

# Field based approach for assessing power-cadence and torque-cadence relationships in professional road cyclists



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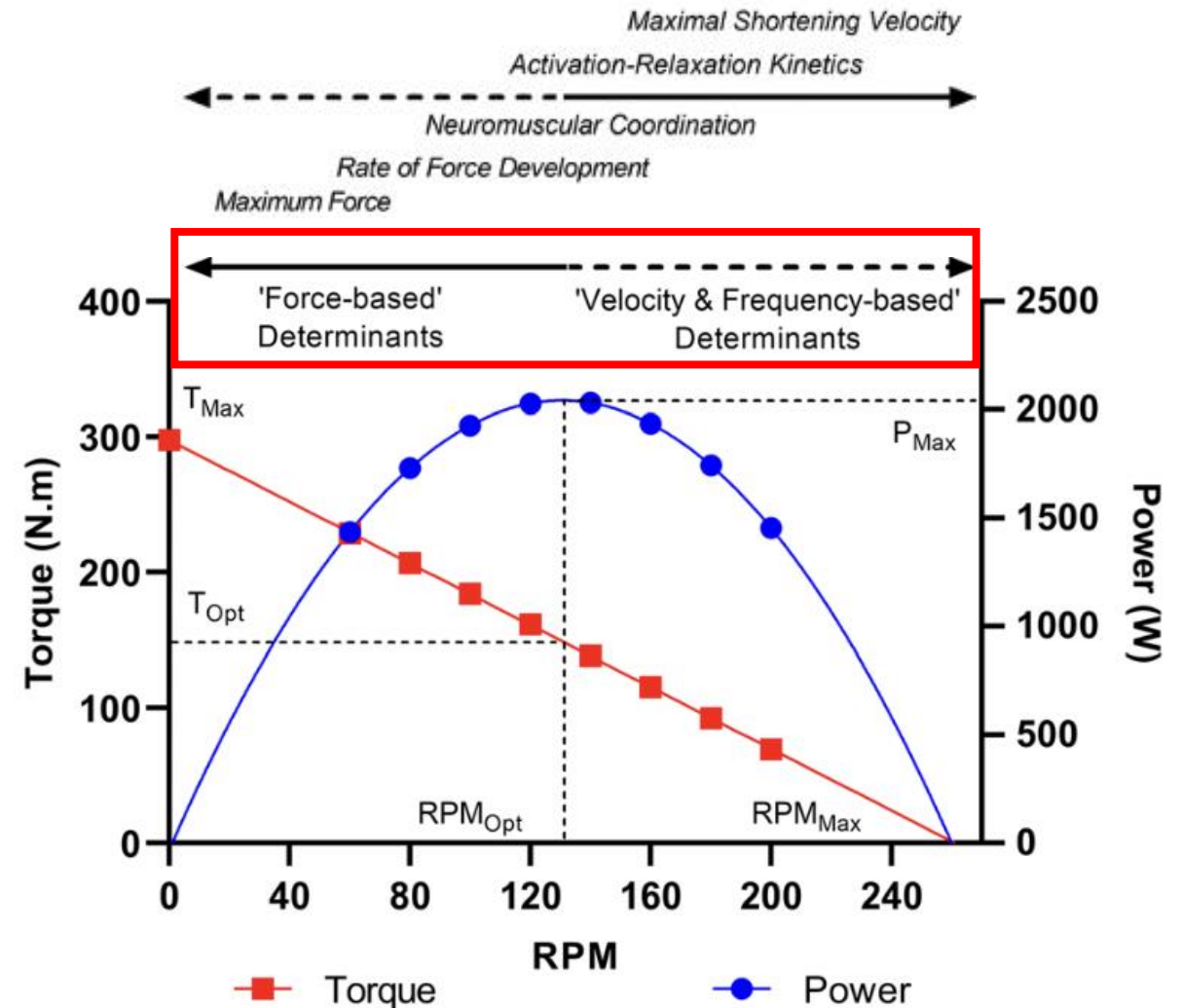
## On the road - Protocol

- 15' Z0/1 – Easy warm-up
- 2 x 6" Warm up sprints @ 80% effort
  - 1x moderate gear (53x16) from rolling start (80rpm)
  - 1 x small gear (39x28) from rolling start (~40rpm) - SEATED
- 10' Z0/1 – easy riding
- 6 x 6" maximal sprints; 5' recovery between sprints
  - 1 x small gear (39x28) from rolling start (~40rpm) - SEATED
  - 2 x moderate gear (53x15/16) from rolling start (80rpm)
  - 2 x big gear (53x11) slow rolling start (~30-40rpm)
  - 1 x small gear (39x23) from rolling start (~40rpm) SEATED



# Introduction

- Power-cadence & torque-cadence relationships in cycling studied extensively
- Quadratic (**P-C**) and linear relationship (**T-C**)
- Gain further insight into Pmax
- Most studies to date lab or track based - Mostly track sprinters
- High frequency measurement (5 Hz+)
- Parameters of interest: Pmax, RPMmax, RPMopt, Tmax
- Can this analysis be done with commercially available power meters and head units sampling at 1 Hz?





