

# TSE Drinking & Feeding Monitor



Automatically recording and analyzing liquid & food consumption in laboratory animals



# ◆ TSE Drinking & Feeding Monitor

The **TSE Drinking & Feeding Monitor** is a versatile system for automatically recording and analyzing the amount of liquid which laboratory animals drink and their feeding behavior.

Basically the system consists of the following components:

- drinking and feeding sensors with special mounting devices,
- one or more control unit(s), each for up to 32 sensors,
- an AT-compatible computer (Pentium) with one or more special interfaces,
- the Drinking & Feeding software *for Windows*.

An **unlimited** number of measuring stations can be monitored by a single personal computer making the system ideally suited for large numbers of animals in screening procedures.



A maximum of four sensors can be used simultaneously for each cage. Liquid and food sensors can be combined according to your special requirements.

A variety of sensor mounting devices are available depending on the type of cage. In order to mount the sensors in the feeding areas of standard animal keeping cages („home cages“) special lids are provided.

The standard configuration is the dual-sensor home-cage system. In order to perform preference studies different types of food or liquid can be offered (e.g.

various concentrations of ethanolic or sucrose solution).

Sensors can also be adapted to activity cages. Rack- or shelf-mounted configurations are also available on request.

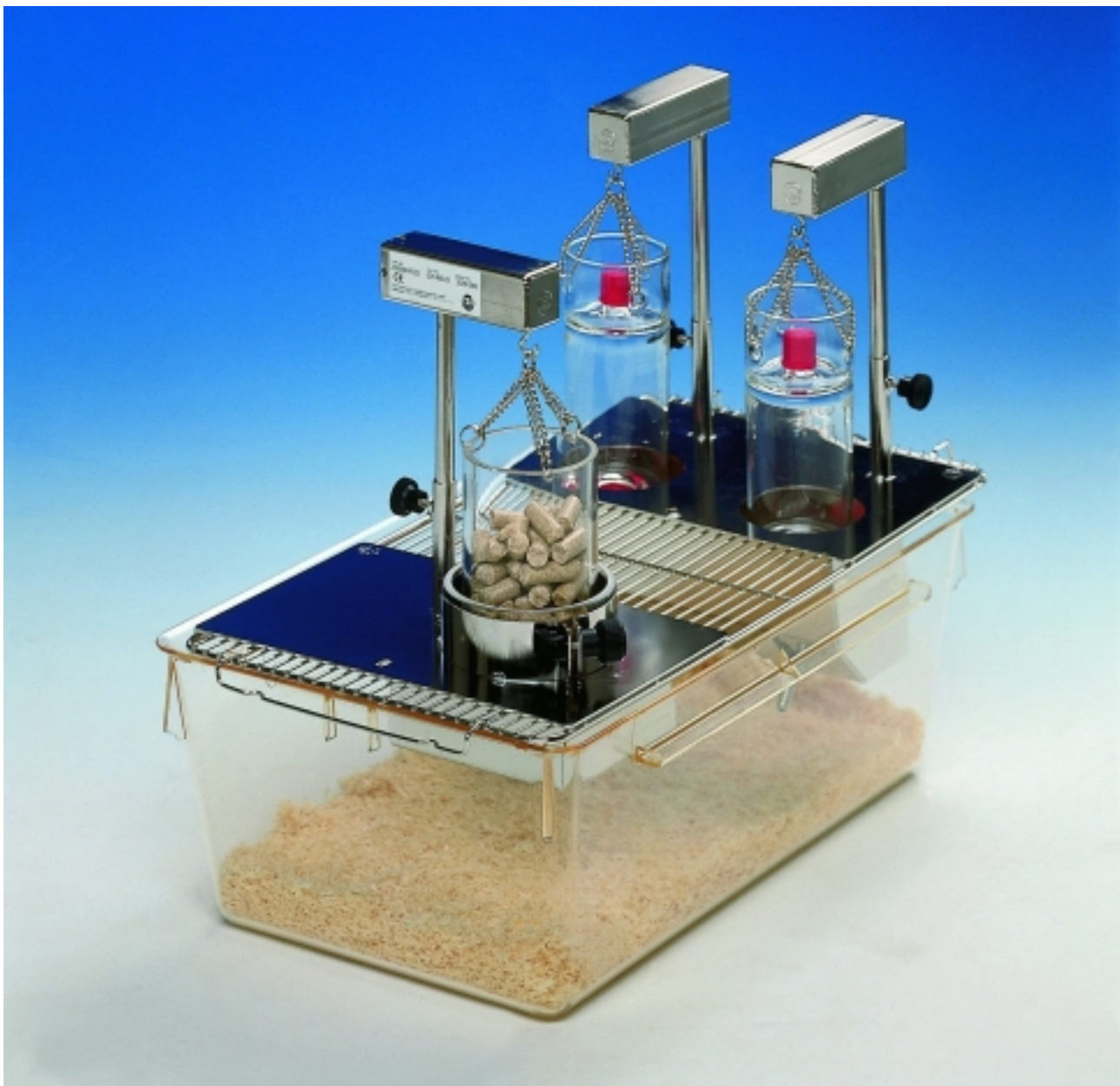
## Drinking Stations

The **drinking stations** consist of a calibrated glass vessel containing the liquid and a sensitive sensor for measuring the amount of liquid removed through the drinking nipple. The measuring system for rats uses sensor vessels with a capacity of 250ml, for mice 100ml vessels are available. Drinking vessels for large animals allow drinking volumes of up to 10 liters!



