



## User Manual

# DICOMscope 2.0

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# Contents

<b>A</b>	<b>INTRODUCTION.....</b>	<b>4</b>
<b>B</b>	<b>INSTALLATION AND GETTING STARTED.....</b>	<b>5</b>
<b>C</b>	<b>BROWSER.....</b>	<b>6</b>
C.1	TOOLBAR .....	7
C.1.1	Load Image File.....	7
C.1.2	Open.....	7
C.1.3	Send .....	8
C.1.4	Refresh.....	8
C.1.5	Delete.....	8
C.1.6	Add Hardcopy to Print .....	8
C.1.7	Create Dump.....	9
<b>D</b>	<b>VIEWER.....</b>	<b>10</b>
D.1	TOOLBAR .....	11
D.1.1	Load Image File.....	11
D.1.2	Apply Presentation State File .....	11
D.1.3	Save to Database .....	11
D.1.4	Save to File .....	12
D.1.5	Save Screen to File .....	12
D.1.6	Add to Print .....	12
D.2	STATUS BAR.....	13
D.3	SHUTTER .....	13
D.3.1	Rectangular Shutter.....	13
D.3.2	Circular Shutter.....	13
D.3.3	Polygonal Shutter .....	14
D.3.4	Bitmapped Shutter .....	14
D.3.5	Shutter Color .....	14
D.4	LAYERS .....	14
D.4.1	Create a Layer.....	15
D.4.2	Modify a Layer.....	16
D.4.3	Delete a Layer .....	16
D.5	ANNOTATIONS.....	16
D.5.1	Create a Graphical Annotation .....	17
D.5.2	Create a Textual Annotation.....	18
D.5.3	Modify an Annotation .....	19
D.5.4	Delete an Annotation.....	20
D.5.5	Move an Annotation to another Layer.....	20
D.6	IMAGE PROCESSING FUNCTIONS.....	21
D.6.1	Reset.....	21
D.6.2	Flip the Image.....	21
D.6.3	Rotate the Image.....	21
D.6.4	Invert the Image.....	21
D.6.5	Apply Presentation LUT.....	21
D.6.6	Apply Correction Curve.....	22

D.6.7	<i>Toggle Presentation State on/off</i> .....	22
D.7	ZOOMING .....	22
D.7.1	<i>Select an Area</i> .....	22
D.7.2	<i>Fit Image</i> .....	22
D.7.3	<i>Zoom Image 1:1</i> .....	22
D.8	WINDOW SETTINGS .....	23
D.8.1	<i>Interactive Windowing on Preview Image</i> .....	23
D.8.2	<i>Select Presets / VOI LUT</i> .....	24
D.9	PRESENTATION SIZE MODE .....	24
D.10	PRESENTATION STATE NAME .....	24
D.11	INFORMATION PANEL .....	25
<b>E</b>	<b>PRINT</b> .....	<b>26</b>
<b>F</b>	<b>OPTIONS</b> .....	<b>28</b>
F.1	GENERAL.....	28
F.2	VIEWER.....	29
F.3	BROWSER.....	30
<b>G</b>	<b>CONFIGURATION</b> .....	<b>31</b>
G.1	CONFIGURATION FILE .....	31
G.2	MONITOR CHARACTERISTICS FILE .....	35
<b>H</b>	<b>COMPILATION</b> .....	<b>36</b>
H.1	MICROSOFT WINDOWS .....	36
H.1.1	<i>Requirements</i> .....	36
H.1.2	<i>Preparations</i> .....	36
H.1.3	<i>Compilation</i> .....	37
H.2	UNIX .....	37
H.2.1	<i>Requirements</i> .....	37
H.2.2	<i>Preparations</i> .....	38
H.2.3	<i>Compilation</i> .....	38
<b>I</b>	<b>SYSTEM REQUIREMENTS</b> .....	<b>40</b>
<b>J</b>	<b>ABOUT THE PROJECT</b> .....	<b>41</b>
<b>K</b>	<b>REFERENCES</b> .....	<b>43</b>

## A Introduction

The NEMA Committee for the Advancement of DICOM and the European Congress of Radiology (ECR) hosted a demonstration of the proposed DICOM supplement 33 Grayscale Softcopy Presentation State Storage at the ECR 1999 in Vienna. After some minor corrections the supplement has been approved in September 1999 and is part of the DICOM standard since then.

For the annual meeting of the Radiology Society of North America (RSNA) 1999 in Chicago the demonstration was extended to support the DICOM Supplement 22 Presentation Look Up Table (LUT). By using this new service together with Grayscale Standard Display Function (part 14) the image appearance for both hardcopy (film) and softcopy (CRT) becomes comparable.

The purpose of supplement 33 is the consistent appearance of images across a network, particularly in order to increase the quality and efficiency of softcopy reading. This new DICOM extension enables a workstation or modality to store any grayscale and spatial transformation as well as textual and graphical annotations and render them in the same way on different workstations.

The Presentation LUT (supplement 22) translates pixel values into device and vendor independent P-values, which facilitates perceptual linearization of grayscale images as specified in the DICOM Grayscale Standard Display Function. All parameters affecting the image rendering in a DICOM printer are transmitted as part of the DICOM print protocol.

DICOMscope is a full DICOM viewer with a large number of features. It allows to process, transmit and receive DICOM studies, series, images as well as presentation states over a DICOM network. Pre-formatted grayscale images with burned-in annotations can be assembled to a print job and sent to a DICOM printer.

The application is divided into three main parts: a study browser, a viewing component to display and process DICOM images, hardcopy images and presentation states as well as a print manager. This manual describes all features of the application as demonstrated at RSNA infoRAD 1999.

For softcopy DICOMscope supports both high resolution (high resolution grayscale monitor with dedicated graphics adapter) and conventional consumer systems (color monitor with conventional VGA graphics adapter). For hardcopy it supports in principle all 8 bit and 12 bit DICOM printers since all relevant print parameters can be configured for each device individually.

## B Installation and Getting Started

DICOMscope is known to run on both MS Windows (32 bit) and some Unix platforms (e. g. Solaris, Linux). Since the Windows version has been tested more intensively we will restrict the following descriptions to this version.

*(Microsoft Windows Version)*

DICOMscope requires a Java 2 compatible system and a 32 bit version of MS Windows. Before installing the application, JRE 1.2 (or compatible) should be installed according to the setup instructions provided with the package. See <http://www.javasoft.com/> for further details.

Afterwards start the setup executable to install the DICOMscope software on your local disk. The setup application will guide you through the installation process. Do not forget to modify the configuration file according to your system configuration (see E.1).

Following a successful installation “DICOMscope 2.0” can be started from the Windows “Start” menu or directly from the “DICOMscope2” group window (fig. 1). The application will be loaded and initialized and the study browser will be displayed showing the contents of the local database.



**Figure 1: DICOMscope Group Window**

Click on the register tabs at the top to toggle between the three main components “Browser”, “Viewer” and “Print” (fig. 2). A status bar at the bottom of the main window often displays some helpful context information while using DICOMscope.

## C Browser

The “Browser” (fig. 2) lists all available images, hardcopy images and presentation states<sup>1</sup> in a hierarchically tree (grouped by studies and series). An instance can be loaded from the local database and displayed in the “Viewer”, as well as transmitted, printed, dumped or deleted by selecting the corresponding entry. In analogy complete series and studies can be transmitted or deleted in a single step. DICOM images and presentation states can also be loaded from file via a standard file open dialog.

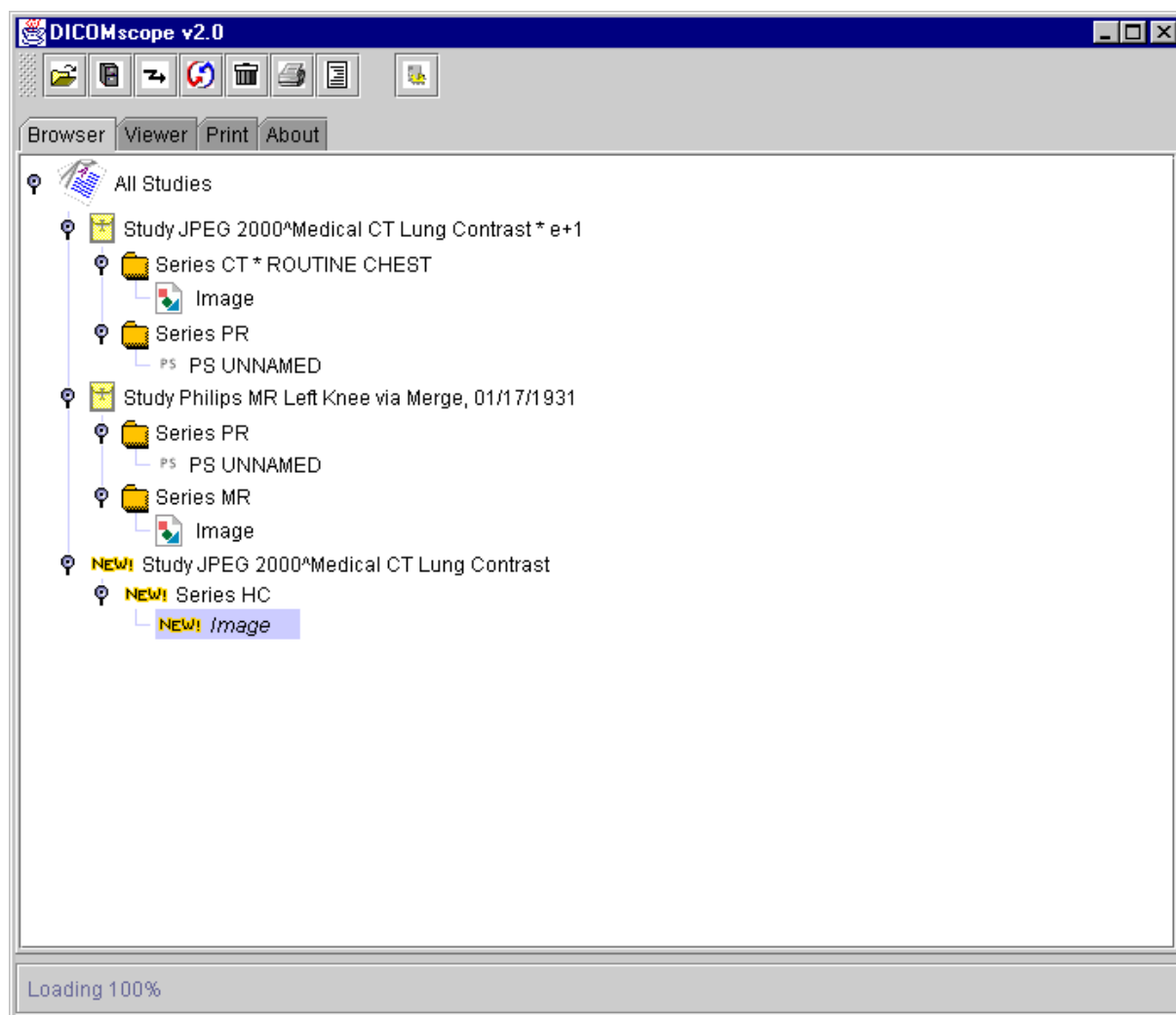


Figure 2: “Browser” Component

Initially only the studies currently available in the database are displayed in the browser. By clicking on the symbol left to the icon of a study or series the contents (series or instances) becomes visible. Doing this one can browse through the hierarchy of studies, series and instances. The top element of this tree (“All Studies”) is always visible, even if no study is available.

