

Integrated Reward Block

Enhanced control for behavioral testing. A project under van der Meer Labs.

Background

The Science of Behavioral Testing

- Aims to understand how the brain anticipates future events and uses this information to make decisions
- Neural activity recorded through implanted tetrodes
- Reward Blocks used as an aid to reward subject interaction, mainly by delivering pellets

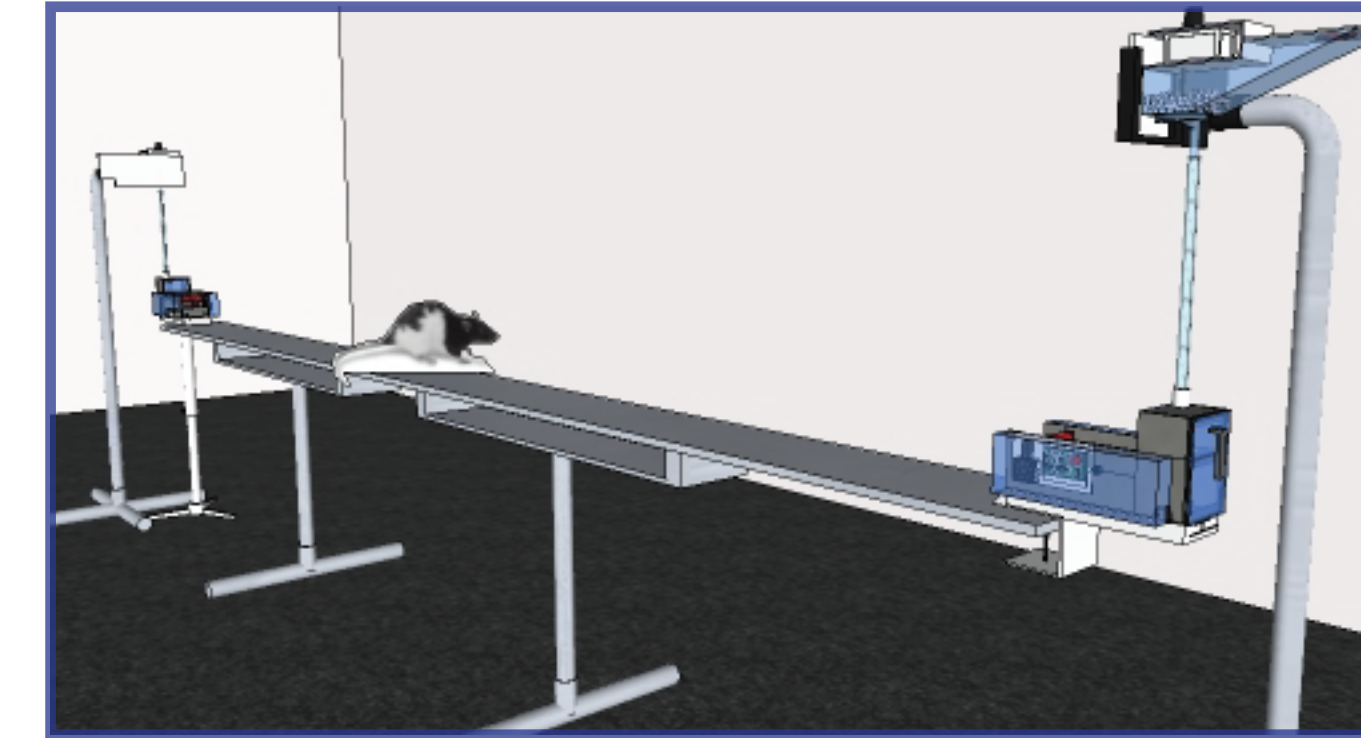
State of Art

- Unable to remove uneaten pellets
- Small dimensions restrict access for implanted test subjects
- Limited compatibility in different environments
- Costly

Objectives

- Accept 45 mg food pellets
- Removal of uneaten pellets
- Illumination
- Activity detection
- Easy to clean
- Modular
- Meet safety requirements
- Minimize electrical interference

Sample Experimental Setup



- Rat is trained to run along a narrow platform
 - A sound is played that corresponds to a certain number of pellets dropped into the food trough at each end of the platform
 - Experiment to determine if the rat can distinguish the sounds and to study the neurons that fire during the decision making process
- Fine control of stimuli required for unbiased results



- Rat with implanted sensors
 - Sensors are implanted into rat's brain to measure neural activity during experiments
 - Sensors are bulky and makes it difficult for rats to access narrow food delivery areas

Methodology and Testing

First Iteration

- User interviews
- Identification of user requirements
- Rat behavioral research
- Generation and selection of concepts
- Initial Prototype construction

