

# Motion Phantom for MRI Automatic Tracking and Gating



# DISCONTINUED

MRIDIAN® 

## USER GUIDE

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**CIRS**

Tissue Simulation & Phantom Technology

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## **Overview**

The phantom is to be used to validate the capability of Viewray® system to track and deliver a gated treatment based on MRI real time imaging. Dosimetry capabilities of the phantom enhance the validation of the whole Viewray system from the planning phase to the final stage of gated treatment delivery. This phantom was designed in collaboration with Viewray and complies with Viewray Requirements Specification document RQ-0034 Rev C. Refer to Viewray protocol FTP-06 Rev B “Functional Test Procedure” for detailed instructions regarding how to use this phantom with the MRIdian system.

\*Viewray® is a registered trademark (Oakwood Village, OH)

## **Description of the Phantom**

The phantom consists of the following subassemblies/components:

- Custom Linear actuator (modified CIRS model 008A Linear actuator as required by input of project 796-01-00).
- Cross bars (front and back) for Actuator indexing to Viewray system treatment couch.
- Custom Motion Controller box (modified CIRS model 008A Motion Controller as required by input of project 796-01-00 – modified firmware) – includes standard 008A communication cables (USB over Ethernet communication Controller-PC).
- MRI signal generating Body with static non-deformable targets and rigid organs at risk. Ion chamber (Exradin A28)\*\* dosimetry enabled for all targets and OARs. \*\*Other ion chambers are available. Refer to CIRS cavity codes at [www.cirsinc.com/support](http://www.cirsinc.com/support) for corresponding CV number.
- MRI signal generating Moving Rod with one dosimetry non-deformable target and non-dosimetry and non-deformable targets.
- Supports (front and back) to index MRI Body to Viewray system treatment couch. Supports allows Viewray Torso Coils placement around the MRI Body.
- Connector shafts between Actuator – MRI Body
- Shipping cases

- Accessories

*NOTE: The MRI signal generating Body does not include any ferrous or metallic parts except for the ¼-20 – 1” long Brass screws used to fasten the couch indexing pegs to the MRI Body supports. These Brass screws were selected accordingly with Viewray input for model 008V. The closest ferrous or metallic parts to the MRI signal generating Body are the ones from the Custom Linear actuator.*

**Specifications**

MRI signal generating Body

Dimensions: Ø254mm x 236mm (Gel Volume ~Ø229.3mm x 220mm)
Weight: ≈30 lb.
Materials: Body Housing – Acrylic; Body and Body targets – CIRS proprietary gels

MRI signal generating Moving Rod

Dimensions: Ø63mm x 290mm (Gel Volume ~Ø57mm x 254mm)
Weight: ≈4 lb.
Materials: Rod Housing – Acrylic; Rod and Rod target – CIRS proprietary gels

## Use of the Phantom



### A. Unpacking Instructions

Before you open the case check the three **Drop 'N' Tell** indicators on the right side of the case. (**Drop 'N' Tell shipping damage indicator shows when a case has been dropped in transit and contains potential damaged goods. The sensor displays a red arrow when applied before shipping. If the container receives a shock exceeding 25 G force, the sensor display arrows will change to blue. If the sensor has been activated and is blue, a claim may need to be filed with the carrier. If activated, take extra care in inspecting the components as they are unpacked, assembled and tested. Note: If there is any damage to the packaging case, containers, foam, and components, or operation, immediately contact the carrier and the phantom supplier, and keep all packaging for carrier inspection.**)



1. Remove MRI Body/Torso Coils supports and set them aside. Pay attention to the foam trays that accommodate these parts as they are fragile.



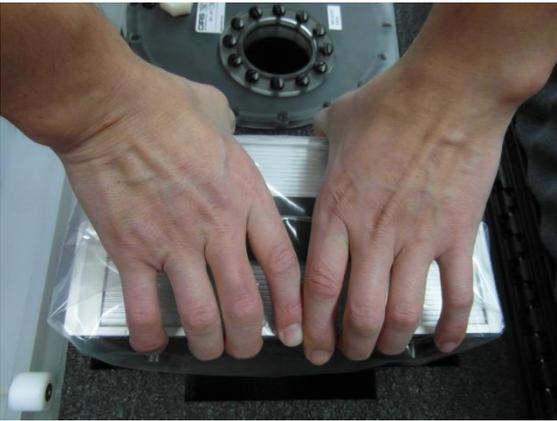
2. Remove cables and accessories bags from case and set them aside.



