**Week 4 HT**

**Build**

Remove baseline + remove outlier + interpolate + smooth. Without removing outliers, however, the interpolated and smoothed data looks like

* **Baseline**

The baseline should not be removed using the dark frame count, as this would only remove the dark current but not the bright current and any current induced by the temperature variation in the presence of the light [verify this].

The baseline can be removed using four algorithms: remove mode, median filter, baseline package and high-pass filter. The first method which is removing the mode is preferred [verify this] by inspection.

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* **Outliers**

The outlier is removed using the where the filter finds the median value of the adjacent points at each point in the original array. The original array and the filtered array is then subtracted, the point in the array is removed if the difference is larger than a certain value [This value needs to be more carefully determined].

* **Interpolate**

The interpolation gives us a uniform between the max and min frequencies. It also gives a finer resolution of the wavelength space. However, we couldn’t claim that this approach improves the accuracy for determining the peak wavelength [something to do with the Nyquist frequency and we need to investigate it].

* **Smoothing**

The algorithm used for smoothing is the filter, which is a commonly used non-parametric (without assuming any distribution) filter to smooth data [discuss the algorithm in the report].

**Week 5 HT**

**Build**

The method can now plot the distribution of the central wavelength, peak intensity, integrated intensity, the scatter plot of peak intensity and integrated intensity, and finally the time series of the above values.

The figures below summarize the experimental results over trials. LHS distribution of central wavelengths around the actual wavelength; RHS distribution of peak intensities

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*Distribution:* The central wavelength shows a Gaussian distribution, with mean roughly at the actual wavelength and standard deviation of around . The peak intensity and the integrated intensity show double Gaussian distribution pattern. The peak intensity and the integrated intensity are linearly correlated, while there isn’t a strong correlation between the intensities with the central wavelength pattern.

*Time Series:* Use the ARIMA process analysis and find the time-stability of the series.

Optimal Exposure Time:Find the optimal exposure time that yields the min standard deviation.

Optimal Trials:Find the optimal trials that yields the error of mean that is within our error budget. Note that assuming the spectrometer measurement is unbiased, the error in the mean where is the number of trials, regardless of the distribution.

**Laser Calibration**

Calibrate the working of the spectrometer with a green laser [we assume constant wavelength and power]. The real spectrum of the laser and that measured by the spectrometer are shown in the diagram below.

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*Bias:*Calculate the mean and uncertainty in the mean for large number of experiments. Verify that the spectrometer is unbiased.

*Spectral Correction:* The FWHM of the laser is around [use software to digitalize it] whereas that of the spectrometer measurement is [write code to calculate it]. The resolution of the spectrometer is obviously not good enough. Nevertheless, as we know the structure of the configuration inside spectrometer [Czerny–Turner], it is possible to find the convolution function from the two distribution and use the deconvolution to find the real spectrum from any spectrometer measurement [of course, we have assumed that the laser specification is the ground truth].

**Build**

The power meter can now plot the distribution of the measured light and the ambient light and their stability over time. This is shown in the diagram below.

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*Distribution:* The distribution of the measured intensity and the ambient intensity are roughly Gaussian with very narrow standard deviation.

*Time Series:* Use the ARIMA process analysis and find the time-stability of the series.

*Stray Light:* Work out the correlation between the measured intensity and the ambient intensity, to demonstrate that there is no stray light leaking into the system.

**Week 6 HT**

**Build**

Use the calibrated spectrum of the spectrometer & the responsiveness of the photodiode, we can calibrate the intensity measurement of the power-meter. This is more accurate than the auto-calibration by the power meter.

**Build**

Find the intensity distribution of the peaks and the photodiode measurements for a set of . Make a comparison of the two. Verify this agrees with the theoretical calculation using the emission curve of the light source, efficiency of the spectrometer + light guide + beam splitter + (spectrometer) or (integrating sphere + power meter).

Report Structure

LSST Project Introduction – Telescope

Aim

Experimental Setup

Calibration

Large Experiment: CCD gate width on the brighter-fatter effect