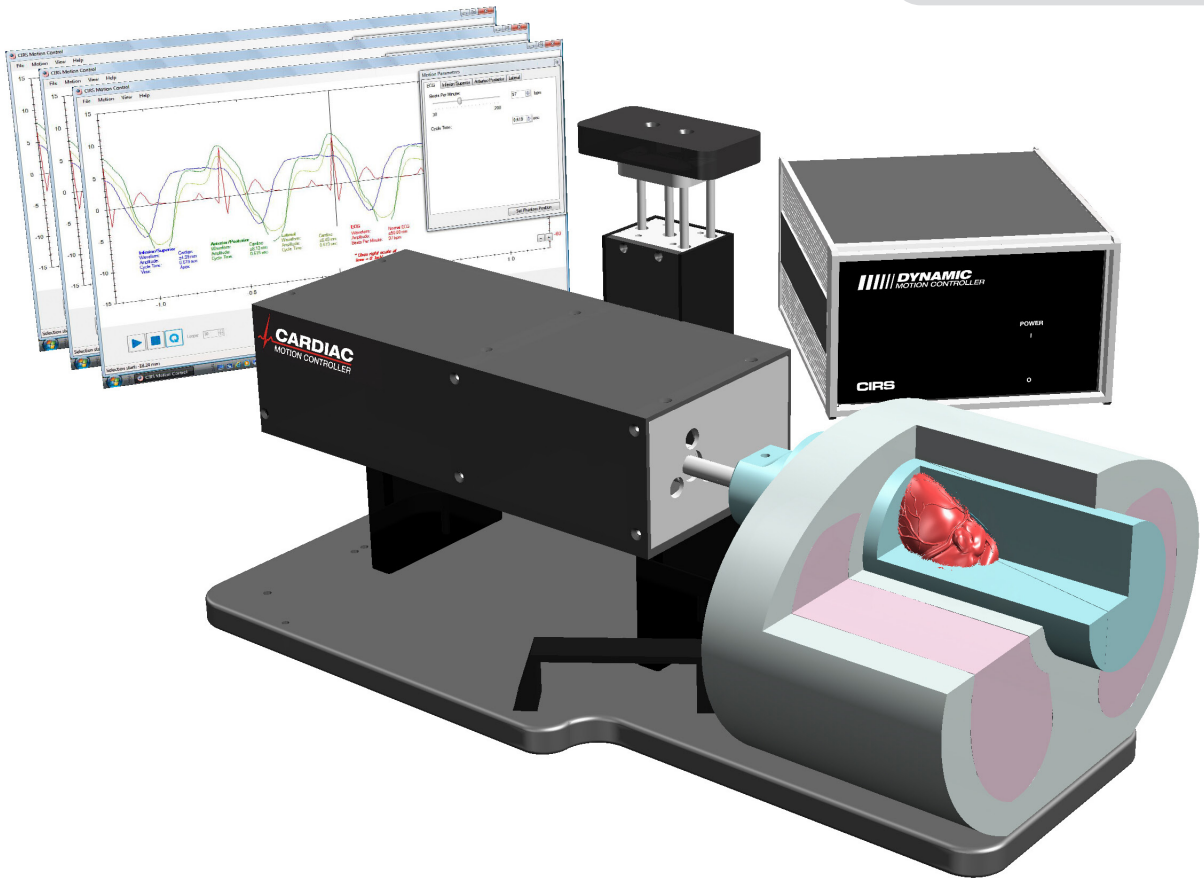
# Dynamic Cardiac Phantom

Model 008C




## *PERFORM COMPREHENSIVE EVALUATION OF CARDIAC IMAGING*

The CIRS Dynamic Cardiac Phantom is a precision instrument that simulates the realistic motion of an average human heart. It provides known, accurate and repeatable 3D motion of a solid heart model inside the tissue-equivalent thorax phantom. The Model 008C-01 rod is designed as a comprehensive image analysis tool for calcification detection, iodine contrast resolution and ECG signal gating.

The cardiac phantom is constructed from the tissue equivalent thorax body, moving rod with the solid tissue equivalent heart inside, motion actuator, motion controller and CIRS Motion Control software.

### *Features*

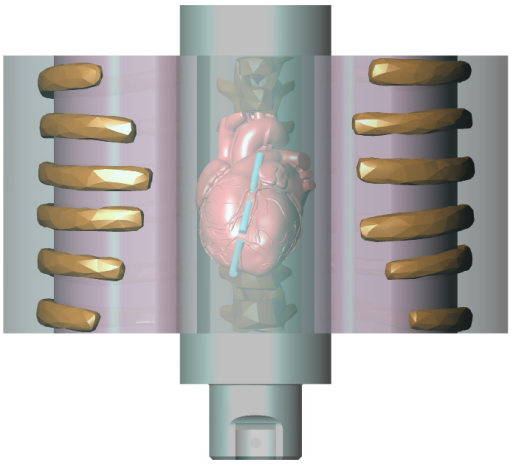
- Anthropomorphic heart inside a thorax body
- Tissue equivalent materials
- Iodine contrast and calcification detection capabilities
- Contrast target interchangeability
- Complex heart motion combined with respiratory motion
- Sub-millimeter accuracy and reproducibility
- Motion software enables different cycles, amplitudes, and wave forms
- Correlated ECG signal with readable output

# Tissue-Equivalent Materials

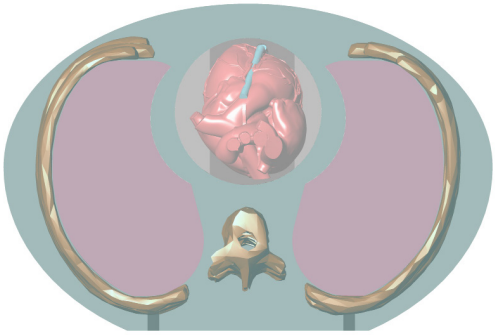
The phantom body represents an average human thorax in shape, proportion and composition. It contains a fully articulated spine, ribs and lungs. A tissue-equivalent rod containing a tissue-equivalent anthropomorphic solid heart is inserted into the mediastinum of a thorax phantom. The rod is split at an angle along the left coronary artery to provide access to replaceable targets. Linear attenuations of the simulated tissues are within 1% of actual attenuation for water and bone, and within 3% for lung from 50 keV to 15 MeV. The body is connected to a Motion Actuator box that induces three-dimensional heart motion through linear translation and rotation of the rod. The movement of the rod is radiographically invisible due to its matching density to the surrounding material, but the movement of the heart and targets, given its density difference, is visible.

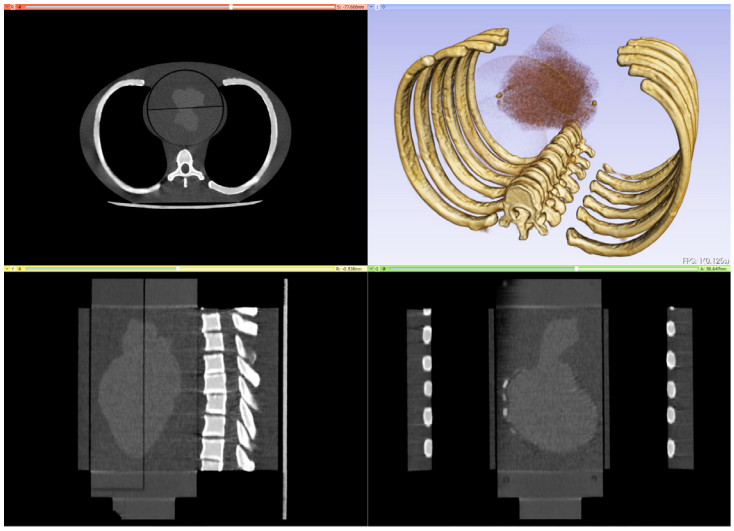
| Material | Density, g/cc | Electron Density x 10^23, per cc | Ratio to $H_2O$ |
|---|---|---|---|
| Plastic Water® DT | 1.04 | 3.35 | 1.003 |
| Plastic Water® LR | 1.03 | 3.33 | 0.998 |
| Lung | 0.21 | 0.69 | 0.207 |
| Cortical Bone | 1.91 | 5.95 | 1.782 |
| Trabecular Bone | 1.20 | 3.86 | 1.156 |
| Average Heart Tissue | 1.06 | 3.48 | 1.043 |

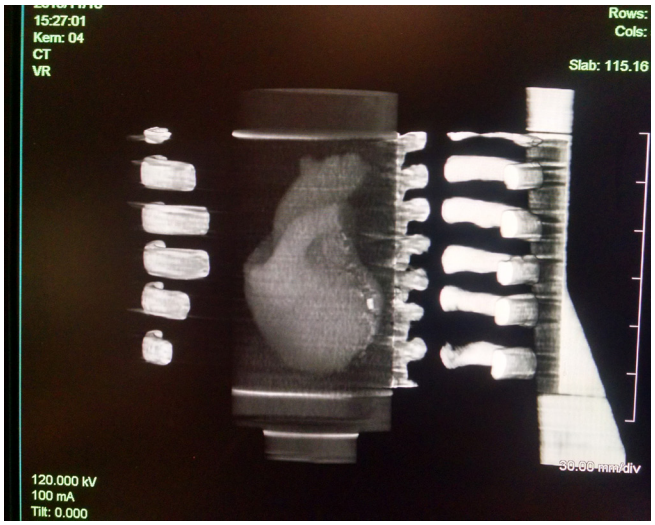
**Tissue equivalent thorax phantom with moving cardiac rod**
**(Top view)**



**(Back view)**





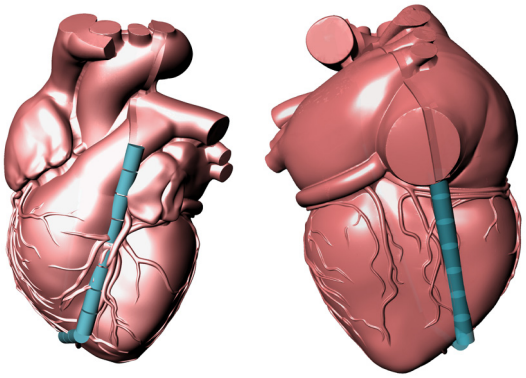



**Volume reconstruction and rendering**

# Iodine and Calcification Targets

The target pockets in the moving rod mimic the left coronary artery and posterior interventricular artery and allow for placement of different levels of iodine contrast or calcification density within the heart. The replaceable targets listed in the table at right are provided.

**Anthropomorphic cardiac tissue equivalent solid heart with replaceable targets mimicking the left coronary artery**



**(front view)**
**Left Coronary artery**

**(back view)**
**Posterior Interventricular Artery**

CALCIFICATION DETECTION TARGETS

| TARGET DIAMETERS | 1.2mm<br>3mm<br>5mm |
|---|---|
| CONCENTRATIONS | 50 mg/cc<br>100 mg/cc<br>250 mg/cc<br>400 mg/cc<br>Qty: 3 each |

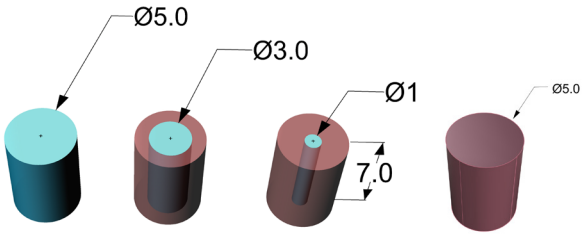
IODINE CONTRAST TARGETS

| TARGET DIAMETERS | 1.2mm<br>3mm<br>5mm |
|---|---|
| CONCENTRATIONS | 0.5 mg/cc<br>1.0 mg/cc<br>5.0 mg/cc<br>10 mg/cc<br>Qty: 3 each |

SOLID TARGETS

| TARGET DIAMETERS | 5mm |
|---|---|
| QTY | 20 |

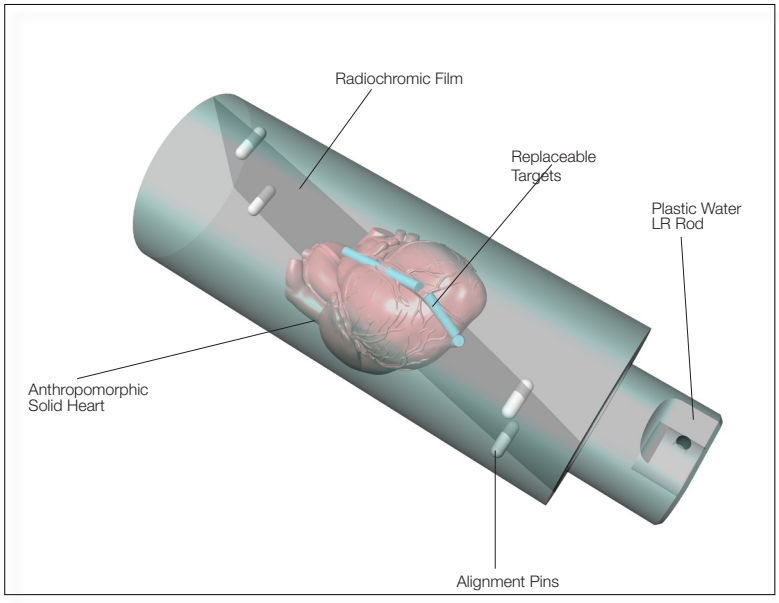
The target diameters listed refer to the core of the target, each target will be encapsulated in a blood equivalent tissue to bring the final dimensions of all rods to 5mm diameter by 7mm in length.



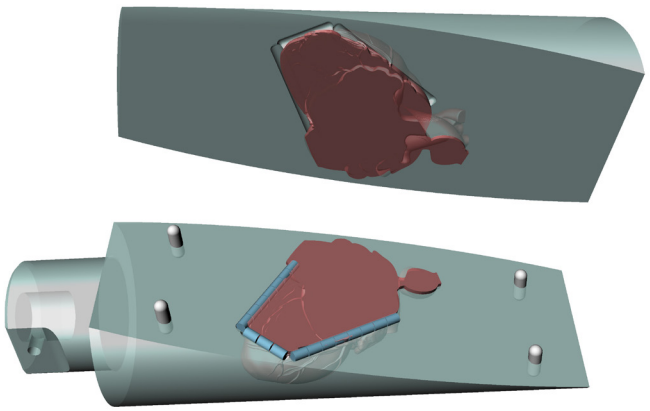

# Dose Studies

The model 008C-01 cardiac rod is split at a 13 degree angle along the left coronary artery. It is possible to place radiochromic film between the two halves of the rod for dose verification studies.

**Assembled Cardiac Rod**

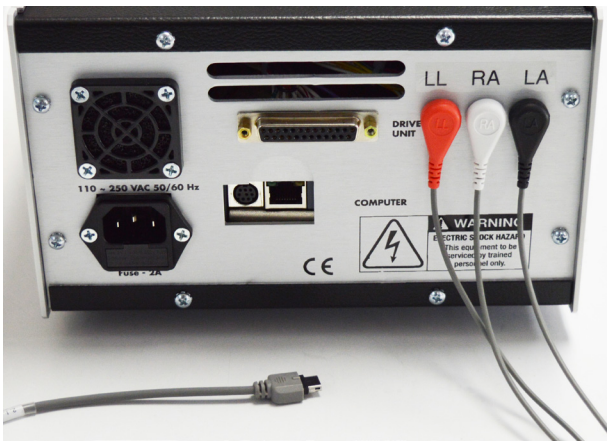



**Opened Plastic Water LR Rod with anthropomorphic heart and replaceable targets**

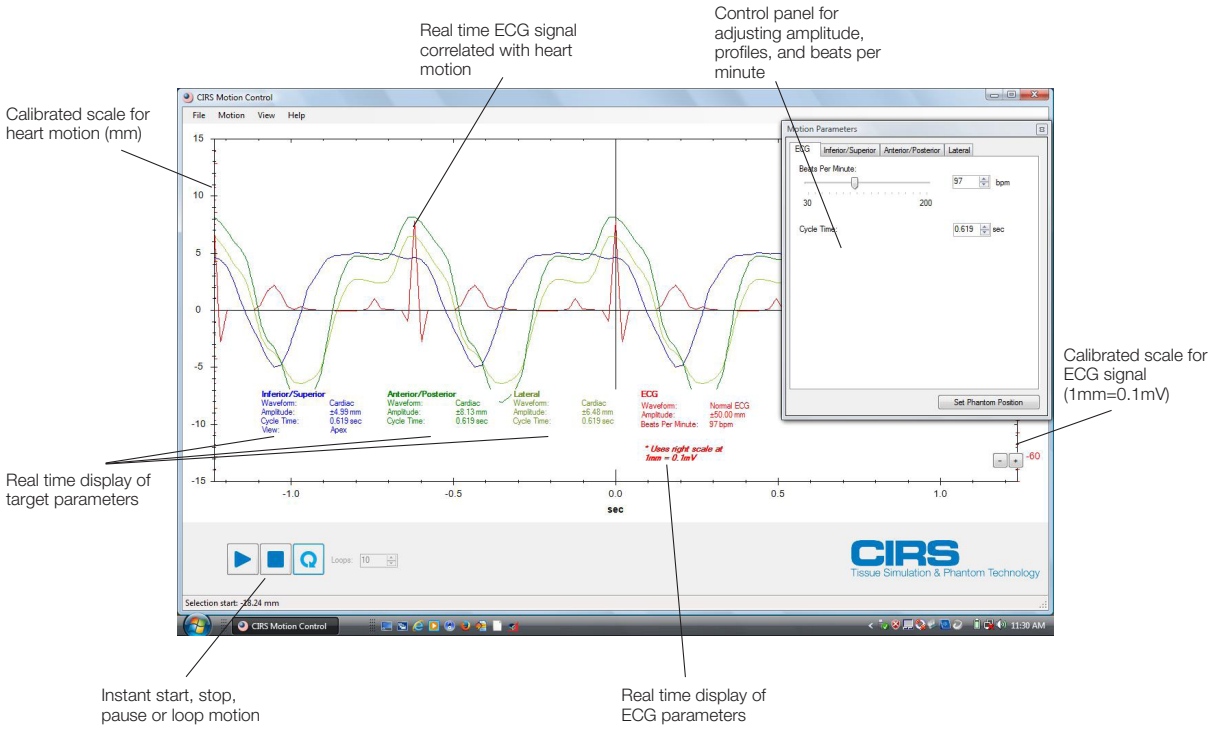


# Motion Correlated to ECG

The 3D movement of the heart is controlled by CIRS Motion Control software which is installed on a Windows PC or Laptop. The software comes loaded with three basic motion profiles that are specific to different anatomical parts of the heart and one correlated ECG profile. The one channel (3 leads) ECG signal, is readable with basic cardiac monitoring devices from the snap on connectors installed on the rear side of the Motion Controller. Through the intuitive user interface, users can adjust motion amplitudes and the heart rate. The scale on the left side of the display is calibrated in millimeters and is used to evaluate the physical motion of the heart. The scale on the right side of the display is calibrated to match the ECG signal equivalent with a typical ECG printed on graph paper (1mm =0.1mV). If the mouse is placed on the ECG signal on the main display the user is presented with information about that point of the ECG with respect to time and amplitude (mm/mV).

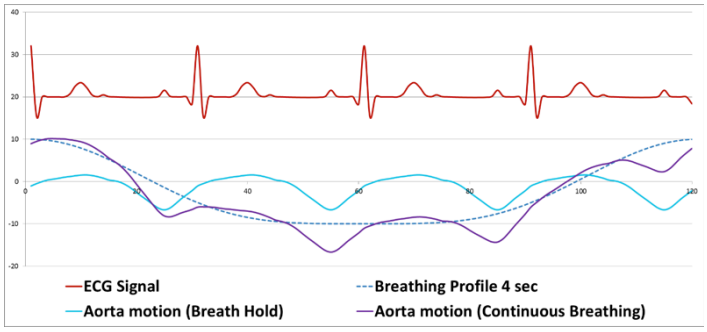



**ECG signal output through snap on connections at the rear of motion controller**




# Combined Heart & Respiratory Motion

The software can overlay respiratory motion with cardiac motion to account for total displacement of the heart. The respiratory motion can mimic either breath hold or continuous breathing of a patient. The software allows the user to import patient-specific cardiac and breathing profiles or build their own ECG signals in a comma separated value to simulate abnormal heart beats.





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