

#### Summary

1		Logir	n in page	3
2		Hom	ne Page	3
	2.1	-	Facility Manager and Researcher Roles	4
	2.2	2	Data Analysis	4
		2.2.1	1 Group name and creation	7
		2.2.2	2 Selection by event	7
	2.3	5	Select Chart Type	8
		2.3.2	2 Select Metric Type	10
		2.3.3	3 Run the analysis	3         3         3         3         4         4         7         7         8         10         10         11         12         13         16         18         18         19         19         19         21         22         24         22         24         24         24         24         25         26         27         28         28         28         28         28         28         28
		2.3.4	4 Prepare Download	13
	2.4	Ļ	Manage Experiment	16
		2.4.1	1 Cage Groups	16
		2.4.2	2 Mice groups	
	2.5	5	Download Area	
	2.6	5	User settings	
	2.7	,	Unit of Measure	18
		2.7.1	1 User Groups	19
		2.7.2	2 DVC <sup>®</sup> Analytics Users	19
		2.7.3	3 DVC <sup>®</sup> Cage Owner Association	21
		2.7.4	4 Settings	22
3		Usef	ful information	24
	3.1	-	DVC <sup>®</sup> board	24
	3.2	2	DVC <sup>®</sup> working principle and derived metrics	24
		3.2.1	1 Animal Activity Index	25
		3.2.2	2 Bedding Status Index	26
		3.2.3	3 Animal Tracking Distance and Speed	26
		3.2.4	4 Running Wheel Rotation, Distance and Speed	27
	3.3	5	How data are calculated and aggregated	27
		3.3.1	1 Line Chart	27
		3.3.2	2 Line chart with SEM	28
		3.3.3	3 Line chart with Interquantile	28
		3.3.4	4 Line Chart cumulative	28
		3.3.5	5 Heatmap	28

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Box Plot	29
	Box Plot

#### **Revision History**

Date	Version	Author	Summary of Changes
15/05/17	V1.0	Giorgio Rosati	First Draft
16/05/17	V1.1	Giorgio Rosati	Explanation how to download raw data
27/07/2018	V2.0	Giorgio Rosati	DVC Analytics version 2
19/09/2019	V3.0	Giorgio Rosati	DVC Analytics version 3

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## 1 Login in page

In order to login into the system, go to: <u>https://analytics.dvc.tecniplast.it/login/XXX</u> (XXX provided to you by Tecniplast) and enter your username and password that have been previously communicated.

	Domain tpdemo	
Dear user		
welcome to the DVC® Analytics login page. Please insert your username and password.	Username 	
If you are experiencing any problem or you need more support, please kindly write your enquire using the ticketing system or directly write to digilab-	Password	ê
<pre>service@tecniplast.it and we will take care of your request shortly.</pre>	Login	

## 2 Home Page

The top part of the home page (dark blue background) displays general information about the Facility (e.g. Facility name). The lower part of the home page (white background) displays the DVC<sup>®</sup> Analytics menu.

The home page varies based on the user role whether Facility Manager or Researcher (the User Setting button is hidden to the Researcher(s) that will have access only to the cages assigned previously by the Facility Manager)

			🖉 🖑 🗒 👯 📢 administra	dmin.it 🚍
		tpdemo niplast Demo Environment		
	DVC RACKS CA			
Data Analysis	5 Save	Interest 11 18	User Settings	
Required Data Analysis tant description.	Regulared Manage Experiment tool description.	Required Download Area text description	Anguined user Settings text description.	

DVC RACKS: how many DVC® Racks currently connected to the DVC® Analytics platform

CAGES: how many cages:

- Running (green): # of registered cages in the DVC<sup>®</sup> system currently inserted in the DVC<sup>®</sup> Rack
- Out of Rack: (yellow): # of registered cages in the DVC<sup>®</sup> system currently removed from the DVC<sup>®</sup> Rack (but still registered)
- Terminated (grey): # of cages properly terminated in the DVC<sup>®</sup> system

USERS: how many registered DVC® Analytics Users in the specific Facility

**RESEARCH PROTOCOLS**: how many DVC<sup>®</sup> Research Protocols have been currently received by the DVC<sup>®</sup> Analytics (sent by the DVC<sup>®</sup> System)

In The lower part of the home page shows different available buttons dependently upon your role (Facility/Researcher):

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Data Analysis	Manage Experiment	Download Area	User Settings
Required Data Analysis text description.	Required Manage Experiment text description.	Required Download Area text description.	Required User Settings text description.

Through those buttons you can analyze data and set different Facility rules.

## 2.1 Facility Manager and Researcher Roles

Facility Manager role has been designed in order to perform any task and have access to all functionalities of the DVC<sup>®</sup> Analytics system. Researcher role has been designed to provided limited access to only a subset of information (only to the Researcher's data) in order to increase privacy and limit any possibility of stolen data.

More specifically, these are the different enabled functionalities for the different roles:

FACILITY MANAGER		RESEARCHER			
	(has full access to the DVC <sup>®</sup> Analytics menu)		(limited access to the DVC <sup>®</sup> Analytics menu)		
•	is enabled to view all DVC <sup>®</sup> cages connected to the DVC <sup>®</sup> Analytics. is enabled to register new DVC <sup>®</sup> Analytics users and associated them to DVC <sup>®</sup> cages. is enabled to group together DVC <sup>®</sup> users and associate them to the DVC <sup>®</sup> cages.	•	is enabled to view only DVC <sup>®</sup> cages that have been previously associated to her/him. Is enabled to create cage and mice groups using only his/her cages		
•	is enabled to set and change the facility settings (e.g. dark hour).				

### 2.2 Data Analysis

In this section it is possible to analyze in depth an individual cage or group of cages selecting across multiple choices from temporal and data presentation perspective. Just clicking on the "Data Analysis" icon, you can enter in a menu section where multiple choices are available:

TECNIPLAST DEMO ENVIRONMENT tpdemo Tecniplast Demo Environment
Group 1 Add Group
Select Cages or Animals RUNNING Diskinssed
OUT-OF-RACK           From         America/New_York (GMT-04:00)           To         America/New_York (GMT-04:00)           Event
Chart Family
Image: Animal Lacomotion Index     Image: Animal Lacomotion Index       Image: Animal Lacomotion Index     Image: Animal Lacomotion Index       Image: Animal Lacomotion Index     Image: Animal Lacomotion Index

The first requested information is to select "Cages" or "Animals" by simply clicking on the corresponding button (all the other fields are disabled until this first selection is performed):

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## + Select Cages or Animals

#### Once you click, a pop-up menu appears with multiple choices:

Cages List	Groups of C	ages 🛛 🕻	Animals List	(10.10) G	roups of Animals
Cage Id	Protocol	Registration	DVC Owner DVCA Ow	ner Animals P	vosition
C-523	DVC Default Protocol	11/09/2019			
C-523	Protocol_1		Researcher	0	Ē
C-523	DVC Default Protocol	08/06/2019			
C-523	Experiment 1	11/09/2019	scott	2 0	:5 📑
C-524	DVC Default Protocol			0	Ē
C-525	DVC Default Protocol			0	Ē
C-526	Protocol_1		Researcher	0	Ē
C-526	DVC Default Protocol	26/06/2019			
			Items per page: 8	201 - 208 of 410	I< < > >I

You can immediately select a cage (or multiple) searching for its Cage Id, you can filter by (research) Protocols (set in the DVC<sup>®</sup> system), time of Registration (when it has been registered in the DVC<sup>®</sup> system), DVC<sup>®</sup> Owner (set in the DVC<sup>®</sup> system). Moreover, there are other information like # animals in the cage ID and current rack position.

