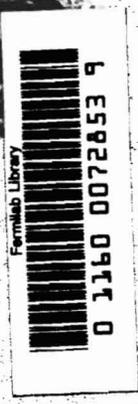


I TEP-46-94



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I TEP-46-94

MAR 2 1994

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VIII. <sup>86</sup>Yttrium Y. DEVELOPMENT OF SEPARATION  
TECHNIQUE

Moscow, I TEP

MOSCOW 1994

UDC 621.039.325

Н-16

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Y. Tolmachev, A. Bruskin, H. Lundqvist - M., 1994 - 8p.

Ref. - 4.

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## INTRODUCTION.

Positron emission tomography (PET) is usually associated with the short-lived radionuclides  $^{11}\text{C}$ ,  $^{13}\text{N}$ ,  $^{15}\text{O}$  and  $^{18}\text{F}$  which have half-lives between 2-110 minutes. In order to widen the application of PET we are investigating the application of other positron emitters which have longer half-lives or other bio-chemical properties.

Yttrium isotope  $^{90}\text{Y}$  is widely used in radiotherapy [1,2]. Since it does not emit any useful gamma the distribution and tumor uptake in vivo is difficult to estimate by external measurements. The idea is to mix therapeutic radioactivity with a positron emitting nuclide,  $^{86}\text{Y}$  ( $T_{1/2} = 14.7$  hours,  $\beta^+$  abundance 34%,  $E_{\beta^+} = 1.2$  MeV). The uptake and distribution in vivo can then be followed quantitatively by PET for about 48 hours yielding data to be used in a better in vivo dosimetry of the therapeutic agents.  $^{86}\text{Y}$  is also a candidate for labeling macro-molecules with chelating technique.  $^{86}\text{Y}$  can be produced by compact cyclotron, available at PET-centres, using  $^{86}\text{Sr}$  (p,n) $^{86}\text{Y}$  nuclear reaction. If enriched target material is used the thick target yield of  $^{86}\text{Y}$  is 426 MBq/MAh (11.5

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mCi/mAh) (proton energy range 15-11 MeV)[3]. A production method has been published [4] which includes several steps of co-precipitation and ion-exchange separation. The aim of this work is to develop a more simple and economically separation method to handle the expensive enriched target material.

#### MATERIALS AND METHODS.

A solid state detector (ultra-pure germanium) coupled to multi channel analyzer was used for measurement of radioactivity. A development of separation method was carried out using strontium with natural isotopic composition. The strontium carbonate target with the thickness  $0,6 \text{ g/cm}^2$  was irradiated at Gustaf Werner Cyclotron (The Svedberg Laboratory, Uppsala University, Sweden) with 45 MeV protons. Integrated beam current was 80 mAh. To monitor the different steps in the separations the long lived isotopes of yttrium and strontium,  $^{87}\text{Y}$  and  $^{85}\text{Sr}$ , were used. These isotopes were produced via  $\text{Sr}(p, xn)$  and  $^{86}\text{Sr}(p, pn)$  respectively. A strong sorption (up to 70%) of yttrium activity on glass walls in neutral or alkaline media was observed. That's why only Teflon or polyethene lab dishes were used in all the handling of yttrium containing solutions.

Solvent extraction and ion-exchange separation were tested. During elaboration of methods small samples (few mg) was used. Optimal conditions for separations were found as follows.

#### Solvent extraction.

Small sample was dissolved in 2 ml 20% nitric acid. Solution was evaporated to dryness and rest was redissolved in 5 ml of Sigma 7-9 buffer solution (pH 8.5). Yttrium was twice extracted with 5 ml 50% solution of 8-hydroxyquinoline in chloroform. The extracts were combined, washed twice 5 ml of buffer solution and radioyttrium was reextracted with 5 ml of 6 M HCl. Dissolved in acidic phase 8-hydroxyquinoline was removed via shaking with activated charcoal powder (until disappearance of yellow color of the solution) with consequent filtration. Acidic solution was evaporate to dryness and the rest was redissolved in appropriate solution for further handling.

The total radioyttrium yield was in order of 75%. No strontium was observed in product.

#### Ion-exchange.

Two pre-filled ion-exchange columns containing 2 ml of AC 1x8 resin, 100-200 mesh (Bio-Rad) were washed with 10 ml of 1M NaOH followed by washing with distilled water until neutral reaction of the eluate.

Small aliquot of irradiated strontium carbonate was dissolved in several ml of 6 M HCl. The solution was evaporated to dryness (using IR-lamp) and the residue was redissolved in 6 ml of distilled water. This solution was put onto the ion-exchange column which was then washed with 40 ml of

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deionized water. At these conditions more than 99% of the yttrium activity was trapped while more than 99.5% of the strontium passed through the column. More precise calculations were complicated due to the insufficient resolution of the annihilation peak of  $^{87}\text{Y}$  and 514 keV gamma-line of  $^{85}\text{Sr}$ .

4 ml of 1 M HCl was then used to elution the yttrium. The eluate was evaporated to dryness (negligible rest of mass was observed) and redissolved in deionised water in order to repeat ion-exchange procedure for final purification. After the second ion-exchange process the eluate was evaporated to dryness and redissolved in appropriate solution for further experiments.

Total separation time was less than 3 hours. The total yield of radioyttrium in final solution was more than 85%.

#### RESULTS AND DISCUSSION.

Both liquid extraction and ion-exchange provide sufficient yield of separation and are acceptable for separation of radioyttrium from irradiated strontium target. Ion-exchange method was preferred because of its simplicity and lower radiation exposure on personal. This separation technique was applied twice to amount of target material (several tens of milligrams) which correspond to the target mass used for enriched targets. The yield was not less than 85%. Produced radioyttrium was used for experiments in labeling of organic compounds.

