TSE
Technical & Scientific
Equipment GmbH

# TSE Running Wheel System

*For small laboratory animals*

# TSE Running Wheel System

## for Small Laboratory Animals

## 1. General information

The **TSE Running Wheel System** is a flexible computer-controlled running wheel system for small laboratory animals (rats, mice) which can be configured for different types of test.

### Passive running wheel

The animal itself sets the running wheel in motion. In this configuration the spontaneous activity of the animal, e.g. in a home cage, can be measured.

### Active running wheel

In this configuration the running wheel is driven by a motor whose speed can be steplessly defined by the operator via the software (animal forced into action). If

the running wheel is operated in a closed compartment then the $O_2$ and $CO_2$ content of the exhaled air can be measured, for example.

Combined systems are available which can be operated in both modes. This means that change-over time between the systems is no longer required.

Up to 32 running wheels can be controlled by a single PC! The experiments can be started and stopped independently from one another in all running wheels which are connected up.

The running wheel system runs under Windows 95/98.

## 1.1. Optional stimulus generator

A stimulus integrator can be integrated in the system, for example to apply an intracranial stimulus in a passive running wheel after the animal has covered a predefined distance (positive reinforcement). In this way increased locomotor activity triggered by self-stimulation can be quantified. The type of impulse volley applied can be defined by the operator (amplitude, time, polarity, etc.).

Alternatively the stimulus generator can be connected directly to the (metallic) grid of the wheel drum in order to apply a **foot shock** if required.

**The configuration "passive running wheel without stimulation option" is described in detail below as an example.**

# 2. Hardware components

The system consists of the following hardware components:

- up to 32 **running wheels** each with a special rotary sensor,
- an IBM-compatible **computer** with **special interface** and
- a **control unit** which is connected to the computer interface and to which the running wheels are connected by 32 leads.

## 2.1. The running wheels

In the standard version the running wheel drums have the following dimensions.

For mice:

- drum diameter: 115 mm
- drum depth: 40 mm
- drum rods: **4mm** dia., **5mm** apart**.**

For rats:

- drum diameter: 250 mm
- drum depth: 80 mm
- drum rods: **5mm** dia., **10mm** apart**.**

***Other measurements are also possible and depend on the customer's specifications.***

In the standard version the running wheels are made of gray PVC, the drums rods are made of stainless steel.

For telemetric and NMR measurements **all** components can be made completely from plastics.

Each running wheel is equipped with a special rotary sensor which records the direction and number of wheel rotations with a resolution of 18° (1/20 turn). These sensors are connected to the common control unit.

The running wheels are designed so that they can be placed in normal home cages. An exactly-fitting separating panel with an opening prevents the sensors from becoming soiled by litter. This means that the running wheels are particularly suitable for long-term experiments, as the animals can be kept in their usual surroundings.

*Please inform us of the dimensions of the holding cages you use when placing an order.*

If required the running wheels can also be supplied free-standing.
The drums have bearings on one side and can be easily dismantled for cleaning purposes.

## 2.2. Control unit / Computer

The control unit contains the electronics for recording the running wheel rotations. It is connected to both the rotary sensors of the running wheels and with the special computer interface. A Pentium processor with a rapid hard disk (access time <12ms) is recommended.

# 3. The experiment

The **RUNNING WHEEL** software is used to control the complete system, to record the running wheel rotations and to store and analyze the measuring data. The system runs under the Windows 95/98 operating system.

In principle an experiment proceeds according to the following scheme:

- preparing for the experiment
- start and execution
- end of experiment
- data analysis
- data export

