

## GaitLab 小動物步態分析系統

**ViewPoint**  
Behavior Technology



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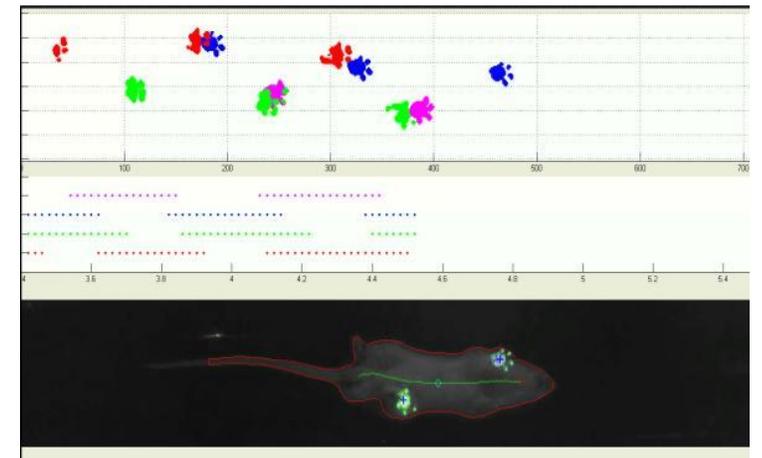
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# GaitLab自動化定量嚙齒類動物步態的分析系統

- GaitLab研究解決方案
- 疼痛研究 Pain:藥物開發/發炎反應/骨癌/
- 帕金森氏病/阿茲海默症/亨丁頓舞蹈症 Parkinson's disease/Huntington's disease
- 周邊循環缺血疾病/小腦運動功能
- 中風/腦部損傷 Stroke/Traumatic brain injury
- 神經損傷/神經毒性 Nerve injury/Neurotoxicity
- 關節炎/肌腱炎 Arthritis
- 脊髓損傷 Spinal Cord injury
- 運動缺陷 Muscular dystrophy/Multiple Sclerosis
- 發育缺陷 Developmental abnormalities
- 可依據您感興趣的領域進行不同數據的評估(動物行走速度，腳印間距，爪子面積，平均強度等...)



## 傳統測量方式-步態/疼痛

- Footprint analysis (inking)

- BBB score

- Von Frey filaments

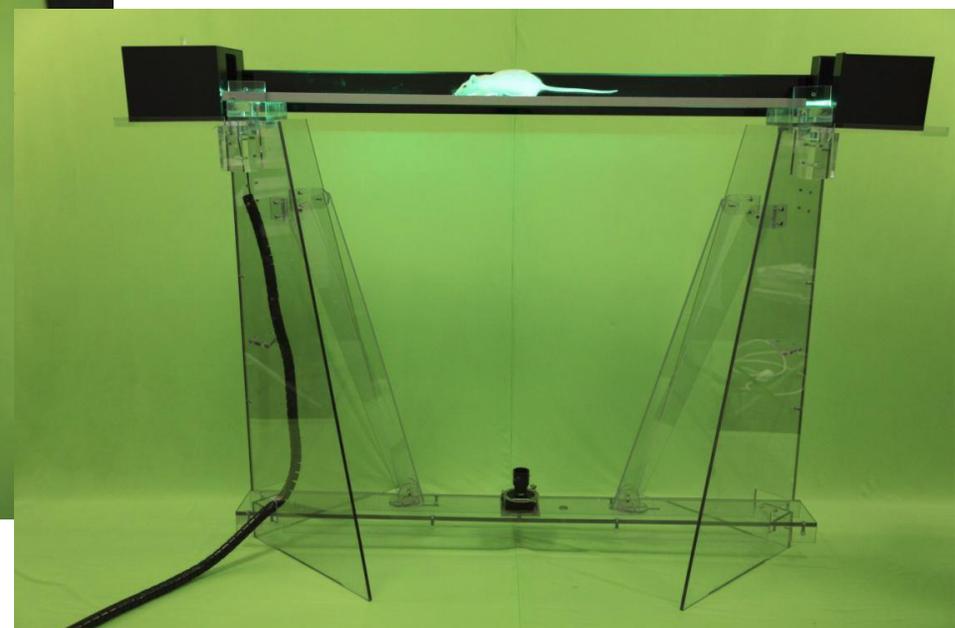
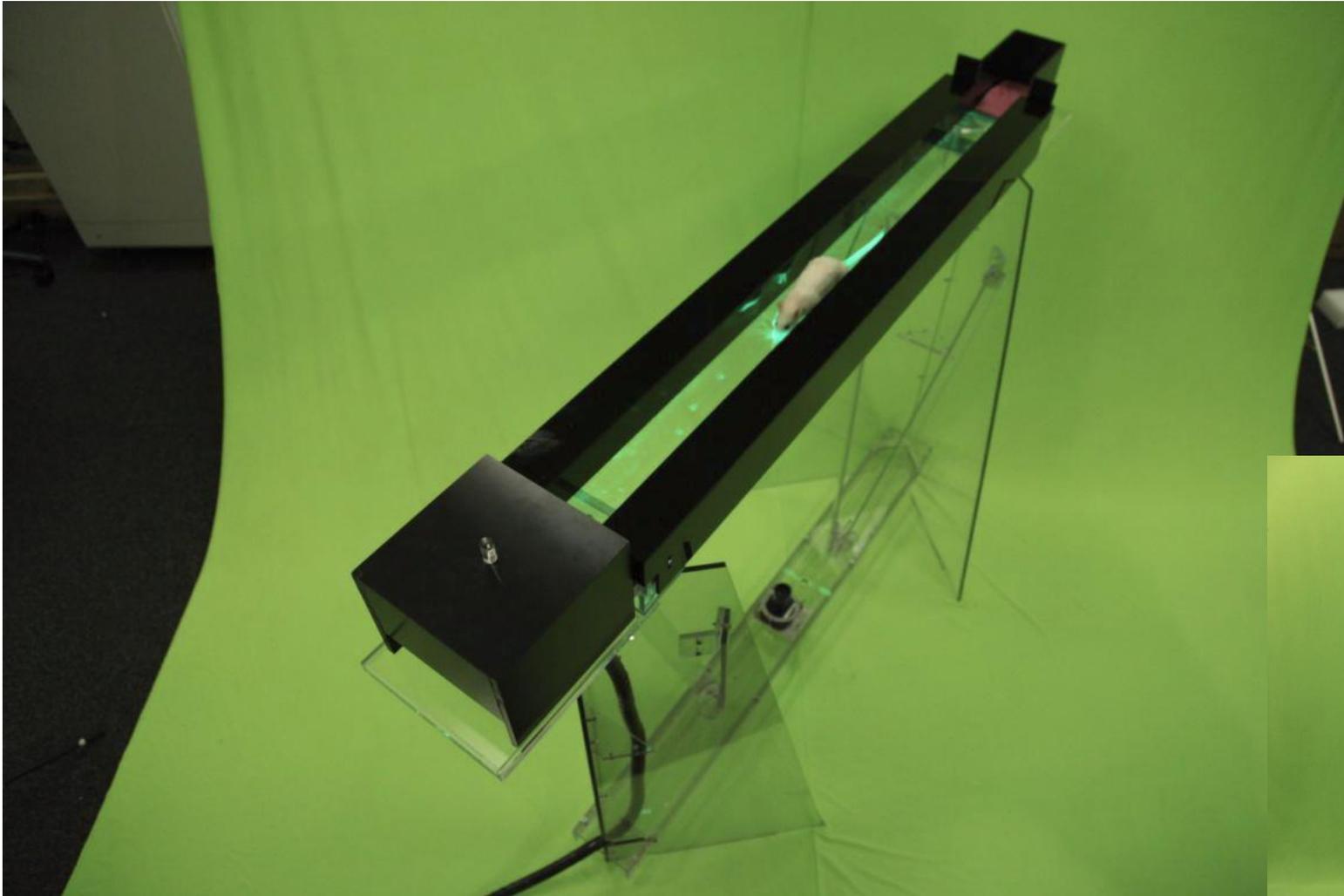
- Tail flick test

