

The Application of Portable Lab in Movement Measurement

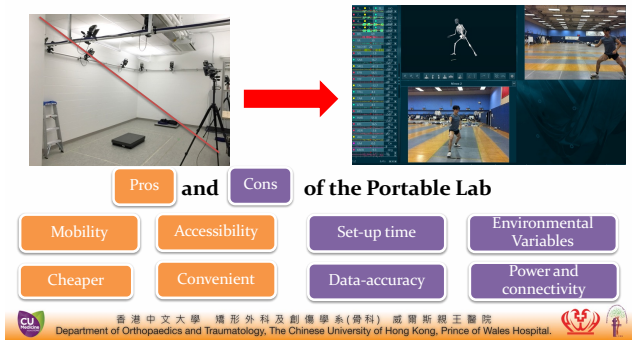


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Demo team



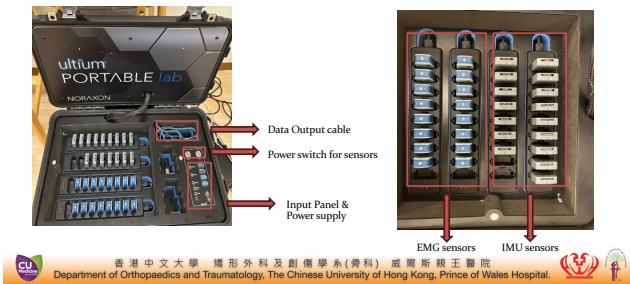
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The Application of Portable Lab

Equipment Overview – Portable Lab Case



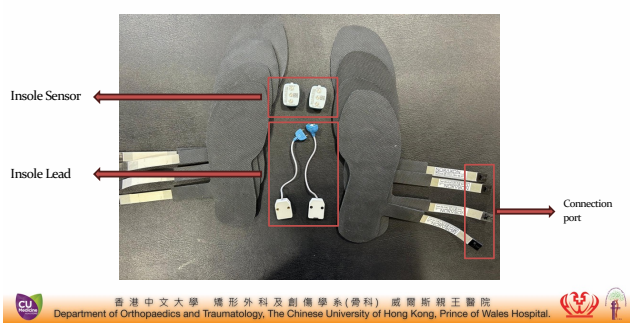
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Equipment Overview – High speed Camera



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Equipment Overview – Force Insole



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Outcome measurement of the portable lab

- Joint angle (degrees)
- EMG (uV)
- Body segment acceleration (mG)
- Ground reaction force (N)
- High speed camera
- Force distribution (normalised by body weight)



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DISCLAIMER

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Aims:

- Portable lab demonstration
 - Set up
 - Data collection
 - Quality check
 - Data analysis (on-site)

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High-speed camera



- Specification: 640x480 (120Hz) or 1920x1080 (60Hz)
- Maximum frame rate: 125 fps/Hz
- Auto-focus, no calibration is required
- Minimum working distance: 1 m

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Electromyograph (EMG) Sensor

Specification of EMG sensor



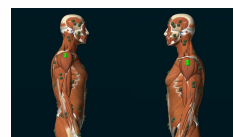
Sampling rate	2000Hz or 4000Hz
High pass cutoff	5Hz, 10 Hz, or 20Hz
Low pass cutoff	500Hz, 1000Hz or 1500Hz



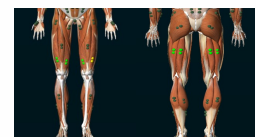
Measurement Functional Accuracy	+/-1%
Analog Output	up
Weight	14 g

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EMG Sensor location guide



Upper body EMG sensor placement



Lower body EMG sensor placement

Sensor Placement Locations

Deltoid Medius	Greatest bulge of the deltoid muscle. In the line between acromion and hand.
Vastus Lateralis	2/3 on the line from the anterior spina iliaca superior to the lateral side of the patella
Vastus Medialis	80% on the line between the anterior spina iliaca superior and the joint space in front of the anterior border of the medial ligament
Riceps Femoris	50% on the line between the ischial tuberosity and the lateral epicondyle of the tibia
Semitendinosus	50% on the line between the ischial tuberosity and the medial epicondyle of the tibia

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EMG Assessment Procedure

Step 1: Cleanse and shave the area for EMG electrode placements.

