The WIDMAPP project

WIDMApp (Wearable Individual Dose Monitor Apparatus) is an innovative dose monitoring system designed for patients that are undergoing a MRT (Molecular RadioTherapy) treatment. A cycle of MRT consists in the administration of a radiopharmaceutical in the form of a highly specific drug designed to be absorbed mainly by carcinogenic cells. These drugs are composed by a carrier molecule bound to a chemical compound marked with a radioactive nucleus.

The therapeutic effects is due to the damages induced to the tumor cells by the isotope decay. For example in the radiopharmaceutical Lutathera (based on Lutetium 177) the carrier is an equivalent molecule of the somatostatin, that can couple with the GePNET (GastroEnteroPancreatic Neuro Endocrine Tumors) receptors, while the therapeutic effect is provided by electrons emitted in the beta decay of 177Lu.

The fraction of the injected drugs that does not couple with the tumor diffuses in the body carried by the blood, and accumulates in the organs responsible for its disposal (kidney, liver, spleen). These organs, called Organs At Risk (OAR), may be damaged by the radioactive decays of the radionuclide, depending on the dose absorbed during the whole treatment.

A fundamental requirement to maximize the therapeutic effect of a MRT treatment, while minimizing the collateral damage caused to OARs, is the knowledge of the absorbed dose distribution of both tumor and OARs, that enable personalized therapies based on the particular physiology of the patient.
In the current clinical practice, dose monitoring is accomplished acquiring a series of SPECT (Single Photon Emission Computer Tomography) scans of the patient, performed periodically after several hours from the injection of the drug. From these measurements it is possible to obtain the accumulation/washout curve for each OAR and therefore, the total absorbed dose from the treatment. The main limitation of this method is that it uses only few measurements to extrapolate the absorbed dose and therefore it provides results with very large errors, of the order of 10-20 percent. Moreover, this clinical practice relies heavily on the resources of the National Health System and, therefore, it is not a standard procedure administered to all patients. In most cases the absorbed dose is inferred from standard pharmacokinetic models.

The WIDMApp project solves these problems, providing a system that is able to measure with high precision the Time Activity Curve (TAC) of tumors and OARs during the whole duration of a MRT treatment. The system is designed to be a low cost, highly customizable tool that will allow the widespread of personalized cancer treatments.

WIDMApp uses a set of multiple wearable detectors that can be applied close to various organs all over the patient body. Thanks to a custom-made deconvolution algorithm that isolates the contribution of each organ to the rate measured by each sensor, it is possible to quantify the activity of different organs during the day, precisely reconstructing the TAC and estimating the total absorbed dose. Each WIDMApp detector is a simple particle counter composed by a scintillating element coupled to a Silicon PhotoMultiplier

(SiPM). At present, a prototype sensor has been developed, exploiting the know-how obtained from the studies of a probe for RadioGuided Surgery (RGS). This prototype is driven by a single channel electronics board derived from the ArduSiPM architecture.