

Annual Report (XXXVII cycle)

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Name and surname: *Marco Spreadico*

Supervisor: *Prof. Marco Battaglieri*

Ph.D. cycle: *XXXVII*

Year: *Second*

1 Research activity

My research activity is focused on possible experiments searching for Physics Beyond the Standard Model to be performed at Jefferson Lab in Newport News, Virginia, USA.

During the first part of this year, I concluded the characterization of CsI crystal to be used in a possible coherent neutrino-nucleus scattering detector. This study, that I initiated in the preceding year of my PhD, was extended to characterize new parameters of the crystals such as scintillation time. I also worked on the measurement of crystal properties at cryogenic temperature (liquid nitrogen temperature).

I dedicated a few months to the test of a streaming readout system for future experiments. The objective of this study was to develop a system capable of performing a quick, real-time analysis of data, resulting in more sophisticated triggers. I performed this study in collaboration with EIC (Electron-Ion Collider) group. I was involved in the commissioning of two prototypes. Since the two prototypes are made of a new scintillating material, I worked on the characterization of the crystals (light yield, attenuation length, scintillation time) and of the readout electronics (amplification, dynamic range, readout design). For the second prototype, which underwent beam measurements at JLab, I also developed new triggers exploiting the existing streaming readout system used at JLab. In particular, I implemented online triggers able to discriminate beam-related events and cosmogenic events.

The last activity, which became my focus in the last months of this year, is the characterization of a potential Dark Matter experiment at JLab that makes use of the existing infrastructure. In particular, I explored the feasibility of assembling a compact detector, hosted inside a well positioned beyond JLab experimental Hall-A beam dump, to explore new Dark Matter scenarios. In particular, I focused my study on Dark Matter produced by secondary muons. To perform this study, I implemented new Dark Matter particles and relative production and decay processes in GEANT4. I conducted extensive simulations to estimate the signal yield and assess the potential reach of a future experiment.

2 Courses and exams

I attended the following courses:

- Machine Learning for Particle Physics (A. Coccaro, F. di Bello)
- The double trouble of the missing matter in the Universe (E. Branchini, M. Raveri)
- FIPs in the ALPs school

I gave the exams for the following courses:

- Machine Learning for Particle Physics
- Particle Physics and Multimessenger Astroparticles

Starting from September 18th I will attend the course QCD and Collider Physics (S. Marzani)

3 Publications

I am coauthor of the following publications:

- Iu. A. Skorodumina et al. "Double-pion electroproduction off protons in deuterium: quasi-free cross sections and final state interactions" (Aug. 2023). arXiv: 2308.13962
- A. Kim et al. "Beam Spin Asymmetry Measurements of Deeply Virtual π^0 Production with CLAS12" (July 2023). arXiv: 2307.07874
- A. Accardi et al. "Strong Interaction Physics at the Luminosity Frontier with 22 GeV Electrons at Jefferson Lab" (June 2023). arXiv: 2306.09360
- C. W. Kim et al. "Measurement of the helicity asymmetry \mathbb{E} for the $\vec{\gamma}\vec{p} \rightarrow p\pi^0$ reaction in the resonance region" (May 2023). arXiv: 2305.08616
- S. Diehl et al. "First Measurement of Hard Exclusive $\pi^-\Delta^{++}$ Electroproduction Beam-Spin Asymmetries off the Proton". Phys. Rev. Lett. 131, 2 (2023), p. 021901. arXiv: 2303.11762
- G. Christiaens et al. "First CLAS12 Measurement of Deeply Virtual Compton Scattering Beam-Spin Asymmetries in the Extended Valence Region". Phys. Rev. Lett. 130, 21 (2023), p. 211902. arXiv: 2211.11274
- A. Celentano et al. "The BDX experiment at Jefferson Laboratory". PoS ICHEP2022, (2022), p. 327
- S. Diehl et al. "A multidimensional study of the structure function ratio $\sigma_{LT'}/\sigma_0$ from hard exclusive π^+ electro-production off protons in the GPD regime". Phys. Lett. B 839, (2023), p. 137761. arXiv: 2210.14557

I am corresponding author of the following publications:

- M. Spreafico et al. "Performance of BDX-MINI veto systems". Nucl. Instrum. Meth. A 1048, (2023), p. 167949.

4 Conferences

I attended the following schools:

- FIPs in the ALPs (<https://indico.cern.ch/event/1247323/>)
- Strong2020 HaSP School (<https://indico.ific.uv.es/event/6803/>)

and I participated to the following conferences with the respective contribution:

- M. Spreafico, "Dark Matter search with the BDX-MINI experiment" - talk at Hadron2023 (<https://agenda.infn.it/event/33110/>), presented by me and awarded as "Best Oral presentation" in the session "Hadrons and Physics Beyond the Standard Model"

5 Comments and notes

During the entire year I was tutor for the course of Fisica Generale 1 in Physics Bachelor degree.

Between October 29th and November 21st 2022 I traveled to JLab to participate to CLAS12 Collaboration meeting and perform the commissioning of the first prototype for Streaming Readout tests for EIC.

Between February 20th and March 2nd 2023 I traveled to JLab for the commissioning of the second prototype for Streaming Readout test for EIC.

From June 19th to June 24th 2023 I travelled to CERN to take part in on-beam tests for modern gas tracking detectors (uRWELL) for the high luminosity upgrade of the CLAS12 experiment.