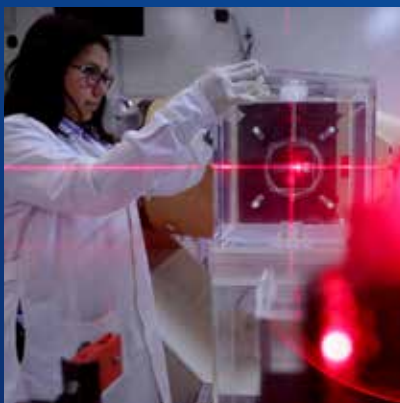


# Women in Medical Physics

## International Women's Day



# NUCLEAR TECHNOLOGY AND SUSTAINABLE DEVELOPMENT

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## **Women in Medical Physics: their contribution to improving the quality and safety of medical services using ionizing radiation.**

By Dr. Eng. Mario Mallaupoma  
President of the Peruvian Institute of Nuclear Energy

Since 1995, when the Peruvian Institute of Nuclear Energy (IPEN) identified the need and importance of training specialists in Medical Physics at the Master of Science level in our country, it has been very positive to see the interest awakened in female professionals in science, who identified a good opportunity to specialize and contribute with their knowledge to improve the safety and quality of medical radio diagnostic services using X-rays, nuclear medicine and radiotherapy. The IPEN, as the governing body specialized in promoting the peaceful and safe use of ionizing radiation, was the promoter of its implementation, through an agreement with the prestigious National University of Engineering (UNI) and the National Institute of Neoplastic Diseases (INEN), with the important support of the International Atomic Energy Agency (IAEA).

On International Women's Day, it is very gratifying to identify and recognize the contribution that female Medical Physicists have been making through their professional participation to benefit the general population. Therefore, this publication seeks to highlight their presence and professional contribution. Many of them have also participated in fellowships promoted by IPEN but financed by the IAEA, which permanently supports its Member States, to reinforce and strengthen the knowledge of nuclear technology in its multiple peaceful applications in the health sector, for the benefit of the population.

I have had the opportunity to meet the female medical physicists interviewed in this publication, and I cannot fail to mention how gratifying it has been to see their commitment and enthusiasm to work within a multidisciplinary team of healthcare professionals, knowing that this contributes to improving patient care but also

to increasing and consolidating their human sensitivity. I would even say that more than a commitment, it is a passion for the work they carry out on a permanent basis. In this sense, they follow in Marie Curie's footsteps, who was twice awarded the Nobel Prize and is considered the pioneer of Medical Physics as well as an inspiration for women in science.



*Marie Curie, winner twice of Nobel Prize*



## Strategic alliances with a future vision to take care of health needs of the population IPEN - UNI - IAEA

Ever since Wilhelm Roentgen discovered X-rays and later Henri Becquerel and Marie Curie discovered the existence of radioactive substances that emitted ionizing radiation, scientists have been studying their properties and possible applications. The discovery was fabulous, as it was the first time that X-rays made it possible to see what was inside the human body. Similarly, the use of radium-226, in multiple applications, increased. However, the medical applications were those that made the most use of this type of radiation for either diagnostic or therapeutic purposes. Many beneficial aspects were identified, but also the professionals who used these radiations more intensively began to show health effects.

Further research showed that just as ionizing radiation could have benefits, it could also have negative effects, requiring that practitioners using it should have a sound knowledge of its applications and risks. Medical applications led to the specialities of X-ray radiodiagnosis, nuclear medicine, and radiotherapy, which require the participation of highly qualified and competent multidisciplinary teams. One of the specialties required is Medical Physics, which is the branch of Physics that encompasses the study and development of its applications in the field of medical sciences, for the diagnosis and treatment of diseases. Considering the needs of the population and the proper and safe use of ionizing radiation, and in order to make up for the large deficit, or non-existence, of qualified medical physicists in the main hospitals in Peru, the Peruvian Institute of Nuclear Energy (IPEN) requested assistance from the International Atomic Energy Agency (IAEA), through the planning and implementation of a national project within the framework of the technical cooperation program.