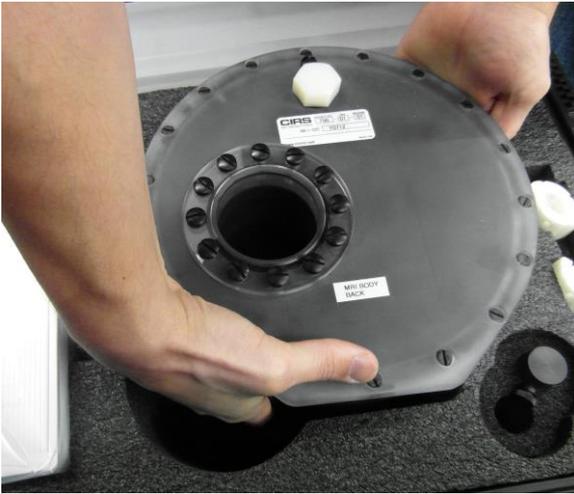
3. Remove MRI Moving Rod and set it aside.



4. Pull base and the actuator assembly from case and set it aside.



5. Remove Motion Controller box from case and then MRI Body Carrying Handle, which is shipped inside of one of the removal cutout of the MRI Body.

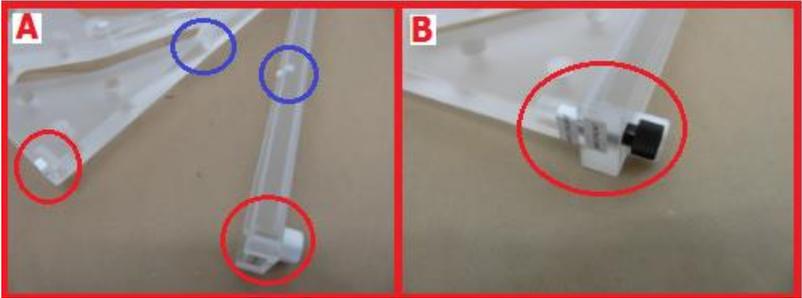


6. Carefully take the MRI Body out from the case and set it aside in a horizontal position laying it on the straight edges of the body's ends.



7. Remove the remaining hardware from the case and set it aside.

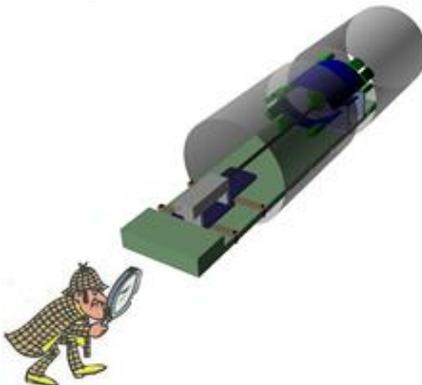
## B. Assembly Instructions

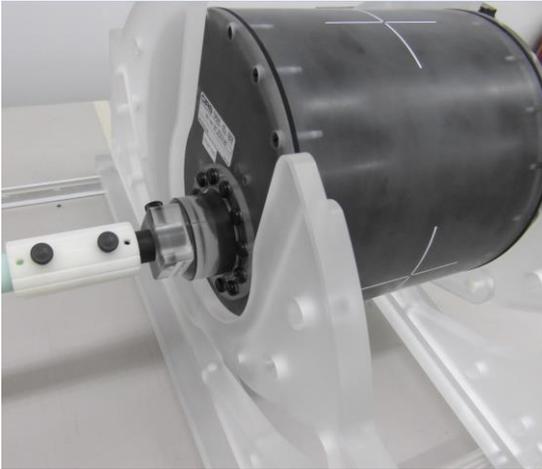


1.

Assemble the MRI Body/Viewray Torso Coils supports and MRI Body crossbars using the alignment pins and corresponding holes (circled in blue) and secure in place with the black  $\frac{1}{2}$ -13 hex nylon screws. Pair the MRI Body/Viewray Torso Coils support with the corresponding MRI Body crossbar, which can be identified by their labels (circled in red).

