

Heidelberg, 20.12.2016

Large MAGIC detector, high efficiency, high resolution in 2θ

Jalousie segments allocated vertically in mounting units of 6 segments with an inclination angle of converter layers to the incoming neutrons of $\eta = 10^\circ$

Converter coatings are arranged to have one coating layer in each voxel only in order to enhance spatial resolution. Detector depth is enlarged correspondingly to collect detection efficiency from nominally 10 Boron layers.

Height of entrance window: 890mm at 1000mm radius from sample position, covering φ from $+30^\circ$ to -18° .

Coverage in 2θ per segment: $1,00^\circ$

Number of segments for full coverage of 162° : 162 (27 mounting units), initial coverage 60° (10 mounting units)

Depth of active detector volume: $\sim 534\text{mm}$

Coordinate φ :

Number of channels in φ along the segment: 128

Width of channel (binning) $\Delta\varphi = 48^\circ/128 = 0,375^\circ$

Resolution in φ : $0,32^\circ$ FWHM ($=5,6\text{mm}$ FWHM at $\varphi=90^\circ$ (horizontal plane) at the entrance window)

Coordinate 2θ :

The volume along cathode strips is divided through anode wires into 32 voxels of 16,7mm length along the cathode strip. The projection of the coating in each voxel onto the entrance window gives the binning in 2θ .

$\Delta 2\theta_{\text{cart.}} = 2,9\text{ mm}$, $\Delta 2\theta = \arctan(2,9/1000) = 0,166^\circ$

Resolution in 2θ : 2,1mm FWHM or $0,12^\circ$ FWHM

Depth:

Number of readout channels in depth: 32

Resolution in depth: 11,8mm FWHM

Handelsregister:

Amtsgericht Mannheim: HRB 700496
USt-IdNr.: DE249715139
Sitz der Gesellschaft: Heidelberg

Bankverbindung:

Volksbank Neckartal eG
Kto-Nr.: 244 587 09, BLZ: 672 917 00
SWIFT/BIC: GENODE61NGD
IBAN: DE41672917000024458709
SFPA-GI -Nr.: DF97AAAA00000821753

Geschäftsführer:

Dr. Martin Klein,
Dr. Christian Schmidt

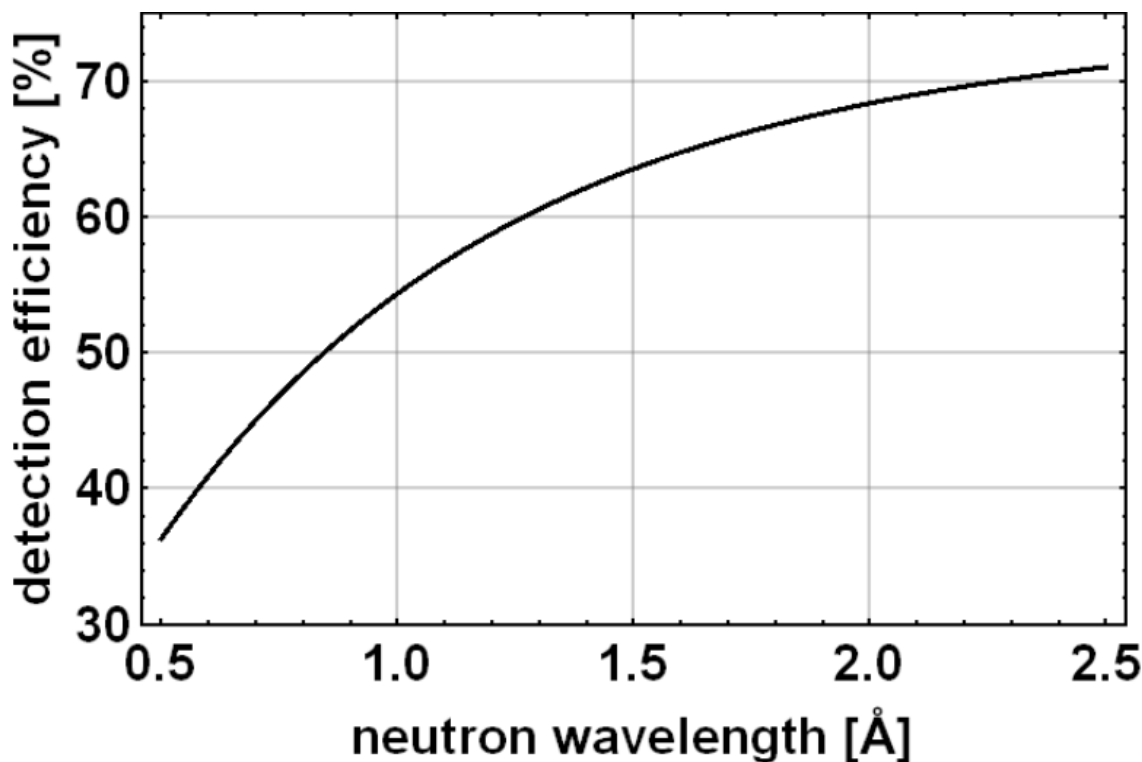
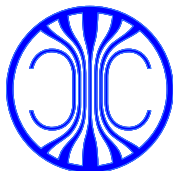


