Nantes clinical dosimetric experience

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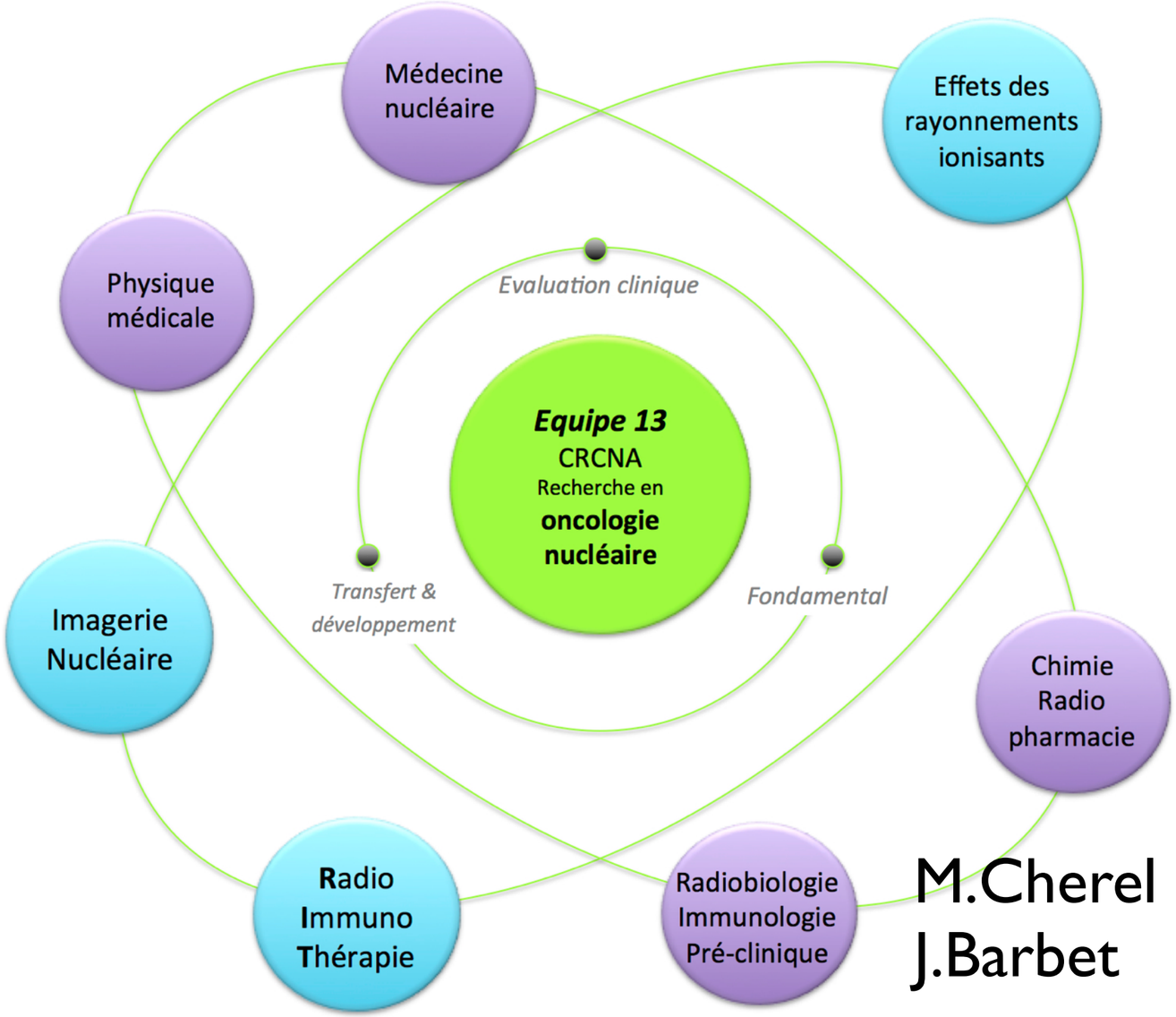

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René Gaudducheau

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University Hospital

Cancer Centre

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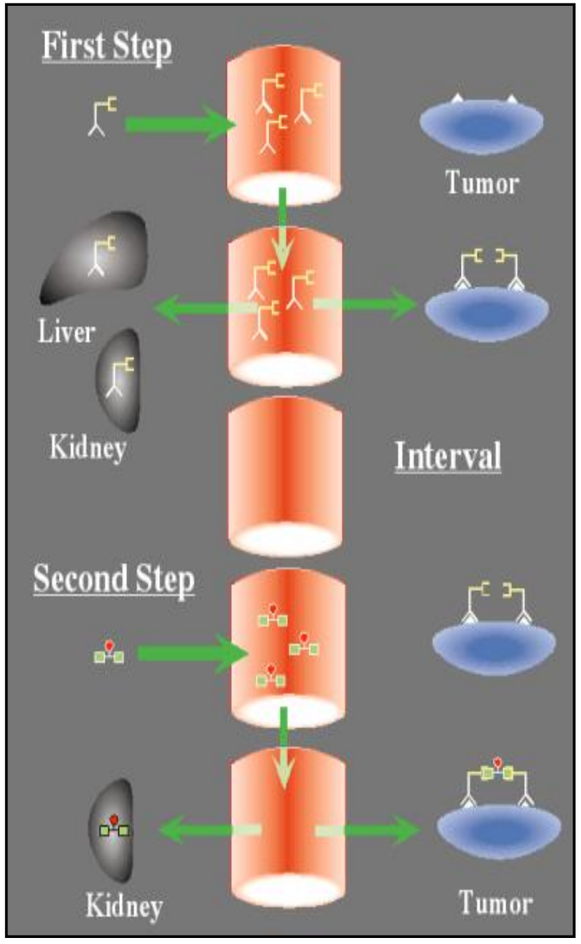
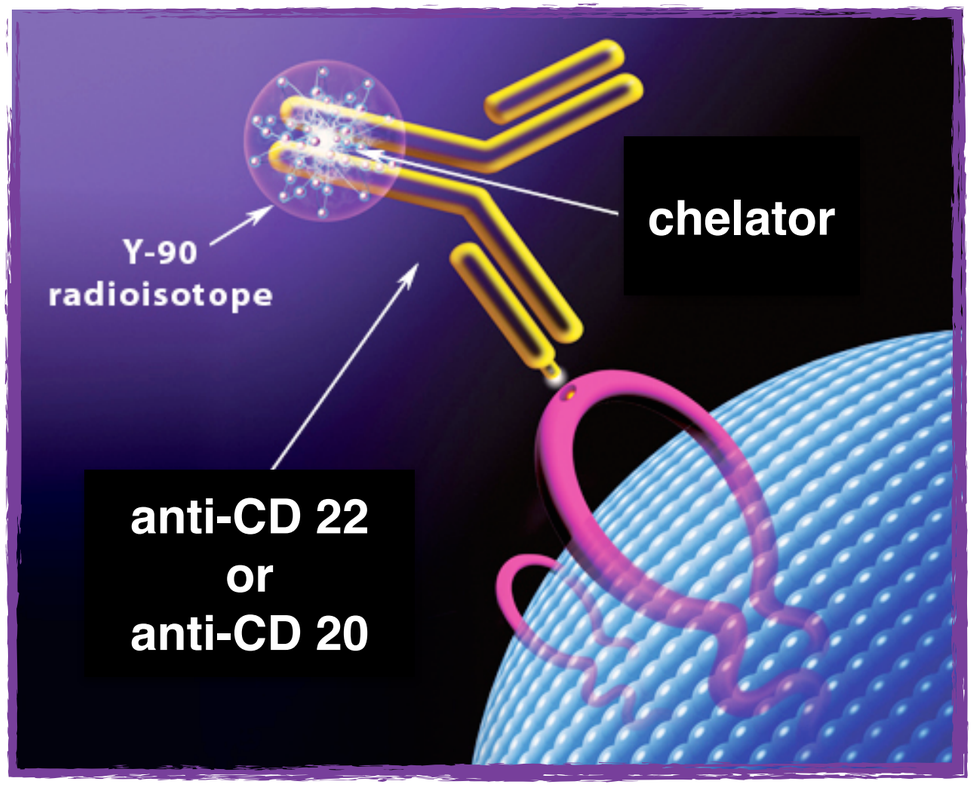
René Gaudducheau

