# $^{117m}$Sn - the promising radioisotope for use in diagnostics

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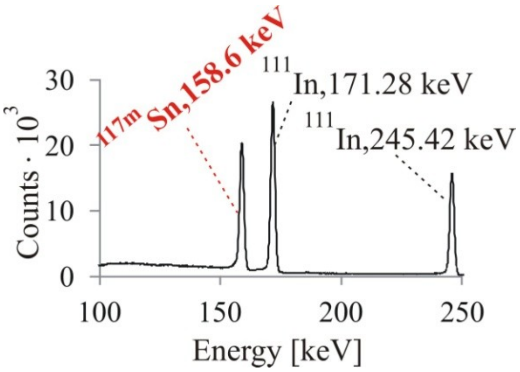
Due to the rapid development of nuclear medicine, the demand for radioactive isotopes used in the diagnostics and the therapy is growing. Currently, most medical radionuclides are produced by irradiation of uranium disks (fission reactions) or targets enriched in the parent isotope (simple capture reactions), in research reactors. In the last decade, several independent reactor shutdowns and outage extensions significantly disrupted global radioisotope supplies. Therefore, new methods of production of radioisotopes and a search of new radioisotopes which can be produced in cyclotrons and linear accelerators for nuclear medicine applications are required. $^{117m}$Sn is a nuclear isomer at the second exited state of tin. It is a diagnostically promising radioisotope, because it emits rays of 158.6 keV, which is close to the energy of $^{99m}$Tc. The gamma-ray energy spectrum from radioactive decay of natural tin activated by a high-energy photon beam is presented in Figure below.




The HPGe gamma-ray spectrum of the radioisotopes produced using targets of natural tin. $^{111}$In is a result of the radioactive decay of $^{111}$Sn originating from the photonuclear reaction $^{112}$Sn($\gamma$,n)$^{111}$Sn. The half-life of $^{111}$Sn (35.3 minutes) is relatively short. In consequence of the latter, it is easy to remove $^{111}$In from the target, because the half-life of $^{117m}$Sn is almost five times longer than the half-life of the undesirable indium radioisotope ($T_{1/2}$ = 2.81 days).

$^{117m}$Sn can be produced in many various reactions described in Table below.

The list of nuclear reactions leading to the formation of $^{117m}$Sn.

| Nuclear reaction | Cross section |
|---|---|
| $^{115}$In($\alpha$,pn) | 16 mb at 31.5 35.4 MeV |
| $^{117}$S(p,p') | 0.37 mb at 23.6 MeV |
| $^{114}$Cd($\alpha$,n) | 480 mb at 20 MeV |
| $^{116}$Cd($\alpha$,3n) | 1200 mb at 36 MeV |
| $^{121}$Sb(p,$\alpha$) | several hundred mb at 30-42 MeV |
| $^{118}$Sn($\gamma$,n) | 290 mb at 15 MeV |
| $^{116}$Sn(n,$\gamma$) | 6 mb at thermal energies |
| $^{118}$Sn(n,n') | 100 mb over 317.2 keV |

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