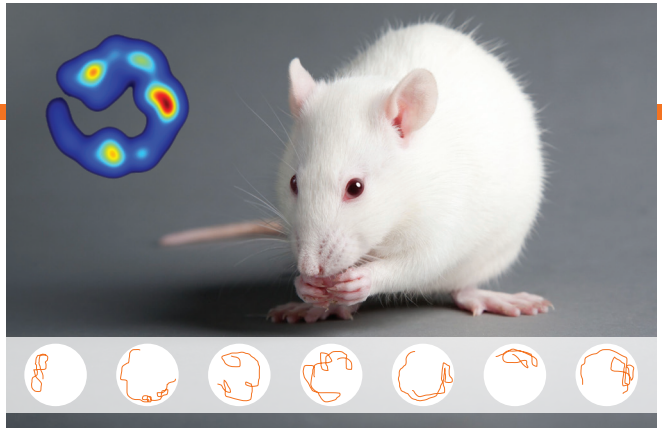
EthoVision XT

- *Reliable tracking of any kind of animal*
- *Cost-effective & easy-to-use software*
- *High-throughput & high-content testing*
- *Powerful analysis tools for insightful results*

EthoVision® XT is the most flexible and versatile system for highly accurate tracking, activity detection, and analysis of animal movement, activity, and behavior. It has evolved over 25 years and is in use at over 2500 sites worldwide in a wide variety of research set-ups. EthoVision XT is a platform for anything from straight-forward testing (such as water maze or open field) to sophisticated protocols including social interaction, hardware control, behavior recognition, operant conditioning, optogenetics, and external (physiological) data collection and analysis. After analysis, you can use graphs and heatmaps in publications and presentations.

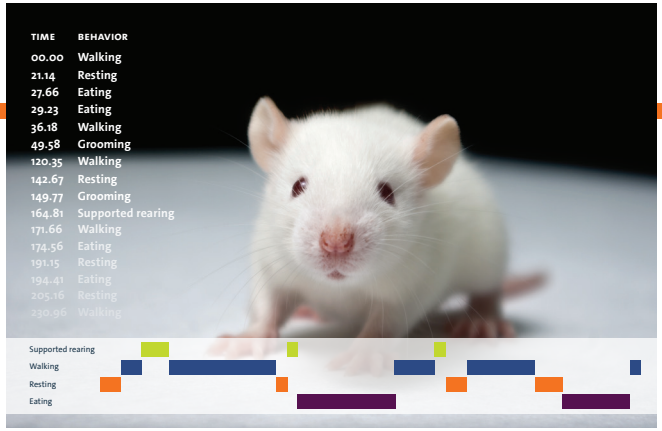


WWW.NOLDUS.COM/ETHOVISION

Rodent Behavior Recognition

- *Automatically detect rat or mouse behaviors*
- *Efficient, objective, reliable*
- *Around-the-clock observations*
- *No training needed*

Revolutionize the way you work with automatic recognition of rodent behavior. This system will make your research more efficient and objective. It is accurate, fast, and has a better repeatability than human observers, giving you consistent results every time. No extra training is needed when using a different experimental set-up or strain of rats or mice. The system is also tireless, allowing you to perform 'around the clock' observations. Rat Behavior Recognition and Mouse Behavior Recognition are optional modules of EthoVision XT. They both recognize a range of ten behaviors, such as grooming and rearing.



WWW.NOLDUS.COM/BEHAVIOR-RECOGNITION

PhenoTyper

- *Home cage testing environment*
- *Instrumented with camera and LED*
- *Suitable for optogenetics and operant conditioning*
- *Special add-ons available*

PhenoTyper® is a flexible instrumented home cage (available in two sizes) to measure the behavior of laboratory rodents in both short-term and long-term studies. Tracking is possible independent of environmental light. PhenoTyper can easily be equipped for a test using optogenetics or an operant condi-tio-ning setup. Special add-ons for home cage assessment include the Activity Wheel for rats, the PhenoWheel for mice, the

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Pellet Dispenser that releases food based on timing or behavior, the Lickometer to measure drinking behavior, and the Mouse Feeding Monitor to measure feeding duration and frequency in mice. PhenoTyper is powered by EthoVision XT.

UltraVox XT

- *Detailed analysis of ultrasonic vocalizations*
- *Full-spectrum sound capture USB microphone*
- *Compact and cost-effective solution*
- *Automatic identification and easy labelling of calls*

UltraVox™ XT is a software tool that analyzes sound, including rodent ultrasonic vocalizations. The signal is displayed in real-time in a waveform and spectrogram. Define frequency range, amplitude, duration, and time gaps to let UltraVox XT find all calls that fit those criteria, then easily label each call with user-defined names. UltraVox XT provides a PDF report with data, statistics, and spectrograms. It also plays back the

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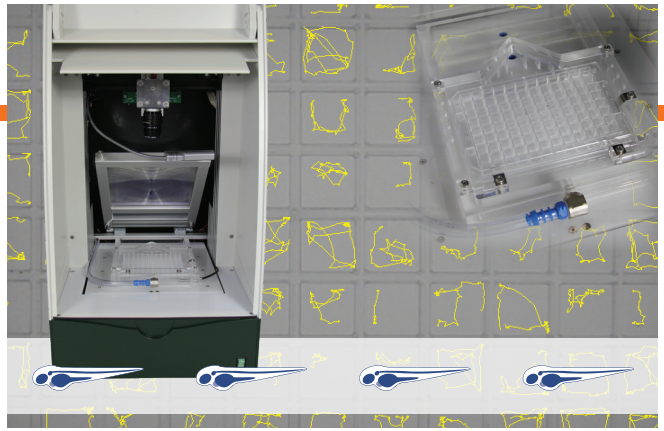
recording in an audible (pitch-reduced) range. You can export data, audio files, and images. Data is fully compatible with EthoVision XT and The Observer XT so that you can integrate the vocalizations with other behavioral and physiological data.

DanioVision

- *Zebrafish larvae activity monitoring*
- *High-throughput research*
- *Controlled plug-and-play environment*
- *Powered by EthoVision XT*

DanioVision™ is an innovative system for high-throughput testing of zebrafish larvae or other very small animals. The Observation Chamber provides a controlled testing environment that holds any standard multi-well plate or other small container (such as a petri dish). It also contains a high speed digital camera, and the basin is backlit with an IR-light for tracking and an adjustable white light that can be used for



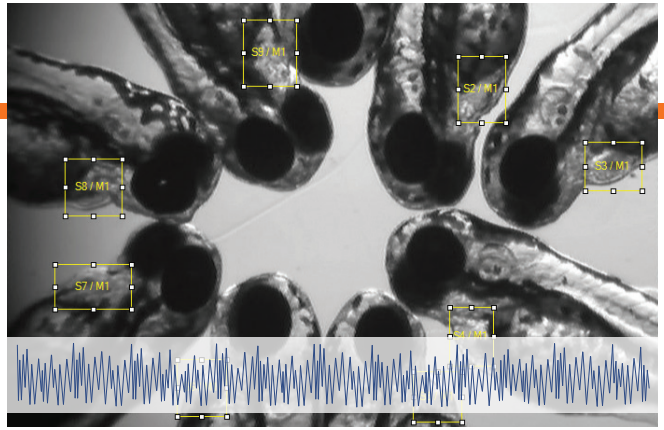
WWW.NOLDUS.COM/DANIOVISION

day/night rhythmicity or to evoke a startle response. The Temperature Control Unit eliminates the need for climatized rooms. Add the Tapping Device, Toplight Unit, or Optogenetics Add-on to complete your setup!

DanioScope

- *Video analysis of zebrafish embryos and larvae*
- *All-in-one tool, easy and cost-effective*
- *Non-invasive video based method*
- *Activity, cardiology, flow, and morphology*

DanioScope™ is a non-invasive and easy video-based software tool that allows you to keep track of zebrafish embryo and larva parameters. Embryos are automatically detected and their activity (tail coiling, convulsions) is automatically measured. To measure the heartbeat of all your subjects in the video, just define the heart areas and DanioScope will extract the heartbeat of each one. Blood flow and gut flow activity can be measured

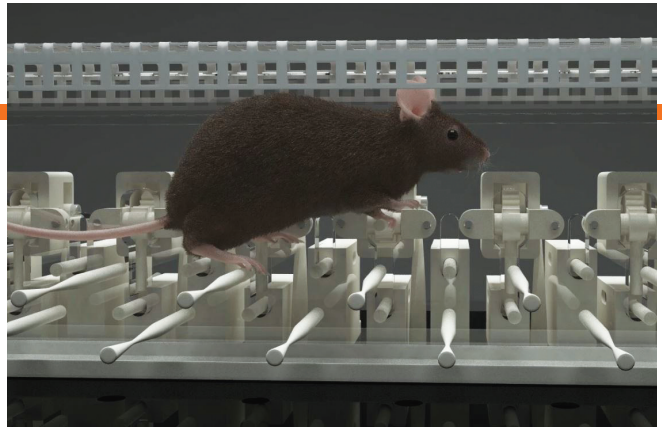


WWW.NOLDUS.COM/DANIOSCOPE

by indicating a circular area of interest, such as the diameter of a vein. Last but not least, still images can be used to monitor morphological parameters, such as eye size, body length, malformations, or any user-defined parameter.