- Hargreaves test

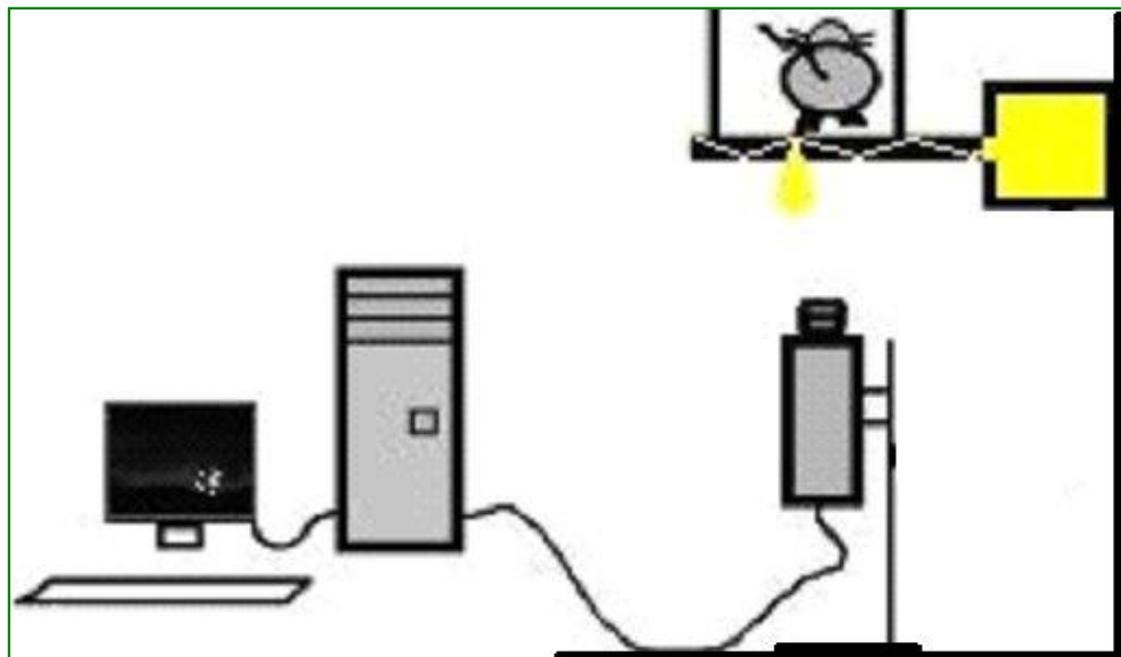
**Gait analysis**

**Touch-evoked pain**

**GaitLab**

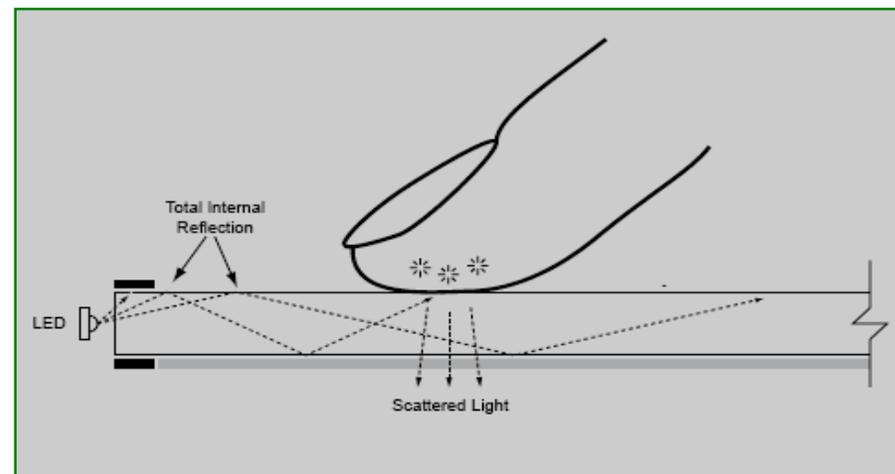


# 原理



格林科技有限公司 2020/9/29  
GERIN Technology Co.,Ltd.

