Opposing Fields Help Documentation

Release 3.1.1

AC Chamberlain

June 28, 2016

Contents:

CHAPTER

ONE

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CHAPTER

TWO

INTRODUCTION

The Opposing Fields program allows the easy calculation of simple radiotherapy treatment plans. Despite its name, it cannot only do opposing parallel fields, but can also calculate plans for single fields as well. For each type of field it can do isocentric treatment, fixed SSD treatment (SSD = 100 cm), and also variable SSD treatments. The Opposing Fields program owes its simplicity to the fact that it uses central axis point calculations in contrast to more complicated three-dimensional treatment planners, which calculate a matrix of dose points. This places some limitations on the use of the Opposing Fields program, but it is not meant to replace the more expensive three-dimensional treatment planners but instead to serve as supplement or as a check against these more complex programs. Opposing Fields should not be used where there is a high degree of tissue inhomogeneity, uneven surfaces or radiosensitive structures. The Opposing Fields program in effect assumes that the patient is a uniform homogeneous tissue equivalent rectangle.

This manual assumes that you are familiar with using Microsoft Windows. If you are not then please consult the Windows Manual, or work through the on- line tour which you will find in the 'Help' option on the 'Start' menu. While a thorough knowledge of Windows is not needed to use the Opposing Fields program, it will certainly be an advantage.

CHAPTER

THREE

CONVENTIONS IN THIS MANUAL

Various typefaces and punctuation symbols are used to indicate actions that the user must perform. Here is a list of these actions and their meanings.

- Words in a courier font indicate letters that must be typed in on the keyboard. These will usually be data that should be typed into a field.
- Words between single quotes, e.g. 'Start', usually indicate the name of a menu option, field or button.
- Words between angular brackets, e.g. <Enter>, indicate a key that should be pressed. A combination of keys is indicated by a dash '-', for example <Alt-F> means you should press the <Alt> key and the <F> key together. Keys following each other are indicated by a comma ',', for example <Alt-F,S> means that you should press the <Alt> key together with the <F> key, release them and then press the <S> key.
- An icon like this  indicates important information about which you should be aware.

It should be mentioned here that when this manual uses the word 'field' it is referring to a place in the program window where data is entered and not a radiation treatment field unless it is specifically stated.

CHAPTER

FOUR

SYSTEM REQUIREMENTS

The Opposing Fields program can run on any machine that can run Windows XP or higher. Thus, the program can be run with 512 MB of RAM. The program needs approximately 5 MB of disk space to install. For ease of use we recommend that you do not use a system smaller than a Pentium 6 1 GHz with 1 GB of RAM. A 15" monitor or larger is not essential but will make viewing easier. Opposing Fields is best viewed at a resolution of 1024x768, but can be viewed at resolutions down to 600x680. To store patient files we recommend that you have at least 100 MB of disk space free. Versions for Linux and Windows 64 bit are available.

CHAPTER

FIVE

INSTALLATION

Installing the Opposing Fields Program is simple, but if you are concerned that you cannot do it ask your System Administrator or Physicist to do it for you.

5.1 Uninstalling previous versions

It is no longer necessary to uninstall previous versions of OPF before installing a new version. The installation utility will backup existing data files and install new files. However, to be safe please save your own copy of your data files. If, for any reason, you still want to uninstall the program please follow the instructions below:

5.1.1 Under Windows

In Windows open the 'Control Panel' from the main menu, double click 'Programs and Features', (previously known as 'Add Programs') and click on the 'OPF' entry. Select 'Uninstall' or 'Remove'. When OPF has been removed close 'Programs and Features' and close the 'Control Panel'

5.1.2 Under Linux

Delete the files in the installation directory. If you have any desktop shortcuts or menu links delete those as well.

5.2 Installing a new version under Windows

Insert your media contain the installation files. Using Windows Explorer navigate to the drive that you inserted. Select the folder containing the files for your site. Double click on the 'setup' program and follow the on screen instructions. It is best to simply accept the default installation values. Verify that you are installing the correct version for your site.

5.3 Installing a new version under Linux

Insert the media containing the installation files and mount it. Copy the tar file to the directory where you want to install it. Extract it to this directory. Make sure that the executable has execute permissions.

CHAPTER

SIX

RUNNING THE OPPOSING FIELDS PROGRAM

Select ‘Start’, ‘Programs’, ‘Opposing Fields’ on the start menu. Alternatively, double click the Opposing Fields icon  on the Windows desktop. A window should appear containing the screen of the Opposing Fields program.

CHAPTER

SEVEN

GETTING STARTED (A TUTORIAL)

Run the Opposing Fields program as described in If you are successful, the Opposing Fields program will appear on the screen with all the fields greyed out as shown in Figure 1.

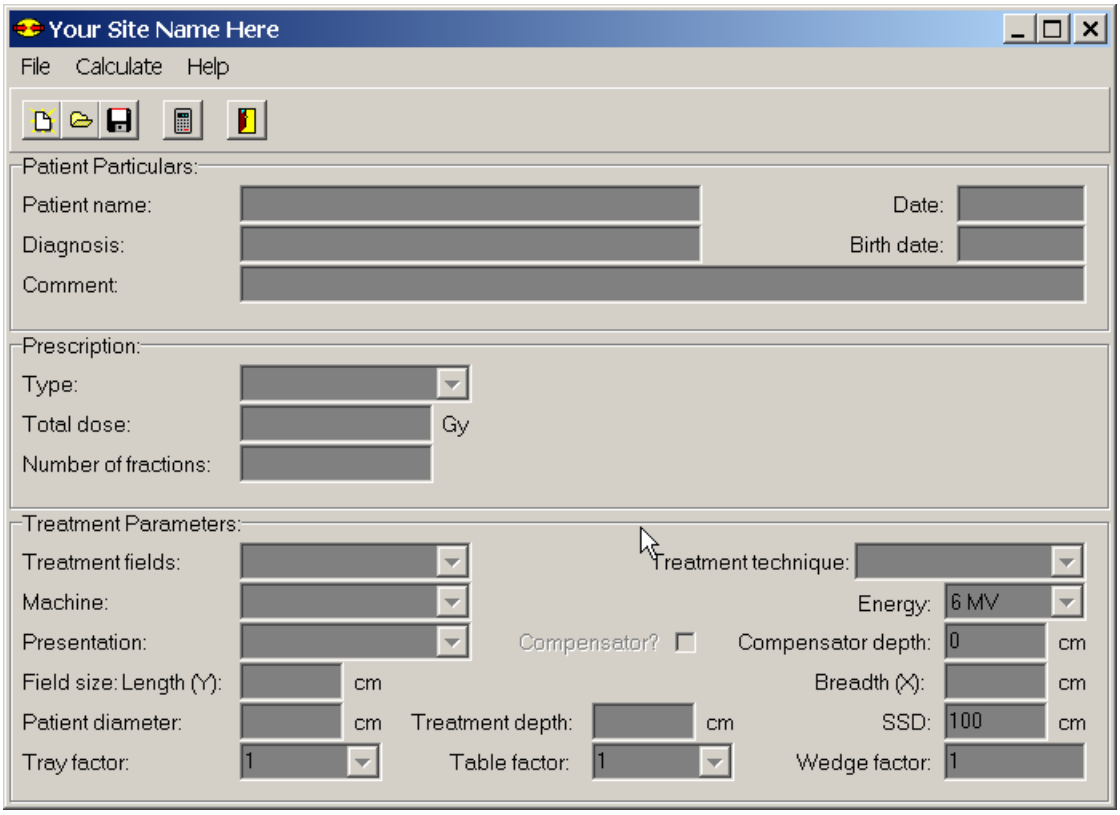

Figure 1: The Opposing fields program.

