Version

4.2

ProjectionVR™

shaderware.com

User Guide

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Introduction

This section will explain what virtual radiography™ is

This software is used to support radiography education. Virtual radiography™ simulations are currently supporting students in over 60 universities across USA, Canada, Sweden, Portugal, Poland, New Zealand, Australia, South Africa and the UK.

In a recent student evaluation, pre-clinical students using virtual radiography™ (year one) showed confidence gains, and integration of theoretical and practical concepts. They scored as highly on practical tests of ability as a comparable group of students trained in a real x-ray room. Year two students suggested virtual radiography™ could help them gain practice in examinations they rarely come across during clinical placement, e.g. facial bones. Radiography lecturers have commented on its utility as a tool to consolidate student clinical learning, in a more controlled environment.

The virtual radiography™ simulator contains no radiographs. A technique similar to radiotherapy planning is used. Digitally Reconstructed Radiographs (DRR) are computed directly from 1,700 CT scan slices, allowing the user to take any radiographic projection, including bad ones!

> "[this software] allows students to work in an environment that safely simulates the conditions of an X-Ray unit",

> Society of Radiographers, 2006

Introducing ProjectionVR™

This section will explain how to start a virtual radiography™ learning session using ProjectionVR™ from the desktop or start menu.. It will explain each window and how to move and look around the virtual radiography™ world .

On installation, two icons will be created on the computer desktop. To start a session, both need to be loaded. There is no specific order that the programs should be run.

Alternatively, if no icons are available, both programs required can be run from the start menu.

ProjectionVR™ provides a complete virtual radiography™ world which comprises an x-ray room and the control console of a piece of modern x-ray equipment. The room and the console each have their own distinct windows. Each has its own menu and status bar. It is designed for optimal use across two monitors, but it can also be used successfully on a single monitor or a laptop.

The ProjectionVR™ x-ray room

The room window shows a view of a radiography room with an x-ray tube and either a table, erect Bucky or trolley.
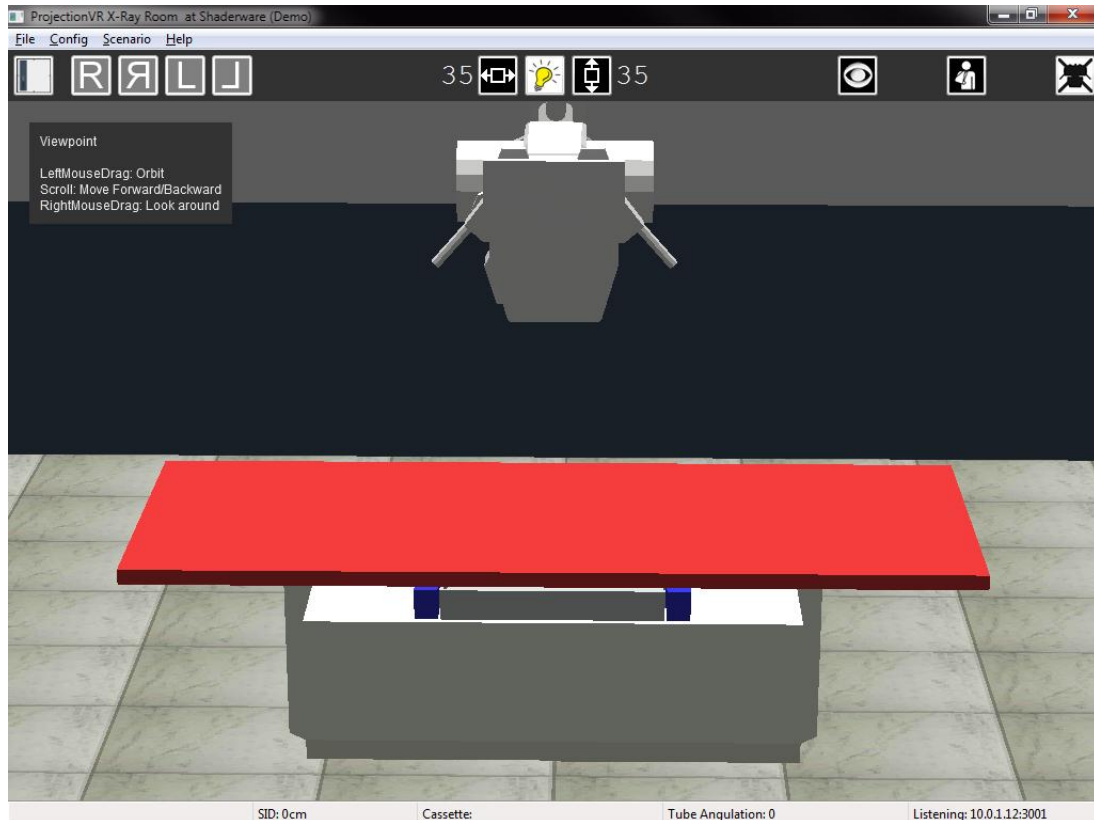
The user's viewpoint is that of first person. The user's position in the room can be controlled.

Besides the objects in the room, three other areas of the screen are dedicated to provide information.

A menu is available, below that there is a tool ribbon, and a status bar is shown across the bottom. Context sensitive help is displayed in a grey area in the left of the window

Help

The HELP pane can be displayed in short or long form, and in a choice of text size selectable by using the Help\On screen help menu. The text displayed is determined by the active object. In the first instance it will be the viewpoint.

Status

The status bar along the bottom of the room window shows information that is difficult to gain from viewing the radiography world directly. This shows the following information from left to right: active object; source image distance (SID, cm/inches); selected cassette size (cm/inch); and the tube angulation; cephalad (+ve) and caudad (-ve). The final section displays the communication status of the room with the console. The status bar constantly updates to give accurate information.


Tool Ribbon

Major radiographic tools are accessible on the tool ribbon. From left to right these are: cassette selection; marker selection; collimation controls; viewpoint mode toggle button; patient call/discharge toggle button; the special 'hide tube' toggle button. Each of these tools will be discussed individually later on in the guide.
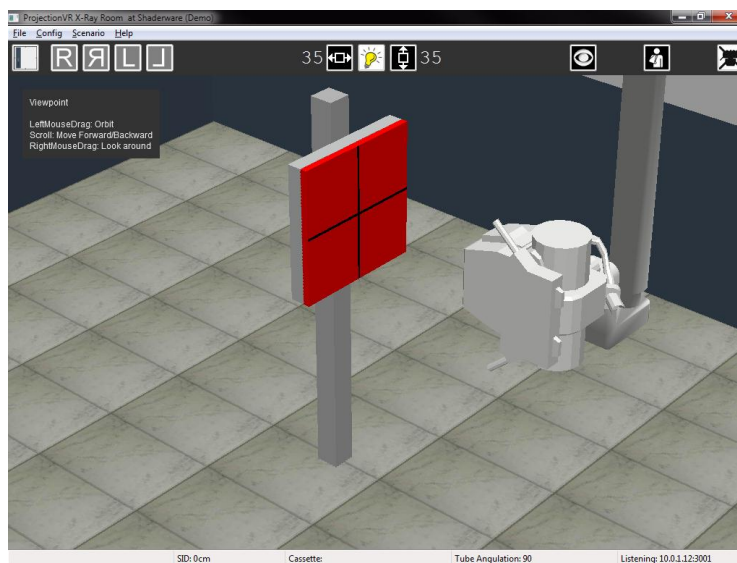
Menu

The standard Menu has various configuration options and a Scenario picker.

The scenario picker allows the radiographic equipment to be altered in position and type. Some scenarios allow different patient models, therefore allow different types of examination. Below are the trolley (gurney) and the erect Bucky scenarios.
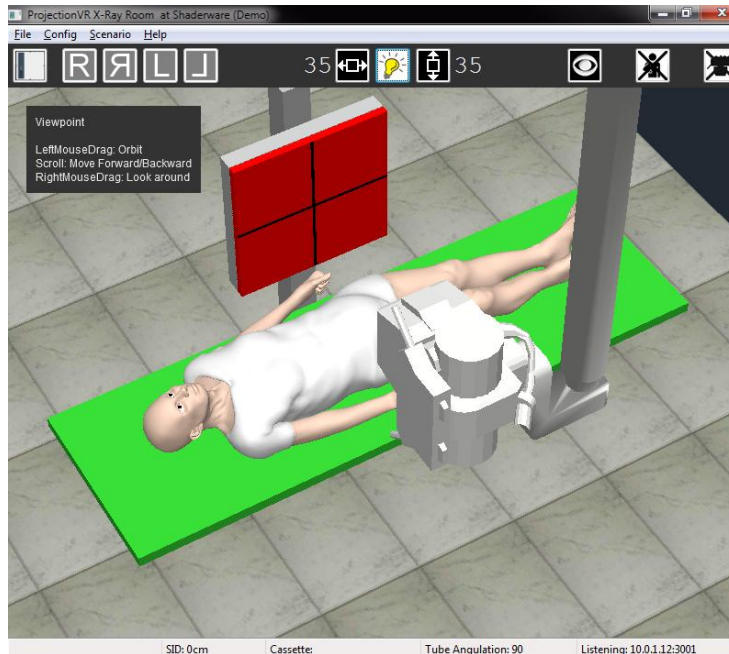
Trolley/Gurney scenario

Erect scenario

<u>Viewpoint</u>

The first requirement is to be able to move and look around this room. ProjectionVR™ gives the user the ability to look from any perspective; 20 feet off the floor to within an inch of the patient's nose.

The simulator indicates the 'viewpoint' is active by using an 'eye' cursor ⬤ . When in 'viewpoint' mode the following controls are available:

If Auto mode is set:
- left click where there is no object to select and drag to 'orbit' the point of interest (viewpoint).
- Right click and drag to move the point of interest (viewpoint).
- Scroll wheel to move in and out of the scene.

