



# The population dose in Belgium

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Health and Environment – Service Health Protection

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**FANC**  **AFCN**

federaal agentschap voor nucleaire controle  
agence fédérale de contrôle nucléaire

[www.fanc.fgov.be](http://www.fanc.fgov.be)

# The population dose in Belgium

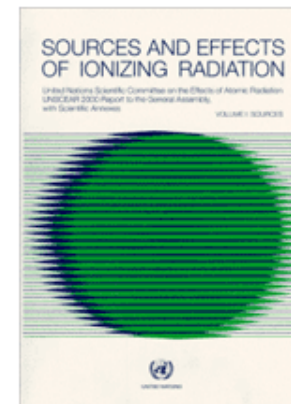
- Introduction
- Estimation of the population dose 2015
  - Exposure due to natural sources
  - Exposure due to Nuclear and Industrial applications
  - Professional Exposure
  - Trends in Medical Exposure
- Population Dose 2015

# Introduction

## Population Dose

- **Estimation** of the mean dose to ionising radiation
- Population dose  $\neq$  Individual dose
- UNSCEAR methodology

UNSCEAR 2000 Report to the General Assembly, Volume I:  
Sources, Annex A, Dose Assessment Methodologies



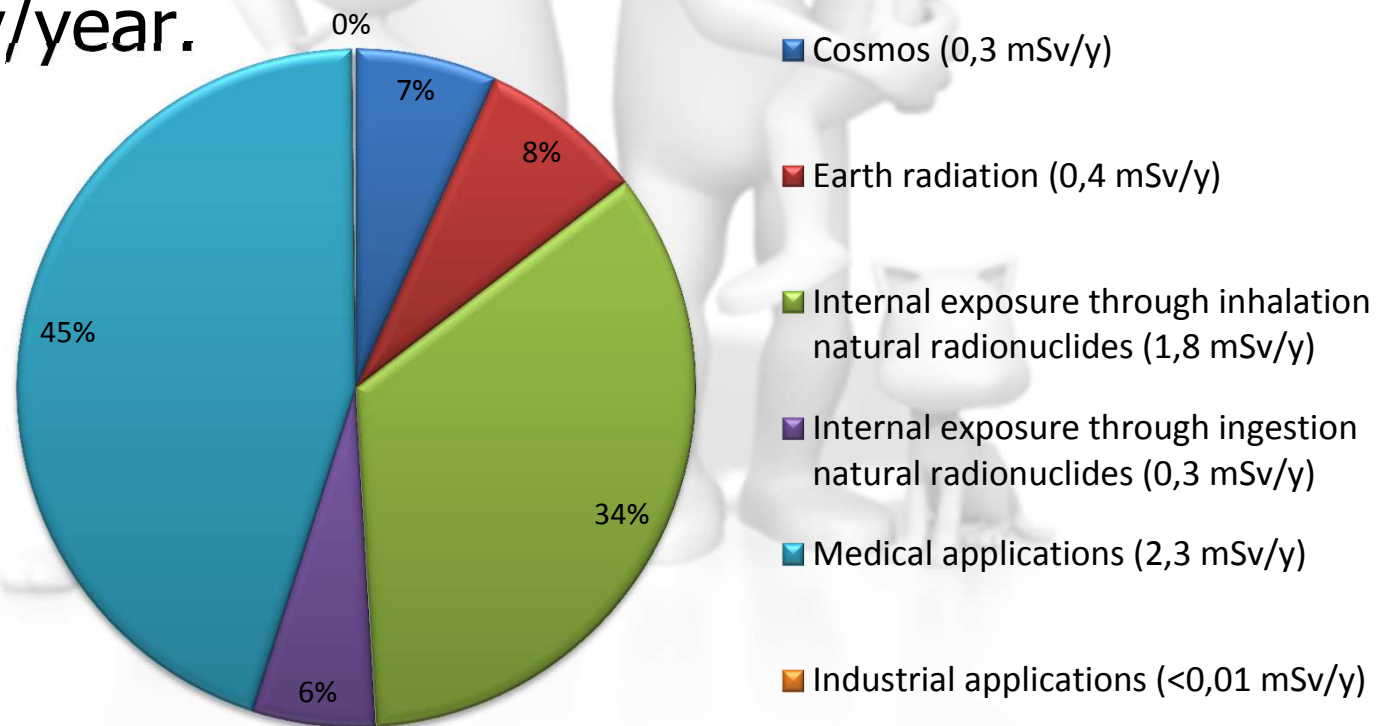
- Comprehensive report 2015 population dose in Belgium:  
[www.afcn.fgov.be](http://www.afcn.fgov.be) → Dossiers d'information → Radioactivité → Exposition moyenne annuelle aux rayonnements ionisants en Belgique  
[www.fanc.fgov.be](http://www.fanc.fgov.be) → Informatiedossiers → Wat is radioactiviteit ? → Jaarlijkse gemiddelde blootstelling aan ioniserende straling in België

# Introduction

## Population Dose

**2010:**

Average dose of ionising radiation in Belgium was **5,1 mSv/year.**



# Estimation of the population dose 2015

## EXPOSURE DUE TO NATURAL SOURCES.

→ **External** natural exposure:

- Cosmic radiation
- Telluric radiation

→ **Internal** Exposure:

- Radon & thoron (inhalation & ingestion)
- Other radionuclides (ingestion)

# External natural exposure

Average dose due to **cosmic radiation** in Belgium

= **0,347 mSv/year**

- Cosmic radiation varies with latitude and height
- Time spent indoors (80%) and shielding factor (0.8)
- Dose from cosmogenic radionuclides (0.012 mSv/year)
- Dose due to air travel and holidays (0.025 mSv/year)

