

Version

1.0

TechnicVR

shaderware.com

Tutor Guide

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Introduction

This section will explain what virtual radiography is



This software is used to support radiography education. TechnicVR is a fully featured simulation of the x-ray field incident on the patient during projection radiography. All types of projection radiographic procedure are possible to set up. Using TechnicVR, lecturers can accurately illustrate their teaching sessions; demonstrating the effects of different radiographic exposure factors on the x-ray beam and the tube itself. Students can explore the effects of all exposure factors at their own pace, safely and wherever a laptop computer can be located.

In the modern digital environment, mAs no longer affects the density of a film; kVp is not the primary control for contrast. Lecturers' materials need to be updated to provide new ways for students to understand the factors that affect the x-ray beam. TechnicVR gives you powerful new tools that enable you to demonstrate the x-ray beam spectrum across the irradiated field. It cuts through any complicated physics and simply shows accurate results, as if you had really done the experiment. It is easier than a real experiment, as you don't have to take a lot of time setting it up. Best of all – it allows you to interact with your students, moving beyond pre-prepared materials to answer the 'what if' questions that capture the class interest.

Installing and starting technicVR

This section will explain how to install TechnicVR from the download.

Minimum Computing Requirements

TechnicVR needs no special computer specifications. It runs under windows Vista, XP and 2000.



After downloading the installer from the website, double click to run. You will need administrator access rights on the computer. In Windows Vista, after installation and before initial invocation of TechnicVR right click the installed start icon and select the 'run as administrator' option from the menu.

Starting TechnicVR

This section will explain how to start TechnicVR from the desktop or start menu.

On installation, the TechnicVR icon will be created on the computer desktop. If you already have other virtual radiography™ modules, the new icon will join these.

To start TechnicVR double-click on its icon. Alternatively, if no icons are available, the module required can be run from the start menu.

Initial Activation & Registration

On the first invocation of the product, a registration screen is displayed. The institution title and activation key provided on purchase are required. If you are evaluating the software for potential purchase, a 15 day trial period is allowed and this screen can be skipped (if you purchase the software during the trial period, entering the activation key supplied will unlock the software permanently, without the need for further installation).

If you do not possess a working activation key, please contact your supplier.

