Prime Focus Spectrograph (PFS): Development of the 2D skysubtraction algorithm

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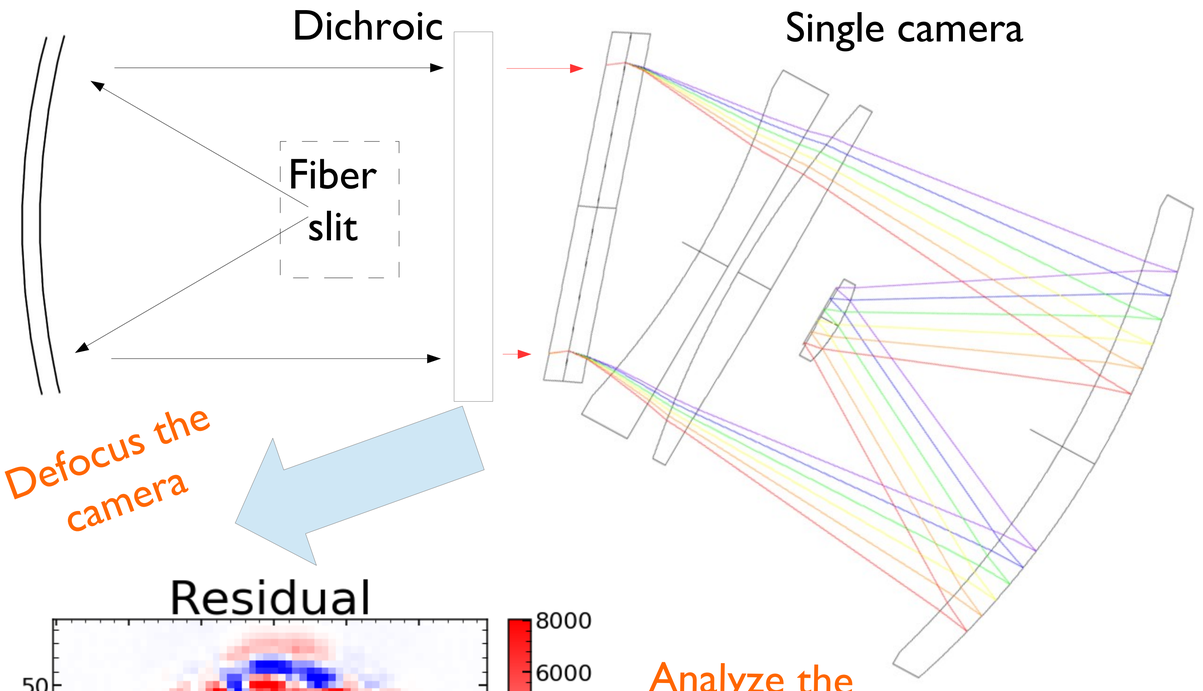
SuMIRe — Prime Focus Spectrograph

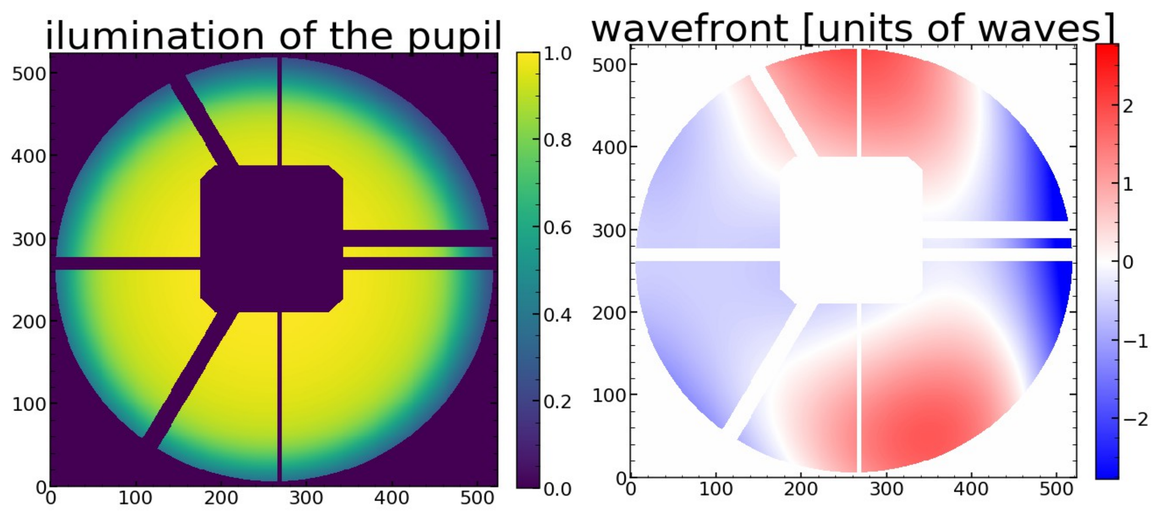
PSF of the Prime Focus Spectrograph will be caused by 3 different components: telescope pupil illumination, focal ratio degradation in the fibres and the optical abberations in the spectrograpic cameras. Goal of the project is to understand and to characterize the contribution of the camera imperfections to the PSF. We are analysing strongly defocused images where the effect of the optical abberations and camera imperfections is more readily seen. The data has been taken by the red arm camera of the spectrograph at the optical bench. We compare the data with the custom generated model in order to estimate coefficients describing best describing the wavefront aberrations. With this information we can predict and precisely model the PSF when the instrument is focused or the illumination of the pupil is modified.