RIT/Pre-targeted RIT

- Epratuzumab, Ibritumomab
- Anti—CD22, Anti—CD20
- Hematological deseases: Lymphoma, Myeloma
  - $^{111}In/^{90}Y$





- Anti—Carcinoembrionic antigen (CEA)
- Solid tumours
  - ^{131}I, $^{111}In/^{177}Lu$

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Image quantification

- 2D: "old fashion", not so quite reliable, intrinsic limitations, organ level
- 2.5D: more reliable (?), CT scan, organ segmentation, organ level,
- 3D: more reliable (in principle) approach, CT scan, limited to 2-3 axial FOV (?), voxel/organ level

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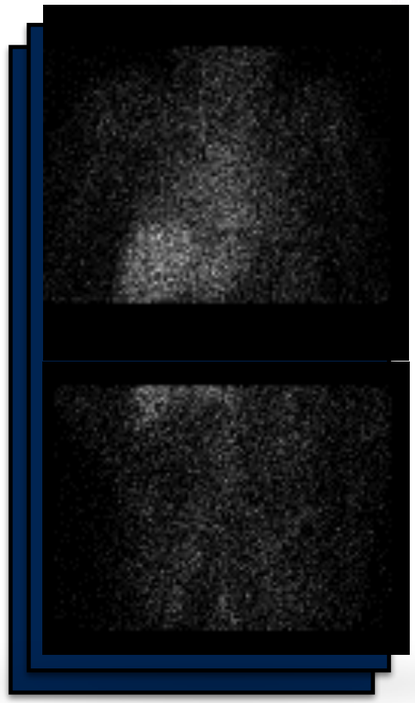
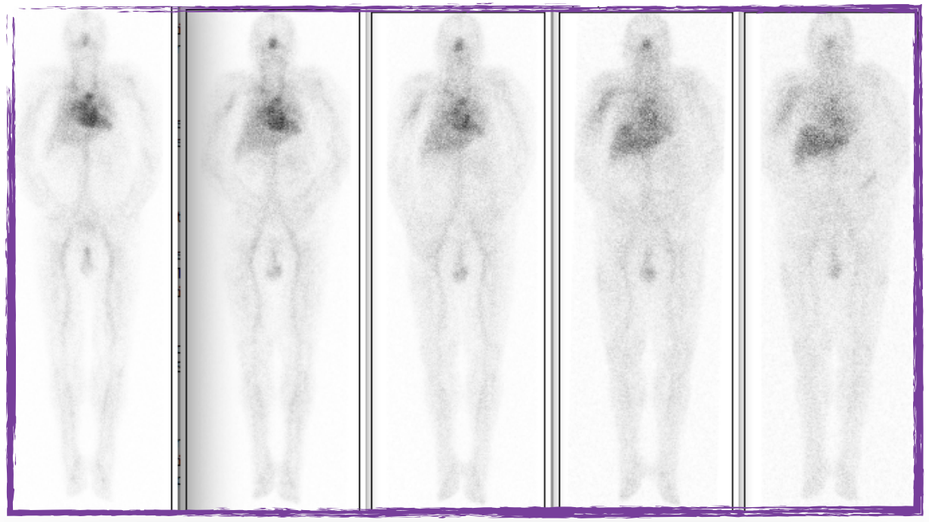
Imaging protocol

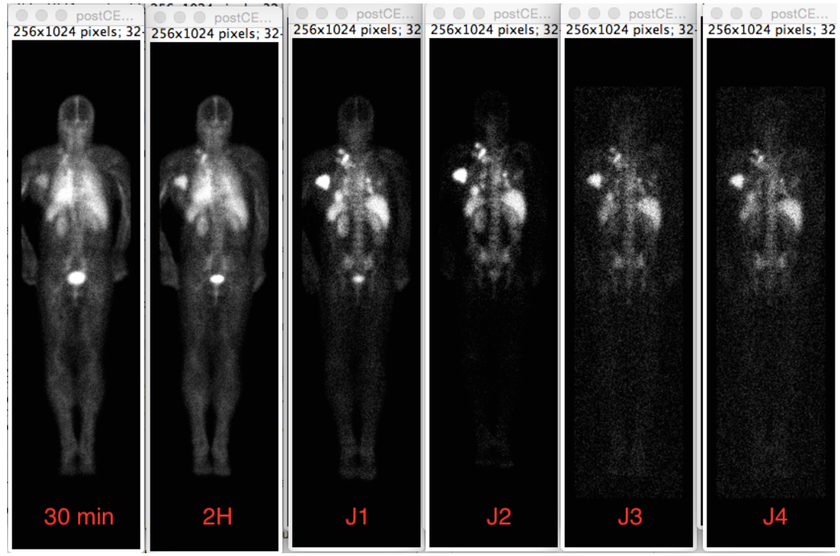


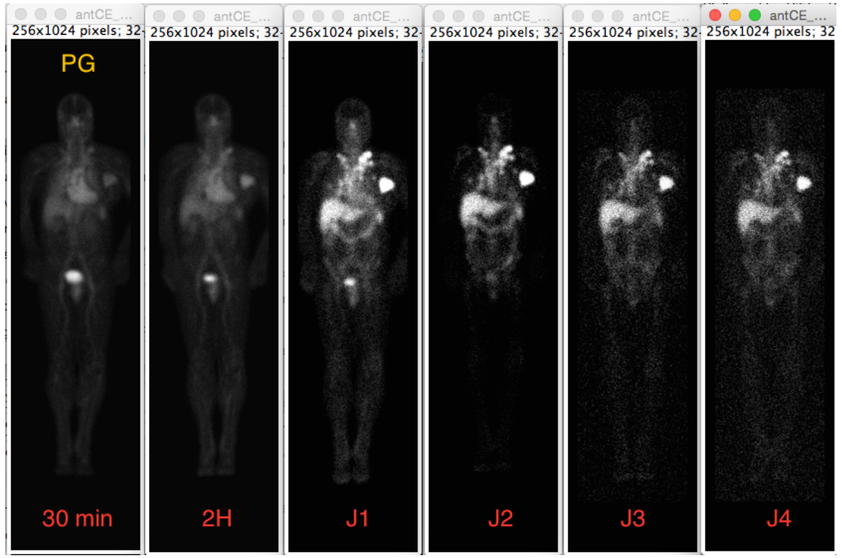


- **SPECT/CT**
- CT Low dose whole body (WB) scan
  - Attenuation map, organ volume
- **4-5 WB emission scans** : D0, D1, D2, D5, D7
  - various sweeping speed: 1-1.6 mm/sec, HEAP or MEAP, Photoelectric + 2 adjacent windows
- **4-5 SPECT/CT scans** : D0, D1, D2, D5, D7 — if feasible
  - Abdomen-pelvis
  - 128x128, 2x32 projections, HEAP or MEAP, 30-45s, Photoelectric + 2 adjacent windows

