Serial Number: _____
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INCAPACITANCE TESTER
INSTRUCTION MANUAL
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Table of Contents

1. Introduction **2**
1.1 Summary 2
1.2 System Overview 2
1.3 Principles of Operation 2

2. Hardware Setup **3**
2.1 Parts 3
2.2 Rear Panel Connections 3
2.3 Front Panel Controls and Menu 4
2.4 Animal Enclosure 5

3. Using the Incapacitance Tester **6**
3.1 Taking Measurements 6

4. Software Setup **7**
4.1 System Requirements 7
4.2 Installing the Incapacitance Tester Software 7
4.3 Preparing the Unit for Communication 8

5. Using the Software **9**
5.1 Software Orientation 9
5.2 Running an Experiment 13
5.2.1 Ad Hoc 13
5.2.2 Fixed Interactive 14
5.2.3 Fully Automatic 14
5.3 Handling Data 14

1. Introduction

1.1 Summary

Columbus Instruments' Incapacitance Tester (InCap) is a stand-alone device for the evaluation of hind-limb support in small laboratory animals. InCap precisely quantifies the force applied by each hind-limb. Once scored, InCap displays the measured force (in units of gram-force) for each limb. The information may be manually recorded or transmitted to an attached PC by serial communication link for use with the included software. InCap may be outfitted with holders for mice, rats, guinea pigs or (by way of special modification) rabbits.

1.2 System Overview

Figure 1 A complete InCap unit

InCap utilizes two precise force transducers onto which are placed the rear pads of the animal under test. A special animal restrainer is provided to promote the proper location of animal pads on the respective force transducers. Once the animal is placed, the user initiates a measurement cycle during which a number of force measurements are performed. At the conclusion of the measurement, the resulting data is displayed to a resolution of 0.01 gram-force. If connected to a PC by RS-232, InCap will transmit the numerical results and a data header containing user-defined information about the experiment and animal(s) under test. Thoughtful design of the user interface allows efficient operation of the measure-transmit sequence without the need for repeated user intervention.

1.3 Principles of Operation

Internal to InCap are two force transducers that have been sized in accordance with the species of application. Models manufactured for mice, rats and guinea pigs employ force sensors with a full scale of 1kg and provide a display readability of 0.01g. Models manufactured for rabbits may be equipped with 5kg or 10kg force sensors and provide a display readability of 0.1g. InCap employs several measurement algorithms that can be switched to meet the needs of the user.

2. Hardware Setup

2.1 Parts

A complete Incapacitance Tester comes with the following:

- Incapacitance Tester main unit
- AC Power Cable
- Footswitch
- RS232 Cable
- Animal Container
- Software Install Disc
- Instruction Manual

2.2 Rear Panel Connections

Figure 2 Rear panel of the InCap unit

Figure 2 shows the rear panel of an InCap unit. To begin setting up the unit for the first time:

1. Place the InCap unit on a flat, stable surface. Make sure the "Mains" switch on the front panel is in the off position.
2. Plug the AC Power Cable into the unit on the left and then into an outlet. The unit operates on any standard line voltage from 85 to 264 VAC.
3. If using the unit in conjunction with a PC, use the included RS232 cable to connect the unit to a PC. The RS232 port on the unit is labeled "RS232 – PC".
    a. If the PC does not have an RS232 port, install a Serial Interface Card in the PC or use a USB to RS232 Adapter.
    b. If an extension cable is required, make sure it is a "straight-through" cable and not a "null modem" cable.
4. *Optional* – Used for networking multiple InCap units together for multi-unit, single-computer software control. Contact Columbus Instruments for details and pricing.

