1.20 这是ppg_package 这个python包的使用说明文档

ppg_package 是对ppg信号进行信号处理 特征提取 绘制图像 深度学习网络模型预测心输出量CO的python包

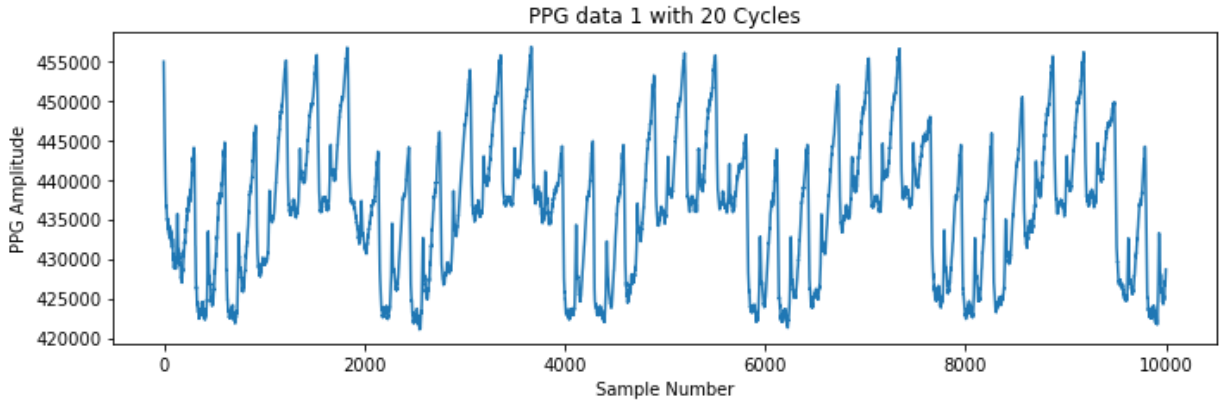
导入包文件

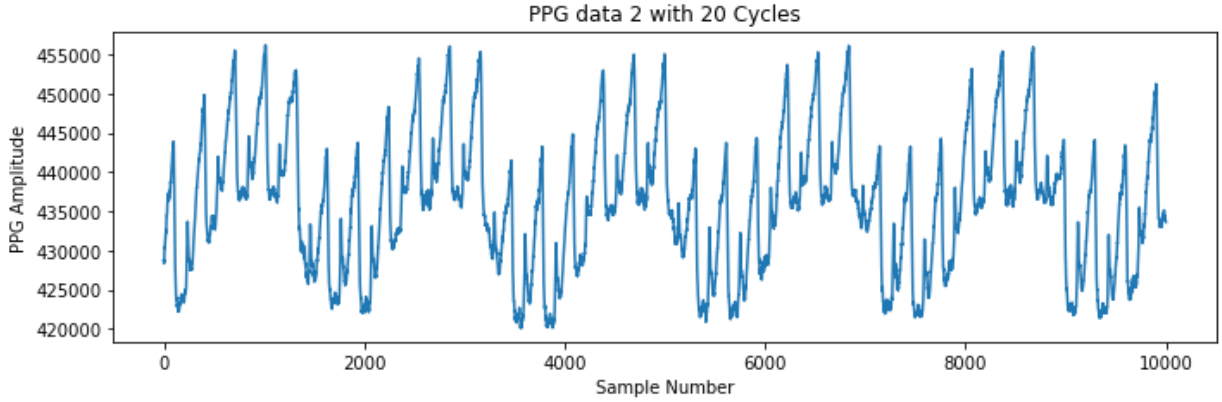
In [1]:
```
import ppg_package
```

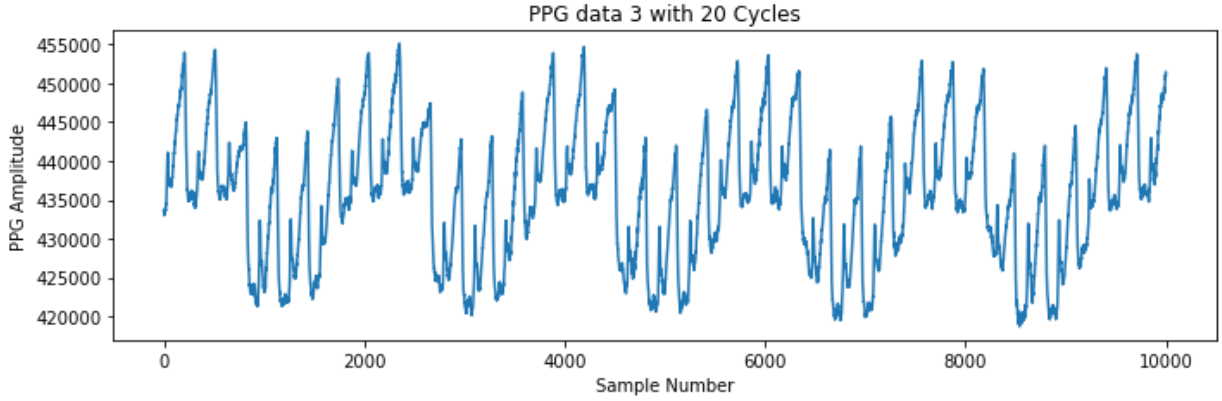
```
D:\Anaconda\lib\site-packages\pandas\core\computation\expressions.py:20: UserWarning:
Pandas requires version '2.7.3' or newer of 'numexpr' (version '2.7.1' currently insta
lled).
  from pandas.core.computation.check import NUMEXPR_INSTALLED
```

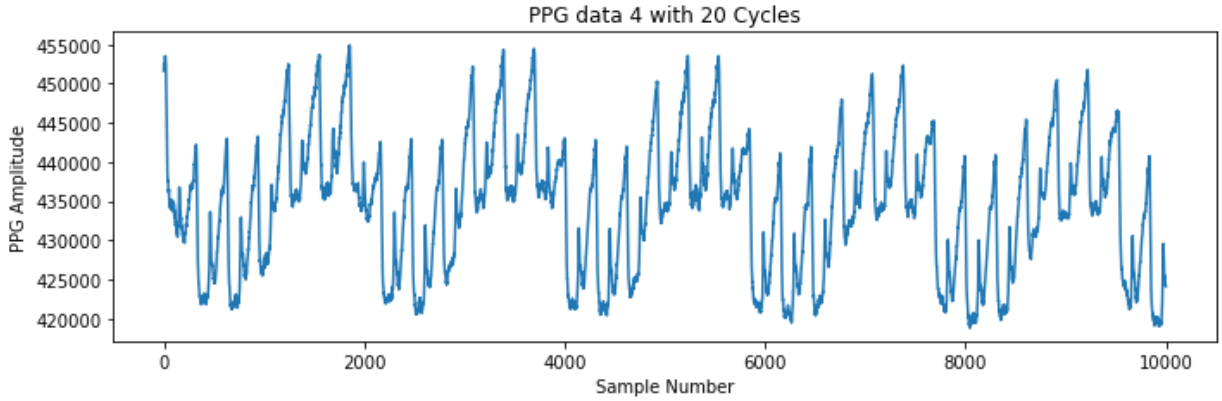
plotter:调用读取特定文件夹路径的txt文件进行分段绘图包函数

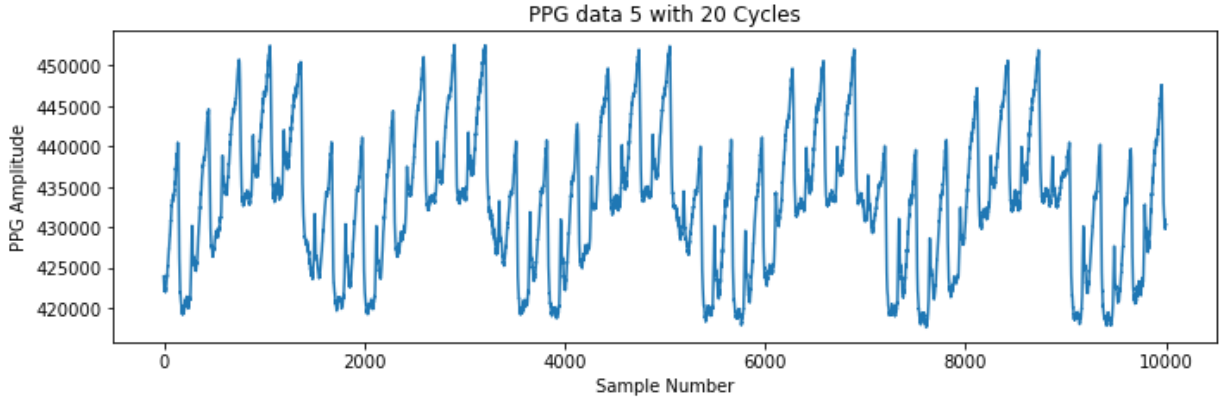
In [5]:
```
from ppg_package.plotter import plot_ppg_segments
file_path = "C:\\Users\\HUAWEI\\Desktop\\p-p-ppg\\CO\\5.1 940nm\\2022.05.01__10_54_inf
plot_ppg_segments(file_path)
```

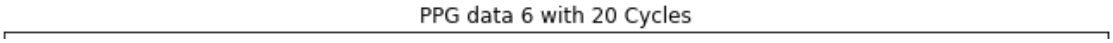

PPG data 1 with 20 Cycles
PPG Amplitude
455000
450000
445000
440000
435000
430000
425000
420000
0
2000
4000
6000
8000
10000
Sample Number

