Spectral Emission Data Processing

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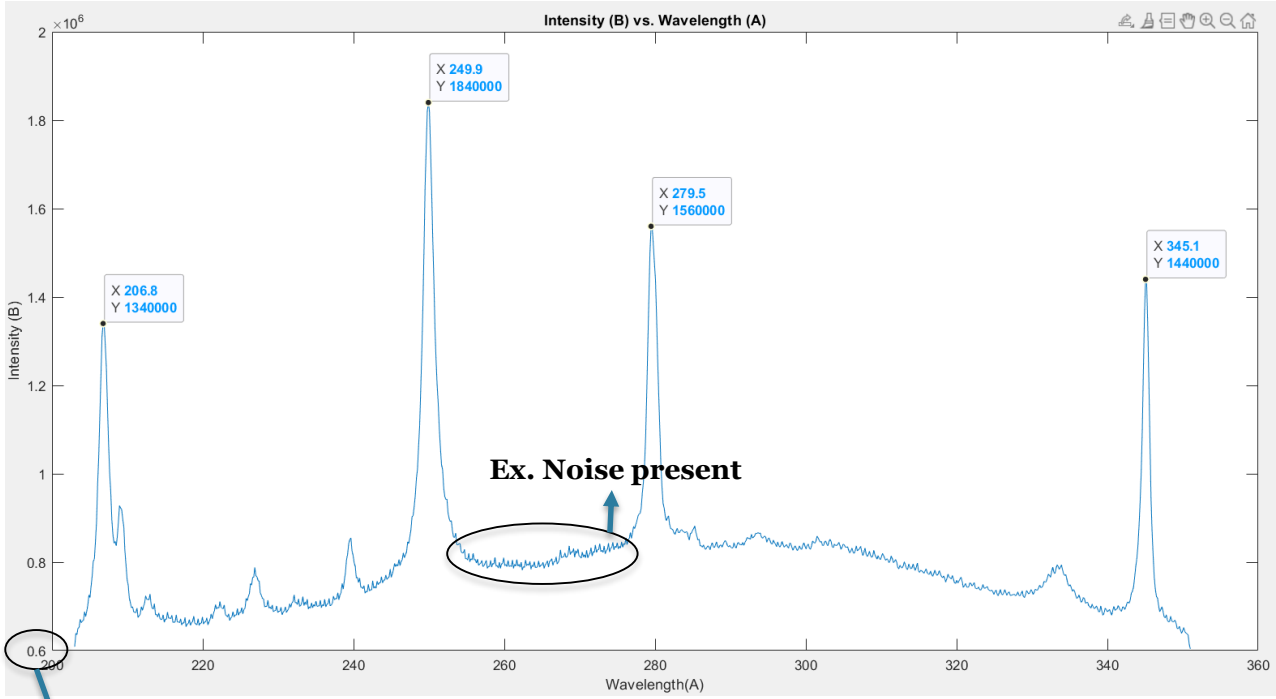
Background and Motivation

- Emission spectra of a laser which hits Boron Nitride
- Motivation: Identify spectral lines and calculate their intensities by an algorithm
  - Automatically calculate plasma electron temperature from the intensities
- Challenging for an algorithm to identify only spectral lines
  - Background and noise hinder the outcome of the Intensity

