I Measure U

Getting Started Guide

IMU Research

Contents

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1 Introducing the Sensor

The IMU Sensor is a lightweight versatile inertial measurement unit that records precise movements in nine axes. You can store the data on board, or wirelessly transmit it to a mobile device.

The motion is captured with three different internal sensors:

1. *Accelerometer* 3-Axis full scale range of ±16g, at a 16bit resolution.

2. *Gyroscope* 3-Axis full scale range of ±2000°/sec, at a 16bit resolution.

3. *Magnetometer* 3-Axis full scale range of ±1200 µT, at a 13bit resolution.

The sampling frequency is selectable from 100Hz to 1000Hz. For more information on the sensor ask us for the Specification Sheet, and to begin capturing data see Starting a new capture.

2 IMU Research Mobile App

The IMU Research app is an application that is used to initialize and configure the IMU sensor, and allows us to time-synchronisation recorded data. It is compatible with Apple iOS devices running iOS 9.0 and greater. Some devices such as the iPad and iPad Pro are currently facing issues connecting to multiple IMU Sensors - please let us know if you encounter any issues.

2.1 Installation on iOS

The IMU Research App is downloadable from the iOS App Store. Simply search "IMU Research" or "IMeasureU" in the App Store on your device, select the **"IMU Research"** app and tap **"Get"**.

IMU Research

Measure. Motion. Anywhere.

OPEN

☆☆☆☆☆   4+
Not Enough Ratings   Age
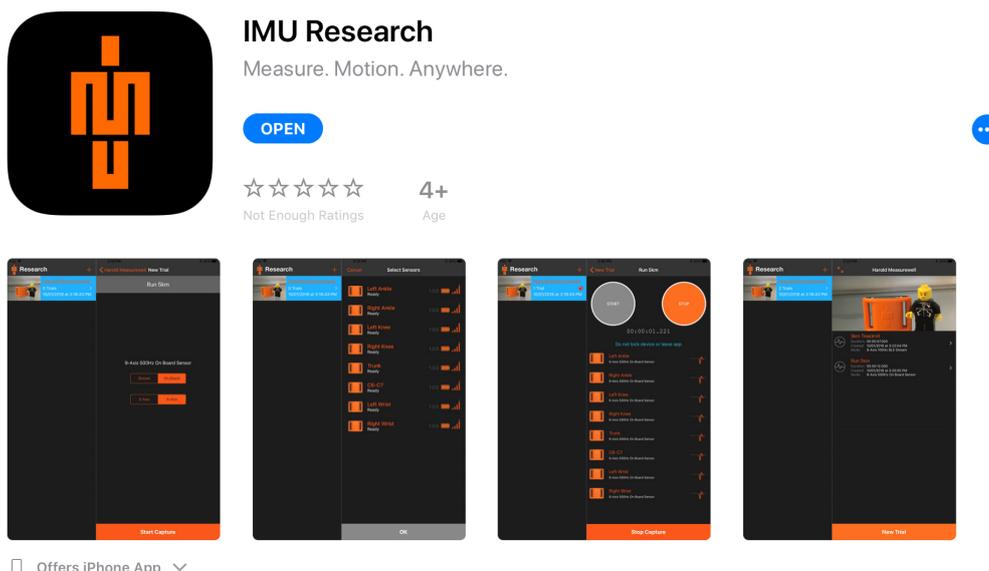
IMU Research captures inertial measurement data from IMU Sensors in a single application. It enables precise, multi-limb, field-based biomechanics data capture via, small, synchronized, high-frequency inertial sensors.

Offers iPhone App

Developer
I Measure U

If you have previously downloaded IMU Research using TestFlight, all of your previous sessions will be retained after downloading from the App Store.

> ### *Note*
>
> All TestFlight versions of the IMU Research will be deprecated after March 15, 2018. IMU Research will only be available on the App Store from then.

3   Lightning Desktop App

IMU Lightning is a desktop app that is compatible with Windows and OSX. It is used to download stored data from up to 2 sensors concurrently, and export it as Comma separated variable (CSV) files.

> ### *Note*
>
> From 3.0.0 we no longer support Windows 32bit machines. If you have a 32bit machine, let us know and we can make available older versions of Lightning for your continued use.

3.1   Drivers

Firstly, please download and install drivers for the sensor from SiliconLabs (see below for link). Select the appropriate version for your system, download the VCP drivers and follow the on-screen instructions.

> ### *Note*
>
> You may be required to reboot your machine after installing the drivers.

Driver link: https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

3.2   Windows

Install Lightning for windows by running the **Lightning x.x.x.exe** installer. This will install Lightning into your program files directory, and add an entry into the start menu. After installation, you can launch lightning from the start menu.

3.3   OSX

Open the **Lightning x.x.x.dmg** archive, and drag Lightning.app into the Applications folder. To launch Lightning, you should now be able to find it in Spotlight, or click on the Lightning icon in Launchpad.

You will have to allow Lightning to be run in your security preferences. The is because OSX has a security measure called Gatekeeper. You can find more information about Gatekeeper here https://support.apple.com/en-nz/HT202491.

The first time launching lightning, you need to:

1. In Finder, Control-click or right click the Lightning icon (cont)...
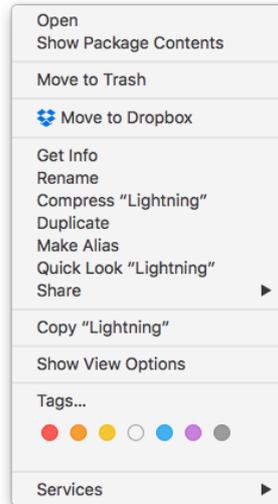
2. Select Open from the context menu that appears.

3. Click Open in the dialog box. If prompted, enter an administrator name and password.

4 Collecting data

When collecting data you have two different collection methods: Stream, and On Board.

> **Note**
>
> Please DO NOT exit the iOS app by pushing the home button and sending the app into the background. Doing this may result in a lost connection with the sensor for the remainder of the trial, which will affect time-synchronising.
>
> You may lock your device when collecting data as long as you don't navigate away from the application, but please note that streaming data or time-synchronisation information will be NOT be collected while it is locked. You will be able to manually reconnect to sensors after unlocking the device.

> **Note**
>
> Please ensure that any other Bluetooth devices are disconnected from the device before logging. E.g. fitness devices (Fitbit, Apple Watch etc), Bluetooth speakers or headphones, wireless keyboards or other Bluetooth devices.
>
> This can affect reliable transmission from the sensor to the device compromising data.

4.1 Stream

The *Stream* method is when sampling data is streamed from the sensor to your iOS device as soon as it is captured via Bluetooth. This grants you immediate access to the data in the form of a CSV file that can be exported from the app. However, the iOS device must be in range to the sensor while collecting data. If the distance between the sensor and iOS device becomes too great, or there are objects in the way, then the connection to a sensor may temporarily be lost. All data streamed by a disconnected sensor will not be stored on your iOS device (Bluetooth packet loss). Once the sensor comes back in range, and reconnects, the streamed data will be recorded.

This makes Stream ideal for a laboratory or classroom setup where the sensor and iOS device are in near proximity, or when instant information on measured motion is required. Up to four sensors can simultaneously stream data with one capture session per iOS device. The time vectors from all four sensors will be synchronised.

4.2 On Board

The *On Board* method stores the data on the sensor's internal memory, and does not have the same proximity restrictions as the Stream method. You can also sample at a higher frequency with this method.

