



L'ÉVALUATION DE LA MARCHE HORS LABORATOIRE : QUELS OUTILS EN 2024 ?

Didier Pradon

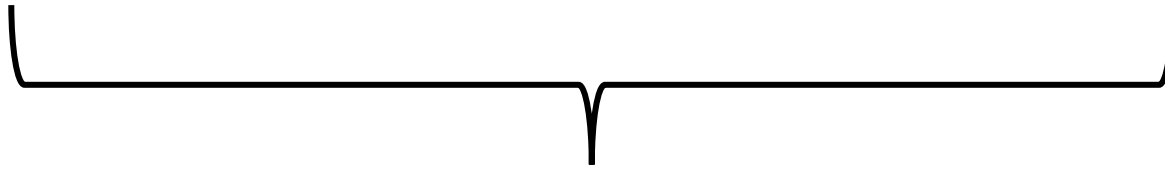
Pôle Parasport - ISPC, APHP, Garches

didier.pradon@aphp.fr





capacités
réhabilitation
prothèse orthèse
appareillage
escalier flexion sport
force marche loisir motrices
autonomie chirurgie
chaussures rééducation
course toxine



Questionnement Clinique



capacités
réhabilitation
prothèse orthèse
appareillage
escalier flexion sport
force **marche** motrices
autonomie chirurgie
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rééducation
course toxine

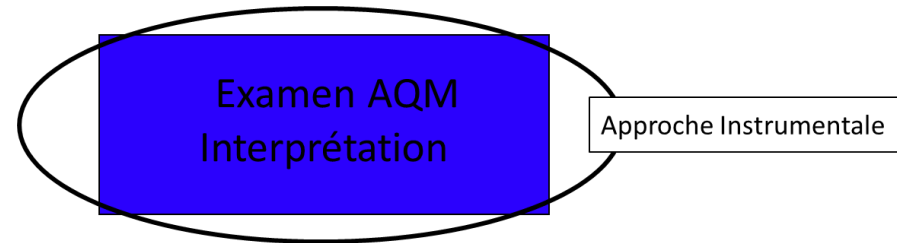
Questionnement Clinique

Examen AQM
Interprétation

Approche Instrumentale

Réponse





Analyse Quantifiée du Mouvement

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Outils d'investigation du mouvement

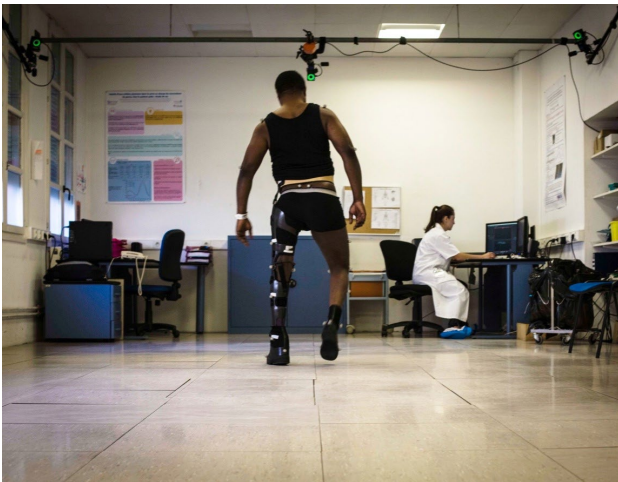
- Données biomécaniques
- Données physiologiques

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Plateau d'Exploration de la Motricité



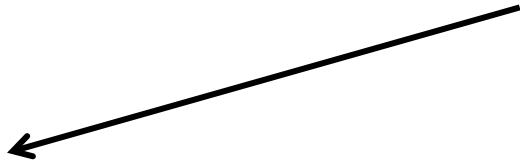
Quantification « *Laboratoire* »



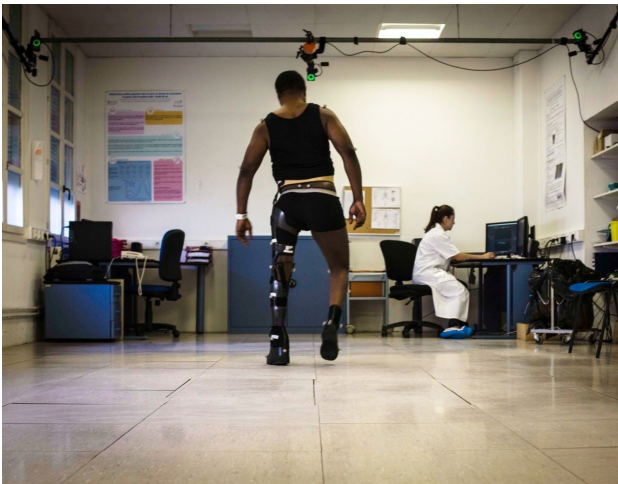
Opto + PF + EMG

Quantification « *Ecologique* »

Analyse Vidéo



Quantification « *Laboratoire* »

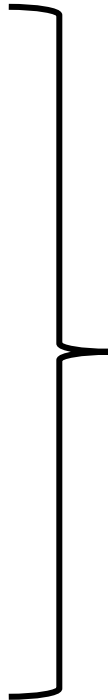


Opto + PF + EMG





Capture 3D dans un environnement virtuel immersif



Plat

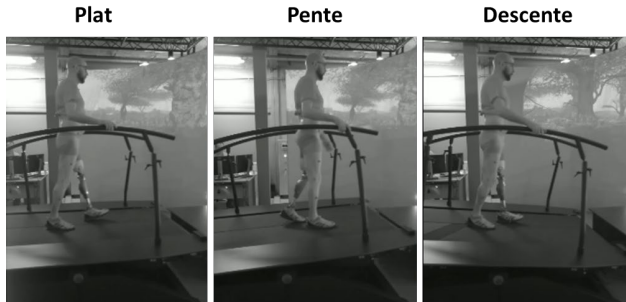
Pente

Descente





Capture 3D dans un environnement virtuel immersif



Effect of slope in an immersive virtual environment on segmental asymmetry in people with femoral amputation and a microprocessor knee