***Note: Throughout this user manual “Front” and “Back” (for both MRI Body and actuator) are referring to such that “Back” is the furthest from the observer when the phantom is on the couch with the MRI Body toward the gantry and the observer at the end of the couch. Also, to aid in correct assembly of the phantom’s parts the identification/matching labels are affixed only on observer’s right side.***





2.

After indexing the two MRI Body/Viewray Torso Coils support - MRI Body crossbar subassemblies to the Viewray couch ( following the naming convention explained before) place the MRI Body between them as shown above.

Make sure the body slides inside the two supports and is guided by the walls of the recess pockets so that it locks on the flat faces of the MRI Body's ends (see below).

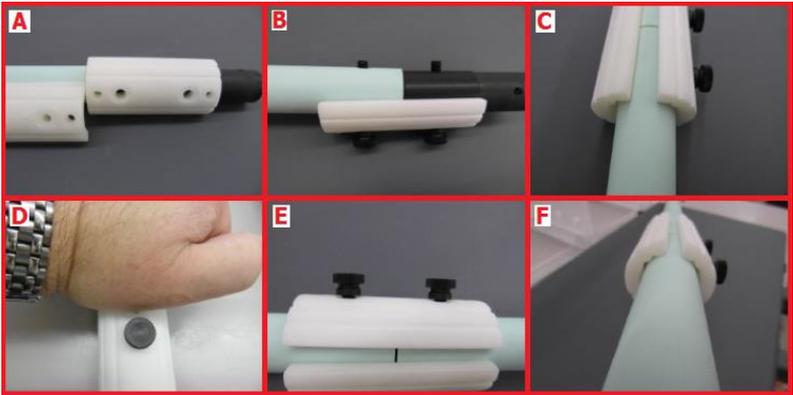


To place the MRI Body on the support use the handle and the straps like shown below (make sure the body do no slips from the straps; carry the body as much as possible in a horizontal position with the straps/handle position in a vertical line/plane with the body's top laser marks).



3.

Position the Linear actuator on the other end of the couch. The crossbars alignment pins and actuator base plate holes facilitate a quick alignment between the Linear actuator and MRI Body (see pictorial A). Secure the linear actuator against tripping using the adjustable legs, which should push against the couch (see circled in blue in pictorial C; screw the adjustable legs through the actuator base plate and into the toggle pads, which are found in the accessories bag).



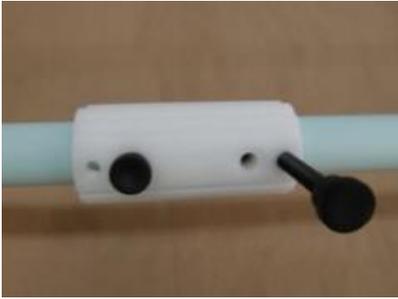
4.

Connect the shafts together and to the actuator push rod following the sequence from the above pictorials.

The recommended procedure is:

- Identify the top connector bridge (white nylon pieces) with un-threaded large holes (pictorial A) and align the holes of shafts/Absylux connectors with the conical posts of the said bridge (pictorial B).
- Pass two  $\frac{1}{4}$ -20 -1.5" long nylon thumb screws through the holes of top connector bridge and shafts/Absylux connectors then screw them in the bottom connector bridge as shown in pictorial C.
- If it becomes hard to screw the thumb screws one can press the whole assembly against a hard flat surface with the bottom connector bridge down (pictorial D) until a result like shown in pictorial E is obtained.
- Tight the thumb screws so that both the top and bottom connector bridges touch the shafts/Absylux connectors. Do not over tight.