- 當動物腳掌接觸到玻璃光線的反射/折射率改變  
光線向下透
- 使用高速攝影機捕捉
- 電腦軟體紀錄與全自動分析

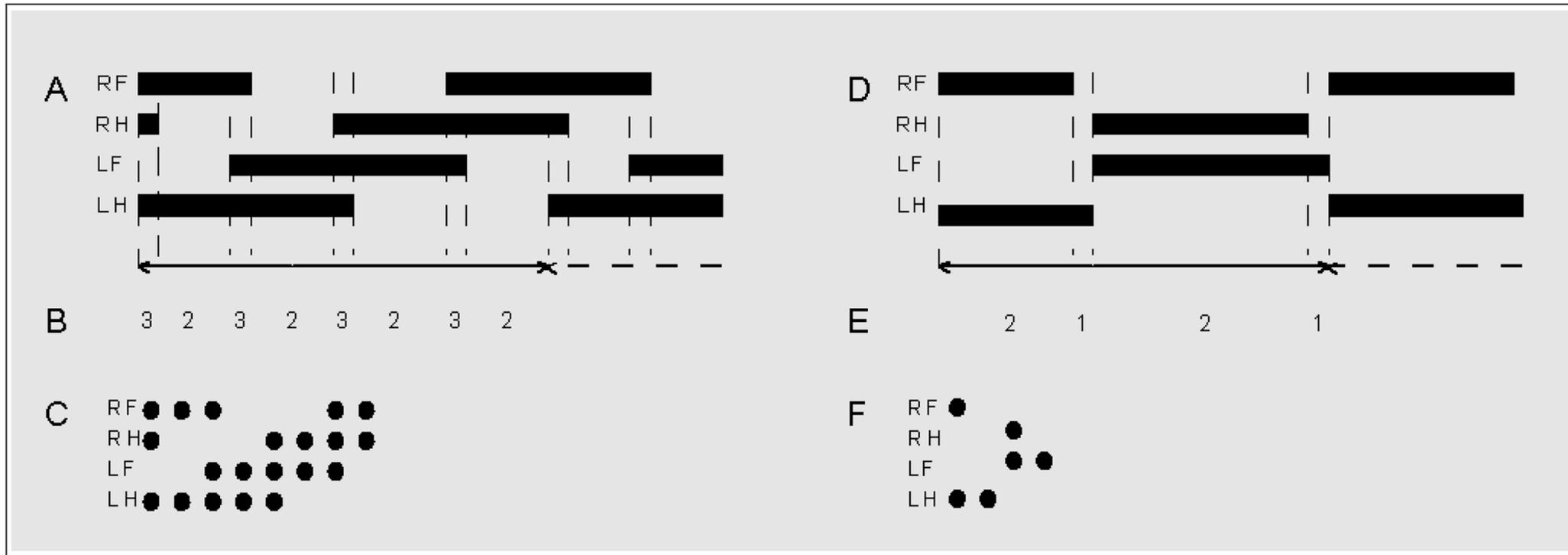


## 特點

- 原始影片與數據皆儲存，可重複分析/驗證
- 足印分析精確（可分析着地力度）
- 跑道長度：125cm，有效檢測範圍0-120cm，高度105cm，適合使實驗者更方便的觀察。
- 目標箱:跑道另一端設有誘惑老鼠的目標箱，可用來吸引老鼠
- 跑道為無頂蓋設計，以方便實驗及時操作和擴展同步做其他的實驗，方便清潔。
- 高速紅外線攝影機:專業的近紅外攝像頭位於跑道下方，實驗可以按動物的習性在黑暗的情況下清晰的捕捉到動物的爪印，以避免燈光對動物的刺激，影響實驗資料
- 即時偵錯:依照動物移動速度判斷數據可信度(即時提醒)，讓使用者可重新進行實驗操作。



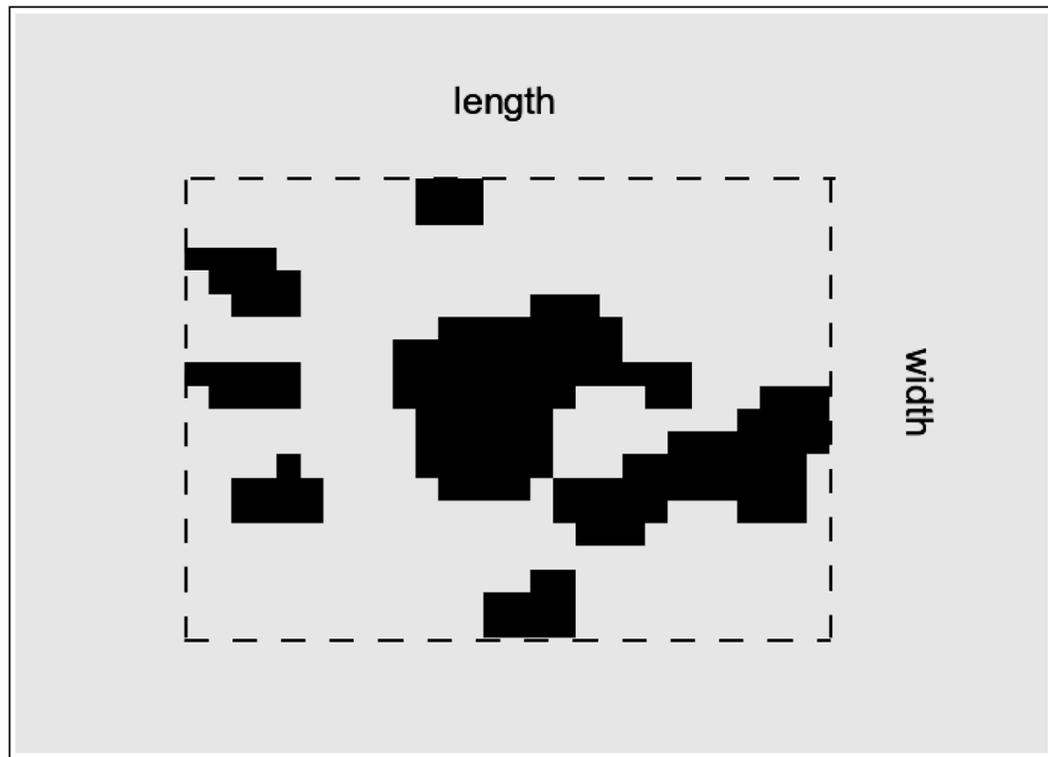
# 布態參數介紹 Gait diagram



- Two examples of gait diagrams for a walking (A–C) and trotting (D–F) animal together with the corresponding support and gait formulas. A and D are the gait diagrams, B and E are the support formulas, and C and F are the gait formulas.
- Both diagrams start at initial contact (IC) of the LH limb and end at next IC of the same limb. Note that in the first example support and gait formulas contain 8 different stance phases, whereas in the second example only four of these are present.