2.3 Front Panel Controls and Menu

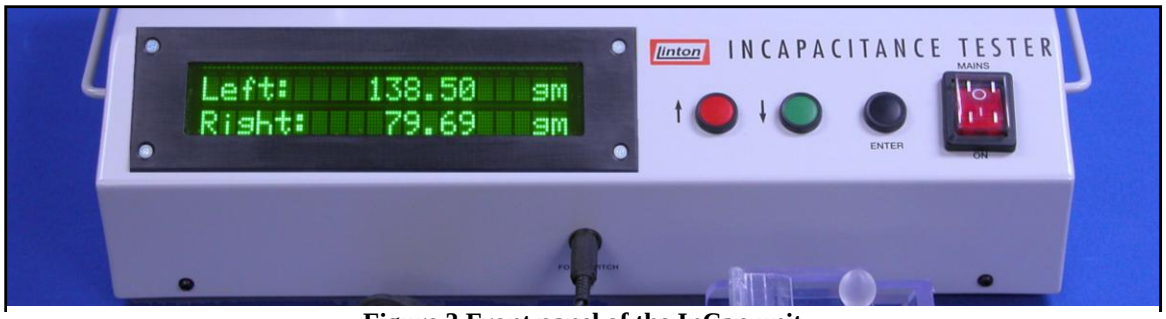


Figure 3 Front panel of the InCap unit

Figure 3 shows the front panel of an InCap unit. Each of the three colored buttons on the front panel serves numerous functions that depend on the unit's current menu. To finish setting up the unit:

1. Plug the included footswitch into the jack in the front of the unit.
2. Turn the unit on by pushing down on the switched labeled "Mains" on the right side of the panel. The unit will briefly display some calibration information followed briefly by "Incapacitance Tester v#.#". The screen will then move on to the main menu.

Use the Red (Up) and Green (Down) buttons to navigate the InCap's main menu. The Black (Enter) button selects the currently listed option. The following is a list of all menu options and functions.

- **Start Weighing** – Initiates a measurement with the unit's current settings.
- **Set Duration** – Allows the user to specify the amount of time (in seconds) the unit will sample the transducers for an Average measurement. The Up/Down buttons raise and lower the current value and Enter commits the new value to memory.
- **Calibrate** – Allows the user to calibrate the transducers with a known mass. By placing a single weight on each transducer one at a time, the use can adjust the gain on each transducer to ensure that an object will register the proper weight on each one. Calibration should be performed each day the unit is used.
- **Data Header** – Contains various menu options for sending data to a connected PC. More on this in Section 4.3 Preparing the Unit for Communication.
- **Send Data** – Used when connected to a PC to send the most recently acquired measurement to the InCap software.
- **Tare** – Used to tare (zero) the scales. This should be performed just before calibration and at least as often.

2.4 Animal Enclosure

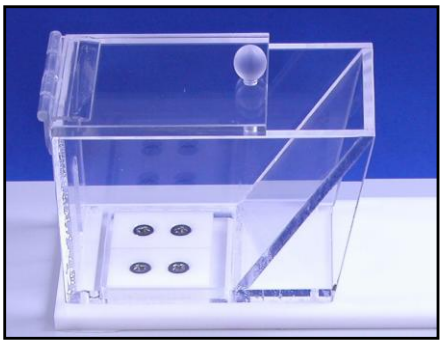


Figure 4 A mounted animal container

Figure 4 shows the correct placement of an animal container on the InCap unit. There are four pegs on the platform that slide into holes cut in the animal container. It will not snap when it is in place, but it will restrict side-to-side movement. It is recommended to place the animal in the container through the bottom before mounting it to make the process easier.

3. Using the Incapacitance Tester

3.1 Taking Measurements

Measurements can be made with the Incapacitance Tester with or without the aid of a PC. This section covers taking measurements with no PC connected to the InCap unit. To take a measurement:

1. If you haven't already, tare and calibrate the unit.
    a. To tare the unit, remove all objects from both pads. Select "Tare" from the unit's menu. Press the Green button to reset the transducers' offsets back to zero. Press the Enter button when finished.
    b. To calibrate the unit, select "Calibrate" from the unit's menu. Place a known mass on the left pad and use the arrow buttons to adjust the displayed value to match its actual mass. Press the Enter button when finished and repeat for the right pad.
2. Navigate to the "Set Duration" option in the unit's menu and press the Enter button.
3. Use the Up and Down buttons to select the desirable measurement duration. Press Enter when finished.
4. Load the animal into the animal container through the opening in its bottom.
5. Place the container on the InCap unit by placing the platform pegs through the holes on the container. In some cases, it may be necessary to manually keep the container's lid closed either by-hand or with some other mass.
6. At this point, there are two different ways to initiate a measurement:
    a. Navigate the menu to the "Start Weighing" option. Press the Enter button to start the measurement.
    b. From any menu, press the Footswitch.
7. At the conclusion of the measurement, the measured values for the subject's left and rear limb pressure will be displayed on the screen in grams.
8. From here, pressing the footswitch or any button will return you to the Main Menu.
9. The unit is ready to make additional measurements.

