

Mobile HomeCage™

Frequently asked questions (FAQs)

What is the Mobile HomeCage?

The Mobile HomeCage is an airlifted head-fixation platform that enables principally 2-photon microscopic imaging and a wide range of electrophysiological tests on awake, behaving, non-anesthetized rodents. It is proprietary and patented by Neurotar Oy, Helsinki, Finland.

Why use the MHC?

- No need for anaesthesia
- In vivo yet highly stable due to the head-fixed configuration
- Techniques can be combined, eg. in vivo imaging, electrophysiological and behavioral experiments
- Enormously reduced stress for animals compared to restraint and comparable systems as the animal is free to run and explore with tactile whisker input

What are the key MHC application areas?

- Two-photon microscopy
- Electrophysiology, intracellular, extracellular, multi-channel
- Optogenetics
- Intrinsic optical imaging
- Voltammetry, ion sensing, microdialysis

What are the alternatives to the MHC?

- Inserting the animal into a tube or wrapping it tightly
- Training it not to move (by giving water/food after water/food deprivation, e.g.)
- Making it run on top of a styrofoam ball with virtual reality (highly stressful, requires various techniques to ensure compliance and long habituation times)
- Treadmill
- Spinning disc
- Head-mounted, low-resolution microscope
- Head-mounted electrophysiology headstage

All create stress for the animal, are low resolution, or are so labour intensive as to be virtually unusable. Better alternative is to let the animal move around and explore the environment.

What are the advantages of the MHC?

- The flat floor is natural for rodents to walk on
- Real walls are critically important for rodents to explore with their whiskers. They are highly tactile animals and respond to touch and smell much better than to visual stimulation.
- Small device, fits under all major microscope brands. Does not require customization of existing equipment.
- Fast and easy insertion and removal of the rodent via the precision engineered head fixation bridge and headplates.
- MHC does not require any anesthesia – neither during nor before the experiment. Other methods require "light and short anesthesia" and are time-consuming.

How does the Mobile HomeCage compare against other methods?

	Mobile HomeCage	Treadmill + VR (linear, spherical)	Head-mounted devices
Short habituation and training	++	-	+++
Low stress	++	-	+
Cost-effectiveness	++	-	+
Natural environment (flat floor, walls, obstacles)	++	-	++ +
Allows high quality optics, multiple precision electrodes	+++	++	-
Size and compatibility with other equipment	+	-	++
Allows place cell research	+	++	+++
Extended time of locomotion	++	+	+++

How do you insert an animal into the MHC?

Our cloth-wrapping technique is fast, and standardized to reduce variability and stress to the animal.

How long can an animal can stay in MHC?

Up to 2 hours (one session). Longer sessions up to 5 hours are possible with adequate hydration and sucrose treats.

How long is the habituation period?

Four days in principle, twice daily training sessions (total 8-10 training sessions, 2 hour sessions). Stress behaviours are markedly reduced and stress-induced dip in body weight recovers on day two.

Movement also increases after only one day's training. See here for our protocol
https://www.jove.com/files/ftp_upload/51869/51869fig1highres.jpg

How can one provide sensory stimulation in the MHC?

Sounds, smells, colours, patterns, or touch switches, touch screens on the walls, rewards (positive and negative) can be mounted on the vertical bridge, clamp, or in the enclosure itself if they do not impede movement.

How can one perform operant conditioning paradigms in the MHC?

It is feasible to implement wireless or tethered touch sensors or screens into the MHC and to set up a reward system, eg. a sucrose lick port. We are actively collaborating with other companies and laboratories to create standardized solution. We also encourage researchers at this early stage to be creative in their approaches, as the system is open for innovation. The cross bar has built-in fixing points and screw holes for such applications.

How do you deliver water and food?

Water and food may be delivered manually or via an automated tube or feeding port.

Is the MHC be suitable for rats?

The current Mobile HomeCage version is designed for mice and other small rodents such as gerbils. We are developing a larger Mobile HomeCage (MHC-L) which will be suitable for rats. The estimated launch date for MHC-L is in summer 2015.

How can you administer drugs in the MHC?

Via chronically implanted tail vein cannula. It is possible to combine the cranial window with a pre-implanted cannula for intracerebroventricular (icv) injection. If the window is open for electrophysiology, topical injection is possible, either by removing dura mater and applying directly to the surface of the cortex (like bath application) or with a sharp pipette straight into the tissue (intra-parenchymal).

Is the noise or vibration stressful?

