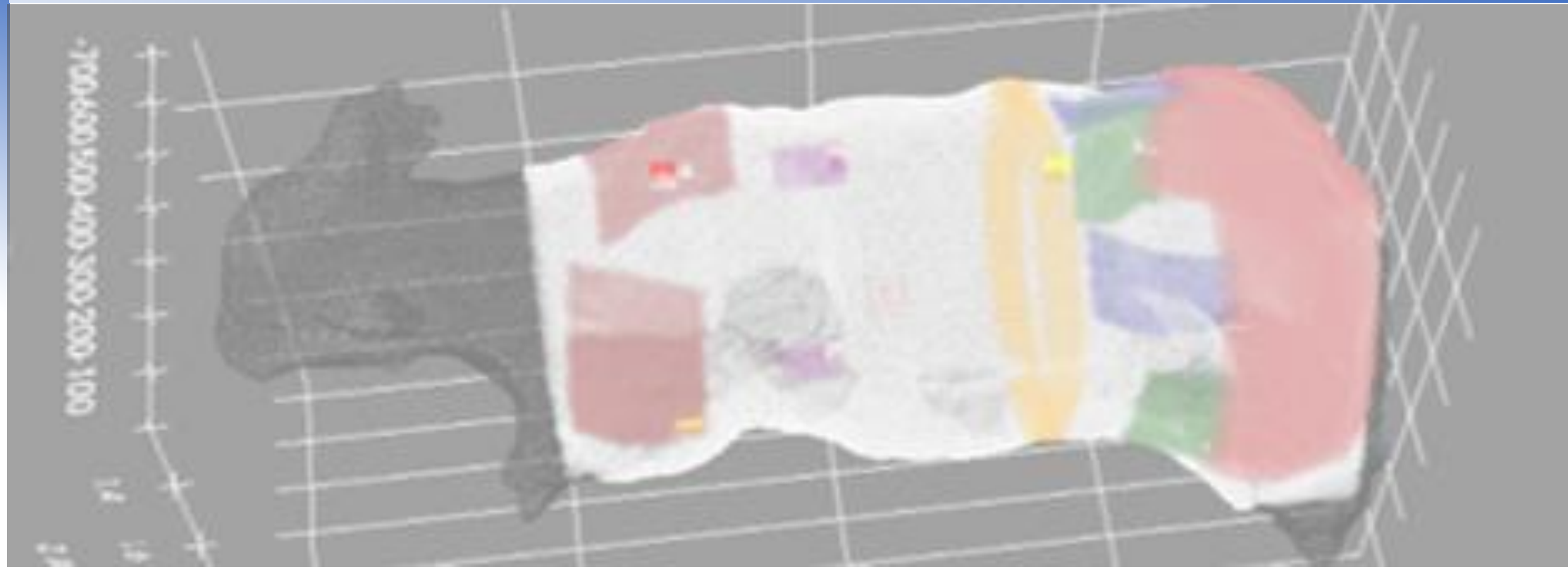

Phenotyping of beef calves BW and morphological scores based on 3D imaging and AI

T. Dechaux, Y. Do, M. El Jabri, E. Deste, C. Allain, L. Delattre, C. Gillé-Perrier, M. Bruyas, A. Lebreton

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Funded by : APIS-GENE Investir Innover Valoriser

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Context : the beef breeding stakeholders interested in modernization of performance monitoring

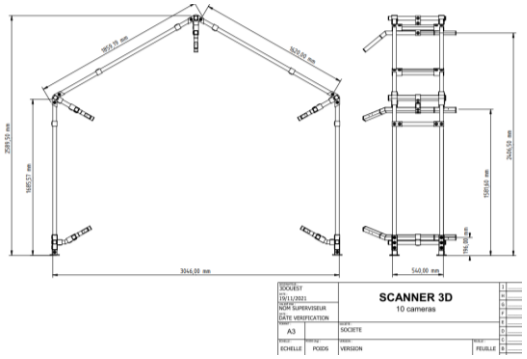
- Performance monitoring **= Body Weight + 19 morphological linear scores**
  - Used for consultancy and animal selection
- **435 000 calves** phenotyped in 2022 (on 10 french breeds)