Avoid placing the sensor above the any obstruction such as hair, scar.

Step 2: Attach the EMG electrodes to the location with the bulkiest muscle area. Try place the sensor at the systematical position on both side(Refer to the muscle map on the right).

Step 3: Connect the EMG sensor with the electrodes and attach the sensor to the subject. Make sure the sensor is secured in place

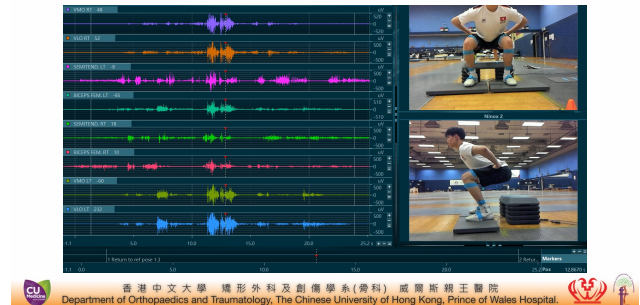
Step 4: Perform baseline calibration and check the EMG signal. Make sure the subject is not moving during the process

Step 5: Start data collection.



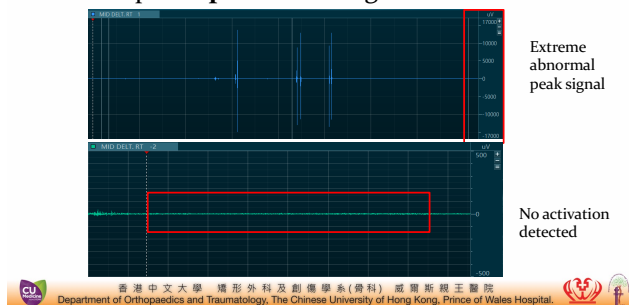
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• Example of good EMG signals



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• Example of **poor** EMG signals



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Tips for using portable EMG

Tip 1: Always check EMG sensor **signals** before the assessment starts.

Tip 2: Make sure to enhance the fixation of the sensor. Intense movements may result in losing **connections** between the sensor and the lead. Check the connection between trials.

Tip 3: To increase the accuracy of the data, make sure the target area for placing the electrodes is properly shaved before placing.

Tip 4: Make sure the sensors are placed on the bulkiest region of a specific muscle group. It will be helpful to ask the subject to contract the muscle before placing the electrodes.



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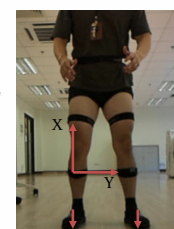
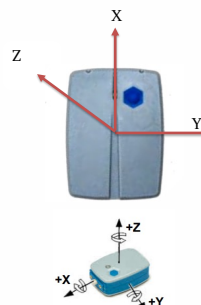
Inertia Measurement Units (IMU)

Specification of IMU

Maximum output rate	400 Hz
Static anatomical angle accuracy	+/- 1.0 degrees
Dynamic anatomical angle accuracy	+/- 2.0 degrees
Gyroscope measurement range	+/- 7000 degrees/sec
Accelerometer measurement range	+/- 200 g
Weight	19 g



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- The X coordinate of the sensors should always have a superior orientation and align towards the proximal joint
- The X coordinate points distally for the feet sensor



