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

Specphan™ 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 Specphan® end plate, follow the instructions listed in this manual. Do not use the nylon screws to set in lid.

To prevent damage to your Specphan™ 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.

8/2/01

The Phantom Laboratory

Specphan™ Manual

Introduction

This phantom has been developed in conjunction with Steve Dyer MHS and The Institute for Radiological Image Sciences, for the purpose of monitoring image quality for single photon emission tomography (SPECT) systems. It can be used both in the application of manual and automated types of evaluation of the image data.

The Specphan™ provides components to visually evaluate image quality aspects including uniformity, spatial resolution and slice width parameters of the SPECT system. Additionally, the Specphan™ components provide data for computer-based analysis for spatial resolution (modulation transfer function), noise (signal-to-noise ratio), integral uniformity, pixel size and slice-width performance parameters in a quick and reproducible process.

We do not make specific recommendations on the content of your quality assurance program, because each medical imaging facility has its own unique set of requirements. 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.

Specphan™ Description
Cylindrical, water filled container divided into three imaging sections.

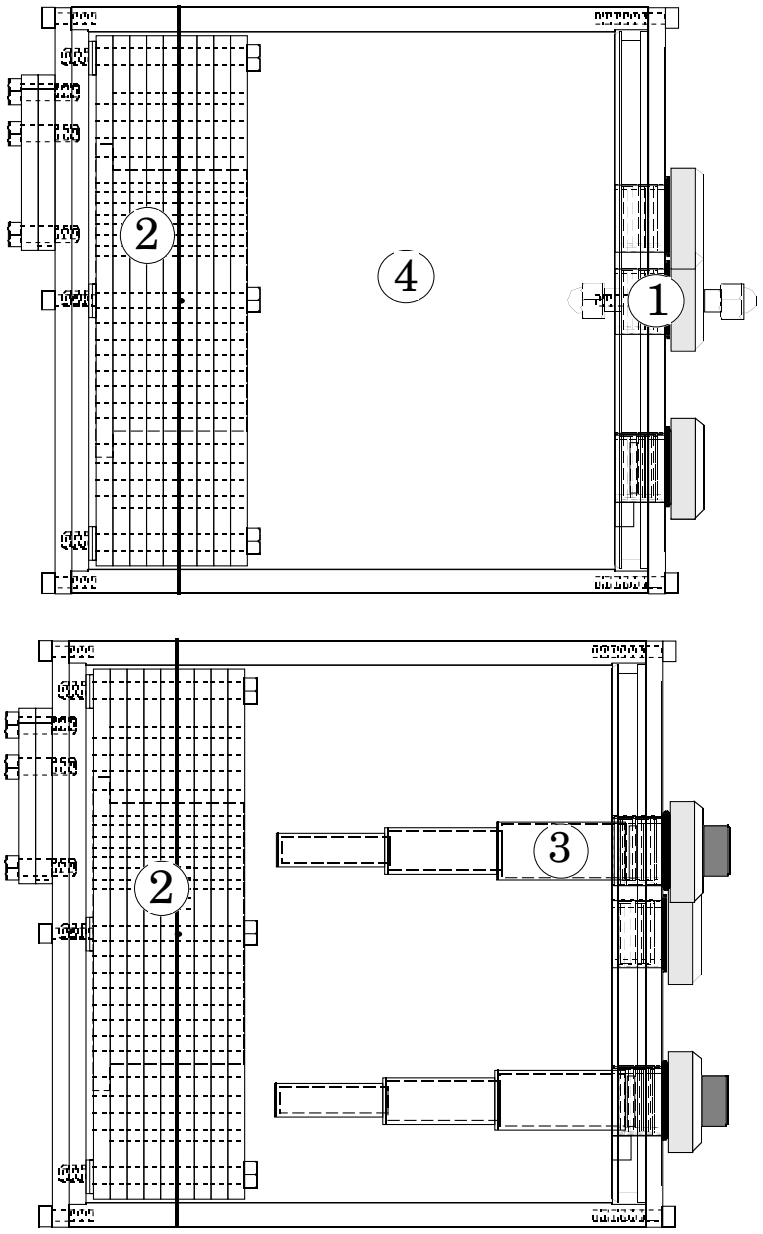
Overall dimensions:

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:

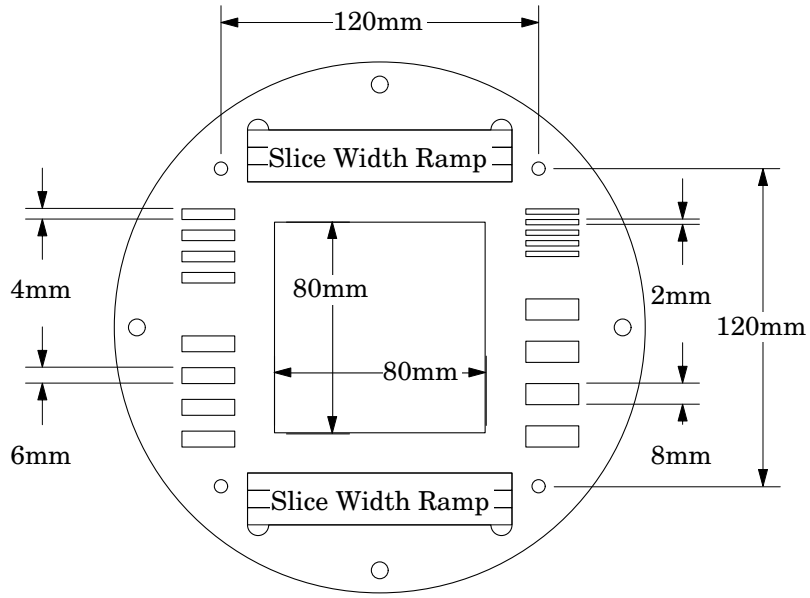
1. Point spread function insert
2. Pixel size, slice width, spatial resolution section
3. Low contrast (3) inserts
4. Uniformity Section



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.

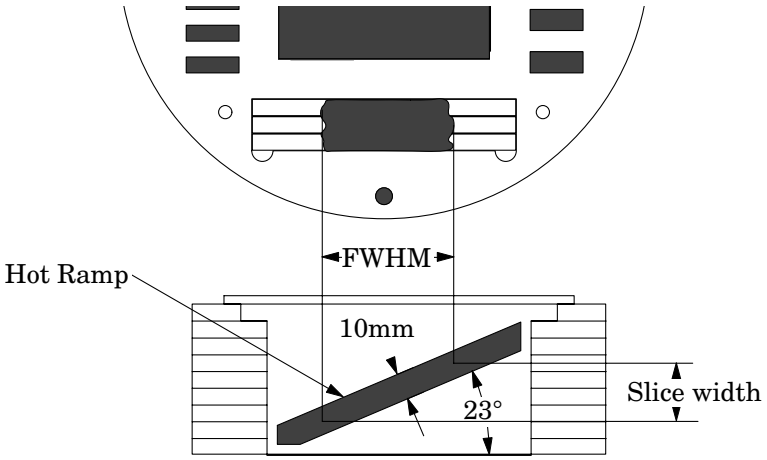
Spatial resolution is measured using “bars” of 2, 4, 6, and 8mm “hot” and “cold” spacings.



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

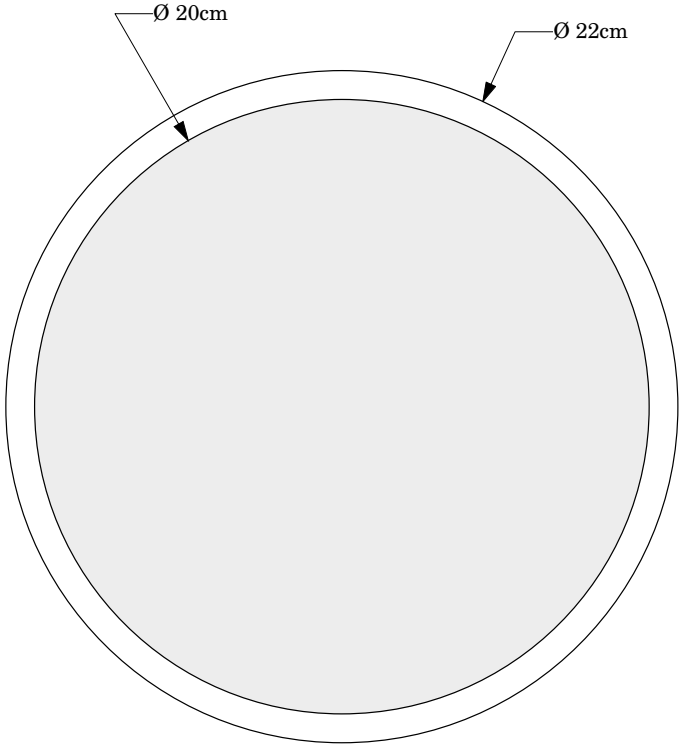
Image uniformity can be evaluated by visual inspection for artifacts and nonuniformities. Also, the image from this section can be used for quantitative measurements as follows.

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

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

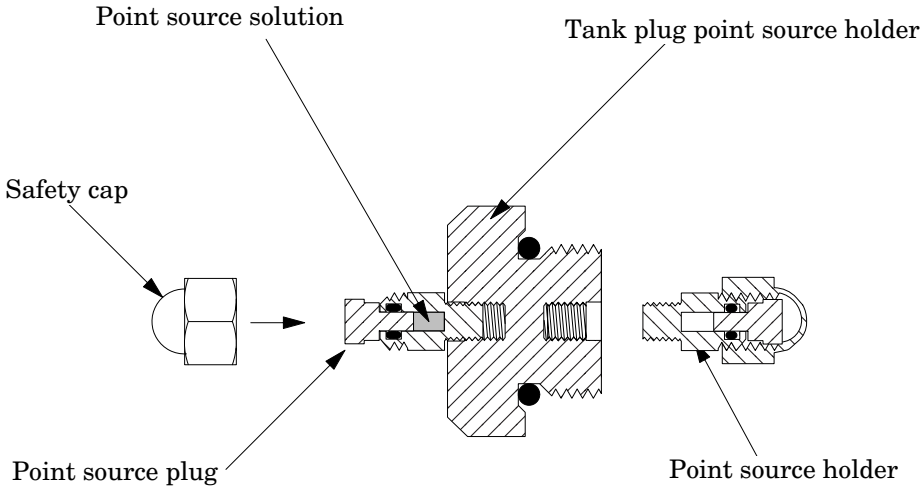
2. Noise Statistics Measurements -rms noise (%) is calculated for a central ROI or multiple ROIs using the mean and standard deviation statistics computed for these ROIs.

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



Point spread function (PSF) test section

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 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.



PSF-Air PSF-Scatter

Assembly

The Specphan™ is shipped fully assembled. The pixel size, slice width and spatial resolution section is secured to the base plate.

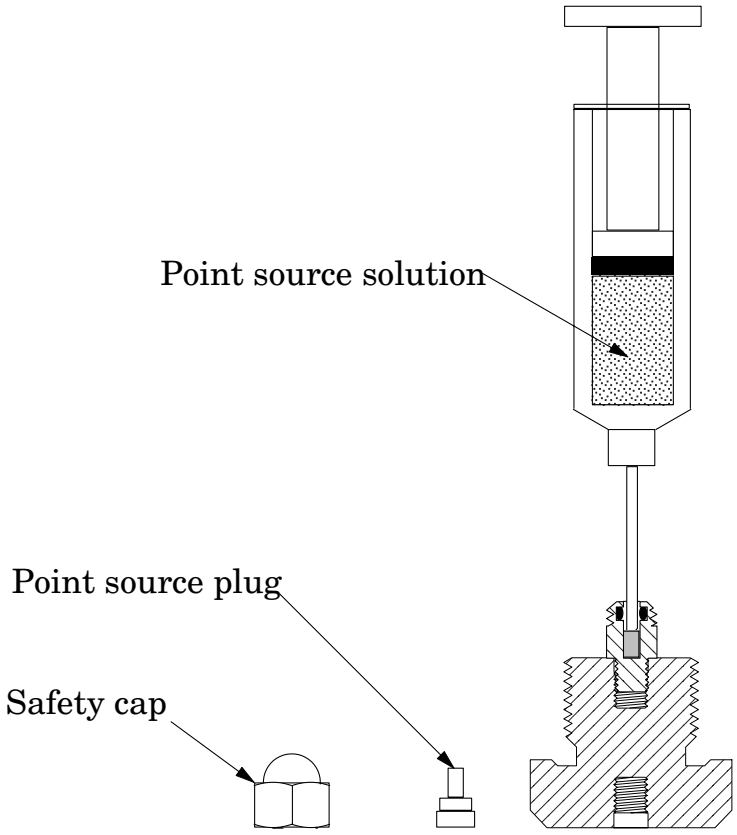
Two point source holders are attached to the center fill plug.

