

Radioisotope production

From nuclear physics to nuclear medicine

Radioisotopes can be used in different fields of medicine like oncology, neurology and cardiology. Different types of applications are possible thanks to the different kinds of radiation available through the radioactive decay of nucleus. Gammas which are penetrating radiation are used for imaging to help diagnosis whereas charged radiations are used for therapy to destroy cells.

Only few radionuclides can be used directly (I131 for thyroid cancer is one example). In most cases, these radionuclides must be coupled to a carrier molecule (a vector) to target the cells of interest. This labelled vector forms a radiopharmaceutical. A vector can be a chemical molecule, a peptide or an antibody and its distribution time in the body is dependent on its size. Peptide can distribute within hours whereas antibodies need days.

Currently, only few isotopes are used in clinical practice (Tc99m, F18 for imaging and I131 and Y90 for therapy). However, many others may be of medical interest due to their emitted radiations (alpha emitters, Auger emitters) and / or their half-lives that can be adapted to the carrier molecule transit time and to the pathology.

Recently, with the recent technological advances, it is possible to combine imaging information and therapeutic use of radionuclides which is called the theranostic approach. This approach allows personalizing the treatment to each patient. The diagnosis test done prior to the treatment allows following and controlling the patient response to the injected radiopharmaceutical. It allows a better control of the targeting and increases the benefit/toxicity ratio as useless treatments on patients with no response to the diagnosis test are avoided. For the theranostic approach, it is preferable to use pairs of radioisotopes of the same element like (I124/I131I, Cu64/Cu67,).

All these points lead to a renewal interest on isotope production and consequently on nuclear physics and radiochemistry.

In this course, I will first start by an overview of the use of radioisotopes in medicine for both imaging and therapy. I will then present the isotope production with some emphasis on the accelerators used and the technical aspects of irradiation. Using the case of the Copper-64, I will describe the whole process from the target preparation to the PET image for small animals. Finally, I will present the potential benefit for the nuclear physics community.