In a couple of cases, it may be difficult to change the viewpoint in this way. For example if you have moved close into a scene to see the details, it can be difficult to find somewhere to click that is not a selectable object, as in the situation below:
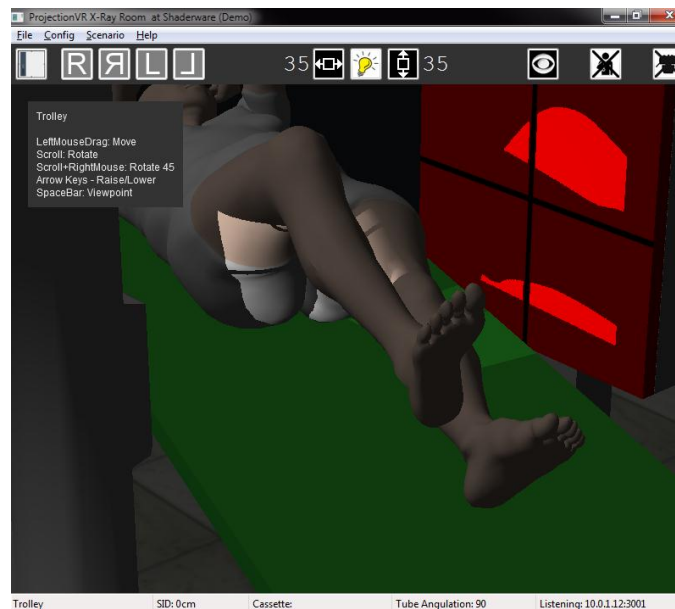
The other case occurs when using the scroll wheel to dolly in and out of the scene. It is possible while scrolling in or out in this way that the cursor alights on a selectable object, if this is the case, the scroll command may be taken to mean move this selectable object, rather than to continued scroll out as intended. In these cases, a solution is to select viewpoint mode by holding down the space bar. As long as the space bar is depressed the room will be in viewpoint mode. If auto mode is not set by default, the space bar will be required all the time.

The ProjectionVR™ console

The console window allows: selection of the examination, controls the exposure, produces output technical data, and displays the radiographs taken. The right hand pane displays the current radiograph (it shows the company logo to begin with).
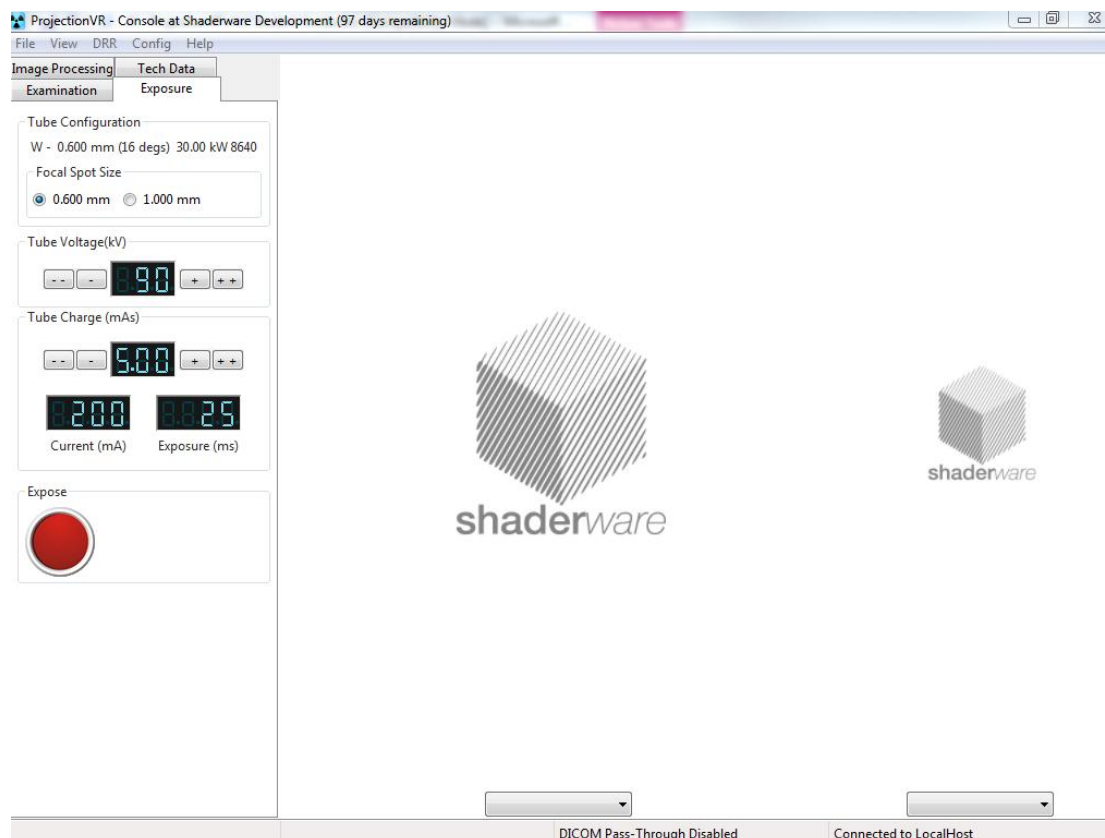
To alter the tube voltage (kV), tube charge (mAs) or the focal spot size click on the buttons as marked on the left panel. To make an exposure move the mouse pointer over the red 'Expose' button. The sound of the generator 'preping' the tube will be heard. The text indicator will move from 'Idle' to 'Prep', then 'Prep Ready'. Now an exposure can be made by left clicking the button. After exposure the stator will be heard to slow the anode.
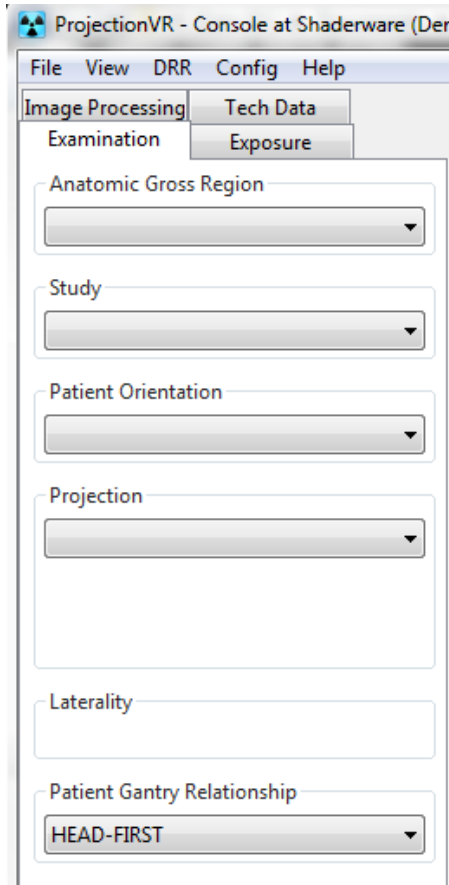
The console is a fully featured simulation of the various screens and control panels radiographers use to control x-ray exposure, complete with the realistic sound effects of the x-ray machine during exposure. The left hand pane displays the currently active tab details. There are four tabs: Examination, Exposure, Image Processing, and Technical Data.

If 'DICOM pass-through' is enabled, the student must enter their ID and name on starting the simulation. Then an examination must be selected prior to exposure. This mimics the workflow using a modern flat panel detector (aka DR)

Further functions of the console are discussed in chapter 5.
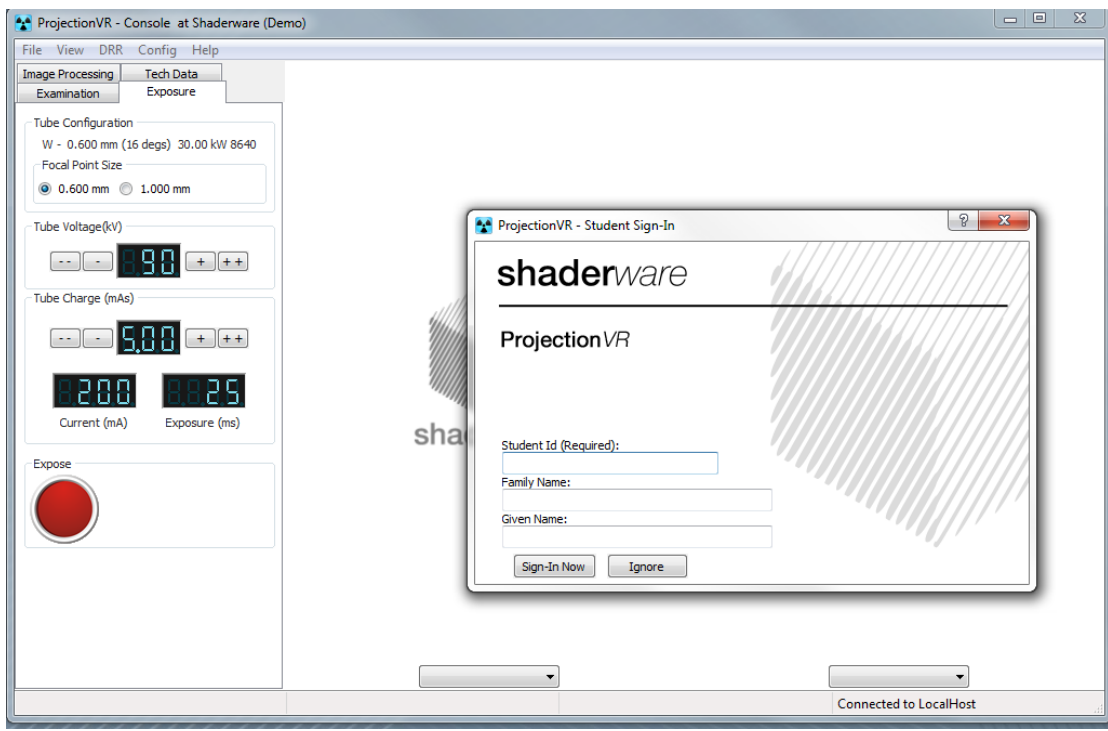
Controlling the Table, Bucky, X-ray Tube and LBD

This section will explain how to control the virtual radiography^{TM}   Table, Bucky, X-ray tube and LBD using the keyboard and mouse.

The patient table

The patient table has a red top that can freely 'float', but is fixed in place by default when electrically powered. In real life it is made of a hard rigid material with a low x-ray attenuation coefficient. This is often some sort of urethane foam coated in carbon fibre. It sits on a motorised table base that can be raised and lowered to a comfortable working height for the radiographer.

