23rd International Workshop on Next Generation Nucleon Decay and Neutrino Detectors (NNN24)

Contribution ID: **25** Type: **Poster**

Development of GAN Models for Simulating Optical Filters in XARAPUCAs Detectors

Mateus Jesus de Oliveira Rodrigues[1], Gustavo do Amaral Valdiviesso[2], Anibal Thiago Bezerra[3]

[1] Universidade Federal de Alfenas, Departamento de Física, Alfenas, Minas Gerais, Brasil

[2] Universidade Federal de Alfenas, Departamento de Física, Poços de Caldas, Minas Gerais, Brasil

[3] Universidade Federal de Alfenas, Departamento de Física, Alfenas, Minas Gerais, Brasil

E-mail: mateus.jesus@sou.unifal-mg.edu.br

Keywords: neural networks; GAN; transmittance; optical filters

\section{Abstract for the NNN event}

The XARAPUCAs are the light detectors aimed to be used in neutrino experiments. They work by trapping light using a sequence of carefully designed optical materials. Given their specialized nature, it is essential to have an accurate simulation of their response. Such simulations must address the intricate details of light-to-matter interactions, providing a realistic representation of the detector's performance under various conditions. This enables researchers to optimize the design and operation of XARAPUCAs to maximize efficiency in detecting neutrinos in the underground environment. A critical component of simulating XARAPUCAs involves understanding the response of the optical dichroic filter layers concerning light of various wavelengths and angles of incidence. Accessing this information relies on obtaining experimental data or conducting simulations. Experimentally, it is necessary to precisely measure the absorbance and transmittance of the filter across different wavelengths and incident angles. However, this is not always feasible. Conversely, simulating the filter response is also challenging, as models may not fully capture the complexities of the materials. Additionally, experimental data is often discrete, requiring interpolation schemes to estimate optical values for unmeasured wavelengths and angles. Ideally, a filter's model should accurately replicate the real behaviors of materials through simulations that cover a continuous parameter space. Furthermore, such a model must be efficient, providing the desired properties quickly, to be seamlessly integrated into the XARAPUCAs' simulation workflow.

Hence, using artificial intelligence methods to simulate the filter's response presents a promising approach. Training AI models with measured and simulated data allows for precise predictions and insights into the filter's behavior across a continuous range of parameters, offering the benefits of efficient numerical models. Based on this, our current efforts have focused on developing architectures based on Generative Adversarial Networks (GAN) combined with Long Short-Term Memory (LSTM) layers to model XARAPUCAS' filters. GANs facilitate the generation of realistic synthetic data by effectively capturing the distribution of underlying physical processes, while LSTMs layers deal with the sequential and temporal dependencies inherent in light-matter interactions in this case.

A notable strength of the presented model is its adaptability, allowing for adjustments in architecture and hyperparameters to accommodate different datasets and simulation needs. This adaptability is important for dealing with the wide range of working conditions that XARAPUCAs may face, which helps with ongoing efforts to make those neutrino detectors better.

Author: JESUS, Mateus (Universidade Federal de Alfenas - UNIFAL)

Session Classification: Poster