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Radiopharmacy/radiochemistry: therapy: alpha - beta emitters

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Room: Poster Exhibition Hall

P467 Medical radioisotopes activation in the JRC cyclotron-driven INBARCA neutron activator

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A compact, accelerator driven, neutron activator based on a modified version of the Adiabatic Resonance Crossing (ARC) concept has been developed, with the aim of efficiently utilising ion-beam generated neutrons for the production of radioactive nanoparticles for brachytherapy. The facility has been tested under various experimental configurations, and the activation yields of different materials, measured with γ -spectrometry techniques, have been compared with those of our Monte Carlo (MCNPX, FLUKA) simulations. In particular two version of the activator were tested: a lead-graphite and an all-graphite configuration. Experimental results, in agreement with Monte Carlo calculations, showed that higher activation rates (factor 1.7) are obtained for the isotopes of interest (^{166}Ho ($T_{1/2}=26.8\text{h}$), ^{186}Re ($T_{1/2}=3.7\text{d}$) and ^{188}Re ($T_{1/2}=0.71\text{d}$)) as a result of the improved neutron moderation/confinement effects of the all-graphite configuration. Experiments showed that a ^{166}Ho saturation yield of $150\text{ MBq}/\mu\text{A}/\text{g}$ can be obtained on $125\ \mu\text{m}$ Ho metal foils (99.9% Ho content, density $8.8\ \text{g}/\text{cm}^3$) at $36\ \text{MeV}$ in the all-graphite configuration. When Ho-oxide $300\ \text{nm}$ nanoparticles are irradiated (87.3% Ho content, variable density depending on nanoparticles conglomeration) a saturation yield of $220\text{ MBq}/\mu\text{A}/\text{g}$ can be achieved. An extrapolation from 36 to $40\ \text{MeV}$ (the maximum energy of the JRC cyclotron) of the experimental results allows estimating a saturation yield of about $350\text{ MBq}/\mu\text{A}/\text{g}$, which can be considered as the present maximum $300\ \text{nm}$ Ho-nanoparticles activation potentiality of the JRC INBARCA activator. Animal tests carried out in the framework of the INBARCA project showed that therapeutic effects on MAT3B tumours implanted in rats can be obtained with injected activities of the order of $50\ \text{MBq}$, corresponding to the injection of $20\ \text{mg}$ of nanoparticles at $2.5\ \text{GBq}/\text{g}$. Such specific activity can be obtained 24h after an irradiation of $12\ \text{h}$ with the INBARCA activator at $40\ \text{MeV}$ and $50\ \mu\text{A}$. Much higher therapeutic doses (estimated at a factor 70 by Monte Carlo codes) can be clearly obtained with

higher energies (70 MeV) and currents ($\sim 350 \mu\text{A}$) currently available in commercial cyclotrons for medical applications. The demonstration of the possibility to obtain a satisfactory distribution and fixation of nanoparticles after intratumoral injection (brachytherapy) in rats was carried out by using Ho and Re loaded nanoparticles activated in the JRC INBARCA activator and visualised/quantified through in-vivo SPECT imaging and ex-vivo g-counting on single organs.