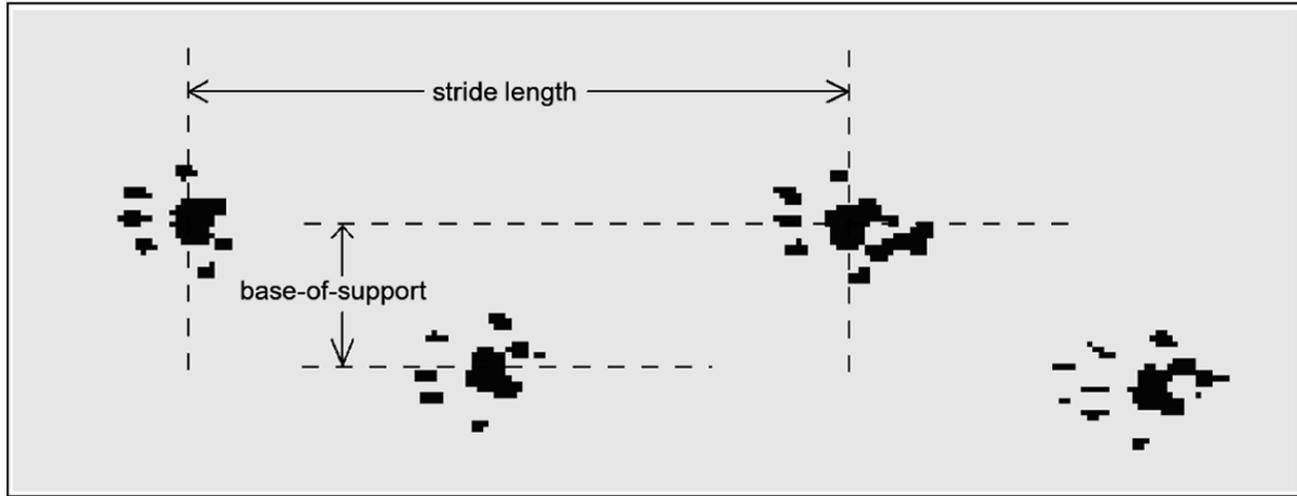


## 腳掌接觸面積 Foot Print contact area



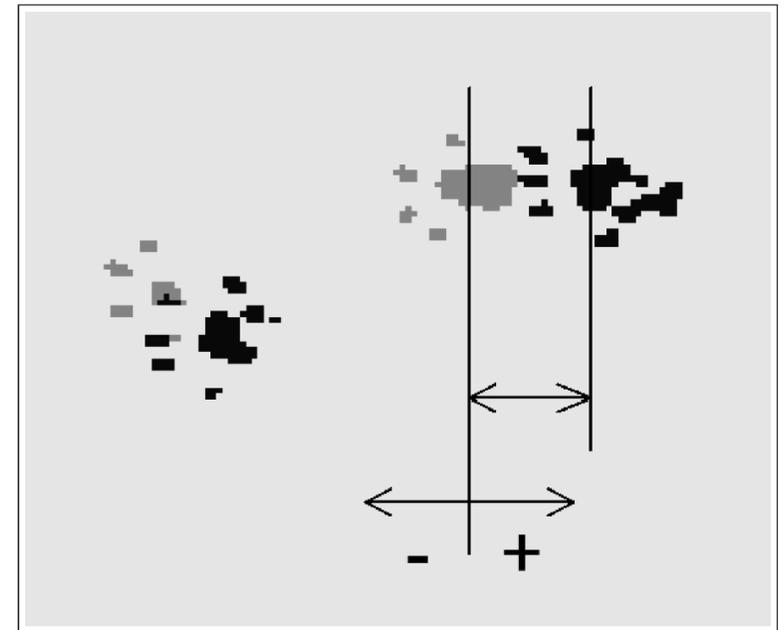
- 腳掌接觸面積
- 長x寬
- 當動物疼痛會習慣性地收縮腳掌，面積變小

# 步距與足底支撐 Stride length and base support



Stride length and base-of-support. For computation hereof, centers of mass of the prints are used.

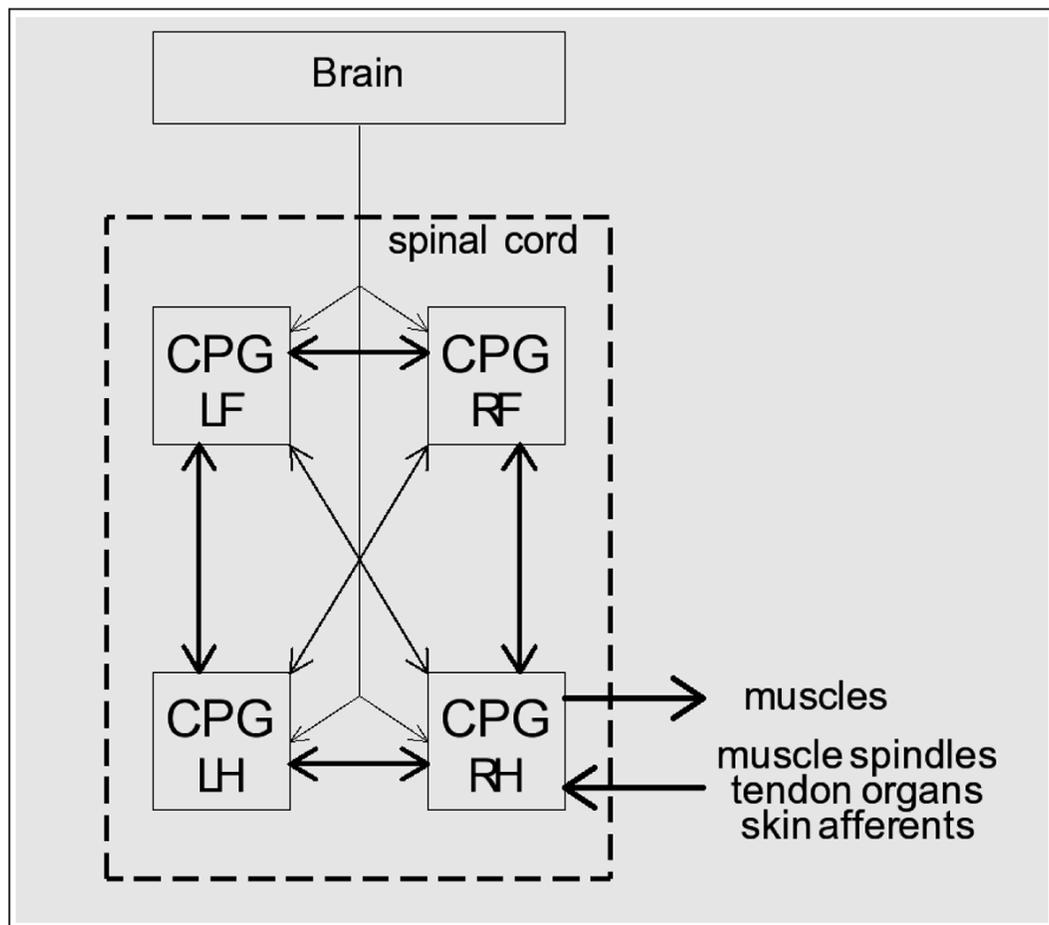
## Relative positions of fore- and hindpaws



**FIG. 8.** Relative positions of fore- and hindpaws. Hindpaw position is related to the previous forepaw position as indicated (note that the relative positions of the centers of mass of the prints are used, and not those of the toes). If the hindpaw is placed (partially) after the forepaw, the distance is positive; otherwise, it is negative.



