Measurements of ^{223}Ra

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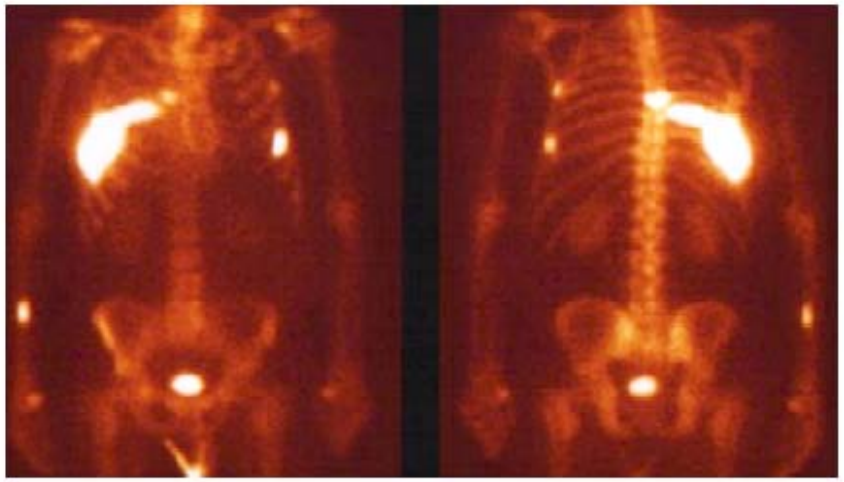
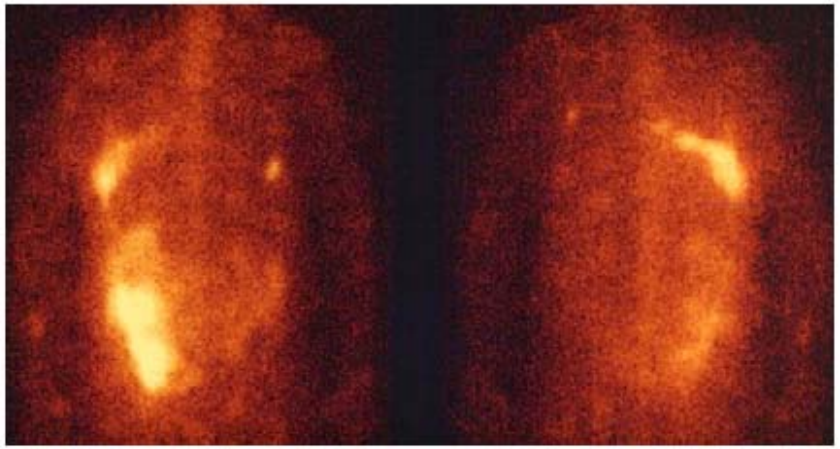
Motivation

- Nuclear Medicine Standardization
- ^{223}Ra used in the treatment of skeletal metastases and for therapy of associated bone pain
- Naturally bone-seeking
- In clinical trials for treatment of skeletal metastases from prostate cancer and breast cancer
- Food and Drug Administration required a NIST standard before initiation of clinical trials in the US



^{99m}Tc-MDP



^{223}Ra

Anterior Posterior

Figure 4. *Scintigraphic images demonstrating accumulation of ^{223}Ra in skeletal lesions in accordance with ^{99m}Tc-MDP uptake . Radium image taken 24 hrs post injection, hence radium excreted and in transit in the large bowel is evident in the lower left image. (Image quality is dependent on dose administered: 750 MBq ^{99m}Tc-MDP vs. 12 MBq ^{223}Ra)*

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Experiments

- E1 – Preliminary measurements
- E2 – Adsorption studies
- E3 – Check for other possible losses, preliminary 2πα proportional counting (PC)
- E4 – LS counting including PTB composition, 2πα PC
- E5 – Final LS counting, Final 2πα PC
- E6 – Dose calibrator settings for vial

E3 - 2πα PC

- Try 2πα gas-flow proportional counting as a second confirmatory measurement, observes only alphas
- 1.5 cm stainless steel disks, 1-2 drops active
- Learn we should cover the sources with collodion film

- Lynne cleans the detector

results agree with LS measurements

Experiment E4

<u>Stock solution received from Algeta, ASA</u>
E4: 20 MBq in 10 mL
Solution consisted of 1.5 mL ^{223}Ra solution in carrier*, diluted to 10 mL with 8.5 mL of 0.9 mol·L^{-1} NaCl solution containing 28 mmol·L^{-1} $Na_3C_6H_5O_7$.

