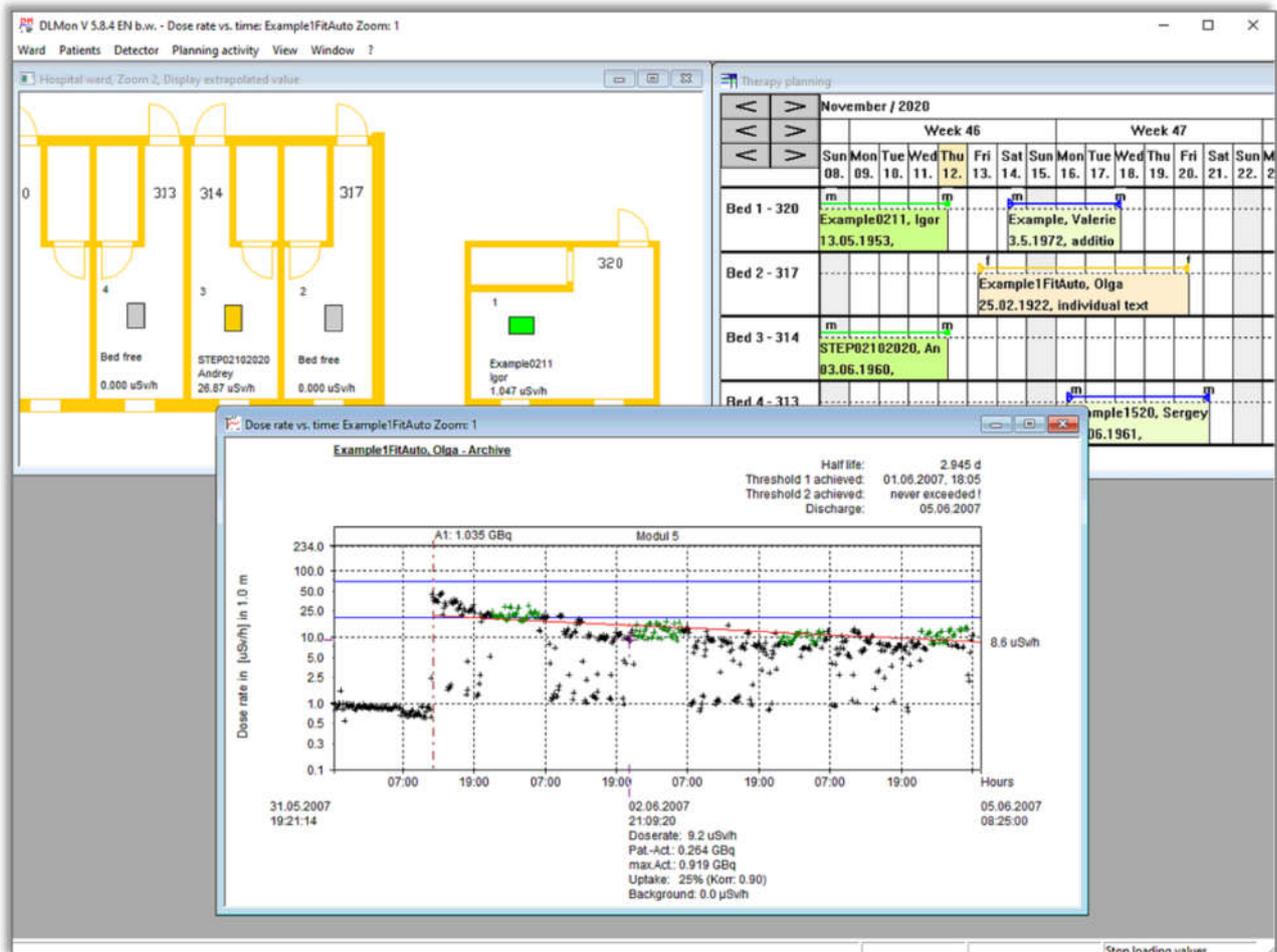


# Software Description

## *DLMon*

### *Dose Rate Monitor*

(Valid from version V 5.8.4 / Sep 2020)



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## 1. System description

The DLMon system is designed to automatically measure the radioactivity of patients at the Nuclear Medicine Station, especially in radio-iodine therapy for the treatment of malignant or benign thyroid diseases. Optionally, further therapies with other nuclides are possible.

A radiation detector (usually invisible in the ceiling) is mounted above the respective patient bed. This detector records the dose rate emitted by the patient in  $\mu\text{Sv/h}$ .

The measured values are transmitted to a PC via a serial bus system (type RS485).

The PC records and archives the measured values via the software STEP-Modulmonitor (SVMO\_V1.exe).

Optionally, the measured dose rate per patient can be displayed via a door display on the ward near the patient bed.

The software DLMon.exe receives the measured values from the software STEP-Modulmonitor and assigns the measured values to the respective patients, who are located in the corresponding bed under the detector.

With the software DLMon the following workflows are feasible:

- Planning of patients in an integrated planning tool
- Admission, transfer and release of patients to ward
- Input / modification of a variety of therapy data (dose, activity, thyroid gland data, data from radio iodine test ...
- Calculation of therapy applications depending on the type of disease
- Automatic recording of the measured values in a freely selectable time window (for example at night)
- Assignment of the measured values to the respective patient
- Automatic calculation of half-life and dose for benign diseases
- Calculation of the necessary length of stay depending on the discharge limits of the DL
- Calculation of follow-up applications for benign diseases
- Archiving of the patient's incl. all data and measured values / measured value progression
- Printout of patient data, therapy data, planned applications...

The patient data is stored in a SQL database, which is managed either locally on the DLMon PC or in the respective hospital network via SQL server. The access to the database 'RJT2000SQL' is done by ODBC driver.

Due to the central database, the DLMon program can be run simultaneously on several computers in parallel, partly with different rights.

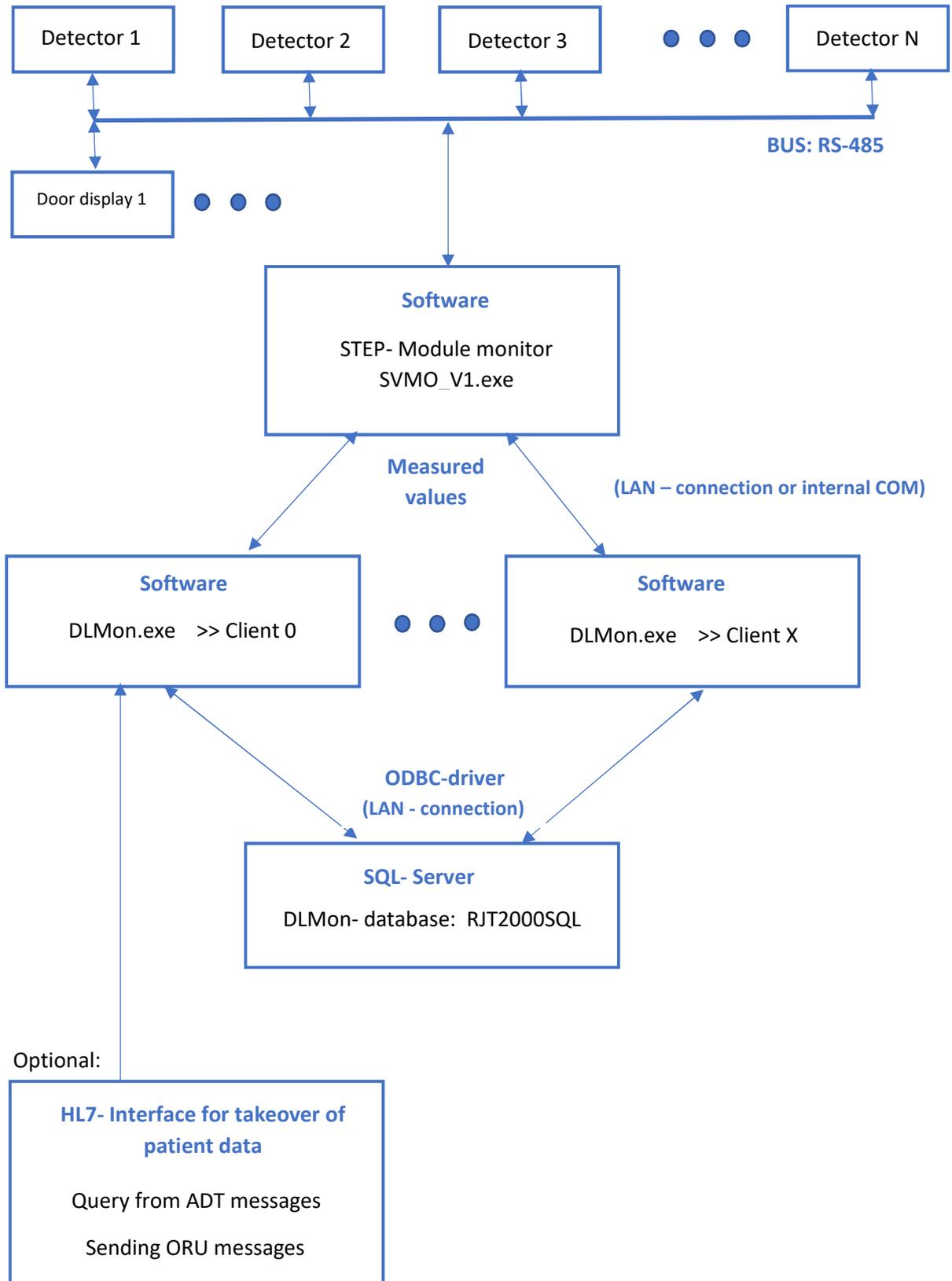
Target of the software DLMon:

- Optimal bed utilization / ward occupancy
- Optimal radiation protection due to constantly available current measured values
- Exact implementation of radio-iodine therapy based on many measured values / good statistic
- Exact calculation of the dose for benign diseases
- Planning, implementation and documentation of therapies with other nuclides
- Precise documentation and archiving of therapies

Supported operating systems:

Depending on the version, the software system can be run under all Windows operating systems, please contact the manufacturer.

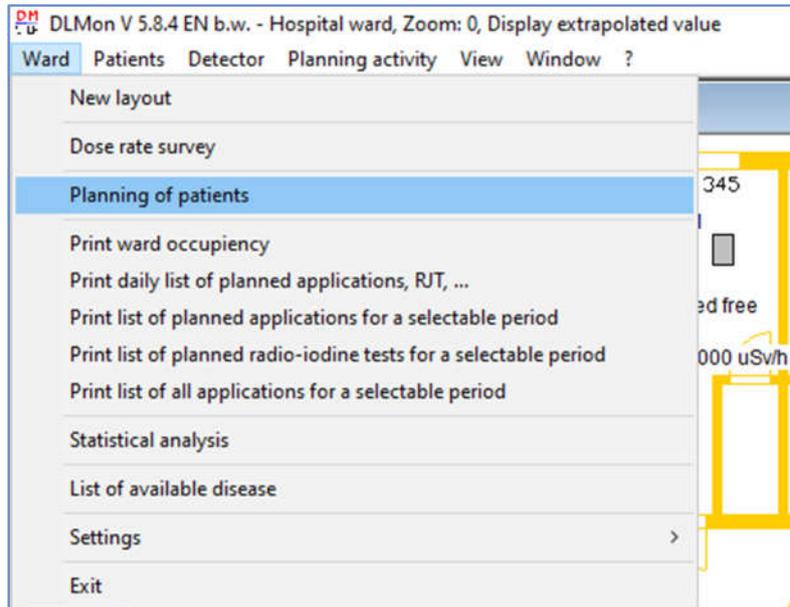
System structure / software and hardware components



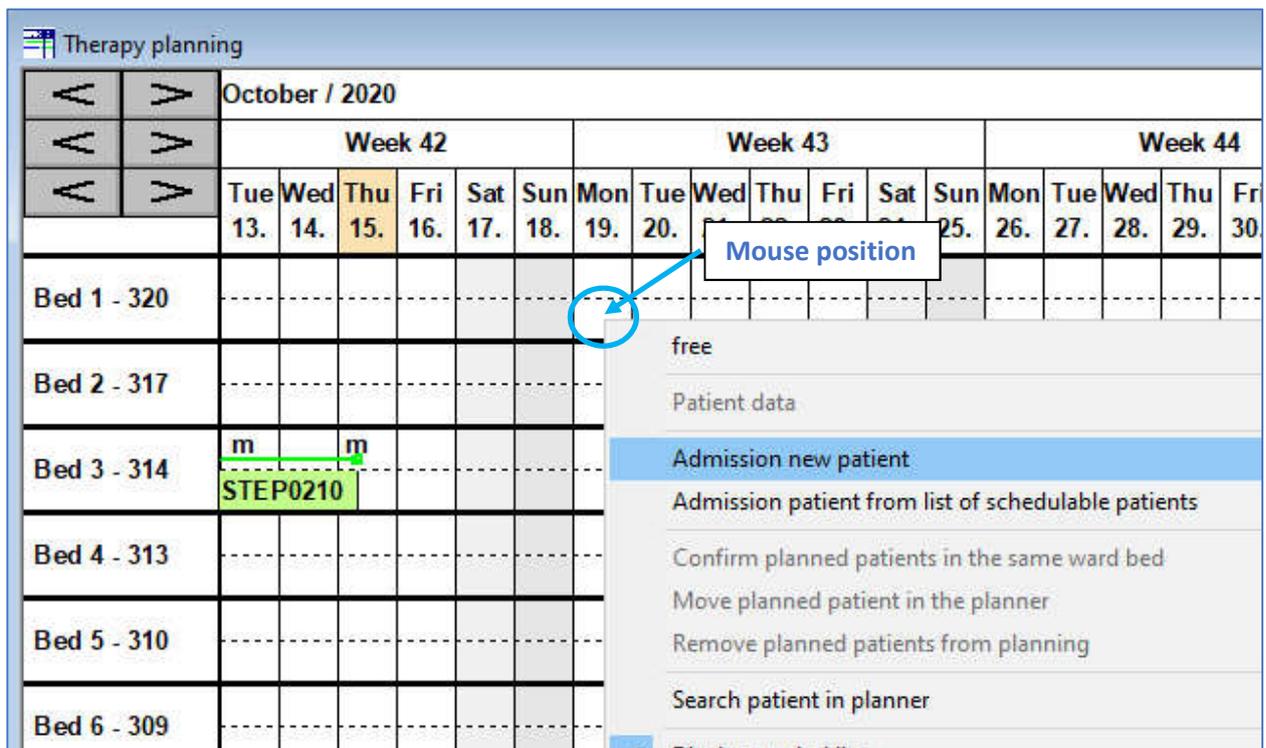
## 2. Quick start

### 2.1 Creating a patient in the planner / planning a therapy

Before a patient is admitted to the ward bed, the patient must be created in the planner / planning window. To do this, open the planning window.



In the planning window, position the mouse in the area of the acquisition bed and acquisition day and open the context menu (right mouse button):



Entry of patient data:

Patient data new planning

Transfer | Application | Dose rate | Dose | Day history

Readings | Extra fields for comments | Discharge

Personal data | Address | Therapy data | Diagnosis / type of disease

Title: Mr.

Name: Example 1520

First name: Sergey

Date of birth: 03.06.1961

Health insurance:

OK Cancel Confirm Help

Confirm with 'Apply' and finish with 'OK' .  
Now the patient appears in the planner:

Therapy planning

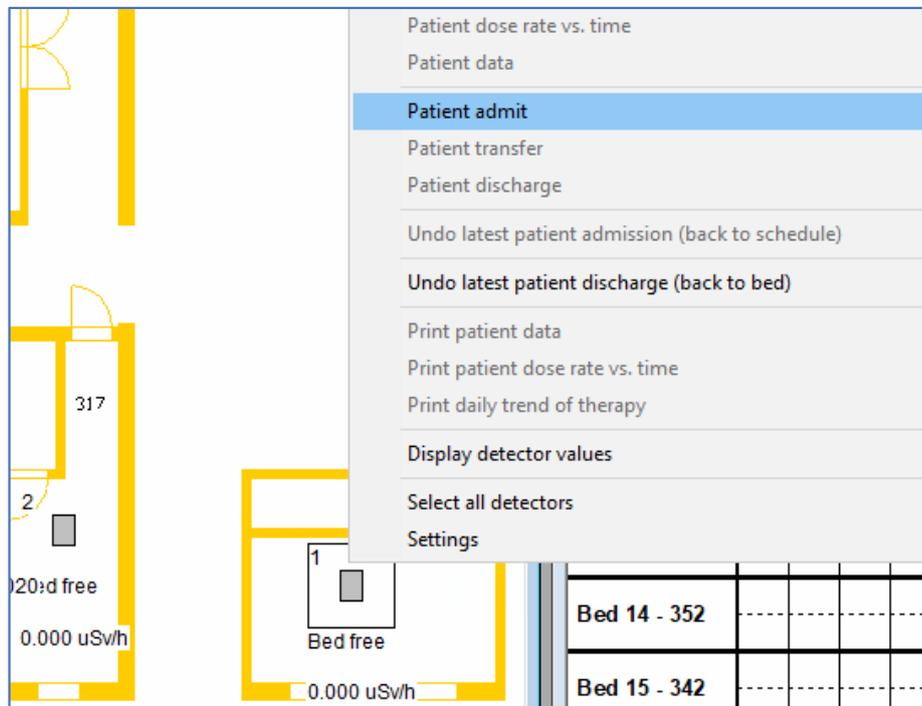
October / 2020

	Week 42					Week 43								
	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon
	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
Bed 1 - 320							m	Example1520, Sergey			m			
Bed 2 - 317														
Bed 3 - 314	m	STEP0210		m										
Bed 4 - 313														

Further therapy data (type of illness, application, planned dose, ...) can be optionally entered in the planner. Here the planning of the therapy start activity (malignant diseases) or the therapy dose (benign diseases) can be done. These data form the basis for an exact planning of the therapy duration and thus bed utilization.

## 2.2 Admit patient from planner to ward

A planned patient is added to the ward bed by selecting the corresponding bed with the mouse in the floor plan and calling the context menu:



In the following dialog box, mark the corresponding patient in the first column with a mouse click:

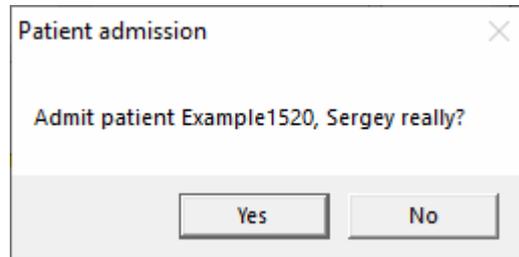
The dialog box is titled 'Admit patient to the ward'. It contains a search bar with a dropdown menu set to 'Last name' and an 'Update list' button. Below is a table with the following data:

Patient name	First name	Date of birth	Residence	planned...	Begin of therapy	P..	T..
Example1520	Sergey	03.06.1961		Bed 1 - ...	19.10.2020 10:00:00	5...	4...

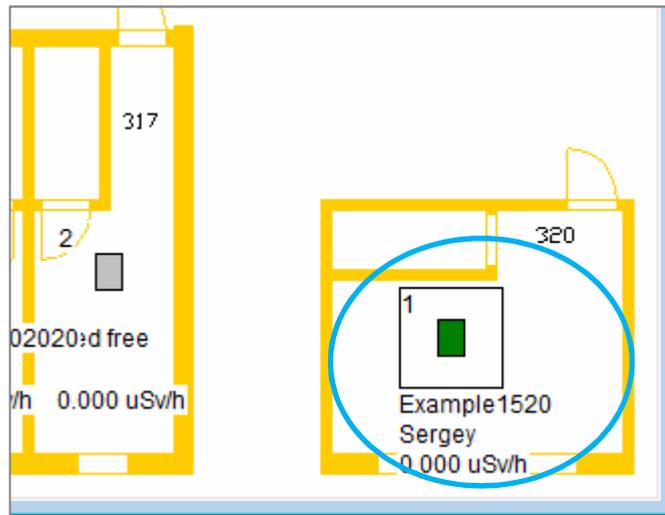
Below the table is a 'Search:' section with a criteria dropdown and a search input field. The 'Admission time:' section has a 'Date:' dropdown set to '10/15/2020' and a 'Time:' dropdown set to '14:54:00'. At the bottom are 'Admit' and 'Cancel' buttons.

If necessary, change the recording time and 'Record'. A recording at a time in the past is possible anytime.

Confirmation of the security question:

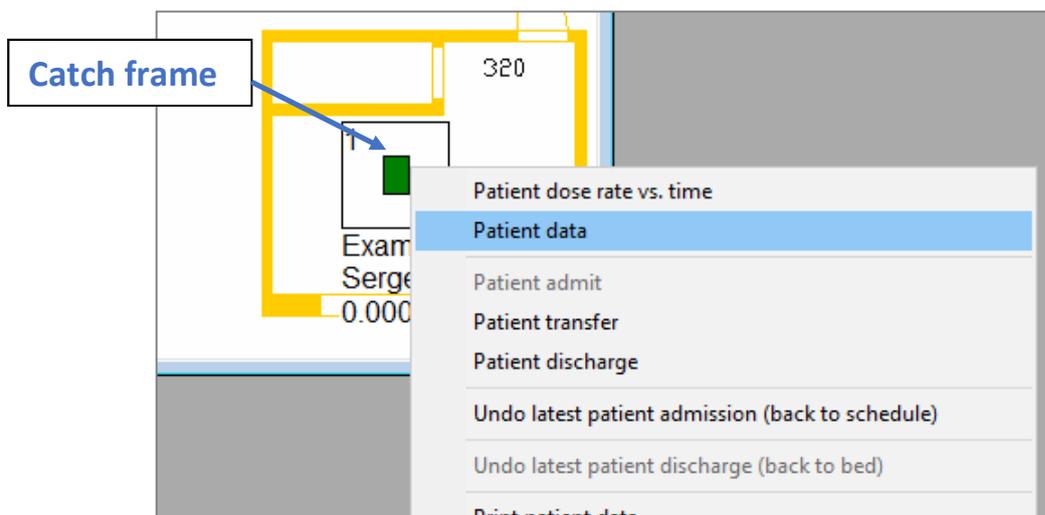


The patient appears in bed:



### 2.3 Input therapy data

Move the mouse in the floor plan window into the area of the bed with the patient until the snap frame appears around the bed and then press the right mouse button. The following context menu opens:



Via menu 'Patient data' you open the dialog box 'Patient data':

Patient data: Example1520, Sergey

Transfer | Application | Dose rate | Dose | Day history

Readings | Extra fields for comments | Discharge

Personal data | Address | Therapy data | Diagnosis / type of disease

Title: Mr.

Name: Example 1520

First name: Sergey

Date of birth: 03.06.1961

Health insurance:

OK Cancel Confirm Help

Here you have access to all patient data. In the tab 'Diagnosis / type of disease' you can select the type of disease and in the tab 'Application' you can enter a therapy activity:

Patient data: Example1520, Sergey

Transfer | Application | Dose rate | Dose | Day history

Readings | Extra fields for comments | Discharge

Personal data | Address | Therapy data | Diagnosis / type of disease

Personal data | Address | Therapy data | Diagnosis / type of disease

Transfer | Application | Dose rate | Dose | Day history

Application list:

Designation	Time	Activity	Drug	Start fit
First application	15.10.2020 ...	0.000 G...	-	15.10.2

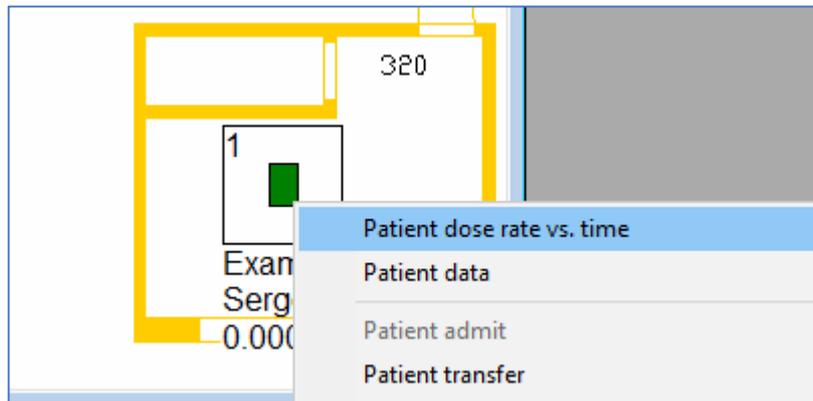
New Edit Delete

OK Cancel Confirm Help

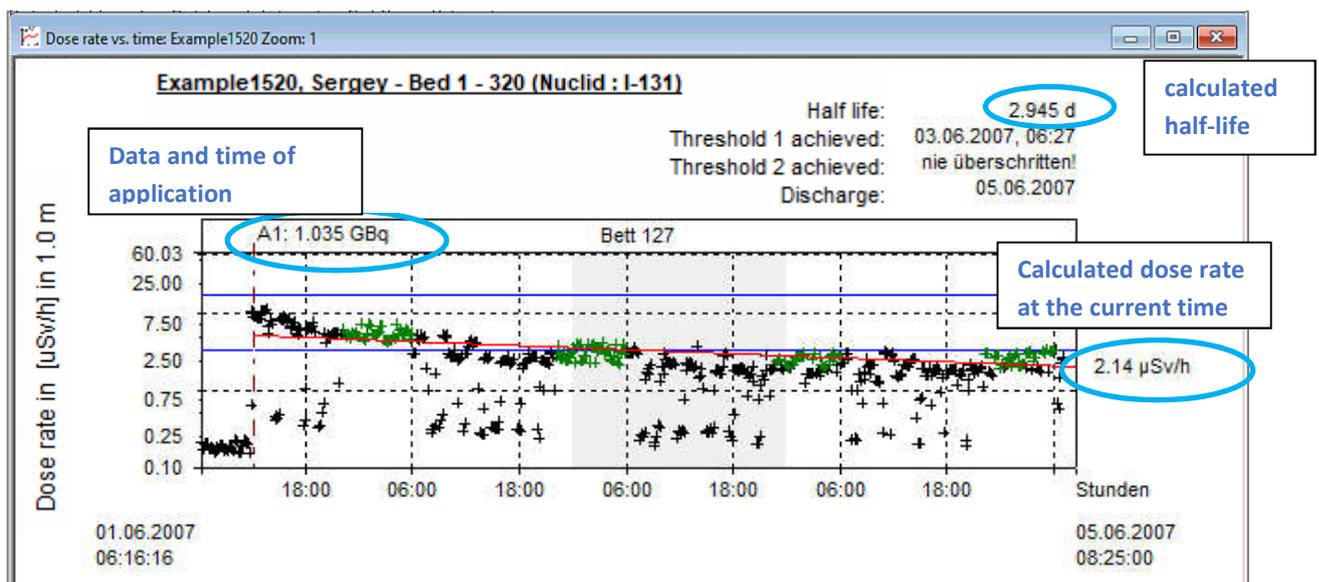
Further explanations can be found in section 3.5 (Modification of patient data) and 3.6 (Procedure for planning patients depending on the type of disease).

## 2.4 Dose rate curve of therapy

Analog to point 2.3, move the mouse in the floor plan window into the area of the bed with the patient until the snap frame appears around the bed and then press the right mouse button. The following context menu opens:



Via the menu item 'Patient dose rate vs. time' you open the window with the diagram of the dose rate curve:



The diagram shows the dose rate in  $[\mu\text{Sv/h}]$  at a distance of 1m /2m from the patient semi-logarithmically over time. The semi-logarithmic representation allows the decay / FIT curve of the thyroid glands enriched with radioactive iodine to be calculated as a **red FIT curve**. In the diagram active measured values are shown with a green cross.

The calculation of the **red FIT- Regression curve / line** is done by the method of least squares, including all active / **green** measured values.

The diagram begins with the admission time of the patient and ends at the current time or, in case of archive data, with the time of discharge.

In the diagram a zoom function is available with mouse.

For further information see point 3.7 (display of patient dose rate history).

## 2.5 Correction of the lying height/ measured values of the patient in the dose rate curve

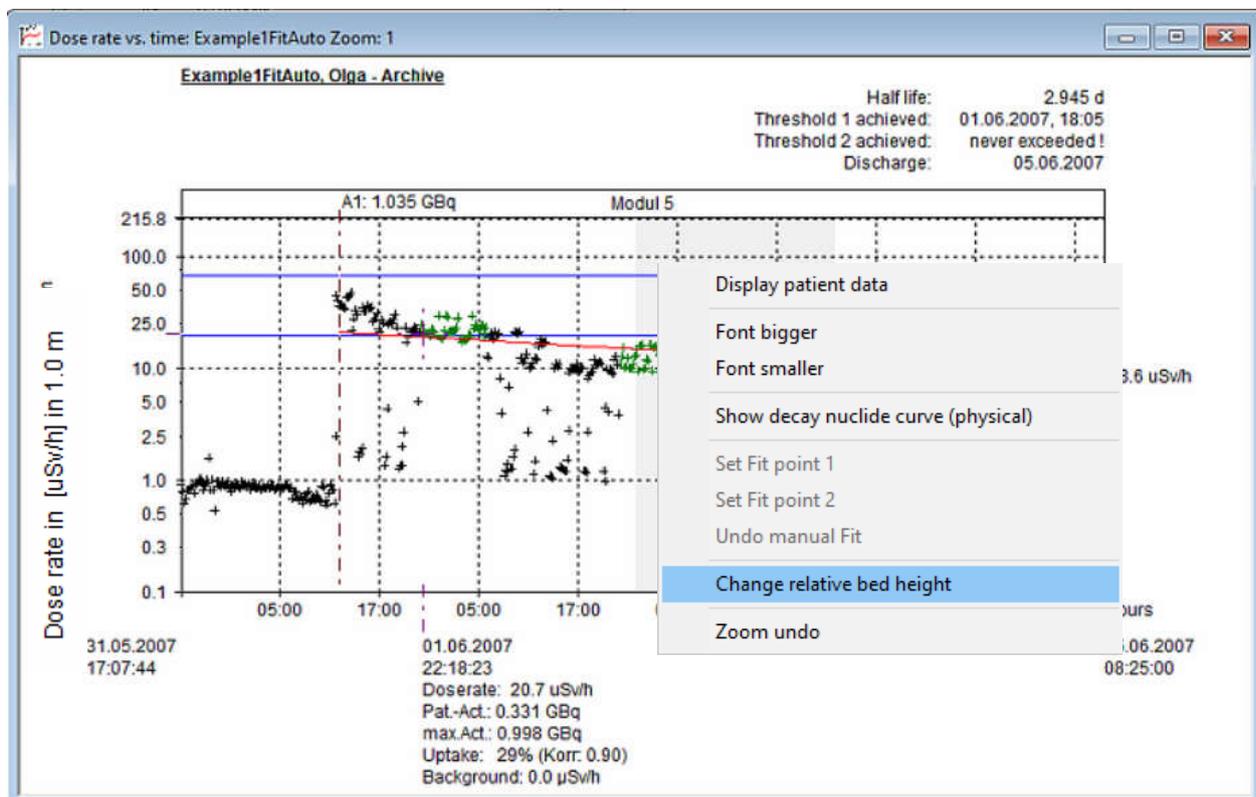
In the dose rate curve you have the possibility to correct the lying height of the patient / bed height. Reasons for this correction can be:

- Patient is abdominal sleeper, therefore more absorption, consequence: measured values too low
- Patient's head section is very steep and thus higher than calibration, consequence: measured values too high

An indicator for too high values is when measured values lie above the physical decay curve shortly after application.

To correct the bed height / measured values, open the context menu in the dose rate history of the patient using the right mouse button and select the entry:

*Change relative bed height*



The dialog box opens:

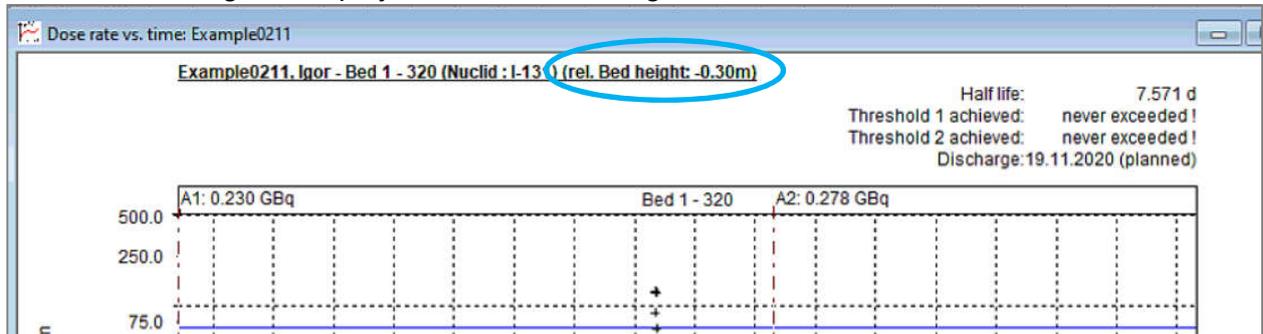
Entering the relative bed height: ✕

Relative bed height in [m]:  ▾

(based on bed height during calibration!)

Here you can change the relative bed height from - 0.40 .... + 0.50 m.  
 With  the measured values are immediately increased or reduced in relation to input!

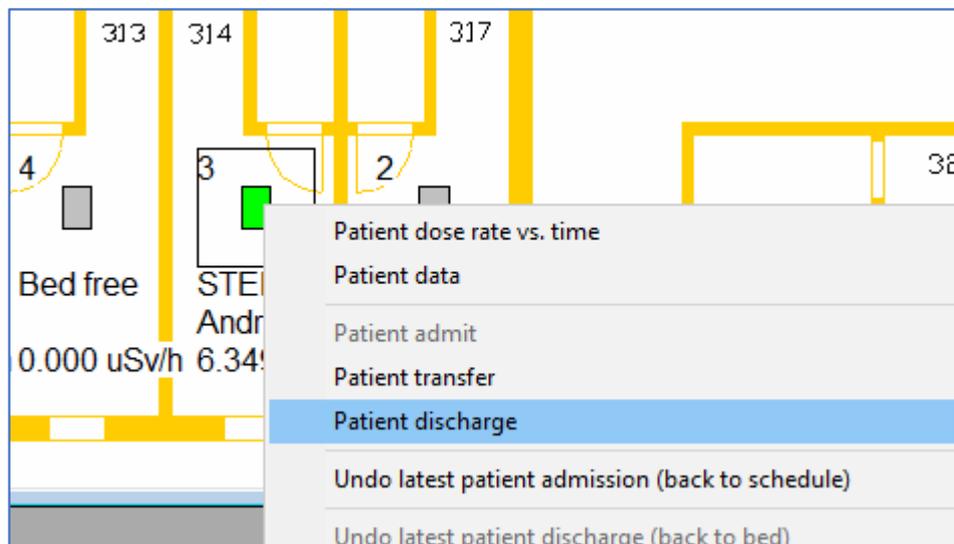
The new bed height is displayed in title line of diagram:



After discharge a patient the relative bed height is reset to 0 !

## 2.6 Discharge patient from ward

The discharge of a patient from ward / bed can also be done via the context menu in the floor plan window analogous to point 2.3. The therapy ends with the release.  
 Move the mouse in the floor plan window into the area of the bed with the patient until the catch frame around the bed appears and then press the right mouse button. The following context menu will open:



Via the menu item '*Patient discharge*' the therapy is terminated and all patient data including dose rate history is stored in the archive. The release dialog box appears:

Discharge a patient: ×

Patient:

Data of discharge:

Date / Time:

Enter dose rate, measured by physician (optional) !

Dose rate [ $\mu$  Sv/h] :  @  [m]

Discharge activity [MBq]  Please check the program value

Note:

Print options:

- Print patient data
- Print patient diagram (dose rate vs. time)
- Print day overview with mean values of dose rate

Here you can change date and time of discharge, dose rate (Recommendation: measured with calibrated meter), discharge activity and discharge notes. Additionally, print options can be enabled / disabled.

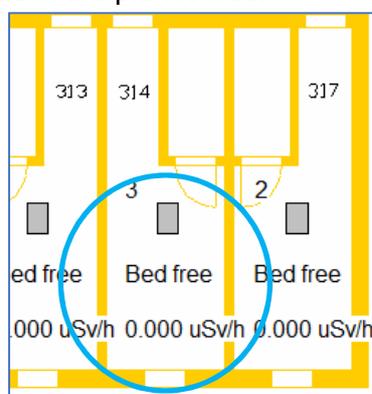
Note: You can print all data / dose rate history from the archive later.

After the confirmation of a security question:

Dlmon ×

 Discharge patient: STEP02102020, Andrey on 15.10.2020 15:37:00 ?