E. Pantera, V. Denys, D. Pradon

2024 Acta of Bioengineering and Biomechanics 25(3)

Objectif : Effet de l'inclinaison du sol sur les variables articulaires cinématiques et l'asymétrie segmentaire

Méthode:

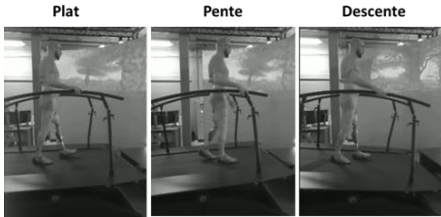
- 10 amputés transfémoraux (genou microprocesseur-contrôlé)
- 5 inclinaisons (Level, 3° and 6° Uphill, 3° and 6° Downhill)

Critères principal et secondaires :

- Paramètres cinématiques articulaires et spatio-temporels du cycle de marche couramment utilisés pour décrire la marche de l'amputé [*Sturk 2019, Thibault 2018*]
- Indice de symétrie pour quantifier globalement et simplement les adaptations cinématiques segmentaires



Capture 3D dans un environnement virtuel immersif



Effect of slope in an immersive virtual environment on segmental asymmetry in people with femoral amputation and a microprocessor knee

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 2024 Acta of Bioengineering and Biomechanics 25(3)

Méthode utilisée en Géographie

452 KIMBERLY J. VAN METER AND NANDITA B. BASU Ecological Applications Vol. 25, No. 2

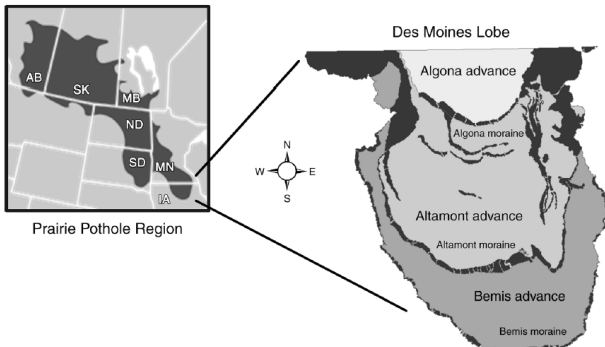
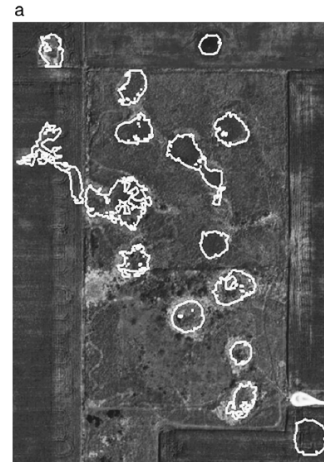
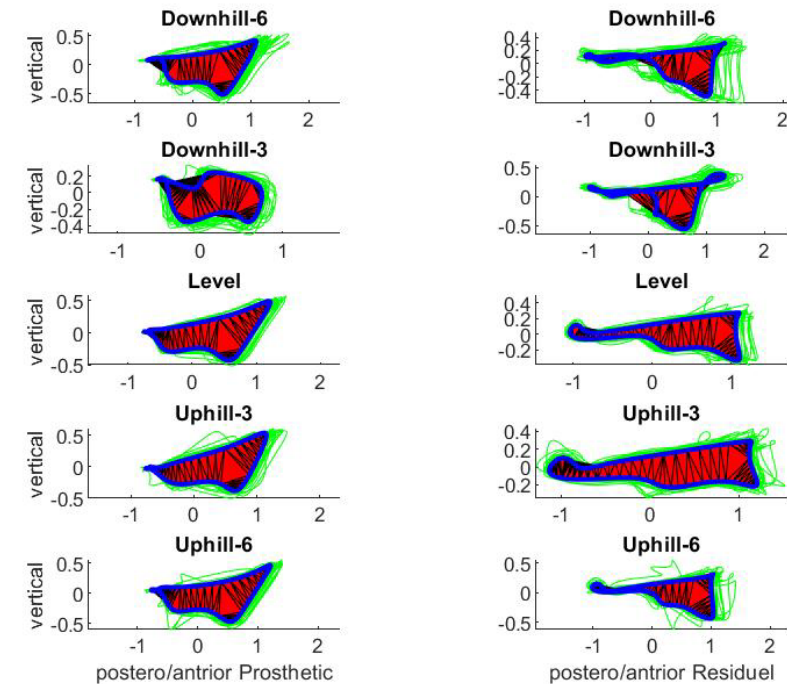


FIG. 1. Map of the North American Prairie Pothole Region (Canada and USA) and the Des Moines Lobe (DML), showing major landforms.

