Instruction

1. Get data (function: loadData)

   Can skip the title then extract the 1st column as x data, 4th column as y data. User can change these two default numbers in line 448&449 of this program.

2. Input

   r: Signal to noise ratio. It represents which peaks we consider as signal and which peaks we consider as noise fluctuation.

   wf: weight factor. A factor to determine the width of non-peak region. Usually choose 1. If some peaks are considered as noise, reduce the width of non-peak region by this parameter.

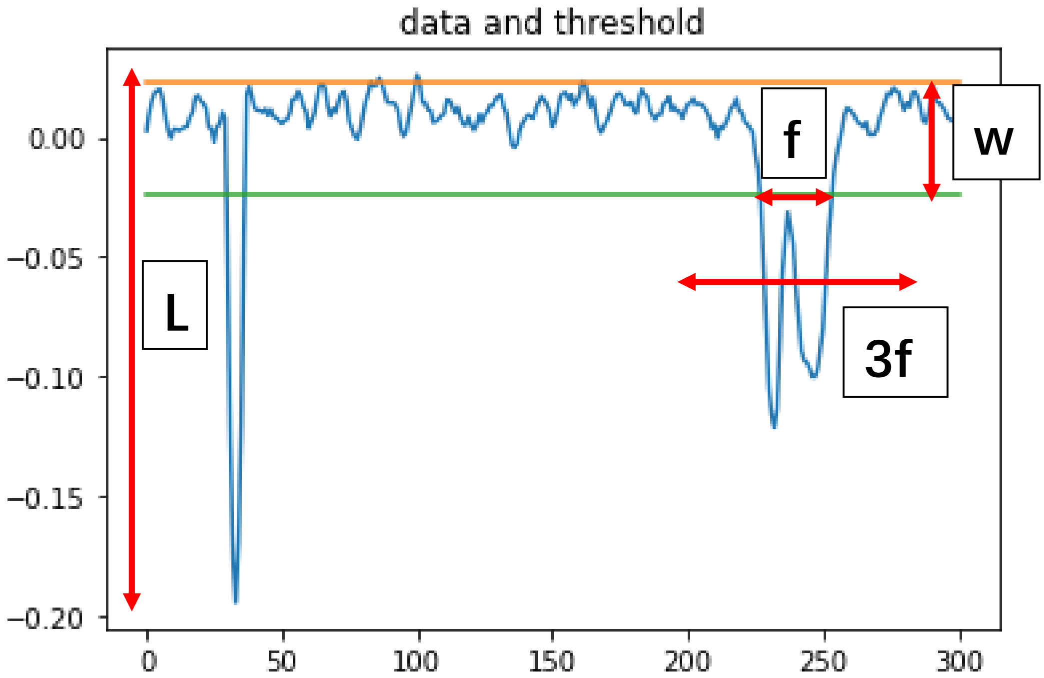
3. Filter (function: DW_cal, smooth_al)

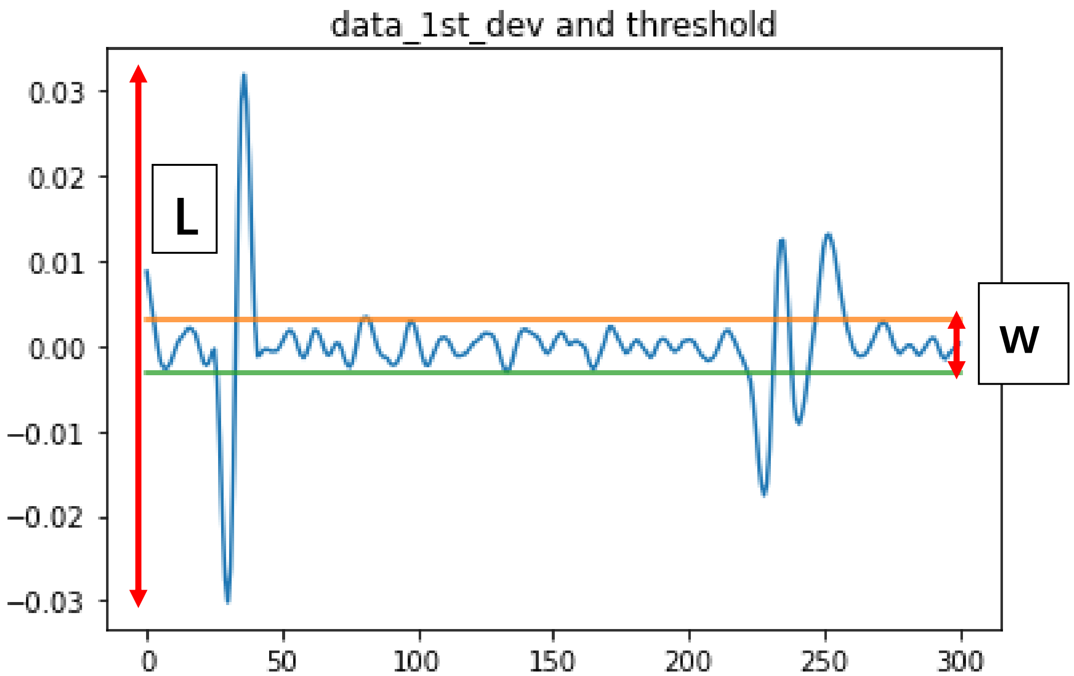
   SG algorithm.