## Feeding Stations

A **feeding station** consists of a food container fixed to an extremely accurate sensor. The container can hold 200g (mice) or 400g (rats) standard food pellets; larger or smaller sizes are available on request. Access to the food is given via a round stainless steel wire basket. The animals can gnaw off pieces of food through the steel bars in the same way as they do with the ordinary food cribs.



### Options

- The drinking sensors can be modified with so-called "**stimulation modules**" in order to assess learning, memory or motivation („Vogel" anxiety test). The cages are then equipped with an additional floor grid or metal floor plates and connected to a shocker. Each time the animal touches the drinking nipple an electrical stimulus of variable length and intensity is applied.
- The sensor mounting devices can be **motorized** in order to move food and liquid out of reach of the animals during certain time intervals (deprivation).
- An extension of the system with sensors to record amounts of faeces and urine in a special metabolism cage is also available.
- Integration of the system into one of our **ActiMot/MoTil** systems allows concurrent measurement of animal activity. Sensors can also be integrated into Operant Behavior systems.
- The Drinking & Feeding Monitor is undergoing continuous development in cooperation with our users and new functions and analysis modules are being added at frequent intervals. If you are interested in hardware modifications or in a new type of analysis please contact us and we will discuss your specific needs!

## Experimental Procedure

The software controls the test, records the amount of liquid and food removed and stores, analyzes and documents all measured data. It currently runs under the operating systems Windows 95, 98 and NT and will also be available for Windows2000.

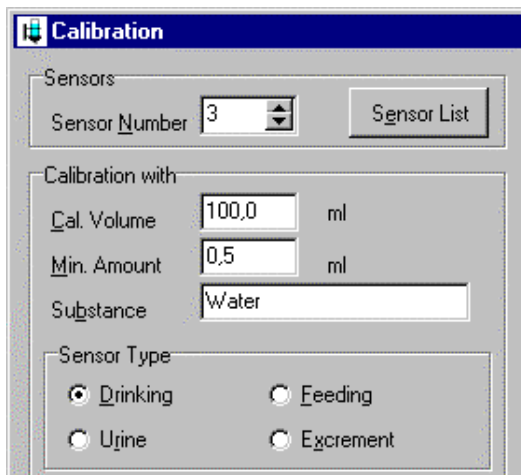
Working with the system is performed according to the following pattern:

- preparing the setup for an experiment,
- running the experiment and
- analyzing the collected data.

## Calibration

The first step is to calibrate the sensors so that exact measurements of the drinking volumes and feeding quantities are possible.

