

Lower Limb Kinematics – Feet & Ankles

FOOT ROTATION



Left foot external rotation (min angle with bike)

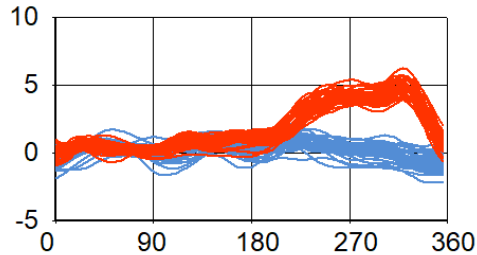
0°

Left foot internal rotation (max angle with bike)

5°

Total rotation range

5°



Right foot external rotation (min angle with bike)

0°

Right foot internal rotation (max angle with bike)

1°

Total rotation range

1°

FOOT ANGLE TO HORIZONTAL



Left foot min/max angle to horizontal

0° / 45°

Crank @ left min/max angle to horizontal

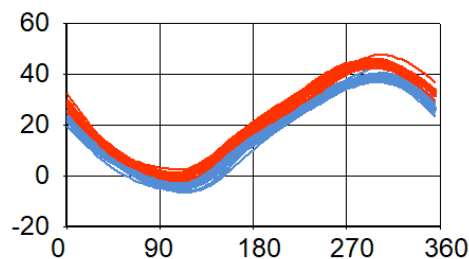
109° / 299°

Left foot angle to horizontal range

45°

Left foot angle to horizontal - Crank @90°/ @270°

1° / 43°



Left foot angle to horizontal @ maximum knee flexion

15°

Right foot angle to horizontal @ maximum knee flexion

11°

Right foot min/max angle to horizontal

-4° / 38°

Crank @ right min/max angle to horizontal

105° / 293°

Right foot angle to horizontal range

42°

Right foot angle to horizontal - Crank @90°/@270°

-3° / 36°

ANKLE FLEXION



Left ankle flexion

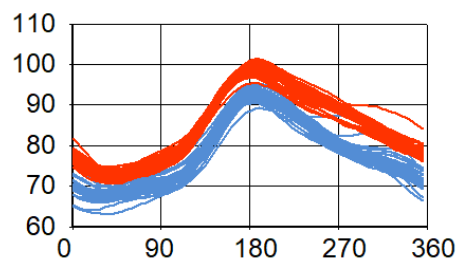
73°

Left ankle extension

100°

Range of motion

27°



Right ankle flexion

68°

Right ankle extension

92°

Range of motion

24°

ANKLE LATERAL OSCILLATION

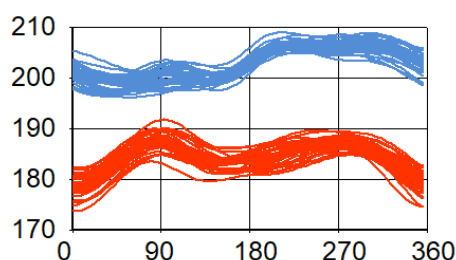


Left ankle position in relation to bike (mean)

184 mm

Total swing range

27 mm



Right ankle position in relation to bike (mean)

203 mm

Total swing range

13 mm

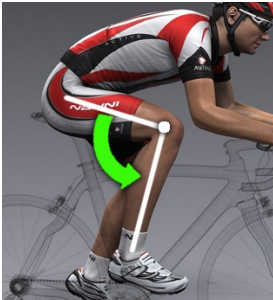
Bike fitting (body & floor)

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Lower Limb Kinematics – Knees