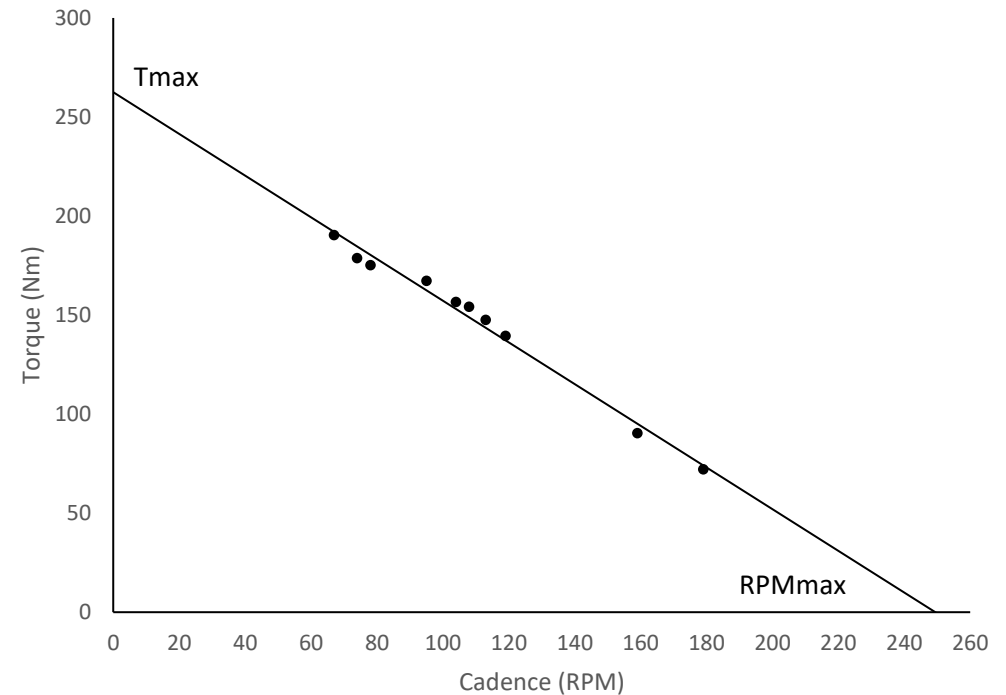
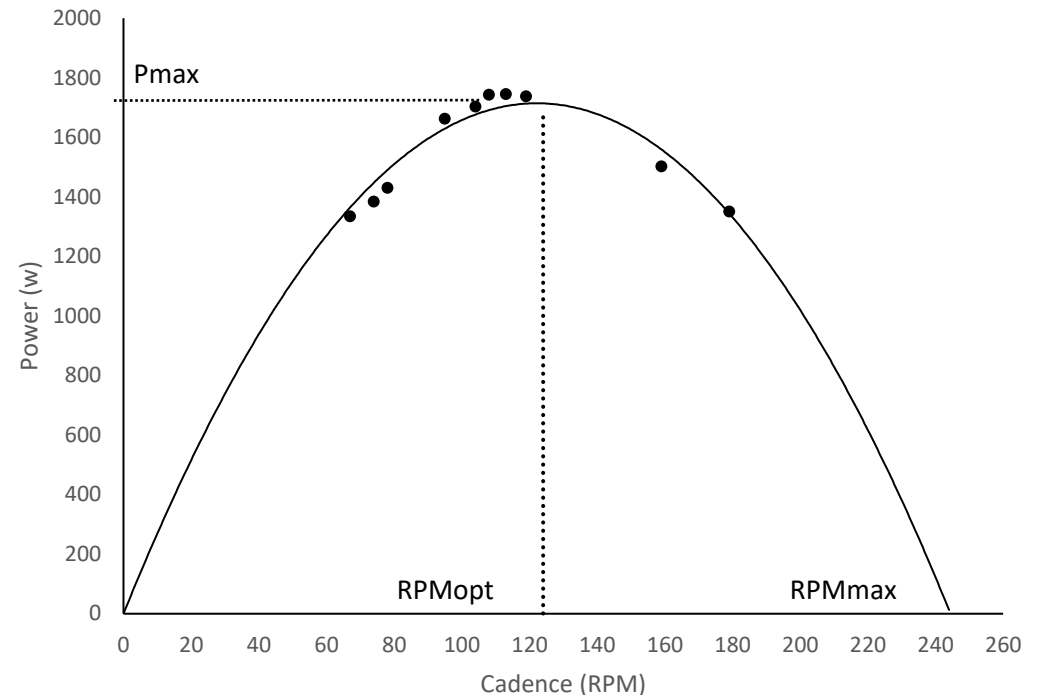
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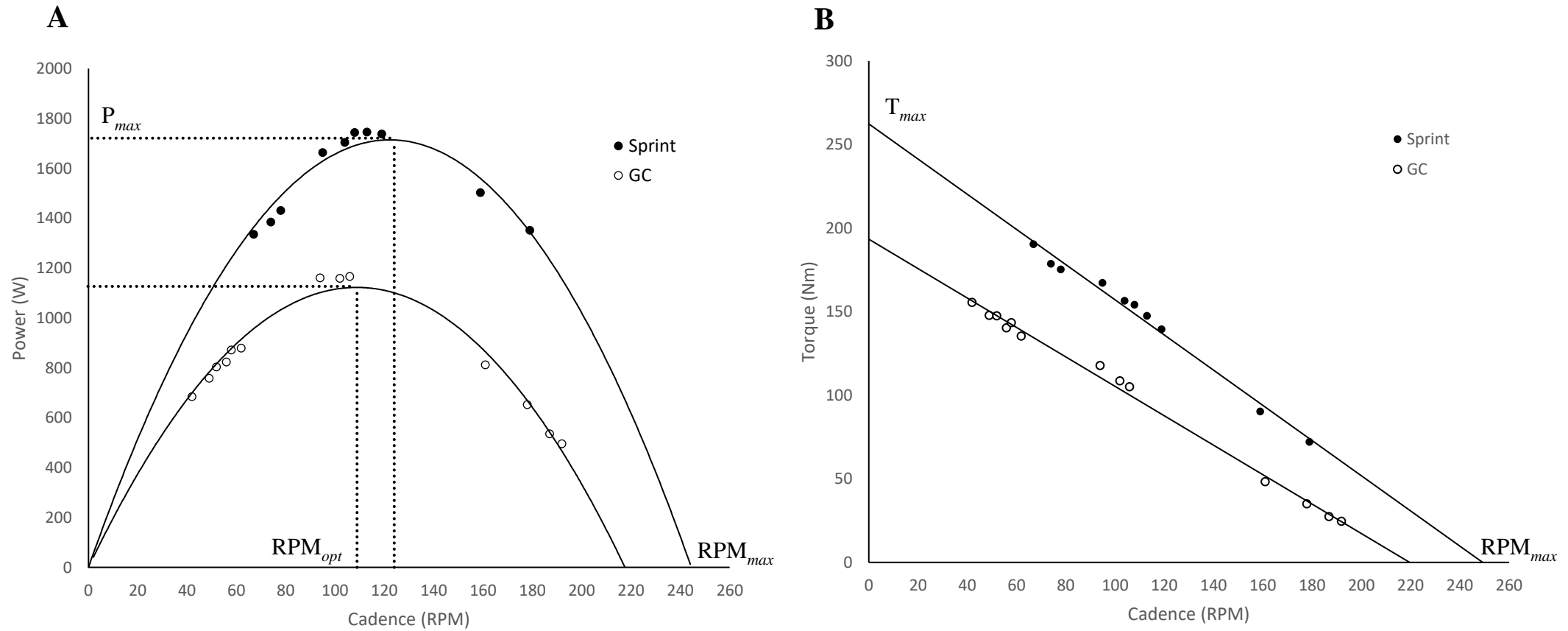
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  - 1 x small gear (39x28) from rolling start (~40rpm) - SEATED
- 10' Z0/1 – easy riding
- 6 x 6" maximal sprints; 5' recovery between sprints (varied resistive loads)
  - 1 x small gear (39x28) from rolling start (~40rpm) - SEATED
  - 2 x moderate gear (53/54x15/16) from rolling start (80rpm)
  - 2 x big gear (53/54x11) slow rolling start (~30-40rpm)
  - 1 x small gear (39x23) from rolling start (~40rpm) - SEATED



