Conceptus **D**ose **E**stimation tool

CODE
User Manual

http://embryodose.med.uoc.gr/

CODE Manual

Contents

Introduction

A substantial increase in the use of radiological procedures for pregnant patients has been observed in developed countries over the last decades, while accidental medical exposure of pregnant patients during the first post-conception weeks may occasionally lead to unnecessary pregnancy terminations. Besides, the remarkable increase in the use of fluoroscopically guided interventional procedures observed over the last decades, induced apprehension and concerns regarding the occupational exposure of pregnant employees involved. In either case, the expectant mother has the right to know the level of radiation burden to the embryo from in-utero exposure. Therefore, determination of embryo dose to pregnant patients undergoing radiological procedures and pregnant workers involved in fluoroscopically guided interventional procedures it is of paramount importance.

Code is a web based application which provides reliable estimation of

a. embryo radiation absorbed dose and radiogenic childhood cancer risk from radiological procedures performed on pregnant patients
b. embryo radiation absorbed dose from occupational exposure of pregnant employees involved in fluoroscopically-guided interventional procedures.

The current instruction manual provides information on how to use the CODE software. The "General Information" paragraphs describe the methods followed to produce embryo dose data for each module, while "How to use paragraphs describe step by step the operation of CODE software.

Medical exposure of pregnant patients

Module 1: Pregnant patient exposure from radiographic procedures

General information

CODE radiography module provides estimates for the embryo absorbed dose and associated risk for childhood cancer from conventional radiographic projections performed on the pregnant patient.

The Monte-Carlo-N-particle transport code and three mathematical phantoms representing the pregnant individual at 1st, 2nd and 3rd trimester of gestation were employed to produce normalized embryo dose data from common radiographic projections (Table 1) performed on the expectant mother. Embryo dose was normalized to entrance skin dose. Normalized embryo dose (NED) data for each radiographic projection have been produced for several combinations of tube potential and total x-ray tube filtration (Table 1). NED data for the first trimester of gestation were generated for various embryo depths below anterior abdominal surface. In total, more than 7000 Monte Carlo simulations were performed. Based on the derived NED data, fitting equations were produced for the estimation of embryo dose for any tube potential, filtration and embryo depth.

The dose to the embryo (ED) from a series of radiographic projections is calculated from the equation:

$$ED = \sum_{i}^{j} \left\{ \left[\left(\frac{FDD_O}{FSD_X} \right) \cdot \left(\frac{kV_X}{kV_O} \right) \right]^2 \cdot I_O \cdot mA \right\}_i \cdot NED_i$$

where NED_i is the normalized embryo dose for the i radiographic exposure performed and exposure parameters of the examination (tube voltage kV_X, total filtration and focus to skin distance FSD_X). I_0 is the tube output measured at a distance of FDD_o for a tube voltage of kV_o.

The theoretical radiogenic risk for childhood cancer associated with in-utero exposure is estimated using a risk coefficient of 1.2×10^{-2} per Gy as recommended by the International Commission on Radiological Protection report 90.

Table 1. Radiographic examinations

Body region under examination	Projections[*]	Field Size (cm^2)	Tube Voltage (kVp)	Filtration (mm Al)
Abdomen	AP	36x43	50-120	2.5-5.0
	PA	36x43	50-120	2.5-5.0
Chest	AP	36x43	50-120	2.5-5.0
	PA	36x43	50-120	2.5-5.0
	LAT	36x43	50-120	2.5-5.0
Kidneys	AP	36x24	50-120	2.5-5.0
	PA	36x24	50-120	2.5-5.0
Lumbar Spine	AP	36x43	50-120	2.5-5.0
	LAT	36x43	50-120	2.5-5.0
	LAT LSJ	18x24	50-120	2.5-5.0
	LPO	24x30	50-120	2.5-5.0
	RPO	24x30	50-120	2.5-5.0
Pelvis/Colon	AP	36x43	50-120	2.5-5.0
	PA	36x43	50-120	2.5-5.0
	AP Hip Joint	24x35	50-120	2.5-5.0
Thoracic Spine	AP	24x43	50-120	2.5-5.0
	LAT	20x49	50-120	2.5-5.0
Urinary Bladder	AP	24x21	50-120	2.5-5.0

[*]Note that the angulations of all projections refer to the position of the x-ray tube with respect to the patient body

How to use radiography module?

The user has to select the Radiography module from the menu.
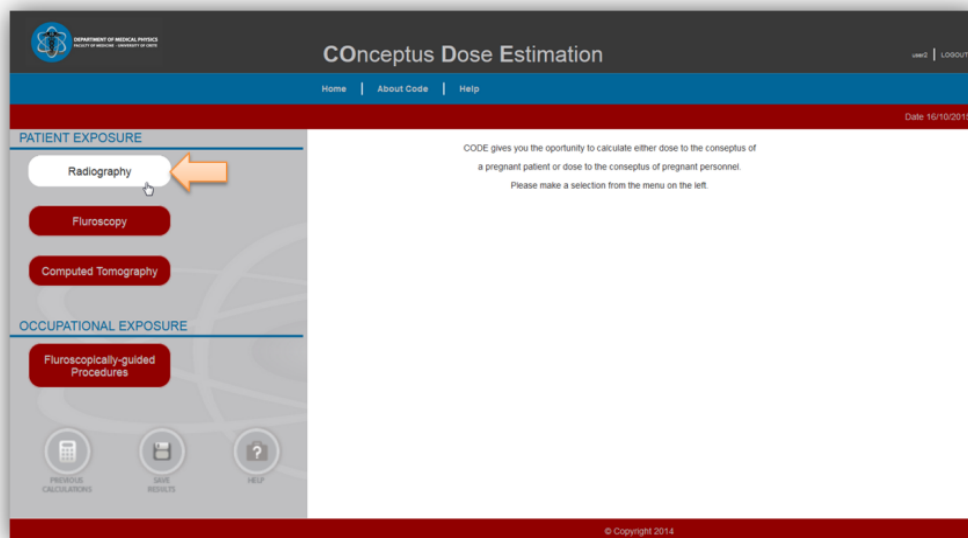
The user has to define/provide the following data regarding the exposure of the pregnant patient for the embryo dose calculation:

1. Gestational stage: A pull down menu guides the user to select the gestational stage of the exposed pregnant individual i.e. 1st, 2nd or 3rd trimester.
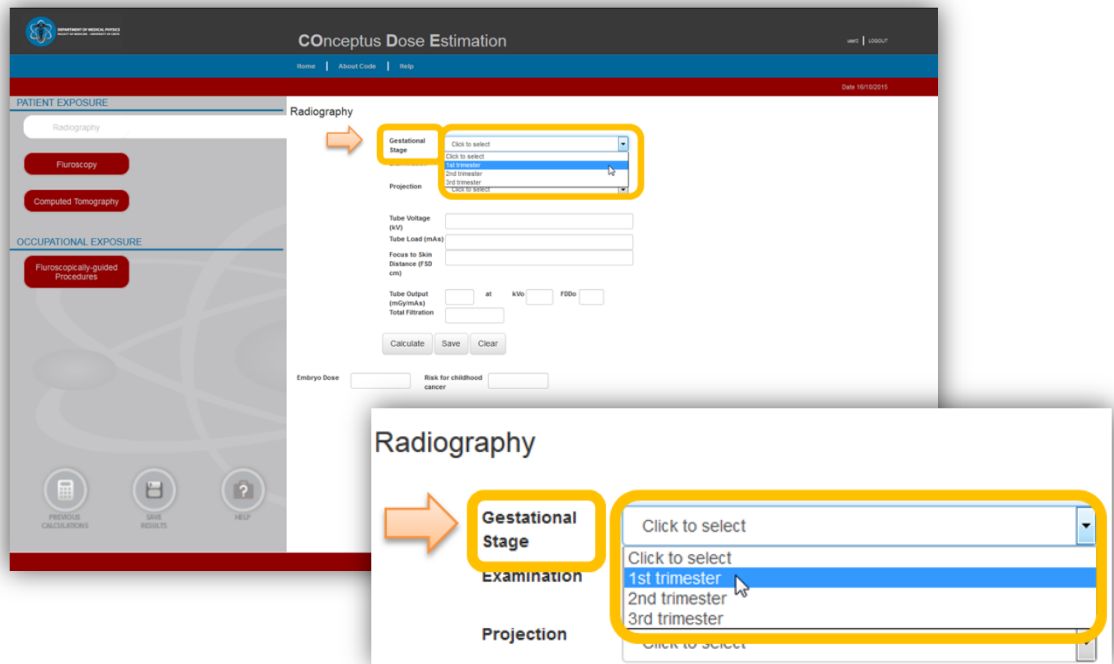
2. Radiographic examination: A pull down menu guides the user to select one of the examinations illustrated in Table 1.
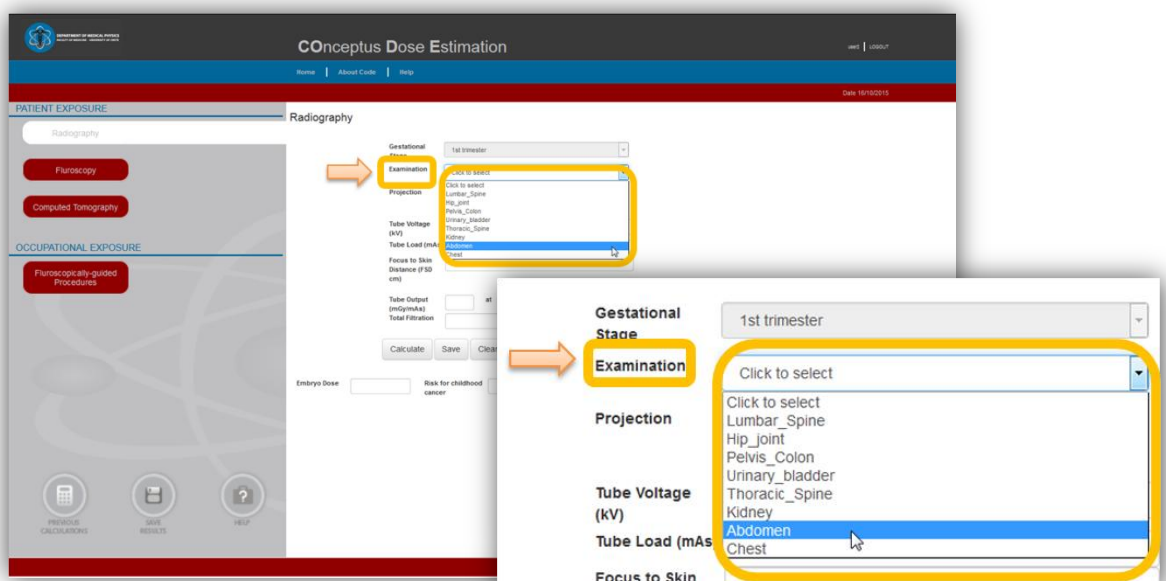
**3.** Projection orientation**:** A pull down menu guides the user to select one of the projections illustrated in Table 1.
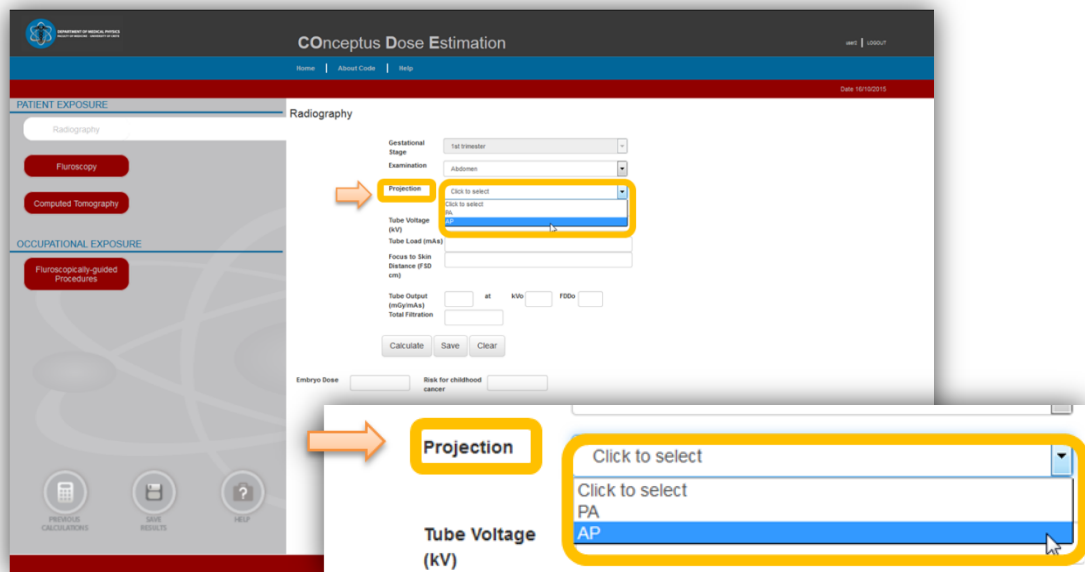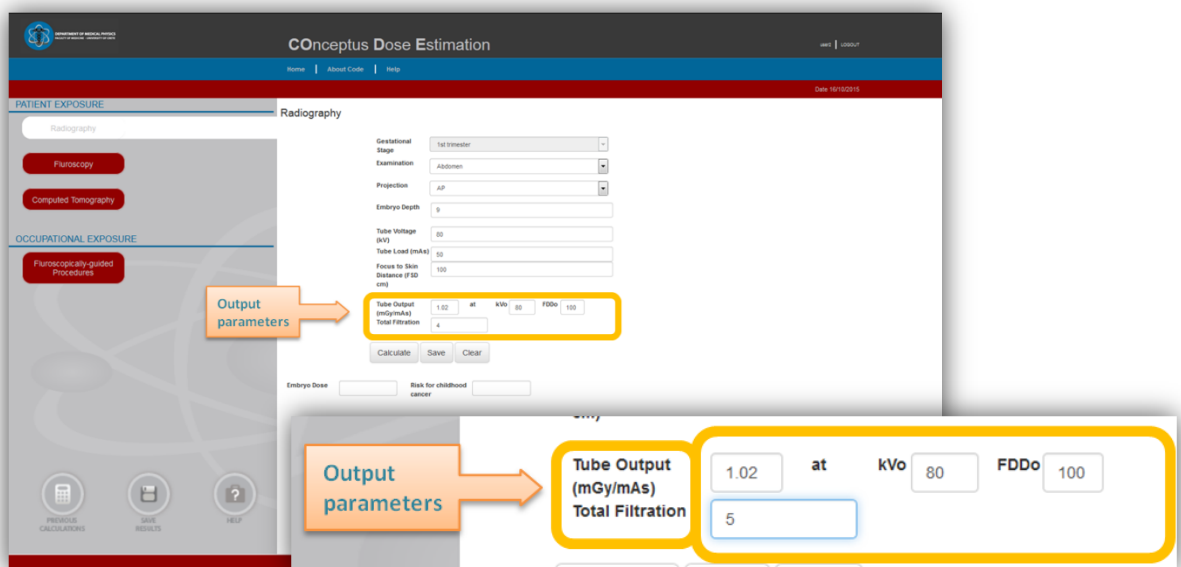