KNEE FLEXION



Left knee flex/extension

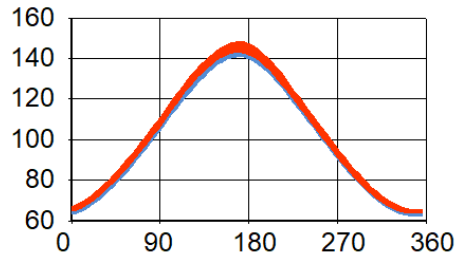
65° / 146°

Crank @ left knee flexion/extension

346° / 168°

Range of motion

81°



Right knee flex/ext

63° / 143°

Crank @ right knee flexion/extension

348° / 168°

Range of motion

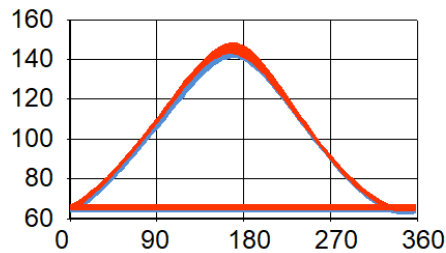
80°

KNEE ANGLE IN RELATION TO CRANK ANGLE



This graph is used for symmetry assessment.

The relationship between knee and crank angle would ideally describe overlapped curves.



KNEE LATERAL OSCILLATION

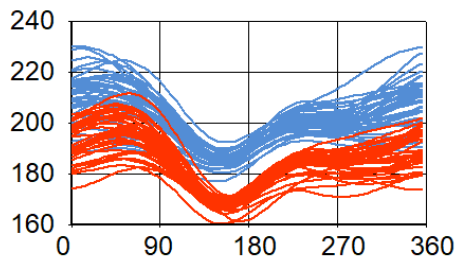


Left knee position in relation to bike (mean)

184 mm

Total swing range

30 mm



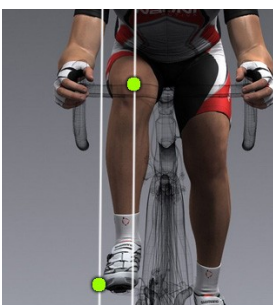
Right knee position in relation to bike (mean)

201 mm

Total swing range

28 mm

KNEE TO M5 LATERAL OSCILLATION

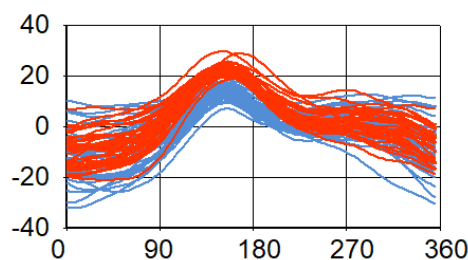


Mean left foot position in relation to left knee

3 mm

Total distance range

51 mm



Mean right foot position in relation to right knee

-1 mm

Total distance range

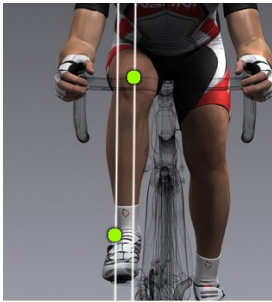
54 mm

Bike fitting (body & floor)

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ANKLE TO KNEE LATERAL DISTANCE

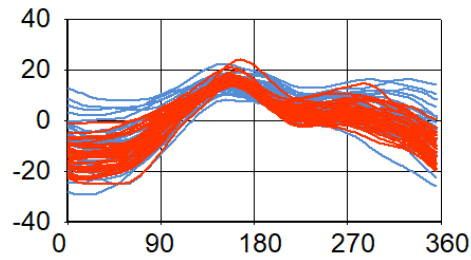


Mean left ankle position in relation to knee

0 mm

Total distance range

29 mm



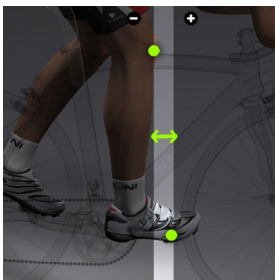
Mean right ankle position in relation to knee

2 mm

Total distance range

26 mm

KOPS (KNEE OVER PEDAL SPINDLE) DISTANCE



Mean left KOPS

-3 mm

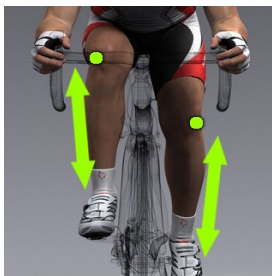
KOPS is defined as the average distance between the tibial tuberosity and the pedal axle in the antero-posterior direction, with a crank angle of 90°. As for the interpretation of the sign (positive or negative):

- ✓ When the knee is ahead of the pedal axle, the KOPS is positive.
- ✓ When the knee is behind the pedal axle, the KOPS is negative.

