

VirtualDose™ User Guide



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1. Introduction

The purpose of this document is to assist the user in the operation of the VirtualDose Software.

For the best use experience, we suggest using the Google Chrome web browser or Internet Explorer 10.0 or newer.

2. Accessing the web-based VirtualDose Software

VirtualDose can be accessed from a web browser directly at www.virtual-dose.com or www.virtual-dose-eu.com (the first being physically located within the US, and the second within the EU). Both sites are exact mirrors, and user credentials may be used at either site (account changes are synchronized once per hour, so changes on one site will not be immediately available on the other).

To access the VirtualDose software, users need a pre-assigned username and password. Enter the user name and password are entered in the available fields, and click the “Log in” button to enter the site.

Beneath the login fields are three additional options:

- “Register with a registration code”: if you have been provided a registration code and have not yet selected your login credentials, click here to set up your account
- “Forget your password?”: use this option to reset your password – you will need access to the email you used to register your account. If you no longer have access to that email, contact support@virtualphantoms.com for assistance.
- “Request a code for a trial account”: use this option to request a 7-day evaluation account for VirtualDose



Log in Form

We strongly advise you to use Google Chrome for the best use experience.

Account name

Password

Remember my login Yes

[Register](#) with a registration code.

[Forget your password? Reset it here.](#)

[Request](#) a code for a trial account.



Figure 1. Log in page

The VirtualDose system consists of two separate tools, **VirtualDoseCT**, for Computed Tomography dose, and **VirtualDoseIR**, for Interventional Radiology/Fluoroscopy dose. An individual user account may have permission to use either or both tools.

If the “login” is successful, the main web-based interface will be displayed, depending upon the account permissions. The user interface of the VirtualDose software tool is friendly and easy-to-use.

3. VirtualDoseCT Software Tool User Interface

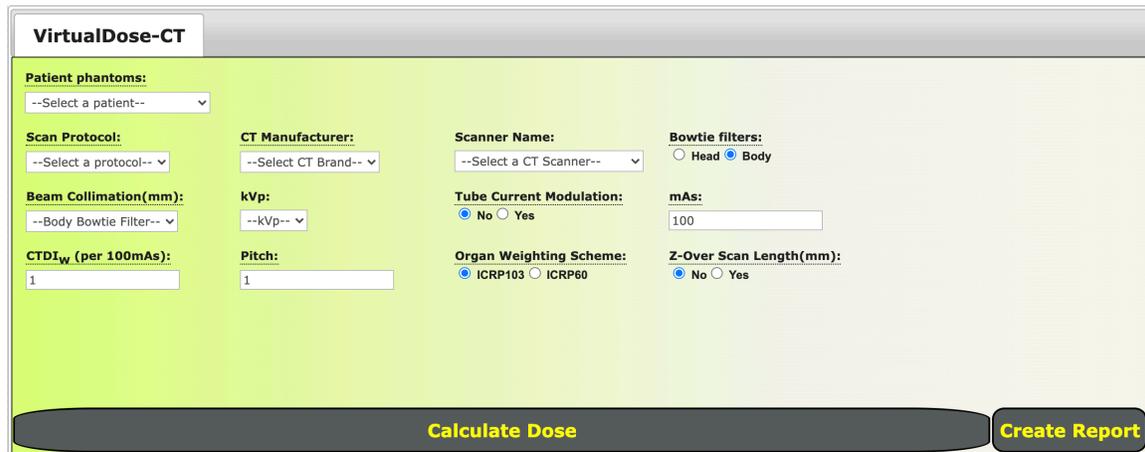


Figure 2. VirtualDoseCT Software Tool User Interface

There are several input parameters that are entered from the main interface, as shown in Figure 2. The user selects or inputs these parameters of the CT scan before performing the patient dose calculation (some drop-down menus depend on previous choices, so it is generally best to enter values from left to right). The main components of the user interface include:

- (1). Virtual Patient Selection
- (2). Scan Protocol List
- (3). CT Scanner
- (4). Bow Tie Filter Type
- (5). Beam Collimation
- (6). kVp
- (7). Tube Current Modulation
- (8). mAs
- (9). CTDI_w
- (10). Pitch
- (11). Z-Over scan length
- (12). Tissue weighting factors

Virtual patient

A user must first select a “virtual patient” best representing the individual being scanned. The phantom can be selected directly from the “Patient Phantoms” dropdown list or by entering patient biometric information. Clicking the “Patient Phantoms” title will reveal inputs for patient age, sex, height, and weight.

