

MarkRT (VGRT) Test Protocol

To be performed by the end user.

Purpose:

To test program MarkRT (VGRT) for correct operation with the user's equipment and method of taking images. The user must consider their particular equipment and circumstances and insure that the test is performed to test the parameters that are likely to change in the clinical use of this system. The below test should generate confidence in the system and find any procedural error. It is the user's responsibility to establish a protocol for the use of this patient location system and ensure that it is working properly.

Materials:

A suitable phantom, CT scanner, treatment planning system, medical linear accelerator treatment machine, spherical BB marker and several additional linear markers (three is a good number), MarkRT (VGRT) program, MarkRT (VGRT) manual, access to System2100 manual and Dosimetry Check manual (on line at www.MathResolutions.com). Lead solder will do for a linear marker.

Variables to Consider:

- Gantry angles used and spread between the gantry angles, which should be close to 90 degrees.
- Method of knowing where the central ray is on each image and the beam's eye view (BEV) x and y axis on the images.
- Does the image receptor fix this location, or must it be determined from the radiographic image?
- If from the radiographic image, will the collimator be rotated?
- Whether the image receptor might be rotated or whether or not that rotation is independent of knowing the location and orientation of the BEV coordinate system?
- Whether the couch might be rotated from its zero position?
- How many markers will be implanted in the patient?

Note, collimator angle and image receptor angles do not matter if the location of the BEV coordinate system is otherwise fixed relative to the image receptor and independent of those rotations, which would typically be the case if using an EPID. Your protocol must

reflect the method of knowing where the BEV coordinate system is on the radiographic images.

You may need to modify the below test to fit your specific situation.

Suggested Method:

Use a spherical BB marker to mark an isocenter location. If possible put the marker someplace where external marks can be used to align isocenter on the treatment machine. Place several markers elsewhere inside or on the surface of the phantom so that all the markers are rigidly and securely attached to the phantom.

CT scan the phantom taking cuts spaced 3 mm or closer. Use the spacing normally used for planning the patients that MarkRT (VGRT) will be used for.

Inspect the Geometry file (see MarkRT (VGRT) manual) for correctness of specifying the coordinate system of the treatment machine. If your couch has the non-coordinate system where moving laterally across zero from positive to negative, the couch position read out jumps to 99 or 999 at -1.0 cm, then you also need the CouchCoord file; otherwise delete the CouchCoord file.

Use the planning system to plan a beam with the isocenter at the location of the isocenter marker. If your plans might include beams with a different isocenter, you might consider adding an addition beam with a different isocenter.

Transfer this plan to MarkRT (VGRT) using either the RTOG or DICOM RT protocol. If neither is available, then read in the same CT scans with MarkRT (VGRT), create a plan and a beam and position the isocenter of the beam at the same location of the isocenter marker.

Using the locate marker tool in MarkRT (VGRT), assign names to the markers and trace then in the CT scan set. The locate marker tool is described in the System 2100 manual under the Points, Labels, and Markers section.

Position the phantom on the treatment couch. Position the phantom as if it were a patient for treatment according to the above treatment plan. Align the phantom so that the BB marker is precisely at isocenter. Take beam films if necessary to confirm the correct positioning of the phantom.

Write down the coordinates of the treatment couch:

Couch Position of Isocenter for the Treatment Beam

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm

Now purposely move the couch a small distance of the order of 1 cm in each of the lateral, longitudinal, and height directions. Write down the coordinates of this new position:

Couch Position of Isocenter for the Location Radiographs

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm

Take two radiographs with a couch angle of zero. Take one near the gantry angle of +45 degrees and one with a gantry angle near -45 degrees. Take a third film at the same gantry angle but with the couch rotated around 10 degrees. Feel free to use other angles, but two images should be close to right gantry angles.

If using film, you must mark these films so that you will know which side of the film faced the x-ray source. You must have the means to locate the beam’s eye view (BEV) coordinate system on the film.

In the unrotated collimator with the gantry pointed at the floor, the x-axis is positive left to right across the couch when looking into the gantry, the y-axis is positive in toward the gantry, and the z-axis is positive toward the source.

With a centered EPID you should not have to locate the BEV coordinate system. However, if the BEV coordinate system must be located, or with film, and you are going to use the field outline, then you must consider whether or not the collimator will be rotated. If the collimator may be rotated, then the test should include some collimator rotation.

Record information about the radiographs below:

Label	Field size x cm	Field size y cm	Gantry angle	Couch angle	Collimator angle	SID cm

For an EPID, it is only necessary to know the pixel size at 100 cm, in which case the SID can be reported as being at 100 cm. For film you may use the rectangle edges of the field to locate the BEV coordinate system. Or you may use pin marks on the film to mark the cross hairs of the field.

If your image receptor can rotate then record the image receptor angle. We would suggest that this test be repeated with the image receptor at an angle of zero for one test

and then at an angle other than zero for the second test if the image receptor angle effects the BEV location method.

Label	Image receptor angle

Read these images with MarkRT (VGRT). Locate the BEV coordinate system for each image and enter the proper angles and SID from above for each image.

On the Trace and Solve popup tool, enter the couch coordinates from above where the couch was when the radiographic images were taken.

Trace one linear marker on each of the two images that do not have couch rotation. Pick the marker that would be most like a clinical case.

Enter the solution for the couch position found and compute the difference with the known solution and the difference with the known position.

Two films, non- couch rotation:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Print the results to verify that the same coordinates are shown on the print out sheet.

Now trace the same marker on the image with couch rotation and use all three images for the solution:

Three films, one with couch rotation:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Next, delete the trace on the film with the same gantry angle with zero couch angle and repeat the solution:

Two films, one with couch rotation:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Delete the trace on the film with couch rotation. Outline all the markers on the images with zero couch rotation and generate a solution:

Two films, non- couch rotation, all markers:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Trace all the markers on the images with couch rotation and generate a solution using all three images:

Three films, one with couch rotation, all markers:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Delete all traces on the image with zero couch angle but the same gantry angle as the iamge with couch rotation, and generate a solution:

Two films, one with couch rotation, all markers:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Delete all the traces on all images. Treat the spherical BB marking isocenter as if it were a marker. Locate it and define it as a single point if you have not done so.

Trace the BB on the two radiographs without couch rotation and generate a solution:

Two films, non- couch rotation, BB marker only:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Add the couch rotated image and solve again:

Three films, one with couch rotation, BB marker:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

Delete the trace for the corresponding non-rotated image and solve:

Two films, one with couch rotation, BB marker:

Lateral (x) cm	Longitudinal (y) cm	Height (z) cm	Difference x cm	Difference y cm	Difference z cm

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Results:

In all cases the isocenter should be found within measurement error. Review the error analysis in the MarkRT (VGRT) manual if necessary.

Do not use this system with patients until isocenter can be correctly found under test conditions for all the circumstances under which the system will be used.