High-resolution and High-rate Boron-lined Detectors for Neutron Science

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

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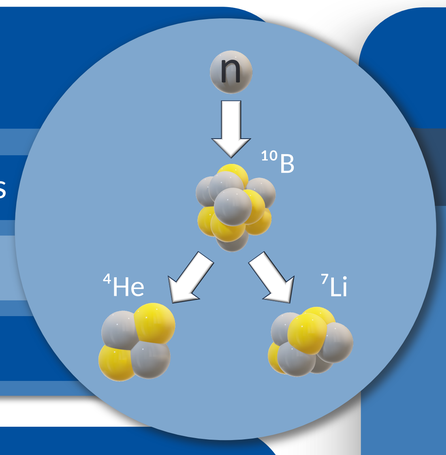
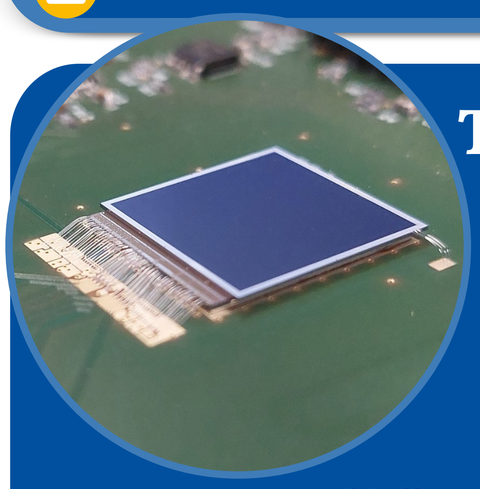
Introduction

- Development of three different types of neutron detectors
- Converter: Boron-10 and sputter-deposited $^{10}B_4C$
- Detection of produced charged particles





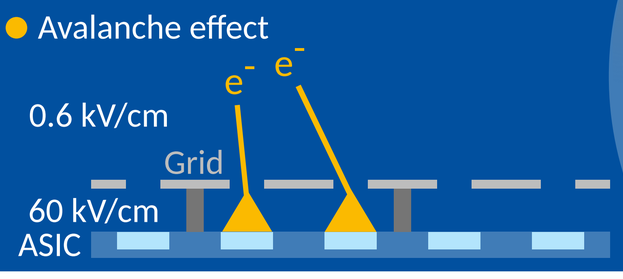
Timepix[1] & Timepix3[2]

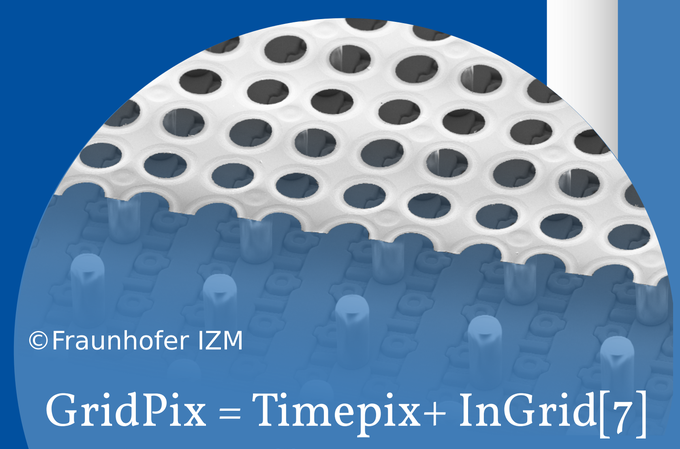
- 256 x 256 pixel ASICs
- 55 µm pixel pitch

Time or charge	Time and charge
Frame readout	Data-driven readout
25 ms dead time	Dead-time free

Gas amplification

- Particles create electrons
- Electrons drift towards grid
- High E-field below grid
- Avalanche effect





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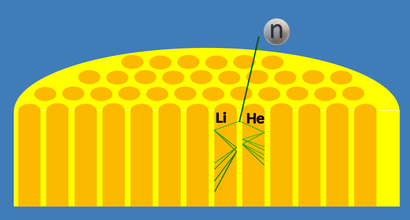
GridPix = Timepix+ InGrid[7]