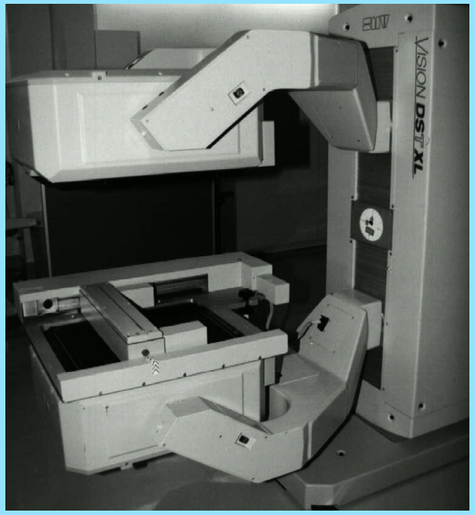
2D approach

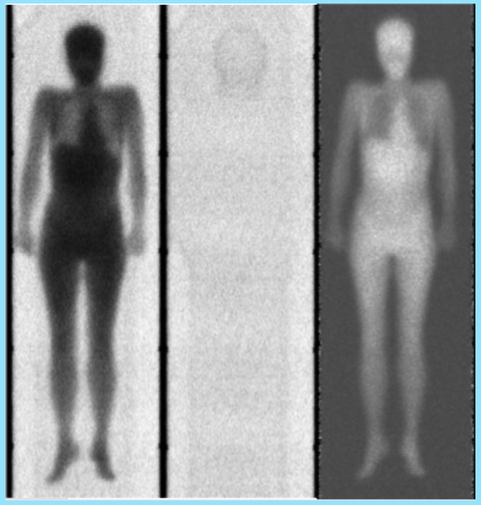
- **conjugated views :**
  - Planar images : anterior and posterior



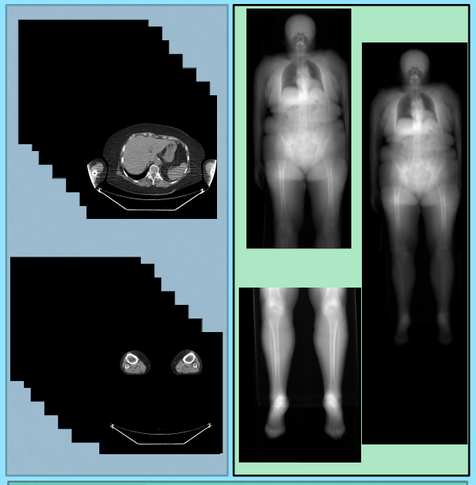


$$A = \frac{\sqrt{C_A \cdot C_B}}{\eta \cdot e^{-\int_0^L \frac{\mu(l)}{2} dl}}$$