Average dose due to **external terrestrial exposure** in Belgium

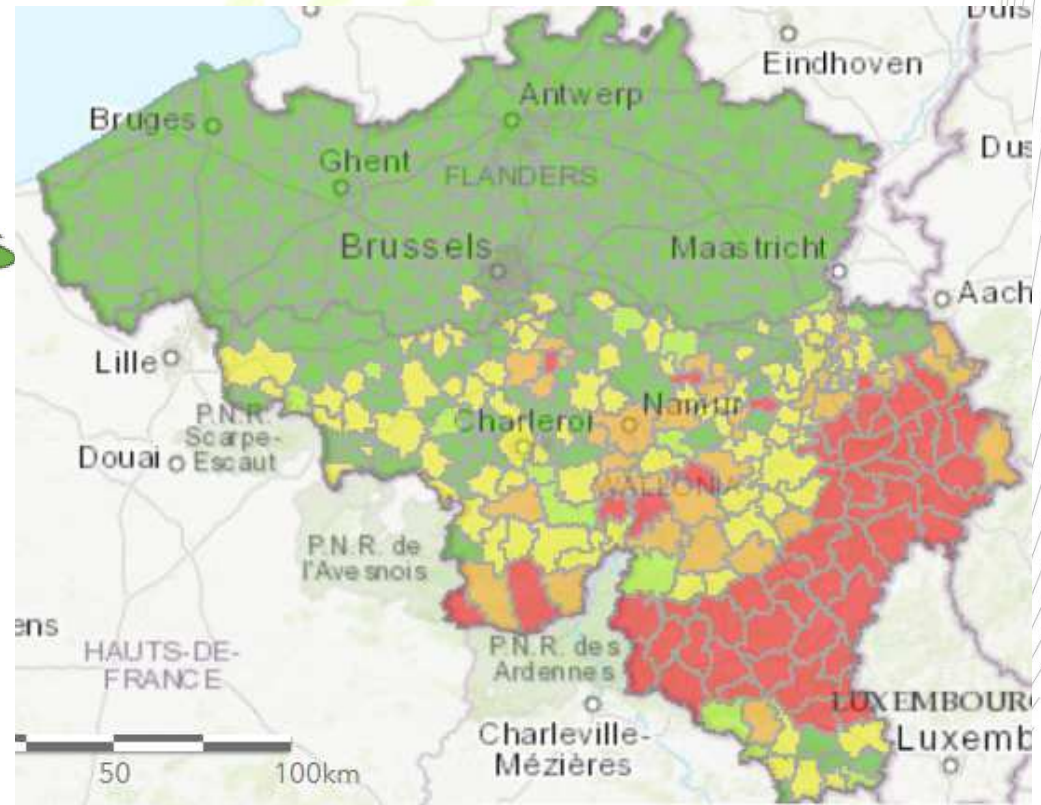
= **0,4 mSv/year**

- Absorbed dose rate outdoors = 44 nGy/h<sup>(a)</sup>
- Absorbed dose rate indoors = 60 nGy/h<sup>(a)</sup>
- Time spent indoors (80%) and shielding factor (0.8)

Average dose due to **External natural exposure** in Belgium  
= **0,747 mSv/year**

# Internal Exposure

## Radon & thoron



# Internal Exposure

## Radon & thoron



[www.afcn.fgov.be](http://www.afcn.fgov.be) → Dossiers d'information  
→ Radon et radioactivité dans votre habitation

[www.fanc.fgov.be](http://www.fanc.fgov.be) → Informatiedossiers  
→ Radon en radioactiviteit in uw huis

<http://www.actionradon.be/>  
<http://www.radonactie.be/>





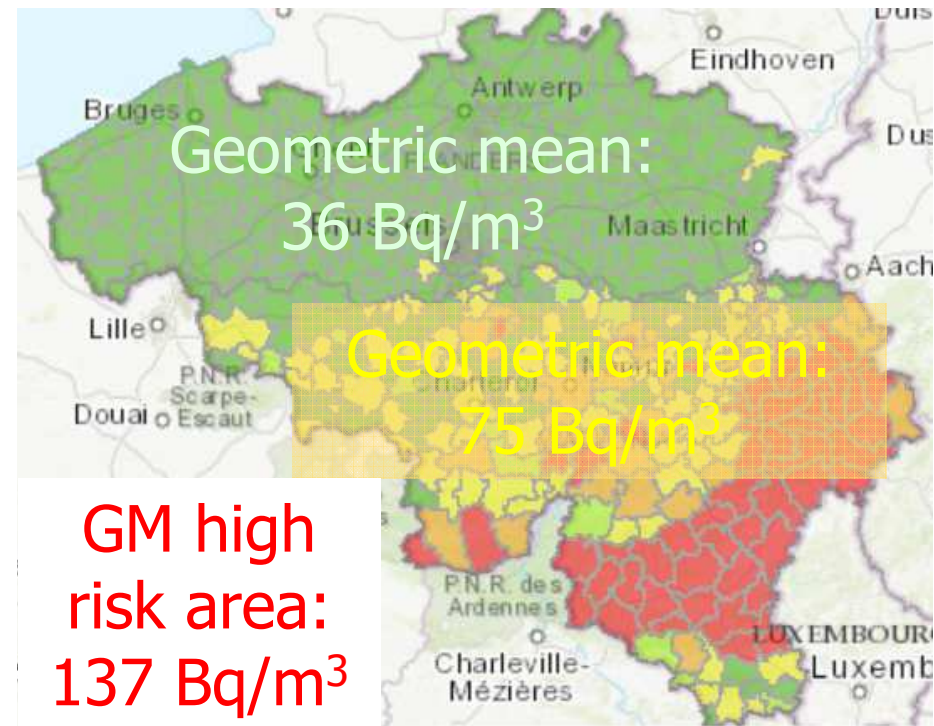
# Internal Exposure

## Radon & thoron



Average radon concentration outdoors in Belgium  
= 10 (3-20) Bq/m<sup>3</sup> (b)

Radon measurements indoors in Belgium<sup>(c)</sup>:



(b) Dehandschutter et al. 2009. The application of radon measurements in the radon action plan in Belgium. Annales de l'Association belge de Radioprotection, Vol. 34, n° 1, 89-110

(c) Superior Health council. Advisory report of the superior health council No. 8794: Indoor air quality in Belgium.

