Setting the scene for Gaia and LAMOST
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Fiber Positioning Test

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Abstract. With the concern that observed flux is very sensitive upon fiber positions, we develop a novel approach measuring the error of fiber positions in this work. More specifically, we compute two orthogonal groups of the flux ratio before and after moving the fiber a few arcseconds, and correct the system coordinate transformation based on the computed fiber position error.

Keywords. techniques: spectroscopic, instrumentation: spectrographs.

Flux received at the fiber output end is sensitive to the relative position of the fiber to the input source (i.e. star). When the fiber sample different sections around the target source, the sampled flux at different position can be used to reconstruct the PSF image at the fiber input end, thus the actual position of the target as well as the fiber position error can be deduced. The accuracy of the measurement increases with the sample points, but when the actual observation is taken into account, a minimal exposure time is preferred. In order to measure the fiber position error in least observation time, we develop a fiber positioner movement scheme with 3 exposures: one in the original position P_0, and the other two in orthogonal direction to P_0, usually we use the direction radial (P_r) and tangential direction (P_t) to the focal plane center. In order to correct for the weather change between these 3 exposures, we leave the fibers in the central part of the focal plane at the same position between different exposures. Different exposures were calibrated by those fibers. The progress was integrated as a function in LAMOST SSS pipeline.

Data from these 3 exposures are first reduced by a quick version of LAMOST 2D pipeline. Since in this case, only the total flux of each fiber is important, the accurate wavelength correction and detail feature of the spectrum does not matter much. The quick 2D pipeline extract and add the flux along the wavelength for each fiber. The extracted flux in different exposures are calibrated by those unmoved fibers in the center of the focal plane, then, the two flux ratio in 2 orthogonal directions (usually these 2 ratios are flux in radial direction and the flux in tangential direction over the flux at original position respectively, i.e., F_r/F_0 and F_t/F_0) are compared with the theoretical model to derive the fiber position error for each fiber. With the position of each fiber and its measured error, a coordinate transformation matrix can be constructed to correct the system coordinate bias between the appointed fiber coordinate and the actual target position. The system coordinate correction will be added to Instrument Control System or Astrometry Support System.

Our method was applied to correct the system error of the LAMOST fiber positioning system, the results shows that the system coordinate accuracy is less than 1", and the system throughput rose from 0.7% to 2% before and after our system coordinate adjustment before the beginning of LAMOST pilot survey.