Second Iteration

- Refinement of design
 - Narrowed feeding area, increased wall height
 - Guide rails added on ramp to direct pellet fall
 - Added wind-directing vent to concentrate airflow
 - Mesh added in front of fan opening to block whisker entry
- Added photoelectric detection system
- Modifications added to first proto

Final Iteration

- Cutplan to optimize
- Battery and external power options
- Implementation of clamp designs
- Second prototype created with integrated electronics

Initial Testing

- Subject fit with ample space
- Pellets dropped too close to fan on disposal area
- Inconsistent removal time and rate
- Subject's whiskers could get caught in fan

Secondary Testing

- Subject's head with implant fit snugly but able to reach pellets
- Presence detectors not functional under different lighting conditions
- Pellets dropped more consistently but still strayed occasionally
- Pellet removal more consistent
- Subject's whiskers were not able to penetrate through the mesh

Next Steps

At van der Meer Labs

- Final testing with final iteration prototype
- Final calibrations and modifications to design
- Create duplicates for laboratory use

Future Improvements

- Expand range of clamp designs for greater flexibility of positioning
- Implement pellet detection system
- Decrease noise of fan

Health and Safety

- Shielded and grounded electrical components
- Guarded fan mesh and vent for subject safety
- Low current rating
- Spacious design for subjects with implanted tetrodes

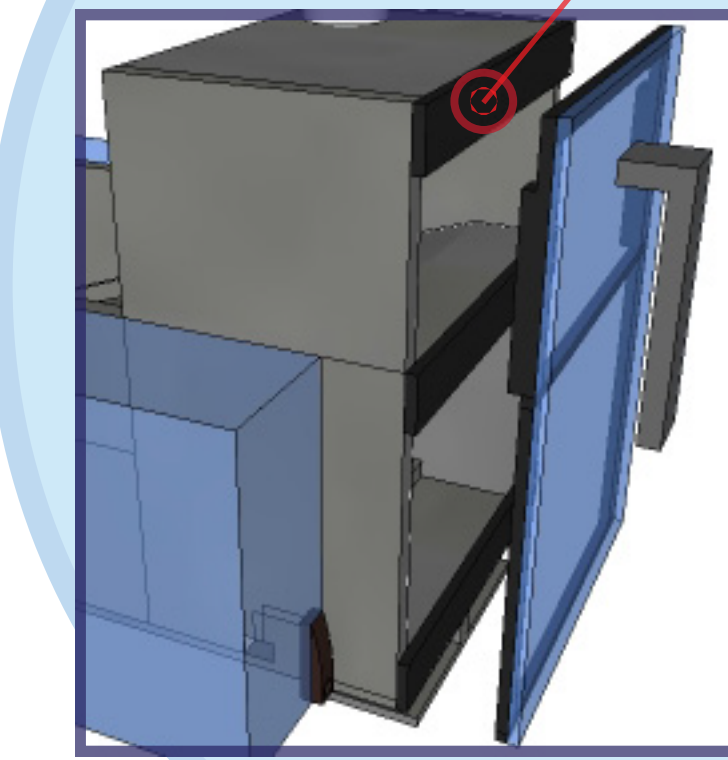
Environmentally Friendly

- Removable electronic components allow for quick and simple replacement in case of failure
- Able to run on batteries as well as through DC Voltage
- Frame and bases made out of 100% recyclable aluminum

Economic Advantage

- Estimated Price
 - Metal Components: \$20
 - Electrical Components: \$30
 - Misc Components: \$10
- Total: \$60
- Compared to >\$200 for leading competitors

