



Shelley Medical's programmable multi-modality Respiratory Tumour Motion Phantom simulates accurate and reproducible tumour motion from patient-specific breathing profiles. The Respiratory Tumour Motion Phantom is ideal for commissioning of new systems and system upgrades/repairs, scheduled testing, quality assurance tests and comparative testing of PET, MRI & CT in radiotherapy planning where respiratory motion is of concern.

This modular PET/MRI/CT compatible respiratory tumour motion phantom includes; a fillable acrylic torso phantom, fillable spine column, two air filled lung compartments, a fillable tumour sphere, a linear motion controller/stage and a rotational motion controller/stage. The linear motion controller/stage and a rotational motion controller/stage can be used independently or they can be combined to allow for synchronized linear motion combined with an up-down arcing motion or side-to-side arcing motion. The rotational motion controller/stage is positioned vertically to achieve an up-down arcing motion or positioned horizontally to achieve a side-to-side arcing motion.

The motion phantom is designed to accurately and reproducibly move a fillable tumour sphere with varying speed and amplitude. The tumour sphere can be filled with imaging contrast agents or tracers.

Arbitrary shaft lengths can be connected to the rotary stage allowing for arbitrary arc in the anterior-posterior (AP) or left-right (LR) planes. Phantoms of different shapes can be positioned on top of the moving carriage. Alternatively an extension arm can be connected to the carriage to push-pull objects (i.e. tumours) or to exert force on an elastic phantom.

Applications

- Quality assurance and comparative testing, commissioning of new systems and system changes for PET/MRI scanners, PET/CT scanners and hybrid MR-Linac scanners
- Verification of gated and adaptive treatment plans
- MR-based attenuation compensation
- Evaluation of motion correction algorithms
- Comparison, co-registration & validation of MRI, PET, SPECT & CT motion correction algorithms
- MRI Elastography testing & validation
- MRI guided robotics applications
- Evaluation of MRI guided MRgFUS treatment

System Features

- MR compatible QA respiratory tumor motion system operates within the magnet bore
- Components are precisely machined MRI-compatible materials
- Maximum MR scanner field strength of 3T
- 3D target motion
- Extension arms can be connected to the carriage to push-pull objects (i.e. tumours) or to exert force on an elastic phantom.
- Phantoms of different shapes can be positioned on top of the moving carriage.
- Accurate & reproducible replication of real time user-defined dynamic and periodic motion profiles
- Programmable and patient specific motion profiles, as well as standard preprogrammed motion profiles
- Torso, lungs, spine & tumor compartments offer known volumes
- Leak free torso, spine & tumour compartments can be filled with water, imaging contrast agents or tracers.
- Tumour spheres available with different volumes

Motion versatility beyond 1 axis...



When using the *linear* controller/stage independently, simultaneous superior-inferior (SI) & left-right (LR) *linear* motion can be achieved by rotating the stage to varying known degrees, similarly simultaneous superior-inferior (SI) & anterior-posterior (AP) *linear* motion can be achieved if the device is secured to angular wedges of varying and known degrees. The MR-1A-XRV2 stage offers default sinusoidal and respiratory motions (adjustable) and is also programmable for user defined motions.

Control Specifications

- Communication: USB
- Memory: Micro SD card
- Input voltage: 12 Volts DC
- Input supply current: 3 Amperes

Linear Stage Specifications

- Accuracy in reaching fixed positions: 0.1 mm
- Maximum (worst case) RMSE for dynamic motion with frequency <1 Hz : 0.3 mm
- Max speed: > 30 mm/sec
- Max force: ~> 20 N
- Max phantom weight/load: 6 kg
- Dimensions: 134 mm W X 72 mm H (90 mm with phantom adapter) X 287 mm L
- Carriage: 102 mm W X 95 mm L
- Range of motion: 50 mm (2.0")
- Weight: 2 Kgs



Rotational Stage Specifications

- Angular motion range: 360°
- Anterior-posterior motion (up-down arc motion)
- Left-right motion (side to side arc motion): 360°
- Accuracy in reaching fixed angles: 0.2°
- Max speed: > 30 mm/sec
- Max force: ~> 20 N
- Max phantom weight/load: 6 kg
- Dimensions: 80 mm W x 165 mm H x 250 mm L
- Weight: 3 Kgs

Modes of Operation

- Manual position control using step and direction keys
- Position control through computer by sending commands through USB port
- Execute sinusoidal trajectory with options of varying motion amplitude or frequency using keys
- Execute user defined dynamic and periodic trajectories with options of varying motion amplitude or frequency in real-time using specific interface keys

Additional Specifications

- Maximum scanner field strength: 3T
- Memory: >32 MB for storing trajectories
- Temporal resolution: > 1 KHz
- LCD position display: Yes
- Safety limit switch: Yes

Accessories

- Two cables with two DB9 connectors are needed for connecting *each* MRI compatible controller/stage to the scanner room penetration panel (length – up to 20 m)
- Various tumour sizes are available upon request.
- Shielded cables from penetration panel to the control unit
- Penetration panel adaptor plates available upon request.
- Micro SD card
- Power supply adapter
- Horizontal actuator arm with vertical plate for push/pull or deformation motion applications (i.e. MRE)

PET/MRI/CT Torso Phantom



Shelley Medical's Torso Phantom includes two lung compartments & a spine compartment. The torso and spine compartments can be filled with saline and contrasts or saline and tracers.

Torso & Tumor Specification

Torso width 305 mm

Torso height 253 mm

Torso volume ~ = 11.7 L

- Filled ~ = 17.8 kg
- Empty ~ = 6.24 kg

*Filled with saline and F18 @ ~ = 4.27 kBq/mL

Spine volume ~ = 347.50 mL

Lesion volume ~ = 22 mL

*Filled with saline and F18 @ ~ = 17 kBq/mL

Custom modifications can be made upon request.