You can also select an already created "Group of Cages"

Select Cages or Animals			
Cages List	Groups of Cages	ک 🖍 Animals List	Groups of Animals
	Group Name	Cages	
0	Control Group	3	
0	Glorgio's Group 2	3	
0	KM Test1	3	
			items per page: 8 💌 1 - 3 of 3 < >
			Deselect all Cancel Confirm

As well as you can select directly Animal IDs:





C	Cages List	Grou	ups of Cages	کې 🗠 the test	List	100 - 100 100	Groups of Animals
	animal Id	Protocol	Registration	DVC Owner DVI	CA Owner Sex	Strain	ALL *
	172	DVC Default Protocol	03/09/2019		UNKNO	WN	265
	175	DVC Default Protocol	11/09/2019	scott	MALI	E BalbJB	z 📤 s
	176	Inverse Circadian Rhythms	11/09/2019	grosati	MAL	E C57BJ	z 📤 s
	187	Running Wheel	21/07/2019		MAL	E C57BJ	z📤
	187	DVC Default Protocol	03/09/2019		UNKNO	WN	z 📤 s
	189	DVC Default Protocol	11/09/2019	grosati	FEMA	LE BalbJB	z 📤 s
	189	DVC Default Protocol	21/07/2019	Guido	MAL	E C57BJ	z 📤 s
	19	GemFree	21/07/2019		FEMA	LE Balb/c	که:
				Items p	ier page: 8 👻	41 - 48 of 112	I< < >

#### Or "Groups of Animals" if already created:

Select Cages or Animals

Cages List	Groups of Cages	مimals List کے	Groups of Animals
	Group Nama	Animals	
0	Test Mouse	0	
0			

**PLEASE NOTE**: you can only select same type of elements (cages with cages or animals with animals, but not cages with animals at the same time).

Then, when at least one element (cage or animal ID) has been selected, other submenus become available.

	$\bigcup_{\mathfrak{s}_{\mathbf{m}}} \bigoplus_{\mathfrak{s}_{\mathbf{m}}} \stackrel{\underset{\mathfrak{s}_{\mathbf{m}}}}}}}{}}{\operatorname{growtrans}} growtrans$
<u>+ 🥰 ±</u>	
TCONTACT TOOD DETINGUISHIET Tooplate Down Devisionment	
Image 1         2         ALS Comp           Image 1         2         ALS Comp           Image 1         2         Image 1         Image 1           Image 1         2         Image 1         Image 1         Image 1           Image 1         2         Image 1         Image 1         Image 1           Image 1         Image 1         Image 1         Image 1         Image 1           Image 1         Image 1         Image 1         Image 1         Image 1	
Chart Family Line Dec Line De	
	Clear All Prepare Doveload Run Analysis

- **Group name and creation**: you can save this selection for further analysis.
- **From To**: automatically filled with the date & Time of Registration and Termination (if any, otherwise the actual time if the cage(s) is still running).
- Chart Family: different available charts.

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- Environmental Data: events generated in the DVC<sup>®</sup> system and environmental data (captured by REM if it is installed).
- DVC<sup>®</sup> available metrics: Animal Locomotion Index and Bedding Status Index

PLEASE NOTE: you cannot "Run Analysis" neither "Prepare Download" until all the selections have been performed.

#### 2.2.1 Group name and creation

It is possible to quickly save the cage(s) or animal(s) selection just performed. Clicking on the small icon



You can then change the name (by default it is Group 1), color in the graphs and finally save the group:

Giorgio's Group	Add	d Group	
+	/	Group name Giorgio's Group	Add new cage group
Select Cages or Animals	۲	Select group color	Giorgio's group
TISMISSED	8	Save group	Ovmer GiorgioM
DUT-OF-RACK	×	Close group	Cancel Confirm

## 2.2.2 Selection by event

Any period (From - To) can be either selected clicking on the date (and a specific date pop-up appears) or clicking on the event button:

From			Europe/	Rome [GN	T+02:00]	То							
Event	02/07/2	2018		l.	ä	Ev	/ent	19/(	Select Event				
	<		J	uly 201	8		>	$\left  \right $		Timestamp	Cage Id	Event Type	Description
Chart Far	Su	Мо	Tu	We	Th	Fr	Sa		0	02/07/2018 22:39	Puck2	REGISTERED	
~					-		_		0	02/07/2018 22:39	Puck2	RACK	INSERTED
Line	1	2	3	4	5	6	/		0	06/07/2018 22:24	Puck2	RACK	REMOVED
	8	9	10	11	12	13	14		0	06/07/2018 22:25	Puck2	RACK	INSERTED
Ani	15	16	17	18	10	20	21		0	16/07/2018 20:55	Puck2	RACK	REMOVED
	15	10	17	10	19	20	21		0	16/07/2018 20:57	Puck2	RACK	INSERTED
Bec	22	23	24	25	26	27	28		0	18/07/2018 11:54	Puck2	RACK	INSERTED
	29	30	31	1	2	3	4		0	25/07/2018 21:11	Puck2	RACK	INSERTED
												ltems per page: 8 👻	1 - 8 of 21  < < > >
	5	6	7	8	9	10	11						
								1					Cancel Confirm

In this latter case, the entire (event) history of the selected element (cage(s) or animal(s)) appears in the chronological list. The currently managed events received from the usage of the DVC<sup>®</sup> systems are:

When the element is a Cage:

- **REGISTERED** (when the cage has been registered into the DVC<sup>®</sup> system)
- **INSERTED** (when the cage has been inserted into the DVC<sup>®</sup> rack)

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- **REMOVED** (when the cage has been removed from the DVC<sup>®</sup> rack)
- **BEDDING\_CHANGE** (when the cage bedding has been properly changed in the DVC<sup>®</sup> system)
- **CAGE\_DISMISS** (when the cage has been properly terminated in the DVC<sup>®</sup> system).
- **RECONCILIATION** (when the cage has been reconciliated in the DVC<sup>®</sup> system, i.e. from cage missing to specific inserted cage. This is a functionality implemented in the DVC<sup>®</sup> system)

When the element is an Animal, it also has some extra events:

- MOVED (when the animal has been moved from a registered cage to the current under analysis)
- **CULLED** (when the animal is culled)
- **ADD** (when the animal is added for the first-time in the cage. It could be during the cage registration but also added from scratch in an already existing cage)

**PLEASE NOTE**: To disable the time selection click on the time disabling icon 0 and the time will be considered from 00:00

### 2.3 Select Chart Type

There are 3 different choices for you to start displaying data: Line, Other and Live.

