TSE systems
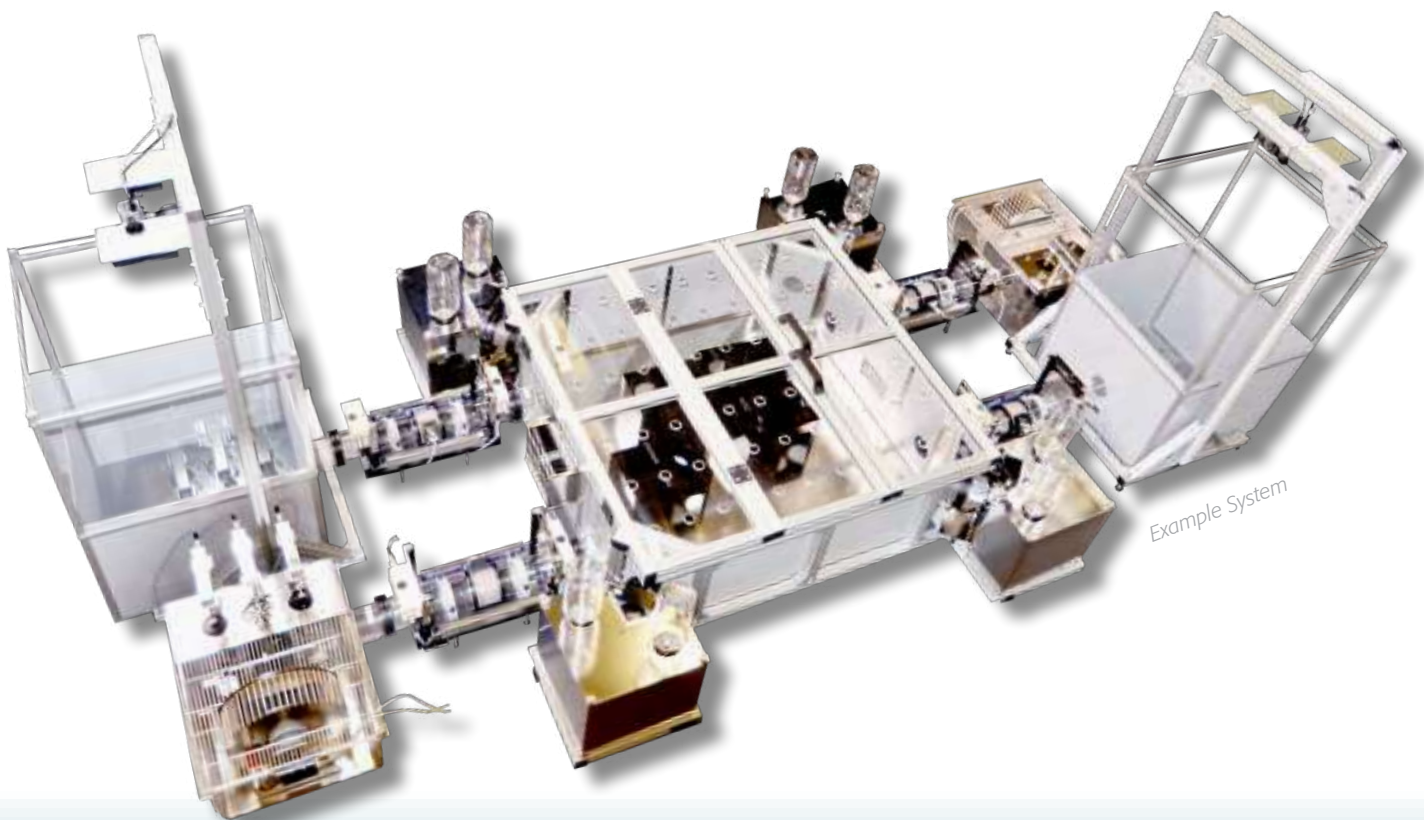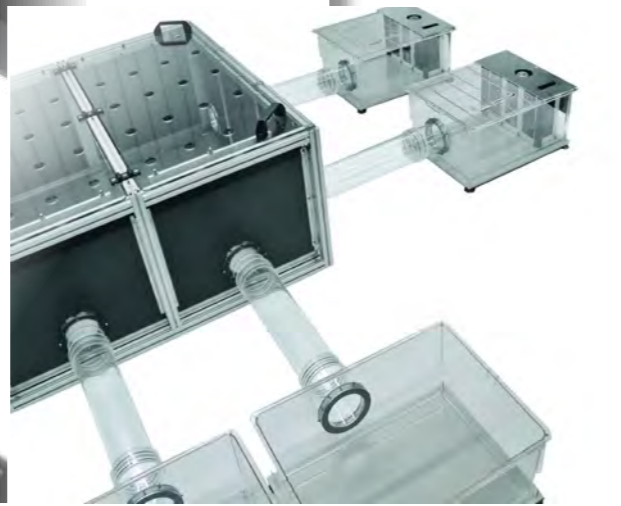
PhenoWorld

