

# Geant4 based simulation of the Multi-Blade detector for investigation of scattering

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EUROPEAN  
SPALLATION  
SOURCE

brightness

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Lund

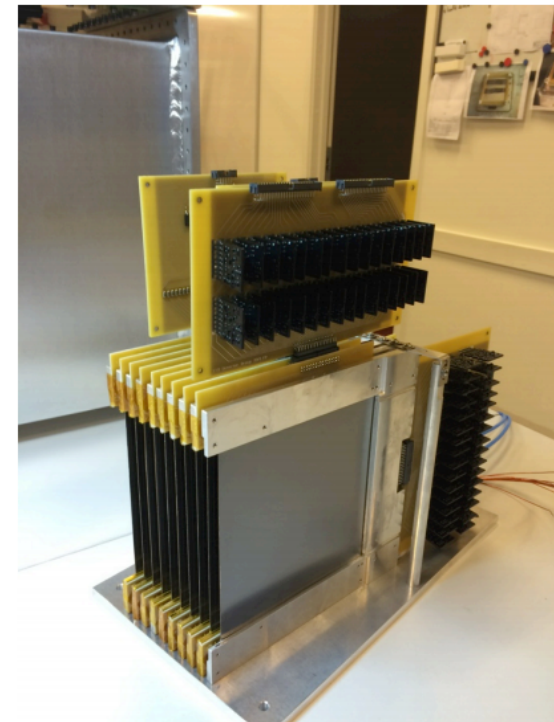
26-29 September, 2017

# Outline

- Multi-Blade detector
- Geometry implementation in Geant4
- Effect of neutron detection on momentum transfer ( $Q$ )
- Scattering studies:
  - Misplaced detections
  - Effect of entrance window on momentum transfer