The patient is archived and the bed in the plan is free:

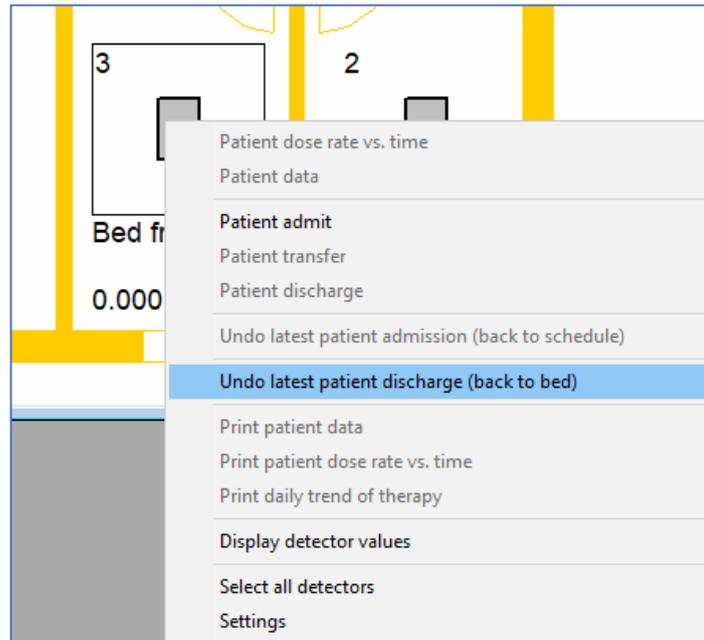


Information how to use the patient archive can be found under 3.9 (Using the patient archive).

## 2.7 Cancel / Undo the last discharge

You can reverse a last discharge (for whatever reason).

To do this, move the mouse in the floor plan window to the area of the bed where the patient was lying at the end until the snap frame appears around the bed and then press the right mouse button. In the following context menu, the menu 'Undo last patient release is activated when the bed is empty:



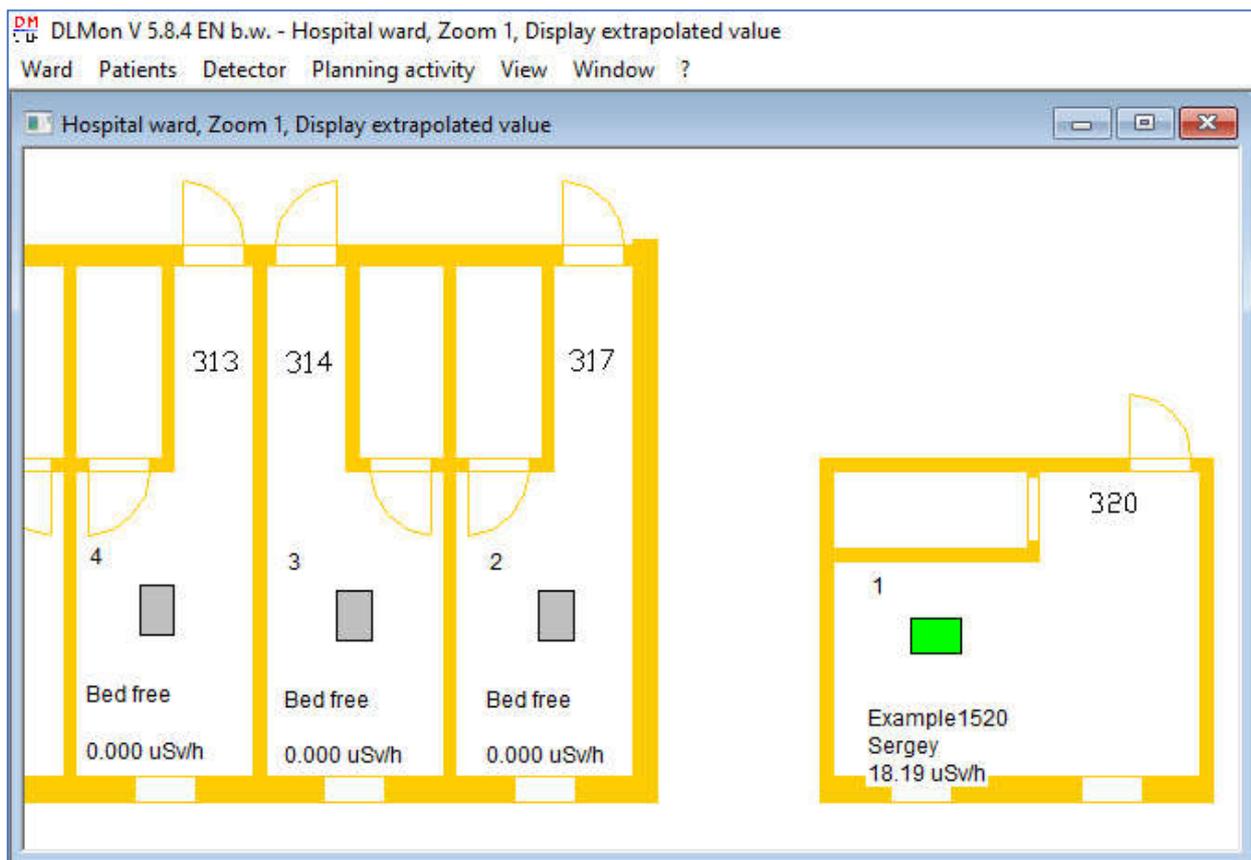
### Important:

This function is only possible as long as no new patient has been admitted. In this case please contact the system administrator.

### 3. Program functions for standard user

#### 3.1. Hospital ward overview

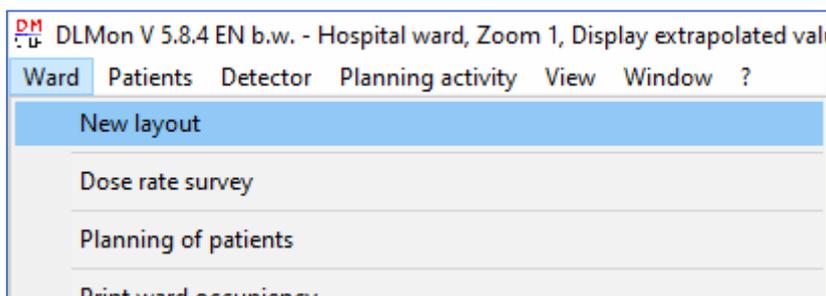
After starting the program, the current hospital ward plan appears:



The following functions can be performed from this window:

- Color display of patients currently on the ward, depending on the dose rate
- Admission, transfer and discharge of patient
- Display and print out patient data
- Display and print out dose rate history of patient
- Take patient back into planning
- Undo last patient discharge

A new window with the hospital ward plan can be opened via :



Note: The window can be opened several times !

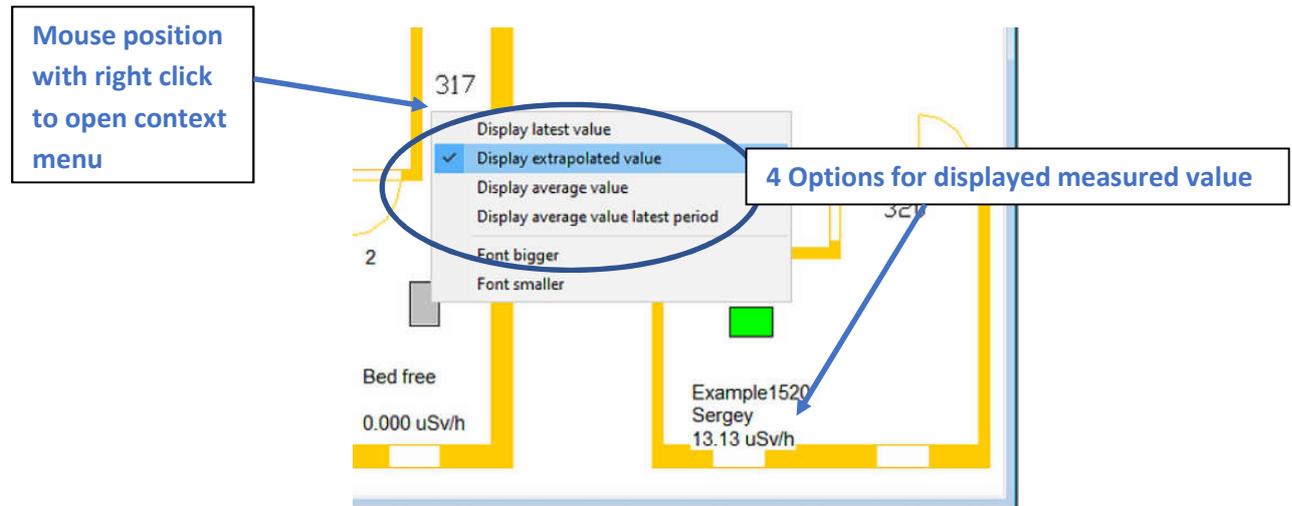


Colored design of the beds:

	empty bed
	occupied bed, dose rate small background / <math>< 0.5 \mu\text{Sv} / \text{h}</math>
	occupied bed, dose rate higher than background and lower limit value 1
	occupied bed, dose rate higher than limit value 1 and lower than limit value 2
	Occupied bed, dose rate higher limit value 2

Context menu "View":

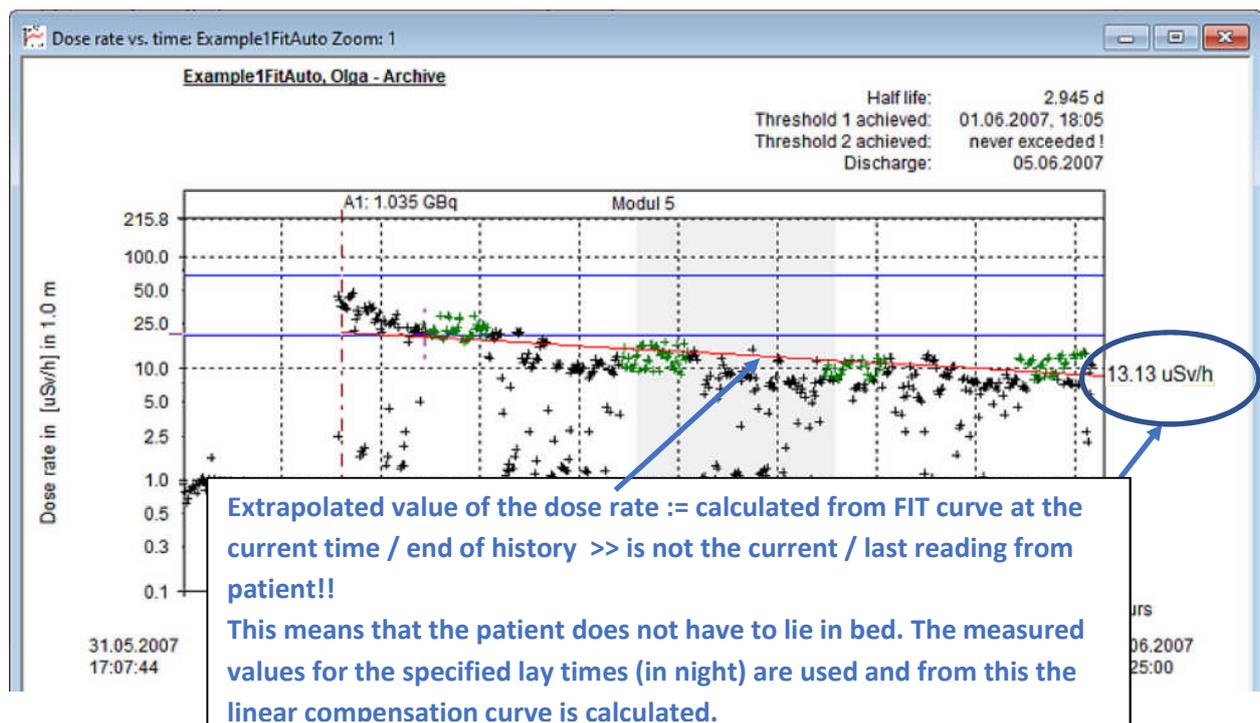
If the mouse is at any position in the ward plan, pressing the right mouse button displays the displayed context menu:



In addition to the adjustment of the font size, there are 4 options to choose from for displaying the measured value.

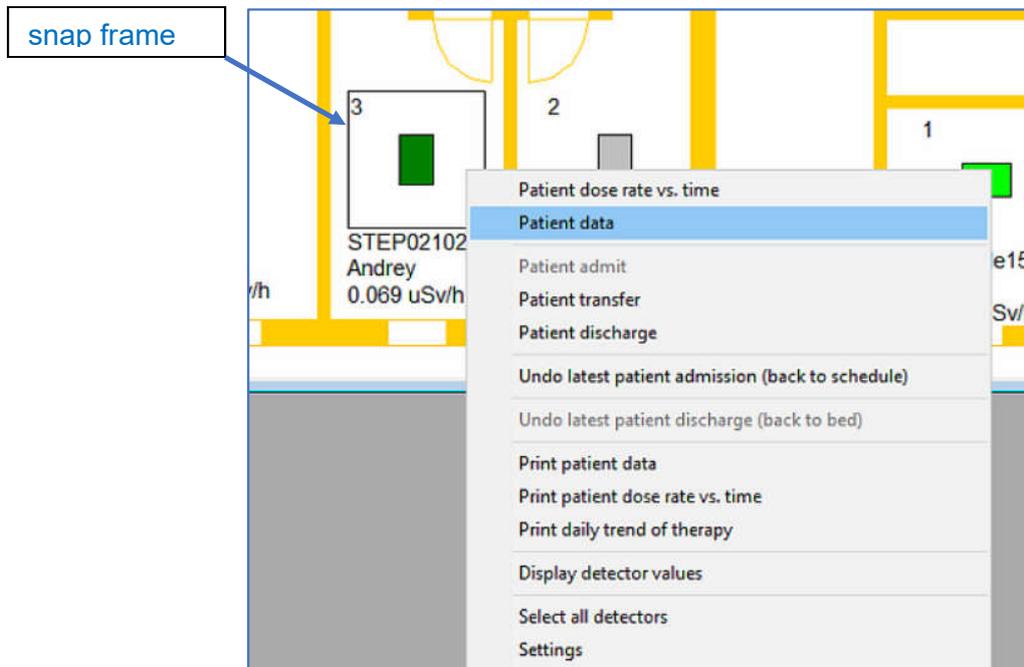
Standard / recommendation:

Show extrapolated value, i.e. the calculated dose rate in  $\mu\text{Sv}/\text{h}$  of the patient at the set distance (1m / 2m) depending on the setting:



### Select bed / patient and open context menu "Bed"/ "Detector":

If a bed is selected with the mouse, a catch frame appears. If the right mouse button is then pressed, the context menu for the bed / patient appears:



Using this context menu, the following operations can be performed for the selected bed / patient:

- Display + print out patient data and dose rate history
- Admit, transfer and discharge patients
- Cancel / Undo last patient admission (Move back to planner)
- Cancel / Undo last patient discharge (Reload from archive)
- Display of the current measured value curve of the bed
- Setting of detector, Location in plan, Size catch frame,...

### **Zoom in ward plan window:**

A zoom function is implemented within the ward plan window for a close look at details. To do this, hold down the left mouse button and adjust the new zoom window from top left to bottom right. Up to 99 zoom windows are possible. Use the ESC key to return to the previous zoom window. The title bar of the ward floor plan window shows the number of the current zoom window:



### **Move the ward plan with arrow keys:**

In addition to the zoom function, you can move the visible area in each ward plan window using the arrow keys.

### 3.2 Admitting patients - starting therapy

A patient can be admitted to bed in 2 different ways, depending on the settings:

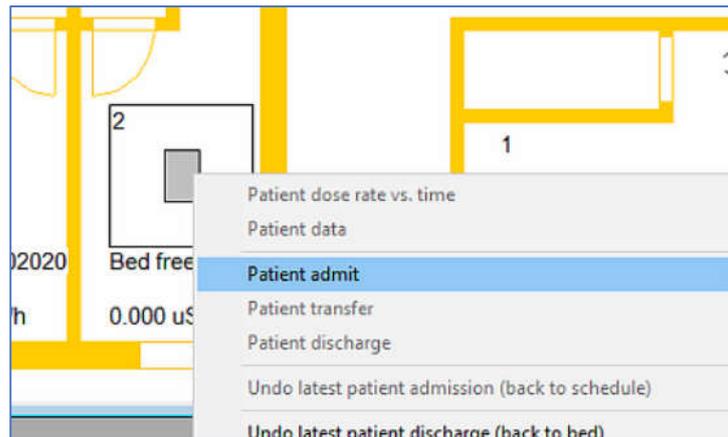
- Direct admission without using planner
- Indirect admission by using planner << recommended method

The recommended method is active, but can be changed by the administrator / manufacturer.

Advantage:

By using the planning window, current and planned therapies are clearly visible with different color's . The result is a better occupancy of the beds.

In general, a free bed must be selected with the mouse in the floor plan window. And open the context menu after the snap frame appears:

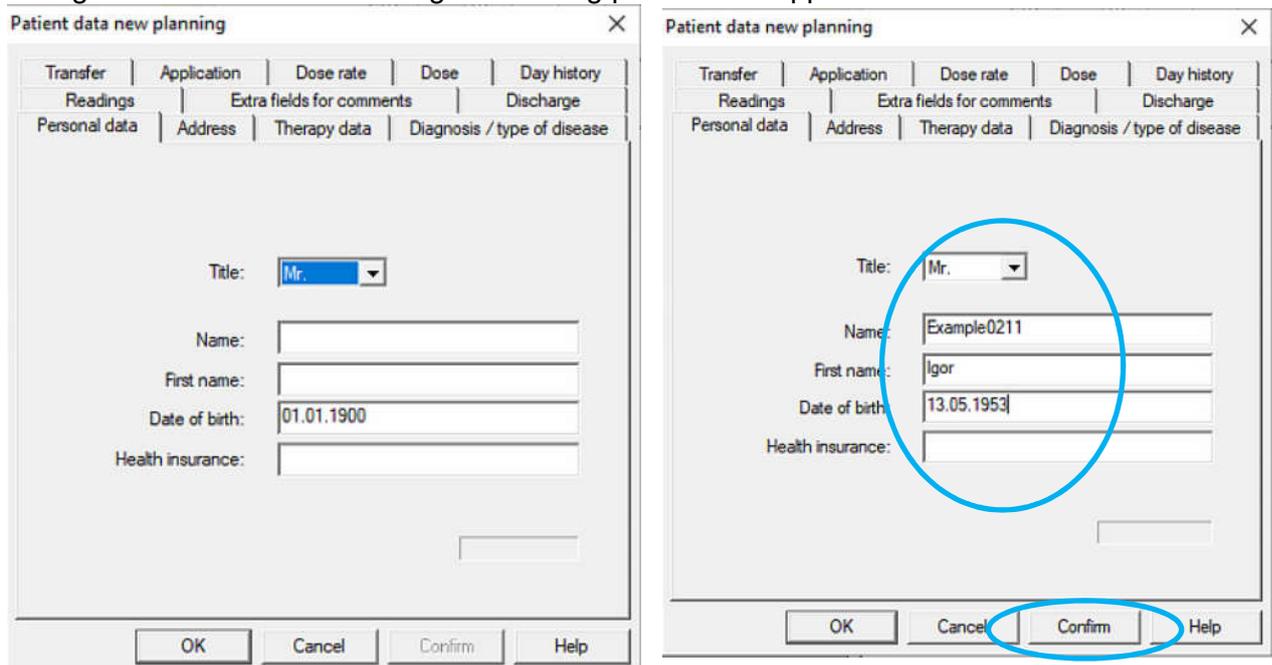


The rest of the procedure differs depending on the selected admission option:

- Direct admission or
- Indirect admission from planner

#### 3.2.1 Direct admission

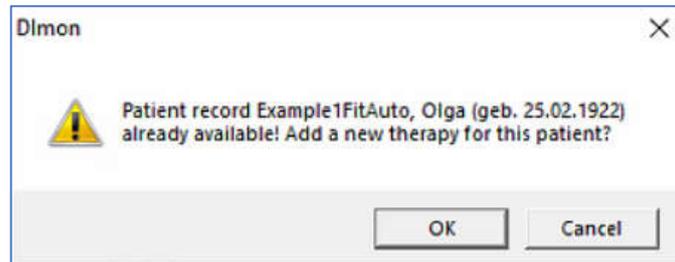
During direct admission the dialog for entering patient data appears:



Here the patient data gender / form of address, surname, first name and date of birth must be entered as unique patient data.

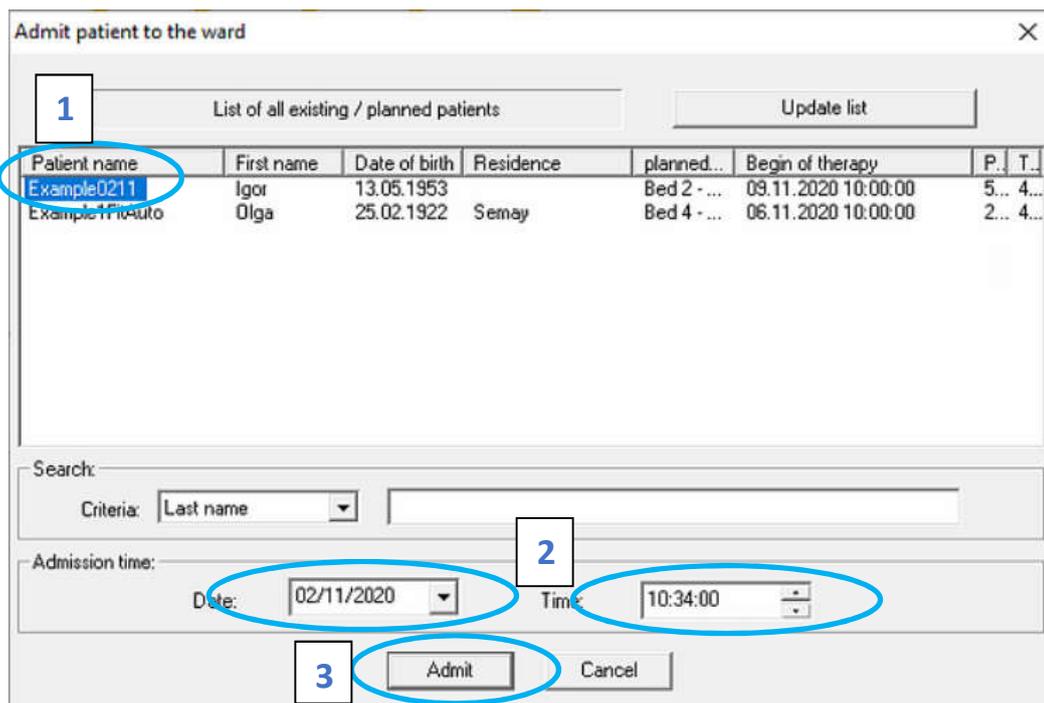
Then press 'Confirm' and 'OK'.

If the patient has already received a therapy in the past, which is stored in the archive, the info:

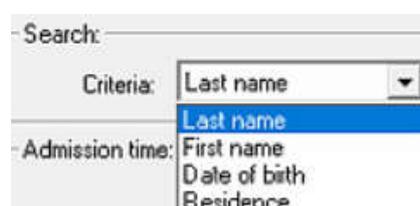


### 3.2.2 Indirect admission from planner

With indirect admission, the patient and his therapy data is completely created in the planner. Therefore a dialog box with a list of all planned patients appears:



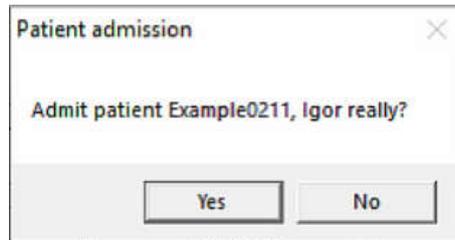
Use the mouse to mark the corresponding patient in the first column with a mouse click. With extensive lists, the list can be limited by a search function. You can search by name, first name, date of birth and place of residence:



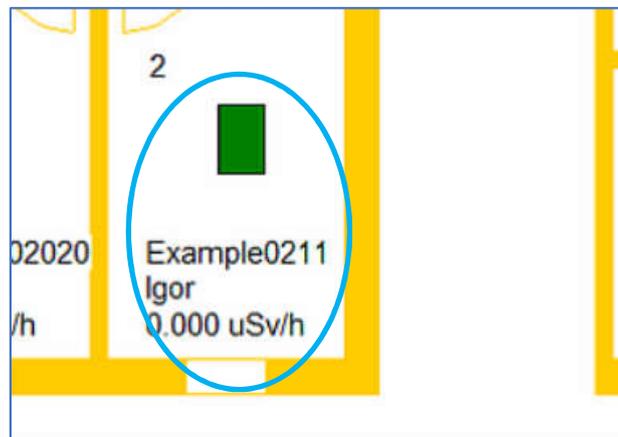
Please pay attention to upper and lower case!

With the button  the list can be reloaded from the database. This takes into account the fact that the list of planned patients can be changed in the background (e.g. on another client computer).

After selecting a patient or entering a new patient, the admission is performed. Before this, a security question must be confirmed:



Now the patient is confirmed to the selected bed:

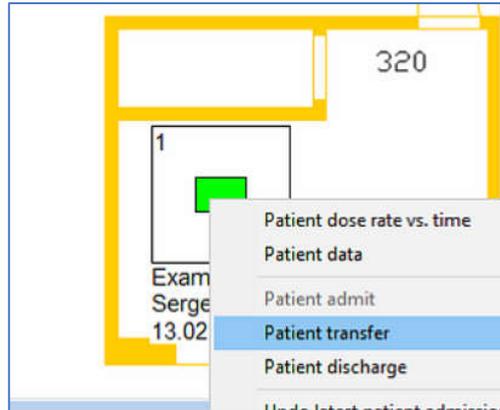


The planned therapy activity is taken over.. This value can later be corrected via patient data - therapy data.

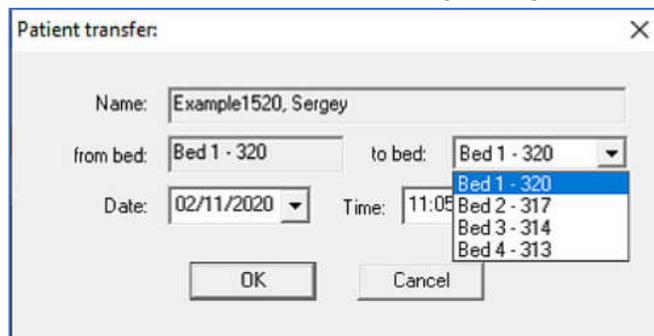
The planned duration of therapy is also taken over.

### 3.3 Transfer patients to another bed

Transferring a patient to another bed is also done in the floor plan window. The patient to be transferred is selected with the mouse and the context menu is opened with the right mouse button:

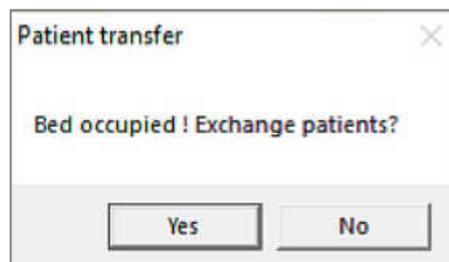


The time and destination can be selected in the following dialog box:



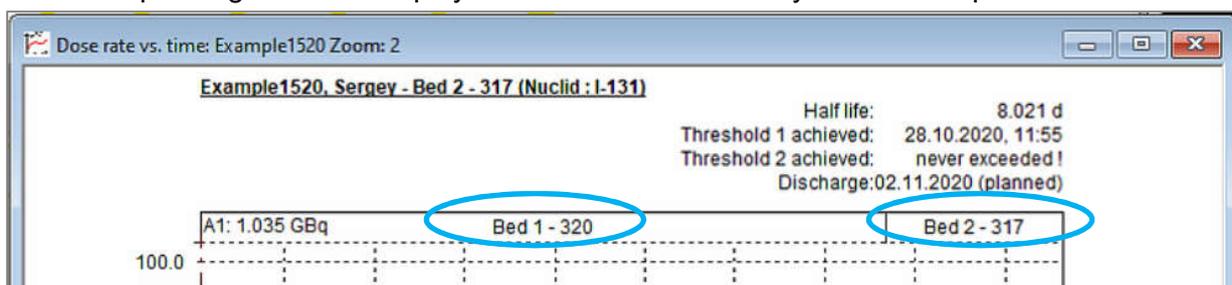
The patient is then transferred by pressing the "OK" button.

If the new bed is not free, the following dialog box recommends exchange the patients:



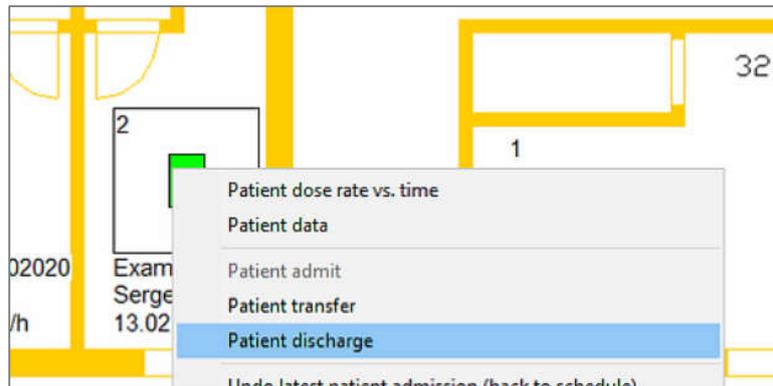
After confirmation with the "Yes" button, the patients are exchanged / transferred.

The corresponding beds are displayed in the dose rate history header of a patient:



### 3.4 Discharge patients - end of therapy

Use the mouse to select the bed with the patient in the ward plan window and open the context menu :



Via the menu item "Discharge Patient" the discharge of the patient is initiated:

Discharge a patient:

Patient: Example1520, Sergey

Data of discharge:

Date / Time: 02/11/2020 11:28:00

Enter dose rate, measured by physician (optional) !

Dose rate [ $\mu$ Sv/h]: 13.005 @ 1.0 [m]

Discharge activity [MBq]: 220 Please check the program value

Note:

Optionally, note comments on the discharge here

Print options:

Print patient data  Print patient diagram (dose rate vs. time)  Print day overview with mean values of dose rate

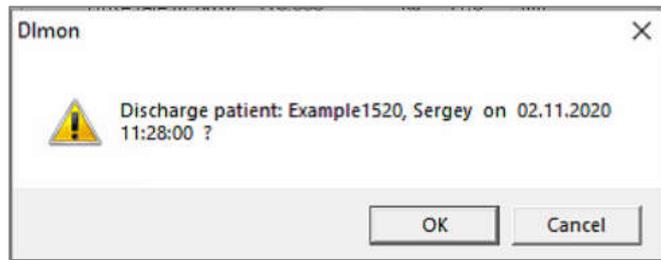
Discharge Cancel

Check the values with a calibrated hand-held measuring device

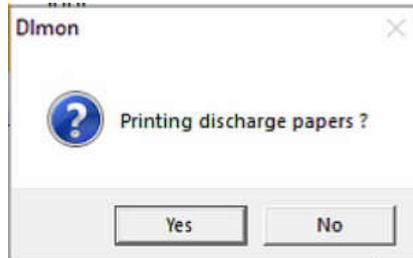
The following data can be entered:

- current date/time of discharge (can also be dated back!)
- Measured local dose rate at the prescribed distance
- Discharge notes (therapy related)

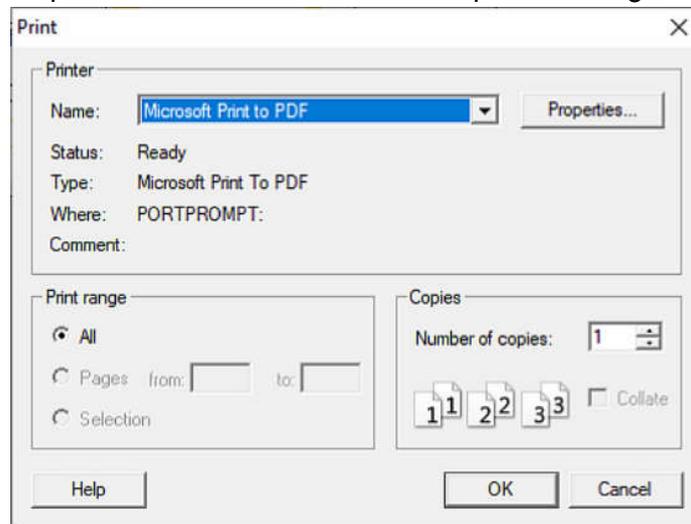
After pressing the "Discharge" button, a security prompt appears:



If you have select print options, you must confirm the print out:



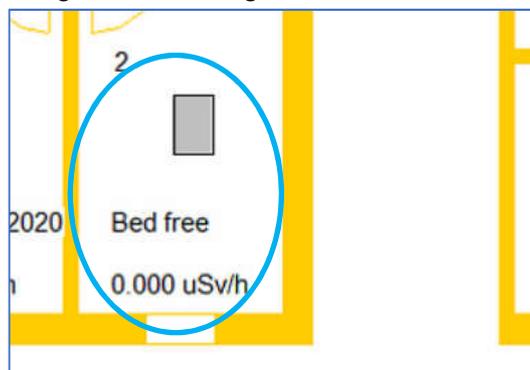
You can then select the printer in the standard Windows printer dialog box.



When printing the dose rate history, the printer should be set to "Landscape".

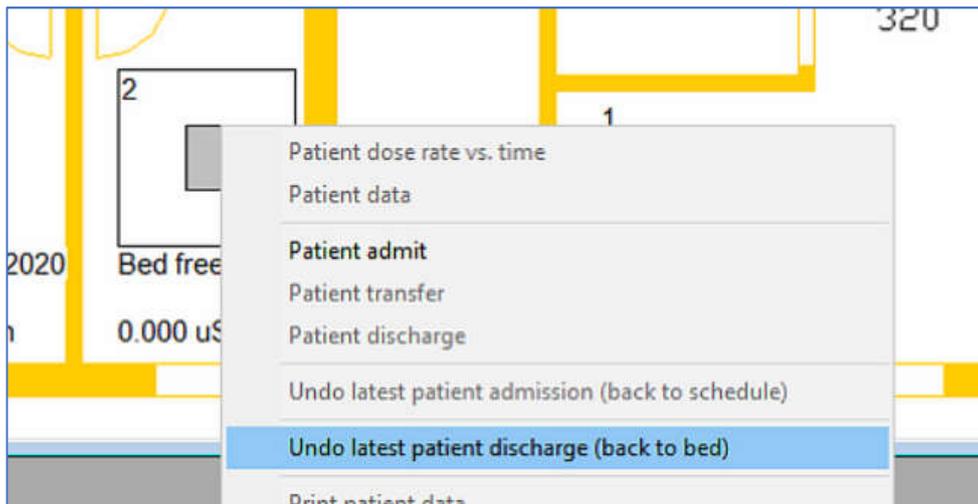
Note: All data can be printed later from the archive at any time.

After printing, the corresponding bed is free again:

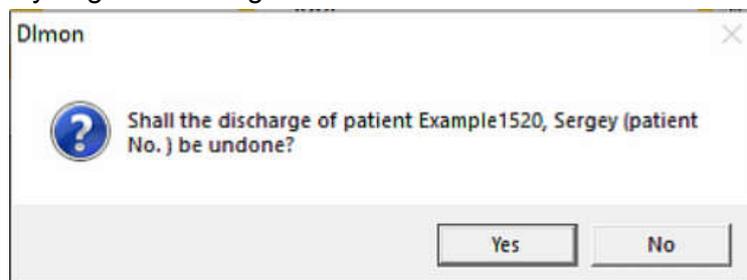


Note: You can cancel the last discharge until a new/other patient is admitted to this bed!

Please use the menu item:



After select the item you get the dialog box to confirm:



Then the patient is put back into bed with all his data and can be discharged at a later date.

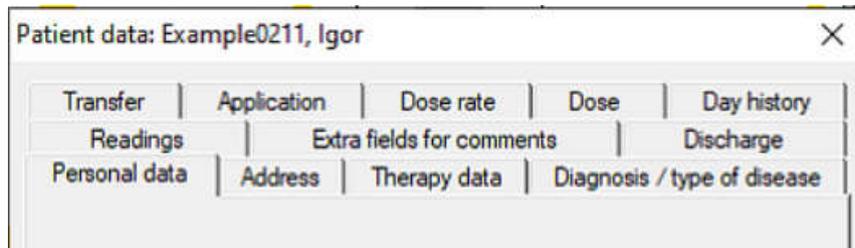
**Note:**

If the bed has already been occupied with the next patient, it is not so easy to return the previous patient in bed.

Please contact the administrator. The problem can be fixed manually in the database.

### 3.5 Display, input and print out of patient data

After selecting the corresponding bed and calling up the context menu, the following therapy / patient data are displayed on separate sheets:



The individual sheets / tabs and their data are described below.