Multi-Arena

Behavioral, Metabolic & Physiological Phenotyping

of Individual Mice or Rats

in Social Groups

Example System

PhenoWorld
A class of its own

- Rodent phenotyping brought to the "group" level
- Multiple arenas, mazes & multiple floors combined in one system
- Simultaneous assessment of behavior (incl. social interaction), cognition, metabolism & physiology
- Social housing - high translational value & animal welfare
- Fully automated stress-free testing - no human interference
- Parameters for individual animals - RFID identification

- We work with you - TSE's scientific experts visit you on-site to plan, design and setup your personalized PhenoWorld with you!
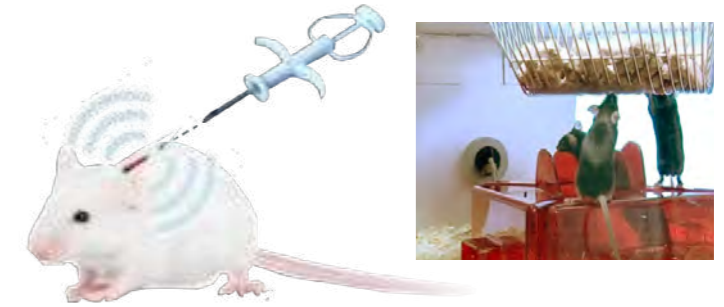

- PhenoWorld is a unique combinatorial approach that integrates functionality from a variety of automated phenotyping systems into one multidimensional setup. Behavior, cognition, metabolism and physiology modules of the TSE PhenoMaster and IntelliCage systems can be implemented into multiple home or satellite cages or mazes, which are strategically interconnectable. Multiple paradigms can be combined and run at the same time, and your research is brought to a new level.

- The complete system is operated by one master software - it operates all modules, synchronizes and integrates all incoming data allowing fully automated experimentation without human interference.

- In PhenoWorld animals live in social groups, which allows them to develop and display species specific natural social behavior - a prerequisite for animal welfare and high translational value of experimental data. Every animal is tagged with an RFID transponder and is recognized at strategic places for individualized data acquisition.

- Animals traverse between PhenoWorld compartments and levels through a number of different gating structures: (1) automated AnimalGates allow restricted access to compartments depending on time and animal ID; (2) tubes with / without trap doors (3) tunnels, and (4) stairways further regulate compartment access.

