# New traits derived from automatically collected data - chances and challenges for horse breeding

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## Objective

- Impartial, unbiased and easy automatic recording of GAITS, FREE JUMPING and MORPHOLOGY
- Analysis of **Gaits**, **Free jumping** and **Morphology** of Jumping horses:
  - To provide tools (breeding values) to direct selection for specific gaits or morphology
  - To find genomic markers for these traits to help selection
  - To compute *Genetic relationship* with jumping in competition
    (the first selection objective of Selle Français)
  - And to conclude about *selection strategy*

_01

# How to record gaits ?



## Data for gaits

**Equimetrix®** 3-dimensions accelerometer device fixed onto the girth

After an official jumping competition for young horses,
each horse performed a **Quick Gait Test** including :

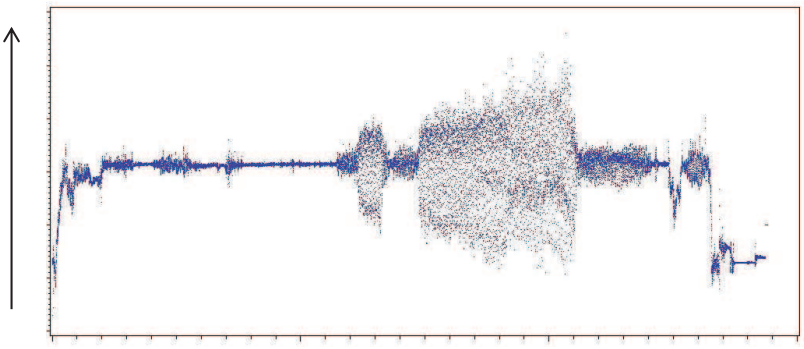
**walk**,
working and medium **trot**,
working and medium **canter**,

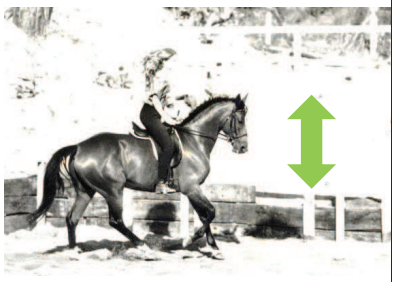
in an arena with **diagonal lines of 60 meters**