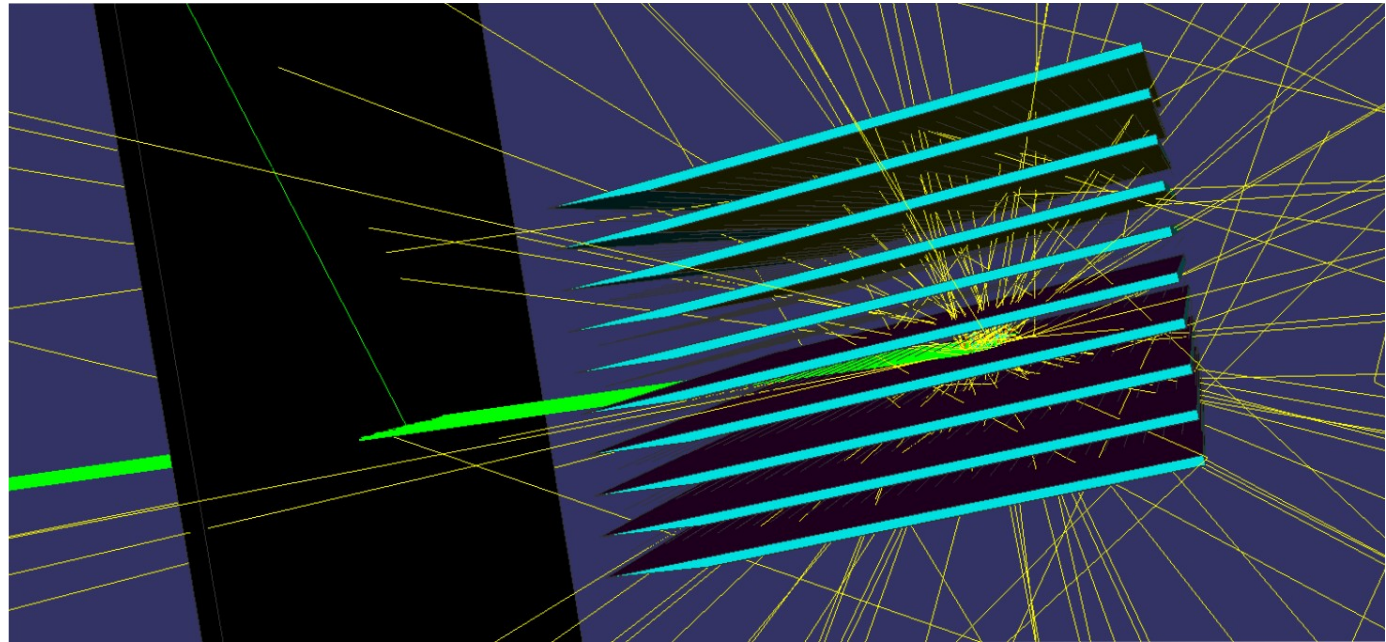
# Multi-Blade

- Multi-Wire Proportional Chambers with  $^{10}\text{B}_4\text{C}$  converter
- New prototype will be tested at ISIS
- Usage:
  - At ESS: FREIA and ESTIA reflectometers
- Requirements:
  - High rate capability:  $10^5 \text{ mm}^{-2}\text{s}^{-1}$
  - Max. window scattering:  $10^{-4}$
  - Spatial resolution (2.5x0.5 mm)
- Aim of the simulation:
  - To understand scattering in the complex geometry



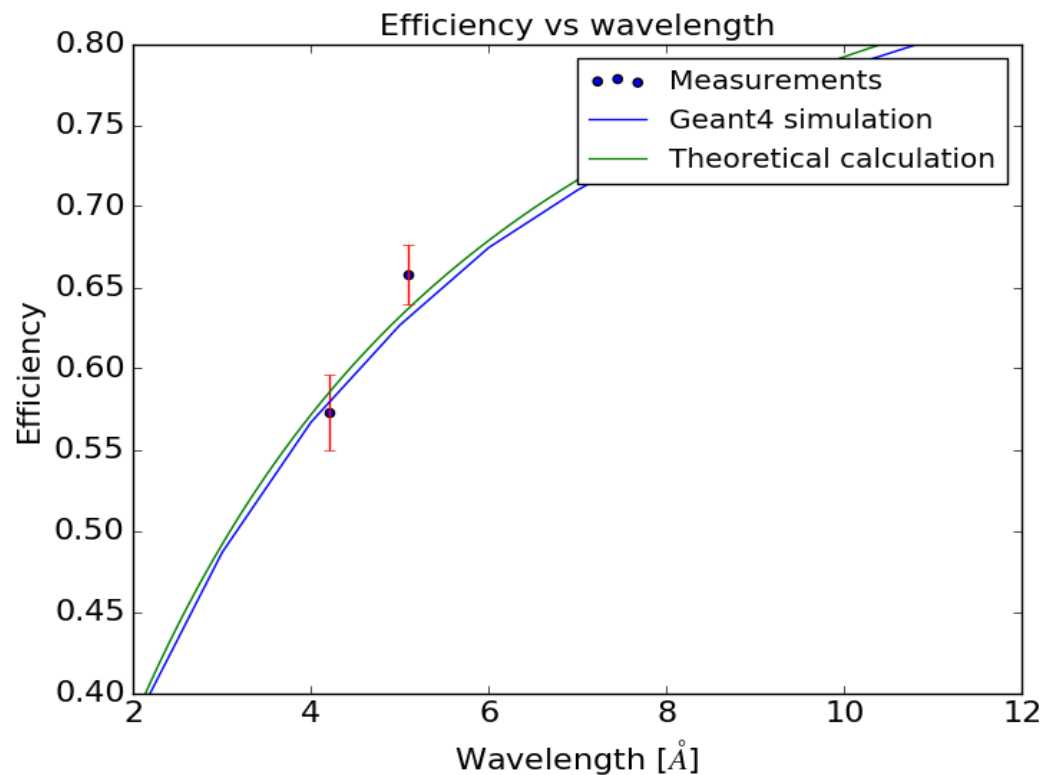
# Geant4 simulation

- Framework developed at ESS
- “Realistic” sample
- Shielding vessel
- Al window
- 10 blades
- Each with:
  - Boron layer
  - Copper strips
  - Kapton layer