Moving the cursor over the red floating table top turns it into a hand ready to grasp. By clicking and dragging with the left mouse pointer the table top can be made to move along and across the table base.

The table itself can be raised and lowered by selecting the upper portion of the table base by moving the mouse pointer over it. A padlock cursor is shown. 🔓 To move the table the 'D' keyboard key must be pressed to release the lock. Left clicking will now allow the table to be dragged up or down. There is a default lock position at a set height – this can be passed by selecting 'D' again and continuing to raise the table to its maximum.

The 'erect Bucky', 'vertical Bucky', or 'wall stand'

The vertical Bucky (more commonly called the erect Bucky) is used to hold the receptor vertical. The x-ray tube assembly is rotated on the supporting gantry so that the central ray (CR) is horizontal to the floor.
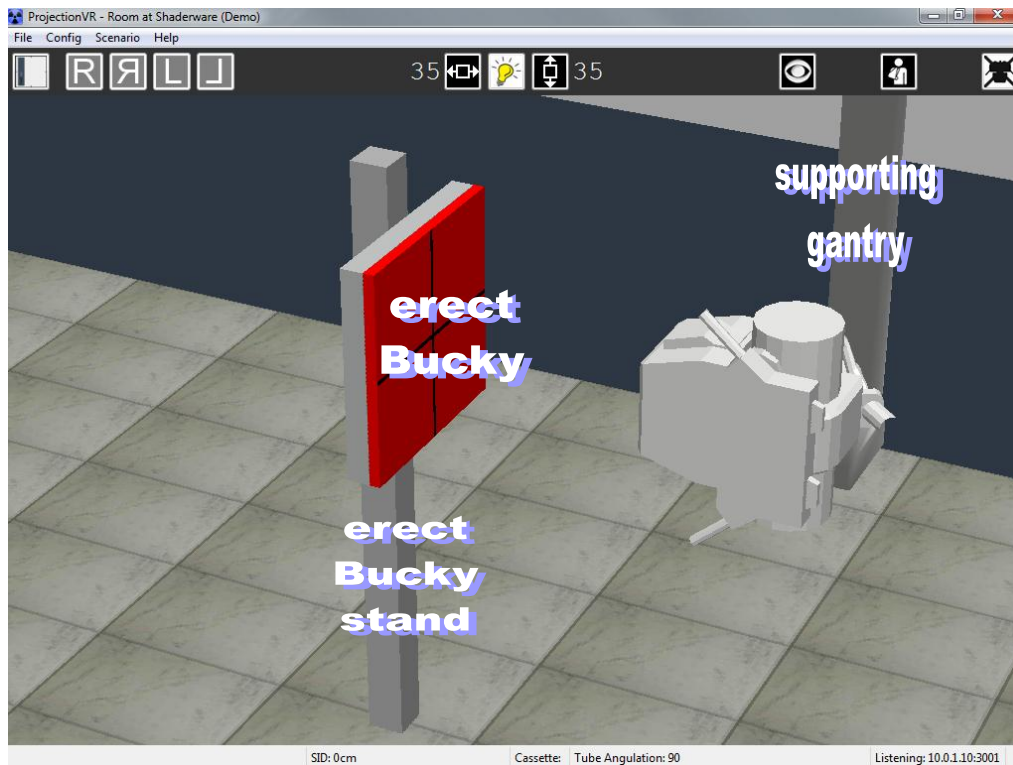
The erect Bucky can be moved up and down its stand by clicking and grabbing the red surface.

The x-ray tube

The x-ray tube is suspended from the ceiling. It runs on rails across and along the room. It is locked in place when the x-ray machine is electrically connected to keep it still. To move the tube lock releases buttons need to be pressed, Radiographers call these 'locks'.
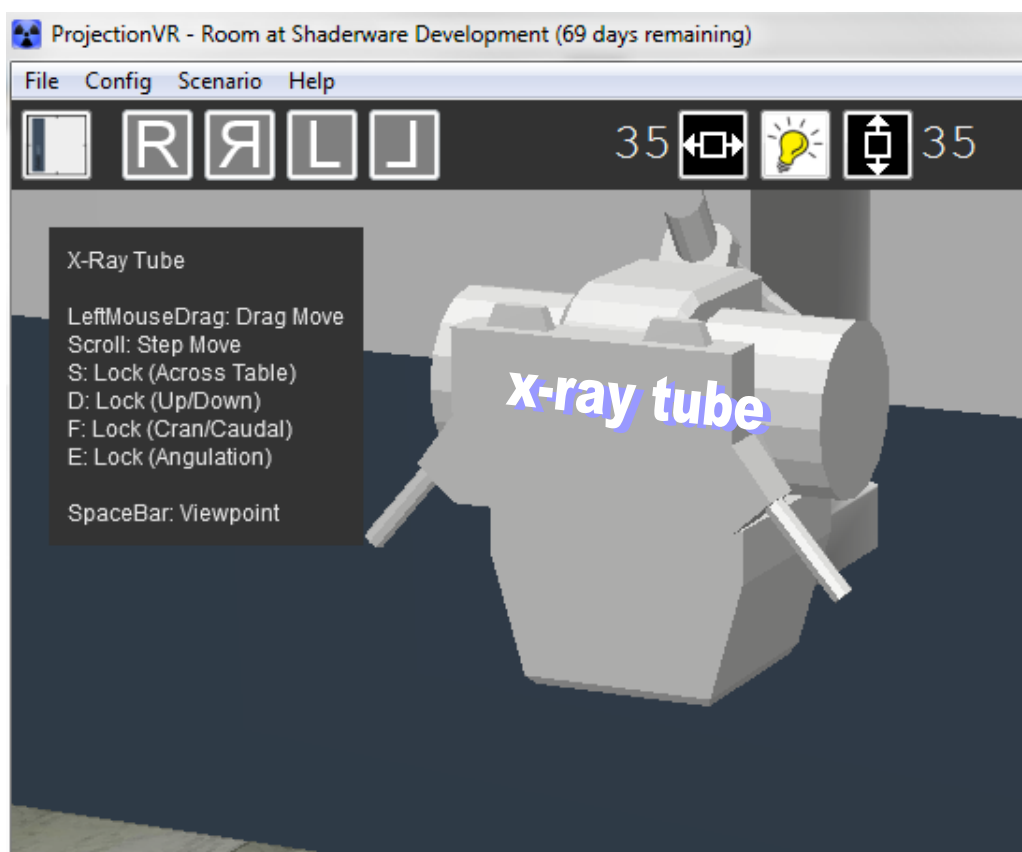
If you select the tube by moving the mouse pointer over it a padlock cursor is shown.

To move the tube a specific keyboard key must be pressed to release the corresponding lock. These can be seen in the help pane.

On key press the cursor will change [hand icon] Left click on the tube will grasp it [hand icon] and drag will now move the tube. Holding down more than one key releases more than one lock. For fine control of the x-ray tube, use the mouse scroll wheel.

'S' - Across the room
'F' – Along the room
'D' – Up/Down
'E' – Angulation

Note:

The real tube assembly is heavy and has great momentum. Attempting to move the tube with only one hand can cause injury. Most radiographers hold the tube assembly with both hands and depress both lock buttons at the same time allowing free movement. You can do this in the virtual radiography™ room by depressing S and F at the same time and then moving the mouse

You will notice that the tube assembly has a rather annoying habit of sticking in certain positions. Why can you only move the tube across half of the table? This is a feature built into x-ray equipment called the detent. Detents are mechanisms that temporarily keep one part in a certain position relative to that of another, and can be released. The installation engineer has set up these fixed positions where Radiographers will want to position the tube time and time again. This particular one corresponds with the centre of the Bucky, front to back and side to side. It is particularly difficult to estimate this position, without moving to the foot of the table each time so this is actually quite useful.

To move past a detent you need to release the lock button and then depress it again, moving in the other direction. Try this out with S.

Height
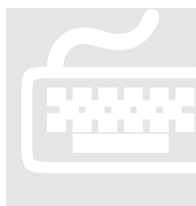
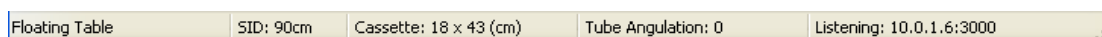To raise and lower the tube on the gantry, you must first unlock the tube assembly by using the 'D' key then move using the mouse. Fine adjustment is again possible using the scroll wheel.

X-ray Tube height above the x-ray table can be measured from Source Image Distance (SID). The read out of SID is displayed in the status bar.

| Floating Table | SID: 90cm | Cassette: 18 x 43 (cm) | Tube Angulation: 0 | Listening: 10.0.1.6:3000 |

It is calculated from the receptor plane. It will therefore alter depending on whether the cassette is in the Bucky or on the table top. Remember, the table top can also be raised and lowered, by selecting the table base and dragging or using the scroll wheel.

Angulation

To apply cranial or caudad angulation you must first unlock the tube assembly by using the 'E' key then move using the mouse. Fine adjustment is again possible using the scroll wheel. The tube angulation is reported in the status bar as +/- degrees from vertically down.
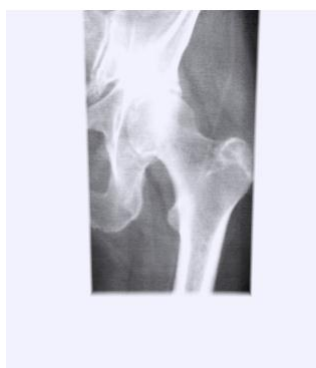
Angling against the cassette is uncommon as it produces a specific distortion called perspective distortion or 'keystoning'. It is called for in some radiographic projections, and is unavoidable in some applied techniques.

The virtual radiograph to the left shows perspective distortion, the collimation is not rectangular in shape; the bottom is narrower than the top.

Light-beam diaphragm (LBD)

Below the tube is a box like structure that can be selected by moving the mouse pointer over it. This is a model of the real Light Beam Diaphragm (LBD) which consists of a simple light from a 50W, 12V halogen bulb reflected in a mirror. During exposure the illuminated area will be irradiated with x-rays; this is commonly called the area of collimation.

