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Motor learning of handrim wheelchair propulsion

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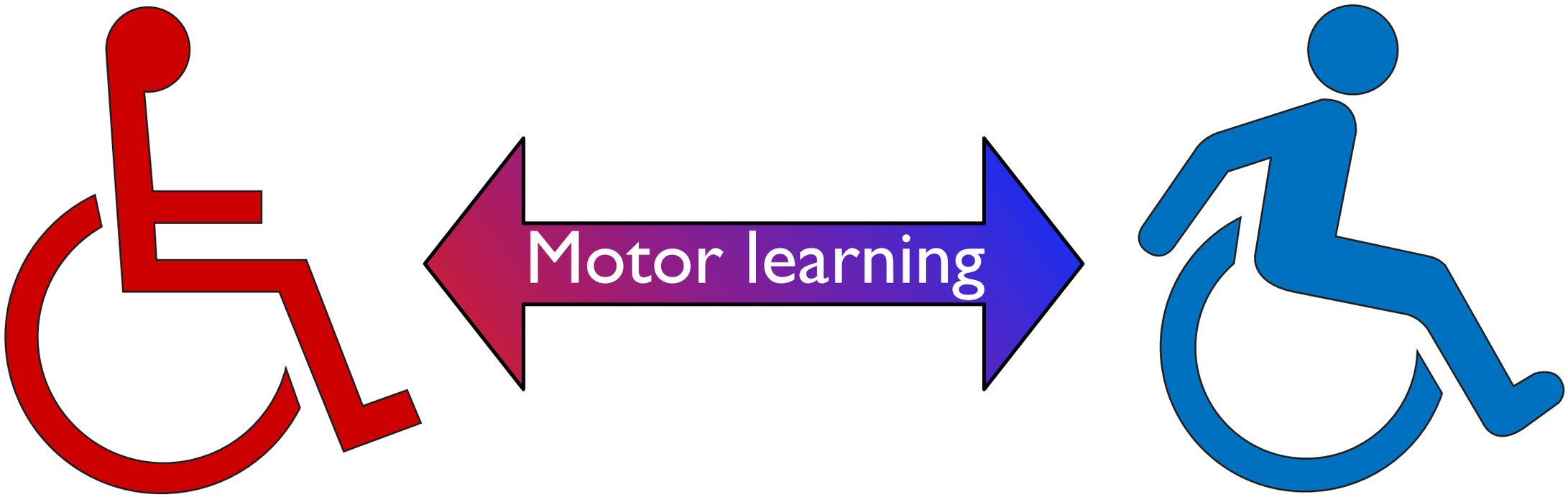
Mission statement



Get from here

To here

Today

- Overview of experiments
- Results of motor learning

Motor learning

1. Improved mechanical efficiency

2. Changes in propulsion technique

1. Mechanical efficiency

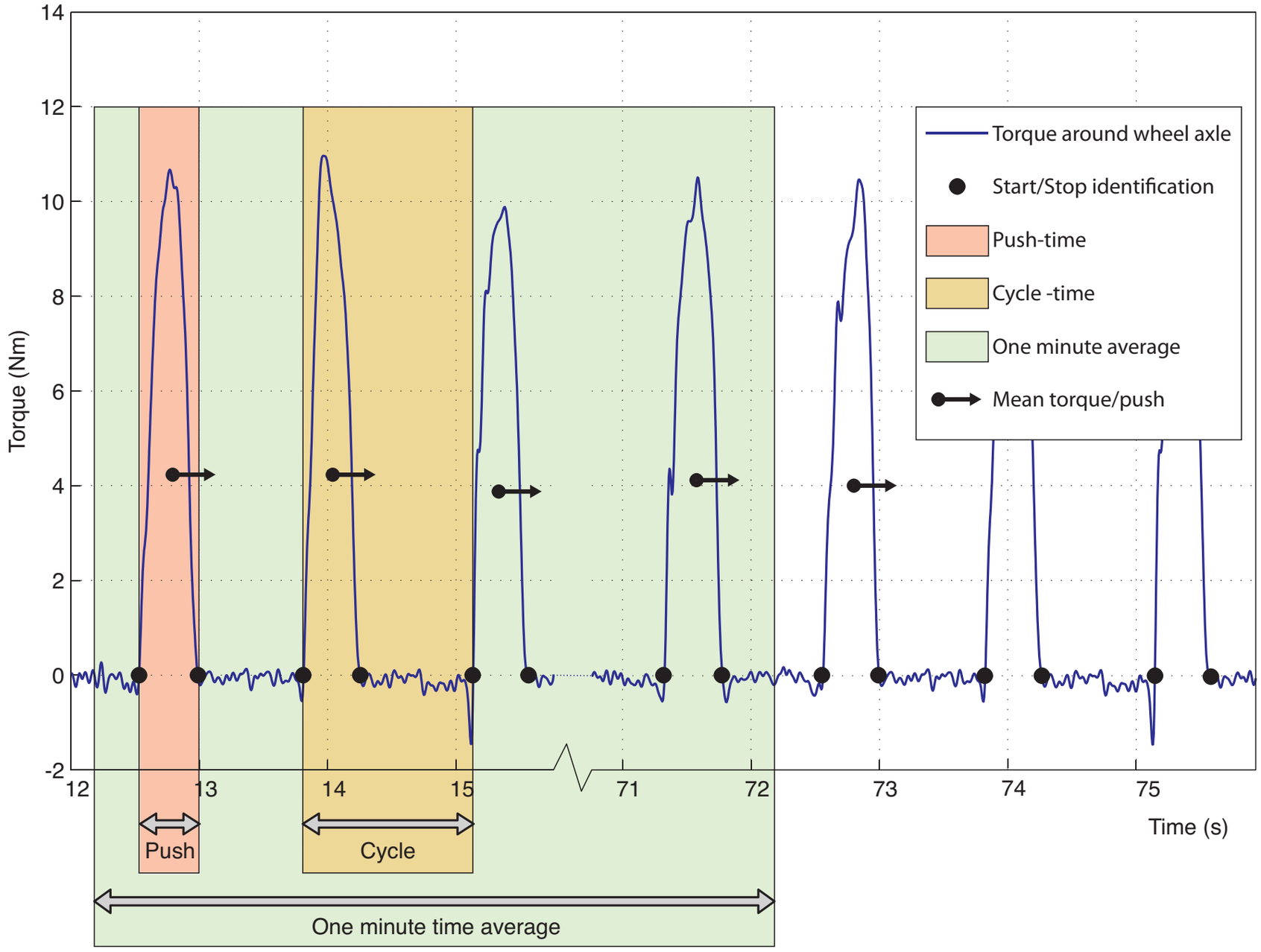
- Percentage of internally liberated energy that is used for propulsion:

$$ME(\%) = \frac{P_{output}}{P_{metabolic}} * 100$$

Measured at the wheels

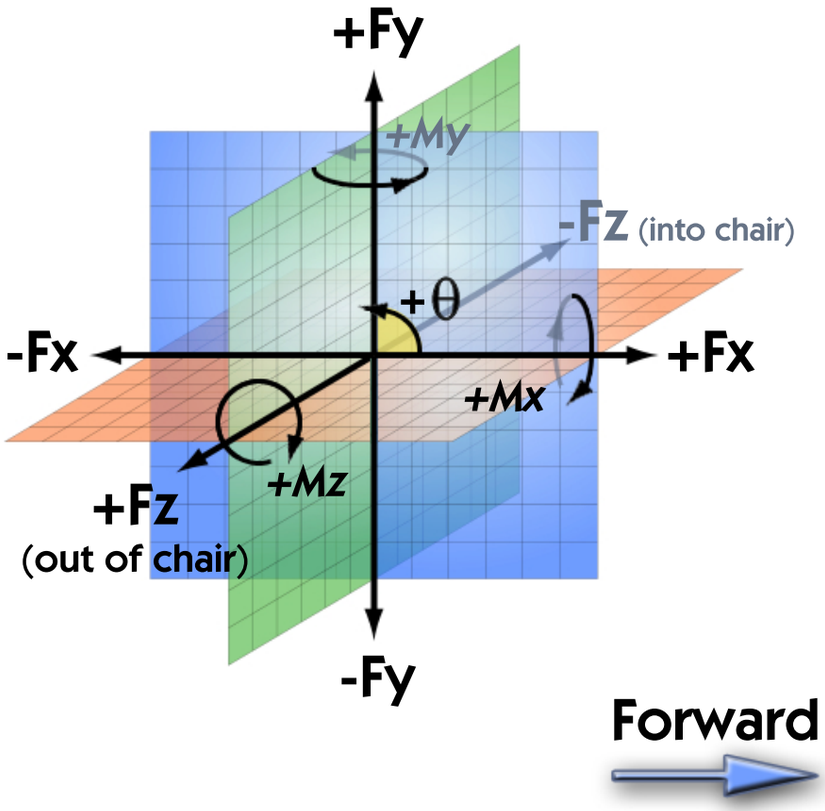
calculated from Cardio-respiratory measurements

2. Propulsion technique



Experiments 2010-2012

Right side of forward facing Wheelchair



B

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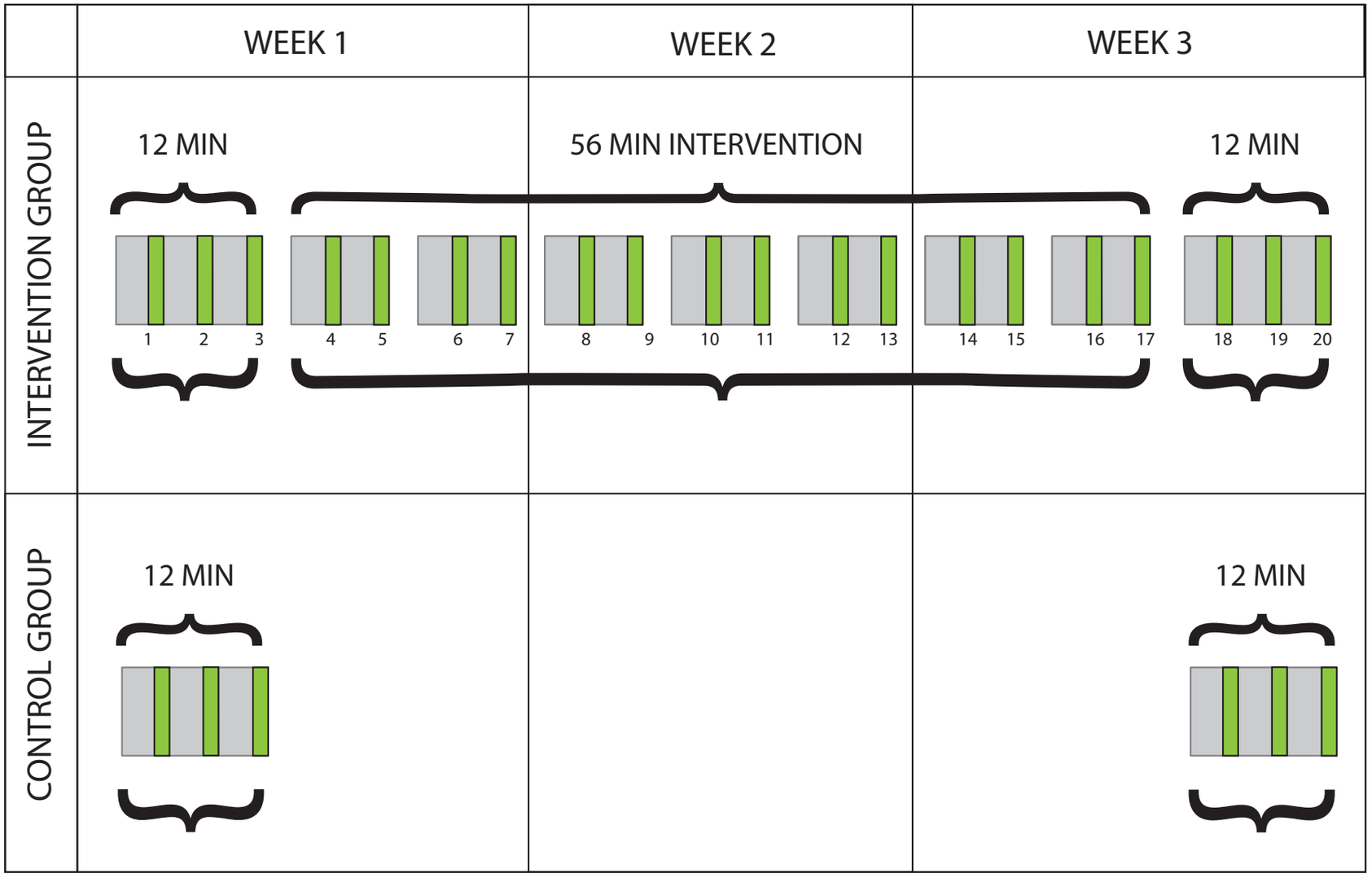
- All interventions followed the same type of trial setup and total dose