Counting in NIST "4π"γ ionization chamber (+ activity calibrators)

Transfer nominally 5 mL to each ampoule

E4A1 **E4A2**

*Dilute A1 (DF = 3.944) with carrier**

*Bring remainder volume to 5 mL with carrier**

Dilute A2 (DF = 3.982) with 6 mol·L^{-1} HNO_3

E4A1D1 **E4A1R1** **E4A2D1** **E4A2R1**

Counting in NIST "4π"γ ionization chamber, activity calibrators

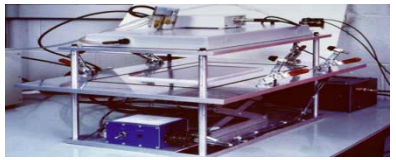
*Dilute A1D1 (DF = 50.263) with carrier**

E4A1D2

Liquid scintillation counting (LSC) with ^{3}H-standard efficiency tracing

Measurement on HPGe systems

Counting in NIST 2πα proportional counter



*Carrier consisted of nominally 5 mmol·L^{-1} $Na_3C_6H_5O_7$, 2 mmol·L^{-1} Sr^{2+}, and 0.5 mmol·L^{-1} Ca^{2+} .

Experiment E5

Counting in NIST “4π”γ ionization chamber

<u>Stock solution received from Algeta, ASA</u>
E5: 10 MBq in 5 mL
Solution consisted of 0.75 mL ^{223}Ra solution in carrier*, diluted to 10 mL with 4.25 mL of 0.9 mol·L^{-1} NaCl solution containing 28 mmol·L^{-1} $Na_3C_6H_5O_7$.

*Transfer contents and bring to 5 mL with carrier**

E5A1

*Dilute A1 (DF = 4.864) with carrier**

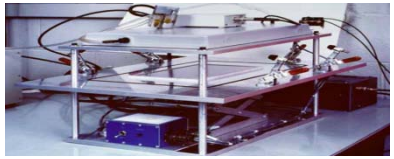
E5A1D1

Counting in NIST “4π”γ ionization chamber, activity calibrators

*Dilute A1D1 (DF = 46.042) with carrier**

E4A1D2

Counting in NIST 2πα proportional counter



Liquid scintillation counting (LSC) with ^{3}H-standard efficiency tracing

Measurement on HPGe systems

*Carrier consisted of nominally 5 mmol·L^{-1} $Na_3C_6H_5O_7$, 2 mmol·L^{-1} Sr^{2+}, and 0.5 mmol·L^{-1} Ca^{2+} .

E4 & E5– 2πα PC

- Repeat 2πα PC
- Source preparation
  - 1.5 cm stainless steel disks
  - 1-2 drops active material
  - collodion film covers to 2 to 8 μg·cm^{-2}
- Weigh a group of covers to determine average thickness
- Perform extrapolation to no covering
  - Using determined thickness
  - Using number of covers
  - Agreement between extrapolations

E6 – Dial Settings

- 5 ml NIST ampoule, 5 ml solution
- 20 ml FIOLAX (MGlas AG, Münnerstadt, Germany) dose vial
  - 3 x 0.5 ml solution
  - 3 x 2 ml solution
  - 3 x 6 ml solution
- Radionuclide Calibrators
  - Capintec CRC-12, 15R, 35R
  - Biodex Atomlab 100
  - NPL 671

E6 – Preliminary Results

	Capintec CRC-12		Capintec CRC-15R		Capintec CRC-35R		Atomlab 100		NPL Chamber		
	Dial Setting	**U_c**	**Dial Setting**	**U_c**	**Dial Setting**	**U_c**	**Dial Setting**	**U_c**	**Calibration Factor**		**U_c**
5 mL ampoule	264	4	265	4	266	4	16.9	0.2	3.49899	pA/MBq	0.04506
20 mL Dose vial	261	4	263	4	266	4	16.9	0.2	3.50187	pA/MBq	0.04504