<sup>1</sup> In the following the term “instance” is used when talking about images, hardcopy images and presentation states.

Newly received images (transmitted via network or stored from the “Viewer”) are shown immediately in the tree; these images are marked as “new” with corresponding icons until they have been displayed for the first time.

## C.1 Toolbar

At the top of the main window there is a toolbar with a number of icons representing the main functions of the “Browser” (fig. 3). The toolbar is moveable and can be docked to all borders of the main window or transformed to a “floating” window by means of “drag’n drop” (click on the left rastered part of the toolbar, move the mouse while pressing the left mouse button and drop the toolbar at the desired position).



Figure 3: “Browser” Toolbar

The toolbar icons in the “Browser” view have the following functions. Some of them are only available if a tree item is selected, some of them are only applicable to instances.

### C.1.1 Load Image File



Loads a DICOM image or hardcopy image from file. In the “Open File” dialog a valid DICOM image file has to be chosen. After the image has been successfully loaded it will be displayed in the “Viewer”.

### C.1.2 Open



Loads the selected instance from the local database and displays it in the “Viewer”. If an image is selected and presentation states are available for this image, a list will be shown to select the desired presentation state (fig. 4). By selecting the “<default>” entry the image is displayed without any presentation state. Otherwise the selected presentation state is applied to the image and the resulting image will be displayed in the “Viewer”.

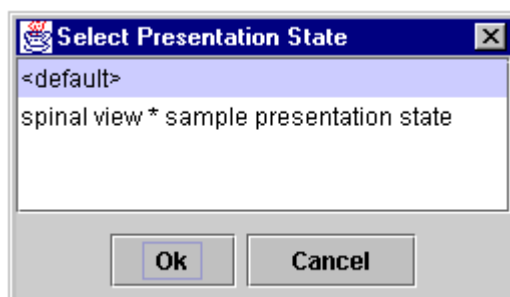


Figure 4: “Select Presentation State” Dialog

If a presentation state is selected from the “Browser” list the first referenced image is loaded (if available in the database) and the selected presentation state is applied to this image.

### C.1.3 Send



Transmits the selected study, series or instance to another workstation via network. The destination can be chosen from the displayed list (fig. 5). The available communication partners have to be added to the configuration file prior to the application start (see G.1). By pressing the “Details...” button some technical information about the selected peer is displayed.

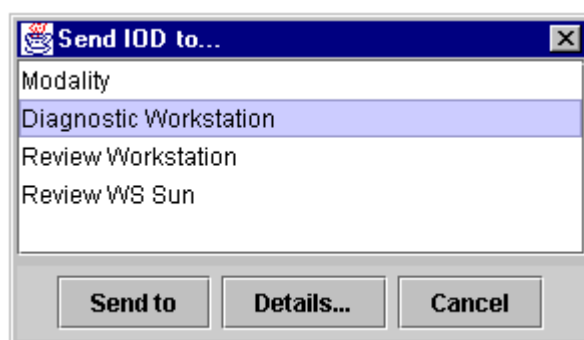


Figure 5: “Send IOD to...” Dialog

### C.1.4 Refresh



Refreshes the “Browser” list after reloading all information from the local database. This function is very useful in case the automatic refresh is not working or disabled (see G.1).

### C.1.5 Delete



Deletes the selected study, series or instance. If the top element “All Studies” is selected all studies will be deleted. For instances the DICOM file stored in the the same directory as the local database will also be deleted. Instances that are only “referenced” by the database (i. e. not stored in the database directory) are only removed from the list, the DICOM file is not deleted. A confirmation dialog is always displayed before deleting the entry.

### C.1.6 Add Hardcopy to Print



If a hardcopy image is selected this image will be added to the current print job. Hardcopy images can be created from the viewer by choosing “Add to Print” (see D1.6). The “Print” component is described in chapter E.

## C.1.7 Create Dump



Creates a dump (textual, human readable version of the file contents) for the selected instance and displays it in a separate application. This requires the installation of the Tcl/Tk package and probably some changes to the configuration file (see G.1).

The dump application supports syntax highlighting and a simple search and select function (fig. 6). Besides the explicit input of a search term a sequence of characters can also be selected by pressing the left mouse button first (while moving the mouse cursor) and then the right mouse button to start the search. A word will be selected by clicking the left mouse button twice, a whole line by pressing it three times.

```
# DICOM File Contents - database\PSg_38d1214200261e27.dcm
Find: UID Hits: 11

# Dicom-File-Format

# Dicom-Meta-Information-Header
# Used TransferSyntax: LittleEndianExplicit
(0002,0000) UL 186 # 4, 1 MetaElementGroupLength
(0002,0001) OB 00\01 # 2, 1 FileMetaInformationVersion
(0002,0002) UI =GrayscaleSoftcopyPresentationStateStorage # 28, 1 MediaStorageSOPClassUID
(0002,0003) UI [1.2.276.0.7230010.3.4.0.199.953229634.3] # 40, 1 MediaStorageSOPInstanceUID
(0002,0010) UI =LittleEndianExplicit # 20, 1 TransferSyntaxUID
(0002,0012) UI [1.2.276.0.7230010.3.0.3.4.1] # 28, 1 ImplementationClassUID
(0002,0013) SH [OFFIS_DCMTK_341] # 16, 1 ImplementationVersionName

# Dicom-Data-Set
# Used TransferSyntax: LittleEndianExplicit
(0008,0005) CS [ISO_IR 100] # 10, 1 SpecificCharacterSet
(0008,0012) DA [20000316] # 8, 1 InstanceCreationDate
(0008,0013) TM [190034] # 6, 1 InstanceCreationTime
(0008,0016) UI =GrayscaleSoftcopyPresentationStateStorage # 28, 1 SOPClassUID
(0008,0018) UI [1.2.276.0.7230010.3.4.0.199.953229634.3] # 40, 1 SOPInstanceUID
(0008,0020) DA (no value available) # 0, 0 StudyDate
(0008,0030) TM (no value available) # 0, 0 StudyTime
(0008,0050) SH (no value available) # 0, 0 AccessionNumber
(0008,0060) CS [PR] # 2, 1 Modality
(0008,0070) LO [Philips Medical Systems] # 24, 1 Manufacturer
(0008,0090) PN (no value available) # 0, 0 ReferringPhysiciansName
(0008,1115) SQ (Sequence with explicit Length #=1) # 132, 1 ReferencedSeriesSequence
  (fffe,e000) na (Item with explicit Length #=2) # 124, 1 Item
    (0008,1140) SQ (Sequence with explicit Length #=1) # 76, 1 ReferencedImageSequence
      (fffe,e000) na (Item with explicit Length #=2) # 68, 1 Item
        (0008,1150) UI =SecondaryCaptureImageStorage # 26, 1 ReferencedSOPClassUID
        (0008,1155) UI [1.3.46.670589.17.1.7.0.18] # 26, 1 ReferencedSOPInstanceUID
      (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 1 ItemDelimitationItem
      (fffe,e0dd) na (SequenceDelimitationItem for re-enc.) # 0, 1 SequenceDelimitationItem
      (0020,000e) UI [1.3.46.670589.17.1.7.2.1.18] # 28, 1 SeriesInstanceUID
    (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 1 ItemDelimitationItem
  (fffe,e0dd) na (SequenceDelimitationItem for re-enc.) # 0, 1 SequenceDelimitationItem
(0010,0010) PN [DSITEST^IMAGE QUALITY PATIENT] # 30, 1 PatientsName
(0010,0020) LO [DSITEST] # 8, 1 PatientID
(0010,0030) DA (no value available) # 0, 0 PatientsBirthDate
```

Figure 6: Dump of a DICOM File

## D Viewer

After successfully loading an image DICOMscope automatically switches to the “Viewer” (fig. 7). Of course, the view can also be changed manually by clicking one of the four component tabs.

The “Viewer” itself is divided into three parts. On the right-hand side<sup>2</sup> the “Function” panel offers the main functionality of the “Viewer” (like windowing, zooming and rotating, as well as layer, annotation, shutter and presentation state management). On the left-hand side the current image is displayed. At the top of the window there is again the toolbar with icons representing some general functions for the “Viewer”.

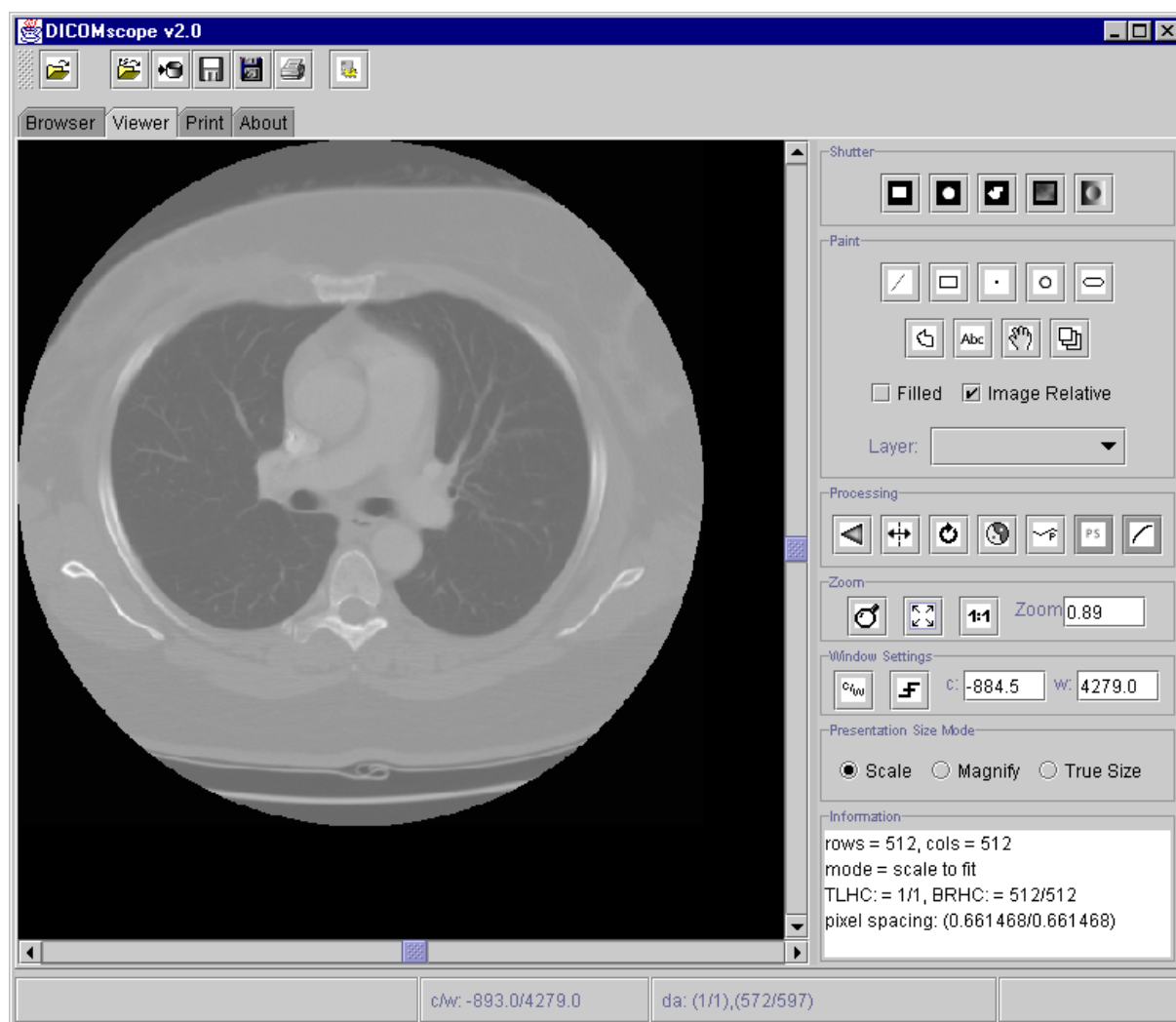


Figure 7: “Viewer” Component

<sup>2</sup> Most of the positions described in the following are not fixed but can be configured (see chapter F).

