

# INFLUENCE OF CHRONIC SMOKING ON THE DOSE DUE TO RADON EXPOSURE

Honorio da Silva, E.<sup>1</sup>; Davesne, E.<sup>1,2</sup>; Bonchuk, Y.<sup>3</sup> Ratia G.<sup>3</sup>; Madas, B.<sup>4</sup>; Berkovskyy, V.<sup>3</sup>  
Broggio, D.<sup>1</sup>

<sup>1</sup>Institut de Radioprotection et de Sûreté Nucléaire, France

<sup>2</sup>Institut National des Sciences et Techniques Nucléaires, France

<sup>3</sup>Ukrainian Radiation Protection Institute, Ukraine

<sup>4</sup>Centre for Energy Research, Hungary

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# Introduction

- RadoNorm project, funded by the Euratom research and training programme 2019-2020 under grant agreement No 900009.
- Collaboration among IRSN, MTA EK, PLUS and RPI
- Aim: to assess the dose in the lungs of smokers using the HRTM from ICRP using data from literature

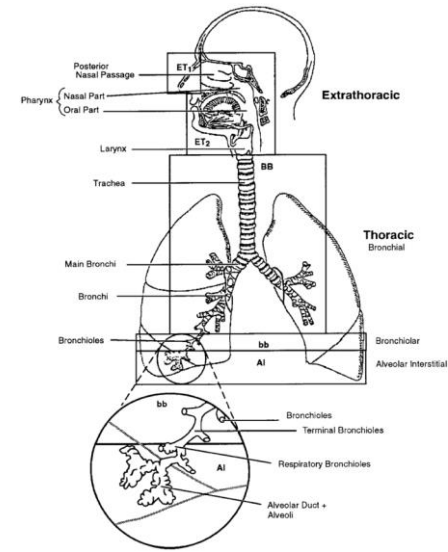
# Introduction

Smoking can lead to several changes in the Human Respiratory Tract

These changes can potentially affect the absorbed dose in the lungs due to exposure to Radon

Based on the literature, parameters that could influence the Human Respiratory Tract Model from ICRP were collected. Literature data was found for the following structures:

- Morphometric model → influences the dose in the radiosensitive cells
- Physiological model → influences the deposition of radon progeny in the airways
- Clearance model → influences how long radon progeny stays in the respiratory tract

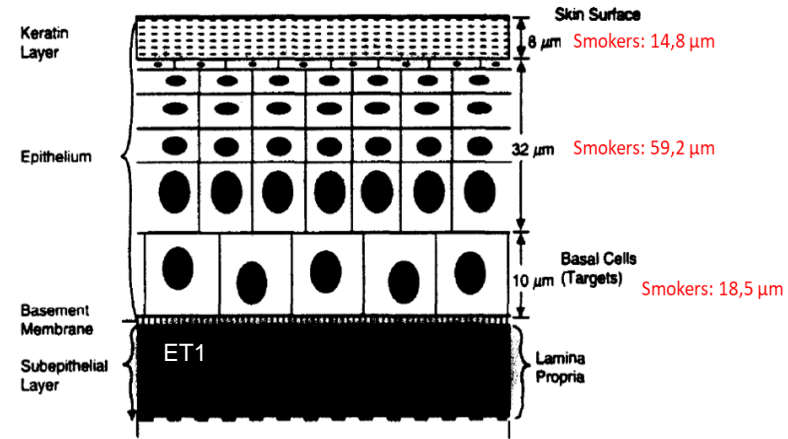
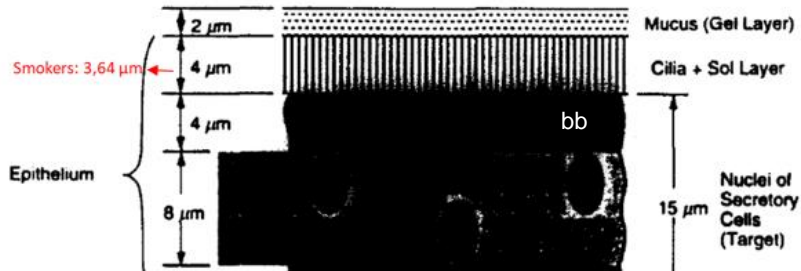


