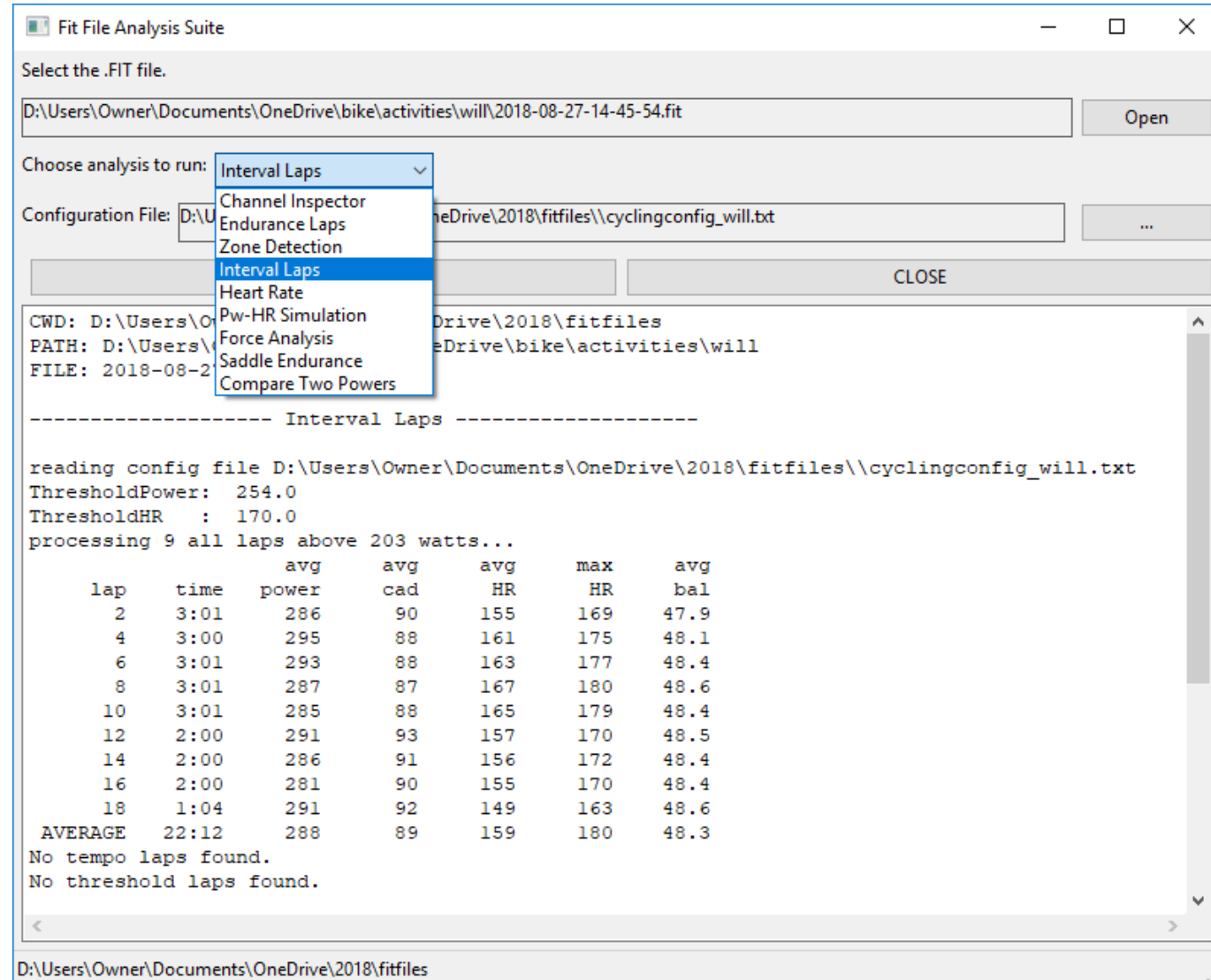


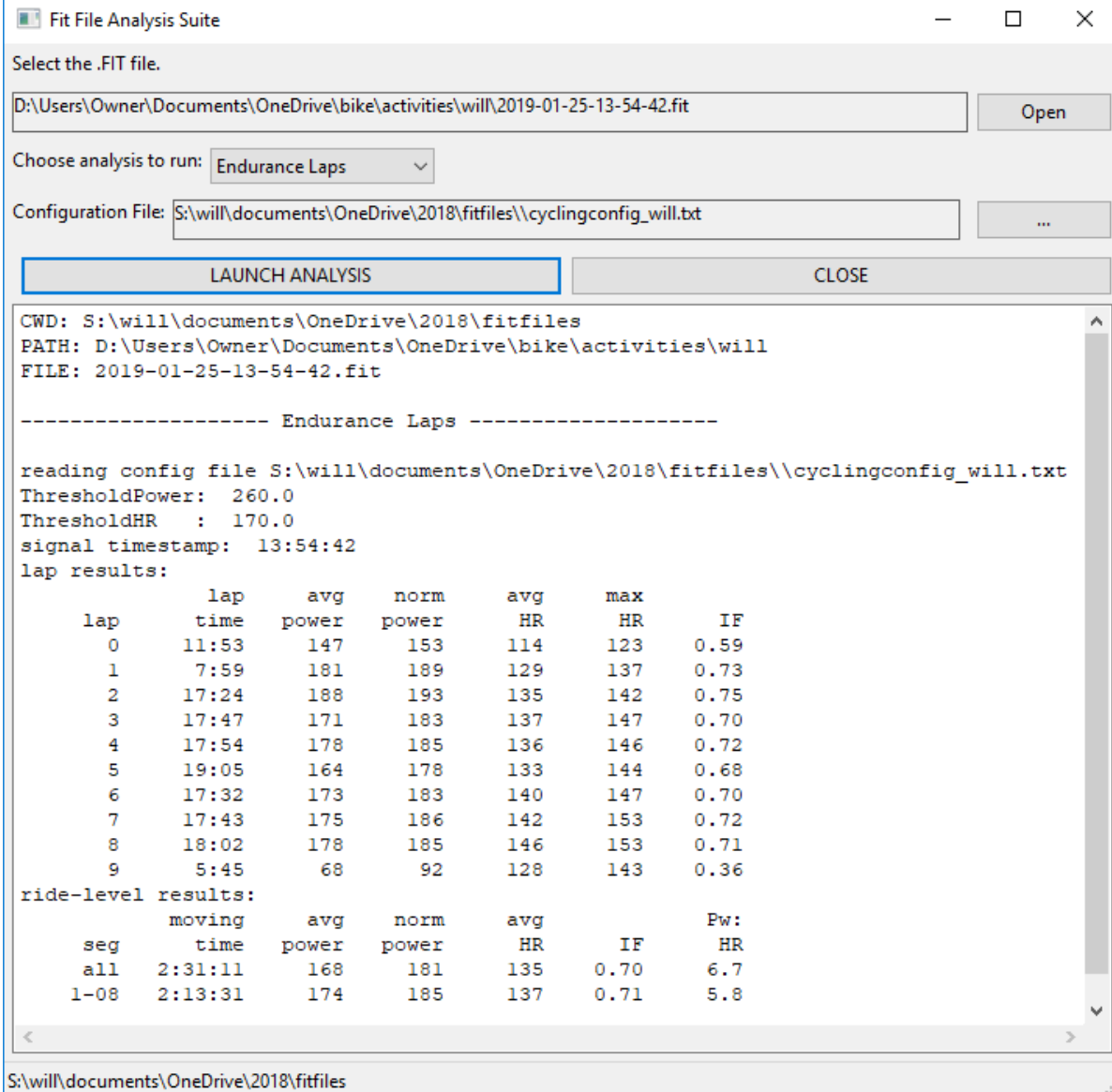
# FitFiles Project

- Fast access to a suite of custom tools for analyzing cycling workouts.
- Drag-drop support for .FIT files.
- Formatted text output for copy-pasting into workout diary.
- Support for user-configuration files.
- Available on GitHub (user: guitarsenall)



# FitFiles: Endurance Summary

- Print lap statistics to show progress.
- Print results for whole ride and inner laps (assume first and last lap are warmup and cooldown).



The screenshot shows the 'Fit File Analysis Suite' window. At the top, it says 'Select the .FIT file.' with a text box containing 'D:\Users\Owner\Documents\OneDrive\bike\activities\will\2019-01-25-13-54-42.fit' and an 'Open' button. Below that, 'Choose analysis to run:' has a dropdown menu set to 'Endurance Laps'. The 'Configuration File:' field shows 'S:\will\documents\OneDrive\2018\fitfiles\cyclingconfig\_will.txt' with a browse button. Two buttons, 'LAUNCH ANALYSIS' and 'CLOSE', are present. The main text area displays the following information:

```
CWD: S:\will\documents\OneDrive\2018\fitfiles
PATH: D:\Users\Owner\Documents\OneDrive\bike\activities\will
FILE: 2019-01-25-13-54-42.fit

----- Endurance Laps -----

reading config file S:\will\documents\OneDrive\2018\fitfiles\cyclingconfig_will.txt
ThresholdPower: 260.0
ThresholdHR : 170.0
signal timestamp: 13:54:42
lap results:
```

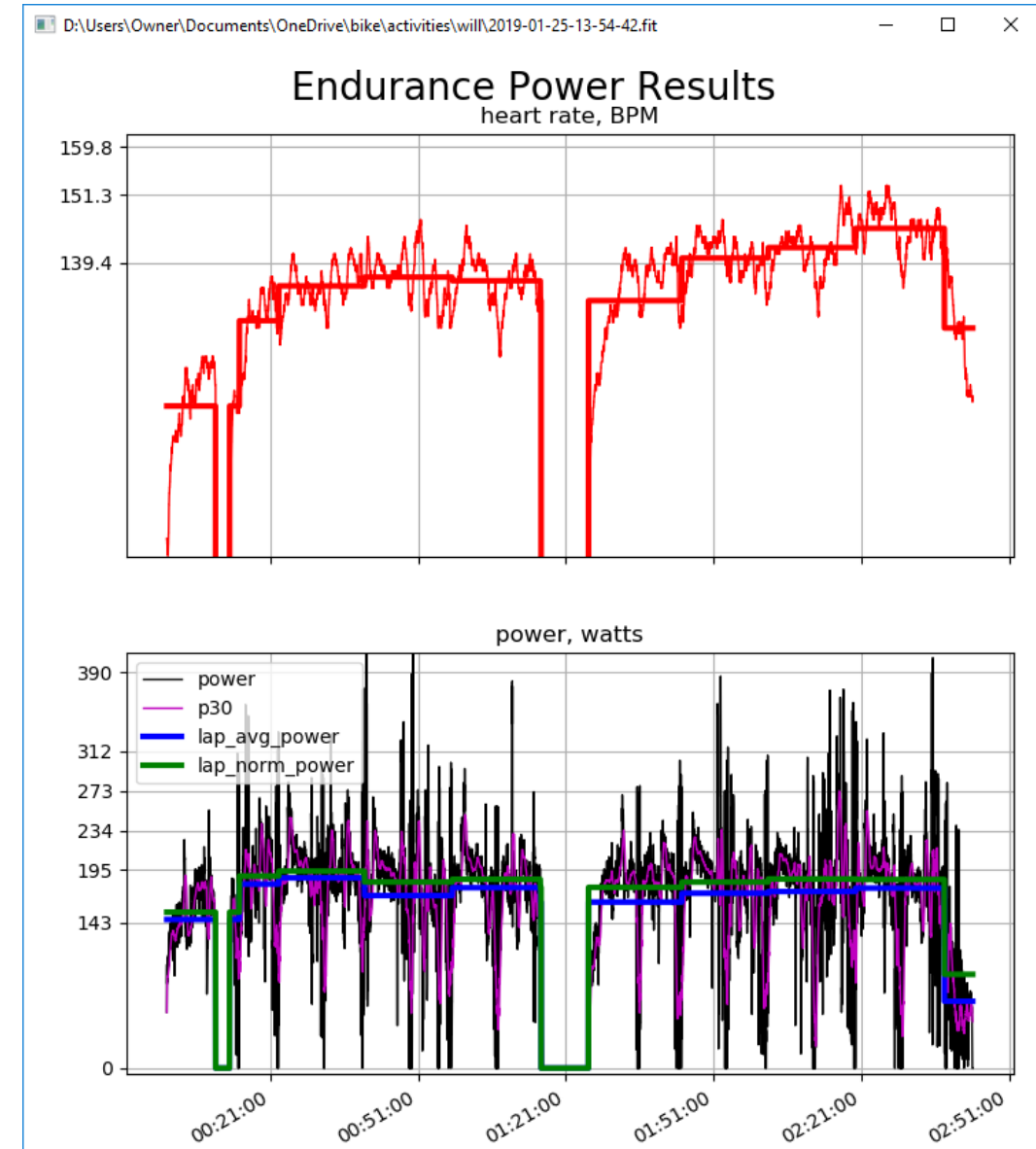
lap	lap time	avg power	norm power	avg HR	max HR	IF
0	11:53	147	153	114	123	0.59
1	7:59	181	189	129	137	0.73
2	17:24	188	193	135	142	0.75
3	17:47	171	183	137	147	0.70
4	17:54	178	185	136	146	0.72
5	19:05	164	178	133	144	0.68
6	17:32	173	183	140	147	0.70
7	17:43	175	186	142	153	0.72
8	18:02	178	185	146	153	0.71
9	5:45	68	92	128	143	0.36

```
ride-level results:
      moving      avg      norm      avg      Pw:
seg  time  power  power  HR      IF  HR
all  2:31:11  168    181    135    0.70  6.7
1-08 2:13:31  174    185    137    0.71  5.8
```

The status bar at the bottom shows the path 'S:\will\documents\OneDrive\2018\fitfiles'.

