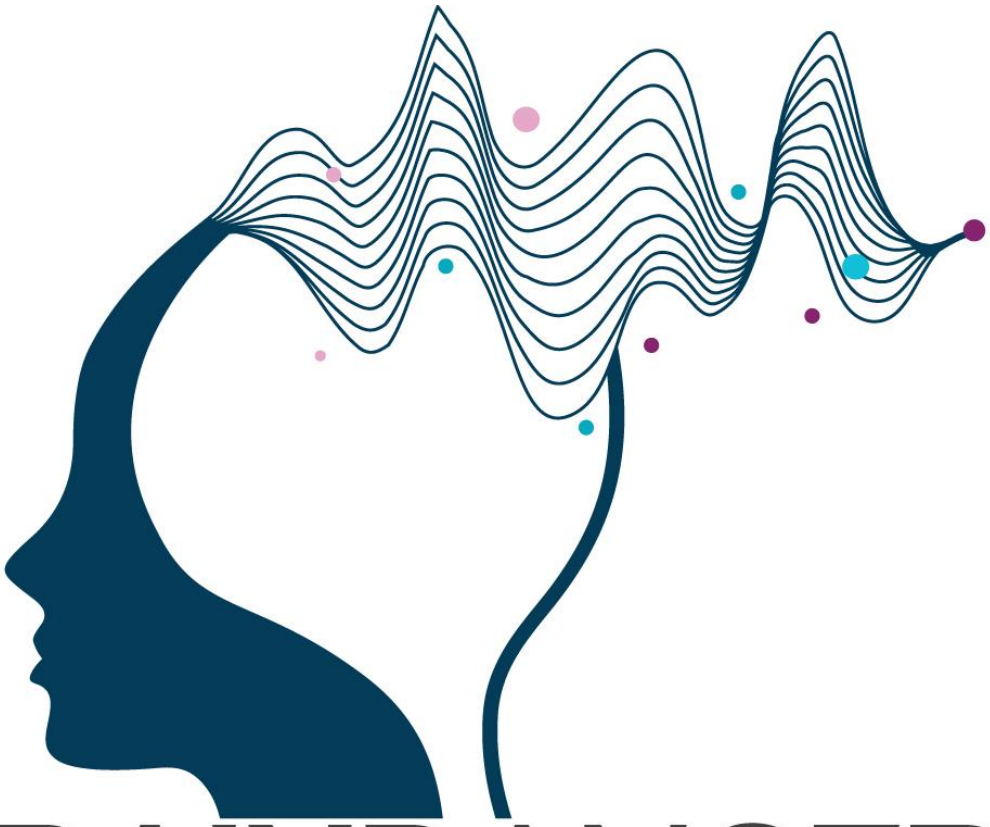

# BRAINDANCER

**Dynamic Phantom for fMRI**

# OPERATOR'S MANUAL

**V2.1 Oct 2022**
**PRELIMINARY Beta 3 Set-up**

Scientific Instruments

ALA Scientific Instruments, 60 Marine Street, Farmingdale, NY 11743
www.alascience.com, Email: support@alascience.com, Tel: (1) 631 393-6401

# ATTENTION

Understand all material presented within this manual before using the Braindancer® system. Refer to this manual for all Braindancer® guidelines, operating procedures, and specifications. Contact ALA Scientific Instruments for any questions not addressed within this manual. Refer to {WEBSITE} for updates to this manual.

Operation of the Braindancer® system outside of the parameters specified within this manual may result in:

- Poor Data Quality
- Excessive Wear and Decreased Service Life
- Damage to the Braindancer® system and/or nearby equipment
- Injury

ALA Scientific Instruments, Inc. is not responsible for any reduction in data quality, wear, damage, or injury resulting from improper use and/or unauthorized modification to the Braindancer system. Improper Use and Unauthorized modifications may void the warranty service agreement. BrainDancer runs on compressed air which is generally quite safe, but proper safety precautions should be taken whenever compressed air is utilized.

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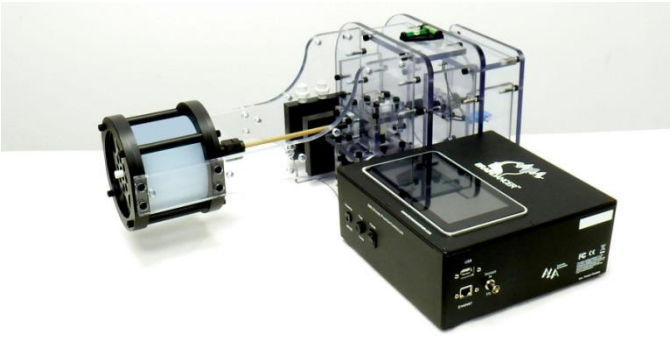
# Introduction

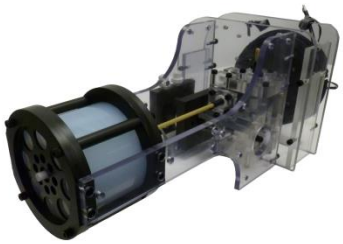
BrainDancer® is a precise and sophisticated calibration system for use with fMRI. Similar to gel phantoms currently in use, BrainDancer® contains agar to produce a known MR signal. Unlike traditional phantoms, BrainDancer® produces dynamic signals for optimal characterization of your fMRI acquisitions. The rotating cartridge contains a doping agent in addition to the agarose which is divided into two concentrations. The interface between these two zones passes back and forth through the voxel of interest to create a known fMRI signal. An air motor with no metal parts creates the motion and an optical encoder records the movements. The logged movements of the cartridge are later correlated with the functional scan of the cartridge. This provides a ground-truth to create a standardized signal that can even be correlated across platforms.



Beta 3 version of BrainDancer Dynamic Phantom for fMRI calibration. In the foreground is the control box that remains in the control room, behind is the phantom that is placed in the head coil of the MRI machine.

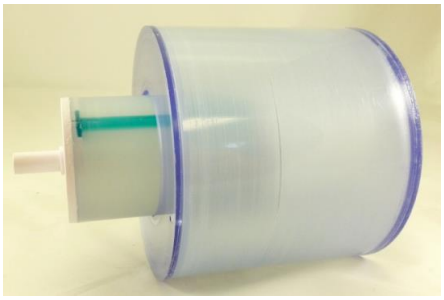
# Parts List

**Dynamic Phantom**
(MR compatible-contains only plastic parts)



**Optical Fibers**

**Agar Cylinder Cartridge**



**Control Box—not MRI compatible**

**Air Compressor**

Not MR compatible.

**Tubing Set**

Black and white tubes are MR compatible, red tube is not.

**Universal Power Supply**

Not MR compatible.

# Preparation Procedures

The BrainDancer® system is composed of multiple devices. Several components are designed to be used within the MR environment whereas other components are not MR-compatible and must remain in the Control Room. To begin setting up your BrainDancer® system for use in an MRI, it is important that you:

## Separate MR-Compatible Components from Incompatible Components

The RED tube is not MRI compatible. The BrainDancer is MR compatible as are the black and white tube as well as the fiber optic cable set. (The control room end of the fiber optic cable has one metal SMA connector) All other parts should be considered not MR compatible.

Begin by following the set-up directions for the compressed air supply in Appendix A

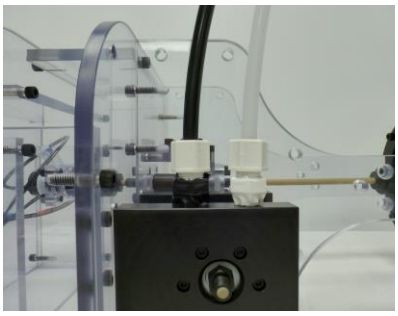
Only the Dynamic Phantom and the Black & White Air Lines and fiber optic cable can be brought into the MR environment.

Accidents can be avoided by always separating the components that go into the MR environment from components that stay outside. Of course the compressor and the control box are not MRI compatible.

## Assembling and Configuring the BrainDancer® System

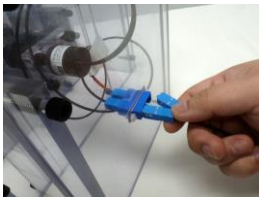
### Inside the MRI Room:

1. Set the **Dynamic Phantom** on a flat surface within the MR room or upon the MRI bed.
2. Take the **Black & White Air Lines** and connect the Black and white connectors to their matching connectors on the **Dynamic Phantom**. Push the tubes down into their receptacles until they stop. Be careful not to damage the connector threads as they are made of a soft plastic. However, they must be securely tightened.



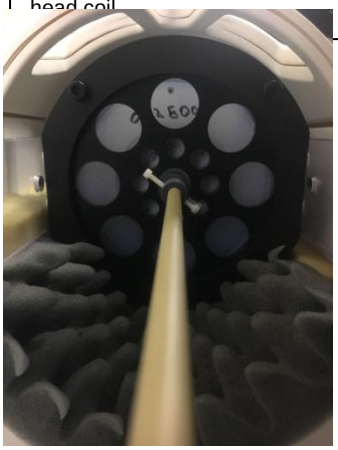
3. Run the **Black & White Air Lines** through the conduit in the MRI room wall so that the other ends are now outside the MRI room.
4. Carefully unspool the **Optical Fibers** and pass them through the conduit in the MRI room wall so that the ends are outside the MRI room. Since the Fiber optic is more delicate than the air tubes, it is best to run the air tubes first and then the fiber optic.