VirtualDose has 25 virtual patients in total, including 50th percentile adults named RPI-Adult-Male (RPI-AM) and RPI-Adult-Female (RPI-AF), pediatric patients of both male and female at different ages (newborn, 1-, 5-, 10-, and 15-year-old), pregnant females at three gestational stages (3-,6-, and 9-month), and a set of obese male and female patients (normal-weight, over-weight, obese level-I, obese level-II, and morbidly obese, as defined by WHO guidelines).

Scan protocol

The next step is to choose a scan protocol for the selected “Virtual Patient” from the “Scan Protocol” dropdown list. When selected, the relevant scan range will then show above the “Virtual Patient” with a red color highlight, as shown in Figure 3.

Virtual dose provides 11 pre-defined protocols including head, neck, chest, heart/cardiac, abdomen, liver, kidney, colon, pelvis, abdomen-pelvis and CAP for the users to choose. Any scan range can be selected manually by using mouse to drag the green-colored sliders to specify the scan range on the “Virtual Patient.” The cross-section images are provided to help the user to better define the start point and the end point of the scan.

CT scanner

After specifying the scan range, user may select the CT scanner. First select a CT manufacturer from the dropdown list, manufacturers like GE, Siemens, Philips, Toshiba, Elscint and Picker are included in the list. Then choose the model of the CT scanner of the selected manufacturer from the scanner name dropdown list. If the scanner model is unknown, there is an option to select a “Generic Scanner.”

Bowtie filter

There are two types of bowtie filters, head and body. VirtualDose can choose the bowtie filter automatically based on the selected protocols, with the head filter used for head and neck protocols, and body filter for all other protocols. The user can override this automatic selection. Take particular care with pediatric protocols that are established using the head bowtie filter.

Beam Collimation & kVp

Beam Collimation & kVp can be selected from the dropdown list after the scanner is chosen. The beam collimation & kVp dropdown list will update automatically based on the available options for the chosen scanner.

Tube Current Modulation

Select “Yes” to approximate the behavior of tube current modulation on the CT system. When selected, the values of mAs and CTDIw below will be taken to be the average of the scan, instead of constant values.

mAs

Enter the value for the mAs per rotation in the scan. When the tube current modulation option is selected, this should be the average mAs per rotation for the entire scan. When tube current modulation is not in use, this will be a constant value.

CTDIw (per 100 mAs)

CTDIw, or weighted CTDI represents the scanner output. When available, the system will supply a default value of the CTDIw per 100 mAs (sometimes called the normalized CTDIw) for the selected scanner. Be sure to check that this value is appropriate for your specific application. The value used in the calculation will be adjusted based on the mAs entered.

In some cases, the CTDIw for the scanner and/or the mAs may not be available, and you will only have the CTDIvol to use. Recall that $CTDIvol = CTDIw / pitch$, so $CTDIw = CTDIvol \times pitch$. Use this relationship to calculate the CTDIw for the scan and enter that value into the selection box, and enter 100 for mAs so that the calculation is scaled correctly.

Pitch

The value of pitch can be acquired from the scanner console or CT DICOM files. Input the value into the text box.

Tissue weighting factors

Two set of tissue weighting factors (ICRP103 and ICRP60) are available. Based on the selection, the appropriate methodology for calculating the displayed Remainder Dose and Effective Dose will be used.

Z-Over scan length

If the user needs to consider Z-over scan length, select “Yes” and input the length of the overscan region in mm for the superior and inferior ends of the scan.

