

“Over-Instrumented” Running: Using Self-Tracking in My Quest to Achieve the Elusive Negative Split

Thomas Blomseth Christiansen
thomas@blomseth.dk
@tblomseth

Show&Tell, QS17, Amsterdam 2017-06-18

Copenhagen Marathon 2004

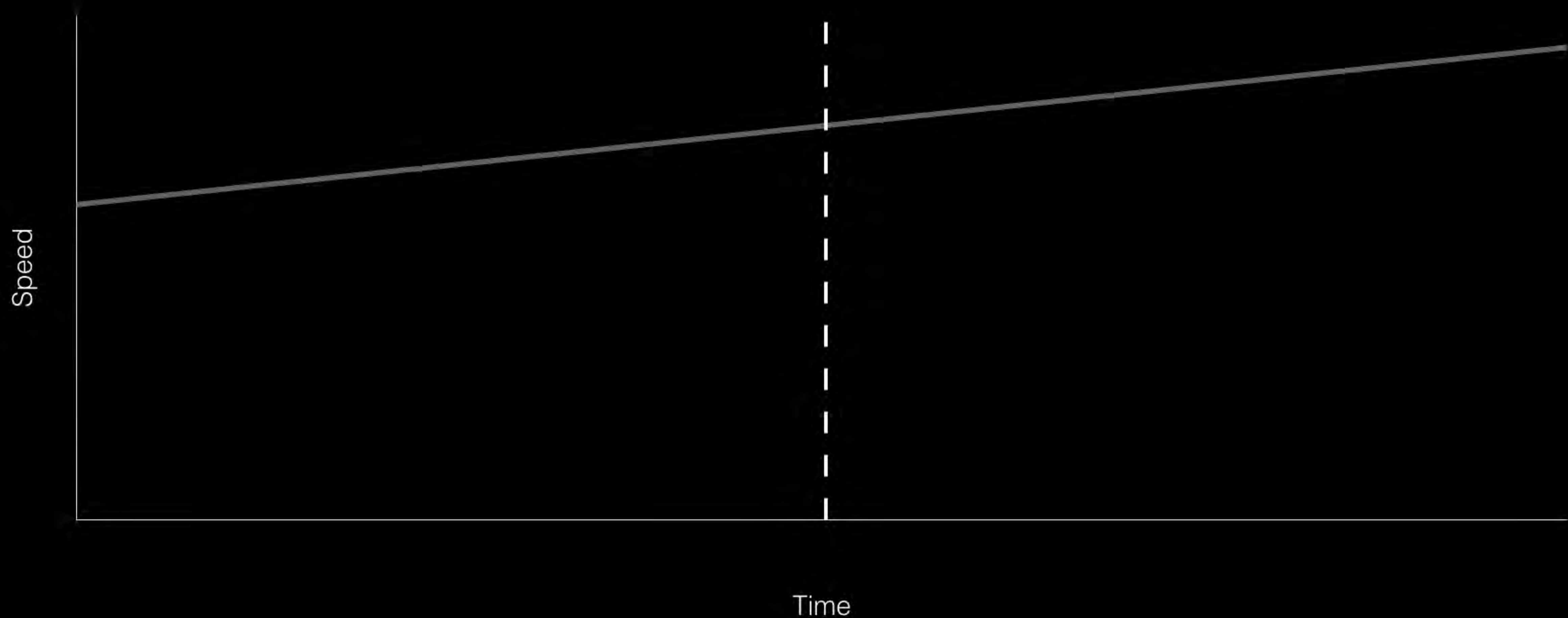
- Grueling experience. Hit the wall hard after 30 km.
- Started out fast. Finished painfully slow.
- Finishing time 3:45:29 was fair for a first-timer
- Haven't felt like running a marathon ever since

Positive split

“Common mistake even among the elite.
You did a *positive split*.”

–*My friend Ejnar, pro swim coach*

Negative split



Making split plans 2015

```
1 |(ns negative-split.experimental)
2
3 (def distance-target 11111)
4 (def lap-length 1000)
5
6 (->> (let [laps (into [] (map #(if (< % distance-target) % distance-target) (range lap-length (+ distance-target lap-length)))
7                                     (if (> (rem (/ distance-target 2) lap-length) 0)
8                                         (sort (conj laps (+ (quot distance-target lap-length) 1)))
9                                         (do laps)))
10                                     (map #(do {:distance % :time nil})))]
11
12 (->> [1000]
13       (mapv #(do %)))
14
15 (if (< 11000 distance-target) 1000 distance-target)
16
17 (into [] (map #(identity %) (range lap-length (+ distance-target lap-length) lap-length)))
18
19 (let [halfway (quot distance-target 2)]
20   (if (zero? (rem halfway lap-length))
21       halfway
22       (if (zero? (rem halfway 5))
23           halfway
24           (inc halfway))))
25
26 or (zero? (rem halfway 10))
27
28 (map #(if (< % distance-target) % distance-target) (range lap-length (+ distance-target lap-length) lap-length))
29
30 (let [laps (into [] (map #(if (< % distance-target) % distance-target) (range lap-length (+ distance-target lap-length) lap-length)))
31       (if (> (rem (/ distance-target 2) lap-length) 0)
32           (sort (conj laps (let [halfway (quot distance-target 2)]
33                               (if (zero? (rem halfway lap-length))
34                                   halfway
35                                   (if (zero? (rem halfway 5))
36                                       halfway
37                                       (inc halfway))))))
38           laps))
```