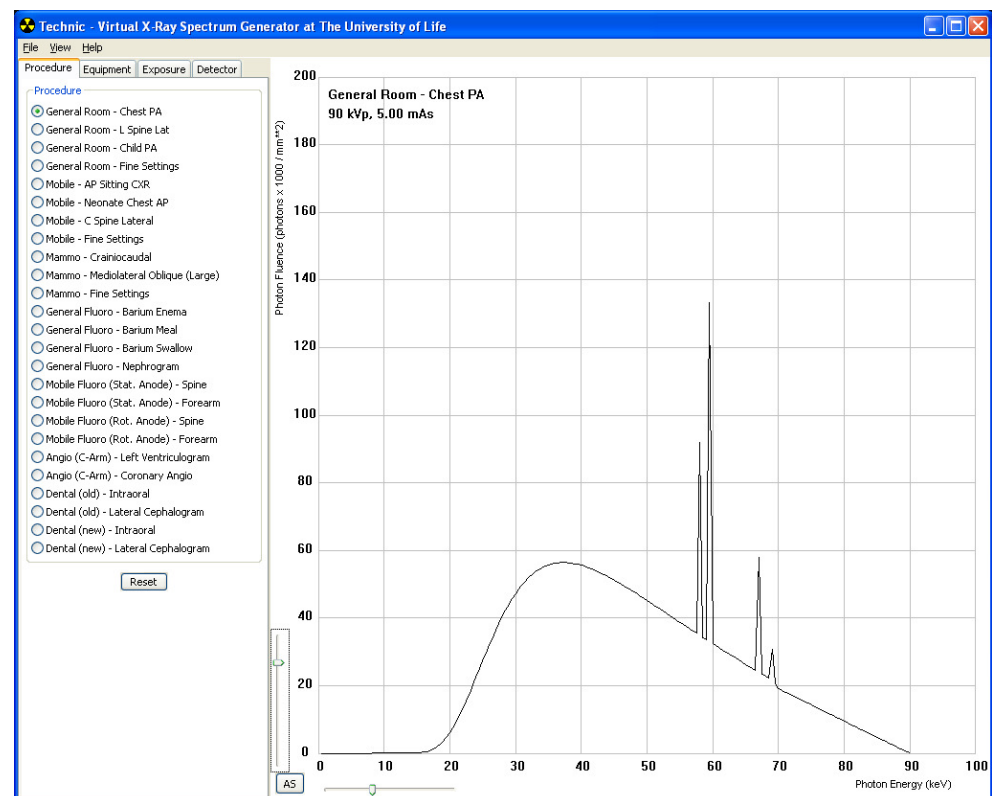


The Main Window

This section will explain the TechnicVR main window and how to modify it to support your session outcomes.

Default start-up screen

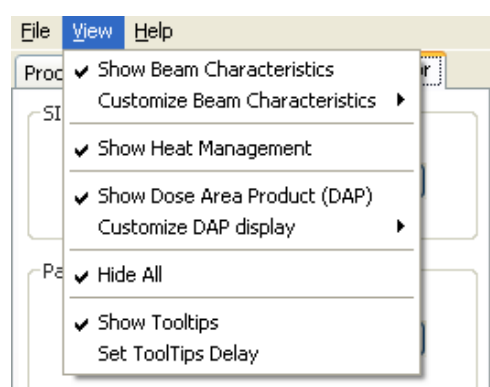
TechnicVR initially starts with the 'Procedure' tab open and the spectrum graph prominently displayed. The right hand output panel is deliberately hidden by default.



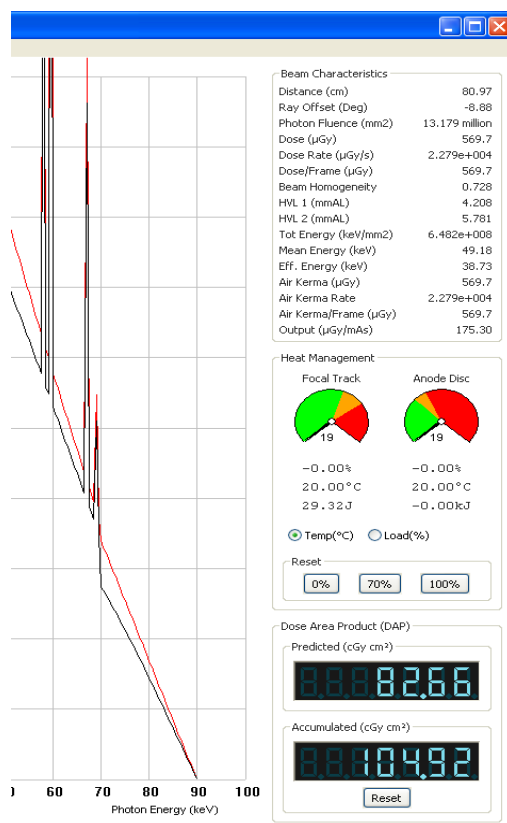
The view menu

By default, the start-up screen is uncluttered and simple. Any changes to the exposure factors result in a simple outcome – changes to the beam spectrum. For many classes, this will be sufficient to show how the x-ray beam can be controlled by the radiographer, and how different equipment also affects it.

For some classes, the outcomes might require some quantitative output. For example; measuring the Entrance Surface Dose for a CXR, Seeing how Dose Area Product changes with collimation, visualising the Heat Units build up on the anode during fluoroscopy. In these cases it is easy to customise the screen by altering configurations in the ‘View’ menu



De-select ‘Hide All’. The user can then choose ‘Beam Characteristics’, ‘Heat Management’ or ‘Dose Area Product’. The screen can display all of these outputs at once if required, and this may be very useful while planning the session; the ‘Beam Characteristics’ and ‘Dose Area Product’ outputs can be further customised.