Easy Accessibility

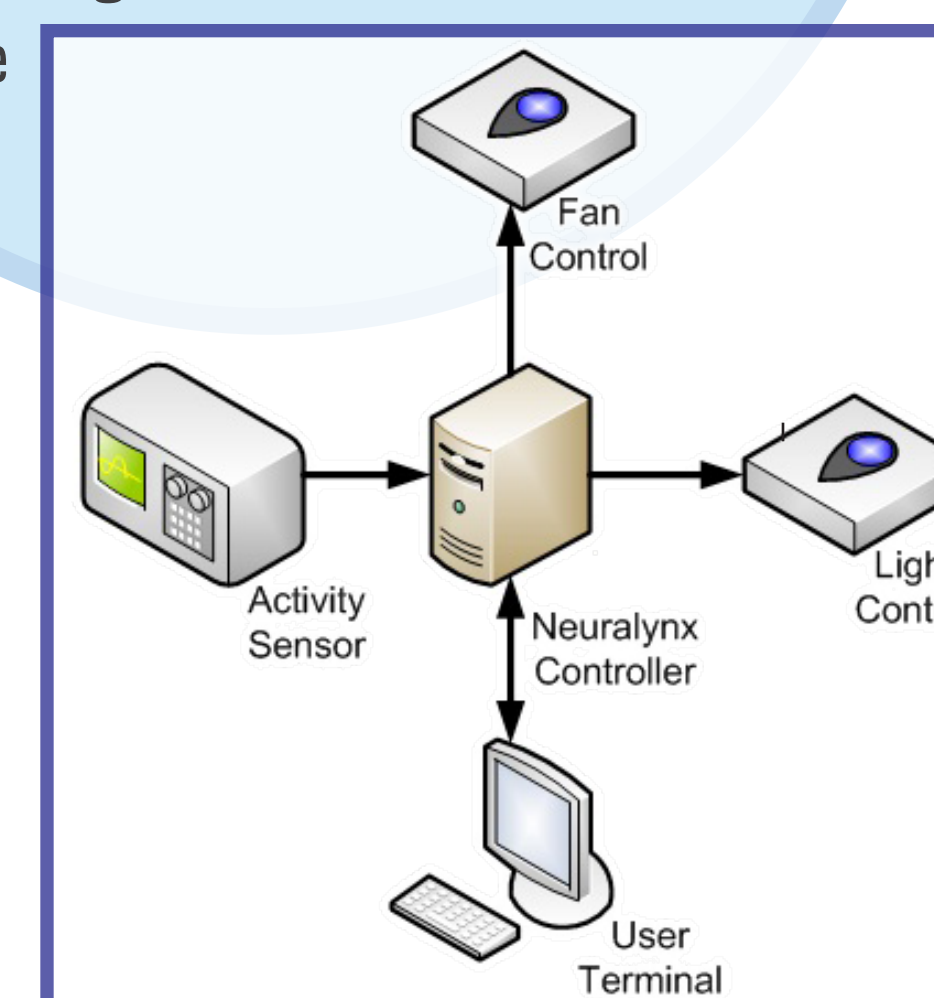


Magnets allow for easy access
Ideal for quick maintenance and cleaning.

Rare Earth magnets provide strong and reliable seal

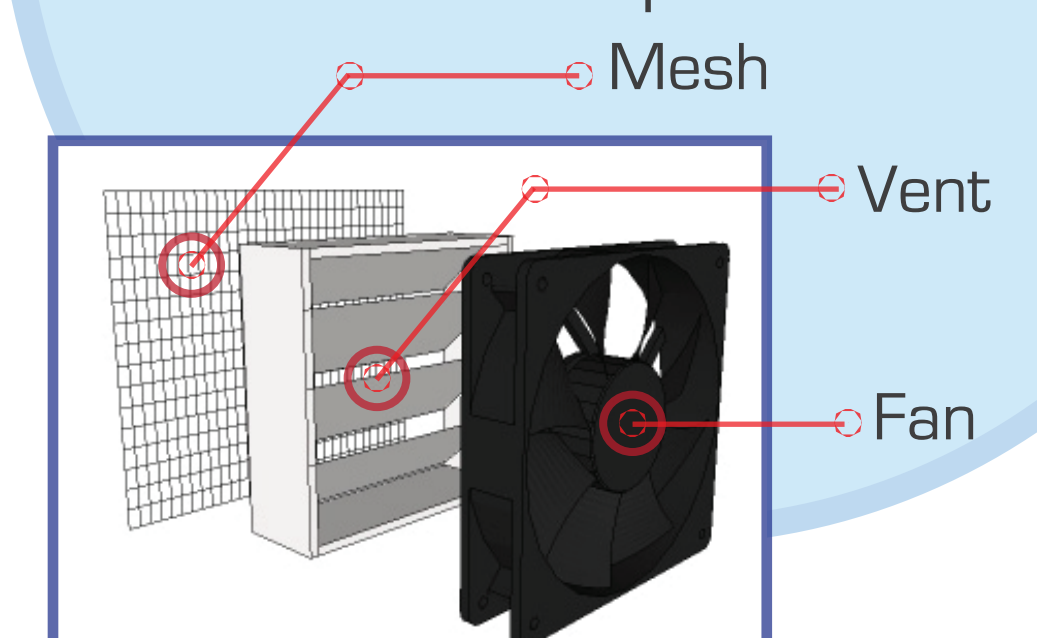
System Integration

- Send and receive signals with TTL Pulse
- Sends TTL pulse output of activity sensor information
 - Ideal for imbedded control in a research setting
 - Shielding for minimal electrical noise



