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Novel Neutron Detector Developments - Three Detectors for Neutron Science

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An increase in demand and the resulting price increase of Helium-3 has sparked the development of alternative kinds of neutron detectors for various applications in neutron science. Our group is developing three detectors with solid Boron-10 converters. With their scalability, up-to-date readout electronics, high-rate capabilities and wide range of active readout areas they are promising candidates as detectors in imaging and scattering experiments.

The first design features a boronated Microchannel Plate and uses a Timepix3 ASIC readout with an active readout of 2.8x2.8 cm². This upgrade improves the resolution of an already successful implementation for the now discontinued Timepix ASIC and guarantees the the accessibility in future uses. The mechanical construction is completed and readout implementation studies are ongoing.

The second detector uses a boron-lined Gas Electron Multiplier, which acts simultaneously as a conversion and gas amplification stage. With an active area of 10x10 cm² and the VMM3a ASIC a highly granular readout with rates above 1e6/s is easily achievable. Currently the construction of the first layer is ongoing. In further stages of development an expansion to an active area of 30x30 cm² and implementation of up to ten layers for enhanced detector efficiency is planned.

Thirdly we develop the BOron DEtector with Light and Ionisation Reconstruction (BODELAIRE), which combines the concept of a Time Projection Chamber (TPC) with a highly granular readout with high time resolution and a boronated glass window for neutron conversion. Boron absorbs incoming neutrons and decays into an alpha particle and a Lithium ion. One of the ions enters the drift volume of the TPC and creates a trace of electron-ion pairs, which the readout detects. The other ion emitted in opposite direction is used to start the readout with the help of a scintillator inside the glass vessel. The light created in the scintillator is coupled to a trigger board via wavelength shifting fibers to generate a start signal in silicon photomultiplier-based electronics. The trigger system is FPGA-controlled, which the user can interface with to set signal thresholds. The TPC has been successfully build and the trigger system is in its final stages of development.

In this work I will give an overview of the neutron detector projects in our group and go into detail over the detector concept of the BODELAIRE and its current status of development.

Autor: BLOCK, Thomas

Co-Autoren: GLOWACZ, Jan (University of Bonn); KAMINSKI, Jochen (University of Bonn); VOLZ, Jonathan (University of Bonn); DESCH, Klaus (University of Bonn); KÖHLI, Markus (Physikalisches Institut, Heidelberg University); LUPBERGER, Michael (University of Bonn); GÜRBÜZ, Saime

Sitzung Einordnung: Session 5: Instrumentation & Data Management II (Chairs: Tobias Neuwirth & Artur Gregor Glavic)

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