Once the logging has started, the sensor will start relaying time-synchronisation information to the app on your iOS device. The longer it is in range of the iOS device, the more time-synchronisation information the app will gather (more time-synchronisation information means a more robust synchronisation). The sensor can move out of range of the app and travel freely around while still capturing data. When the sensor returns in range of the iOS device, the sensor will reconnect to your iOS device and resume relaying time-synchronisation information to the app.

To retrieve the data from the sensor, you need to connect it via USB to a PC or Mac computer and download the data with the Lightning Desktop App.

This makes logging perfect for scenarios where a higher sampling frequency is required, or the sensor will travel a significant distance from the iOS device.

Up to **8 sensors** can simultaneously connect to one iOS device, across a maximum of **2 trials**. When the data from each sensor is downloaded via Lightning Desktop App, stored synchronization data exported from the app is required to time synchronise the sensors.

> *Note*
>
> There is a known issue with some iOS devices where you cannot log with more than 6-7 sensors. Please let us know if you face this issue.

4.3 Starting a new capture

Open the IMU Research Mobile App, and create a new session by tapping the '+' icon in the top bar.
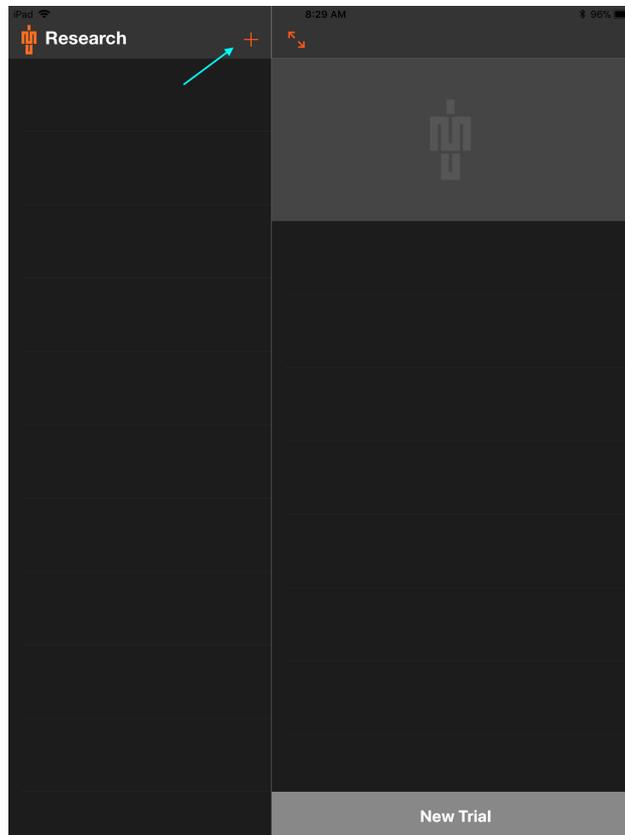
Name the session something memorable, as you can export the entire session as a .zip file. Additionally, we recommend you take a photo to make it easier to find the session when there are many in the list. When finished, tap **Done**.
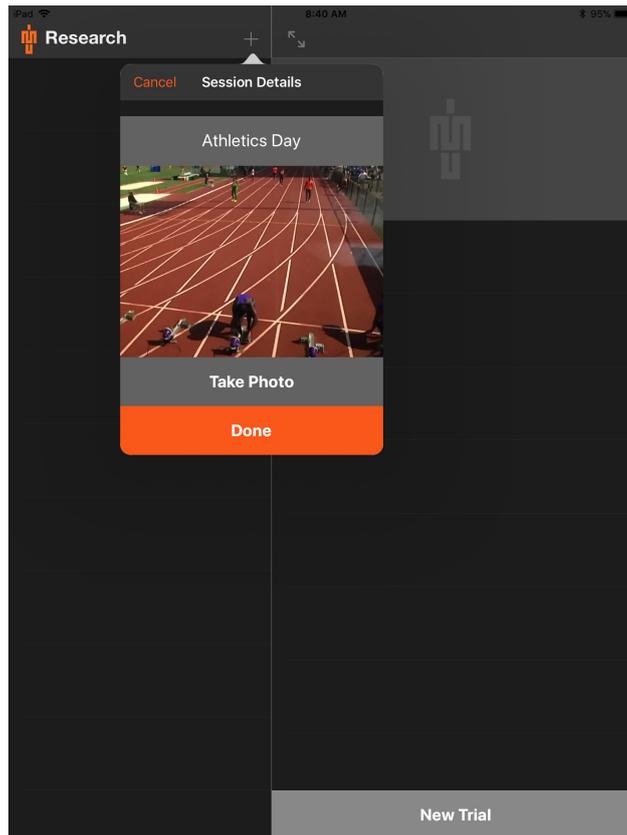
4.3.1   Example 100m Sprint Training (On Board)

Tap on the newly created session, and select **New Trial**
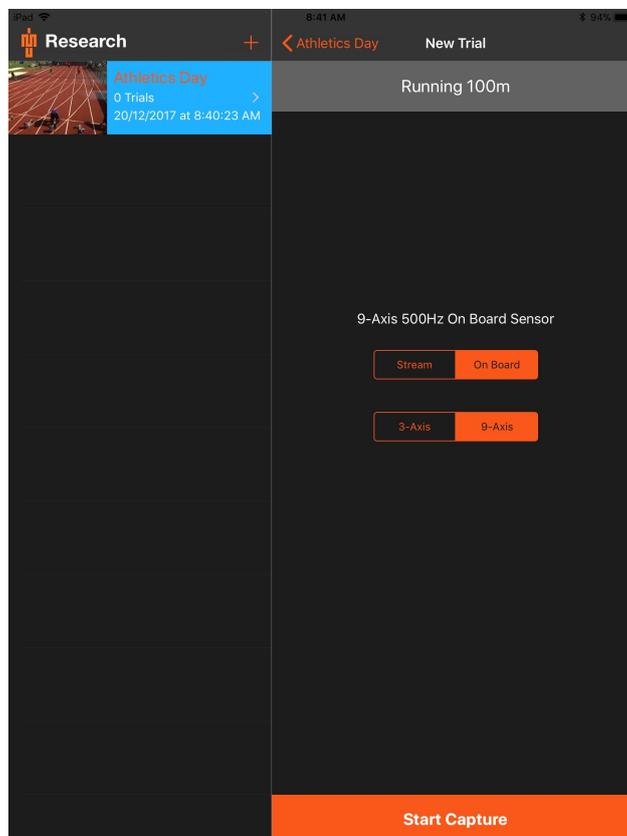
You need to enter a unique name for each trial. This name will be part of the exported file names, so you can identify the exported data.

Select the appropriate logging method (Stream or On Board), along with the number of axes and sampling speed. *3-Axis* only uses the accelerometer, *9-Axis* uses the accelerometer, gyroscope and magnetometer.

In this example, the *On Board* method is used, where time-synchronisation information gets sent back to the iPad.