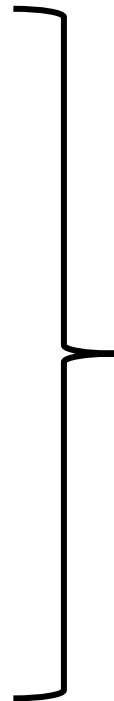
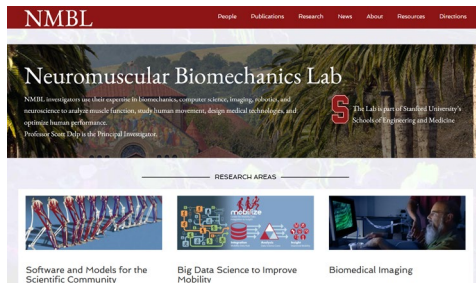


Méthode utilisée en Analyse de la Marche



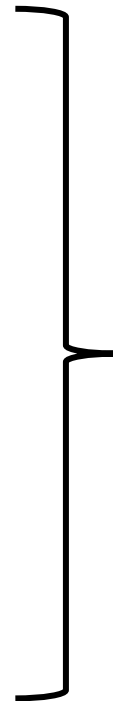


Développement de la Capture 3D sans Marqueur

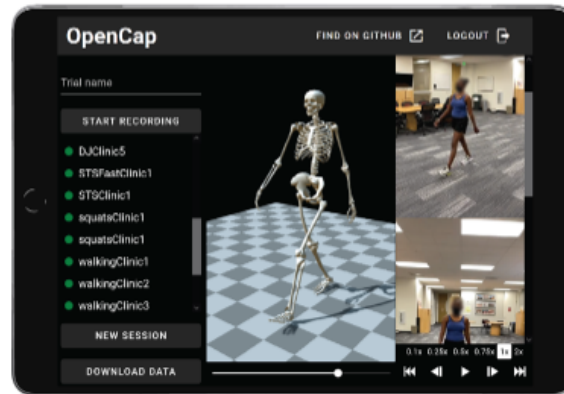




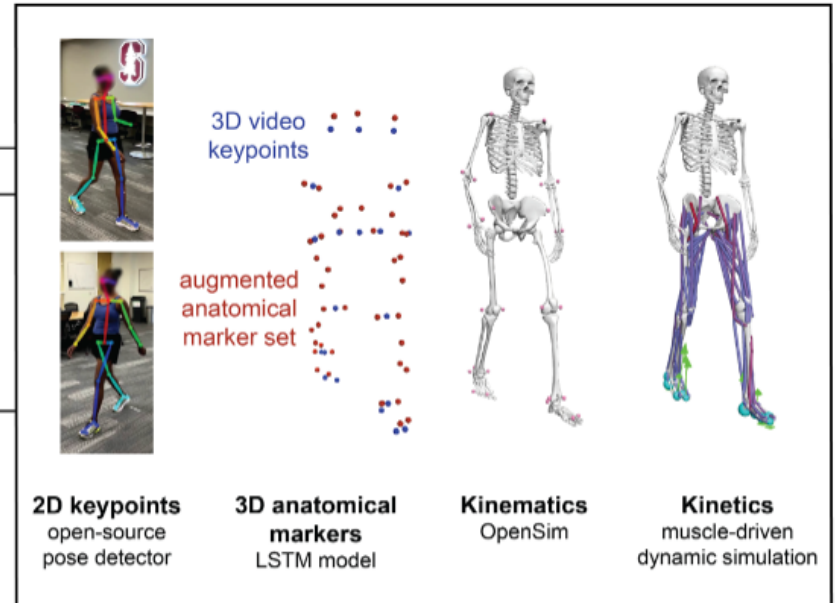
Développement de la Capture 3D sans Marqueur



iOS application
simultaneous video capture



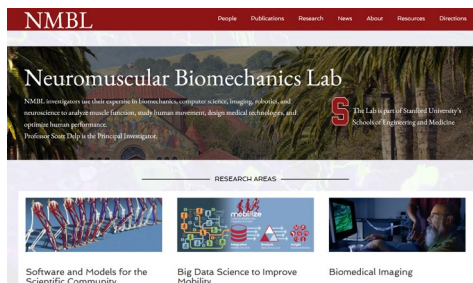
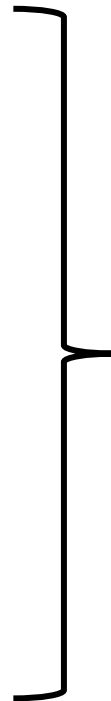
Web application
data collection and visualization



Scalable cloud computing
biomechanical analysis from video



Développement de la Capture 3D sans Marqueur



OpenCap: 3D human movement dynamics from smartphone videos

Scott D. Uhlich, Antoine Falisse, Łukasz Kidziński, Julie Muccini, Michael Ko, Akshay S. Chaudhari, Jennifer L. Hicks, Scott L. Delp

doi: <https://doi.org/10.1101/2022.07.07.499061>

This article is a preprint and has not been certified by peer review [what does this mean?].



[Front Bioeng Biotechnol.](#) 2022; 10: 857975.

Published online 2022 Aug 10. doi: [10.3389/fbioe.2022.857975](https://doi.org/10.3389/fbioe.2022.857975)

PMCID: PMC9399401

PMID: [36032709](https://pubmed.ncbi.nlm.nih.gov/36032709/)

The reliability and validity of gait analysis system using 3D markerless pose estimation algorithms

[Shengyun Liang](#), ^{1, 2, 3} [Yu Zhang](#), ^{1, 2, 3} [Yanan Diao](#), ^{1, 2, 3} [Guanglin Li](#), ^{1, 3} and [Guoru Zhao](#) ^{1, 3, *}



Développement de la Capture 3D sans Marqueur

Step 1 : Calibration iPhone



Step 3 : Acquisition

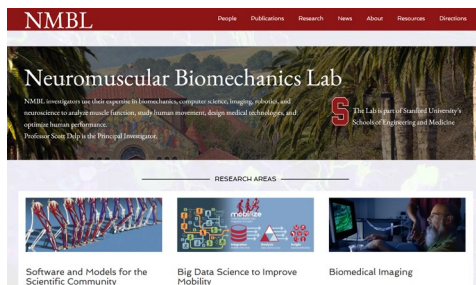
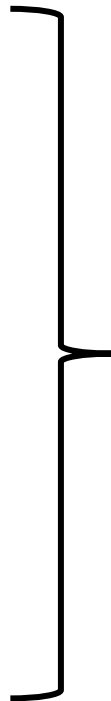
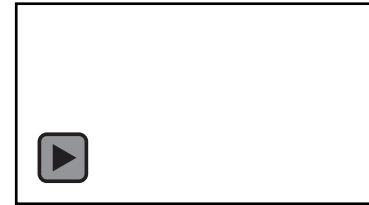