# Internal Exposure

## Radon & thoron

Exposure due to:	Annual effective dose (mSv/year)
Radon decay products	1,254
Inhalation of Radon gas	0,058
Ingestion of Radon gas	0,002
Thoron and decay product	0,091
<b>Total</b>	<b>1,405 mSv/year</b>

### Assumptions:

- Effective dose conversion factors (UNSCEAR 2006) for inhalation of radon gas decay products, radon gas, thoron and thoron decay products
- Time spent indoors (80%) and shielding factor (0.8)

# Internal Exposure

## Other

- Ingestion pathway
- Potassium-40; average concentration in body
  - Adults: 55 Bq/kg → 0.165 mSv/year
  - Children: 61 Bq/kg → 0.185 mSv/year
- the uranium and thorium decay series ( $^{210}\text{Po}$ )
  - Adults: 0.11 mSv/year ( $^{210}\text{Po}$  contribution=0.07 mSv/year)
  - Children: 0.20 mSv/year ( $^{210}\text{Po}$  contribution=0.10 mSv/year)
  - Infants: 0.26 mSv/year ( $^{210}\text{Po}$  contribution=0.18 mSv/year)
- Estimated total exposure = **0,292** mSv/year



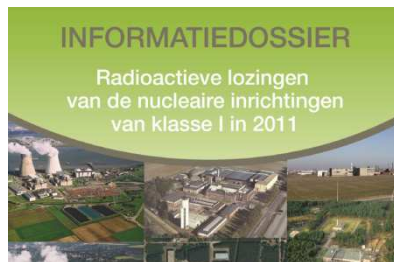
# Estimation of the population dose 2015

## EXPOSURE DUE TO NUCLEAR AND INDUSTRIAL APPLICATIONS



# Nuclear installations

Nuclear installations are obliged to follow-up their radioactive discharges.



Doses:  
estimations  
based on worst  
case scenario

Maximum annual dose (mSv/year)	2011	2012	2013	2014	2015
<b>NPP Doel</b>	0.02	0.02	0.02	0.02	0.02
<b>NPP Tihange</b>	0.05	0.05	0.049	0.049	0.048
<b>Fleurus (IRE)</b>	0.025	0.016	0.017	0.013	0.013
<b>SCK-CEN</b>	<0.001	0.0015	<0.001	<0.001	<0.001
<b>IRMM</b>	<0.001	<0.001	<0.001	<0.001	<0.001
<b>Belgonucléaire</b>	<0.001	<0.001	<0.001	<0.001	<0.001
<b>Belgoprocess</b>	0.009	0.0106	0.0105	0.0085	0.009
<b>FBFC int</b>	<0.001	<0.001	<0.001	<0.001	<0.001
<b>Totaal</b>	<b>0.108</b>	<b>0.1011</b>	<b>0.1005</b>	<b>0.0945</b>	<b>0.094</b>

# Nuclear installations

Radioactive discharges from Nuclear installations

→ Impact on belgian population is insignificant.

Nuclear fall-out (Chernobyl<sup>(d)</sup> & Fukushima)

→ Impact on belgian population is negligible.

Artificial radionuclides in food

→ Impact on belgian population is minimal.

⇒ **In general overview: <0,01 mSv/year**

(d) J.Uytenhove, S. Pommé, B. Van Wayenberge, F. Hardeman, J. Buysse, J-P. Culot,  
SURVEY OF THE <sup>137</sup>Cs CONTAMINATION IN BELGIUM AFTER THE CHERNOBYL ACCIDENT BY IN-SITU GAMMA  
SPECTROMETRY Health Physics, vol. 73, Nb. 4 (1997) 644-646

# Estimation of the population dose 2015

## PROFESSIONAL EXPOSURE



# Professional exposure (2013)

Total number of monitored workers = 38594

→ Average  $E_m$ , all monitored workers = 0,28 mSv

→ Average  $E_m$ , workers with measurable dose = 0,69 mSv

Field	Monitored workers	Monitored worker %	Collective dose (man.Sv)
Medical field	19019	49,3	3,132
Industry	5808	15,0	0,855
Nuclear field	6545	17,0	1,540
Transport	98	0,3	0,063
Research & education	3455	9,0	0,527
Natural sources	3291	8,5	4,509
Other	378	1,0	0,210





# Professional exposure (2013)

Total number of monitored workers = **38594** 0,3% Belgian pop

→ Average  $E_m$ , all monitored workers = 0,28 mSv

→ Average  $E_m$ , workers with measurable dose = 0,69 mSv

# workers (%)	$E_y < DL^{(a)}$	$DL \leq E_y^{(b)}$ <1mSv	$1mSv \leq E_y$ <5mSv	$5mSv \leq E_y$ <10mSv	$10mSv \leq E_y$ <15mSv	$15 \leq E_y$ <20mSv	$20mSv \leq E_y$
<b>All fields</b>	22914 (59,37)	11864 (30,74)	3682 (9,54)	121 (0,31)	12 (0,03)	1 (0,003)	0 (0,00)
<b>Medical Field</b>	12681 (35,92)	5709 (16,17)	550 (1,59)	66 (0,19)	12 (0,03)	1 (0,003)	0 (0,00)

