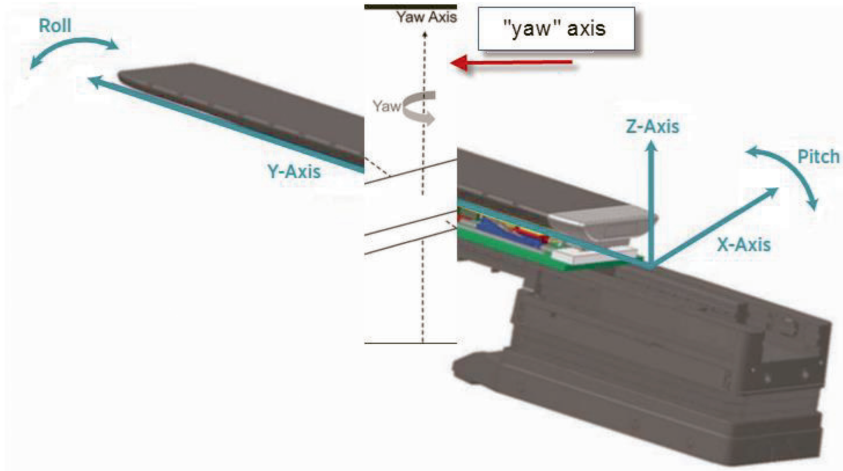
MORNING QA
ELEKTA INFINITY HEXAPOD COUCH

Objective of this test is to independently verify the rotational couch accuracy in the 3 rotational axes shown below (roll, pitch and yaw)



1. Place the cube phantom on the "base plate" over the center pin on the white index locking bar. The RPD logo on the cube should line up with the same logo on the base plate. **Figure 1** below gives the correct orientation of the cube on the baseplate in the Infinity Linac room
   In **figure 1** (see below) I have attached the index bar at "2" location on the couch and the Hexapod bridge at "C". However you can choose a different location if you so choose.

Adjust the table in x, y, z directions such that the lasers and cross hair are approximately in the center of the cube. Please NOTE that the lasers will be NEVER perfectly aligned to the center of the cube markings because the baseplate is perfectly engineered at a 2.5 degree tilt in all 3 rotational axis. Just get the lasers close to CAX in AP and Lateral axis and you are ready to perform CBCT

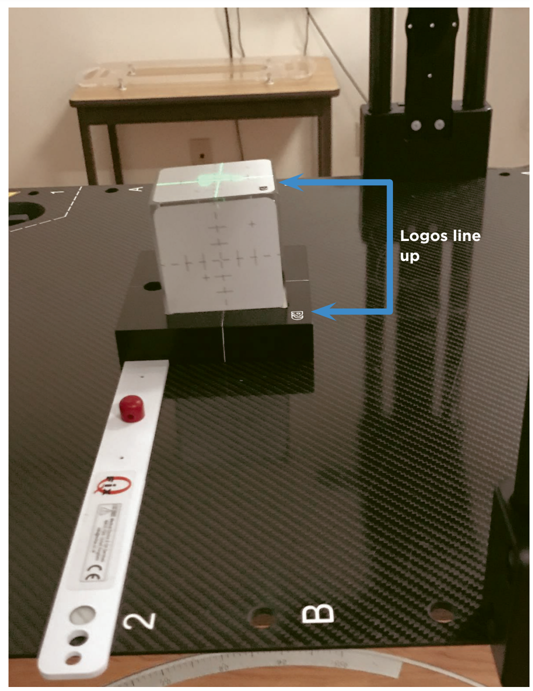
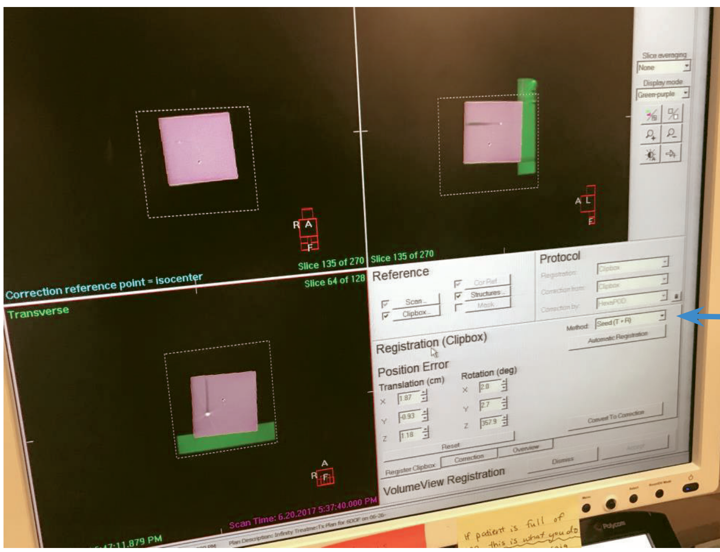