# Data : raw data from accelerometry

Acceleration recorded at 100Hz
in the dorsoventral

DorsoVentral
Acceleration





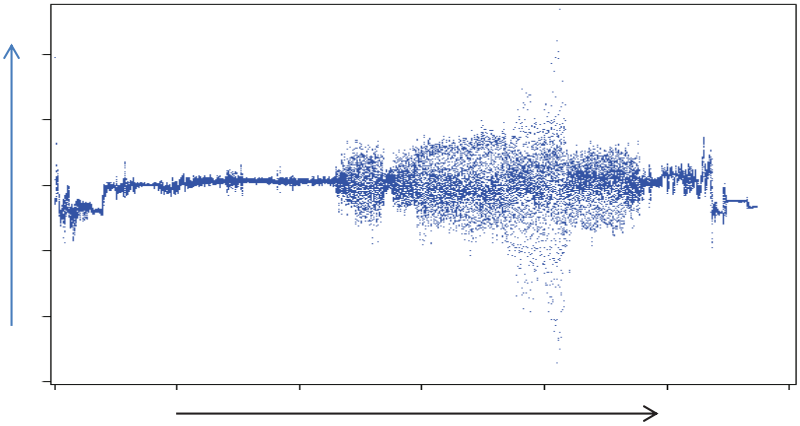
time

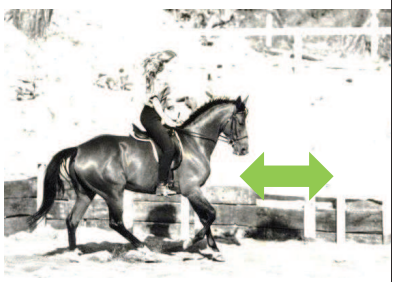


# Data : accelerometry

Acceleration recorded at 100Hz
in the dorsoventral, longitudinal

Longitudinal
Acceleration

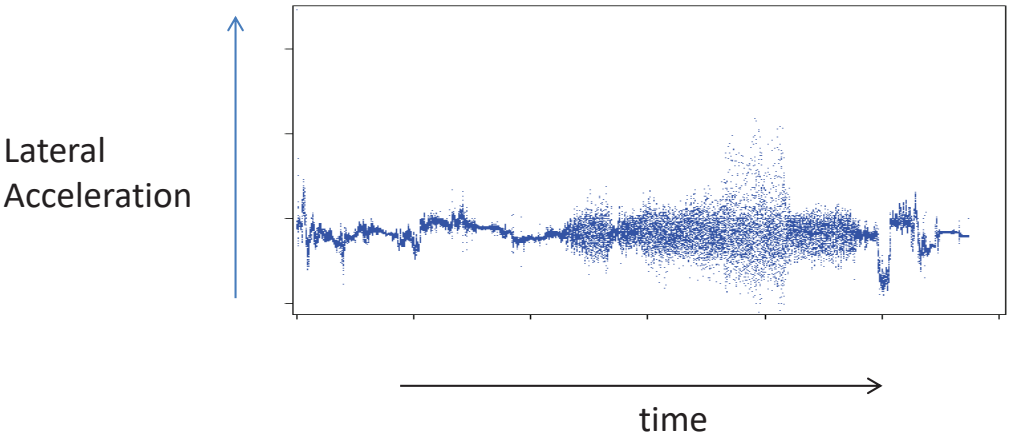


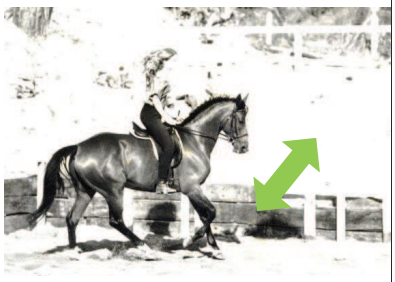


time

# Data : accelerometry

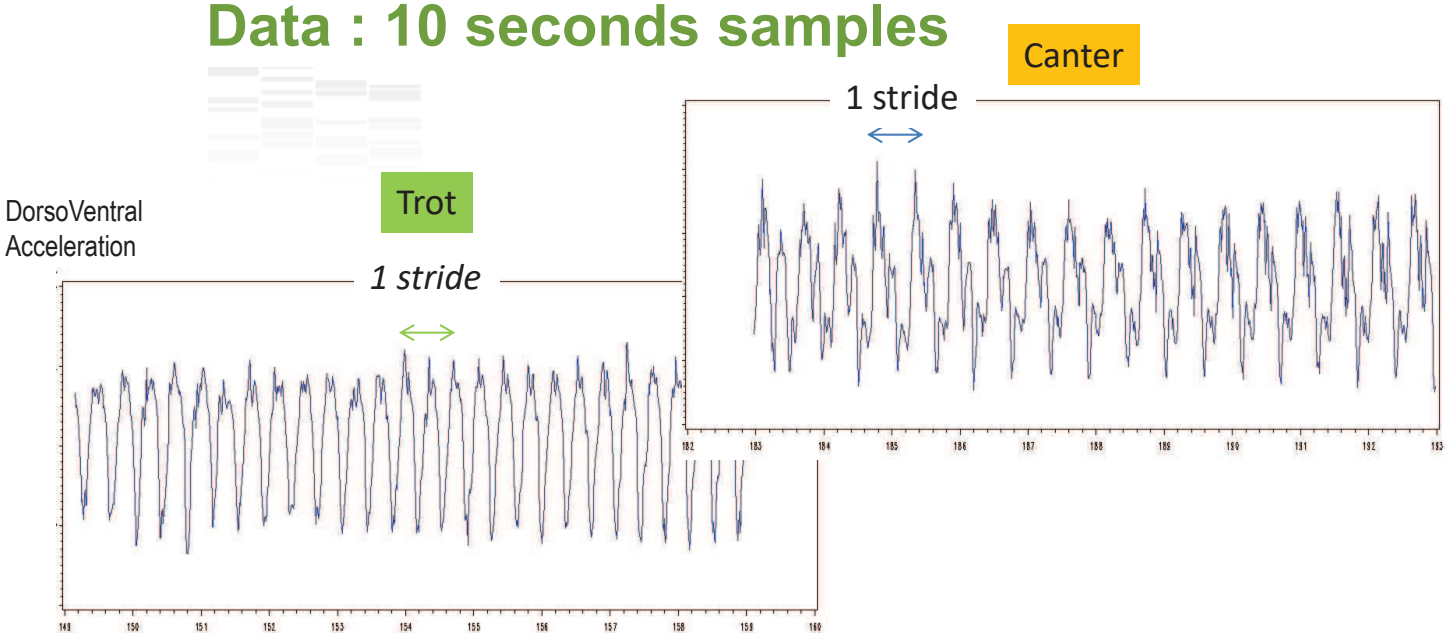
Acceleration recorded at 100Hz
in the dorsoventral, longitudinal and lateral axis of the horse