The MHC is designed from aircraft-grade aluminium alloy and carbon fibre to be maximally silent and vibration free. Noise is no higher than laboratory background noise, at 35-40dB. An electric airblower increases ambient noise, however, according to Jensen et al. "Vacuum cleaner noise and acute stress responses in female mice" Journal of American Association for Laboratory Animal Science, 2010 there is no effect of vacuum cleaner noise on the animal (vacuum cleaner – 85 decibels, an hour of which has no effect). You may however wish to play white noise to standardize the auditory environment if this is a factor in your experiment.

Where can we get a surgery protocol?

We provide full, detailed, tried-and-tested protocols for all surgeries on request and will support you with videos, photos, via Skype, email and telephone.

How do I order head holders for the MHC?

Various designs of head holders (helicopter-shaped metal bars) are available from us Neurotar at €20/piece (reusable) on request, just place an order. Use one piece per mouse. Clean after use (e.g. with acetone to remove superglue and then sterilize with alcohol).

Can head holders be reused?

Yes. They are manufactured from stainless steel and can be reused.

How long an animal can live with an implanted headholder window?

From one month until the end of its life, theoretically. We have kept them for up to one year.

At what age can you implant a window?

After four weeks; otherwise the skull grows and the window does not.

Does the focal plane shift or drift whilst taking a series of pictures?

Z-stacks can be taken in a stable manner. As the skull plates have a degree of elasticity around the sutures, any movement artefacts will spring back to their original position and do not require correction.

What type of objective to you recommend for 2-photon imaging via cranial window?

We recommend a 25x high NA (eg. 1.05) water immersion objective. The maximum imaging depth typically achievable is 1mm.

Is there any limit to which part of the brain can be imaged/accessed?

The only real limit to imaging position for stability is which part of cortex you can physically access without the animal being in too unnatural a position. For imaging work you can place a window unilaterally over primary sensory cortex (S1), so the mice's heads are at an angle of about 20 degrees. For electrophysiology you can place window over the entire dorsal surface of the parietal bones, from V1 to S1, and teardrop-shaped windows over bregma for access to striatum and M1.

Which microscopes and tables are compatible with the MHC?

MHC is compatible with most popular microscope models: Olympus, Zeiss, Leica, Nikon, Scientifica and ThorLabs. Further information about distance between microscope's objective, motorized stage/table and distance between the optical axes of the objective and the vertical stand of the microscope frame may be required.

Are there any publications yet using the MHC?

We have produced one peer-reviewed paper ourselves using real experimental data generated for private clients, internally generated data to show several methods, and produce white papers prior to publication. Reference research labs are starting to produce data in the MHC and there are a large and rapidly increasing number of projects using the MHC worldwide. Please see:

<http://www.jove.com/video/51869/flat-floored-air-lifted-mobile-homecage-new-method-for-head-fixation>

<http://www.neurotar.com/wordpress/wp-content/uploads/2014/11/Mobile-HomeCage-Inserm-multiunit-recording-28.10.2014.pdf>

Are there any example or instructional videos?

See below. If a password is requested, please use "training".

Close-up of patch-clamping facial neurons in L5 M1 with whisking behaviour:

<https://vimeo.com/125573214>

Inserting- and removing a mouse from the Mobile HomeCage:

<http://www.neurotar.com/support/>

First training session (in full):

<https://vimeo.com/121023491>

Final (8th) training session (in full):

<https://vimeo.com/121023492>

Mobile HomeCage webinar recording from 25th of March, 2015

<http://www.insidescientific.com/webinars/item/358-neurotar-optical-electrophysiological-measurements-brain-head-fixed-conscious-rodents>

What sort of air supply is needed?

The MHC requires a standard laboratory air source, required air flow is 150 liters per minute and air pressure 20 psi. If laboratory air supply is not sufficient, we can recommend reasonably-priced external air pumps.

What comes in the MHC kit?

- 1x 180 mm diameter carbon cage, 7.2cm high
- 4x additional door shutters
- 1x 3 meters of air feeding tube and hose clamps
- 1x wrench kit and all security items
- 10x standard helicopter bars for imaging (request at time of ordering for alternative models, or a selection)

How is the MHC maintained?

The MHC is a robust device that does not require cleaning on regular basis. Please note that pouring a solution into the MHC might block the air holes. It is however easy to open, wash and reassemble.

How is the MHC stored?

There are no special temperature and humidity requirements. The MHC kit (standard delivery) comes in a cardboard box with an insert. A special aluminum storage case with trolley can be purchased separately.

What other items are there in the MHC line of products?

- Mobile HomeCage Standard Model; firm head fixation and airlift functionality when experimenting with awake and behaving animals
- HeadFix platform singly for firm head fixation when experimenting with anesthetized animals
- AirLift platform singly without firm head fixation
- Mobile HomeCage accessories including head plates, hippocampal windows, carbon cages and aluminum storage cases.

How long is the warranty?

One year standard warranty.