

# CALDose\_X online: Web-based, real time Monte Carlo calculations for patient dosimetry in X-ray diagnosis

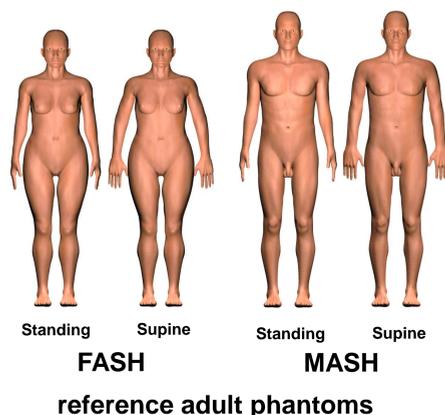
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## 1. INTRODUCTION

### Caldose\_X

Software program for the assessment of absorbed doses and radiological risks in the human body caused by exposure of patients in radiodiagnosis using real time Monte Carlo calculation via the Internet.



CALDose\_X 5.0, available at [www.caldose.org](http://www.caldose.org) for download, is a software program for the calculation of absorbed doses and radiological risks in the human body caused by exposure of patients in radiodiagnostic.

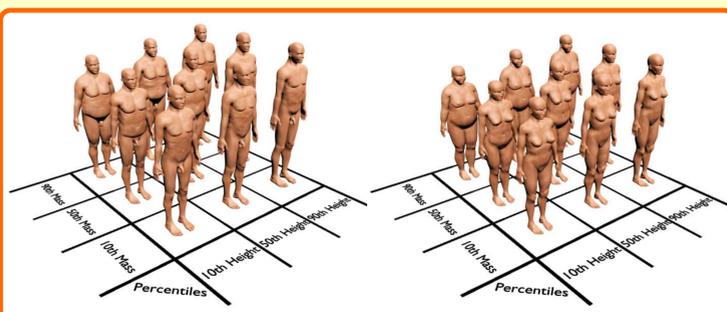
The software uses conversion coefficients (CCs) between organ absorbed doses and incident air kerma (INAK), entrance air kerma (ESAK) and air kerma area product (AKAP) for the MASH and FASH reference phantoms in standing and supine position. However, most patients have not the anatomical properties of the ICRP reference adults

The answer to this problem is CALDose\_X **online**, a dosimetric service on the internet ([www.caldose.org](http://www.caldose.org)) for real time Monte Carlo (MC) calculation of organ and tissue absorbed doses as well as radiological risks from conventional diagnostic X-ray examinations taking into account body mass, standing height and posture of the patient.

## 2. MATERIALS AND METHODS

### 2.1 Dosimetry

36 anthropometric phantoms, 18 in standing and 18 in supine position, 9 per gender and posture with combinations of 3 different body masses and 3 different heights are connected to the EGSnrc MC code.



24 different X-ray examinations with various projections can be simulated using spectra with 2.0 – 5 mm Al filtration between 60 and 150 kVp and different focus-to-detector distances (FDD).

### 2.2 The Internet connection

CALDose\_X **online** was designed to work via the Internet as a web server. Communication between the server and the database, containing information about user records and examinations, are made using PHP and SQL scripting.

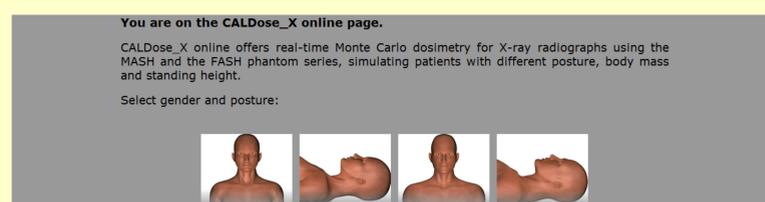
## 4. Conclusion

CALDose\_X **online** ([www.caldose.org](http://www.caldose.org)) provides organ and tissue absorbed dose assessment for male and female adults as a function of posture, body mass and height by real time Monte Carlo calculation via the internet. The software covers 24 X-ray examinations for standing and supine posture for adult patients with body masses between 59.3 kg and 108.5 kg for males and between 48.6 kg and 94 kg for females. Standing heights cover the range from 167.3 cm to 185.6 cm for males and from 155.5 cm to 172.2 cm for females. Typical run time for the simulation of a radiograph is 60-90 seconds. CALDose\_X 5.0 and **online** are used every day by more than 700 registered users in more than 40 countries.

