T 11: Data, AI, Computing, Electronics I (Statistical Methods, Applications)

Time: Monday 16:45–18:00 Location: VG 2.101

T 11.1 Mon 16:45 VG 2.101

Performance measurements of Tau identification tools in ATLAS — •David Dahiya, Christian Schmidt, Arno Straessner, and Asma Hadef — Technische Universität Dresden

Tau leptons are fundamental in a variety of Standard Model and Beyond Standard Model processes currently being studied at the LHC. Their identification is crucial for exploring new physics, as they often serve as key signatures in searches for novel particles and interactions. This work focuses on improving Tau Lepton Identification (TauID) by conducting performance measurements and comparing different TauID models. Current tau identification approaches utilize Recurrent Neural Networks (RNNs), which are trained on a combination of tracks, clusters, and high-level variables to produce a predictive score for each tau candidate. However, recent advancements in machine learning introduce Graph Neural Networks (GNNs) as a promising alternative. GNNs are trained on jet and track-level variables and exploit graph-based attributes to predict features such as vertex position, jet flavor, and track origin, potentially offering a more robust and detailed analysis. This study provides a comparison of the performance of RNN-based and GNN-based models to evaluate the impact of GNNs' added complexity on tau identification. Additionally, GNNs are used to compare and evaluate tau fake factors based on a control data set using the latest Run 3 data.

T 11.2 Mon 17:00 VG 2.101

Adaptation and Optimization of Large Radius Tracking in Athena — •Doğa Elitez[1], Paul Gessinger[1], and Lucia Masetti[2] — [1]CERN — [2]Johannes Gutenberg University of Mainz

Large Radius Tracking (LRT), is a specialized tuning of charged particle track reconstruction algorithms, designed for particles originating far from the main interaction point. It has been integrated into the ATLAS experiment's primary particle reconstruction workflow as of Run-3. For the upcoming High Luminosity upgrade of the LHC, the inner detector is planned to be replaced by an all-silicon inner tracker, ITk, and the implementation of tracking algorithms plays a crucial role. This presentation describes the work focusing on the necessary adaptation and optimization of the LRT workflow within the offline ATLAS track reconstruction software, the Athena framework. The effectiveness of the LRT workflow, strongly linked to both physics and computing performance, is also examined in this study.

T 11.3 Mon 17:15 VG 2.101

Making your analysis reusable with model-agnostic likelihoods and their serialization — •Lorenz Gärtner[1], Thomas Kuhr[1], Slavomira Stefkova[2], Danny van Dyk[3], Lukas Heinrich[4], Méril Reboud[5], Nikolai Krug[1], and Malin Horstmann[4] — [1]LMU, Munich, Germany — [2]University of Bonn, Bonn, Germany — [3]IPPP Durham, United Kingdom — [4]Technical University Munich, Germany — [5]Université Paris-Saclay, France

What constitutes a "signal" in particle physics? Typically, a signal is defined by a specific physical process of interest. Using simulations, we approximate the probability densities of such processes and compare them to known backgrounds through likelihood-based methods.

What happens when parameters for the process need to be revised? What if more precise theoretical predictions become available? How can we search for an entire class of similar processes parameterized by multiple variables? Moreover, can we leverage results from multiple analyses to constrain these parameters?

We address these questions with a simple and efficient reinterpretation approach. We construct model-agnostic likelihoods by employing kinematic reweighting techniques, enabling flexible exchanges of signal models and inference on underlying physical parameters. This method's generality ensures compatibility across analyses, while its straightforward serialization facilitates easy distribution and reuse.

To demonstrate the power and simplicity of our approach, we use the likelihoods of the Belle II $B^+ \to K^+ \nu\bar{\nu}$ analysis to constrain theory parameters.

T 11.4 Mon 17:30 VG 2.101

Hypothesis tests and model parameter estimation on data sets with missing correlation information — •Lukas Koch — JGU Mainz

Ideally, all analyses of normally distributed data should include the full covariance information between all data points. In practice, the full covariance matrix between all data points is not always available. Either because a result was published without a covariance matrix, or because one tries to combine multiple results from separate publications. For simple hypothesis tests, it is possible to define robust test statistics that will behave conservatively in the presence on unknown correlations. For model parameter fits, one can inflate the variance by factor to ensure that things remain conservative at least up to a chosen confidence level. In this talk I will describe a class of robust test statistics for simple hypothesis tests, as well as an algorithm to determine the necessary inflation factor for model parameter fits.

T 11.5 Mon 17:45 VG 2.101

Impact and improvement of handling uncertainties regarding R(D) and R(D*) combining algorithms — •Stefanie Meinert, Ilias Tsaklidis, Florian Bernlochner, and Markus Prim — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

Unexplained phenomena like the matter-antimatter asymmetry and neutrino masses motivate precise measurements of Standard Model (SM) parameters. Testing Lepton Flavor Universality (LFU), which predicts equal coupling of all lepton flavors to the W boson, offers a promising approach to uncover new physics. The analysis of $R(D)$ and $R(D^*)$ in semileptonic B decays is ideal due to its theoretical predictability and experimental accessibility.

HFLAV combined results from LHCb, BaBar, Belle, and Belle II to estimate $R(D)$ and $R(D^*)$, finding deviations of 1.6σ and 2.5σ from SM predictions. Their χ^2-based Combination Code (CoCo), which accounts for statistical and systematic correlations, yields a significance of 3.31σ relative to the SM, indicating potential new physics.

These results rely on assumptions and approximations about systematic correlations, and inconsistent reporting of uncertainties challenges result combinations. Using HFLAV data, we explore the impact of systematic uncertainty variations and present a first average of $R(D)$ and $R(D^*)$ from three internal Belle II measurements via likelihood combinations, leveraging pyhf and SysVar, a Python-based package developed at the University of Bonn for consistent treatment of systematic uncertainties.