Step 2 : Calibration Model





Développement de la Capture 3D sans Marqueur



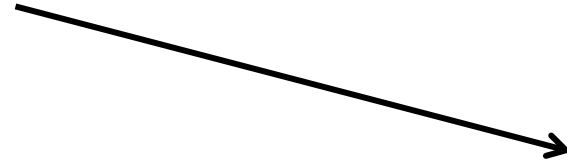
OpenCap: 3D human movement dynamics from smartphone videos

Scott D. Uthairi, Antoine Falgaux, Lukasz Kizilewicz, Julie Musconi, Michael Ko, Akshay S. Chaudhuri, Jennifer L. Hicks, Scott L. Delp
doi: <https://doi.org/10.1101/2022.07.07.499061>

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Front. Biomech. 2022; 10: 857975. PMID: 36032709
The reliability and validity of gait analysis system using 3D markerless pose estimation algorithms
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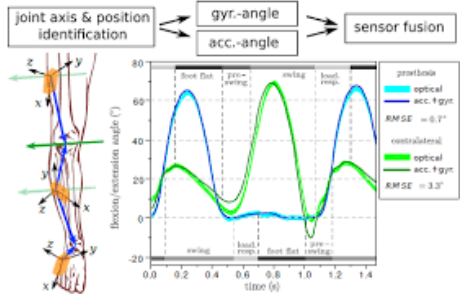
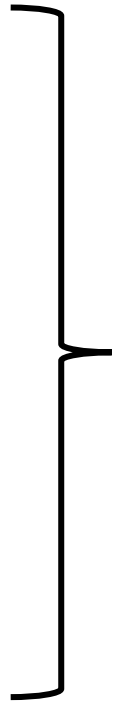
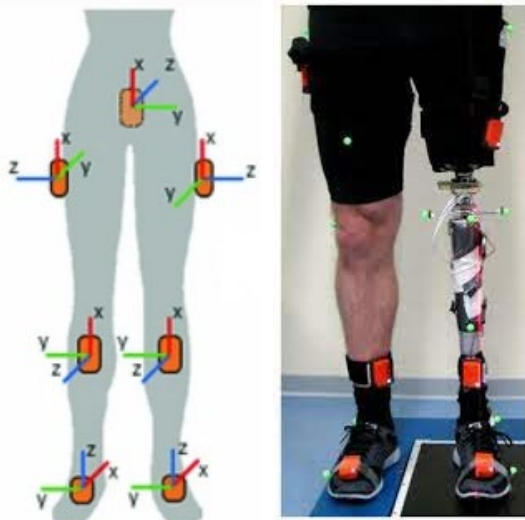
Quantification « *Ecologique* »



Analyse Vidéo

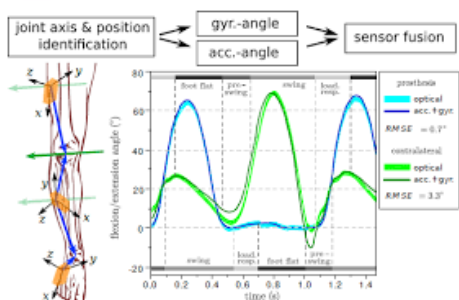
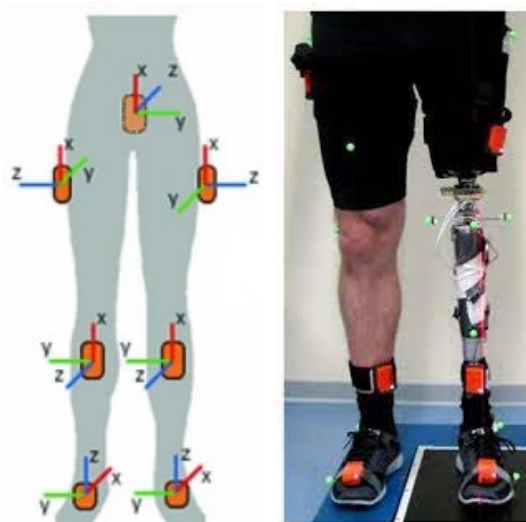


Capture 3D via capteurs embarqués : les centrales inertielles





Capture 3D via capteurs embarqués : les centrales inertielles



[Sensors \(Basel\)](#), 2020 Mar; 20(5): 1255.
 Published online 2020 Feb 25. doi: [10.3390/s20051255](https://doi.org/10.3390/s20051255)

PMCID: PMC7085729
 PMID: [32106577](https://pubmed.ncbi.nlm.nih.gov/32106577/)

[Review](#) > [Gait Posture](#). 2017 Jan;51:239-246. doi: [10.1016/j.gaitpost.2016.11.008](https://doi.org/10.1016/j.gaitpost.2016.11.008).
 Epub 2016 Nov 5.



A Comparison of the Conventional PiG Marker Method Versus a Cluster-Based Model when recording Gait Kinematics in Trans-Tibial Prosthesis Users and the Implications for Future IMU Gait Analysis

[Manunchaya Samala](#),^{1,*} [Philip Rowe](#),² [Jutima Rattanakoch](#),¹ and [Gary Guerra](#)¹



25 years of lower limb joint kinematics by using inertial and magnetic sensors: A review of methodological approaches

[Pietro Picerno](#) ¹



Capture via capteurs embarqués : Semelles instrumentées



18 capteurs de pression
Répartis sur la semelle

1 Centrale inertielle 6 axes
3 accel, 3 gyro

Algorithme de calculs
détection de mvt
reconnaissance cycle



> [Sensors \(Basel\)](#). 2021 Sep 30;21(19):6543. doi: 10.3390/s21196543.