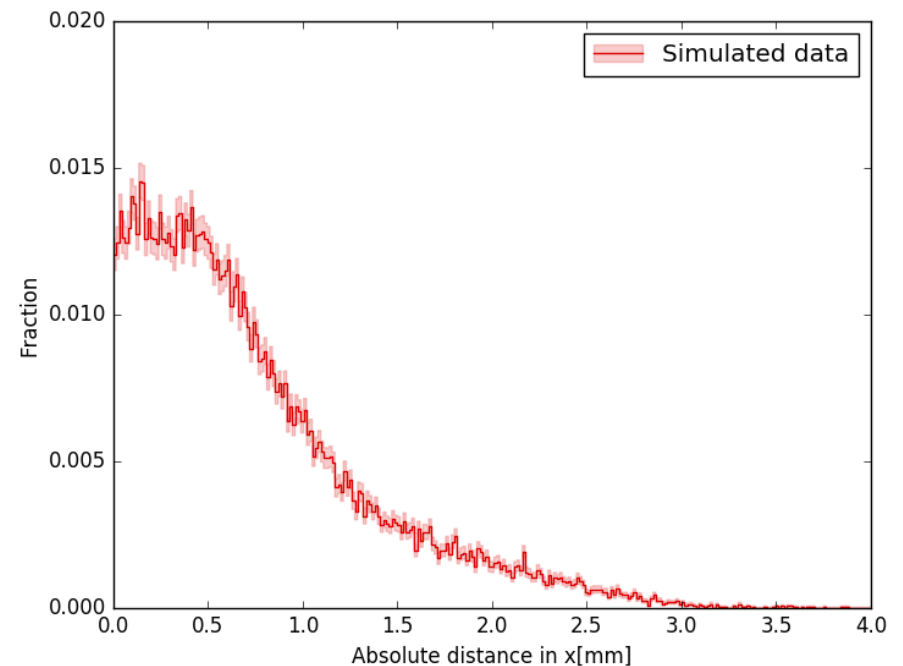
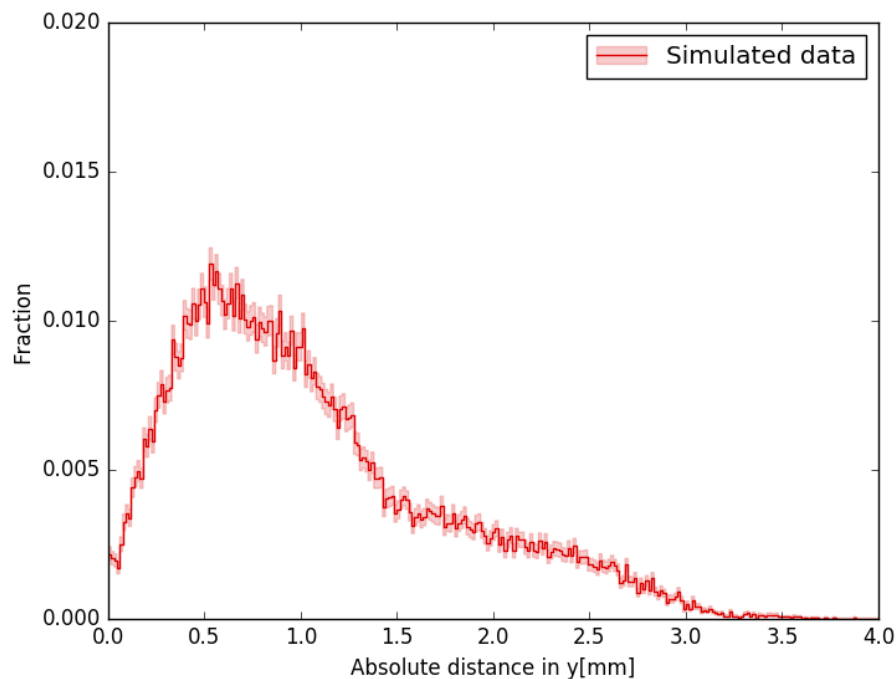
# Efficiency validation

- Measurements took at BNC
- Efficiency for 2 wavelengths measured
- **Simulation was validated**



# Offset of conversion wrt detection

- Detection at the center of  $\alpha$ , Li track
- **$1.48 \pm 0.60 * 10^{-4}$  misplaced detections**
- Generic investigation for all Boron based neutron detectors