### 2.3.1.1 Chart Family Line

Selecting "Line", by default the interface proposes you the standard selection composed by the next selections:



Chart Type:

- **Simple**: displays a continuous line in the selected time. Every point is the data collected by the DVC<sup>®</sup> system.
- **Cumulative**: all data are summed up and show a cumulative progression of the selected data along the selected time

Time Interval Visualization:

- Continuous: the line is continuously showing data along the selected time interval
- **Daily**: 7 different graphs corresponding to the 7 days of the week are displayed. If the time interval is longer than 1-week, multiple lines will be created for each day of the week.
- **Weekly**: one single weekly graph showing multiple lines corresponding to the multiple weeks (if any) in the selected period.
- Custom: multiple weekly graph based on number of selected weeks.



Day Time Filtration:

- **None**: no filtration applied. All day data are displayed.
- Light: Only light data are showed (light period based on Facility settings)
- Night: Only dark data are showed (night period based on Facility settings)
- Custom: it is possible to select days and hours to show data

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From 10:00	Sun	Mon	Tue	Wed
™ 20:00	Thu	Fri	Sat	

Data Time Aggregation:

- Hour: data are aggregated by hour
- Minute: data are aggregated by minute
- Custom: data can be aggregated by multiple minutes or multiple hours



## 2.3.1.2 Chart Family Other

Selecting "Other", by default the interface proposes you the standard selection composed by the next selections:

Chart Family	Chart Type	Day Time Filtration	Data Time Aggregation	Environmental Data
Line Other	Heatmap	None	Custom Hour Custom	B Environment DVC Events

The only differences compared to the previous "Line" option is on the Chart Type selection that offers 2 different types of charts:

- Heatmap: data are aggregated day by day (each line is 24h data from midnight to midnight) and every point is corresponding to the "Data Time Aggregation" selection (hour, minute, custom). The data are color-coded (blue is a low value, red is a high value)
- Actigram: data are aggregated day by day (each line is 24h data from midnight to midnight) and every point is corresponding to minute aggregation (it is not possible to select other aggregation in this current version) and the magnitude of the line is corresponding to the data value collected.

## 2.3.1.3 Chart Family Live

The DVC<sup>®</sup> Analytics features a very powerful opportunity related to "see" live data coming from selected elements (cage(s)/animal(s)).

Selecting "Live", by default the interface proposes to "see" the last 15min of the selected elements.



You can select other predefined time intervals (15-30-60min) as well as setting custom's ones simply clicking on the corresponding icon and then inputting your choices.



In this powerful feature, data are updated every minute.

PLEASE NOTE: this feature is available ONLY for RUNNING cages.

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### 2.3.2 Select Metric Type

In your current version, there are 2 different DVC<sup>®</sup> metrics available:

- Animal Locomotion Index: it is expressed in arbitrary unit normalized between 0% and 100% representative of the animal activity performed in the cage by the animals (no activity = 0% - all electrodes simultaneously activated by the movements of the animals = 100%)
- **Bedding Status Index**: it is expressed in arbitrary unit representative of the dielectric (cage, bedding, moisture) materials immersed into the Electromagnetic Field (EMF) generated by the DVC<sup>®</sup> board.

Moreover, it is possible to apply these metrics only to specific set of electrodes of the DVC<sup>®</sup> board simply selecting the proper icon representing the board next to animal locomotion index and Bedding status index button. The representation can be divided into: all, front, rear, corner, wall, center.

Animal Locomotion index	
Bedding Status Index	

PLEASE NOTE: In this version of the DVC® Analytics you can select multiple metrics at once.

#### 2.3.3 Run the analysis

Once all the selections have been made (elements, time intervals, charts, metrics), it is possible to start analyzing data (the buttons are now activated and they can be clicked).



Clicking on "Run Analysis", dependently on your specific selections, the corresponding graphs appear.



You can easily zoom any graph simply clicking in any position and keep pressed the left mouse button till the end of the area you want to zoom:

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Releasing the button of the mouse, the graph is zooming in the selected area as well as all the other graphs are zoomed to show the corresponding data:



To reset the zoom, simply click on the corresponding icon of the zoomed graph

Moreover, if you want to better analyze any graph, there is the opportunity to magnify it simply clicking on the corresponding icon 💙 below the graph itself.

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Furthermore, when you perform comparison between different groups, by default the y-axis autoscales on the highest value present in the selected time window. Otherwise, you can manually set the range of y-axis (minimum and

maximum) accordingly to your need simply by clicking on this icon  $\square$  , located on the top-left side of the graph.

Setting Y Axis	
series *	
Group 1	*
max	
min	
Apply	

## 2.3.3.1 Multiple groups – SEM, INTERQUARTILE and BOX PLOT

Selecting multiple groups while performing the "Data Analysis" enables extra functionalities of the application. Selecting "Line", in the "Chart Type" is then possible to select also the Simple Line with Standard Error of the Mean (SEM) or INTERQUARTILE. In this case, extra vertical lines (SEM or INTERQUARTILE) are added to any extra point of the consequent graphs.



If you select "Other" in the Chart Family, a new graph becomes available "Box Plot":

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30 20	∎Ī																							Reset zoom
o Value	Ļ	Ĭ	Ţ	ŢŢ		Ť	Ţ	Ţ	Ţ	- <u>-</u> -	Ĩ	, , I		_L	ŦŢ	Ī	Ĩ	Ĭ	Ĭ	Č.	ě,	T.	Ļ	Ţ
-10	2018-07-02	2018-07-03	2018-07-04	2018-07-05	2018-07-06	2018-07-07	2018-07-08	2018-07-09	2018-07-10	2018-07-11	2018-07-12	2018-07-13 Group 0	2018-07-14 Date Group 2	2018-07-15	2018-07-16	2018-07-17	2018-07-18	2018-07-19	2018-07-20	2018-07-21	2018-07-22	2018-07-23	2018-07-24	2018-07-25

## 2.3.4 Prepare Download

When all the selections have been performed, it is also possible to prepare the download of the corresponding selected data.

