

The Phantom Laboratory

Ordering Information

Please contact us if you have any questions or if you would like a quote or delivery schedule regarding the Catphan® phantom.

phone
800-525-1190, or 518-692-1190

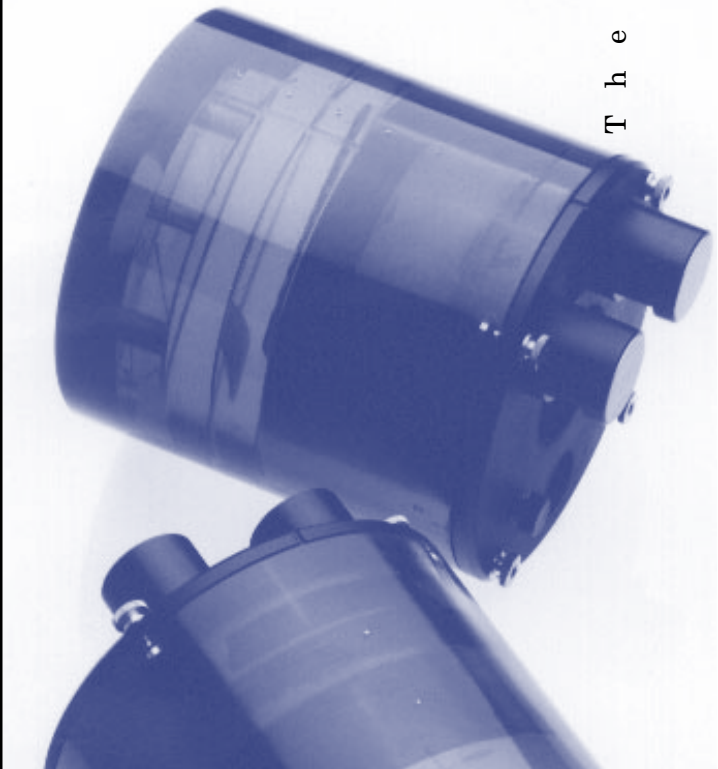
fax
518-692-3329

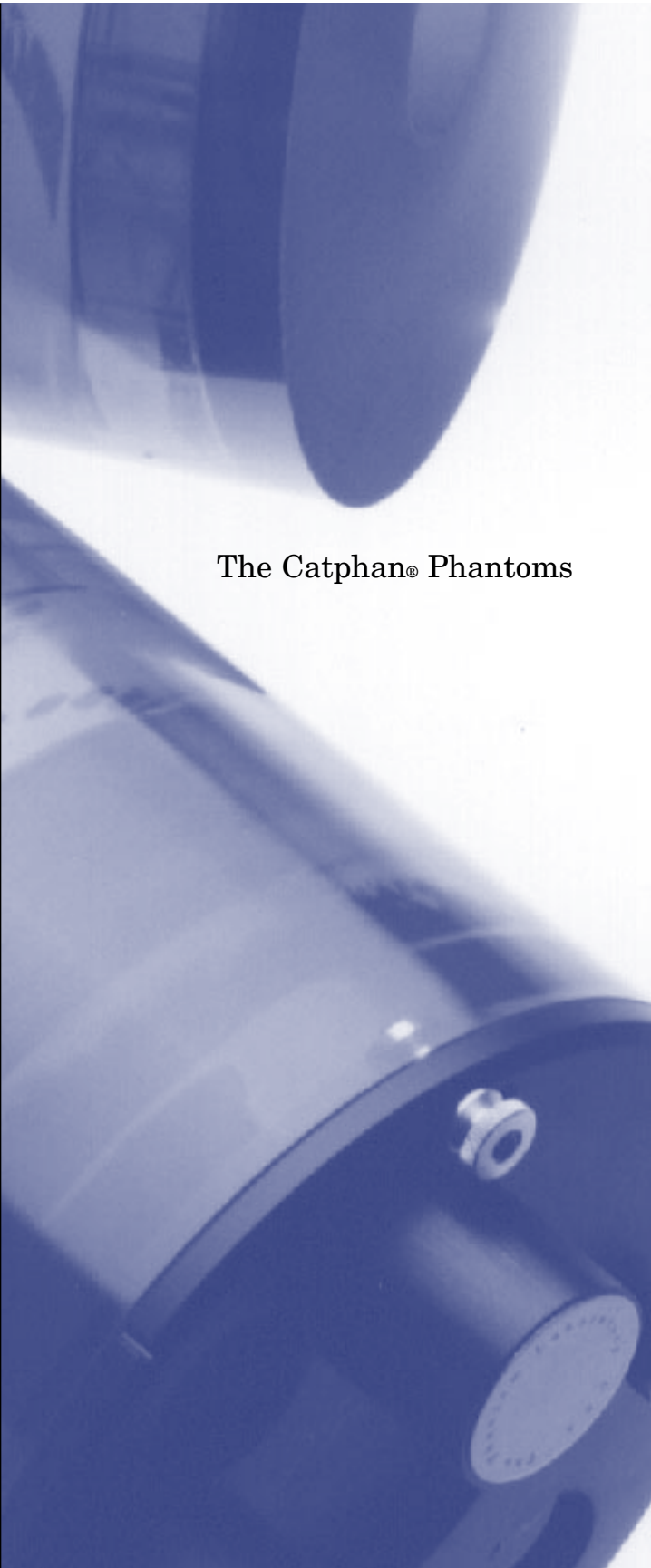
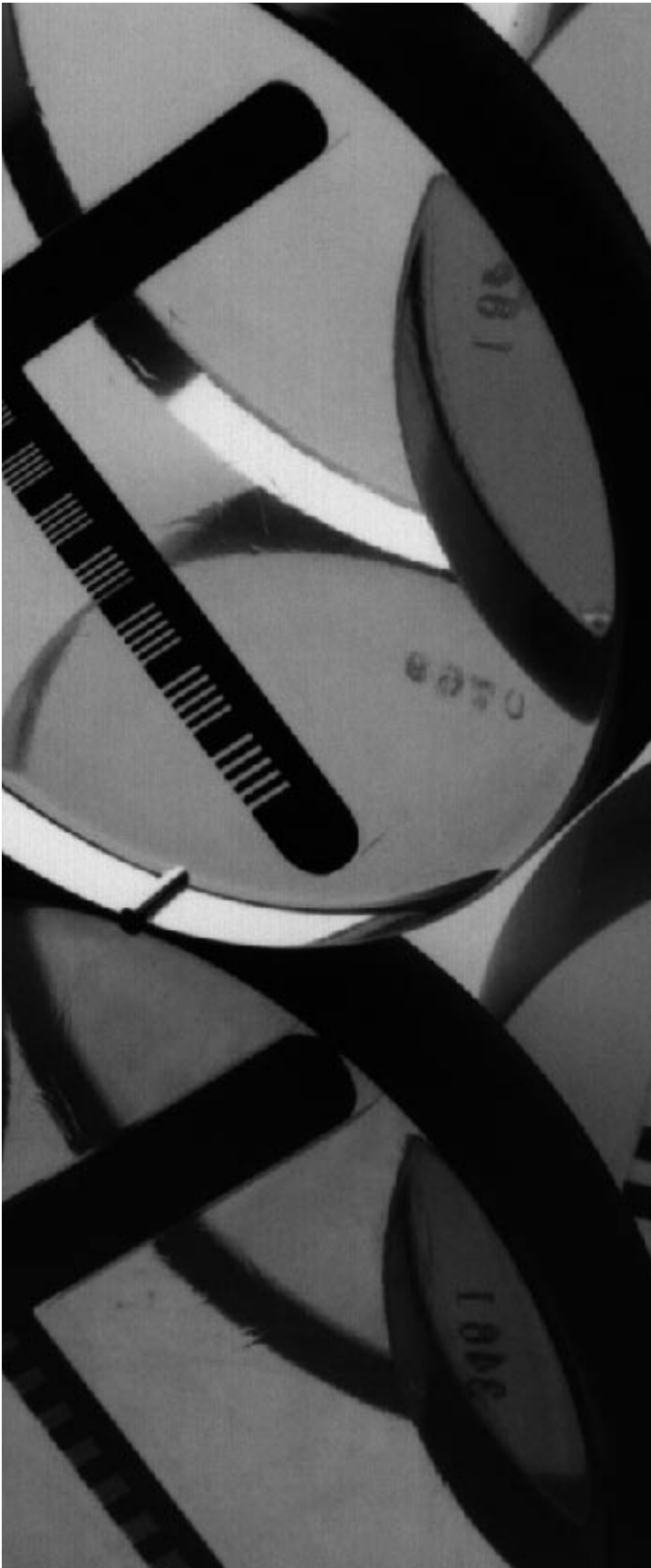
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C a t p h a n ®





