T h e P h a n t o m L a b o r a t o r y

3D Fusion Cube SMR356 and SMR357 M a n u a l

WARNING

1. The use of this phantom requires radioactive fill solutions. Only people trained in the safe handling of these materials following all applicable safety requirements should fill and use this phantom.

2. This product has an FH3-4 mm/min flame rating and is considered to be flammable. It is advised not to expose this product to open flame or high temperature (over 125° Celsius or 250° Fahrenheit) heating elements.

The Phantom Laboratory

3D Fusion Cube SMR356 and SMR357 Manual

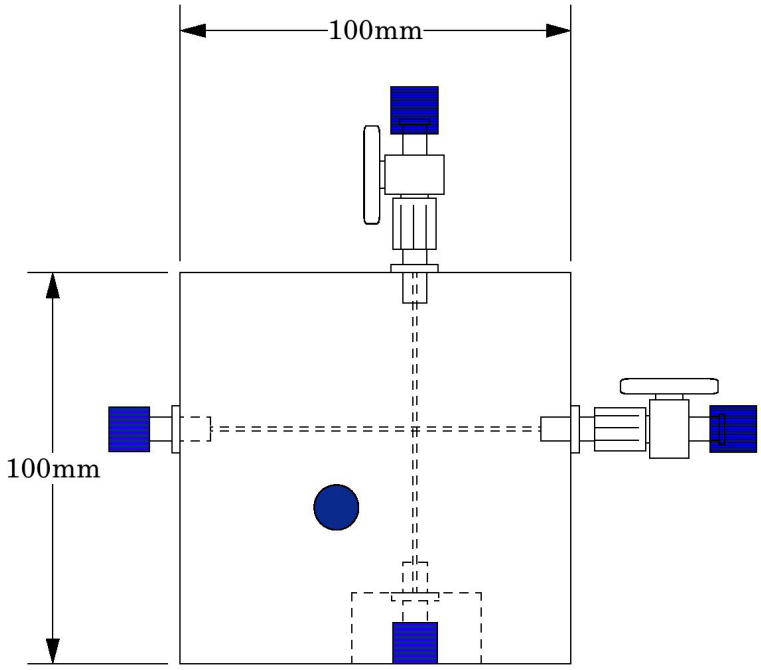
Introduction

This phantom has been developed in conjunction with Steve Dyer, MHS, and David Goodenough, Ph.D. for the purpose of testing image fusion between CT and PET and CT and SPECT imaging systems.

Because each medical imaging facility has its own unique set of requirements, we do not make specific recommendations on the content of your quality assurance program. We suggest a review of local governing regulations, manufacturer's specifications, and the needs of your clinicians and physicists before developing your Fusion Imaging Quality Assurance Program.

3D Image Fusion Perpendicular Cube, SMR356, Description

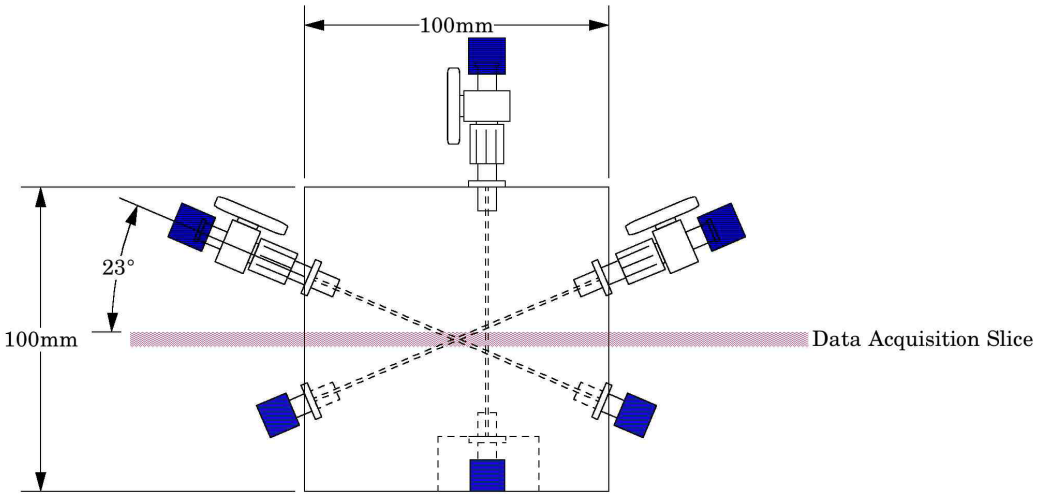
The 3D Image Fusion Perpendicular Cube consists of a 10cm clear urethane cube with three 1mm diameter channels each fitted with standard Luer connections designed to be filled with a radioactive solution. Inserted into each channel is a 0.4mm diameter steel wire. When imaged with a CT scanner, the wire creates a high contrast image. When imaged with SPECT or PET, the radioactive solution creates a high contrast image. By fusing the two images and comparing the positions of the wires and channels, the registration can be accurately verified and misregistration measured. By reconstructing an axial, coronal, and sagital image through the cube, x, y, and z fusion can be measured and verified.



