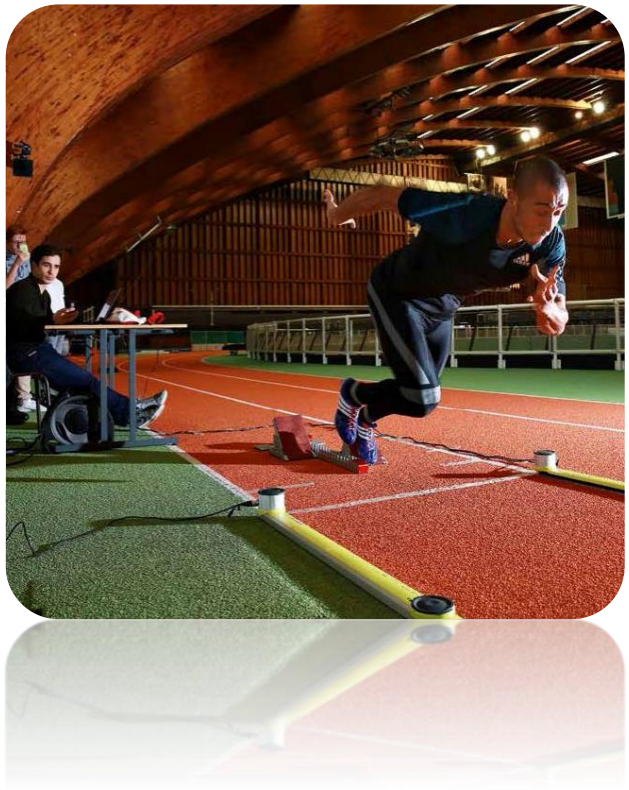
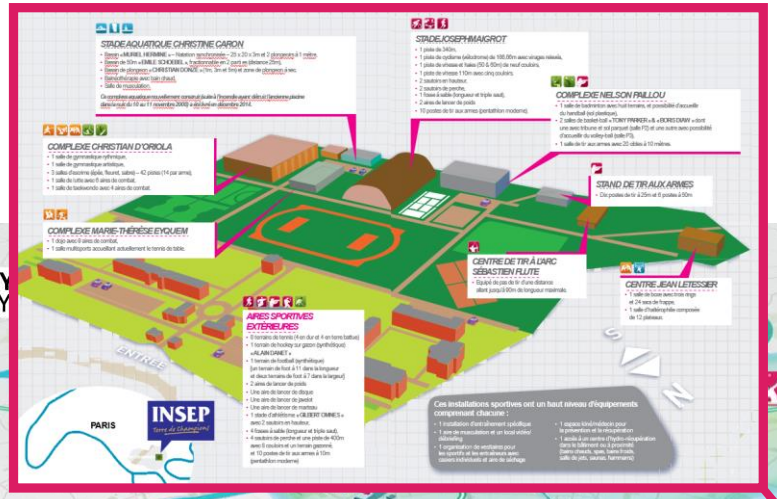


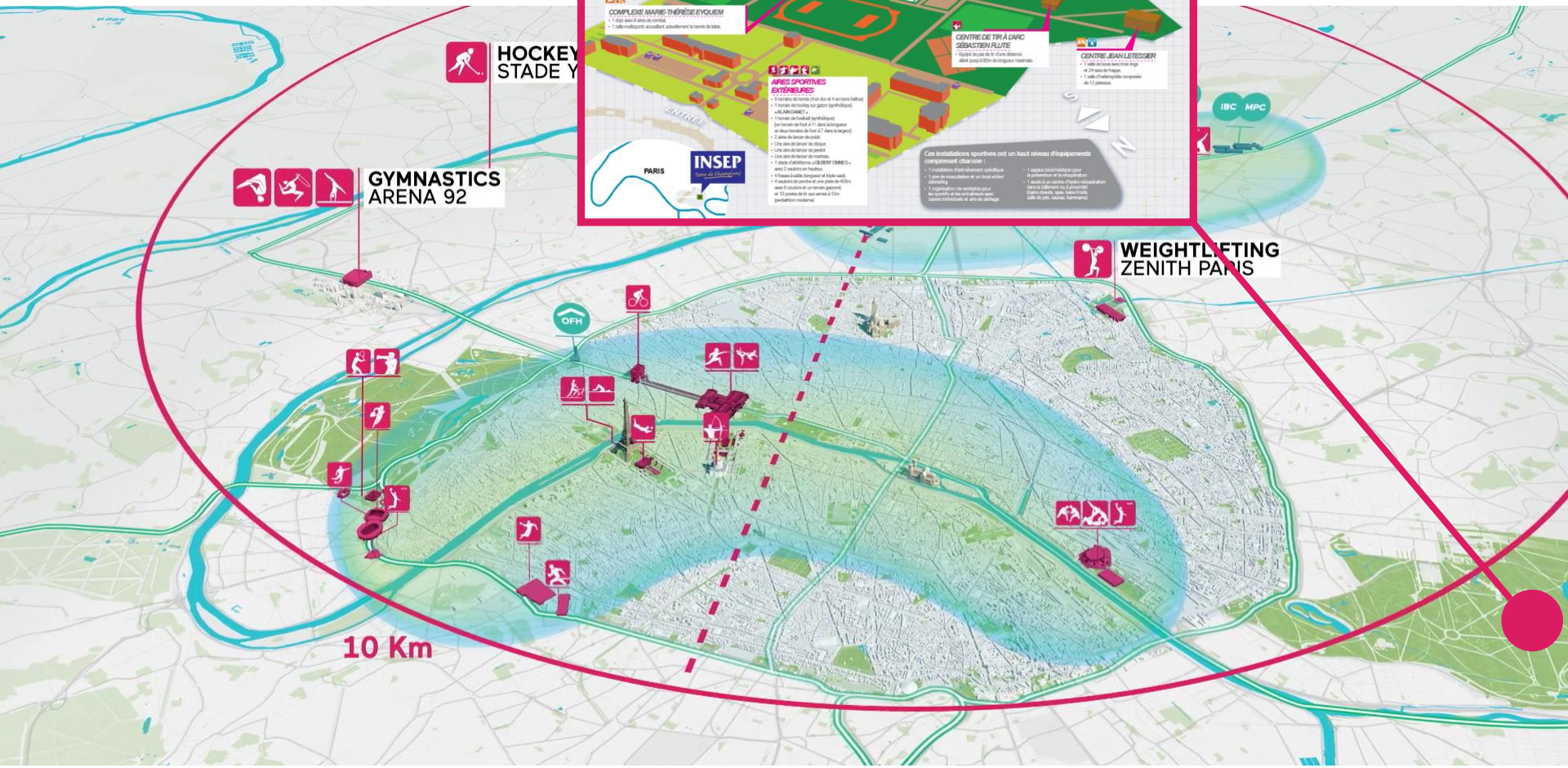
Tech in the French High Performance Support System

Gaël GUILHEM, Lab Head

Laboratory Sport Expertise and Performance (EA 7370)

THE FRENCH INSTITUTE OF SPORT





The French Institute of Sport

Training facilities

DUAL CAREER

Academics


MINISTÈRE DE L'ÉDUCATION NATIONALE, DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE

ACADÉMIE DE PARIS

DIPLÔME
DU BACCALAURÉAT GÉNÉRAL

Vu le procès-verbal de l'examen du baccalauréat général subi le 07 Juillet 2004
par le président du jury, enseignant-chercheur
Le diplôme du baccalauréat général
en Série SCIENTIFIQUE AVEC LA MENTION ASSEZ BIEN
est conféré à
né(e) le 18 Juillet 1986 à PARIS 13e (075)

pour en jouir avec les droits et prérogatives qui y sont attachés.