ErasmusLadder

- *Assess motor learning and performance in mice*
- *Non-invasive, automated, reliable method*
- *Designed to test cerebellar functioning*
- *Validated in scientific publications*



WWW.NOLDUS.COM/ERASMUSLADDER

The ErasmusLadder® is a fully automated system that tests and challenges motor performance and motor learning abilities in mice. It is a unique, non-invasive, and easy-to-use method to effectively screen for cerebellar behavioral phenotypes. The ErasmusLadder is a horizontal ladder in between two goal boxes. It has touch-sensitive rungs to measure the stepping behavior. Over several sessions, motor performance and learning is assessed. In the second phase, mice can be challenged with a precisely timed obstacle paradigm: a rung is raised above stepping level and announced by a tone. How the mouse reacts indicates how good its reflexive motor learning abilities are.

CatWalk XT

- *Quantification of footprints and gait in rodents*
- *Real footprints and body weight distribution*
- *Plug-and-play high-throughput method*
- *Validated for many disease models*

WWW.NOLDUS.COM/CATWALK

CatWalk™ XT is a highly sensitive tool for the assessment of gait and locomotion in rodents. While the animal traverses a glass plate, Illuminated Footprints Technology captures the actual footprints with a high-speed video camera for maximum spatial and temporal resolution. The movement of the animals is unforced, giving you the most realistic picture of their gait. The software visualizes the prints and calculates statistics related to the print dimensions and the time and distance relationships between footfalls. This method has been validated in disease models such as Parkinson's, spinal cord injury, neuropathic pain, and cerebellar ataxia.

The Observer XT

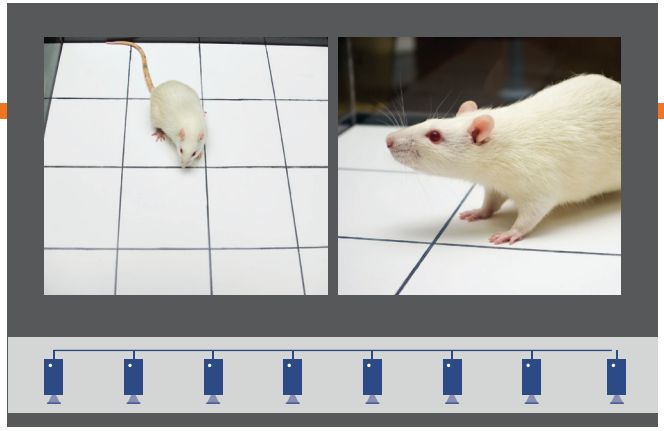
- *Describe and score behavior in detail*
- *Integration platform for external data*
- *Collect, integrate, analyze, and manage data*
- *Score on-the-go and share the work*

WWW.NOLDUS.COM/OBSERVER-ANIMAL

The Observer® XT is the professional and user-friendly event logging software for the collection, analysis, and presentation of observational data, used by more than 20,000 researchers worldwide. It supports the entire workflow of a research project, from ethogram to presentation of the results. You can integrate external (physiological) data streams in your visualization and analysis. With several modules, you can adapt this tool to your research needs. Need to score on-the-go? Pocket Observer works on a range of handhelds and smartphones for research in any environment. Working on a large or educational project? Share the work with Coder Licenses.

MediaRecorder

- *Synchronize up to eight video recordings*
- *View side-by-side or picture in picture*
- *Save separate or integrated files*
- *Synchronize video with behavioral data*



WWW.NOLDUS.COM/MEDIA-RECORDER-ANIMAL

The MediaRecorder is a software tool that enables the synchronous recording of up to eight different video and audio sources. You can view videos side by side or use picture in picture. When saving the videos files, you can combine all media files into one, or save them separately. MediaRecorder is compatible with EthoVision XT, The Observer XT, and a broad range of cameras (such as FireWire, GigE, industrial USB cameras, and IP cameras), and is designed to be at the core of your lab. You can switch between different cameras and control them with your mouse or joystick. With IP cameras you can use pan-tilt-zoom, meaning that you can position your camera very precisely.

MORE THAN 25 years OF INNOVATION

Innovative solutions for zebrafish research

Powerful software tools, fully integrated labs, and expert consultancy.
Trust our 25 years of experience to make your project a success.

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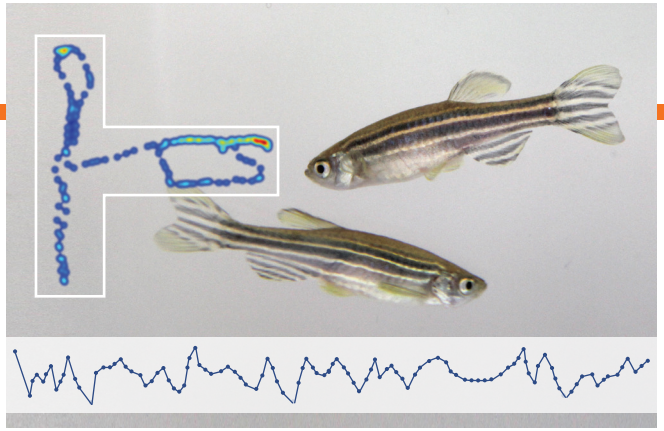
Noldus
Information Technology

EthoVision XT

- *Reliable tracking of any animal*
- *Cost-effective & easy-to-use software*
- *High-throughput & high-content testing*
- *Powerful analysis tools for insightful results*

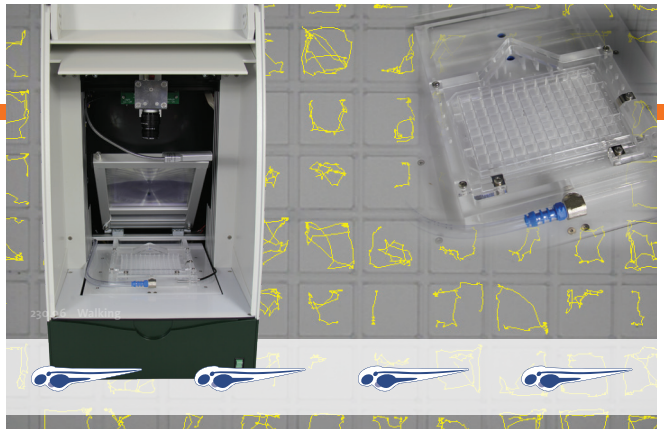


WWW.NOLDUS.COM/ETHOVISION

EthoVision® XT is the most flexible and versatile system for highly accurate tracking, activity detection, and analysis of animal movement, activity, and behavior. A special algorithm for zebrafish, combined with the multiple body points tracking algorithm, provides accurate data on swimming paths and patterns. You can track multiple fish together and automatically measure inter-fish distances (for shoal-density), as well as track in multiple tanks simultaneously. Because EthoVision XT is not limited to one specific kind of test, you can use it for multiple studies in the lab; from small to large aquaria, from T-maze to well plate, from activity measurements to learning tasks. The ideal tool!

DanioVision

- *Zebrafish larvae activity monitoring*
- *High-throughput research*
- *Controlled plug-and-play environment*
- *Powered by EthoVision XT*



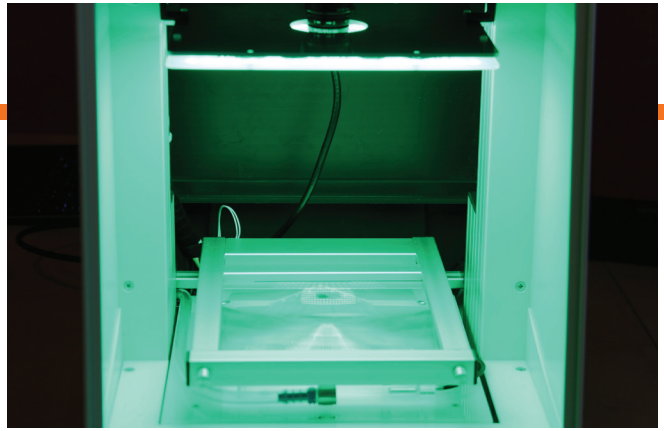
WWW.NOLDUS.COM/DANIOVISION

DanioVision™ is a complete system designed for high throughput testing of zebrafish larvae or other small organisms. The Observation Chamber provides a controlled testing environment, with built-in IR backlit well-plate/petri dish/container holder, a high speed digital camera, specialized lens to prevent distortion in the well-plate, and a white light that is programmable in the software. There is also enough room in the chamber for add-ons such as the Tapping Device, colored/white LED Toplight Unit, Optogenetics equipment, or other custom options. Tracking occurs with a fully functional version of EthoVision XT, which can be used for other tracking experiments as well.

