## Introduction

DSI telemetry allows scientists to monitor physiologic parameters such as blood pressure, heart rate, temperature, EEG, and activity in freely moving laboratory animals. The recent introduction of the HD-XG glucose telemetry implant offers exciting research possibilities for diabetes and metabolic disease studies. The BioDAQ system from Research Diets is a valuable tool for monitoring food and liquid intake as well as automating access to or restriction from food and liquid. Integration of the DSI telemetry system with Research Diets' BioDAQ system enables correlation of physiologic monitoring with ingestive behavior and/or ingestive restrictions.

This technical note provides options and considerations for integrating the DSI telemetry system with the BioDAQ monitoring system.

Hardware Setup

Set up each system per guidance provided by the manufacturer. Additionally implement the below accommodations.

- Install a fixture allowing for DSI receiver placement under the cage and BioDAQ Peripheral Sensor Controller (PSC) placement on a stable platform. Examples of two simple fixtures are a block placed between the PSC and the shelf (figure 1) or a 3/8 inch (0.95cm) thick clear acrylic plate placed between the receiver and the cage providing a new surface for the PSC to rest on (figure 2).

Figure 1   **Figure 2**
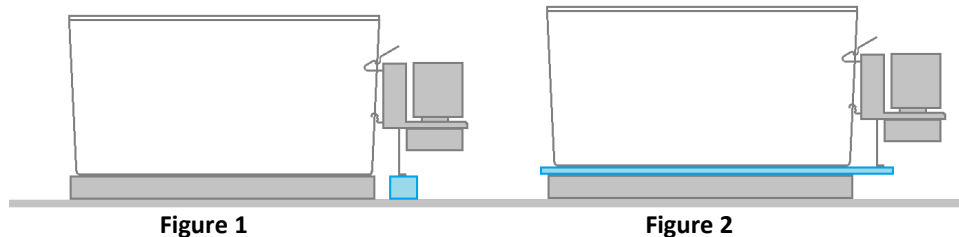
- Space cages at least 50 cm apart, center-to-center. If it is necessary to place cages closer together due to space limitations, the use of stainless steel shielding[1] may be required to minimize cross-talk or signal loss from the implants.

- Run the DSI acquisition software and Research Diets acquisition software on the same computer to maintain time synchronization between the two systems. If this is not possible, time synchronize the separate computers on a weekly or more frequent basis[2] to avoid significant differences. If using multiple computers ensure they are also set to the same local time zone.

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[1] 0.059 inch thick type 304#4 recommended

[2] Ideally, one would define the amount of drift that is scientifically acceptable and then evaluate the drift that occurs between the multiple computers to determine synchronization frequency.

Data Collection

Configure and acquire data on each system independently.

Data Integration

Integrate the data in the following manner:

1. DSI Telemetry Data Analysis

    a. Analyze the telemetry data in Dataquest A.R.T. software.

2. BioDAQ Data analysis

    a. Analyze the ingestive data in DataViewer software.

    b. Export the summarized tables into a comma separated value (CSV) format text file.

    c. Modify that file to match import requirements for Dataquest A.R.T.

3. Integration

    a. Import the BioDAQ data file created above into Dataquest A.R.T.

    b. Plot data and perform additional analyses such as group averaging as appropriate.

4. Time synchronization

    a. Correct for time synchronization concerns within Dataquest A.R.T. as needed.

Dataquest A.R.T. Import File Requirements

Following is a description of the Dataquest ART import file format and requirements with an example. Note that the "LINE" designators in the example are not part of the actual file. They are included only for descriptive purposes. ASCII files in this format can be imported directly into Dataquest ART and BioDAQ DataViewer software.

```
# Time: 2014/02/12 16:57:10                                          LINE #1
# UTC: 2014/02/12 22:57:10                                           LINE #2
# Period: Stamp                                                      LINE #3
# Col: Rat1.CG, Rat1,0, CG,g                                         LINE #4
# Col: Rat1.Rate, Rat1,0, Rate,mg/min                               LINE #5
# Col: Rat1.SSPS, Rat1,0, SSPS,sec                                  LINE #6
# Col: Rat1.Duration, Rat1,0, Duration,sec                         LINE #7
# Col: Rat1.PMI, Rat1,0, PMI,sec                                    LINE #8
# Col: Rat1.Lights, Rat1,0, Lights,N/A                             LINE #9
# Col: Rat1.Temp, Rat1,0, Temp,deg C                               LINE #10
# Col: Rat1.RH, Rat1,0, RH,Percent                                 LINE #11
2013/09/11 16:57:10,3.38,36.25,987,1534,4061,75,24.3,35            LINE #12
2013/09/11 18:30:25,3.27,38.03,1187,1085,4074,1,23.7,38            LINE #13
2013/09/11 19:56:24,3.22,20.04,6346,1151,8492,1,23.8,37            LINE #14
2013/09/11 22:37:07,3.3,24.71,15989,758,7256,1,23.7,35             LINE #15
2013/09/12 00:50:41,2.39,6,24003,2792,21097,1,23.9,35              LINE #16
…                                                                   LINE #17
```

Note: Al lines which include a date and time must be in the format yyyy/mm/dd HH:mm:ss where yyyy/mm/dd is the four digit year, two digit month and two digit day and HH:mm:ss is the two digit hour of day from 00 to 23, two digit minutes, two digit seconds.

LINE #1 (required) – "Time:" is recognized as a keyword indicating that the starting date/time will follow.

LINE #2 (recommended) – "UTC:" is recognized as a keyword indicating that the starting date/time in Greenwich Mean Time (GMT) will follow. If UTC time is not included, then it is assumed that the local time zone of the computer that is importing the data file is the same time zone used when acquiring data.

LINE #3 (required) – "Period:" is recognized as a keyword indicating that the following text will indicate the format of the time column. Valid options are "Stamp," "Days," "Hours," "Minutes," and "Seconds." Stamp indicates that the first column of data will include timestamps in the format yyyy/mm/dd HH:mm:ss. Any of the other options indicate that the first column will include elapsed time in the designated units.

LINE #4-11 (required for columns chosen to be included) – "Col:" is recognized as a keyword describing data in each column starting in column two following the rows in the file starting with "#." Each entry is separated by a comma. The first entry, "Rat1.CG," will be the series name when importing into Dataquest A.R.T. The second entry, "Rat1," will be the subject ID. The third entry, "1," is the telemetry channel number associated with the data. The fourth entry,

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"CG," is the data type used in the analysis program. The fifth entry, "g," is the units associated with the data type. There must be one "#Col:" row for each column of data to the right of the date/time column.   It is up to the researcher to decide which columns are of interest and to then include them or not as they see fit.

For reference, the following abbreviations were used above in order to have brief entries:

- •   CG = Consumed Grams
- •   Rate = Rate of Consumption
- •   SSPS = Seconds Since Period Start
- •   Duration = Duration of Meal/Bout
- •   PMI = Post Meal Interval
- •   Lights = Light measurement
- •   Temp = Temperature
- •   RH = Relative Humidity

LINE #12 and above (required) – Each file will include multiple lines of values with the date/time or elapsed time in the first column, and data associated with the COL order defined above. Note that the dates and times in the file must be sequential. If the values are not entered in sequential order the file should be edited with a text editor such as Notepad to place them in time order (or they will not be able to be imported).

Note: If using Excel to create these files the date/time column must be custom formatted as "yyyy/mm/dd HH:mm:ss" prior to saving as a CSV file to avoid importation errors.

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