   It can give smoothed data, 1st_derivative_data,

4. Zero point and noise

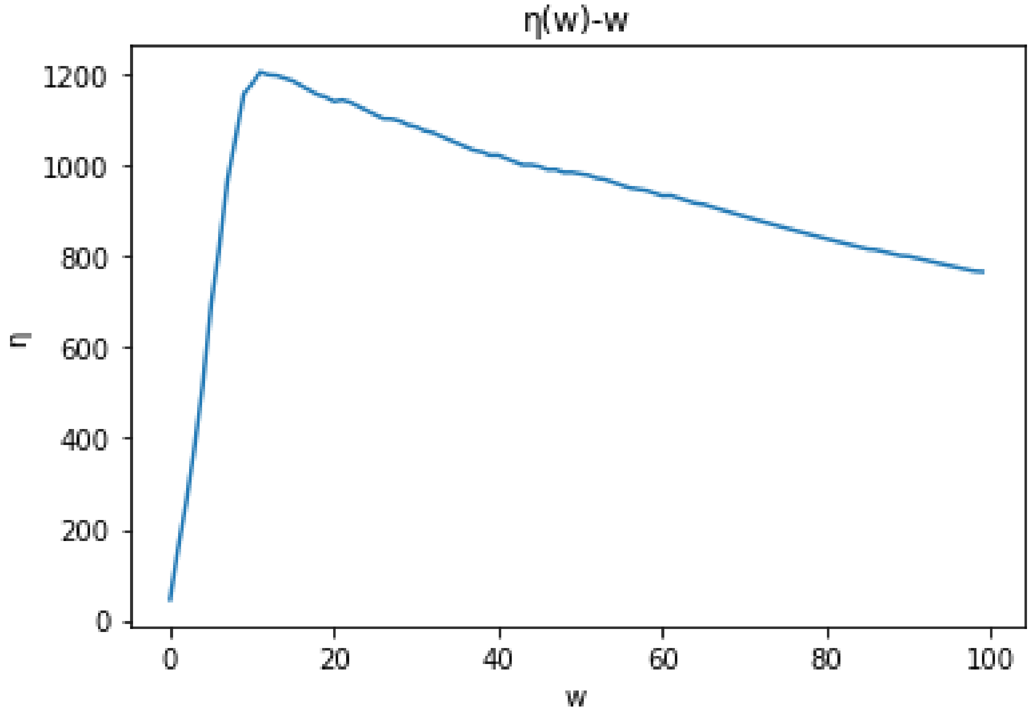
   Step1. Calculate the median of the ogrinal data and every point minus the median. Calculate the length(L) of this data. 1st_deviation_data don't need to minus median.