The operator defines the type of sensor and enters volume and name of the substance to be used for calibration. After the calibration quantity has been filled in the system records the alteration in pressure/weight compared to the initial value.



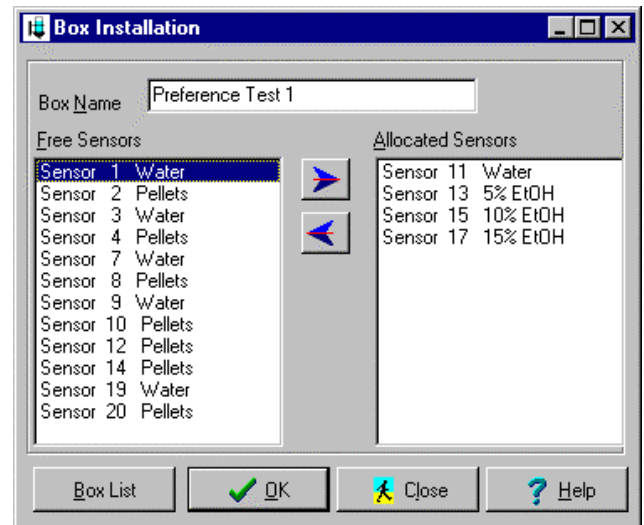
The minimum amount is a threshold value used to influence the **sensitivity** of the system. Only when the amount removed by the animal is larger than this threshold the system registers and stores a „removal“.

## Box Installation

In the box installation procedure calibrated sensors are allocated to an animal cage.

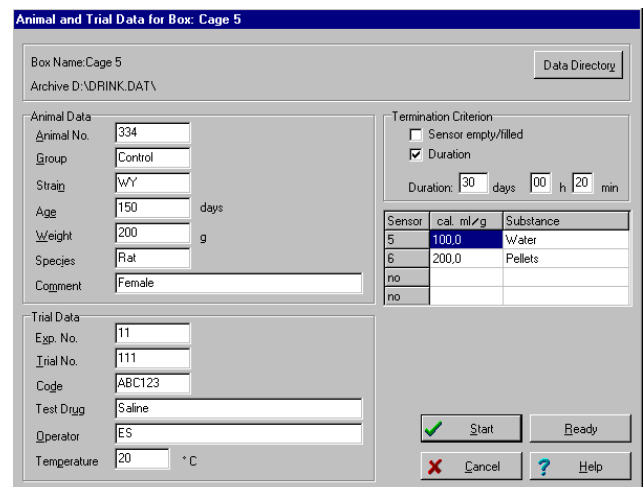
A single box can be equipped with a maximum of 4 sensors and is defined by the operator giving it a name. It is then available for a test.

Installed boxes can always be “deinstalled” if individual sensors are to be allocated to other setups.



## Entering Animal & Control Parameters

All descriptive parameters which characterize the animal and the test are then made.



The experimental procedure is controlled by definition of the **termination criterion**.

A test can be automatically ended when a pre-determined test period has elapsed (the total duration is unlimited as sensors can be refilled as often as is required!) and/or when all the liquid or food at a sensor station has been consumed.

Some of the entries are later used as filter criterions for data base management. They allow to easily sort the data and to filter any data record from a large group of experiments.

## Experiment Start

After the test preparation has finished, the animal is placed in the cage and data acquisition is started.

Alternatively cages can first be put into a “ready” state in order to start several trials simultaneously by a mouse click therefore facilitating handling of larger setups.

## The Running Experiment



The trial monitor

An overview of the current status of the boxes, the “trial monitor”, enables the filling levels of the sensors of up to 16 cages to be seen at a glance. If more than 16 cages are observed the screen automatically switches to display the other boxes.

The different types of sensors are shown as differently colored bar graphs. The accumulated amount already removed is given in millilitres/grams (or liters/kg with large sensor capacities) and is continually updated in user-defined intervals.



At trial start

After removal of substance

During the test the sensor signals are monitored every second.

