20231113-StudyOfStretch

November 14, 2023

1 Measuring Blood sample on day 13-11-2023

We measured the stretched and non-stretch skin on index (twice) and middle finger.

Laser power is set at 5.5 (0.39A, 30mW)

The assessment duration is 120 seconds with no accumulation.

Before the analyse, we performed `python3 _preprocess.py -d data/20231113-stretch/ --upper_bound 1570 --lower_bound 0` to add meta data and limit the range of spectra

[ ]:
```
import spectrochempy as scp
from glob import glob
```

[ ]:
```
files = sorted(glob(pathname="data/20231113-stretch/*"))
files
```

[ ]:
```
['data/20231113-stretch/index2blood_600_785 nm_120
s_1_2023_11_13_18_52_41_01.txt',
 'data/20231113-stretch/index2noblood_600_785 nm_120
s_1_2023_11_13_18_55_21_01.txt',
 'data/20231113-stretch/indexblood_600_785 nm_120
s_1_2023_11_13_18_40_10_01.txt',
 'data/20231113-stretch/indexnoblood_600_785 nm_120
s_1_2023_11_13_18_43_15_01.txt',
 'data/20231113-stretch/middleblood_600_785 nm_120
s_1_2023_11_13_18_46_40_01.txt',
 'data/20231113-stretch/middlenoblood_600_785 nm_120
s_1_2023_11_13_18_49_32_01.txt',
 'data/20231113-stretch/noise_600_785 nm_120 s_1_2023_11_13_18_07_22_01.txt',
 'data/20231113-stretch/nothing_600_785 nm_120 s_1_2023_11_13_18_18_24_01.txt',
 'data/20231113-stretch/nothing_600_785 nm_120 s_1_2023_11_13_18_36_56_01.txt',
 'data/20231113-stretch/nothing_600_785 nm_120 s_1_2023_11_13_18_58_03_01.txt']
```

[ ]:
```
all = scp.read_labspec(files)
all.preferences.figure.figsize = (10, 5)
all
```

