15th International Symposium on Radiopharmaceutical Chemistry
Sydney 10-14 August 2003

ADIABATIC RESONANCE CROSSING FOR ACCELERATOR PRODUCTION OF NEUTRON-RICH ACTIVATED NANOSPHERES FOR BRACHYTHERAPY

S. Buono[1], G. Ber[1], P. Dasse[1], H. Fessi[4], Y. Kadi[2], L. Maciocco[1], H. Mehier[3], L. Zanini[2].

[1]Advanced Accelerator Applications, 190 hameau du grand champ, 01710 Thoiry, France - info@adacap.com.
[2]CERN, European Organisation for Nuclear Research, CH-1211 Genève 23, Switzerland – yacine.kadi@cern.ch.
[3]CERMA, Domaine de Chosal, 74160 Archamps, France - hm@cerma-med.com.
[4]LAGEP, Laboratoire d'Automatique et de Génie des Procédés, UCB Lyon 1 – ESCPE-Lyon – Bat. 308 G 43 blvd. du 11 Novembre 1918, 69622 Villeurbanne, France - fessi@univ-lyon1.fr.

Keywords: brachytherapy, nanoparticles, microtubes, Rhenium, Lutetium.

Adiabatic Resonance Crossing (ARC) has been proposed by Nobel laureate Carlo Rubbia as a new method to enhance neutron capture for the activation of radioisotopes for medical and industrial applications. The ARC method, which was developed at the European Organization for Nuclear Research (CERN), allows using the neutrons produced on an accelerator target as an efficient radioisotope-production alternative to the use of nuclear reactors.

The ARC method, when coupled with small sized cyclotrons currently used for PET isotopes production (16-19 MeV, 100 μA), can be efficiently used to produce therapeutic doses of radiopharmaceuticals for brachytherapy. We have chosen to activate Rhenium-186, Rhenium-188, Lutetium-177 and Holmium-166. Activation rates can be efficiently calculated through advanced numerical calculations.

Activations are performed on ferrite nanospheres (500 nm diameter) that can contain virtually any radioactive material. The isotope to activate inside the nanosphere can be chosen according to the kind and the size of tumour to treat.

Ferrite nanospheres mixed into a sterile liquid solution, are efficiently injected with the help of implanted perforated microtubes using a new and fast technique. Microtubes are 20 to 50 cm long, 200 μm external diameter (100 μm internal) and are perforated with 50 μm holes at one extremity, where the treatment has to be done. The sterile solution is activated into the ARC target for a few hours before injection, already in its final galenic form, into sealed Aluminium capsules.

Particles can spread uniformly up to several millimetres from the microtube, thanks to their reduced size, and the high-pressure injection technique. Considering the additional range of the decay particle emitted by the active radioisotope, larger areas can be efficiently and uniformly treated.

Nanospheres diffuse efficiently into the irradiated tissue thanks to their size, but, without a conglomerating effect, they tend to subsequently migrate into the body. Due to their magnetic properties, ferrite nanoparticles should form micro conglomerates that remain into the irradiated tissues and do not enter into the main blood circulation, reaching healthy organs. Injection can be repeated several times for an increased therapeutic efficiency.

The advantage of this technique is its reduced cost, its extreme rapidity (a few seconds) and the possibility of efficiently treating large volumes of tissue. Microtubes can be implanted during surgery or with the help of echography, scintigraphy or MRI (Magnetic Resonance. Imaging) in the non-operable metastasis and they can stay for long time in the organism.

The viability of this technique has now to be proved through pre-clinical studies. We believe this technique can be extremely efficient for the treatment of a variety of non-operable cancers.