*Note: If there is a need to remove the bridge connectors and they seem to be locked on the shafts use the thumb screws to push against (by screwing them in the outer treaded holes) the shaft, which will un-lock them (see below).*



**Seen on the right side when looking toward MRI Body**



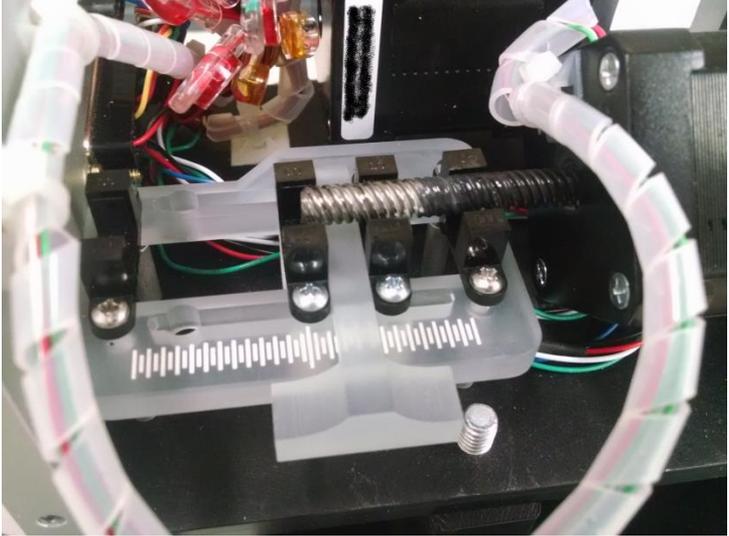
**Support the fiberglass shaft assembly while connecting it to the MRI Moving Rod**

5. For proper alignment of actuator with MRI Moving Rod follow the assembly steps shown above.

### C. Oscilloscope Connection

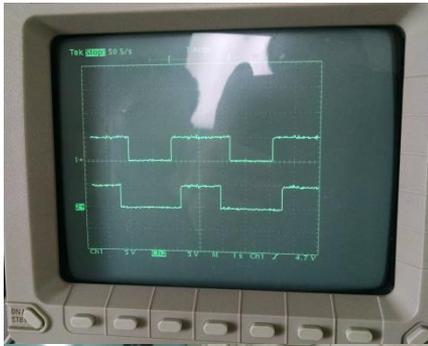
The phantom is equipped with a special feature that allows the end user to check whether there is latency between the position of the MRI moving target and the release of the beam based on MRI imaging of the this target.

To accomplish this task the phantom is equipped with:



I.

An assembly containing two optical switches, which is housed inside of the main linear actuator of the phantom. When the lead screw of the linear motor crosses the optical switches it provides two electrical signals that can be analyzed on an oscilloscope. The signal from each individual optical switch is a square wave as shown below.



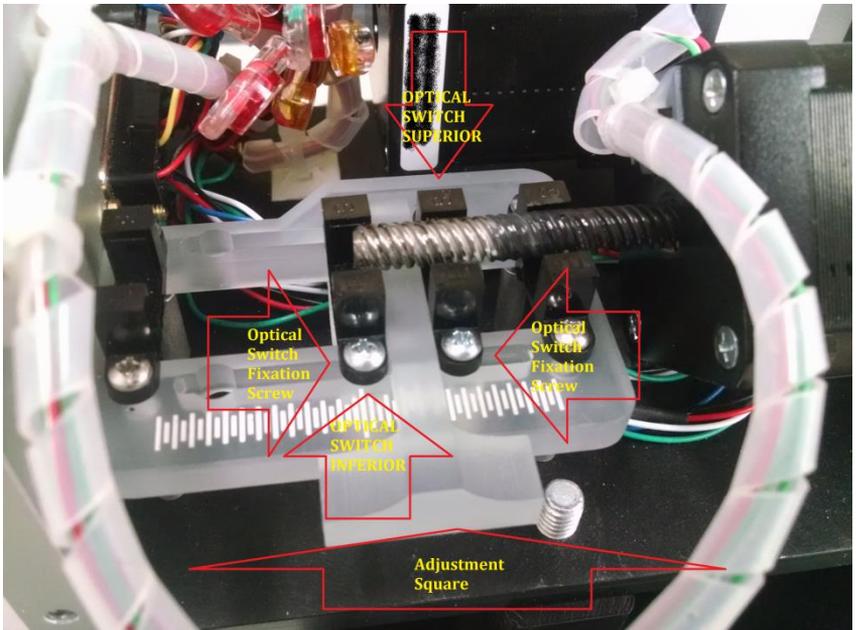
II.

Cable that allows analyzing two signals at once, on channel 1 and 2 of an oscilloscope respectively.