[ ]:
```
NDDataset: [float64] unitless (shape: (y:10, x:745))
```

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```

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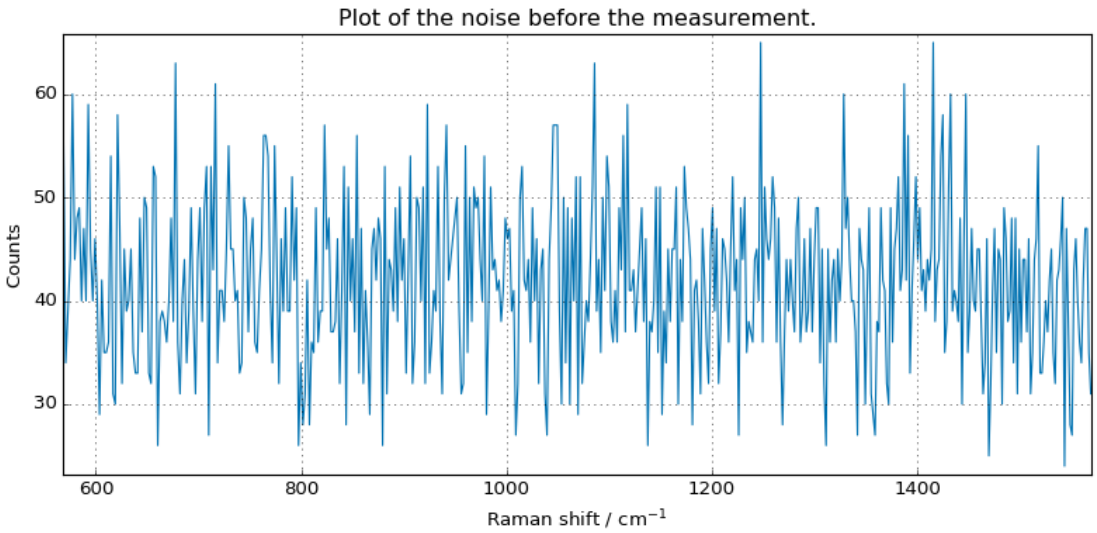
No such comm: b3d40d5f448a45199922496eef357efe
```

[ ]:
```
index2 = all[0:2, 0:500]
index = all[2:4, 0:500]
middle = all[4:6, 0:500]
noise = all[6, 0:500]
```

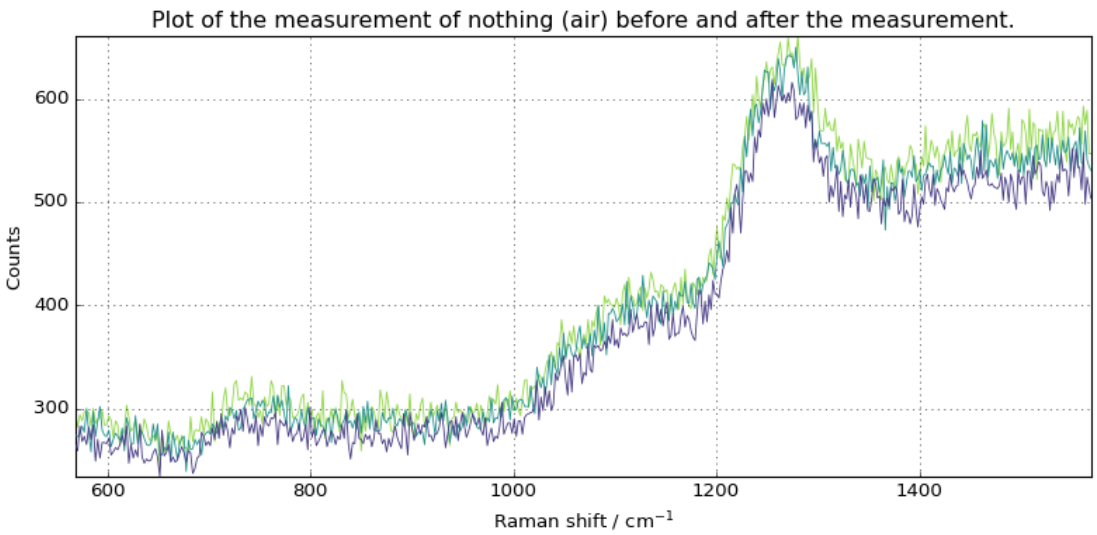
```
nothing = all[7:10, 0:500]
```

2 Let's check the noise

[ ]:
```
ax = noise.plot()
ax.set_title(f"Plot of the noise before the measurement.")
ax.grid()
```



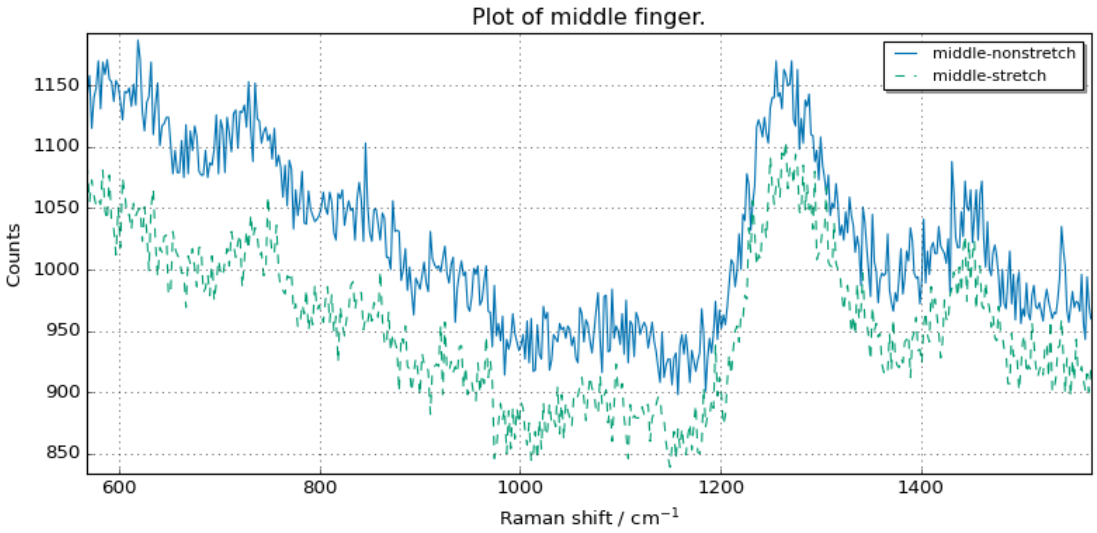
[ ]:
```
ax = nothing.plot()
ax.set_title(f"Plot of the measurement of nothing (air) before and after the␣
 ↪measurement.")
ax.grid()
```



[ ]:
```
ax = scp.plot_multiple(method="pen", datasets=[index[0], index[1]],␣
↪labels=['index-nonstretch', 'index-stretch'], legend='best')
ax.set_title(f"Plot of the index finger.")
ax.grid()
```

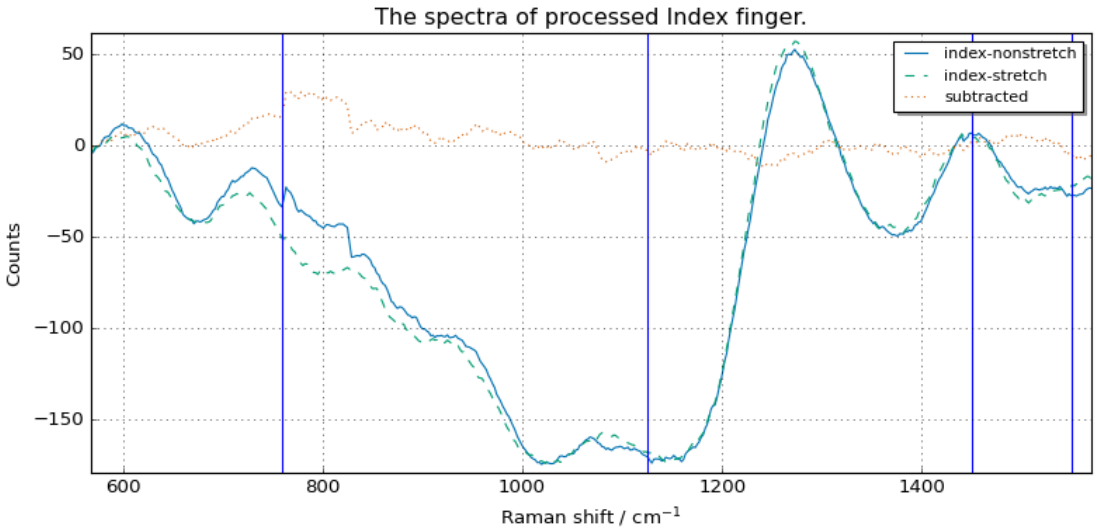
[ ]:
```
ax = scp.plot_multiple(method="pen", datasets=[index2[0], index2[1]],␣
↪labels=['2nd-index-nonstretch', '2nd-index-stretch'], legend='best')
ax.set_title(f"Plot of index finger (2nd time).")
ax.grid()
```

[ ]:
```
ax = scp.plot_multiple(method="pen", datasets=[middle[0], middle[1]],␣
↪labels=['middle-nonstretch', 'middle-stretch'], legend='best')
ax.set_title(f"Plot of middle finger.")
ax.grid()
