

# BSc in Medical Physics at the University of Campinas

## Bacharelado em Física Médica na Universidade Estadual de Campinas

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### Abstract

Several Medical Physics university programs have started in Brazil in the last decade. They are mainly taken at the undergraduate level. At UNICAMP, we combined the teaching expertise of several units, including the Physics Institute, the Institute of Biology, the School of Medical Sciences and the Center for Biomedical Engineering, to create a course that starts with Core Physics, Mathematics, Computing and Chemistry, then follows with specific courses in Medical Physics intertwined with advanced courses belonging to a strong BSc in Physics, and concludes with a one-year traineeship at the University Hospital. The UNICAMP Medical Physics undergraduate course began in 2003, lasts five years and has formed 67 students up to 2010, most of them have got stable working positions as Medical Physicists. This article presents the conception, structure and the first outcomes of this course.

**Keywords:** UNICAMP, medical physics, undergraduate courses.

### Resumo

Diversos programas universitários de Física Médica se iniciaram no Brasil na última década. Tais programas são principalmente realizados nos cursos de graduação. Na Universidade Estadual de Campinas (UNICAMP), combinou-se a técnica de ensino de diversas unidades, incluindo o Instituto de Física, o Instituto de Biologia, a Faculdade de Ciências Médicas e o Centro de Engenharia Biomédica, para criar um curso que começa com Física Básica, Matemática, Computação e Química. Segue-se com cursos específicos em Física Médica, mesclando-os com cursos avançados pertencentes a um ótimo bacharelado em Física, e conclui-se com um estágio de um ano no Hospital Universitário. O curso de graduação em Física Médica da UNICAMP começou em 2003, tem duração de cinco anos e já graduou 67 estudantes até 2010, a maioria deles com cargos profissionais estáveis como físicos médicos. Este artigo apresenta a concepção, a estrutura e os primeiros resultados desse curso.

**Palavras-chave:** UNICAMP, física médica, cursos de graduação.

### Introduction

The UNICAMP Medical Physics undergraduate course was conceived in 1999 by several university units, coordinated by the *Gleb Wataghin* Physics Institute (IFGW), in order to meet the growing demand for physicists in the medical field. Many studies were conducted on the composition of the curriculum and course programs, until the final program was reached in 2001. The course was implemented in 2003, when the first class of Medical Physics began at UNICAMP. Because it is an interdisciplinary program, also participated in its design and currently participate in its implementation lecturers from the Institute of Biology (IB), from the School of Medical Sciences (FCM) and from the Center for Biomedical Engineering (CEB), everyone with specific contributions related to their research and work fields. The course's final year

consists of traineeship at the UNICAMP University Hospital in the areas of Nuclear Medicine, Radiotherapy, Radiology and Radiation Protection conducted by CEB Medical Physics division. Thus, over the five-year duration of the course, students have contact with professionals with extensive experience in each of the covered topics. So far, UNICAMP has formed four Medical Physics classes, totalizing 67 students.

### Course description

#### Course summary

The disciplines that make up the BSc in Medical Physics are organized in three blocks corresponding to three different levels that are subsequently accessed by the students as they progress along the course.

The student starts taken classes in a four-semester basic course that is offered to those enrolled in the hard sciences. The program of this short course, which offers a background in Physics, Mathematics, Computing and Chemistry, is shown in Table 1.

After that, the student is prepared to take advanced classes of the block that includes specific courses of the BSc in Medical Physics intertwined with advanced courses of the BSc in Physics. These courses are presented in Table 2. Again, this block takes two semesters to be completed.

The third and final block consists basically of a two-semester traineeship in Medical Physics, which is performed at the UNICAMP University Hospital (Table 3). This block has also an introductory course at the hospital called "Clinical Aspects of Medical Physics" which includes topics of medical ethics and professional relationships, oncology, diagnosis and treatment, and biosecurity.

### Mandatory traineeship

The disciplines of the cited mandatory traineeship (Table 3) are held during the 5<sup>th</sup> year of the course and conducted in the hospital for 720 hours under the supervision of a medical physicist from the respective area.

**Table 1.** Basic courses offered to students of hard sciences.

Code	Course	Credits
1 <sup>st</sup> semester		20 credits
*F 128	General Physics I	04
*F 129	Experimental Physics I	02
*FM003	Profession Related Seminars	02
*MA111	Calculus I	06
*MA141	Analytical Geometry and Vectors	04
*MS149	Mathematics Complements	02
2 <sup>nd</sup> semester		22 credits
*F 228	General Physics II	04
*F 229	Experimental Physics II	02
*MA211	Calculus II	06
*MA327	Linear Algebra	04
*MC102	Algorithms and Computer Programming	06
3 <sup>rd</sup> semester		20 credits
*F 328	General Physics III	04
*F 329	Experimental Physics III	02
*MA311	Calculus III	06
†ME210	Probability	04
†MS211	Numerical Calculus	04
4 <sup>th</sup> semester		22 credits
*F 315	General Mechanics I	04
*F 428	General Physics IV	04
*F 429	Experimental Physics IV	02
*MA044	Mathematics IV	04
†QG101	Chemistry I	04
†QG102	Experimental Chemistry I	04

\*Common core courses.