Mean right KOPS

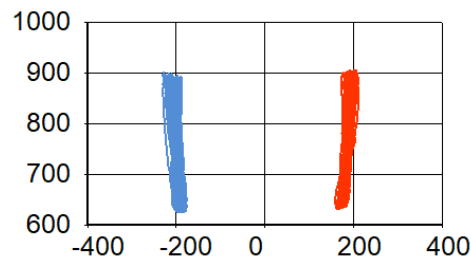
8 mm

KNEE TRAJECTORIES (FRONT VIEW)



Left knee angle with vertical

4°



Right knee angle with vertical

4°

■ Left ■ Right

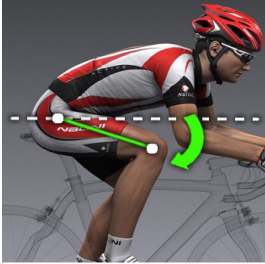
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Lower Limb Kinematics – Thighs

THIGH TILT



■ Left ■ Right

Left thigh min angle

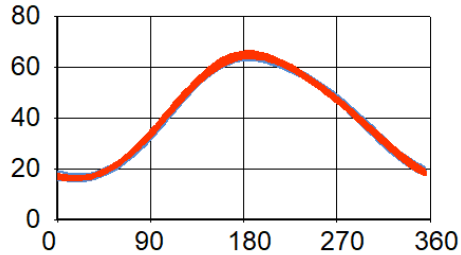
16°

Left thigh max angle

65°

Range of motion

49°



Right thigh min angle

16°

Right thigh max angle

64°

Range of motion

48°

Lower Limb Kinematics – Hips & Pelvis

HIP FLEXION



Left hip flex/extension

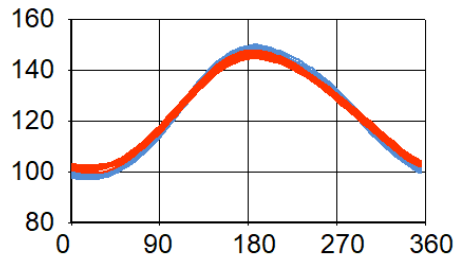
101° / 146°

Crank @ left hip flexion/extension

14° / 181°

Range of motion

45°



Right hip flex/extension

98° / 148°

Crank @ left hip flexion/extension

15° / 184°

Range of motion

50°

HIPS CENTER TO BOTTOM BRACKET AP DISTANCE

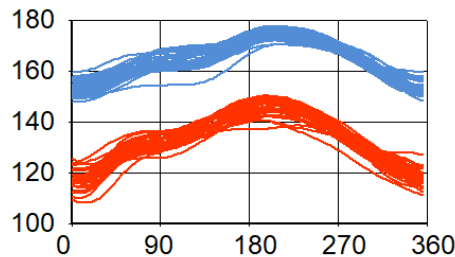


Left minimum distance

117 mm

Left maximum distance

147 mm



Right minimum distance

153 mm

Right maximum distance

175 mm

ANKLE TO HIP LATERAL DISTANCE

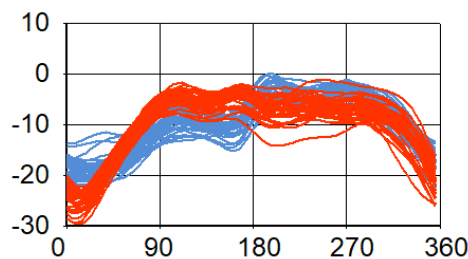


Mean left ankle position in relation to left hip

-10 mm

Total distance range

20 mm



Mean right ankle position in relation to right hip

-10 mm

Total distance range

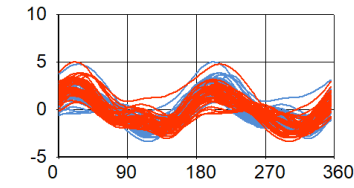
12 mm

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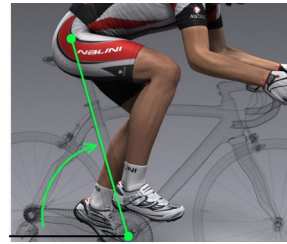