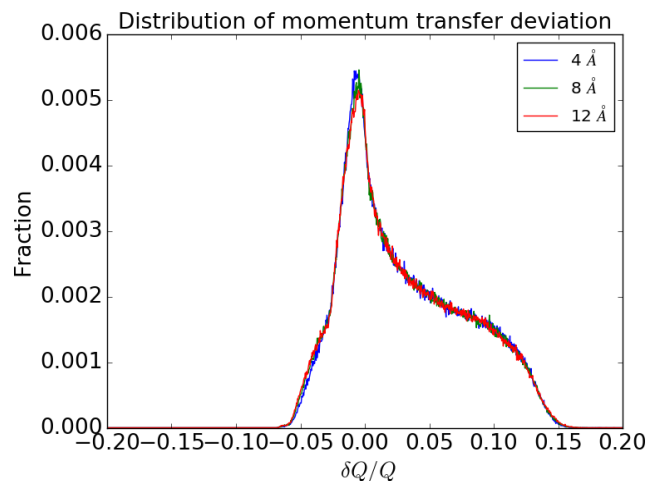
# Momentum transfer

- Value of merit
- 9 realistic scenarios investigated without window
- Accuracy is sufficient for reflectometry (< 5%)

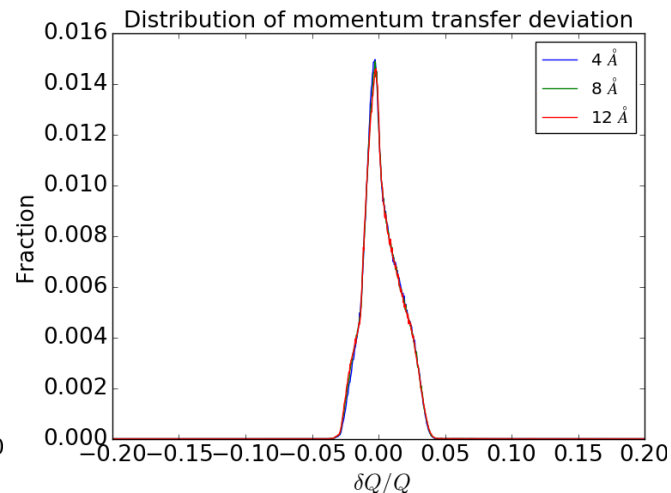
$$Q = \frac{4\pi}{\lambda} \sin(\theta)$$