Take some time to look at the window containing the Opposing Fields program. You will see that there are a number of different sections. We will not go into these sections in detail now, but will discuss them later on. For the time being, select 'File' on the menu bar and click on 'New' to create a new patient. The grey fields will now become white as illustrated by Figure 2

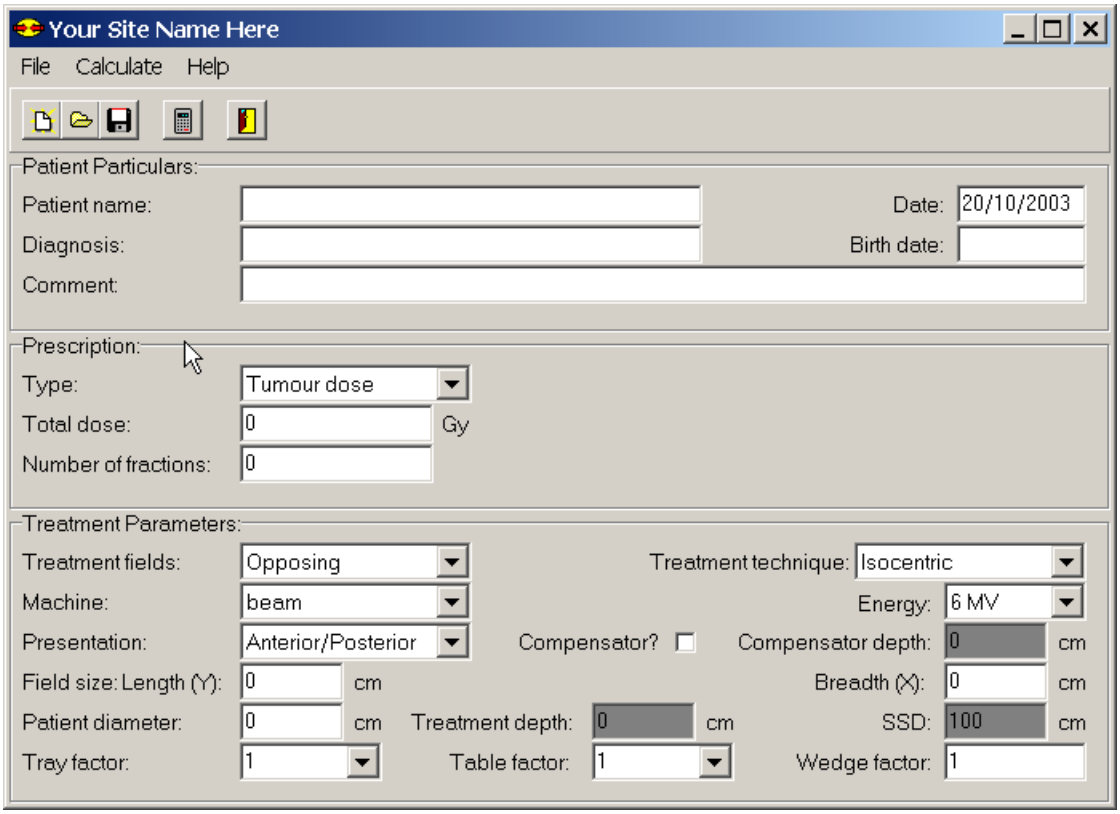

Figure 2: A new patient.

Various fields must now be filled in with the details of the treatment plan. Some fields require values and others do not but for the purposes of this tutorial we will fill them all in. Select the 'Patient name' field by clicking on the white box next to the label, 'Patient name:'. The cursor should now appear in the box and you should be able to type in it. Type the name `Joe Soap`. Now press the <Tab> key to move you into the next field, which will be the 'Date' field. Type today's date in this field. You may type the date in any format you like. When you have typed in the date, press the <Tab> key once more to bring you to the next field, which will be the 'Diagnosis' field. For the diagnosis, type `CA Prostate`. Press <Tab> to bring you to the birth date field and type `2/4/72`. Press <Tab> and then type in the comment, `This is a test`.

You have now completed the 'Patient Particulars' section. Press <Tab> again to bring you into the 'Prescription' section. You will see that the next field, the 'Dose type' field becomes highlighted in blue. This is the type of dose that you want to prescribe. You can either choose 'Tumour dose', or 'Maximum dose'. To choose click on the little down arrow next to the field and a list will be displayed allowing you to select which dose type you require. Click on this arrow and practice moving between tumour dose and maximum dose. For the purposes of this demonstration we will remain with tumour dose. Press <Tab> again to take you to the next field. This is the total dose that must be prescribed. Enter in `30` for this field and press <Tab> again. Enter in `10` for the number of fractions, and press <Tab> to bring you into the 'Treatment Parameters' section.

Here again we have a selection field. We are going to do an Opposing Fields treatment, so it is not necessary to click on the down arrow to select it; it is already there. So we can just press <Tab> to move onto the next field which is the 'Treatment Technique' field. We are going to do an isocentric treatment, so again we don't need to select an alternate option, so press <Tab> to bring you onto the 'Machine' field. Normally your accelerator will be the default machine so press <Tab> to go to the 'Energy' field. In the 'Energy' field we want to select the 6 MV photons so click on the down arrow with the mouse and select 6 MV. This now sets the energy selection to the low-energy photons. Press <Tab> to bring you to the 'Presentation' field. As our treatment is going to be anterior and posterior we don't need to make any selection. Press <Tab> again to move to 'Field Size'. You must now define the Y field size or length. We will make it a 15 x 20 field. Type `15` in the Y field and press tab to move to the X or breadth and then type in `20`.

Press <Tab> again to bring you to the 'Patient Diameter' field. Type in `25` for the patient diameter.

You will notice that the next two fields are grey. This means that you cannot enter data into them. They only become available when certain options have been selected. Press <Tab> again and the cursor will jump the 'Treatment Depth' field and the 'SSD' field and you will go to the 'Normalisation' field. Note however, that the values in the Treatment Depth and SSD have been updated. This is because the program calculates them automatically to eliminate the possibility of mistakes. We will not be using any tray, table or compensator factors, so these will all remain '1'. Simply press <Tab> until you reach the 'Compensator Factor' field. Your screen should look like Figure 3. We are now ready to calculate the treatment plan.

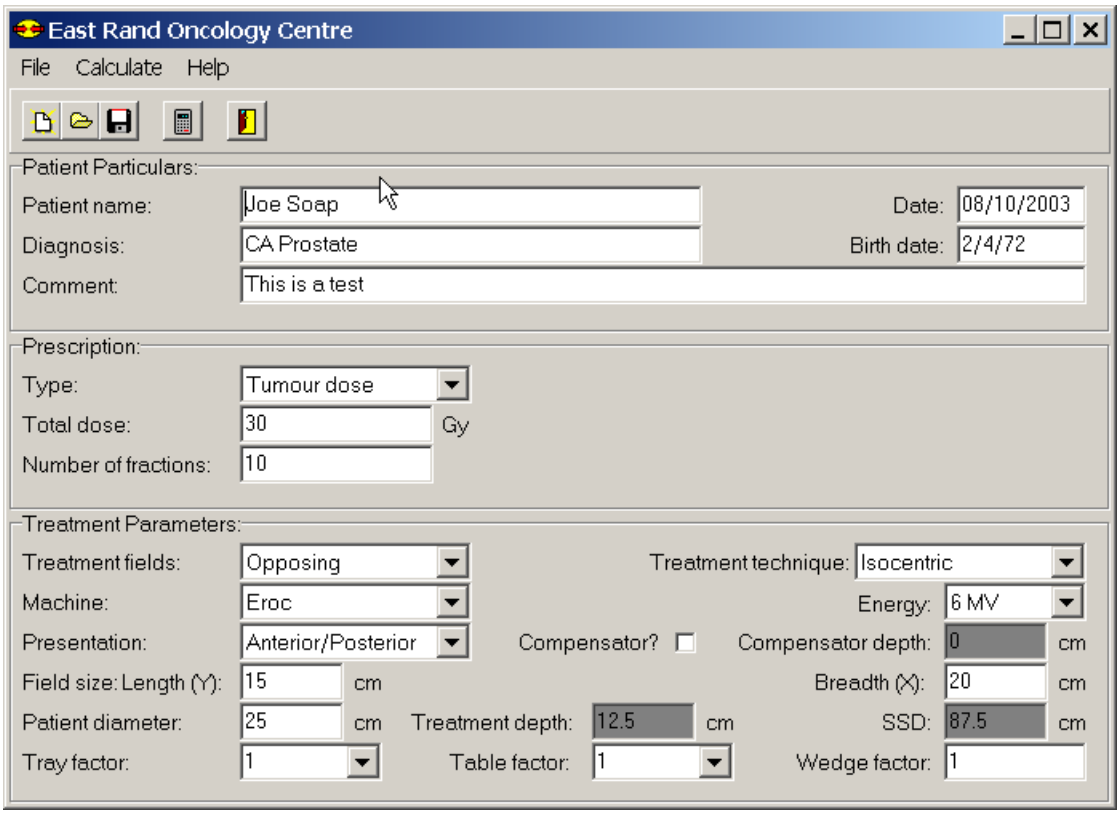

Figure 3: The completed tutorial.

