# Geant4 Monte Carlo Simulation of the Boron Coated Straw Detector

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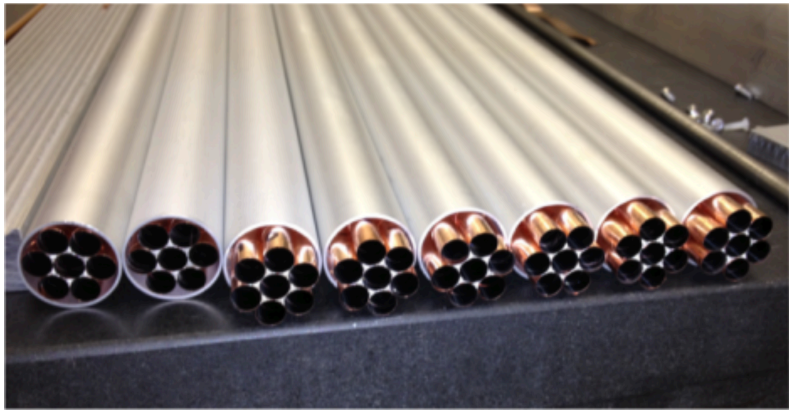
# Boron Coated Straw Detector

- Proportional Technologies, Inc. http://www.proportionaltech.com/

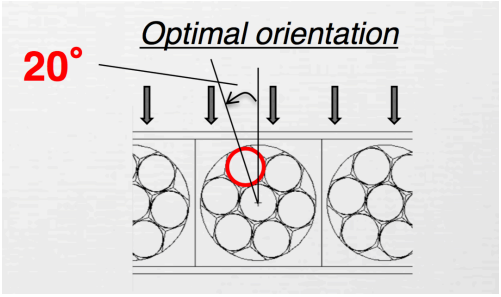


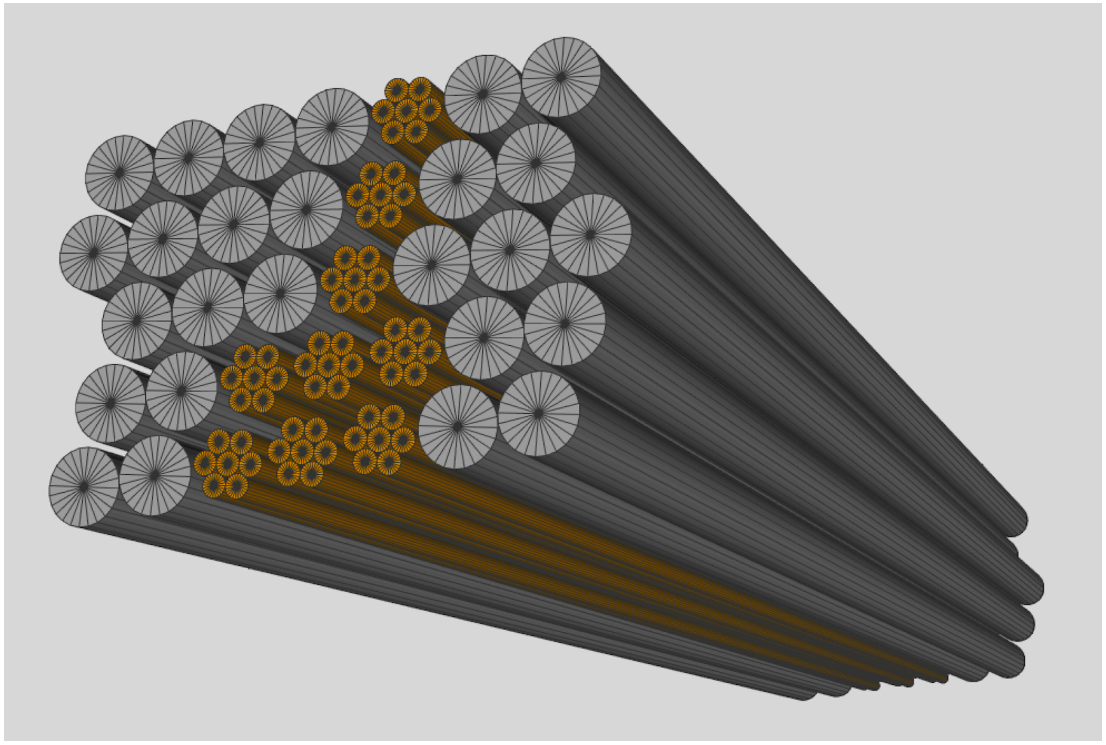
- Aluminium tube (d=25.4 mm, t=0.88 mm )
- 7 copper straw tubes (d=7.5 mm, t=25 μm)
- $^{10}B_4C$ layer (1 μm)
- Ar/$CO_2$ gas mixture (0.7 atm)
- Resistive wire

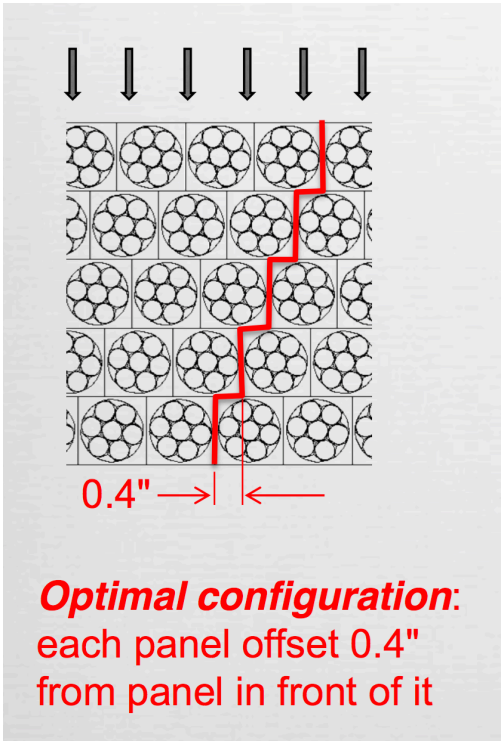
- 1-3 m length
- Readout at both end of the straws

# BCS layout and model

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

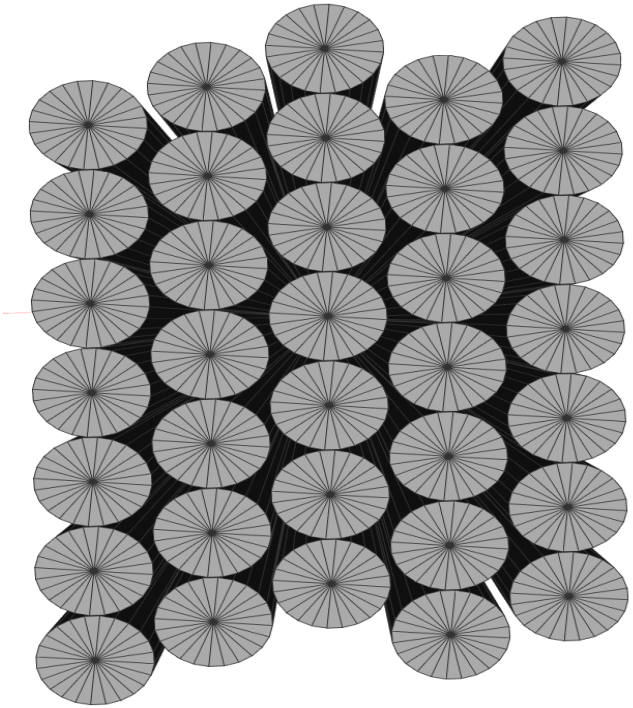





***Optimal configuration***: each panel offset 0.4" from panel in front of it

# Data representation



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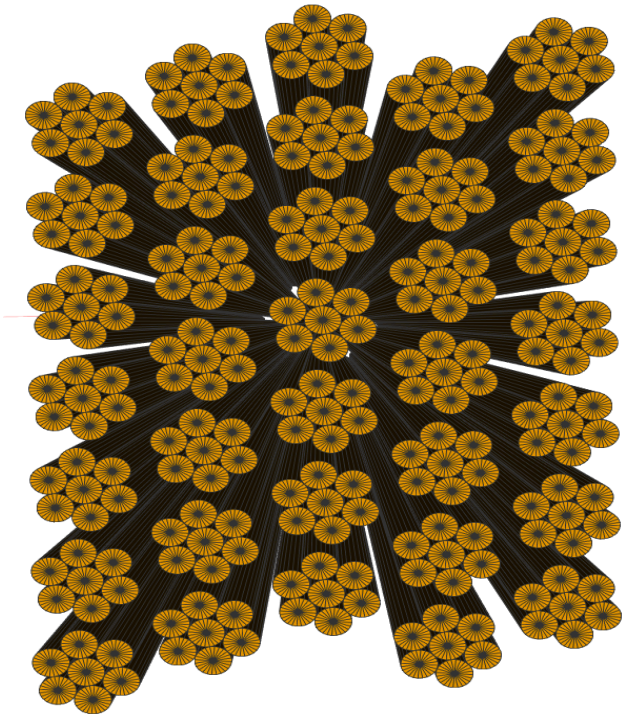

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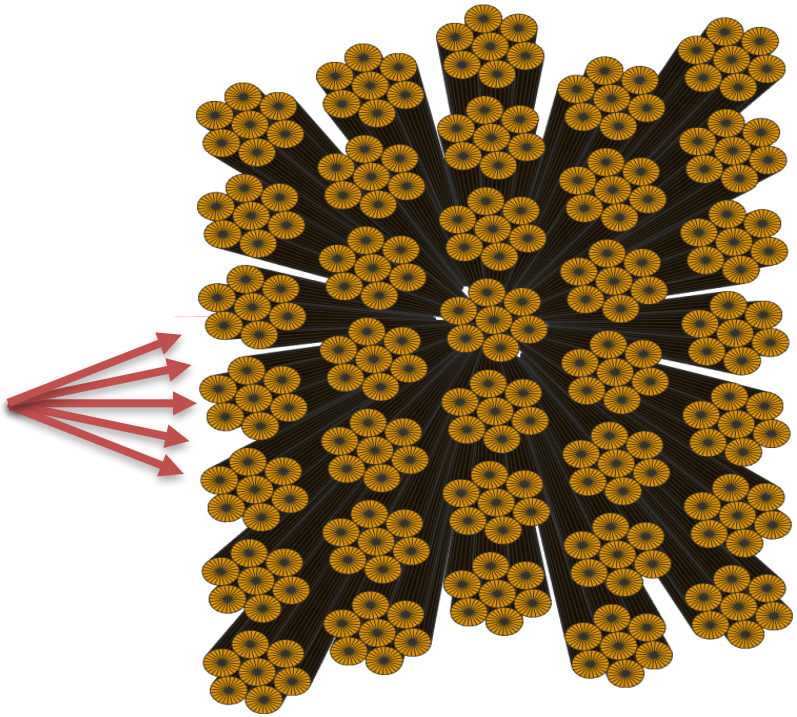

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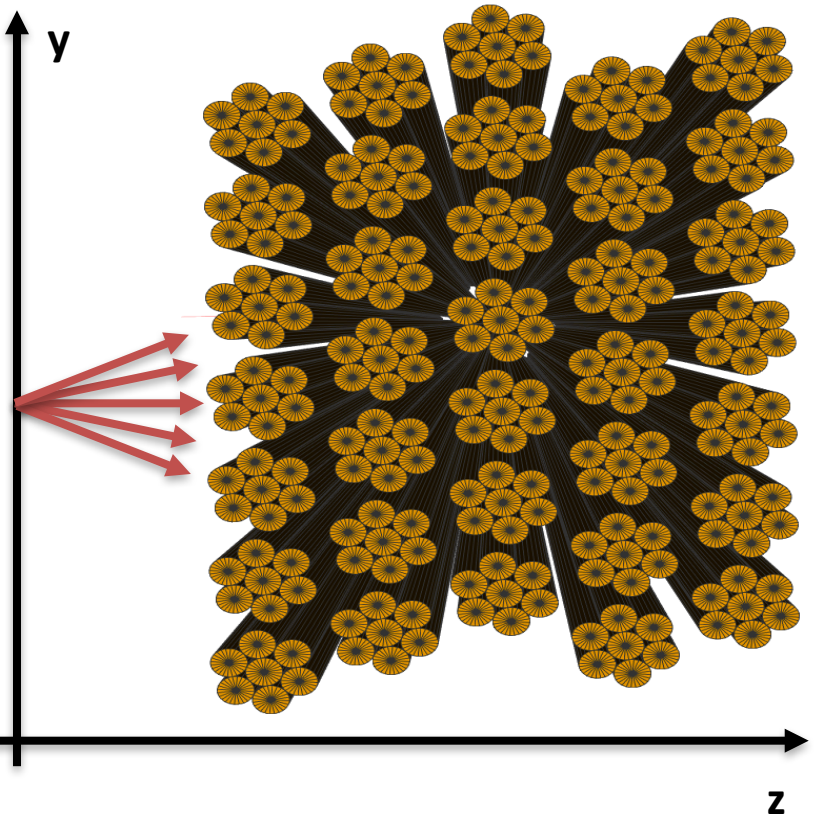

