

Theoretical modelling and experimental study of the electromagnetic compatibility of active medical implants at low frequency magnetic field (50 Hz / 60 Hz): case of insulin pumps

Université de Lorraine



NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	Université de Lorraine - CNRS
Name of the host laboratory / research team	Institut Jean Lamour
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Internship offer

Topic of the internship (title) Theoretical modelling and experimental study of the electromagnetic compatibility of active medical implants at low frequency magnetic field (50 Hz / 60 Hz): case of insulin pumps

Proposed dates of the internship* **Start** 2020-08-31 **End** 2021-01-31

* The supervisors have indicated the dates proposed are flexible and are able to be postponed subject to COVID-19 border closures.

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

Context: For more than a decade, studies on the EMF of active medical implants have been carried out by the "Electronic Measurements" team at the Jean Lamour Institute (Université de Lorraine-CNRS) in partnership with the EDF group. This collaboration made it possible to establish several results regarding the behaviour of cardiac implants at low frequencies (50/60 Hz). These studies were carried out for magnetic fields then electric fields, on pacemakers then cardiac defibrillators. Theoretical modelling has thus been carried out, leading to calculate the voltages induced on the probe of an implant in a human body model, and experimental in vitro modelling on a phantom. The behaviour of the implant subjected to an electric or magnetic field at 50/60 Hz was thus characterized.

Problem: among the problems remaining to be solved:

- The theoretical study of the field distributions which deserves to be deepened as a function of the nature of the electrical and / or magnetic signal at 50/60 Hz and above all of the variations in the conductivities and permittivity of the organs of the human body in a more detailed manner, this aspect does not only concern the EMC of active medical implants but also the broader aspect of dosimetry. Our team specializes in the measurement of these parameters (2003; «Dielectric properties of blood: an investigation of haematocrit

dependance», Jaspard F, Nadi M., , Physiological Measurement, Vol 24 17 137-147). Another point is to further refine the models previously developed (2017; Computation of Pacemakers Immunity to 50 Hz Electric Field: Induced Voltages 10 times greater in unipolar than in bipolar detection mode ; C Gercek , D Kourtiche , M Nadi, I Magne , P Schmitt , M Souques ; Bioengineering 2017;4(1):19).

- For this internship : Other active medical devices deserve attention: neurostimulators (especially in the treatment of pain), medication pump (especially insulin pump), implanted blood sugar detector ... In this project, we propose to answer these questions by looking for robust theoretical and experimental solutions to the specific case of the insulin pump. We have already initiated reflections on this subject and if the theoretical simulation should not pose strong constraints, the experimental study requires the design of a bench of measurements and tests in order to answer the question of the risk assessment when a worker bearing such implant return to his work where an electromagnetic environment exist.

(2020) Phantom Model Testing of Active Implantable Cardiac Devices at 50/60Hz Electric Field; C Gercek ; D Kourtiche ; M Nadi; I Magne; P Schmitt; P Roth; M Souques; BioElectromagnetism; Volume41, Issue2 ; February 2020 ; Pages 136-147 (2017) An in-vitro cost-effective test bench for active cardiac implant reproducing human exposure to electric fields at 50/60 Hz ; C Gercek, D Kourtiche, M Nadi, I Magne, P Schmitt, M Souques and P Roth ; International Journal on smart sensing and intelligent systems ; vol. 10, N° 1 March 2017 ; pp. 1-17.

Name of industrial partner EDF Service des études médicales

Role of the industrial partner in the internship project Interests: EDF as well as other companies having employees working in an electromagnetic fields environment are mainly concerned. If an employee has an implant and want to come back to his post after surgery, the company must conduct a risk assessment according to the European legislation. Our studies are done as a support for occupational medicine, within the framework of European decree 2016-1074. IJL competence is recognized in standardization by its participation in the work of the CENELEC TC106X WG15 (series of standards EN 50527) French ANSES also referred to our expertise on the electromagnetic compatibility of medical devices exposed to radio frequency sources following a referral in 2011 (Referral no. 2011-SA-0211).

Non exhaustive references : EN 50527 1:2016, Procedure for the assessment of the exposure to electromagnetic fields of workers bearing active implantable medical devices - Part 1: General Directive n° 2013/35/UE du 26/06/13 concernant les prescriptions minimales de sécurité et de santé relatives à l'exposition des travailleurs aux risques dus aux agents physiques (champs électromagnétiques) (vingtième directive particulière au sens de l'article 16, paragraphe 1, de la directive 89/391/CEE)

Main contact at the French industrial partner Dr Martine SOUQUES
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Expected profile of applicant

Level of study	Master
Discipline	Electronic and electrical engineering
Required qualities, knowledge and skills	<p>Profile and expected skills: The candidate, holder of an appropriate master's degree (Electronics, electrical engineering, Measurement and Instrumentation...) must have in-depth knowledge in all or part of the following fields:</p> <ul style="list-style-type: none">• Electronic instrumentation, electronic card development, CAD• Electromagnetism, Finite element modelling• Electrical and magnetic metrology <p>His skills should allow him to quickly master:</p> <ul style="list-style-type: none">• CST and / or COMSOL type simulation software• the use of electrical and magnetic measuring instruments