# Data processing

- Torque values calculated from cadence and power
- 2 step filter
  - Maximal values (3 rpm buckets)
  - Highest  $R^2$  value
- Parameters of interest calculated
  - $T_{max}$  – Y-intercept
  - $P_{max}$  – Y co-ordinate at vertex
  - $RPM_{opt}$  – X co-ordinate at vertex
  - $RPM_{max}$  – X-intercept





**Figure 1.** Comparison of Sprint and GC power-cadence (A) and Torque-cadence (B) relationships including individual datapoints. Abbreviations:  $P_{max}$  modelled maximum power;  $RPM_{max}$  maximum pedaling rate;  $RPM_{opt}$  optimum pedaling rate;  $T_{max}$  maximum torque

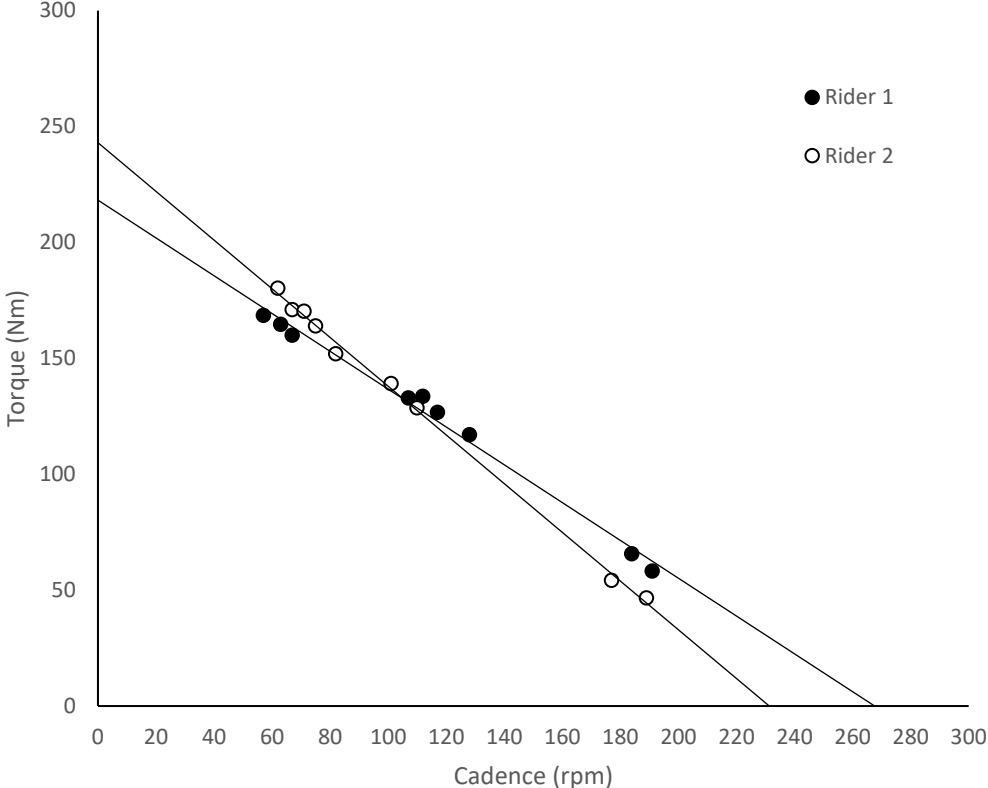
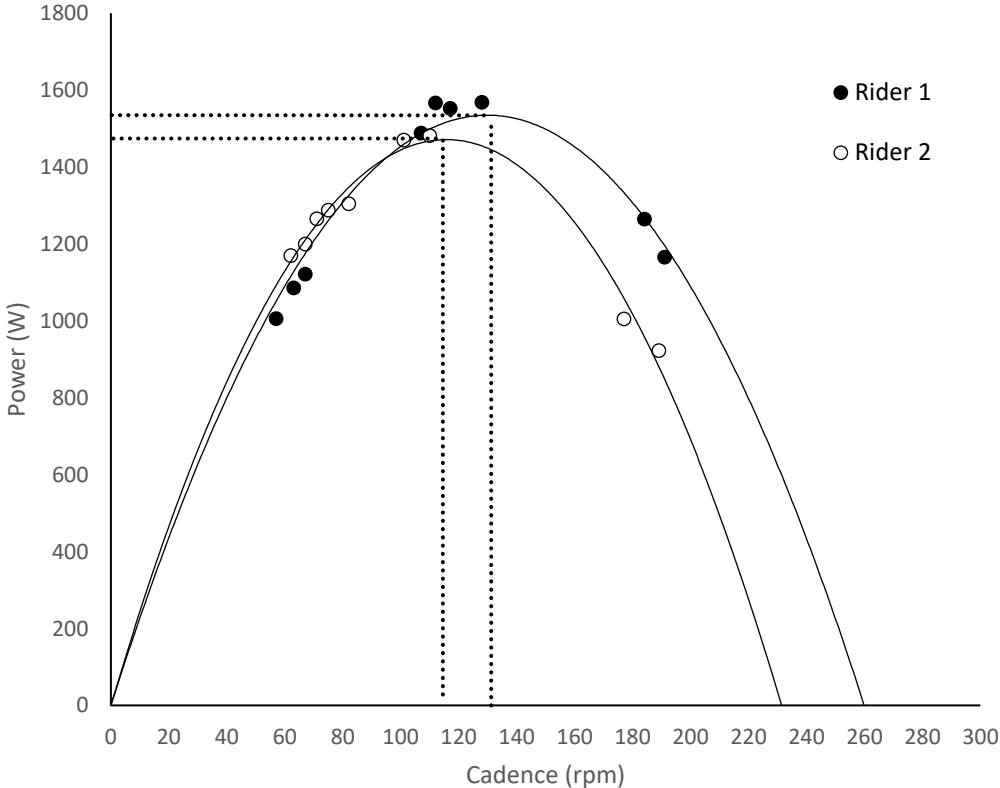


**Table 1 – Sprint characteristics of different rider categorizations**

	N	Body weight (kg)	1s peak power (W)	1s peak power (W/kg)	10s peak power (W)	10s peak power (W/kg)	Optimal cadence (RPM)	Maximum cadence (RPM)	Maximum torque (N·m)	Maximum torque (N·m/kg)	Modelled maximum power (W)	Modelled maximum power (W/kg)
GC group	8	67.4 ± 4.0 <sup>bc</sup>	1236 ± 65 <sup>b</sup>	18.2 ± 0.7 <sup>b</sup>	1028 ± 61 <sup>bc</sup>	15.2 ± 0.5 <sup>b</sup>	112 ± 2 <sup>b</sup>	227 ± 5 <sup>b</sup>	184 ± 10 <sup>bc</sup>	2.7 ± 0.2 <sup>b</sup>	1101 ± 62 <sup>b</sup>	16.4 ± 1.0 <sup>b</sup>