The Catphan® Phantoms

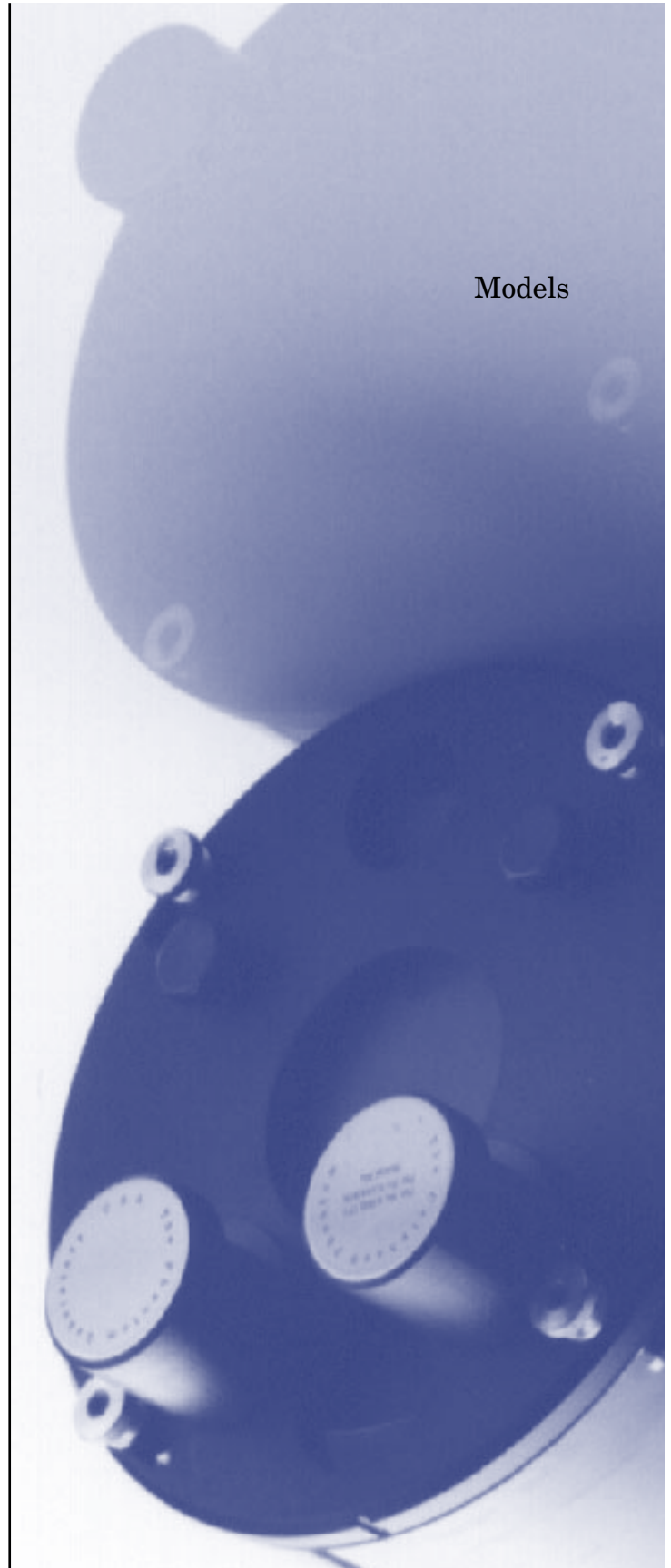
The Catphan® Phantoms

Catphan® phantoms are used to conduct comprehensive performance evaluations of axial and spiral CT scanners and to implement quality assurance programs.

The Phantom Laboratory and physicist David Goodenough, Ph.D., have worked together to develop the Catphan® phantoms. The new Catphan® designs are based on two decades of scientific research and direct field experience in the evaluation of medical imaging equipment.

In this brochure, we introduce you to each Catphan® model, describe some of the features that distinguish Catphan® phantoms from other devices, and then provide detailed information about the form and function of the different test modules that are included with each Catphan®

Models



Catphan® 412

The Catphan® 412 has earned an international reputation as a dependable tool for conducting a variety of rigorous scientific tests. Many physicists and engineers around the world carry the Catphan® 412 with them as they travel to monitor the system performance of CT scanners.

The Catphan® 412 allows the following measurements and tests:

- scan slice geometry (slice width and sensitivity profile)
- high resolution (up to 20 line pairs per cm)
- phantom position verification
- patient alignment system verification
- low contrast sensitivity
- spatial uniformity
- scan incrementation
- noise (precision) of CT systems
- circular symmetry
- sensitometry (linearity of CT numbers)
- pixel (matrix) size
- point spread function
- modulation transfer function (MTF)



Catphan® 424

The Catphan® 424 is similar to the Catphan® 412 discussed on the previous page. The 424 differs from the 412 in its use of a liquid-filled uniformity module instead of the solid cast uniformity material.

The Catphan® 424 allows the following measurements and tests:

- scan slice geometry (slice width and sensitivity profile)
- high resolution (up to 20 line pairs per cm)
- phantom position verification
- patient alignment system verification
- low contrast sensitivity
- spatial uniformity
- scan incrementation
- noise (precision) of CT systems
- circular symmetry
- sensitometry (linearity of CT numbers)
- pixel (matrix) size
- dynamic scanning
- modulation transfer function (MTF)
- point spread function
- research testing, including in vitro
- sample tests

Catphan® 500

The Catphan® 500 is designed to address the specific testing needs and challenges associated with spiral CT scanning. While the Catphan® 500 performs most of the tests done by the Catphan® 412 and 424, it also incorporates design modifications to evaluate the z-axis variables encountered in spiral CT imaging.

The Catphan® 500 performs the following measurements and tests:

- scan slice geometry (slice width and
- sensitivity profile)
- high resolution (up to 21 line pairs per cm)
- phantom position verification
- patient alignment system verification
- supra-slice low contrast sensitivity
- subslice low contrast sensitivity
- spatial uniformity
- scan incrementation
- noise (precision) of CT systems
- circular symmetry
- sensitometry (linearity)
- pixel (matrix) size
- point spread function and modulation
- transfer function (MTF) for the x, y,
- and z axes





Catphan® Technology

The Catphan® phantoms are constructed from modules that fit snugly into a durable 20cm housing. With the exception of the CTP422 water tank modules used in the Catphan® 424, all Catphan® modules are made from solid-cast materials. Solid-cast construction eliminates the difficult component changes and leaks associated with water bath phantoms, as well as problems related to uncertain water sources. Since the cast modules don't need to be drained between uses, little time is needed to prepare Catphan® phantoms for transportation. This feature makes Catphan® phantoms ideal for traveling physicists and engineers who conduct comprehensive evaluations of CT scanners at multiple locations.

The Catphan® modular design allows test modules to be interchanged. If your testing needs change, you can purchase new test modules that are compatible with your Catphan® system. The Phantom Laboratory has an ongoing commitment to develop new test modules and phantoms that will enable you to keep pace with changes in imaging technology.

The Phantom Laboratory is committed to the manufacture of high quality products.

Our comprehensive quality system is registered in compliance with the internationally recognized ISO9002 standards.

The design specifications for the Catphan® phantoms take into consideration the recommendations of domestic and international scientific and regulatory groups. This, and its ease of use, make it ideal for quality assurance (QA) programs.

To reduce daily set-up time, the Catphan® phantom's patented design includes features that make it easy to achieve perpendicular alignment. Since all of the test sections are arranged at standard intervals from the first module (CTP401), operators can quickly scan all test sections in a single sequence. This design feature eliminates the need to reposition the phantom for each section, saving valuable time in daily QA programs. The Catphan® instruction manuals explain how

to perform each of the numerous tests, and provide guidance to help operators set up QA analysis programs.

The phantom test objects are manufactured to the precise tolerances needed for accurate and reproducible tests. The design and highquality construction of Catphan® phantoms and test objects make them readily adaptable to automated QA programs.

Each Catphan® is shipped with a cantilevered case that allows the phantom to be positioned in the scanner, supported off the end of the table, thereby eliminating table artifacts. The case is equipped with a level to aid in positioning, and the cantilever mount is easy to move and align.

Test Modules



CTP401

included with all Catphan® models

The CTP401 module has a diameter of 15cm and is 2.5cm thick. This module is used for the following measurements and tests:

- scan slice geometry (slice width and sensitivity profile)
- circular symmetry
- phantom position verification
- sensitometry (CT number linearity)
- patient alignment system verification
- pixel (matrix) size
- scan incrementation

Two sets of opposing wire ramps aligned with the x and y axes are cast into the CTP401 module. These ramps are used to measure scan slice geometry, verify phantom position, and check the patient alignment system and the scanner table incrementation. The CTP401 uses a 23° ramp angle instead of the 45° angle commonly used in phantoms. As a result, its ramp images are about 2.4 times longer than the images produced with a 45° ramp. This amplified ramp image reduces the effects of imprecise image measurements.

The thin wire ramps used in the CTP401 are particularly well-suited for measurements of thin slice geometry (1 or 2mm slice widths), because the wires reduce the overrange streaking artifacts often seen in phantoms that use thick ramps. The two opposing pairs of ramps in the CTP401 allow operators to easily verify whether the phantom is correctly aligned with the scanner axis and thereby avoid erroneous measurements.

Sensitometry (CT number linearity) is measured through the use of four cylindrical samples that are each 1.25cm in diameter. The samples consist of Teflon (highest density, similar to bone), acrylic, low-density polyethylene (LDPE), and air (lowest density).

In addition, the phantom material itself can be used as a fifth sensitometry sample. The Teflon, acrylic, and LDPE samples can be removed from the test section to allow exact measurements of their specific gravity.

To measure pixel size, four cylindrical test objects (each 3mm in diameter) are positioned to form a 5cm square at the center of CTP401.

The pixel size can be calculated by counting the number of pixels between the cylinders in the x and y directions.

The module contains five acrylic spheres to evaluate the scanner's imaging of subslice spherical volumes. The diameters of the acrylic spheres are 2mm, 4mm, 6mm, 8mm, and 10mm.