The screen below will appear for you to select the sensors to be used in this trial.
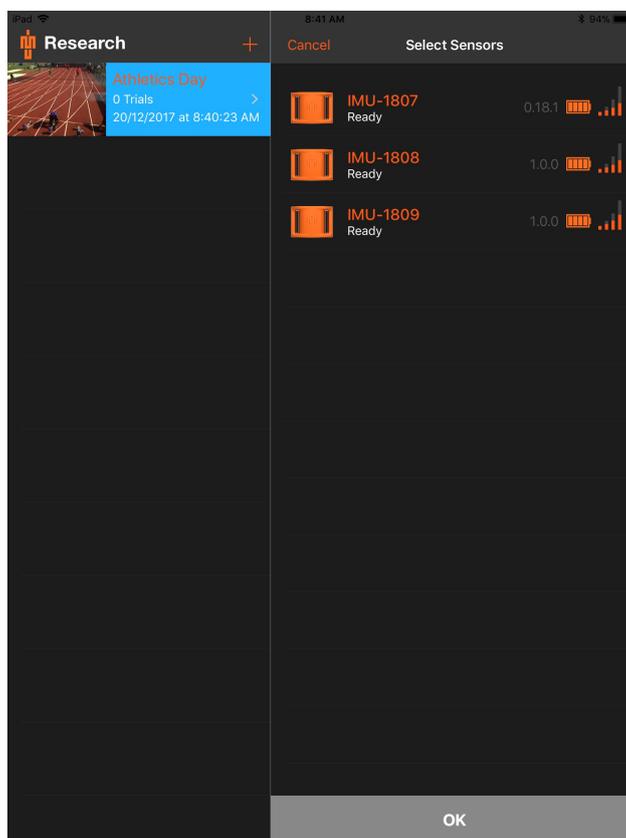
The signal bars () show the signal strength of the sensor, and will be full if the sensor is very close. This can be used to identify sensors when many are discovered.

If the sensor version is not compatible it will appear in red, and the app will prompt you to update the sensor if selected. Contact IMU on how to update the sensor for your device.

Enter a unique name for each sensor. These names will be included in the outputted Comma separated variable (CSV) files. Use them to identify the trial, subject/person, or sensor position on the body.
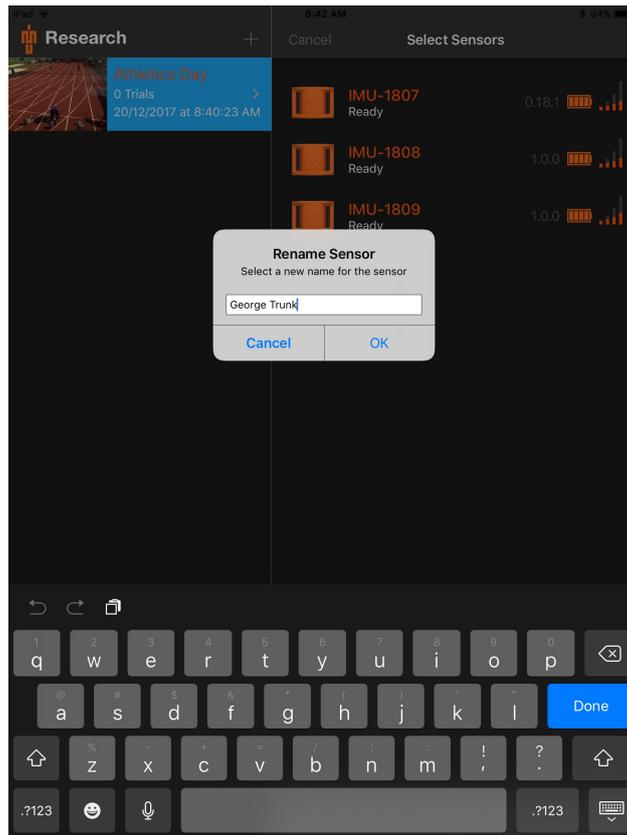
If you need to rename a sensor, simply swipe it left, and tap **Rename**
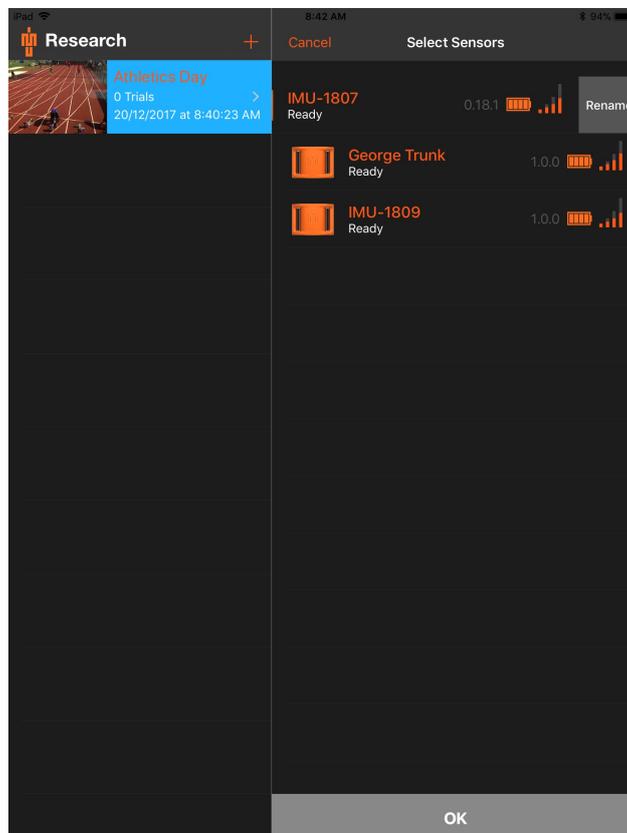
Once one or more non-unique sensors have been selected, you can tap **OK** to begin the logging.
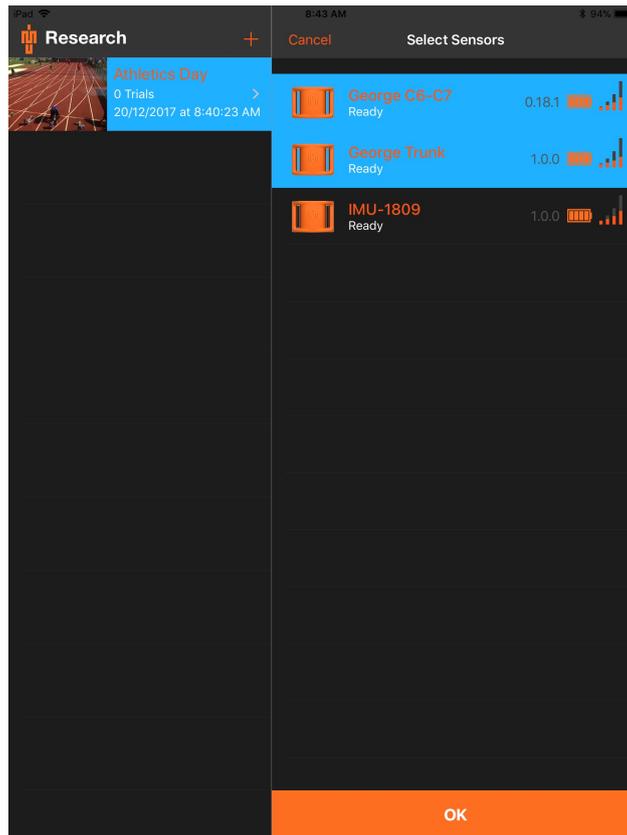
It will take a few seconds to configure the sensors, if it takes longer than 60 seconds, then tap the screen to cancel and try again.
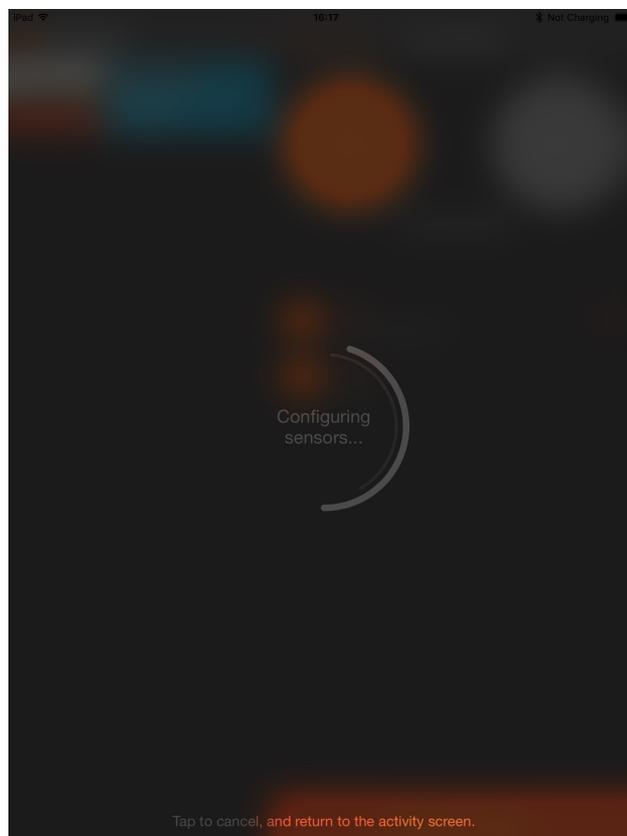
The sensors are now logging to the internal memory, and can move outside the iPad's range if need be. If you are using On Board mode, make sure you wait about 30 seconds before the sensors get out of range.

