



SCAN \Rightarrow PLAN \Rightarrow LOCALIZE \Rightarrow TREAT \checkmark



"THE" COMPREHENSIVE END-TO-END SRS PHANTOM



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OVERVIEW





Stereotactic Radiosurgery (SRS) involves high dose fractions delivered to tightly constrained treatment volumes with sharp dose fall-off toward critical structures. MAX-HD is a high-definition anthropomorphic QA phantom specifically designed for End-to-End SRS commissioning and an unrivaled SRS training resource.

MAX-HD provides QA for image acquisition from both CT and MR modalities, image fusion, multiple target simulation, IGRT localization, and dosimetric plan verification. **MAX-HD** is an efficient tool for complete comprehensive End-to-End system testing.

The MAX-HD SRS Phantom is a human-scale anthropomorphic casting based on the CIRS (Norfolk, VA) Head Phantom made from proprietary tissueequivalent materials and providing linear attenuations of tissue within 1% of actual attenuations from 50 keV to 25 MeV and bone from 50keV to 15MeV. The anthropomorphic features simulate brain, vertebrae, sinus cavities, cortical and trabecular bone structure, larynx, trachea, oral cavities and teeth. These highdefinition features are combined with multiple planes of film and point-dose measurement locations to provide comprehensive analysis of high-resolution dose distribution coupled to critical structures.

MAX-HD utilizes a range of intracranial inserts to support Winston-Lutz evaluation, blind target couch shift studies, volumetric dose distribution, MR/CT fusion, laser/isocentric verification, ion chamber pointdose measurements, and image-guided topographic localization.

Key Features & Uses

- MAX-HD's anthropomorphic features support all IGRT procedures including imaging, localization, targeting, image fusion, and target delivery
- Flexible & Intuitive Setup MAX-HD can be placed flat on an imaging or treatment couch; Can be used with thermoplastic immobilization or an invasive frame
- MAX-HD is the only SRS phantom to feature multiple point-dose and film planes throughout the entire phantom enabling high-dose gradient analysis
- Complete SRS plan verification in critical regions using multiple dosimetric QA tools; lonization Chambers, nanoDots[™], and GAFCHROMIC[™] Film
- Supports multiple AAPM TG SRS testing protocols including TG101 and TG135 for:
 - ✓ Complete End-To-End Tests
 - ✓ Winston-Lutz test
 - ✓ Blind Target Study
 - ✓ Isocentric Verification
 - ✓ Bony Anatomy Localization
 - ✓ Laser Alignment
 - ✓ Localization / Repositioning with Couch Shift
 - ✓ Patient Orientation / Image Transfer QA
 - ✓ IGRT QA for X-Ray and On-board kV and MV images, including CBCT
 - ✓ MR/CT Image Fusion





AN-ATOMIC EQUIVALENCE



ANTHROPOMORPHIC ANATOMY

- High-Definition Cortical & Trabecular Bone
- Trachea, Sinus & Oral Cavities
- Spinal Cord & Vertebral Structure
- Upper & Lower Dental Structure
- Optional Dental Amalgam Inserts
- Unparalleled Bone & Tissue AN-ATOMIC EQUIVALENCE™



MAX-HD is constructed of CIRS' proprietary tissuematerials. equivalent Linear attenuations of the simulated tissues are within 1% of actual attenuation for soft tissue and bone from 50keV to 15MeV. CIRS tissue simulation technology has been validated through specific testing, continuous monitoring of manufacturing applications and worldwide use and acceptance of CIRS products for over 30 years.















INTUITIVE ASSEMBLY











Precision pins and location holes ensure components assemble in exact location and only in the correct configuration during every assembly



Unique pin locations within phantom and precise hole locations in film ensure film can only be inserted into the phantom in one secure orientation



Every phantom component and film plane utilizes a minimum of two pin locations to ensure precise positioning and proper orientation



All film is custom-cut by IMT using our precision laser cutting system



3





FLEXIBLE SETUP



Flexible & Simple Design

- Intuitive setup without secondary tools and fasteners
- MAX-HD is designed to lay flat on any couch allowing quick and stable setup for both imaging and treatment
- MAX-HD can be positioned using standard thermal plastic immobilization or traditional invasive frames
- External engraved laser target lines and MR marker locations are coincident with the central Winston Lutz fiducial and corresponding central ion chamber location
- Multiple Ion chamber holes at the superior and inferior facilitate easy and repeatable point dose measurements
- Pre-Cut GAFCHROMIC[™] films and nanoDots[™] are easily inserted and removed without the use of cumbersome tools and fasteners



Optionally Locate with Standard Index Bar



LOCATES WITHOUT FIXATION DEVICES OR ACCESSORIES



Multiple Ion Chamber Locations



1D-2D-3D DOSIMETRY

1D DOSIMETRY

- Multiple Ion Chamber Locations
- Multiple nanoD ot[™], TLD, or MOSFET Locations
- Steep Gradient Point Dose Measurements
- MAX-HD is customized to meet your clinic's ion chamber requirements











IMT

- The MAX-HD phantom features multiple locations for LANDAUER nanoDot[™] Optically Stimulated Luminescent Dosimeters (OSLDs)
- Incorporating the use of the nanoDot[™] OSLDs into a clinic's SRS QA program provides a simple and flexible solution for independent verification of dose quantity delivered from radiation-producing devices during imaging and treatment
- Each nanoD ot™ OSLD contains a unique serial number with 2D barcode and alphanumeric sensitivity code to ensure proper chain of custody throughout the QA process



1D-2D-3D DOSIMETRY

2D DOSIMETRY

- MAX-HD is the only SRS Phantom to feature film planes across multiple axes
- Superior and Inferior Axial Film Planes
- Superior Axial Film Plane position verifies dose distribution relative to the spinal cord, trachea, and larynx
- Inferior Axial Film Plane position verifies dose distribution relative to additional critical structures coupled to point-dose measurements
- Spatial dose distribution is verified using Ashland Self-Developing GAFCHROMIC[™] Film











SUPERIOR AXIAL FILM PLANE



1D-2D-3D DOSIMETRY



3D DOSIMETRY

- MAX-HD captures 3D target measurements using intersecting film planes
- 3D Film Stack Cube features nine closely-spaced film planes enabling volumetric dosimetry
- Anterior & Posterior 3D Film Cubes feature CTVs with intersecting film planes
- IMT supplies all film and is Pre-Cut



ANTERIOR 3D FILM



Posterior 3D Film









Film + Spherical Target

• MAX-HD places coronal and axial film planes within a spherical target



Figure 1



Figure 2



Spherical Target 3D Image

TWICE VERIFIED



FILM + ION CHAMBER

- Multiple point-dose and film plane single exposure measurements
- Unique to MAX-HD, the active volume of an ionization chamber intersects film plane; (See Figure 1A, 1B)
- Allows Point Dose & Spatial Dose Distribution in the same exposure

With Active Volume of Ion Chamber Centered on both the Film Plane & Spinal Cord



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FIGURE 1A



WITHOUT ION

CHAMBER



FILM + NANODOT IN SINGLE EXPOSURE

- MAX-HD is the only SRS phantom to feature film planes and nanoDots[™] in the same exposure
- Provides an additional method for Point Dose & Spatial Dose Distribution verification in the same exposure







INTRACRANIAL INSERTS



INSERT OPTIONS

- MAX-HD supports full range of SRS End-To-End Tests
- IMT Supplies all film Pre-Cut
- High-Definition MR Markers available
- Available Insert Cubes include:
 - ✓ Central & Offset **Fiducial Target**
 - ✓ Anterior 3D Film
 - ✓ Posterior 3D Film
 - ✓ 3D Film Stack
 - ✓ Ion Chamber
 - ✓ MRI Target Vessel with Contrast
 - ✓ Winston-Lutz
 - ✓ Calypso Beacon / Gold **Fiducial Insert**



CENTRAL & OFFSET FIDUCIAL TARGET



MR TARGET VESSEL



ION CHAMBER



ANTERIOR 3D FILM



POSTERIOR 3D FILM



WINSTON-LUTZ



3D FILM STACK INSERT





MR/CT FUSION



CT/MR Image Fusion Inserts



MR TARGET VESSEL INSERT



FUSED CT/MR TARGET IMAGES







3D RECONSTRUCTED IMAGE









CT TARGET IMAGE



MR TARGET IMAGE

SPECIFICATIONS



MAX-HD Specifications

- ✓ SHIPPING & STORAGE CASE INCLUDED
- ✓ INTRACRANIAL INSERTS CONFIGURED UPON ORDER
- ✓ IMT PRE-CUT FILM AVAILABLE FOR ALL COMPONENTS
- ✓ CUSTOM-CONFIGURED TO CUSTOMER-SPECIFIC POINT-DOSE MEASUREMENT INSERTS

Length:	24cm
WIDTH:	23cm
Height:	25cm
WEIGHT:	5.4Kg

CIRS MATERIAL TECHNICAL SPECIFICATIONS

MAX-HD is constructed of CIRS' proprietary tissueequivalent materials. Linear attenuations of the simulated tissues are within 1% of actual attenuation for soft tissue and bone from 50keV to 15MeV. CIRS tissue simulation technology has been validated through specific testing, continuous monitoring of manufacturing applications and worldwide use and acceptance of CIRS products for over 30 years. CIRS is a Registered Trademarks of Computerized Imaging Reference Systems, Inc. (CIRS) 2428 Almeda Ave, Suite 316 Norfolk, Virginia 23513

		Trabecular Bone	Soft Tissue	Brain	Spinal Cord	Cortical Bone
	En, MeV	Ratio, %	Ratio, %	Ratio, %	Ratio, %	Ratio, %
	0.04	99.8	100.0	100.0	100.0	99.3
	0.06	100.1	100.2	100.1	100.0	99.7
	0.08	100.3	100.3	100.3	100.0	99.8
	0.10	100.3	100.3	100.3	99.9	100.0
	0.20	100.5	100.4	100.3	99.9	99.8
	0.40	100.5	100.4	100.4	100.0	100.0
	0.60	100.5	100.3	100.3	100.0	100.1
	0.80	100.4	100.4	100.4	99.9	100.1
	1.00	100.5	100.3	100.4	99.9	100.1
	2.00	100.5	100.4	100.4	100.0	100.1
	4.00	100.5	100.3	100.0	99.7	99.7
	6.00	100.3	100.0	100.0	100.0	99.6
	8.00	100.0	100.0	99.6	100.0	99.6
	10.0	100.0	100.0	99.6	100.0	99.3
	20.0	99.5	99.5	99.5	100.0	99.5
	30.0	99.5	99.4	98.9	100.0	99.2
	Density, g/cc	1.20	1.06	1.07	1.07	1.93
	Electron Density X 10 ²³ , per cc	3.863	3.434	3.470	3.488	5.958

GAFCHROMICTM EBT3 FILM SPECIFICATIONS

- ✓ Pre-Cut by IMT
- ✓ Supports ALL major RT technologies
- \checkmark Wide dose range, 1cGy to > 40 gy
- ✓ Uniformity Better than +/- 3% in dose
- ✓ Peaks at 636 nm
- ✓ High Spatial Resolution
- ✓ Anti-Newton ring coatings
- ✓ Density changes stabilize rapidly
- ✓ Reduces scatter radiation
- ✓ Near Tissue-Equivalent
- ✓ Self-Developing Film
- ✓ Develops in real time, no processing
- ✓ Can be handled in room light

LANDAUER nanoDot[™] TECHNICAL SPECIFICATIONS

Accurate within ±10% over diagnostic energy range 70-140 kV; within ±5% for photons and electrons from 5 MeV–20 MeV			
0.1 mGy	DN093 Z8606N		
lcm x lcm			
red Trademark of Science Road inois 60425			
	Accurate within ±1 70-140 kV; within from 5 MeV-20 N 0.1 mGy 1 cm x 1 cm red Trademark of Science Road nois 60425		



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dose operating range:	For medical dosimetry applications, linear response with dose up to 300 rad (cGy), soft ware-supported non-linear calibration up to 1500 rad (cGy)		
USEFUL ENERGY RANGE:		From 5 keV to 20 MeV	
ACCURACY (TOTAL UNCERTAINTY - SINGLE MEASUREMENT):		+/- 10% with standard nanoDot™ +/- 5% with screened nanoDot™	
PRECISION:		+/- 5%, k=2 for both standard and screened nanoDot™	

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