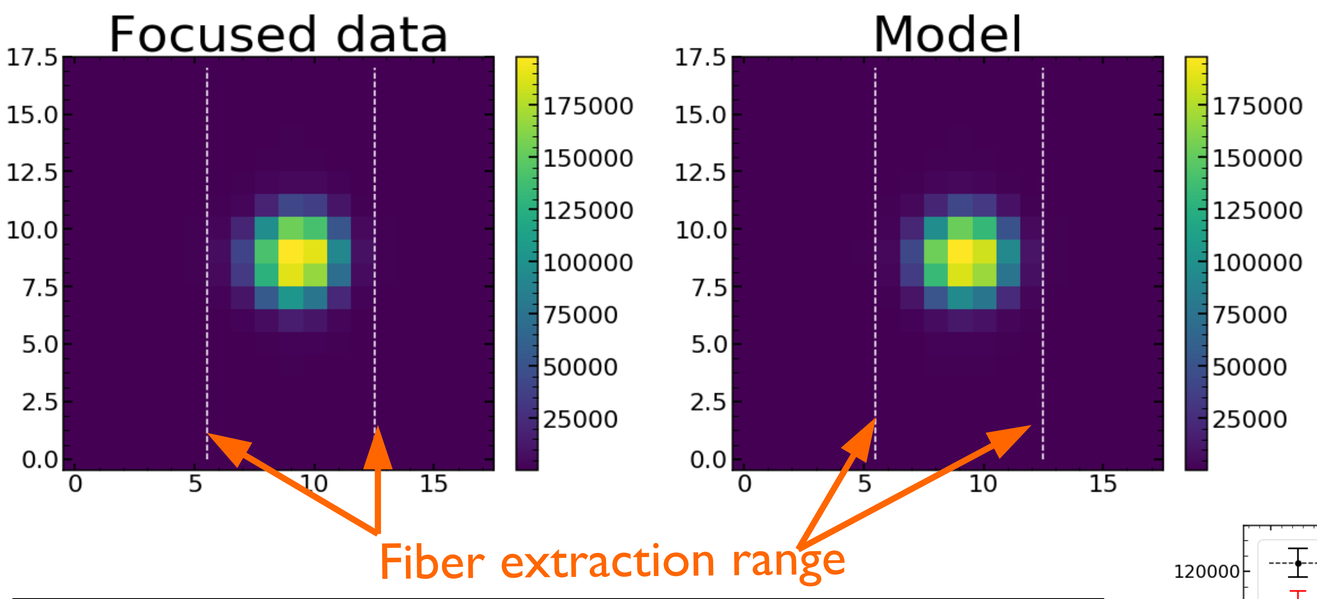
Defocusing the spectrographic camera enables us to analyze the details of the optical setup in detail. Below we can see an example of the defocused data and our modelling. We can see clearly see various components of the obscurations along the light-path, described with arrows in orange. Residual is shown in the right panel. Note the small-angle, speckly, nature of the residual. This is consequence of the fact that we are modelling only relativly low-order wavefront abberations which are not able to fully capture small-angle distortions. Improvment can be achived by considering higher-order wavefront corrections.



We apply the analaysis demonstrated above on a number of images with different amounts of defocus, and interpolate so that we can deduce the illumination of the pupil and wavefront abberations in the focus. These are shown on the right. Note the decrease of flux towards the edges of the pupil, consequence of the focal ratio degradation (FRD) in the fibers.

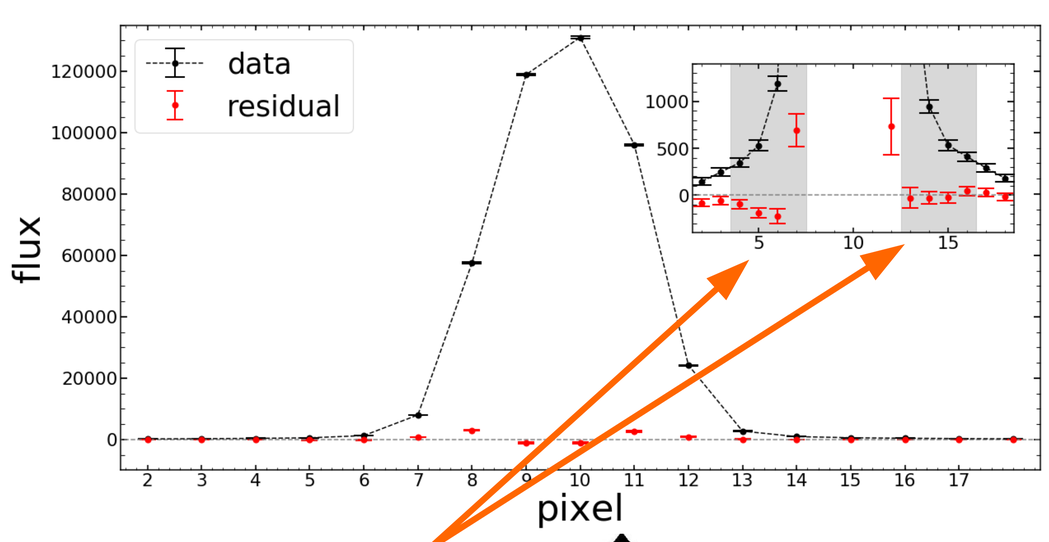
Use this information to predict PSF of in-focus images





Subtract the model and extract 1d spectrum

We create 2d model of the PSF which can be subtracted from the data. This is the same procedure which we will use to eliminate the bright sky lines from the scientific data. We plan to improve existing residuals by better modelling of the defocused data and the post-processing algorithm characterizing the residuals with the PCA methods.
After the 2d subtraction, in order to create 1d spectrum we extract the flux along the fiber in a standard ``optimal extraction'' fashion. We show the result on the right, with a zoomed-in central region in the inset.
We are primarly concerned about good quality of the subtraction in the wings of the PSF, given that high flux of bright sky lines will make it impossible to remove fully the central cores of the these lines.



Wings of bright sky lines – the most important region

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