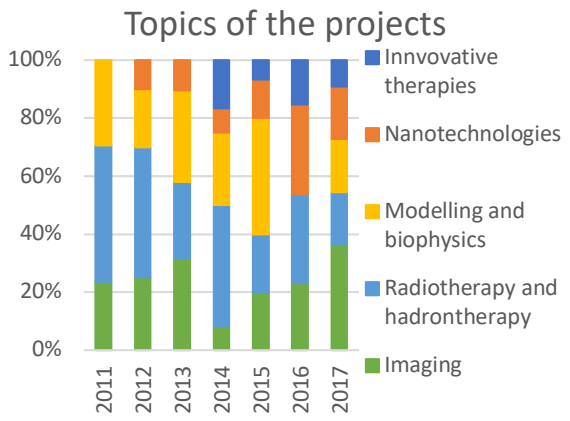
Ex post Analysis of an Interdisciplinary Funding Programme: Physics, Mathematics and Engineering Sciences Applied to Cancer

ITMO cancer of the Alliance for Life Sciences and Health (Aviesan) is conducting *ex post* analyses of its funding programmes launched in the frame of the national Cancer Plan. Among them, the "Physics, Mathematics and Engineering Sciences Applied to Cancer" programme is an important instrument to foster multidisciplinary research on cancer. This call for projects aims at attracting physicists, mathematicians and engineers to the question of cancer and at supporting multidisciplinary research in these scientific fields to provide novel therapeutic and diagnostic approaches or improve the understanding of the disease. Since its implementation in 2011, this call for projects has provided funding for **108** projects, led by **247** partners, including **95** coordinators.

Analysis of the profiles of the project coordinators has shown that the majority was physicists, and that 44 coordinators were newly interested in the topic of cancer. Almost half of the consortia were involving 3 disciplines or more. The rest were mainly physics - biomedical sciences consortia.



The great majority of the projects had the objective of developing therapeutic or detection and diagnostic approaches. A minority was either developing models or aiming at a better understanding of cancer. The main topics of the projects are imaging, radio- and hadron-therapies (including dosimetry), modelling and biophysics, nanotechnologies and new therapies (acoustic, optic, plasma and electroporation-based therapeutic approaches) that appeared in the programme in 2014.

The tools developed in the completed projects of the 2011-2013 period were mainly:

- Methods or tools for therapy (mainly dose calculation programmes) or detection (mainly for image processing or for assessing stiffness of tissue for diagnosis purposes);
- Experimental setups or methodology to assess the effects of irradiation and/or nanoparticles or to study cancer cells growth;
- Mathematical models mainly of tumour growth or of responses to irradiation or nanoparticles;
- Detectors (miniaturized or not) and endomicroscopes.

These tools have helped gather knowledge on tumour growth, impact of irradiation, physical characteristics of cancer cells, and effects and behaviour of different types of nanoparticles. Furthermore, some of the tools are now used outside the field of oncology (e.g.: a tool to assess tissue elasticity was also used on cornea).

The financed projects allowed the development of 25 new international collaborations and the recruitment of 2 persons in average per project (a total of 102 persons), half of which were postdoctoral fellows, the quarter engineers, and another quarter were students (Masters or Doctorate). The postdocs and students mainly remained in the academic sectors (continued their studies or work in laboratories either in France or abroad).

The impacts of the projects were multiple:

- Availability for the scientific community of open-access software modules for Monte Carlo simulations, on the GATE or GIANT4-DNA open-access platforms.
- Secured funding to continue the work (leverage effect of the programme for half of the projects)
- Further development of the tools in clinical settings
- Broadenings of the possible uses of the tools
- Creation of 2 start-ups
- 9 patent deposits
- Creation of 3 new interdisciplinary research units (including two international ones)
- Implementation of new strategic axes at the interface of physics and biology in two institutions

The analysis concludes that, in 7 years, the programme demonstrated its ability to generate new knowledge on the processes in oncogenesis; to generate new tools and disseminate them; to have a leverage effect on the teams involved. Moreover, the increase of high-quality project submissions, the help of the programme for the creation of three new research laboratories and new strategic axis linking physics and biology in two institutions indicate an increase in the capacity in France for this type of research and a strong structuring effect of the programme. Thus, the goal of the programme to foster a genuine interdisciplinary research ecosystem at the interface between physics, mathematics, engineering and oncology has been achieved.

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