If at any time the sensors comes back in range, the iPad will find and reconnect to the sensor to update the time-synchronisation information. Use the Start/Stop buttons to create event epochs in the time-synchronisation data during logging.

> **Note**
>
> If you are running multiple trials, the start/stop event epochs will appear in **all trial time-synchronisation files**.
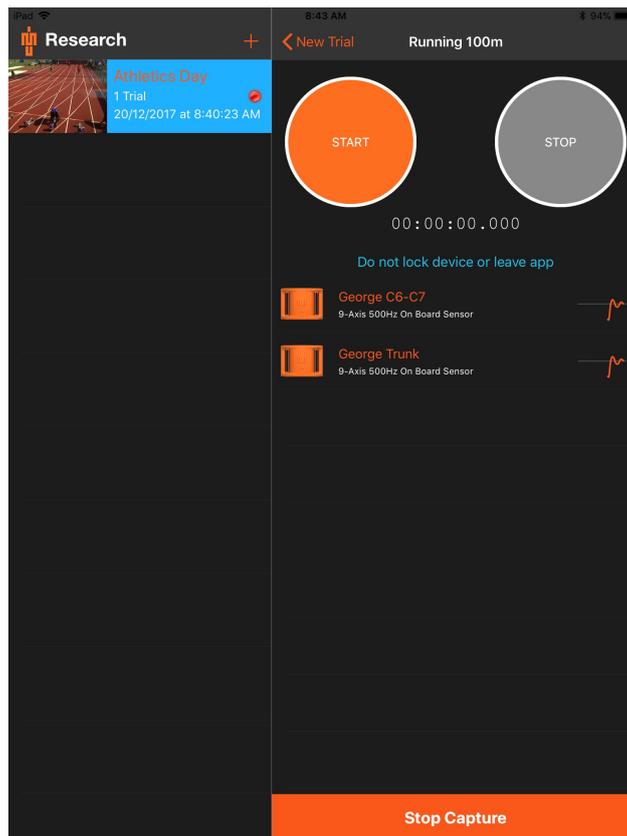
When a trial is running, a red "recording" icon will appear next to it in the sessions pane (as below). This helps you quickly identify which trials are active. You can have up to **2** *On board* trials running simultaneously with up to a total of 8 sensors, allowing greater control for stopping/starting when you are measuring multiple subjects.
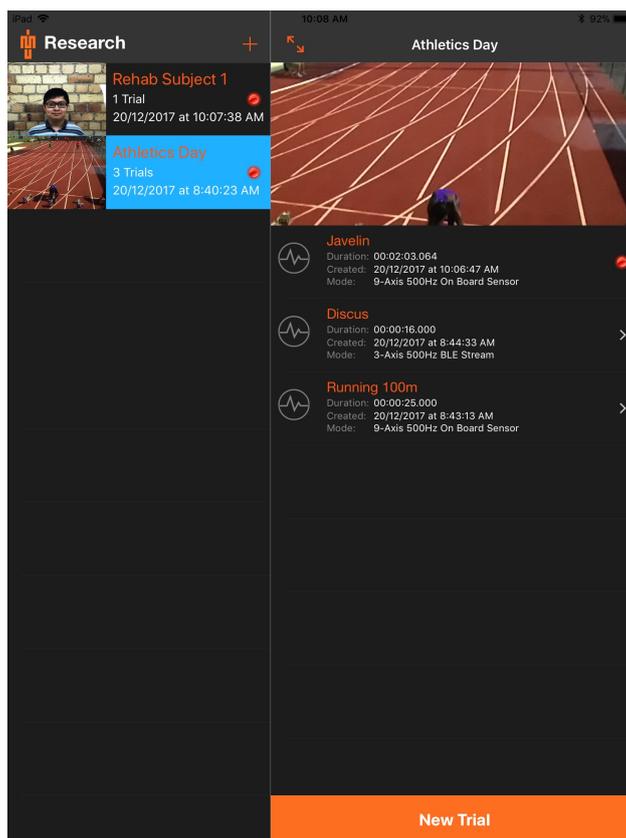
Once you have finished your session, you can finish the logging. Make sure the sensors are connected to the iPad before ending. Press **Finish Capture**. You are given two options; continue logging, or stop logging the sensors so you can export the synchronisation information.
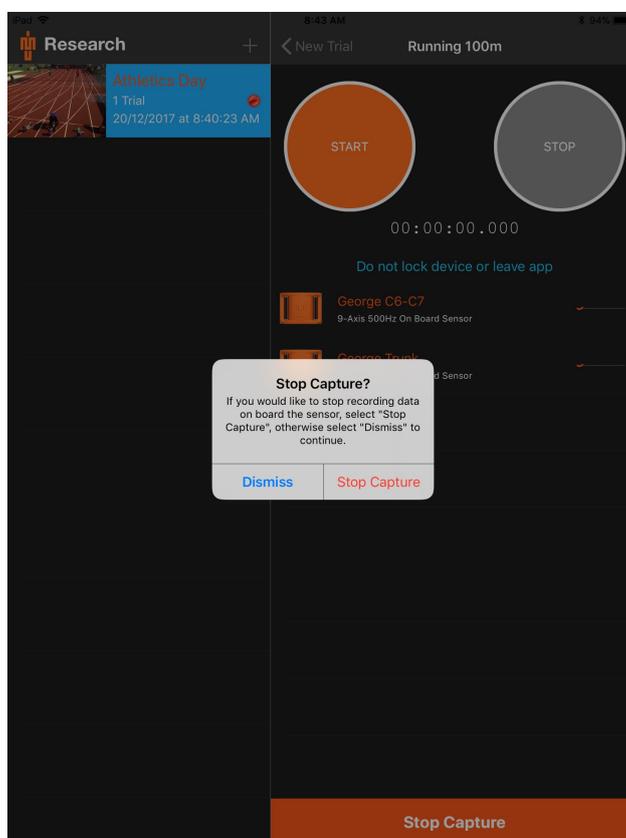
4.3.2 Example Discus (Stream)