The image can be scrolled by means of the scroll bars located at the right and bottom border. The current position of the displayed area (top left-hand corner and bottom right-hand corner) is always displayed in the status bar (section “da:”).

Moving the mouse cursor while pressing the right mouse button changes the grayscale window settings. To start this interactive windowing the mouse cursor must be located inside the image area when pressing the right mouse button. The current window center and width values are always displayed in the status bar (section “c/w:”).

## D.1 Toolbar

At the top of the main window there is a toolbar with a number of icons representing some general functions of the “Viewer” (fig. 8). A detailed description on how to place the toolbar within the application window can be found in section C.1.



Figure 8: “Viewer” Toolbar

The “Viewer” toolbar icons have the following functions. Some of them are only available if an image is loaded.

### D.1.1 Load Image File



Loads a DICOM image or hardcopy image from file. In the “Open File” dialog a valid DICOM image file has to be chosen. After the image has been successfully loaded it will be displayed in the “Viewer”.

### D.1.2 Apply Presentation State File



Loads a presentation state from file. In the “Open File” dialog a valid DICOM presentation state file has to be chosen. After the presentation state has been successfully loaded it will be applied to the current image. There is no check whether the presentation state refers to the image or not.

### D.1.3 Save to Database



Stores the current presentation state in the local database. If the current image is not yet stored in the database (e. g. if the image was loaded from file) this image will also be stored.

### D.1.4 Save to File



Saves the current presentation state and image to a DICOM file. The file name (without file extension) can be chosen or entered in the “Save File” dialog. The file extension is assigned automatically: “.dcm” is added to the image file name and “.pres” to the presentation state file name. The DICOM files can be stored in little endian explicit or implicit (big endian encoding is not supported).

### D.1.5 Save Screen to File



Saves the current image (including applied presentation state) to a secondary capture DICOM file. This function works like a screen capturing program. After choosing or entering the file name (with file extension) the transfer syntax (little endian explicit or implicit) has to be chosen.

### D.1.6 Add to Print



Creates a hardcopy image, stores it in the local database and adds it to the print queue in the “Print” panel (see chapter E). The stored hardcopy image can be loaded from the “Browser” and displayed in the “Viewer” or re-added to the print queue.

There are two options to create a hardcopy image: if the answer to the question (fig. 9) is “Yes” the current displayed area is reset to the original image size, i. e. the whole image will be printed; if the answer is “No” the current displayed area (see status bar, “da:”) will be used instead.

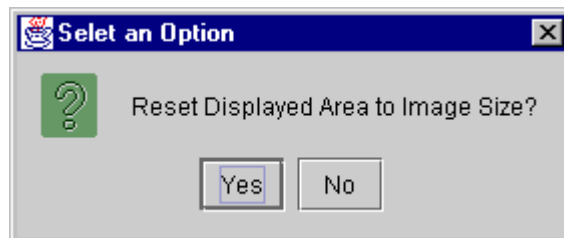


Figure 9: “Select an Option” Dialog

However, all transformations and annotations specified in the presentation state will be burned into the hardcopy image. The reason for this is that DICOM printers do not support presentation states but only pre-formatted grayscale images.

## D.2 Status Bar

The status bar (fig.10) at the bottom of the main window is divided into four sections. The first section contains some context dependent information to the user (e. g. what to do next with the mouse), the second section contains the current values for window center / width and the third one contains the coordinates of the current displayed area. The last section is not used in this release.



Figure 10: "Status Bar" Panel

## D.3 Shutter

The purpose of display shutters is to hide unwanted parts of an image (e. g. unexposed parts of X-ray images). The DICOM standard defines graphical shutters and bitmapped shutters (fig. 11) which are mutually exclusive. Graphical shutters have the shape rectangular, circular or polygonal. Each type of shutter may appear only once in a presentation state but the three graphical types can be combined to create a more complex shutter shape.

Bitmapped shutters can not be created but displayed by the current release of the software. If more than one bitmapped shutter is available in a presentation state one (or none) of them has to be selected for display.



Figure 11: "Shutter" Panel

### D.3.1 Rectangular Shutter



Rectangular shutters are created by specifying the top left-hand (TLHC) and bottom right-hand corner (BRHC) of the visible region. To do this press the left mouse button at the TLHC, move the mouse cursor to the BRHC (without pressing the mouse button) and press the left mouse button again to confirm the size. The order of specifying TLHC and BRHC is not significant.

The presence of a rectangular shutter is indicated by a dark gray background of the corresponding icon. By clicking the icon again the shutter will be removed.

### D.3.2 Circular Shutter



Circular shutters are created by specifying the center and the radius of the visible region. To do this press the left mouse button at the center, move the mouse cursor

to specify the radius (without pressing the mouse button) and press the left mouse button again to confirm the size.

The presence of a circular shutter is indicated by a dark gray background of the corresponding icon. By clicking the icon again the shutter will be removed.

### D.3.3 Polygonal Shutter



Polygonal shutters are created by specifying the vertices of the visible region. To do this press the left mouse button at the starting point, move the mouse cursor to the next position (without pressing the mouse button), press the left button again to confirm the position, and so on. The polygon can be closed by choosing the corresponding entry from the context menu (press right mouse button to display this menu).

The presence of a polygonal shutter is indicated by a dark gray background of the corresponding icon. By clicking the icon again the shutter will be removed.

### D.3.4 Bitmapped Shutter



The current release of this application does not support creating bitmapped shutters. However, bitmapped shutters stored in a presentation state can be activated as well as overlay planes having an appropriate size (i. e. same as image).

The presence of a polygonal shutter is indicated by a dark gray background of the corresponding icon. By clicking the icon again the shutter will be removed.

### D.3.5 Shutter Color



The color used to replace those parts of the image occluded by the shutter can be changed in this dialog. All values between 0.0 (black) and 1.0 (white) are valid.

## D.4 Layers

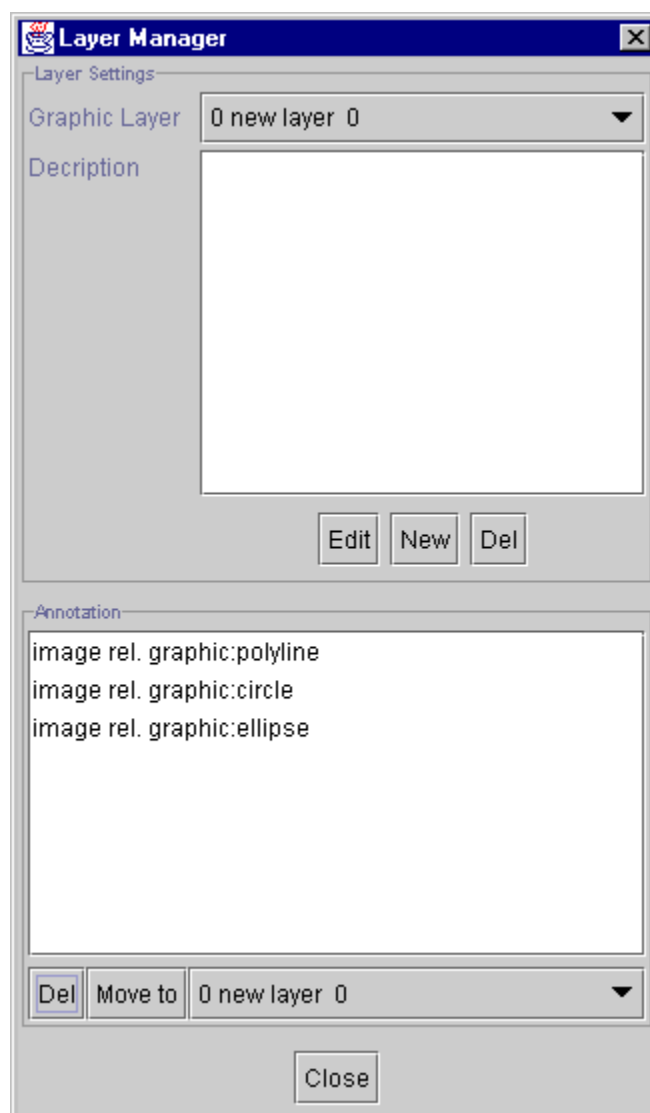
Layers group together annotations which are related. Each annotation has to be assigned to exactly one layer and is displayed in the color associated with this particular layer.



The “Layer Manager” (fig. 12) allows to add, delete and modify layers as well as to delete or move annotations to another layer.

The current layer can be changed by means of the combobox “Graphic Layer”. The associated layer description and the annotations defined in this layer are displayed in the boxes below.

The layer “deactivate” is used to store overlay planes which have been deleted (directly or by deleting the associated layer). This allows to restore overlay planes (by moving the annotation from this special layer to another layer) .

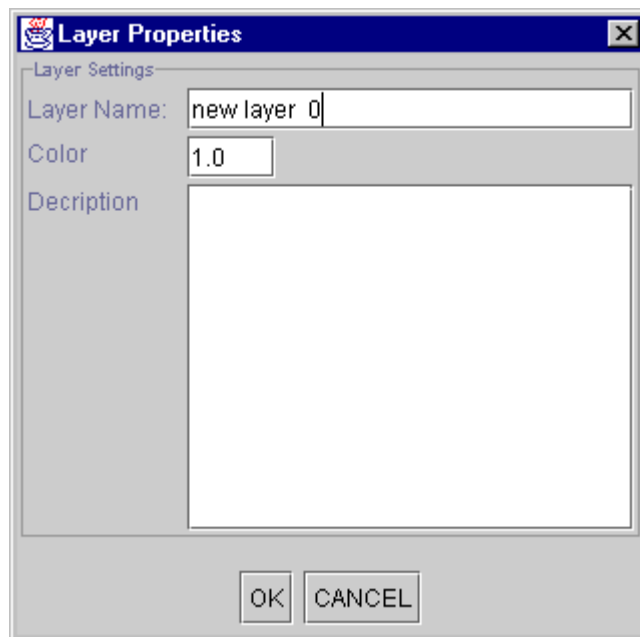


**Figure 12: “Layer Manager” Dialog**

#### **D.4.1 Create a Layer**

The “New” button in the “Layer Manager” creates a new layer with the specified name, color and description (fig. 13). “Color” is a value between 0.0 (black) and 1.0 (white). RGB colors are not supported yet by this application.

A layer will be created automatically (after confirming the corresponding dialog) for the first annotation if necessary.