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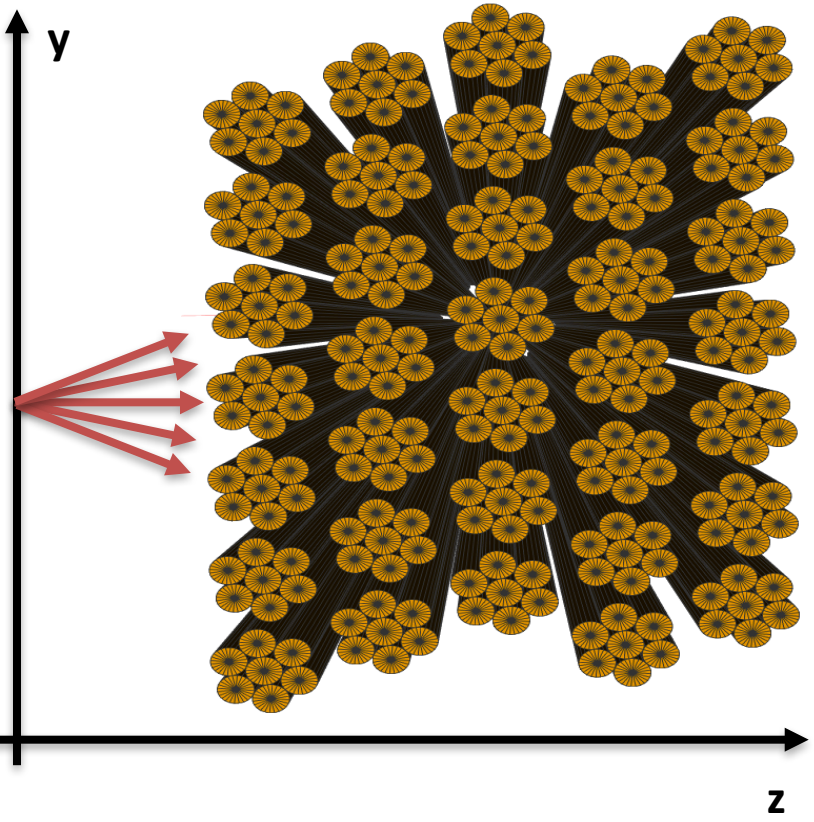


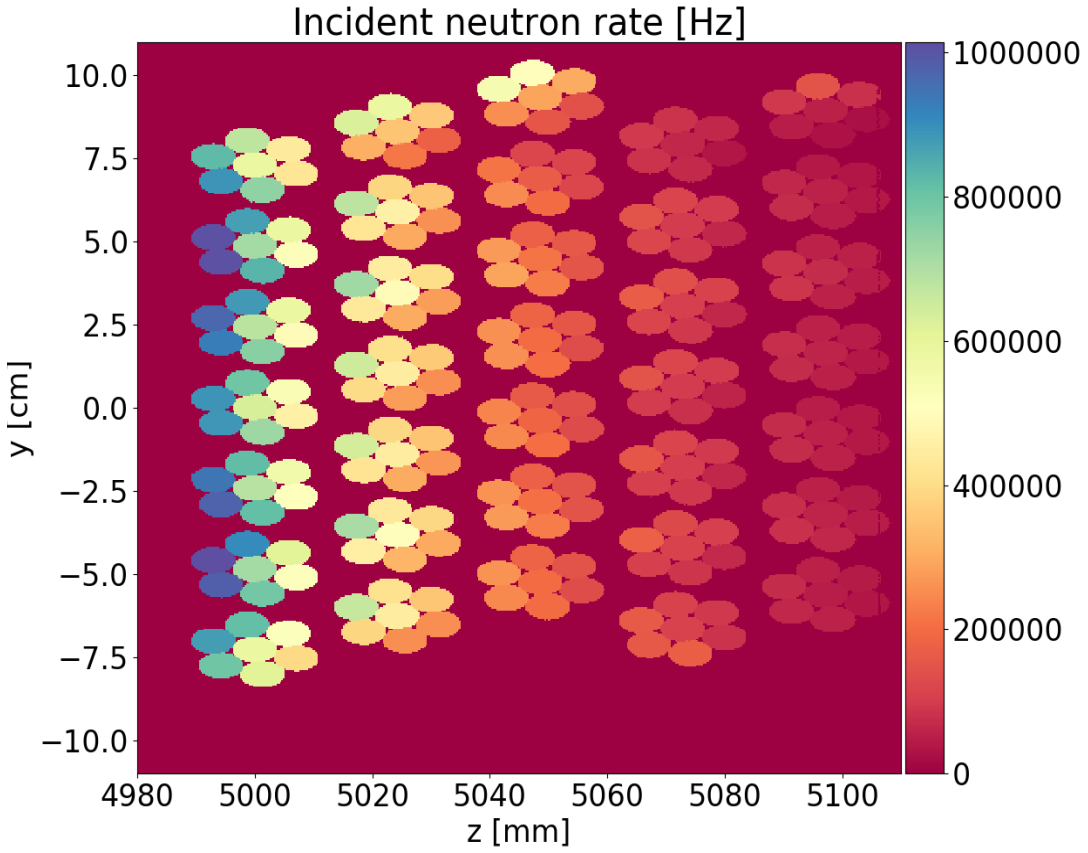

# Detection efficiency

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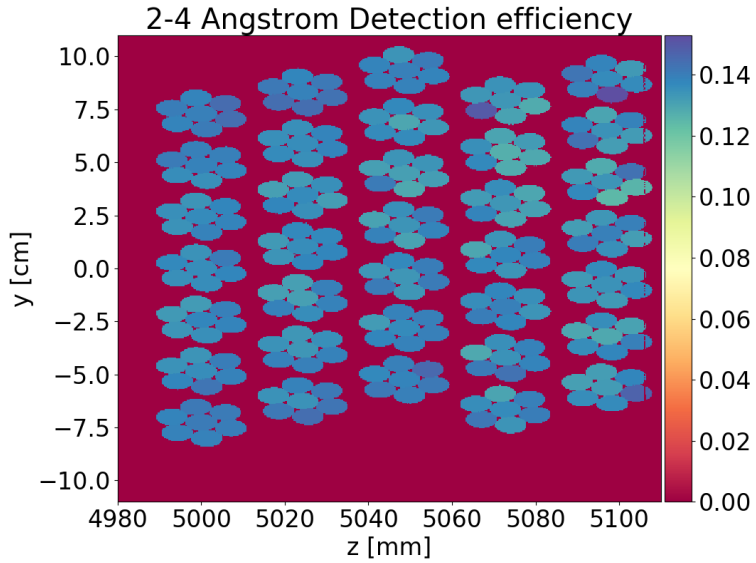

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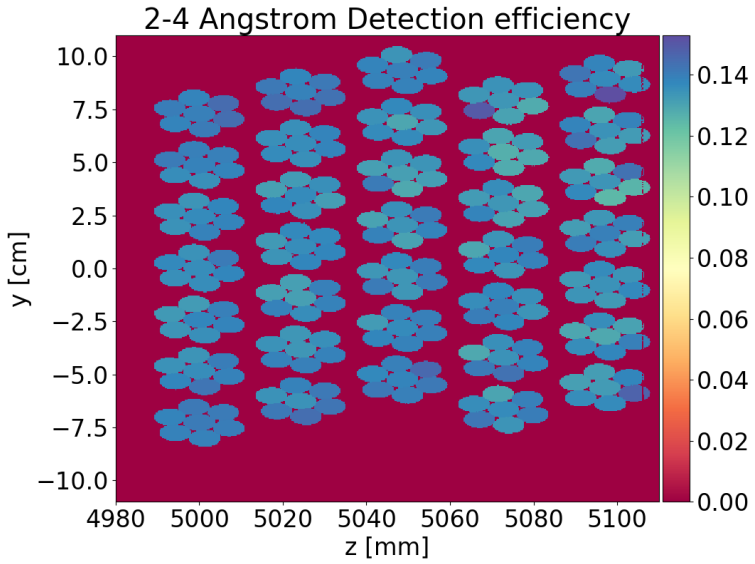


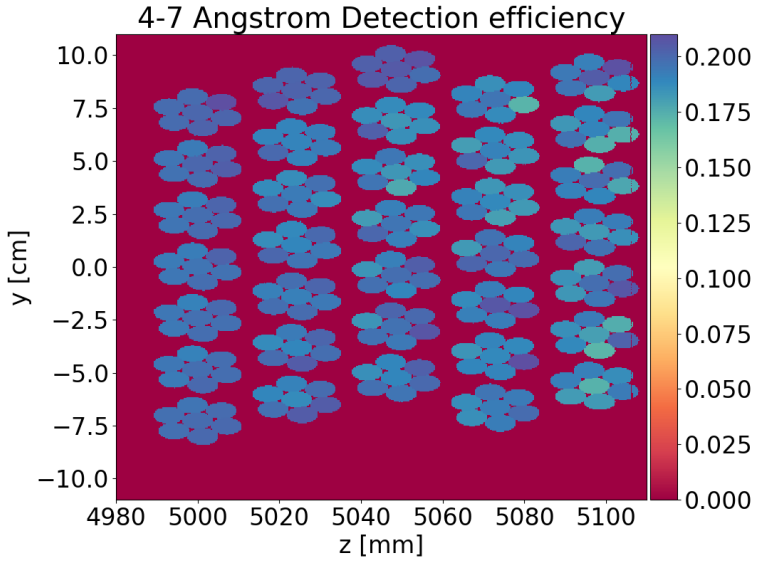

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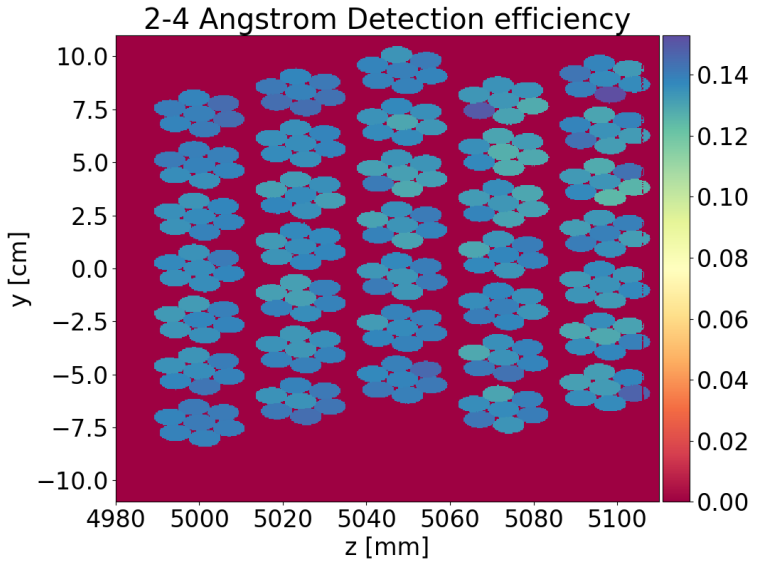