Create a new trial with the **New Trial** button, but this time select Stream. This way the data will be streamed directly to the iPad. Press **Start Capture** You can only have **1** streaming trial at one time.
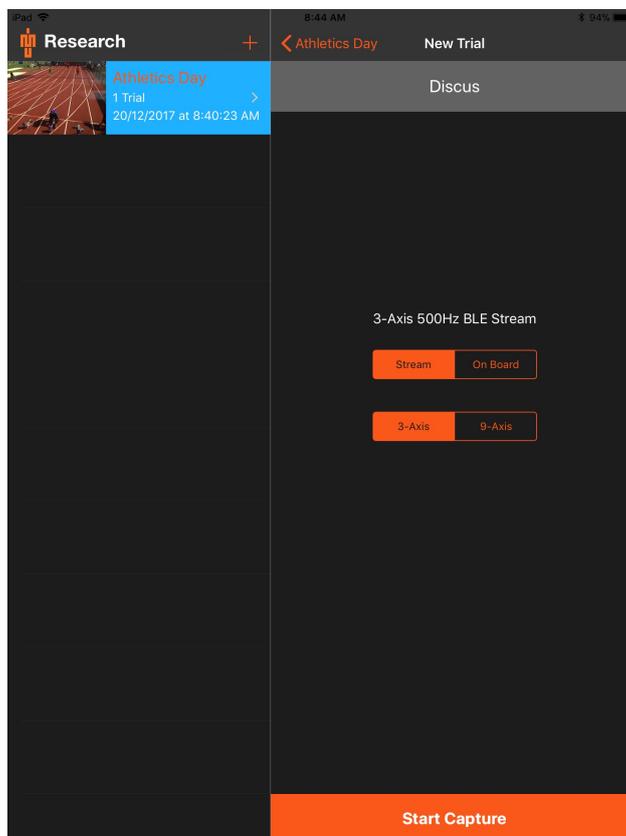
After selecting sensors just like in the Example 100m Sprint Training (On Board), you will see the stream logging screen.
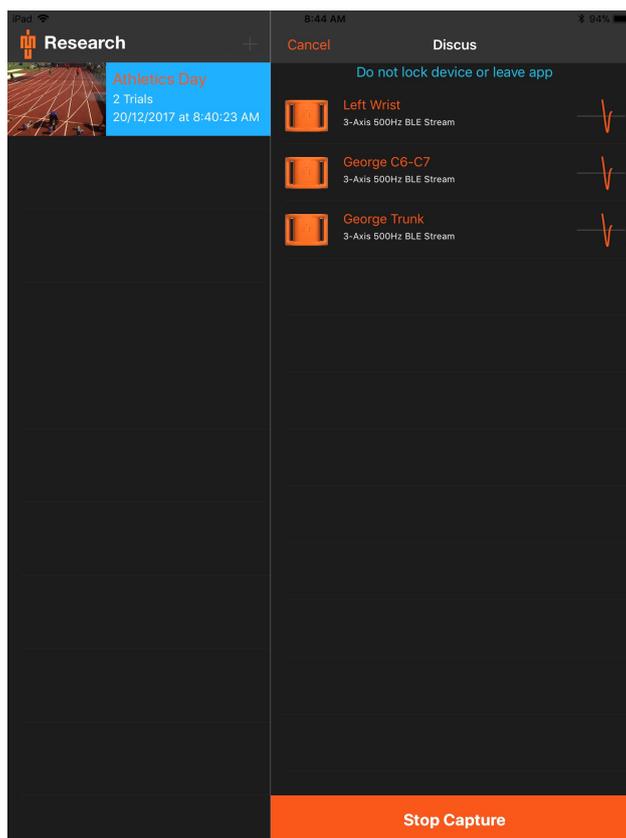
While this screen is open, data will be collected and saved to the iPad. If you need to reconnect to any device for any reason, just tap the device name.

4.4   Exporting Data

4.4.1   Exporting Data/Sync Files via the App

To export the data from an trial, swipe the trial to the left to reveal **Export** and **Delete** buttons.

> ### Note
>
> Exporting data from a Streamed trial will export the raw inertial data, and exporting data from an On Board trial will export the time-synchronization data.

The exported time-synchronization file is used in the Lightning Desktop App to time synchronize On Board data sets.

> ### Note
>
> Please do not rename your sync files after exporting from your device.
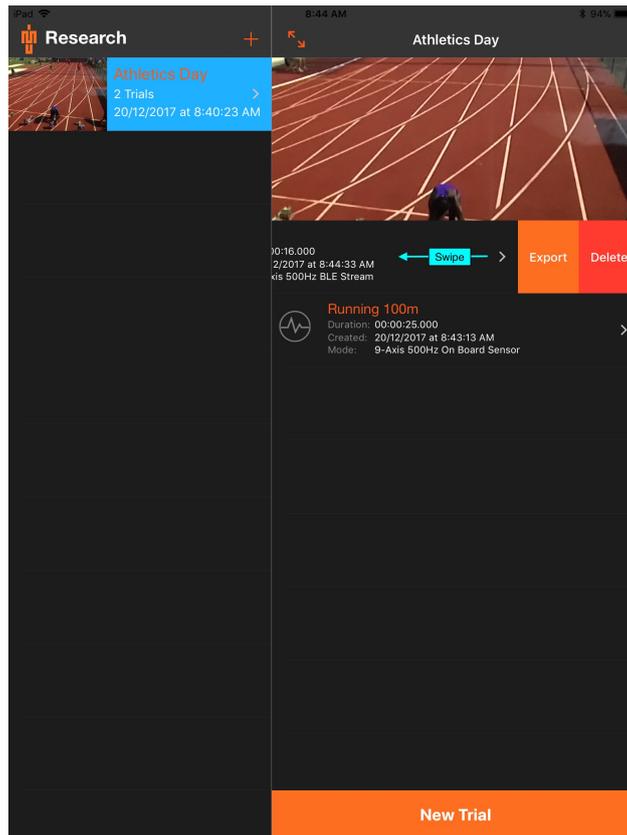
After tapping **Export** you will be prompted with the standard iOS share dialog, where you can use email, Dropbox, Google Drive or Air-Drop to transfer the exported data to your PC. When using Email, sometimes outbound emails can get "stuck", so you may need to launch the email client and refresh.
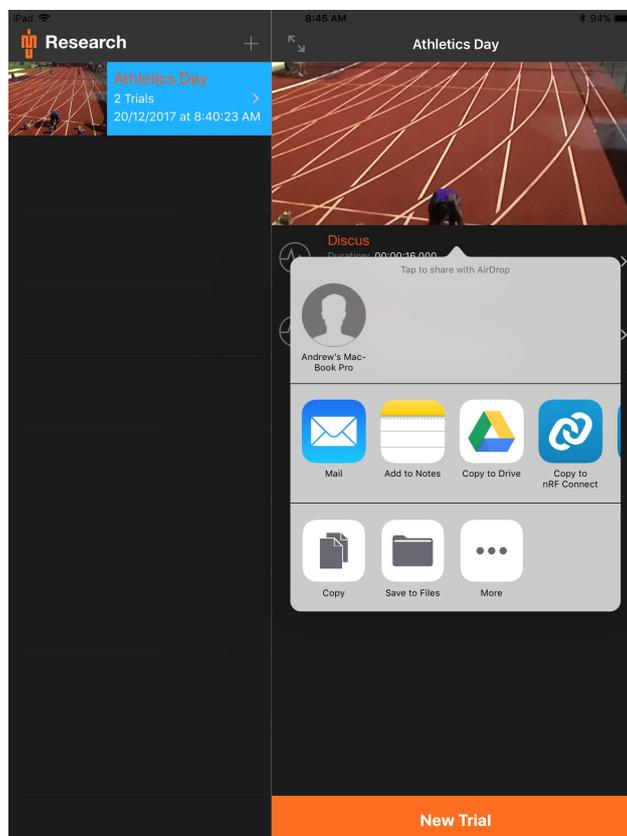
4.4.2 Exporting Data/Sync Files via iTunes

Plug your iOS device into your computer and open iTunes.