4. Software Setup

4.1 System Requirements

- PC using an up-to-date version of Microsoft Windows 2000/XP/Vista
  - Must have .NET Framework 2.0+ installed
  - Must have Windows Installer 2.0+ installed
- At least 10MB free hard disk space for software installation
- At least 128MB of RAM
- CD-ROM Drive
- One open RS232 Serial Port *or* one open USB Port and one USB to Serial Adapter
- Serial Cable
- At least one InCap unit using firmware Version 5.5C or greater

4.2 Installing the Incapacitance Tester Software

All Columbus Instruments Incapacitance Testers come with software that can be used to perform and log measurements with the InCap unit. Before attempting to install, make sure that currently logged in user account has installation permissions. To install the software:

1. Place the included Install Disc into the PC's CD-ROM Drive
2. The Installer should run automatically, but in the case that it does not:
   a. Click "Start >> Run" to open the Run dialog window.
   b. Click "Browse" and navigate to the PC's CD-ROM Drive.
   c. Select "setup.exe" and click "OK".
   d. Click "OK" to run the Installer.
3. If your PC does not have the .NET 2.0 Framework or Windows Installer installed, you should be prompted to install them at this time. After their installation, you may be asked to restart the PC. Once restarted, repeat steps 1 and 2 to return to the Installer.
   a. In the event that the included installers for the required Windows components fail, run Microsoft Windows Update and install all recommended updates.

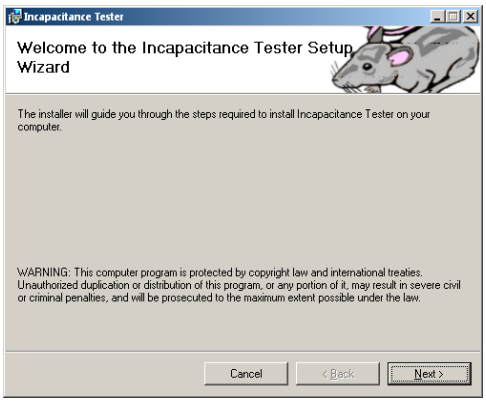


Figure 5 Installer window

4. The first screen for the Installer will look like that of Figure 5. Click "Next" to proceed.

5. By default, the Incapacitance Tester software is installed in “C:\Program Files\Columbus Instruments\Incapacitance Tester”, but can be changed at this time. After selecting the installation directory, click “Next” to proceed.
6. The installation is ready to proceed, click “Next” to install the software.
7. After a few seconds, the installation will conclude. The Installer’s header will read “Installation Complete”. Click “Close” to complete the installation.

4.3 Preparing the Unit for Communication

When using an Incapacitance Tester with a PC, the unit needs to be given an address for the software to communicate with it. For systems with multiple Incapacitance Testers, each unit needs a unique address in order to communicate with the PC. To set the unit’s address:

1. Navigate the unit’s menu to “Data Header” and press Enter.
2. The menu will read “Unit ID”. Use the Up and Down buttons to change the unit’s address. Press Enter to commit that address to memory.
3. Continue pressing Enter through the other menu options (“Exp ID”, “Animal ID”, and “Experiment Time”) until you reach the “Send Header with Data?” option.
4. If it is not already, use the Up and Down buttons to set this option to “Yes”. This option is required in order to use the unit with a PC. Press enter to commit this change.
5. If using multiple units, repeat these steps for each unit making sure to give them each a different address. Label the units with their addresses for the sake of clarity.
6. The system is now prepared to work with a PC.

5. Using the Software

5.1 Software Orientation

After installation, a shortcut to the Incapacitance Tester software is placed in the Start Menu in the "Columbus Instruments" folder. Click this icon to load the Incapacitance Tester software.