A system that has worked for decades but which have now limits (cost of maintaining the skills in the operators)

The PHENO3D project

Goal : Automate the collection of live weight and the 19 scores (done visually today) on 10 beef breeds

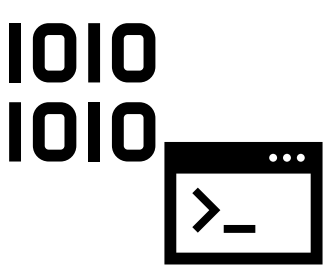
3 bricks of project deliverables :



A 3D scanner for high-throughput phenotyping in farm

3D OUEST

Focus of today



Prediction algorithms

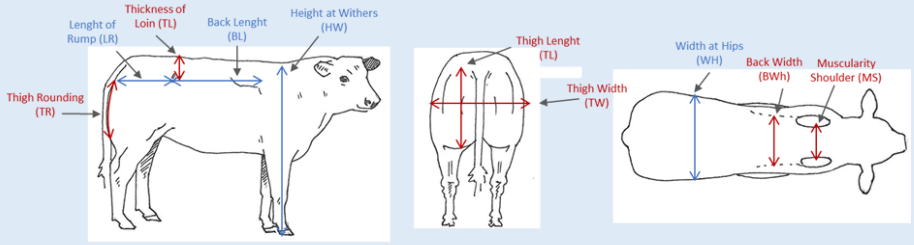
Service for breeders

Consortium Animal 3D

Validated by Lebreton et al. (2023)

M&M : Reference data collection

Calves were weighed and scored



2 synthetic scores (rated from 1 to 100) : **Muscle development (MUS)** and **Skeletal development (SKE)**

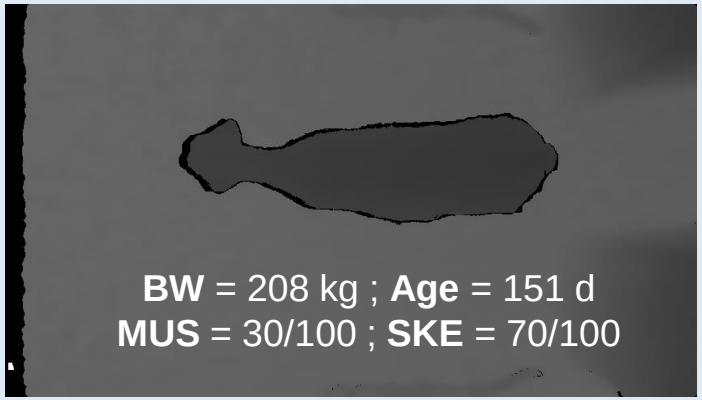
BW prediction dataset

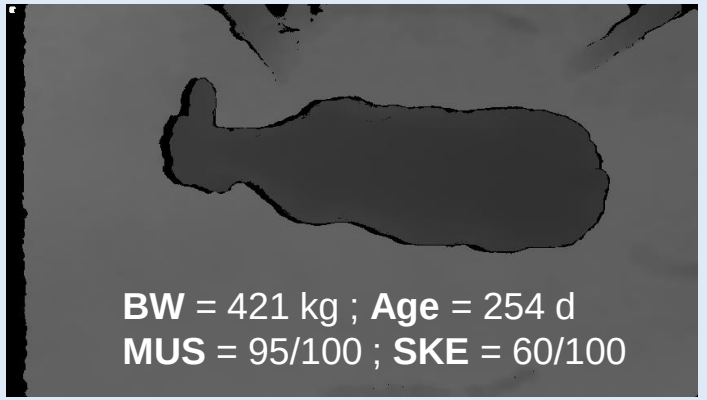
N = 1114 Charolais calves
Age : 4 to 18 months ; 217 ± 50,7 d
BW = 287,5 ± 81 kg