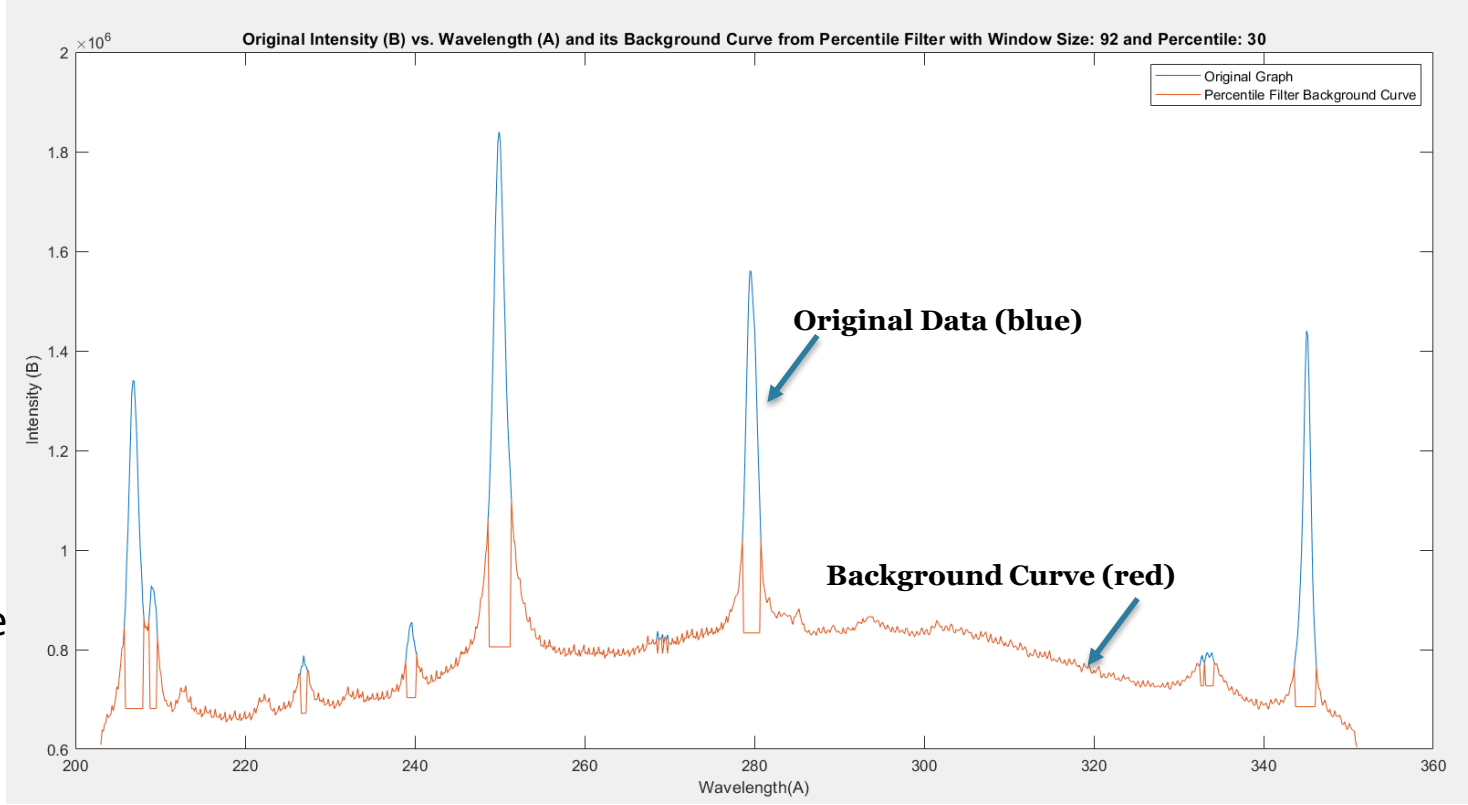


How is the Background and Noise Filtered Out?

- Algorithm
  1. Create a Background Curve
     - Background Curve: Curve which consists of low frequencies and no spectral lines
  2. Subtract the background curve from the original data
  3. Filter out the high frequency noise
- How to establish a background curve?
  - Low pass Filter
  - Median Filter
  - Fast Fourier Transform
  - Percentile Filter
- How to filter out high frequency noise?
  - Low pass Filter

