NDET

Neutron detectors

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1 ***Technician(s):***
João Saraiva (15)

1 ***Master Student(s):***
Giorgio Canezin (100)

5 ***Undergraduated Student(s) and Trainee(s):***
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1 ***External collaborator(s):***
Luís Pereira

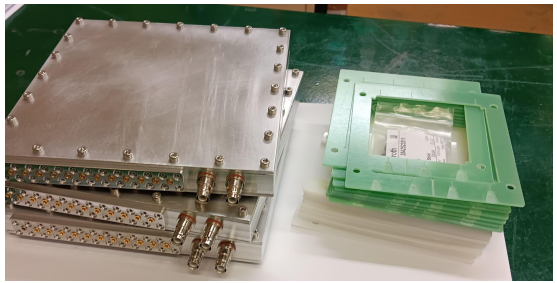
Total FTE:
3.2

Highlights

A nRPC-4D detector assembled and tested at ILL

- 200 mm x 200 mm sensitive area
- 10 D-Gap RPCs (20 layers of $^{10}B_4C$)
  - RPC 1 to 9: float glass
  - RPC 10: low resistivity glass (AIDAINOVA)

Fast neutron RPC detectors for tests at HISPANOS (with RPC and NUC-RIA groups)
Manufactured **@** LIP MW



Student training

- MSc Thesis (G. Canezin)

We join the DRD1 Collaboration, WP9 BEYOND HEP

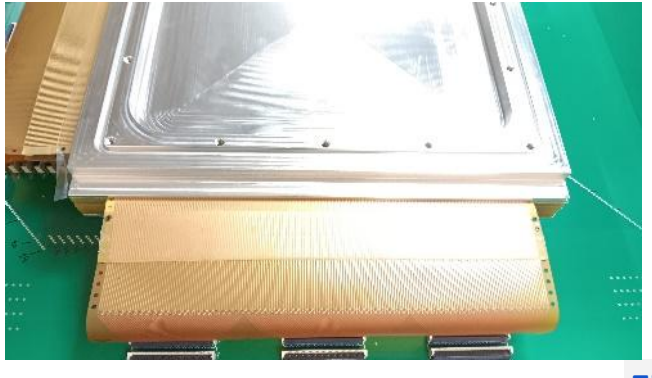
Applied for funding

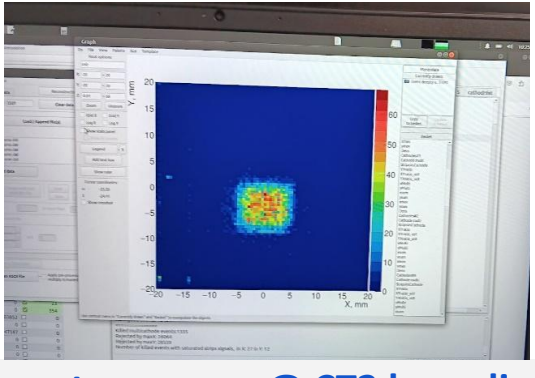
- Horizon EU call HORIZON-INFRA-2024-TECH-01-01 (jointly with the mayor neutron facilities in EU)
- FCT: 2023.15652.PEX (collaboration with ILL)

Highlights

nRPC-4D detector tests at ILL

nRPC-4D Detector



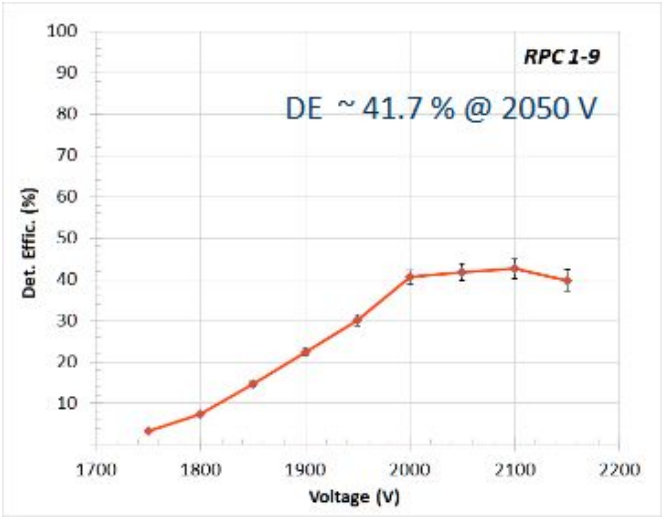


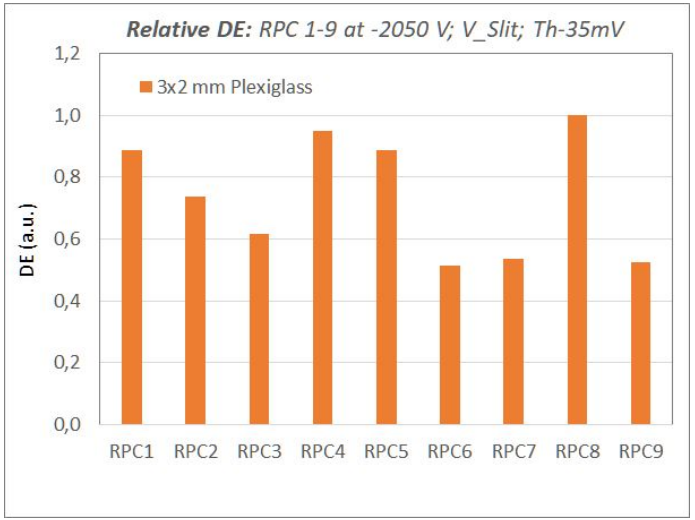
First neutrons seen @ CT2 beamline (ILL)

Highlights

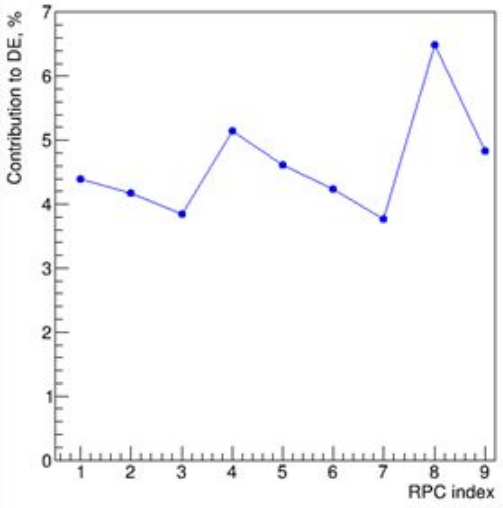
A nRPC-4D detector tested at ILL

- RPC 1 to 9 (float glass): Neutron Detection Efficiency





Simulation prediction (GEANT4 /ANTS3)

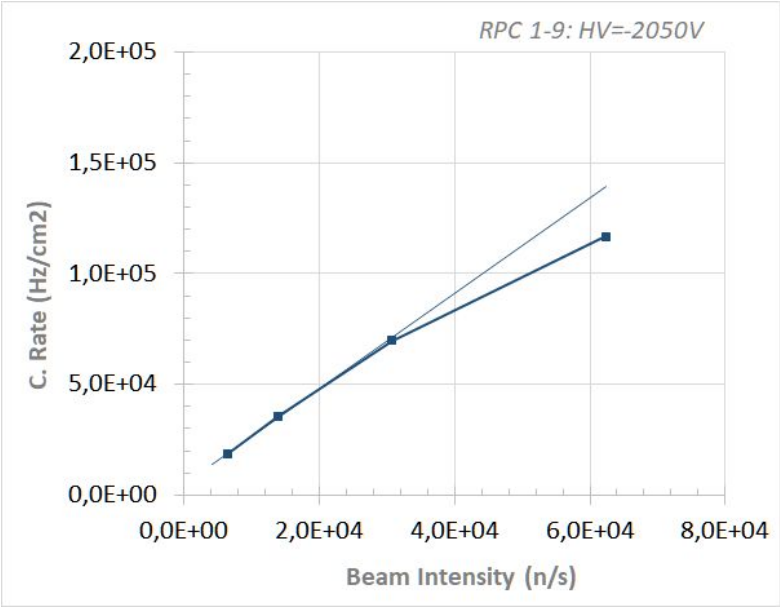


Total DE of **41.5%** for λn=2.5 Å
(57% for λn = 4.5 Å)

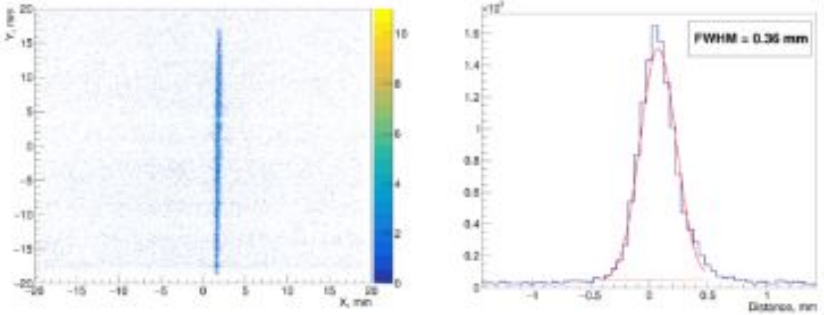
Highlights

A nRPC-4D detector assembled and tested at ILL

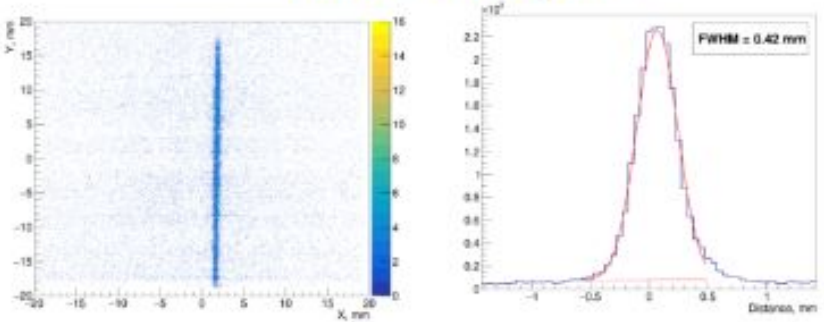
- **RPC 1 to 9 (float glass): Count Rate**



C. Rate ~ **19 kHz/cm²**



C. Rate ~ **70 kHz/cm²**

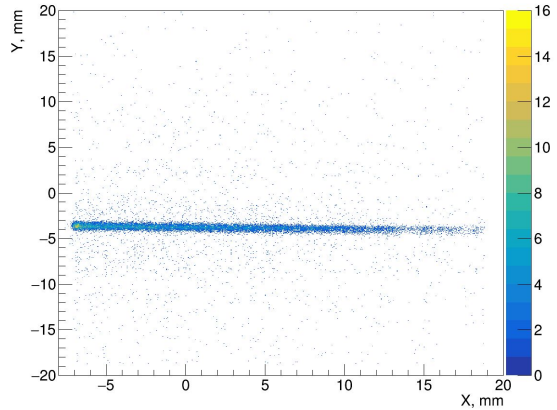


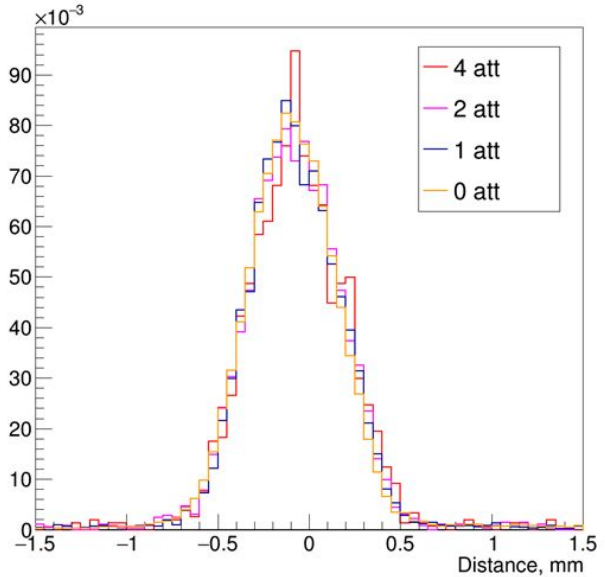
Local count rate is almost linear with the beam intensity ~ **70 kHz/cm²**
(~15% deviation @ ~120 kHz/cm²)

Highlights

A nRPC-4D detector assembled and tested at ILL

- **RPC 10 (low resistivity glass): Count Rate**



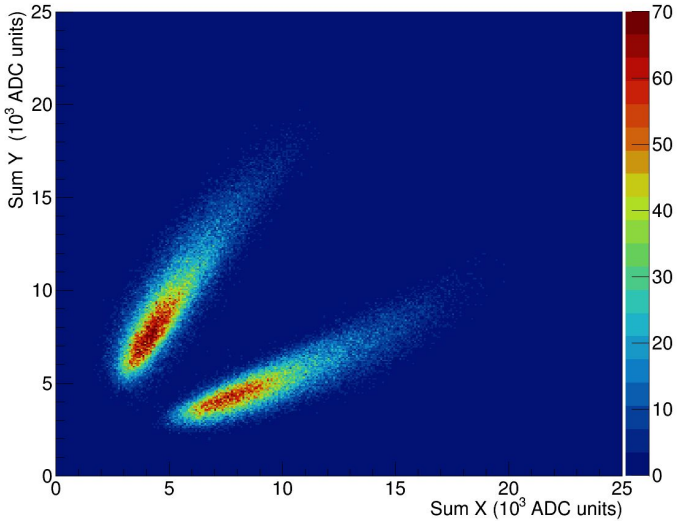


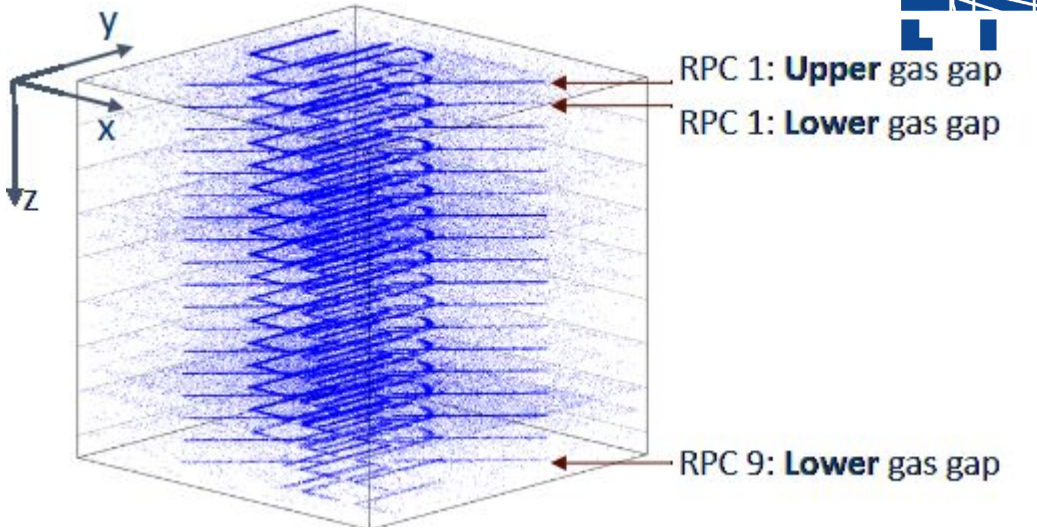
No changes are observed in the profile at Máx. Neutron Flux

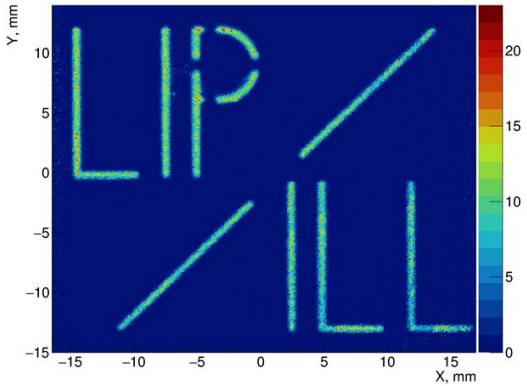
Highlights

A nRPC-4D detector tested at ILL

- **RPC 1 to 9 (float glass): Z-coordinate**







Identification of the $^{10}B_4C$ layer along the stack (Z-direction) where neutron capture

Highlights

nRPC-4D tests results summary

- Location of neutron **capture in three dimensions (XYZ) demonstrated.**
- Capability to measure **nToF**.
- The scaling of the detection area of a factor 4 in relation to the first prototype shows no impact on spatial resolution, **staying below 0.3 mm FWHM.**
- Overall **detection efficiency** of ~42 % (λn=2.5 Å) for 9 RPCs is in good **agreement with the simulation** prediction.
- The **increase of the count rate capability**, scaling with the number of detection modules, was observed.
- **RPC 10, with low resistivity glass**, does not seems to be affected by the high neutron beam flux - spatial resolution kept unchanged.
- Prospects of achieving count rates of a **few hundred kHz/cm2** may become realistic.

SWOT

Strengths

Extensive knowledge in the development of neutron detectors.

Strong background in simulations and position reconstruction.

Long-standing collaboration with detector groups from ILL, FRM II and ISIS neutron facilities.

Weaknesses

Limited human resources.

Absence of a neutron source in LIP for testing detectors.

Opportunities

^{10}B-RPC technology demonstrates a strong potential for applications at large scale neutron facilities.

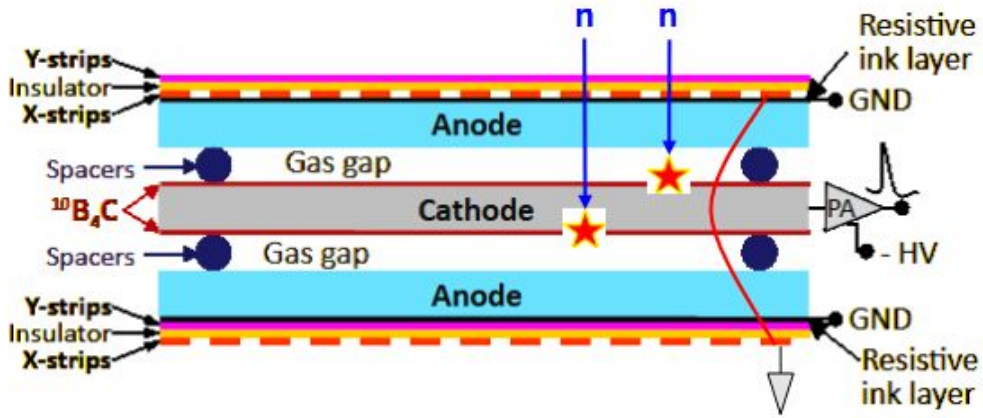
Neutron facilities are driving the development of new types of neutron detectors.

Threats

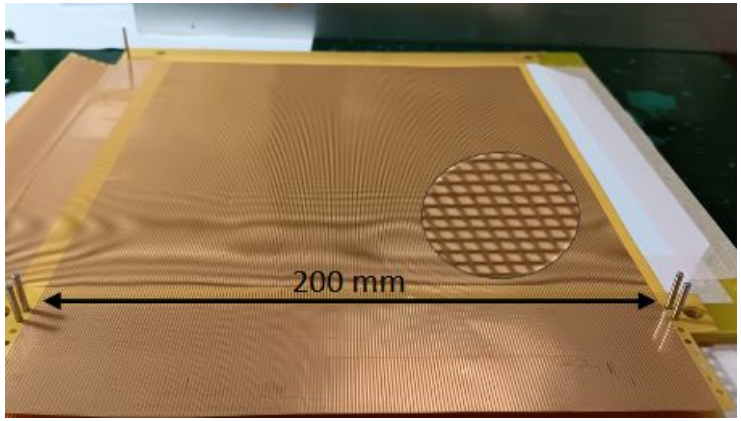
Not sustainable funding.

Extra Slides

XYZ coordinates and time



$$n + {}^{10}B \rightarrow \begin{cases} {}^{7}\mathrm{Li}(0.84\ \mathrm{MeV}) + {}^{4}\mathrm{He}(1.47\ \mathrm{MeV}) + \gamma(0.47\ \mathrm{MeV}), & 94\% \\ {}^{7}\mathrm{Li}(1.01\ \mathrm{MeV}) + {}^{4}\mathrm{He}(1.78\ \mathrm{MeV}), & 6\%. \end{cases}$$



XY-coordinates: arrays of parallel Cu-strips mutually orthogonal,

- Pitch: 1 mm
- Strips width: 0.3 mm

Z-coordinate: asymmetry of signal sum in x- and y-strips,

- X- Sum signal > Y- Sum signal (Neutron capture in the top 10B4C layer)
- X- Sum signal < Y- Sum signal (Neutron capture in the bottom 10B4C layer)

nToF measurement at BOA beamline at PSI