Using split plans 2015

km	tid	gnsn fart	km	tid	gnsn fart
0,5	3:10	9,5	5,5	33:55	9,73
1,0	6:18	9,5 ⁻³	6,0	36:16 ⁻⁶⁹	9,93
1,5	9:28	9,5	6,5	38:36	10,10
2,0	12:37	9,5 ⁻¹⁶	7,0	40:57 ⁻⁵³	10,26
2,5	15:47	9,5	7,5	43:17	10,39
3,0	18:56	9,5 ⁻²⁰	8,0	45:38 ⁻⁴⁶	10,52
3,5	22:06	9,5	8,5	47:58	10,63
4,0	25:15	9,5 ⁻³⁹	9,0	50:19 ⁻²⁴	10,73
4,5	28:25	9,5	9,5	52:39	10,82
5,0	31:34	9,5 ⁻⁷⁴	10,0	55:00 ⁺¹	10,91

Split plans 2016

negative SPLIT

“I want to run
 11 km
 in 0h 58min 0s
 at a starting pace
 of 6min 00s per 1000 m
 with a negative split and
 gradually increasing speed

Starting pace 06:00 speed 10 km/h
Finishing pace 04:42 speed 12.76 km/h
Average pace 05:16 speed 11.38 km/h
Split percentage 6% ratio 53:47

Distance mark	Time	Pace	Speed	Average speed
0	00:00	06:00	10.00	0.00
1000	05:55	05:50	10.28	10.14
2000	11:40	05:41	10.56	10.28
3000	17:17	05:32	10.82	10.41
4000	22:46	05:24	11.08	10.54
5000	28:07	05:17	11.34	10.67
6000	33:21	05:10	11.59	10.79
7000	38:28	05:04	11.83	10.92
8000	43:30	04:58	12.07	11.03
9000	48:25	04:52	12.30	11.15
10000	53:15	04:47	12.53	11.27
11000	58:00	04:42	12.76	11.38

Starting pace 06:00 speed 10 km/h
Finishing pace 04:42 speed 12.76 km/h
Average pace 05:16 speed 11.38 km/h
Split percentage 6% ratio 53:47

Distance mark	Time	Pace	Speed	Average speed
0	00:00	06:00	10.00	0.00
1000	05:55	05:50	10.28	10.14
2000	11:40	05:41	10.56	10.28
3000	17:17	05:32	10.82	10.41
4000	22:46	05:24	11.08	10.54
5000	28:07	05:17	11.34	10.67
6000	33:21	05:10	11.59	10.79
7000	38:28	05:04	11.83	10.92
8000	43:30	04:58	12.07	11.03
9000	48:25	04:52	12.30	11.15
10000	53:15	04:47	12.53	11.27
11000	58:00	04:42	12.76	11.38