4. Embryo depth**:** The user has to define the embryo depth (in cm) i.e. the distance from the anterior abdominal surface of the patient. This field is available only when the user selects 'first trimester' as the gestational stage and an examination associated with direct exposure of the embryo.
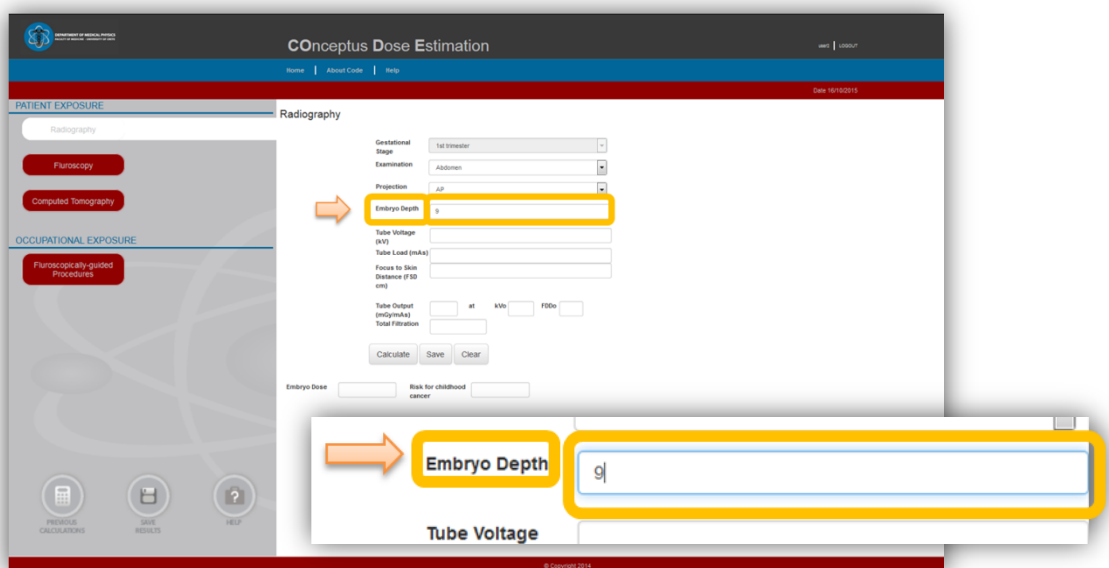
5. <u>Exposure parameters of the examination:</u> The user has to define tube potential (kV), tube load (mAs), and focus to skin distance (FSD (cm)) used for the specific radiographic exposure.
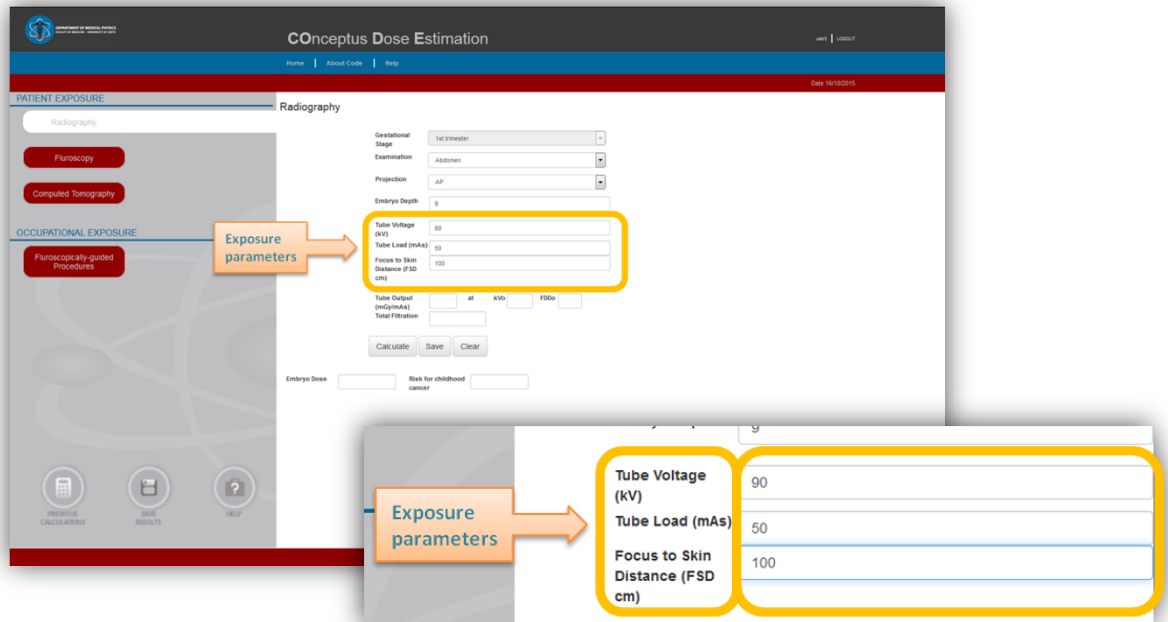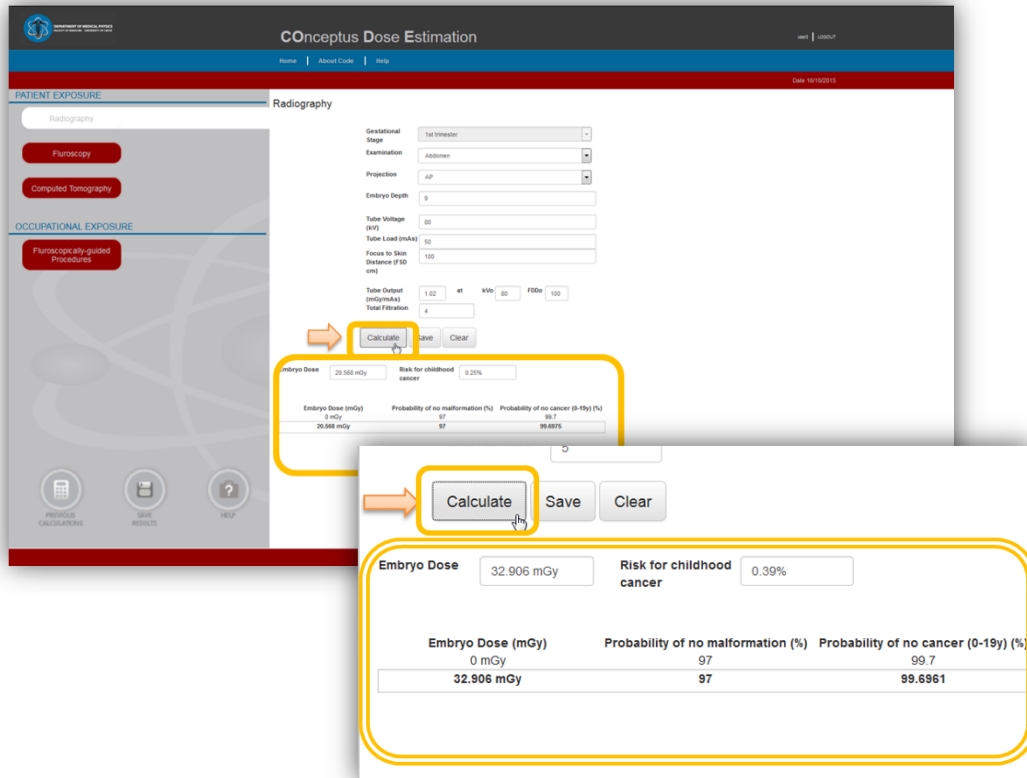

6. <u>Output of the x-ray unit:</u> The user has to provide the output (mGy/mAs) of the x-ray system. The tube voltage and focus to detector distance (FDD_o) used for the output measurement shall be defined in the corresponding fields. The total filtration (mm Al) of the x-ray tube used for the radiographic examination and the measurement of the output should be the same and should be defined in the relevant field.
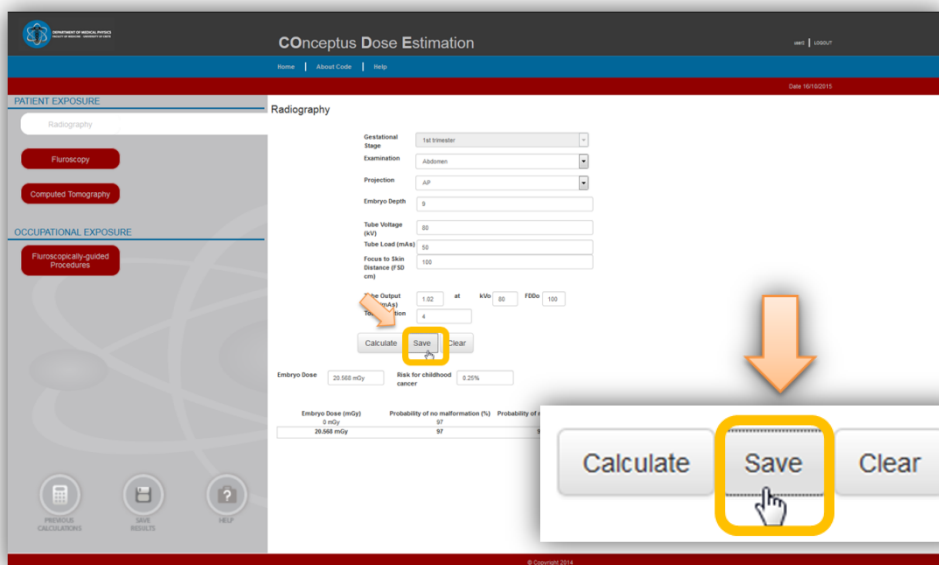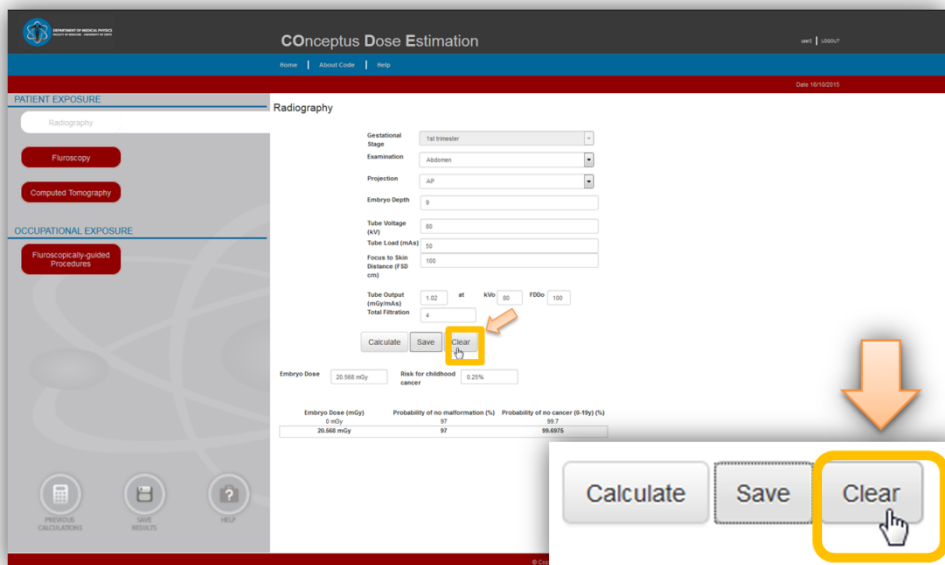
❖ When all the necessary data has been supplied, the embryo dose and the corresponding theoretical radiogenic risk for childhood cancer are calculated by pressing the <Calculate> button and presented in the corresponding fields.
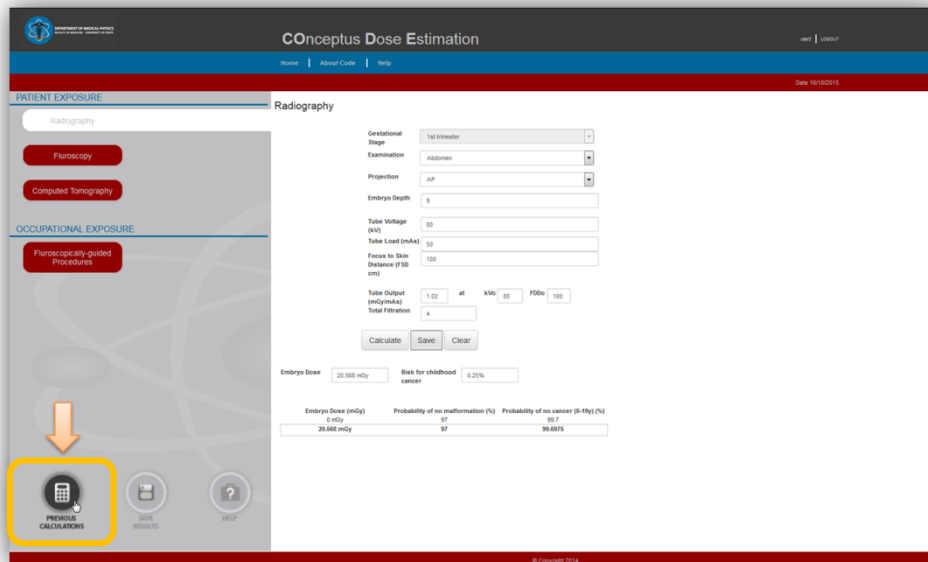

❖ Using the <Save Results> button, the registered user can also save a calculation, including all exposure data and date and time of submission for later revision.