SKE/MUS prediction dataset

N = 919 Charolais calves
Age : 4 to 12 months ; 214 ± 45 d
BW = 293 ± 78,6 kg

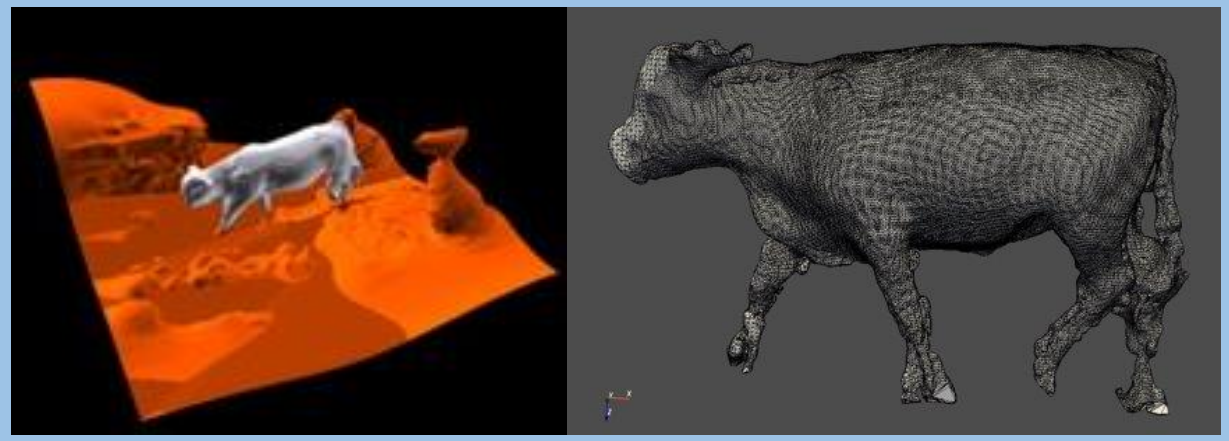
Calves top-view examples





M&M : 3D images data collection

A movable gantry
Embedding **10 RGB-D sensors**



Proprietary algorithm:
Merging of 10 RGB-D images to **a unique animal 3D mesh**
Refining images and **removing** noises

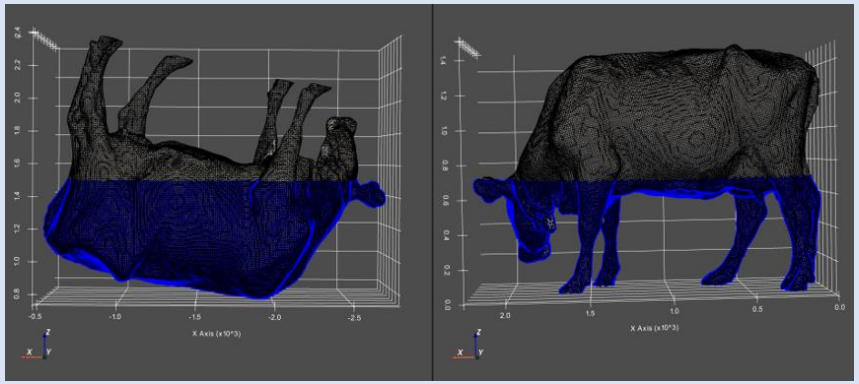
Scanner described and validated by Lebreton et al. (2023)

3D OUEST

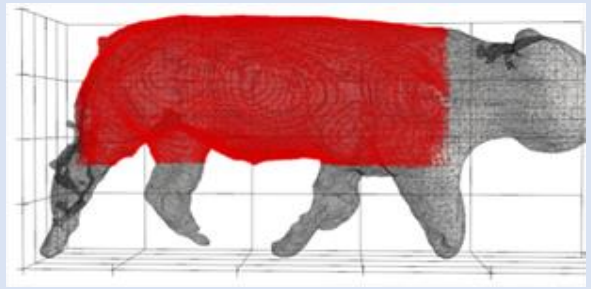
Set up in 14 commercial farms in various conditions
Most animals were scanned twice .
Resulting in 2079 images

