ECTphan™ Phantom SMR330 M a n u a l

WARNING
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.

When inserting the ECTphan™ Phantom end plate, follow the instructions listed in this manual. Do not use the nylon screws to set in lid.

To prevent damage to your ECTphan™ Phantom do not let it freeze when filled with a solution.

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.

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.

ECTphan™ Phantom M a n u a l

Introduction

This phantom has been developed in conjunction with Steve Dyer, MHS and David Goodenough, Ph.D., for the purpose of monitoring image quality for single photon emission tomography (SPECT) systems. It can be used in the application of both manual and automated types of image evaluation.

The ECTphan™ Phantom can be used to evaluate the following SPECT system parameters: reconstructed uniformity, spatial resolution, low contrast resolution, pixel size, slice width, and center of rotation (COR). Additionally, the ECTphan™ Phantom data is suited for computer based analysis for the system parameters listed above.

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. This manual includes proposed solutions and test parameters to give you ideas for possible program content. We suggest a review of local governing regulations, manufacturer's specifications, and the needs of your clinicians and physicists before developing your SPECT quality assurance program.

ECTphan™ Phantom Description

The ECTphan™ Phantom is a cylindrical, liquid filled container with a variety of tests. The tests are located in three different areas: the end plate mounted inserts #1 and #3, the test plate area #2, and the center uniformity section #4.

The phantom enables some flexibility in its configuration. There are 4 threaded holes that can each hold the different insert plugs in central or 75mm offset positions. There are also blank SMR168 plugs for use when other tests are not required or a larger uniformity area is desired. There are options on how ECTphan™ Phantoms are configured. They are either supplied with fillable "hot" low contrast inserts or solid "cold" inserts. See the "Low Contrast Inserts" section of this manual for more details. The resolution plates can also be removed by removing the 4 nylon retaining screws, which are accessed by removing the ported tank end.

Overall dimensions:

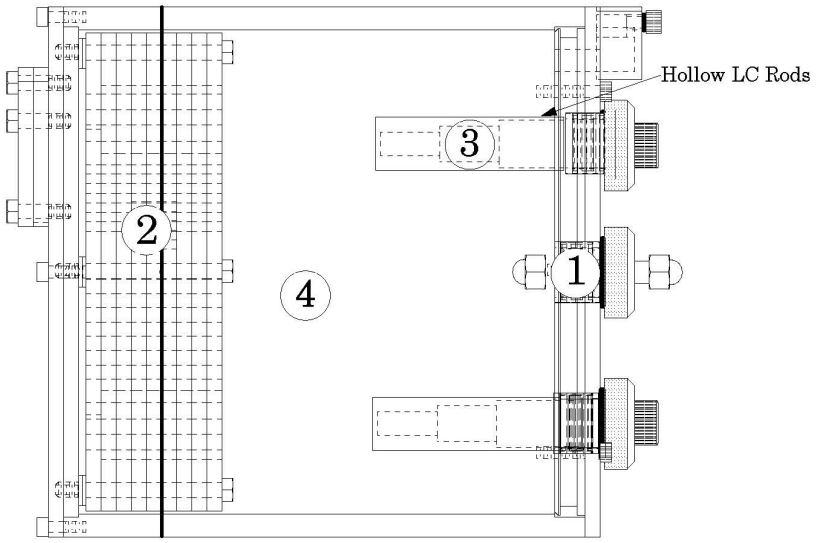
Diameter	20.3cm ID, 22.2cm OD
Length	20.0cm ID, 23.2cm OD

Composition:

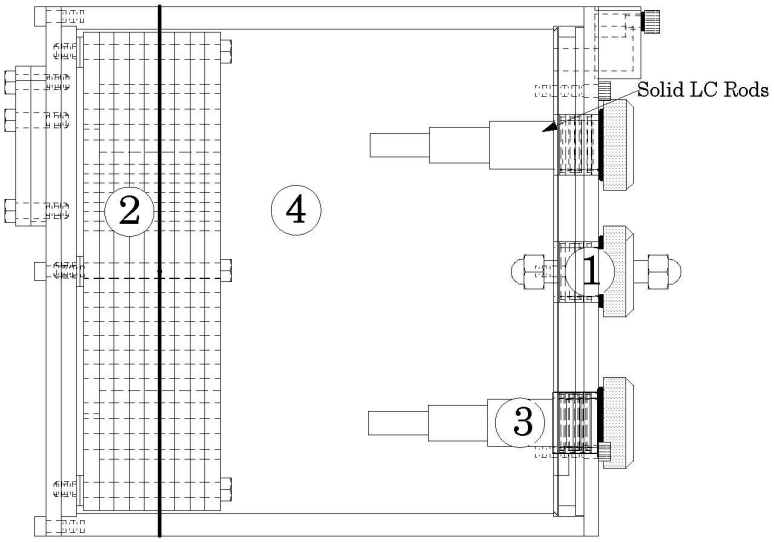
Acrylic housing and acrylic and polycarbonate inserts (liquid filled)

