

Live 2025-11-05

November 5, 2025

## 1 2025-11-05 Live INTEUM War Stories continued

```
[1]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

[2]: filenames = [ "../Labs/Data/4Stu_2022_1117_1219_DataWithToolInfo.csv", "../Labs/
        ↪Data/4Stu_2023_0118_0127_DataWithToolInfo.csv" ]

X = pd.DataFrame()

for f in filenames:
    Xn = pd.read_csv(f,
                      sep=";",
                      parse_dates = ["timestamp_skv"],
                      dayfirst = True,
                      encoding = None,
                      encoding_errors = 'replace')
    X = pd.concat([X,Xn])

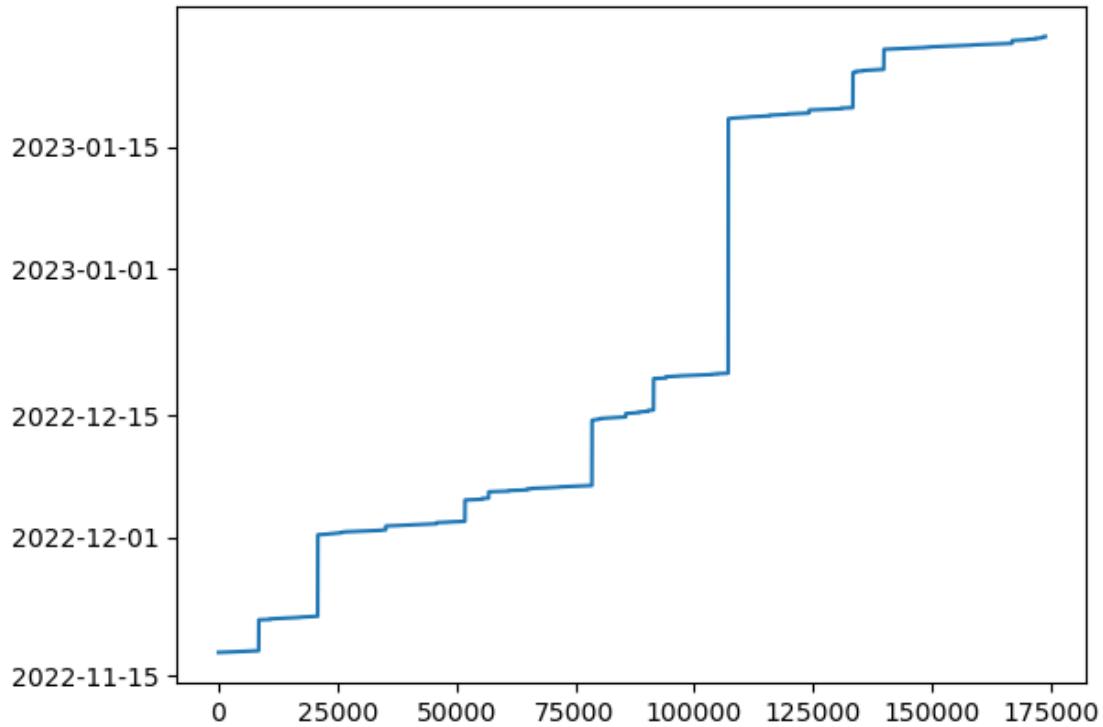
[3]: X.index = range(0,X.shape[0])

[4]: X.shape

[4]: (173863, 165)

[5]: plt.plot(X.index,X.timestamp_skv)

[5]: [<matplotlib.lines.Line2D at 0x7f8734784c40>]
```



```
[6]: # Write code to make code :-  
print("[")  
for c in X.columns:  
    print(f"'{c}'", " ")  
print("]")
```

```
[  
'timestamp_skv',  
'timediff_skv',  
'timestamp_sensor',  
'timediff_sensor',  
'SynchroDiff',  
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'ST_CH1_P_F1',  
'ST_CH1_P_F2',  
'ST_CH1_P_F3',  
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'ST_CH1_P_F9',  
'ST_CH1_P_F10',
```

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'ST_CH2_P_F5',
'ST_CH2_P_F6',
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'0.604 min SKV#1',  
'0.604 max SKV#1',

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'0.74 max SKV#1',
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'4,40 SKV#1',
'5,36 SKV#1',
'5,92 SKV#1',
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'timestamp.1',
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'Beacon INT0028 - BMP280_TEMP',
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```

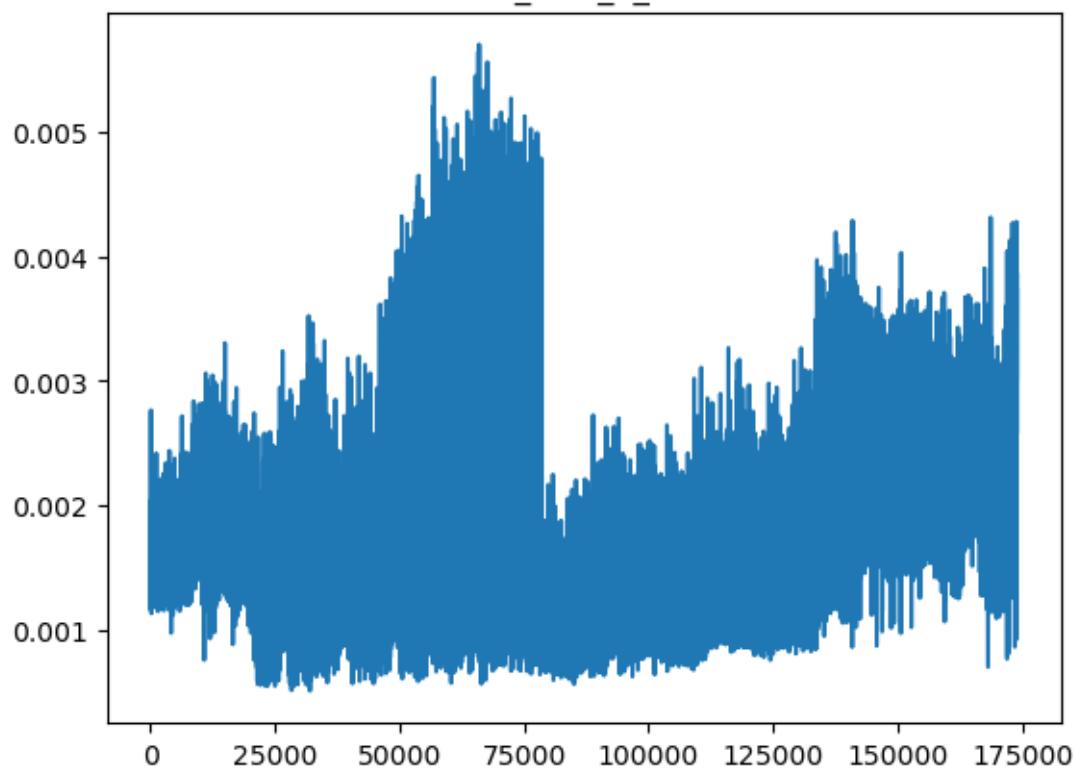
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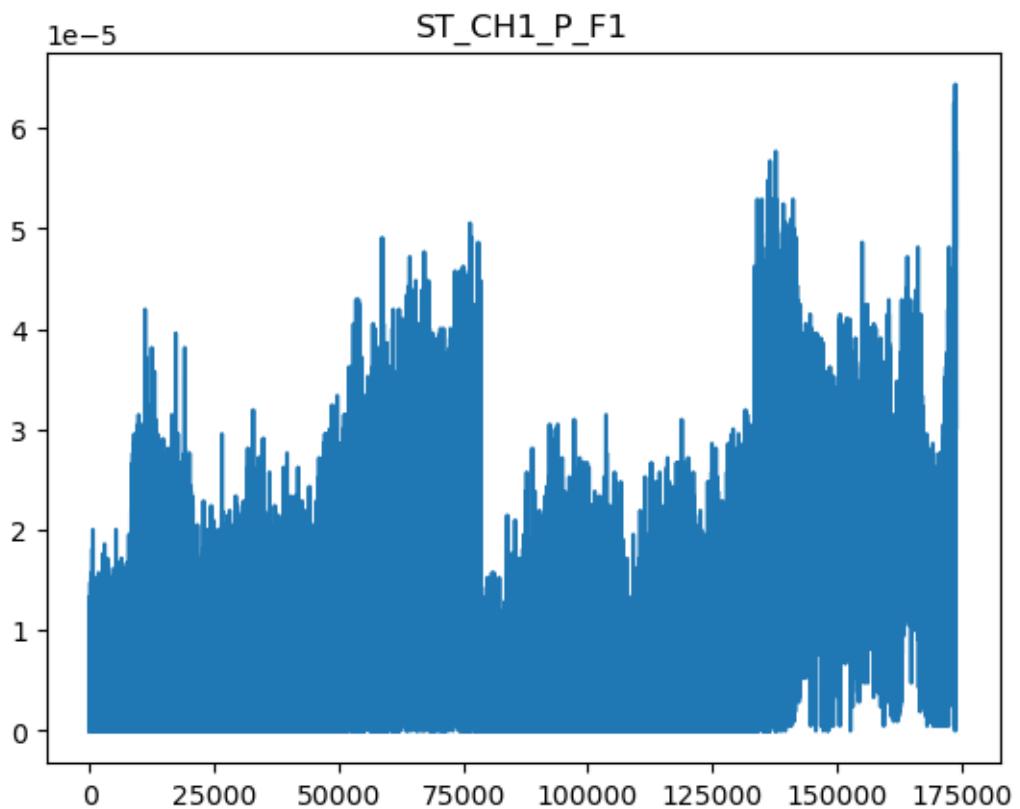
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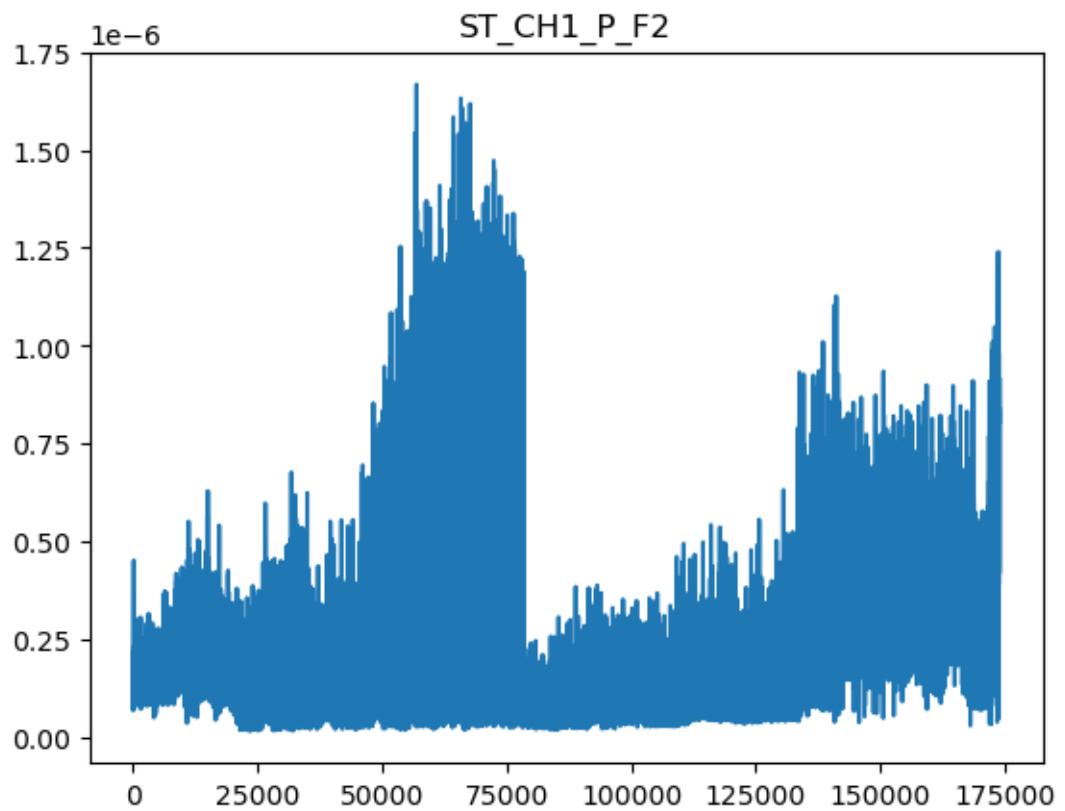
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'4,40 SKV#3',
'5,36 SKV#3',
'5,92 SKV#3',
'Sym Einstich SKV#3',
'Sym aussen SKV#3',
'Licht-Einstich frei SKV#3',
'4.713 SKV#4',
'0.604 min SKV#4',
'0.604 max SKV#4',
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'0.74 max SKV#4',
'4,96 SKV#4',
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'5,36 SKV#4',
'5,92 SKV#4',
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#'timestamp.1',
'Beacon INT0028 - BMP280_PRESS',
#'timestamp.2',
'Beacon INT0028 - BMP280_TEMP',
#'pieces',
#'tool io',
]
```