Figure 1: Correct orientation of Cube phantom on the baseplate. Note that the RPD logo on the baseplate matches the logo on the cube

Open the patient "6DOF" in Mosaiq under "QA mode"
Perform CBCT

1. Make sure the "S20" filter is inserted.CT1 field is selected under RO Treat and scan the phantom.
2. Use Seed (T+R) algorithm in XVI on the auto fusion settings for the CBCT to align with the center (iso) BB. After that use Manual Match to fine tune and finish the alignment. (see figure 2 below)
3. Verify alignment of CBCT using the BBs and the phantom. Make sure you look at all 3 planes (Transverse, sagittal and coronal) as each of the planes have unique marker locations. The auto match "Seed(T+R)" algorithm gets it very close
   (see figure 2 below)
4. Zoom in and make any needed adjustments especially "X rotation" in the sagittal plane. Do NOT pay attention to translational shifts although there will be a minimal shift required. Focus on the BB and marker alignment in all 3 planes. I use "F3" keyboard stroke to toggle between CBCT and Treatment planning CT.

5. Use the external contour (skin) on treatment planning CT to see if it's parallel to the surface of the phantom in CBCT. (especially in X rotation sagittal plane)
6. Record CBCT couch rotational shift in the Excel sheet under Hexapod tab. This is the same excel sheet one uses for Penta guide QA but a different tab. The expected values are
   X Rotation 2.5 degrees,
   Y rotation 2.5 degrees and
   Z rotation 357.5
   (see Figure 3 below for the attached screen shot from Hexapod software)
7. Apply the shifts. (Rotational and translational)
8. VERIFY the shifts recorded are within 0.5 degree of the expected values. Usually the values are within 0.2 degrees of the expected but a deviation of 0.5 degrees is acceptable for regular TX (NOT SRS) Record values in the excel sheet under Hexapod tab.
9. Load CT2 field and scan the phantom again. You are now scanning the phantom with the couch rotated in all 3 axes. This second CBCT scan is important to do and verify that the BBs are aligned perfectly after the original shift is performed. (See figure 4 below after the scan is done).



Seed(T+R)

NO rotations or translations should be required

Figure 2. Results of phantom alignment after auto-match using Seed(T+R) algorithm