Sprinter group	10	75.1 ± 5.1 <sup>a</sup>	1585 ± 159 <sup>ac</sup>	21.1 ± 1.7 <sup>ac</sup>	1379 ± 141 <sup>ac</sup>	18.4 ± 1.5 <sup>ac</sup>	121 ± 5 <sup>ac</sup>	247 ± 13 <sup>ac</sup>	228 ± 22 <sup>a</sup>	3.0 ± 0.3 <sup>a</sup>	1478 ± 148 <sup>ac</sup>	19.7 ± 1.6 <sup>ac</sup>
- <i>Finish</i>	4	75.6 ± 7.6	1725 ± 132	22.9 ± 0.7	1487 ± 147	19.7 ± 1.0	124 ± 6	251 ± 16	245 ± 21	3.2 ± 0.2	1613 ± 134	21.4 ± 0.5
- <i>Lead-out</i>	6	74.7 ± 3.3	1491 ± 93	20.0 ± 1.1	1307 ± 86	17.5 ± 1.0	120 ± 5	244 ± 10	216 ± 14	2.9 ± 0.2	1388 ± 67	18.6 ± 0.7
Classics group	6	74.1 ± 4.3 <sup>a</sup>	1393 ± 169 <sup>b</sup>	18.8 ± 1.4 <sup>b</sup>	1206 ± 157 <sup>ab</sup>	16.2 ± 1.3 <sup>b</sup>	110 ± 5 <sup>b</sup>	221 ± 10 <sup>b</sup>	212 ± 16 <sup>a</sup>	2.9 ± 0.1	1241 ± 119 <sup>b</sup>	16.7 ± 1.0 <sup>b</sup>

<sup>a</sup>Significant difference from GC; <sup>b</sup>Significant difference from Sprint; <sup>c</sup>Significant difference from Classics. Significance  $P < 0.05$ . Peak power data from 45-day period pre- and post-testing protocol. Data represented as mean ± standard deviation.