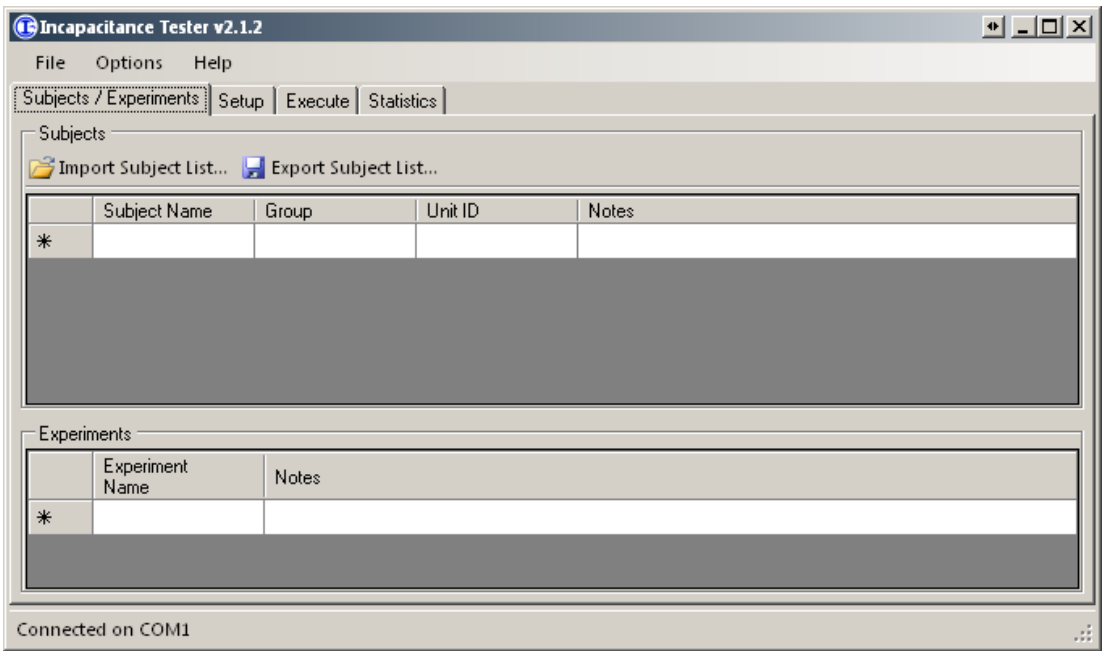


Figure 6 Incapacitance Tester software main window

Error! Reference source not found. shows the software as it looks when first loaded. The following is a breakdown of the software's menus:

- **File**
  - **New** – Creates a new Incapacitance Tester Data File (*.IDF) with no subjects, experiments or data.
  - **Open** – Opens an existing InCap Data File.
  - **Save** – Saves the current InCap Data File. After a file has been saved, new measurements will automatically be saved as they are acquired.
  - **Export Data** – Saves all measurement from the current file to one of the following spreadsheet formats:
    - Comma Separated Values (*.CSV)
    - Semicolon Separated Values (*.TXT)
    - Tab Separated Values (*.TXT)
  - **Export Raw** – Saves all samples from the current file to the selected location and format.
  - **Export Statistics** – Saves the statistics table to the selected location and format.
  - **Exit** – Quits the application.

- **Options**
    - **Serial Port** – Allows the user to select the Serial Port to use when communicating to InCap units.
- **Help**
    - **Manual** – Opens this instruction manual.
    - **About** – Displays the software's About dialog.

The status bar on the bottom of the window is used to display system information while communicating with InCap units. Each time an experiment setting is altered, all listed units are updated and the results of those updates are displayed here.

Tabs are used to separate the programs functions into four groups: Subject / Experiments, Setup, Execute and Statistics. The "Subjects / Experiments" tab (shown in **Error! Reference source not found.**) is first displayed when the program loads and allows the user to create the subject and experiment lists for the current data file. For each subject, the user can specify a unique identifier, a group and any comments about that subject that might need recorded.

