Development and validation of an embedded tool to measure postural activity of lactating sows

Laurianne CANARIO, Yann LABRUNE, Mathieu BONNEAU, Yvon BILLON, Laure RAVON, Sébastien REIGNIER, Jean BAILLY, Jean-François BOMPA, Edmond RICARD

laurianne.canario@inra.fr

Longitudinal study of Sow postural activity
Time spent in different positions **LR, LL, LV, SI, ST**

Change in **time budget**

⇔ Welfare and Health issues

- Farrowing difficulties -> lying
- Unwillingness to nurse -> lying ventrally
- Post-farrowing restlessness -> sitting + standing crushing of piglets
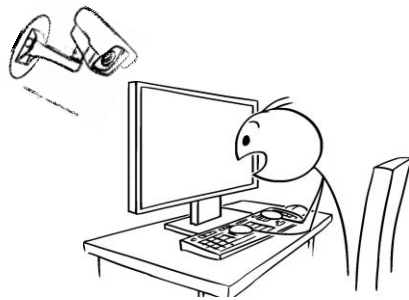- Lameness -> latency to lie down

Objective

powerful tool to measure automatically sow postural activity

Question

Can a (combination of) <u>sensor(s)</u> provide accurate information on sow time budget ?
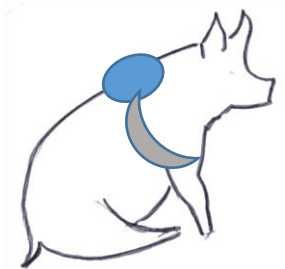
Sources of information

SENSOR DATA FUSION

or/and?
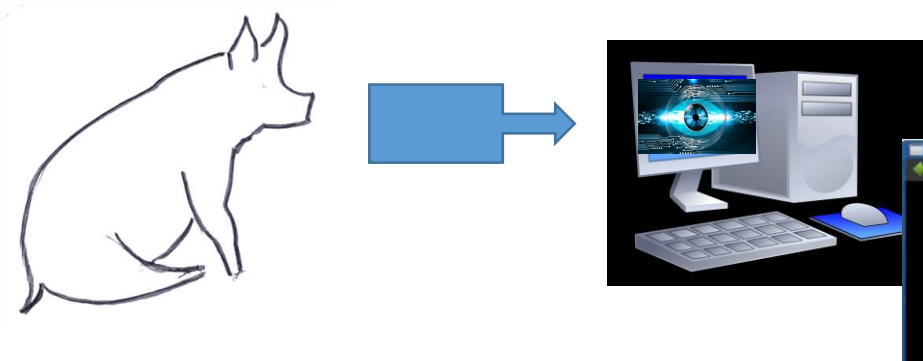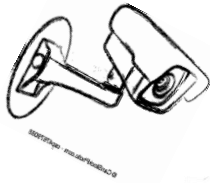
vs

| Human vision | Computer vision | Embedded accelerometer |

Methodology 1 – visual assessment

1. Human video analyses : gold standard
LR, LL, LV, SI, ST
2. Automatic video image analysis

14 variates

area=68860
majoraxi=414.6708
minoraxis=229.9688
orientation=-1.5011
eccentricity=0.83213
equivdiamsquarred=87675.2751
extent=0.69351
perimeter=1869.8519
Minor/Major=0.55458
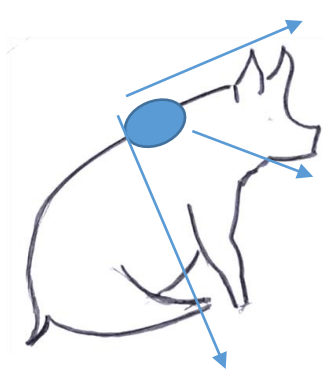width=241
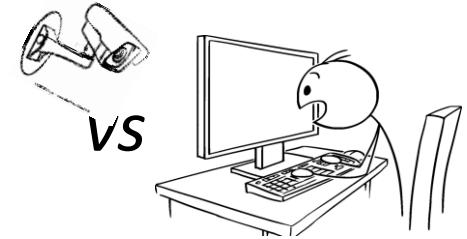height=412
SumLeft=31936
SumRight=41

0:29 / 6:54
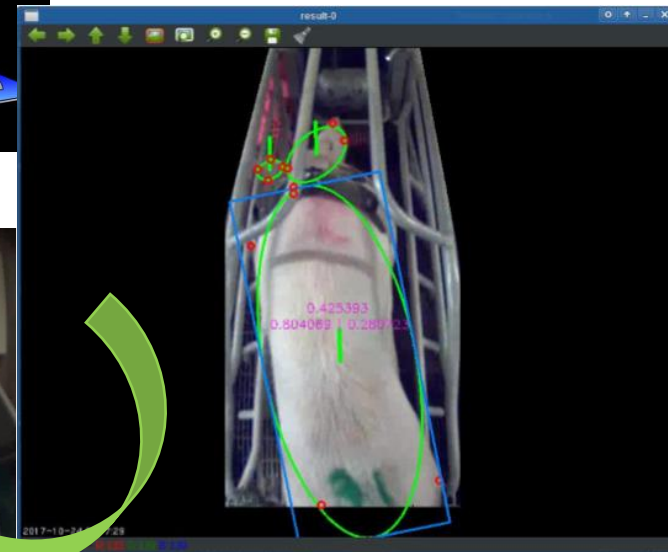
13 images / sec

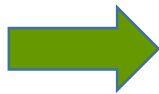# Methodology 2 – embedded accelerometer

3 axis variates (x, y, z)

vs
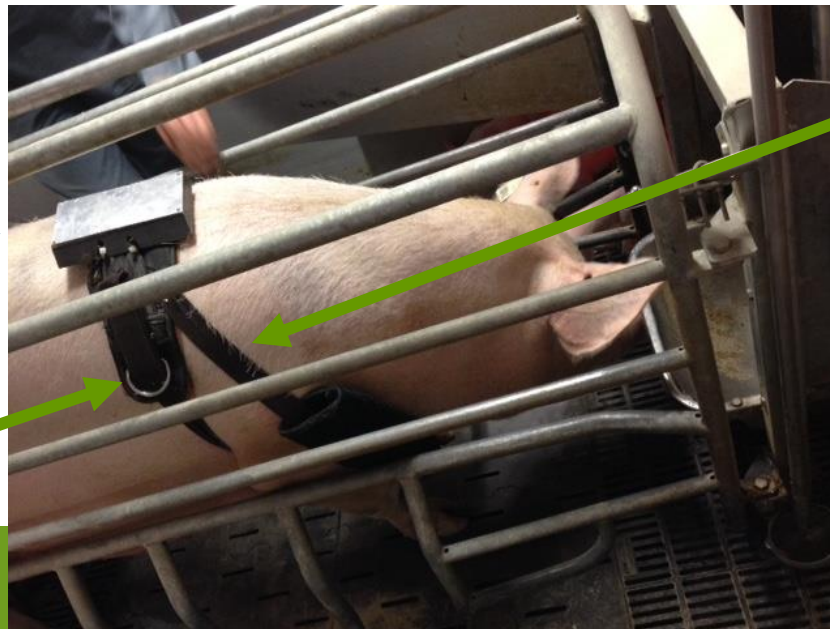
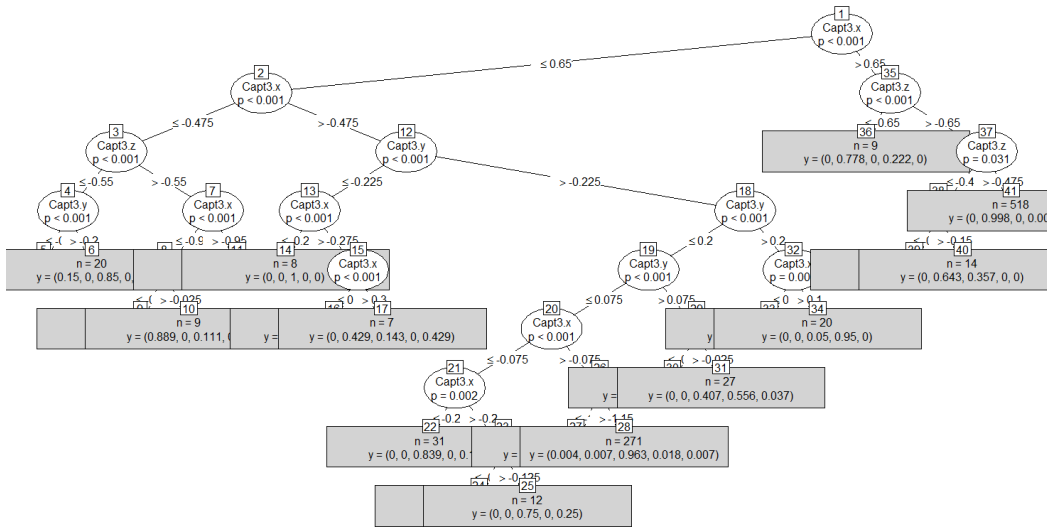Custom-built belt: adjusted to avoid friction in long term => girthes

Metal box holding 1 to 3 accelerometers

Bilateral fasteners

INRA
SCIENCE & IMPACT

Statistical validation

Calculations
For each position
- Sensitivity
- Specificity
Global prediction error rate

Machine learning
Random forest
Sensors *vs* real behaviour

Trial 1: 70% training data
30% test data
800 trees
Accel. 1 obs / 10-30 sec

Trial 2: 30% training data
70% test data
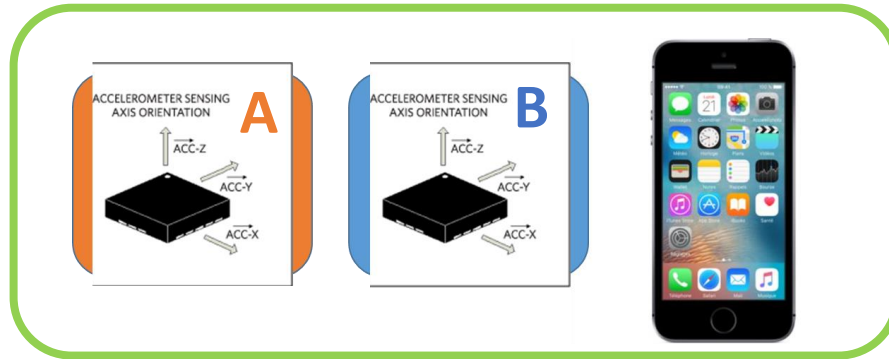500 trees
Accel.+image   1 obs / sec

R software, Random Forest Package

Results – Accelerometers   Trial 1

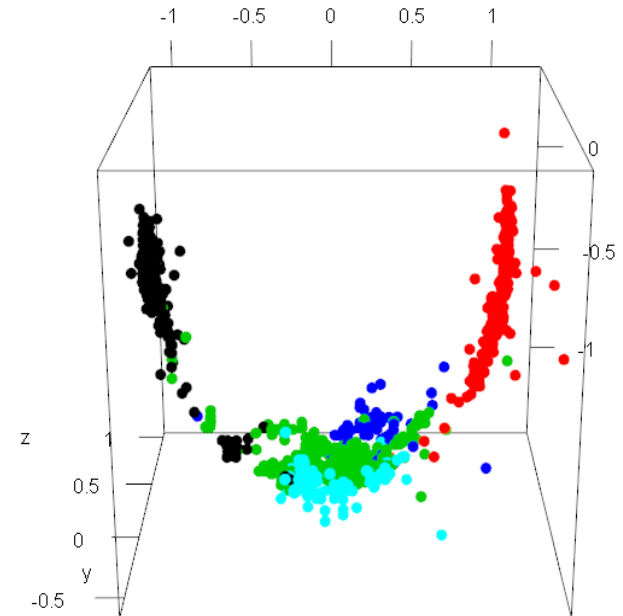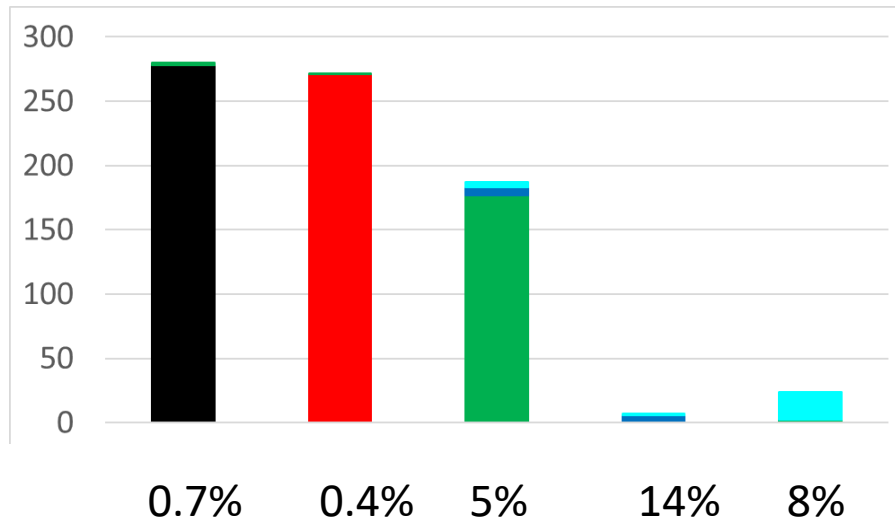STEP 1

A   B

Detection error rate

2.08%   3.11%   4.81%

1 obs / 30 sec
24h

● Lying right side LR 38%
● Lying left side   LL   34%
● Lying ventrally LV 22%
● Sitting   SI   2%
● Standing   ST   4%

0.7%   0.4%   5%   14%   8%

Results – Accelerometers

Accel. A power of detection

STEP 1

A

B
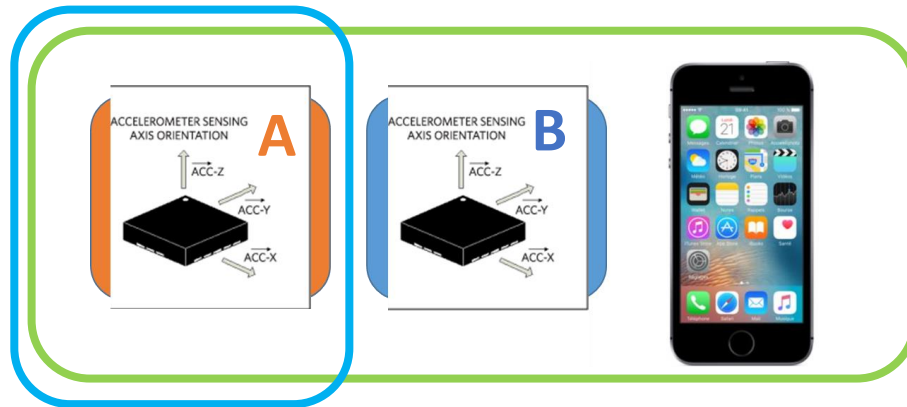
STEP 2

N=5 sows
1 obs / 10 sec

Position	% time	Sensitivity	Specificity
LR	28.83	0.96	0.97
LL	35.69	0.96	0.97
LV	20.76	0.87	0.94
SI	4.15	0.19	0.98
ST	10.57	0.65	0.98

Results – Image analysis   Trial 2

N=3 sows   Global error rate
1 obs / sec   1 to 10%

Sensitivity

	SOW 1			SOW 2			SOW 3	
	IMAGE			IMAGE			IMAGE	
LR	1,00			1,00			0,90	
LL	0,92			0,99				
LV	0,80			0,96			0,99	
SI	0,64						0,69	
ST	0,22			0,27			0,96	
Error rate	**9,7**			**1,00**			**8,19**	

Sow 1 - Test Time Budget

4,51   1,89
13,09
30,63
49,88

LR LL LV SI ST

Sow 2 - Test Time Budget

2,84   1,02
51,23
44,91

LR LL LV SI ST

Sow 3 - Test Time Budget

3,34   0,46
28,98
67,23

LR LL LV SI ST
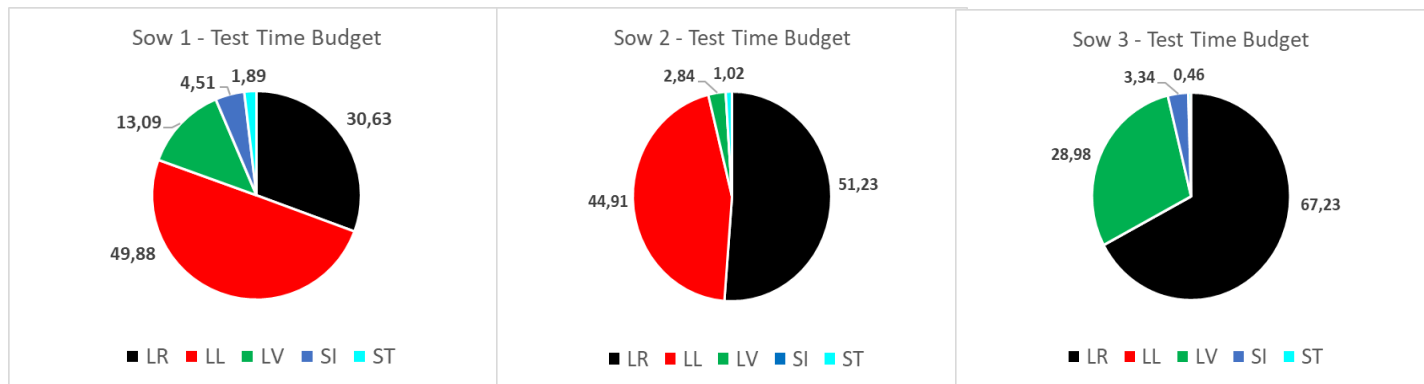
Results – Image vs accelerometer A

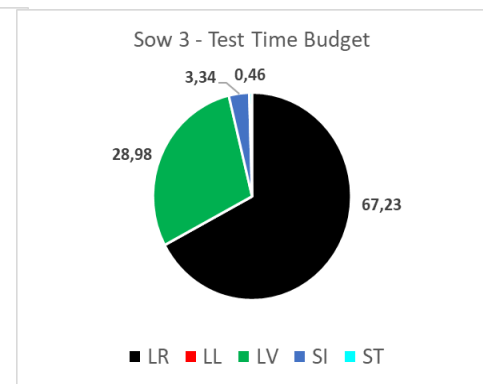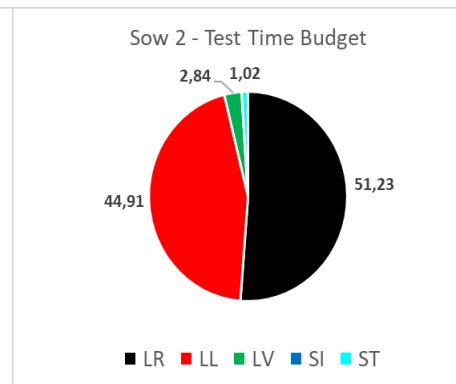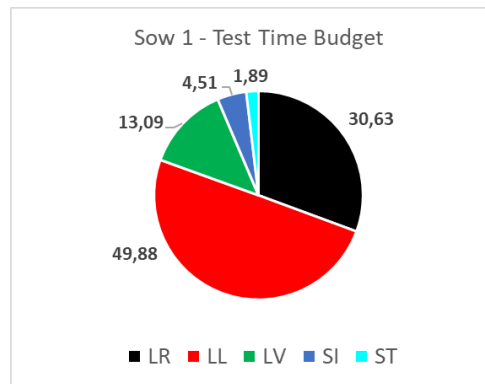|	SOW 1			SOW 2			SOW 3	
	IMAGE	ACCEL		IMAGE	ACCEL		IMAGE	ACCEL
LR	1,00	1,00		1,00	0,96		0,90	0,99
LL	0,92	0,92		0,99	1,00			
LV	0,80	0,56		0,96	0,89		0,99	0,98
SI	0,64	0,27					0,69	0,20
ST	0,22	0,41		0,27	0,77		0,96	0,52
Error rate	**9,7**	**14,0**		**1,00**	**2,40**		**8,19**	**3,89**

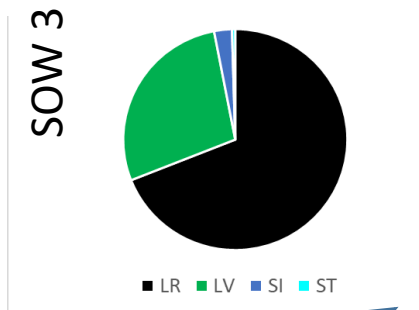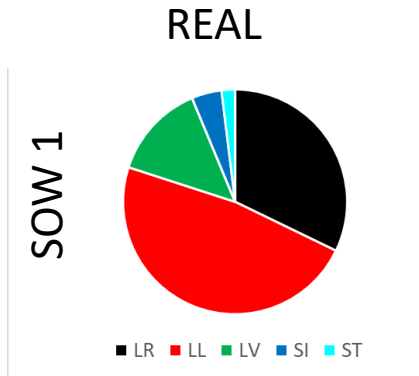Image and accelerometer analyses may reveal different advantages
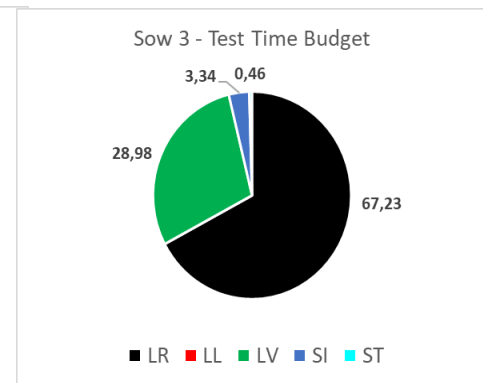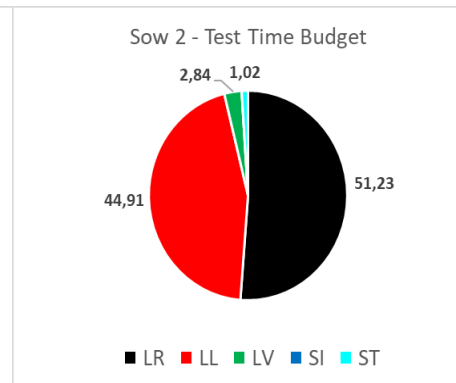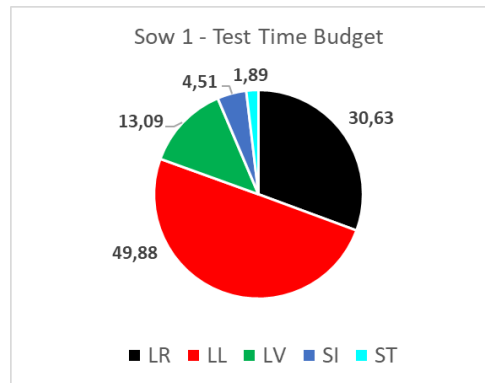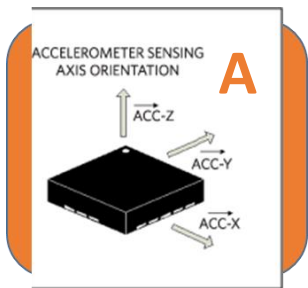
Results – Fusion

	SOW 1			SOW 2			SOW 3		
	IMAGE	ACCEL.	COMBI	IMAGE	ACCEL.	COMBI	IMAGE	ACCEL.	COMBI
LR	1,00	1,00	1,00	1,00	0,96	1,00	0,90	0,99	1,00
LL	0,92	0,92	0,92	0,99	1,00	1,00			
LV	0,80	0,56	0,97	0,96	0,89	0,98	0,99	0,98	0,99
SI	0,64	0,27	0,33				0,69	0,20	0,68
ST	0,22	0,41	0,24	0,27	0,77	0,19	0,96	0,52	0,95
Error rate	**9,7**	**14,0**	**8,5**	**1,00**	**2,40**	**1,00**	**8,19**	**3,89**	**1,35**

Fusion ⇨ gain in capacity of prediction

Accelerometer sensing axis orientation: ACC-Z, ACC-Y, ACC-X. **A**

Sow 1 - Test Time Budget
30,63 · 1,89 · 4,51 · 13,09 · 49,88
LR · LL · LV · SI · ST

Sow 2 - Test Time Budget
51,23 · 1,02 · 2,84 · 44,91
LR · LL · LV · SI · ST

Sow 3 - Test Time Budget
67,23 · 0,46 · 3,34 · 28,98
LR · LL · LV · SI · ST
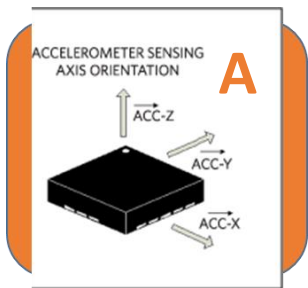
Results – Time budget detection

Test data

REAL

SOW 1

■ LR ■ LL ■ LV ■ SI ■ ST

SOW 3

■ LR ■ LV ■ SI ■ ST

Very good concordance

Conclusion

- Accelerometer harnessment on the upper part of the back = effective to distinguish 5 positions and study time budget

- Accelerometer A: better compromise between detection capacity and system autonomy

- Image analysis leads to meaningful detection of lying positions + sitting

- Sensor data fusion is highly promising

Perspectives

- Validation of sensor data fusion

- on longer records in progress (Trial 1)

- experiment with several sows equipped and filmed simultaneously per batch

- Other phenotypes: time to lying postures related to crushing of piglets, sow lameness

- Multi-sensors approach: larger number of behaviours

- Adaptation for the study of sows in free-farrowing pen
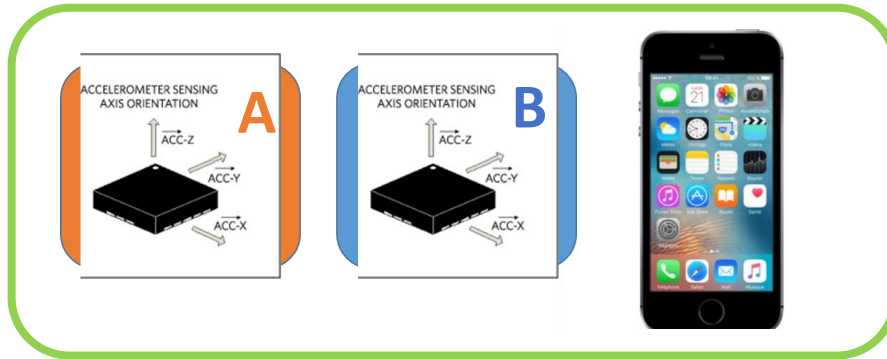
Acknowledgements

CATI SICPA Plateform : Information Systems and Computation for Animal Phenotyping

Pig Experimental Unit – GENESI Le Magneraud

Funding   INRA Animal genetic division

Thank you for your attention

Results – Accelerometers

1 obs / 30 sec

STEP 1