```
[8]: for f in interestingColumns:
    plt.plot(X.index,X[f])
    plt.title(f)
    plt.show()
```

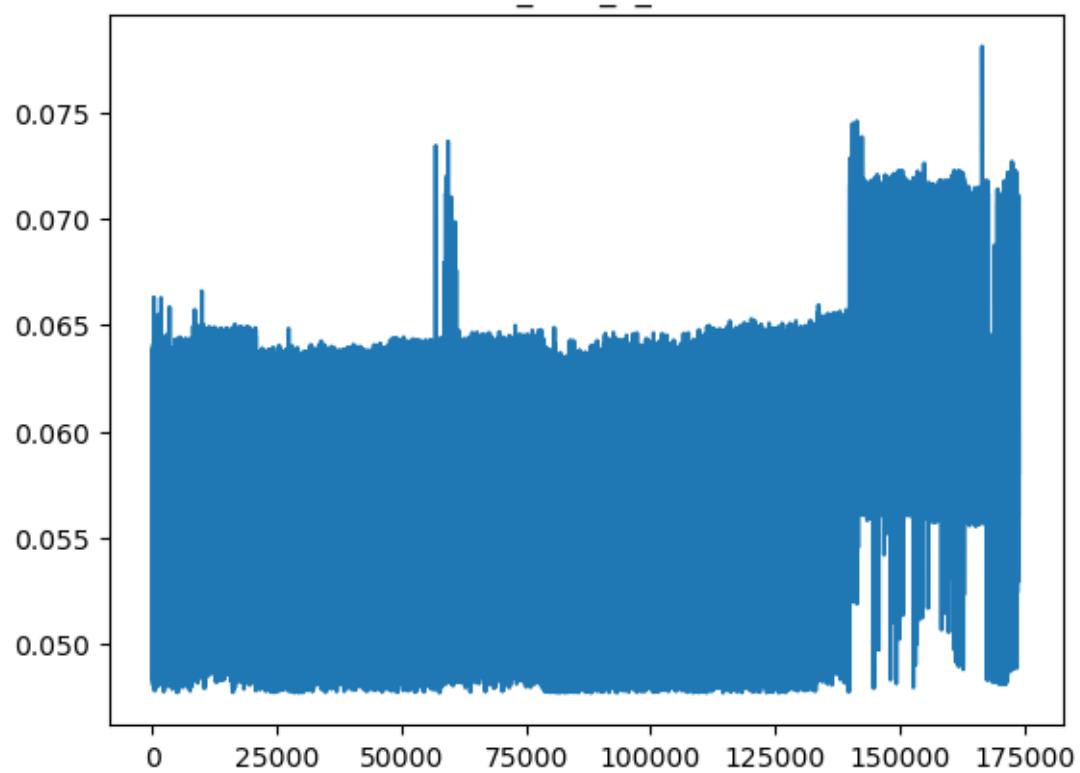
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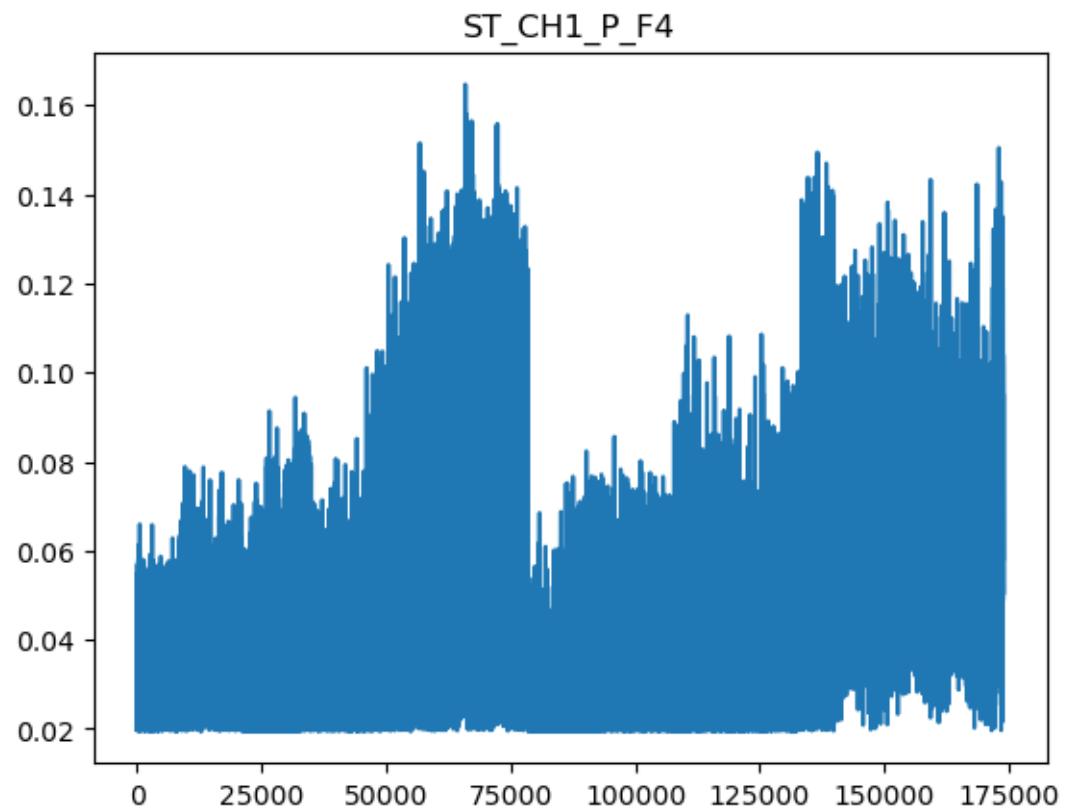




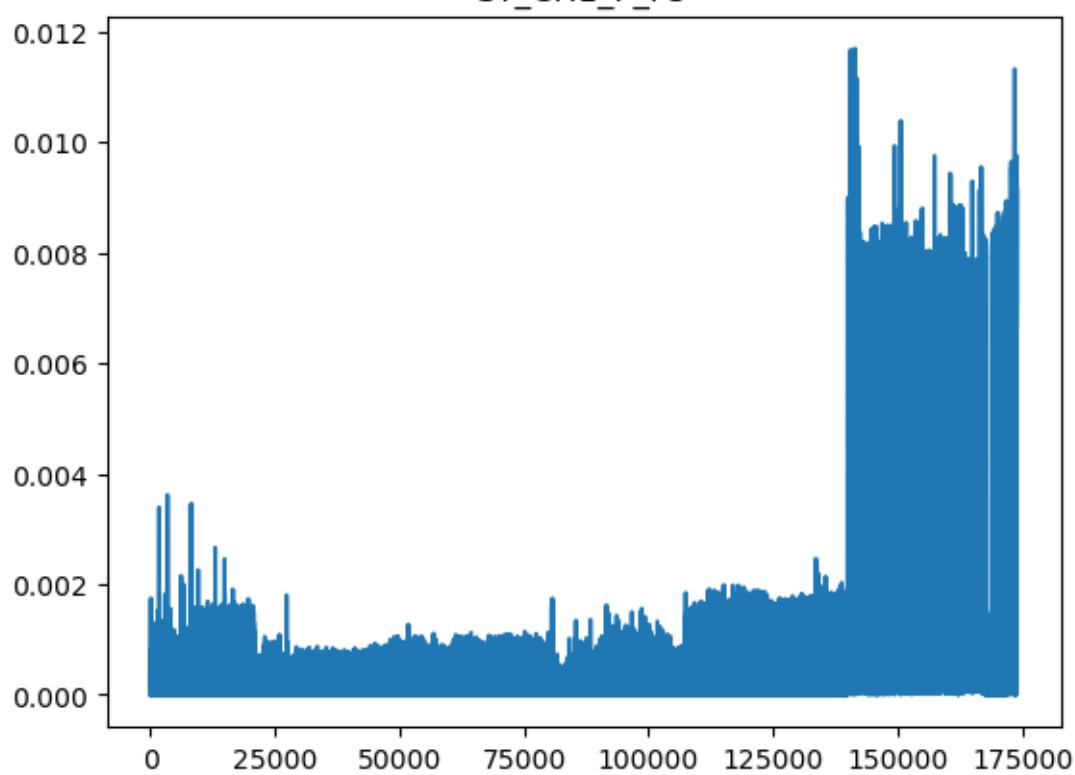


ST\_CH1\_P\_F3

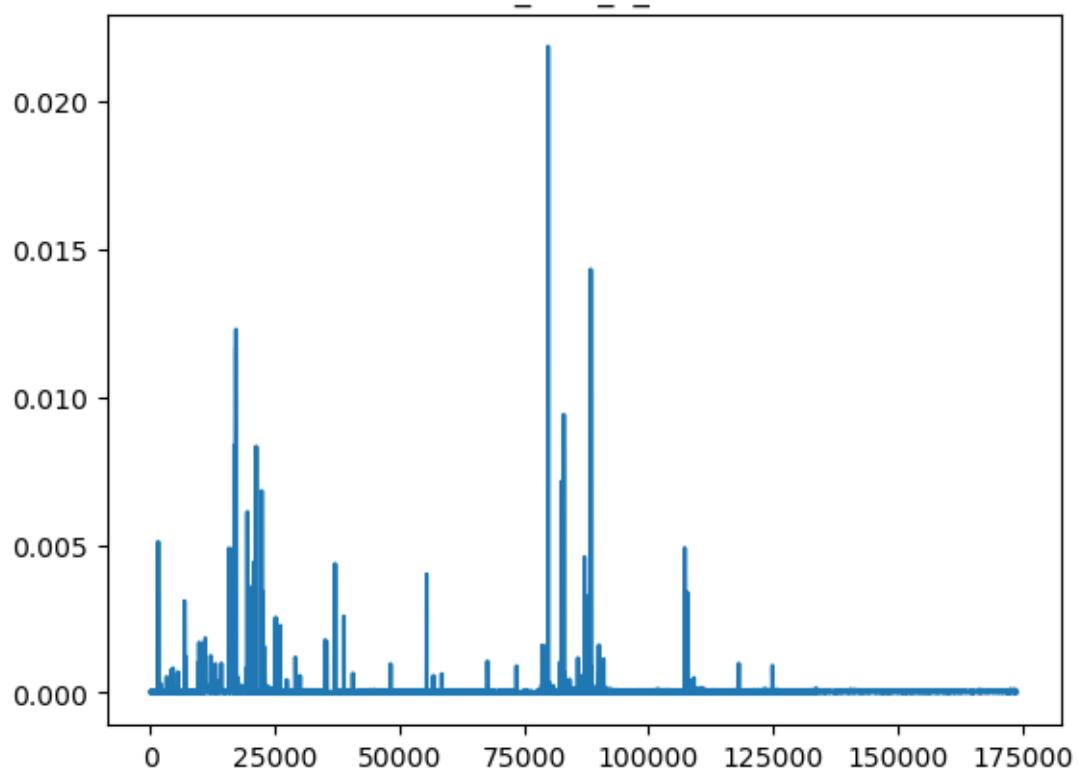


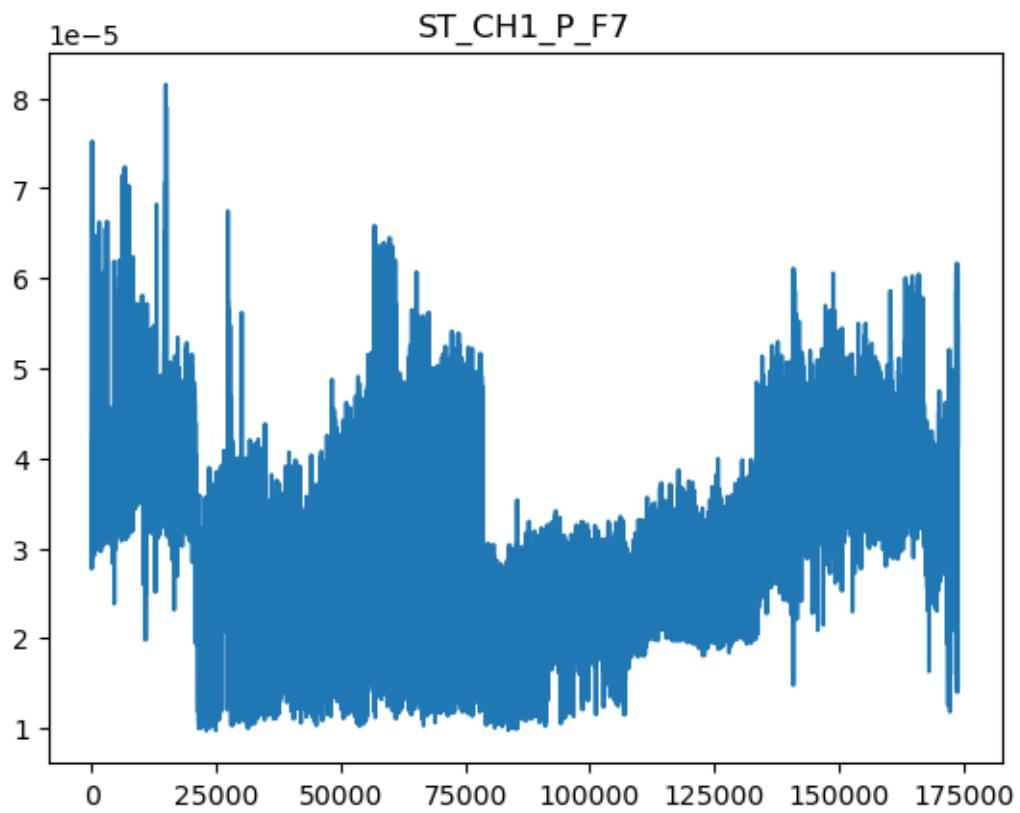


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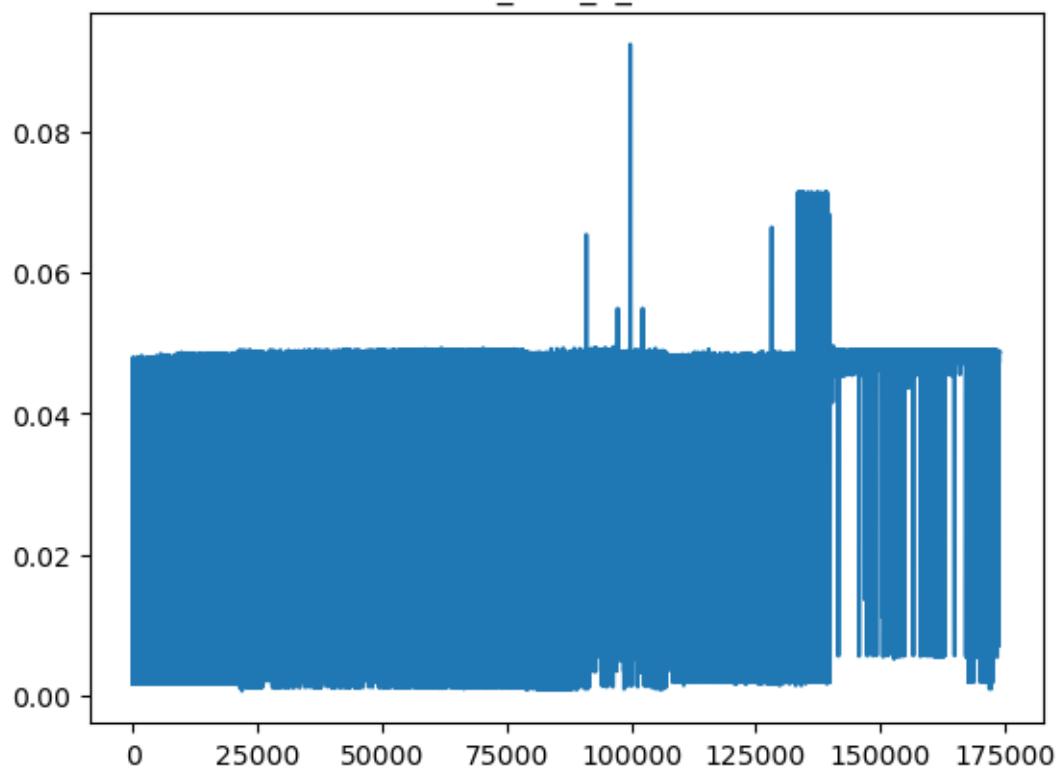


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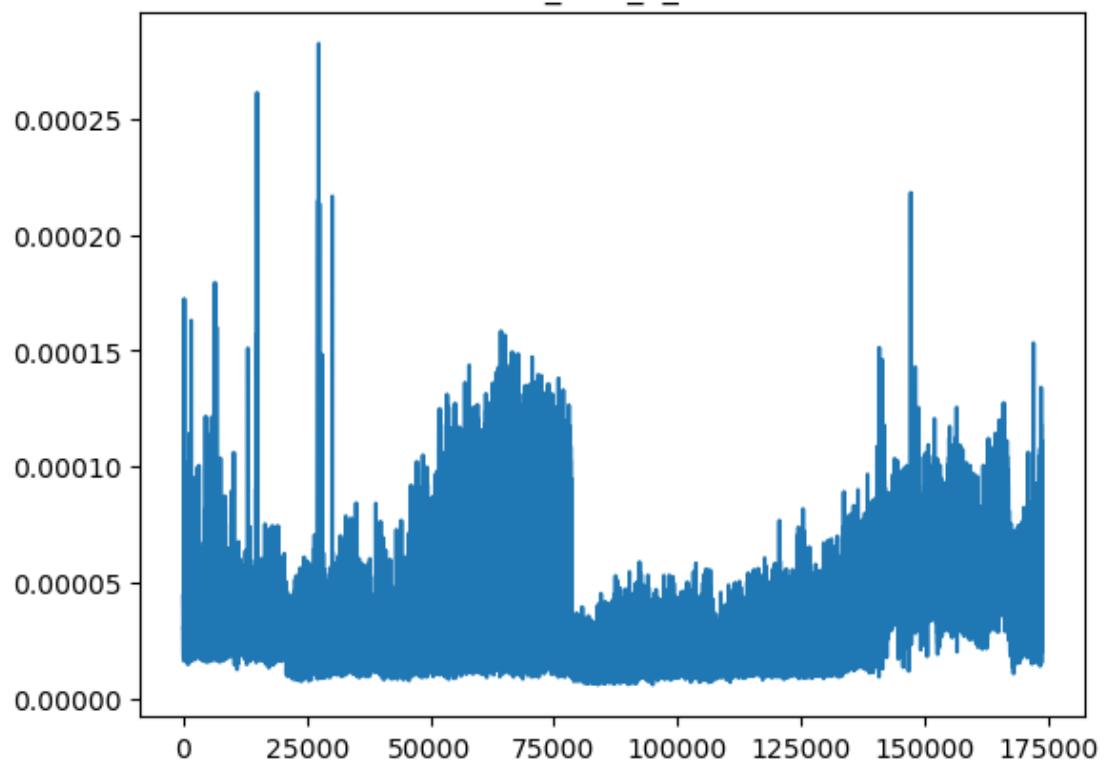




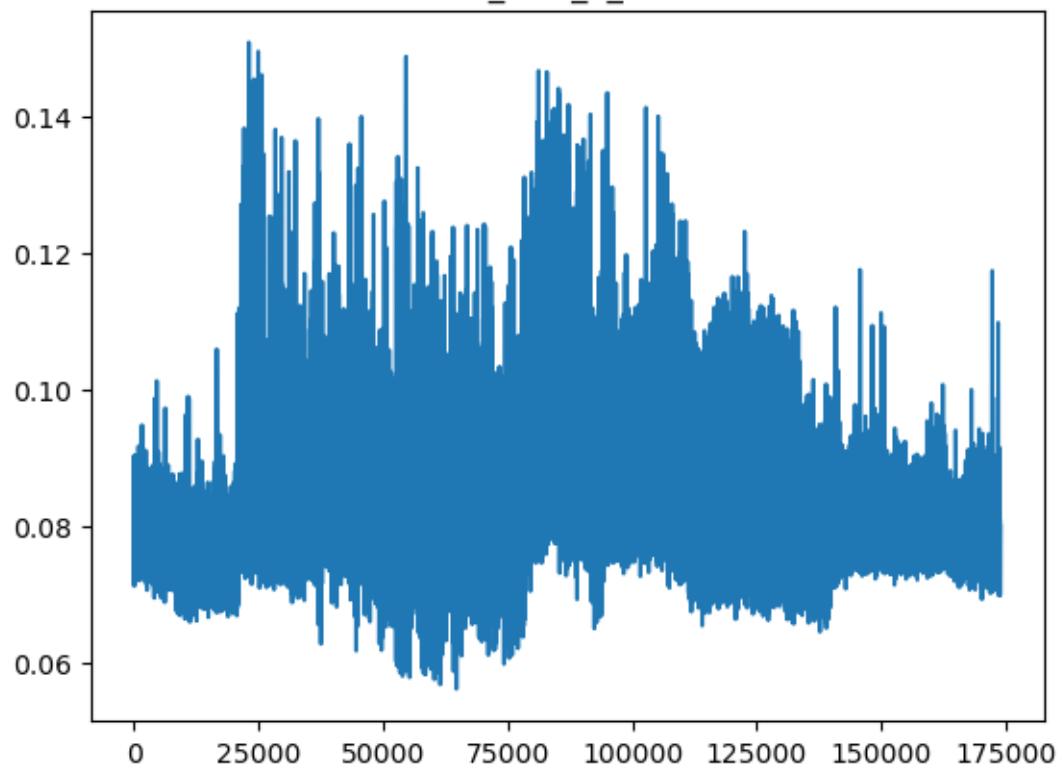
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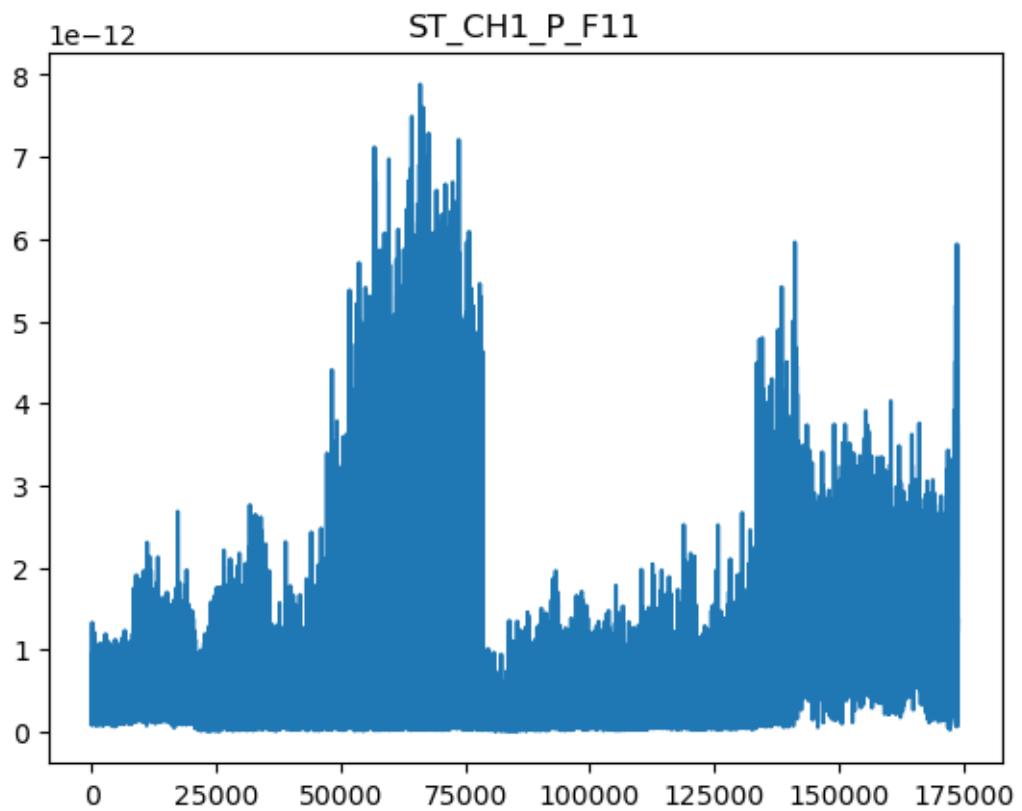


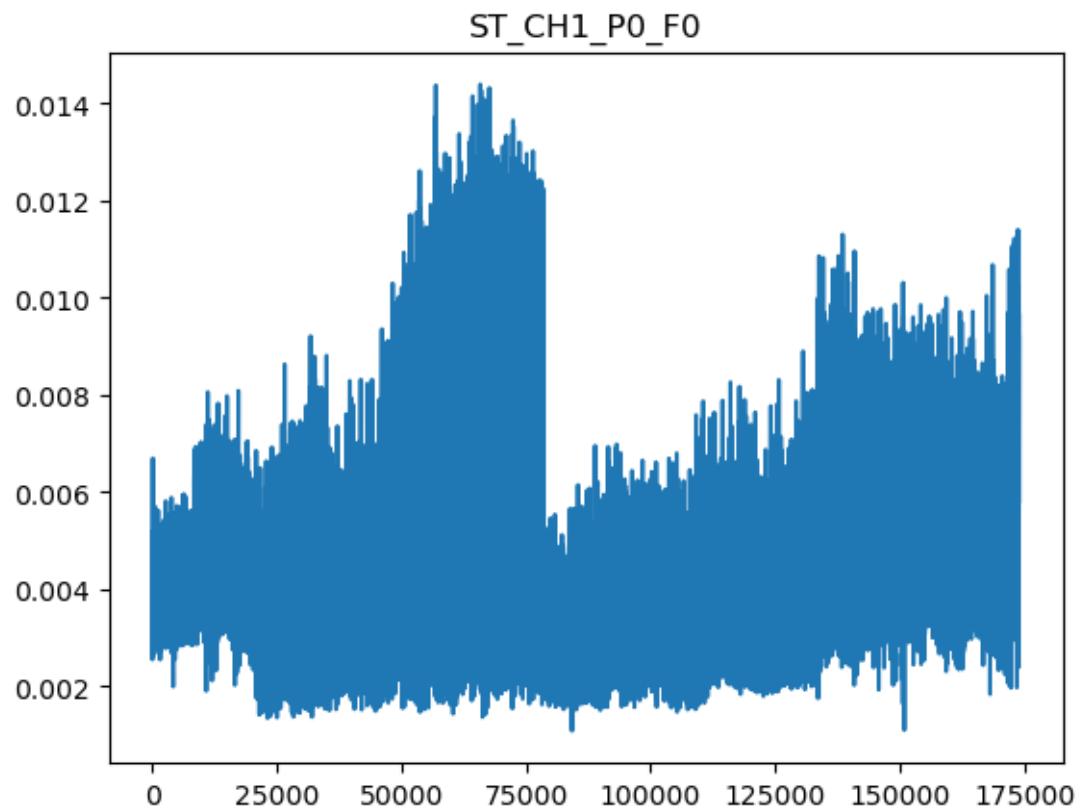
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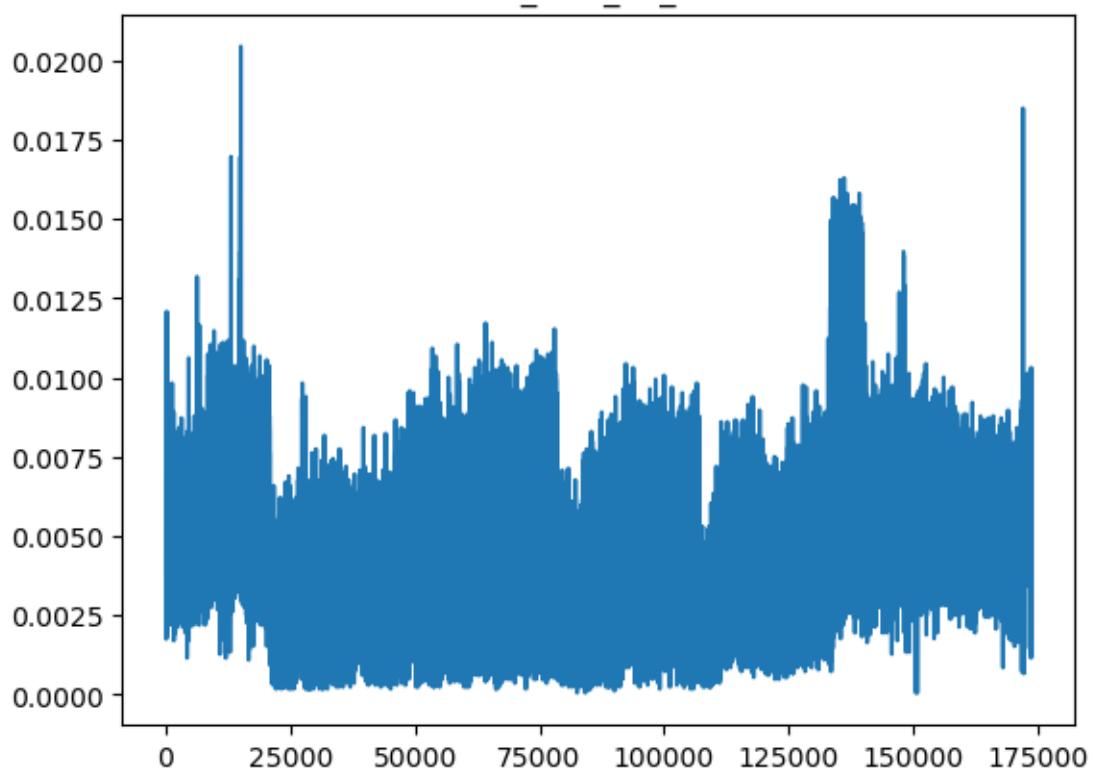
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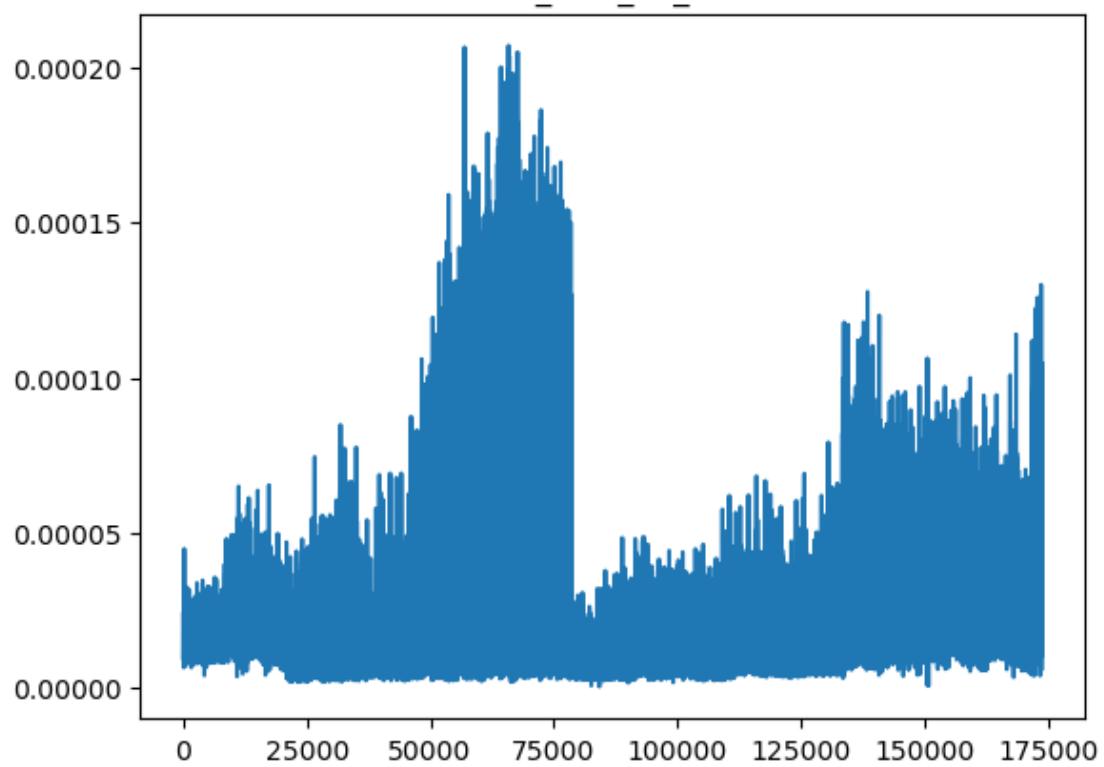




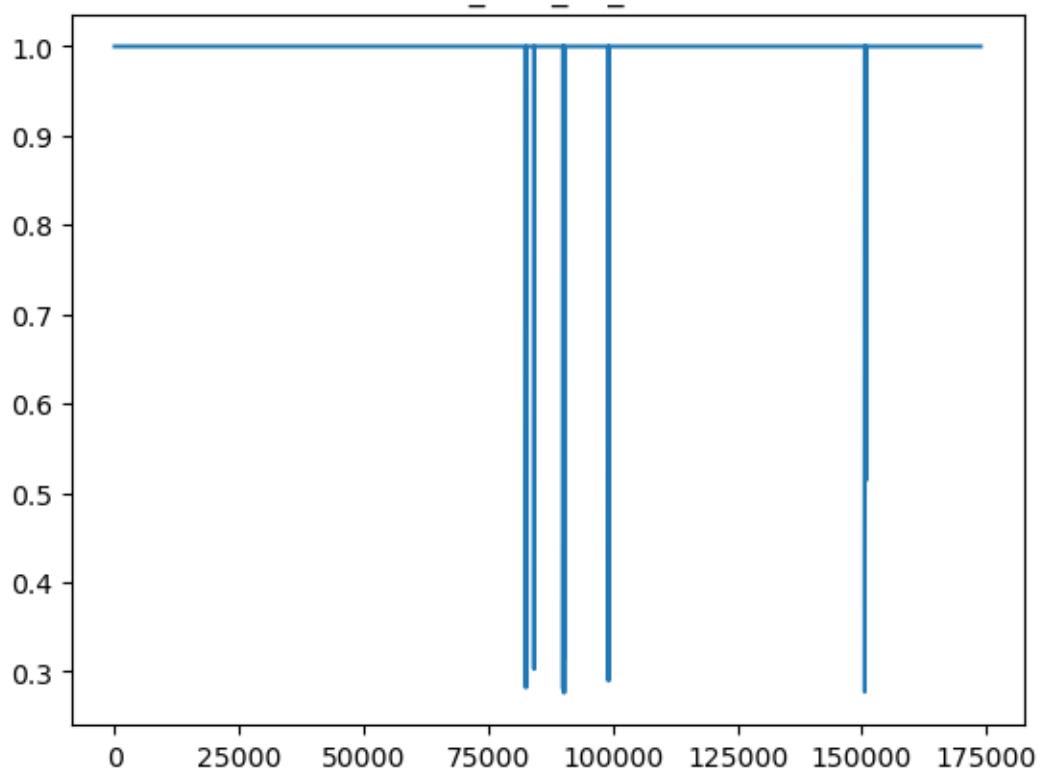
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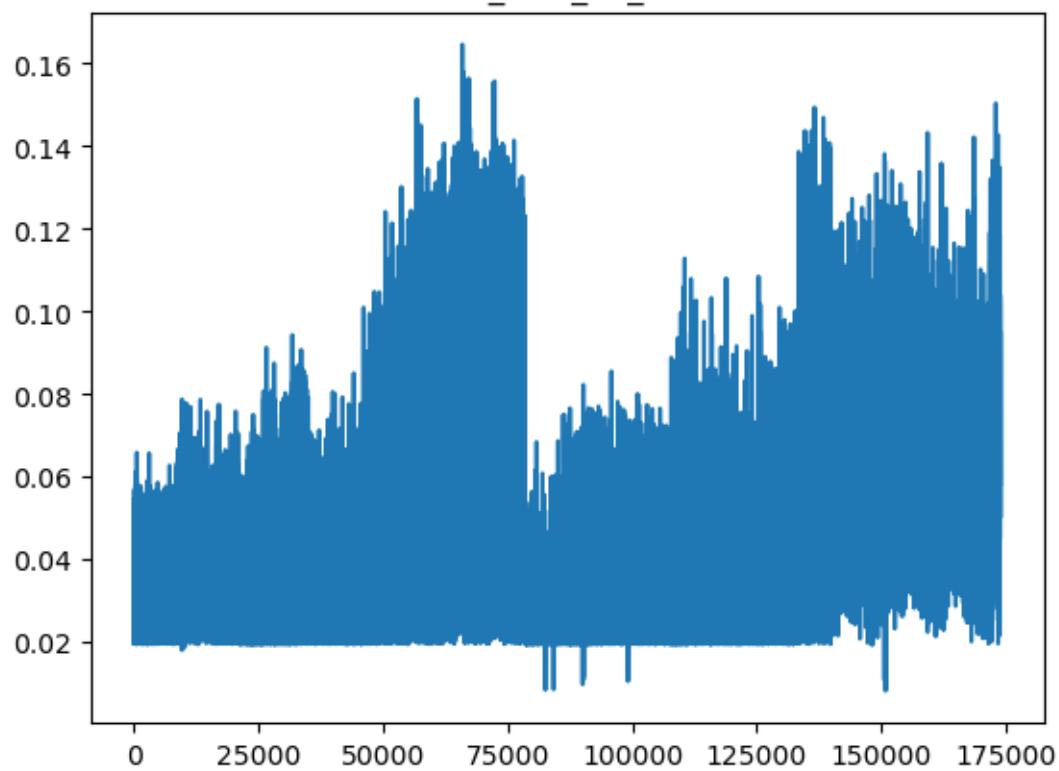
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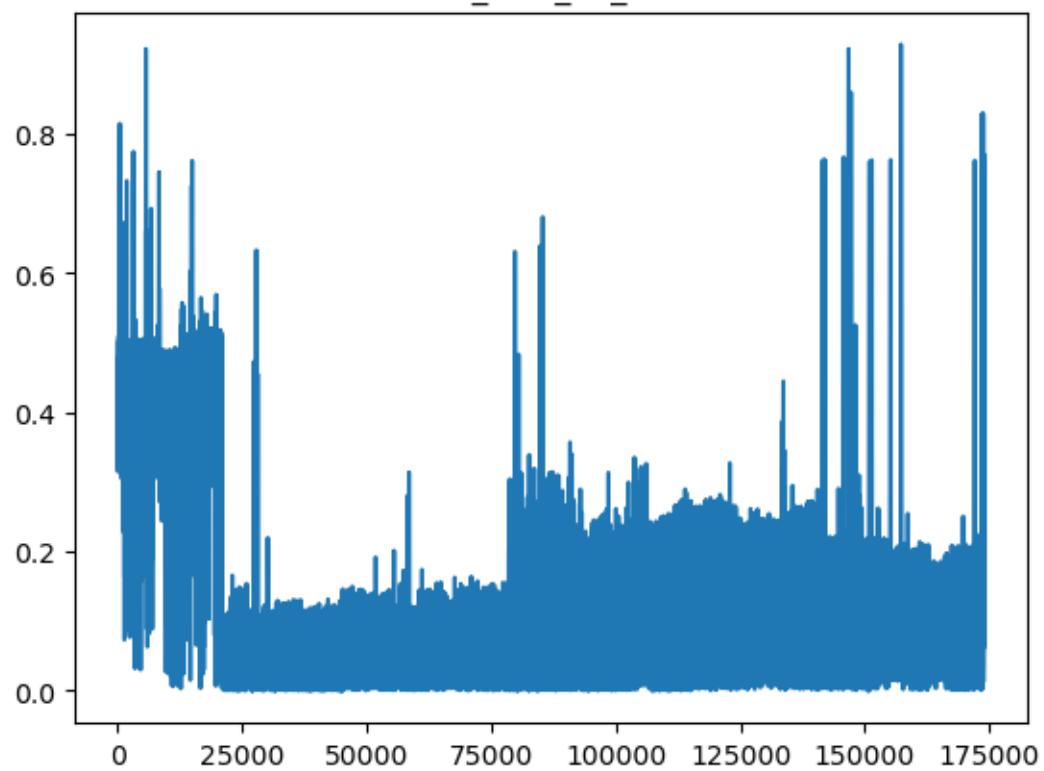
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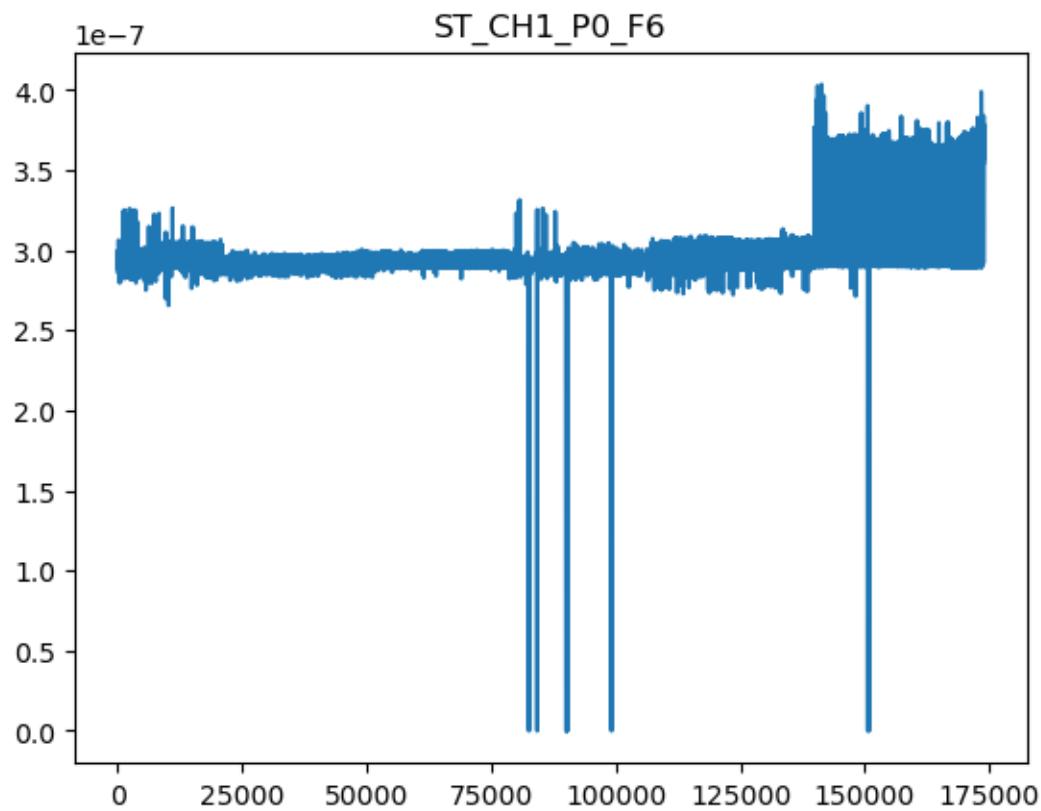


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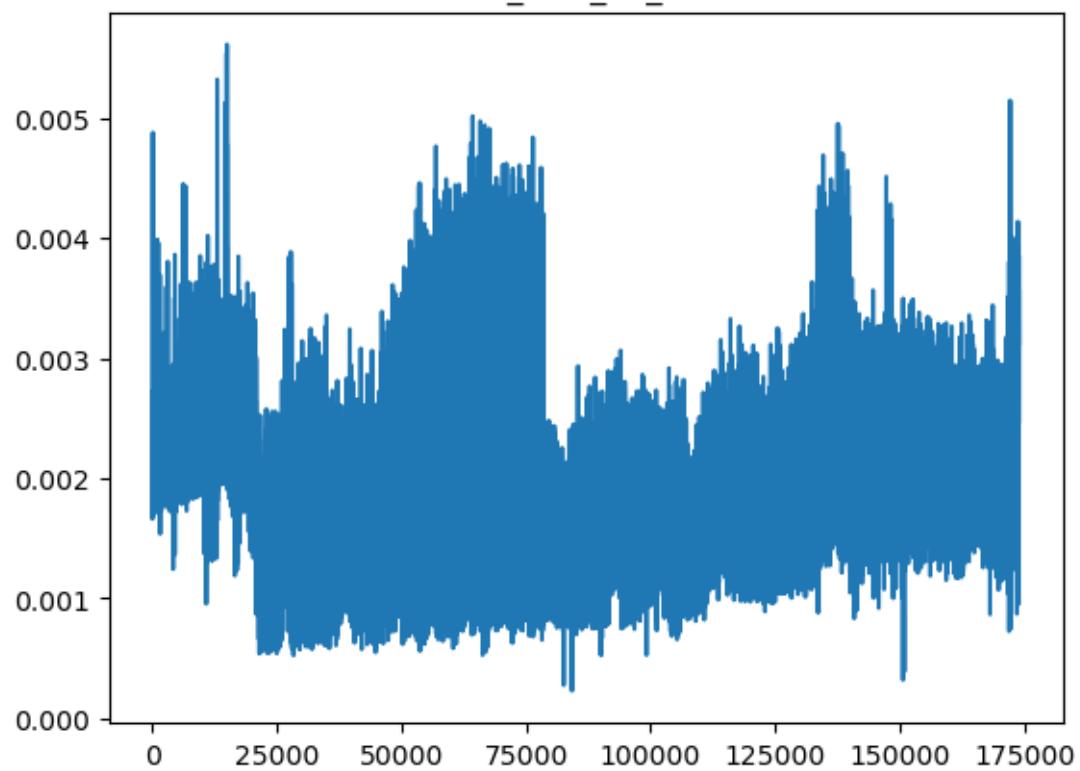


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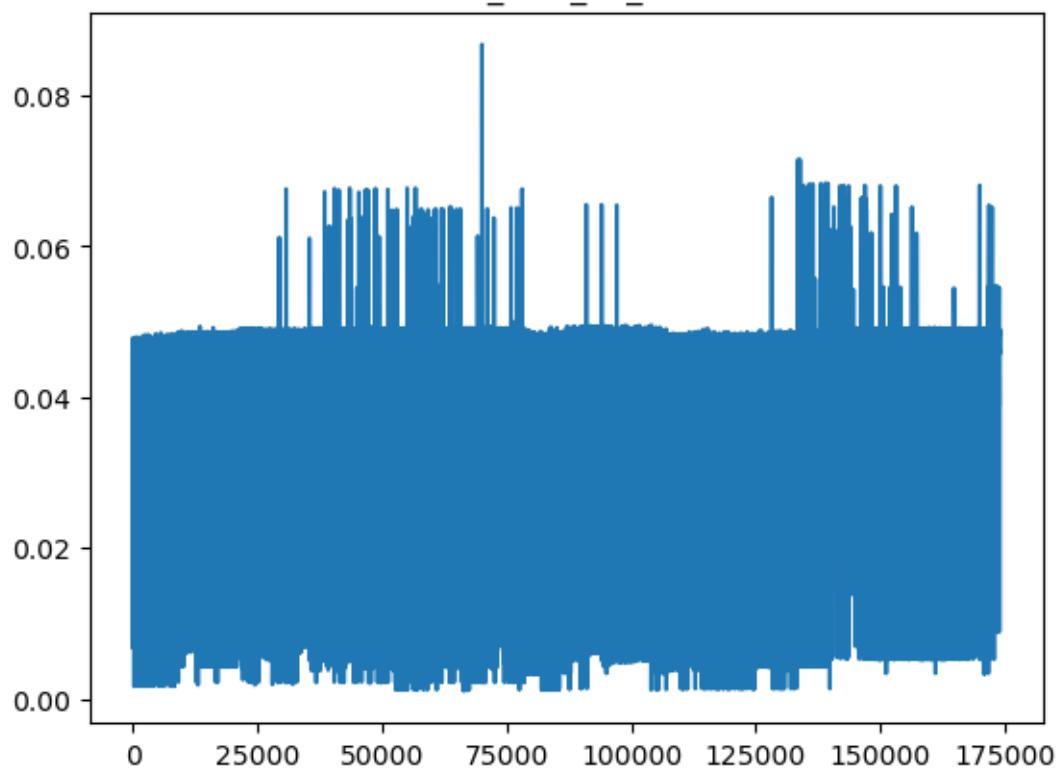




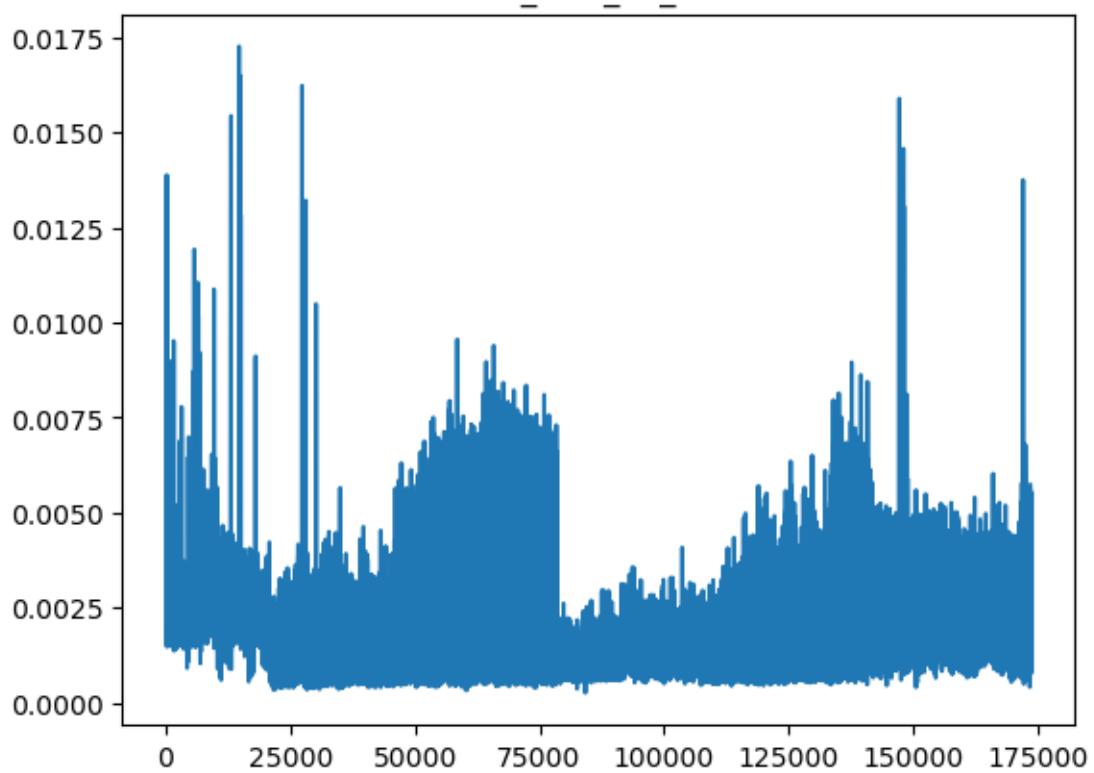
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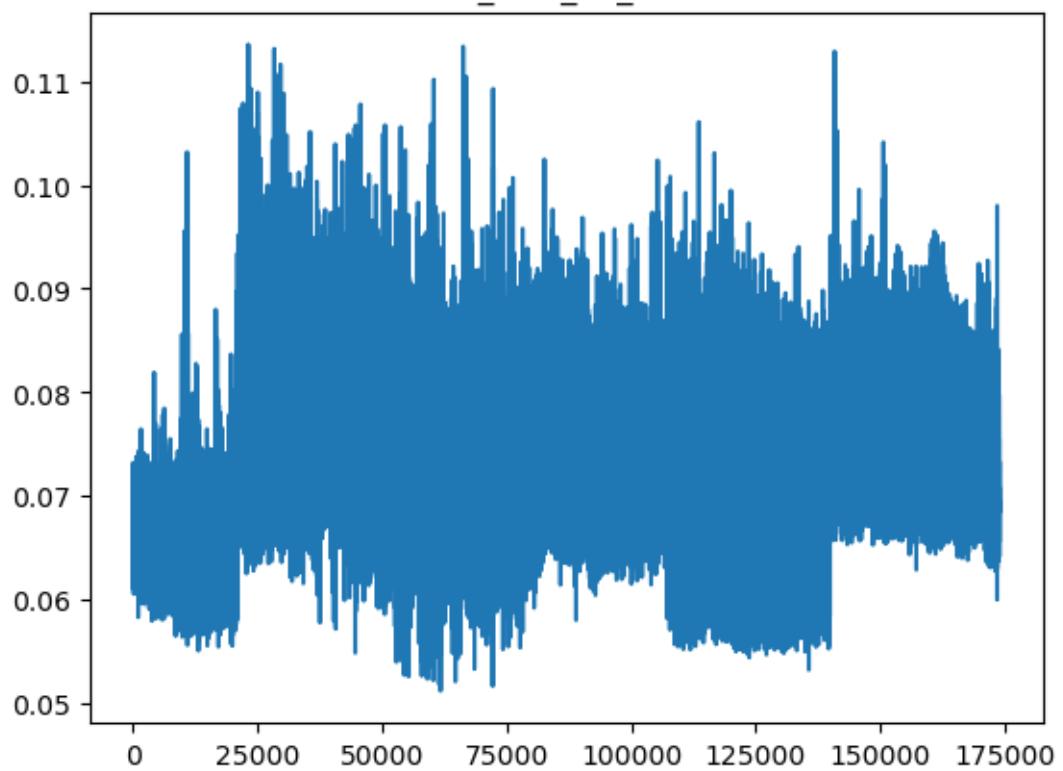
ST\_CH1\_P0\_F8

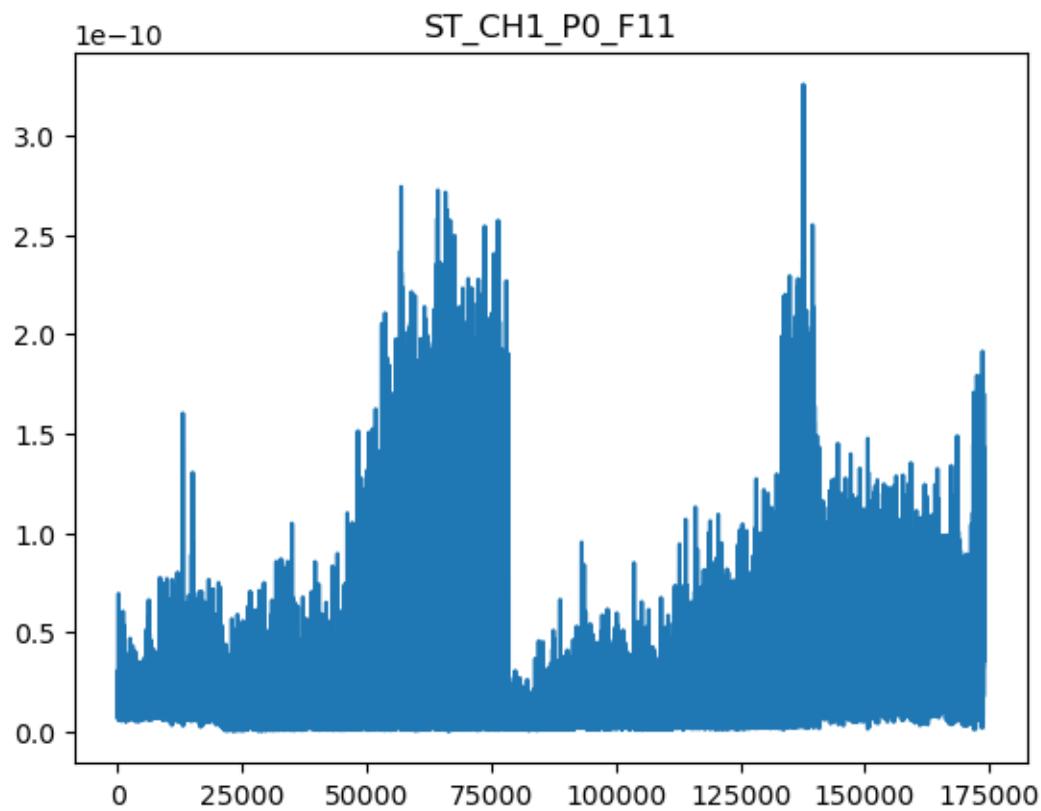


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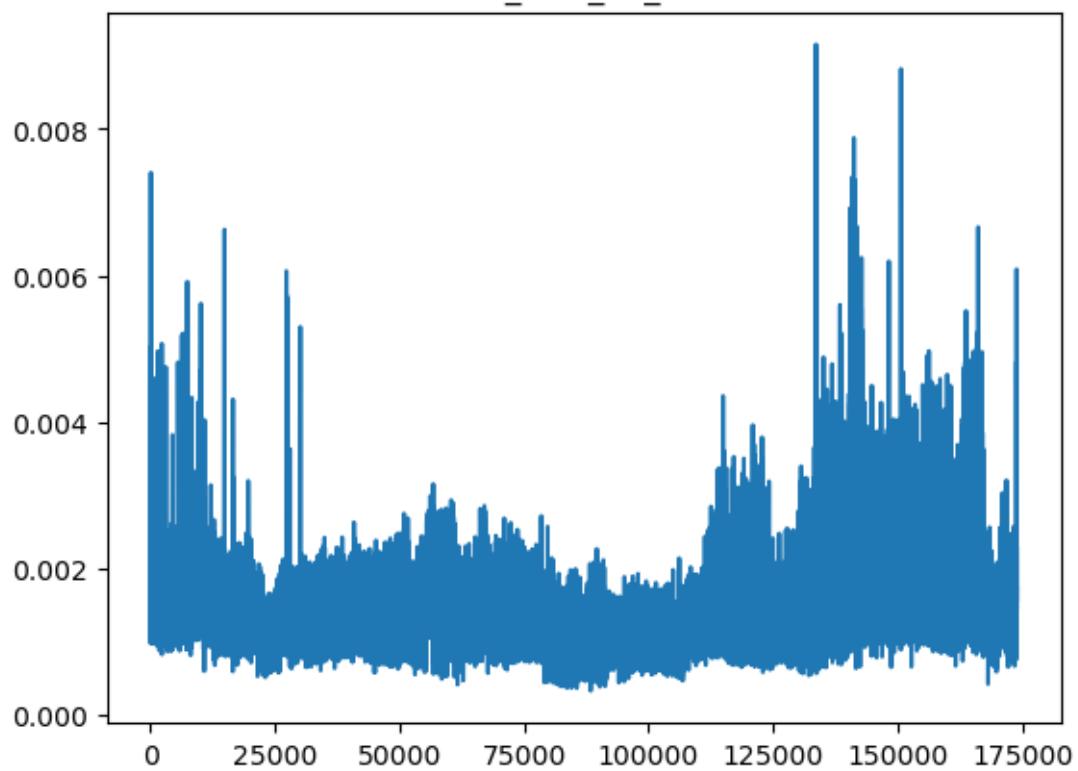


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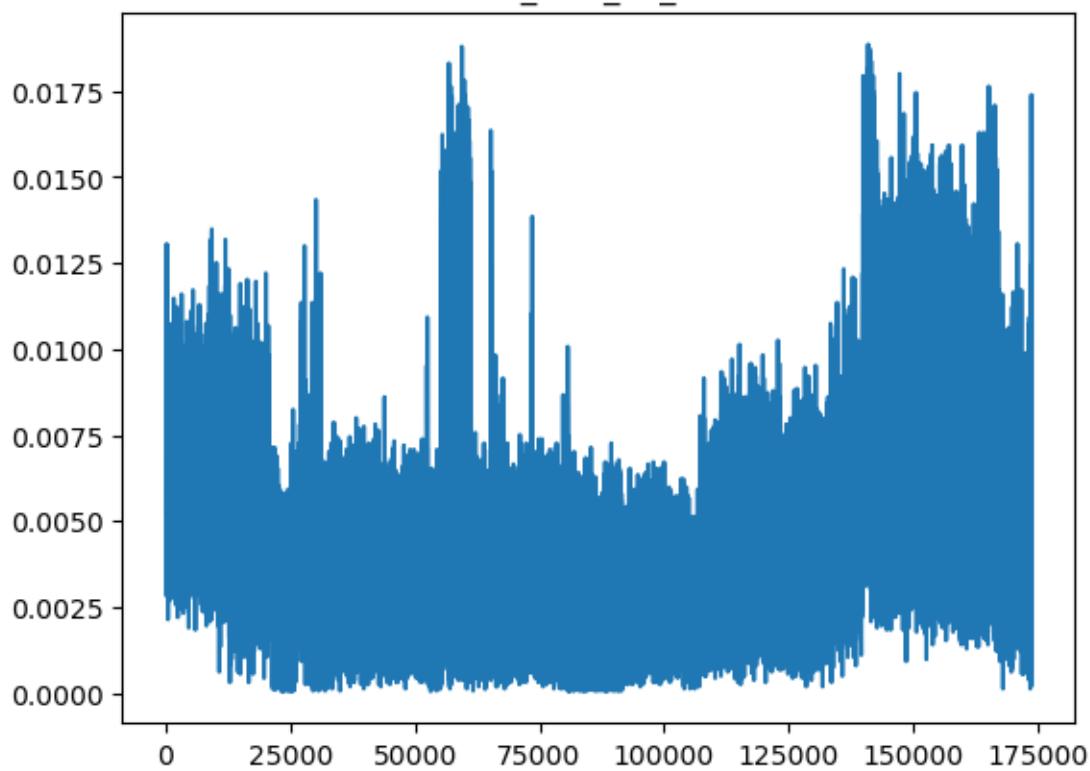