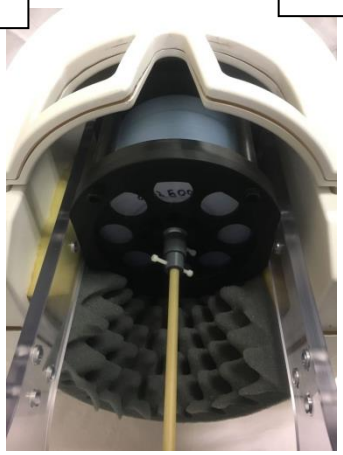
Depending on the model, unspool or plug in the fiber optic cables. The slots are keyed so they only fit one way.



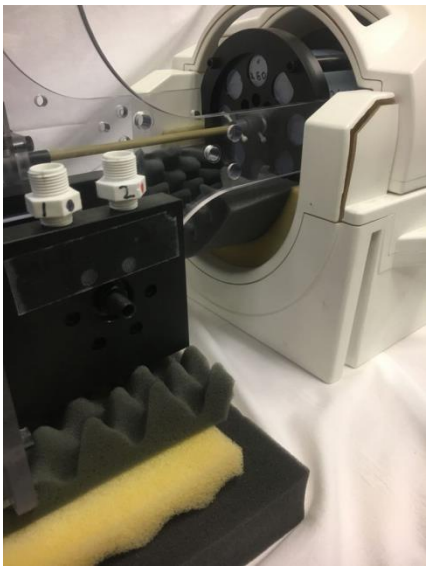
5. Position the Dynamic Phantom in the coil. Use padding to ensure a centered and snug fit that is level to the patient table.

Foam supports the Dynamic Phantom in the head coil.





Pitch and roll levels are provided.



Different angles showing positioning of Dynamic Phantom in head coil.

Caution: the **Air Lines** and **Optical Fibers** must be placed so that they do not get caught on anything when operating the patient table. Ensure lines and fibers do not kink. Securing the **Optical Fiber**s to the patient table reduces the chance of damaging them.

6. Send the Dynamic Phantom to Isocenter. You are finished with preparation within the MR environment

## Outside the MRI Room, in the control room:

1. Connect the **Control Box** to AC Wall Power and power it on. You will see a Red LED indicator on the **Micronor Module**
2. Connect the **Black & White Air Lines** and **Optical Fibers** that were passed through the wall conduit to the **Control Box** and **Micronor Module**, respectively. The Green LED will blink when the Optical FIbers are first connected.

Make sure tubes are pushed in all the way before tightening the nuts, twist until secure, but do not over-tighten as the fittings are made of plastic.

Black fiber must be inserted fully and held in place while tightening the blue nut. Do not over tighten as fitting is plastic. Silver SMC is inserted and twisted until it stops turning.

3. Connect the **Red Air Line** to the **Control Box**.
4. Connect the **Red Air Line** to the **Air Compressor**.
5. Power on the **Air Compressor**. Make sure the **Air Compressor** has sufficient regulated pressure NOT TO EXCEED 95 PSI. We recommend operating at 90 PSI.

6. Connect the **MRI trigger** to the **Control Box**.
7. Insert a USB thumb drive into the control box

USB Thumb Drive

TTL Trigger in

8. Plug in power to BrainDancer Controller

9. Turn on power switch

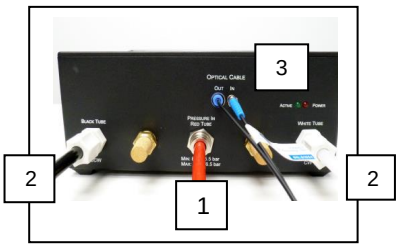
## Running the Phantom

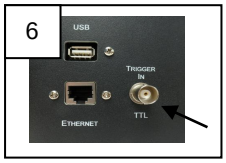
Upon power up the touch screen will come up in approximately 5 seconds.

## Quick Start Guide

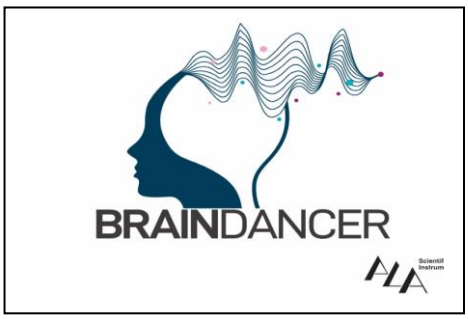
### 1.1 Make All Connections

1) Air input tubing (red color) from compressor to controller; **Danger: Do not bring it into MRI room, ferromagnetic parts are in use!**
2) Air output tubing (white & black color) from controller to phantom;
3) fiber cable connects from controller to phantom;
4) Plug in usb flash drive;
5) connect power to controller, switch on;
6) connect BNC trigger from MRI to Controller






Start up screen:




After 10 seconds

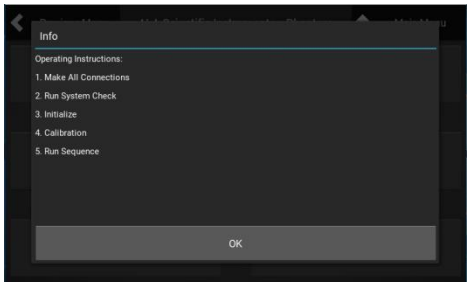


Fig. 1

Fig 1

When everything is connected, and no warning appears on the LCD, please touch “OK” to continue.

**For Air connection details, please refer to Appendix A. (Compressor will need to be connected and charged)**

## 1.2. Operation

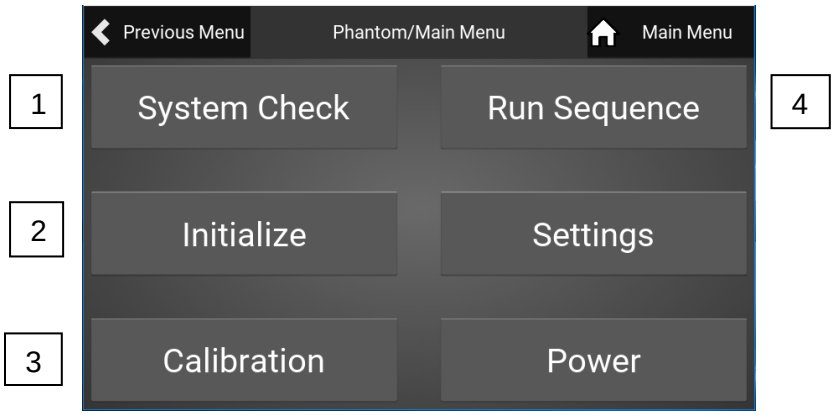



Fig. 2

### 1.2.1 System Check

Select [System Check] to check if all connections are ready to go. The unit will run a short cycle to determine if the set-up and connections are correct. You will hear valves clicking and air flowing.

If system check has passed, go to step 2;
If not, please check connections above in 1.2.1;

### 1.2.2 Initialize

Select [Initialize] to bring phantom to zero position (it will be around 0 or 8191);
If screen displays [Initialization time out], please select [Initialize] again;
Go to step 3 when finished initialization.

### 1.2.3 Calibration

Select [Calibration];
Select [Run] on left bottom, phantom will move for about 5 mins to calibrate the speed and resolution of the whole pneumatic system.
Select [Abort] if you want or need to stop running the sequence.

After calibration, a fitting graph will be plotted to show how the derived profile fits in relation to the desired profile of the pneumatic system. This is a test of how close the actual stopping positions matched to what the desired stopping positions were. The differential is caused by the run-out inherent in a pneumatic system.

Go to step 4 if no warning message appears on LCD;

### 1.2.4 Trigger In

Trigger in from MRI must be connected to BNC on side of Control Box. Trigger should be set to fire with each TR. Phantom triggers on rising edge of TTL pulse but the pulse should be at least 3V and 20msec.

### 1.2.5 Run Sequence

Select [RunSequence];
Select [Download Sequence] on bottom left if you need to download your own sequence, then you will be led to a folder that you created on the Flash Drive. Select the sequence file and then select [DownLoad] on top right.
Select [Run], to run the sequence.
When the sequence has finished, a prompt will tell you to save, select [save], if not, select [cancel]; if you accidentally select [cancel], you still can select [Save Result] on the bottom right.
Select [Abort] whenever you want to stop running a sequence; all information will be cleared.

## 1.3 Display information

Orange: Is for software bug information;
Red: Phantom running errors or exceptions;
Yellow: Warnings that need to taken care of, otherwise the phantom will not run normally.
White : Normal information—no action required

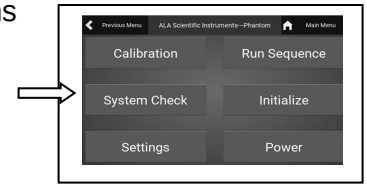
**---End of Quick Start---**

# 2. Detailed System Operation

Begin by referring to Appendix A to see how all air, optical, and power connections are made. Compressor operation is also covered.

## 2.1 System Check

System Check is going to check tubing and encoder connections by running the phantom back & forth for several minutes.