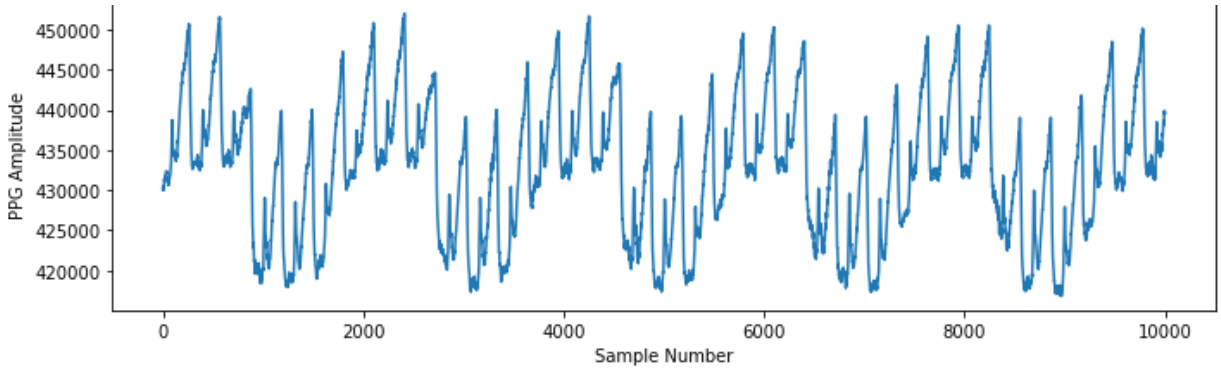

PPG data 2 with 20 Cycles
PPG Amplitude
455000
450000
445000
440000
435000
430000
425000
420000
0
2000
4000
6000
8000
10000
Sample Number


PPG data 3 with 20 Cycles
PPG Amplitude
455000
450000
445000
440000
435000
430000
425000
420000
0
2000
4000
6000
8000
10000
Sample Number


PPG data 4 with 20 Cycles
PPG Amplitude
455000
450000
445000
440000
435000
430000
425000
420000
0
2000
4000
6000
8000
10000
Sample Number


PPG data 5 with 20 Cycles
PPG Amplitude
450000
445000
440000
435000
430000
425000
420000
0
2000
4000
6000
8000
10000
Sample Number


PPG data 6 with 20 Cycles

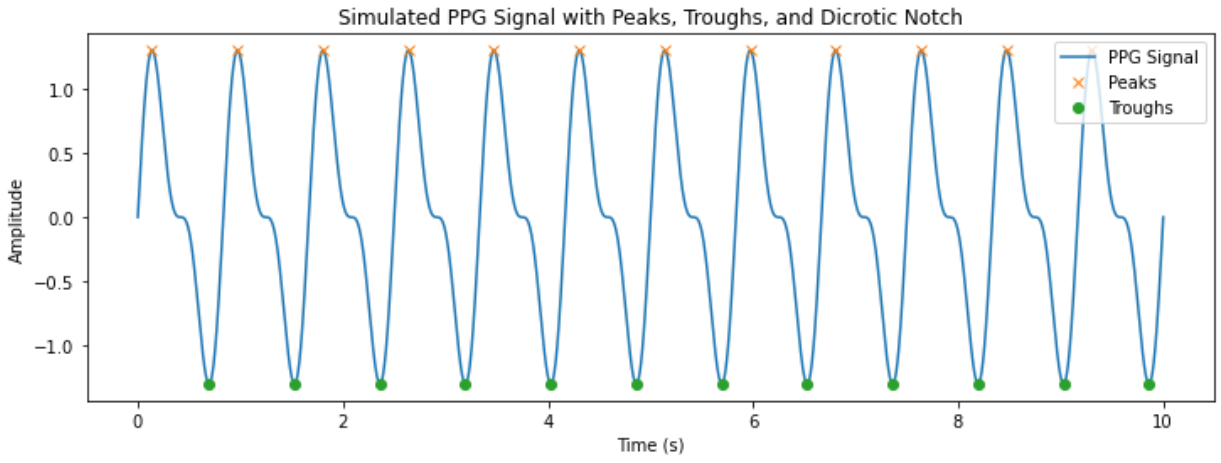


Out[5]: True

模拟一段ppg波形

In [3]:

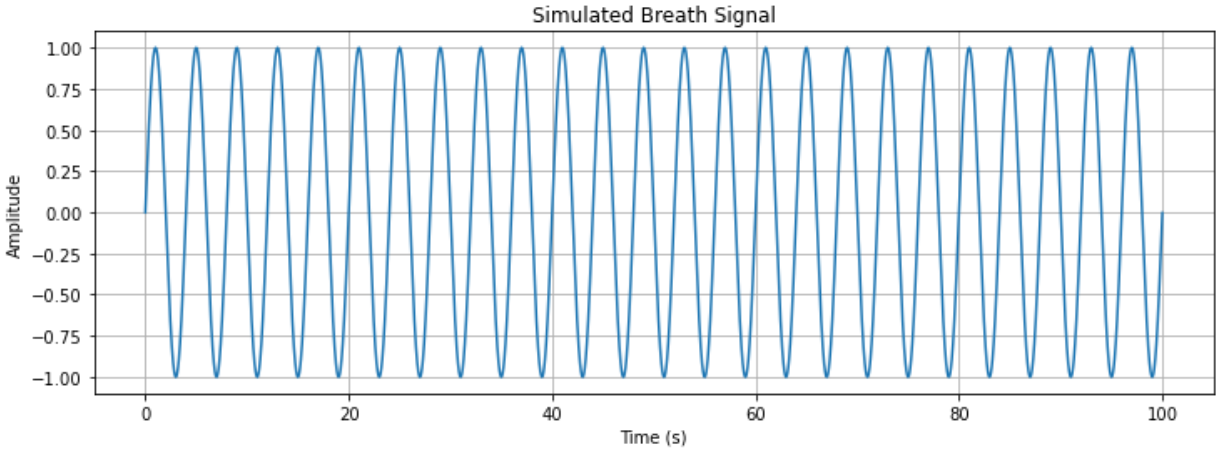
```
import numpy as np
import matplotlib.pyplot as plt
from scipy.signal import find_peaks

# 创建时间序列
t = np.linspace(0, 10, 5000)

ppg = np.sin(2 * np.pi * 1.2 * t) + 0.5 * np.sin(2 * np.pi * 2.4 * t)

# 寻找峰值和谷值
peaks, _ = find_peaks(ppg, height=0)
troughs, _ = find_peaks(-ppg, height=0)



# 绘制模拟的PPG波形
plt.figure(figsize=(12, 4))
plt.plot(t, ppg, label='PPG Signal')

# 标注峰值、谷值和二尖瓣波值
plt.plot(t[peaks], ppg[peaks], "x", label='Peaks')
plt.plot(t[troughs], ppg[troughs], "o", label='Troughs')

plt.title("Simulated PPG Signal with Peaks, Troughs, and Dicrotic Notch")
plt.xlabel("Time (s)")
plt.ylabel("Amplitude")
plt.legend()
plt.show()
```



模拟一段呼吸波形

In [20]:

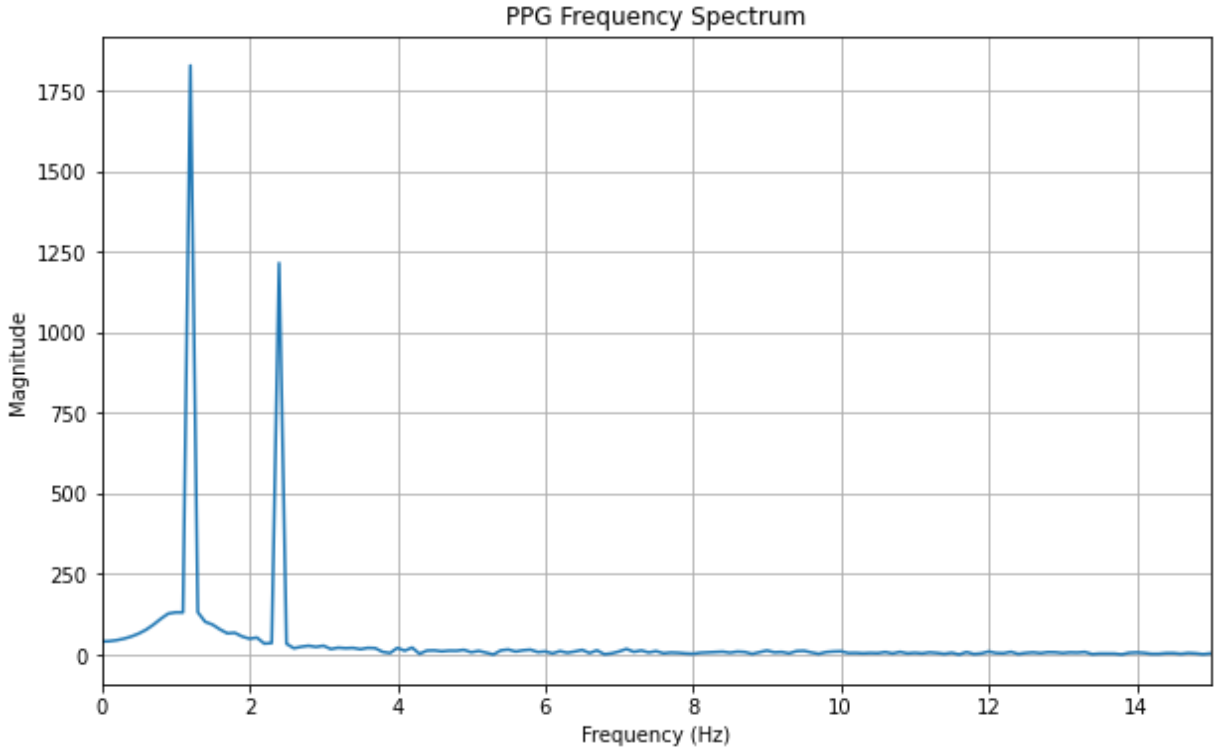
```
import numpy as np
import matplotlib.pyplot as plt

# 模拟呼吸波形的参数
sampling_rate = 500  # 采样率 500 Hz
duration = 100  # 持续时间 10 秒
frequency = 0.25  # 呼吸频率 0.25 Hz (每分钟约 15 次呼吸)

# 生成时间序列
t = np.linspace(0, duration, int(sampling_rate * duration), endpoint=False)

# 生成呼吸波形，简单地使用正弦波模拟
breath_signal = np.sin(2 * np.pi * frequency * t)

# 绘制呼吸波形
plt.figure(figsize=(12, 4))
plt.plot(t, breath_signal)
plt.title("Simulated Breath Signal")
plt.xlabel("Time (s)")
plt.ylabel("Amplitude")
plt.grid(True)
plt.show()
```

