Feasibility studies towards future self-sufficient supply of the ^{99}Mo-^{99m}Tc isotopes with Japanese accelerators

In order to establish a self-sufficient supply of the ^{99}Mo-^{99m}Tc isotopes, we carried out a series of experiments at RCNP to explore possibilities. The ^{99m}Tc isotope is indispensable for medical diagnosis. It has so far been generated through decay of its parent isotope ^{99}Mo separated from fission products available only fom a limited number of nuclear reactors using highly enriched ^{235}U (HEU). In Japan, since we do not have the HEU reactor, ^{99}Mo had to be supplied totally from abroad. However, it is a major worldwide concern that the HEU reactor is difficult to build successor(s)

Using proton beams with energies from 20 to 400 MeV from the RCNP AVF- and Ring- cyclotron complex we explored alternative ways to produce the isotopes with existing Japanese accelerators. Through the experiments we got two possible solutions : (http://jlc.jst.go.jp/DN/JST.JSTAGE/pjab/90.413)

First, we studied possibility to use spallation neutrons generated from J-PARC, the world top class high intensity proton accelerator, for production of ^{99}Mo through the ^{100}Mo(n,2n)^{99}Mo reaction. Based on RCNP simulation data we were able to estimate the yield for the case using 400 MeV x 330 μA proton beam from the injector LINAC to be ^{99}Mo to be 1,500T Bq/year. This is much more than present Japanese yearly consummpution, 350 TBq/year.

Second possibility is to produce ^{99m}Tc directly through ^{99}Mo(p, 2n)^{99m}Tc reaction using the PET cyclotrons which are in operation at various locations more than 50. PET cyclotrons deliver 100 μA proton beam of 15～20 MeV. Through simulation experiment with lower intensity of 50 na on natural Mo target, we were able to estimate the yield of ^{99m}Tc to be 350 GBq(EOB) in case of 10 hour bombaradment of 100 μA proton beam on enriched ^{99}Mo target. This amount of yield is sufficient to use in local university hospitals. In this case, however, we learned that the target must be highly enrichrd ^{100}Mo, at least 99%. Then, we designed a new target-system which would allow multiple use of the expensive enriched ^{100}Mo.