FIVE QUESTIONS WITH

M. F. RICARDO MONTOYA

Radiofrequency Cavities: The engines of particle accelerators

Radiofrequency cavities (**RFCs**) are metallic structures that store electromagnetic fields. These fields provide energy to the particles when the particles pass through the cavity. In addition, **RFCs** can make manipulations in the longitudinal plane of the beam, the so-called RF gymnastics. Early accelerators used electrostatic potential cavities, DC, where the energy gained by the particles is proportional to the voltage difference inside it. However, these have a limitation about the maximum potential that can be stored due to electrostatic breakdown. Thus, DC cavities have a limit of the maximum energy that can provided to the beam. This constraint was overcome with the introduction of **RFC**, in which the electromagnetic fields are oscillating inside the cavity at a given frequency.

Could you introduce yourself?

My name is Gaspar Ricardo Montoya Soto [1]; I am from Guasave, Sinaloa, Mexico. I obtained my Bachelor's and Master's degree in Physics from the University of Sinaloa (UAS). Currently, I am a PhD student in Physics at the Science and Engineering Division, that is part of the Leon Campus of the University of Guanajuato**.**

Figure 1. M. F. Ricardo Montoya during research stays in different laboratories around the world.

Could you tell me about your institute and research topic?

I am working in the particle accelerator group at the University of Guanajuato. The topics of my research are the design, construction, and characterization of an **RFC** to accelerate electrons to an energy of 2 MeV in just 10 cm.

To carry out the challenge of building a functional **RFC,** the first step is to model the cavity's geometry using software, then to compute the electromagnetic fields and the figures of merit, and finally, to make beam dynamics simulations to

compute the acceleration in the particles. After that, we make some optimizations in the cavity geometry and the process is repeated until we reach certain goals important goals such as maximum energy gain and lower emittance growth. Once the design goal is reached, the next step is the prototyping of the cavities [2,3].

Figure 2 Analysis of the resonance frequencies of an RF cavity using a network analyzer.

Additionally, I am part of a collaboration with the Thomas Jefferson National Accelerator Facility (Jefferson Lab), working in beam dynamics studies. In that study, we include the true geometries of the accelerator components and their electromagnetic fields [4]. In addition, we compute the behavior and production rate of ions that are generated by collisions of the electron beam with the residual gas inside the vacuum chamber. Through beam dynamics studies, it is possible to estimate the ideal strength of the focusing devices, magnets, used to guide the particles, suggest modifications in the beam line, and even simulate failures.

The development of particle accelerators in Mexico is an area that has not been consolidated, and we are taking the steps towards the goal of building the first high energy particle accelerator in Mexico [5].

How or why did you choose that topic?

During my master's degree, I attended a lecture given by *Dr. Cristhian Valerio,* in which he talked about particle accelerators, his simulation work, and involvement in the assembly of different components of the Linac4 linear accelerator at CERN. After listening to him, I did some research about the use of accelerators and found that their applications extend from basic science, to industrial applications and cancer treatments. Even though my work focuses on **RFC**, I find everything related to this area very interesting.

Right now, what is the biggest challenge of your work?

The human resources and laboratory equipment. For example, for the machining of the **RFC** we had to learn how to operate a Computer Numerical Control (CNC) machining center because there is not staff member who can operate it. Therefore, it took us about three months to machine the first piece.

What did you think that will be the future of you research area?

We are going to be able to build the first high-energy particle accelerator in Mexico and once it starts to operate, it will attract attention to build more for specific purposes, such as food irradiation, X-ray generators to scan containers, cancer treatment, and even a synchrotron light source.

References

[1] Follow me on Facebook, sometimes I upload interesting things https://www.facebook.com/ricqasoto

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