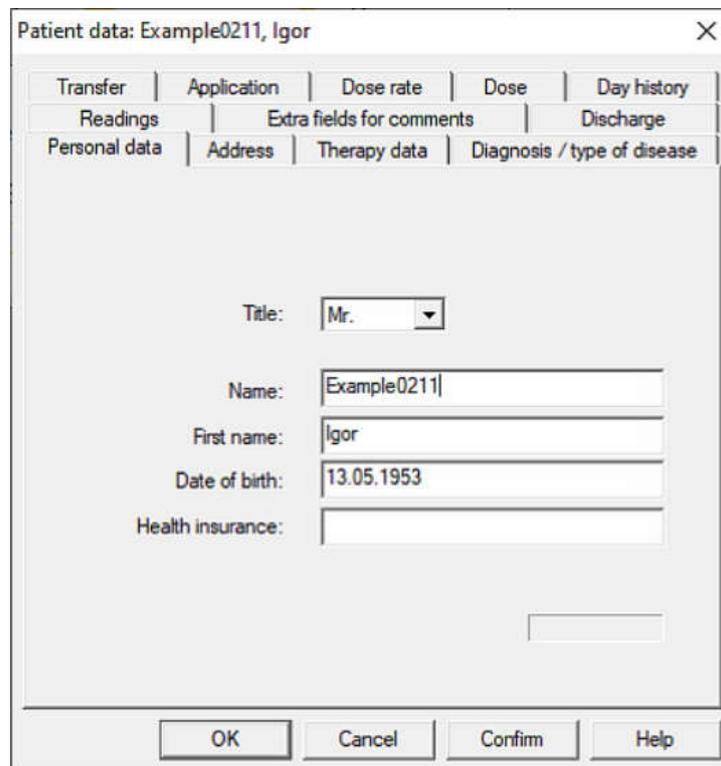
All data are therapy-related, i.e. if a patient receives several therapies, a separate record is created in the database for each therapy.

Important to confirm data:

If changes are made, always accept them first with  and as second press  !



#### 3.5.1 Personal data



The screenshot shows the "Personal data" tab selected in the "Patient data: Example0211, Igor" window. The form contains the following fields:

- Title:  (dropdown menu)
- Name:
- First name:
- Date of birth:
- Health insurance:

At the bottom of the window, there are four buttons: "OK", "Cancel", "Confirm", and "Help".

Note:

Name, first name, date of birth and gender are the characteristics used to **identify** a patient in the database.

### 3.5.2 Address

Patient data: Example0211, Igor

Transfer	Application	Dose rate	Dose	Day history
Readings	Extra fields for comments		Discharge	
Personal data	Address	Therapy data	Diagnosis / type of disease	

Road / Street:

House number:

Place of living / residence:

Postcode:

OK Cancel Confirm Help

### 3.5.3 Patient therapy data

Patient data: Example0211, Igor

Transfer	Application	Dose rate	Dose	Day history
Readings	Extra fields for comments		Discharge	
Personal data	Address	Therapy data	Diagnosis / type of disease	

Internal patient number:

Type of disease:  ?

Start of therapy :

End of therapy :

Radio iodine test:  Days before therapy:

Time of 1st application:

Number of applications:

Total appl. Activity in [GBq]:

Therapy nuclide:  For this bed available nuclides:

physical half-life:

Gamma doserate constant:  [ $\mu\text{Sv} / \text{h} / \text{GBq} \cdot \text{m}^2$ ]

Nuclide correction factor:

OK Cancel Confirm Help

Patient number	Internal hospital number to identify the patient
Type of disease	Adjustable in the sheet 'Diagnosis' For disease type 'Other' the nuclide can be selected
Admission date	Start of therapy for the patient
Discharge date	Therapy end (planned) Corrected automatically if patient stays longer on ward Starting time is taken over from planning according to the therapy duration
Radio-Jod-Test	If a radio-iodine test (whether outpatient or inpatient) is planned before the actual therapy, then enter it here. Days before therapy: >> Important for planning to order capsules for testing
Time 1. application	For your information, same data as in the 'Application' tab
Data on the nuclide	For your information, data from nuclide database
Available nuclides	The list of available nuclides is entered by the system administrator and is effective when selecting 'Other' disease type in sheet 'Diagnosis'

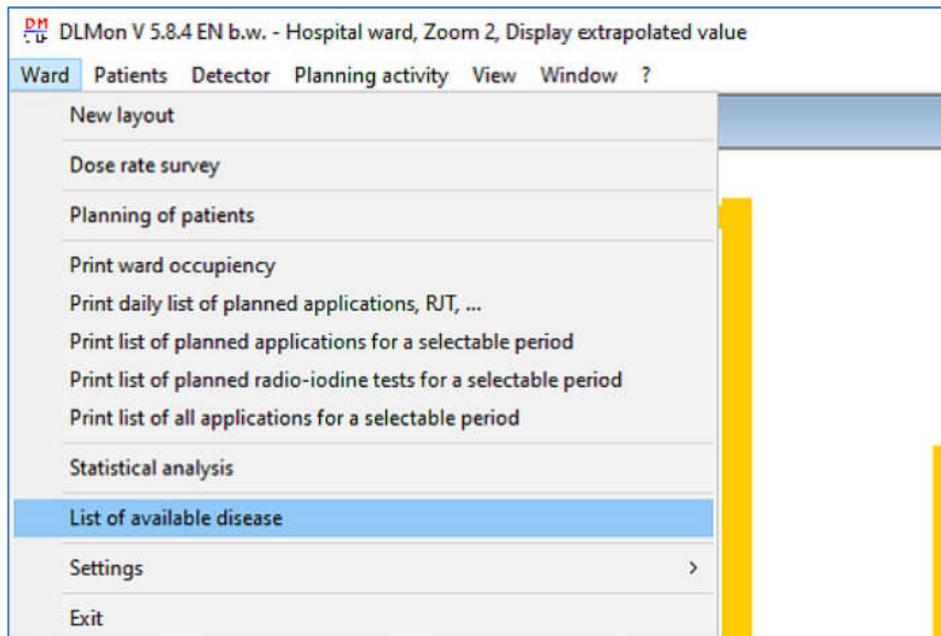
### 3.5.4 Diagnosis - selection of available disease types

Here the type of disease is selected from the table of available disease types.

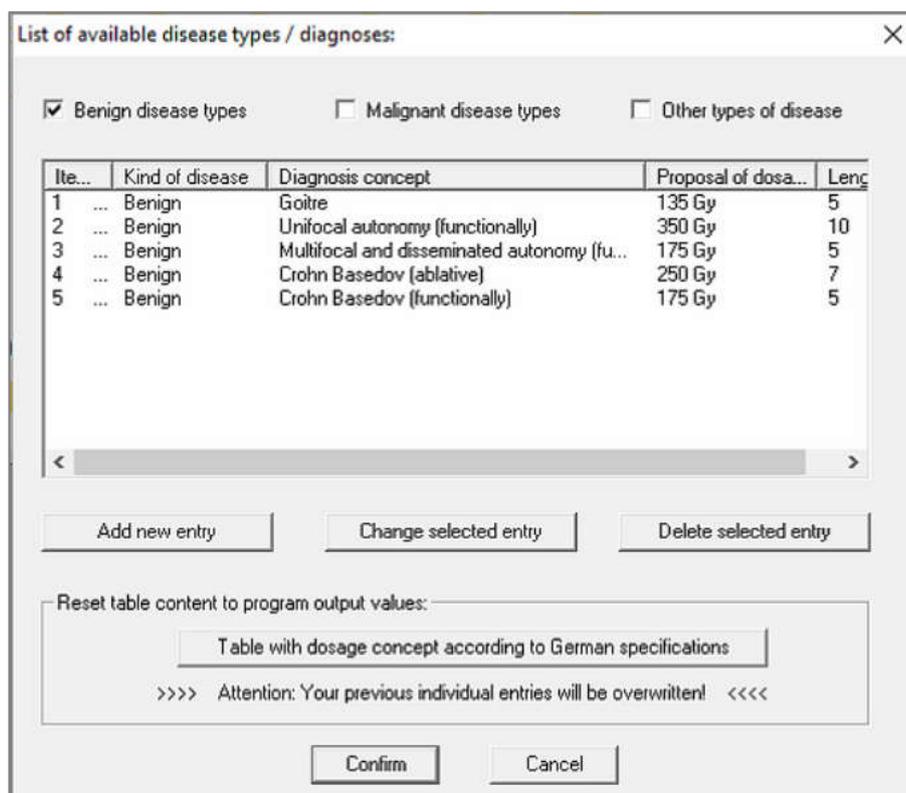
The exact selection of the type of disease is particularly important when using the planner, since the planned duration of therapy can be calculated more precisely due to the type of illness. In

addition, the selection 'Other Disease' is important for changing the therapeutic nuclide, which is always I-131 in benign and malignant diseases!

The list of available disease types is predefined by the administrator and can be called up via the menu:



After entering the password, the dialog box for entering the possible types of disease appears:



Here you have the possibility to individually create / edit all types of diseases of the hospital.

### 3.5.5 Bed occupancy - Table with all transfers

Designation	Transfer to	Transfer time
Patient admission	in Bed 2 - 317	02.11.2020 10:00:00
1. Transfer	in Bed 1 - 320	02.11.2020 11:05:22

Here is a list of all previous transfers of this patient during the current therapy.  
For selection: please click with the mouse in the 1st column on the corresponding entry.  
Use the "Change" button to change the transfer bed and the time (but not the bed of the last transfer):

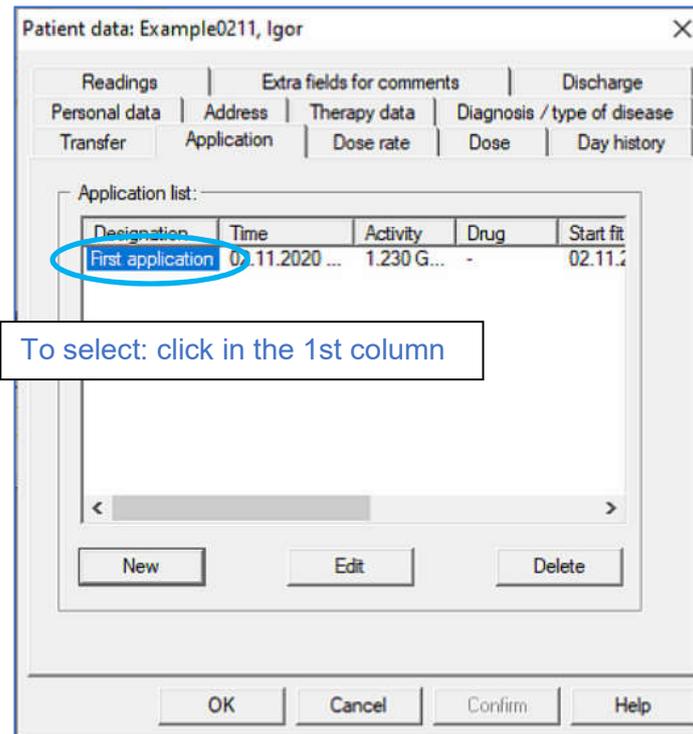
Name: Example0211, Igor  
from bed: Bed 2 - 317 to bed: Bed 1 - 320  
Date: 02/11/2020 Time: 11:05:22

The exact time of transfer is important for the assignment of the measured values of the different detectors to the patient.

**Attention:** No transfer are entered in this dialog box, only changes to existing transfers!  
Only the time of a transfer can be corrected.

No checks for incorrect entries are made at this point. Overlaps, double assignments and incorrect measured value assignments can be the result.

### 3.5.6 Applikation

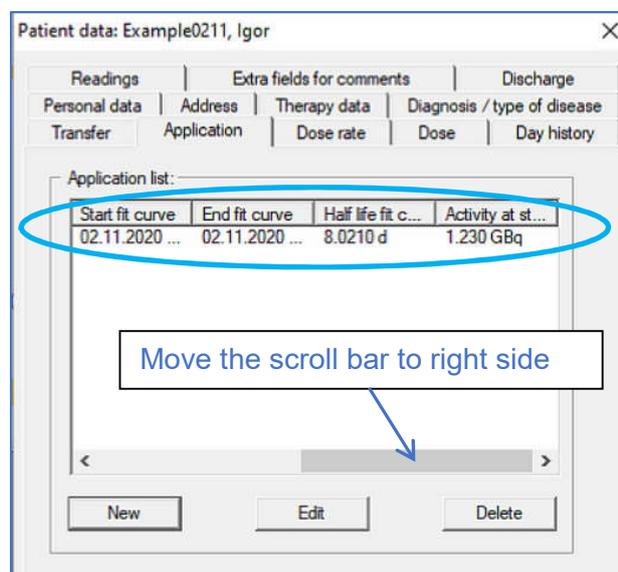


Here is a list of all previously performed applications in the current therapy. With the buttons "New", "Change" and "Delete" applications can be added, existing applications can be changed or deleted.

For selection: please click with the mouse in the 1st column on the corresponding entry.

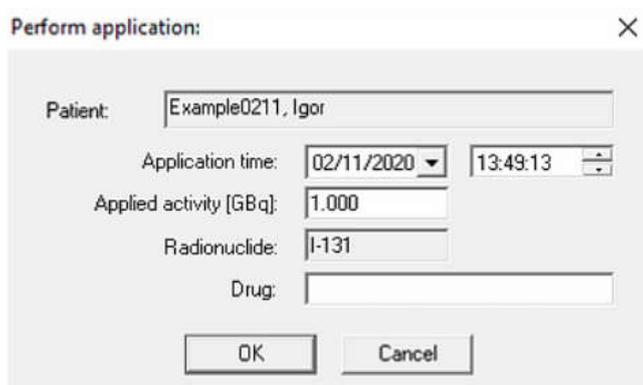
Besides activity and time of the application, parameters of the compensation calculation during the relevant period are displayed:

- Fit-Begin
- Fit- End
- Determined effective half-life from FIT curve
- the start activity, calculated from FIT curve of dose rate at application time (for multiple application: Sum of residual activity from previous application + newly applied activity)



### 3.5.6.1 Enter new application

After pressing the  button, the dialog box for entering a new application appears:



The 'Perform application' dialog box contains the following fields:

- Patient: Example0211, Igor
- Application time: 02/11/2020 13:49:13
- Applied activity [GBq]: 1.000
- Radionuclide: I-131
- Drug: (empty)

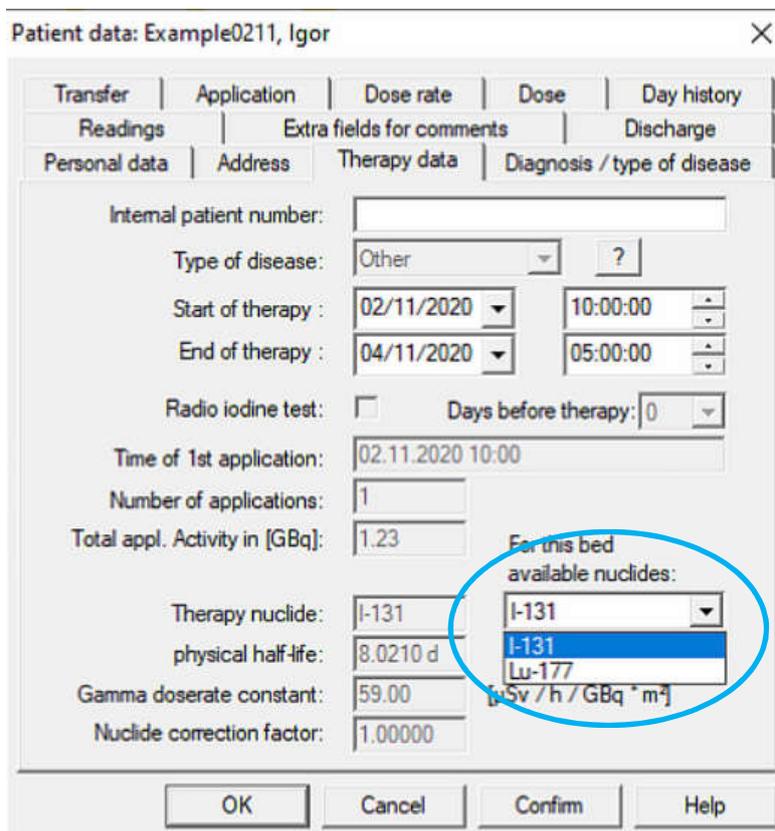
Buttons: OK, Cancel

In addition to time, the applied activity of the application must also be entered in [GBq]. The field 'Drug' is for information only.

Note: A new application is always added at the end of the list and must therefore be after the last application!

#### Selection of the therapy nuclide:

The active therapeutic nuclide for benign and malignant diseases is always I-131 and fixed. If the option 'Other disease' was selected under Patient data >> Diagnosis, then you can change the therapy nuclide under Patient data >> Therapy data:



The 'Patient data' dialog box for 'Example0211, Igor' shows the following details:

- Transfer | Application | Dose rate | Dose | Day history
- Readings | Extra fields for comments | Discharge
- Personal data | Address | Therapy data | Diagnosis / type of disease
- Internal patient number: (empty)
- Type of disease: Other
- Start of therapy: 02/11/2020 10:00:00
- End of therapy: 04/11/2020 05:00:00
- Radio iodine test:  Days before therapy: 0
- Time of 1st application: 02.11.2020 10:00
- Number of applications: 1
- Total appl. Activity in [GBq]: 1.23
- Therapy nuclide: I-131
- physical half-life: 8.0210 d
- Gamma dose rate constant: 59.00 [Sv / h / GBq \* m<sup>2</sup>]
- Nuclide correction factor: 1.00000

A blue circle highlights the 'For this bed available nuclides:' dropdown menu, which lists I-131 and Lu-177.

Buttons: OK, Cancel, Confirm, Help

### 3.5.6.2 Changing an application

After pressing the "Change" button, a selected application (activity, time) can be changed. The same dialog box appears as for a new application.

### 3.5.6.3 Delete an application

After selecting an application to be deleted in the list of available applications and pressing the "Delete" button, this application is removed from the list.

### 3.5.7 Dose rate

Current dose rate	Calculated dose rate (not actual measured value!) corresponding to the active measured values and the calculated half-life from FIT curve
related to	current reference distance of the displayed dose rate Default as station value, valid for the complete station Germany: 2m , Austria 1m, Kazakhstan: 1m
Calculated effective half-life	Actual calculated half-life If no calculation with measured values is possible: >> the software take the physical half-life.
Fit line Start	Start time for regression analysis >> FIT curve (Standard: application

	time) Due to the semi-logarithmic representation, the FIT curve follows with the half-life as negative rise. The FIT curve is displayed as a red line in the patient dose rate history.
Fit line Start End	End time for regression analysis >> FIT curve
Threshold 1	Dose rate limit value 1 in [ $\mu\text{Sv/h}$ ], fixed, depending on nuclide and location / country / region
Threshold 2	Dose rate limit value 2 in [ $\mu\text{Sv/h}$ ], fixed, depending on nuclide and location / country / region
achieved at	The system calculates the time when the respective limit value is reached by the patient. Basis is the FIT curve. The time can be used to estimate the length of stay / duration of therapy at an early stage.

### 3.5.8 Dose

This page is used to enter data for benign diseases:

- input data from the radio-iodine test
- calculation of the start activity, depending on the planned target dose
- display of the achieved Focal dose for 1. / 2. applications

Desired dose in [Gy]	Planned target dose, which can be entered / changed in sheet 'Diagnosis' for benign diseases, depending on the kind of disease
Uptake from RJT test in [%].	Determined uptake value in [%] from ambulatory / stationary

	radio-iodine test, is needed to calculate the planned start activity
Half-life from RJT test in [d]	Determined half-life in days from ambulatory / stationary radio-iodine test, is needed to calculate the planned start activity
Focus volume of thyroid gland in [ml]	Fixed / known / determined volume of the thyroid gland in [ml]
Dose factor	Dose factor according to method of 'Sabri' to calculate the starting activity according to formula 'Marinelli' See calculation under point 3.12.1 'Basics' for planning the start activity
Activity	Start activity in [MBq] calculated by the system according to formula 'Marinelli'
Duration	Lie down time calculated by the system, based on the calculated start activity and the data from the radio iodine test
Achieved total dose in [Gy]	Based on the regression curve ( half-life) in the patient dose rate diagram, the system calculates the achieved focal dose according to:  $D = ( A_0 * \text{Uptake} * \text{HWZ} ) / F * m$ with: $A_0$ ... applied therapy activity in [MBq] Uptake ... Uptake in [%] from dose rate curve or RJT test HWZ ... Half-life in [d] F ... Dose factor according to 'Sabri' m ... Volume / mass of the thyroid gland in [ml]

### 3.5.9 Daily overview - Development of the half-lives periods

Only important for benign therapy.

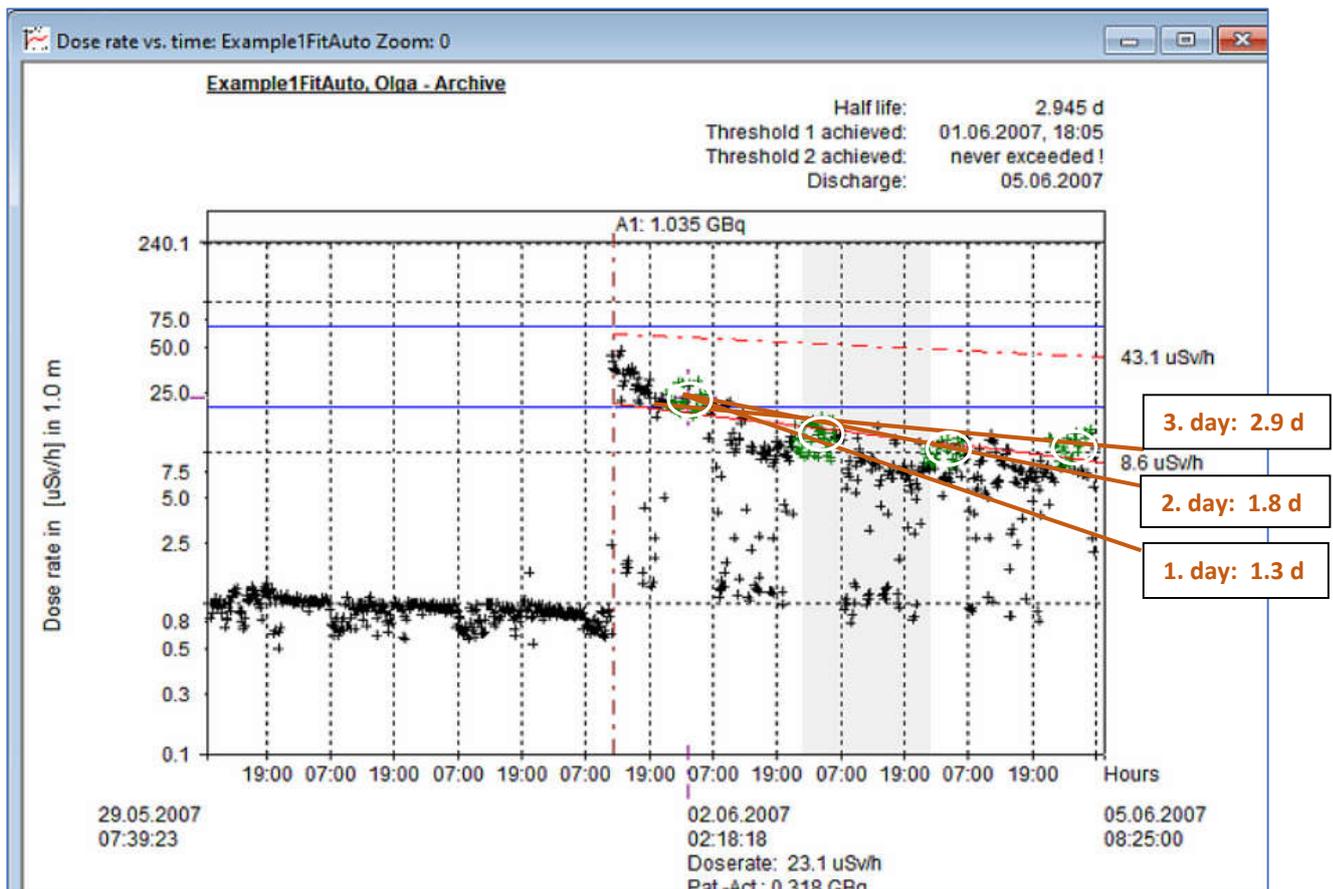
The daily overview shows the development of the half-life, based on the development of the dose rate per day.

At the beginning of benign therapy, the drop in dose rate is greater and therefore the half-life is shorter.

At the end of the benign therapy the half-life increases.

The daily overview shows this tendency of dose rate and half-life per day as an informative overview.

The following example shows the development of the half-life over 3 days.:



is based on the following daily overview:

Patient data: Example1FitAuto, Olga

Readings	Extra fields for comments	Discharge
Personal data	Address	Therapy data
Transfer	Application	Dose rate
		Dose
		Day history
Daily course of therapy / Daily course Half-life:		
Period	Average dose r...	Half life fit c...
1 Period: 29.05.2007 22:00...	0.0 uSv/h	-
2 Period: 30.05.2007 22:00...	0.0 uSv/h	-
3 Period: 31.05.2007 22:00...	0.0 uSv/h	-
4 Period: 01.06.2007 22:00...	26.9 uSv/h	3.051 d
5 Period: 02.06.2007 22:00...	16.1 uSv/h	1.309 d
6 Period: 03.06.2007 22:00...	11.6 uSv/h	1.784 d
7 Period: 04.06.2007 22:00...	13.0 uSv/h	2.945 d

Change doserate background per day

Declaration:

The first 3 days of therapy was the mean dose rate  $\geq$  the station background ( 0.0  $\mu$ Sv/h), because the application was applied on the 4th day

In the measured value interval of the night from the 4th to the 5th day the mean DL = 26.8  $\mu\text{Sv/h}$ , but the HWZ was not calculable. No regression curve can be calculated with the measured values of the 1st night (after application)

In the therapy period 4th - 6th day a half life is = 1.3 days was calculated

In the therapy period 4th - 7th day a half-life is = 1.8 days was calculated

In the therapy period 4th - 8th day the final half-life is = 2.945 was determined.

### 3.5.10 Measured values / Readings

This sheet shows the total available measured values, in this example: 1006

In the upper area, the start time and the end of the therapy for this patient is displayed next to the number of available measured values.

Patient data: Example1FitAuto, Olga

Personal data | Address | Therapy data | Diagnosis / type of disease  
Transfer | Application | Dose rate | Dose | Day history  
Readings | Extra fields for comments | Discharge

Number of available measured values: 1006 Refresh

Therapy of: 29.05.2007 07:39:23 to: 05.06.2007 08:25:00  
Active detector: Main detector ?

Export to text file (processable in Excel):

Start time: 29/05/2007 07:39:23  
End time: 05/06/2007 08:25:00

all measured values in the time int  
 only measured values that are used for FIT line (green)

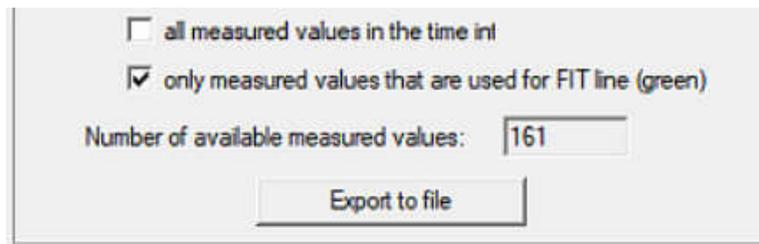
Number of available measured values: 161  
Export to file

OK Cancel Confirm Help

This sheet allows the export of measured values from the program into a Txt-file:

In the lower area, various options can be set before the actual export:

- Start and end of the time for measured value export
- Which measured values should be exported.

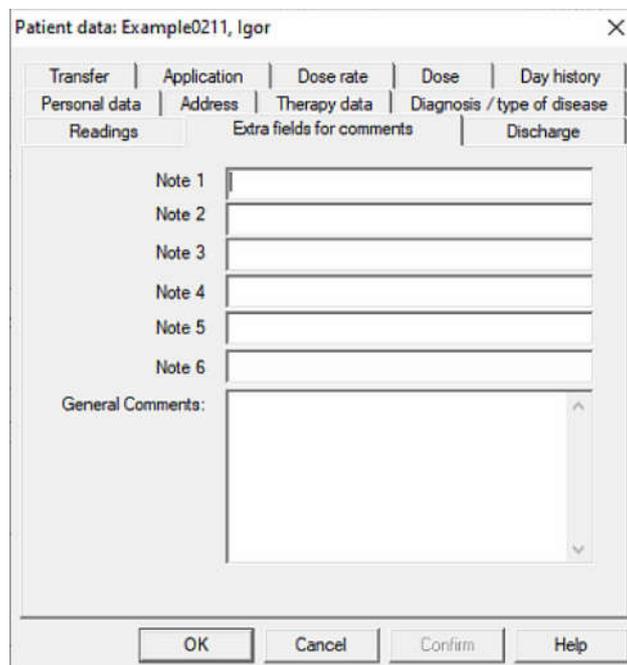


After pressing the 'Export' button, a Txt file with the following structure is created in the target directory:

Date / Time	Measured values for FIT
21.05.2002 12:44:49	6,6380e-002
21.05.2002 12:49:49	7,0758e-002
21.05.2002 12:54:49	9,9110e-001
21.05.2002 12:59:49	1,4035e+000
21.05.2002 13:04:49	5,7210e+000
21.05.2002 13:09:49	9,9013e+000
21.05.2002 13:14:49	1,6494e+000
21.05.2002 13:19:49	1,6757e+000

Due to the separation of time and measured value via tabs, importing the text file e.g. in EXCEL is possible without any problems.

### 3.5.11 Extras



For each patient there are 7 database fields per therapy, where information can be stored.

Note: The designations "Note 1" etc. can be changed to customer requirements.

### 3.5.12 Patient discharge

This sheet contains information about the discharge, the data are not editable. The current dose rate is displayed for patients who are still on the ward:

Patient data: Example0211, Igor

Transfer	Application	Dose rate	Dose	Day history
Personal data	Address	Therapy data	Diagnosis / type of disease	
Readings	Extra fields for comments	Discharge		

Patient discharge on: 07.11.2020 05:00:00 (planned)

Discharge dates:

Dose rate: 0.2 uSv/h @ 1.0 m [m]

Discharge activity [MBq]:

Notes:

Patient still on ward

OK Cancel Confirm Help

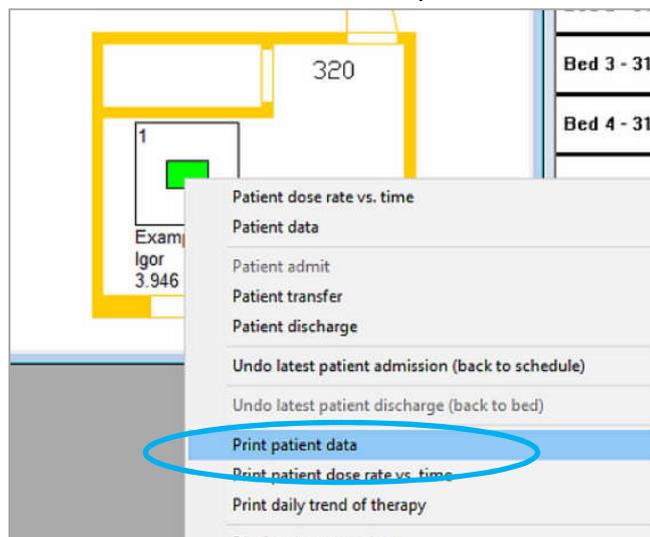
For archive patients (already discharged patients) the discharge data (dose rate, Discharge activity, Notes) displayed here.

### 3.5.13 Print out therapy data

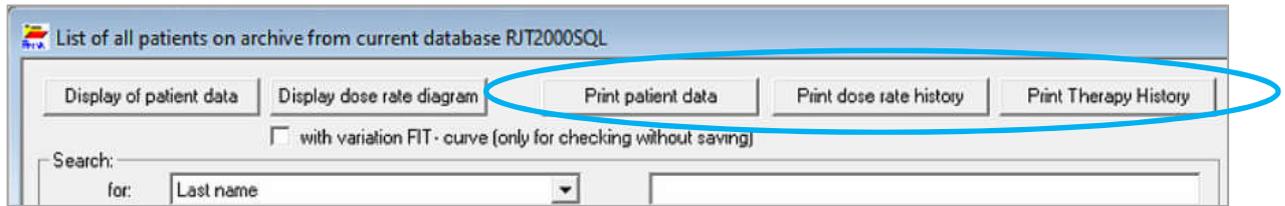
The print out of therapy data is possible at any time for patients who

- on ward
- or in the archive

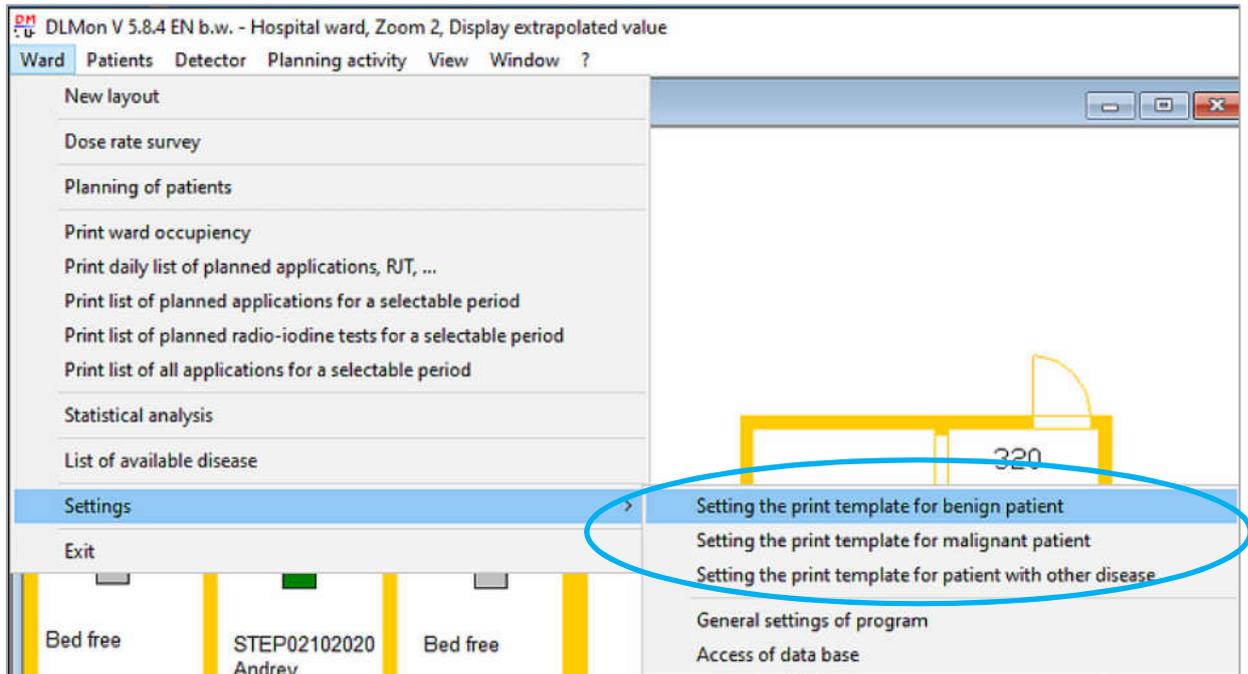
For patients on ward use the context menu in the floor plan window:



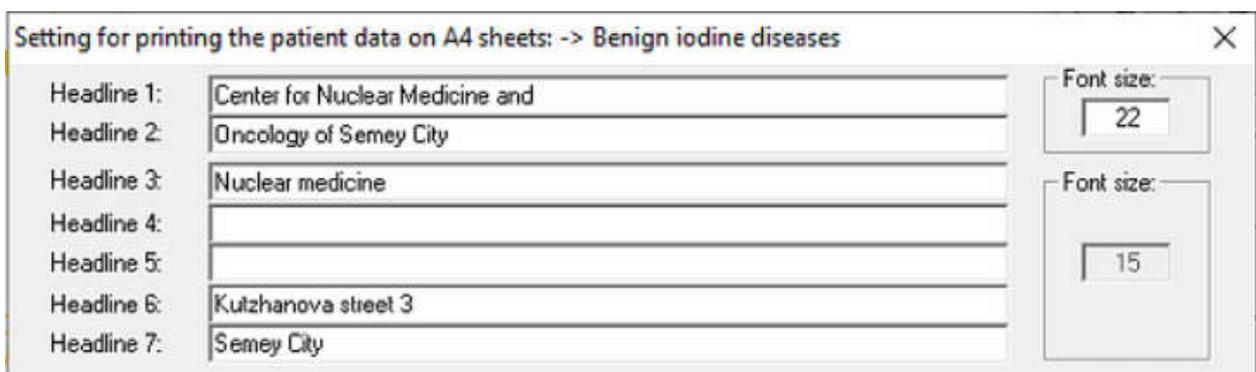
For archived therapies, use the print functions in the archive dialog box:



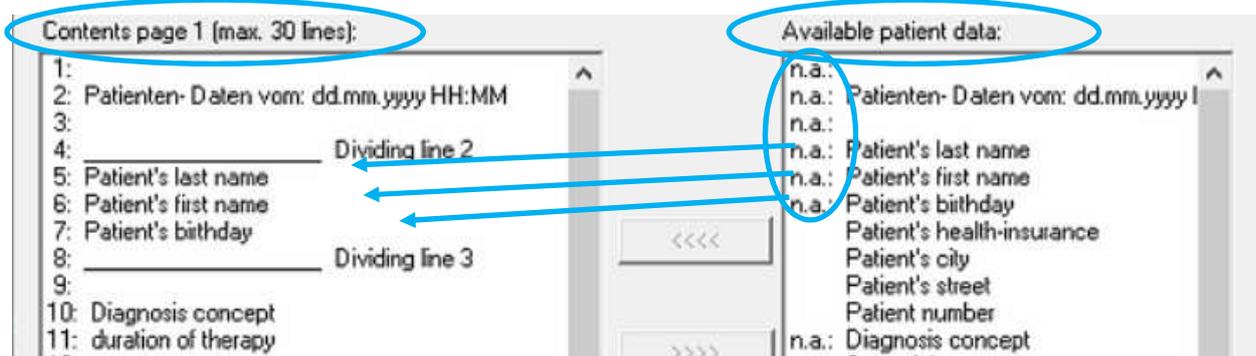
The print out of the therapy data can be customized depending on the type of disease (Benign / Malignant / Other). Use setting menus to change print out template :



The following can be set: header data, font height of heading, width of the margin, signature lines and all available database elements.