# FitFiles: Endurance Summary

- Plot heart rate with grids at zone boundaries and lap averages.
- Plot raw and 30-second-average power with lap averages and grids at zone boundaries.



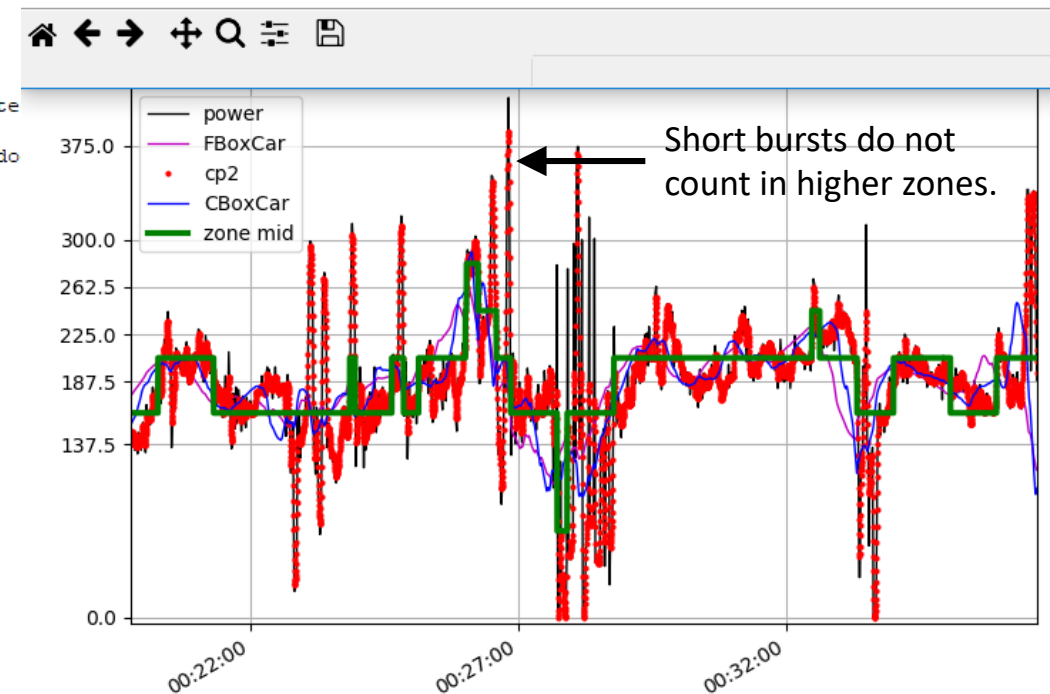
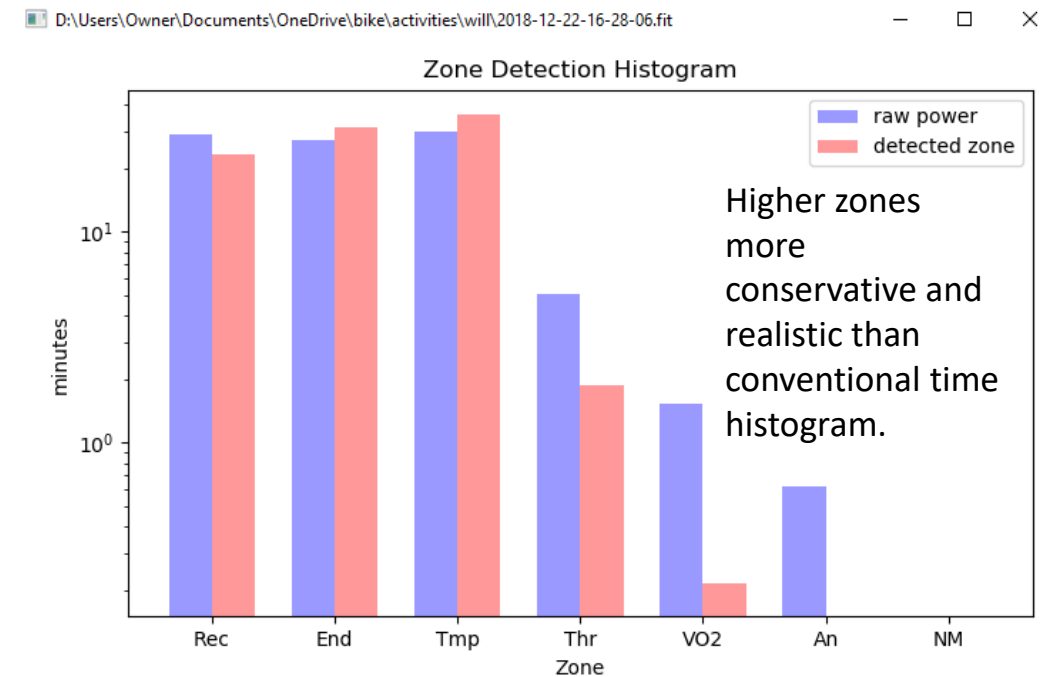
# FitFiles: Zone Detection Analysis

A better way of measuring time spent in power zones.

**Innovation:** To my knowledge, no one else offers this feature.

- Attaining a power zone should require more than spending one second at that power. Model as a state machine with transitions based on rules regarding time spent in new zone.
- Formatted print of histogram for training diary.

```
----- Zone Detection -----
reading config file S:\will\do
ThresholdPower: 260.0
ThresholdHR : 170.0
Power Zone Histogram:
Zone 1: 0:26:58 (28%)
Zone 2: 0:39:57 (42%)
Zone 3: 0:25:53 (27%)
Zone 4: 0:00:33 (0%)
Zone 5: 0:00:00 (0%)
Zone 6: 0:00:00 (0%)
Zone 7: 0:00:00 (0%)
total: 1:33:23
```



# Heartrate Simulation

Predict heartrate from power based on a first-order, linear ODE. Four parameters:

- Time constant: how quickly HR rises in response to power.
- Functional Threshold Power (FTP): Max power sustainable for one hour.
- Functional Threshold Heartrate (FTHR): Average heartrate during FTP.
- Drift rate. Cardiac drift proportional to fatigue (BPM/TSS).