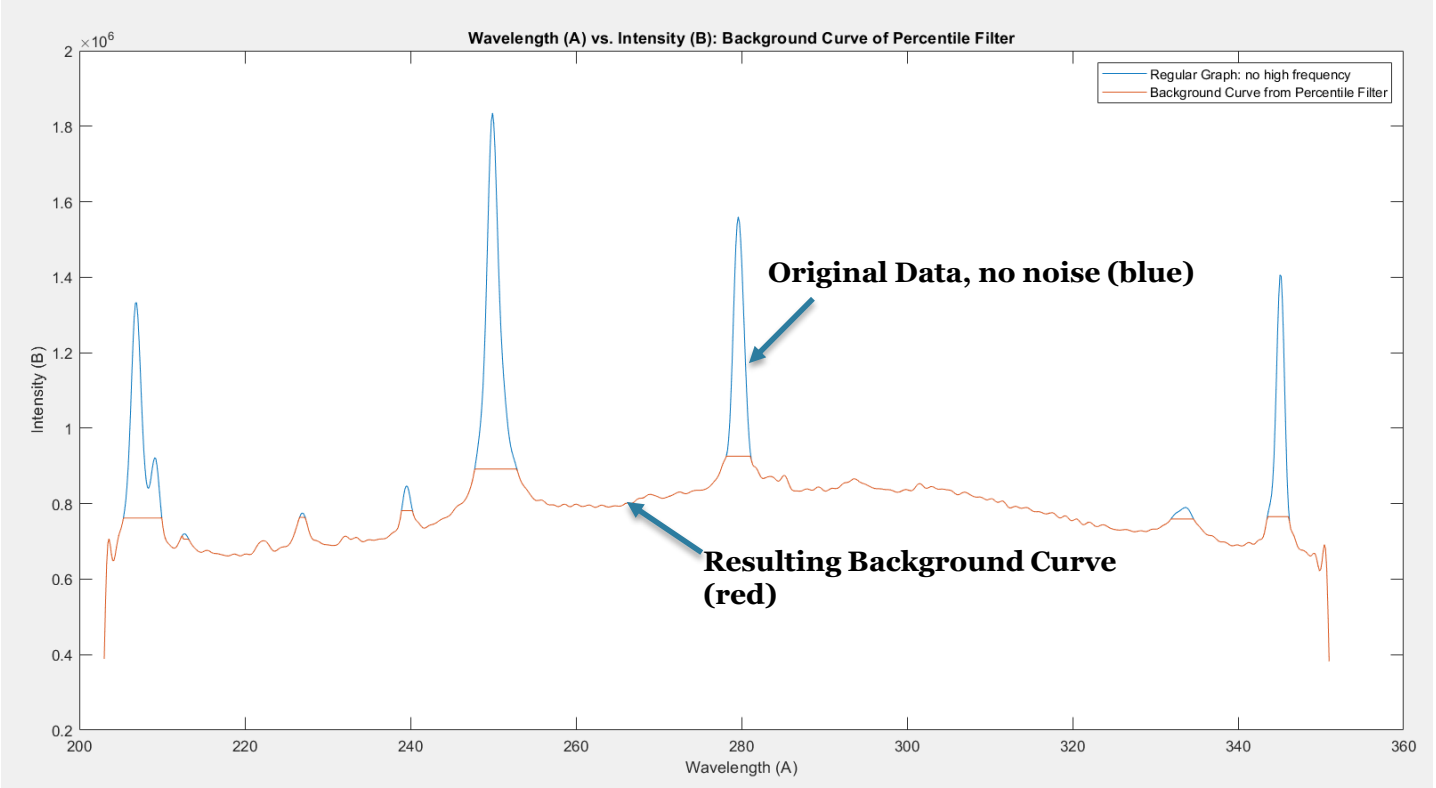
Percentile Filter

- Percentile Filter: Separates the data into windows (groups of data) and within each window the filter looks for the outstanding values which are then replaced with a new value.
  - This new value is determined by a chosen percentile in that window.