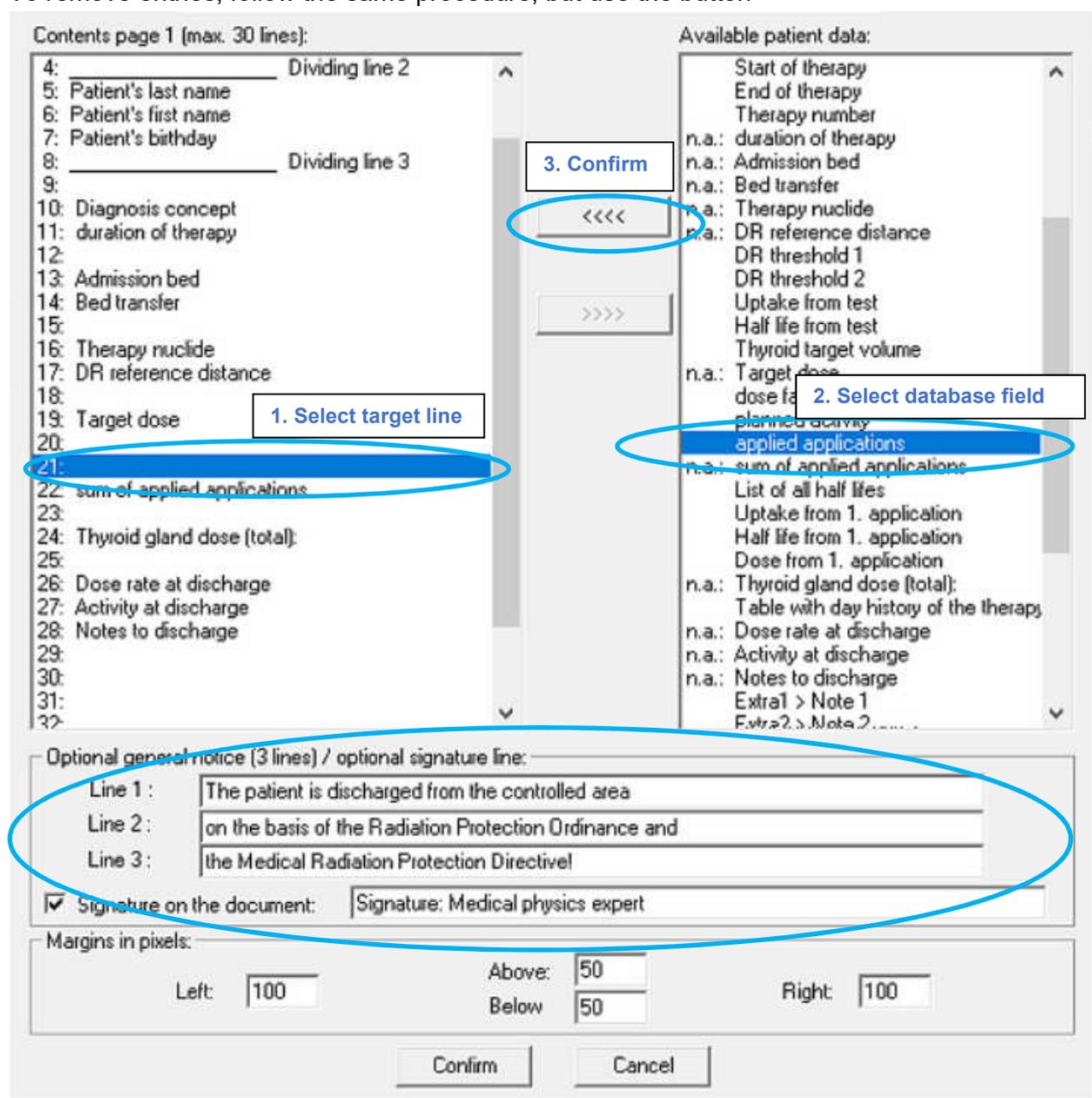
On the left side in dialog box you see the 30 available print lines and their current assignment. All available database elements are listed on the right. If there is a "n.a." in front of the database element, this element is 'not available' because already in use:



To assign a new database element to one of the 30 lines, proceed as follows:

1. selection the line on the left side
2. select the database element on the right
3. click button 

To remove entries, follow the same procedure, but use the button 



A fixed text with a maximum of 3 lines and a signature line can optionally be printed out in the lower part of the sheet

As a result you get the following print out for benign therapies on A4:

<b>Center for Nuclear Medicine and Oncology of Semey City</b>	
Nuclear medicine	
Kutzhanova street 3 Semey City	
Dosimetry Protocol from: 03.11.2020 11:38 ( Patient on ward )	
Last name	: Example0211
First name	: Igor
Date of birth	: 13.05.1953
Diagnosis concept	: Goitre
Therapy duration	: Patient currently on ward!
Admission bed	: Bed 2 - 317
Transfer 1	: in Bed 1 - 320 >> 02.11.2020 11:05 Uhr
Nuclide	: I-131
Dose rate reference distance	: 1.0 m
Target dose	: 135 Gy
Application 1	: 0.230 GBq >> 02.11.2020 10:00 Uhr
Overall applied activity	: 0.230 in GBq
Thyroid gland dose (total):	: 0 Gy
Discharge dose rate	: Patient currently on ward!
Discharge-activity	: Patient currently on ward!
 <b>Note:</b> The patient is discharged from the controlled area on the basis of the Radiation Protection Ordinance and the Medical Radiation Protection Directive!	
<hr/> <b>Signature: Medical physics expert</b>	

### 3.6 Patient planning process depending on the type of disease

The DLMon software allows the planning of the duration of therapy depending on the type of disease

- Benign thyroid diseases
- Malignant thyroid diseases
- Other diseases (e.g. Radio peptid Tx with Y-90, Radio peptid Tx with Lu-177,...)

This planning has the following advantages:

- Planning the duration of therapy in accordance with the clinic's specifications
- Colored overview of the planning depending on disease or gender
- optimal bed occupancy

E.g. Duration for benign disease:

Item...	Kind of disease	Diagnosis concept	Proposal of dose	Length...
1	Benign	Goitre	135 Gy	5
2	Benign	Unifocal autonomy (functionally)	350 Gy	10
3	Benign	Multifocal and disseminated autonom...	175 Gy	5
4	Benign	Crohn Basedov (ablative)	250 Gy	7
5	Benign	Crohn Basedov (functionally)	175 Gy	5

Planning a new patient should be done as follows:

1. Create Patient Name
2. Input of patient address (optional)
3. Selection of the type of disease in the 'Diagnosis' tab
  - 3.1 Planning malignant thyroid disease
  - 3.2 Planning benign thyroid disease
  - 3.3 Planning other disease
4. Planning of the start activity in the tab 'Dose' for benign diseases

Patient data: Example1FitAuto, Olga

Transfer | Application | Dose rate | Dose | Day history

Readings | Extra fields for comments | Discharge

1 Personal data | Address | Therapy data | Diagnosis / type of disease 3

2 ( optional ) 4

Title: Mrs.

Name: Example1FitAuto

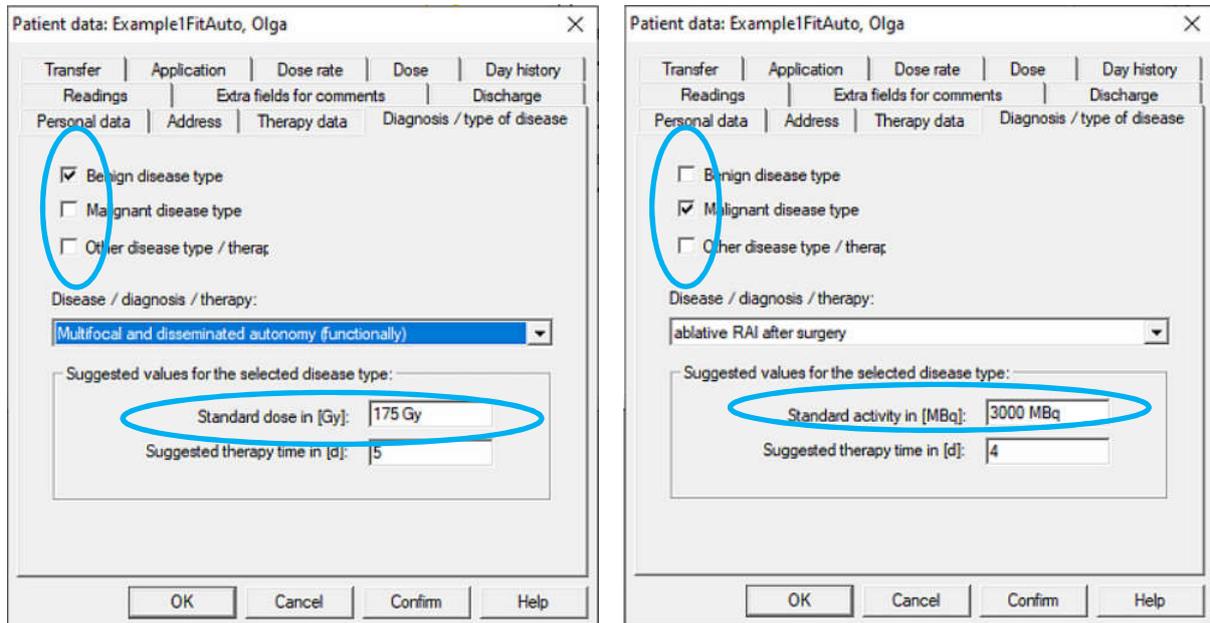
First name: Olga

Date of birth: 25.02.1922

Health insurance:

Select the type of disease in sheet 'Diagnosis / type of disease'

In the tab Diagnosis the type of disease can be selected until the time of the 1st application is reached: Benign / Malignant / Other

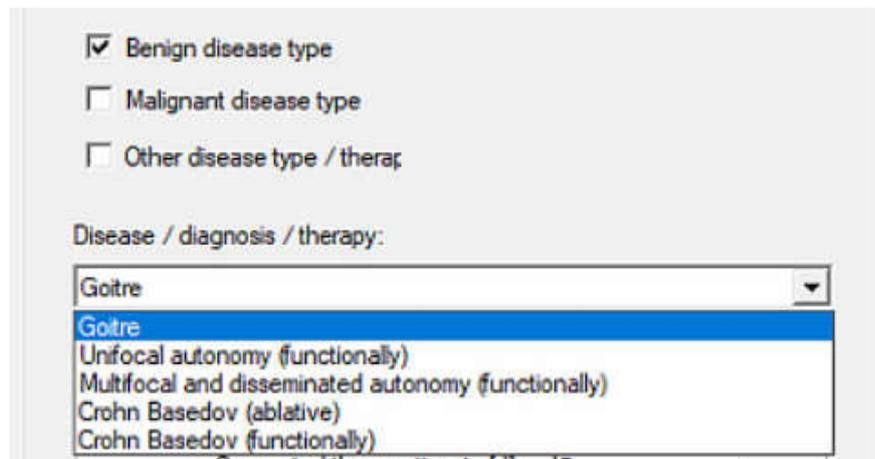


Different values are suggested depending on the disease:

for malignant / other: activity

for benign: dose

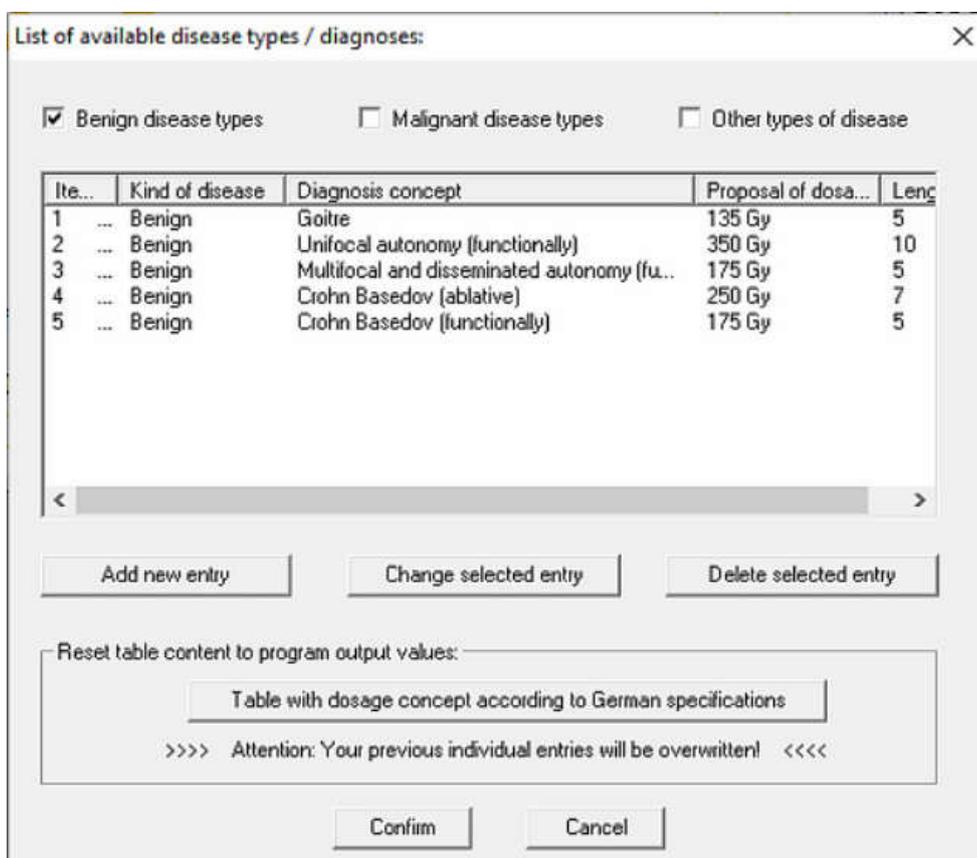
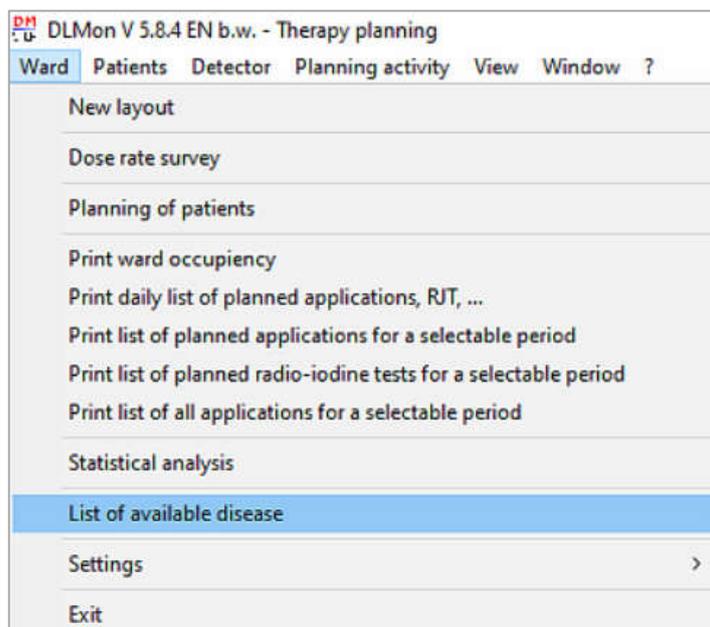
For each type of disease the available therapy can be selected from a list:



The default values dose or application activity and the Duration of therapy can be edited as long as the time of the 1st application has not been reached! I.e. also with patients on ward the data can be changed until the current system time has reached the 1st application time!

You can create and change the list of available types of illness in the menu:

Ward >> List of available diseases :



### 3.6.1 Malignant thyroid diseases / Other diseases

For malignant as well as other types of diseases in the list of available diseases is stored:

- the standard therapy activity and
- the standard duration time of therapy

Both therapy data are automatically transferred and can be changed individually!

The suggested standard activity is automatically confirmed as the 1st application activity

(Setting value in registry: `BoolWithTakePlannedApplicationAsFirstApplication` REG\_SZ true ):

Patient data: Example1FitAuto, Olga

Transfer | Application | Dose rate | Dose | Day history

Readings | Extra fields for comments | Discharge

Personal data | Address | Therapy data | Diagnosis / type of disease

Benign disease type  
 Malignant disease type  
 Other disease type / therap

Disease / diagnosis / therapy:  
ablative RAI after surgery

Suggested values for the selected disease type:

Standard activity in [MBq]: 3050 MBq

Suggested therapy time in [d]: 5

OK Cancel Confirm Help

Patient data: Example1FitAuto, Olga

Readings | Extra fields for comments | Discharge

Personal data | Address | Therapy data | Diagnosis / type of disease

Transfer | Application | Dose rate | Dose | Day history

Application list:

Designation	Time	Activity	Drug	Start fit
First application	06.11.2020	3.050 G...	-	06.11.2020

< [ ] >

New Edit Delete

OK Cancel Confirm Help

In case of malignant or other diseases no 'desired dose' and no 'resulting values' are displayed in sheet 'Dose' :

### 3.6.2 Benign thyroid disease

For the benign diseases in the list of available diseases is stored:

- the standard therapy dose and
- the standard duration time of therapy

Both therapy data are automatically transferred and can be changed individually!

In case of benign disease the suggested / editable value of the standard dose is transferred to the 'Dose' tab.

In addition, the sheet 'Dose' allows a more precise planning of the start activity and consequently of duration time with the available data from the RJT tests:

The start activity and duration of benign therapy is calculated on base of RJT test data (uptake, volume, .... ) as follows:

Planned duration of benign therapy in [d]:

$$T_{\text{Therapy}} = 1 + [ \ln ( A * \text{uptake} / 100 ) - \ln(250) ] * T_{\text{eff}} / \ln ( 2 )$$

( minimum time of duration: 4 days ! )

With planned therapy activity A:

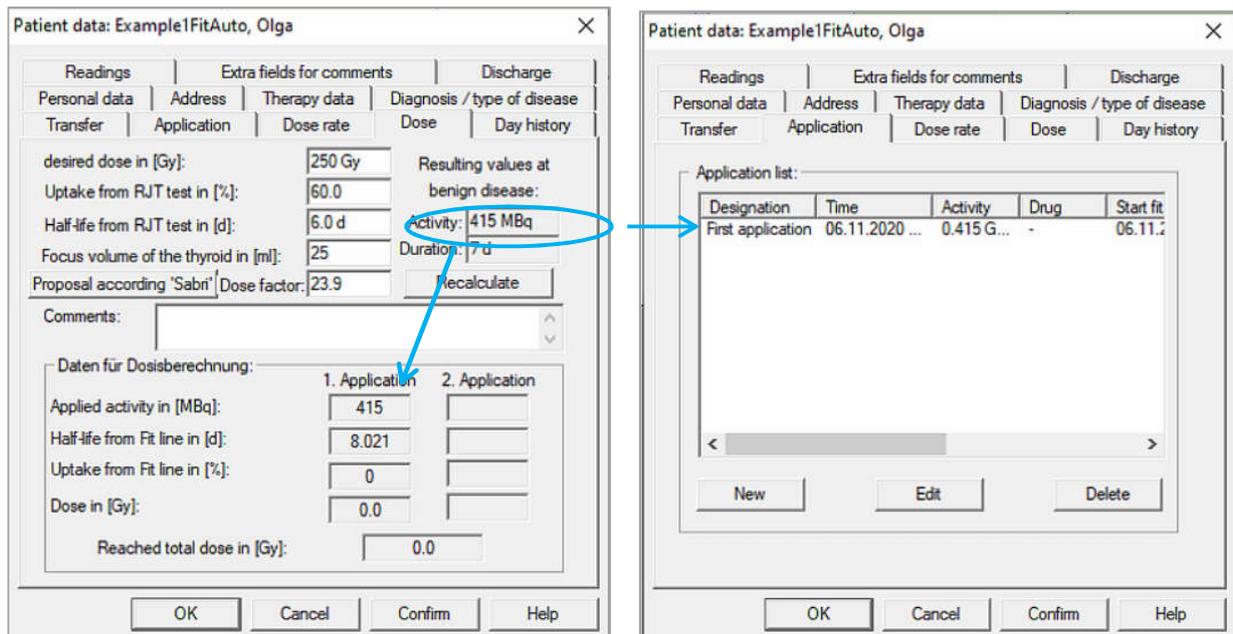
$$A = \frac{F \cdot D \cdot m}{Upt \cdot T_{1/2}}$$

Declaration:

- A ... planned therapy activity in [MBq]
- F ... Volume-related dose factor (according to 'Sabri')
- D ... desired target dose in [Gy]
- m ... Mass of thyroid in [ml] (sonography) (data from RJT test)
- Upt ... relative iodine uptake of thyroid gland in [%] (data from RJT test)
- T<sub>1/2</sub> ... Effective half-life of iodine storage (data from RJT test)

if the original data has been changed, recalculation takes place with the button Recalculate .

The calculated therapy duration has an effect on the end of the therapy and the calculated activity is taken over as the 1st application activity:



### 3.6.3 Write protection in sheet 'Dose'

In case of malignant / other diseases all input fields / buttons are write-protected, because the therapy activity is determined by the diagnosis:

Patient data: STEP02102020, Andrey

Readings	Extra fields for comments	Discharge
Personal data	Address	Therapy data
Transfer	Application	Diagnosis / type of disease
	Dose rate	Dose
		Day history

desired dose in [Gy]:

Uptake from RJT test in [%]:

Half-life from RJT test in [d]:

Focus volume of the thyroid in [ml]:

Proposal according 'Sabri' Dose factor:

Resulting values at benign disease:

Activity:

Duration:

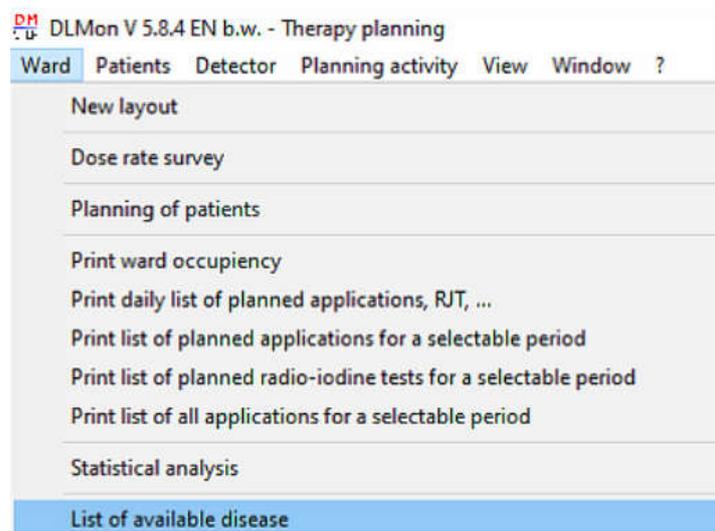
Comments:

Daten für Dosisberechnung:

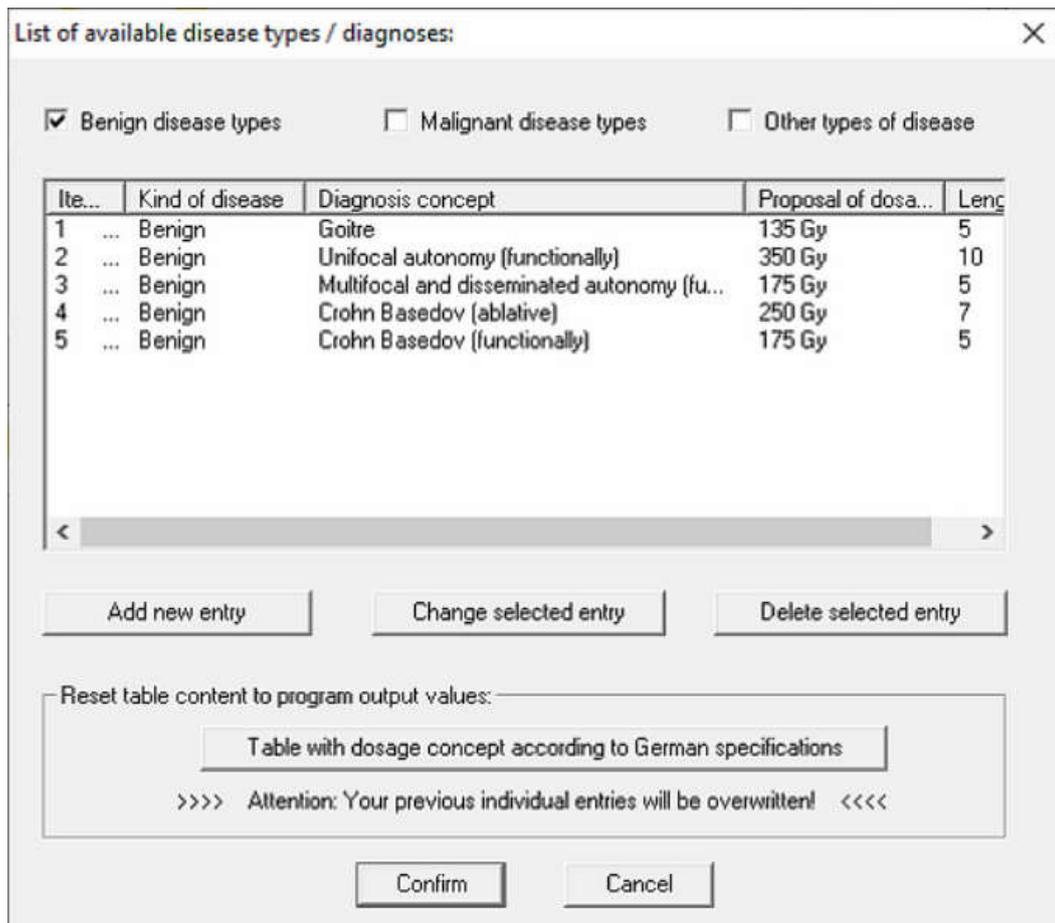
	1. Application	2. Application
Applied activity in [MBq]:	<input type="text" value="1000"/>	<input type="text"/>
Half-life from Fit line in [d]:	<input type="text" value="2.726"/>	<input type="text"/>
Uptake from Fit line in [%]:	<input type="text" value="0"/>	<input type="text"/>
Dose in [Gy]:	<input type="text" value="0.0"/>	<input type="text"/>
Reached total dose in [Gy]:	<input type="text" value="0.0"/>	

### 3.6.4 Create and change available type of disease

Open the menu Ward >> List of available disease :



After entering the password you get the dialog:



Several therapies with data for therapy activity, therapy dose rate and therapy duration can be stored as a template for the 3 disease types.

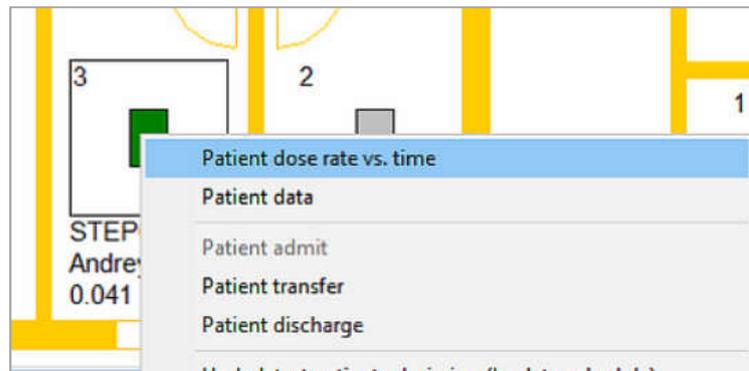
The German guidelines can be adopted with the button:

Table with dosage concept according to German specifications

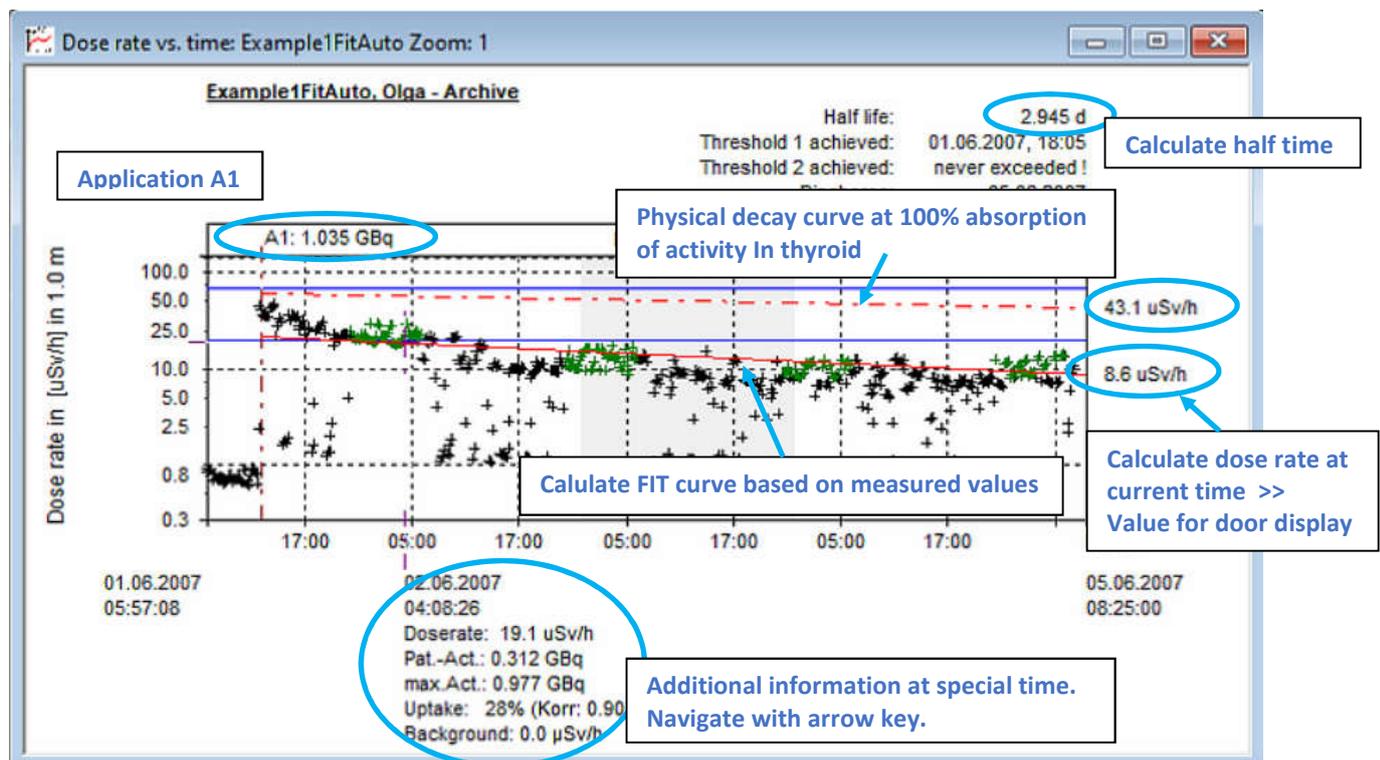
Attention: After press this button the current items will be overwrite !

### 3.7 Display patient dose rate diagram

To display the dose rate course of a patient, select the corresponding patient in ward plan with the mouse and open the context menu with the right mouse button:



Then please select the menu item "Patient dose rate vs. time":



All measured values recorded between admission and current time / discharge are displayed in diagram dose rate vs. time. If the patient has been in different beds, the measured values of the respective beds are also used. The bed name is shown in diagram title bar.

The dose rate vs. time is displayed in logarithmic form in relation to a distance of 1 m or 2 m (depending on region/country), with automatic scaling. The time of patient admission or the current system time is displayed at the bottom left or right. This axis is also scaled automatically.

In the upper area of the window is visible:

- Name, first name and therapy nuclide of the patient
- Current bed number
- Calculated effective half-life
- Calculated times for reaching threshold 1 / 2
- Planned date of discharge
- Application name / maximum patient activity at the time of application / bed number

Assuming an exponential decrease of the activity / dose rate in patient, a compensation calculation is performed according to the method of least squares. Only measured values (shown in green) that meet the following criteria are included:

- An application must have been executed.
- The measured value must be greater than setting 'min dose rate'.
- The measured value must be within the time window.
- There must be at least 2 valid measured values in time window.

The following lines are drawn in the dose-rate time diagram:

*FIT curve / regression curve (red line):* —————

The calculation of the FIT curve based on selected measured values (green) is carried out according to the method of least error squares. An exponential decrease of the patient dose rate is assumed. If no FIT curve is displayed, no calculation could be performed or the result is not plausible. The crossing of this FIT curve with the ordinate at the current time (system time) gives the extrapolated value for the dose rate and the value for door display.

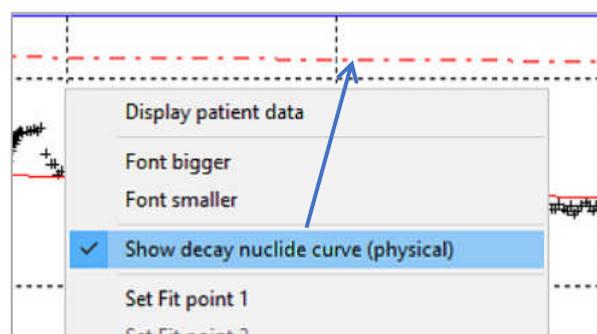
The FIT curve always shows the dose rate emitted by the patient, even if the patient is not in bed/ under the detector.

The software checks, if the calculated effective half-life is greater than the physical half-life or less than zero. In this case, no FIT curve is displayed, only the physical decay curve is shown and no half-life information is given.

In patient data sheet 'Dose rate' the calculated half-life can still be viewed, also negative values!

*Dose rate curve based on the physical half-life (red, dashed line):* - - - - -

Starting point for the calculation of the time course of the dose rate is the applied activity or the maximum possible activity in case of multiple applications. The line of the dose rate is determined on the base of the physical half-life and thus represents the upper limit of the dose rate at any given time. This curve can be displayed / hidden with the context menu of the dose rate history:



Threshold values for discharge dose rate (blue line): 

The threshold values for the discharge thresholds defined in the "Ward Settings" menu are drawn as blue lines in the diagram.

If no clearing calculation can be carried out, please check the above requirements.

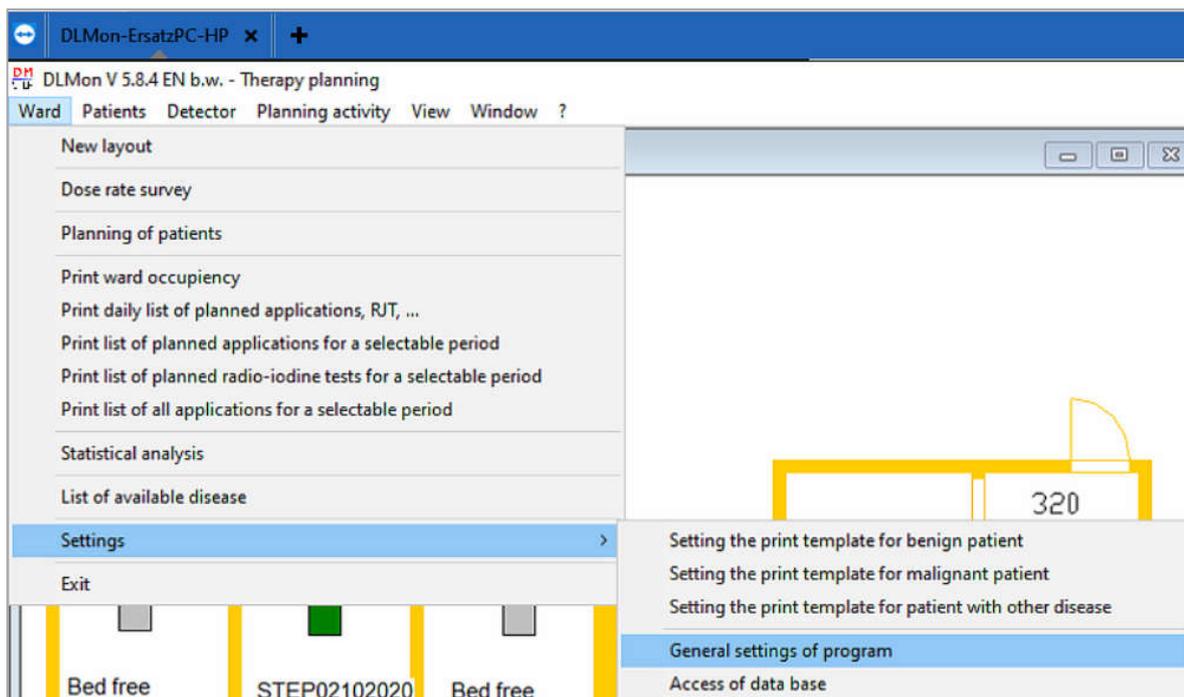
### Settings for FIT curve:

The measured values must meet the following criteria in order to be used for the FIT curve:

- Measured values must be within the daily dwell time interval / measured value period
- A waiting time after an application must have passed
- The station background is subtracted from each measured value
- Each measured value must be greater than setting: minimum dose rate
- The bandwidth can be used to exclude a percentage of valid measured values

The settings described below are ward settings that apply to all beds in the ward. These settings can only be changed by the system administrator. After changing the station settings the program should be restarted.

