

Task 9.4.1

Development of Resistive Plate Chambers (RPCs) at LIP-Coimbra



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Outline

- Previous Results
- Multilayer RPC Prototype
- Detector design and assembly
- Tests at FRMII TREFF neutron beamline
 - Efficiency
 - Spatial resolution
- Summary



Previous Results

Two RPCs were investigated: 0.35 mm and 1 mm gas-gap widths

Stack of two RPCs





Previous Results: Plateau, Efficiency and Spatial Resolution





Previous Results: Plateau, Efficiency and Spatial Resolution



Detection efficiency estimated using a ³He-Proportonal Counter (efficiency ~ 97 % @ 4.7 Å) as a reference



Cadmium slits width ~ 0.2 mm; Moving Table shifted in steps of 0.5 mm;

Spatial resolution better than 236 µm FWHM for both X and Y



Multilayer RPC Prototype: Stack of 10 Double-Gap RPCs

x 20 Layers of ¹⁰B₄C





Schematics of the Detector



Top View



Glass electrodes (anodes) preparation

Resistive Ink: 90 mm x 90 mm

20 glass plates were coated with Resistive Ink





Holding the Al-Plates (cathodes) between the spacers

10 Al-Plates double side coated with ${}^{10}B_4C$ (1.15 mm thick)





Details of the Detector Assembly

Stacking the various elements



Glass plate facing the Al-Plate

Thin PCB with signal pickup strips: 2D readout



Details of the Detector Assembly





FEE and DAQ system

One central FPGA with trigger management capabilities plus 4 sockets with capability to operate.

- 64 Multi-hit TDC
- 48 ADCs channels @ 40 MHz





The output of the charge sensing amplifiers is digitized by 40 MHz streaming ADCs (AD9219)



Detector at TREFF - FRMII neutron beamline





Detection efficiency



A correction factor was applied using a Signal to BKG ratio extracted from the reconstructed events ³He-Proportonal Counter used as reference (efficiency ~ 97 % @ 4.73 Å)

Cadmium Slit: 2 mm x 35 mm



The counting rate was given by the trigger of each individual cathode: **C1**, **C2**, **C3**, ..., **C10**

Cathodes area = 90 x 90 mm

Readout area: 43 x 43 mm



Detection efficiency



- Transmission T measured for neutrons of $\lambda = 4,73$ Å
 - Glass (0,52 mm thick): T=99,30%
 - Glass + ink: **T=98,56%**
 - Glass + ink + 50 µm Kapton: T=98,18%
 - 50 µm Kapton: T=99,70%

Efficiency computed with ANTS

(http://coimbra.lip.pt/ants/ants2.html)

Stack of 10 x Double-Gap RPCs ${\rm ^{10}B_4C}$ thickness = 1.15 μm

	Detection efficiency (%)					
λ (Å)	0 KeV	50 KeV	100 KeV	150 KeV		
4.7	65.5	62.1	58.5	54.6		





Spatial resolution

Cd Slit (Vertical): 0.075 mm x 35 mm X-direction: FWHM (X) ~ 0.300 mm

Run204 (HV = -2.3 kV)



Cd Slit (Horizontal): 0.075 mm x 16 mm Y-direction: FWHM (Y) ~ 0.390 mm

Run208 (HV = -2.3 kV)



Obs.: Beam divergence ~30 μm







Vertical Slit





Horizontal Slit





Charge PHS





Aluminium plates not flat at all

Some scratches on the surface

Cute with a guillotine \Rightarrow Deformation

Pressing is not enough to correct non-planarity (Nor is it the solution)





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Triggers distributed by cathodes





Multiplicities

Multiplicity on the strips

Multiplicity on the cathodes





Multiplicities

Multiplicity on the strips



Plate of Boron-10 in front of the Cd Slit





Cd Mask (1mm thick)









Work in progress

□ Fine data analysis of the tests realized at FRMII

□ ANTS2 is being also prepared to handle TRB3 data (Profiting from the powerful features of CERN Root already integrated in ANTS2)







Status of the Boron-10 Multigap RPC development

¹⁰B4C (1150 nm) coatings on glass exhibiting a surface resistivity > 1E6 Ω / \Box were provided by the ESS Detector Coatings Workshop



\circ Two MG-RPCs were assembled and taken to FRMII

- \circ One of the MG-RPCs was tested.
- ${\scriptstyle \odot}$ We realized that the device was broken.





Summary

- It was designed and assembled a Multilayer Boron-10 detector comprising 10 double-gap RPCs
- □ The detector was taken to FRMII where it was tested in the TREFF neutron beamline
- Achieved Detection efficiency shows to be in good agreement with the calculations by simulation
- Despite the issues related with the aluminum plates, a spatial resolution of FWHM ~ 0.300 mm was obtained
- □ The work on the Boron-10 Multigap RPCs should pursue as well as the characterization of the gamma sensitivity

Thank you for your attention

Backup Slides

Multigap RPC









Multigap-RPC

A batch of soda lime glass plates (100mm x 100mm, 0.4mm thick) coated with ¹⁰B4C (1150 nm) exhibiting a surface resistivity > 1E6 Ω / □ was already provided by the ESS Detector Coatings Workshop – Until the present the coatings adhesion on glass remains stable







Previous Results

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Backup Slide







Timeline

	Year 1	Year 2	Year 3	Year 4
MC SIMULATIONS				
PROTOTYPE DESIGN ; 10B4C COATINGS MANUFACTURE				
BUILDING OF FIRST 10B4C COATED RPCs; EXPLORTORY TESTS				
STUDY 10B4C COATED RPCs OPERATION IN AVALANCHE MODE				
2D POSITION RECONSTRUCTION				
PROTOTYPE'S CHARACTERIZATION (Detailed Tests with a neutron beam and gamma sources); Report conclusions				