To do adjustments to the signal that is provided by the optical switches and to analyze them on an oscilloscope follow the following steps:



1. Open the cover of the actuator box by unscrewing the aluminum thumb screws (see above) and remove it.



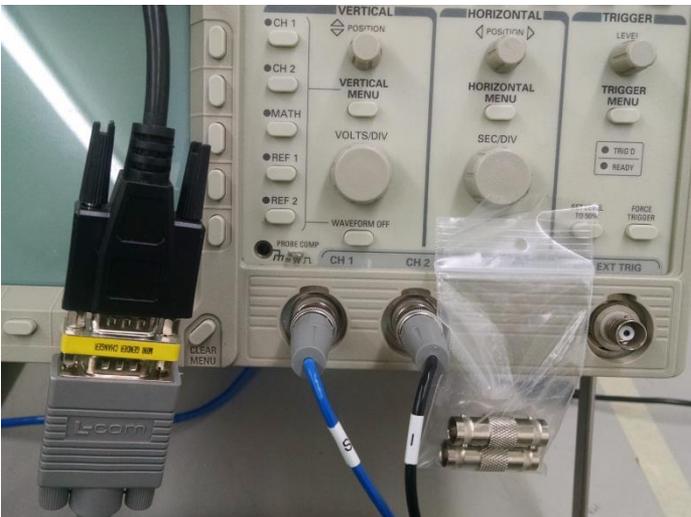
2. Unscrew the Optical switch fixation screw of the two inner Optical Switches and adjust the distance between them according to your research study. Use the Adjustment Square to align the Optical Switches at 90° with respect the slots of the assembly support.

**Note: The position of the outer two Optical Switches is not adjustable. Do not unscrew their fixation screws. These two Optical Switches are used for safety limits of the travel of the linear motion and for the homing sequence.**

- 3. Close the cover of the actuator box by hand tightening the aluminum thumb screws.

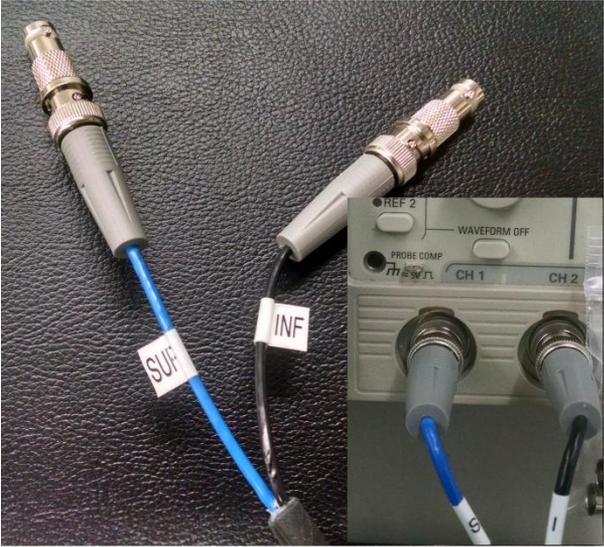


- 4. Connect one of the provided DB9 shielded cable to the DB9 Female connector at the back of the actuator.



- 5. Connect the short DB9 to Oscilloscope cable to the DB9 cable that was connected to the actuator. A DB9 Female to DB9 Female and extra connectors are provided for convenience.

**Note:** The short DB9 to Oscilloscope cable has its oscilloscope labeled as SUP for the Optical Switch that is toward the linear motor and INF for that is toward the back of the actuator due to the fact that the Phantom is designed for “Supine Head First”. As shown below it is recommended that SUP signal is analyzed on Chanel 1 and INF on Chanel 2 of the oscilloscope.



### D.. Repacking Instructions

User should try to follow the unpacking steps in a reverse order.

