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

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

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**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 nat\(^{136}\)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 nat\(^{136}\)Ba metal and purified by extraction from NH\(_4\)OAc (aq. 30 mM, pH 4.7) onto hydroxamate resin (see \(^{44}\)Sc from nat\(^{45}\)Ca\(^1\)). A DTPA-functionalized-IgG\(_1\) 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 nat\(^{136}\)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% \(\beta^+\) branch for PET imaging. The chemical separation was 96% efficient for La recovery, reducing the Ba content by a factor of \(\sim10^4\).

**Conclusions:** \(^{135}\)La production from nat\(^{136}\)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.

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