Bundesministerium
für Bildung
und Forschung

Novel Neutron Detectors based on the Time Projection Method

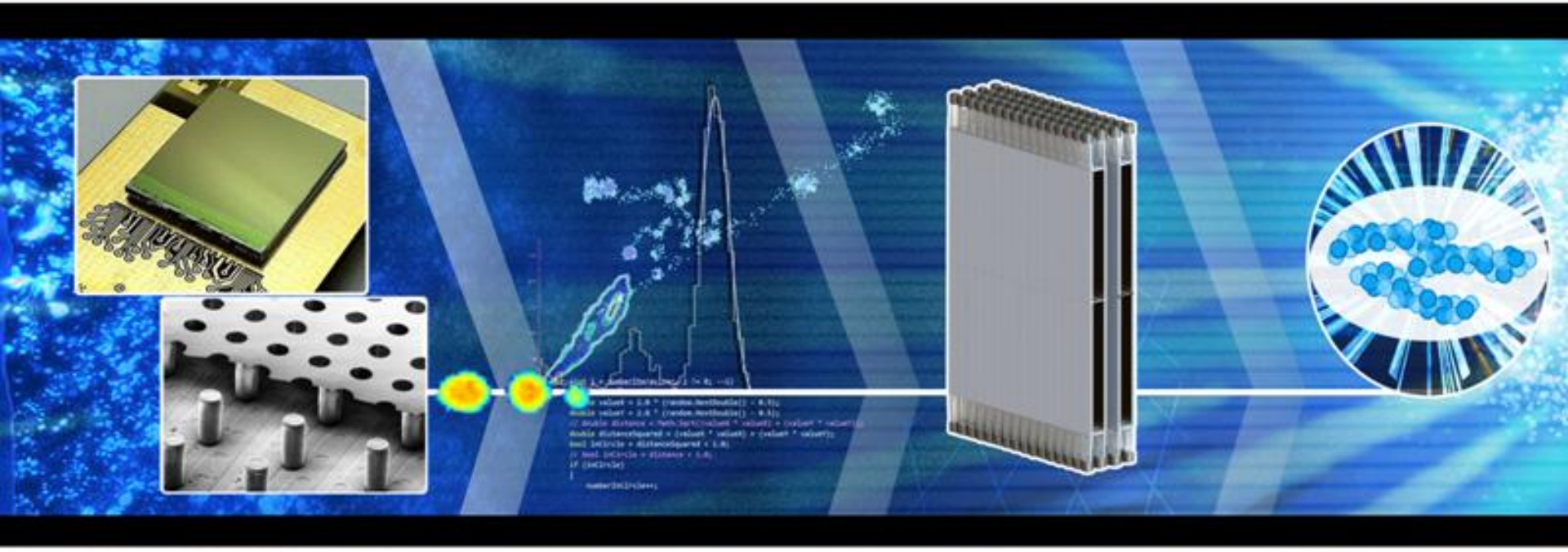
ICNS 2017
13.07.2017

universitätbonn

Physikalisches Institut (LCTPC)
Rheinische
Friedrich-Wilhelms-Universität
Bonn

Markus Köhli

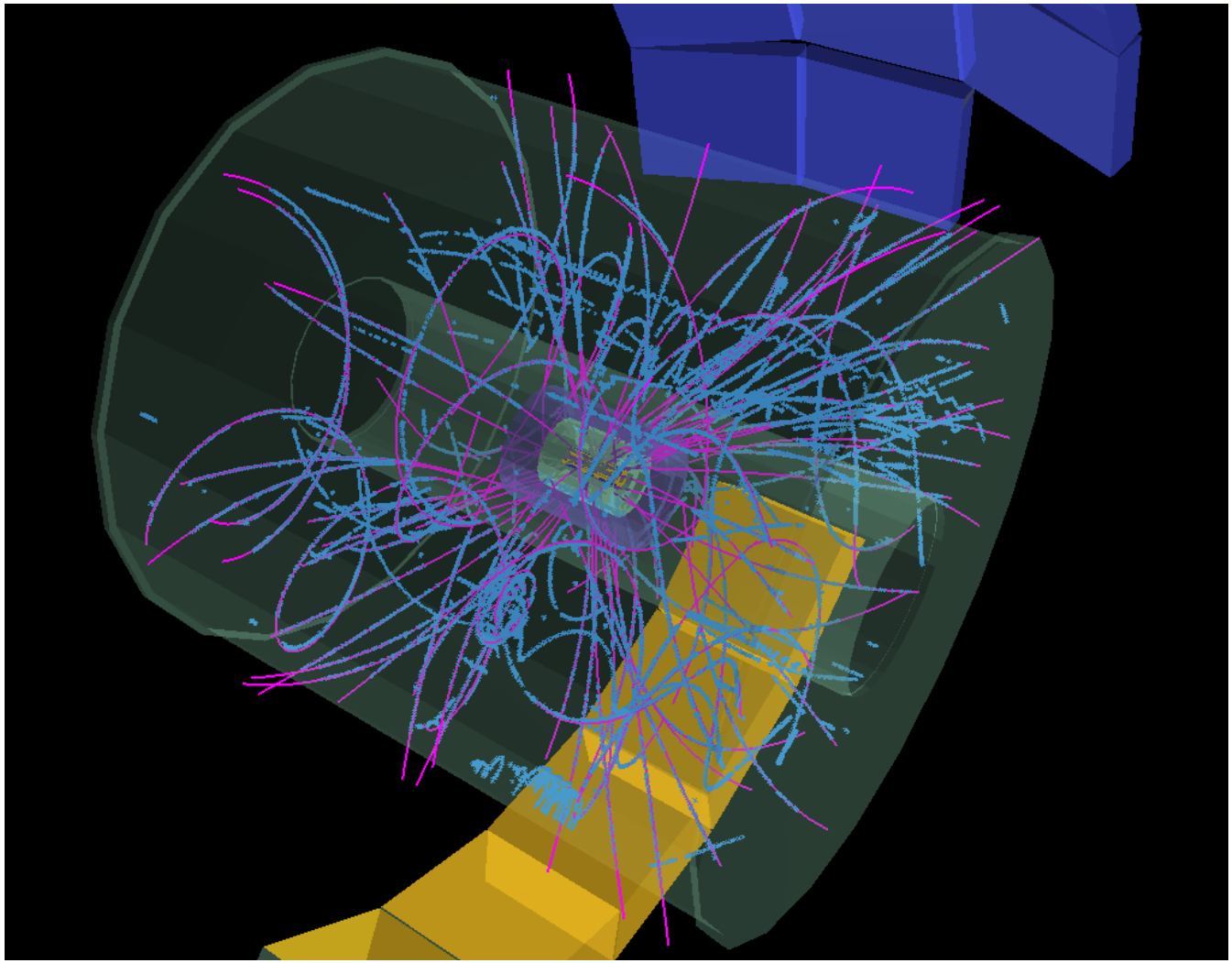
T. Wagner, F. Schmidt, J. Kaminski, U. Schmidt, K. Desch



BASTARD & BODELAIRE

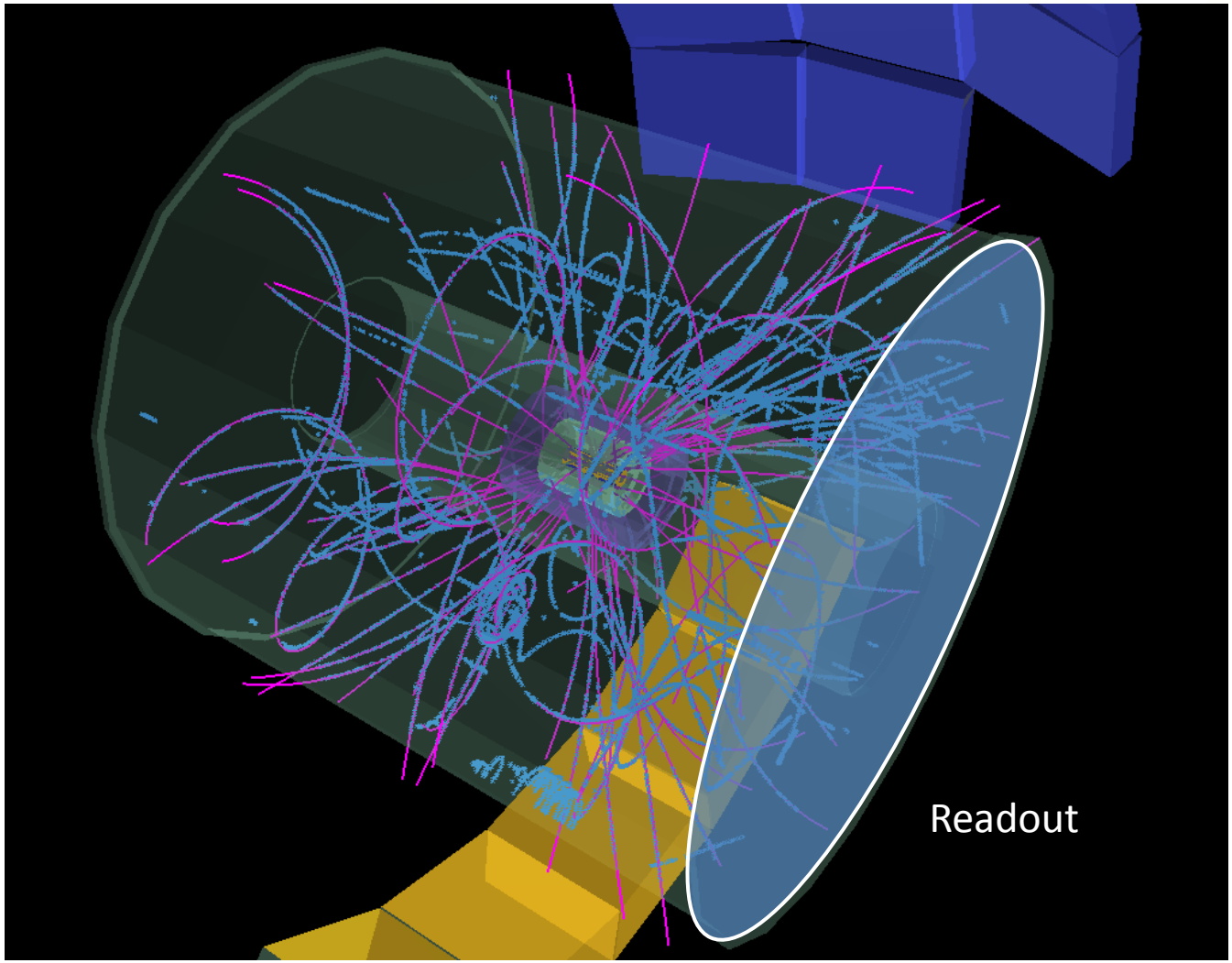
High Rate High Resolution

The TPC



[1] http://www-alice.gsi.de

The TPC



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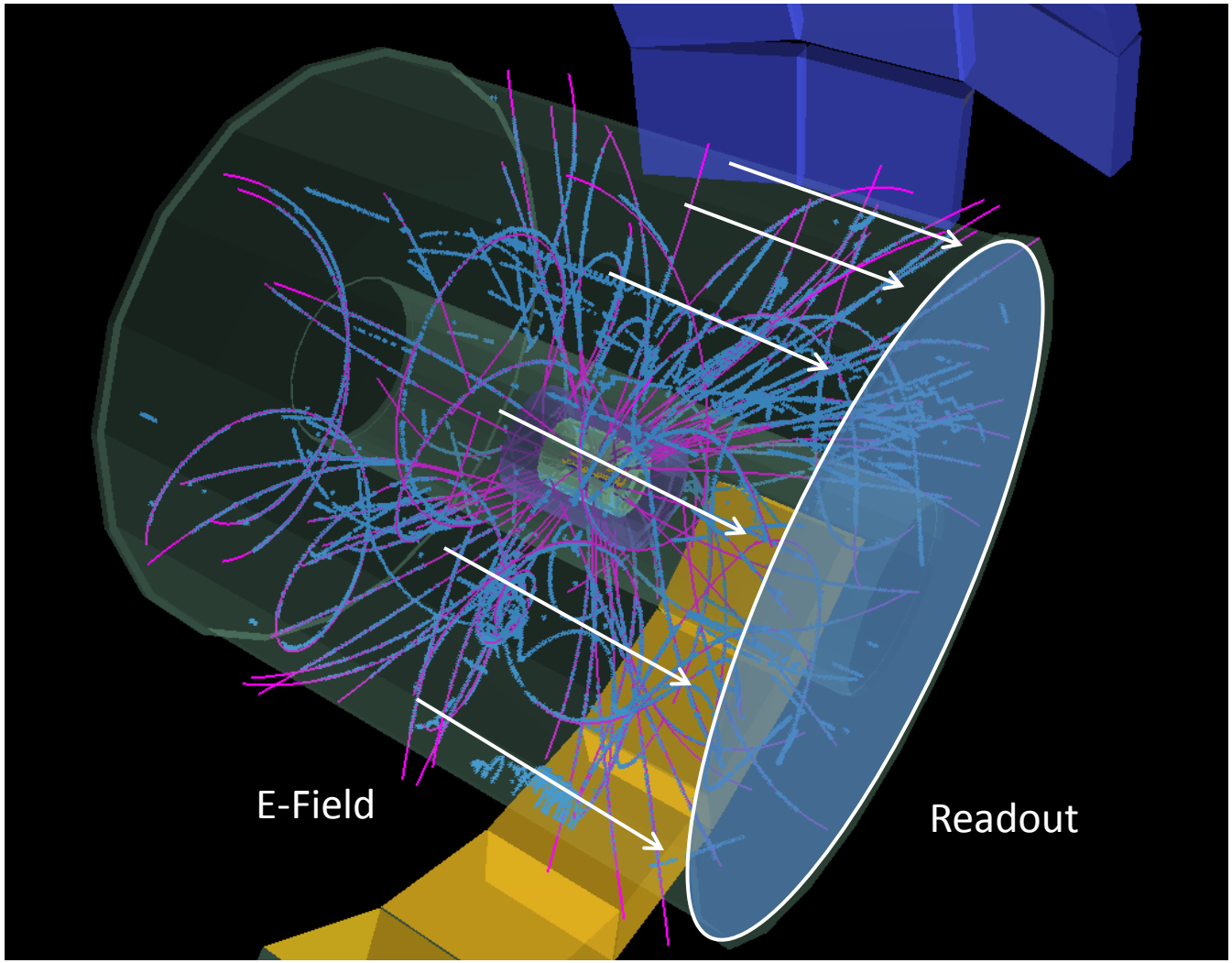

