T 26: Methods in Particle Physics II

Time: Tuesday 16:15–17:30 Location: KH 00.020

T 26.1 Tue 16:15 KH 00.020

Luminosity Calibration in the 2025 Oxygen Runs for the ATLAS Experiment using van der Meer Scans — •Jon Hoxha, Cigdem Issever, and Clara Elisabeth Leitgeb — Humboldt-Universität zu Berlin

The ATLAS experiment is a general-purpose detector at the Large Hadron Collider (LHC) at CERN, which conducts precise measurements for a wide range of physics phenomena. To obtain precise cross-section measurements, it is crucial to properly calibrate the luminosity detectors. ATLAS employs dedicated van der Meer (vdM) scan sessions to calibrate them, during which interaction rates are measured in certain beam conditions. Most importantly, during these scans, the beams are transversely separated in a controlled manner to understand changes in the interaction rate with separation, which is ultimately used for the luminosity calibration.

This presentation will outline the methodology, the analysis workflow, and the specific challenges for the luminosity calibration of the oxygen collision runs, which were conducted in July 2025. These runs represent the first time such collisions happened at the LHC, providing unique information into the dynamics of light-ion collisions, as well as the potential for improving of the modeling of the high energy cosmic ray air showers. Particular attention will be given to the data analysis procedure.

T 26.2 Tue 16:30 KH 00.020

Precision Luminosity Measurement with Standard Candles using HLT Scouting Data — •Tatiana Selezneva — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

Precise determination of instantaneous and integrated luminosity at the LHC becomes increasingly challenging as collision rates rise and radiation damage accumulates in the CMS detector. Alongside the baseline luminosity determination, Standard Candle processes offer valuable complementary constraints. Although an absolute calibration below the 1% level is limited by theoretical cross-section uncertainties, such measurements are essential for validating long-term stability and linearity.

CMS has extensive experience with Z counting, benefiting from the clean $Z \to \mu\mu$ signature and efficient high-p_T muon reconstruction. A complementary approach is based on J/ψ production, which features a much larger cross section and thus higher event rates, including during van der Meer scans. By recording most reconstructed muons in a reduced data format, the HLT Scouting stream enables rates up to 30 kHz without degrading reconstruction performance, compensating for the suppression of low-p_T muons by standard triggers.

While the statistical gain for Z counting is moderate, the rapid availability of Scouting data enables near real-time luminosity monitoring using both Z and J/ψ. In addition, first results on W counting are presented, providing an orthogonal observable that can further constrain Z-based luminosity through its dependence on the electroweak mixing angle.

T 26.3 Tue 16:45 KH 00.020

Position monitoring system for the LHCb Upgrade II downstream tracker — •Todor Todorov[1], Marco Gersabeck[1], Flo Reiss[1], and Pascal Sainvitu[2] — [1]Albert-Ludwigs-Universität Freiburg — [2]CERN

The LHCb Upgrade 2 has the ambitious goal of increasing the instantaneous luminosity in the detector by a factor of 5. Due to the increase in detector occupancy and pileup, upgrades of many detector systems will be required, including the tracker. A new hybrid tracker will be installed downstream from the magnet, the Mighty Tracker, that will consist of silicon pixel sensors in the most occupied regions near the beam pipe and improved scintillating fibres in the remaining areas. The detector alignment and physics results will benefit from a real-time position monitoring system, but any such system will have to adhere to the strict material budget and space constraints. Frequency sweeping interferometry is chosen as a technique capable of fulfilling all requirements. A study on its use for effective position monitoring in the Mighty Tracker is presented.

T 26.4 Tue 17:00 KH 00.020

Proof of Concept for a Brute-Force Alignment Approach for the CBM STS Detector — •Nora Bluhme[1], Sergey Gorbunov[2], and Volker Lindenstruth[1,2] for the CBM-Collaboration — [1]Goethe-University Frankfurt, Frankfurt am Main, Germany — [2]GSI, Darmstadt, Germany

The Compressed Baryonic Matter experiment (CBM) at FAIR will study heavy-ion collisions at interaction rates of up to 10^7 events per second. For this purpose, accurate alignment of the detector systems is essential to exploit the high resolution of the sensors. This is typically achieved through track-based software alignment, which minimises a global χ^2 over a set of high-quality tracks.

To complement existing alignment tools, we investigate a brute-force χ^2 minimisation approach that can be applied with minimal analytical prerequisites. The method allows individual alignment parameters to be treated independently and enables the straightforward inclusion of various constraint types.

In this contribution, we present a proof-of-concept study demonstrating that this brute-force optimisation strategy is viable for the CBM Silicon Tracking System (STS) under idealised conditions. Using MC events with randomized sensor shifts and rotations, we evaluate the method's ability to recover the imposed misalignments. We show that the approach converges stably across a range of test configurations and discuss its potential and limitations as a part of the alignment strategy within CBM.

This work is supported by BMFTR (05P24RF3).

T 26.5 Tue 17:15 KH 00.020

Track Based Software Alignment Using the General Triplet Track Fit — •David Fritz, Tamasi Kar, and André Schöning for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg, Germany

The Mu3e experiment aims to observe the charged-lepton-flavour-violating decay $\mu^+ \to e^+e^-e^+$ at the Paul Scherrer Institut with a signal sensitivity of 1 in 10^{16} muon decays. To reach the physics goals and tracking performance of Mu3e, precise alignment of the tracking detector is crucial. Whereas optical surveillance systems provide an initial reference, track-based software alignment is required to achieve the resolution required.

A new alignment procedure based on the General Triplet Track Fit (GTTF) [1] enables the simultaneous determination of track and alignment parameters. The GTTF is a non-iterative triplet-based track fit that incorporates hit uncertainties and multiple scattering. It is highly parallelizable and suitable for implementation on, for example, GPUs or FPGAs.

This talk introduces the Mu3e experiment and places the GTTF-based alignment in the context of standard track based alignment approaches. Results from simulation studies and first applications to Mu3e commissioning data collected in June 2025 are presented, thereby demonstrating the potential of the GTTF-based alignment for the experiment.

[1] A. Schöning, 2025, A General Track Fit based on Triplets, https://doi.org/10.1016/j.nima.2025.170391