Reference letter on PhD thesis
“Study of proton-proton interactions at the ATLAS experiment at CERN”
by Mr. Stanislav Polacek

The thesis presents an experimental study of various aspects of the hadron jet production in proton-proton collisions using the ATLAS detector at the Large Hadron Collider at CERN.

The thesis is written in a clear and concise manner. It consists of five chapters: the first chapter provides a summary of the theoretical foundations of the Standard Model of particle physics; the second chapter offers a concise description of the ATLAS detector and its subsystems; the third chapter details the Tile Calorimeter and the methodology employed for cell timing calibration; the fourth chapter covers the jet reconstruction procedure and the steps for jet energy calibration; and the fifth chapter presents the measurement of the two-differential di-jet production cross sections. The Conclusions section summarizes the thesis and highlights the author’s personal contributions to the results obtained.

The scientific outcome of the thesis could be conceptually split in two parts. The first part involves Mr. Polacek’s precision timing calibration of TileCal electronics channels and the implementation of a monitoring system that enabled prompt detection and correction of timing issues during the Run-3 data-taking. Additionally, the author has enhanced and applied techniques to address various timing offsets and the double-peak structures in E-cell timing distributions observed during the 2022-2024 TileCal operation. These timing calibration results have already been utilized in several ongoing and published ATLAS analyses based on Run-3 data and will be a key component of an upcoming TileCal Run-3 operations journal publication.

The second part presents the measurement of di-jet production cross sections. The author proposed a trigger scheme to maximize statistical precision, performed a dedicated data selection procedure to mitigate any data corruption, and conducted numerous checks, such as time and pile-up stabilities, to ensure high precision of the reported cross sections. The author identified a set of systematic uncertainties and developed a correlation model to describe measurement precision. The measurement uncertainties were propagated to particle-level results using a detector effects unfolding procedure. Special attention was given to removing statistical jitter from the reported systematic uncertainties to ensure accurate and precise interpretation of the measured cross sections. Although the di-jet production cross section measurement

reported in this thesis has not yet been published, the ATLAS internal review has already begun, and the paper is expected to appear in print in the near future.

Hereafter, I have few comments regarding the thesis style and content:

- The thesis presentation assumes the reader has in-depth knowledge of the ATLAS performance and operations, whereas it might be beneficial to address a broader audience.
- The timing calibration methods are presented concisely, but there is a lack of explanation regarding the causes of timing problems and the reasoning behind the proposed solutions.
- The author chose to measure two double-differential cross sections, while a triple-differential measurement might have been a more natural choice for this study. The discussion of the pros and cons of this choice is missing.

Despite these remarks, I am impressed by the quality of the research and the novelty of the results obtained. The thesis “Study of Proton-Proton Interactions at the ATLAS Experiment at CERN” represents a valuable contribution by Mr. Polacek to the ATLAS experiment’s physics program and to experimental high-energy physics in general. The Tile Calorimeter timing calibration methods developed in this thesis are now integral to Tile Calorimeter performance and may be used by current and future hadron calorimeters. The di-jet production cross sections measured by the author will aid the high-energy physics phenomenology community in validating state-of-the-art perturbative quantum chromodynamics calculations and improving precision in proton parton density functions and the strong coupling constant at high momentum transfer ranges.
In my opinion, Mr. S.Polacek has demonstrated significant potential for creative scientific work. I have no doubt that he deserves the Ph.D. title

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