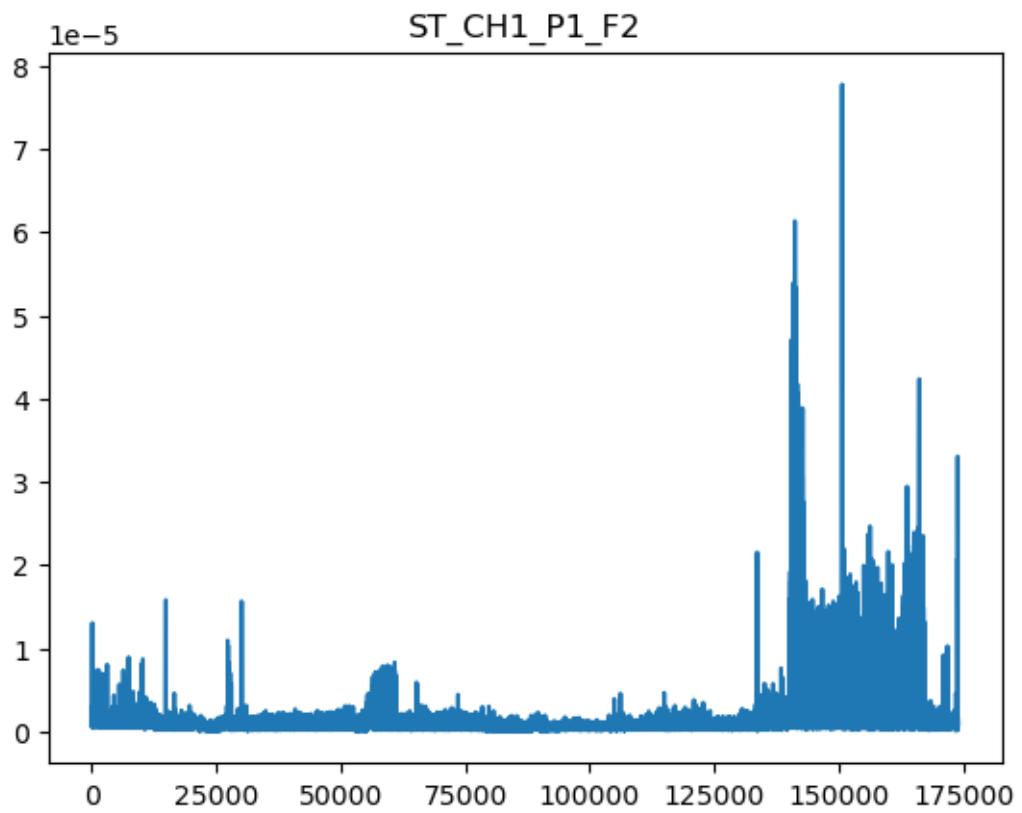


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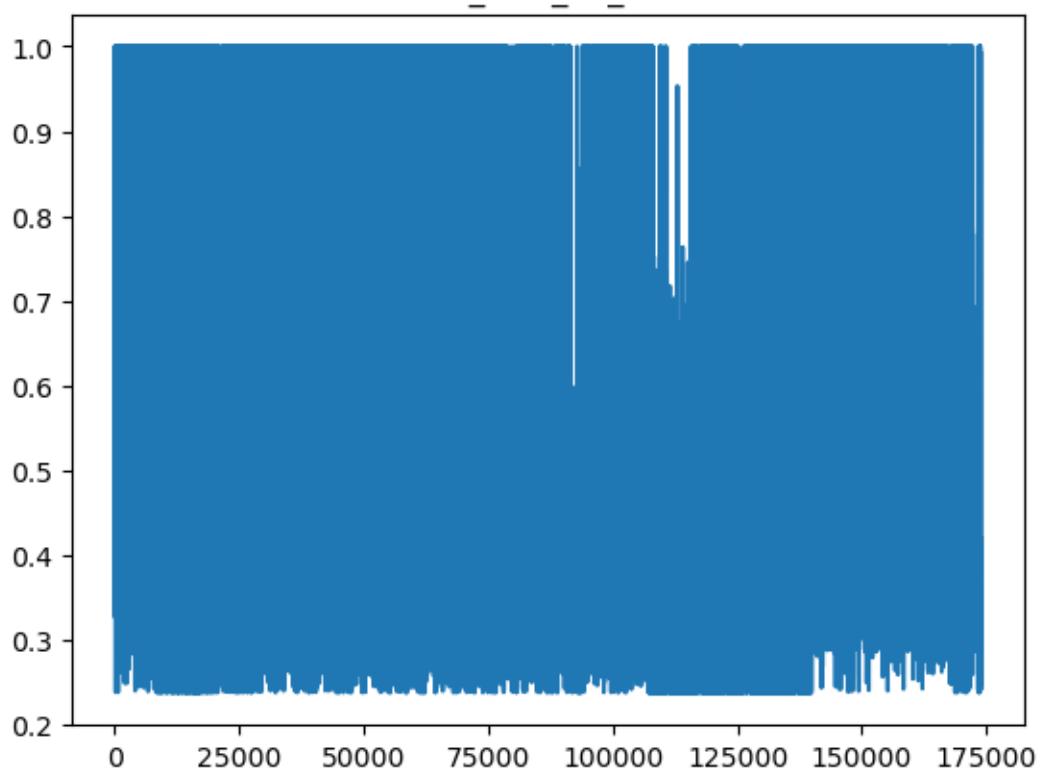


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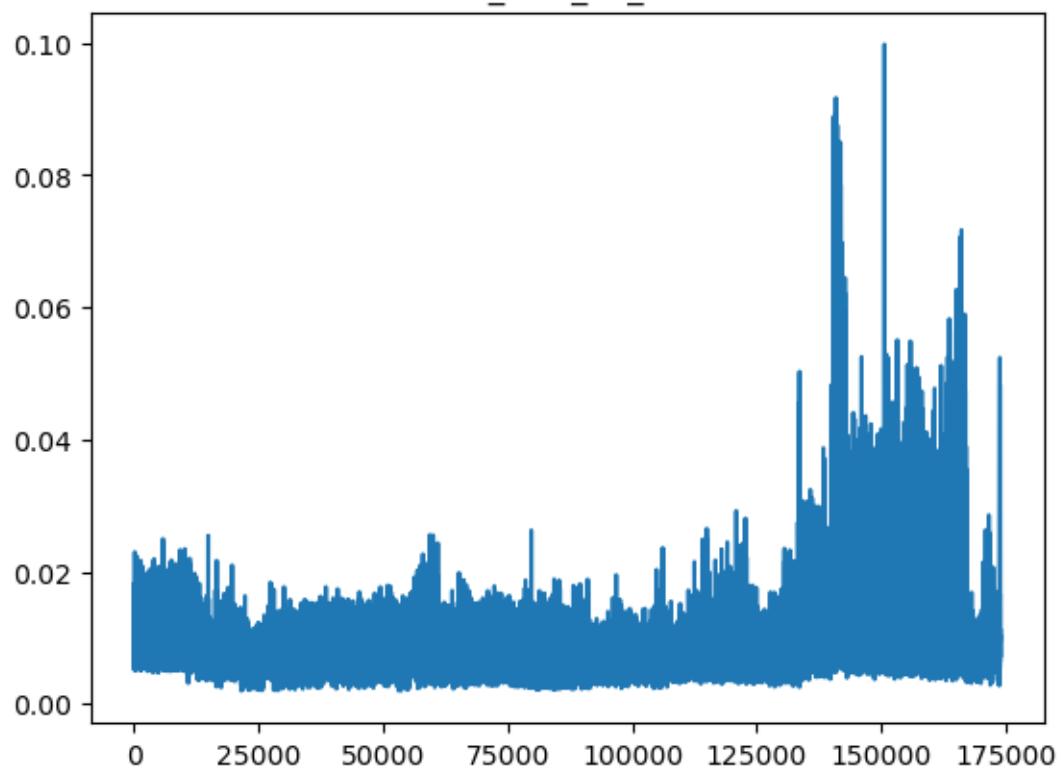




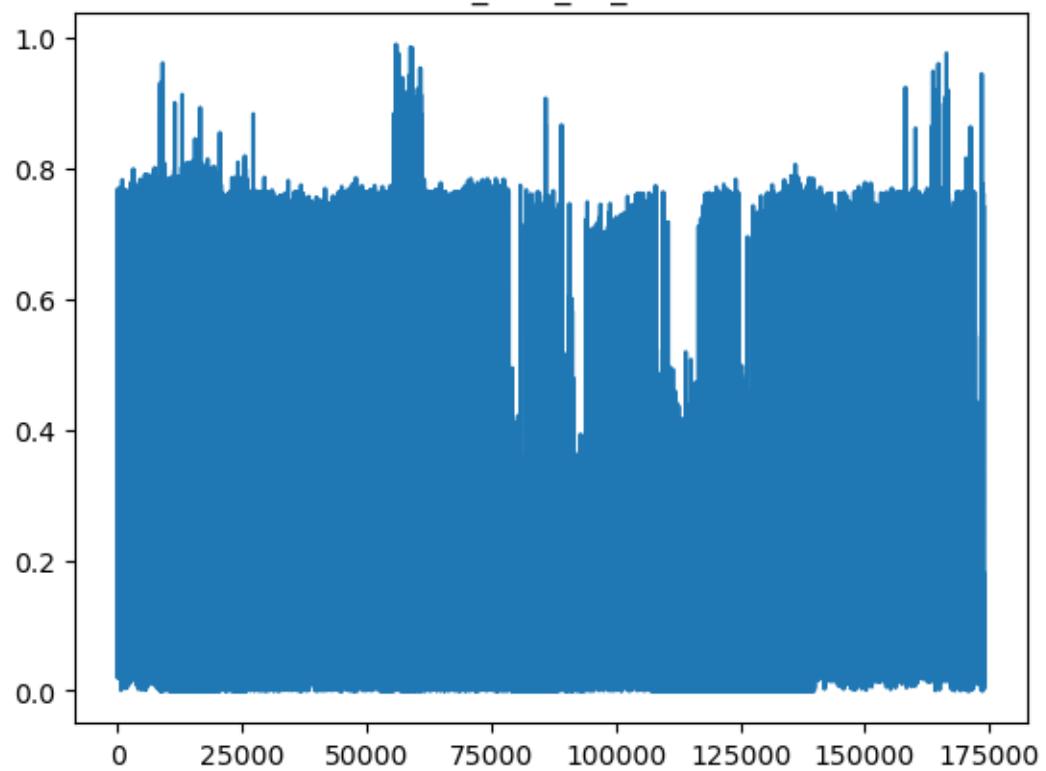
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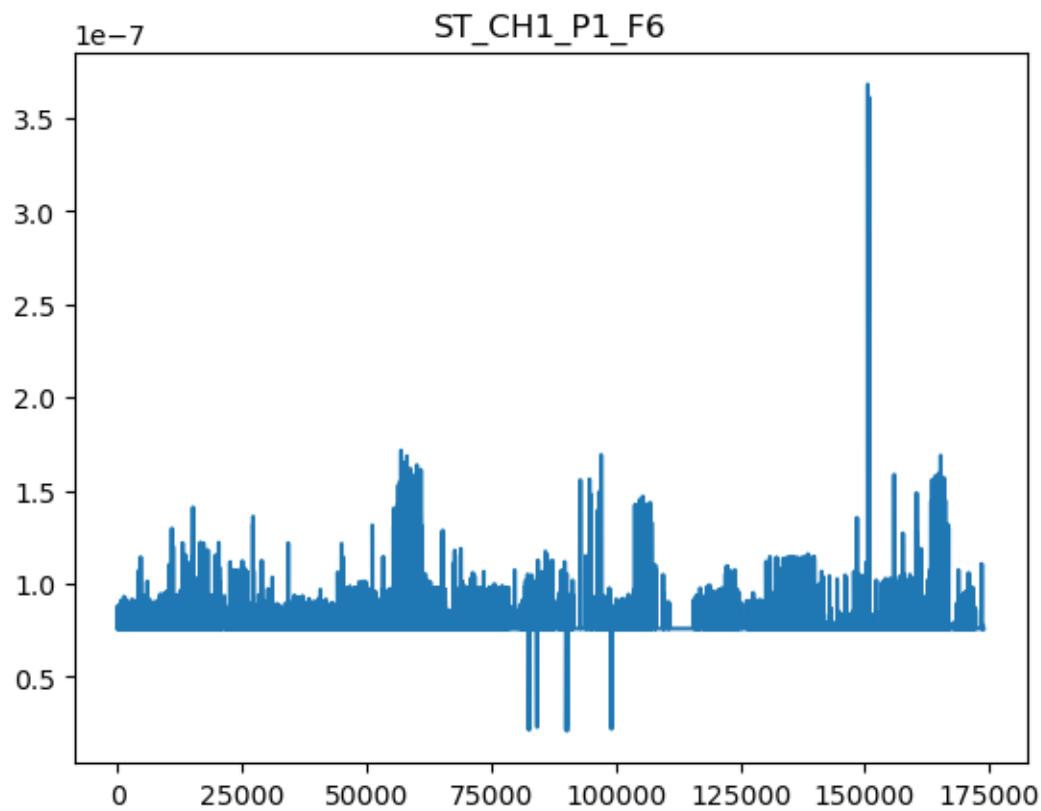


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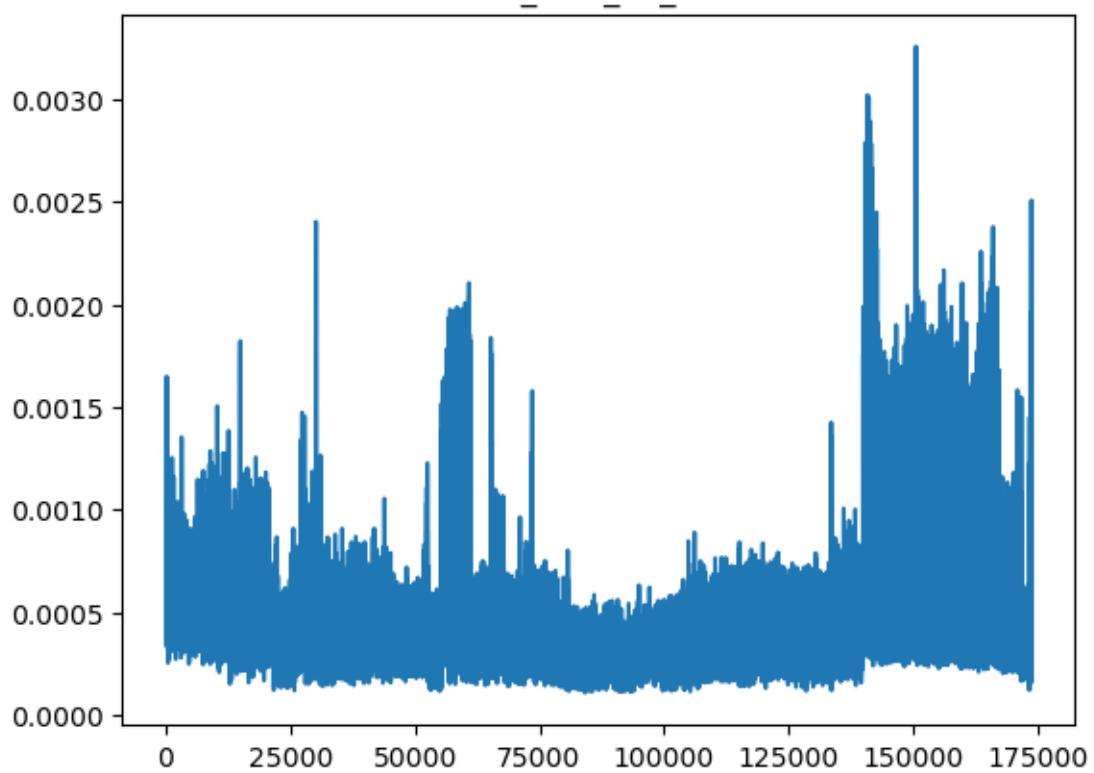


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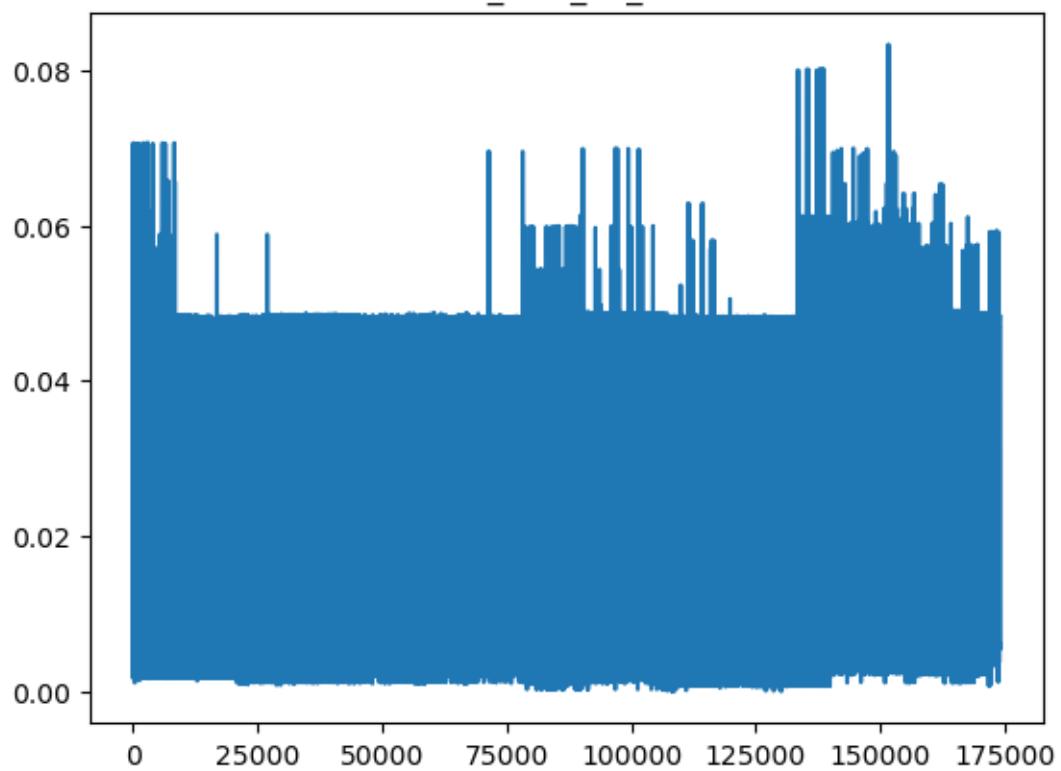




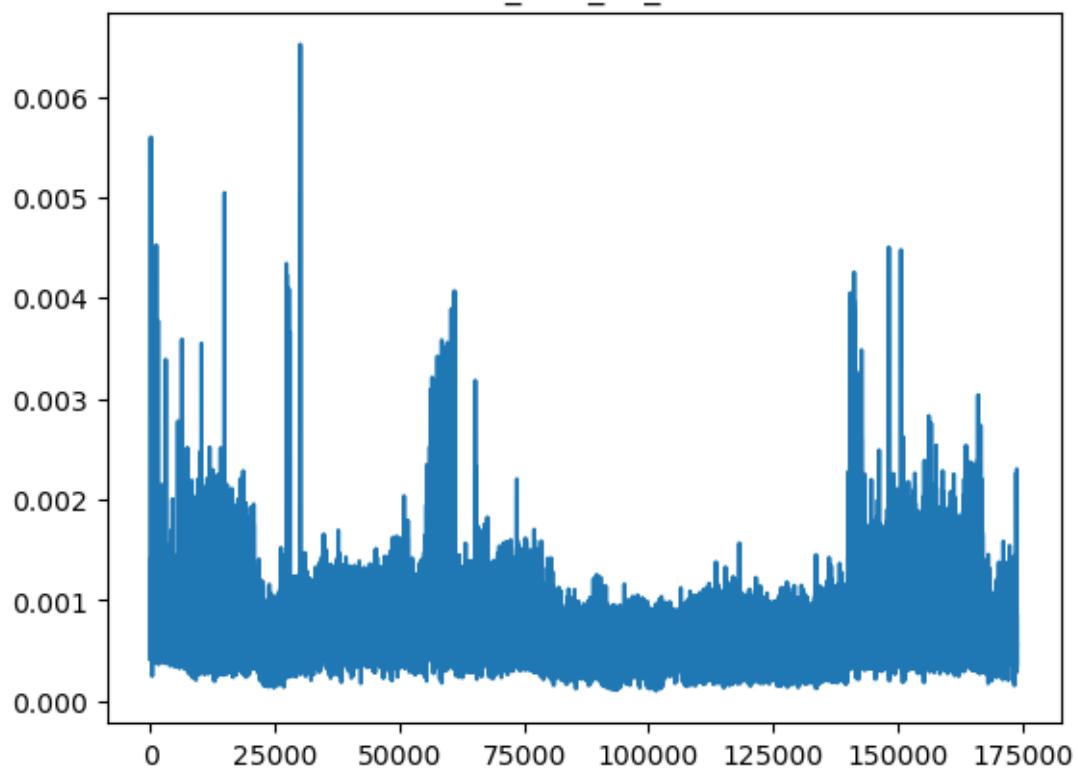
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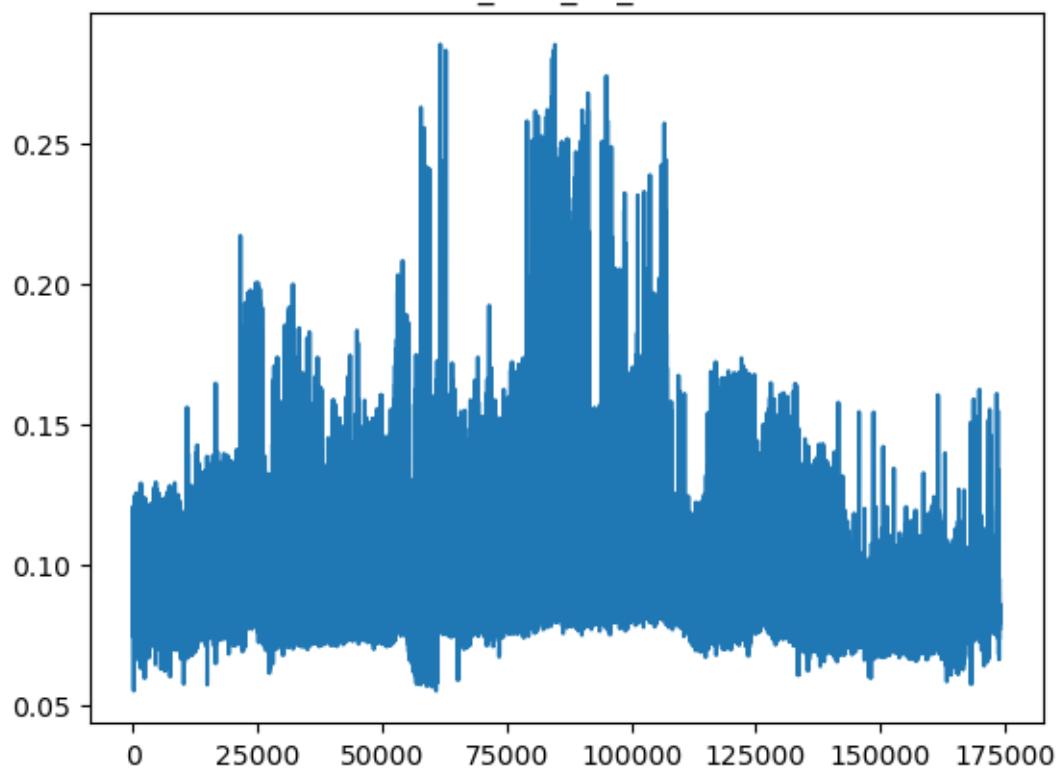
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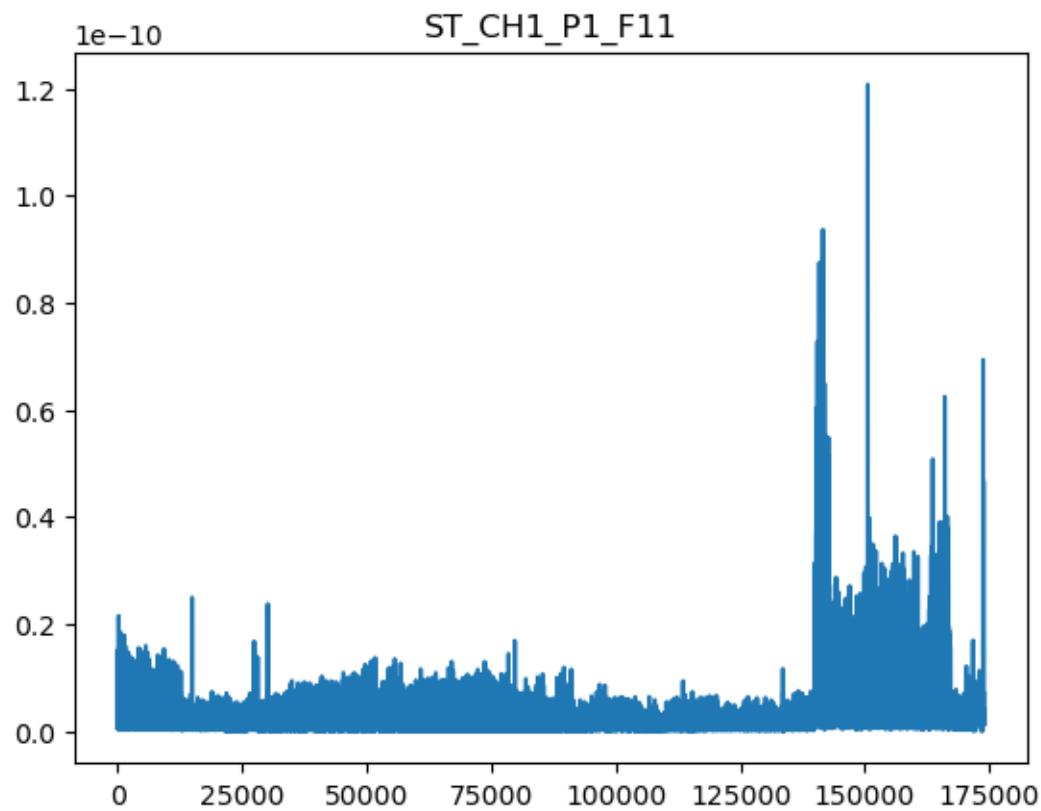


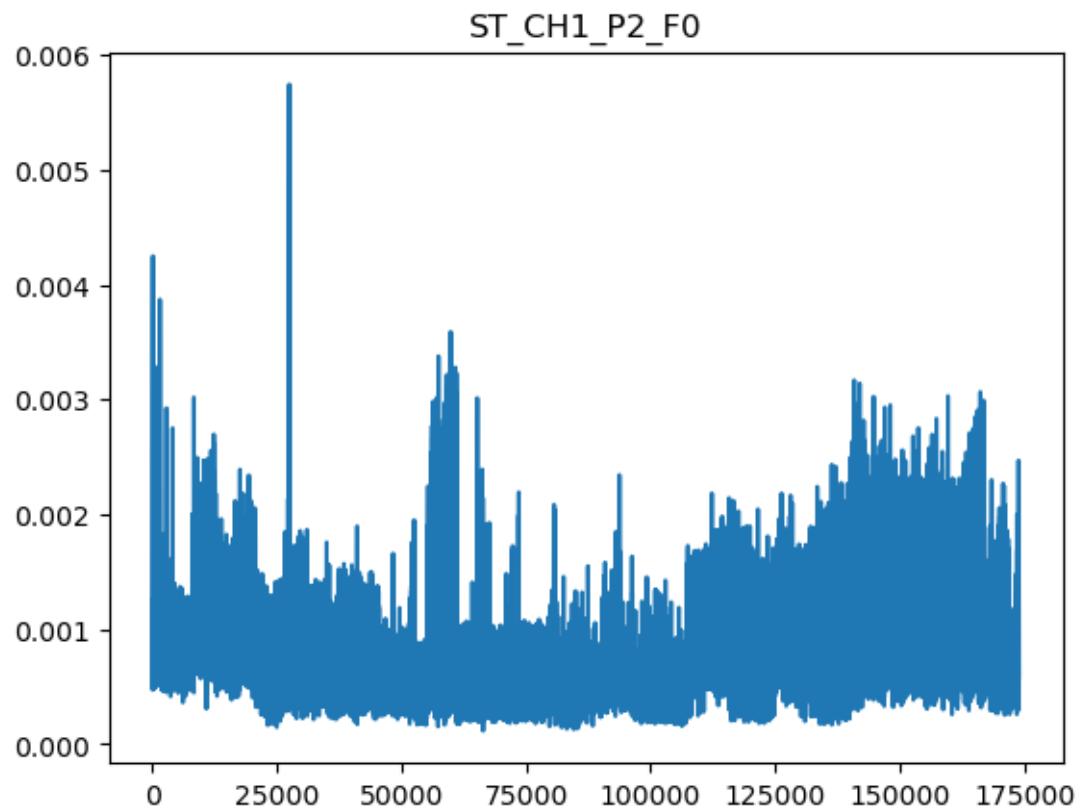
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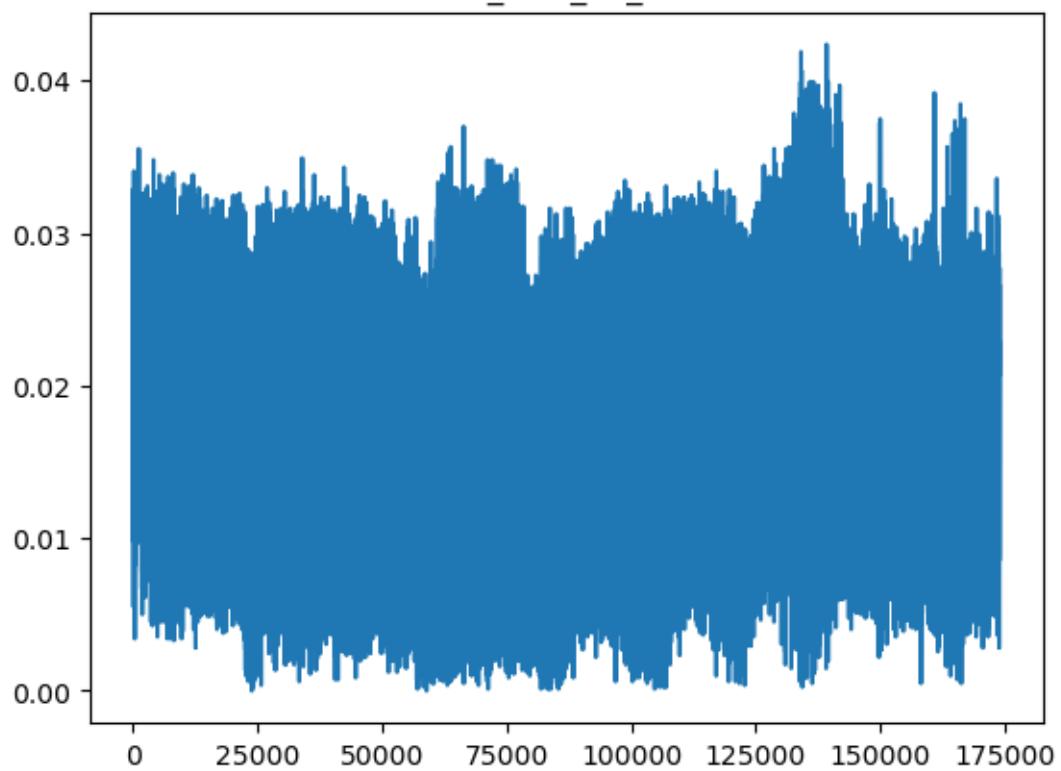
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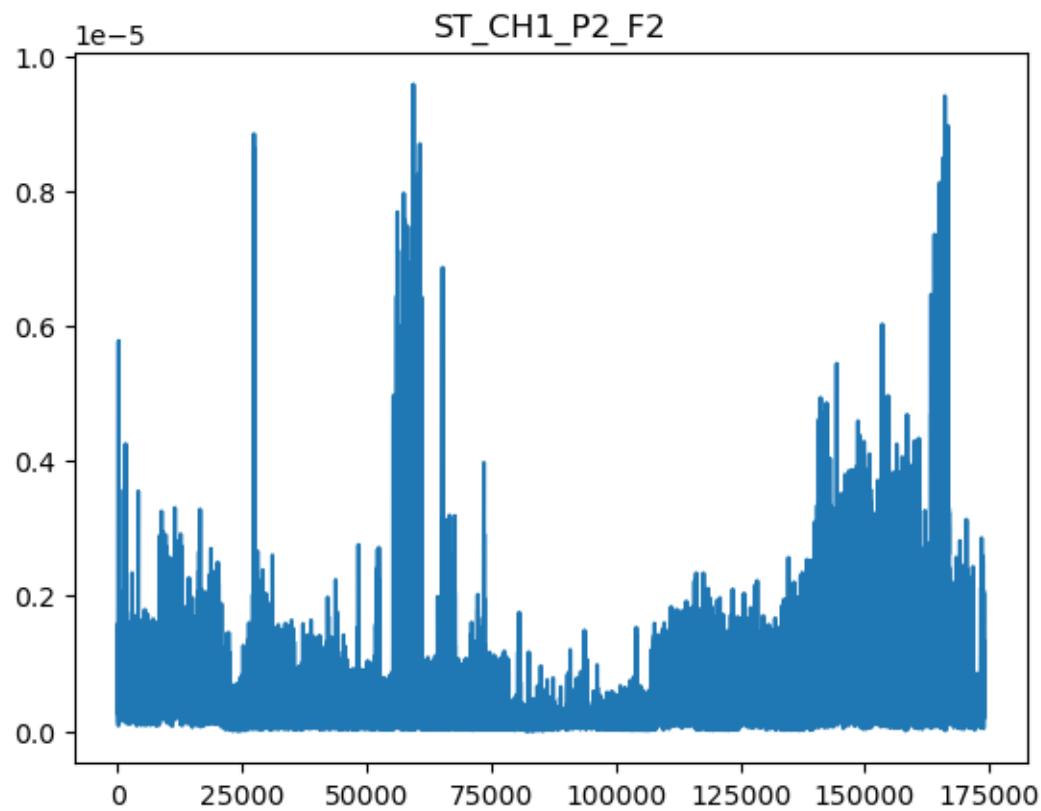




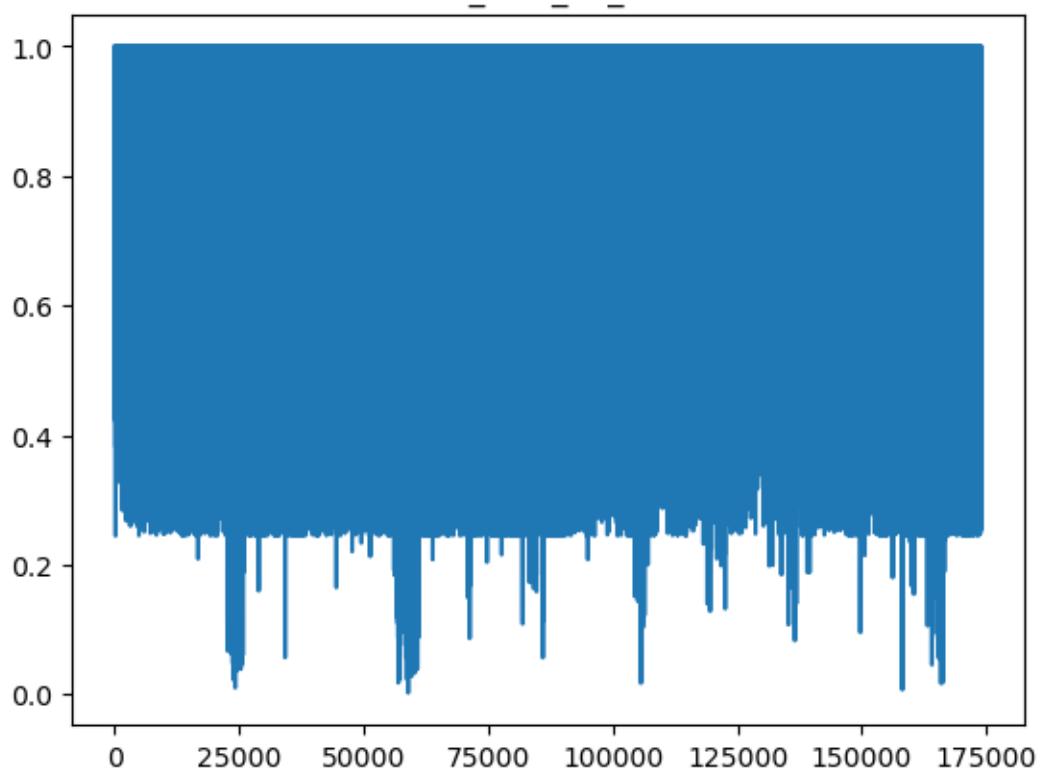


ST\_CH1\_P2\_F1

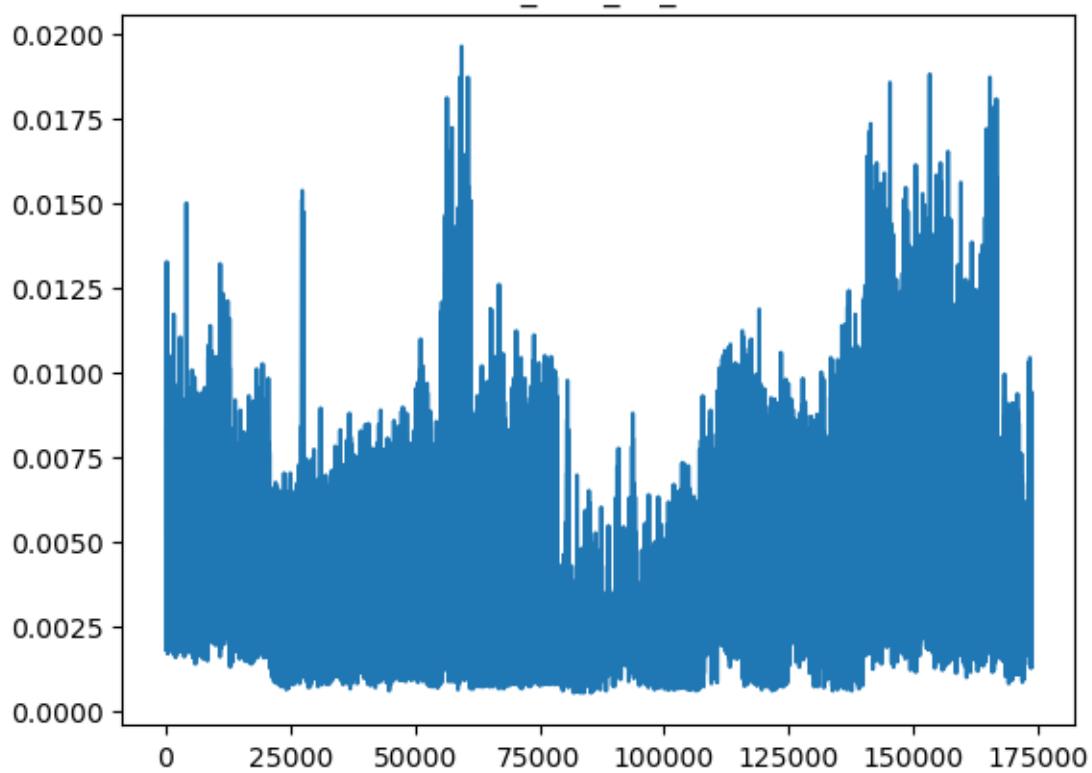




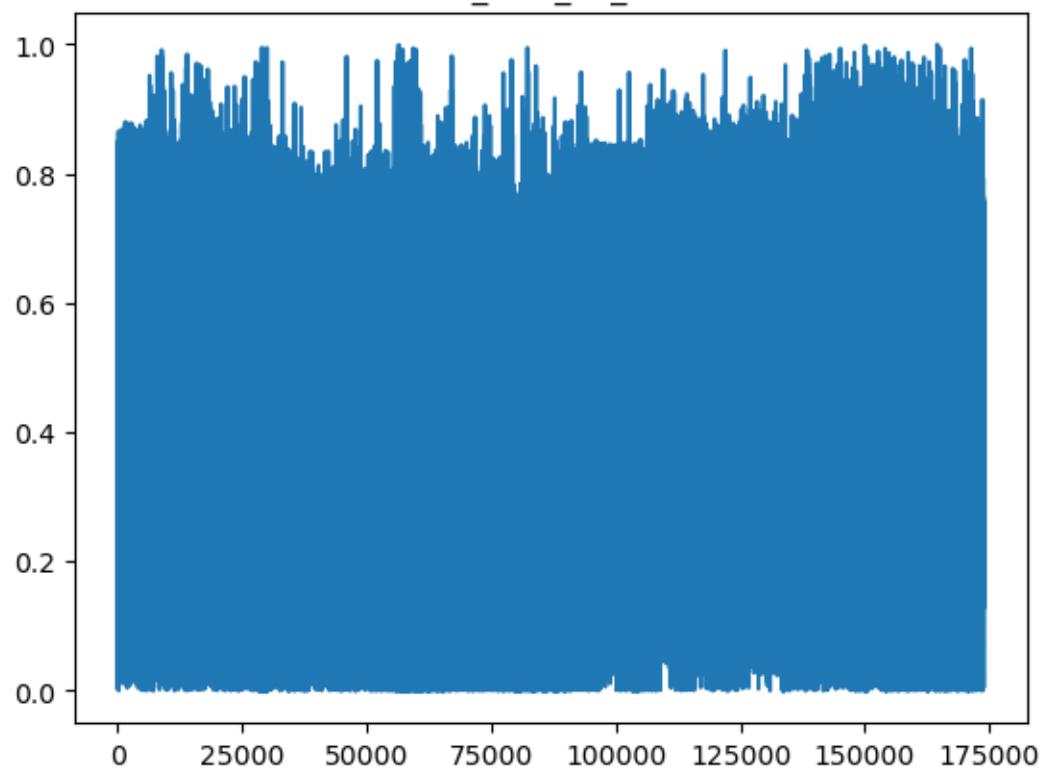
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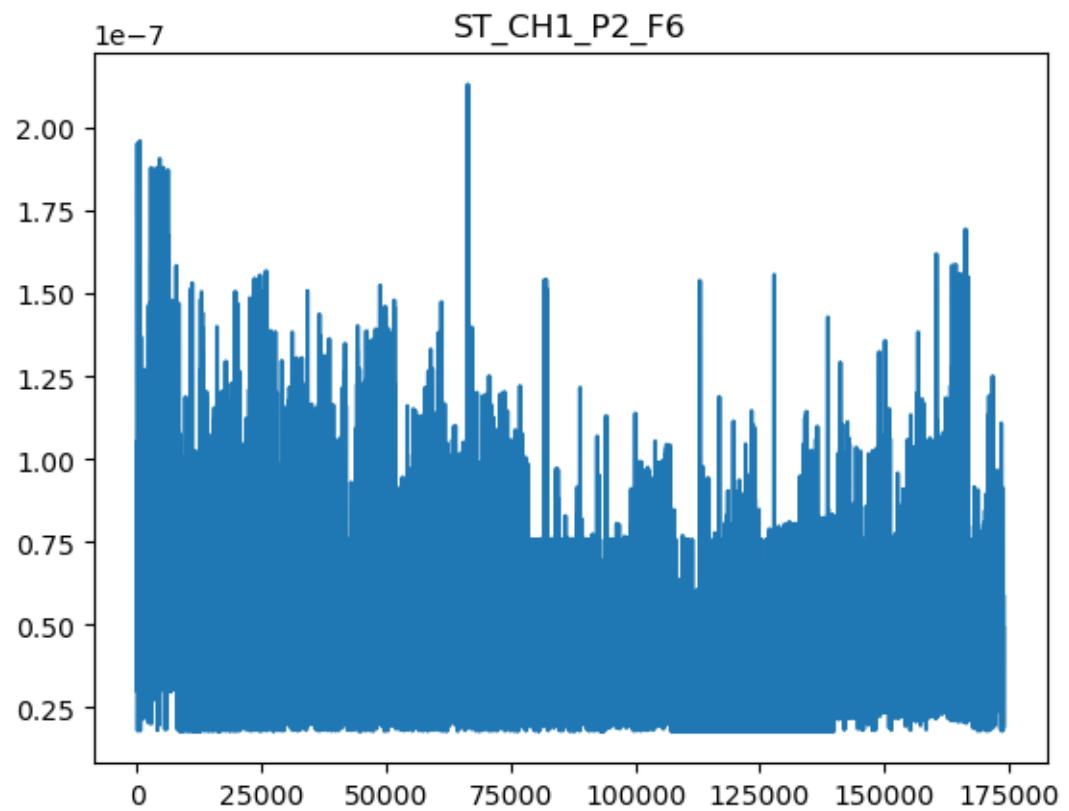


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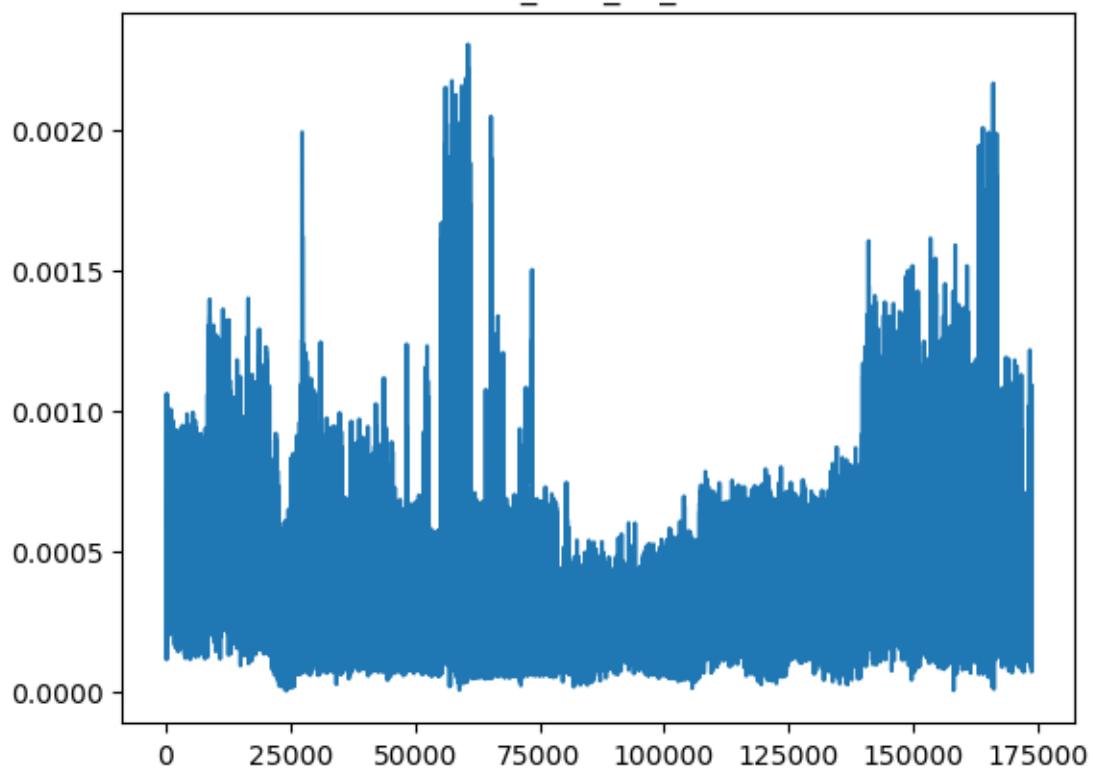


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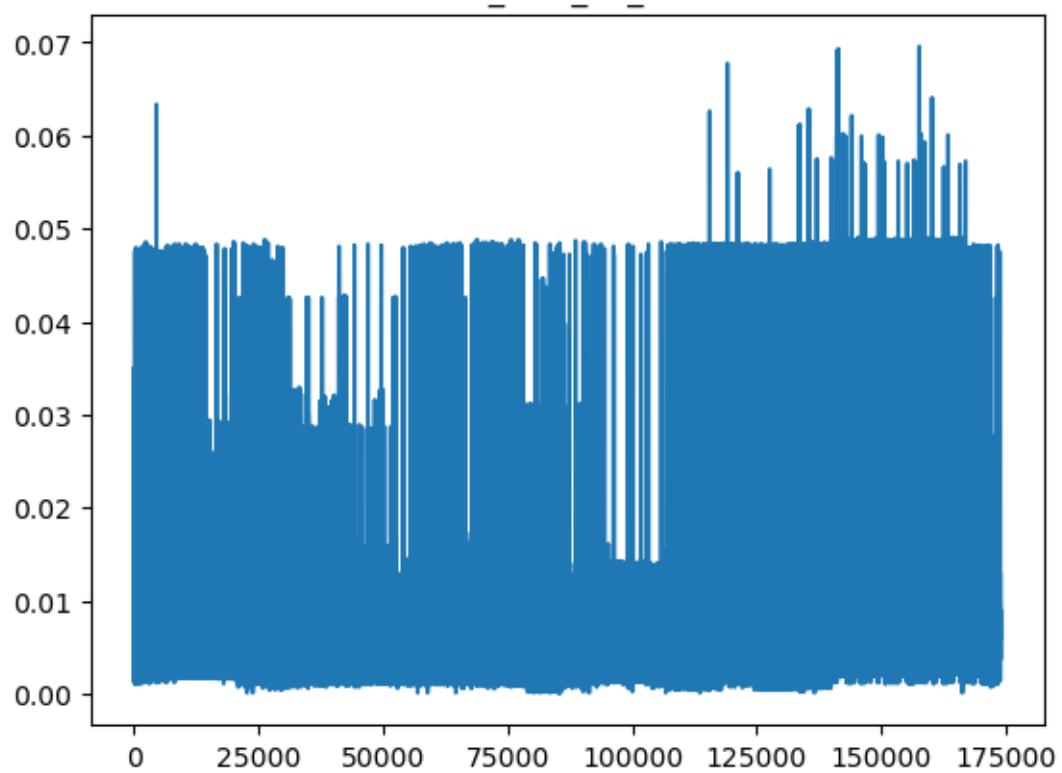




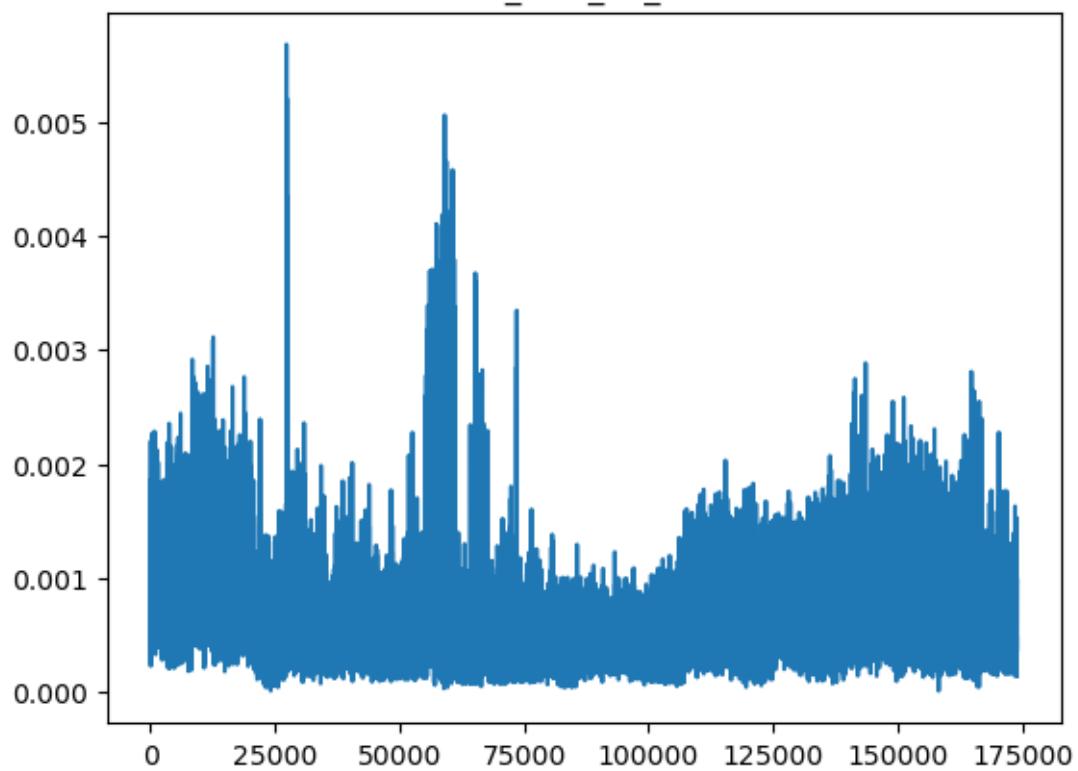
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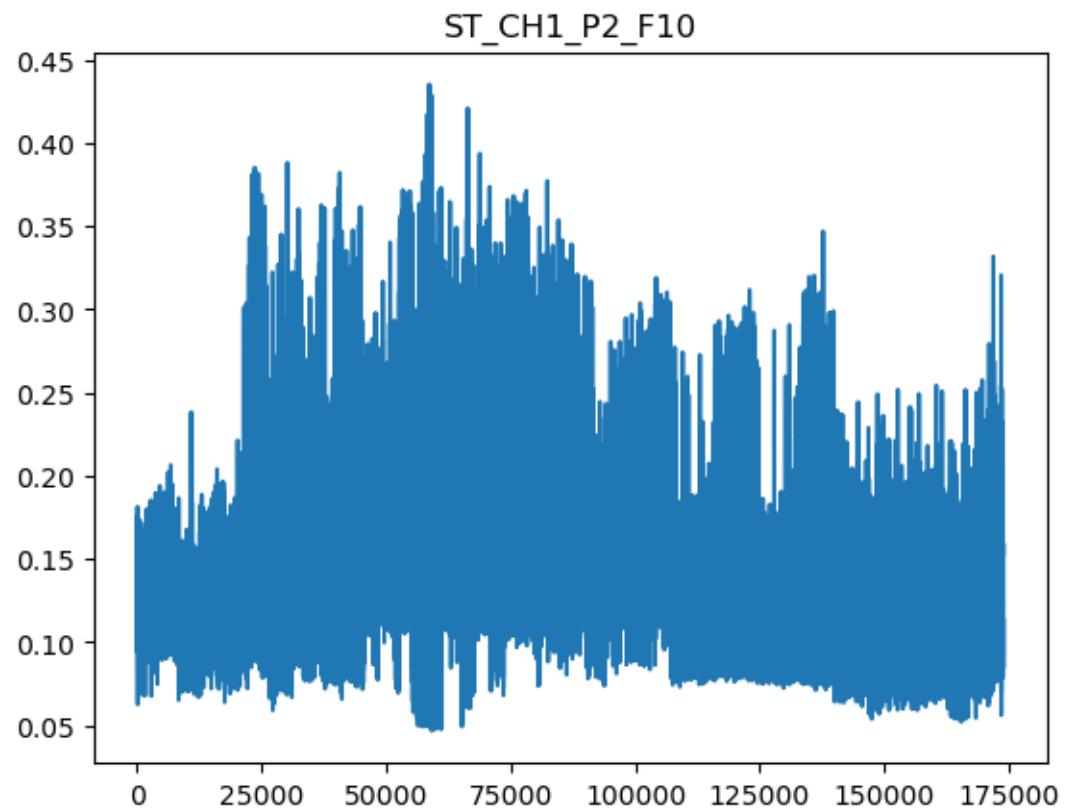


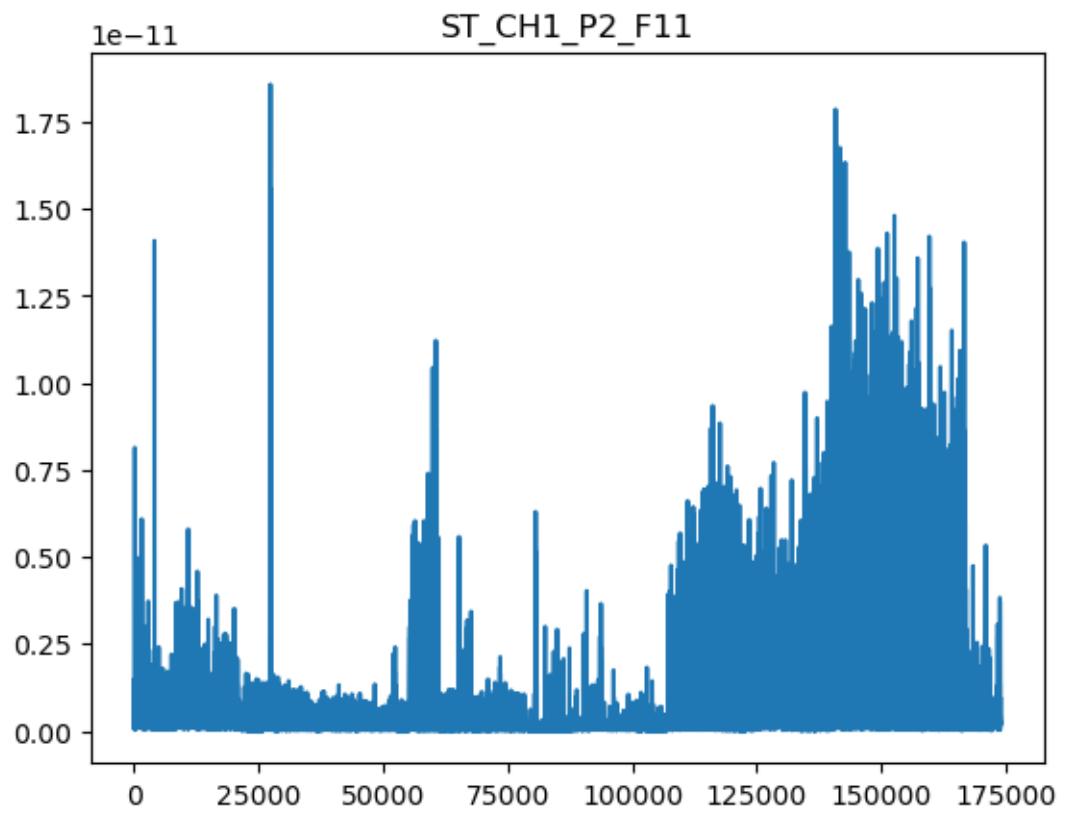
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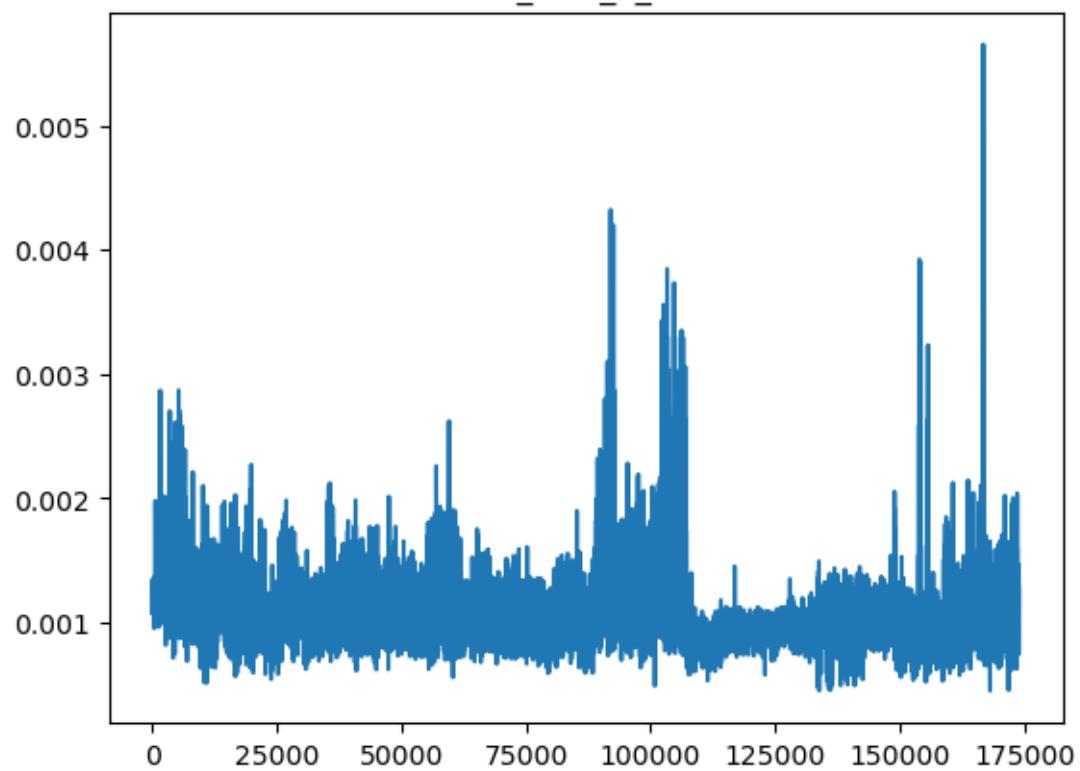