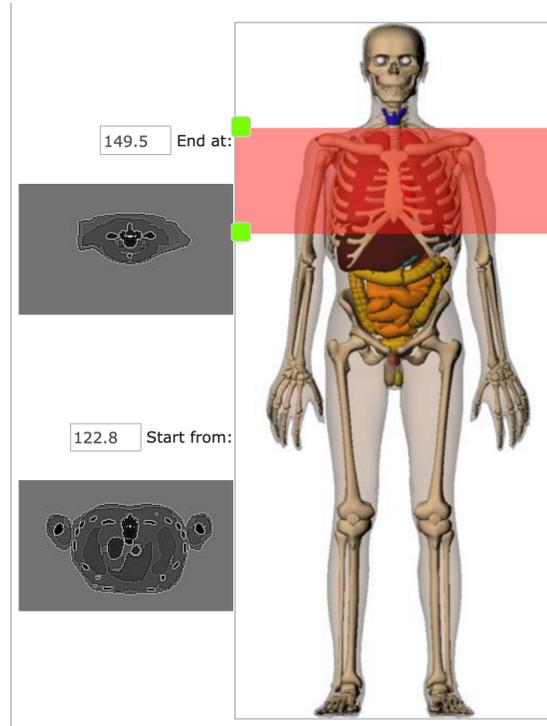
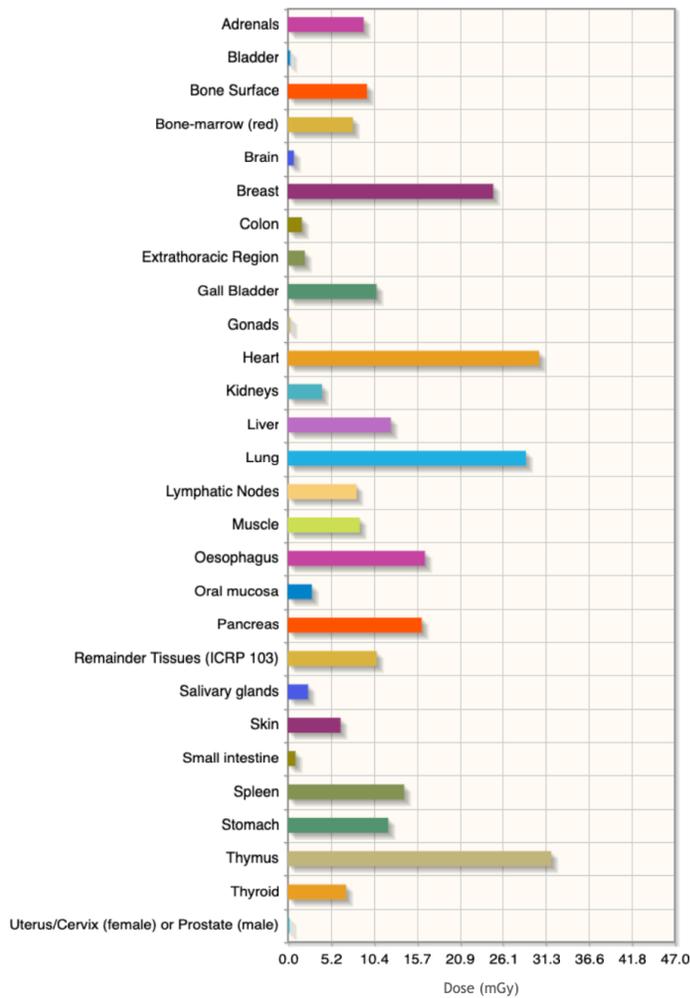


Figure 3. "Virtual Patient" shown within the browser

To calculate the CT dose based on the selected settings, click the "Calculate Dose" button and the results will be immediately plotted and tabulated in the third section of the main user interface, as shown in Figure 4.