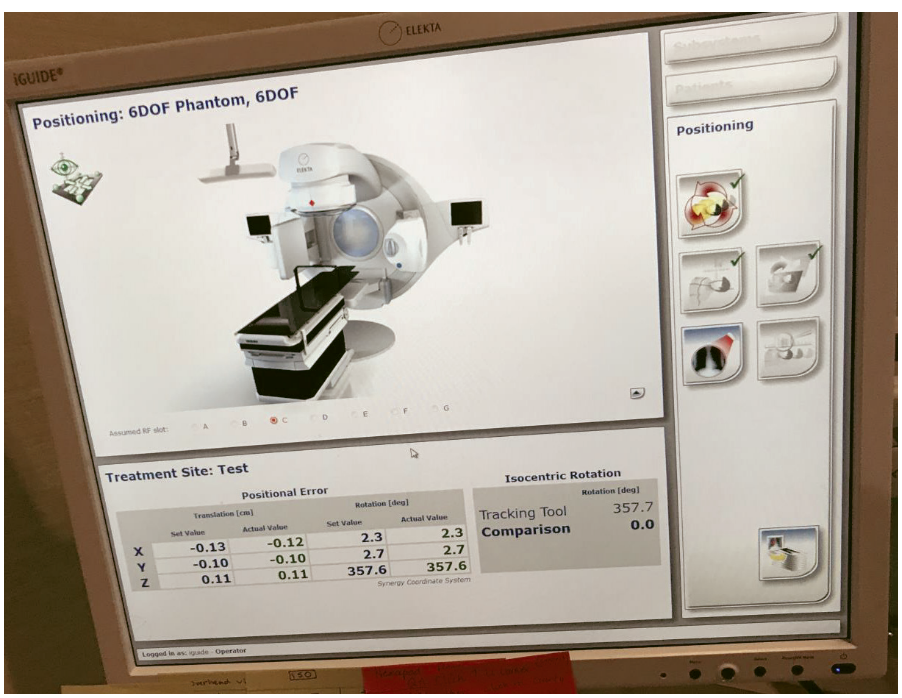


Figure 3. Results of phantom alignment in Hexapod after auto-match using Seed(T+R) algorithm and manual refine

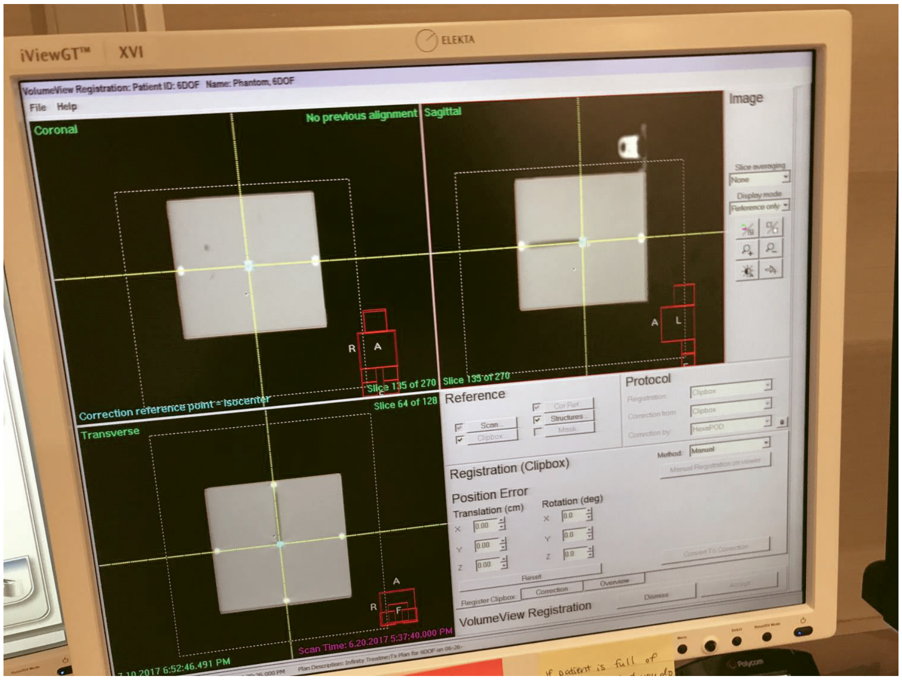


Figure 4. Results of phantom alignment after auto-match using Seed(T+R) algorithm after the original shifts are performed. This is the CBCT performed when the couch has been tilted 2.5 degrees. NO rotations or translations should be required

SRS Daily QA

(To be done later when we start the SRS program. Physics will train the therapists)
KV/KV Imaging: this test will verify the machine iso with the kv imaging iso.

1. Choose KV/KV pair and image.
2. Perform 2D/2D Manual Match.
3. Verify alignment by checking phantom and BBs.
4. Go to the isocenter and adjust the window and level to visualize the iso BB.
5. Zoom in and make any needed adjustments (look at sup/inf closely).
6. Check that the couch shifts are ≤ 0.1mm and record PASS/FAIL in Total QA.
7. Apply the couch shifts.