PhenoWorld: Novel Working Principles

Every PhenoWorld setup is unique, tailored to the specific needs of each customer, and may consist of any combination of two or more interconnected compartments. These may all be arranged on one floor level or may extend across several levels adding further enrichment while saving space. All compartments can be flexibly equipped with a multitude of functional modules for high throughput experimentation.
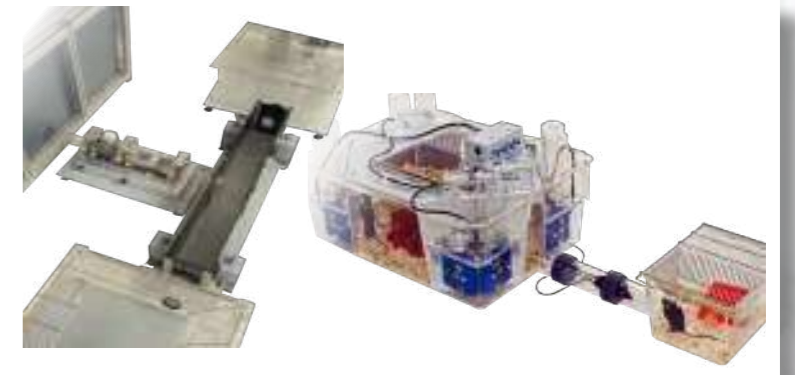
- **Social Housing & Animal Identification**
  In PhenoWorld setups multiple animals can be tested simultaneously - the number of animals depends on setup size. All animals are tagged with RFID transponders. Antennas placed at strategic places, e.g. the entrance and exit of a compartment or at functional modules recognize animals and allow individualized data analysis.
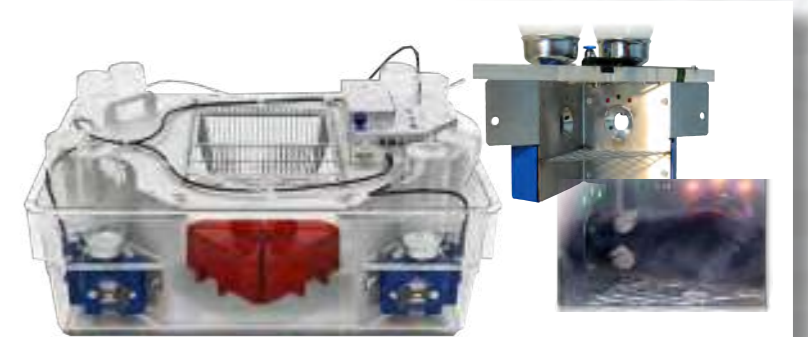

- **Mazes & Satellite Cages**
  Combine any type of arena, test system or maze to create a multi-compartment system. Each compartment can be equipped with unique functionality to evaluate a large range of parameters within a single experimental setup: Social behavior, learning & memory, circadian activity patterns, decision making, etc. **NEW** Metabolic satellite cages equipped for indirect calorimetry.
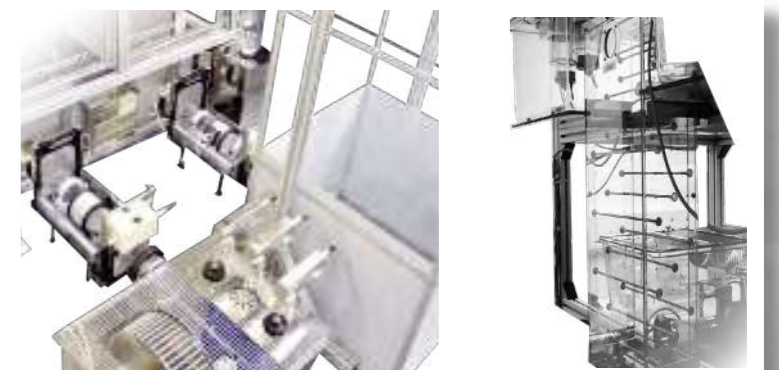

- **IntelliCage**
  This unique field-proven home cage system offers a magnificent range of possibilities to study rodent behavior and cognitive abilities. IntelliCage consists of (1) a central main compartment with food tray and shelter, and (2) four operant corners each equipped with RFID antenna, two nose poke units, two drinking bottles, light cues and air puff. Various temporal-spatial learning regimens can be programmed and assigned to individual animals within a group of rodents.
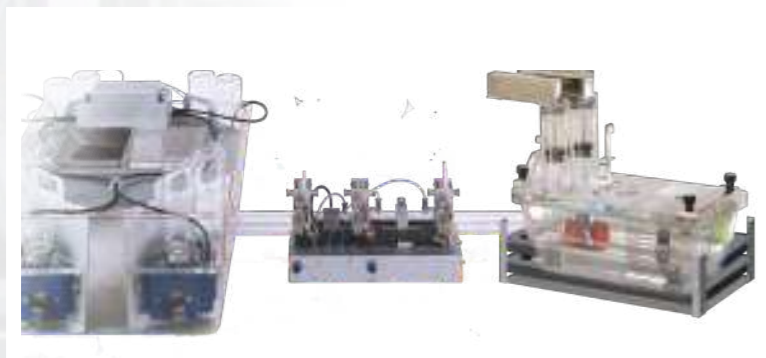

- **Transition between Compartments**
  Transition tubes, gates & stairways connect compartments. Animal Gates are key components of PhenoWorld: RFID antennas recognize the entering animal, infrared sensors register the direction of passage and automated doors allow selective compartment access to predefined individuals.