❖ The user can clear the form and start over a new calculation using the <Clear> button.

❖ Additionaly, the user has the oppurtunity to calculate the cumulative embryo dose from several exposures for which calculation of embryo dose has been performed and saved. The user has to press <Previous Calculations> button and select the specific exposures. The cumulative embryo dose from the selected exposures is then calculated and presented.

Return to HELP

Module 2: Pregnant patients exposure from fluoroscopic procedures

General information

CODE fluoroscopy module provides estimates for the embryo absorbed dose and associated risk for childhood cancer from fluoroscopically guided (FG) procedures performed on the pregnant patient.

The Monte-Carlo-N-particle transport code and three mathematical phantoms representing the pregnant individual at 1st, 2nd and 3rd trimester of gestation were employed to produce normalized embryo dose data from common fluoroscopic projections involved in FG procedures (Table 2) performed on the expectant mother. Embryo dose was normalized to dose area product (DAP). Normalized embryo dose (NED) data for each fluoroscopic projection have been produced for several combinations of tube potential and total x-ray tube filtration (Table 1). NED data for the first trimester of gestation were generated for various embryo depths below anterior abdominal surface. Based on the derived NED data, fitting equations were produced for the estimation of embryo dose for any tube potential, filtration and embryo depth.

The dose to the embryo (ED) from a series of fluoroscopic projections is calculated from the equation:

$$ED = \sum_{i}^{n}(DAP_i \cdot NED_i)$$

where DAP_i is the DAP recorded for the projection i performed at a specific tube voltage, total filtration and focus to skin distance, and NED_i is the normalized to DAP embryo dose for the i fluoroscopic projection and the same exposure parameters

The theoretical radiogenic risk for childhood cancer associated with in-utero exposure is estimated using a risk coefficient of 1.2×10^{-2} per Gy as recommended by the International Commission on Radiological Protection report 90.

Table 2A. Gastrointestinal fluoroscopically guided procedures

Procedure	Projection*	Field size (cm^2)	Tube Voltage (kVp)	Total Filtration (mm Al)
Barium Enema	AP Colon/Pelvis	24x30	50-120	2.5-9.0
	AP Rectum	15x15	50-120	2.5-9.0
	LAO Colon	35x35	50-120	2.5-9.0
	LAO Flexure	28x35	50-120	2.5-9.0
	LAT Rectum	17x17	50-120	2.5-9.0
	LPO Colon	35x35	50-120	2.5-9.0
	LPO Rectum	19x19	50-120	2.5-9.0
	PA Pelvis/Colon	40x40	50-120	2.5-9.0
	PA Rectum	15x15	50-120	2.5-9.0
	RAO Colon	35x35	50-120	2.5-9.0
	RAO Flexure	28x35	50-120	2.5-9.0
	RAO Rectum	19x19	50-120	2.5-9.0
Barium Follow Through	AP Small Intestine	22x18	50-120	2.5-9.0
	PA Small Intestine	22x18	50-120	2.5-9.0
Barium Meal	AP Duodenum	15x15	50-120	2.5-9.0
	AP Stomach	18x22	50-120	2.5-9.0
	AP Upper Stomach	15x15	50-120	2.5-9.0
	LAO Stomach	21x21	50-120	2.5-9.0
	LAT Stomach	19x24	50-120	2.5-9.0
	LPO Duodenum	19x19	50-120	2.5-9.0
	LPO Stomach	21x21	50-120	2.5-9.0
	PA Duodenum	15x15	50-120	2.5-9.0
	PA Stomach	18x21	50-120	2.5-9.0
	PA Upper Stomach	15x15	50-120	2.5-9.0
	RAO Duodenum	19x19	50-120	2.5-9.0
	RAO Stomach	21x21	50-120	2.5-9.0
Barium Swallow	LAO Oesophagus	13x47	50-120	2.5-9.0
	LAT Throat	18x24	50-120	2.5-9.0
	LPO Oesophagus	13x47	50-120	2.5-9.0
	RAO Oesophagus	13x47	50-120	2.5-9.0

*Note that the angulations of all projections refer to the position of the tube with respect to the patient body.

Table 2B. Cardiac fluoroscopically guided procedures

Procedures	Projection*	Field size (cm^2)	Tube Voltage (kVp)	Total Filtration (mm Al)
Coronary Angiography/ Angioplasty	PA	12.5x12.5	70-100	3-13
	PA CRANIAL 30	12.5x12.5	70-100	3-13
	PA CAUDAL 30	12.5x12.5	70-100	3-13
	LLAT	12.5x12.5	70-100	3-13
	RAO 30	12.5x12.5	70-100	3-13
	LAO 40	12.5x12.5	70-100	3-13
	LAO45 CRANIAL 20	12.5x12.5	70-100	3-13
	RAO 20 CRANIAL 20	12.5x12.5	70-100	3-13
	RAO 20 CAUDAL 20	12.5x12.5	70-100	3-13
	LAO 40 CAUDAL 30	12.5x12.5	70-100	3-13
Pacemaker Implantation	PA	12.5x12.5	50-120	2.5-9.0
	RAO 30	14x14	50-120	2.5-9.0
	LAO30	14x14	50-120	2.5-9.0
Cardiac Ablation	AP	12.5x12.5	50-120	2.5-9.0
	LAO 30	14x14	50-120	2.5-9.0
	RAO 30	14x14	50-120	2.5-9.0
	Guidance iliac	6x6	70-100	3-13
	Guidance jugular	6x6	70-100	3-13

*Note that the angulations of all projections refer to the position of the image intensifier with respect to the patient body.

Table 2C. Orthopedic fluoroscopically guided procedures

Procedures	Projection*	Field size (cm^2)	Tube Voltage (kVp)	Total Filtration (mm Al)
Femoral Fractures	Hip joint LAT	15x15	70-100	3-13
	Hip joint PA	15x15	70-100	3-13
Kyphoplasty	AP Lumbar Spine	8x15	70-100	3-13
	LAT Lumbar Spine	8x15	70-100	3-13

*Note that the angulations of all projections refer to the position of the image intensifier with respect to the patient body.

<div align="center">

Table 2D: Other fluoroscopically guided procedures

</div>

Procedures	Projection*	Field size (cm^2)	Tube Voltage (kVp)	Total Filtration (mm Al)
Endoscopic retrograde cholangio-pangratography(ERCP)	LLAT Abdomen	20x20	80-100	2.5-9.0
Inferior Vena Cava filter placement	Guidance iliac	6x6	70-100	3-13
	Guidance jugular	6x6	70-100	3-13
	Suprenal placement	15x8	80-100	3-13
	Subrenal Placement	15x8	80-100	3-13
Cysteourethrography	AP^T Bladder	24x21	50-120	2.5-9.0
Prophylactic hypogastric artery balloon occlusion (HABO)**	PA^T Left artery	18x22.5	80-100	3-13
	PA^T Right artery	18x22.5	80-100	3-13
	RA 20 Left artery	18x22.5	80-100	3-13
	RAO 20 Righ artery	18x22.5	80-100	3-13
	LAO 20 left artery	18x22.5	80-100	3-13
	LAO 20 Right artery	18x22.5	80-100	3-13

*Note that the angulations of all projections refer to the position of the image intensifier with respect to patient body.

^{T} The angulation of these projections refers to the position of the tube with respect to patient body.

**NED data for HABO procedures have been produced only for the 3rd trimester of gestation, since this procedure is performed in parturient women.

How to use fluoroscopy module?

The user has to select the fluoroscopy module from the menu.
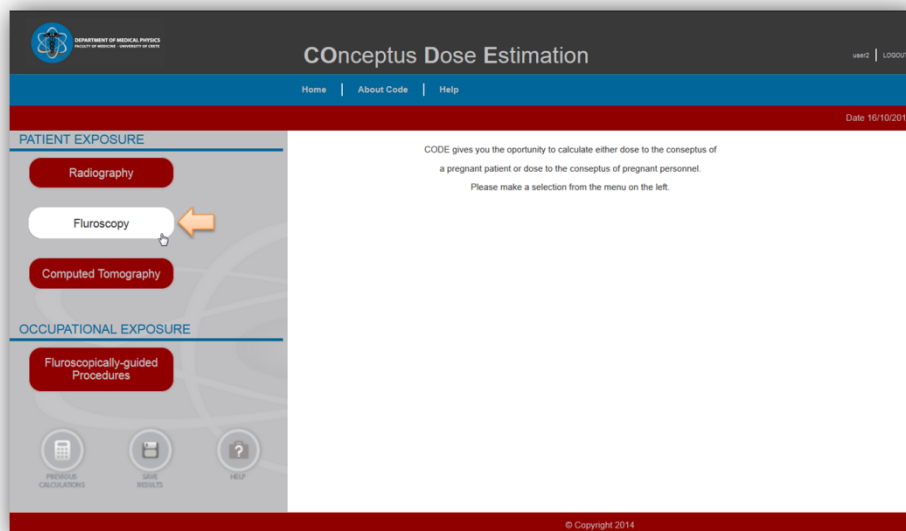
The user has to define/provide the following data regarding the exposure of the pregnant patient for the embryo dose calculation:

1. Gestational Stage: A pull down menu guides the user to select the gestational stage of the exposed pregnant individual i.e. 1ˢᵗ, 2ⁿᵈ or 3ʳᵈ trimester.
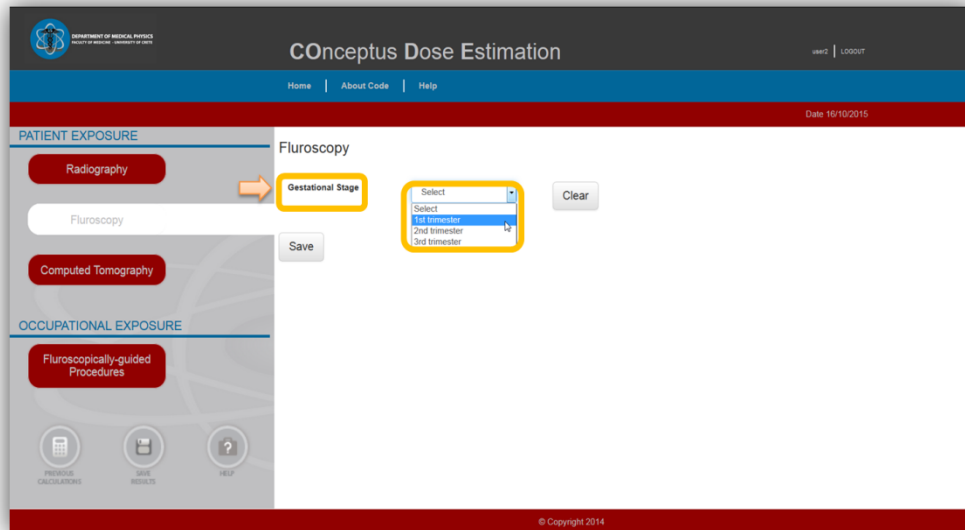
2. Fluoroscopic procedure or projection: The user has the opportunity to select either a single fluoroscopic projection
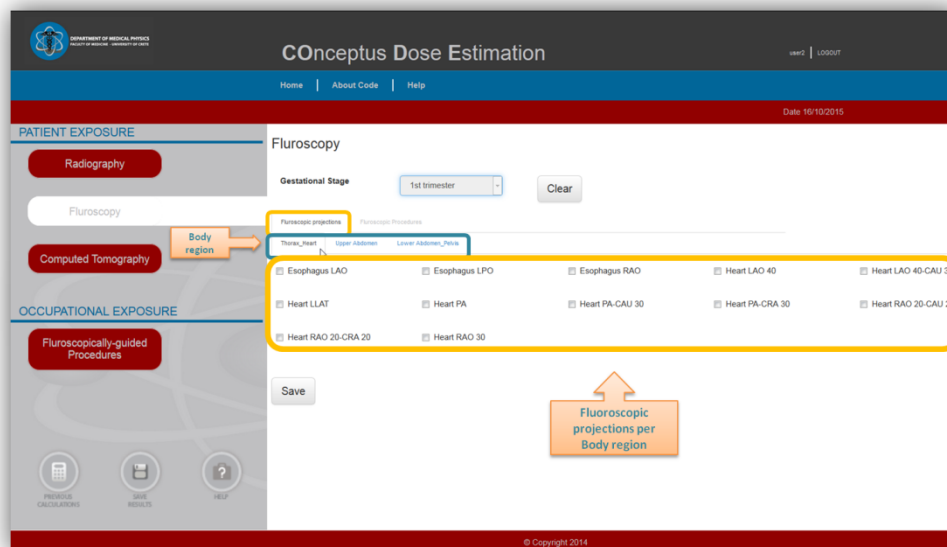
or a series of projections commonly used during a common FG procedure (Tables 2A, 2B, 2C and 2D). In each case a menu guides the user to select the body region imaged and one of the projections illustrated in Tables 2A, 2B, 2C and 2D.
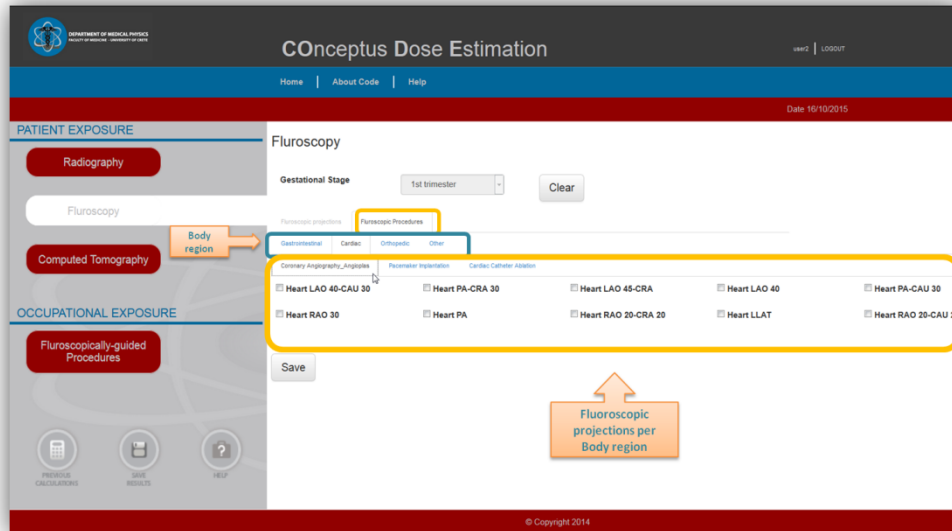
3. Embryo depth: The user has to define the embryo depth (in cm) i.e. the distance from the anterior abdominal surface of the patient. This field is available only when the user selects 'first trimester' as the gestational stage and a projection associated with direct exposure of the embryo.
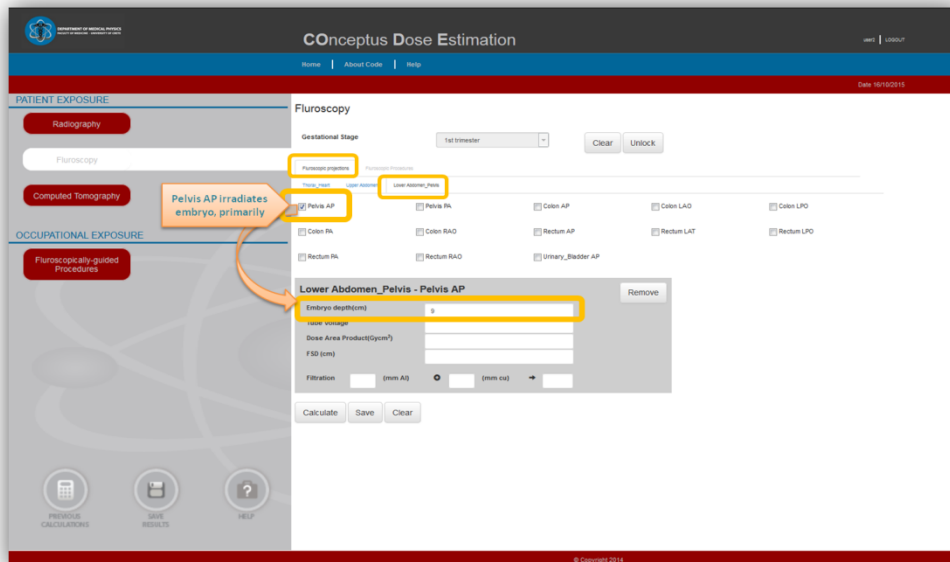
4. <u>Exposure parameters of the examination:</u> The user has to define tube potential (kVp), tube inherent and added filtration (mm Al/mm Cu), focus to skin distance FSD (cm), and DAP used for the specific fluoroscopic projection.
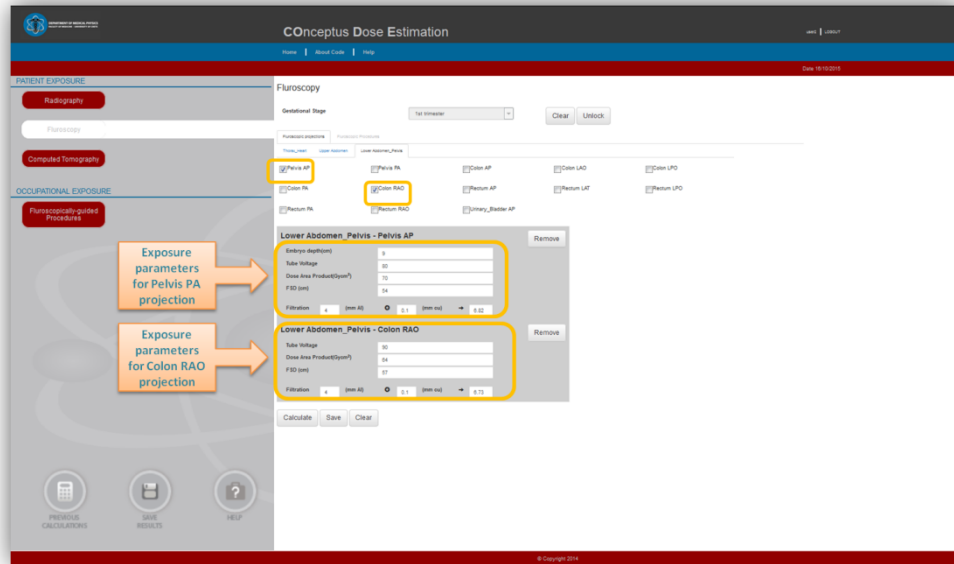
❖ When all the necessary data has been supplied, the embryo dose and the corresponding theoretical radiogenic risk for childhood cancer are calculated by pressing the <Calculate> button and presented in the corresponding fields.
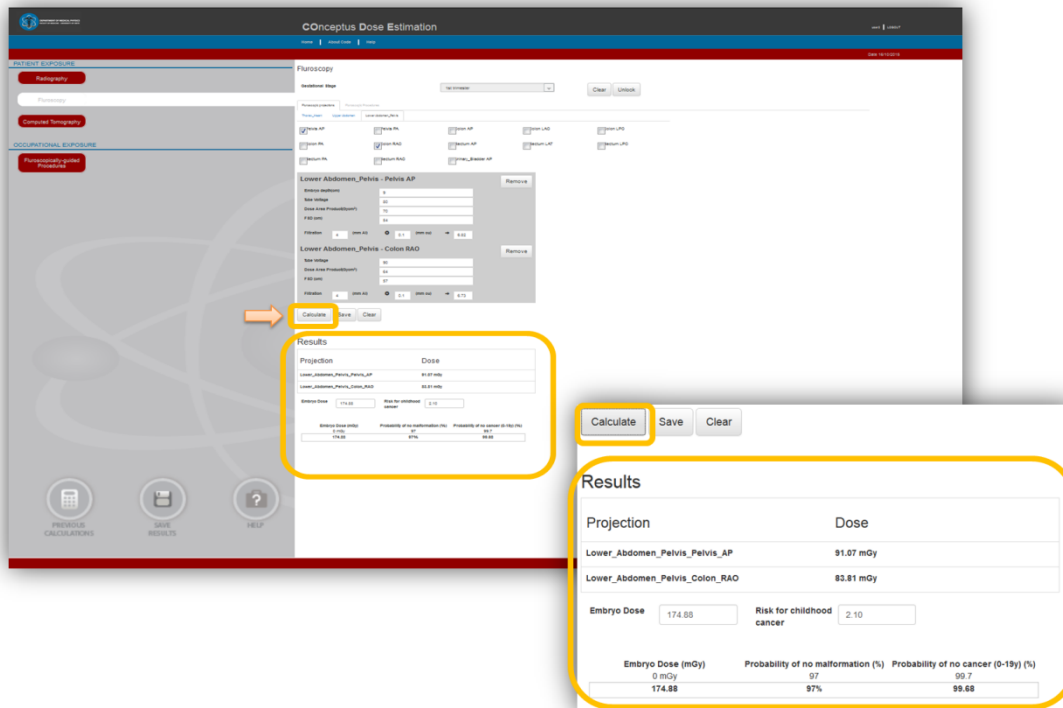
❖ Using the <Save> button, the user can also save a calculation, including all exposure data and date and time of submission for later revision.

❖ The user can clear the form and start over a new calculation using the <Clear> button.

❖ Additionaly, the user has the oppurtunity to calculate the cumulative embryo dose from several exposures for which calculation of embryo dose has been performed and saved. The user has to press <Previous Calculations> button and select the specific exposures. The cumulative embryo dose from the selected exposures is then calculated and presented.

Return to HELP

19

Module 3: Pregnant patient exposure from computer tomography procedures

General information

CODE CT module provides estimates for the embryo absorbed dose and associated risk for childhood cancer from computed tomography examinations of the trunk performed on the pregnant patient.

Normalized to free in air computed tomography dose index (CTDI) embryo dose coefficients (f(z)) for single sequential scans at different positions along z-axis to cover the whole trunk of the pregnant individual were produced through Monte Carlo simulation experiments. The Monte-Carlo-N-particle transport code and four mathematical phantoms representing the average pregnant individual at first post-conception weeks (0-7 weeks), 1st trimester (8-12 weeks), 2nd trimester (13-25 weeks) and 3rd trimester (26-40 weeks) of gestation were employed. Phantoms were generated by using the Body Builder software and the abdominal circumference of these phantoms was 88.7 cm, 88.7 cm, 102.3 cm and 108.2 cm, correspondingly. Regarding phantoms representing the average pregnant individual during first post-conception weeks and 1st trimester, the embryo depth (i.e. the distance from anterior abdominal surface) was assumed 9 cm. Dosimetric data were derived for a Siemens Sensation 16 CT scanner. Further details on the methodology used to derive the normalized embryo dose data can be found elsewhere (Damilakis et al Med Phys 2010).

The embryo dose (ED) from a specific CT exposure performed on a pregnant patient is estimated using the formula

$$ED = CTDI_F \cdot NCD_{p_0} \cdot f_{p,d} \cdot f_{scanner} \qquad (1)$$

where

a. $CTDI_F$ is the free-in-air CTDI (mGy) of the user's CT scanner for the tube voltage, tube load and beam collimation employed,

b. NED_{po} is the cumulative normalized embryo dose for the specific boundaries of the scanned body region modified for the beam collimation and pitch used for the examination as calculated from:

$$NCD_{p_0} = \frac{20mm}{BC(mm)} \cdot \frac{1}{pitch} \cdot \sum_{z_1}^{z_2} f_z \left(\frac{mGy}{mGy_{air}}\right) \qquad (2)$$

where p_0 is the abdominal circumference of the average pregnant individual at the gestational stage of the examined pregnant patient.

c. $f_{p,d}$ is the correction factor for embryo depth d and abdominal circumference p

d. $f_{scanner}$ is the correction factor for the specific scanner used for the examination

Further details on embryo dose calculation may be found in previous publications (Damilakis et al Med Phys 2010, and Damilakis et al Radiology 2010).

How to use computed tomography module?