### 2.1 If Warning regarding Check air tubing connection is displayed

1) Air input to Phantom from compressor; red tube which connects compressor to controller and carries high pressure air into the control box. Use caution to be sure all connections are secure before releasing pressure to the Phantom.

**Red Tube Danger Note: This tube cannot be taken into MRI room due to ferro-magnetic metal components.**

2) Two air tubing outputs in white and black respectively, connect phantom-controller to phantom-device.

A) These tubes terminate in screw-on connectors, be sure all tubes are inserted fully and then securely tightened.

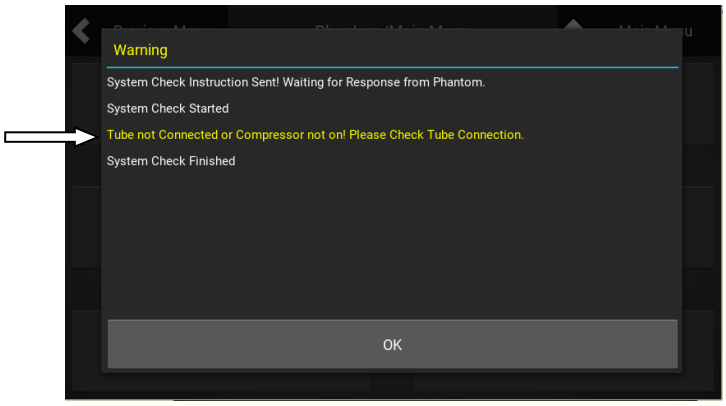



Fig 3; if tubes are not connected or compressor not running

### 2.2 Check encoder connection

A pair of fiber optic cables connect phantom controller to the phantom device to track the position. A loose connection here will result in an error reading the position of the Phantom

1) Primary connection is at phantom end, if connectors are present, connect fiber cable to sensor.

2) Second connection is at the controller end, connect fiber cable to sensor-controller;

*Black fiber must be inserted fully until stop and then secured by tightening blue nut.*

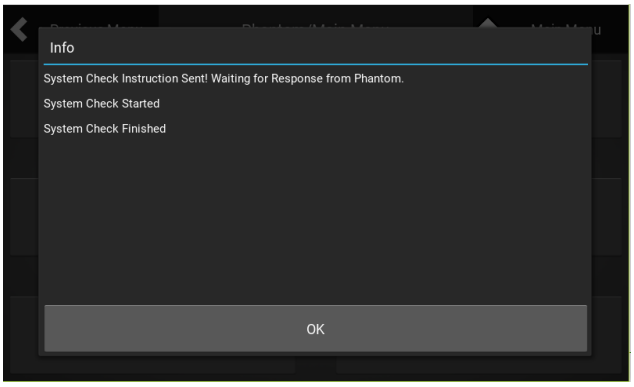
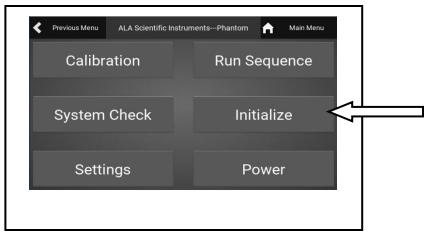



Fig. 4 All connections are correct

If all connections are correct and System Check clears, no yellow warnings are displayed and user can proceed to [**Initialize]**. Press [OK] when Main Menu is displayed, select [Initialize]




## 2.2 Initialize

Initialization brings the phantom to “zero” position. Due to the air control resolution and variation of air pressure, the initialized position will be +/- 90 around the 0 position instead of exactly at 0.

NOTE: Initialization is supposed to be done before each scan. Failure to initialize first, before running a sequence, may cause an excessive use of air pressure in the first step.

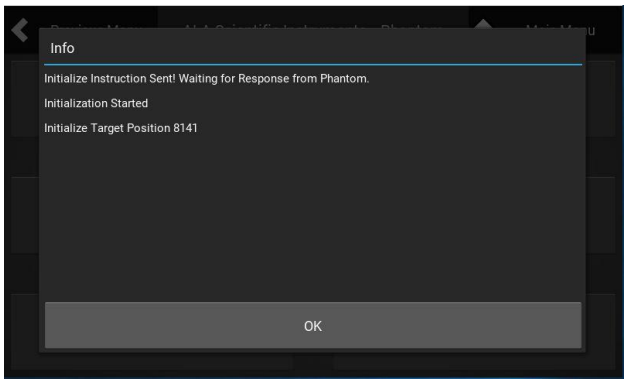



Fig. 5 initialization Success

If the controller responds: **“Initialization timeout” (Fig. 6)**, you can select **[Initialize]** again. The timeout may be caused by the compressor not running, or running at too low pressure, or phantom air motor stalling. If **[Initialize]** times out again, check all connections for leaks and notice the air pressure reading of the compressor, or if it seems to be running excessively--which may indicate a leak or unsecured air hose in the MRI room. Also, check the connections of the fiber optic system.

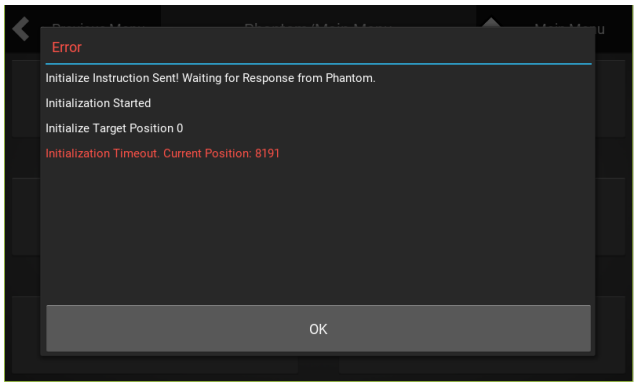
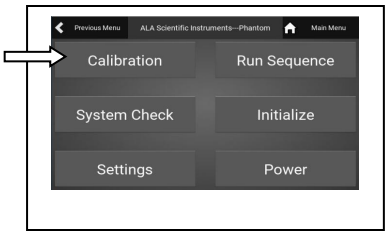



Fig. 6 Initialize time out

If [Initialize] is successful, press [OK] to return to the home menu.

## 2.3 Calibration



### 2.3.1 Calibration

Calibration is designed to get the speed profile of the Phantom with the current setup. Phantom will run continuously for about 5 minutes.

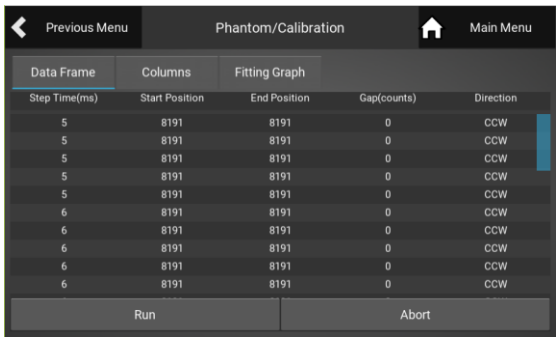
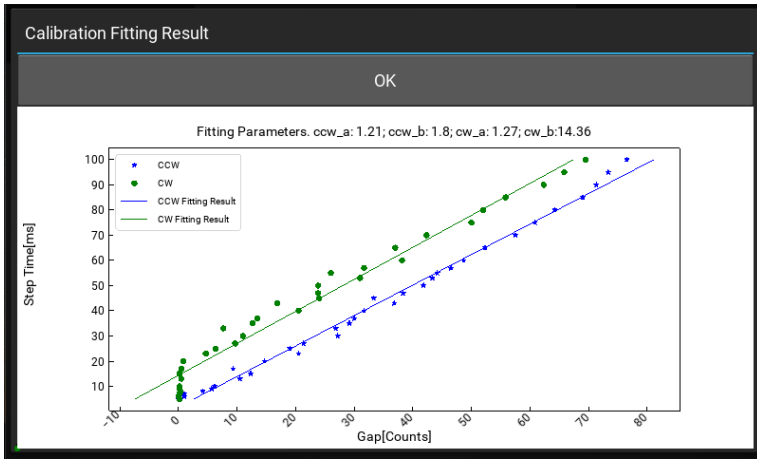



Fig 7, Normal calibration run

Select [Calibration] and then press [Run] and the sequence will commence. It can be aborted at any time just by pressing [Abort].

The [Data Frame] refers to the chart that you see above and the [Fitting Graph] refers to the graph shown below where position achieved vs. desired position is plotted.

After calibration, a fitting graph will be displayed (Fig. 8) to show how close the requested movements came to the actual stop positions of the pneumatic system. A clockwise and counter-clockwise plot are generated. **If they barely match each other, you should run calibration again.**




For instance if the dots on the graph at left were to be scattered around the graph and not generally in line with the linear best-fit plot, then a re-calibration should be done.

Fig 8, fitting profile if everything goes well

### 2.3.2 Calibration Issues

User might encounter “Encoder Error” during the calibration. If the Error message on the LCD is “Encoder Error”, then you should abort the process.

