we are now putting more effort to establish a feedback mechanism for the development through the data processing and QA to improve performance of DRP. We are also now testing the on-site processing and evaluating the scientific quality of processed data based on the effective exposure time. We are devising a way to release the processed products to users via the PFS Science Platform. In this presentation, we report the current status of the DRP development and processing of engineering run data.

Overview of the PFS Data Reduction Pipeline (DRP)

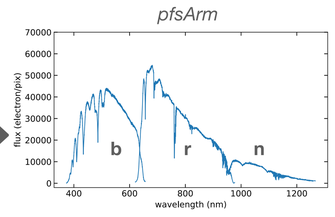
"2D-DRP"

2D raw images



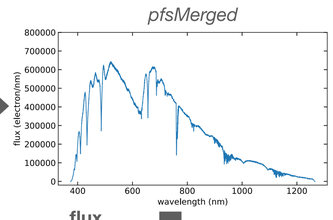
spectral extraction

pfsArm



merge 3 arms

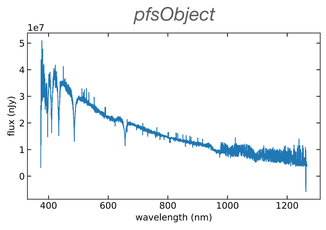
pfsMerged



flux calibration

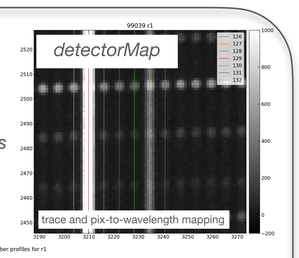
coadd

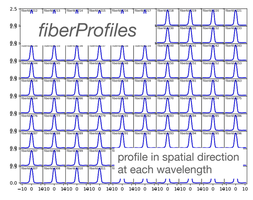
pfsObject



CALIB data

- *defects*
- *biases*
- *darks*
- *detectorMaps*
- *fiberProfiles*
- *fiberNorms*





Reduction of 2D raw images to 1D calibrated spectra

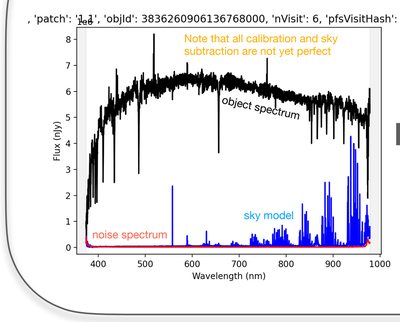
- Basic instrumental signature removal (ISR)
- Wavelength calibration
- Spectral extraction
- Merge 3 arms
- Sky subtraction
- Flux calibration
- Coadd multiple visits

(work by Princeton 2D DRP team)

Basic ISR and spectral extraction are carried out to generate wavelength calibrated 1D spectra (*pfsArm*) in each camera using calibration data set (*CALIB*). *pfsArm*s of 3 cameras are merged into a single spectra (*pfsMerged*). Flux calibration is done and coadd multiple spectra into a single flux-calibrated spectrum (*pfsObject*).

"1D-DRP"

1D extracted spectrum (*pfsObject*)



spectral fitting

Measurement of physical quantities

- Object classification (stars/gals/QSO)
- Redshift of galaxies
- Emission line fluxes
- Radial velocity of stars
- etc.

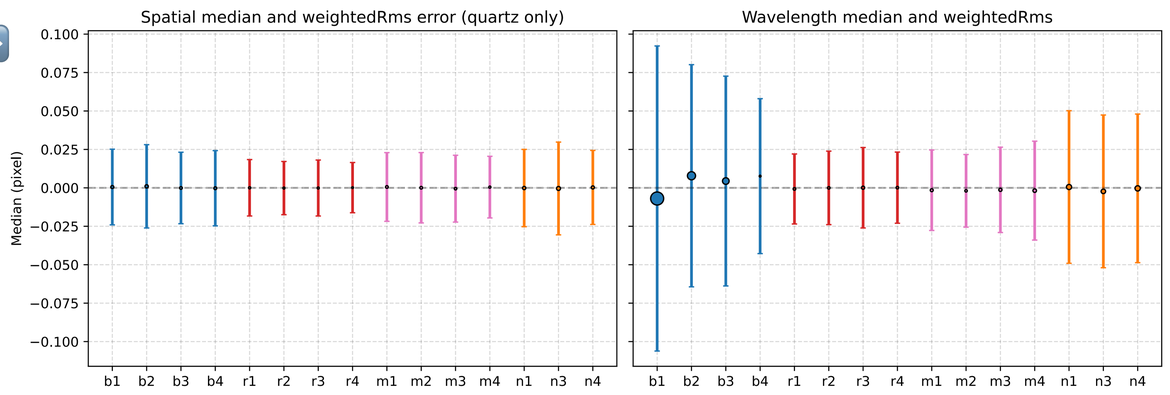
(work by LAM 1D DRP team)

PFS DRP is consist of 2 different pipelines; one reducing raw 2D images to extract 1D spectra (2D-DRP) and one fitting 1D spectra to extract physical information (1D-DRP). Basic functionality of processing has been mostly developed, and now various tests with on-sky data are on-going. Currently, Understanding scattering in the optical components (and extracting spectra taking into consideration the scattered light) and improvement of the data reduction of NIR data (non-linearity, persistence, etc.) are urgent tasks.

QA of calibration and data reduction

Quality of the calibration data and the reduced data is assessed from various points of view (e.g., accuracy of wavelength solution, spectral extraction, flux calibration, and sky subtraction). Various tools for these quality assurance (QA) for the science operation are under development by using actual data obtained in the engineering runs. Here, some examples are shown before.