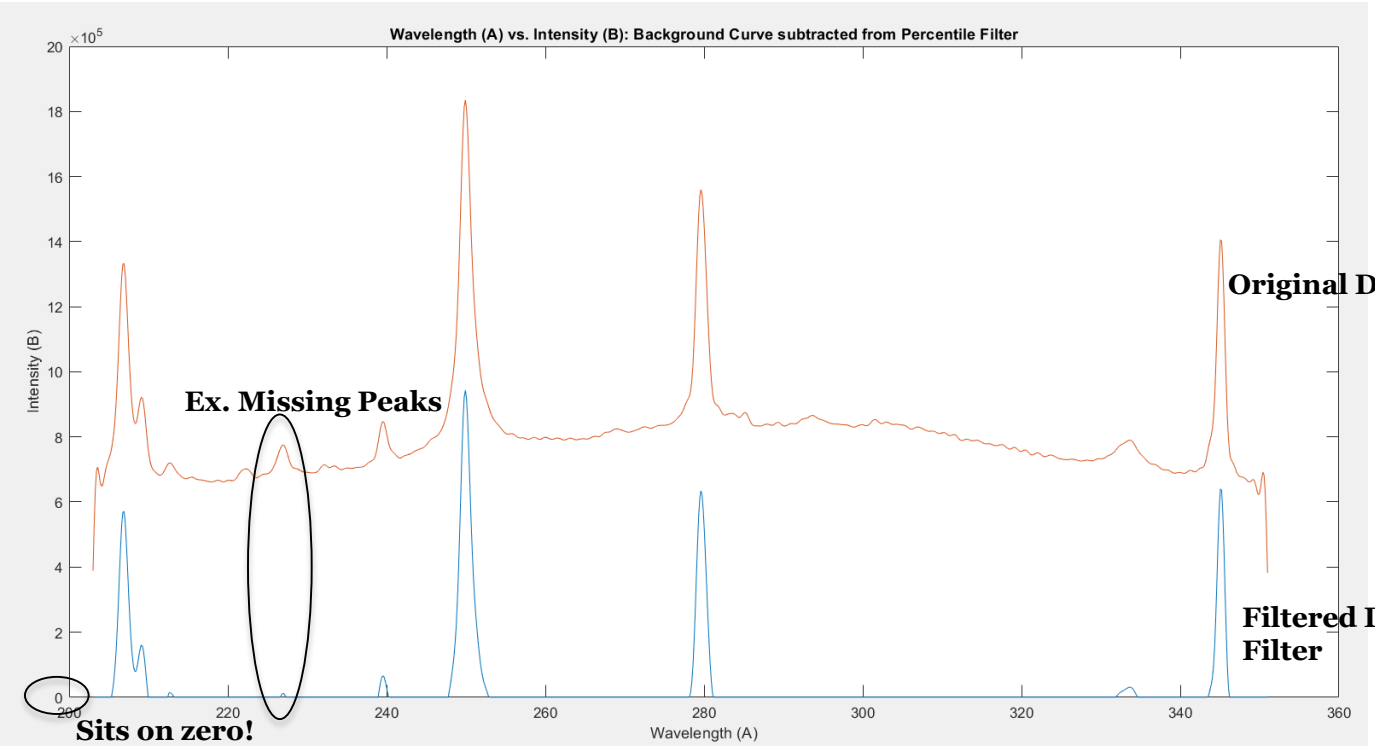
Rethinking the Percentile Filter Parameters

- Filter out high frequency noise first
- Differentiate the window size and chosen percentile for different intensity peaks



Percentile Filter Results

- Subtracting the background curve from the original data
  - Result: Missing small peaks, only shortens large peaks, unsuccessful background curve



