# Optimization of Mouse Cage Change Cycles Using Continuous Home Cage Monitoring.

John J Hasenau, DVM, DACLAM

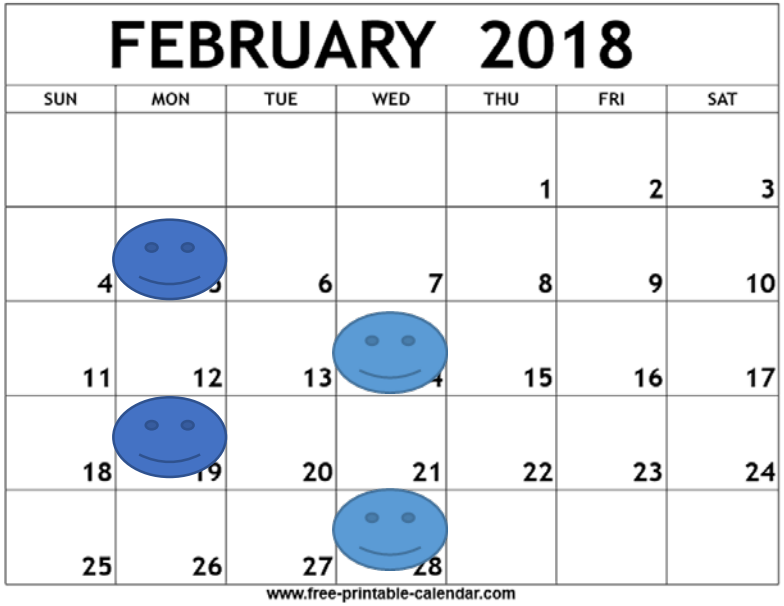
Principal

Lab Animal Consultants

Jan 29th, 2018

# COLONY MANAGEMENT: A CHALLENGE!!

# Mouse Cage Change Cycle's



# Automated Continuous Home Cage Monitoring Systems.

- Automated systems, capturing data 24/7 from the HOME CAGE.
- Started in Europe primarily and are being more commonly seen in North America.
- Primarily started as physiological monitoring (telemetry) then advanced on to neurobehavioral monitoring (video) with the advantage of not disturbing the animal by use of the home cage.
- Current basic technologies for activity/behavioral monitoring:
  - Camera and RFID.
  - Infrared beam and vibration analysis
  - Metabolic analysis of cage air
  - Extremely Low Electromagnetic Fields (EMF)
- Use of EMF technology is newer and is more focused on cage management as well as animal activity/behaviors.

# Home Cage Monitoring Systems

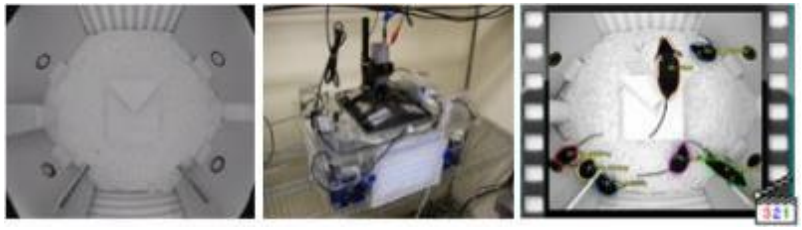
- A few commercially available systems

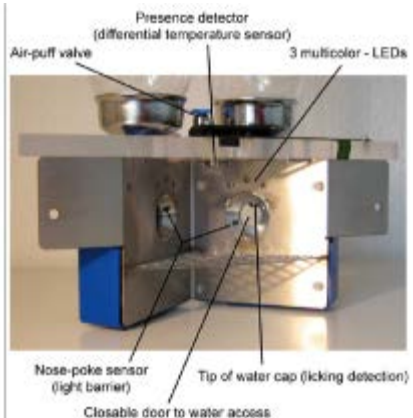
| Company - Product | Technology | Pro | Con |
|---|---|---|---|
| CleverSys- HomeCageScan | Automated video analysis | Detect behavior | Individual housing |
| TSE- IntelliCage | RFID | Group housing<br>Activity, Consumptions | Not behaviors |
| PsychoGenics- Phenocube | RFID, Automated video analysis | Group housing<br>Activity, Consumptions,<br>Behavior, metabolism | Not home cage |
| Promethion | Beam break, vibration. | Activity, Consumptions, metabolism | Individual housing |
| Actual Analytics- ActualHCA (Rodent Big Brother) | RFID, Automated video analysis | Group housing<br>Activity, Consumptions<br>Behavior<br>Home cage | Decreased housing density on rack |
| Tecniplast -<br>- Digital Ventilated Cage (DVC) | EMF, Electromagnetic Fields | Activity, Consumptions<br>Home cage<br>Husbandry management | Activity, Not specific behaviors |