$$\frac{dH}{dt} = \frac{1}{\tau} [H_T(p) + H_D F - H(t)]$$

Heartrate at  $t$

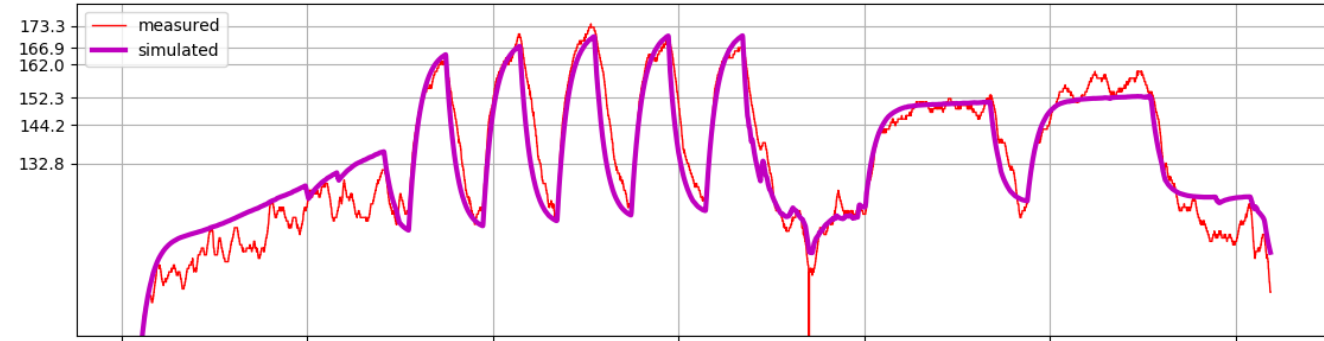
Heartrate drift-rate times fatigue (TSS at  $t$ )

Heartrate target: function of power at  $t$

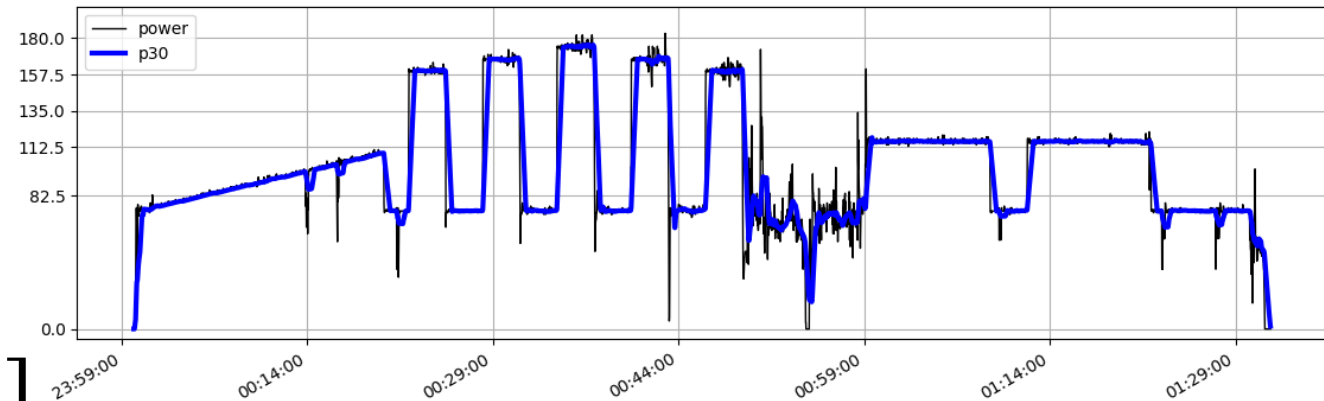
Time constant

Heartrate derivative at  $t$

Pw:HR Transfer Function  
heart rate, BPM



power, watts



Inspired by treadmill-control research:

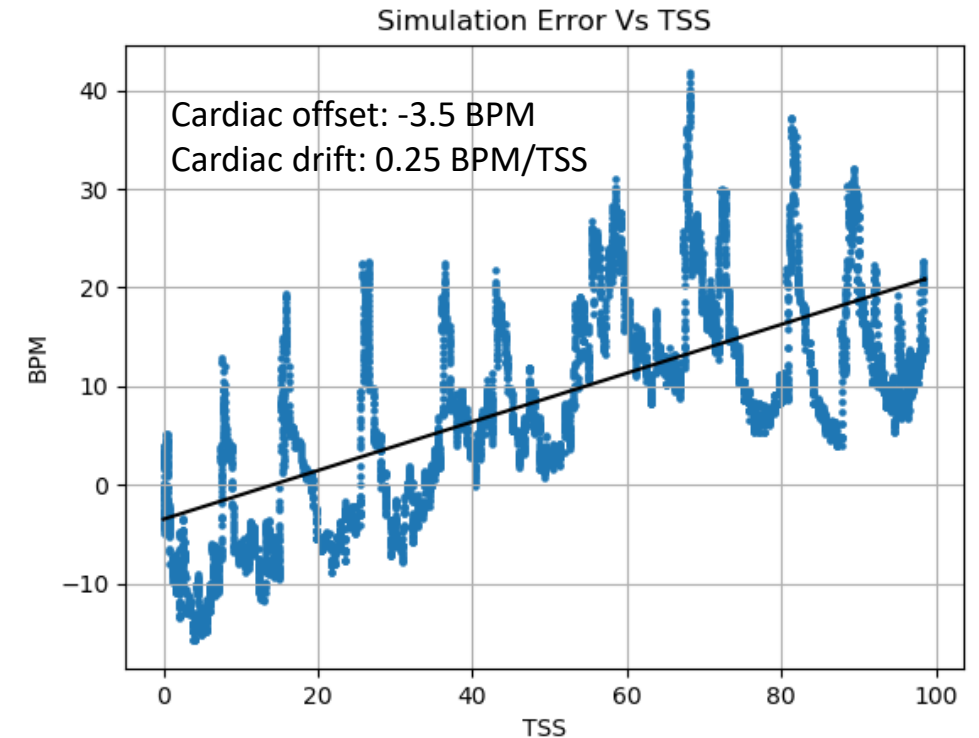
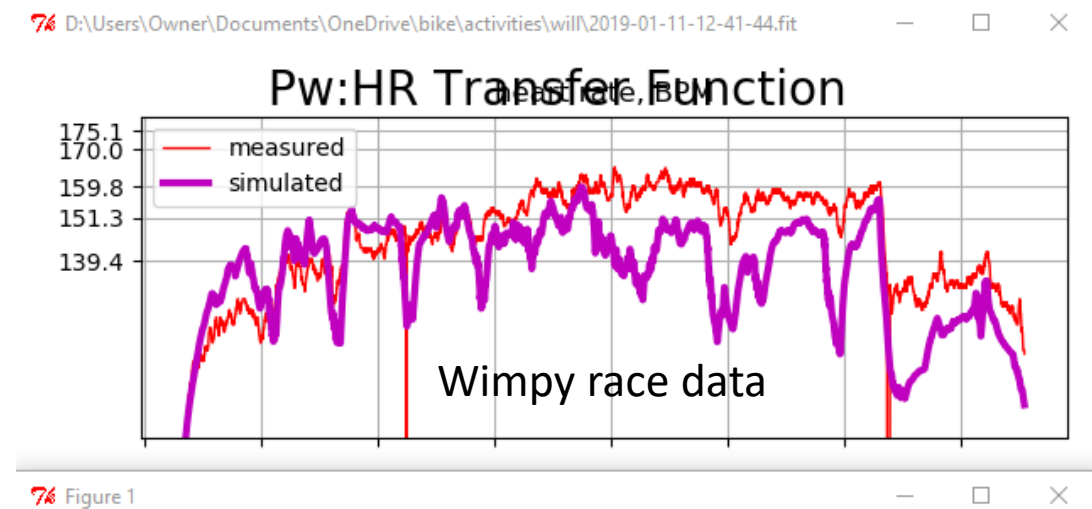
$$H(s) = \frac{k}{\tau s + 1} P(s)$$

