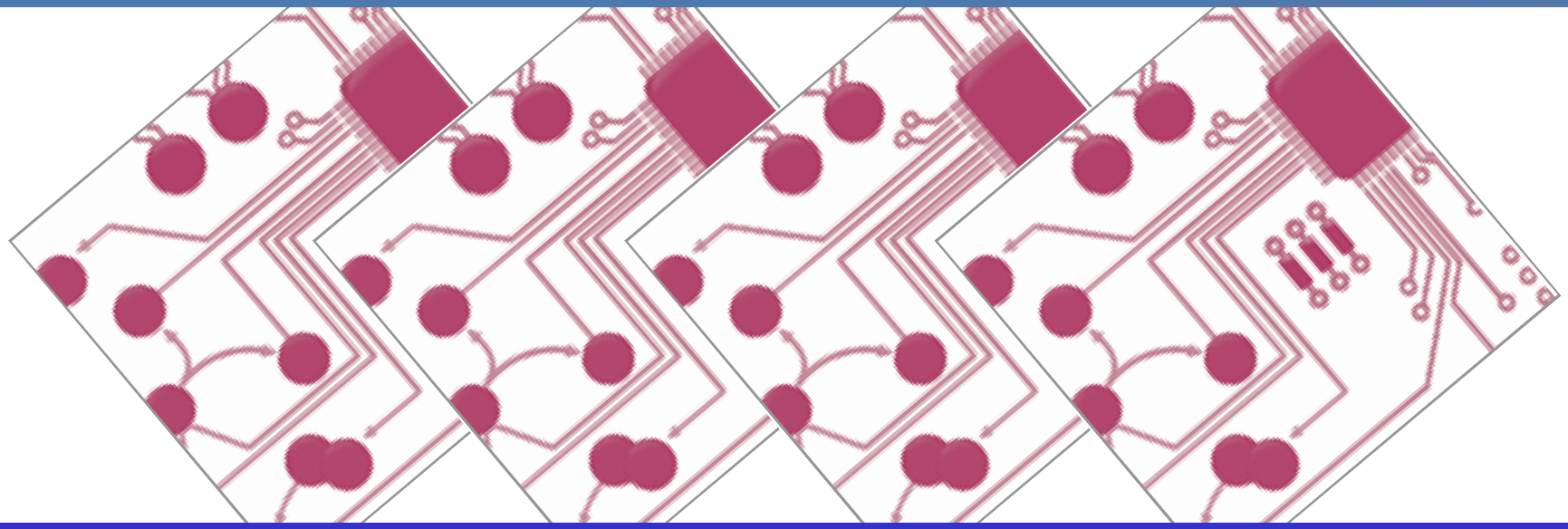
EAAP 2010
61st Annual Meeting of the European Association
for Animal Production
AUGUST 23rd-27th, 2010 - HERAKLION, CRETE ISLAND, GREECE



Innovative technologies for sustainable management of small ruminants (a review)

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Animal identification (AID): Aims

- **Primary: Animal ID systems**
  - **Tamper-proof & permanent ID**
  - **Management of computerized Data Bases**
  - **Animal health programs & traceability**

- **Secondary: Automation and 'precision farming'**
  - **Monitoring (i.e. behavior, physiological traits)**
  - **Performance recording: Milk, weight, herd-flock books**
  - **Management sorting gates**
  - **Feeding stations**
  - **Inventory, etc.**

- Reducing labor time & costs
- Improving data management quality & time

Current European Regulations on animal identification & registration: Sheep & goat

- **Regulation CE 21/2004: Sheep & goat**
  - **Art. 2: All S&G after 6/1/2005, ...shall wear 1 ear tag + 2nd device at >6 mo of age or before leaving the farm where it was born.**
  - **Art. 9: 2nd device: Compulsory use of e-ID after 1/1/2008 (if > 0.6 Million animals).**

Spain (27 Million): Started in 1/1/2006 (RD 97/2005) ☐

- **Decision CE 1560/2007**

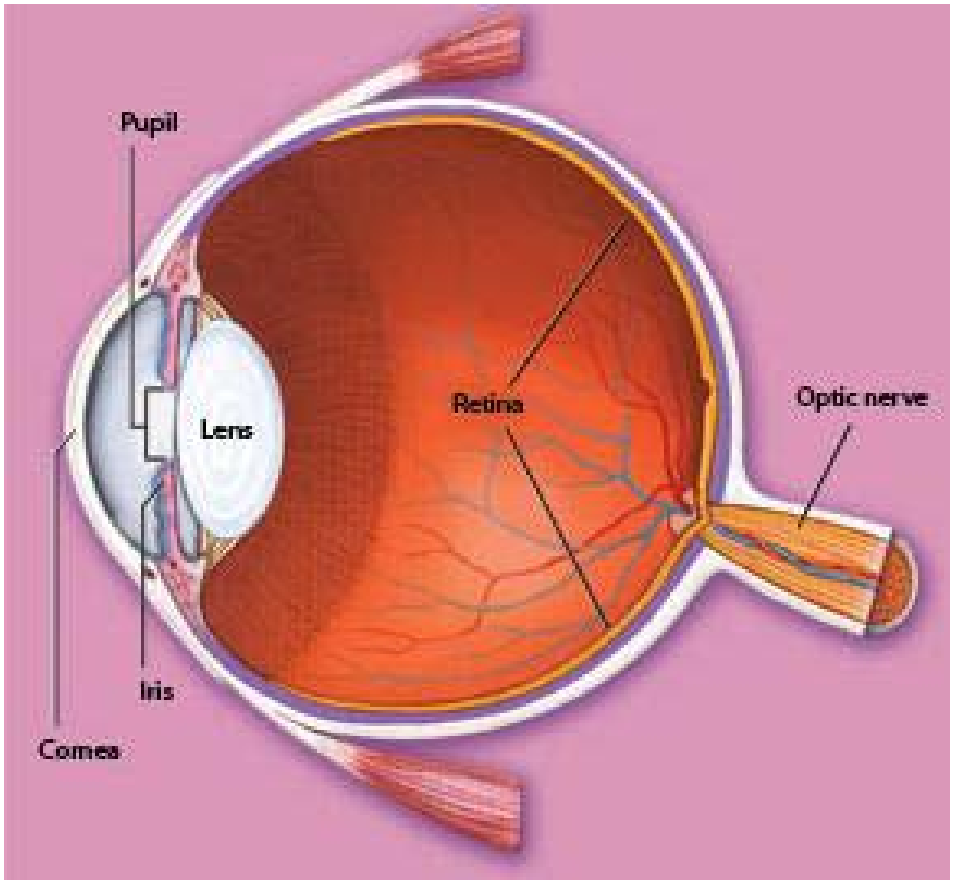
Compulsory deployment of CE 21/2004 was delayed to 1 Jan 2010

…but they lose and eat it !

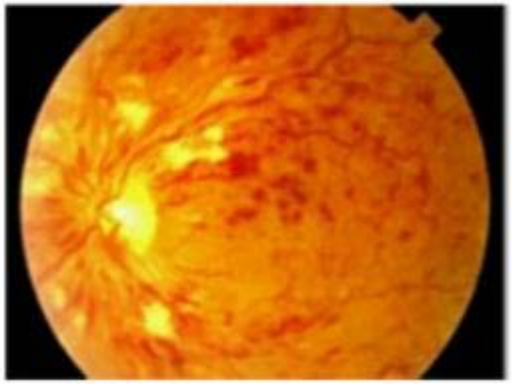
Retinal imaging

Retina = Sheet of nervous cells and visual receptors lining the eye's back.

Vascular pattern = Blood vessels image.



Healthy retina

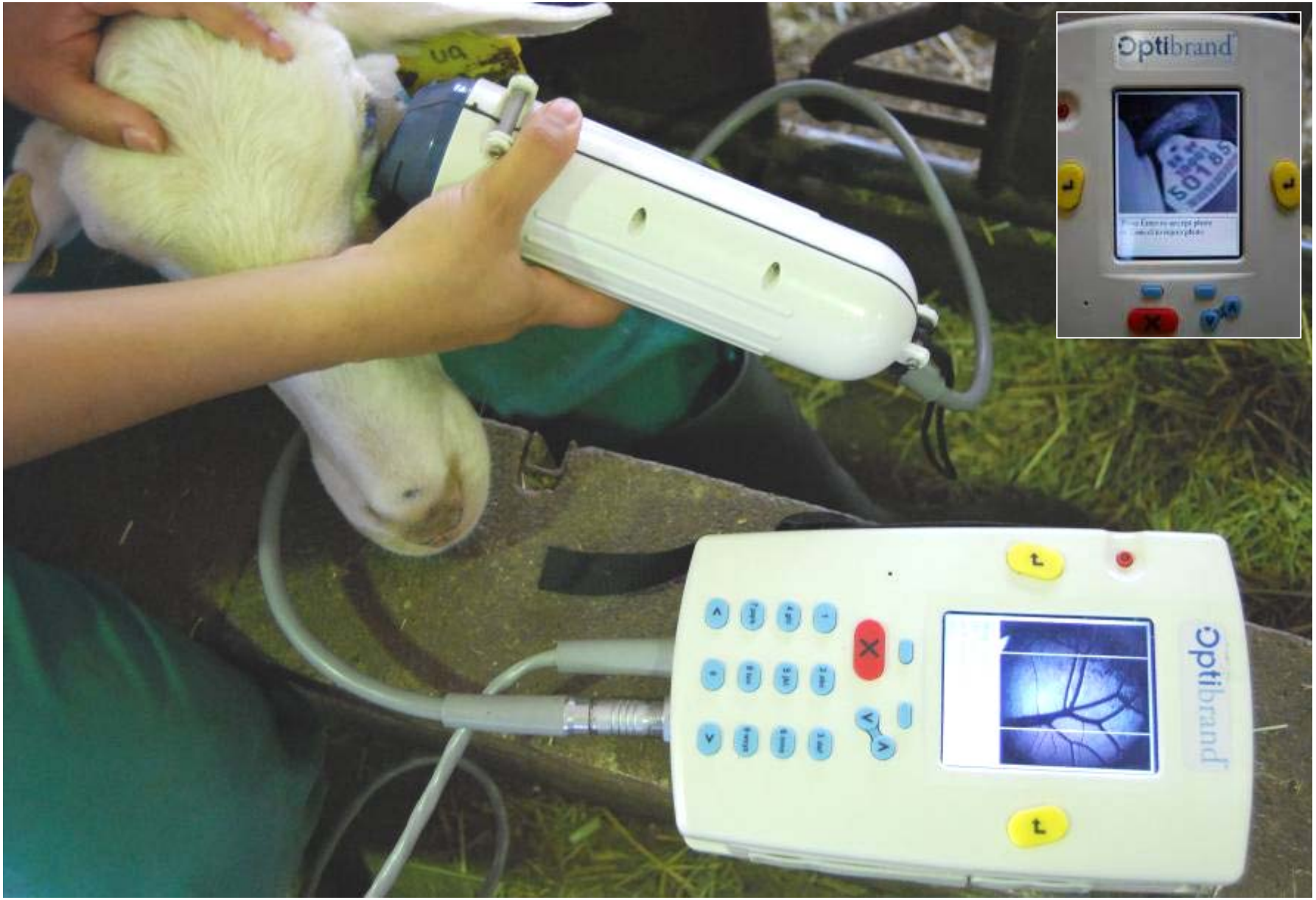


Unhealthy retina

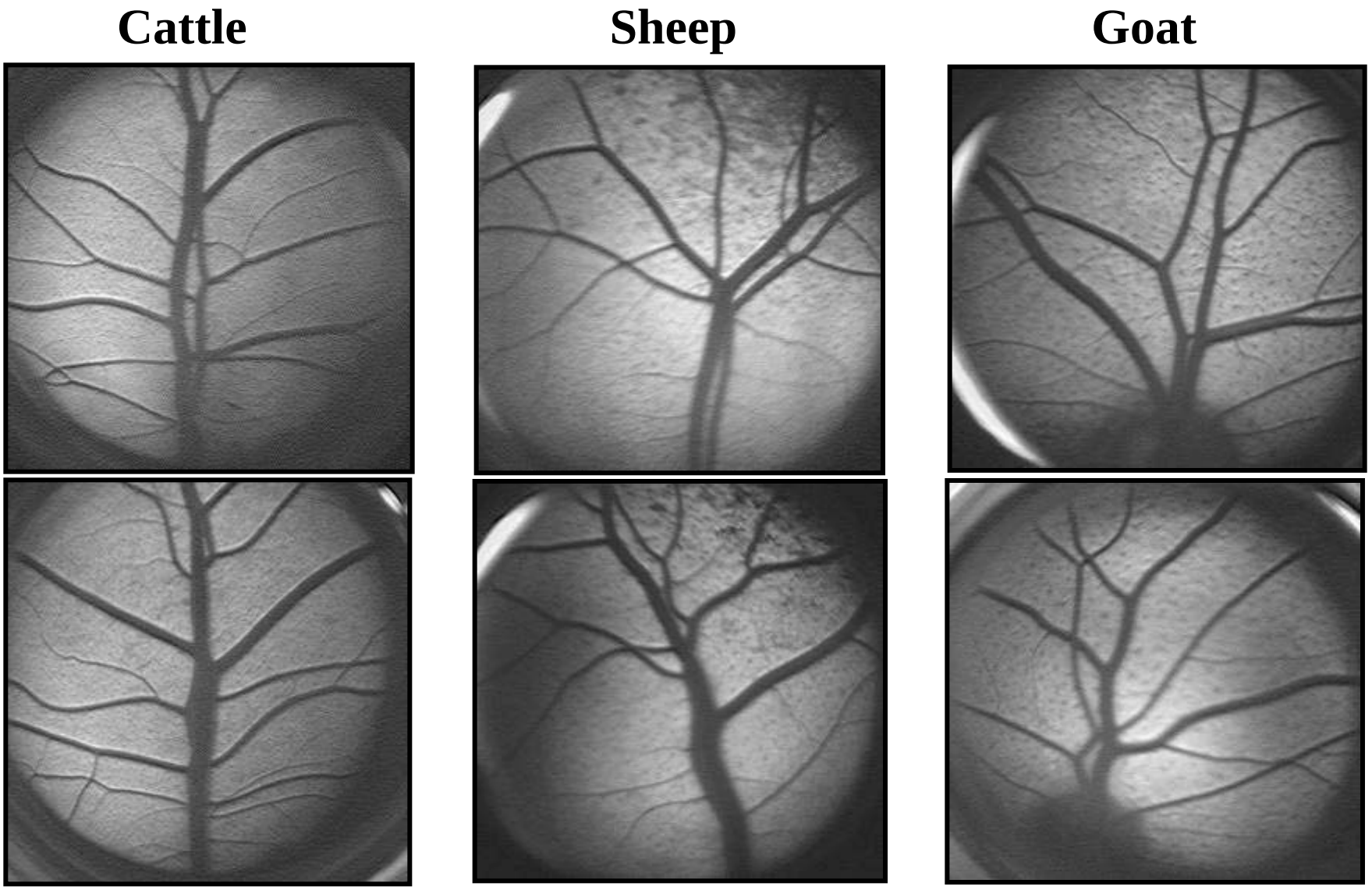
Retinal imaging basis

- **Uniqueness of retinal vascular pattern of each eye during the animal life-span.**
- **Differences between:**
  - **Eyes (left vs. right)**
  - **Species**
  - **Twins, clones...**
- **Adapted camera and data treatment software for livestock identification (*Optibrand*, Fort Collins, CO).**
- **Previous research on retinal identification of cattle (Allen et al., 2008; Rusk et al., 2008) and sheep (Barry et al., 2008; Rojas et al., 2009, 2010).**
- **Agreement on procedures and matching score threshold by ROC curve analysis (MS = 70).**

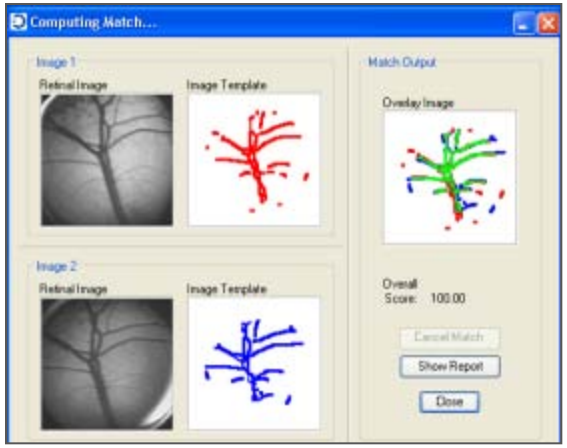
Capturing the retinal image in sheep



Retinal Vessel Pattern differences among species using the Optibrand system (Rojas-Olivares et al., 2008)



Retinal imaging procedure



Previously <u>trained operator</u> (!)

1) Lamb identification and ear tag scanning.

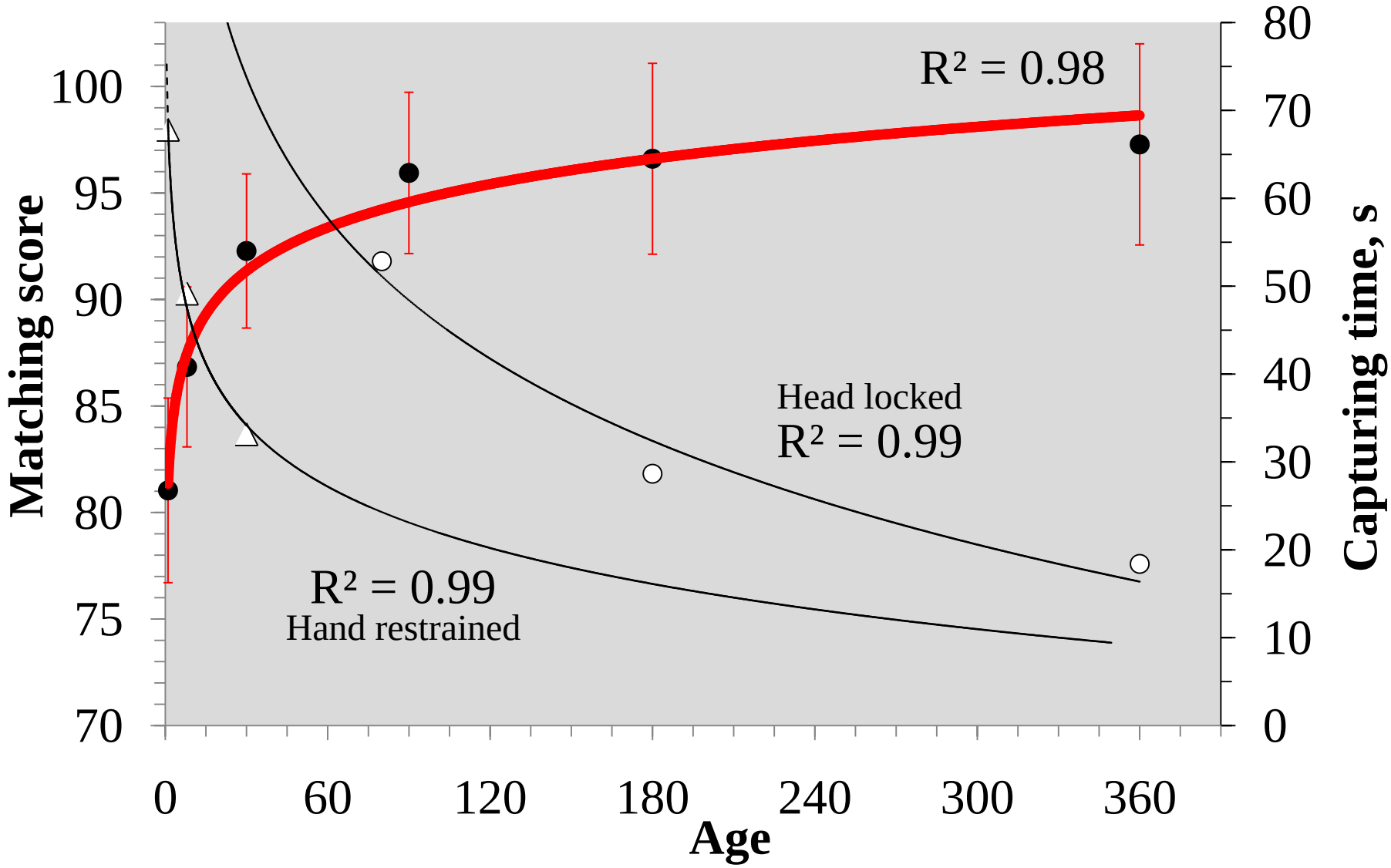
2) Capture of retinal images:

- **Quality approval**
- **Duplicate**
- **Blob files downloading**

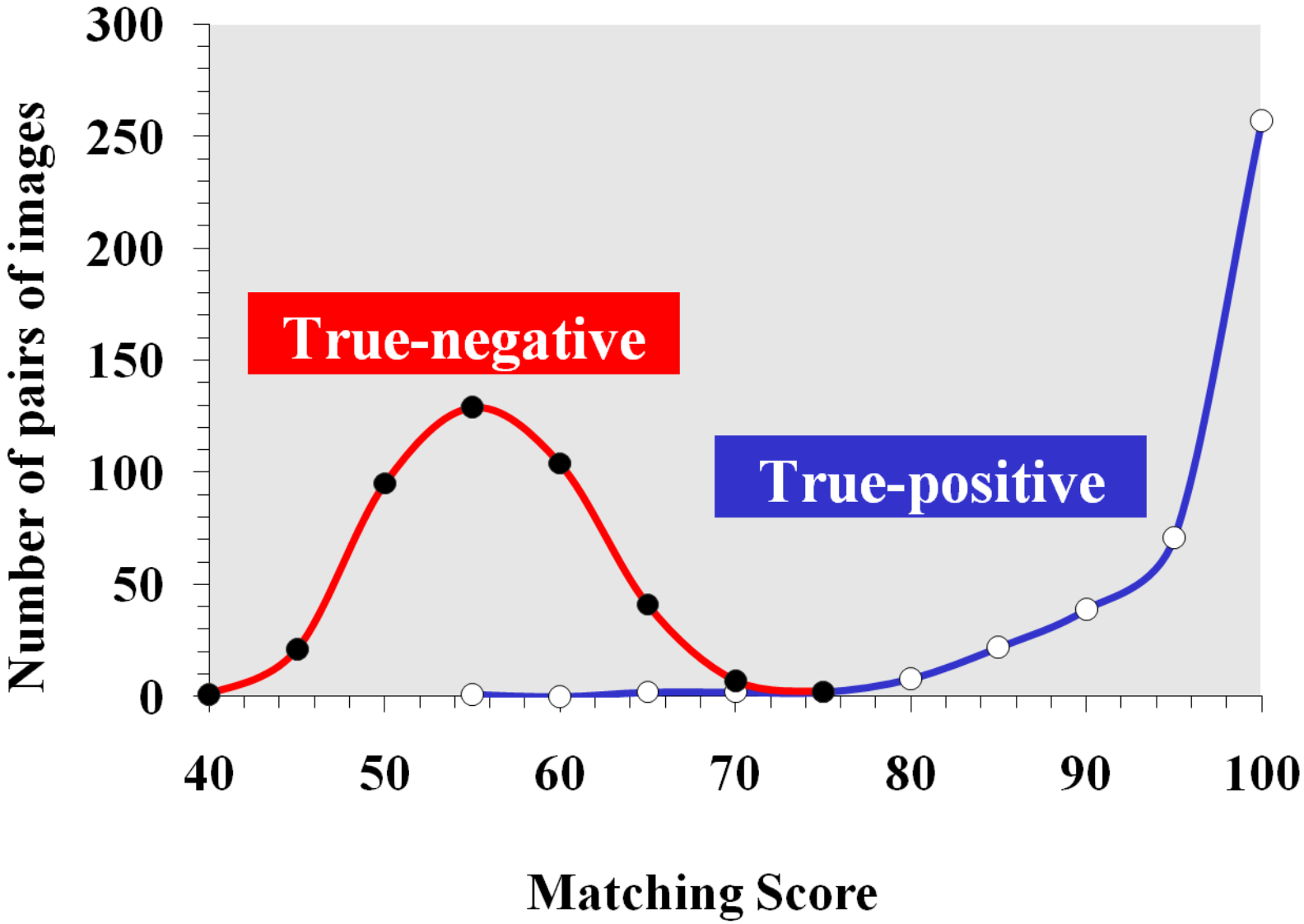
3) Evaluation of matching scores:

- **Intra-age (repeatability)**
- **Inter-age (traceability)**

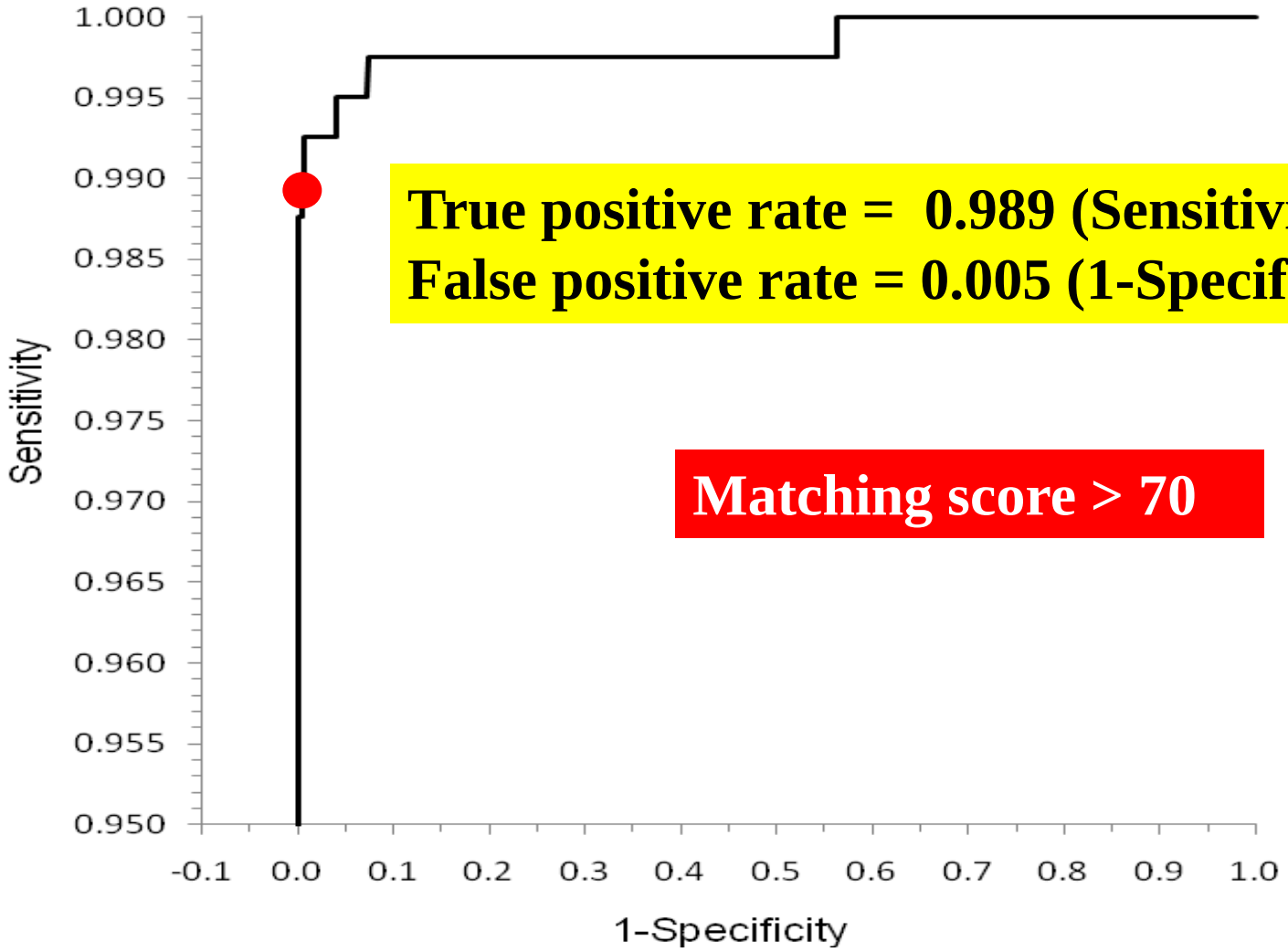
Matching score and capturing time of retinal images according to lamb age (Rojas et al., 2010)



Retinal imaging accuracy in lambs: Matching score threshold (Rojas et al., 2010)



Receiver operating characteristic (ROC) of retinal images in lambs (Rojas et al., 2010)



True positive rate = 0.989 (Sensitivity)
False positive rate = 0.005 (1-Specificity)

Matching score > 70

Matching score in sheep according to age using the Optibrand system (Rojas-Olivares et al., 2008)

Sheep, n	BW, kg	Same eye		Different age	
		Left	Right	Left	Right
Live lambs:					
152	22.3 ± 0.2	93.9 ± 0.7 (93.4%)[1]	95.1 ± 0.7 (93.3%)[1]		
58	41.6 ± 0.9	98.1 ± 0.4 (100%)[1]	94.3 ± 1.1 (94.8%)[1]	93.8 ± 1.1 (93.1%)[1]	88.1 ± 1.9 (79.3%)[1]
Slaughtered lambs (cut heads):					
50	24.3 ± 0.2	66.0 ± 2.6 (22.2%)[1]	69.2 ± 2.5 (34.0%)[1]	59.6 ± 2.0 (8.0%)[1]	57.3 ± 2.2 (14.0%)[1]

[1]Declared as the same between replicates

Right eye: Percentage of retinal images matching (MS>70) according to lamb's age

Age, d	1	8	30	80	180	390
1	76.2					
8	89.6	87.8				
30	89.5	94.7	97.1			
80	-	96.2	100	100		
180	-	93.0	98.2	100	100	
390	-	91.7	100	100	100	100

Blue figures = between duplicates

Left eye: Percentage of retinal images matching (MS>70) according to lamb's age

Age, d	1	8	30	80	180	390
1	75.4	85.6	85.3	-	-	-
8	89.6	89.8	94.9	91.0	83.1	88.0
30	89.5	94.7	94.1	99.2	96.6	96.0
80	-	96.2	100	99.2	100	100
180	-	93.0	98.2	100	100	100
390	-	91.7	100	100	100	100

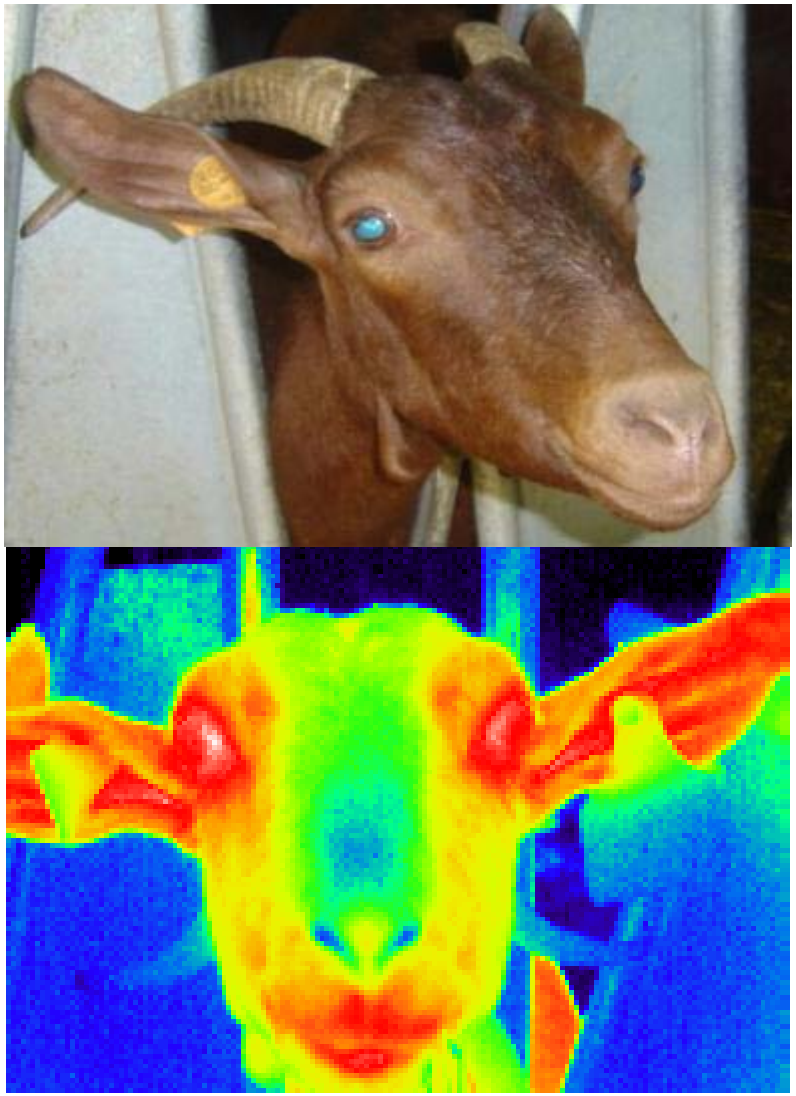
Blue figures = between duplicates; Right eye values under the diagonal.

Final traceability according to identification system in living lambs (Rojas et al., 2010b)

Age period, d	No. of lambs	Ear tags		Retinal images
		Temporary	Permanent	
1 to 30	136	97.1	-	83.7
30 to 80	134	97.1	100	99.2
30 to 180	59	93.2	100	94.8
30 to 390	25	92.0	100	98.0
80 to 390	25	92.0	100	100

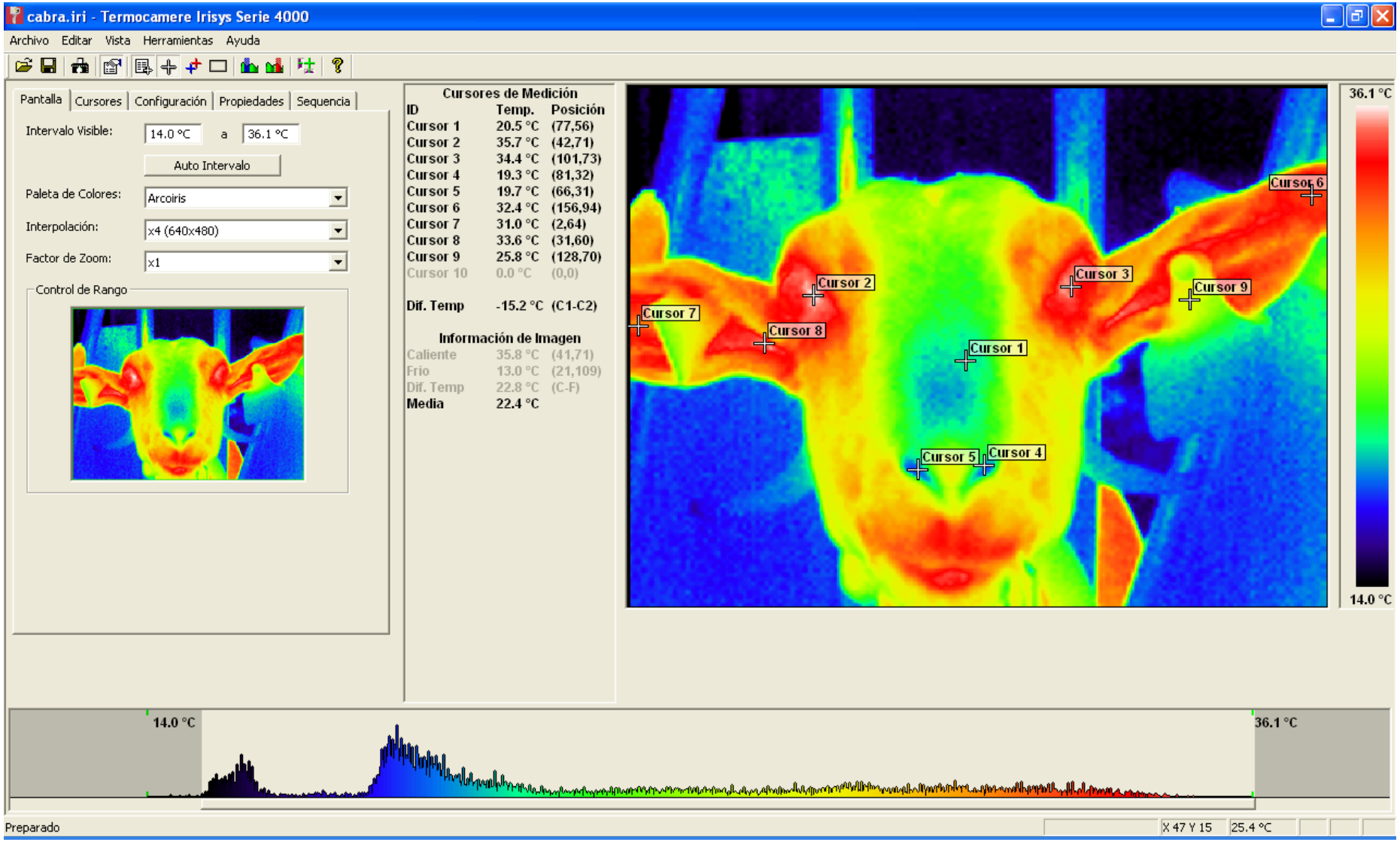
Infrared termograhy in livestock

Irisys IRI4010 (emisivity = 0.98; resolution = 0.15ºC)



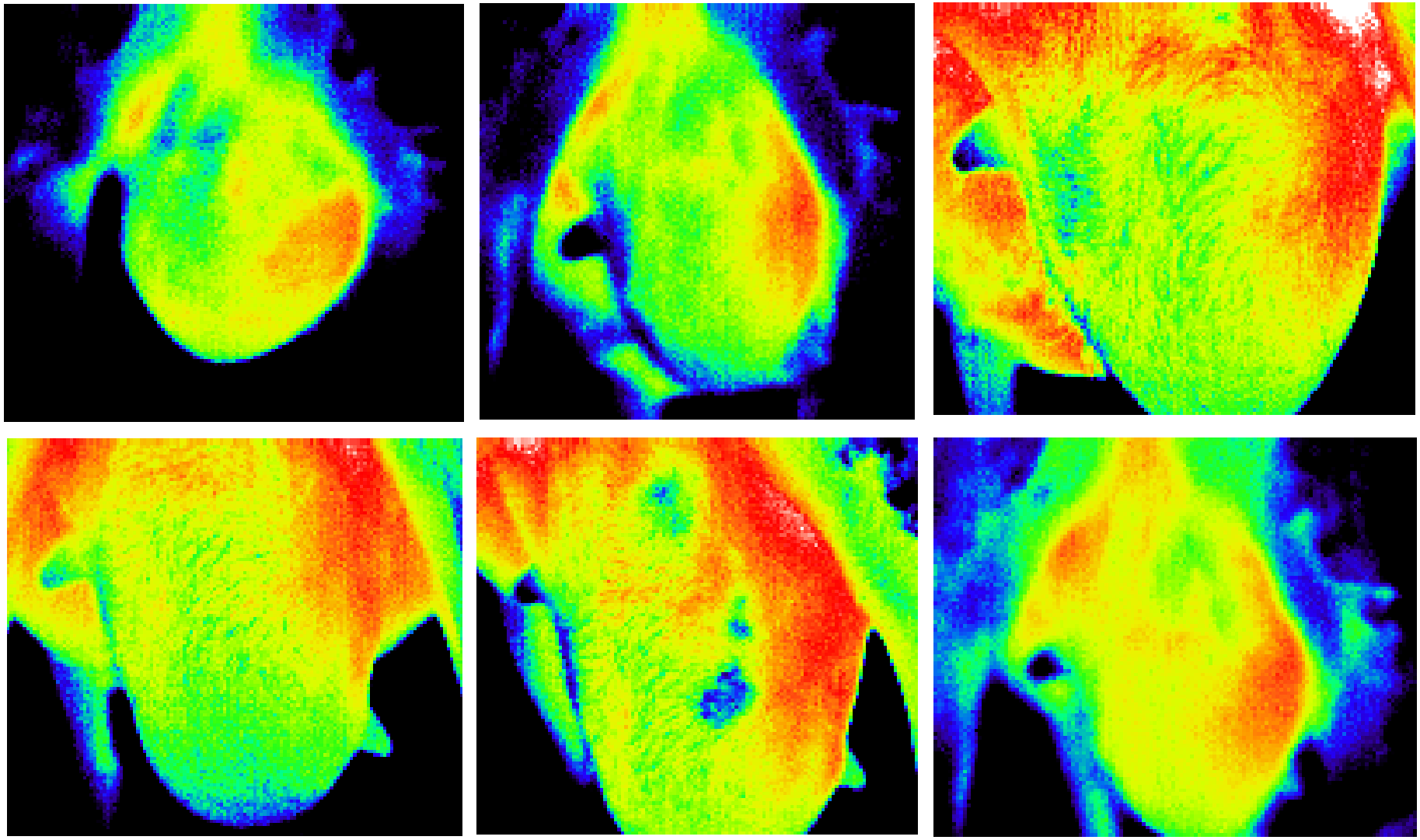
Measuring skin temperatures by infrared termograpphy in small ruminants

Irisys IRI4010 (emisivity, 0.98; resoluction, 0.15ºC)



Mammary termography for mastitis detection in dairy sheep (Costa et al., 2010)

Macrophagal response to intramammary injection of 5 mg *E. coli* 055:B5 endotoxin (Lipopolysacaride, Gram -; n = 9)



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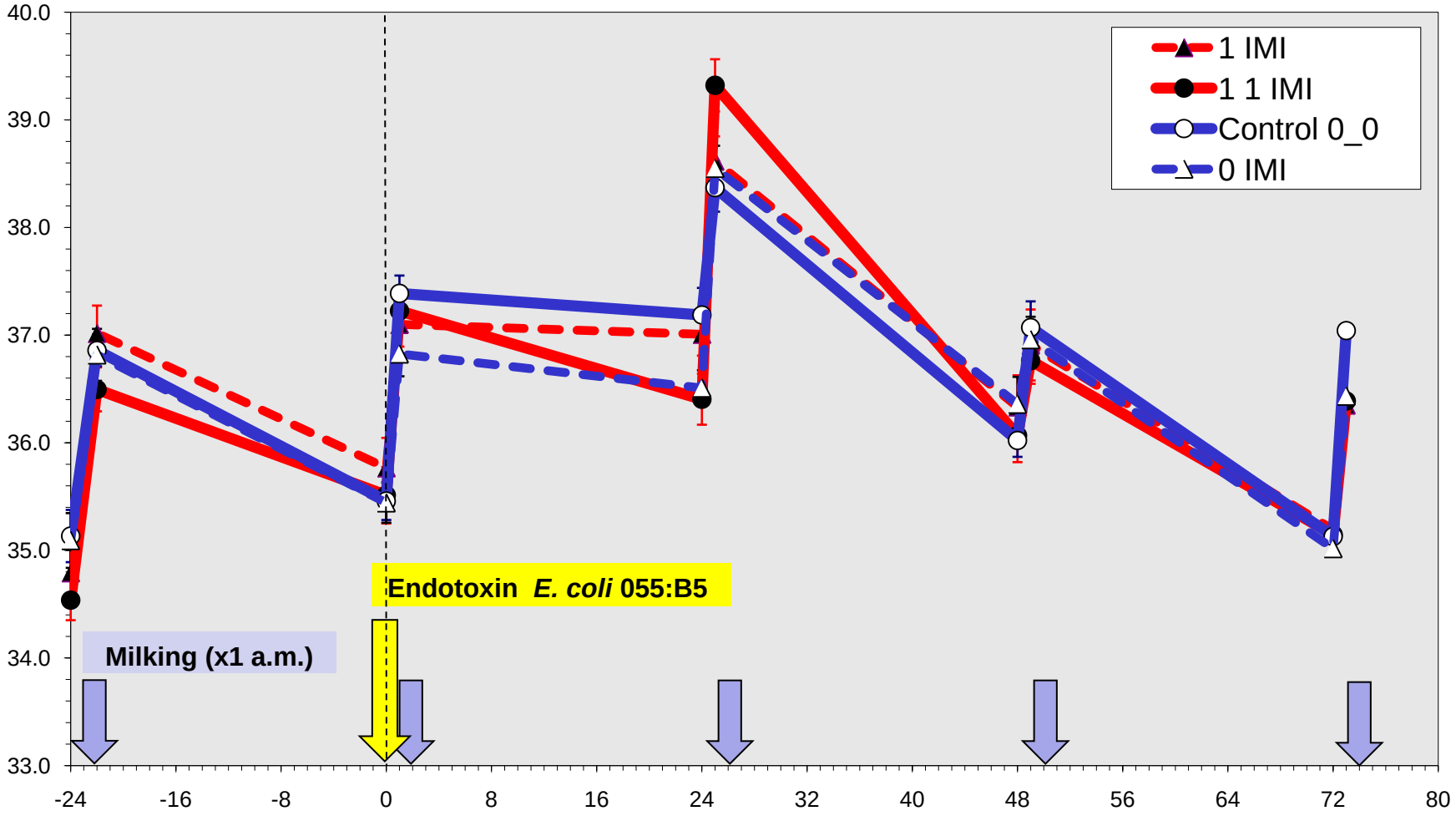
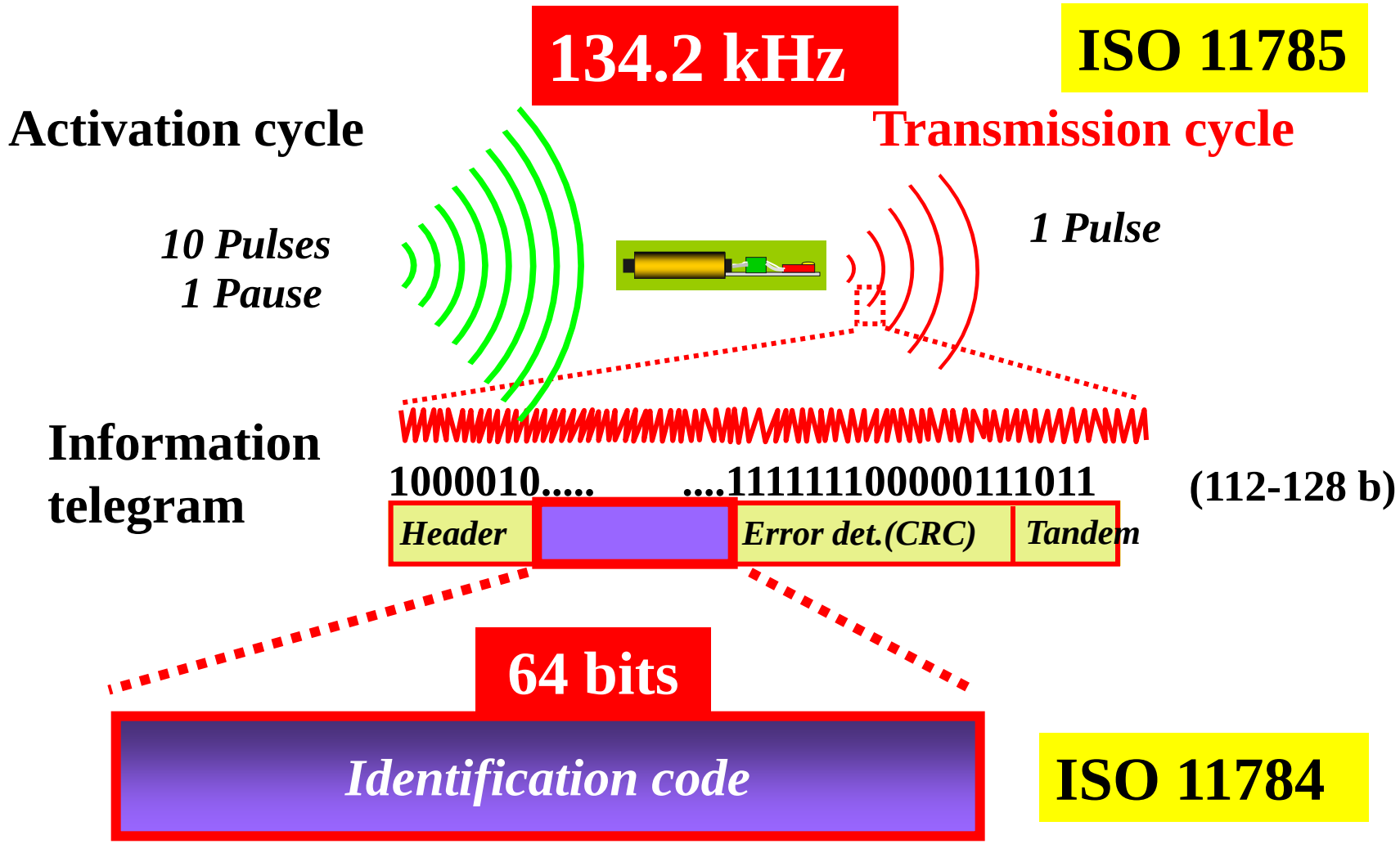


RFID Technology: LF passive transponders



ISO 11784 Code for e-ID animal (16 digits)
- Modification 2004 -

1 000 00000 000000 0 1010111011 0101111000011100001110001000010001011

8 8 = 64 bits

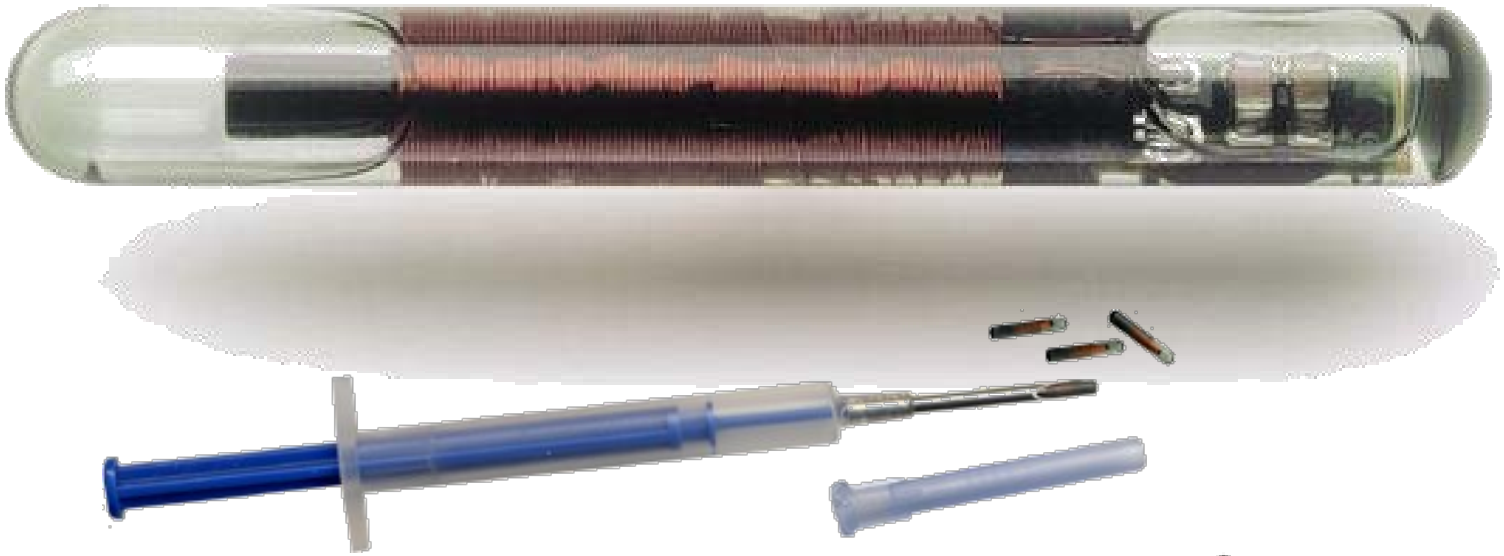
1	*2-4*	*5-9*	*10-15*	*16*	*17-26*	*27-64*
1	Re-ID (3 b)	Specie (5 b)	Reserve (6 b)	0	Country (10 b)	Individual (38 b)

Country: $2^{10} = 1024$ (ISO 3166) — 4 digits

Animals: $2^{38} = 274\,877\,906944$ — 12 digits (*ISO 11784*)

16 digits (4+12) = (0) 999 123456789012

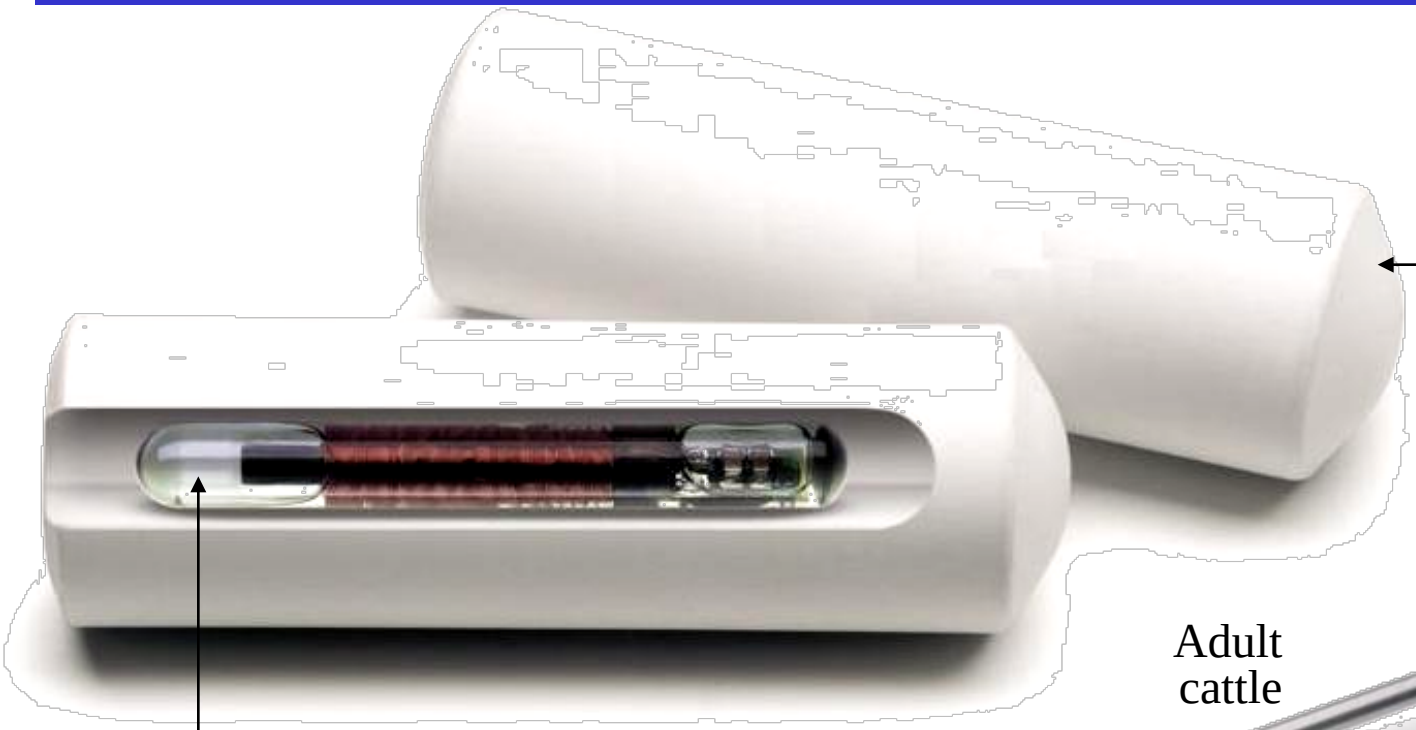
Injectable transponders



Injection of transponders in the metatarsus
(Carné et al., 2009)

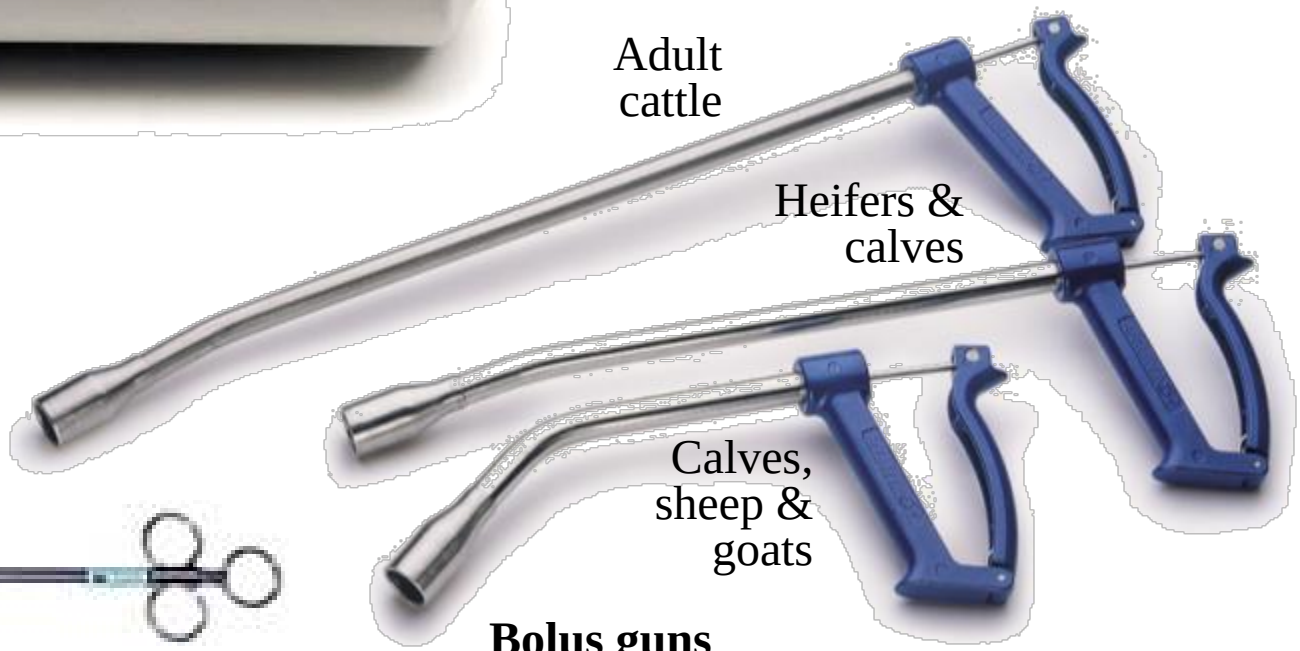
Ear tag transponders

Reticulo-rumen bolus transponders



Inert high density capsule

Glass encapsulated passive transponder



Bolus guns

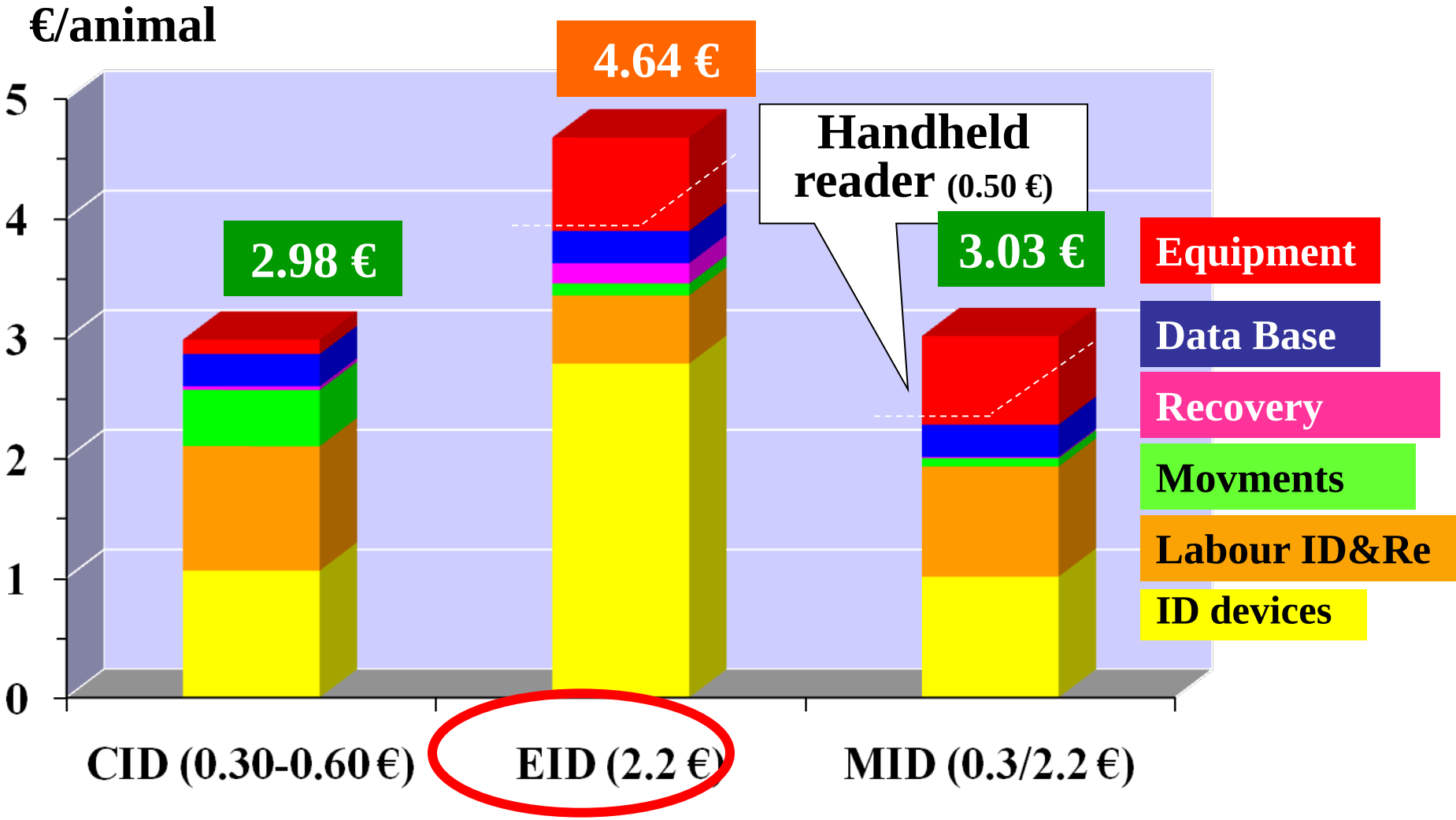
Bolus administration in a suckling lamb (> 8 kg BW)

Mini-bolus 20 g in a Ripollesa lamb, UAB, Bellaterra (Spain).

Cost for sheep & goat ID in Spain (23.7 Mill.) according to CE 21/2004

(CID = plastic ear tag, EID = e-bolus; MID = ear tag + e-bolus)

(Saa et al., 2005)



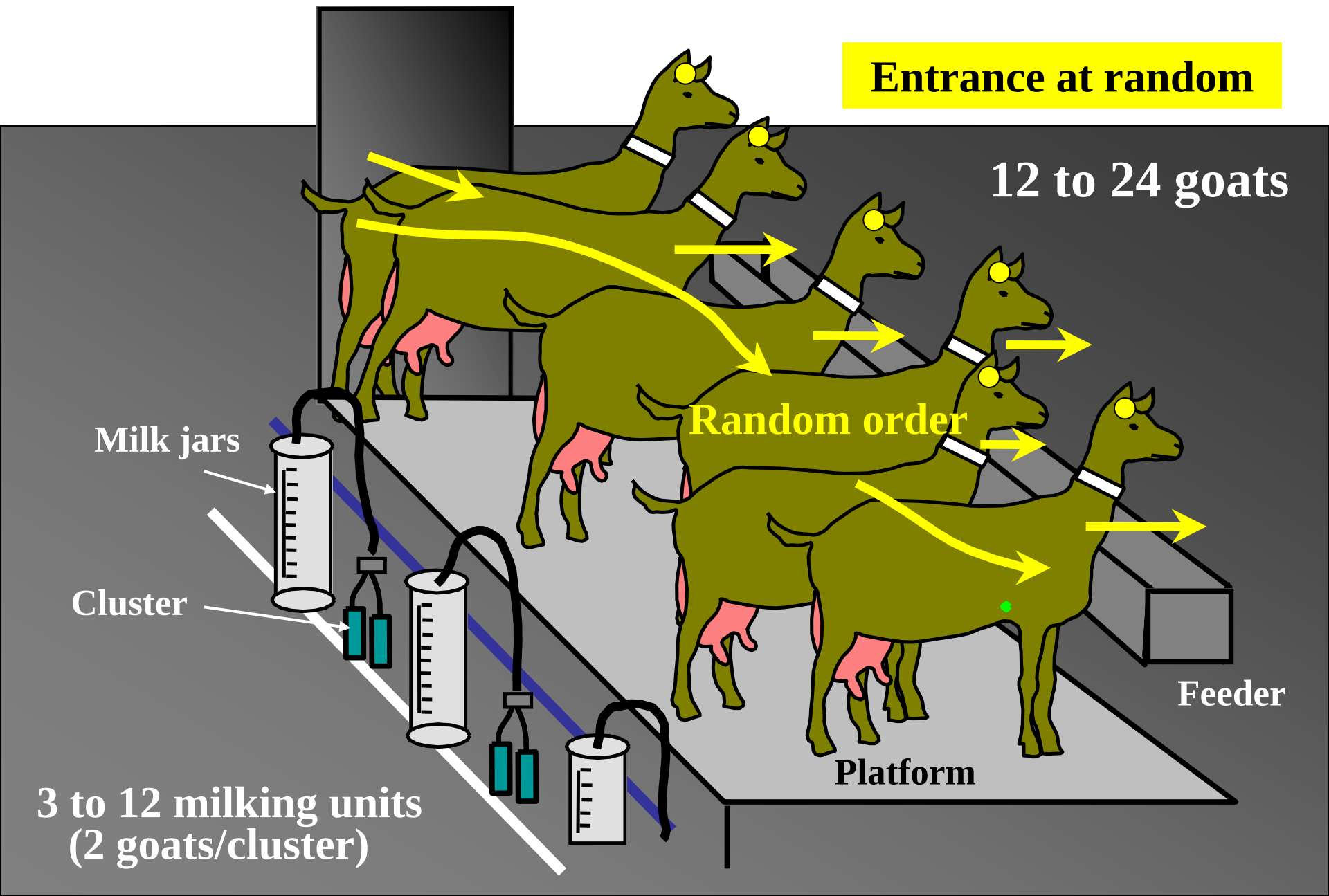
Automatic milk recorders approved by ICAR for small ruminants (updated 17/5/2010)

Model	Company	Measuring unit	Species
Afifree	Afikim (IR)	-	Goat
Afifree	Afikim (IR)	AfiFree 155	Goat
Afifree	Afikim (IR)	AfiFree 155i	Goat
Afifree	Afikim (IR)	-	Sheep
Afifree	Afikim (IR)	AfiFree 155i	Sheep
MM25 SG	De Laval (SD)	SCR Engineers	Sheep
Lactocorder	WMB AG (SW)	-	Goat

AfiFree 155i milk recorder for sheep

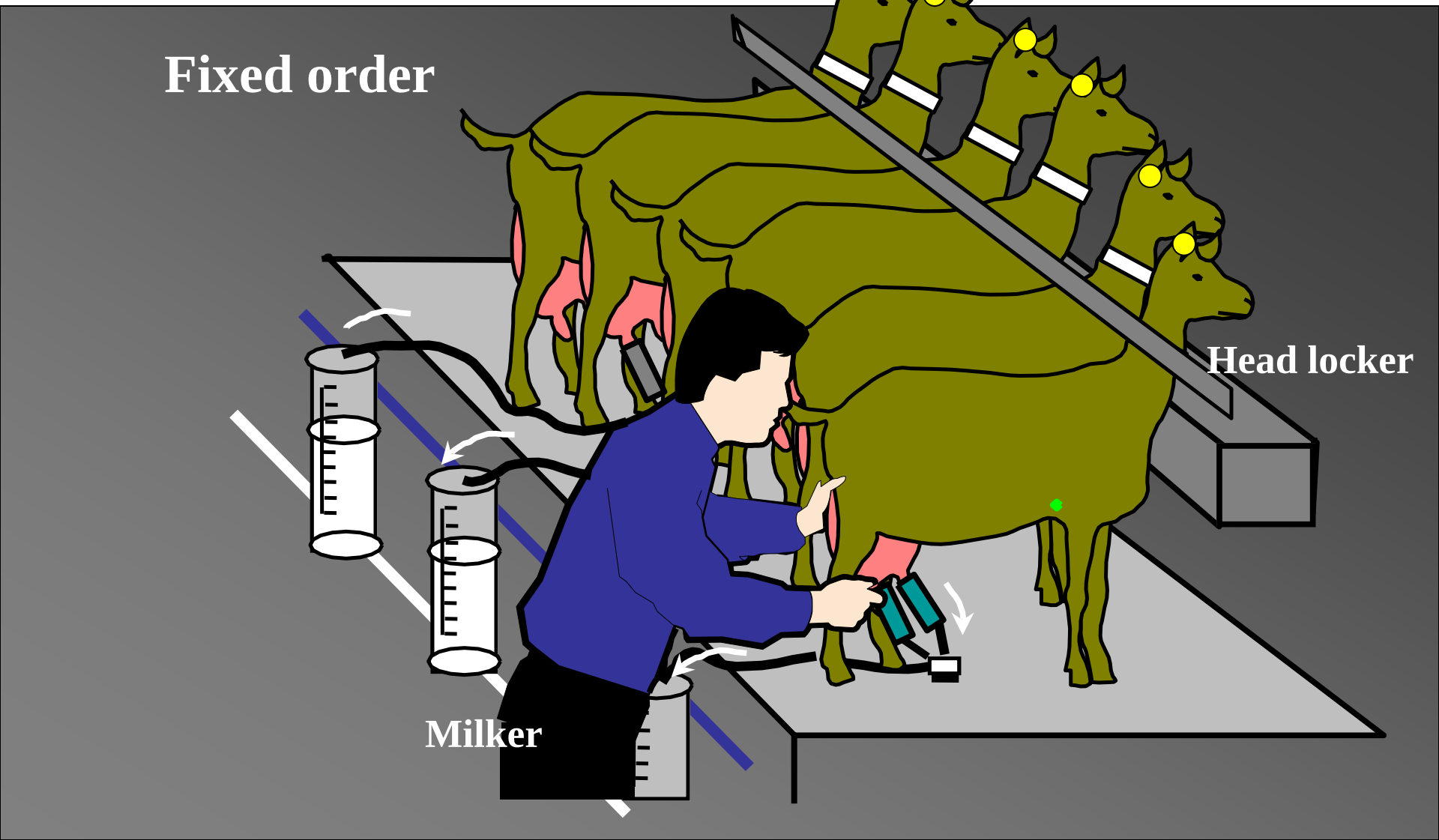
De Laval MM25 SG with ACR system for dairy sheep

Milking & milk recording process in dairy goats: 1/3



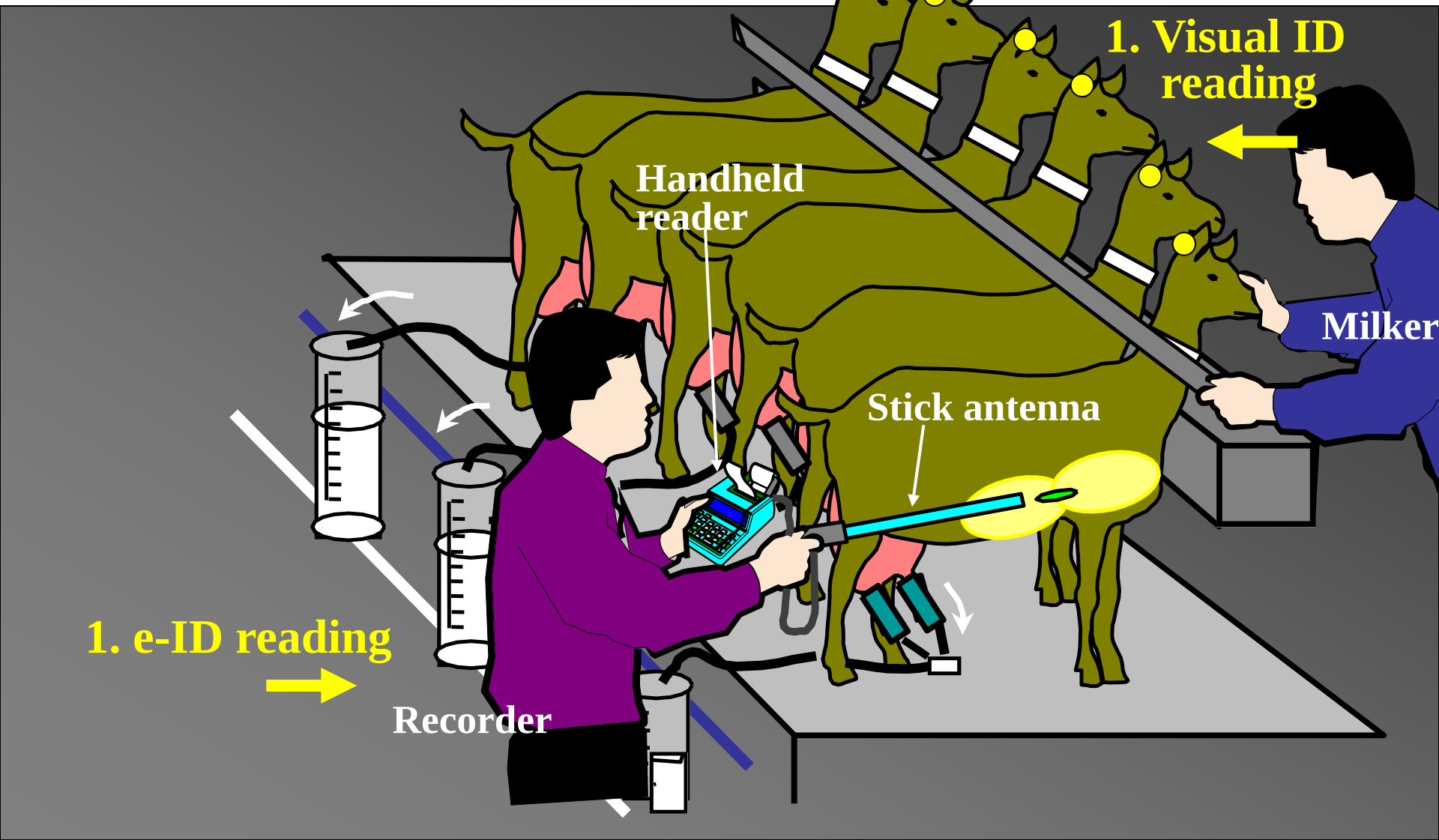
Milking & milk recording process in dairy goats: 2/5

Head locking & cluster attaching

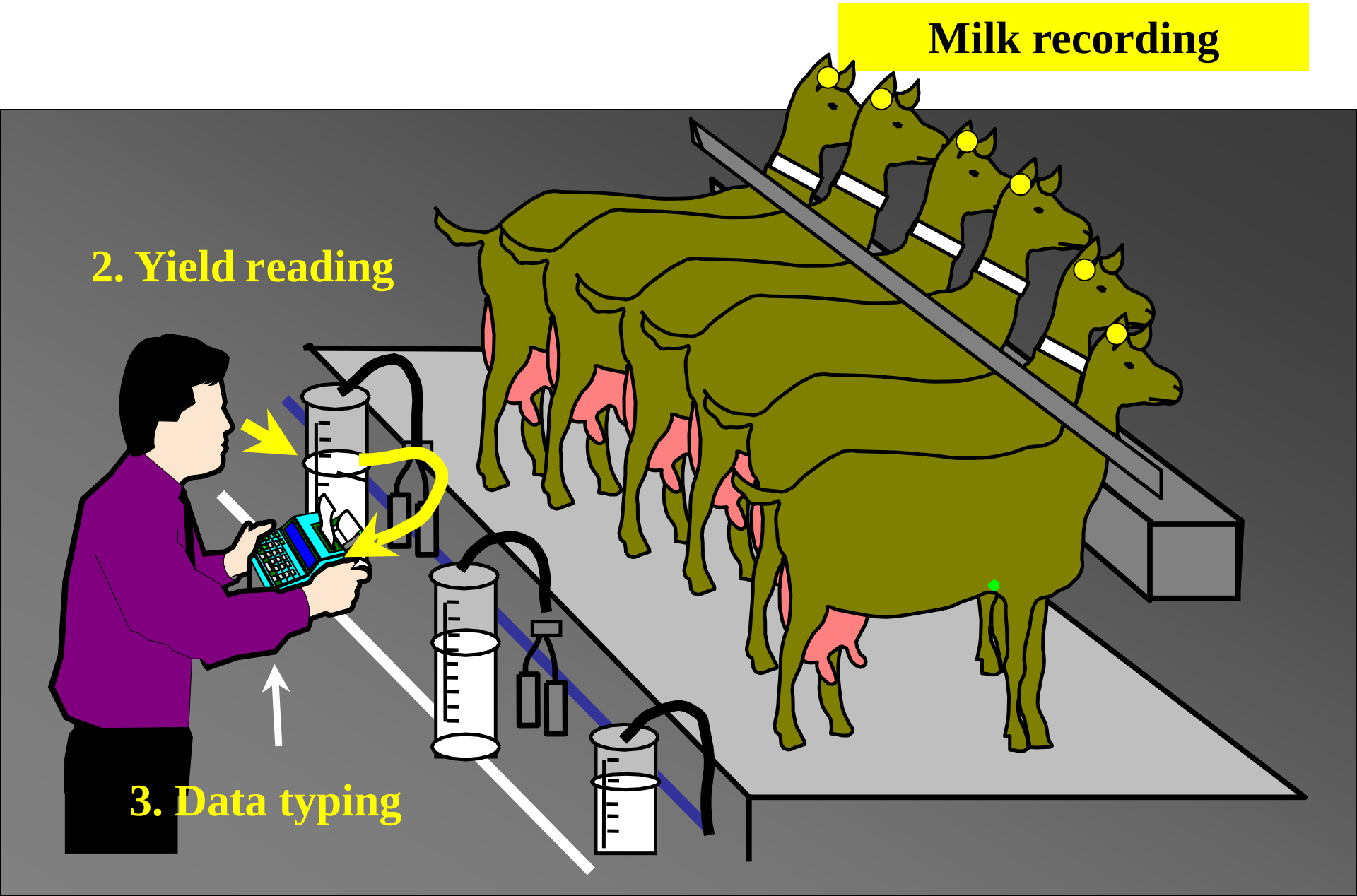


Milking & milk recording process in dairy goats: 2/5

Goat identification



Milking & milk recording process in dairy goats: 3/3



Comparison of manual and semiautomated milk recording systems in dairy goats
(Ait-Saidi al., 2008)

Item	System		P
	Manual	Semiautomatic	
Records, n	360	360	—
Milk yield per goat, L/d	1.91 ± 0.04	1.94 ± 0.04	0.156
Milk rate at recording, L/min	1.45 ± 0.03	1.46 ± 0.04	0.539
Group recording time, min/24 goat[1]			
Milk recording[2]	31.45 ± 0.60	32.16 ± 0.69	0.505
Data transfer[3]	4.81 ± 0.34	1.09 ± 0.10	0.001
Overall	36.26 ± 0.91	33.25 ± 0.91	0.011
Unitary recording time, min/goat[1]			
Milk recording[2]	1.32 ± 0.03	1.34 ± 0.03	0.511
Data transfer[3]	0.20 ± 0.01	0.05 ± 0.01	0.001
Overall	1.52 ± 0.04	1.39 ± 0.04	0.002
Errors, n			
Milk recording	2 (0.6%)	2 (0.6%)	—
Data transfer	4 (1.1%)	0	—

[1]Group of 24 goats in a double-12 stall parallel (side by side) milking parlor; time expressed in a decimal scale (1 min = 100 s).

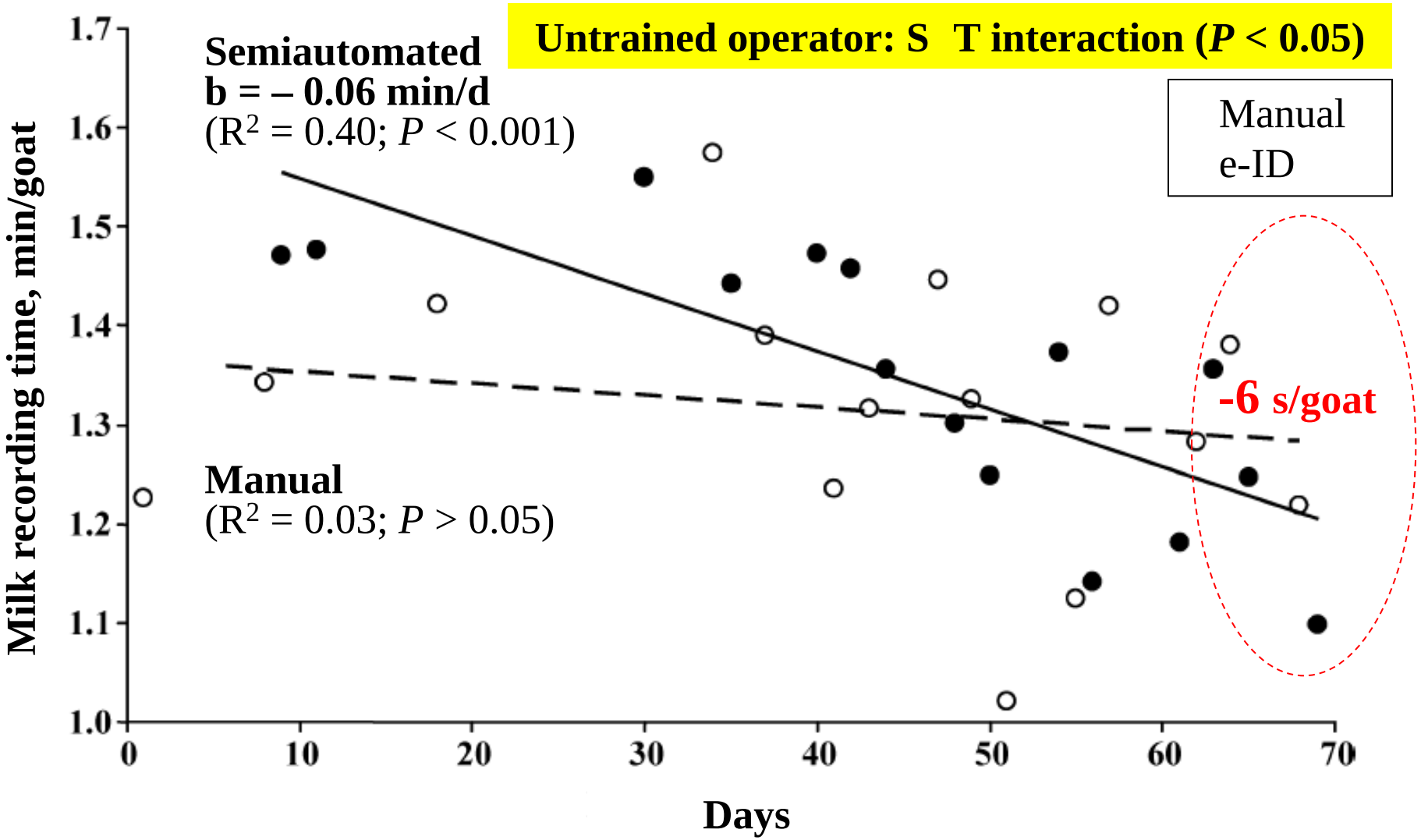
[2]Includes goat identification, machine milking, machine stripping, and collecting milk recording data.

[3]From paper forms or intelligent transceiver to computer database.

Time reduction: 0.13 min/goat (-9%)

Manual vs. Semiautomated milk recording systems in dairy goats: System Time interaction

(Ait-Saidi al., 2008)



Comparison of manual and semiautomated milk recording in dairy goats: Herd savings

Milking parlor = 2 12 (side-by-side)
Yield = 40 to 200 goats/h
Herd size = 24 to 480 goats
Work wage = 10 €/h

Savings/milk recording:
0.13 min/goat (3.01 min/24 goats)

Savings/milk recording:
0.5 to 12.9 €/recording

Paying back
40% investments

Net costs/milk recording:
0.5 to 12.9 €

Milk test-days/lactation = 6
e-ID cost = 1.4 €
Goat life span = 5 yr
Reader prize = 400 €
Reader's use = 5 yr
Readings/yr (200 d 100 goats/d) = 20,000

e-ID investment
2.2 €/goat

Extra cost/milk recording:
1.22 to 24.48 €

Extra costs/milk recording = 0.051 €/goat

Comparison of manual and semiautomated milk recording systems in dairy sheep

(Ait-Saidi al., 2008; *unpublished data*)

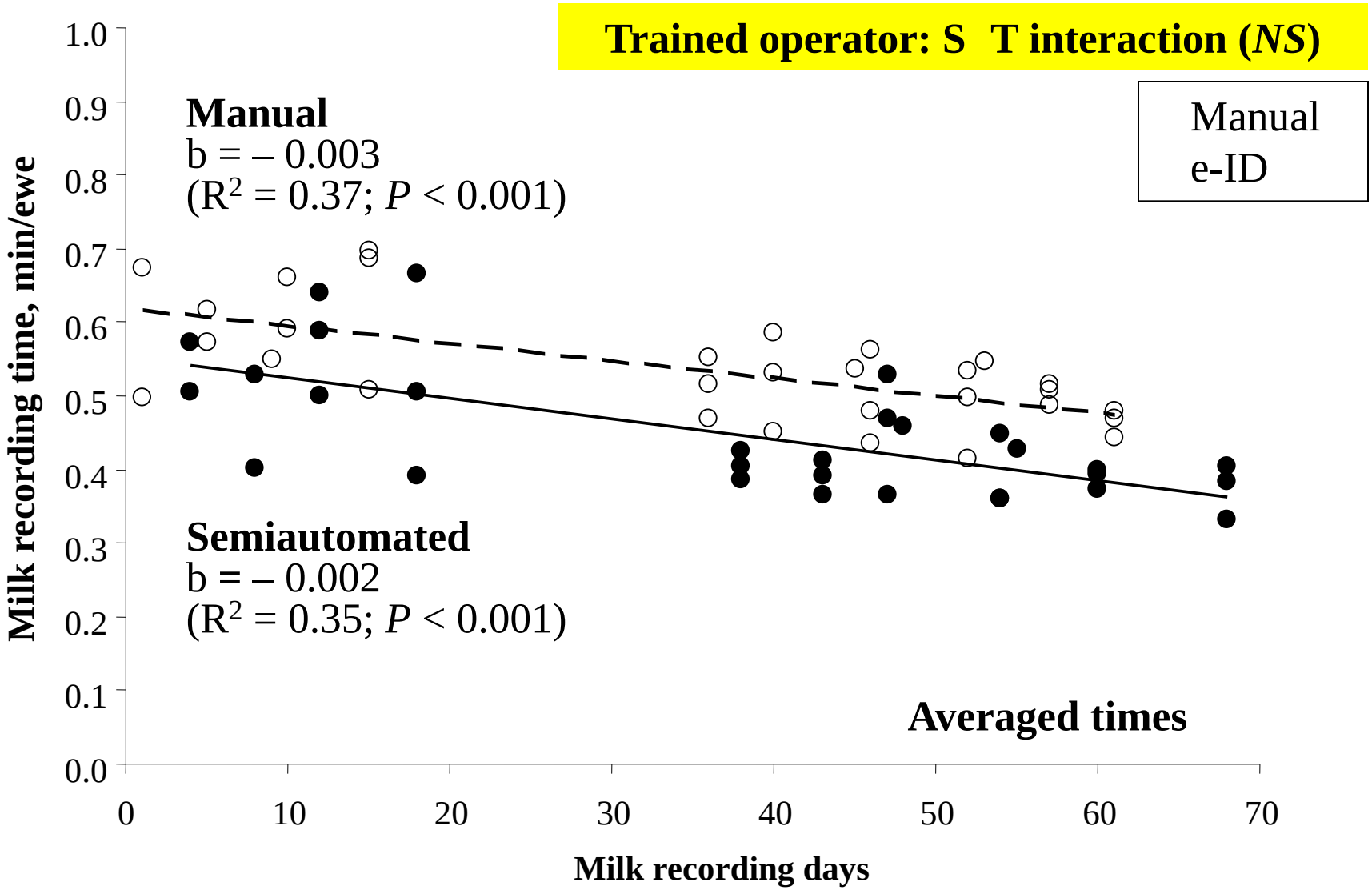
Item	Yield, L/ewe	Unitary recording time, min/ewe			Errors, n
		Milk recording	Data transfer	Overall	
Records, n	720	-	-	-	-
Manual					
Once daily (1)	0.99 ± 0.04[a]	0.56 ± 0.02[a]	0.13 ± 0.01[a]	0.69 ± 0.02[a]	7 (2.9%)
Twice daily (2)					
am	0.89 ± 0.05[bd]	0.56 ± 0.02[a]	0.14 ± 0.01[b]	0.70 ± 0.03[a]	13 (5.4%)
pm	0.56 ± 0.04[c]	0.49 ± 0.01[b]	0.13 ± 0.01[a]	0.62 ± 0.02[b]	6 (2.4%)
Total[4]	1.45 ± 0.08	1.05 ± 0.03	0.27 ± 0.02	1.32 ± 0.05	19 (3.9%)
Semiautomatic					
Once daily (1)	0.96 ± 0.05[ad]	0.47 ± 0.03[c]	0.03 ± 0.01[c]	0.50 ± 0.03[c]	0
Twice daily (2)					
am	0.82 ± 0.05[b]	0.46 ± 0.02[c]	0.03 ± 0.01[c]	0.49 ± 0.03[c]	0
pm	0.56 ± 0.03[c]	0.40 ± 0.02[a]	0.03 ± 0.01[c]	0.43 ± 0.02[d]	0
Total[4]	1.38 ± 0.08	0.86 ± 0.04	0.06 ± 0.02	0.92 ± 0.05	0

a, b, …d $P < 0.05$

Time reduction: 0.2 to 0.4 min/ewe (-29%)

Comparison of manual and semiautomated milk recording in dairy sheep: System Time interaction

(Ait-Saidi al., 2008; *unpublished data*)



Savings & Benefits of implementing e-ID in dairy & meat sheep farms in Spain

(Ait-Saidi al., 2008; *unpublished data*)

	Dairy		Meat	
	1	2	Extensive	Intensive
Sheep, n	400	400	700	700
Savings, €/sheep yr $^{-1}$				
Milk recording	0,126	0,266	-	-
Flock book	0,095	0,095	0,095	0,142
Weighing	0,188	0,188	0,125	0,188
Inventory	0,060	0,060	0,060	0,060
Total, €/ sheep yr $^{-1}$	0,469	0,609	0,280	0,390
Benefits				
€/sheep yr $^{-1}$	-0,037	0,099	-0,047	0,030
€/flock yr $^{-1}$	-14,60	39,80	-32,67	21,00
Breaking point, n sheep	477	279	1.110	565

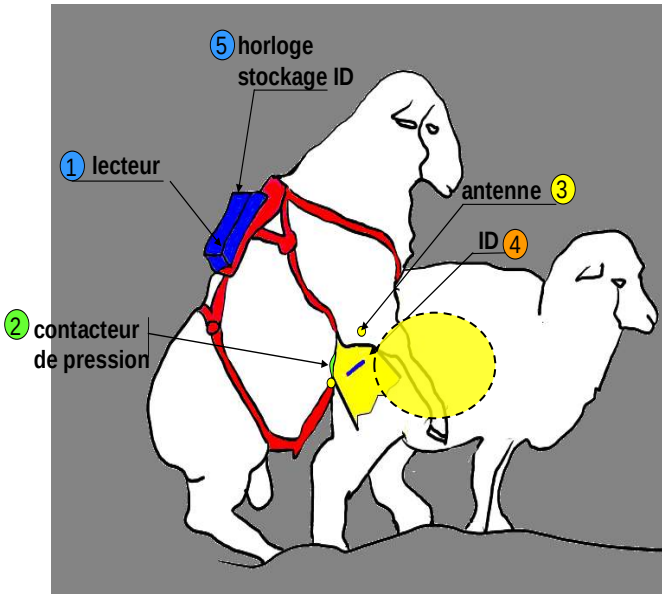
93%

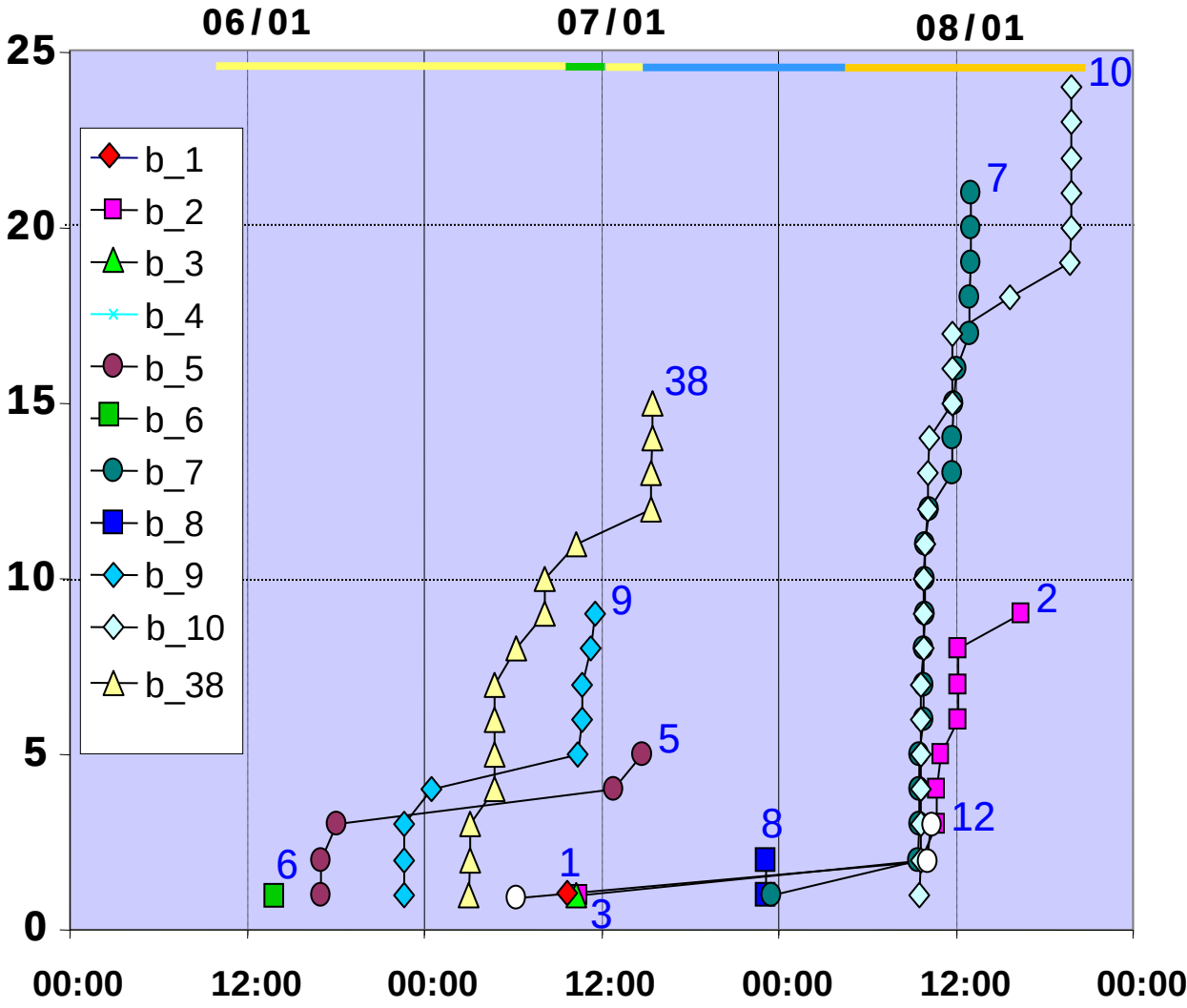
87%

> 100%

> 100%

Use of electronic identification for estrus detection (Pat. FR: Bocquier et al., 2005)



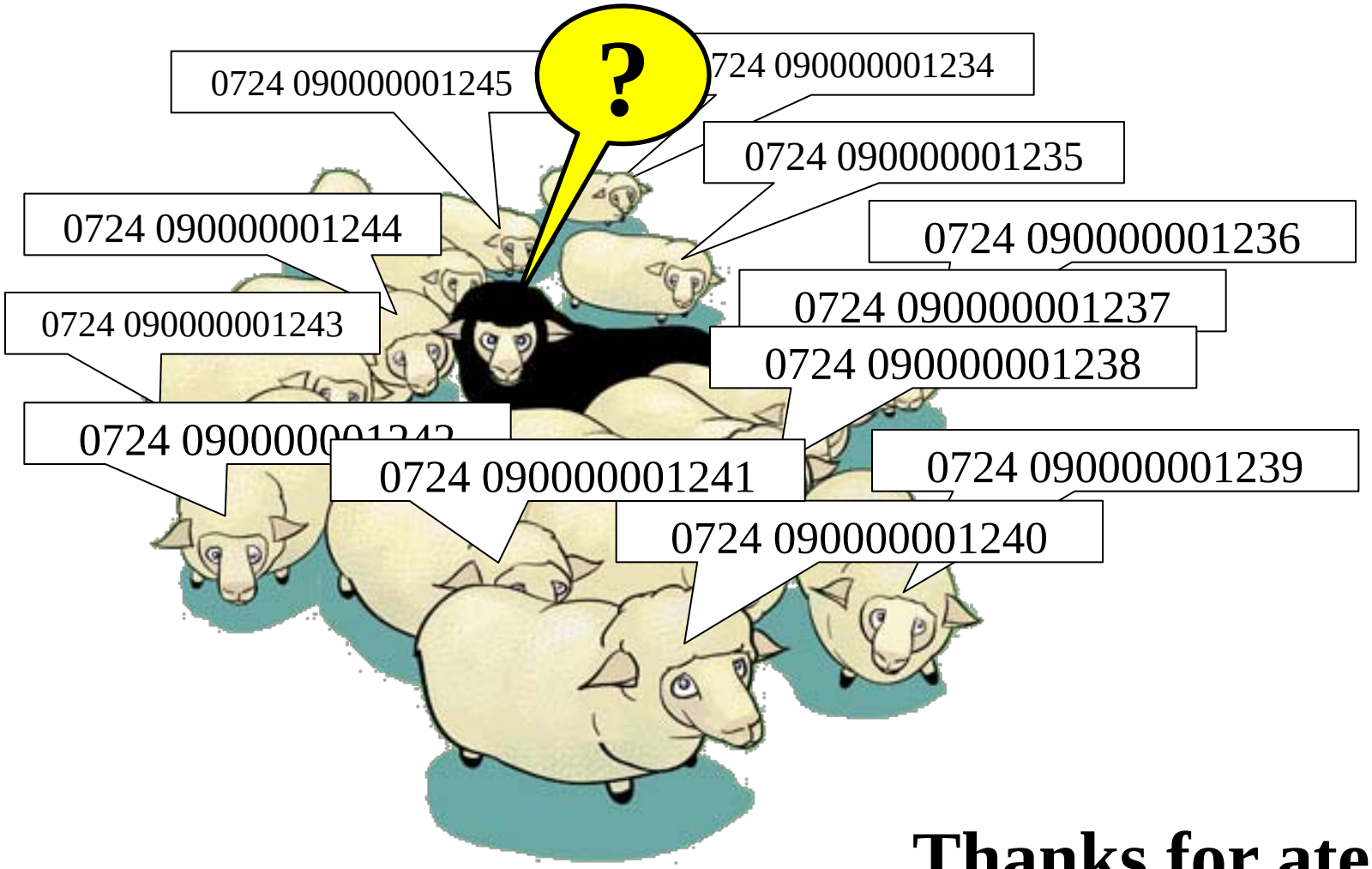


Bolus sensors for rumen monitoring (Kahne)

Conclusions & implications:

- **Many technologies able to be implemented in livestock industry:**
  - **Artificial vision**
  - **Thermographical vision**
  - **Radiofrequency ID and sensoring**
- **Technology is ready but user-friendly software is needed.**
- **Who is the user generation?: Training is today needed!**
- **Cost-benefit studies proved that there are benefits at current prices for many applications**
- **Non-contact ID systems are key for telemetry and automation: e-ID is the ‘first step’ for today?**

Black sheep will be the non-electronically tagged sheep…



Thanks for atention