Send Split Plan



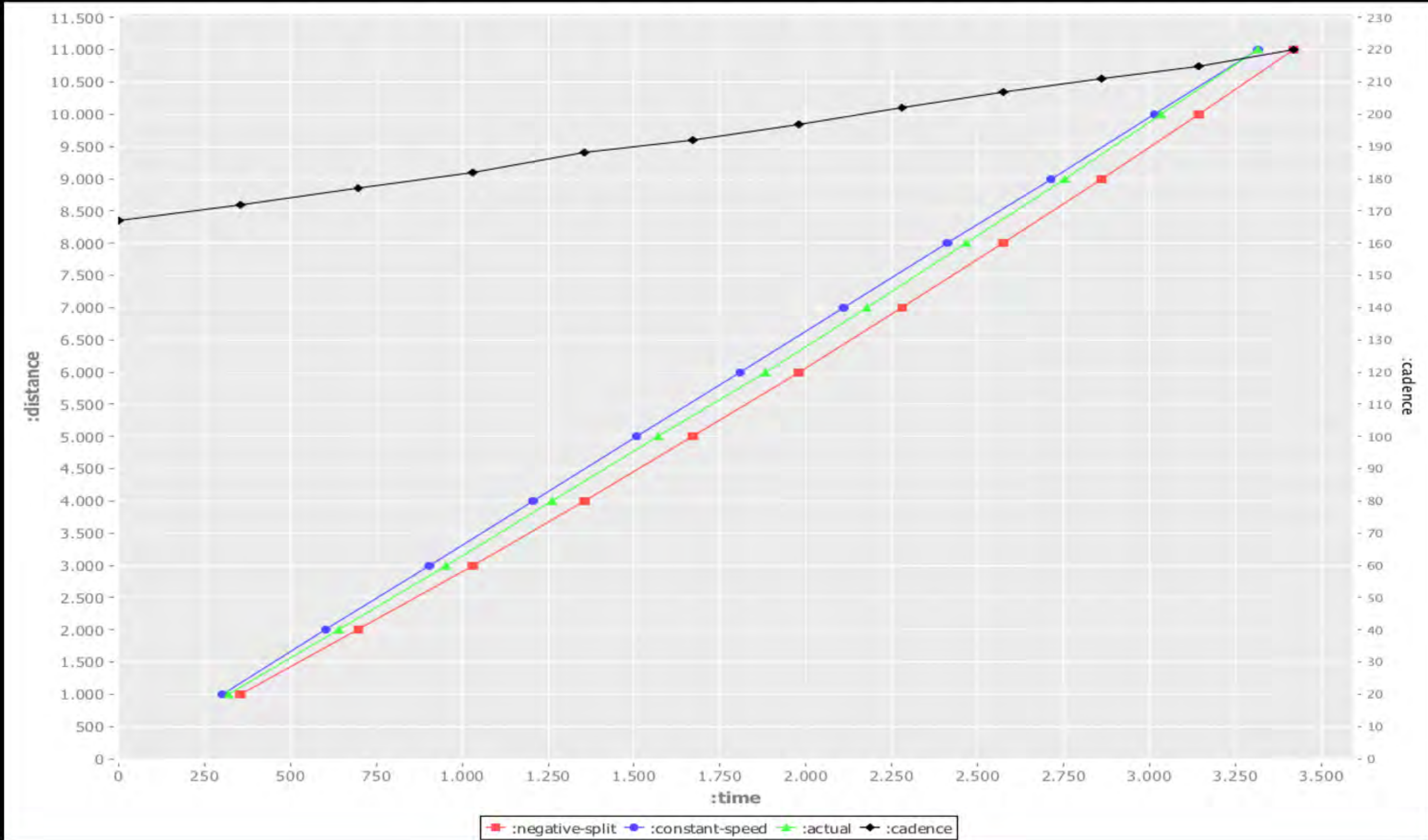
First principles of running

- Step rate: Steps per unit of time (s^{-1})
- Step length: Distance per step (m)
- Speed: step rate \times step length (m/s)

Using a metronome for the cadence



First run with metronome



More instrumentation

- LG Watch Urbane
 - Split plan display
- Fitbit Blaze
 - Steps

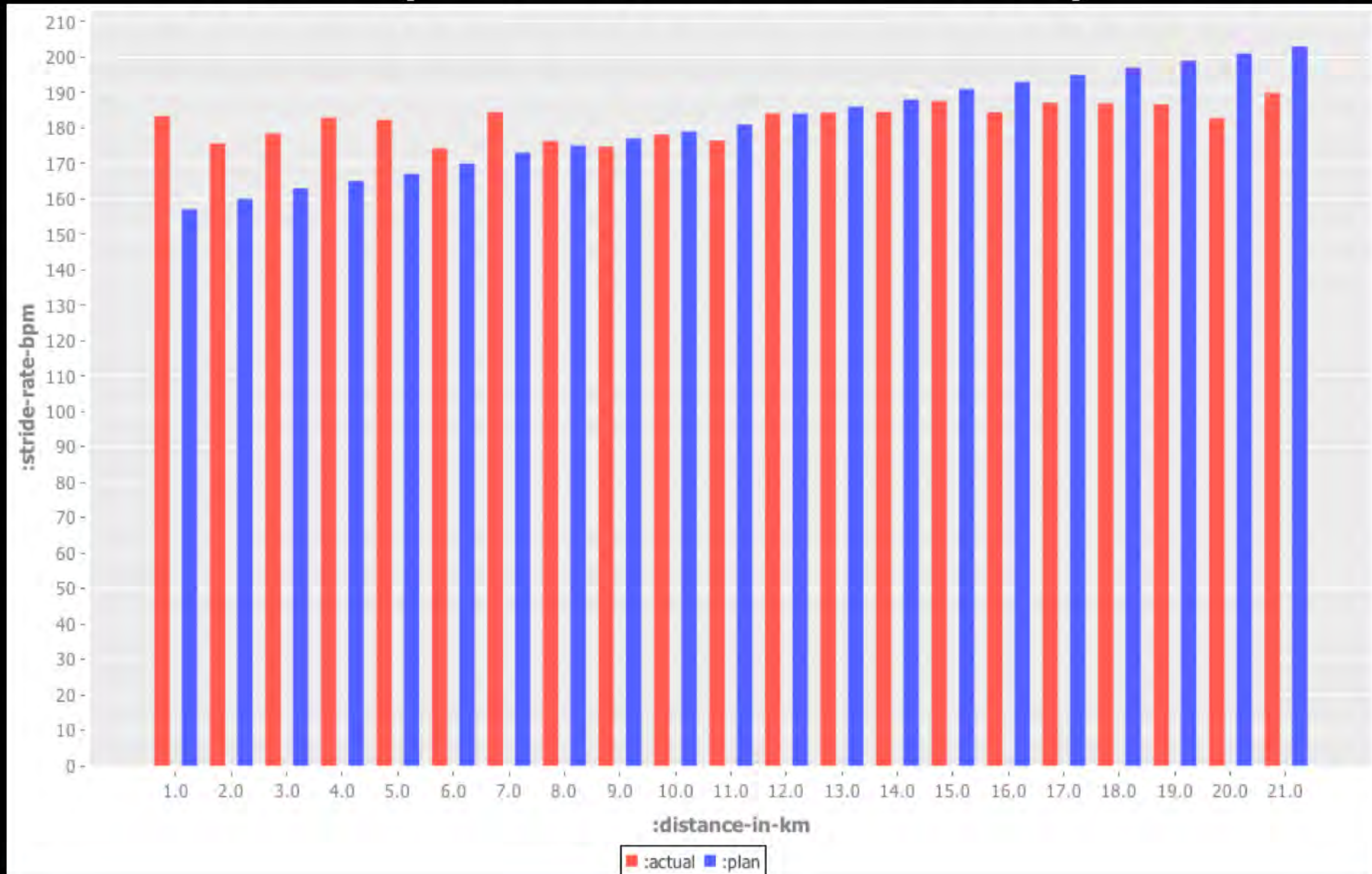


- iPhone 5
 - Metronome
- iPod touch 4G
 - Sound recording
- Nexus 5X
 - Run tracking
 - Steps