Figure 1 Calculated effective detection efficiency of the proposed large MAGIC detector for thermal neutrons. Efficiency losses through scattering off Aluminum structural material are included in the model (housing, cathodes and converter substrates). The large MAGIC detector is projected for neutron wavelengths above 0.6 Ångström.

Handelsregister:

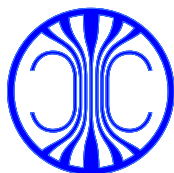
Amtsgericht Mannheim: HRB 700496
UST-IdNr.: DE249715139
Sitz der Gesellschaft: Heidelberg

Bankverbindung:

Volksbank Neckartal eG
Kto-Nr.: 244 587 09, BLZ: 672 917 00
SWIFT/BIC: GENODE61NGD
IBAN: DE41672917000024458709
SFPA-GI -Nr.: DF97AAAA00000821753

Geschäftsführer:

Dr. Martin Klein,
Dr. Christian Schmidt



| | Jalousie barrel detector type | Large MAGIC D10-1000 |
|---|---|-------------------------|
| Configuration | Distance sample-detector [mm] | 1000 |
| | Length entrance window [mm] | 890 |
| | Nominal no. of inclined Boron layers | 10 |
| | Depth of detector [mm] | 535 |
| | | |
| 2Theta-Resolution | Delta 2Theta binning [°] | 0,50 |
| | Delta 2Theta FWHM [°] | 0,12 |
| | | |
| Resolution in Depth | Delta L binning [mm] | 16,7 |
| | Delta L FWHM [mm] | 11,8 |
| | | |
| Phi-Resolution | Delta Phi binning [°] | 0,38 |
| | Delta Phi FWHM [°] | 0,32 |
| | | |
| Costs (2015) | No. of detector segments for 60° | 60 |
| | Coverage in total [°] | 60,0 |
| | Serial-Costs per segment incl. electronics [€] | 16.588,90 |
| | Total costs of this coverage incl. electronics [€] | 1.068.768,52 |
| Layout of Costs (Calulation without electronics) | <i>Components without coating [%]</i> | 33 |
| | <i>Coating [%]</i> | 29 |
| | <i>Mounting and Assembly [%]</i> | 38 |
| | Costs per sr [€] | 980.702,42 |
| | Costs per qm [€] | 895.916,24 |
| | Costs per Voxel [€] | 1,70 |
| old nomenclature of previous calculations | | MAGIC groß B |

Handelsregister:

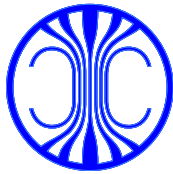
Amtsgericht Mannheim: HRB 700496
UST-IdNr.: DE249715139
Sitz der Gesellschaft: Heidelberg

Bankverbindung:

Volksbank Neckartal eG
Kto-Nr.: 244 587 09, BLZ: 672 917 00
SWIFT/BIC: GENODE61NGD
IBAN: DE41672917000024458709
SFPA-GI -Nr. : DE97AAAA00000821753

Geschäftsführer:

Dr. Martin Klein,
Dr. Christian Schmidt



Small MAGIC detector, high efficiency, high resolution in 2θ

Design along the CDT endcap detector concept with anode wires oriented towards the scattering sample.

Converter coating inclination angle $\eta = 10^\circ$.

Converter coatings are arranged to have one coating layer in each voxel only in order to enhance spatial resolution. Detector depth is enlarged correspondingly to collect detection efficiency from nominally 10 Boron layers.

The active detector is grouped along 2θ in mounting units termed SUMO.

Height of entrance window: 100mm at 1000mm radius from sample position, covering $\varphi \pm 2,862^\circ$

Coverage in 2θ : 120° comprising 8 mounting units (SUMO)

Coverage of mounting unit in 2θ : 15°

Depth of active detector volume: $\sim 500\text{mm}$

Coordinate φ :

Number of channels in φ (vertical): 16

Width of channel (binning) $\Delta\varphi = 4,724^\circ/16 = 0,358^\circ$

Resolution in φ : $0,311^\circ$ FWHM ($=5,43\text{mm}$ FWHM at $\varphi=90^\circ$ (horizontal plane) at the entrance window)

Coordinate 2θ :

The volume along anode wires is divided through cathode strips into 32 voxels of 15,63 mm length along the anode wire. The projection of the coating in each voxel onto the entrance window gives the binning in 2θ .

$\Delta 2\theta_{\text{cart.}} = 2,71 \text{ mm}$, $\Delta 2\theta = \arctan(2,71/1000) = 0,156^\circ$

Resolution in 2θ : 1,89 mm FWHM or $0,108^\circ$ FWHM

Depth:

Total depth of the active detector volume along converter planes: 500mm.

Number of readout channels in depth: 32, each 15,63 mm along anode wire, 15,39 mm along neutron path.

Resolution in depth: 11.0 mm FWHM

Electronics: For each SUMO there are 128 channels for anodes and 128 channels for cathodes, 1 CDRS-Board.