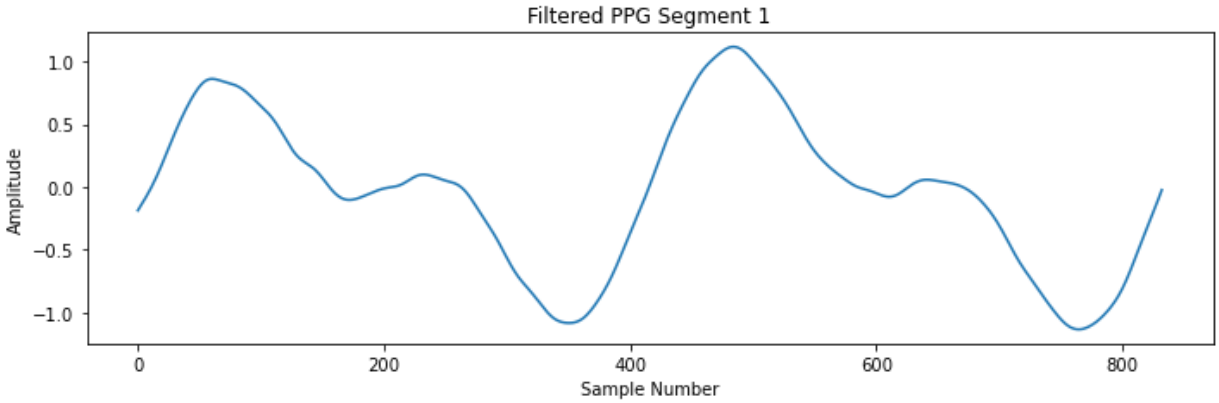


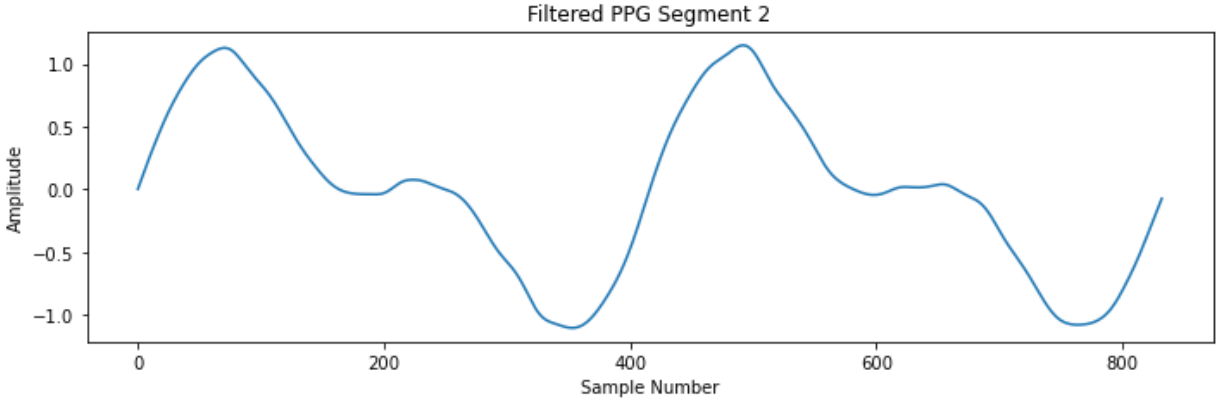
filter_ppg :输入ppg信号 对ppg信号进行滤波 输出滤波后频谱图

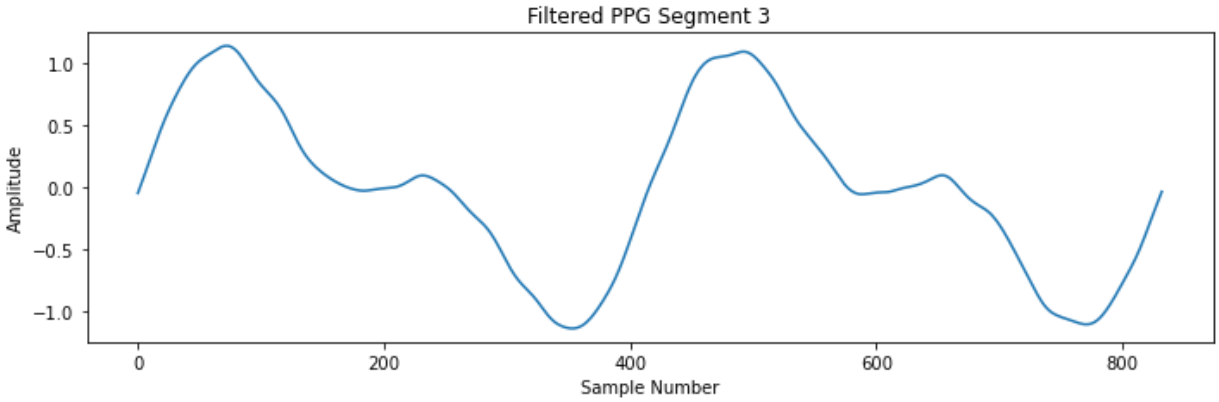
In [27]:

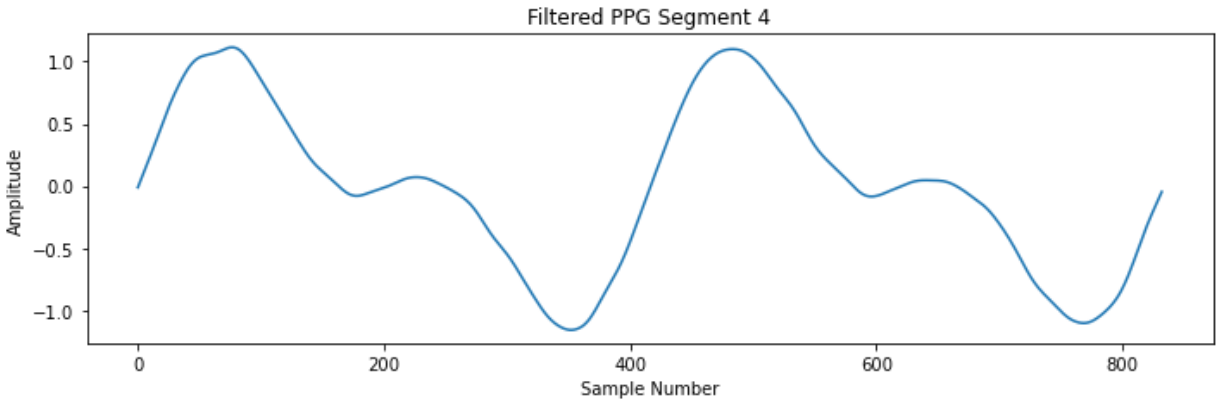
```
from ppg_package.filter_ppg import process_ppg_signal
process_ppg_signal(ppg)
```

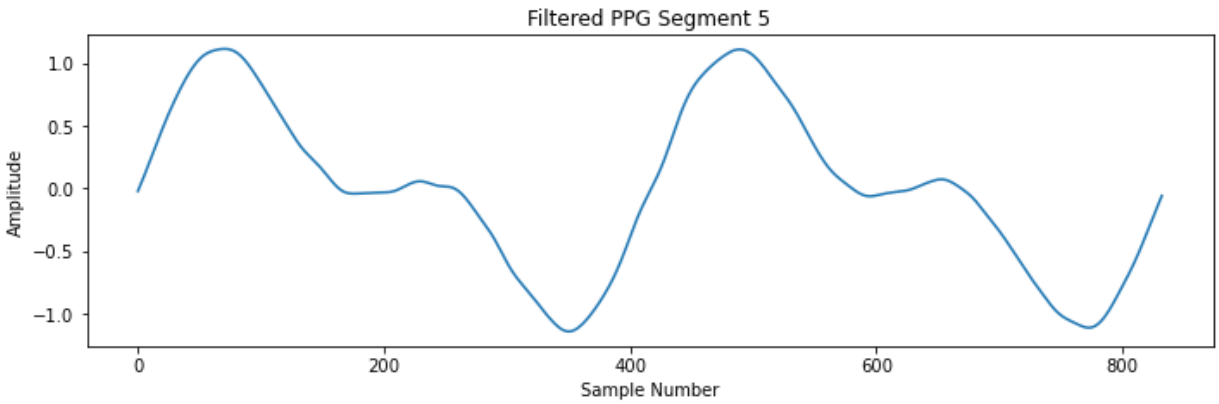

PPG Frequency Spectrum
Magnitude
Frequency (Hz)
0
250
500
750
1000
1250
1500
1750
0
2
4
6
8
10
12
14

