T 48: Exp. Methods I

Time: Tuesday 17:00–18:15 Location: WIL/C129

T 48.1 Tue 17:00 WIL/C129

Tau-lepton decay mode classification using machine learning in ATLAS — •Jonathan Pampel[1], Duc Bao Ta[2], Christina Dimitriadi[1], Jochen Dingfelder[1], Tatjana Lenz[1], and Eckhard von Törne[1] — [1]University of Bonn, Germany — [2]University of Mainz, Germany

The tau-lepton is the heaviest charged lepton with a mass of about twice the mass of the proton. It can decay leptonically into a neutrino and other leptons or hadronically into a neutrino and hadrons, the latter being mostly pions. In the ATLAS collaboration at CERN, there are already several algorithms for the decay mode classification of hadronically decaying tau-leptons (tau-jets).

This talk presents a novel technique based on convolutional neural networks to classify the hadronic tau-lepton decay modes. The goal is to count the number of neutral and charged pions in a tau-jet using calorimeter information. To do this, for each calorimeter layer, a 'picture' of the tau-jet is generated. These 'pictures' are used as input for a neural network built from several 2D convolution and pooling layers and flattening layer followed by a number of dense layers.

The preliminary results of this study will be presented based on ATLAS Run 2 Monte Carlo samples, i.e. pp-collisions at a center of mass energy of 13TeV. This includes an introduction into the problem as well as a visualization of the preprocessed data which is fed into the neural network. Finally, the best performing neural network's architecture and its performance will be presented.

T 48.2 Tue 17:15 WIL/C129

Photon identification efficiency measurement with the Matrix Method using $139\,\mathrm{fb}^{-1}$ of data collected by the ATLAS experiment at $\sqrt{s} = 13$ TeV — •Nils Julius Abicht and Tomas Dado — Technische Universität Dortmund, Fakultät Physik

Photon identification (ID) is an integral part of many analyses, for example, measurements of Higgs boson properties or hypothetical pro cesses involving isolated photons in the final state. As the photon ID efficiency is not necessarily modeled well in Monte Carlo simulations, data-driven approaches are employed. One of these approaches is the Matrix Method, which estimates the efficiencies between a loose and a tight selection. For this selection, two sets of variables are used. The first set describes the longitudinal and lateral shape of the calorimeter shower and the second the topology of the center of the calorimeter shower. For calculating the photon ID efficiency, track isolation criteria that are weakly correlated with with the second set of variables are used. A description of the Matrix Method, the systematic uncertainties of the measurement as well as the resulting photon ID efficiencies and corrections to simulated efficiencies, calculated on full Run-2 samples, corresponding to $139\,\mathrm{fb}^{-1}$, are presented.

T 48.3 Tue 17:30 WIL/C129

Improvement of Electron identification with the ATLAS detector and performance with first Run3 data — Asma Hadef and •Lucia Masetti for the ATLAS-Collaboration — Johannes Gutenberg Universität, Mainz, Germany

Electrons are important objects both for the search for new physics and for precision measurements. An algorithm to identify electrons in the ATLAS experiment based on a deep neural network was recently developed. Inputs to the network are high-level discriminating variables derived from the reconstructed electron track and cluster of energy depositions in the calorimeter system. The performance is estimated in simulated proton-proton (pp) collisions at $\sqrt{s}$=13 TeV and compared to the current identification algorithm which is based on a likelihood approach. Depending on the kinematics of the electron candidate, an increase in background rejection between 1.7 and 5.5 at the same signal efficiency can be observed. The performance of the electron identification algorithms is evaluated by measuring efficiencies using tag-and-probe techniques with large statistics samples of isolated electrons from $Z \to ee$ resonance decay. The first results of Run3 data recorded in 2022 from pp collisions at $\sqrt{s}$=13.6 TeV, corresponding to an integrated luminosity of 3.4 fb^{-1}, will also be presented.

T 48.4 Tue 17:45 WIL/C129

A Particle Identification Framework for Future Higgs Factories — •Ulrich Einhaus — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg

The particle physics community has concluded that the next collider should be an $\mathrm{e}^+\mathrm{e}^-$ Higgs factory. Such a collider would also enable many other precision measurements, e.g. of the top quark and in the electroweak sector, as well as searches for exotic particles. In the ongoing discussions it has become increasingly clear that particle identification including charged hadron ID is a key feature that enables a number of analyses and improves many. A number of different PID systems - from the simple muon ID to gaseous dE/dx and dN/dx to calorimeter shower shapes and time of flight (and more) - are being envisioned for the proposed future Higgs factory detector concepts. It is desirable to assess their impact and the effect of combining them in a common tool to enable fair comparisons.

This talk presents a new modular approach to a generic PID framework for the different possible future Higgs factories, embedded in the Key4HEP framework. It discusses implementation questions, performance measures and possible physics applications, exampling the International Large Detector (ILD) concept for the International Linear Collider (ILC).

T 48.5 Tue 18:00 WIL/C129

Time-of-flight particle identification at future Higgs factories — •Bohdan Dudar[1,2], Jenny List[1], Annika Vauth[2], and Ulrich Einhaus[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [2]Universität Hamburg, Hamburg, Germany

It is established that particle identification of charged hadrons with $\gtrsim 5$ GeV momentum plays an important role at future e^+e^- Higgs factories to achieve outstanding precision in Higgs and electroweak physics, which can be covered by dE/dx (or dN/dx) in a gaseous tracker or RICH. However, at low momentum these methods become inefficient, while also some detectors don't have a gaseous tracker or RICH in their designs at all. Modern Si sensors technologies that can achieve time resolutions of 10 – 30 ps, such as LGADs, allow us to use the time-of-flight technique to identify $\pi^\pm$, $K^\pm$ and p at low momentum by placing fast timing layers in the ECAL or as an outer tracker. This should enhance the particle identification at the future Higgs factory. Thus, achievable time resolutions of the LGADs together with time-of-flight particle identification technique are interesting points to investigate for the future detector R&D.

In this talk, we present test beam measurements of time resolution of LGAD samples with an electron beam at the DESY II test beam facility, the latest developments of the time-of-flight technique as well as its realistic momentum reach and limitations of integrating it into the detector at a future e^+e^- Higgs factory, using the International Large Detector at the International Linear Collider as an example case.