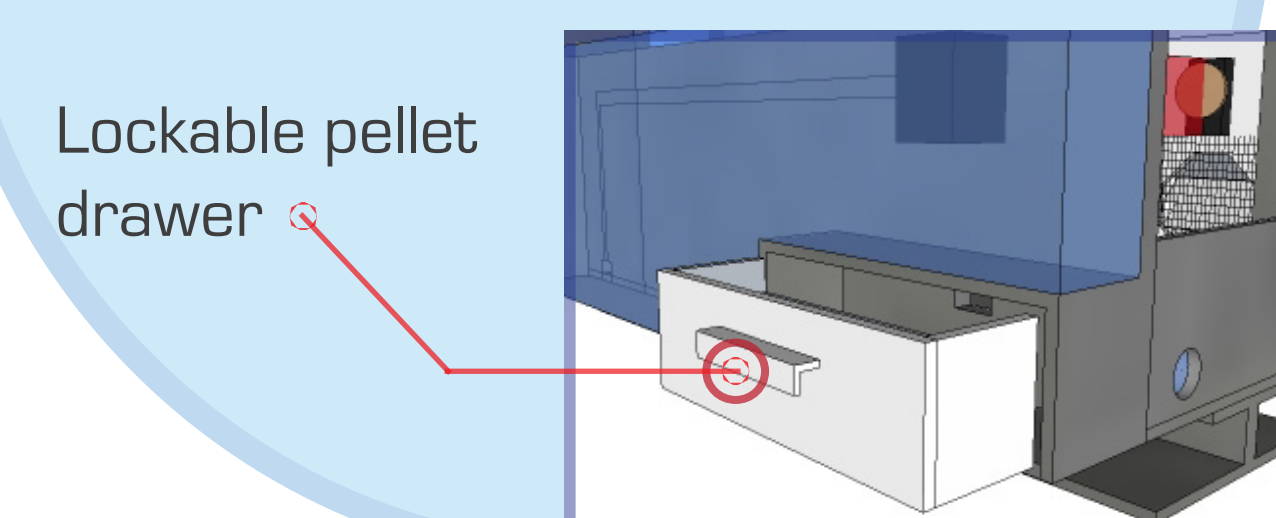
Pellet Removal

- Miniature fan blows excess pellets from the feeding trough into small bin at other end of reward block
- Allows for consistent and unbiased experimental results



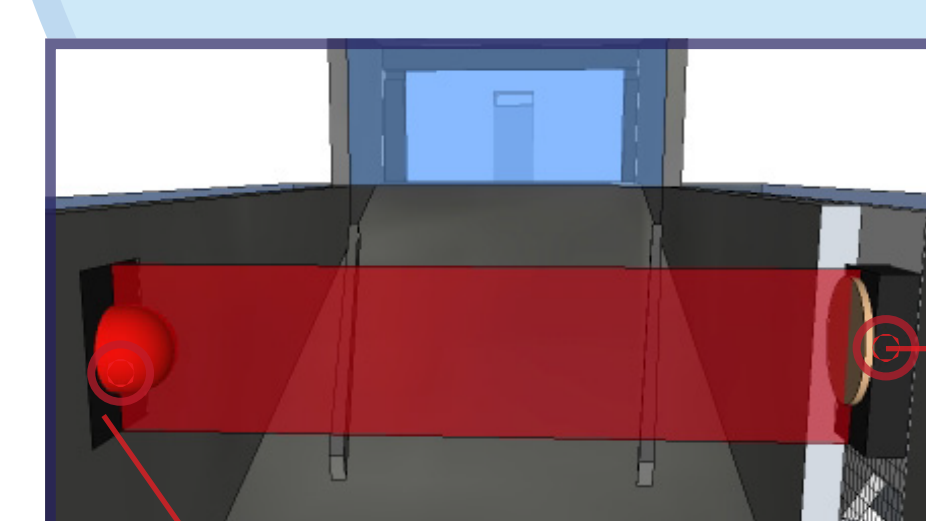
Pellet Storage

- Easily accessible pellet collection bin
 - Lockable to prevent subject interaction
 - Large capacity supports longer experiment durations



Activity Detection

- Photocell + LED Diode
 - Output 0-5 Volts to controller
- Ideal for detecting subject presence in feeding area
- Adjustable sensitivity for various light settings



Programmable Components

- Fan and headlights programmable and controllable by TTL pulse
 - Allow flexible integration with lab system and software
 - Suitable for a wide range of behavioral testing experiments

Modular Bases

- Modular base rail allows exchange of multiple base components
- Base designs allow reward block to be:
 - Clamped onto surfaces,
 - Fitted into cages,
 - Positioned anywhere across the floor