# Heartrate Simulation

Provides a better estimate for two useful metrics which used to require a structured workout:

- Threshold Estimate:
  - Provides estimate of Functional Threshold Heart Rate (FTHR) for ANY workout (e.g., racing); structured endurance workout not necessary.
  - If FTHR is well known, it answers the question, “how much higher or lower than normal is my heartrate for this workout?”
- Cardiac drift:
  - Now modeled as proportional to fatigue (BPM/TSS) rather than a percentage over duration.
  - Available for ANY workout (e.g., racing); structured endurance workout not necessary.

**Innovation:** To my knowledge, no one else offers this feature.

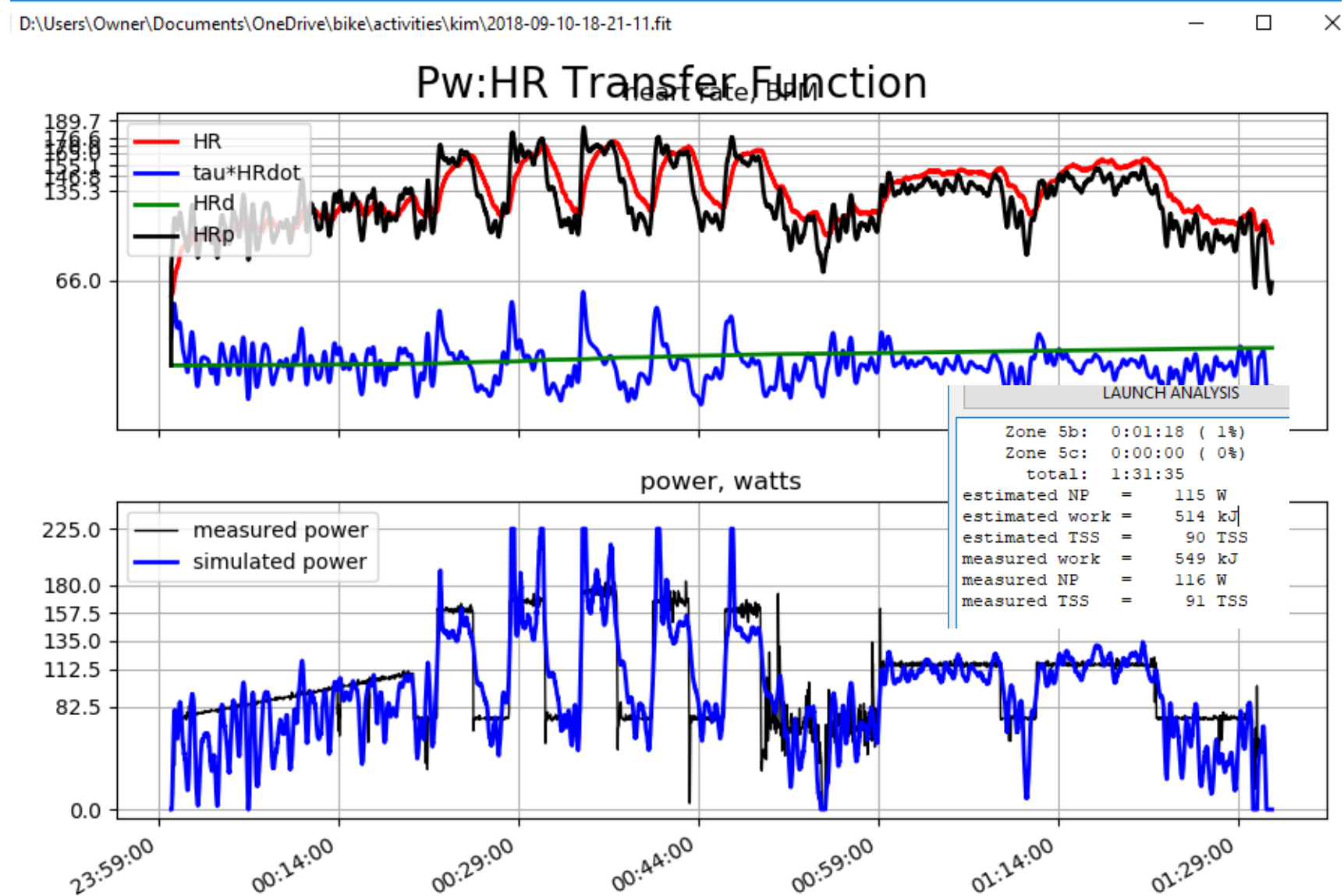


# Heartrate Simulation

Also provides for going the other way—simulating power from heart rate!

- Estimate work, intensity, and TSS for workouts that lack a power signal.

