

Development of microfluidic chips to immobilize living organisms for irradiation with a proton microbeam.

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Abstract:

Since their first use on cells, either individual cells or on cell populations, ion microbeams have proven their interest in exploring the effects of ionizing radiation. With the growing interest to go towards irradiating multicellular organisms, the need to immobilize the samples to allow a fast, precise, and reproducible irradiation represents a non-negligible technical challenge. Although the use of anesthetics can be efficient to transiently stop the movements of some models, it can induce bias, and is not ideal to study phenomena such as motor function.

Microfluidics is a technology that has appeared in the 90's. It is quickly developing, with the use of new materials and fabrication techniques. With the development of bio-compatible materials, it can be applied to many biology domains, such as radiation biology. The versatility and precision of the fabrication techniques allows the design of microfluidics chips adapted to microbeam experiments, thus significantly improving the variety of biological samples that can be studied.

Two types of microfluidic chips have been developed for proton microbeam irradiation on the MIRCOM facility, based in Cadarache (France). The first one is dedicated to the irradiation of the nematode *Caenorhabditis elegans*, a reference model in biology. It has been designed to immobilize adult nematodes, allowing head irradiation to study the effects of proton irradiation on the central nervous system. The second one is dedicated to the irradiation of sea bass (*Dicentrarchus labrax*) and zebrafish (*Danio rerio*) embryos. It has been designed to immobilize embryos, allowing their irradiation with protons to reproduce the radiative environment of an Earth-Moon travel, to study the feasibility of space aquaculture on the Moon, in the framework of the Lunar Hatch project.

In addition to the chips themselves, we will present the first validation studies of both designs, and the first results obtained during recent experimental campaigns.