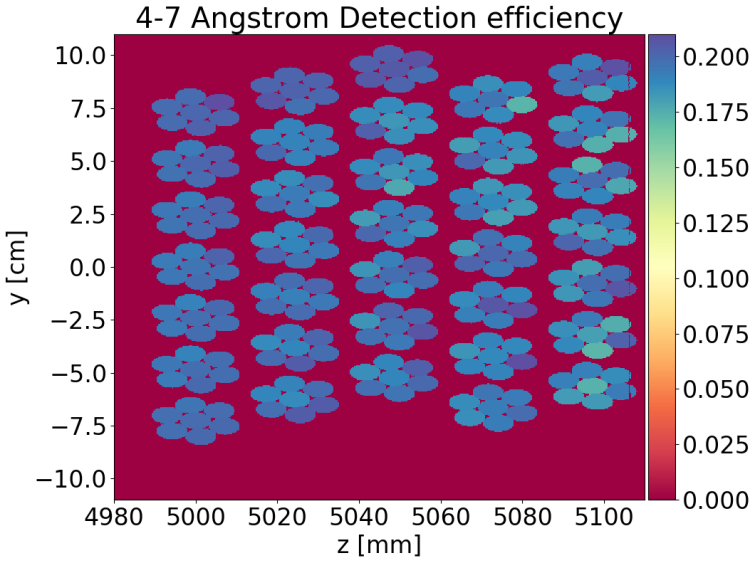


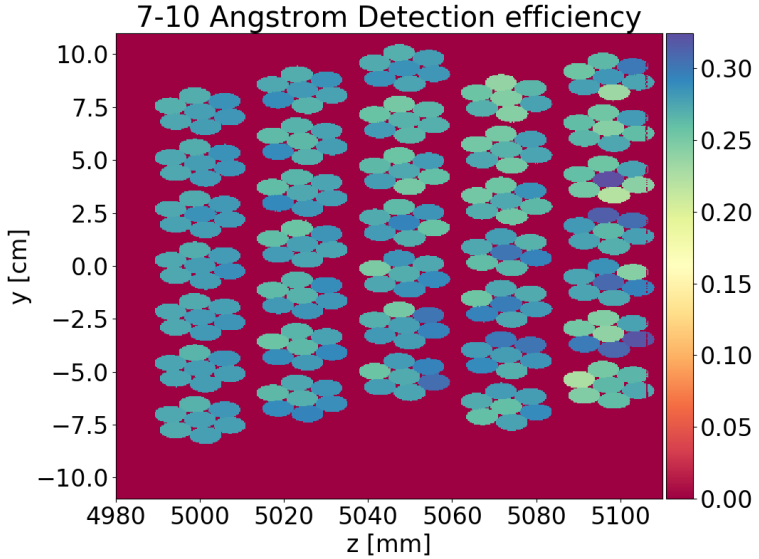

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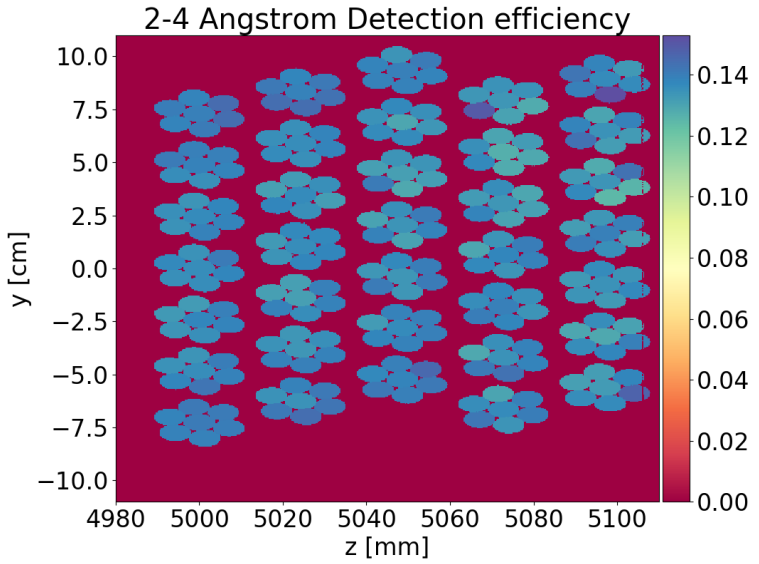
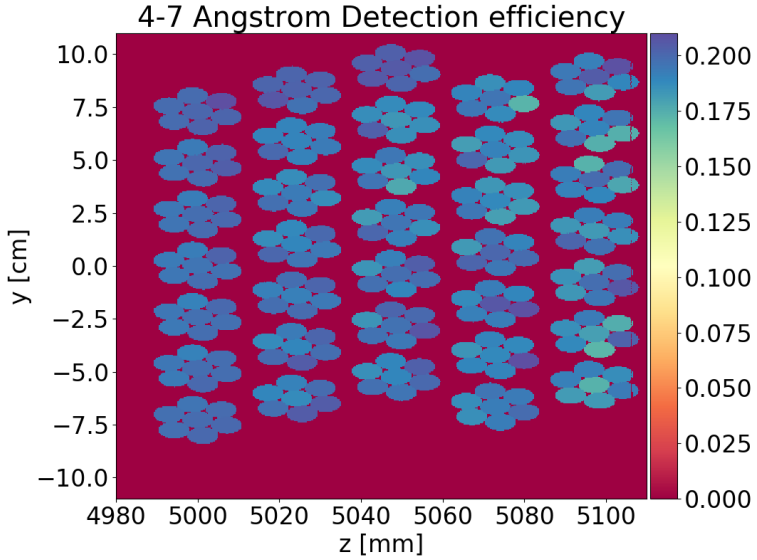
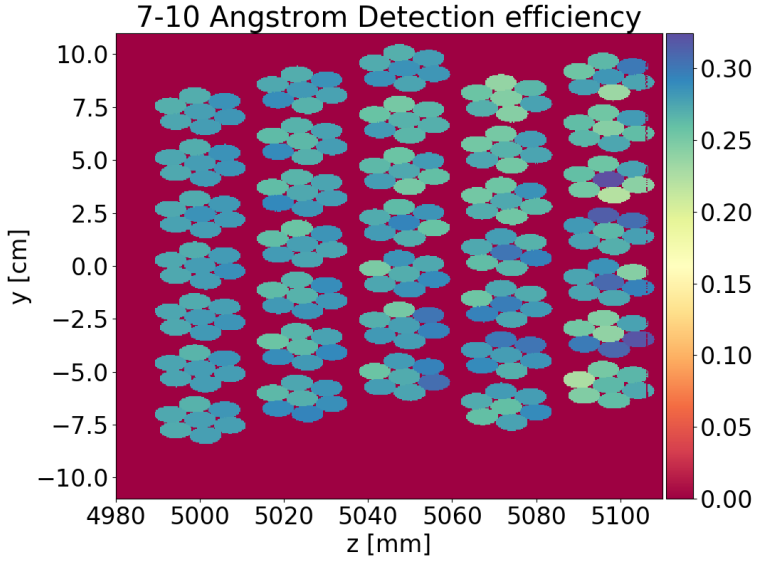
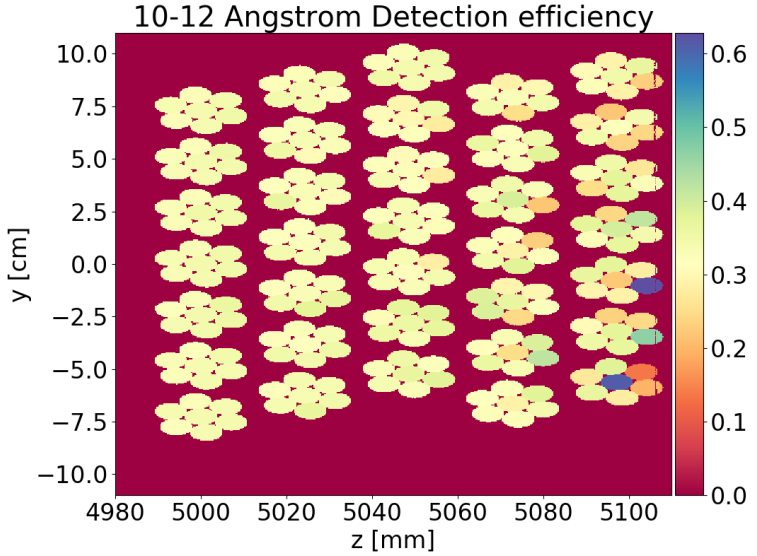