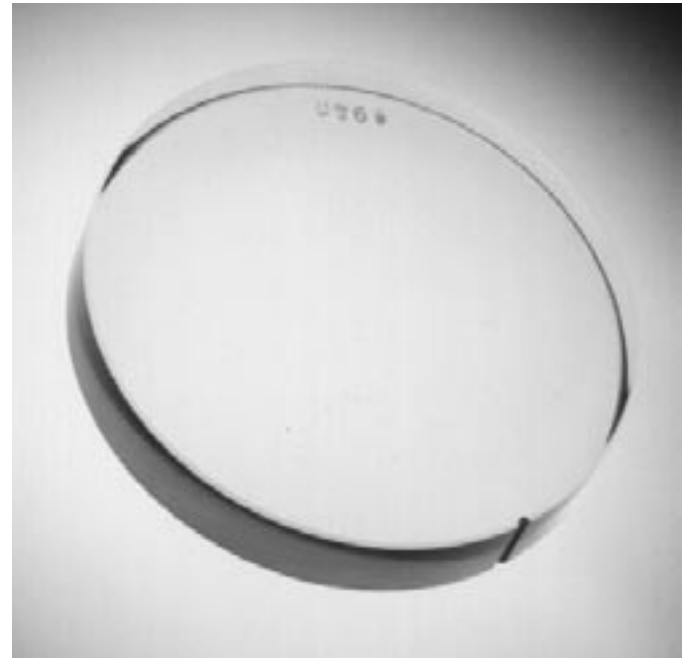
CTP445

included with Catphan® 412 and 424

The CTP445 module has a diameter of 15cm and is 2.5cm thick. This module is used for the following tests:

- point spread function
- modulation transfer function (MTF)

A high-density, tungsten carbide bead is cast within the CTP445 module to create an impulse or point source from which the modulation transfer function (MTF) can be calculated. Since the module uses a spherical bead, rather than wire, for MTF measurements, it allows operators to avoid the tedious and time-consuming step of positioning and aligning MTF wires with the z axis. The bead module also eliminates the overranging problems and streaking artifacts that occur with MTF wires, because the bead density is volume averaged with the surrounding material.



CTP446

included with Catphan® 412 and 424

The CTP446 module has a diameter of 15cm and is 2.5cm thick. This module is used for the following measurement:

- high resolution (up to 20 line pairs per cm)

A precisely manufactured, high-resolution gauge is cast into CTP446. The gauge has been carefully designed to ensure that its imaging artifacts do not cause streaks in the resolution tests. The gauge is 2mm thick and has 16 resolution sections in single line pair increments over the range of 5 to 20 line pairs per cm (LPC). Due to the effects of volume averaging, the contrast will vary according to the slice width. It is worth noting that the gauges used in most other phantoms provide a maximum resolution of only 11 to 13 LPC. Although some other gauges do provide high resolution, they are not usually machined with sufficient precision to differentiate between single LPC increments above 13 LPC.

CTP528

included with Catphan® 500

The CTP528 module has a diameter of 15cm and is 4cm thick. This module is used for the following tests and measurements:

- scan slice geometry (slice width and
- sensitivity profile)
- high resolution (up to 21 line pairs per cm)
- point spread function and modulation transfer function (MTF) for the x, y, and z axes

This section combines a high-resolution gauge (up to 21 line pairs per cm) and the MTF bead used in the CTP445 module. The 2mm thick aluminum contrast figures are cast into position on the radial gauge, which has resolution sections ranging from 1 to 21 line pairs per cm. Due to the effects of volume averaging, the contrast will vary according to the slice width. The unique design of the CTP528 minimizes visual artifacts by reducing the amount of high contrast material.



CTP263

included with Catphan® 412 and 424

The CTP263 module has a diameter of 15cm and is 2.5cm thick. This module measures the following:

- low contrast sensitivity

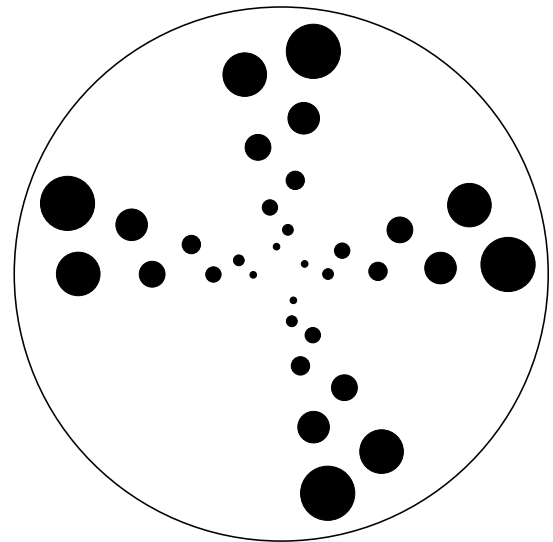
CTP263 consists of a series of cylindrical rods of various diameters and contrast levels to measure low contrast performance. The rods, which are each 25mm long, provide consistent contrast values for all slice widths under 25mm. The diameters of the rods in each contrast level are 2, 3, 4, 5, 7, 9, 12, and 15mm. The nominal contrast levels are 0.1%, 0.3%, 0.5%, and 1%. The various samples and the background material have equivalent effective

atomic numbers. Only the density is varied to produce changes in the effective attenuation coefficients.

Most other phantoms rely on volume-averaging or mixed contrast solutions to create low contrast variations.

With volume averaging, the phantom contrast readings vary depending

on the position of the test object and selected scanner slice width. Because of this limitation, the phantom may not provide consistent results for all slice thicknesses and may yield erroneous readings in spiral CT measurements. The solid-cast design of the Catphan® CTP263 module avoids the inconsistencies of volume averaging in low contrast measurements, and eliminates the need to formulate special contrast solutions.



CTP515

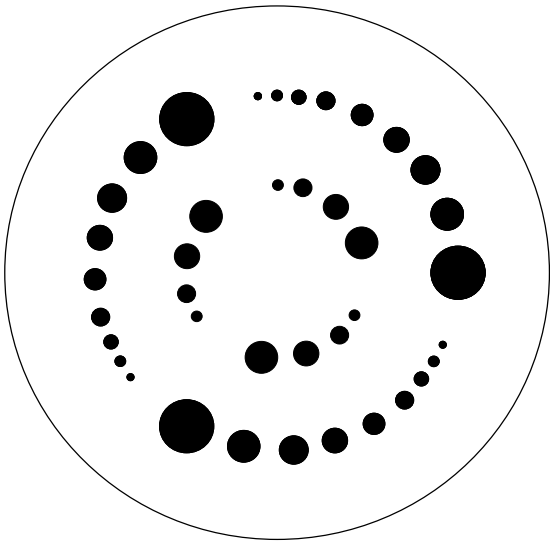
included with Catphan® 500

The CTP515 module has a diameter of 15cm and is 4cm thick. This module is used for the following measurements and tests:

- low contrast sensitivity
- subslice low contrast
- supra-slice test targets

CTP515 consists of a series of cylindrical rods of various diameters and contrast levels to measure low contrast performance. The 40mm-long rods provide consistent contrast values at all z-axis positions, thereby avoiding any volume-averaging errors as you spiral through the section. The diameters of the rods in each contrast level are 2, 3, 4, 5, 6, 7, 8, 9, 10, and 15mm. The nominal contrast levels are 0.3%, 0.5%, and 1%.

The module also includes subslice targets (truncated cylinders) with nominal 1% contrast and z-axis lengths of 3, 5, and 7mm. For each of these lengths, there are targets with diameters of 3, 5, 7, and 9mm. The use of solid contrast materials eliminates the need to formulate special contrast solutions. The various samples and the background material have equivalent effective atomic numbers. Only the density is varied to produce changes in the effective attenuation coefficients.



CTP486 Uniformity Module

included with Catphan® 412 and 500

The CTP486 uniformity module is made up of two parts, each 15cm in diameter. This module performs the following measurements and tests:

- spatial uniformity (noise)
- noise (precision) of CT systems

While water is generally considered the ultimate calibration material, many physicists prefer using our CTP486 solid image uniformity module, because it provides consistent results and is more convenient to use than water. The CTP486 module is cast from a uniform material that has a CT number within 2% of water. This solid material's high radial and axial uniformity makes it an ideal substitute for water. The use of a solid uniformity module eliminates the water handling required for liquid tanks, as well as variations associated with changes in water sources. Unlike water-filled tanks, the CTP486 module does not leak, and is not damaged by exposure to freezing temperatures.

CTP422 Liquid Bath Module *included with Catphan® 424*

The CTP422 module has a diameter of 15cm and is 7.5cm thick. This module is used for the following measurements and tests:

- spatial uniformity (noise)
- noise (precision) of CT systems
- dynamic scanning
- research testing, including in vitro
- sample tests

This acrylic module is a sealable, cylindrical tank. When filled with water, the CTP422 module can be used to measure the noise amplitude (standard deviation) and uniformity of the mean CT numbers within the scan field. Water is added or removed through a 2" port, which is sealed with a pressure-fitted insert plug for ease of use. The size of this port also makes it easy to insert optional Catphan® test objects, other research apparatus, or in vitro samples into the CTP422 tank. In addition, one end of the tank can be removed to allow even larger test objects to be placed in the module. Two small ports are provided for dynamic scanning studies. The CTP422 module also comes equipped with a false wall that allows air to be trapped and readily removed from the scanning area.



Options

Optional Catphan® Liquid Bath Module Inserts

CTP295 Scan Alignment Insert

This insert contains a 3/16" aluminum pin for testing mechanical alignment.

CTP291 Acrylic LSF Insert

This acrylic insert, which is triangular with a 50mm edge, is used to determine the scanner edge response. This value can then be used to calculate the line spread function (LSF) and modulation transfer function (MTF). This procedure is described in the english translation of Japanese CT Phantom Standards.



Optional Phantom Annuli

The annuli below are designed to slide over the 20cm Catphan® housing.

CTP299 Teflon Annulus

This Teflon ring slides over the Catphan® housing to simulate the high absorption value of bone.

CTP539 30cm Body Annulus

This 30cm annulus is cast from the same uniformity material used in our CTP486 image uniformity modules.

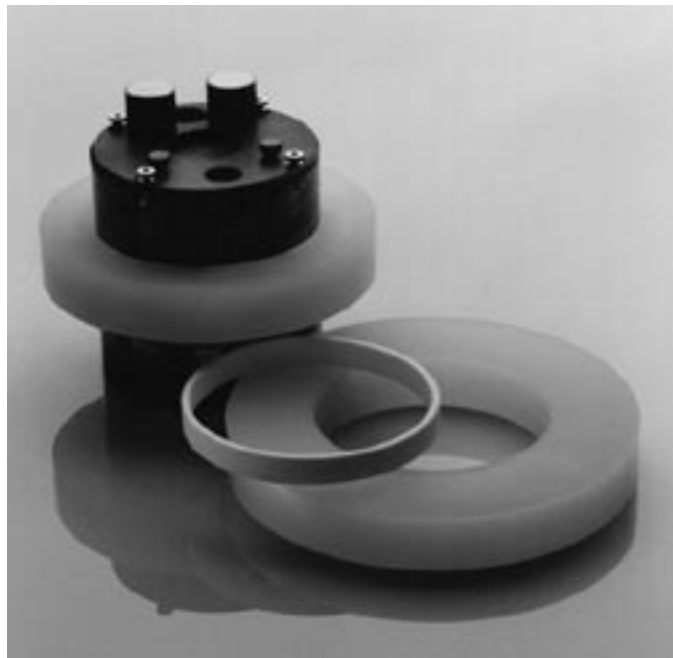
CTP540 35cm Body Annulus

This 35cm annulus is cast from the same uniformity material used in our CTP486 image uniformity modules.

CTP326 Acrylic Body Annulus

This acrylic ring slides over the Catphan® housing. It is used to evaluate increased attenuation for body scan simulation.

Please note that The Phantom Laboratory can also build custom body annuli with outside diameters up to 50cm.



Other Module Housings

CTP541 16cm Housing

This housing is 16cm across and can hold all standard Catphan® test modules.

CTP536 35cm Housing (center or off-center)

This phantom housing can hold all standard Catphan® test modules. It is also designed to allow test objects to be scanned in any position from the center to as much as 6cm off-center, while maintaining a consistent outer diameter position.

The Phantom Laboratory can also build customized, anatomically shaped housings to hold Catphan® modules.