Click on the little 'Calculator' button  on the tool bar at the top of the program screen. A new window will appear containing the results of the data that has just been typed in looking like Figure 4. The monitor units that must be given to the patient are displayed in the middle of the 'Results' window. The monitor units are presented in the middle of the screen. You can scroll through the data by pressing the <Page Up> and <Page Down> keys to have a look at what you have typed and to make sure that everything is correct.

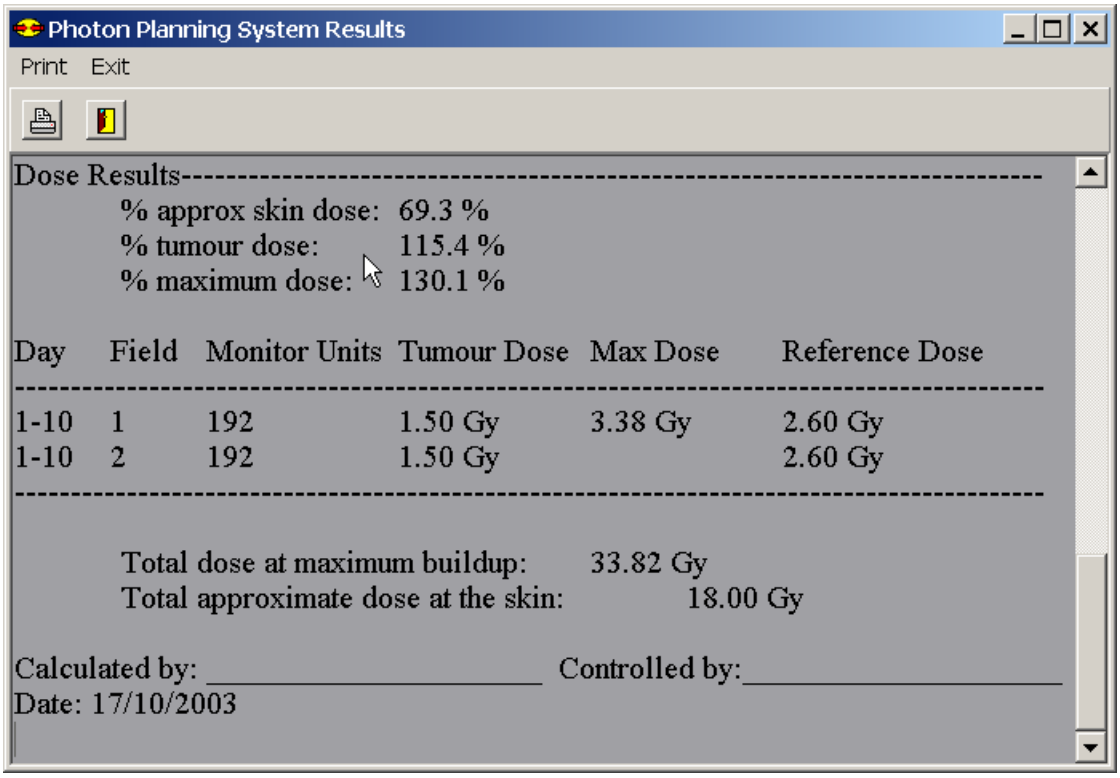

Figure 4: The Results Window.

Our next step is to print the plan that we have created. Click on the printer icon in the menu bar in the new window. Make sure that your printer is ready and has paper. The print dialogue box will appear. If you are ready to print, press 'OK'; otherwise press 'Cancel'. If you have done everything correctly, your plan should now be appearing out of the printer. For further information see Printing a plan. The plan can now be placed in the patient's file and verified. Close the 'Results' window by clicking on the little door icon next to the printer icon on the tool bar. This will return you back to the Treatment Parameters window.

Now we must save our treatment plan. Click on the floppy disk icon on the tool bar and the Save dialogue box will appear. Type in the file name for the patient. This can be as long as you like but should not contain any extensions, as the program will add its own special extension to your filename. When you have done this click the 'Save' button on the dialogue box to save the patient under your new file name. Now our data is saved in case anything should go wrong. For further information see Saving a plan.

Congratulations, you have successfully calculated your first plan. Take some time now to play with the program. Try out the various different options and try displaying and printing various different treatment plans. Don't worry about doing anything wrong; the program has various safeguards built in that will not allow you to make mistakes. Likewise, it is very difficult for you to lose data.

CHAPTER

EIGHT

USING OPPOSING FIELDS

Now that you have gained some experience in using the Opposing Fields program, we will look at each field in detail and discuss its meaning and range. Before describing each field, let's have a look at the different sections of the screen, an example of which is shown in Figure 5.

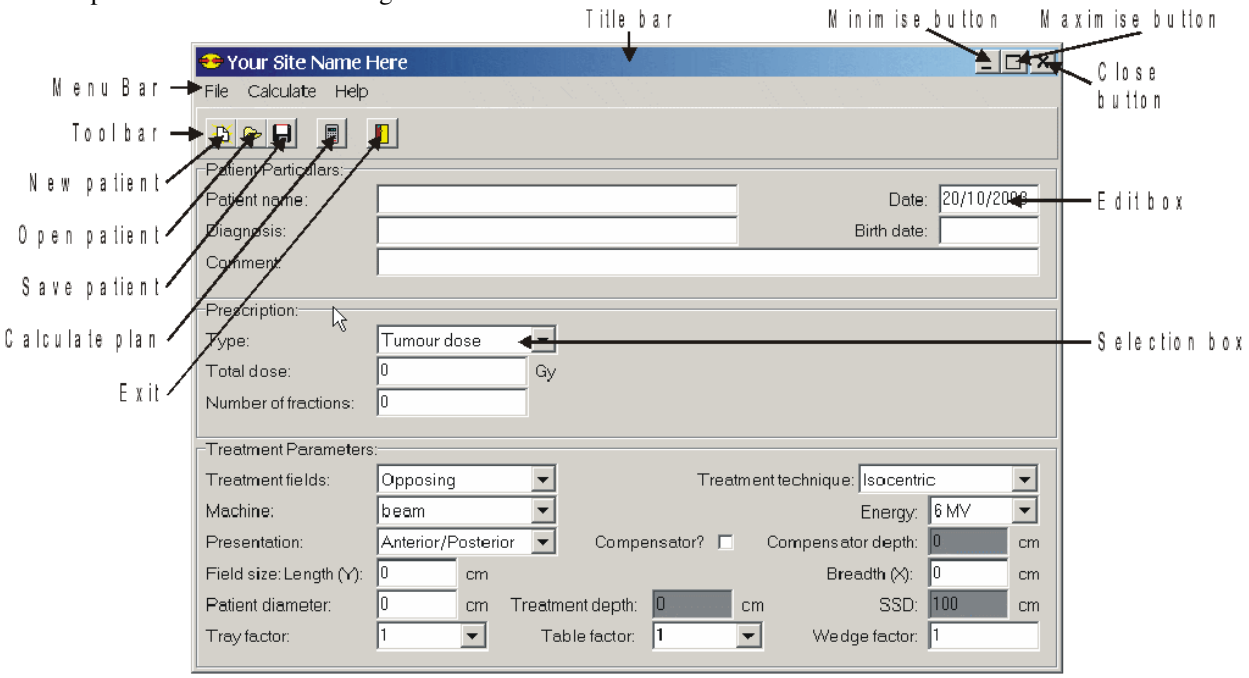

Figure 5: Sections of the Opposing Fields window.

8.1 Title Bar

At the top of the Opposing Fields window is the title bar. This tells you where you are. Currently it should be displaying the name of your centre. It also contains the icon for the Opposing Fields program on the right hand side of the title bar and the standard three Windows buttons; 'Minimise', 'Maximise' and 'Close' on the right hand side. Directly underneath the title bar is the menu bar. This contains the options 'File' and 'Calculate'. You can either select a menu item by clicking on it with the mouse, or by using the <ALT> key and the underlined letter. For example, if you want to access the File menu, press <ALT>-<F> and the 'File' menu will appear. To access one of the options on this menu, simply press the underlined letter again. For example, press <O> to open a file.

8.2 Tool Bar

Underneath the menu bar lies the speed button bar or tool bar. This contains a series of buttons distinguished by icons. Starting from the left-hand side, the first button is the 'New patient' button  , which corresponds to the 'File', 'New' menu option. Directly next to it is the 'Open patient' button  , corresponding to the 'File', 'Open' menu option. The third button in this group is the 'Save patient' button  , corresponding to the 'File', 'Save' menu option. The 'Calculate Plan' button  is separate from these. This button calculates the treatment plan once all the data has been entered. The last speed menu button is the 'Exit' button  . Click on this button to exit from the program. It has the same function as choosing 'File', 'Exit' or clicking on the 'Close' button right at the top right hand corner of the window. To use a speed menu button, simply click on it. It provides a fast and easy way of accessing the menu options.