Instead of storing each single value the system first carries out a **scatter control** to compensate for vibrations caused by the animal. Only if the variation

of the signals is less than a preset variation over a user-defined time period then the calculated mean is available for storage (minimum averaging: every 10 seconds); otherwise the signals are rejected. This smoothing of measuring values allows an adjustment to the individual conditions in the laboratory.

**Event marker** can be entered via the keyboard in order to record any event that is of importance for the test procedure. They are assigned a text by the user and are added to the data file.

## Displaying, Analyzing and Exporting Data

While a test is running a **data table** can be called up at any time that lists time of drinking and feeding events and the cumulative amount removed for the individual sensors in an active box.

Consumption data gathered so far can also be analyzed with the integrated analysis functions that are described later. This is ideal for **intermediate** analyses of longer-lasting experiments! They can be performed even while a test is being carried out. The normal measuring procedure is not stopped: the program continues to observe all active sensors in parallel in the background.

## Refilling Sensors

In tests which take a long time it may be necessary to refill the sensor stations. This can be done even during an active test as often as necessary.

## Storing Data / Trial End

Since data is only stored when it is different from the previous measuring value data file sizes are reduced to a minimum. When the termination criterion has been achieved a test is terminated automatically: data acquisition in other boxes is not affected. The test can also be terminated prematurely in any box independently or in all boxes simultaneously.

If an interruption occurs, e.g. due to a power cut, special routines allow to continue active trials after restarting the computer. The system determines the time elapsed between the interruption and the last intermediate storage. This time difference is taken into account when the events are stored and analyzed.

The **TSE Drinking & Feeding Monitor** prevents the program being terminated inadvertently when boxes are still active. This procedure is in accordance with the provisions of the Good Laboratory Practice code (GLP).

## Evaluation

The **TSE Drinking & Feeding Monitor** permits simultaneous data acquisition **and** data analysis on **one** computer: data acquisition continues in the background during analysis. If necessary data can also be transferred to another computer (e.g. via a network connection) for analysis purposes.

**Note:** All calculations output either absolute values or take the **animal's body weight** into account (consumption per 100g or 1000g body weight) !

### Evaluating Single Trials

These analyses generate detailed information on each single trial selected by the user.

#### 1. Run Table

The **run table** is a chronological list supplying detailed consumption information for each sensor in the cage over the course of the experiment.

Animal 3  
 Group 1 Exp. 1  
 Start 29.09.99 17:34 h  
 Duration 11 days 14 h 34 min  
 1. Sensor Water  
 2. Sensor Food

Sensor	with Water			
29.09.99	17:36:16	after	00:01:43	1,6 ml
29.09.99	18:00:30	after	00:25:57	2,1 ml
29.09.99	18:10:36	after	00:36:03	2,6 ml
29.09.99	18:20:42	after	00:46:09	4,3 ml
29.09.99	18:25:45	after	00:51:12	5,0 ml
29.09.99	19:00:06	after	01:25:33	5,8 ml
29.09.99	19:05:09	after	01:30:36	6,4 ml
29.09.99	19:08:11	after	01:33:37	7,0 ml

Only the beginning of the table is shown (water sensor)

The run table lists for each sensor :

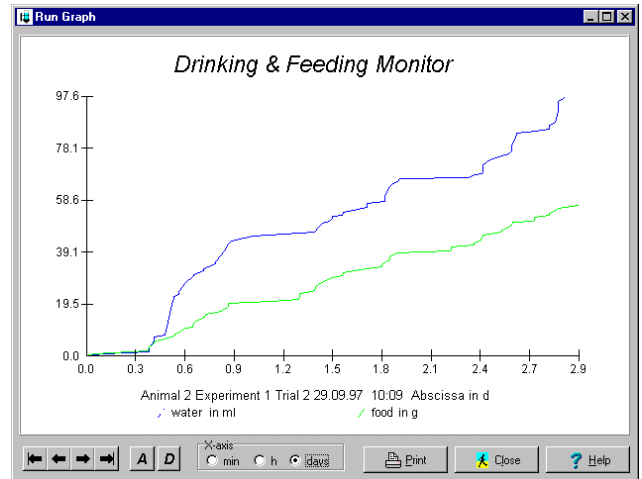
- ◆ the test day with time of each single drinking/feeding event,
- ◆ the elapsed time since test start and
- ◆ the substance removal as cumulative value.