**Figure 13: “Layer Properties” Dialog**

### **D.4.2 Modify a Layer**

The properties (name, color and description) of the current layer can be modified by pressing the “Edit” button (fig. 12 and 13).

### **D.4.3 Delete a Layer**

The current layer can be deleted by pressing the “Del” button. All annotations associated with this layer will also be deleted without any warning. Overlay planes will be moved to the layer “deactivate” (see D.4).

## **D.5 Annotations**

There are two types of annotations which can be created by the application and stored in a presentation state: graphical and textual annotations.

A new annotation is always associated with the current layer which can be changed in the „Paint“ panel (fig.14) or in the „Layer Manager“ (see D.4). The color assigned to this layer is used to draw the annotation.

Annotations can be displayed “image relative” (coordinates are related to the underlying image) or to “display relative” (coordinates are related to the displayed area). All annotation can be modified (moved, made image relative or display relative, etc.) after they have been created. For some types of annotations the modifications are limited (e. g. a rectangle can not be resized).

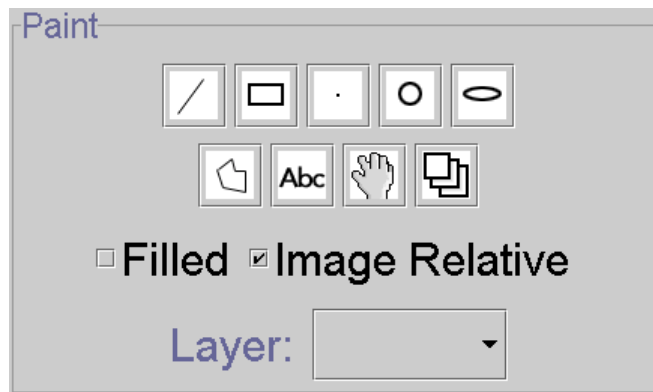


Figure 14: “Paint” Panel

## D.5.1 Create a Graphical Annotation

The DICOM standard only defines five types of graphical annotations: point, polyline, interpolated, circle and ellipse. However, DICOMscope offers some additional types (line and rectangle) which are mapped to the standard types to facilitate the use of the application.

New graphical annotations are created according to the checkbox “filled” and “image relative” in the “Paint” panel.

### D.5.1.1 Create a Line



To create a line two points have to be specified. Press the left mouse button for the first point, move the mouse cursor (without pressing the mouse button) and press the button again for the second point.

The line is stored in the presentation state as a polyline with two points.

### D.5.1.2 Create a Rectangle



To create a rectangle the top left-hand corner (TLHC) and the bottom right-hand corner (BRHC) have to be specified. Press the left mouse button at the TLHC, move the mouse cursor (without pressing the mouse button) and press the left mouse button again at the BRHC to confirm the size. The order of specifying TLHC and BRHC is not significant.

The rectangle is stored in the presentation state as a polyline with four points.

### D.5.1.3 Create a Point



To create a point press the left mouse button at the desired position in the image.

#### D.5.1.4 Create a Circle



To create a circle the center and the radius have to be specified. Press the left mouse button at the center, move the mouse cursor (without pressing the mouse button) to specify the radius and press the left mouse button again to confirm the size of the circle.

#### D.5.1.5 Create an Ellipse



To create an ellipse the corners of the surrounding rectangle have to be specified. Press the left mouse button at the top left-hand corner, move the mouse cursor (without pressing the mouse button) and press the left mouse button again to specify the bottom right-hand corner.

#### D.5.1.6 Create a Polyline



To create a polyline the vertices have to be specified. Press the left mouse button at the starting point, move the mouse cursor to the next position (without pressing the mouse button), press the left button again to confirm the position, and so on. The polyline can be closed by choosing the corresponding entry from the context menu (press right mouse button to display this menu). Open polylines can be created by choosing the “stop” entry from the context menu. Note that only closed polylines can be filled.

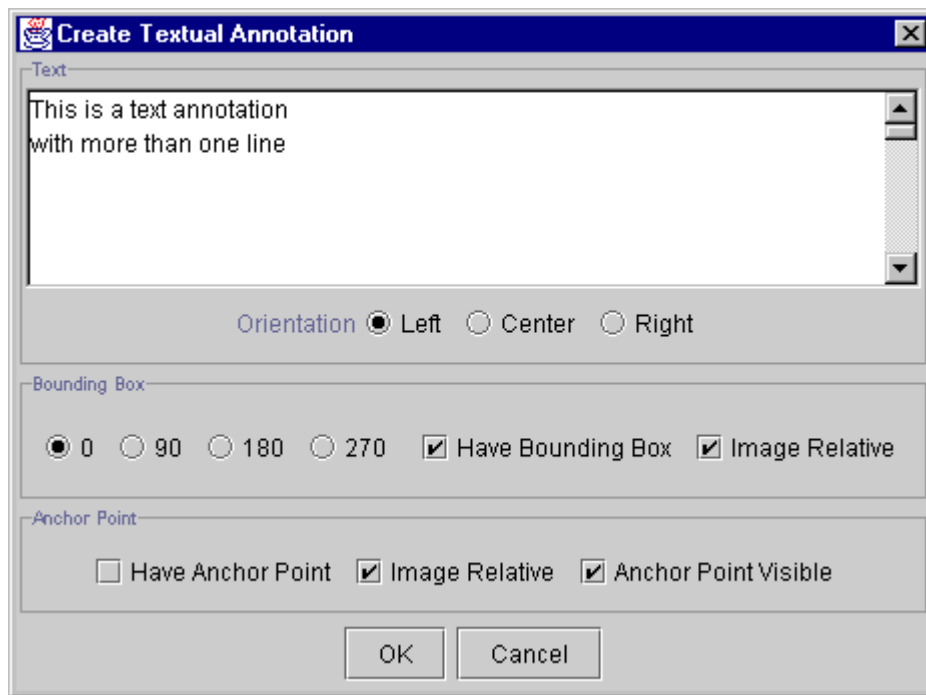
### D.5.2 Create a Textual Annotation

The DICOM standard defines a variety of options regarding textual annotations: bounding box and/or anchor point, support for multiple lines of text, horizontal text justification, etc. The font type/name and size are not defined in the DICOM standard. These properties are implementation dependent and can be configured (see G.1).

Please note that international character sets are not supported by the current release of the software.



Pressing the icon shown on the left side a dialog for creating a new textual annotation (fig. 15) will appear. Type in the text and set the options you want. Start a new line by pressing Enter/Return. The “orientation” option is used to horizontally justify text of multiple lines.



**Figure 15: “Create Textual Annotation” Dialog**

When the option “have bounding box” is activated the rotation of the text (in steps of 90 degrees) can be specified as well as whether the annotation should be displayed “image relative” or “display relative” (see D.5).

An anchor point refers to a specified point in the image. In this implementation a line is drawn from the annotation to the point if the anchor point is made “visible”. This point can also be specified “image relative” or “display relative” – independent from the bounding box. A good example for this is a display relative bounding box (e. g. in a corner of the image) with an image relative anchor point referring to a region of interest (ROI). When scrolling or zooming the image the textual annotation remains in the corner while the anchor point is moving with the image.

After setting all options the dialog is closed by pressing the “OK” button and the textual annotation can be placed in the image.

## **D.5.3 Modify an Annotation**



The properties of an annotation can be still modified after it has been created. By pressing the icon shown on the left side the “Edit” mode is activated. This is indicated by a “hand” cursor when moving the mouse cursor over the image.

Select the annotation to be modified first (by pressing the left mouse button) and then press the right mouse button to display a context menu. All annotations can be deleted and moved.

### **D.5.3.1 Modify a Graphical Annotation**

For graphical annotations the additional options „filled“ and „image relative“ are available. If the option „image relative“ is switched off the annotation is drawn „display relative“.

### D.5.3.2 Modify a Textual Annotation

For textual annotations a number of modifications are available. The text can be edited, the orientation of the bounding box can be changed, etc. (fig. 16). Furthermore, an anchor point can be moved, removed, added or made visible.

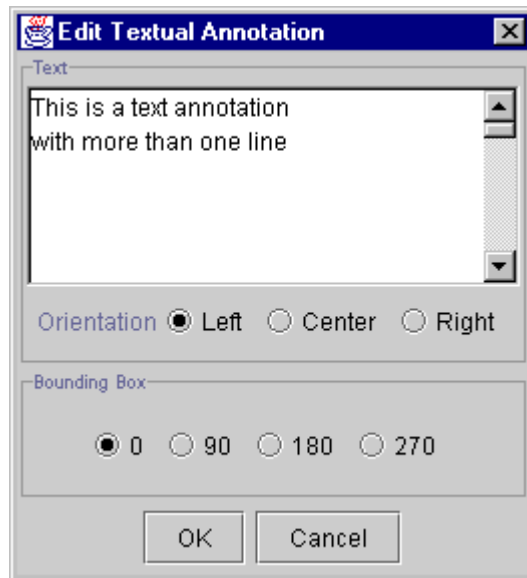


Figure 16: “Edit Textual Annotation” Dialog

### D.5.4 Delete an Annotation

There are two ways to delete an annotation. The first one has been described in the section “Modify an Annotation” (D.5.3). The second one is available via the “Layer Manager” (fig. 12, see D.4). Select the layer in which the annotation resides first. Then select the annotation itself and press the “Del” button.

### D.5.5 Move an Annotation to another Layer

An annotation is always bound to a specific layer which specifies the order and color in which the annotations are drawn. To move an annotation to another layer the annotation has to be selected in the “Layer Manager” (fig. 12, see D.4). Then the layer to which it should be moved has to be selected in the combobox next to the “move to” button and finally the button has to be pressed.

## D.6 Image Processing Functions

A number of image processing functions are available in the “Processing” panel (fig.17).



Figure 17: “Processing” Panel

### D.6.1 Reset



Resets the current presentation state to its last saved state. All changes since then will be lost.

### D.6.2 Flip the Image



Flips the image horizontally. The current flip status is indicated by the background color of the icon. Mid gray means off, dark gray on.

### D.6.3 Rotate the Image



Rotates the image by steps of 90 degree. The current rotation is indicated by the arrow in the icon.

### D.6.4 Invert the Image



Inverts all grayscale values of the image. If the background color of the icon is dark gray the image is inverted.

### D.6.5 Apply Presentation LUT



A predefined presentation LUT (for configuration see G.1) can be chosen to be applied to the image. If the background color of the icon is dark gray a presentation LUT currently selected.

## D.6.6 Apply Correction Curve



Applies a correction curve to the image. Two correction curves are provided: the Grayscale Standard Display Function (GSDF) defined in the DICOM standard and additionally the CIELAB curve. If the background color of the icon is dark gray one of the two correction curves is applied to the image.

A monitor characteristics file is required to perform the correction (see G.2). This function is not available on high resolution systems (see G.1).

## D.6.7 Toggle Presentation State on/off



Switches the presentation state on or off. If the background color of the icon is dark gray the presentation state is activated.

## D.7 Zooming

The “Zoom” panel (fig. 18) provides a number of functions to zoom the image. The current zoom factor is always indicated in the text box on the right. The zoom factor can be entered directly into the text box or changed by using one of the following functions. The aspect ratio of the image is always maintained.

