

# AdvantageSim MD

Adaptive virtual simulation planning.

In the era of advanced radiation therapy, contouring organs at risk and targets, often using multiple datasets showing anatomical, functional and metabolic or respiratory induced motion information requires an environment and tools that facilitate productivity and accuracy through efficient automated and manual tools and intuitive user interface. Isocenter marking and beam planning tools are essential for quick and precise patient positioning, plan setup and efficient palliative and emergency planning cases.

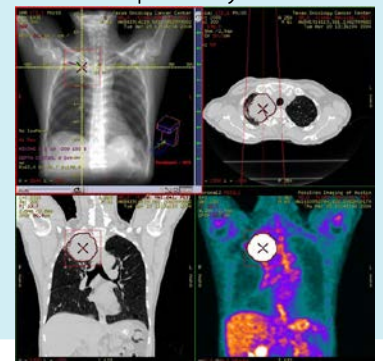
## Overview

The AdvantageSim MD virtual simulation software automatically defines contours and volumes and determines geometric beam placement to improve accuracy and speed of planning for high-precision radiotherapy techniques.

AdvantageSim MD's simulation tools provide the latest in simulation and localization technology improving productivity and accuracy.

## What's new

- Automated CT atlas-based contouring helps speed up OAR definition
- Automated re-planning helps adapt the initial plan to the follow-up CT to account for weight loss during the course of the treatment
- Semi-automated MR pelvic organ segmentation.
- Adaptive paintbrush tool for fast manual contouring
- Enhanced user interface and workflow for more efficient and intuitive planning experience
- Innovative 4D CT and 4D PET/CT workflow
- Paperless support with pdf printing
- DICOM-RT and IHE-RO compliance for seamless interoperability



Visit us:

[www.gehealthcare.com/aw/applications/advantagesim-md/](http://www.gehealthcare.com/aw/applications/advantagesim-md/)



## Features

- With AdvantageSim MD, you can prepare geometric and anatomical data for external beam radiation treatment before dosimetry planning. Using a set of CT images of the patient in the proposed therapy position, you can automatically or manually define anatomical volumes.
- You can utilize additional CT, MR, or PET studies co-registered with the CT scan to assist planning.
- For advanced clinical functionality and flexibility, you can aid the CT simulation with these available advanced options:
  - Multi-modality target definition
  - 4D CT and 4D PET respiratory review
  - Synchronized and fused 4D PET/CT phase movie
  - A suite of automated and semi-automated CT-based organ segmentation tools
- Automated CT atlas-based contouring for brain, head&neck, thorax and pelvis organs as well as re-planning to adapt the initial plan to the follow-up CT to account for weight loss during the course of treatment is available.
- Semi-automated MR model-based segmentation for pelvis organs.
- You can take advantage of 3D contour interpolation that lets you define a full volume contour with a minimum of 3 contours in orthogonal planes.
- The application lets you define and manipulate volumes with automatic thresholding tools, structure drawing (with or without Live Wire to pixel value gradients), and automatic interpolation. Beam placement is facilitated with the automatic isocenter placement and the beam's eye view (BEV) features.
- The mouse-driven package has an easy to use, intuitive user interface.
- With the touch of a button you can access pre-defined, configurable treatment plan templates, load geometry and field shapes from a palette of templates, and apply pre-defined action sequences for additional ease of use.
- Modify contour and field definition parameters on the fly to tailor thresholds, margins, and display characteristics to individual patient data sets.
- The ability to change the reference dataset during the planning session removes the need to restart planning in case the wrong dataset was chosen as reference at the start of the simulation.
- Use AdvantageSim MD independently of the treatment planning system to increase your workflow efficiency. The application can be accessed from a dedicated workstation, a networked client computer, or a compatible scanner console.
- You can push completed plans to an RTP system in standard DICOM RT format. DICOM RT data can be received from DICOM RT compliant systems and re-simulated in AdvantageSim MD.
- You can automatically remove the couch from the image volume for even greater efficiency.

- The program's 3D based display and manipulation features give you full patient anatomy visualization.

## System Requirements

- AW Workstation 4.6
- AW Server 2

## Indications for Use

AdvantageSim MD is used to prepare geometric and anatomical data relating to a proposed external beam radiotherapy treatment prior to dosimetry planning. Anatomical volumes can be defined automatically or manually in three dimensions using a set of CT images acquired with the patient in the proposed treatment position. Definition of the anatomical volumes may be assisted by additional CT, MR or PET studies that have been co-registered with the planning CT scan. Additionally, CT & PET data from a respiratory tracked examination may be used to allow the user define the target or treatment volume over a defined range of the respiratory cycle.