Collimation is properly defined as 'to align', x-rays come from a single point in the tube, and fan out from this to cover the irradiated area, those at the edges are not aligned (parallel) with those in the centre. If the area of irradiation is made smaller, then the difference in angle between the straight central ray and rays at the edge will be less, they will be more aligned; i.e. the x-ray beam will have been collimated.

After pressing the LBD button in real life, the light will dim after approximately 60 seconds. This is to prolong light bulb life and also to ensure the bulb housing does not get so hot that it burns the radiographer! In a busy room used by a team of radiographers this can still happen – so be careful of touching it. Our light dims after 60 Seconds (it can be stopped at any time by selecting the collimation light again on the tool ribbon).

To see the area of collimation, press [lightbulb icon] on the tool ribbon. To alter the size of the collimated area, hover over [horizontal arrows icon] or [vertical arrows icon] on the tool ribbon and then adjust by using the scroll wheel. The readout indicates the size of the irradiated area in cm at 100cm/40in SID.
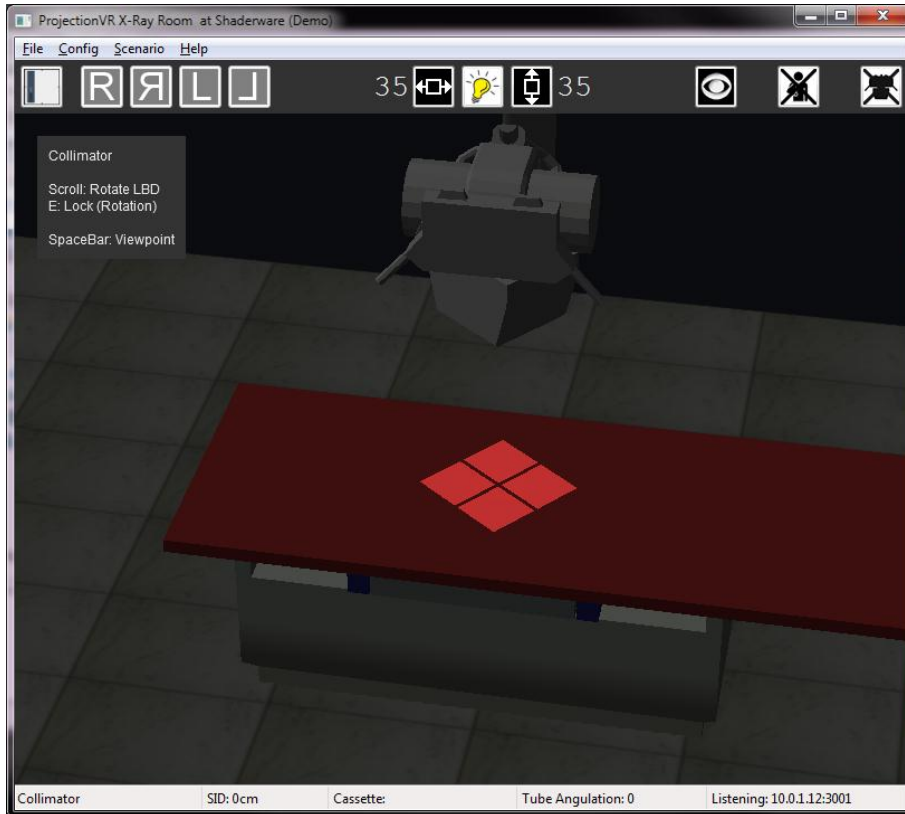
The LBD can be rotated by hovering over it in the room, unlocking it by depressing 'E' and using the scroll wheel. This will allow a diamond shaped collimated area to be used.

It can be difficult to see the collimation in the Erect scenario at times. There is a special feature to help with this. The tube and gantry can be made to disappear using the icon on the tool ribbon. [icon]

Receptor selection

This section will explain the choice of cassette, how to select them, move them and use the Bucky

Modality (CR or DR)

A receptor receives the x-rays that make up the radiographic image. In storage phosphor radiography (SPR aka 'CR') an imaging plate contained within a cassette is the active sensor, whereas in flat panel detectors (FPD aka 'DR') solid state electronics within the receptor detect the irradiation.

The practical differences are twofold: in CR the cassette must be removed and placed in a reader after each exposure, and there are a multitude of sizes available. In DR the receptor can remain after exposure, and there are only two sizes.
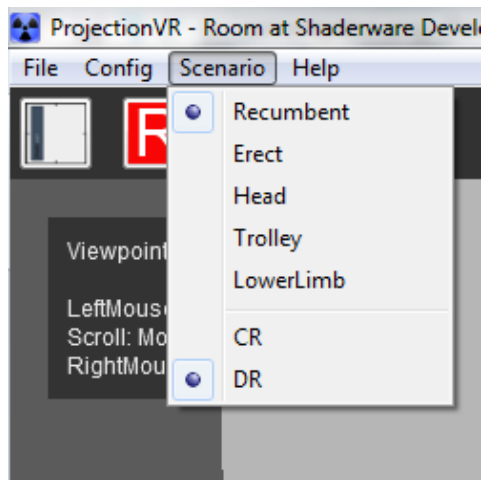
The simulation can be configured to operate as a DR or CR system. It will default to DR but this can be changed in the 'Scenario' menu.

Selection of CR cassettes or DR receptors

CR Cassettes can range from 35 x 43cm (17 x 14in) to 18 x 24cm (10 x 8in). In DR there are two sizes, the 35x43cm (17 x 14in) and the 24x30cm (12 x 10in)

To select a Receptor, left click the icon on the tool ribbon
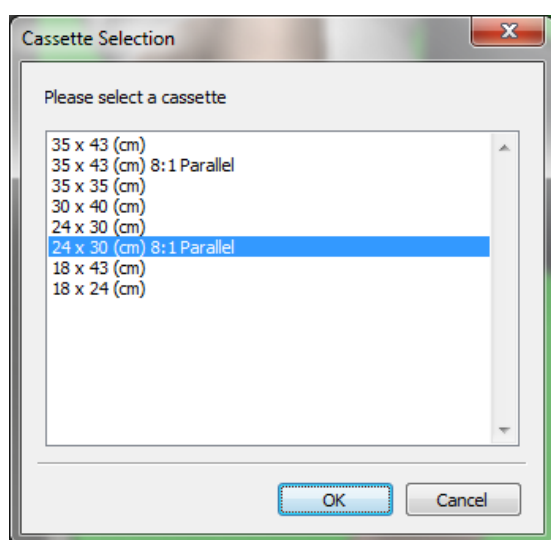
Receptors are selected from the receptor dialogue box and confirmed by selecting OK. The mouse cursor will then become a receptor icon. A 'Not Permitted' sign will be overlaying if the receptor cannot be placed on the currently selected object. Receptors can be placed on the table, on the erect Bucky or in the Bucky tray. CR cassettes will disappear after exposure, DR receptors will remain.

Using the Bucky tray

A Bucky tray is a 'draw' that can contain a Receptor in a predetermined position. The Bucky usually incorporates a grid, which can improve the quality of the radiograph if the body part under examination is quite thick (>15cm). This simulation has a grid in the Bucky at all times.

The Bucky tray can be opened and closed by left mouse click and drag or the scroll wheel.

The Bucky can be moved along rails to the head or foot of the table by left mouse click and drag on the blue edges.

Receptor on the table top/chest stand

The receptor can be dragged into and out of the open Bucky tray as required by clicking and dragging.
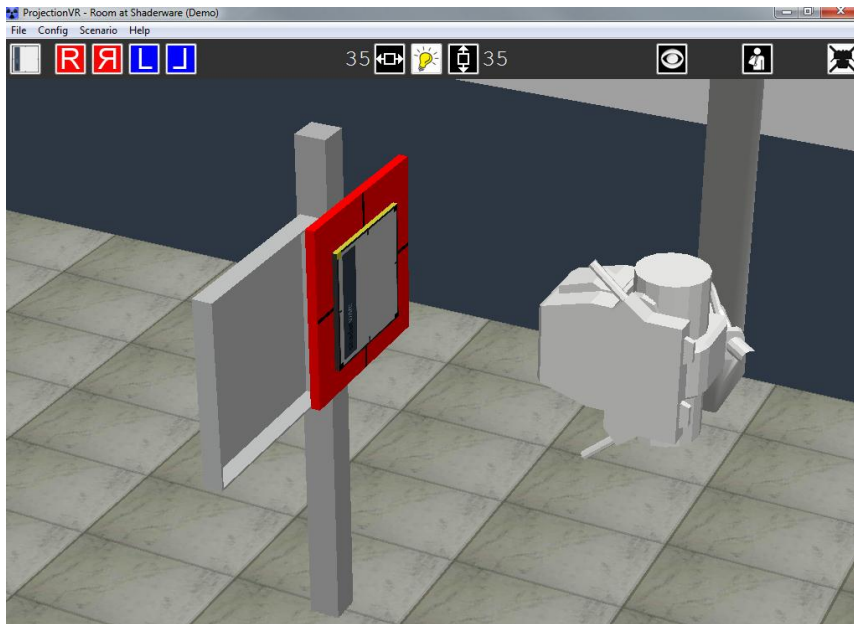
In the trolley/gurney trauma module, the receptor can be dragged off the Bucky top to be used on the trauma trolley/gurney for 'cross table' lateral projections.
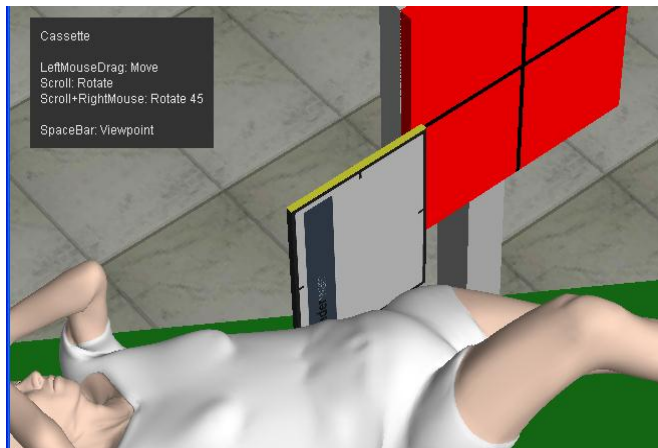
One edge of the cassette is coloured yellow and one corner is yellow. This indicates receptor orientation. Whatever anatomy is at the yellow edge in portrait orientation will be displayed in the console at the top. i.e. the image will be "hung" from the yellow edge when viewed. (see ch 5)

Use the scroll wheel to rotate the receptor. Quick steps of 45 degrees can be made by right clicking while scrolling (you can also rotate the receptor when it is in the Bucky tray this way)

Side marker placement

Once a receptor has been 'dropped' in the room, the side marker icons become active. There are both Right and Left side markers, also available inverted.