Clicking on the icon

Prepare Download it is then possible to choose between 2 different options:

	day	hour	minute	relativeTime	timestamp	group	cage	sample	s v_1	v_2 v	_3 v_4	V.	5 V	6 v_7	v_8	v_9	v_10 v	11 v_1
1	0	0	0	0	2019-01-01 00:00:00+000	00 Group_	0 A-01	1.0	1.0	1.0 1	.0 1.0	1	.0 1.	0 1.0	1.0	1.0	1.0	.0 1.0
2	0	0	0	0	2019-01-01 00:00:00+000	00 Group_	0 A-01	1.0	1.0	1.0 1	.0 1.0	1	.0 1.	0 1.0	1.0	1.0	1.0	.0 1.0
3	0	0	0	0	2019-01-01 00:00:00+00	00 Group	0 A-01	1.0	1.0	1.0 1	.0 1.0	1	.0 1.	0 1.0	1.0	1.0	1.0	.0 1.0
-1	0		0	0	0 0			0	0	0	0		0	0	0	0	0	0
1	0	~														-	-	
1	0	0	0	0	0 0	0		0	0	0	0		0	0	0	0	0	0
1 2 3	0	0	0	0	0 0	0 0		0	0	0	0		0	0	0	0	0	0
1 2 3	0	0	0	0	0 0	0	_	0	0	0	0		0	0	0	0	0	

#### Type 1 (upper choice):

Reporting data aggregated in rows by minute or by hour (or custom aggregation, dependently on your specific selection) for all the electrodes of any cage of any group In sequential order.

	day	hour	minute	relativeTime	timestamp	group	cage	samples	v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9	v_10	v_11	v_12
1	0	0	0	0	2019-01-01 00:00:00+0000	Group_0	A-01	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	0	0	0	0	2019-01-01 00:00:00+0000	Group_0	A-01	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	0	0	0	0	2019-01-01 00:00:00+0000	Group_0	A-01	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Day	Day from date selected in the observation time
Hour	Hour of that day 1-24
Minute	Minute of that hour 1-60
relative Time	Absolute value (in seconds) of the timing from the previous midnight of the starting date
Timestamp	Absolute Time Stamp in UTC time (https://en.wikipedia.org/wiki/Coordinated Universal Time)
Group	Name Group
Cage	Cage name within the selected cage group

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Samples	Number of collected samples, detected in the specified time frame. Such information
	are useful to understand if the cage has been removed from the rack thus providing an
	estimation on how much data have been lost due to this event.
V_1/2/3/4/5/6/7/8/9/10/11/12	Value of activity detected on electrode 1/2/3/4/5/6/7/8/9/10/12 of the DVC <sup>®</sup> board

#### Type 2 (lower choice):

Reporting data aggregated in rows following your time aggregation (minute, hour or custom) and cage groups and cages by coloumns with some basic descriptive statistics (i.e. average, quartile, SEM)

		day	hour	minute	relativeTime	g1_TIMESTAMP	g1_AVG	g1_SEM	g1_QRT	g1_SAMPLES	g1_cage1	g2_TIMESTAMP	g2_AVG	g2_SEM	g2_QRT	g2_SAMPLES	g2_cage1	g2_cage2
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					***				***									

day	Day from date selected on the observation time
hour	Hour of that day 1-24
minute	Minute of that hour 1-60
relative Time	Absolute value (in seconds) of the timing from the previous midnight of the starting date
g1_TIMESTAMP	Absolute Time Stamp in UTC time for group 1 (https://en.wikipedia.org/wiki/Coordinated Universal Time)
g1_AVG	Metric Average of group 1
g1_SEM	SEM Group 1
g1_QRT	Quartile Group 1 [Minimum, Lower Quartile, Median, Upper Quartile, Maximum]
g1_SAMPLES	Collected samples, detected in the specified time frame and for the entire group. Such information are useful to understand if the cage has been removed from the rack thus providing an estimation on how much data have been lost due to this event.
g1_cage1	Metric Average of the first selected cage within group 1
g2_TIMESTAMP	Absolute Time Stamp group 2
g2_AVG	Metric Average of group 2
g2_SEM	Standard Error Group 2
g2_QRT	Quartile Group 2 [Minimum, Lower Quartile, Median, Upper Quartile, Maximum]
g2_SAMPLES	Amount of information, samples, detected in the specified time frame and for the entire group. Such information are useful to understand if the cage has been removed from the rack thus providing an estimation on how much data have been lost due to this event.
g2_cage1	Metric Average of the first selected cage within group 2
g2_cage2	Metric Average of the second selected cage within group 2





In order to start preparing the Download, it is mandatory to fill the File name section to activate the Download button



PLEASE NOTE: you find the "Downloaded data" in the dedicated section called Download Area



Where you can finally now really download on your PC the data simply clicking on the  ${}^{ ext{eq}}$  icon.

						ð 🛱	<b>≣</b> ₩ (	💡 admin@admin.it 🚍
			<u>+ « Ł</u>					
		Require	Download Area d Download Area text description.					
File Name	Size	User	Creation	Termination	Status	Action	Resource Type	9
Test_Giorgio	314.53 KB	adminTP	19/09/2019 16:00	19/09/2019 16:01	COMPLETED	RAW	CAGE	90
KM Test Summary	0.00 bytes	kyle	15/04/2019 15:29		FAILED			

The file you download is a .zip file that contains .csv files (comma separated file), one each metric you have previously selected (in this case average = Bedding Status Index, activation = Animal Locomotion Index, events = DVC events)

C:\Users\grosati\Desktop\Test_Giorgio (1).zip\					
Nome	Dimensione	Dimensione co	Ultima modifica	Creato	Ult
Revents.csv	1 888	517	2019-09-19 16:01		
🔯 average.csv	466 052	138 334	2019-09-19 16:01		
activation.csv	508 162	182 857	2019-09-19 16:01		

