

The Research Group

Elementary Particle Physics

has the honor to invite you to the public defense of the PhD thesis of

Emil Bols

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:
Machine Learning for Top Quark Physics

Promotors:

Prof. dr. Jorgen D'Hondt

The defense will take place on
**Thursday, July 7, 2022 at 16h in auditorium
D.2.01, Promotiezaal.**

Members of the jury

Prof. dr. Nick van Eijndhoven (VUB, chair)
Prof. dr. Alberto Mariotti (VUB, secretary)
Prof. dr. Steven Lowette (VUB)
Prof. dr. Pieter Libin (VUB)
Prof. dr. Wouter Verkerke (Universiteit van
Amsterdam)
Dr. Maria Aldaya (DESY)

Curriculum vitae

Emil Bols graduated in 2017 as with a Master of Science in physics at the University of Copenhagen. Next he started as a PhD student in elementary particle physics at the Vrije Universiteit Brussels. He is a member of the CMS Collaboration at the Large Hadron Collider at CERN, where he was responsible for the development of techniques to identify heavy flavor jets. He has developed a Deep Neural Network to identify jets from heavy flavour jets as well as light quarks and gluons. He also has developed new techniques that make use of Machine Learning algorithms to reduce the systematic uncertainties observed in physics analysis.

Abstract of the PhD research

In the last 5 years, machine learning algorithms, in particular the neural network, have proven to be a very powerful tool for high energy physics at the LHC. In the realm of top quark physics, machine learning has risen to prominence both in event selection and event reconstruction.

In this thesis a Deep Neural Network for jet flavour identification is presented. It is capable of identifying b jets, c jets, light quark jets and gluon jets. By utilizing a novel neural network architecture that can efficiently exploit the full jet information it achieves state of the art performance in each of the jet classification tasks. This neural network is extended further to estimate jet energy corrections. Since the jet energy response depends on the flavour of the jet, the architecture and inputs for jet flavour identification can be utilized for making a general jet energy correction, which leverages the flavour information going beyond the standard approach of jet energy corrections that has no jet flavour dependence.

Machine learning has not just found success for particle physics reconstruction, but it is also heavily used for particle physics event selection. In this case the machine learning methods are optimized to minimize the statistical uncertainty on the measurement by increasing selection efficiency and reducing the rate of background. However in modern particle physics analyses the systematic uncertainty is the dominant component of the total uncertainty. In this thesis a novel machine learning method is developed that makes an event selection that reduces the systematic uncertainty. A showcase of the method is done in the setting of a top quark mass measurement.