Comparison of dosimetric results obtained with different software for the cyclotron produced ^{47}Sc labeling a DOTA-folate radiopharmaceutical

De Dominicis L.[1,2], De Nardo L.[2,3], Meléndez-Alafort L.[4], Pupillo G.[1], Mou L.[1]

[1]Istituto Nazionale di Fisica Nucleare-Laboratori Nazionali di Legnaro (INFN-LNL), Legnaro.
[2]Università degli Studi di Padova, Dipartimento di Fisica e Astronomia, Padova.
[3]INFN-Sezione di Padova, Padova.
[4]Istituto Oncologico Veneto IOV-IRCCS, Padova.

lucia.de.dominicis@lnl.infn.it

Introduction

^{47}Sc decay characteristics		
Half-life (d)	γ-emission (SPECT imaging)	β-emission (small-medium sized tumor treatment)
	Energy [keV] (I [%])	Energy [keV] (I [%])
3.3492	159.381 (68.3)	142.6 (68.4) 203.9 (31.6)

^{47}Sc is a promising radionuclide for the development of new **theranostic** radiopharmaceuticals thanks to its decay characteristics. Its production at cyclotrons, via the $^{nat}V(p,x)^{47}Sc$ nuclear reaction, is possible but co-produced Sc-contaminants should be considered since they may increase the exposure of a patient to the ionizing radiation.

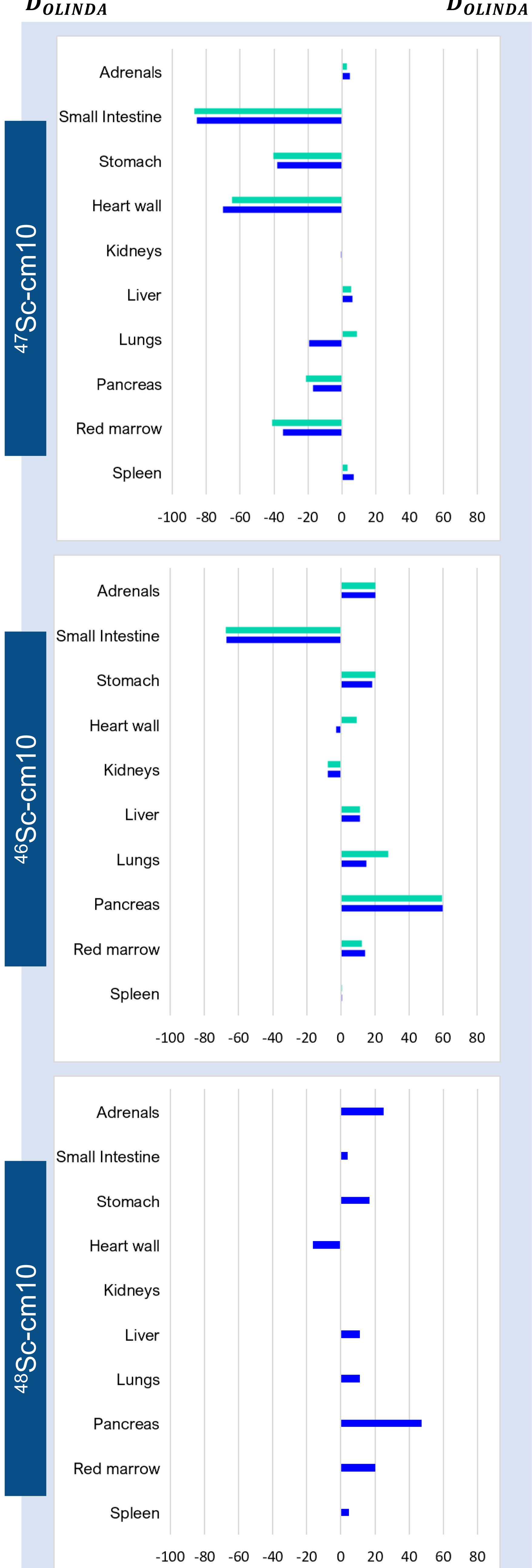
The radiation dose to a patient, due to ^{47}Sc and its contaminants, after the administration of a **DOTA-folate conjugate cm10** [1] labeled with cyclotron produced ^{47}Sc can be evaluated using some organ level dosimetry software, namely MIRDCalc 1.1 and IDACDose 2.1 [2,3]. The number of disintegrations, required as input by those software, are calculated scaling to humans the biodistribution studies carried out on mice [1].