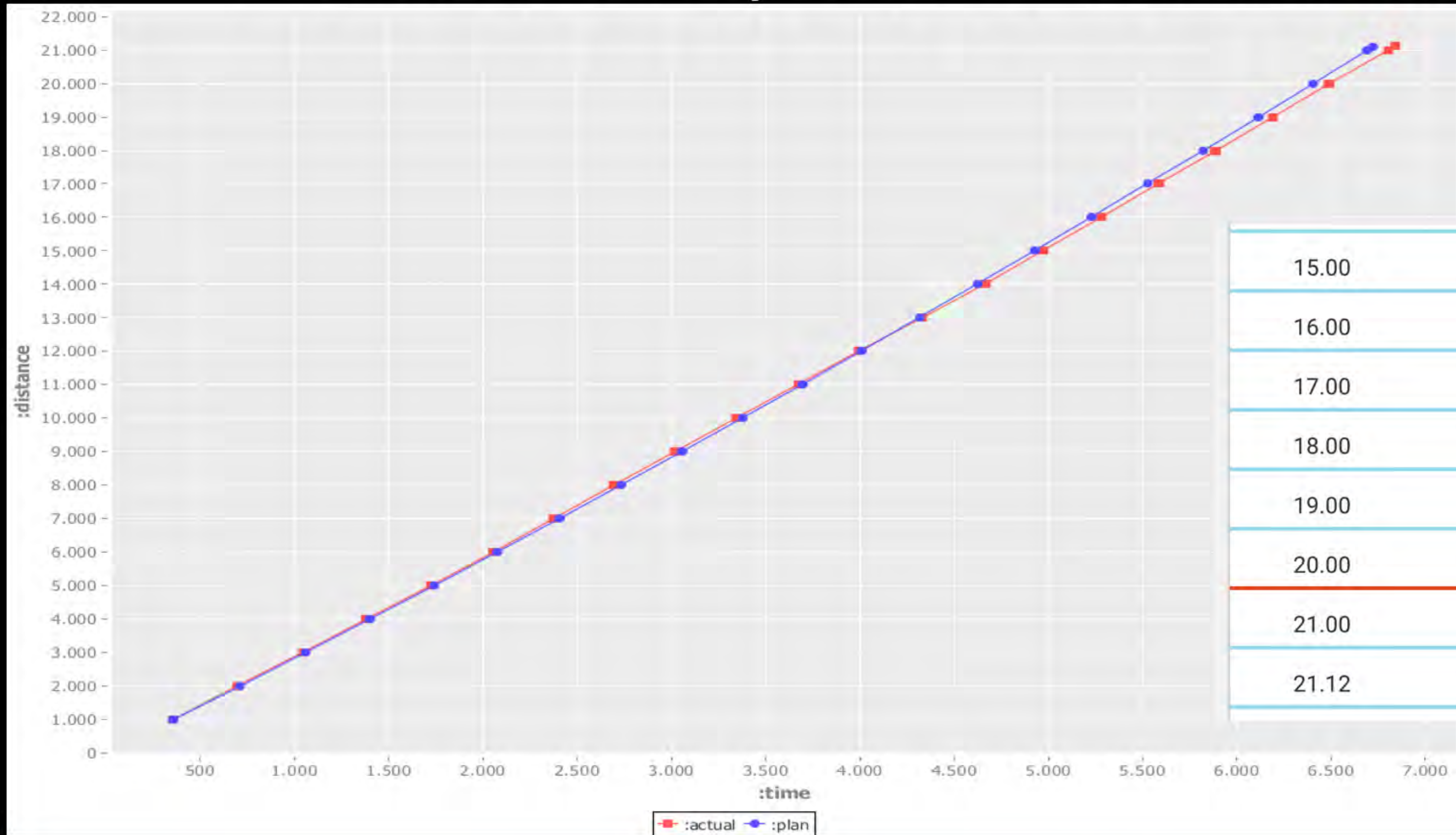
Protocol

Making observations on the run

What's up with the step rate?