Evaluation of the Validity and Reliability of Connected Insoles to Measure Gait Parameters in Healthy Adults

Damien Jacobs ¹, Leila Farid ¹, Sabine Ferré ¹, Kilian Herraes ², Jean-Michel Gracies ^{3, 4}, Emilie Hutin ^{3, 4}



> [Sensors \(Basel\)](#). 2020 Feb 11;20(4):957. doi: 10.3390/s20040957.

A Systematic Approach to the Design and Characterization of A Smart Insole for Detecting Vertical Ground Reaction Force (vGRF) in Gait Analysis

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Capture via capteurs embarqués : Semelles instrumentées



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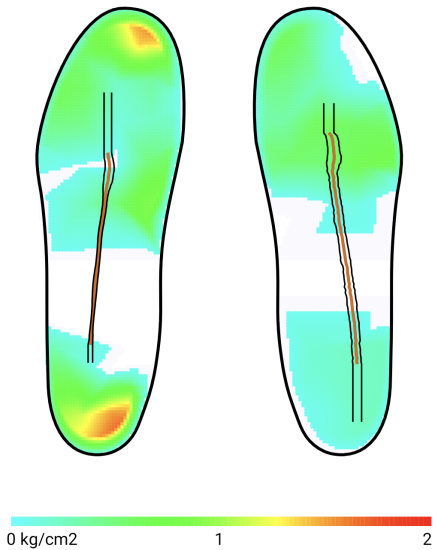
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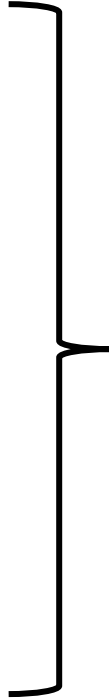


Capture via capteurs embarqués : Semelles instrumentées



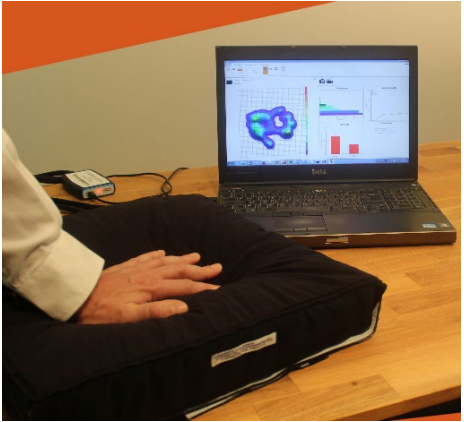


Capture 3D via capteurs embarqués : Capteurs de Pression



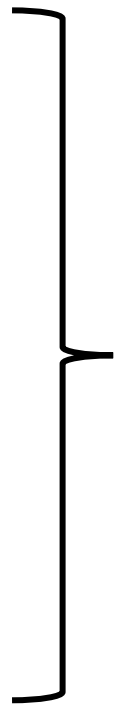


Capture 3D via capteurs embarqués : Nappe instrumentée





Capture via capteurs embarqués : Semelles instrumentées + Capteur Force + IMU



KINVENT
PHYSIO

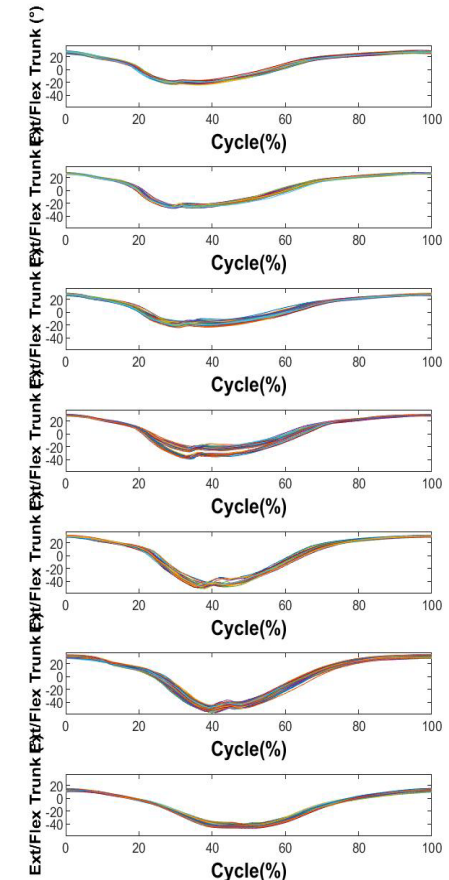
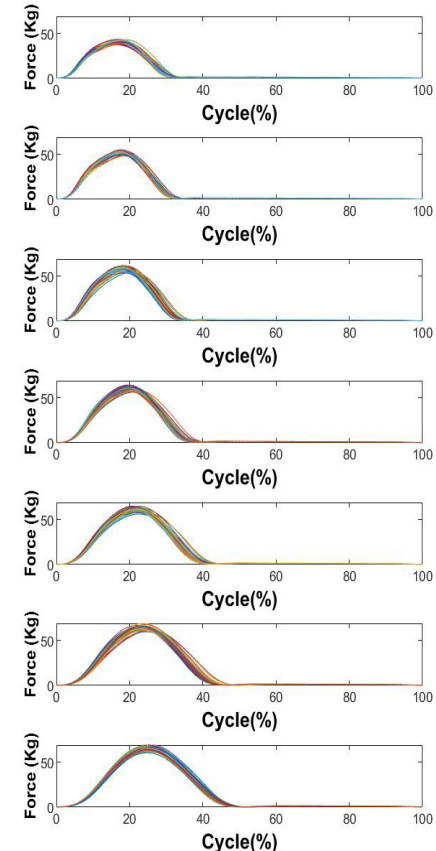
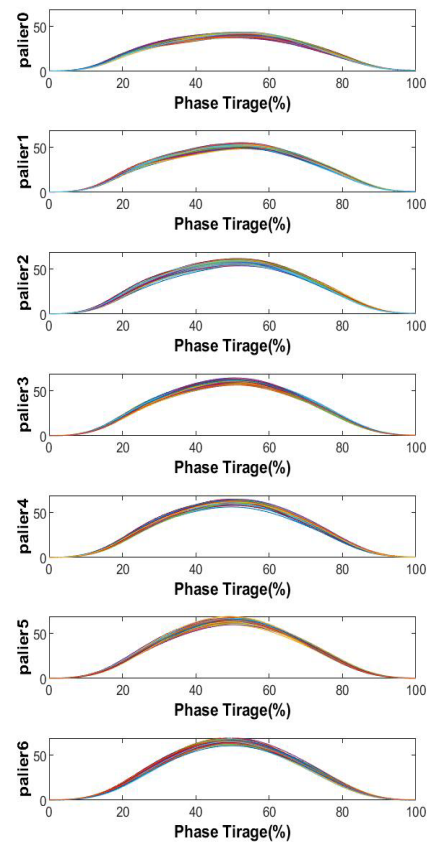
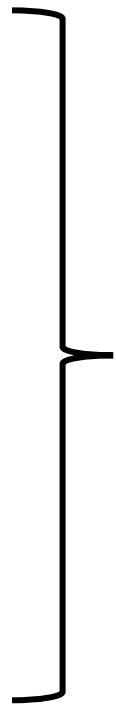