8.3 Data Entry

The rest of the screen is known as the client area and contains the fields where you will be entering data. This area is divided into three sections; the 'Patient Particulars' section, the 'Prescription' section, and the 'Treatment Parameters' section. These sections and the fields in them will be discussed in detail in the section Data fields and their meanings.

8.4 Fields

A field is an area where you enter data. There are two types of fields; edit boxes and selection boxes. An edit box allows you to type in data such as the name of the patient.

8.4.1 Edit Boxes

To enter data into an edit box click on the white area of the edit box with the mouse. A thin vertical line will appear in the white area of the edit box. This line is called the cursor and shows where any characters will appear when you type. If the edit box already contains data which you want to over write or change you can either press the backspace or delete keys to erase the data or double click the characters with the mouse so that they are highlighted in blue. You can also press <TAB> until the interior of the edit box is highlighted in blue. Anything that you type now will replace the highlighted characters.

8.4.2 Selection Boxes

A selection field allows you to select an item from a list. They can be distinguished by the small down pointing arrowhead  on the right-hand side of the field. The list can be accessed by either clicking on the arrowhead with the mouse cursor, or by pressing the down arrow on the cursor keypad. If you already know what the options are you can also select them by pressing the first letter of the item. Some selection fields allow you enter data or to select it from a list. These are known as combo-boxes.

8.5 Moving between Fields

You can either press the <TAB> key to move you from one field to the next, or you can select each field by clicking on it with the mouse. If the field already contains data, you can select that data by double clicking that field. The data

will then appear highlighted in blue and any typing will now will erase all the data. The easier method is to use the <TAB> key. This automatically highlights data in the field, and then you can either overwrite it or retain the data.

To move between fields click on the next field with the mouse cursor or press the <TAB> key. Data can only be entered into a field when it is displayed in white. When the field is displayed as a dark grey colour it is disabled or greyed and you will not be able to access the field. When the colour of the field changes from grey to white it is enabled and you can now enter data into it.

We are now ready to discuss the meaning of each field.

CHAPTER

NINE

DATA FIELDS AND THEIR MEANINGS

There are three sections where data can be entered. Each section handles a different type of data.

9.1 The Patient Particulars section

In the Patient Particulars section the patient demongraphics are entered along with a basic description of the diagnosis and some identifying comments.

9.1.1 Patient Name

This field is optional; however, we recommend that you enter the name of the patient in this field. The patient's name can be as long as 255 characters.

9.1.2 Date

This is the current date. You may enter the date in any format that you wish but the field is constrained to a maximum of 10 characters.

9.1.3 Diagnosis

This field is optional, but should reflect the diagnosis of the patient or any other identifying comment that you wish to make. It can contain up to a maximum of 255 characters.

9.1.4 Birth date

This is the date of birth of the patient. Again the date may be in any format that you wish, but it is constrained by a maximum of 10 characters. This field is optional.

9.1.5 Comment

Enter in any comment that you want about the patient this field. This field is optional and does not have to be filled in. A maximum of 255 characters may be entered in this field.

9.2 The Prescription section

The treatment prescription given by the Oncologist is entered here:

9.2.1 Type:

This field is a selection field. There are two options; tumour dose and maximum dose. The tumour dose is the dose specified to the tumour while the maximum dose is the dose specified at maximum build-up. Select whichever is appropriate for your treatment by clicking on the down arrow button  or alternatively by pressing the first letter of each option. For example, press 'm' to choose maximum dose or choose 't' to choose tumour dose. The options may also be selected by pressing the <down arrow> or <up arrow> keys. You may not type any data in this field.

9.2.2 Total Dose

This is the total dose specified for the patient. It is a numeric field. The dose is restricted to between 0 and 100 Gy. Should you enter a value outside these limits, a dialogue box will appear giving you an error message and warning you that your value should be between 0 and 100 Gy. Press the 'OK' button to acknowledge the dialogue box and then enter in the correct value into the 'Total dose' field. You will not be allowed to enter any other data into any other fields until you have created a correct value for the total dose. This field is compulsory.

9.2.3 Number of Fractions

This is the number of fractions over which the treatment will be given. The number of fractions must be between one (1) and fifty (50). This field is again compulsory.

9.3 The Treatment Parameters section

Here the physical parameters for the treatment of the patient are entered. All the fields in the 'Treatment Parameters' section are compulsory and must have values entered. If they are not filled in you will not be able to calculate a plan and an error will be generated. Some of the fields will, however, give you default values which you can use.

9.3.1 Treatment Fields

This is a selection field allowing you to choose between opposing fields and a single field. Remember that opposing fields always means parallel opposing beams, whereas a single field is just one beam. Again you cannot type anything in this field; you must choose between opposing and single. You can either use the mouse, or you can press 'o' for opposing or 's' for single, or you can use the <down arrow> or <up arrow> keys. Your selection affects the way the treatment depth is described. For opposing fields the treatment depth is half the patient diameter. In the case of a single field any treatment depth can be specified.

When the 'Opposing' option is selected the 'Treatment depth' field is disabled and you can only enter the patient diameter. Selecting 'Single' disables the 'Patient diameter' field and enables the 'Treatment depth' field. The type of treatment field also affects the 'Prescription Type' field, the 'Presentation' field and the 'Table' field. If the 'Single' beam option is selected the 'Presentation' field and 'Table' field are disabled as it is assumed the treatment does not go through the table. The 'Prescription Type' field defaults to 'Tumour dose' and is disabled as the 'Maximum dose' prescription applies only to opposing fields.

9.3.2 Treatment technique

This is also a selection field. You may select between three types of treatment; isocentric treatment, fixed SSD or variable SSD. Isocentric treatment is the conventional treatment for a Source Axis Distance (SAD) of one hundred centimetres (SAD = 100cm). Normally the tumour is placed at the isocentre. The fixed SSD treatment sets the Source Surface Distance (SSD) to one hundred centimetres (SSD = 100 cm). The variable SSD treatment allows you to specify the SSD. Again you may select the different options either by pressing the first letter of the option, or by using the mouse, or by using the <up> and <down> arrow keys. You will notice that according to the options you select; the patient diameter, treatment depth, and SSD fields will be greyed or enabled according to the options you chose. For the isocentric and fixed SSD treatment, you will only be able to enter in the patient diameter. However, for the variable SSD treatment you will be able to enter the patient diameter and the SSD.

9.3.3 Machine

In the event that your site has more than one linear accelerator, select the machine to be used here. Otherwise press <Tab> to continue to the next field. Depending on the machine selected, different energies and tray factors will be available.

9.3.4 Energy

This is a selection field giving the photon energies that are available. You may either select the energy by pressing the number corresponding to the energy, by using the mouse or by using the <up> and <down> arrows on the keyboard. Select whichever energy is appropriate.

9.3.5 Presentation

The presentation may either be anterior/posterior or lateral. This field affects whether the table factor is enabled or not. In the lateral position, no table factor is used, so if you choose lateral the table factor field will be blanked out. Again you may select the options by using the mouse, the first letter of each option, or the up and down arrows on the keyboard. The presentation field is disabled if the 'Single' option in 'Treatment field' is selected.

9.3.6 Compensator

Check this field if you want to use compensators in the beam. Make sure you are familiar with the way the Opposing Fields program handles compensators before checking this option. Selecting this field causes the 'Compensator depth' field to be enabled. The 'Treatment fields' is disabled and set to the default option of 'Single Field' as a compensator can only be used with a single field. Selecting the 'Single' option causes the 'Prescription type' to be disabled and set to 'Tumour dose' as described for the 'Treatment fields'.

9.3.7 Compensator depth

This is the tissue equivalent thickness of the compensator. A depth of 0 cm has the same effect as deselecting the 'Compensator' field.

9.3.8 Field Size

'Field size' is a compulsory numeric field that must be entered. The field size must be between 3 cm and 40 cm. Any value outside this will result in an error dialogue box appearing, and you will not be allowed to continue until you have entered in a correct value. Enter in the Y or length value, and then the breadth or X value.

9.3.9 Patient Diameter

This is a numeric value between 0 and 40 cm. Depending on whether you have chosen 'Single' or 'Opposing' in the 'Treatment fields' the 'Patient Diameter' field may not be available. If you have chosen single fields, the patient diameter will be blanked out and you will be taken automatically onto the treatment depth field. If you chose opposing fields, then you will be able to enter the patient diameter. The patient diameter is the full cross- section of the patient that you are treating through.