Fait à ARCUEIL le 15 Juillet 2004

Le recteur de l'académie de PARIS

Y. LE GOFF

M. QUENET

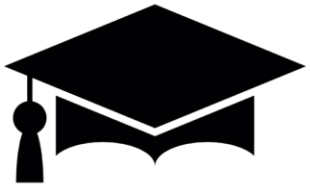
Baccalauréat 2016

100% of success

& **73%** with honors

52

Teachers

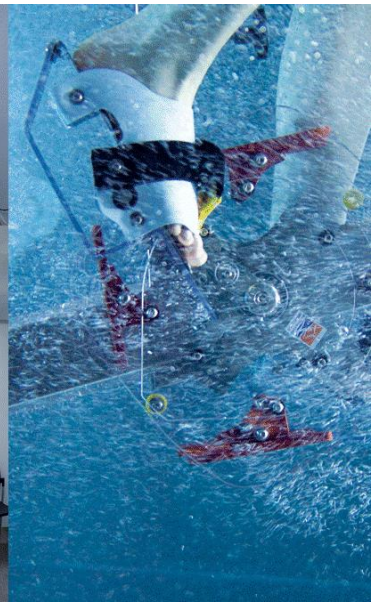


133

Elite athletes
graduated in 2016

The French Institute of Sport

Medical center



80
staffs

INSEP
Terre de Champions

INSEP IN SHORT

69
acres

30
courses

300
residents

27
sports

750
athletes

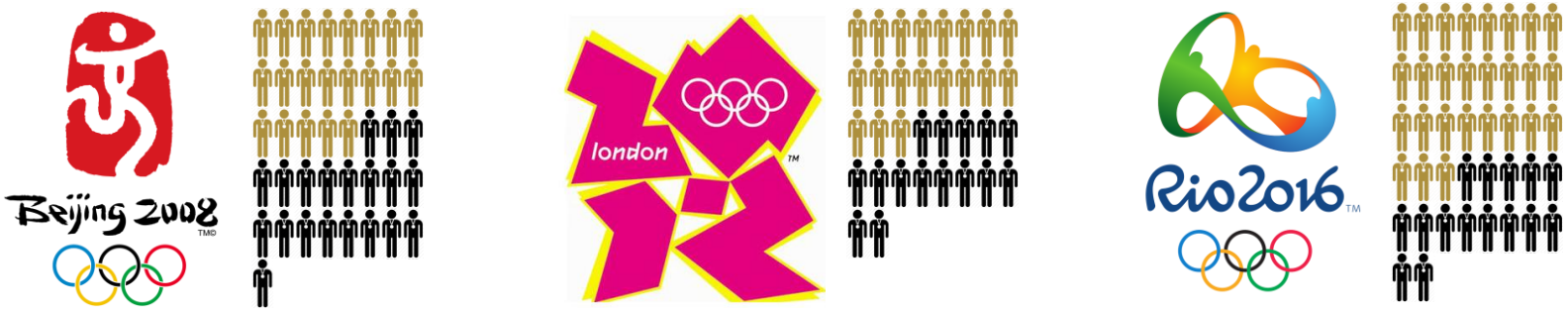
150
coaches

+300
collaborators

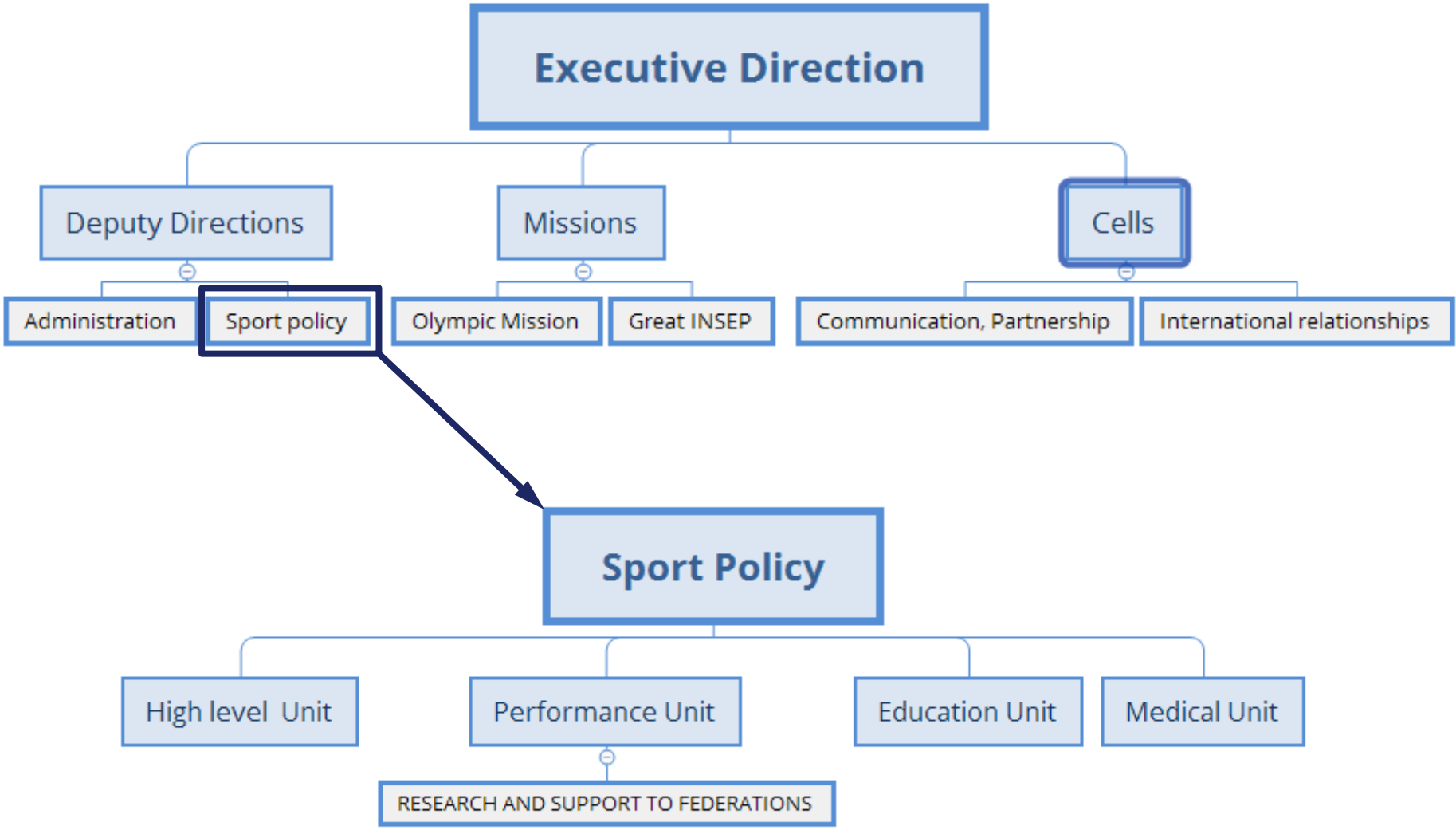
INSEP IN SHORT

1 / 3 of the athletes selected to the last Olympics

+50% medalists



ORGANIZATION CHART



RESEARCH LAB

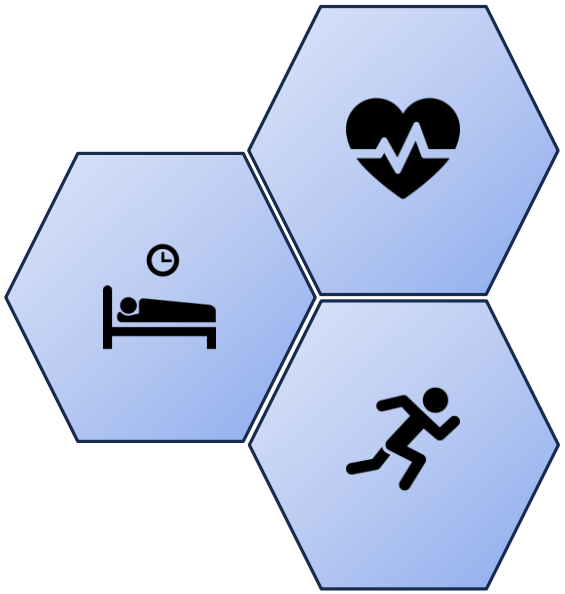
AIM: to **develop** and to **transfer knowledge** with practical applications for **sport performance**

RESEARCH PROGRAM

Laboratory Sport, Expertise and Performance - EA 7370

Understanding and optimization
of **elite sport performance**

- **Theme 1 :** Stress
- **Theme 2 :** Recovery
- **Theme 3 :** Movement



THEME 1 - STRESS

Nutritional strategies

65%

3 studies

Activity analysis

45%

8 studies

Psychological preparation

67%

13 studies

Workload management

13 studies

50%

Athlete lifestyle

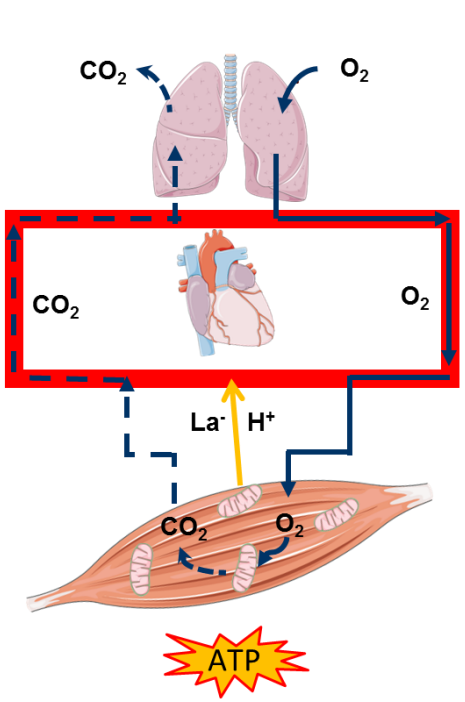
2 studies

73%

Concurrent training, from cell to performance

Claire Thomas-Junius

> To determine and analyze the effects of competition and training sessions on physiological responses



Macroscopic level

- Oxygen uptake kinetics,
- respiratory capacities…

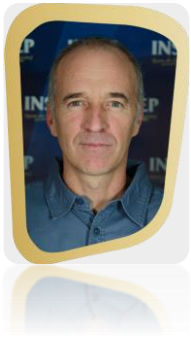
- HR / RQ …
- pH
- $[La^-] / [H^+]$
- $H^+ + HCO_3^- = CO_2 + H_20$

- pH
- Sarcolemmal transporters
- Mitochondrial respiration
- Buffer capacity
- Oxidative stress

Microscopic level

Conditions of performance project for Olympic and Paralympic athletes

Fabrice Burlot and Helene Joncheray



> Elite athletes' lifestyle

What preparation? How to organize and prepare (physical, mental, nutrition, recovery, etc.) to perform?

Nutritional habits & performance: « knowing and engaging » or « knowing and resisting » against the advises from the nutritional mission.

Injuries & performance: The conditions of injury occurrence in the medical system.

Research Article

irss

The life of high-level athletes: The challenge of high performance against the time constraint

International Review for the Sociology of Sport
1–16

DOI: 10.1177/1012690216647196
irs.sagepub.com
SAGE

Fabrice Burlot
National Institute of Sport, Expertise and Performance (INSEP), France

Rémi Richard
University of Montpellier, France

Helene Joncheray
Paris Descartes University – Sorbonne Paris Cité, France

Abstract
The conditions for high performance have changed considerably over the last few years. Athletes must spend more time training and competing, devote a lot of time to mental, physical and nutritional professionals and continue to respond to some constraints such as studying, spending time with their families, friends and quality of life. In this context and based on the work of Rosa, we wonder about the capacity of elite athletes to combine all these constraints, namely to manage the acceleration in their pace of life, in order to be able to achieve always

Theme 1 - Stress

Individual and collective stress management

Julie Doron, Chloé Leprince

> Stress, coping and sport performance

> Perceived control

> Threat appraisal

> Challenge appraisal

> Problem-focused coping

> Emotion-focused coping

> Positive affects

> Negative affects

THEME 2 - RECOVERY

Sleep environment

33% 7 studies

Nutrition & recovery

25% 8 studies

Psychological factors

20% 2 studies

Technology & methods

10 studies 37%

Recovery & injury

3 studies 30%

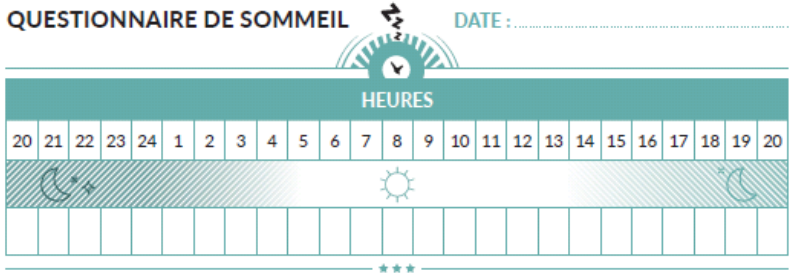
Impact of sleep environment on performance

Mathieu Nédélec, Anis Aloulou

- > Assessing the influence of night exercise-induced fatigue on sleep
- > Implementing sleep hygiene strategies (mattress)

Polysomnography

Actigraphic sleep assessment



Sleep diary

Groupe Cofel

THEME 3 - MOVEMENT

Perception

59%

6 studies

Injury prevention

46%

6 studies

Innovative training

70%

9 studies

Muscle-tendon properties

7 studies

79%

Movement analysis

8 studies

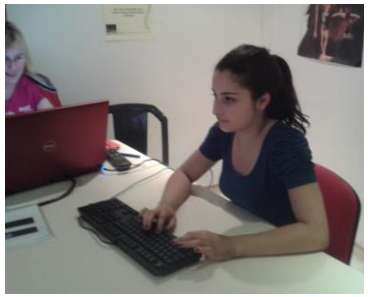
53%

Conscious and inconscious visual perception

Impact of motor expertise or injury

Claire Calmels

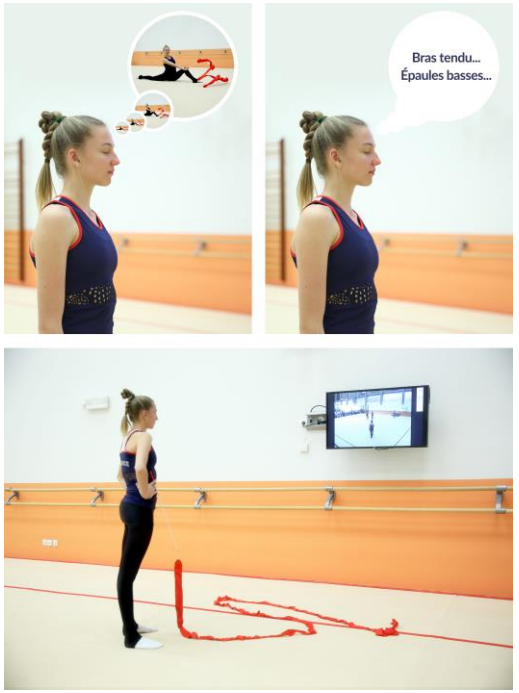
> Sport injury prevention, rehabilitation and optimization of sport movements via the use of motor simulation



Priming, Interview

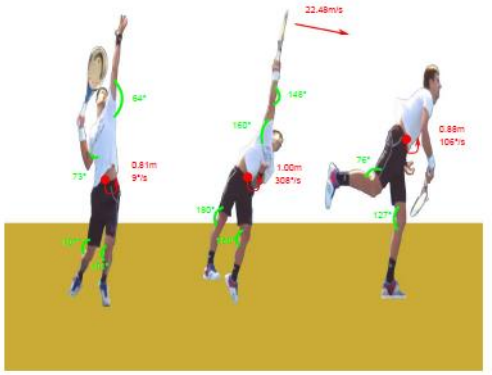
EEG

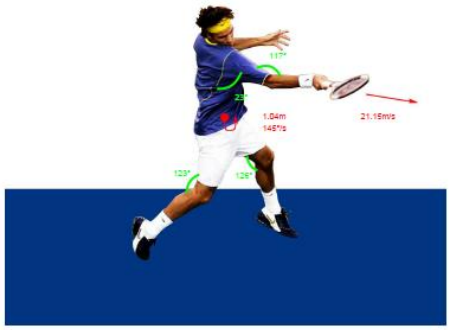
fMRI



Conception of a **biomechanical scan**

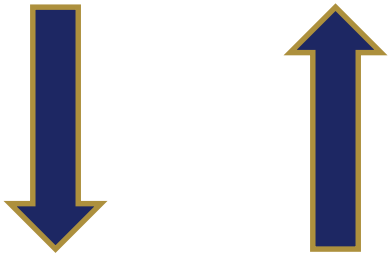
Daniel Dinu





Approach

Applied Research



Scientific Support to Federations

SPORT BIOMECHANICS

Performance optimization

Injury prevention

THE PLAYER LOAD PARAMETER MEASURED BY ACCELEROMETRY AS AN INDEX OF THE CENTER OF MASS DISPLACEMENTS? A VALIDATION STUDY

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DES SPORTS, DE LA JEUNESSE, DE L'ÉDUCATION POPULAIRE ET DE LA VIE ASSOCIATIVE