The national project, entitled “Training in Medical Physics”, was approved under code PER0020 and started to be implemented in 1995, with the objective of establishing a Master of Science (MSc)’s program in Medical Physics in Peru. The technical counterpart of IPEN was Mr. Modesto Montoya Zavaleta, with counterparts at the IAEA in the Technical Officer, Mr. Heikki Tapani Toelli, and the Managing Program Officer, Mr. Bernd Radischat. Three national institutions collaborated in the establishment of this postgraduate program: the

Peruvian Institute of Nuclear Energy, the National University of Engineering and the National Institute of Neoplastic Diseases. The IAEA's important contribution consisted of experts and equipment. Seven expert missions advised on the didactic programming of the courses, gave lectures on medical physics, prepared teaching materials and carried out laboratory experiments on medical ultrasound, image processing and biosignal processing. The expert missions also provided advice on computer methods for dose calculation and quality procedures. In addition, the IAEA provided materials and equipment for the laboratory sessions.

The implementation of the project was very successful as it has made a substantial contribution to improving the number of adequately trained medical physicists in the country. For the public, the direct result has been the improvement of health care through improved imaging and dosimetry techniques in radiation oncology. It can be asserted that the implementation of this project marks a historic milestone in Peru, since over the years it has succeeded in training professionals, in many cases female medical physicists, who have managed to substantially improve the conditions of safety and quality assurance in the provision of medical diagnostic and therapeutic services.

Therefore, it can be seen that the institutions that joined forces, seeking synergies, having identified national needs in the area of health, really had a future vision, and it marks a milestone in the process of continuous improvement of health care for the population. It also provides qualified personnel in the speciality of Medical Physics, and its participation in programs such as the "National Comprehensive Cancer Care Plan (2020 - 2024)" in Peru, which seeks to contribute to reducing morbidity and mortality from cancer in Peru, through strategic actions with equity, and focused on health promotion, prevention, early diagnosis, treatment and palliative care of cancer, and likewise to be integrated into IAEA initiatives, called "Rays of Hope", which contributes to the fulfillment of the 2030 Agenda and Sustainable Development Goal 3 (health and well-being).





# **Interview with Women Peruvian Medical Physicists**



# Kelita Erika Jara Matienzo

Medical Physicist  
Radiation Therapy Service  
Edgardo Rebagliati Martins National Hospital  
Lima - Peru

## Tell me a little about yourself.

I am the daughter of Ancashino parents, born in Lima, the oldest of 04 siblings. My mother taught me to read and write before entering primary school and I really enjoyed doing Palmer calligraphy. Since I was a child, I liked sports and practiced basketball, volleyball, karate for several years, 100m sprints, and I like climbing, especially in the snow.

In August 2001, I migrated to the United States to pursue postgraduate studies there, unfortunately, the September 11 attack affected many students.

## How did you become interested in Medical Physics?

From a very young age, I was inclined toward science and mathematics. During school time, I was very sure that I liked research, I read books about discoveries in the world, and also took courses in electricity, among others.

My dad's younger brother was an Electronics student at the National University of Engineering and brought magazines from European universities. At that time, I thought of studying astrophysics and read about the various applications of physics.

Finally, I entered the Federico Villarreal National University, School of Physical Sciences, I did my pre-professional internships at the National Institute of Neoplastic Diseases, which led me to follow the path of Medical Physics.

## **Tell me about the role of a Medical Physicist in radiation therapy.**

In radiation therapy, a multidisciplinary team of professionals is required to administer treatment to cancer patients.

The role of a Medical Physicist in radiation therapy is of great responsibility, basically establishing and developing the procedures that guarantee the quality and effectiveness of the treatment, including quality control of equipment (Linear Accelerators and HDR), treatment planning, and radiation safety in the Service.

## **In your own experience, what technical aspects would you consider to be evolving in radiation therapy?**

The advancement of radiation therapy has mainly been in treatment equipment, with guided image systems for real-time analysis and correction. This state-of-the-art equipment allows us to develop treatment techniques for each patient based on the type and location of the tumor and increase the treatment dose to destroy tumor cells and safely avoid irradiating surrounding organs at risk.