Capture 3D via capteurs embarqués : Semelles instrumentées + capteurs + IMU



KINVENT
 PHYSIO



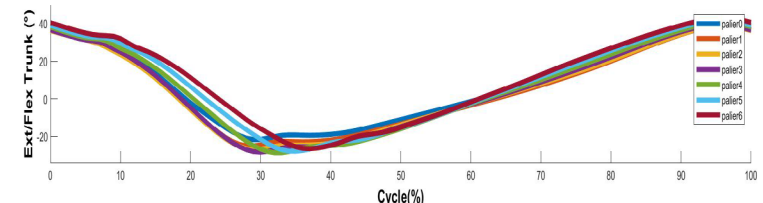
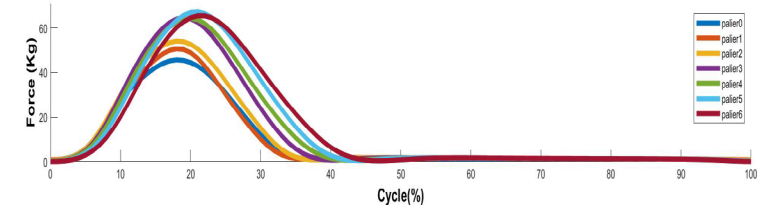
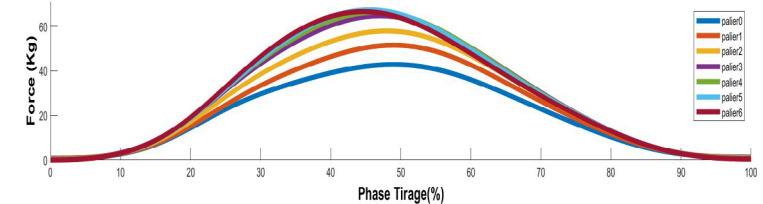
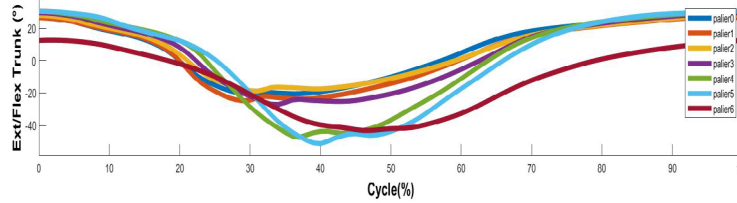
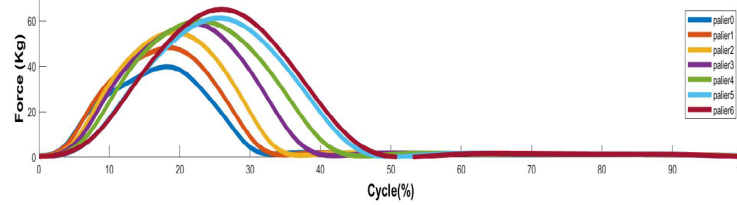
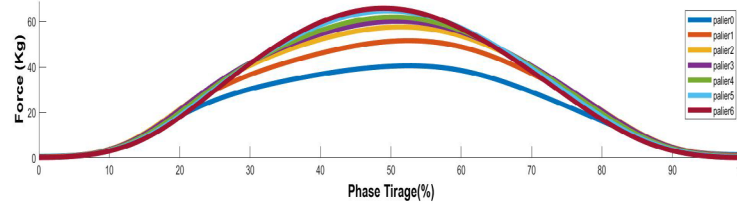
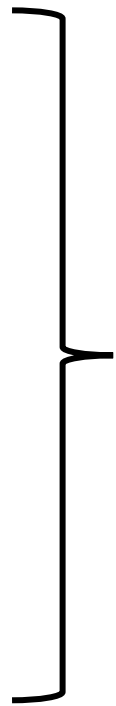
Evolution de la force de traction lors du test à l'effort : Palier 100w à 200w



