FIVE QUESTIONS WITH DR. JUAN REYES HERRERA

Synchrotron radiation: a bright tool to develop science

In 1947, the *Synchrotron Radiation* (**SR**) was observed for the first time at the General Electric Research Laboratory in the United States [1]. At the beginning, this type of radiation was considered to be "parasitic". However, it did not take long for scientists to find the benefits of this type of radiation. Today, there are several accelerator facilities dedicated to produce high brilliance **SR** beam sources.

Could you introduce yourself?

My name is *Juan Reyes Herrera*; I am from a small village called Huejúcar, in the north part of Jalisco, Mexico. I got my bachelor's degree in physics from the Autonomous University of Zacatecas (UAZ). After that, I moved to Mexico City, where I obtained a Master and a PhD degree in Physics from the National Autonomous University of Mexico (UNAM). During that time, I spent around one year working in ALBA the Spanish **SR** source in Barcelona, Spain.

Figure 1. Dr. Juan Reyes Herrera.

Currently, I am working at the European Synchrotron Radiation Facility (ESRF) [2], in Grenoble, France. I started as a Postdoc in the beamline named ID21 [3], under a two years grant by the Mexican Council of Science and Technology (CONACYT) in 2018. After that, I started a temporary contract as a scientist in the Advance Analysis and Precision Unit in the Instrumentation Services & Development of the ESRF.

Could you tell me about your institute and research topic?

The ESRF is a joint research facility of 22 partner nations, and it is one of the most intense sources of synchrotron-generated light; producing X-rays 100 billion times brighter than the X-rays used in hospitals. These X-rays, endowed with exceptional properties, are produced at the ESRF by the high energy electrons (6 GeV) that race around the storage ring, a circular tunnel of 844 meters of circumference.

Figure 2. Aerial picture of the ESRF site, which is between two rivers, l'Isère and le Drac, in Grenoble, France.

Each year, the demand to use these X-ray beams increases and near to 9000 scientists ("users") from around the world come to the ESRF to perform their experiments in the "beamlines", each equipped with state-of-the-art instrumentation, operating 24 hours a day, seven days a week.

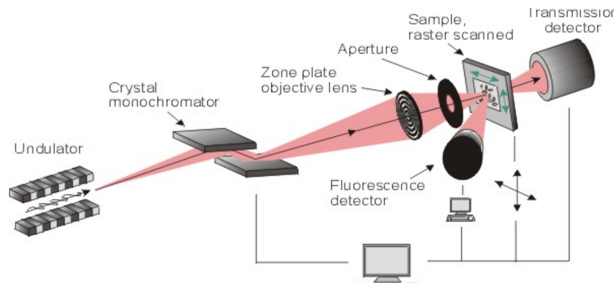

Figure 3. A scanning X-ray Microscope example (ID21, ESRF).

My research topics are diverse, mainly focused in the interaction of radiation with matter. From the beginning of my postgraduate formation, I have been using particle accelerators as a radiation source to perform X-ray based analysis techniques; hence, my natural interest on particle accelerators and its applications. More recently, during my postdoc at ID21, I worked on X-ray microscopy applications, for instance, elemental and chemical mapping of samples with different origins like environmental sciences, biology or cultural heritage.

In parallel, I am working on **SR** sources and X-ray optics (XRO) components present in synchrotron beamlines. Aiming to optimize the photon beam characteristics, for present or new beamlines designs, I have been performing XRO simulations for many ESRF beamlines. In fact, this last subject is my main activity during my current research position.

How or why did you choose that topic?

Regarding my current job research topic, honestly, similar to many things in life, I ended up working on the XRO simulations more by chance than by choice. Briefly, my first encounter to XRO happened during my stay at ALBA light source. Fortuitously, I had the opportunity to work there and I decided to learn about these matters with the hope to contribute in the Mexican synchrotron project, which was in development at that time (2013) [4].

After, when I arrived to ID21 beamline at the ESRF, they were planning a refurbishment, and I got involved in ray tracing simulations. Thus, I continued my activities collaborating with many **SR** and XRO experts at the facility; and now, I am fully dedicated to this type of simulations.

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

In December of 2019, the commissioning of a new storage ring, called Extremely Brilliant Source (EBS), has started. This was based on an ESRF-developed hybrid multi-bend achromat (HMBA) lattice [5]. Due this major upgrade, the ESRF became the first high-energy fourth-generation synchrotron, with X-ray performances increased by a factor of two order of magnitude.

Now, the implementation of new beamlines at EBS and the upgrade of existing ones requires a considerable simulation effort to anticipate potential difficulties. It is necessary to check that the optical elements will manage the high power, evaluate and compare different optical setups, verify the suitability of working conditions, optimize the optics, compare performances with old sources, and assist in the commissioning by comparing experiment and calculations. Optimization on the optical layout requires a detailed simulation of the optics imperfections, which in many cases are the limiting factor of the beamline optics. There is a continuous effort to include deformations of the optical elements due to heat load, which presumably will be higher under EBS high photon fluxes; therefore, optics simulations have to include results from engineering modelling of the thermal deformations, usually carried out using fine-element analysis. It is important to mention that there is a considerably short time to carry out the above-mentioned tasks, due to the (everyday closer) deadline for opening the facility to user's community.

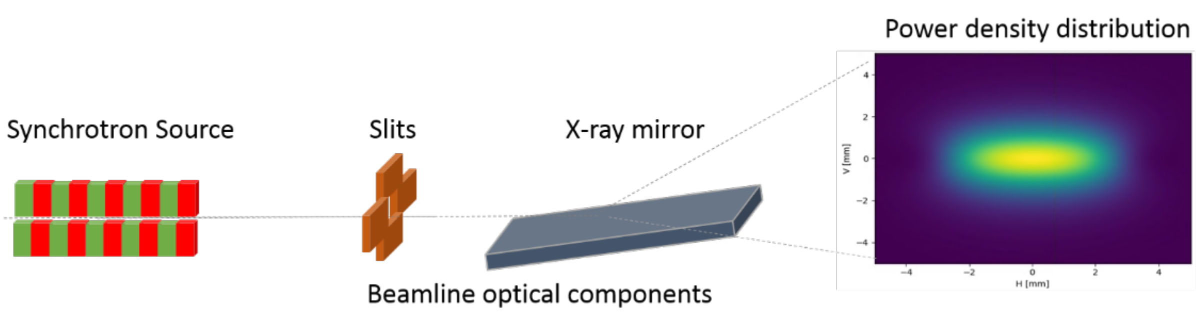

Figure 2. Simulation del studio Example of a basic SR and XRO simulation to study the heat load on a component due the photon beam power.

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

In the present, there are many well-built and robust codes to perform XRO simulations, which have demonstrated their utility and adequacy to fulfil the needs of optics simulations for existing and newly upgraded storage rings [6]. Nevertheless, many tools are still under development in order to improve the codes that perform optical simulations considering partial coherence of the **SR** source; for example, by reducing the complexity of the methodologies, which normally consumes high computer resources and requires long time-consuming calculations.

References

[1] H. C. Pollock, *Am. J. Phys.*, 51(3), 278 (1983).

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