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IMU Assessment procedure

Step 1 – Motion sensor placement



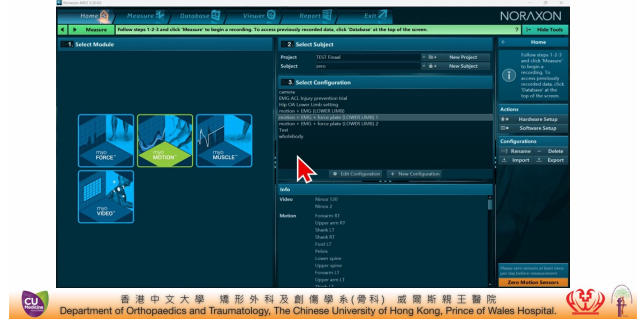
Sensor Placement Locations

Head	Middle of the back of the head
Upper Thoracic	Below C7 in line with the spinal column, but high enough to not be affected by upper trapezius muscle movement
Lower Thoracic	In line with the spinal column at L1/L12. Strap belt will be positioned on lower ribs on the front side of the body
Pelvic	Body area of sacrum
Upper Arm	Midway between the shoulder and elbow joints, lateral to the bone axis
Forearm	Posterior and distal, where there is a low amount of muscle tissue
Hand	Dorsal
Thigh	Frontal and distal half, where there is a lower amount of muscle displacement during motion
Shank	Front and slightly medial to be placed along the tibia
Foot	Upper foot, slightly below the ankle

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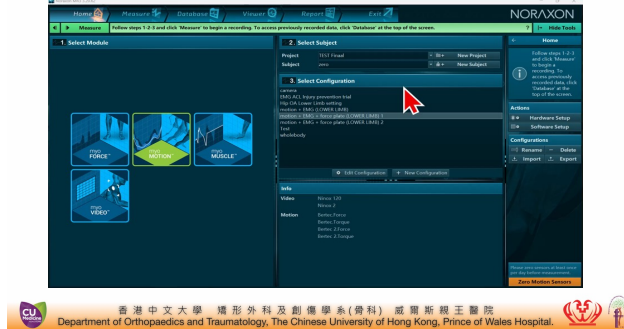
Step 2 – Before starting the measurement – select module and create project etc



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Step 2 – Before starting the measurement – hardware set up and configuration



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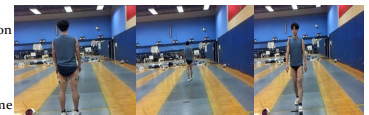
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Step 3 – Calibration for IMU sensors



For calibration

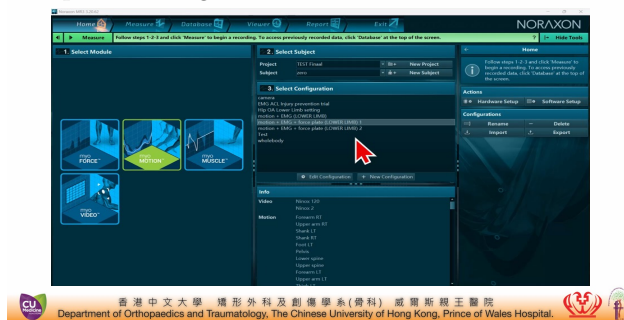
- Choose walking for functional calibration when space is not limited
- Follow the steps from the software
- Make sure the subject returns to the same start point after walking



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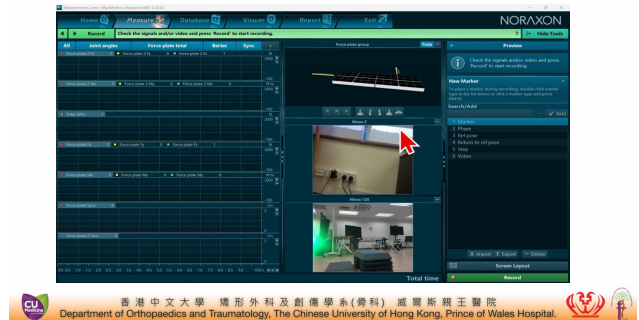
Step 3 – Activating the sensors and calibration



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Step 4 – Data collection



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Step 5 – Data extraction

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Export the data with desired file type
The Excel.slk file will include the processed data with time frames measured by sensors