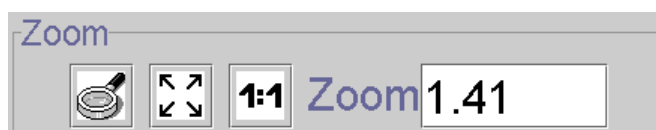


Figure 18: “Zoom” Panel

### D.7.1 Select an Area



The image can be magnified by selecting a rectangular area. The zoomed image usually does not exactly match with the selected area since the aspect ratio of the image is preserved. However, the selected area is always contained in the zoomed image.

### D.7.2 Fit Image



Zooms the image to fit in the display.

### D.7.3 Zoom Image 1:1



The image is displayed with a zoom factor of 1. Each pixel value in the image is displayed as one pixel on the display (“1:1”).

## D.8 Window Settings

Images or presentation states may contain VOI LUTs, VOI windows, both or none of them. Per default the first VOI LUT will be selected. If there is no VOI LUT the first VOI window is selected if existing. Otherwise no windowing is performed on the image, i. e. the full range of pixel values is displayed on the screen.

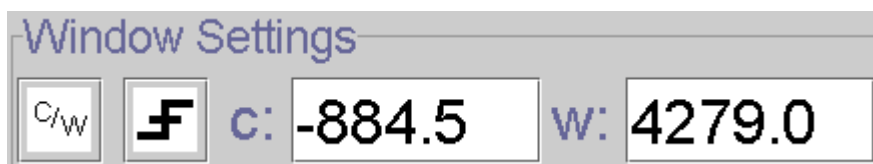


Figure 19: “Window Settings” Panel

If no VOI LUT is selected the window center and width can be modified by a number of ways. First, the values can be entered directly into the text boxes “c:” and “w:” in the “Window Settings” panel (fig. 19). Second, the window can be specified interactively by moving the mouse cursor over the image while pressing the right mouse button.

### D.8.1 Interactive Windowing on Preview Image



Especially on high resolution monitors the interactive windowing on the whole image might be too slow. Therefore, the windowing can be performed on a small preview image. The “Apply” button applies the current window settings to the whole image. “OK” does the same but also closes the “Preview Window” (fig. 20). Choosing “Cancel” aborts without changing the window center and width values of the original image.

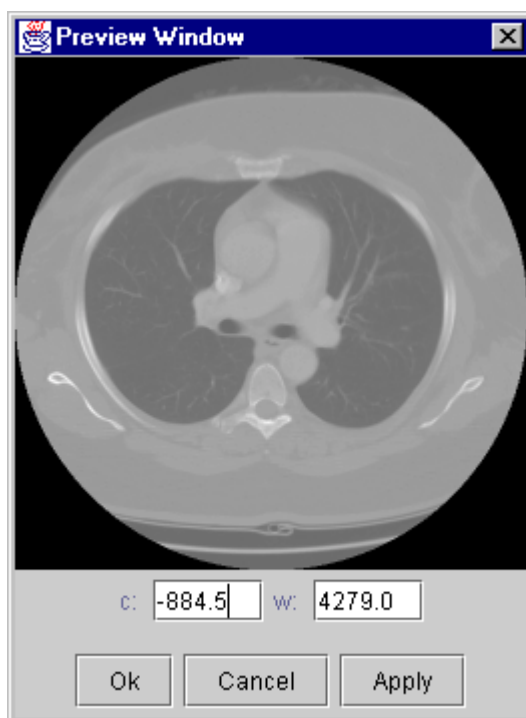


Figure 20: “Preview Window” Dialog

## D.8.2 Select Presets / VOI LUT



Modality specific presets (see G.1), stored VOI windows or LUTs can be selected from this context menu. Furthermore, two automatically computed window settings can be chosen which are always available: “min - max” sets window center and width according to the minimum and maximum pixel value actually existing in the image; “max range” sets the values according to the full pixel range (e. g. for 12 bit signed images to  $c / w = 0 / 4096$ ).

## D.9 Presentation Size Mode

The “Presentation Size Mode” panel shows and allows to change the presentation size mode of the current image. According to the DICOM standard three different presentation size modes are available:

- **Scale to fit:** The specified displayed area shall be displayed as large as possible within the available area on the window, i. e. magnified or minified if necessary to fit the window space available.  
NB: Changing the presentation size mode to „Scale to fit“ will not change the image on the display. This mode is only useful for transferring presentation states to another workstation where the available space to display the image might be different.
- **Magnify:** In this mode the factor that shall be used to spatially interpolate image pixels to create pixels on the display is defined.  
NB: Changing the presentation size mode to „Magnify“ will not change the image on the display. This mode is only useful for transferring presentation states to another workstation where the available space to display the image might be different.
- **True Size:** The physical size of the rendered image pixels shall be the same on the screen as specified in the DICOM image or presentation state.  
To use this mode the physical size of the screen (i. e. the active area used for display) has to be defined in the configuration file (see G.1) or in the “Options” dialog (see F.2) and the pixel spacing attribute has to be stored in the DICOM file.

## D.10 Presentation State Name

The “Presentation State” panel shows and allows to modify the “Name” and the “Creator” of the current presentation state (fig. 21). It is important to enter at least a meaningful name (description) since this field is used to decide which presentation state should be applied to an image when loaded from the browser (see C1.2, fig. 4).

Figure 21: “Presentation State” Panel

## D.11 Information Panel

The „Information” panel (fig. 22) shows additional information about the loaded presentation state and image, such as resolution of the image, presentation size mode, displayed area and pixel spacing.

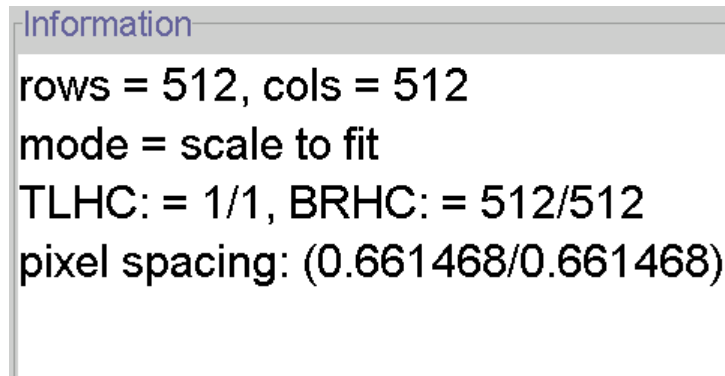


Figure 22: “Information” Panel

## E Print

The “Print” component (fig. 23) is used to manage all print related tasks. Hardcopy images added from the browser or the viewer are collected here in a queue before sent to a printer.

The “Print” component is divided into two parts. On the left-hand side there is a preview of the last page in the print queue. New images are added to the end of the queue. Each black box represents an image, each gray box indicates a free position.

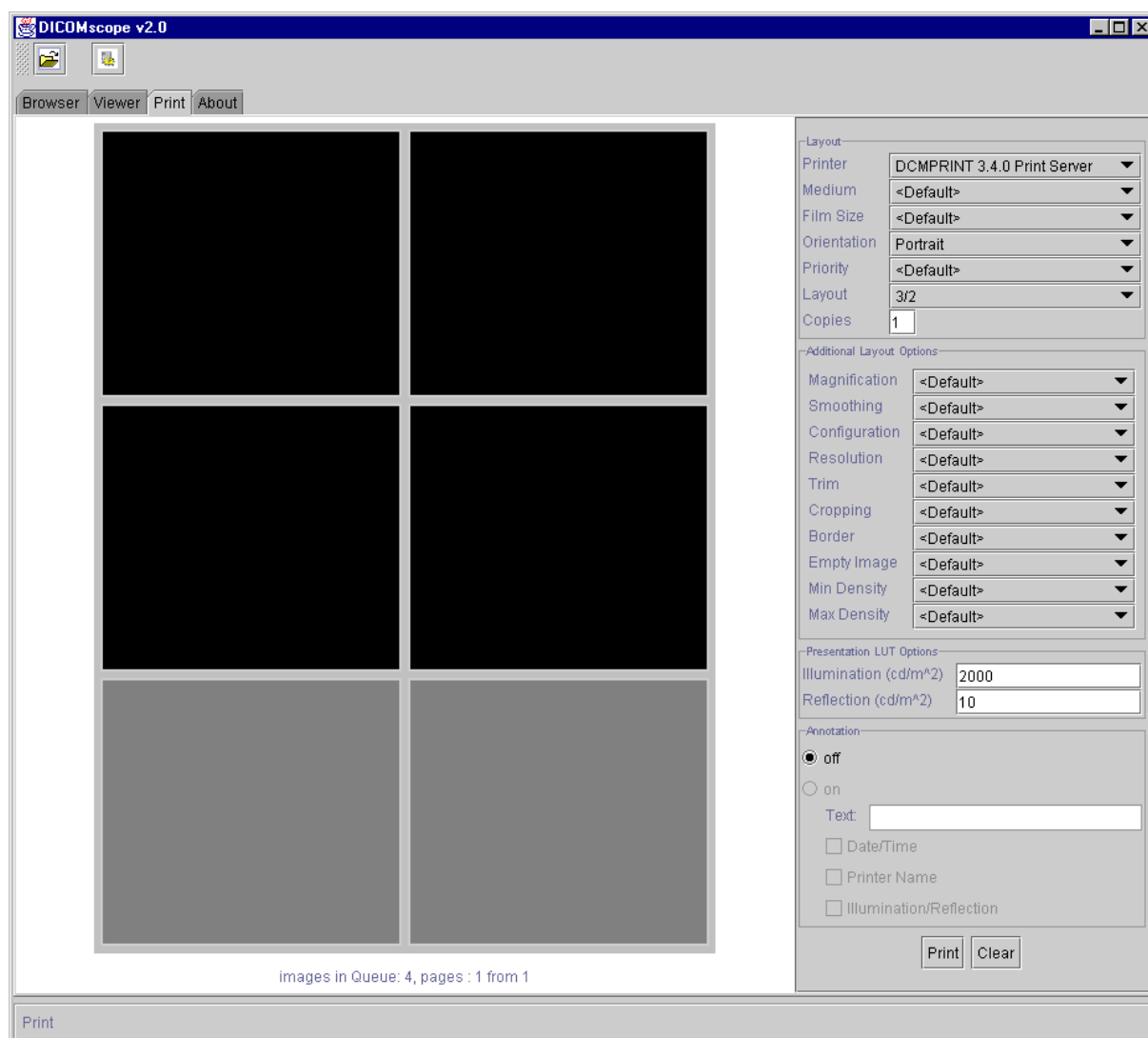


Figure 23: “Print” Component

On the right-hand side there is a number of options which are described in the following table. Most of them are printer dependent and can be configured (see G.1). “<Default>” means that no value is sent to the printer.

By pressing the “Print” button the last page of the print queue will be send to the current printer using the currently selected options. By pressing the “Clear” button the current print queue will be cleared.