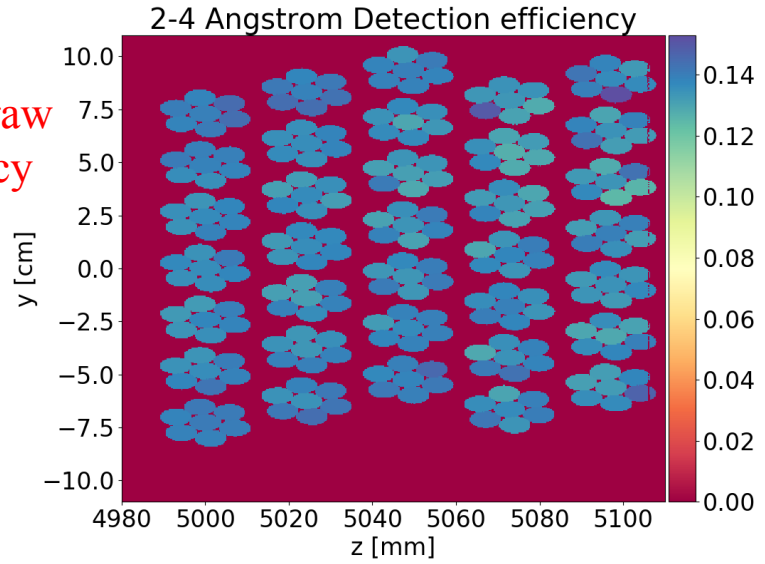



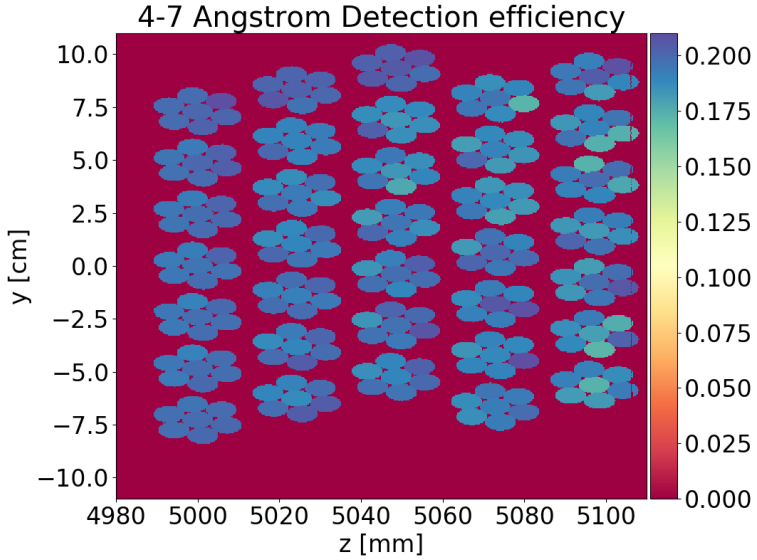



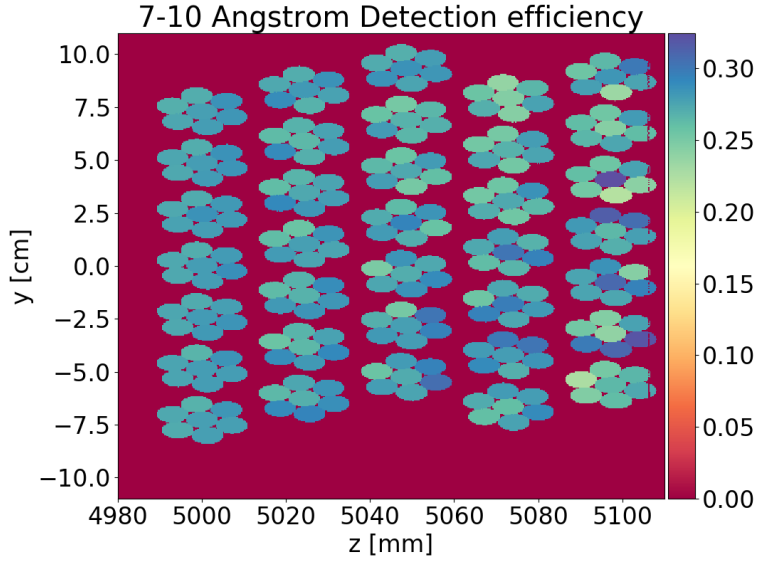



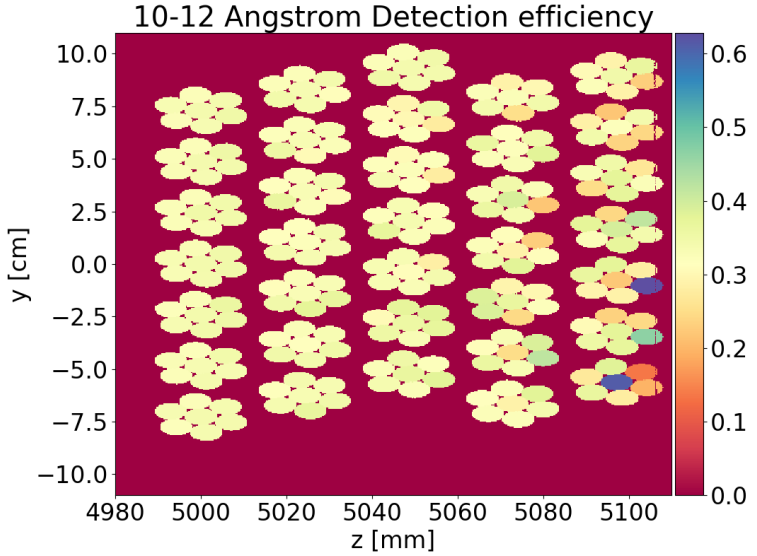
# Detection efficiency

14% Straw efficiency



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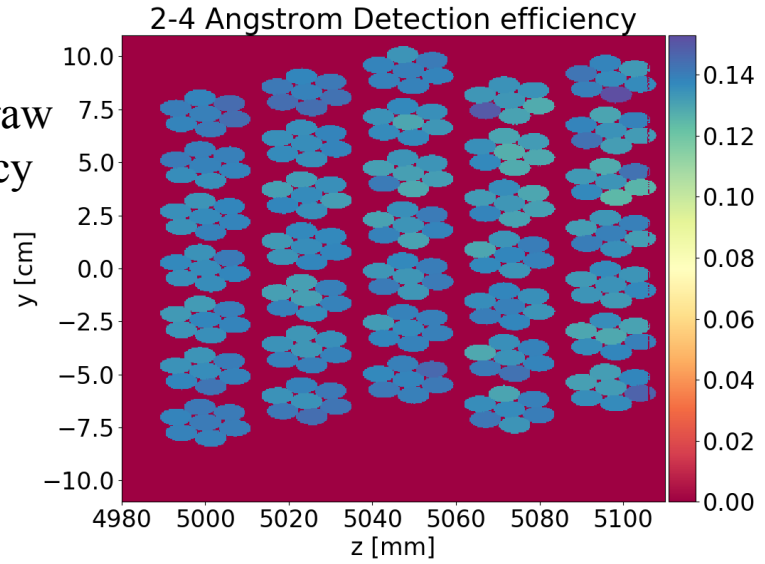
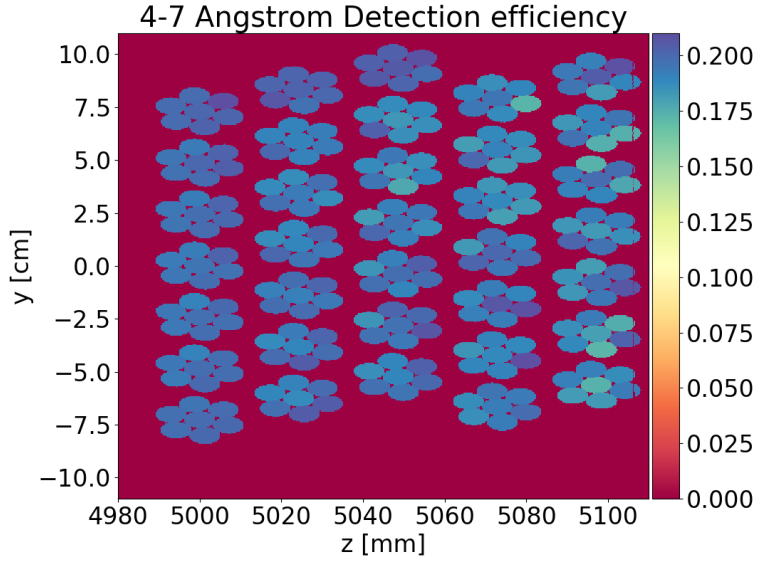
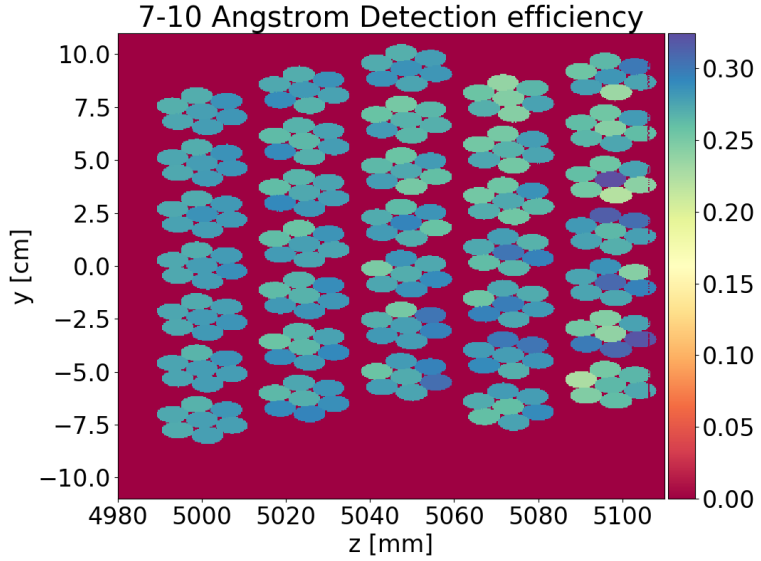
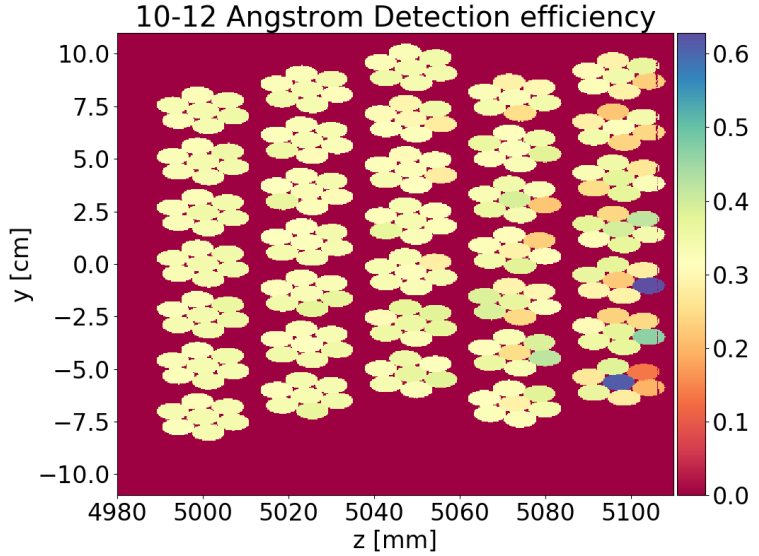



20% straw efficiency



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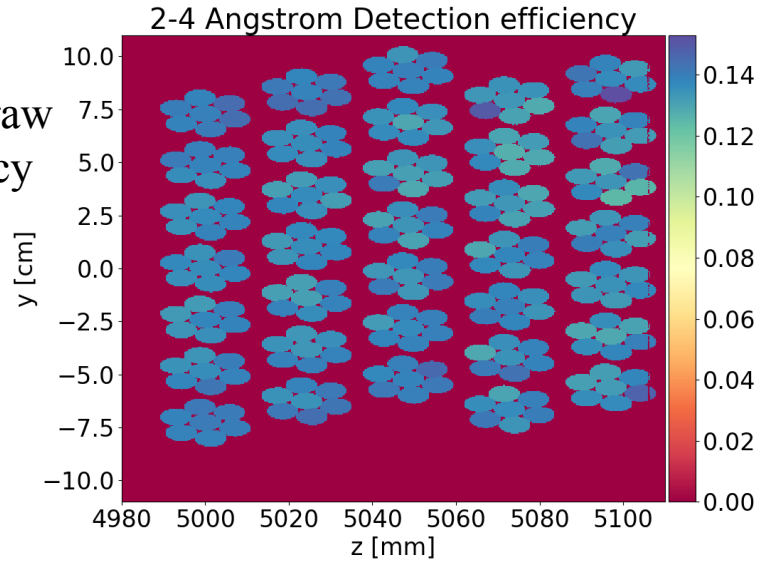
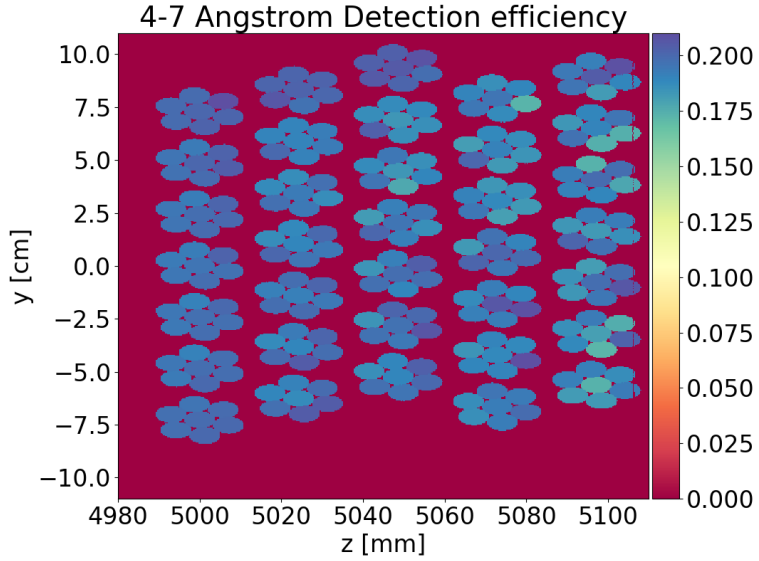
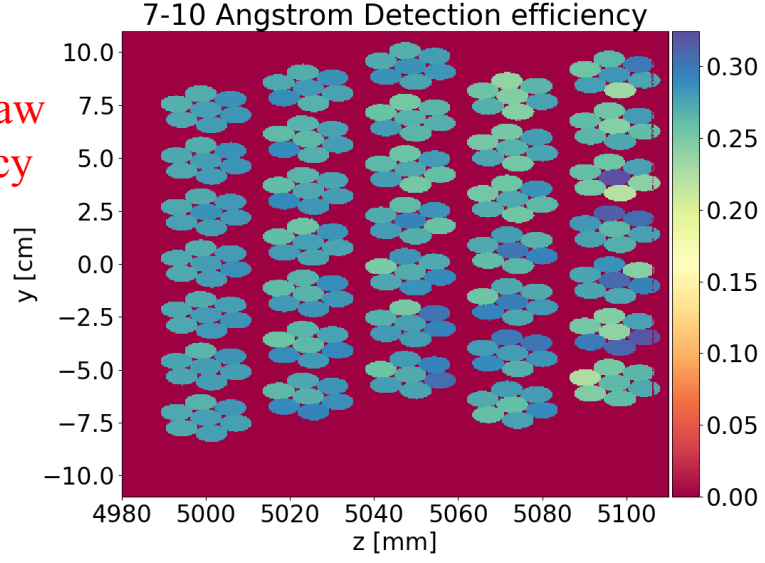
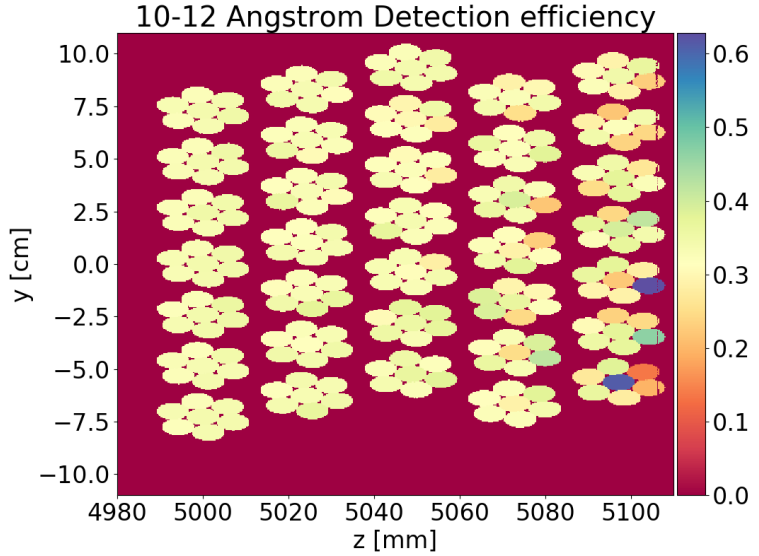



20% straw efficiency

26% straw efficiency



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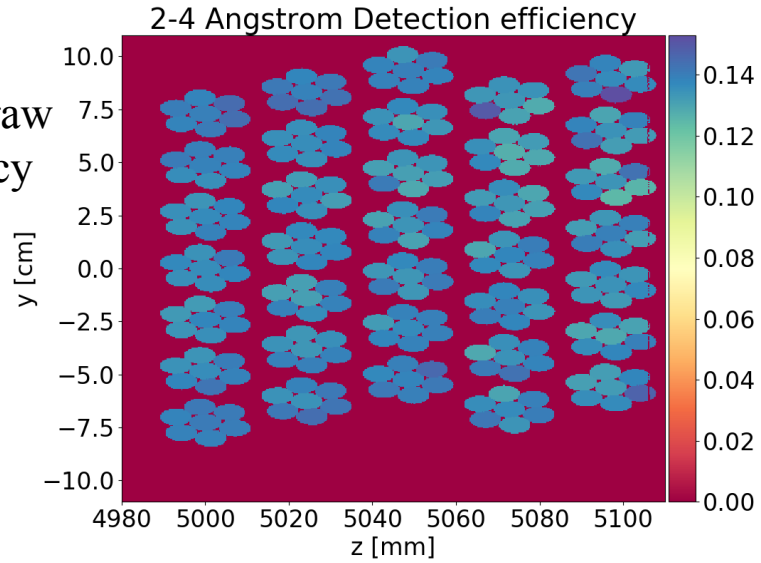


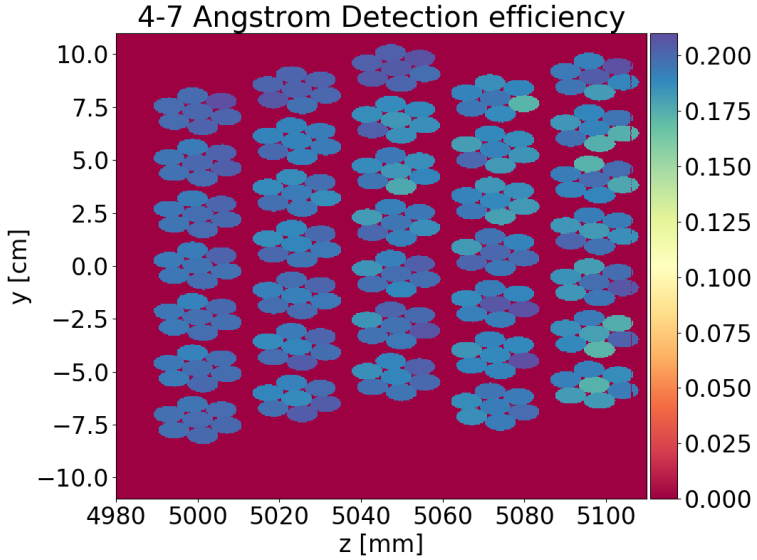


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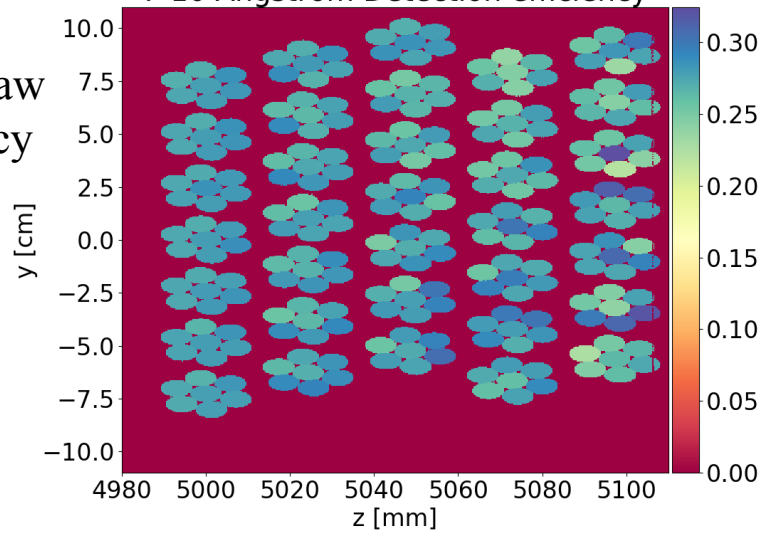
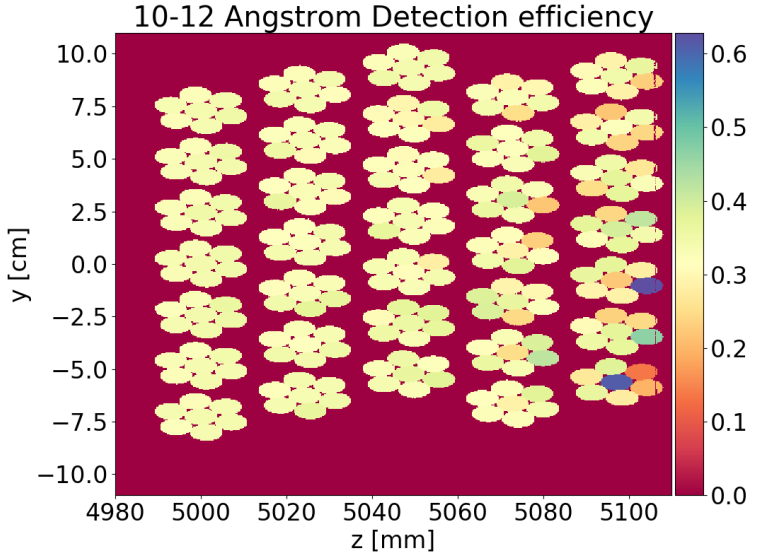