# Two sprinters – different profiles





A photograph of two cyclists in a race. The cyclist in the foreground is wearing a black jersey with 'Youfone' and 'DSM' logos, a blue helmet, and blue sunglasses. He is celebrating with his mouth open and his right arm raised. The cyclist behind him is wearing a green jersey with 'JACOBS' and 'DSM' logos, a white helmet, and green sunglasses. The background is a blurred crowd of spectators.

# Training Implications



# Tmax Sprints

Seated/Standing

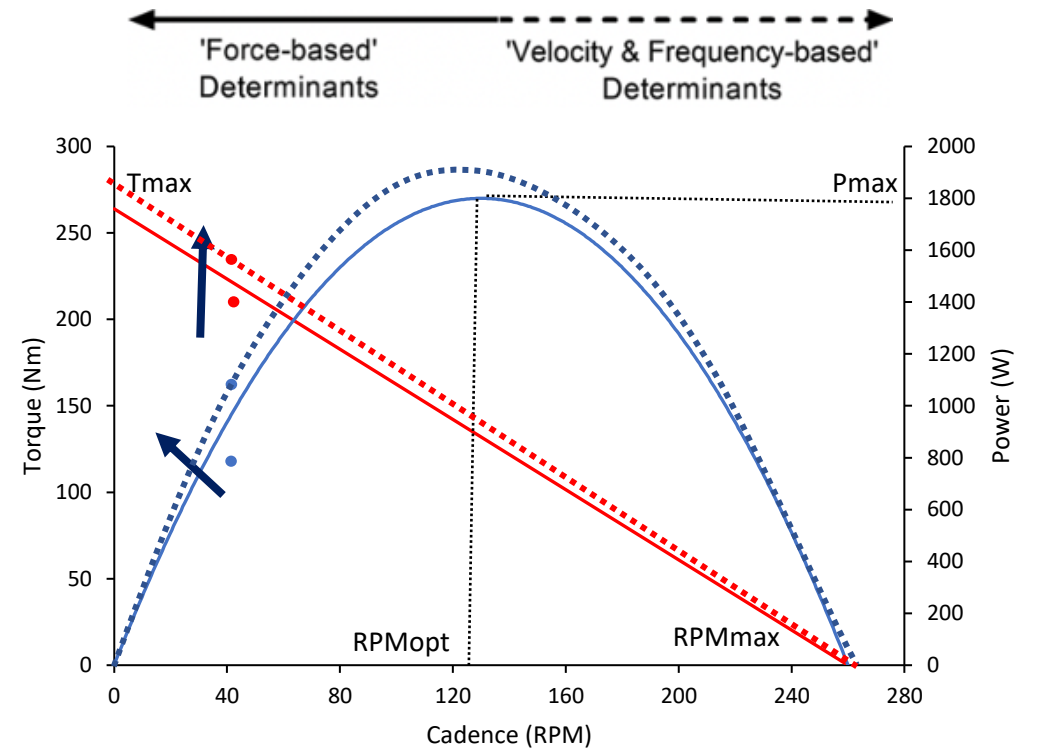
54/13-11

RPM target

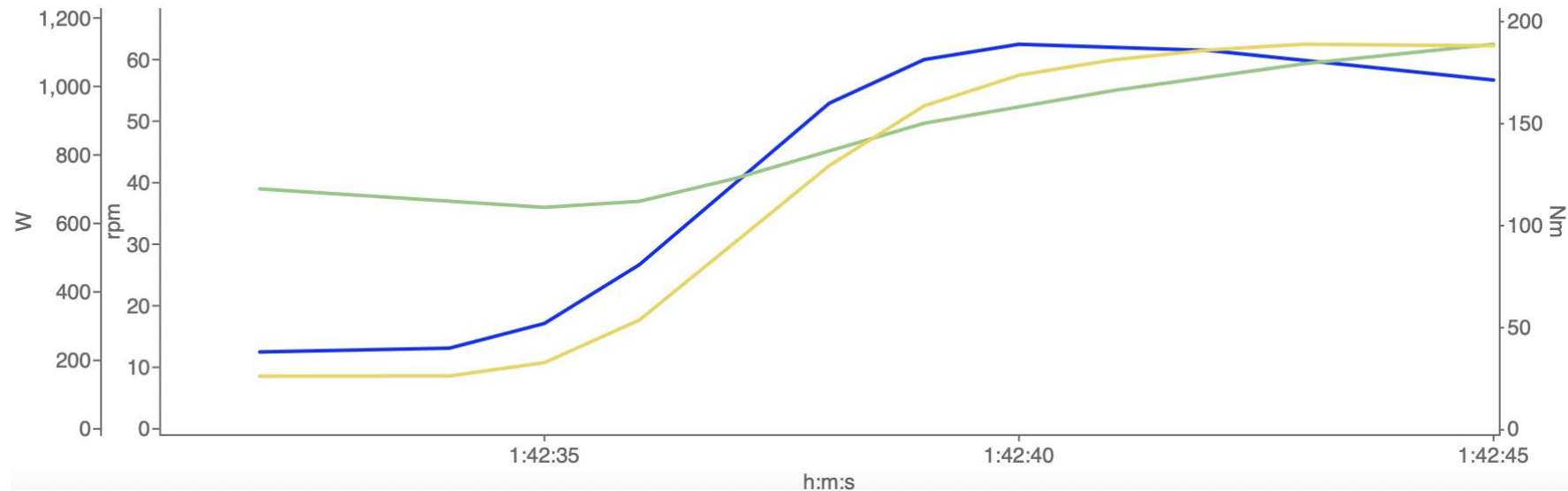
2-4 sets; R:10', 3-5 reps; R: 3'