Capture 3D via capteurs embarqués : Semelles instrumentées + capteurs + IMU

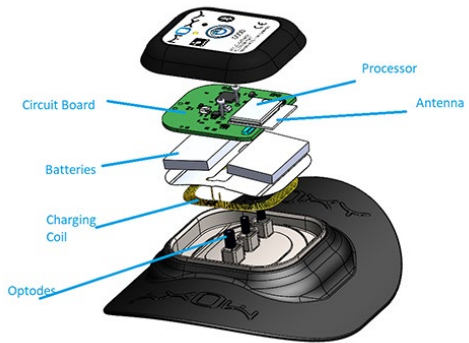


KINVENT
 PHYSIO





Mesures Physiologiques embarquées : NIRS SaO2



[J Biomed Opt.](#) 2019 Nov; 24(11): 115001.
 Published online 2019 Nov 18. doi: [10.1117/1.JBO.24.11.115001](https://doi.org/10.1117/1.JBO.24.11.115001)

PMCID: PMC7003144
 PMID: [31741352](https://pubmed.ncbi.nlm.nih.gov/31741352/)

Near-infrared spectroscopy-derived muscle oxygen saturation on a 0% to 100% scale: reliability and validity of the Moxy Monitor

[Andri Feldmann](#),^{a,*} [Roger Schmitz](#),^b and [Daniel Erlacher](#)^a

> [J Biomed Opt.](#) 2018 Jan;23(1):1-14. doi: [10.1117/1.JBO.23.1.015007](https://doi.org/10.1117/1.JBO.23.1.015007).

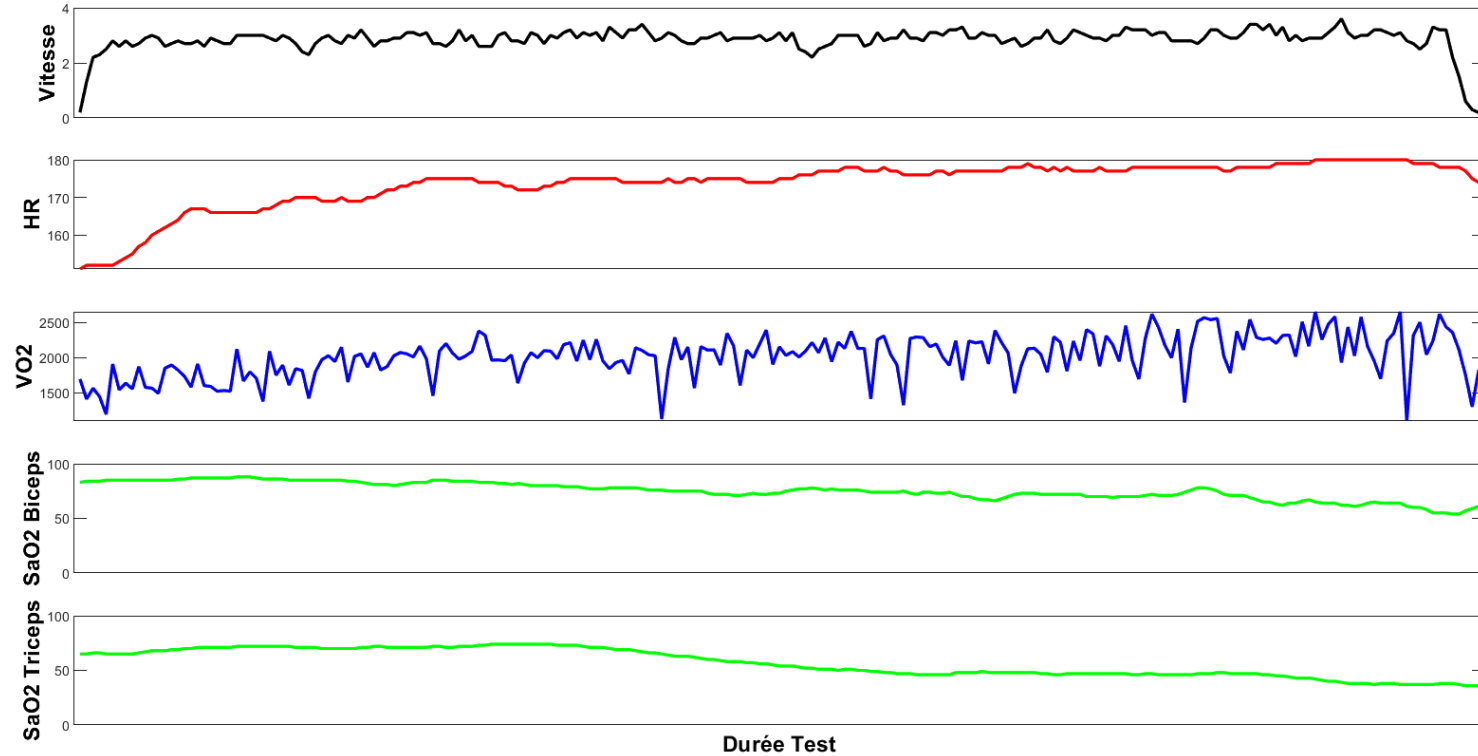
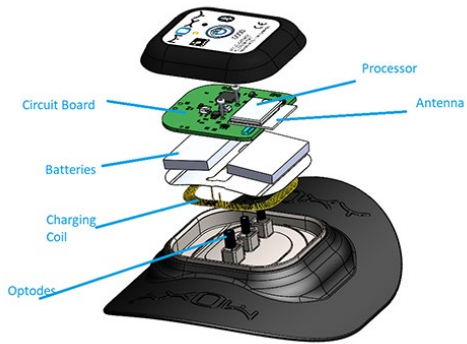


