Annual Report (XXXVIII cycle)

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Ph.D. cycle: *XXXVIII*

Year: *First*

1 Research activity

My current research activity is primarily focused on developing a new and efficient method for container's inspection against transportation of illicit Special Nuclear Material (SNM). This includes devising a strategy to collect the necessary information in an innovative way and explore the application of artificial intelligence techniques, specifically tailored to detect and distinguish between various radiation arising from different types of nuclear materials. This work is part of RAISE, a PNRR-funded project, aiming to harness innovative methodologies to address challenges in nuclear safety in maritime transportation.
During this year, I designed a detector prototype specifically meets the RAISE project's stringent criteria. Emphasis was laid on ensuring that the detector was not just efficient, but also compact and lightweight. The rational behind this was to conceive a device that could potentially be integrated with robotic components for easy operation and transportation. Other constraints were given by the minimum detection activity imposed by the standard nuclear detection norms.
Once the prototype has been conceptualized through simulations, a prototype version of it has to be built, in order to verify the design.
A fundamental phase of this work involved an in-depth characterization of signals emanating from various radioactive sources. Alongside this, I also paid significant attention to the background, that mimicking the signal, makes the signal detection challenging. By studying and differentiating these signals, my goal was to extract features and patterns.
This preparatory work will allow me, in the later stage of my PhD, to develop AI algorithms to efficiently identify different radioactive sources. By doing so, not only we can enhance the detection accuracy, but we can also ensure a rapid response about a possible threat, which is crucial for RAISE.
In parallel to the RAISE project, I also developed AI-supported tools to analyze data of the JLAB-CLAS experiment. This activity, conducted in collaboration with US data scientists from Old Dominion University and JLab researchers, gave me the opportunity to interact with and learn from experts in the field. This reserach broadened my understanding of various ML models and ensured a solid foundation for the subsequent stages of my PhD work.

2 Courses and exams

I attended the following courses:

- Machine Learning for Particle Physics (A. Coccaro, F. di Bello)
- Neutrinos and Nuclear Astrophysics (S. Zavatarelli) - Exam not given yet
- QCD and Collider Physics (S. Marzani) - Exam not given yet

3 List of publications

- T. Alghamdi et al. "Toward a generative modeling analysis of CLAS exclusive 2π photoproduction". https://doi.org/10.1103/PhysRevD.108.094030
- M. Battaglieri et al. "Secondary beams at high-intensity electron accelerator facilities". arXiv:2311.08440

4 Schools and conferences

I attended the following school:

- Eighth edition of MLHEP school (`https://indico.cern.ch/event/1229514/`)

and I attended the following conferences:

- Hadron2023 (`https://agenda.infn.it/event/33110/`)
- MENU2023, T. Vittorini, "A(i)DAPT collaboration" - poster presented(`https://indico.him.uni-mainz.de/event/171/`)

5 Comments and notes

Between May 10th and May 19th 2023 I visited Jefferson Lab to work with with ML experts to deepen my knowledge of the subject and devise an optimal AI-supported strategy for SNM detection.

Between November 2nd and November 13th 2023 I visited Jefferson Lab to partecipate to the collaboration meeting, where I presented my AI related work on data analysis of CLAS experiment.