

Visual Examination of JET RIP Data via Konno-Mead Method

Summary

DSI's Ponemah software is able to visualize JET Respiratory Inductive Plethysmography (RIP) data for synchrony, asynchrony, and paradoxical breathing patterns using the method of Konno and Mead¹ wherein Chest and Abdomen excursions are plotted on separate axes of a XY loop plot. This document will explain the steps required to perform this visualization.

Method

To display a plot of chest and abdomen excursions one should set up a graph page per the following conventions and similar to the representation in Figure 1.

- Enable Page = **Checked**
- Type = **XY-Loop**
- X = The channel associated with the abdomen belt for a specific animal
- Y = The channel associated with the chest belt for the same specific animal
- Presentation = **Input** for both the Abdomen and Chest Channels

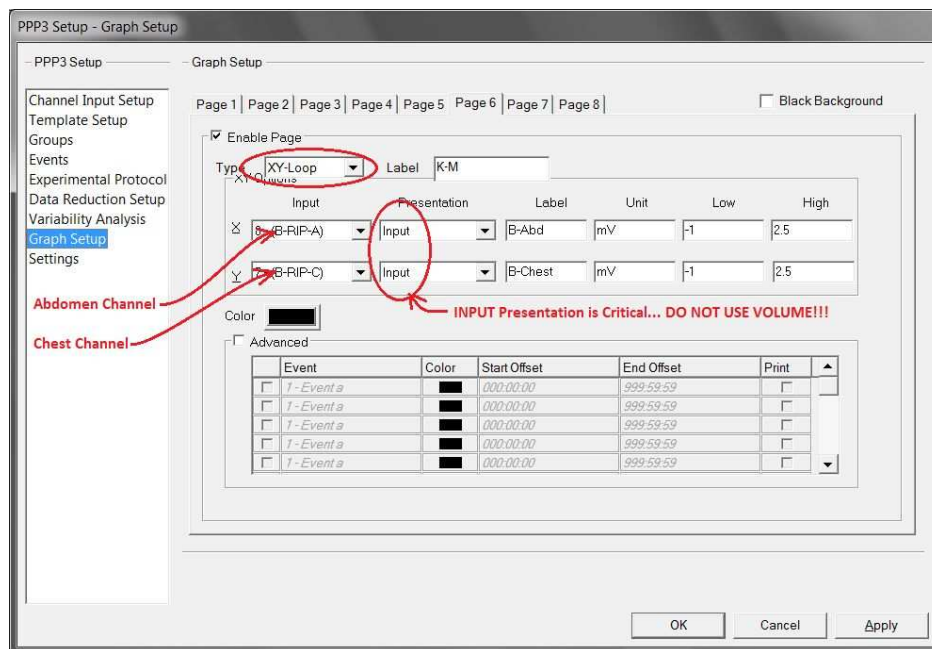


Figure 1 - Graph Setup

¹ Konno K, Mead J. Measurement of the separate volume changes of ribcage and abdomen during breathing. J Appl Physiol 1967; 22:407-22.

Example Data - Normal

JET RIP data collected on a beagle during a period of time with no activity or artifact is presented below.

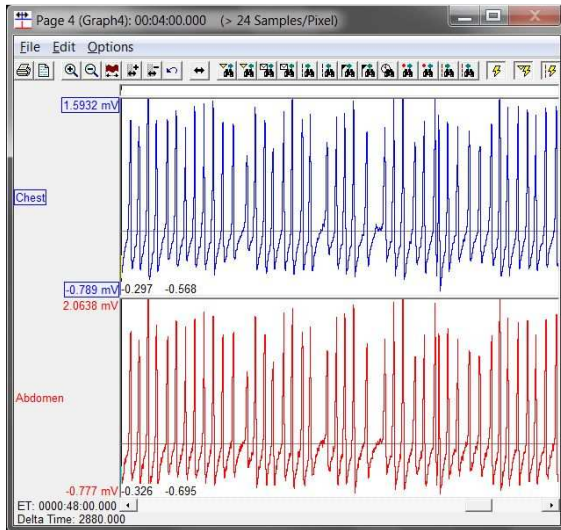


Figure 2 - Plot of Chest and Abdomen excursions (4 minute period)