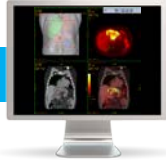
The geometric parameters of a proposed treatment field are selected to allow non-dosimetric, interactive optimization of field coverage. Defined anatomical structures and geometric treatments fields are displayed on transverse images, on reformatted sagittal, coronal or oblique images, on 3D views created from the images, or on a beam eye's view display with or without the display of defined structures with or without the display of digitally reconstructed radiograph.

## Regulatory Compliance

AdvantageSim MD complies with the European CE Marking directive for Medical Devices 93/42/EEC.



GE imagination at work



## Features Detail

### Clinical applications

Use AdvantageSim MD virtual simulation to prepare geometric and anatomical data for proposed external radiation therapy before or after dosimetry planning on a treatment planning system that supports the exchange of DICOM RT Plan and RT Structure Set objects, AdvantageSim MD, Complex Multi-modality CT, MR, and PET 3D objects.

The program allows you to interactively optimize field coverage in a non-dosimetric environment. The anatomical structures and geometric fields that you define are displayed on transverse images, on reformatted sagittal, coronal, or oblique images, on 3D views created from these images, or in a beam's eye view display with or without the display of defined structures, and with or without the display of digitally reconstructed radiograph.

With AdvantageSim MD, you are able to visualize volumes and field geometries for rapid plan preparation. With AdvantageSim MD, you can:

- Select multi-image views from 3D, transverse, sagittal, coronal, oblique planes, or BEV
- Define volumes from transverse, sagittal and coronal planes
- Define beam placement and beam dimensions
- Define shape(s)
- Position multi-leaf collimator leaf positions, even for MLCs, with variable leaf widths (up to 100 leaf pairs), MLC minimum field and inter-digitation
- Get a beam's eye view of contoured volumes
- Reconstruct radiographs digitally
- Load, re-plan or merge DICOM RT Structure Sets and DICOM RT Plan objects
- Save DICOM RT Structure Sets, DICOM RT Plans, 4D MIP, Ave-IP, Min-IP series, DICOM RT Images and DICOM SC Images
- Lock exams (user preference on AW Server 2) to prevent other users from modifying the active RT Plan
- Handle boluses.
- Employ a variety of distance measurement tools
- Employ a variety of annotation tools

From an image series, select a set of images with which you wish to generate a 3D model. When built, you can interactively view and manipulate the 3D model with a full range of cut plane, rotation, shading and windowing features. Define volumes automatically by advanced thresholding and segmentation methods, or with manual freehand tracing tools. You can place beams, and fields are

defined either manually or automatically (which conforms the beam to multiple selected structures of outline traced on BEV).

### Display

Multiple view ports let you simultaneously view axial, coronal, sagittal, oblique, 3D, digitally reconstructed radiograph (DRR), and BEV cutaway images. Magnify images within selected view ports or magnify a selected port to full screen. View 3D or DRR displays in maximum pixel intensity (MIP) or ray-sum modes. All images display patient ID, and field projection is shown on all views, including 3D, BEV, and DRR, which show block coverage as well.

### Multi-modality display and contouring

AdvantageSim MD lets you load and display multiple previously registered CT, MR, and PET data sets for improved flexibility. You can define contours in any modality and orthogonal plane. Resulting Radiation Therapy Structure Sets (RTSS) reference the primary simulation CT. Optionally you may specify that the RTSS reference all image data used during the Sim session in addition to the primary CT.

Drag one modality or image volume data set (CT, MR, PET) over another to generate a blended data set for visualization and contouring. Modality-specific units (e.g. PET SUV) are maintained, ensuring clinical assessment consistency.

### 4D respiratory image and simulation

Review 4D CT and 4D PET data acquired with a GE PET/CT system to analyze and characterize respiration-induced motion. This feature allows you to derive clinically relevant information on the true shape of anatomy in motion, reducing structural distortion and allowing you to identify the dynamic range of motion. From this data you are able to assess the impact of motion and verify treatment parameters, making tumor irradiation more precise and sparing healthy tissue.