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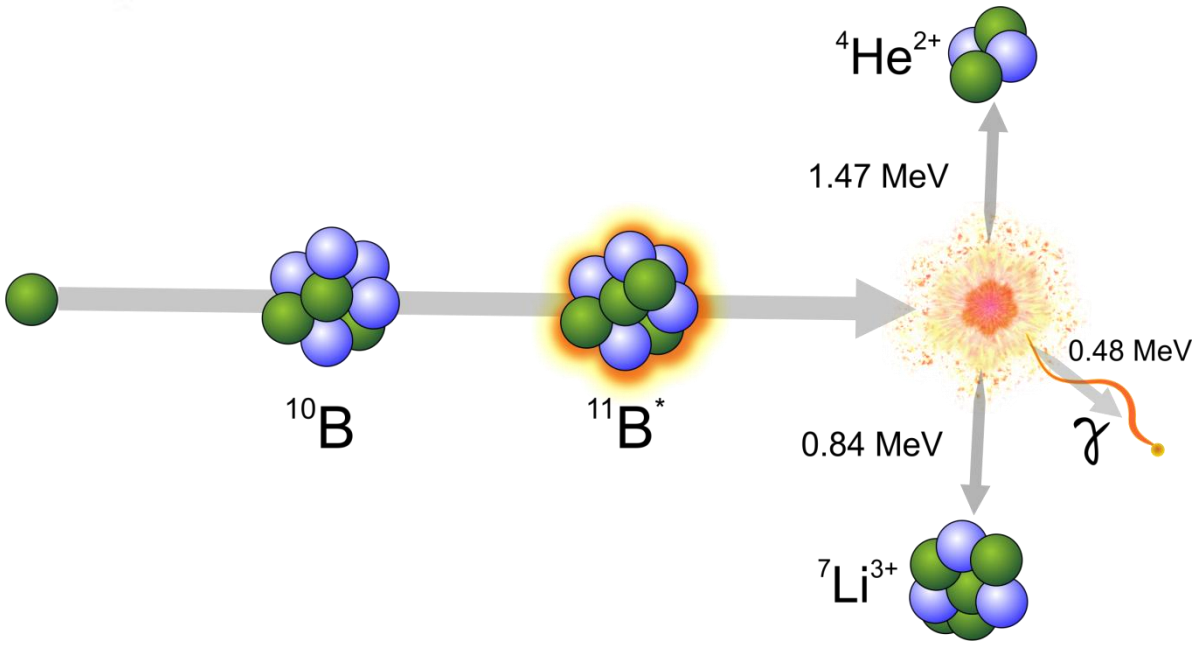
The Neutron TPC Trigger



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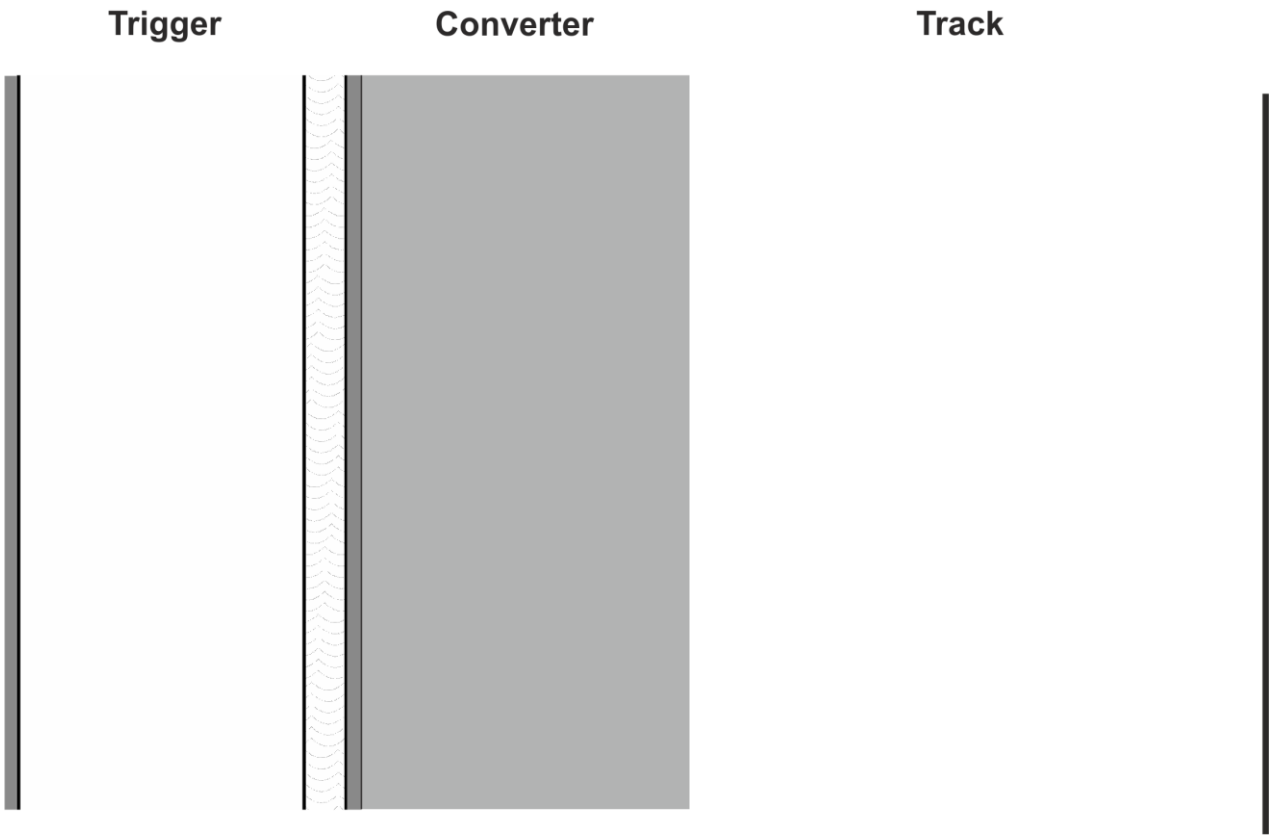

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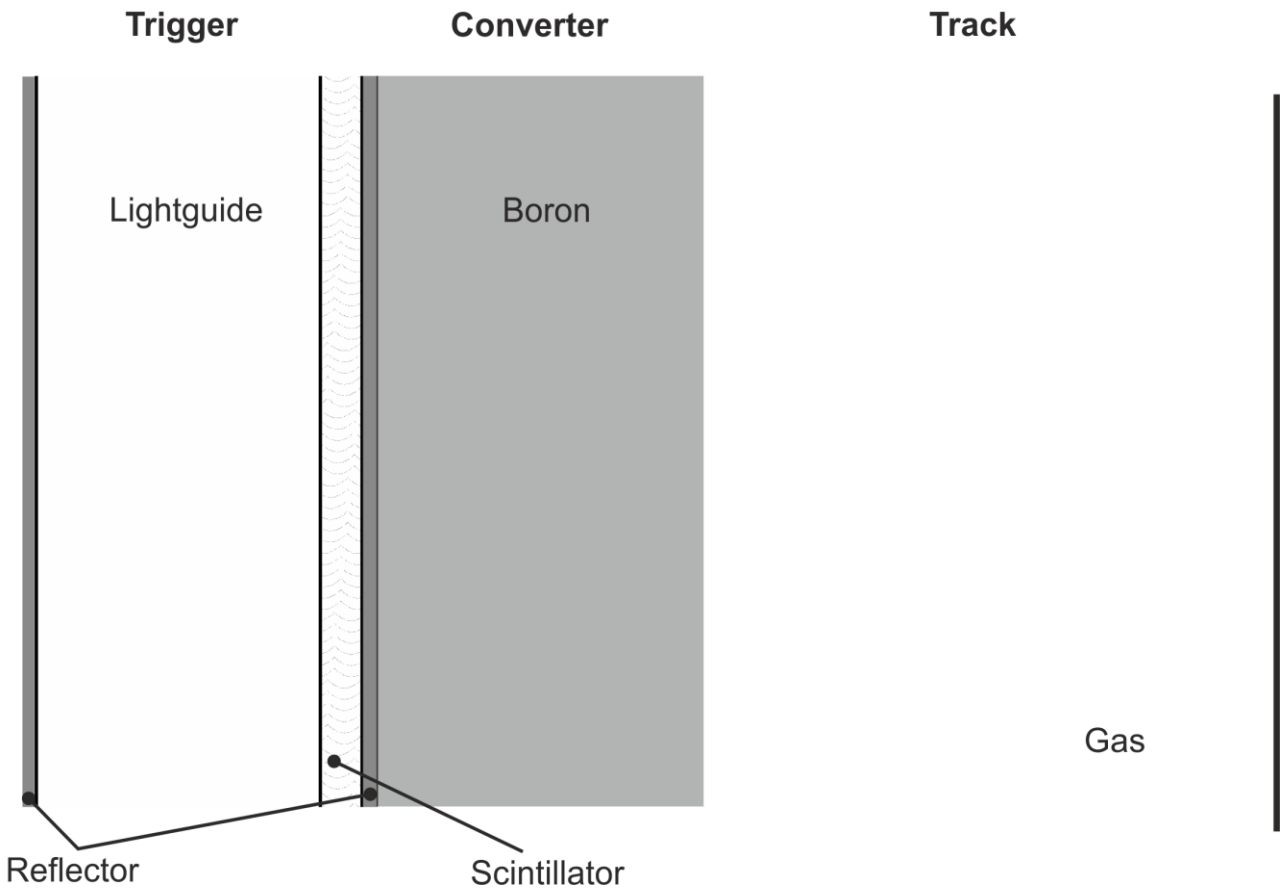

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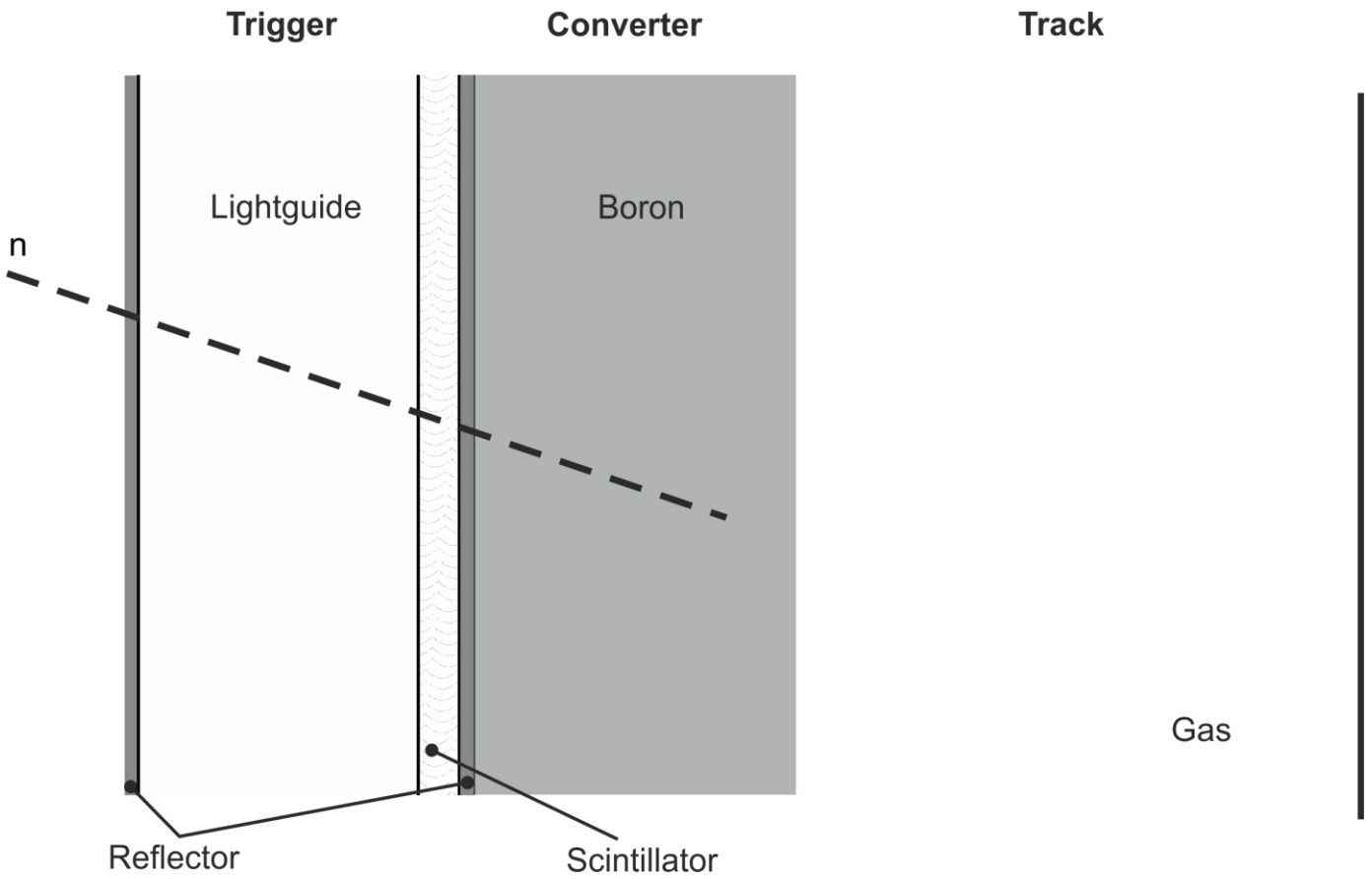