<sup>(a)</sup>DL = detection limit  
<sup>(b)</sup> $E_y$  = effective dose/year

**Interventional radiologist/cardiologist**

# Estimation of the population dose 2015

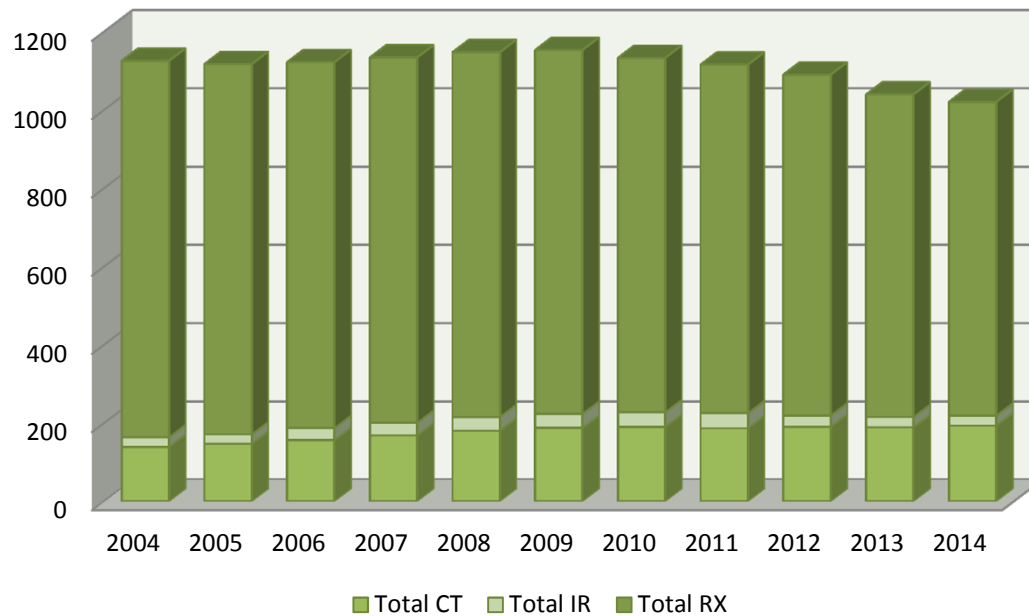
## TRENDS IN MEDICAL EXPOSURE

- Number of procedures
- Dose Burden

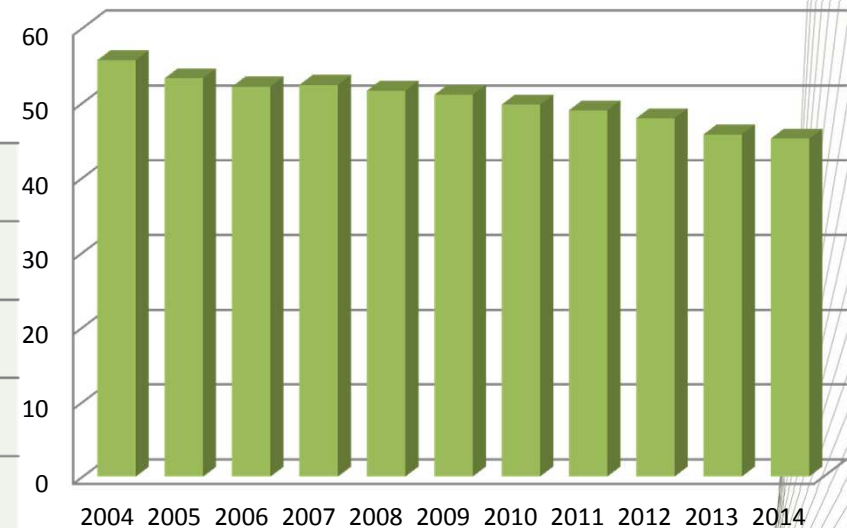
# Number of procedures Belgium

2004 – 2014

Diagnostic X-ray procedures per 1000 in Belgium (excluding dental exposures)



Diagnostic nuclear medicine procedures per 1000 in Belgium

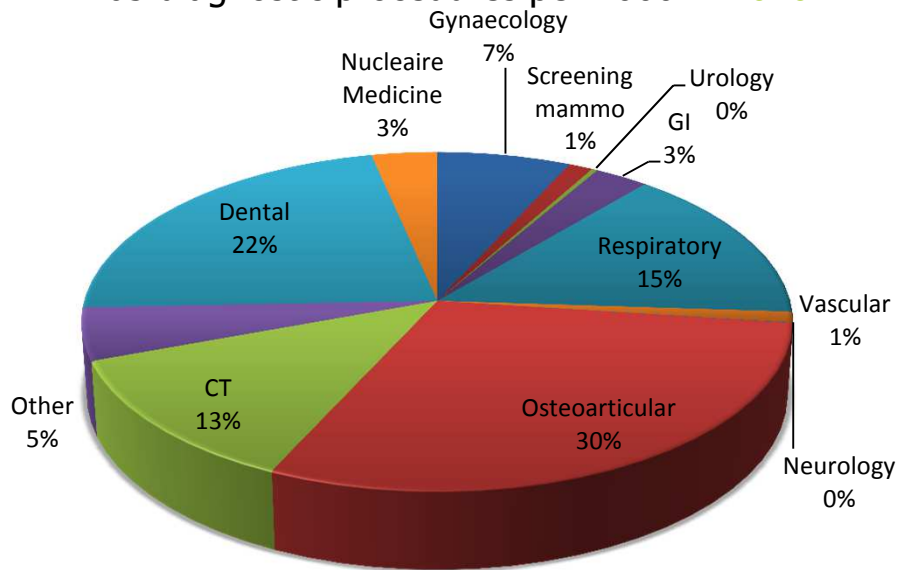


Data source: National Institute for Health and Disability Insurance (INAMI-RIZIV)

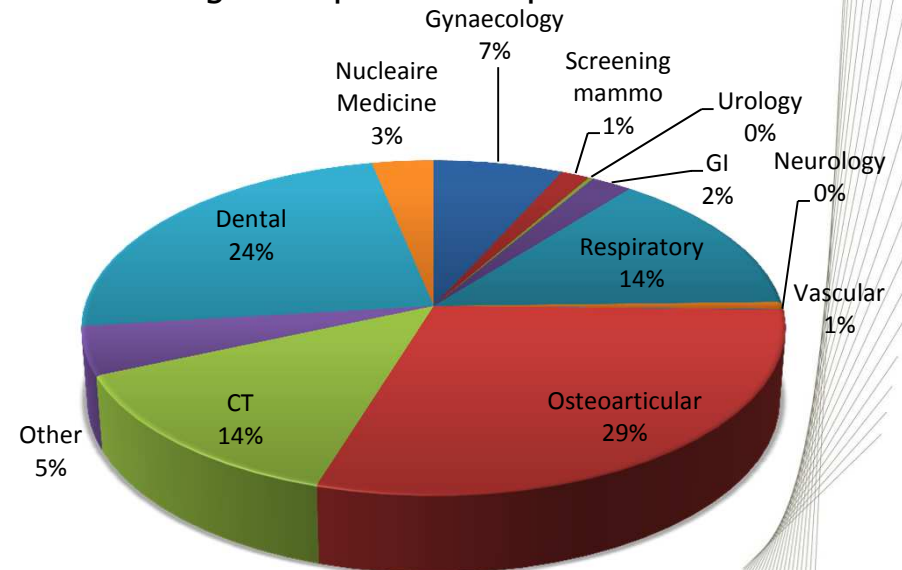
# Number of procedures Belgium

Number per 1000	2010	2013	2014	2015
<b>RX (excl dental)</b>	1089,86	1030,95	1006,94	1013,78
<b>Dental</b>	326,11	325,06	320,48	328,44
<b>Nuclear Medicine</b>	49,24	45,55	44,97	44,71
<b>Total</b>	<b>1465,21</b>	<b>1401,56</b>	<b>1372,39</b>	<b>1386,93</b>

1465 diagnostic procedures per 1000 in 2010



1342 diagnostic procedures per 1000 in 2015



# Dose Burden

## Belgium

Dose burden due to medical, diagnostic procedures =

(number of procedures \* patient dose)