Once the device has been recognized, it will show up in the left-hand menu of iTunes. A device icon will also appear in the top menu bar of iTunes – click this icon (see image below).

Once you've selected your device, the left hand menu will show categories associated with that device – click on the Apps button (see image below).
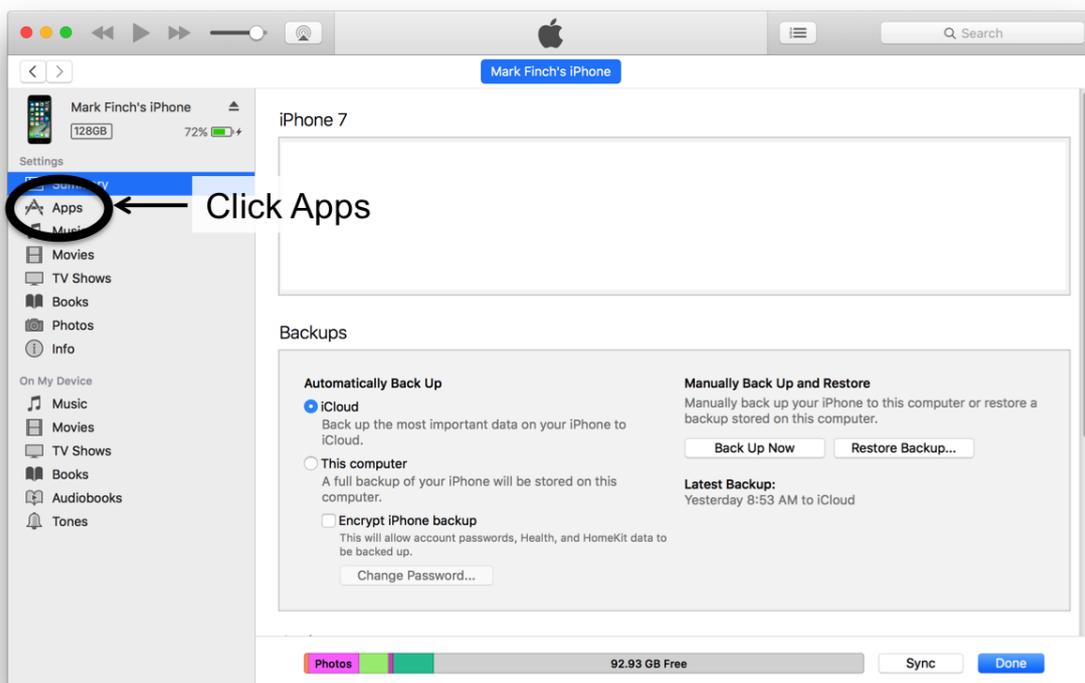
Once you've selected "Apps", the right hand side of iTunes will show all the apps that are currently installed on your device, as well as all of the home screens. Select the furthest most right hand scroll bar and scroll down to the bottom of the window.
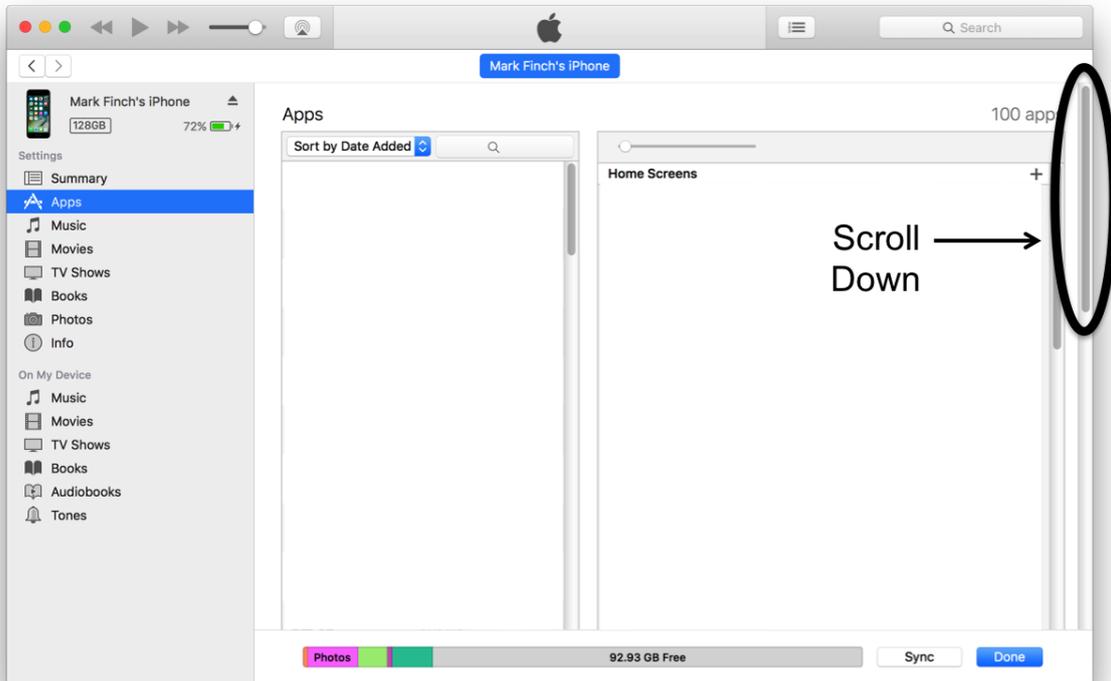
Once you scroll to the bottom of the window you'll be shown all the apps that have 'File Sharing' enabled. IMU Research will show up in this list. When you click on the IMU Research app all the 'Sessions' that you have in your IMU Research app will show up in the right hand window (see image below).
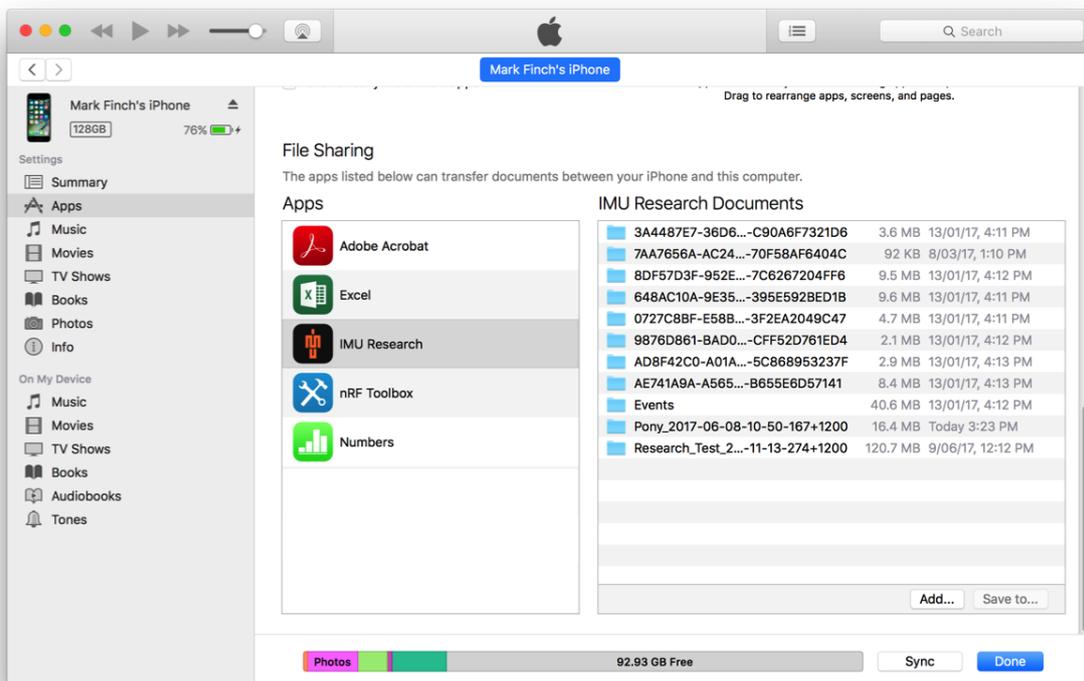
> **Note**
>
> Any sessions created before IMU Research v.161 will show up in the window named as long ID numbers (e.g. 3A4487E7…) that do not match the title of your session in your app. The title of these can be identified by either the photo in the folder or in the notes file inside the folder. However, any sessions created with IMU Research v.161 will show up in iTunes with its respective name. **This has been done to ensure backwards compatibility with older versions of IMU Research.**

To download a folder, select the folder and then click "Save to...". Save the data to the appropriate folder on your machine.