## ***Included with Model 008V***

- (1) Base Plate with Linear Actuator mounted (with 2 Adjustable Legs already mounted)
- (1) MRI Moving Rod
- (2) Motion Transmission Shaft
- (1) MRI Body/Torso Coils Front support
- (1) MRI Body/Torso Coils Back support
- (1) Bag with mandatory fasteners: 4 x Nylon Socket Head Cap Screw 1/2"-13 Thread, 1-1/2" Length, Black 6 x 1/4-20 1.5" long Nylon Thumb Screw, 1 x 1/4-20 1" long Nylon Thumb Screw
- (1) CIRS Motion Control Software USB Drive
- (1) Motion Controller Power cord
- (1) Cable Kit, CAT5e - 75 feet with USB 3.0 Gigabit Ethernet Adapter
- (1) Oscilloscope Cable [VGA to DB9/4BNC Breakout cable Male
- (2) DB-25 male to male cable (EMI Shielded)
- (2) DB-9 male to male cable (EMI Shielded)
- (2) Gender Changer DSUB 9POS F-F
- (1) Gender Changer DSUB 25POS F-F
- (1) User's Guide
- (1) Motion Controller Box
- (1) MRI Body
- (1) MRI Body Carrying handle (with 2 straps already mounted)
- (1) Linear Actuator Crossbar Front
- (1) Linear Actuator Crossbar Back
- (2) MRI Body Crossbar
- (3 sets) Connection bridges for Motion transmission Shaft (2 parts per set)
- (1) Connector Motion transmission Shaft-to-MRI Moving Rod
- (1) Nonsparking (nonmagnetic) Hex L-Key 3/8" Hex Size, 4-1/2" Long
- 10-24x1" (5); Nylon Hex Screw 1/2-13x1.5" (2)

## ***Included with Model 008V***

- (2) 2 amp fuses
- (1) Extra fasteners pack (min quantity in brackets): Nylon Thumb Screw ¼-20x1.5" (6); Nylon Thumb Screw ¼-20x1" (2); Nylon Pan Screw ¼-20x5/8" (2+2 with O-rings); Nylon Pan Screw 10-24x3/4" (8); Nylon Pan Screw 10-24x1" (5); Nylon Hex Screw 1/2-13x1.5" (2)

## ***Care & Handling***

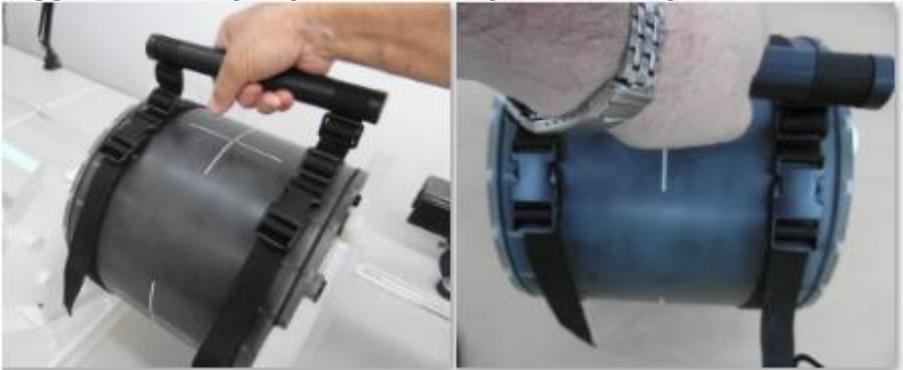
### **Cleaning:**

The phantom is manufactured from acrylic. It is recommended that the phantom only be cleaned with mild soap and water.

Caution: DO NOT USE ANY ABRASIVES, ALCOHOL OR SOLVENTS ON THE PHANTOM. These will damage your phantom.

### **Carrying:**

- *Short Distances* (between couch and plastic storage case) - Use the provided handle and straps to lift MRI Body from Coils Support and carry it (horizontal only - see below).



- *Long Distances* - Use as much as possible the plastic storage/shipping case. Make sure the MRI Body is fully secured inside the case by using the appropriate foam blocks as seen below.



### **Long Term Storage:**

For longest life, the MRI Body and Moving Rod should be stored at room temperature. These phantom parts **SHOULD NOT** be subjected to freezing or boiling conditions such as those encountered in the trunk of a car during a South Dakota winter or Arizona summer. If MRI Body and Moving Rod are accidentally frozen or heated, bring them back to room temperature prior to use (usually takes 24 hours).

The MRI Body should be stored in its plastic carrying case.

## ***Warranty***

<b>Product</b>	<b>Warranty Period</b>
Model 008V: Viewray Dynamic Phantom	02 Months

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Specifications subject to change without notice.