```



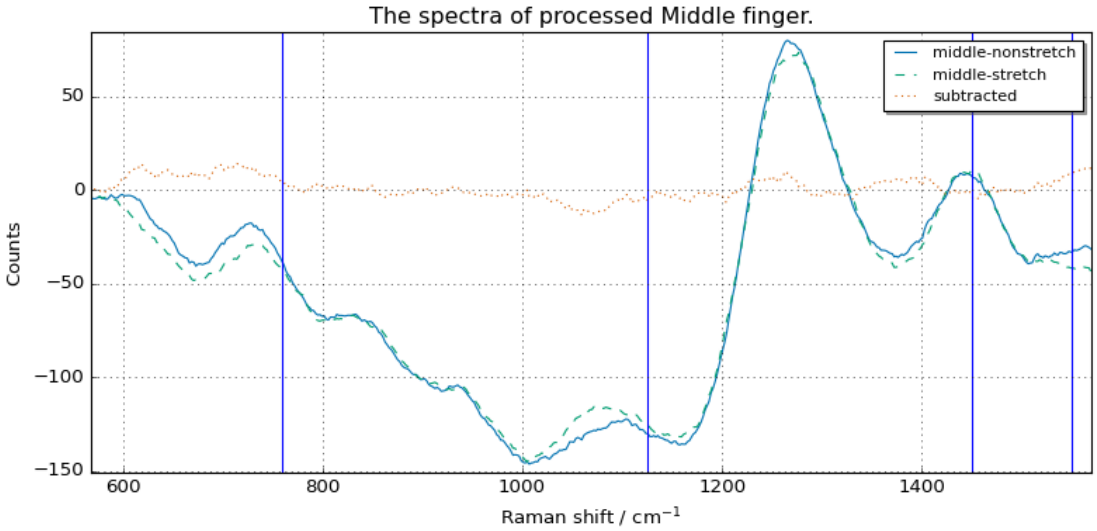
3 Noise then Baseline Removal

[ ]:
```
# Baseline at 1450
blc = scp.Baseline(ranges=(1430,1470))
# blc = scp.Baseline()
blc.fit(index.smooth(31))
data = blc.transform()
index_subtract = data[0] - data[1]
ax = scp.plot_multiple(method="pen", datasets=[data[0], data[1],␣
 ↪index_subtract], labels=['index-nonstretch', 'index-stretch', 'subtracted'],␣
 ↪legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f'The spectra of processed Index finger.')
ax.grid()
```

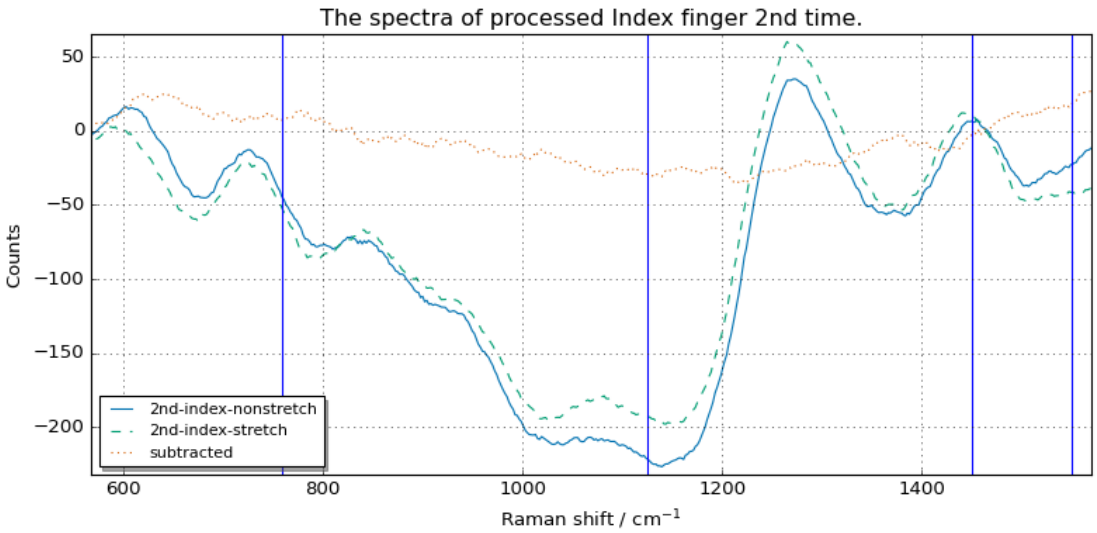


[ ]:
```
# Baseline at 1450
blc = scp.Baseline(ranges=(1430,1470))
# blc = scp.Baseline()
blc.fit(middle.smooth(31))
data = blc.transform()
middle_subtract = data[0] - data[1]
ax = scp.plot_multiple(method="pen", datasets=[data[0], data[1],␣
 ↪middle_subtract], labels=['middle-nonstretch', 'middle-stretch',␣
 ↪'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
```

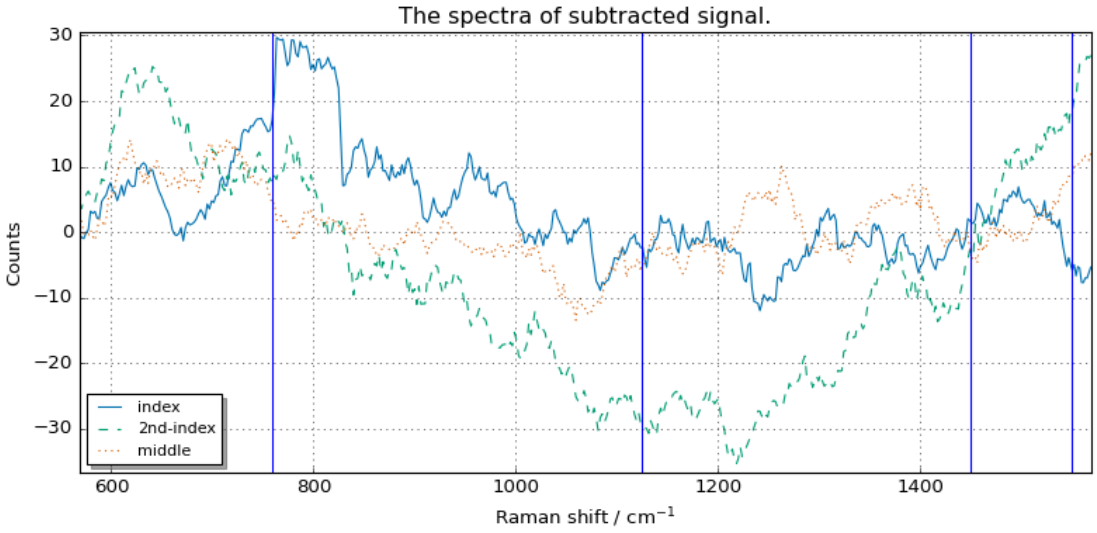
```
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f'The spectra of processed Middle finger.')
ax.grid()
```



[ ]:
```
# Baseline at 1450
blc = scp.Baseline(ranges=(1430,1470))
# blc = scp.Baseline()
blc.fit(index2.smooth(31))
data = blc.transform()
index2_subtract = data[0] - data[1]
ax = scp.plot_multiple(method="pen", datasets=[data[0], data[1],␣
 ↪index2_subtract], labels=['2nd-index-nonstretch', '2nd-index-stretch',␣