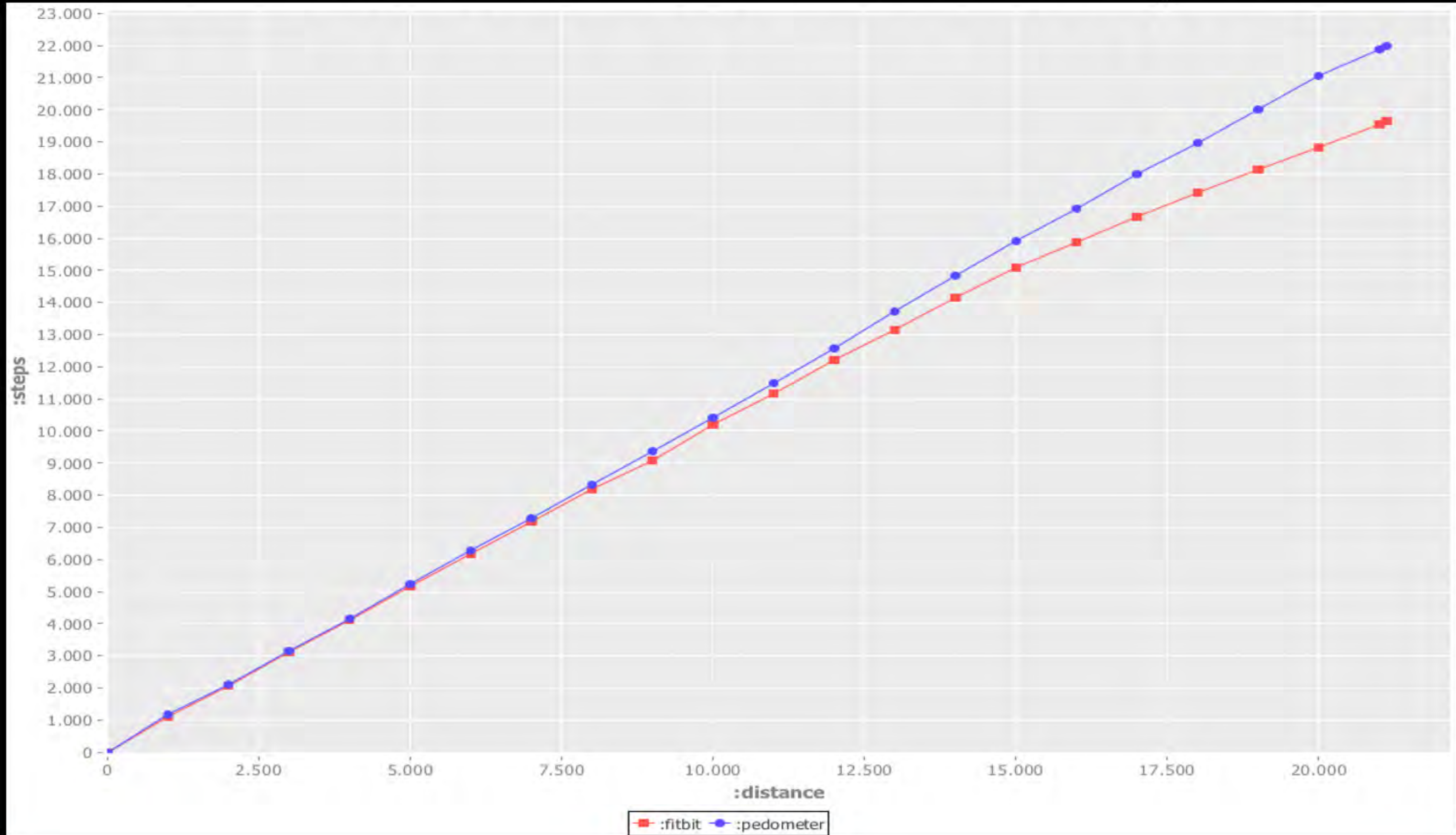
Actual vs. plan a week later



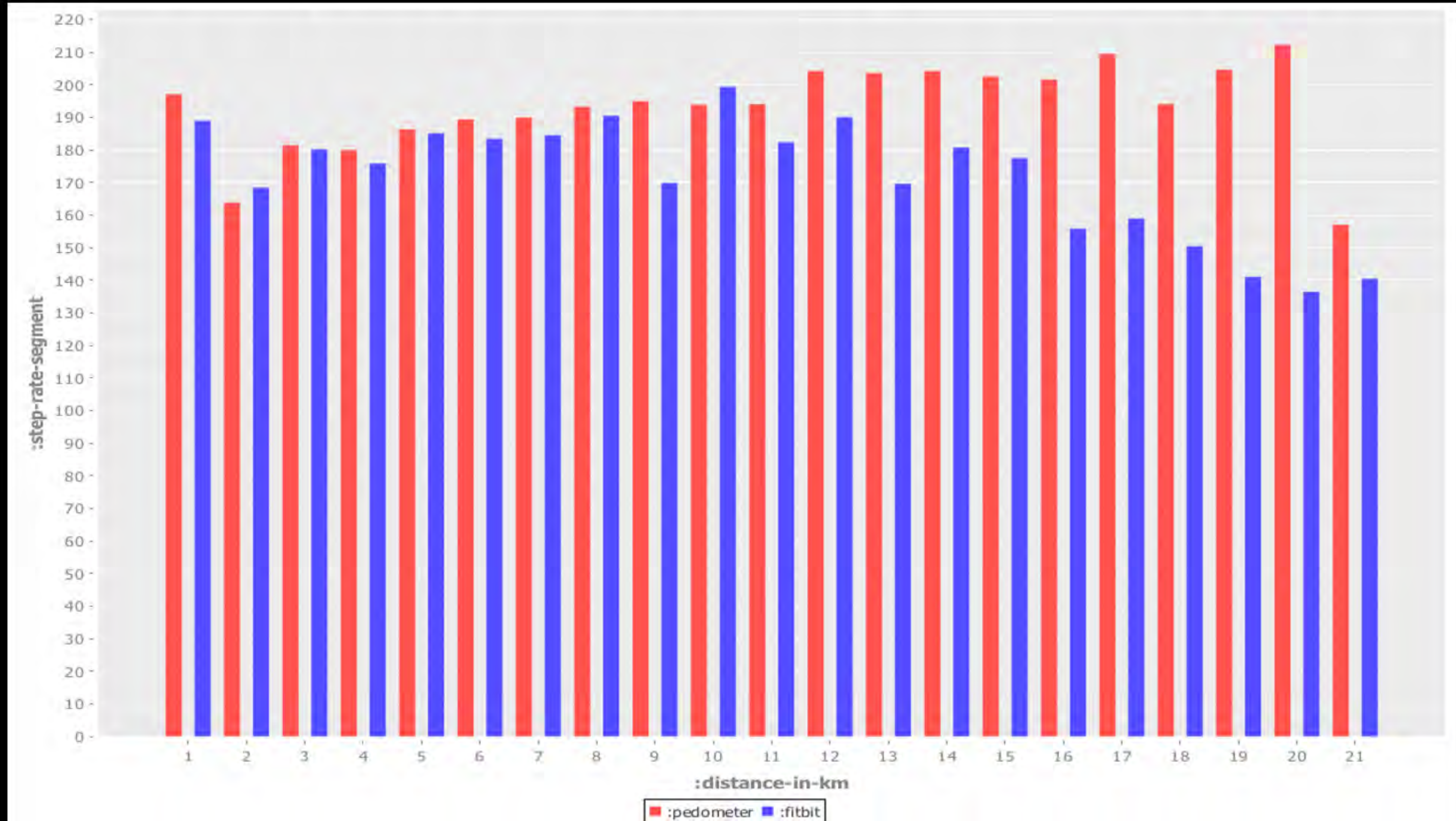
Plan: 1:52:00

15.00	1:22:55	5:11
16.00	1:28:03	5:08
17.00	1:33:05	5:02
18.00	1:38:08	5:03
19.00	1:43:10	5:02
20.00	1:48:09	4:59
21.00	1:53:23	5:14