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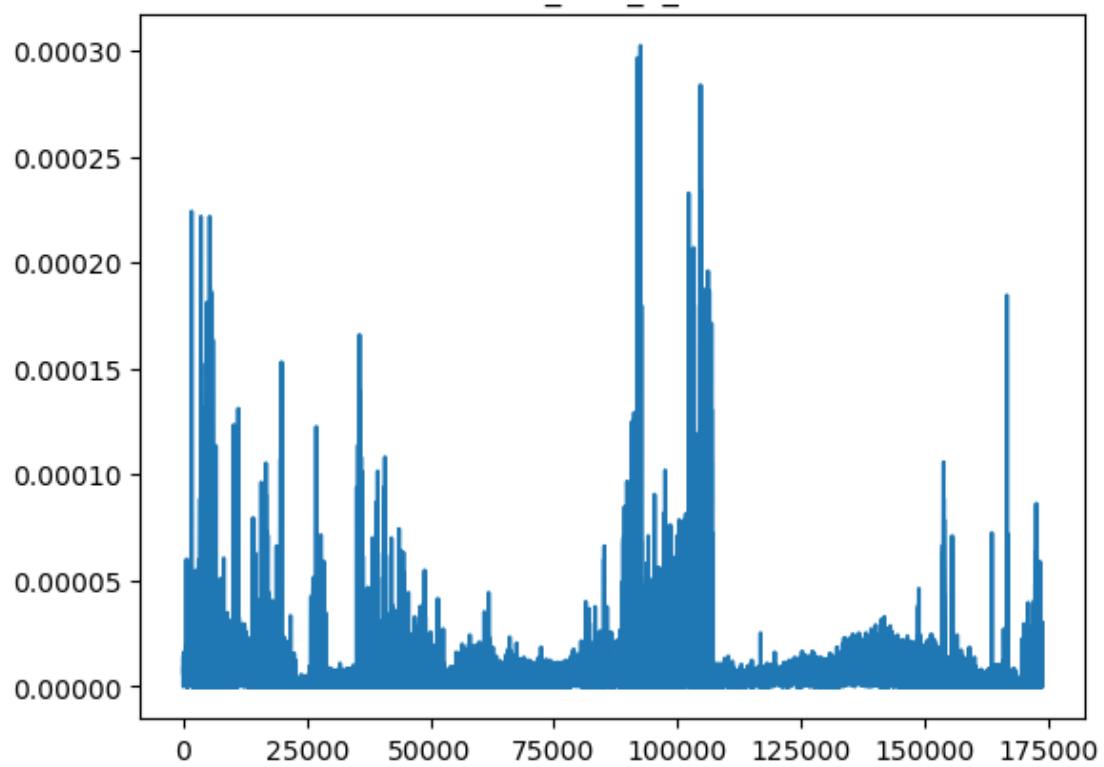


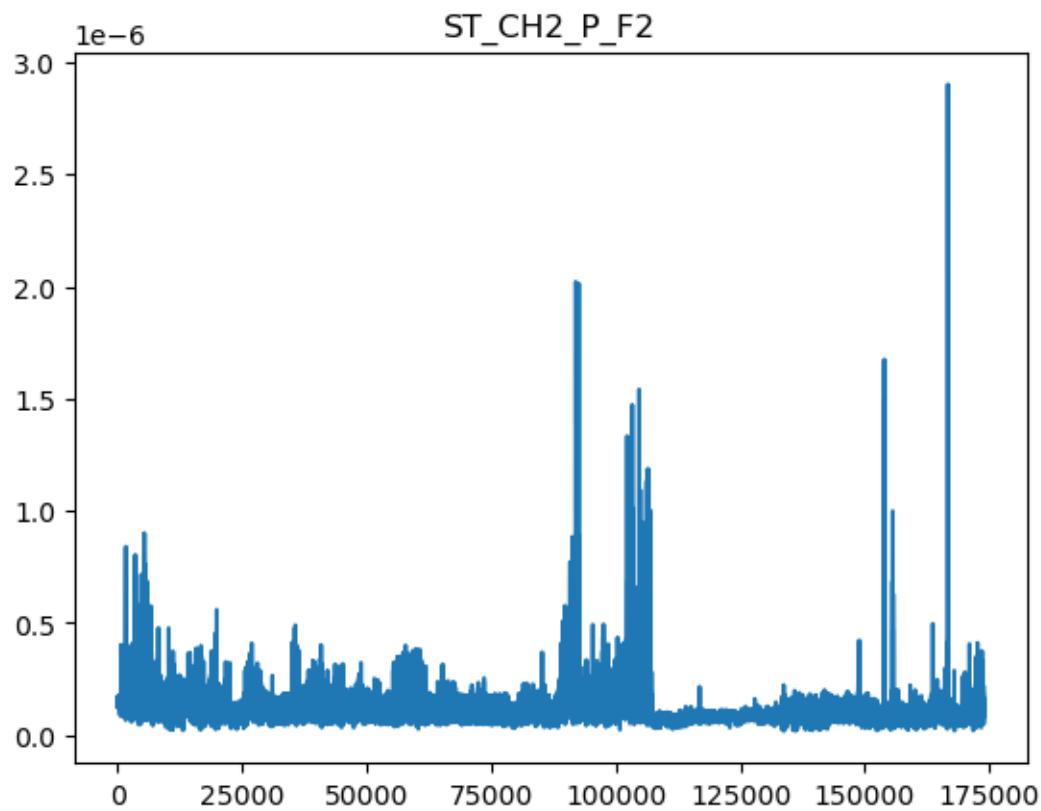


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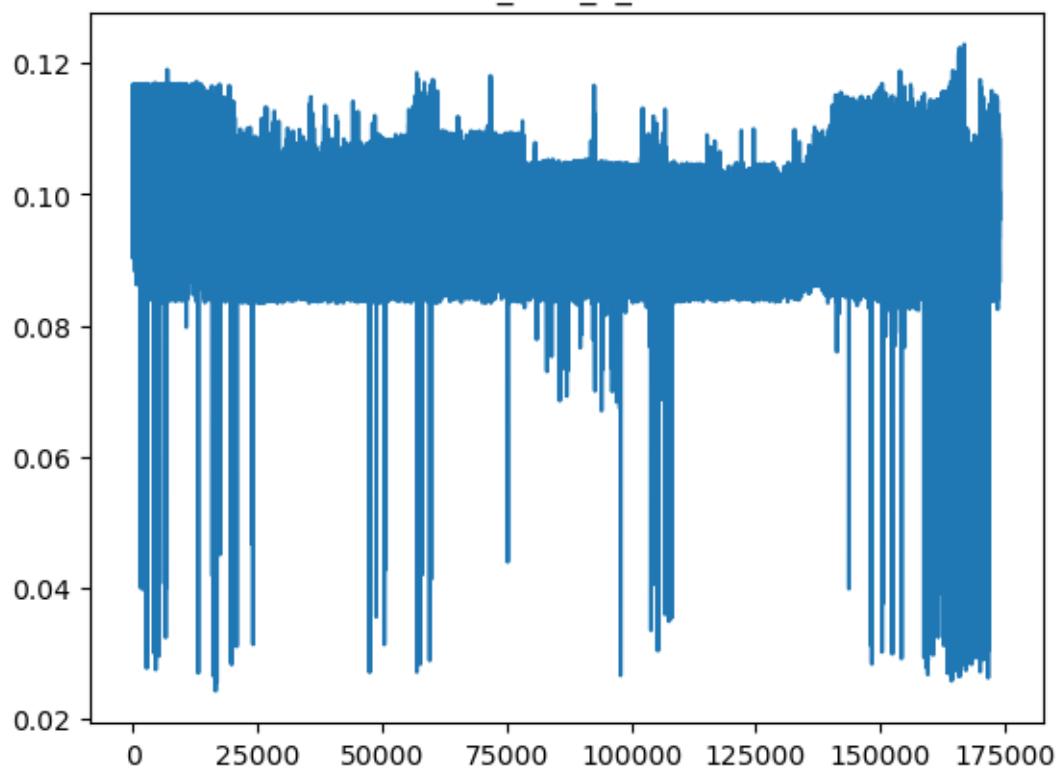


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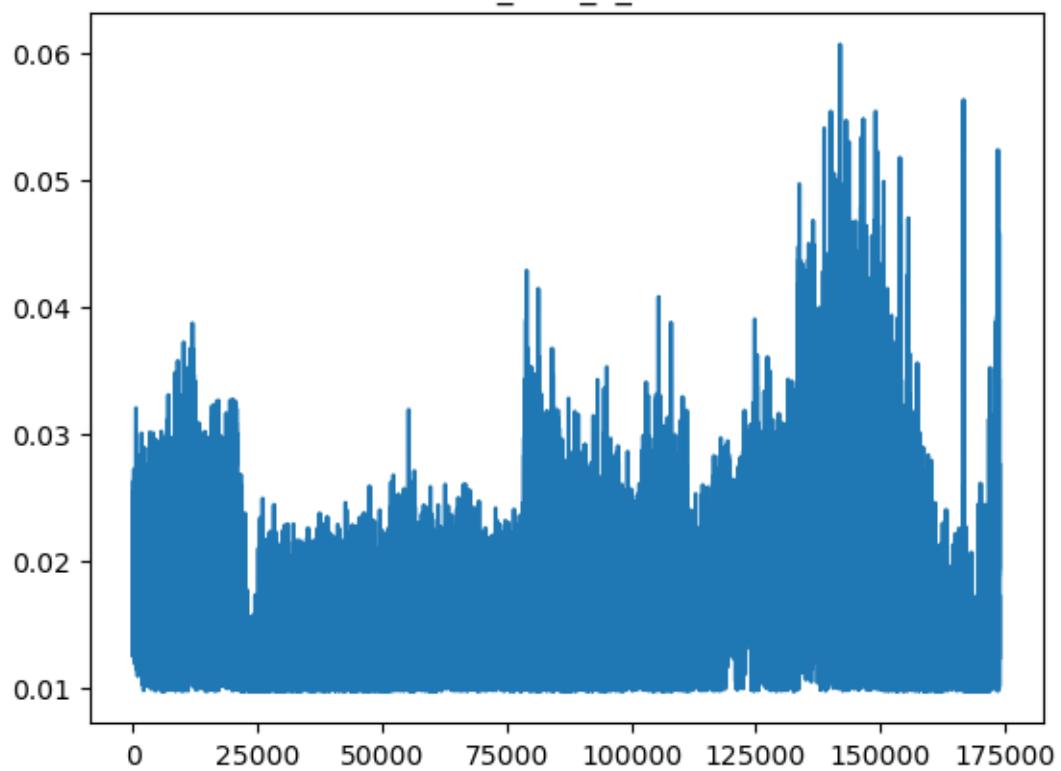




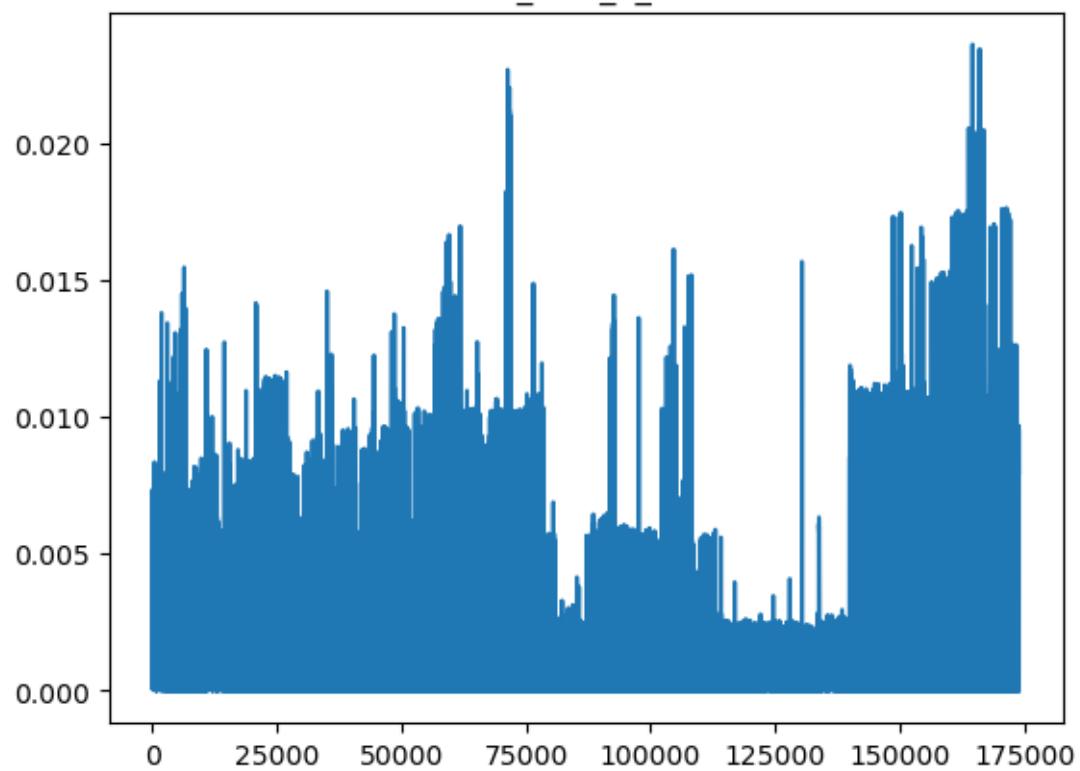
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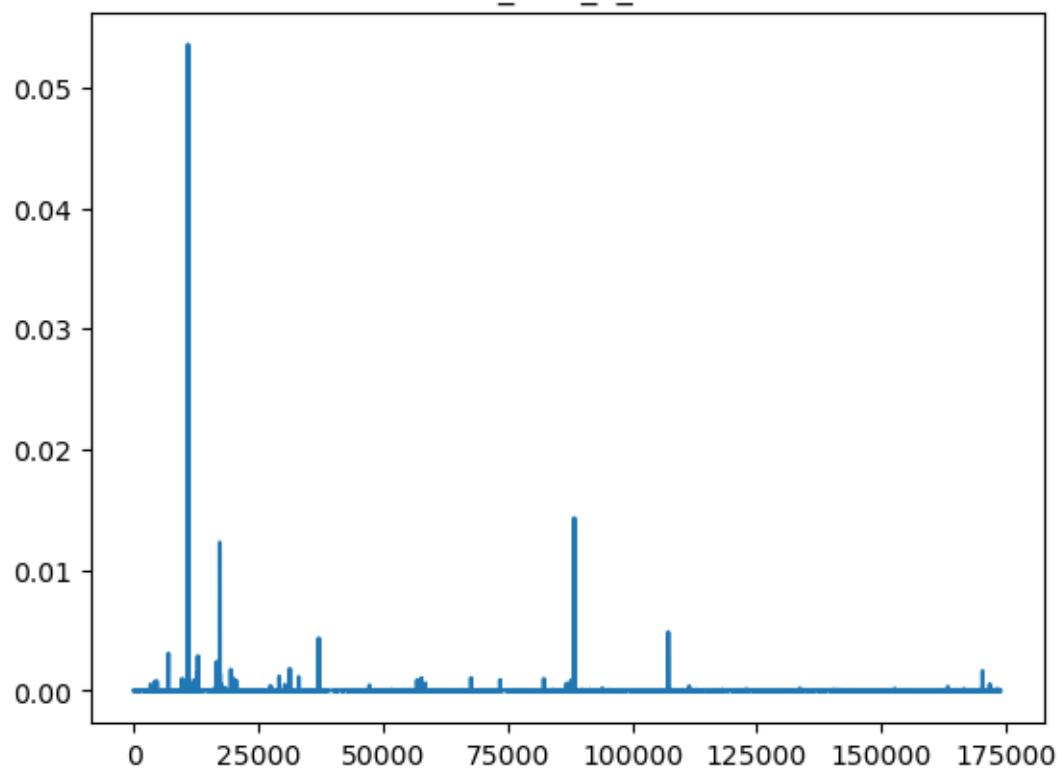
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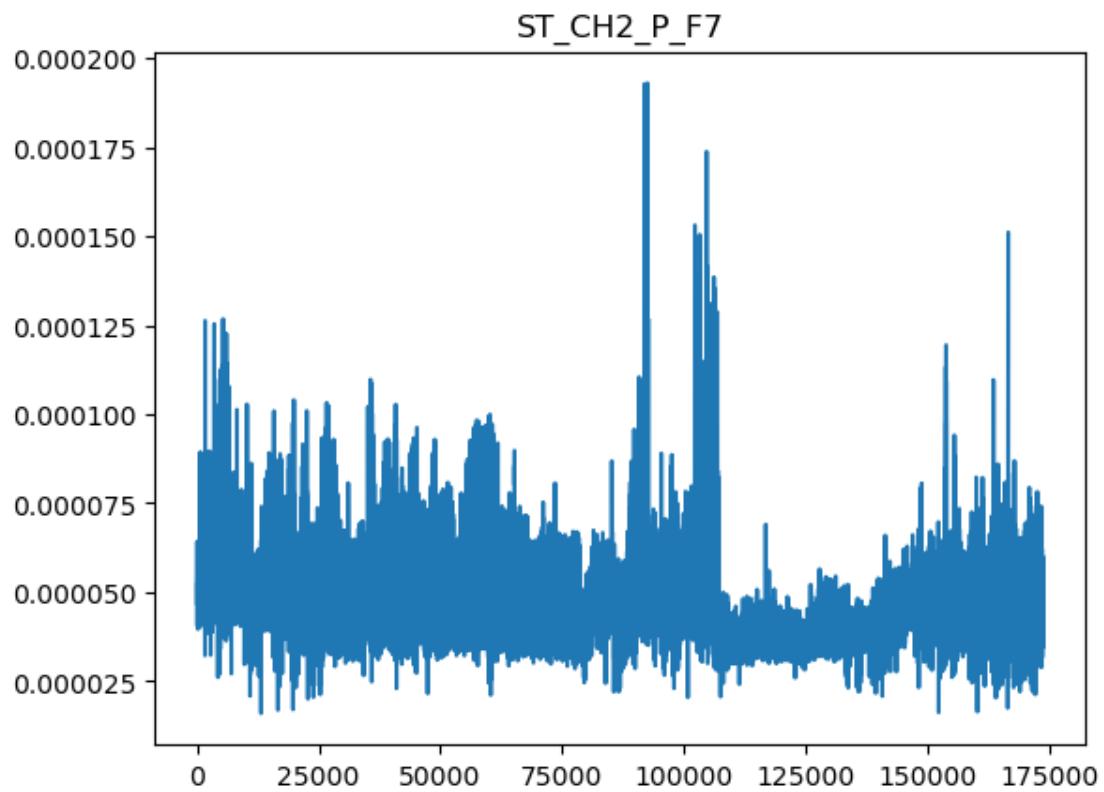


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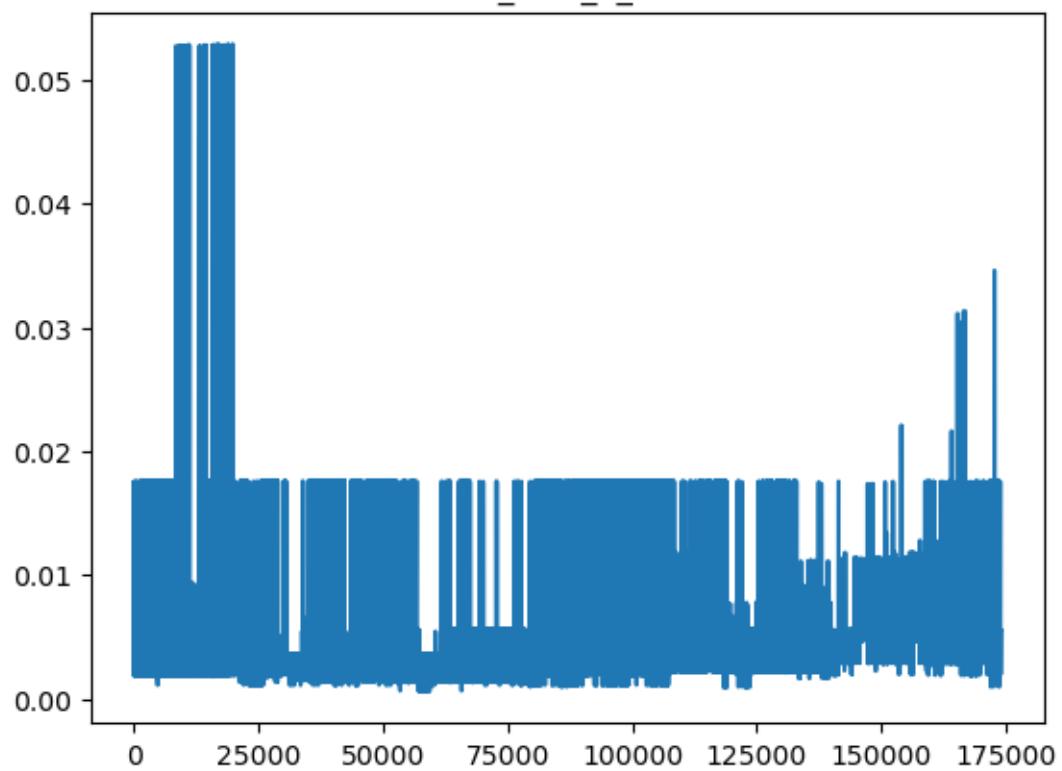


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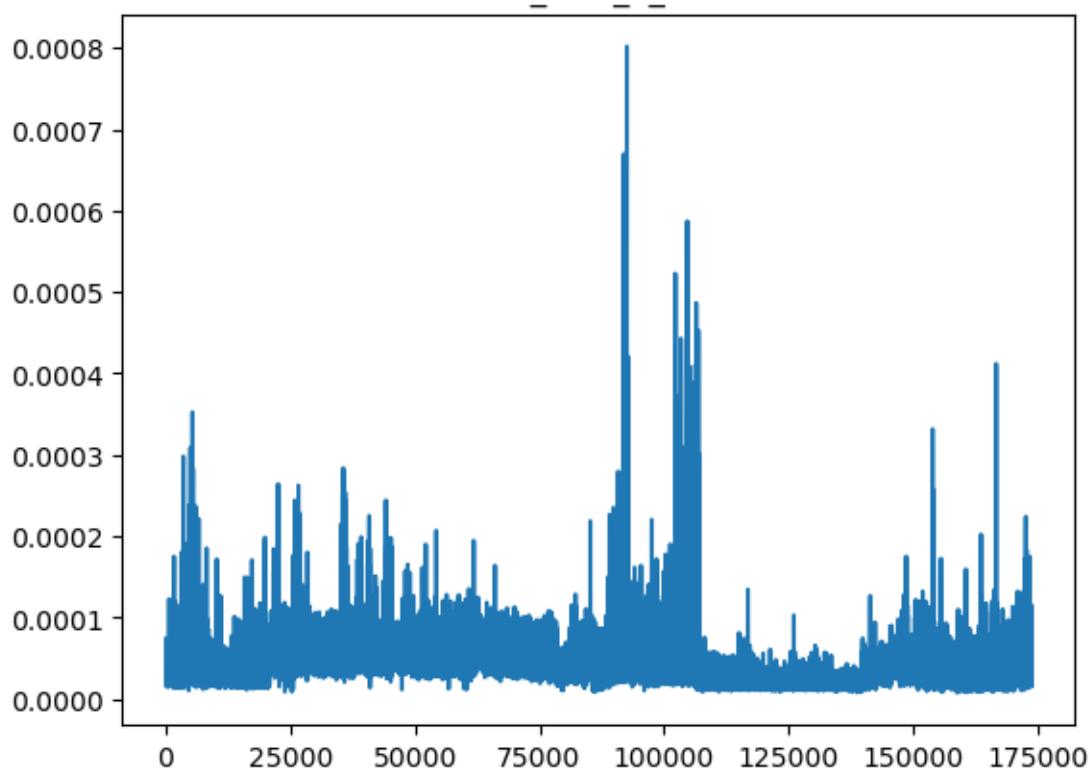




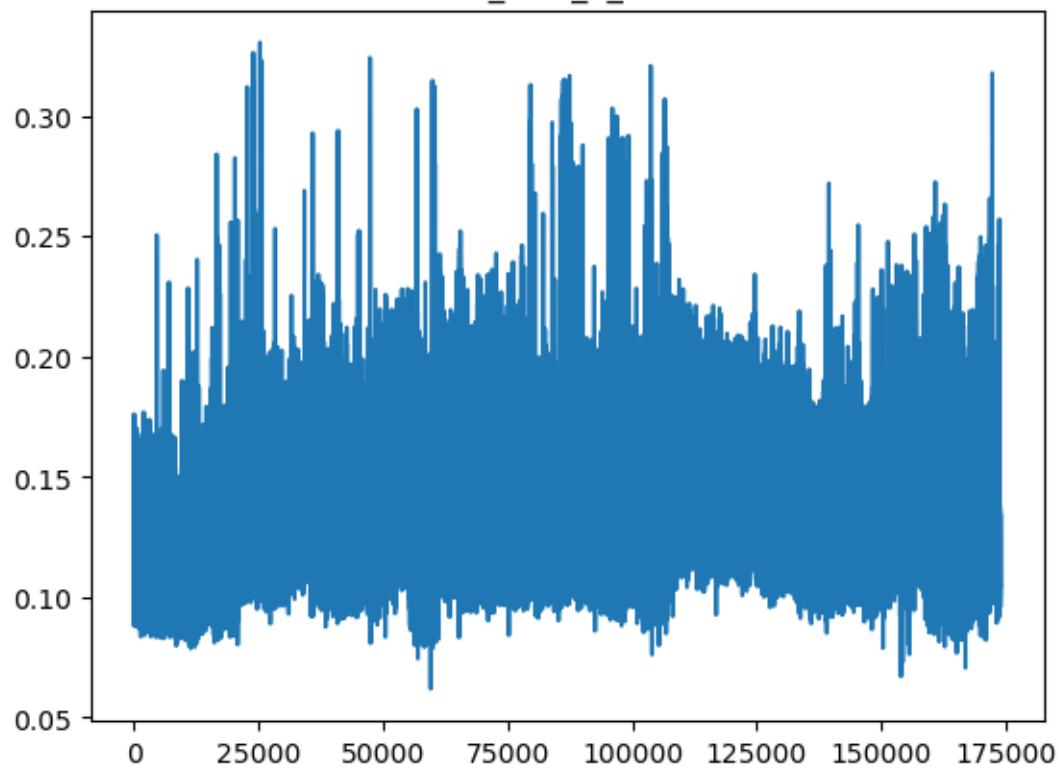
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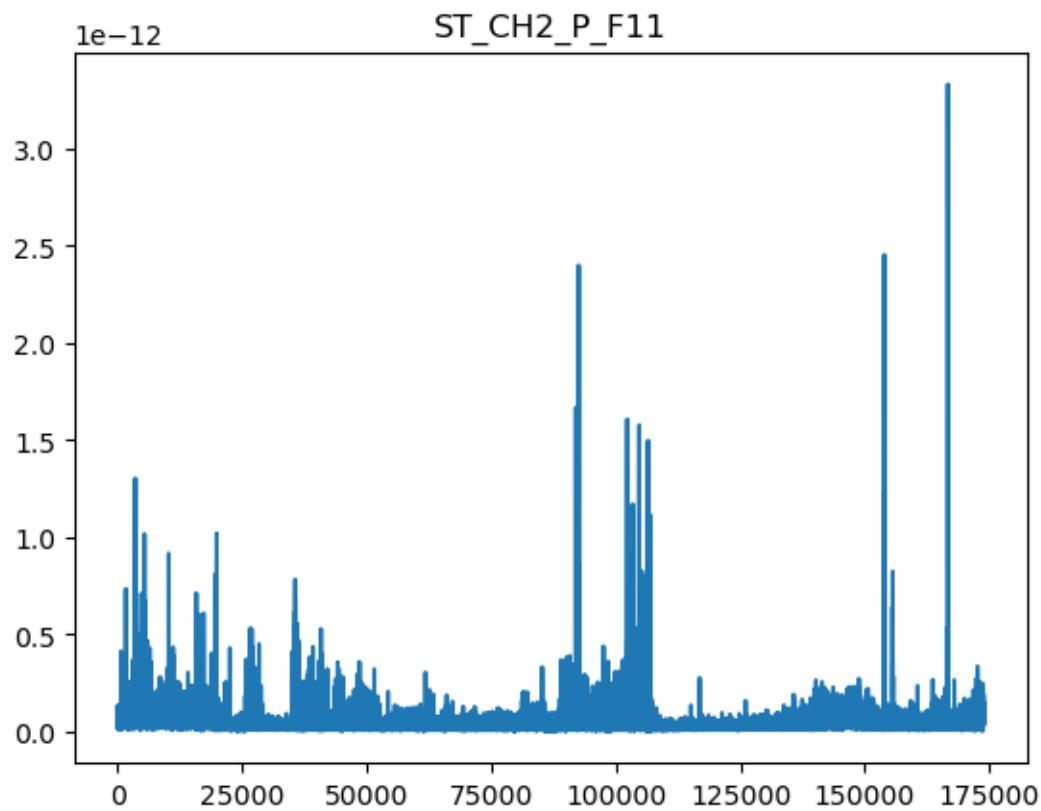


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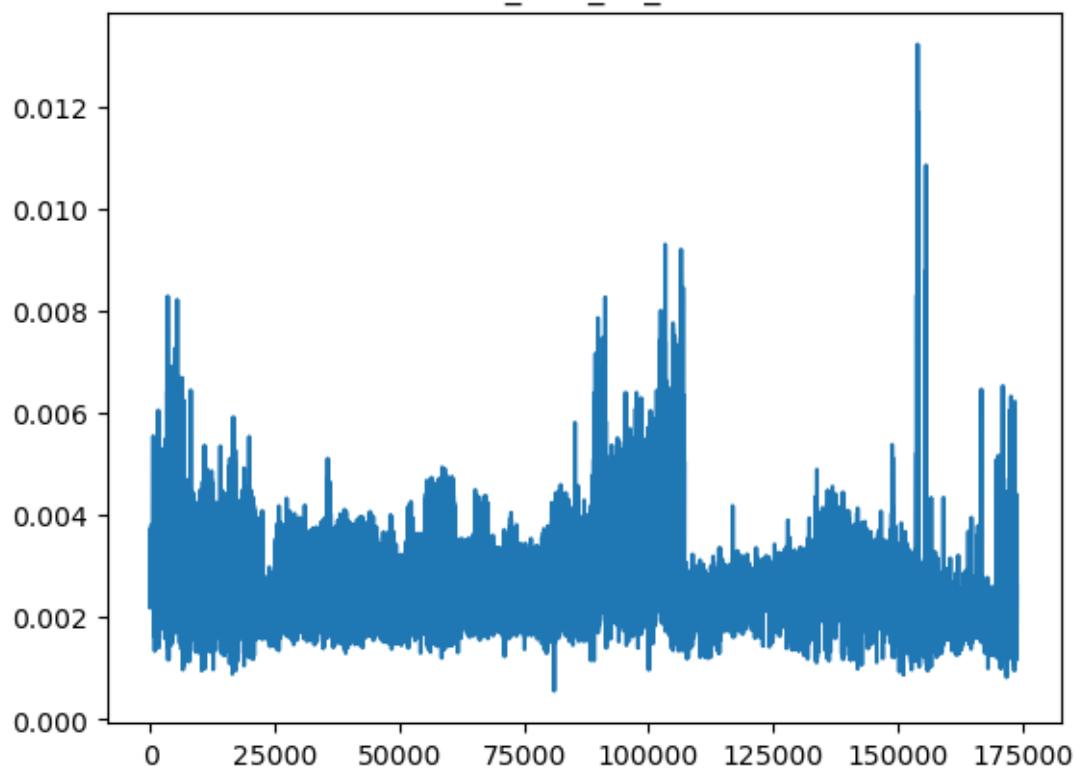


ST\_CH2\_P\_F10

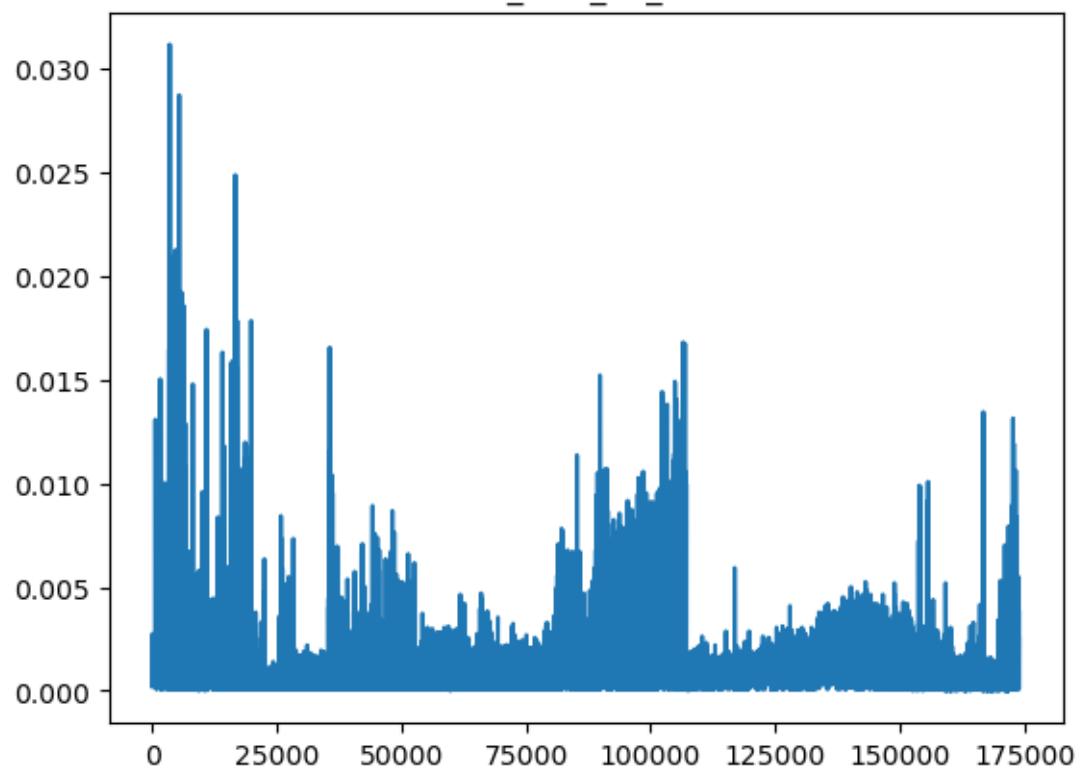




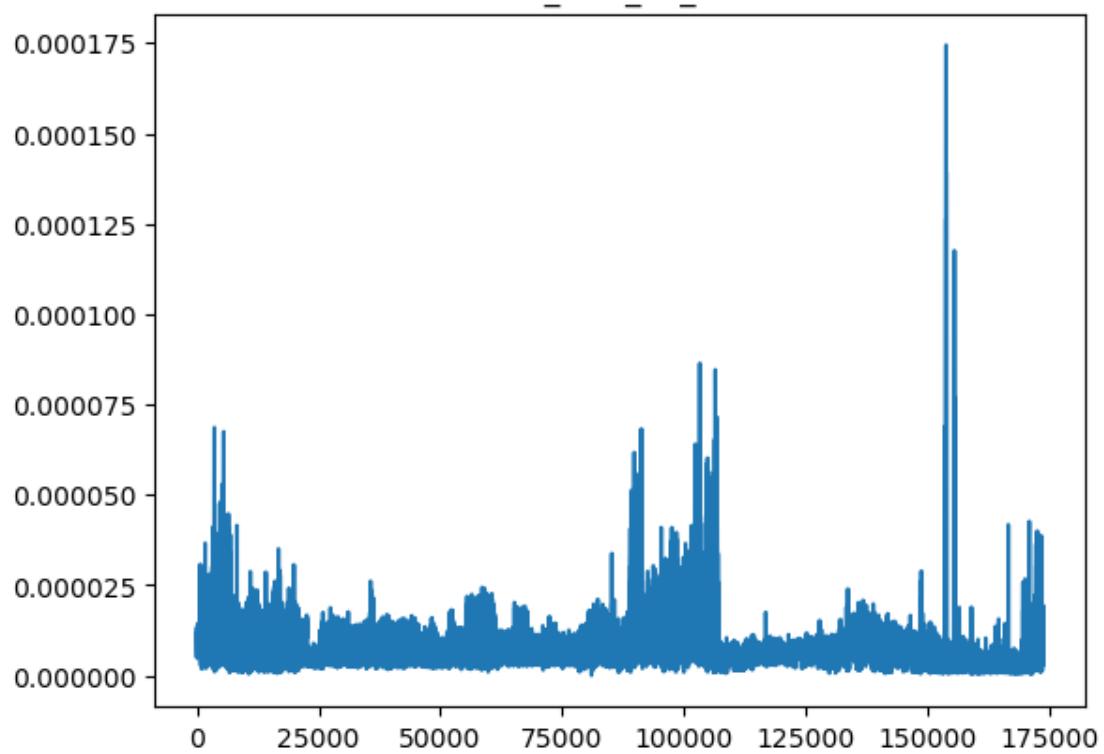
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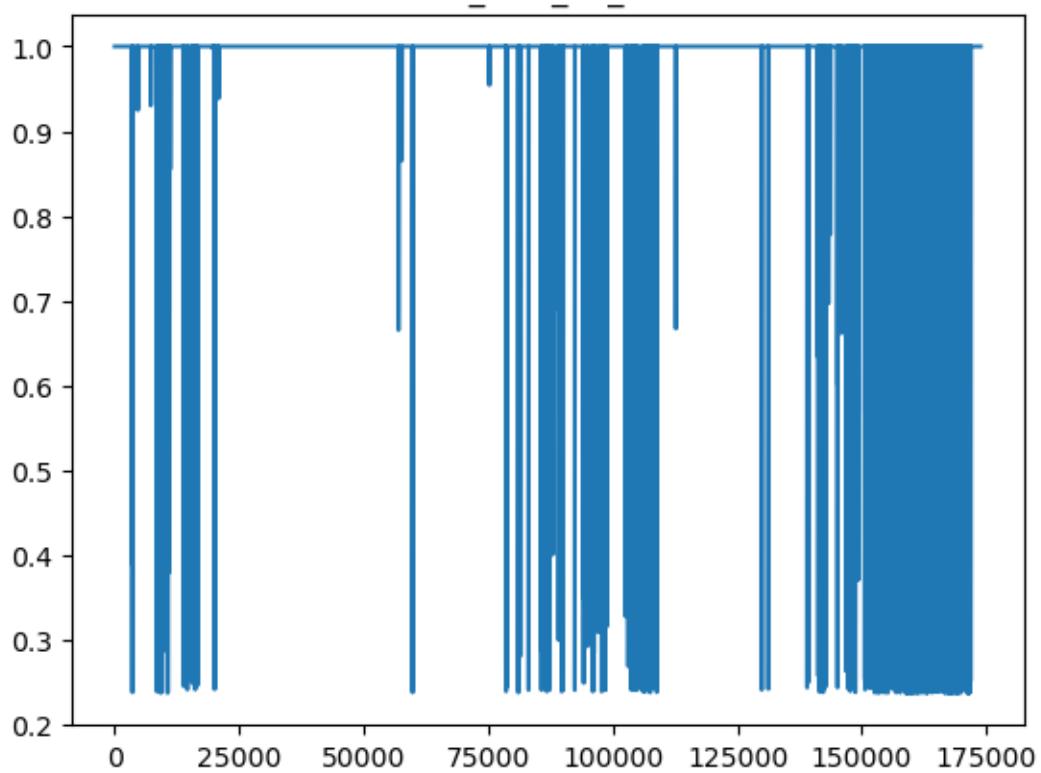
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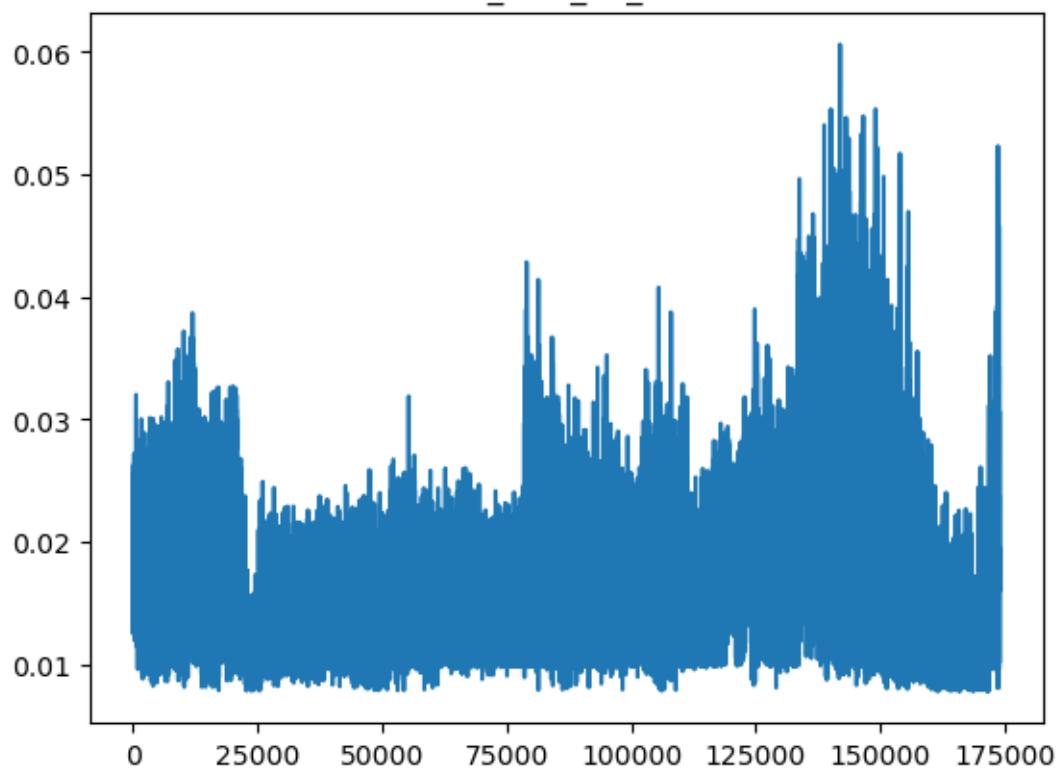
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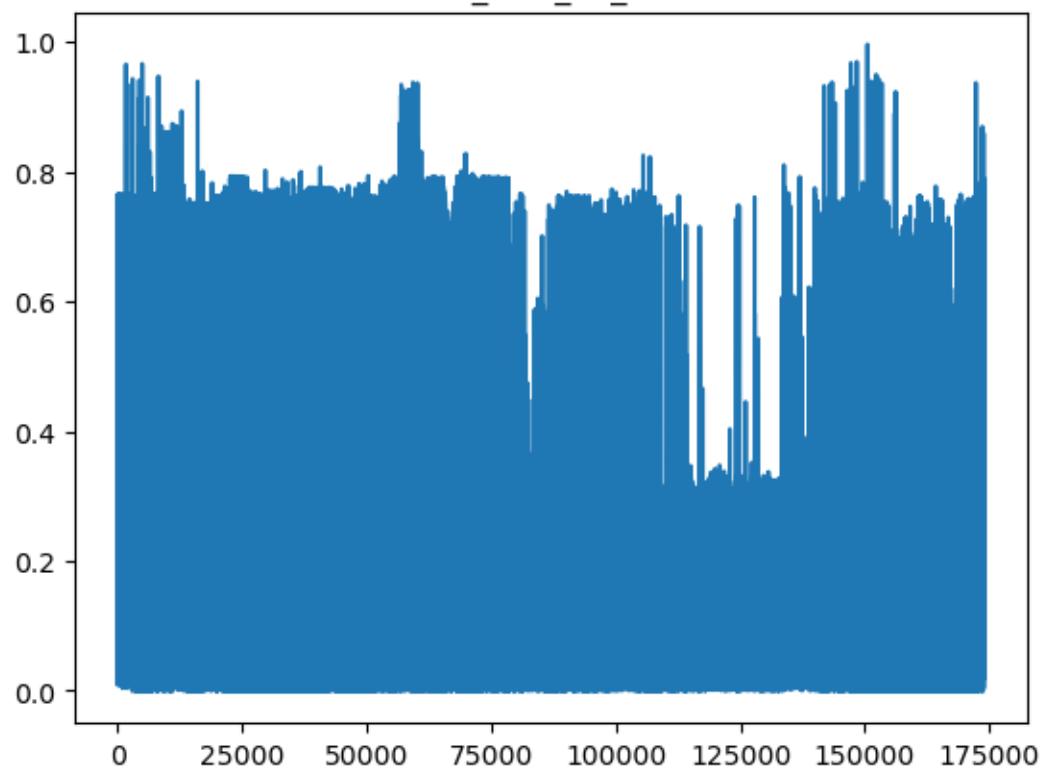
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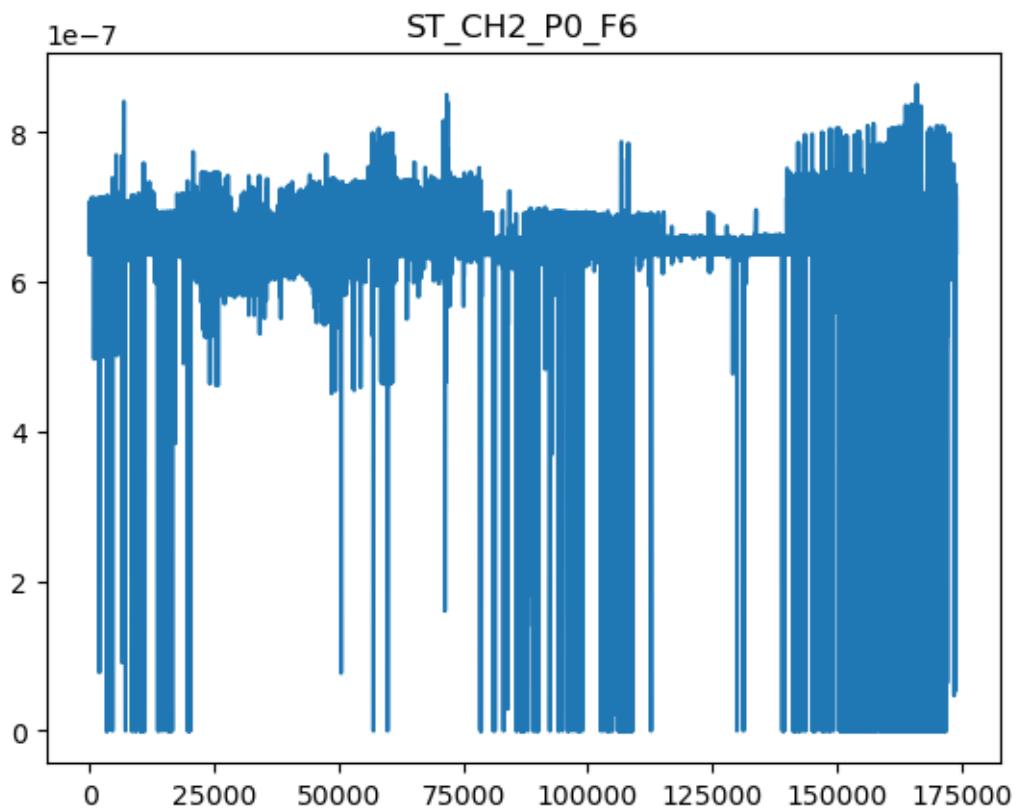


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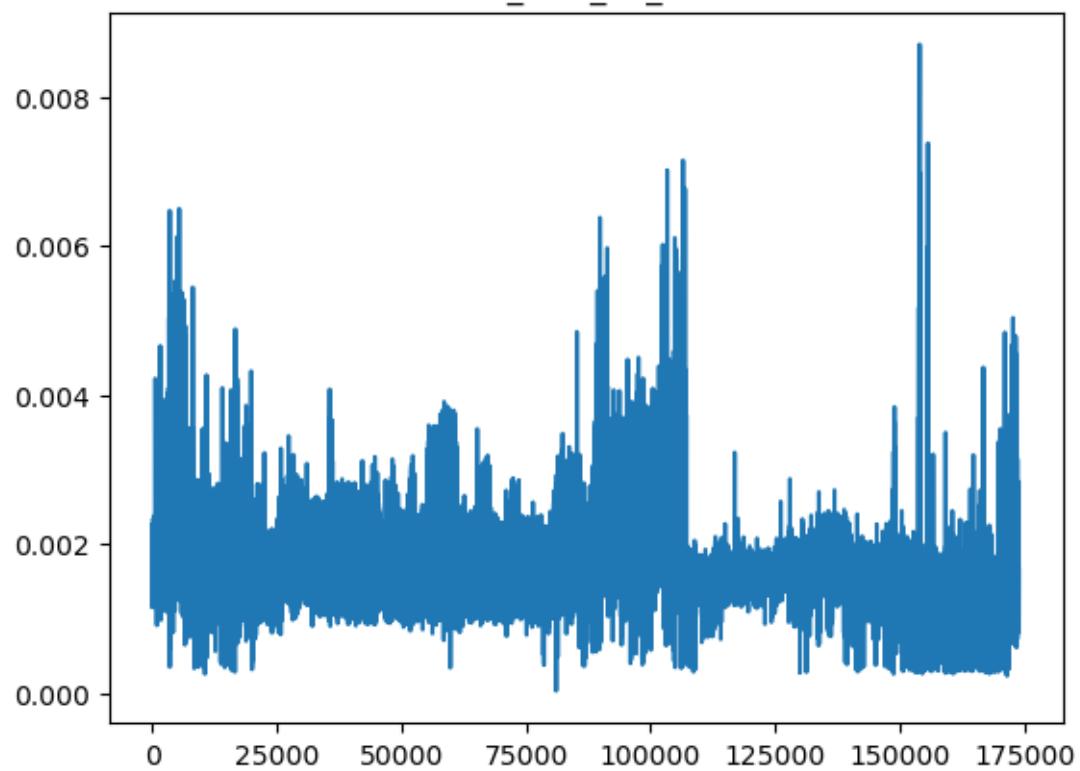


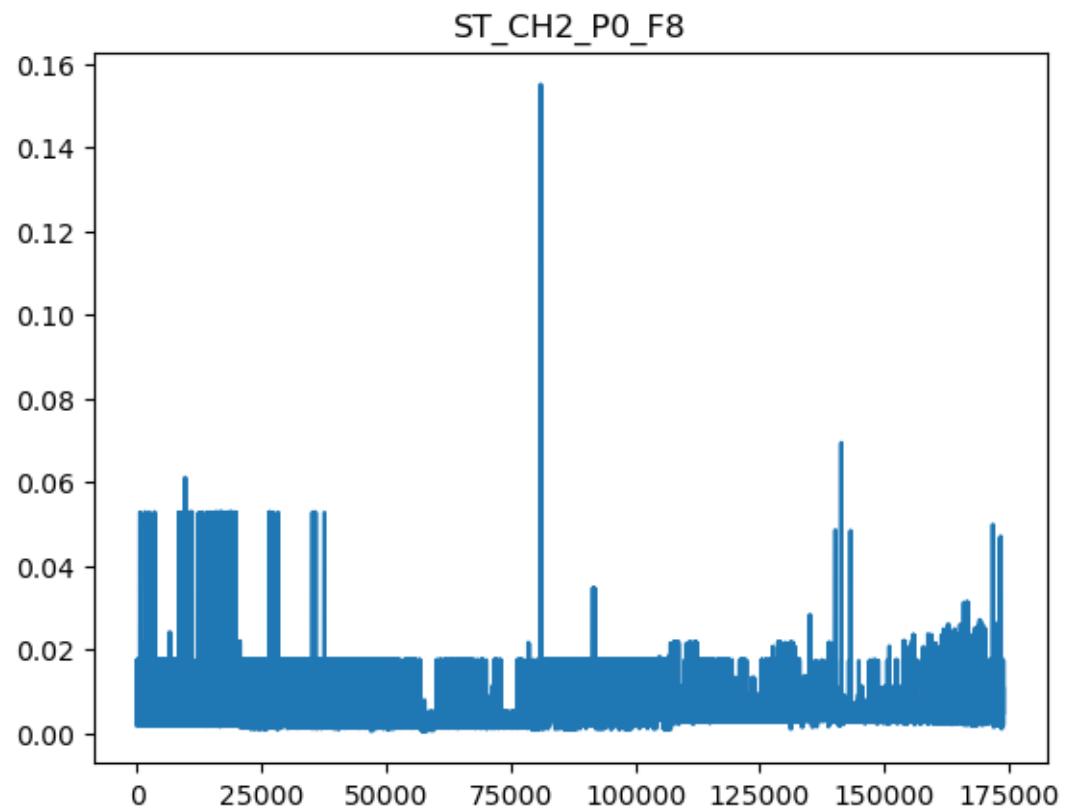
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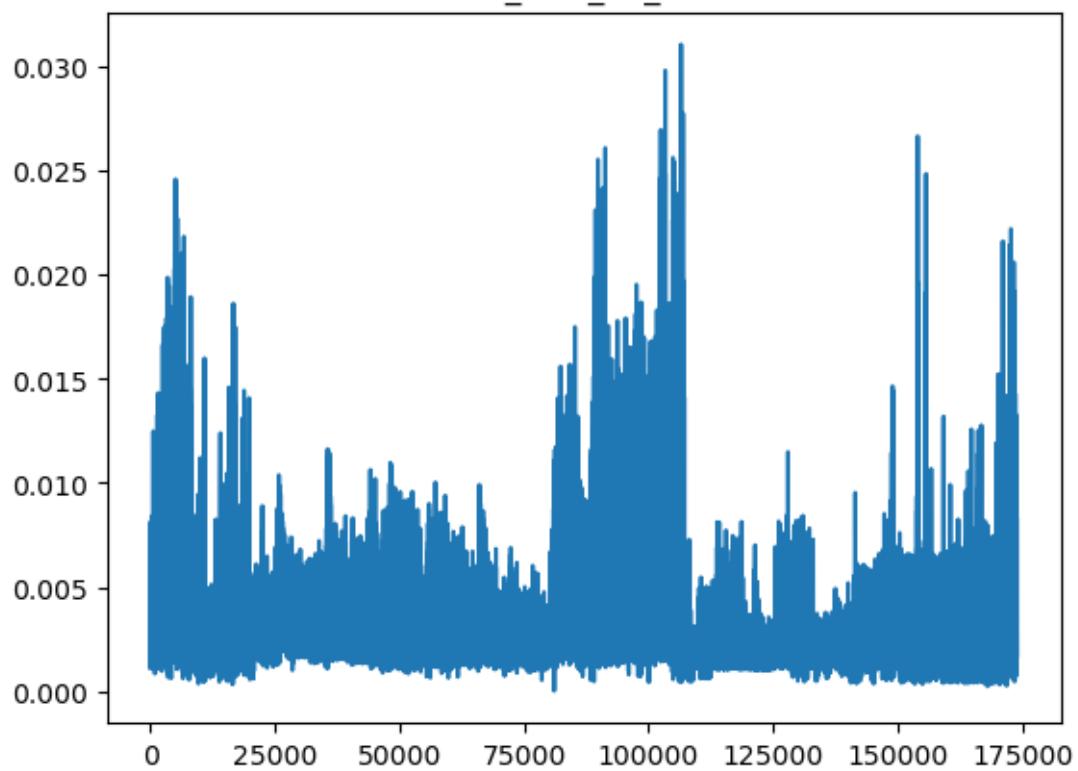


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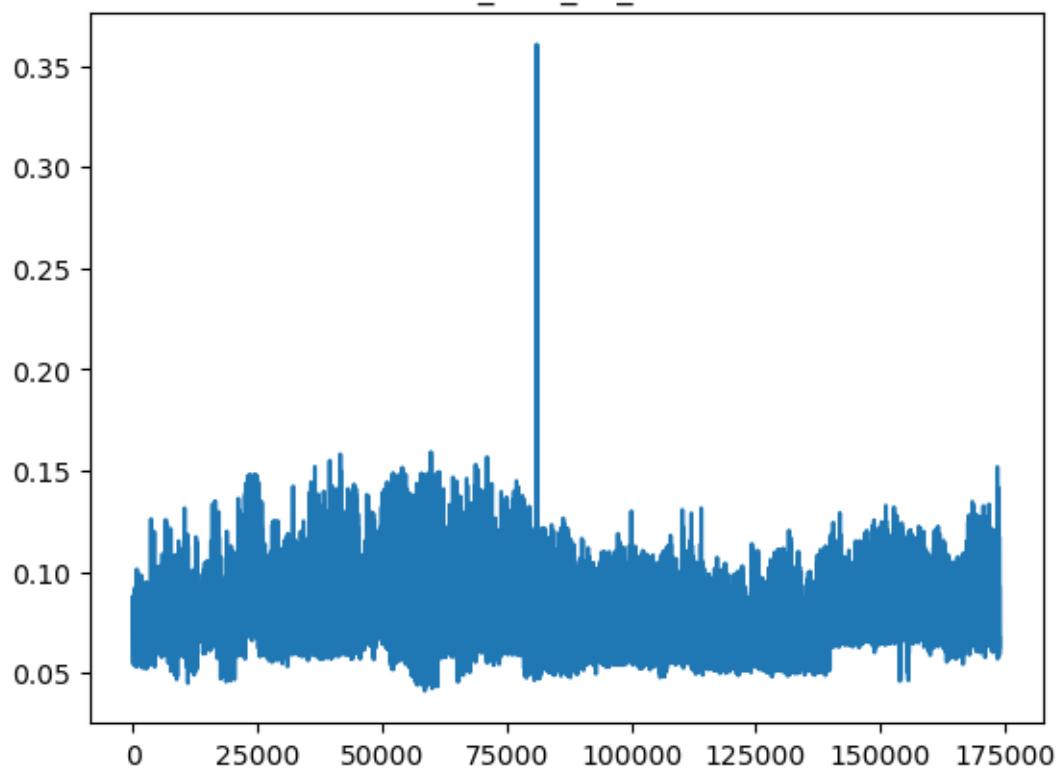


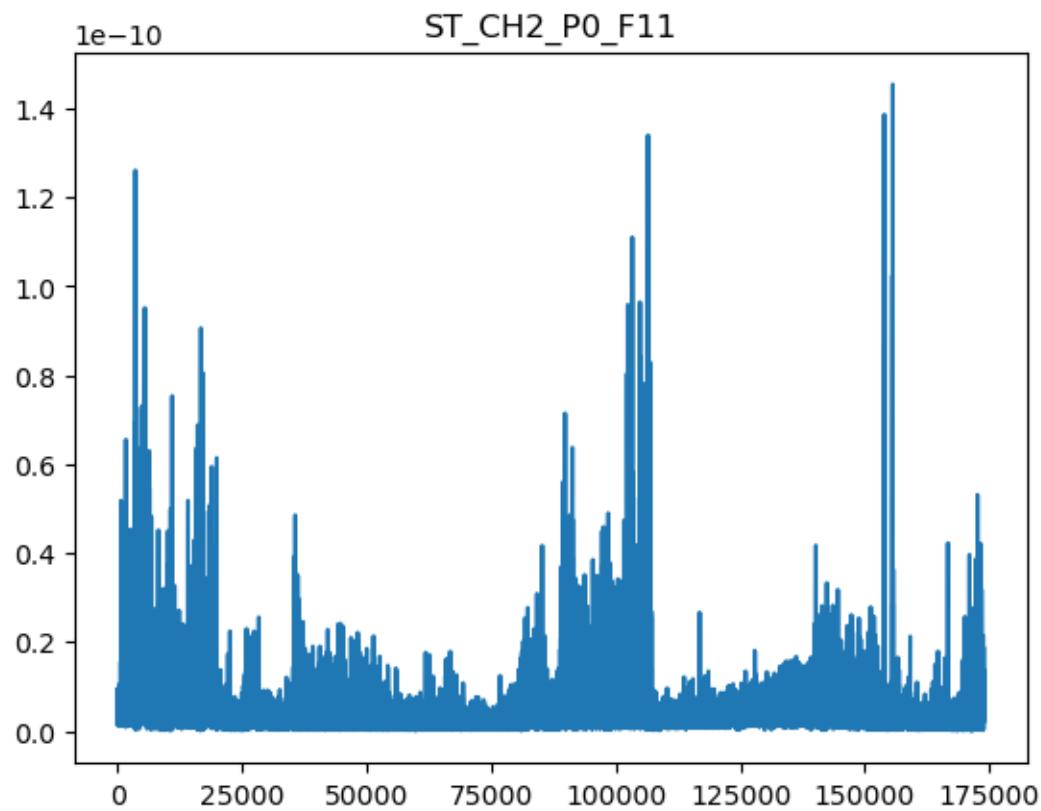