Data NIHD

dose coefficient

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number of population

Belgian population

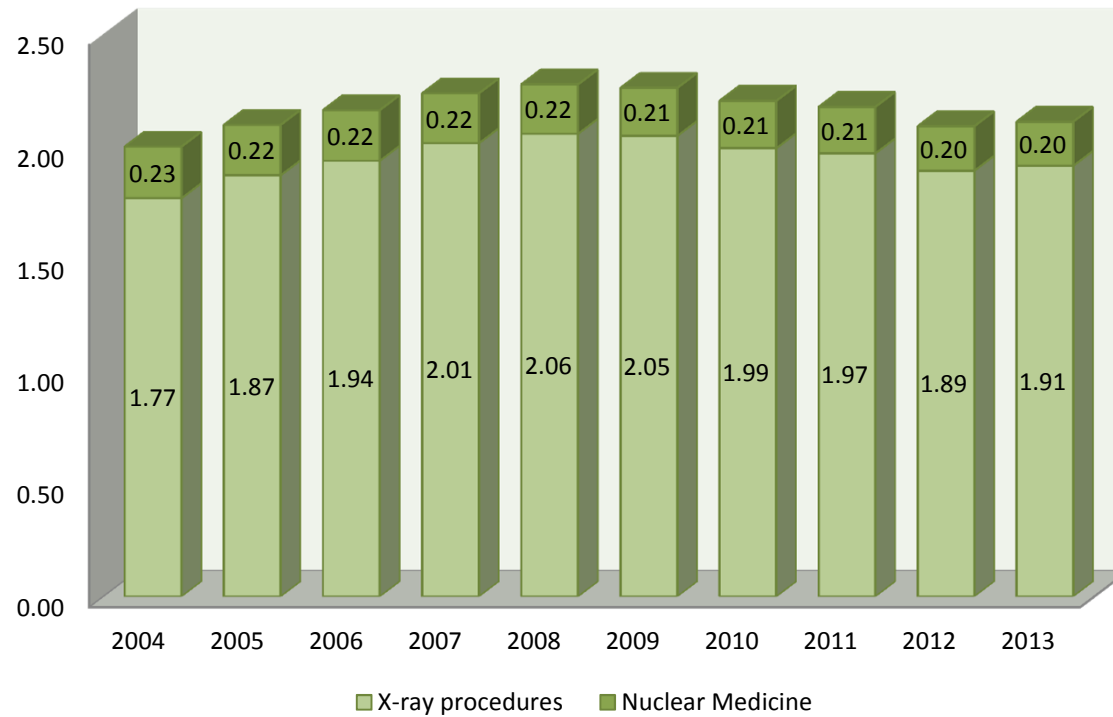


# Dose Burden

## Belgium

2004 – 2013

Theoretical, annual effective dose (mSv/person) due to diagnostic procedures



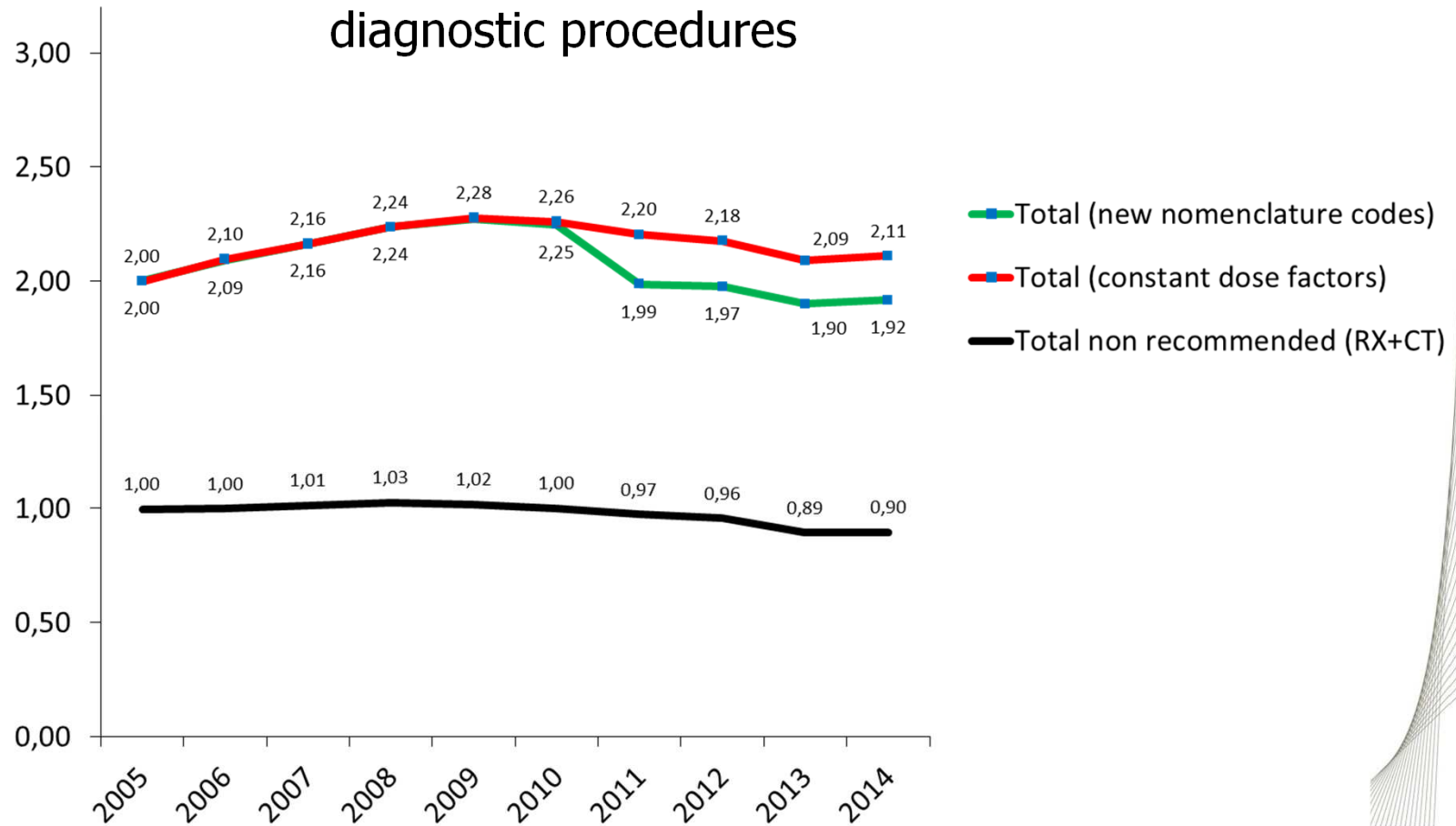
Data source: National Institute for Health and Disability Insurance (INAMI-RIZIV)