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	A	В		с	D	E		F	G	н	I	J	к	L	м	N	0	Р	Q	R	S	т	U
1	day,hou	r,minute	relativ,	veTime	e,Group_1	TIMES	TAMP,Gr	roup_1_/	AVG,Grou		Group_1_	QRT,Group	_1_SAMPL	ES,Group_	1_1267_DX	_							
2	0,15,50,	57019,201	19-09-2	25T13:5	0:19.443+	0000,0.0	6209150	3267973	86,NaN,'	[0.062091	503267973	86,0.06209	1503267973	86,0.06209	9150326797	386,0.0620	915032679	7386,0.062	091503267	97386]",153	3.0,0.0620	9150326797	386
з	0,15,51,	57060,201	19-09-2	25T13:5	1:00.164+	0000,0.0	3908554	5722713	87,NaN,'	[0.039085	545722713	87,0.03908	5545722713	87,0.03908	3554572271	387,0.0390	855457227	1387,0.039	085545722	71387]",220	5.0,0.0390	3554572271	387
4	0,15,52,	57120,201	19-09-2	25T13:5	2:00.176+	0000,0.0	5162241	.8879056	046,NaN	"[0.05162	241887905	6046,0.051	6224188790	56046,0.05	5162241887	9056046,0.	051622418	879056046,	0.0516224	1887905604	46]",226.0,	0.05162241	8879056046
5	0,15,53,	57180,201	19-09-2	25T13:5	3:00.229+	0000,0.0	3666666	6666666	66,NaN,'	[0.036666	566666666	66,0.03666	6666666666	66,0.03666	5666666666	666,0.0366	666666666	5666,0.036	666666666	56666]",225	5.0,0.0366	5666666666	666
6	0,15,54,	57240,201	19-09-2	25T13:5	4:00.062+	0000,0.0	4203539	8230088	5,NaN,"[	0.0420353	982300885	,0.0420353	982300885,	0.04203539	982300885,0	0.04203539	82300885,0	.04203539	82300885]"	,226.0,0.04	20353982	300885	
7	0,15,55,	57300,201	19-09-2	25T13:5	5:00.089+	0000,0.0	04166666	6666666	68,NaN,'	[0.041666	566666666	68,0.04166	6666666666	68,0.04166	5666666666	668,0.0416	666666666	5668,0.041	666666666	56668]",226	5.0,0.0416	5666666666	668
8	0,15,56,	57360,201	19-09-2	25T13:5	6:00.164+	0000,0.0	4977876	1061946	904,NaN	"[0.04977	876106194	6904,0.049	7787610619	46904,0.04	1977876106	1946904,0.	049778761	061946904,	0.0497787	5106194690	04]",226.0,	0.04977876	1061946904
9	0,15,57,	57420,201	19-09-2	25T13:5	7:00.262+	0000,0.0	3592592	5925925	924,NaN	"[0.03592	592592592	5924,0.035	9259259259	25924,0.03	3592592592	5925924,0.	035925925	925925924,	0.0359259	2592592592	24]",225.0,	0.03592592	5925925924
10	0,15,58,	57480,201	19-09-2	25T13:5	8:00.030+	0000,0.0	2986725	6637168	143,NaN	"[0.02986	725663716	8143,0.029	8672566371	68143,0.02	2986725663	7168143,0.	029867256	537168143,	0.0298672	5663716814	13]",226.0,	0.02986725	6637168143
11	0,15,59,	57540,201	19-09-2	25T13:5	9:00.076+	0000,0.0	3576696	1651917	4,NaN,"[	0.0357669	516519174	,0.0357669	616519174,	0.03576696	516519174,	0.03576696	16519174,0	.03576696	16519174]"	,226.0,0.03	57669616	519174	
12	0,16,0,5	7600,2019	9-09-25	5T14:00	:00.185+0	000,0.02	29498525	0737463	12,NaN,'	[0.029498	525073746	312,0.0294	9852507374	6312,0.029	498525073	746312,0.0	294985250	73746312,0	.02949852	5073746312	2]",226.0,0	.029498525	073746312
13	0,16,1,5	7660,2019	9-09-25	5T14:01	:00.216+0	000,0.02	22222222	2222222	23,NaN,"	[0.022222	2222222222	223,0.0222	22222222222	2223,0.022	22222222222	222223,0.0	2222222222	22222223,0	.02222222	222222222	3]",225.0,0	.022222222	222222223
14	0,16,2,5	7720,2019	9-09-25	5T14:02	:00.011+0	000,0.03	31342182	8908554	55,NaN,'	[0.031342	182890855	455,0.0313	4218289085	5455,0.031	1342182890	855455,0.0	313421828	90855455,0	.03134218	2890855455	5]",226.0,0	.031342182	890855455
15	0,16,3,5	7780,2019	9-09-25	5T14:03	:00.108+0	000,0.04	1666666	6666666	64,NaN,'	[0.041666	566666666	664,0.0416	6666666666	66664,0.041	1666666666	666664,0.0	416666666	56666664,0	.041666666	56666666664	l]",226.0,0	.041666666	666666664
16	0,16,4,5	7840,2019	9-09-25	5T14:04	:00.133+0	000,0.03	39823008	8495575	2,NaN,"[	0.0398230	088495575	2,0.039823	0088495575	2,0.039823	3008849557	52,0.03982	300884955	752,0.0398	230088495	5752]",226.	0,0.03982	3008849557	52
17	0,16,5,5	7900,2019	9-09-25	5T14:05	:00.197+0	000,0.03	37037037	0370370	35,NaN,'	[0.037037	037037037	035,0.0370	3703703703	7035,0.03	7037037037	037035,0.0	370370370	37037035,0	.03703703	7037037035	5]",225.0,0	.037037037	037037035
18	0,16,6,5	7960,2019	9-09-25	5T14:06	:00.031+0	000,0.01	1430678	4660766	96,NaN,'	[0.011430	578466076	696,0.0114	3067846607	6696,0.011	1430678466	076696,0.0	114306784	56076696,0	.01143067	8466076696	5]",226.0,0	.011430678	466076696
19	0,16,7,5	3020,2019	-09-25	5T14:07	:00.054+0	000,0.02	29867256	6371681	43,NaN,'	[0.029867	256637168	143,0.0298	6725663716	8143,0.029	9867256637	168143,0.0	298672566	37168143,0	.02986725	5637168143	3]",226.0,0	.029867256	637168143
20	0,16,8,5	3080,2019	9-09-25	5T14:08	:00.116+0	000,0.02	27654867	2566371	73,NaN,'	[0.027654	867256637	173,0.0276	5486725663	7173,0.02	7654867256	637173,0.0	276548672	56637173,0	.02765486	7256637173	3]",226.0,0	.027654867	256637173
21	0,16,9,5	3140,2019	9-09-25	5T14:09	:00.219+0	000,0.02	28518518	5185185	16,NaN,'	[0.028518	518518518	516,0.0285	1851851851	8516,0.028	3518518518	518516,0.0	285185185	18518516,0	.02851851	8518518516	j",225.0,0	.028518518	518518516
22	0,16,10,	58200,201	19-09-2	25T14:1	0:00.006+	0000,0.0	02148148	1481481	48,NaN,'	[0.021481	481481481	48,0.02148	1481481481	48,0.02148	3148148148	148,0.0214	814814814	8148,0.021	4814814814	48148]",225	5.0,0.0214	8148148148	148
23	0,16,11,	58260,201	19-09-2	25T14:1	1:00.064+	0000,0.0	02765486	7256637	166,NaN	"[0.02765	486725663	7166,0.027	6548672566	37166,0.02	2765486725	6637166,0.	027654867	256637166,	0.0276548	5725663716	66]",226.0,	0.02765486	7256637166
24	0,16,12,	58320,201	19-09-2	25T14:1	2:00.167+	0000,0.0	2986725	6637168	146,NaN	"[0.02986	725663716	8146,0.029	8672566371	68146,0.02	2986725663	7168146,0.	029867256	537168146,	0.0298672	5663716814	6]",226.0,	0.02986725	6637168146
25	0,16,13,	58380,201	19-09-2	25T14:1	3:00.198+	0000,0.0	04166666	6666666	68,NaN,'	[0.041666	566666666	68,0.04166	6666666666	68,0.04166	5666666666	668,0.0416	666666666	5668,0.041	666666666	56668]",220	5.0,0.0416	5666666666	668
26	0,16,14,	58440,201	19-09-2	25T14:1	4:00.233+	0000,0.0	01444444	4444444	446,NaN	"[0.01444	144444444	4446,0.014	4444444444	44446,0.01	1444444444	444446,0.	014444444	44444446,	0.01444444	14444444444	6]",225.0,	0.01444444	444444446
27	0,16,15,	58500,201	19-09-2	25T14:1	5:00.066+	0000,0.0	02507374	6312684	37,NaN,'	[0.025073	746312684	37,0.02507	3746312684	37,0.0250	7374631268	437,0.0250	737463126	8437,0.025	073746312	58437]",220	5.0,0.0250	7374631268	437
28	0,16,16,	58560,201	19-09-2	25T14:1	6:00.115+	0000,0.0	02074074	0740740	744,NaN	"[0.02074	074074074	0744,0.020	7407407407	40744,0.02	2074074074	0740744,0.	020740740	740740744,	0.02074074	4074074074	14]",225.0,	0.02074074	0740740744
29	0,16,17,	58620,201	19-09-2	25T14:1	7:00.158+	0000,0.0	3037037	0370370	367,NaN	"[0.03037	037037037	0367,0.030	3703703703	70367,0.03	3037037037	0370367,0.	030370370	370370367,	0.0303703	7037037036	57]",225.0,	0.03037037	0370370367
30	0,16,18,	58680,201	19-09-2	25T14:1	8:00.009+	0000,0.0	02359882	0058997	'05,NaN,'	0.023598	820058997	05,0.02359	8820058997	05,0.02359	882005899	705,0.0235	988200589	9705,0.023	598820058	99705]",226	5.0,0.0235	9882005899	705
31	0,16,19,	58740,201	19-09-2	25T14:1	9:00.038+	0000,0.0	3355457	2271386	43,NaN,'	[0.033554	572271386	43,0.03355	4572271386	43,0.03355	5457227138	643,0.0335	545722713	8643,0.033	554572271	38643]",220	5.0,0.0335	5457227138	643
32	0,16,20,	58800,201	19-09-2	25T14:2	0:00.081+	0000,0.0	03392330	3834808	26,NaN,'	[0.033923	303834808	26,0.03392	3303834808	26,0.03392	2330383480	826,0.0339	233038348	0826,0.033	923303834	80826]",226	5.0,0.0339	2330383480	826
33	0,16,21,	58860,201	19-09-2	25T14:2	1:00.176+	0000,0.0	3834808	2595870	21,NaN,"	[0.038348	082595870	21,0.03834	8082595870	21,0.03834	1808259587	021,0.0383	480825958	7021,0.038	348082595	37021]",226	5.0,0.0383	4808259587	021