Printer	All available printers are listed here. The last page of the print queue will be sent to the currently selected printer when pressing the “Print” button.
Medium	Medium Type identifiers supported by the current printer. Possible values are: ”PAPER”, “CLEAR FILM”, etc.
Film Size	Film Size ID identifiers supported by the current printer. Possible values are: “14INx14IN“, “17INx14IN“, etc.
Orientation	Orientation of the film/paper. The following values are available: “PORTRAIT”, “LANDSCAPE” and “<Default>”.
Priority	Priority used by the printer to handle the print job. The following values are available: “HIGH”, “MED”, “LOW”.
Layout	Layout of the current print page. Defined for portrait orientation. Possible values are: “1/1”, “1/2”, etc.
Copies	Number of copies to be printed .
Magnification	Magnification Type identifies supported by the current printer. Possible values are: “REPLICATE”, “BILINEAR”, “CUBIC”, etc.
Smoothing	Smoothing Type identifies supported by the current printer.
Configuration	Configuration Information that can be sent to the current printer.
Resolution	Resolution identifies supported by the current printer. Possible values are: “STANDARD”, “HIGH”, etc.
Trim	If the current printer supports the Trim attribute then this attribute can be enabled or disabled.
Cropping	If the current printer supports the Cropping attribute then this attribute can be enabled or disabled.
Border	Border Density identifiers supported by the current printer. Possible values are: “BLACK”, “WHITE”, etc.
Empty Image	Empty Image Density identifiers supported by the current printer. Possible values are: “BLACK”, “WHITE”, etc.
Min Density	Min Density values supported by the current printer. Possible values are: “330”, “290”, etc.
Max Density	Max Density values supported by the current printer. Possible values are “20”, “40”, etc.
Illumination	Illumination to be transmitted to the printer when using the Presentation LUT SOP Class.
Reflection	Reflected Ambient Light to be transmitted to the printer when using the Presentation LUT SOP Class.
Annotation	Annotations added to the print out if supported by the current printer. Add the current date / time, the printer name and the Illumination / Reflection value by activating the corresponding checkboxes. Additionally a free text can be entered. NB: There is a limitation of the total length of such annotations for most printers.

The attributes “Magnification”, “Smoothing” and “Configuration” can also be changed for each image by double-clicking the corresponding black image box in the preview.

## F Options



This icon is always available in the toolbar. By pressing this button a dialog appears which allows to modify a number of application specific options which are divided into three groups.

### F.1 General

In this register page (fig. 24) the general “Look and Feel” and the placement of the main “Tabbed” panel (with the registers “Browser”, “Viewer”, “Print” and “About”) can be modified.



Figure 24: “Options” Dialog – “General”

## F.2 Viewer

In this register page (fig. 25) the placement of the “Function” panel in the “Viewer” can be changed. The “Image Processing” and the “Presentation State” panel can be switched on and off. Furthermore, the position of the “Paint” panel can be chosen, integrated into the “Function” panel or into the “Toolbar” or disabled.

The “Ambient Light” value (measured in  $\text{cd/m}^2$ ) used for the correction curve (see D.5.6) can be modified here. The default value is taken from the monitor characteristics file (see G.2).

Finally, the physical size of a pixel as displayed on the screen can be defined. These values are used to display an image in the “True Size” mode. The default value is computed from the figures defined in the configuration file (see G.1).

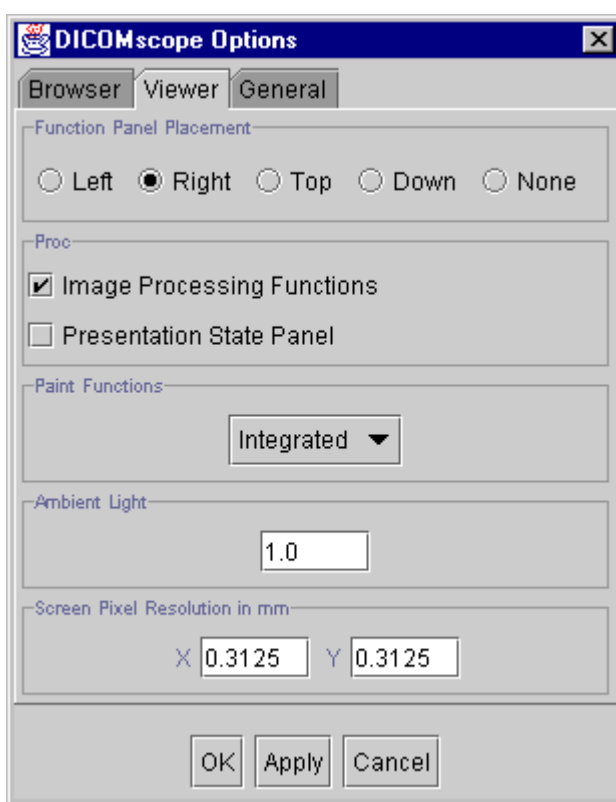


Figure 25: “Options” Dialog – “Viewer”

## F.3 Browser

In the upper part of this register page (fig. 26) a number of attributes shown in the “Browser” list can be switched on and off. This allows to specify how many and which details are to be displayed:

- Pat.Info: Toggles patient information on/off (on study layer)
- Modality: Toggles modality on/off (on series layer)
- Date&Time: Toggles date and time on/off (on study and series layer)
- Descr.: Toggles description (on study / instance layer) on/off
- New items: Shows new/received studies, series and images with a “new” icon
- UID: Toggles UID on/off (all layers)
- Filename: Toggles the filename on/off (on instance layer)
- Label: Toggles the label on/off (on instance layer)

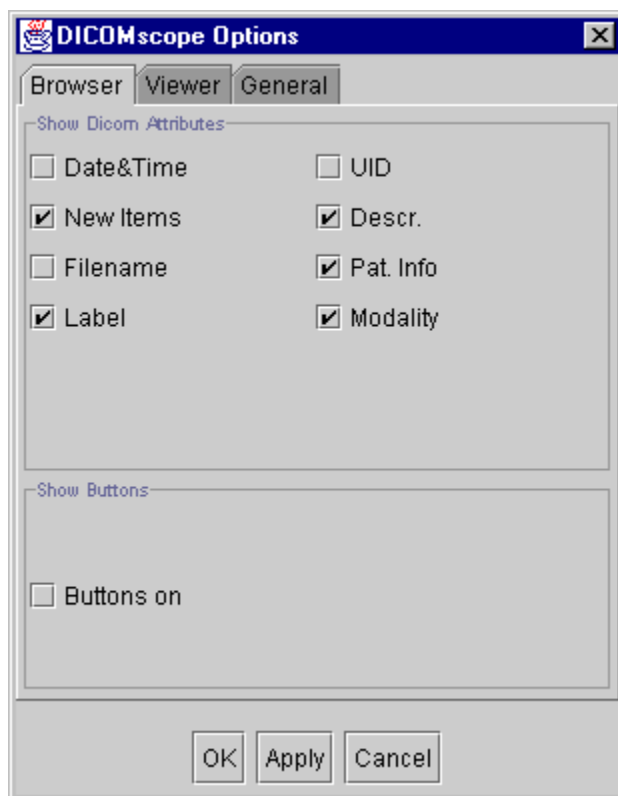


Figure 26: “Options” Dialog – “Browser”

Furthermore, a panel with some buttons having the same functionality as the toolbar can be switched on and off. This feature is a remnant from the first release of this application.

# G Configuration

## G.1 Configuration File

All information DICOMscope needs to run proper on different systems and in different environments is stored in a single configuration file (`DICOMscope.cfg`). This text file is read only once during the application start-up process, i. e. if you have modified anything to application need to be restarted.

The configuration file consists of a number of entries which have the form

```
keyword = value
```

It is important that the keyword begins in the first column of a newline. Keywords are not case sensitive, but values are. Entries in the configuration file are grouped in a section, which is identified by a keyword in square brackets:

```
[section]
```

Multiple sections are grouped into a main section, which is identified by a keyword in double square brackets:

```
[[main_section]]
```

The first part of the configuration file for DICOMscope is identified by the main section heading `[[GENERAL]]`. This part defines the settings of the local system, e. g. database directory and local network characteristics. The following table describes the defined sections and entries:

Section	Keyword	Value	Description
Monitor	Characteristics	filename	Name of the monitor characteristics file. If omitted, no grayscale correction according to DICOM Part 14 (GSDF) or CIELAB is performed on consumer systems. See G.2 for further details on this file.
	Resolution	width\height	Screen resolution in pixels. Used for the “true size” presentation size mode.
	ScreenSize	width\height	Size of the visible screen area in mm. Used for the “true size” presentation size mode.
	PreviewSize	width\height	Size of the preview window in pixels. Used for the interactive windowing.
Print	Spooler	executable	Path to the DICOM print spooler (Print Management SCU) application to be used.
	Directory	directory	Directory in which spooled print jobs reside.
	LogDirectory	directory	Directory in which log files are stored. Default: same as spool directory.
	DetailedLog	true or false	Log complete DICOM protocol (--dump --verbose) in print spooler. Default: false.
	Sleep	double word	Time (in seconds) the print spooler should wait before polling (again) the spool directory. Default: use spooler default.

	MinPrintResolution	width\height	Minimum resolution for a print bitmap (in pixels). If bitmap to be printed is smaller, it is scaled to 200% before burning in graphical annotations. This allows to have acceptable annotation visibility on low resolution bitmaps. Default: No minimum resolution.
	MaxPrintResolution	width\height	Maximum resolution for a print bitmap (in pixels). If bitmap to be printed is smaller, it is scaled to 200% before burning in graphical annotations. This allows to have acceptable annotation visibility on low resolution bitmaps. Default: No minimum resolution.
	DefaultIllumination	0..65535	Specifies the default value for the Illumination (in cd/m <sup>2</sup> ) to be transmitted to the printer when using the Presentation LUT SOP Class. Default: 2000.
	DefaultReflection	0..65535	Specifies the default value for the Reflected Ambient Light (in cd/m <sup>2</sup> ) to be transmitted to the printer when using the Presentation LUT SOP Class. Default: 10.
	DeletePrintJobs	true or false	Delete print job files from spool directory after processing. If false, spool jobs are renamed instead. Default: false.
	AlwaysDelete TerminateJobs	true or false	Always delete terminate job files from spool directory (these special print job files are created to inform the spool processes that the application has been terminated). If false, terminate jobs are handled like normal print jobs (see DeletePrintJobs). Default: false.
Database	Directory	directory	Directory in which the image database resides.
	Dump	executable	Path to the dump tool used to display the contents of DICOM files located in the database.
LUT	Directory	directory	Directory in which presentation LUT files reside.
Network	Sender	executable	Path to the DICOM sender (Store SCU) application to be used. Should never be changed.
	Receiver	executable	Path to the DICOM receiver (Store SCP) application to be used. Should never be changed.
	Port	1..65535	IP Port number on which the receiver listens for new connections. On Unix platforms, the receiver must be started with setuid root if port numbers < 1024 (i. e. the standard DICOM port number 104) should be used.
	MaxPDU	8192..65536	Maximum PDU (protocol data unit) size to use when negotiating incoming connections. Default: 16384.
	AETitle	string	Application entity title with which both sender and receiver will identify themselves. Max 16 uppercase characters.
	ImplicitOnly	true or false	Only negotiate Implicit VR Little Endian transfer syntax on incoming connections. This is useful only for some old and buggy DICOM Store SCUs (i. e. modalities).
	DisableNewVRs	true or false	Do not create data types (VRs) that were defined in post-1993 editions of the DICOM standard when converting implicit VR network data to explicit VR files.
	BitPreservingMode	true or false	Receive data in “bit preserving mode”. In this mode, data is stored to file directly as read from network. Transfer syntax in file is identical to transfer syntax used for network transmission. If this mode is switched off (default), images are converted to explicit VR Little Endian format before storing in file, which makes it easier to burn images on CD-R in “General Purpose Image Exchange Profile” format.
GUI	HighResolution Graphics	true or false	If this setting is true, we assume a system with very high resolution (2x2.5K) and a graphics board that performs calibration according to the DICOM GSDF in hardware. Therefore, we display much larger icons and disable rendering of the GSDF in software. This setting requires that a static 256 grayscale color palette is used by the operating system to access the graphics board.