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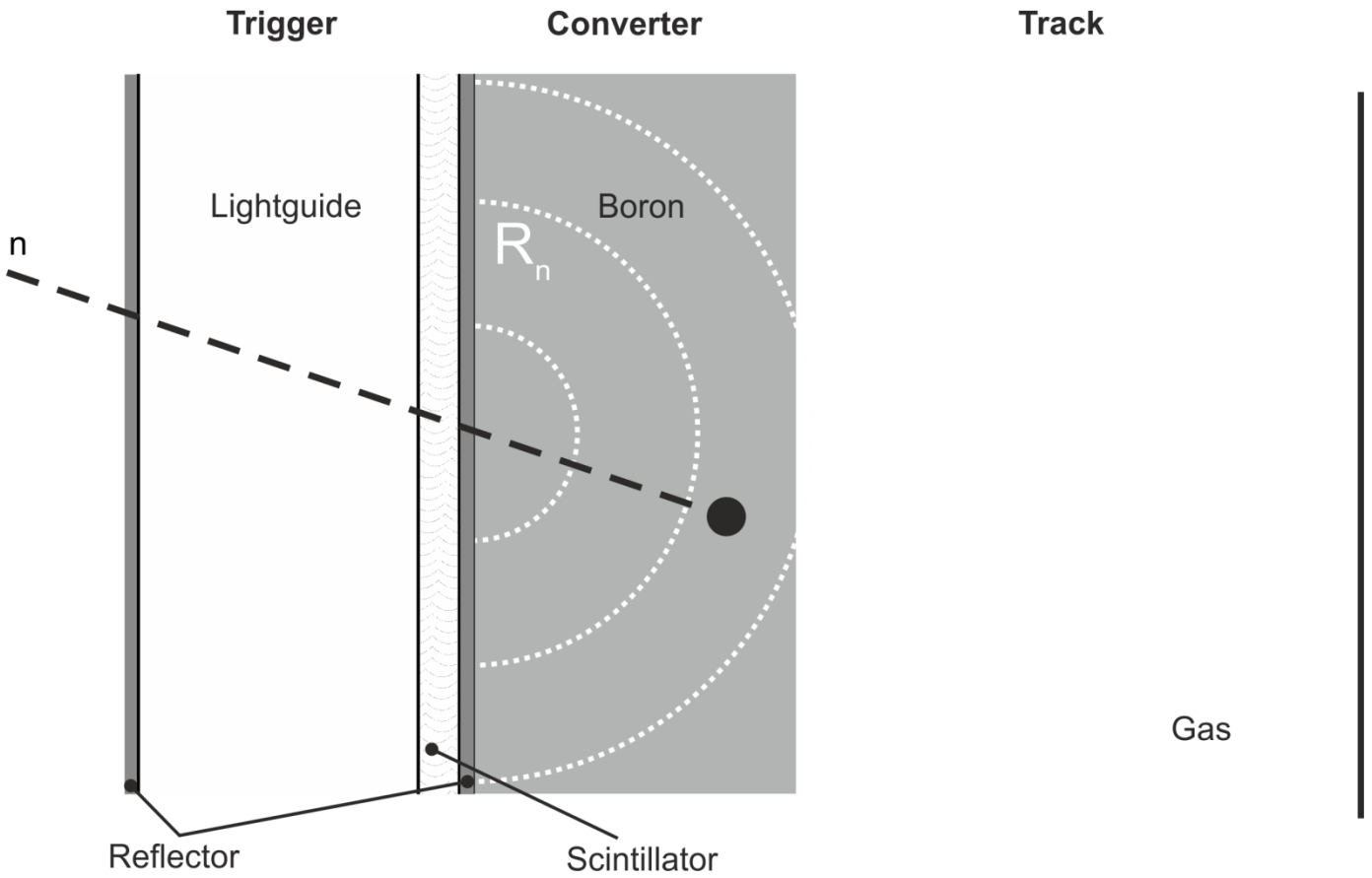

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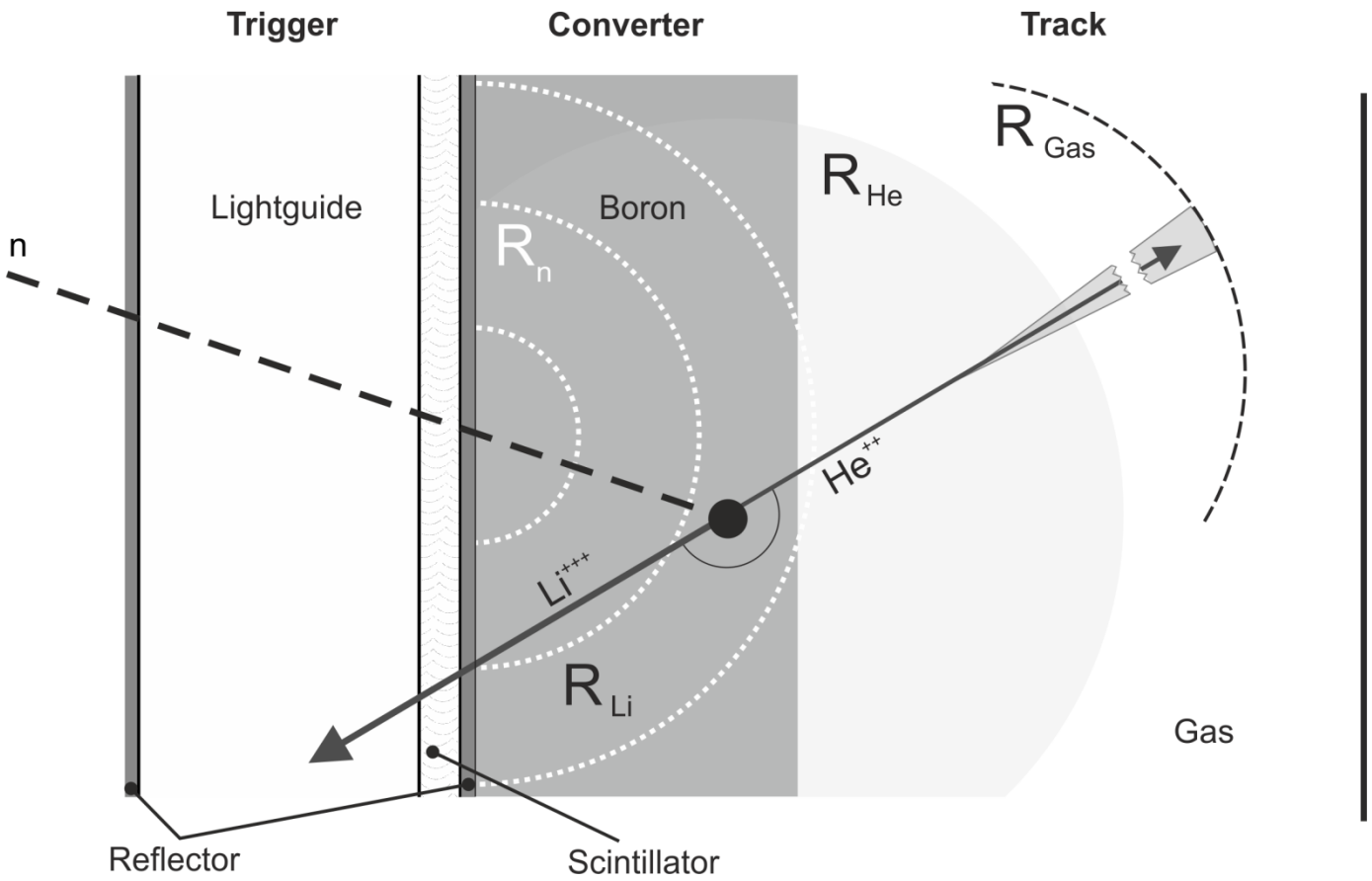

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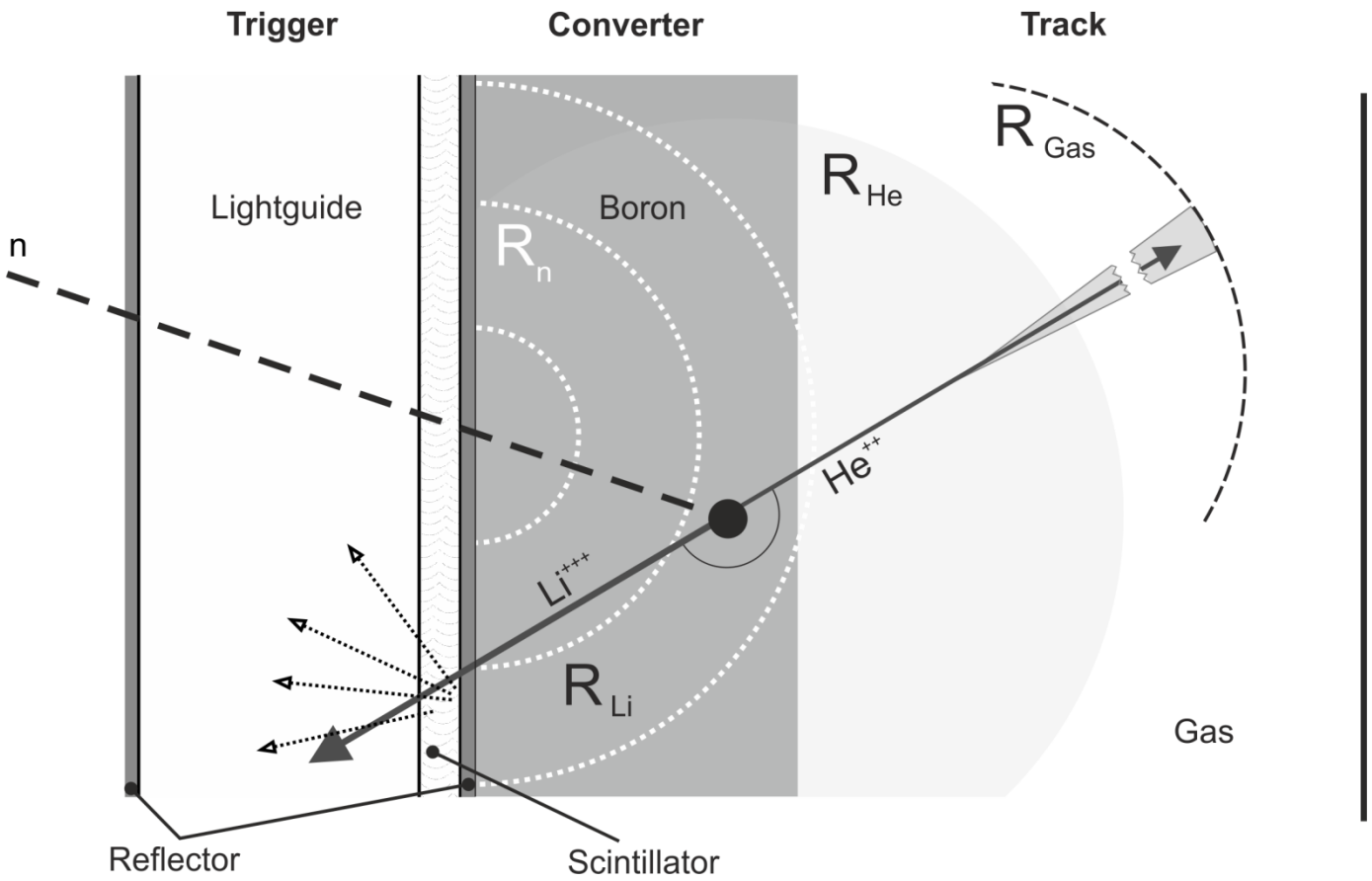
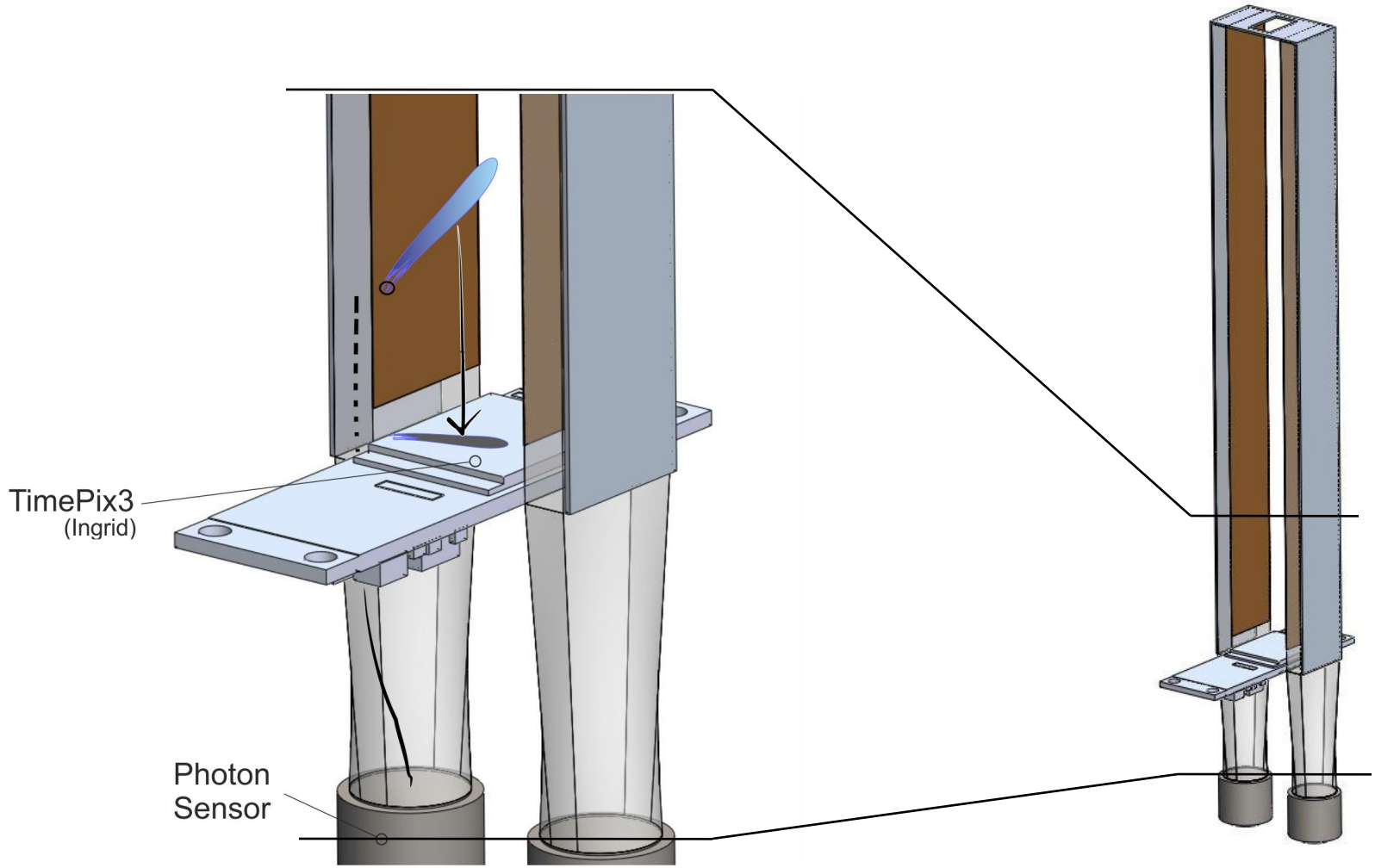