Toplight Unit

- *Add-on for DanioVision Observation Chamber*
- *Stimulus light from above*
- *Two options in one: colored or white LED sides*
- *Programmed and controlled by EthoVision XT*

The Toplight Unit is an add-on component for the DanioVision Observation Chamber. The lights provide illumination above the well-plate or arena, and do not obscure the view of the camera. For multifunctional purposes, one side consists of white LEDs, while the other contains red, green and blue LEDs. Compared to the standard white light included in the Observation Chamber, this Toplight Unit provides a more 'natural' position of light. As



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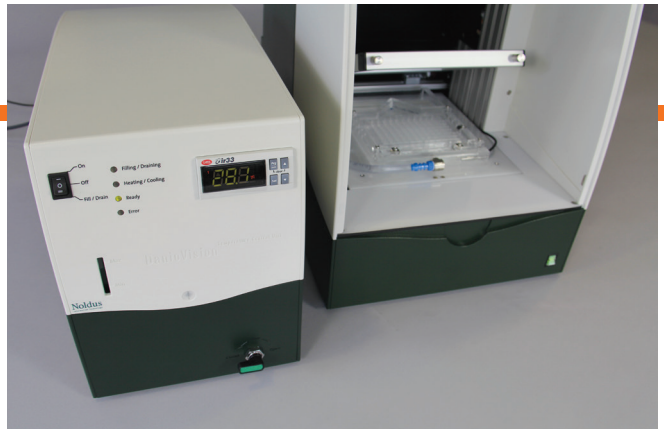
zebrafish see color and different strains show different color preferences, the Toplight Unit allows you to easily incorporate color stimulation into your experiments. You can pick the colors that best fit the aims of your study and zebrafish strain.

Temperature Control Unit

- *Control temperature of water surrounding the well plate*
- *Easy to install component for DanioVision*
- *Eliminates the need for climatized rooms*
- *Cooling and heating options*

Temperature has a large effect on zebrafish larvae behavior; unless this is the focus of your study, varying temperatures can have a big influence of the validity of your data. The Temperature Control Unit prevents this by controlling the temperature of the water that surrounds the well-plate in the DanioVision Observation Chamber. It is a flow-through system that does not disturb your animals and allows you to either cool or heat the water.



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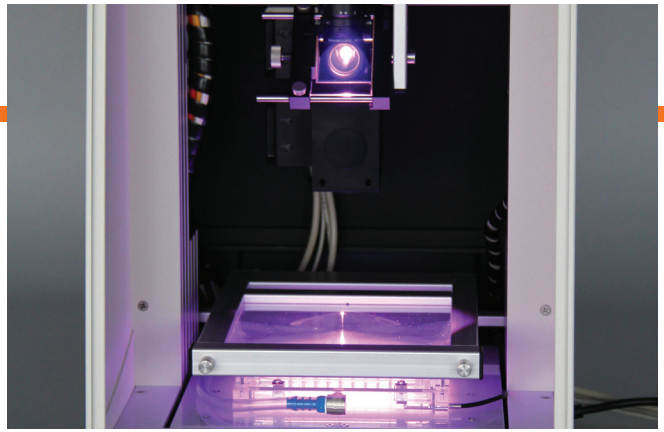
The unit is compact and can be placed next to the Observation Chamber or on the floor. To hook it up, simply connect two water tubes and two cables, set the desired temperature, and you are good to go!

Optogenetics Add-on

- *Add-on for DanioVision Observation Chamber*
- *Stimulate with two or three wavelengths (LED colors)*
- *Ideal for zebrafish larvae*
- *Programmed and controlled by EthoVision XT*



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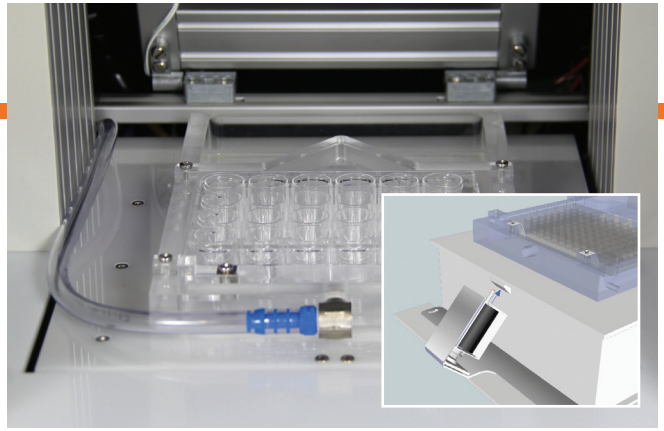
Because zebrafish larvae are transparent, the application of optogenetic stimulation is even more practical than in rodents, and far less invasive. With the Optogenetics Add-on, researchers can now very easily test the role of specific neurons in zebrafish larvae behavior. The add-on consists of an LED light source (Prizmatix) that can be installed in your DanioVision Observation Chamber. EthoVision XT allows for the control and programming of the stimulation: you can set user-defined time conditions to trigger the LED light(s). In comparison to manual control, this offers far better temporal precision and adds efficiency to longitudinal studies.

Tapping Device

- *Add-on for DanioVision Observation Chamber*
- *Vibration stimulus to evoke a startle response*
- *Adjustable force and tapping rate*
- *Programmed and controlled by EthoVision XT*



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Zebrafish larvae display a robust startle response which can be evoked by light or vibration. A light stimulus is part of the basic DanioVision Observation Chamber; the vibration stimulus can easily be added by installing the Tapping Device at the bottom of basin where your well plate or petri dish is placed. The taps cause vibration in the water and the intensity can be set at any of eight different levels. You can also adjust the tapping rate to a maximum of three taps per second. The Tapping Device can be combined with the white light stimulus, and both are controlled via EthoVision XT software (included in the DanioVision system).

Track3D

- *Study swimming behavior in 3 dimensions*
- *Individual calibration for accurate results*
- *EthoVision XT add-on*
- *Accurate and cost-efficient solution*

When interested in the specific swimming patterns of your zebrafish, behavioral assessment in a 2-dimensional plane may be insufficient for your study. Track3D is a video-based system for automated tracking of animals in a 3D space. The 3D trajectory is based on a combination of two 2D tracks recorded by EthoVision XT via two separate high-resolution cameras. Calibration is an essential step in this procedure. To guarantee a highly accurate

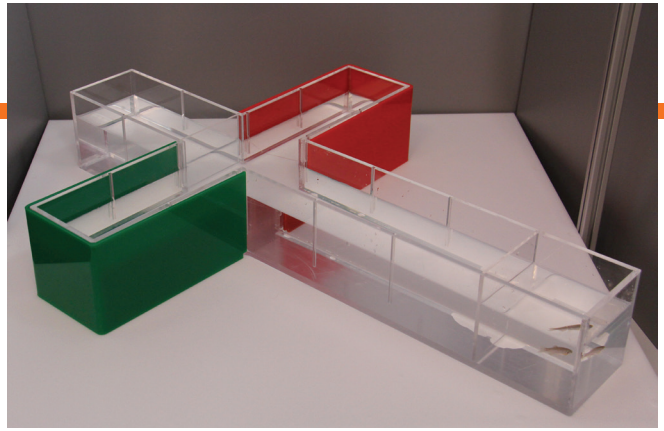
WWW.NOLDUS.COM/TRACK3D

calculation of the 3D trajectory, a custom calibration frame is built for the tank or arena in which your experiments take place. Track3D visualizes the resulting trajectory in a dynamic 3D image and calculates a number of movement-based parameters.

Mazes

- *Specifically designed for zebrafish*
- *Many custom options available*
- *Great for video tracking with EthoVision XT*
- *Package deals available*

Several behavioral paradigms are successfully translated from rodent to adult zebrafish behavioral studies. Examples includes tests for learning and memory, anxiety, and social behavior. Noldus offers several mazes specifically designed for zebrafish. A good example is the multi-purpose zebrafish maze. Shaped like a cross, it can be sectioned off to create different set-ups, including a T-maze, plus maze, and social preference configura-



WWW.NOLDUS.COM/MAZES

tion. Combined with an infrared backlight and an infrared-sensitive camera, it is ideally suited for video tracking with EthoVision XT. If needed, Noldus is also able to create custom configurations for researchers!

The Observer XT

- *Describe and score behavior in detail*
- *Build and share your ethograms*
- *Collect, integrate, analyze, and manage data*
- *Share the work and perform reliability analysis*

Some studies require a more detailed look at behavior; manual observation is therefore best. This can be a laborious process, and The Observer® XT is here to help streamline the process. This user-friendly event logging software helps to collect, analyze, and present your data. It supports the entire workflow of a research project, from ethogram to presentation of the results. You can score live, and even on the go with Pocket Observer on your smartphone. You can score from a single video, or multiple camera angles at once. Coding can be carried out continuously, or using instantaneous sampling, or a combination. You can also easily share the work with coding licenses.