Terrain progression

- Maximum force
- Rate of force-development
- Neuromuscular co-ordination



Lap 10 Power -- W Cadence -- rpm Torque -- Nm



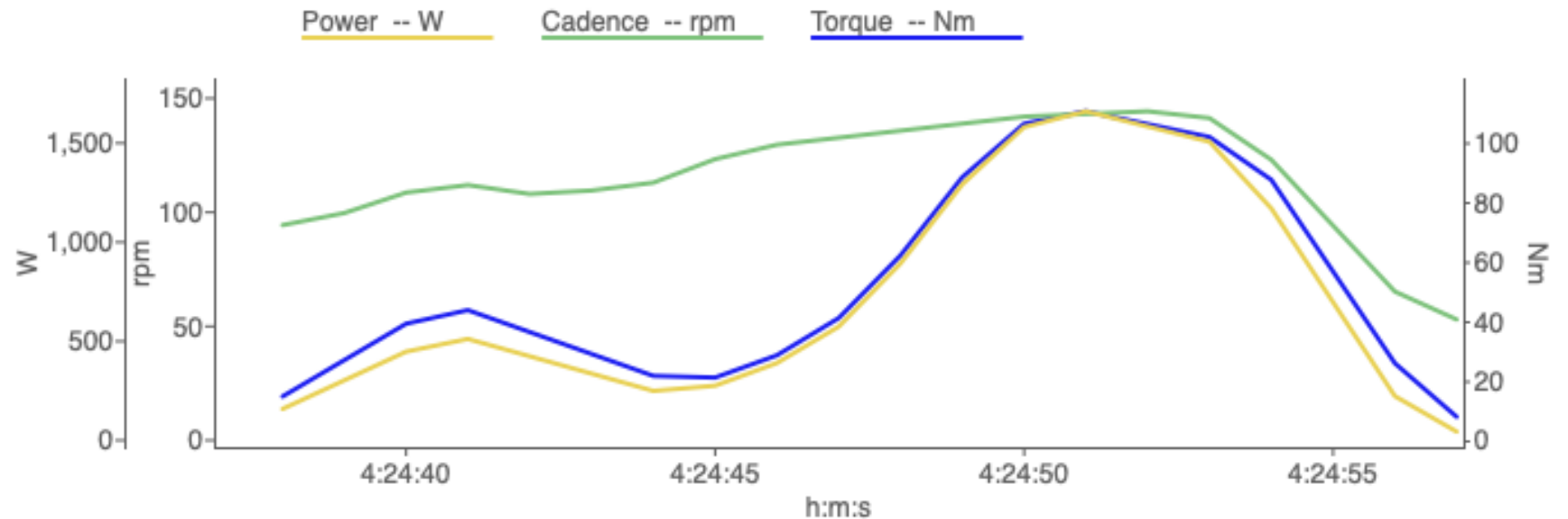
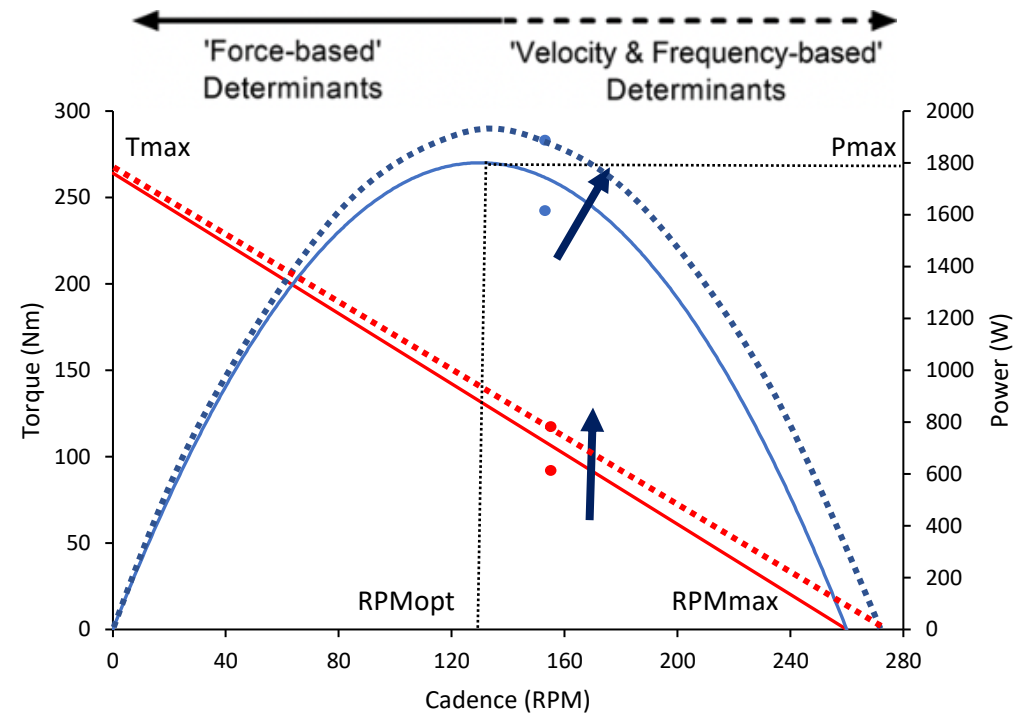