The Detector

The Neutron TPC



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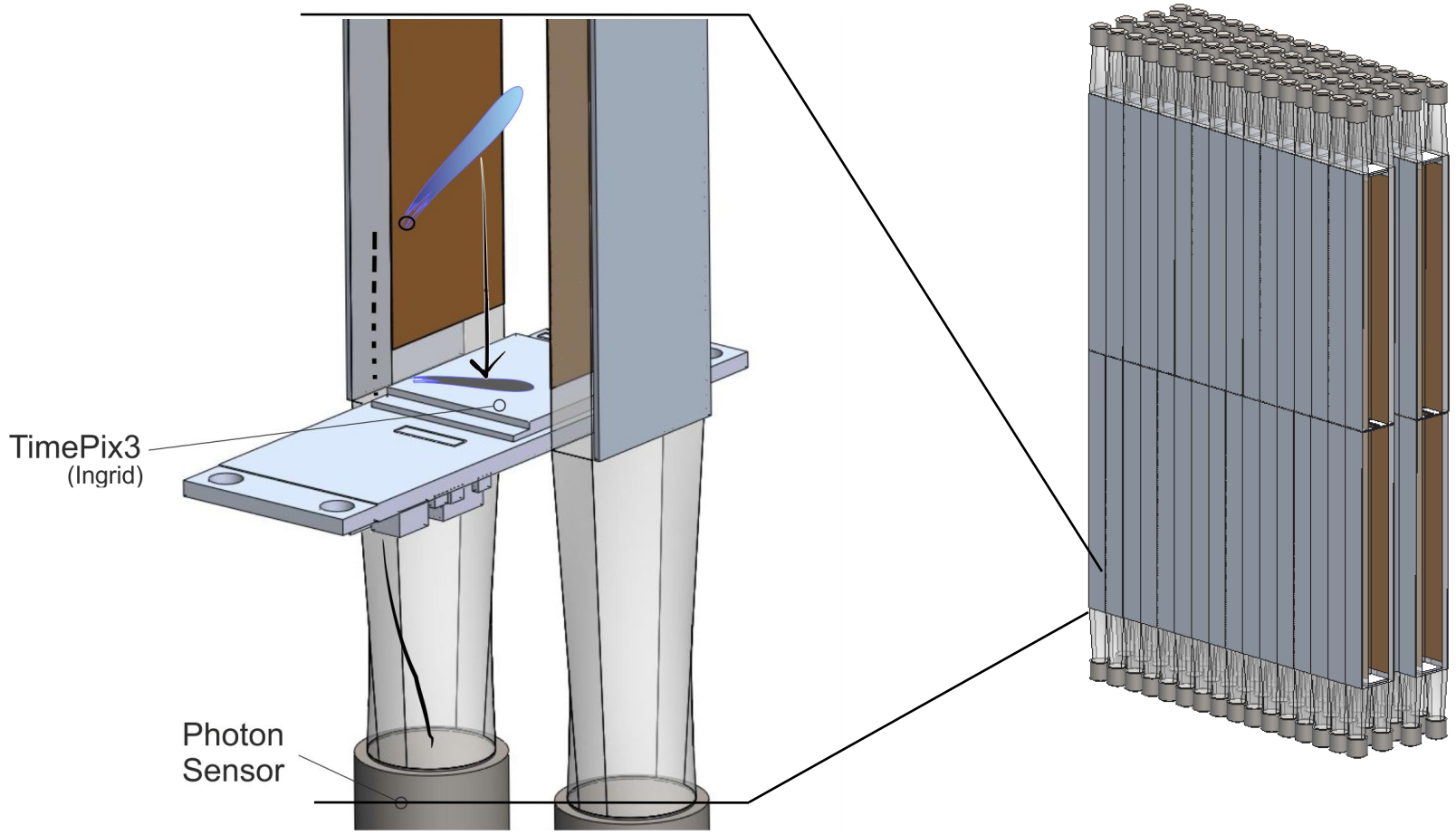
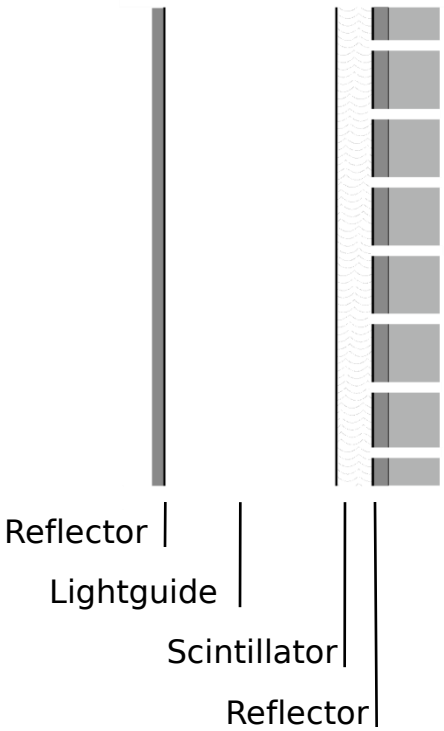
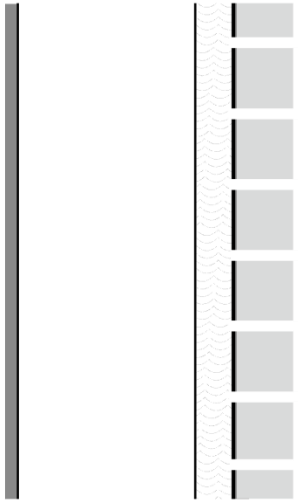


Field Cage Design

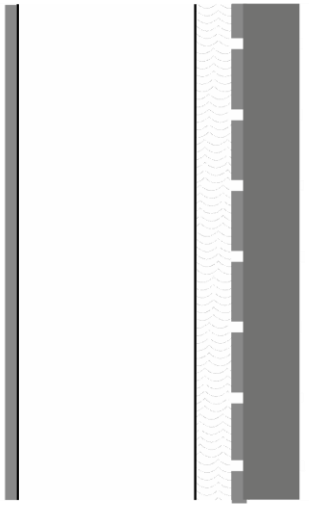
Boron Carbide



Boron Nitride



Boron



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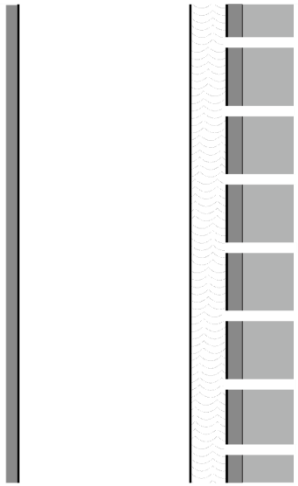


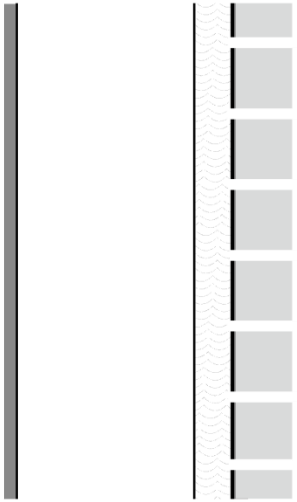
Reflector

Lightguide

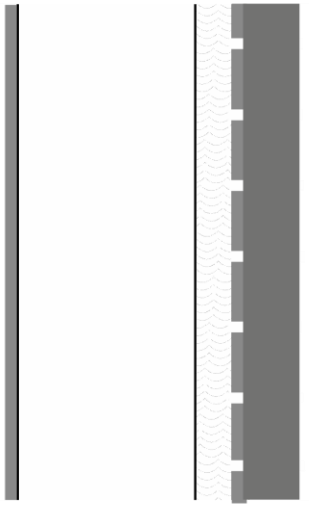
Scintillator

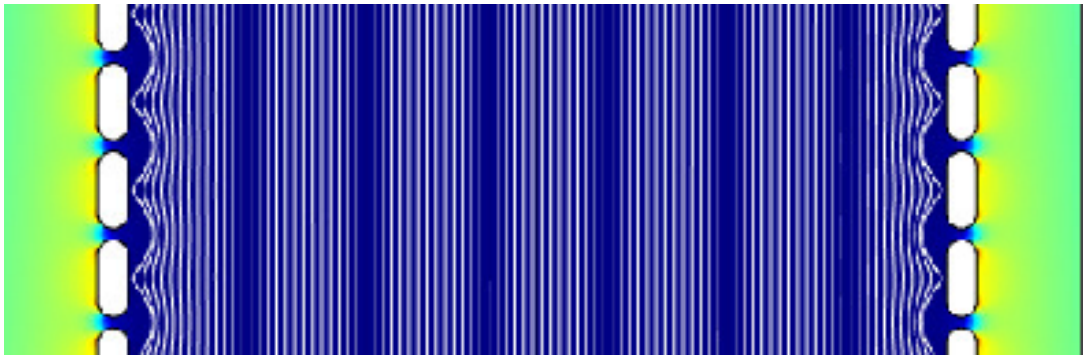
Reflector

Boron Nitride

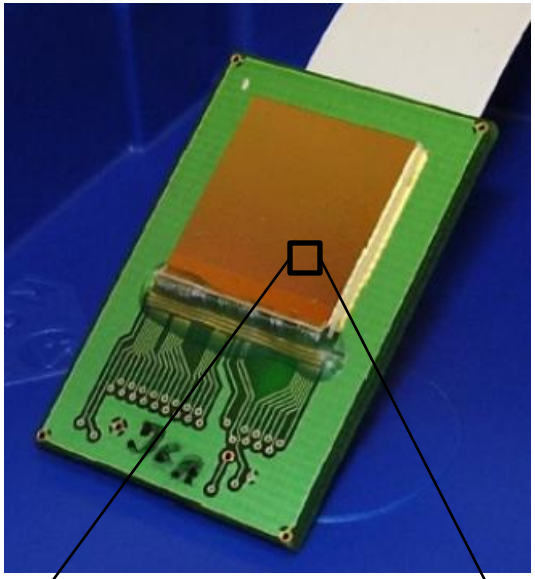


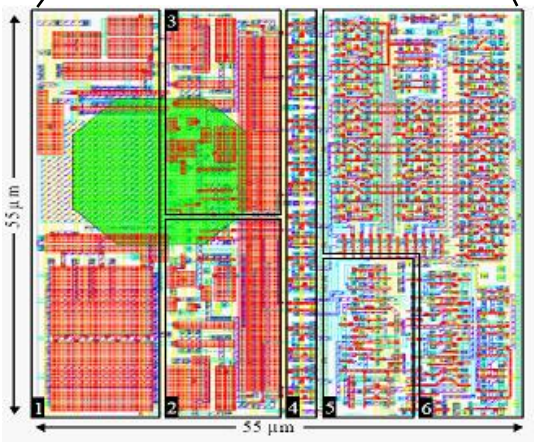
Boron

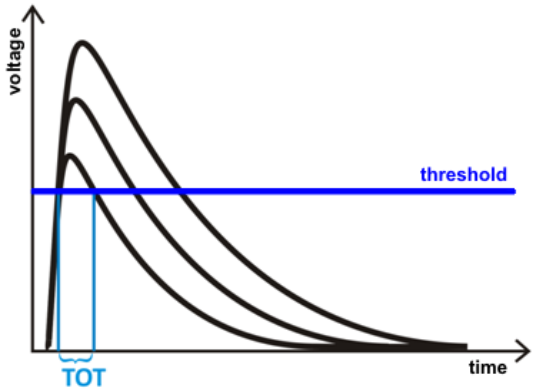




The TimePix Chip







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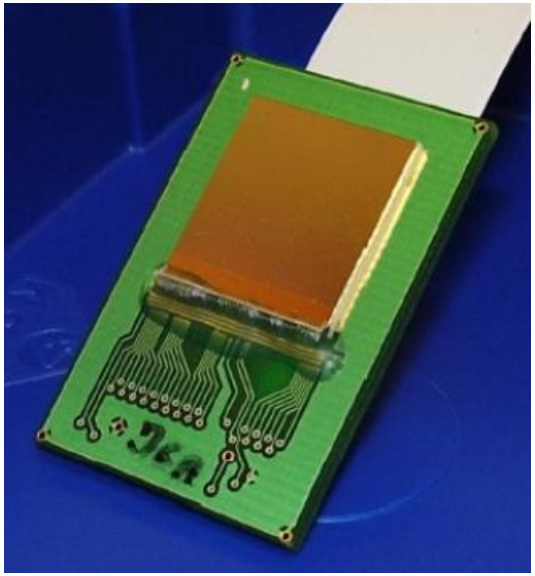
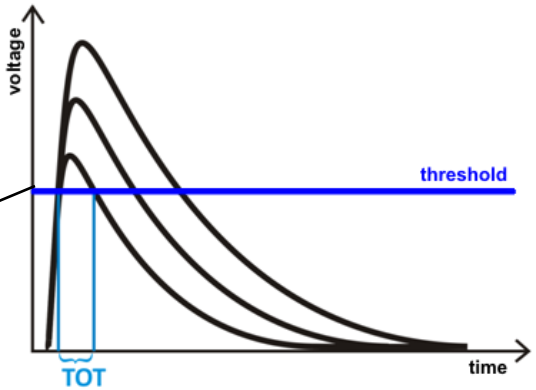


- 256 × 256 pixels @ 55 × 55 µm²
- 1.4 × 1.4 cm²
- 40 MHz clock
- ENC ca. 90 e^-

Modes:
- Time Over Threshold (TOT)
- Time of Arrival (ToA)
- Geiger Counter



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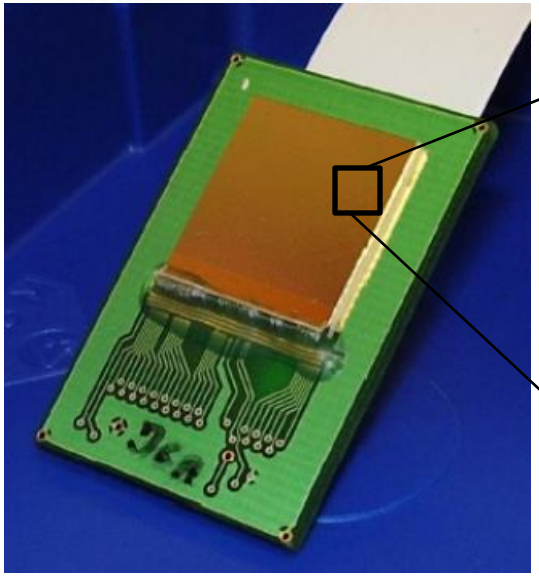