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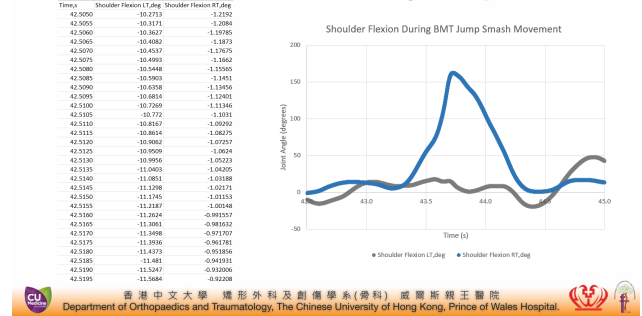
Tips for setting IMU

- Tip 1:** Always check sensor signals before the assessment start. After calibration, simple task such as squat, jump can be performed to ensure there is no error.
- Tip 2:** Make sure there is no rotation of the sensor during the placement.
- Tip 3:** Sensors of the contralateral body part should be placed at the symmetrical position.
- Tip 4:** The subject must calibrate facing the same direction of the assessment movement
- Tip 5:** Place markers on the floor to make sure the subject return to the same position during walking calibration

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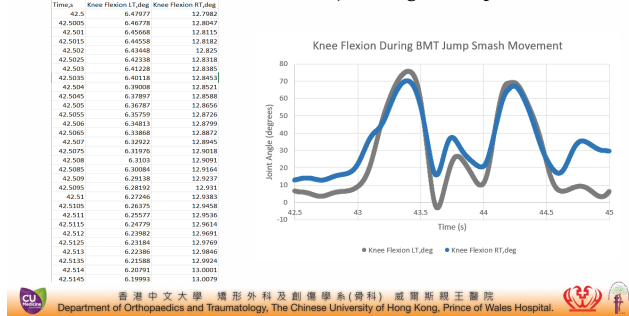
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Example of Output data – Shoulder angular displacement



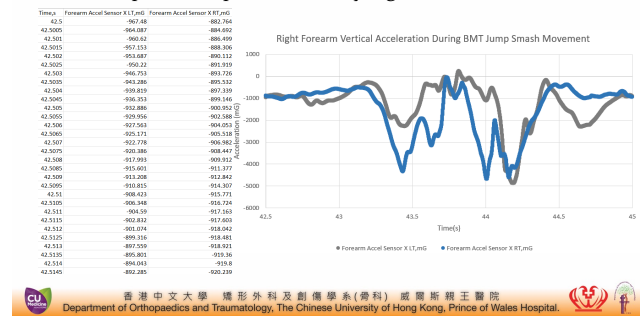
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Example of Output data – Knee joint angular displacement



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Example of Output data – Body segment acceleration



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Assessment Procedure for Force Insole



Step 1: Connect the sensor with the force insole. And assign the insole to the subjects with accurate size

Step 2: Calibrate the insole before the recording. Subjects will be instructed to shift all the weight to left and right to finish the calibration.

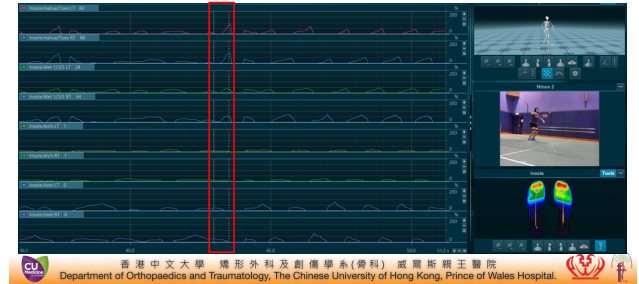
Step 3: Start recording. Data will be presented as per cent of body weight.

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Example of Force insole data

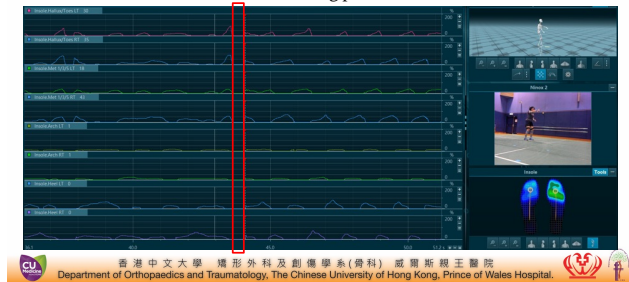
Preparation of taking off phase



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Example of Force Insole Data