## **How would you summarize the precautions to be taken for patient protection in the Radiation Therapy Service?**

Comply with the quality assurance program developed in the Service, which means periodically and continuously executing all safety protocols and procedures, which include clinical prescription and dose administration, to ensure that the dose was delivered to the patient with precision and accuracy.

## **What can you tell us about the importance of quality control of radiation therapy equipment?**

Quality control of radiation therapy equipment is part of the quality assurance program. These controls must be periodically executed and corrected if necessary to avoid errors in the prescribed dose calculation. This would imply underdosing or overdosing the patient. As long as these quality controls are met, we can maintain and/or improve the quality of treatments.

## **Similarly, what can you tell us about the need to implement quality assurance programs in radiation therapy services?**

Definitely, every radiation therapy service must implement a quality assurance program according to its clinical environment and comply with at least the minimum requirements to achieve an acceptable level of quality.

In each Radiation Therapy Center, not only should the appropriate documentation be available, but it should also be executed responsibly and techniques of feedback should be developed to correct or improve the different aspects of the process contained in a quality assurance program. Many times only incidents occur, and if we downplay them, the result will be a radiological accident.

## **What challenges are you setting for the future?**

In 2010, I participated in one of the technological changes at the Rebagliati Hospital, the arrival of Linear Accelerators and the process of changing from conventional 2D radiotherapy to 3CRT and IMRT radiotherapy.

I hope to contribute and be part of another new technological change so that the hospital's Radiation Therapy Service can become a specialized cancer center with state-of-the-art technology. As we all know, the ultimate goal is for the patient to receive quality treatment.



# Maria Giselle Bernui de Vivanco

Medical Physicist  
Radiation Therapy Service  
Carlos Alberto Seguin Escobedo Hospital  
Arequipa - Peru

## Tell me a little bit about yourself.

I enjoy my profession and dedicating myself to the different activities I perform as a Medical Physicist with 19 years of experience in active practice in different fields such as radiation therapy, radiodiagnosis, radiation protection, and personal dosimetry. It has been gratifying.

## How did you become interested in Medical Physics?

When I finished my degree in Physical Sciences, I started looking for specialization options, and just at that time, Dr. Modesto Montoya gave a talk about the Master's degree in Medical Physics at the Physics faculty of the National University of San Marcos, which sparked my interest in applying physics in medicine, especially because of the importance this career has for the health of the population.

## Tell me about what a Medical Physicist does in radiation therapy.

The main objective of the work of the Medical Physicist in radiation therapy is to ensure that patients receive the prescribed radiation doses in the most optimal and safe way possible. To achieve this goal, the Medical Physicist performs multiple tasks such as calibration of radiation therapy equipment, treatment planning, and quality controls. In addition, the Medical Physicist is also responsible for the safety of occupationally exposed personnel, so he or she must be aware of compliance with radiation protection regulations at the facility.

## Based on your own experience, what technical aspects do you consider to be evolving in radiation therapy?

Radiation therapy technology is advancing very rapidly for the benefit of patients. Radiation therapy equipment is currently designed to deliver a more focused dose of radiation to the patient, avoiding irradiation of organs at risk, which makes it possible to scale up the doses of radiation prescribed by radiotherapists, benefiting patients treated with radiation therapy. Another important aspect of the technological benefit is that it allows for more accurate knowledge of the radiation doses received by patients, which is essential for the studies conducted by radiotherapists.

## How would you summarize the care to be taken for patient protection in the Radiation Therapy Service?

There are many precautions that must be taken with radiation therapy patients to prevent accidents. Radiation protection for the radiation therapy patient includes many aspects, some of which are apparently simple, such as identifying the patient correctly. However, an identification error could have serious consequences. It is important that radiation therapy personnel follow established protocols and maintain adequate communication to prevent accidents and maintain patient safety in radiation therapy.

## What can you tell us about the importance of quality control of radiation therapy equipment?

Quality control of radiation therapy equipment is vital for the safety of patient treatments. The radiation doses prescribed by radiation therapists aim to irradiate tumor cells while avoiding irradiation of healthy tissue, which is why they must be delivered as accurately as possible. To ensure that radiation doses are being delivered to patients correctly, it is essential that the radiation therapy equipment is in condition to deliver the treatments, and this verification is performed in the equipment's quality control.