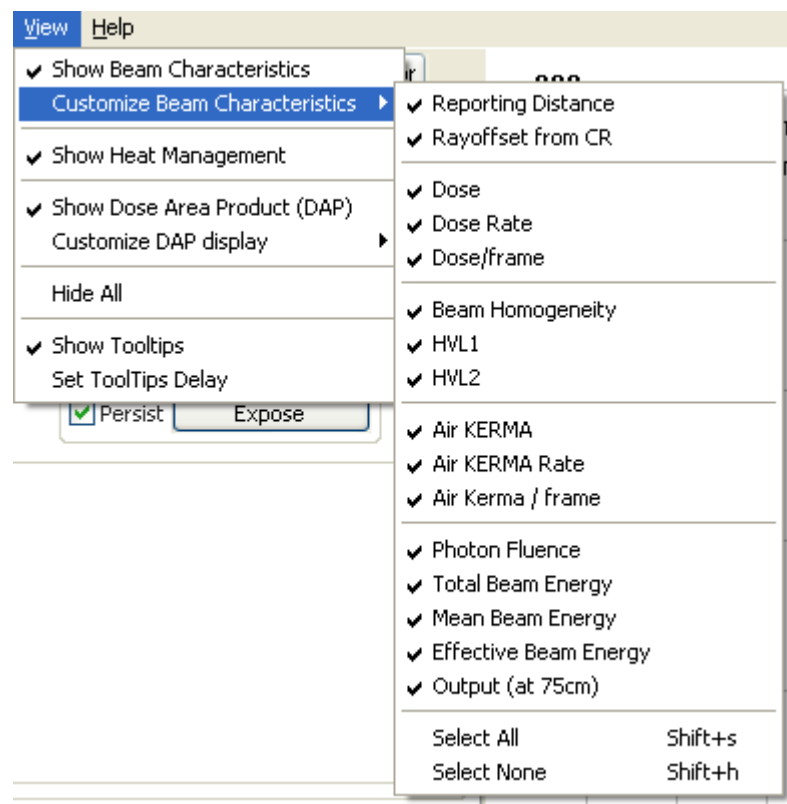


The right hand panel displayed with ‘Beam Characteristics’, ‘Heat Management’ and ‘Dose Area Product’ all selected.

In this example all possible options are selected.

Customising the 'Beam Characteristics' in the right hand panel

All possible reporting units can be selected or deselected. For example, Air KERMA and Dose in Air are virtually identical values for the diagnostic energy range, so it would be pointless to display both, but you can choose which to display. On the same lines, 'Dose Rate' and 'Dose/Frame' are needed for Fluoroscopy exposures, but can be left out for all others.



There are two special values that are on this menu which are not outputs, but are there to remind the user where all the other values are calculated from. These are 'Reporting Distance' and 'Ray Offset'. The 'reported units' are from a certain detector location in the beam, which is set in the 'Detector' Tab. Once set there they are displayed here for ease of reference.

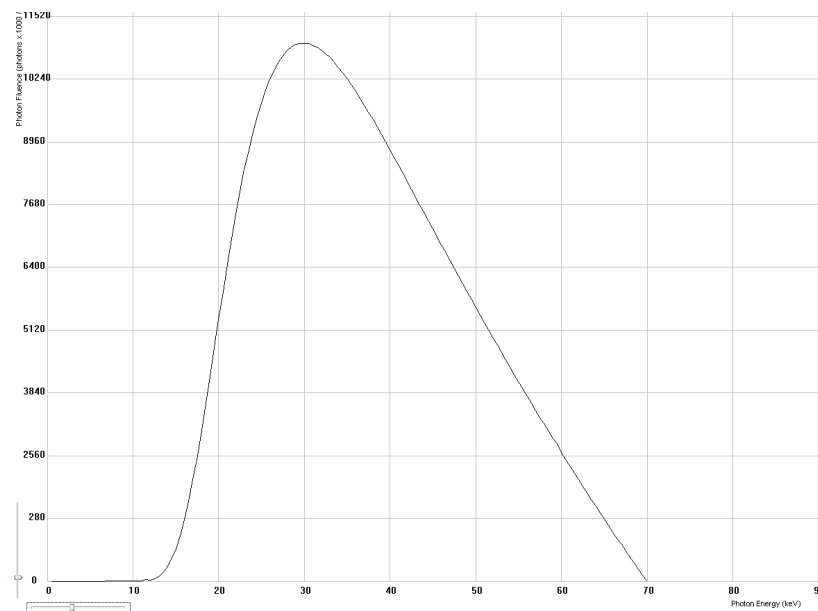
The simulated x-ray spectrum

This section will explain the simulated x-ray beam and the quantitative measurements related to the spectrum displayed.