Rethinking the Background Curve

- No longer want a background curve

- New algorithm:
  1. Filter out high frequency noise

  2. Find the peaks in the data set

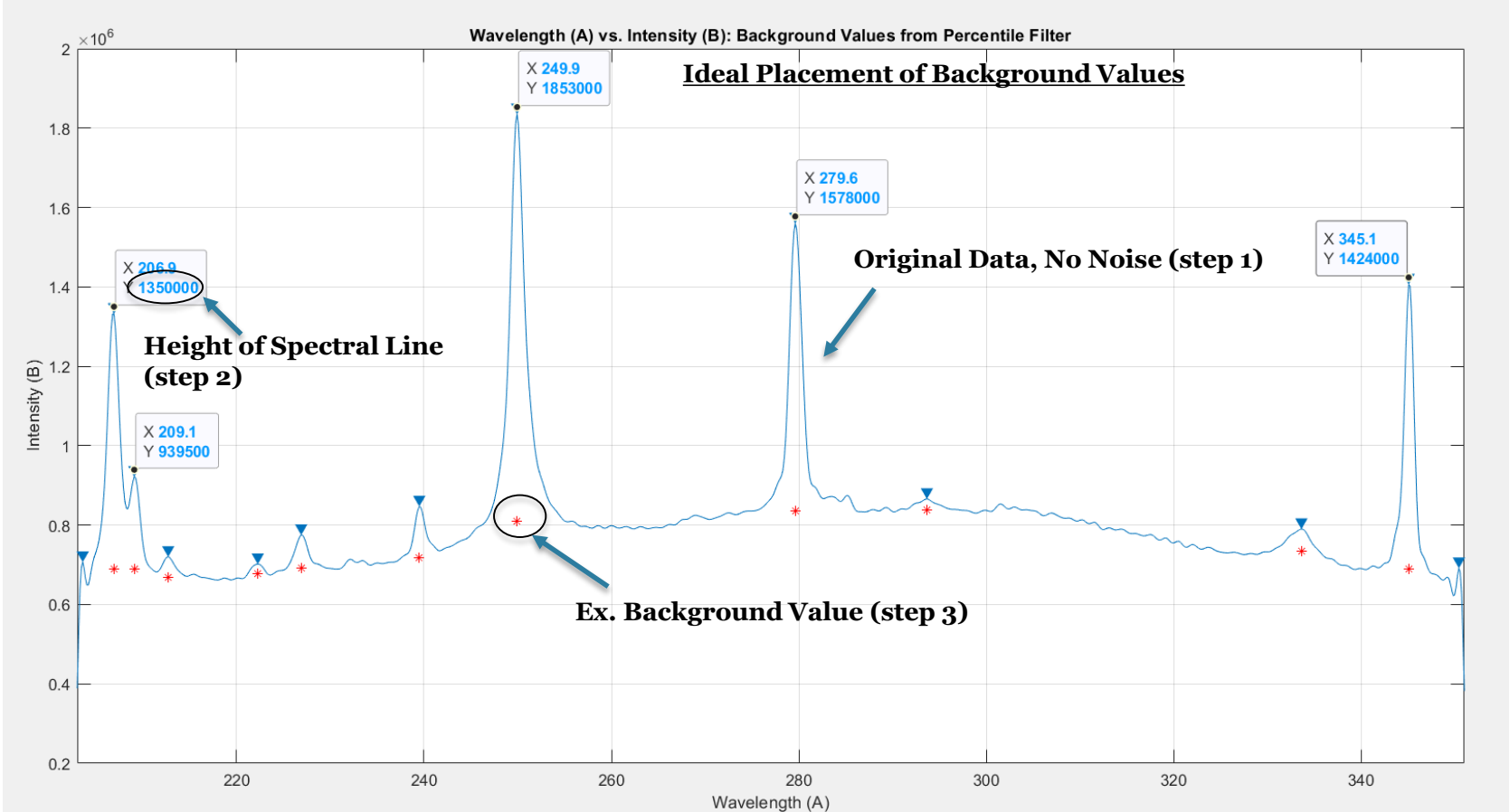
  3. Find background values for each peak using the Percentile Filter
     - Decide the appropriate window size and percentiles for each peak