## 3.1. Preparing for the experiment

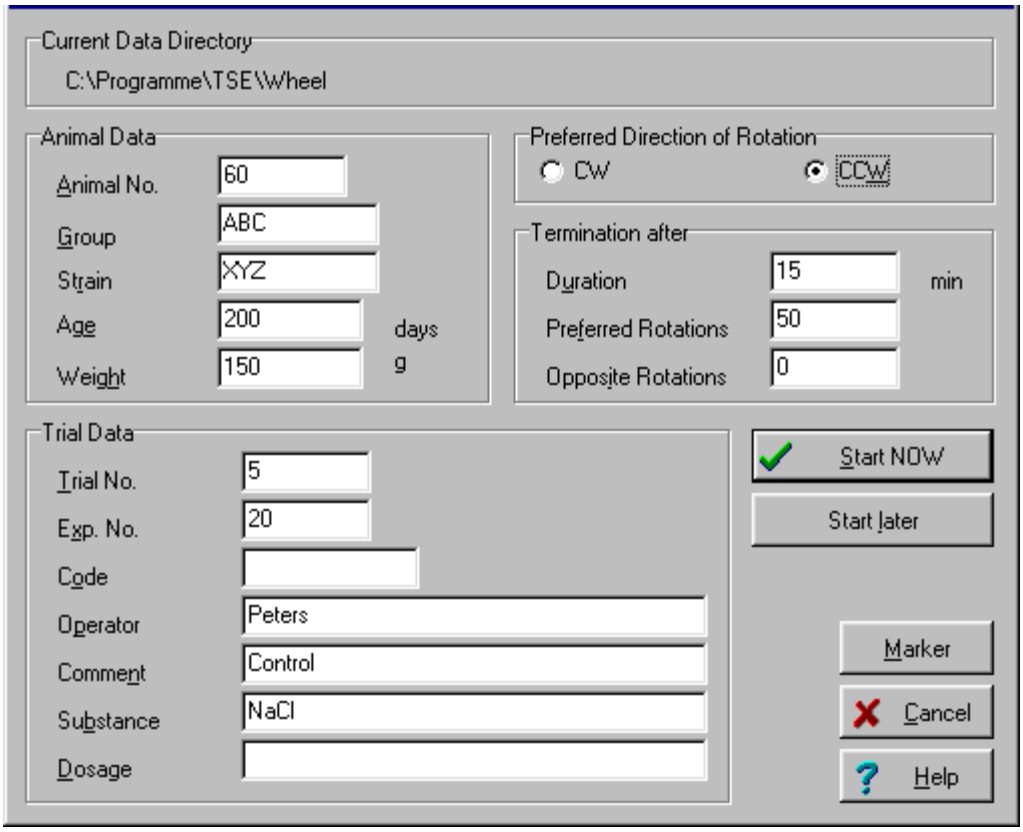
Before the start of the experiment all the data which describe the laboratory animal and the experiment are defined by the operator. This information can be used later in data evaluation for selection of the experimental data.

Several control parameters influence the course of the experiment.

The **termination criterion** defines when an experiment will be stopped automatically:

1. When a certain maximum time has elapsed. The maximum time of 99 999 minutes, i.e. approx. 10 weeks, means that the system is suitable for long-term experiments.

2. After a fixed number of rotations in the preferred direction, or
3. After a fixed number of rotations in the direction opposite to the preferred direction.




Trial Preparation

The **preferred direction** of rotation can result from a unilateral cerebral lesion of the laboratory animal, for example. It can be freely defined by the operator.

