Clinic for Ruminants and Swine
Faculty of Veterinary Medicine, University Leipzig, Germany

More Animal Welfare and Protection Through Intelligent Technology in The Barn

40th Chemnitz Seminar »Sensor Systems for One Health«
Session 6: Food and Animal Welfare
Chemnitz, 4th December 2024

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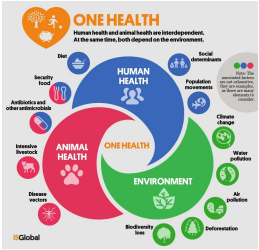
Do we need educated vets and farmers in the modern agriculture / the future ?



World Health Organization
https://www.who.int/news-room/questions-and-answers/item/one-health

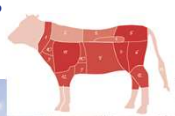
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
https://www.bmz.de/de

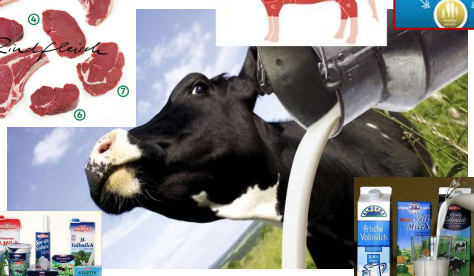
What is the part of the vet ?

Source: WikiCommons, Heck cattle at Grubenfelder Leonie Nature Reserve (Germany)

Source: P. Hufe

Why / with which aim do we work with cows.... ?





http://www.deutschlandfunk.de/media/thumbs/a/a891da875d40340efd17093181ad9f63v1_max_755x425_b3535db83dc50e27c1bb1392364c95a2.jpg?key=9ecd2f

Endemic diseases are controlled and regulated by regional, national or international laws !

Verordnung zum Schutz gegen die Salmonellose der Rinder (Rinder-Salmonellose-Verordnung)

http://de.wikipedia.org/wiki/Maul-_und_Klauenseuche

Which are the area of risk ?

http://de.wikipedia.org/wiki/Maul-_und_Klauenseuche

Skript München – Speicheln, „MKS-Bart"

What does herd health mean ?

- High level of productivity corresponding to hereditary factors
- Absence of herd diseases — Wiesner und Ribbeck (1983)
- Animal health, productivity, (animal) welfare — Dairy Herd health Uni Nottingham

Productivity and animal health in harmony with welfare…

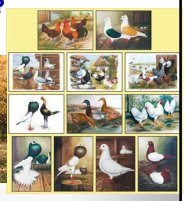
What is the challange ?

Source: WikiCommons, Heck cattle at Gruberfeldler Leonie Nature Reserve (Germany)

Source: P. Hufe

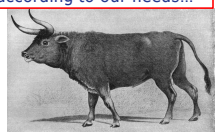
Domestication

What do we do with our animals…?



What did we do with our animals…?

We formed animals according to our needs…



Source: WikiCommons, Brehms Tierleben, Small Edition 1927

Source: EIP-Project „MinN-Navigator"

Source: WikiCommons, Heck cattle at Gruberfeldler Leonie Nature Reserve (Germany)

Source: P. Hufe

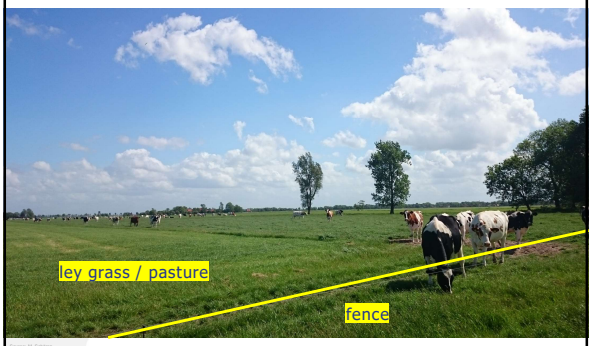
What do we do with our animials…?

The domestication, confining and genetic alteration of the animal

Source: Pixabay (Viewer) – https://pixabay.com/de/photos/mongolei-steppe-weite-wolken-kh%C3%A9Che-7398610/

What do we do with our animials…?

The domestection, confining and genetic alteration of the animal



Source: M. Schlüter

Housing Conditions – Current situation

- Free stall
- Slurry (concrete, slatted floor, rubber mats, cubicles, etc. mostly inelastic, hard flooring)

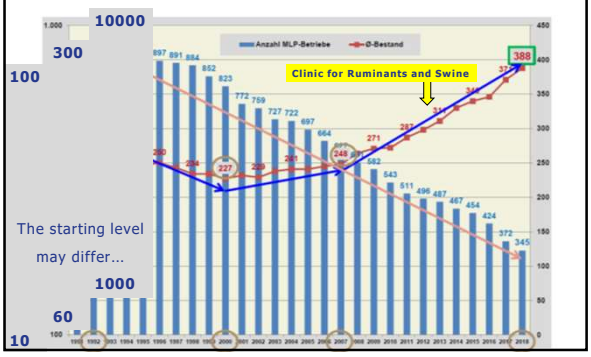
Changed Housing Conditions – In the Past

Mostly on pasture - Soft, elastic surface

Dairy cows – Developement of herd size

Farms are still groving, and we have less animals with higher milk yield

Dr. Manfred Hammel, LKV Berlin-Brandenburg



American Buffalo: Herds with until 1000 animals...

African Kaffernbuffalo herds form ducents until tousends of animals

Big groups only temporary depends on season and avalibility of food and water

Housing Conditions – Current situation

- Free stall
- Slurry (concrete, slatted floor, rubber mats, cubicles, etc. mostly inelastic, hard flooring)

We formed the enviroment and group sice according our „ideas"...

Health Disorders related to milk yield

(Wangler und Sanftleben ; Tierärztliche Praxis (G) 2007)

WIEDERKÄUER

Domestication

Means

We exclude natural evolution !

That means

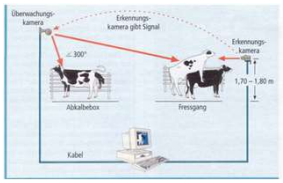
We are responsible for our work / for the animal we keep !

Under good management, feeding, environmental... conditions cows are able to produce high amount of milk without any higher risk of health disorders...

Vet in the field of production animals ?

How can I identify the sick animal ? Usefull digital tools

Video analysis



Messuring of activity

Pedometer

Lemmer-Fullwood

Gea Rescounter II

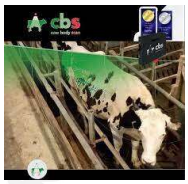
Qwes-HR, Lely, DeLaval

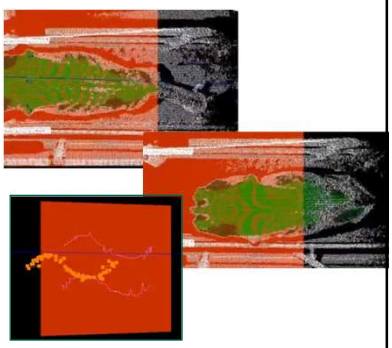
Heatime™, *milkline*

Respaktor

Body Condition Scroe (BCS)

Cow movement score





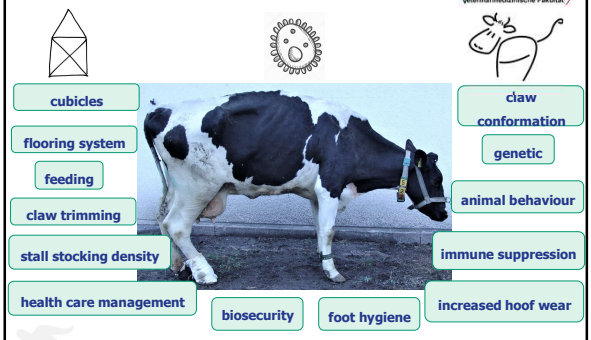
https://www.youtube.com/watch?v=q_dsE6Grv3Q

How can I find the animal...

GEA CowScout

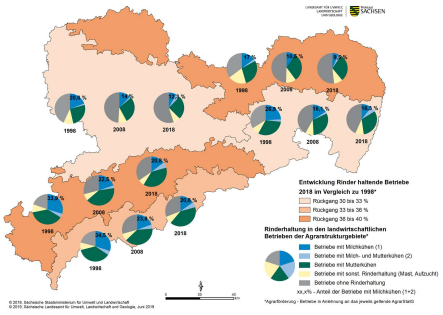
- heat detection
- surveillance of parturition
- localization of the animal

Multifactorial diseases



Holzhauer et al. (2006); Oliveira et al. (2017); Oniyoro et al. (2008); Palmer und O'Conell (2015); Relun et al. (2013); Somers et al. (2005), Weber et al. (2013); Wells (2006)

Changes in the dairy industry / agriculture…



seit 1998

- **Anteil Betriebe ohne Rinderhaltung gestiegen**
- **starker Rückgang v. a. Milchkuhhaltung**
- **Anteil Rinder haltender Betriebe in Vorgebirgs- und Kammlagen am höchsten aufgrund natürlicher Bedingungen**

bi.FLOW systems GmbH
biofluidic integration

Fraunhofer ENAS

MANTRA

Mastitiserreger- und Antibiotika-Resistenz-Test für die Vorort-Analyse

Rapid Mastitis Lab-on-a-Chip System

bi.FLOW systems GmbH
biofluidic integration

Lab-on-a-Chip - Cartridge

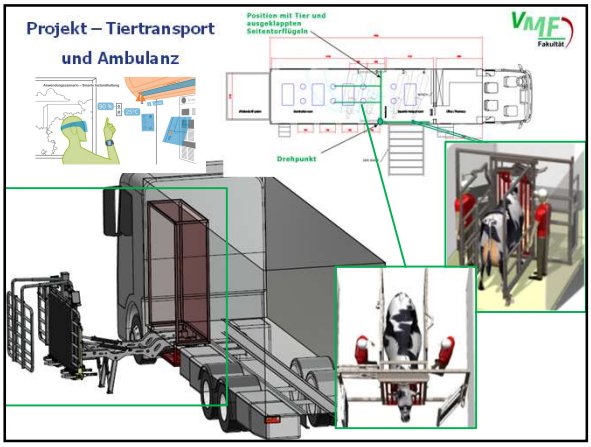
Control- / Readout - Unit

inotec FEIGHMR | bi.FLOW systems GmbH biofluidic integration

Laborpraxis (Jan, 2020), J. Nestler, A. Morschhauser, H. Peter:
https://www.laborpraxis.vogel.de/vor-ort-antibioikaresistenz-detektion-mit-chiplaborkartbrmsat-a-900426/

https://www.biflow-systems.com/content/18-applications_mastitis

Projekt – Tiertransport und Ambulanz



simul+

DIE KUH

Megatrends – Treiber des Wandels

Digitalisierung & künstliche Intelligenz	Klimawandel & Ressourcenknappheit	globale Wertschöpfungsketten & Konkurrenz	demografischer & sozialer Wandel
› Automation › Transparenz › neue Chancen & Risiken	› ökologischer Fußabdruck	› faire Lieferketten › steigende Komplexität	› neue Arbeit › neue Rahmenbedingungen

Produktion und Produktionsprozesse in der Land- und Viehwirtschaft

- Tiergesundheitsmanagement
- Innenmechanisierung
- Stallbau & Basicherheit
- Lebensmittelsicherheit

DIE KUH INNOVATIONSNETZWERK

- Automation & Konstruktion
- Sensorik & Datenauswertung
- Simulation & Berechnung
- Netzwerkmanagement

ICM

Digitalisierung, Automation und ganzheitliches Ressourcenmanagement in der Rinderhaltung (kurz: DIEKUH)

DIEKUH | Ein Netzwerk des ICM e.V. ICM

Transition period – Transit cow management

Dry cows | Fresh cows | Early Lactation

3 weeks ante partum | High disease risk | 3 weeks post partum

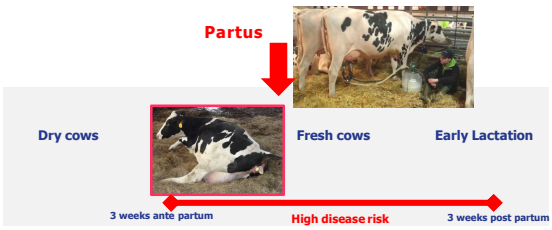
Retentio secundinarum
Displaced abomasum – Metabolic disorders
Metritis, Mastitis

Mastitis
Lameness

Endometritis

(Grummer, 1995; Drackley, 1999)

Transition period – Transit cow management



(Grummer, 1995; Drackley, 1999)

Cows health begins in the calving barn (and even before that) !

Amount of stillbirths

	Heifers	Cows
Australia	10,8%	5,1%
The Netherlands	11,4%	6,9%
Norway	3,0%	2,0%
UK	10,9%	5,3%
USA	12,1%	8,0%

Universität Bern | Universität Zürich
vetsuisse-fakultät

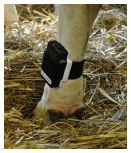
Prediction of calving time in dairy cows by using digital systems
- Rumiwatch and Pedometer -

Department of Clinical Veterinary Science, Clinic for Ruminants, Vetsuisse-Faculty University of Bern
Klauentierklinik, Universität Leipzig, Deutschland

RumiWatch

noseband sensor

with data logger registered the pressure during jaw movements to measure ruminating, eating, drinking, or other activity

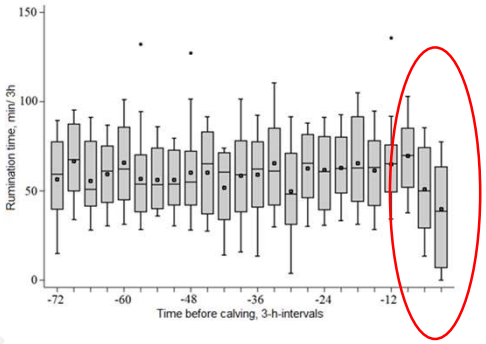


pedometer

locomotion activities (walking, lying, standing) were measured by a three-dimensional accelerometer

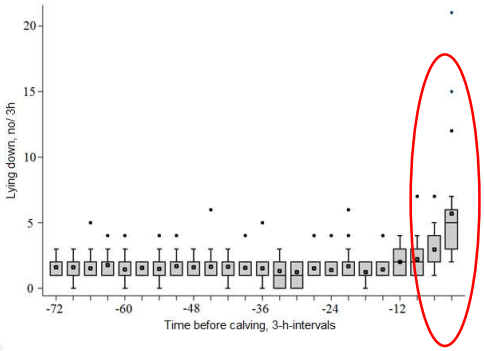
RumiWatch - System (ITIN+HOCH GmbH, Fütterungstechnik CH-4410 Liestal, Switzerland)

Jaw movements to measure Rumination



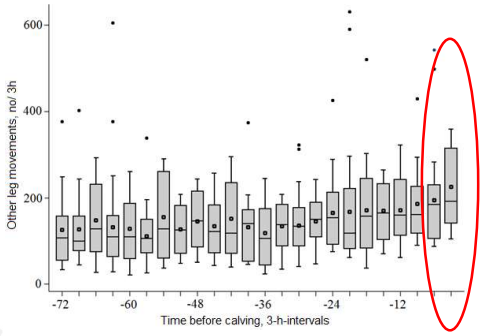
Bogdahn (2016)

Lying Time



Bogdahn (2016)

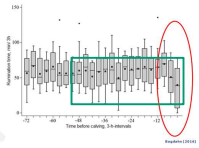
Other leg movements – Without walking



Bogdahn (2016)

Partly too low accuracy…

Jaw movements to measure Rumination



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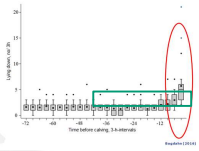

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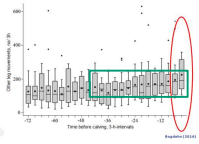
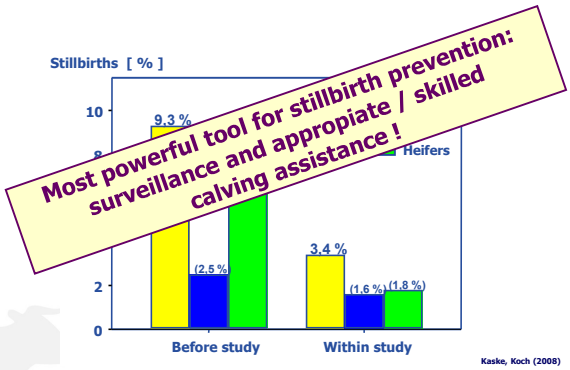
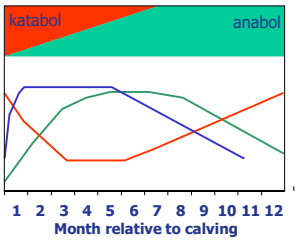


Study results



Kaske, Koch (2008)

Challenge - Energy intake, milk yield and body condition post partum



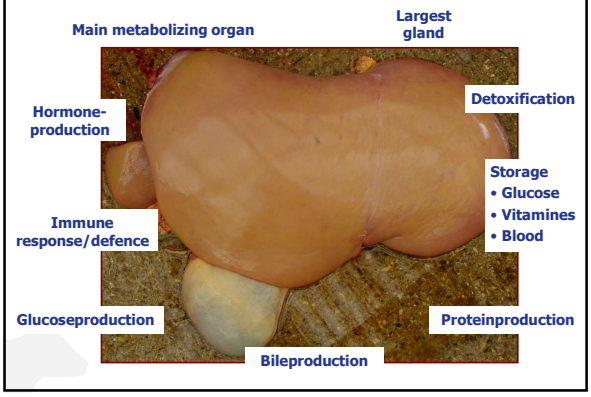
Compensation of energy deficit

- lipomobilization
- proteinolysis
- reduced extramammary substrate utilisation

Feed intake | Milk yield | Body condition

Modifiziert nach Bell (1995) J. Anim. Sci. 73, 2804-2819

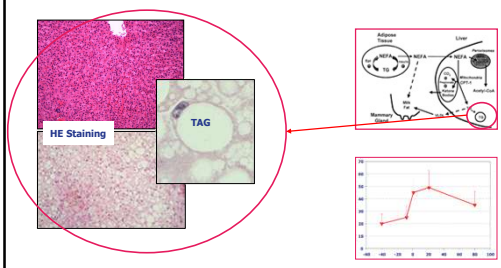
Key role of the liver



Fatty liver
Current and ongoing problem in dairy cows (and humans)

- over 50% dairy cows – moderate - severe Fatty Liver (Reid 1980, Gerloff 1984, Jorritsma et al. 2001)
- Reduction of productivity (Reid & Roberts 1982 , Reid 1983, Sweeney et al. 1988, Drackley et al. 1992)
- High risk for other periparturient diseases (Morrow 1976, Gerloff 1984, Herdt 1988, Rehage et al. 1996, Bobe et al. 2004)
- High economic damage (Bobe et al. 2004)

Fat infiltration in the Liver – *Liver cells*



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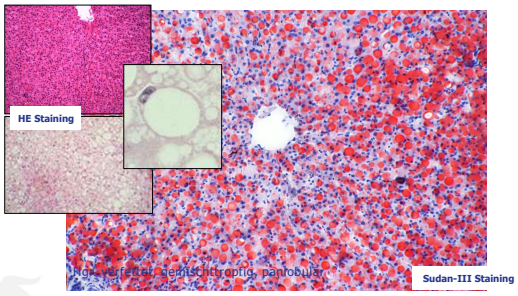


Non invasive detection of the liver fat content

Fat storage ➡ echogenicity increase

Toshiba Power Vision 6000, B-Mode, 5 MHz, convex probe

(Grote 1992, Lauener 1993, Delling 2000)

Size of the speckles

- positive correlation to fat content

Distance between the speckles

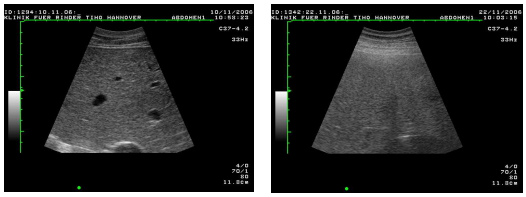
- positive correlation to fat content

Differentiation of the speckles

- speckles become washy and cloudy with increasing fat content

(Grote 1992, Lauener 1993, Delling 2000)

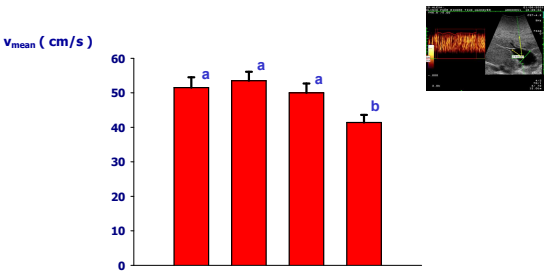
Higher liver fat content - Less blood vessels ?



Liver fat content

low	high
(41.6 ± 1.5 mg/g)	(246.8 ± 9.2 mg/g)

Influence - Liver fat content - Hemodynamic in the portal vein



a, b, c $p < 0.05$

(Starke et al. 2011)

Fatty liver and hemodynamic changes

Liver fat infiltration

⇩

Enlargement of the organ (Morrow 1979, Haudum et al. 2010)

⇩

Higher intrahepatic pressure (Orrego et al. 1981)

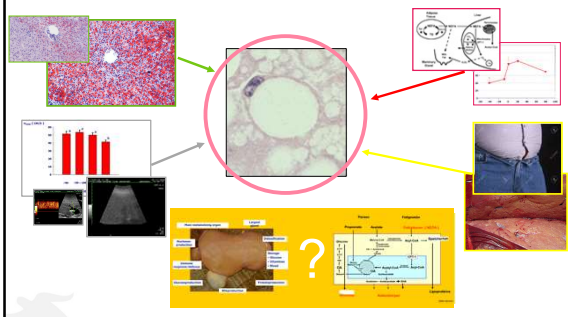
⇩

Compression of blood vessels (Mortens 1992, Weijers et al. 2010)

⇩

Deminished hepatic perfusion (Dietrich et al. 1998, Seifalian et al. 1999, 2001)

Fat infiltration in the Liver – *Liver cells, What happens ?*



Fatty liver and hemodynamic changes

Liver fat infiltration

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Enlargement of the organ (Morrow 1979, Haudum et al. 2010)

⇩

Higher intrahepatic pressure

⇩

Compression of blood vessels (Mortensen et al. 2010 ; Weijers et al. 2010)

⇩

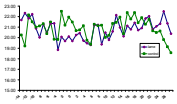
Deminished hepatic perfusion (Dietrich et al. 1998, Seifalian et al. 1999, 2001)

Cell necrosis, Chronic liver disease, Steatosis to non-alcoholic steatohepatitis (NASH) to Cirrhosis

= Non-alcoholic fatty liver disease (NAFLD) in Humans

Injuries during parturition, stress, crowding, bad cubicles, displaced abomasum, food quality, pain, insufficient water supply...

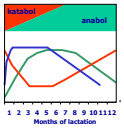
↓



Reduced feed intake

↓

Negative Energy Balance



↓

Lipomobilization

↓

Ketosis / Fatty Liver

Reduced Fertility | **High Risk for Mastitis** | **Loss of Milk yield**

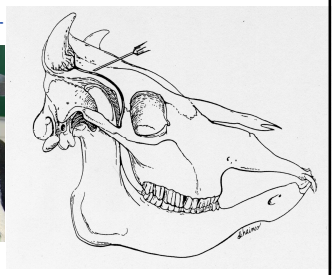
(Lucey et al. 1986; Collick et al. 1989; Lee et al. 1989; Hernandez et al. 2000)

Pain management

Local anaesthetic

of the *ramus cornualis* of the *n. frontalis*, of the *n. maxillaris* (*n. trigeminus* (V2))

Entlang der Linea temporalis
(Crista frontalis)
ca. 3 - 5 cm in Tiefe bis auf Knochen einstechen -
10 ml Lokalanästhetikum als Depot absetzen

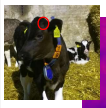


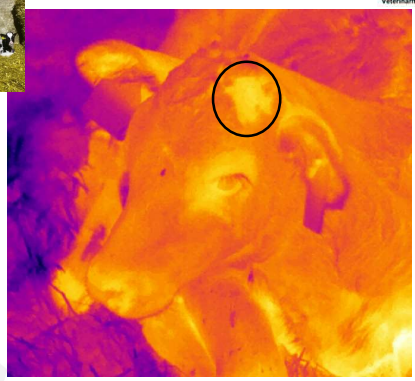
RIEBOLD, GEISER u. GOBLE (1995): Large Animal Anaesthesia. 2. Aufl., Iowa State University Press

Study protocol

Minuts		
	-60	
	0	Dehorning
	+5	
	+30	
	+60	
	+90	
	+120	
	+240	
	+480	

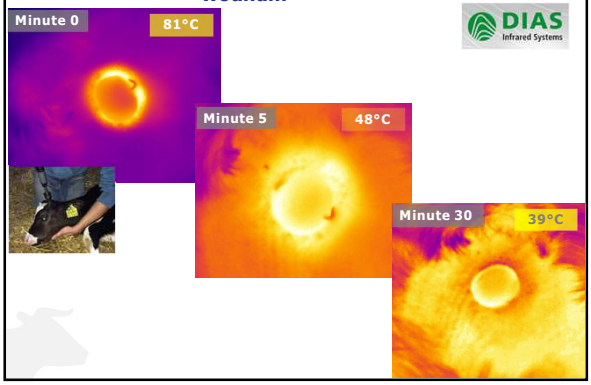
Lokalization



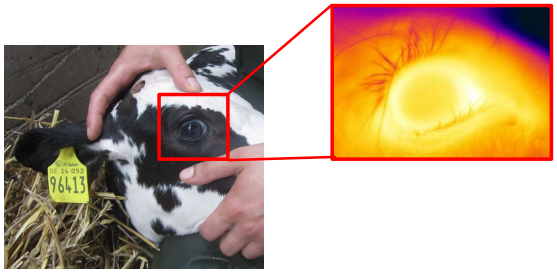


Lokalization

Temperature protocol on the dehorning wound…

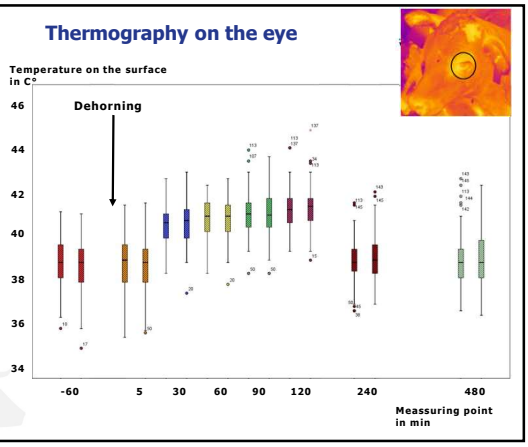


Thermography on the eye



Schaefer et al. (2007), Stewart et al. (2007), Johnson et al. (2011), Hoffmann et al. (2013)

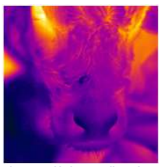
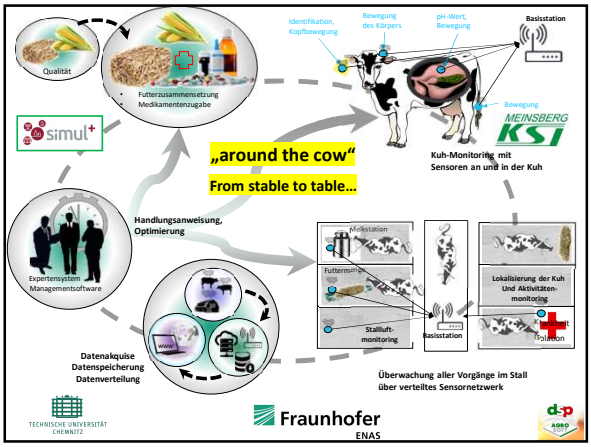
Thermography on the eye



The Future…

Controlling….

Thermographische Darstellung eines gesunden Kalbes mit oberflächlicher Temperatur am Flotzmaul von 35,4°C



Thermographische Darstellung eines kranken Kalbes mit einer oberflächlichen Flotzmaultemperatur von 21,5 °C; Klinische Symptome: Apathie, Nasenausfluss, Lungengeräusche