     - Group peaks based on their height

  4. Subtract the background values from the data

Rethinking the Background Curve Results

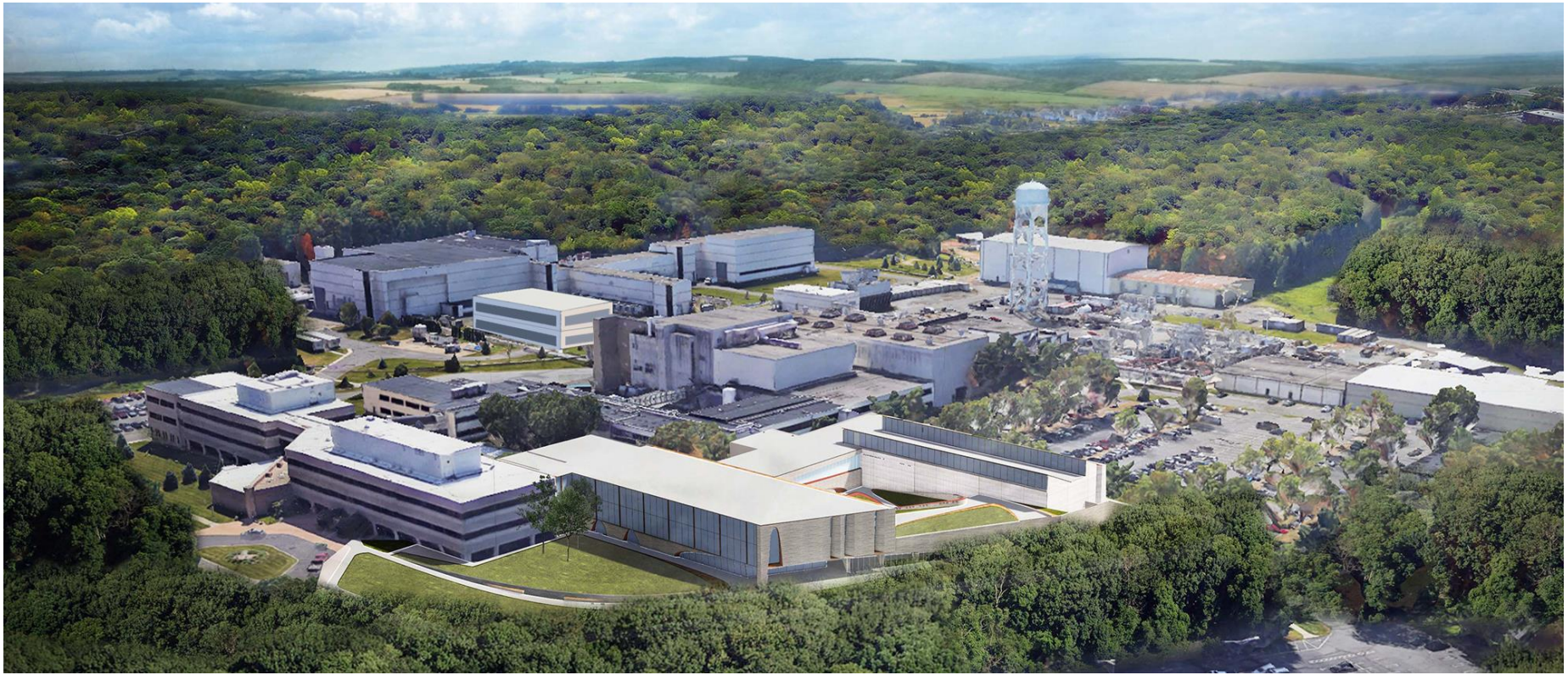
- First application of new algorithm to figure out placement of background values