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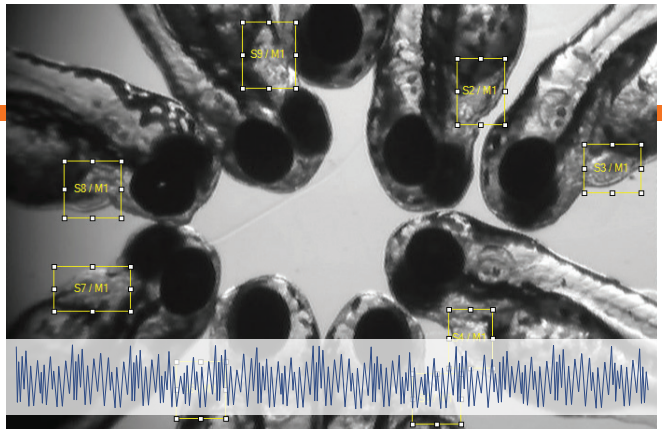
DanioScope

- *Video analysis of zebrafish embryos and larvae*
- *Easy and cost-effective all-in-one tool*
- *Non-invasive video based methods*
- *Activity, cardiology, flow, and morphology*

DanioScope™ is a non-invasive and easy to use video-based software tool that allows you to assess and analyze zebrafish embryo and larva parameters. Embryos are automatically detected and their activity (e.g. tail coiling, convulsions) is automatically measured. To measure the heartbeat of all subjects, simply define the heart areas and DanioScope will extract the heartbeat of each one. Blood flow and gut flow activity can be measured by indicating a circular area of interest, such as the diameter of a vein. Last but not least, still images can be used to monitor morphological parameters such as eye size, body length, malformations, or other user-defined parameters.



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Innovative solutions for insect behavior research

Powerful software tools, fully integrated labs, and expert consultancy.
Trust our 25 years of experience to make your project a success.

EthoVision XT

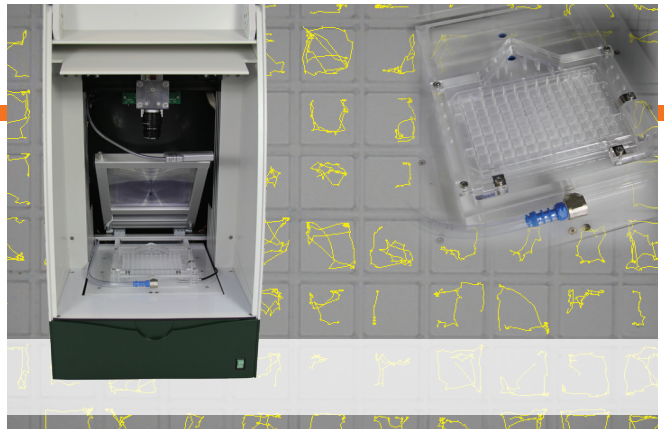
- *Reliable tracking of any insect*
- *Easy-to-use software*
- *Tracking multiple subjects in multiple arenas*
- *Extensive data selection and analysis*

WWW.NOLDUS.COM/ETHOVISION

EthoVision® XT is the market-leading scalable video tracking platform that offers flexibility, versatility, and highly accurate data. Do not just take our word for it- over 2500 labs use EthoVision XT and it is validated in thousands of publications. With EthoVision XT, you can automatically track and analyze insect movement and behavior. The video tracking software makes it very easy to assess mobility and velocity, for example, but is also efficient in assessing path shape, interaction between individual insects, plant infestation, learning and memory, and much more. Data selection and analysis tools, including track visualization and heat maps, allow you to perform in-depth analysis.

DanioVision

- *Detailed activity monitoring*
- *High-throughput research*
- *Controlled plug-and-play environment*
- *Powered by EthoVision XT*

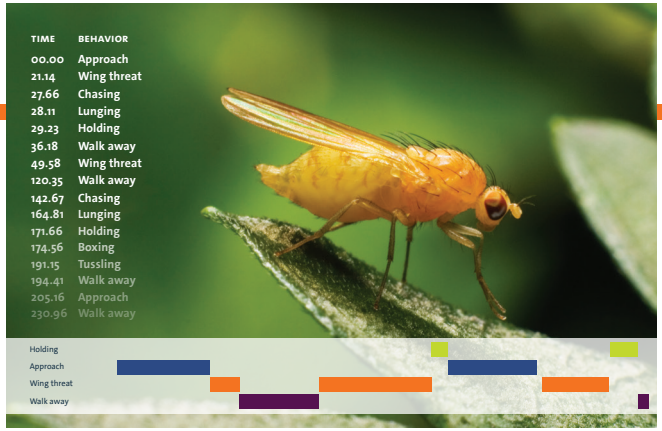


WWW.NOLDUS.COM/DANIOVISION

DanioVision™ is an innovative and complete system suitable for high-throughput testing of insects and insect larvae, such as fruit flies and mosquitoes. The Observation Chamber provides a controlled testing environment that holds any standard multi-well plate, petri dish, or other small container and makes sure it is perfectly fixated underneath the high-speed digital camera. The basin is backlit with IR-light for tracking and white light that can be used for gradual light changes or pulses. The spacious design provides easy access and allows for add-ons such as the Toplight unit, optogenetics, the Tapping Device, or custom equipment.

The Observer XT

- *Study behavioral elements in great detail*
- *Share the work and check reliability*
- *Integrate your data for extensive analysis*
- *Flexible scoring with on-the-go solutions*



WWW.NOLDUS.COM/OBSERVER-ANIMAL

Some insect studies focus on detailed behaviors and require a more detailed look. The Observer® XT is the professional, adaptable and user-friendly event logging software, ideal for manual observations. From building a coding scheme (ethogram) to the analysis and presentation of your results, this software allows you to study oviposition, courtship, feeding, and aggression-behaviors that are difficult to automate. You can score behaviors live or from video, which you can slow down to record the start and stop of certain behaviors. Choose continuous or instantaneous sampling, or combine both. Working on a large or educational project? Share the work with Coder Licenses.

Pocket Observer

- *On-the-go flexible scoring solution*
- *Maximum freedom in moving about*
- *Observe unobtrusively*
- *Compatible with handheld devices*

WWW.NOLDUS.COM/POCKET-OBSERVER-ANIMAL

Pocket Observer offers the best solution for your research by combining the power of The Observer XT with the portability of a handheld device. Code on a smartphone, tablet, or rugged handheld computer. With Pocket Observer, you can record observational data in detail and data coding is easy with its user-friendly interface. Just like with The Observer XT, you can add behaviors while you are observing and score continuously as well as instantaneously (at set intervals). We offer several rugged handheld devices that are ideal for live scoring of animal behavior in the field. Rugged handheld computers can withstand high humidity and extreme environmental temperatures.

Track3D

- *Study spatial behavior in 3 dimensions*
- *Ideal for wind tunnels and other chambers*
- *Individual calibration for accurate results*
- *EthoVision XT add-on*

Many insects fly; therefore, behavioral assessment in a 2D plane may be insufficient to fully analyze your subjects' behavior. Track3D, developed in collaboration with Wageningen University, is a video-based system for automated tracking of animals in a 3D space. Researchers can record the movement of an insect in a test chamber, visualize and present the resulting trajectory in a 3D image, and calculate a number of movement parameters.

WWW.NOLDUS.COM/TRACK3D

The 3D trajectory is based on a combination of two 2D tracks recorded by EthoVision XT with two separate high-resolution cameras. To assure a highly accurate calculation of the 3D trajectory, a custom calibration frame is built for each specific arena.

Wind Tunnel

- *Study flight behavior in response to stimuli*
- *Uniform air speed and direction*
- *Ideal for light and dark conditions*
- *Optimized for video tracking with Track3D*

For studies of insect orientation and flight in relation to visual and odor stimuli, a wind tunnel is the optimal setup. Noldus offers a complete solution with a high quality and flexible wind tunnel, optimized for video tracking with Track3D. The wind tunnel consists of a tracking chamber and an airflow production system comprised of a fan and an air lamination diaphragm. Infrared lighting is possible for dark conditions. Air speeds can

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be set up to approximately 40 cm/s. The multi-layer air lamination diaphragm ensures that air speed and direction are uniform throughout the tracking chamber. The standard wind tunnel model is 160 x 60 x 60 cm (LxWxH) but other sizes are possible.

MediaRecorder

- *Record up to eight videos at once*
- *View side-by-side or picture in picture*
- *Save separate or integrated files*
- *Synchronize video with behavioral data*

WWW.NOLDUS.COM/MEDIA-RECORDER-ANIMAL

Need to study insects at different locations or at different angles? MediaRecorder is a software tool that enables the synchronous recording of up to eight different video and audio sources at a time. You can view videos side by side or use picture in picture. MediaRecorder is compatible with EthoVision XT, The Observer XT, and a broad range of cameras (such as FireWire, GigE, industrial USB cameras, and IP cameras), and is designed to be at the core of your lab. You can switch between different cameras and control them with your mouse or joystick. With IP cameras you can use pan-tilt-zoom, meaning that you can position your camera very precisely.

Portable Observation Lab

- *On-site recording of behavior*
- *Complete and compact*
- *Robust*
- *Quick set-up in any environment*

WWW.NOLDUS.COM/PORTABLE-LAB-ANIMAL

Some phenomena are difficult to study in a lab; for example, insects' behavior in their natural ecosystem. In those cases, you can achieve the best results with live and on-site observation using our compact portable lab. Designed for travelling, the lab weighs less than 11 kg (25 lbs) and is built into a rugged, wheeled carrying case. It contains all equipment needed to make live behavioral recordings in any context. With all components labeled and ready for assembly, be ready to record quickly once you've arrived onsite, and save valuable time. A Noldus portable lab is built on a modular platform; it can even be extended with additional third party hardware such an event logging keyboard.