RFID = radio frequency identification

# Definition of a home cage?

- **Variable**, some of the “systems” still require animals coming out of their regular holding cages and placed into a different “home cage” where they stay for extended periods of time.  Especially metabolism based caging.
- Others require replacement of the top of the cage lid with specialized lids during the testing.  More so with metabolism analysis components.

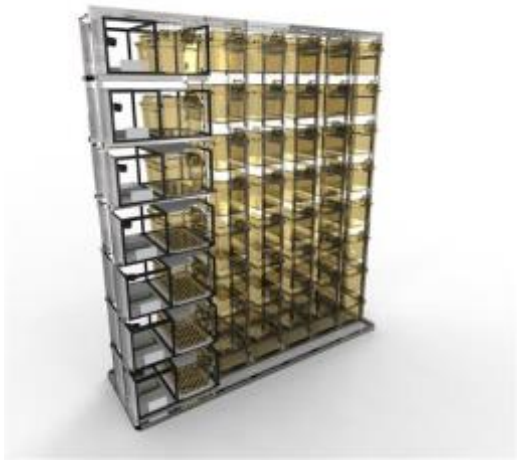


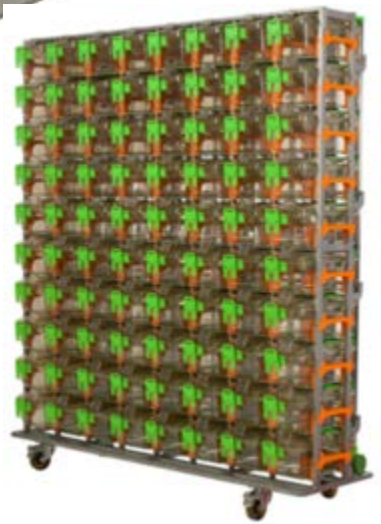


# Definition of a home cage?

- **Variable**, Others only use the actual holding cage but alter the environment around the cage allowing data capture.

- Most systems have some scalability in customized analytic processes.





## CCP-IMG campus Krč, Prague Czech Republic

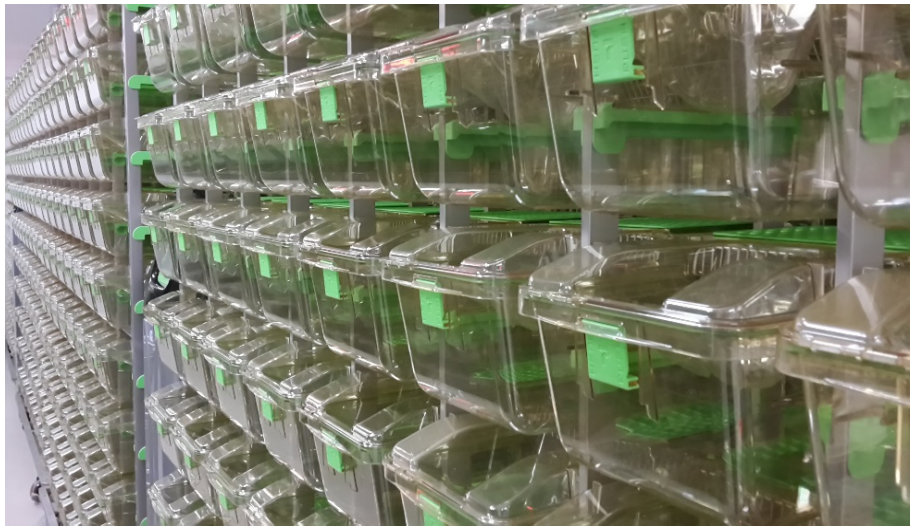
- 3 buildings - 3600 m2
- Mice capacity 10.000 cages
- IVCs and conventional cages