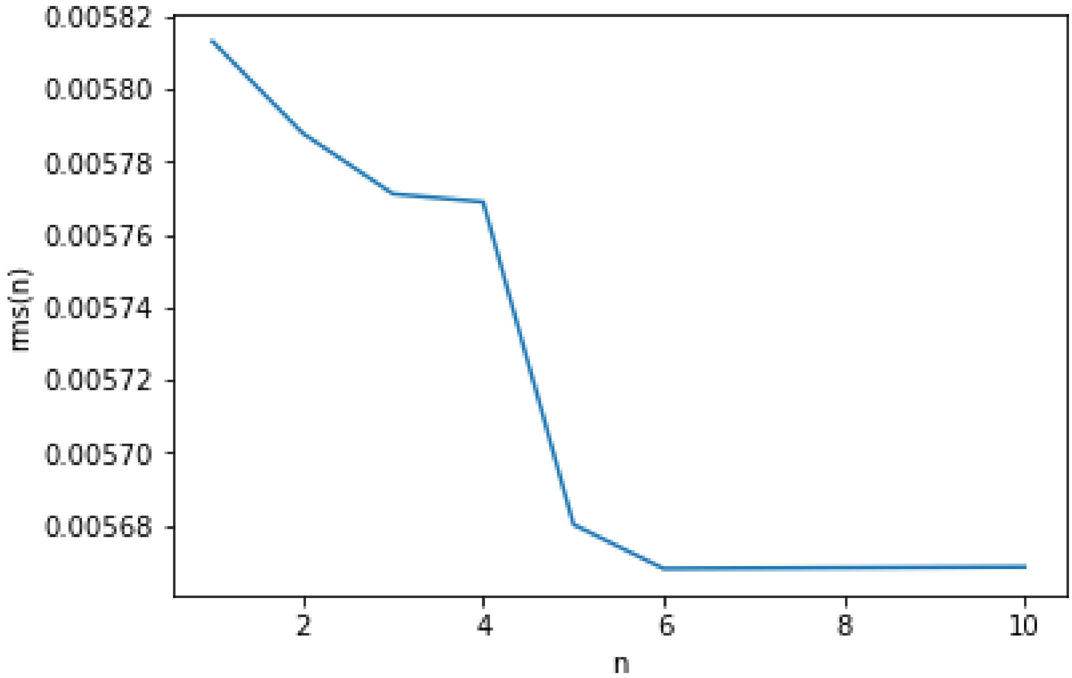
Step2. Change the size of the window. $\eta = \frac{N_w}{w+L}$, where N_w is number of points in this window, w is the width of window, L is the total length of data.

Choose the w where $\eta(w)$ is biggest. Consider wr*w as size of non-peak window, where wr is weight factor the user input.



Step3. Width of the area above the threshold is f, then consider the region with width 3*f may conclude more than one peaks. The set of non-peak region of smoothed data is α1. The set of non-peak region of 1st derivative data is α2. Then the total non-peak region is $\alpha 1 \cap \alpha 2$.

Step4. Select an appropriate polynomial degree. Use a polynomial with degree n, and n increase from 3. When $\frac{rms(n+1)}{rms(n)} \geq 0.98$, use a polynomial with degree n to fit the total non-peak region, where rms(n) is root mean square of the fitting with degree n. Then we consider this fitting result as zero point.



Step5. Determine the noise level. Sort the deviation between the smoothed data and the fitting data in the non-peak region. The 98% biggest data is considered as noise. (select 98% biggest but not the biggest is to avoid the extreme data).

5. Fitting

Step1. Do subtraction between the zero points and smoothed data points. Then get the absolute value.

Step2. Scan the whole area. When we find a point bigger than r*noise, we consider there exist some peaks. If the fluctuation is bigger than r*noise the number of the peaks increase 1. Record all these sections.

Step3. Use lmfit packet to fit the signal with Gaussian and

Lorentzian models. The lmfit needs initial value.

Use maximum value as initial value of height.

Use position of maximum to estimate center of peak.

Use maximum point and another point to calculate and estimate σ or γ.

6. Output

   Noise level.

   Polynomial degree.