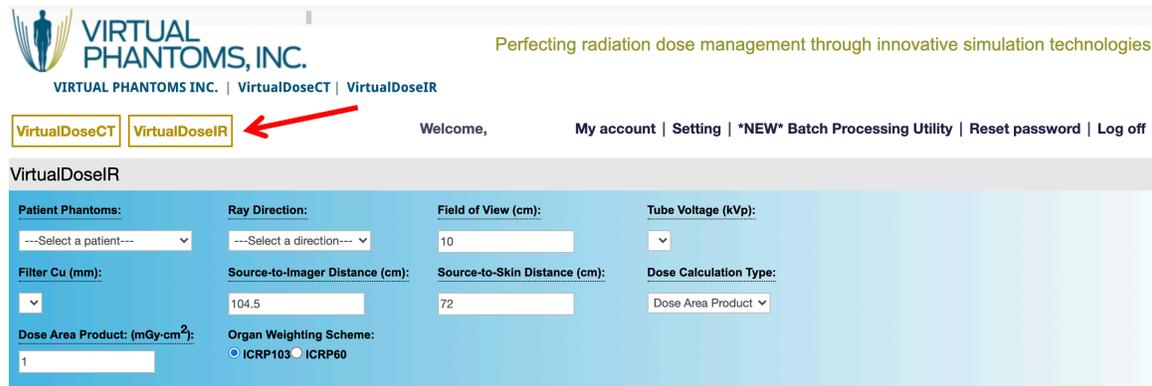
Organ Dose	
Organ/Tissue Name	Dose (mGy)
Bladder	0.31
Bone Surface	9.61
Bone-marrow (red)	7.89
Brain	0.76
Breast	24.89
Colon	1.73
Gonads	0.32
Liver	12.49
Lung	28.86
Oesophagus	16.62
Remainder Tissues (ICRP 103)	10.77
Salivary glands	2.48
Skin	6.40
Stomach	12.18
Thyroid	7.08
Effective Dose (mSv): 12.04	

Remainder Organs	
Organ/Tissue Name	Dose (mGy)
Adrenals	9.20
Extrathoracic Region	2.08
Gall Bladder	10.76
Heart	30.44
Kidneys	4.15
Lymphatic Nodes	8.33
Muscle	8.72
Oral mucosa	2.93
Pancreas	16.24
Small intestine	0.95
Spleen	14.09
Thymus	31.90
Uterus/Cervix (female) or Prostate (male)	0.23

Figure 4. Plotted and tabulated dose results

The calculated data may be saved to an Excel-formatted report by selecting the “Generate Report” button.

4. VirtualDoseIR Software Tool



The screenshot displays the VirtualDoseIR software interface. At the top, the logo for VIRTUAL PHANTOMS, INC. is visible, along with the tagline 'Perfecting radiation dose management through innovative simulation technologies'. Below the logo, there are navigation links for 'VirtualDoseCT' and 'VirtualDoseIR', with a red arrow pointing to the 'VirtualDoseIR' link. The main interface area contains several input fields and dropdown menus for configuring simulation parameters:

- Patient Phantoms:** A dropdown menu with the text '---Select a patient---'.
- Ray Direction:** A dropdown menu with the text '---Select a direction---'.
- Field of View (cm):** A text input field containing the value '10'.
- Tube Voltage (kVp):** A dropdown menu.
- Filter Cu (mm):** A dropdown menu.
- Source-to-Imager Distance (cm):** A text input field containing the value '104.5'.
- Source-to-Skin Distance (cm):** A text input field containing the value '72'.
- Dose Calculation Type:** A dropdown menu with the selected option 'Dose Area Product'.
- Dose Area Product: (mGy·cm²):** A text input field containing the value '1'.
- Organ Weighting Scheme:** Radio buttons for 'ICRP103' (selected) and 'ICRP60'.

