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135La for Auger-based therapy: preparation, imaging and emissions

Fonslet, Jesper; Tran, T. A.; Lee, B. Q.; Siikanen, J.; Larsson, E.; Kibédi, T.; Stuchbery, A. E.; Elema, Dennis Ringkjøbing; Severin, Gregory

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TITLE: ^{135}La for Auger-based therapy: preparation, imaging and emissions

AUTHORS (FIRST NAME INITIAL LAST NAME): J. Fonslet¹, T. A. Tran², B. Q. Lee³, J. Siikanen^{4, 5}, E. Larsson⁴, T. Kibédi³, A. E. Stuchbery³, D. R. Elema¹, G. W. Severin¹

INSTITUTIONS (ALL):

1. Hevesy Laboratory, Technical University of Denmark, Roskilde, Denmark.
2. Lund University Bioimaging Center, Lund University, Lund, Sweden.
3. Department of Nuclear Physics, Australian National University, Canberra, ACT, Australia.
4. Lund University Hospital, Lund University, Lund, Sweden.
5. Department of Nuclear Medicine, Karolinska University Hospital, Stockholm, Sweden.

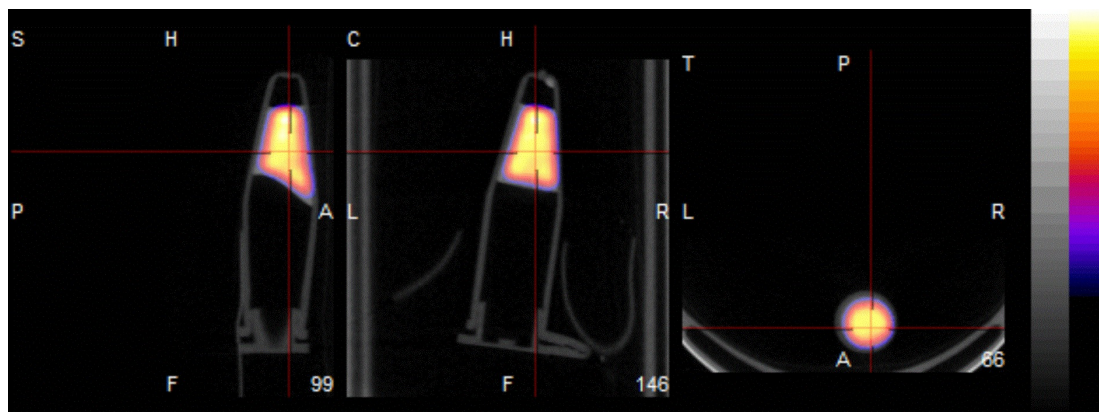
Objectives: Our aim was to determine the suitability of ^{135}La for Auger-based internal radiotherapy. We set out to produce and purify ^{135}La (EC, 19.5 h) from $^{\text{nat}}\text{Ba}$, radiolabel DTPA-mAbs with high specific activity, test X-ray based SPECT/CT imaging capabilities, and calculate detailed X-ray and Auger emission spectra.

Methods: ^{135}La was produced by 16 MeV proton irradiation of $^{\text{nat}}\text{Ba}$ metal and purified by extraction from NH_4OAc (aq. 30 mM, pH 4.7) onto hydroxamate resin (see $^{44\text{g}}\text{Sc}$ from $^{\text{nat}}\text{Ca}$ [1]). A DTPA-functionalized-IgG₁ mAb, h11B6 [2], was labeled in NaOAc, pH 5.5, RT. X-ray emissions were used for SPECT/CT (BioScan) phantom imaging. X-ray and Auger spectra were determined by Monte-Carlo simulation of the atomic relaxation process[3].

Results: The saturation production yield of ^{135}La was 431 MBq/ μA on the thick $^{\text{nat}}\text{Ba}$ target. At 13 h post-bombardment the radionuclidic purity was over 95%. The main impurities were the short-lived ^{136}La and ^{134}La (10 min, 6 min), and ^{133}La which is dosimetrically similar to ^{135}La but with a potentially useful 7% β^+ branch for PET imaging. The chemical separation was 96% efficient for La recovery, reducing the Ba content by a factor of $\sim 10^4$. DTPA-IgG₁ labeling reactivity was >70 GBq/ μmol at 20 h post EOB. A phantom SPECT/CT image, **figure 1**, illustrates the promise of preclinical imaging. The Auger cascade from the isolated neutral atom was calculated to emit $7.7 e^-$ per decay, ranging in energy from 1 eV to 36 keV ($E_{\text{ave}} = 0.8$ keV).

Conclusions: ^{135}La production from $^{\text{nat}}\text{Ba}$ and its ultimate chemical and radionuclidic purity are appropriate to begin preclinical studies. These studies will be augmented by SPECT/CT. Dosimetry on both the cellular and organ level are now calculable using emissions from the entire Auger cascade.

References: [1] Severin GW, et al. (2012) AIP Conf Proc 125:125–128. [2] Tran T, et al Soc Nucl Med Annu Meet Abstr 55:1024. [3] Lee BQ, et al (2012) Comput Math Methods Med 2012:651475.



Phantom SPECT/CT (BioScan) image of 1-1.5 MBq ^{135}La in an Eppendorf tube.