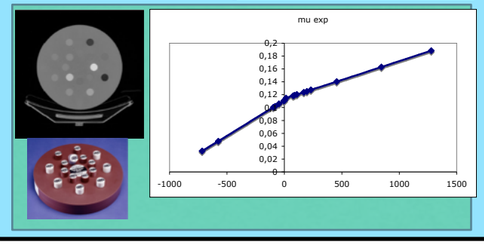


Whole body (WB) TAC

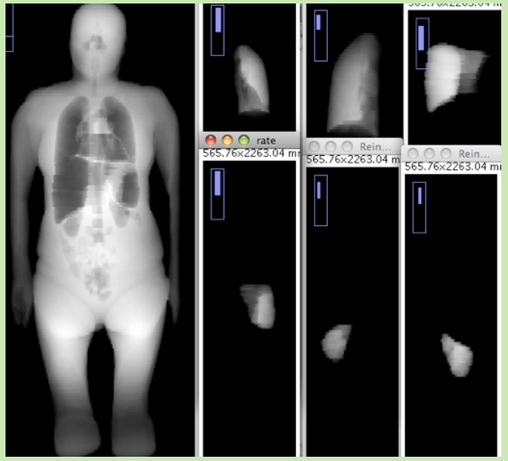


2D correction

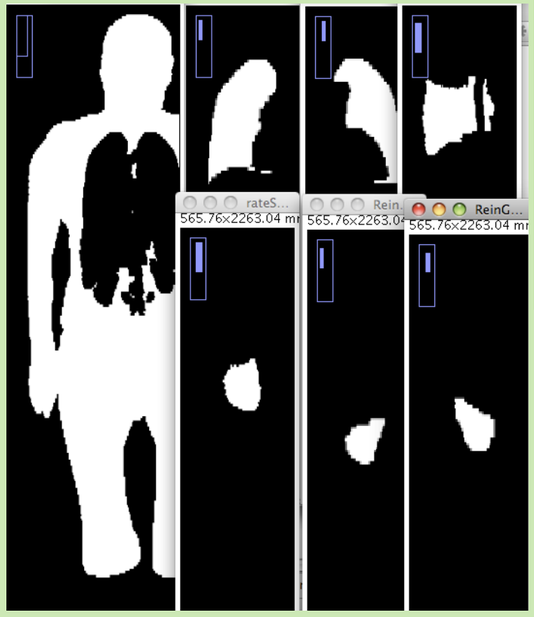
WB CT TAC



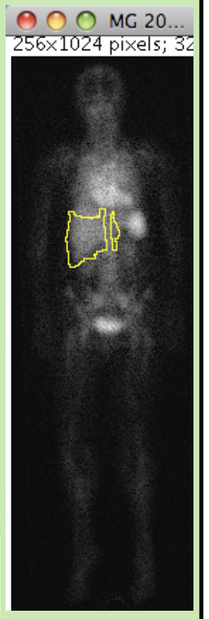
Organ overlapping



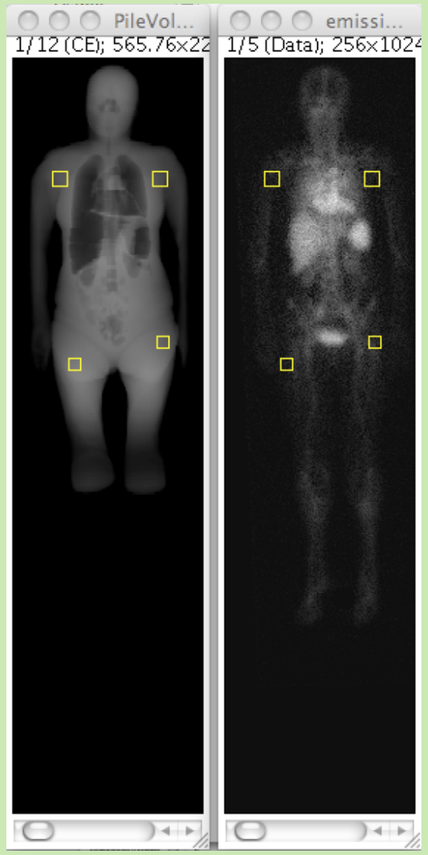
segmented projections



XOR mask



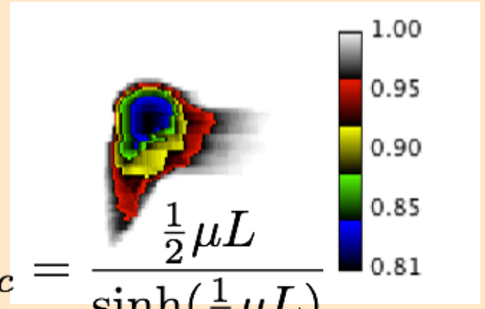
background



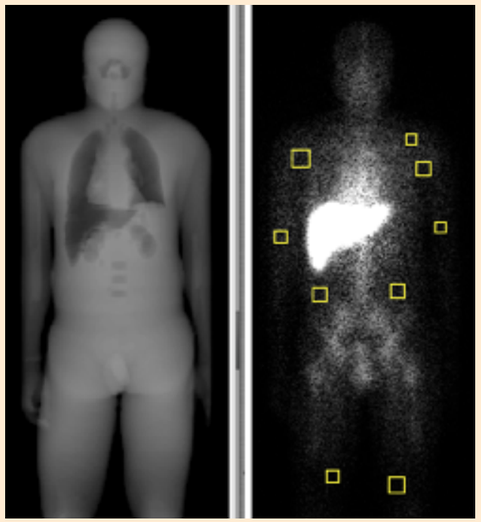
Background ROIs

2D

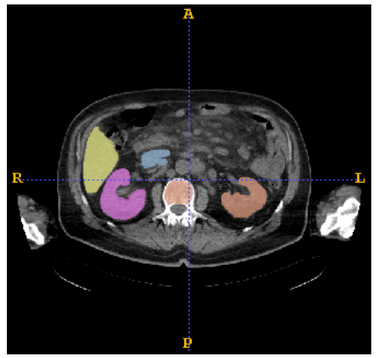
auto-attenuation

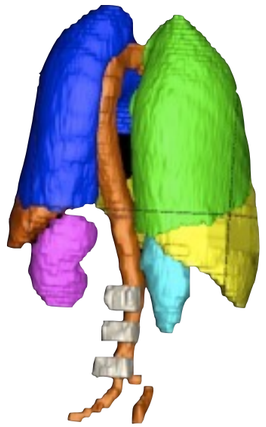


$$f_c = \frac{\frac{1}{2}\mu L}{\sinh(\frac{1}{2}\mu L)}$$



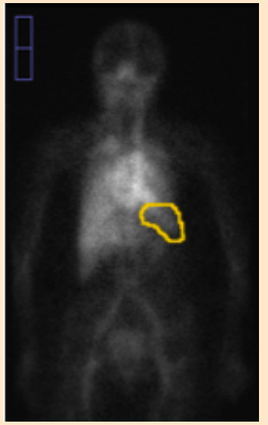
backgound (BDF)





ITK-SNAP

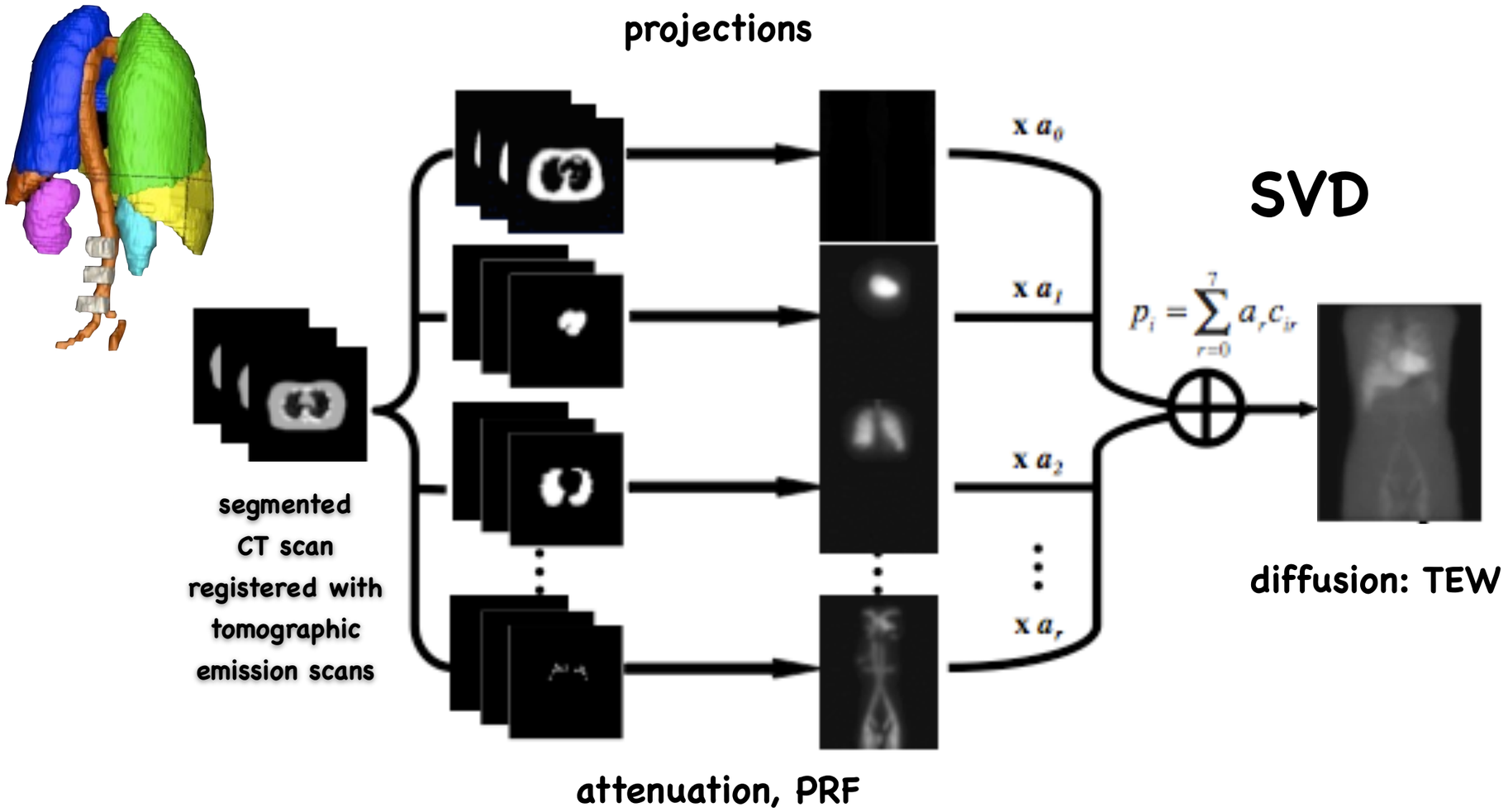
P. Yushkevich Neuroimage 2006 Jul 1;31(3):1116-28



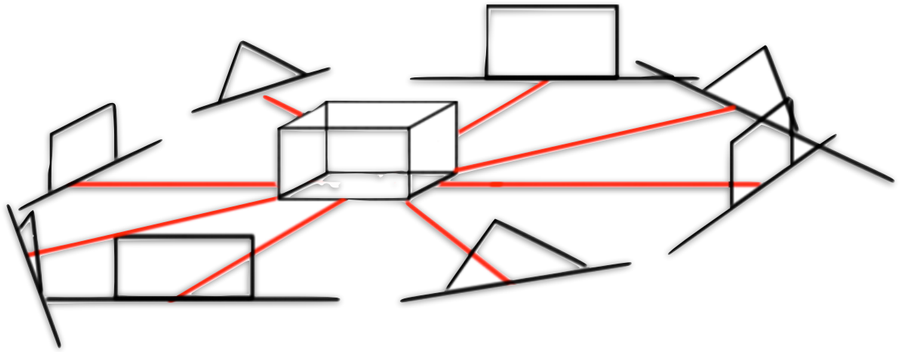
region of interest

organ overlapping

2.5D approach

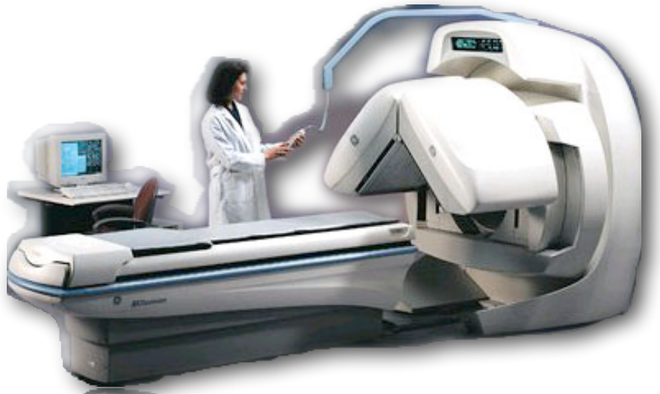


He B Phys Med Biol. 2006 Aug 21;51(16):3967-81.