Figure 5. VirtualDose-IR™ Software Tool User Interface

There are several input parameters that are entered from the main interface. Some options depend on previous selections – a warning will be generated if selections are not made in the correct order. The main components of the user interface include:

- 1) Virtual Patient List
- 2) Ray direction List
- 3) Beam position selection
- 4) Field of View
- 5) Tube Voltage List
- 6) Cu Filter thickness List
- 7) Source to Imager distance
- 8) Source to Skin distance
- 9) Dose Calculation List
- 10) Organ Weighting Scheme

Virtual patient

The user must first select a “virtual patient” first from the “Patient Phantoms” dropdown list, as shown in Figure 5. VirtualDoseIR has 23 virtual patients in total, including 50th percentile adults named RPI-Adult-Male (RPI-AM) and RPI-Adult-Female (RPI-AF), reference adults for the Chinese population (Male – USTC and Female – USTC), pediatric patients of both male and female at different ages (5-, 10-, and 15-year-old), pregnant females at three gestational stages (3-, 6-, and 9month), and a set of obese male and female patients (normal-weight, over-weight, obese level-I, obese level-II, and morbidly obese, as defined by WHO guidelines). The user can select the model that is closest to the

studied clinical case for accurate patient dose calculation. The patient is assumed to be lying on a 2.15 mm Al equivalent thickness operating bed.

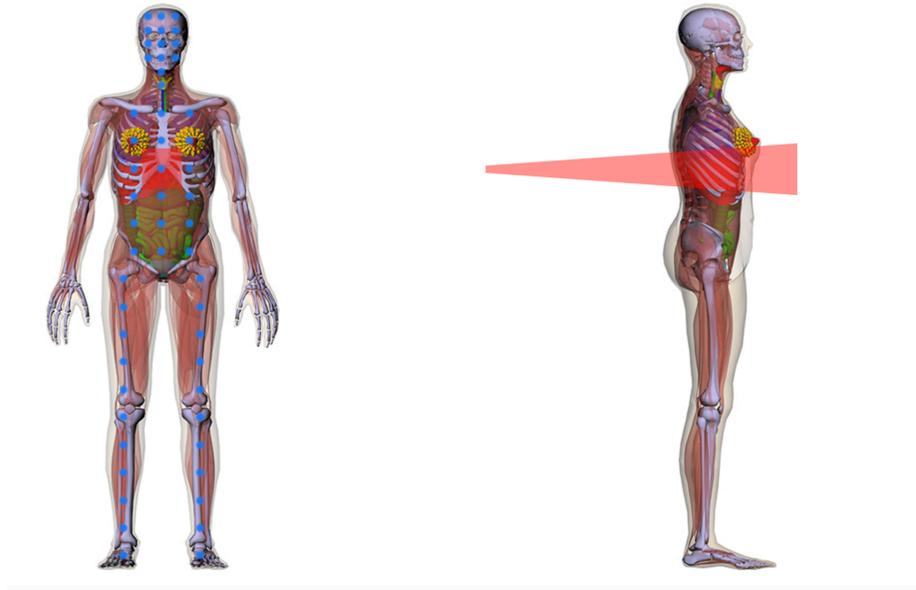


Figure 6. “Virtual Patient” as shown within the browser

Ray direction

The next step is to choose a ray direction for the selected “Virtual Patient”. Users can select the direction from those provided in the dropdown list and the corresponding X-ray projection will then show on the “Virtual Patient” in red color as shown on Figure 5. VirtualDose provides 6 pre-defined directions including posterior anterior, left lateral, right lateral, cranial, left anterior oblique and right anterior oblique for users to choose. If the direction is posterior anterior, cranial, left anterior oblique or right anterior oblique, the X-ray projection will show on the right picture and users can choose irradiation region on the left picture as shown on Figure 6. If the direction is left lateral or right lateral, the X-ray projection will show on the left picture and users can choose irradiation region on the right picture. As irradiation region changed, the X-ray beam in red color will also change to the corresponding region.

Beam position selection

When the beam direction is chosen, the options for beam position are displayed on the phantom image. Users may click on the blue points to localize the position of the beam. The position of the red beam indicator will update as the beam position is selected. Only after choosing the beam position may users select Tube Voltage and Filter Cu.

Field of View

After choosing the ray direction and irradiation region, users select the field of view. The dimension of the closest square field should be entered in the selection box. The red region of field of view will update automatically with the chosen field of view.