9.3.10 Treatment Depth

This is a numeric field between zero (0) and thirty (30) centimetres. Depending on the number of fields you chose this option might not be available. If you chose single fields, then you will be able to enter the treatment depth. If you chose opposing fields, you will not be able to enter the treatment depth. You will move automatically to the next field.

9.3.11 SSD

This is the source to surface distance at the central axis of the beam that you are treating over. Depending on whether you chose isocentric, fixed SSD or variable SSD treatment, you may not be able to enter data in this field. If the 'Isocentric' or 'Fixed SSD' options were chosen this field will be disabled and you will advance automatically to the next field. If you chose variable SSD treatment, then you must enter a value into this field. The SSD should be between 5 and 200 centimetres. If you are using compensators and a variable SSD please make sure you understand fully how the Opposing Fields program handles compensators.

9.3.12 Normalisation Factor

This is a general adjustment factor for any beam weighting, or modifiers such as trays that may be used in the beam. The number should be between zero (0) and one (1). It is a selection field. However, you may also type the factor into this field. Commonly used normalisation factors should already be entered into the program and by using the mouse or the <down> and <up> arrow keys you should be able to select the appropriate factor. The factor changes according to the photon energy that has been chosen. Make sure that the correct energy is chosen before you choose the normalisation factor. If you are not using normalisation, then make certain that the factor is set to one.

9.3.13 Table factor

The table factor is the attenuation factor for the table, if any. This factor should be between zero (0) and one (1). If no factor is being used make sure the factor is one. It is a selection field so you should be able to select your commonly used table factors. The field is disabled if the 'Lateral' option for the 'Presentation' field was selected, or if the 'Single' option for the 'Treatment fields' was selected. Treatment is not normally performed through the table in these instances.

9.3.14 Wedge factor

This is the factor for any wedges or any other beam modifiers that may be used. It should be between zero and one and should be calculated by your medical physicist. If no wedges are being used, this factor should remain one.

Once all the data has been entered you are ready to calculate a treatment plan by pressing either the 'Calculate' speed button  , or by selecting the 'Calculate' menu option. Please note that you may at any time go back and change an option that you have entered. Before you calculate a treatment plan we recommend that you save your data by clicking

on the 'Save patient' speed button  or by selecting 'File', 'Save'. For further information on saving your data see Saving a plan.

CHAPTER

TEN

WORKING WITH PLANS

10.1 Creating a new plan

There are two ways of creating a new plan, either click on the 'New patient' speed button  , or select the 'File', 'New' menu option. When the program is first run the fields will be greyed, and before you can continue you must either create a new plan or open an existing plan. Once you have created a new plan the fields will become white, indicating that you can now enter data.

10.2 Opening an existing plan

There are two ways of opening an existing plan, either by selecting 'File', 'Open' on the menu bar, or by clicking on the 'Open patient' speed button  . This will cause the 'Open File' dialogue box to be displayed. See Error: Reference source not found below. The dialogue box contains a list of available files that you can select from. Select your file either by clicking on it and then clicking on 'OK' or pressing <Enter> or by double-clicking the file name. The dialogue box will close and the fields in the data entry screen will contain the data from the file. You can now either use this data as is or you can change it and create a new plan from this previously existing data. If you have certain plans that are commonly used, you may want to create template files containing the parameters that you use often, which you can open and edit according to your needs.

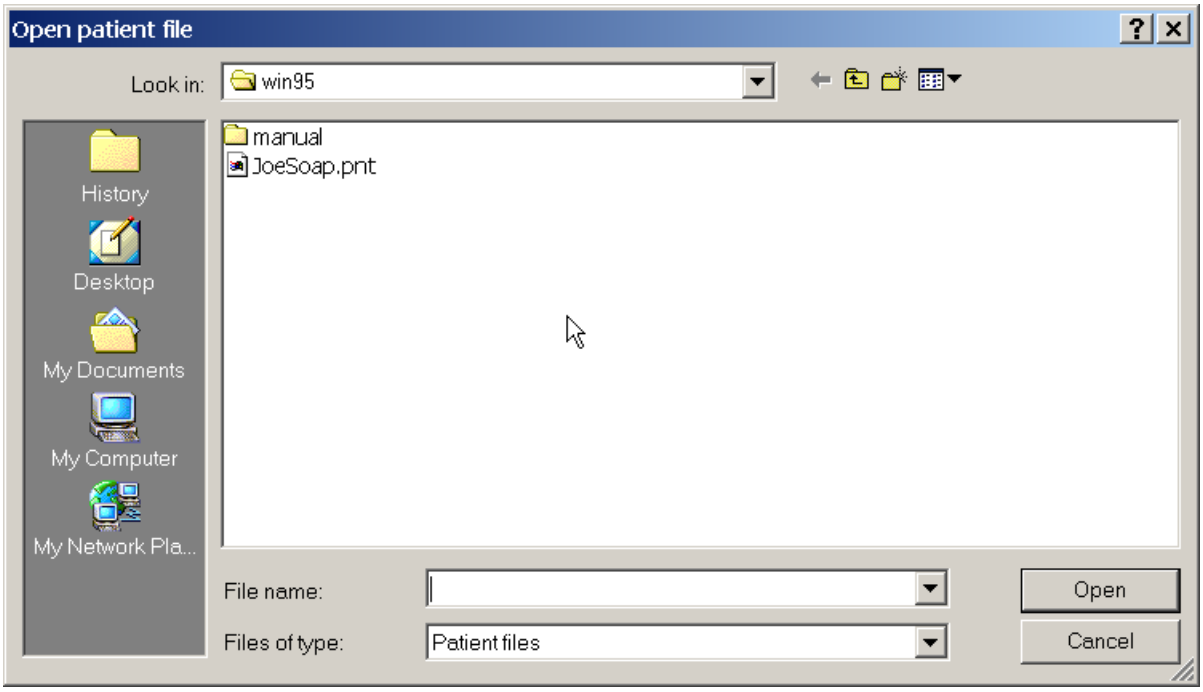

Figure 6: The 'Open patient' dialogue box.

10.3 Saving a plan

There are also two ways of saving a treatment plan. Either click on the 'Save patient' speed button containing the floppy disk icon, or select the 'File', 'Save' option on the menu bar. This will open the 'Save patient' dialogue box, see Error: Reference source not found, that contains a list of previously saved files as well as an edit box where you can enter in your file name. You may enter a file name as long as you like, but it must not contain any extensions as the program adds its own unique extension. Enter a file name and then either click on the 'OK' button, or press <Enter>. This will close the dialogue box and save the file. Please note that the 'Save patient' dialogue will also appear if you try and open another patient, if you try to create a new patient, or if you try to exit the Opposing Fields program when the data of the current patient has been modified and has not been saved. This is to ensure that you do not lose your data. If you do not wish to save the plan, simply click on the 'Cancel' button, or press <Esc>.

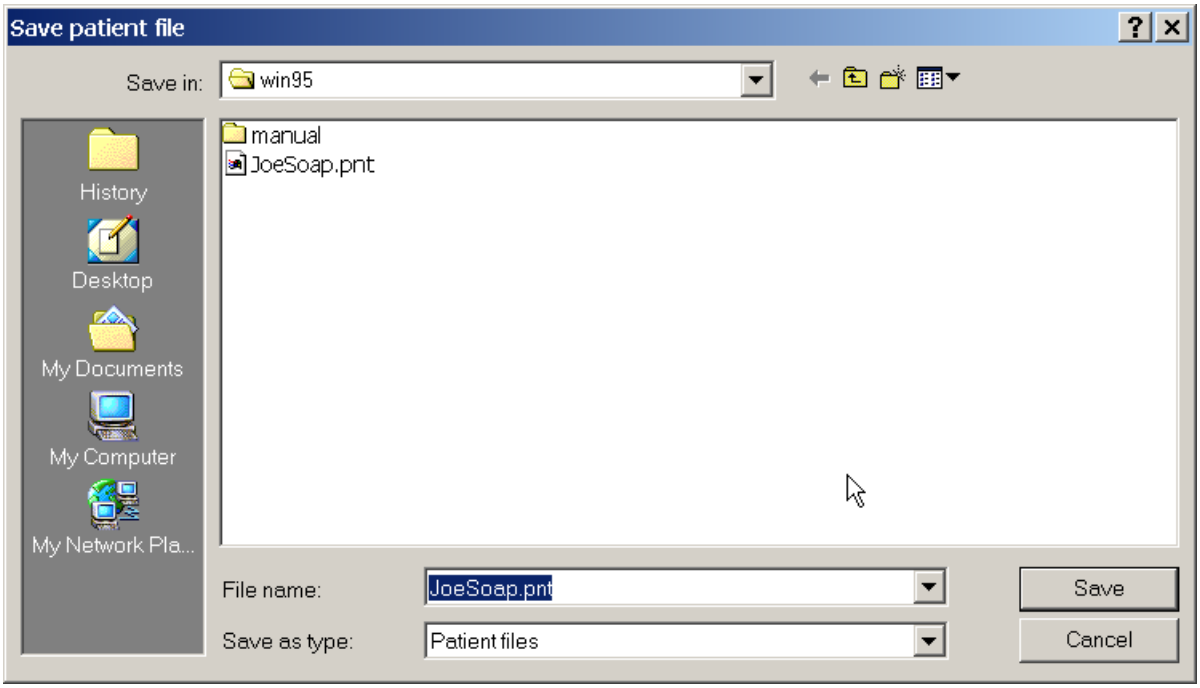

Figure 7: The 'Save patient' dialogue box.