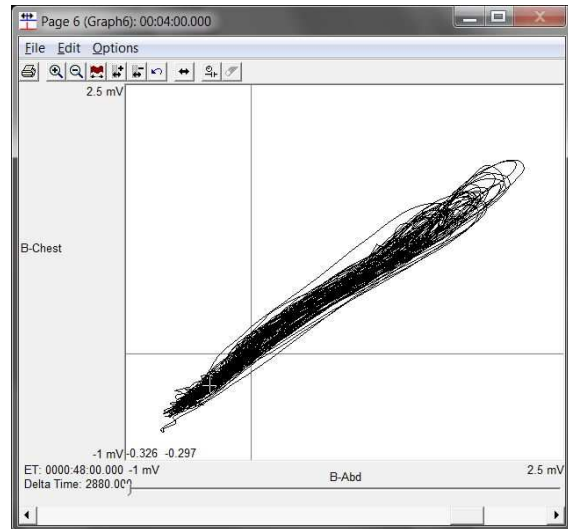


Figure 4 - Plot of Chest vs. Abdomen excursions (4 minute period)

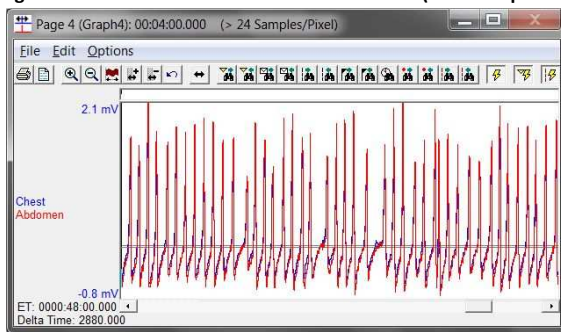


Figure 3 - Plot of above - Signals Overlaid

Example Data - Asynchrony

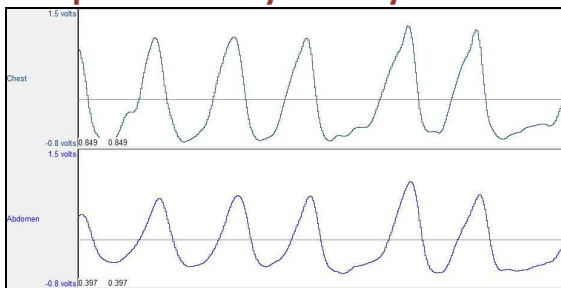


Figure 5 - Plot of Chest and Abdomen excursions (10 second period)

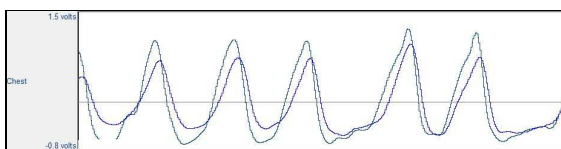


Figure 6 - Plot of above - Signals Overlaid

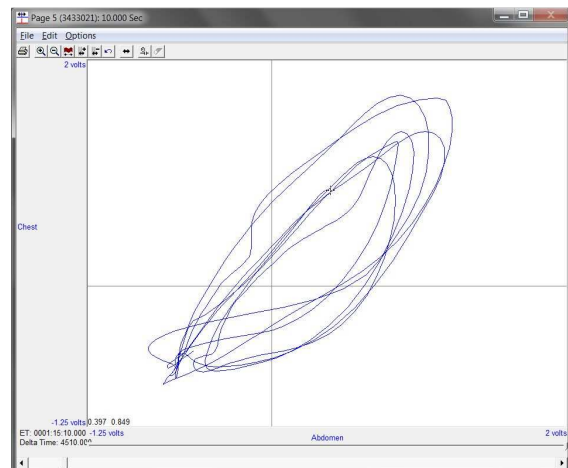


Figure 7 - Plot of Chest vs. Abdomen excursions (10 second period)

Example Data - Paradox

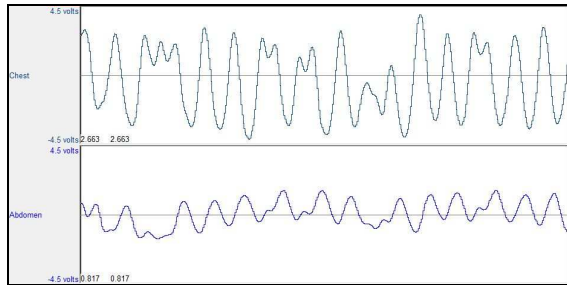


Figure 8 - Plot of Chest and Abdomen excursions (10 second period)