# RPM+ Sprints

Seated/Standing  
 Peak +30RPM from RPMopt  
 5-15"  
 4-10 reps

- Neuromuscular coordination
- Activation-relaxation kinetics
- Maximum shortening velocity



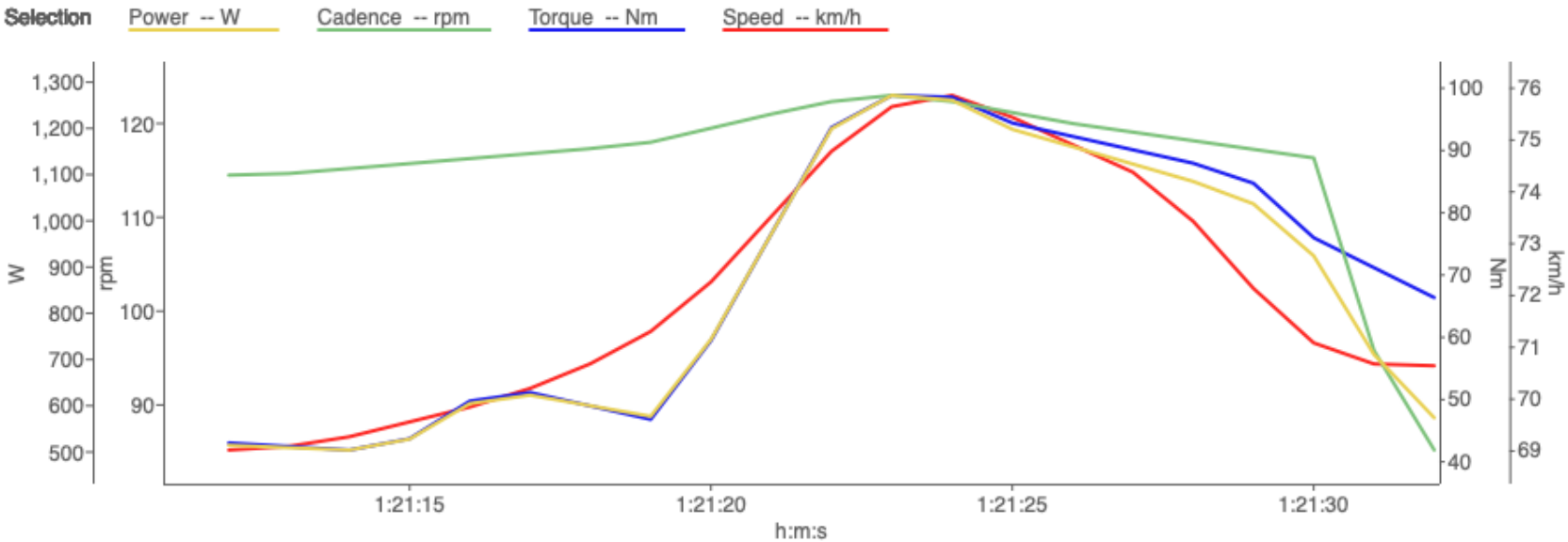
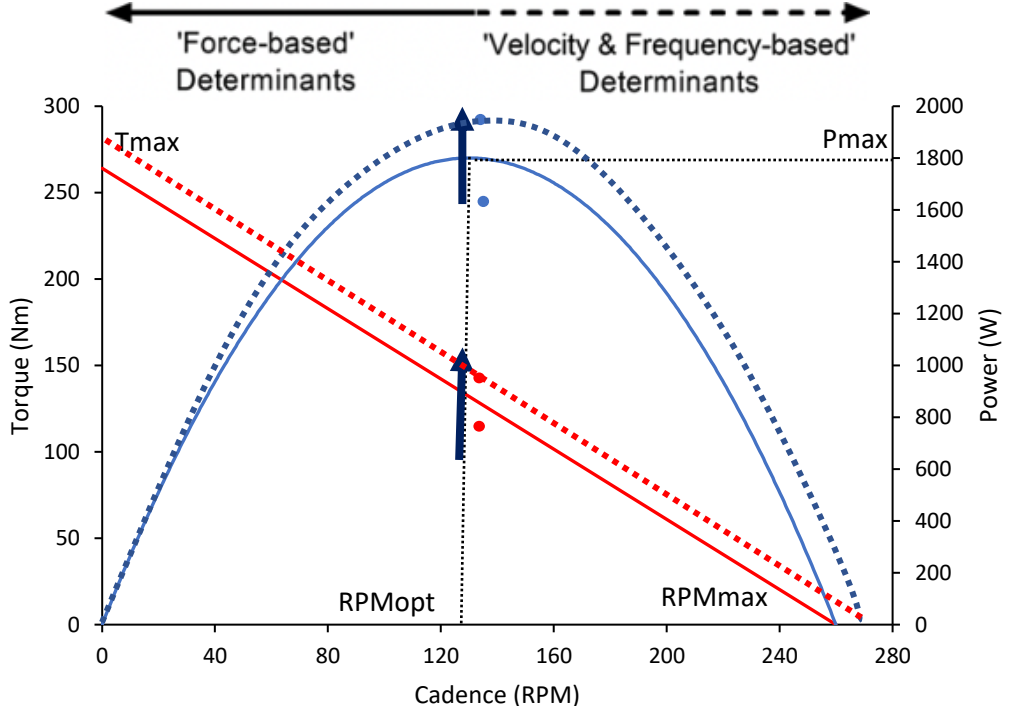