AutoUpdateStudy Browser	true or false	Starts the update thread for the study browser. Defaults: true.
BackgroundColor	0..255/0..255/ 0..255	Sets the background color of the study manager as RGB color.
FontSize	int	Sets the size of the fonts used in all GUI components.
FontName	string	Sets the name of the fonts used in all GUI components.
FontSizeText	int	Sets the size of the fonts used for textual annotations.
FontNameText	string	Sets the name of the fonts used for textual annotations.
TabPlacement	„North“, „South“, „East“, „West“.	Sets the placement of the main tab in the GUI.
FunctionPanel Placement	„North“, „South“, „East“, „West“, „None“	Sets the placement of the function panel in the viewer.
PaintPanelPlacement	„North“, „South“, „East“, „West“, „None“, „Toolbar“, „Integrated“	Sets the placement of the paint function panel in the viewer.
PSPanelOn	true or false	Checks if the presentation state information panel should be visible.

The second part of the configuration file for DICOMscope is identified by the main section heading [ [COMMUNICATION] ]. This part defines the communication partners to which DICOM images and presentation states can be sent or printed to. For each communication partner, one section needs to be defined (i. e. [PEER\_1] .) The section heading is arbitrary but must be unique within the configuration file. It may only contain uppercase characters, numbers and underscore characters. The following table describes the entries for each communication partner:

Keyword	Value	Description
Hostname	string	Hostname, IP number or domain name in conventional TCP/IP notation.
Type	printer or storage	Service type. Keywords in italics are only applicable to printers. Default: storage.
Description	string	Description of the communication partner. Used in the GUI to present the send targets to the application user.
Port	1..65535	IP port number under which the communication partner receives DICOM associations
MaxPDU	8192..65536	Maximum receive PDU (protocol data unit) size to use. Must be between 8192 and 65536. Default: 16384.
AETitle	string	Application entity title of the communication partner (in DICOM lingo: Called application entity title). Max 16 uppercase characters.
ImplicitOnly	true or false	Only negotiate Implicit VR Little Endian transfer syntax. This is useful only for some old and buggy DICOM Store SCPs.
<i>DisableNewVRs</i>	true or false	Do not create data types (VRs) that were defined in post-1993 editions of the DICOM standard when converting implicit VR files to explicit VR network transmission. Maybe necessary for old DICOM Store SCPs.
<i>Supports12Bit</i>	true or false	Printer supports 12-bit transmission of image data, 8-bit otherwise. Default: true.
<i>Supports PresentationLUT</i>	true or false	Printer supports Presentation LUT SOP Class (Supplement 22). Default: false.
<i>PresentationLUT inFilmSession</i>	true or false	Referenced Presentation LUT, Illumination and Reflected Ambient Light are either set in the Basic Film Session (if this flag is true) or in the Basic Film Box (if flag is false, conforms with DICOM CP 173). Default: false.

<i>PresentationLUT MatchRequired</i>	true or false	Printer requires that a Presentation LUT matches the characteristics of the transmitted image data, i. e. for 8-bit image transfer 256 LUT entries and for 12-bit image transfer 4096 LUT entries. Default: true.
<i>PresentationLUT PreferSCP Rendering</i>	true or false	If the printer supports 12-bit image transmission and the film is to be printed with a Presentation LUT that could be rendered either in the print client or in the printer, prefer rendering in the printer. Default: false.
<i>SupportsImage Size</i>	true or false	Printer supports optional “Requested Image Size” attribute in Basic Grayscale Image Box. Default: false.
<i>SupportsDecimate Crop</i>	true or false	Printer supports optional “Requested Decimate/Crop Behaviour” attribute (Supplement 37) in Basic Grayscale Image Box. Default: false.
<i>SupportsTrim</i>	true or false	Printer supports optional “Trim” attribute in Basic Film Box. Default: false.
<i>DisplayFormat</i>	int,int\...	Image Display Format: supported STANDARD\C,R column,row combinations for Portrait orientation. Landscape image display formats are derived automatically by exchanging column and row for each format. MANDATORY ENTRY, NO DEFAULT.
<i>FilmSizeID</i>	string\...	Film Size ID identifiers supported by the printer for the Basic Film Box. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify film size ID, use printer default.
<i>MediumType</i>	string\...	Medium Type identifiers supported by the printer for the Basic Film Session. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify medium type, use printer default.
<i>ResolutionID</i>	string\...	Requested Resolution ID identifiers supported by the printer for the Basic Film Box (optional attribute defined in Supplement 37). Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify resolution ID, use printer default.
<i>Magnification Type</i>	string\...	Magnification Type identifiers supported by the printer for the Basic Film Box or Image Box. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify magnification type, use printer default.
<i>SmoothingType</i>	string\...	Smoothing Type identifiers supported by the printer for the Basic Film Box or Image Box. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify magnification type, use printer default.
<i>BorderDensity</i>	string\...	Border Density identifiers supported by the printer for the Basic Film Box. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify border density, use printer default.
<i>EmptyImage Density</i>	string\...	Empty Image Density identifiers supported by the printer for the Basic Film Box. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify empty image density, use printer default.
<i>MaxDensity</i>	string\...	Max Density values supported by the printer for the Basic Film Box. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify max density, use printer default.
<i>MinDensity</i>	string\...	Min Density values supported by the printer for the Basic Film Box. Multiple values can be specified, must be separated by ‘\’ characters. Default: don’t specify min density, use printer default.
<i>Annotation</i>	0..65535\string	If the printer supports the optional Basic Annotation Box SOP Class, we can select the position and layout for the single annotation that is supported in the GUI. Two values must be specified: First the Annotation Position, then the Annotation Display Format ID, separated by ‘\’. Default: don’t use Basic Annotation Box.
<i>SessionLabel Annotation</i>	true or false	Some printers use the Film Session Label as a replacement for annotations. If this flag is switched on (set to true), any annotation defined in the user interface is replicated in the Film Session Label. Default: false.
<i>Configuration_N</i>	string	Configuration Information that can be sent to the printer for the Basic Film Box or Image Box. Only a single value per entry can be specified (VR=ST). Keywords are “Configuration_1”, “Configuration_2”, etc., without leading zeroes. Default: don’t use configuration information.

The third part of the configuration file is identified by the main section heading [ [LUT] ]. This part defines the presentation look-up tables (LUT) which can be used from the DICOMscope application. For each LUT, one section needs to be defined (i. e. [LUT\_1] ).

The section heading is arbitrary but must be unique within the configuration file. It may only contain uppercase characters, numbers and underscore characters. The following table describes the entries for each LUT:

Keyword	Value	Description
Description	string	Description of the LUT. Used in the GUI to present the selectable LUTs to the application user.
Filename	filename	Filename of the LUT file, should reside in LUT directory (see above).

The fourth part of the configuration file is identified by the main section heading `[[VOI]]`. This part defines the window level/width presets which can be used from the DICOMscope application. For each VOI (value of interest) preset, one section needs to be defined (i. e. `[VOI_1]`.) The section heading is arbitrary but must be unique within the configuration file. It may only contain uppercase characters, numbers and underscore characters. The following table describes the entries for VOI preset:

Keyword	Value	Description
Description	string	Description of the preset. Used in the GUI to present the selectable VOIs.
Modality	string	Modality to which this preset applies. Must be one of the DICOM defined terms for element (0008,0060) Modality, see PS3.3 C.7.3.1.1.1 in DICOM standard.
Center	float	Value for window center.
Width	float	Value for window width.

## G.2 Monitor Characteristics File

To perform the GSDF/CIELAB transform you need a text file describing the characteristic curve of your display device (monitor). This file can be created automatically by using a calibration tool like VeriLUM (from IMAGE Smiths) and converting its output to a more common format which can be read by DICOMscope<sup>3</sup>. You can also try to adapt the sample file (`monitor.lut`) which is part of this distribution manually by editing the luminance values for each DDL (device driving level).

---

<sup>3</sup> This conversion can be done by the console application `dconvlum` from the DCMTK (see `dcmtool/dcmimgle/docs/dconvlum.txt` for further details).

# H Compilation

This section describes how to build DICOMscope from the source code. This might be of interest to users who wish to modify the application to fit their needs. We recommend that you install a binary distribution of DICOMscope first to see which files are expected in which subdirectory.

## H.1 Microsoft Windows

### H.1.1 Requirements

DICOMscope for Windows requires a 32 bit version of Microsoft Windows. It has been tested successfully with Windows 95, 98, NT 4.0 and Windows 2000 Professional. Other versions might also work.

Please note that the full compilation of the source code requires typically more than 100 MB of disk space. Further requirements for running the software are mentioned in chapter I.

#### H.1.1.1 Tools

The following tools are required in order to compile the DICOMscope source code:

- Tool to unzip the source code (e. g. WinZIP, available from <http://www.winzip.com/>)
- C++ Compiler with support for C++ templates: tested successfully with MS Visual C++ 5.0 and 6.0
- Java Development Kit (JDK) 1.2 or newer, available from <http://java.sun.com/jdk/>
- Tcl/Tk is not required for compiling the application, but it is required if you want to use the “Create Dump” function. It is available from <http://dev.scriptics.com/software/tcltk/>

#### H.1.1.2 Sources

The following source code packages have to be downloaded:

- dcmtool 3.4.1: <ftp://dicom.offis.uni-oldenburg.de/pub/dicom/offis/software/dcmtool341.zip>
- dsgui 2.0: <http://www.microtherapy.de/e/imt/fi/medinf/download/dsgui20.zip>

### H.1.2 Preparations

- Install WinZIP, JDK and Tcl/Tk if necessary.
- Unpack the dsgui (Java) source code package to your local drive and make sure that the stored directory structure is restored correctly.
- Unpack the dcmtool (C/C++) source code package to the directory dsgui20 extracted from the tkgui archive and make also sure that the stored directory structure is restored.

## H.1.3 Compilation

### H.1.3.1 C++ Code

When using a Microsoft Visual C++ (MSVC 5.0 and above) compiler the existing project files can be used to compile the C/C++ part of the source code.

- Open the workspace file `dcmTk.dsw` (stored in the `dcmTk` sub directory) and compile all sub projects as “release” or “debug” versions. To save time and disk space it would be sufficient to compile the following (required) sub projects only: `dcmdata`, `dcmdump`, `dcmimgle`, `dcmnet`, `dcmprtsv`, `dcmpsrcv`, `dcmpssnd`, `dcmpstat`, `imagectn` and `ofstd`.
- Open the workspace file `jInterface.dsw` (stored in the `interface\C++\jInterface` sub directory) and compile the project as “release” or “debug” version (this requires the corresponding compiled version of the `dcmTk`). The project file refers to the include directory of the installed JDK package. It might be necessary to adjust ...
- After a successful compilation the DLL (Dynamic Link Library) and the command line tools should be copied to the DICOMscope application folder by starting the `copy_bin.bat` batch file from the main directory. This only works for the “release” version but the same result can be achieved by copying the files manually.

