



Contribution ID: 76

Type: **Presentation**

Development of Three Novel Neutron Detectors for Neutron Science

Thursday, 23 October 2025 10:00 (15 minutes)

The helium-3 crisis sparked the development of alternative neutron detection technologies with solid converters. With their scalability, fast readout electronics, high-rate capabilities and wide range of active readout areas they are promising candidates for detectors in imaging and scattering experiments. Our group is developing three such detectors based on solid boron converters.

The first design features a boronated Microchannel Plate and uses a Timepix3 ASIC readout with an active readout of 2.8-by-2.8 cm². This upgrade improves the resolution of a successful previous implementation for the now discontinued Timepix ASIC and guarantees 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-like foil, which acts simultaneously as a conversion and gas amplification stage. With an active area of 10-by-10 cm² and the VMM3a ASIC a highly granular readout with rates above 1 MHz is easily achievable. Currently the construction of the first layer is ongoing. In further stages of development an expansion to an active area of 30-by-30 cm² and implementation of up to ten layers for enhanced detector efficiency is planned.

Thirdly we develop a detector with an active readout area of approximately 100 cm², which combines the concept of a Time Projection Chamber (TPC) and a boron-coated scintillator for neutron conversion. One of the daughter ions of the conversion process enters the drift volume of the TPC and creates a trace of electron-ion pairs, which the Timepix-based readout detects. The other ion emitted in opposite direction creates a light signal in the scintillator, which is used to start the readout. The TPC has been successfully build and the trigger system is in its final stages of development.

This contribution will give an overview of the neutron detector projects in our group and its current status of development.

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Session Classification: DETECTORS AND HOUSINGS