The main graphic output from TechnicVR is the simulated x-ray spectrum. This alters in real time with the exposure factors selected. There are also a range of quantitative values associated with this spectrum that are reported as 'Beam Characteristics'.

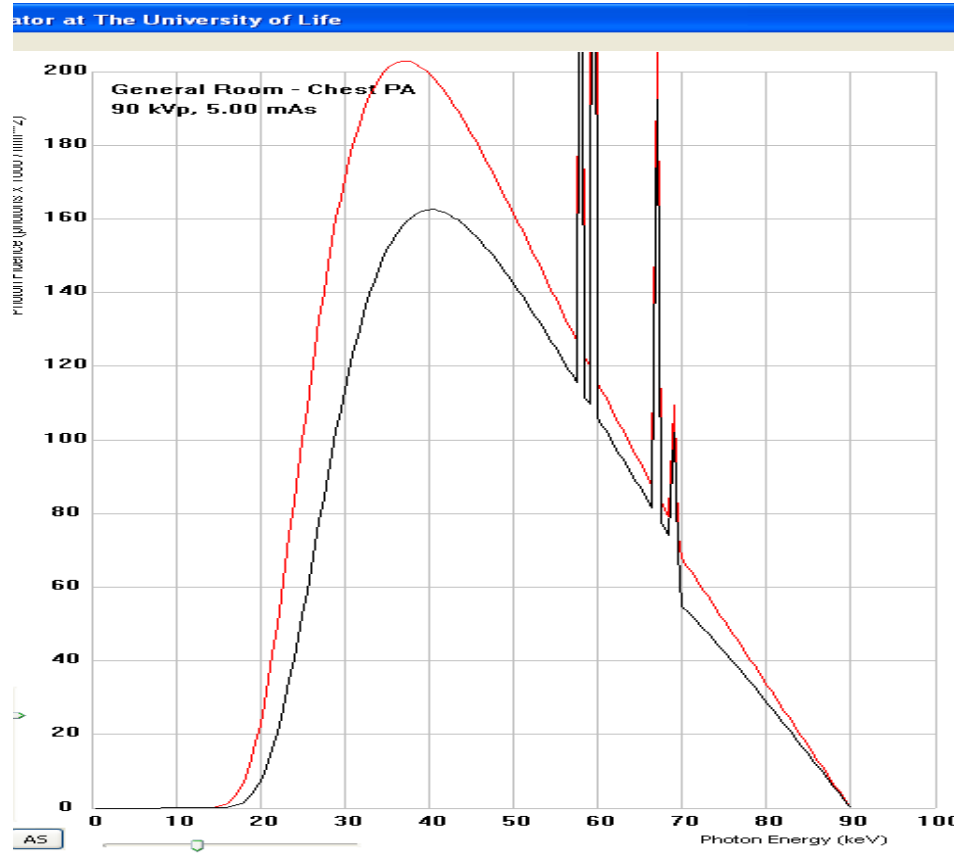
The spectrum graph

The graph responds to all exposure factors. It always displays Photon fluence (the number of x-ray photons per mm^2) against Photon energy (units of keV)



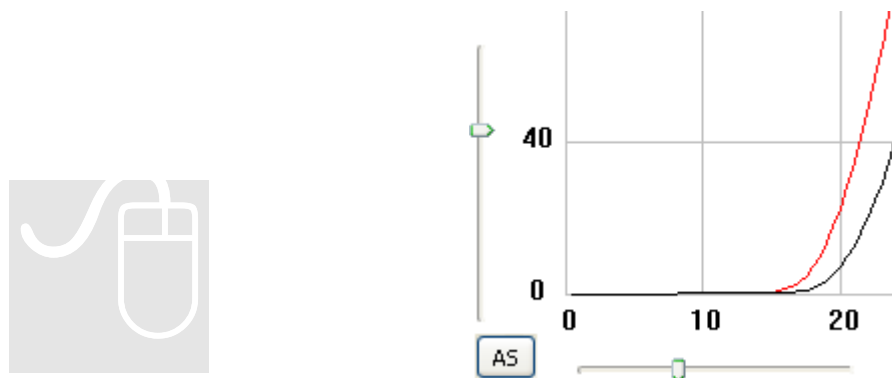
The 'predicted' spectrum is always shown; this allows a dynamic display of any alteration in exposure factor which is a very powerful learning tool.