You reach the settings via Station >> General Station Settings >> Measured Value Selection:



The following station settings are relevant:

### 1. General daily time interval

Here you can select the time period whose measured values are used for the calculation. During this period the patients should be in bed. Standard is the period in the night of 23 - 5 o'clock.

However, it is also possible that patients have to stay in their beds, e.g. during a obligatory lunch break from 12:30 - 13:00 ....

### 2. Waiting time after application

Measured values immediately after an application are incorrect / too high.

Taking into account the biokinetics of the I-131 uptake and the general behavior of the patients after the application, a waiting time can be set in seconds.

### 3. Dose rate lower limit

A measured value is only used for regression, if it is greater than the set dose rate lower limit. This makes it possible to exclude measured values that lie within the daily measured value interval, but are obviously too small.

### 4. Measured value bandwidth

By this definition, only a certain percentage of the measured values lying in the time interval is considered for the compensation calculation. At a bandwidth of 80%, 10% of the smallest and 10% of the largest measured values are excluded.

This is to exclude statistical 'outliers' of measured values. ( e.g. the patient sits in bed during the night > values too high or he goes to the toilet > values too low ).

### 5. General background of the ward

This value reflects the dose rate background of ward. (Contamination, ....) All previously recorded measured values are corrected by subtracting this value.

## Multiple applications

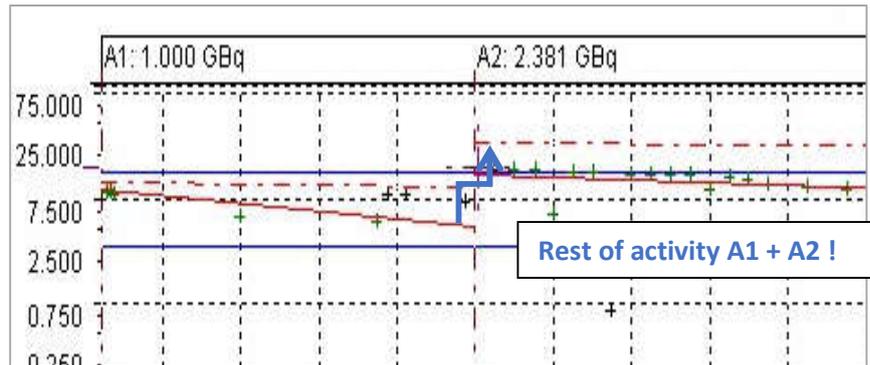
If a further application is performed, the maximum patient activity is determined as follows:

$$\text{Patient activity} = \text{New applied activity} + \text{current patient activity from last applications}$$

(from the dose rate value of FIT curve at the time of new application)

The maximum patient activity is the starting point for the physical half-life curve.

The above right results for the effective half-life and reaching threshold 1/2 are determined from the FIT curve after the last application.



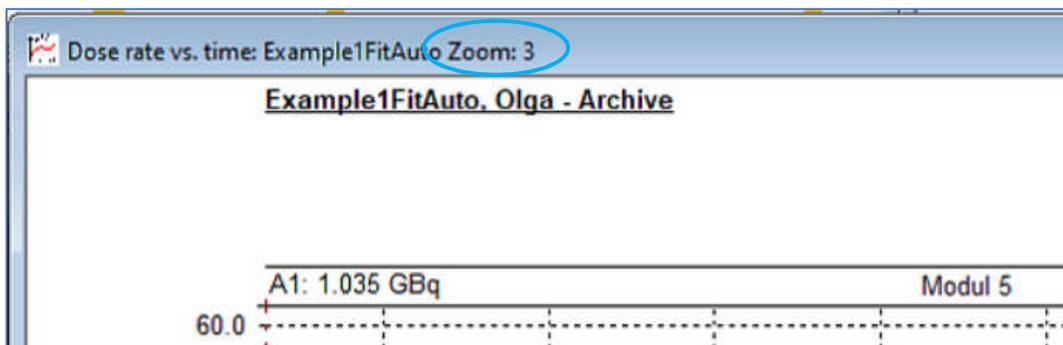
### Zoom function:

A zoom function is implemented within the dose rate diagram. For this purpose the new zoom window can be adjusted from top left to bottom right by holding down the left mouse button. Up to 99 zoom windows are possible.

The ESC key returns to the previous zoom window. Normally the new zoom window contains the measured values determined by the new limits of X- or Y-axis.

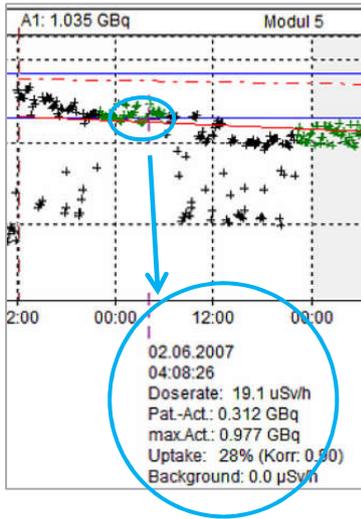
However, if the new zoom window is extended beyond the right edge of the existing diagram, the right limit of the time axis is updated depending on the system time. This automatically displays new measured values in the new zoom window.

The number of the current zoom window is displayed in the title bar of the measured value window:



### Measured value selection:

In a dose-rate diagram, individual measured values can be selected with double click of left mouse button. The mouse position in the time axis decides on the selection



The following are displayed below the measured value:

- Date and time of the measured value
- Dose rate value of the FIT curve at this time
- Calculated activity of the patient from FIT curve
- Maximum possible physical activity of the patient
- Uptake of the patient at this time
- Dose rate background from settings

If the selected measurement value is outside the zoom window, all the above information is displayed in violet color and the crosshairs are at the bottom of the diagram.

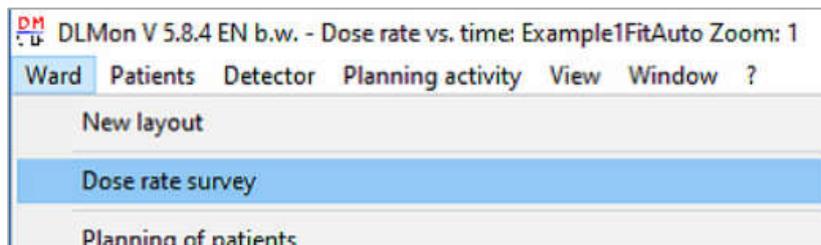
### Measurement value navigation:

You can navigate between measured values by using the arrow keys  and  .

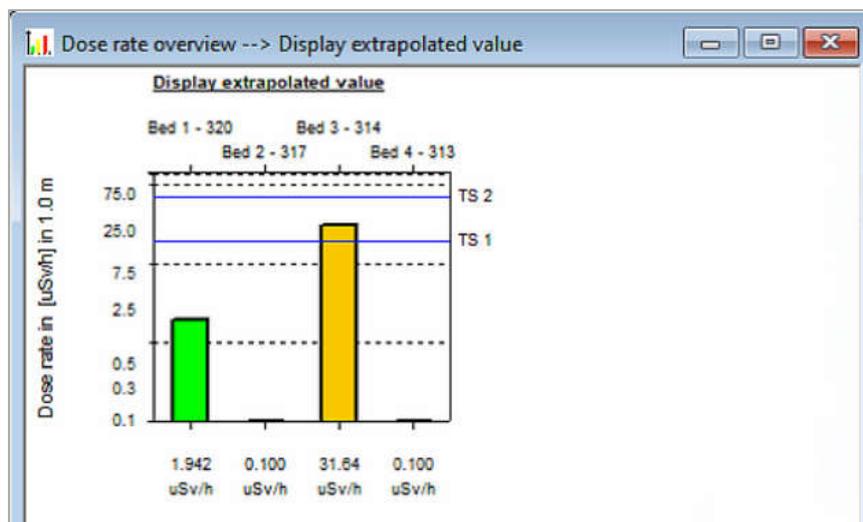
## 3.8 Display the dose rate overview of ward

The measured value representation in the form of the *dose rate overview* provides a quick overview of the dose rate values of all patients.

It is called up in manu 'Ward':



It is represented by a bar chart containing the number of the bed and dose rate value.



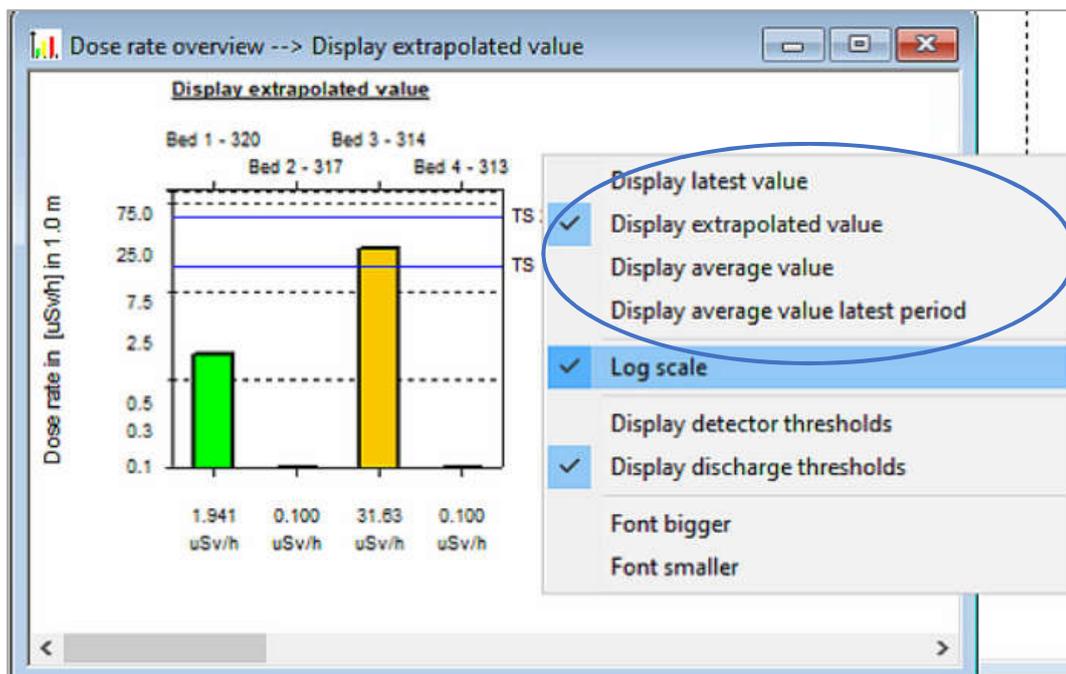
The color of the respective bars depends on the following criteria:

grey	free bed
dark green	occupied bed, dose rate $\leq$ background
green	occupied bed, background $<$ dose rate $\leq$ Threshold 1
yellow	occupied bed, Threshold 1 $<$ dose rate $\leq$ Threshold 2
red	occupied bed, Threshold 2 $<$ dose rate

When displaying the dose rate overview, you can choose between 4 possible display values:

Display last measured value	Detector measured value at current time
Display extrapolated value	A compensation calculation is performed on the basis of selected measured values. The specified value is the corresponding dose rate at current system time. If no compensation calculation can be performed, the value determined on the basis of the physical half-life is given.
Display average value	Average value of the last measured values
Display mean value of last measuring value interval	Average value of the last measured value interval (usually overnight)

The context menu is obtained by pressing the right mouse button when the mouse pointer is located in the window:



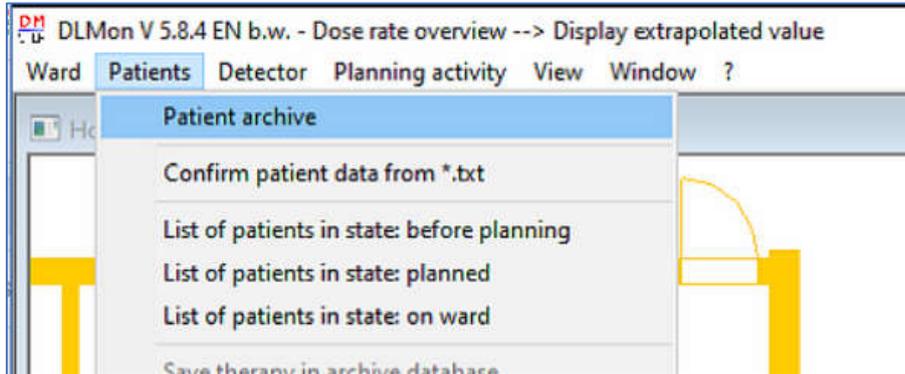
This menu allows the display of the dose rate overview to be adapted to individual requirements:

- Alternative display of measured values
- Display of the dose rate (logarithmic or linear)
- Insertion of the set display thresholds and the discharge thresholds
- Font bigger / smaller

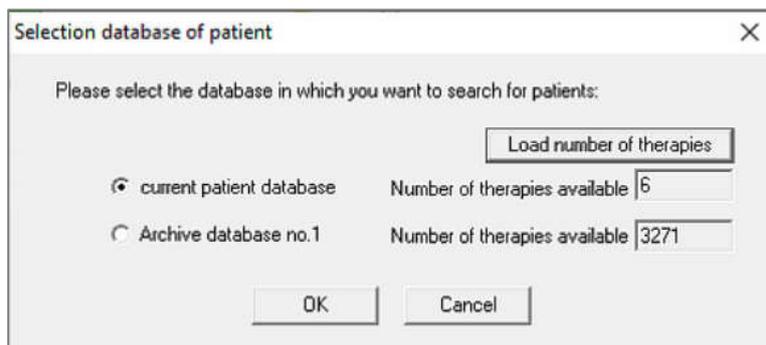
### 3.9 Using patient archive

All data (patient data and measured values) of a patient are stored in the patient database, (SQL database with name RJT2000SQL). In addition, an optional second archive database (with name RJT2000SQL\_ARCHIV1) can be available to reduce the number of data records in the current patient database. The 2nd database is not active by default.

The archive is called up via the main menu 'Patients':



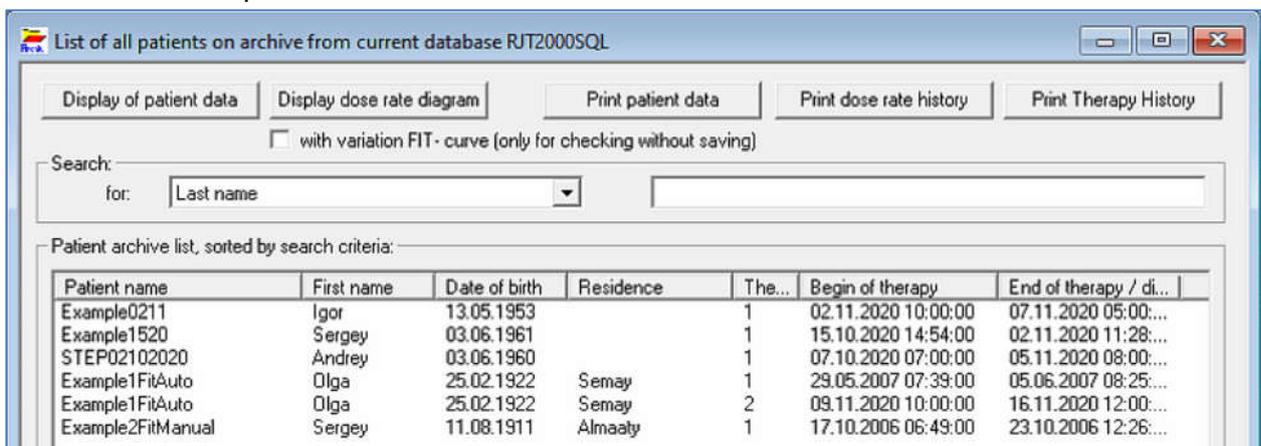
If there is a current database and an archive database, the respective database must be selected in the following dialog:



Depending on the size, it takes several seconds to call up a larger database. During this time the mouse pointer turns into an hourglass and in front of status line show the found patient records:

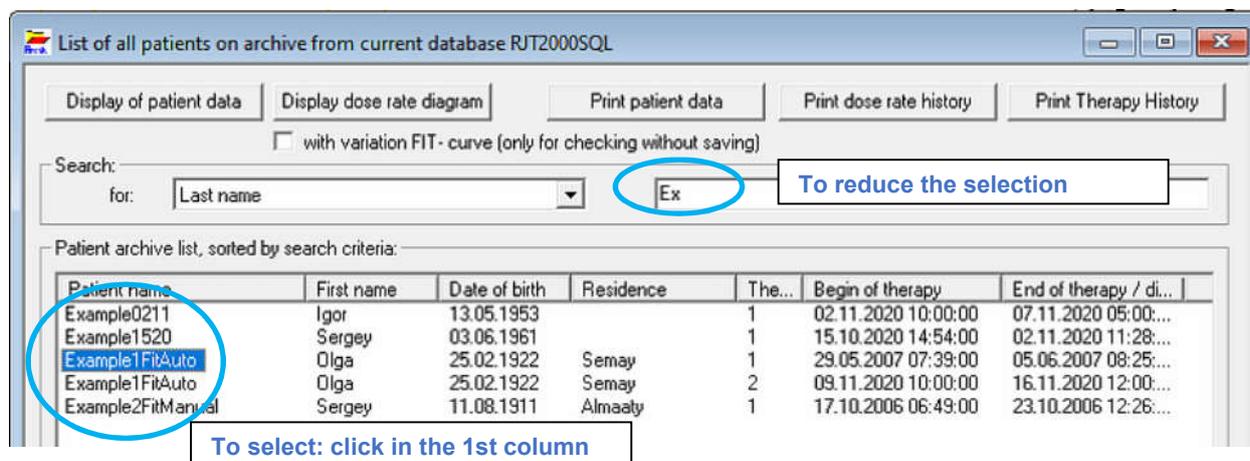
Number of therapies found := 3271

Select the current patient database with OK:



Patient data and the associated dose rate diagram can be viewed. In addition, it is possible to print all data. The archived therapy data cannot be changed.

To select a patient from the list, it must be selected with the mouse by left-clicking on the patient name / first column:

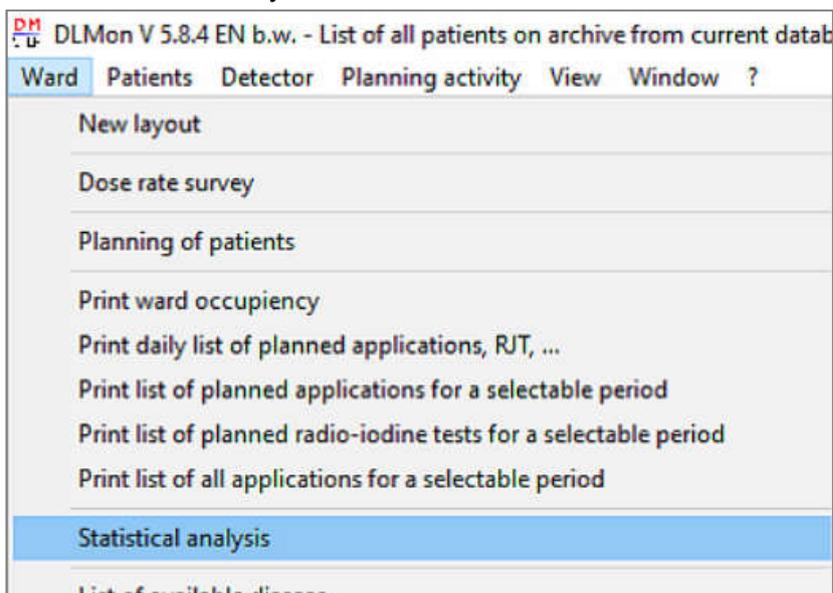


To search for patients, you can reduce the list by using the search criterion "Search for:".

The data of the selected patient are displayed or printed out using the buttons above.

### 3.10 Statistical analysis

Open menu 'Ward' > 'Statistical analysis':



Statistical values for the utilization of beds and applications can be displayed / printed out here d printed out. The following dialog box appears:

Statistical analysis: X

Period from:  (00:00:00) to:  (23:59:59)

Results:

Number of patient:	<input type="text" value="3"/>	Overall treatment time [days]:	<input type="text" value="9.5"/>
		Average treatment time [days]:	<input type="text" value="0"/>
Bed occupancy [%]:	<input type="text" value="47.5"/>	for really available bed number:	<input type="text" value="4"/>
Number of treatments began during and completed after period of analysis:			<input type="text" value="1"/>
Number of treatments began before and completed during period of analysis:			<input type="text" value="2"/>
Number of treatments began and completed during period of analysis:			<input type="text" value="0"/>
Number of applications in period of analysis:	<input type="text" value="1"/>		
Overall activity [GBq]:	<input type="text" value="0.23"/>		
Average activity [GBq]:	<input type="text" value="0.23000000"/>		
Minimum activity [GBq]:	<input type="text" value="0.23"/>	Maximum activity [GBq]:	<input type="text" value="0.23"/>

The evaluation period can be set in the upper area. The 1st day always starts at 00:00:00 and the last day ends at 23:59:59. Thus the shortest evaluation period is 1 day.

The individual statistical values have the following meaning:

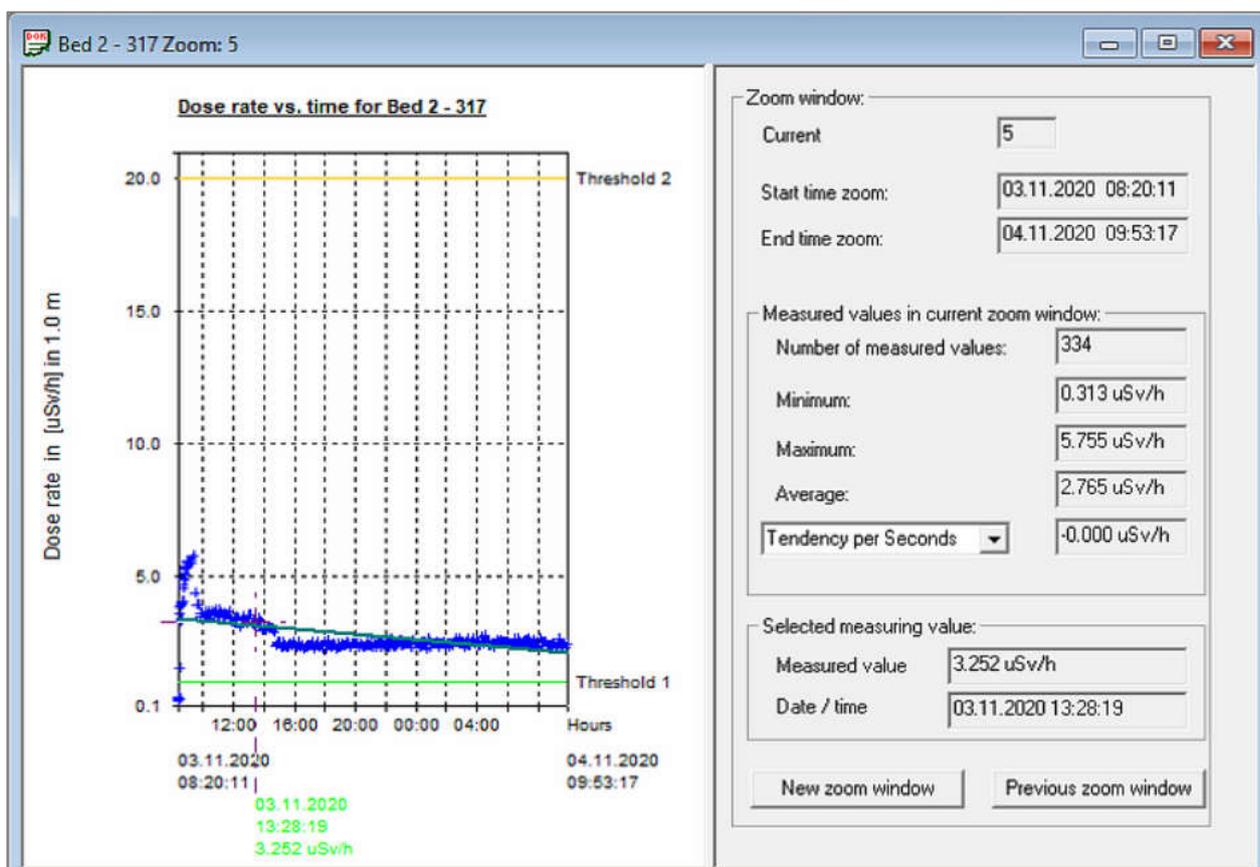
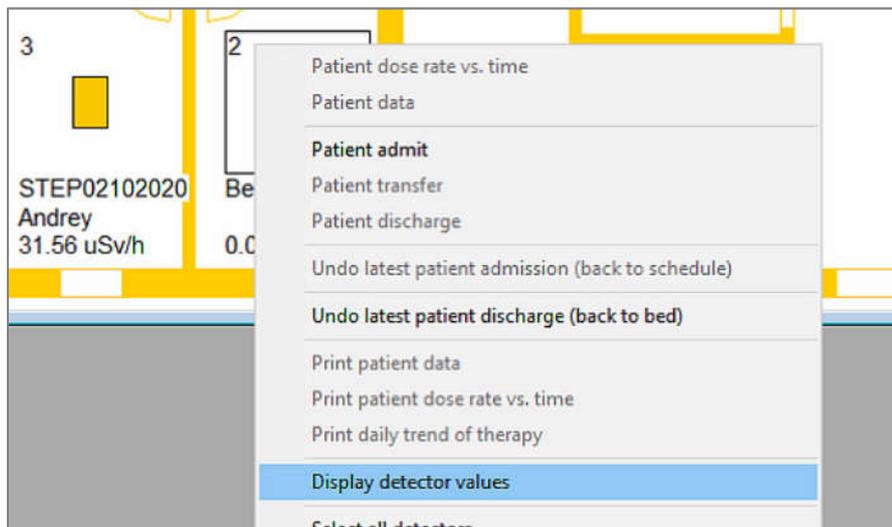
<i>Number of patients</i>	Therapies found in the evaluation period (can also include repeat therapies)
<i>Overall treatment time in [d]</i>	Sum of all days of all therapies, whereby only 1 day is charged for admission and discharge day.
<i>Average treatment time in [d]</i>	Sum of all treatment days of all therapy / number of found therapies
<i>Bed occupancy in [%]</i>	Ratio of all treatment days and max. possible number of days of treatment (according to the number of beds and days in the period)
<i>For really available bed numbers</i>	Number of available beds, preset to ward number of beds, changeable if not all beds were available in period (Reconstruction, renovation, downtime...)

The lower part of the dialog box contains the values related to the applied activity. The 'Print' button can be used to output all values to a printer.

### 3.11 Display and analysis of detector readings

The 'raw measured values' of the respective detector can be queried here.

Select the respective detector in the ward plan with the mouse and open the context menu item 'Display detector values' :



In the left side of window all measured values are displayed. The display is initially in a sliding time window. The data of the currently selected measured value ( marked by a cross) are displayed below the time axis. The colored representation is done according to the set display threshold values. The selection of a single measured value is taken by double click on left mouse button. Navigation via arrow keys.

If the selected measured value is outside the zoom window, the cross and the additional information about the measured value are displayed in violet.

To show Regression curve of measurement value, the time base can be selected in the pull-down menu (seconds ... month). Please note that only the measured values of the current zoom window are considered for the calculation.

The values specified in the right window always refer to the current zoom window.

There are two possibilities for selecting the zoom window:

a) Mouse

The size of the zoom window is set by dragging the mouse with the left mouse button pressed down. If the new zoom window is dragged beyond the right edge of the diagram, the right limit of the time axis is updated depending on the system time. Thus new measured values are automatically displayed in the new zoom window.

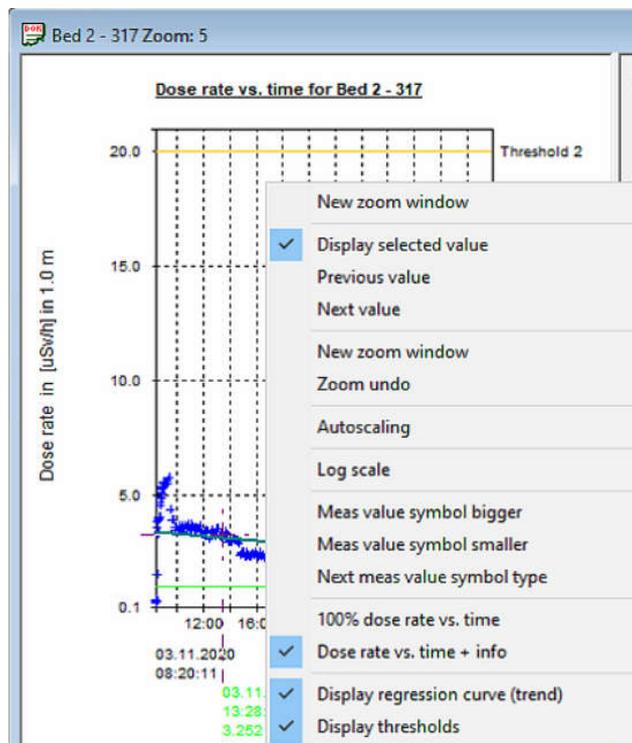
In the title bar of the measured value window the number of the current zoom window is displayed.

b) Keyboard input

You can go back one zoom level with the button "Previous zoom window" or with ESC. With "New zoom window" a range of measured values can be selected by entering the limits for dose rate and time. If the option "Current system time" is activated for End time, the right margin of the zoom window is continuously updated. This means that new incoming measurement values are also displayed.

### Context menu in diagram window:

If the mouse is within the diagram window, you can open the context menu with double click of right mouse button. You get follow menu:



The menu items are self-explanatory

## 3.12 Planning benign therapy activity

### 3.12.1 Basics

For benign disease the DLMon software allows the user to plan / calculate required therapy activity, provided that the user knows

- the volume of the thyroid,
- the uptake and
- the effective half-life

For this, an RJT test is necessary before therapy. Under these conditions the required therapeutic activity can be calculated according to 'Marinelli' as follow:

$$A = \frac{F \cdot D \cdot m}{Upt \cdot T_{1/2}}$$

With:	A	...	required therapy activity in [MBq]	
	F	...	Volume-related dose factor (according to 'Sabri')	
	D	...	desired target dose in [Gy]	
	m	...	Mass of thyroid in [ml] (sonography)	(data from RJT test)
	Upt	...	relative iodine uptake of thyroid gland in [%]	(data from RJT test)
	T <sub>1/2</sub>	...	Effective half-life of iodine storage	(data from RJT test)

If the pretherapeutic values for uptake and/or effective half-life cannot be reached intra therapeutic, the desired target dose may also be not reached.

The comparison between the desired target dose and the actually achieved focal dose (from the first application) results in the activity required for a re- dosing / subsequent application, taking into account the stunning factor (literature: 'Sabri'):

$$A_2 = \frac{D - D_1}{D_1} \cdot A_1 \cdot S_f$$

mit	A <sub>2</sub>	...	required activity of the 2nd application	
	D	...	desired target dose in [Gy]	
	D <sub>1</sub>	...	achieved dose for target tissue from 1st application in [Gy]	
	A <sub>1</sub>	...	Activity of 1st application	
	S <sub>f</sub>	...	Stunningfactor	

### 3.12.2 Planning initial activity

The planning of the initial activity is done at the planning stage. If a patient has already been admitted to the ward / bed, the planning of the start activity is of course still possible. For malignant diseases, the initial activity is already specified via the list of available disease types, which is of course customizable.

For benign diseases the initial activity is planned depending on:

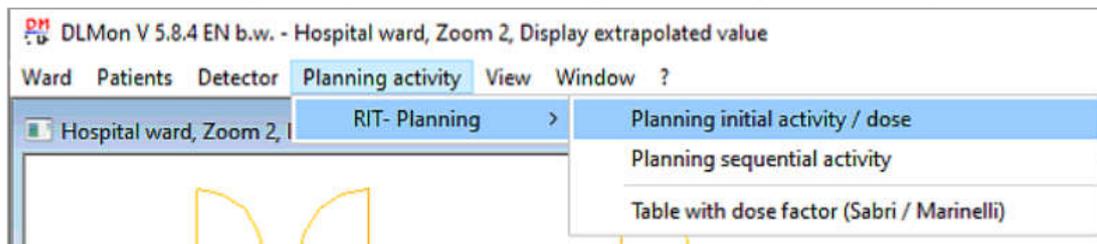
- desired target dose according to disease
- Volume / mass of the thyroid gland
- Absorption capacity / Uptake of the thyroid gland

There are 2 options for planning the initial activity:

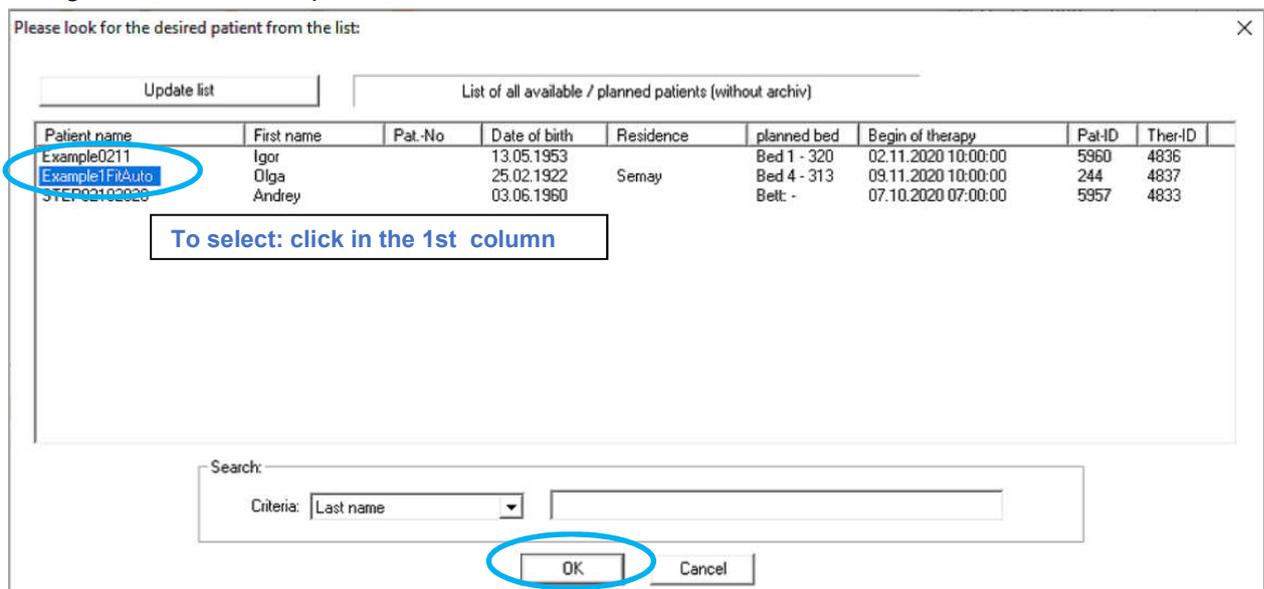
- Via patient data >> in sheet 'Dose' ( see 3.6.2)
- Via menu: *Planning activity* > *RJT- Planning* > *Planning initial activity / dose*

Planning initial activity via menu *Planning activity* :

Open the menu *Planning activity* > *RJT- Planning* > *Planning initial activity / dose*:



You get to the list of all patients:

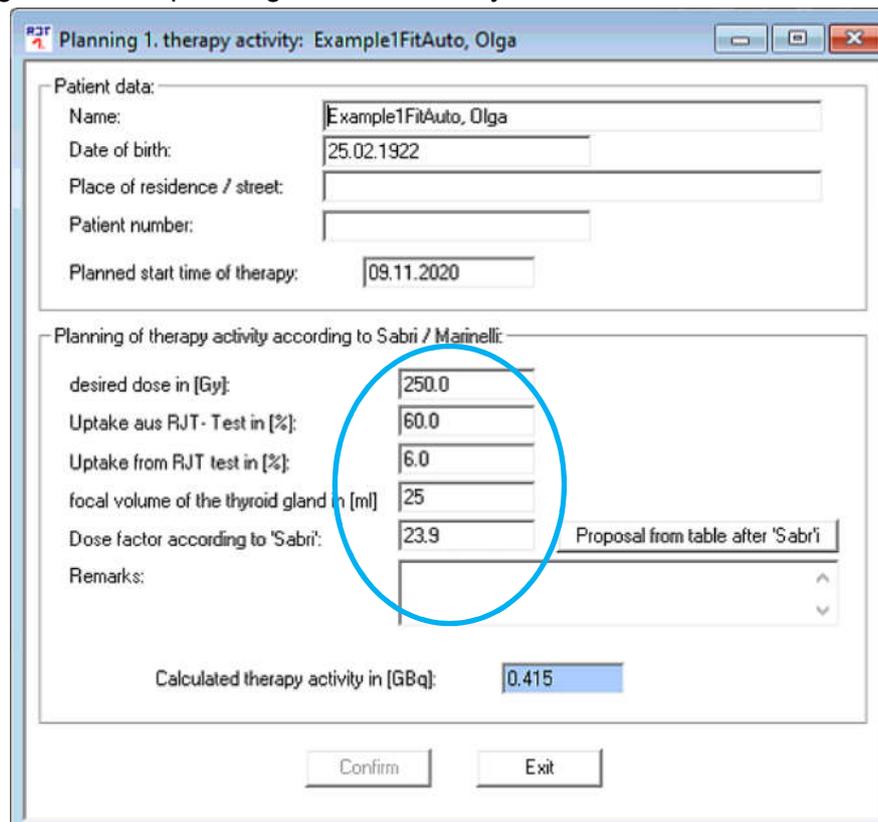


Select your patient from this list by clicking in 1. column and confirm with the 'OK' . Using the search function, you can find the patient you are looking for more quickly by entering the first letters / numbers of a known name, first name, date of birth, place of residence or patient number.