10.4 Calculating/Displaying a plan

Once you have entered the data in all the fields you are now ready to calculate a plan. You can cause the Results window to be displayed either by clicking on the 'Calculate' button on the speed bar, or by clicking on the 'Calculate' option on the menu bar. This window is a scrollable page with the various parameters you have entered and the results of the treatment plan.

10.5 Printing a plan

To print a plan you must be in the Results window. You cannot print a plan from the Data Entry window. If you are in the Data Entry window, press the Calculate button to calculate the plan, and the Results window will appear. The Results window has a menu bar and a speed bar with two different options, 'Print' and 'Exit'. Click either on 'Print' on the menu bar or on the 'Print' speed button to print a plan. The Print dialogue box, illustrated in Error: Reference source not found, will appear. Make sure the printer is ready and then either click on 'OK' or press <Enter> to print. If you wish to cancel printing, press 'Cancel' or <Esc> and you will return to the Results window.

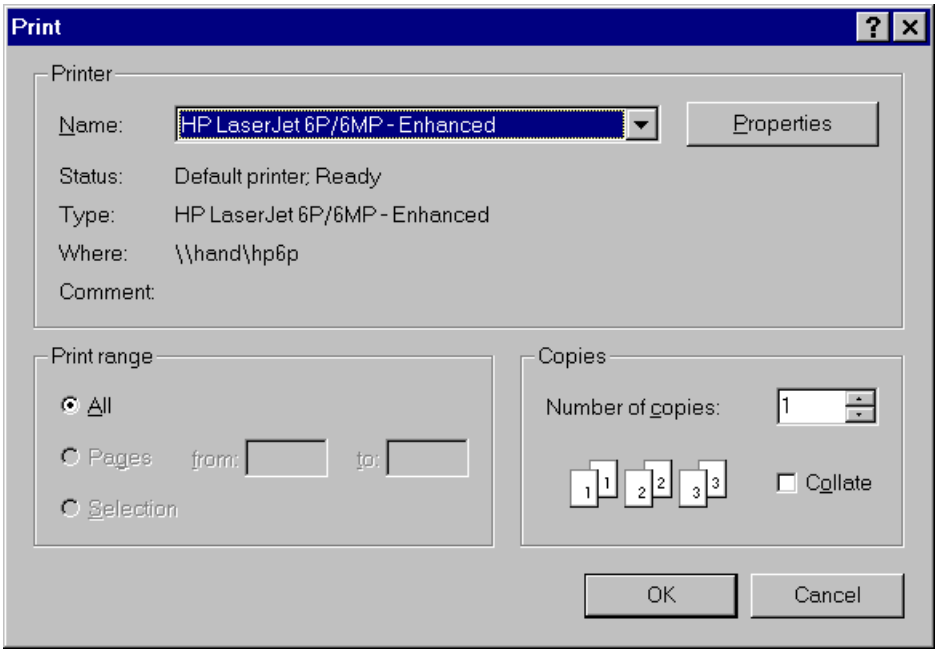

Figure 8: The Print dialogue box.

CHAPTER

ELEVEN

THE RESULTS PAGE

Calculating the plan will display the results page if you have not made any mistakes in entering the data.

11.1 Viewing the results page

Take a while to have a look at the Results window page as shown in Figure 6

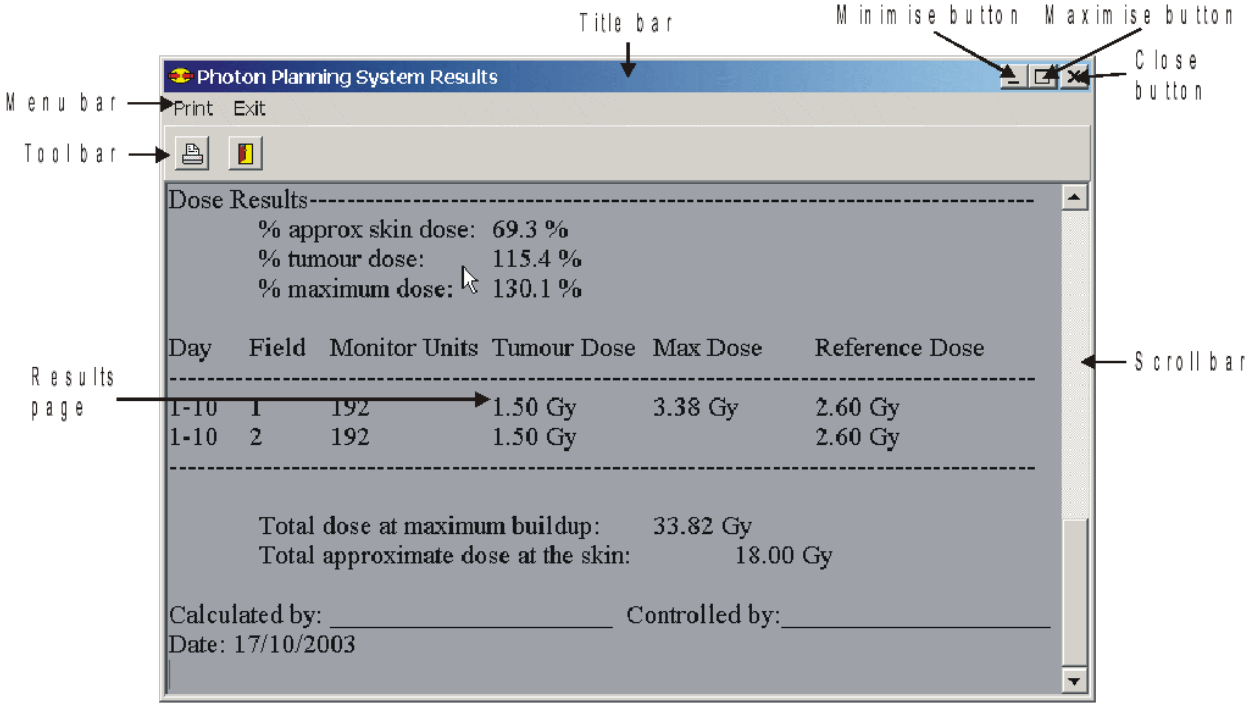

Figure 6: Components of the Results window.

The Results window has its own Title bar, Menu bar and Speed button bar with different options from the Data Entry window. The results are displayed underneath the Speed button bar. You may view the different part of the Results page by using the Scroll bar situated to the right hand side of the Results page. Move to top of the page by dragging the block in the scroll bar up. Move to the bottom of the page dragging the block in the scroll bar down. Alternatively you may use the <Page Up> and <Page Down> keys on the keyboard. The <up> and <down> arrow keys will also perform the same function, but will move through the text one line at a time. Practice viewing the different parts of the Results page. The results will be printed exactly as they are displayed here, so make sure that your parameters are correct before you print.

11.2 Sections of the results page

The Results page is divided into five sections. The first section is the General Particulars section containing the file name and the date that it was generated on. The next three sections, the Patient Particulars, Prescription, and Treatment Parameters sections, correspond to the data entry sections of the same name. The fields are also the same, so they will not be discussed here.

The last section is the Dose Results section. Here the results calculated are displayed. This section varies according to the prescription type that was selected. The first three results remain the same for both prescription types, namely; the % Skin Dose, the % Tumour Dose and the % Maximum Dose. The % Skin Dose is the percentage of the total dose at the skin. The % Tumour Dose is the percentage dose at the tumour and the % Maximum Dose is the percentage of the total dose at the depth of maximum build-up.