Once the settings have been finalised for any given procedure, the exposure button can be depressed and the spectrum is fixed (if 'persist' option is selected). Changes to the exposure factors will now create a new 'predicted' spectrum; this makes it easy to compare any changes to the original exposure.



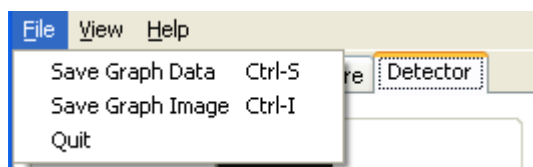
Resizing the Graph

The axes are linear, which allows direct comparison between the spectra. If the new spectrum is too large or too small to be displayed, the axes can be rescaled using the sliders manually or the 'Auto Scale' button (AS)



Exporting the graph or spectrum data

TechnicVR makes it easy to create copyright free content for your PowerPoint presentations, websites or documents. The graph or the data behind it can be exported from the file menu.



TIP: To quickly save a graph, right click on the plot area and a 'save file' dialogue will appear.

The data table used to create the graph is saved (File\Save) as a comma separated variable file (.csv) which is compatible with most spreadsheet programmes, e.g. Microsoft Excel. All the beam characteristics (even those that are not currently displayed) and the current exposure parameters are saved to this file alongside the individual photon energy data.

If the output is to be used in published work, TechnicVR can be cited as follows in that work:

Willis, R.N., and Cosson, P., (2008) TechnicVR: A Software Catalogue of Spectral and Tube Ratings Data for Diagnostic Radiography, Shaderware Limited, UK

Chapter 4

The detector(s)

This section will explain the TechnicVR detectors and the controls available on the 'Detector' tab

Types of Detector

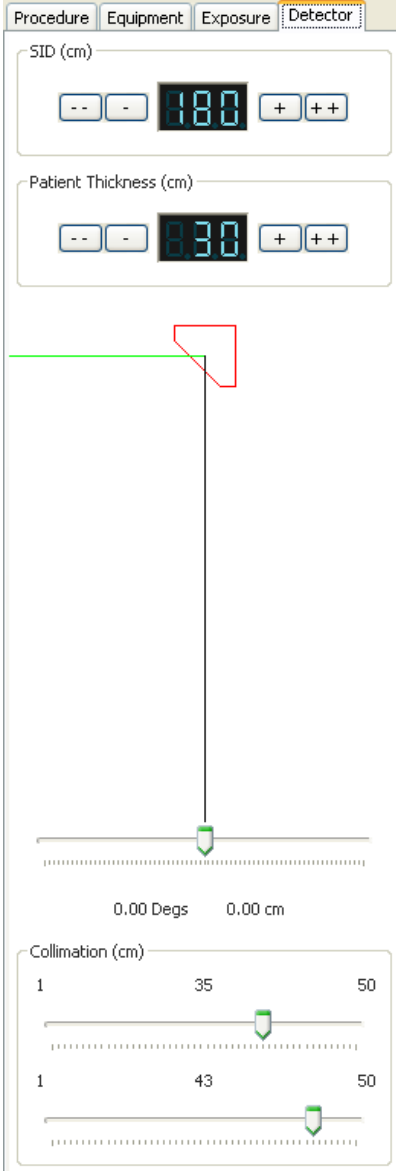
Chapter 2 described how the outputs from the detectors modelled by TechnicVR can be displayed to the user. The 'Detector' tab has options to select the entrance surface detector position and to alter collimation of the beam (which will alter the Dose Area Product reading.