21.12	1:54:02	5:29

What about those steps?



The step rates don't make sense



High-cadence step
(dis)counting?

Some more instrumentation

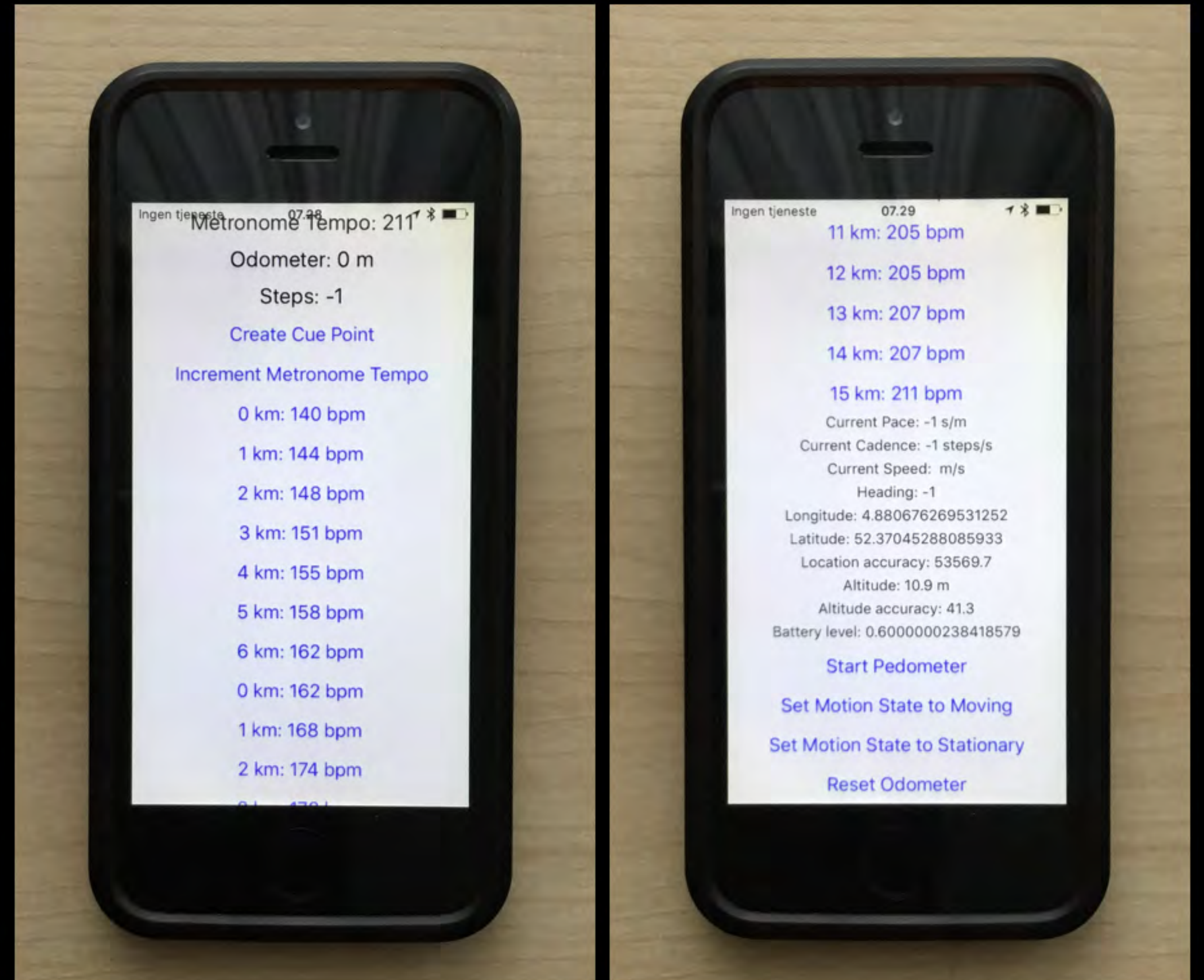
- Wahoo TICKR X
- Steps + cadence
- Heart rate
- Running dynamics
- Polar H10
- Heart rate