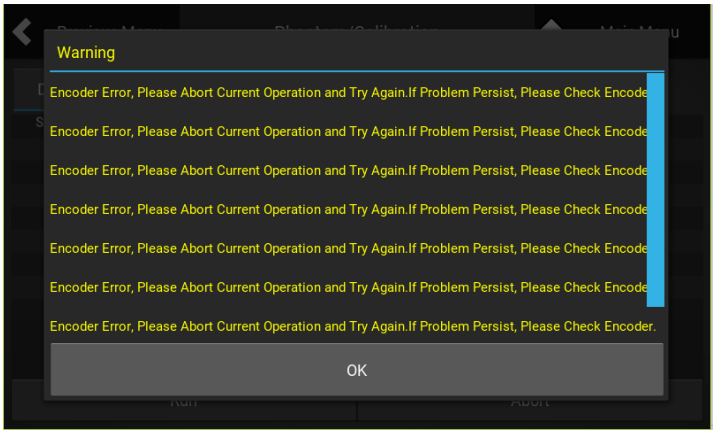
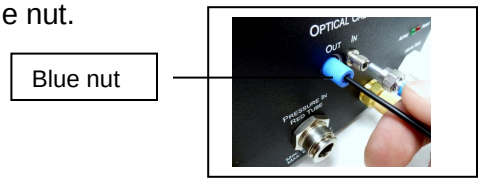



Fig. 9 Encoder error

Please try these two solutions below:

1)Try to disconnect the black fiber at the control box, rotate the fiber about 90 degrees and reconnect it tightly by first loosening the blue nut, then using one hand to hold the fiber in all the way, use the other hand to tighten the blue nut.




Run calibration again.

If no success, then:

2) Turn off power and try to disconnect and reconnect fiber optical cables at both controller and phantom ends if possible, then power on and try to try run calibration.

If the above two solutions do not solve problem, please contact the factory or your distributor.

**Note:** The effect of an air leak will usually result in a slowing down, or decrease of Dynamic Phantom motion in one or both directions depending on the leak location.

## 2.4 Run Sequence

This section provides information for the user to run a real sequence for fMRI calibration.

### 2.4.1 download sequences

#### Download sequence

The BrainDancer comes with a preloaded sequence, but if the user wants to run a different sequence(s), then user can download their own sequence by pressing [Download Sequence],

and then select their sequence file (highlight the folder) which they have preloaded in the USB flash drive, then select [DownLoad] at mid right. (How to create a sequence is explained in 2.4.2 below.)

User should create and copy the sequence to a folder (user created folder) in USB flash drive before downloading.

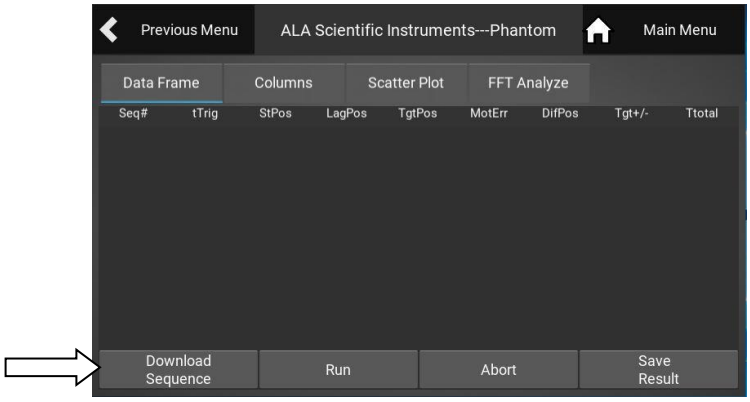



Fig 10 click “Download Sequence” at bottom left

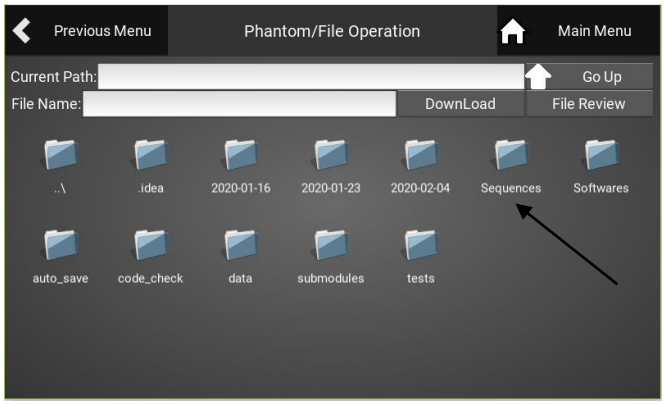



Fig 11 Find folder containing sequence in USB flash drive

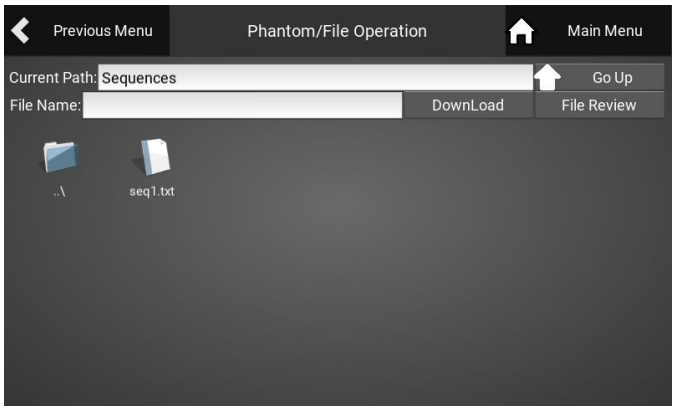



Fig 12 Select the path “Sequences” then select the actual Sequence file and then select “DownLoad” to place it in the BrainDancer memory.

### 2.4.2 How to Create a user defined sequence

*1) Standard rules*

The resolution of position encoder is 13 bit per revolution, which means 360 degree will include 2^13 counts. So, the position of the phantom can be from 0 to 8191. In this way, the resolution of position in degree is (360/8192) ~=0.0439° .

Due to the inertia and air pressure/flow lag, the phantom is set to move at minimum 10 counts but no more 80 counts during any one step motion. So the phantom can move no less than 0.44 degree and no more than 3.52 degree in one step motion.

*2) Examples*

Consider a sequence: [30 39 56 33 12 26 111]

Here the first step is to move from 30 to 39, the gap counts between the two positions is |39 - 30|=9. It is less than 10 counts. So user has to re-adjust these two positions, changing 39 to 41 for instance can avoid the issue.

Another issue is that from position 26 to 111, the gap counts are 85 which is bigger than the maximum count of 80. So changing 111 to 100 will solve the problem.

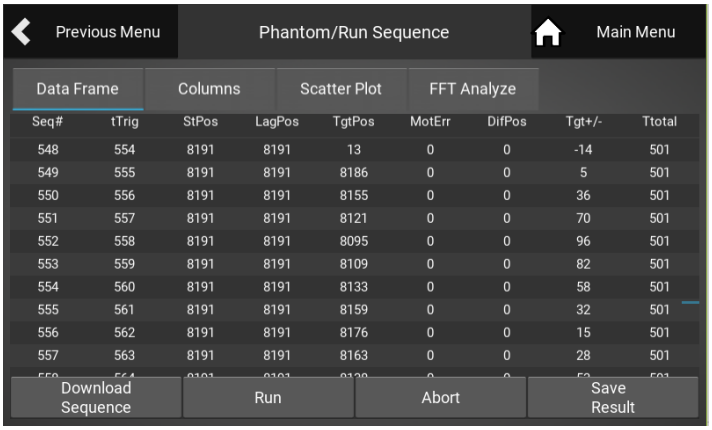
All in all, just make sure that the gap counts of two adjacent positions in the sequence will be no less than 10 and no bigger than 80.

*3) sequence format*

The sequence should be .txt file and put a comma between positions.

### 2.4.2 Run sequence

Select [Run], to run the sequence. Phantom will move to each step, and on-screen target position and final position are displayed with some additional information.




| Seq# | tTrig | StPos | LagPos | TgtPos | MotErr | DifPos | Tgt+/- | Ttotal |
|---|---|---|---|---|---|---|---|---|
| 548 | 554 | 8191 | 8191 | 13 | 0 | 0 | -14 | 501 |
| 549 | 555 | 8191 | 8191 | 8186 | 0 | 0 | 5 | 501 |
| 550 | 556 | 8191 | 8191 | 8155 | 0 | 0 | 36 | 501 |
| 551 | 557 | 8191 | 8191 | 8121 | 0 | 0 | 70 | 501 |
| 552 | 558 | 8191 | 8191 | 8095 | 0 | 0 | 96 | 501 |
| 553 | 559 | 8191 | 8191 | 8109 | 0 | 0 | 82 | 501 |
| 554 | 560 | 8191 | 8191 | 8133 | 0 | 0 | 58 | 501 |
| 555 | 561 | 8191 | 8191 | 8159 | 0 | 0 | 32 | 501 |
| 556 | 562 | 8191 | 8191 | 8176 | 0 | 0 | 15 | 501 |
| 557 | 563 | 8191 | 8191 | 8163 | 0 | 0 | 28 | 501 |

Fig 13 Running a sequence, notice the stack builds at the bottom, i.e. the latest motion is displayed on the bottom.

### 2.4.3 Save data

When a Sequence has been finished, a prompt will tell you to save, select [save]; Then the user will be asked to give a name to the file.