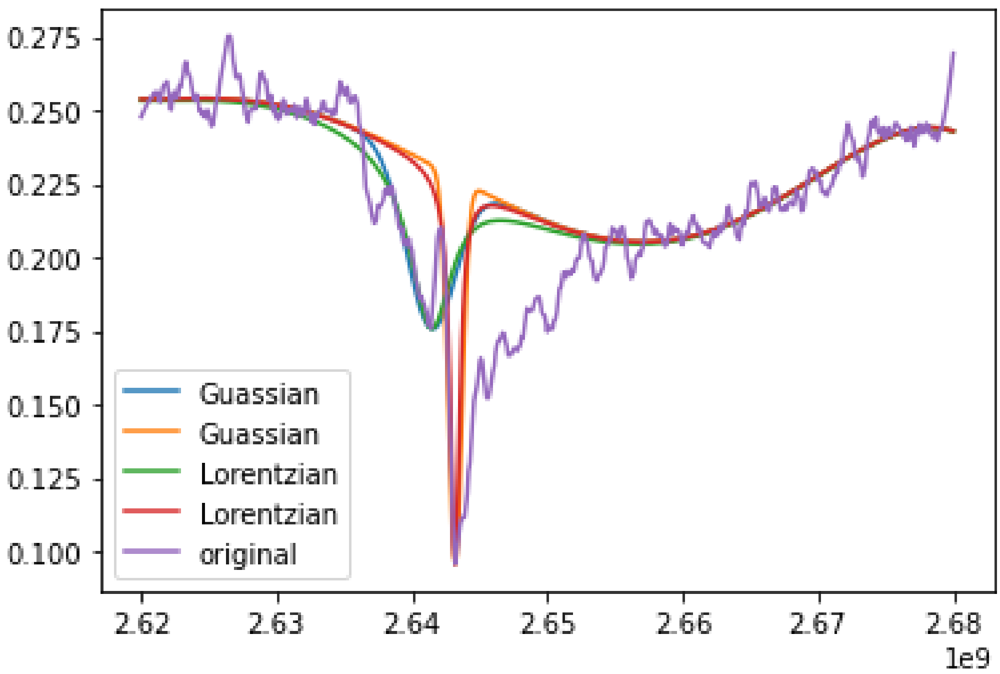
   Gaussian model: $\mathrm{g(x)} = \mathrm{A} * e^{-\frac{(x-\mu)^2}{2*\sigma^2}}$

   Lorentzian model: $\mathrm{l(x)} = \frac{A}{\frac{(x-\mu)^2}{\gamma^2}+1}$

Report

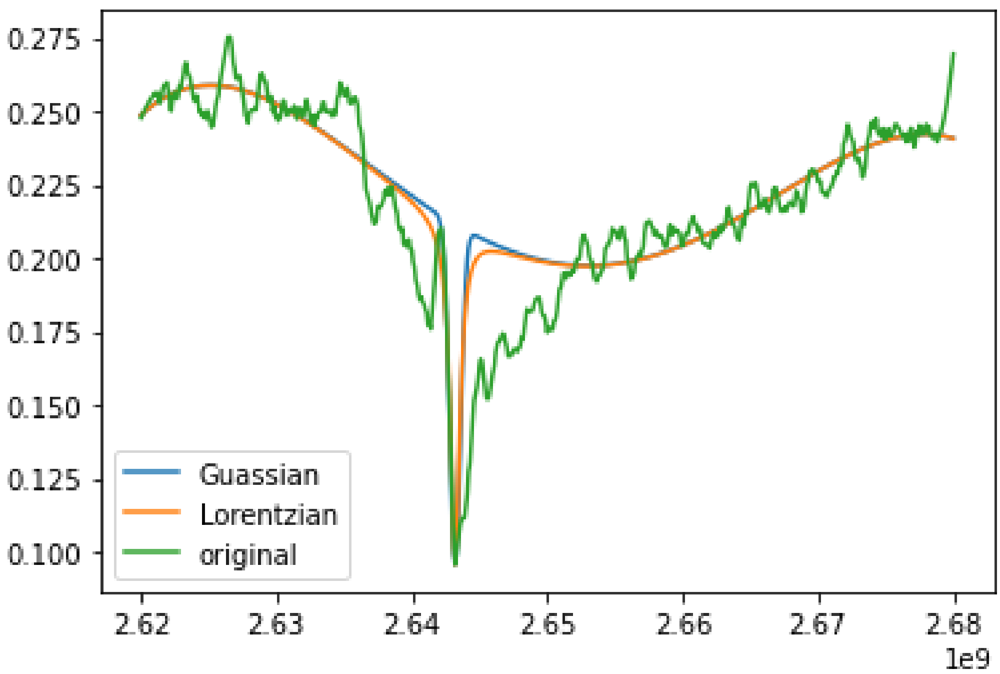
1. Pulse_20200831-110833_data

   r=1.5 wf=0.8



Two peaks.