> **Note**
>
> Please do not rename your sync files after exporting from your device.

4.5   Comma separated variable (CSV) files

The Streamed data, and data exported from Lightning will be a comma separated variable file. Each line in the file has a time stamp followed by three or nine data values. The first row contains the headers with units for the dataset.

Example 3-Axis data:

```
timestamp,accel_x (m/s2),accel_y (m/s2),accel_z (m/s2)
0.749958375161668,-0.756567724609375,9.73961235351562,-0.488417138671875
0.751958375161668,-0.723048901367187,9.76355437011719,-0.454898315429687
0.753958375161668,-0.699106884765625,9.74918916015625,-0.392649072265625
0.758737530272356,-0.742202514648437,9.80186159667969,-0.40222587890625
0.760737530272356,-0.732625708007812,9.85453403320312,-0.430956298828125
0.762737530272356,-0.699106884765625,9.79707319335937,-0.569819995117188
```

Example Time-Synchronization data:

```
timestamp,address
139.268178291667,26944
142.778336291667,27008
146.348402708334,27072
153.398345666667,27200
529.4973945,0
542.514689541667,1
584.680071708333,45952
588.219667708333,46016
591.789946583333,46080
```

In the address column corresponds to points on the On Board memory, and the Lightning Desktop App uses these numbers to synchronize the stored data. The '0' and '1' addresses are Epoch markers where the user presses **Start** and **Stop** respectively.

Note

Most data processing applications will be able to import a CSV file, including Microsoft Excel. However, Microsoft Excel isn't designed handle a large numbers of rows. A 60-minute data log could have up to 3.6 million rows! Ask your nearest data scientist how to open the CSV files if you are unsure.

5 Downloading Data

Open the Lightning Desktop App before plugging the sensor in. Turn the sensor on, then plug it into the USB port. You can plug up to two sensors at a time, they will have a tab each. You can view which sensors are plugged in by viewing their respective ID's as the title in the tabs.

Lightning will automatically download a preview of all the stored data from the sensor.
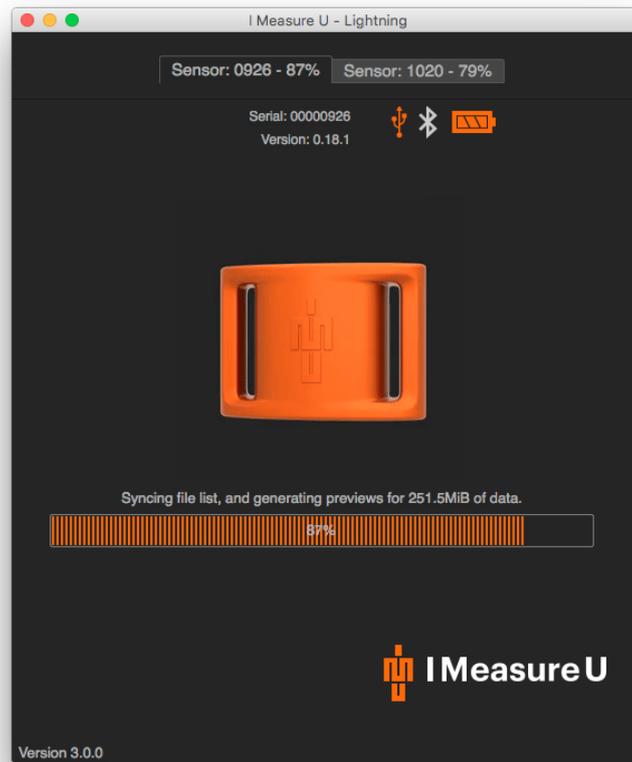
Once the sync has finished, you will be presented with a list of all the stored downloads, their modes and sampling frequencies. The Serial Number of the sensor and firmware version is displayed at the top of the window. The version of Lightning is displayed in the bottom left.

> ### *Note*
>
> The order in which this list is displayed is from oldest On Board session at the top, to the newest On Board session at the bottom.
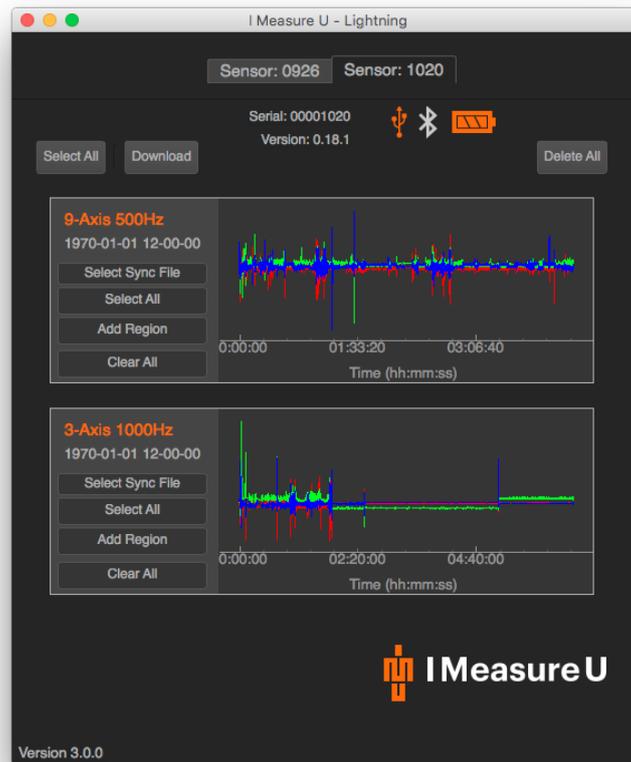
Use the **Select Sync File** button to choose the corresponding time-synchronization file of the download you wish to save. This is the file that you exported from the IMU Research App in Exporting Data.
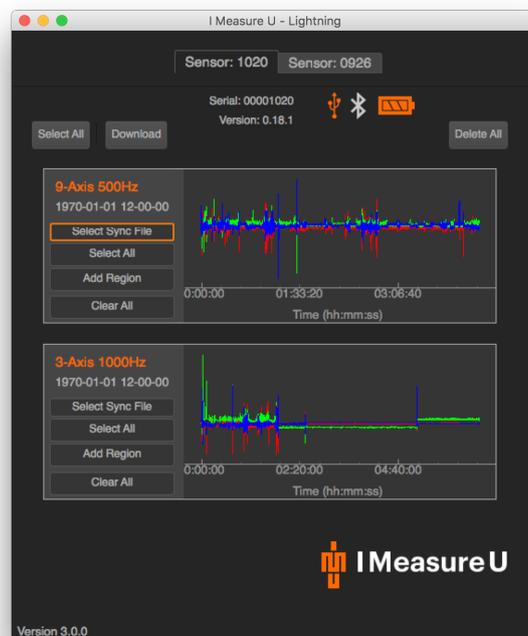
A prompt window will appear allowing you to choose the time-synchronization file. It's name will contain:

