FIVE QUESTIONS WITH

DR. BRUCE YEE RENDON

ADS: Reliability-oriented accelerator

Accelerator-driven Subcritical System (**ADS**) is an efficient solution to reduce the lifetime and the radiotoxicity of nuclear residuals by the transmutation of the minor actinides. **ADS** projects employ high-intensity proton accelerators to produce spallation neutrons in a subcritical reactor. The main characteristic of the **ADS** accelerator is its extreme reliability required, which is beyond that of the present performance of the high-intensity linacs. Thus, a reliability-oriented accelerator is adopted to fulfill that stringent requirement [1].

Could you introduce yourself?

Figure 1. Dr. Bruce Yee-Rendon

My name is Bruce Yee-Rendon, I am from Culiacan, Sinaloa, Mexico. I obtained my bachelor's in physics from the Facultad de Ciencias Físico-Matemáticas from the Universidad Autonoma de Sinaloa [3] in 2007. Then, I moved to Mexico City to study my master (2007-2009) and doctorade (2010-2014) in physics in Physics deparment of the Centro de Investigacion y de Estudios Avanzados (CINVESTAV) del Instituto Politecnico Nacional (IPN) [4]. My bachelor's and master's thesis were in the area of high-energy physics. I analyzed data from the experiment H1 of the Hadron Elektron Ring Anlage (HERA) at the German Electron Synchrotron (DESY). At the end of 2009, I joined the field of particle accelerators. One year later, I became a summer student at the European Organization of Nuclear Research (CERN) [5] in Switzerland, and from 2011 to 2013, I did my doctorate research in Crab Cavities at CERN. In 2015, I moved to Japan to become a postdoctoral fellow at the High Energy accelerator research organization (KEK) at the Japan Proton Accelerator Research Complex (J-PARC) [6]. From 2018 to now, I am a senior postdoctoral at Japan Atomic Energy Agency (JAEA) in J-PARC, but in the **ADS** project.

Could you tell me about your institute and research topic?

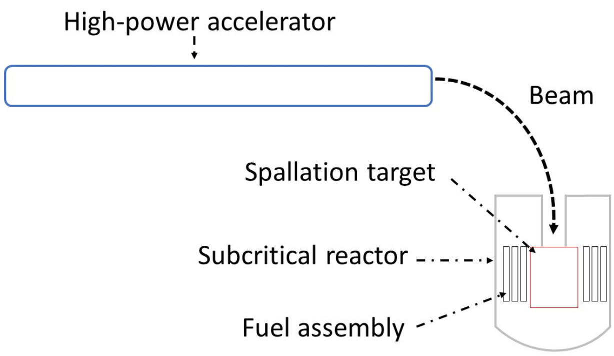

Figure 2. A schematic design of an ADS.

JAEA is the main institute that develops nuclear research in Japan. JAEA and KEK operate the highest intensity proton accelerator, J-PARC, in Asia. Nuclear energy is a competent source of energy, but it has some critical challenges, such as the storage of residual nuclear. Thus, since the end of the 80s, JAEA has been developing the **ADS** project for the transmutation of nuclear waste. The **ADS** accelerator demands stringent reliability, i.e., the number of beam trips must be small to avoid thermal stress in the subcritical reactor structure. My work is the development of beam optics, i.e., the arrangement of the elements that compose the linac, and strategies to fulfill the conditions for the **ADS** projects.

How or why did you choose that topic?

Well, physics is a kind of family business: my two older brothers are physicists (Cristo and Ana); therefore, I just followed their steps. My eldest brother (Cristo) was a summer student at DESY; as a result, I became very interested in high-energy physics. However, my supervisor, Dr. Ricardo Lopez Fernandez (CINVESTAV), always encouraged me to work in accelerators. In 2009, I attended a CERN Accelerator School (CAS), where I met Dr. Oliver Bruning, the head of the Beam Department at CERN. He contacted me with Dr. Frank Zimmermann, who eventually became my Doctorate Supervisor. Since I was a doctorate student, my main work was related to high-intensity proton machines, LHC, J-PARC, and now **JAEA-ADS**. Most of my work involves beam tracking simulations with an emphasis on beam loss distributions. Thus, when I finished my KEK postdoctoral, I continued in J-PARC but worked on the **ADS** challenge.

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

ADS is a project in the high-intensity frontier; thus, we need to face the challenges of any high-beam power machine: control the beam loss to allow accelerator maintenance. To this end, we need to understand and find ways to compensate for the space charge effects, which are the dominant source of beam degradation when the beam current is increased. Thus, it is necessary to have an accurate model for developing robust optics designs that allow operating at high intensities with the proper control of the beam. Furthermore, the demanded reliability is beyond the present operation of the high-intensity accelerators. As a result, we must develop a fault-tolerance scheme that allows linac operation even in the presence of failures in the elements. In addition, we must create an efficient design to reduce operation costs and maintenance that make the project viable.

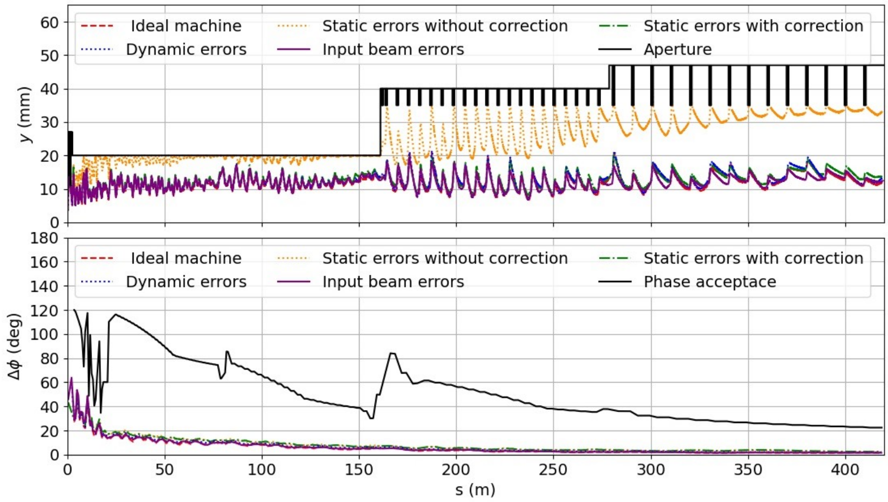

Figure 3. Vertical and Phase beam envelope for the JAEA-ADS linac for baseline and error cases.

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

More reliable machines are required to continue expanding the frontier in particle accelerators; thus, Reliability-oriented accelerators will become the mainstream for the design and operation of future particle accelerators.

References

[1] J. L. Biarrotte, Reliability and fault tolerance in the European ADS project, CERN Report No. -2013-001.481 (European Organization for Nuclear Research, Geneva,2011).

[2] B. Yee-Rendon, et al., Design and beam dynamic studies of a 30-MW superconducting linac for an accelerator-driven subcritical system. Phys. Rev. Accel. Beams. 24,120101 (2021).

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