Main co-produced Sc-contaminants characteristics			
Radioisotope	Half-life (d)	γ-emission	β-emission
		Energy [keV] (I [%])	Energy [keV] (I [%])
^{48}Sc	1.82125	983.526 (100) 1037.522 (97.5) 1312.120 (100)	142.6 (9.88) 203.9 (90.12)
^{46}Sc	**83.79**	889.277 (99.9840) 1120.545 (99.9870)	111.8 (99.9964) 580.8 (0.0036)

Organs absorbed doses

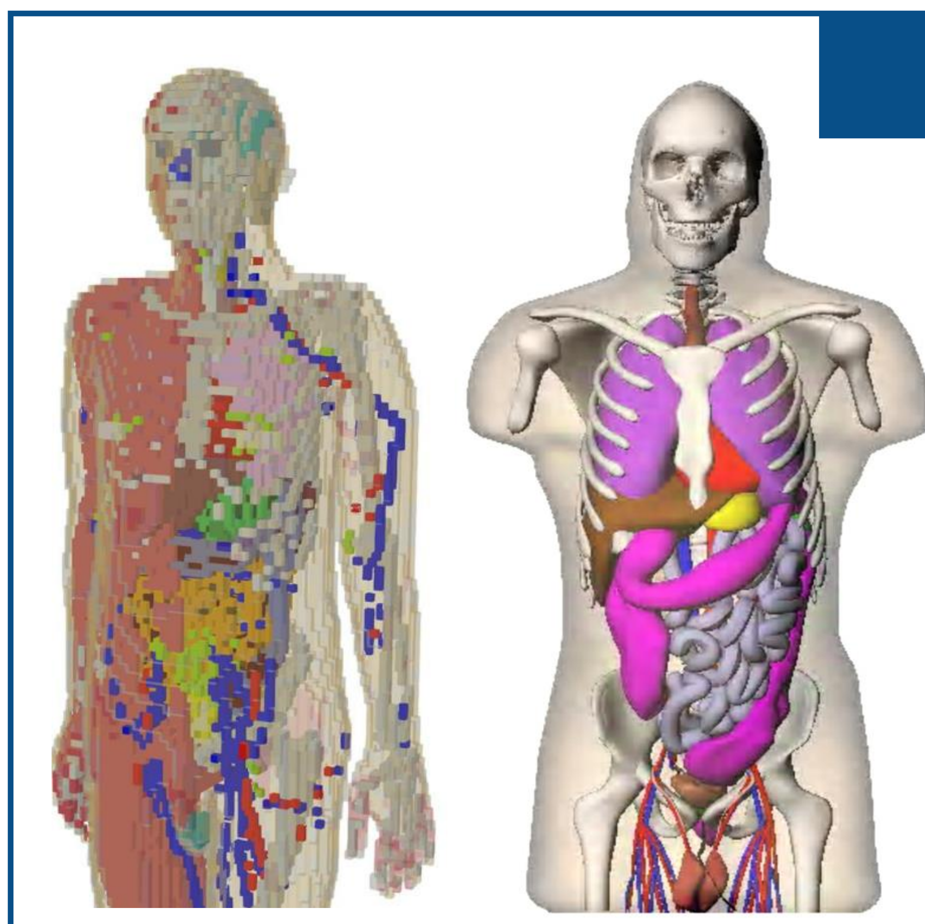
The absorbed dose for each organ returned by MIRDCalc 1.1 software or IDACDose 2.1 software are compared to the OLINDA 2.1.1 absorbed doses [4] by considering the relative differences.

$$\frac{(D_{MIRDCalc} - D_{OLINDA})}{D_{OLINDA}} \cdot 100 \qquad \frac{(D_{IDACDose} - D_{OLINDA})}{D_{OLINDA}} \cdot 100$$



^{48}Sc is not implemented in the MIRDCalc sofware

Phantom models



Voxel phantom NURBS phantom

MIRDCalc 1.1 and IDACDose 2.1 are both based on an anatomically realistic **voxel phantom** [5, 6] while the OLINDA 2.1.1 software uses a Non-Uniform Rational B-Splines (NURBS) phantom model [7].

