T 5: Methods in particle physics 1 (e/gamma, SciFi)

Time: Monday 16:00–17:45 Location: Geb. 20.30: 2.066

T 5.1 Mon 16:00 Geb. 20.30: 2.066

Photon identification at the CMS experiment using transformer networks — Johannes Erdmann, •Tim Kappe, and Florian Mausolf — III. Physikalisches Institut A, RWTH Aachen University

Particle identification is essential for experiments like CMS at the Large Hadron Collider (LHC). One important physics object is the photon, its main signature being an energy deposition in the electromagnetic calorimeter. In physics analyses as carried out, for example in the diphoton decay of the Higgs boson, it is important to distinguish between the real prompt photons and other physics object which produce similar signatures. For example this can be the case for the two usually strongly collimated photons from the decay of neutral pions, which can be reconstructed as a single photon. The latter often appears in jets, which are abundant at the LHC. Such fake photons tend to have wider and less isolated signatures compared to real photons.

Transformers are state-of-the-art neural networks with a wide range of applications. A vision transformer is a transformer architecture specialized to analyze images like the energy depositions in the electromagnetic calorimeter. In this talk, our study of vision transformers for photon identification and comparisons with convolutional neural networks are presented.

T 5.2 Mon 16:15 Geb. 20.30: 2.066

Measurement of photon identification efficiencies with the inclusive photon method using 2022 CMS data — Johannes Erdmann, •Nitish Kumar, and Jan Lukas Späh — III. Physikalisches Institut A, RWTH Aachen University

The measurement of the photon identification efficiency is an essential component of all analyses using photons. Currently, the CMS collaboration uses the tag-and-probe technique to measure the photon identification efficiencies up to photon p_T of 500 GeV. This method is limited by small event yields in the high-p_T region and the extrapolation beyond 500 GeV is associated with additional uncertainties, which is relevant for analyses involving high-p_T photons.

The inclusive photon method, also known as the matrix method, allows a precise measurement of the photon identification efficiencies at high photon p_T. This method uses an inclusive photon sample selected with single photon triggers. It utilizes isolation criteria to obtain the fraction of prompt photons in the whole sample and the subsample meeting the identification criteria. This enables the extraction of the photon identification efficiency in a data-driven way. In this talk, we present the preliminary measurement results of photon identification efficiencies with the inclusive photon method using data collected by the CMS experiment in 2022.

T 5.3 Mon 16:30 Geb. 20.30: 2.066

Photon identification and associated uncertainties for photons originating from displaced vertices in the search for ALPs with ATLAS — Peter Krämer, Kristof Schmieden, Matthias Schott, and •Olivera Vujinović — Johannes Gutenberg University, Mainz, Germany

Some puzzling questions in particle physics, such as the strong CP problem or the discrepancy of the muon magnetic moment could be solved by introducing light scalar or pseudo-scalar axion-like particles (ALPs). According to theoretical models, a wide range of ALP-masses and couplings to standard model (SM) particles, such as photons and Higgs bosons, is allowed. A large part of this parameter space can be probed by collider experiments.

In this analysis, conducted within the ATLAS experiment at the LHC, we search for the SM Higgs boson decaying into a pair of ALPs further decaying into two photons each, with a special focus on photons originating from the displaced vertices. This resulted in the development of a dedicated approach estimating the systematic uncertainties, taking into account the displaced origin of the photons from the primary vertex. In this talk, the final results of the analysis will be presented.