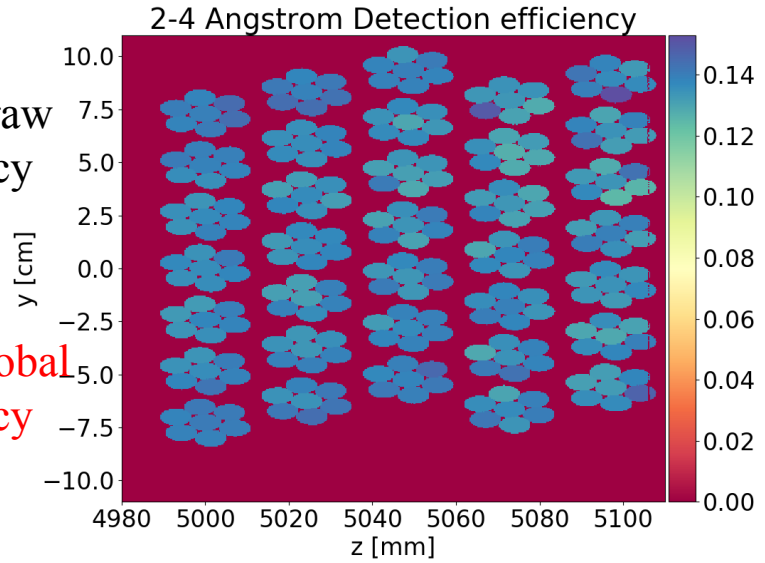



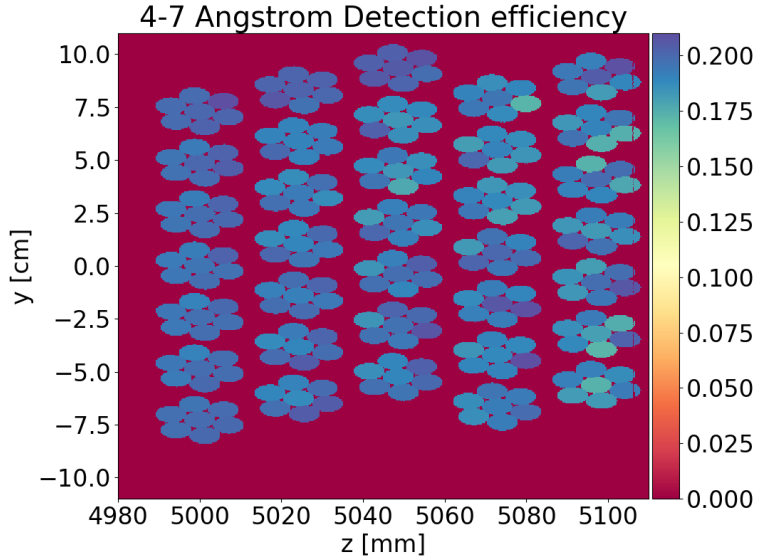

30% straw efficiency

# Detection efficiency

14% Straw efficiency

32% Global efficiency

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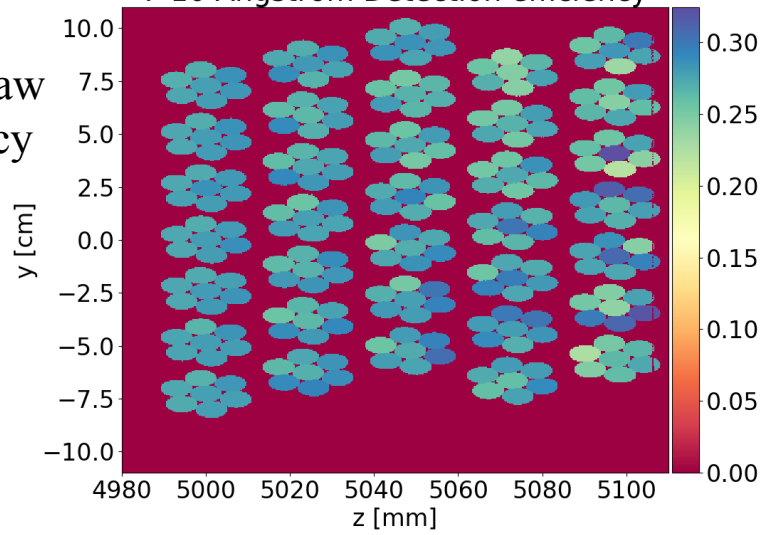


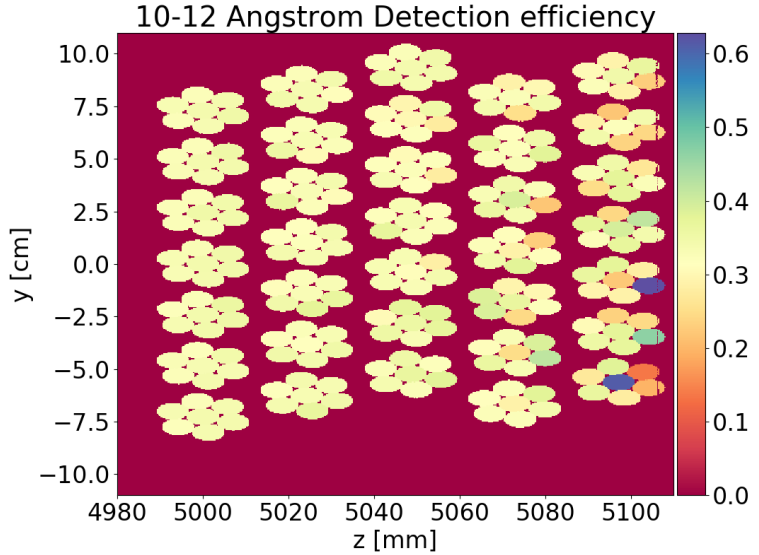


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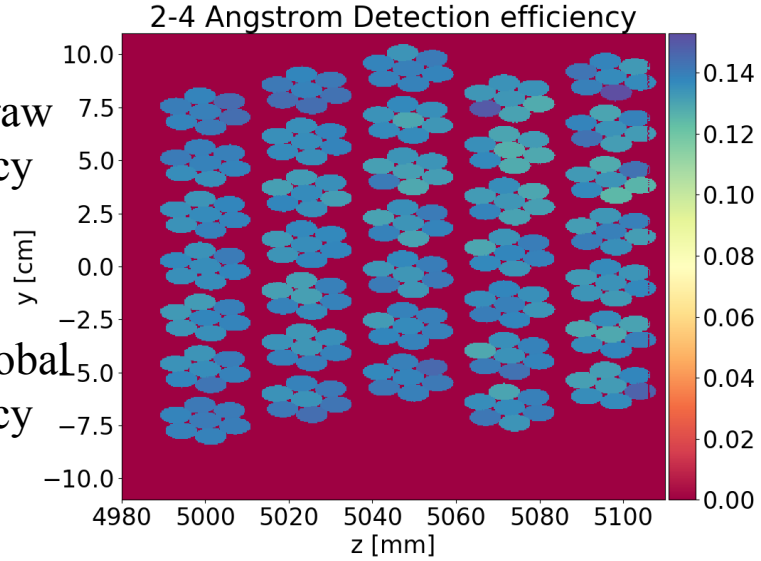
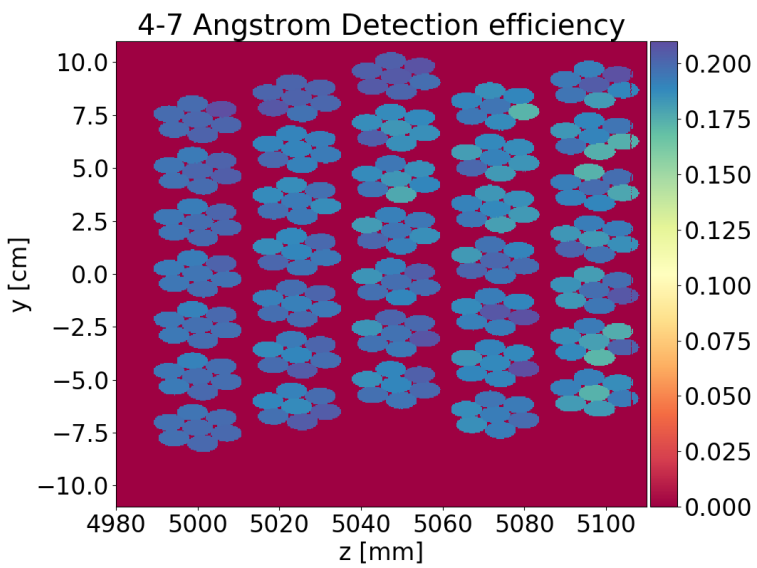
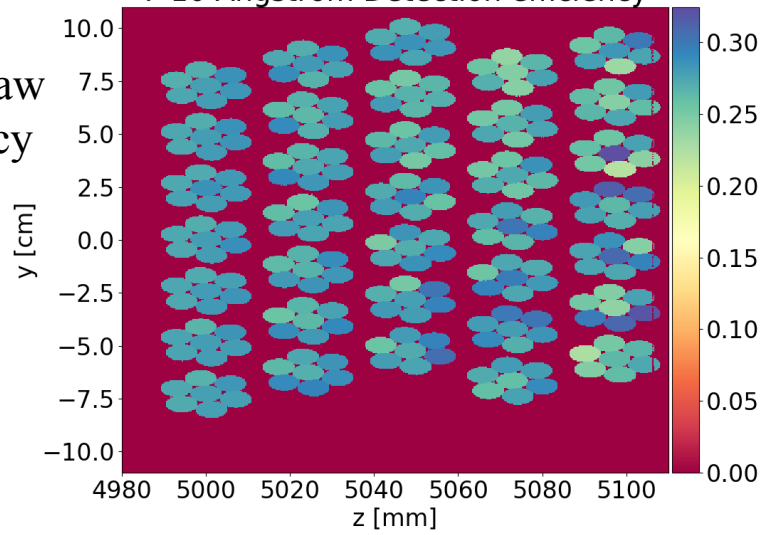


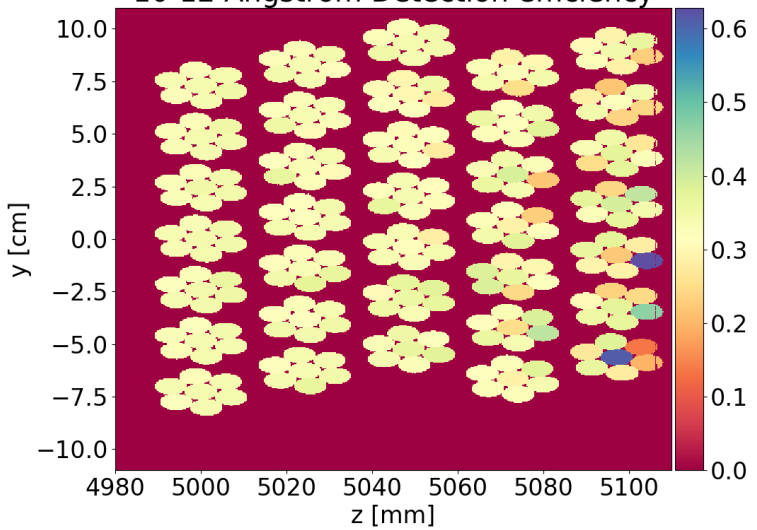




20% straw efficiency

39% Global efficiency

26% straw efficiency

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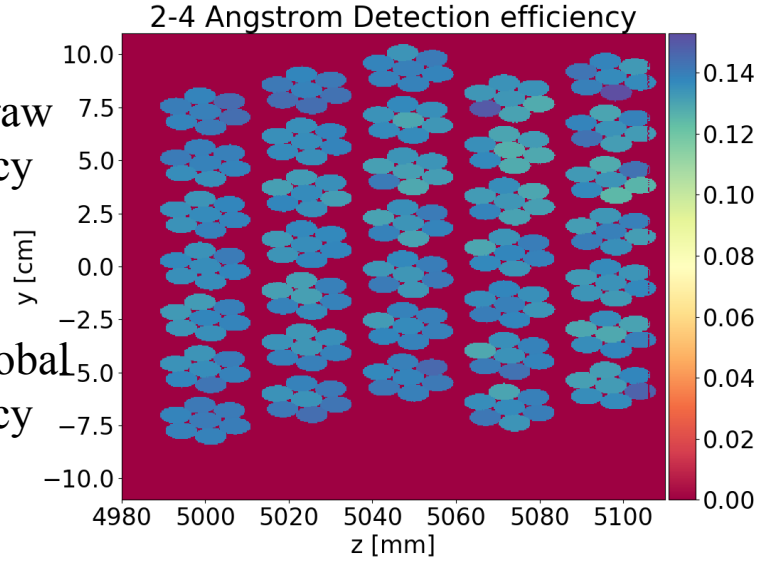