Side Marker Selection Mode

Left clicking to select the side marker icon required will take the user to 'side marker selection mode'. In this special view of the room, the user's viewpoint is automatically moved to directly above the cassette, and any objects on the cassette are rendered invisible (i.e. the Patient or the table top). The collimation controls will still operate.
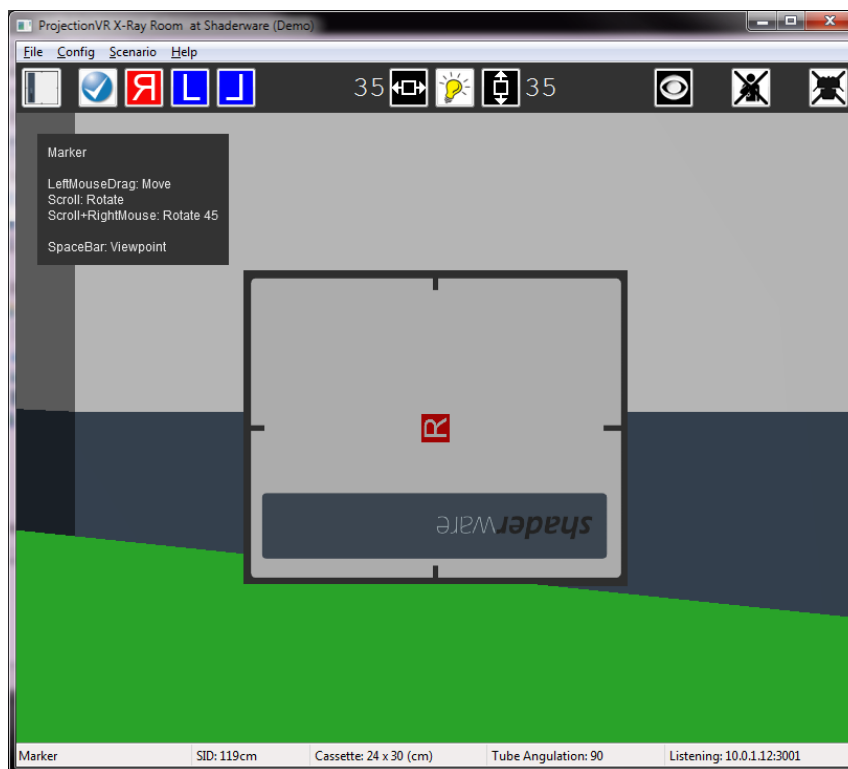
The side marker is initially positioned in the centre of the receptor, it can be moved by clicking and dragging; or rotated by use of the scroll wheel (holding right click down while scrolling speeds up rotation).

To exit this mode, click the 'tick' on the tool ribbon.

Anti-scatter grids

Both Buckys contain an unseen anti-scatter grid that attenuates preferentially scattered radiation. This is a fine line grid with a 10:1 ratio.

There are two options of grids that can be used with receptors out of the Bucky. These are used in examining body parts of a thickness greater than 15cm.
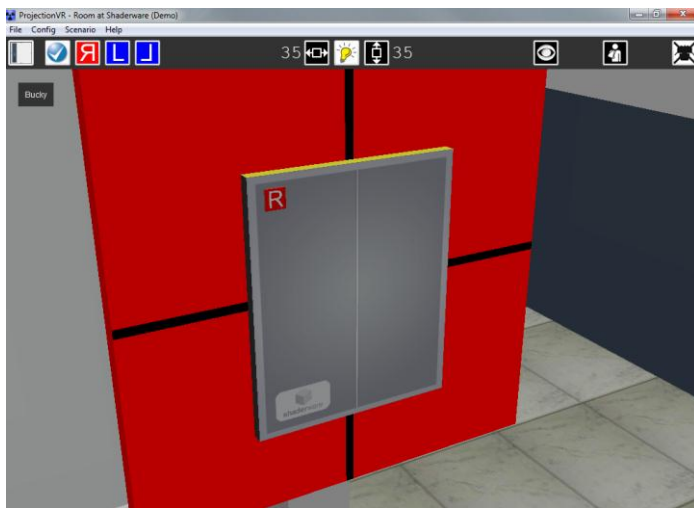
This is the smaller option. It is 24 x 30cm in size and is 8:1 ratio. The outer surface is made of aluminium as is the interspace material. It attenuates quite a bit of the primary x-ray beam so it is not very 'optimized'.

This is the larger option. It is 35 x 43 cm in size and is also 8:1 ratio. The outer suface is made of carbon fibre and has cotton interspace material. It attenuates less primary x-ray beam so it is optimised.

Patient Positioning

This section will explain how to position the patient/phantom

Selecting the patient

Initially, the patient is not in the room. This enables the radiographer to prepare the receptor and to select the correct scenario and examination.

On selecting the patient, a new attendance (visit) will be created if DICOM Pass-Through mode is enabled . Patients must be named (if an exposure is required without a patient – select 'test object' – it still needs a name)
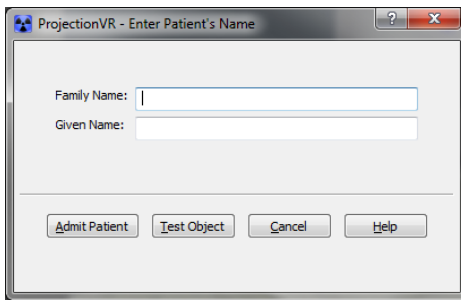
To remove the patient completely from the room, and complete an attendance (visit), click on the de-select patient button on the tool ribbon.

Patients position and scenario

Patient position is defined with respect to gravity. This is the terminology as used by DICOM tags. Therefore the patient can either be 'erect' or 'recumbent'. Additionally, the scenarios also allow 'seated' and 'recumbent on a trolley' by selecting Head and Trolley scenarios respectively. One final scenario is possible - this allows for the lower limb to be moved at the hip thus achieving abduction, adduction, flexion, extension and rotation.

In head and trolley scenarios, the patient cannot leave the stool or trolley, but in the recumbent and lower limb scenarios the patient appears first stood in the room, and has to be brought to the table by left clicking and moving them to the table edge. However, they will only alight when the table is set to the lowest height. The patient may disappear from view but will be standing in the room, just move back to see them; they can leave the table by moving them to the table edge (again, only when table is at its lowest).

Recumbent/Erect patient positioning

To achieve an oblique, lateral, prone oblique or prone position the patient can be selected and the mouse scroll wheel used to rotate them. By clicking on the right scroll wheel before scrolling, the patient rotates in 45 degree steps.

The patient can change their arm and leg positions by clicking an arm or foot to allow for lateral projections with the arms removed (no radiographs of the flexed arms and legs can be taken. This is also possible in the erect scenario, where only the arms move.)
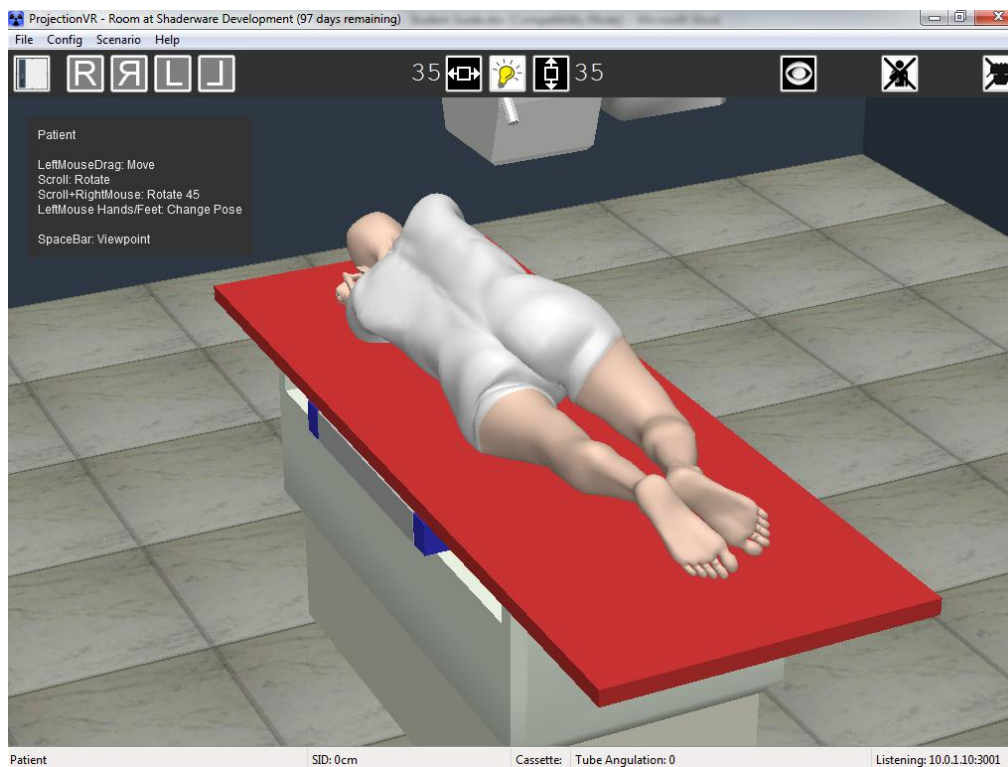
Lower limb patient positioning

Using the Lower limb scenario allows accurate projections of the knee, leg and ankle. In this scenario, only the left lower limb can be radiographed. Movement of the left lower limb at the hip can be achieved by clicking and dragging; scroll will initially achieve rotation. At the extremes of movement range, click and drag may give odd results; therefore key-presses can direct the scroll wheel to accurately control any of the three movements possible. These are documented in the help pane.