T 5.4 Mon 16:45 Geb. 20.30: 2.066

Modern electron reconstruction for future Higgs factories — •Leonhard Reichenbach[1,2], André Sailer[1], Christian Grefe[2], Philip Bechtle[2], and Klaus Desch[2] — [1]CERN, Geneva, Switzerland — [2]Universität Bonn, Germany

The precise reconstruction of electrons is an important ingredient for the proposed physics program at future Higgs factories (HF). This becomes especially important in the Standard Model precision measurements with the highest indirect sensitivity for new physics: m_W and triple gauge couplings. These were also identified as two high-priority focus topics of the ongoing HF study of the European Committee for Future Accelerators (ECFA). The track reconstruction is particularly challenging for electrons due to their increased material interaction probability. The ECFA HF study is performed with multiple detectors and accelerators in mind, sharing the common Key4hep "turn-key" software framework. We are extending this framework with a dedicated electron reconstruction algorithm utilizing state-of-the-art methods from LHC experiments. For this, we will investigate the usage of a Gaussian sum filter (GSF) based track fit using the ACTS tracking framework and evaluate its performance in a detector-agnostic Key4hep $e\nu W$ benchmark analysis

T 5.5 Mon 17:00 Geb. 20.30: 2.066

Measuring time resolution of the LHCb SciFi detector — •Sebastian Schmitt[1], Guido Haefeli[2], Stefan Schael[1], and Ettore Zaffaroni[2] — [1]RWTH Aachen — [2]École polytechnique fédérale de Lausanne

The LHCb experiment at the LHC is an experiment optimised for the precision measurement of b-hadron decays. Following a successful Run I and Run II, the detector underwent upgrades for Run III and IV, known as LHCb Upgrade I. Notably, Upgrade I features a Scintillating Fibre (SciFi) detector as part of its tracking system. Looking ahead to Runs V and VI, the subsequent LHCb Upgrade II will feature a combination of a Silicon Pixel detector and a SciFi tracker, in order to cope with the increased pileup.

Both the Upgrade I and II are going to operate under higher instantaneous luminosities, presenting challenges from increased neutron radiation damage and backsplash from the calorimeter situated downstream of the tracking stations. To address the first issue, the readout will be cooled to cryogenic temperatures, as detailed in the talk by Th. Oeser. Additionally, timing could prove to be a valuable factor, particularly in countering noise originating from ECAL backsplash. In this talk, for the first time, the measured timing resolution of large-scale 2.5 m long SciFi mat is presented.

T 5.6 Mon 17:15 Geb. 20.30: 2.066

The commissioning and performance of the Scintillating Fibre Tracker of LHCb — Xiaoxue Han, Blake Leverington, Ulrich Uwer, •Chishuai Wang, Lukas Witola, and Ya Zhao — Physikalisches Institut, Heidelberg, Germany

During LS2, the LHCb collaboration has installed a new tracking detector, the Scintillating Fibre (SciFi) Tracker, as a part of the LHCb Upgrade I.

The detector uses scintillating fibres as active material and silicon photomultiplier arrays for the electronic readout. The detector has been designed to be readout at 40MHz and to be operated at a five times higher instantaneous luminosity than in LHCb Run2.

The SciFi tracker has been completed in early 2022 and has been commissioned since. The commissioning includes the calibration of the thresholds used for digitalisation and the time alignment of the signal integration window with respect to the physics signal.

First performance studies have been performed and will be presented.

T 5.7 Mon 17:30 Geb. 20.30: 2.066

Concept for a Cryogenic SciFi Detector for the LHCb Upgrade II — David Fehr, •Thomas Oeser, Stefan Schael, Thorsten Siedenburg, and Michael Wlochal — I. Physikalisches Institut B, RWTH Aachen

The Upgrade II of the LHCb detector at the Large Hadron Collider (LHC), scheduled to be installed during Long Shutdown 4, is intended to prepare the detector for the challenging environment of the High Luminosity LHC, operating at luminosities of around $1.5 \times 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ with the aim of integrating $\sim 300\,\mathrm{fb}^{-1}$ of collision data through its lifetime.
A central part of Upgrade II is the Mighty Tracker, which comprises

an inner silicon pixel tracker around the beam pipe and an outer Scintillating-Fibre (SciFi) tracker. The readout silicon photomultipliers of the SciFi tracker are cooled to cryogenic temperatures, significantly reducing the dark count rate and ensuring a high hit efficiency at larger luminosities.
This talk presents a concept for a cryogenic SciFi tracker, focussing on the realisation of the cooling system and its coupling to the readout electronics.