The user has to select the fluoroscopy module from the menu.
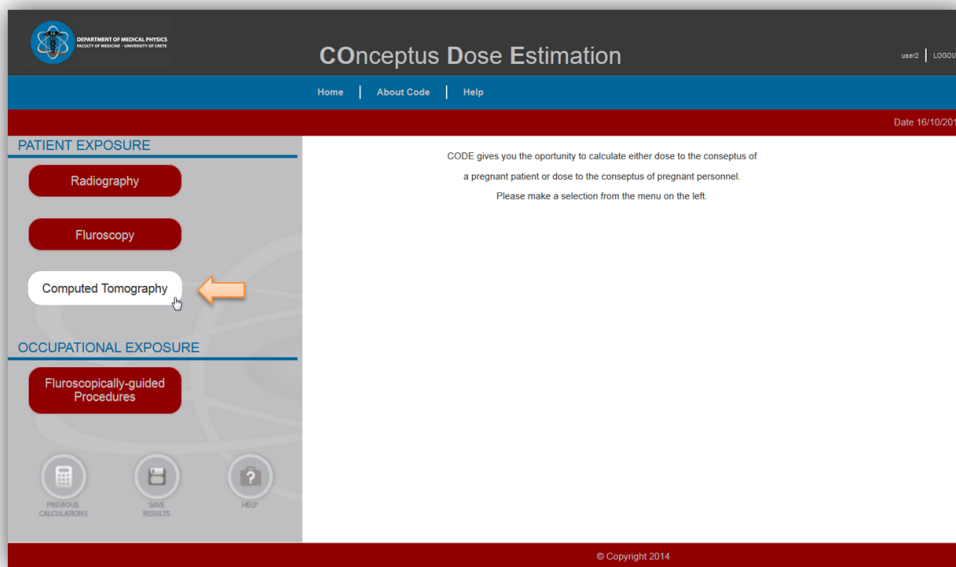
The user has to define/provide the following data regarding the exposure of the pregnant patient for the embryo dose calculation**:**

1. Gestational stage: A pull down menu guides the user to select the gestational stage of the exposed pregnant individual i.e. 0-7 weeks, 8-12 weeks, 13-25 weeks, and 26-40 weeks.
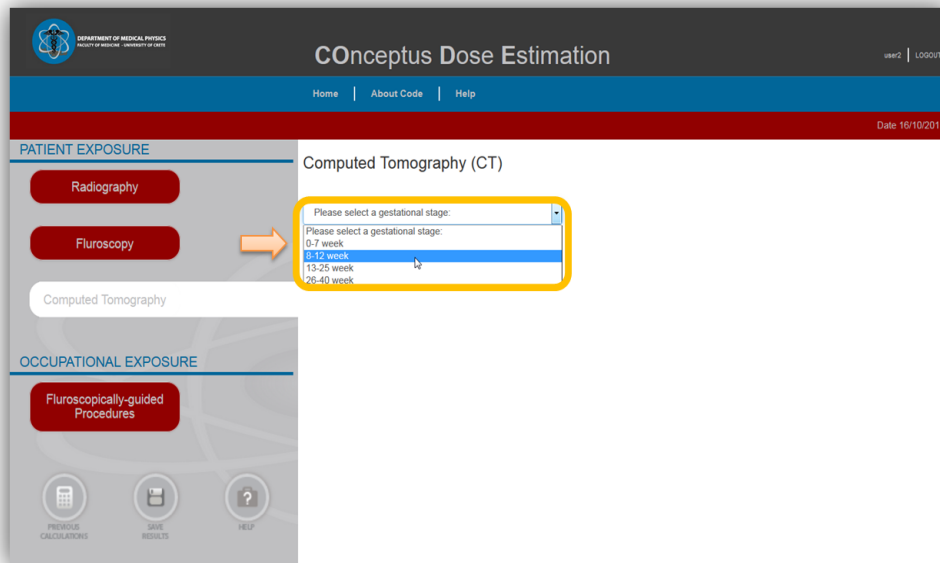
2. Embryo depth: The user has to define the embryo depth (cm) i.e. the distance from the anterior abdominal surface of the patient. This field is available only when the user has selected the first postconception weeks (0-7 weeks) or the first trimester of gestation (8-12 weeks).
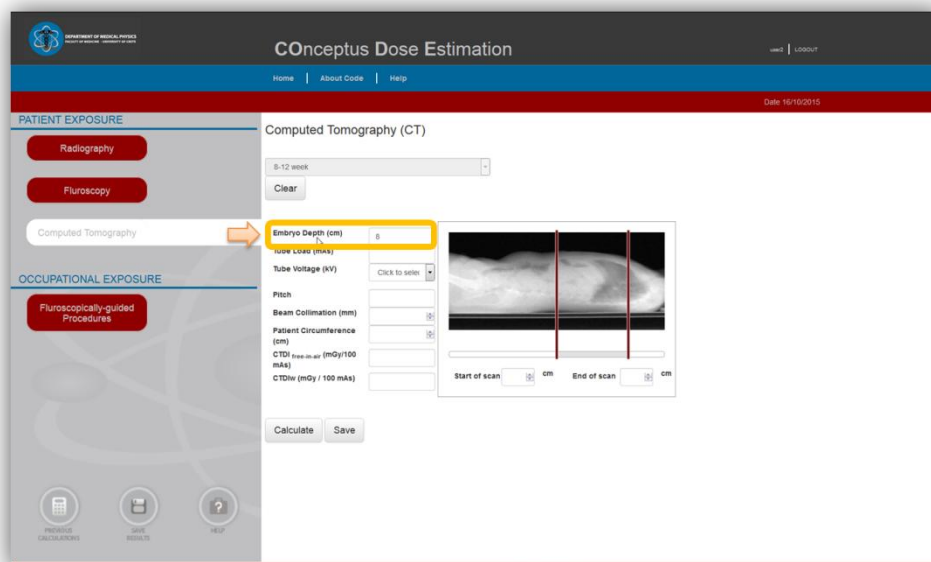
3. Exposure parameters of the examination: The user has to define from pull down menus the tube potential (kV) and the beam collimation used during the examination. Also, the tube load (mAs), and the pitch of the examination has to be defined in the relevant fields.
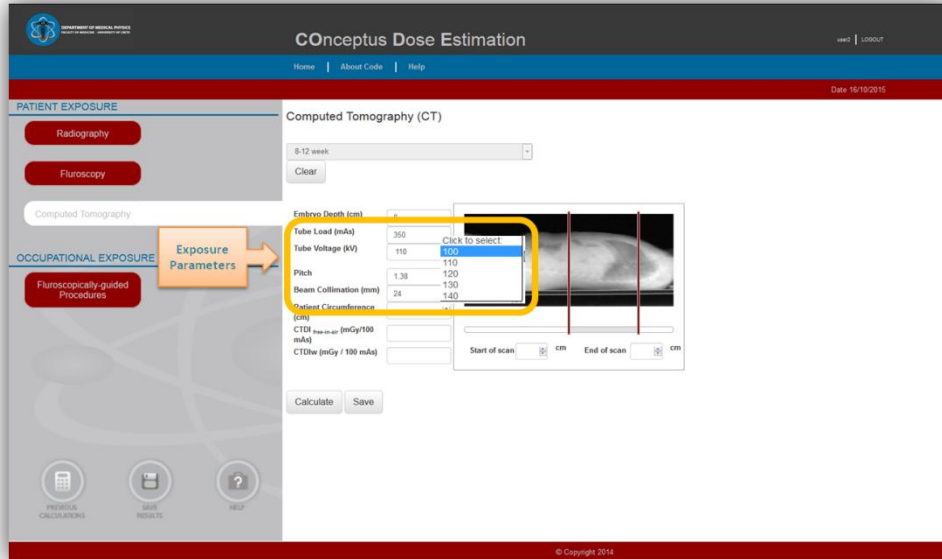
4. Patient circumference: The user has to define the abdominal maternal circumference in cm.
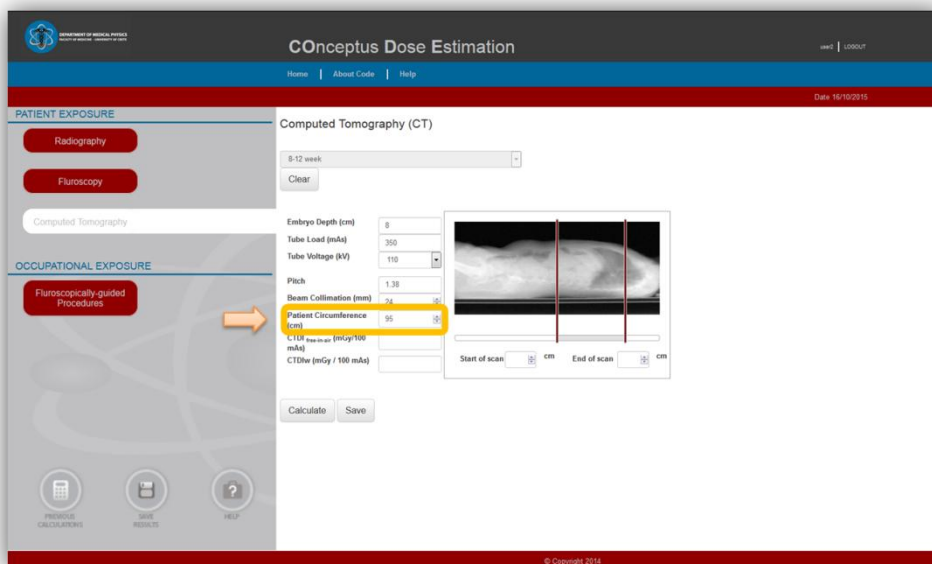
5. <u>CTDI_{free in air} and CTDI_w:</u> The user has to provide the $CTDI_{free\ in\ air}$ and $CTDI_W$ (mGy/100 mAs) of the scanner used, at the same kV and beam collimation (mm) set for the patient examination.
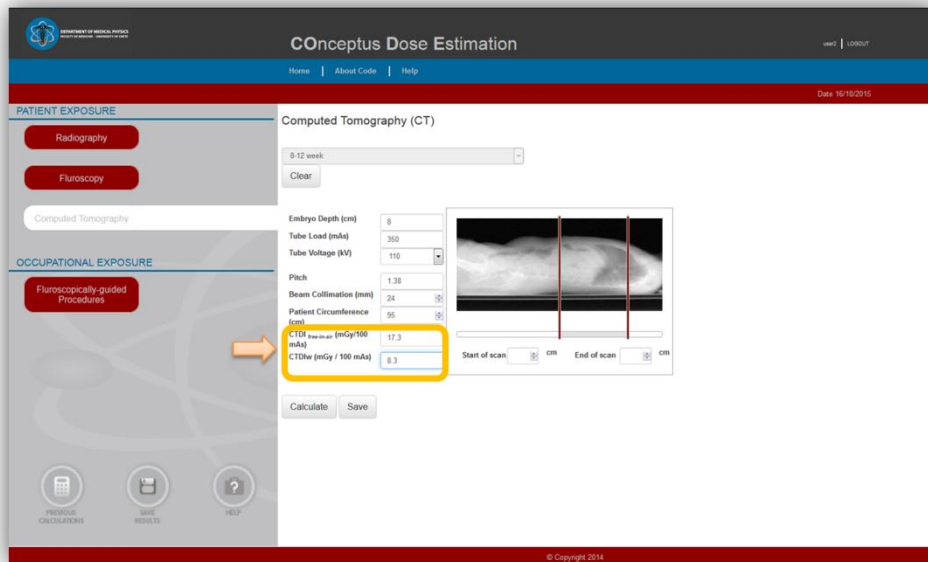
6. <u>Body region scanned:</u> The user has to define the boundaries of the scanned volume (the start and the end of the scan) moving appropriately the cursors at the corresponding anatomical locations on the provided trunk topogram.

❖ When all the necessary data has been supplied, the embryo dose and the corresponding theoretical radiogenic risk for childhood cancer are calculated by pressing the <Calculate> button and presented in the corresponding fields.

❖ Using the <Save Results> button, the registered user can also save a calculation, including all exposure data and date and time of submission for later revision

❖ The user can clear the form and start over a new calculation using the <Clear> button.

❖ Additionaly, the user has the oppurtunity to calculate the cumulative embryo dose.from several CT exposures for which calculation of embryo dose has been performed and saved. The user has to press <Previous Calculations> button and select the specific exposures. The cumulative embryo dose from the selected exposures is then calculated and presented.
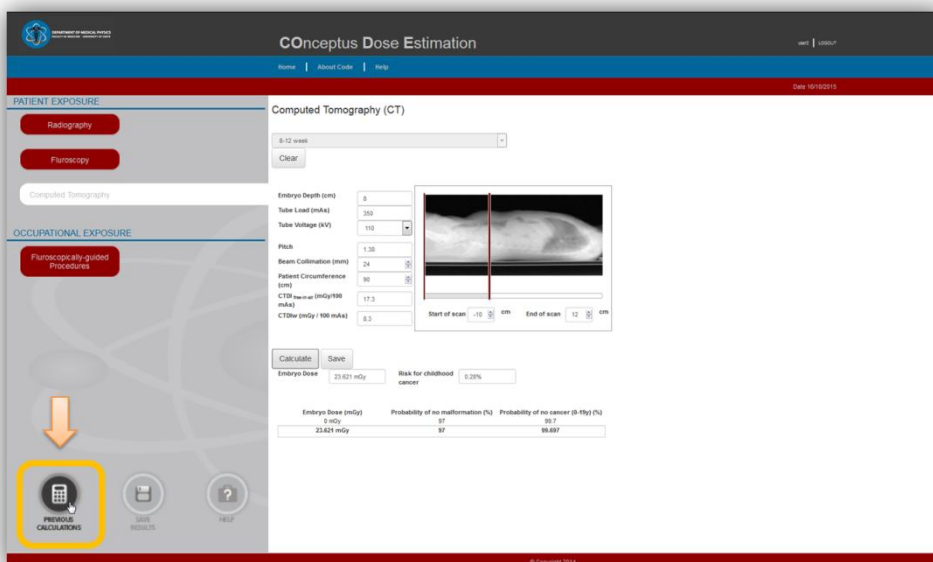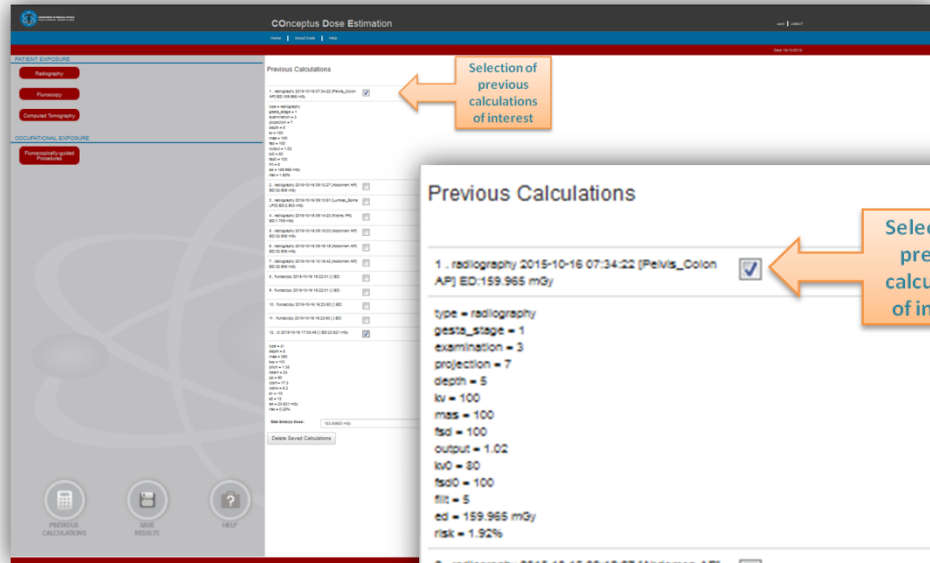
Previous Calculations