Seated patient positioning (Skull)

The seated patient can be moved toward and away from the Bucky on the stool, her head can be moved by clicking and dragging in the same way the lower limb is moved. Again, more precise movements can be made using the scroll wheel and S, D or F keys.
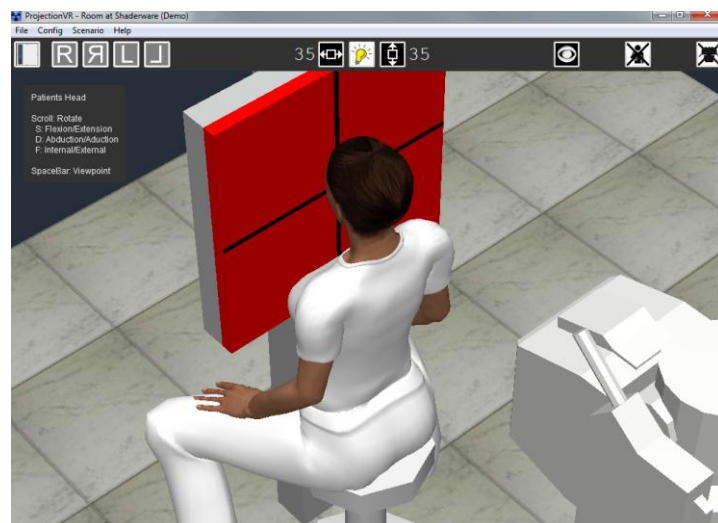
Trolley(Gurney) positioning

The trolley/gurney patient can be moved toward and away from the Bucky on the trolley/gurney; they can be rotated using the scroll wheel. The patient can be rotated on the trolley in the same way as in the recumbent scenario, and the patient can assume either of two pre-determined poses (only the left leg can be radiographed).
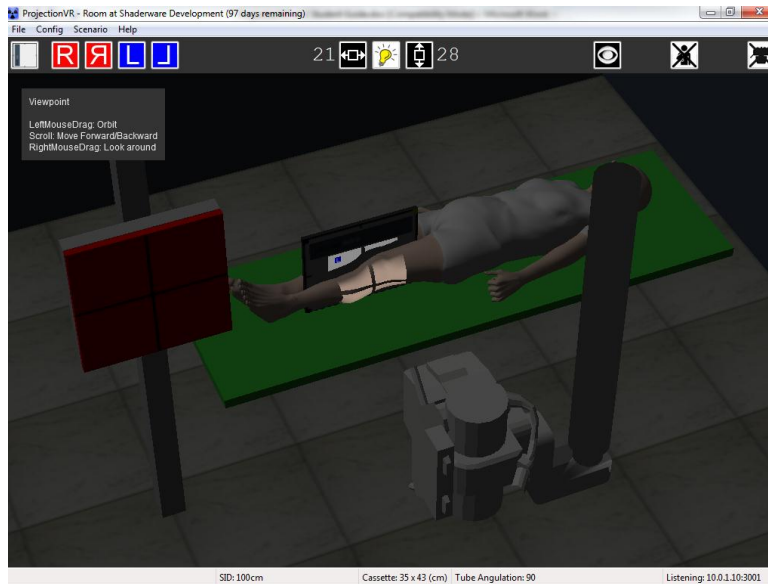
Selecting Examinations and Projections

This section will explain how to select examinations, modify exposure factors and view the resultant radiographs using the virtual radiography^{TM} console.

Examinations and projections

A radiographic examination can be selected from a comprehensive list. The virtual radiography^{TM} definition of 'Examination' used in ProjectionVR^{TM} is synonymous with Study or Procedure in various health informatics standards (HL7, DICOM, SNOMED CT, LOINC, etc.)

- Any one patient may have more than one examination during a single visit (attendance) to the radiology department.

- An examination is usually defined in terms of a single anatomical area. However this is not always the case, skeletal surveys are a specific case in point.

- Even if only a single anatomical area is indicated in an examination, it is common for more than one radiographic exposure (projection) to be undertaken. Generally two or more projections will be needed to adequately complete an examination.

- The projections indicated for an examination are guided by protocol. However, a specific patient may require adaptation from this protocol and selection of a different projection. This may be due to differing patient mobility, body habitus, clinical indication or referrer requirement.

The design of the examination database has been guided by this definition. Students will first be asked to select an anatomic region (skeletal surveys cover the 'whole skeleton'). Once this region is selected, a list of possible examinations (studies) is presented. This list derives from various health informatics standards (HL7, DICOM, SNOMED CT, LOINC, etc.) and is mapped to the National Codes for Medical Imaging Procedures as prescribed by the UK National Health Service.

Once the examination has been selected, a list of possible radiographic projections is presented. The database comprises of a long list of commonly described projections taken from the literature and surveys.

Receptor Orientation

Receptor orientation cannot simply be predicted from the projection alone. It depends on the patient and local protocol. It is important, for proper display of the resultant radiograph, to indicate the orientation prior to exposure. The possible values are taken from SNOMED CT codes adopted by DICOM and found in many manufacturers' conformance statements.

To orientate a receptor, the 'top' must be indicated. The means of identifying the 'top' of a receptor differs from manufacturer to manufacturer. For receptors fixed into a Bucky, a 'head' end of the bed or table is usually identified. For cassette-based systems a coloured corner is common to identify the top.

Where the receptor is rectangular there is also the concept of 'portrait' and 'landscape'. It is convention that the 'top' of a rectangular receptor to be one of the short sides.
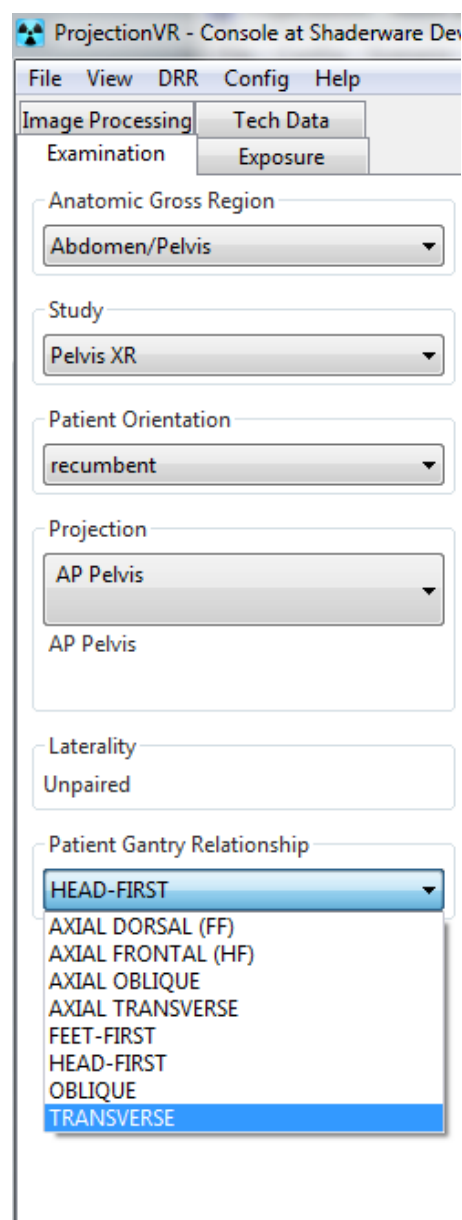
| Receptor Orientation	Receptor Orientation Description
Head-first	Receptors yellow edge is positioned toward the head of the patient. This could be called 'portrait' orientation. The image plane is roughly perpendicular (+-45 degrees) to the axial plane of the patient.
Feet-first	Receptors yellow edge is positioned toward the feet of the patient. Again 'portrait' orientation. The image plane is roughly perpendicular to to the axial plane of the patient. (+-45 degrees)
Transverse	Receptors yellow edge is positioned toward the lateral aspect of the patient. This could be called 'landscape' orientation. The yellow dot must be toward the patients head. The image plane is roughly perpendicular to to the axial plane of the patient. (+-45 degrees)
Oblique	Receptors yellow corner is positioned toward the head of the patient. This could be called 'diagonal' orientation.. The image plane is roughly perpendicular to to the axial plane of the patient. (+-45 degrees).
Axial-Frontal (HF)	As Head-first, except the yellow edge of the receptor is toward the frontal aspect of the patient and the image plane is coincident with the axial plane of the patient (+-44 degrees).
Axial-Dorsal (FF)	As Feet-first, except the yellow edge of the receptor is toward the dorsal aspect of the patient and the image plane is +-44 degrees to the axial plane of the patient.
Axial-Transverse	As Transverse, except the image plane is +-44 degrees to the axial plane of the patient.
Axial-Oblique	As Oblique, except the yellow edge of the receptor is toward the frontal aspect of the patient and the image plane is +-44 degrees to the axial plane of the patient.

Exposure Factors

The quality of the x-ray beam, the amount of x-ray tube charge, the size of the beam source and the exposure time can be set from the 'Exposure Factors' tab.
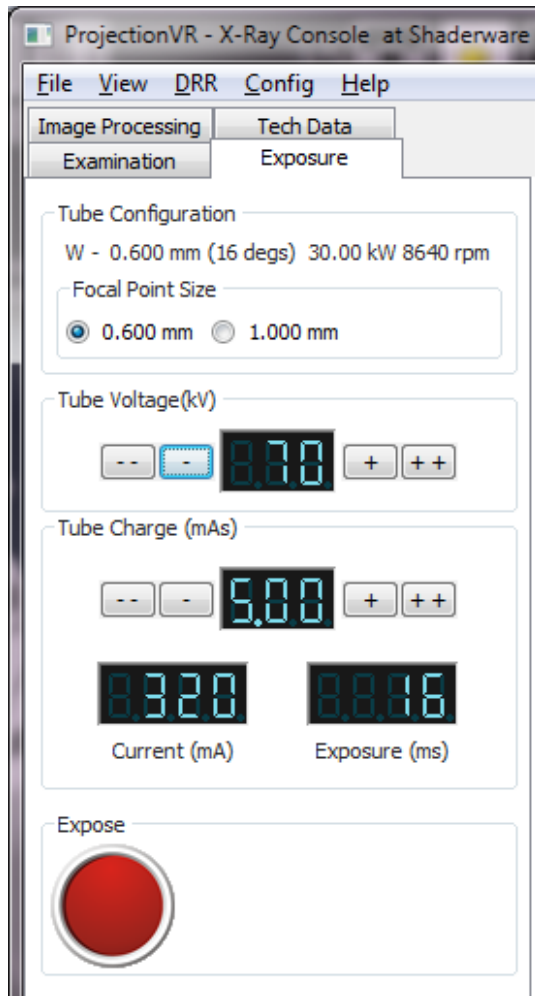
The tube charge (mAs) can be increased in 'steps'. Different manufacturers use different steps. It is common for roughly exponential steps to be used. Tube voltage controls the quality of the beam, and alters in smaller steps.