**Innovation:** To my knowledge, no one else offers this feature.

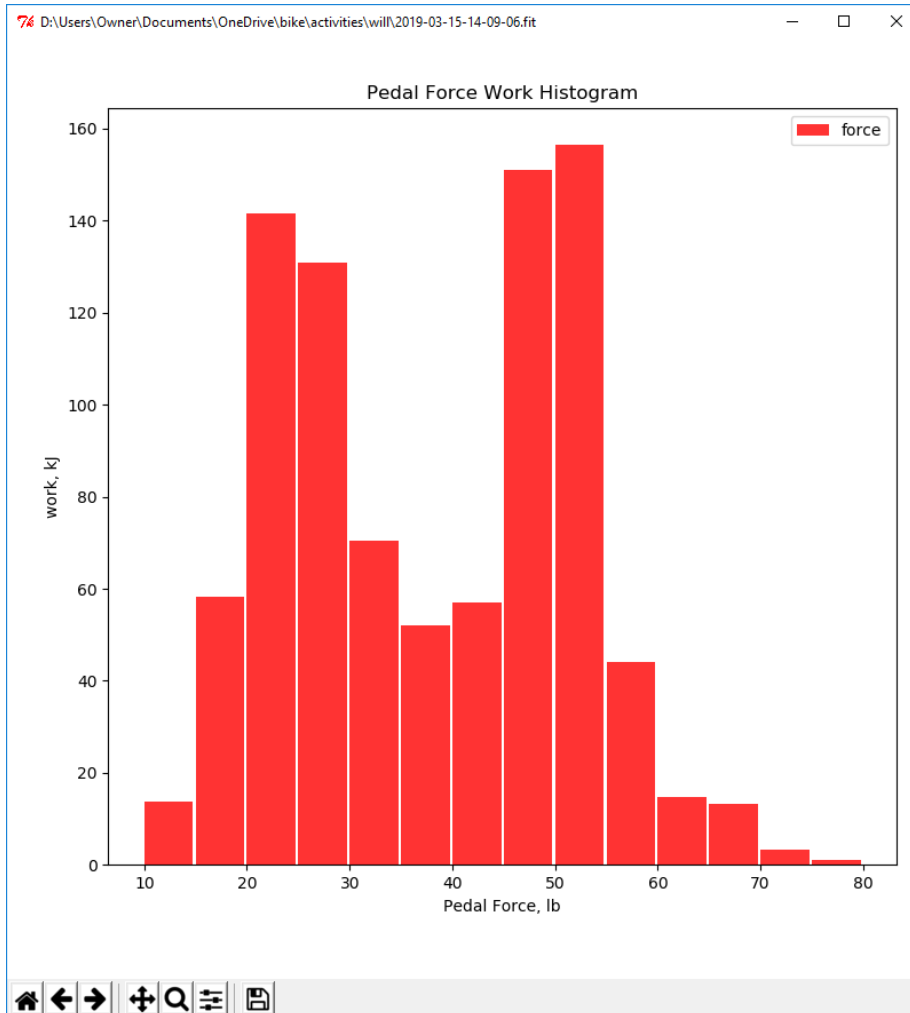




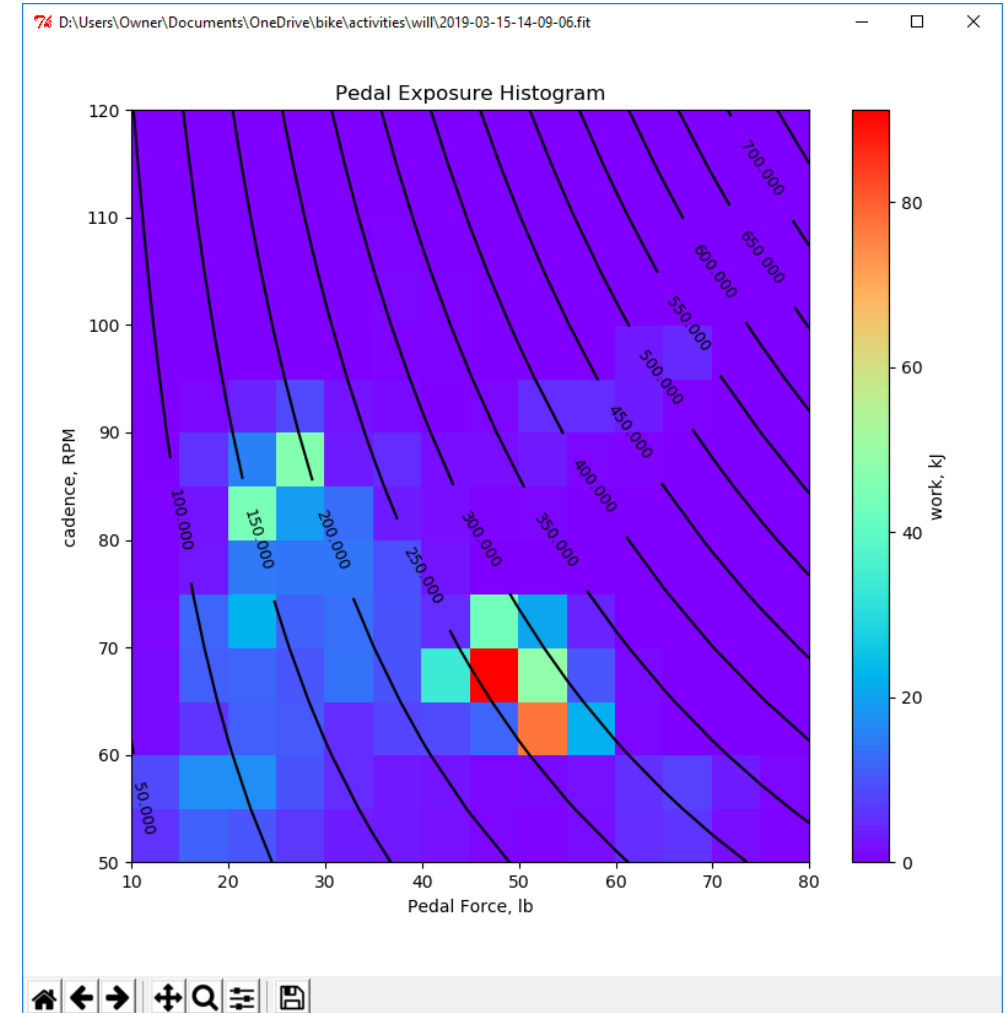
# Force Analysis

Useful for analyzing force workouts (e.g. hill repeats) and fast interval sessions to verify targets are met.

One-way histogram shows work (kJ) done at various levels of pedal force.