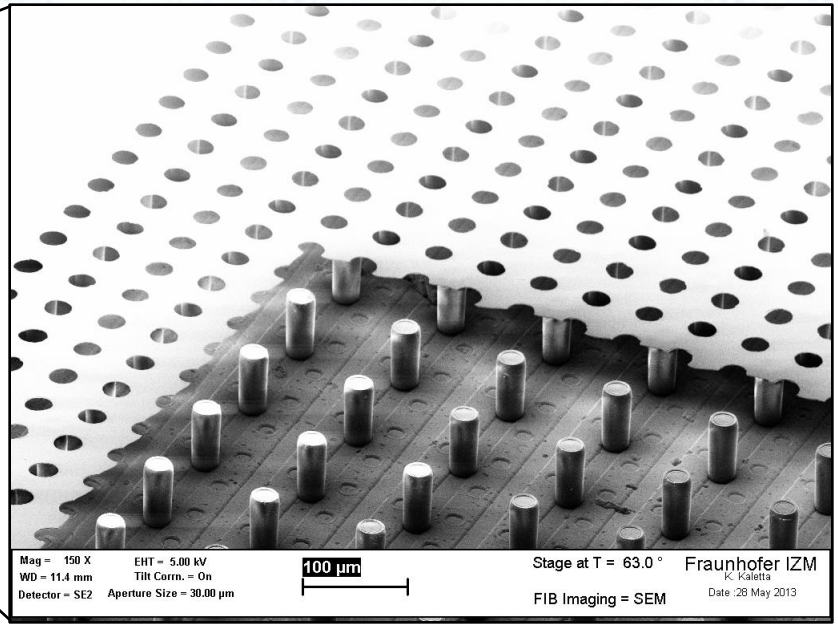

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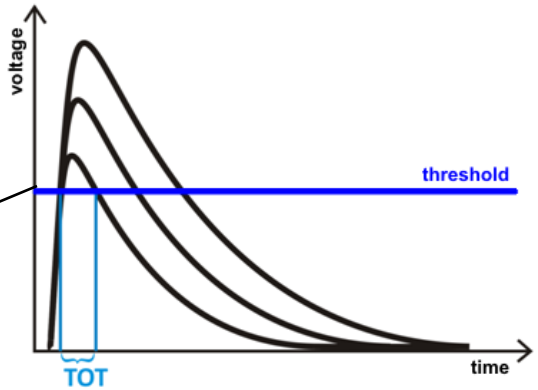

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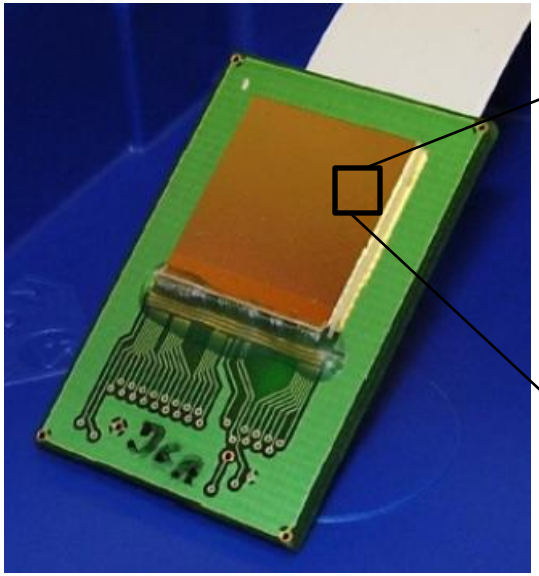

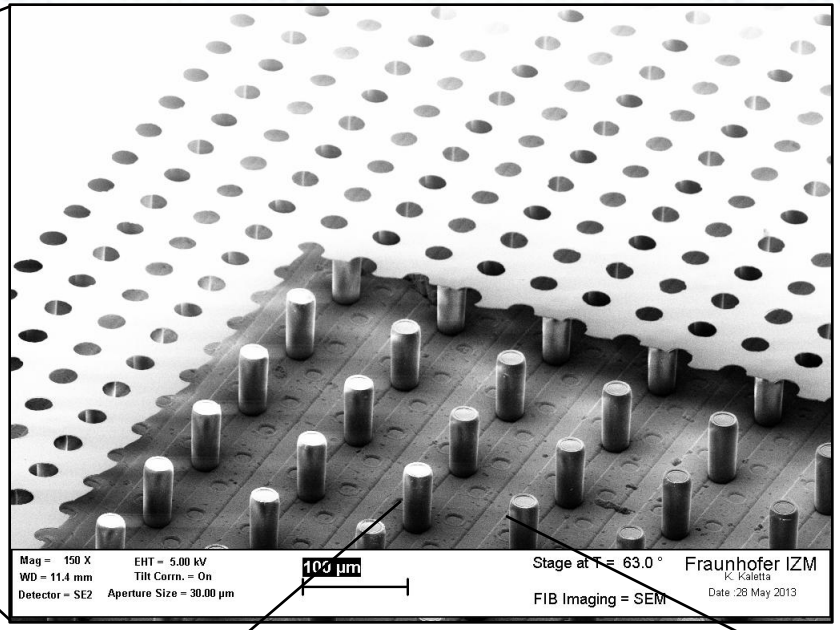

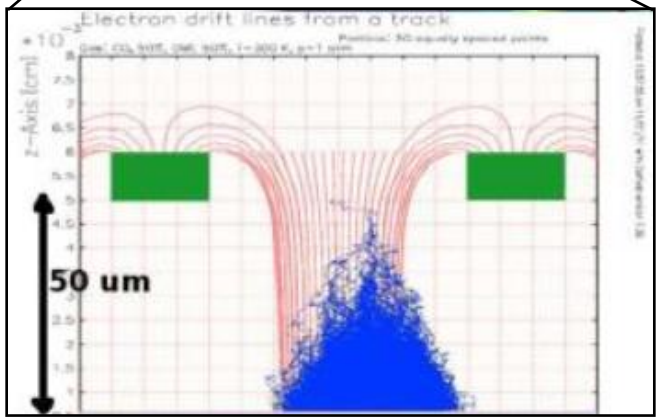

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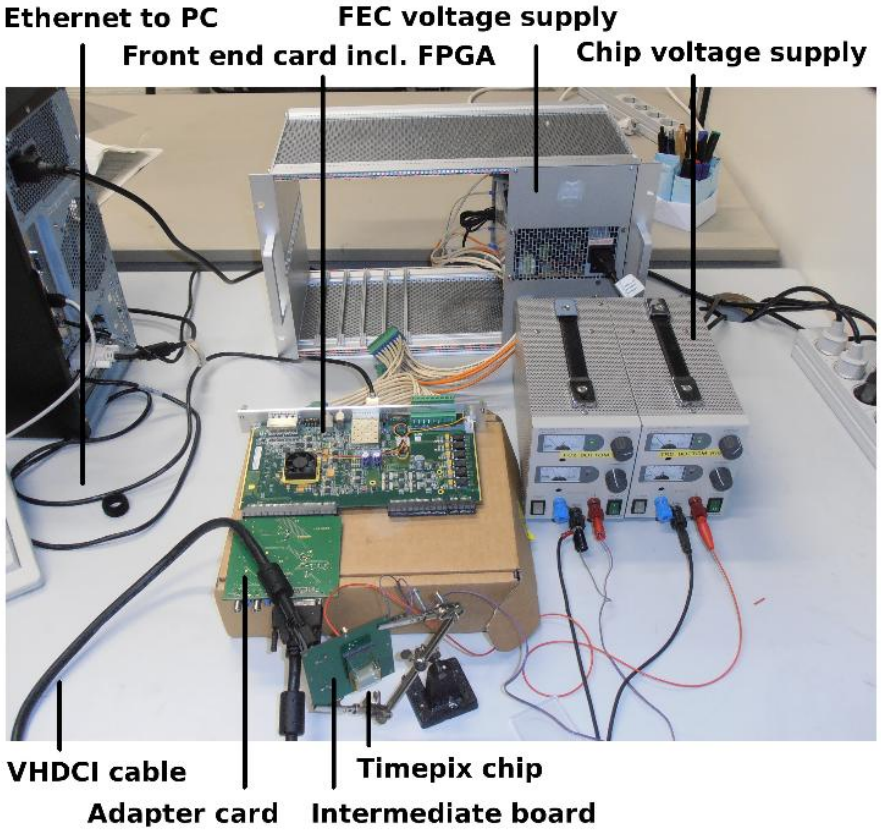
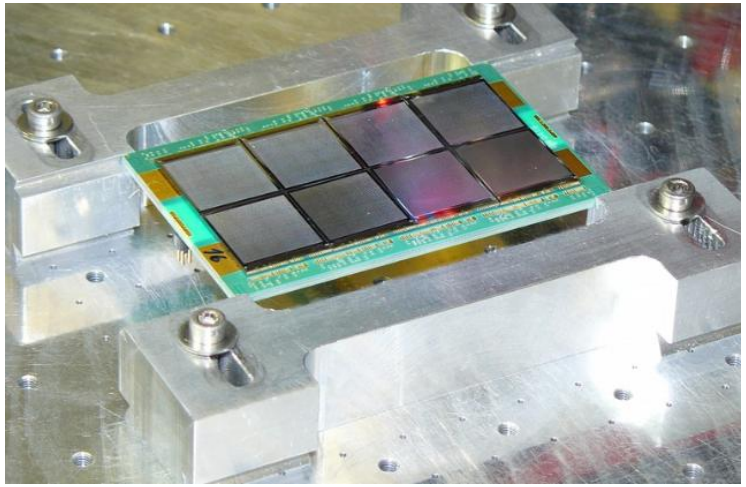
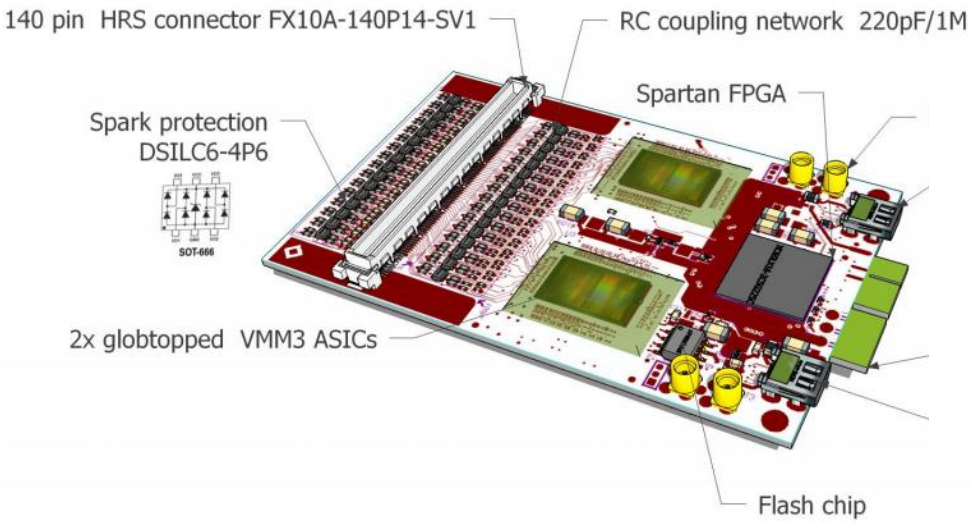
TimePix Readout System

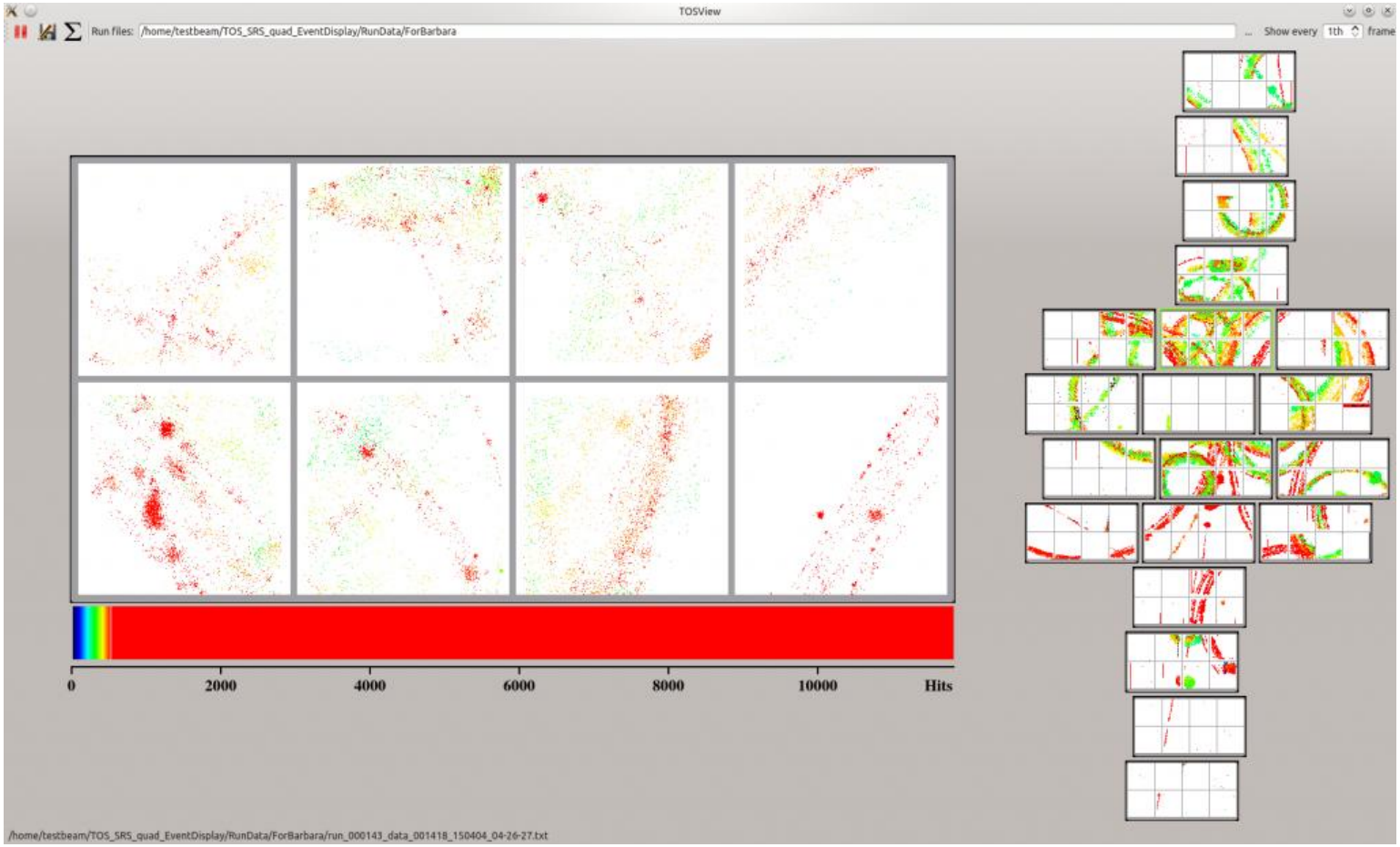






[1] M. Lupberger, The Pixel-TPC – A feasibility study, Thesis 2016
[2] H. Muller, RD51 SRS Status December 2016, CERN