After these parameters, the number of monitor units per field per fraction is shown. This is the value that will be set on the accelerator console. If the 'Tumour dose' was specified in the prescription type then the tumour dose per fraction per field is given followed by the maximum dose per fraction. If the dose to maximum build-up was specified then the number of monitor units is followed by the maximum dose per fraction per field followed by the tumour dose per fraction. Underneath the monitor units either the 'Total dose at maximum build-up' is given if the 'Tumour dose' was prescribed or the 'Total dose at the isocentre' is given if the 'Maximum dose' was prescribed. The Reference dose is the dose at Dmax for each field. This can be used to check In-Vivo Dosimeter (IVD) readings. Lastly, the 'Total Dose at the Skin' is given.

When you are sure the Results page is correct you may print it.

CHAPTER

TWELVE

EXITING THE PROGRAM

There are three ways to exit the program. You may either use the ‘Close’ button on the top right hand corner of the title bar, or you may use the ‘File’, ‘Exit’ option on the menu bar, or you may click the ‘Exit’ button  on the speed bar. If the Results window is still open, you will need to close this first.

You close the Results window in the same fashion as closing the Data Entry window, either by clicking the ‘Close’ button, or by selecting ‘File’, ‘Exit’ or by clicking the ‘Exit’ speed button  . If you have data that has not been saved, the program will ask you before closing whether the data should be saved or not. Click ‘Yes’ to save the data; click ‘No’ to exit without saving the data; and click ‘Cancel’ to return to the program again.

CHAPTER

THIRTEEN

USING COMPENSATORS

The Opposing Fields program caters for compensators in the beam. As there are a number of way of using compensators it is important to understand how the Opposing Fields program implements them.

A compensator is a mass of material placed in the beam contoured so as to provide a homogeneous dose distribution in the tumour volume. The compensator is place as close to the head of the accelerator as possible to reduce electron contamination of the photon beam. A wide variety of material may be used to construct the compensator, among them lead, brass, aluminium, polystyrene and other tissue equivalent plastics. The thickness of the compensator is specified in terms of its tissue equivalent thickness along the central beam axis because of the variation in attenuation between the different materials. The tissue equivalent thickness is the amount of tissue that the compensator is intended to replace or fill in.

When planning a compensator most books recommend that the SSD be taken from the highest point on the patient in the field. While this is quite easy to do when using bolus to fill in any irregularities in practice it is quite difficult to do using compensators. Normally the highest point on the patient is not on the central axis of the beam. This makes patient positioning more difficult. Also patients are normally positioned using the distance indicator on the central axis.

A related problem is that a compensator plan quite often originates from a prescription requiring opposing fields place isocentrically. For these reasons the Opposing Fields program always takes the SSD as the distance from the source to the patients skin on the *central* beam axis no matter if compensators are used or not.

The compensator depth is the tissue equivalent thickness of the compensator on the central axis of the beam. This depth is subtracted internally in the program from the given SSD and added to the treatment depth so that the effective SSD is to the highest point of the patient.

To prevent confusion compensators may only be used on single beams. Selecting the compensator field will cause the ‘Treatment Fields’ to default to single. This will in turn inactivate the ‘Prescription Type’ and ‘Patient diameter’ fields. If other values have been selected various warnings will be generated before the defaults are set.

CHAPTER

FOURTEEN

ERRORS AND TROUBLE SHOOTING

A number of errors may occur during operation of the program. If you encounter one of these, don't panic; it is probably part of the built-in checking system of the program. The errors are normally displayed in a message box and you need to close the message box before continuing. Some errors will not allow you to continue and will shut the program down.

14.1 Beam data file errors

The first set of errors that can occur concern the Beam Data file. The program keeps its data in files with a '*.bdf' extension. If these files have become corrupted or have been deleted or are missing for any reason, the program will not run but will instead generate an error. The following errors are possible.

14.1.1 Beam Data File error:

This means that the program cannot find the Beam Data file. Either the file has been deleted, or it cannot be opened, or for some reason it is missing. The Beam Data file will need to be regenerated. Please contact the medical physicist who installed the program to regenerate the Beam Data file.

Figure 10: Beam data file error.

14.1.2 Integrity of Beam Data File has been compromised:

This means that the Beam Data file has become corrupted in some fashion. The Opposing Fields Program checks the data file before using it to ensure that the file is okay. Again the Beam Data file will have to be reloaded and regenerated. Contact the medical physicist who installed this program to do this.

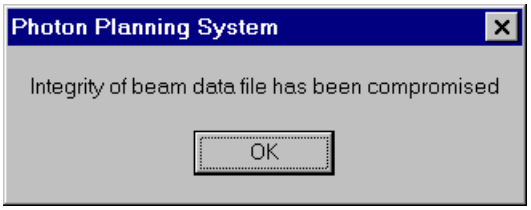

Figure 11: Data file integrity error.

14.2 Data errors

The second set of errors concern the data entered. As stated before, a number of validation checks are carried out on the data. If you receive a data error, first of all check your most recently entered value. When you press the 'Calculate' button or select the 'Calculate' option, another check is performed on the data as well. In addition to the warning messages you may receive one of the following errors.

14.2.1 Data Out of Range:

You have tried to calculate a plan with data that is invalid. Go back and scan through your data making sure your values are correct. Be careful of spaces, characters and punctuation marks in numeric fields.

Figure 12: Data range error.

14.2.2 Econvert:

One or more of your values cannot be converted to a number. Go back and scan through your data making sure your values are correct. Be careful of spaces, characters and punctuation marks in numeric fields.

14.2.3 EinvalidNumber:

One or more of your fields contains invalid characters. Go back and scan through your data making sure your values are correct. Be careful of spaces, characters and punctuation marks in numeric fields.

14.2.4 Not a valid floating point number:

One or more of your fields contains invalid characters. Go back and scan through your data making sure your values are correct. Be careful of spaces, characters and punctuation marks in numeric fields.

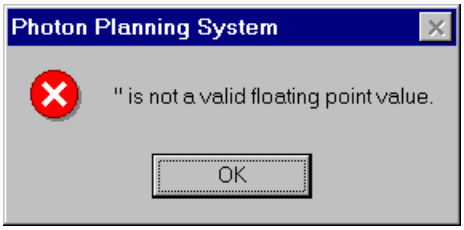

Figure 13: Invalid floating point number error.

Other errors may be generated by the Windows sub-system. Please note the error, where it occurred and contact technical assistance.

If going through your plan data does not solve your problem, then try exiting the program and starting it again as a final measure.

CHAPTER

FIFTEEN

TECHNICAL ASSISTANCE

If you need help using the program speak to your local physicist or the installer of the software, or contact the authors at the address below:

There are, of course, no bugs in the software. However, it may happen that the software does not behave in a manner you expect or generates a plan that you think is wrong. If so, we would like to know about it. Likewise, if you feel OPF should be doing something that it isn't, please tell us.

The authors can be contacted on alanc@oncology-sa.co.za.

CHAPTER

SIXTEEN

FOR THE MEDICAL PHYSICIST

The Opposing Fields program uses the system of dosimetric calculations as laid down by Khan [1] and Johns and Cunningham [2]. The tissue maximum ratios (TMRs) are calculated by interpolation from tables. Output factors are calculated from an exponential fit to measured data. A summary of these methods is given below to aid quality assurance procedures.

16.1 Quality Assurance Procedures

A number of quality assurance checks should be carried out on the program and plans generated by it. These will usually be carried out during the normal site quality assurance and are as follows:

- Each plan generated must be checked. The procedures for checking the plans are given later in this chapter.
- Whenever the Opposing Fields program is installed or re-installed a number of test plans from the Opposing Fields program should be compared to equivalent plans from the primary planning system, for each energy, covering a range of field sizes and depths. The monitor units generated by each should not differ by more than 2%.
- If the data in the primary planning system changes for any reason the Beam Data file must be regenerated with the new data. Please consult the Beam User Manual for generating the Beam file.
- After every major service or repair on the linac the percentage depth dose data should be compared to the values in the appendix. If the data has changed significantly new TMR's must be calculated and the beam file regenerated.

16.2 Quality assurance on single beam treatments

16.2.1 Isocentric treatments

Treatments that are not carried out at a SSD of 100 cm are best calculated using TMR's, as percentage depth dose tables are not usually available for other SSD's. For a *single* field the relation between monitor units and dose to the isocentre is as follows:

$$MU = \frac{ID \cdot 100}{TMR(d, r_d) \cdot S \cdot \left(\frac{SCD}{SAD}\right)^2} \tag{16.1}$$

where:

- MU are the monitor units

- ID is the isocentre dose in Gy
- TMR(d,rd) is the tissue maximum ratio at depth d and field size r at depth d
- S is the output factor
- SCD is the source calibration distance, usually 100 + dmax cm.
- SAD is the source axis distance, usually 100 cm.