 ↪'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f'The spectra of processed Index finger 2nd time.')
ax.grid()
```



[ ]:
```
# Baseline at 1450
ax = scp.plot_multiple(method="pen", datasets=[index_subtract, index2_subtract,␣
 ↪middle_subtract], labels=['index', '2nd-index', 'middle'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f'The spectra of subtracted signal.')
ax.grid()
```



4 Second attempt

We observed that the measurement is not showed any sing of blood.

Our guess is that the laser power might not penetrate the skin and reach the blood.

Therefore, we increased the power of the laser to 9 (0.63-0.64, 240mW) and reduced the exposure to 60 seconds

[ ]:
```
files = sorted(glob(pathname="data/20231113-stretch-2/*"))
files
```

[ ]:
```
['data/20231113-stretch-2/indexblood_600_785 nm_60
s_1_2023_11_13_19_47_52_01.txt',
 'data/20231113-stretch-2/indexnoblood_600_785 nm_60
s_1_2023_11_13_19_49_47_01.txt',
 'data/20231113-stretch-2/nothing_600_785 nm_60 s_1_2023_11_13_19_51_29_01.txt',
 'data/20231113-stretch-2/nothing_600_785 nm_60 s_1_2023_11_13_19_52_37_01.txt',
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s_1_2023_11_13_19_54_46_01.txt',
 'data/20231113-stretch-2/thirdnoblood_600_785 nm_60
s_1_2023_11_13_19_56_29_01.txt']
```

[ ]:
```
all = scp.read_labspec(files)
all.preferences.figure.figsize = (10, 5)
all
```

[ ]:
```
NDDataset: [float64] unitless (shape: (y:6, x:745))
```