1 . radiography 2015-10-16 07:34:22 [Pelvis_Colon AP] ED:159.965 mGy ☑

Selection of previous calculations of interest

type = radiography
gesta_stage = 1
examination = 3
projection = 7
depth = 5
kv = 100
mas = 100
fsd = 100
output = 1.02
kv0 = 80
fsd0 = 100
filt = 5
ed = 159.965 mGy
risk = 1.92%

2 . radiography 2015-10-16 09:12:27 [Abdomen AP] ED:32.906 mGy ☐

3 . radiography 2015-10-16 09:13:51 [Lumbar_Spine LPO] ED:2.903 mGy ☐

4 . radiography 2015-10-16 09:14:23 [Kidney PA] ED:1.709 mGy ☐

5 . radiography 2015-10-16 09:15:03 [Abdomen AP] ED:32.906 mGy ☐

6 . radiography 2015-10-16 09:16:19 [Abdomen AP] ED:32.906 mGy ☐

7 . radiography 2015-10-16 10:16:42 [Abdomen AP] ED:32.906 mGy ☐

8 . fluroscopy 2015-10-16 16:22:01 [ ] ED: ☐

9 . fluroscopy 2015-10-16 16:22:01 [ ] ED: ☐

10 . fluroscopy 2015-10-16 16:23:50 [ ] ED: ☐

11 . fluroscopy 2015-10-16 16:23:50 [ ] ED: ☐

12 . ct 2015-10-16 17:08:49 [ ] ED:23.621 mGy ☑

type = ct
depth = 8
mas = 350
kvp = 110
pitch = 1.38
beam = 24
pp = 90
ctdiff = 17.3
ctdiw = 8.3
z1 = -10
z2 = 12
ed = 23.621 mGy
risk = 0.28%

Total Embryo Dose: 183.58600 mGy

Delete Saved Calculations

Return to HELP

Occupational Exposure of Pregnant Employees

: Occupational exposure from fluoroscopically guided procedures

General information

CODE occupational exposure from fluoroscopically guided (FG) interventional procedures module provides prospective or retrospective estimates of absorbed dose to the embryo of a pregnant employee involved in such procedures.

A C-arm unit and an anthropomorphic phantom simulating an average patient were used to determine scatter exposure rates at specific locations over a 50 cm x 50 cm grid around the table of the angiography suite. Data were collected for all commonly used fluoroscopic projections centered on three different anatomical regions i.e. chest, abdomen or pelvis. These projections are shown in Table 3. For each projection, exposure data were obtained for various combinations of tube voltage and total filtration. Exposures in μSv/h were measured at operator's waist i.e. 110 cm from the floor. Projection-specific spatial 2-d maps of normalized to dose-area product (DAP) scatter exposure rate were derived.

Scatter exposure data were obtained for various fluoroscopy beam field sizes. Monte Carlo simulation was employed to determine the exposure reduction factor achieved by using radioprotective apron for different values of operating tube voltage and protective apron lead equivalence.

Scatter exposure at the specific position of the pregnant employee in the operating room is converted to embryo dose using gestation stage-specific air kerma to embryo dose conversion factors previously published (Damilakis et al, JCE 2005).
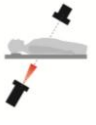
Embryo dose (ED) from a specific FG procedure for which n different projections are involved is calculated from:
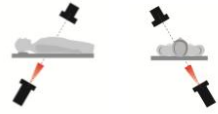
$$ED = \sum_{i}^{n}(NE_i(p, kV, filtration) \times DAP_i \times f_{field\ size} \times f_{gest.stage} \times f_{Pb\ apron})$$

where NE_i is the normalized scatter exposure at the waist level for the fluoroscopic projection i determined for the same tube voltage and total beam filtration, DAP_i is the cumulative DAP recorded for the specific projection i, $f_{field\ size}$ is the correction factor for the specific beam field size at entrance skin surface, $f_{gest.stage}$ is the correction factor for the selected

gestational stage of the pregnant employee, and $f_{Pb\ apron}$ is the correction factor for the specific lead apron worn by the pregnant employee.

TABLE 3. The fluoroscopic projections investigated

Projection*	Abbreviation	
Posterior-Anterior	PA	
Posterior-Anterior/Caudal 30°	PA/CAU30	
Posterior-Anterior/ Cranial 30°	PA/CRA30	
Right Anterior Oblique 30°	RAO30	
Left Anterior Oblique 30°	LAO30	
Left Anterior Oblique 45°	LAO45	
Right Anterior Oblique 45°	RAO45	
Left Lateral	LLAT	
Right Lateral	RLAT	

Left Anterior Oblique 40°/Caudal 25°	LAO40/CAU25	
Right Anterior Oblique 40°/Caudal 25°	RAO40/CAU25	
Left Anterior Oblique 40°/Cranial 25°	LAO40/CRA25	
Right Anterior Oblique 40°/Cranial 25°	RAO40/CRA25	
Left Anterior Oblique 20°/Caudal 20°	LAO20/CAU20	
Right Anterior Oblique 20°/Caudal 20°	RAO20/CAU20	
Left Anterior Oblique 20°/Cranial 20°	LAO20/CRA20	
Right Anterior Oblique 20°/Cranial 20°	RAO20/CRA20	

* All projection angulations refer to the position of image intensifier with respect to the vertical axis

How to use the occupational exposure module?

The user has to select the occupational exposure module.
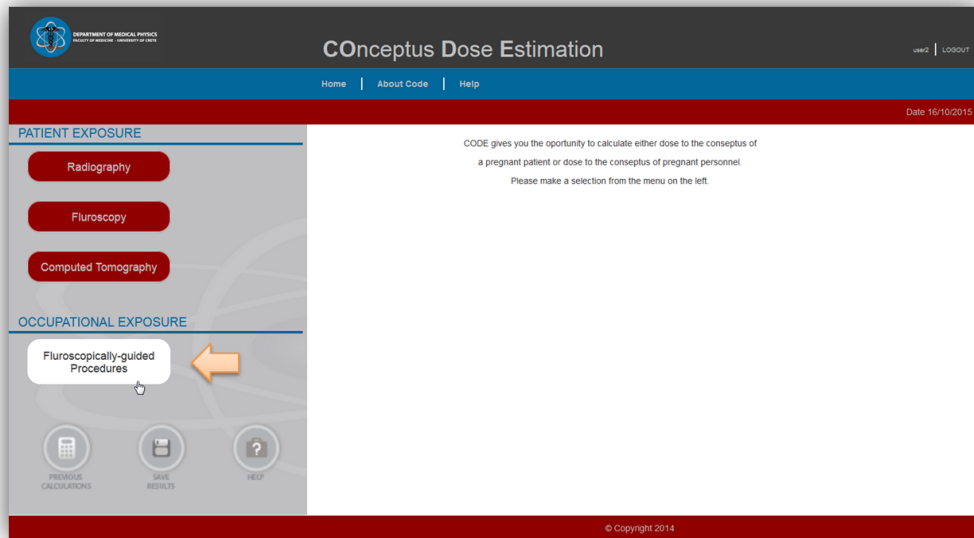
The user has to define/provide the following data regarding the occupational exposure of the pregnant employee:

1. Anatomical region of interest: A pull down menu guides the user to define the exposed patient anatomical region. Three options are available: chest, pelvis and abdomen.
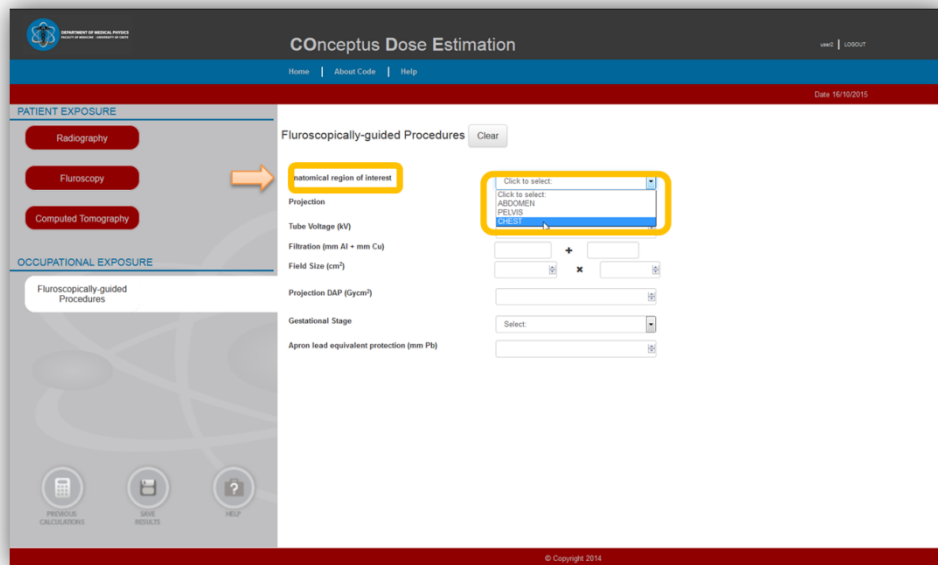
2. Orientation of the projection: A pull down menu, guides the user to select one of 17 different fluoroscopic beam projections illustrated in Table 3.
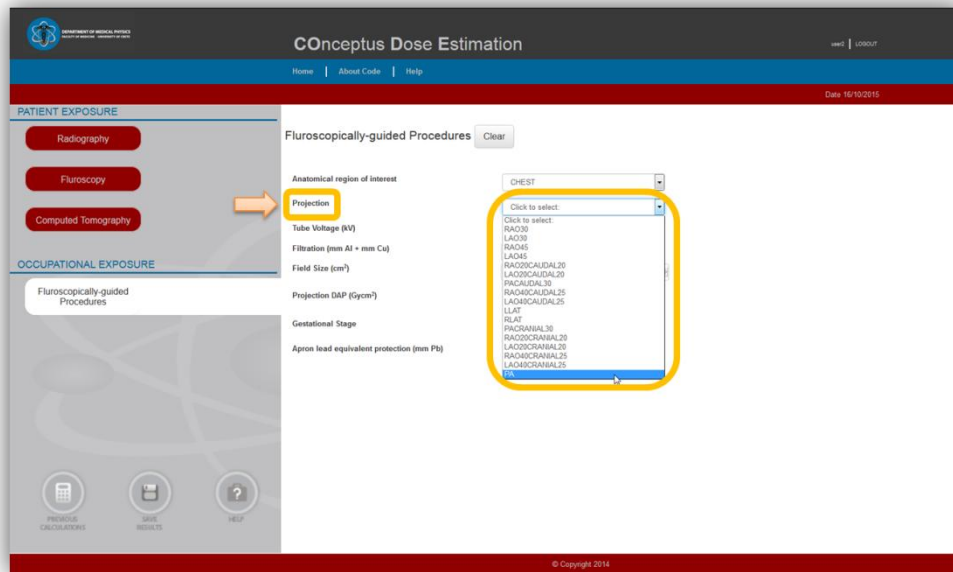
3. Exposure parameters of the examination: The user has to define tube potential (kV), and tube inherent/added filtration (mm Al/mm Cu) used for the specific projection selected.
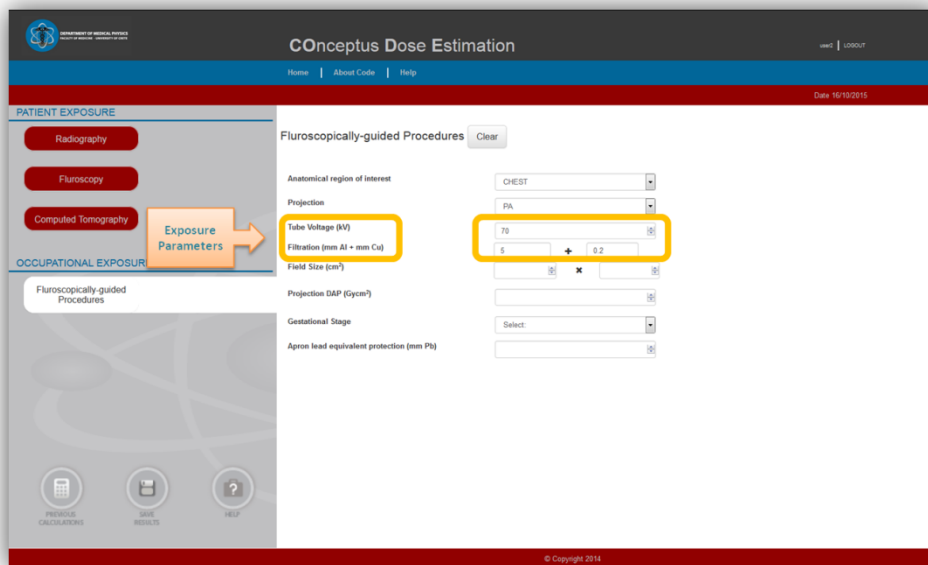
4. Field size: The user has to select the field size of the fluoroscopic beam for the selected projection (acceptable values 25 cm^2 to 625 cm^2).
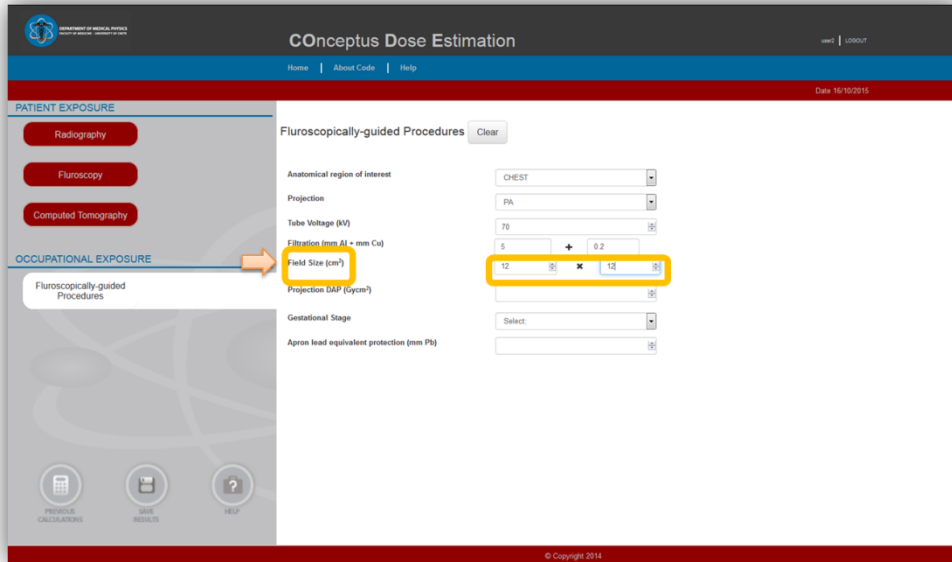
5. DAP: The user should define the DAP value of the specific selected projection in Gy cm^2.
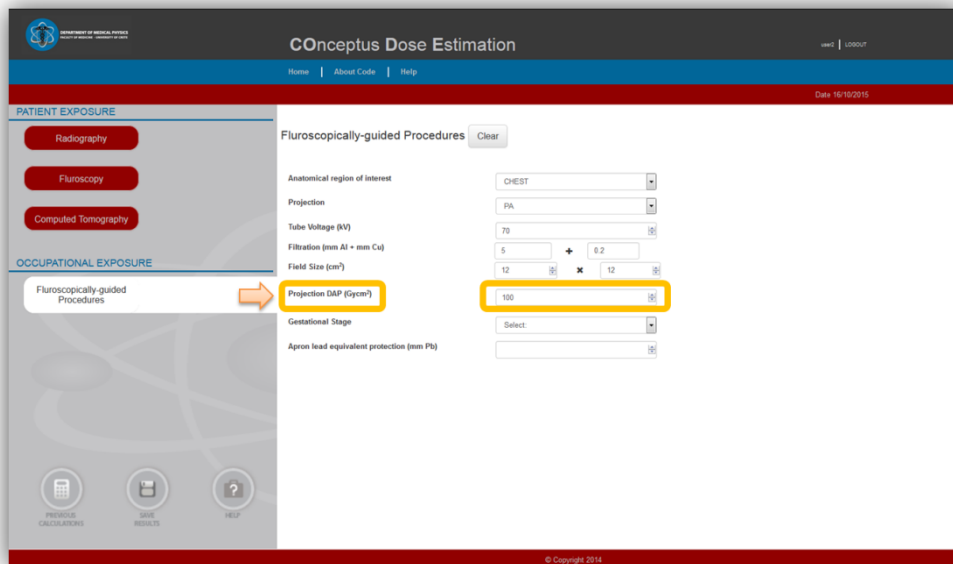
6. Gestational stage: A pull down menu guides the user to select the gestational stage of the exposed pregnant employee i.e. 1st, 2nd or 3rd trimester.
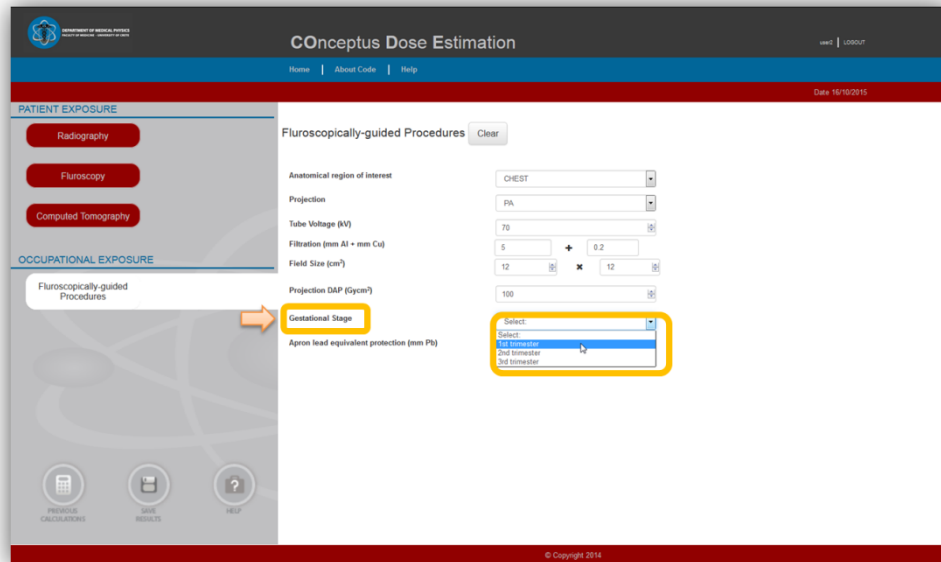
7. Lead apron: When the pregnant employee uses a radioprotective lead apron, the user has to define Pb-equivalent thickness of the apron in mm (acceptable values 0.0 to 0.5 mm Pb)
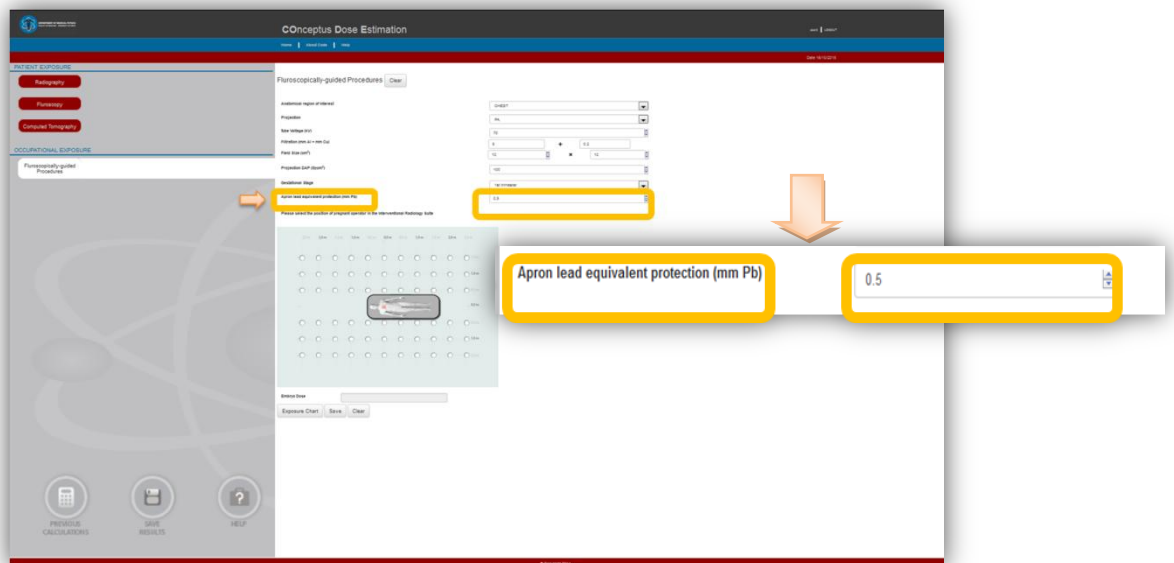
8. <u>Position of pregnant operator:</u> The user has to define the position of the pregnant operator in the operating room by selecting the corresponding bullet on the operating room grid show.
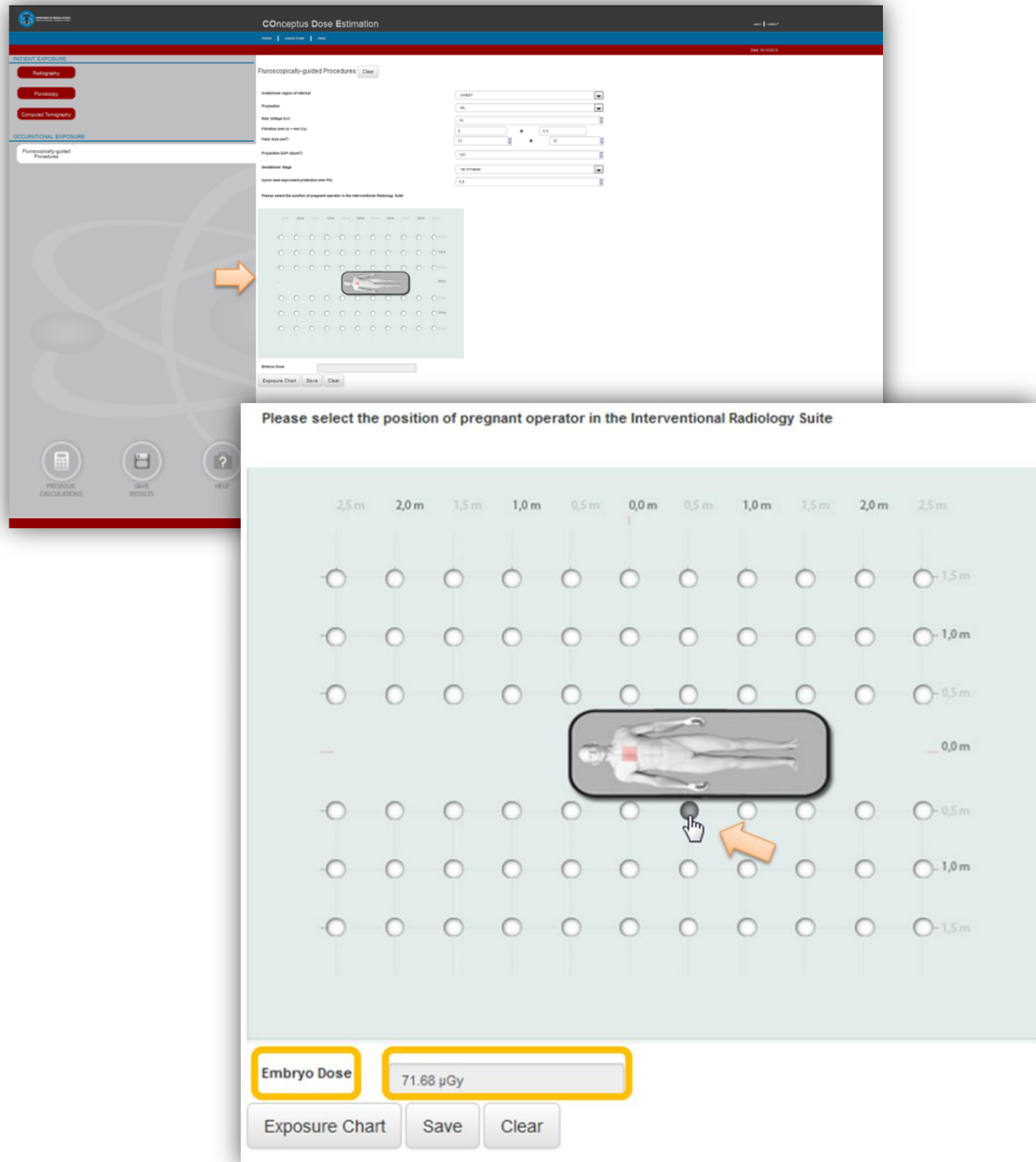
❖ When all the necessary data has been supplied, the dose absorbed by the embryo of the pregnant employee is calculated and presented in the corresponding field. The scatter exposure map corresponding to the selected fluoroscopic projection is presented if the user presses the button <Exposure chart>.
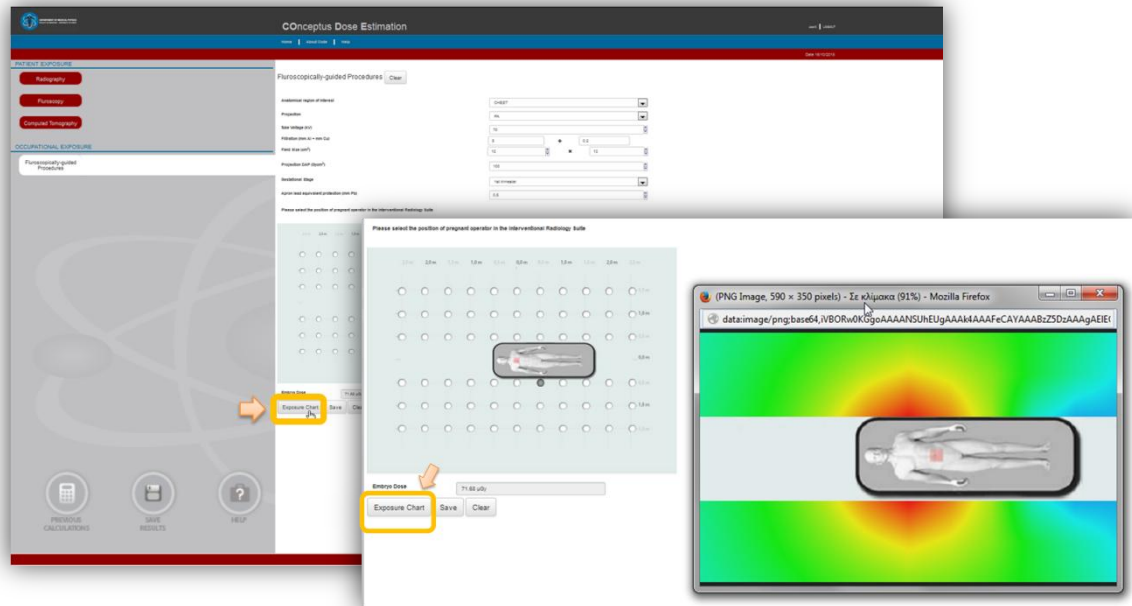
❖ Using the <Save Results> button, the registered user can also save a calculation, including all exposure data and date and time of submission for later revision.
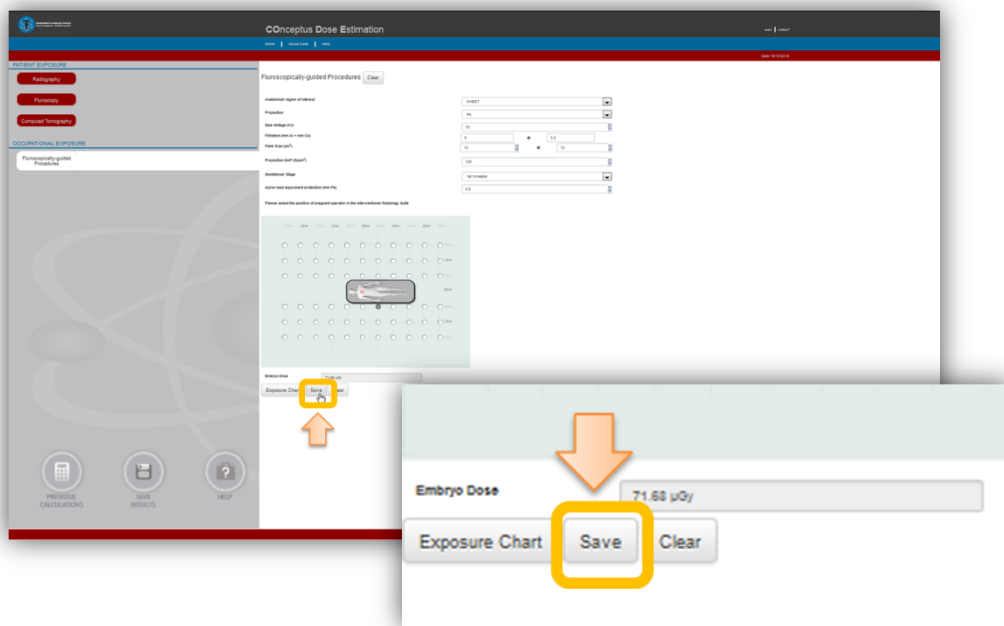
❖ The user can clear the form and start over a new calculation using the <Clear> button.
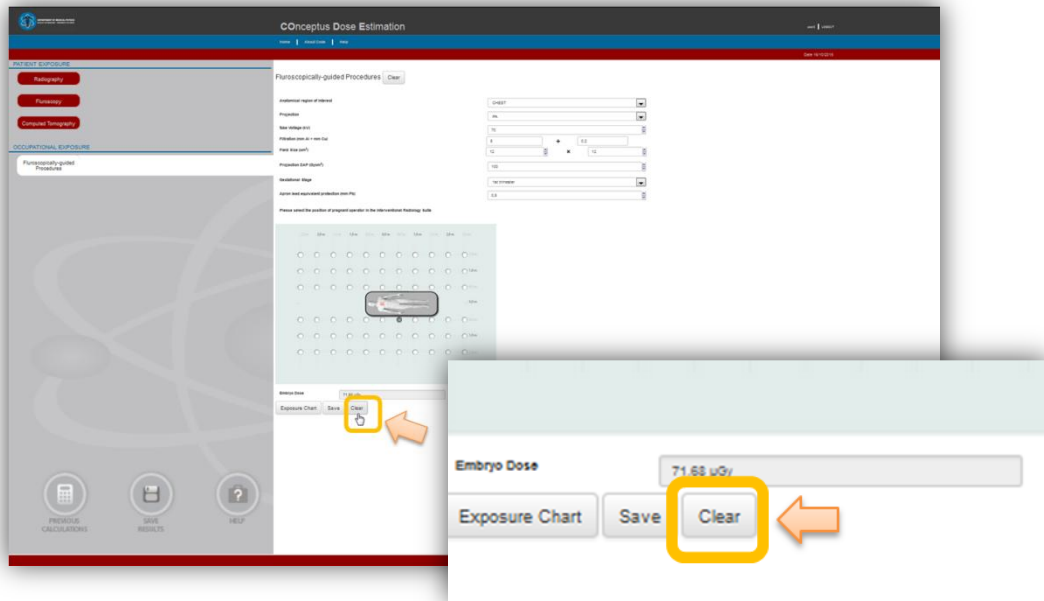
❖ Additionaly, the user has the oppurtunity to calculate the cumulative embryo dose.from several fluoroscopic exposures for which calculation of embryo dose has been performed and saved. The user has to press <Previous Calculations> button and select the specific exposures. The cumulative embryo dose from the selected exposures is then calculated and presented.