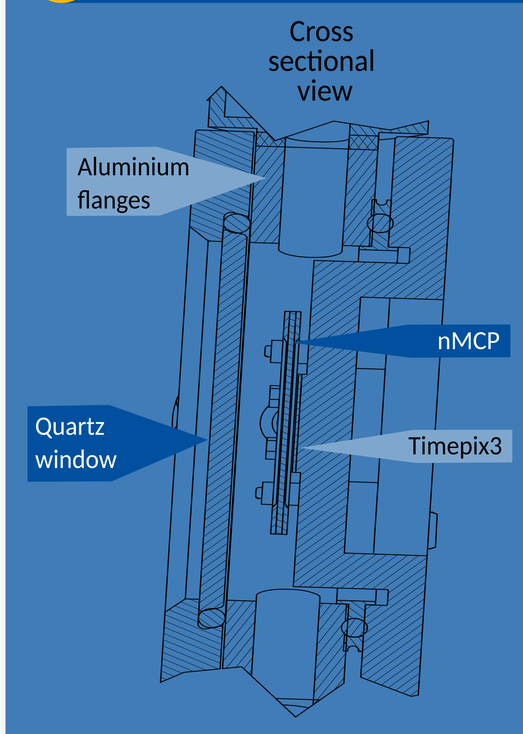
- MicroMegas like structure
- Photolithographically built, perfectly aligned
- Pixelated ASIC (Timepix(3))

nMCP[5]

Neutron sensitive Microchannel Plate

- For high-resolution neutron radiography
- Boron and Gadolinium doped MCP
- Amplification in microchannels





High neutron detection efficiency[8]

thermal neutrons	cold neutrons
50 %	75 %

High spatial resolution[5]: 15 µm

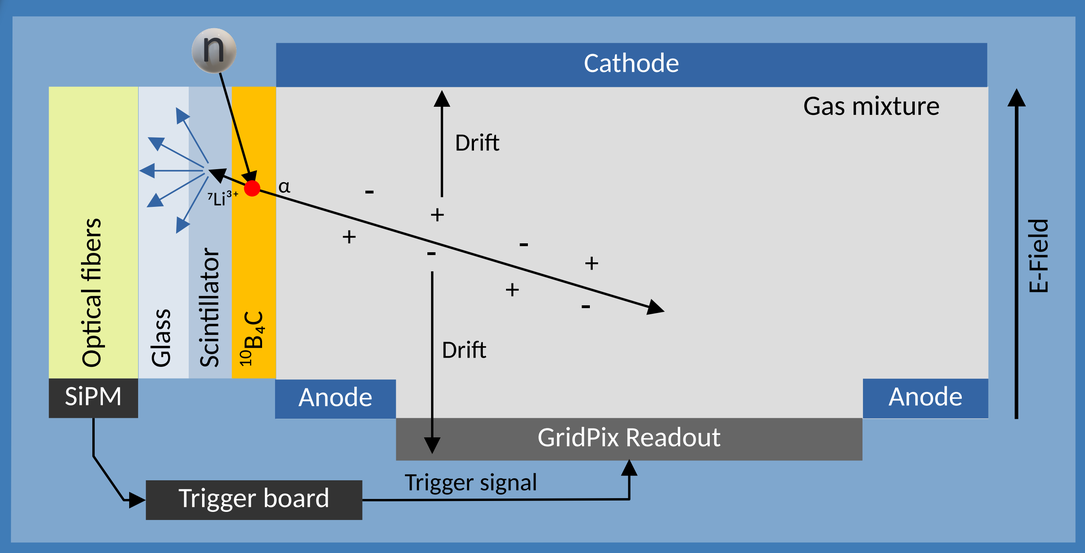
Construction of a vacuum system
Desired pressure: $<10^{-6}$ mbar

- 2x2 Timepix3 readout with SRS
- 8 cm² active readout area
- Currently working on implementation of readout system