Tomographic Reconstructions

- Iterative reconstruction (OSEM)
  - Corrections
    - Attenuation
    - PRF (w/wo septal penetration),
    - Compton scattering
  - # iterations



SPECT & CT

Some corrections included in vendors software

Tomographic Reconstructions

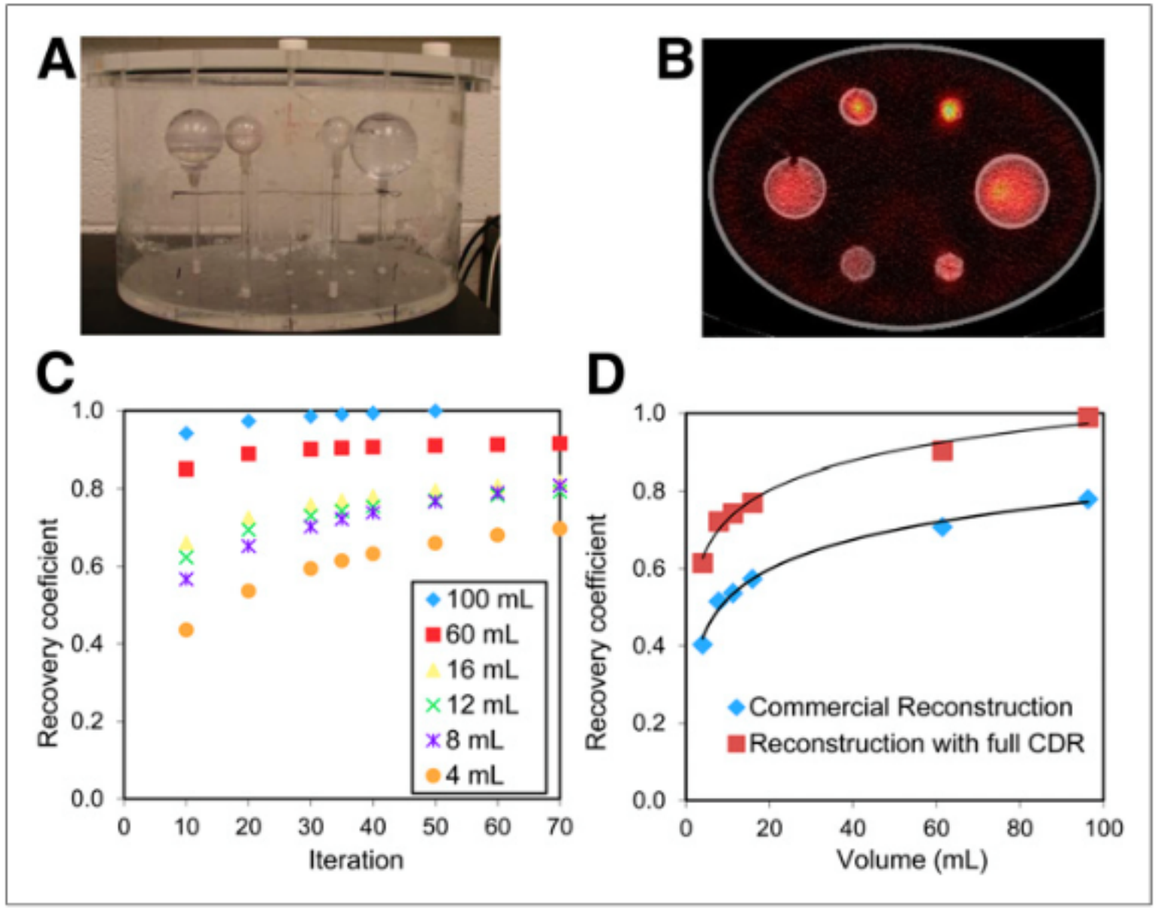
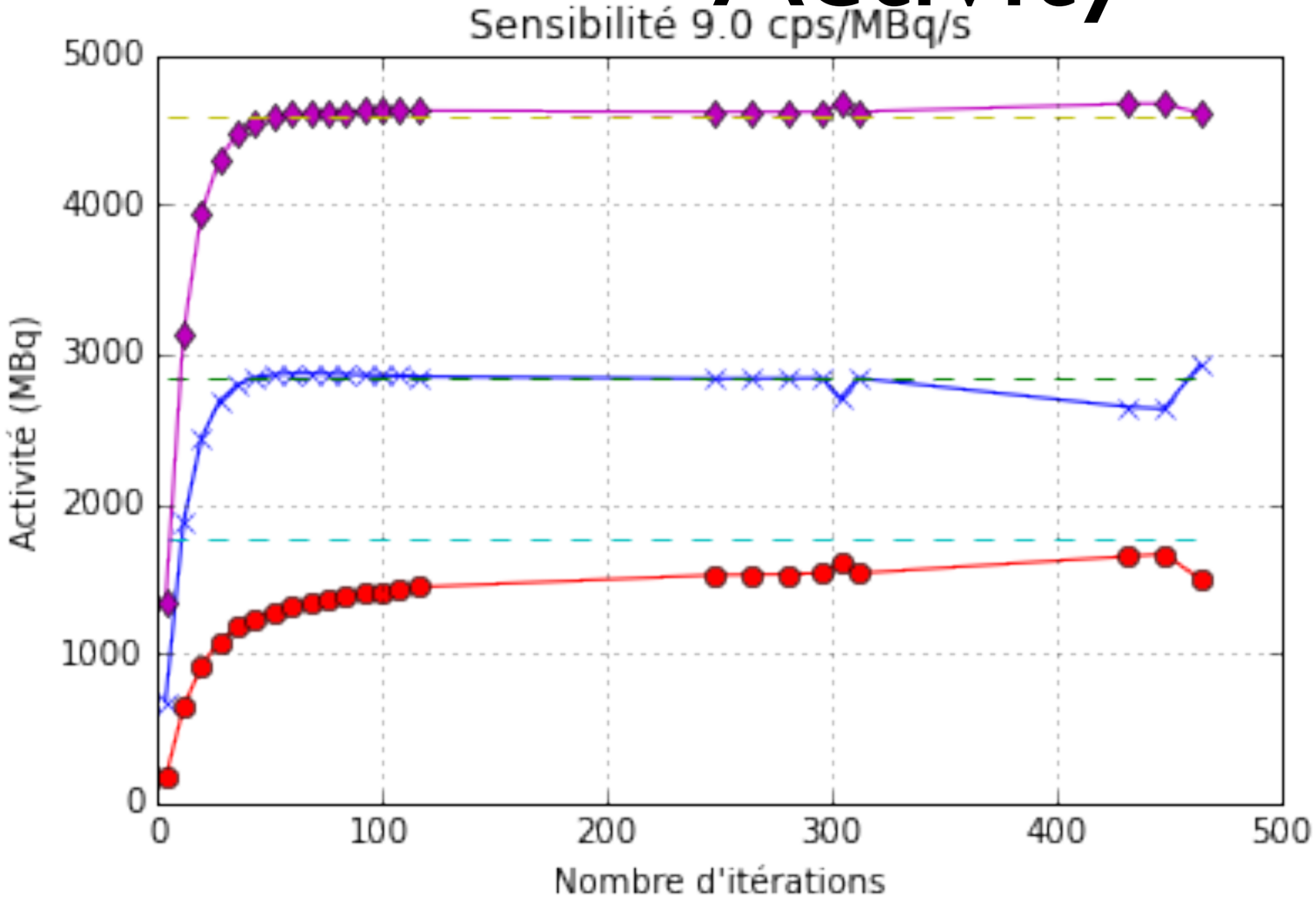
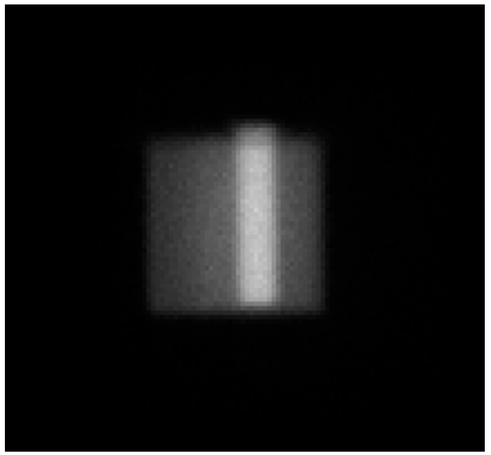


