2024

Developments for a proposed Muon Identification Detector for the ALICE 3 Experiment at CERN. — Beam test measurements, performed jointly with teams from Mexico [1], confirmed that a proposed detector system based on MWPC-s is compatible with the requirements of the ALICE-3 Muon Identification Detector (MID).

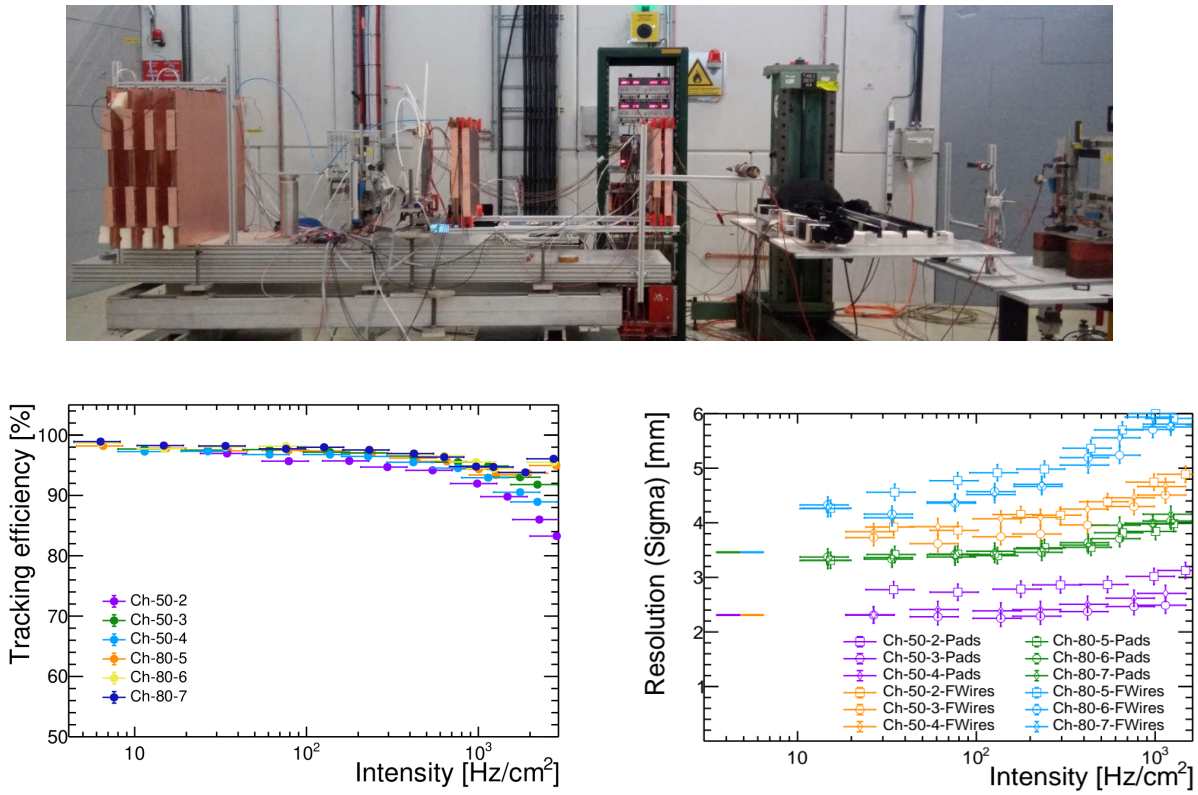

Figure 1. Test beam setup at CERN T10, on the left showing the MID prototype. The results [1] show that the efficiency remains high up to intensities well above the MID expectation (lower left panel) whereas the position resolution accordingly does not get worse (lower right panel)