## Likewise, what can you tell us about the need to implement quality assurance programs in radiation therapy services?

Quality assurance programs are essential for the safety of both patients and personnel working in radiation therapy. Currently, healthcare centers that have a radiation therapy service are well organized and are aware of the importance of quality assurance programs in radiation therapy. These quality assurance programs cannot be static, they must be updated as required. That is why it is very important to maintain constant meetings with the personnel involved in the quality assurance program.



# María Socorro Velásquez Campos

**Medical Physicist**  
**Nuclear Medicine Service**  
**Worked at the National Institute of Neoplastic Diseases**  
**Lima - Peru**

## Tell me a little about yourself.

I completed a degree in Electronic Engineering and then pursued a Master's in Medical Physics offered by the National University of Engineering in partnership with IPEN and INEN.

## How did you become interested in Medical Physics?

As an engineer, I joined the Department of Nuclear Medicine to work on the installation of interfaces on compatible computers. These electronic interfaces allowed nuclear medicine equipment (planar equipment) to be repowered in equipment similar to the most modern ones. My knowledge of nuclear physics was very basic, and I became interested in the topic, so I applied for the first class of the Master's in Medical Physics promoted by IPEN, UNI, and INEN. The knowledge gained from these studies was very helpful for working in nuclear medicine and cyclotron.

## What does a Medical Physicist do in Nuclear Medicine?

- Radiological surveillance to protect occupationally exposed workers, the public, and patients
- Dosimetry for workers, optimizing the dose reduction as much as possible
- Quality control of nuclear medicine equipment under a program
- Management of radioactive material and waste
- Radiation protection of occupationally exposed workers, the public, patients, and the environment.

## Based on your experience, what technical aspects would you consider to be evolving in nuclear medicine?

Technology in hybrid or multimodal equipment, such as SPECT CT, PET CT. Currently, the country has 5 SPECT CT and 5 PET CT machines.

Radiopharmacy, with the inclusion of new drugs and new radionuclides in diagnosis and therapy.

## How would you summarize the care needed for patient protection in the Nuclear Medicine Service?

- More care in the dose to be administered to each patient.
- Minimizing the possibility of confusion.
- Calibration of equipment.
- Dosimetry in therapeutic treatments.

## What can you tell us about the importance of quality control in nuclear medicine?

Very important, conducting controls within a program ensures that preventive maintenance is more efficient, avoiding the need for corrective maintenance. Ensuring clinical images are error-free.

## Similarly, what can you tell us about the need to implement quality assurance programs in nuclear medicine services?

Necessary because it guarantees patient care with quality and sustainability, optimizes human resources, supplies, and equipment.

## What challenges do you set for the future?

To serve where I am needed, in teaching, in nuclear medicine services, and working with biomedical equipment.



## Nora del Pilar Acosta Rengifo

Medical Physicist  
Radiation Protection Service  
2 de Mayo National Hospital  
Lima - Peru

### Tell me a little about yourself. How did you become interested in Medical Physics?

I am a woman passionate about science and technology, which prompted me to prepare myself both personally and professionally. I graduated from the National University Federico Villarreal with a degree in Medical Technology specializing in Radiology. I started my work activities at the Nuclear Medicine Service of Dos de Mayo National Hospital, where I discovered a field that fascinated me, "radiation protection". To learn more about this discipline, I began attending courses at the Centro Superior de Estudios Nucleares (CSEN) of the Peruvian Institute of Nuclear Energy (IPEN), where I met my radiation protection and medical physics teachers and mentors, to whom I am deeply grateful, not only for training me with their knowledge and experience but also for their advice and for believing in me.

After completing my master's studies, I did a practical internship in Spain, which allowed me to visit and learn about the hospital radio physics and radiation protection services of hospitals in Extremadura, Salamanca, and Madrid. It was an enriching experience thanks to my mentor and the Ibero-American Group of Radiation Protection Scientific Societies.