Filling point sources and Specphan™ tank

Filling 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 and PSF-scatter sources. Before filling point source holder remove any residual liquid that remains. First, fill the point source on the threaded side of the fill plug. Insert needle below rubber collar and add about 4-6 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 tank

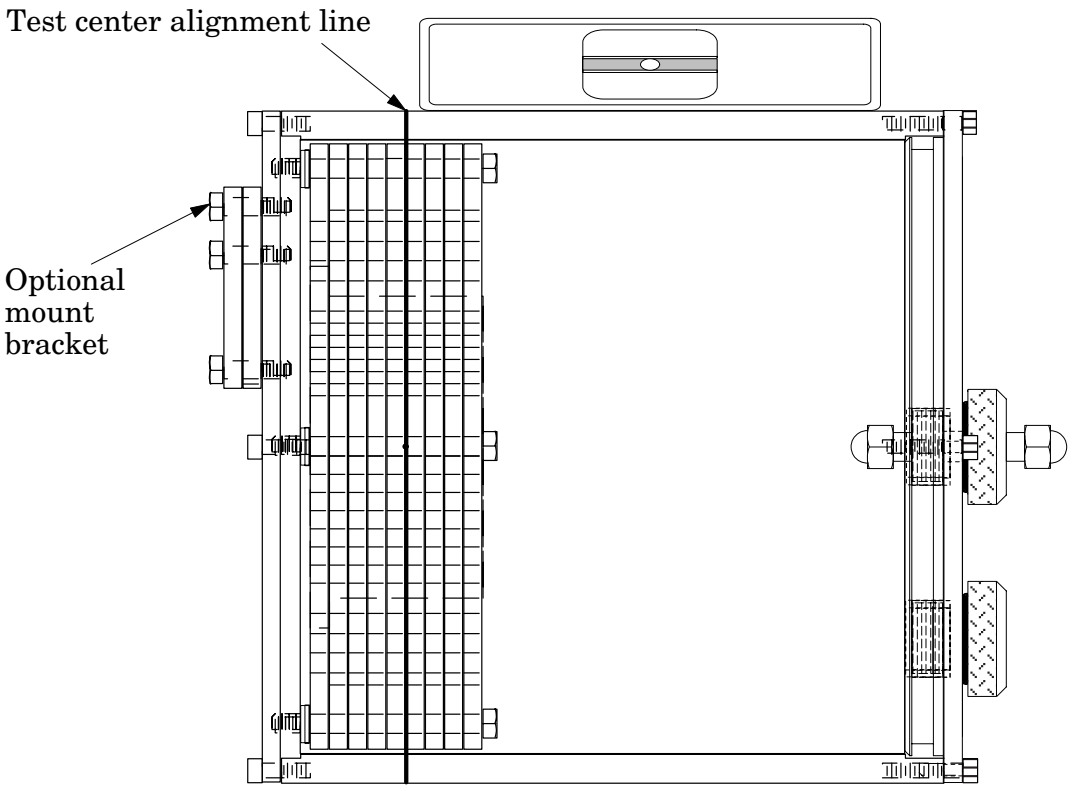
Fill the Specphan™ tank with water (distilled or deionized is preferred), using funnel provided to avoid spillage. Do not completely fill to allow for proper mixing. After drawing the prescribed Tc99m

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

Note the time of Assay. Then add the isotope to tank and rinse syringe in tank water by withdrawing and injecting tank water several times. Then secure both fill plugs and mix by inverting phantom several times. Finally, open fill plug and top off tank with distilled water, do not over fill the tank, a small air pocket or bubble should remain to allow for expansion and contraction.

Phantom positioning for scanning

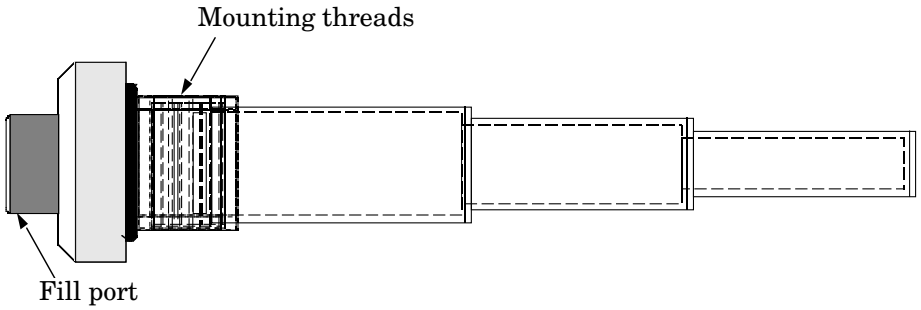
The Specphan™ phantom should be mounted on a patient table, using a head or phantom holding device, if available. Use the smallest possible rotation radius for scanning the phantom. Check that the phantom is level by using the level provided. Position the phantom in the center of the gantry by adjusting 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 optional mount bracket is rotated towards the top of the phantom as illustrated below. In this position, check that the Specphan™ 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.



Low contrast inserts

The Specphan™ phantom is supplied with 3 low contrast inserts. These inserts can be threaded into the phantom end plate in a radial pattern 63.5mm 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 inserts are filled through a port at the threaded end. The inserts can be used to simulate 'hot' or 'cold' lesions.



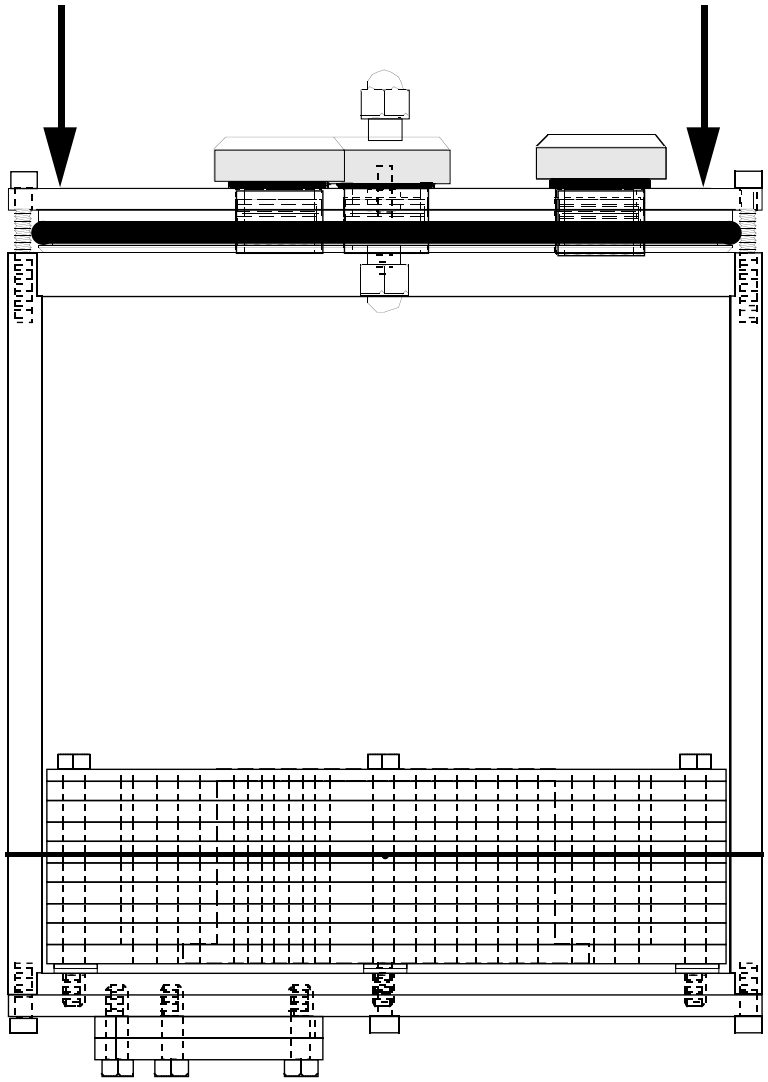
Mounting and removing tank end plate

Empty liquid from the Specphan™ 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 Specphan™ cylinder. The use of a lubricating jell, 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.



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Specphan™ 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.