HIPS CENTER VERTICAL TRAVEL



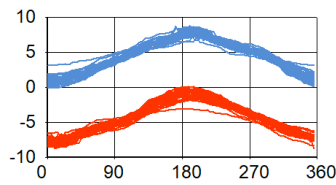
Total vertical travel (range of motion)
4 mm

HIP SETBACK



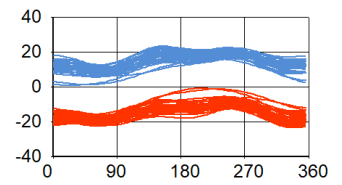
Mean hips center setback
78°

PELVIS ROTATION



Left/right rotation (mean)
1° / 8°
Total rotation (range of motion)
7°

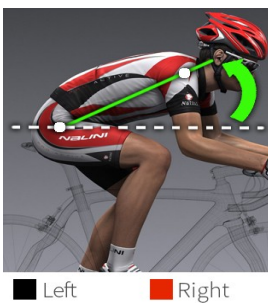
PELVIS LATERAL OSCILLATION



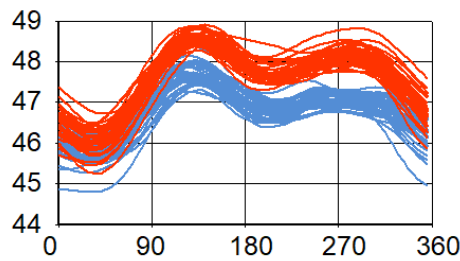
Left swing (mean)
9 mm
Right swing (mean)
20 mm
Total swing (range of motion)
11 mm
Pelvis position in relation to bike
14 mm

Trunk Kinematics

HIP TO SHOULDER TILT



Minimum left hip-shoulder angle
46°
Maximum left hip-shoulder angle
48°
Range of motion
2°

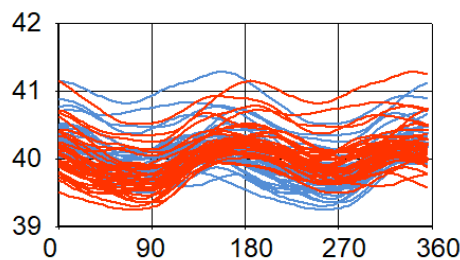


Minimum right hip-shoulder angle
46°
Maximum right hip-shoulder angle
48°
Range of motion
2°

TRUNK TILT (SACRUM-NECK)



Average trunk angle to horizontal (Sacrum to neck segment)
40°
Range of motion
27°



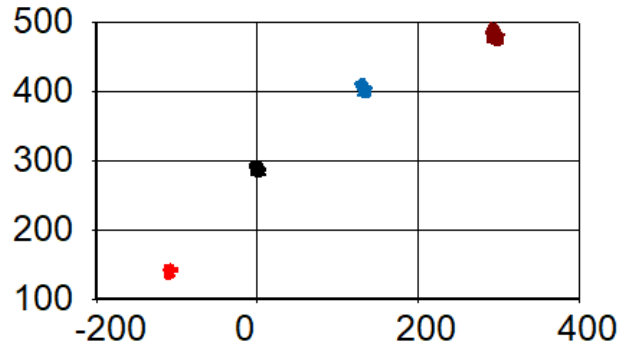
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Back & Shoulders Kinematics