If not using a Microsoft Visual C++ compiler you have to create the project make files for your own. Be sure to compile all C/C++ modules in multi-threaded mode. At least the Microsoft compilers have problems when mixing multi-threaded and single-threaded code or single-threaded C/C++ code with Java.

### H.1.3.2 Java Code

Open a command prompt window, change the directory to `tkgui` and type

```
javac -d ../DICOMscope DICOMscope.java
```

If the `bin` directory of the JDK is not part of your search path you have to use the explicit path to the Java compiler (e. g. `jdk1.2\bin\javac` ...).

Change the directory to `DICOMscope` and type

```
java DICOMscope
```

to start the application or use the explicit path to `java` if necessary. Do not forget to adjust the configuration file before starting the application for the first time (see G.1).

## H.2 Unix

### H.2.1 Requirements

#### H.2.1.1 Tools

- A reasonably modern C++ Compiler with support for C++ templates. GNU `gcc` 2.95 and `egcs` 1.1.2 are known to work. Earlier releases of GNU `gcc` are likely not to work. We have also successfully compiled with the Sun Workshop Compilers 4.x for Solaris.

- Tar and gzip (gzip, gunzip or zcat):
  - Tar should be available on all modern Unix installations.
  - Gzip is available from most GNU mirror sites, e. g. <ftp://prep.ai.mit.edu/pub/gnu/gzip>
- Tool to unzip the Java source code (e. g. Info-ZIP from <http://www.cdrom.com/pub/infozip/>)
- Java Development Kit (JDK) 1.2 or newer, available from <http://java.sun.com/jdk/>
- Tcl/Tk is not required for compiling the application, but it is required if you want to use the “Create Dump” function. It is available from <http://dev.scriptics.com/software/tcltk/>

### H.2.1.2 Sources

- dcmtdk 3.4.1: <ftp://dicom.offis.uni-oldenburg.de/pub/dicom/offis/software/dcmtdk341.tar.gz>
- dsgui 2.0: <http://www.microtherapy.de/e/imt/fi/medinf/download/dsgui20.zip>

## H.2.2 Preparations

- Install infozip, gzip, JDK and Tcl/Tk if necessary.
- Unpack the dsgui20.zip package.
- Unpack the dcmtdk341.tar.gz package to the dsgui20 directory, e. g. by typing
 

```
zcat dcmtdk341.tar.gz | tar xvf -
```
- You might need to consult the manual pages for tar and gzip (or zcat) if this does not work.

## H.2.3 Compilation

### H.2.3.1 C++ Code

- *Important:* Read the compilation instructions for the DCMTK package (filename: INSTALL).
- Run “rootconf” and “configure” according to the compilation instructions. If you don’t want the DCMTK tools to be installed in /usr/local/dicom, remember to use the --prefix option for configure.
- *Before* compiling the toolkit, edit the file config/Makefile.def. Add the compiler flags required for multi-thread support and position independent code to the CXXFLAGS variable. For GNU gcc on most platforms, this means adding -D\_REENTRANT -fPIC. For the Sun Workshop Compilers on Solaris, add -D\_REENTRANT -PIC. We also recommend that you switch on the optimizer, e. g. -O2 for GNU gcc or -fast for the Sun Workshop Compilers.
- Compile and install the DCMTK package according to the installation instructions. It is important that at least the DCMTK data dictionary file “dicom.dic” is installed in the default location (if you prefer to have the data dictionary built-in into the applications, read the DCMTK FAQ which is included in the package on how to achieve that).
- Copy all C++ class (“.cpp”) files and header files (“.h”) from the DSGUI package into the dcmtdkstat/jni subdirectory of DCMTK. You will need to rename the file extension to “.cc” for all class files.
- Edit dcmtdkstat/jni/Makefile. Adjust the following settings:

- `javainc` must point to the include directories for your Java JDK installation, e. g. `javainc=-I/usr/java1.2/include -I/usr/java1.2/include/solaris`
- `soflags` must contain the compiler flag telling the compiler to produce a shared object instead of a standard executable. For GNU gcc, this is `-shared`, for the Sun Workshop Compilers it is `-G`.
- `solibs` may optionally contain additional libraries that must be linked to the shared object. For GNU gcc, this is normally not required. For the Sun Workshop Compilers, use `-lC`.
- Build the shared object `libjInterface.so` by running “make” in the `dcmpstat/jni` directory.
- Copy the required binaries into the DICOMscope installation directory. `libjInterface.so` is located in `dcmpstat/jni`, the tools `dcmpsrv`, `dcmpsdmp.tcl`, `dcmpsrv` and `dcmpssnd` are located in `dcmpstat/apps`. The tool `dcmdump` is located in `dcmdata/apps`.
- *Warning:* the database index file used by DICOMscope has a different format on different operating systems and *must not* be copied e. g. from the Windows version into a Linux or Solaris installation. See the documentation for the “dbregimg” tool in DCMTK’s `imagectn/docs` directory on how to rebuild an index file.

### H.2.3.2 Java Code

Follow the compilation instructions for compiling the Java code on Windows (see H.1.3.2).

# I System Requirements

*(Microsoft Windows Version)*

## **Consumer System:**

- PC with Pentium 200 MHz (Pentium II, 266 MHz recommended)
- Microsoft Windows (32 bit), tested with Windows 95, 98, NT 4.0 and 2000 Professional
- Java 2 Runtime Environment (also known as JRE 1.2) / Sun Microsystems
- 64 MB memory (128 MB recommended)
- VGA graphics adapter with true color support (1024×768 pixel recommended)
- Mouse recommended
- TCP/IP network recommended

## **High Resolution System:**

- PC with Pentium II, 333 MHz or above
- Microsoft Windows (32 bit), tested with Windows 95, 98, NT 4.0 and 2000 Professional
- Java 2 Runtime Environment (also known as JRE 1.2) / Sun Microsystems
- 256 MB memory
- High resolution grayscale monitor with dedicated graphics adapter (tested with Siemens/Dome and Barco/Metheus)
- Mouse recommended
- TCP/IP network recommended

## **Disk Space:**

- 21 MB for Java Runtime Environment
- 5 MB for DICOMscope (minimum, without images and tools)

## J About the Project

The project team for the implementation consists of:

OTech Inc.: Main contractor and project management  
Kuratorium OFFIS e.V.: Implementation of the DICOM toolkit software  
Institute for Microtherapy; University of Witten/Herdecke: Graphical User Interface

This software is available in the public domain at:

<http://www.microtherapy.de/go/dicomscope/>  
<http://www.offis.de/projekte/dicom/>

The DICOM standard is available at:

<http://medical.nema.org/dicom.html>

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- NEMA – National Electrical Manufacturers Association
- ECR – European Congress of Radiology
- RSNA – Radiological Society of North America

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- Agfa-Gevaert N.V.
- Aycan Digitalsysteme GmbH
- Barco Display System Inc. / Metheus
- Cedara Software Corporation
- CEMAX-ICON, A Kodak Company
- Clinton Electronics Corporation
- Compaq Computer Corporation
- DOME imaging systems Inc.
- Eastman Kodak Company
- GE Medical Systems
- Gossen Foto und Lichtmesstechnik
- IMAGE Smiths Inc.
- Imation Enterprises Corporation
- ISG technologies
- Merge Technologies Inc.
- Philips Medical Systems
- Quintiles Intelligent Images
- Siemens AG / Siemens Display Technologies
- Sun Microsystems Inc.

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TX 76227 (USA)  
<http://www.otechimg.com/>



## K References

A number of documents on the new DICOM extensions and the experiences gained from the two demonstrations have been published by the project team so far:

German language:

- Sandra von Gehlen, Jörg Riesmeier, Marco Eichelberg, Peter Jensch: *Einführung in neue DICOM-Serviceklassen – Teil: Presentation States*, in: 3. DICOM-Anwendertreffen und Workshop, Mainz, 1999.
- Marco Eichelberg, Jörg Riesmeier, Peter Jensch: *Standardisierte Darstellung medizinischer Bilder mit DICOM Softcopy Presentation States*, in: Sechster interdisziplinärer Workshop KIS/RIS/PACS, Schloß Rauischholzhausen, 1999.
- Marco Eichelberg, Jörg Riesmeier: *Ein Meilenstein auf dem Weg zum "filmlosen" Krankenhaus*, in: OFFIS Datawork 17, Dez. 1999.
- Marco Eichelberg, Jörg Riesmeier, Klaus Kleber, Jörg Holstein, Dietrich H. W. Grönemeyer, Peter Jensch: *DICOM Presentation States – ein neuer Dienst für die digitale Bildverteilung und Softcopy-Befundung*, in: Bildverarbeitung für die Medizin 2000: Algorithmen - Systeme - Anwendungen; Proceedings BVM 2000; Alexander Horsch, Thomas Lehmann (Hrsg.); Informatik aktuell, Springer, Seite 223-227 (2000), ISBN 3-540-67123-4.
- Marco Eichelberg: *Ein neuer Dienst für die filmlose Befundung*, in: OFFIS Jahresbericht 1999.
- Jörg Riesmeier: *Vergleichbare Darstellung medizinischer Bilder auf Monitor und Film*, in: OFFIS Jahresbericht 1999.
- Jörg Riesmeier, Marco Eichelberg, Klaus Kleber, Dietrich H. W. Grönemeyer, Peter Jensch: *Einheitliche Darstellung medizinischer Bilder auf unterschiedlichen Ausgabe-geräten*, in: Telemedizinführer 2001 (to appear)

English language:

- Marco Eichelberg, Jörg Riesmeier, Peter Jensch: *Grayscale Softcopy Presentation States – a new DICOM Service for Documenting Image Appearance in a Softcopy Environment*, in: Proceedings EMBEC '99, Vol. 37 Suppl. 2, pp. 1544-1545 (1999)
- Jörg Riesmeier, Marco Eichelberg, Peter Jensch: *Quality control for softcopy environments using standardized display functions*, in: Proceedings EMBEC '99, Vol. 37 Suppl. 2, pp. 1546-1547 (1999)
- Marco Eichelberg, Jörg Riesmeier, Klaus Kleber, Jörg Holstein, Herman Oosterwijk, Peter Jensch: *Consistency of Softcopy and Hardcopy: Preliminary Experiences with the new DICOM Extensions for Image Display*, in: Proceedings SPIE 2000 (to appear)
- Marco Eichelberg, Jörg Riesmeier, Klaus Kleber, Jörg Holstein, Herman Oosterwijk, Dietrich H. W. Grönemeyer, Peter Jensch: *Softcopy display consistency by means of the DICOM Grayscale Standard Display Function*, in: Proceedings ECR 2000 (to appear)
- Marco Eichelberg, Jörg Riesmeier, Klaus Kleber, Herman Oosterwijk, Dietrich H. W. Grönemeyer, Peter Jensch: *A Prototype Implementation of the new DICOM Services for Softcopy and Hardcopy Display Consistency*, in: Proceedings CARS 2000 (to appear)
- Marco Eichelberg, Jörg Riesmeier, Klaus Kleber, Dietrich H. W. Grönemeyer, Herman Oosterwijk, Peter Jensch: *New DICOM Extensions for Softcopy and Hardcopy Display Consistency*, in: Proceedings MIE 2000 (to appear)