- Barrier breeding facility
- Experimental facility
- 2x Quarantine

## Headquarter - campus BIOCEV, Vestec Czech Republic

- 1 sandwich structure building, 4 floors
- 7200 m2 (64,800 ft2)
- Mice capacity 13,070 cages
- Rat capacity 3,360 cages

- IVCs only
- Barrier breeding facility
- Barrier experimental facility
- Quarantine

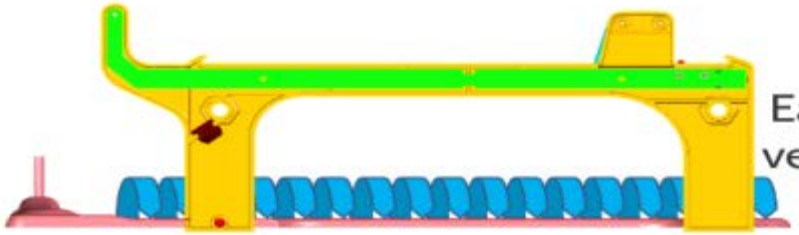


# Second basement

## Breeding core – mice and rats

DVC™ DIGITAL VENTILATED CAGE

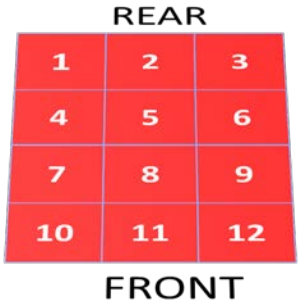
# The working principle

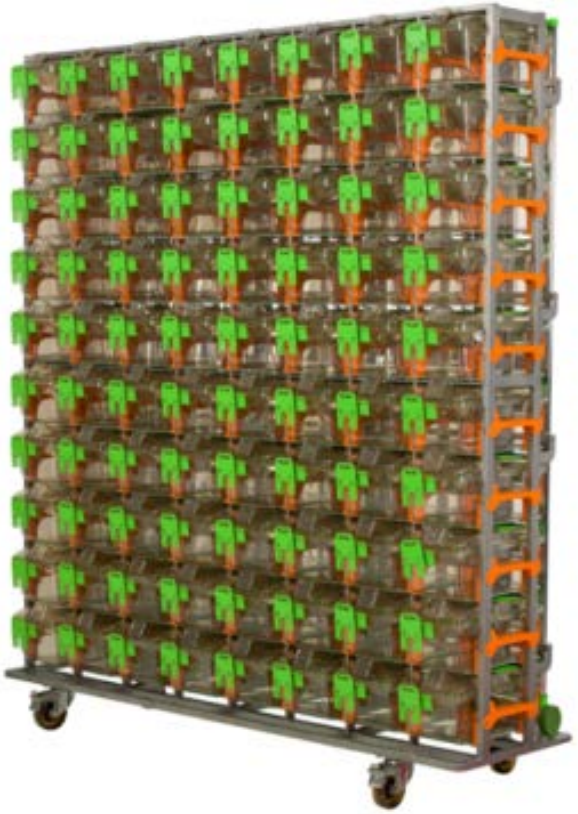


Each electrode is generating a very tiny electromagnetic field

All the materials above these fields are affecting them based on their physical properties

# Digital Ventilated Caging (DVC) utilizes EMF/ELF for automated home cage monitoring



12 sensors map cage floor
Each has a low frequency/energy EMF/ELF which is impacted by *dielectric materials*, e.g. mice
(Faraday's Law)