Services

- *Customized training courses*
- *Behavioral coding services*
- *Rent a system or software license*
- *Protect your investment with NoldusCare*

Noldus offers a wide range of services, from our consulting services and training, to rentals and NoldusCare. Our consultants understand how to turn raw data into meaning. They can advise you on how to perform your research in the most efficient and effective way. You can also outsource your video coding work to our experts to analyze already-collected data. Furthermore, you can easily rent equipment and software, or schedule a training course for your group. With NoldusCare you receive all software upgrades, technical support, and warranties on Noldus hardware. It gives you peace of mind, guaranteed project quality, and continuity, and protects your investment for the long-term.

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Noldus Information Technology

- *Leading in behavioral observation and analysis systems*
- *User centered design*
- *Over 25 years of product innovation*
- *Worldwide service, support, and expert advice*

Noldus Information Technology was established in 1989 by Lucas Noldus, who holds a Ph.D. degree in animal behavior from Wageningen University. During his research on the behavioral ecology of parasitoid wasps, he developed the first version of what later became The Observer software package. The company now has offices in nine different countries and is represented by distributors worldwide. With this global team, Noldus develops innovative solutions for behavioral research. These can vary from industry standard software packages and lab equipment to fully integrated observation labs including on-site installation, training, and support.

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MORE THAN 25 years OF INNOVATION

Innovative solutions for animal behavior research

Powerful software tools, fully integrated labs, and expert consultancy.
Trust our 25 years of experience to make your project a success.

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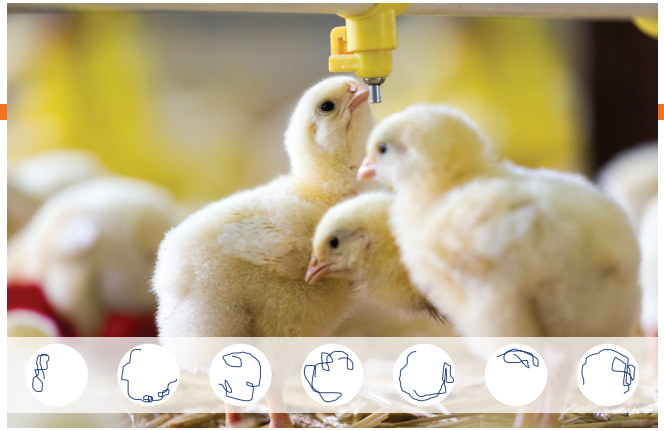
Noldus
Information Technology

EthoVision XT

- *Reliable video tracking of animals*
- *Cost effective & easy-to-use software*
- *Track multiple animals in multiple arenas*
- *Extensive data selection and analysis*



WWW.NOLDUS.COM/ETHOVISION

EthoVision® XT is the market-leading video tracking platform that offers flexibility, versatility, and highly accurate data for a wide range of animal behavioral experiments. Do not just take our word for it - over 2000 labs use EthoVision XT and it is validated in thousands of publications. With EthoVision XT, you can automatically track and analyze any animal in any kind of enclosure. The software makes it very easy to assess variables such as velocity, distance moved, zone visits, and much more. Perform in-depth analysis with data selection and analysis tools such as track visualization and heat maps. Pick and combine modules to create the solution that meets your research needs.

UltraVox

- *Detailed analysis of (ultrasonic) vocalizations*
- *Full-spectrum sound capture with USB microphone*
- *Compact and cost-effective solution*
- *Easy identification and labelling of calls*

WWW.NOLDUS.COM/ULTRAVOX

UltraVox™ XT is a software tool that analyzes sound, including ultrasonic vocalizations. The signal is displayed in real-time in a waveform and spectrogram. You can define frequency range, amplitude, duration, and time gaps to let UltraVox XT find all calls that fit those criteria, then easily label each call with user-defined names. UltraVox XT provides a PDF report with data, statistics, and spectrograms. It also plays back the recording in an audible (pitch-reduced) range. You can export data, audio files, and images. The data is fully compatible with EthoVision XT and The Observer XT so that you can integrate the vocalizations with other behavioral and physiological data.

TrackLab

- *Analysis of a wide range of life stock behaviors*
- *Extensive and clear data representations*
- *Save time with automated data collection*
- *Easily gather welfare and health insights*

TrackLab is the integrated system for the recognition and ana-lysis of spatial behavior. The system can be used to gain insight into animal behavior and their social dynamics to improve their health and welfare. You can schedule recording sessions and analyze the movement data of multiple animals at your desk. TrackLab works with ultra-wideband technology and GPS, which automatically collects and sends the exact location

WWW.NOLDUS.COM/TRACKLAB

of each animal to TrackLab for processing. Compute statistics per track, per defined zone or time interval. Data can be visualized as tracks on a map, heat maps, or graphs. TrackLab is compatible with the Observer XT for enhanced analysis and visualization.

The Observer XT

- *Study behavioral elements in great detail*
- *Share the work and check reliability*
- *Integrate your data for extensive analysis*
- *Flexible scoring with on-the-go solutions*

The Observer® XT is the professional and user-friendly event logging software for the collection, analysis, and presentation of observational data, used by more than 20,000 researchers worldwide. It supports the entire workflow of a research project, from ethogram to presentation of the results. You can integrate external (physiological) data streams in your visualization and analysis. With several modules, you can adapt this tool

WWW.NOLDUS.COM/OBSERVER-ANIMAL

to your research needs. You can score animal behaviors live or from video, which you can slow down to record the start and stop of certain behaviors. Choose continuous or instantaneous sampling, or combine both.

Pocket Observer

- *On-the-go flexible scoring solution*
- *Maximum freedom in moving about*
- *Observe unobtrusively*
- *Compatible with handheld devices*

With Pocket Observer, you can score on the go! Code on a smartphone, tablet, or rugged handheld computer. Simply design your ethogram with The Observer XT on your PC, transfer it to your handheld device, perform the observations, and then import the results back into The Observer XT for analysis. With Pocket Observer, you can record observational data in detail and data coding is easy with its user-friendly interface. Just like with

WWW.NOLDUS.COM/POCKET-OBSERVER-ANIMAL

The Observer XT, you can add behaviors while you are observing and score continuously as well as instantaneously. You will be able to move around to keep the animal of interest within view. Ideal for studying animals in their natural habitat or in a zoo!

MediaRecorder

- *Record up to eight synchronic videos at once*
- *View side-by-side or picture in picture*
- *Save separate or integrated files*
- *Synchronize video with behavioral data*

Need to study animals at different locations or at different angles? MediaRecorder is a software tool that enables the synchronous recording of up to eight different video and audio sources at a time. You can view videos side by side or use picture in picture. MediaRecorder is compatible with EthoVision XT, The Observer XT, and a broad range of cameras (such as FireWire, GigE, industrial USB cameras, and IP cameras), and is designed

WWW.NOLDUS.COM/MEDIA-RECORDER-ANIMAL

to be at the core of your lab. You can switch between different cameras and control them with your mouse or joystick. With IP cameras you can use pan-tilt-zoom, meaning that you can position your camera very precisely.

Portable Observation Lab

- *On-site recording of behavior*
- *Complete and compact*
- *Robust*
- *Quick set-up in any environment*

Some phenomena are difficult to study in a lab; for example, deer behavior in their natural ecosystem. In those cases, you can achieve the best results with live and on-site observation using our compact portable lab. Designed for travelling, the lab weighs less than 11 kg (25 lbs) and is built into a rugged, wheeled carrying case. It contains all equipment needed to make live behavioral recordings in any context. With all components

WWW.NOLDUS.COM/PORTABLE-LAB-ANIMAL

labeled and ready for assembly, be ready to record quickly once you've arrived onsite, and save valuable time. A Noldus portable lab is built on a modular platform; it can even be extended with additional third party hardware such an event logging keyboard.

Track3D

- *Study spatial behavior in 3 dimensions*
- *Ideal for swim tanks, wind tunnels and other chambers*
- *Individual calibration for accurate results*
- *EthoVision XT add-on*

Animals move around in a 3D space: they fly, jump and climb. Therefore, behavioral assessment in a 2D plane may be insufficient to fully analyze your subjects' behavior. Track3D is a video-based system for automated tracking of animals in a 3D space. It allows the researcher to record the movement of an animal in a test chamber, visualize and present the resulting trajectory in a 3D image, and calculate a number of movement parameters.

WWW.NOLDUS.COM/TRACK3D

The 3D trajectory is based on a combination of two 2D tracks recorded by EthoVision XT with two separate high-resolution cameras. To assure a highly accurate calculation of the 3D trajectory, a custom calibration frame is built for each specific arena.

Services

- *Customized training courses*
- *Behavioral coding services*
- *Rent a system or software license*
- *Protect your investment with NoldusCare*

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WWW.NOLDUS.COM/ABOUT-NOLDUS

into practical and proven solutions. Our consultants have advanced degrees in the behavioral sciences, which provides a unique ability to uncover behavioral patterns and turn them into actionable results.