# Data : 10 seconds samples



## 8 measurements * 5 gaits = 38

- Velocity (m/s)
- Stride Frequency (stride/s)
- Regularity (correlation between strides)
- Symmetry (correlation between the right and left beat, Log)
- DorsoVentral displacement (cm)
- DorsoVentral activity = vertical ($g^2$/Hz), Log transform
- Longitudinal activity = front/back ($g^2$/Hz), Log transform
- Lateral activity = right/left ($g^2$/Hz), Log transform

- Walk
- Working Trot
- Medium Trot
- Working canter
- Medium canter

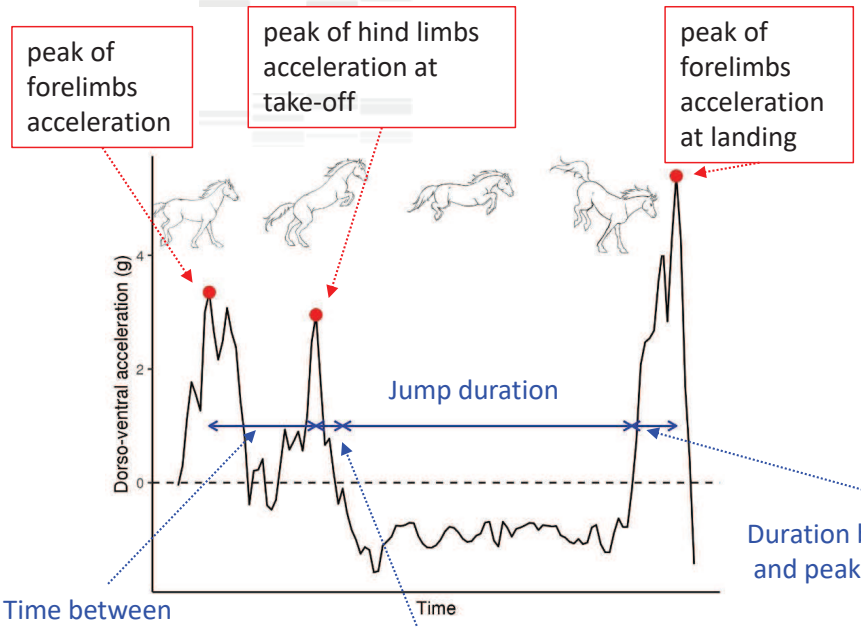


## Data for free jumping

**Equimetrix®** 3-dimensions accelerometer device fixed onto the girth

During regular free jumping examination in Selle Français breeding shows

# Free Jumping

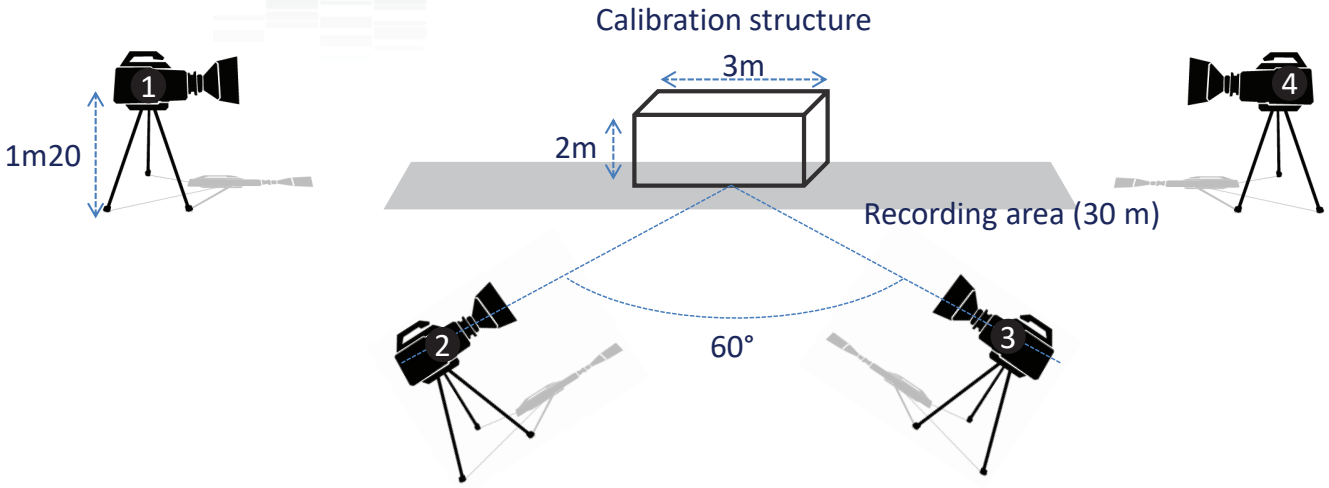





# _02

# How to measure morphology ?

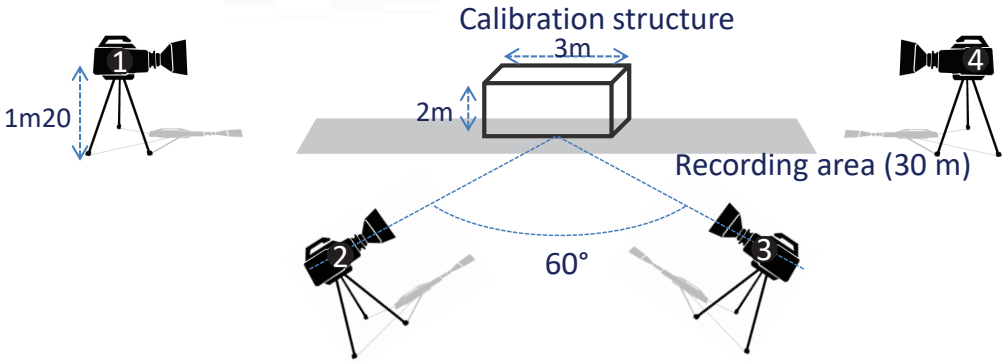