SMR356 Fusion Cube

3D Image Fusion Ramp Cube, SMR357, Description

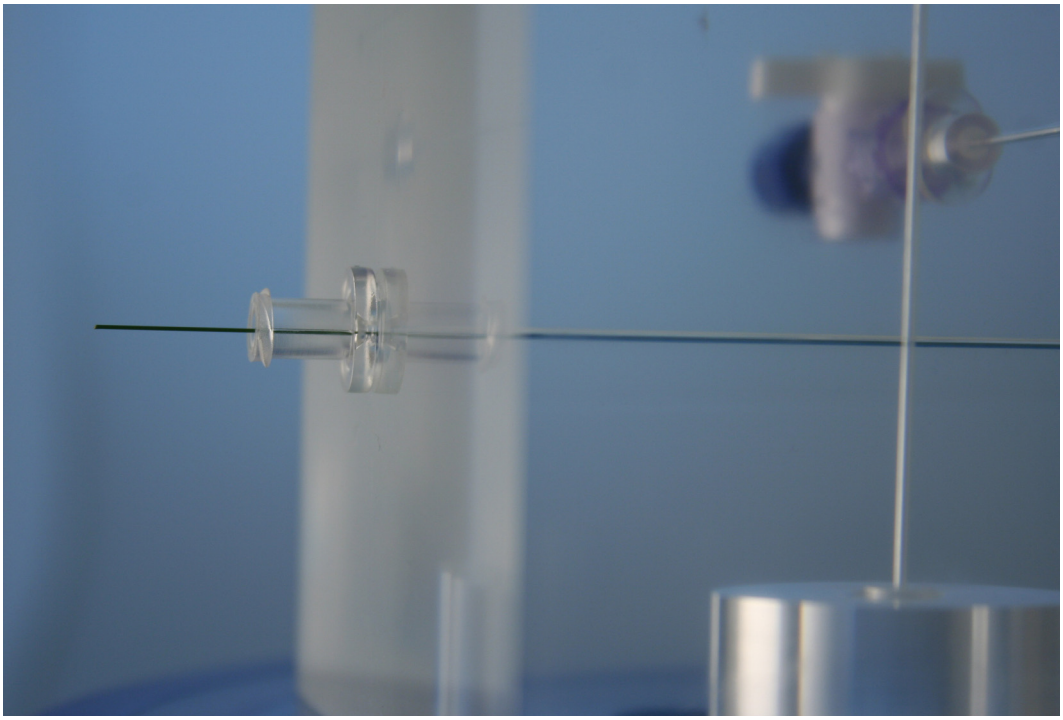
The 3D Image Fusion Ramp Cube consists of a 10cm clear urethane cube with three 1mm diameter channels each fitted with standard Luer connections designed to be filled with a radioactive solution. Inserted into each channel is a 0.4mm diameter steel wire. In this cube the ramps are set at 23° angles in order to bisect the fused scan slice. When imaged with a CT scanner, the wire creates a high contrast image. When imaged with SPECT or PET, the radioactive solution creates a high contrast image. By fusing the two images and comparing the positions of the wires and channels, the registration can be accurately verified and misregistration measured.



SMR357 Fusion Cube

Inserting the wires

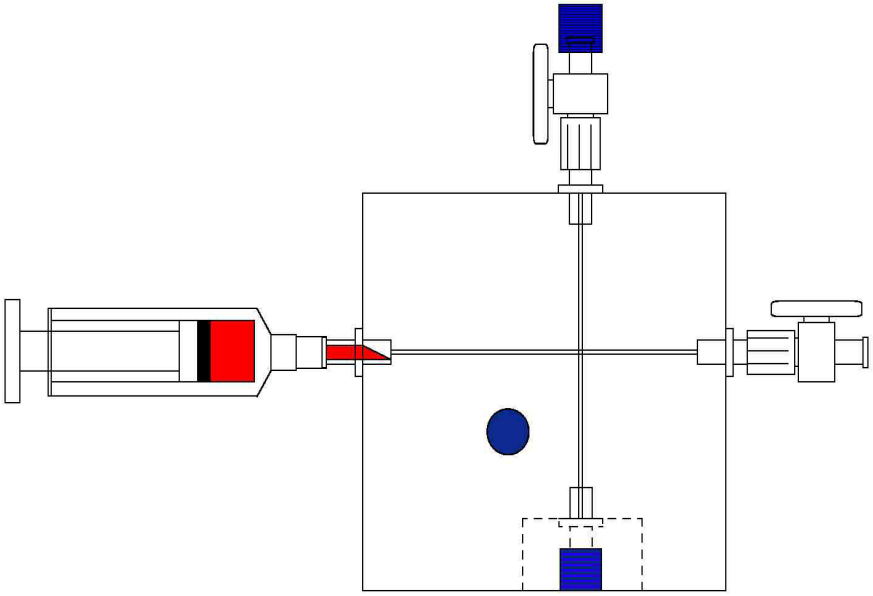
The Fusion Cube is supplied with 3 wires inserted into the cube. The wires may be removed for cleaning after use. Before using the phantom, the wires need to be slid into the vessels as illustrated below.



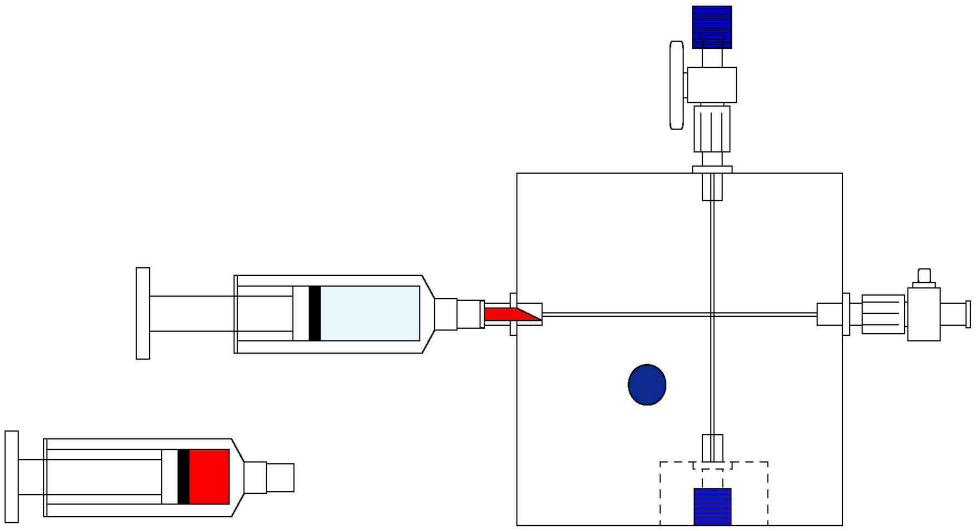
Wire inserted into empty vessel

Filling the vessels

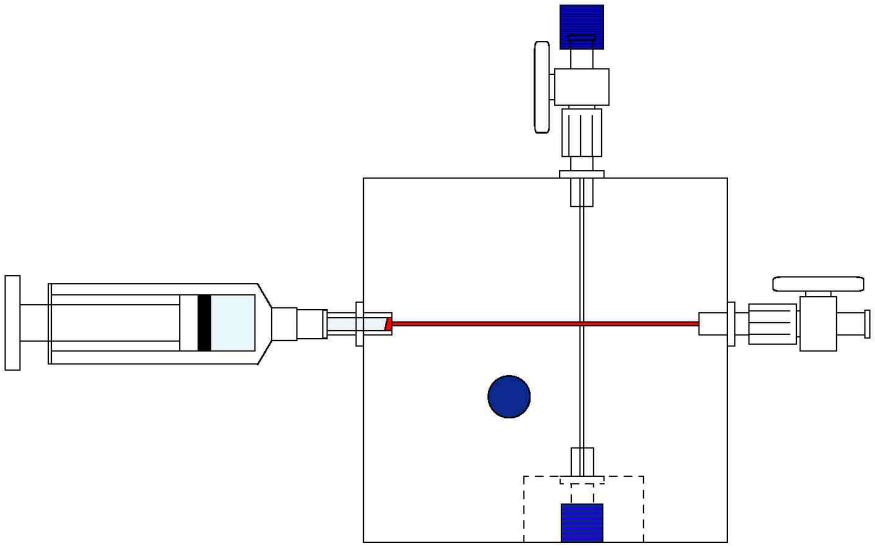
Before filling make sure the .4mm wires are inserted into the vessels. Carefully fill a syringe with a concentrated solution of ^{99m}Tc or (^{18}F). The solution should be around 0.8cc in volume with a concentration of about 148-296 MBq/ml (4-8 mCi's/ml). If any dilution of the solution is required or if any coloring dye is added, make sure the solution is well mixed. Adding dye to the solution makes it easier to view the filling process.



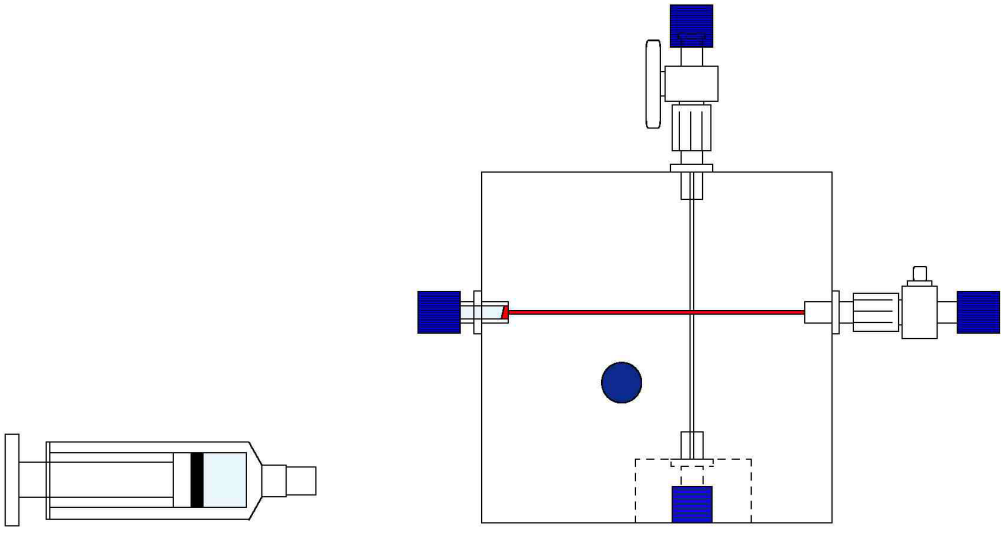
1. Remove the blue caps and open the valve on the vessel to be filled. With the needle removed attach the syringe on the Luer of the vessel. Inject about a third of the solution into the vessel partially filling the Luer connector.



2. Close the valve and remove the syringe.



3. Attach an empty syringe with the plunger about half way removed. Open the valve and inject air into the vessel so the hot liquid fills the 1mm vessel. Close the valve, remove the syringe and cap the Lure connectors.