# 步態特性 Step Patterns



## 中樞神經系統

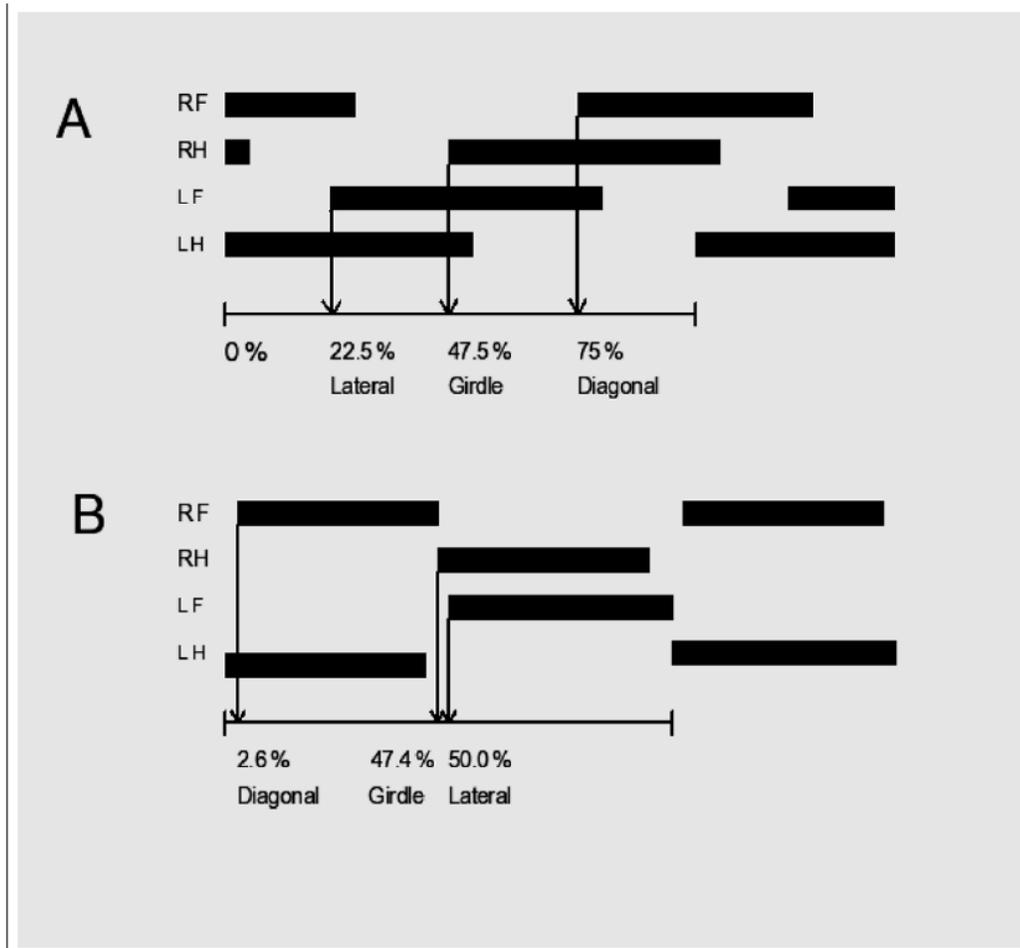
### Coordination of movements by the central nervous system (CNS)

<i>Category</i>	<i>Abbreviation</i>	<i>Sequence</i>
Cruciate	Ca	RF-LF-RH-LH
	Cb	LF-RF-LH-RH
Alternate	Aa	RF-RH-LF-LH
	Ab	LF-RH-RF-LH
Rotate	Ra	RF-LF-LH-RH
	Rb	LF-RF-RH-LH

<sup>a</sup>A graphical representation is provided in Figure 4. (Cheng et al., 1997).



## 相位延遲 Phase Lag



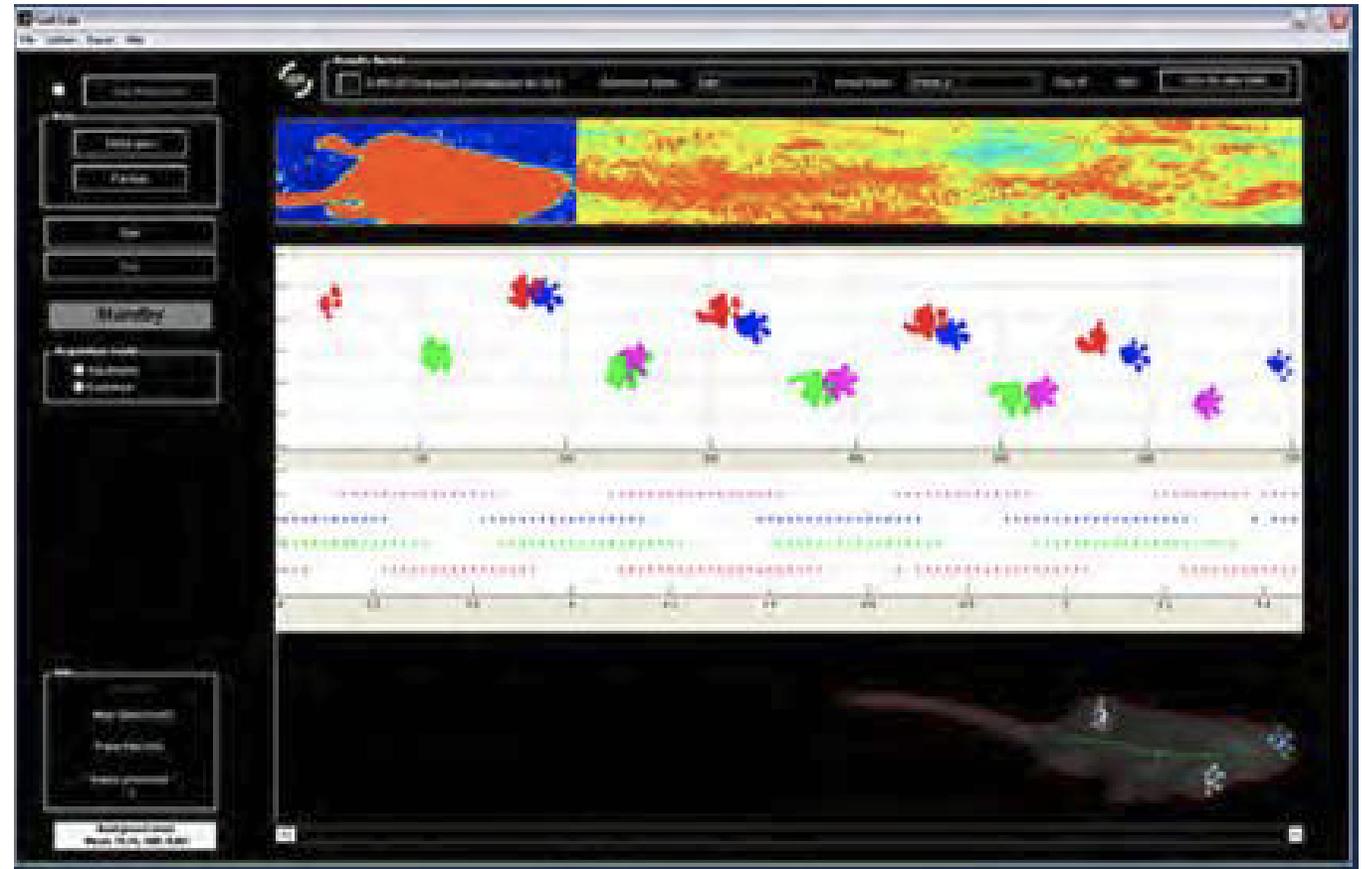
- Phase lags 使用左後肢the left hindpaw (錨點) (Kloos et al., 2005)
- 正常走路狀態phase lags數值約在 25% 與 75%,
- 小跑步會達到 50% 與 0%.