**PLEASE NOTE**: TIMESTAMP are produced in UTC time (<u>https://en.wikipedia.org/wiki/Coordinated Universal Time</u>). If you are using MS Excel to open these files, remember to set the "." as decimal separator.

#### 2.4 Manage Experiment

Clicking on the icon "Manage Experiment" other choices appear:



## 2.4.1 Cage Groups

In this section it is possible to create specific groups of cages and assign to (already) existing DVC® Analytics users.





		Cage Groups Manage groups of cages.	
Group Name	Cages	Owner	<del>()</del> (+)
group 3	3	laura	
KM Test1	3	kyte	20

First step is to create the group, simply clicking on the corresponding icon +. A specific pop-up area appears and you are requested to insert the name of this group as well as the owner of the group.

Test Group		
Owner *		
GiorgioM		
	C	firm

Then, you can start adding cages to this group simply clicking on the icon 😨 and then selecting the cages to be included in this group.

	Cage Id Puck	Protocol	Registration	DVC Owner	DVC Analytics O	Terminated ALL T
~	Puck1	DVC Default Protocol				Ē
<b>~</b>	Puck2	DVC Default Protocol				ē
<b>~</b>	Puck3	DVC Default Protocol				Ē
<b>~</b>	Puck4	DVC Default Protocol				Ē
<b>V</b>	Puck5	DVC Default Protocol				Ē
	Puck6	DVC Default Protocol				Ē
	Puck7	DVC Default Protocol				Ē
	Puck8	DVC Default Protocol				Ē
				Items per page: 8	▼ 1 - 8 of 8	< < > >

PLEASE NOTE: same cage(s) can be assigned to different groups.

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17	



**PLEASE NOTE**: in order to delete a group, you must deselect all the cages before being able to delete the Cage Group with the corresponding icon

### 2.4.2 Mice groups

To create a Mouse group, please follow exactly the previous workflow with the only different that you must choose between available mice IDs (instead of cage IDs).

		A 🔍 🚣	
	٨	Mice Groups Aanage groups of mice.	
Group Name	Animals	Owner	<del>()</del> +
Test Mouse	0	GiorgioM	

#### 2.5 Download Area

As already anticipated, in this section, you can immediately find all the requested-to-be-prepared data.

						Ý 🗒	🖷 👯 📀	admin@admin.it 🚍
			<u>↑ ≪ ±</u>					
		Require	Download Area ed Download Area text description.					
File Hame	Size	User	Creation	Termination	Status	Action	Resource Type	Ø
Test_Giorgio	314.53 KB	adminTP	19/09/2019 16:00	19/09/2019 16:01	COMPLETED	RAW	CAGE	
KM Test Summary	0.00 bytes	kyle	15/04/2019 15:29		FAILED			0

Additionally, you have other information such the status of the requested task (Running, Failed, Executed) as well as who requested it, the size of the file and the date of starting (Creation) and Termination.

#### 2.6 User settings

As described in section 2.1, this section is available only for the DVC<sup>®</sup> Analytics users registered as Facility Manager and not available to the users registered as Researchers.

			User Settings Required User Settings text description.
			User Settings
Unit of Measure Configuration of unit of measure	User Groups Wavaye groups of users and associate capes.	DVC* Analytics Users Image Dic Designs uses.	DVC <sup>4</sup> Cage Owner Association Associate VC Analytics existing uses to DVC sage survers inherited from registered sages in the facility.
Settings Int facility parameters (x.g., dark period).			

There are different options you can set

#### 2.7 Unit of Measure

Clicking on the corresponding button, you can see which are your current settings set by Tecniplast

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	<u> </u>
	Unit of Measure Configuration of unit of measure
Label	Unit Of Measures
Animal Locomotion index	Percentage (x100) [0, 100]
Bedding Status Index	None [0, 1024]

### 2.7.1 User Groups

You can create groups of users able to access to groups of cages.

		<b>^</b>	<u> </u>	
	Manag	User e groups of us	Groups sers and associate	e cages.
Group Name	Owner	Users	Cages	<del>()</del> (+)
Squola	Danny	2	3	

This functionality is similar to the abovementioned Cage group (sect. 2.4.1) but with the difference that more users can now access to the same cages. You can simply add more users to the group clicking on the corresponding icon 2 and then chose from the list, as well adding cages clicking on the icon 3 and then choosing the selected ones from the list of available.



PLEASE NOTE: to delete a User group, you must deselect all the users and all the cages from the User group.

## 2.7.2 DVC® Analytics Users

In this section you can create unlimited users simply clicking on the corresponding icon  $\oplus$ .

You must enter different information for any user:

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Giorgio	W	
		_
Name *		
Surnam	e *	
		_
Role *		,
		_
Email *		
Password		
	•••••	
Enter a or	i password. Use min 8 characters or more, min one number a ne simbol and min one special symbol as [@\$!%?&~()_[] : "~;	nd €]
Confirm	n password *	

**PLEASE NOTE**: The minimum requirements to create your password are: 8 characters or more, one number and one symbol and one special symbol as  $[@$!\%^*?\&^{()}]$ 

Any new user must have an initial password that can be easily changed when entering for the first time in the application and clicking on the top right area



And then "Profile" and finally "Change Password" where the (new) user is requested to insert OLD password and new one.