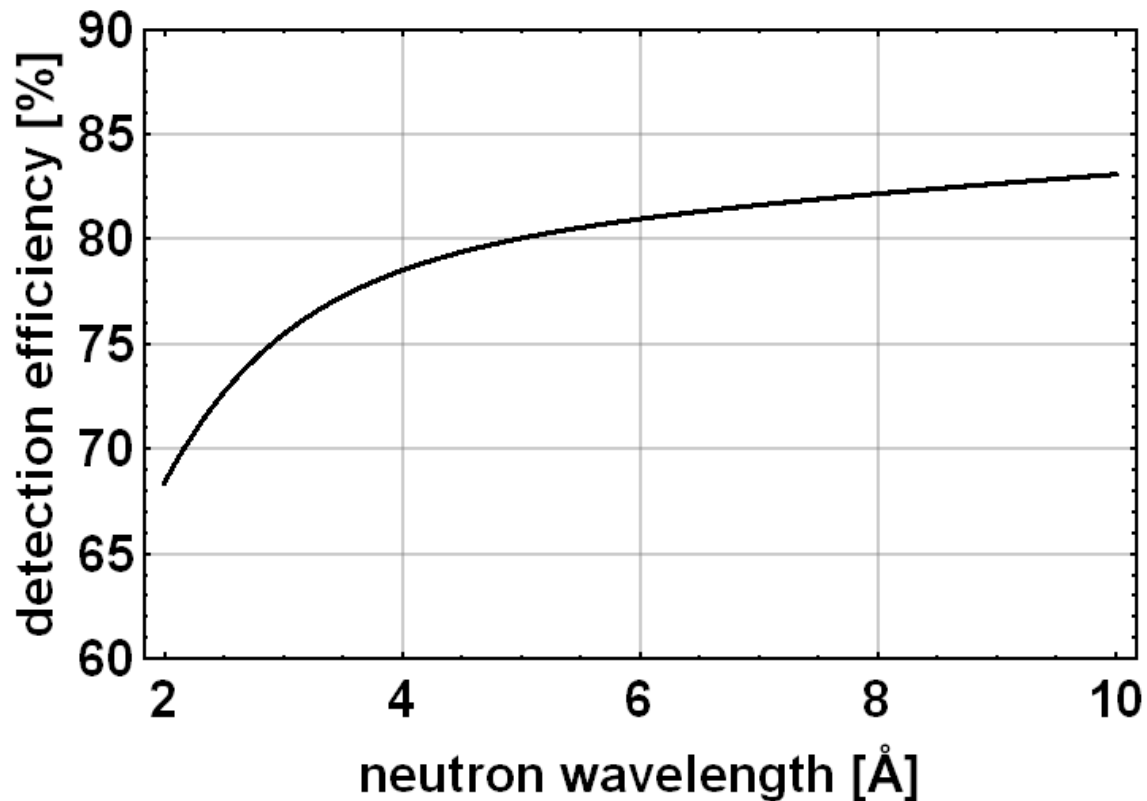
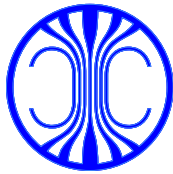


Figure 2 Calculated effective detection efficiency of the proposed small MAGIC detector for cold neutrons. Efficiency losses through scattering off Aluminum structural material are included in the model (housing, cathodes and converter substrates). Wavelengths above 2 Ångström are relevant for this detector application.

Handelsregister:

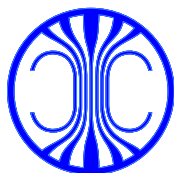
Amtsgericht Mannheim: HRB 700496
UST-IdNr.: DE249715139
Sitz der Gesellschaft: Heidelberg

Bankverbindung:

Volksbank Neckartal eG
Kto-Nr.: 244 587 09, BLZ: 672 917 00
SWIFT/BIC: GENODE61NGD
IBAN: DE41672917000024458709
SFPA-GI -Nr.: DE97AAAA00000821753

Geschäftsführer:

Dr. Martin Klein,
Dr. Christian Schmidt



| | Jalousie end-cap detector type | Small MAGIC D10-1000 |
|---|---|-------------------------|
| Configuration | Distance sample-detector [mm] | 1000 |
| | Height entrance window [mm] | 100 |
| | Nominal no. of inclined Boron layers | 10 |
| | | |
| 2Theta-Resolution | Delta 2Theta FWHM [°] | 0,11 |
| | | |
| Resolution in Depth | Delta L FWHM [mm] | 11,0 |
| | | |
| Phi-Resolution | Delta Phi binning [mm] | 6,2 |
| | Delta Phi FWHM [mm] | 5,4 |
| | | |
| Costs (2015) (for 120°-Coverage using 8 pieces of 15°- segments) | No. of SUMOs for 120° coverage | 8 |
| | Serial-Costs per segment incl. electronics [€] | 24.505,30 |
| | Total costs of this coverage incl. electronics [€] | 243.865,44 |
| Layout of Costs (Calculation without electronics) | <i>Components without coating [%]</i> | 44 |
| | <i>Coating [%]</i> | 27 |
| | <i>Mounting and Assembly [%]</i> | 28 |
| | Costs per sr [€] | 910.265,11 |
| | Costs per qm [€] | 909.129,40 |
| | Costs per Voxel [€] | 1,45 |
| | old nomenclature of previous calculations | MAGIC klein |