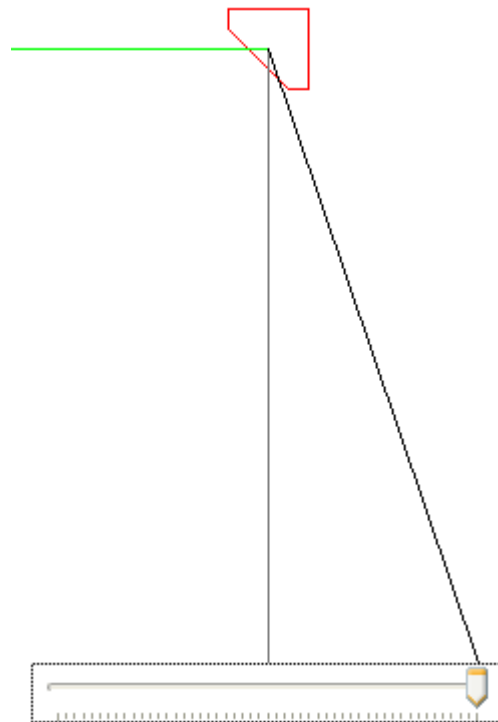
The entrance surface detector

This is notionally a small device that can be positioned on the entrance surface of a patient or phantom. It might be envisaged as a thermoluminescent material or a solid state device of a small size.

By altering the Source Image Distance (SID) and the patient thickness, the Source Detector Distance (SDD) can be calculated (remember to add 8-12cm to the patient thickness for Bucky examinations)

By default the detector is positioned at the central ray. But its location across the radiation field from cathode to anode can be altered. This will affect the spectrum and beam characteristics reported.





The range the detector can be moved is determined by the collimated area, and is reported in degrees.

This allows demonstration of the Anode Heel Effect dynamically to students.

The 'Dose Area Product' (DAP) meter

Modern radiography equipment often has a DAP meter attached to the light beam diaphragm (LBD). This provides a measure of both the ionisation of air due to the intensity of the radiation AND the area irradiated. Although it is unrealistic to have a DAP meter on some equipment, TechnicVR simulates a DAP reading for all procedures so that comparisons are possible. There are two readouts, a predicted value for any individual exposure and an accumulated reading for fluoroscopy systems.



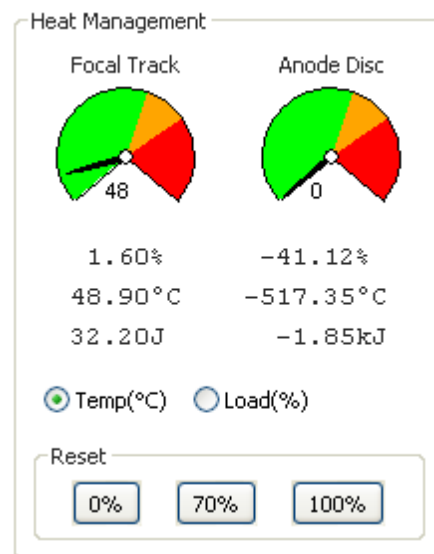
Two sliders are available to alter the collimated area for most procedures; The intra oral dental equipment and some fluoroscopy systems have a circular collimator with only one slider.

The tube loadings

The x-ray spectrum generated by a set of technical factors is only half the story and TechniVR also simulates the effects the Radiographers settings have on the tube.

Heat management

Only a small fraction of the electrical energy supplied by the generator is converted into x-rays; the majority heats up the anode target. The type of exposure and tube design all affect the rating of the tube. All these factors are used in the simulation, to achieve very realistic temperature values. These are put into the context of the tube heat capacity and are also shown as % tube loadings or temperatures on degrees Celsius.



Once the exposure button is depressed (on the 'Exposure' tab) the heat is applied to the anode and dynamic cooling occurs, in real time, showing the effect of repeat exposures.