# Method : device




Four digital cameras were placed on the sides and at each end of a 30 meters long track



# Method : device




- The calibration structure provides the parameters needed for the 3D calculation of the coordinates of the horse's anatomical landmarks.
- After recording of the calibration structure, each horse , led by hand at the walk, is filmed (away and back)

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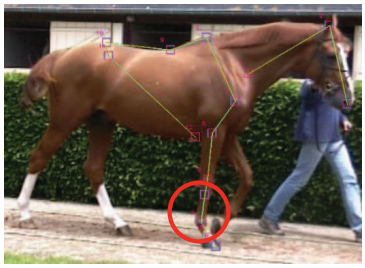
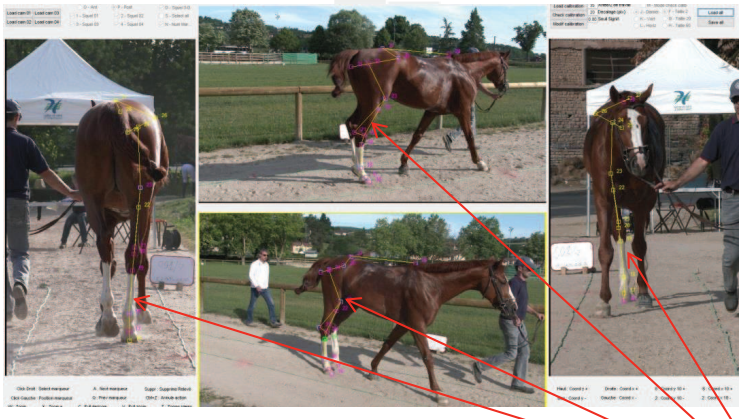
# Method : data processing

- Data processing was performed off-line : the 4 digitized films were synchronized and two sets of reference images on which the metacarpus and metatarsus of the right fore and hind limbs are in vertical positions were selected.