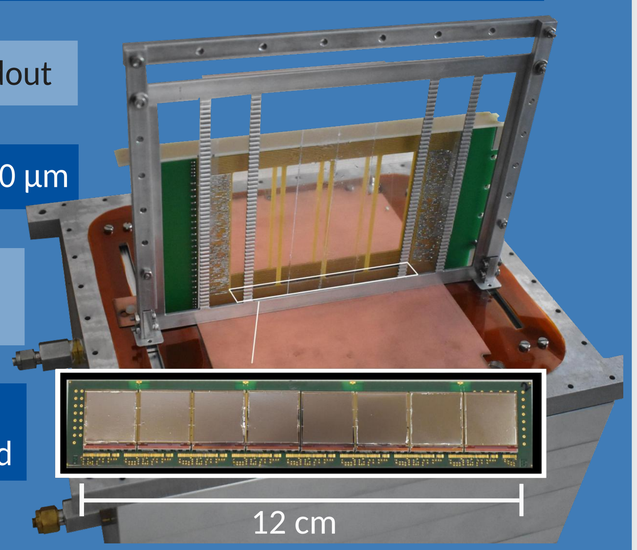
BODELAIRE

Boron Detector with Light and Ionisation Reconstruction

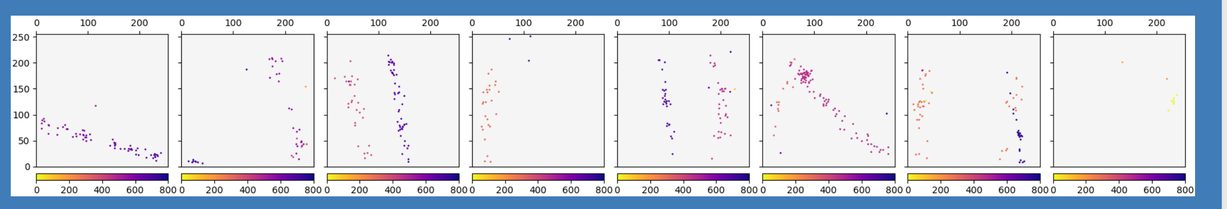
- Time projection chamber combined with a neutron conversion stage



- 3D-track reconstruction gives position of neutron conversion
- GridPix-Octoboard + SRS[3] readout
- Spatial resolution of track: ~ 100 µm
- Neutron detection efficiency: 5 % per 1.1 µm layer of $^{10}B_4C$
- To achieve high-rate readout: GridPix3-Octoboard will be used



- Test measurements with cosmic muons

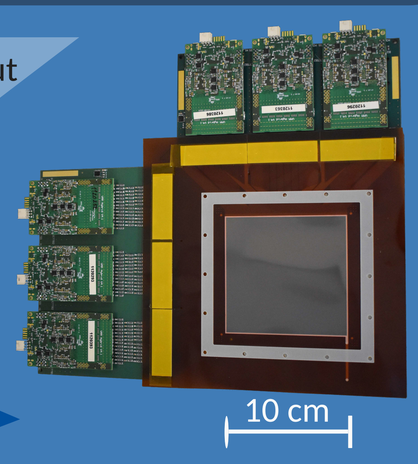


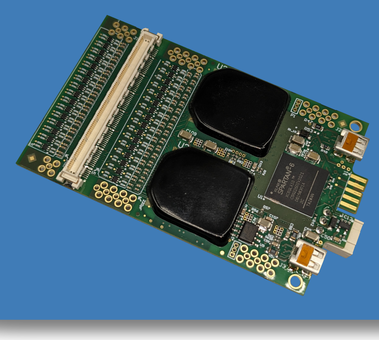
- To be implemented: Scintillator-based, FPGA controlled trigger

BASTARD

Boron Based Multi Stage Tracking Detector

- Neutron detector with GEM[6] style readout
- Amplification in micropattern holes
- Boron coated cathodes
- Multiple layers
- 128 channels per chip, 384 channels per direction per layer





- Readout of LV and HV strips
- VMM3a[4] & SRS[3] Readout
- Spatial detection with high rates

Poster & Abstract

1. Timepix, X. Llopart et al., DOI: 0.1016/j.nima.2007.08.079
2. Timepix 3, T. Poikela et al., DOI: 10.1088/1748-0221/9/05/C05013
3. SRS, S. Martious et al., DOI: 10.1088/1748-0221/8/03/C03015
4. VMM3a, G. de Geronimo et al., DOI: 10.1109/TNS.2022.3155818
5. Neutron MCP, A. S. Tremsin et al., DOI: 10.1016/j.nima.2009.01.137
6. GEM, F. Sauli, DOI: 10.1016/S0168-9002(96)01172-2
7. InGrid, J. Timmermans et al., DOI: 10.1016/j.nima.2005.11.065
8. Neutron imaging, S. Duarte Pinto et al., DOI:10.1088/1748-0221/12/12/C12006

Webpage