LINEAR TREADMILL
SpeedBelt

PHENOSYS
Technology for Behaviour Analysis

BACKGROUND

Behavioural neuroscience benefits tremendously from the ability to study awake animals which are able to move while still under head-fixed conditions. In general, linear treadmills require relatively little effort in animal training yet open wide possibilities in combination with additional methods such as virtual reality or external stimuli.

The PhenoSys SpeedBelt is designed for stand-alone use or for the integration with our JetBall virtual reality systems. It is particularly compact to allow the easy combination with electrophysiology, advanced imaging as well as optogenetic methods.

Design Considerations

- Compact design for flexible integration
- Solid ground for the animal
- User friendliness for belt exchange and cleaning
- Mechanically compatible with PhenoSys JetBall holder and operant units
- Easy to synchronize with recording equipment

Benefits

- Natural movements
- Accurate measurement of speed and distance
- Minimum training requirements

Linear treadmill for easy integration with advanced microscopy and electrophysiology

PhenoSys SpeedBelt – Linear treadmill

PhenoSys SpeedBelt on JetBall base with JetBall operant devices

APPLICATIONS

- Voluntary running behavior
- Behavioral tasks employing navigation, cognition, learning, or memory
- Coupling with virtual reality for the study of brain functions
- Habituation and training for PhenoSys JetBall experiments

KEY FUNCTIONS

- Effortless motion by low friction support and ball bearings
- Reliable optical speed sensor with USB output
- Analog output for speed (BNC 0-5V)
- Adjustable height, tilt, and belt tension

OPTIONS

- Custom stands
- Replacement belts (consumable)
- Add-on to JetBall Virtual Reality Systems

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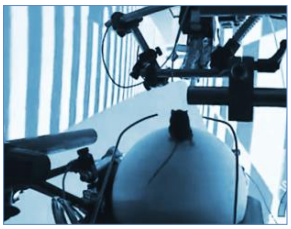
VIRTUAL REALITY
JetBall

PHENOSYS
Technology for Behaviour Analysis

BACKGROUND



Virtual reality (VR) systems create experimental environments with unlimited possibilities. They allow to investigate fundamental mechanisms of navigation, cognition, learning, or memory in animals.

The JetBall is an air cushioned spherical treadmill in combination with screens or a projection dome. It allows an animal to navigate and to perform behavioral tests in a virtual space, while it is examined by in-vivo imaging, optogenetic, or electrophysiological methods.

The JetBall enables new applications in neuroscience.

ADVANTAGES

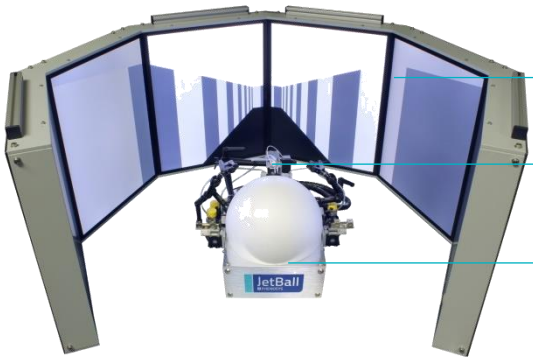
- The VR allows flexible modifications of experimental environments and fast repetitions of simple tasks.
- The animal remains completely stationary while interacting with a virtual world.
- Animal activity can be correlated with external measurement data such as optical imaging or electrophysiology.
- Many different additional stimuli and reward systems may be added to make the VR more realistic and interactive.
- Standard mazes and experiments are provided that can be modified and extended according to specific experimental needs.
- Hardware synchronization and data export allow the easy integration with complex experimental setups

VIRTUAL REALITY VARIANTS

The virtual reality is either displayed on a TFT surround monitor or via a spherical mirror projection to the inner surface of a section of a sphere. A common equipment rack integrates power supplies, control PC, and the air flow regulation system for JetBall and accessories.

JetBall-TFT

- Easy accessibility for external setups, e.g. microscopes and manipulators
- High contrast and luminance.



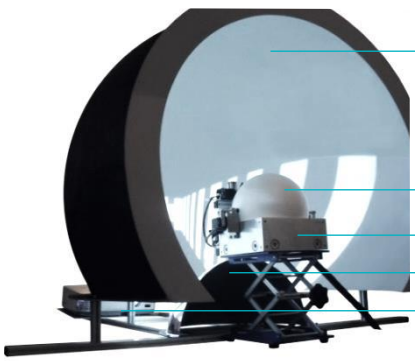
TFT surround monitor with virtual reality scene (270°) with six 19“ sub-units

Air cushioned spherical treadmill

Ball holder

JetBall-Dome

- Larger field-of-view for presenting the virtual reality
- Seamless projection surface.



Dome (1.2m) with spherical mirror projection

Air cushioned spherical treadmill

Ball holder with stand

Spherical mirror

Projector

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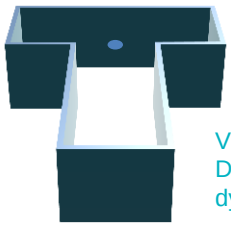
VIRTUAL REALITY
JetBall

PHENOSYS
Technology for Behaviour Analysis

TYPICAL VIRTUAL MAZES & PARADIGMS

Create your own virtual maze with our software, place own landmarks variable in size and shape appearing and disappearing at defined times, create endless mazes, run different mazes as test batteries without moving the animal from the top of the ball, or uncouple the virtual reality and the actual movement of the animal.



Virtual T-maze
Decision making using dynamic landmarks

Virtual Open Field
Exploratory behavior using elevated 3D landmarks

Virtual Corridor
Training task with frequent rewards and reinforcement

Virtual Plus Maze
Light-Dark-Discrimination
Reaction to olfactory cues

BALL HOLDER & OPERANT MODULES

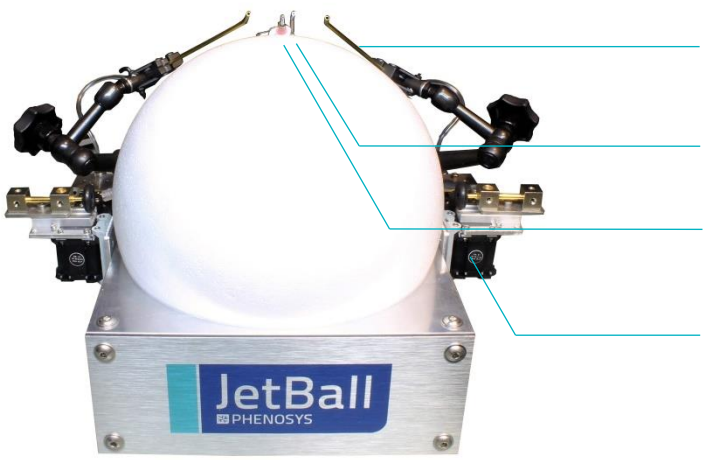
The heart of a JetBall system is the ball holder made of solid aluminum. An air-cushion is generated by compressed air on which a custom made ball can float with minimal friction. The aerodynamically optimized inner surface guarantees a laminar flow and stable, quiet motion. Two XY-motion sensors pick up any movement of the ball and translate it into VR coordinates.

The stimulation is not purely visual but can be extended to sound, odor, whisker stimulation, negative reward by air puff, positive reward by liquids and a brake system.

Ball Holder System
- 20 cm ball holder system: for mice
- 30 cm ball holder system: for rats < 300g

Stereo sound (optional)
Our 3D acoustic system consists of two active monitor speakers, audio-interface, and software.

Odor (optional)
Our multi-channel Olfactometer provides fast-response olfactory stimulation.



Whisker stimulation (optional)
Air flow is presented to left or right whiskers whenever the animal touches the boundary of a virtual wall.

Air puff system (optional)
Negative reward by frontal air puff. Retractable.

Liquid reward system (optional)
Equipped with a lick sensor and a peristaltic pump for positive reward. Retractable.

Brake system (optional)
One frontal and two lateral brakes stop the ball, e.g. at the end of a virtual corridor.

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PHENOSYS
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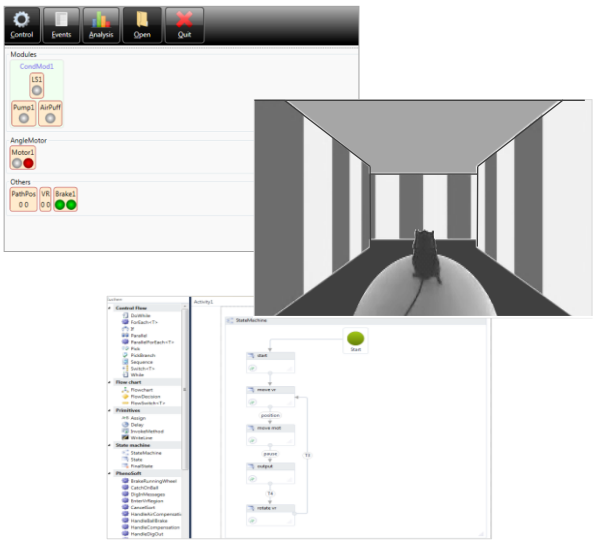
FLEXIBLE AND POWERFUL SOFTWARE

The JetBall system includes the following modules:



PhenoSoft Control
For experimental control and data acquisition.
Graphical user interface with visual indicators and extensive data logging of all relevant events.