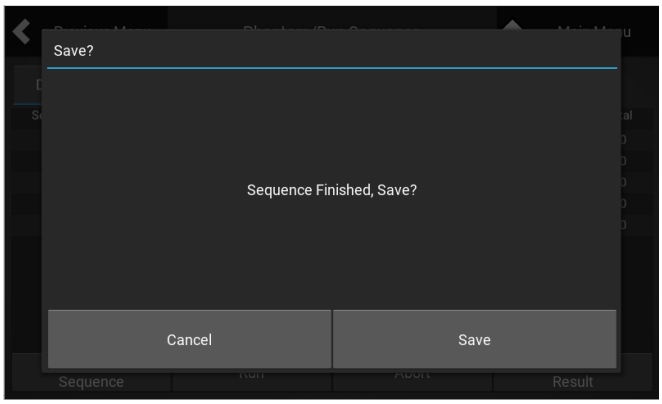



Fig. 14 Save data file

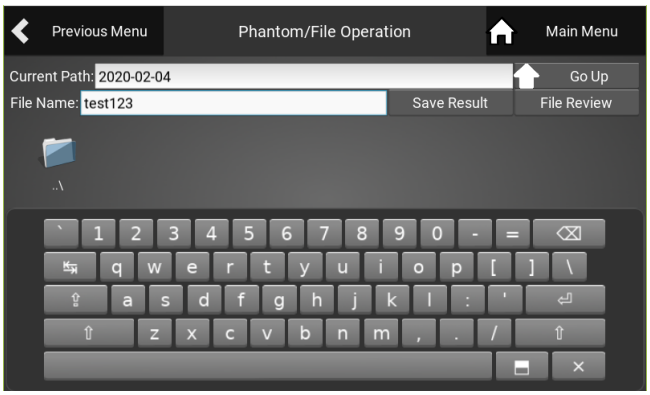



Fig. 15 Name the data file

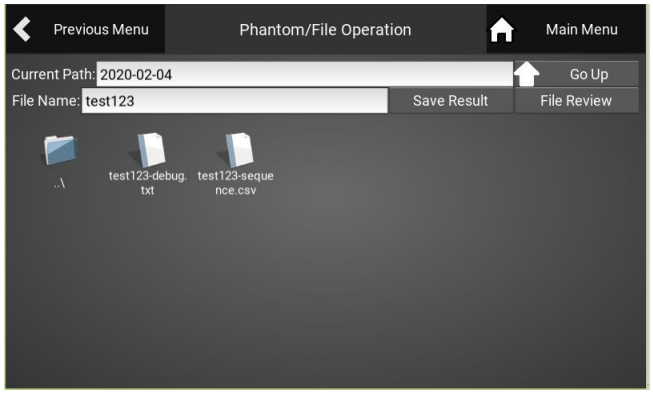



Fig.16 Data file saved

The device will only generate a folder name with the date of the corresponding date of use in the name. Then all the running data will be automatically saved into that folder with names given by the user. For example, if today is 2020-02-04, then a folder will be generated automatically in USB flash drive with the name”2020-02-04” (Year-Month-Day), and all running data during today will be saved in this folder.

If the user accidentally selects [cancel] when they were asking to save the data, they still can select [Save Result] at the bottom right before the next run to save the current running data.

### 2.4.4 Other functions

Select [Abort] whenever you want to stop running a sequence, then all information will be cleared.

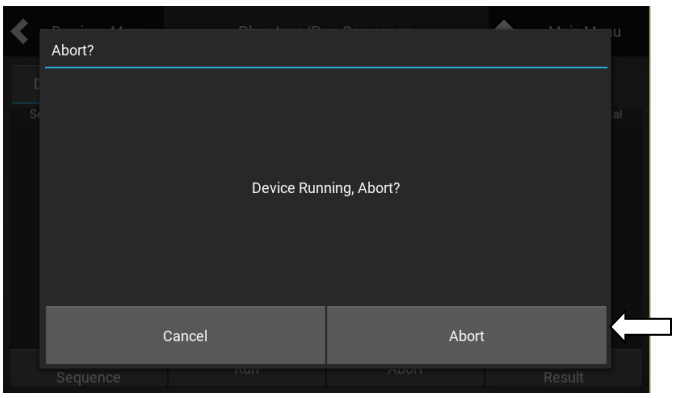



Fig. 17 Abort process

FFT analyze provides a quick frequency analysis and comparison of target sequence and actual running sequence.

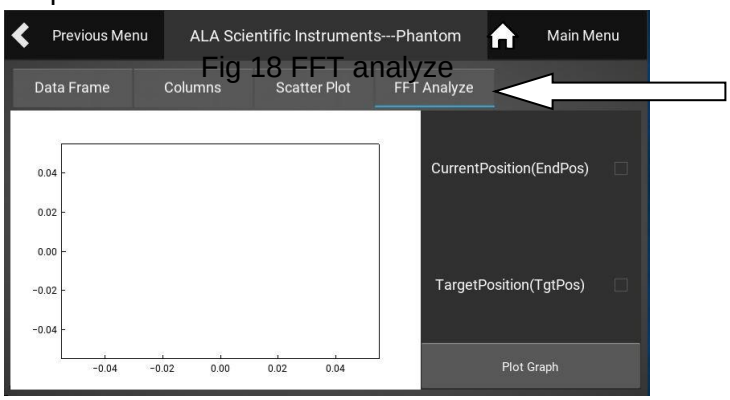



Fig 18 FFT analyze

## 2.5 System Settings and Software upgrade

Settings provides 4 main operations:

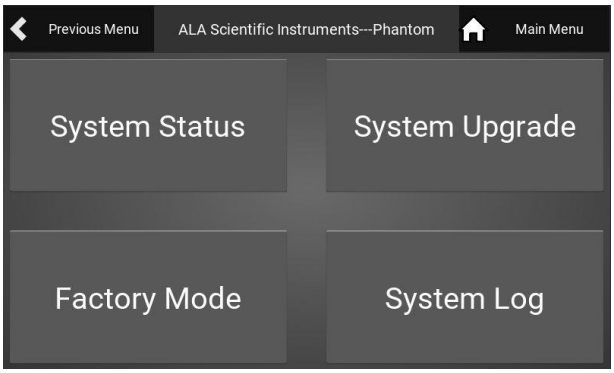



Fig 19 System settings

### 2.5.1 System status

Information includes: Software version, Firmware version, Phantom running time, IP address, Calibration fitting parameters, etc.

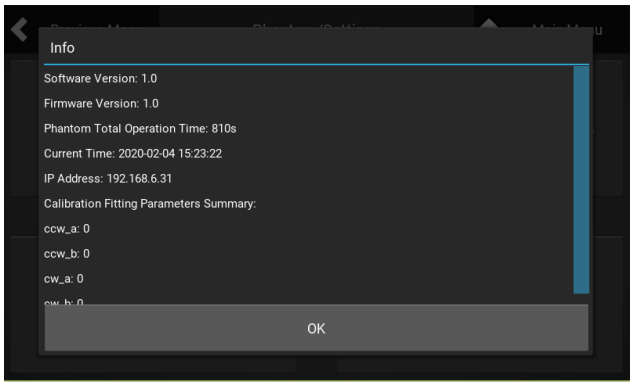



Fig. 20 System status

### 2.5.2 System upgrade

Select the latest “software” package in the “software” folder on the USB flash drive and then select [upgrade}:

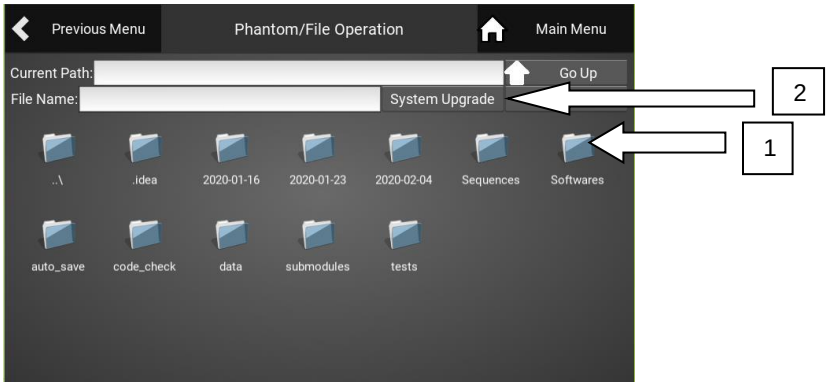


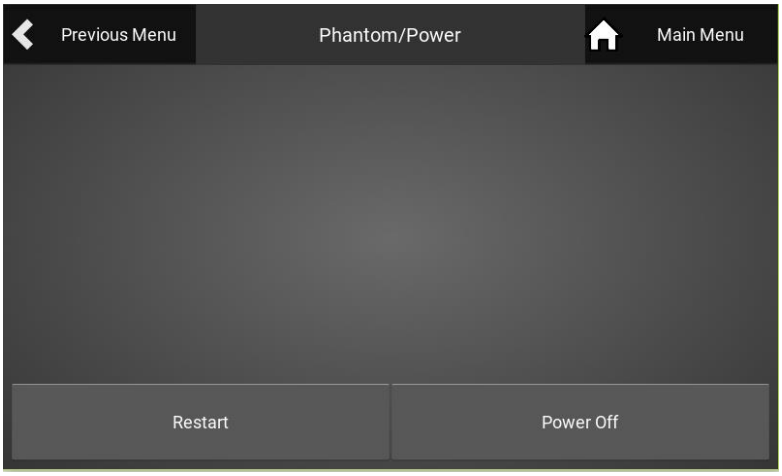

Fig. 21 System upgrade

### 2.5.3 System log

A “System Log” folder will be created and log the phantom status. This log is used to keep track of the phantom system operations and run time for maintenance purposes.  These logs will need to be forwarded to ALA via the BrainDancer web portal at regular intervals.