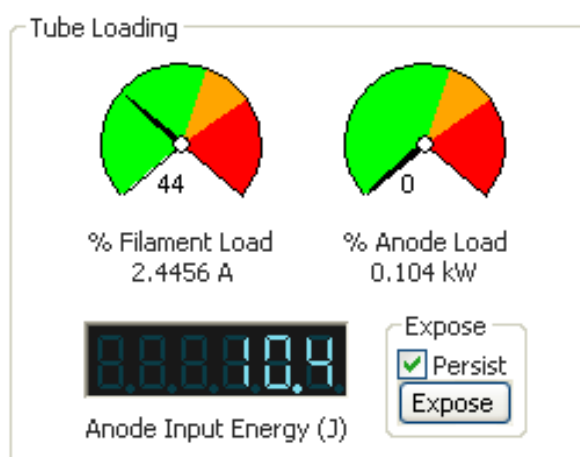


If a new simulation is required, the tube can be reset to either 'cold' (0%) 'warm' (70%) or 'hot' (100%) by clicking on the appropriate button

Predicted filament and anode loadings

Most x-ray tubes fail due to filament breakage. Even a small increase in filament temperature can shorten the life of the x-ray tube. The simulation has a very sophisticated model of various tube types and filament sizes. The tube type, mA, filament size and kV are all used to calculate a predicted filament current and this is displayed on a meter to show how close this is to the maximum allowable for this tube.

The anode load, and energy incident on the anode is also predicted and shown against the maximum permissible ratings; TechnicVR will allow overload conditions to be simulated, and the effects are shown.



The filament and anode predicted loadings are only displayed on the 'exposure' tab.

Selecting procedures and equipment

This section will explain how to select a procedure and make changes to the default exposure parameters

Selecting procedures

Projection radiography includes a wide range of practice. The equipment used can vary enormously from one procedure to the next. To allow comparisons and accurate simulation, TechnicVR includes the following procedure types to be selected.

Dental Intraoral

Mobile

Chest

General room

Bariums

Angiography

Mobile II

Mammography



The procedure choices will only be displayed when the 'procedure' tab is selected.

When a procedure is selected, default exposure factors populate all the fields. These can then be altered individually

Equipment Choice

Radiographers have to be flexible enough to carry out procedures on a variety of different equipment. There are often both modern and older x-ray rooms in use at a particular clinic, for example. Different manufacturer's equipment may also have some characteristics that affect the x-ray spectrum. In TechnicVR the tutor can make changes to equipment to show how these affect the x-ray spectrum. These factors are not normally in the control of the radiographer in day to day operation (unless they select to use a particular room). It is becoming more common for filtration to be altered per patient however.

Control of exposure factors can either be by kVp and mAs (2 point) or kVp, mA and time (3 point). Changes here will affect the 'exposure' tab layout



The equipment choices will only be displayed when the 'equipment' tab is selected.

The screenshot shows the 'Equipment' tab selected in a software interface. The interface has four tabs: 'Procedure', 'Equipment', 'Exposure', and 'Detector'. The 'Equipment' tab is active and contains the following settings:

- Available Anode Targets:** A list with 'Tungsten' selected.
- Tube Age:** A slider ranging from 0 to 100, currently set at 0.
- Filtration:** A table with four rows, each with a dropdown menu and a numerical input field.

aluminium	3.2
	0
	0
	0
- Console Type:** Radio buttons for '3 Knob', '2 Knob' (selected), 'Pulsed', and 'Dental'.
- Power Supply:**
 - Frequency (Hz):** Radio buttons for '50' (selected) and '60'.
 - Wave Form:** Radio buttons for 'High Frequency' (selected), 'Single Phase / Halfwave', 'Single Phase / Fullwave', '3 Phase / 6 Pulse', and '3 Phase / 12 Pulse'.