PhenoWorld: Combine any of these Modules

Every compartment of PhenoWorld can modularly be equipped with all PhenoMaster and IntelliCage functionalities. These are fully automated sophisticated slide in modules that assess specific behavioral, cognitive, physiological and **NEW: metabolic!** parameters of individual animals.
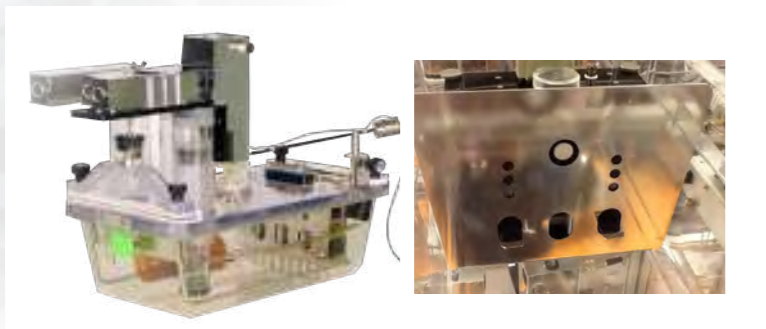
METABOLISM

- **Indirect Gas Calorimetry Module**
  The new *Calo***AnimalGate** with an air-tight door shuttles an individual animal (ID and order predefined by the experimenter) into a metabolic cage equipped for continuous PULL mode indirect calorimetry. Oxygen and carbon dioxide are quantified with exceptional accuracy to derive key metabolic parameters (VO2, VCO2, RER, EE) at high temporal resolution.

- **Feeding, Drinking & Body Weight Module**
  High precision **weighing sensors** hold spill / leak proof food containers / drinking bottles or a body weight tube housing. Sensors continuously monitor the attached weight allowing most accurate analysis of intake behavior and/or body weight over time. Modular **access control units** restrict food / liquid consumption by time, duration or amount according to customized schedules.

BEHAVIOR

- **Learning & Memory Module**
  Operant walls fit into any arena allowing stress-free voluntary conditioning around the clock. Walls can feature combinations of different light stimuli, levers, nose poke elements, liquid or pellet dispensers for reinforcement, and flexible operative integration of other modules.

- **Activity Modules (ActiMot2 & SocioMot)**
  ActiMot2 (for single animal)**:** The high resolution infrared light beam sensor frame is placed around a satellite compartment. Based on light beam interruptions, a large range of temporal-spatial locomotor and rearing parameters is calculated. **SocioMot** (for multiple animals): RFID antennas within compartment floors detect animal position and activity patterns.

- **Exercise Module**
  A variety of specialized in-cage voluntary running wheels allow measurement of circadian activity profiles, evaluation of motor skills, and exposure to defined exercise / running schedules using the time and distance (workload) control function. In addition, running wheels can be connected to an operant wall and be integrated into the learning task.

- **VideoTracking Module (VideoMot2)**
  Live video feeds from a camera above a satellite cage can be used by VideoMot2 software to track animal movements, activity, and behavior. Based on XY coordinates it calculates a large variety of parameters (e.g., temporal & spatial movement parameters, rearing, running path, turns, zone entries, etc.) and recognizes a number of standard behaviors fully automatically, incl. social contacts and novel object recognition.