Laser Check: this checks the laser and machine crosshair with the radiation & mechanical iso.

1. Check the crosshair and lasers vs. the etched crosshairs on the phantom.
2. Using a 1mm tolerance record PASS/FAIL in Total QA.

Winston-Lutz Test: this test will check how accurate small tx fields are delivered to the iso with different gantry, collimator and couch angles.

NOTE: To be done when we start the SRS program. Physics will train therapists

1. Select the first treatment field .
2. Add imaging using the parameters: MV, before, planned, treatment port and apply to all beams.
3. Take a MV image for each treatment field. Continue to monitor with OSMS and change the couch angles on OSMS accordingly.
4. You do not have to analyze the MV images, physics will analyze the images offline.

SSD/ODI Check: mechanical SSD vs. the ODI

1. Check the AP SSD on the cube using the ODI and record the value in Total QA. Check the SSD using the green tip front pointer. Record the value in QA tan under Hexapod . Nominal value is 92.5cm.

Physics Notes: (For Physicists only)

Cube Specifications:
Material: Acrylic

Cube: Each cube dimension should be within 0.1 mm (.004”) in size. Each pair of parallel surfaces should be within 0.1 degree.

Crosshair Decal Alignment: Three (3) crosshairs decals are to be located on 3 planes, anterior, and both lateral faces of the cube. These decals should be within 0.1mm (.004”) tolerance with the iso-center titanium sphere. Also, 2.38mm Aluminum ball markers are essential on all 4 sides to verify the block alignment during the initial CT scan.

CT-KV Marker Specifications:

Markers Shape:

Linear aluminum markers (wires) are used. The markers length is 1.0 cm long each. This projects on 4 CBCT axial slices, 2mm thick. The markers diameter is 2mm. This size is within the CBCT axial actual resolution of 7 line pairs/cm. i.e. 1.5mm. Thicker wires, or denser materials, tend to show more artifacts. On the other hand, spherical markers, 2mm in diameter, are inadequate for the CBCT scans. It shows unavoidable artifacts, For example, a 2mm sphere projects as ~~ 4.0. on both the coronal and sagital views due to the fact that the CBCT slice thickness itself is 2.0 mm in size (Nyquest Effect). The center of the 1cm long aluminum marker to the isocenter titanium ball is 51.9mm.

Markers Placement:

Eight (8) linear markers are used. Each linear marker should be parallel to 1 cube surface and is 8mm deep. Placement accuracy should be within 0.1mm (.004”). Each opposite pair should be places in a skew format to minimize the CBCT imaging short comings.

MV Marker:

Isocenter Titanium Marker 2.0 mm Diameter, Density: 4.51g/cm3
Aluminum Markers: Density 2.7g/cm3

A. 2.5 Degree Roll

B. 2.5 Degree Pitch

C. 2.5 Degree Rotation

The accuracy of CBCT alignment and couch shift process is of fundamental importance in the accuracy of delivered dose in Image Guided Radiation Therapy (IGRT). The 73mm Cube, has one (1) Central axis titanium marker and two (2) offset titanium markers 2.0 mm for the testing and verification of predetermined measurable couch shifts. This phantom can be used to test the accuracy of CBCT alignment and couch shift in a simple and efficient manner. Images can be transferred to the treatment planning system to check coincidence of treatment planning system to couch shifts.

Markers:

4 Aluminum Balls 2.38 mm Diameter on four outside sides and 1 Titanium Ball 2.0 mm in Center for the CT scan

8 Aluminum Wire Markers 10mm x 2mm diameter set in two rows which project on 4CBCT axial slices

2 Titanium Balls 2 mm diameter for Table Offset

Titanium Marker Locations in Cube:

One at Isocenter: X; Y; Z=0
One located from Isocenter: X: -2 cm; Y: -2 cm; Z: +2 cm
One located from Isocenter: X: +2 cm; Y: +1 cm; Z: -1 cm

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