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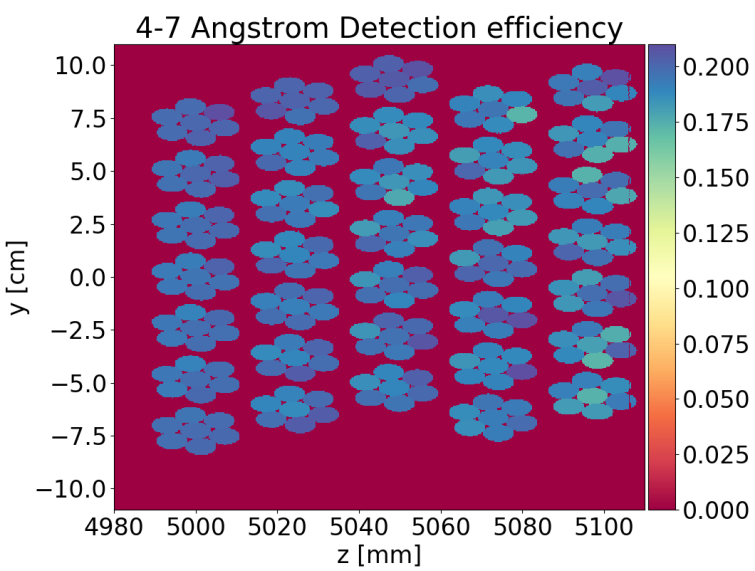
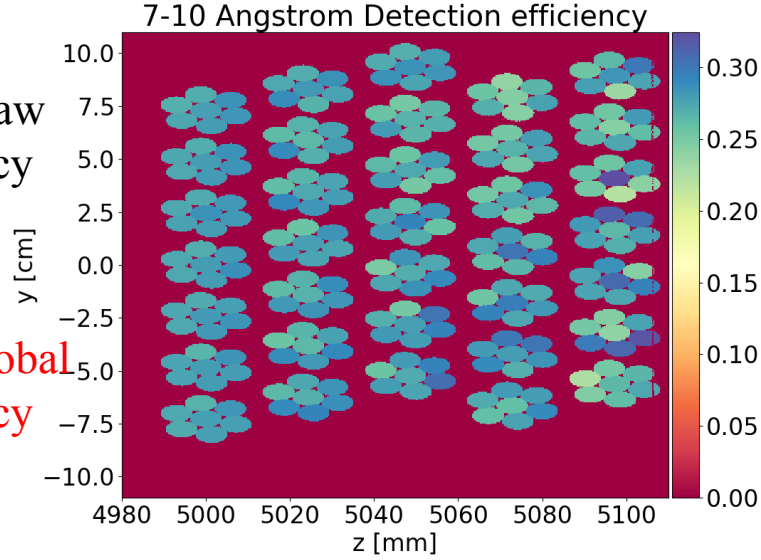
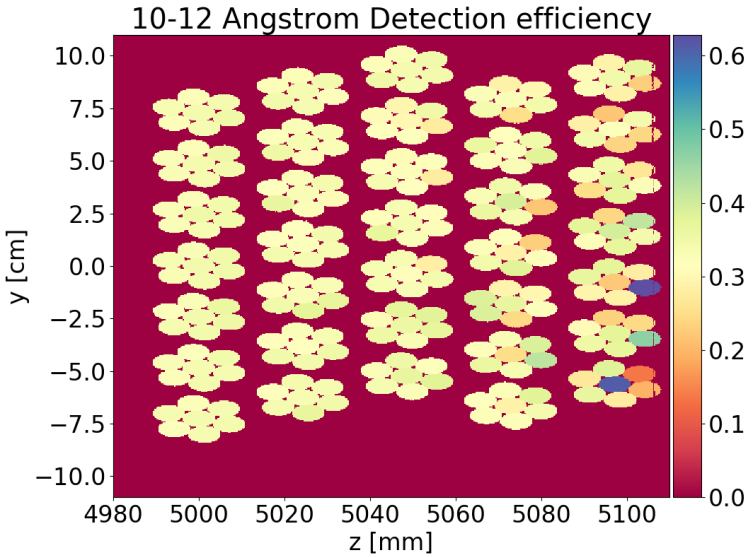



26% straw efficiency

47% Global efficiency




30% straw efficiency



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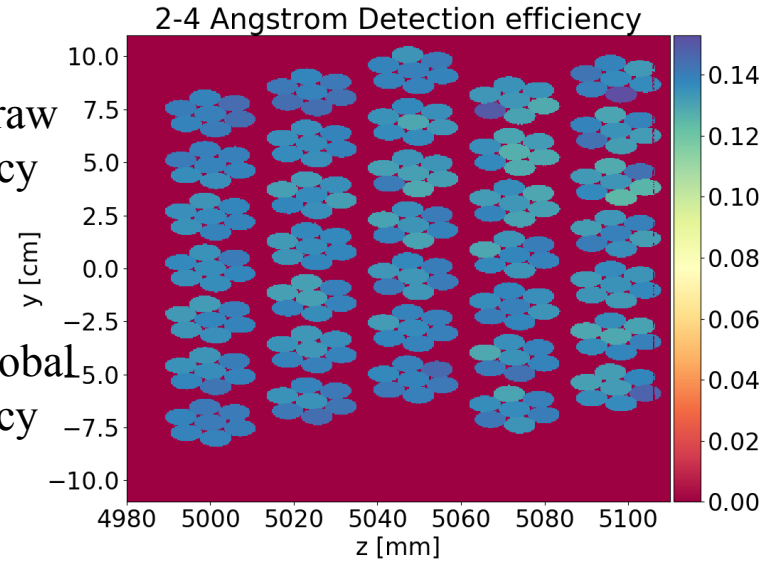
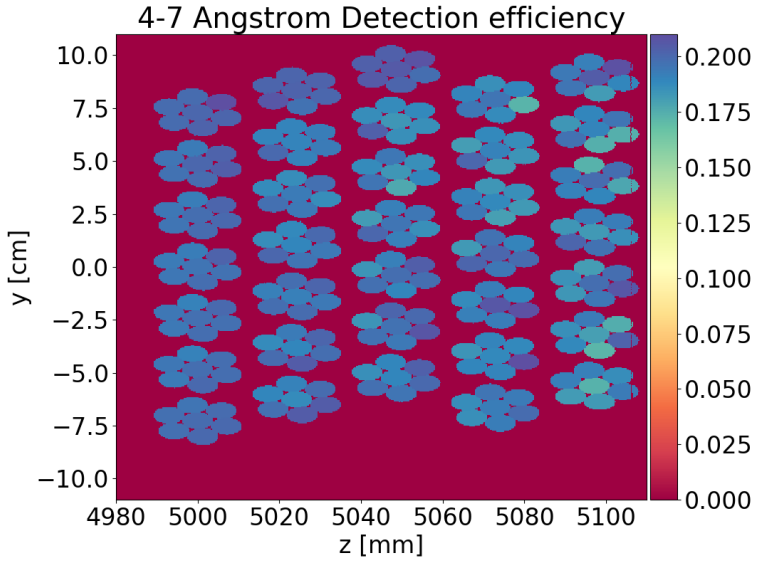


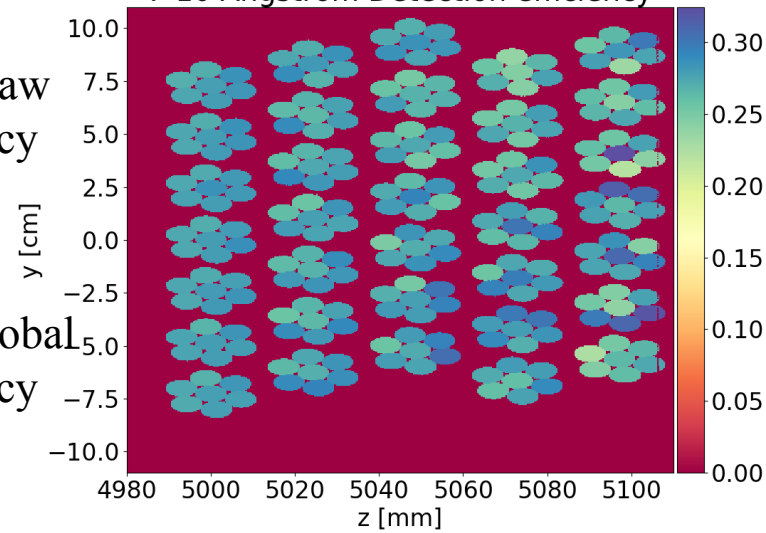

14% Straw efficiency

32% Global efficiency



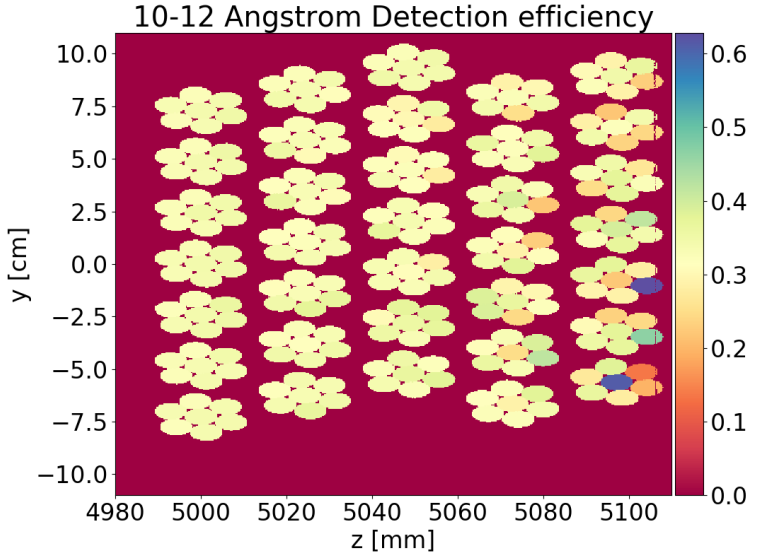

20% straw efficiency

39% Global efficiency




26% straw efficiency

47% Global efficiency




30% straw efficiency

50% Global efficiency

# Fraction of detection events

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

# Fraction of detection events

| Panel / λ | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 2 Å | 0.9067 | | | | 0.0933 |
| 7 Å | 0.5951 | 0.2671 | 0.0916 | 0.0337 | 0.0126 |
| 12 Å | 0.7354 | 0.2176 | 0.0384 | 0.0071 | 0.0015 |

# Fraction of detection events

| λ \ Panel | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 2 Å | 0.9067 | | | | 0.0933 |
| 7 Å | 0.9537 | | | 0.0337 | 0.0126 |
| 12 Å | 0.7354 | 0.2176 | 0.0384 | 0.0071 | 0.0015 |

# Fraction of detection events

| λ \ Panel | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 2 Å | 0.9067 | | | | 0.0933 |
| 7 Å | 0.9537 | | | 0.0337 | 0.0126 |
| 12 Å | 0.9530 | | 0.0384 | 0.0071 | 0.0015 |