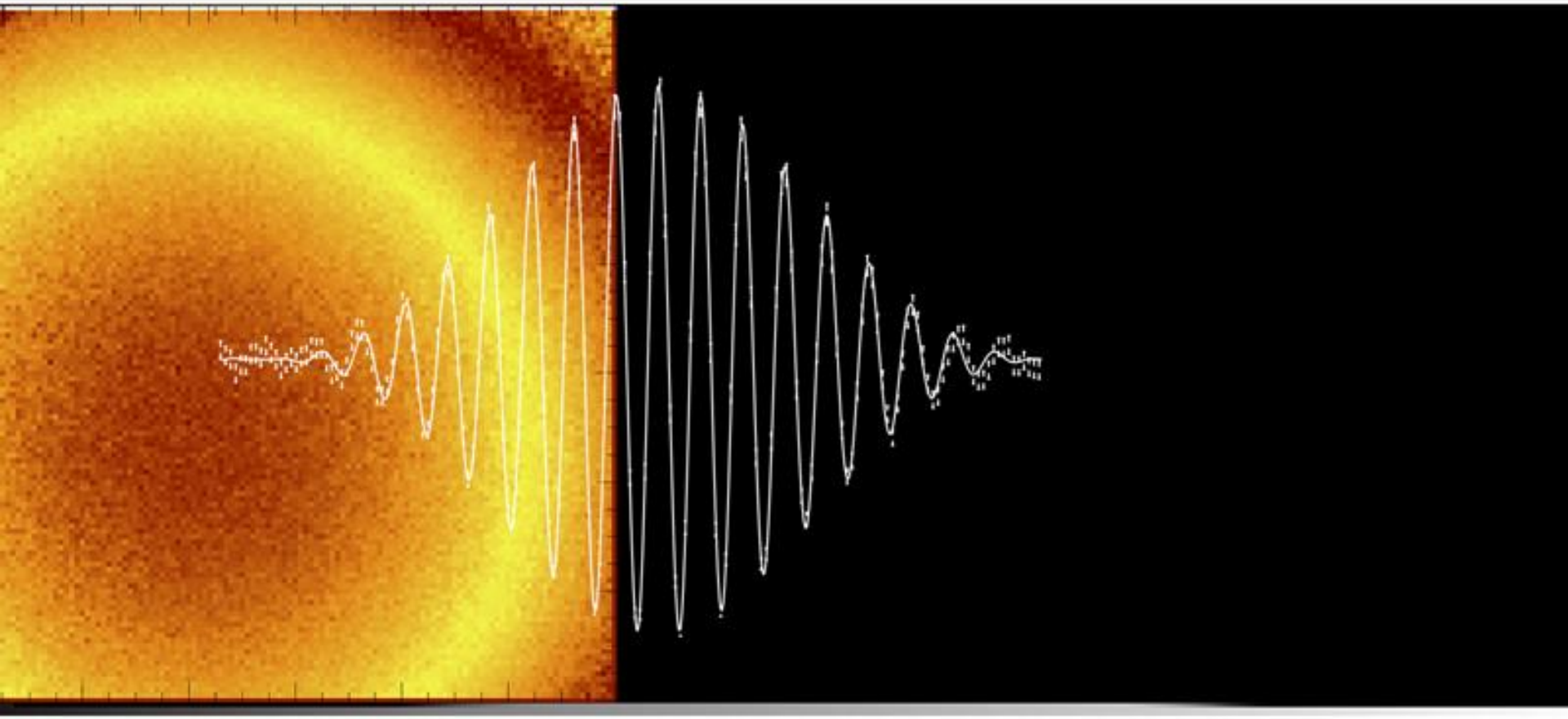
LCTPC Event Display



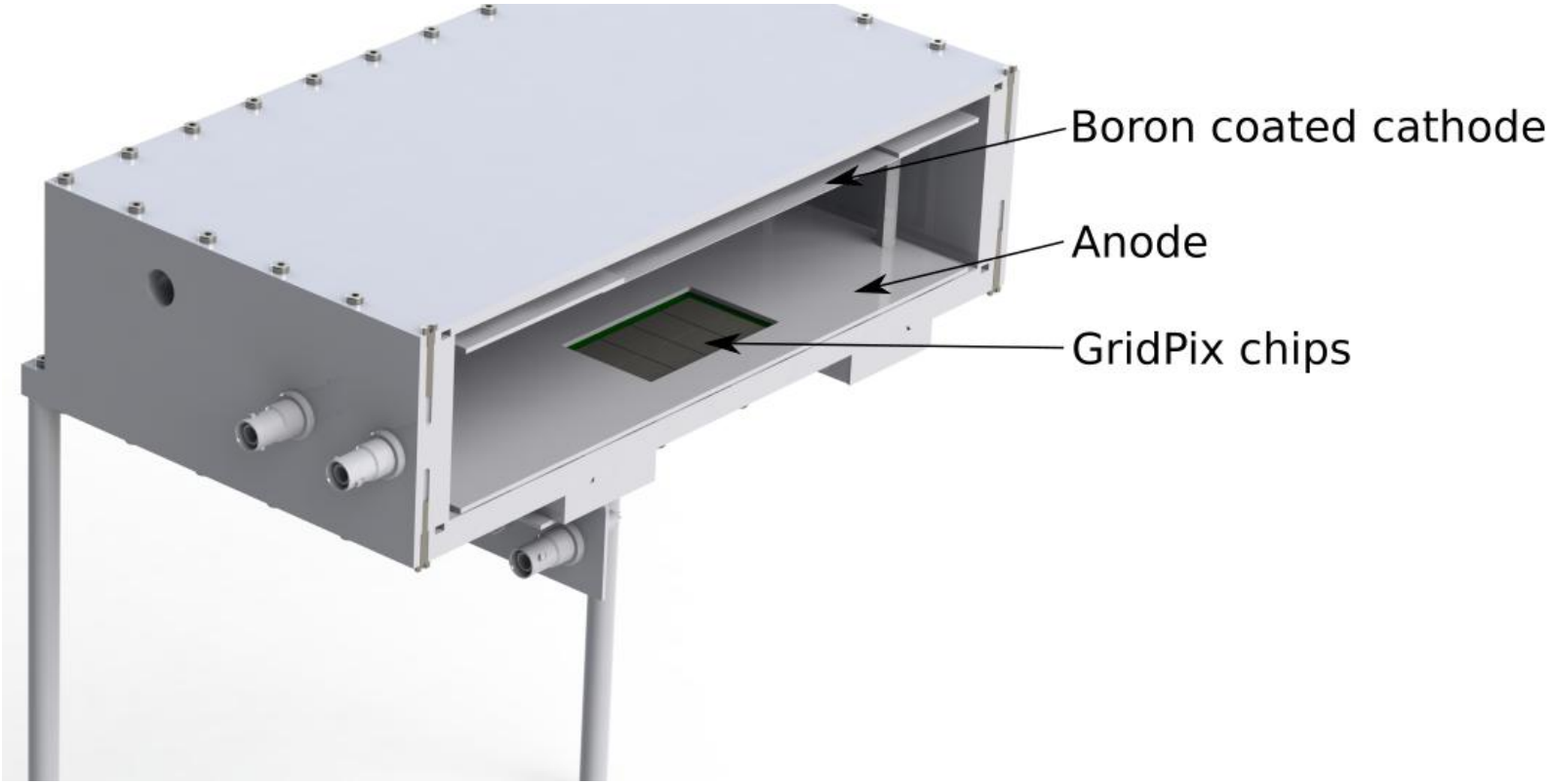
[1]