```
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```

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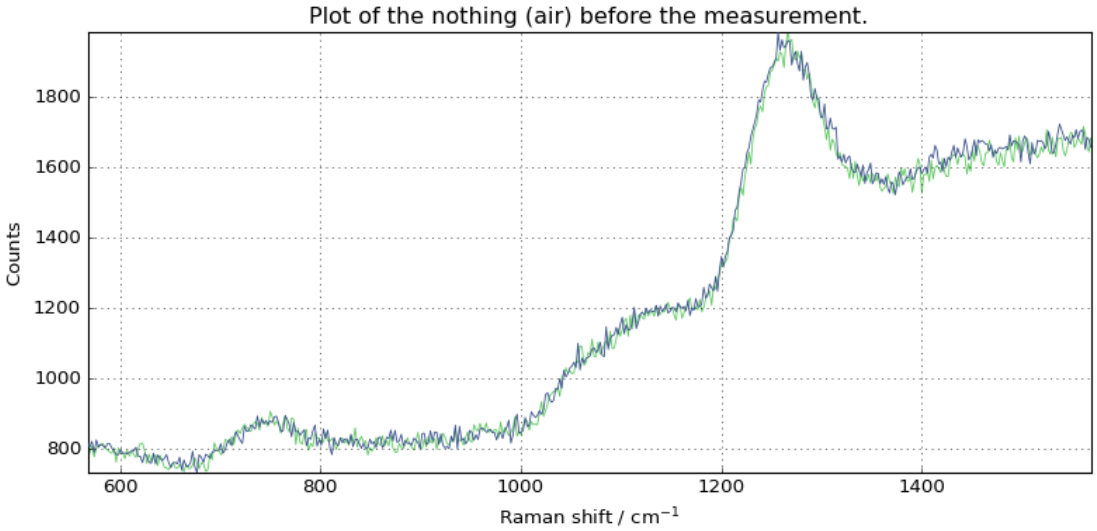
No such comm: 33c85d78599748f1806d0b3a4e4e7b64
No such comm: 33c85d78599748f1806d0b3a4e4e7b64
```

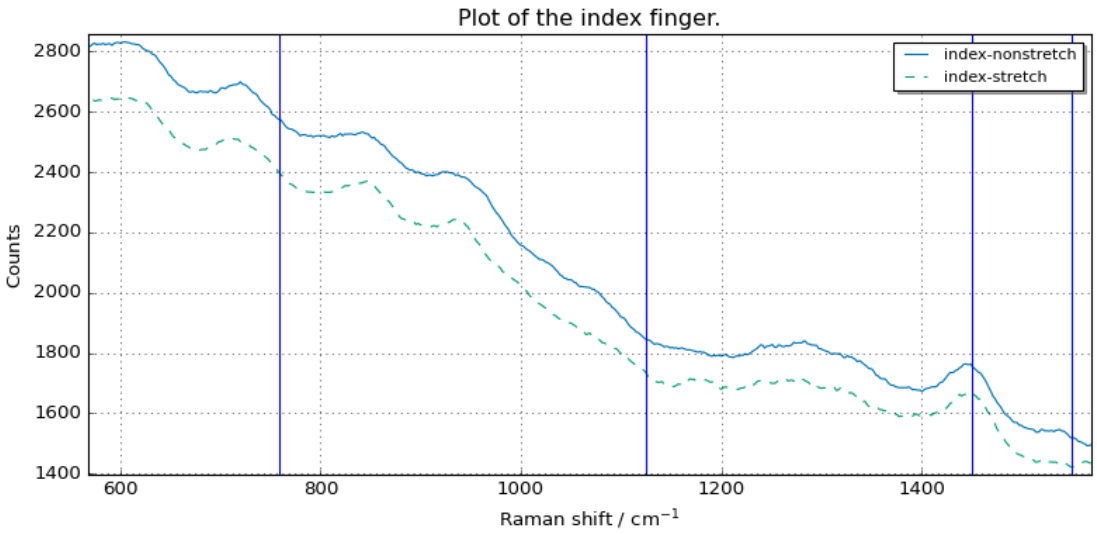
[ ]:
```
index = all[0:2, 0:500]
nothing = all[2:4, 0:500]
```

