Letter of intent: proposal template

**Please specify an acronym, a project title and the name(s) of the project leader(s)**

**University of Montenegro**

**Prof. Nataša Raičević**

**In the sections below, please provide details on** *(2 pages max.):*

1. **Research objectives**

We would like to express our intention to continue and extend our phenomenology research on the 3D structure of the proton using the Transverse Momentum Dependent (TMD) Parton Branching (PB) method. This work aligns closely with the goals of the STRONG-2020 program, particularly in improving our understanding of hadron structure in the non-perturbative QCD regime.

Besides the phenomenological work, we will also undertake an experimental analysis related to investigations of jet substructure, in which some members of our group are involved. Additionally, our group will contribute to Phase II of the project.

* Phenomenology

**We will perform QCD fits to high-precision DIS HERA data to constrain the small transverse momentum behavior in the extrapolation to the soft, non-perturbative region.**

**This behavior plays a crucial role in the small parton transverse momentum (kₜ) region of Transverse Momentum Dependent Parton Distribution Functions (TMDs), and is therefore important for understanding Drell–Yan production at small transverse momenta (qₜ). It also significantly affects the small transverse momentum behavior of single-inclusive hadron production in DIS (SIDIS), which reflects both the transverse momentum of the incoming parton and additional transverse momentum generated during the hadronization process.**

**We will use a parameterization of αₛ in the soft region and also incorporate predictions from an analytic continuation of αₛ into the non-perturbative domain.**

* Experimental analysis

The production of jets is one of the crucial processes used to improve our understanding of the strong force, described by quantum chromodynamics (QCD).Important information about processes such as parton shower, hadronization and underlying event can be extracted by studying the internal structure of the jet.

In recent years, significant efforts have been made to overcome experimental and theoretical difficulties to obtain valuable information from the jet substructure. The development of new experimental declustering techniques enabled the reconstruction of the evolution of the jet shower and access to the splittings at the smallest angles. These techniques allowed for the first experimental observation of the dead-cone effect. In recent years, many different substructure variables have been defined, with varying sensitivity to the momentum and angular properties of the jet constituents. On the theoretical side, many of these variables are IRC safe, which allows the high-precision pQCD calculations, in some cases up to NLO+NNLL accuracy. Further exploitation of these variables can open a new window for a better understanding of QCD effects, and the results of the measurement can be used as valuable input for the improvement of MC generators.

Moreover, these techniques can be used in heavy-ion collisions, and comparison with the corresponding proton-proton results would allow studying the medium-induced radiation pattern.

* LHC Phase II contribution

After Long Shutdown 3 (LS3), the Gas Electron Multiplier (GEM) system at CMS, CERN, will consist of three stations: GE1/1, GE2/1, and ME0. The aim of this research, conducted within the GEM collaboration, is to develop a next-generation Detector Control System (DCS) for the Phase II upgrade of the GEM detectors at CERN. While the current DCS has performed well for earlier configurations, it lacks the scalability and modularity needed for the upgraded system. This project will focus on designing a new, flexible DCS architecture capable of managing the increased complexity and performance requirements of all three GEM stations. An important feature of the new DCS will be the integration of a Detector Protection System (DPS), which will enable the detector to automatically transition to a safe state in response to external conditions such as changes in the LHC or CMS magnet status. To ensure stable operation in the harsh radiation environment, particularly in the ME0 subsystem, the project will also develop and implement a high-voltage compensation mechanism that dynamically stabilizes detector performance. The final objective is to deliver a DCS that is not only robust and adaptable but also fully interoperable with the existing CMS infrastructure

1. **Connection to Transnational Access infrastructures (TAs) and / or Virtual Access projects (VAs)**

The development of the next-generation DCS for the Phase II GEM detector upgrade relies on access to CERN’s research infrastructure. Through Transnational Access (TA), the project benefits from physical access to GEM chambers, control electronics, and associated laboratory resources needed for the integration, testing, and validation of the new DCS components.

In addition, the project will make use of Virtual Access (VA) resources, including online repositories, control system frameworks (e.g., WinCC OA, JCOP), and CMS collaboration tools for cross-collaborative development and deployment of the DCS.

We also have close collaborations with several institutions, including CERN, DESY, and ULB, Sapienza. Therefor Transnational Access (TA) is essential to this project, as it enables early-career researchers to participate in conferences, present results, and engage with the broader research community. TA also supports the organization of workshops and meetings, as successfully done during STRONG project. Our group is actively involved in on-site responsibilities at CERN, including DAQ and DQM shifts, where mobility support is necessary. Regular institutional visits are also important for maintaining effective collaboration with our partners.

**3. Estimated budget requeste,**

* **3 years post-doctoral (or doctoral student) ~70 000 euro**
* **TA – 2-3 days per month during 4 years (or cumulatively) ~ 13000 euro**
* **Travel support mainly for participating in conferences ~ 18000**

**4. Participating and partner institutions**

In the above projects we are collaborating with colleagues from CERN, DESY, ULB and Sapienza University in Rome.