M&M : 3D image treatment

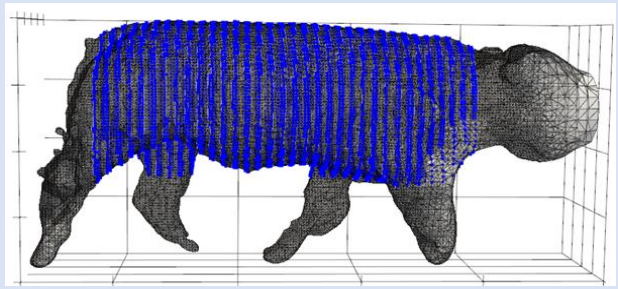
Step1 : Cow aligment



Step 2 : Features extraction



General view *Ex : Volume, Surface*



Specific view *Ex : chest depth, sacrum height*

283 features calculated for 2079 images

Described by Do et al. (2024)

M&M : Models/AI development

Data cleaning

Outliers detection algorithm based on Isolation Forest and DBSCAN

Machine Learning methodology

Training set (80%)

Algorithms tested :
Xgboost, random forest, SVM, Lasso regression

Testing set (20%)

*Models evaluation using **MAE** (Mean absolute error), **RMSE** (Root Mean Squared Error) and **Spearman rank correlation** (rs)*

Results : BW

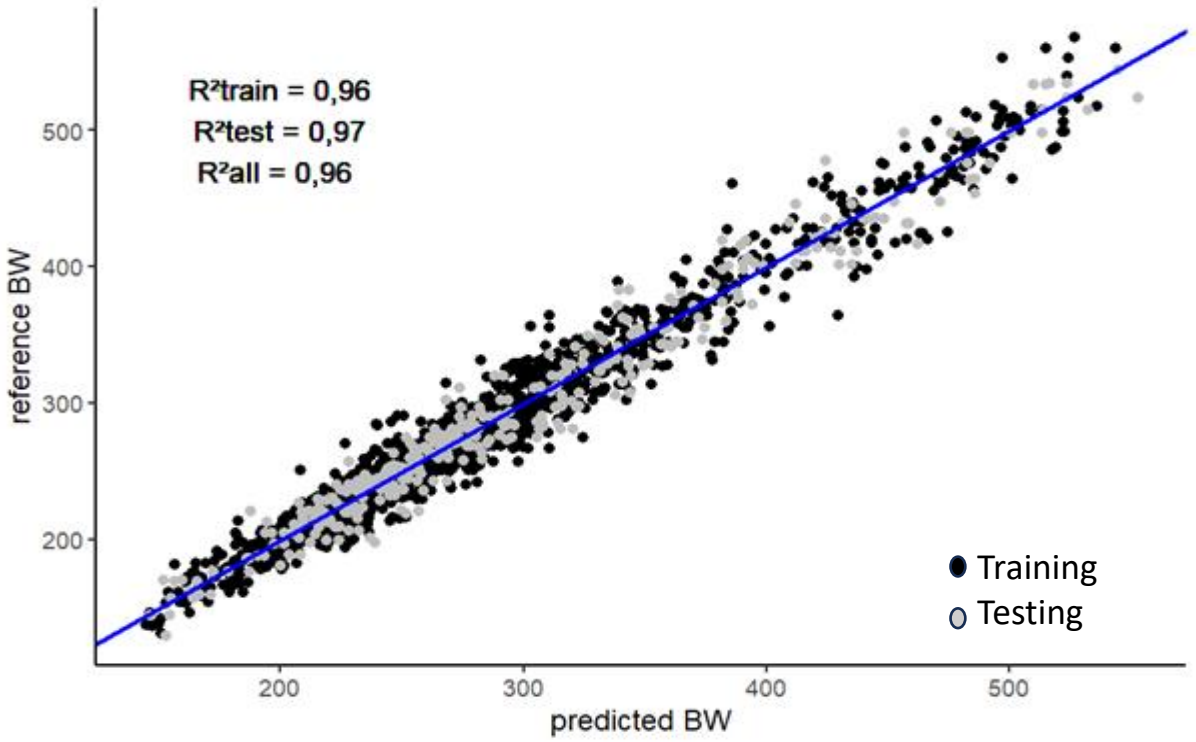
Model's performance

MAE (testing) : **12,1 kg (4,2%)**

RMSE (testing) : **15,6 kg**

Spearman correlation for **repeatability** (images from the same animal)

0,98



Best model : Extreme gradient boosting

The model achieves an error of 4,2%, with a good repeatability and is fully automated !