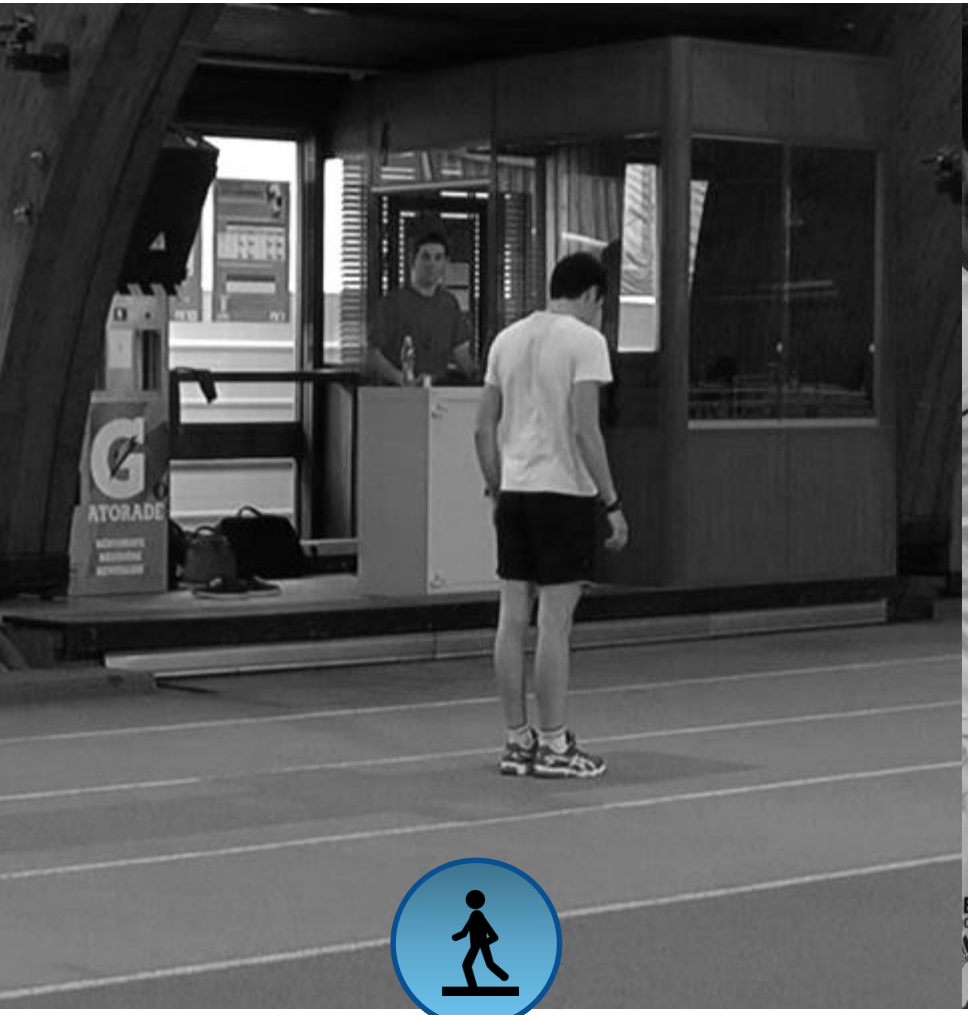
UNIVERSITÉ PARIS DESCARTES

INSEP
Terre de Champions

FF HANDBALL

INSEP
Terre de Champions

Design



Study 1

Study 2

PHYSICAL DEMAND QUANTIFICATION

Physical demand

- Training load adaptation to competitive load

  Reilly et al. 2000, Vaeyens et al., 2009

- Talent identification

  Banister et al. 1975, Foster et al. 1998, Impellizzeri et al. 2004, Halson et al. 2014

Numerous studies in **team sports**

Buchheit, 2009 ; Cunnife, 2009 ; Weston, 2011 ; Waldron 2011 ; Póvoas, 2012 ; McLellan, 2011 ; Gray, 2010

CURRENT METHODS

Heart rate monitoring

Buchheit et al., 2009 ; Coutts et al., 2009

Video analysis

Green et al., 1976 ; Dawson et al., 2004

Global Positioning System (GPS)

Aughey et al., 2001 ; Dellaserra et al. 2014

Numerous tools allow to analyze the physical demands

TRACKING METHODS

Heart rate monitoring

Buchheit et al., 2009 ; Coutts et al., 2009

Video analysis

Green et al., 1976 ; Dawson et al., 2004

Global Positioning System (GPS)

Aughey et al., 2001 ; Dellaserra et al. 2014

Accelerometry

McCullom et Peters 1924 ; Walter 1996

PLAYER LOAD

$$Player\ Load = \sqrt{\frac{(a_{y1} - a_{y-1})^2}{\text{ANTERO POSTERIOR}} + \frac{(a_{x1} - a_{x-1})^2}{100\ \text{MEDIOLATERAL}} + \frac{(a_{z1} - a_{z-1})^2}{\text{VERTICAL}}}$$

Montgomery et al. 2010; Boyd et al. 2011

BACKGROUND

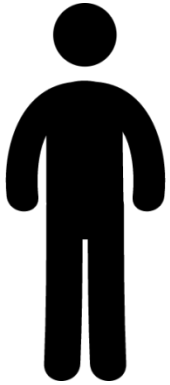
Authors	Year	Sport	Parameter / context
Boyd et al. Gallo et al. Gastin et al. Coad et al.	**2011** **2013** **2014** **2015**	Australian Football Australien	Reproducibility **Player Load**
Casamichana et al. Castellano et al. Scott et al. Terje et al	**2012** **2013** **2015**	Football / Soccer	**Player Load**
Chandler et al.	**2014**	Netball	Training / competition **Player Load**
Gabbett et al. Jones et al.	**2012** **2015**	Rugby	**Player Load**
Montgomery et al.	**2010**	Basketball	Training / competition **Player Load**
Wundersitz et al.	**2013** **2014** **2015**	Walking / running / jumping / cutting manoeuvers	Validity peak accel vs PFF Validity MinimaxX peak accel vs video analysis Validity MinimaxX for contact

Aims

- To assess the **concurrent validity** of the **player load** parameter measured from **accelerometers** (vs. a reference **force plates** method)
- To estimate the **effect of the intensity**
- To optimize the **computation** methods

METHODS

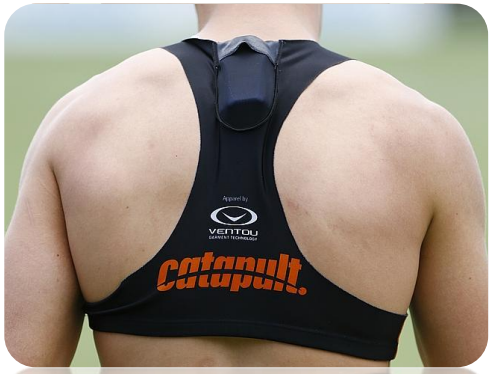
21 participants



age: 29.5 ± 7.9 y

height: 179.2 ± 4.8 cm

mass : 76.0 ± 5.6 kg



Upper back
'classical' location

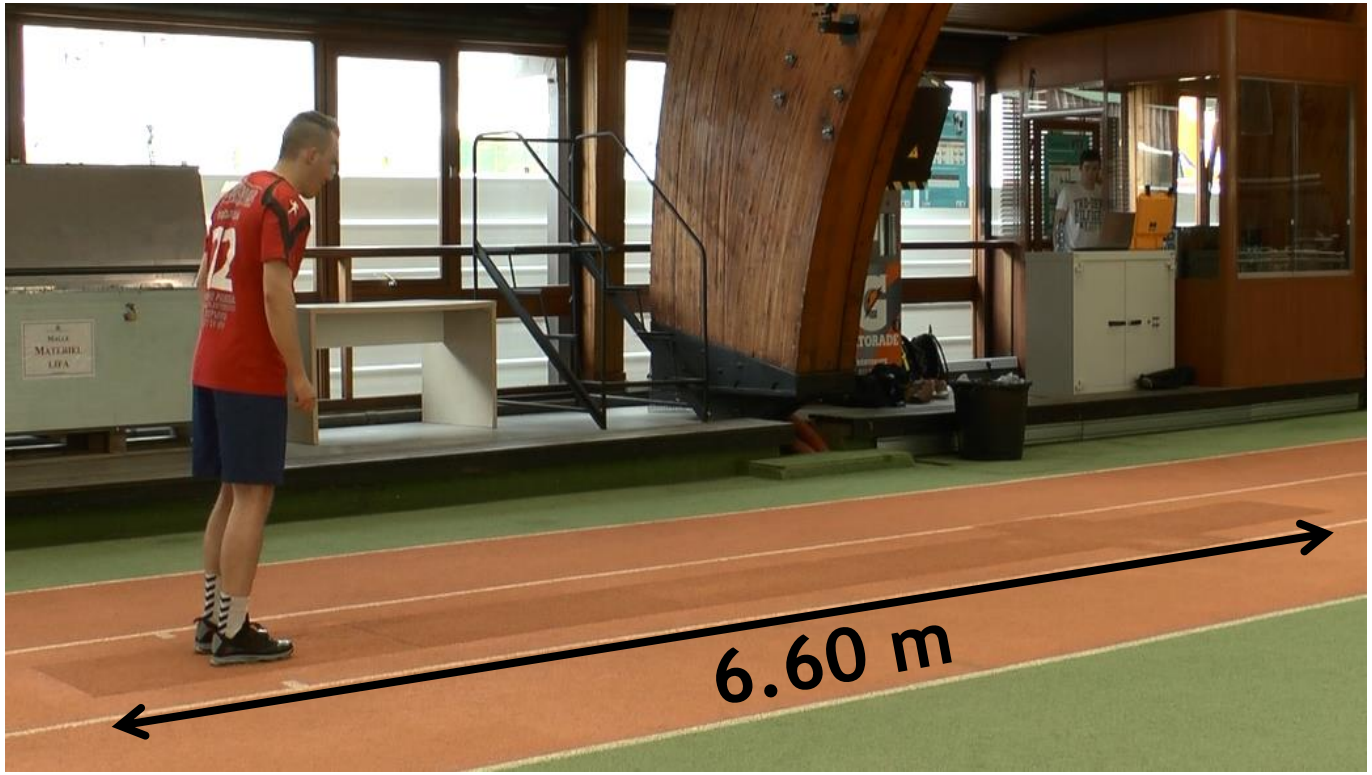
METHODS

6.6 m force plates system (Kistler) (standard method)