I returned to Peru with a new challenge, presenting to the management of Dos de Mayo National Hospital the project of "Creation of the First Radiation and Medical Physics Safety Unit in the country." Our journey was not easy. Throughout this time, the Radiation and Medical Physics Safety team has worked intensively to consolidate and position itself in the hospital, and now we can say that "we have achieved it". Likewise, our experience of almost 23 years has allowed us to become a reference in the country, as we support hospitals



and private clinics that require our advice and training of their professionals in radiation protection and medical physics.

Currently, I am also the Postgraduate Coordinator of the Professional School of Medical Technology at the Faculty of Medicine of the Cayetano Heredia University in Peru.

### Can you tell me what a Medical Physicist does in medical X-ray diagnosis?

A Medical Physicist in the Radiodiagnosis Service must perform, among others, the following:

- Implements, in coordination with the head of the Radiodiagnosis Service, the Quality Assurance Program (QAP) of the Radiodiagnosis Service.
- Implements the physical, technical, and patient dose optimization aspects contained in the Radiation Protection Manual (RPM) of the Radiodiagnosis Service.
- Participates in the review of diagnostic and medical treatment procedures with X-rays, for the optimization of patient doses.
- Estimates patient doses in Radiodiagnosis Service procedures.
- Obtains and establishes reference levels for diagnosis in the Radiodiagnosis Service.
- Implements the Dose Optimization Program (DOP) and applies institutional diagnostic reference levels.
- Verifies compliance with acceptance tests, start-up, and calibration protocols of recently acquired equipment.
- Supervises the quality control service of X-ray equipment and auxiliary systems.
- Supervises the preventive and corrective maintenance of equipment and evaluates the report of the results of post-maintenance quality control tests.
- Participates in staff training through the annual program of continuous education and training in radiological procedures and radiation protection of the Radiodiagnosis Service.

Estimates doses in cases of improper, involuntary, or accidental exposure, and evaluates the involved risk.

### Based on your own experience, what technical aspects would you consider are evolving in medical X-ray radiodiagnosis?

Technological development in medical radiodiagnosis means improving diagnosis while keeping radiation dose as low as possible and increasing efficiency to reduce costs. This development has led to increased productivity for radiodiagnosis services and professionals, improved accessibility to higher-quality medical images, reduced unnecessary testing and patient wait times, and access to studies and reports from anywhere with an internet connection through electronic devices.

The development of new technologies in radiodiagnosis, including digital detectors, has brought significant innovation to digital radiology.

It is worth noting that technological advances limit patient exposure. A report published by the National Council on Radiation Protection and Measurements in 2019 demonstrated that doses decreased between 15% and 20% in US patients between 2006 and 2016. The report attributes the decrease in doses to the development and improvement of equipment design (hardware) and configuration (advanced software), Image Gently and Image Wisely campaigns, along with increased utilization of the ACR Dose Index Registry, and mandatory accreditation requirements for imaging diagnostic centers.

## How would you summarize the care to be taken for patient protection in X-ray radiodiagnosis medical services?

Radiation protection for patients in radiodiagnosis services must comply with the principles of justification and optimization, establishing and applying reference levels for diagnosis, to avoid exposing patients to unnecessarily high doses.

Similarly, procedures should always be optimized to reduce doses without affecting the quality of diagnostic information. Special attention should be paid to children's exposure due to their greater sensitivity to radiation. Measures must be taken to ensure fetal radiation protection, especially regarding justification, emergency cases, and procedure optimization.