Results : SKE

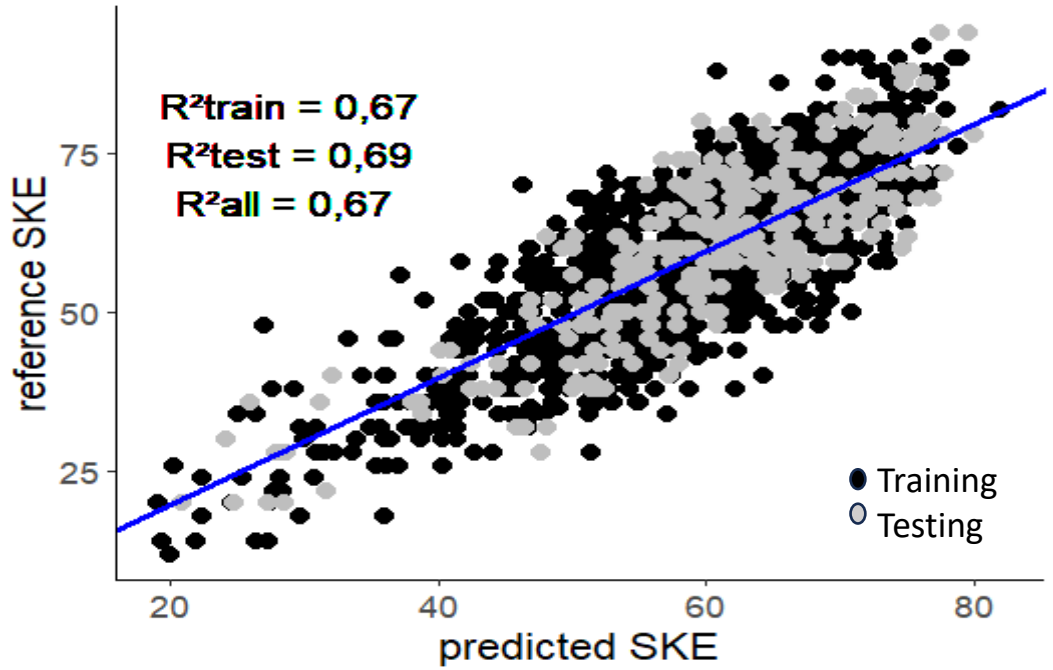
Model's performance

MAE (testing) : **6,3 (11,3%)**

rs (testing) : **0,78**

Spearman correlation for **repeatability**
(images from the same animal)