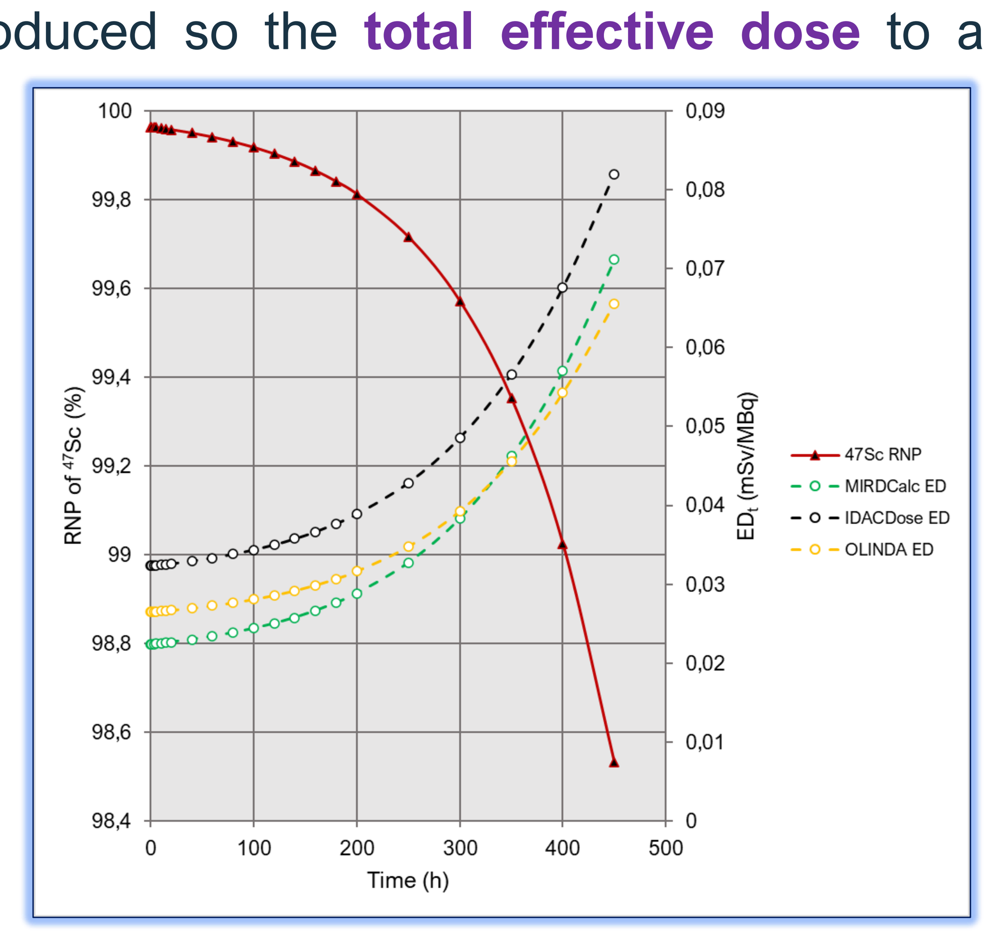
The strongest accordance between the absorbed doses obtained with MIRDCalc 1.1 and IDACDose 2.1 software can be explained with the similar phantom model implemented which is different from the one used in OLINDA 2.1.1.

However, the three software are perfectly in agreement in the case of the kidney which is the organ receiving the highest absorbed dose.

Effective doses

For the ^{47}Sc production via the natV(p,x) nuclear reaction, the optimal irradiation conditions to maximize the amount of ^{47}Sc produced while minimizing the contaminants are **80 h** as irradiation time and **35-19 MeV** as energy interval [8]. In this energy interval ^{48}Sc is not produced so the **total effective dose** to a patient is only given by ^{47}Sc and ^{46}Sc.

While the total effective doses obtained with the three software increase with time due to the long ^{46}Sc half-life, the RadioNuclidic Purity (RNP) of ^{47}Sc decreases for the same reason.



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