Via a security query with data of the selected patient



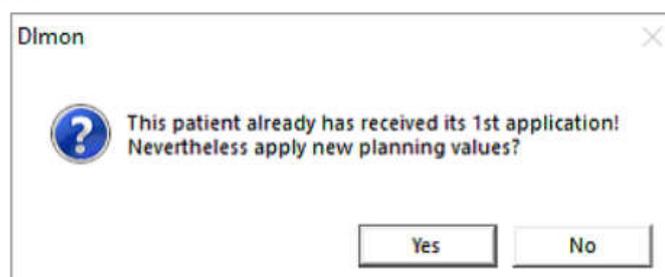
You get dialog window for planning the initial activity:



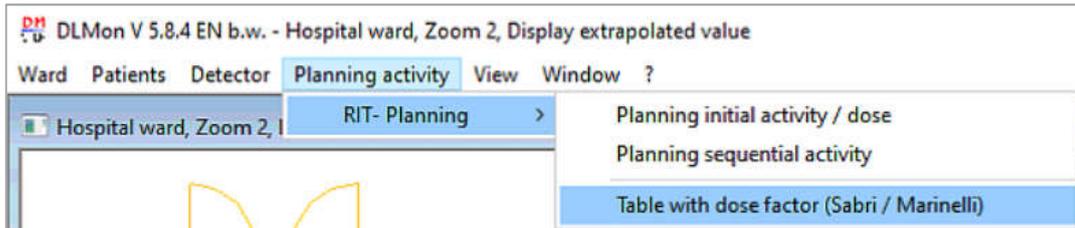
The dose factor can be entered manually or automatically taken over from the stored table via the button ' Proposal from the table after Sabri'.

After entering all necessary values, the calculated therapy activity appears in the read-only field highlighted in light blue. Remarks for planning can be entered in the field 'Remarks'. To accept and save all data, press 'Confirm' button.

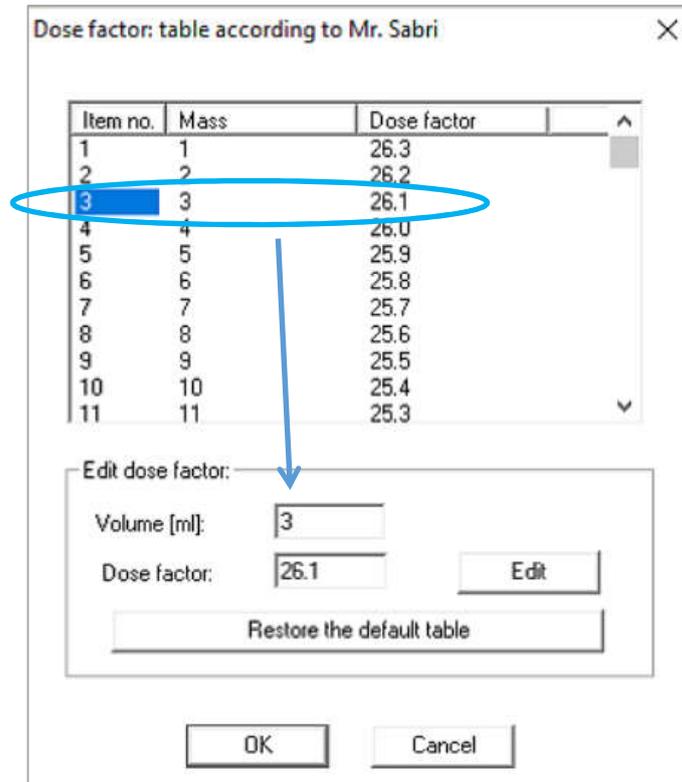
If the selected patient is already on the ward and has already received an application, the following warning is issued.



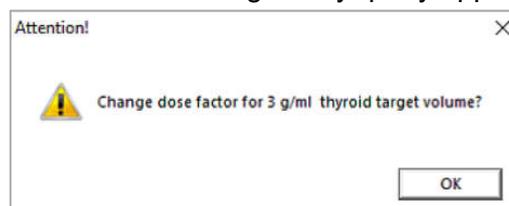
The table with the dose factor according to 'Sabri' can be edited under:



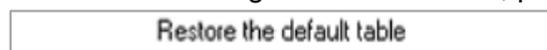
In the table, the factor is dependent on the volume of the thyroid gland:



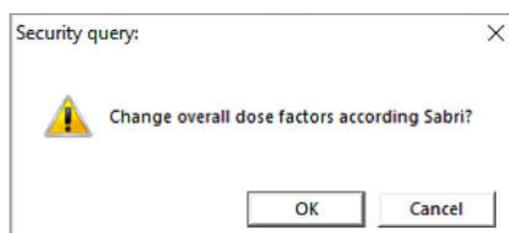
After selecting an entry by clicking in 1. Column 'Item no.' the current value (volume and dose factor) displayed in lower input fields. Afterwards the dose factor can be changed manually and saved by clicking the 'Edit' button. The following safety query appears:



If you want to reactivate the table with the original default values, press the button:



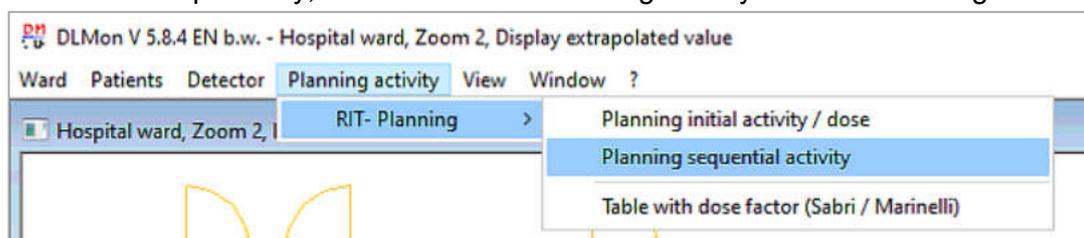
Restoring the default table must be confirmed with a security question:



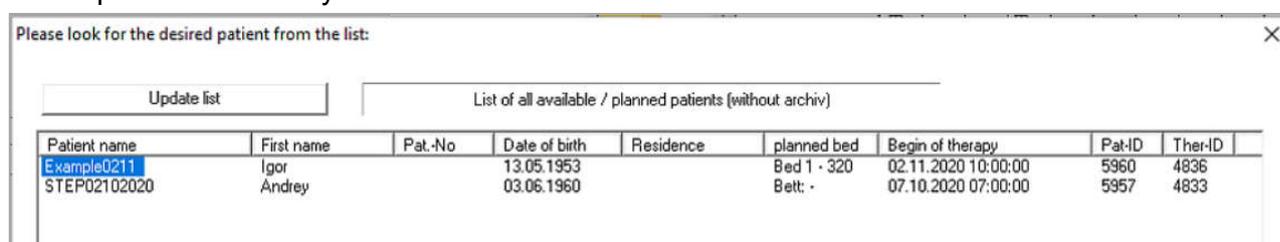
### 3.12.3 Planning follow-up activity

As described in the basics under 3.12.1, the program can calculate the achieved focal dose during a therapy. The comparison between the desired target dose and the achieved focal dose results in the activity required for a follow-up dose / application, taking into account the stunning factor (according to Sabri O.).

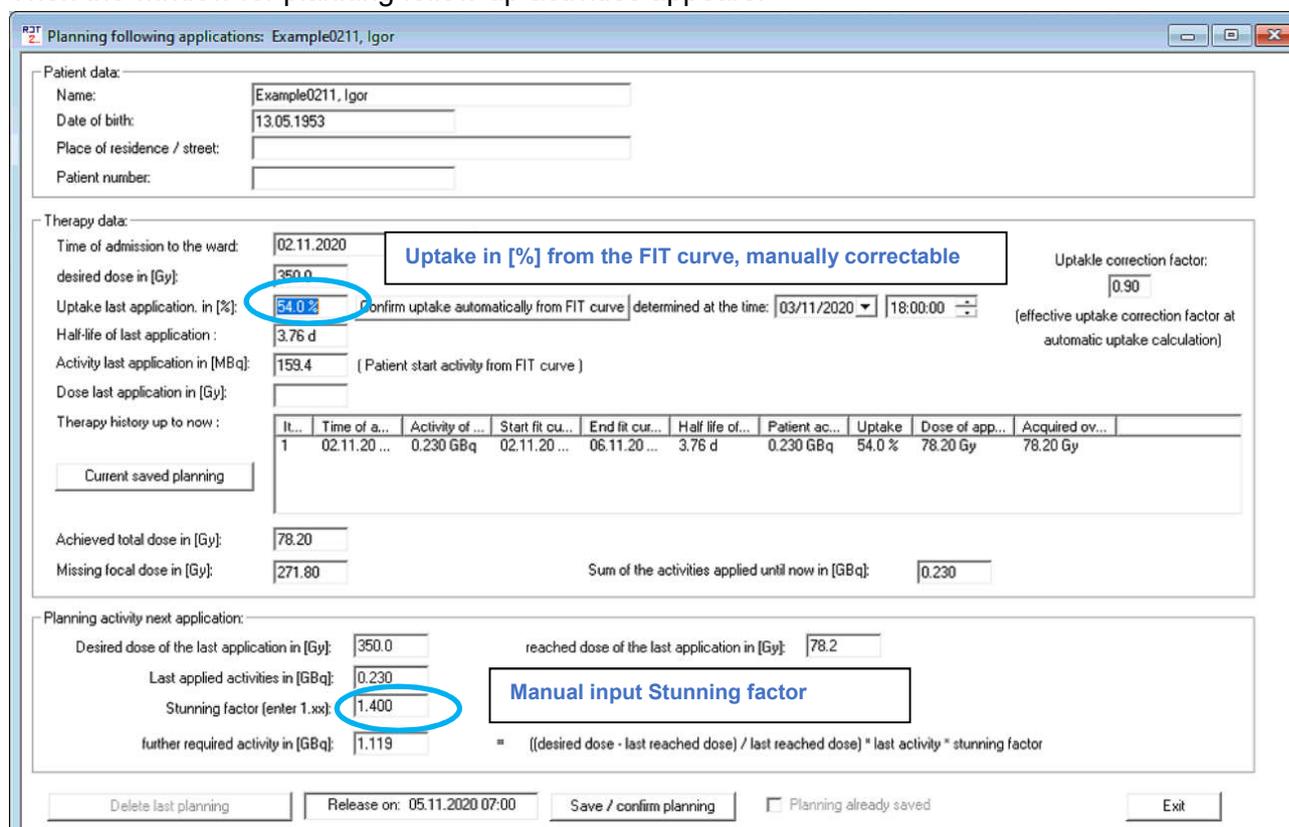
To calculate follow-up activity, select the menu Planning activity > RJT Planning:



Select patient from list by click in 1. Column:



Then the window for planning follow-up activities appears:



**Attention:** The planning of the follow-up application requires the planning of the initial activity with entering the volume of the thyroid gland.

*Input / correction uptake of the 1st application:*

To calculate the follow-up application, the uptake automatically calculated from the 1st application can be corrected manually. When the uptake is determined automatically, a correction with the uptake correction factor is already made (default: 0.9).

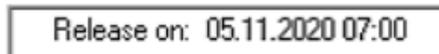
In addition, by selecting the uptake time, the program can determine this value from the measured dose rate FIT curve. All other values such as half-life, dose of previous application are visible in the table.

To calculate a follow-up activity, only the stunning factor must be entered.

The calculated activity is saved with  and confirmed with:



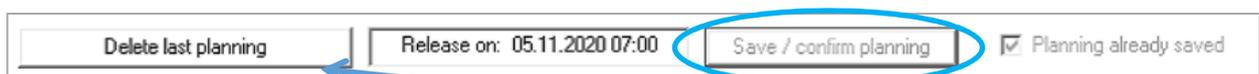
**Important:** It is only possible to save the planning of the follow-up activity on the 3rd day 7:00 a.m. after an application. The earliest time is indicated in the info field:





From this point on, the planning is saved with all data in the database and the button

 is locked:



To change a planning of the follow-up activity, the last planning must be deleted!

**Note:**

A planned follow-up activity is not entered in patient list of applications. It is stored as planned activity in database. The value is only for planning purposes!

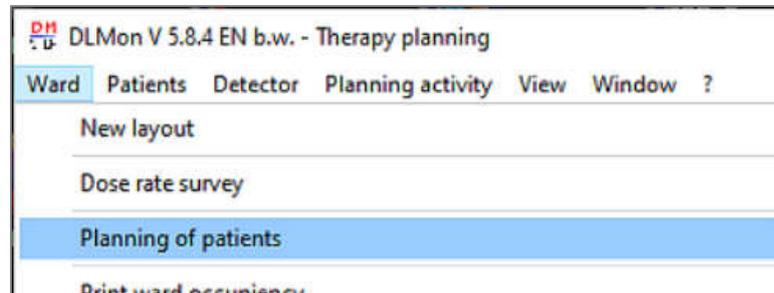
### 3.13 Patient- Planning

The DLMon software includes a very comprehensive tool for long-term planning of patients. With the visual representation of the planned therapies you get a precise overview of your bed occupancy.

The colored representation (according to gender / type of illness) simplifies planning / overview, especially when planning the occupancy of double rooms:

Therapy planning																					
November / 2020																					
		Week 45						Week 46						Week 47							
		Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
		03.	04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Bed 1 - 320		m					m										m		m		
		Example0211, Igor															Example, Valerie				
Bed 2 - 317																					
Bed 3 - 314		m			m																
		STEP02102020																			
Bed 4 - 313								f						f							
								Example1FitAuto, Olga													

Every time you can open a new planning window with menu:



#### 3.13.1 Basics

The planning window allows the user a fast patient planning by the optimal visualization of all planned therapies. Thereby the utilization of the ward can be optimized.

By using colors, the planning of different types of therapy, taking into account the patient gender, becomes simple and clear.

All data of the planning module are stored in the patient database, so that no further data need to be entered when patients are later admitted from the planning to the ward.

The software (client server model) also allows the installation of additional DLMon clients, so that, for example, patient planning can also be carried out on another PC. Please contact administrator.

The basic structure of the planning window is as follows:

Therapy planning																				
November / 2020																				
Week 45							Week 46							Week 47						
	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
	03.	04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Bed 1 - 320	m					m										m			m	
	Example0211, Igor															Example, Valerie				
Bed 2 - 317																				
Bed 3 - 314	m			m																
	STEP02102020																			
Bed 4 - 313							f												f	
							Example1FitAuto, Olga													

The period of the planning window can be selected via the 3 header lines, the available ward beds are listed in the lines below. Single and double bed rooms are separated by a thick line. The current day (here Friday, 6.Nov 2020) is highlighted in light yellow.

All functions can be called via the context menu (right-click in the window):

free
Patient data
Admission new patient
Admission patient from list of schedulable patients
Confirm planned patients in the same ward bed
Move planned patient in the planner
Remove planned patients from planning
Search patient in planner
<input checked="" type="checkbox"/> Display symbol line
<input checked="" type="checkbox"/> Display line 'extra'
Edit therapy color
Edit extra text
Fixed therapy color female / male
<input checked="" type="checkbox"/> Fixed therapy color benign / malignant
Column width
Row height symbol line
Row height 'extra' line
Print list of planned applications
Print current planner view
Current day
1 Day >>
1 Day <<
1 Week >>
1 Week <<
Set holiday
Delete holiday
Update planner

Several lines can be shown / hidden per station bed (1 toolbar and maximum 4 extra info text lines):



(Example with symbol line and 2 extra info lines)

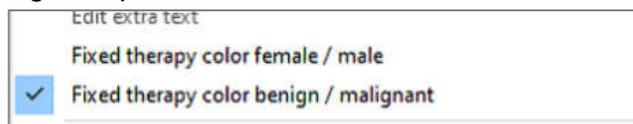
In the symbol line (1st line), the individual therapies are displayed with a line in different colors. On the planned day of admission or discharge, the patient sex is marked with an **f** for female and **m** for male.

List of implemented colors:

- Green** current therapy, patient on ward
- Grey** archived therapies
- Yellow** planned therapies for female patients
- Blue** planned therapies for male patients

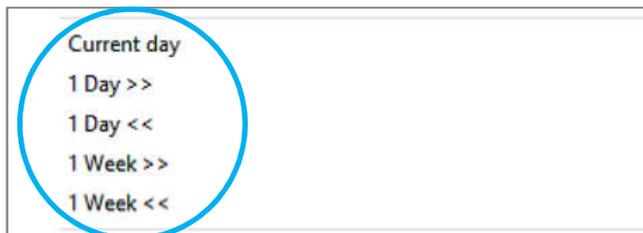
The possible 4 info lines can be used variably and are individually adjustable. In addition, the area of the extra text fields can be colored variably.

The following color settings are possible via the context menu:



- Color depending on the type of disease:
  - \* **Blue** malignant Radio Iodine therapy
  - \* **Black** benigne Radio Iodine therapy
  - \* **Violet** other type of disease
- Color depending on gender
  - \* **Green** woman
  - \* **Brown** man

Time navigation: Use the arrow keys or the context menu:



Selection of planned therapies with the mouse pointer

When moving the mouse over the area of the occupancy table, the respective therapy is automatically selected and the corresponding patient name is displayed in the status bar in the 1st field:

Therapy planning

November / 2020

	Week 45							Week 46							Week 47							
	Tue 03.	Wed 04.	Thu 05.	Fri 06.	Sat 07.	Sun 08.	Mon 09.	Tue 10.	Wed 11.	Thu 12.	Fri 13.	Sat 14.	Sun 15.	Mon 16.	Tue 17.	Wed 18.	Thu 19.	Fri 20.	Sat 21.	Sun 22.	Mon 23.	
Bed 1 - 320	m Example0211, Igor 13.05.1953,														m Example, Valerie 3.5.1972, additio							
Bed 2 - 317																						
Bed 3 - 314	m STEP02102020 03.06.1960,																					
Bed 4 - 313								f Example1FitAuto, Olga 25.02.1922,														

Example, Valerie

Patient name in status line when mouse over therapy

Even in case of overlapping (marked with a red exclamation mark), both therapies can be selected with the mouse:

Fri 06.	Sat 07.	Sun 08.	Mon 09.	Tue 10.	Wed 11.	Thu 12.	Fri 13.
m		m !		m		m	
, Igor		Example, Valerie		3.5		2, additio	

In this area mouse select 1. Patient

In this area mouse select 2. Patient

The 1st patient is selected in the 1st half of day and the 2nd patient in the 2nd half of the day!

After the exact positioning of mouse in planning window, the context menu can be called up with the right mouse button:

m							
e, Valerie							
2, additio							

assigned to: Example, Valerie

Patient data

Admission new patient

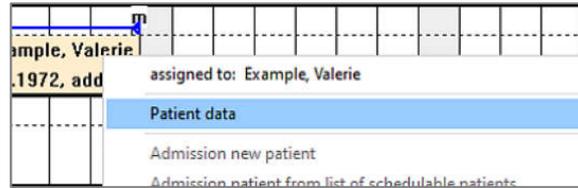
Admission patient from list of schedulable patients

Confirm planned patients in the same ward bed

Move planned patient in the planner

If a therapy / patient was selected with the mouse, the corresponding patient name appears in the 1st entry of the context menu.

With the menu item



the dialog with patient data can be displayed and data changed:

A screenshot of a dialog box titled 'Patient data: Example, Valerie'. The dialog has several tabs: 'Transfer', 'Application', 'Dose rate', 'Dose', 'Day history', 'Readings', 'Extra fields for comments', 'Discharge', 'Personal data', 'Address', 'Therapy data', and 'Diagnosis / type of disease'. The 'Personal data' tab is active. It contains the following fields:  
Title: Mr. (dropdown menu)  
Name: Example (text field)  
First name: Valerie (text field)  
Date of birth: 3.5.1972 (text field)  
Health insurance: (empty text field)  
At the bottom, there are four buttons: OK, Cancel, Confirm, and Help.

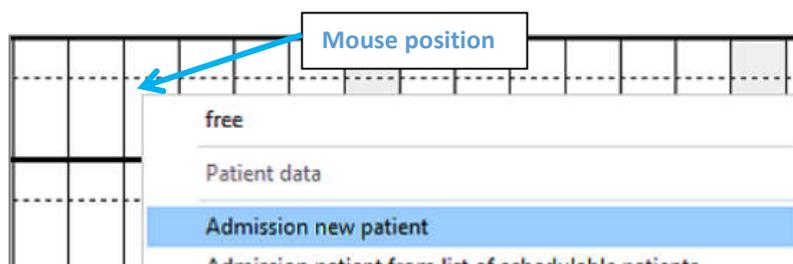
### 3.13.2 Plan new patient

To plan a new patient, select with the mouse the point with:

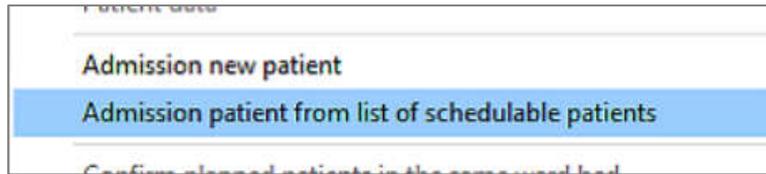
- the corresponding calendar column to start the therapy
- and the row with the bed

and open context menu with the item "Admission new patient".

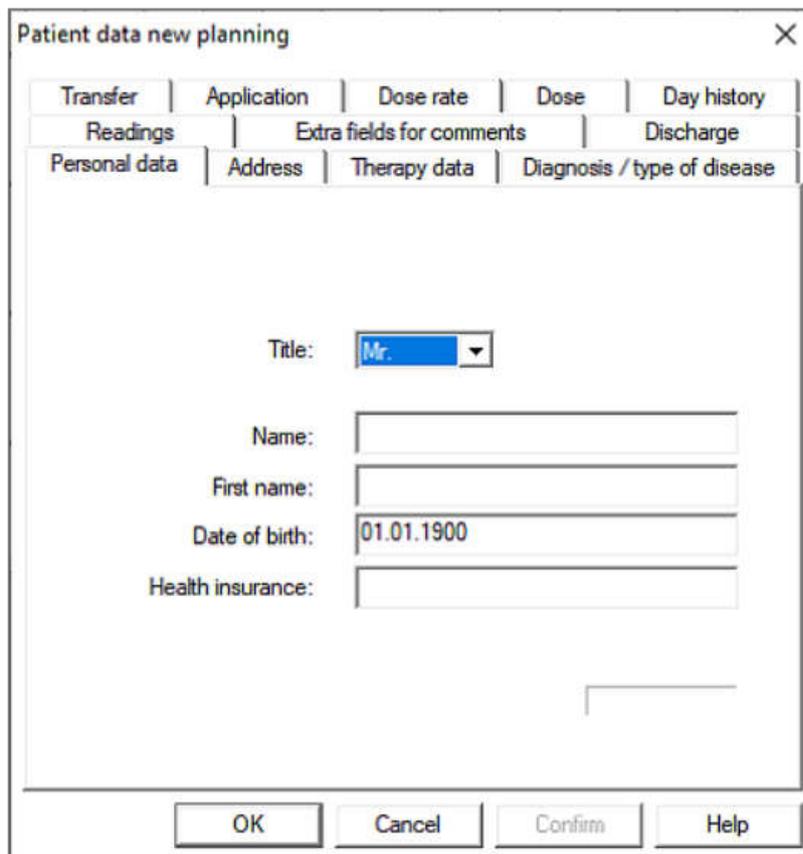
**Attention:** This menu item is only enabled if this calendar cell / bed is still free !



When transferring patient data via HL7-interface or text transfer, the planning of patient can be done with a list of schedulable patients (in standard case the list is empty):

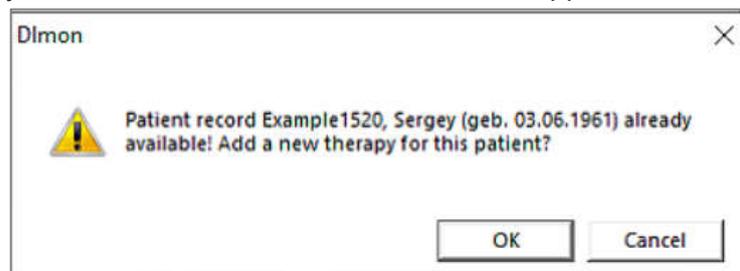


After pressing the menu item, the dialog box for input/display of patient data appears:



You must enter name, first name and date of birth and press . The patient is planned with a standard therapy duration of 5 days. The therapy start is determined by the calendar cell selected with the mouse.

If the patient already exists in the database, the information appears:

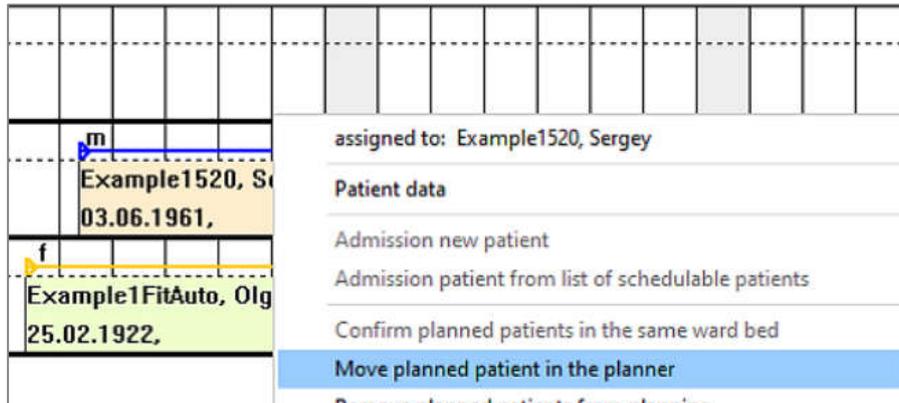


Here you can create a new therapy with OK or cancel the planning of new therapy.

The next steps for planning see: 2.3 Input of therapy data

### 3.13.3 Move patient

To move a planned therapy in the planner, select the corresponding therapy with the mouse. Via the context menu:



With the following dialog you can input data for moving:

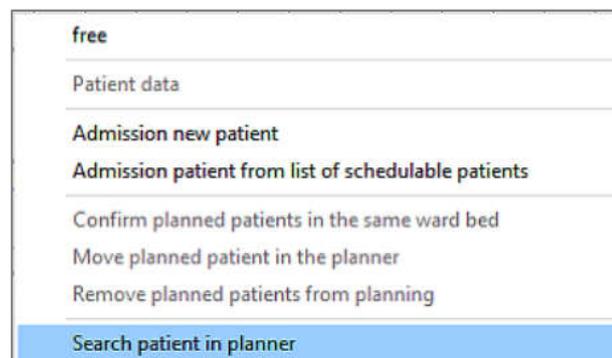
The 'Moving therapy' dialog box contains the following fields and controls:

- Name: Example1520, Sergey
- from bed: Bed 3 - 314
- to bed: Bed 3 - 314
- New time of start therapy: 10/11/2020, 10:00:00
- Buttons: OK, Cancel

Select new target bed and/or the new therapy start. Possibly existing application data are retained and will be shifted accordingly with 'OK'.

### 3.13.4 Search Patient

With this function you can search a unknown therapy period of an already planned patient. To do this, select the menu item:



In the following dialog box a list with all planned patients appears:

Please look for the desired patient from the list: ✕

Update list      List of all available / planned patients (without archiv)

Patient name	First name	Pat.-No	Date of birth	Residence	planned bed	Begin of therapy	Pat-ID	Ther-ID
Example	Valerie		3.5.1972		Bed 1 - 320	11.11.2020 10:00:00	5961	4838
Example1520	Sergey		03.06.1961		Bed 3 - 314	14.11.2020 10:00:00	5959	4839
Example1FitAuto	Olga		25.02.1922	Semay	Bed 4 - 313	09.11.2020 10:00:00	244	4837

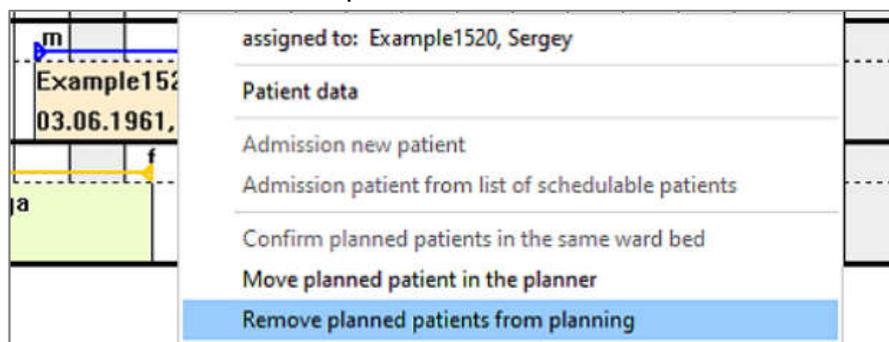
Search: Criteria: Last name

OK      Cancel

You can use the search function to reduce the list of displayed patients. Then select the patient whose planned therapy you would like to view in the first list field (Patient Name). After pressing OK, the planner window will be positioned chronologically so that the patient you are looking for appears in the first column of the planner.

### 3.13.5 Remove patient from planning

You can undo the planning of a patient, then the patient will be removed from the planning. Select the patient with the mouse and open the context menu:



Confirm the security query:

✕

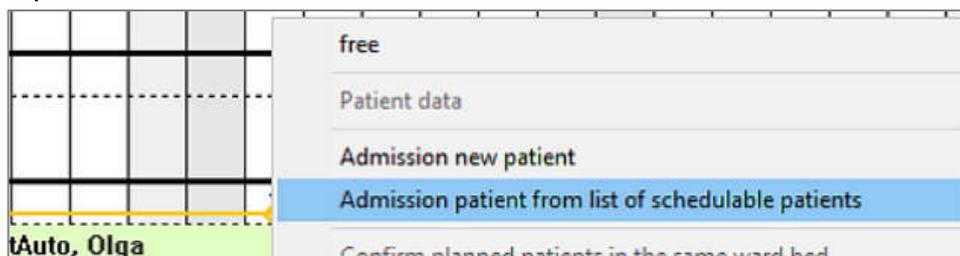
Security query

Do you really want the patient Example1520, Sergey take out the plan?

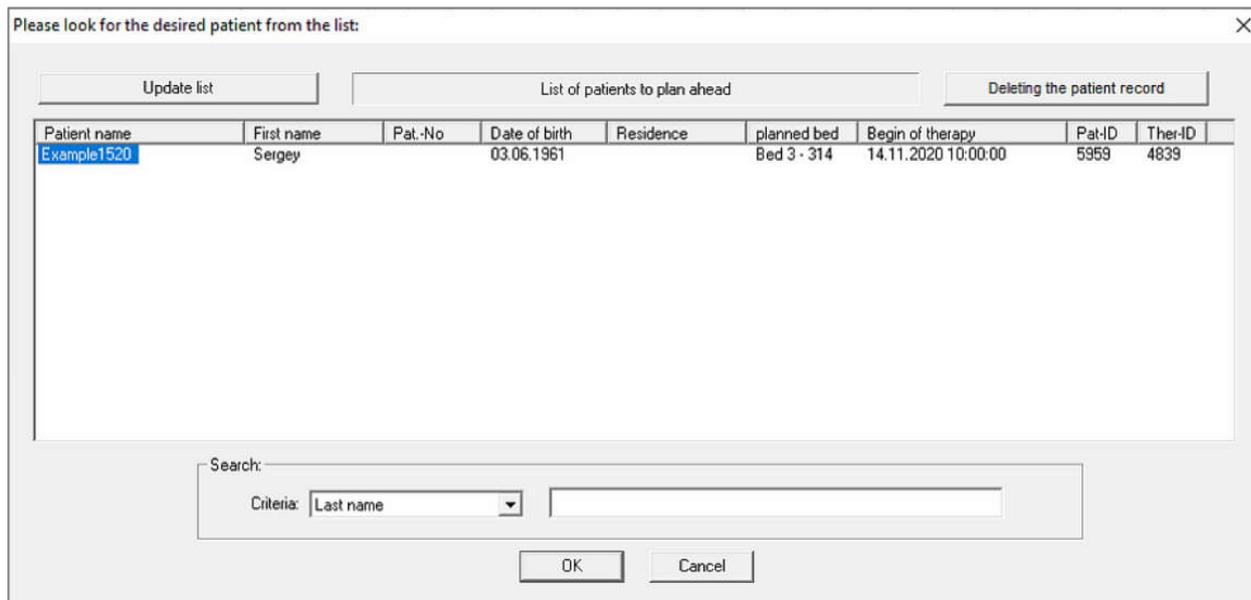
OK      Cancel

and then the selected therapy is removed from the planning, but the already existing data (patient data, planned first application, therapy duration) are not deleted!

If this patient is to be planned again at a later time, this is done via the menu item 'Plan from list of plannable patients':



Then the list with all patients that can be scheduled appears:



After selecting the respective patient and confirming with 'OK', the patient appears again in the planner in the newly selected period.

### 3.13.6 Therapy color

Four variants are provided for the colored representation of the therapies, selectable in context menu. The selection of the 4 possibilities is done via the two context menus:

Fixed therapy color female / male  
Fixed therapy color benign / malignant

1. no therapy color:

Fixed therapy color female / male  
Fixed therapy color benign / malignant

	<	>	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
			04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.		
Bed 1 - 320			m					m			m		m										
			Example0211, Igor 13.05.1953,							Example, Valerie 3.5.1972, additio													
Bed 2 - 317													f								f		
													Example1FitAuto, Olga 25.02.1922,										
Bed 3 - 314			m					m															
			STEP02102020, Andrey 03.06.1960,																				

Here all therapies are displayed in gray (font color according to type of disease)

2. therapy color by gender:

Fixed therapy color female / male  
Fixed therapy color benign / malignant

	<	>	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
			04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.		
Bed 1 - 320			m					m			m		m										
			Example0211, Igor 13.05.1953,							Example, Valerie 3.5.1972, additio													
Bed 2 - 317													f								f		
													Example1FitAuto, Olga 25.02.1922,										
Bed 3 - 314			m					m															
			STEP02102020, Andrey 03.06.1960,																				

Female patients: **sand color**

Male patients: **light green**

For patients on the ward, the color tone will be slightly darker!

3. Therapy color according to disease type:

Fixed therapy color female / male  
 Fixed therapy color benign / malignant

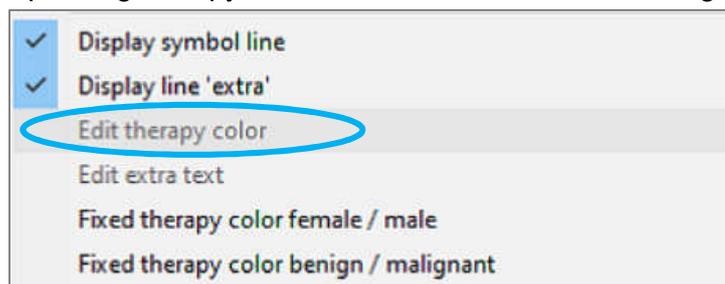
	<	>	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
			04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.		
Bed 1 - 320			m					m		m			m										
			Example0211, Igor 13.05.1953,							Example, Valerie 3.5.1972, additio													
Bed 2 - 317													f							f			
													Example1FitAuto, Olga 25.02.1922,										
Bed 3 - 314			m					m															
			STEP02102020, Andrey 03.06.1960,																				

benigne therapies: sand color  
 malignant therapies: light green  
 For patients on the ward, the color tone will be slightly darker!