Next Steps

- Automate plotting of the background values so under each peak the algorithm detects
- What characteristics of the data make for an appropriate window size and percentile?
- Check that the new algorithm creates background values for any set of data
- Subtract background values from their peaks to measure the new intensities
- Automatically calculate the plasma electron temperature from the intensities

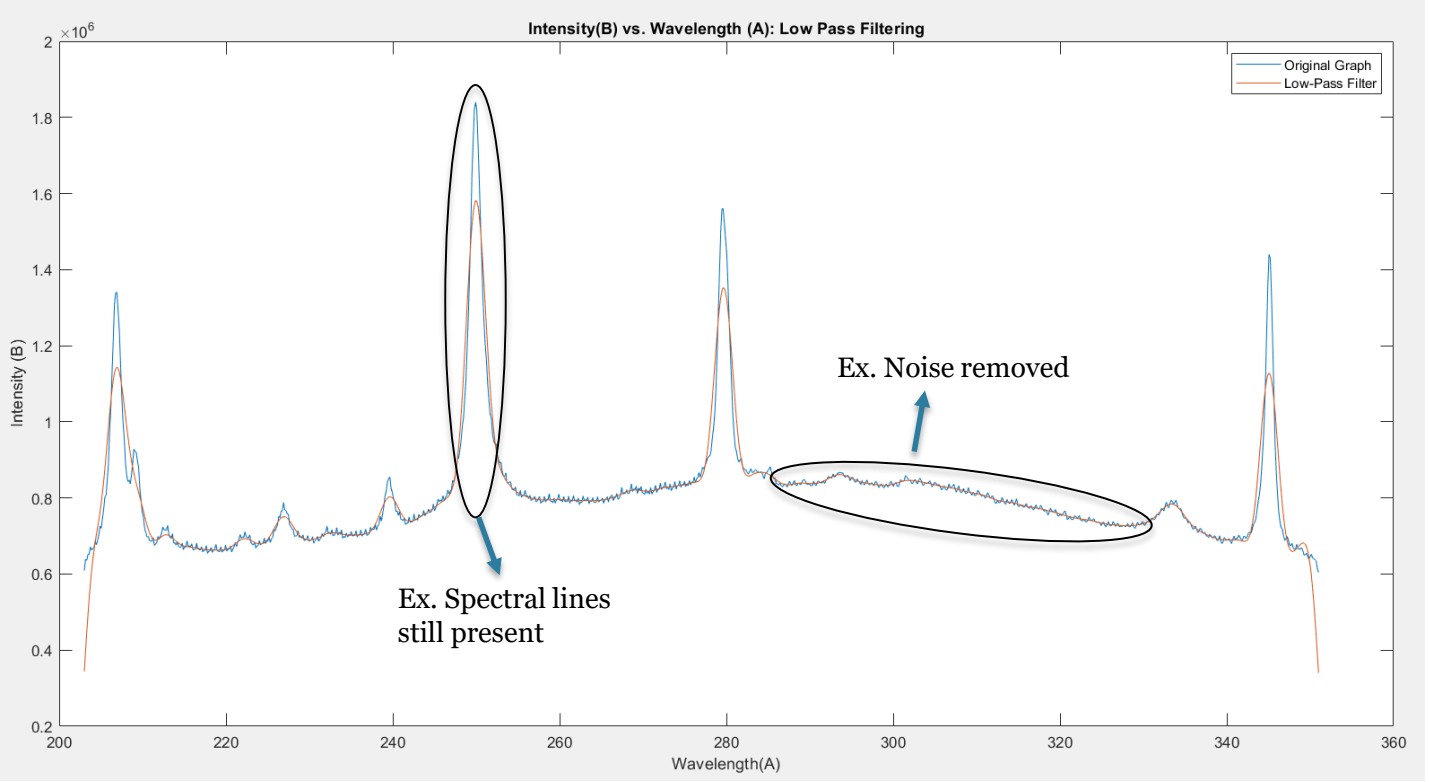
Thank you! Any questions?