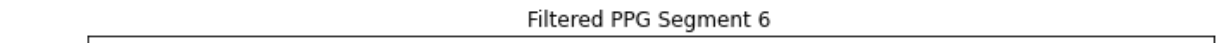

Filtered PPG Segment 1
Amplitude
Sample Number

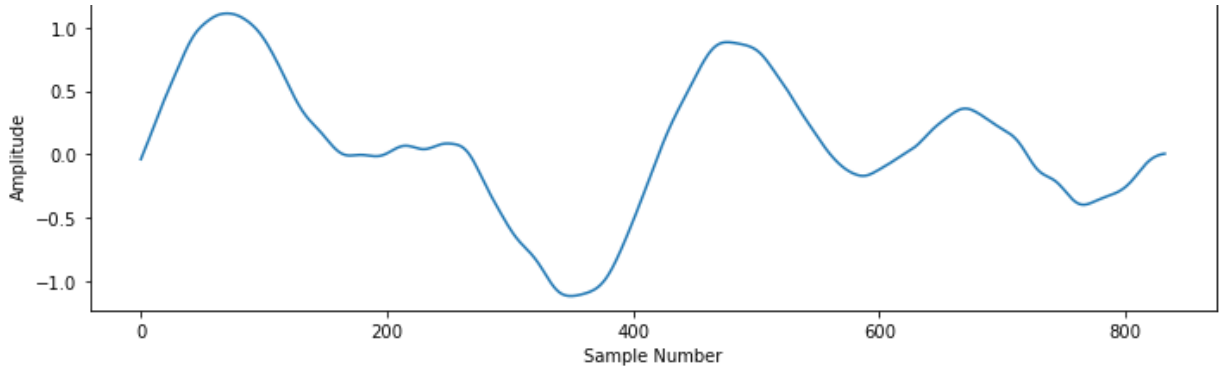

Filtered PPG Segment 2
Amplitude
Sample Number


Filtered PPG Segment 3
Amplitude
Sample Number


Filtered PPG Segment 4
Amplitude
Sample Number


Filtered PPG Segment 5
Amplitude
Sample Number

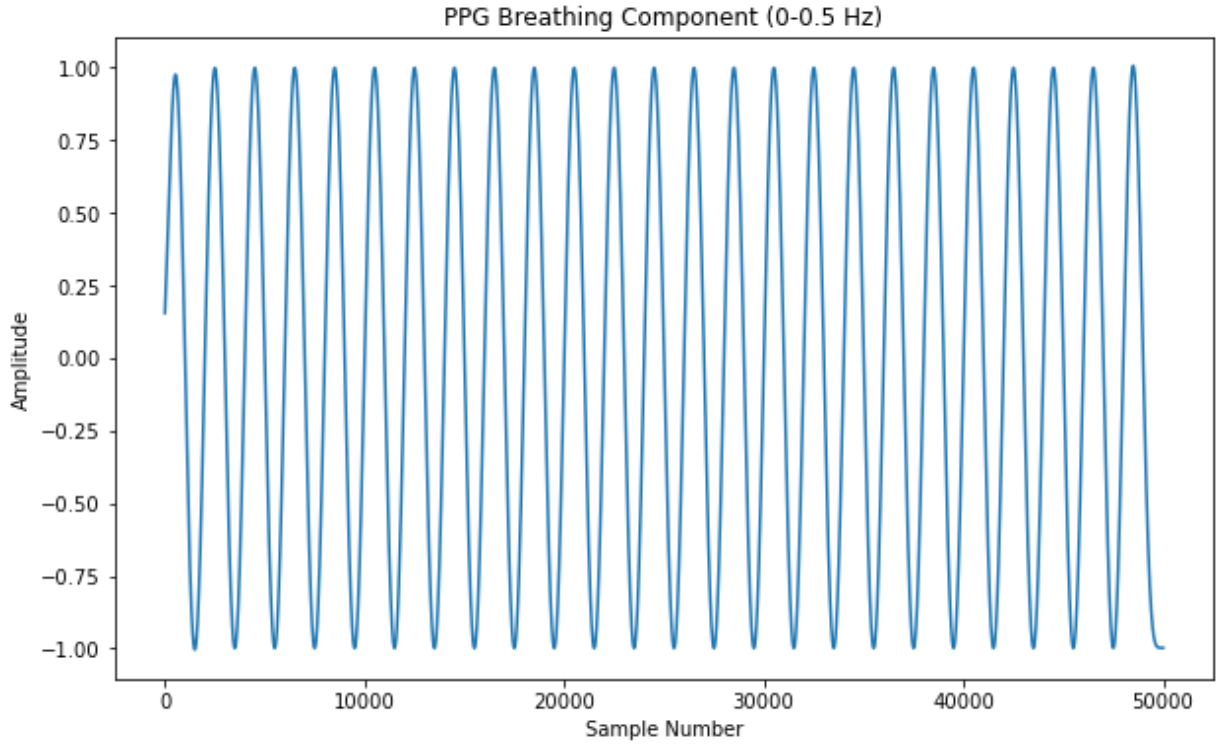

Filtered PPG Segment 6



Out[27]:
```
array([-0.18676262, -0.17081113, -0.15492333, ...,  0.00542917,
        0.00653815,  0.00731371])
```

ppgbreathing:提取ppg信号中的呼吸成分

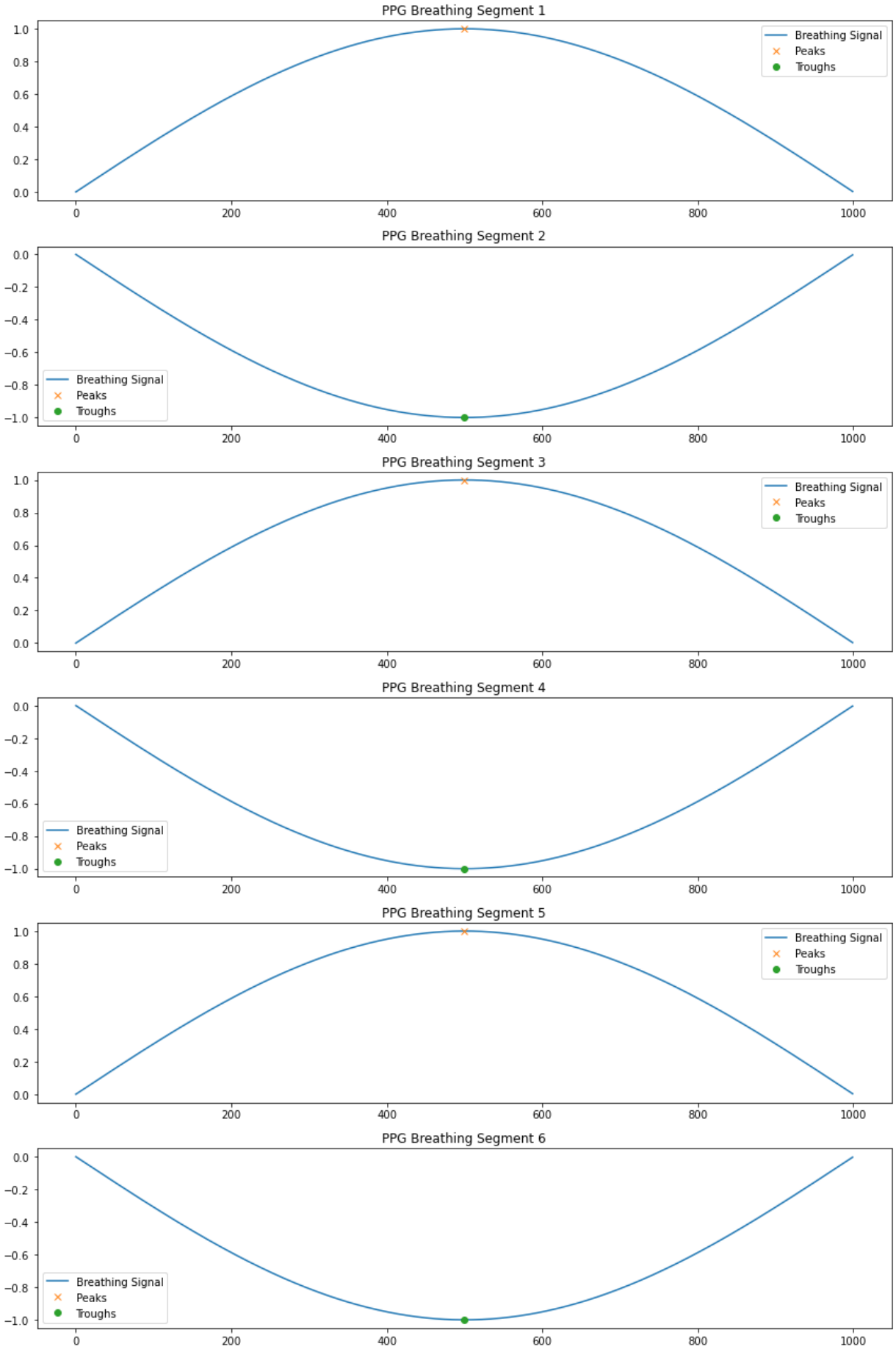
In [21]:
```
from ppg_package.ppgbreathing import extract_breathing_component
extract_breathing_component(breath_signal)
```



Out[21]:
```
array([ 0.1546265 ,  0.15631284,  0.15800374, ..., -0.99808268,
       -0.99808268, -0.99808268])
```

analysis 对ppg信号的呼吸成分进行峰值标注分析呼吸周期以及呼吸周期变异率

In [22]:
```
from ppg_package.analysis import analyze_breathing
analyze_breathing(breath_signal,500,1000)
```