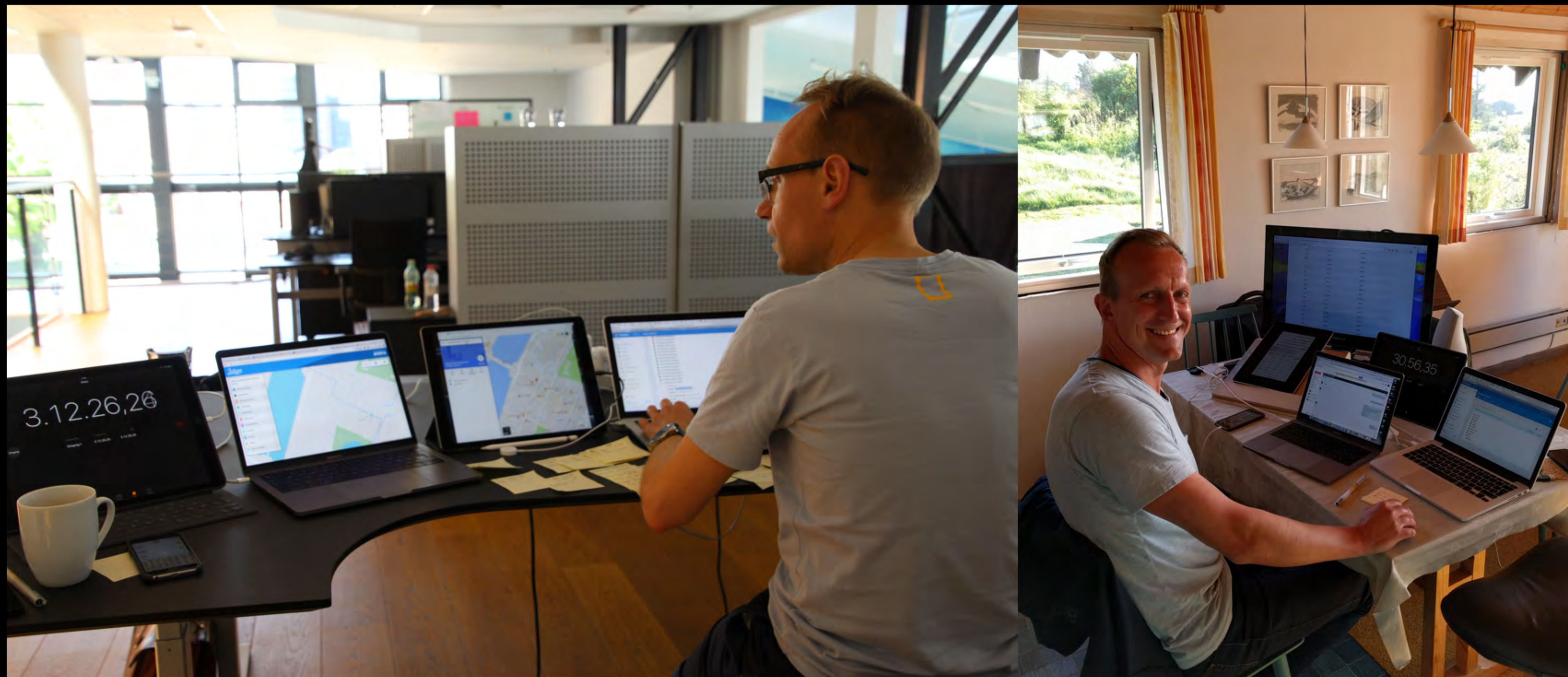
- Apple Watch Series 2
- Distance + time
- Steps
- Heart rate