# GaitLab全自動分析數據

包含:

- 1.步態分析數據
- 2.步態順序
- 3.腳掌(每一肢)壓力數據
- 4.足印寬度/長度
- 5.幾隻腳指
- 6.時間順序

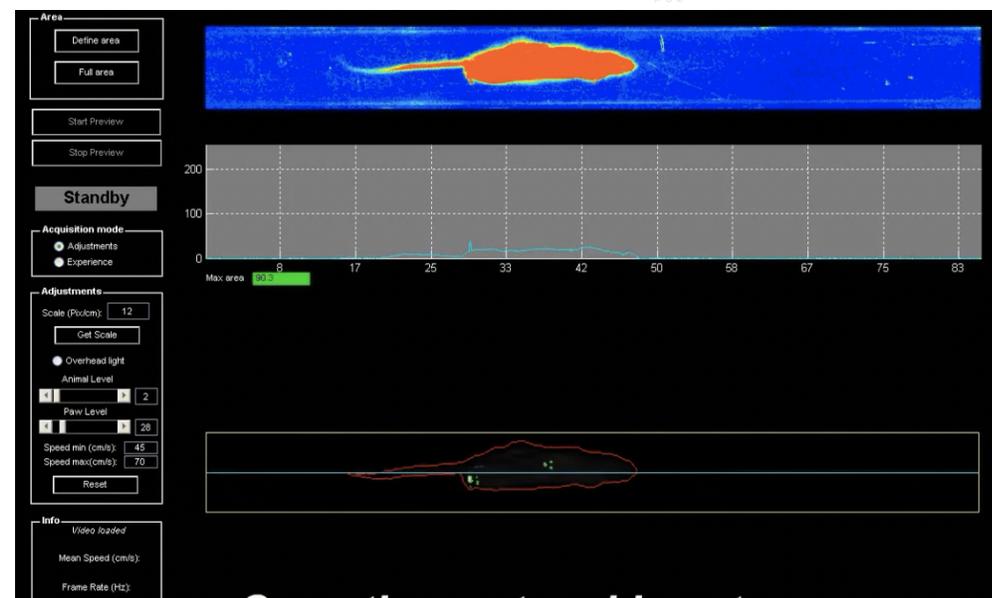
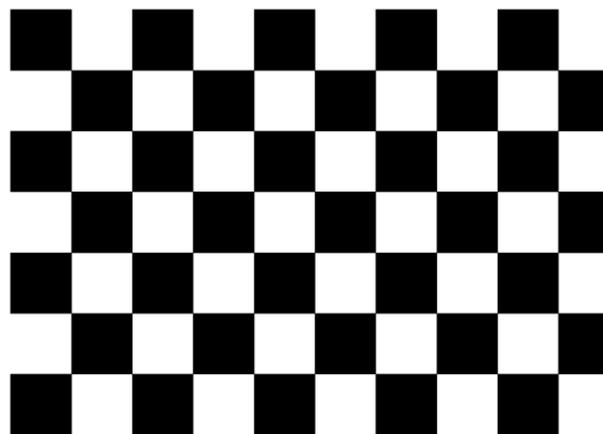




## 調整及校正

### 第一次使用

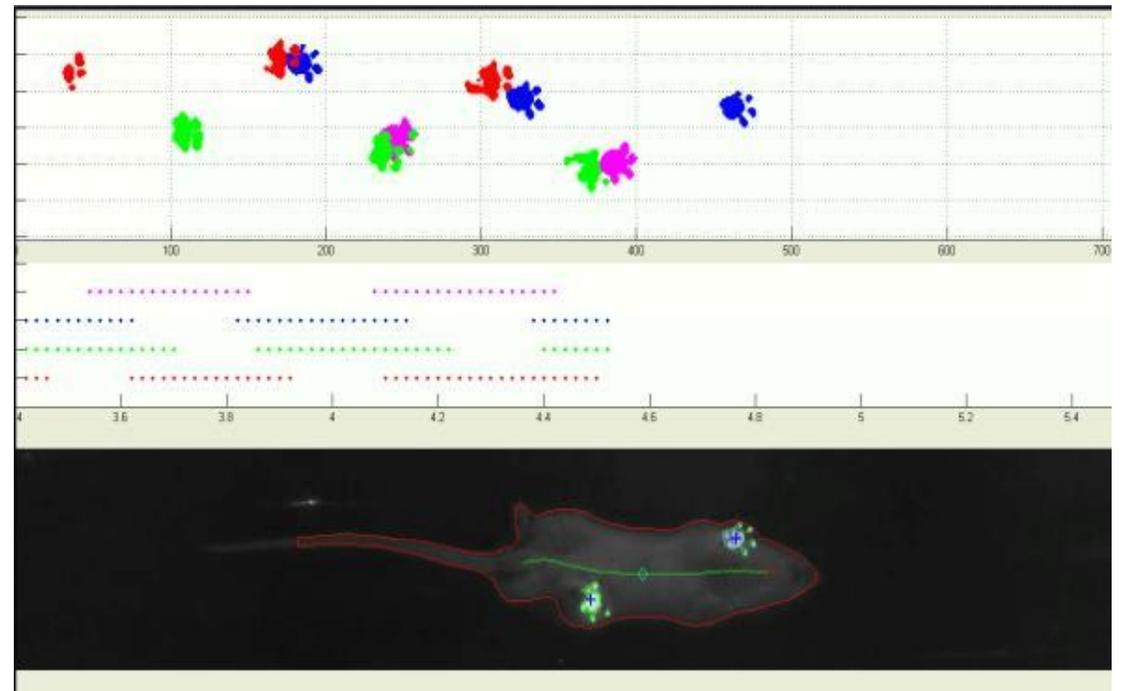
- 攝影機焦距
- 把標準方格紙放置在走道上，得到清晰的格子
- 選擇Adjust->Get Scale  
A4 -> 29.7cm