User profile	User profile	
Username GiorgioM	Username GiorgioM	
Name Giorgio	Old Password	â
Sumame Rosati	New Password	â
Email grosati@tecniplast.it	Confirm Password	Min length 8 character
Change password Edit profil	Le Cancel	

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## 2.7.3 DVC<sup>®</sup> Cage Owner Association

This section is fundamental especially if you are (or have) Researcher users, because it is the only way to analyze cages when using this profile.

	<u>↑ 🔍 🚣</u>
	DVC <sup>®</sup> Cage Owner Association Associate DVC Analytics existing users to DVC cage owners inherited from registered cages in the facility.
DVC User	DV/C Analytics User
TUK Scientist	lauraR C C
NeuroScience	6
Researcher_4	
Reseracher_3	
Diabetic Group	
Researcher_1	66
Anonymous	
Anonymous	6
	Items per page: 8 💌 1 - 8 of 9 < 🗲

Every cage prepared in the DVC<sup>®</sup> system can have a DVC<sup>®</sup> Owner associated to it (it is not mandatory but highly suggested when used in combination with DVC<sup>®</sup> Analytics). If so, this DVC<sup>®</sup> Owner is pushed to the DVC<sup>®</sup> Analytics and

it is called DVC User and can be associated to already existing DVC<sup>®</sup> Analytics users simply clicking on the <sup>(C)</sup> icon.

**PLEASE NOTE**: only 1 DVC<sup>®</sup> Analytics user can be associate to the DVC User (it is not possible to associate multiple DVC<sup>®</sup> Analytics users to the same cages – you can manage this situation using.





#### 2.7.4 Settings

This button allows you to set different Facility information

	Required	User Settings J User Settings text descripti	on.
Dark Peri	od	Timezone	Starting day of the week
Start 18:00	End 06:00		<b>(</b>
			Reset

#### 2.7.4.1 Dark Period

This section is fundamental to properly set your official night period in the Facility. This setting is used in the "Day Time Filtration" section.

Day Time Filtration



If you manage time-shift in your facility because of summer-winter time, you can click on the + and then select the new time interval and the date of start from this interval

	Required	User Settings User Settings text desc	cription.	
Dark Period		Timezone		Starting day of the week
Start 18:00	End 06:00			
Start 17:00	End 05:00	Since 25/	: 10/2019	• <b>•</b>

PLEASE NOTE: you can change/delete this time interval and original data are not affected.

#### 2.7.4.2 Time Zone

This is also important to "see" your data in the graph/charts considering your Facility Time zone. Simply start typing in the corresponding area and the field will autocomplete with your timezone

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R	User Settings equired User Settings text descript	tion.
Dark Period	Timezone	Starting day of the week
Timezone settings:		
acility timezone: Europe/R		
Europe/Riga		

## 2.7.4.3 Starting of the week

In order to allow you maximum flexibility, it is possible to set the "first" day of the week that will be then used to display data especially in the daily and weekly graph selection:

User Settings Required User Settings text description.			
Dark Period	Timezone	Starting day of the week	
Select the starting day of th	e week		
lay .			

PLEASE NOTE: Sunday and Monday are currently the available "first" days of the week.





### 3 Useful information

In this section, we would like to provide you some tips and information that would be important to know in order to better understand how the DVC<sup>®</sup> Analytics works and get the most from it.

### 3.1 DVC<sup>®</sup> board

The DVC<sup>®</sup> board is the core of the DVC<sup>®</sup> system. There are 12 different electrodes that are mapping the entire base of the cage. These electrodes are numbered in the next way:



For some metrics (Animal Activity Index and Bedding Status Index) it is possible to select ONLY some electrodes (corners, walls, center, etc) if you want to deeply analyze specific patterns.



For some other metrics, such as Running Wheel or Animal Tracking for instance, it is not possible to select specific electrodes because the data are calculated using the Running Wheel or the entire DVC<sup>®</sup> board respectively.

#### 3.2 DVC<sup>®</sup> working principle and derived metrics

Basically, the working principle of the DVC<sup>®</sup> system is based on an electrical capacitance sensing technology (CTS). As said, the DVC<sup>®</sup> board is composed of 12 electrodes connected to an integrated circuit that continuously measures their electrical capacitance every 250msec (roughly). Since capacitance is influenced by the matter present in each electrode's surrounding, its measurements are affected by the presence of, e.g., water and animals. Note that, materials with high water content are characterized by large values of relative permittivity (with respect to air), which in turns has a direct effect on capacitance (high relative permittivity means higher capacitance). Since mice are characterized by high water content, their movements performed while close to an electrode induce significant capacitance changes, and thus, by properly tracking these changes over time it is possible to monitor animal activity. Note that, capacitance remains substantially unchanged when material compositions around an electrode is unvaried. Additionally, the capacitance readings are affected by the presence of water (due to e.g., bottle leakage) or urine. However, animal activity occurs on a time scale substantially different than that of water leakage or urine and thus the two variables can be easily distunguished. Furthermore, even when water/urine are present in an electrode surrounding (clearly not a flooded cage, but common amount of water/urine in a dirty cage) the capability of the system to discern animal movements is substantially unchanged. In fact, the presence of water/urine can change absolute capacitance readings, but not capacitance variations due to animal movements.

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Keeping in mind this working principle, there are some important metrics that can be applied. The currently available metrics in the DVC<sup>®</sup> Analytics systems are:

- Animal Activity Index
- Bedding Status Index
- Animal Tracking Distance
- Animal Tracking Speed
- Running Wheel Rotation
- Running Wheel Distance
- Running Wheel Speed

**PLEASE NOTE**: every element (cage or animal) has specific capabilities assigned by the DVC<sup>®</sup> system that enable or not correspondent DVC<sup>®</sup> metrics (a cage without Running Wheel doesn't enable the Running Wheel metric).

#### 3.2.1 Animal Activity Index

This DVC<sup>®</sup> metric is extremely robust because it uses the so called "Activation Density" metric that has been extensively validated in the field across different experiments and validation processes (you can find detailed information in this publication <u>https://www.heliyon.com/article/e01454</u>).