General displacements

Running accelerations

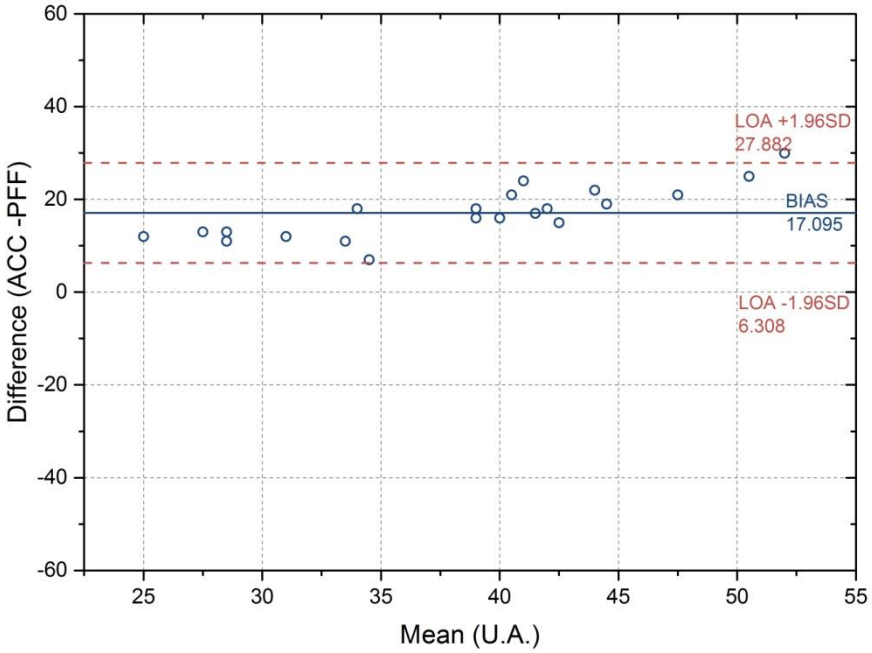
Handball spec. 1 vs 1



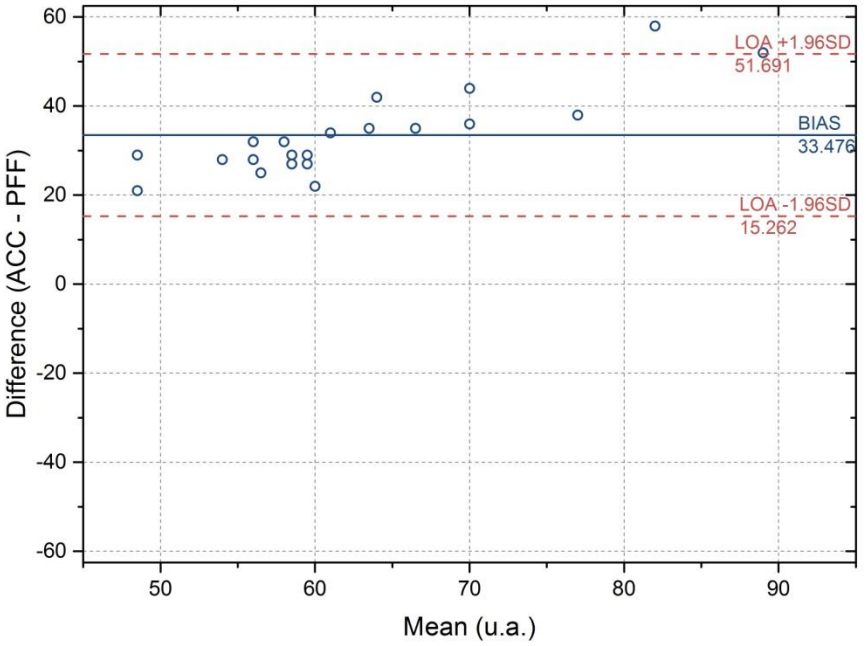
Low and maximal intensity

INTENSITY EFFECT

General displacements



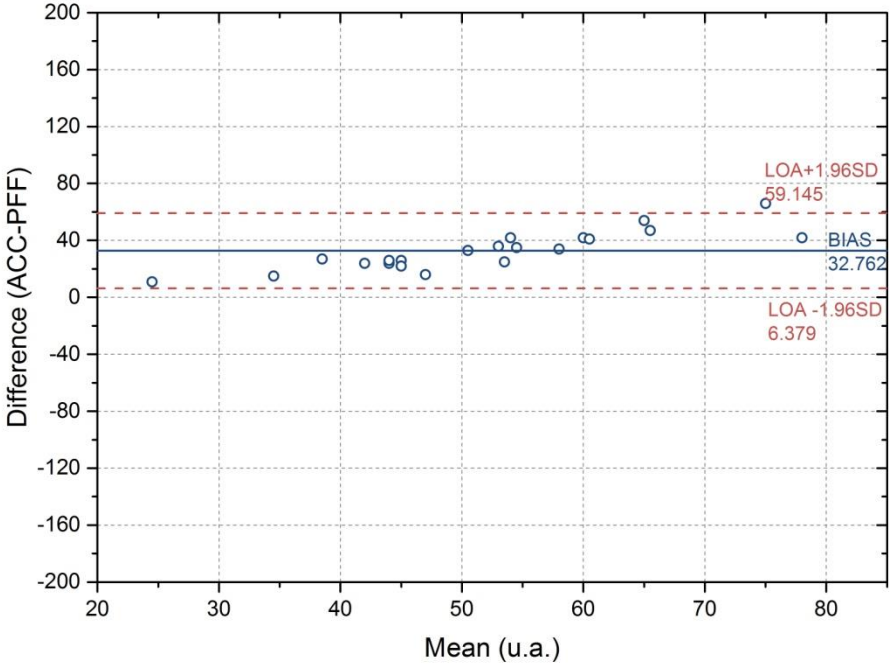
Low intensity



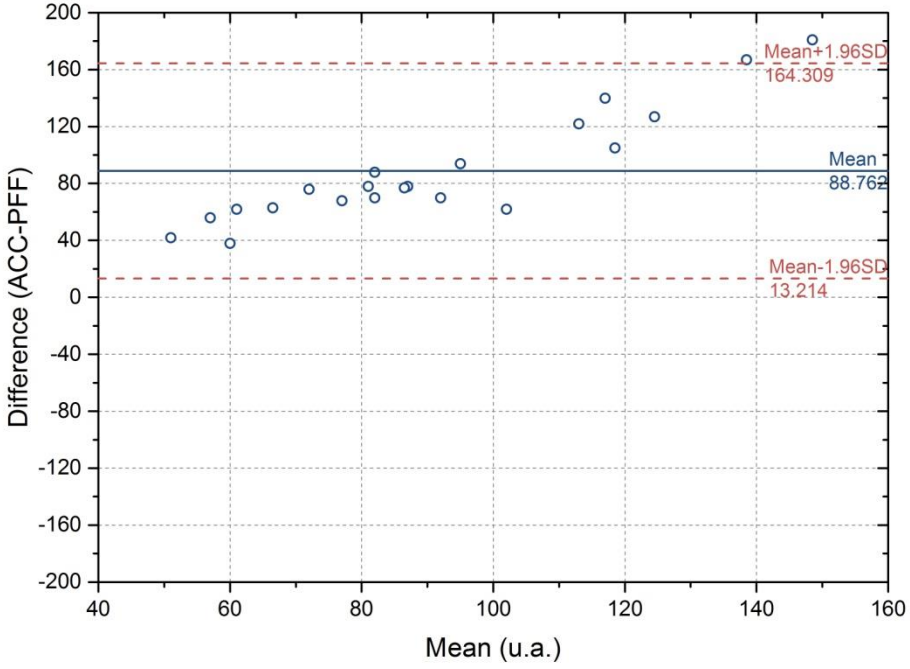
High intensity

INTENSITY EFFECT

Running accelerations



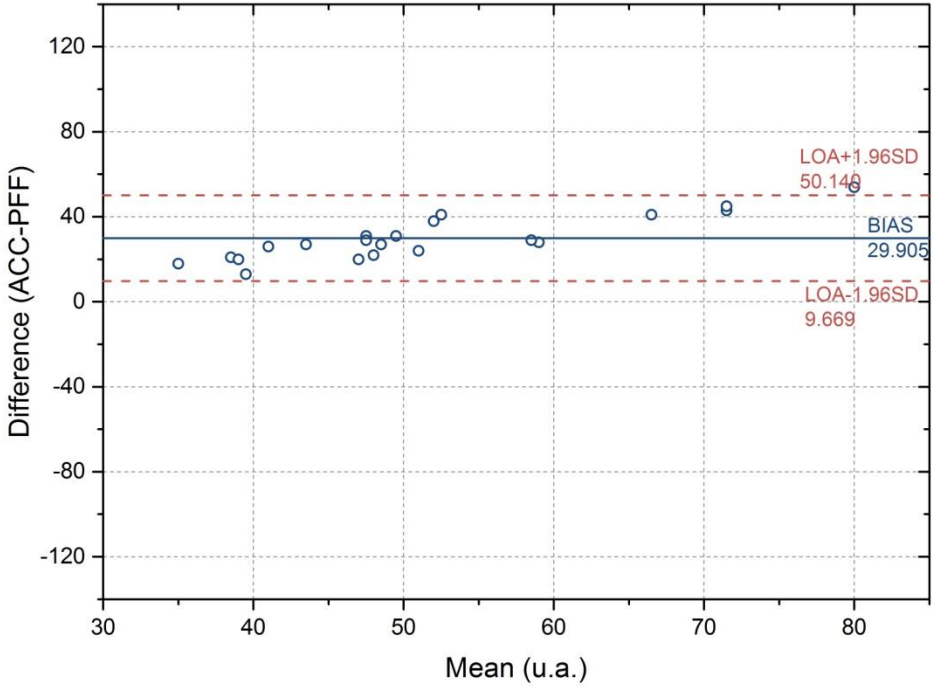
Low intensity



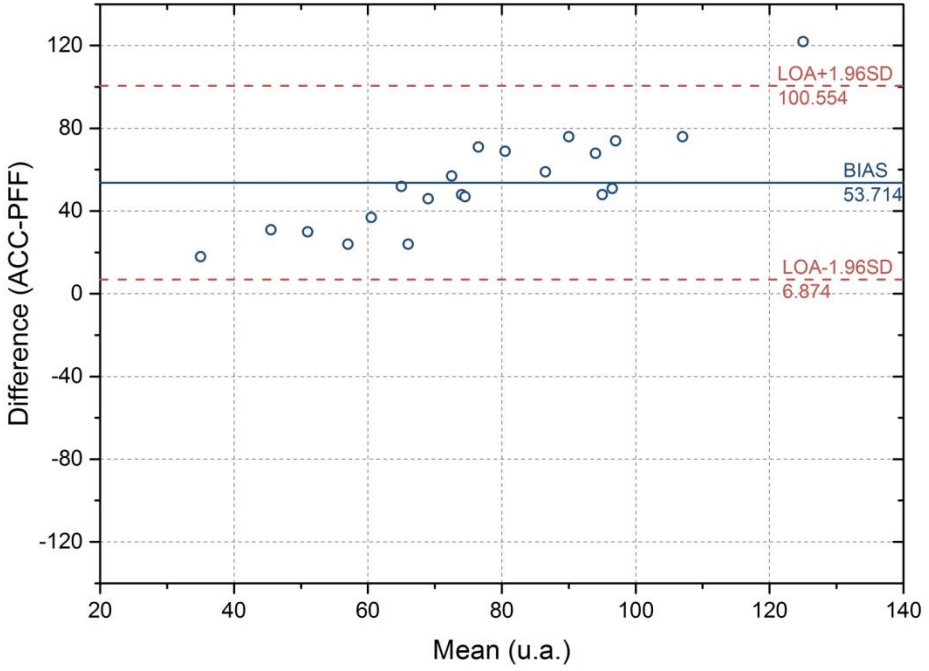
High intensity

INTENSITY EFFECT

Handball spec. 1 vs 1



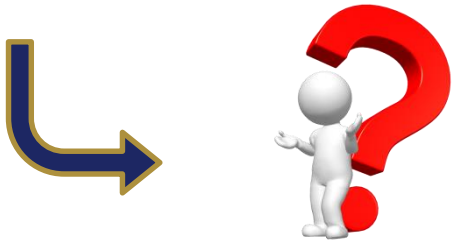
Low intensity



High intensity

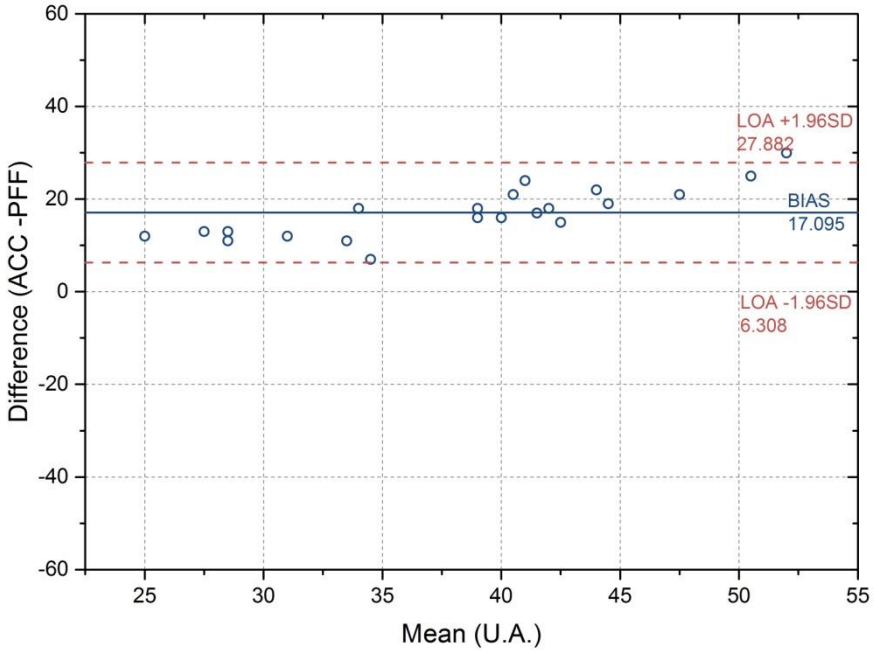
Player Load calculation method

Optimized processing : equation / filters