Homemade smartphone app

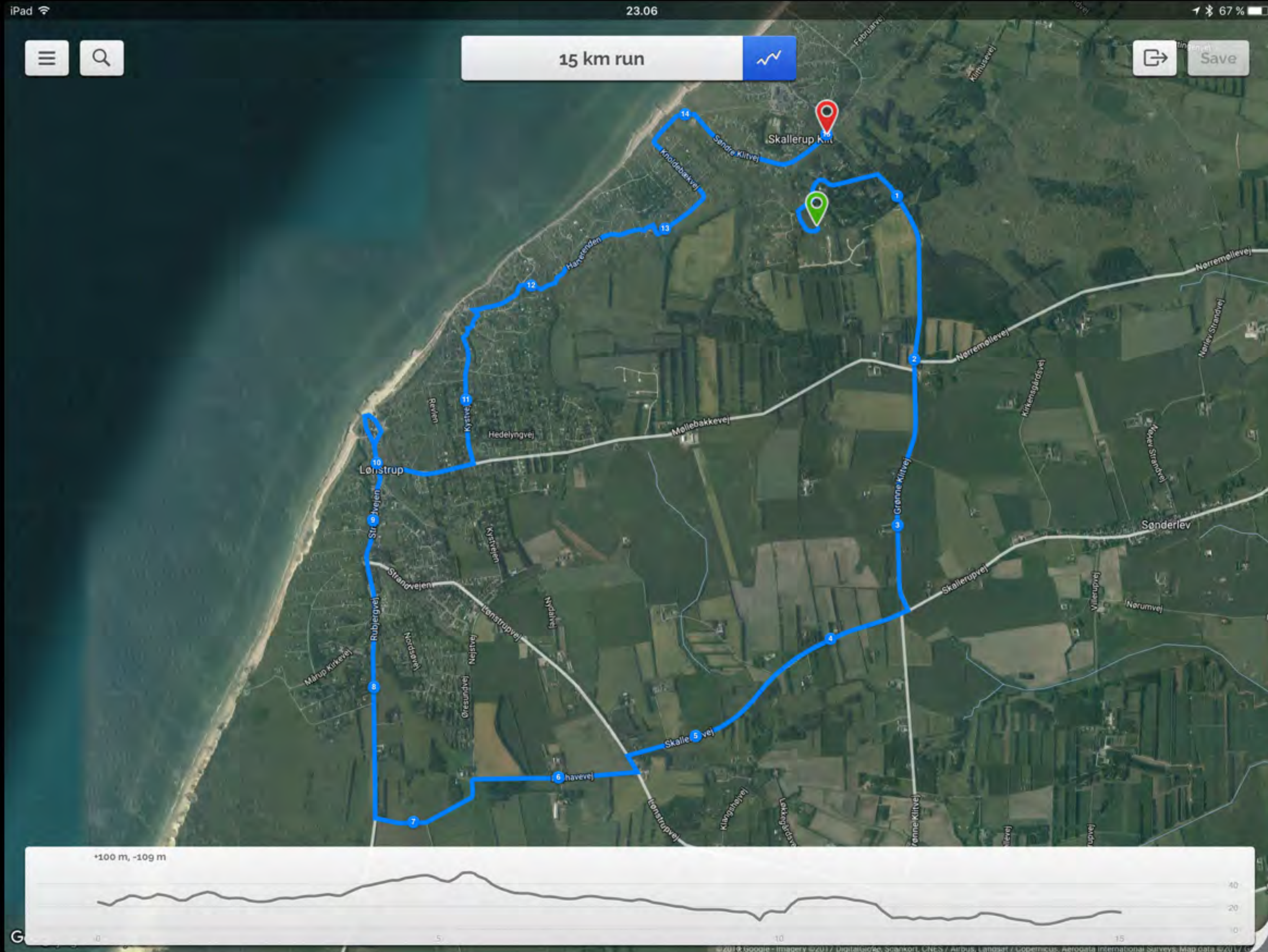
- Remote control of metronome
- Real-time telemetry
- Resilient to loss of mobile data connection



Mission Control



Repeat 15 km course and plan



0	-	00:00	-	06:30	-	0.95	-	162
1000	-	06:23	-	06:16	-	0.95	-	168
2000	-	12:34	-	06:04	-	0.95	-	174
3000	-	18:33	-	05:54	-	0.95	-	178
4000	-	24:22	-	05:44	-	0.98	-	178
5000	-	30:02	-	05:34	-	0.98	-	183
6000	-	35:32	-	05:26	-	0.98	-	188
7000	-	40:55	-	05:18	-	0.98	-	193
8000	-	46:10	-	05:11	-	0.98	-	197
9000	-	51:18	-	05:04	-	0.98	-	201
10000	-	56:19	-	04:58	-	1.00	-	201
11000	-	1:01:14	-	04:52	-	1.00	-	205
12000	-	1:06:03	-	04:46	-	1.03	-	204
13000	-	1:10:47	-	04:41	-	1.03	-	207
14000	-	1:15:26	-	04:36	-	1.05	-	207
15000	-	1:20:00	-	04:31	-	1.05	-	211

On-time performance

Plan: 15 km in 1:20:00 (4800 s)

Date	Time	Deviation (s)	Deviation (%)	Mean dev. (s/km)
2017-04-23	1:20:42	+42	+0.9	+2.8
2017-05-03	1:20:33	+33	+0.7	+2.2
2017-05-09	1:19:18	-42	-0.9	-2.8
2017-05-12	1:20:51	+51	+1.1	+3.4
2017-05-15	1:19:37	-23	-0.5	-1.5
2017-05-28	1:19:48	-12	-0.3	-0.8
2017-06-01	1:20:20	+20	+0.4	+1.3
2017-06-06	1:19:54	-6	-0.1	-0.4

What did I learn?

- Step counting is not (really) step counting
- At a cadence above ≈ 210 bpm I have to move my feet really fast
- Controlling step length is not trivial
- Approach for steep slopes: Stick to cadence, shorten steps
- You can work with other factors than speed in running
- Quantitative understanding of my running \rightarrow Defining new challenges

FIN

thomas@blomseth.dk
@tblomseth