This work was made possible by funding from the Department of Energy for the Summer Undergraduate Laboratory Internship (SULI) program. This work is supported by the US DOE Contract No. DE-ACO02-09CH11466

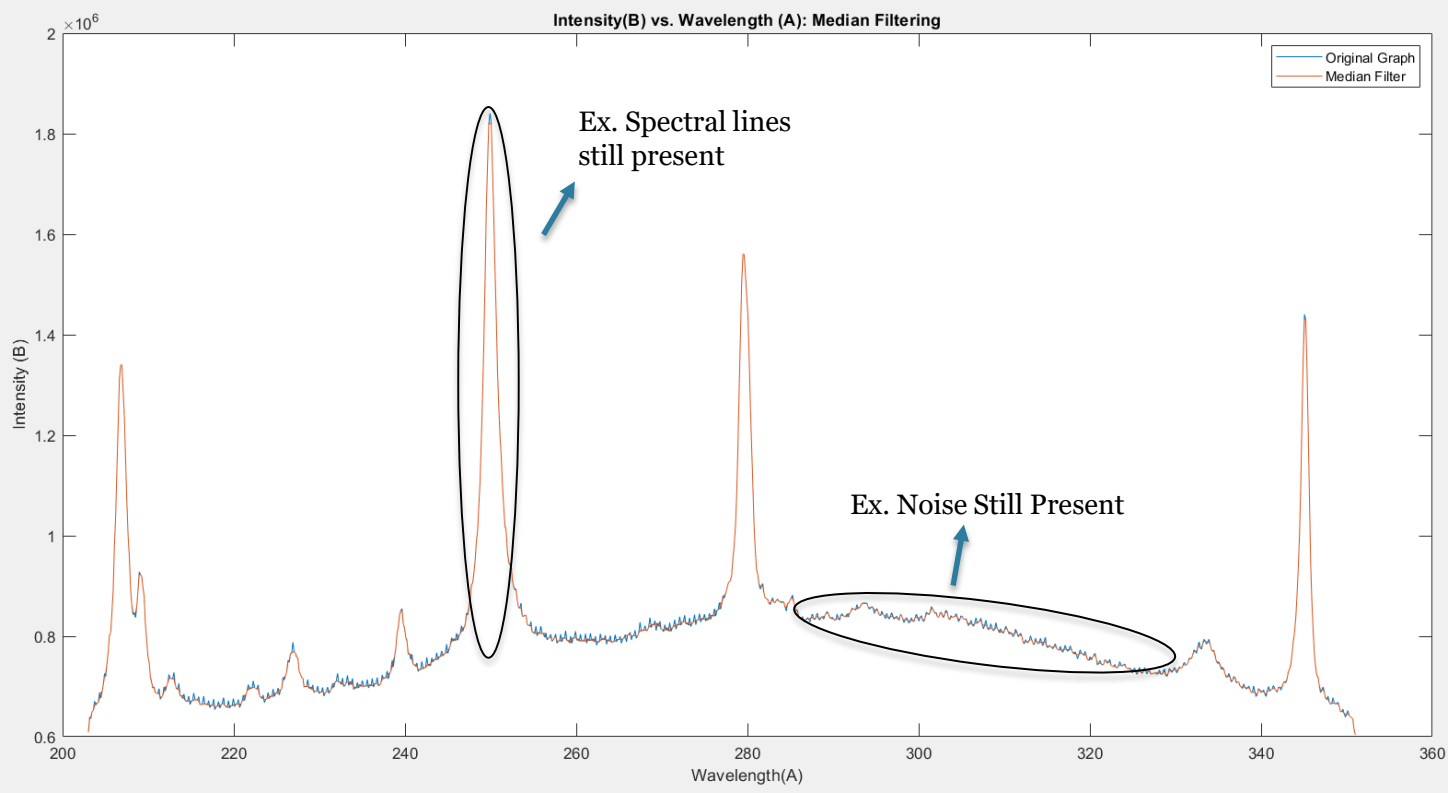
Low Pass Filter

- Low pass Filter: Attenuates high frequency while allowing low frequencies to pass through
- Result:
  - Unsuccessful background curve
  - Removed high frequency noise



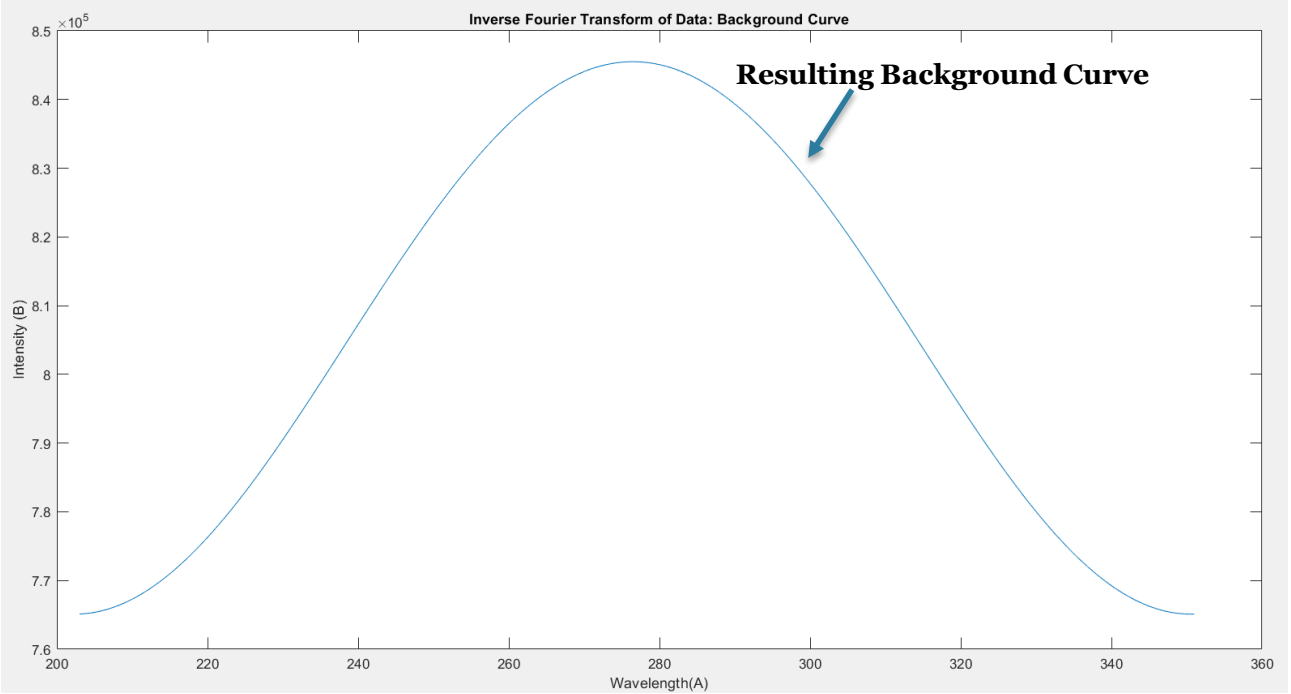
Median Filter

- Median Filter: Separates the data into windows (groups of data) and within each window the filter looks for the outstanding values which are then replaced with a new value. This new value is determined by the median in that window.
- Result:
  - Unsuccessful background curve



Fast Fourier Transform

- Fast Fourier Transform: Converts a signal into its individual spectral components pulling out the frequencies of the original signal
  - Only include the intensities of the first 2 frequencies
- Inverse Fourier Transform: Converts the frequency components of the Fast Fourier Transform back into the original time wave



Fast Fourier Transform Results

- Subtracting the background curve from the original data
  - Result: does not sit on zero, unsuccessful background curve