

Geant4 Monte Carlo Simulation of the Boron Coated Straw Detector

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Boron Coated Straw Detector

- Proportional Technologies, Inc.
 <u>http://www.proportionaltech.com/</u>
- Aluminium tube (d=25.4 mm, t=0.88 mm)
- 7 copper straw tubes (d=7.5 mm, t=25 μ m)
- ${}^{10}B_4C$ layer (1 μ m)
- Ar/CO_2 gas mixture (0.7 atm)
- Resistive wire
- 1-3 m length
- Readout at both end of the straws









BCS layout and model





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- Optimal layout for parallel and small angle beam to increase path length in ${}^{10}B_4C$







Optimal configuration: each panel offset 0.4" from panel in front of it







































2-4 Angstrom Detection efficiency







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4

5020

4980

5000

5040

z [mm]

5060 5080 5100





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0.00





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4







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2-4 Angstrom Detection efficiency 4-7 Angstrom Detection efficiency 10.0 10.0 0.200 0.14 0.175 20% straw 14% Straw 7.5 7.5 0.12 0.150 efficiency 5.0 efficiency 5.0 0.10 2.5 2.5 0.125 y [cm] y [cm] 0.08 0.0 0.0 0.100 0.06 -2.5 -2.5 0.075 -5.0 0.04 -5.00.050 -7.5 -7.5 0.02 0.025 -10.0-10.00.00 0.000 4980 5000 5020 5040 5060 5080 5100 5000 5020 5040 5060 5080 5100 4980 z [mm] z [mm] 7-10 Angstrom Detection efficiency 10-12 Angstrom Detection efficiency 10.0 10.0 0.6 0.30 26% straw 7.5 7.5 0.5 0.25 efficiency 5.0 5.0 0.4 0.20 2.5 2.5 y [cm] y [cm] 0.0 0.0 0.15 0.3 -2.5 -2.5 0.10 0.2 -5.0 -5.0-7.5 0.05 -7.5 0.1 -10.0-10.00.00 4 0.0 5060 5080 5100 4980 5000 5020 5040 5040 5060 5080 5100 5020 4980 5000 z [mm] z [mm]





2-4 Angstrom Detection efficiency 4-7 Angstrom Detection efficiency 10.0 10.0 0.200 0.14 0.175 20% straw 14% Straw 7.5 7.5 0.12 0.150 efficiency 5.0 efficiency 5.0 0.10 2.5 2.5 0.125 y [cm] y [cm] 0.08 0.0 0.0 0.100 0.06 -2.5 -2.5 0.075 -5.0 0.04 -5.00.050 -7.5 -7.5 0.02 0.025 -10.0-10.00.00 0.000 4980 5000 5020 5040 5060 5080 5100 5020 5040 5060 5080 5100 4980 5000 z [mm] z [mm] 7-10 Angstrom Detection efficiency 10-12 Angstrom Detection efficiency 10.0 10.0 0.6 0.30 26% straw 7.5 30% straw 7.5 0.5 0.25 efficiency 5.0 efficiency 5.0 0.4 0.20 2.5 2.5 y [cm] y [cm] 0.0 0.0 0.15 0.3 -2.5 -2.5 0.10 0.2 -5.0 -5.0 -7.5 0.05 -7.5 0.1 -10.0-10.00.00 4 0.0 5000 5020 5060 5080 5100 4980 5040 5060 5080 5100 5020 5040 4980 5000 z [mm] z [mm]



z [mm]



2-4 Angstrom Detection efficiency 4-7 Angstrom Detection efficiency 10.0 10.0 0.200 0.14 0.175 20% straw 14% Straw 7.5 7.5 0.12 0.150 efficiency 5.0 efficiency 5.0 0.10 2.5 2.5 0.125 y [cm] y [cm] 0.08 0.0 0.0 0.100 0.06 -2.5 -2.5 0.075 32% Global_{5.0} 0.04 -5.00.050 efficiency _7.5 -7.5 0.02 0.025 -10.0-10.00.00 0.000 5000 5020 5040 5060 5080 5100 4980 5020 5040 5060 5080 5100 4980 5000 z [mm] z [mm] 7-10 Angstrom Detection efficiency 10-12 Angstrom Detection efficiency 10.0 10.0 0.6 0.30 26% straw 7.5 30% straw 7.5 0.5 0.25 efficiency 5.0 efficiency 5.0 0.4 0.20 2.5 2.5 y [cm] y [cm] 0.0 0.0 0.15 0.3 -2.5 -2.5 0.10 0.2 -5.0 -5.0 -7.5 0.05 -7.5 0.1 -10.0-10.00.00 4 0.0 5000 4980 5020 5040 5060 5080 5100 5100 5020 5040 5060 5080 4980 5000 z [mm]























Panel λ	1	2	3	4	5
2Å	0.3348	0.2578	0.1833	0.1307	0.0933
7Å	0.5951	0.2671	0.0916	0.0337	0.0126
12Å	0.7354	0.2176	0.0384	0.0071	0.0015





Panel λ	1	2	3	4	5
2Å		0.0933			
7Å	0.5951	0.2671	0.0916	0.0337	0.0126
12Å	0.7354	0.2176	0.0384	0.0071	0.0015





Panel λ	1	2	3	4	5
2Å		0.0933			
7Å		0.9537	0.0337	0.0126	
12Å	0.7354	0.2176	0.0384	0.0071	0.0015





Panel λ	1	2	3	4	5
2Å		0.0933			
7Å	0.9537			0.0337	0.0126
12Å	0.9	530	0.0384	0.0071	0.0015

Effects of detector materials

- Scattering effects are under study
- Preliminary results with reduced detector materials
 - 9.4% more detected neutrons without aluminium and copper

mta

- 1.8% more detected neutrons without aluminium
- 7.3% more detected neutrons without copper
- 8 times more aluminium than copper in the detector
- 8 times longer average aluminium path than copper path

LoKI detector system





- BCS is a backup design for the LoKI
- McStas simulation:
 - 14 Hz
 - Short collimation
 - Diblock copolymer sample
- Geant4 simulation:
 - 5 m sample-detector distance













Neutron spectrum in panels



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Panel λ	1	2	3	4	5
2Å		0.0933			
7Å		0.9537	0.0337	0.0126	
12Å	0.9530		0.0384	0.0071	0.0015
LoKI	0.4993	0.2677	0.1358	0.0625	0.0347





Panel λ	1	2	3	4	5
2Å		0.0933			
7Å		0.9537			0.0126
12Å	0.9	530	0.0384	0.0071	0.0015
LoKI		0.9028			0.0347

Time of Flight spectrum





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11

Time of Flight spectrum





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11

Detection rate





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Peak detection rate [kHz]



Detection rate





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Peak detection rate [kHz]









- The rate capability will be challenging
- Efficiency is a convolution of several parameters:
 - Energy and incident angle of the neutrons
 - Rotation of the tubes
 - Number and rotation of panels
 - Thickness of the detector components
- Detailed quantification of scattering effects is in progress







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Thank you for your attention!