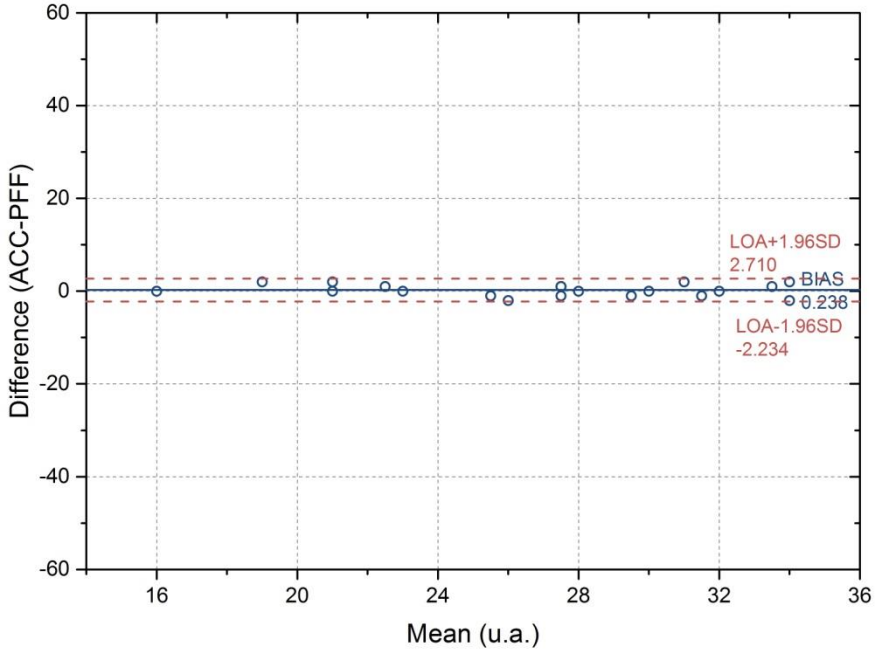


OPTIMIZATION

Classical calculation



Optimization

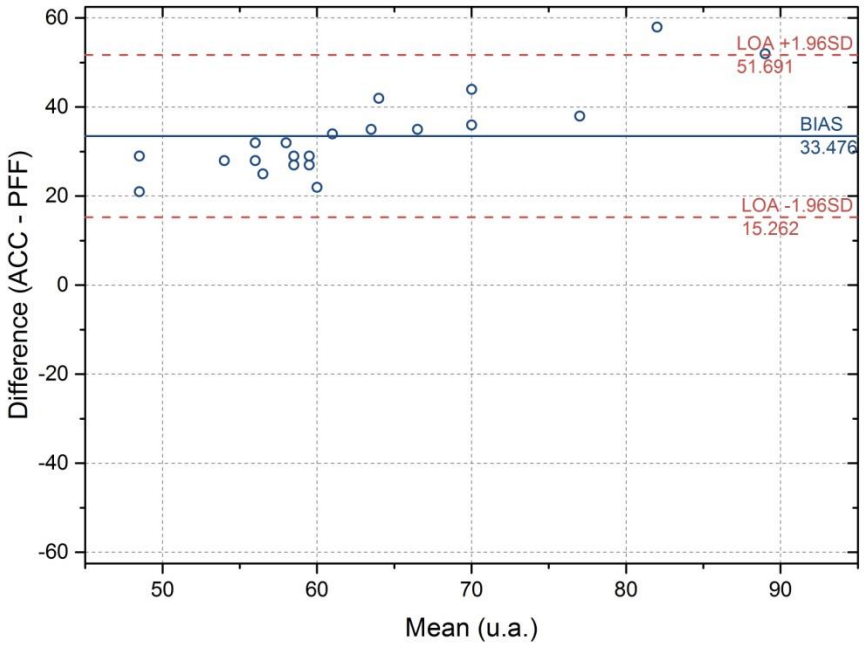


General displacements

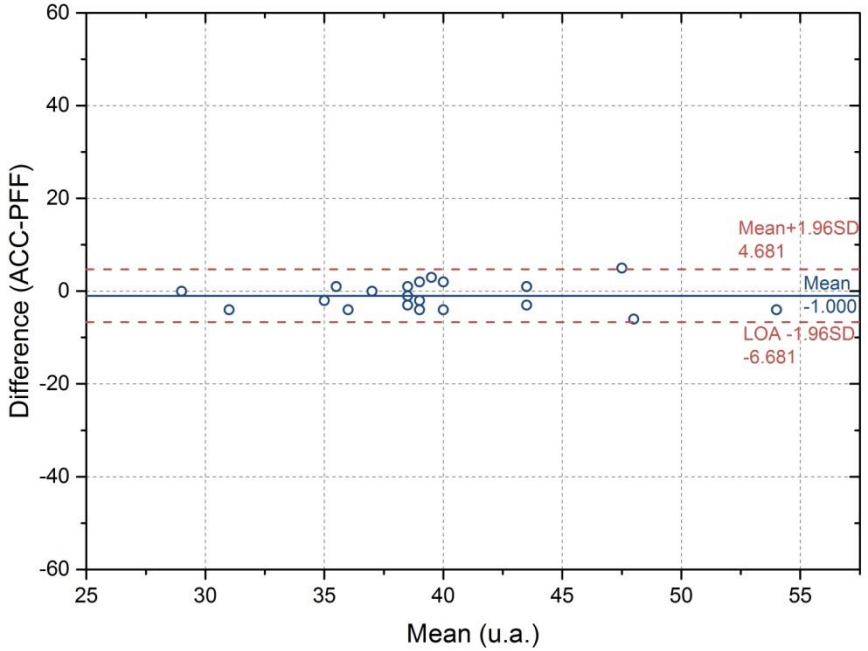
Low intensity

OPTIMIZATION

Classical calculation



Optimization



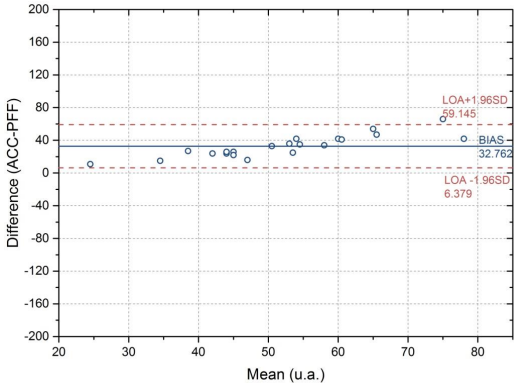
General displacements

High intensity

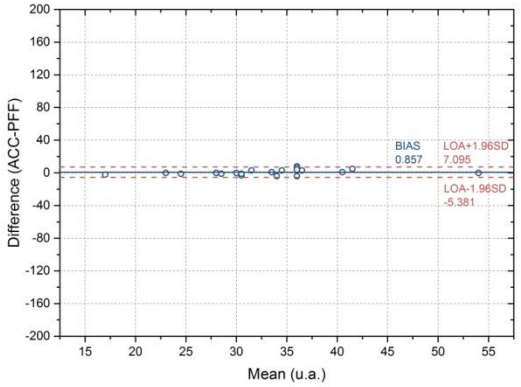
OPTIMIZATION

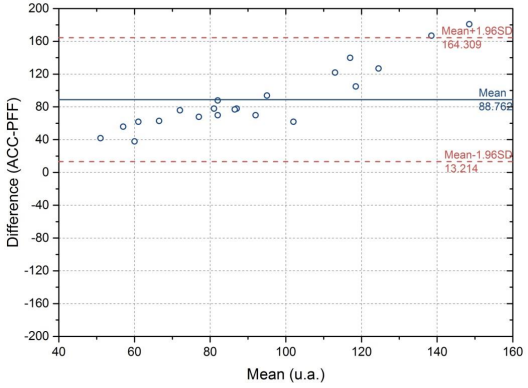
Classical calculation

Optimization

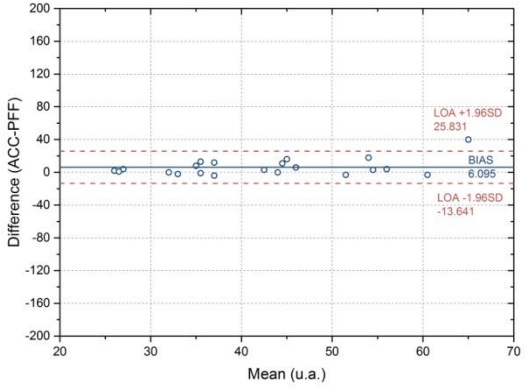


Low intensity





High intensity

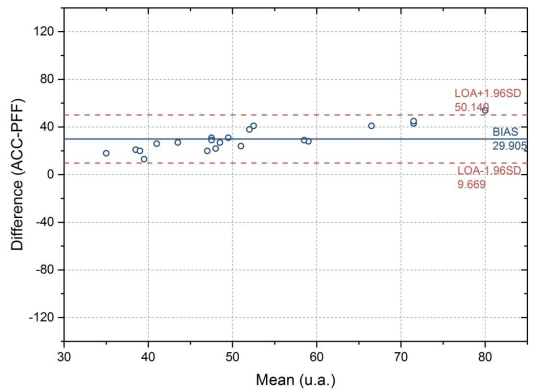


Running Acceleration

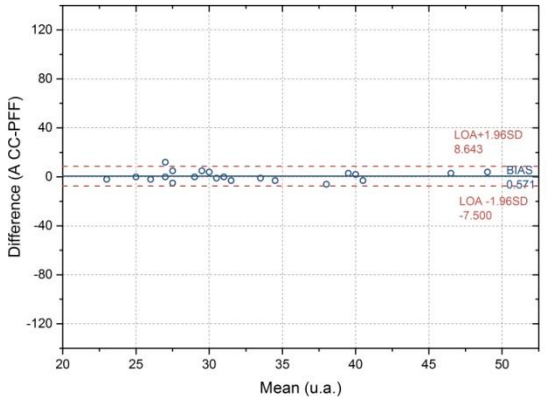
OPTIMIZATION

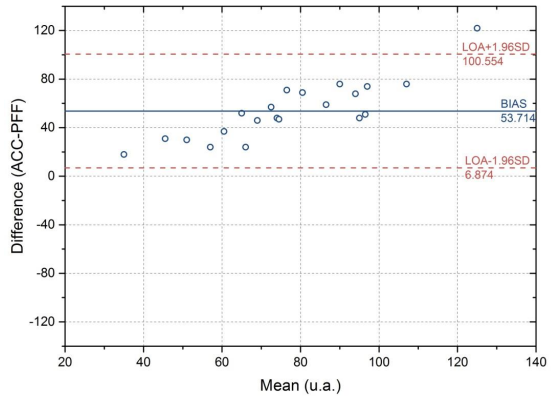