## 實驗前準備

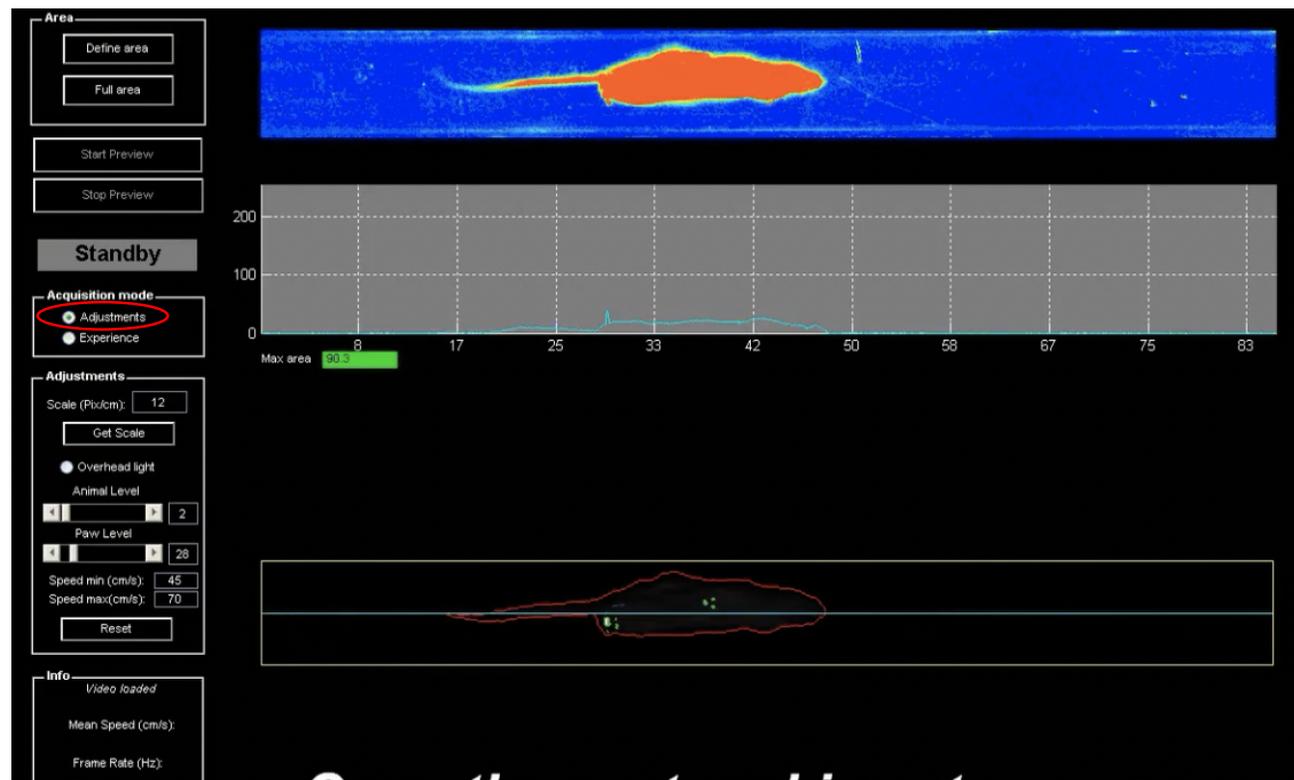
- 動物需要訓練/練習走步道(在目標箱放置食物/墊料)->動物是否等速前進
- 出發端放濕紙巾,加濕腳掌





# 調整分析參數

- 先開啟存檔影片(或讓動物重新走過走道錄影)
- 點選Adjustments
- 調整Animal Level->得到清楚的動物邊緣
- 調整Paw Level->得到清楚的腳印
- 完成設定
- 點選Experience
- 再點Start->軟體開始自動分析



# 即時驗證動物數據

**Gait Analysis**  
File Options Report Help

Results Names  
C:\data\demo Gait Experience Name: Animal Name: 2020/9/29 Trial N°: 0001 Go to the data folder

Area  
Define area  
Full area

Start  
Stop

**No Camera**

Acquisition mode  
 Adjustments  
 Experience

Info  
Impossible to set the light intensity  
Mean Speed (cm/s):  
Frame Rate (Hz):  
Images processed:

**GaitLab presentation**

# 分析步態參數

- 選取要分析影片(可選取10個以上影片檔案)
- 點Start->軟體開始自動分析
- 依照移動速度是否等速，軟體會驗證數據是否良好(預設值Conformity>97%以上)
- 點選Yes,數據驗證





## 數據/群組分析

- 軟體可以將多個數據分析，計算平均值，邊準差
- 群組分析:可以對照兩組實驗，對照觀看數據
- 有步態數據、腳掌壓力數據等
- 可以比對移動速度，四肢分別的數據
- 數據皆可輸出到Excel

The screenshot displays the Gait Analysis software interface. The main window is titled "Gait Analysis" and contains several panels:

- Area:** Includes buttons for "Auto Background", "Define area", and "Full area".
- Start/Stop:** Buttons for "Start" and "Stop".
- Standby:** A button labeled "Standby".
- Acquisition mode:** Radio buttons for "Adjustments" and "Experience".
- Info:** Displays "BackGround ok", "Mean Speed (cm/s)", "Frame Rate (Hz)", and "Images processed: 1".
- Background level:** Shows "Mean: 1.27, Std: 0.83".
- Results Names:** Fields for "Experience Name: FRat", "Animal Name: FRat0", and "Trial N°: 0004".
- Results:** A sub-window with tabs for "Gait parameters", "Dynamics parameters", and "Operation". It shows:
  - Results displayed:**
    - Gait Parameters: Speed min (cm/s): 45
    - Dynamics Parameters: Speed max(cm/s): 70
    - Mean number of valid strides per paw (group1): 0
    - Mean number of valid strides per paw (group2): 0
  - Refresh:** A button to update the data.
  - Color-coded indicators:** A vertical stack of colored boxes (pink, blue, green, red) labeled "R", "L", "R", "L".