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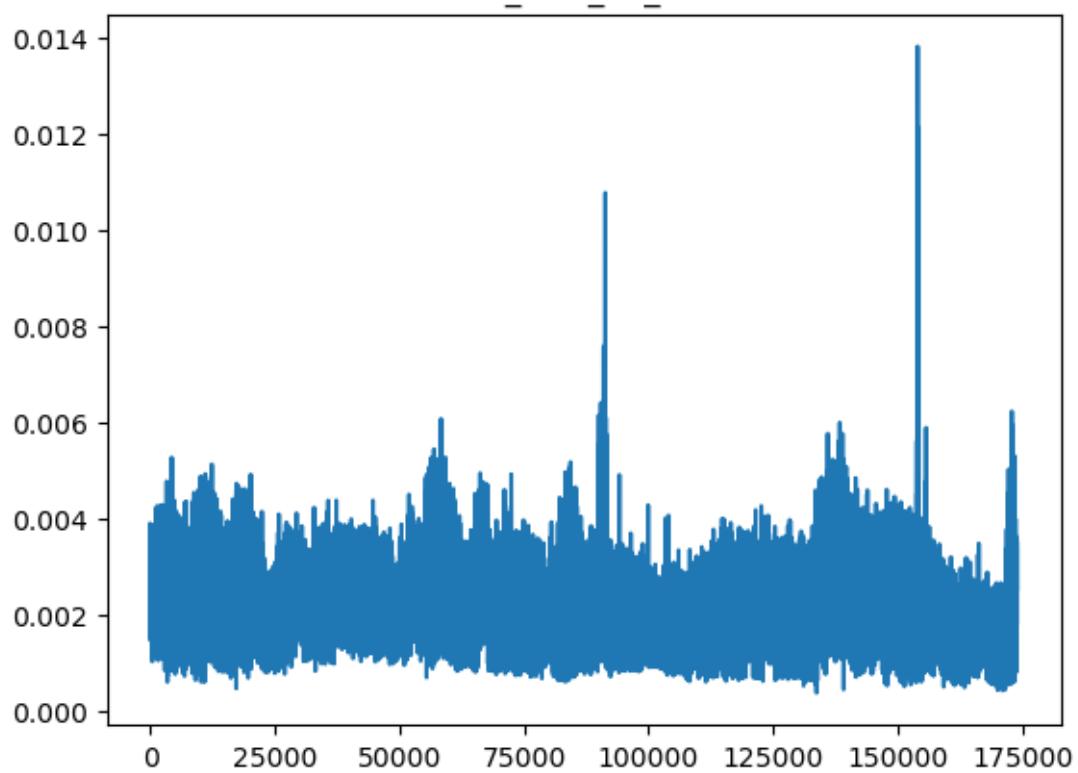


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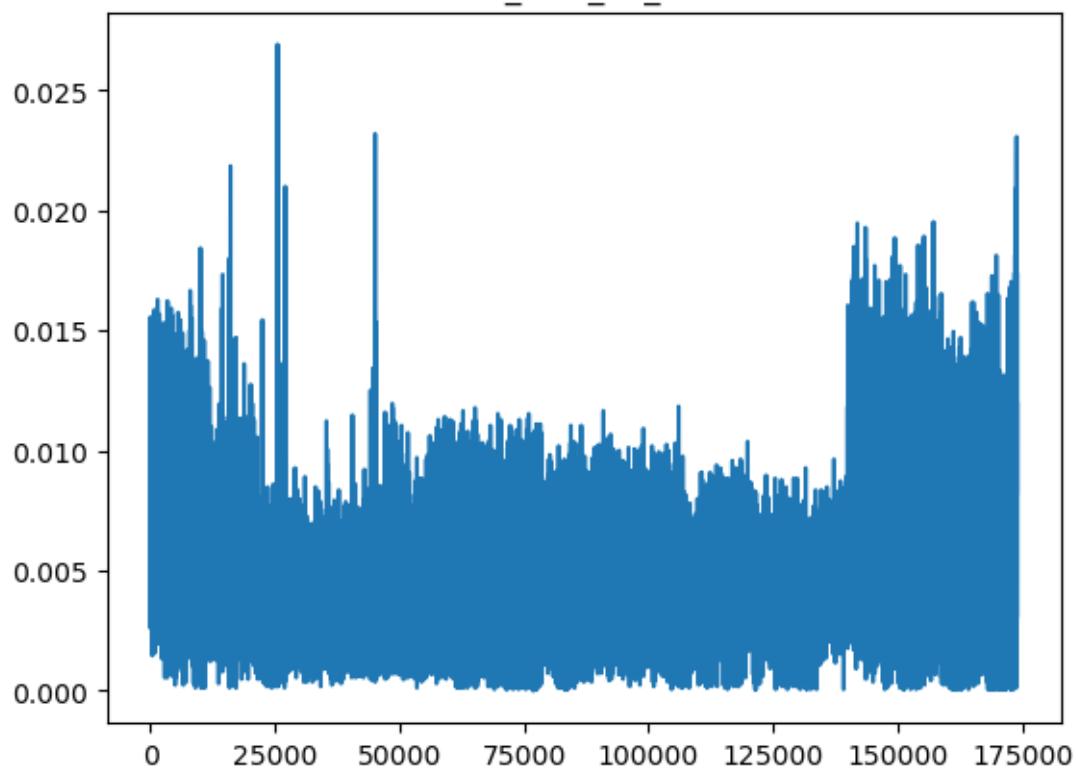


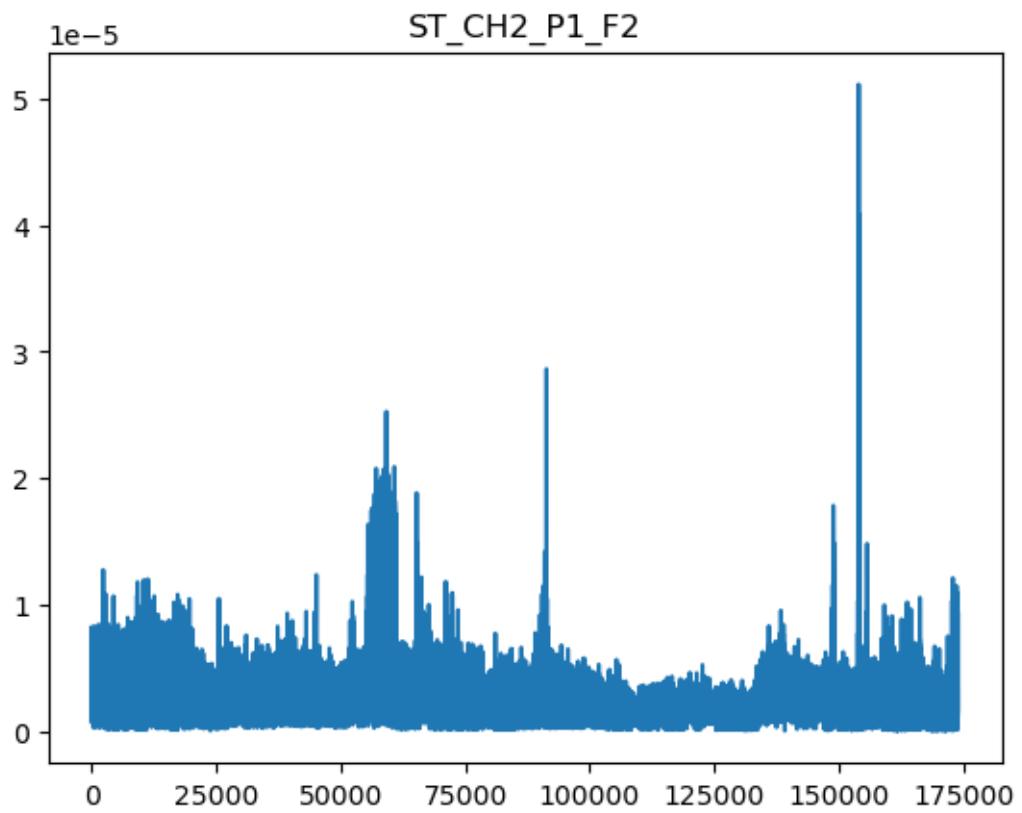


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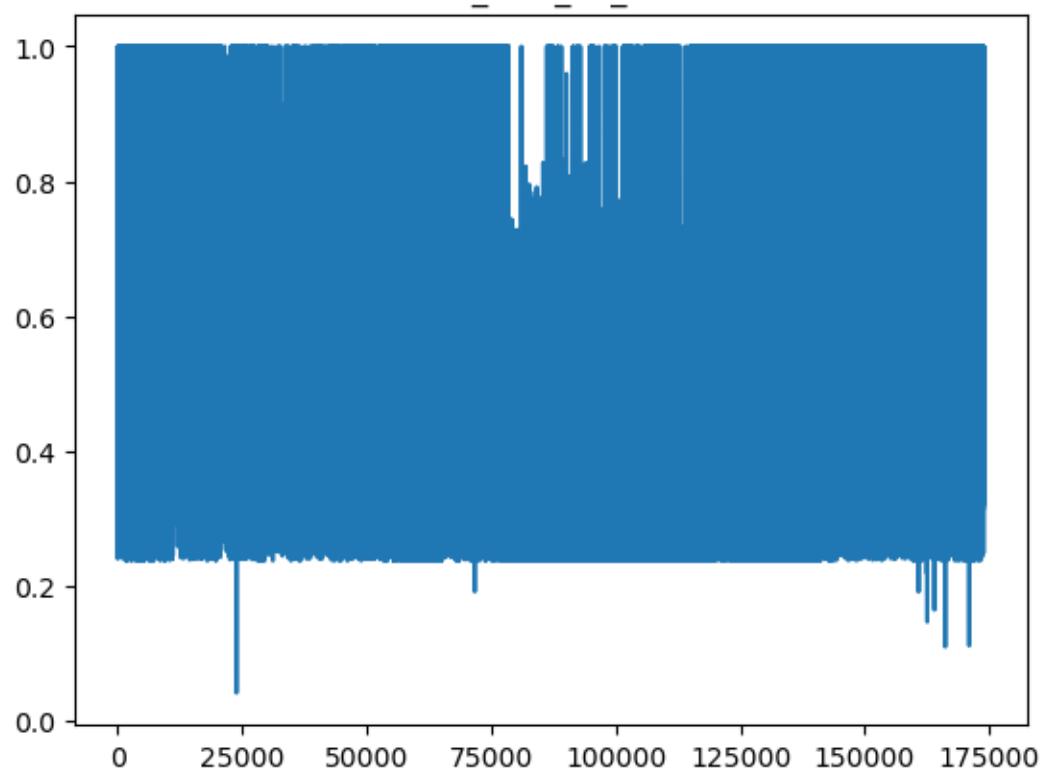


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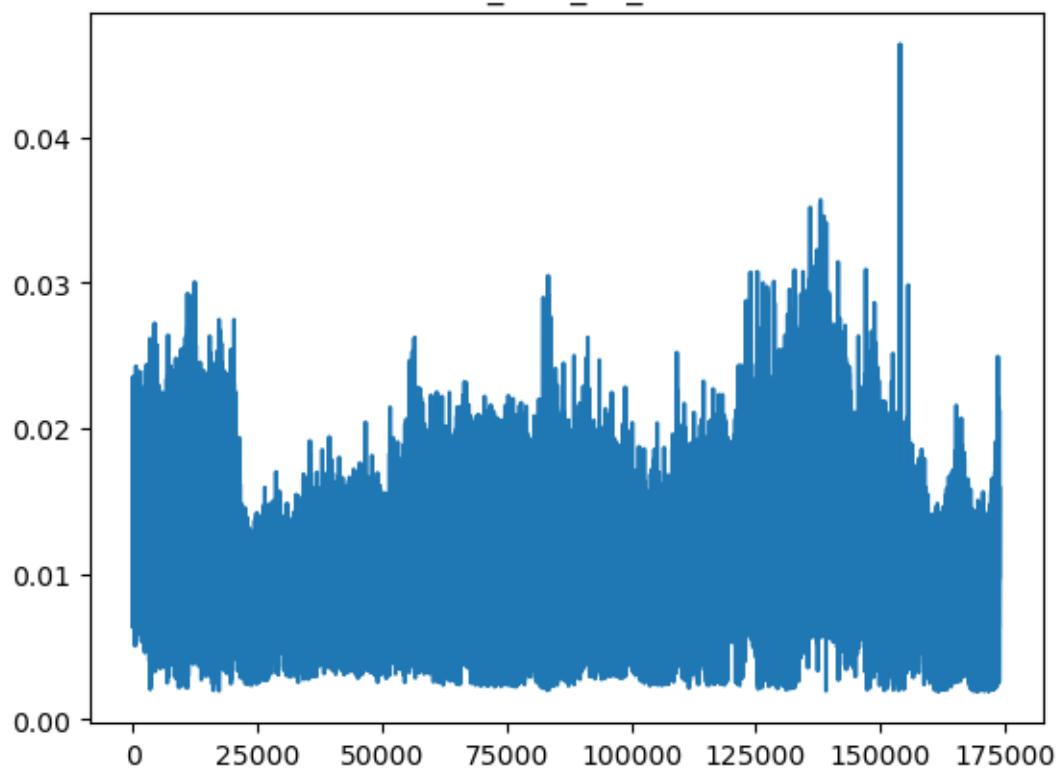




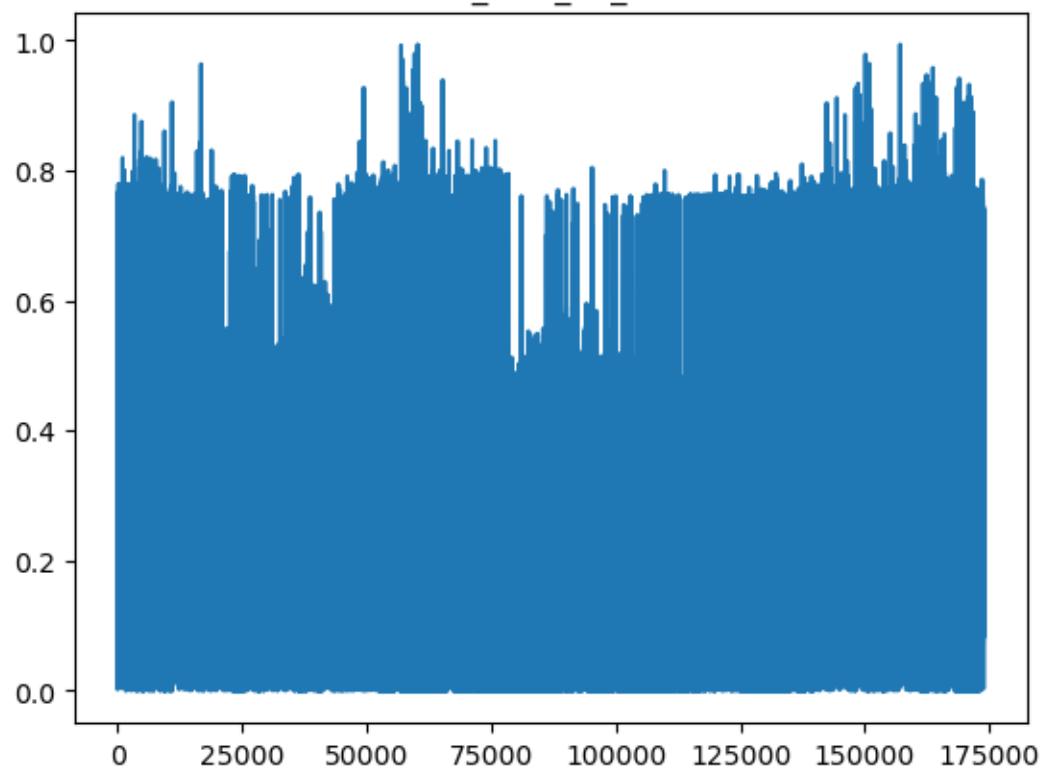
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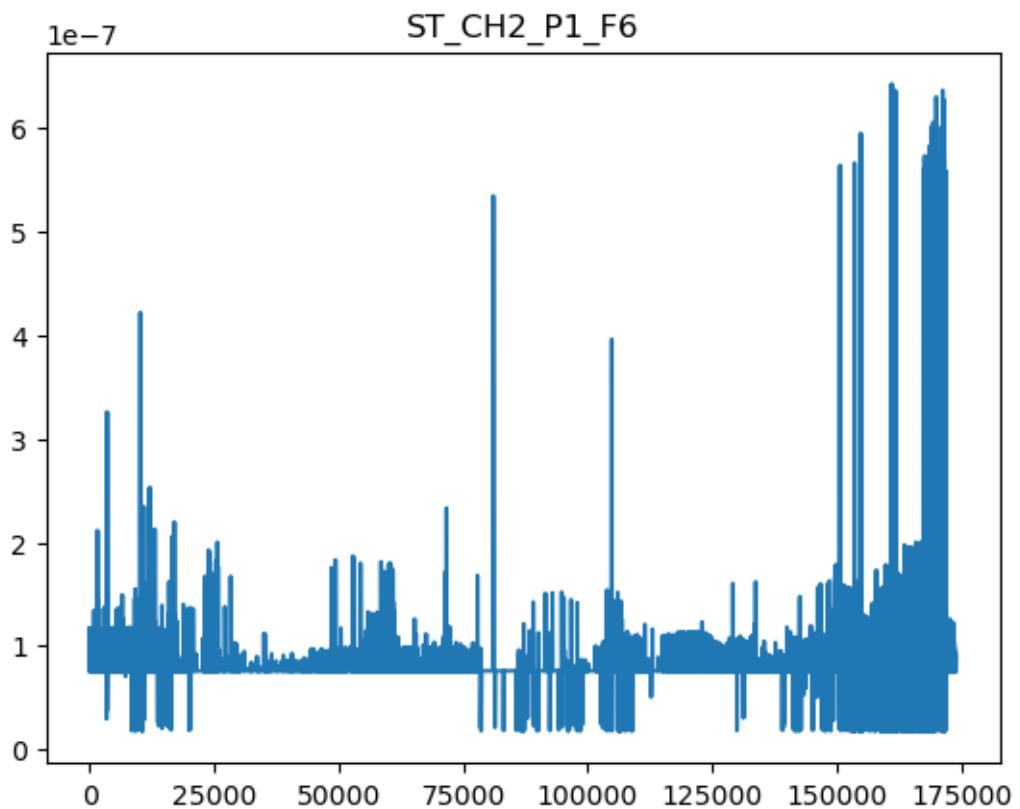


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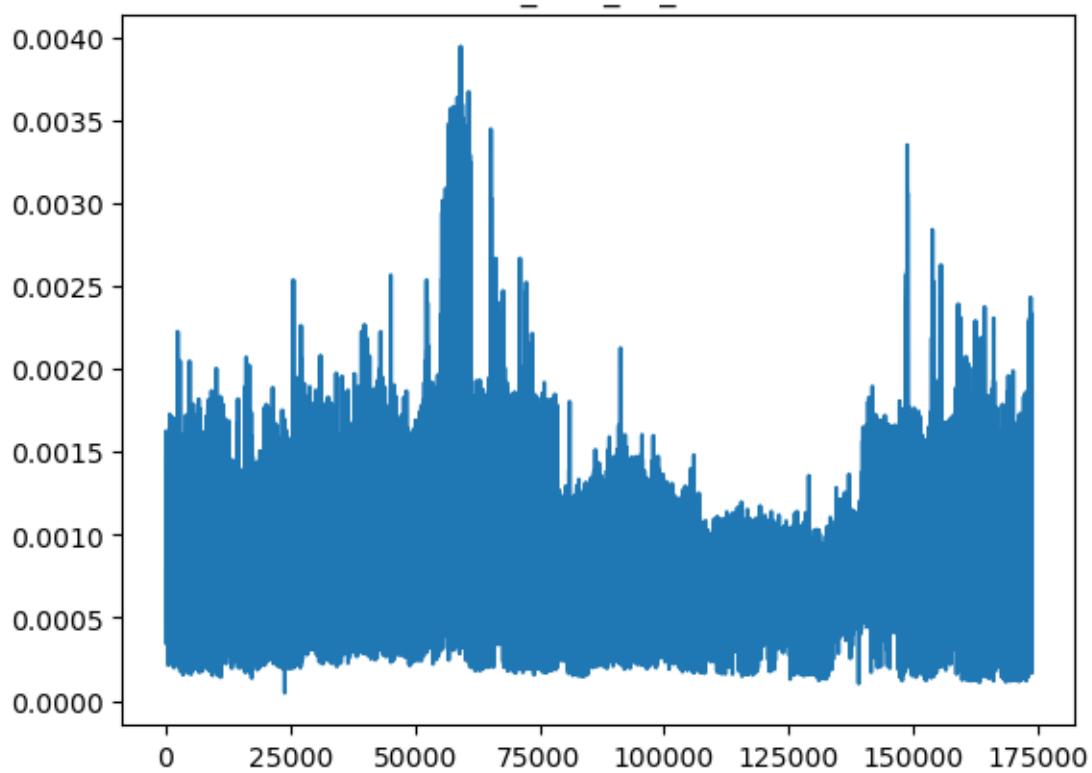


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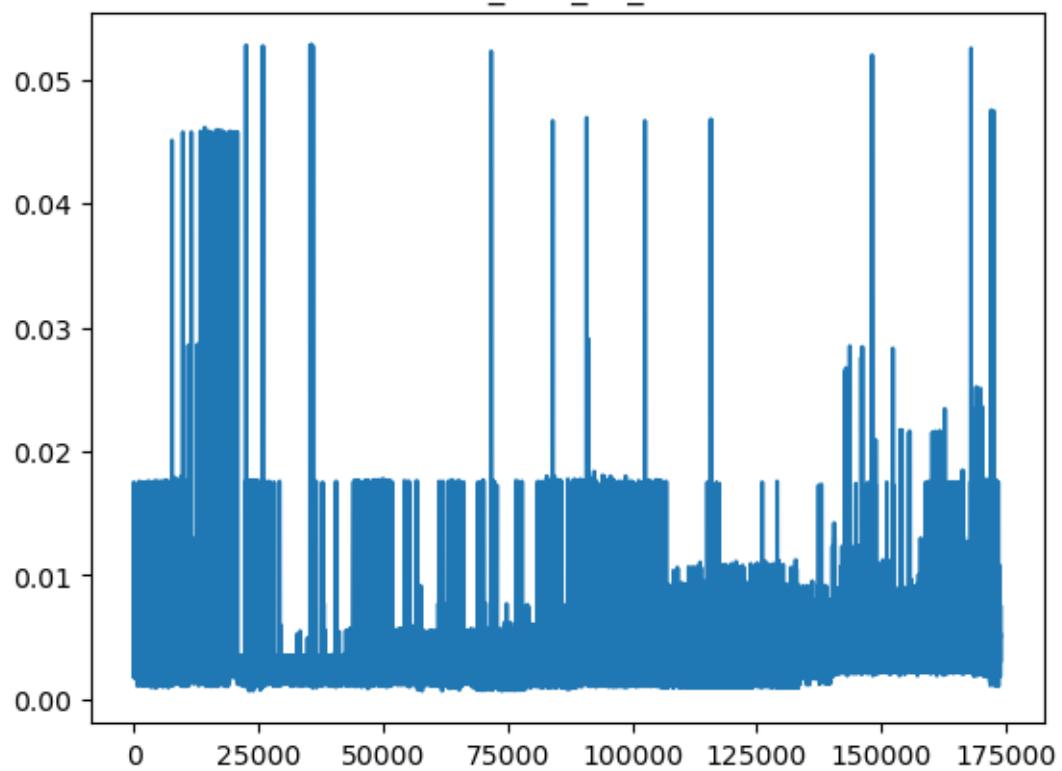




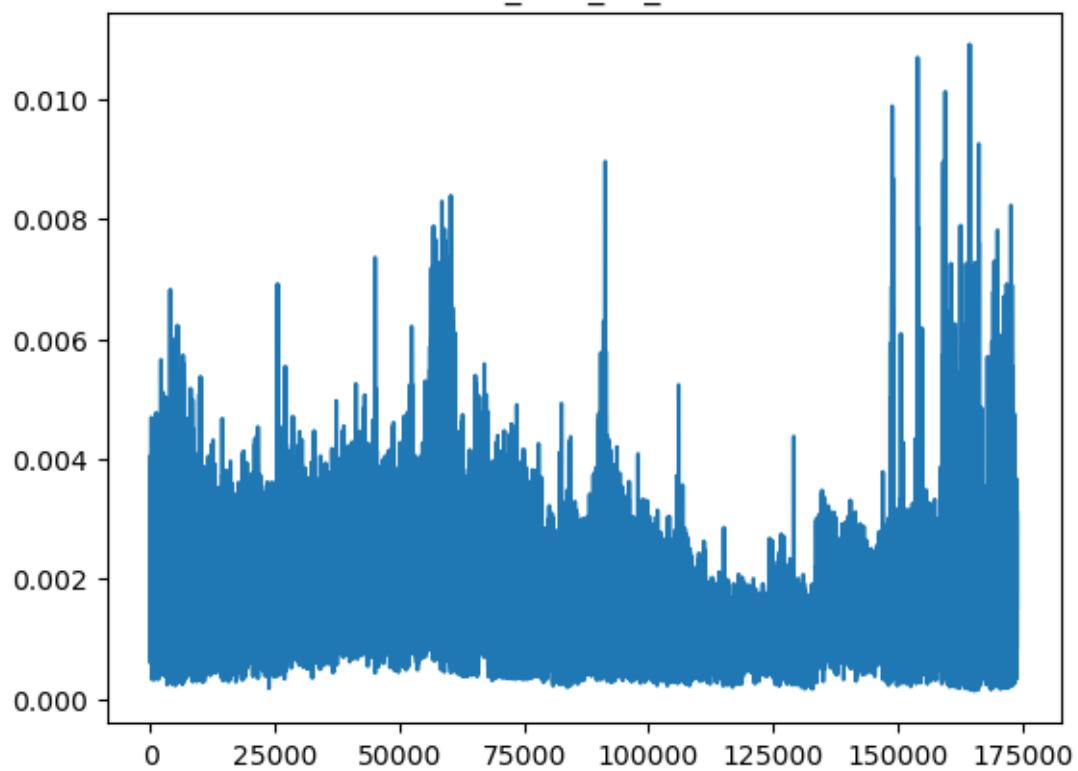
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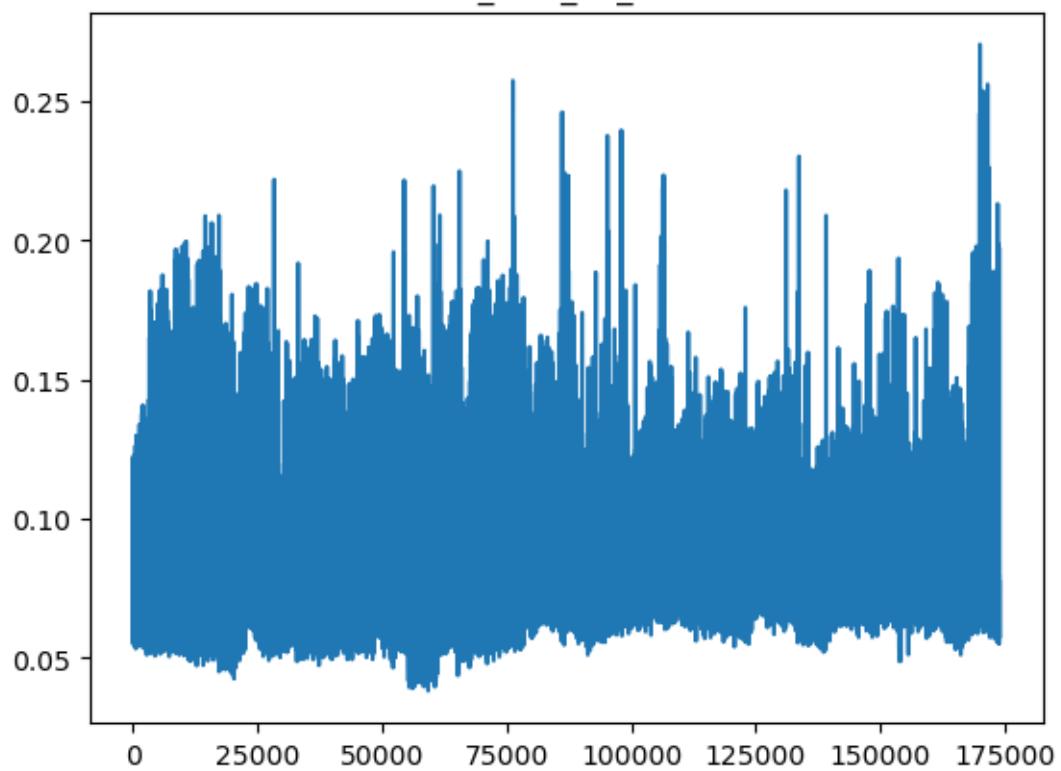
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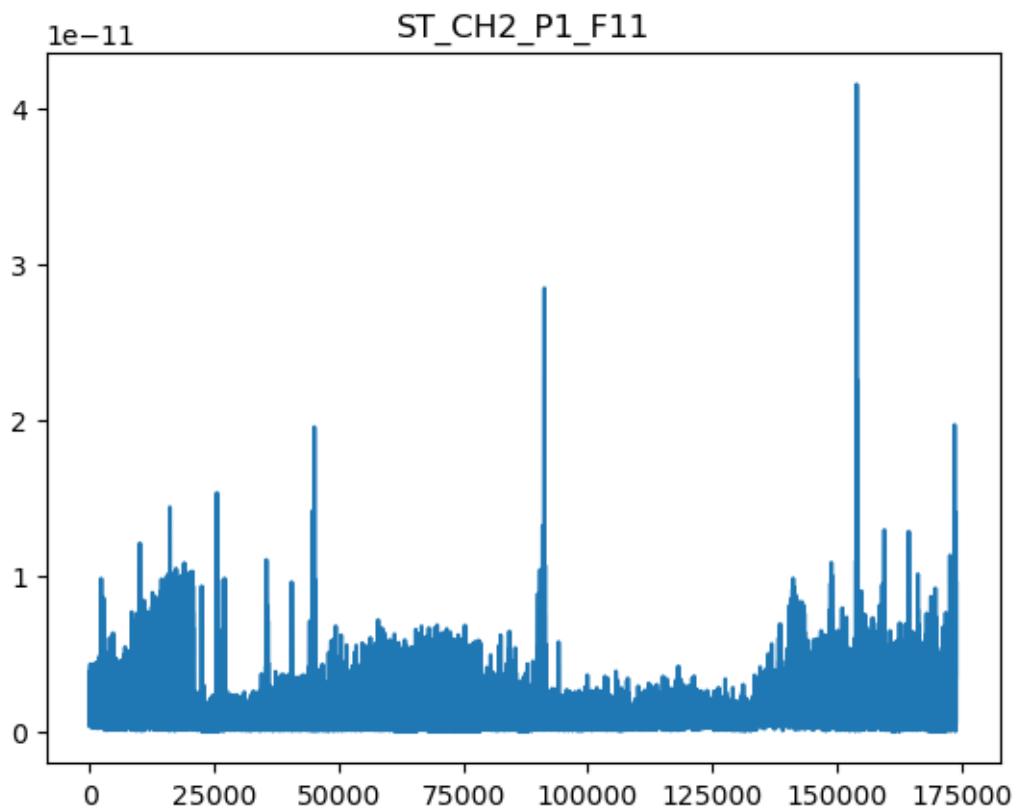


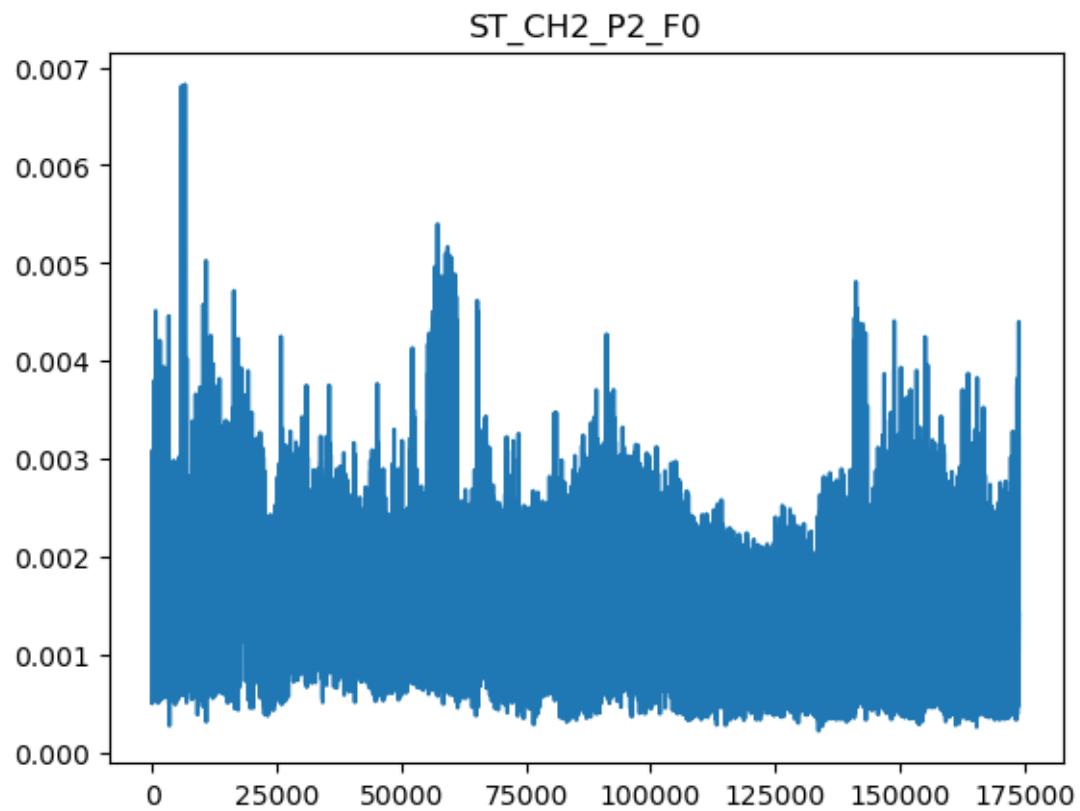
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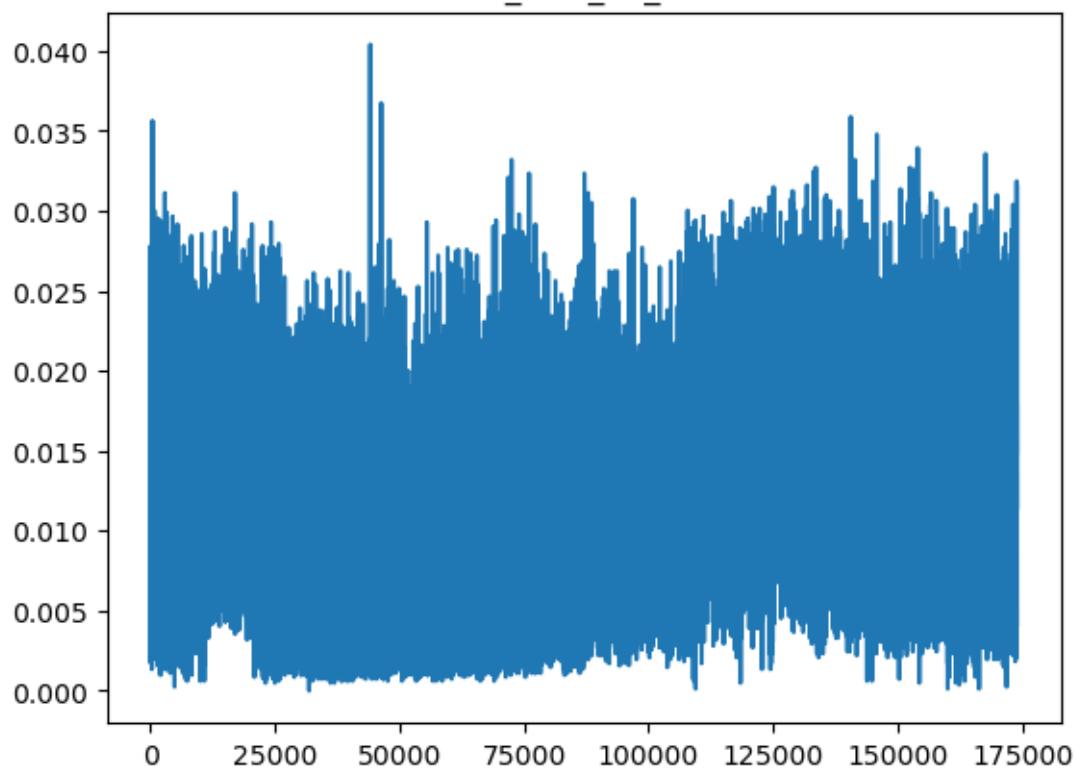
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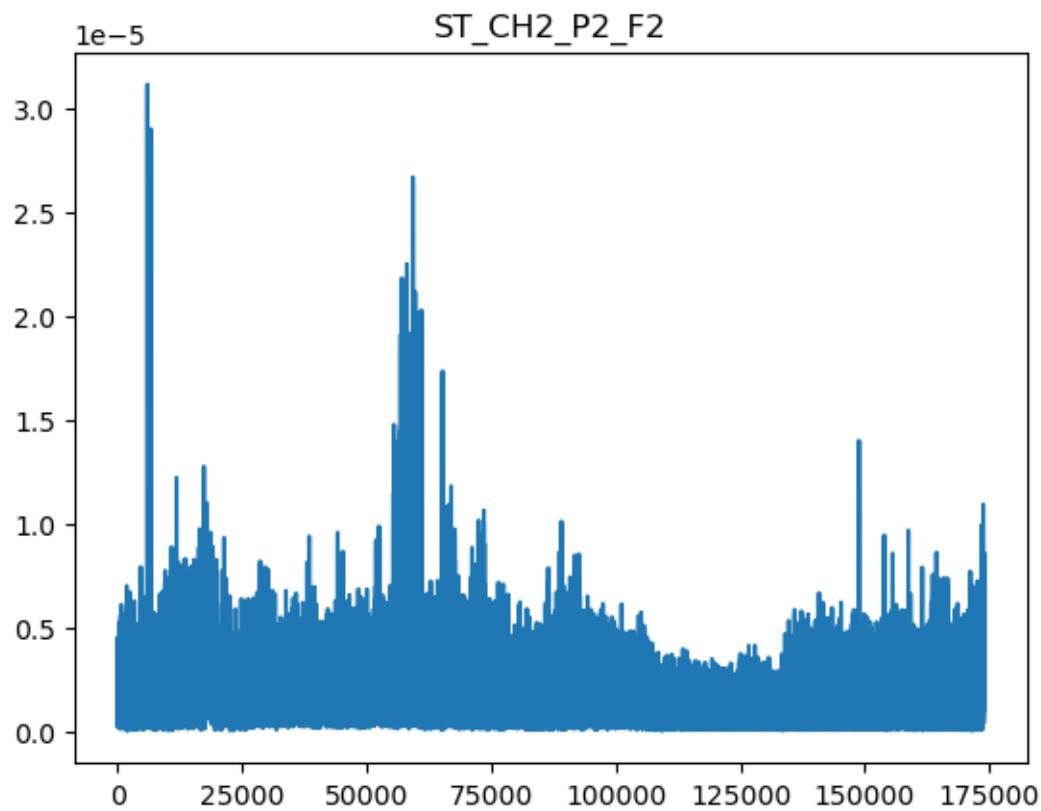




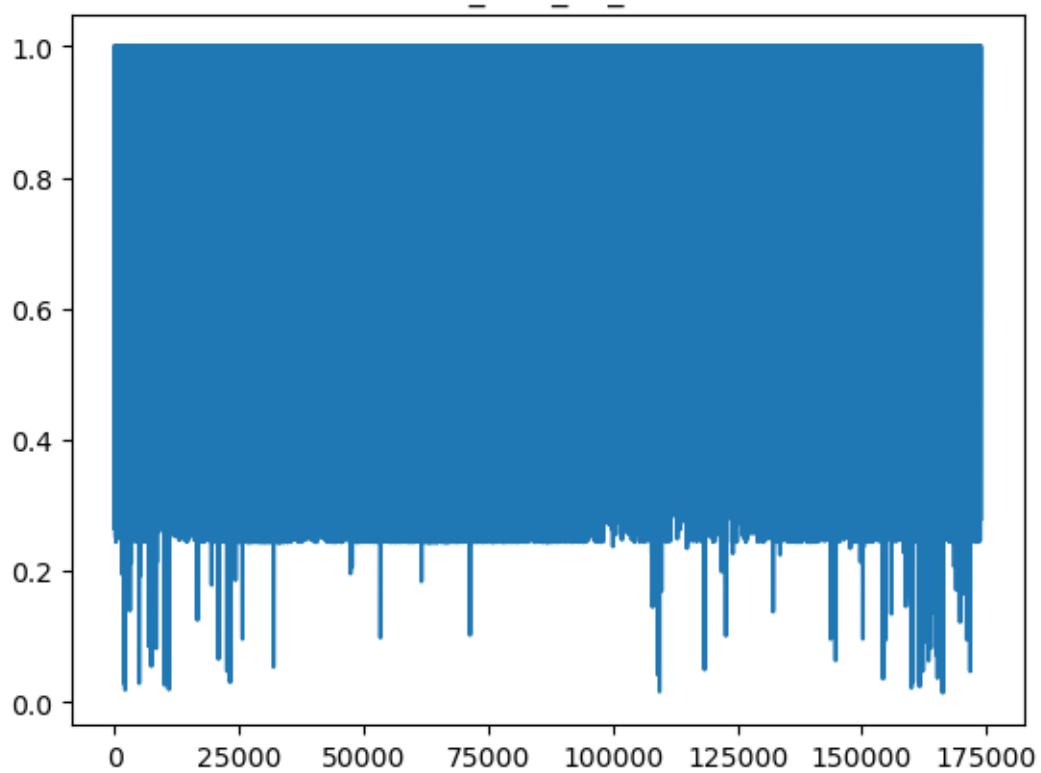


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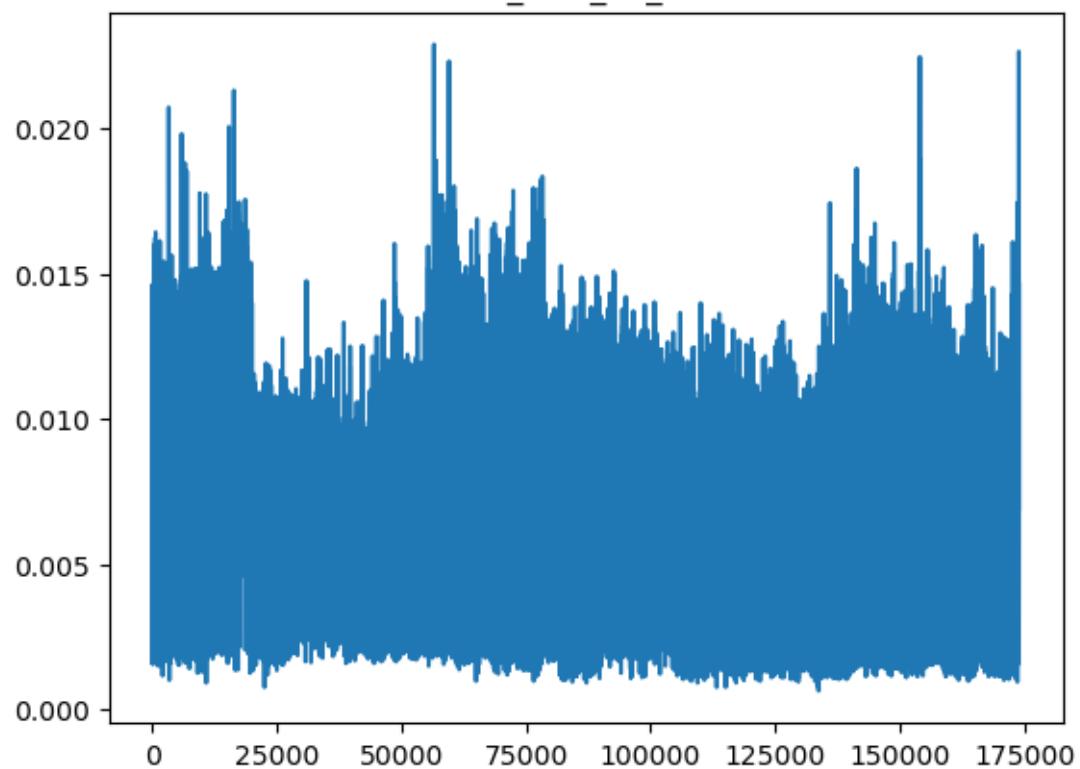




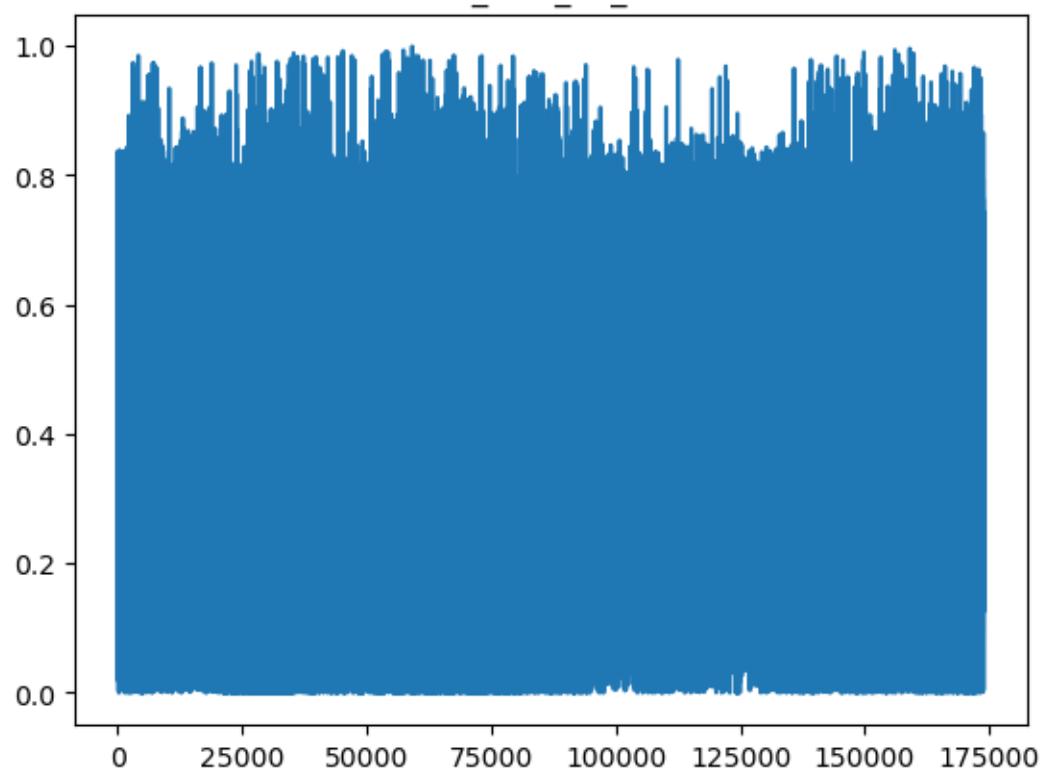
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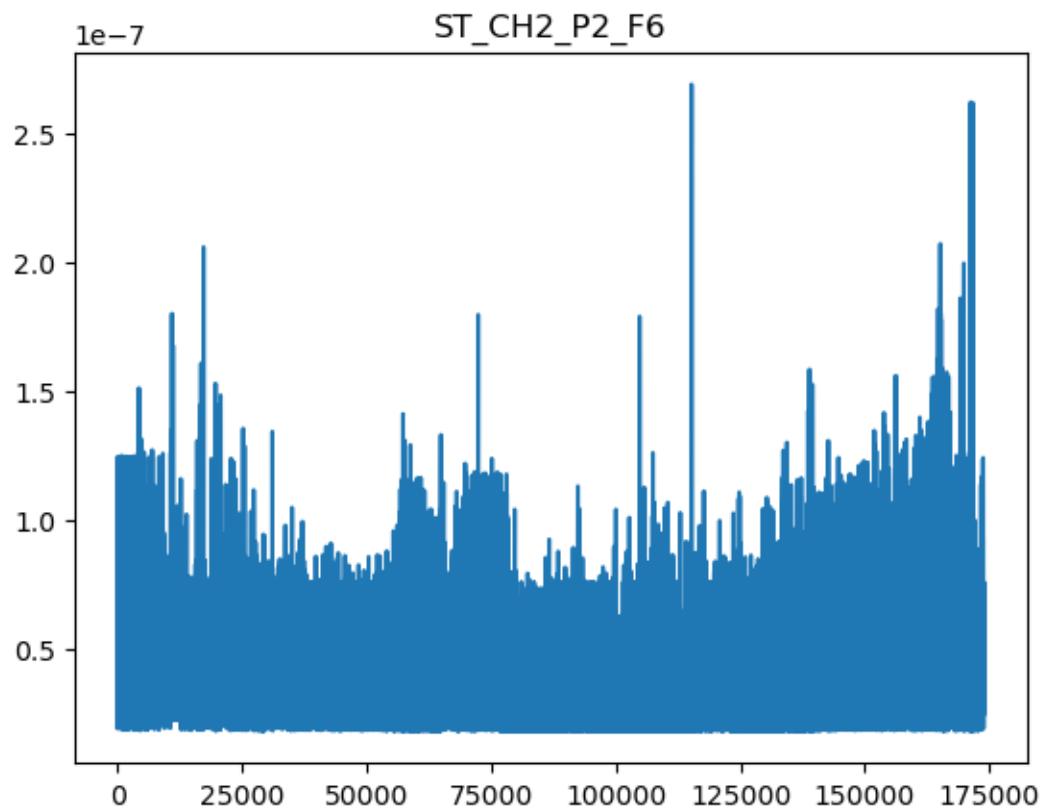


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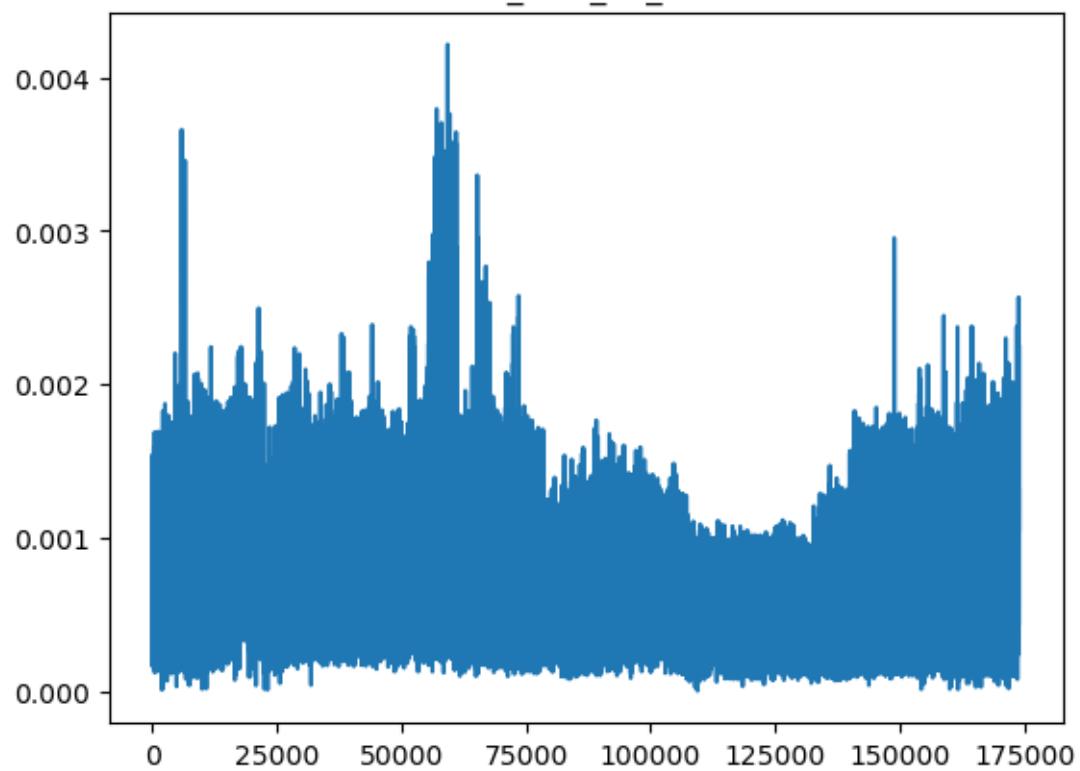


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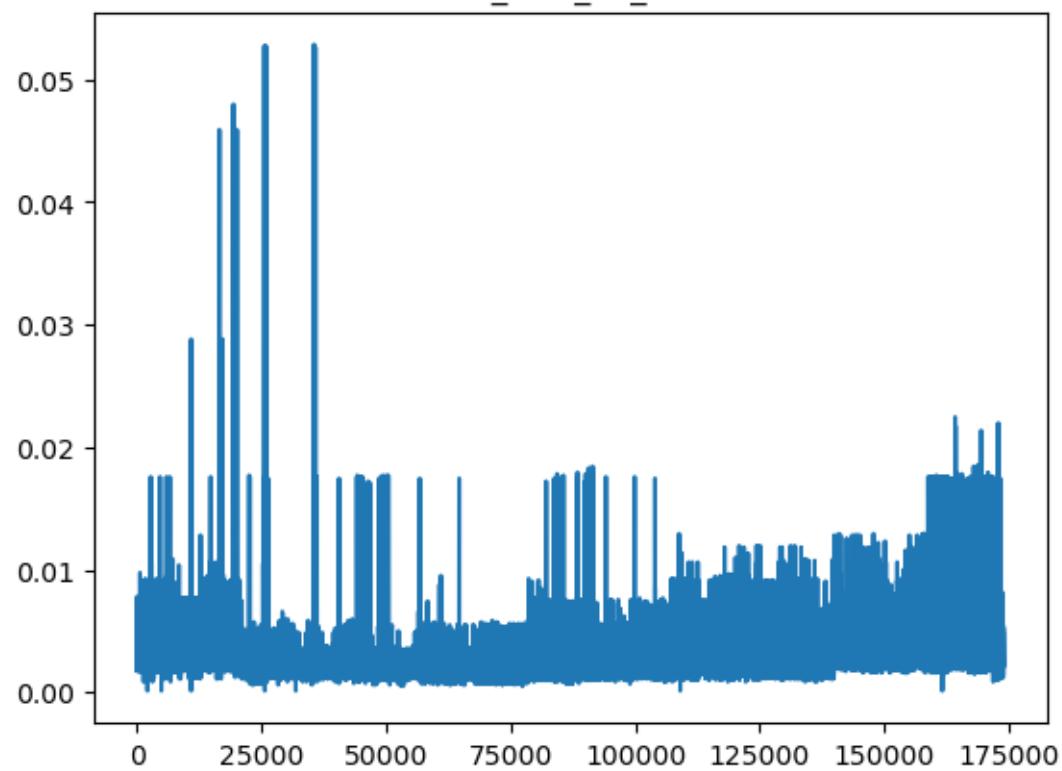




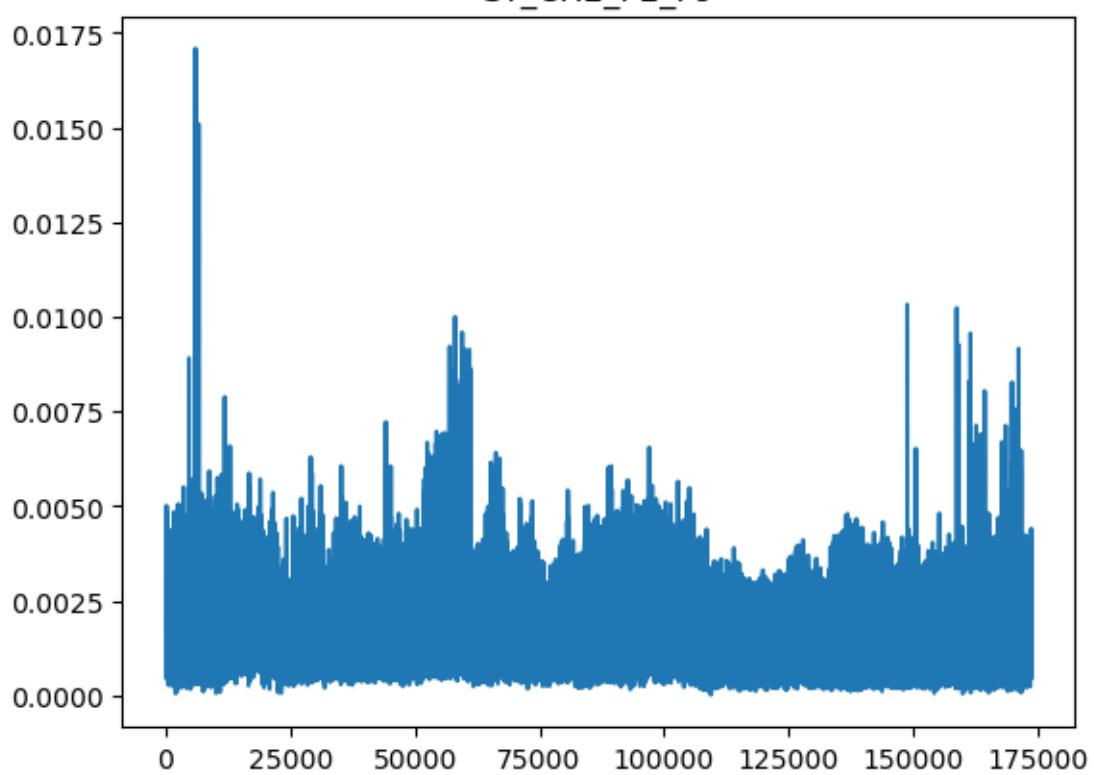
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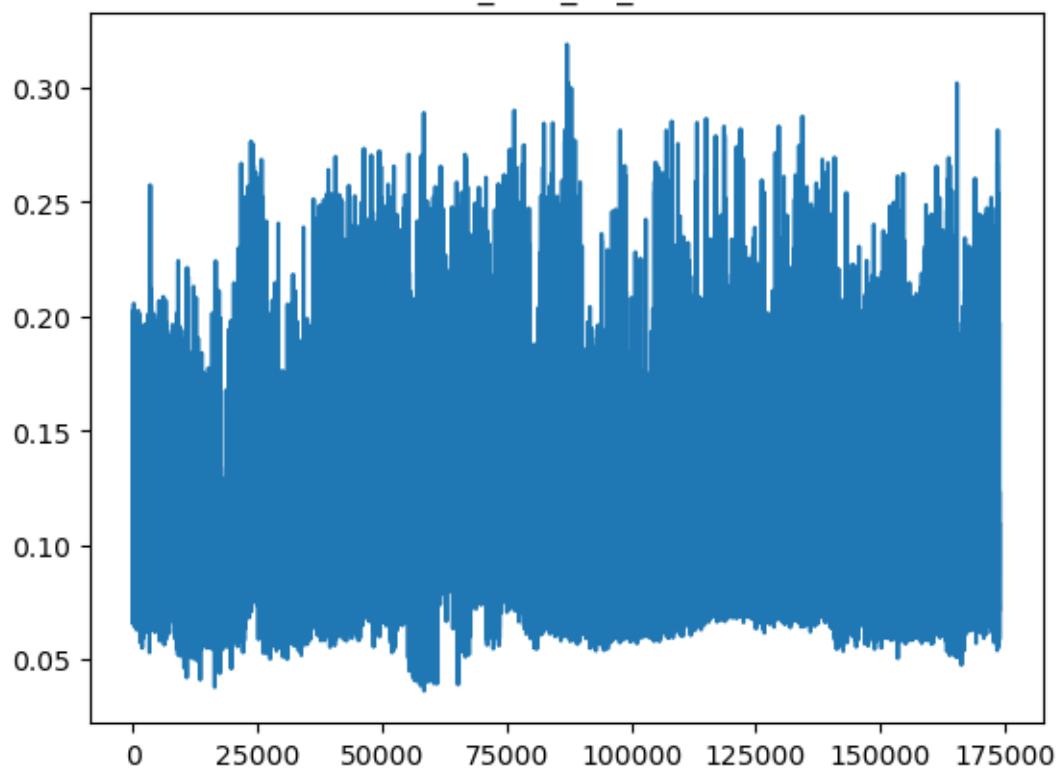