The new 4D workflow enhancements further streamline planning with respiratory gated CT and PET/CT thus help speed up planning in 4D. The following tools help facilitate motion assessment and contouring for 4D gated treatment planning:

- Creating 4D MIP, Ave-IP and Min-IP datasets on-the-fly
- Saving 4D MIP, Ave-IP and Min-IP datasets and exporting to 3rd party planning systems
- Movie-loop a desired range of 4D CT and/or 4D PET phases



## 4D contouring

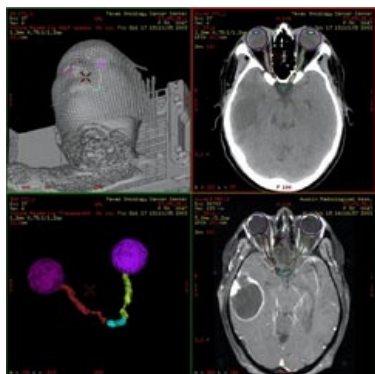
You can contour using either the full respiratory cycle or a sub-selected phase range from the CT and/or PET movies. You can then play the motion across the range with the contour to confirm that the proposed treatment plan encompasses the entire tumor throughout the respiratory segment. The ability to perform real-time contour editing during movie review or to automatically freeze\*\*\* the 4D movie upon contouring provides an efficient 4D simulation workflow.

## CT-based automated contouring

Entry level option:

A selection of automated and semi-automated CT-based segmentation tools is available that enables you to generate complex structures around organs at risk. The supported anatomy includes:

- Body
- Lungs
- Spinal cord
- Liver
- Kidneys
- Spleen
- Ocular globes and lenses
- Optic nerves and chiasm



Advanced option:

Complete CT atlas-based contouring and re-planning:

- CT atlas-based contouring provides fully automated contouring of organs at risk for brain, head and neck, thoracic (male and female) and pelvic (male and female) organs when advanced radiation therapy techniques require precise contouring of multiple avoidance structures.
- Clinically validated atlases and results ensure superior accuracy.
- The results in form of 2D contour sets can be exported in DICOM RT Structure Set or RT Plan formats to 3rd party planning systems.

Benefits:

- Helps speed up time consuming manual contouring of organs at risk (OAR).
- Helps to improve contouring consistency, i.e. to reduce inter-operator variability between contours.

- Adaptive CT atlas-based re-planning uses the initial planning CT and RT Plan to apply deformable fusion and proprietary algorithms to adapt the initial plan to the follow-up CT to account for weight loss and other anatomical changes during the course of treatment.

Benefits:

- Helps significantly decrease time needed to update a treatment plan upon a follow-up CT simulation.
- Helps to improve contouring consistency, i.e. to reduce inter-operator variability between contours.

## MR-based semi-automatic contouring

A suite of semi-automated MR based pelvic organ segmentation contouring tools allowing complex structures to be generated around organs at risk and overlaid on the co-registered CT planning image. Segmentation performs optimally on high resolution, high soft tissue contrast T2 weighted images.

Currently supported anatomy includes structures:

- Prostate
- Bladder
- Femoral Heads
- Rectum

Key benefits:

- MR improves visualization of the prostate and OARs required for treatment planning for improved confidence in tumor targeting and to help increase radiation therapy effectiveness
- Helps speed up time consuming manual contouring of OARs; Average time savings of 19%<sup>1</sup> for prostate, bladder plus femoral head segmentation.
- Improves consistency of inter-operator contours; decreases inter-observer variability by an average of 14% for prostate, bladder plus femoral head segmentation.
- Equivalent accuracy to manual contouring<sup>2</sup>

<sup>1</sup> 95 % CI between 11 % - 27 %

<sup>2</sup> Accuracy of auto-seg + manual adjustments are within 2mm (ave 2D distance) of manual contours

## Volume definition

To define volumes using a 3D image data set, you have access to a variety of tools:

- **Volume segmentation using thresholding:** Lets you include or exclude data based on pixel value.
  - Thresholding plus erosion and dilation lets you erode layers of thresholding-defined pixels from a surface and dilate the volume to the original size.



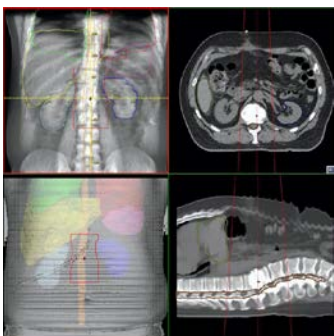


This allows small bridges between different volumes to be broken before you begin contouring. You may also constrain volume segmentation within a volume of interest.