Existence theorem on the UV limit of Euclidean Wilsonian RG flows. — Quantum Field Theory (QFT) is the most cutting edge established theory framework to model elementary interactions in particle physics. Its modern formulation describes a quantum system via a probability measure called Feynman measure, on the field confiurations. Despite of decade long experience, there are still puzzles within the deep foundations of QFT. The most important issue with QFT is that when certain field quantities are spacetime pointwise multiplied for defining the interaction potentials, they tend to be infinite. In order to still be able to define these, an approximation procedure is needed, called renormalization. The approximating family is called a Wilsonian renormalization group (RG) flow. In [2] we mathematically proved that under mild conditions, a Wilsonian renormalization group flow of correlators of Feynman measures, not terminating at some finite regularization, have a

factorization property. Namely, there exists a regularization-independent Feynman correlator (ultraviolet limit), from which the flow originates. Moreover, the flow obeys an algebric ansatz against this ultraviolet limit. The significance of this existence theorem is that the complicated concept of renormalization can now be better understood: it is merely a technical tool for describing an ultimate Feynman measure in the ultraviolet limit.

Vector-based Muometric Positioning. — Muography is an imaging tool based on the attenuation of cosmic muons to observe the density distribution of large objects, such as underground caves or fractured zones. Cosmic-ray muons have strong penetrating power and a relativistic nature, which means they can be used in a range of technologies, including imagery; positioning, navigation, timing (PNT); and secured communication in environments where conventional techniques are unavailable.

A paper, authored by D. Varga and H.K.M. Tanaka [3], demonstrated a method (patented in 2023, with PCT filed in 2024) for efficient, high precision positioning possibility, using the coincidence of muons through a Reference station, and an unknown “Receiver” placed above or below.

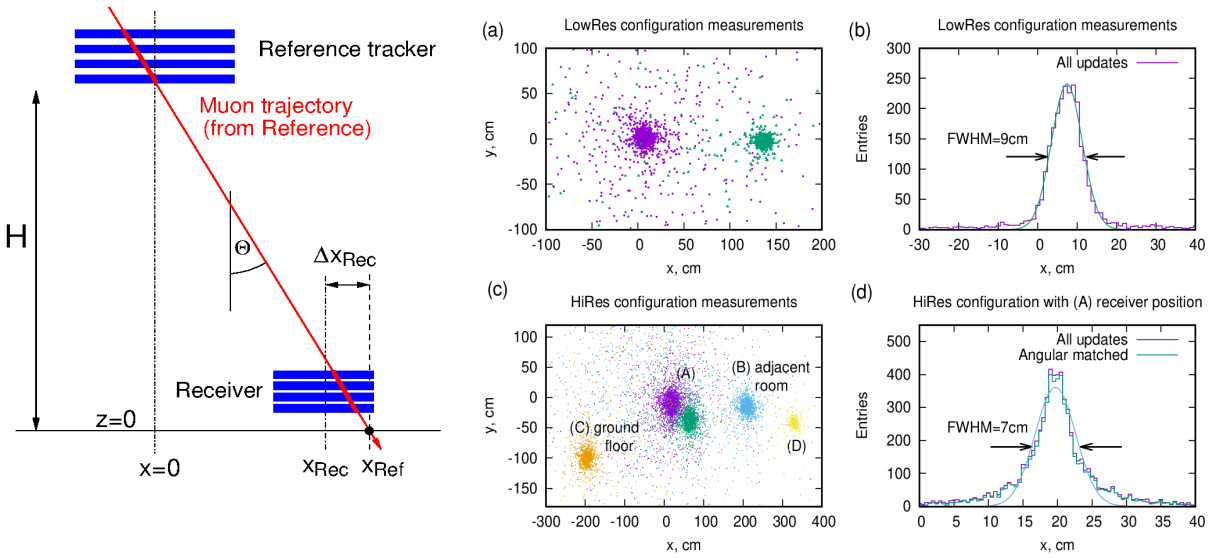

Figure 1. Vector-based muometric positioning. Left panel shows the principle, middle panels the pointing of the coincident trajectories outlining the position of the Receiver. Right panels show the measured indoors position resolution.

References

[1] https://doi.org/10.1088/1748-0221/19/04/T04006

[2] https://doi.org/10.1088/1361-6382/ad4a1a

[3] https://www.nature.com/articles/s41598-024-57857-7