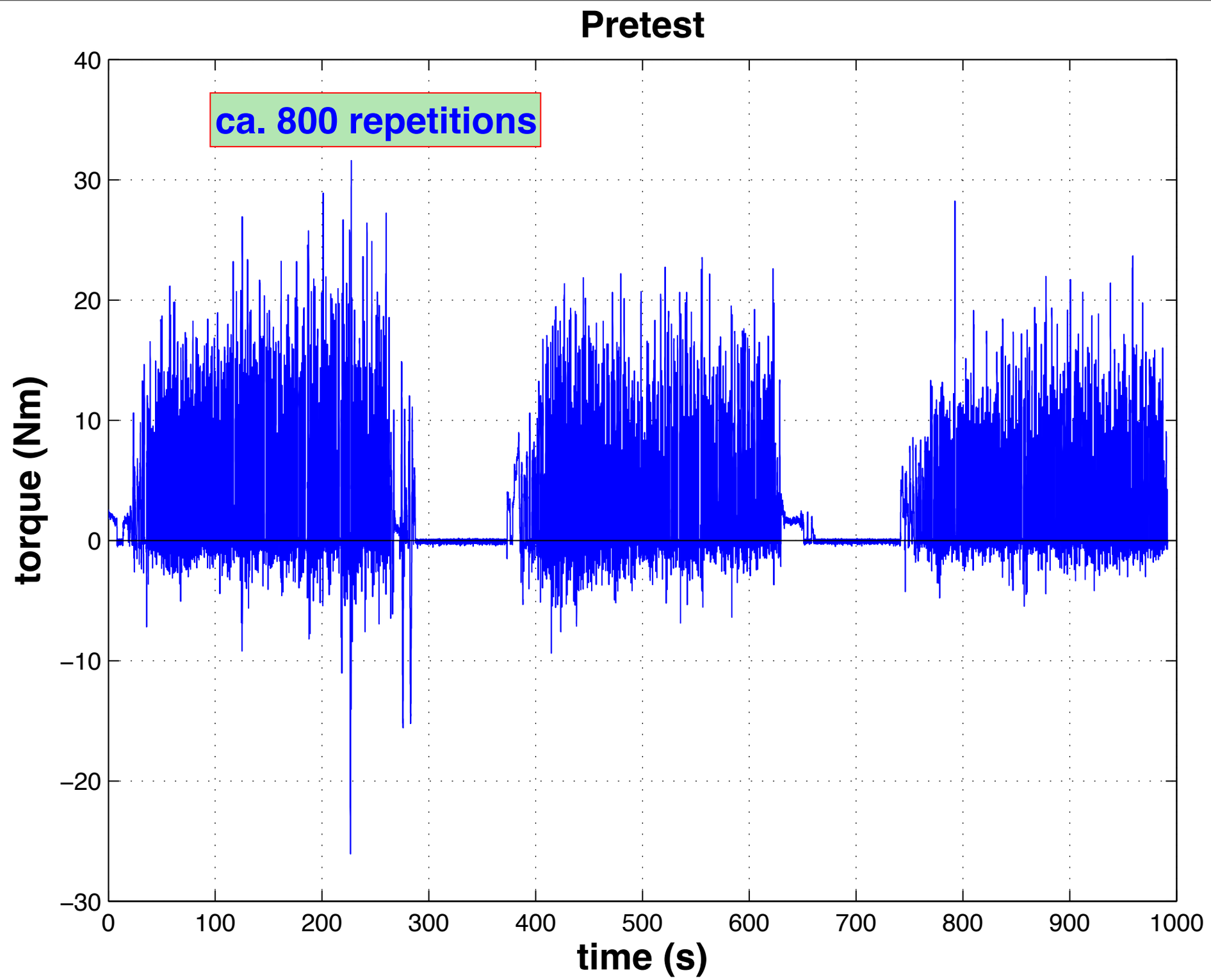


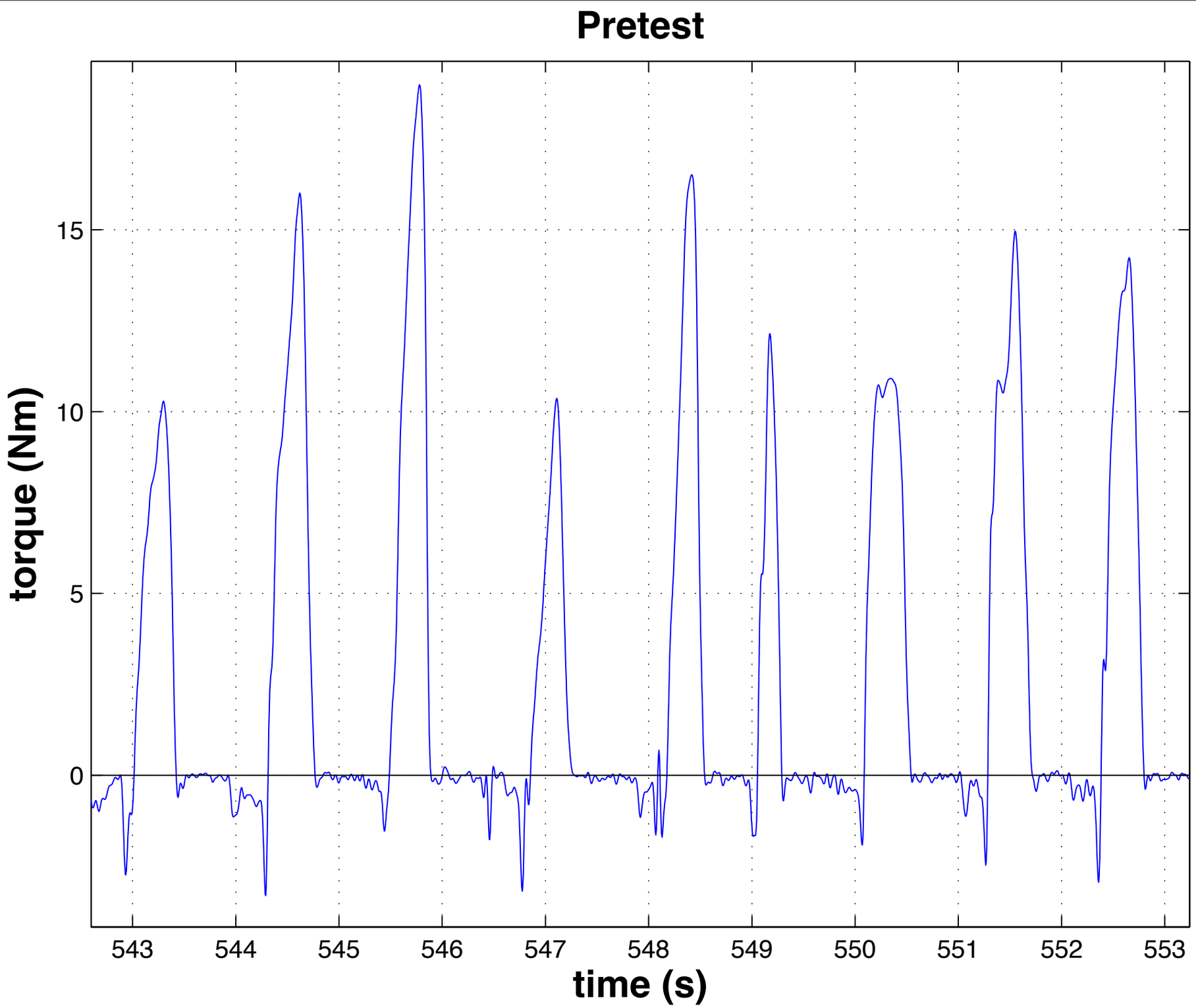
INTERVENTION GROUP	12 MIN 1 2 3	56 MIN INTERVENTION 4 5 6 7 8 9 10 11 12 13	14 15 16 17 12 MIN 18 19 20
CONTROL GROUP	12 MIN		12 MIN

Database of 83 subjects

- The same pretest
- Different interventions
- The same posttest

n=83	Mean	Std
age	22.8	3.6
body mass	80.2	11.4
height	1.87	0.07


Pretest
ca. 800 repetitions
torque (Nm)
40
30
20
10
0
−10
−20
−30
0
100
200
300
400
500
600
700
800
900
1000
time (s)


Pretest
torque (Nm)
15
10
5
0
543
544
545
546
547
548
549
550
551
552
553
time (s)

Matlab

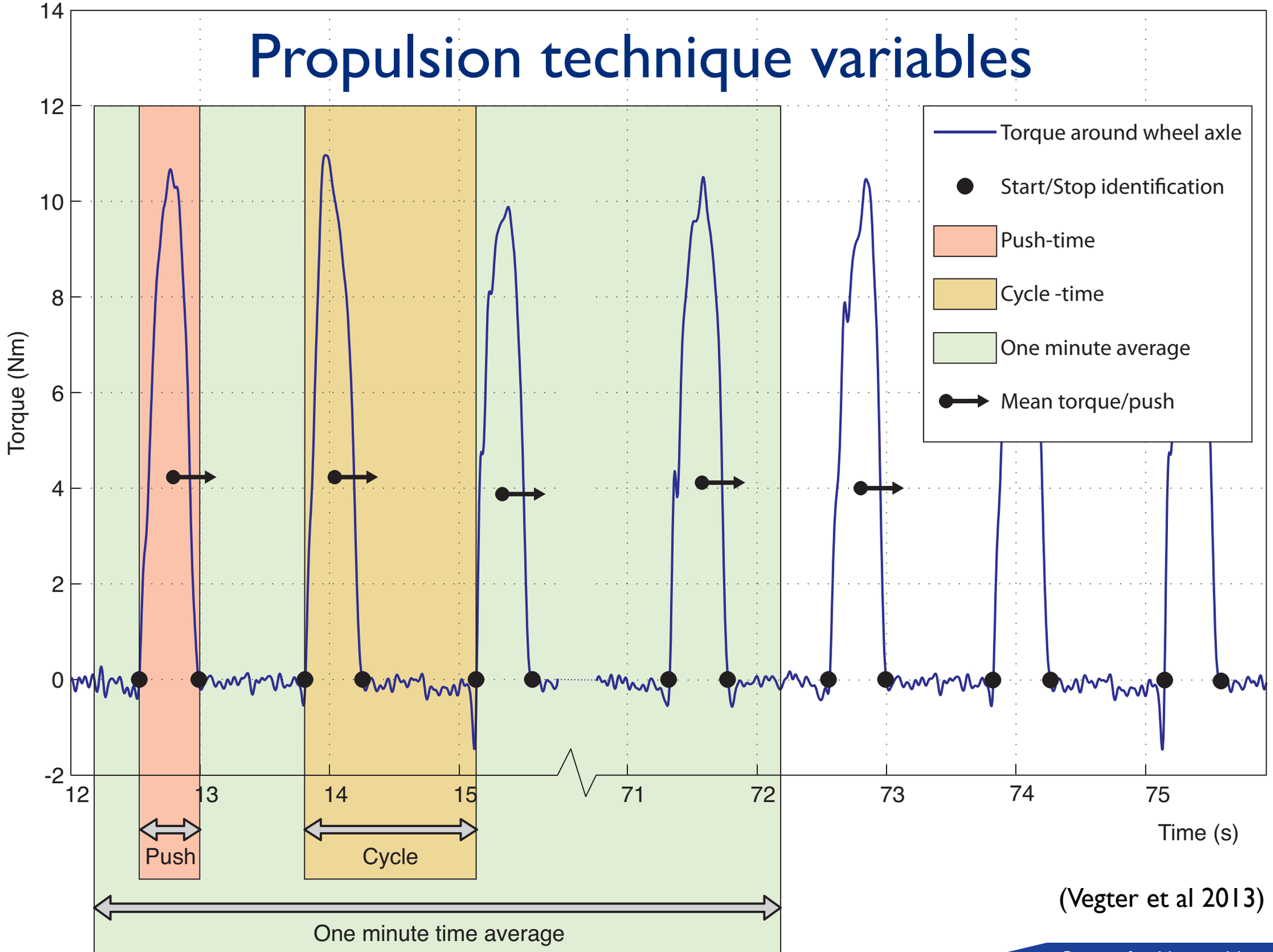
- Function to do Push-detection

```
function [Pushstart,Pushstop,PushstartLocation,PushstopLocation] = PushbyPush4(Torque,Cutoff,Noise)

% Function that determines the pushes from a torque signal measured around the axle of a handrim.
% A push is defined as a period of positive torque with a max torque higher then the Nm specified
% by Cutoff:

%Input:
%Torque: Torque around the z-axis (axle) of a wheelchair;
%Cutoff: Maximum allowable torque to count as a push;
%Noise:  Noise on the signal;

%Output:
%Push identification

%Copyright 2011, Riemer Vegter
%mailto://r.j.k.vegter@med.umcg.nl
%%
```