# Dose Burden

## Belgium

2005 – 2014

Theoretical effective dose (mSv/person) due to diagnostic procedures

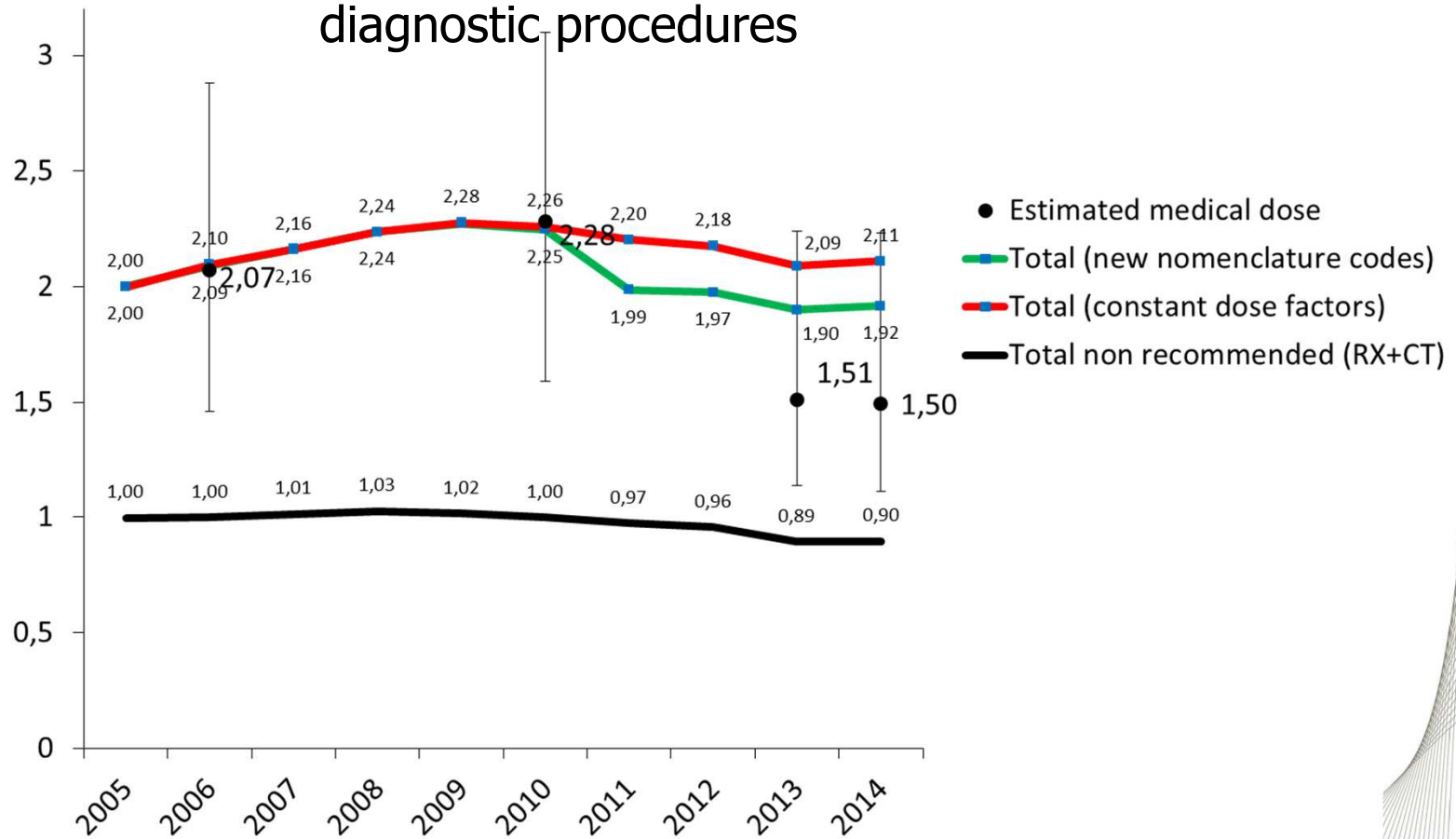


# Dose Burden

## Belgium

2005 – 2014

Theoretical effective dose (mSv/person) due to diagnostic procedures