BACK VERTICAL OSCILLATION



HIP - SHOULDER - ELBOW



Minimum left hip-shoulder-elbow

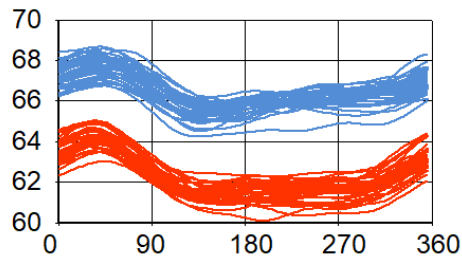
61°

Maximum left hip-shoulder-elbow

64°

Range of motion

3°



Minimum right hip-shoulder-elbow

65°

Maximum right hip-shoulder-elbow

68°

Range of motion

3°

SHOULDER LATERAL OSCILLATION



Left swing (mean)

12 mm

Right swing (mean)

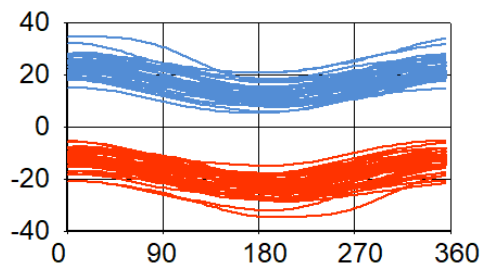
24 mm

Total swing (range of motion)

12 mm

Average shoulder position in relation to bike

18 mm



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Arms Kinematics

ELBOW FLEXION

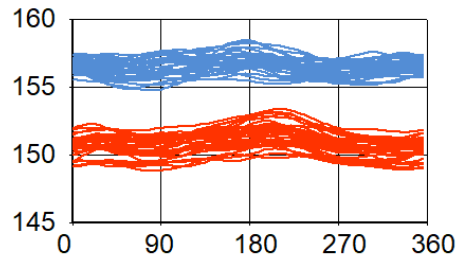


Average left elbow flexion

152°

Range of motion

5°



Average right elbow flexion

157°

Range of motion

4°

FOREARM TILT



Min left forearm angle to horizontal

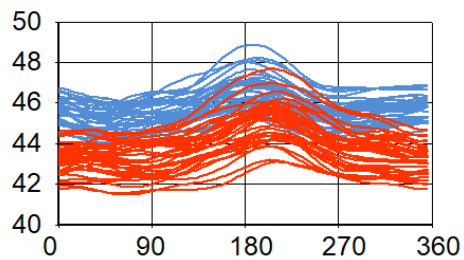
43°

Max left forearm angle to horizontal

45°

Range of motion

2°



Min right forearm angle to horizontal

45°

Max right forearm angle to horizontal

47°

Range of motion

2°

SHOULDER TO WRIST LATERAL DISTANCE

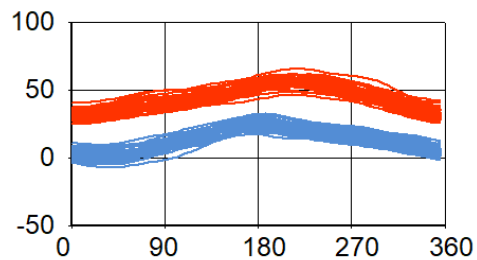


Mean lateral distance between left shoulder and wrist

44 mm

Range of motion

41 mm



Mean lateral distance between right shoulder and wrist

13 mm

Range of motion

40 mm

Bike fitting (body & floor)

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Automated anthropometry measures



Upper arm length
(Shoulder to elbow segment)

338 mm 345 mm

Forearm length
(Elbow to wrist segment)

238mm 252mm

Spine length
(Sacrum to neck segment)

542 mm

Shoulder distance
(Right shoulder to left shoulder segment)

373 mm

Thigh length
(Hip to knee segment)

359 mm 403 mm

Tibia length
(Knee to ankle segment)

414 mm 409 mm

Hip to wrist - vertical
(Mean distance from hip to wrist)

65 mm 87 mm

Hip to wrist - horizontal
(Mean distance from hip to wrist)

660 mm 693 mm

Notes: