Development of RPC-based neutron detector

LIP Summer Internship Program 2022

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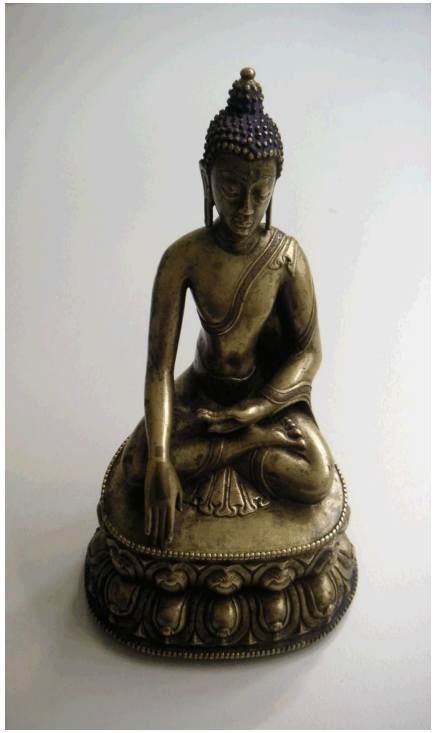
Why neutrons are important?

- Electrically neutral -> they can go deep into matter
- They have magnetic moment -> they can be used to prob magnetism
- De Broglie wavelength for thermal neutrons is comparable to the distance between the atoms in solid matter -> they can be used to study structure of the condensed matter
- They can be used in radiography and tomography -> Complementary to X-ray based techniques.

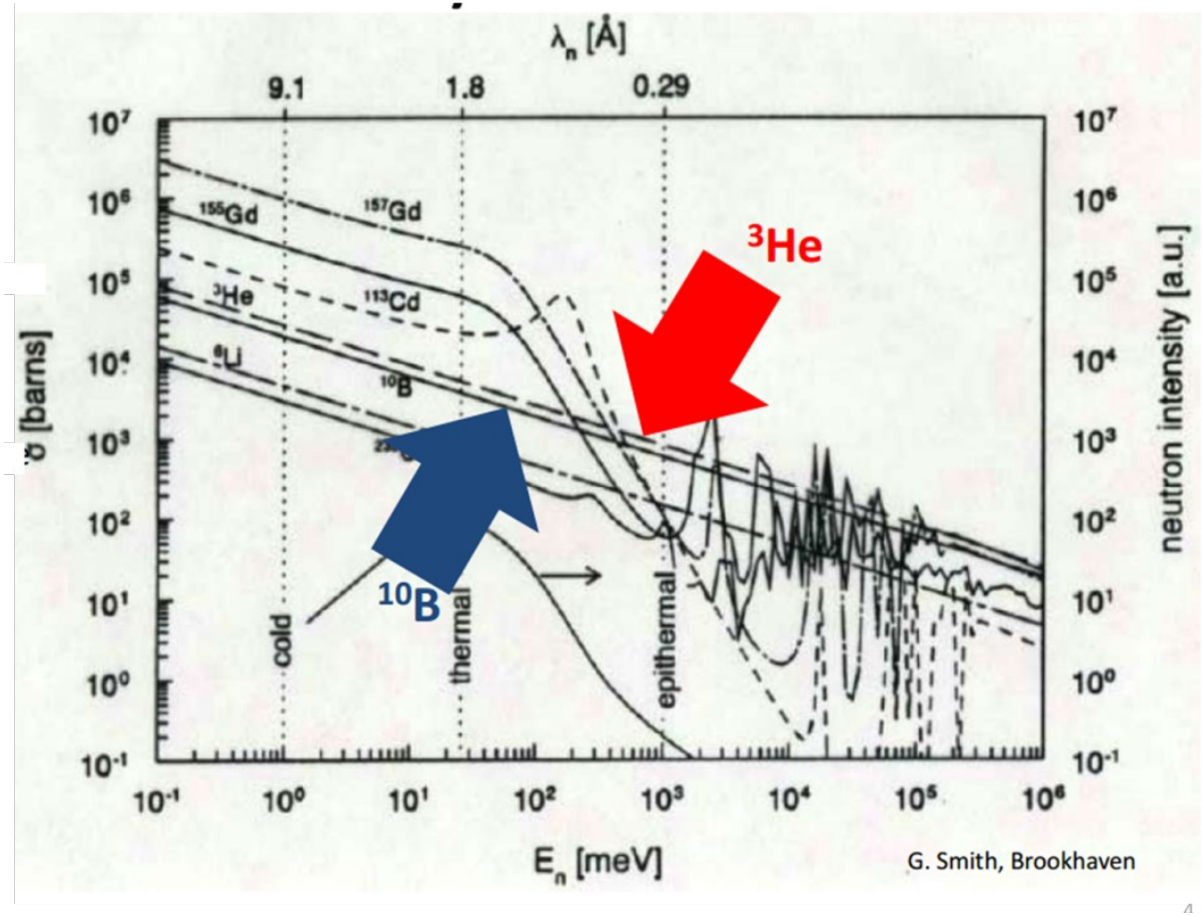


X-Ray image

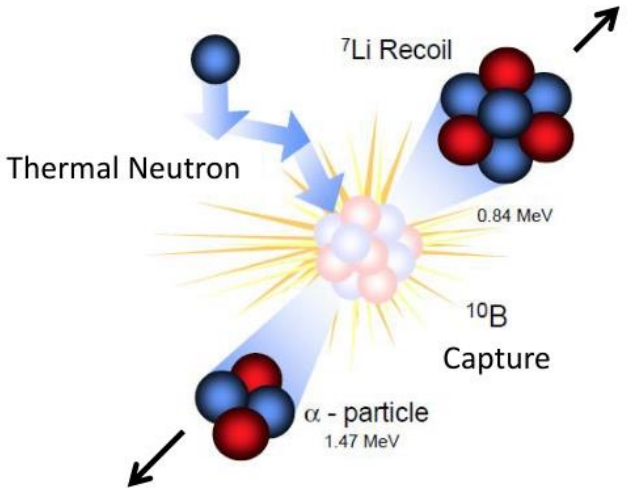
Neutron image

Neutron is electrically neutral → Detection based on indirect interactions

Cross-sections

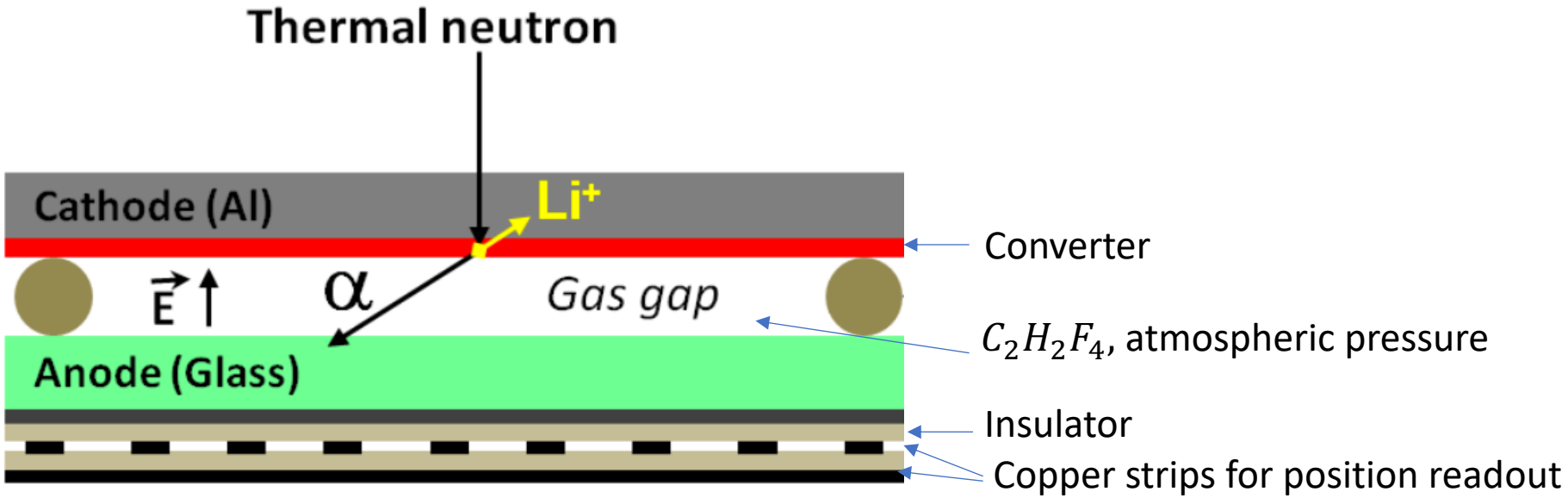


The $^{10}B(n,\alpha)^{7}Li$ reaction



Novel neutron detection concept

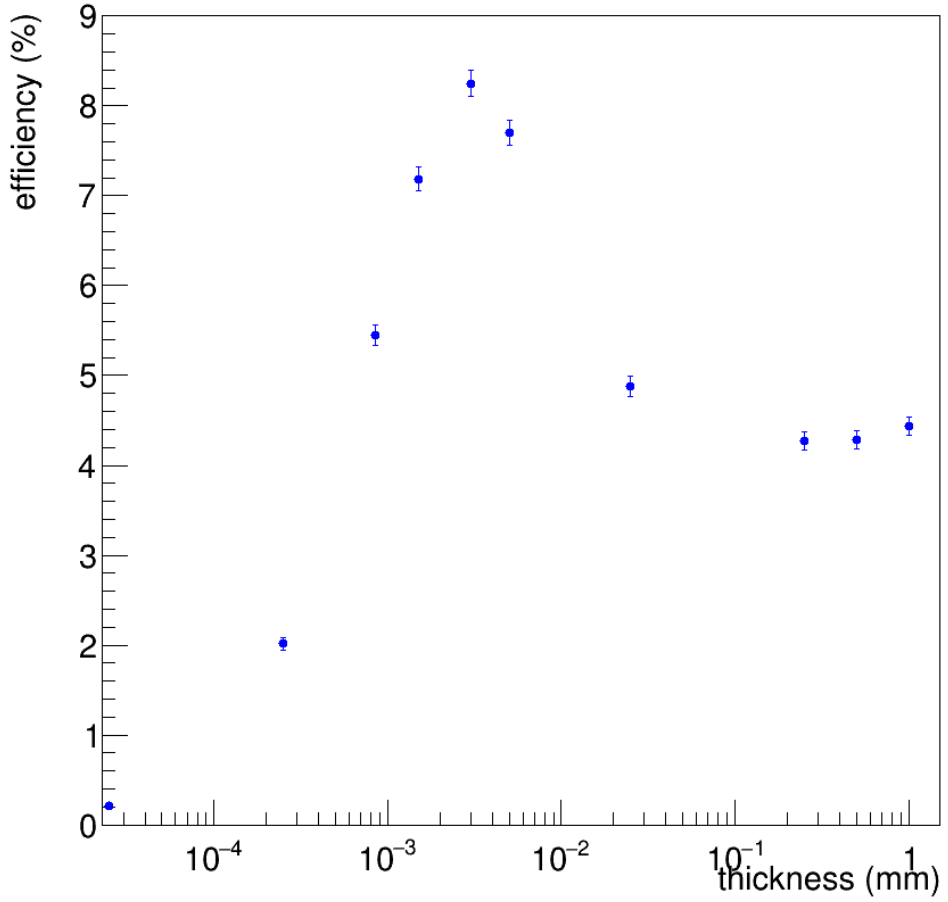
Single-gap Hybrid RPC coated with $^{10}B_4C$



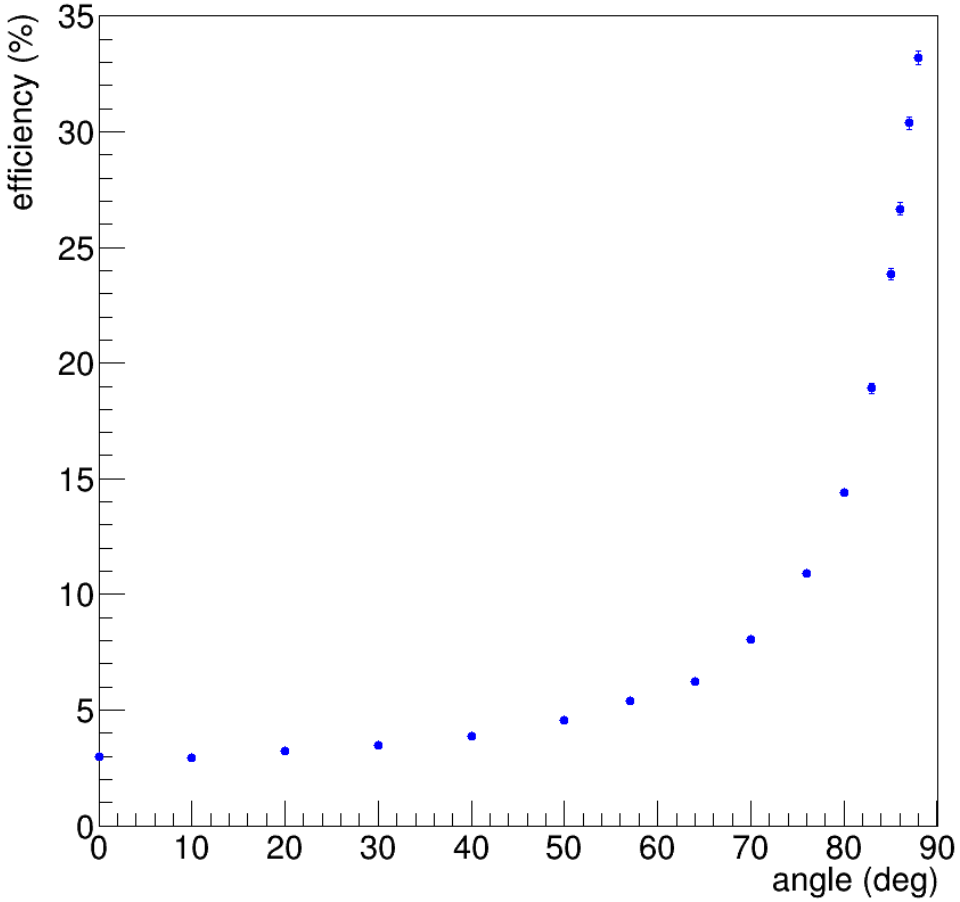
Electron avalanches is triggred inside the gas gap by the alpha and Li ionizing particles

Simulations with ANTS2/Geant4

Efficiency versus neutron converter thickness



Efficiency versus angle of neutron incidence on the RPC



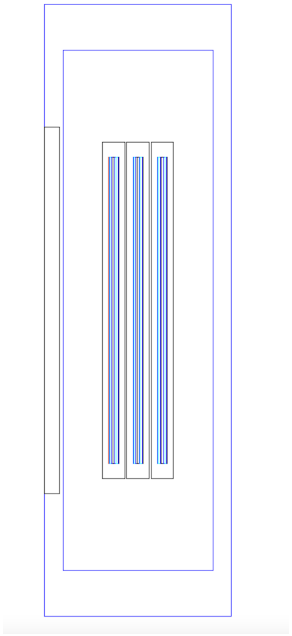
Optimization of a multilayer ^{10}B-RPC detector

- **Goal**:

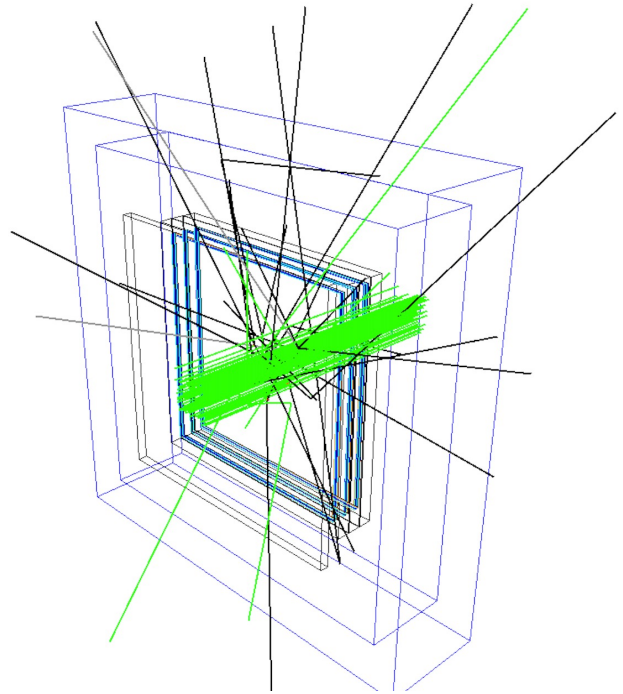
Maximum total detection efficiency and flatness

- **Optimization parameters**:

Thickness of the converter layers of each RPC

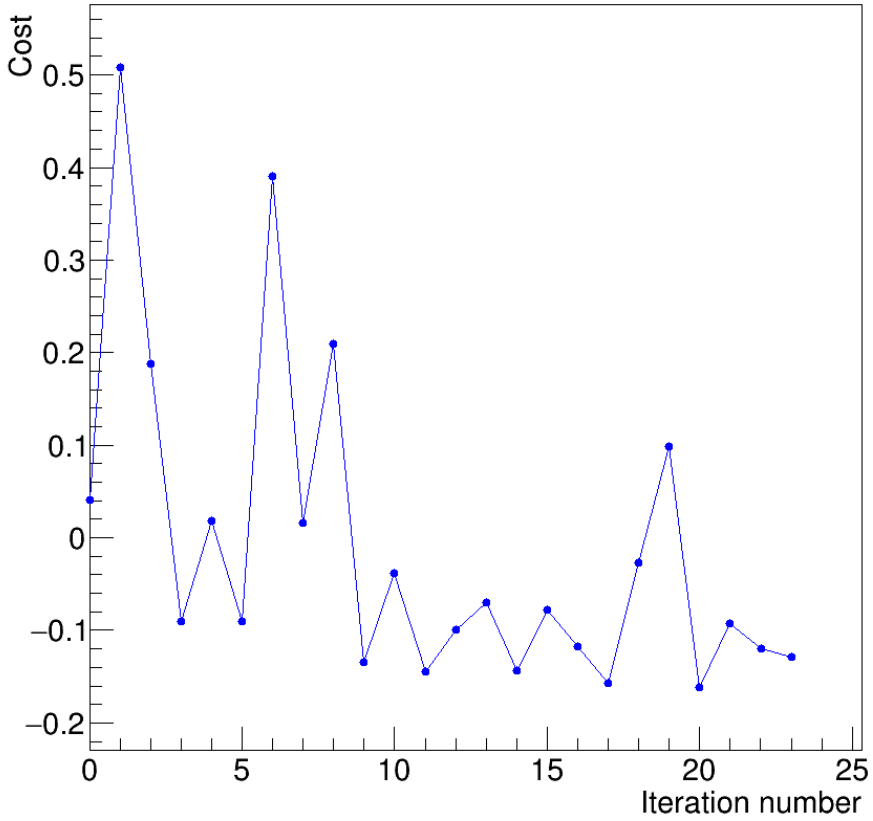


Cross-section view of the detector



Perspective view of the detector

Multilayer optimization results



Cost function value returned to the optimizer

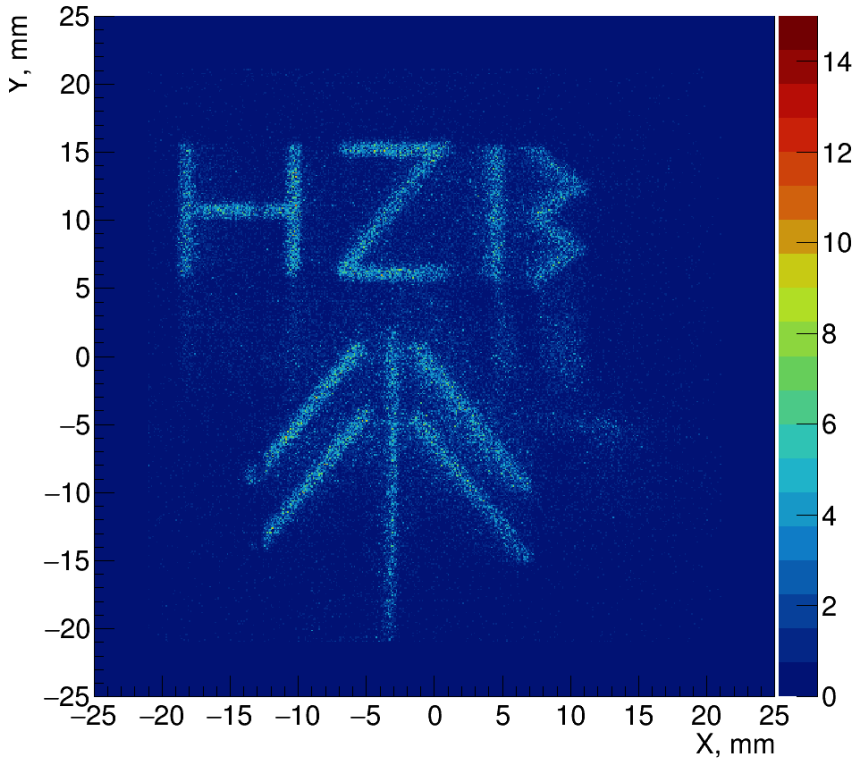
Total detection efficiency: 0.17
Flatness: 5.0e-7

Thickness layer 1: 0.92 μm

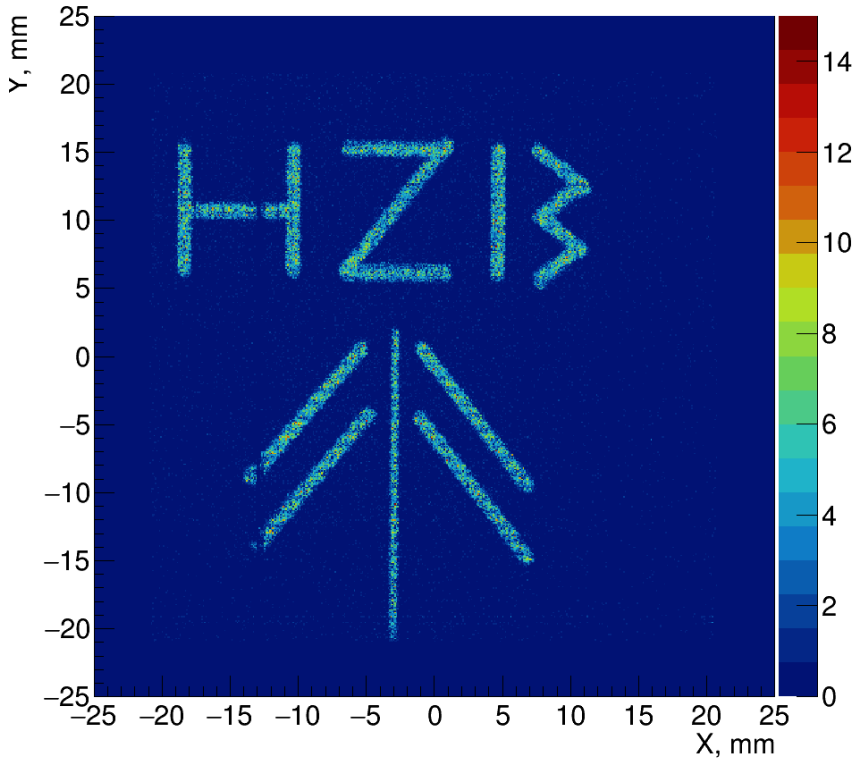
Thickness layer 2: 1.06 μm

Thickness layer 3: 1.35 μm

Neutron event position reconstruction from experimental data



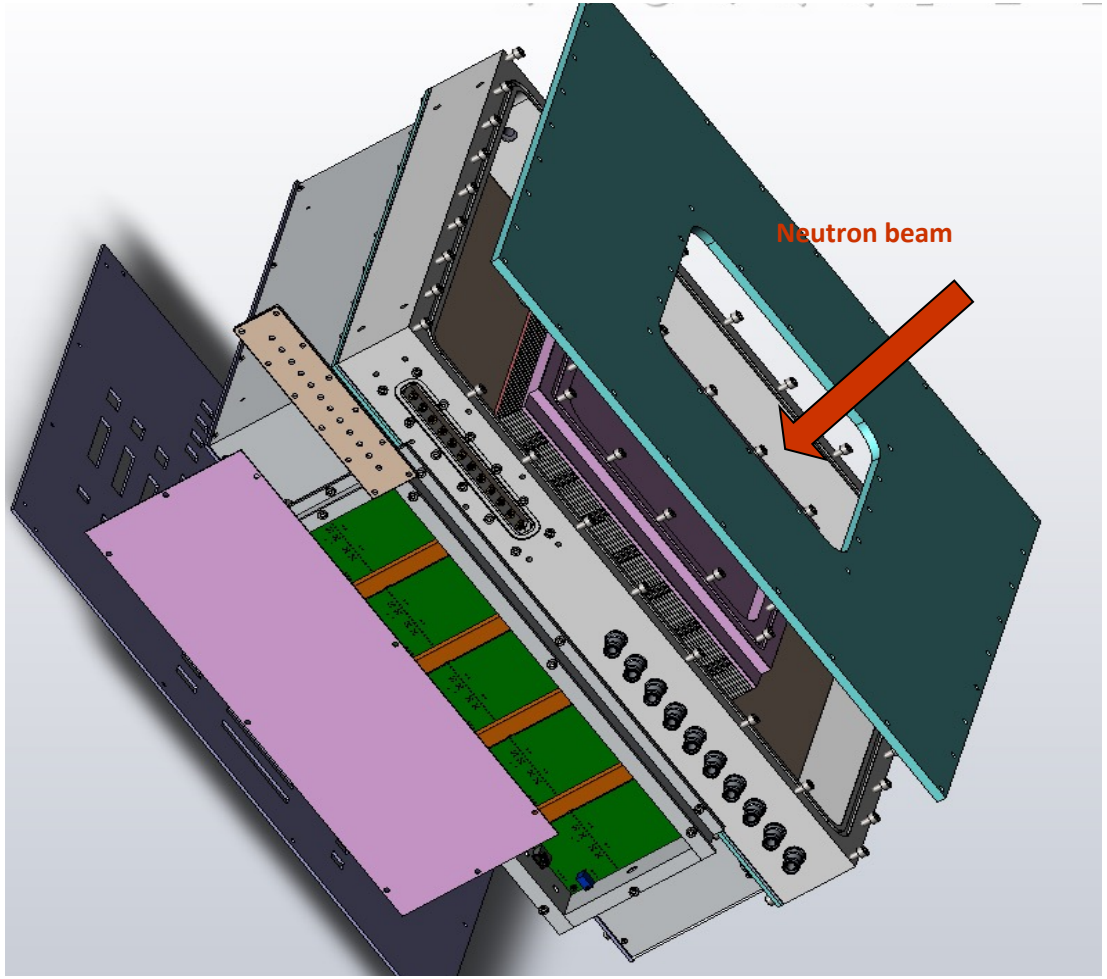
Original simplistic centroid reconstruction



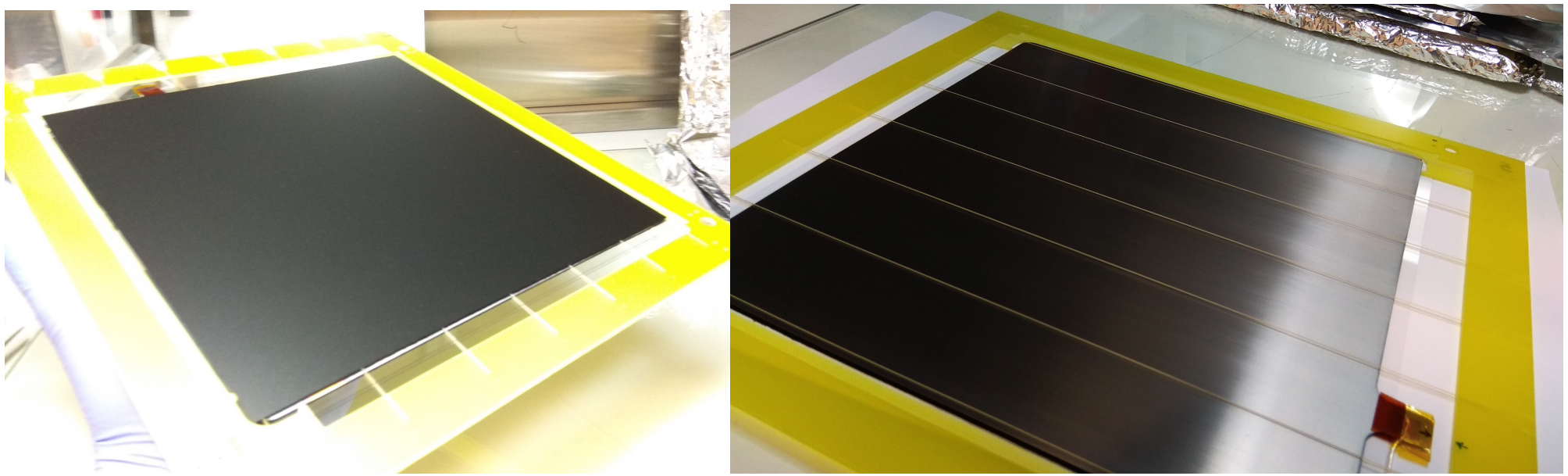
Final image after the introduction of my modifications in the reconstruction algorithm

Assembly of a ^{10}B-RPC multilayer prototype

Exploded view of the detector prototype



Assembly of a ^{10}B-RPC multilayer detector protype



Pictures of a detection unit (Hybrid Double-Gap RPC) being assembled

Assembly of a ^{10}B-RPC multilayer detector protype

Thank you for your attention

Backup slides

Double gap ^{10}B-RPC