[1] http://newsline.linearcollider.org

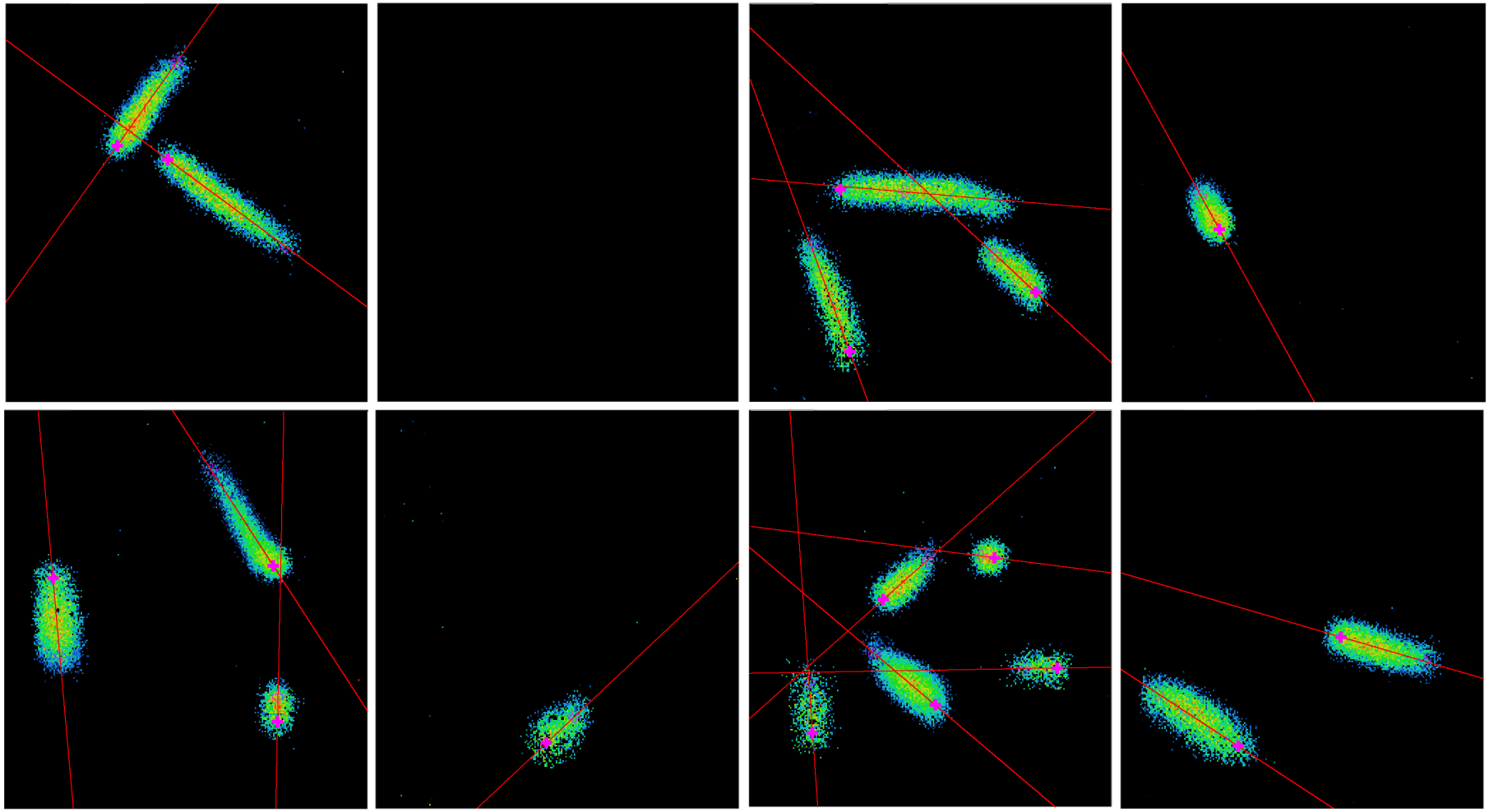
Neutrons



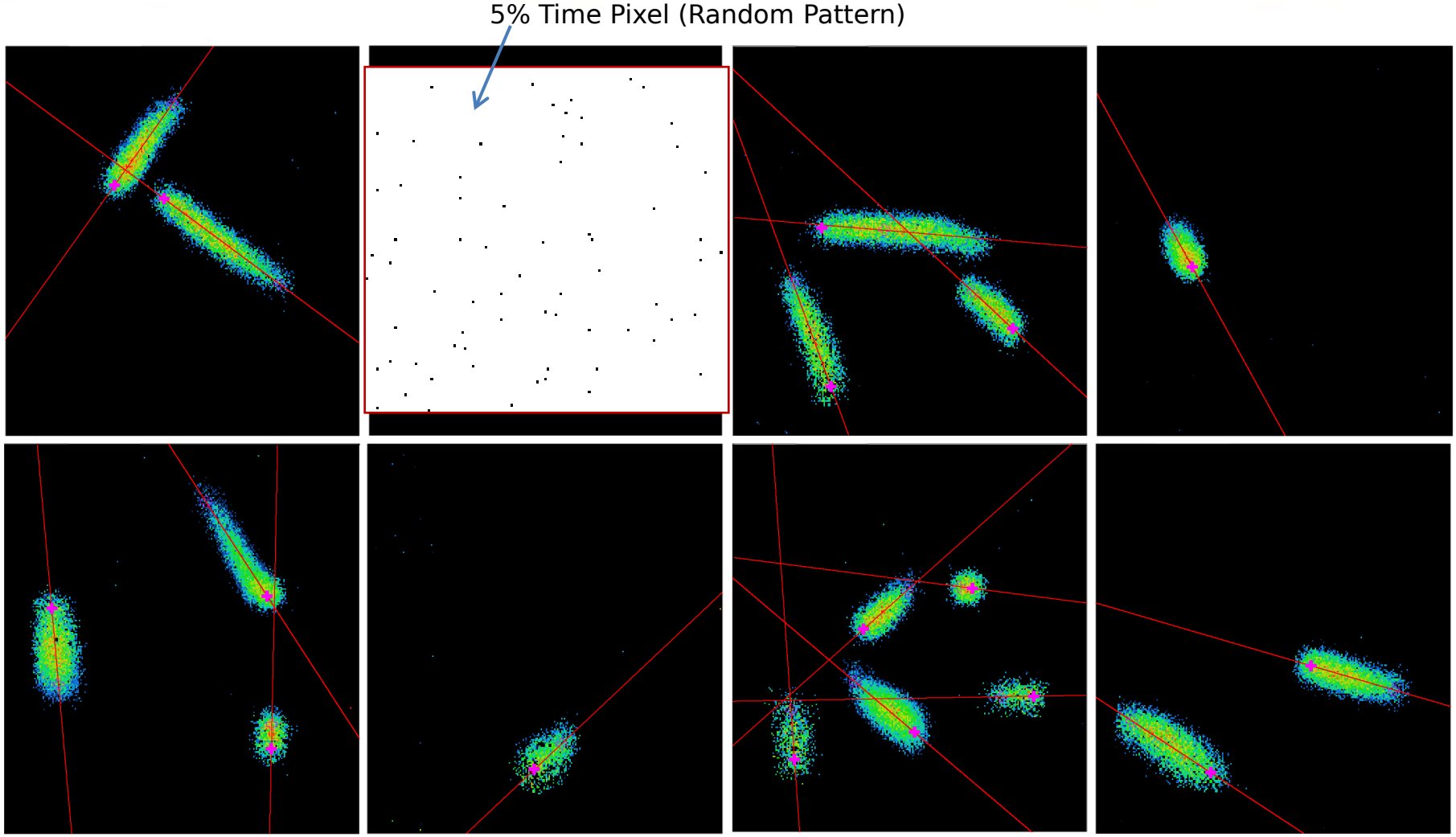
Test Detector



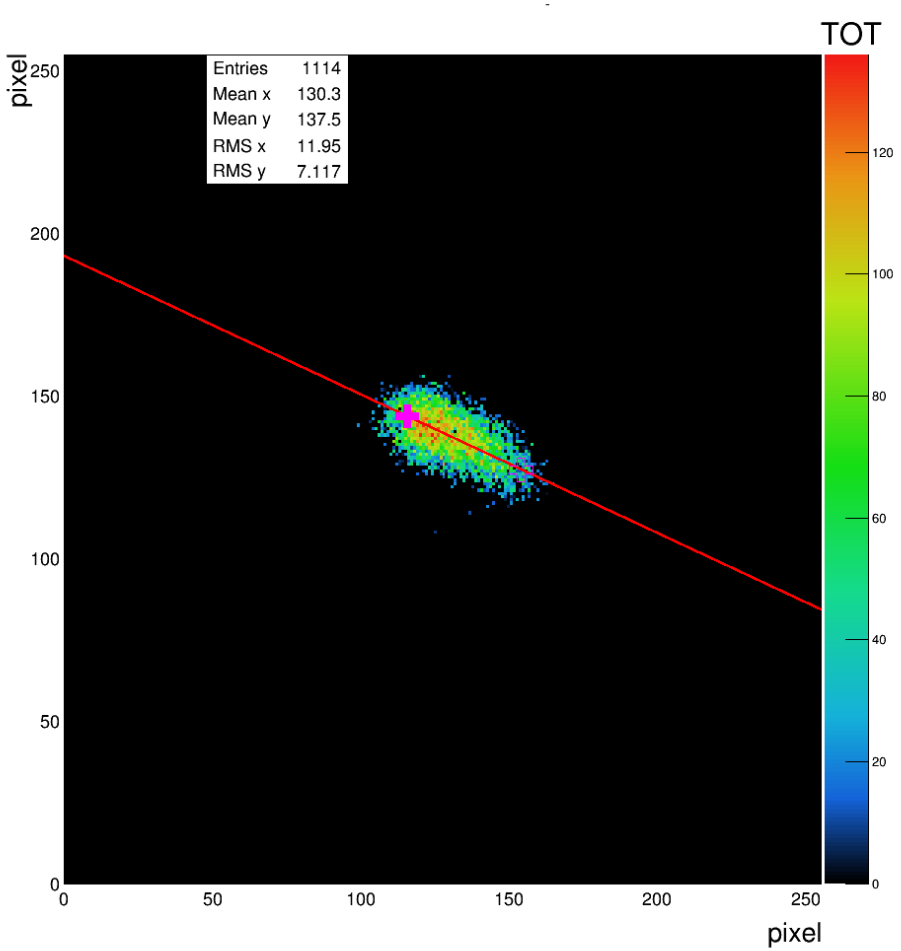
Neutron Conversion Tracks

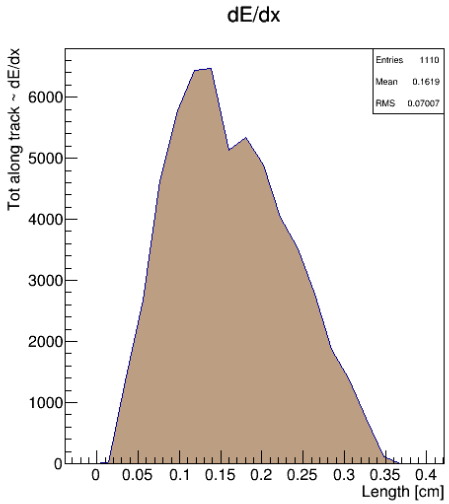


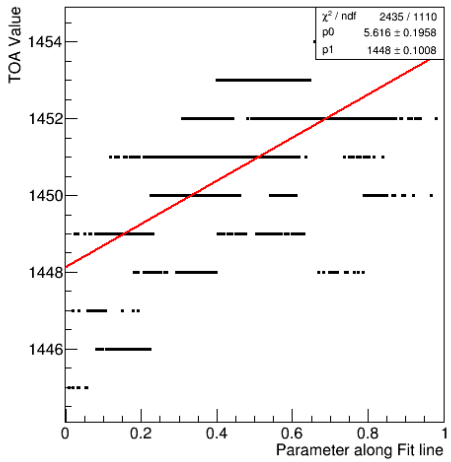
Neutron Conversion Tracks



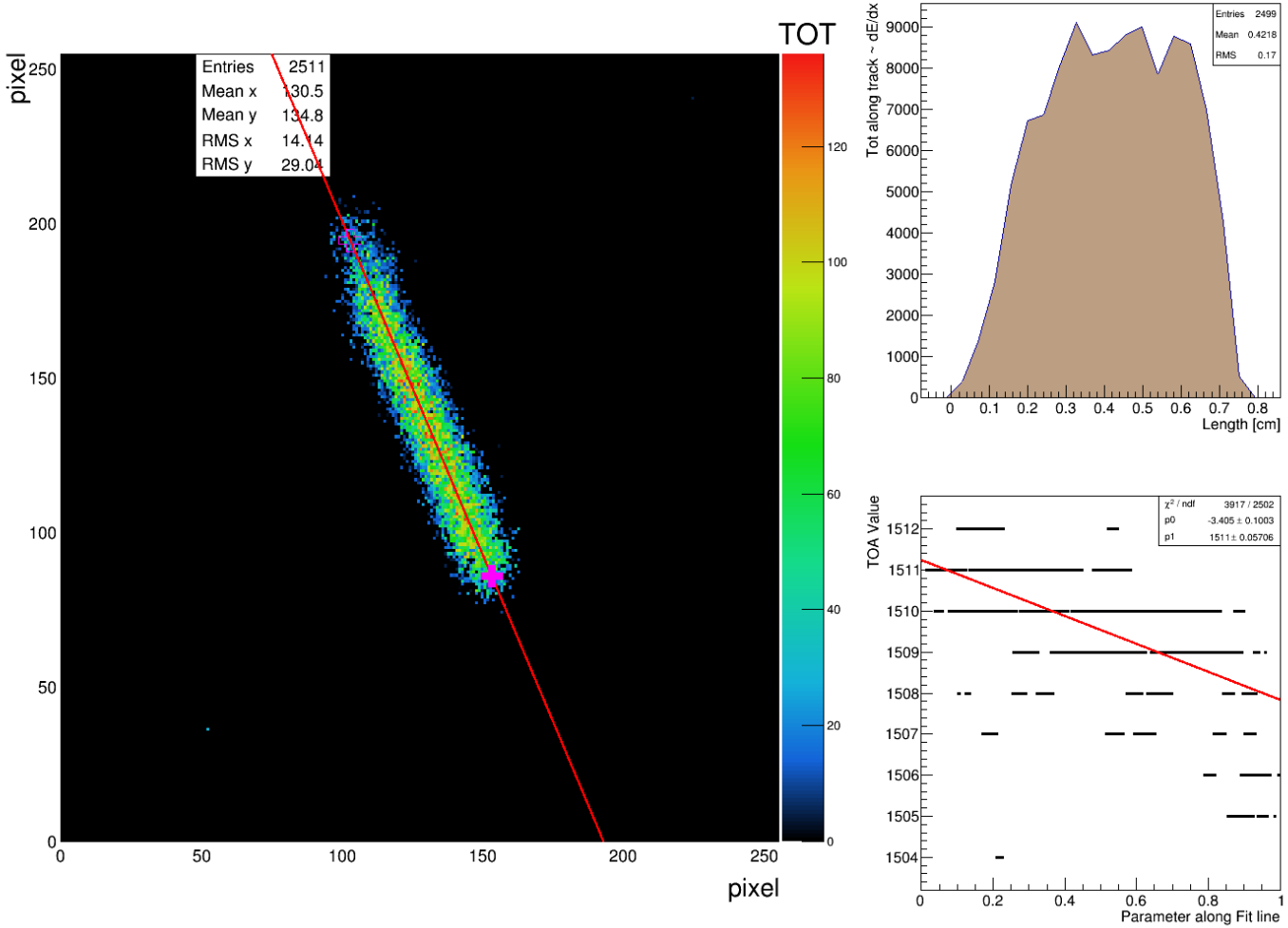
Event Example: Lithium



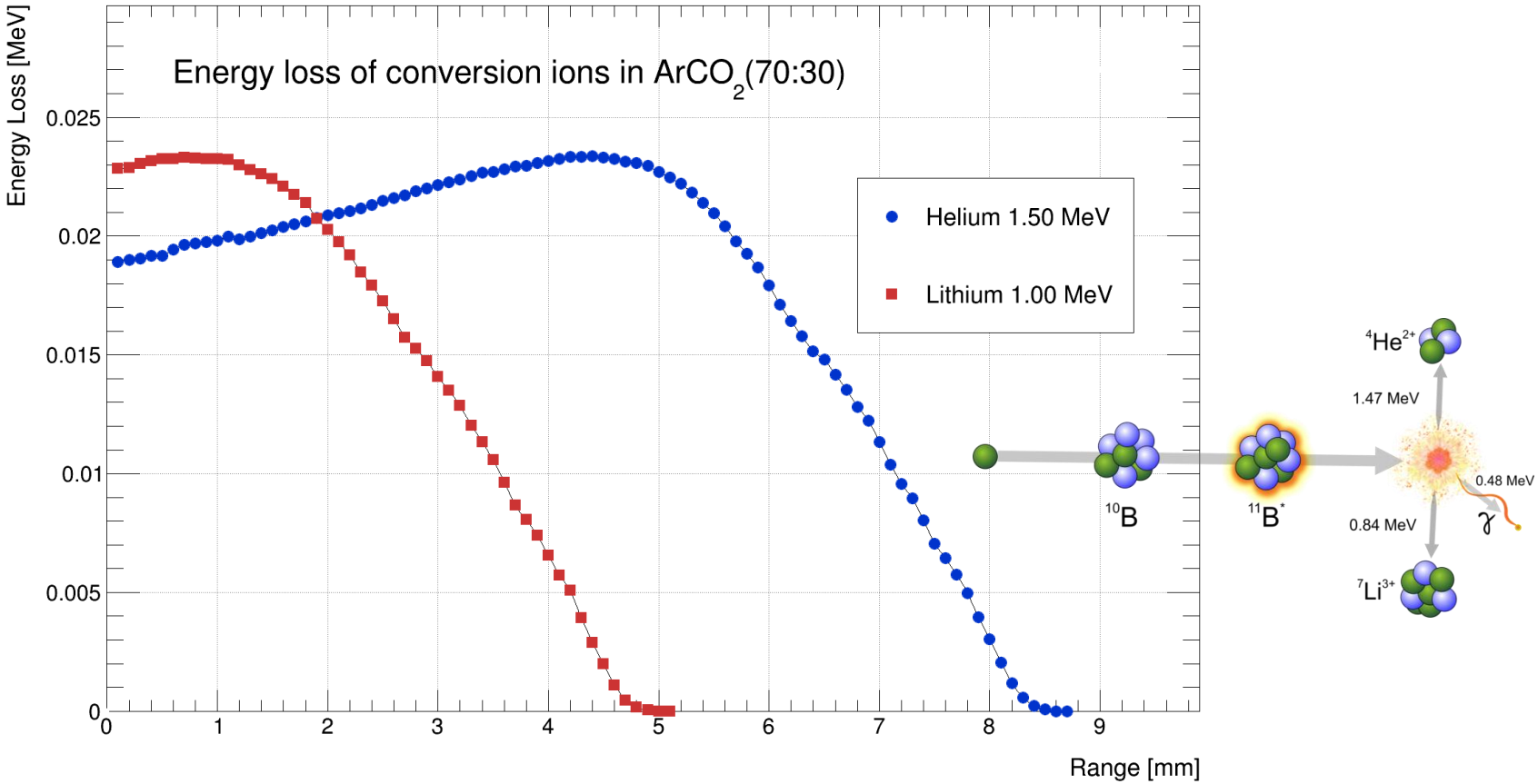




Event Example: Helium

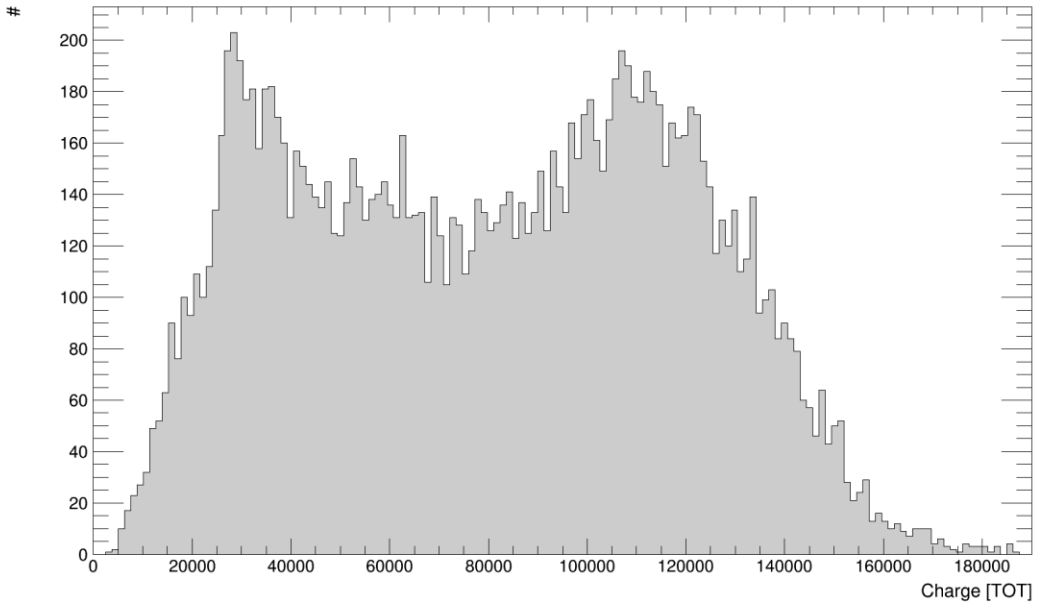


Energy Loss in Gas

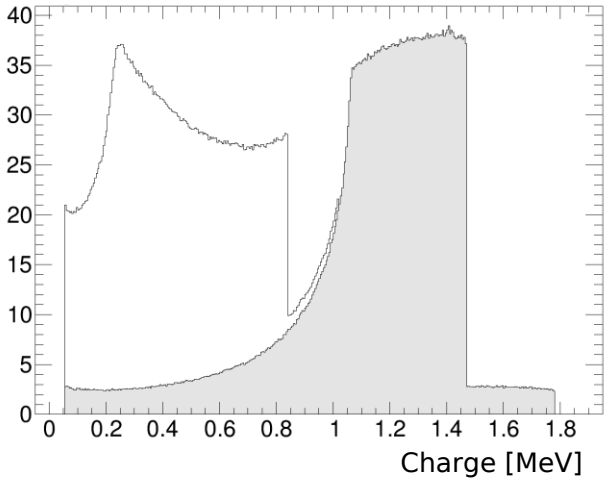


Energy Spectrum

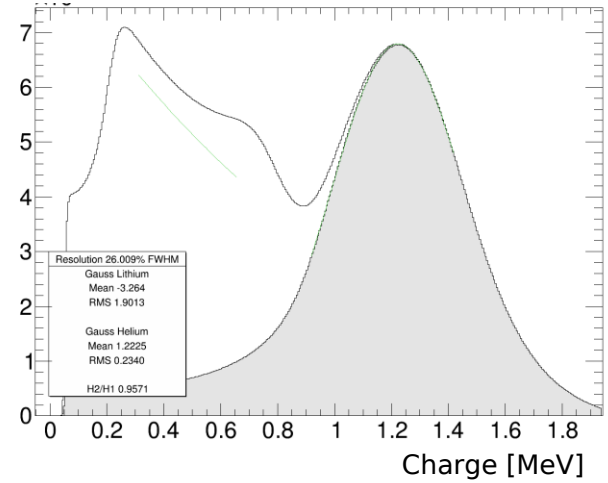
TOT Spectrum (fiducialized)