†Courses in common with the BSc in Physics.

*Radiotherapy:* Monitoring of treatments, monitoring and implementation of treatment planning from simulation to approval by the physician, dosimetry and quality control of equipment used in therapy, including brachytherapy for High Dose Rate.

*Nuclear Medicine:* Monitoring and implementation of activities of radiation levels assessment and surface contamination, monitoring and implementation of instrumentation

**Table 2.** Advanced courses taken by Medical Physics students.

Code	Course	Credits
5 <sup>th</sup> semester		26 credits
§BD580	Fundamentals of Cellular and Molecular Biology	04
†F 502	Electromagnetism	04
†F 520	Mathematical Methods for Physics I	04
†F 540	Methods for Experimental Physics I	04
†F 589	Structure of Matter	04
§MC202	Data Structure	06
6 <sup>th</sup> semester		20 credits
§BD681	Fundamentals of Human Anatomy, Histology and Physiology	04
†F 320	Thermodynamics	04
§F 550	Radiation: Interaction and Detection	04
†F 620	Mathematical Methods for Physics II	04
†F 689	Quantum Mechanics I	04
7 <sup>th</sup> semester		20 credits
†F 604	Statistical Physics	04
†F 740	Methods for Experimental Physics III	04
§F 752	Magnetic Resonance Applied to Medicine	04
§F 758	Radiobiology and Radioprotection	04
§MC920	Introduction to Digital Image Processing	04
8 <sup>th</sup> semester		20 credits
**	Elective course	04
§F 837	Medical Physics Laboratory	04
§F 852	Physics of Radiology	04
§F 853	Physics of Nuclear Medicine	04
§F 854	Radiotherapy Physics	04

\*Common core courses; †Courses in common with the BSc in Physics; §Courses specific of BSc in Medical Physics; \*\*Elective courses: 04 credits among: †F 602 Electromagnetism II; †F 789 Quantum Mechanics II; §F 856 Biophotonics; †F 885 Elementary Particles and Fields; †F 888 Solid State Physics

**Table 3.** Traineeship at the University Hospital.

Code	Course	Credits
9 <sup>th</sup> semester		28 credits
§MD760	Clinical Aspects of Medical Physics	04
§MD947	Supervised Traineeship on Medical Physics I: Radiology, Radiotherapy & Nuclear Medicine	24
10 <sup>th</sup> semester		24 credits
§MD948	Supervised Traineeship on Medical Physics II: Radiology, Radiotherapy & Nuclear Medicine	24

§Courses specific of BSc in Medical Physics

quality programs, medical image processing, and study of clinical protocols under development.

*Radiology and Radiological Protection:* Tracking surveys, monitoring and implementation of quality programs in radiology and in radiation measurement equipment, monitoring and implementation of radiometric surveys and testing of radiation leakage in X-ray equipment, individual monitoring management and radioactive waste management.

All information included in Tables 1-3 were taken from the UNICAMP undergraduate courses catalogue of 2011<sup>1</sup>.

### Graduate Programs

At UNICAMP, the Medical Physics student can pursue graduation studies at the Department of Biomedical Engineering (School of Electrical and Computing Engineering) or at the Physics Institute. The Physics Institute has only one graduate program. There are, however, lecturers who can guide students at MSc and PhD research in Medical Physics subjects.

### Conclusions

The proposal to create a BSc in Medical Physics at UNICAMP came from the idea of combining the strong background in Mathematics and Physics, usually provided to students of the BSc in Physics, with the extensive educational resources that the University has in the Biomedical field and Health Sciences.

As mentioned, in four years since the Medical Physics BSc program started at UNICAMP, 67 students graduated. From these, 29 (43%) have gone to specific traineeship in Physics of Radiotherapy, which is the preferred area for those who enter the Medical Physics course.

In the last three years (2008-2010), from the 60 radiotherapy traineeship positions available in Brazil (20 positions/year), 38% have been taken by UNICAMP students.

The remaining students are either working in Physics of Radiology (7%), Physics of Nuclear Medicine (6%), Radiation Protection (3%) or other activities including graduate studies. Most of the former students have got stable working positions. For us, this is the best indication that our course is achieving its purpose.

However, a series of difficulties still remain, not specifically related to our course, but mostly related to working positions for medical physicists in Brazil. Only Radiotherapy Centers are required by law to hire medical physicists. For Radiology and Nuclear Medicine, Medical Physics is still a relatively new area in Brazil. The work of medical physicists in these activities has been established by law since 1998 and 2005, respectively, but just as part-time job and, in some cases, it is accepted that the work be carried out by other professionals. Physicians and clinic owners have not yet understood the importance of the work of medical physicists, particularly in what concerns quality control. Therefore, there is still a large field to be explored by medical physicists in Brazil, and certainly the job market of this area will grow up in the near future. Nuclear energy and radioisotope production are areas which are growing in the country and will certainly need good medical physicists to work in radiation protection and quality control.

### Acknowledgment

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### References

1. UNICAMP Undergraduate courses catalogue (2011) [internet]. Available from: <http://www.dac.unicamp.br/sistemas/catalogos/grad/catalogo2011/index.html>