## 2.6 Power Options

You can restart the system if you need to re-set it.  Always [Power Off] the system via the touch screen in order to protect the system from file or system damage. Once it is off you may turn off the main power switch.



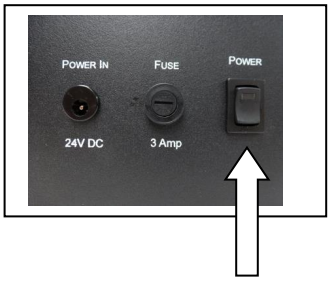




Fig 22 Power options

# Storage

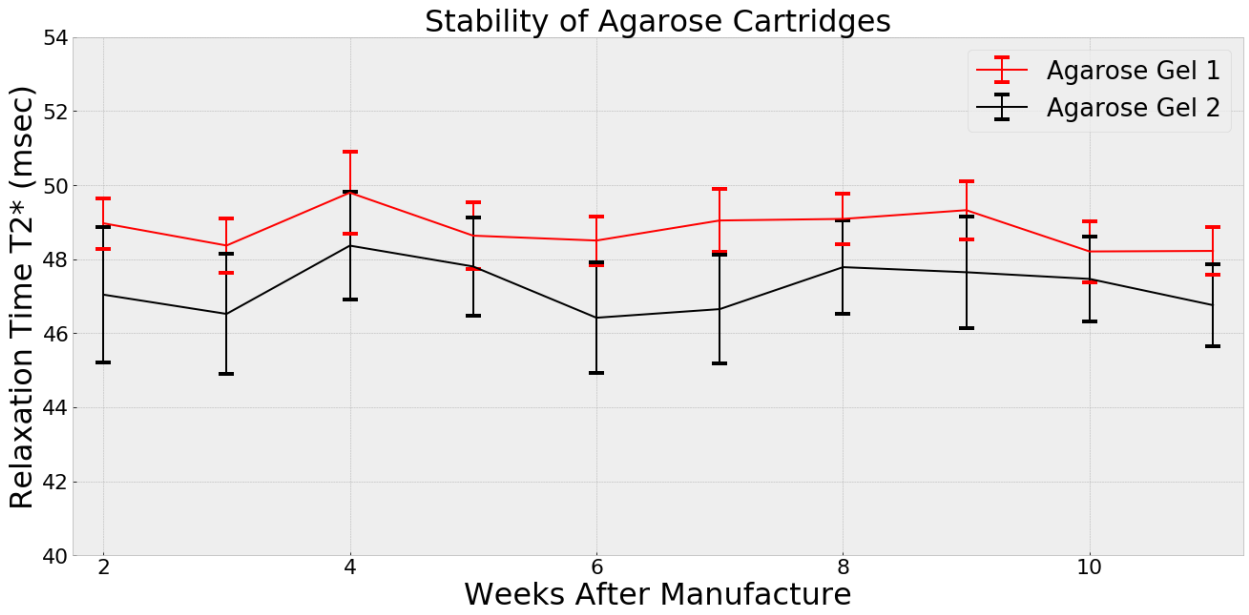
Braindancer® must always be stored in an air-conditioned room. To avoid premature deterioration of the agar, the **Dynamic Phantom** must never be stored in direct sunlight. When transporting, store all components in their containers. Ensure components are not left in cold/hot weather for extended periods of time during transit. Freezing will permanently damage the agarose cartridges.

# Maintenance

Regular maintenance will ensure proper function and prolonged lifespan.

The pnuematic **Air Lines** may show wear at the ends near the fittings. Excess wear and deformation will result in poor fitment and air leaks. Operation under these conditions may hinder performance. Trim approximately ¼” behind a deformed end and reseat the fitting when excessive wear is observed.

The **Agar Cylinder Cartridge** has an expected lifespan of 6 months when properly stored and handled. Replacement is highly recommended after 6 months to insure accuracy.




**Troubleshooting**

Some of the most common problems experienced while working with the Braindancer® system can be remedied by the user. This guide may help you identify and correct a problem with your Braindancer® system. ALA Support is able to assist you with any troubleshooting questions or concerns at support@alascience.com or call 631 393 6401

The **Optical Encoder** signal is unstable or absent:

Are the **Optical Fibers** properly connected to the **Control Box**?

Is the **Control Box** properly powered using the **Power Cable**? The Red LED indicator on the **rear panel** will be powered on when the **Control Box** is properly powered.

Are there kinks in the **Optical Fibers**? Kinks in optical fiber will severely restrict light, possibly damage the fiber and result in signal loss. Proper storage of the fibers will prevent kinks. Do not step on the optical fibers.

Is there debris in the **Optical Fiber** contact points? Debris can be carefully removed using a puff of compressed air. Gently wipe the end of a fiber with a soft cloth if you suspect it is dirty.

Did the **Dynamic Phantom** or **Control Box** recently experience a rapid change in temperature or humidity? Rapid changes in temperature and humidity may temporarily affect the optical signal.

Are the **Optical Fibers** damaged? Optical fibers are very fragile and must be handled with care. Send the **Dynamic Phantom** to ALA for repair if you observe splits or cracks in the fiber or if it becomes detached from the back of the encoder.

The **Dynamic Phantom** does not move when initialized:

Are the **Air Lines** properly connected to the:

**Air Compressor**?
**Control Box**?
**Dynamic Phantom**?

The Dynamic Phantom does not respond to new commands:

Reset the **Control Box**. New commands will be ignored while the **Control Box** is awaiting trigger signals in Run mode.

No movement is triggered during Run:

Is your **Control Box** configured to receive MRI triggers during fMRI? Check that your settings are configured to receive triggers via USB or BNC and that the proper trigger cable is connected.

Is your **Air Compressor** properly connected and pressurized? You will hear audible ‘clicks’ when the **Control Box** valves are actuated. If no movement is observed despite valve actuation upon triggering, increase the regulated pressure.

Was the Run-Out test properly executed? You will see varying values in the log for each movement during correct execution. No change in value during the Run-Out test is indicative of no **Optical Encoder** signal found. Ensure a proper signal is received from the **Optical Encoder** and try again.

The Dynamic Phantom takes longer than 220 ms to complete a Run movement:

Is the regulated pressure provided by the **Air Compressor** below the recommended 90 PSI? Increase the regulated pressure to 90 PSI.

Are your **Air Lines** crossed? Incorrectly connecting the **Air Lines** will result in an 'inverse' movement that may last a few seconds. Abnormally long valve activations and large movements across multiple images (especially if your sequence has a short TR) are indicative of an incorrect **Air Line** connection.

Is there excessive resistance when turning air motor the **Drive Shaft (the transverse shaft at the bottom of the motor)** by hand? The pneumatic gearbox is tuned to tight tolerances. As such, it has a finite lifespan due to wear from normal operation. Wear will result in increased resistance, leading to longer movement time. Friction or jumpy movement on the **Drive Shaft** (felt when manually turning the shaft) indicates that the **Dynamic Phantom** requires a rebuild. Send the **Dynamic Phantom** to ALA for repair.

The Localizer Image is not centered. How will this affect my data?:

The **Dynamic Phantom** will function reliably regardless of its orientation within a coil. The data are useable; however, extra steps must be followed to correct for off-centered placement during analysis. Ensuring that the **Dynamic Phantom** is centered within the head coil and level to the patient table prior to data acquisition will reduce or eliminate the need for position corrections during analysis.

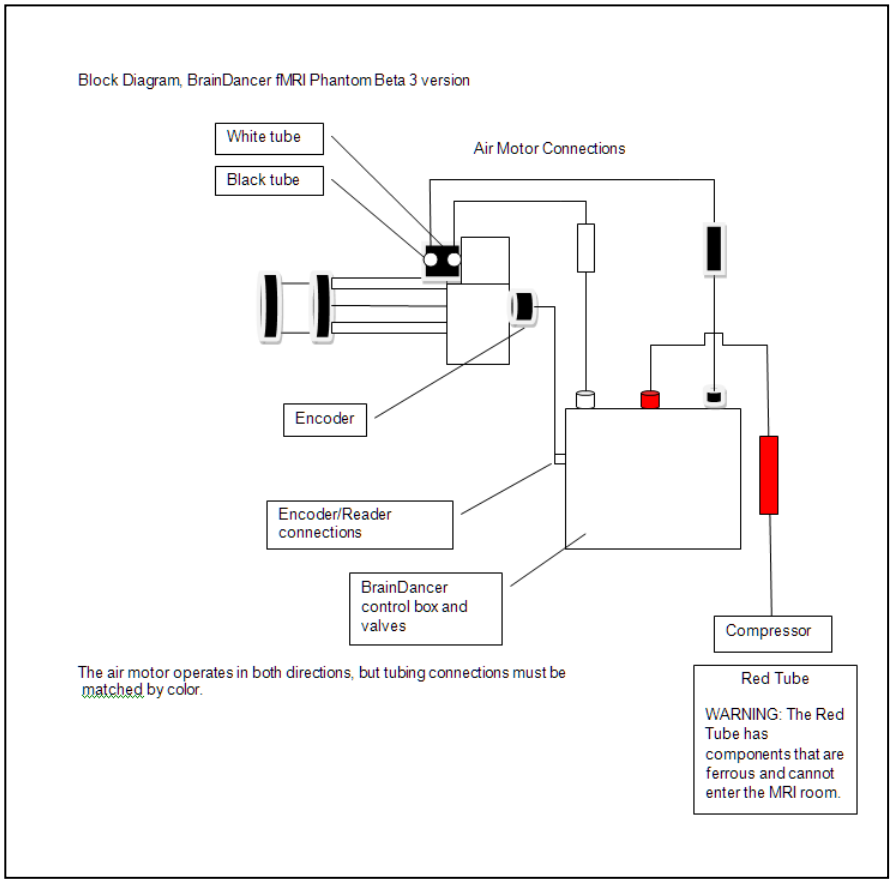
Agar concentrations are no longer discernible:

The agar cylinder will lose signal due to aging or prolonged exposure to extreme temperatures and light . Replace the agar cylinder according to Maintenance instructions.