#### 2. Run Graph

Here the liquid and/or food consumption of one animal is documented graphically.

Data is displayed in a coordinate system with the **time** as the X-axis and the **amount** drunk/fed as the Y-axis. All sensors allocated to each cage are displayed simultaneously. The units of the X-axis can be selected as is required (min, h, days).

The curves show the total amount of substance removed for each registration point (**cumulative** curve) or can be switched to show the amount removed to one time (**differential** curve).



Configuration with one feeding & one drinking sensor (1 animal)

The representation of the curves can be varied to meet the needs of the operator. In the absolute form predefined final values for X- and Y-axis are used. This representation is suitable whenever different animals are to be compared with each other.

#### 3. Results Table

In the **results table** the amount consumed is calculated for definable time intervals, e.g. 1 hour.

Animal 3  
 Group 1 Exp. 1  
 Start 29.09.99 17:34 h  
 Duration 11 days 14 h 34 min  
 1. Sensor Water  
 2. Sensor Food

Analysis Interval 01:00:00 (h:min:s)

	Interval End		Sensor1	Sensor2	
	h:min:s		ml	g	
29.09.99	18:34:33	after	01:00:00	5,0	3,3
29.09.99	19:34:33	after	02:00:00	4,3	3,2
29.09.99	20:34:33	after	03:00:00	0,0	0,0
29.09.99	21:34:33	after	04:00:00	3,4	2,4
29.09.99	22:34:33	after	05:00:00	5,3	2,9
29.09.99	23:34:33	after	06:00:00	2,2	3,3
30.09.99	00:34:33	after	07:00:00	0,5	0,0
30.09.99	01:34:33	after	08:00:00	0,0	0,0
30.09.99	02:34:33	after	09:00:00	0,0	0,5

Analysis interval=1 hour (differential display)

The operator first defines the **analysis interval**. The calculation and output of the consumption follows beginning with the trial start and continuing at this time interval.

The results can be outputted cumulatively or as individual measurements (differentially).

#### 4. The Meal Analysis

The **meal analysis** allows to evaluate the drinking and feeding **episodes** of animals by defining a (species-specific) **intermeal interval**.

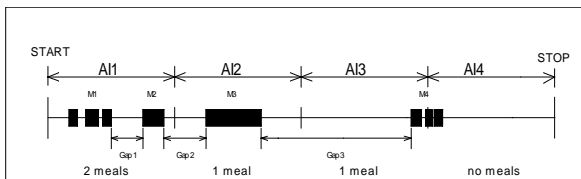
A single meal is composed of various drinking/feeding events (=changes in sensor levels) separated from each other by small inactivity gaps. Events which are separated by time gaps larger than the intermeal interval are considered as belonging to separate meals.

Typical intermeal intervals for rat food consumption – used for example in the study of food intake characteristics in obese rats - lie between 10 and 40 minutes.

Intermeal Interval 00:15:00 (h:min:s)							
Sensor1	Time h:min:s	No.	Dur. h:min:s	Qty. ml	Gap h:min:s	Rate/Meal ml/min	
29.09.99	17:36:16	00:01:43	1	00:01:00	1,6	00:23:14	1,6
29.09.99	18:00:30	00:25:57	2	00:26:15	3,4	00:33:20	0,1
29.09.99	19:00:06	01:25:33	3	00:14:08	2,6	00:15:10	0,2
29.09.99	19:29:23	01:54:50	4	00:02:01	1,8	01:35:58	0,9
29.09.99	21:07:22	03:32:48	5	00:15:08	3,4	00:33:20	0,2
29.09.99	21:55:50	04:21:17	6	00:03:01	4,5	00:34:21	1,5
29.09.99	22:33:13	04:58:39	7	00:40:23	3,0	00:50:31	0,1
30.09.99	00:04:07	06:29:33	8	00:01:00	0,5	02:30:30	0,5
30.09.99	02:35:37	09:01:04	9	00:12:07	3,2	00:16:10	0,3
30.09.99	03:03:54	09:29:20	10	00:01:00	2,1	00:16:10	2,1

Water sensor

In the **meal sequence table** all meals are listed chronologically. The table shows starting time of each meal, meal duration, the total amount ingested per meal, the gap between individual meals and the rate per meal. In addition the parameters total rate, meal rate and latency to first meal are calculated (*not shown*).