Handelsregister:

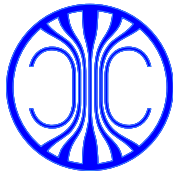
Amtsgericht Mannheim: HRB 700496
UST-IdNr.: DE249715139
Sitz der Gesellschaft: Heidelberg

Bankverbindung:

Volksbank Neckartal eG
Kto-Nr.: 244 587 09, BLZ: 672 917 00
SWIFT/BIC: GENODE61NGD
IBAN: DE41672917000024458709
SFPA-GI -Nr. : DE97AAAA00000821753

Geschäftsführer:

Dr. Martin Klein,
Dr. Christian Schmidt



The very small MAGIC detector allocated below or above the sample could be realized with the GEM-based detector CASCADE 2D-200 of 200mm x 200mm size.

Sensitive area: 200 mm x 200 mm in 128 x 128 pixels

Blind area: frame of 17,5 mm width

Pixel size: 1,56 mm x 1,56mm

Resolution: 2,6 mm FWHM

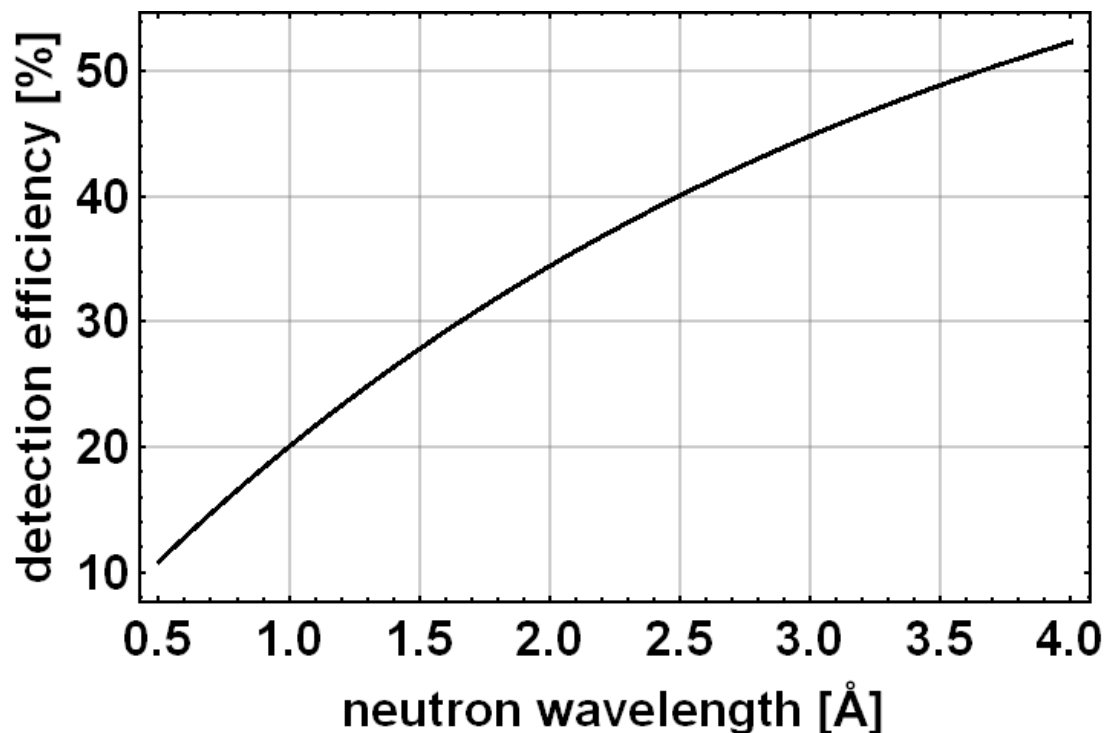


Figure 3 Calculated detection efficiency of the CASCADE-2D-200 detector with 10 converter coatings.