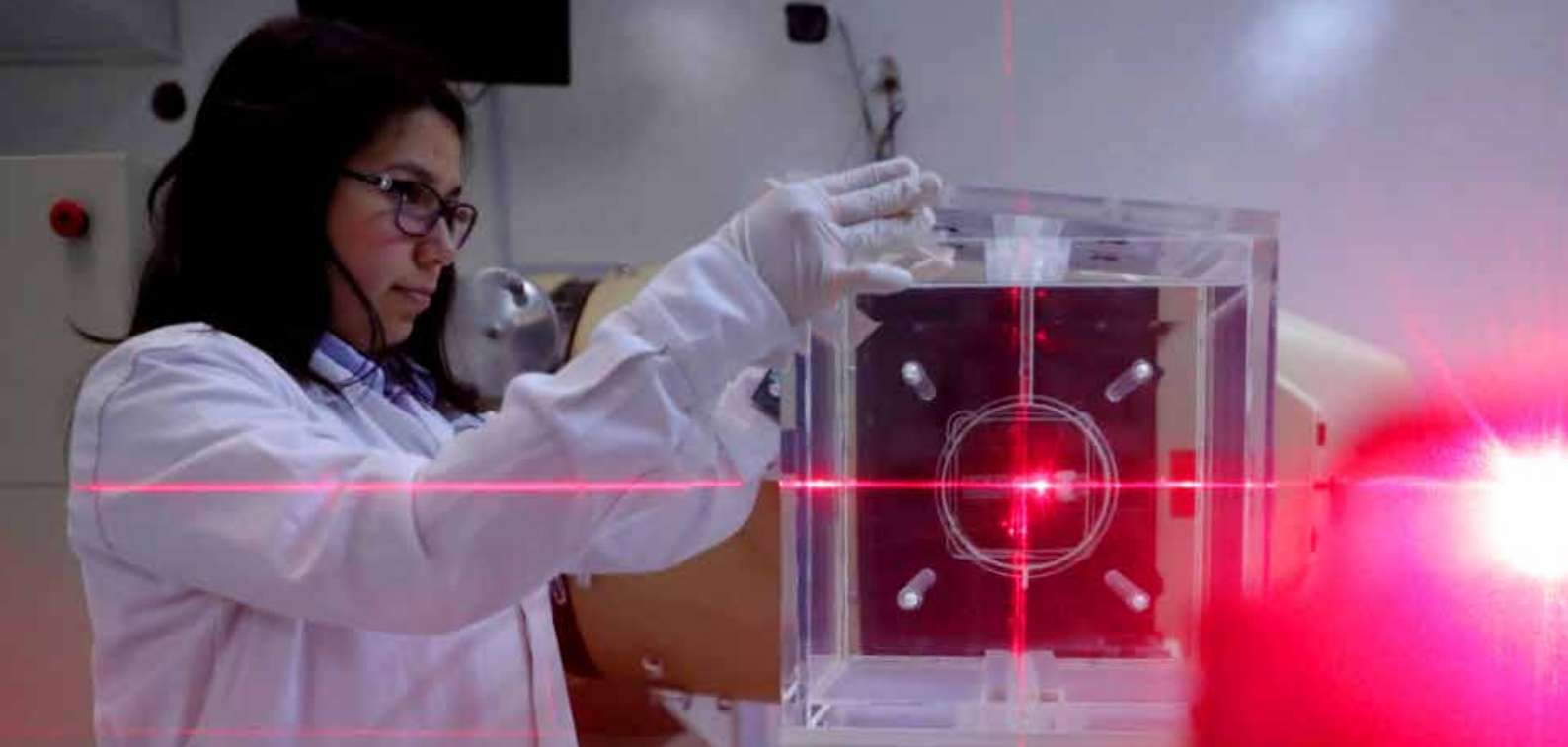
On the other hand, to guarantee the optimization of the dose delivered to the patient, X-ray equipment must undergo regular maintenance and calibration to reduce the possibility of failure and ensure continuous, reliable, safe, and cost-effective equipment operation. Similarly, X-ray systems must undergo quality control annually and when required, to verify their stability, operability, and optimal performance, as well as their clinical performance.

## Similarly, what can you tell us about the need to implement quality assurance programs in radiodiagnosis services?

The implementation of quality assurance programs in radiodiagnosis services is a priority to plan and systematize their administrative and assistance activities, aiming to ensure that the final product, the medical image produced and managed in their radiological facilities, has a high diagnostic quality that allows obtaining timely information that motivated the prescription, at the lowest possible cost, and with minimal patient exposure to radiation.