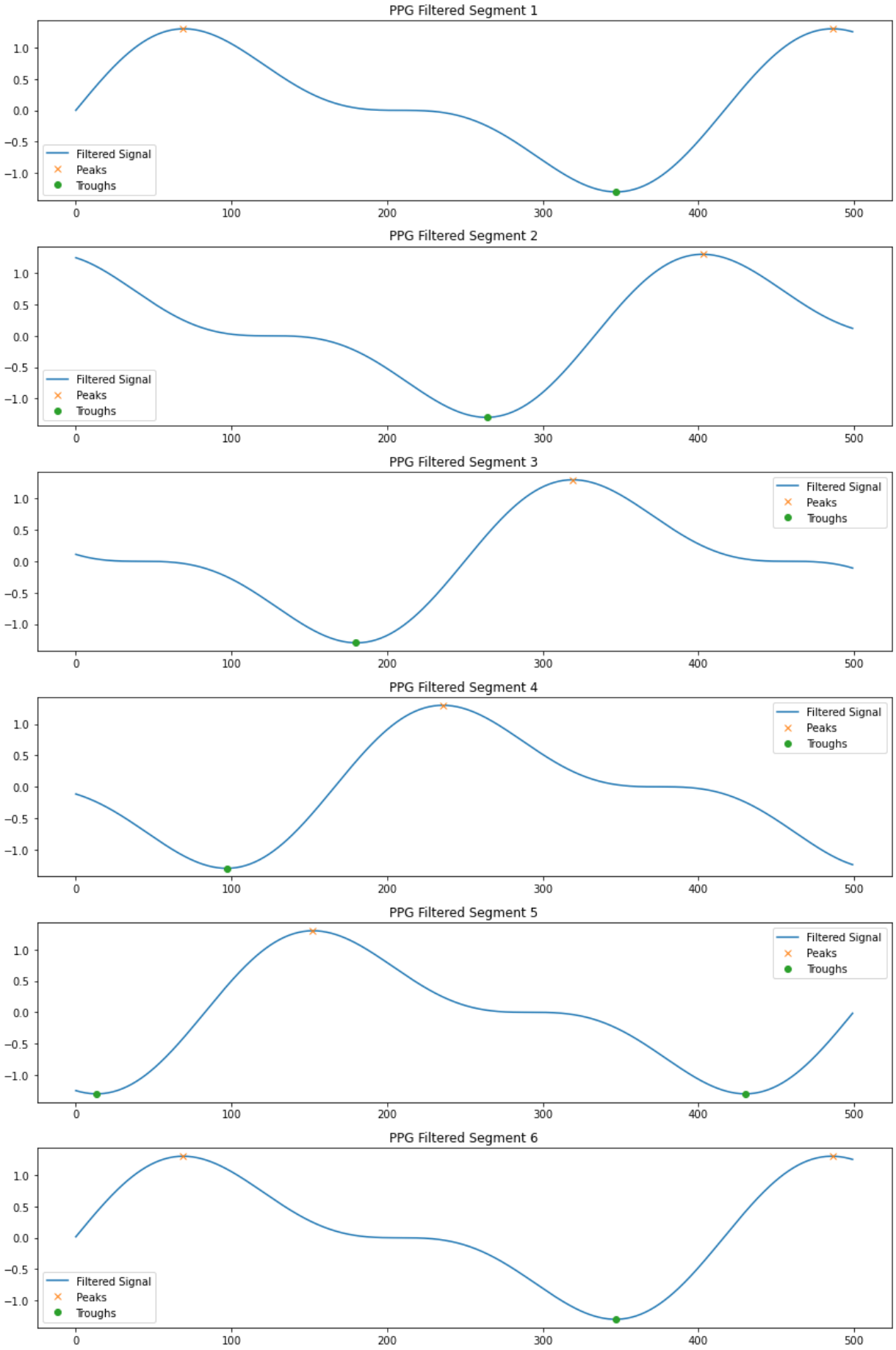
Out[22]:
{'average_breathing_interval': 4.0,
 'breathing_period_variability': 0.0,
 'breathing_periods': array([4., 4., 4., 4., 4., 4., 4., 4., 4., 4., 4., 4., 4., 4., 4.,
       4., 4., 4., 4., 4., 4., 4.]),
 'breathing_intervals': array([2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000,

```
        2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000,
        2000, 2000], dtype=int64)}
```

period_analysis 对ppg信号的心率成分进行峰值标注分析心率周期以及心率周期变异率

In [30]:

```
from ppg_package.period_analysis import analyze_ppg_period
analyze_ppg_period(ppg,500,500)
```

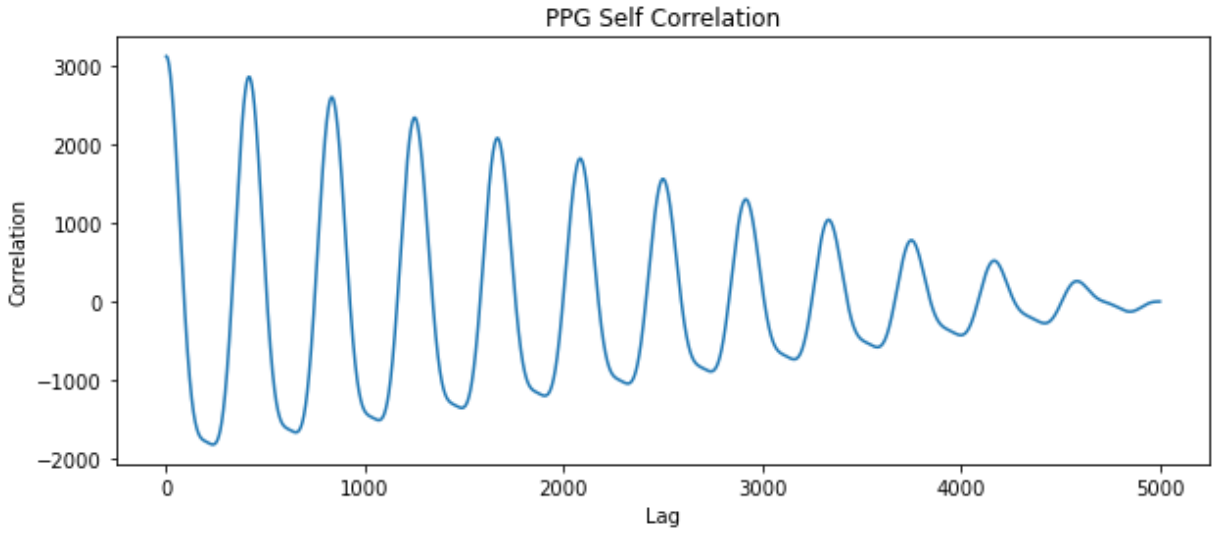


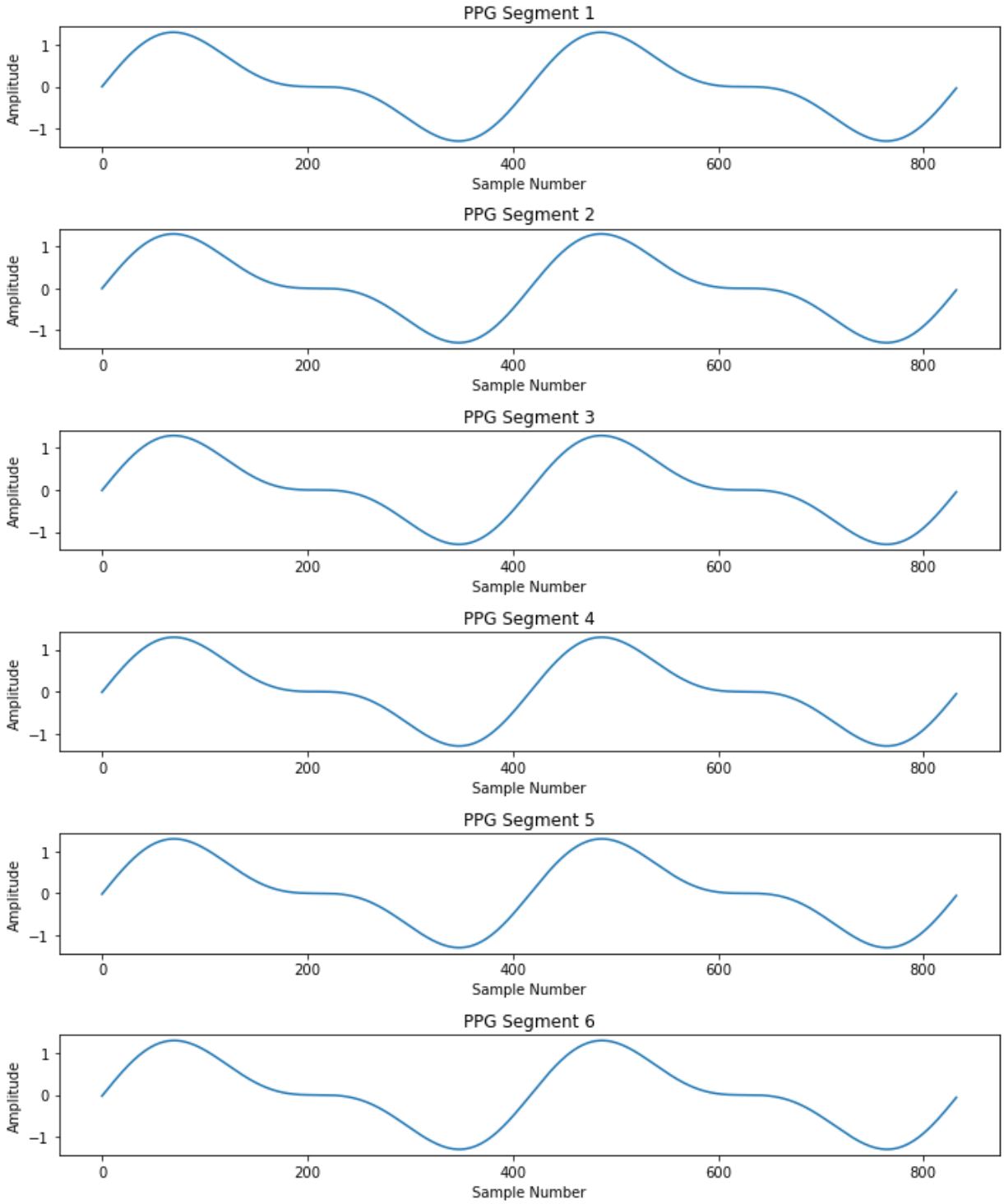
Out[30]:
{'average_filtered_interval': 0.8332727272727273,
 'filtered_period_variability': 0.001154593633456074,
 'filtered_periods': array([0.834, 0.834, 0.832, 0.834, 0.832, 0.834, 0.834, 0.832, 0.834,
        0.832, 0.834]),
 'filtered_intervals': array([417, 417, 416, 417, 416, 417, 417, 416, 417, 416, 417],
dtype=int64)}