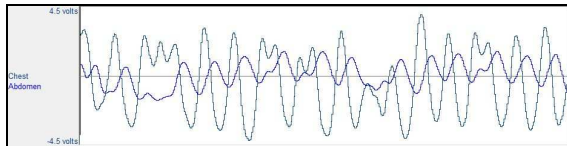


Figure 9 - Plot of above - Signals Overlaid

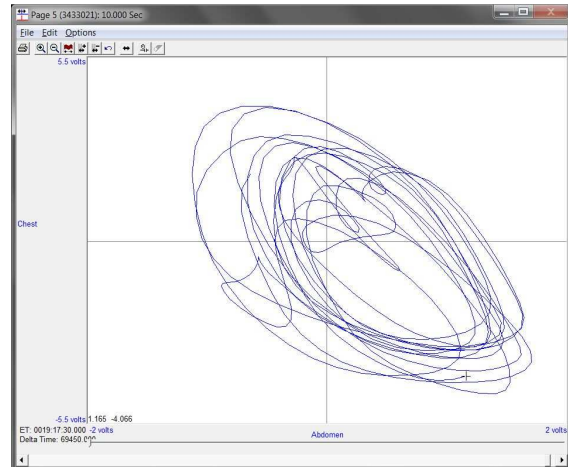


Figure 10 - Plot of Chest vs. Abdomen excursions (10 second period)

Cautions

- XY-Loop graphs will display all data. They do not hide any data marked as bad. As such, when motion artifact or other data marked as bad is present it will be displayed and may impact the ability to assess data using this graph unless caution is taken to define the time and span appropriately or to use parser segmentation to remove it from the data set.
- The Input signal presentation represents the belt excursions in millivolts as reported by the JET RIP Module in use. Since this module has a variable gain pot the millivolts signal from the chest module may not be scaled identically to the millivolts signal from the abdomen module. The JET RIP Calibration takes care of this when summing for volume and flow. Unfortunately, the current software cannot display individual chest and abdomen volumes for the XY-Loop analysis. As such, and since the axes do not represent the same scaling, the magnitude of the slope may be variable from setup to setup. Fortunately, the Konno and Mead conclusion relative to tight loops with positive slope for normal breathing, and open loops for asynchrony, and loops with negative slopes for paradox are still valid and the use of auto-scaling should still provide a good qualitative review.

Reference Information

JET RIP Calibration Equation

The equation for JET RIP Calibration is

$$V_{\text{Total}} = M * (k * V_{\text{chest}} + V_{\text{abdo}})$$

Where

V_{Total} - represents the scaled total volume signal from the chest and abdomen

V_{chest} - represents the raw input signal from the chest

V_{abdo} - represents the raw input signal from the abdomen

M - represents the fixed volume scaling factor between the total RIP volume and a reference source (such as a calibrated pneumotachograph or user specified tidal volume value).

k - represents the relationship of the volumes from the chest and abdomen.

Ponemah JET RIP Presentation Conventions

Ponemah defines the presentation of JET RIP waveforms and data based upon some unique conventions.

For example, when displaying the Chest Channel, the Volume and Flow Presentations actually display the Total Volume and Total Flow based upon the JET RIP Calibration equation. When displaying the Chest or Abdomen Channel, the Input Presentation displays the raw input signal for the individual channel. No other presentations should be used and it is not possible to display either the Chest or Abdomen Volume independently.

Additionally, with respect to derived data, the output from the Chest Channel represents the derived data for the Total Volume and Total Flow. Derived data on the abdomen channel should not be used.

The presentations and a description of the convention are documented in the below table.

Channel	Presentation	Description
RIP Chest	Flow	The derivative of the summed volume signal based upon the JET RIP Calibration equation and the defined M & K values
RIP Chest	Volume	Displays the summed volume signal based upon the JET RIP Calibration equation and the defined M & K values
RIP Chest	Input	Displays the raw input signal from the RIP module in millivolts
RIP Abdomen	Input	Displays the raw input signal from the RIP module in millivolts

Note: No other display presentation should be used!!!