## What challenges lie ahead for the future?

Challenges and difficulties will always be present. Therefore, I would love to consolidate the Radiation Safety and Medical Physics Research Area so that young students and professionals can carry out their research projects. Of course, there are often difficulties due to the lack of instrumentation and budget to complete these projects. However, we now have sponsors who collaborate by providing us with the necessary instrumentation or with the support of their engineering staff for a comprehensive evaluation. For example, for my research on the quality of reconstructed images in digital breast tomosynthesis, we needed phantoms to evaluate the modulation transfer function in the XY and Z directions, as well as to evaluate the artifact scattering function. Since we did not have them in Peru, the collaboration of our sponsors allowed us to develop the first phantoms of this type in the country.



# Natali Cecilia Palomino Figueroa

**Medical Physicist**  
**Specialist in Ionizing Radiation Metrology**  
**Peruvian Institute of Nuclear Energy (IPEN)**

Natali joined the Secondary Standard Dosimetry Laboratory of the Peruvian Institute of Nuclear Energy (IPEN PERU SSDL) in 2019. Currently, Natali is on maternity leave, and her colleagues at the IPEN PERU SSDL commented on her work:

Natali obtained her undergraduate degree in Physics from the National University of Trujillo and her Master of Science (MSc)'s degree in Medical Physics from the National University of Engineering. At the IPEN PERU SSDL, she works as a Specialist in Ionizing Radiation Metrology, calibrating equipment for radiotherapy and activimeters used in nuclear medicine. She is also the alternate responsible for the IAEA TSA-3 project "Radiological Protection in Patients."

Her work at the IPEN PERU SSDL is of utmost importance as she is responsible for the conservation and stability control of secondary standards in ionizing radiation metrology, calibration of ionization chambers used in radiotherapy and radiodiagnostics, participation in performance tests in radioprotection, radiotherapy, radiodiagnostics, implementation of calibration procedures based on reference methods of IAEA, ISO, and other international regulations and rules .

Dosimetric calibration ensures the validity of results from equipment used in radioprotection, radiotherapy, radiodiagnostics, and nuclear medicine, allowing users to have certainty about the dose received in practices involving the use of ionizing radiation.

The IPEN PERU SSDL, a member of the IAEA/WHO network, is the only one in the country with this recognition. In 2022, the IPEN PERU SSDL obtained its accreditation from the National Institute of Quality (INACAL),

becoming the first IPEN laboratory to receive this recognition. Not only does it provide high-quality metrological services, but it also develops and transfers scientific knowledge in the field of ionizing radiation, being the bridge between the primary laboratory and the users. All these challenges have been very interesting, and Natali has had a very active participation, so together with the entire team working at the IPEN PERU SSDL, she has received important recognitions.





## Contribution of Women to the Development of Medical Physics in Peru

Dr. Rosendo Ochoa

Director of Postgraduate Unit of the Faculty of Science  
National University of Engineering

On July 12, 1995, the National University of Engineering (UNI) approved the creation of the Master of Science's Program in Medical Physics, entrusting its implementation to the Faculty of Sciences in coordination with the Peruvian Institute of Nuclear Energy (IPEN).

The purpose of Medical Physics is the application of resources and procedures of the physical sciences, especially ionizing radiation, for the prevention and diagnosis of diseases.

Since the creation of the Master's Program in Medical Physics at the UNI, women have played a significant role, with an average of 50% of professionals interested in these disciplines being women. This percentage is maintained in the number of students who enroll in courses and obtain their degrees.

Currently, around 50% of the teaching staff is composed of women, who contribute notably to the teaching of courses and transfer their experience to students. Women also stand out in the generation of new knowledge in the field of Medical Physics, developing research projects, advising students in courses and thesis preparation, and serving as members of thesis defense committees as Specialist Professors.

Thus, it is evident that in recent decades, women have not only increased their interest and presence in professional careers related to basic sciences such as Physics and Mathematics or in engineering, but also play an important role in different areas of the development of Medical Physics in our country, occupying leadership positions in medical centers, hospitals, and institutes, and actively participating in projects promoted by the International Atomic Energy Agency - IAEA.

Therefore, on International Women's Day, we recognize the hard and dedicated work of women in the field of Medical Physics.



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