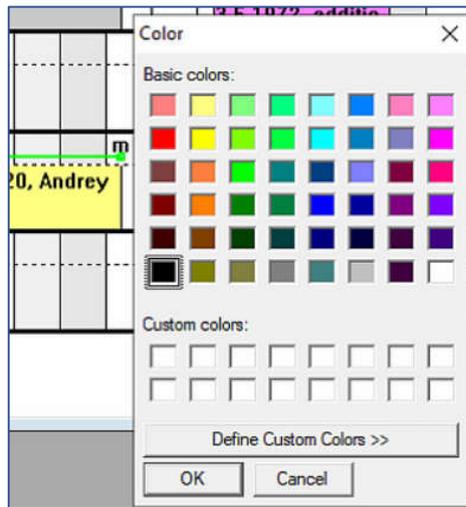
#### 4. Individual therapy color:

	<	>	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
			04.	05.	06.	07.	08.	09.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.		
Bed 1 - 320			m					m		m			m										
			Example0211, Igor 13.05.1953,							Example, Valerie 3.5.1972, additio													
Bed 2 - 317													f							f			
													Example1FitAuto, Olga 25.02.1922,										
Bed 3 - 314			m					m															
			STEP02102020, Andrey 03.06.1960,																				

If neither of the two options is active, an individual therapy color can be entered. This is done after selecting the corresponding therapy via the context menu 'Enter / Change therapy color':



This menu item is only enabled if no other color option is active!  
 After selecting these menus, the color selection dialog box appears:

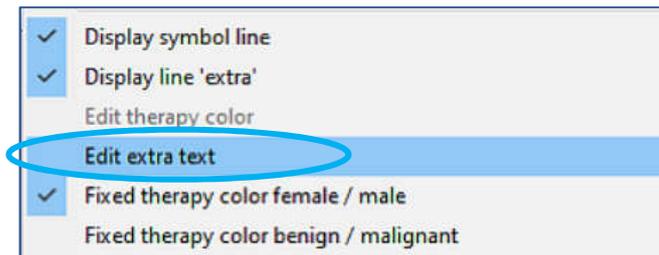


After selecting the color, the selected therapy appears in exactly this color!

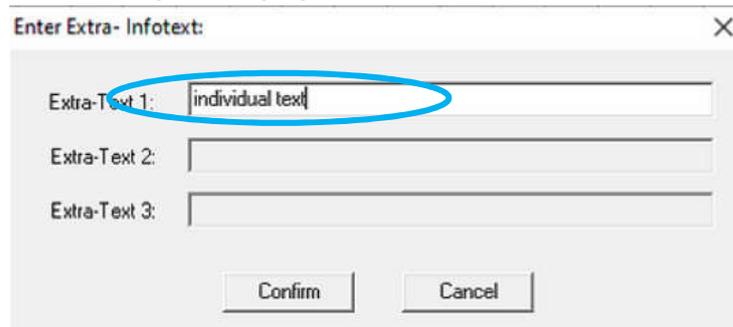
### 3.13.7 Input extra text

Depending on the settings, a maximum of 4 info lines can be entered individually for each therapy.

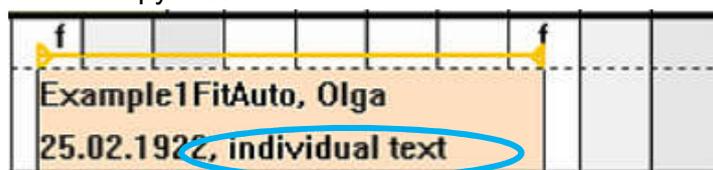
For this purpose the corresponding therapy is selected with the mouse and the menu item 'Enter / change extra info text' is chosen from the context menu:



Then the dialog box for entering / changing the extra text appears:



Depending on the settings, up to 3 extra lines are enabled. The entered text will appear in the corresponding line in the therapy area:



### 3.13.8 Print functions

- print templates are implemented in the planner



Via the context menu 'Print current view'/'Print current planner view' the current planner window can be printed 1:1 in color.

The second print option is a list of planned applications for each selected day. The day is selected with the mouse and then the list of all planned applications including the planned radio-iodine tests can be printed as follows:

## Center for Nuclear Medicine and Oncology of Semey City

Nuclear medicine

Kutzhanova street 3  
Semey City

---

### Daily list (admissions / discharges / RJT) from: 13.11.2020

**Admission:**

Patient name	Date of birth	plan. discharge	plan. Activity	Type of illness	Comment
Example1FitAuto, Olga	25.02.1922	20.11.2020	0.415 GBq	Benign	Benign

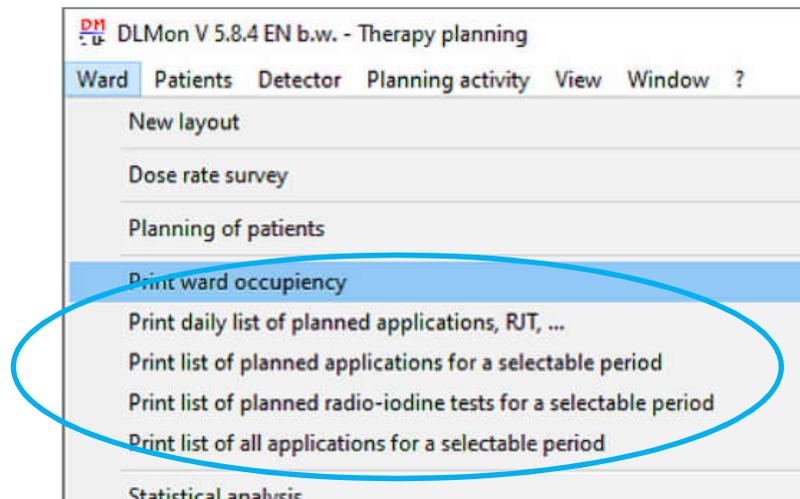
**Discharge:**

Patient name	Date of birth	Duration of therapy
--------------	---------------	---------------------

**Radiolodine test:**

Patient name	Date of birth	Start of therapy:
--------------	---------------	-------------------

Further printouts are possible via menu 'Ward':



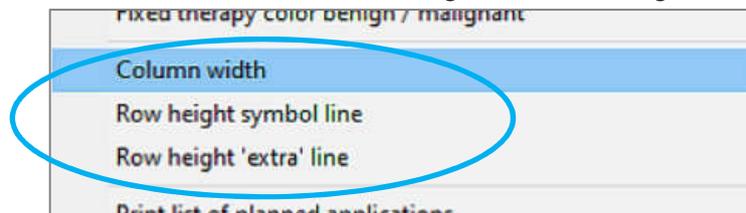
Here you can print lists with planned applications for individually adjustable periods (e.g. per week).

### 3.13.9 Settings

Basically, the settings are only valid locally for this PC. On other DLMon client computers other options / colors can be set individually. The entered patient data incl. additional texts are of course identical on all DLMon- clients.

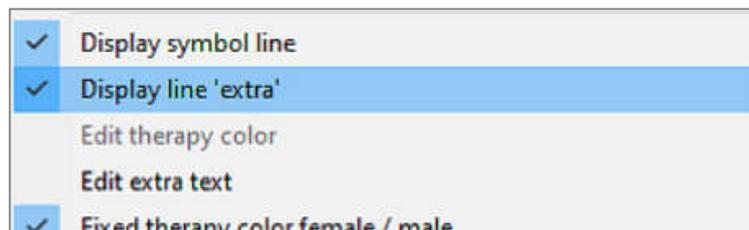
#### Setting column width and row height

Via the 3 menu items the column width and row height can be changed:



#### Setting the type and number of extra text lines

A maximum of 4 info lines are provided for each therapy. The settings are made via the context menu 'Display' extra field:



The dialog box for selecting possible display options appears:

The image shows a dialog box titled "Settings for additional information lines" with a close button (X) in the top right corner. The dialog contains four sections for configuring information lines:

- Addition info line 1:**
  - Show 1. info line with patient name + first name
- Addition info line 2:**
  - Show 2. info line with variable text
  - Show automatically the date of birth before the info text
- Addition info line 3:**
  - Show 3. info line with variable text
- Addition info line 4:**
  - Show 4. info line with variable text

At the bottom of the dialog, there is a checkbox labeled "Show margin around patient info lines" which is currently unchecked. Below this checkbox are two buttons: "Confirm" and "Cancel".

1. Line Additional information text:
  - always contains the name of the patient without variable text
  
2. Line Additional information text:
  - variable text input
  - optionally the date of birth can be automatically displayed before additional text
  
3. Line Additional information text:
  - variable text input
  
4. Line Additional information text:
  - variable text input

### 3.14 Use HL7- Data interface

Health Level 7 (HL7) is a group of international standards for the exchange of data between healthcare organizations and their computer systems.

An additional software module 'HL7-DLMon' enables patient data transfer from an HL7 interface via a direct TCP/IP socket connection. The software supports:: HL7 version 2.2

2 HL7 message types are implemented:

1. reception of ADT messages for patient admissions
2. sending of ORU messages when entering an application or when patient discharge

The following ADT messages can be processed:

- |   |          |     |   |
|---|----------|-----|---|
| - | ADT- A01 | ... | Admission of a patient to a nuclear medicine ward |
| - | ADT- A02 | ... | Transfer  |
| - | ADT- A03 | ... | Discharge   |
| - | ADT- A08 | ... | Correction of patient data                        |
| - | ADT- A11 | ... | Cancellation of a stay                            |
| - | ADT- A13 | ... | Cancellation of a discharge                       |
| - | ADT- A23 | ... | Cancellation of a patient record                  |
| - | ADT- A31 | ... | Correction of patient demographic data            |
| - | ADT- A34 | ... | Merge patients with different ID's                |

For ORU messages related to an application the following data is sent:

- running time No. of the application
- Date / time of application
- Activity of the application
- Unit of the application
- Pharmacon
- Nuclide of the application
- Status of the application

When a patient is discharged, the following data is sent in the ORU message:

- Discharge activity
- Unit of discharge activity
- Discharge date
- Discharge notes

#### Note:

The advantage of the HL7 module is the automatic transfer of patient data including the patient number. Typing errors are impossible.

A disadvantage is the timing of the HL7 messages, which are usually only generated when a patient arrives at the clinic for in-patient admission. Therefore, the use of the planning tool is very limited, as the patient data is only available on the day of admission. Therefore a long term patient planning with optimal utilization of the ward is not possible.

## 4. Functions for admin

### 4.1. General information

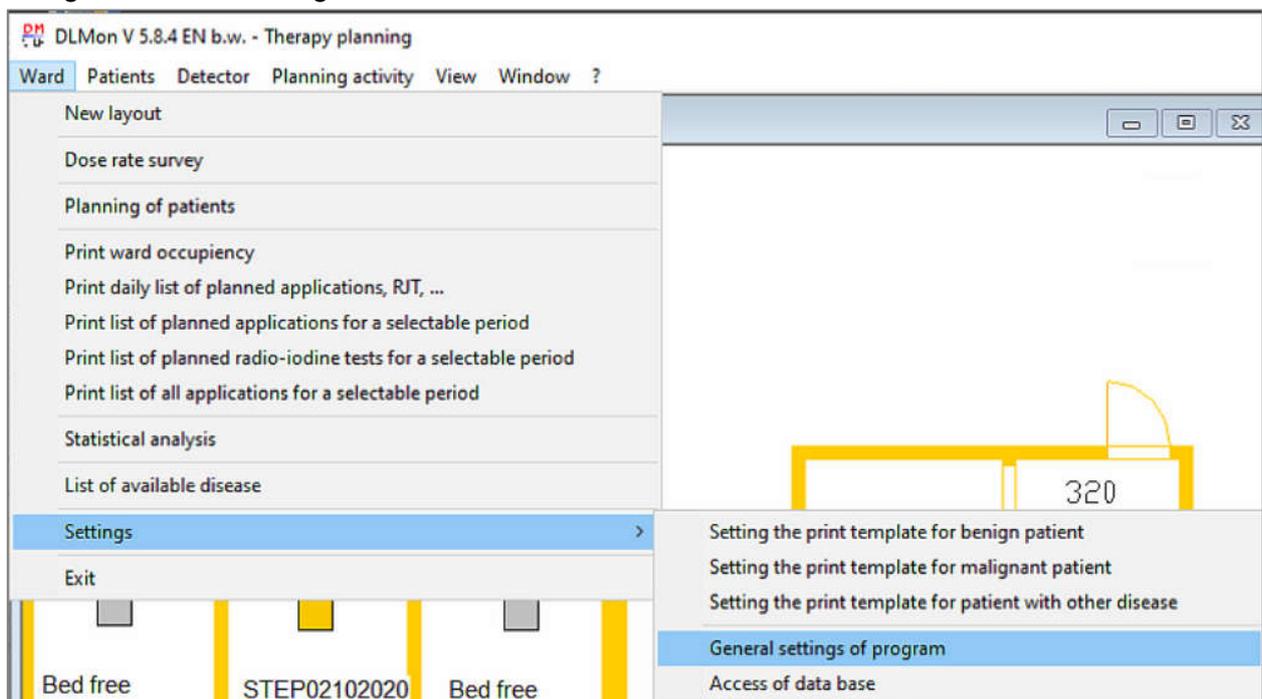
All settings, which may only be changed by instructed persons / administrators, are protected with a password:



Please ask the manufacturer / administrator for the password.

### 4.2 Ward settings

The general ward settings can be accessed via the menu:



After entering the password you get to the dialog box:

Adjustments of DLMon

Nuclide | Measured values | ward layout

Standard nuclide:

Name of nuclide: I-131

Dose rate constant [ $\mu\text{Sv/h} / \text{GBq} \cdot \text{m}^2$ ]: 59

Half-life [sec]: 693014

Discharge threshold 1 [ $\mu\text{Sv/h}$ ]: 20

Discharge threshold 2 [ $\mu\text{Sv/h}$ ]: 68

General values:

Dose rate reference distance [m]: 1

General ward background [ $\mu\text{Sv/h}$ ]: 0

Uptake correction factor: 0.9

OK Cancel Apply Help

Name Standard- Nuclide	I-131: fixed and not changeable for these nuclides the detectors are calibrated
Gamma-DL-constant	fixed, can only be changed by the manufacturer with this constant is realized the calibration of detectors
Half-life	for I-131, fixed, can only be changed by the manufacturer
Discharge threshold 1	Fixed setting in consultation with the clinic / ward, can only be changed by the manufacturer
Discharge threshold 2	Fixed setting in consultation with the clinic / ward, can only be changed by the manufacturer
Reference distance for dose rate	Changeable, depending on region / country Germany: 2m Austria / Kazakhstan: 1m
General station background	This dose rate value is subtracted from the measured value and can be used in case of increased background / contamination / increased radiation exposure from adjacent areas
Uptake correction factor	Additional factor to correct the uptake value during the automatic calculation of uptake from the FIT curve (in the dose rate diagram) Standard: 0.9

**Measured value selection:**

The screenshot shows a dialog box titled "Adjustments of DLMon" with a close button (X) in the top right corner. It has three tabs: "Nuclide", "Measured values" (which is selected), and "ward layout".

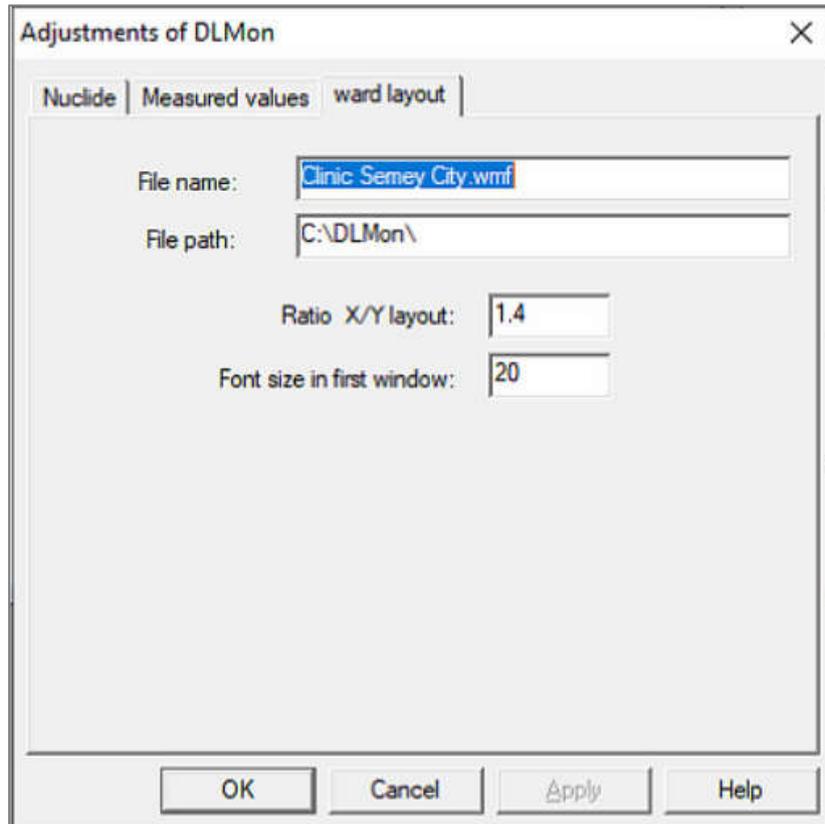
Under the "Measured values" tab, there are several sections:

- Daily measuring period for FIT curve:**
  - Start time for FIT curve per day ( e.G. 22:00):
  - End time for FIT curve per day ( e.G. 06:00):
- Color for inactive measured values:**
  - A black color swatch is shown next to the text "Color for inactive measured values:". To its right is an "Edit" button.
  - Below this is the text "( Color for active measured values is green! )".
- Conditions for calculating the FIT curve:**
  - Wait after application [sec]:
  - Dose rate lower level [ $\mu\text{Sv/h}$ ]:
  - Band width [%]:
  - Below these fields is the text "(e.g. 80%=10% of the smallest and 10% of the largest values are discarded)".
- Average value of dose rate:**
  - Number of values for average (for daily period):

At the bottom of the dialog box, there are four buttons: "OK", "Cancel", "Apply", and "Help".

Start time for measured value use	Start time for bed time / sleeping time, from when all patients should lie in bed
End time for measured value use	End time for bed time / sleeping time, until then all patients should be in bed
Color tone for inactive measured values	Color for all measured values that are <u>not used</u> to calculate the regression line / FIT curve in the dose rate diagram All used measured values are always displayed in <b>green</b>
Waiting time after an application in [sec]	Immediately after an application it is not useful to use measured values to calculate the regression line. Depending on the disease, a waiting period of up to 18 h (64800 sec) is useful
Dose rate lower limit	Only measured values that are greater than this lower limit are used to calculate the regression line / FIT curve in the dose rate diagram. Standard: $\leq 1 \mu\text{Sv/h}$
Measured value bandwidth	Percentage to exclude the largest and smallest measured values. With a bandwidth of 80%, 10% of the largest and 10% of the smallest measured values are ignored.
Number of measured values for daily time interval	Number for averaging

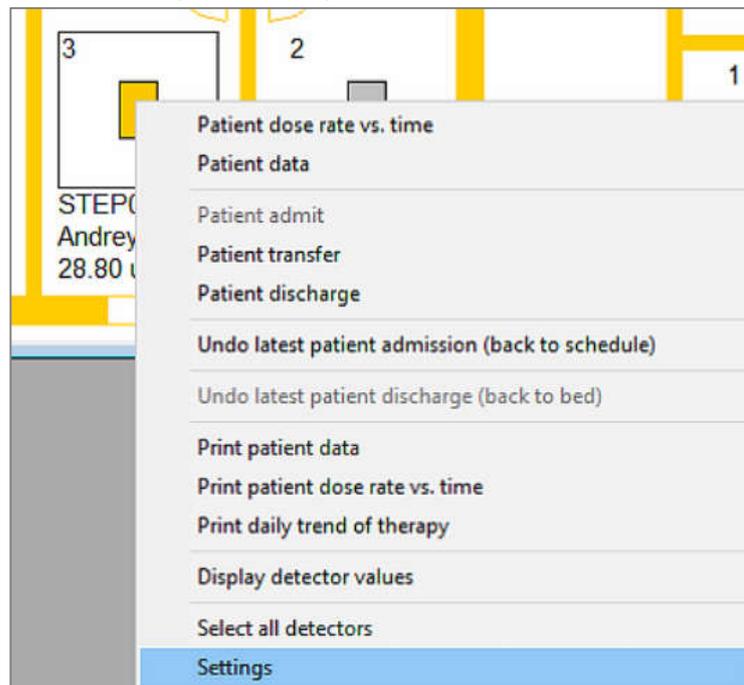
**Ward plan:**



File Name	Name of the file containing ward plan as WMF- file
File- Directory	Name of the folder that contains ward plan
Ratio X/Y ground plan expansion	With this ratio the ground can be stretched or compressed. This will adjust the ward plan window on pc monitor
Front size	This font size is used to display the font in the initial ward plan window

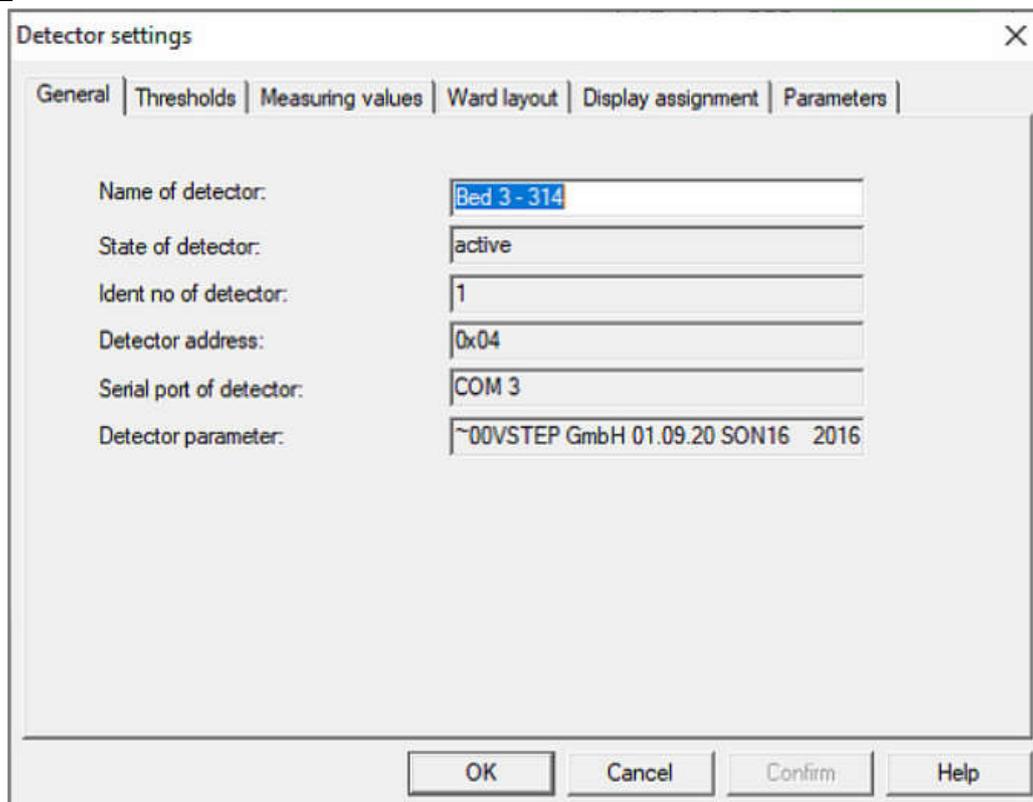
### 4.3 Detector settings

The special detector / bed setting can be adjusted via context menu in ward plan:



The settings are password protected.

#### General:



This property page displays name, state, address, port and parameter of the selected detector. Only the name can be changed here.

### Threshold values:

Detector settings

General | **Thresholds** | Measuring values | Ward layout | Display assignment | Parameters

Selected detector: Bed 3 - 314-NT

Threshold 1 (green) :	1	µSv/h
Threshold 2 (yellow) :	20	µSv/h
Threshold 3 (red) :	68	µSv/h

OK Cancel Confirm Help

Here 3 threshold values for the dose rate in  $\mu\text{Sv/h}$  can be entered separately for each detector. The colors of the threshold values cannot be changed and are used to get a quick overview of the measured value in the possible representations.

### Measured values

Detector settings

General | Thresholds | **Measuring values** | Ward layout | Display assignment | Parameters

Selected detector: Bed 3 - 314-NT

Max number in memory:: 20000

Current number in 16306

Latest value: 4.689 uSv/h from: 09.11.2020 13:28:21

OK Cancel Confirm Help

The maximum number of measured values determines the size of the local measured value file and should be set to 20,000. Thus, measured values of the last 10 weeks are available in the system.

## Display in ward plan

Detector settings

General | Thresholds | Measuring values | **Ward layout** | Display assignment | Parameters

Change affect only select detector:

Selected detector:

Position / size of detector:

X-position:

Y-position:

Angle [ °]:

Width:

Length:

Margin:

Line assignment below detector:

1. line:

2. line:

3. line:

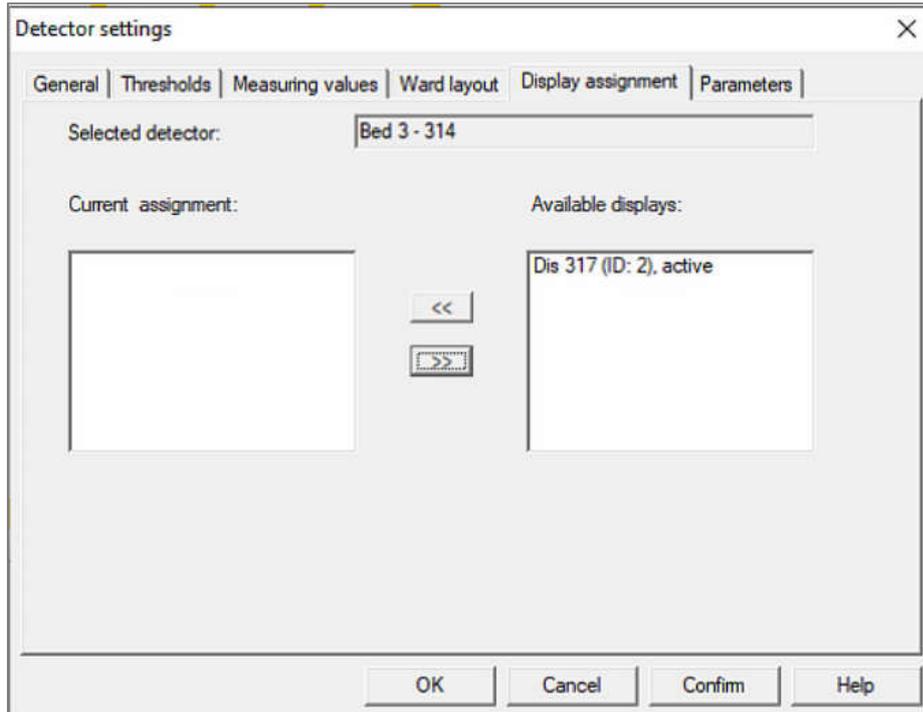
4. line:

OK Cancel Confirm Help

On this property page the position and outfit of a bed / detector in the ward plan can be adjusted individually:

X-Position	X-position of the detector / bed in floor plan Adjustable only via the side scroll bars, no input of a value possible
Y- Position	Y-position of the detector / bed in floor plan Adjustable only via the lateral scroll bars, no input of a value possible
Angle	Angle of the detector / bed in floor plan Adjustable only via the lateral scroll bars, no input of a value possible
Width	Width of the detector / bed in floor plan Adjustable only via the lateral scroll bars, no input of a value possible
Length	Length of the detector / bed in floor plan Adjustable only via the lateral scroll bars, no input of a value possible
Frame	Size of the snap frame for selecting the detector / bed in the floor plan Adjustable only via the lateral scroll bars, no input of a value possible
1. Line	Content of the 1st line under Detector in the ward plan window
2. Line	Content of the 2nd line under Detector in the ward plan window
3. Line	Content of the 3rd line under Detector in the ward plan window
4. Line	Content of the 4th line under Detector in the ward plan window

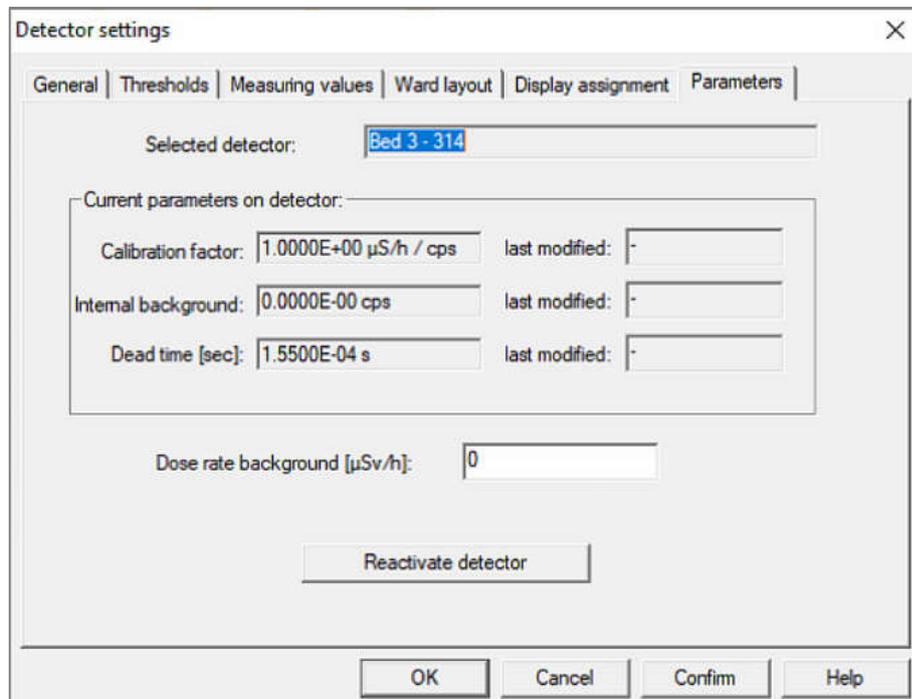
Assigned door display:



Via the 'Assigned displays' property page, one or more displays can be assigned to each detector. All available displays are shown in the right list field with name, ID number and current state.

Via the button  a display from the list of available displays is added to the selected detector. Via the button  you can remove an already assigned ad

Parameters:



The current detector parameters (calibration factor, level2 / background, dead time) are displayed here, but cannot be changed.

The dose rate background is individually adjustable for each detector.

## 4.4 Detector Calibration

Each detector measured the equivalent dose rate  $\dot{H}$  in [ $\mu\text{Sv/h}$ ] at a distance of 1m from the patient.

The detector works with a counting tube, which can measure radiation in the energy range from 20 keV to 2 MeV. Beta- radiation  $> 0,5$  MeV can be detected. The dose rate can be measured in a range of 1 - 1000  $\mu\text{Sv / h}$

### Geometry:

The purpose is to measure the dose rate that the patient emits at a distance of 1 m.

Since the patient lies in bed under the detector and the distance to the detector is  $> 1$  m, this distance must be calculated using a calibration factor.

For this purpose a microcontroller is built into the detector which multiplies the counting rate of the counter tube by the internally stored calibration factor. In addition, a dead time correction is made.

The calibration factor must be determined in the clinic under the real geometric condition.

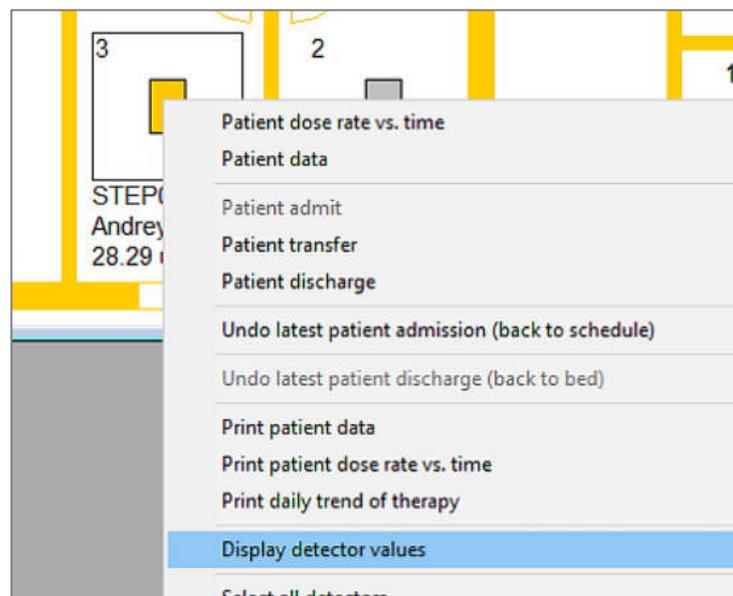
We recommend a calibration source I-131 with approx. 1 GBq activity and a measuring time of 5 min. The use of a thyroid phantom is advantageous. Place the thyroid phantom with the source in the bed where the patient's thyroid is located. Adjust the height of the bed to a fixed standard position.

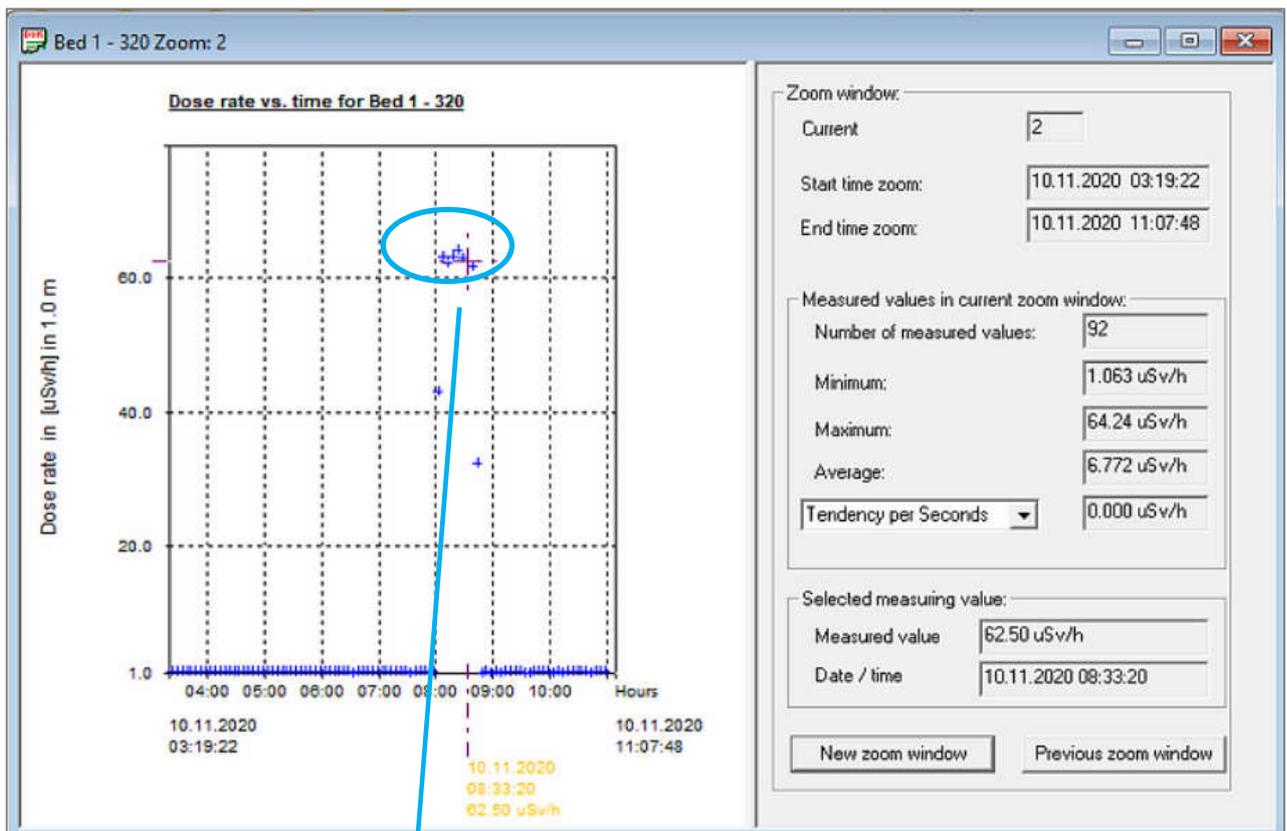
Check the calibration once a year.

