T 19: Methods in particle physics 2 (alignment, luminosity)

Time: Monday 16:00–18:00 Location: Geb. 30.41: HS 1

T 19.1 Mon 16:00 Geb. 30.41: HS 1

Track-Based alignment for the SciFi detector at the LHCb experiment — •Miguel Ruiz Díaz[1], Giulia Tuci[1], Nils Breer[2], and Biljana Mitreska[2] — [1]Physikalisches Institut, Universität Heidelberg — [2]Technische Universität Dortmund

A precise knowledge of the position and orientation of the different sub-detectors is crucial for the operation of any particle physics experiment. The LHCb detector has undergone a major upgrade for Run 3, and the alignment of its sub-detectors has played a central role in its commissioning.

A central part of the LHCb upgrade is the installation of a Scintillating Fiber (SciFi) detector featuring three layers of tracking stations downstream of the magnet. An accurate alignment of the SciFi tracker is essential to achieve the best possible charged particle momentum resolution and tracking efficiency, impacting most of the measurements conducted at the LHCb experiment.

This talk presents the application of track-based alignment techniques to compute the position and orientation of the SciFi detector. Results from the Run 3 commissioning period are presented, showing the impact of the SciFi alignment on track residuals and mass distributions. The alignment of the SciFi detector will be monitored in real-time during the data-taking period. The alignment constants -rotations and translations of the SciFi components- will be automatically updated if the change in their values exceeds certain thresholds. These thresholds have been evaluated in a precision study employing Monte Carlo simulated data. The results of the study are discussed.

T 19.2 Mon 16:15 Geb. 30.41: HS 1

Alignment of the CMS tracker with Run 3 data — •Lucia Ximena Coll Saravia — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

The Compact Muon Solenoid (CMS) has the world's largest silicon tracker, comprising 1856 pixel modules and 15148 strip modules that ensure accurate track reconstruction. In order to maintain high precision one must compensate for significant time variations caused by magnet cycles, temperature variations and ageing of modules that lead to changes in the track reconstruction. Consequently, throughout data-taking it is necessary to continuously correct the position, rotation and curvature of these modules in a procedure called tracker alignment. The focus of this talk is on the performance of the CMS tracker alignment in Run 3, with particular attention to the strategies employed to derive alignment calibrations for the reprocessing of the 2022 and 2023 data. Results showing the impact of tracker alignment on physics are also presented.

T 19.3 Mon 16:30 Geb. 30.41: HS 1

Global alignment of the LHCb SciFi Tracker and Vertex Locator — •Nils Breer, Biljana Mitreska, and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The LHCb tracking systems including the Scintillating Fibre Tracker (SciFi) and the VErtex LOcator (VELO) underwent a major upgrade as part of the LHCb upgrade I. As part of the upgrade, it is crucial for the VELO and the SciFi to be aligned to achieve the best possible physics performance and data quality.

A new alignment strategy is developed combining the VELO together with the SciFi to form a combined procedure named global alignment. This allows for studying effects on different constraints and weak modes, that can further enhance the precision, by also using the VELO information for the track reconstruction in the SciFi. A more realistic description of the SciFi modules is implemented to represent the bending of the modules. This is a key piece of the current alignment strategy.

The alignment configuration of multiple detector elements of the VELO and the SciFi is discussed using the 2023 LHCb data. The updates to the alignment strategy by adding a more realistic description of the SciFi modules will be presented.

T 19.4 Mon 16:45 Geb. 30.41: HS 1

Illuminating heavy ion collisions with tracks: Track-based measurements of the luminosity of Pb+Pb collisions with the ATLAS detector — •Kartik Deepak Bhide, Valerie Lang, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

Precisely determining the luminosity of collisions delivered by the LHC is the goal of the ATLAS luminosity program. The dedicated sub-detector LUCID is used as the reference luminometer for all types of colliding beams. In p+p collisions, several other sub-detectors and algorithms are used for calibration, cross-checks and long-term stability, both during the LHC Run 2 (2015-2018) and Run 3 (since 2022). In contrast, for heavy ion collisions, mainly luminosity algorithms based on LUCID were available during the LHC Run 2.

In this work, the potential of luminosity measurements using particle tracks reconstructed with the ATLAS Inner Detector, as a new luminometer for heavy ion collisions in the LHC Run 3 will be discussed. The performance of two track-based luminosity algorithms, namely track counting and event counting, will be presented, using Pb+Pb collision data recorded in 2023. The impact of the track selection requirements on the performance of the algorithms, and the statistical precision achieved will be shown. Comparisons to LUCID and Zero Degree Calorimeter-based luminosity will be presented.

T 19.5 Mon 17:00 Geb. 30.41: HS 1

Emittance Scans at the LHCb Detector in Run 3 — Johannes Albrecht, Elena Dall'Occo, Hans Dembinski, and •Jan Ellbracht — TU Dortmund University, Dortmund, Germany

Luminosity is a key component for daily operations and accurate measurements of cross-sections at the LHCb detector. Therefore, a luminosity calibration is performed once per year and per centre-of-mass energy in dedicated van-der-Meer scans. These are performed under specific beam conditions, leading to a maximum number of visible proton-proton interactions of $\mu \sim 1$ when the beams are colliding head-on.

In Run 3, the LHCb detector operates at a five times higher instantaneous luminosity compared to the previous LHC runs, with a μ of 5.5. Hereby, it is planned to perform regular emittance scans during data taking fills in order to verify the linearity of luminosity in μ from calibration to data taking conditions. An important component of these emittance scans is a new set of luminosity counters, needed to determine luminosity. These quantities are expected to scale linear to luminosity. Hence, this is studied extensively to make sure that the counters are linear and, therefore, accurate.

This talk will focus on the emittance scan analysis, procedure, linearity studies and first results of Run 3 data.

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T 19.6 Mon 17:15 Geb. 30.41: HS 1

Luminosity measurements using the ATLAS Forward Proton (AFP) detector — Jan Broulim, •Petr Fiedler, and Andre Sopczak — Czech Technical University in Prague

The latest results of luminosity measurements using the AFP detector are presented.

T 19.7 Mon 17:30 Geb. 30.41: HS 1

Studies of ATLAS Forward Proton (AFP) ToF performance with Run-3 data — •Viktoriia Lysenko and Andre Sopczak — Czech Technical University in Praguw

Performance studies of ATLAS Forward Proton (AFP) ToF with Run-3 data are presented.

T 19.8 Mon 17:45 Geb. 30.41: HS 1

The Experiment Control System for the LHCb BCM in Run 3 — Johannes Albrecht[1], Federico Alessio[2], Martin Bieker[1], Elena Dall'Occo[1], and •David Rolf[1,2] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland

The Beam Conditions Monitor (BCM) is a safety system of the LHCb experiment, designed to prevent radiation damage to sensitive detector components due to bad beam conditions. Should an adverse beam scenario occur, the BCM will trigger a beam dump, thus preventing the beam from damaging the detector.

As part of the comprehensive upgrade of the LHCb detector, the readout of the BCM has been upgraded. The outdated hardware is replaced by a newly designed Machine Interface Beam Abort Decision (MIBAD) board. To operate and monitor the MIBAD a new Experiment Control System (ECS) has been implemented and integrated into

the global LHCb control system.

This contribution presents the BCM and MIBAD board, with a focus on the implemented ECS. In particular, the communication protocols and design considerations of the individual components of the ECS are discussed in detail.