Micro-CT Performance Evaluation Phantom - vmCT 610

Product Description

Shelley's Model vmCT 610 micro-CT phantom provides users with a unique comprehensive test object designed for routine reproducible performance evaluation for micro-CT imaging systems. The phantom incorporates six cylindrical plates – each plate designed to evaluate one aspect of micro-CT image quality.

Image-quality parameters that can be evaluated with a single volumetric scan include:

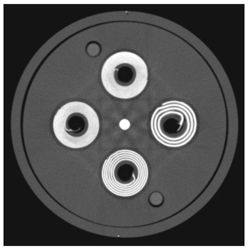
- CT number calibration
- CT number linearity
- Image noise
- Image uniformity
- Spatial resolution (qualitative)
- Spatial resolution (quantitative)
- Geometric accuracy and pixel size calibration

Be confident in the precision and accuracy of critical high-resolution micro-CT measurements.

Features

- Quick and easy phantom setup.
- All in one design allows users to assess multipe image quality parameters from one single volumetric scan, covering 5.4 cm within the axial field of view, saving valuable time.
- Each polycarbonate plate provides a quantitative assessment of an image quality parameter.
- Quantifiable measurement results.
- Provides reproducible and comparable performance evaluation of micro-CT systems.
- Reliable measurement of voxel spacing for measurement of organ volume, airway dimensions and vessel diameters/dimensions.
- Proprietary automated software allows for quick automated micro-CT analysis of image quality parameters, saving valuable time.
- Calibration record is supplied with each phantom.
- Includes a robust protective foam form-fitting carrying case.

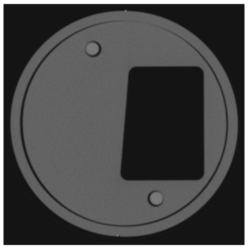
Resolution Coil Plate



The resolution coil plate provides a visual qualitative measurement of the spatial resolution of the micro-CT system. Embedded in this plate are four spiral coils of alternating Mylar and aluminum sheets, with layer thicknesses of 150, 200, 300, and 500 µm (corresponding to 3.3, 2.5, 1.67, and 1 line-pairs per mm, respectively). For each of the four coils, the alternating sheets of Mylar and aluminum are tightly rolled around a 6.6 mm diameter polyethylene tube, with the diameter of the final assembly being 16.4 mm in diameter. A polyethylene tube of the same diameter is used to enclose and support the coil.

A quantitative parameter related to resolution can be obtained by calculating the standard deviation of voxel values in a region of interest (ROI) within the image of a cyclic bar pattern – the coils. This parameter can be used to estimate the modulation transfer function (MTF) of the system. This analysis can be applied to the resolution coil plate with the modulation measured as the average of four ROIs 1.5 x 1.5 x 1.5 mm for each coil (top, bottom, left, right). The average measured modulation at each spacing thickness can then be plotted against the nominal spatial frequency.

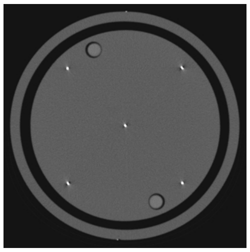
Spatial Resolution Slanted Edge Plate



To obtain a quantitative measurement of spatial resolution, the modulation transfer function (MTF) of the system can be measured using the slanted edge method. This plate has a slanted edge consisting of a plastic-air boundary positioned at an angle of 5° relative to the CT scanner image matrix.

Ten reconstructed slices of the slanted edge plate can be averaged to generate an image with reduced noise. Using this averaged image, an over-sampled edge response function (ERF) can be generated from the change in voxel intensity from air to plastic in each row of the image. The derivative of ERF gives the line-spread function (LSF), from which the pre-sampled MTF of the detector can be calculated by taking the Fourier transform.

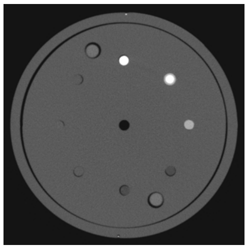
Geometric Accuracy Plate



The geometric accuracy plate allows for accurate measurement of the true voxel size in the reconstructed volume. Embedded in the is an array of five tungsten-carbide beads, each 280 µm in diameter. Four beads are positioned in four corners at 35 mm apart, with one bead in the center at a distance of 24.75 mm from the other four beads.

The true in-plane voxel spacing can be determined from the reconstructed images of the geometric accuracy plate with the five beads placed at known distances.

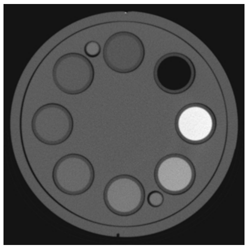
CT Number Evaluation Plate



Eight sample materials commonly encountered in animal experiments are embedded into the CT number evaluation plate in a concentric circle with a diameter of 40 mm. Each material sample is 3.0 mm in diameter. The eight materials are as follows: cortical bone equivalent tissue-mimic; a silicone-based vascular contrast agent compound; polytetrafluoroethylene; high-density polyethylene; fat-mimicking epoxy resin; muscle-mimicking epoxy resin; polymethyl methacrylate plastic; and water-equivalent epoxy resin. A 3-mm diameter air hole is positioned in the center of the plate, to evaluate the air signal within an object.

The CT number and standard deviation for air and each of the eight material samples on the CT number evaluation plate can be obtained from a 1.2 x 1.2 x 1.2 mm^3 ROI in the center of each material sample.

CT Number Linearity

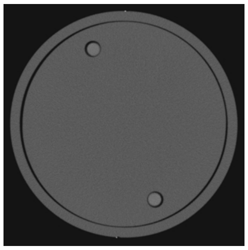


The linearity of the system can be determined using the linearity plate, which consists of vials of varying iodine concentration, covering the range of signal intensities seen in contrast-enhanced animal experiments.

Six vials containing iodine solutions prepared from non-ionic iohexol contrast material in the following concentrations are included: 0.9375, 1.875, 3.75, 7.5, 15, and 30 mg ml^{-1}. The sealed non-permeable polypropylene vials prevent fluid penetration into plastic or evaporation over prolonged periods of time. Two additional vials of water and air are included to facilitate calibration in HU. The eight vials are arranged in a concentric circle (44 mm diameter) and inserted into three polycarbonate plastic plates (each of 12.7 mm in thickness) to support the vials and to provide tissue-equivalent surrounding material.

In order to determine the linearity of the system, the signal intensity and standard deviation for each iodine concentration can be measured in a 3 x 3 x 3 mm^3 ROI in the center of each vial. The relationship between signal intensity and iodine concentration can be determined by linear regression analysis.

Uniformity and Noise Plate



The phantom design includes a uniform polycarbonate plate positioned near the centre of the phantom to measure the uniformity and noise of the system.

To visually compare the variation across the FOV, radial signal profiles can be taken through the center of the plate. In addition, a quantitative assessment of signal variation, from center to periphery, can be performed. For this measurement, the signal intensity can be measured in four peripheral ROIs and one central ROI; the average signal difference (center to periphery) in HU can then be calculated. For uniformity and noise measurements an ROI size of 3 x 3 x 1 mm^3 is recommended.

Noise can be measured within the uniformity plate in the same five ROIs used to measure uniformity, as described above. Report the measured standard deviation for each ROI, as well as the average of the five.

Automated Performance Evaluation Software

Automated performance evaluation software (Model vmCT-SOFT) designed for the Model vmCT 610 micro-CT phantom. This time saving proprietary software will provide a quick (minutes)and accurate quantitative analysis of the measurements acquired by a single scan of the Model vmCT 610 micro-CT phantom.

Model vmCT 610 micro-CT Phantom Specifications

Cylindrical acrylic wall, dimensions: 70 mm O.D., 90 mm in length • weight: 350 grams • six 63-mm diameter polycarbonate plates

Journal Publication Reference

A quality assurance phantom for the performance evaluation of volumetric micro-CT systems, Louise Y Du, Joseph Umoh, Hristo N Nikolov, Steven I Pollmann, Ting-Yim Lee and David W Holdsworth, **Phys. Med. Biol. 52 (2007) 7087–7108.**

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