Phantom test sections:

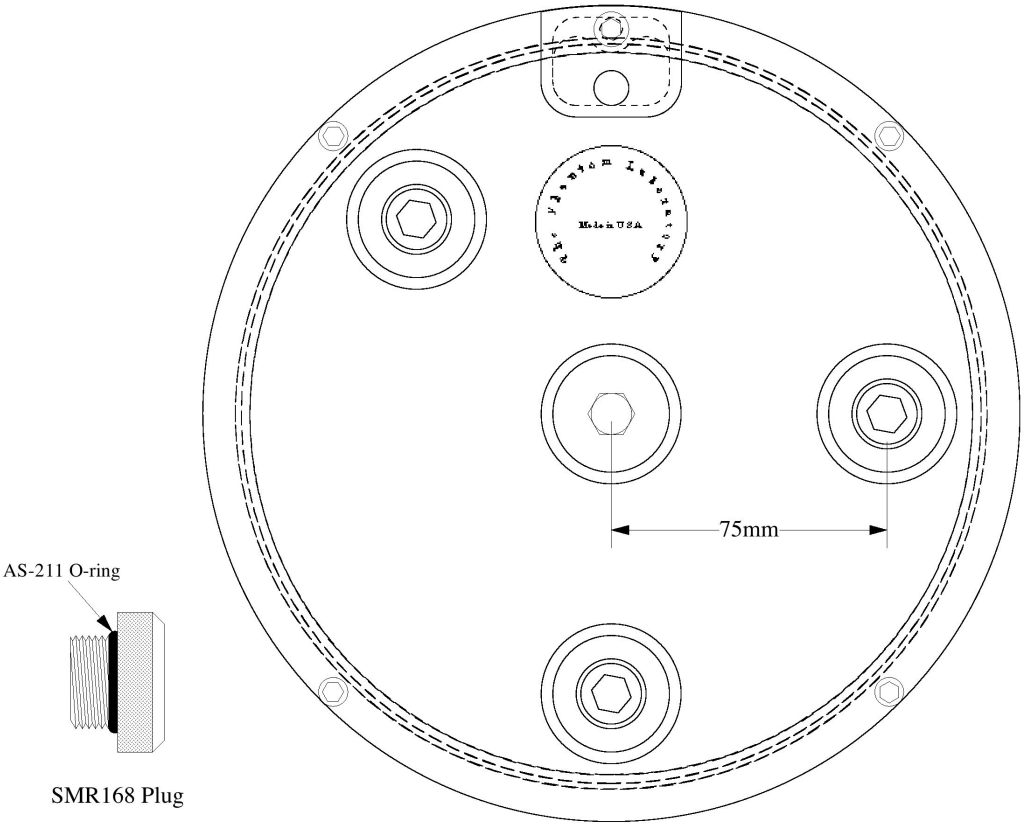
1. Point spread function insert
2. Pixel size, slice width, spatial resolution section
3. Low contrast (3) inserts (hollow and solid rods)
4. Uniformity section



ECTphan™ Phantom shown with hollow low contrast rods



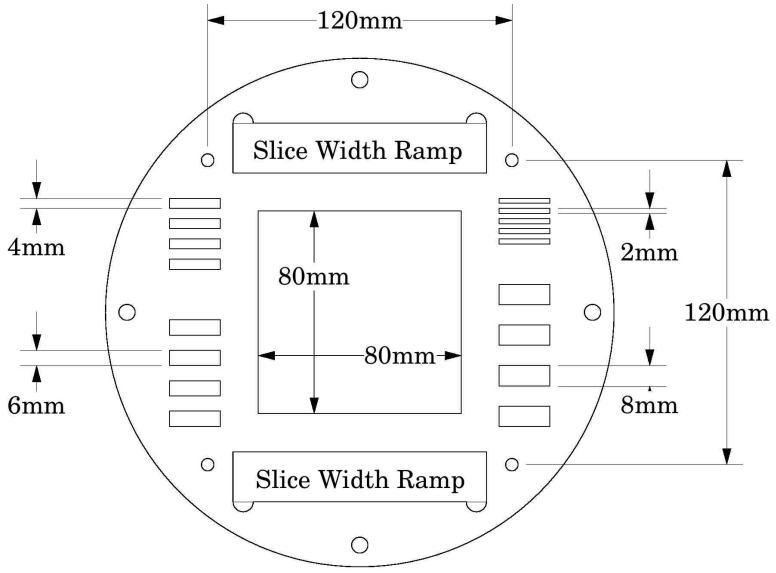
ECTphan™ Phantom with solid low contrast rods