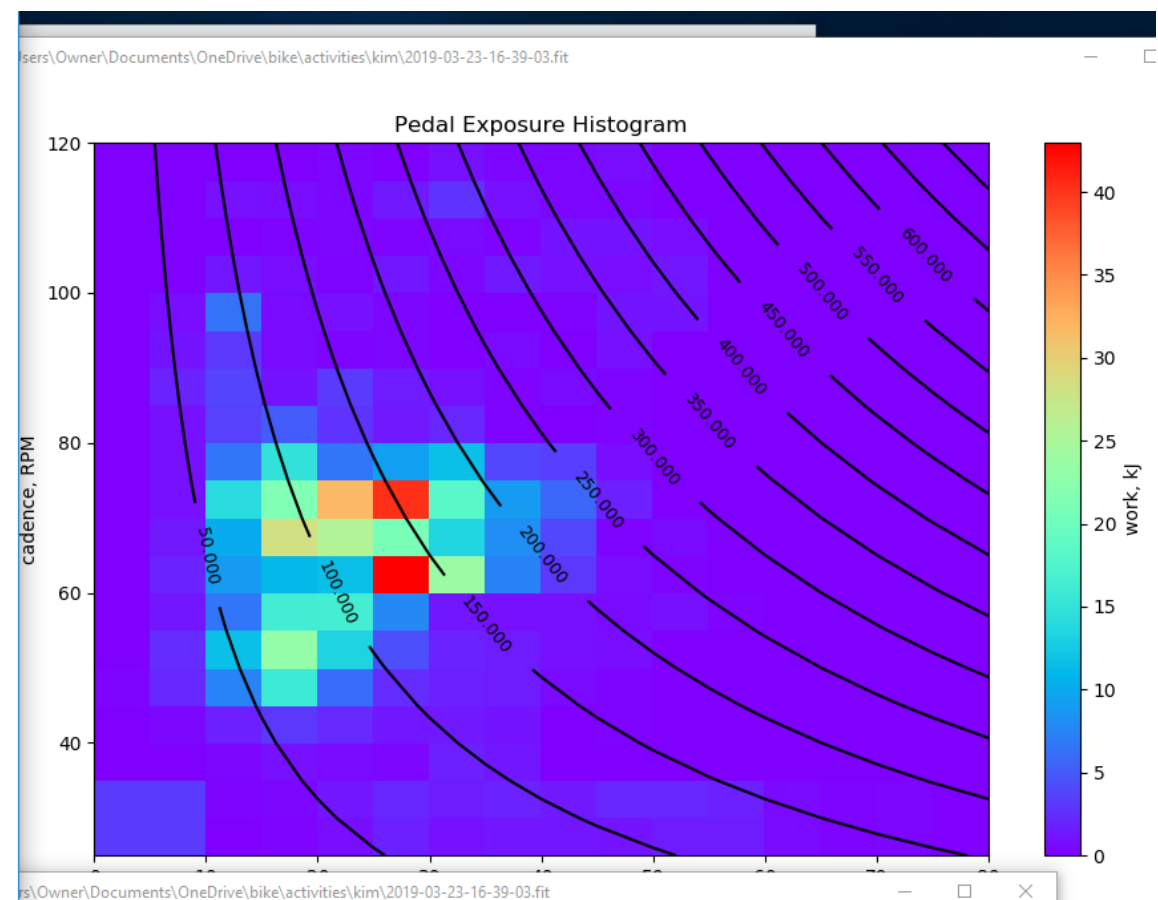
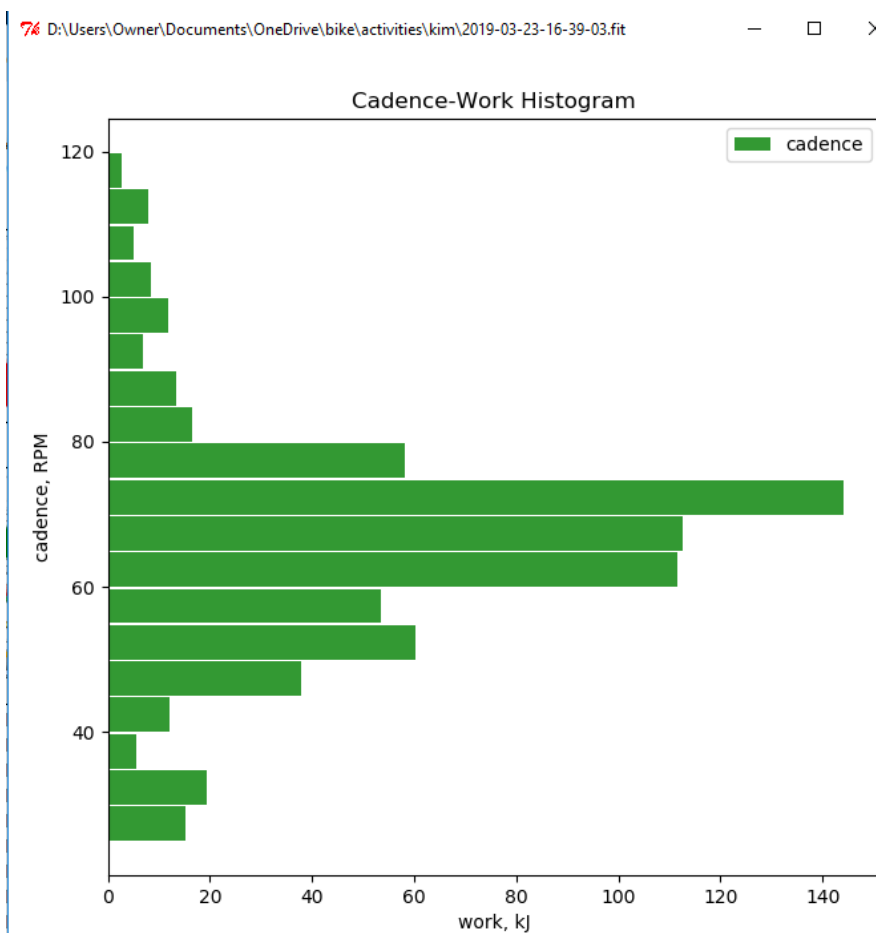
Two-way histogram includes cadence with contour lines indicating power.



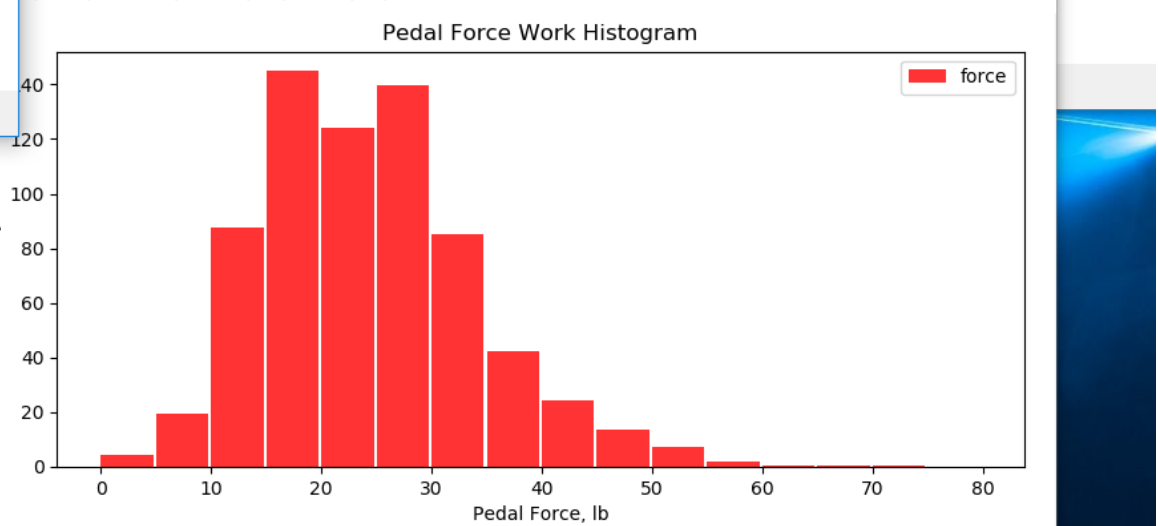


# Force Analysis

A horizontal cadence-work histogram captures work done at various cadences, just as the force-work histogram captures work done as a function of pedal force.