- Function to do Push-by-push analysis

```
function [matrix1, matrix2, matrix3, matrix4, Headers]= Handrim_Analyses10(Matrix,SampleFreq,Cutoff,Noise)

%function to analyse handrim data from instrumented handrimmed wheels
%
%Input:
% SampleNr:     vector;Sample number
% Time:         vector;Time dependend on sample number and samplefrequency
% Angle:        vector;Angle in RADIANS
% Fx:           vector;Newton, Local, non rotating x-axes of the wheel axle.
% Fy:           vector;Newton, Local, non rotating y-axes of the wheel axle.
% Fz:           vector;Newton, Local, non rotating zx-axes of the wheel axle.
% Mx:           vector;Newton*Meter, Local, non rotating x-axes of the wheel axle.
% My:           vector;Newton*Meter, Local, non rotating y-axes of the wheel axle.
% Mz:           vector;Newton*Meter, Local, non rotating z-axes of the wheel axle.
% SampleFreq:   scalar;Sample frequency of the data
%
%Output:
%struct1: 9 input columns and 9 calculated columns for each sample.
%struct2: In each row a push, indices, time and calculated variables.
%struct3: Mean and std of important variables over the total time period
%
%Copyright 2011, Riemer Vegter
%mailto://r.j.k.vegter@med.umcg.nl
```