- **Contour tracing:** Enables you to trace, with the cursor, the external surface of a volume in any parallel plane (axial, sagittal, or coronal) and define the complete volume by interpolation. You can define contours using a paintbrush tool that optionally adapts to quasi-homogeneous image contrast region of interests a freehand tool with a magnetic option, a simple point-to-point method, or a live-wire tool with a "magnetic" cursor that follows discontinuities in image contrast. Contours can be created and displayed in axial, sagittal, or coronal views.
- **Contour editing:** You can manually redraw sections of contour traces. And you can select a structure name for a pre-defined list or enter your own using the keyboard.
- **3D anisotropic margins:** Expand structures to create a new 3D volume with elliptical kernel margins that you define in all 6 directions (anterior, posterior, left, right, inferior, and superior). With this tool, you can combine two or more existing structures with a specified margin.
- **Floating contour toolbar\*:** You can place a floating contour toolbar in any part of the screen to make your workflow more flexible and efficient.
- **Link to GE multi-modality Fusion software\*:** AdvantageSim MD lets you load DICOM RT Structure Sets or registered image data sets that were created with GE Fusion software. AdvantageSim MD can be launched directly from the GE Fusion application to enhance your productivity even further.

## Beam placement

- Manual or automatic beam placement tools allow you to adjust isocenter position and collimator settings to accord with the selected volume. For fixed SSD treatment techniques, you can enter the SSD value. You can also interactively select and modify table, gantry, and collimator angles, and a mid-plane tool facilitates parallel opposed treatment setups.

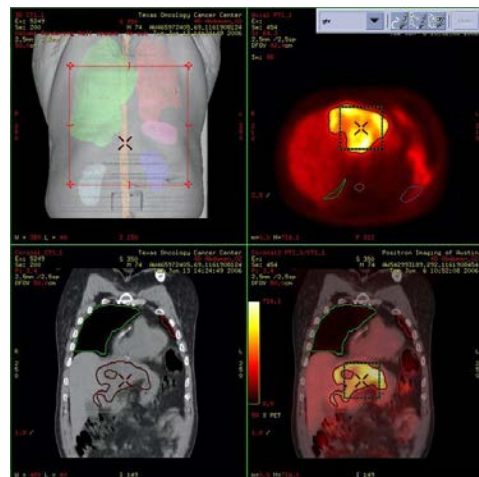


- AdvantageSim MD lets you define and save beam groups for commonly used beam arrangements, allowing rapid definition of beam sets for virtual simulation. Within each beam group you can specify if all beams should have identical isocenters. Parameters such as machine type, energy mode, table, gantry, collimator angle values, and collimator mode can be saved to define treatment protocols. You can easily appose beams for rapid setup of 2D plans or duplicate beams to facilitate boost field setup.
- The DRR/BEV displays a machine diagram to let you perform real time checks of machine and patient geometry. Type in isocenter coordinates using the RAS convention. You can shift the isocenter automatically by typing in an SSD value.

## Field definition

AdvantageSim MD gives you several options for beam shaping:

- Automatic shielding block definition that conforms to selected volumes with specified margins.
- A graduated bull's eye cursor for manual block margin definition.
- Block definition as aperture or shielding.
- Manual freehand or point and click block definition on the DRR.
- Automatic collimator jaws or multi-leaf position definition conforming to selected volumes.



- Manual entry of gantry, collimator, and table angles and jaw limits.
- Automatic field conformation, with margins that you define, to an aperture block.

## Field visualization

With AdvantageSim MD, you can visualize fields in several ways:

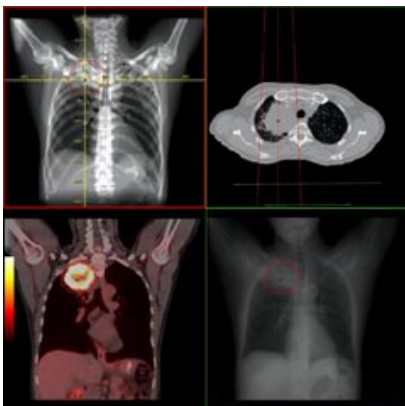


- **Beam's eye view:** Displays a semitransparent conic projection of defined volumes and field shapes as seen from the radiation source.
- **Digitally Reconstructed Radiograph (DRR):** Displays an integration of pixel values along a conic projection from the radiation source with a beam's eye view superimposed.
- **3D patient model:** Displays the beam axis and field projection on the patient surface in patient context according to the angle of view.
- **3D cut away:** Displays the patient model with semi-transparent field visualization along selected 3D cut planes.