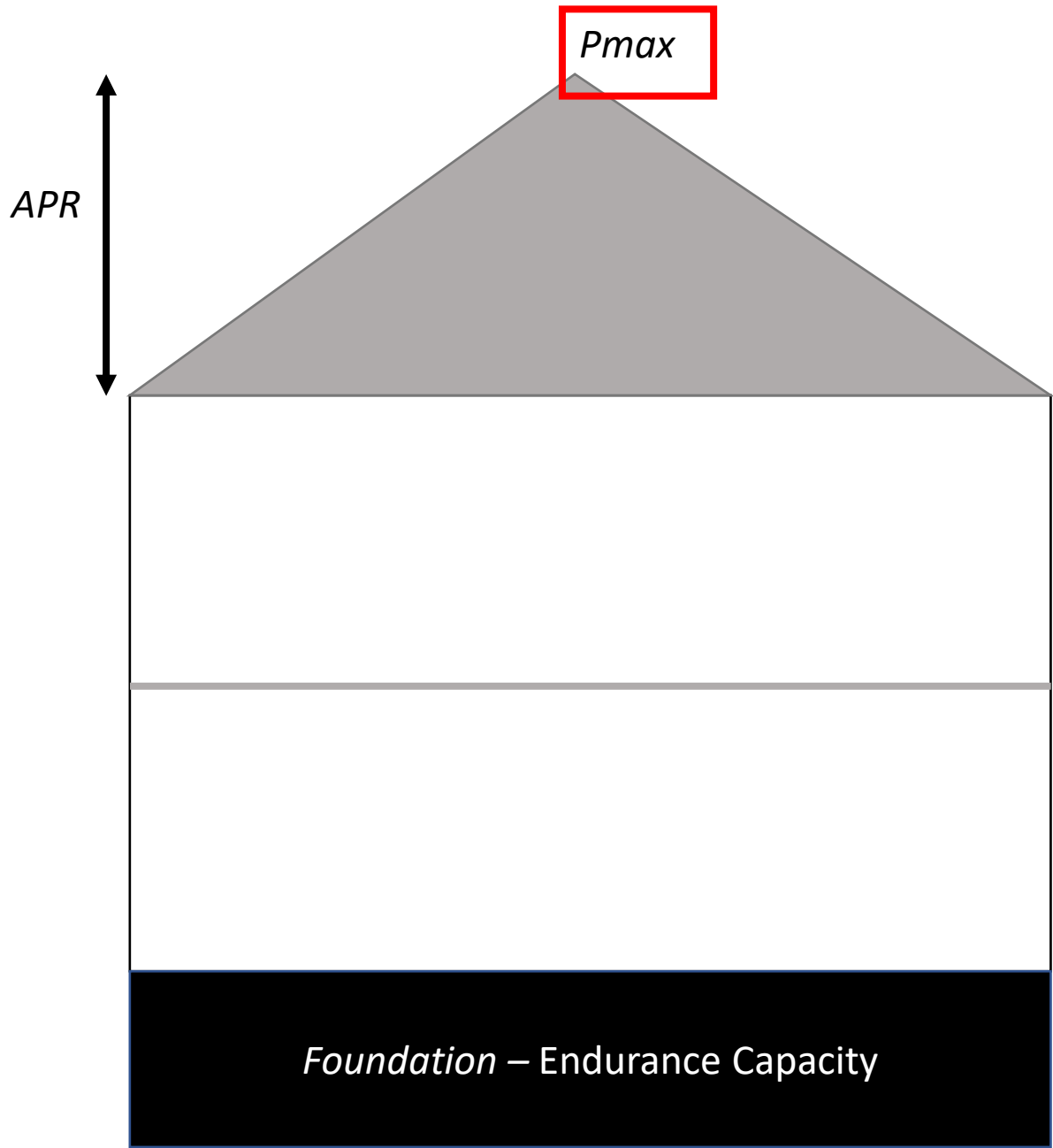


# RPMopt Sprints

5-20"  
 4-8 reps  
 RPMopt peak (110-130rpm)  
 High starting speed

- Combination
- Speed specific – Inertial load
- Reaction/skill component





*Pmax*

*APR*

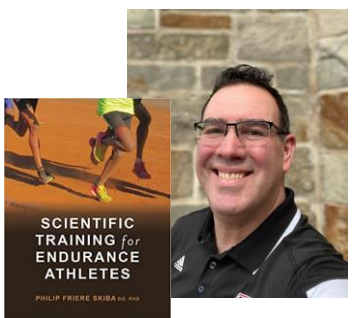
*Maximal Aerobic Power*

*Critical Power*

*Lactate Threshold*

*Foundation – Endurance Capacity*

Putting it all together  
'Building the house'



*Skiba, 2022*

# Concluding remarks

- Field based protocol using commercially available power meters sampling at 1 Hz is able to differentiate between different rider specialisations
- Modelled parameters can be used to assess strengths/weaknesses compared to normative data
- Inform specific training interventions – Force  $\rightarrow$  velocity
- Inform gearing selection
- Practical non-invasive tool to monitor progression
- Future insight: Novel interventions, strength training interactions, how this profile changes over the season with races and periodisation







*Thankyou for your attention!  
Any questions?*

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# Limitations

- Collection frequency (1 Hz)
- Power meter issues (low/high RPM no collection)
- Standing/seated
- Fatigue vs Fresh