Landing phase



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Demonstration of Utilizing Portable Lab in Badminton Jump Smash Movement

Assessment procedure of badminton jump smash

- Both motion sensors and EMG sensors were placed at the location according to the user manual.
- A marker was placed in the middle of the centre line of the court as the starting point.
- The subject was given around 15 mins of warm-up before the assessment started.
- Shuttlecocks were fired from the opposite court by another player. The firing position is symmetrical to the starting point.
- From the starting point, the subject was asked to perform a maximum-effort jump smash to hit the incoming shuttlecock and return to the starting point.
- The subject performed 5 trials for the movements.

Equipment

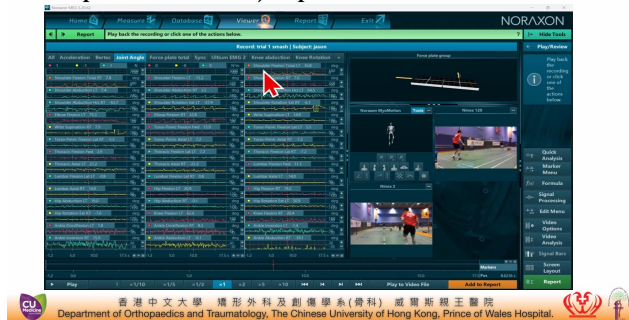
Subject

Actual Testing



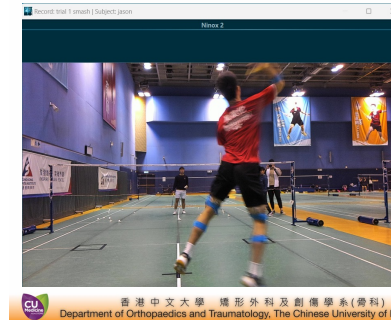
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Example in badminton jump smash



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Example in badminton jump smash

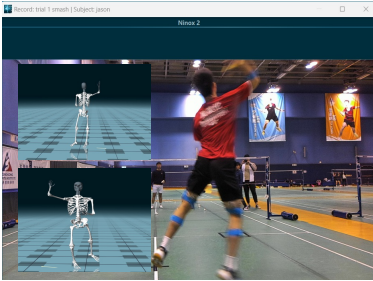


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Data collected

- Body segment acceleration
- Upper arm, forearm
 - Upper spine, lower spine
 - Pelvis
 - Shank
 - Thigh
 - Foot
- Joint angle
- Shoulder
 - Elbow
 - Wrist
 - Thoracic
 - Hip
 - Knee
 - Ankle
- EMG
- Quadriceps
 - Hamstring

Example in badminton jump smash



Right upper limb joint angle

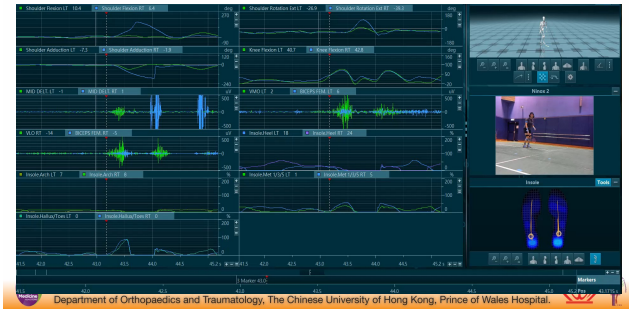
Shoulder external rotation: 59.6
Shoulder flexion: 91.6
Shoulder abduction: 92.0
Elbow flexion: 104.3