The other control selectable from here is the focal spot size. This has no discernible effect on image quality, but does alter the tube ratings and therefore the maximum settings of tube current (mA).

Exposure time is given as an indication, but cannot be set independent of tube charge (mAs) in ProjectionVR (more detailed simulation of technical factors can be achieved in our TechnicVR product).

Image processing and viewing
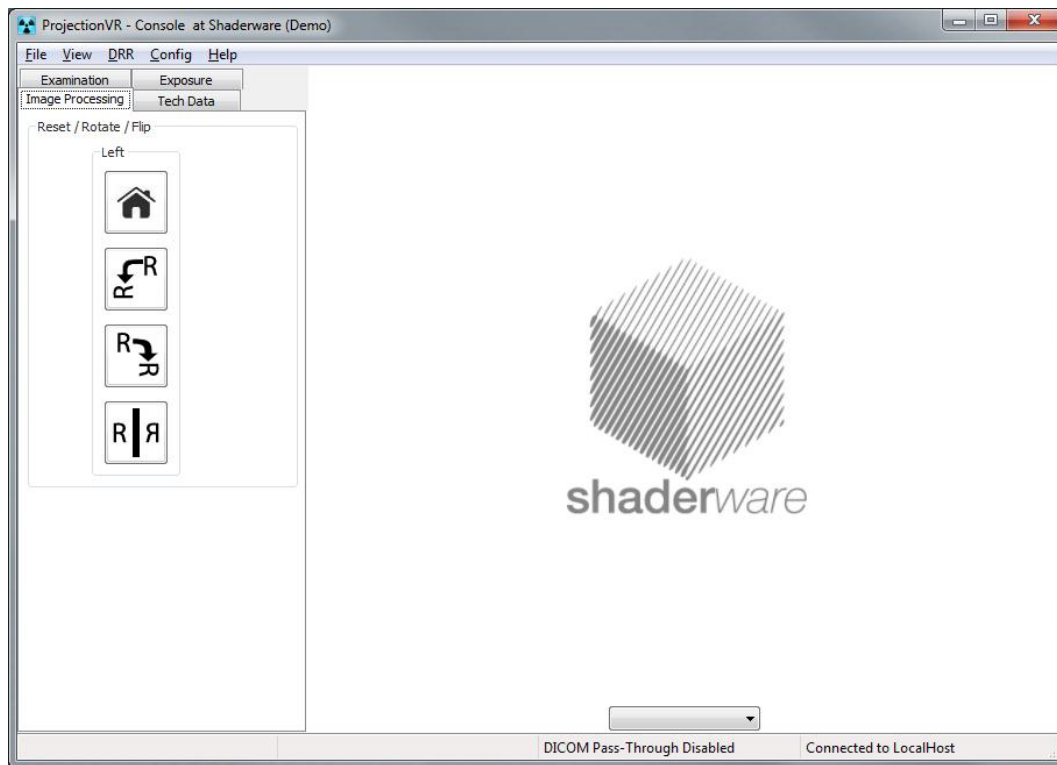
Despite the receptor orientation selection on the examination screen, it is still a common occurrence that the radiograph be initially displayed in an incorrect orientation. To "hang" the radiograph in the correct orientation tools are provided on the 'Image Processing' tab. To rotate the image, use the rotate or flip buttons in the left pane. A 'home' button will reset the radiograph orientation to initial settings.

Local protocols can differ in hanging requirements. In the ProjectionVR.ini configuration file the system manager can set either 'strict' or 'lax' hanging rules. The default is 'lax', where only PA projections and PA obliques are flipped before display. Applying the 'strict' rules will also force Lateral and Supero-Inferior axial projections to be flipped before display.

To examine the radiograph more thoroughly – the console can be maximised and resized by dragging the corner of the window or by using the standard window controls (left clicking the middle of the three buttons on the right above the status bar; click again to restore)

Comparing radiographs

While training, it is often important to compare the new radiograph with the original attempt. The console default is to display one large radiograph. Below the radiograph is a drop down list which allows selection of previous radiographs for comparison. The number of previous radiographs held in memory is defaulted to four, but can be set up to any integer in the initialisation file (see chapter six).
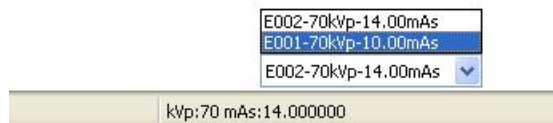
Comparing radiographs side by side:
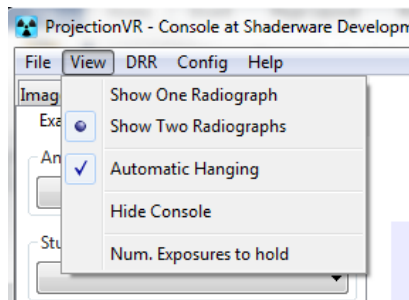
Another feature allows comparison of radiographs side by side. To set this mode go to the console menu and select 'view'; select 'Show Two Radiographs'

If the radiographs are too small to see fine detail, the console controls can be hidden to increase the view port size

Saving radiographs and further image processing

When a radiograph is to be kept, it can be saved. To save an image based on the
virtual radiograph, go to the menu and select 'File'. Either of the radiographs visible
on the dual viewport, or the single radiograph in the single view port can be saved.
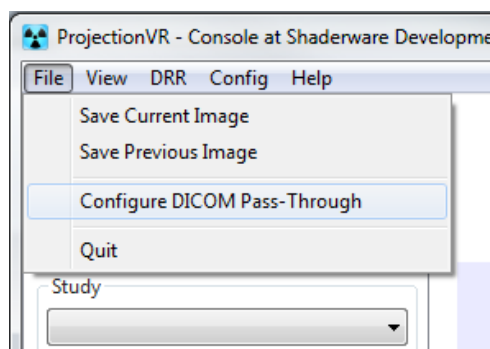
Radiographs can be saved in a variety of formats: png, jpg, tif, or bmp.

DICOM capabilities
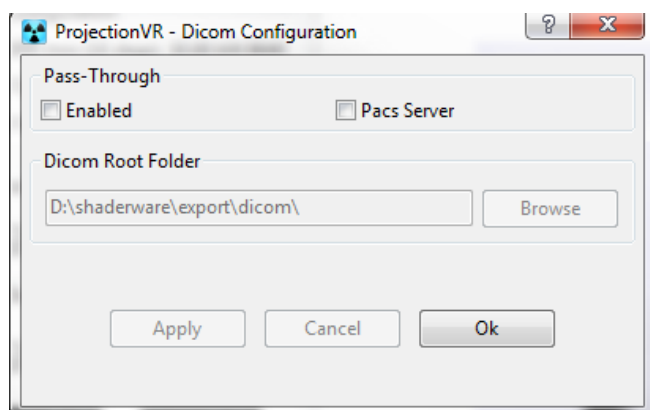
DICOM Pass-through is not enabled by default – but can be via the initialisation file.
It can be enabled during a session via the console 'File' menu. The two options are
'Enabled' or 'PACS server'. If 'Enabled' is set, the patient and visit (attendance) details
are saved in the location (default set in the ProjectionVR.ini file) as a directory
structure Patient Name\Visit-DateTime\ individual exposures will give rise to
individual files. These will be accompanied by a DICOMDIR file. Any examination
details set form the first 'Study' in this file and exposures subsequently taken will
provide data to populate a new 'Series'.

If 'PACS server' is chosen individual .dcm files are saved in the DICOM directory
specified in the DICOM Pass-Through configuration window without any
DICOMDIR or any directory structure. The PACS can then load the files as they are
written.

It is important to realise that much more than the image is saved. A DICOM object is saved that comprises all the DICOM tags and the relevant data therein. This DICOM object can be archived to a PACS and viewed and manipulated on any DICOM workstation.