```
third = all[4:6, 0:500]
```

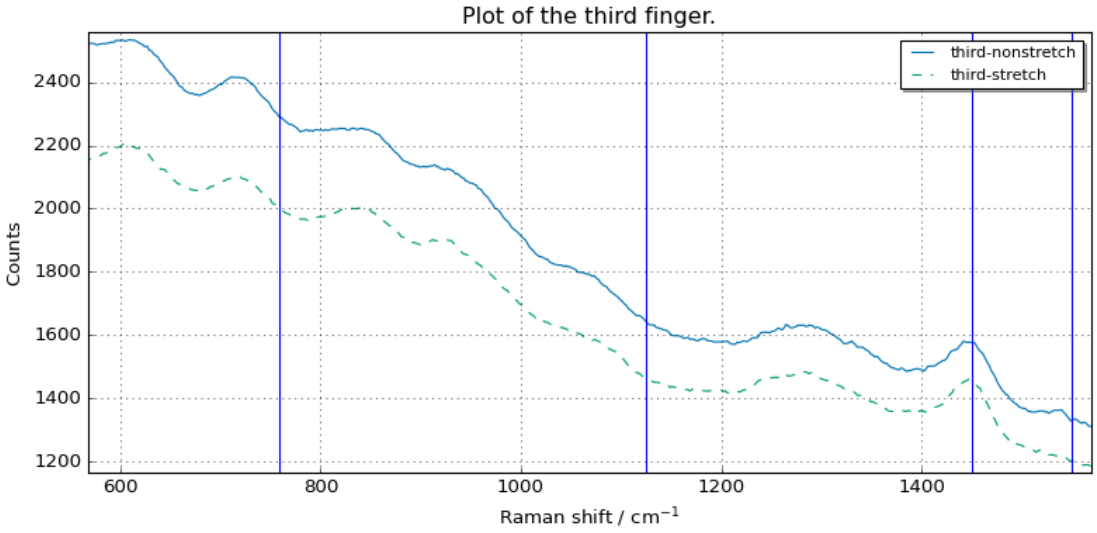
[ ]:
```
ax = nothing.plot()
ax.set_title(f"Plot of the nothing (air) before the measurement.")
ax.grid()
```



[ ]:
```
ax = scp.plot_multiple(method="pen", datasets=[index[0].smooth(15) - nothing[0].
 ↪smooth(15), index[1].smooth(15) - nothing[0].smooth(15)],␣
 ↪labels=['index-nonstretch', 'index-stretch'], legend='best')
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of the index finger.")
ax.grid()
```

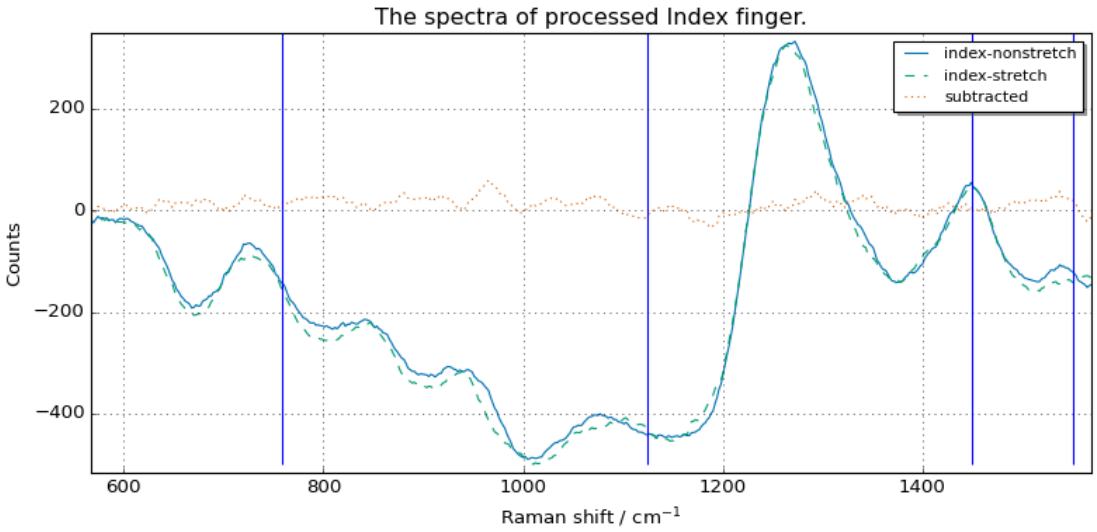


[ ]:
```
ax = scp.plot_multiple(method="pen", datasets=[third[0].smooth(15) - nothing[0].
↪smooth(15), third[1].smooth(15) - nothing[0].smooth(15)],␣
↪labels=['third-nonstretch', 'third-stretch'], legend='best')
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of the third finger.")
ax.grid()
```



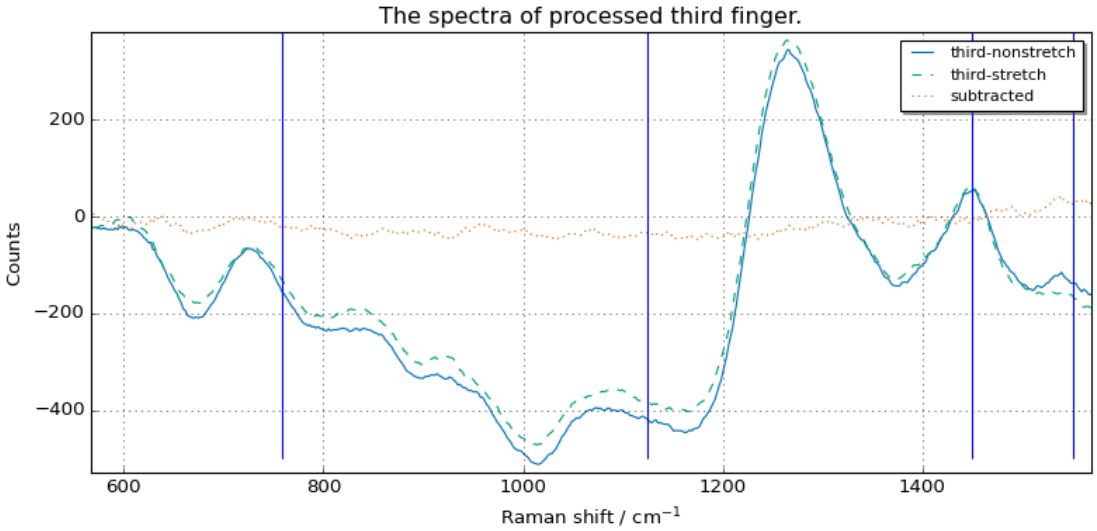
5 Noise then Baseline Removal

[ ]:
```
# Baseline at 1450
blc = scp.Baseline(ranges=(1430,1470))
# blc = scp.Baseline()
blc.fit(index.smooth(15))
data = blc.transform()
index_subtract = data[0] - data[1]
ax = scp.plot_multiple(method="pen", datasets=[data[0], data[1],␣
 ↪index_subtract], labels=['index-nonstretch', 'index-stretch', 'subtracted'],␣
 ↪legend='best')
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f'The spectra of processed Index finger.')
ax.grid()
```



[ ]:
```
# Baseline at 1450
blc = scp.Baseline(ranges=(1430,1470))
# blc = scp.Baseline()
blc.fit(third.smooth(15))
data = blc.transform()
third_subtract = data[0] - data[1]