Right Lower limb joint angle

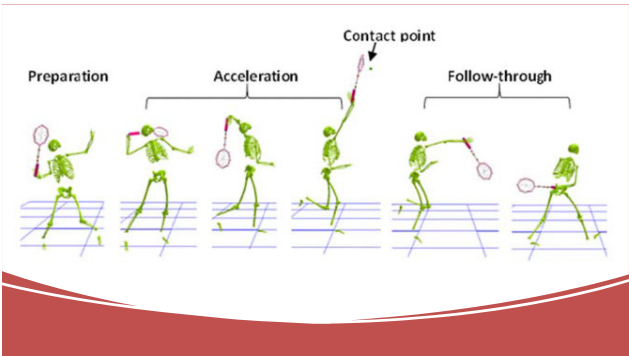
Hip flexion: 16.0
Hip abduction: 16.4
Knee Flexion: 34.2
Knee abduction: -12.9
Ankle Inversion: -4.2

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Overview of badminton jump smash movement



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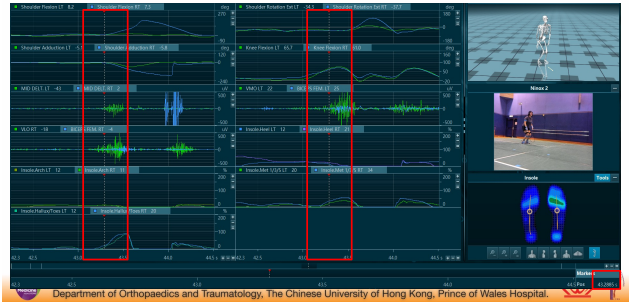
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Phase 1
Standing: Before the movement start



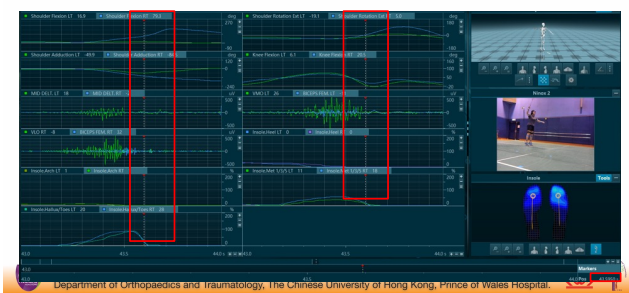
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Phase 2
Preparation of taking off: Subject getting ready to jump



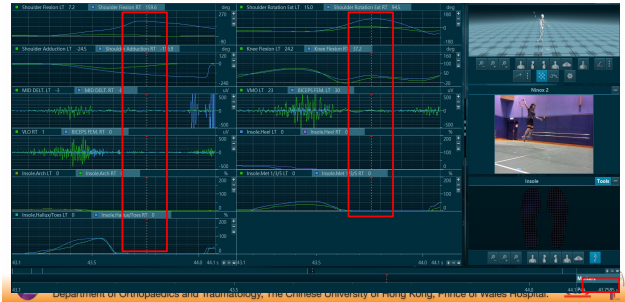
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Phase 3
Start of swing: Subject flexes the shoulder and prepares to hit the shuttlecock



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Phase 4
End of backswing: Subject further flexes the shoulder to generate momentum



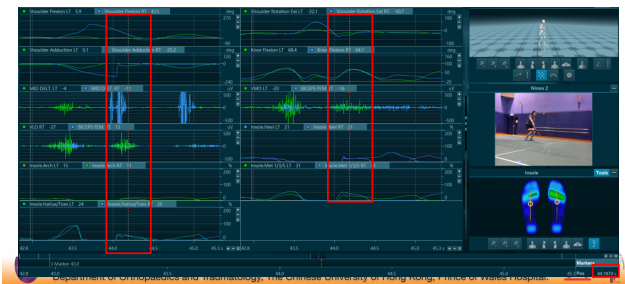
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Phase 5
Racket-shuttle contact moment: when the subject hit the shuttlecock



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Phase 5
Landing: Ground contact after subject finish the smash



