SUPERVISOR'S ASSESSMENT OF FINAL WORK

I. IDENTIFICATION DATA

Title:	Efficiency and accuracy of time-of-flight detector measurements in the ATLAS experiment and di-photon vertex reconstruction for the search for an axion-like particle in data from LHC Run -3
Author´s name:	Viktoriia Lysenko
Type of assignment:	Master Thesis
Faculty:	Faculty of Nuclear Sciences and Physical Engineering (FNSPE)
Department:	Department of Physics
Supervisor:	Doc. Dr. André Sopczak
Supervisor´s affiliation:	IEAP CTU in Prague, Husova, 240/5, 11000 Prague 1

II. ASSESSMENT OF CRITERIA

Work assignment and topic motivation — **demanding**

Assess how demanding the assigned topic is. Brief introductory word on motivation for choosing the topic.

The topic has been demanding as the analysis is mostly based on new data recorded in 2022 and 2023, which had not been studied before. This novelty of the data resulted in many technical challenges, as in particular the analysis framework had a major upgrade in the ATLAS experiment from LHC Run-2 to Run-3. Therefore, related tools for the analysis, like the vertex reconstruction code had to be adapted to the new analysis framework. Another challenge with the Time-of-Flight (ToF) analysis part has been the need for a complex calibration. Compared to her previous work, she added a new HPTDC calibration. A general motivation for this project is the search for axion-like-particles (ALP). The ALP search within the ATLAS collaboration including the AFP detector data. In 2019 I introduced this ALP search and led the Run-2 analysis to the recent publication JHEP 07 (2023) 234. The thesis title was chosen quite general and the specific aspects of the analysis developed during the work on the project with Run-3 data.

Fulfilling the assignment — **fulfilled**

Consider whether the work submitted meets the assignment topic. Comment, if necessary, on items of the assignment not fully answered, or mention whether the scope of the assignment has been broadened. If student failed to fully treat the assigned topic, try to assess the importance, impact and/or the reasons for failings.

All aspects of the thesis assignment have been fulfilled. Technical challenges appearing during the project executing were mastered. A table of differences with respect to her previous work (Master thesis, Kyiv University is attached.

Student´s effort and independent approach to the topic solution — **excellent**

Assess whether student displayed constant effort while investigating the problem, whether they regularly consulted the issues and whether they attended consultations well prepared. Assess student´s creativity and independence.

The student has been excellent in finding solutions to the problems occurring during the execution of the project. She used very efficiently the ATLAS analysis framework and in particular the AFP detector software.

Professional standard — **excellent**

Give your opinion on the professional standard of the work, application of course knowledge, references, and data from student´s practice.

The student's research has a high professional standard. The course knowledge in particle physics, detector physics, statistics and computing skills where very well applied. Furthermore, she integrated very well into the ATLAS data analysis teams, in particular the combined performance group for the AFP detector.

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Level of formality and of the language used	**excellent**
Assess the use of scientific formalism, the typography and language of the work.	
The language used in her thesis is of high quality, and the descriptions are clear.	

Choice of references, citation correctness	**average**
Give your opinion on student´s effort in utilizing references in their investigation. Characterize the choice of references and say whether all relevant sources were utilized. Verify whether all resource facts were properly distinguished from student´s own findings and results, whether there was no breach of citation ethics, and whether all reference citations are complete and agree with the citation usage and standards.	
Citations are properly set. As the citations fulfil the standard, and are not exceeding the expectations an average mark is given.	

Further comments and assessment
Give your opinion on the quality of the main results obtained in the work, e.g. on the level of quality of theoretical results, or the applicability of the engineering and programming outputs of the solutions obtained, on publication activity, experimental skills, etc.
Owing to the novelty of data, there has been a large interest in the student's results from the AFP detector community, both for the 2022 and 2023 data on the performance studies of the first LHC Run-3 data. The efficiency and precision of the ToF detector, as part of the AFP detector system, has been presented by the student in several AFP meetings and she received very positive feedback. Her results on the calibration of the ToF detector and the resulting vertex reconstruction demonstrated for the first time the ability of this detector and connects to the ALP search. In the ALP search the precise vertex reconstruction using the ToF allows a much better background reconstruction. The thesis results demonstrate both, based on simulation the much improved background rejection using the ToF detector for the vertex reconstruction, and the actual ToF performance with recorded data.

III. OVERALL ASSESSMENT AND SUGGESTED GRADE

Summarize all aspects of the work most influential for the overall assessment. If adequate, write questions to be answered by student during the defence of their work before the board.

The thesis work of the student was very well carried out independently, exceeding the expectations. The task was challenging as newly recorded data has been used, and thus many technical challenges arose. New aspects leading to the result where mastered very well, in particular the change of the ATLAS analysis release software for LHC Run-3, and the ToF calibration for the vertex reconstruction. An efficiency summary was completed for the ToF detector for the whole 2022 data taking. The student is an excellent presenter and she communicated well and adequately with colleagues in the ATLAS and AFP community. She was already allowed by the collaboration to present her results in the student session of the German Physical Society meeting in Dresden in March 2023 and the Particle Physics Summer School Alumni Conference in Krakow in July 2023.

Enclosure: Table detailing difference to her previous work.

Suggested grade: **A - excellent.**

Date: 30.8.2023

Signature: André Sopczak

Thesis differences May (OLD) versus August (NEW), Viktoriia Lysenko, 2023

OLD	NEW
Different data sets	
Chapter 3: Analysis of the ToF detector with LHC Run-3 data	
3.2. Single-Gaussian fit and double-Gaussian fit, conclusion – double-Gaussian works better. Single-Gaussian removed (approx. minus 4 pages) No HPTDC calibration.	**3.2.** Single-Gaussian fit removed, used only double-Gaussian fit (conclusion from previous work). **3.2.1.** Multi-peak structure analysis (3 new pages – new section). **3.2.2.** HPTDC calibration and likelihood procedure (12 new pages – new section).
Tables with results removed. Some plots moved to appendix (approx. minus 4 pages)	Instead of tables, plots with results added.
3.3. Two methods for efficiency determination. Little background analysis.	**3.3.** Comparison of two methods added, differences explained. **3.3.1.** Background analysis – new method added, hit correlation map (3 new pages). **3.3.2.** Efficiency summary for all data 2022 added (1 page – new section).
Some plots moved to appendix (approx. minus 3-4 pages)	
Exchanged chapter 4 <-> 5	
Chapter 4: ToF vertex reconstruction (in old thesis – chapter 5)	
Different data sets, same analysis	
	Plot for the precision of the fit added (Fig. 4.8)
Chapter 5: Di-photon vertex reconstruction (in old thesis – chapter 4)	
4. Vertex reconstruction on data 2017 (simulations + recorded data) and data 2022 (only recorded). Section with data 2017 removed. **4.1.** Removed comparison of two methods on simulated data and usage on recorded data 2017. Removed background rejection analysis on simulated data. **4.2.** Calorimeter pointing method was used on recorded data 2022. (6 pages removed).	**5.** Now only one section – recorded data 2022. Calorimeter pointing method was used on recorded data 2022 for a different data set.
Total	
Removed about 18 pages	About 20 new pages in main text and 75 new pages in Appendix