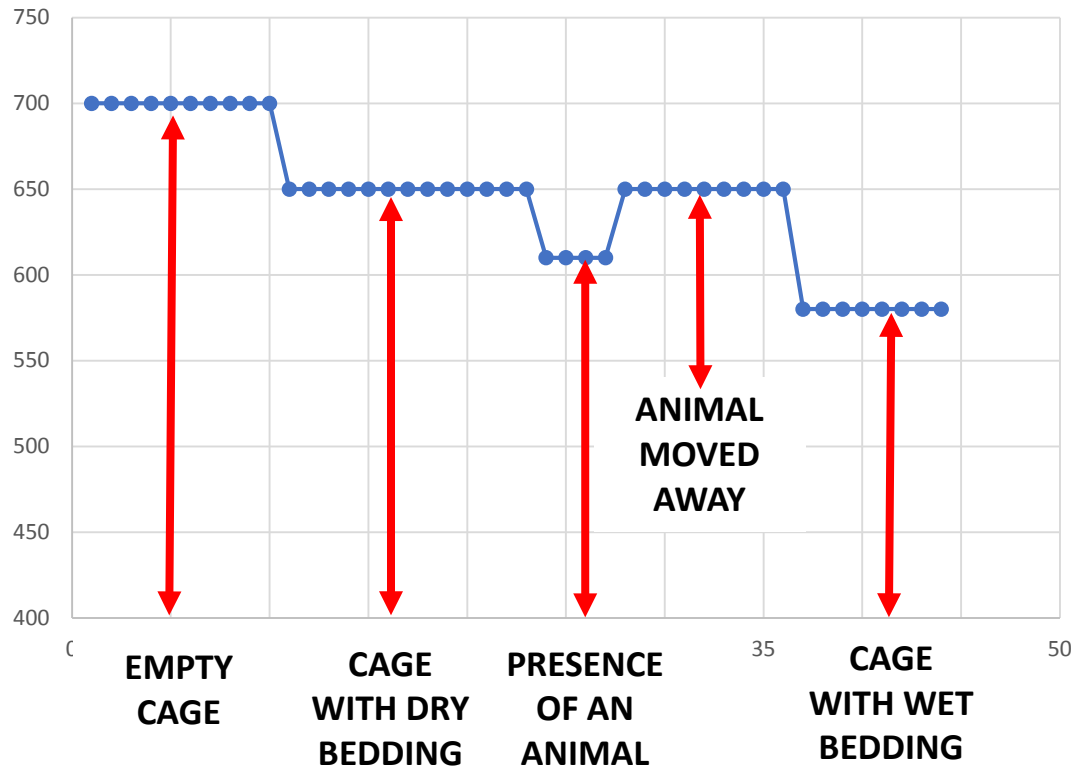
**Goals**

**1)** Continious 24/7 Welfare check

**2)** Auto-Phenotyping

i.e. “aberrations” from standard

# DVC Board working principle



# DVC LEARNING PHASE

Before starting the running phase, a specific dedicated phase to establish BIOCEV thresholds for declaring a cage dirty was completed: the DVC LEARNING Phase.

During this phase, a DVC Rack was populated with:

20 cages with 2 animals

20 cages with 3 animals

20 cages with 4 animals

20 cages with 5 animals

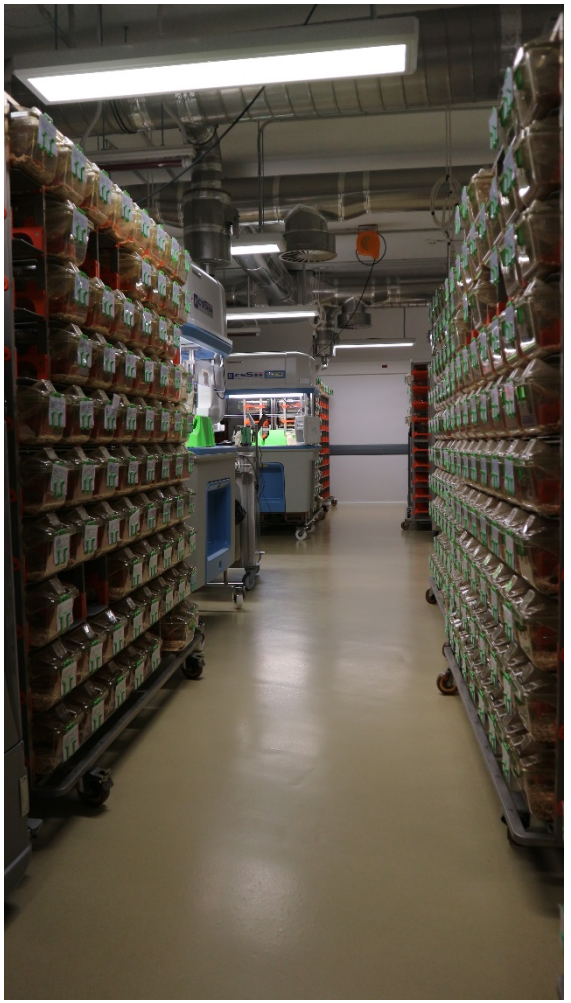
# Cage change comparison

## 1) Period 15/02/2017 – 15/05/2017

FIXED BIWEEKLY CAGE CHANGE (some exceptions due to the breeding cages) Calendar based.

## 2) Period 16/05/2017 – 12/08/2017

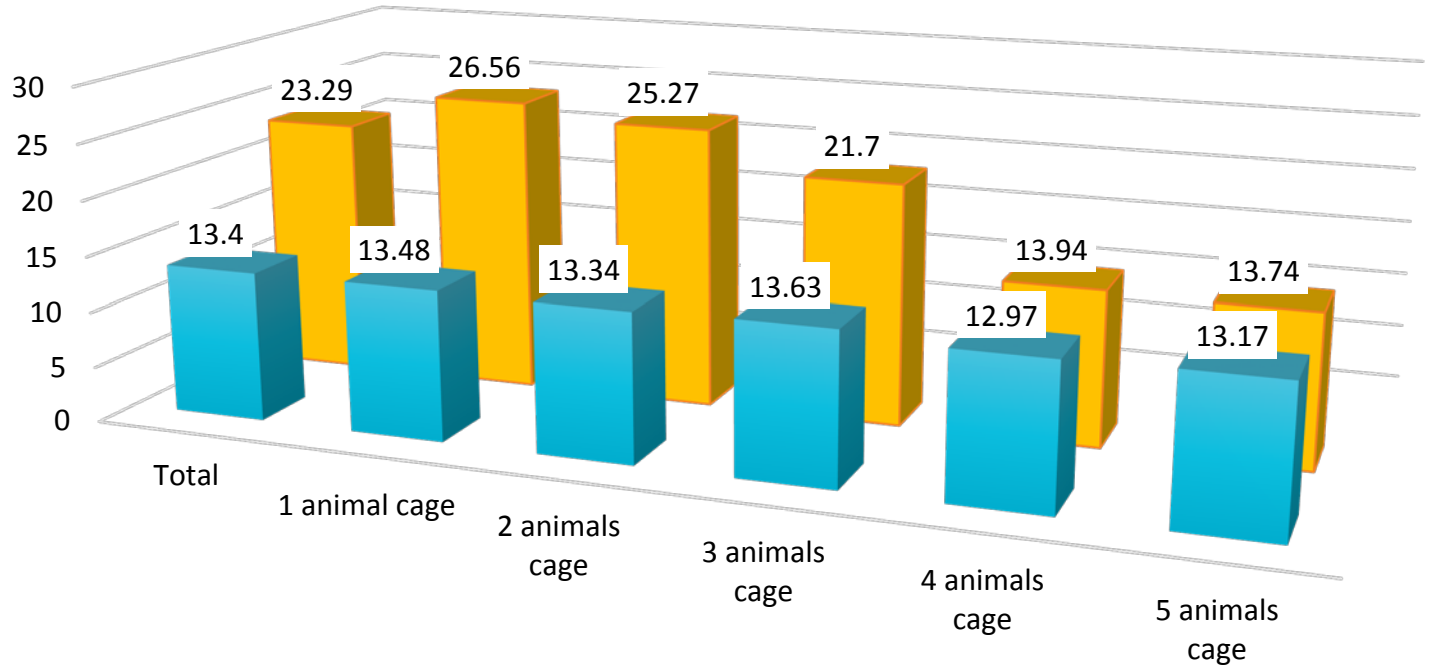
CAGE CHANGES triggered by DVC system, Criteria based.