autocorr.py 对ppg波形进行自相关分析ppg波形质量 自相关波形有明显周期性峰值则说明质量良好

In [31]:

```
from ppg_package.autocorr import analyze_ppg_autocorr
analyze_ppg_autocorr(ppg)
```

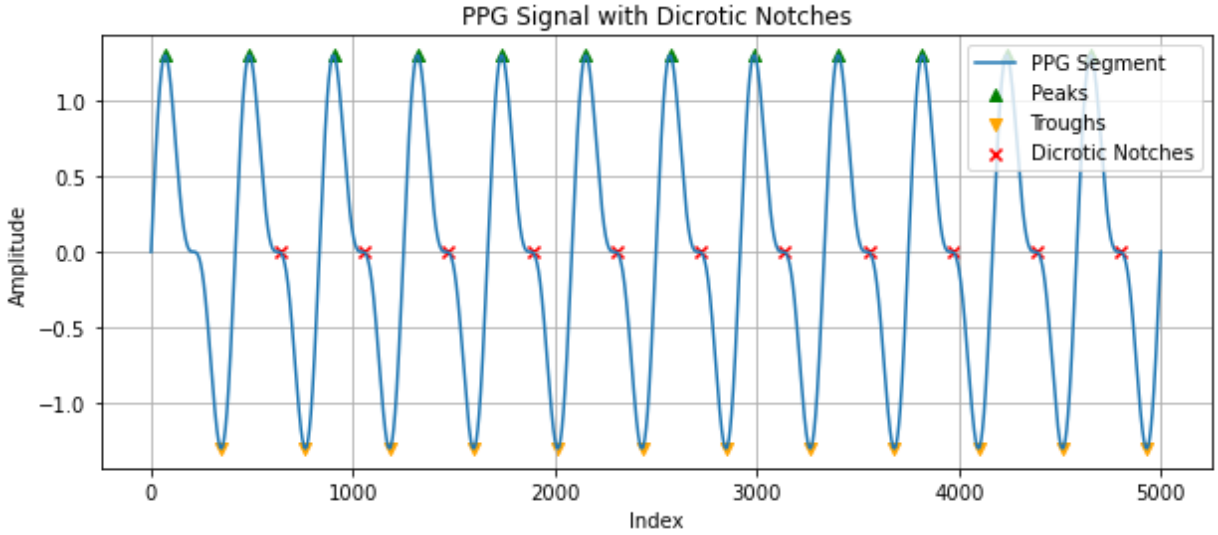




Out[31]:
```
(array([-5.02754052e-03,  2.51361142e-02,  5.52854748e-02, ...,
        -6.03077746e-02, -3.01624634e-02, -5.87830464e-15]),
 833)
```

notch_analysis 对ppg波形进行二尖瓣波值的标注

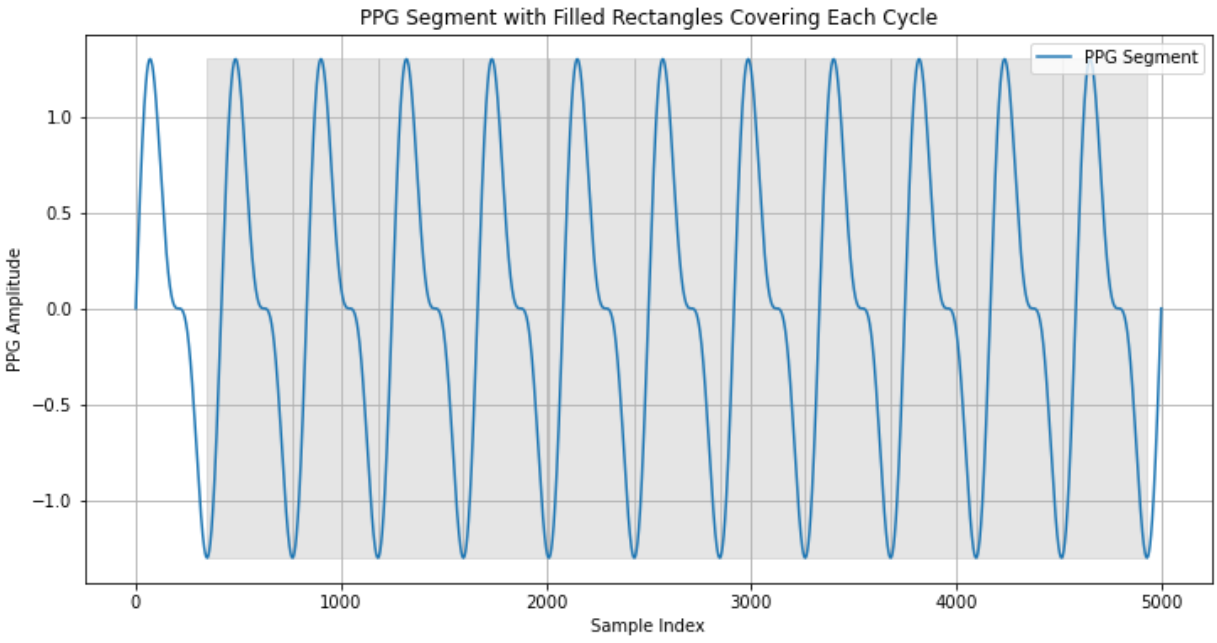
In [35]:
```
from ppg_package.notch_analysis_ratio import find_dicrotic_notches_by_ratio
find_dicrotic_notches_by_ratio(ppg)
```

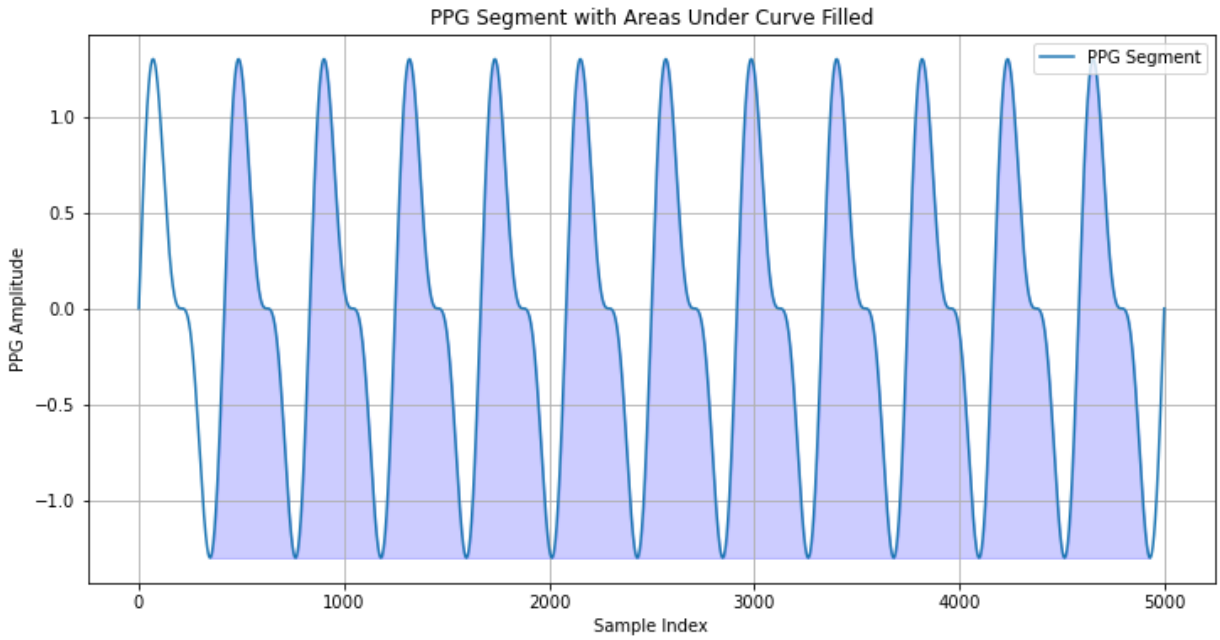


Out[35]: [638, 1055, 1471, 1888, 2304, 2721, 3138, 3554, 3971, 4387, 4804]

area_calculation 计算ppg波形周期矩形面积以及线下面积

In [40]:
```
from ppg_package.area_calculation import calculate_ppg_areas
calculate_ppg_areas(ppg,peaks,troughs)
```