The **meal interval analysis** allows to evaluate the daily rhythms of meal pattern by defining an additional constant analysis interval (AI).

Intermeal Interval 00:15:00 (h:min:s)							
Analysis Interval 01:00:00 (h:min:s)							
Sensor1	Interval Start h:min:s	Nos.	Dur. h:min:s	Qty. ml	MV Dur. h:min:s	MV Qty. ml	
29.09.99	17:34:33 after	00:00:00	2	00:27:15	5,0	00:13:38	2,5
29.09.99	18:34:33 after	01:00:00	2	00:18:09	4,3	00:08:04	2,2
29.09.99	19:34:33 after	02:00:00	0	00:00:00	0,0	00:00:00	0,0
29.09.99	20:34:33 after	03:00:00	1	00:15:08	3,4	00:15:08	3,4
29.09.99	21:34:33 after	04:00:00	2	00:43:24	7,5	00:21:42	3,8
29.09.99	22:34:33 after	05:00:00	0	00:00:00	0,0	00:00:00	0,0
29.09.99	23:34:33 after	06:00:00	1	00:01:00	0,5	00:01:00	0,5
30.09.99	00:34:33 after	07:00:00	0	00:00:00	0,0	00:00:00	0,0
30.09.99	01:34:33 after	08:00:00	0	00:00:00	0,0	00:00:00	0,0
30.09.99	02:34:33 after	09:00:00	3	00:14:07	5,8	00:04:42	0,0
30.09.99	03:34:33 after	10:00:00	0	00:00:00	0,0	00:00:00	1,9
30.09.99	04:34:33 after	11:00:00	0	00:00:00	0,0	00:00:00	0,0
30.09.99	05:34:33 after	12:00:00	1	00:01:00	0,5	00:01:00	0,0

The table lists :

- ◆ the interval start with calendar date, clock time and elapsed time since start of test,
- ◆ the number of meals, meal duration, amount removed *per analysis interval*,
- ◆ the mean duration and mean quantity removed *per analysis interval* as well as
- ◆ the total number of meals, total meal duration, total intake and mean duration and mean quantity *over the whole trial (not shown)*.

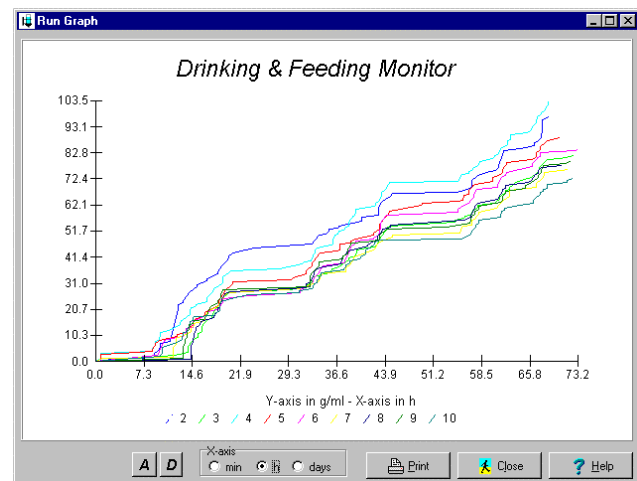
Whether the temporal distribution of meals is circadian controlled can be easily recognized in these tables. If the analysis interval is set to 12 hours (*see below*) the intake pattern over the light-dark-cycle can be shown. Consumption takes place – as expected – preferably in the dark phase.