For the sake of simplicity no tray, table or compensator factors have been included in the equation given above. When a factor is used, divide through by the appropriate factor.

16.2.2 Variable SSD treatments

For variable SSD treatment equation (16.1) can be extended to:

$$MU = \frac{TD \cdot 100}{TMR(d, r_d) \cdot S \cdot \left(\frac{SCD}{STD}\right)^2} \tag{16.2}$$

where:

- STD is the source treatment distance (STD = SSD + d)
- TD is the tumour dose in Gy
- d is the treatment depth

16.2.3 Fixed SSD treatments

While fixed SSD (SSD = 100cm) treatments can certainly be checked using the methods outlined above the medical physicist may find it easier to use percentage depth doses (**%DD**). This is a more suitable quantity for calculations involving SSD techniques. The monitor units MU necessary to deliver a tumour dose **TD** in Gy at a depth **d** for a field size **r** is:

$$MU = \frac{TD \cdot 100}{\frac{\%DD_d}{100} \cdot S \cdot \left(\frac{SCD}{SSD + d_{max}}\right)^2} \tag{16.3}$$

When the SSD = 100 cm and SSD + dmax = SCD then equation (16.3) simplifies to:

$$MU = \frac{TD \cdot 100}{\frac{\%DD_d}{100} \cdot S} \tag{16.4}$$

16.2.4 Dose at maximum build-up prescriptions

Normally the dose at maximum build-up prescription is not used for isocentric treatments, particularly for single beams. However, should such a situation occur the isocentric technique may be adapted as follows:

The accelerator is calibrated to give 1 MU/cGy at maximum build-up for a 10x10 field at the SCD, i.e. TMR(dmax,10) = 1.0. For any other field size and SSD equation (16.2) becomes:

$$MU = \frac{MD \cdot 100}{S \cdot \left(\frac{SCD}{SSD + d_{max}}\right)^2} \tag{16.5}$$

where **MD** is the dose at maximum build-up in Gy for a *single* beam.

When the SSD is fixed at 100 cm the situation is even simpler. Equation (16.5) becomes:

$$MU = \frac{MD \cdot 100}{S} \tag{16.6}$$

16.3 Quality assurance on parallel opposing beam treatments

16.3.1 Isocentric treatments

For parallel opposing beams the dose to the isocentre **ID** in Gy is divided equally between the beams giving:

$$MU = \frac{ID \cdot 100}{2 \cdot TMR(d, r_d) \cdot S \cdot \left(\frac{SCD}{SAD}\right)^2} \tag{16.7}$$

for each beam.

16.3.2 Variable SSD treatments

A similar equation holds for variable SSD treatments:

$$MU = \frac{TD \cdot 100}{2 \cdot TMR(d, r_d) \cdot S \cdot \left(\frac{SCD}{STD}\right)^2} \tag{16.8}$$

where:

- STD is the source treatment distance (STD = SSD + d)
- TD is the tumour dose in Gy
- d is the treatment depth

16.3.3 Fixed SSD treatments

For parallel opposing fields the tumour dose **TD** in Gy is divided equally between the two beams giving:

$$MU = \frac{TD \cdot 100}{2 \cdot \frac{\%DD_d}{100} \cdot S} \tag{16.9}$$

16.3.4 Dose at maximum build-up prescriptions

For parallel opposing beams the situation is a little more complex. Fortunately the dose at maximum build-up prescription is not normally used for parallel opposing beams. The dose at maximum buildup, Equation 5, from the previous

section must be modified to take into account the contribution from the opposing beam giving:

$$MU = \frac{MD \cdot 100}{S \cdot \left[\left(\frac{SCD}{SSD + d_{max}} \right)^2 + TMR(d, r_{d_{max}}) \cdot \left(\frac{SCD}{SSD + d} \right)^2 \right]} \tag{16.10}$$

where **d** = patient diameter - dmax. It is recommend that this equation be used for isocentric, variable SSD and fixed SSD treatments.

For the sake of simplicity no tray, table or compensator factors have been included in the equations given above. When a factor is used, divide through by the appropriate factor.

16.4 Calculation of dose parameters

In addition to the given monitor units a number of other parameters are also calculated. These can generally be derived from the equations given previously but for completeness will be given here.

16.4.1 Approximate percentage skin dose calculation.

Equation 3 from Quality Assurance on Single Beam treatments is used to calculate the proportion of dose at 1 mm below the skin surface. The result is expressed as a percentage. Contributions from all beams are considered giving:

$$SK = 100 \cdot \left[\left(TMR(d, r_{0.1}) \frac{SCD}{SSD + 0.1} \right)^2 + TMR(d, r_{diam}) \cdot \left(\frac{SCD}{SSD + diam} \right)^2 \right] \tag{16.11}$$

This result should be viewed as an approximation only as the TMR's can be quite inaccurate near the skin surface.

16.4.2 Percentage tumour dose calculation

This is an estimate of the percentage depth dose to the tumour. For a single field it is:

$$\%DD_{TD} = 100 \cdot TMR(d, r) \left(\frac{SCD}{SSD + d} \right)^2 \tag{16.12}$$

For opposing fields it is:

$$\%DD_{TD} = 200 \cdot TMR(d, r) \left(\frac{SCD}{SSD + d} \right)^2 \tag{16.13}$$

16.4.3 Percentage maximum dose calculation

For a single field the percentage maximum dose **%DD** is the dose at Dmax. For other SSD's an inverse square correction factor needs to be made giving:

$$\%DD_{d_{max}} = 100 \cdot \left(\frac{SCD}{SSD + d_{max}} \right)^2 \tag{16.14}$$

When parallel opposing fields are used the contribution from the other beam must be taken into account and equation 4 from Quality assurance on parallel opposing beam treatments holds, giving:

$$\%DD_{d_{max}} = 100 + 100 \cdot TMR(d, r_{d_{max}}) \left(\frac{SCD}{SSD + diam - d_{max}} \right)^2 \tag{16.15}$$

16.4.4 Absolute maximum dose calculation

This is the dose at dmax. For parallel opposing fields the contribution from both beams must be taken into account.

$$MD = \frac{Dose \cdot \%DD_{D_{max}}}{\%DD_r} \tag{16.16}$$

Note that if compensators are used the maximum dose and the reference dose are adjusted for the attenuation due to the compensator.

16.4.5 Reference dose calculation.

The reference dose is the dose at dmax for one beam. Thus, for single beam treatments the maximum dose and the reference dose will be the same. For parallel opposed treatments the reference dose is the dose at dmax for the given beam without any other contributions. This should correspond to the in- vivo diode reading assuming the diodes have been calibrated to give a reading of 100 cGy at 100 cm SSD for a 10x10 cm field.

$$RD = \frac{Dose}{\%DD_r} \tag{16.17}$$

16.5 Beam Data File formats

Since the 2003 version the Opposing Fields program caters for sites with more than one linear accelerator. Each machine is defined by a beam data file containing a list of photon energies with their associated parameters. The name of the file defines the name of the machine. When it initialises the program looks in the program directory for files with the extension '.bdf' and places these names in a list.

Since 2011 the data has been stored in text format. Although the data may be examined using any text editor it should only be altered using the 'Beam' program in the program directory. This program calculates a check sum. If the calculated and stored check sums do not match the Opposing Fields program will not start.

Only a medical physicist or authorised person should use the Beam program and utmost care should be exercise to avoid accidentally altering the beam data.

The beam data format is as follows:

Line	Description
1	Title
2	Short machine name
3	Number of photon energies
4	Program expiry date
•	Repeating block for each photon energy
5	Energy
6	Depth of d_{max}
7	Table factor
8	5 Tray factors
9	Regression parameters of the output factor curve
10	Number of lines of TMR values
11	Number of columns of TMR values
12	Field sizes for TMR table
13	Depth and TMR values
.	.
.	.
.	.

16.6 References

[1] Khan FM. The Physics of Radiation Therapy. Chap 10. ISBN: 0-683-04501-6. Pub: Williams and Wilkins. 1984.

[2] Johns HE, Cunningham JR. The Physics of Radiology. Chap 10. Pub: Charles C Thomas, 1983, 4th Ed.

CHAPTER

SEVENTEEN

INDICES AND TABLES

- genindex
- modindex
- search

Q

R

S

T

U

W