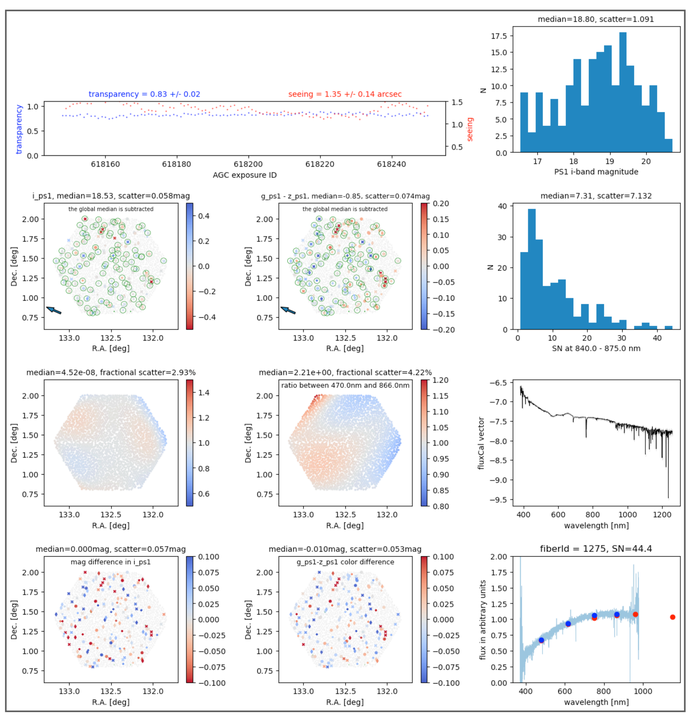
Example of residuals of detectorMap solution (measured position - modeled position in pix) on detector plane in both (spatial and wavelength) direction. In this case, the detectorMap solution in spatial direction is as good as ~0.25 pix rms, but the tool caught that the solution in wavelength direction is bad in blue arm, which was due to a lack of some data sets critical for detectorMaps generation for b-arm.

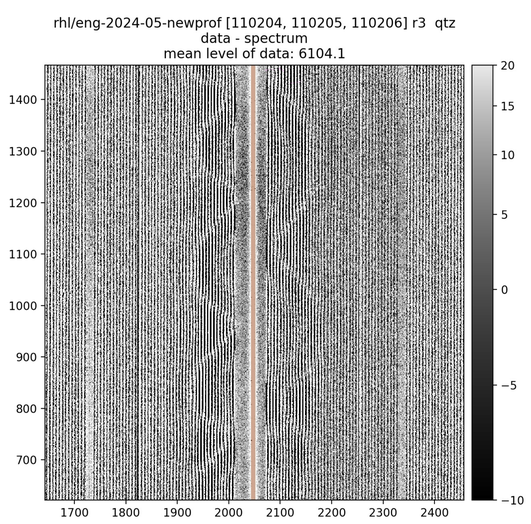


(work by Hilo DRP team)

Example of QA for flux calibration accuracy. In this case, the flux calibration accuracy is about 5%, which is probably due to the low S/N of flux standards because of the bad seeing and the observed standards are relatively faint to usual observation.

(work by Mitaka DRP team)





The quality of the spectral extraction will be checked by the residuals of extracted spectra in 2D. Here the evaluation of scattered light (which depends on input light flux) is critical to extract spectra with fiberProfiles in an consistent way. Left figure shows an example of a residual image with preliminary modeling of scattered light, where an instrumental feature on detector is shown implying the reasonable spectra extraction.

(work by Princeton DRP team)

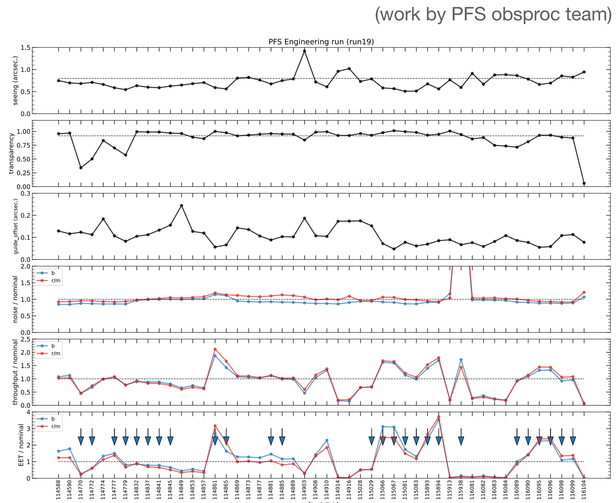
(work by Princeton DRP team)

Sky subtraction accuracy is assessed by using the sky subtraction of sky fibers. The χ distribution of the sky subtraction residual per pix for each fiber is compared to a Gaussian distribution of N(0,1) and the accuracy is evaluated from the deviation.

On-site QA for the quality of science data

On-site data processing is automatically started just after the SpS exposures are done. We use a dedicated PFS cluster system in Hilo. The individual QA mentioned above will be also run in the processing. The scientific quality of each data is assessed by using the effective exposure time, which is calculated by the relative difference of the system throughput and noise level from the nominal condition.

(work by PFS obsproc team)



Effective Exposure Time and the various condition. Good cases of the field acquisition and guiding are indicated by arrows.

Future prospects

Since we had the issue about the fiber throughput variation, which is critical for the sky subtraction, the validation of the detailed performance of instrument and the data quality is still insufficient. In the recent engineering run, we have tested the clue to this problem, and we will be working on the verification based on the data. Improving the sky-subtraction is also an important task and preliminary study of the sky-subtraction in 2D by modeling the point-spread-function (PSF) on detectors has been started. The data delivery will be done via the PFS Science Platform in the future operation and the initial test is on-going in the internal data release to the PFS science working groups.

Let us know if you have any questions and requests!