### 4.4.1 Check calibration factor

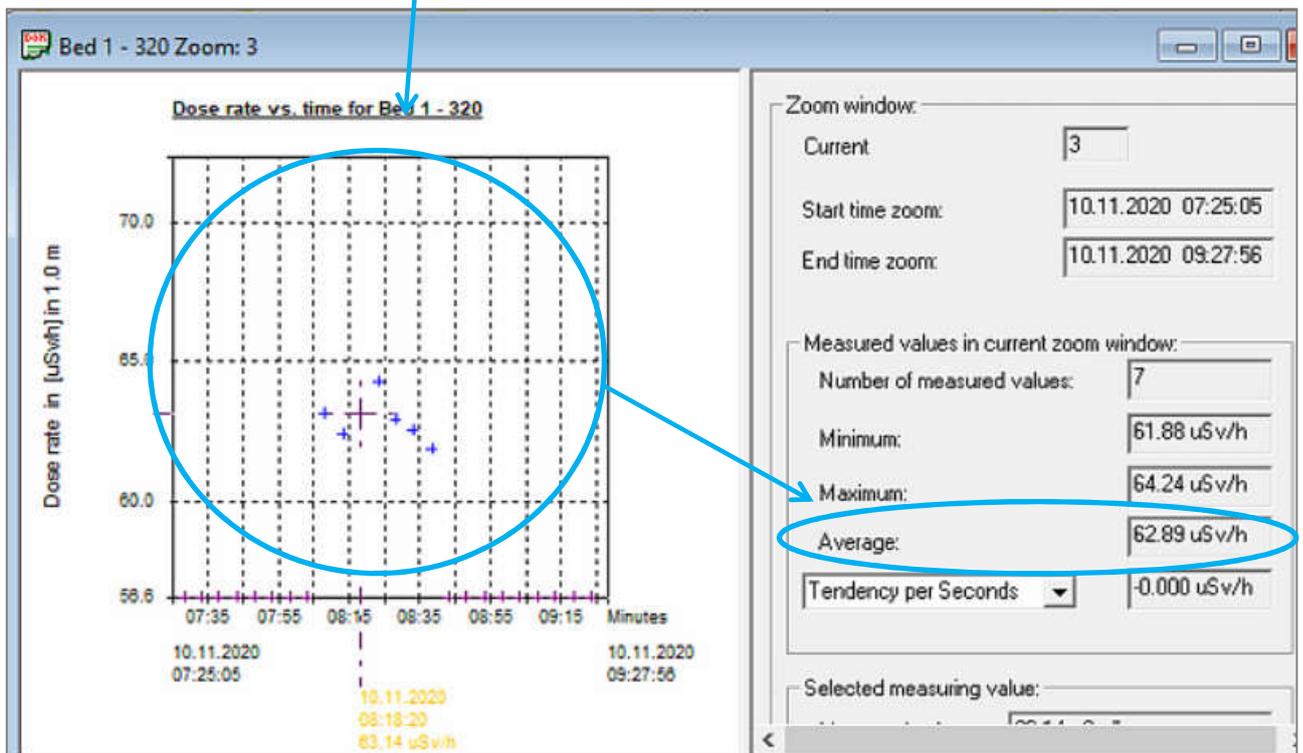
Use the DLMon software to check the calibration factor. As described above, place a calibration source with known activity in the bed at the location of the thyroid gland.

Check the raw measured values of the detector via the detector context menu 'Display detector values' in the ward plan:





Use the zoom function for check the values:



Compare the displayed measured values with your calculated expected values.

Calculation example:

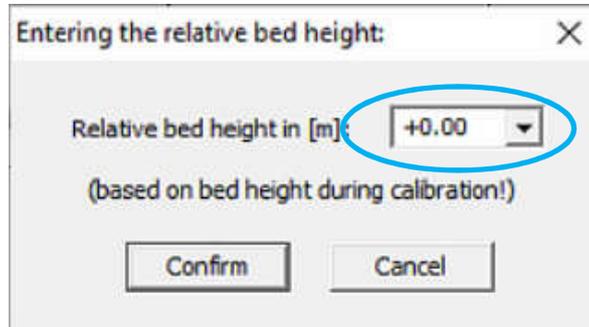
For a I-131 check source with 1 GBq and gamma constant of 59  $\mu\text{Sv/h} / \text{GBq} \cdot \text{m}^2$  and the reference distance of 1 m the expected dose rate should be:

$$\text{Dose rate} = 59 \mu\text{Sv/h}$$

Deviations of  $\pm 25\%$  are acceptable, taking into account the possible sources of error (activity of the source, position, ...).

Important:

The relative bed height must be 0,00 m ! Otherwise the measured values are corrected.

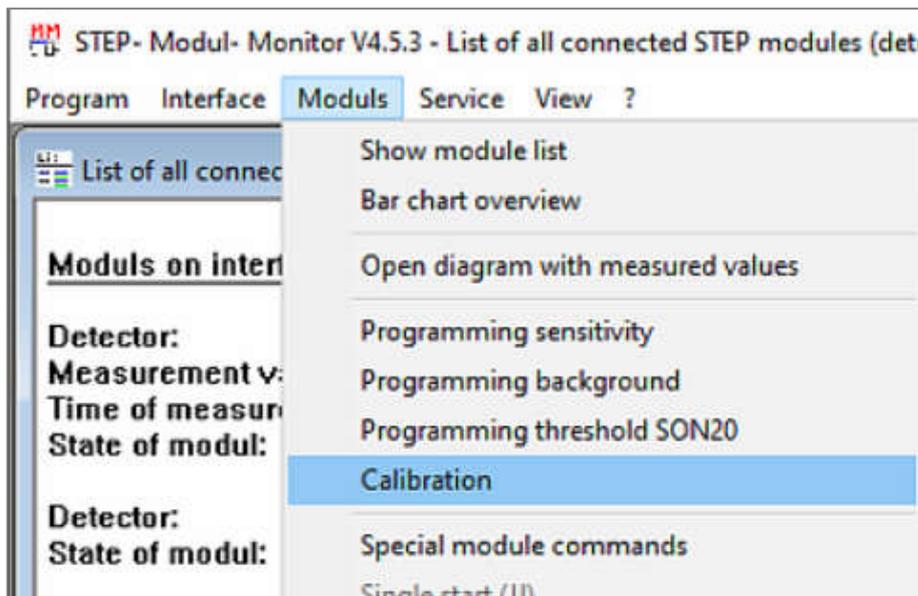


#### 4.4.2 Performing the calibration

A new calibration is not done with the DLMon software, but with the STEP- Modulmonitor software. For this purpose, the program DLMon must be exited and then the STEP- Modulmonitor must be opened (e.g. via the icon on the desktop).



Open the menu 'Calibration':



and after input password you get the dialog "Detector Calibration" dialog:

Calibration of connected detectors: X

List of detector: Select detector

LUM 3 \* ModuHD: 1 active: Bed 4 - 313

Current calibration factor in [  $\mu\text{Sv/h}$  / cps ]: 1.0000E+00

---

Calibration settings:

Activity of source

Activity [GBq]: 1.013

calculated dose rate in 1m in [  $\mu\text{Sv/h}$  ]: 59.767

Distance detector - calibration source center [m]: 2.132

Distance floor - calibration source in [m]: 0.75

Distance wall (head end) - calibration source [m]: 0.8

Measurement time [sec]: 30 sec

Number of measurements: 5

Name of calibration source: Check source I-131 1 GBq

Name of source as info

Nuclide: I-131

Dose rate constant: 59 [  $\mu\text{Sv/h}$  / GBq \* m<sup>2</sup> ]

Gamma constant for I-131  
56 .. 60  $\mu\text{Sv/h}$  / Gbq \* m<sup>2</sup>

Start

Start Calibration Active calibration: 1 remaining measurement time in [sec]: 18

Info State of calibration

Results:

Readings:

Average dose rate (1m) [  $\mu\text{Sv/h}$  ]:  

New calibration factor / sensitivity:   [  $\mu\text{Sv/h}$  / cps ]

New factor

Exit Cancel Confirm Print protocol

Detector	Selection of the detector to be calibrated from a list of available detectors with display of the currently stored calibration factor
Activity in [GBq]	Activity of the I-131 calibration source, measured shortly before calibration
Calculated dose rate in 1m in [ $\mu\text{Sv/h}$ ]	Target dose rate calculated from activity and gamma constant at 1 m distance
Distance detector - calibration source [m]	This distance depends on the mounting height of the detectors and is measured by the manufacturer when the station is commissioned. The height of the I-131 capsule above the floor must be subtracted from this mounting height
Measuring time [sec]	Duration of a calibration measurement <u>Note:</u> With a calibration activity of 1 GBq is

	recommended 5 measurements of 30 sec (for good statistics)
Number of measurements	Number of consecutive automatic measurements <u>Note:</u> With a calibration activity of 1 GBq is recommended 5 measurements of 30 sec (for good statistics)
Dose rate constant	Dose rate constant valid for I-131

The calibration is started by pressing the button **Start Calibration** . The window to the right shows the status of the calibration.

After finishing the routine the results are displayed.

- Measured values*    Dose rate of single measurement, related to 1 m distance
- Average dose rate*    Average value from all individual measurements
- Calibration factor*    Calibration factor calculated from mean value of measured values

The newly determined calibration factor is only effective if the calibration is completed by pressing the button **Confirm** .

You can print out a calibration protocol by clicking the **Print protocol** button. A later access to the parameters of the calibration is no longer possible!

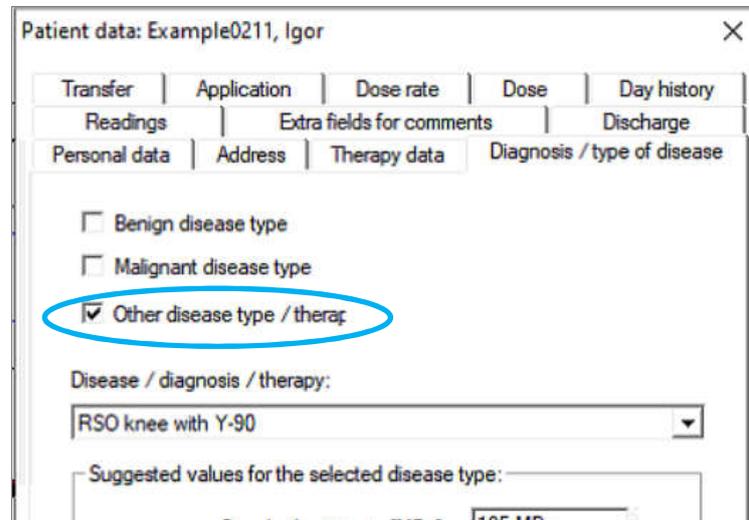
The determination of the calibration factor for another detector is done analogously after selecting the corresponding module in the "List of detector".

By pressing "Exit" or "Cancel" the calibration routine is exited.

## 4.5 Calibration of additional nuclides

In this program version it is possible to switch between the station nuclide (usually I-131) and other nuclides for each detector (bed).

The requirement for this is the selection 'Other disease type' in sheet 'Diagnosis / type of disease' in patient data:



Patient data: Example0211, Igor

Transfer	Application	Dose rate	Dose	Day history
Readings	Extra fields for comments		Discharge	
Personal data	Address	Therapy data	Diagnosis / type of disease	

Benign disease type  
 Malignant disease type  
 Other disease type / therap

Disease / diagnosis / therapy:  
RSO knee with Y-90

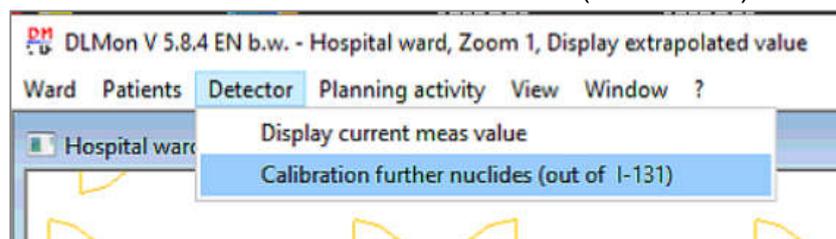
Suggested values for the selected disease type:

For malignant and benign radio-iodine therapies the nuclide I-131 is fixed!

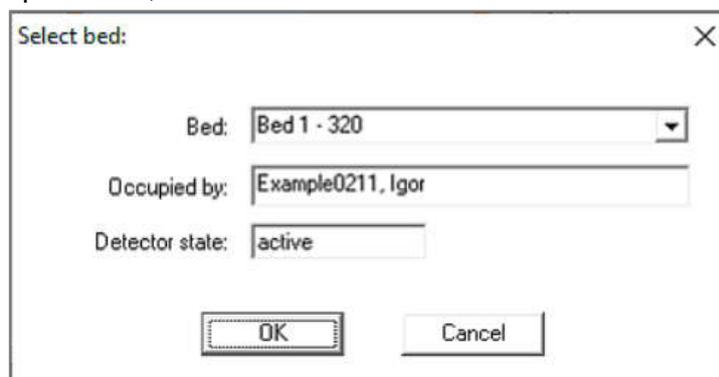
In principle, the following setting values are accepted when activating another therapy nuclide:

- additional calibration factor to calculate the dose rate
- Half-life of the additional nuclide
- Gamma constant of the additional nuclide
- Discharge threshold 1
- Discharge threshold 2

The condition for the use of other therapies is the creation and calibration of these additional nuclides Via menu "Detector >> Calibration further nuclides (out of I-131)":



After entering the password, the bed/detector must be selected:



Select bed:

Bed: Bed 1 - 320

Occupied by: Example0211, Igor

Detector state: active

OK Cancel

The bed should be free, because we work with a calibration source.

After selection bed the following dialog box appears:

This dialog box is used to:

- Create new nuclides
- Change existing nuclides
- Calibration of existing nuclides.

The nuclide to be calibrated must be selected in the list field 'List of existing nuclides'. If the nuclide is not available in the list field, it can be created using the button 'Add new nuclide':

After entering all data and pressing the 'Apply' button and the new nuclide immediately appears in the list.

Display / change nuclide data

Changes to existing nuclides are made via the button

After selecting the nuclide, the data of the calibration source must be entered:

- Calibration activity and determination time (automatic decay correction)
- Distance detector - calibration source
- Number of measurements to be performed

Calibration for selected nuclide:

Nuclide: Lu-177 Current nuclide correction factor: 0.2000

Calibration activity in [GBq]: 1.000 at the time: 12/11/2020 11:01:48

Name of calibration source: Calibration source 0815

Distance calibration source - detector in [m]: 2.46

Target dose rate at a distance of 1 m in [ $\mu$ Sv/h]: 1.235  $DI = (A * \text{Gamma}) / r^2$  with:  $A = A_0 * \exp(-\text{Lambda} / \text{Half life})$

Number of measurements to be performed: 1

Start new calibration measurement

measured dose rate at a distance of 1 m in [ $\mu$ Sv/h]: measured on:

The calibration can be started with

Start new calibration measurement

In the info field you get the state of measurement:

Name of calibration source: Calibration source 0815

Distance calibration source - detector in [m]: 2.46

Target dose rate at a distance of 1 m in [ $\mu$ Sv/h]: 1.235  $DI = (A * \text{Gamma}) / r^2$  with:  $A = A_0 * \exp(-\text{Lambda} / \text{Half life})$

Number of measurements to be performed: 1

Start new calibration measurement

1.. measurement runs! Remaining 290 second!

measured dose rate at a distance of 1 m in [ $\mu$ Sv/h]: measured on:

After the measurement has been completed, the mean value of the measured dose rate and the newly calculated nuclide correction factor appear in the lower part of the dialog box:

Compare new with current calibration factor

Start new calibration measurement

Loading value from detector

measured dose rate at a distance of 1 m in [ $\mu$ Sv/h]: 4.5657E+00 measured on: 12.11.2020 11:22:13

Average measured dose rate in [ $\mu$ Sv / h]: 4.5657

Newly calculated nuclide correction factor: 0.271

Confirm new nuclide correction factor + print protocol

Exit

Confirm the new factor with button:

Confirm new nuclide correction factor + print protocol

Confirm the follow dialog to save new calibration factor in database:

Dlmon

Additional calibration factor saved to database!

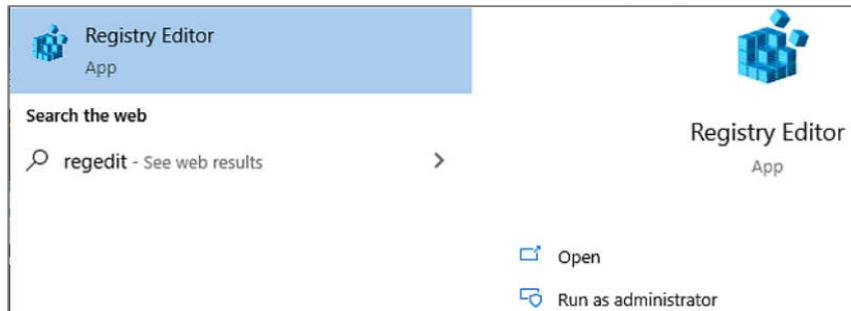
OK

With 'Printout' the data is transferred to the database with a printout of the calibration protocol:

<b>Calibration protocol</b>	
for calibration from	: 12.11.2020 11:16 Uhr
<b>Data of detector</b>	
Detector ID	: 1
Detector name	: Bed 1 - 320
Room name	: Ro 320
current ward-nuclide	: I-131
calibration factor for ward-nuclide in [( $\mu$ Sv/h)/cps]	: 1.0000E+00
<b>Data for calibration with additional nuclide</b>	
Name for additional nuclide	: Lu-177
Nuclide half life in [d]	: 6.7100
Dose rate constant in [ $\mu$ S/h / GBq * m <sup>2</sup> ]	: 7.483e+000
Name of the calibration source	: Calibration source 0815
Activity of the calibration source in [GBq] (12.11.2020 11:01)	: 1.000
Activity of the calibration source in [GBq] (12.11.2020 11:16)	: 0.999
Distance of calibration source to the detector in [m]	: 2.46
Target dose rate at 1m distance in [ $\mu$ Sv/h]	: 1.235
Calibration measuring time in [sec]	: 300
Measurements per calibration	: 1
Current additional calibration factor	: 0.2000
<b>Calibration results:</b>	
Average of measurement at 1m distance in [ $\mu$ Sv/h]	: 4.5657
New calibration factor	: 0.271

## 4.6 Settings in Registry

Many software settings are stored in the registry. Open the Registry editor with reedit.exe:



You find the adjustments under the key:

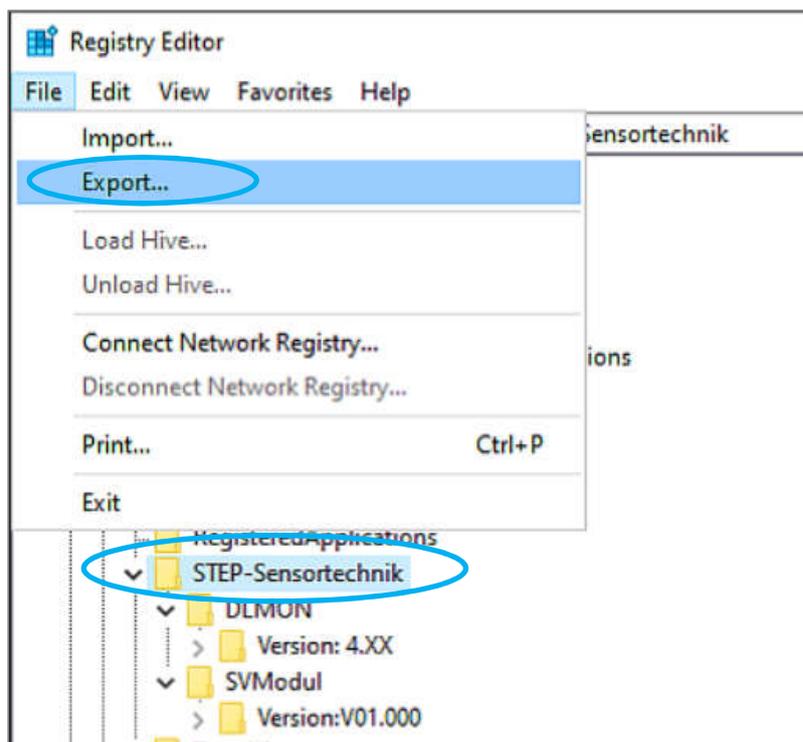
HKEY\_CURRENT\_USER >> Software >> STEP-Sensortechnik

For the module monitor in key: SVModul

For the DLMon software in key: DLMON

Please note that changing individual keys without exact knowledge of the function can result in a partial or complete malfunction of the DLMon system.

To be on the safe side, always make a copy of the complete STEP Sensortechnik key using the export function:

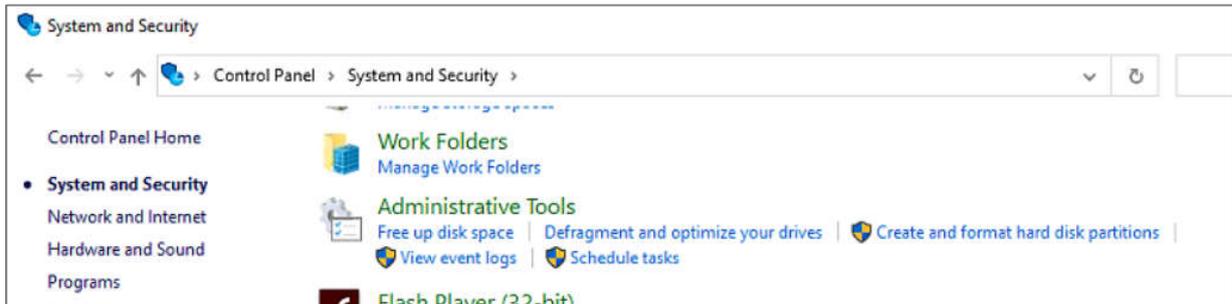


Please contact the manufacturer if you have any questions for changing any adjustents!

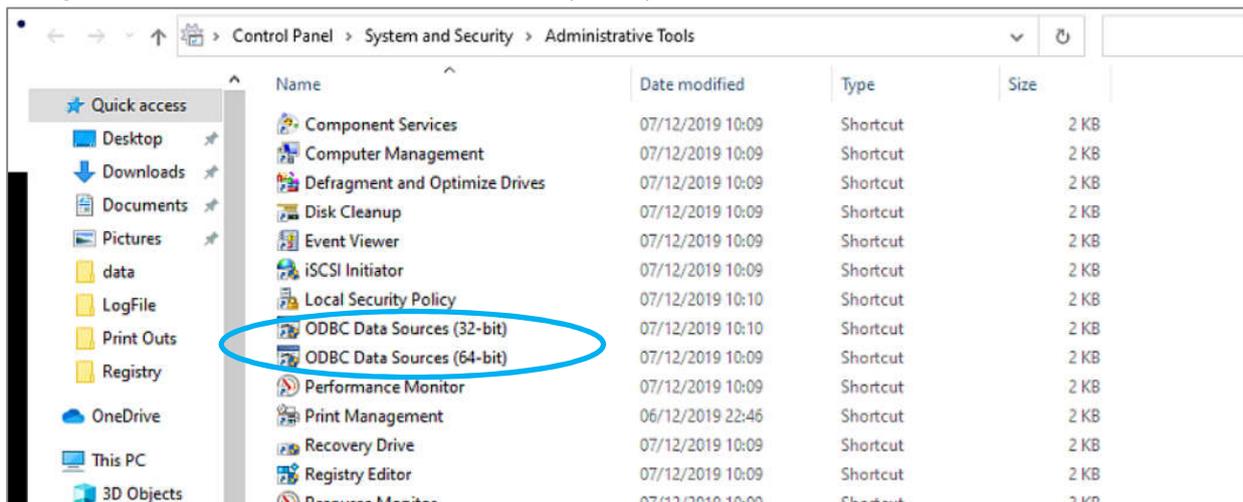
## 4.7 ODBC- Driver

All therapy data and measured values are stored in SQL database, named RJT2000SQL. This database is connected to a Microsoft SQL server (2008 or higher). For reasons of availability and security the SQL server and therefore the database should not run locally on the DLMon PC but in the hospital network!

The DLMon software uses an ODBC driver to access the database.  
Over the system control panel >> Administrative Tools:

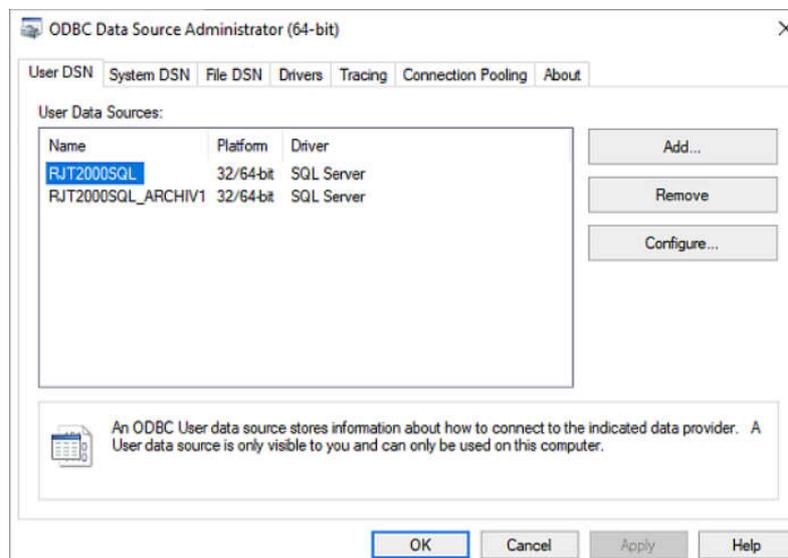


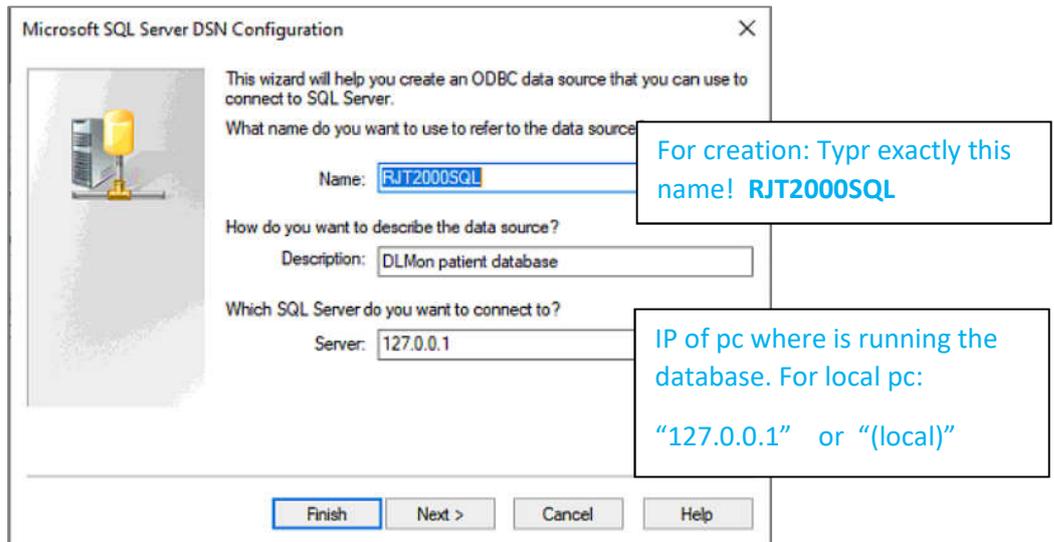
You get access to >> ODBC Data Sources (xx-bit) :



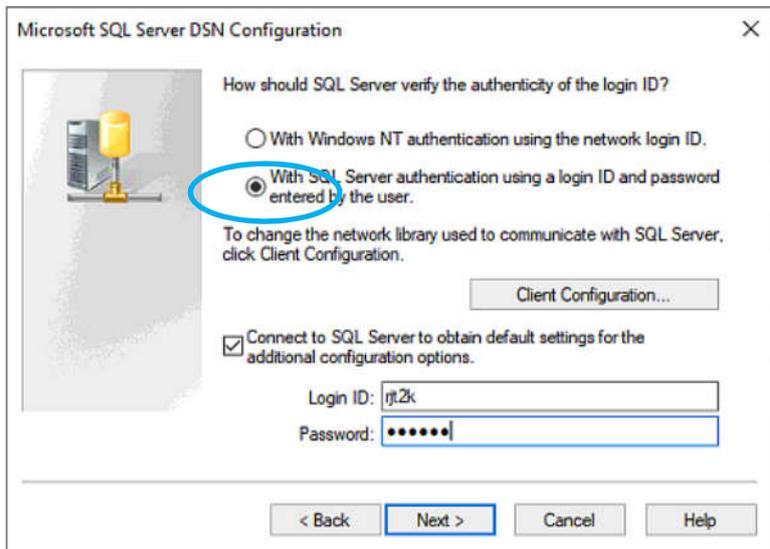
Open one of this menu and add or configure the ODBC driver as follow:

:



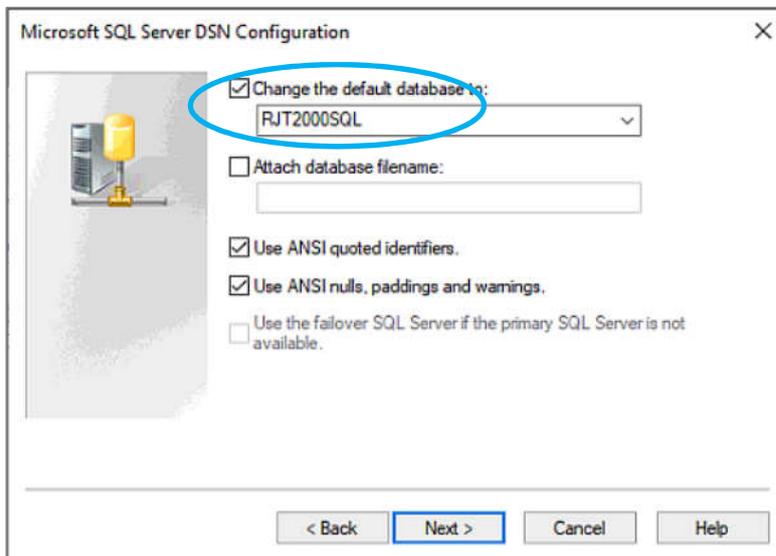


Name: **RJT2000SQL**  
 Server: according to IP or (local)

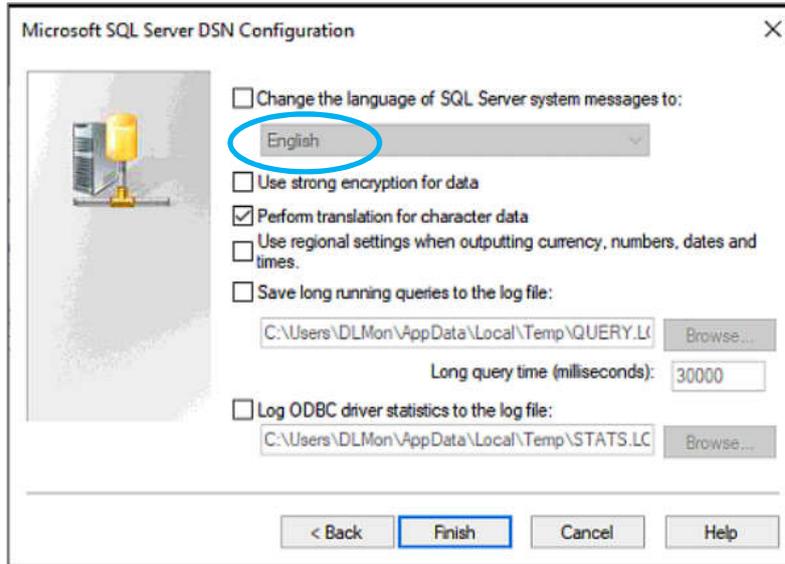


Username: **rjt2k**  
 Password: please ask the manufacturer!

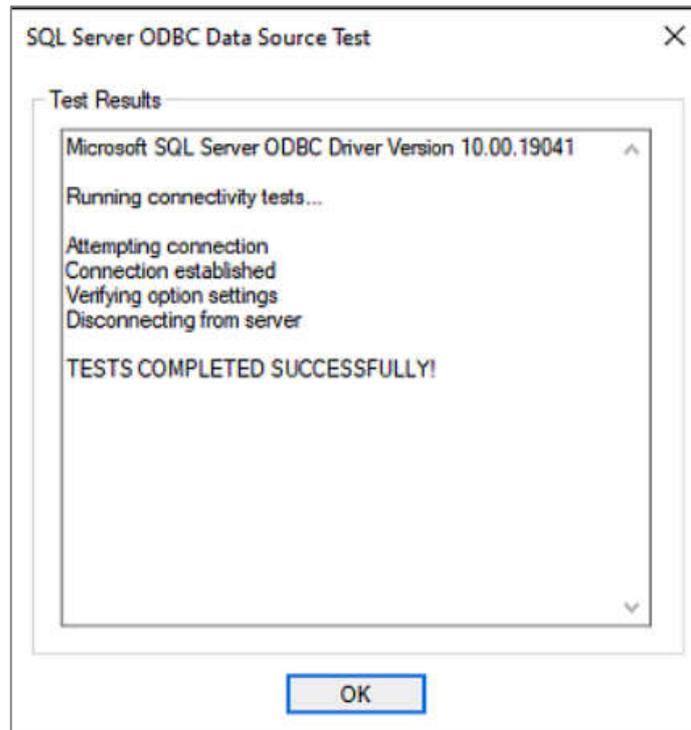
Selection of the RJT2000SQL database



Select language: For English operating system choose : English



Test ODBC driver / access to database:

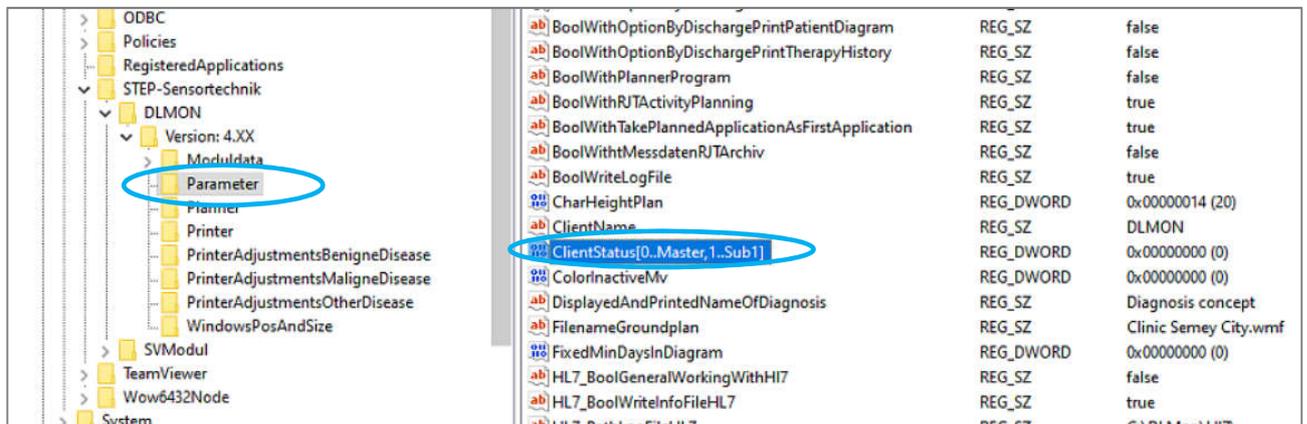


## 4.8 Setting up additional DLMon clients on other PCs

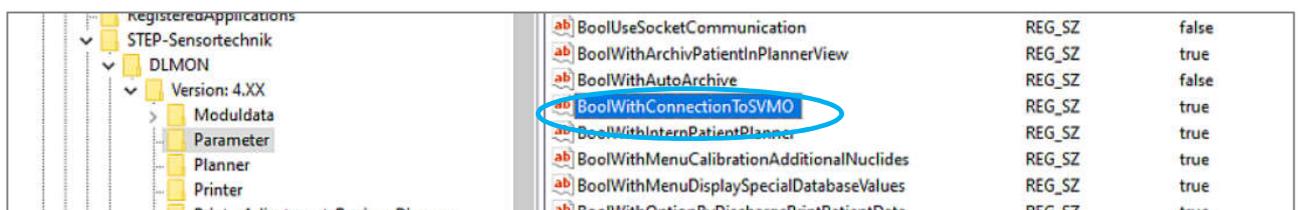
The DLMon software is programmed as client-server software. Several DLMon clients can be installed on other computers. The PCs must be in the same domain. It is important that there is only one master client!

To install the DLMon software on an additional PC the following steps are necessary:

1. Copy the folder 'C:\DLMon' to the new PC
2. Configure ODBC driver for access to database
3. Export of the Registry *STEP-Sensortechnik* from the master client PC and import on new PC, activate file \*.reg on new PC with double click.
4. Change registry key '*ClientStatus(0..Master, 1...Sub)*' from master client **0** to sub-client **1**



5. If DLMon- Sub- Client should only be used for planning or display of the occupancy, the access to measured values / connection to the module monitor can be disabled. For activation / deactivation of the measured value transmission the key '*BoolWithConnectionToSVMO*' exists:



Instead of **true** >> enter **false** when you don't need measuring values.

6. If the screen resolution of the new PC differs from the PC of the master client, the position of the beds / detectors in the floor plan must be shifted / adjusted according to point 4.3 (Display in floor plan).

## 5. Notes on error handling

If software errors occur, you should

- log the error / the error message, if possible via a screen copy
- Please note down your last activities in handling the software in order to reconstruct the error case
- Exit the software DLMon and restart the program after 30 sec.
- If the problem occurs again, contact the manufacturer
- Please also tell us the software version you work with

Contact details:

Mail: [info@step-sensor.de](mailto:info@step-sensor.de)  
[b.winkler@step-sensor.de](mailto:b.winkler@step-sensor.de)

Tel: 0049 (0) 37367 9791