# Dose Burden

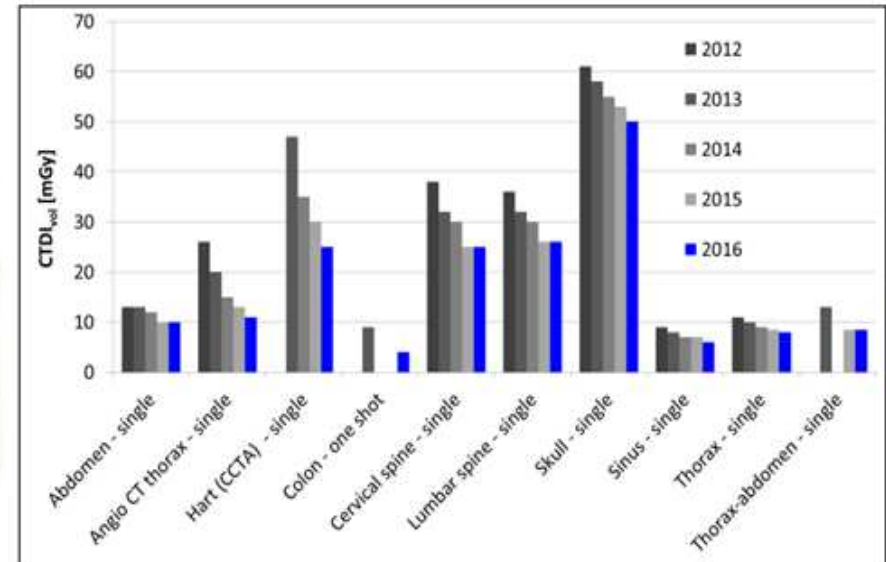
## Belgium



Renewal radiological devices



Optimisation

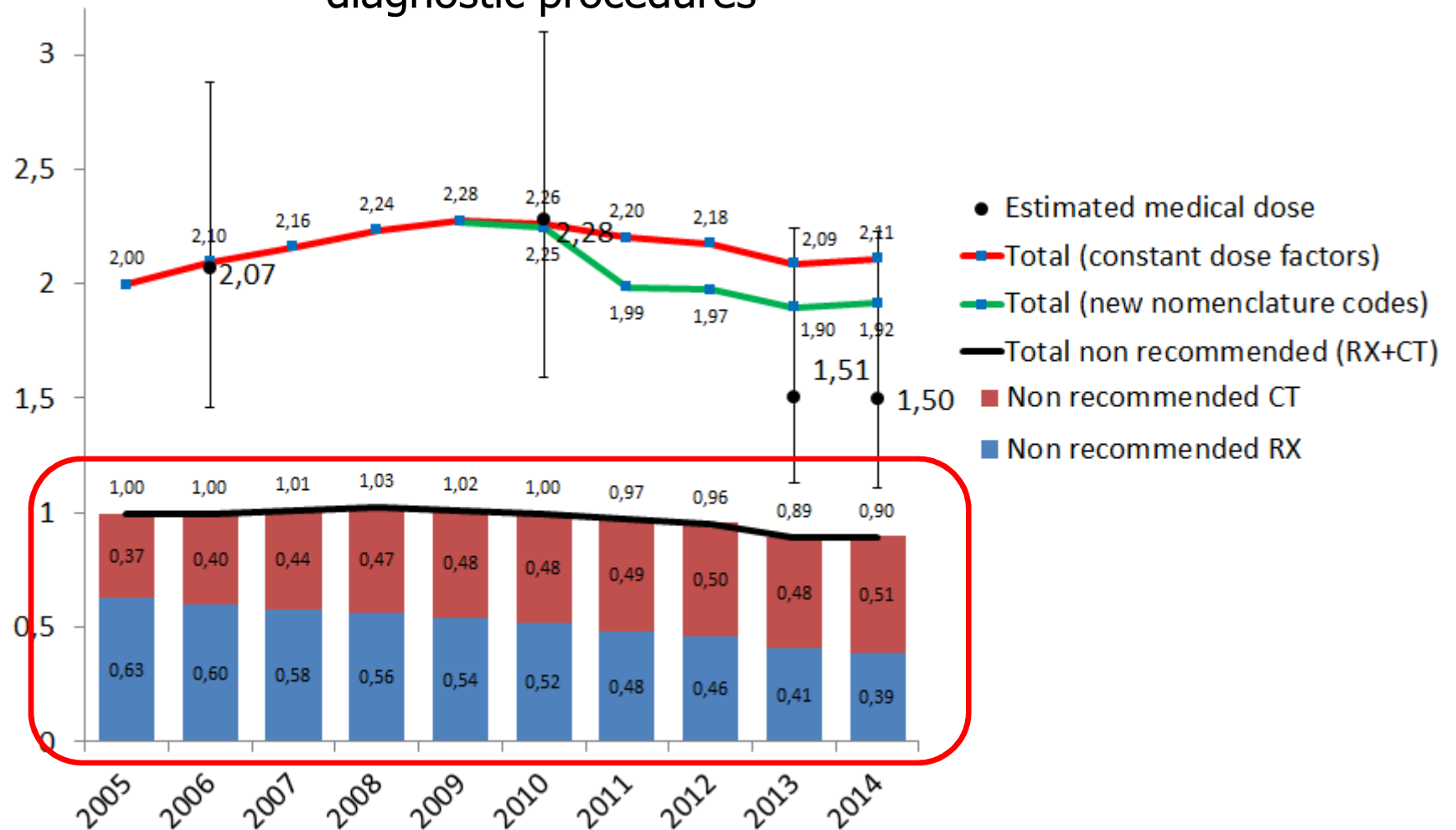


Diagnostic reference levels (P75) of the  $CTDI_{vol}$  of single CT procedures in adults.