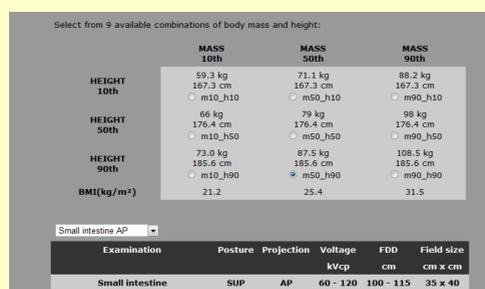
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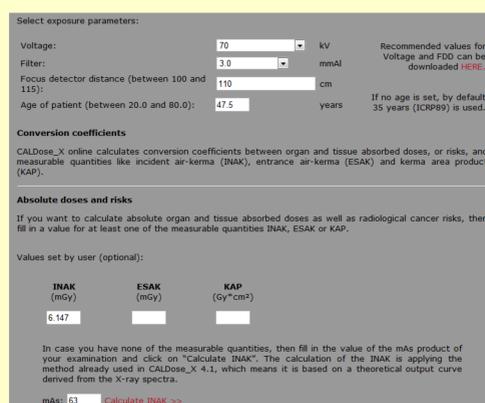
## 3. RESULTS



On the first page of the CALDose\_X **online** website the user is asked to select gender and posture. Here: Male patient in supine position.



Next the phantom and the examination have to be selected. Here: A 50<sup>th</sup> mass and 90<sup>th</sup> height percentile male phantom and a radiograph of the small intestine.



Now, the user has to define exposure parameters like peak voltage, aluminium filter and FDD, as well as the age. At this point, CALDose\_X **online** is ready to calculate CCs for organ and tissue absorbed doses, as well as cancer risks normalized to INAK, ESAK and AKAP for the X-ray examination selected.

CALDose\_X **online** also calculates absolute organ and tissue absorbed doses for measurable quantities provided by the user (here: INAK = 6.147 mGy). The table with the results presents the name of the phantom, the examination and all exposure parameters in the header. Organ and tissue absorbed doses are displayed in mGy together with the statistical error of the MC calculation. Risks of cancer incidence and mortality are shown for the age given by the user (here: 47.5 years.)

MASH3\_m50\_h90\_SUP: SMALL INTESTINE, ANTERIOR-POSTERIOR IMAGE BEHIND THE BODY MALE ADULT  
70 kVcp 3.0 mm Al 17 Deg Tungsten IPeM/SR78  
MEAN SPECTRAL ENERGY: 39.9 keV ABSORBED FRACTION: 0.62  
SOURCE-TO-DETECTOR (FILM): 110.0 cm  
SOURCE-TO-SKIN: 83.4 cm  
FIELD SIZE IN DETECTOR PLANE: 35.0 cm x 40.0 cm  
FIELD POSITION: STANDARD POSTURE: SUPINE  
BODY MASS: 87.5 KG, STANDING HEIGHT: 185.6 CM  
AGE: 47.5 YEARS USER INAK: 6.147 mGy

ABSORBED DOSE		
ORGAN/TISSUE	mGy	%
ESAK CALCULATED FROM USER INAK	8.735	1.18
ADRENALS	0.481	3.48
BLADDER WALL	0.247	2.56
COLON WALL	1.975	0.33
BREASTS, glandular	0.099	8.07
KIDNEYS	0.538	0.73
LIVER	2.307	0.14
LUNGS	0.124	0.71
OESOPHAGUS	0.110	4.28
PANCREAS	1.943	0.58
SMALL INTESTINE WALL	1.729	0.27
SKIN ENTRANCE 7.2cm X 7.2cm	8.835	1.18
SPLEEN	1.186	0.67
STOMACH WALL	2.950	0.42
THYMUS	0.059	7.39
HEART WALL	0.143	1.35
LYMPHATIC NODES	0.761	0.54
GALL BLADDER WALL	4.283	1.34
SKELETON AVERAGE	0.377	0.17
MAXIMUM RBM ABSORBED DOSE	0.242	1.01
MAXIMUM BSC ABSORBED DOSE	0.308	2.46
WEIGHTED MASH DOSE	0.857	0.40

RISK OF CANCER INCIDENCE: 4.050 CASES PER 100000  
RISK OF CANCER MORTALITY: 2.243 CASES PER 100000