# Method : vue of images of the software

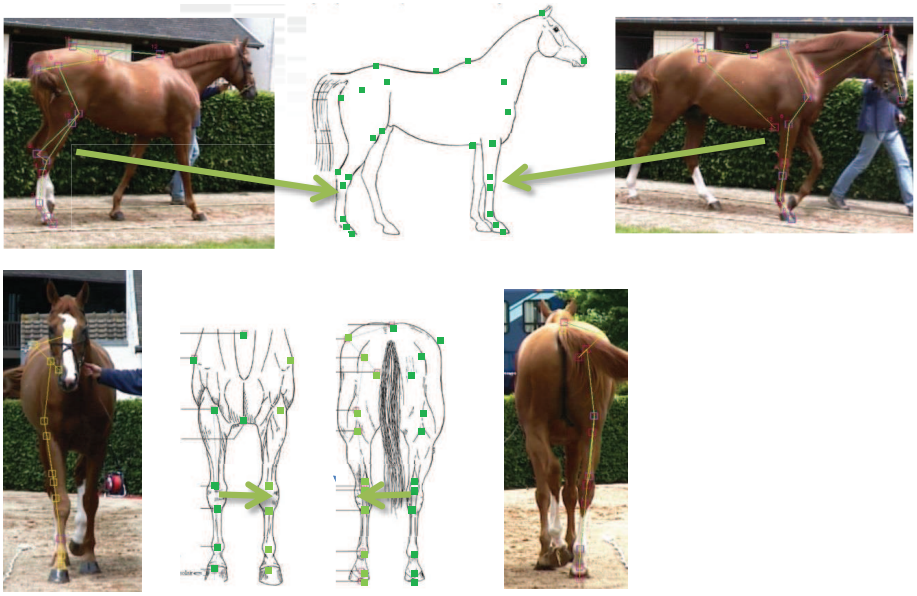


*Hind legs*

*Front legs*

A total of 28 landmarks were tracked manually (yellow skeleton, pink marks)
Landmarks are visible simultaneously on the 4 images (moving on one image induce move on all of them)

# Method : synthetic 3D image

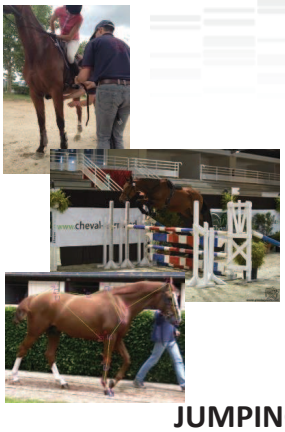


We built a synthetic image of the horse in 3D

- Adding Fore and Hind limbs
- Adding left size mirror of right side



# Number of horses



**GAITS: 1,477** jumping horses (mostly Selle Français) aged 4 and 5 years, in 27 events during 2 years of recording

**FREE JUMPING: 1,056** jumping horses (Selle Français) aged 3 years , 3,125 jumps in 10 events during 3 years of recording

**MORPHOLOGY**: **2,092** jumping horses (63% in 2015-2016, 37% in 2002) , aged 4 and 5 years, in 24 events, during 3 years of recording, mostly Selle Français

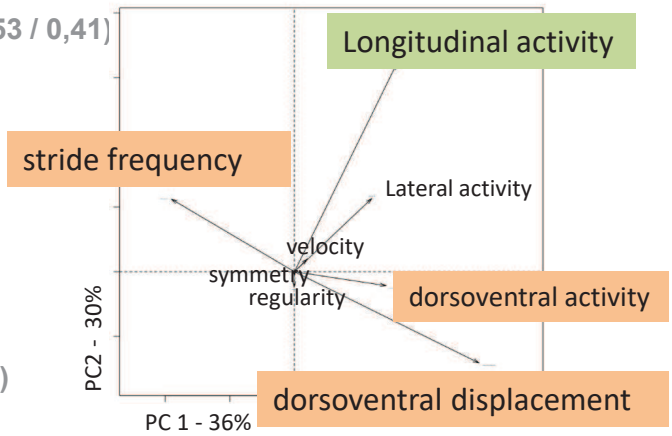
**JUMPING COMPETITION :** annual criteria : sum of points (depending on ranks and technical difficulty) and ranking (depending on competition in the event), All horses with performances in official Jumping Horse Show born from 1997; **160,056** horses; **649,491** annual performances; **352,696** horses in the *pedigree* (4 generations)