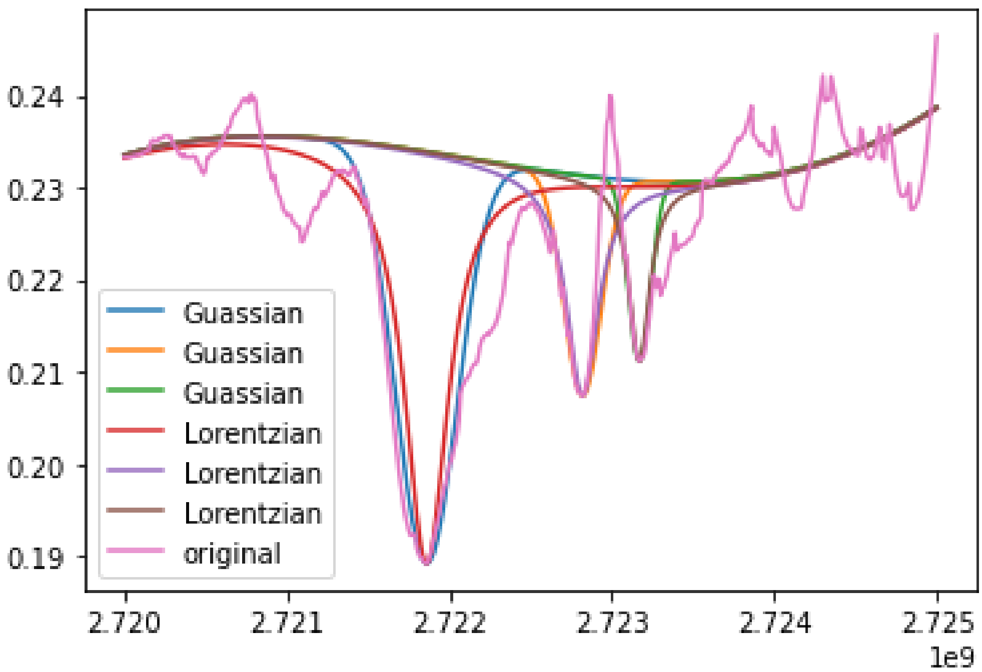
r=1.5 wf=1



One peak.

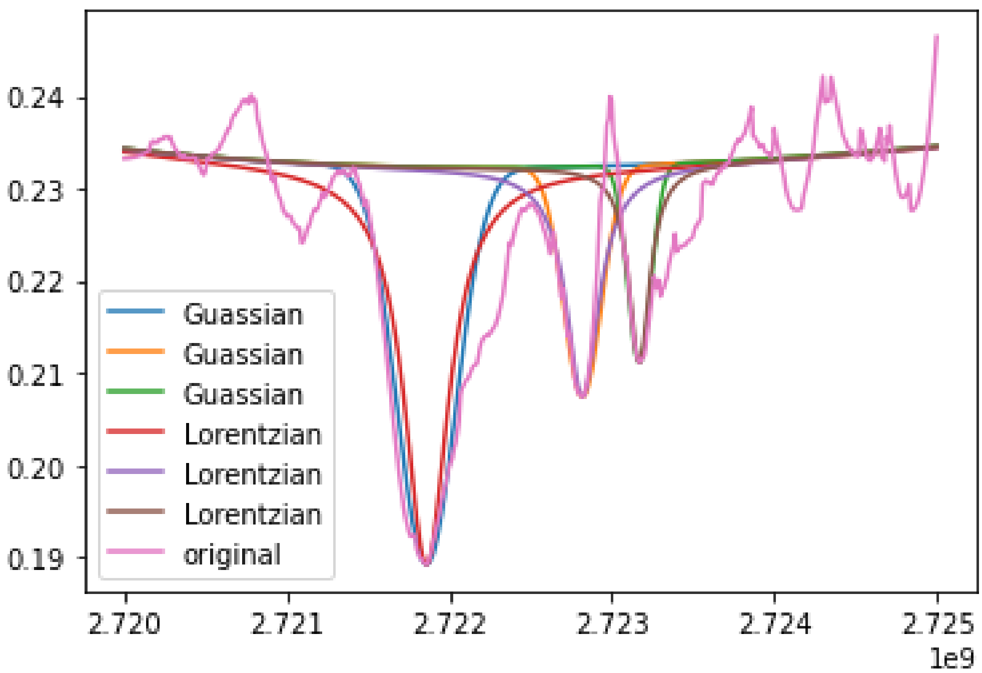
2. Pulse_20200913-162824_data

r=1 wf=1



Three peaks.(r=1.5 get 2 peaks)