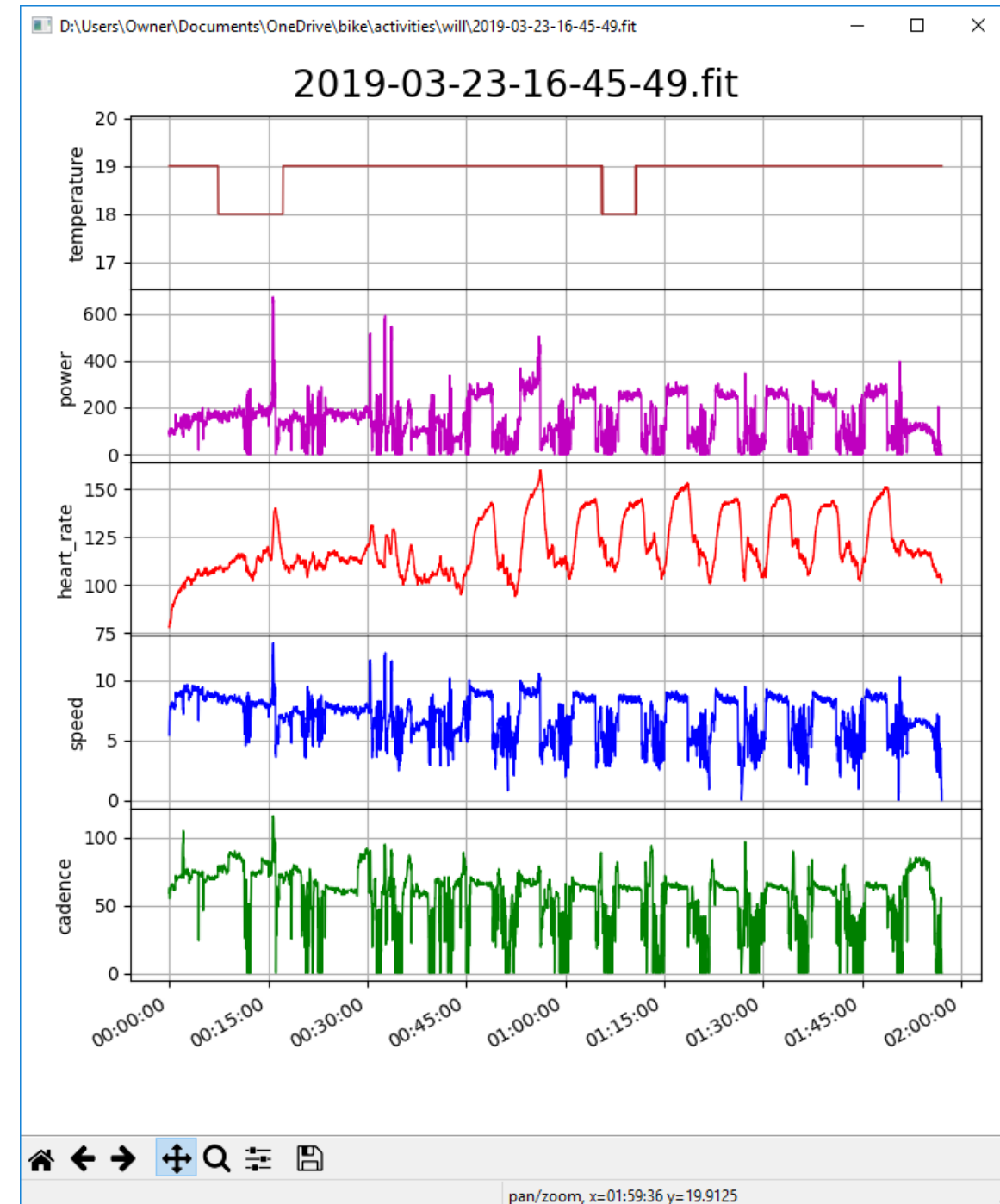
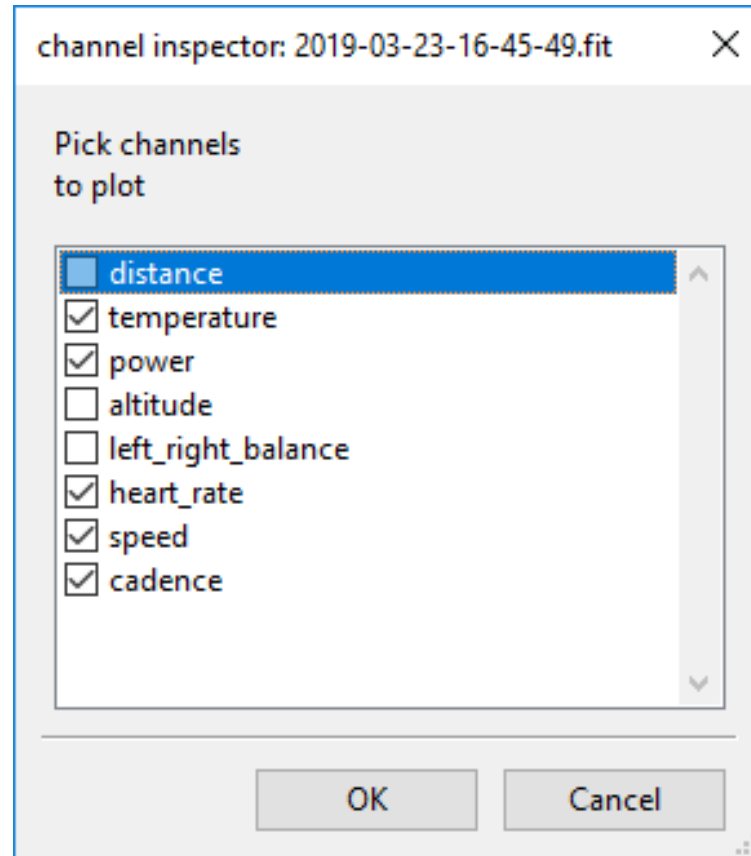


```
123 # compute the cadence-work histogram
124 nCBins = len(cadence_bins)-1
125 cadence_width = (cadence_bins[1:nCBins+1] - cadence_bins[0])
126 cadence_work = np.zeros(nCBins)
127 for i in range(nCBins):
128     CBinLo = cadence_bins[i] if i>1 else leg_force.min()
129     CBinHi = cadence_bins[i+1] if i<nCBins else cadence.max()
130     ii = np.nonzero( np.logical_and(
131         cadence >= CBinLo,
132         cadence < CBinHi ) )[0]
133     cadence_work[i] = sum(power[ii]) / SampleRate \
134         / 1000.0 # J -> kJ
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# Channel Inspector

Nothing revolutionary here—just quick access to see what a .FIT file contains and quickly plot channels of interest.



# Saddle Endurance

A sophisticated state-machine algorithm senses when I am seated or standing (to relieve saddle fatigue). I generally need to stand every 10 minutes and do so by pedaling three strokes, resting a few seconds, pedaling another three strokes, and so on. But I am trying to improve my saddle endurance, so I want to measure it.