# Cage change Interval comparison

**Phase 1**: Biweekly cage change [average days]

**Phase 2**: DVC cage change [average days]




From 13.40 days to 23.29 days (as an average of all the cage groups)

~ 40%

reduction

# The Math!!

13.4 days/23.29 days x 100 = 57.54% - 100 =

42.46% reduction

With 5K cages.

# changeouts/yr, **calendar** based:

365/13.4 = 27.2 cage changes/yr per cage x 5k= 136,194 total cage changes year.

# changeouts/yr, **criteria** based:

365/23.29 = 15.67 cage changes/yr per cage x 5K=

78,360 total cage changes year.

| No. of DVC cages | estimated CC per year without DVC | estimated CC per year with DVC | No. of unused cages per year |
|---|---|---|---|
| 5000 | 136,194 | 78,360 | 57,834 |

# CAGE CYCLE IN ANIMAL FACILITY

**WASHING AREA**

**CLEAN CAGE TRANSPORT**

**100 s**

**ANIMAL HOLDING ROOM**

**DIRTY CAGE TRANSPORT**

# The Math!!

Use of 100 secs for technical handling/cage in cage change out with 5K cages.

76.04 x  57,834= 4,397,697 secs/ 3600 secs per hour = 1,222 hrs.

23.99 x 57,834= 1,387,438 secs/ 3600 secs per hour =385 hrs.

| | time spent with 1 cage in s | time saved per year in s | time saved per year in hour | time saved per year in days ( 8 hr day) |
|---|---|---|---|---|
| Clean Side Tech Time | 76.04 | 4,397,679 | 1,222 | 153 |
| Dirty Side Tech Time | 23.99 | 1,387,443 | 385 | 48 |
| TOTAL | 100.03 | 5785157 | 1607 | 201 |

# 5000 DVC CAGE FACILITY SAVINGS/YEAR

Dirty Technician time

48 days or

55 days (7 hr day)

DIRTY CAGE TRANSPORT

11 200 kg

CLEAN CAGE TRANSPORT

Clean Technician time

153 days or

176 days (7 hr day)