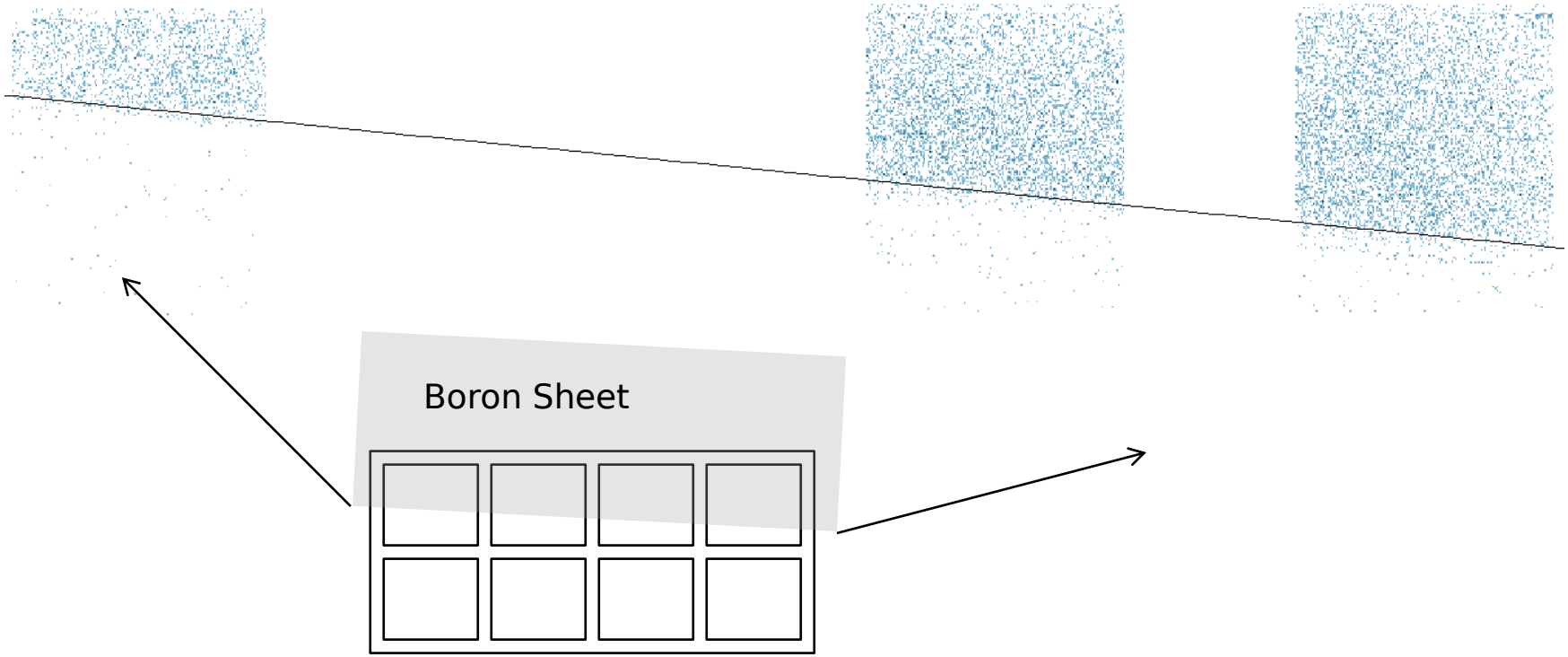
Simulation: 1 µm Layer



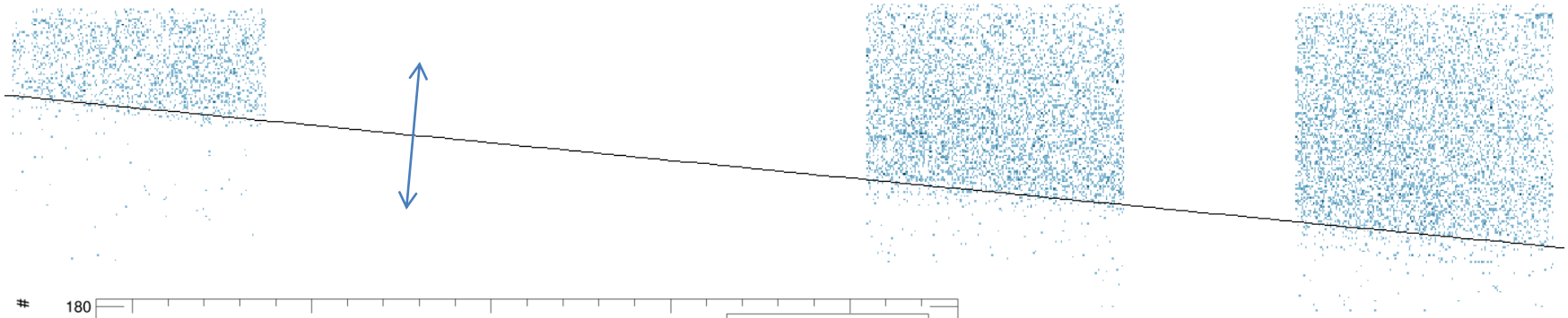
Folded with 25 % FWHM

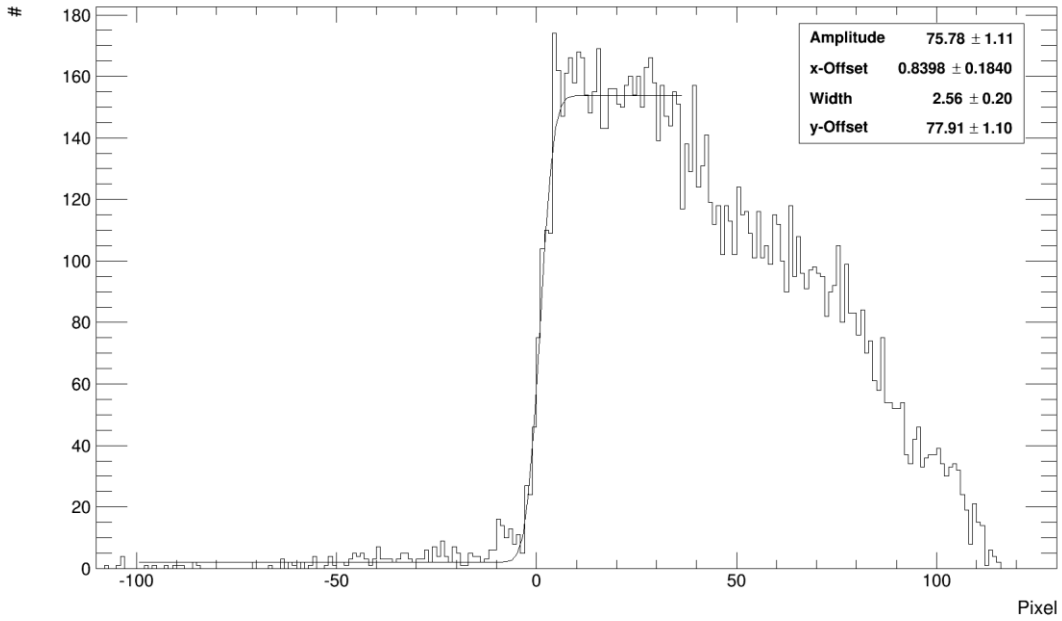


Spatial Resolution



Spatial Resolution





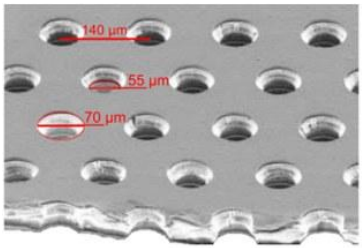
Spatial Resolution σ
(140 +/- 10) µm

To New Shores

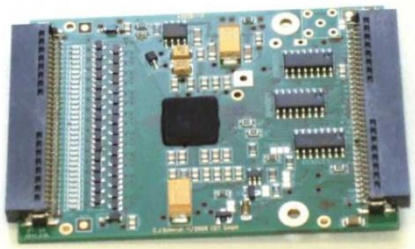
CASCADE
Uni Heidelberg

Technology available in 2000

GEM



CiPix
Multichannel
ASIC



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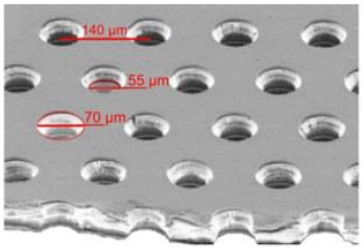

CiPix
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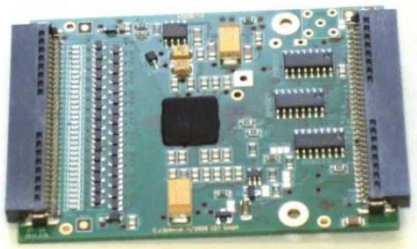
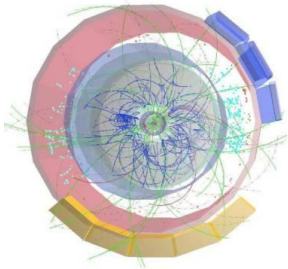
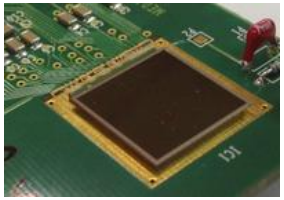


New Project
Uni Bonn

Technology available in 2017



TPC



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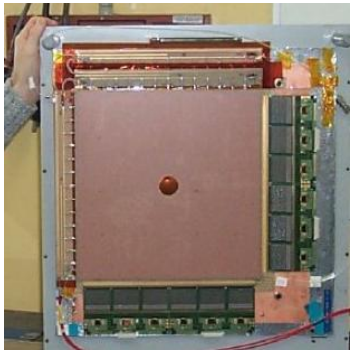

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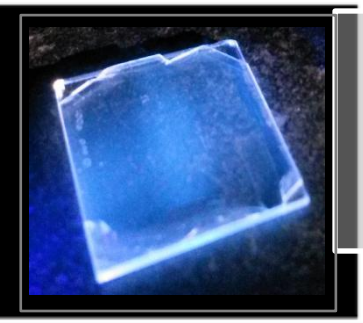

The Neutron Time Projection Chamber

BODELAIRE

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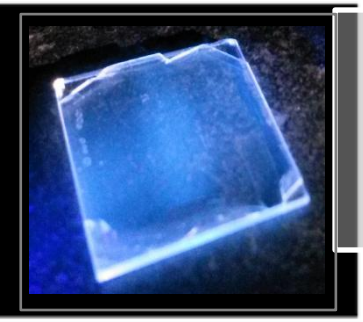

The Neutron Time Projection Chamber

- Trigger & Track Principle

BODELAIRE

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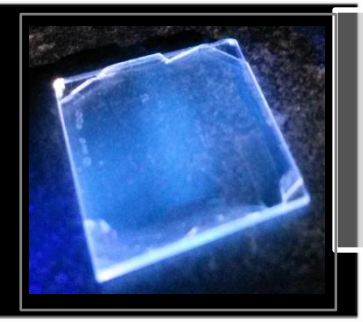

The Neutron Time Projection Chamber

- Trigger & Track Principle
  - Using both conversion products

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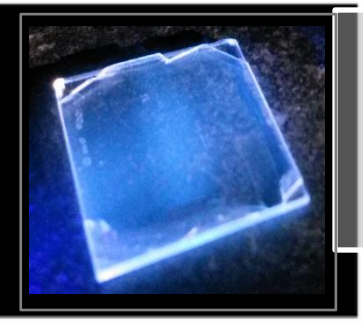

The Neutron Time Projection Chamber

- Trigger & Track Principle
  - Using both conversion products
  - Combination of gaseous tracking detector [TimePix] and a photo sensitive detector [SiPMs]

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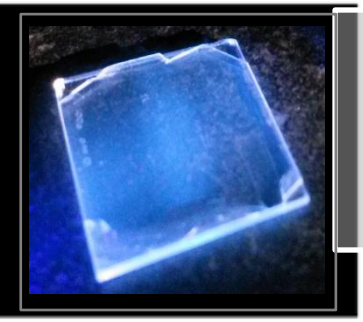

The Neutron Time Projection Chamber

- Trigger & Track Principle
  - Using both conversion products
  - Combination of gaseous tracking detector [TimePix] and a photo sensitive detector [SiPMs]
  - [Spatial Resolution σ (140 +/- 10) µm]

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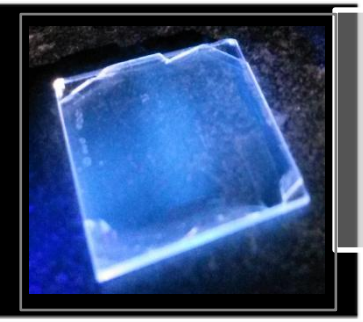

The Neutron Time Projection Chamber

- Trigger & Track Principle
  - Using both conversion products
  - Combination of gaseous tracking detector [TimePix] and a photo sensitive detector [SiPMs]
  - [Spatial Resolution σ (140 +/- 10) µm]

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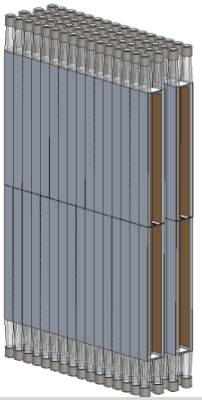

to be continued