Altering common exposure factors

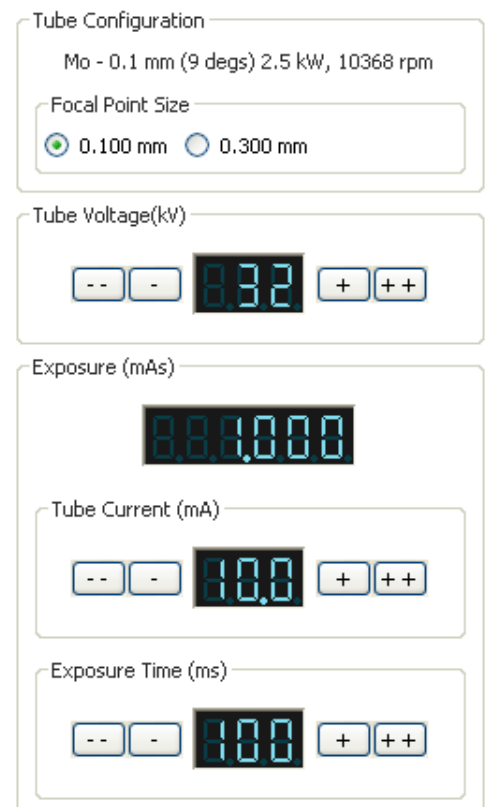
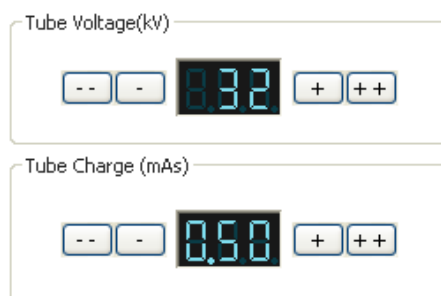
This is an everyday activity. Although the use of automatically programmed radiography factors (APR) is increasing with modern generator control panels, it is important to optimise exposure factors for each and every patient. These controls are found on the 'Exposure' tab

Filament size

A smaller filament size is desirable for improved image quality. But this puts a strain on the equipment, and can involve a reduction of image quality if the exposure time increases enough to allow movement blur. The focal spot can be selected from those available in the 'exposure' tab.

Two or three point control

For most procedures, there is a choice of selecting tube potential difference (kV) and tube charge (mAs) [two point] or selecting tube current (mA) and time (s) separately [three point].



Dental

Most older intra-oral machines don't set exposure time in conventional units, but set the number of 'impulses'. Each impulse is a single mains voltage cycle. In the UK this is 0.02 seconds long, or 1/50th of a second. In the USA it is 0.016666 seconds, 1/60th of a second.

Tube Voltage(kV) 87.0

Exposure (mAs) 0.120

Tube Current (mA) 87.0

Impulses () 888

Fluoroscopy and fluorography

Mode Fluoroscopy Fluorography

Tube Voltage(kV) 87.0

Tube Current (mA) 10.0

Duty Cycle (%) 20 Continuous

Pulse Width (ms) 16.0

Pulse Frequency (per sec) 12.5

There are separate settings for fluoroscopic kVp and mA on most fluoroscopy equipment to allow high quality 'spot imaging' or 'acquisition' and low quality 'scout' imaging that is not archived, but is used to position the instruments or fluoroscope. Older systems have continuous fluoroscopy, but modern systems can pulse the fluoroscopy for considerable radiation dose savings to both patients and operators. The rate of 'acquisition' is often just a single exposure, but for some procedures, such as angiography, the rate can be between 6 and 50 images per second.

Validation of TechnicVR

The data presented by the software must be accurate and reliable. This section explains how this is achieved.

Spectrum data

There are two methods of determining the number of photons of a given photon energy in an x-ray beam. The first is to calculate it from first principles, and the second is to measure it with a suitable detector; both are difficult. Several researchers have published work describing their methods; TechnicVR is mainly based on the work of Birch and Marshall (1979). This work has been widely verified against measured data.

Attenuation coefficient data

TechnicVR allows a wide range of filtration materials to be selected. The software calculates the attenuation of these materials from very high-resolution data supplied by the National Institute of Standards and Technology, Gaithersburg, MD (Berger, Hubbell, Seltzer, et al., 2005)

Ratings data

The ratings for each x-ray tube are based on real ratings charts published by tube manufacturers. This is why certain constraints are applied to the settings, for example, the selection of anode target angle can only be achieved by selecting a different tube; the same is true for focal spot size.

Generator control panel setting data

The choice of kVp, mA, s, (or mAs) is based on the real settings possible when using a real x-ray unit. Most manufacturers use a system of semi-logarithmic steps for these settings; TechnicVR adopts this type of setting as default. This makes it difficult to set all possible values however – as there are large steps between the higher values. One leading manufacturer uses their own system for step setting which allows finer settings. TechnicVR has procedures that specifically use this method allowing a very wide range of possible settings.

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