ax = scp.plot_multiple(method="pen", datasets=[data[0], data[1],␣
 ↪third_subtract], labels=['third-nonstretch', 'third-stretch', 'subtracted'],␣
 ↪legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
```

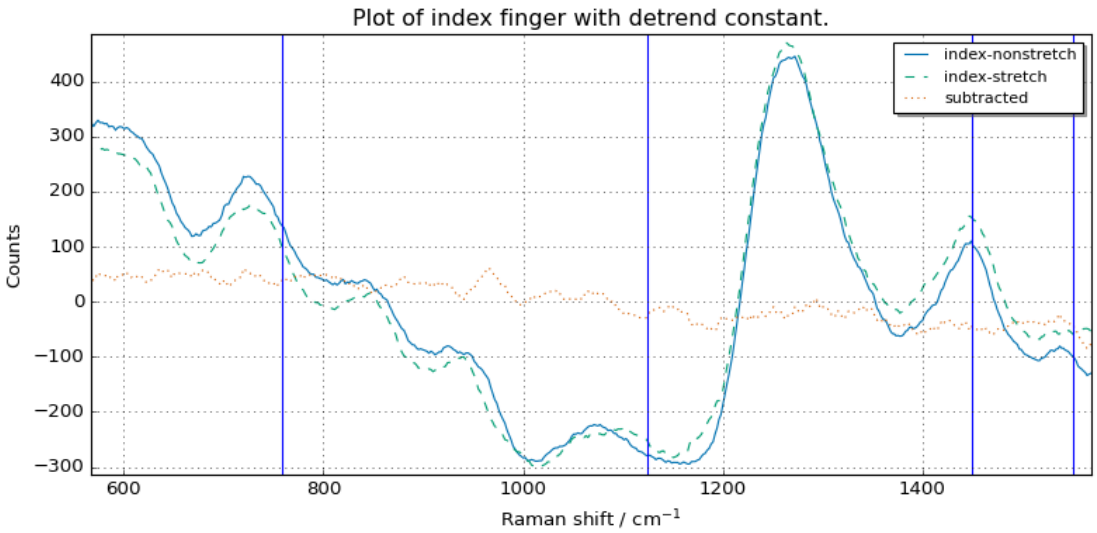
```
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f'The spectra of processed third finger.')
ax.grid()
```



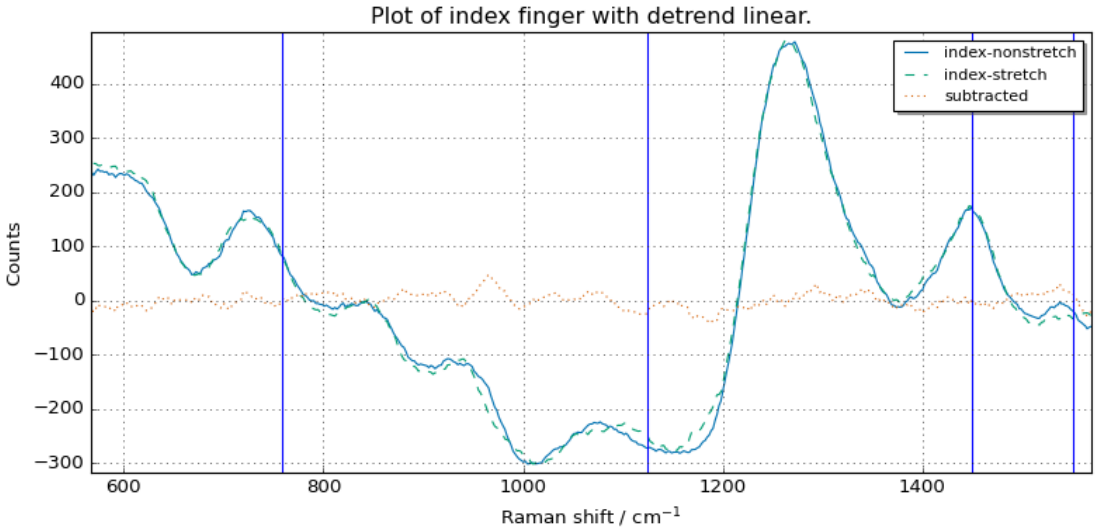
6 Let try detrend

When we observed ther measurement of the third finger (and some other before this), there is an obvious change of slope in the spectra.

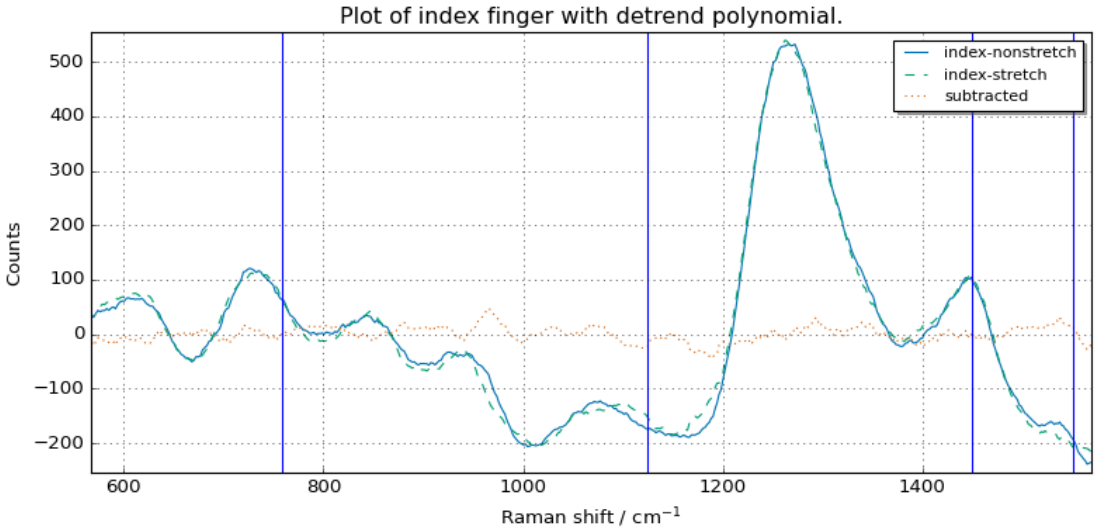
[ ]:
```
index_detrend = index.detrend(order='constant').smooth(15)
ax = scp.plot_multiple(method="pen", datasets=[index_detrend[0],␣
 ↪index_detrend[1], index_detrend[0] - index_detrend[1]],␣
 ↪labels=['index-nonstretch', 'index-stretch', 'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of index finger with detrend constant.")
ax.grid()
```



[ ]:
```
index_detrend = index.detrend(order='linear').smooth(15)
ax = scp.plot_multiple(method="pen", datasets=[index_detrend[0],␣
 ↪index_detrend[1], index_detrend[0] - index_detrend[1]],␣
 ↪labels=['index-nonstretch', 'index-stretch', 'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of index finger with detrend linear.")
ax.grid()
```

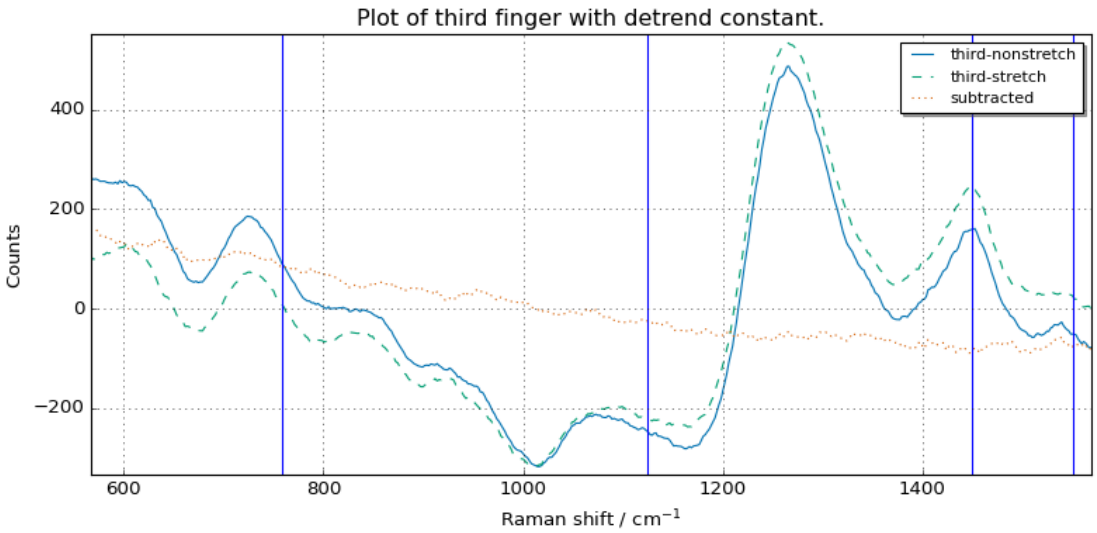


[ ]:
```
index_detrend = index.detrend(order=2).smooth(15)
ax = scp.plot_multiple(method="pen", datasets=[index_detrend[0],␣
 ↪index_detrend[1], index_detrend[0] - index_detrend[1]],␣