# Methods

- Literature search in Scopus, Google Scholar and cited works
  - Only articles distinguishing between smokers and non-smokers
  - Exclusion of animal models and *in-vitro* studies
- Specific Absorbed Fractions (SAF) for smokers were calculated using MCNPX (morphological changes)
- Deposition for smokers was calculated using an in-house developed IDL tool (physiological changes)
- Doses were calculated using ICARE (IRSN developed software) that uses the HRTM from ICRP
- Only health smokers were considered (normal spirometry, no lung diseases)
  - Other profiles still to be considered in other tasks

# Results - SAF

- Morphological changes: smoking increases the thickness of the epithelium in the respiratory tract and decreases cilia length
- Alpha particles have a longer path length before reaching target cells
- Decreased SAF:
  - ET1 more than 99%
  - Bronchi from 7% to 99%
- Increased SAF
  - Bronchiole up to 3%



## Results - Deposition

- Physiological changes: smokers have less physical volume available in their lungs
- Smaller volumes of air are exchanged at each breath



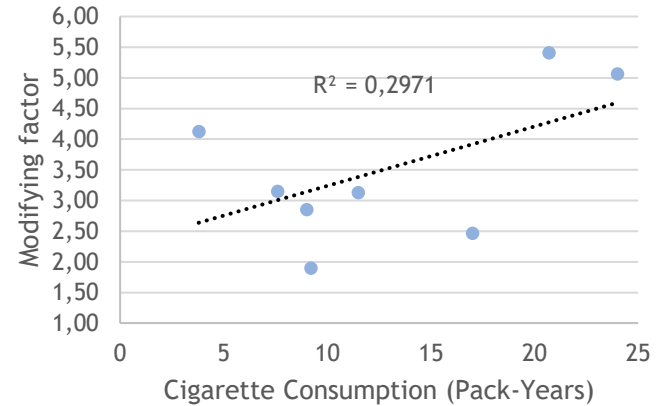
It affects each mode size distribution composing radon progeny differently, at different working environments:

- Total unattached fraction deposition remained the same, but decreased at bronchiolar and alveolar compartments
- Other aerosol modes total deposition increased up to 11%

# Results – clearance: absorption

Reference	Aerosol	Modifying factor - Absorption (ratio smokers/non-smokers)
Minty 1984 [36]	Tc-DTPA	1,6
Nolop 1987 [37]	In-DTPA	1,8
Nolop 1987 [37]	Tc-DTPA	2,2
Bhure 2009 [38]	Tc-DTPA	2,4
<b>Kennedy 1984 [34]</b>	<b>Tc-DTPA</b>	<b>2,6</b>
Inoue 1995 [30]	Tc-DTPA	2,7
Taylor 1988 [39]	Tc-DTPA	2,9
Schmekel 1992 [40]	Tc-DTPA	3,1
Thunberg 1989 [41]	Tc-DTPA	3,1
<b>O'Byrne 1984 [33]</b>	<b>Tc-DTPA</b>	<b>3,2</b>
Schmekel 1991 [35]	Tc-DTPA	3,4
Minty 1981 [42]	Tc-DTPA	3,7
Coates 1986 [43]	Tc-DTPA	4,0
Scherrer-Crosbie 1996 [44]	Tc-DTPA	4,1
Mason 2001 [45]	Tc-DTPA	4,3
Morrison 1999 [46]	Tc-DTPA	5,1
Mason 2001 [45]	In-DTPA	5,2
Mason 1983 [47]	Tc-DTPA	5,4
<b>Schmekel 1991 [35]</b>	<b>terbutaline</b>	<b>8,7</b>
Geometric Average		3,4

## Absorption occurs faster in smokers



Only few studies also controlled for appearance of the tracer in blood  
Modifying factor = 4