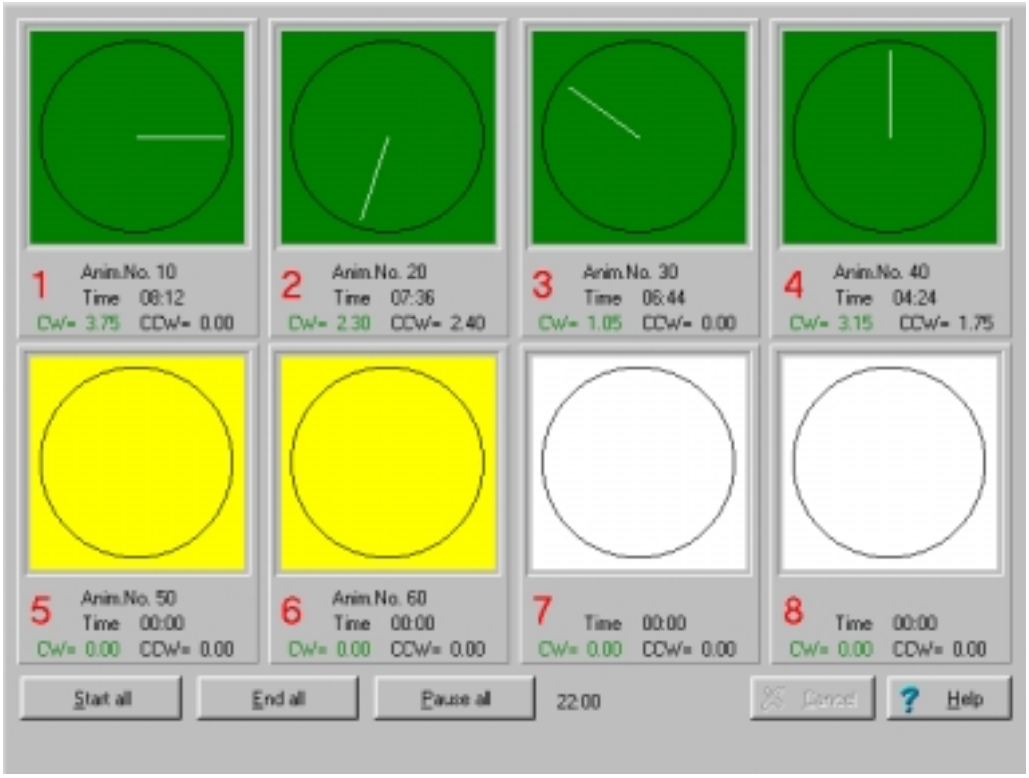
The first termination criterion to occur ends the experiment. It can also be ended **manually** at any time**.**

## 3.2. Start – Experimental procedure

Two different starting modes are available.

- After definition of all parameters the experiment can be started immediately for an individual wheel. The animal is placed in the wheel and the start key is pressed. Data recording starts for this wheel and is symbolized by a green color on the test monitor. All required units can be started independent of one another in this way.

- Alternatively a wheel can first be placed in a “ready” condition (yellow color). The experiment can be started simultaneously at a later time for all wheels activated in this manner by pressing a single key.



Trial Monitor

During the experiment a schematic overview of 8 running wheels is displayed in the so-called **test monitor**. A switch can be made to the next group of 8 wheels by a mouse click.

When a running wheel has been started a pointer (“radius“) which moves synchronously with the rotation of the wheel allows the experiment to be checked continuously.

White wheels have not yet been activated for an experiment.

Status information is displayed continuously:

- actual time of experiment,
- number of **wheel rotations** determined by the rotary sensor
  - clockwise (CW), resolution: 18° (1/20 turn).
  - counterclockwise (CCW), resolution 18° (1/20 turn).

The values for CW and CCW are updated once per minute. The set preferred direction of rotation is indicated in green. The **number** of the animal is shown for each running wheel as a check.

Each unit has its own clock and works independently of the other units.

If a further test is to be started in a different running wheel then the required unit is selected with the left-hand mouse key. Data recording for the units which have already been started continues in the background while preparations for the new wheel are being made.

The data are stored in an intermediate memory at definable intervals.

## 3.3. Setting event markers

While the experiment is being carried out so-called **event markers** can be set in order to document particular events. The event markers appear in the evaluation table and in the export file.

Event markers can be defined before the start of the experiment and while the experiment is being carried out.

- 5 **global** markers are available; during the experiment they apply simultaneously to all active wheels.
- 5 further **wheel-specific** markers characterize events which only affect individual running wheels.

## 3.4. Interrupting the experiment

It is possible to interrupt an experiment. A selection can be made as to whether

- the clock should be stopped, or
- the clock should continue to run.

During the **interruption** it is possible to carry out an intermediate evaluation of the previously recorded data in tabular and graphical form. All analytical possibilities (see below) are available. This is of major importance for long-term experiments.

During the interruption rotations are no longer recorded.

## 3.5. End of experiment/Data storage

In normal cases the experiment in a specific running wheel will be stopped **automatically** when the preset time has elapsed or when the preset number of rotations

in either the preferred direction or opposite to the preferred direction has been reached.