PHYSIOLOGY

- **Stellar Telemetry Module**
  Stellar - the next generation implantable telemetry technology. One receiver monitors (blood)pressure, heart rate, ECG, EMG, EEG, gross motor activity and core body temperature in hundreds of animals at the same time. Programmable & scheduled autonomous recording to on board data storage permit high fidelity, data acquisition, no dropouts, scheduled read-outs. **NEW Mouse transmitter.**
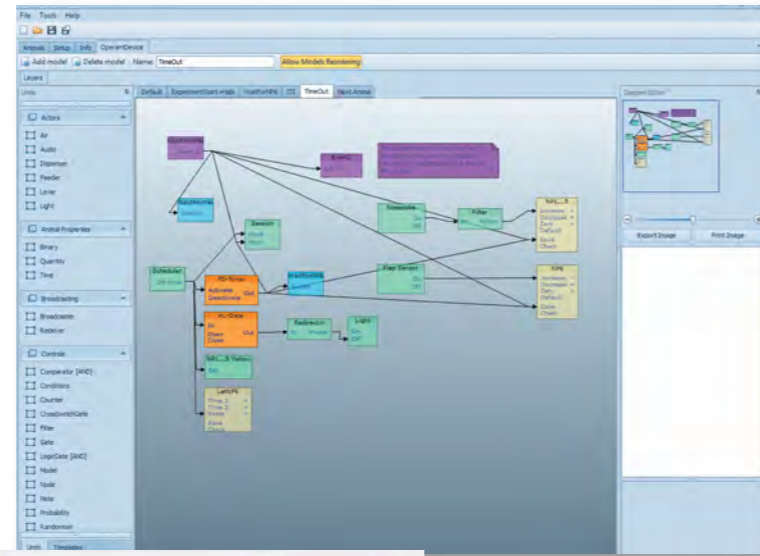
- **NeuroLogger Module**
  This cutting-edge technology enables wireless surface or deep brain 4 channel EEG recordings in freely moving animals living in social groups. Intruiging working principle with on-board data storage and infrared communication with external event recorder: Plug the NeuroLogger into the head station - record data - plug out & connect to PC - download data & analyze. That simple!
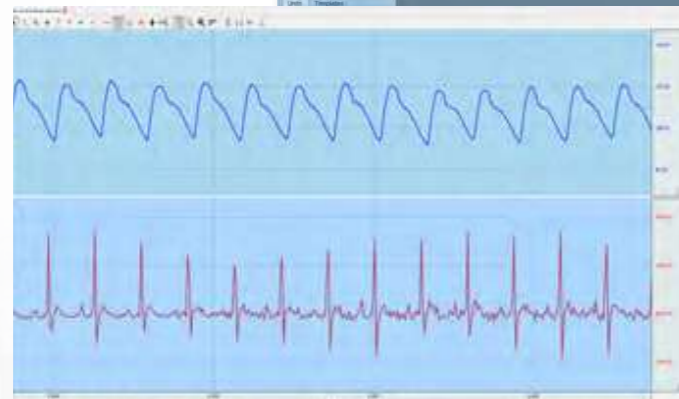
PhenoWorld: Data Handling & Software
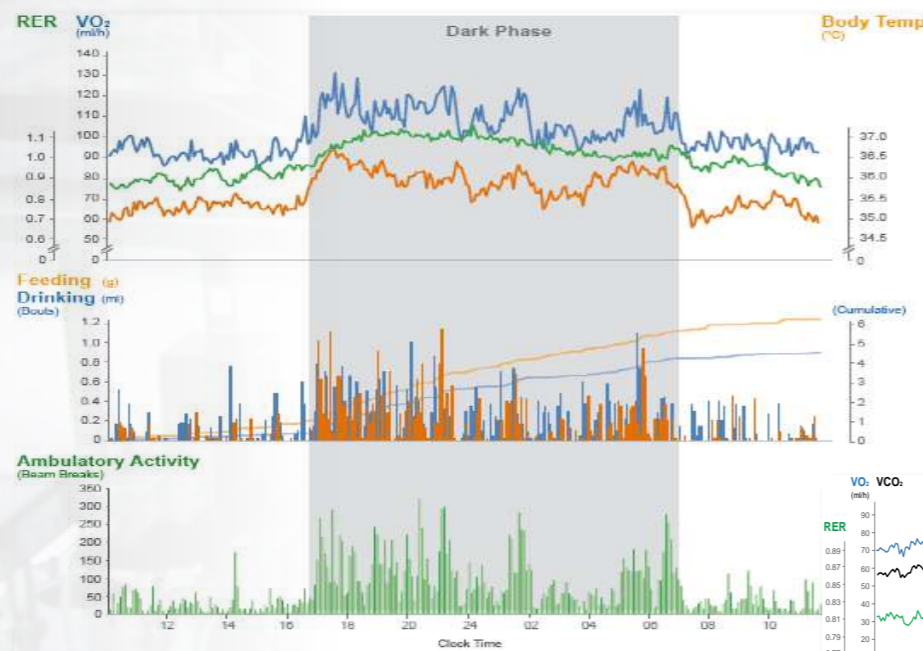
Integrative Software