 ↪labels=['index-nonstretch', 'index-stretch', 'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of index finger with detrend polynomial.")
ax.grid()
```

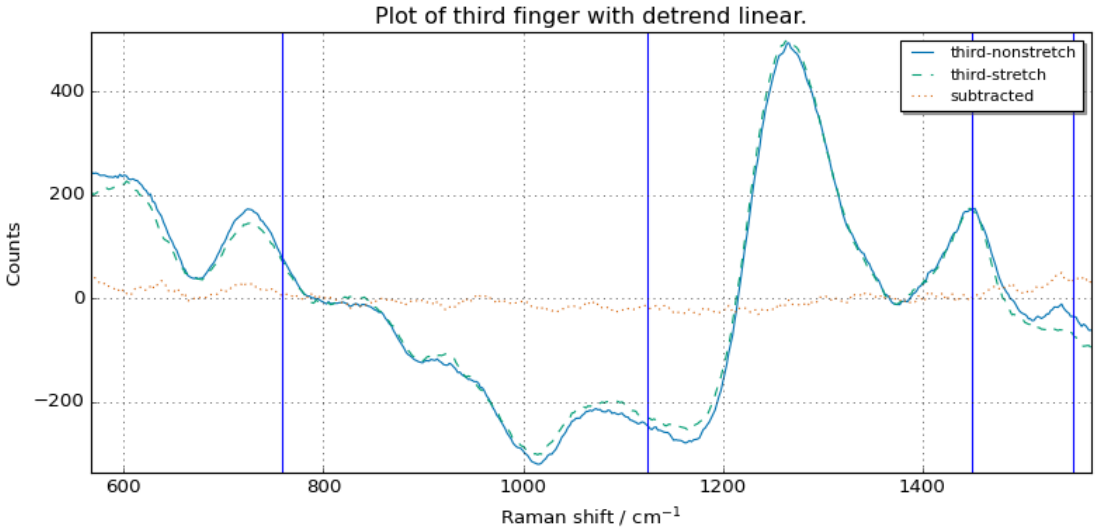


6.1 Third finger

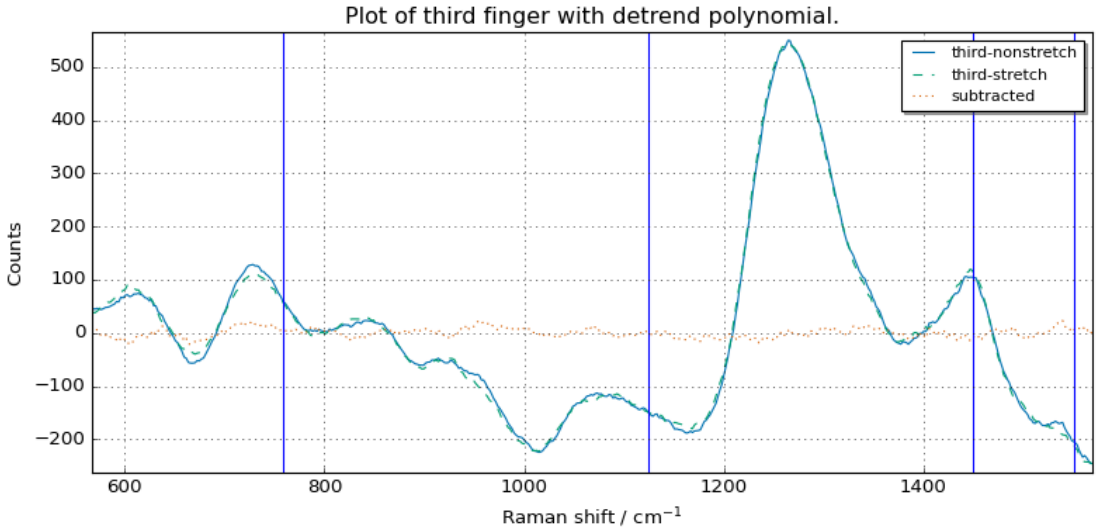
[ ]:
```
third_detrend = third.detrend(order='constant').smooth(15)
ax = scp.plot_multiple(method="pen", datasets=[third_detrend[0],␣
 ↪third_detrend[1], third_detrend[0] - third_detrend[1]],␣
 ↪labels=['third-nonstretch', 'third-stretch', 'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of third finger with detrend constant.")
ax.grid()
```



[ ]:
```
third_detrend = third.detrend(order='linear').smooth(15)
ax = scp.plot_multiple(method="pen", datasets=[third_detrend[0],␣
 ↪third_detrend[1], third_detrend[0] - third_detrend[1]],␣
 ↪labels=['third-nonstretch', 'third-stretch', 'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of third finger with detrend linear.")
ax.grid()
```



[ ]:
```
third_detrend = third.detrend(order=2).smooth(15)
ax = scp.plot_multiple(method="pen", datasets=[third_detrend[0],␣
 ↪third_detrend[1], third_detrend[0] - third_detrend[1]],␣
 ↪labels=['third-nonstretch', 'third-stretch', 'subtracted'], legend='best')
ax.vlines(x=1125, ymin=-500, ymax=10000)
ax.vlines(x=759, ymin=-500, ymax=10000)
ax.vlines(x=1450, ymin=-500, ymax=10000)
ax.vlines(x=1550, ymin=-500, ymax=10000)
ax.set_title(f"Plot of third finger with detrend polynomial.")
ax.grid()
```



7 Summary

The evidence of blood raman spectra is not shown yet.