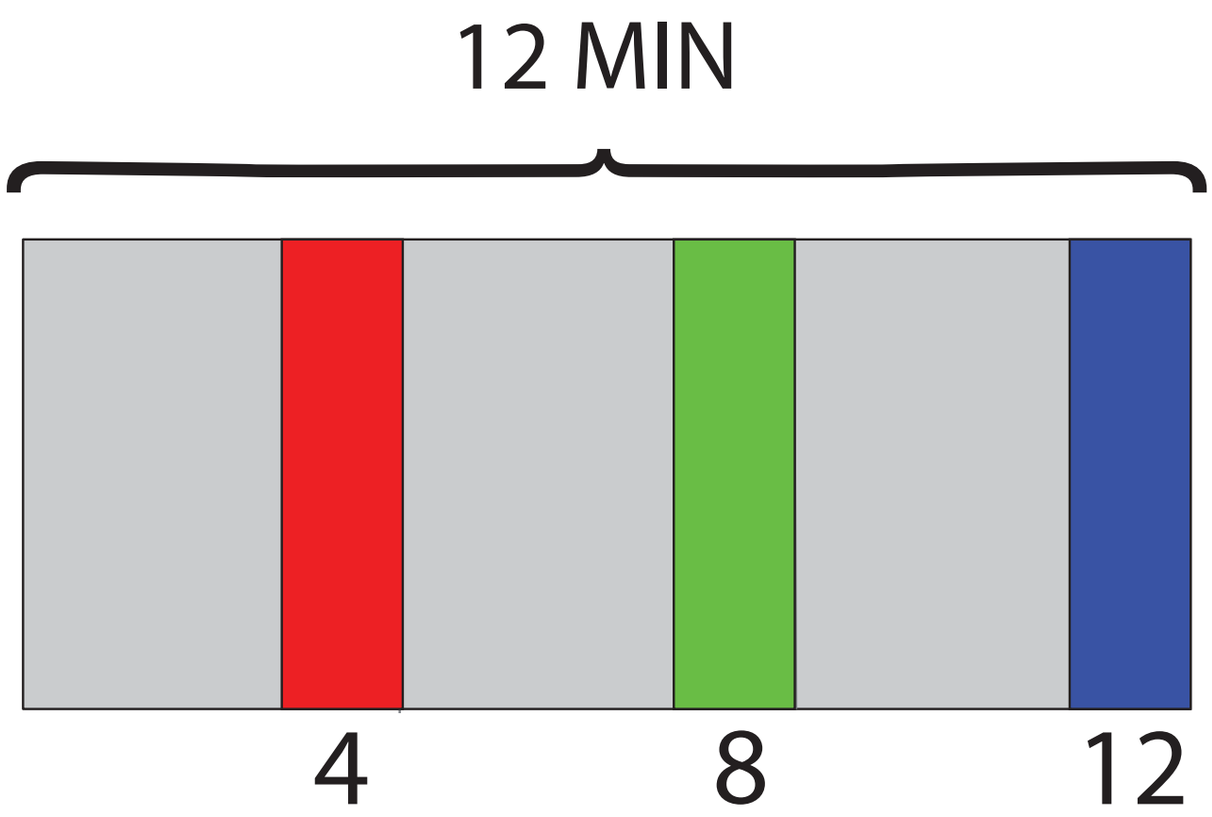
Propulsion technique variables



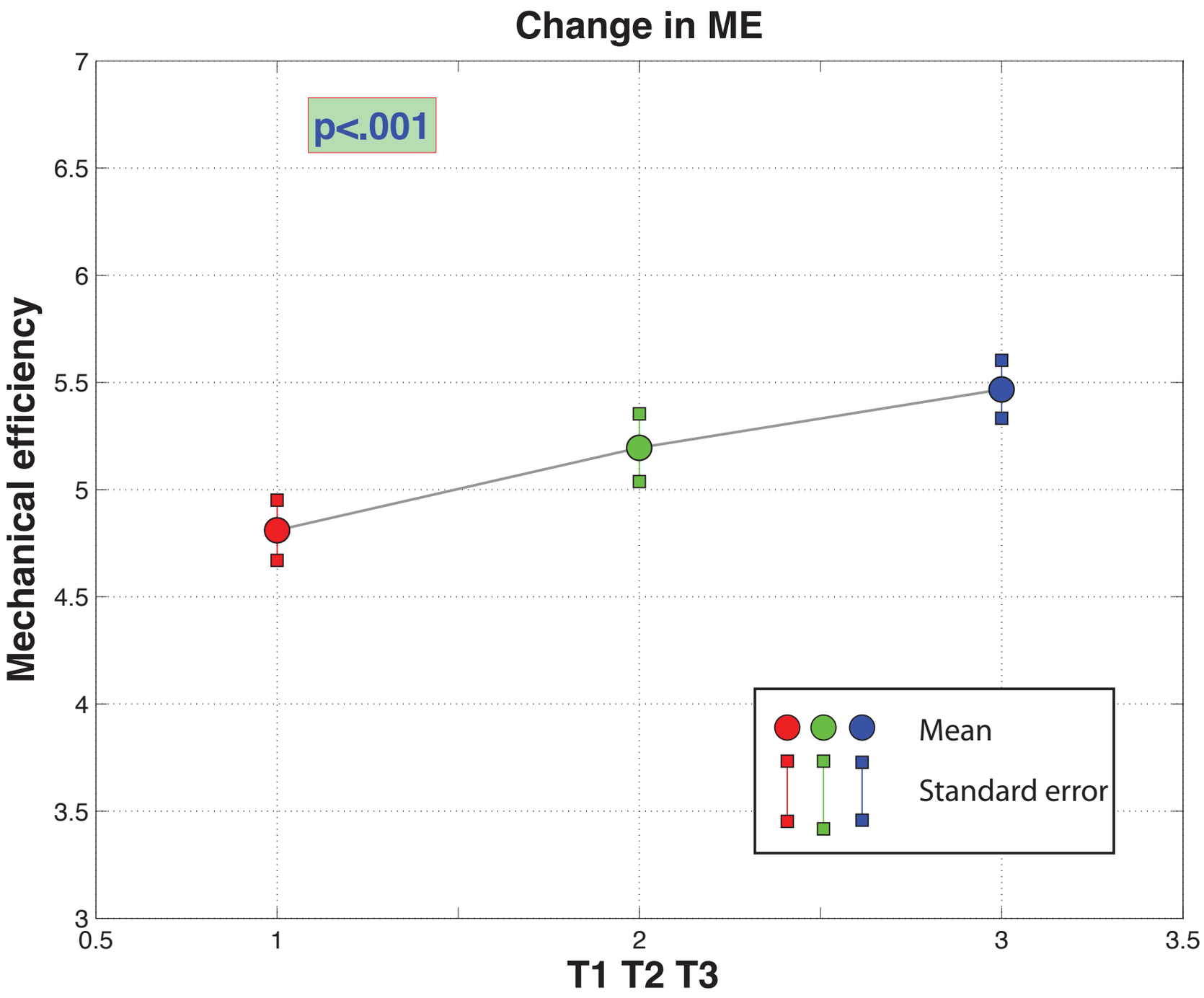
(Vegter et al 2013)

Research question

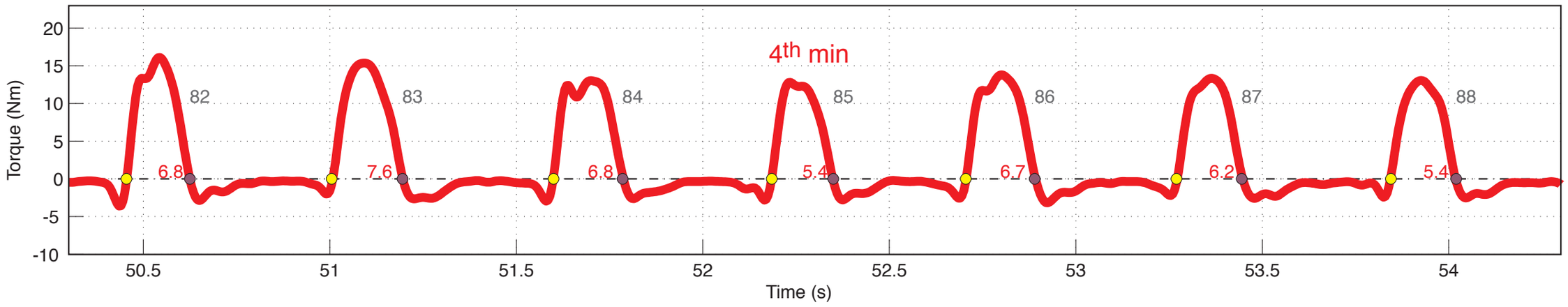
- What motor learning processes take place during the 12 min pretest for all subjects in the database?