# Collaboration in the Development

Leiden University Medical Center

# Perspectives from the institutional leadership

Jan-Bas Prins

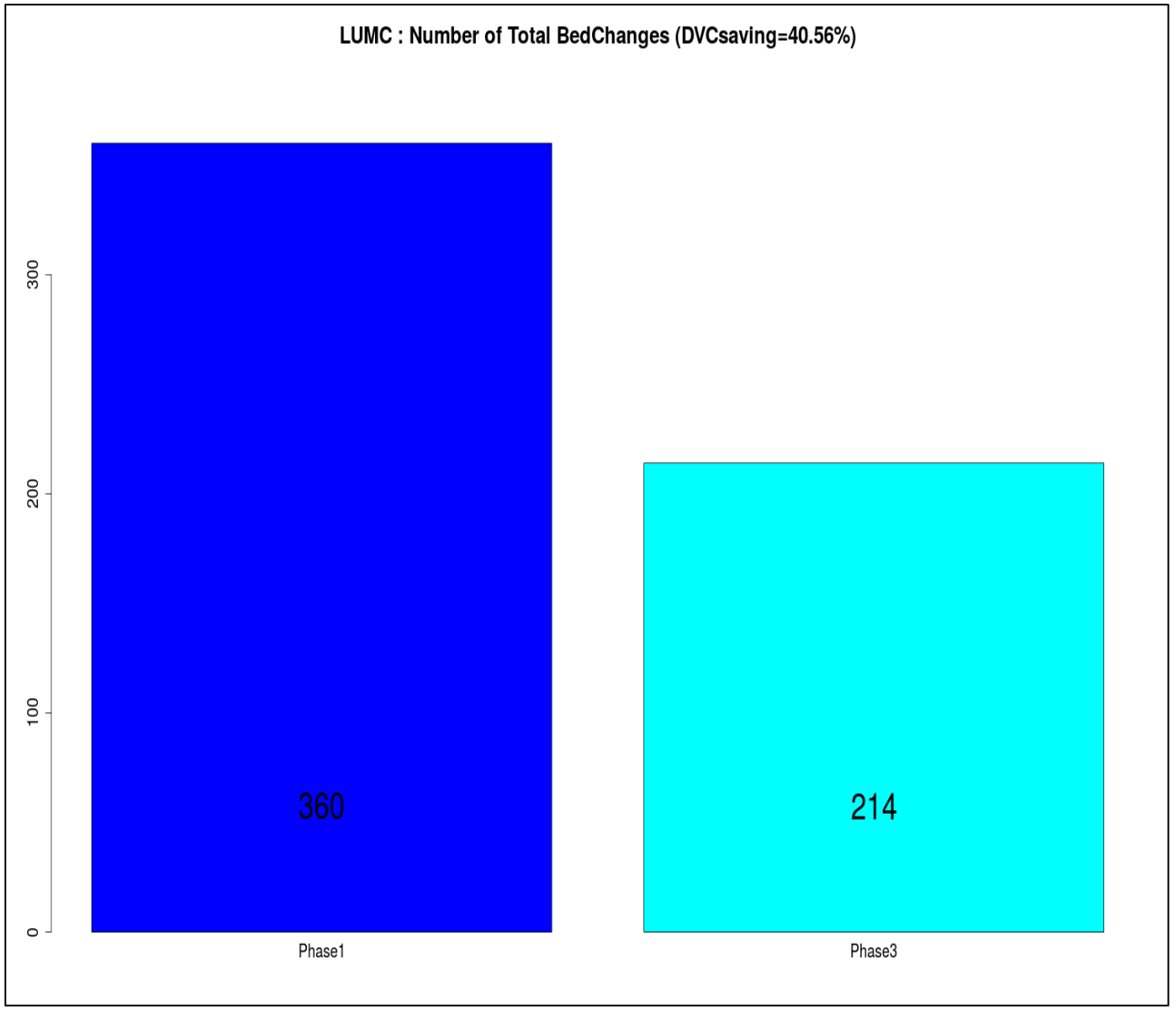
Central Animal Facility

Leiden University, Medical Center

LUMC, LEIDEN, THE NETHERLANDS

# LUMC - Beta site results

**Difference between Phase 1 and Phase 3: 40.56% of Bedding Changes**



# Significant reduction of cage changes per unit of time while maintaining acceptable cage conditions

# Conventional cage change – routine – turned upside down if not reduced to non-existent?!

# Automated Home Cage Monitoring Systems provides other cage management technologies

- Activity condition(s).
- Water supply and leak detections.
- Food supply.

In facilitation of:
- ✓ Daily checks
- ✓ “Disaster” detection

- Census of cages and animals.
- And Ultimately to really work toward study reproducibility and “The Internet of Things”

VOEN Analytics Conference 2018

# Impact Summary

Title: Optimizing Mouse Cage Change Intervals Using Continuous Home Cage Monitoring Systems.

Problem and analysis method: What are Appropriate Mouse Cage Change Cycles and how can these be optimized? Use of Automated Continuous Home Cage Monitoring to determine this.

Summary: 5K cage vivarium going from 14 day cage change cycle to cage change criteria basis achieving an ~40% reduction in cage changes on the average and in some cages extending cage change intervals out to 27 days.

## Impact of the analytics study

**Decisions made/Actions Taken:** **Implementation of the DVC system for continuous cage monitoring and cage criteria change outs.**

**Calculated or actual Improvements:**

Animal Welfare *(reduced cage change stress and study impacts, ability to monitor animal movements 24/7 for improved health concerns)*

Resource use *(Based on a 5K cage facility and an average 40% reduction in cage changes, representing Technician time savings of 48 annual days for cage wash and associated duties (based on an 8hr day) and 153 annual day savings in the animal rooms as well as 11,200 kg savings in bedding materials )*

Cost avoidance (Figures given above are in time and weight as there are huge cost differences across Institutions for these charges) It should also be noted utility charges were not realized in the cost avoidance.

# Thank you for your attention!
# Questions???