# _03
# Results

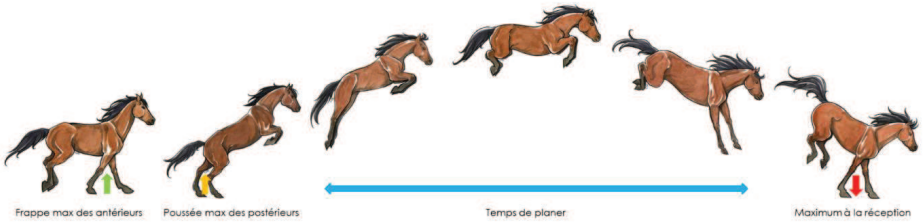


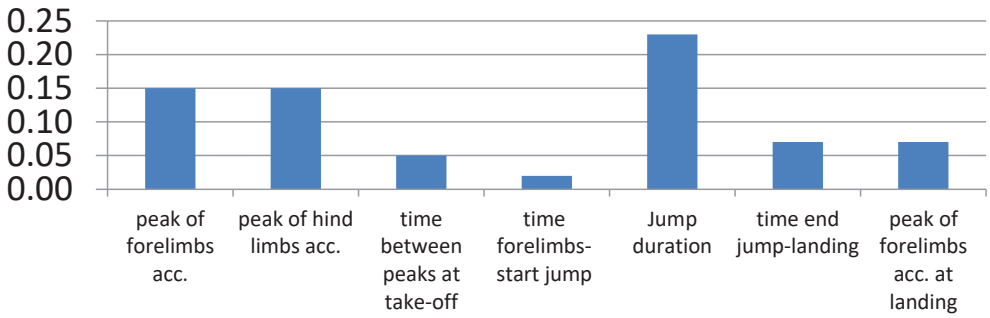
## Heritability of the gait traits

- 3 major traits heritable traits similar for trot and gallop:
  - Stride frequency and vertical displacement (0,53 / 0,41)
  - Longitudinal activity (0,33 / 0,19)
  - Lateral activity (0,11 / 0,07)
- 3 major less heritable traits for walk :
  - Vertical activity and regularity (0,16)
  - Stride frequency and longitudinal activity (0,15)
  - Symmetry (0,09)