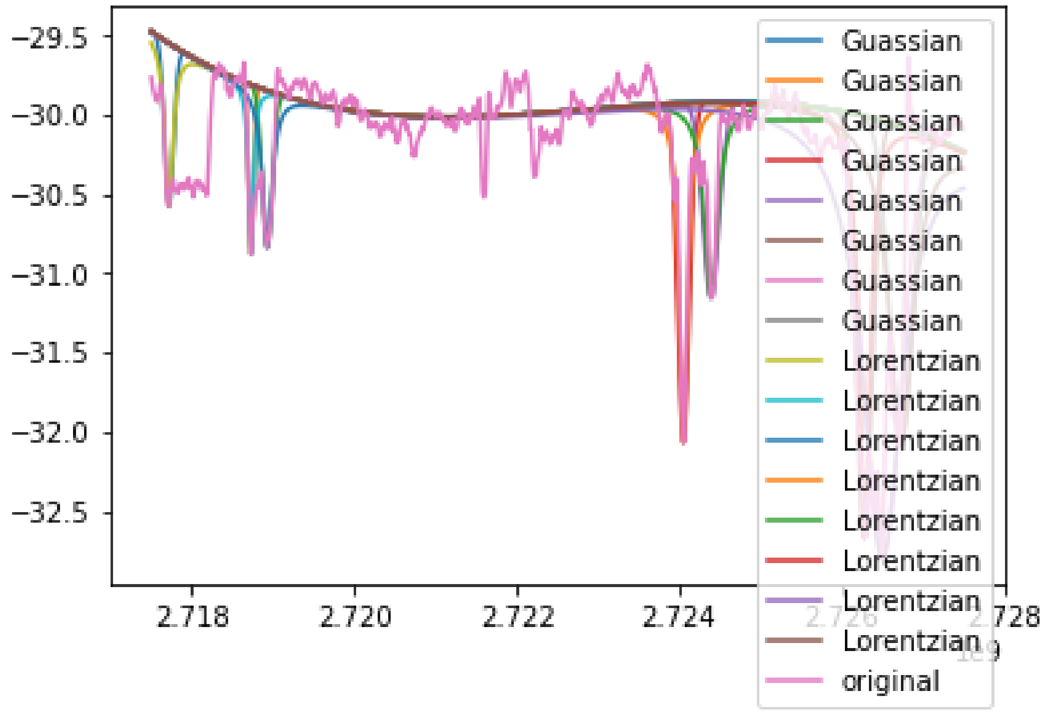
r=1.5 wf=0.7



Three peaks.(lower wf, more peaks)

