An experimental approach for quantitative scattering correction in neutron imaging

11th World Conference on Neutron Radiography, Sydney, 2018
Outline

• Scattering and background/biases correction for quantitative neutron imaging
• Image model
• Experimental data
• Dedicated data processing
• MuhRec 4.0
• Development within SINE2020
Introduction

Lambert-Beer’s law

\[ \int \sum(s)ds = -\log \frac{(I-DC)}{(OB-DC)} = -\log \]

Data taken at NEUTRA, PSI
“Sample scattering”
- Incoherent scattering caused by neutrons colliding with the sample
- Sample geometry and composition
- Detector distance

“Background scattering” (systematic biases)
- Additional neutrons scattered at the shielding or the instrumentation
- Light backscattered from the mirror of the camera box
Introduction: effect on uncorrected images
Lamber Beer’s law

\[ \int \Sigma(s) ds = -\log \frac{(I-DC-S)}{(OB-DC-BG)} = -\log \]
Method: how to measure

Holding frames with "black bodies" (BB):

- aluminium frame
- BBs = cylindrical objects made of $^{10}$B$_{4}$C
Method: how to measure

Boillat 2018, Optics Express
Method: how to measure

Neutron beam

BB frame

detector

rotation axis

mirror

camera box

open beam images with BB

sample images with BB
Method: how to process

open beam image with BB → BB mask → Interpolated background

\[ \int \sum(s)ds = -\log \left( \frac{(I-DC-S)}{(OB-DC-BG)} \right) \]

background scattering

Poster A. Kaestner: WCNR11
Method: how to process

Sample images with BB – sparse CT

0°  14.4°  28.8°  .....  360°
Method: how to process

Sample images with BB – sparse CT

\[
\int \sum(s)ds = -\log \frac{(I - DC - S)}{(OB - DC - BG)} \quad \text{sample scattering}
\]
Method: how to process

Sample images with BB – sparse CT

\[ \int \sum(s) \, ds = - \log \frac{(I_{DC} - S)}{(OB_{DC} - BG)} \] sample scattering
Method: MuhRec implementation
Method: MuhRec implementation
Method: MuhRec implementation
Results
Results

Uncorrected

BB corrected

Uncorrected

BB corrected

horizontal profiles

intensity distribution

# counts
Results

- **no correction**
- **BH correction**
- **BB correction**
- **BB and BH correction**

**Horizontal profiles**

**Intensity distribution**

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>no correction</td>
</tr>
<tr>
<td>Green</td>
<td>BH correction</td>
</tr>
<tr>
<td>Red</td>
<td>BB correction</td>
</tr>
<tr>
<td>Purple</td>
<td>BB and BH correction</td>
</tr>
</tbody>
</table>

Sigma (cm⁻¹)

Distance (mm)

Counts x 10⁴

Sigma (cm⁻¹)
Conclusions

- Acknowledgements: NIAG
- Validation with experimental datasets
- Simulated datasets (McStas)
- Several parameters were tested (#BB projections, interpolation scheme, mathematical formulation..)
- Integration in KipTool
Thank you