Each subject also has a field labeled "Unit ID" which specifies the unit address that subject will be tested with. This field is required. When the user leaves this tab, the software will attempt to connect to each InCap unit listed in the Subjects table.

The software can reuse subject lists through multiple experiments by loading them from plain text files. Clicking the "Import Subject List" box allows the user to select a saved subject list from the computer to use.

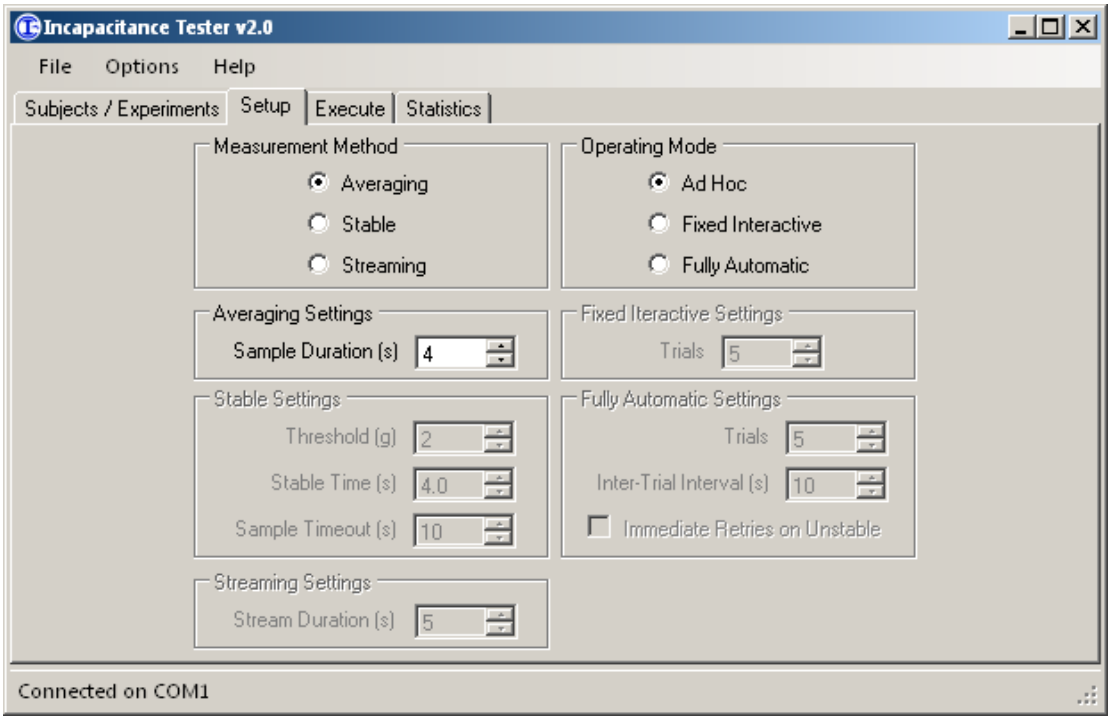


Figure 7 The Setup tab

The "Setup" tab (shown above in Figure 7) is used to configure the InCap unit's various acquisition settings. The user can select one of these Measurement Methods:

- **Averaging –** This method uses an averaging algorithm that minimizes influence of vertical motion artifact in the displayed values. Following the initiation of a measurement, InCap samples the transducers at a rate of 4Hz and averages the results over the period specified in "Sample Duration".
- **Stable** – This method is useful for subjects that do not remain motionless during the measurement process. The InCap will continuously sample the transducers until the readings remain within "Threshold" number of grams specified for the amount of time specified in "Stable Time". If the animal remains too active to meet the parameters for the time specified in "Sample Timeout", the measurement will be flagged as "Unstable" and not recorded.
- **Streaming** – When a measurement is initiated, the InCap will stream samples to the unit's Serial Port at a rate of 20Hz for the specified amount of time. This method is useful in situations where the user wishes to employ a measurement algorithm after acquisition. Streaming can only be performed "Ad Hoc" and is not available under the other two operating modes.