Tube Voltage & Filter Cu

Tube Voltage and filter Cu can be selected from the dropdown list after the patient phantom, ray direction and irradiation region are chosen, the Tube Voltage and filter Cu dropdown list will update automatically with the chosen patient phantom, ray direction and irradiation region. Users should note that in addition to the copper filtration, there is a 3.5mm Al filter that an inherent filter applied to all X-ray tubes and is not selectable by the user.

Dose Calculation Type

There are two kinds of dose output measurement methods that users can choose in the dropdown list to provide the fluoroscopic output. One is using dose area product, the other one is using air kerma rate at a reference point. If the user selects the dose-area-product method, a text box will be available to input the DAP in units of mGy cm^2 (be careful, as fluoroscopic machines may display the output in other units). If the user selects the air-kerma-rate method, a text box will appear for the air kerma rate measurement at the Reference Point (15 cm below isocenter) in mGy/s and the total time text in seconds.

Tissue weighting factors

Two set of tissue weighting factors (ICRP103 and ICRP60) are available. Based on the selection, the appropriate methodology for calculating the displayed Remainder Dose and Effective Dose will be used.

When all of the parameters are set, users can click “Calculate Dose” button and the results will be immediately plotted and tabulated below the phantom images, as shown in Figure 7. Optionally, users can click “Create Report” button to download dose report in Excel file format.