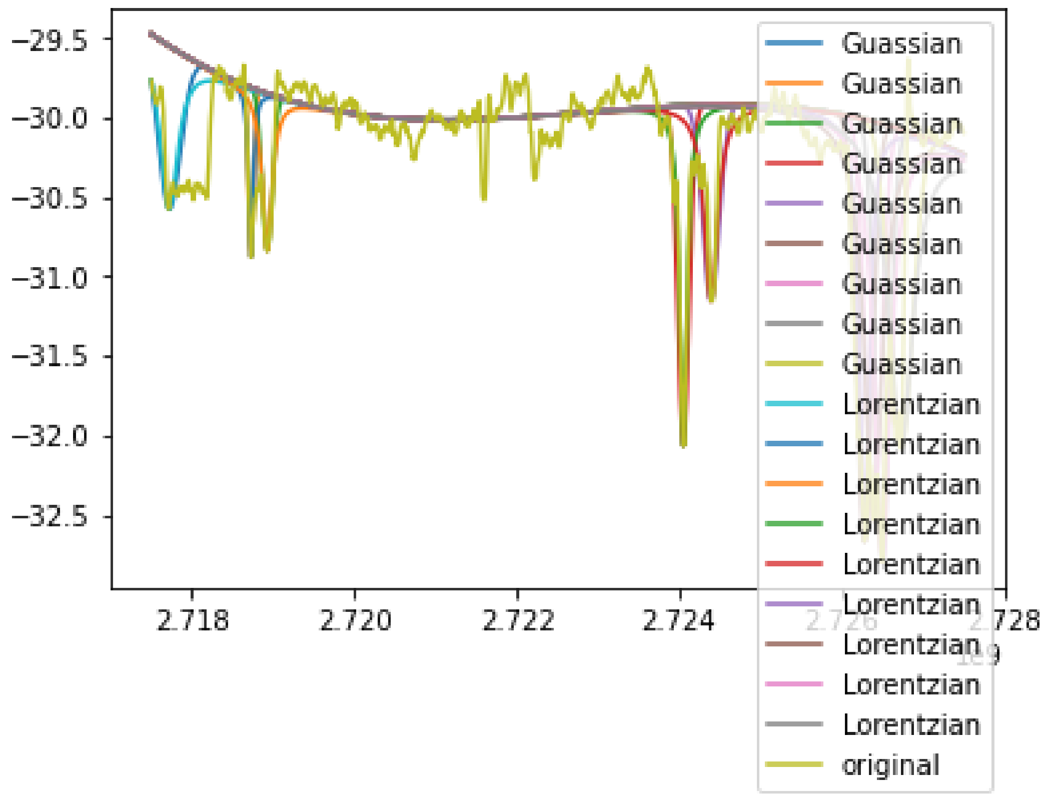
3. vna_cont_spec_pulselike

r=1.5 wf=0.8



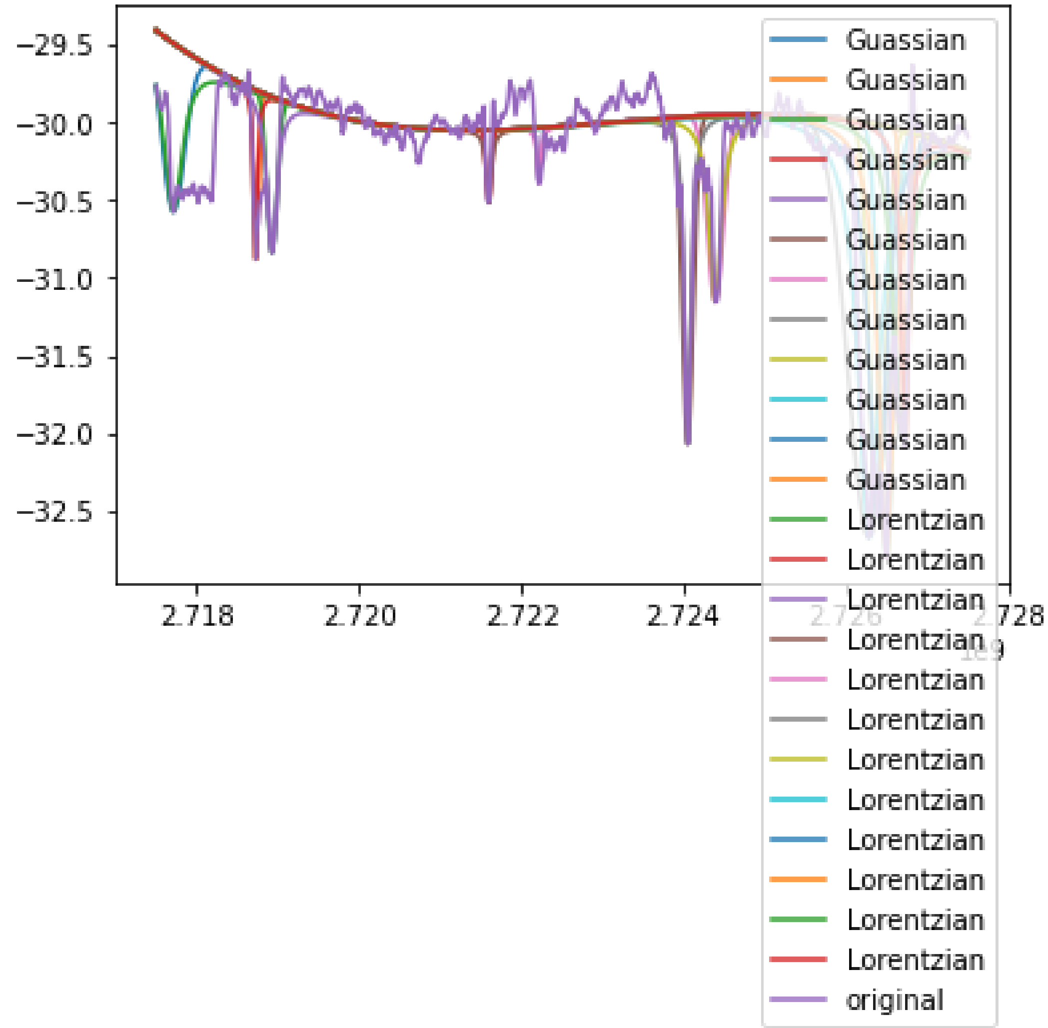
Eight peaks.

r=1 wf=0.8



Nine peaks.

r=1 wf=0.5



Twelve peaks.