PhenoWorld systems can differ tremendouly in terms of composition and complexity. PhenoWorld software is an advanced highly flexible software that has been designed to manage the coordination, integration, and the data flow among all integrated modules. With its well structured and user-friendly graphical inter face it can be programmed to control any type of experiment. Well configured analysis and graphing options provide quick insight into acquired data. The export function allows customized analysis with common statistical software packages.

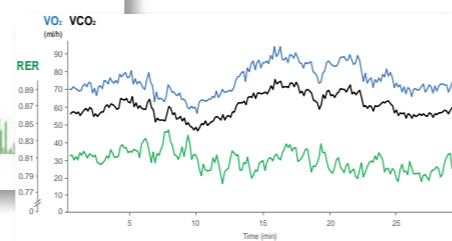Up: PhenoWorld Software Designer: graphical design of experimental logic.

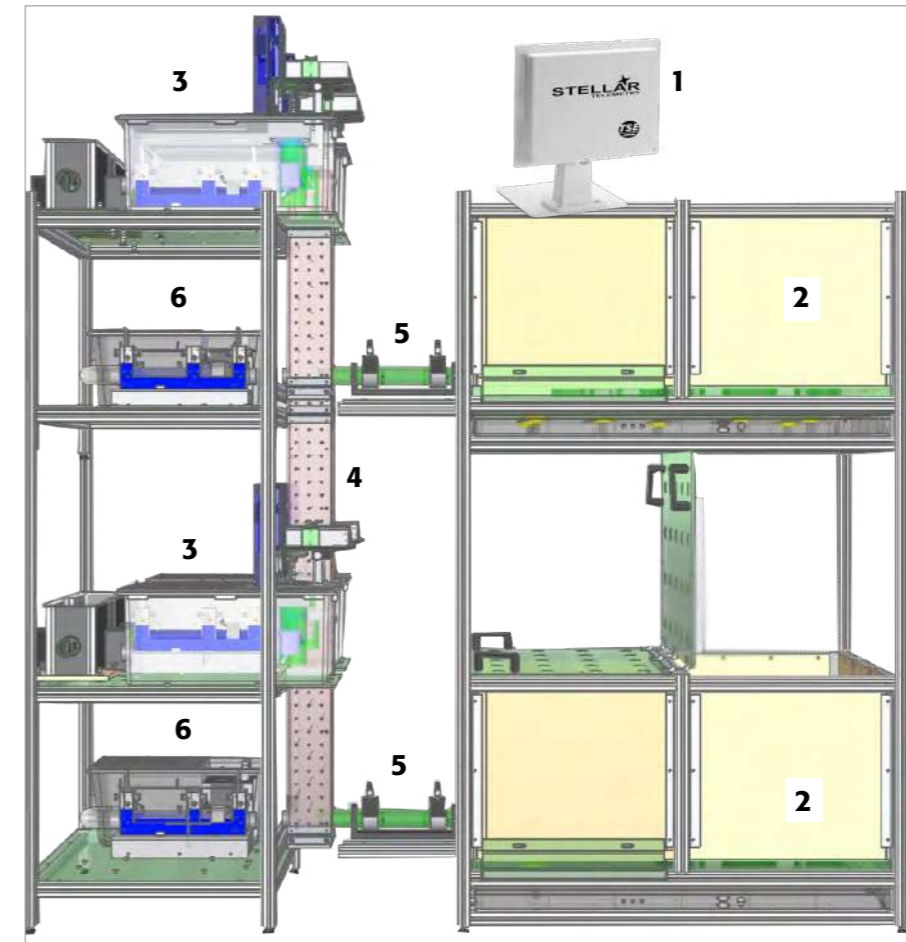Left: Simultaneous Blood Pressure (top) and ECG (bottom) of rat.