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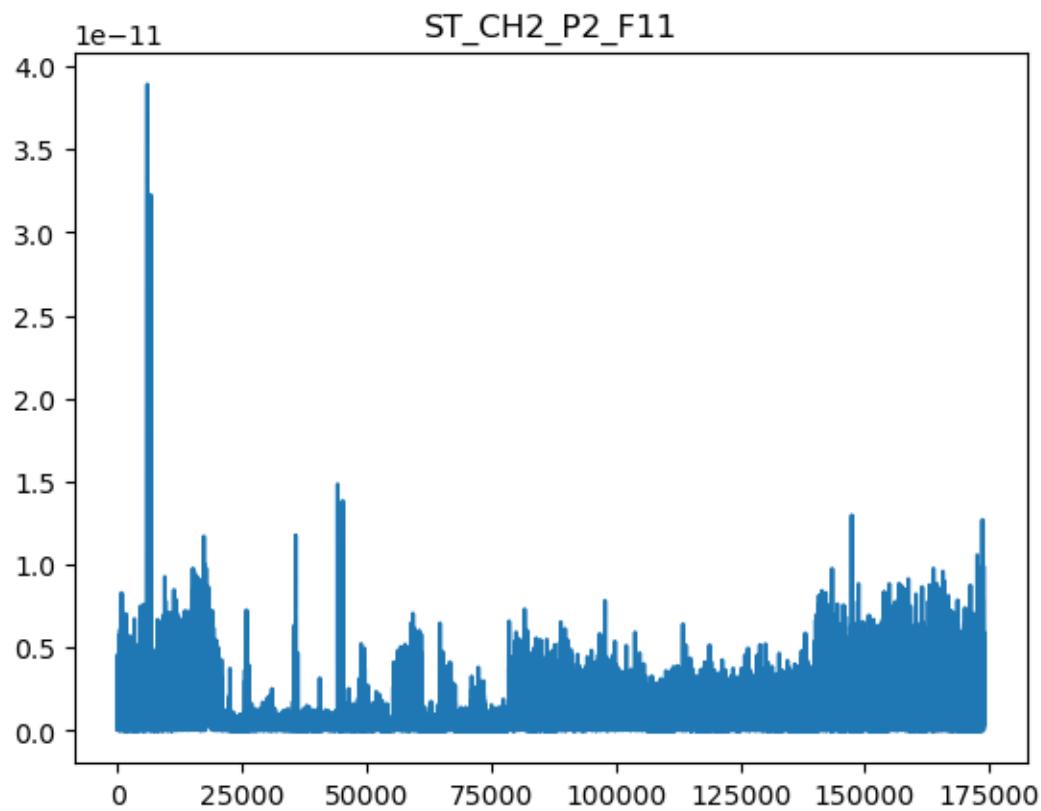


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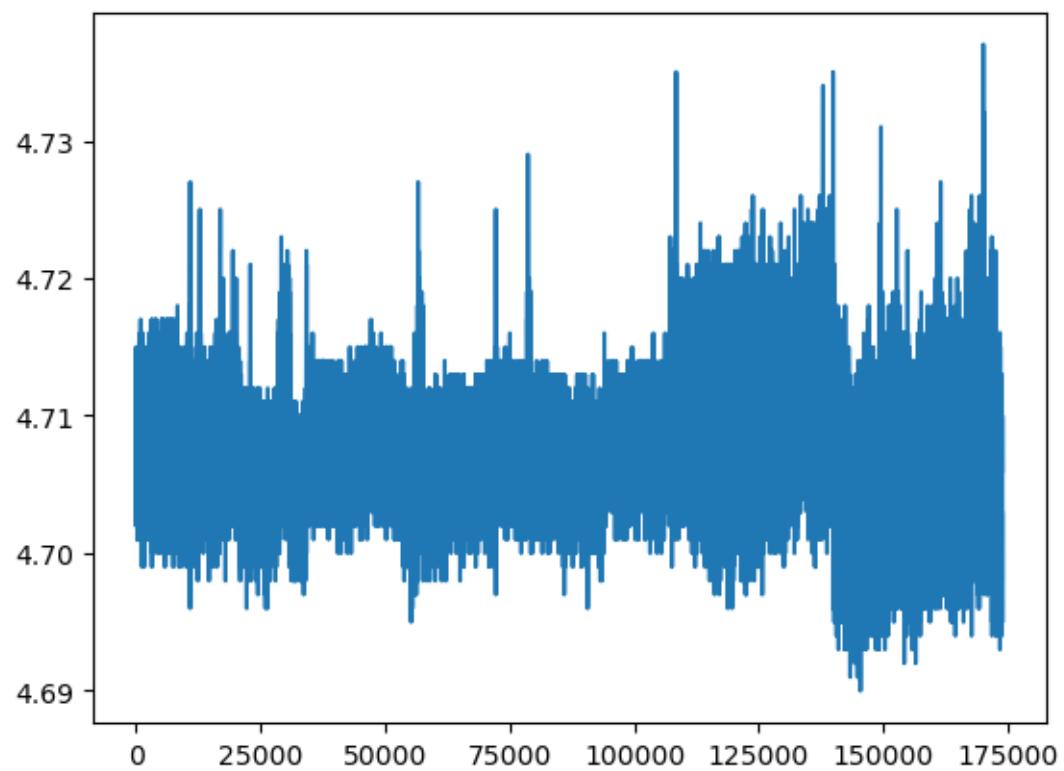


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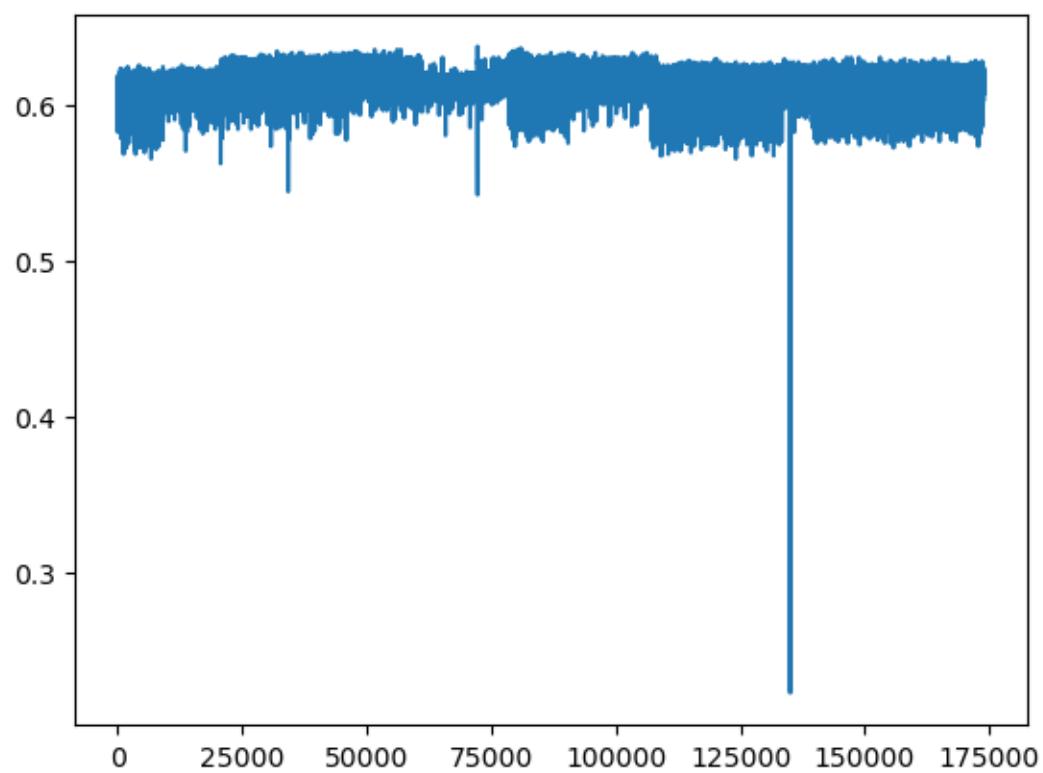




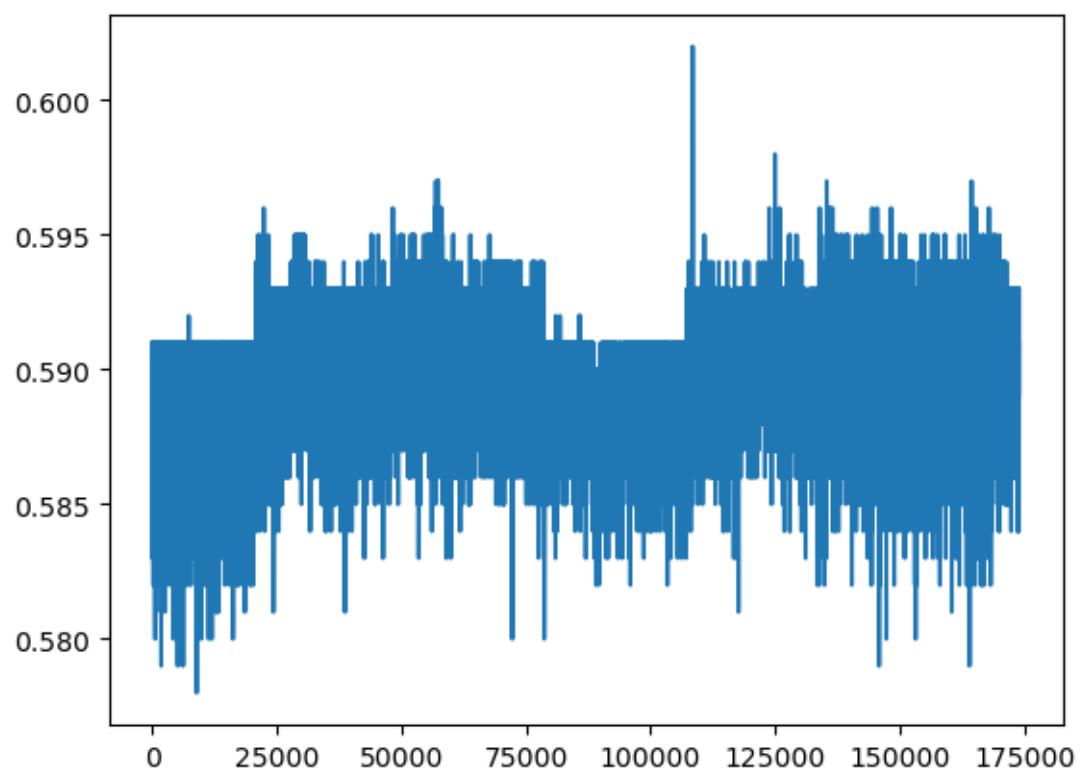
4.713 SKV#1

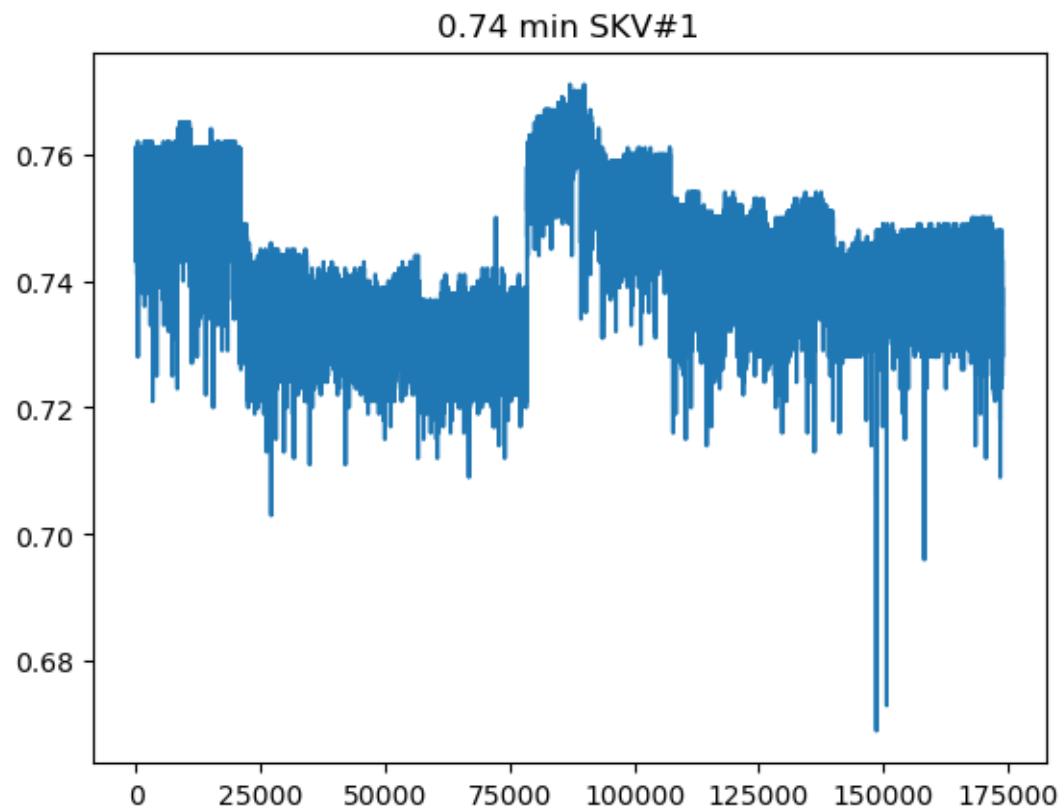


0.604 min SKV#1

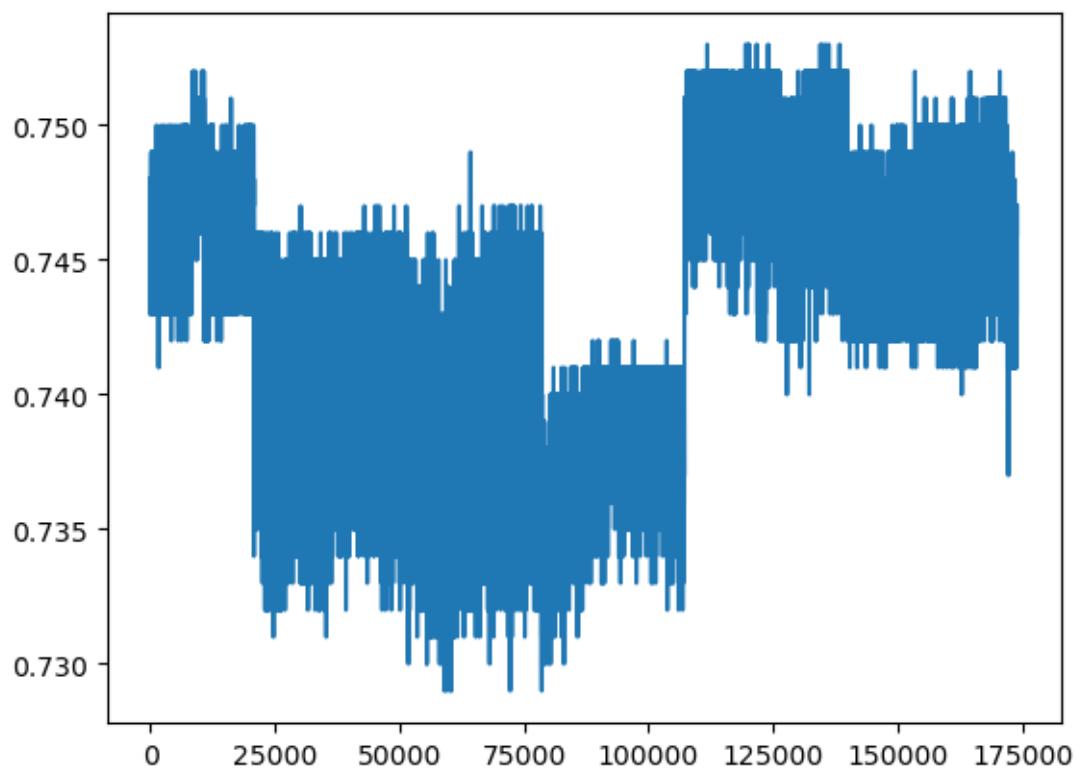


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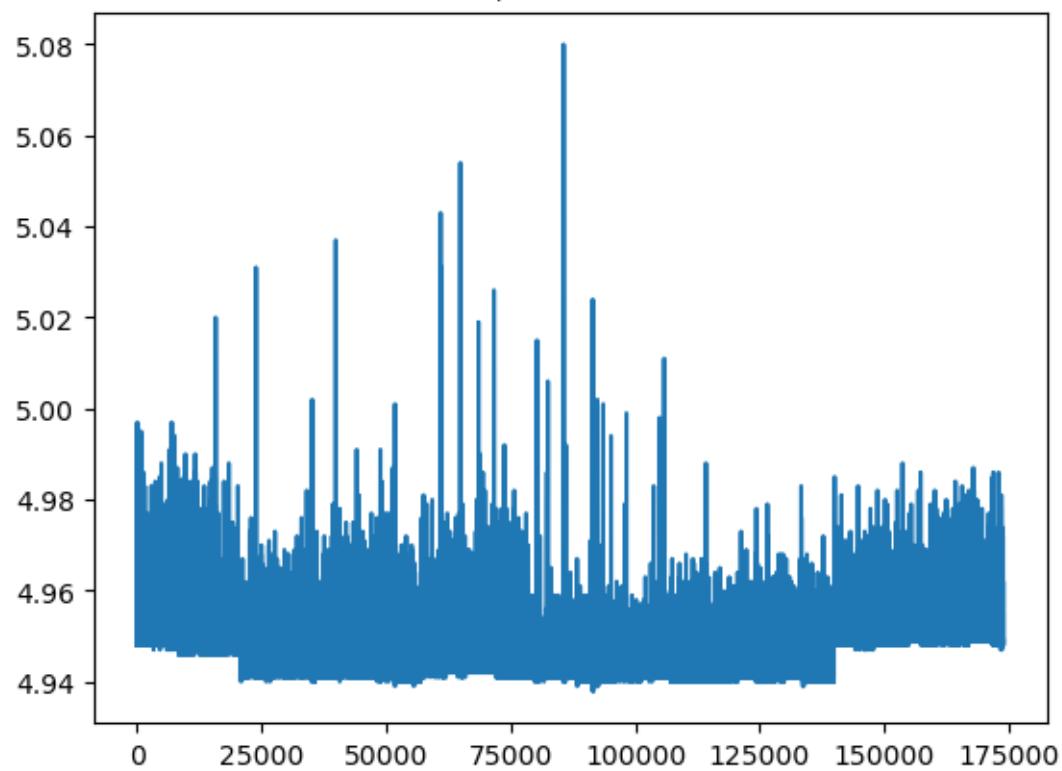




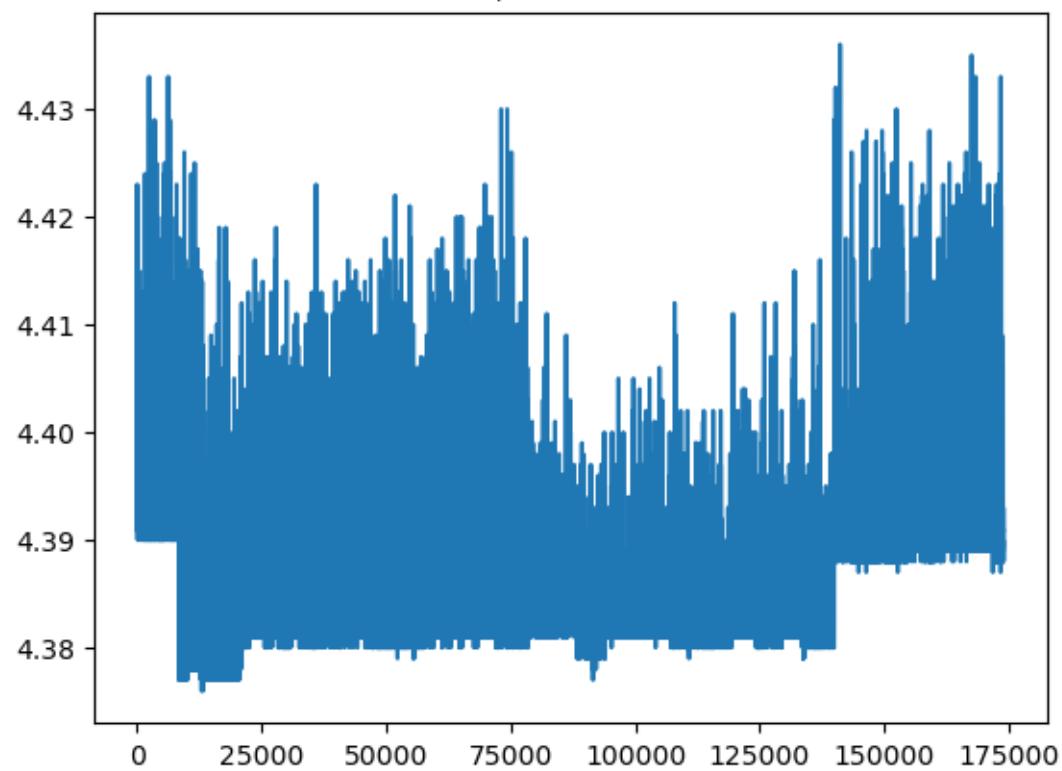
0.74 max SKV#1



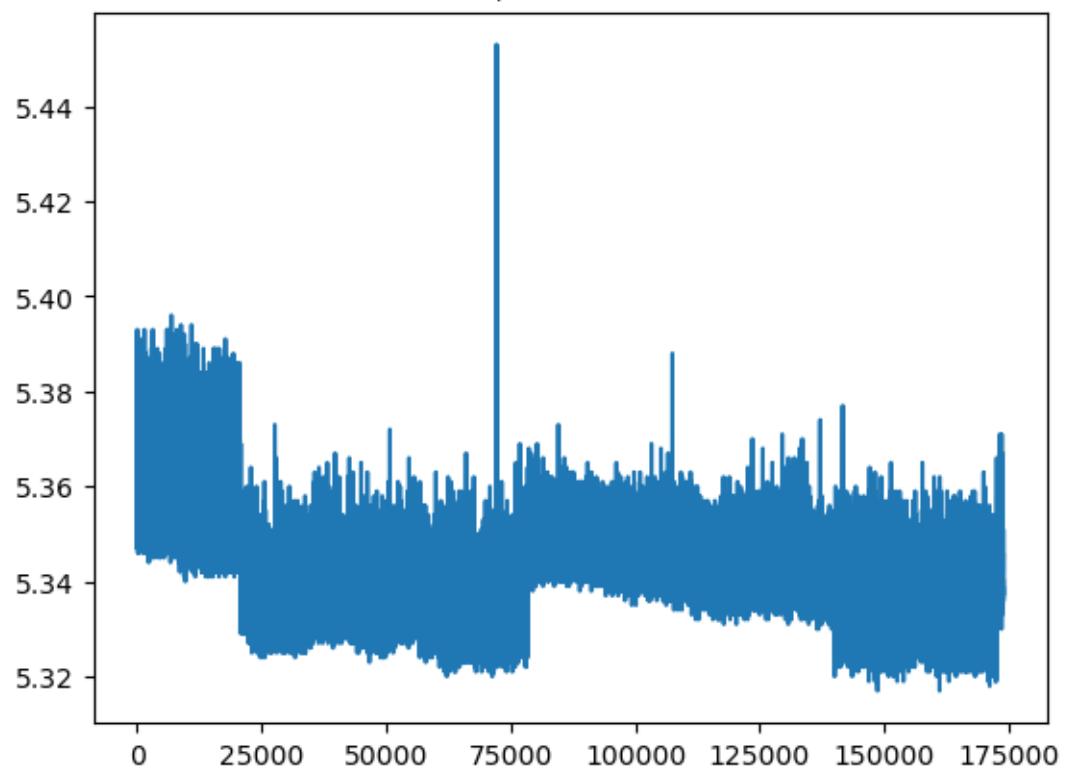
4,96 SKV#1



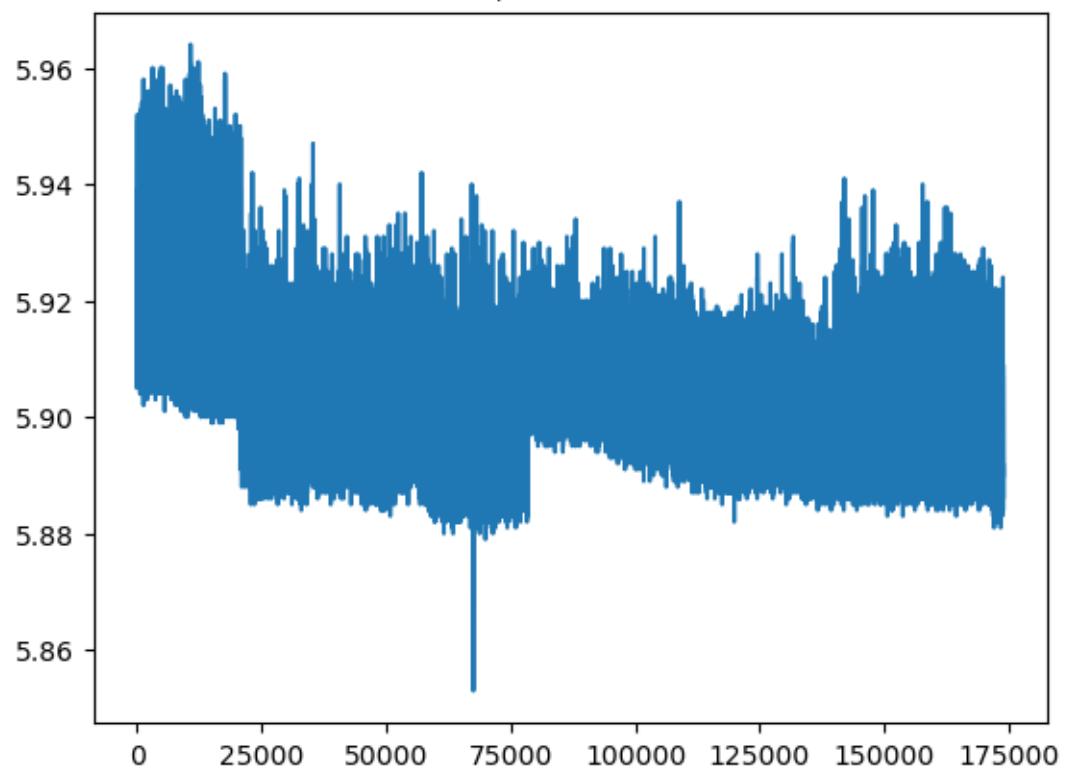
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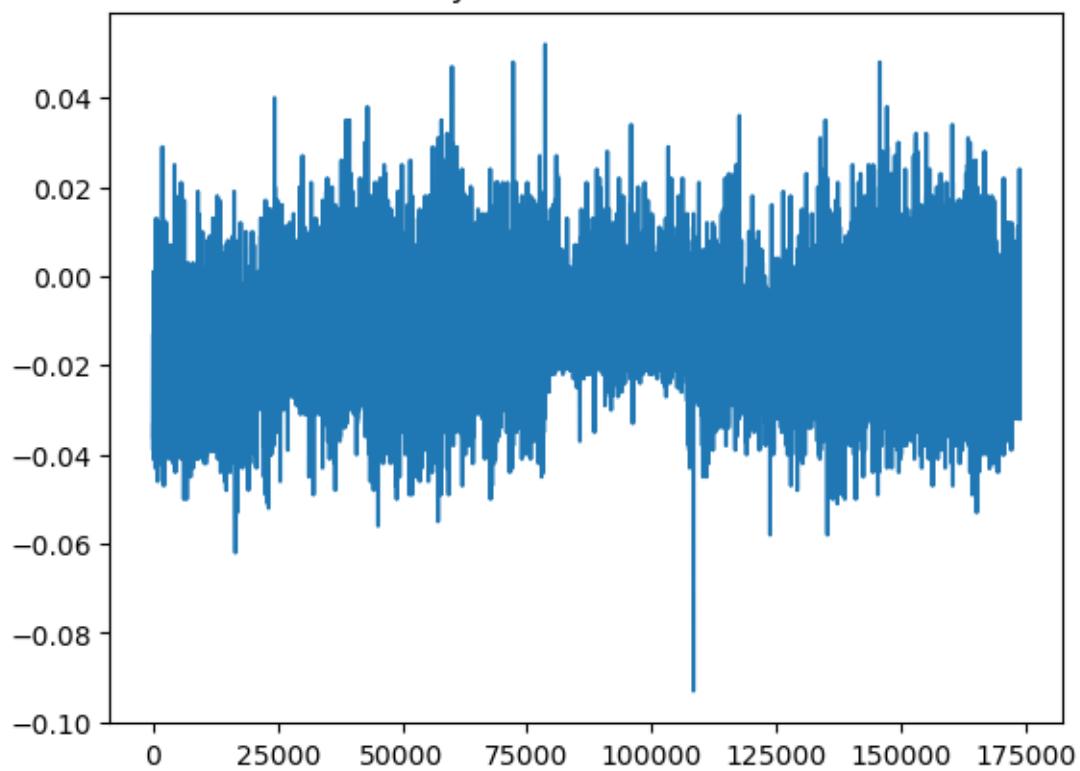
5,36 SKV#1



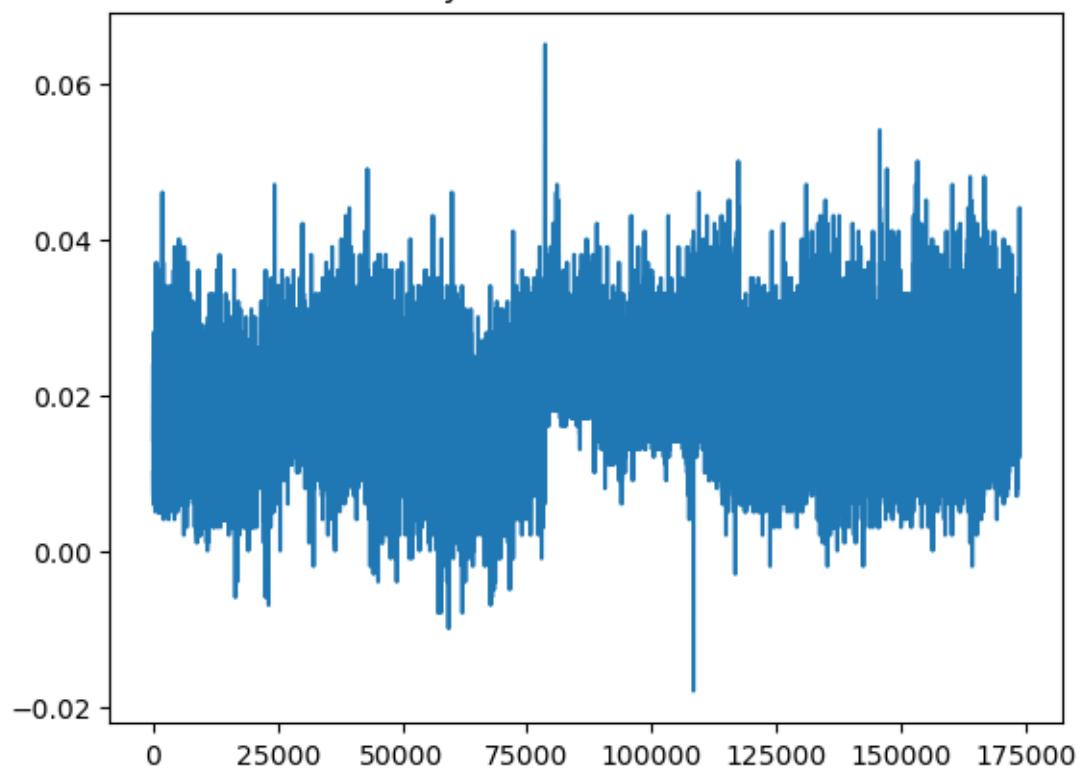
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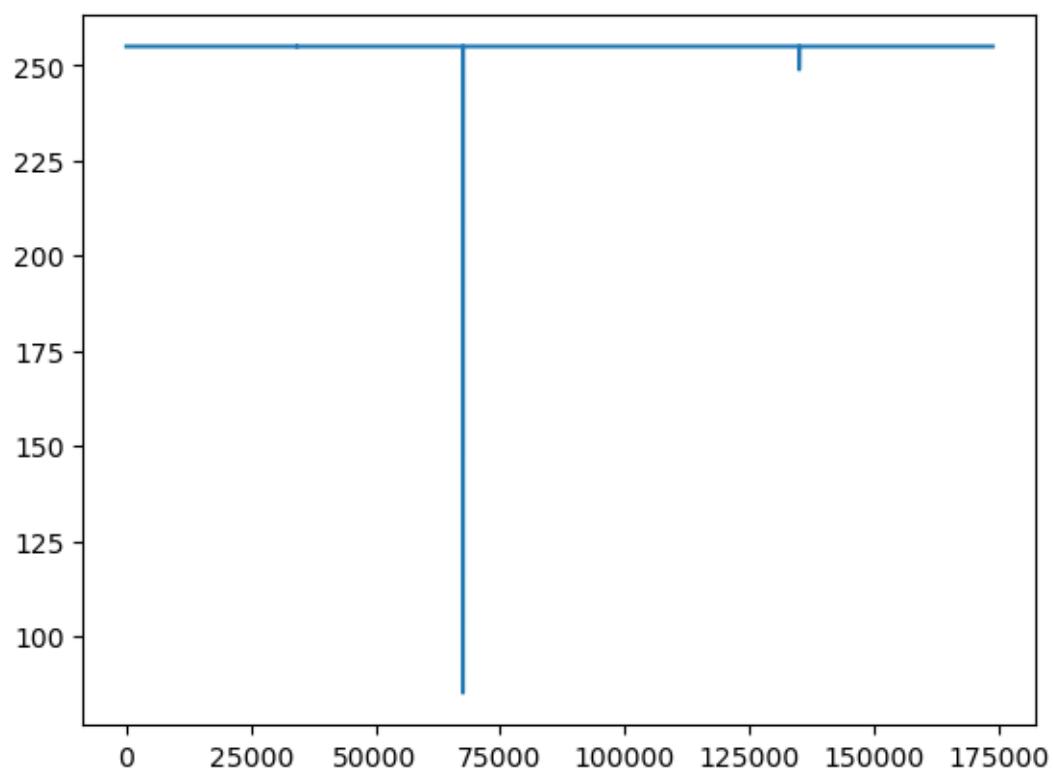
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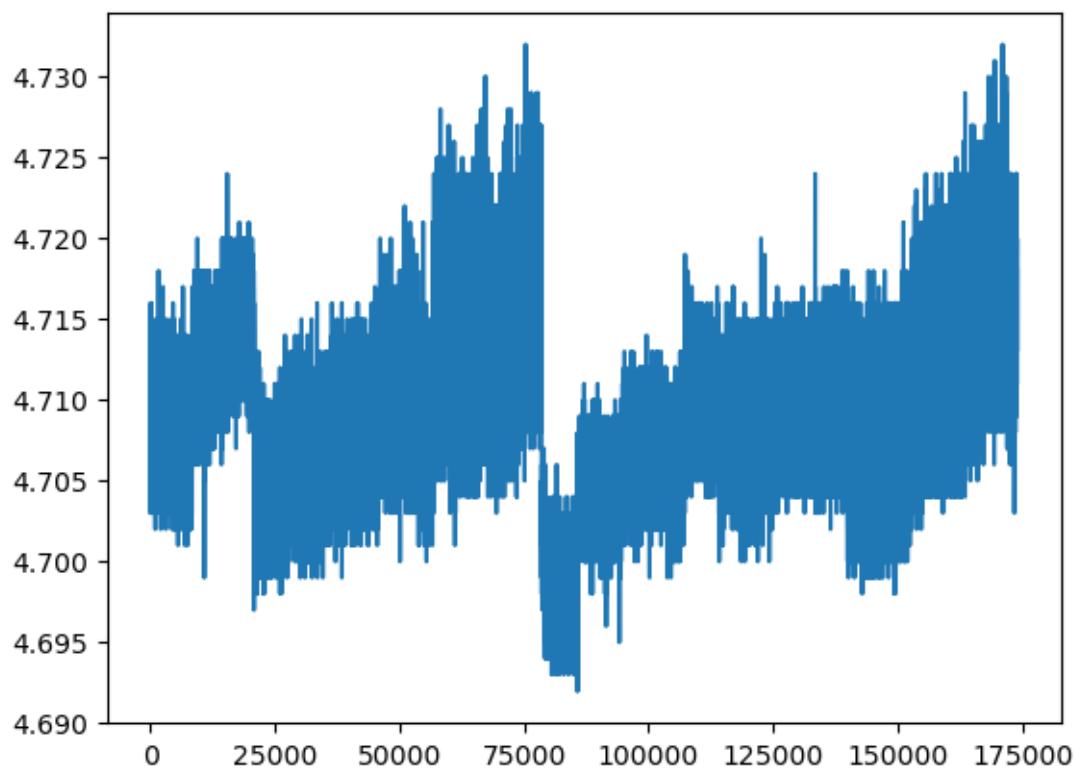
Sym Einstich SKV#1



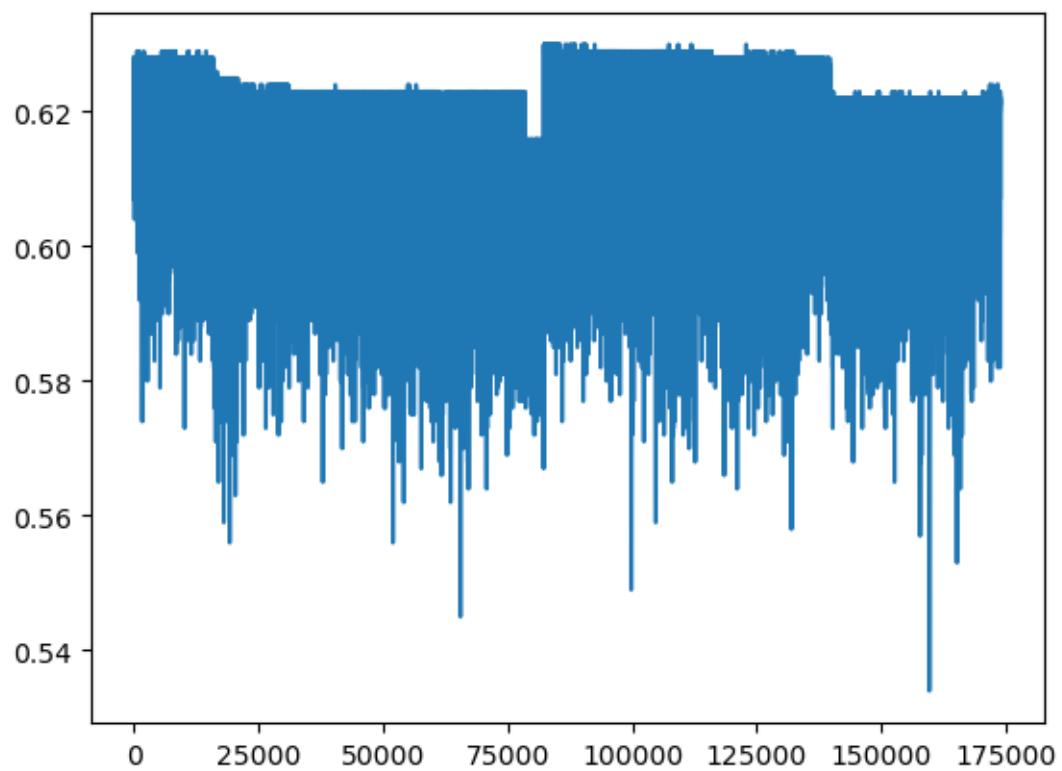
Licht-Einstich frei SKV#1



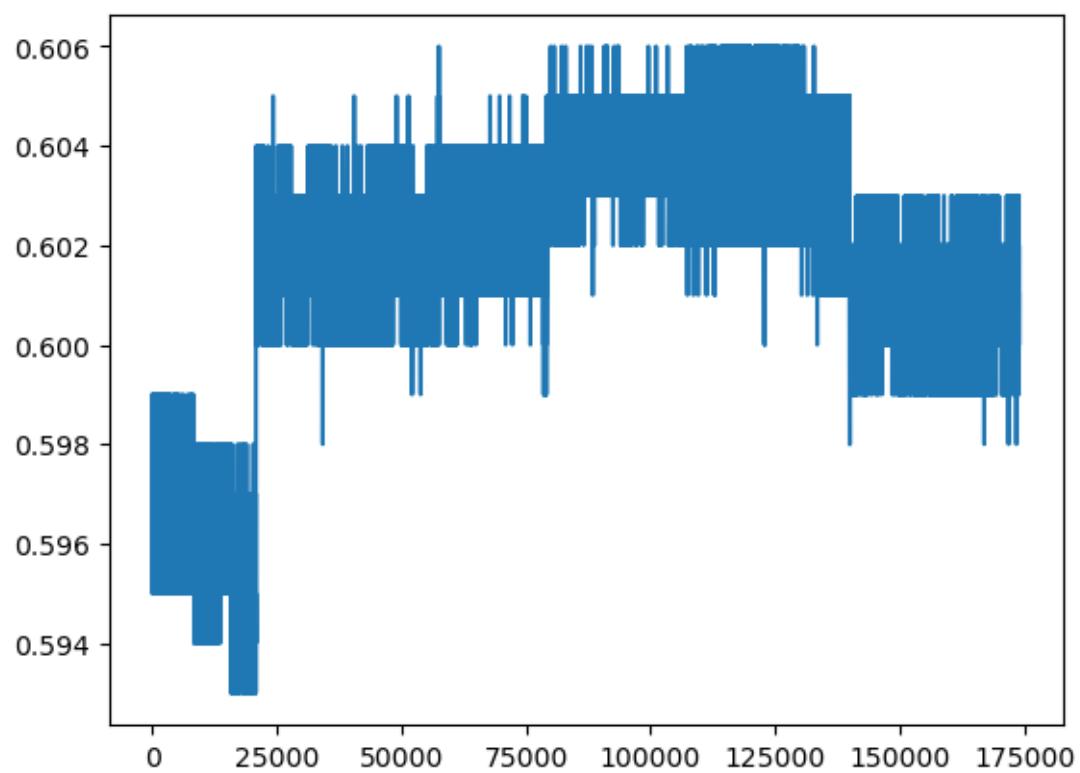
4.713 SKV#2



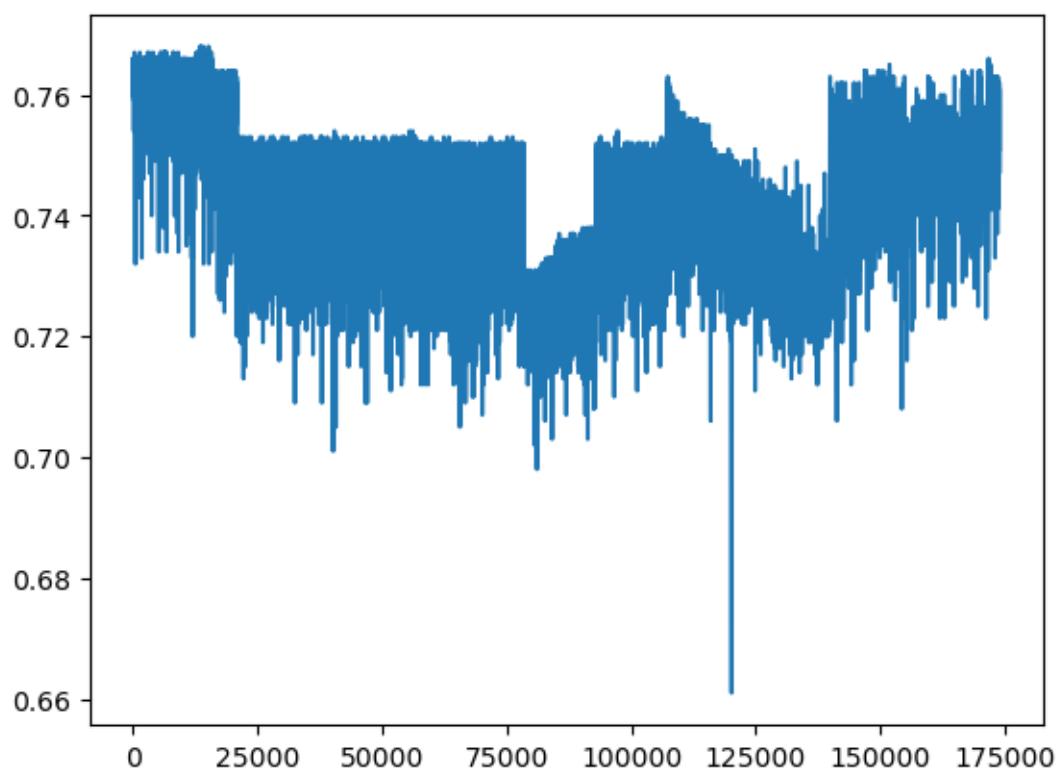
0.604 min SKV#2

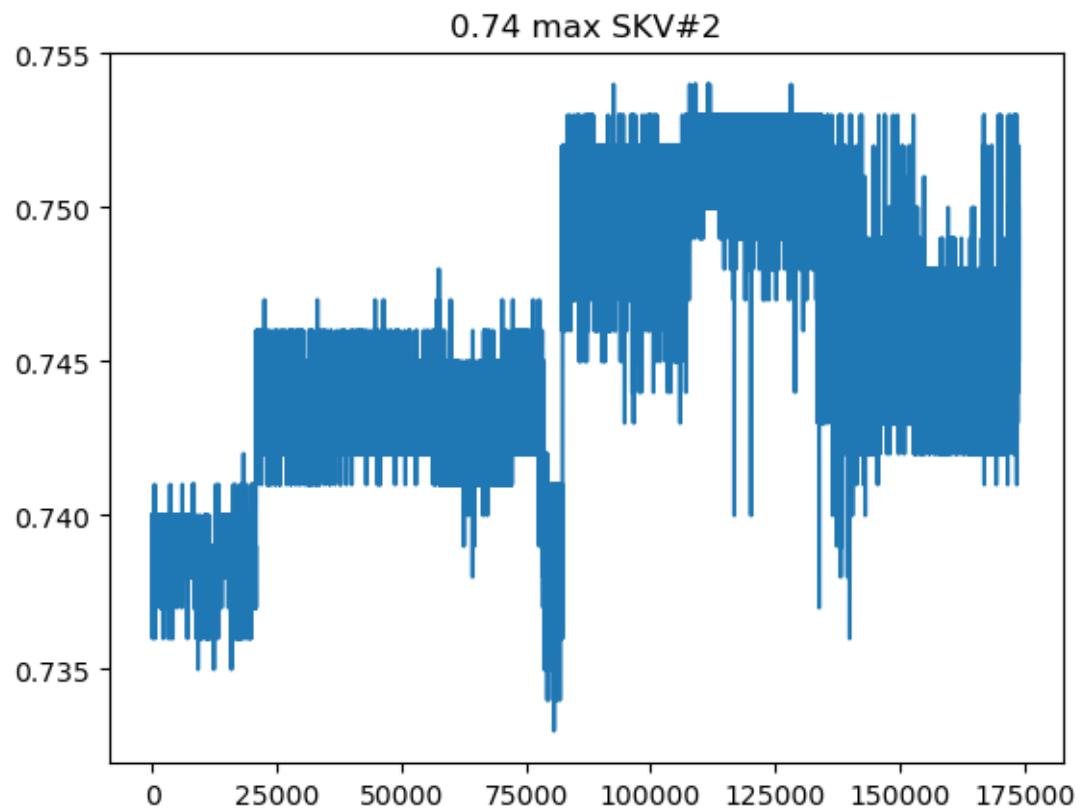


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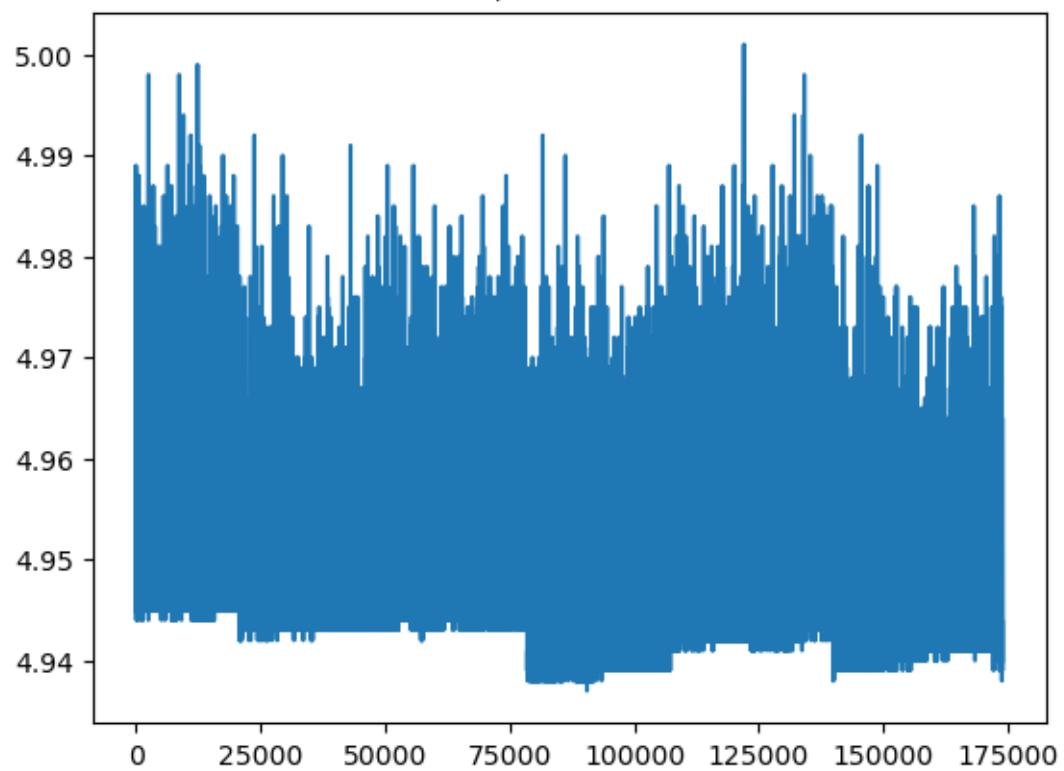


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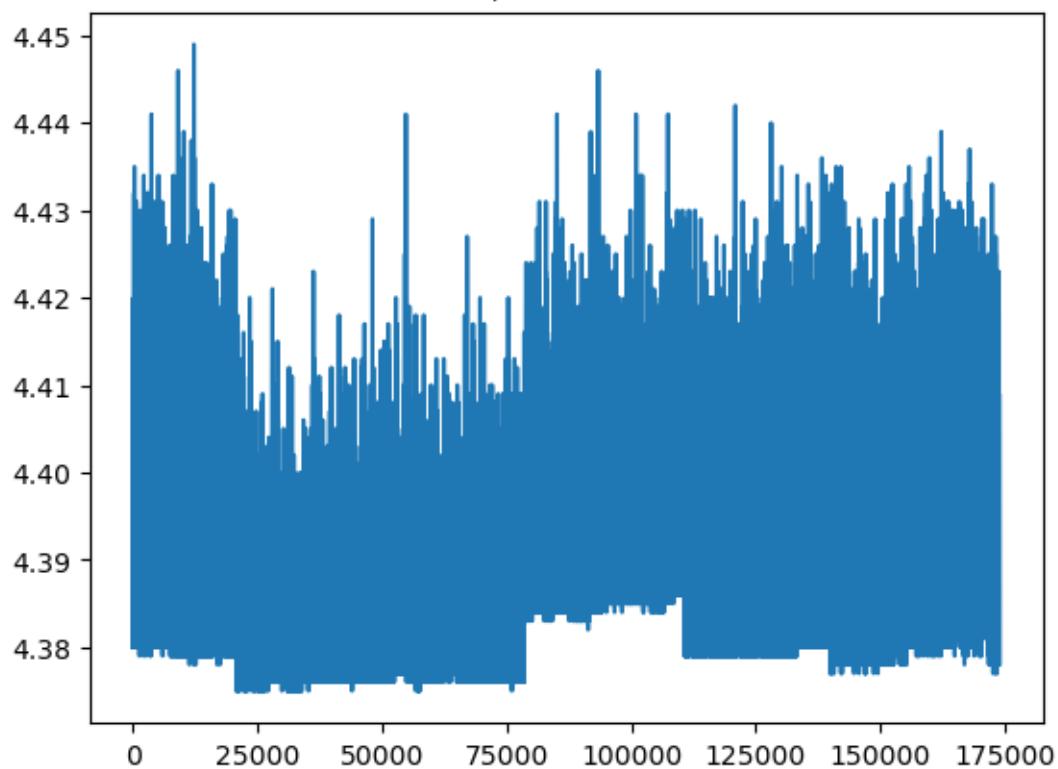




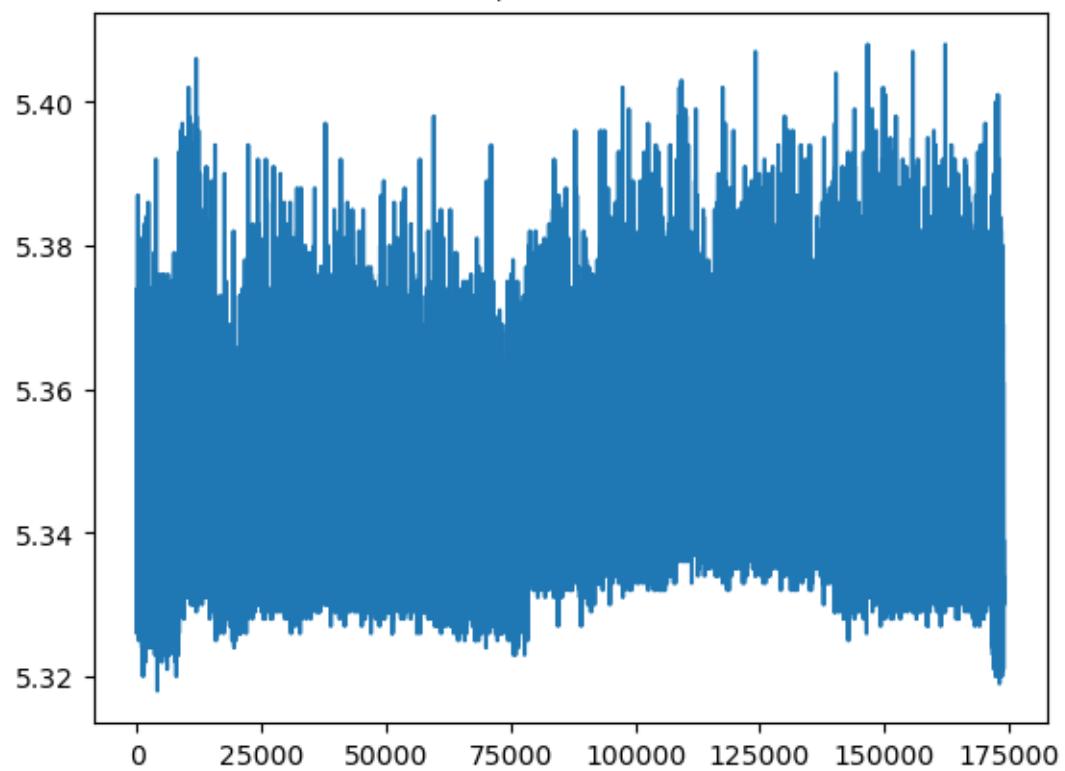
4,96 SKV#2



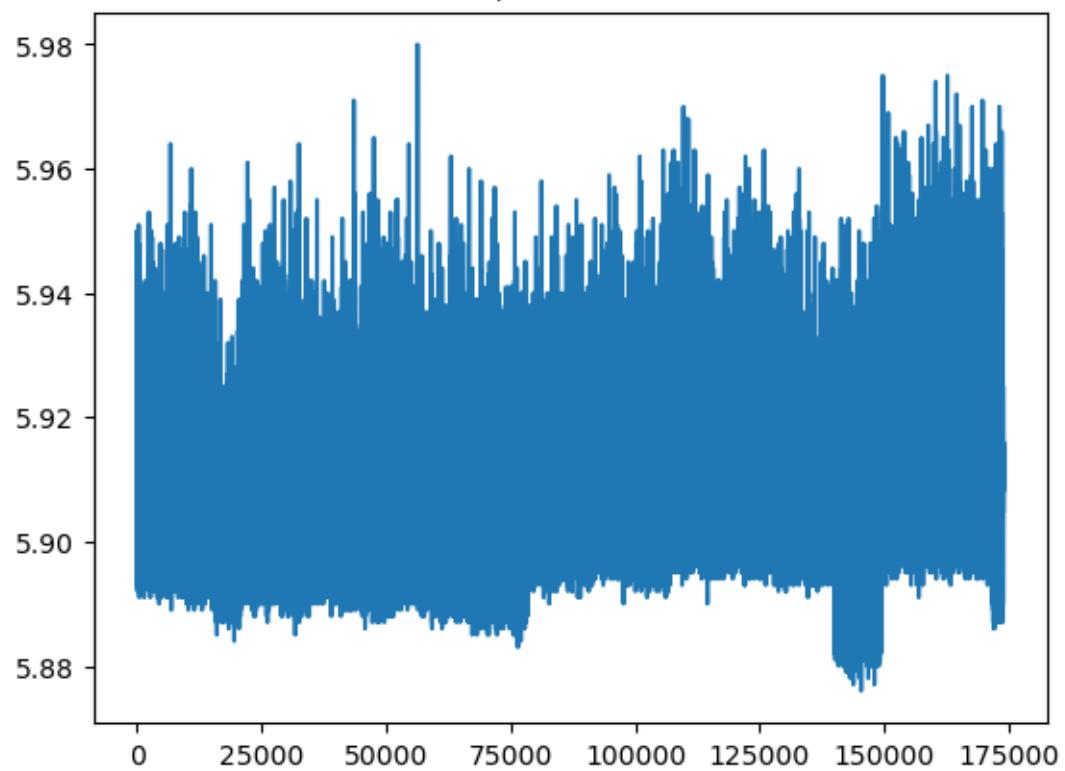
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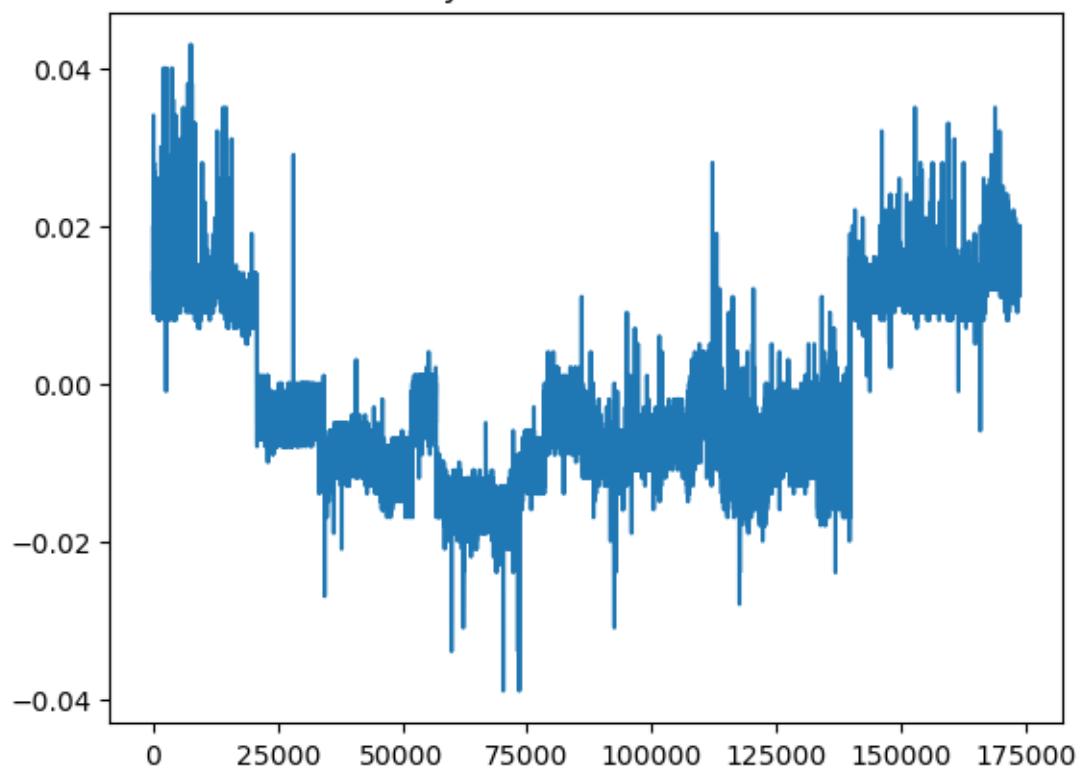
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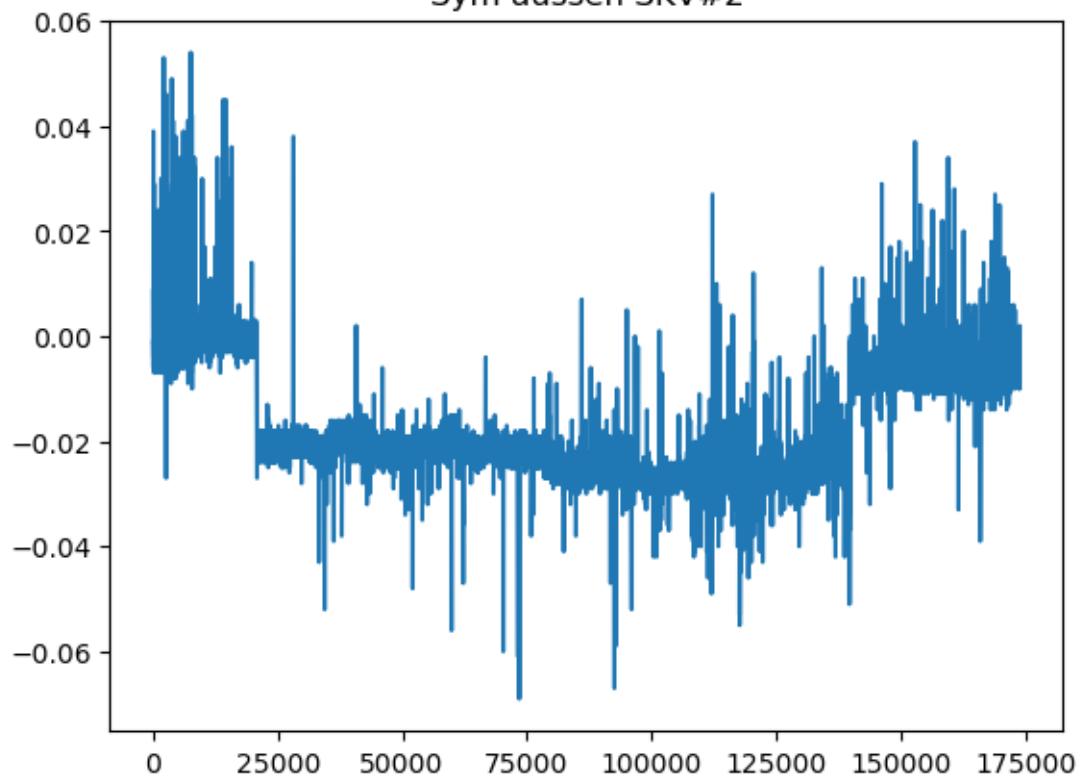