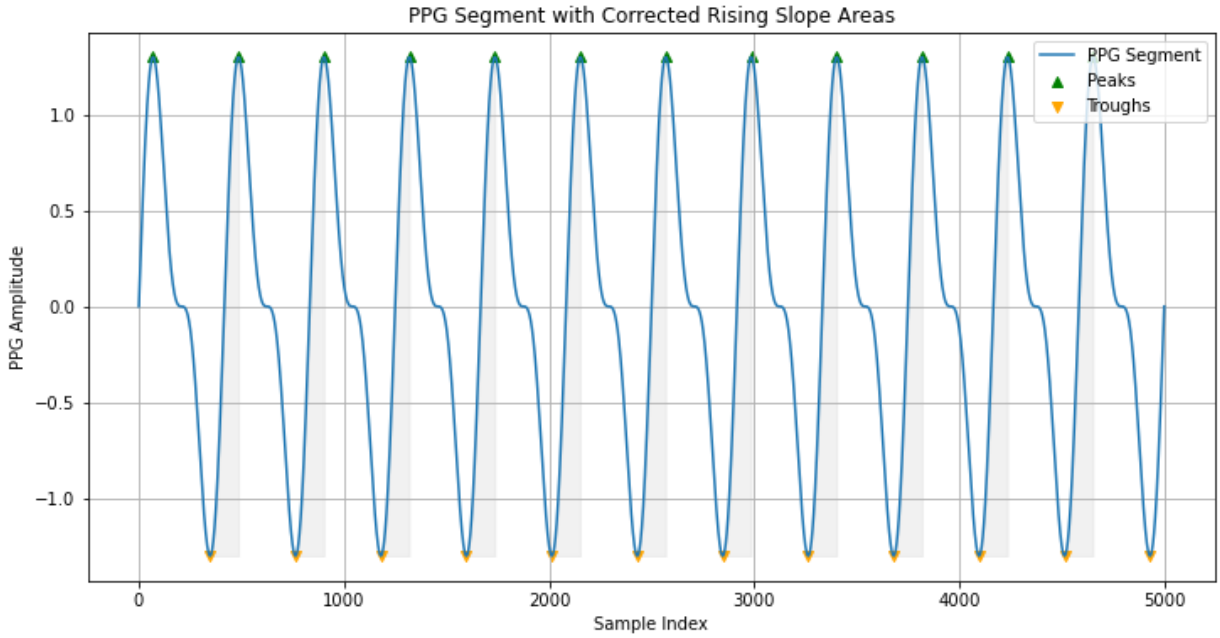




Out[40]:
```
([1083.3948813409975,
  1080.7712165820312,
  1083.381197555557,
  1080.7916929571045,
  1083.3538302439779,
  1083.3965918202548,
  1080.755859428045,
  1083.3897499113282,
  1080.7831611105796,
  1083.3692243141998,
  1083.3948813409975],
 [541.154688570017,
  541.1487724480695,
  541.1449934513611,
  541.1560648492313,
  541.1284784015121,
  541.1569754908442,
  541.1425563834213,
  541.1506941369669,
  541.1532748635416,
  541.1375877809406,
  541.1575536478679])
```

slope_calculation 计算ppg上升支的波形面积

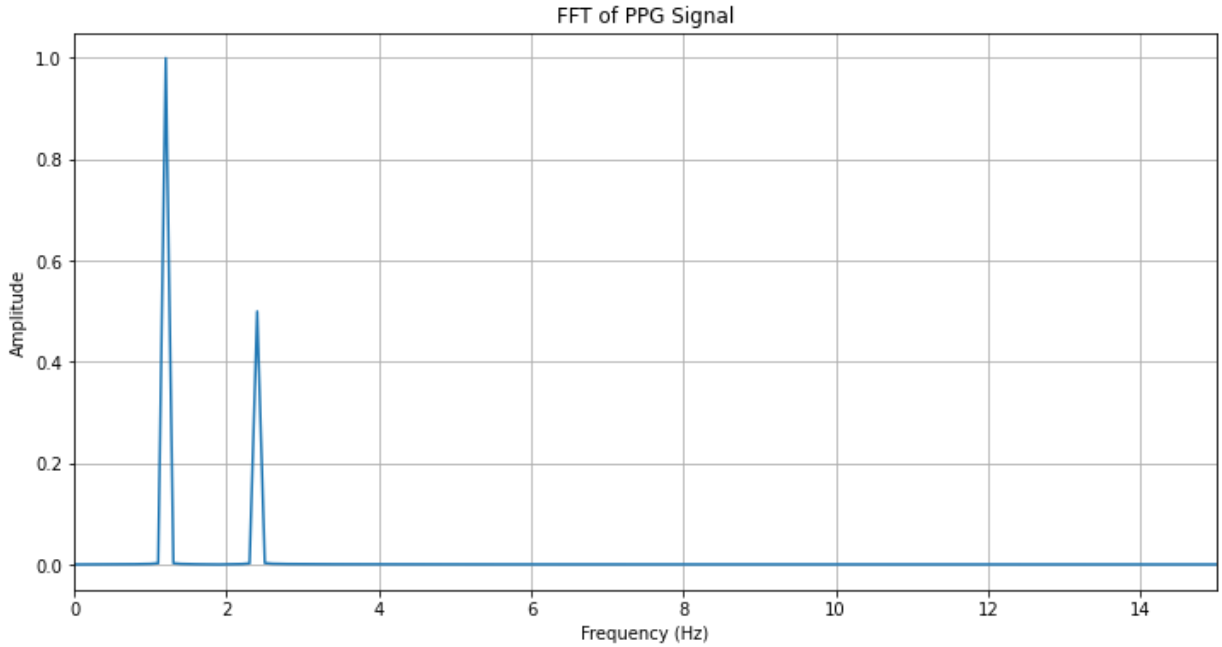
In [42]:
```
from ppg_package.slope_calculation import calculate_rising_slope_area
calculate_rising_slope_area(ppg,troughs,peaks)
```