Left: Simultaneous measurement of respiratory exchange rate (RER), oxygen consumption (VO2), food and liquid intake, locomotor activity and core body temperature.

Bottom: Continuous calorimetry with 10s intervals.

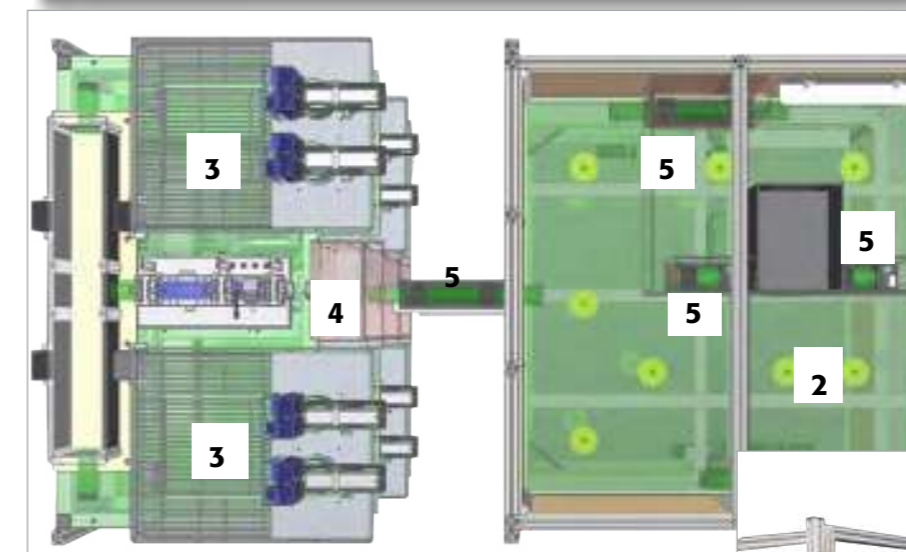# PhenoWorld: Example System for 48 Mice

1 Stellar Telemetry

One receiver monitors key physiological parameters of all animals simultaneously.

2 Social Main Arenas

Subdivided into three com partments, all connected via social tubes. One compartment is equipped with a dark shelter box to test anxiety. Floors are covered with RFID antennas to track individual animal location and activity.

3 Choice Arenas

An AnimalGate leads pre-defined individual animals to a T-Maze. Tubes connect each T-Maze arm with a home cage, equipped with: two wheighing sensors each associated to a liquid or food dispenser with access control unit to restrict liquid access according to the learning task.

4 Stairway

Metal bar stairways surrounded by a clear Plexiglas housing allow animals to traverse vertically between levels.

5 AnimalGate/Tubes

Tubes allow traversion between two compartments; additional trap doors allow movements in only one direction.

6 Operant Conditioning Arenas

An AnimalGate leads the animal into a home cage equipped with an operant wall allowing fully automated conditioning experiments.

Publication

- **Castelhano-Carlos M et al.** (2014) PhenoWorld: a new paradigm to screen rodent behavior. Transl Psychiatry, 4:e399

This PhenoWorld is equipped with: Food & liquid intake monitoring, operant wall, ActiMot2 for activity monitoring, running wheels, light-dark arena, and AnimalGate

"[...] PhenoWorld, a new setting in which groups of six rats lived in an ethological enriched environment, and have their feeding, locomotor activity, sleeping and social behavior automatically monitored."

Service & Warranty

TSE Systems offers a Two (2) Years ALL-IN Premium Warranty with all new products, including:

- 24/7 technical hotline
- Remote maintenance and update function
- On-site visits upon necessity
- Free replacement parts during warranty

After the expiry of the warranty period, TSE Systems offers comprehensive extensions of the warranty or economical maintenance and repair contracts to ensure the continued smooth running of your instruments. Please contact us for further details.