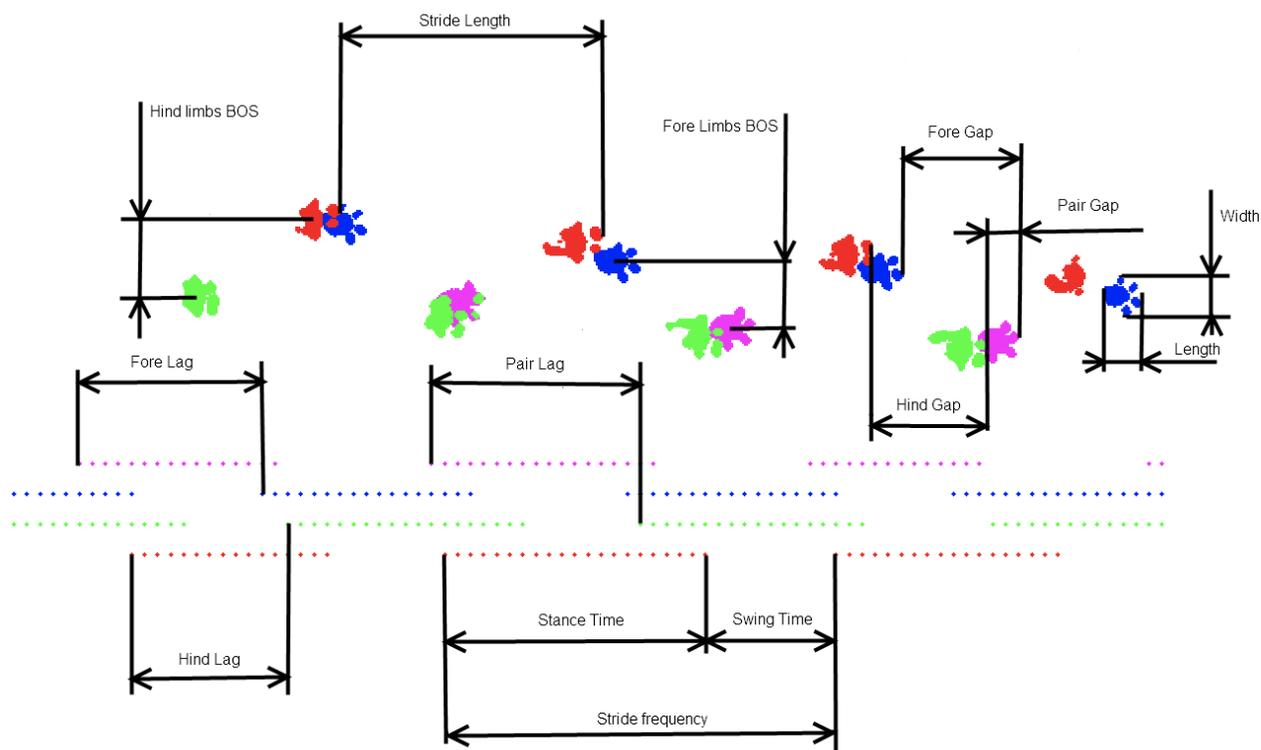


# 特點

- 大鼠/小鼠一鍵切換分析。可自己設置動物的速度範圍，以便記錄自己所需要的實驗資料
- 資料對比-可進行多個實驗對比分析，並可用圖表顯示不同資料的對比結果。
- 記錄重播-軟體可以重播、慢鏡實驗錄影。可對動物的每次步伐進行重播，並可通過修改動物速度範圍以得到不同的資料結果
- 快速紀錄-自動開始停止，10 分鐘內快速記錄 16 個動物的步態
- 群組數據分析-統計功能
- 數據匯出



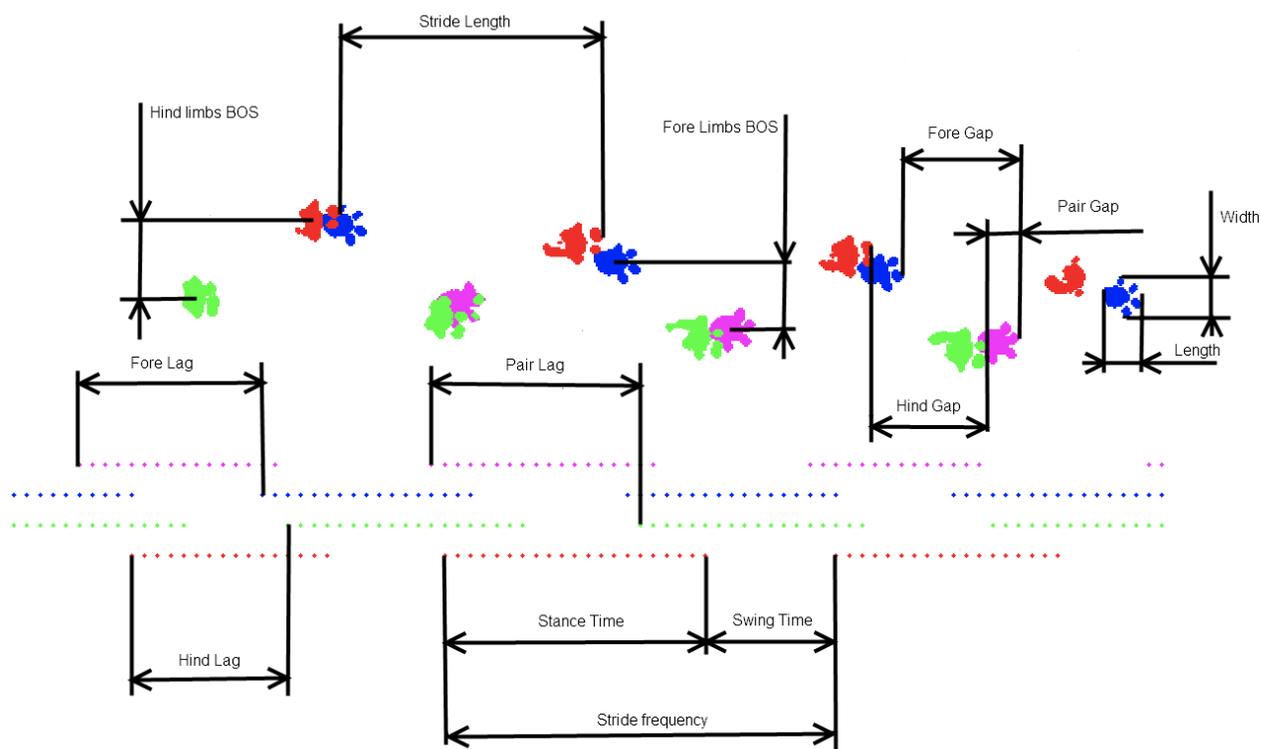
# 小動物步態分析系統參數 \_Gaitlab result parameters



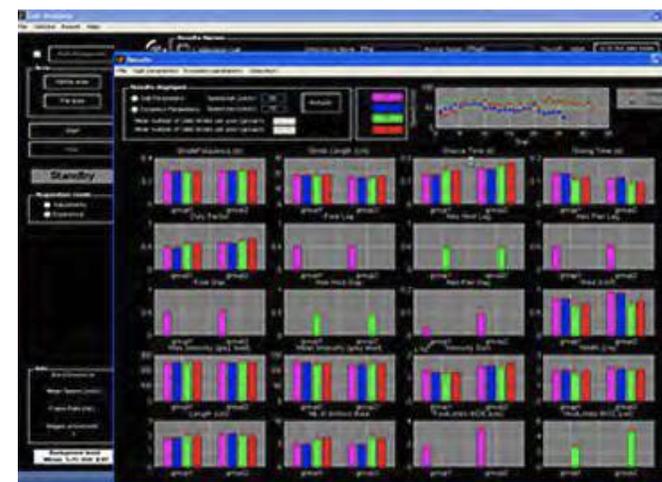
- 1. Hind limbs BOS 後肢間距 \_
- 2. Fore Lag 前肢延遲 \_
- 3. Hind Lag 後肢延遲 \_
- 4. Pair Lag 一對足的延遲 \_
- 5. Stride Length 步長 \_
- 6. Stride frequency 步頻 \_
- 7. Stance Time 觸地時間 \_
- 8. Swing Time 擺動時間 \_
- 9. Fore Limbs BOS 前肢間距 \_
- 10. Fore Gap 前肢距離 \_
- 11. Hind Gap 後肢距離 \_
- 12. Pair Gap 一對足距離 \_
- 13. Width 足印寬度 \_
- 14. Length 足印長度 \_
- 15. Duty Factor 觸地時間與步頻的比值 \_
- 16. Abs Hind lag 絕對後肢延遲 \_
- 17. Abs Pair Lag 絕對一對足的延遲 \_



# 小動物步態分析系統參數 \_Gaitlab result parameters



- 18. Abs Hind Gap 絕對後肢距離
- 19. Abs Pair Gap 絕對一對足距離
- 20. Area 足印面積
- 21. Max Intensity 最大力度
- 22. Intensity Sum 力度總和
- 23. Mean Intensity 平均力度
- 24. Nb of distinct Area 足印區域數





Thanks for your attention