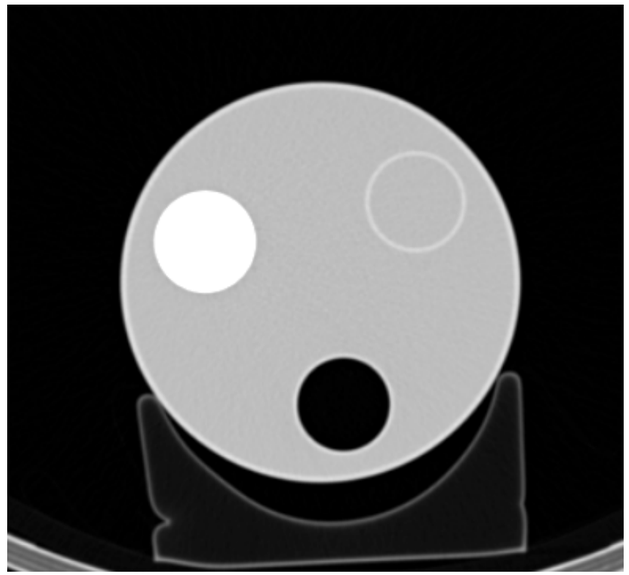
FIGURE 3. Measurement of RCs discussed in patient example 1. (A) Phantom set-up. (B) SPECT/CT image. (C) RC as function of OSEM iteration number. (D) RC as function of volume at 35 iterations. RCs that were determined with commercial OSEM reconstruction are also shown.

SPECT & CT

Reconstruction parameters vs Activity





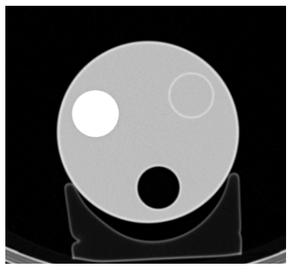


Sensitivity factor

- Known (?) activity source

- 2D
  - in air
  - point (or flat disc) ~ weak diffusion/attenuation

- 3D
  - in air if you're confident in implemented corrections & reconstruction software
  - Scattering test-object to mimic patient
    - same reconstruction parametres as clinic practice (or vis-versa)

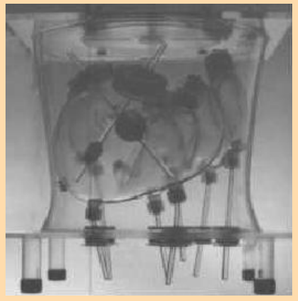


Validation: eg ^{111}In

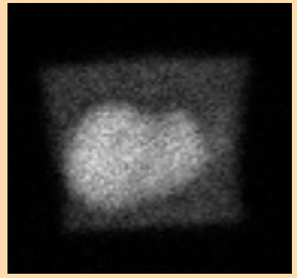
- ^{111}In (172 keV, 245 keV)
- Liqui-Fil^{TM} :
  - Tank (25,2 MBq), Liver (21 MBq), Spleen (1,5 MBq), R Kidney (0,9 MBq), L kidney (1,0 MBq)
- SPECT/CT (Millenium VG) : 156 keV(4%), 172 (14%), 205 (4%), 245 (14%)
- CT (Discovery LS) : 512^2, 120 kV, 90 mA, ep.=5mm, Δz=5mm

- Activity organ quantification: 2D, 2,5D et 3D

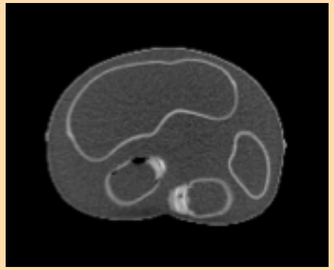
liqui-Fil^{TM}



emission images



CT scan



Validation

	Tank	Liver	Spleen	R. K.	L. K.
MBq	25.2	20.9	1.5	0.9	1.0
			MBq (Δ%)		
2D	24.1(4)	20.9(0)	1.1(24)	0.4(**51**)	1.4(-39)
2.5D	27.4(-9)	23.9(-14)	1.4(4)	0.6(31)	0.9(5)
3D	27.4(-9)	19.9(5)	1.3(13)	0.8(11)	0.9(10)

Recent
clinical applications

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UNIVERSITAIRE DE NANTES

Institut de
Cancérologie
de l'Ouest
René Gaudducheau

Lung cancer and anti-CEA pretargeting

- Lung Cancer represents is the most common cause of cancer death worldwide.
- Despite the development of targeted therapies, prognosis of advanced or relapsed forms remains poor.
- More than 50% of lung cancer shows carcinoembryonic antigen (CEA) expression.
- Our team obtained promising results obtained using anti-CEA bispecific antibody and radio-labeled hapten for **radioimmunotherapy** (RIT) in metastatic medullary thyroid cancer patients.

Design

Three cohorts of 3 patients were studied

S1: Pre-therapy imaging study					S2: Therapy study		
	TF2 dose	delay	111In-IMP	1 / 2 WEEKS	TF2 dose	Interval	177Lu-IMP
Cohort 1	7 mg/m2	48h	185 MBq		37.5 mg/m2	48h	1.1 GBq/m2
Cohort 2	14 mg/ m2	48h	185 MBq		75 mg/m2	48h	1.1 GBq/m2
Cohort 3	14 mg/ m2	24h	185 MBq		75 mg/m2	24h	1.1 GBq/m2

Five whole body scintigraphy (WBS) and four 2-beds SPECT/CT acquisitions were performed during S1 and S2: at (1), 4, 24, 48 and 96 hours post injection.

Tumours and organs absorbed doses were compared at S1 and S2 for each schedule using Kruskal-Wallis (KW) and paired Wilcoxon statistical tests

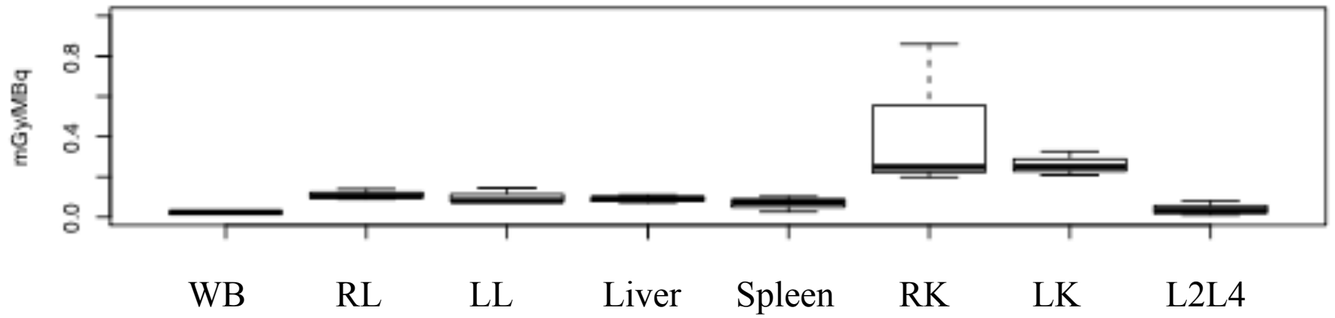
For each patient, Spearman statistical test were conducted to evaluate whether S1 absorbed doses were able to predict absorbed doses during S2.