Interval Start h:min:s	Nos.	Dur. h:min:s	Qty. ml	MV Dur. h:min:s	MV Qty. ml
00:00:00	11	01:57:03	26,4	00:10:38	2,4
12:00:00	3	00:16:08	3,0	00:05:23	1,0
24:00:00	12	02:21:18	31,6	00:11:48	2,6
36:00:00	2	00:03:01	3,5	00:01:30	1,8
48:00:00	12	02:19:16	30,0	00:11:36	2,5
60:00:00	5	00:07:02	5,8	00:01:24	1,2
72:00:00	14	02:35:25	34,0	00:11:06	2,4
84:00:00	3	00:03:00	3,7	00:01:00	1,2
96:00:00	11	03:09:47	34,7	00:17:15	3,2
108:00:00	3	00:11:05	3,5	00:03:42	1,2
120:00:00	11	01:42:56	28,3	00:09:21	2,6

#### Performing Group Analyses

In contrast to analyzing each trial separately the group analysis allows to directly compare liquid and food consumption in a selected **group** of animals in graphical and tabular form.

##### 1. Group Graph



Comparison between 9 animals – water consumption



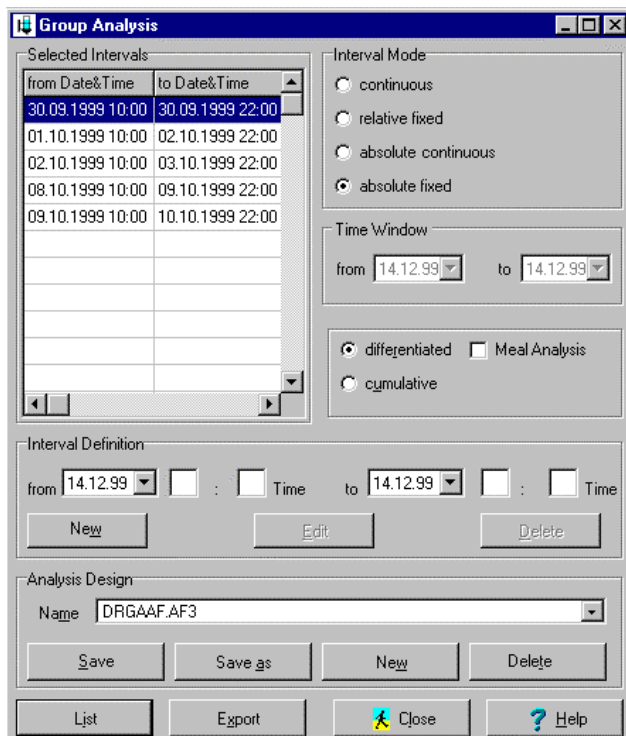
Any number of data records, each representing one trial with one animal, can be displayed simultaneously, each generating a differently colored curve. Typically only 1 type of sensor (e.g. all drinking sensors filled with the same substance) is integrated into the graph.

The time axis units can be chosen as is required; data may be presented for the whole trial or just for part of it. Designed to be an overview this graph allows the operator to quickly compare the consumption of several animals at a glance.

## 2. Group Tables

Longer-lasting experiments require more complex and flexible evaluation functionalities. The group tables have been implemented to analyze consumption data according to **user-defined analysis designs** that can be stored in files for further use.

Choose between a variety of **interval modes** in order to adapt the data output to meet your individual requirements.



The group analysis definition window

Data records can be analyzed using one **continuous** analysis interval that is applied to the whole experiment. Mean values per interval and for each single animal over all intervals are also calculated.

