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FPGA-BASED MUON REGISTRATION CHANNEL FOR POSITIONING SYSTEM

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FPGA-BASED MUON REGISTRATION CHANNEL FOR POSITIONING SYSTEM

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Cosmic-ray muons are a natural source of penetrating particles that can be used for positioning and navigation in underground environments where conventional positioning systems have limited applicability [1, 2]. Muon-based positioning methods can use the temporal correlation of muon detection events recorded by surface and underground detectors to estimate the relative position of the underground detector. This work presents the development of an FPGA-based muon registration channel intended for a positioning system of a borehole muon cylindrical detector [3] of muon tomography system for undeground geological object investigation or for in build positioning systems. The proposed channel is a compact reference detector located at the surface above the borehole or installed above the second muon detector for in-building systems. Its main purpose is to register the passage of a muon and generate an event timestamp in the same time reference system as the borehole detector, without the need for muon track reconstruction. The reference detector is planned to be based on a plastic scintillator and a silicon photomultiplier (SiPM), while the signal processing is performed using an FPGA (Xilinx Artix 7) operating at a frequency of 100 MHz. The surface muon registration channel and underground muon detector (of second flat muon detector) are planned to be synchronized using synchro pulse sended via suspension cable for a borehole muon detector. The resulting timestamps can be used to identify correlated muon detection events recorded by both detectors and determine the time difference between their detection. In the future, this technology can be used to estimate the angular azimutal position of the borehole detector. The proposed approach does not require reconstruction of individual muon tracks in the reference detector and therefore allows a relatively simple detector configuration to be used. The developed system is considered as a basis for further experimental studies of the possibility of positioning borehole instruments and underground navigation using cosmic-ray muons.

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