Do I need to lubricate the **Dynamic Phantom** or **Air Compressor**?:

You do not need to lubricate the **Dynamic Phantom**. Self-lubricating components are used in high wear areas. Refer to the **Air Compressor** manual for manufacturer guidelines on maintaining and servicing the **Air Compressor**.

## APPENDIX A: Installation of the Phantom in the head coil and vital connections



Typical compressor supplied with BrainDancer

The block diagram above indicates the connections that must be made before the BrainDancer can function.

**Appendix A; Section 1**: Compressor set up and air connections to the BrainDancer Control box

Step 1: Unpack the compressor from its packaging. Inspect it for any damage. If any is seen, contact ALA Scientific Immediately or California Air Tools. Follow any instructions that came with the compressor with regard to setting it up. Compressors may come with automatic bleeding valves to drain air periodically to keep the tank dry, those need to be installed properly according to the compressor instructions.

Step 2: Place the compressor within the control room near the BrainDancer Control box. It does not need to be closer than 2 meters, but can be placed right next to it. The compressor needs a mains power connection to a circuit with 15 amps in the US and 10 amps outside with US where local power is 240V. Plug in the compressor and switch it on. It may hiss loudly at first, but will quiet down as it charges. The tank pressure gauge should read around 120psi before the motor shuts off.

Be sure the output pressure is set to 90psi. This can be adjusted with the red knob on the front panel.

Output pressure adjustment, set to 90psi.

Step 3: Be sure the red tube is inserted into the BrainDancer control box. Insert the tube fully until it stops. Make sure the shut off valve is closed, handle will be perpendicular to tube when the valve is closed off.

Some installations where tubing lengths are more than 8 meters will require a booster tank on the input. See below for more information.

Step 4: Plug the red tube quick connector into the front panel of the compressor. This will take some force when the system is new. Make sure it is fully inserted and cannot come out. To remove it you need to push in the sleeve with one hand and hold the fitting firmly in the other. The pressure will pop it out.

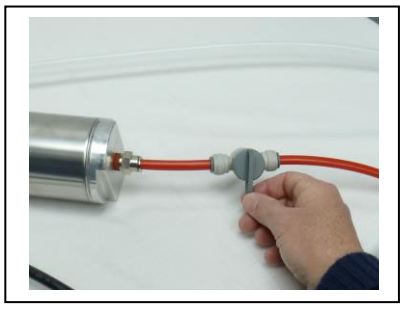
Step 5:  Once the red tube is secure at both ends, Open the valve in Step 3 to allow air to flow into the controller.

**Appendix A; Section 2**: Disconnecting air pressure safely

Step 1:  Close the plastic valve in step Appendix 1.3.
Step 2:  Remove the red tube from the compressor panel by pushing in the brass sleeve and holding the tube fitting firmly in your other hand.  It will pop out and release the pressure in the tube.

Step 3: <u>If your BrainDancer is equipped with a booster tank, you must shut off the plastic valve in step 1.3 above first!</u>  This prevents the rapid release of the booster pressure from the tube as it disconnects from the compressor. Close the valve first, remove the tube from the compressor then gradually turn the valve to release the pressure in the booster tank to atmosphere from the compressor plug-in fitting.

Booster tank required for tubing installations of greater than 8 meters.

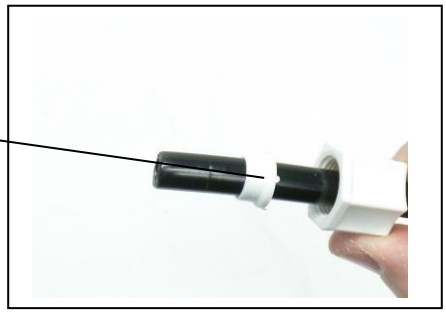


Close this valve prior to removing red tube from compressor. Then, open this valve slowly to safely release air pressure from booster tank.

No air pressure is stored in the BrainDancer controller so when the red tube is discharged so is the control box.

NOTE:  All thread-on plastic fittings have ferrules inside that may be loose from the securing nut, they are not broken, this is how they are made.  Be sure that the ferrule is not lost from the tubing end when handling the tubing.  Loss of the ferrule will result in a leaky seal and failure of the Phantom to run correctly.

Do not lose tube Ferrule!



# APPENDIX B: BrainDancer™ Controller Box Features

Touch Screen, commands BrainDancer Controller.