Classical calculation

Optimization

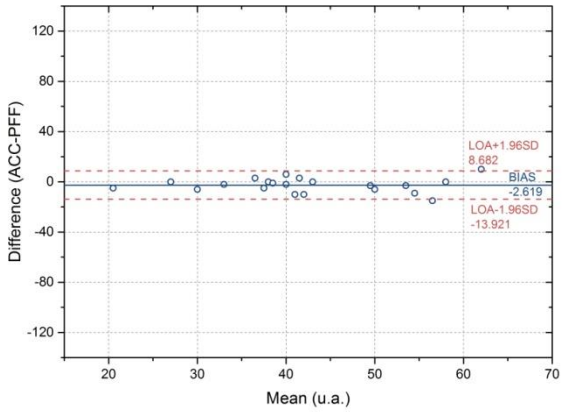


Low intensity





High intensity



Handball spec. 1 vs 1

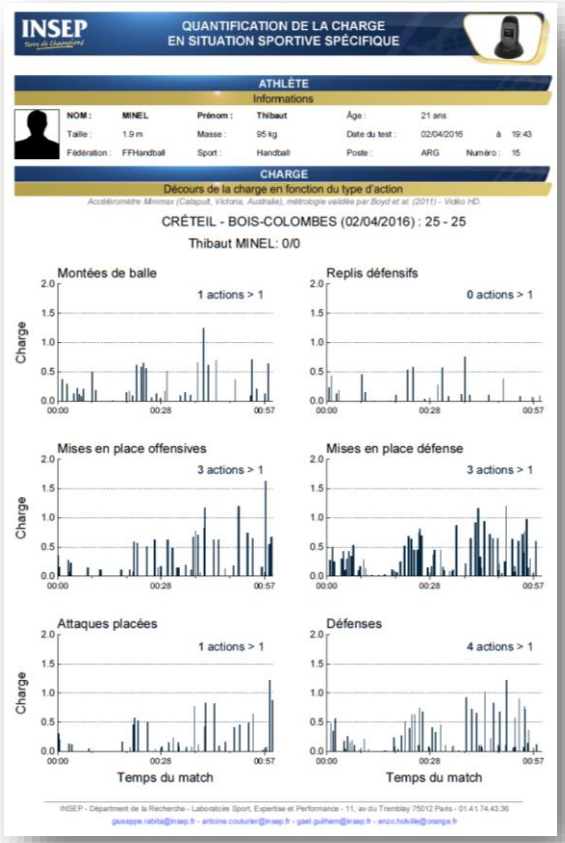
INSEP
Terre de Champions

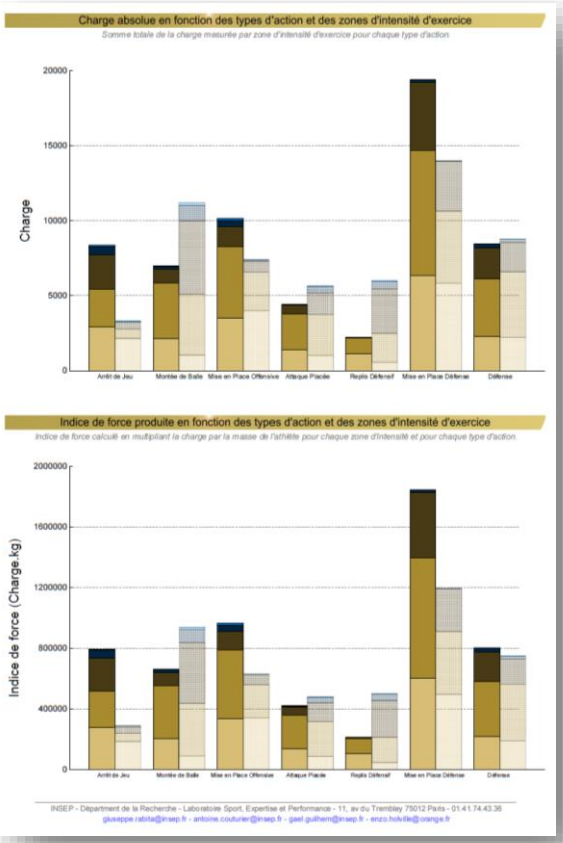
APPLICATIONS

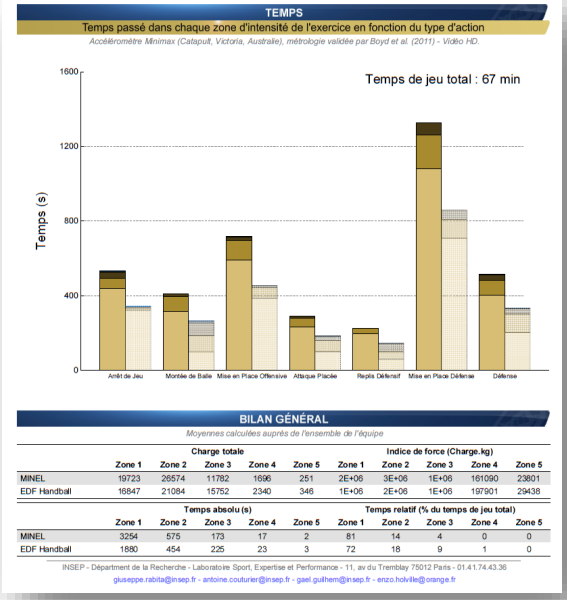
GOLDEN LEAGUE

6 MATCHES

AUTOMATIC PROCESSING







INDIVIDUAL REPORT SHEETS

INSEP
Terre de Champions

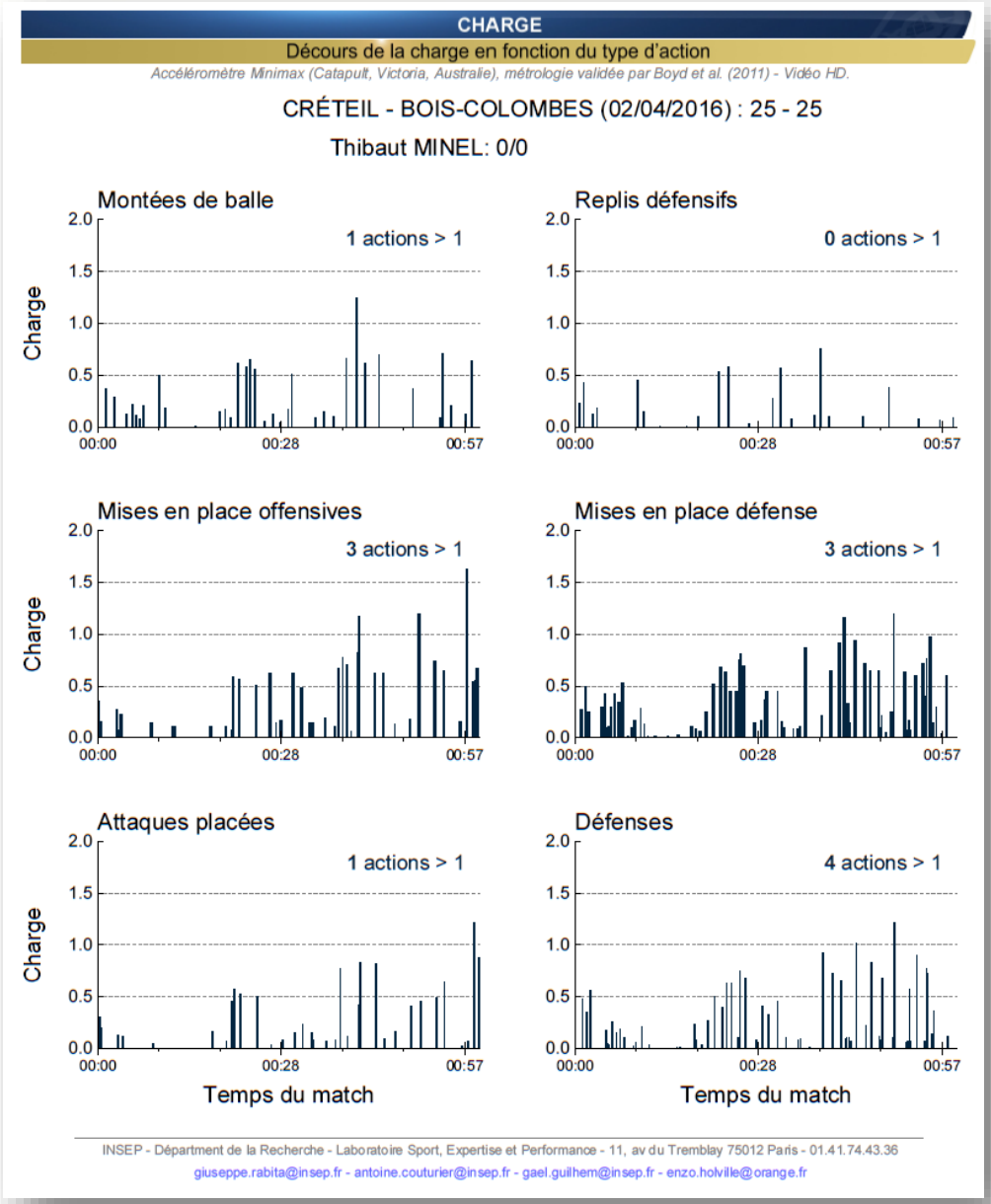
QUANTIFICATION DE LA CHARGE EN SITUATION SPORTIVE SPÉCIFIQUE

ATHLÈTE

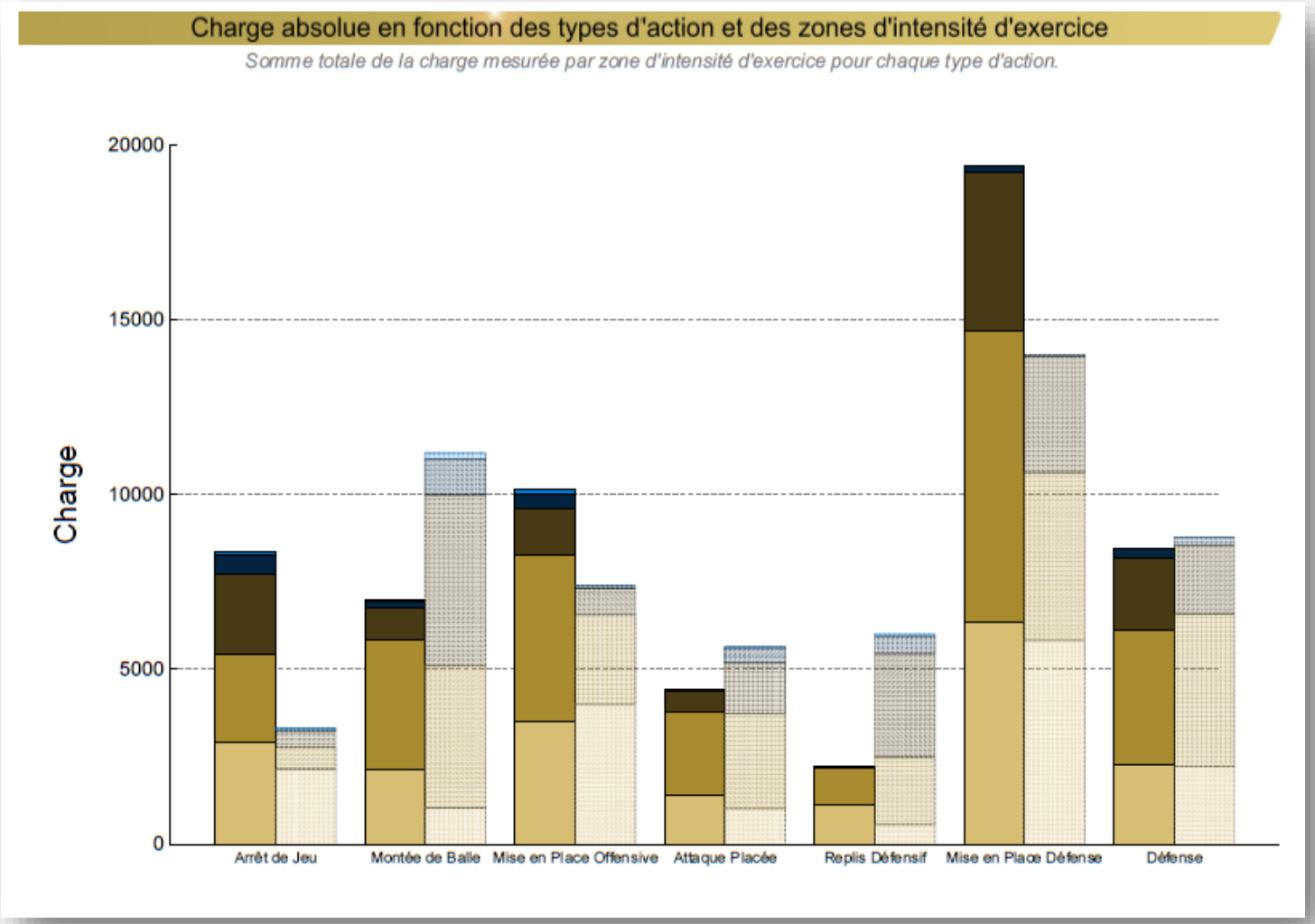
Informations

				Âge :	21 ans		
Taille :	1.9 m	Masse :	95 kg	Date du test :	02/04/2016	à	19:43
Fédération :	FFHandball	Sport :	Handball	Poste :	ARG	Numéro :	15