For each experiment with one animal the animal and experiment parameters together with the measuring data are stored in a *single* file. This storage structure satisfies the preconditions for a high level of data security.

# 4. Evaluating the measuring data

When all experiments are finished **data analysis** is carried out.

The measuring data can be listed in the **run table** as numerical values.

```
Running Wheel

C:\Programme\TSE\Wheel\WH000001.DAT

Anim.No.:  1     Trial No.: 1     Exp.No.:   2
Operator:
Start Time:  17/03/98   12:19    Duration:  5 min
Comment:
Strain:
Age:  150 days   Weight:    200 g
Substance:       Dosage:
Direction: CW

           Time     CW    CCW  Changes  SumCW   SumCCW    Total   Marker
17.03.1998 12:20   0,0    0,0        0    0,0      0,0      0,0
17.03.1998 12:21   0,0    0,0        0    0,0      0,0      0,0
17.03.1998 12:22   7,5    0,0        0    7,5      0,0      7,5
17.03.1998 12:23   0,0    0,0        0    7,5      0,0      7,5
17.03.1998 12:24   4,3    3,3        1   11,8      3,3     15,0
```

The run table provides detailed information about the temporal course of the experiment. The data of the selected records are shown in the form of a list. A selection of information about each record is given at the start of the table.

Calculation and output of the results is carried out continually beginning from the start of the experiment at **analytical intervals** determined by the operator (1 minute in the above example).

The run table contains the following columns:

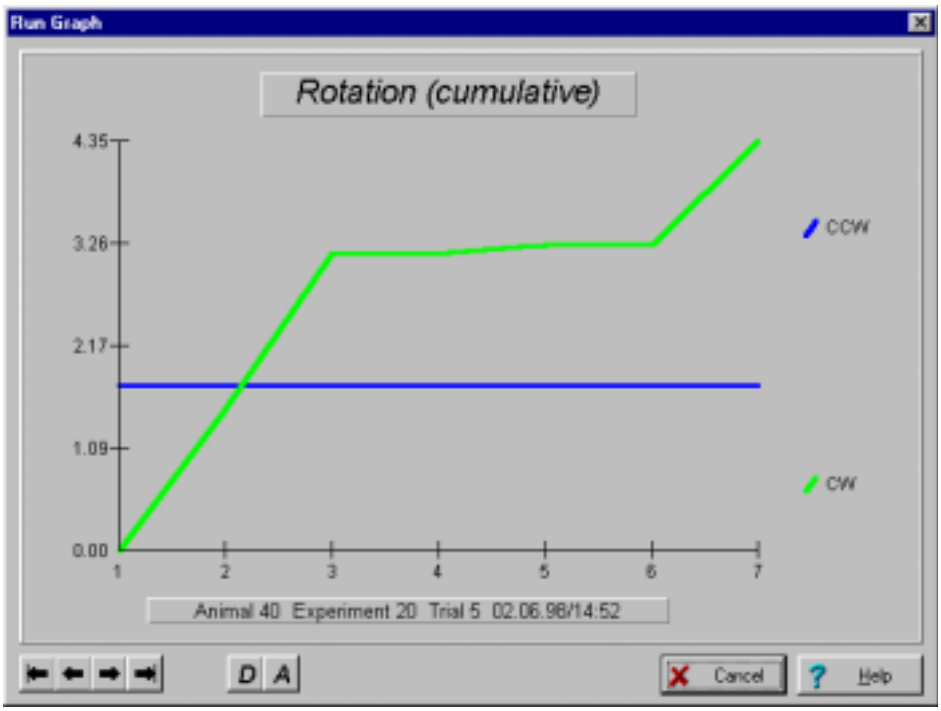
| | |
|---|---|
| Time | continuous analysis interval |
| CW | clockwise rotations |
| CCW | counterclockwise rotations |

| | |
|---|---|
| Changes | changes of direction |
| Sum CW | Total number of clockwise rotations |
| Sum CCW | Total number of counterclockwise rotations |
| Total | Total number of CW and CCW rotations |
| Marker | Marker text |

The table can be printed out.

