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Scintillating fibre-based muon beam monitor for the FAMU experiment

Thursday, 29 May 2025 14:50 (8 minutes)

The FAMU experiment aims at measuring the Zemach radius of the proton with an accuracy better than 1% through accurate spectroscopy of the ground state hyperfine splitting of muonic hydrogen atoms. This measurement plays a crucial role in validating high-precision QED calculations, and testing the proton-muon interaction. Muonic hydrogen atoms are produced by injecting a pulsed low-momentum (55 MeV/c) negative muon beam in a pressurised 1-litre 8 bar gaseous target. The exotic atoms are let thermalise for a few hundreds of ns and then hit with a tunable mid-infrared laser to excite the transition. The experimental data need to be normalised as a function of the muon beam intensity in order to take into account of the number of muonic atoms in the chamber when the laser is injected. This normalisation is made possible thanks to a beam monitor composed of two layers of 1 mm pitch squared fibres, read-out at alternate ends by SiPM's. This system, initially designed as a position-sensitive hodoscope, proved to be a linear and sensitive flux monitor by taking into account of the total integrated charge collected by the SiPM circuit during beam pulses. This observable has been thoroughly studied in order to check for its linearity and determine its value for single muon interactions. Thanks to dedicated low flux measurements and accurate simulations, the detector has eventually been used as a flux-meter, with a measured resolution below 2%. In addition, the detector played a crucial role in observing beam fluctuations and beamline faults, which can now be promptly corrected as they occur. In conclusion, the FAMU experiment has been provided with a beam monitor capable of beam shape analysis, flux measurement and extraction of time information, which has been playing a crucial role in the data acquisition and data analysis of the experiment. Similar detectors can be applied in other experiments to fully characterise low-momentum muon beams; some specific applications at ISIS are currently under development.

Muon dipole moments (magnetic and electric): theory, experiments and future perspectives

Charged lepton flavor violation: theory, experiment and future perspectives

New Physics opportunities with low and high energy muon beams

Neutrino physics with muon beams: theory, experiments and future perspectives

Muons beams technologies: production, cooling and acceleration at different energy

none

Advancements in Muon-based Facilities and Broader Applications

none

Muons in other fields: muography, muon spin spectroscopy, muon-catalyzed fusion

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Session Classification: New Physics oppportunities with low and high energy muon beams