An electrode is considered activated when its measurements are perturbed significantly over a limited time interval, which generally occurs when a mouse performs activity while sufficiently close to an electrode (see below). Density indicates that the total number of activations are divided by the duration of the time interval considered and the number of electrodes of interest (up to twelve). A sketch of the Capacity Sensing Technology activation density metric is the following. Recall that the Capacity Sensing Technology board provides measurements related to electrode capacitance every 250ms and let  $c_k(t)$  be the (filtered) capacitance measurements from the kth electrode at time t. Then, we compare the difference between two adjacent capacitance measurements as

$$\Delta_k(t) = c_k(t) - c_k(t-1).$$

The rationale behind this is that when no animal movements occur the difference  $\Delta k(t)$  is approximately zero as there are no variations in electrode capacitance, while absolute values  $|\Delta k(t)| > 0$  indicate capacitance variations that are generally caused by animal movements. According to these observations, we consider that an electrode is activated when we observe a change in adjacent measurements larger than a fixed threshold  $\lambda$ . The threshold is conveniently chosen to separate noise induced capacitance variations from animal movements. Finally, the binary information indicating whether the electrode is activated at time t is given by:

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 $a_k(t) = \mathbb{1}[\left|\Delta_k(t)\right| \ge \lambda]$ 

where 1[x] is the indicator function for the event x, with 1[x]=1 if event x is true and 1[x]=0 otherwise. Finally, one is generally interested in measuring the average amount of activations, occurring across a given set of electrodes (i.e., area of the cage) and within a given time interval. To do so, the CST activation density within time periods t1 and t2, across set of electrode S, can be computed as

$$A_{CST}(t_1, t_2) = \frac{1}{|S|(t_2 - t_1)} \sum_{k \in S} \sum_{t=t_1}^{t_2 - 1} a_k(t)$$

where |S| indicates the cardinality (i.e., number of electrodes) of set S. Note that, the CST activation density does not indicate the type of movement performed, but it only accounts whether activity occurred close to an electrode.

This Animal Activity Index is expressed in % arbitrary unit and it is normalized between 0% and 100%.

### 3.2.2 Bedding Status Index

This DVC<sup>®</sup> metric has been developed in order to provide the possibility to determine and analyze the status of the bedding. There are basically 2 different events that affect bedding status:

- Growing moisture due to latrine creation
- Water flooding due to water bottle leakage and/or Automatic Watering System valve failure

In both cases, this DVC<sup>®</sup> metric is calculated starting from the absolute value collected by the CST and applied a specific-time-interval average function (minute, hour, custom)



PLEASE NOTE: this DVC<sup>®</sup> metric lends itself well to use the different mapping electrodes opportunity



## 3.2.3 Animal Tracking Distance and Speed

The distance walked accounts for the total distance covered by the mouse within a given time interval, while the average speed is the distance walked divided by the duration of the time interval considered. We assume that the mouse position on the cage floor is identified in terms of its centroid, while the distance walked is computed via the sum of the Euclidean distances of the mouse centroid in successive frames within the time interval of interest. The distance walked is defined as follows. Let  $\mathbf{p}(t) = [p_x(t), p_y(t)]$  be a 2 ×1 vector of coordinates on the plane (cage floor) representing the position of the centroid of the mouse at time *t*. Then, the distance walked within the time interval *t* tand *t* can be computed as:

$$S(t_1, t_2) = \sum_{t=t_1+1}^{t_2} d(t)$$

Where:

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$$d(t) = \sqrt{(p_x(t) - p_x(t-1))^2 + (p_y(t) - p_y(t-1))^2}$$

is the Euclidean distance between two positions in adjacent frames.

The average speed is instead defined as the ratio between the cumulative walked distance and the duration of the time interval:

$$V(t_1, t_2) = \frac{1}{t_2 - t_1} S(t_1, t_2)$$

## 3.2.4 Running Wheel Rotation, Distance and Speed

Using the product DVC<sup>®</sup> Running wheel, it is possible to automate several metrics. The diameter of the plastic DVC<sup>®</sup> Running wheel is 110,4 mm (4,35 inch) that corresponds to a perimeter of about 34,54 cm (13,6 inch).



The minimum time resolution is the minute and the metrics are expressed in:

- Running Wheel rotation: # complete rotations in the selected time-resolution (minute, hour, custom)
- Running Wheel distance: # complete rotations \* 34,54 cm (13,6 inch) in the selected time-resolution
- Running Wheel Speed: expressed in cm/min or m/min

## 3.3 How data are calculated and aggregated

Considering the different data and the different charts, it is fundamental to understand how these are calculated.

## 3.3.1 Line Chart

Every point of the line is calculated in the next way:

**SPATIAL AGGREGATION**: average of the selected DVC<sup>®</sup> boards electrodes (by default the 12 electrodes). The result is one single data point (if you select only the corners, the data point is the average of the 4 electrodes).

**TEMPORAL AGGREGATION:** the default temporal window (minute and hour) are automatically calculated by the DVC<sup>®</sup> system while they are occurring. Vice versa, if you have selected a custom temporal window, the result is the average of all the minutes included into the custom temporal interval if the time is not a multiple of the hour.

## Activation (3min) = [activation (min $1^{\circ}$ ) + activation (min $2^{\circ}$ ) + activation (min $3^{\circ}$ )] / 3

If the custom temporal interval is a multiple of the hour:

## Activation (3h) = [activation (hour $1^{\circ}$ ) + activation (hour $2^{\circ}$ ) + activation (hour $3^{\circ}$ )] / 3

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**GROUP AGGREGATION:** the data point in the graph is the calculated as the average of the single calculated metric.

### Activation (3 cages) = [activation (cage 1°) + activation (cage 2°) + activation (cage 3°)] / 3

### 3.3.2 Line chart with SEM

As explained in section 2.3.3.1, the SEM is enabled by selecting multiple cages in the same group. Everything is calculated the same as above in terms of spatial and temporal aggregation and then, the SEM (Standard Error of the Mean), it is simply calculated as (where SD = Standard Deviation):

## SEM = SD / $\sqrt{(\#samples)}$

In the correspondent Linechart it is shown as average (central data point) ± SEM.

#### 3.3.3 Line chart with Interquantile

As explained in section 2.3.3.1, the INTERQUANTILE is enabled by selecting multiple cages in the same group. Everything is calculated the same as above in terms of spatial and temporal aggregation and then, the INTERQUANTILE feature enables 6 different points per data sample:

- Average
- Median
- Quantile
- 3\* Quantile
- Interquantile min range
- Interquantile max range



#### 3.3.4 Line Chart cumulative

Spatial and temporal aggregation follow the abovementioned scheme, and in this specific case, every data point is the sum of the previous ones:

$$d(0) = A(0)$$
$$d(1) = A(0) + A(1)$$
$$d(2) = A(0) + A(1) + A(2)$$
$$d(n) = A(0) + A(1) + A(2) + \dots + A(n)$$

#### 3.3.5 Heatmap

Spatial, temporal and group aggregation are exactly calculated as above, the only difference with the Line Chart is the chromatic visualization (from blue as lower value to red as higher value). Every block is representative of the Data Time Aggregation chosen.

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## 3.3.6 Box Plot

Spatial aggregation is the same of the Line Chart. Temporal aggregation is forced to be calculated on 24 hours (the day). Result is a single data point for each selected element (cage or animal). The Box Plot chart is available only when multiple elements (cages or animals) are selected.

The BOX PLOT feature enables 5 different points per data sample:

- Median
- 1<sup>st</sup> Quantile
- 3<sup>rd</sup> Quantile
- Min
- Max



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