PLAYER LOAD TIME-COURSE OVER THE GAME



Comparison to living databases

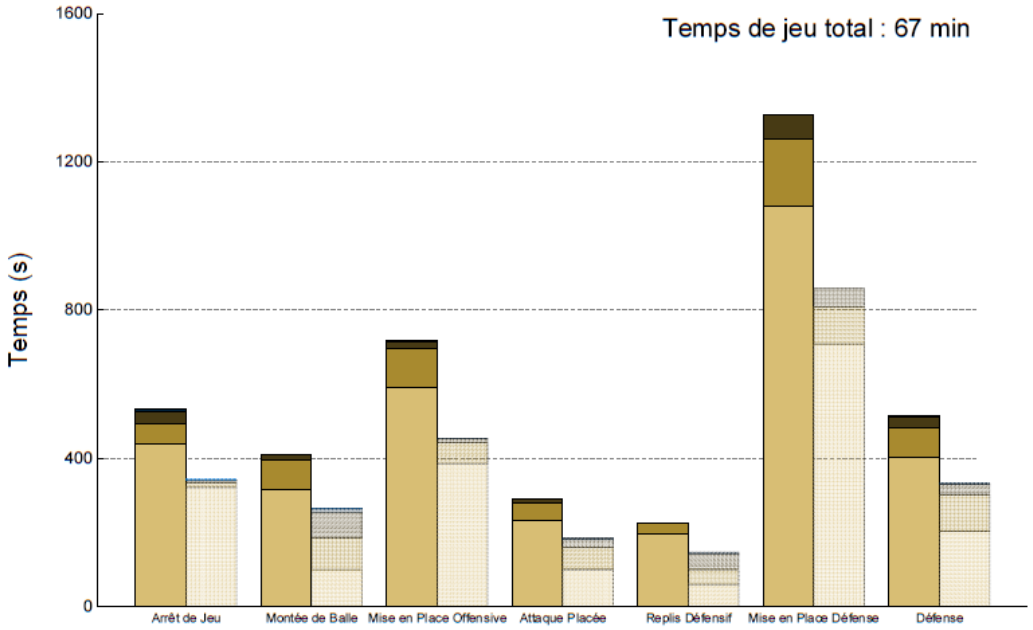


INTENSITY DISTRIBUTION

TEMPS

Temps passé dans chaque zone d'intensité de l'exercice en fonction du type d'action

Accéléromètre Minimax (Catapult, Victoria, Australie), métrologie validée par Boyd et al. (2011) - Vidéo HD.



BILAN GÉNÉRAL

Moyennes calculées auprès de l'ensemble de l'équipe

	Charge totale					Indice de force (Charge.kg)				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
MINEL	19723	26574	11782	1696	251	2E+06	3E+06	1E+06	161090	23801
EDF Handball	16847	21084	15752	2340	346	1E+06	2E+06	1E+06	197901	29438

	Temps absolu (s)					Temps relatif (% du temps de jeu total)				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
MINEL	3254	575	173	17	2	81	14	4	0	0
EDF Handball	1880	454	225	23	3	72	18	9	1	0

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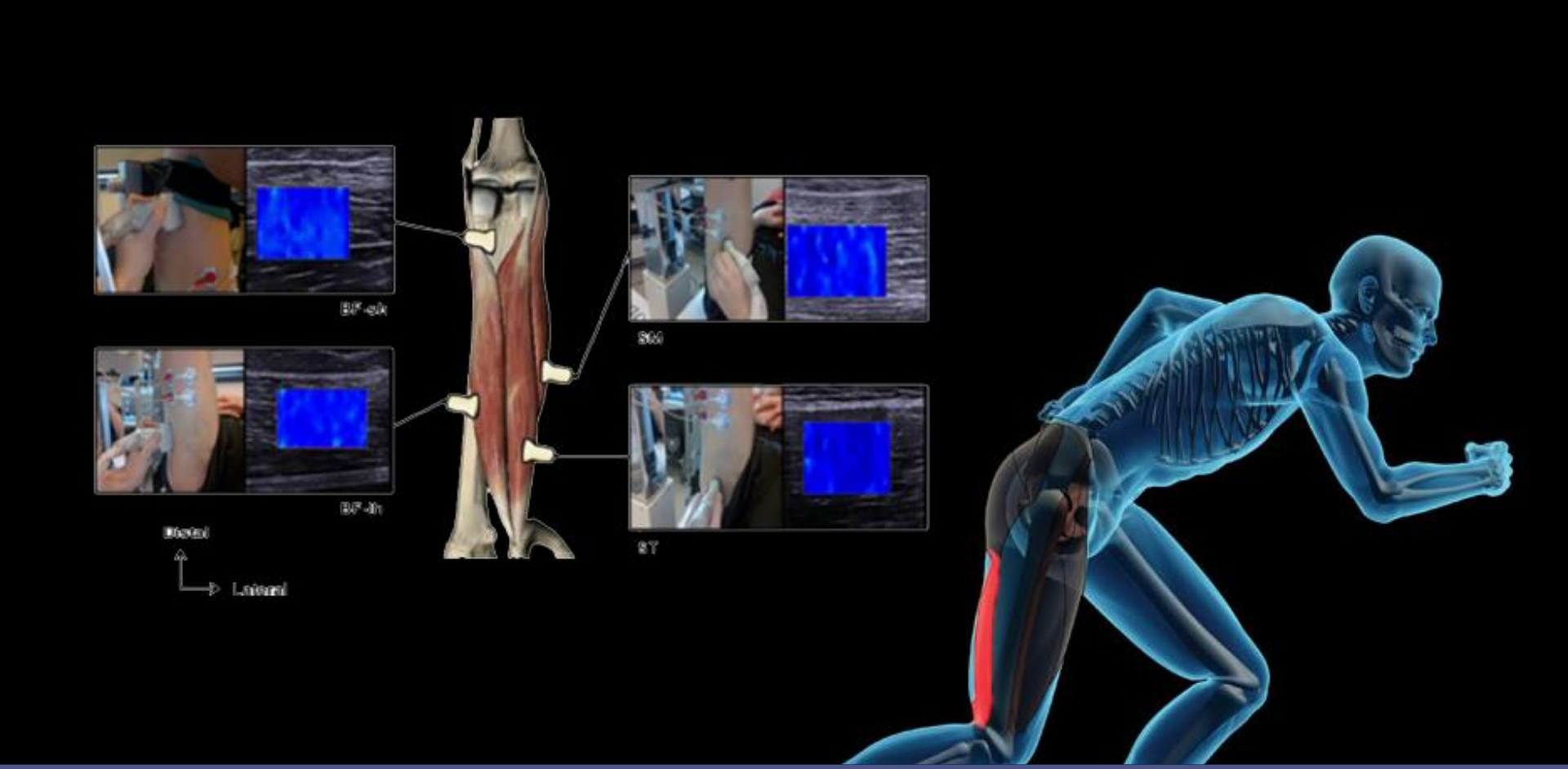


HAMSTRING STIFFNESS AMONG ELITE ATHLETES

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DES SPORTS, DE LA JEUNESSE, DE L'ÉDUCATION POPULAIRE ET DE LA VIE ASSOCIATIVE

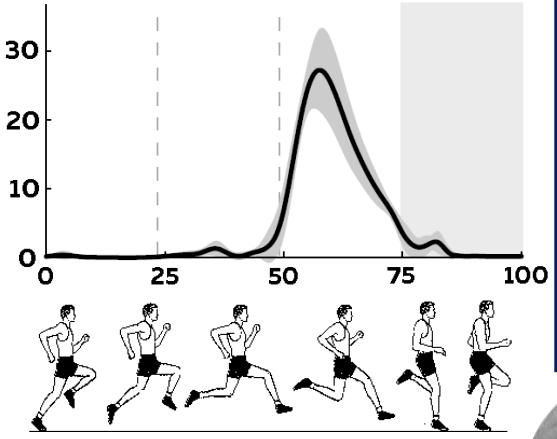
INSEP
Terre de Champions

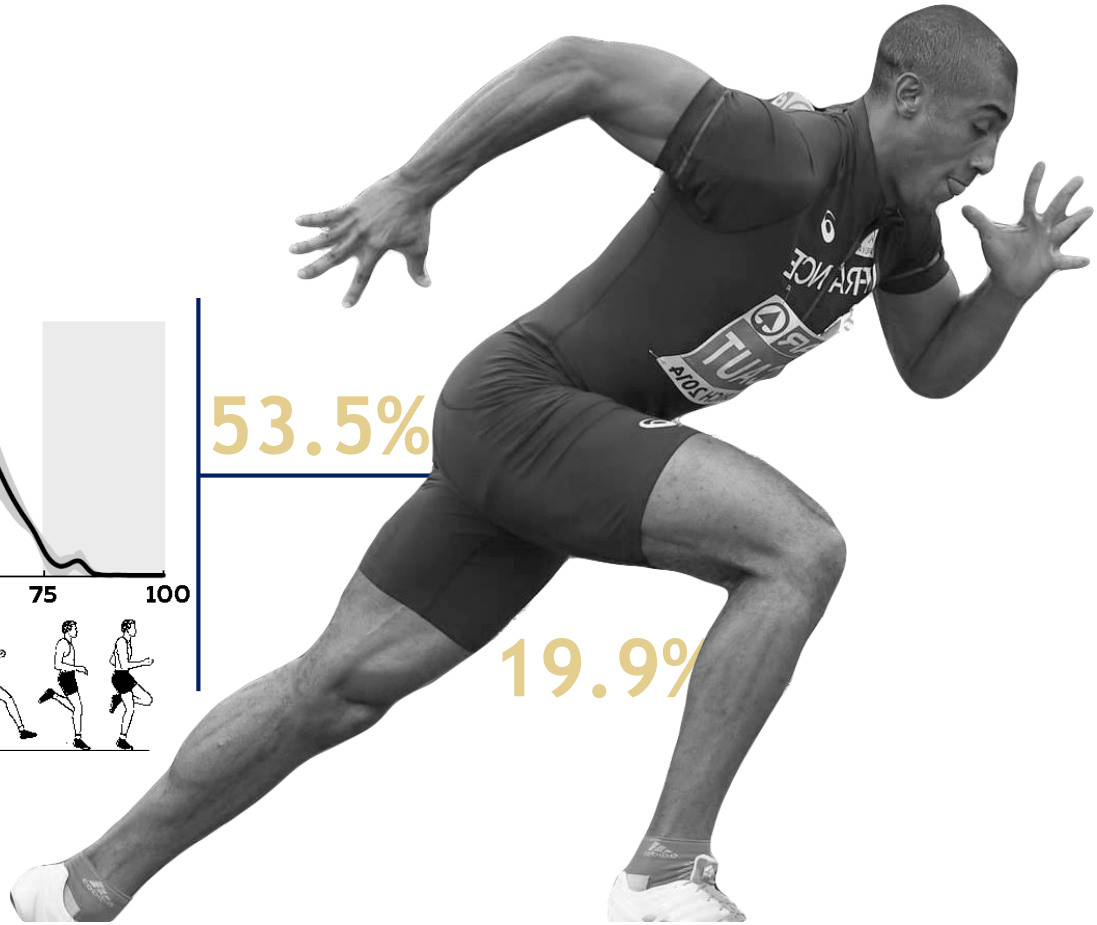
université PARIS-SACLAY

UNIVERSITÉ DE NANTES

HAMSTRING FUNCTION

Edouard et al. (2016) - Schache et al. (2012)