Selection of previous calculations of interest

Previous Calculations

12 . occupational_exposure 2015-10-16 17:21:58 [ ]
ED:69.24 ?Gy

Selection of previous calculations of interest

13 . occupational_exposure 2015-10-16 17:22:45 [ ]
ED:12.09 ?Gy

type = occupational_exposure
aroi = 3
projection = 0000000002
kv = 81
filt_al = 4
filt_cu = 0.2
filt_total = 9.53
field_size_x = 15
field_size_y = 15
dap = 120
gesta = 1
lead = 0.5
ed = 12.09 ?Gy

14 . occupational_exposure 2015-10-16 17:23:28 [ ]
ED:179.89 ?Gy

15 . occupational_exposure 2015-10-16 17:24:08 [ ]
ED:100.00 ?Gy

type = occupational_exposure
aroi = 2
projection = 0000000002
kv = 80
filt_al = 6
filt_cu = 0.0
filt_total = 6.00
field_size_x = 20
field_size_y = 24
dap = 150
gesta = 1
lead = 0.5
ed = 100.00 ?Gy
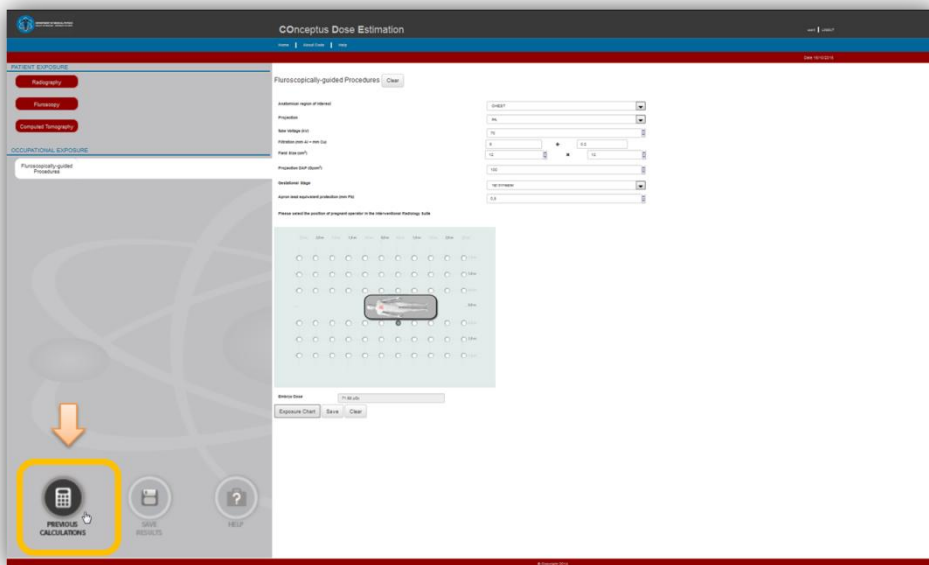
Total Embryo Dose: 0.11209 mGy

Delete Saved Calculations

Return to HELP

References

1. Damilakis J. Perisinakis K, Prassopoulos P, Dimovasili E, Varveris H, Gourtsoyiannis N (2003) Embryo radiation dose and risk from chest screen-film radiography. Eur Radiol.13:406–412

2. Damilakis J. Tzedakis A, Sideri L, Perisinakis K, Stamatelatos IE, Gourtsoyiannis N (2002) Normalized embryo doses for abdominal radiographic examinations calculated using a Monte Carlo technique. Med Phys. 29(11)

3. Theocharopoulos N, Perisinakis K, Damilakis J, Varveris H, Gourtsoyiannis N (2002) Comparison of four methods for assessing patient effective dose from radiological examinations. Med Phys DOI: 10.1118/1.1500769

4. Samara E, Stratakis J, Enele Melono J.M, Mouzas I.A, Perisinakis K, Damilakis J 2009Therapeutic ERCP and pregnancy: is the radiation risk for the embryo trivial? Gastrointest Endosc;69:824-31.)

5. Damilakis J. Tzedakis A, Perisinakis K, Papadakis AE (2010) A method of estimating embryo doses resulting from multidetector CT examinations during all stages of gestation. Med Phys DOI: 10.1118/1.3517187

6. Damilakis J. Perisinakis K, Theocharopoulos N, Tzedakis A, Manios E, Vardas P, Gourtsoyiannis N (2005)Anticipation of Radiation Dose to the Embryo from Occupational Exposure of Pregnant Staff During Fluoroscopically Guided Electrophysiological Procedures. J Cardiovasc Electrophysiol 16:773-780

7. Theocharopoulos N, Damilakis J. Perisinakis K, Papadokostakis G, Hadjipavlou A, Gourtsoyiannis N (2004) Occupational Gonadal and Embryo/Fetal Doses From Fluoroscopically Assisted Surgical Treatments of Spinal Disorders. SPINE 29(22):2573–2580

8. Damilakis J, Perisinakis K, Tzedakis A, Papadakis A, Karantanas A (2010) Radiation dose to the embryo from NDCT during early gestation: A method that allows for variations in maternal body size and embryo position. Radiology;257:483-489.

9. Damilakis J, Perisinakis K, Voloudaki A, Gourtsoyiannis N (2000) Estimation of fetal radiation dose from computed tomography scanning in late pregnancy: Depth dose data from routine examinations. Investigative Radiology; 9:527-533.

10. Damilakis J, Theoharopoulos N, Perisinakis K, Papadokostakis G, Hadjipavlou A, Gourtsoyiannis N (2003) Embryo radiation dose assessment from fluoroscopically assisted surgical treatment of hip fractures. Med Phys;30:2594-601

11. Damilakis J, Theoharopoulos N, Perisinakis K, Manios E, Dimitriou P, Vardas P, Gourtsoyiannis N (2001). Embryo radiation dose and risk from cardiac cathter ablation procedures. Circulation;104:893-7.

12. Theocharopoulos N, Damilakis J, Perisinakis K, Papadokostakis G, Hadjipavlou A, Gourtsoyiannis N (2006) Fluoroscopically assisted surgical treatments of spinal disorders: embryo radiation doses and risks. Spine (Phila Pa 1976).15;31(2):239-44.

13. Damilakis J, Perisinakis K, Koukourakis M, Gourtsoyiannis N (1997) Maximum embryo absorbed dose from intravenous urography: Interhospitalvariations. Radiation Protection Dosimetry; 72:61-65.

14. Damilakis J, Perisinakis K, Grammatikakis J, Panayiotakis G, Gourtsoyiannis N (1996) Accidental embryo irradiation during barium enema examinations. An estimation of absorbed study. . Investigative Radiology; 31:242-245.

15. Perisinakis K, Damilakis J, Vagios E, Gourtsoyiannis N(1999) Embryo depth during the first trimester: Data required for embryo dosimetry. Investigative Radiology; 34:449-454

16. Damilakis J, Perisinakis K, Theocharopoulos N, Tzedakis A, Manios E, Vardas P, Gourtsoyiannis N (2005) Anticipation of radiation dose to the embryo from occupational exposure of pregnant staff during fluoroscopically guided electrophysiological procedures. J Cardiovasc Electrophysiol;16:773-80

17. Theocharopoulos N, Damilakis J, Perisinakis K, Papadokostakis G, Hadjipavlou A, Gourtsoyiannis N (2004) Occupational gonadal and embryo/fetal doses from fluoroscopically assisted surgical treatments of spinal disorders. Spine;29:2573-80.

Return to HELP