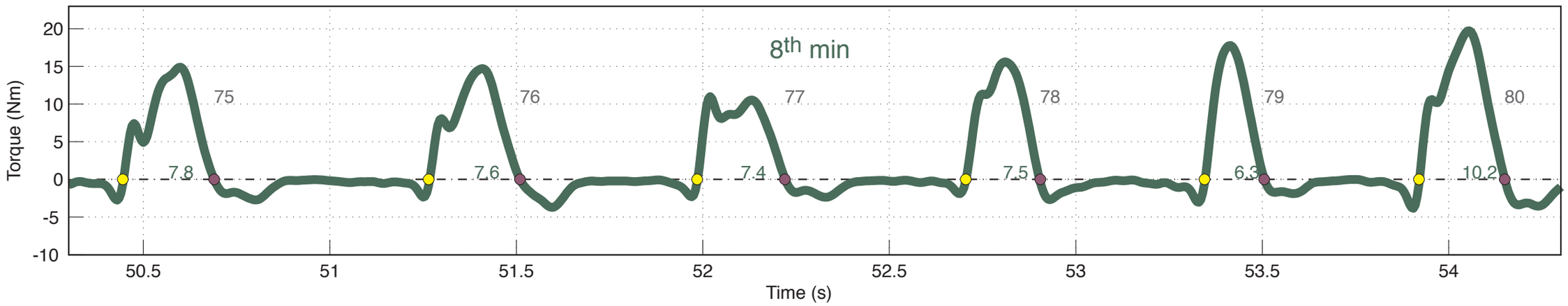


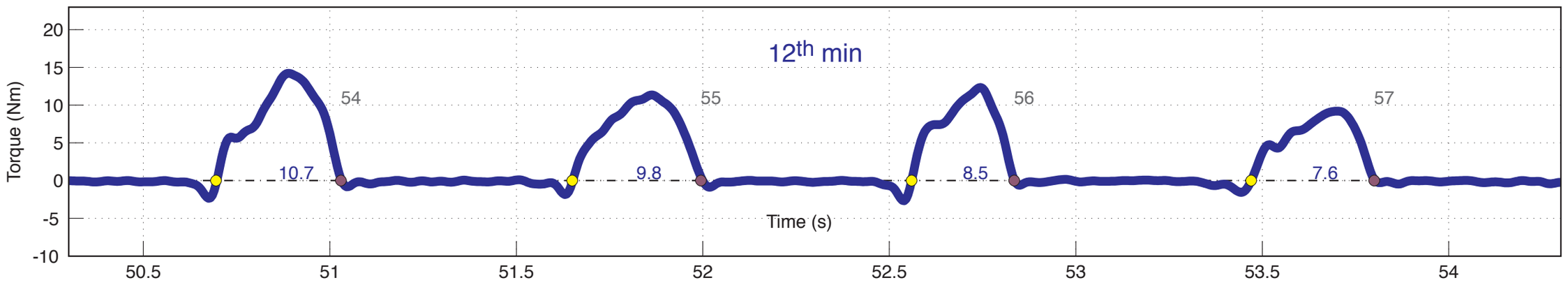
Change in mechanical efficiency

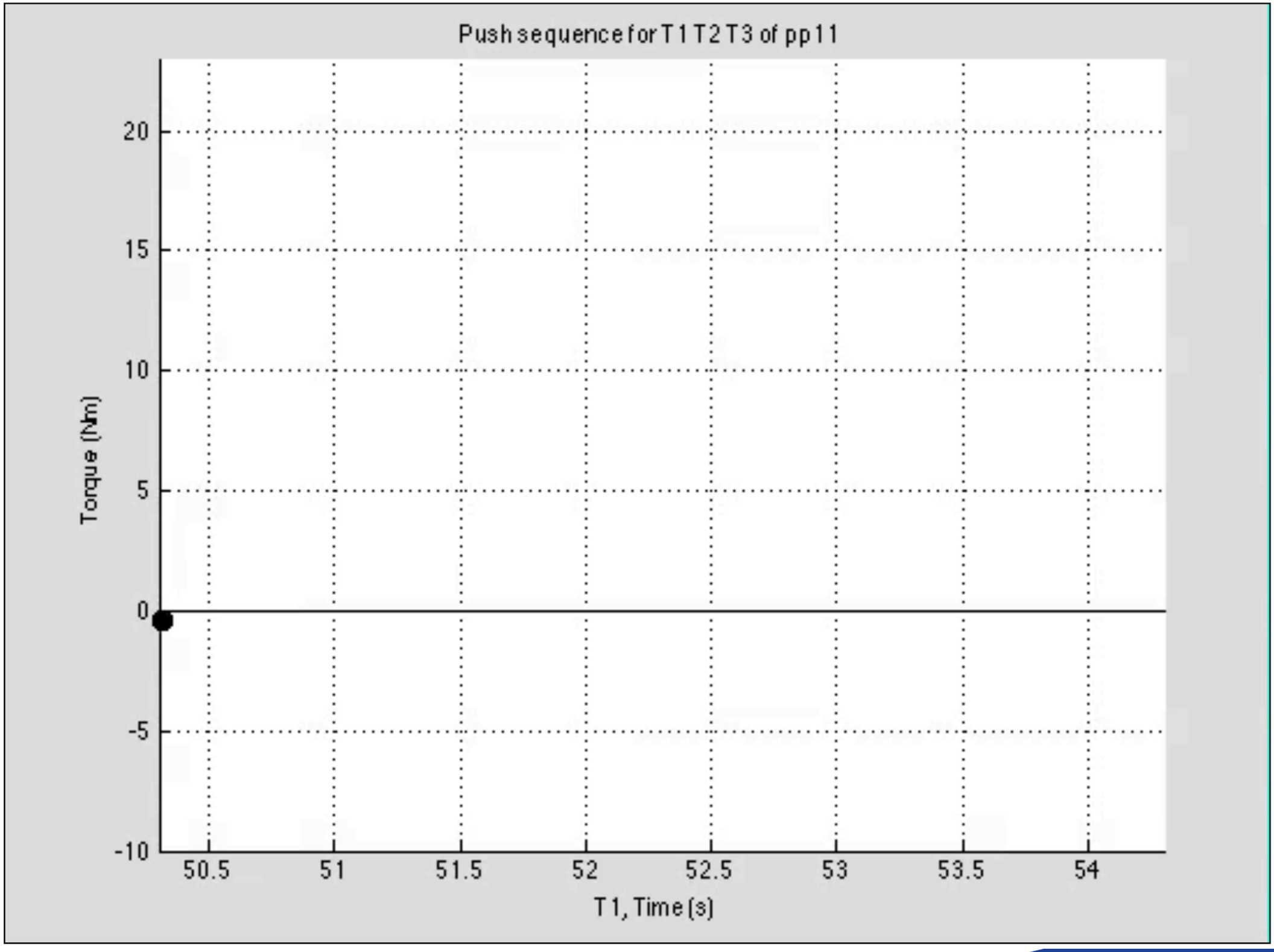


Change in propulsion technique








Push sequence for T1 T2 T3 of pp11
Torque (Nm)
20
15
10
5
0
-5
-10
50.5
51
51.5
52
52.5
53
53.5
54
T1, Time (s)

Conclusion

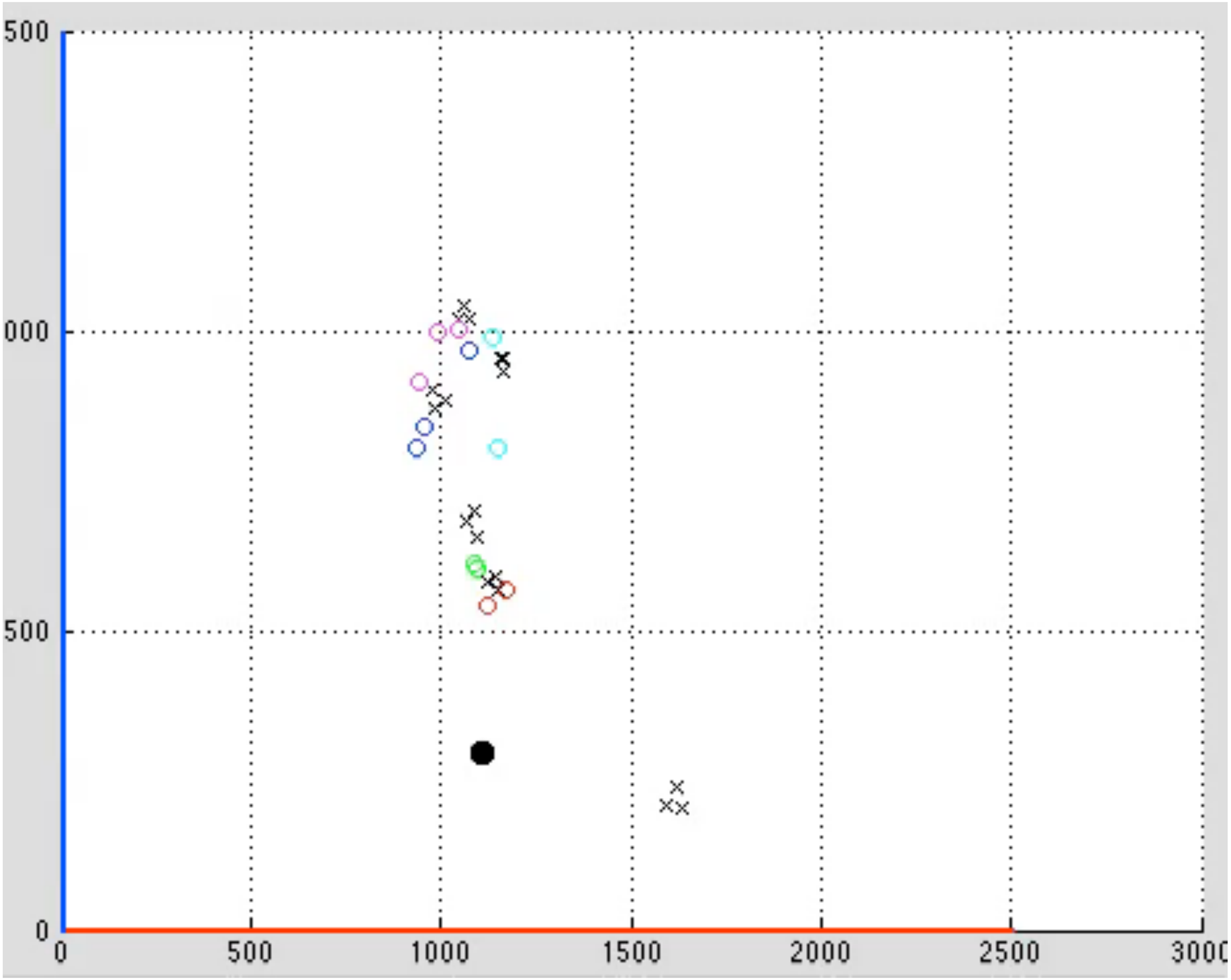
- In the first 12 minutes people reduce their energy cost

- In the first 12 minutes subject change their propulsion technique

Future work

- Further explore the relation of propulsion technique with mechanical efficiency

- Add kinematics (3d position registration) to kinetic (Measurement-wheels) data


500
000
500
0
0
500
1000
1500
2000
2500
3000

Questions ?

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