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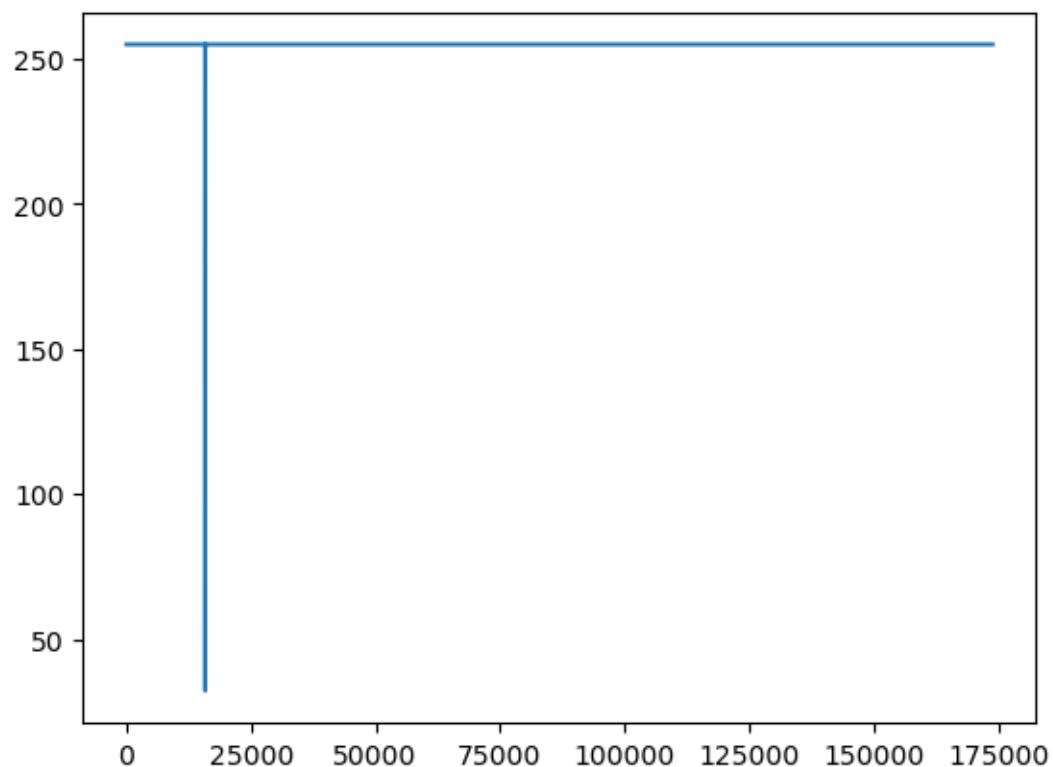
Sym Einstich SKV#2



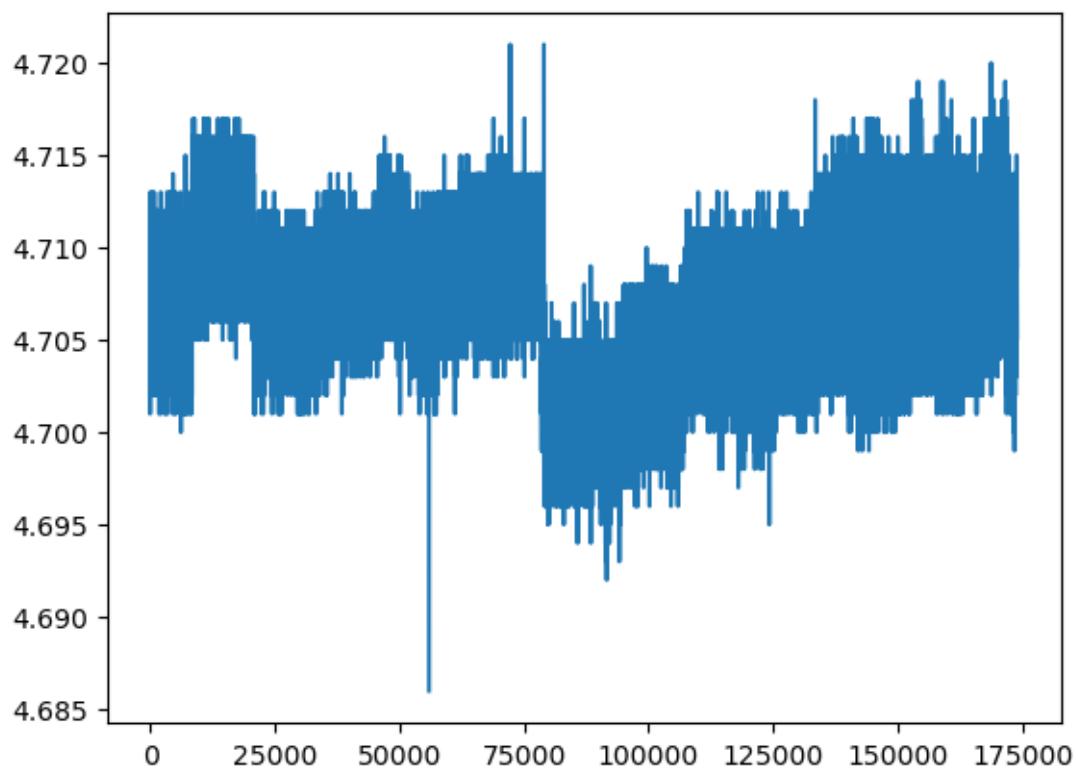
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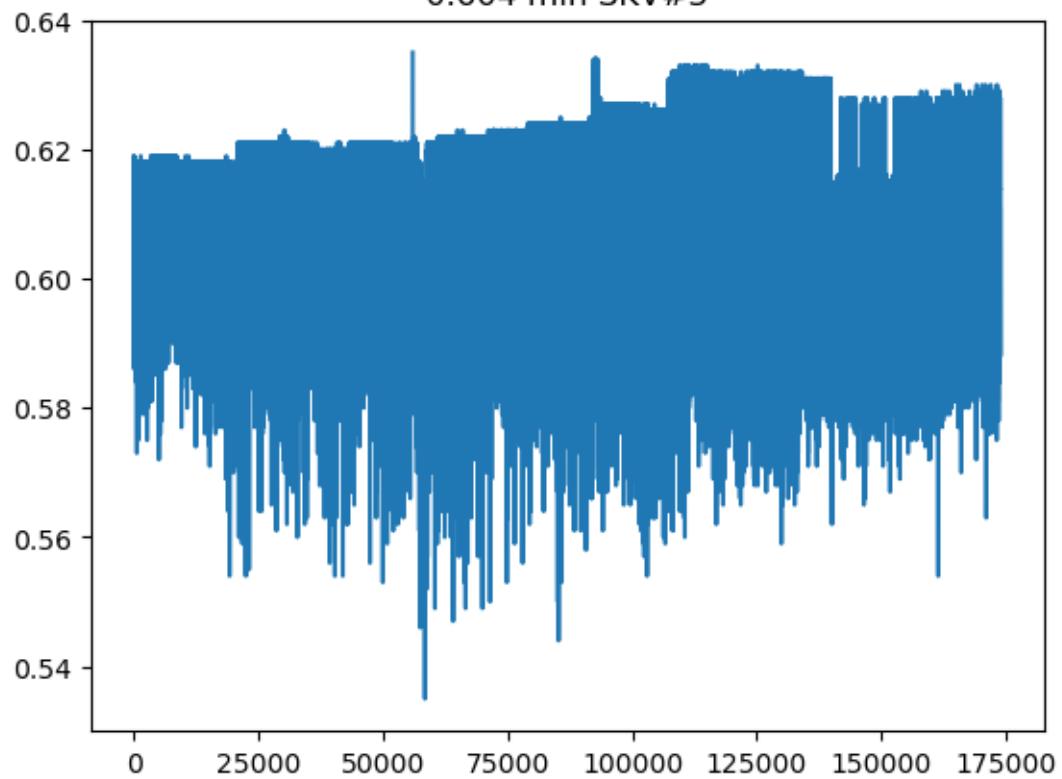
Licht-Einstich frei SKV#2



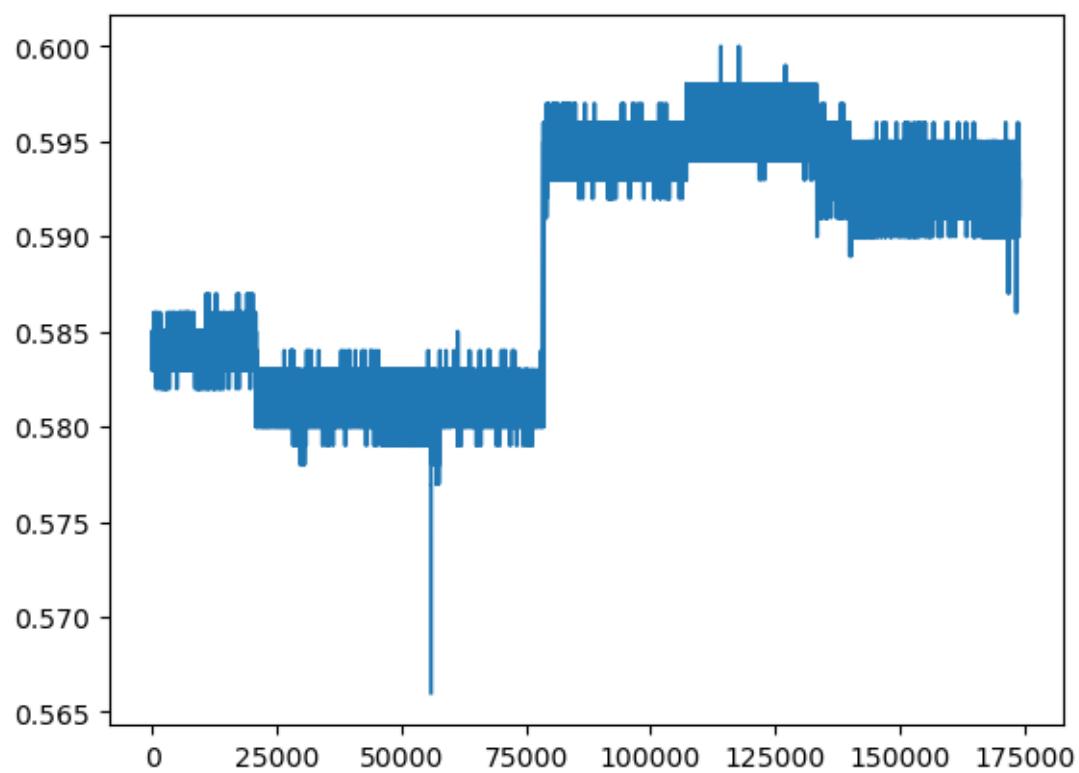
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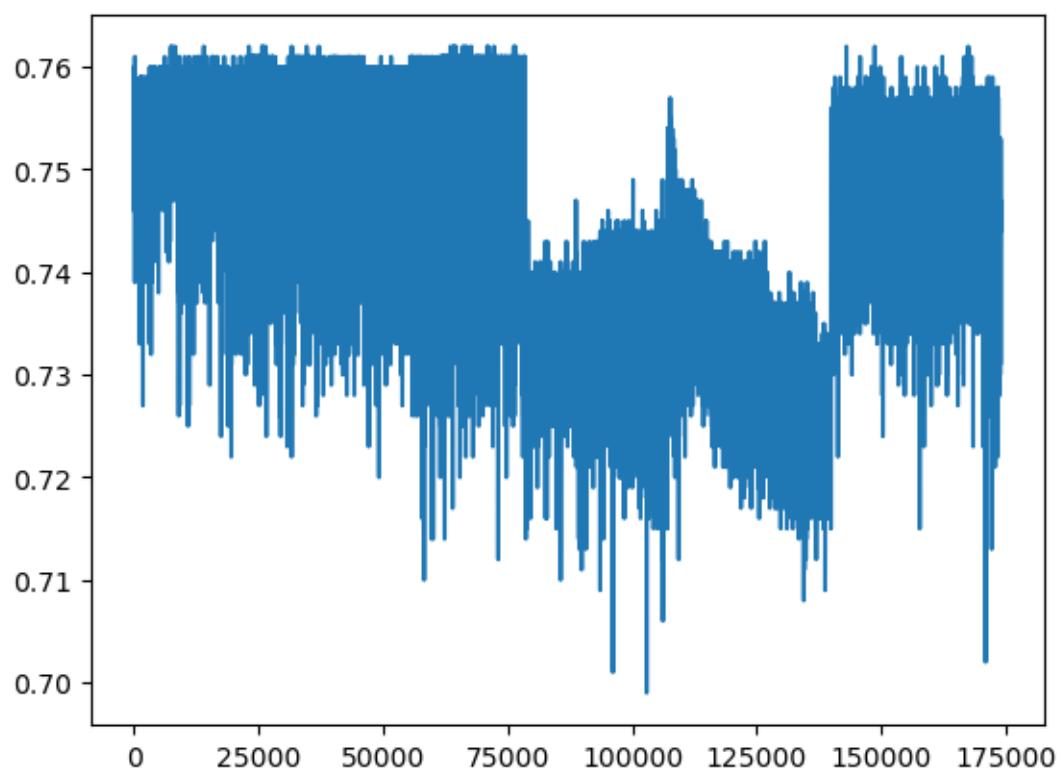
0.604 min SKV#3



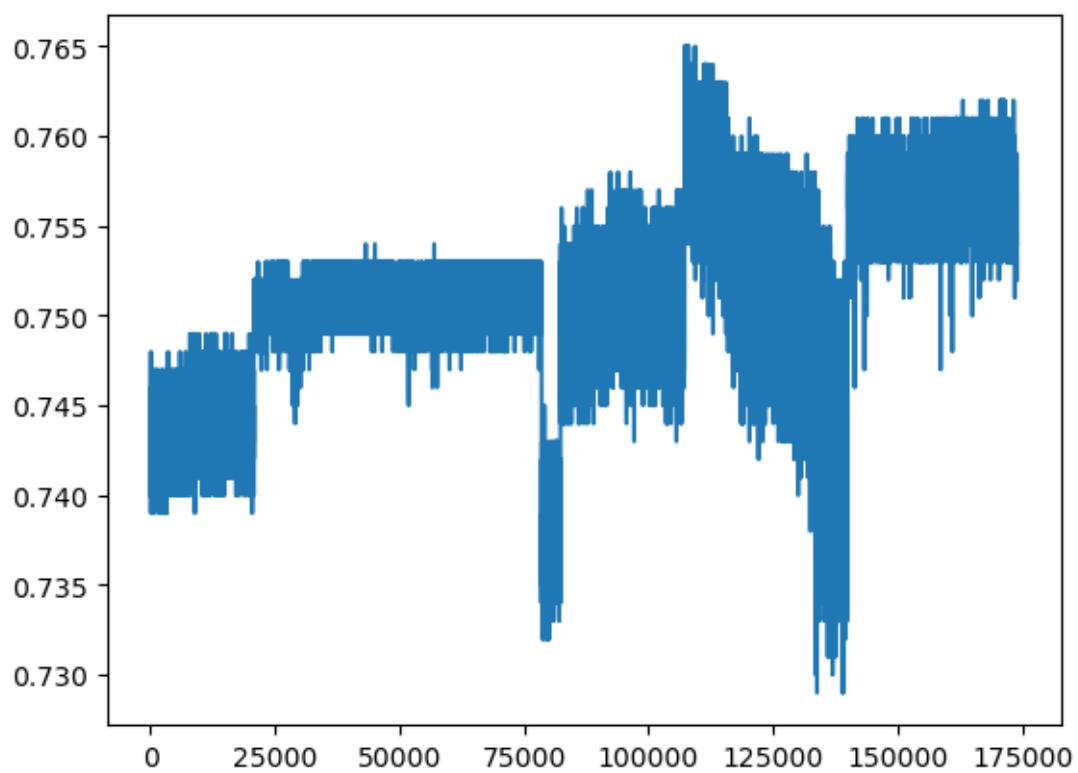
0.604 max SKV#3



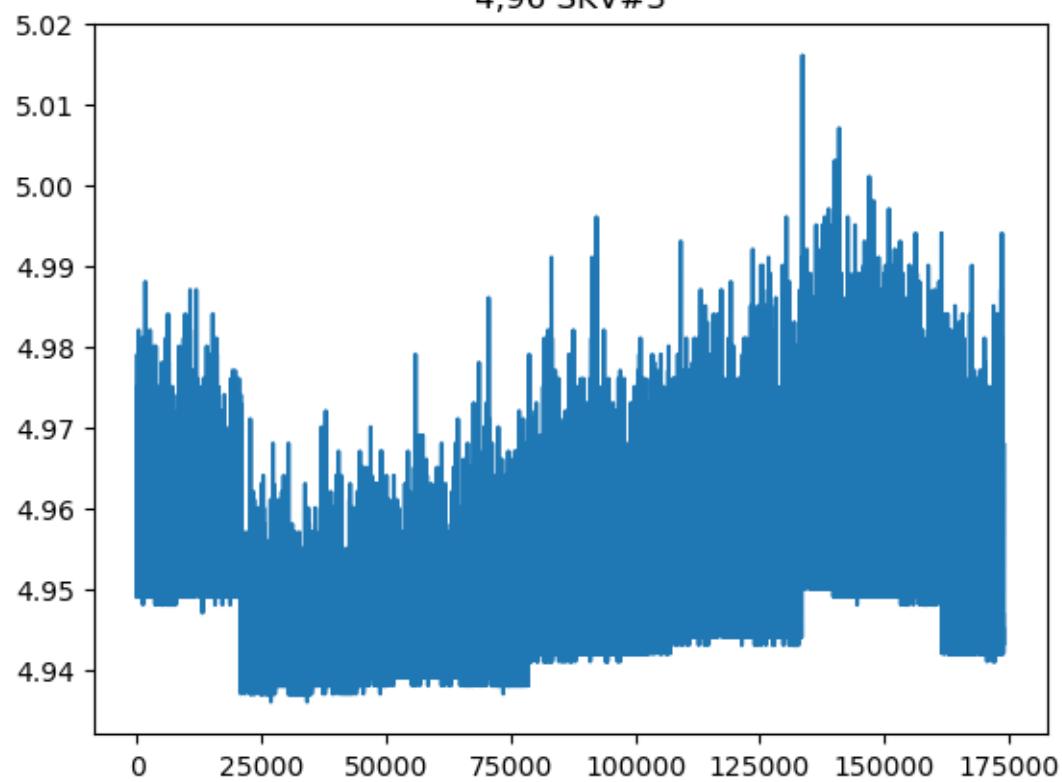
0.74 min SKV#3



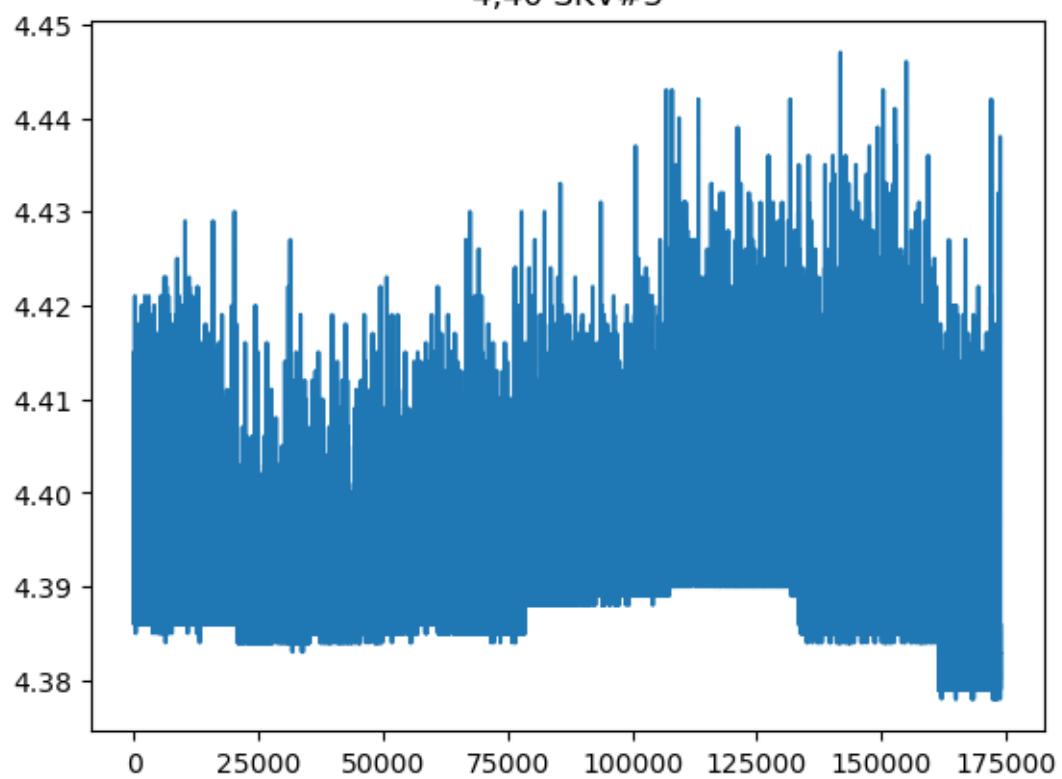
0.74 max SKV#3



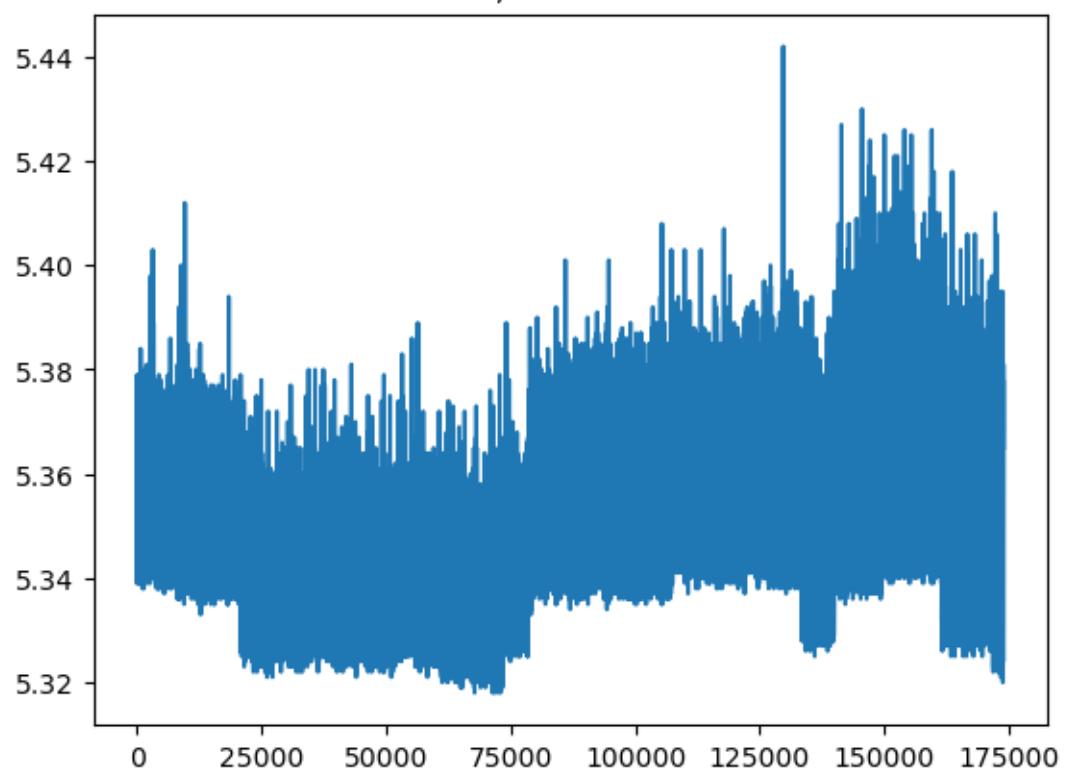
4,96 SKV#3



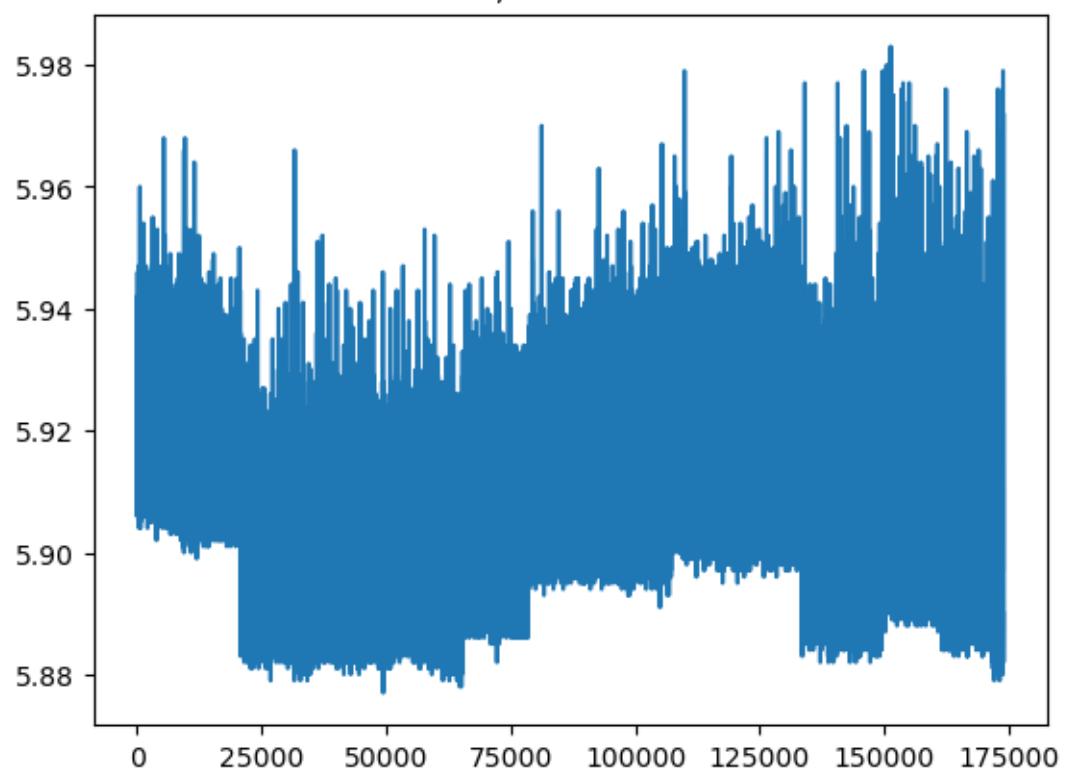
4,40 SKV#3



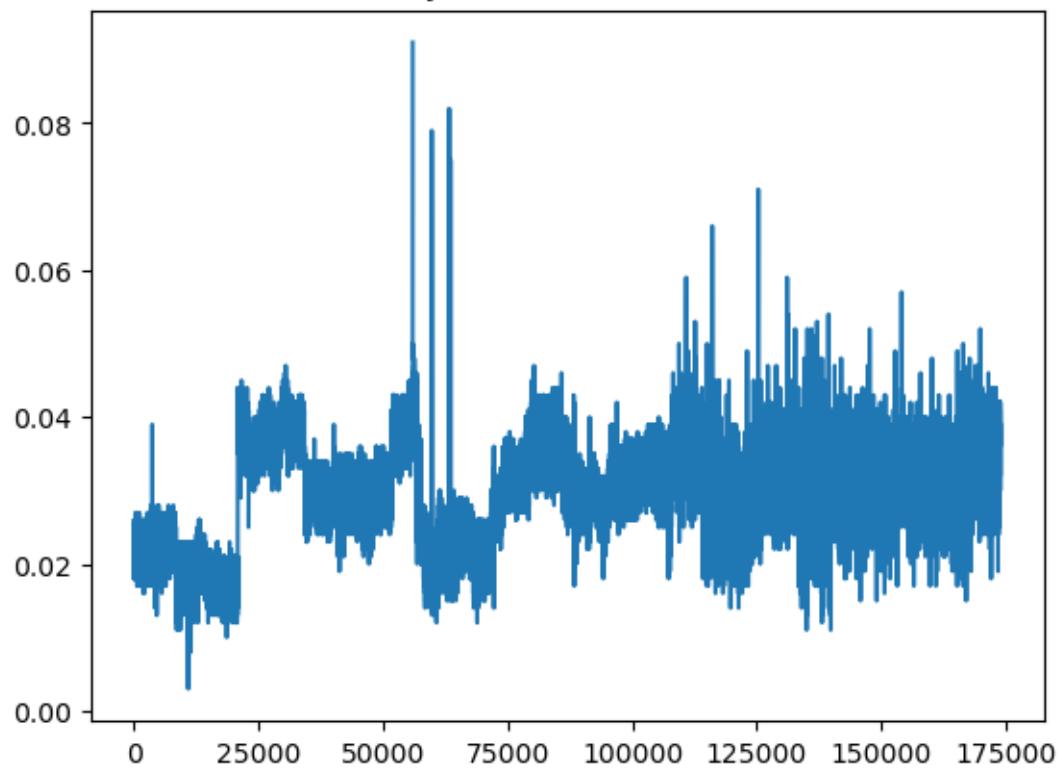
5,36 SKV#3



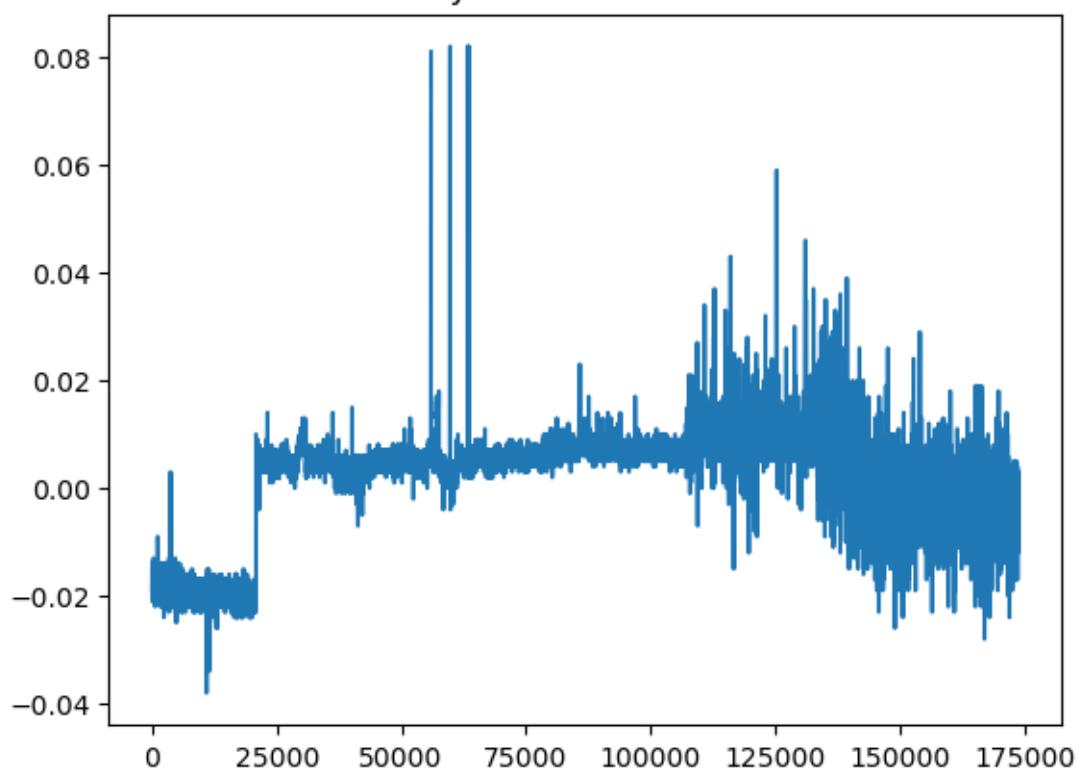
5,92 SKV#3



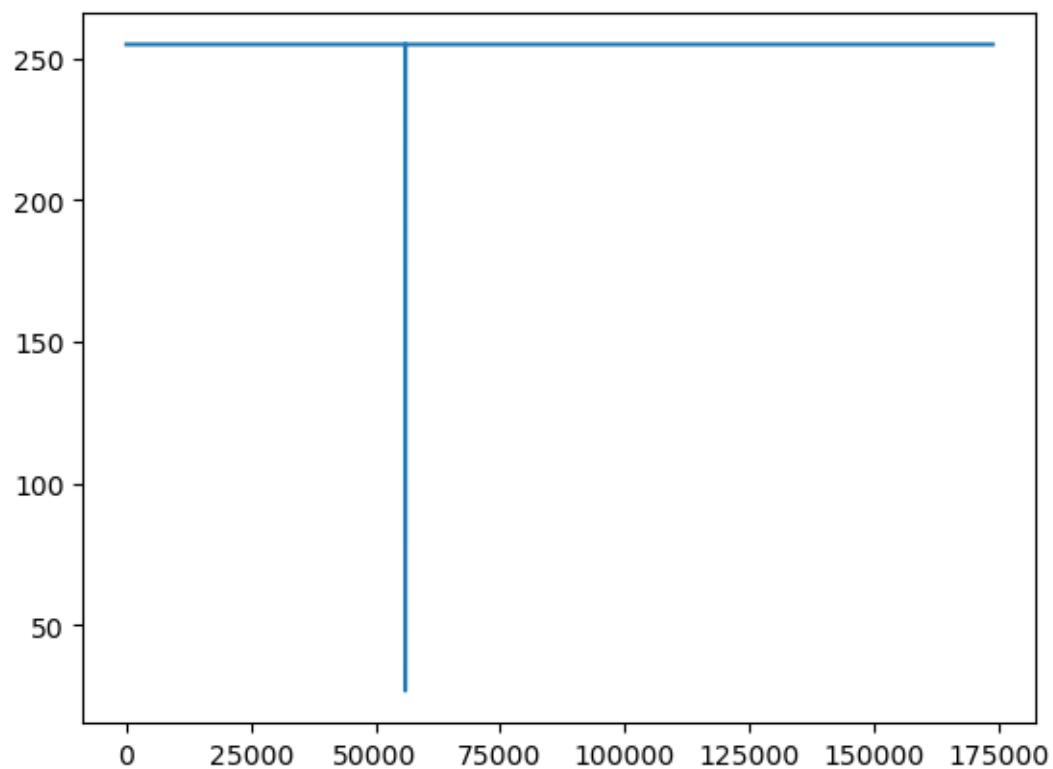
Sym Einstich SKV#3



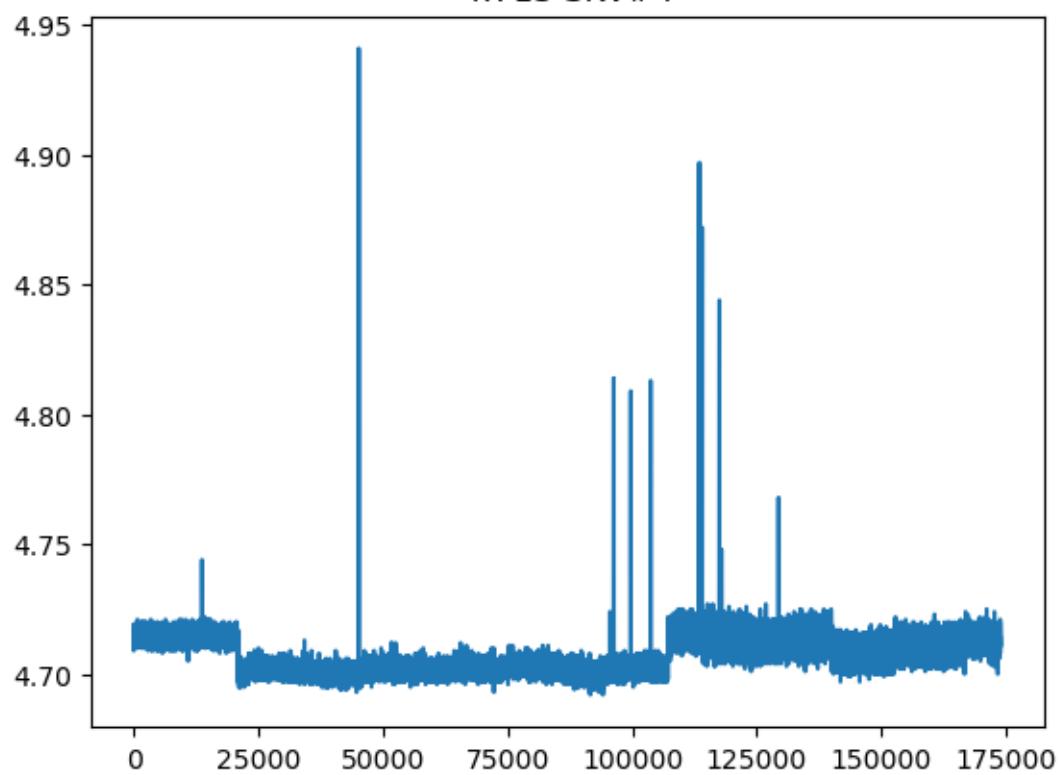
Sym aussen SKV#3



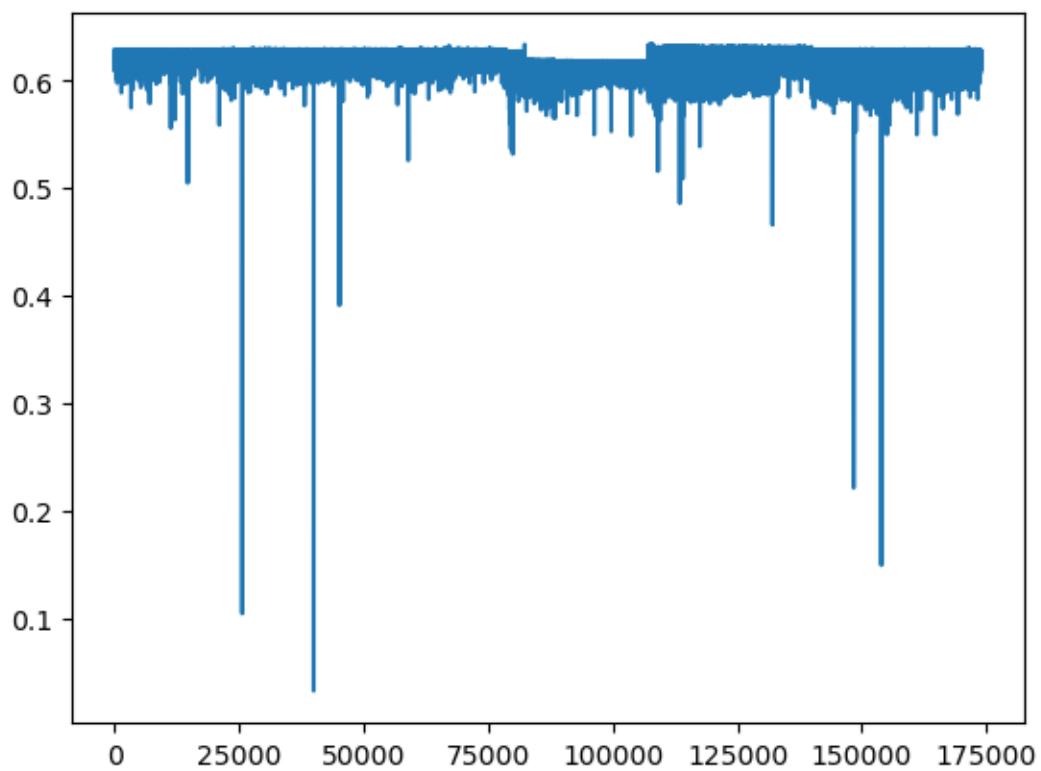
Licht-Einstich frei SKV#3



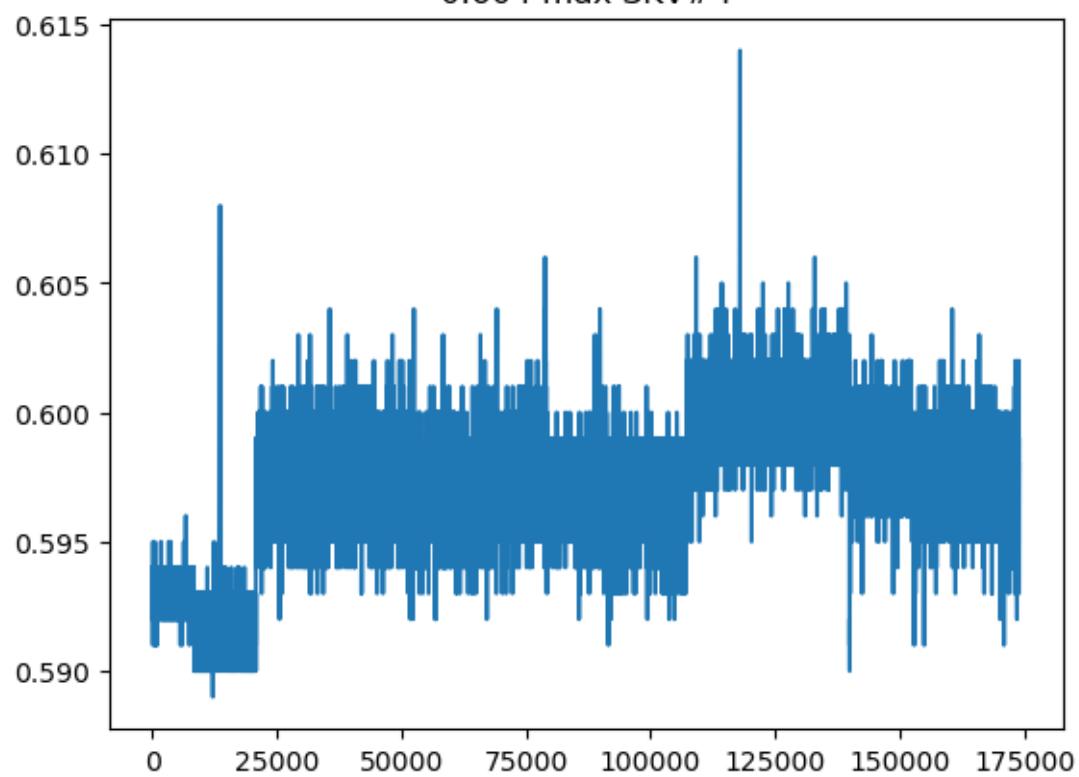
4.713 SKV#4



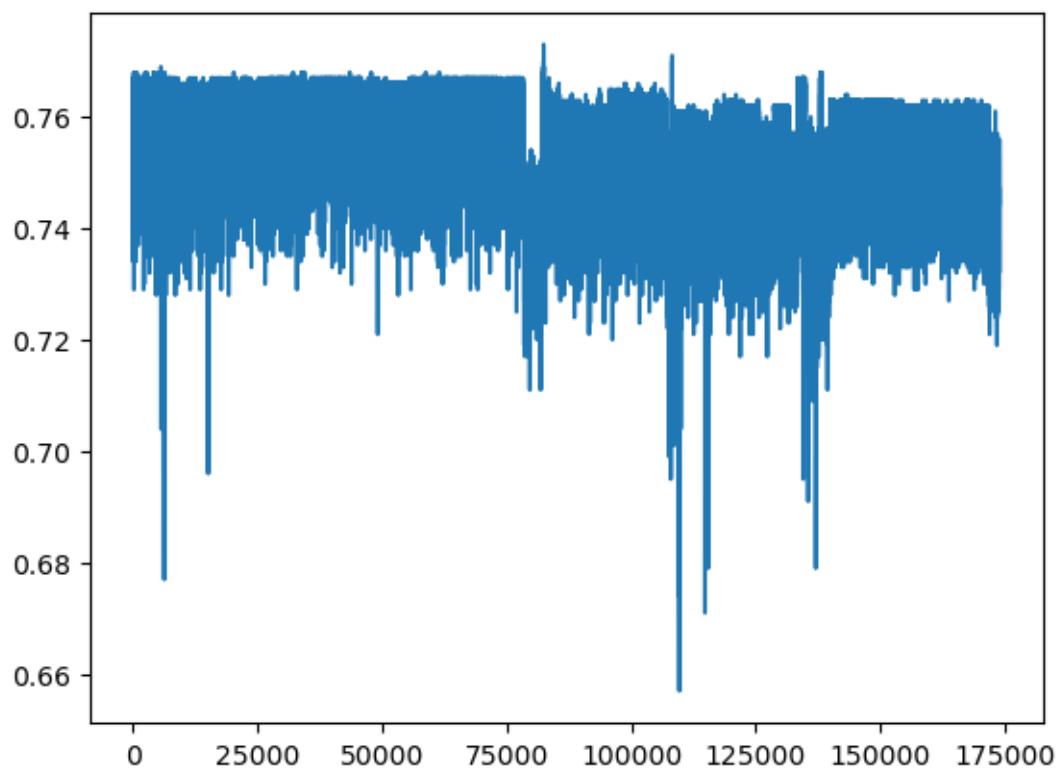
0.604 min SKV#4



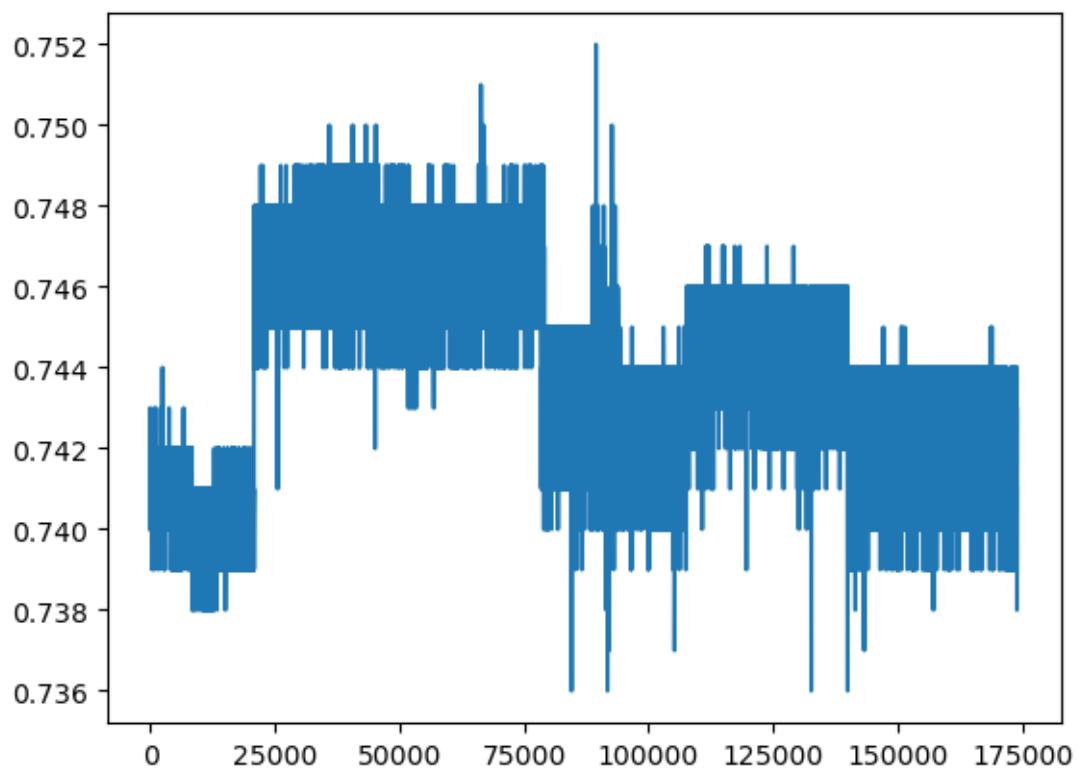
0.604 max SKV#4



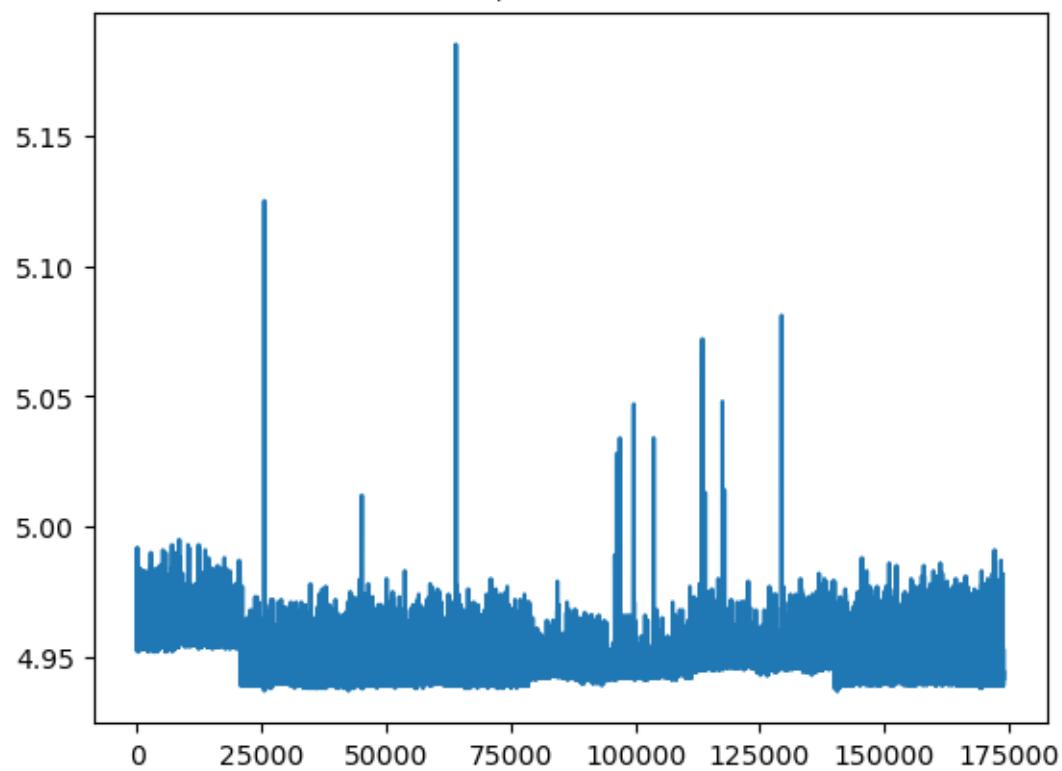
0.74 min SKV#4



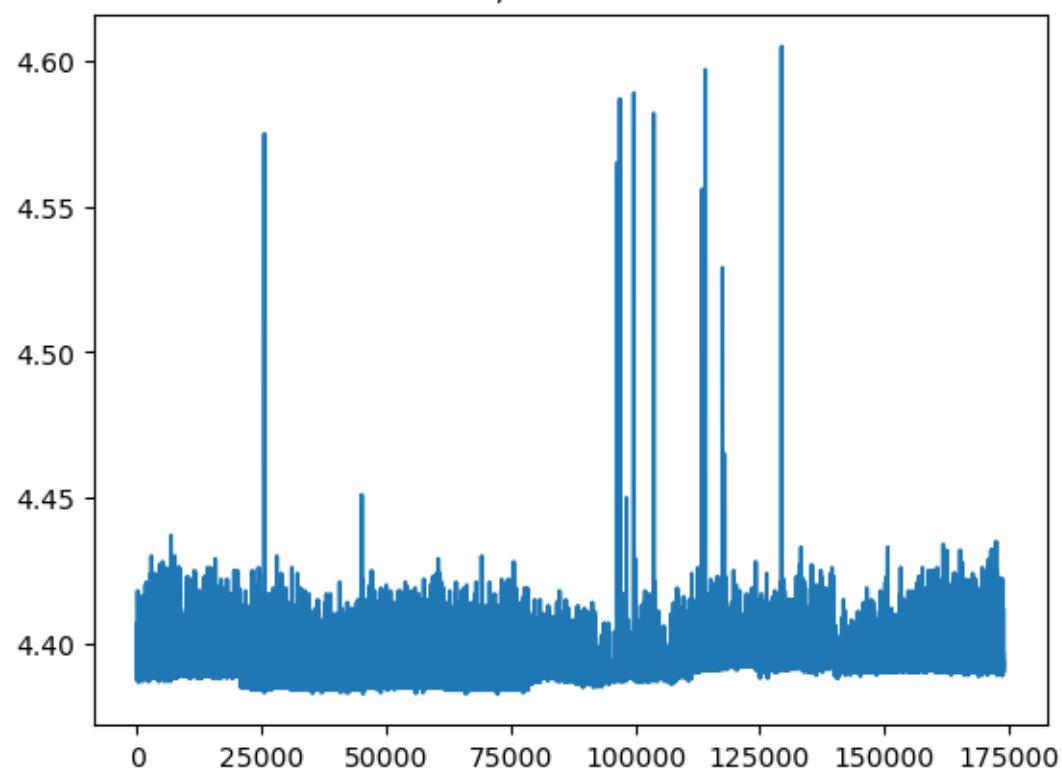
0.74 max SKV#4



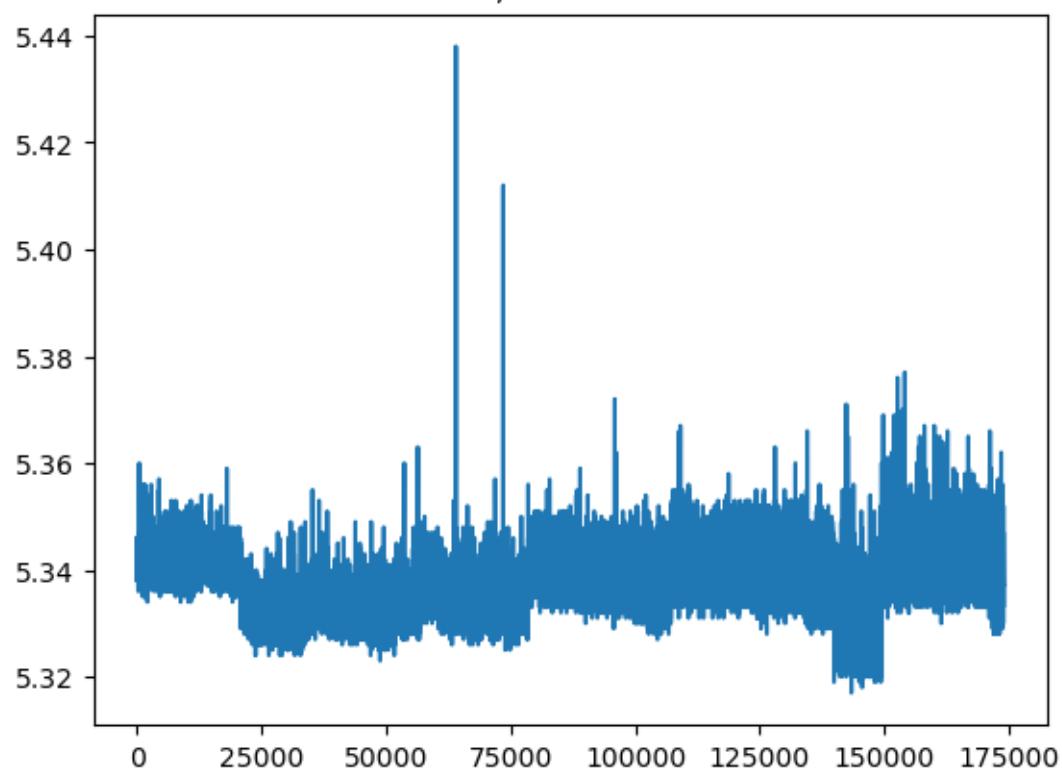
4,96 SKV#4



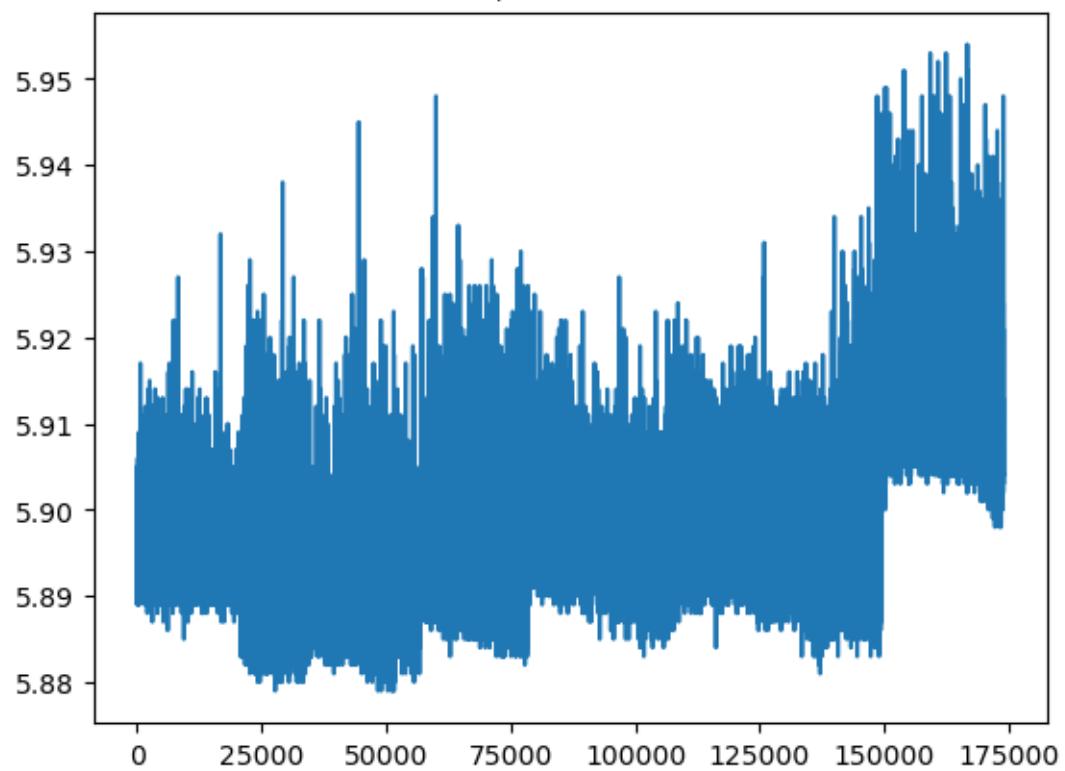
4,40 SKV#4



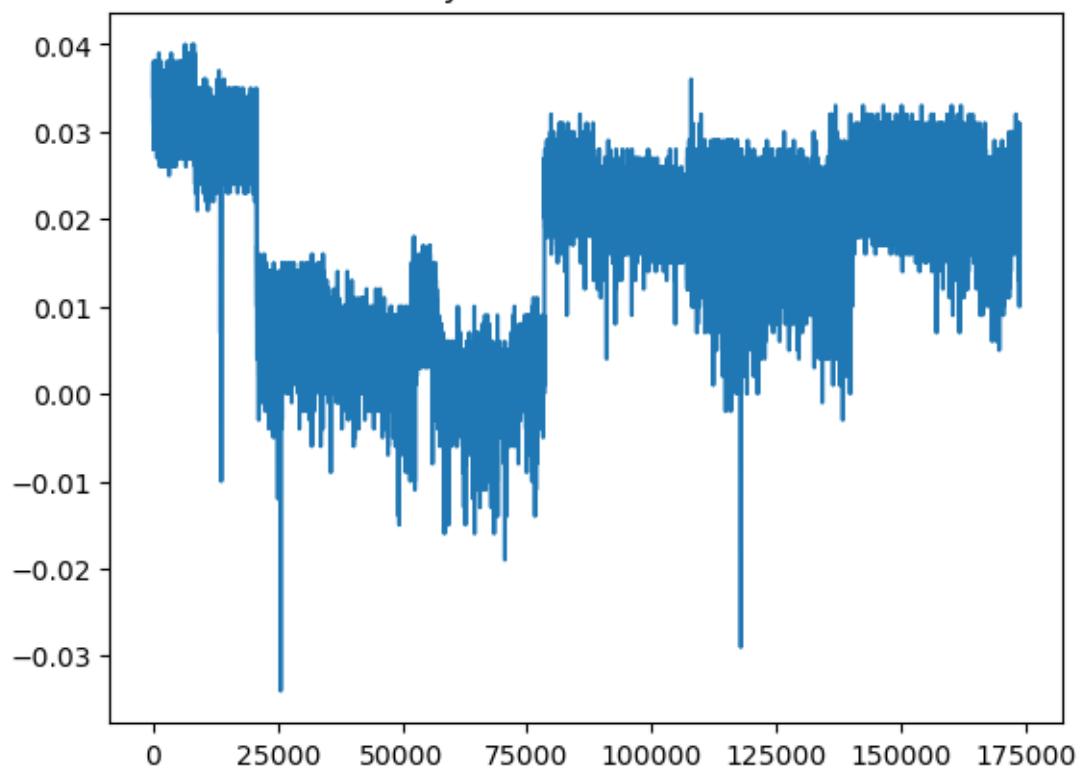
5,36 SKV#4



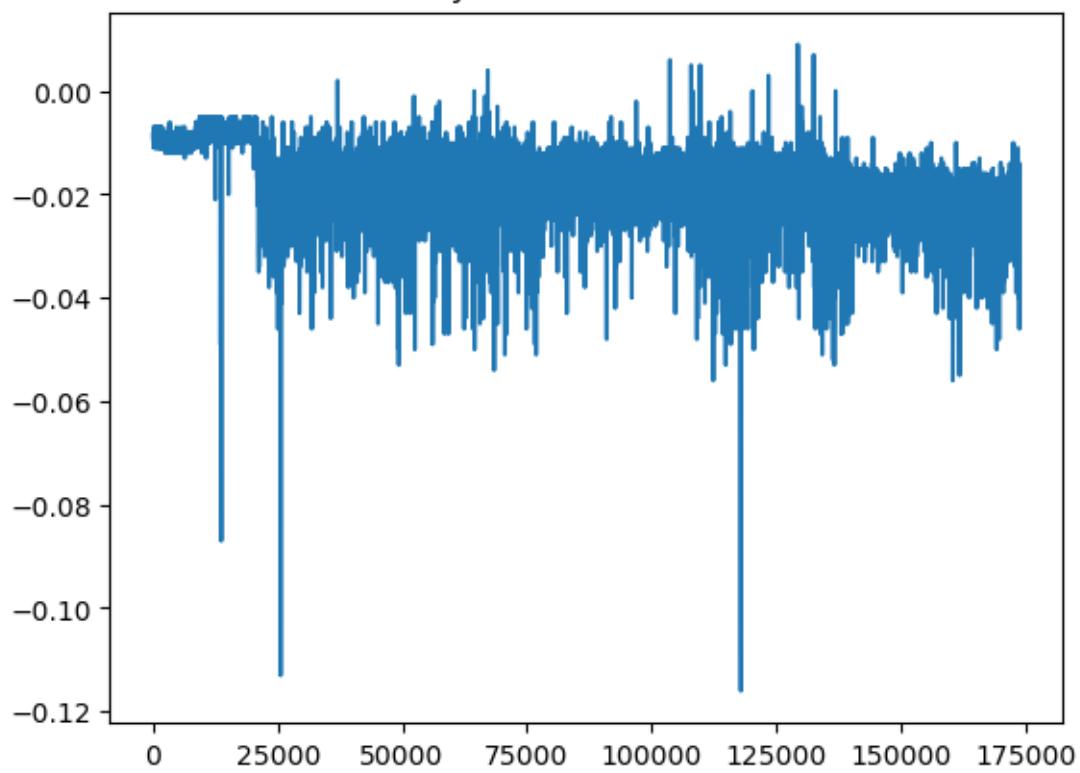
5,92 SKV#4



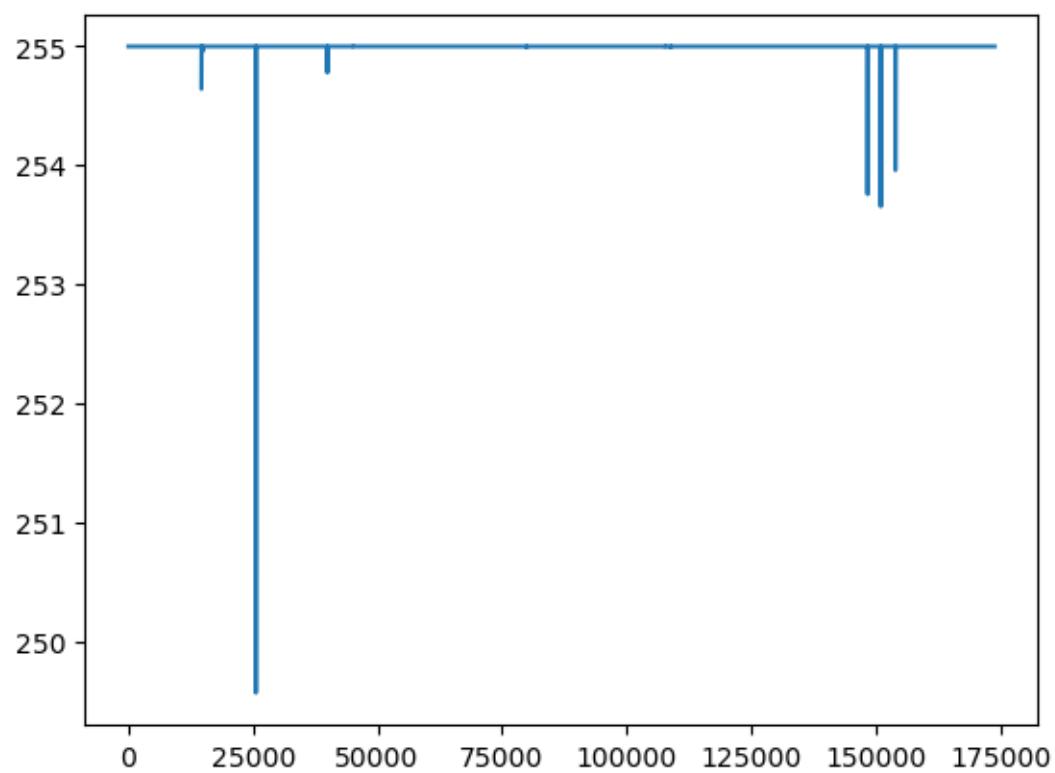
Sym Einstich SKV#4



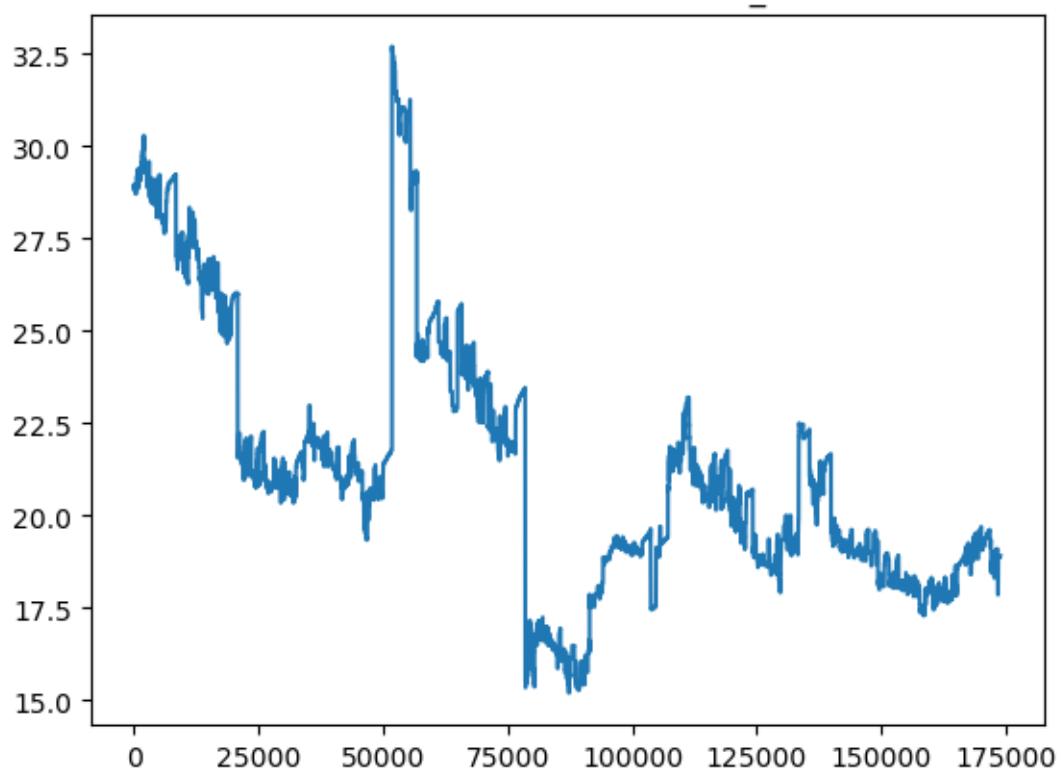
Sym aussen SKV#4



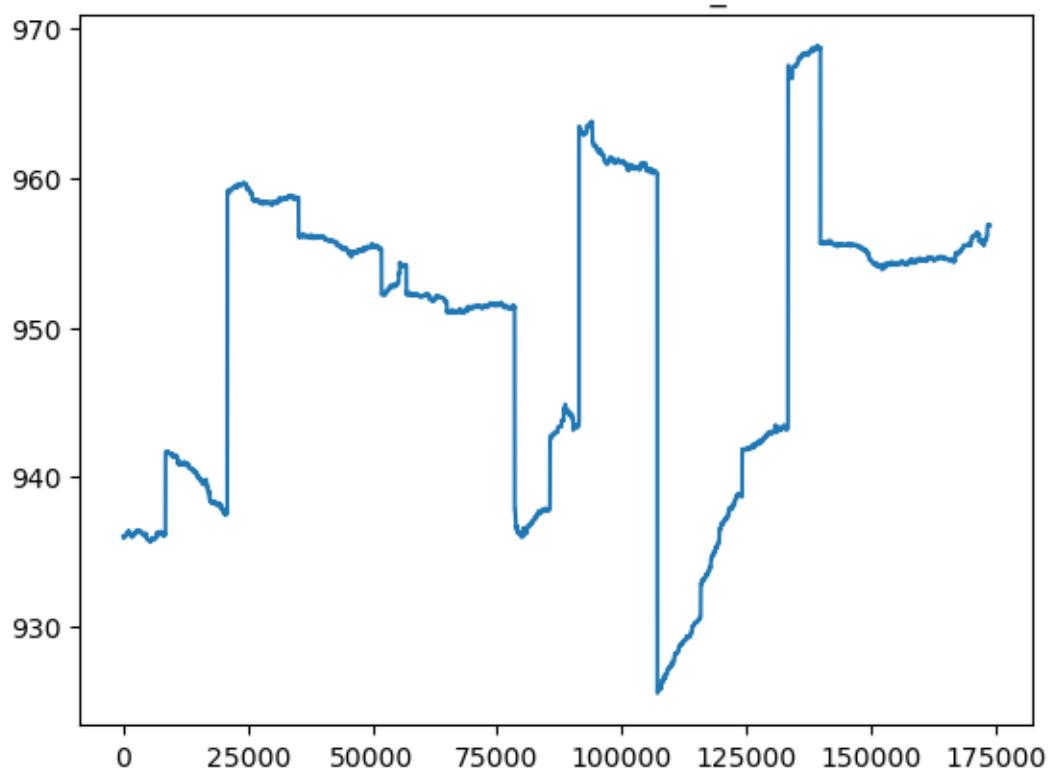
Licht-Einstich frei SKV#4

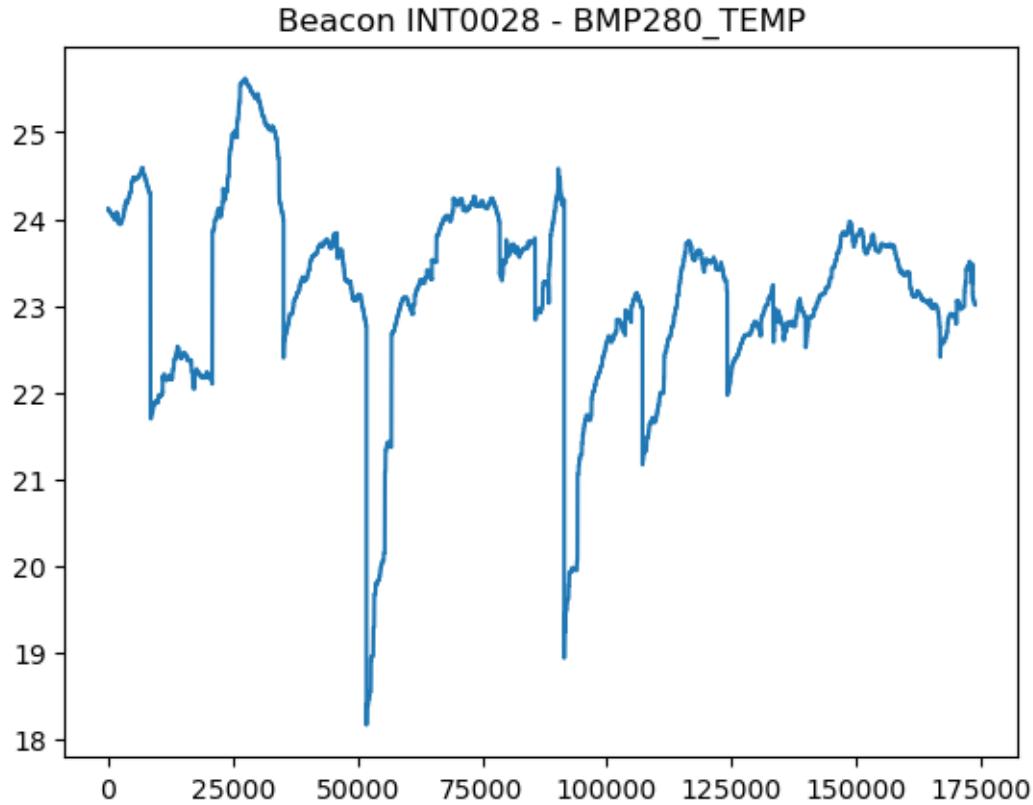


Beacon INT0028 - BME280\_RH



Beacon INT0028 - BMP280\_PRESS