On the right, the user can select one of three Operating Modes:

- **Ad Hoc** – All measurements are user-initiated. Measurements can be started at the unit itself or through the software, but will only be started by the user.
- **Fixed Interactive** – The user specifies the number of trials for each subject and the user initiates those measurements. They can be initiated either through the software or the unit itself. The software will alert the user when a subject has completed its course of trials and inform the user of which subject to use next.
- **Fully Automatic** – The user specifies the number of trials and an "Inter-Trial Interval" to delay in between measurements. The software initiates and records all measurements; the user should not press buttons on the unit while the experiment is running. The only action the user needs to perform is the loading of each subject into the unit.
    - While using the "Stable" measurement method with this mode, the user can specify how the system handles "Unstable" measurements. By checking "Immediate Retries on Unstable", the software will automatically start a new measurement when the animal fails to remain still enough to take a measurement. When unchecked, the software will wait for an interval before trying again.

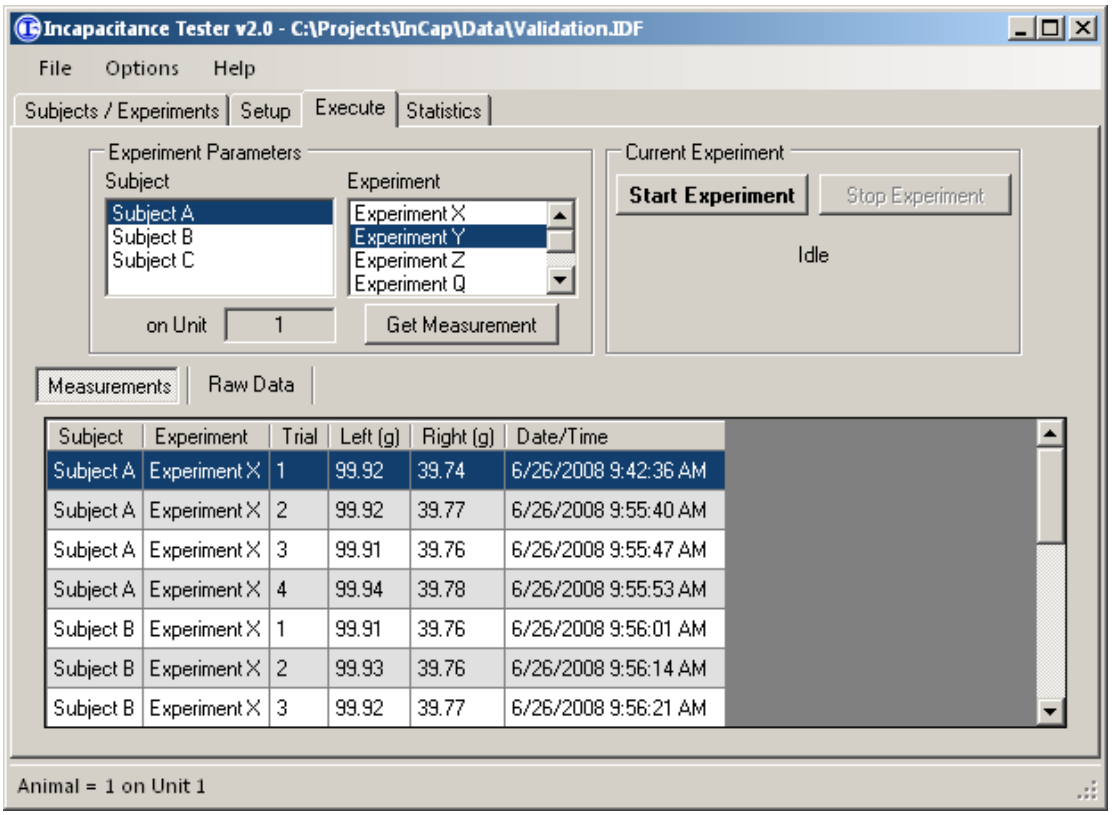
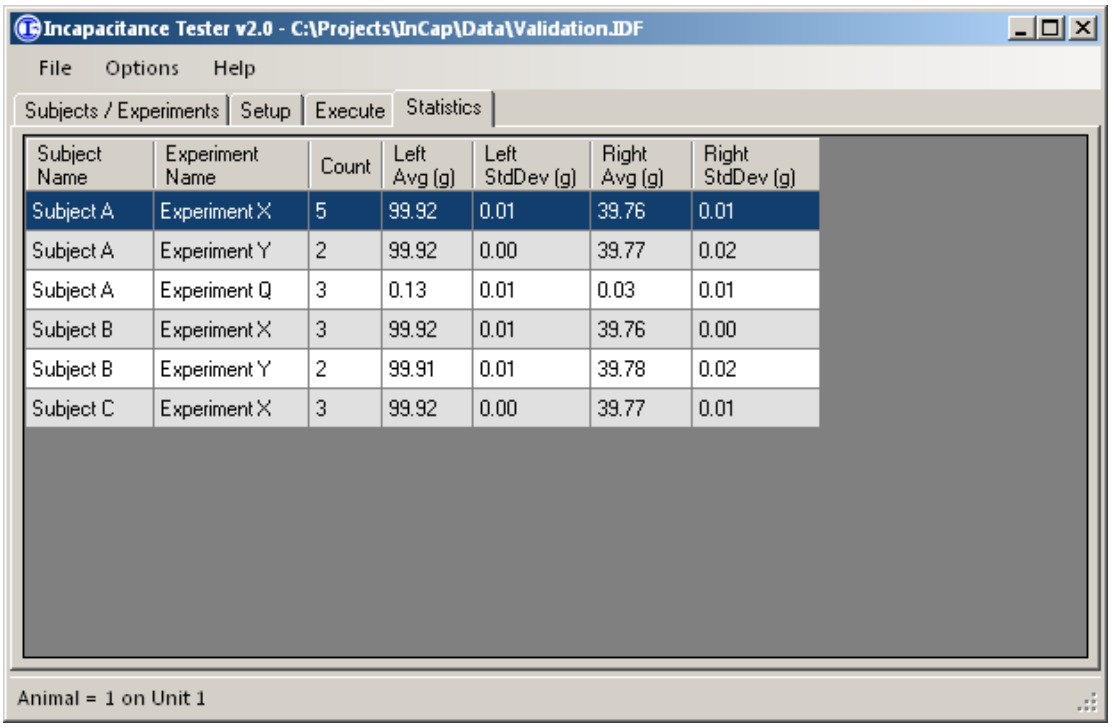