# Effects of detector materials

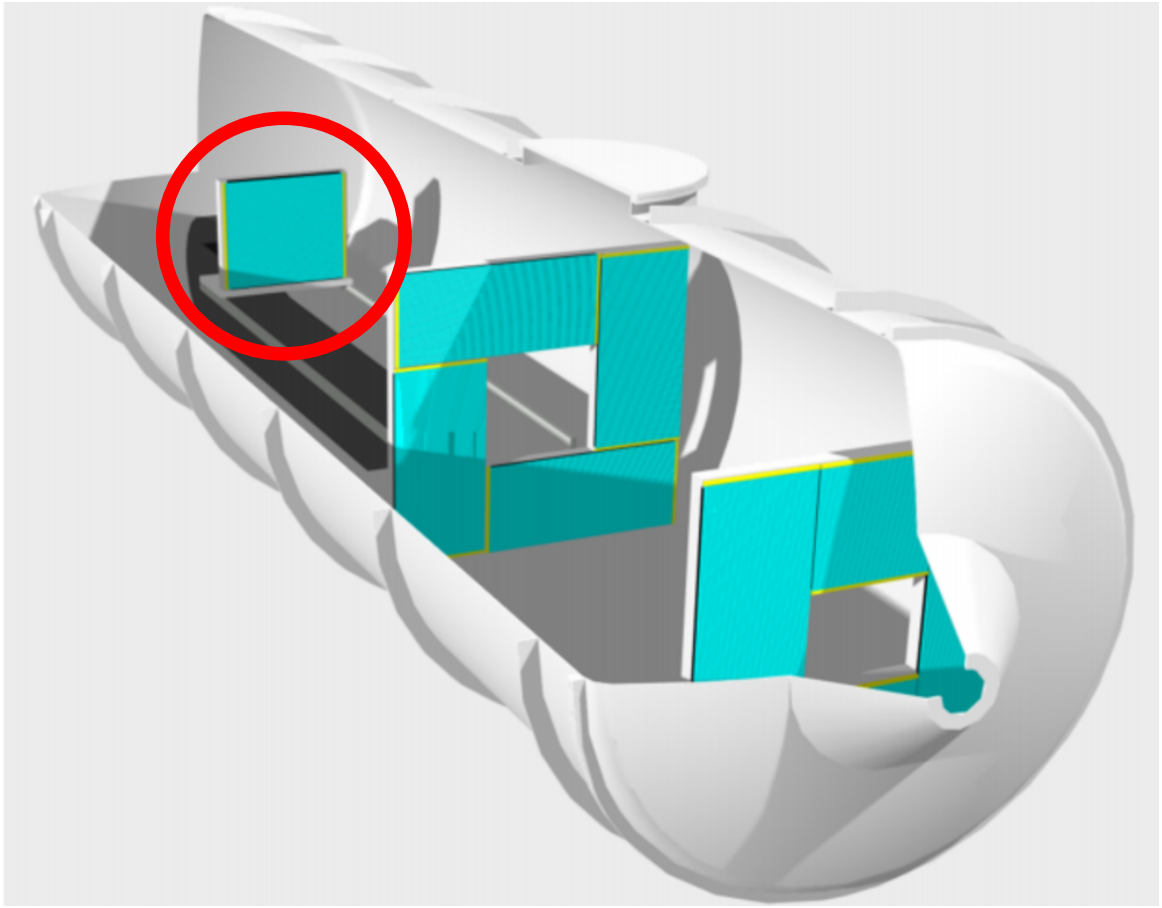
- Scattering effects are under study

- Preliminary results with reduced detector materials
  - 9.4% more detected neutrons without aluminium and copper
  - 1.8% more detected neutrons without aluminium
  - 7.3% more detected neutrons without copper

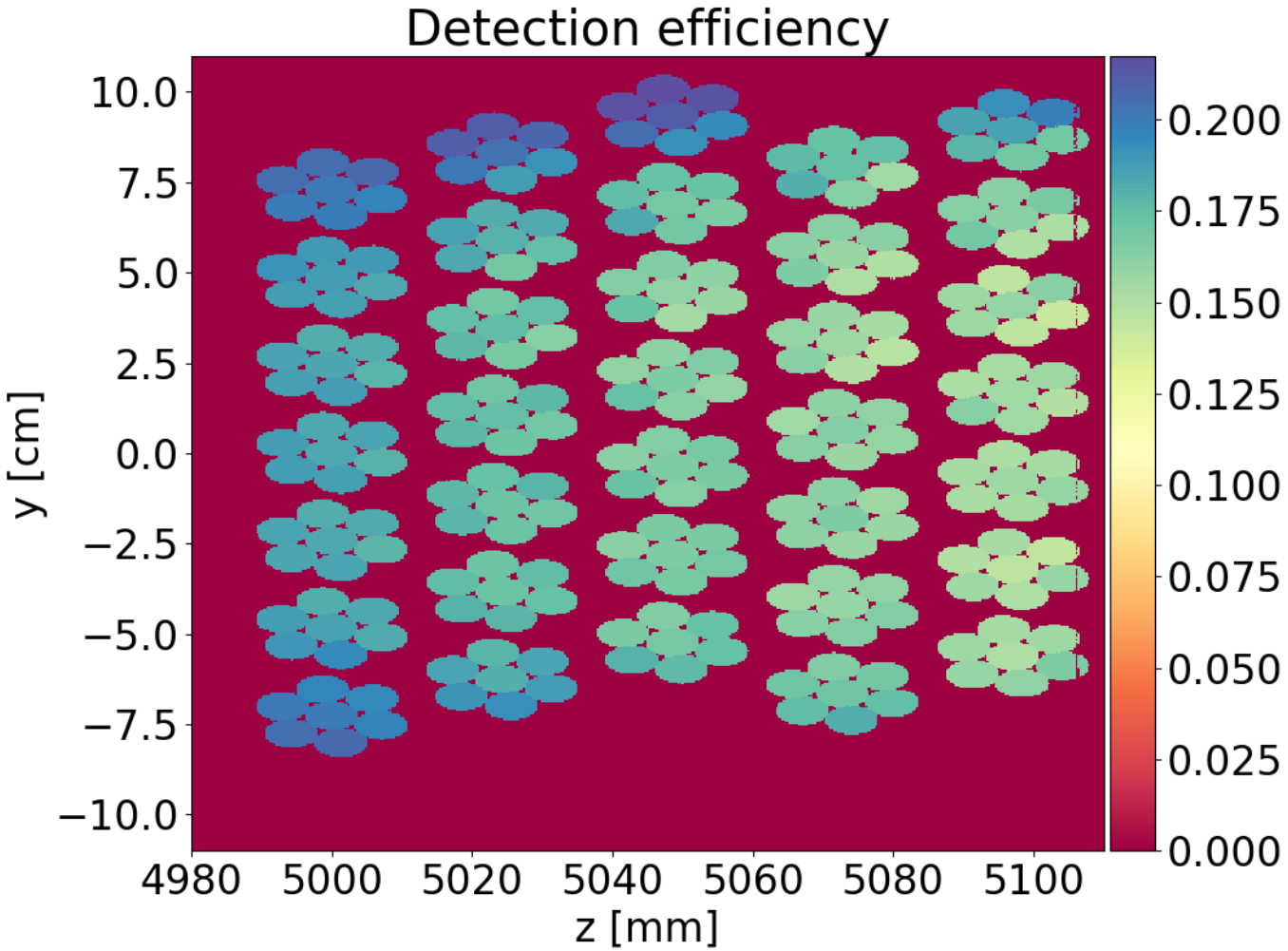
- 8 times more aluminium than copper in the detector
- 8 times longer average aluminium path than copper path

# LoKI detector system

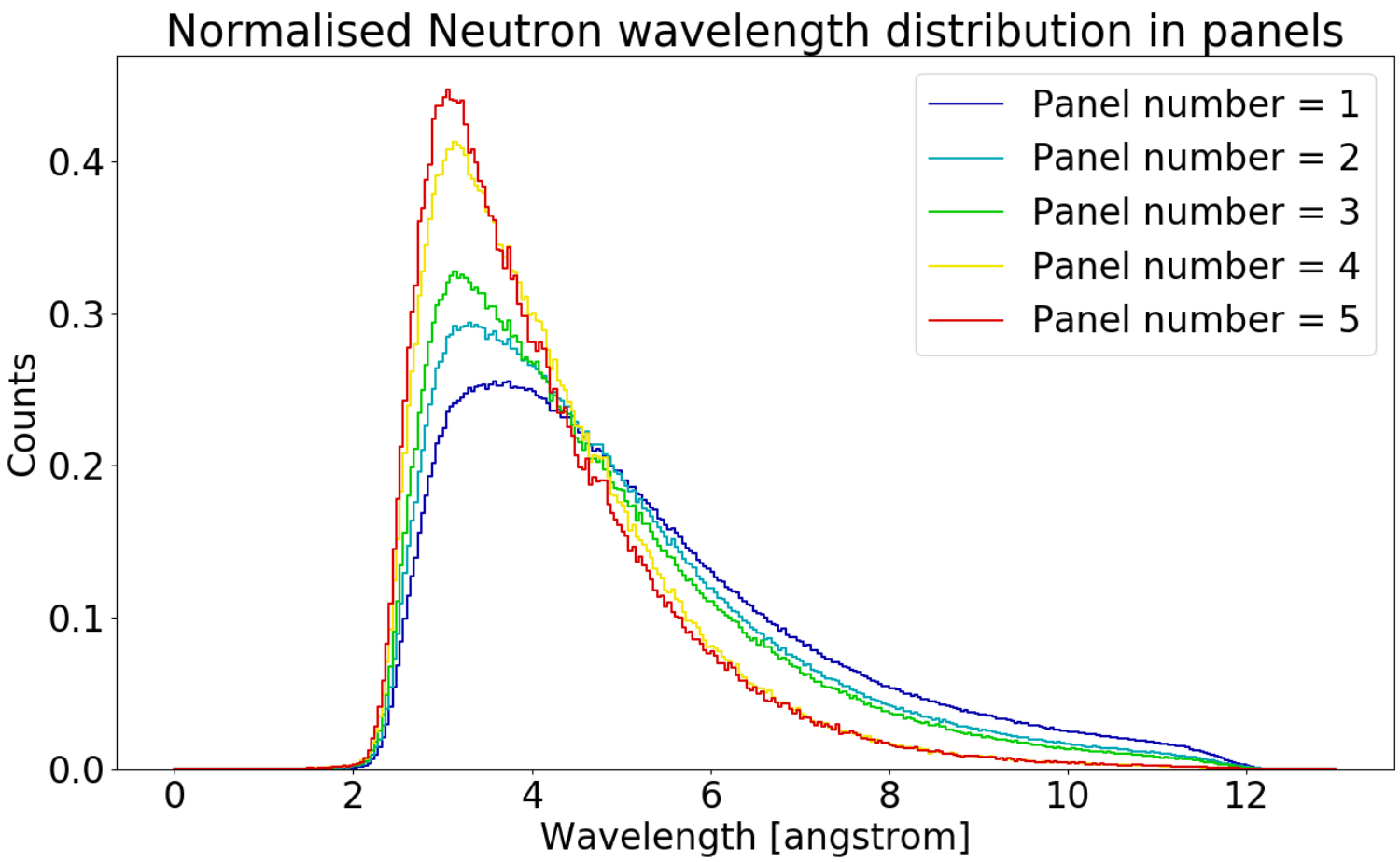
- BCS is a backup design for the LoKI
- McStas simulation:
  - 14 Hz
  - Short collimation
  - Diblock copolymer sample
- Geant4 simulation:
  - 5 m sample-detector distance



# Detection efficiency



# Neutron spectrum in panels



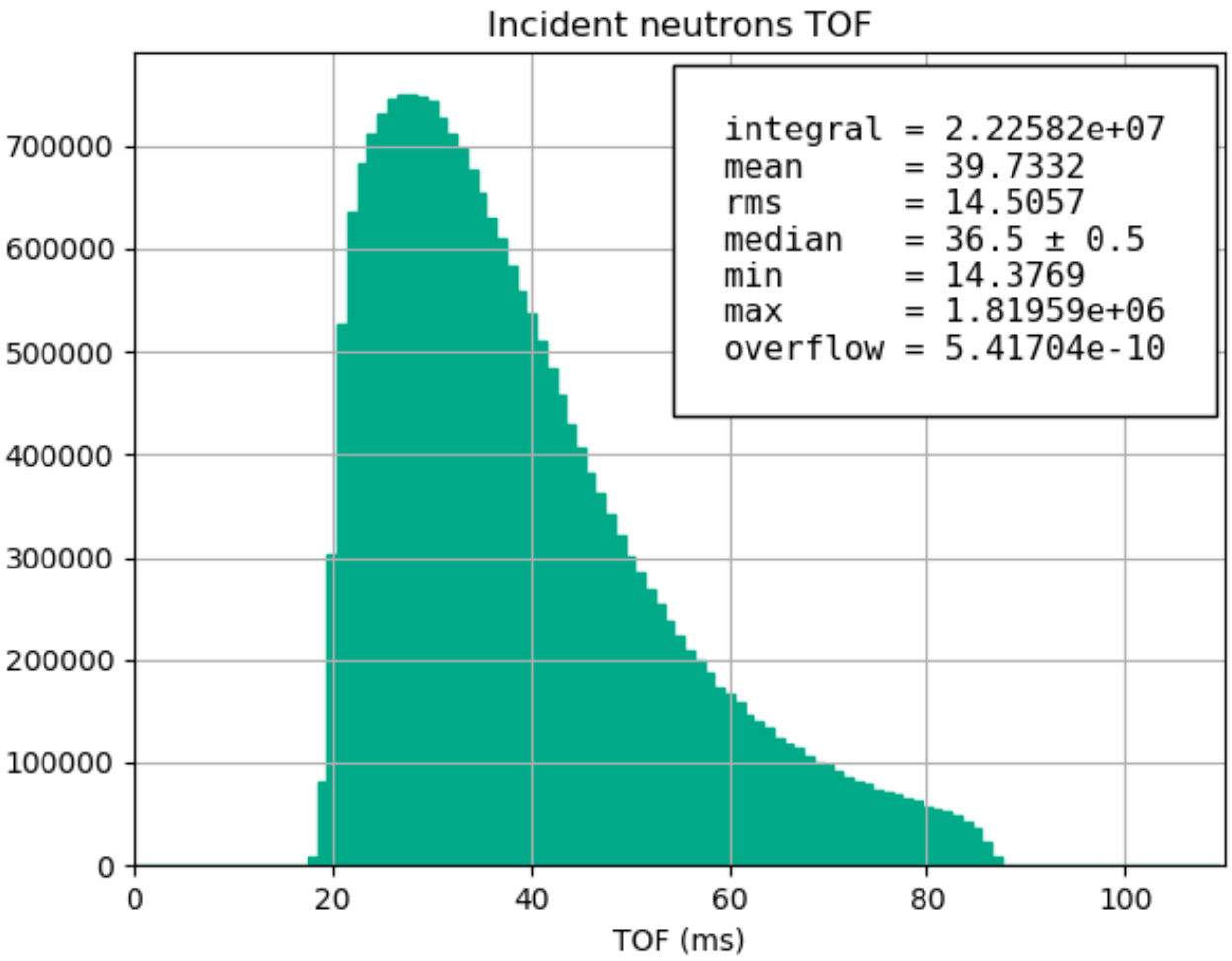
# Fraction of detection events

| Panel / λ | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 2 Å | 0.9067 | | | | 0.0933 |
| 7 Å | 0.9537 | | | 0.0337 | 0.0126 |
| 12 Å | 0.9530 | | 0.0384 | 0.0071 | 0.0015 |
| LoKI | 0.4993 | 0.2677 | 0.1358 | 0.0625 | 0.0347 |