Fiber optic inputs from Phantom

Red light: power on
Green light: system active

White air tube to Phantom

Black air tube to Phantom

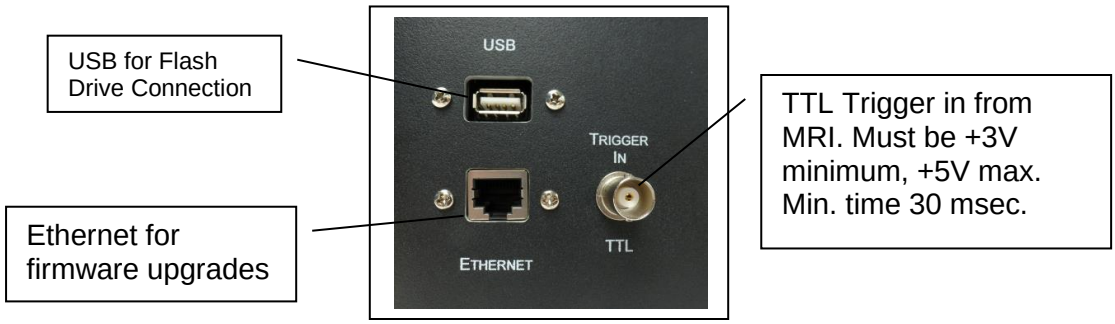
Red air line in from compressor

Valve Ventilation ports

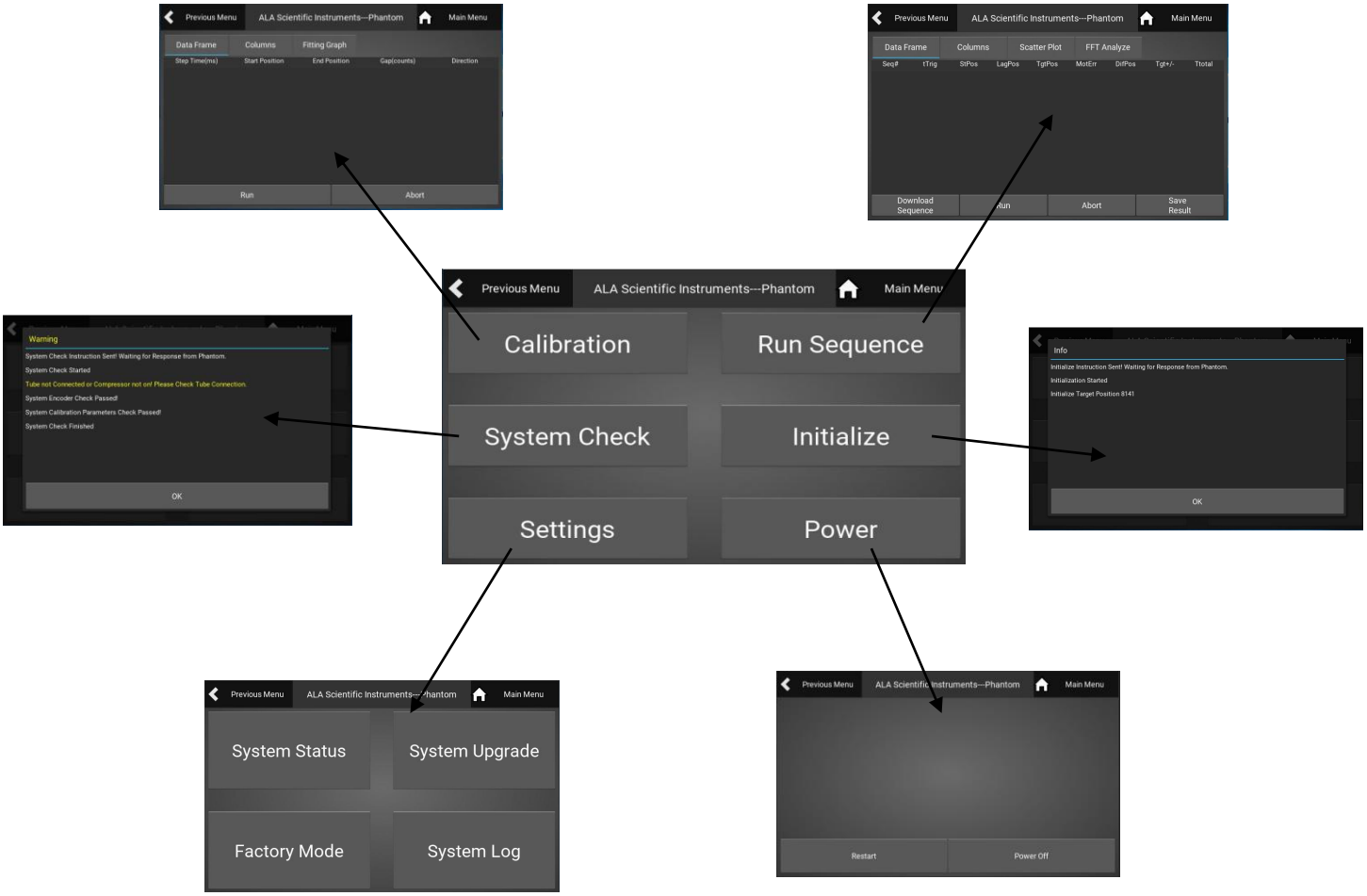
Illuminated Power Switch

Power in, 24V DC
3 Amp. Min.
2.5 x 5.5mm plug

3Amp slow blow fuse




## Appendix C: Software Structure



# Appendix D:  Replacing the Cartridge Assembly

**How To Replace The Agarose Cartridge Assembly**

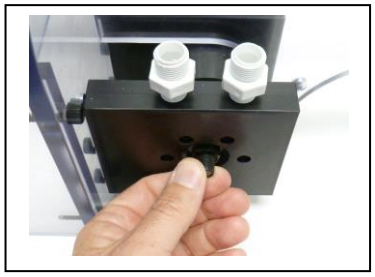
Cartridges should be replaced every 6 months to insure accurate performance.  Contact ALA Scientific Instruments to arrange for shipment or to be placed on an automatic renewal service. Cartridges need to be handled carefully and should not be dropped or exposed to strong physical shock.  Cartridges can be destroyed if they freeze.  They should only be stored in temperature stable environments such as the MRI suite.

A new cartridge is shipped as an assembly of both the inner and outer cartridge ready to be installed.

## Cartridge replacement procedure:

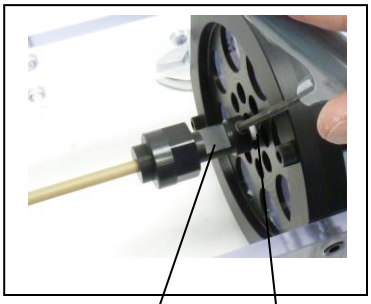
Caution, metal tools will be used for this process and it should only be performed outside the MRI containment.

Step 1



**Step 1:** Rotate the motor shaft by hand so that the wrench flats on Shaft Coupling  are angled at least 20° above even to accept an adjustable wrench.

**Step 2**



Wrench flats on Shaft Coupling offset 20°. From horizontal.

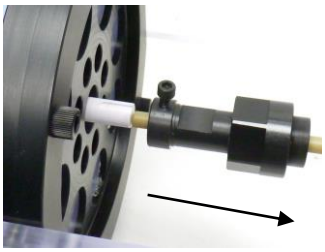
**Step 2:** Use 9/64 Allen key to loosen 8-32 plastic screw that locks into inner cartridge keyway. Rotate the screw CCW at least 4 times.

## Step 3

**Step 3:** Using an 8 inch Crescent adjustable wrench, or similar, secure the wrench flats part of the Shaft Coupling. Grasp the nut portion with your hand and rotate the nut CCW to loosen it. Caution: do not expose Phantom drive shaft to excessive torque.

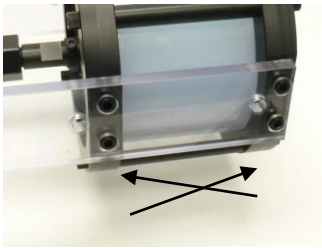
After the initial ½ turn it can be finger loosened

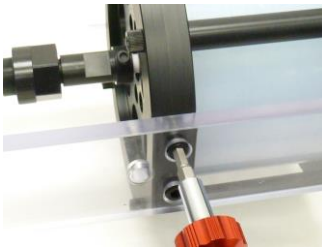
## Step 4

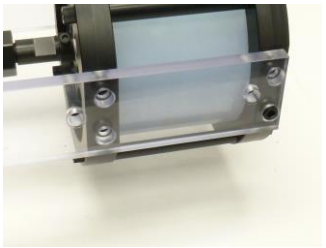


**Step 4:** Slide Shaft Coupling away from Cartridge and onto yellow Drive Shaft.

## Step 5

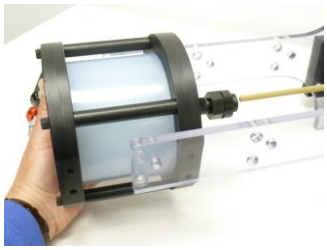






**Step 5:** Remove 7 of the 8 plastic screws that secure the Cartridge Assembly using a 3/16 Allen key. It is best to remove them in an X pattern leaving one screw installed before removing three on the other side…

## Step 6



**Step 6:** Remove the final screw while securing the cartridge with your other hand or a foam support.

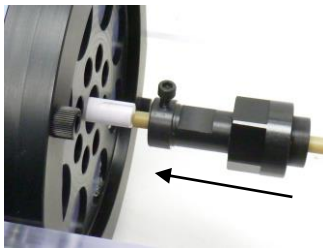
Carefully remove the cartridge assembly and prepare to ship it back to the factory or your supplier for re-cycling.

## Step 7

**Step 7:** Install the new Cartridge Assembly by following steps 4-6 in reverse order.

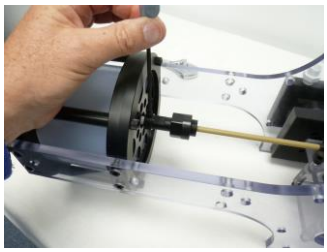
Note: It is best to use a torque driver set to 1-2 ft-lbs to tighten plastic screws.

## Step 8



Slide the coupling back onto the white cartridge shaft.

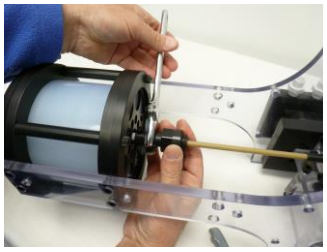
Use your fingers to adjust the 8-32 set screw until its position in the key way slot is confirmed.



Use the Allen Key gently when securing the 8-32 set screw.

**Step 8:** Slide Shaft Coupling back onto the Cartridge Shaft keeping the set screw in alignment with the key-way on the white Cartridge Shaft. To assist in the alignment process, Tighten the black 8-32 screw down to the yellow shaft using just your fingers—then back it off 1.5 turns. This will leave a short length of the screw protruding so it will catch the key-way as you slide it onto the white shaft. Slide the whole assembly onto the white shaft until it stops. Using just your fingers, turn the screw to see if it has gone down into the slot. If you have any doubt, loosen the screw back up a few turns and grab the tail of the White Shaft on the front of the Cartridge. While you hold the black Shaft Coupling, try to turn the cartridge from the tail in the front. As the cartridge rotates, adjust the 8-32 screw downward until you feel it enter the Key Way slot. When you are sure, use the 9/64 Allen key to gently tighten the 8-32 screw into the Key-Way and against the shaft.

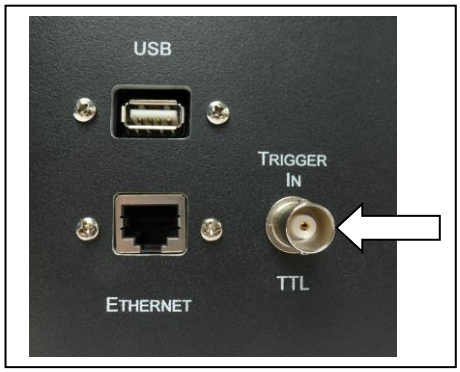
## Step 9



**Step 9:** Hold the Shaft Coupling wrench flats with a wrench and use your hand to lock the Shaft Coupling onto the Yellow Drive Shaft. Firm hand-tight is all that is required, it does not need to be tightened with a tool.

The BrainDancer is now ready to return to service. It is a good idea to write the date of installation on the cartridge with a marker as a reminder of when it will need to be changed.

## Appendix E: Trigger input




The Trigger Input accepts the trigger from the MRI to coordinate the scanner with the BrainDancer. At each TR, the BrainDancer should receive a trigger signal that will initiate a movement. The BrainDancer will move for about the first 200msec of an 800msec TR. The first few slices will be discarded from the data as the BrainDancer was moving when those scans occurred.

The input trigger that comes from the MRI must be at least 20msec long and no less than 3V although a proper TTL is 5V. The BrainDancer will be triggered by the rising edge of the TTL so there is no delay.

If your system does not produce an acceptable trigger or you are limited to a USB trigger, contact ALA for a “Trigger Box” that will condition your signal to a proper TTL.

Warranty Information

Beta Systems , N/A