Figure 8 The Execute tab

The "Execute" tab (show above in Figure 8) is used to start measurements and experiments as well as display acquired data. When an experiment is not running or the software is setup to take measurements "Ad Hoc", the user can specify the current subject and experiment before taking a measurement.

Software managed experiment are started from the "Current Experiment" box in the upper-right corner.

The table in the bottom of the window can display either calculated measurements or samples from streamed measurements. Clicking "Measurements" shows all measurements with the "Averaging" and "Stable" modes, while "Raw Data" displays samples taken with "Streaming".



Subject Name	Experiment Name	Count	Left Avg (g)	Left StdDev (g)	Right Avg (g)	Right StdDev (g)
Subject A	Experiment X	5	99.92	0.01	39.76	0.01
Subject A	Experiment Y	2	99.92	0.00	39.77	0.02
Subject A	Experiment Q	3	0.13	0.01	0.03	0.01
Subject B	Experiment X	3	99.92	0.01	39.76	0.00
Subject B	Experiment Y	2	99.91	0.01	39.78	0.02
Subject C	Experiment X	3	99.92	0.00	39.77	0.01

Figure 9 The Statistics tab

The "Statistics" tab (shown above in Figure 9) displays simple statistics about measurements taken for this data file. Samples taken in "Streaming" are not included in these calculations. The "StdDev" (Standard Deviation) for each collection of samples is calculated as follows:

$$\sigma = \sqrt{\frac{1}{N} * \sum_{i=1}^{N} (x_i - \bar{x})^2}$$

5.2 Running an Experiment

After adding all applicable subjects and experiments to the current data file, it's advisable to save before continuing. Since a data file can contain measurements acquired with any number of unique settings, the settings themselves are not saved in the data file. It's good practice to record experiment parameters in the "Notes" section in the experiments list on the "Subjects / Experiments" tab.