End plate with four test rod locations which can also be plugged with the SMR168 plugs.

Pixel size, slice width, and spatial resolution test section

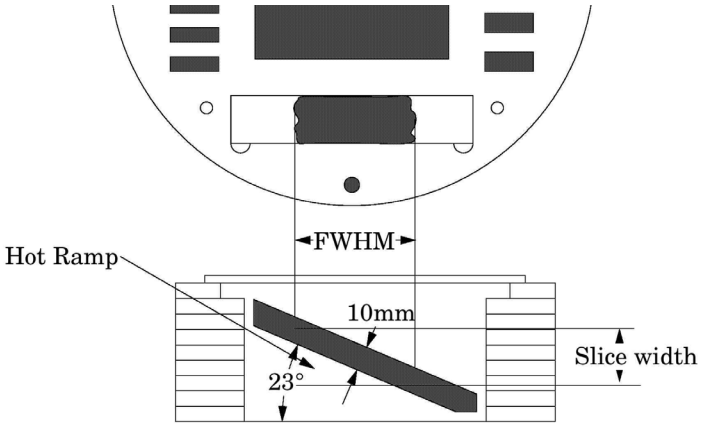
Pixel size determination is based on linear measurements of the 4 “hot” holes spaced at 120mm apart in the x and y axis. Spatial resolution is measured using “bars” of 2, 4, 6, and 8mm “hot” and “cold” spacings.



Pixel size, slice width and spatial resolution test section

Slice width measurements are based on count profiles of the opposed angled ramps. These “hot” ramps are generated by a fluid filled 10mm by 10mm square channel angled 23° from the x, y, or transverse plane. Using a trigonometric conversion of the measured ramp profile, the z dimension of the image volume can be verified.

To measure the slice width, measure the full width at half maximum (FWHM) of the ramp profile. Then multiply the measured FWHM of the ramp image by 0.42 to determine the thickness of the slice volume (slice thickness or slice width). The maximum slice thickness that can be measured is 34mm due to the limited ramp length provided in this section.



FWHM * 0.42 = Slice width

Uniformity test section

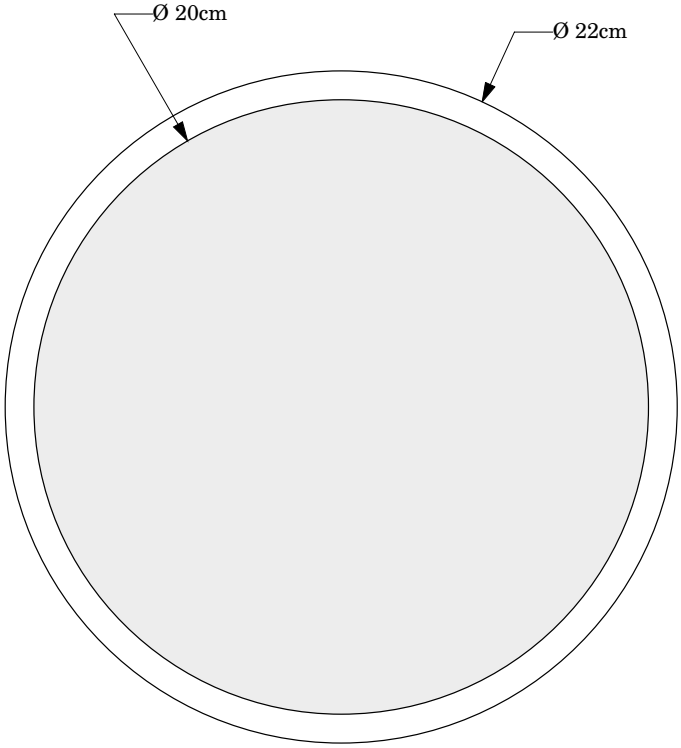
Reconstructed image uniformity can be evaluated by visual inspection for artifacts and nonuniformities. Also, the image from this section can be used for quantitative measurements as follows:

1. Reconstructed image uniformity - integral uniformity is determined from the maximum and minimum pixel values in a central region of interest (ROI).

2. Noise Statistics Measurements - rms noise (%) is calculated for a central ROI or multiple ROIs using the mean and standard deviation statistics computed for these ROIs.

$$\text{Integral Uniformity}(\%) = 100\% \times \frac{\text{Maximum - Minimum}}{\text{Maximum + Minimum}}$$

$$\text{rms noise}(\%) = \frac{\text{Standard deviation}}{\text{Mean pixel value}} \times 100$$

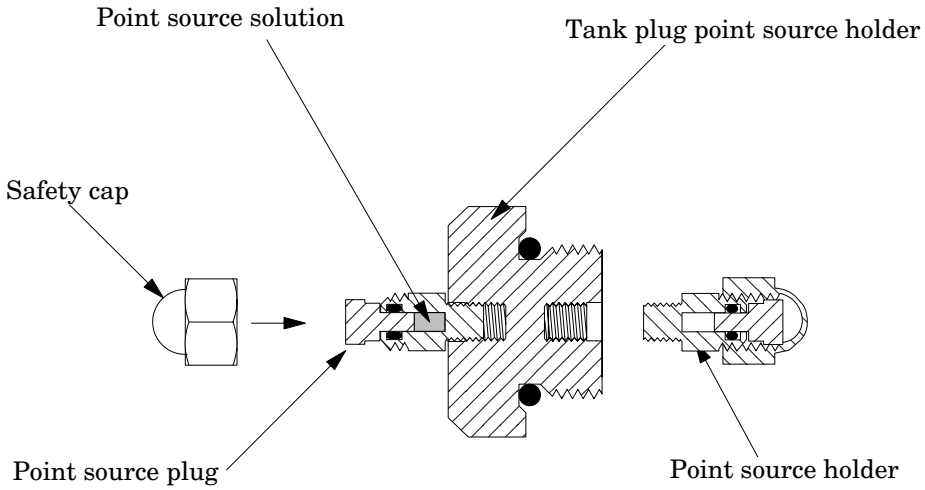


Point source test insert

The point source holder can be positioned and imaged at the phantom center. The holder is designed for imaging the point sources in air and with scatter. From the reconstructed point source data, a point spread function (PSF) is generated and the full width at half maximum (FWHM) and full width at tenth maximum (FWTM) values are measured. The modulation transfer function (MTF) can be generated from the PSF if software is available.

The external point source insert can be used to evaluate tilt of the camera heads. This is done by visual inspection of a rotating cine of the point source projection data and noting any significant change in the y-axis position of the point source.

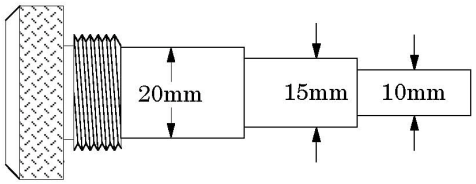
The reconstructed point source data can also be used to demonstrate errors in the center of rotation (COR). Items to note on the reconstructed data are point source width in three dimensions, shape, and indications of streaking or other artifacts.



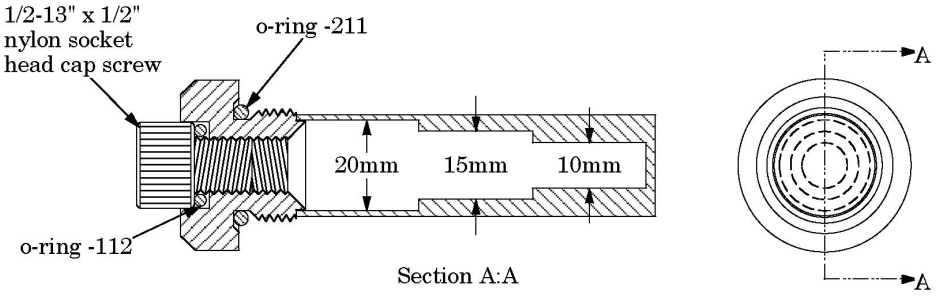
Low contrast inserts

The ECTphan™ Phantom is supplied with either 3 solid or 3 hollow low contrast inserts. These inserts can be threaded into the phantom end plate in a radial pattern 75mm off the center axis, or one can be placed in the phantom's central axis. The inserts are comprised of three sections: 10, 15, and 20mm in diameter and 40mm long.

The hollow inserts are filled through a port at the threaded end. The hollow inserts are used to simulate "hot" lesions. The solid inserts are used to simulate "cold" lesions.



SMR350 Solid Low Contrast Rod



SMR341 Hollow Low Contrast Rod

Assembly

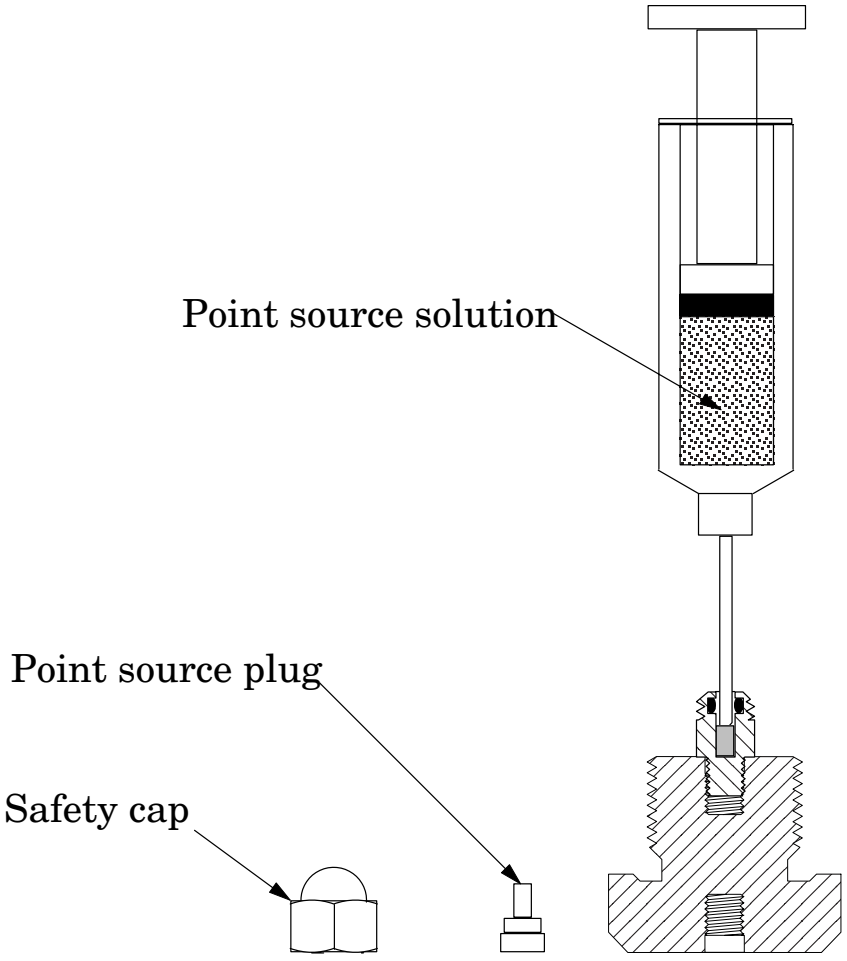
The ECTphan™ Phantom is shipped fully assembled. The pixel size, slice width, and spatial resolution section is secured to the base plate and the two point source holders are attached to the center insert plug. However, you will need to position the desired inserts on the end plate and to fill the phantom and inserts.

Filling the point sources

Fill a 3cc syringe (26g needle) with approximately 1cc of a Tc99m solution of 5mCi/cc concentration (185MBq/cc).

The phantom's center fill plug is the holder for both PSF-air (external) and PSF-scatter (internal) sources. Before filling point source holder, remove any residual liquid that remains. Fill the point source on the threaded side of the fill plug. Insert needle below rubber collar and add about 3-4 drops, insert cap, assay activity, and record.

Next, fill the second point source on the non-threaded end with about 1-2 drops. Cap the point source holder, assay, and record amount. Activity of the second (air) point source represents the total activity minus the activity of the first point source. Insert the fill plug and point source assembly into the center hole of the phantom's end plate.

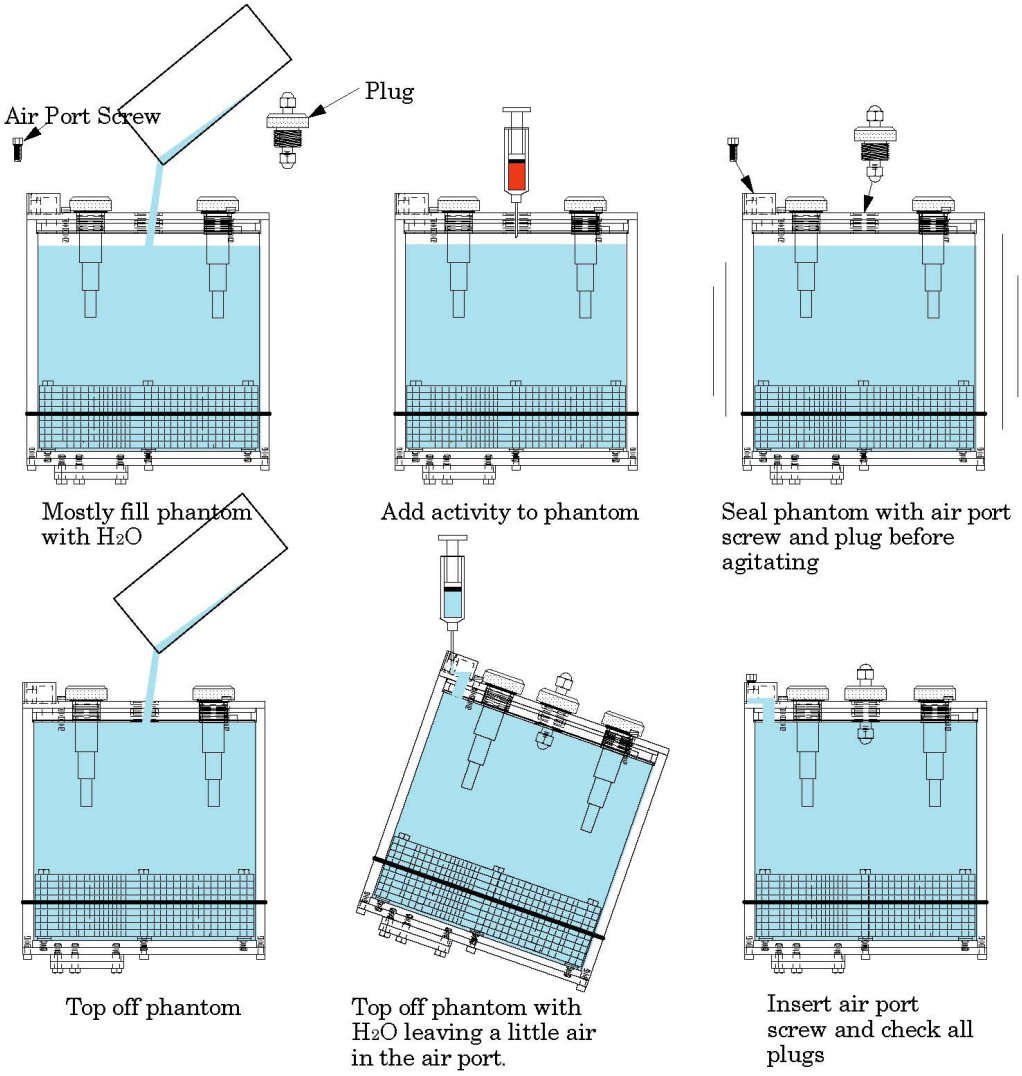


Filling the ECTphan™ Phantom tank

Fill the ECTphan™ Phantom tank with water (distilled or deionized is preferred). To allow for proper mixing do not completely fill. After drawing the prescribed Tc99m

Tc99m	COLLIMATOR
20 mCi (740 MBq)	LEUHR
15 mCi (555 MBq)	LEHR
10 mCi (370 MBq)	LEAP