```
[9]: for f in interestingColumns:
    na = X[f].isna()
    toDrop = X[na].index
    print(f"{f} dropped {toDrop}")
    X = X.drop(toDrop)

#Xna = X[na > 0].drop()
```

```
ST_CH1_P_F0 dropped Index([], dtype='int64')
ST_CH1_P_F1 dropped Index([], dtype='int64')
ST_CH1_P_F2 dropped Index([], dtype='int64')
ST_CH1_P_F3 dropped Index([], dtype='int64')
ST_CH1_P_F4 dropped Index([], dtype='int64')
ST_CH1_P_F5 dropped Index([], dtype='int64')
ST_CH1_P_F6 dropped Index([], dtype='int64')
ST_CH1_P_F7 dropped Index([], dtype='int64')
ST_CH1_P_F8 dropped Index([], dtype='int64')
ST_CH1_P_F9 dropped Index([], dtype='int64')
ST_CH1_P_F10 dropped Index([], dtype='int64')
ST_CH1_P_F11 dropped Index([], dtype='int64')
ST_CH1_P0_F0 dropped Index([], dtype='int64')
```

```
ST_CH1_P0_F1 dropped Index([], dtype='int64')
ST_CH1_P0_F2 dropped Index([], dtype='int64')
ST_CH1_P0_F3 dropped Index([], dtype='int64')
ST_CH1_P0_F4 dropped Index([], dtype='int64')
ST_CH1_P0_F5 dropped Index([], dtype='int64')
ST_CH1_P0_F6 dropped Index([], dtype='int64')
ST_CH1_P0_F7 dropped Index([], dtype='int64')
ST_CH1_P0_F8 dropped Index([], dtype='int64')
ST_CH1_P0_F9 dropped Index([], dtype='int64')
ST_CH1_P0_F10 dropped Index([], dtype='int64')
ST_CH1_P0_F11 dropped Index([], dtype='int64')
ST_CH1_P1_F0 dropped Index([], dtype='int64')
ST_CH1_P1_F1 dropped Index([], dtype='int64')
ST_CH1_P1_F2 dropped Index([], dtype='int64')
ST_CH1_P1_F3 dropped Index([], dtype='int64')
ST_CH1_P1_F4 dropped Index([], dtype='int64')
ST_CH1_P1_F5 dropped Index([], dtype='int64')
ST_CH1_P1_F6 dropped Index([], dtype='int64')
ST_CH1_P1_F7 dropped Index([], dtype='int64')
ST_CH1_P1_F8 dropped Index([], dtype='int64')
ST_CH1_P1_F9 dropped Index([], dtype='int64')
ST_CH1_P1_F10 dropped Index([], dtype='int64')
ST_CH1_P1_F11 dropped Index([], dtype='int64')
ST_CH1_P2_F0 dropped Index([], dtype='int64')
ST_CH1_P2_F1 dropped Index([], dtype='int64')
ST_CH1_P2_F2 dropped Index([], dtype='int64')
ST_CH1_P2_F3 dropped Index([], dtype='int64')
ST_CH1_P2_F4 dropped Index([], dtype='int64')
ST_CH1_P2_F5 dropped Index([], dtype='int64')
ST_CH1_P2_F6 dropped Index([], dtype='int64')
ST_CH1_P2_F7 dropped Index([], dtype='int64')
ST_CH1_P2_F8 dropped Index([], dtype='int64')
ST_CH1_P2_F9 dropped Index([], dtype='int64')
ST_CH1_P2_F10 dropped Index([], dtype='int64')
ST_CH1_P2_F11 dropped Index([], dtype='int64')
ST_CH2_P_F0 dropped Index([], dtype='int64')
ST_CH2_P_F1 dropped Index([], dtype='int64')
ST_CH2_P_F2 dropped Index([], dtype='int64')
ST_CH2_P_F3 dropped Index([], dtype='int64')
ST_CH2_P_F4 dropped Index([], dtype='int64')
ST_CH2_P_F5 dropped Index([], dtype='int64')
ST_CH2_P_F6 dropped Index([], dtype='int64')
ST_CH2_P_F7 dropped Index([], dtype='int64')
ST_CH2_P_F8 dropped Index([], dtype='int64')
ST_CH2_P_F9 dropped Index([], dtype='int64')
ST_CH2_P_F10 dropped Index([], dtype='int64')
ST_CH2_P_F11 dropped Index([], dtype='int64')
ST_CH2_P0_F0 dropped Index([], dtype='int64')
```

```
ST_CH2_P0_F1 dropped Index([], dtype='int64')
ST_CH2_P0_F2 dropped Index([], dtype='int64')
ST_CH2_P0_F3 dropped Index([], dtype='int64')
ST_CH2_P0_F4 dropped Index([], dtype='int64')
ST_CH2_P0_F5 dropped Index([], dtype='int64')
ST_CH2_P0_F6 dropped Index([], dtype='int64')
ST_CH2_P0_F7 dropped Index([], dtype='int64')
ST_CH2_P0_F8 dropped Index([], dtype='int64')
ST_CH2_P0_F9 dropped Index([], dtype='int64')
ST_CH2_P0_F10 dropped Index([], dtype='int64')
ST_CH2_P0_F11 dropped Index([], dtype='int64')
ST_CH2_P1_F0 dropped Index([], dtype='int64')
ST_CH2_P1_F1 dropped Index([], dtype='int64')
ST_CH2_P1_F2 dropped Index([], dtype='int64')
ST_CH2_P1_F3 dropped Index([], dtype='int64')
ST_CH2_P1_F4 dropped Index([], dtype='int64')
ST_CH2_P1_F5 dropped Index([], dtype='int64')
ST_CH2_P1_F6 dropped Index([], dtype='int64')
ST_CH2_P1_F7 dropped Index([], dtype='int64')
ST_CH2_P1_F8 dropped Index([], dtype='int64')
ST_CH2_P1_F9 dropped Index([], dtype='int64')
ST_CH2_P1_F10 dropped Index([], dtype='int64')
ST_CH2_P1_F11 dropped Index([], dtype='int64')
ST_CH2_P2_F0 dropped Index([], dtype='int64')
ST_CH2_P2_F1 dropped Index([], dtype='int64')
ST_CH2_P2_F2 dropped Index([], dtype='int64')
ST_CH2_P2_F3 dropped Index([], dtype='int64')
ST_CH2_P2_F4 dropped Index([], dtype='int64')
ST_CH2_P2_F5 dropped Index([], dtype='int64')
ST_CH2_P2_F6 dropped Index([], dtype='int64')
ST_CH2_P2_F7 dropped Index([], dtype='int64')
ST_CH2_P2_F8 dropped Index([], dtype='int64')
ST_CH2_P2_F9 dropped Index([], dtype='int64')
ST_CH2_P2_F10 dropped Index([], dtype='int64')
ST_CH2_P2_F11 dropped Index([], dtype='int64')
4.713 SKV#1 dropped Index([], dtype='int64')
0.604 min SKV#1 dropped Index([67529], dtype='int64')
0.604 max SKV#1 dropped Index([], dtype='int64')
0.74 min SKV#1 dropped Index([], dtype='int64')
0.74 max SKV#1 dropped Index([], dtype='int64')
4.96 SKV#1 dropped Index([], dtype='int64')
4.40 SKV#1 dropped Index([], dtype='int64')
5.36 SKV#1 dropped Index([], dtype='int64')
5.92 SKV#1 dropped Index([], dtype='int64')
Sym aussen SKV#1 dropped Index([], dtype='int64')
Sym Einstich SKV#1 dropped Index([], dtype='int64')
Licht-Einstich frei SKV#1 dropped Index([], dtype='int64')
4.713 SKV#2 dropped Index([15807, 15808, 15809, 15810, 15811, 15812, 15813,
```

```

15900, 16556, 17224,
    18655, 19591, 19649, 20690, 20694, 82760],
      dtype='int64')
0.604 min SKV#2 dropped Index([], dtype='int64')
0.604 max SKV#2 dropped Index([], dtype='int64')
0.74 min SKV#2 dropped Index([], dtype='int64')
0.74 max SKV#2 dropped Index([], dtype='int64')
4,96 SKV#2 dropped Index([], dtype='int64')
4,40 SKV#2 dropped Index([], dtype='int64')
5,36 SKV#2 dropped Index([], dtype='int64')
5,92 SKV#2 dropped Index([], dtype='int64')
Sym Einstich SKV#2 dropped Index([], dtype='int64')
Sym aussen SKV#2 dropped Index([], dtype='int64')
Licht-Einstich frei SKV#2 dropped Index([], dtype='int64')
4.713 SKV#3 dropped Index([55958, 55959, 55960, 55961, 55962, 55963, 55964,
55965, 55966, 55967,
    55968, 55969, 55970],
      dtype='int64')
0.604 min SKV#3 dropped Index([], dtype='int64')
0.604 max SKV#3 dropped Index([], dtype='int64')
0.74 min SKV#3 dropped Index([], dtype='int64')
0.74 max SKV#3 dropped Index([], dtype='int64')
4,96 SKV#3 dropped Index([], dtype='int64')
4,40 SKV#3 dropped Index([], dtype='int64')
5,36 SKV#3 dropped Index([], dtype='int64')
5,92 SKV#3 dropped Index([], dtype='int64')
Sym Einstich SKV#3 dropped Index([], dtype='int64')
Sym aussen SKV#3 dropped Index([], dtype='int64')
Licht-Einstich frei SKV#3 dropped Index([], dtype='int64')
4.713 SKV#4 dropped Index([25593], dtype='int64')
0.604 min SKV#4 dropped Index([], dtype='int64')
0.604 max SKV#4 dropped Index([], dtype='int64')
0.74 min SKV#4 dropped Index([], dtype='int64')
0.74 max SKV#4 dropped Index([], dtype='int64')
4,96 SKV#4 dropped Index([], dtype='int64')
4,40 SKV#4 dropped Index([35250], dtype='int64')
5,36 SKV#4 dropped Index([], dtype='int64')
5,92 SKV#4 dropped Index([], dtype='int64')
Sym Einstich SKV#4 dropped Index([], dtype='int64')
Sym aussen SKV#4 dropped Index([], dtype='int64')
Licht-Einstich frei SKV#4 dropped Index([], dtype='int64')
Beacon INT0028 - BME280_RH dropped Index([], dtype='int64')
Beacon INT0028 - BMP280_PRESS dropped Index([], dtype='int64')
Beacon INT0028 - BMP280_TEMP dropped Index([], dtype='int64')

```

[10]: X.isna().sum()

```
[10]: timestamp_skv          0
timediff_skv            7
timestamp_sensor         0
timediff_sensor          7
SynchroDiff              0
..
Beacon INT0028 - BMP280_PRESS 0
timestamp.2              0
Beacon INT0028 - BMP280_TEMP 0
pieces                   0
tool io                  0
Length: 165, dtype: int64
```

```
[13]: len(interestingColumns)
```

```
[13]: 147
```

## 1.1 Let's reduce the number of features; do a PCA

first we need to scale our features

e.g:  $(\text{value} - \text{min\_value}) / (\text{max\_value} - \text{min\_value})$

```
[15]: from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()

scaler.fit(X[interestingColumns])

Xscaled = pd.DataFrame(scaler.
    ↪transform(X[interestingColumns]), columns=interestingColumns)
```

```
[ ]: for f in interestingColumns:
    plt.plot(Xscaled.index,Xscaled[f])
    plt.title(f)
    plt.show()
```

```
[18]: from sklearn import decomposition

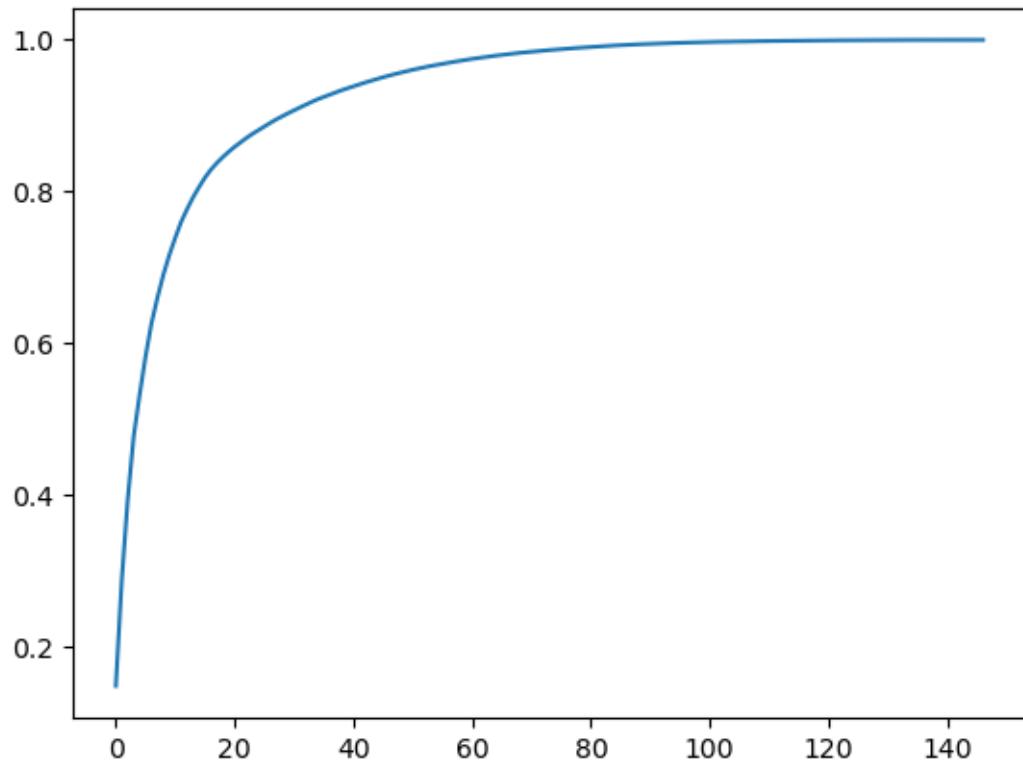
pca = decomposition.PCA(n_components=len(interestingColumns))

pca.fit(Xscaled)

Xpca = pd.DataFrame(pca.transform(Xscaled))
```

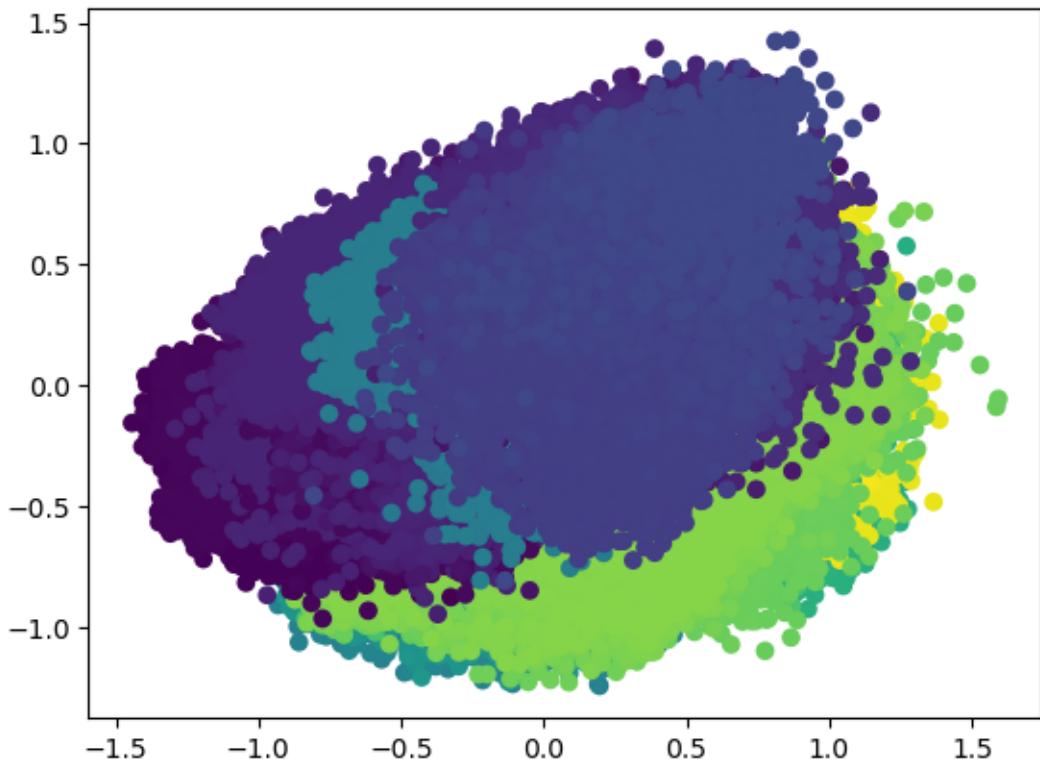
```
[22]: plt.plot(np.cumsum(pca.explained_variance_ratio_))
```

```
[22]: [<matplotlib.lines.Line2D at 0x7f871b4aff70>]
```



```
[26]: plt.scatter(Xpca[0],Xpca[1],c=X.pieces)
```

```
[26]: <matplotlib.collections.PathCollection at 0x7f871ba62f50>
```



```
[39]: movingAverageWindow = 500

Xavg = Xscaled.copy()

for col in Xscaled.columns:
    Xavg.loc[:,col] = Xscaled[col].rolling(movingAverageWindow).mean()

Xavg = Xavg.bfill(axis=0)

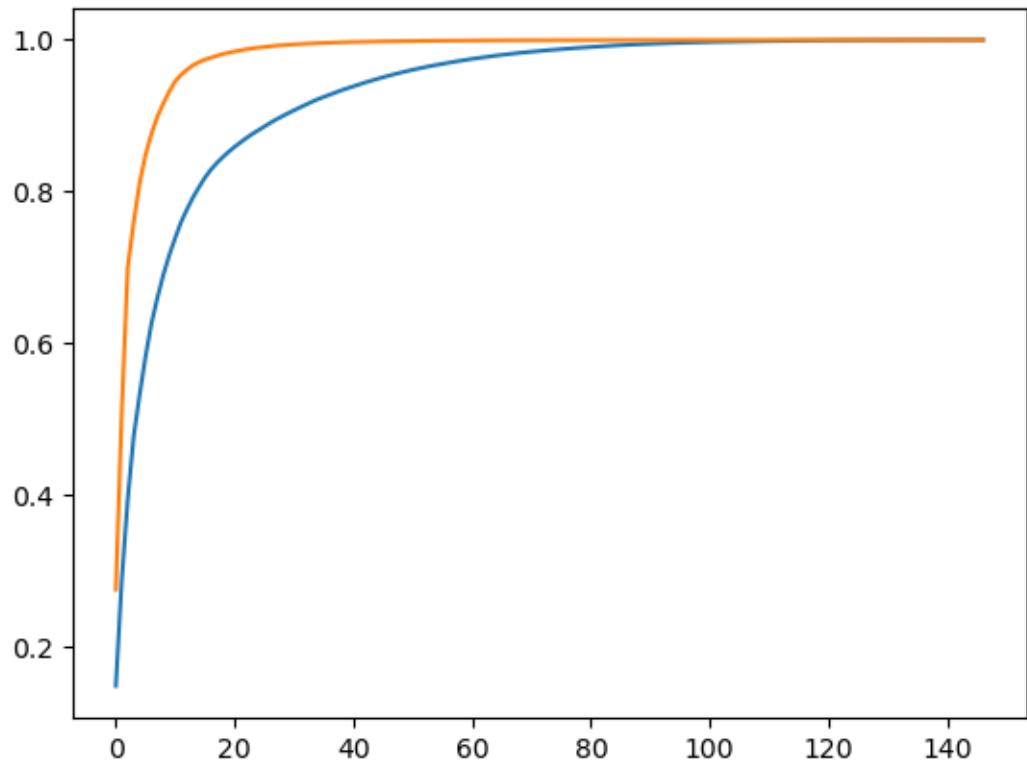
pcaAvg = decomposition.PCA(n_components=len(interestingColumns))

pcaAvg.fit(Xavg)

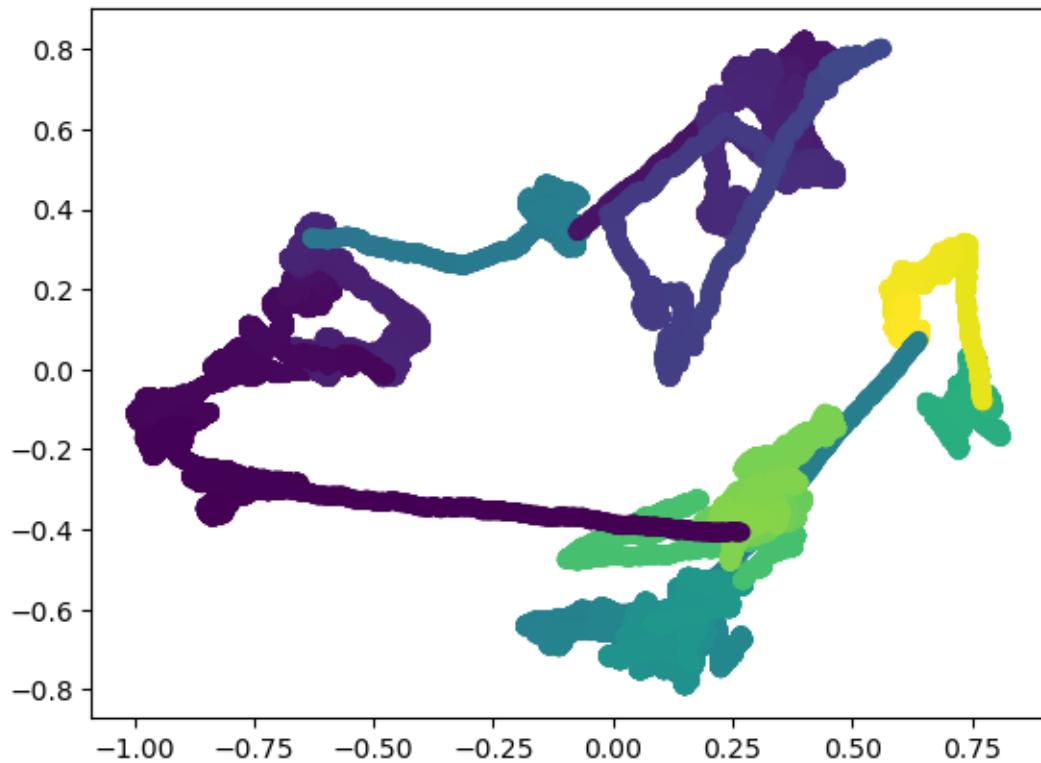
XpcaAvg = pd.DataFrame(pca.transform(Xavg))

plt.plot(np.cumsum(pca.explained_variance_ratio_))
plt.plot(np.cumsum(pcaAvg.explained_variance_ratio_))
plt.show()

plt.scatter(XpcaAvg[0],XpcaAvg[1],c=X.pieces)
```



[39]: <matplotlib.collections.PathCollection at 0x7f8721030670>



[ ]: