

TrackLab 2: Automatic recording and analysis of the behavior of animals kept in groups



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NOLDUS INFORMATION TECHNOLOGY



- Developer of software, hardware and integrated solutions for measurement and analysis of animal behavior, health and welfare
- Founded in 1989 (spin-off from Wageningen University)
- Headquarters in Wageningen, The Netherlands, offices in 9 countries
- 165 employees
- > 10,000 customers
- Clients: universities, research institutes, corporate R&D departments



INDIVIDUAL BEHAVIOR OF GROUP-HOUSED ANIMALS

Trends

- Farm animals are increasingly kept in groups
- Farms are becoming larger
- Adoption of Precision Livestock Farming methods

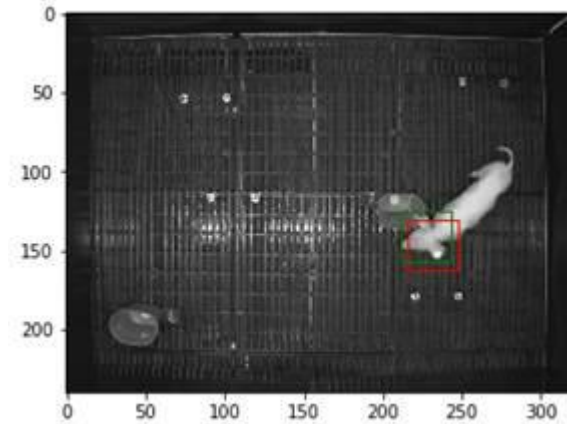
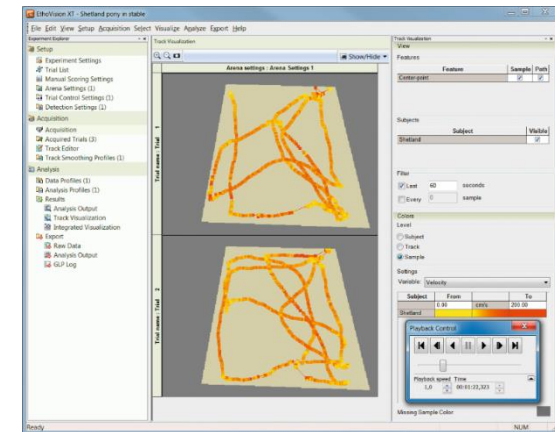
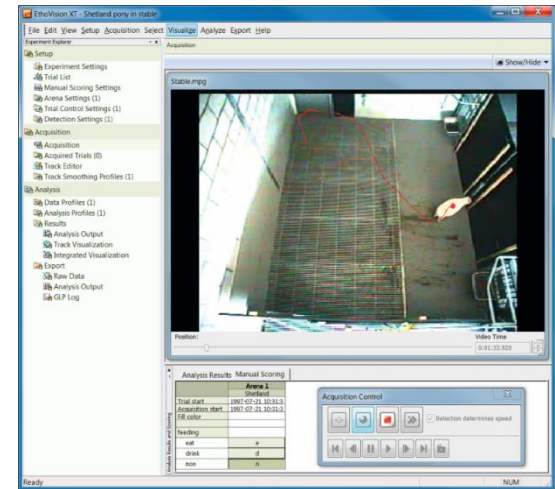
Needed

- We should be able to monitor the behavior, performance and welfare of **individual animals** housed in (large) groups



VIDEO TRACKING

- Automated measurement of activity, locomotion, spatial behavior, presence in zones, interaction with other animals
- High spatial accuracy
- High temporal resolution
- Automatic behavior recognition using AI
- Identification based on body size or color
- Works well in small arena (pen, box), with small numbers of animals, and homogeneous light



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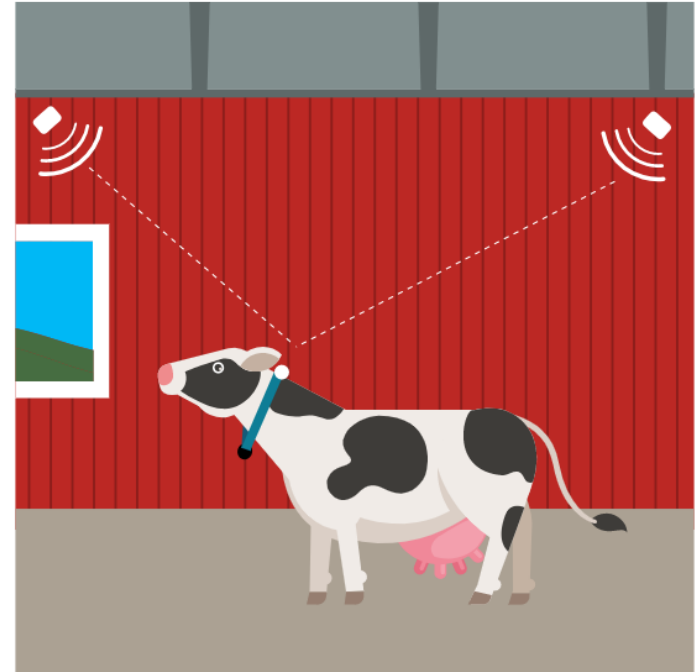
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LIMITATIONS OF VIDEO TRACKING

- Does not work with large numbers of similarly looking animals (identification)
- Does not work in large spaces (perspective distortion, occlusion)
- Does not work under variable light conditions
- Does not work well with changing backgrounds
- Beyond body center tracking: each animal species requires a different shape model

ULTRA WIDEBAND TRACKING

- Animal positioning based on ultra wideband (UWB) radio communication between tag (on animal) and sensors (mounted on wall or ceiling)
- Tags on collar, ear tag or backpack
- UWB tracking: accurate (30 cm), reliable, scalable
- Can be extended with other sensor technologies
- For animal studies in large indoor spaces or outdoor enclosures (e.g. feedlot)
- For tracking of one to many animals (with identification)



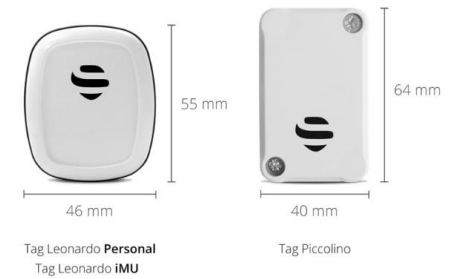
Ultra-wideband tracking hardware



Sensor mounted to wall



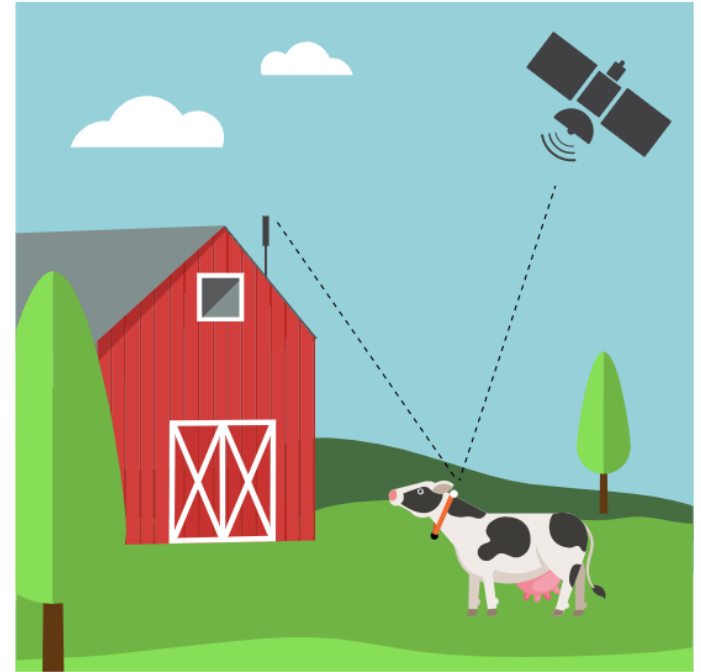
Backpack for chicken



Tag attached to animal

GPS TRACKING

- Animal positioning based on GPS sensing, followed by LoRa data transmission
- Tag on collar or ear tag
- Spatial accuracy approx. 2.5 m
- Can be extended with other sensor technologies
- For animal studies in large outdoor spaces (up to 10 km from LoRa gateway)
- For tracking of one to many animals (with identification)



GPS tracking hardware



GPS collars with battery or solar panel



LoRa gateway (10 km range)

SOFTWARE: OUR AMBITION

Needed

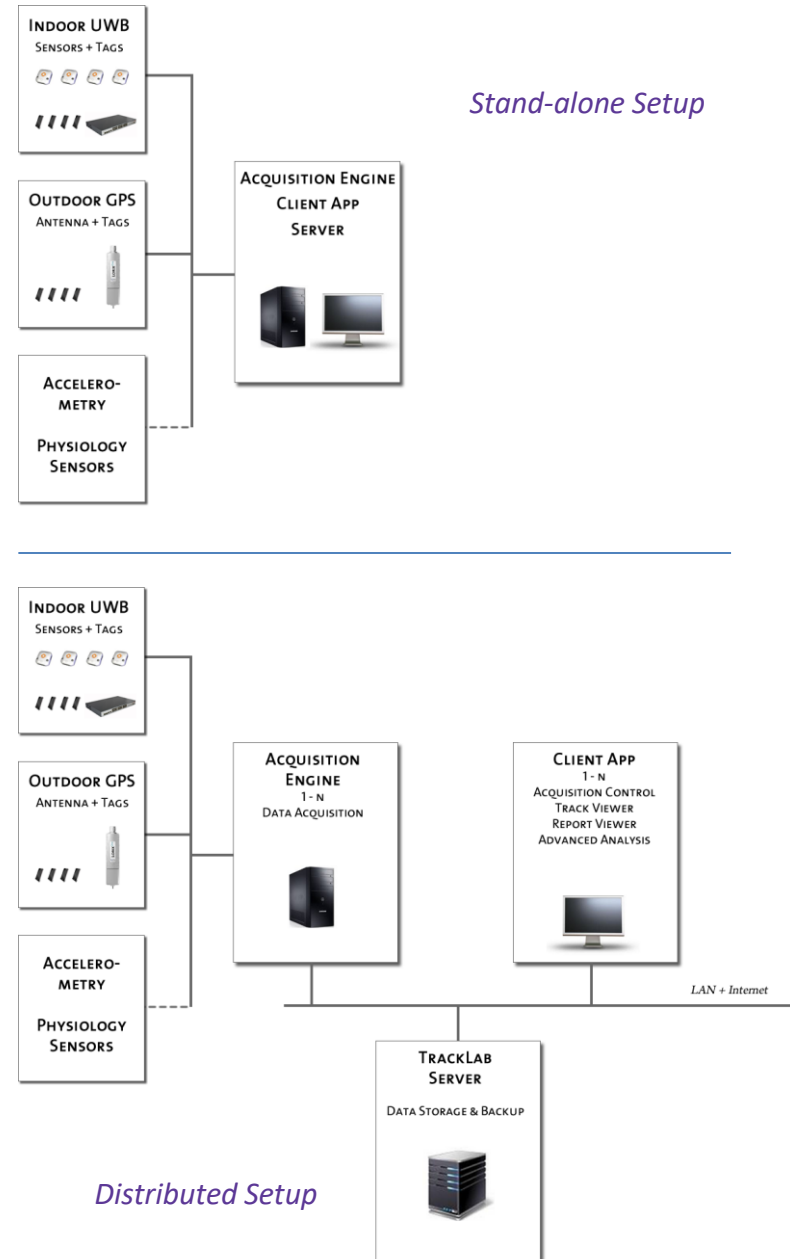
- Software package for experiment design, data acquisition, storage, visualization and analysis
- Sensors + data processing hardware + software = seamlessly integrated end-to-end solution for livestock research and R&D in the livestock industry

Requirements

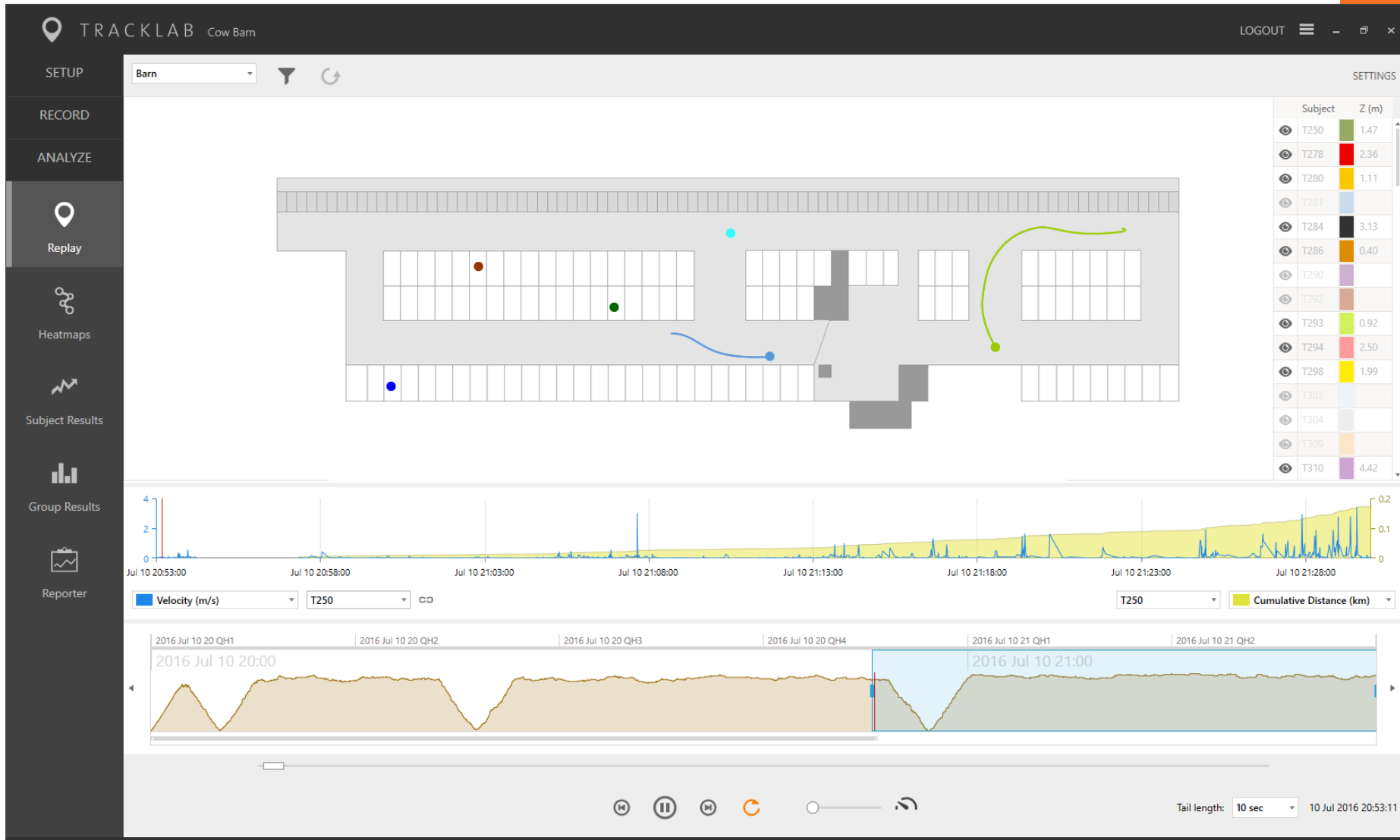
- Stand-alone (single computer) or distributed setup (network)
- Scalable: multiple animals, multiple locations, multiple users
- Multi-sensor support (UWB, GPS, 3D accelerometer, gyroscope, magnetometer)
- Researcher-centered design: white box, open I/O
- User friendly interface

TRACKLAB 2.0 SYSTEM ARCHITECTURE

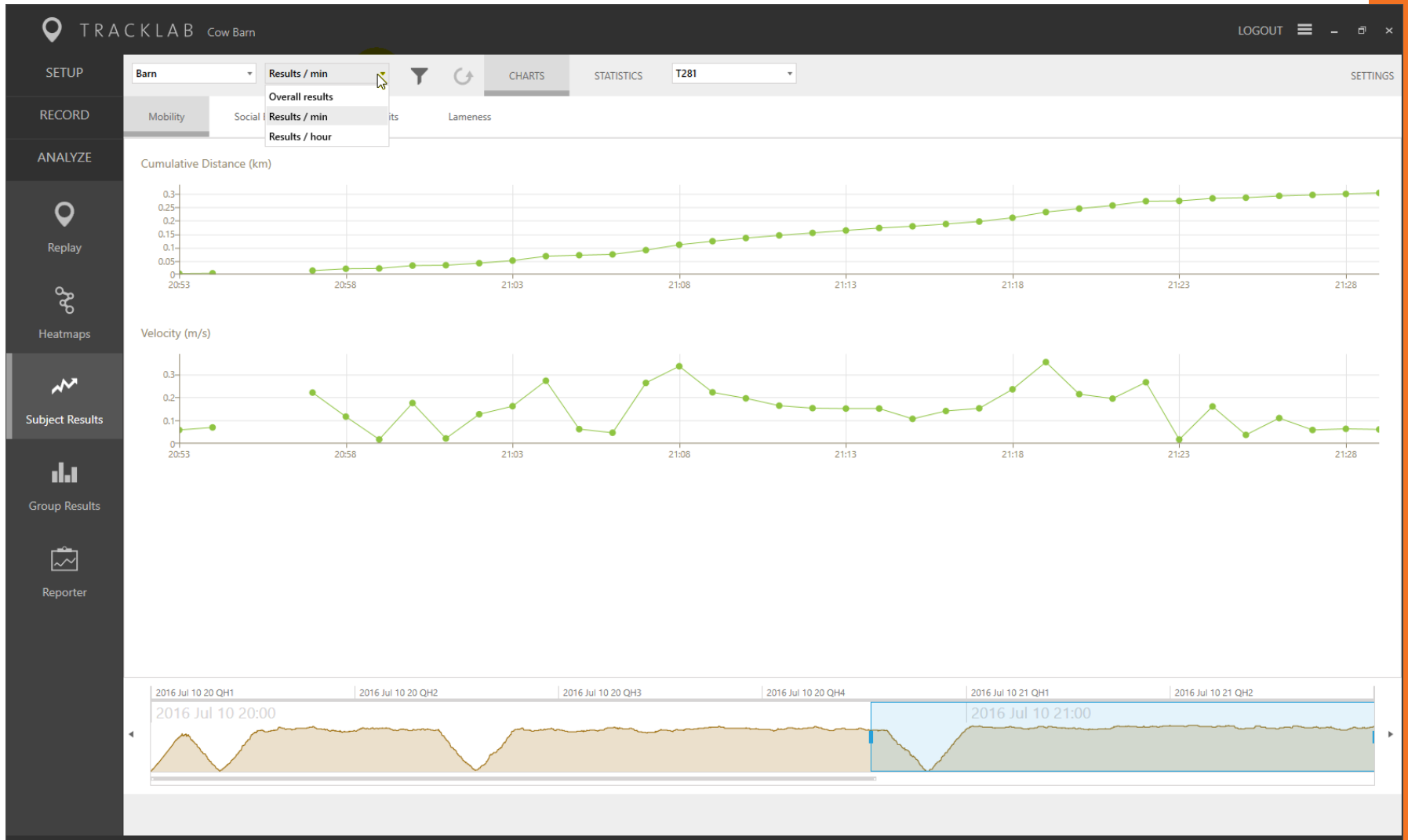
- Stand-alone or distributed setup
- Distributed setup:
 - Measure in the barn
 - Store and process data on the server
 - Analyze at your desk
- Scalable setup:
 - Multiple barns
 - Multiple software users
 - Central data storage



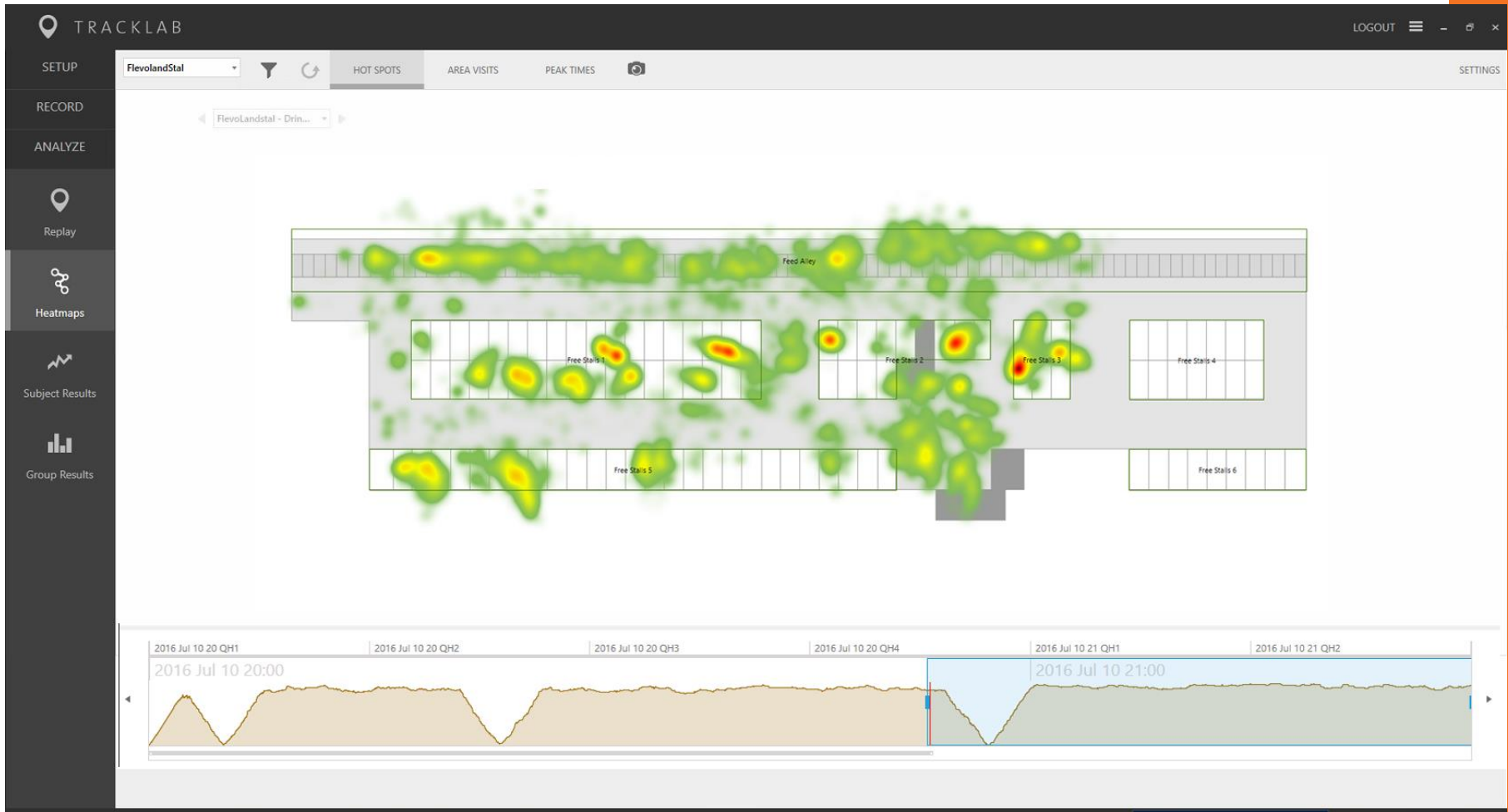
TrackLab: Data replay



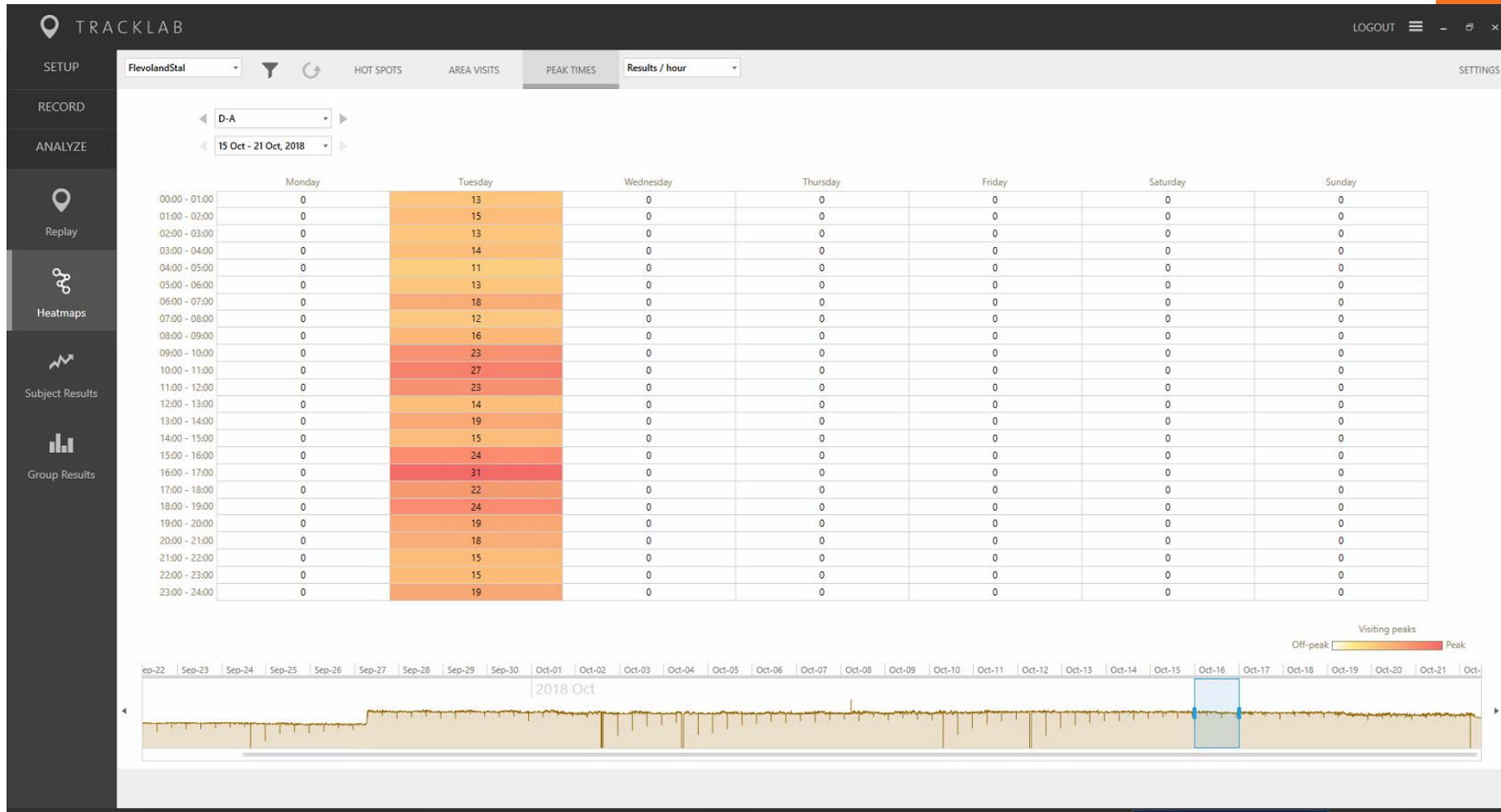
TrackLab: Statistics per user-selectable timebin



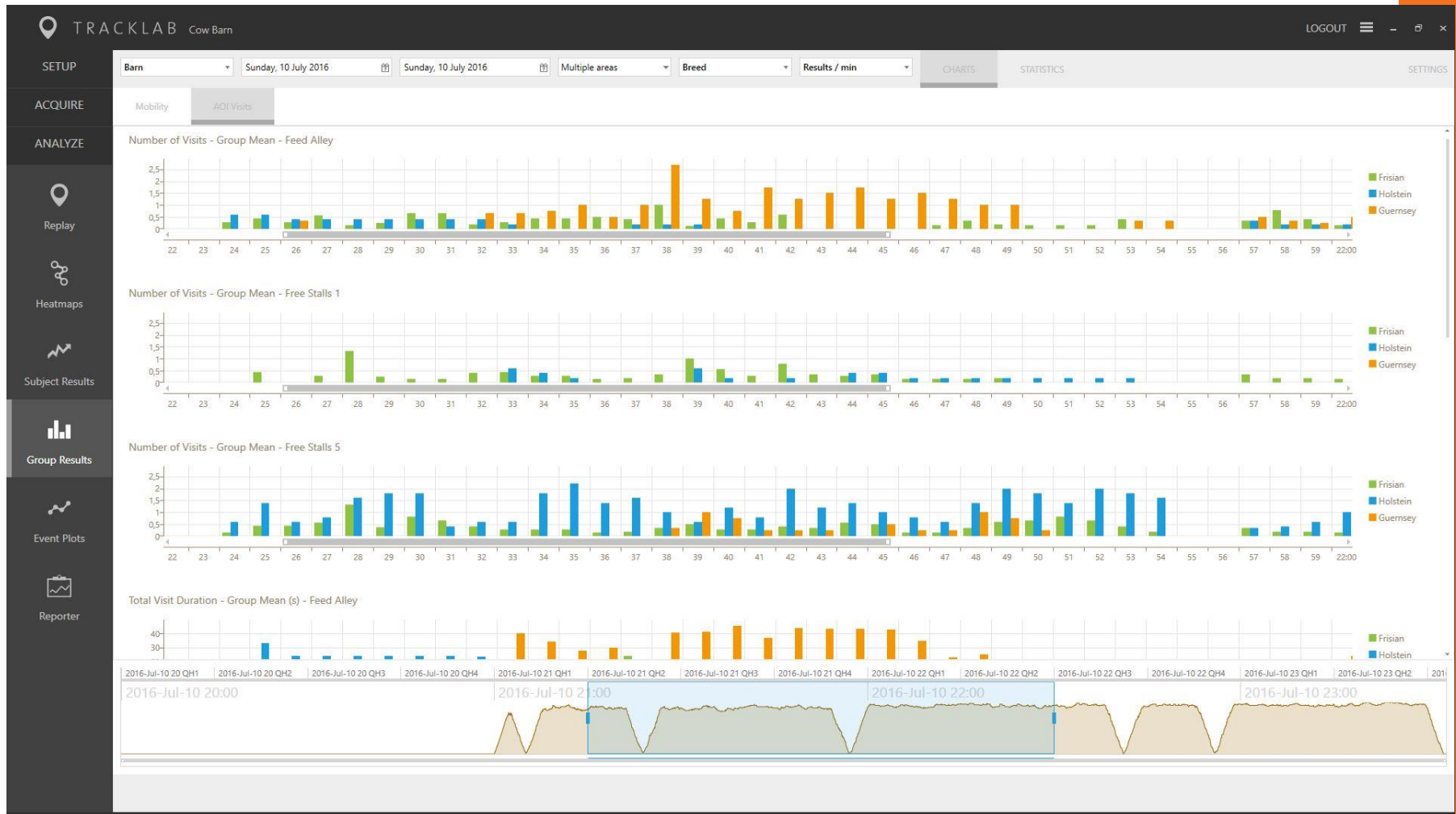
TrackLab: Qualitative heatmap



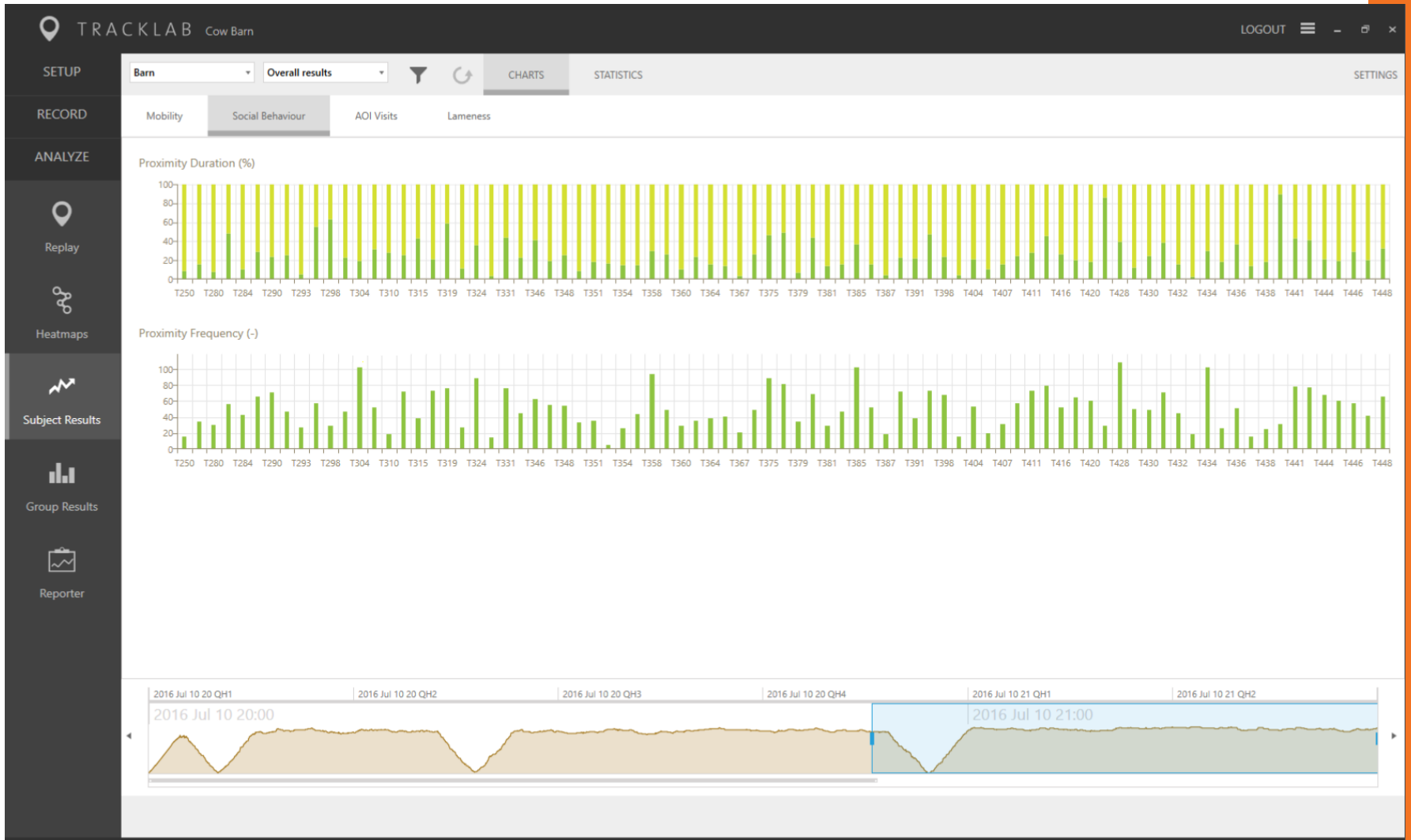
TrackLab: Timetable heatmap



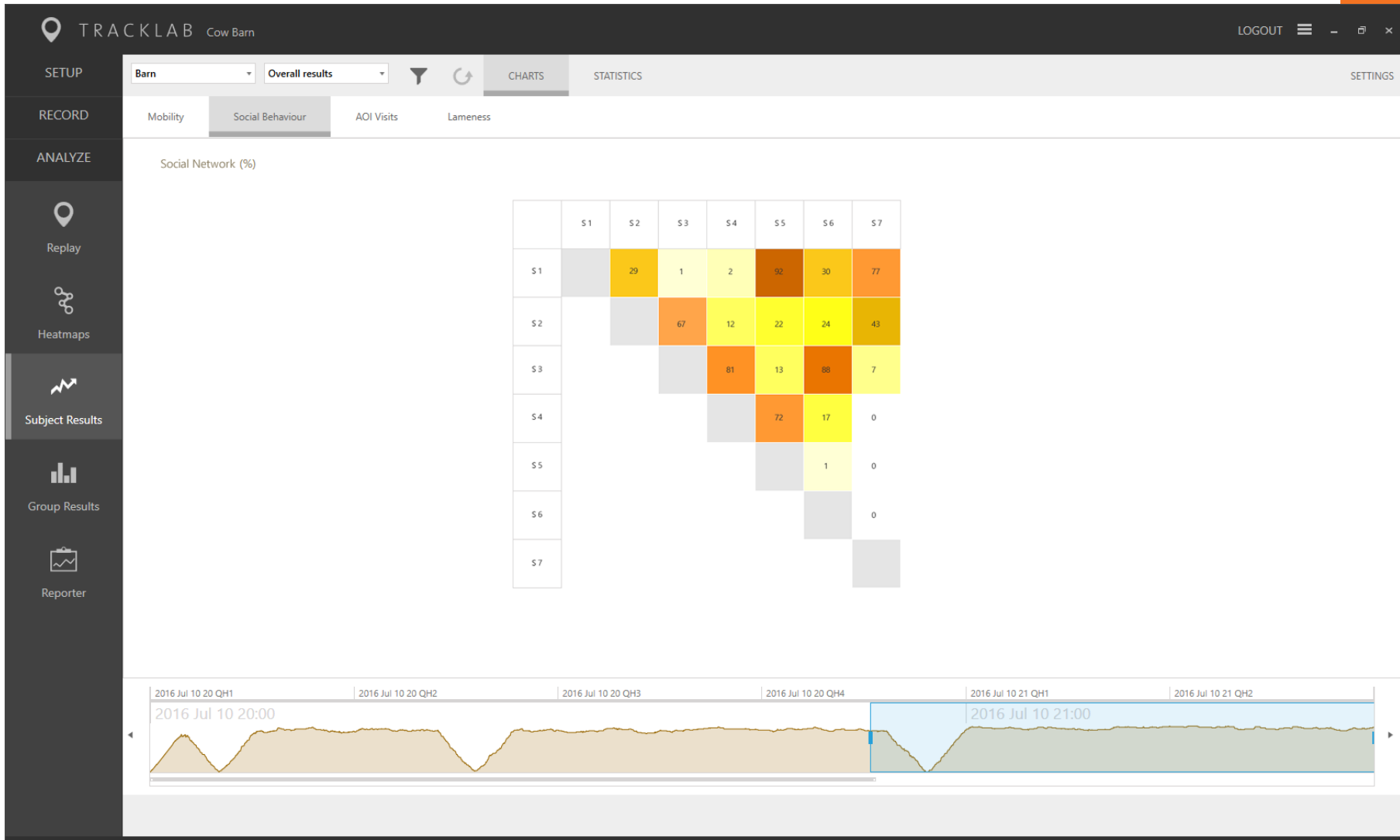
TrackLab: Area visit statistics



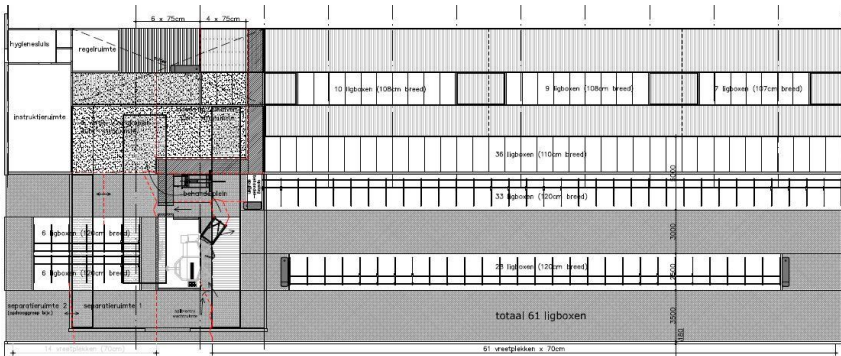
TrackLab: Social behavior – proximity statistics



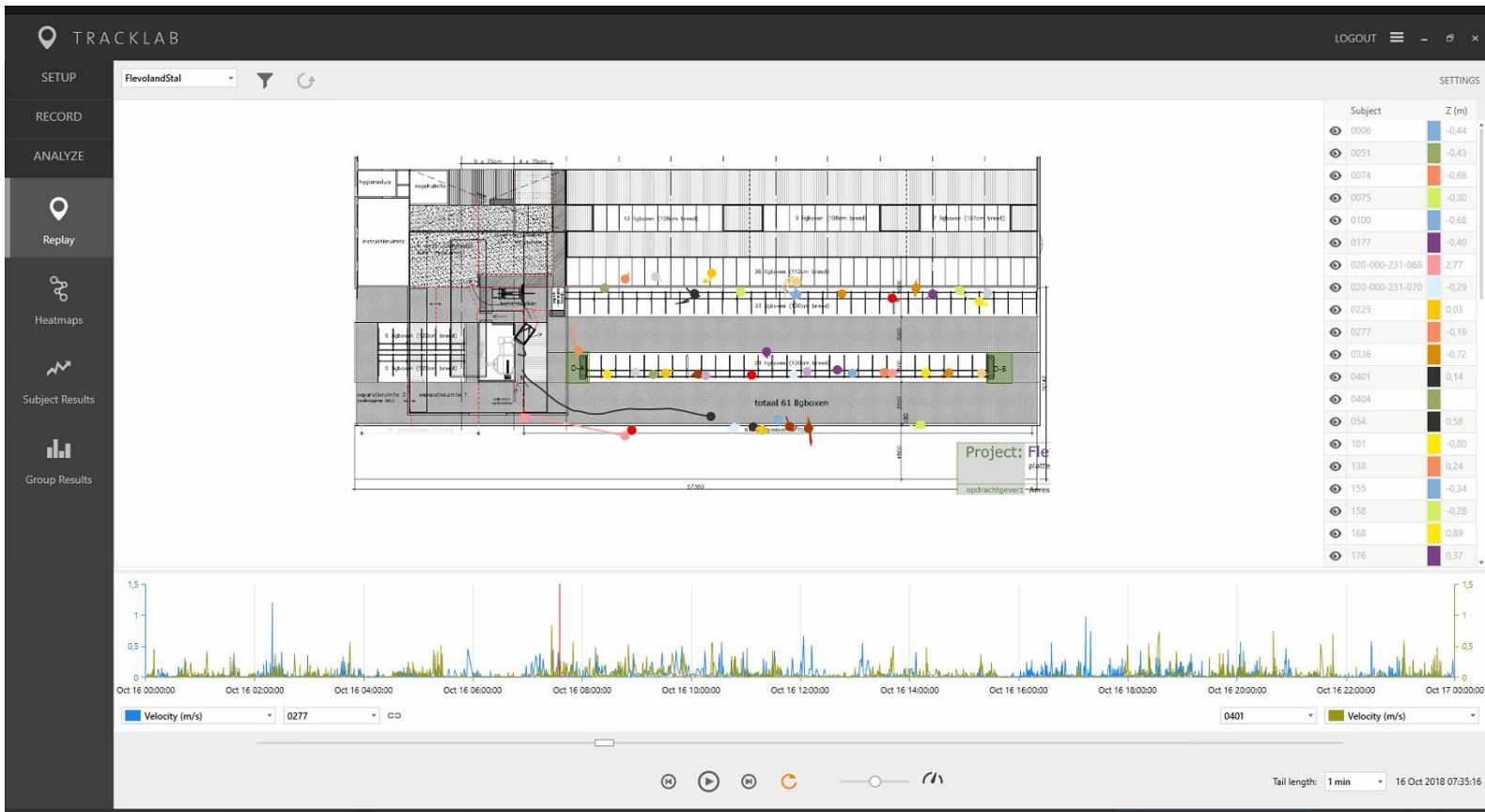
TrackLab: Social behavior – pair relations



Aeres University of Applied Sciences Dronten, Netherlands



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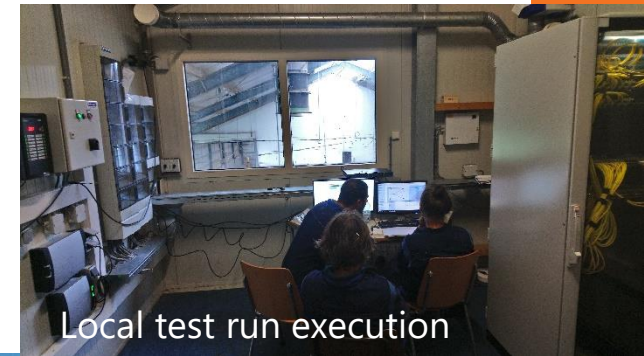
Dairy Campus (Wageningen University) Leeuwarden, Netherlands



Straw bed



Porous textile bed



Local test run execution



Sensor calibration

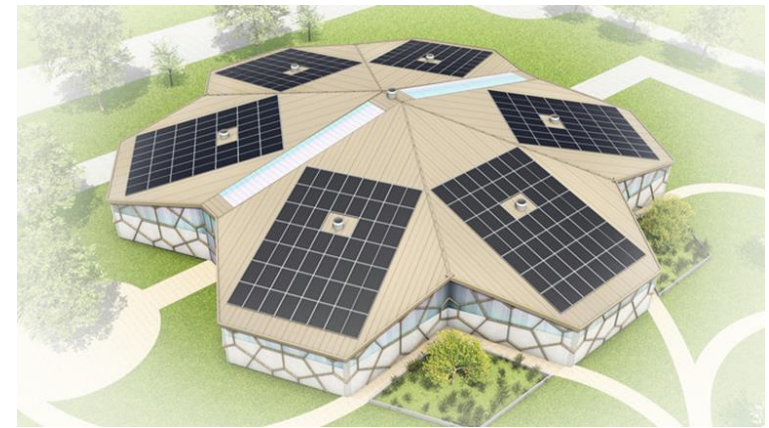


Remote monitoring (wired or wireless)

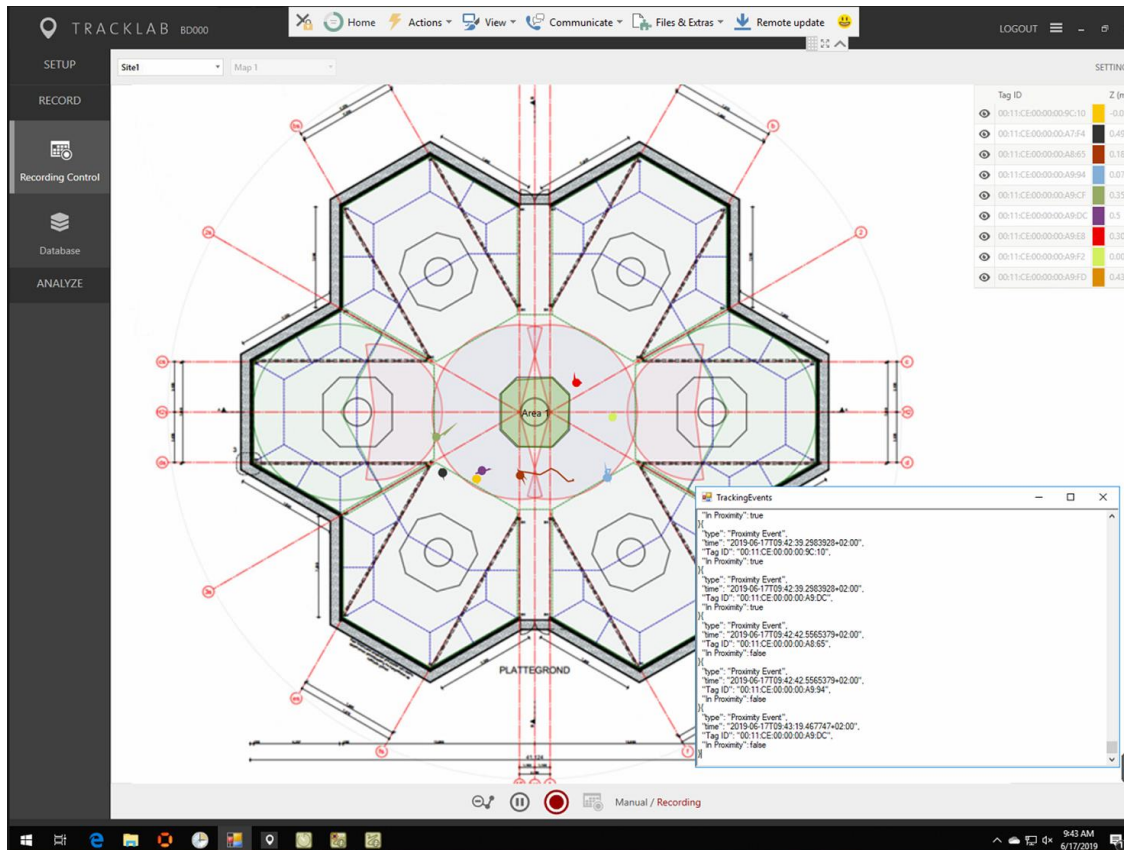
TRACKLAB SITE

Animal Sciences Group, Wageningen University Wageningen, Netherlands



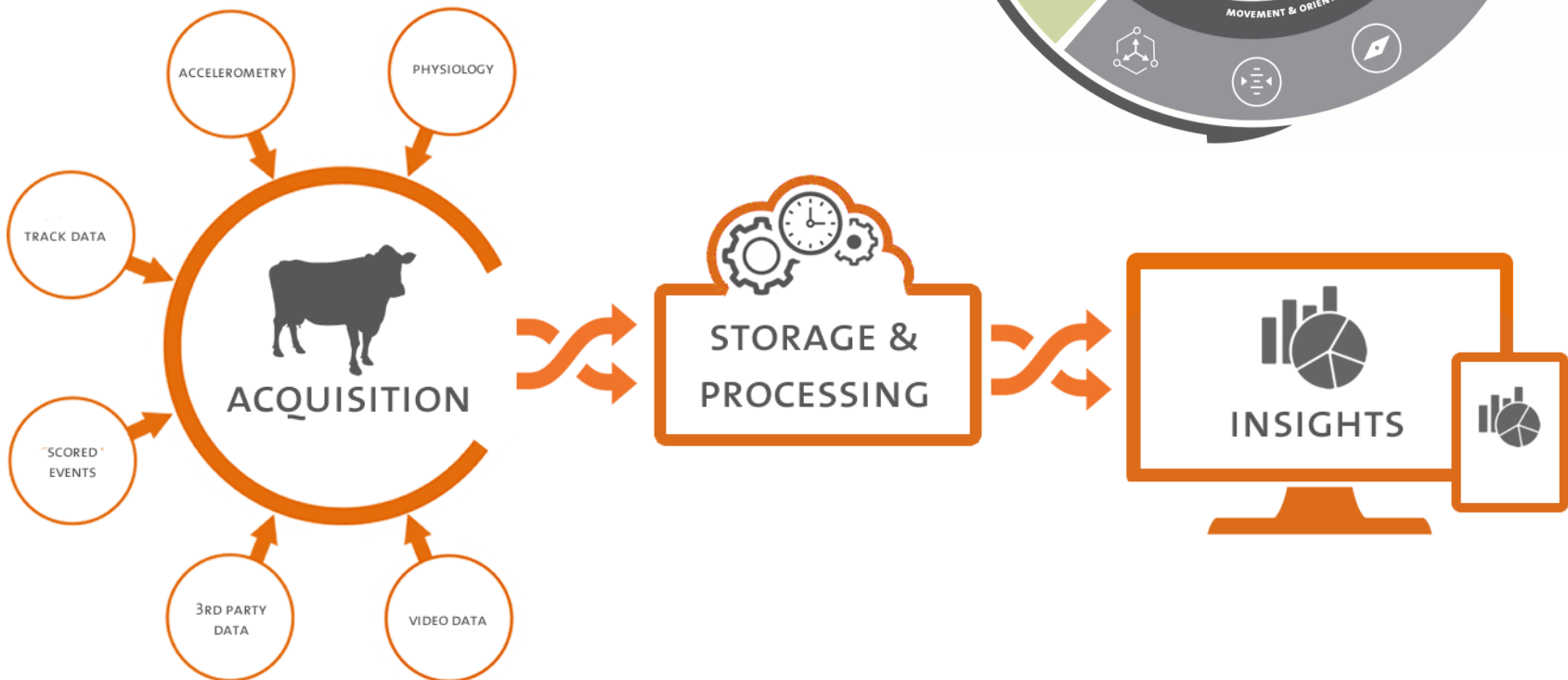


Family Pig Farm Venhorst, Netherlands



- First use in practical (pig) farming context
- Behavior analysis output (subject proximities, area visits) is used as input for individualized feeding and toilet systems
- Improve animal welfare, productivity and emissions reduction

TRACKLAB ROADMAP

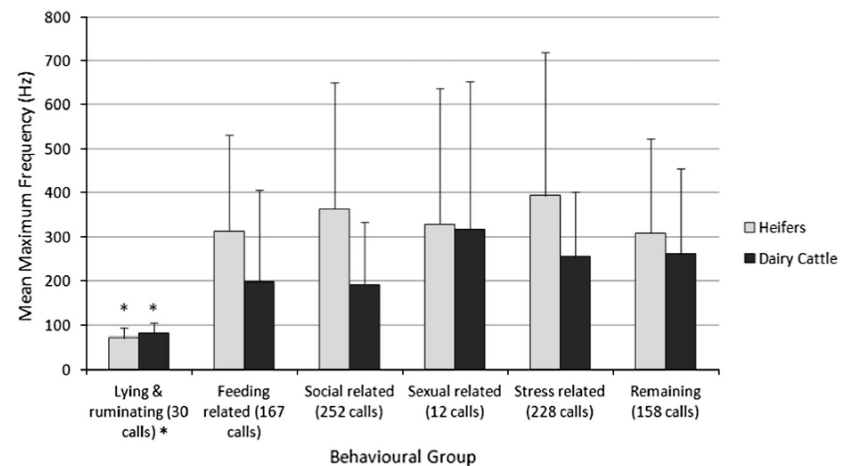


MULTISENSOR PATTERN RECOGNITION

- Sensor fusion and pattern recognition:
 - Detection of complex behaviors
 - Increased reliability of results
- Relevant livestock behaviors:
 - **Posture:** lying, standing, walking, falling, jumping
 - **Feeding:** eating, drinking, ruminating
 - **Social:** grooming
 - **Disease:** lameness
 - **Aggression:** tail biting, head butting, feather pecking
 - **Reproduction:** mounting, calving, estrus

SOUND ANALYSIS

- Analyze animal vocalizations, e.g. in studies of animal welfare
- For cows, pigs, chicken



Sound analysis in dairy cattle vocalisation as a potential welfare monitor



G.H. Meen^{a,*}, M.A. Schellekens^{a,1}, M.H.M. Slegers^a, N.L.G. Leenders^a, E. van Erp-van der Kooij^a, L.P.J.J. Noldus^b

^a Department of Applied Biology, HAS University of Applied Sciences, 's-Hertogenbosch, The Netherlands
^b Noldus Information Technology B.V., Wageningen, The Netherlands

Computers and Electronics in Agriculture 118: 111–115 (2015)

CONCLUSIONS



- TrackLab 2 was successfully tested with **cow**, **chicken** and **pig** behavior
- Tracking hardware:
 - Compatible with farm conditions (e.g. humidity, low temperature)
 - Works well on larger animals (cattle, pigs, adult chicken, sheep)
 - Needs to be optimized (lighter, smaller) for young birds and piglets
- We hope that TrackLab 2 will contribute to:
 - **Livestock research**: behavioral phenotyping, testing diets, welfare and health monitoring
 - **Precision livestock farming**: monitoring individual animal health and welfare, enhancing housing and management systems

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THANK YOU FOR
YOUR ATTENTION

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