Performance comparison of the MOXY and PortaMon near-infrared spectroscopy muscle oximeters at rest and during exercise

[Chris J McManus](#)¹, [Jay Collison](#)¹, [Chris E Cooper](#)¹



Mesures Physiologiques embarquées : NIRS SaO2



[J Biomed Opt.](#) 2019 Nov; 24(11): 115001.
 Published online 2019 Nov 18. doi: [10.1117/1.JBO.24.11.115001](https://doi.org/10.1117/1.JBO.24.11.115001)

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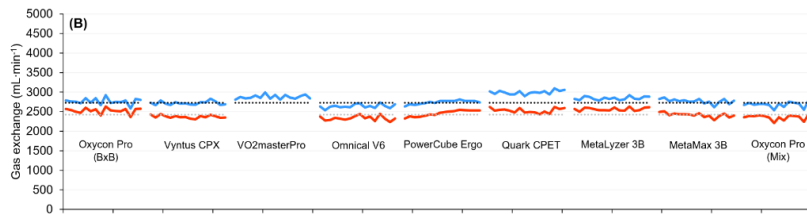


Mesures Physiologiques embarquées : VO2

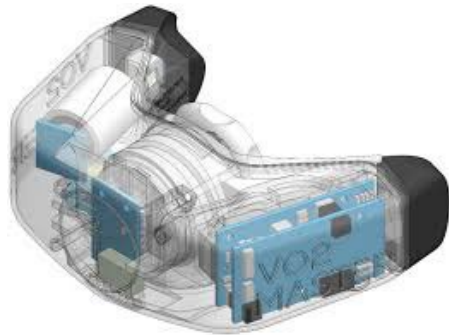
> Scand J Med Sci Sports. 2024 Jan;34(1):e14490. doi: 10.1111/sms.14490. Epub 2023 Sep 11.

Accuracy of respiratory gas variables, substrate, and energy use from 15 CPET systems during simulated and human exercise

Bas Van Hooren ¹, Tjeu Souren ², Bart C Bongers ^{1,3}



System	%e VE	%e BF	%e VO ₂
Vyntus CPX	-4.15 ± 1.92	-2.90 ± 1.30	1.15 ± 1.07 *
Oxycon Pro BxB	-1.84 ± 1.17 *	-3.79 ± 2.67	0.24 ± 1.33 *
Oxycon Pro MC	-7.86 ± 1.59	-3.75 ± 2.69	-2.28 ± 1.23
Omnicall V6	-6.52 ± 4.57	-2.78 ± 1.58	-2.24 ± 1.77
Ergostik	-3.93 ± 1.16	-3.75 ± 2.89	-0.91 ± 3.14
MetaLyzzer 3B	1.24 ± 1.81	-2.50 ± 1.34	2.85 ± 2.22
MetaMax 3B	0.89 ± 1.35	-2.79 ± 1.28	1.64 ± 1.87
VO2masterPro ^a	-3.84	-2.17	-11.68
PowerCube Ergo	-3.34 ± 3.81	-3.70 ± 2.93	2.90 ± 7.80
Quark CPET	0.24 ± 2.00	-2.77 ± 1.25	0.60 ± 1.18 *
Ultima CPX	-8.91 ± 1.29	-2.84 ± 1.28	-8.97 ± 1.17
Ergocard CPX Clinical	5.80 ± 2.24	-2.78 ± 1.24	-3.10 ± 1.54
Ergocard CPX Pro	6.47 ± 2.03	-2.56 ± 1.45	-2.52 ± 2.14
K5	-0.80 ± 1.03 *	-2.85 ± 1.31	-7.80 ± 2.93
PNOË	44.3 ± 8.22	-1.22 ± 1.30	8.25 ± 5.72
Calibre	-2.33 ± 2.84	-1.69 ± 1.63	0.23 ± 1.41 *





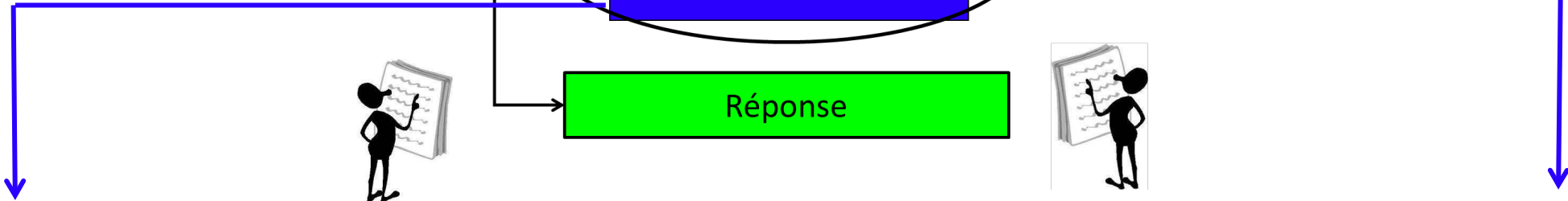
capacités
 réhabilitation
 appareillage
 prothèse
 orthèse
 marche
 motrices
 force
 autonomie
 chirurgie
 chaussures
 rééducation
 course
 toxine

Questionnement Clinique

Examen AQM
 Interprétation

Approche Instrumentale

Réponse



Quantification « *Laboratoire* »

Quantification « *Ecologique* »





Société de Réadaptation du Nord-Est
Une prise en charge globale et pluridisciplinaire



L'ÉVALUATION DE LA MARCHÉ HORS LABORATOIRE : *pour une nouvelle analyse de la marche ?* *pour une nouvelle analyse de la motricité/locomotivité ?*

Didier Pradon

Pôle Parasport - ISPC, APHP, Garches

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