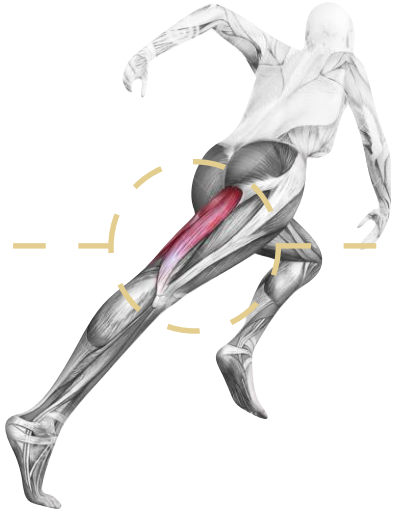




HAMSTRING INJURY

Chumanov et al. (2012) Br J Sports Med

Hamstring behavior



Mechanical properties

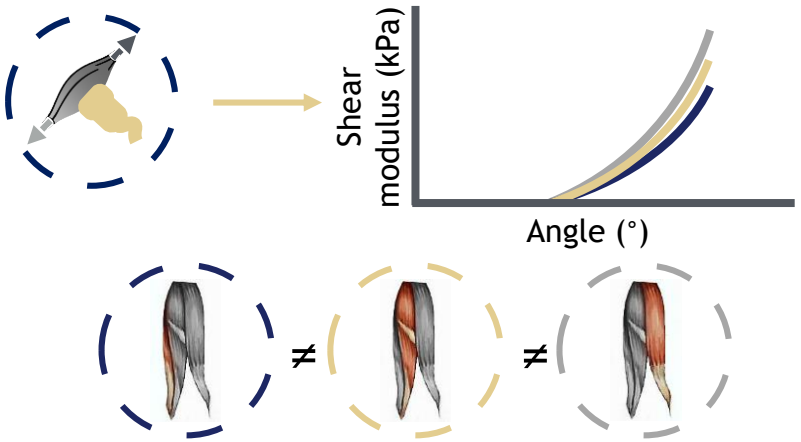
HAMSTRING PROPERTIES

Passive resistive torque

Nordez et al. (2008) Int J Sports Med

Ultrasound shear-wave elastography

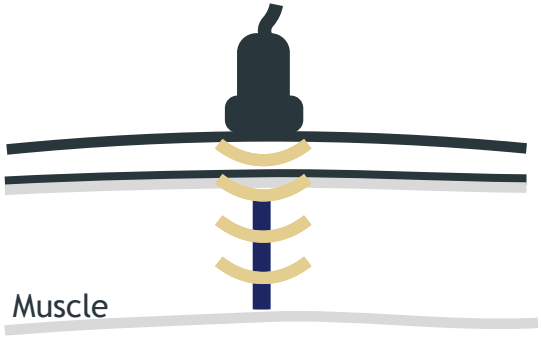
Le Sant et al. (2015) Plos One



SHEAR-WAVE ELASTOGRAPHY

Bercoff et al. (2004) IEEE Trans Ultrason Ferroelectr Freq Control

1



Aims

113 Athletes

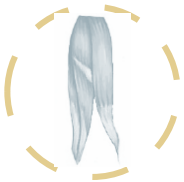
Soccer

Fencing

Taekwondo

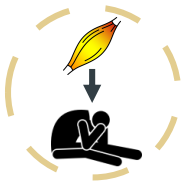
Track and Field

Field hockey



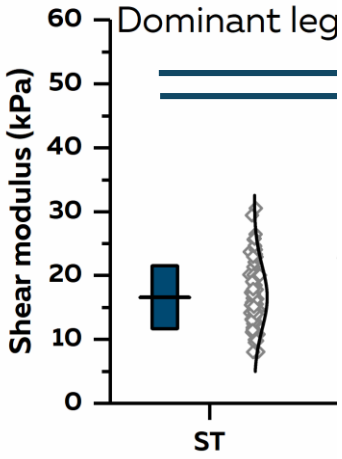
How does muscle stiffness differ among hamstring muscles?

How does hamstring stiffness differ between males and females and between sport?



Is there a relationship between a stiff muscle and the prevalence of hamstring injury?

BETWEEN-MUSCLES DIFFERENCES



Previous studies

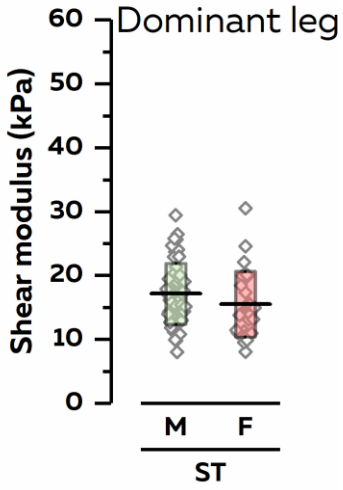
BFlh > SM > ST
Le Sant et al. (2015)

SM > BFlh > ST
Umegaki et al. (2015)

Muscle geometry (Volume, Fascicle length, PCSA)
Koo & Hug (2015)

Tendon mechanical properties
Magnusson et al. (2008) - Herbert et al. (2011)

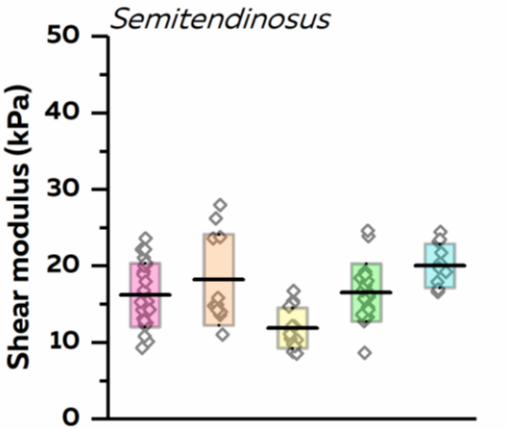
Between-gender differences



Higher muscle stiffness in males related to other parameters than shear modulus
Eby et al. (2015)

Stiffness was greater in males and linearly correlated with CSA
Blackburn et al. (2009)

BETWEEN-SPORTS DIFFERENCES



Chronic training

Fascicle length increases with velocity training
Blazevich et al. (2003)

Hamstrings PCSA increases with strength training
Seymore et al. (2017)

Hamstrings stiffness decreases with stretching
Magnusson et al. (1996) - Miyamoto et al. (2015)

Muscle stiffness & injury

Soccer players with a lower flexibility had a higher risk of injury

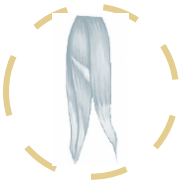
Witvrouw et al. (2003)

No relationship between range of motion and risk of injury for Australian footballers or sprinters

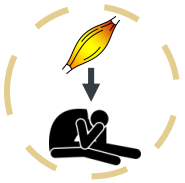
Gabbe et al. (2005) - Yeung et al. (2009)

TAKE HOME MESSAGE

Ultrasound shear-wave elastography is a reliable and valid technique **to assess non-invasively mechanical properties of hamstring muscle**

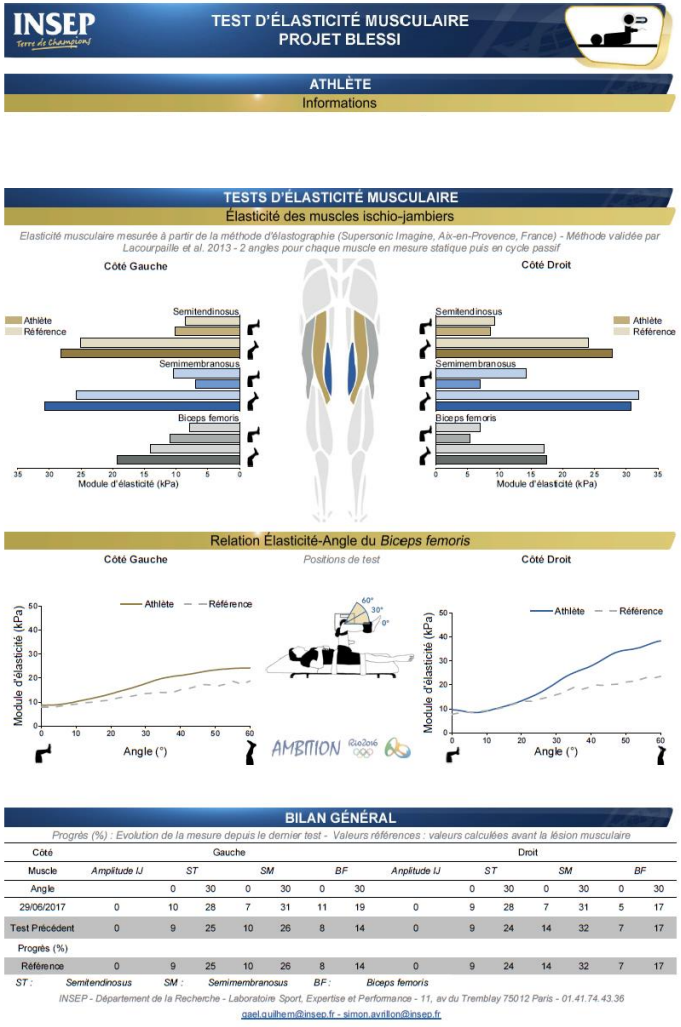


A **high inter-individual variability** exists among elite athletes when considering muscle stiffness. It may be impacted by intrinsic factors and chronic practice.



The shear modulus value failed to predict hamstring injuries.
A **systemic approach** may help to a better understanding of injury risk.

APPLICATIONS AT INSEP


INSEP Terre de Champions

TEST D'ÉLASTICITÉ MUSCULAIRE
PROJET BLESSI

ATHLÈTE
Informations

TESTS D'ÉLASTICITÉ MUSCULAIRE
Élasticité des muscles ischio-jambiers

Elasticité musculaire mesurée à partir de la méthode d'élastographie (Supersonic Imagine, Aix-en-Provence, France) - Méthode validée par Lacourpaille et al. 2013 - 2 angles pour chaque muscle en mesure statique puis en cycle passif

Côté Gauche — Côté Droit

Athlète / Référence

Semitendinosus
Semimembranosus
Biceps femoris

Module d'élasticité (kPa)

Relation Élasticité-Angle du *Biceps femoris*

Côté Gauche — Positions de test — Côté Droit

Athlète — Référence

Module d'élasticité (kPa)

Angle (°)

60° 30° 0°

AMBITION Rio2016

BILAN GÉNÉRAL

Progrès (%) : Evolution de la mesure depuis le dernier test - Valeurs références : valeurs calculées avant la lésion musculaire

Côté		Gauche							Droit						
Muscle	*Amplitude IJ*	*ST*		*SM*		*BF*		*Anplitude IJ*	*ST*		*SM*		*BF*	
Angle		0	30	0	30	0	30		0	30	0	30	0	30
29/06/2017	0	10	28	7	31	11	19	0	9	28	7	31	5	17
Test Précédent	0	9	25	10	26	8	14	0	9	24	14	32	7	17
Progrès (%)														
Référence	0	9	25	10	26	8	14	0	9	24	14	32	7	17

ST : Semitendinosus SM : Semimembranosus BF : Biceps femoris

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Partnership with the **medical** and **physiotherapy** department

Follow-up of injured athletes to assess the recovery of initial stiffness

Collaborators

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M Simon Avrillon
M Robin Hager
M Enzo Hollville

University of Nantes

Dr François Hug
Dr Antoine Nordez
Dr Sylvain Dorel
Dr Arnaud Guével
Dr Marc Jubeau

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Ville candidate
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