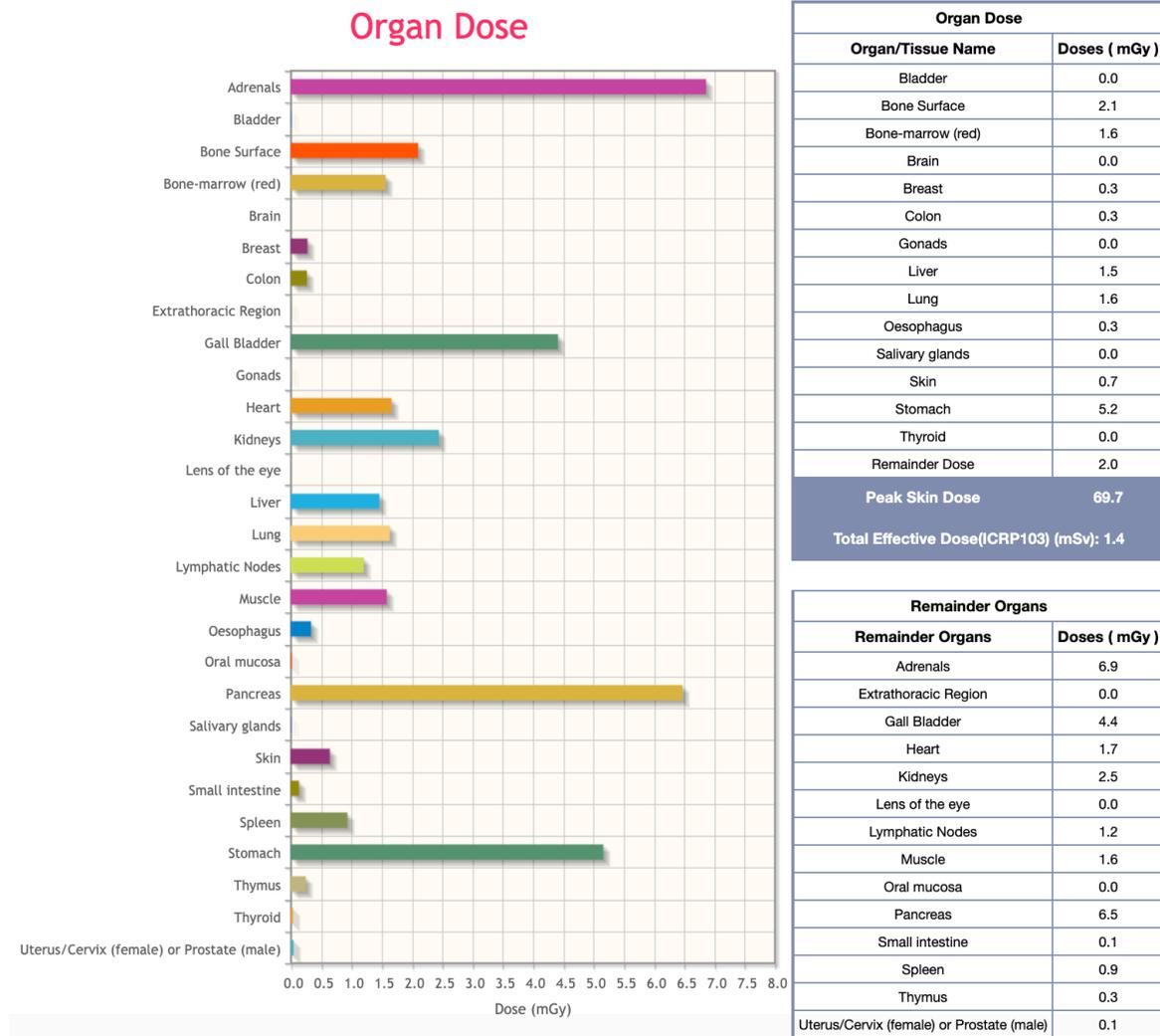


Figure 7. Plotted and tabulated dose results after use click the “Calculate Dose” button

5. User account management

The top-right menu bar provides several account management functions, shown in Figure 8:

- “My account” to view most of the account attributes (except for the user password)
- “Settings” which allows the user to edit the Organization, Email and Telephone on record
- “Reset password” to update the user Password

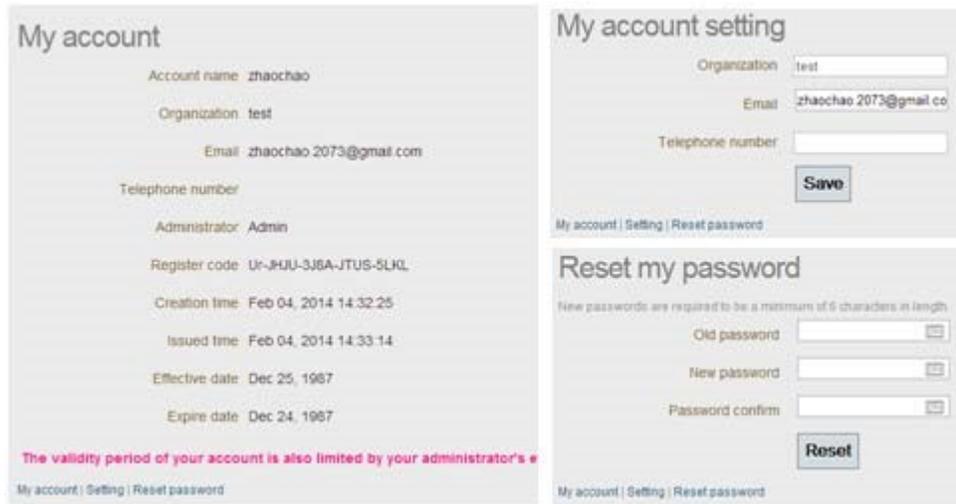


Figure 8. Screen capture of **User** account self-management

6. Batch Processing Utility

Subscribers to VirtualDose may download and use a utility to process multiple cases in a batch calculation by formatting the input in an Excel document. Information on the Batch Utility can be found from a link in the top right menu bar.

7. References

More information on the VirtualDose system modules can be found in our reference publications:

Ding A, Gao Y, Liu H, Caracappa PF, Long DJ, Bolch WE, Liu B, Xu XG. VirtualDose: a software for reporting organ doses from CT for adult and pediatric patients. *Phys Med Biol.* 2015 Jul 21; 60(14):5601-5625.

Huo W, Pi Y, Feng M, Qi Y, Gao Y, Caracappa PF, Chen Z, Xu XG. VirtualDose-IR: a cloud-based software for reporting organ doses in interventional radiology. *Phys Med Biol.* 2019 Apr 26; 64(9): 095012.

<https://doi.org/10.1088/1361-6560/ab0bd5>