# Results – clearance: particle transport

Reference	Aerosol	Compartments	Modifying factor - Particle Transport (ratio smokers/non-smokers)
Lourenço 1971 [25]	Fe3O4-Au	BB -> ET2	0,1
<b>Goodman 1978 [48]</b>	<b>Teflon</b>	<b>BB -&gt; ET2</b>	<b>0,3</b>
<b>Toomes 1981 [49]</b>	<b>Teflon</b>	<b>BB -&gt; ET2</b>	<b>0,4</b>
Foster 1985 [50]	Fe2O3-Tc	BB -> ET2	0,4
Camner 1972 [51]	Tc-Teflon	BB -> ET2	0,7
Agnew 1986 [52]	Tc	BB -> ET2	0,7
Vastag 1985 [53]	Tc-erythrocytes	BB -> ET2	0,8
		Geometric average	0,4
Foster 1985 [50]	Fe2O3-Tc	bb -> BB	0,6
Cohen 1979 [54]	Fe3O4	ALV -> bb	0,2
Moller 2001 [55]	Fe3O4	ALV -> bb	0,4
Moller 2001 [55]	Fe3O4	ALV -> bb	0,6
		Geometric average	0,3
Kathren 1993 [56]	Pu/AM	ALV -> LN	0,4

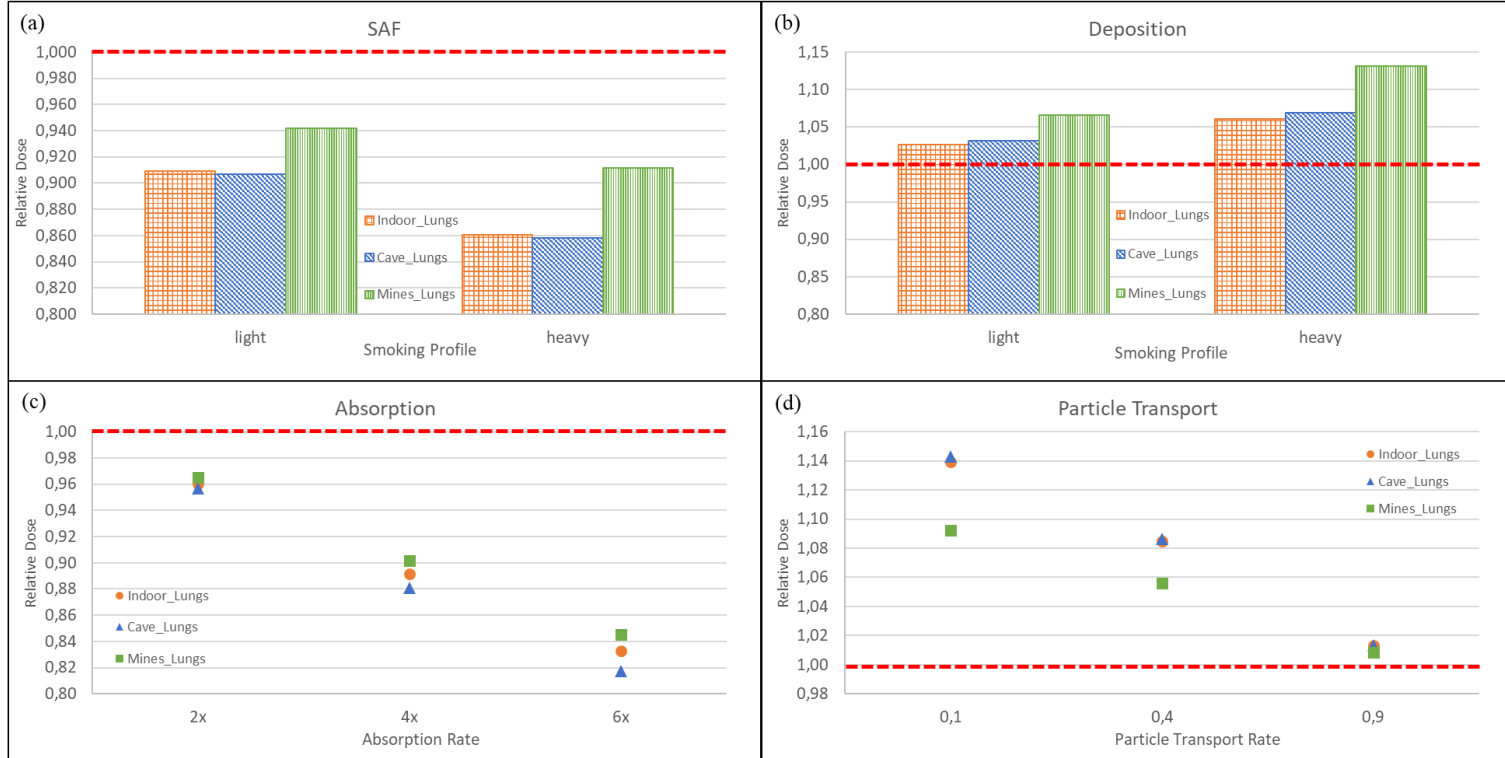
Particle transport occurs slower in smokers  
Shorter cilia