Dosimetric results S1 ^{111}In: Organs

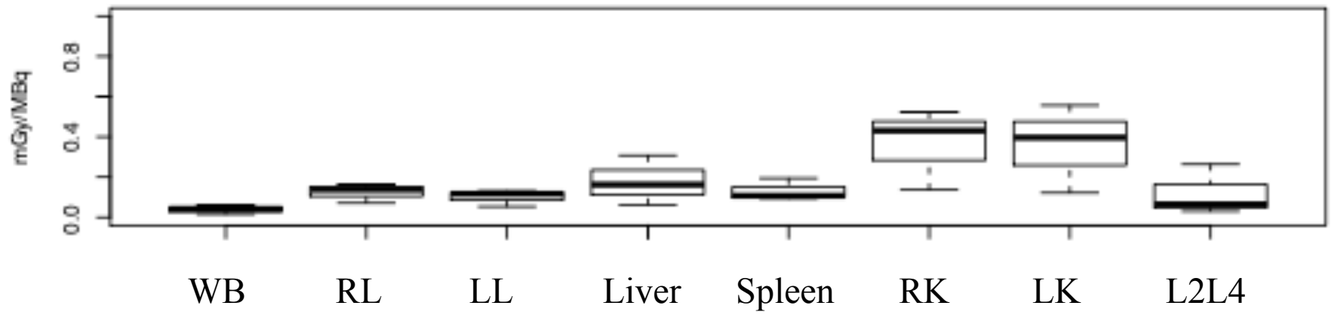
Inter-group:

No significant differences
p > 0.15 (KW-test)

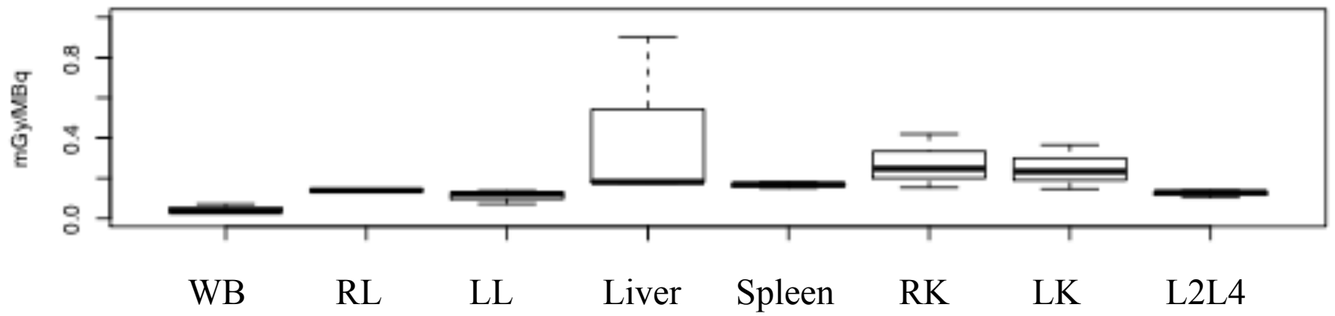
Cohort 1



Cohort 2



Cohort 3

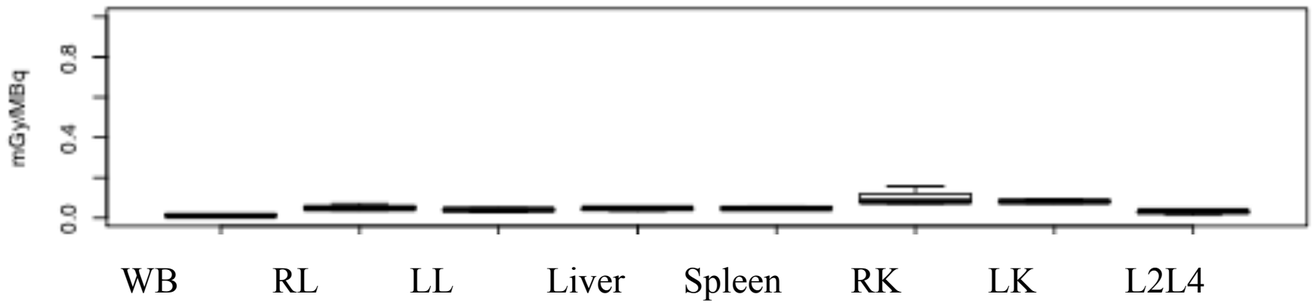


Dosimetric results S2 ^{177}Lu: Organs

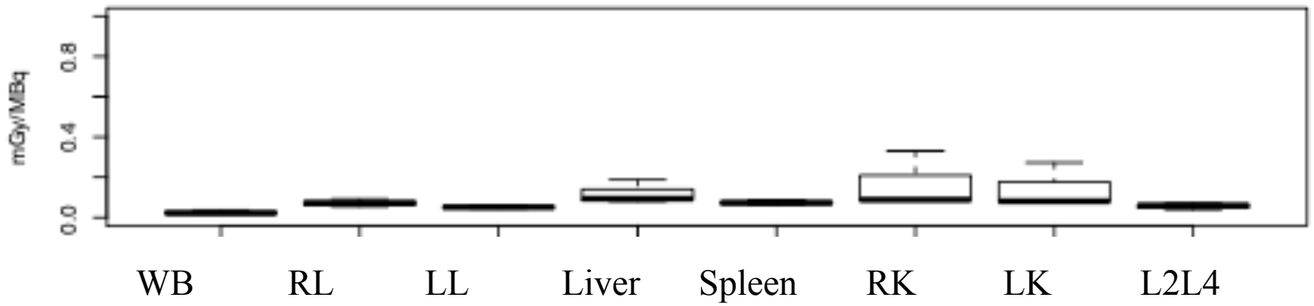
Inter-group:

No significant
Differences
P > 0.61 (KW-test)