*Adaptation of the results output to meet operator-specific requirements is possible. For example, the **distance covered** in the wheel can also be outputted.*

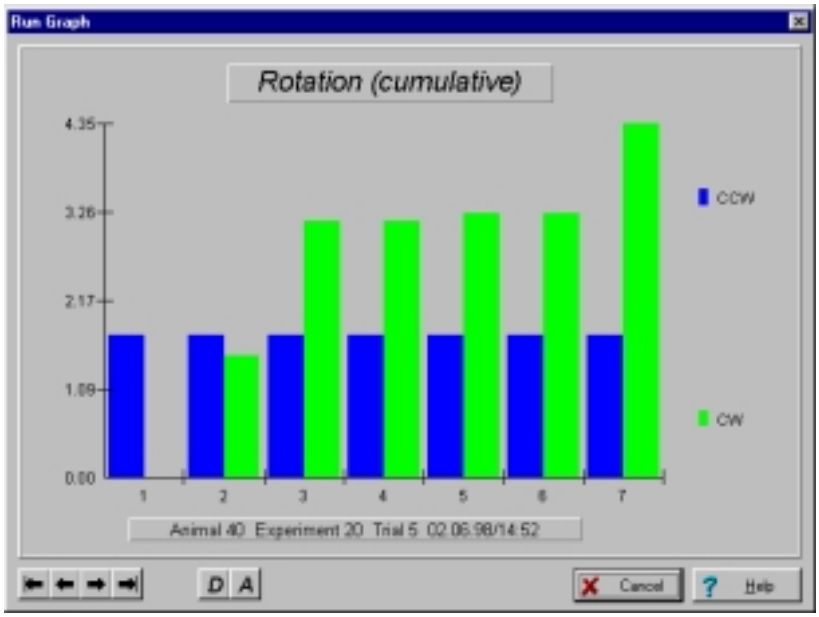
In the **run graph** the rotation events are shown graphically. Both directions of rotation appear as separate curves in a coordinate system with time as the X-axis and number of rotations as the Y-axis.



Run Graph

The presentation can be carried out differentially (rotations per unit of time) or cumulatively (rotations from the start of the experiment added together). In addition, a switch can be made between absolute and relative presentation. Absolute presentation with standardized axis scales makes it easier to compare the run data of different experiments.

Numerous possibilities for individually altering the standard graph are available. The graph can be printed out and stored in various graphical formats (e.g. for import into word processing programs).



Bar Graph

# 5. Data export

For further statistical calculations in special statistics packages or spread sheet programs (e.g. SAS or Excel) the results of the run table can be stored in an **export file**. The results are completed by information about the animal, trial and experiment number as well as the date and starting time.

This ASCII-compatible orthogonal export file (CSV-format) contains the data of all those records which had previously been selected. Each line represents 1 analysis interval.

| Anim.No | Trial No. | Exp. No. | Date | Time | Min | CW | CCW | Sum | Change | Marker |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 17.03.1998 | 12:19 | 2 | 0 | 0 | 0 | 0 | |
| 1 | 1 | 1 | 17.03.1998 | 12:19 | 4 | 7,5 | 0 | 7,5 | 0 | |
| 1 | 1 | 1 | 17.03.1998 | 12:19 | 6 | 4,3 | 3,3 | 7,5 | 1 | |
| 2 | 1 | 1 | 17.03.1998 | 12:30 | 2 | 0 | 0 | 0 | 0 | |
| 2 | 1 | 1 | 17.03.1998 | 12:30 | 4 | 3,3 | 5,5 | 8,8 | 1 | |
| 2 | 1 | 1 | 17.03.1998 | 12:30 | 6 | 0 | 0 | 0 | 0 | |
| 3 | 1 | 1 | 17.03.1998 | 12:55 | 2 | 0 | 0 | 0 | 0 | |
| 3 | 1 | 1 | 17.03.1998 | 12:55 | 4 | 0 | 10,8 | 10,8 | 0 | |
| 3 | 1 | 1 | 17.03.1998 | 12:55 | 6 | 0 | 2,8 | 2,8 | 0 | |

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