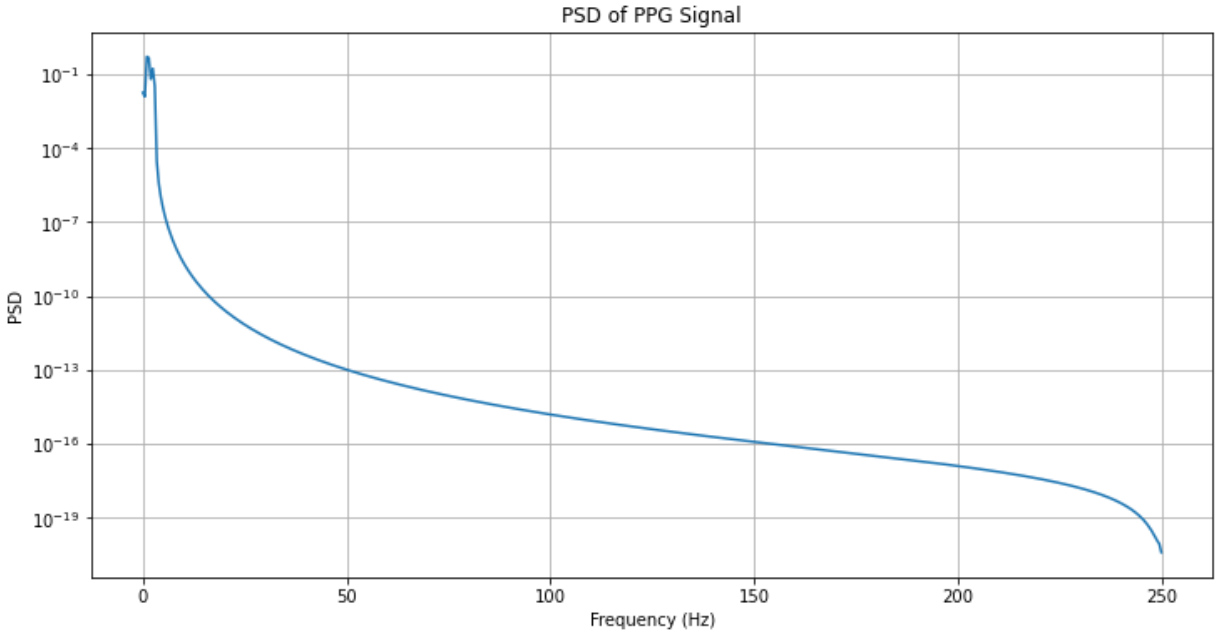


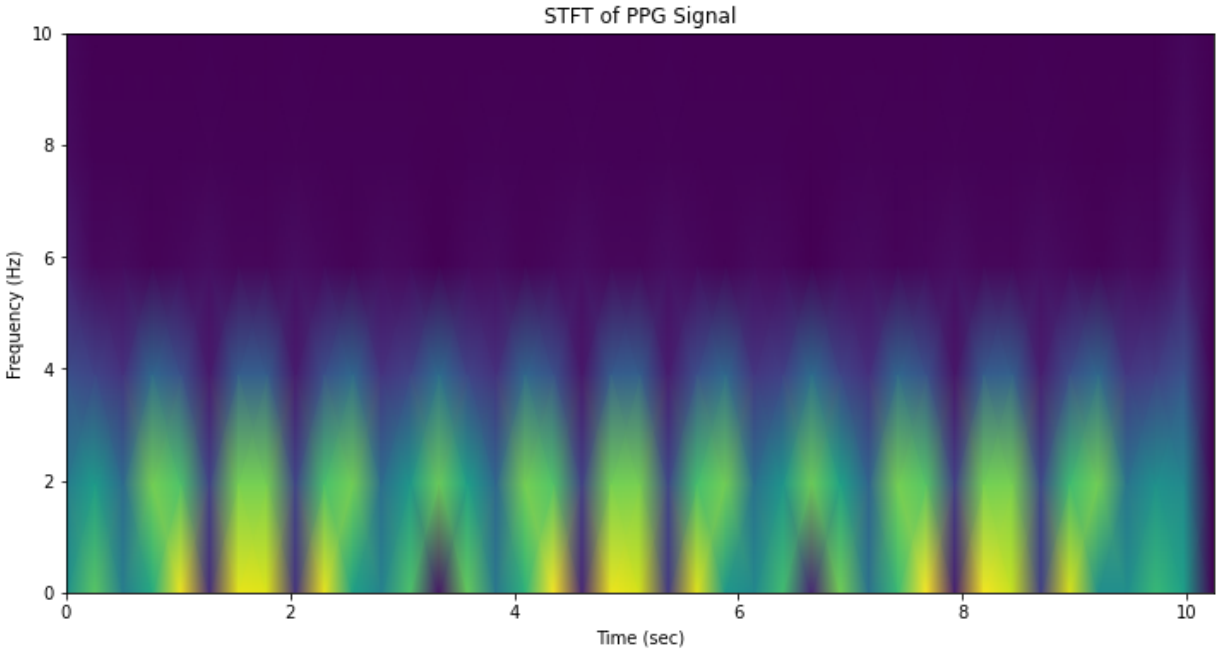
Out[42]:
```
[177.75092359249436,
 178.83143951975092,
 177.31478366898233,
 178.40092444911093,
 176.87640923774723,
 177.96815284958484,
 179.04584812576513,
 177.53313349771898,
 178.61646459740618,
 177.09587521265388,
 178.18482016792515]
```

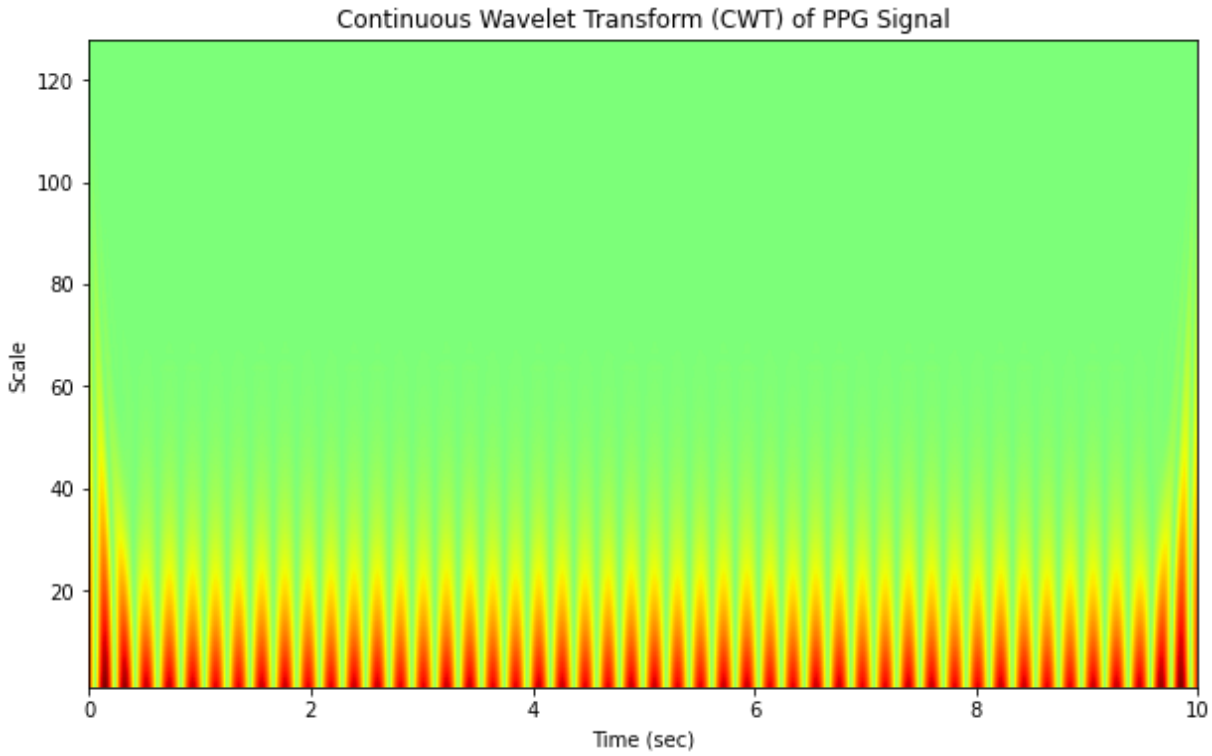
signal_analysis 对ppg信号输出傅里叶变化图 短时傅里叶变化图 功率谱图 cmor小波基变化图 庞家莱图

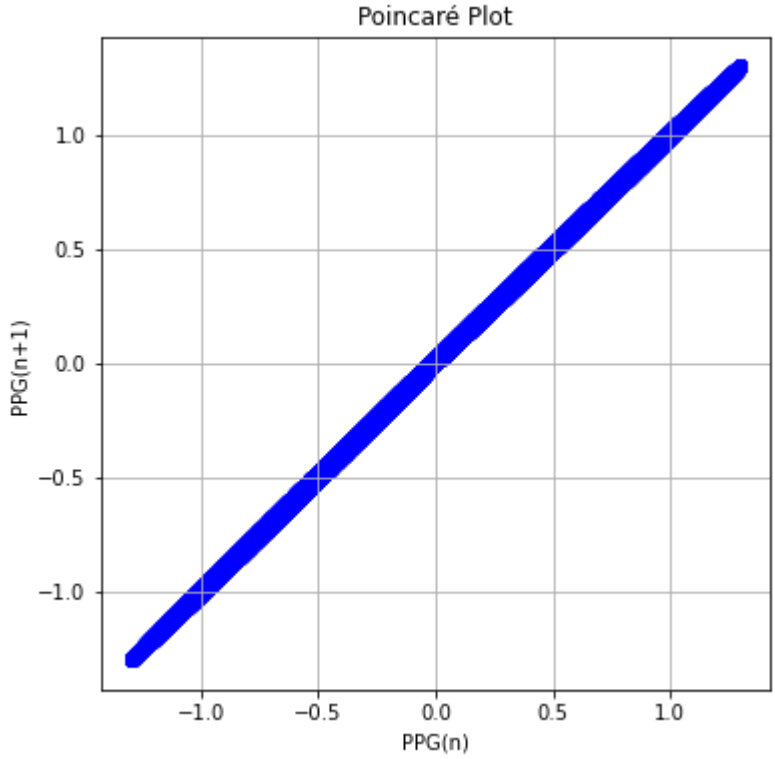
In [4]:
```
import ppg_package
from ppg_package.signal_analysis import process_and_plot_ppg_signal
process_and_plot_ppg_signal(ppg)
plt.close()
```




PSD of PPG Signal
PSD
Frequency (Hz)
10^{-1}
10^{-4}
10^{-7}
10^{-10}
10^{-13}
10^{-16}
10^{-19}
0
50
100
150
200
250


STFT of PPG Signal
Frequency (Hz)
Time (sec)
0
2
4
6
8
10





调用ppg_package包中的深度学习预测CO模型 输出CO预测值

In [10]:

```
import ppg_package
from ppg_package.utils import read_and_predict

# 定义数据目录和模型路径
data_directory = r"C:\Users\HUAWEI\Desktop\data"
model_path = r"C:\Users\HUAWEI\model_weights_fold_10.pth"

# 定义数据集的列
columns_of_interest = ['Average Heartbeat Interval 3.12 (s)', 'Heartbeat Period Variab
                       'R1 AC/DC Component Ratio 3.12', 'Dicrotic Notch Component to D
                       'ln Average DC Component 3.12', 'R1', 'R2', 'R3', 'R4',
                       'PPG Pulse Wave Dynamics Parameters 3.12', 'CO']
```

```python
# 调用函数进行预测
predictions = read_and_predict(data_directory, model_path, columns_of_interest)

# 打印预测结果
#print("Predictions:", predictions)
for pred in predictions:
    print(f"Deep learning model Predictions CO:{pred}\n")
```

```
Deep learning model Predictions CO:[[3.214189]]

Deep learning model Predictions CO:[[3.2039566]]

Deep learning model Predictions CO:[[3.327508]]

Deep learning model Predictions CO:[[3.253348]]

Deep learning model Predictions CO:[[3.217325]]

Deep learning model Predictions CO:[[3.3351197]]

Deep learning model Predictions CO:[[3.1886125]]

Deep learning model Predictions CO:[[2.2320888]]

Deep learning model Predictions CO:[[2.595568]]

Deep learning model Predictions CO:[[2.537807]]

Deep learning model Predictions CO:[[2.3100865]]

Deep learning model Predictions CO:[[2.1083827]]

Deep learning model Predictions CO:[[2.1814477]]

Deep learning model Predictions CO:[[2.1288776]]

Deep learning model Predictions CO:[[2.0918021]]

Deep learning model Predictions CO:[[2.2275157]]

Deep learning model Predictions CO:[[2.4546275]]

Deep learning model Predictions CO:[[2.1552513]]

Deep learning model Predictions CO:[[2.4452603]]

Deep learning model Predictions CO:[[2.7703667]]

Deep learning model Predictions CO:[[2.636267]]

Deep learning model Predictions CO:[[2.3208714]]

Deep learning model Predictions CO:[[2.8387504]]

Deep learning model Predictions CO:[[2.6983762]]

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