THESIS SUPERVISOR'S REPORT

I. IDENTIFICATION DATA

Thesis title:	Application of Machine Learning for the Charged Higgs Boson Search Using ATLAS Data.
Author's name:	Jiří Pospíšil
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	André Sopczak
Reviewer's department:	Institute of Experimental and Applied Physics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	**challenging**

How demanding was the assigned project?

The thesis was very demanding as it applied Machine Learning to a challenging task of separating a specific signature (signal) and unwanted background events. In addition to the machine learning optimizations, the project also required to get familiar with data format used in the ATLAS experiment, and also using ATLAS software like root and trexfitter. Further challenges were the network optimization with the provided features, and the determination of the working point for highest signal sensitivity. The developed machine learning should also be flexible to cope with different signal masses, having very different signal kinematics.

Fulfilment of assignment	**fulfilled**

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

The thesis fulfilled all tasks. The primary goal to develop and test machine learning algorithms is fulfilled. As the simulation of the signal by the ATLAS collaboration took several weeks, the student developed the machine learning code first on a similar signal to separate the background. Important for the task was the statistical analysis. Over the assigned task, the student also learned to use the trexfitter package to calculate the significance (confidence level) in a separate way, which is compatible to the method used in other analyses by the CERN collaborations for a better compatibility in the comparison of the results. The trexfitter package was also used for producing plots of signal background processes with a high standard.

Activity and independence when creating final thesis	**A - excellent.**

Assess whether the student had a positive approach, whether the time limits were met, whether the conception was regularly consulted and whether the student was well prepared for the consultations. Assess the student's ability to work independently.

The student met the time limits very well and reported more than weekly on the progress of his studies. Jiri was well prepared for the discussions on the progress. He also presented his results at a meeting at CERN and received positive feedback. He was also able to answer questions on specific analysis aspects during and following his presentation. He demonstrated very good research capabilities and solving problems independently.

Technical level	**A - excellent.**

Is the thesis technically sound? How well did the student employ expertise in his/her field of study? Does the student explain clearly what he/she has done?

Technical aspects are well explained and expertise from his field of studies on machine learning is applied. Jiri used several machine learning algorithms and compared their performance. Very good separation power was achieved between the signal and background.

Formal level and language level, scope of thesis	B - very good.
Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?	
The standard formalism of the thesis and the notations are correct. The thesis has sufficient details and is well presented. The English language is very good and clear.	

Selection of sources, citation correctness	B - very good.
Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?	
The thesis lists previous work adequately. The reference list is rather short, but sufficient. The selection of sources is adequate. The student's work is very clear. The bibliography style in the reference list could be more unified.	

Additional commentary and evaluation (optional)
Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.
Overall, the student performed very well in this research project applying the machine learning techniques. The topic is novel and it extends previous research in a new analysis channel. The result is promising and shows for small signal masses significant improvement over previous results. The code is well written and documented which allows the future use to follow up on this analysis. The student has been very skillful in scientific research with the application of machine learning tools.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading.
In summary, the thesis contains a solid piece of research work with the application of machine learning. The student performed very well, worked independently and communicated his ideas and progress regularly.

The grade that I award for the thesis is **A - excellent.**

Minor comments / questions:

How is made use of the GPU and how much does it speed up the training?

Date: **30.5.2022**