1. What you named the sensor
2. The sensor's serial number

3. The mode of logging.

E.g. "Example1 00000607 9-Axis 500Hz SDLogging.csv"

If the Serial Number in the name of the sync file you chose DOES NOT MATCH the sensor you have plugged in, the prompt window will appear again for you to choose the correct sync file. If you have renamed your sync file (UNRECOMMENDED) or have selected the wrong sensor sync file to upload, you will be prompted to confirm. **IMU recommends you leave the sync files names unchanged to ensure correct synchronisation.**

After selecting the sync file, the text of the "Select Sync File" button will change color to indicate you have selected a sync file.
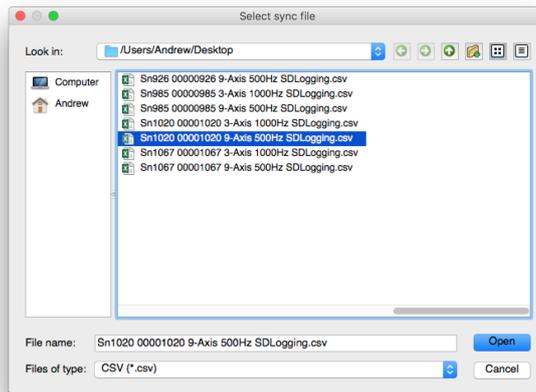
Use the **Select All** or **Add Region** buttons to choose which parts of the download you wish to save. This can be useful if you have long periods of inactivity that you don't need to download, since downloading large amounts of data can take a while.
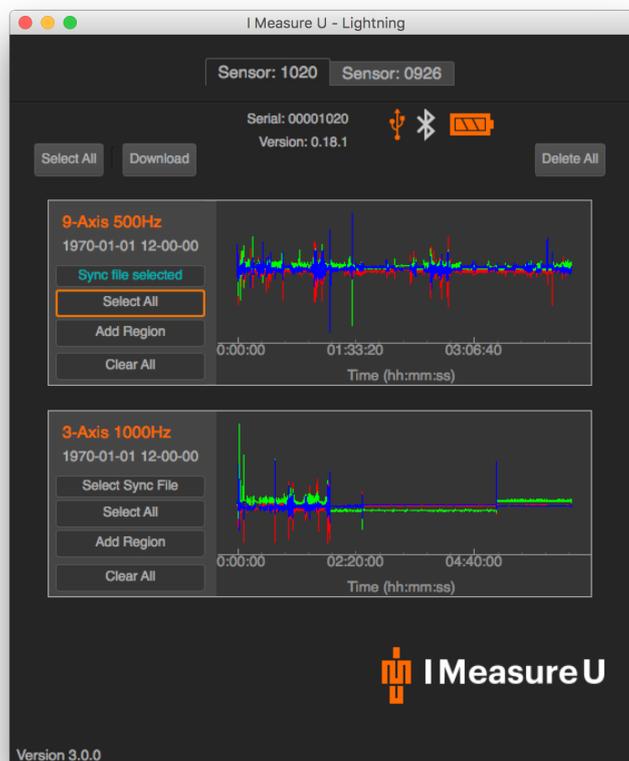
Once all the **regions of interest** and **correct time sync files** have been selected, click on the **Download** button.

Lightning will now prompt you where you would like to **save the data**. If you are downloading multiple files/regions, it will save the data to a folder within the location you choose, named after the sensor serial number.
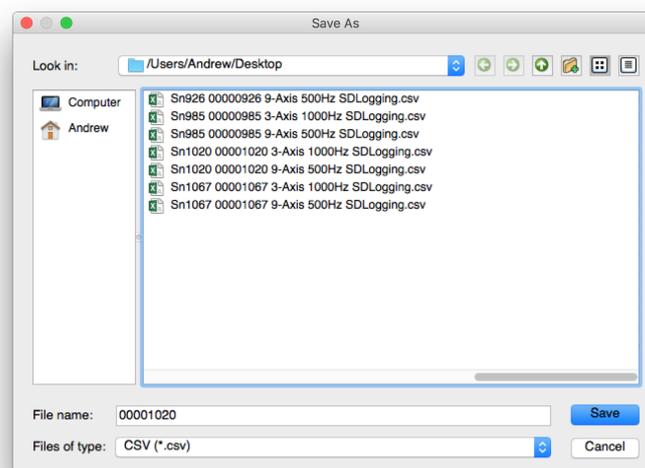
After choosing the save directory, Lightning will now download your data. This process can take a while for large amounts of data. On a 3.5 hour capture, it would typically take an hour to download. Once the download is complete, the data is verified and then saved. The verification stage can on occasion, appear to look like it has become 'stuck' or 'crashed'. If we detect that there is missing data, we re-download that

section, and depending on what was missing, it can take a while. Please be patient, we have had examples where it has taken up to 45 minutes to verify.

Note

Please **DO NOT** let your computer fall asleep - it may affect the downloading process. If you wish to save power, we recommend dimming the screen.
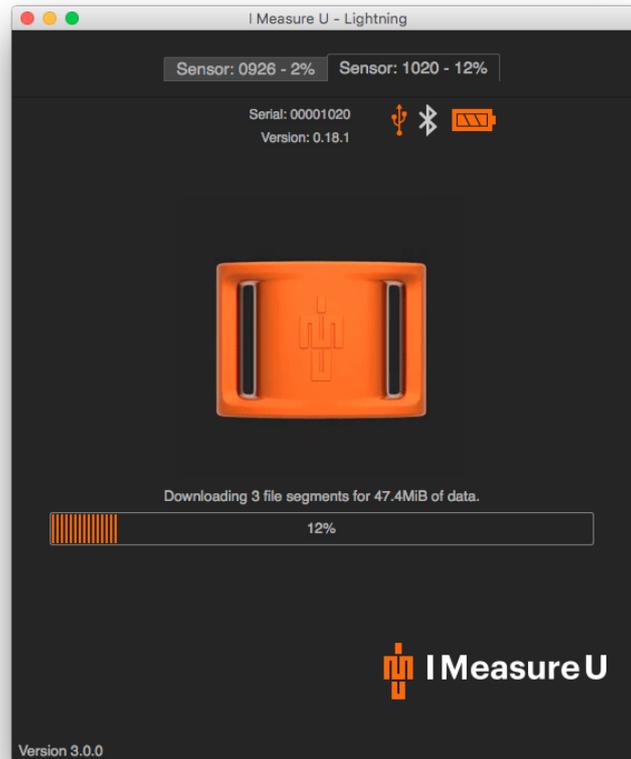
As soon as all the data has been received and verified it will save the data as Comma separated variable (CSV) files.

Your data will be saved with the default name set as:

1. Sensor Name

2. Serial Number

3. Mode of Logging

4. Region start/finish times

5. Region number (if you have downloaded multiple regions).

All these components are separated by an underscore. If there is no sync file selected, the Sensor Name portion will be "No sync file". If you have downloaded multiple regions, they will all be saved in a folder named after the sensor Serial Number.

E.g.: ExampleSensorName_00000999_9-Axis-500Hz-00.00.00_to_01.23.45_1.csv

The regions in the app will change to blue to let you know which regions were downloaded in case you need to extract more data.

When you are finished, just unplug the sensor from the USB port, and Lightning will return to the splash screen ready for the next sensor. You can now turn the sensor off.