# Dose Burden

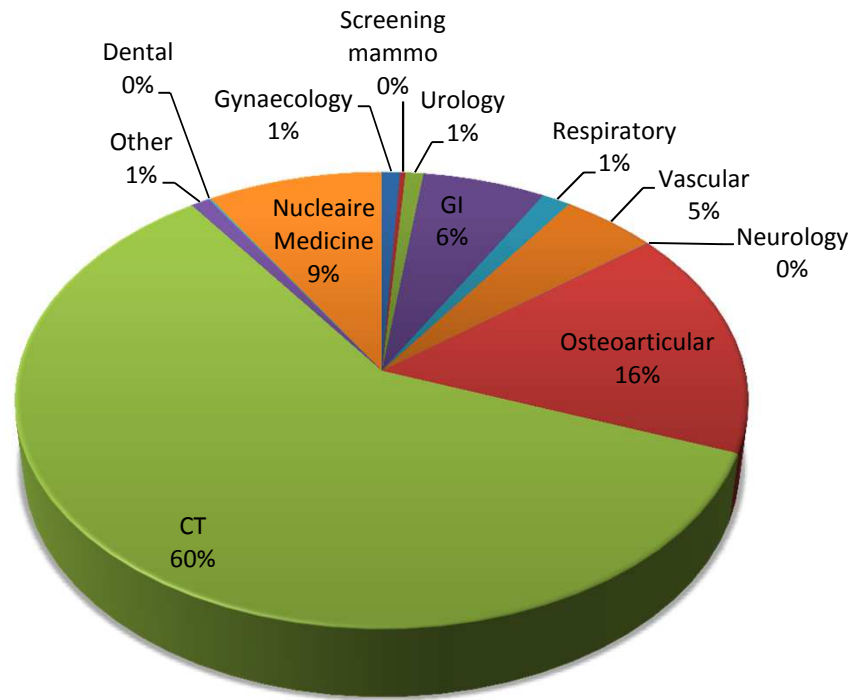
## Belgium

Theoretical effective dose (mSv/person) due to diagnostic procedures

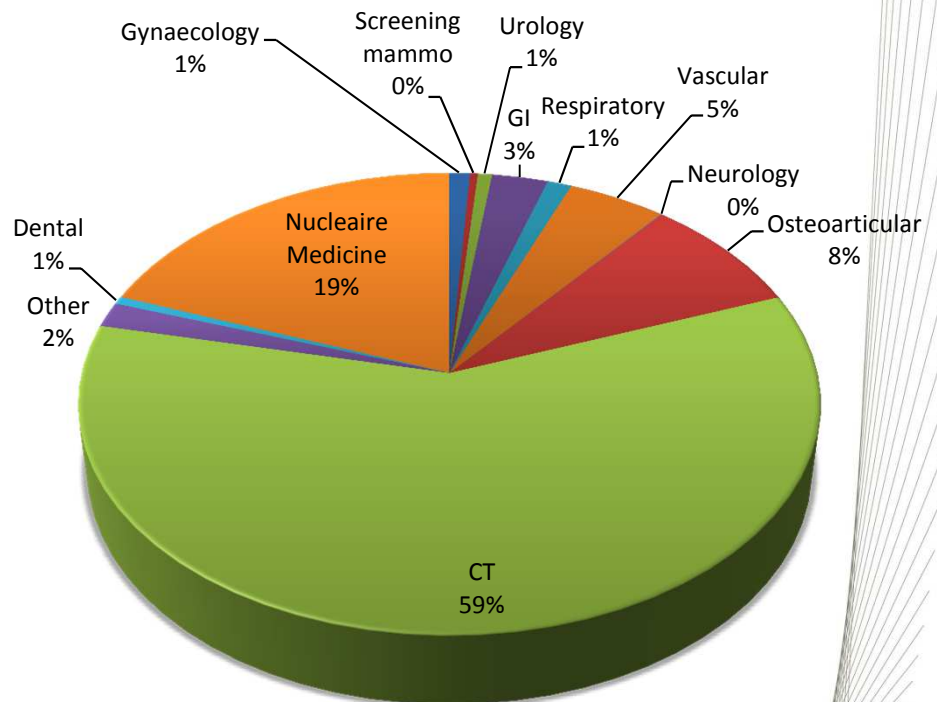


# Dose Burden Belgium

## Dose distribution from diagnostic procedures



2010 (2,28 mSv/person)



2015 (1,65 mSv/person)

# POPULATION DOSE 2015



## Dose burden per individual in 2015 (mSv/year).

### Cosmos

Cosmic radiation:	0,310
cosmogenic radionuclides:	0,012
air travel and holidays:	0,025
Total Dose burden due to cosmic radiation:	0,347

### Earth radiation

0,400

### Internal Exposure through inhalation of natural radionuclides

Exposure to radon decay products through inhalation:	1,254
Exposure to radon gas through inhalation:	0,058
Exposure to Thoron and decay products through inhalation:	0,091
Total exposure through inhalation of natural radionuclides:	1,403

### Internal Exposure through ingestion of natural radionuclides

Exposure to radon gas through ingestion:	0,002
Natural radionuclides, other than Radon and Thoron:	0,290
Total exposure through ingestion of natural radionuclides:	0,292

### Industrial Applications

<0,01

### Medical Applications

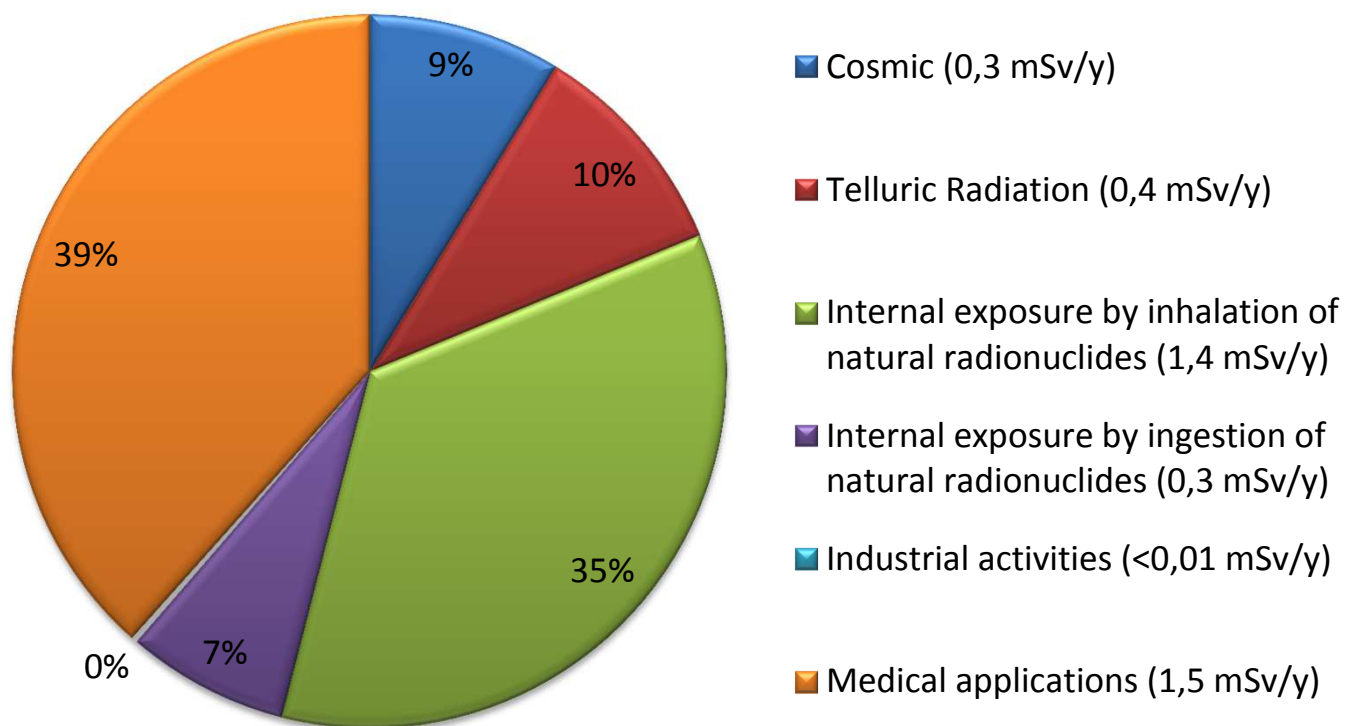
1,529

### Total:

**3,981**

# POPULATION DOSE 2015

Average exposure to ionising radiation in Belgium  
is **4 mSv/year** in 2015



# Q&A

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