The "Settings" tab contains all of the settings needed to run each experiment type. When preparing to run an experiment, make sure any and all InCap units are connected and powered on before choosing your settings to ensure the units are being set up properly.

5.2.1 Ad Hoc

Ad Hoc experiments are easy to perform in that after setting up the subjects and experiment lists, little else is required in order to ensure proper data acquisition. Before beginning the actual experiment, navigate the software to the "Execute" tab. Be sure to select the proper subject and experiment from the lists when starting an experiment or switching subjects. The unit will only know what subject and experiment combination is being used when it is selected from the lists. The "on Unit" box displays the InCap unit address that the selected subject belongs to.

When using the software, there a few different ways to initiate measurements. If using the "Get Measurement" button on the "Execute" tab, results from the measurement are saved into the

data table immediately. Measurements taken at the unit either from the Footswitch or the Enter button are subject to user-review before being recorded. After a measurement is taken from the unit, the results are displayed on the unit's screen. At this point, pressing the Red button will invalidate the measurement and it will not be recorded by the PC. Pressing the Footswitch, Green or Enter buttons will send the results to the software to be recorded. Any button press will send the unit back to the main menu. These rules for user-review are the same for Ad Hoc and Fixed Interactive measurements initiated at the unit.

5.2.2 Fixed Interactive

To start a Fixed Interactive experiment, select the desired number of trials on the "Setup" tab before proceeding to the "Execute" tab. Select the experiment name with which to tag the measurements and click the "Start Experiment" button. The following dialog box will appear:

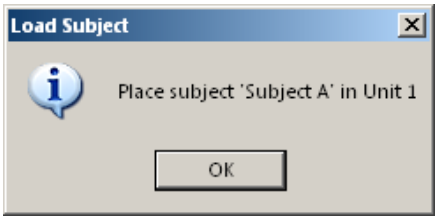


Figure 10 Load Subject dialog

The software will always request subjects in the order they appear in the subject list. Each time an experiment starts or a subject finishes, a dialog box (shown in Figure 10) will appear and an audible warning will play to alert the user to load the next subject in the roster. For Fixed Interactive experiments, a measurement will begin immediately after clicking "OK". The trial currently being recorded will appear in the "Current Experiment" box as well as the total number of trials to run for each subject.

When the last trial for the last subject is over, a message box indicating the experiment is over will appear. The experiment can also be cancelled at any time by clicking the "Stop Experiment" button.

5.2.3 Fully Automatic

To start a Fully Automatic experiment, select the desired number of trials and the Inter-Trial Interval on the "Setup" tab before proceeding to the "Execute" tab. As with the Fixed Interactive mode, select the experiment name with which to tag measurements and click the "Start Measurement" button. The first measurement will begin immediately after clicking "OK". **Do not initiate measurements or press any other buttons on the unit while an automatic experiment is running**. The amount of time left in the Inter-Trial Interval will be displayed under the trial count in the "Current Experiment" box while the experiment is running. The same message box pictured in Figure 10 will appear each time a subject completes their trials and it is time to move on to the next subject.

5.3 Handling Data

Data files can be opened and appended to several times. At the completion of a study, it might become necessary to export acquired data to another program for analysis. All of the three different data tables can be exported to a spreadsheet friendly format. The export options in the file menu can generate files that can be read by such spreadsheet programs as Microsoft Excel. Comma Separated Values files can be read by Excel immediately, but Semicolon or Tab

Separated Values files need to be imported by Excel with special options. To open these files in Excel:

1. Open Microsoft Excel.
2. Click “File >> Open”.
3. Select the exported data file. These other formats will have a .TXT extension.
4. Excel will open the “Text Import Wizard”.
5. Select “Delimited” under “Original Data Type” and leave “Start import at row” equal to 1. Click “Next” to proceed.
6. Under “Delimiters”, select the delimiter that was used for the file (comma, semicolon or tab). Click “Next”.
7. Preview the data to make sure it’s tabulated properly and then click “Finish”.
8. Selected table should now be imported as a spreadsheet in Excel.