# Heritability of free jumping (3 jumps)



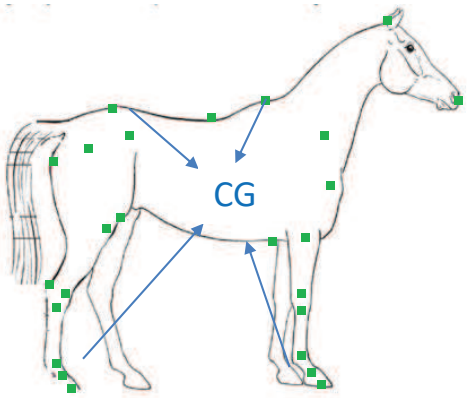



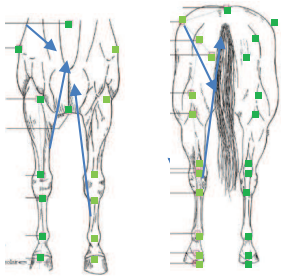



# Analysis of morphology

Advances in Geometric Morphom

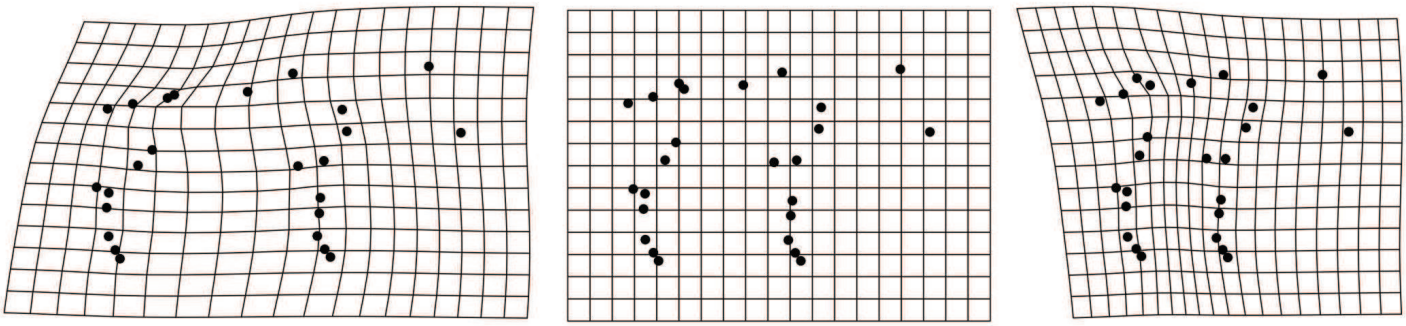
Philipp Mitteroecker · Philipp Gunz



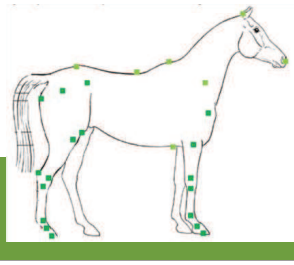
A centroid size is first defined to standardized all horses to the same size, so that a horse is define by
1) his centroid size 2) his shape
This is done in 3D

# Analysis of morphology : sagittal view (1)



← extreme | Standard | extreme →

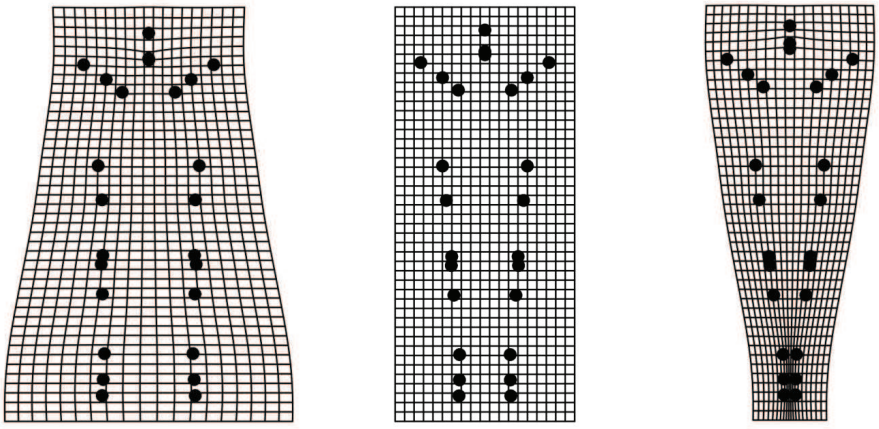
*Longer than taller*
*Sloping shoulder*
*Bent hocks*
*Withers higher than croup*



*Taller than longer*
*Vertical shoulder*
*Strait hocks*
*Croup higher than withers*



# Second component : back view



← extreme | Standard | extreme →

*Spread hind legs*
*Valgus*

*Tied hind legs*
*Varus*

# Heritability of morphology

heritability of centroid size : 0.18

heritability of the different components : 0.06 to 0.25

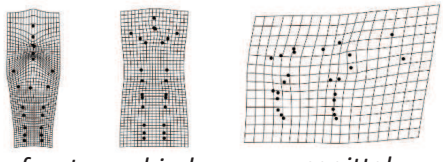


# Genetic correlation with jumping performance

- **Gaits** : only the longitudinal activity at canter was negatively linked to jumping results in competition, representing loss of power with variation of speed (acceleration / deceleration) during canter to maintain regular speed (-0.22)

- **Morphology** : only global format (0.28) and weak correlation with large shoulders (0.05)

*Large at shoulders*
*Neck in high position*



*front* *hind* *sagittal*

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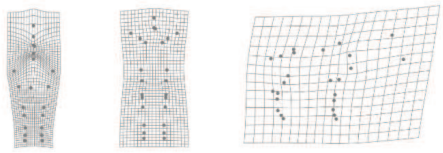

*front* *hind* *sagittal*

- **Free jumping** : High genetic correlation between jump duration (equivalent to height jumped) and results in competition **(0.60)**
  -> this is a possible impartial trait for selection for jumping



# In process…

- Correlation with linear profiling and judgment of breeding show
  - Judgment and linear profiling are efficient tools for sport breeding
  - Impartial measurement can be used to explained subjective and efficient judgments
  - Heritability/genetic correlation are less biased by involuntary information owned by the judges (knowledge of the quality of the sire, breeders etc…)

- Genomics evaluation and markers detection

# Conclusion

- Breeding values for these objective characteristics of gait and morphology can be made.
  - In-process automation of all procedures
- Little relationship between gaits - morphology and performance in competition
  - This is good news: it is possible to choose/select a horse with gaits and morphology adapted to the different riders without losing on the aptitude for show jumping.
- Free jumping can be a useful early criterion for the selection of the jumping horse and can be objectified



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