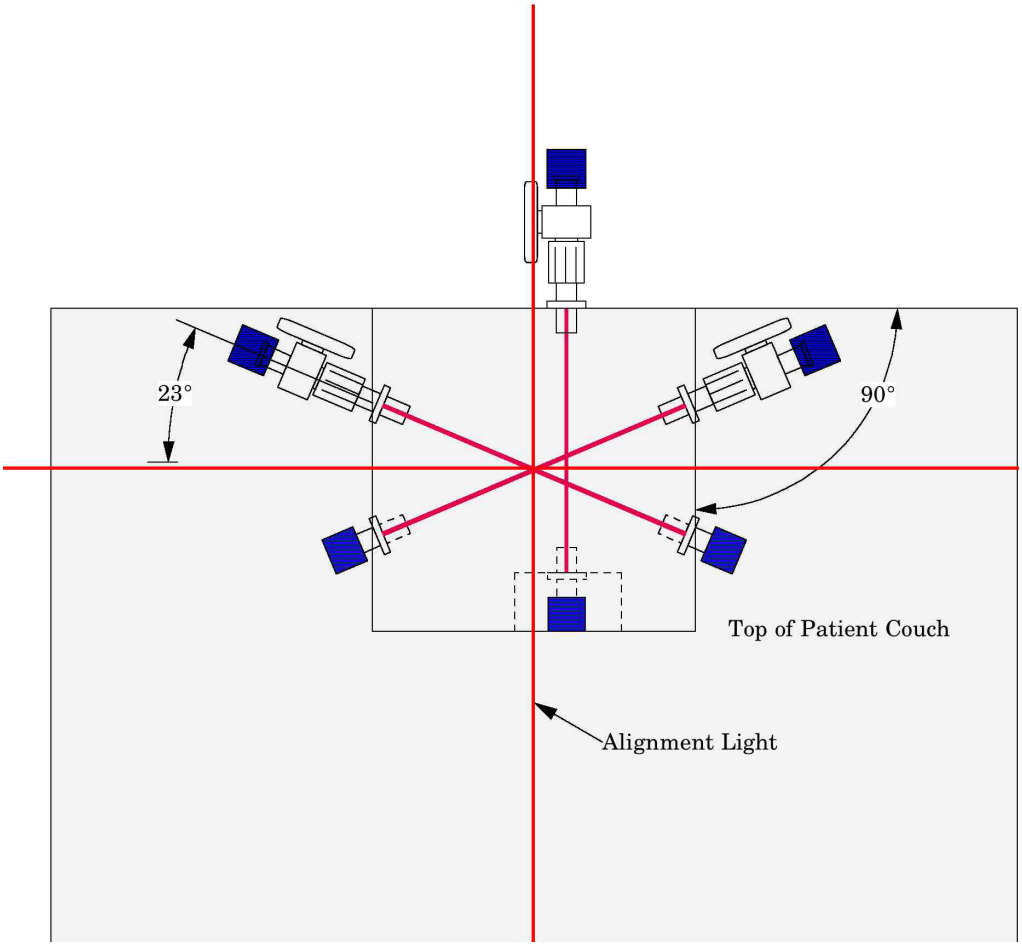


Repeat these steps on the other two vessels.

Phantom positioning for scanning

Use either the table alignment marks or the edge of the table to align the cube ensuring that the cube is parrallel with the scan slice.

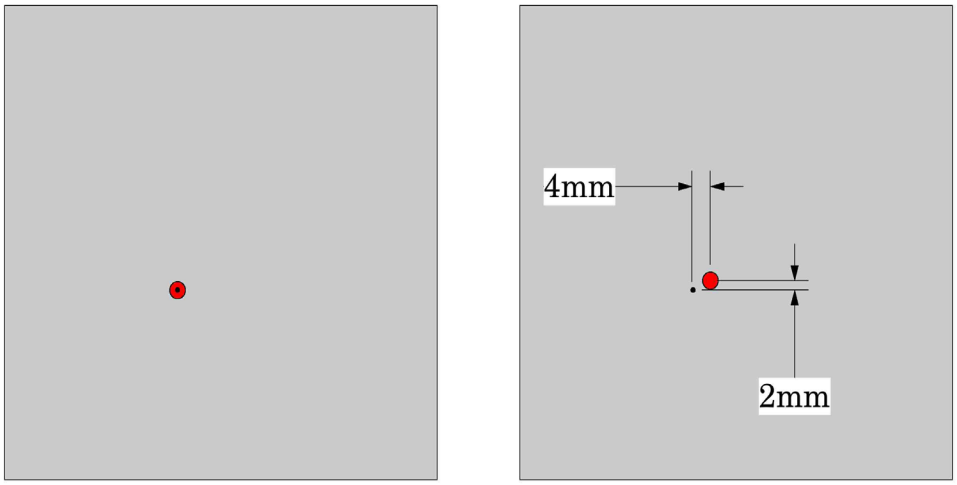
For the SMR357 Cube it is important to scan through the plane that bisects the two angled ramps as illustrated below.



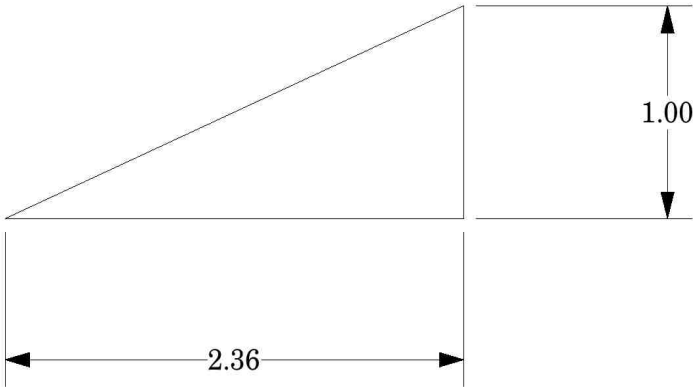
After positioning the Cube perform both PET or SPECT and CT scans through the cube volume.

Measurement of fusion alignment from Cube images

To identify fusion alignment or measure misalignment with the 3D Perpendicular Image Fusion Cube, SMR356, select images that are perpendicular to the vessels' axes. Then measure from the center of the hot image of the vessel to the center of the wire image on CT to evaluate alignment in the scan plane axes.



The image on the left above illustrates good fusion alignment and the image to the right illustrates 2 and 4mm off alignment depending on the axes. Measurements of x, y and z fusion alignment are made from, axial, sagittal and coronal image slices through the phantom.



2.36 * .42 =1

The 3D Image Fusion Ramp Cube, SMR357, has opposed ramped vessels that rise through the image slice. These angled vessels offer information on both alignment of the test object with the slice and information on the slice geometry. There is a long history of using slice thickness ramps in tomographic imaging for the measurement of slice thickness. In the Ramp Cube the vessels are 23° from the scan slice plane. The 23° provides a magnification in the image in respect to the z-axis length of approximately 2.5 times. By applying a conversion factor of .42 we can accurately measure z-axis data in the x and y plane.

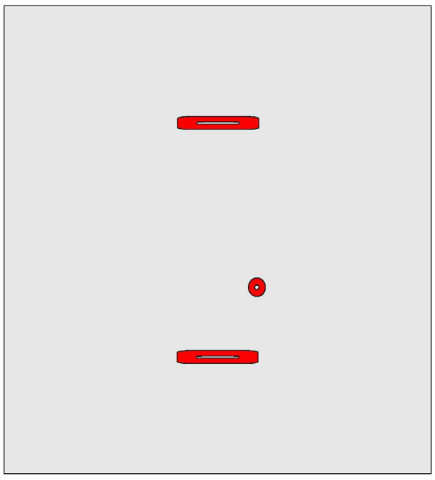


Image with good alignment x, y and z

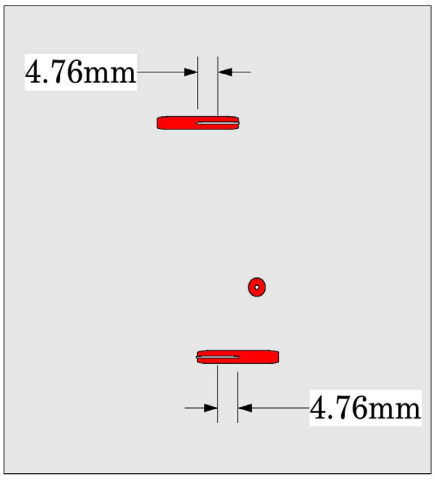


Image with good alignment x, y and off in z axis by 2mm. The measured offset 4.76mm is multiplied by the scaling factor .42 to get 2mm

To identify fusion alignment or measure misalignment with the 3D Image Fusion Ramp Cube, SMR357, select an image that is perpendicular to the 90° vessel and bisects the two 23° ramped vessels. The x and y fusion can be verified by measuring the alignment of the center of the hot image of the perpendicular vessel to the center of the perpendicular wire image on CT image. The z fusion is measured by locating the center of the opposing 23° hot vessels and measuring the distance from them to the center of the 23° wire images on the CT scan. This measurement must be multiplied by .42 to compensate for the 23° scaling factor.

Bibliography

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Eur J of Nucl Med (1999) 26:527-532

WARRANTY

THE PHANTOM LABORATORY INCORPORATED ("Seller") warrants that this product shall remain in good working order and free of all material defects for a period of one (1) year following the date of purchase. If, prior to the expiration of the one (1) year warranty period, the product becomes defective, Buyer shall return the product to the Seller at:

The Phantom Laboratory Incorporated
2727 State Route 29
Greenwich, NY 12834
or
PO Box 511
Salem, NY 12865-0511

Seller shall, at Seller's sole option, repair or replace the defective product. The Warranty does not cover damage to the product resulting from accident or misuse.

IF THE PRODUCT IS NOT IN GOOD WORKING ORDER AS WARRANTED, THE SOLE AND EXCLUSIVE REMEDY SHALL BE REPAIR OR REPLACEMENT, AT SELLER'S OPTION. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT. THIS LIMITATION APPLIES TO DAMAGES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, DIRECT OR INDIRECT DAMAGES, LOST PROFITS, OR OTHER SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER FOR BREACH OF CONTRACT, TORT OR OTHERWISE, OR WHETHER ARISING OUT OF THE USE OF OR INABILITY TO USE THE PRODUCT. ALL OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANT ABILITY AND FITNESS FOR PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.