Any combination of up to 100 (!) **fixed** intervals with user-defined starting and ending points can be

applied to the trial data if you are only interested in consumption data during **specific** time windows.

from h:min:s	to h:min:s	1	2	3	4	5	6	Mean
00:00:00	01:00:00	2,9	3,7	5,0	3,8	2,3	3,9	3,6
01:00:00	02:00:00	3,9	0,5	4,3	1,8	5,5	3,2	3,2
02:00:00	03:00:00	3,2	2,7	0,0	4,9	2,5	0,8	2,4
03:00:00	04:00:00	0,0	4,7	3,4	3,8	3,3	4,4	3,2
04:00:00	05:00:00	6,5	2,1	5,3	2,9	0,0	0,0	2,8
05:00:00	06:00:00	0,0	6,6	2,2	2,8	0,0	2,4	2,3
06:00:00	07:00:00	2,1	2,7	0,5	6,3	4,7	3,4	3,3
07:00:00	08:00:00	3,9	0,0	0,0	3,4	3,5	1,5	2,0
08:00:00	09:00:00	2,6	0,5	0,0	1,9	0,0	4,4	1,6

Continuous interval=1 hour / 6 animals

It is possible to make a selection according to trial days irrespective of the calendar days in order to compare experiments that have not been started simultaneously (**relative fixed** interval).

In case it is necessary to take the absolute calendar day and clock time into account the **absolute fixed** interval definition is suited.

from	to	1	2	3	4	5	6	Mean
30.09.99 10:00	30.09.99 22:00	17,0	16,7	15,7	20,8	20,3	12,1	17,1
01.10.99 10:00	02.10.99 22:00	62,5	50,2	58,1	68,5	58,1	48,9	57,6
02.10.99 10:00	03.10.99 22:00	68,0	46,1	58,8	73,1	60,5	51,0	59,6
08.10.99 10:00	09.10.99 22:00	54,8	39,0	48,9	59,0	66,1	54,4	53,7
09.10.99 10:00	10.10.99 22:00	65,4	48,6	63,1	61,6	64,1	55,9	59,8
Mean		53,6	40,1	48,5	56,8	53,8	44,5	

5 absolute fixed intervals / 6 animals

It is also possible to apply a combination of time intervals (clock time from...to...) **repeatedly** to all days of the trial or just to the days inside a specific time window (**absolute continuous** intervals).

You can always choose between cumulative and differentiated consumption display depending on the information you are interested in.

## Other Features & Data Export

A **group meal analysis** is in preparation and will be finished soon. This will allow you to directly compare the meal pattern in a group of animals!

A **protocol editor** allows an operator-specific protocol header to be defined for all results tables, i.e. it is possible to arrange all trial and animal data in the printouts according to the wishes of the user.

All analytical results can be printed out or used for further-reaching complex statistics in the form of user-defined **export files**. All graphs can be stored as bitmap-files for integration into word-processing programs.

## ◆ Ordering Information

Cat.No.	Description
259998-SEN/DRI	Drinking sensor, complete *
259998-SEN/FED	Feeding sensor, complete *
259998-SEN/EXC	Excrement sensor, complete
259998-SEN/URI	Urine sensor, complete
259998-VT	„Vogel Test“ extension module for 1 cage complete with shocker and floor grid (please specify cage size used)
259998-ADPT/DR-FE	Cage adaptation for Drinking/Feeding sensors (1 cage) **
259998-ADPT/EX-UR	Cage adaptation for Excrement/Urine sensors (1 cage) **
259998-C	Control unit, suitable for up to 32 sensors ***
259998-C/E	Control unit upgrade for up to 8 extension modules „Vogel Test“ ***
259998-INT/32	Interface, each for up to 32 sensors ***
259998-S	Software package
995100-MC-M	Metabolism cage for mice
995100-MC-RS	Metabolism cage for rats (up to 150g BW)
995100-MC-RL	Metabolism cage for rats (over 150g BW)
995100-MC-G01	Single unit stand for metabolism cage
995100-MC-G12	Mobile rack for up to 12 metabolism cages

\* Please specify capacity

\*\* Please specify number of sensors per cage

\*\*\* Several units can be combined

## TSE Technical & Scientific Equipment GmbH

Saalburgstr. 157  
D-61350 Bad Homburg / Germany

Phone: +49 (0) 6172-789-0  
Fax: +49 (0) 6172-789-500  
E-mail: [info@TSE-Systems.de](mailto:info@TSE-Systems.de)  
Internet: <http://www.TSE-Systems.de>