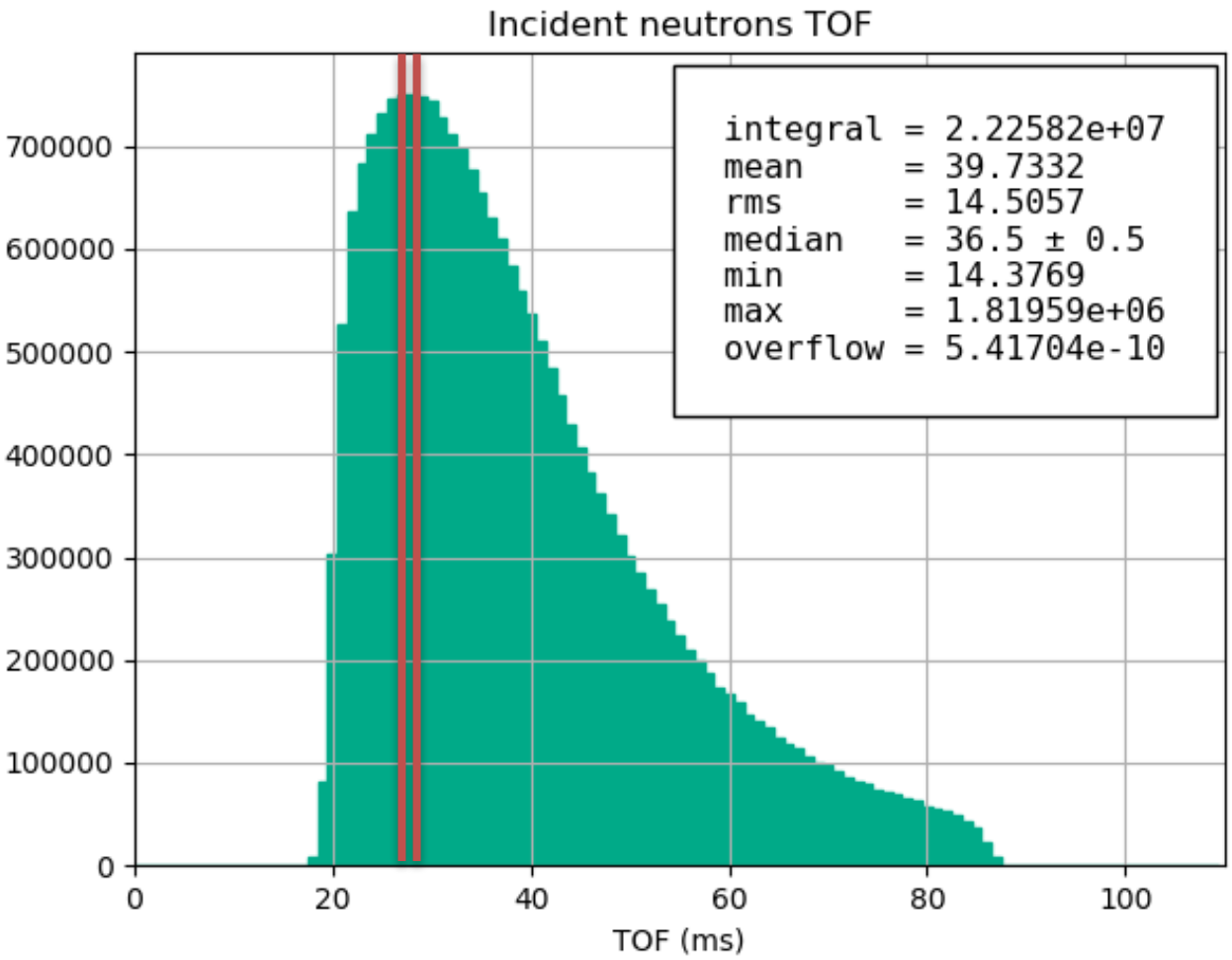
# Fraction of detection events

| Panel / λ | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 2 Å | 0.9067 | | | | 0.0933 |
| 7 Å | 0.9537 | | | 0.0337 | 0.0126 |
| 12 Å | 0.9530 | | 0.0384 | 0.0071 | 0.0015 |
| LoKI | 0.9028 | | | 0.0625 | 0.0347 |

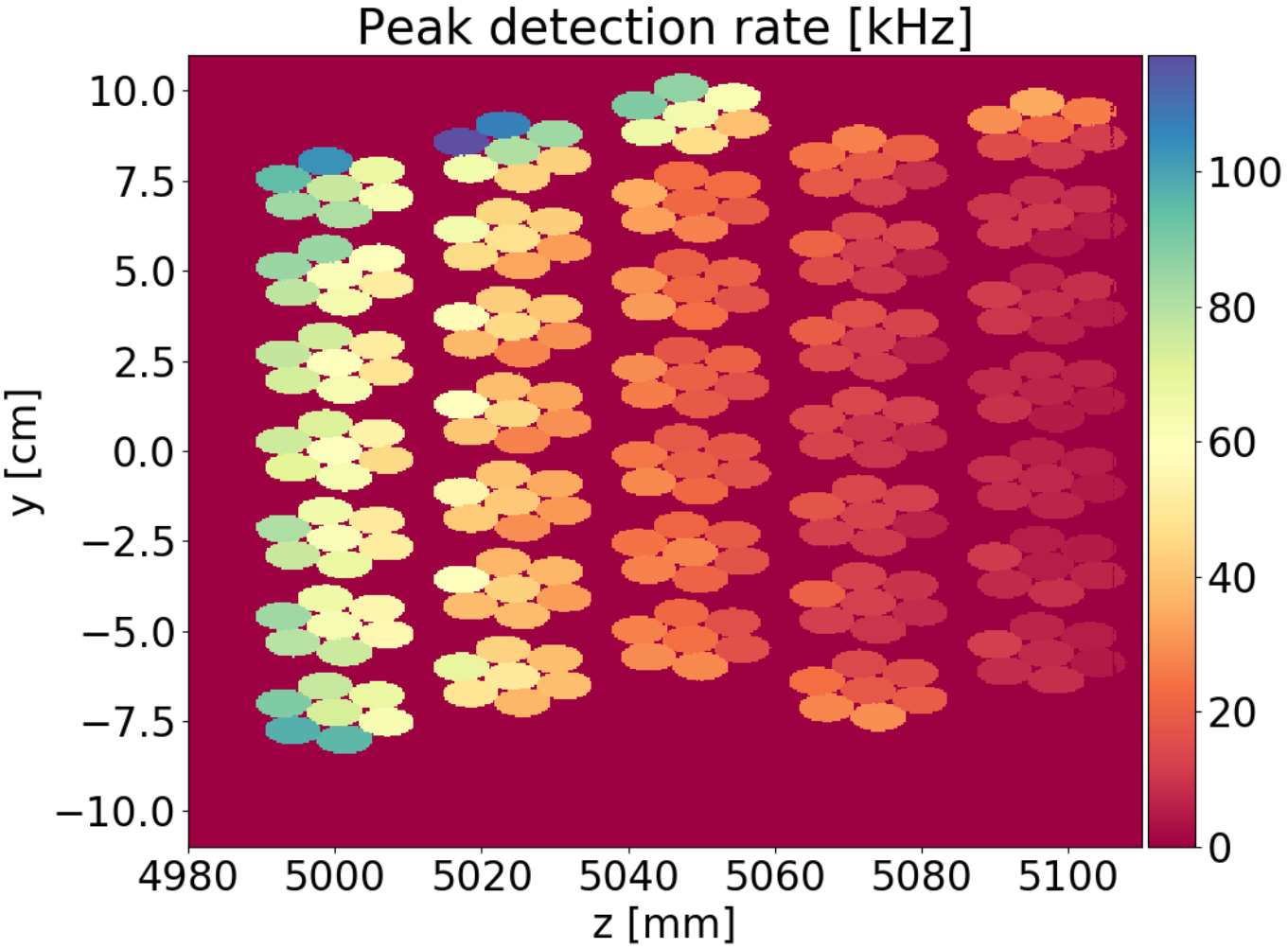
# Time of Flight spectrum



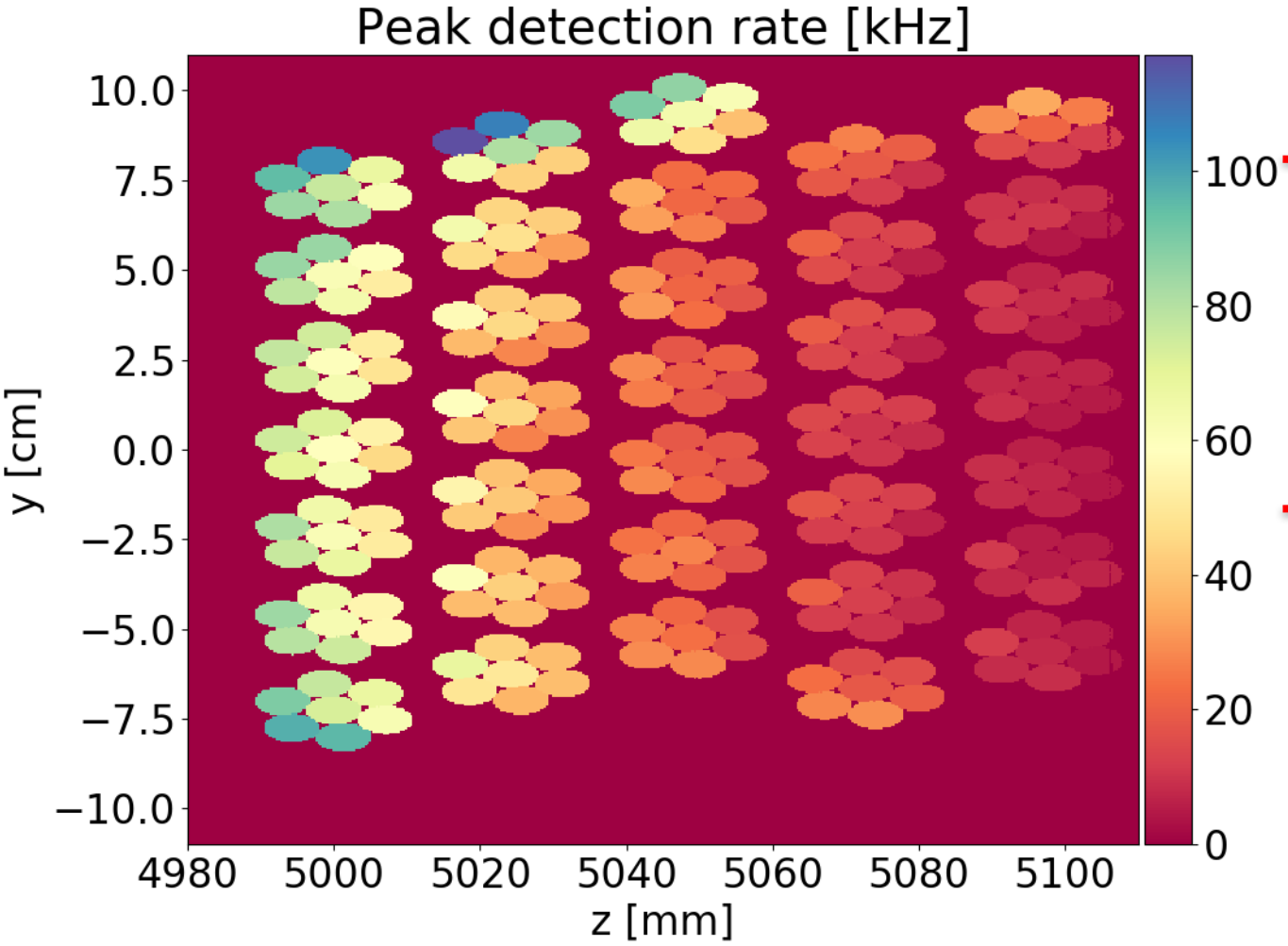
# Time of Flight spectrum



# Detection rate



# Detection rate




**Max. detection count rate capability: 50-100 kHz**

# Conclusions

- 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

# Thank you for your attention!