PhenoSoft VR
To display all kinds of virtual mazes with full flexibility regarding size, shape, walls, sky, floor, textures, landmarks, colors, and images.

PhenoSoft Schedule
For designing complex experimental schedules.
A graphic programming environment combines flexibility and complexity.

EXPORT OF DATA

Data transfer and synchronization

The current VR position and all related events of operant units can be transmitted by the JetBall to external devices in real time. TTL trigger signals can be received and sent to wait for or start external equipment.

Coordinates

Two sets of coordinates are registered by the JetBall system:

- XY position: the actually recorded raw data of the xy-motion sensors (independent of the VR).
- VR position: the corresponding position of the animal within the virtual reality.

Both sets of coordinates can be transferred to external hard- and software by:

- Analog data transfer:
  The optional analog output board (8-Channel analog data 12-bit) provides access to position data via four outputs with +-10V output range.
- Digital data transfer:
  Coordinates can also be transferred via TCP/IP (Ethernet) to an external computer.

Events

Accessible events of operant units include:

- Lick sensor activation (liquid reward)
- Pump (liquid reward)
- Air puff (negative reward)
- Whisker stimulation left/right
- Brake activation
- Olfactory stimuli presentation
- Virtual reality events
- External TTL-trigger signals

Operant units are controlled by a PCI interface board. The corresponding I/O-signals (24 lines) are directly available as TTL signals at the Interface Connector Box mounted to the ball holder.

PhenoSys provides several ways to access this data:

- BNC cable connectors for TTL-In and TTL-Out
- Use of a PCI-board (NI PCI-6503) in an external computer directly connected to the Interface Connector Box

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INDIVIDUAL TRACKING
Activity Monitor

PHENOSYS
Technology for Behaviour Analysis

BACKGROUND

Activity and movement is a fundamental diagnostic parameter of animal behavior. However, measuring long-term individual movement within groups was not possible until now. Our Activity Monitor provides accurate individual movement data with full automation. It is a unique solution for the long-term tracking of individual animals living in groups.

The sensor plate placed underneath a cage detects individuals and tracks them as they move through the cage. Automated and long-term assessment of individual activity is made possible without having to place individuals in separate cages. The Activity Monitor utilizes RFID-technology.

RFID TECHNOLOGY

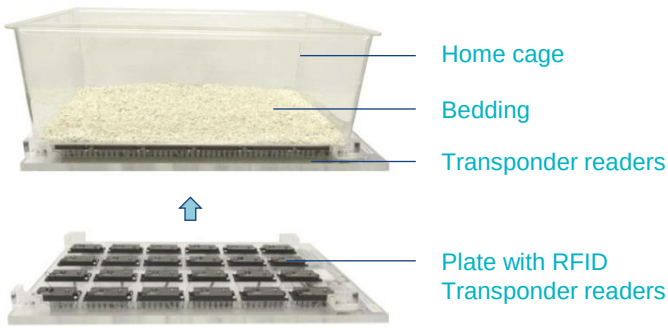
Radio-frequency identification (RFID) is a technology to identify and to track an individual within a group of animals. Individual tags are placed under the skin and are detected by sensors when in proximity. Subcutaneous tags are approximately the size of a corn of rice and require no battery.

CALCULATION OF

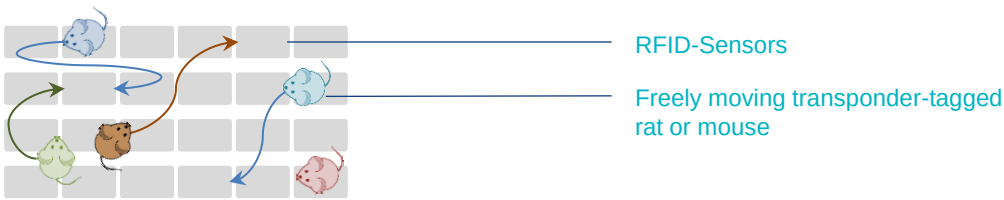
- Distances travelled
- Spatial preferences
- Move time
- Rest time
- Movement velocity

SETUP WITH 24 TRANSPONDER SENSORS

PhenoSys
Activity monitor type IV-24



Schematic presentation of movement by tracked animals living in a group



APPLICATIONS

- Measurement of individual locomotor activity and distances
- Ideal for rat and mouse models of hyperactivity, movement disorders (i.e. ADHD, Parkinson), neuropathic pain, and arthritis
- Determination of individual spatial preferences within a group cage

KEY FUNCTIONS

- Based on RFID-technology (transponder)
- Fully automated, 24/7 for every tagged animal
- Efficient space use since individuals stay in group cage

OPTIONS

- Available for different cage types

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MULTI-CAGE ENVIRONMENTS
IDsorter.2

PHENOSYS
Technology for Behaviour Analysis

BACKGROUND

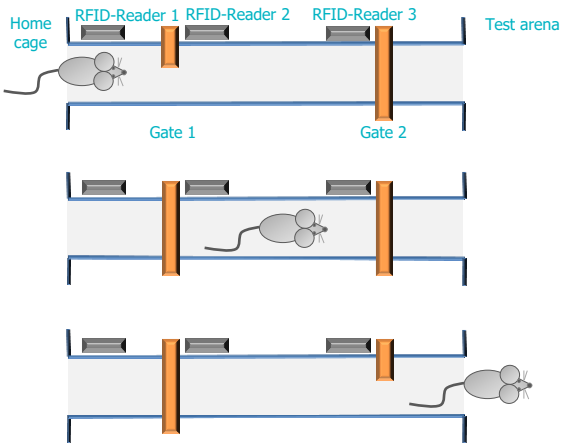
It is beneficial for animals to live in groups rather than in single housing. Many behavioural diagnostic tests, however, require an individual animal to be alone while tested. Traditionally, this requires manually placing an animal from a home cage to the test arena and back. With the IDsorter, connecting the home cage to a test arena, this process is fully automated.
Our system can be interfaced to operant systems from other vendors or to video observation systems.

RFID TECHNOLOGY

The IDsorter is based on RFID-technology. It allows the selective passage of a single animal to the test arena and back, while individual experiments can be conducted in the operant chamber with independent experimental control software.
Radio-frequency identification (RFID) technology identifies and tracks an individual within a group of animals. All animals have to wear subcutaneous transponders. These transponders require no battery and are powered by the electro-magnetic fields emitted by the RFID-Readers in its proximity.

ID-SORTER

PHASES OF SORTING PROCESS (EXAMPLE)



An animal is detected at RFID-Reader 1.
If the experimental protocol gives permission, gate 1 opens.

The animal is detected at RFID-Reader 3. Gate 1 closes when it is safe for the aninmal. Gates 1 and 2 remain closed for 30 s.

After 30 s gate 2 opens. The animal can enter the operant compartment. Gate 2 closes if the animal is registered at any RFID-Reader within the operant compartment.

APPLICATIONS

- Combining group living with testing arenas
- Fully automated 24/7 experimentation for individual operant procedures
- High-throughput phenotyping

KEY FUNCTIONS

- Based on RFID-technology
- 24/7 operant experimentation and observation system
- Gate position sensors for improved animal wellbeing
- Compatible with operant boxes or mazes from third party vendors

OPTION

- Automated body mass measurement with integrated electronic balance
- Two sizes available: ID-Sorter mouse, ID-Sorter rat

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OPERANT MODULES

Olfactometer

PHENOSYS
Technology for Behaviour Analysis

INTRODUCTION

The multi-channel olfactometer provides fast-response odour stimulation. It is a sophisticated tool for visualising and quantifying activity in olfactory sensory neurons and the olfactory bulb for investigating olfactory quality coding. Our olfactometer systems allow perfect control of multiple stimuli and stimulus concentration.

The preparation of high quality odour mixtures is a complex process. With the automated olfactometer and its software this process becomes a standard laboratory routine. The olfactometer can be used and integrated easily for the behavioural assessment of odour-detection and for odour discrimination behaviour.

MODE OF OPERATION

The Olfactometer can have **one to several parallel channels** leading to one or two separate odour delivery ports. Each odor channel is an air dilution odour delivery system.
The air flow through the odorant line is controlled by a **mass flow controller** (range 0-100 sccm/min). For most of the time, this continuous air (or nitrogen) flow is diverted through an empty vial without odour substance. During odour delivery, the gas flows through one or several odorant vials. After exiting from the valve behind the odour vial, the odorant flow merges with the dilution air line. This is controlled by another **mass flow controller** (range 0-500 sccm/min).
The port valve switches rapidly between odour and background gas streams delivered to the odour port.

SETUP

Special valves are located in the main stream flow. This ensures continuous washing of the odorant residues and only negligible dead space. After activation of the odour flow, its concentration stabilizes after 0.5-1 sec.
A final valve allows the switching of rapid onset/offset odour pulses delivered as transient stimuli. The **dual synchronous 3-way valve** with 4 ports and minimal dead space allows rapid switching between odour and background gas streams.

Nearly rectangular odour stimuli can be generated. Thin **teflon tubing** throughout the system ensures fast odour delivery and minimizes odour contamination. Additional **flow meters and manual gas valves** allow matching the impedances of the background line and the odour line to prevent pressure jumps during stimulus application.