Millimetric particles = no absorption  
Modifying factor = 0,4



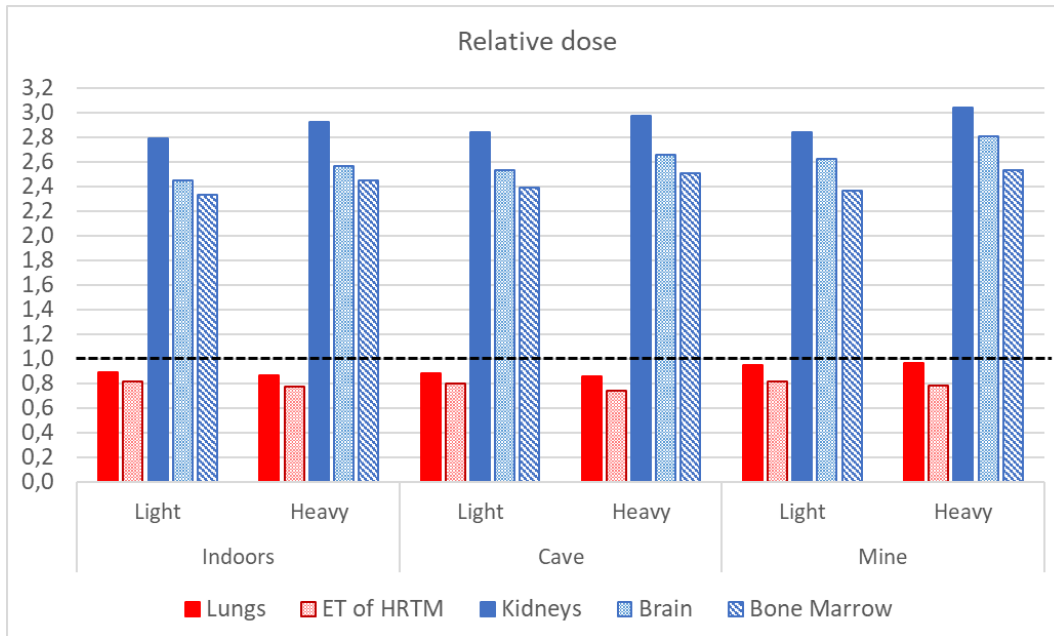
# Results – Lung dose; indoor workplace

$$\text{Relative Dose} = \frac{\text{Dose smokers}}{\text{Dose non\_smokers}}$$



# Results – Relative dose

Smoker Profile	SAF	Deposition	Absorption	Particle transport
Light	light (9% - 40%)	light (3% - 16%)	4x	0,4
Heavy	heavy (20% - 85%)	Heavy (10% - 25%)	4x	0,4



Smokers: lower dose in the lungs and ET of HRTM (SAF)

Dependence on the environment (deposition)

Higher doses in organs outside the HRT (absorption)

- Smoke from cigarettes affects the aerosol size distribution, which also decreases the dose received by smokers
  - At an environment with constant cigarette smoke, smokers might receive even lower doses compared to non-smokers
- Non-healthy smokers might be affected differently

# Conclusion

- Cigarette smokers receive lower doses to their lungs and ET of extrathoracic region
  - Within +/- 20%
  
- But higher doses to their kidneys, brain and bone marrow
  - Still at least 2 orders of magnitude smaller than lung dose

*The same exposure does not lead to the same dose for cigarette smokers and non-smokers*

Thanks for the attention!

Questions?



*Don Draper, Mad Men*

[edilaine.honoriodasilva@irsn.fr](mailto:edilaine.honoriodasilva@irsn.fr)