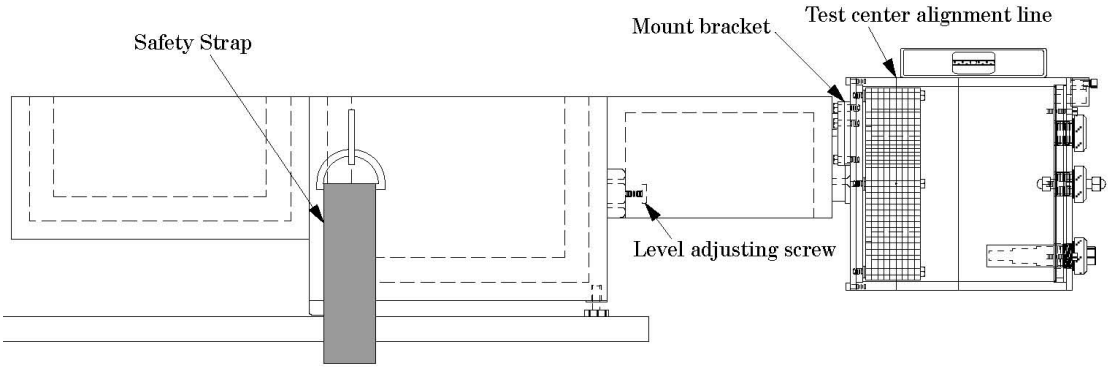
Note the time of assay.



Add the isotope to tank and rinse syringe in tank water by withdrawing and injecting tank water several times. Next, secure both fill plugs and mix by inverting phantom several times. Finally, top off tank with distilled water as illustrated above. Do not over fill the tank. A small air pocket or bubble should remain in the air trap to allow for expansion and contraction.

Phantom positioning for scanning

The ECTphan™ Phantom should be mounted on a patient table using a head or phantom holding device, if available. Use the smallest possible rotation radius for scanning the phantom. Check that the phantom is level by using the level provided. Position the phantom in the center of the gantry by adjusting the camera head in a lateral position (90 or 270 degrees), and moving the table so the center fill plug is at the center of the camera field of view. Be sure that the mount bracket is rotated toward the top of the phantom as illustrated below. In this position, check that the ECTphan™ Phantom is parallel to the collimator. Recheck that the phantom remains level. If using the point sources, verify that both point sources are visualized within the image field of view. The SPECT acquisition can now begin.



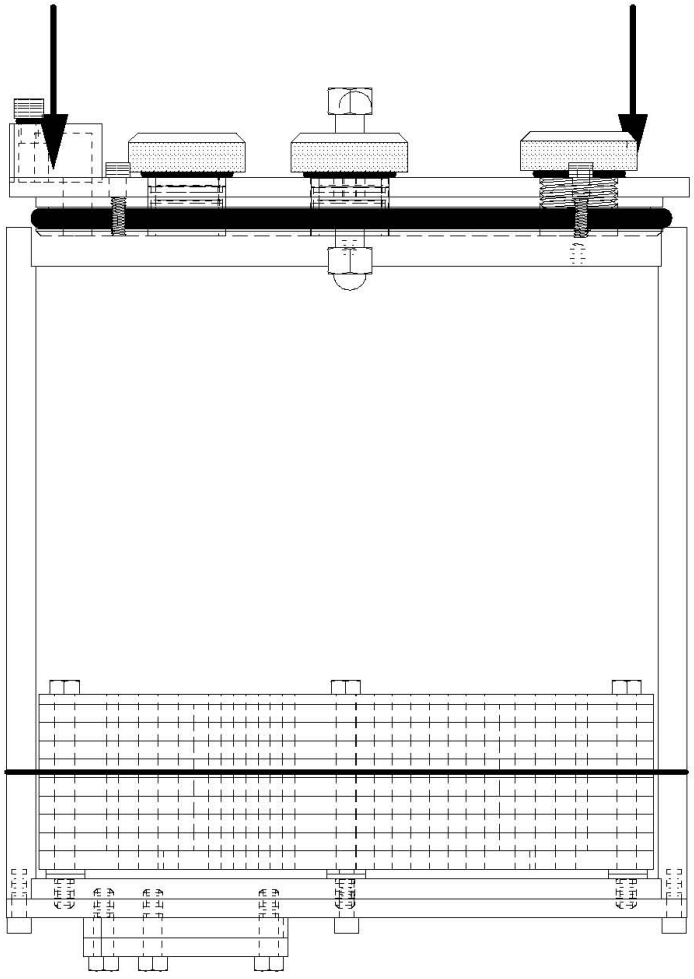
Mounting and removing tank end plate

Empty liquid from the ECTphan™ Phantom cylinder by removing the fill ports at the end of the phantom.

The cylinder end plate can be removed after draining the liquid. Remove the 4 nylon screws that go through the end plate. Hook your fingers through the plug holes in the end plate and work it out of the ECTphan™ Phantom cylinder. The use of a lubricating gel, such as K-Y® Jelly, will make it easier to open and close the o-ring seal and will help to prevent leaks.

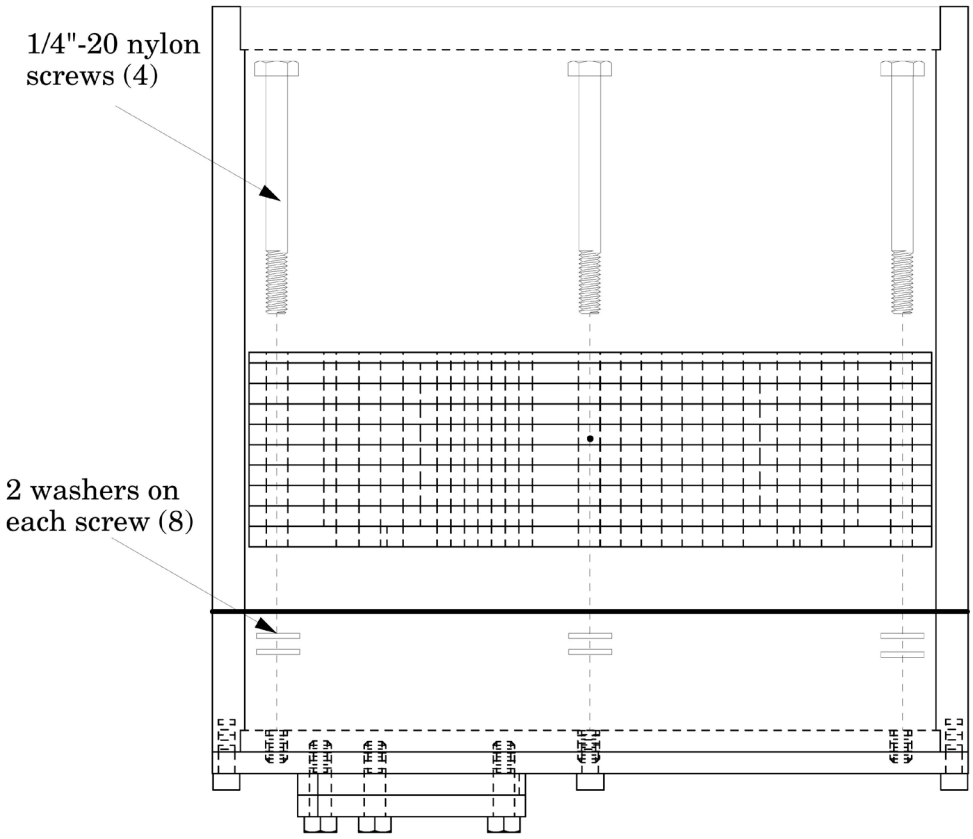
Once the end plate has been removed, the pixel size, spatial resolution, and slice width test section can be accessed.

To mount the tank end plate, loosely place it on the phantom. Loosely thread the 4 nylon screws into the phantom (do not tighten these screws). Evenly press the end plate with your hands into the phantom (do not use the screws). Once the end plate is seated, lightly tighten the 4 nylon screws.



Preparation for use of optional ECTphan™ Line Source Plugs

To use the optional ECTphan™ Line Source Plugs the pixel size, spatial resolution, and slice width test section needs to be removed. First see section “Mounting and removing tank end plate” in this manual for instructions on removing the phantom’s end plate. Remove the 4 1/4”-20 nylon screws which retain the end plate assembly and remove the assembly.



Then follow instructions in the ECTphan™ Line Source Phantom SMR355 Manual which is available on our website www.phantomlab.com

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ECT phan™ Phantom Data Worksheet

Site Name:_____
Contact Person:_____
Date of Acquisition: / /
Camera Vendor/Model: _____
Technologist:_____

Phantom Activity Information

Tank:_____mCi, or_____MBq
Scatter point source (inside):_____uCi, or_____Bq
Air point source (outside):_____uCi, or_____Bq
Time of Assay:_____

Acquisition Setup

	Recommended	Actual
Rotation Range	360 degrees	_____
Steps	64	_____
Time/Frame	30 seconds	_____
Energy Window	20%	_____
Matrix	128	_____
Zoom Factor	1.0	_____
Radius of Rotation	as small as possible	_____
Count Rate	25-30 K cps	_____
Collimator*		_____
Time of Acquisition		_____

*Collimator used for clinical studies should be used for the phantom.