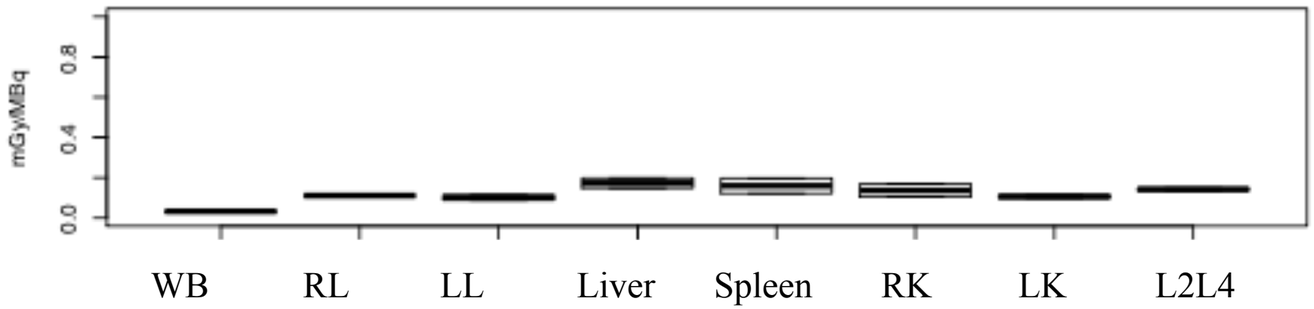
Cohort 1



Cohort 2

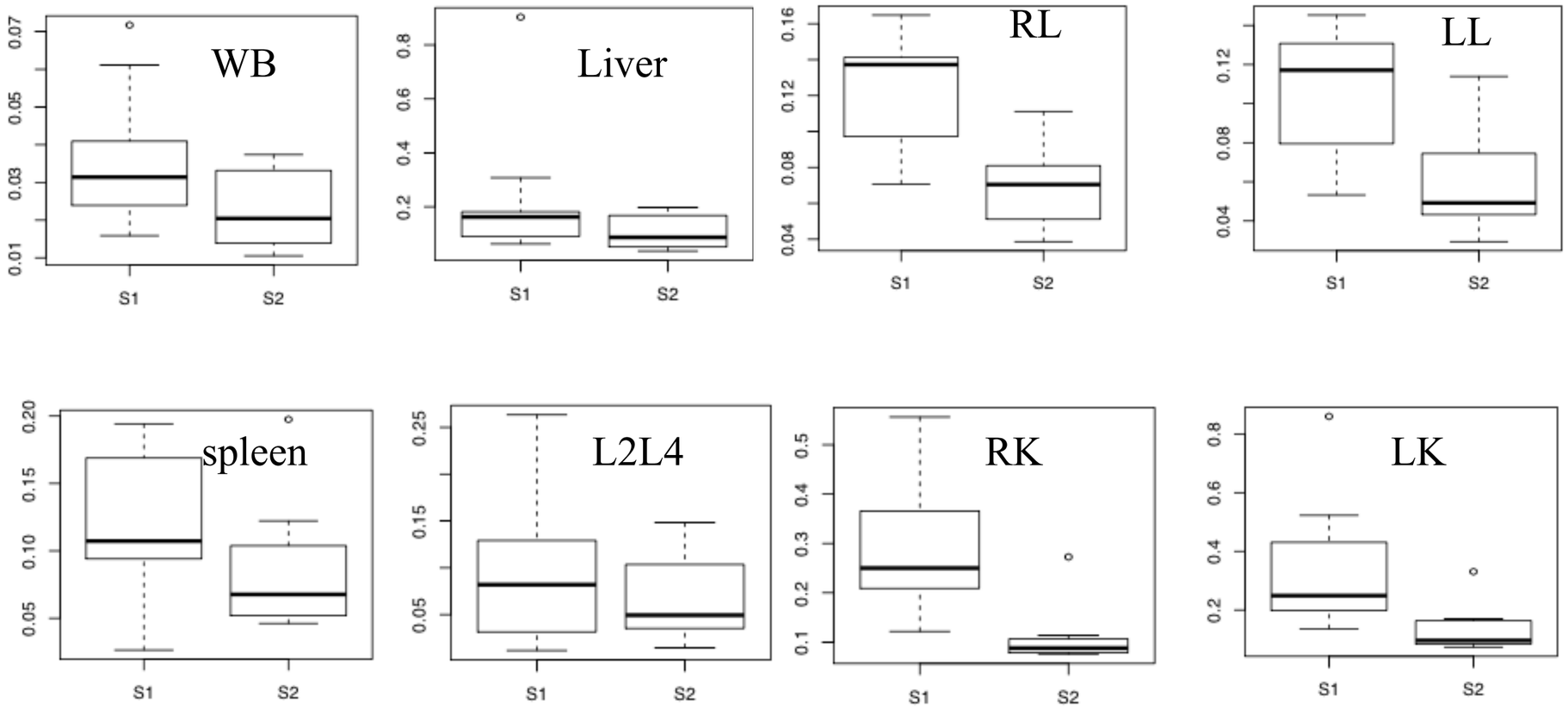


Cohort 3



Dosimetric results : S1 & S2 correlation

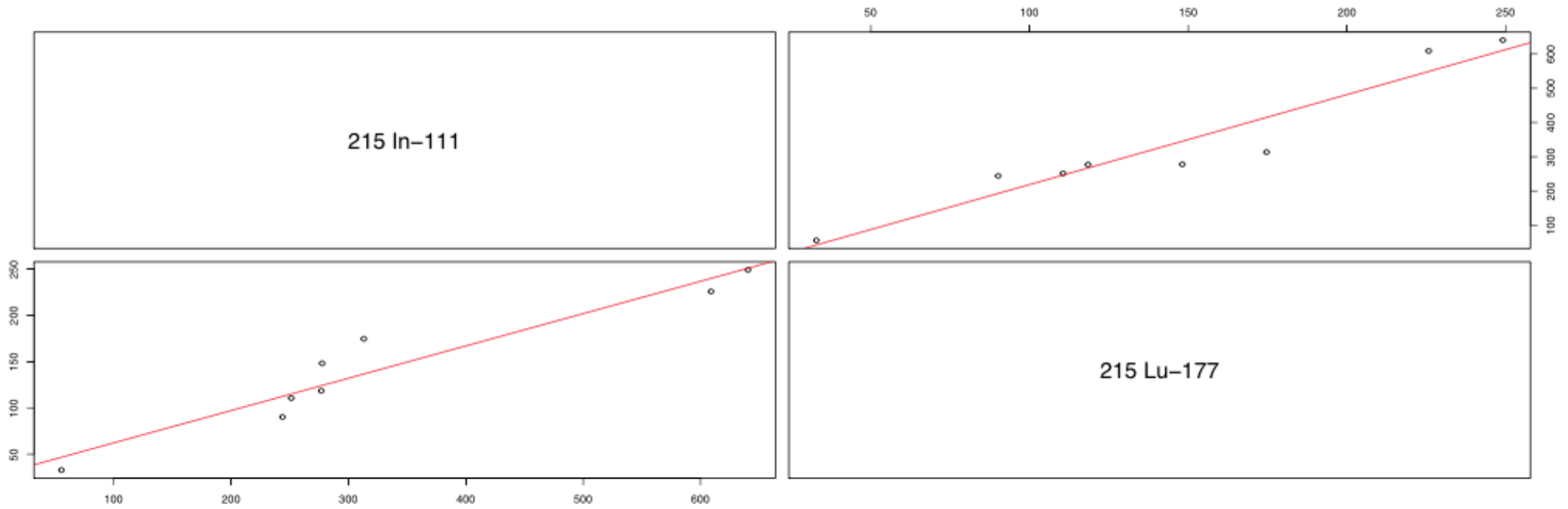
S1 & S2 organ absorbed doses [mGy/MBq]: all patients together



Using wilcoxon paired test, S1 & S2 organ absorbed doses were not significantly different except for kidneys

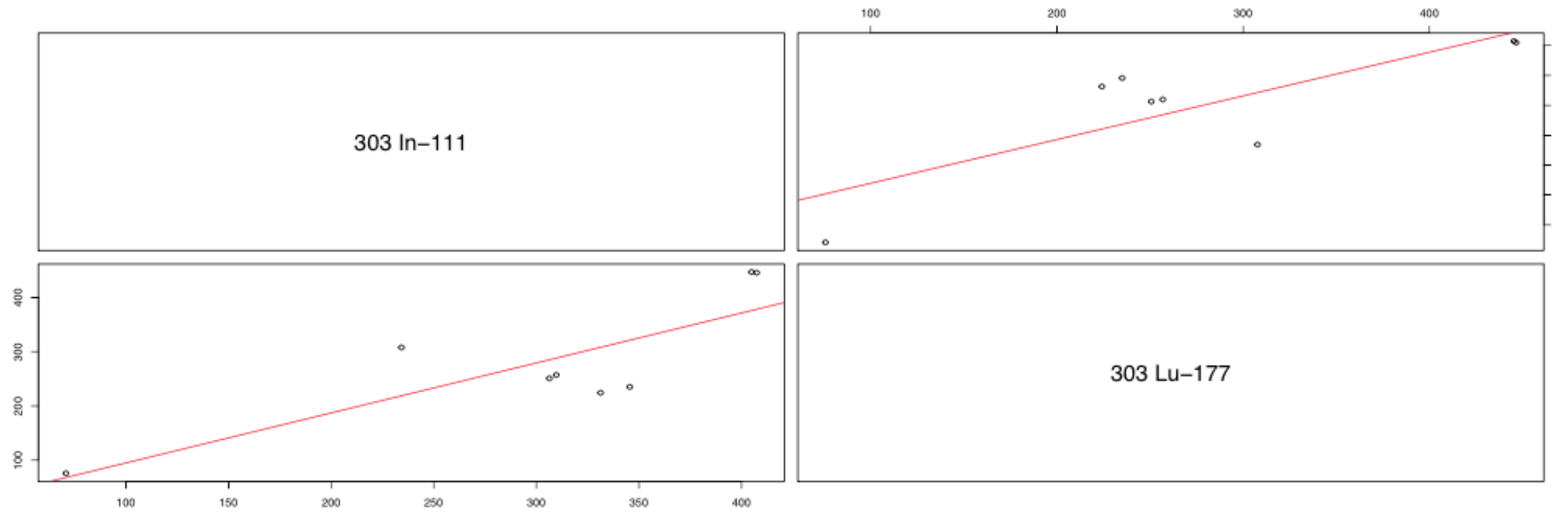
Dosimetric results : S1 & S2 correlation

S1 & S2 organ absorbed doses: intra-patient correlation



One of the best correlation
Spearman
rho: 0.9 $p < 10^{-3}$

The worst correlation
Spearman
rho : 0.7 $p < 0.02$



Thank you

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