0,91



Best model : Random Forest

Benchmark

rs (scorers) : 0,70

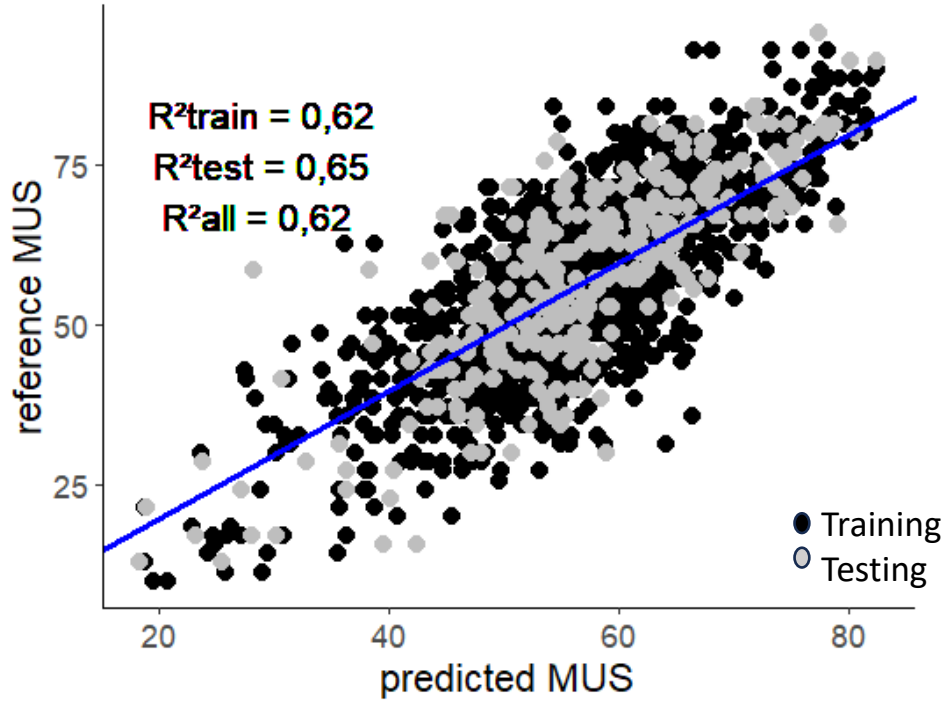
Repeatability of scorers : 0,78

The model surpass the benchmarks in performance

Results : MUS

Model's performance
MAE (testing) : **7,1 (14,5%)**
rs (testing) : **0,78**

Spearman correlation for **repeatability**
(images from the same animal)
0,81



Best model : Extreme gradient Boosting

Benchmark

rs (scorers) : 0,69
Repeatability of scorers : 0,75

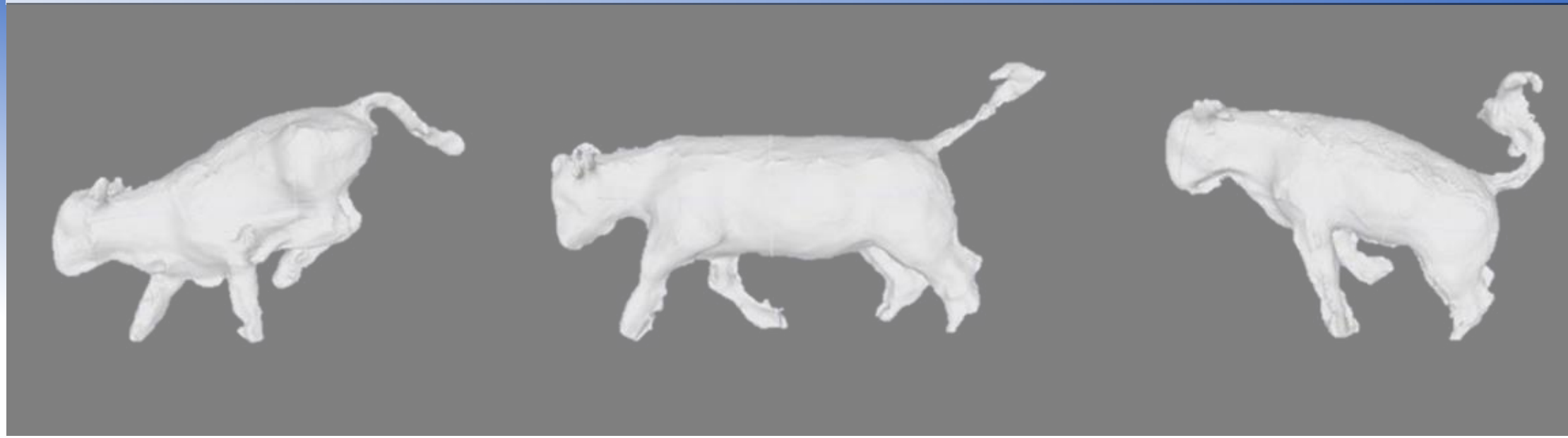
The model surpass the benchmarks in performance

Take home messages

- **Good and robust** estimation of **BW** utilizing three-dimensional imaging and IA techniques were obtained on **Charolaise**.
- Performances obtained with a lot of images and a **fully-automated** process
- It works for more complex indicators like MUS and SKE

- Limits : dealing with specific postures

- To do : Similar analysis for other breeds



Thank you for your attention !

Contact : adrien.lebreton@idele.fr

***Session 42**, Monday September 2nd - 17:15*

Lebreton et al. (2023)
Do et al. (2024)
Dechaux et al (2024)

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