### DRR features

The list of Digitally Reconstructed Radiography capabilities and features includes:

- Fast recalculations, in the DRR calculation mode, while modifying beams.
- Automatically selects optimum window width and level settings for DRR.
- When using fluoroscopic mode, isomove mode updates DRR when isocenter position is modified with the 3D cursor in all views.
- A mixing mode lets you modify the DRR to highlight or suppress each of 4 pixel value ranges: low density (lungs), soft tissue, bone density, and a range of density values that you define.
- A depth control mode calculates a DRR over a thickness that you define.
- A cross hair feature that you can choose to display on a DRR provides scale information and wedge direction as indicated.



- A grid dot pattern that you can choose to display that emulates a traditional BB tray.
- The ability to capture and overlay a positive or negative reference DRR onto another, active, DRR with weighting values for each image that you define.
- The ability to copy current DRR settings quickly

and easily to adjacent beams.

### Connectivity

**Data export:** Image, volume, and plan data are exported in accordance with DICOM V3.0 standards and IHE-RO (user preference) standards, with all radiation therapy specific data compiled in the DICOM V3.0 object (including RT Plan, RTSS structure set and RT Image).<sup>†</sup>

**Laser marking systems:** AdvantageSim MD can export isocenter(s), beam corner and MLC shapes to laser marking systems. Gammex and LAP are currently supported vendors

Laser shifts sent to external laser systems can be corrected for table deflection by identifying the fiducial landmark location within the image volume.

In the AW Server 2 environment, one or more client computers may be dedicated authorized stations to communicate coordinates to and from the marking system(s).

**RT Data Import:** Image, volume and plan data can be imported in accordance with the DICOM Standard and IHE-RO (latter as a user preference). Import of treatment plan data from an external system, and its correct interpretation by AdvantageSim MD, must be validated before use. Implementation profile is available on request.

### Hardcopy

You can print hardcopies of all displays and plan data at a magnification you choose on paper or transparency material. You can print DRRs to film if you work with a film printer\*\* that is AW Workstation or AW Server 2 compatible with the appropriate AW film printer interface. You can print a hardcopy of beam parameters and isocenter coordinates, using IEC standard, on an optional Postscript printer. You may support a paperless environment by the new pdf printing capability.

### Archiving

With the AW Workstation, you can save DICOM images and DICOM RT objects on DICOM CD/DVD or USB device.

### Intended use

AdvantageSim MD is used to prepare geometric and anatomical data relating to a proposed external beam radiotherapy treatment prior to dosimetry planning. Anatomical volumes can be defined automatically or manually in three dimensions using a set of CT images acquired with the patient in the proposed treatment position. Definition of the anatomical volumes may be assisted by additional CT, MR or PET studies that have been co-registered with the planning CT scan. Additionally, CT & PET



data from a respiratory tracked examination may be used to allow the user define the target or treatment volume over a defined range of the respiratory cycle.

The geometric parameters of a proposed treatment field are selected to allow non-dosimetric, interactive optimization of field coverage. Defined anatomical structures and geometric treatment fields are displayed on transverse images, on reformatted sagittal, coronal or oblique images, on 3D views created from the images, or on a beam eye's view display with or without the display of defined structures with or without the display of digitally reconstructed radiograph.

### System Requirements

- AW VolumeShare 5 or later or AW Server 2
- Color Landscape Monitor
- Up to two display monitors

AdvantageSim MD radiation DICOM V3.0, including RT Plan and RTSS object structure set. Export of treatment plan data to any external system and its correct interpretation by that system must be fully verified before use.

### Standards and Regulations

This product complies with the European CE Marketing regulation for Medical Devices Directive: Directive 93/42/EEC, dated 14 June 1993.

\* AW only

\*\* Film printer must be adequate for scaled printing.

\*\*\* Available on AW Server

†Treatment planning systems connected to AdvantageSim MD must be DICOM 3.0 compatible and capable of reading AdvantageSim MD radiation DICOM V3.0, including RT Plan and RTSS object structure set. Export of treatment plan data to any external system and its correct interpretation by that system must be fully verified before use