APPLICATIONS

- Olfactory stimulation with pure or mixed odours, concentration gradients
- For electrophysiology or imaging studies of olfactory quality coding
- Investigation of higher cognitive functions using odour
- Translational research: test routines for specific human disease models

KEY ADVANTAGES

- Multiple odour sources
- Fast switching of odour pulses
- High-pressure small diameter tubing system
- Training, two-odour, and multiple-odour discrimination tasks
- Concentration gradients adjustable automatically with multiple high precision mass flow controllers

OPTIONS

- Multiple combinations: 1 or 2 separate odour channels with 2 to 17 odours each leading to 1 or 2 different stimulus ports
- Can be combined with operant systems, e.g. Jet Ball
- Operant schedule programming on request
- Can be used with humans

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Optomotor Response
qOMR

PHENOSYS
Technology for Behaviour Analysis

INTRODUCTION

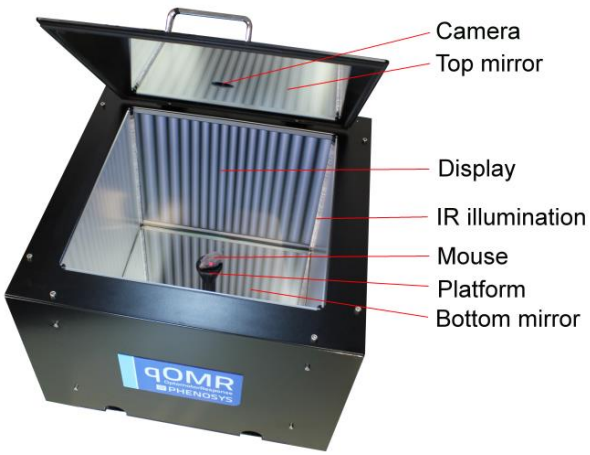
The optomotor response (OMR) is a reflex often used to assess visual abilities. To evoke OMR a rotating cylinder with a striped pattern is presented to an animal on an elevated platform. The resulting head movements are evaluated in relation to the presented stimulus to determine thresholds of visual recognition.

The PhenoSys qOMR (quantitative OMR) is a unique system that automatically measures OMR with minimal experimenter effort. It uses a virtual stimulation cylinder that constantly aligns with the animal´s head position. Real-time head tracking delivers quantitative OMR data with fully automatic measurement procedures.

qOMR System Setup

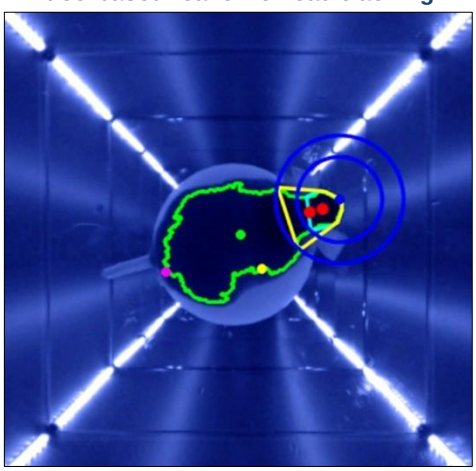
Basic configuration:

- Calibrated 4 screen environment for presenting the virtual stimulation cylinder
- Elevated central platform for placing a freely moving animal
- Top and bottom mirror to create an illusion of infinite depth
- Adjustable infrared illumination
- IR-camera for automatic head tracking undisturbed by the visual stimulus.



omrStudio Software

Video-based real-time head tracking

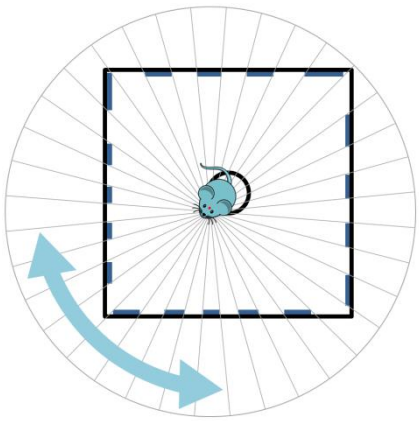


A video-based real-time tracking of the animal position and head angle is employed to :

1. the continuous automated re-centering of the virtual cylinder according to the animal´s head position
2. the evaluation of head movement in sync with the stimulation for a quantitative measure of the OMR. This analysis is fully automated.

Batch runs with multiple stimulation protocols are easily defined, saved and reloaded

Continuous centering of the rotating virtual cylinder



Easy operation by an intuitive three step procedure:

1. Stimulus design - flexible and easy configuration of experiment (pattern, rotation, repetitions, etc.)
2. Run experiment - place animal on the platform and start the fully automated measurement
3. Data Analysis - analyze multiple data sets, export to various formats or directly generate publication-ready figures

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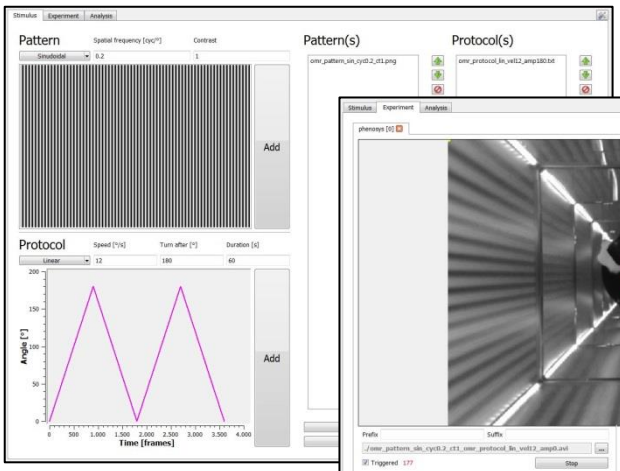
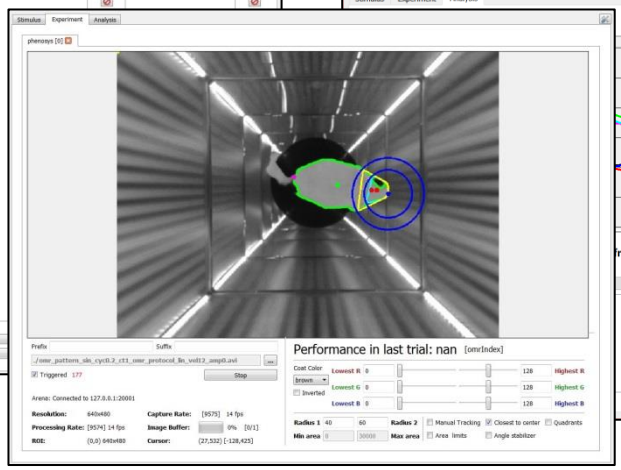
Optomotor Response
qOMR

PHENOSYS
Technology for Behaviour Analysis

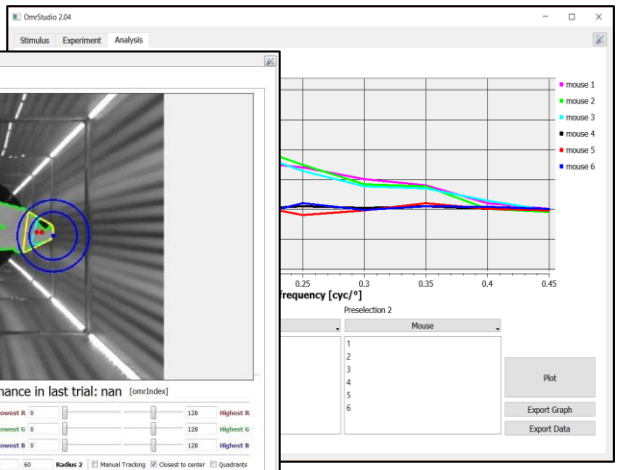
omrStudio – Three Step Procedure



Stimulus esign



Run Experiment



Data Analysis

Results

- Typical measurement take a few minutes and consist of a series of different stimuli with intermittent gray-out periods
- 3-5 measurements are required to receive a solid baseline curve e.g., for the visual acuity
- Visual acuity, contrast sensitivity, differences between clockwise and anti-cw stimulation, and scotopic/photopic conditions are possible measurement parameters
- The speed of the stimulus rotation is variable

Advantages

- Simple, robust, and non invasive test to examine vision in rodents
- Fully automated measurement and analysis: no manual positioning of the stimulus, no specially trained operator required
- Time and cost effective
- Using a natural reflex, qOMR measurements do not require animal training
- Freely behaving animals, no surgery, no fixation
- Flexible, user-friendly experimental design and data analysis
- Operator independent results

Applications

- Investigation of various aspects of vision in mice and other rodents:
  - Visual acuity
  - Contrast sensitivity
  - Spectral sensitivity
  - Temporal sensitivity
- Characterization or preclinical testing in relevant disease models, for example:
  - Glaucoma
  - Retinal degeneration
  - Diabetes
  - Ageing
- Examination of axonal regeneration

PhenoSys Collaboration

The PhenoSys qOMR is a *PhenoSys Collaboration* product. These products are brought to market together with the scientists who developed them.

qOMR is a joint product of Dr. Friedrich Kretschmer and PhenoSys.

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