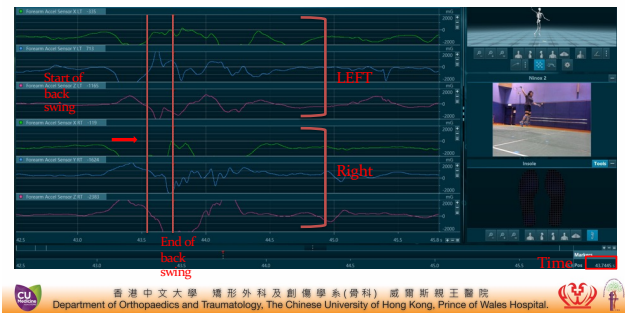
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Upper Limb Acceleration data during the start of back swing to the shuttlecocks contact moment (around 43.5s to 44s)



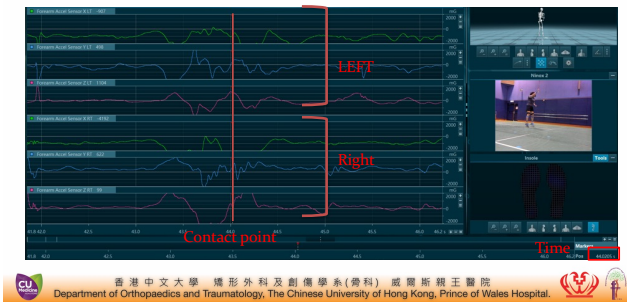
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Forearm acceleration at the end of back swing



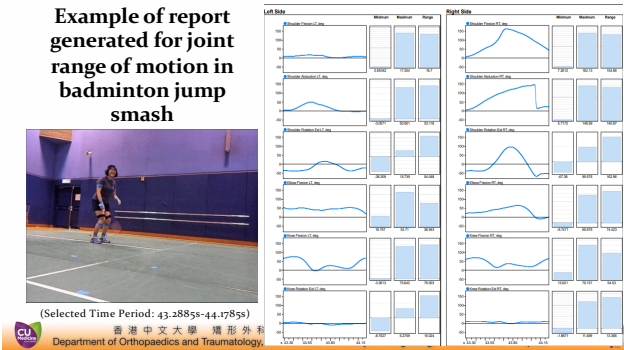
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Forearm acceleration at the contact point



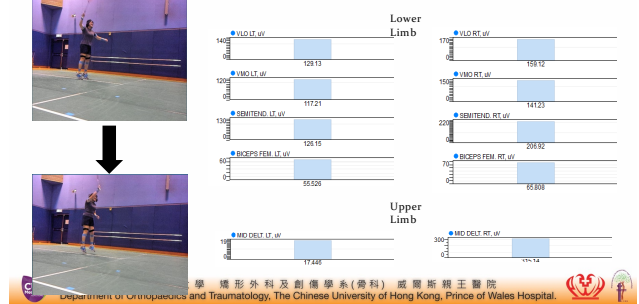
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Example of report generated for joint range of motion in badminton jump smash



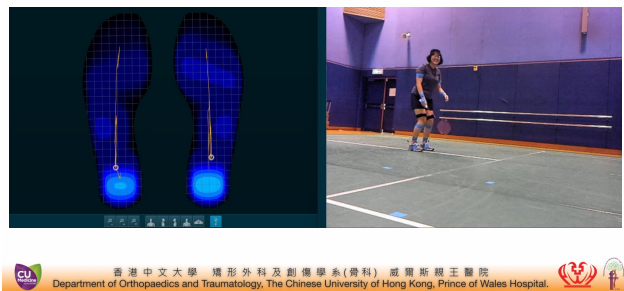
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Example of report on maximum EMG during the start of back swing to the shuttlecocks contact moment



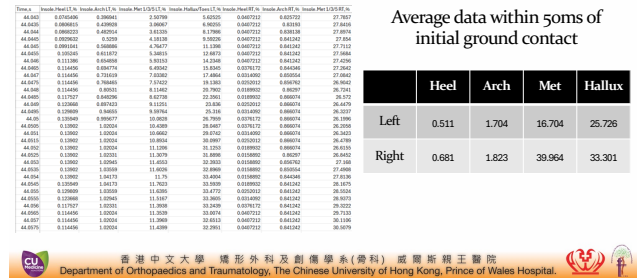
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Landing pattern from force insole during jump smash movement



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Example of output results from force insole



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Thank you

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