Powerful DICOM workstation software (available as a separate installation from a variety of third party suppliers) allows measurement, zoom, window and many other image processing tasks to be performed on the archived virtual radiographs. There are many free DICOM applications available, but Shaderware do not guarantee all will be compliant with the DICOM standard, therefore we cannot guarantee they will all read the DICOM file saved by ProjectionVR™.
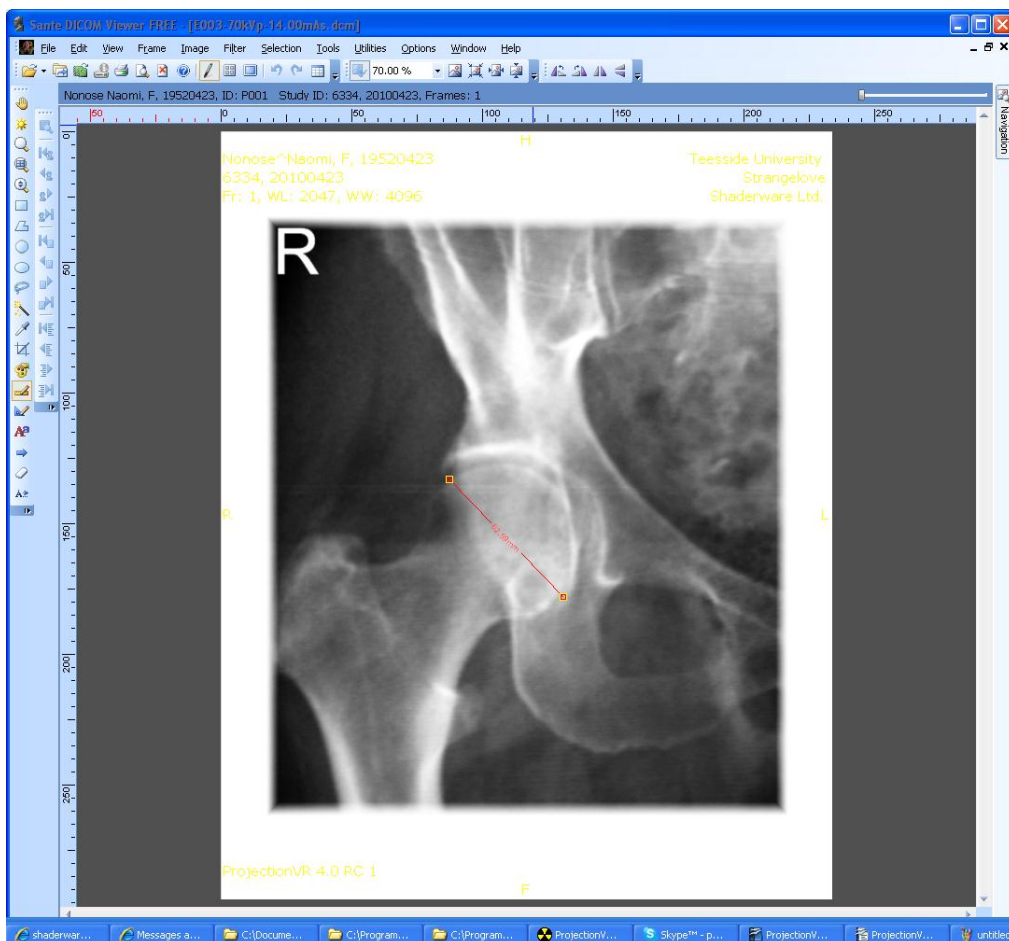
Configuration of the ProjectionVR.ini file

This section will explain how to set the default configuration for the system.

Location of the ProjectionVR.ini file

On installation the system will copy the default ProjectionVR.ini file into the Shaderware Directory. It is important that this file should not be renamed, deleted, edited inappropriately or moved.

Function of the ProjectionVR.ini file

The file sets the default value for the parameters that are customisable by the user. A system manager can use this file to direct the program in various ways. The file is written in plain english with explanation notes. It can be viewed and edited by a simple text editor such as 'Notepad'. It is strongly advised that technical help from your IT technicians is sought before making changes to this file.

The next section will identify all the parameters that can be set and give acceptable value ranges.

[licence] - There are two parameters, location and name of the licence file.

The location of the directory containing the licence file. Accepted values:
- UNC path to license file   eg \\MyServerName\MyDirectory
- local windows filepath   eg D:\dirName1\dirName2
- default - search in the same directory as the executable, and then up through the parent directories until a file is found or the root is encountered

    NOTE: backslash is an escape character so they must be doubled up e.g. \\\\MyServerName\\MyDirectory.

    licenceFileDirPath = default

The name of the licence file can be defined. Only the name in the form <name>.<ext> is allowed, it cannot contain a path. "default" - will use "licence.xml"

    licenceFileName = default

[signin] - controls sign in requirements for ConsoleVR start up.

User details will be required if DICOM export is enabled. Accepted values:

- "none" - Student will not be prompted to sign in
- "optional" - Student will be prompted to sign in but can dismiss dialog without entering details
- "mandatory" - Student must enter their student id as a minimum

    signin = none

[metrics] - Not currently used.

    capture = none

[console_view] – There are four parameters: initial number of viewboxes, automatic 'hanging', hanging flip rule and exposure history.

Initial number of viewboxes displayed by ConsoleVR can either be "1"or "2" (this can be changed via the menu when the program is running).

    viewboxCount = 2

When automatic hanging orientation is enabled the resultant radiograph is 'hung' based on user entered "Examination" values. When disabled, the radiograph is displayed with the top of cassette up and as if looking at the tube surface of the receptor. Accepted values are "true" or "false"

    autoHangingEnabled = true

If autohanging is enabled either the 'strict' or 'lax' orientation rules, as defined in the examinations database, can be applied. Accepted values are either "lax" or "strict"

hangingFlipRule = lax

The initial number of exposures held for display by ConsoleVR. Any integer can be selected. However, each exposure requires resources and setting this too high may cause stability problems.

exposureHistory = 4

[scenario] – Four parameters can be set here: initial scenario, initial modality, cassette retention in CR, metric or imperial reporting units and metric or imperial collimation.

The initial scenario is the room setting that will display on program start (this can be changed via the menu when the program is running). Accepted values:

- "1" - Erect Bucky
- "2" - Head
- "3" - Recumbent
- "4" - Trauma Trolley
- "5" - Lower limb

scenario = 3

The initial simulated modality is a choice between modelling a flat panel display (FPD) "DR" or storage phosphor radiography (SPR) "CR" (this can be changed via the menu when the program is running).

modality = dr

If or when the "CR" mode is selected by the user via the menu, the program can be set to remove the cassette after each exposure as in real life. Accepted values "yes" or "no"

retainCassette = no

Reporting units and distances can either be set as metric (centimetres) or imperial (inches). Accepted values:

- "default" - will use locale obtained from operating system
- "en-gb" - English - Great Britain (centimetres)
- "en-us" - English - United States (inches)

localeCode = default

Collimation adjustment can be separately set in either as metric (centimetres) or imperial (inches) units. Accepted values:
- "cm" - centimeters, collimation will be adjusted in steps of one centimeter
- "in" - inches, collimation will be adjusted in steps of one-half of an inch

- "default" - will be based on the localeCode, Inches for US, cm for rest of the world

collimationUnits = default

[preferences] – Five parameters can be set: sound effects, control of the first person view of the x-ray room, which monitor the room and console are displayed on, and duration of the light on the collimator.

Console sound effects can be initially enabled or disabled. (this can be changed via the menu when the program is running). Accepted values are "yes" or "no".

consoleSoundEffectsOn = yes

The initial method of selecting viewpoint mode is set here. Viewpoint mode allows the user to dolly in and out of the scene, change their focus of attention and orbit this focus (see chapter one, page 6). If this is set to "manual", the user will have to engage viewpoint mode by holding the space bar down. If set to "automatic" viewpoint mode is engaged as soon as the cursor is not selecting an object in the room.

viewpointMode = automatic

If two or more monitors (or a projector) are connected to the computer, the monitor that the room and console are displayed on should ideally match the graphics adaptor the program expects the setting choosen here. The program will work if swapped around, but performance may be impaired. The adaptors are numbered from "0", the primary monitor in windows will be numbered from 1, i.e.) matches 1 and 1 matches 2 and so on. (This parameter can be changed via the menu when the program is running).

monitorXrayroom = 0

monitorConsole = 1

The collimation light, also known as the light beam diaphragm (LBD) light, automatically switches off. The time it stays on is set here in seconds. Accepted values are any integer.

collimationLightDuration = 60

[network] – The initial network port used by XrayroomVR and ConsoleVR to communicate (this can be changed via the menu when the program is running). Accepted values include any valid unused network port.

port = 3001

[drr] – These are the initial Digital Reconstructed Radiograph (DRR) image generation parameters.

The DRR Generation Transfer Function controls how the CT data is re-sampled to create the DRR. The choice of transfer function is based on the capabilities of the graphics hardware. This parameter can be used to force a particular technique if the default settings determined by the program for a particular hardware configuration are sub-optimal.

It is recommended that the as part of the installation the user should try each of the options using the ConsoleVR and if the they find a more suitable transfer function than the default, that optimal function should be set here. Accepted values:

- "T01SM2EO" - Shader Model 2, Multipass using hardware 8Bit alpha-blending (this should only be used if all others fail)
- "T01SM2AB" - Shader Model 2, Multipass using hardware FloatingPoint alpha-blending (this could be the fastest setting)
- "T01SM2PP" - Shader Model 2, Multipass using software FloatingPoint alpha-blending (can cause artefacts on some graphics adaptors)
- "T01SM3AB" - Shader Model 3, Multipass using hardware FloatingPoint alpha-blending
- "T01SM3PP" - Shader Model 3, Multipass using software FloatingPoint alpha-blending
- "Default" - let virtual radiography decide at runtime

transferFunction = default

The DRR Raw Image Pixel resolution controls the size of the internal DRR created, it will be processed before display or export by scaling and upsampling to match the required aspect ration. The choice is based on the capabilities of the hardware. Higher pixel resolutions should improve the image. However, they also increase the generation times and may exceed the hardware's capabilities, resulting in undefined behaviour. Accepted values are 256, 512, 1024, 2048, default

imagePixelResoultion = default

[export] – Five parameters that govern the way images can be exported from the program.

An alternative path where exported images are to be saved (this can be changed via the menu when the program is running). If nothing is set here images will be suggested for export in the normal windows standing protocol; the user can alter this in the pop up dialog box. Accepted values are any existing valid path, but remember to double up the backslashes. It is usually commented out using the # symbol.

 # imagesRoot = D:\\shaderware\\export\\images

Users can be forced to set up DICOM parameters each time the program starts. Acceptable values are "true" or "false"

showDicomConfigAtStart = false

This sets the initial DICOM behaviour after every exposure. If enabled every exposure is exported as a DICOM file immediately without user intervention. This is useful if you wish to monitor all exposures each student has made for formative assessment. By default a sub-folders for each student and session is created. This is intended to facilitate the reviewing of exposures using a DICOM viewer. This can be switched on and off via menus when the program is running. Accepted values are "true" or "false"

dicomPassThroughEnabled = false

The initial path to DICOM export root folder (this can be changed via the menu when the program is running). Accepted values are any path, but remember to double up the backslashes.

dicomRoot = D:\\shaderware\\export\\dicom

If a Picture Archive and Communications System (PACS) archive tool is being used then DICOM objects should be created in the PACS 'incoming' directory without any directory structure or the accompanying DICOMDIR file. By default, the program will create these, so this parameter has to be set to enable plain DICOM fit for a PACS. The acceptable values are therefore "true" or "false".

pacsServerEnabled = false