$$\delta Q/Q = \frac{Q_{\text{det}} - Q_{\text{true}}}{Q_{\text{true}}}$$

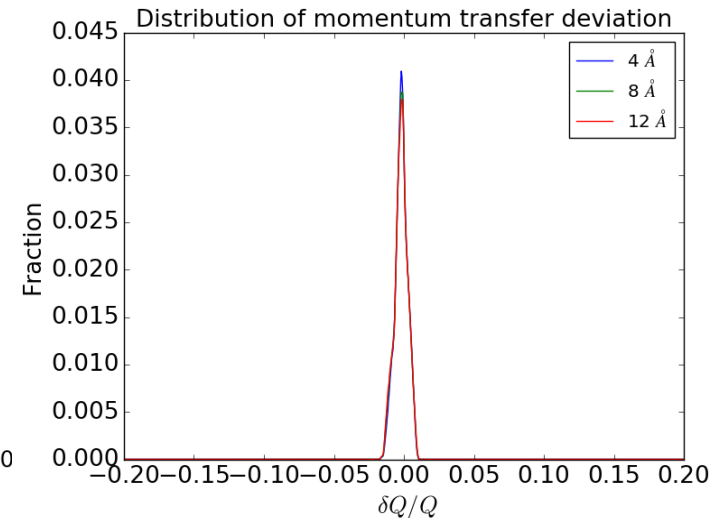
Emission angle 1 degree



2 degrees



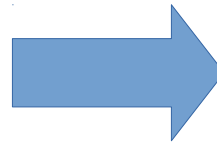
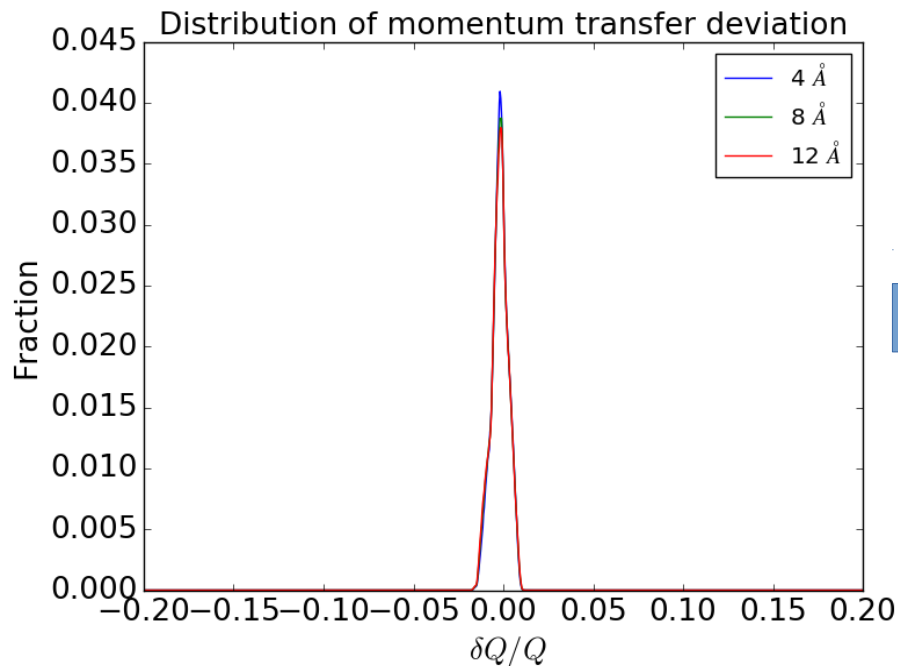
4 degrees



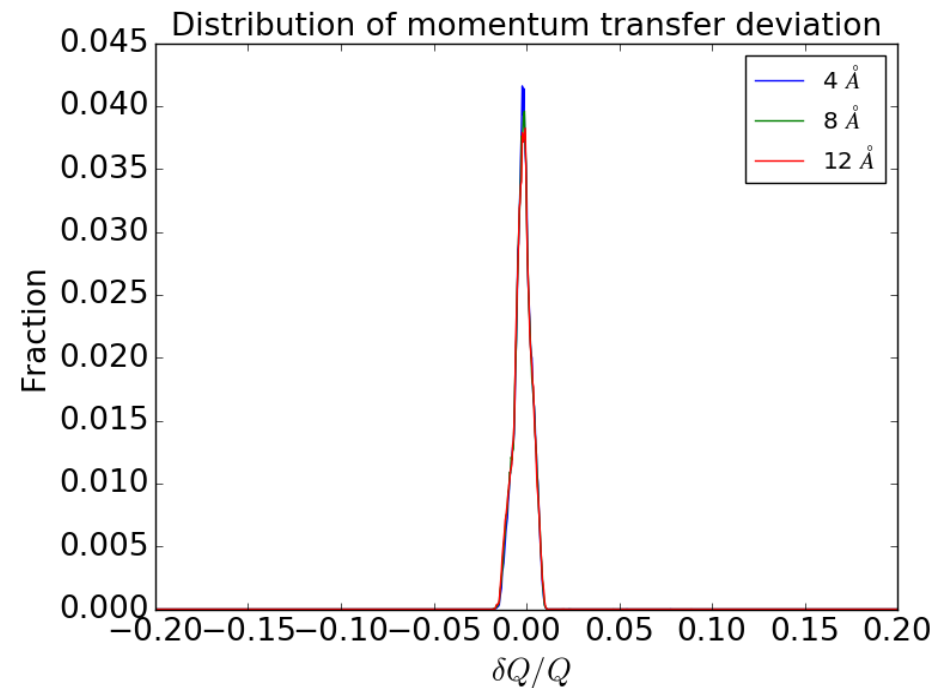
# Effect of window on momentum transfer

- Al window with 1 mm thickness introduced
- Momentum transfer distribution does not change

No window



Window





# Summary

- Geant4 simulated efficiency validated
- $1.48 \pm 0.60 * 10^{-4}$  misplaced detections
- Momentum transfer accuracy investigated:
  - Less than 5% required for reflectometry
  - AI window has negligible effect

# Outlook

- Contribute to the detector optimization for each instrument
- Take into account **instrument effects**, by use of realistic neutron input
- Investigation of:
  - Effect of sample size
  - Effect of window
  - Effect of different atmospheres

# Backup slides

# Scattering with respect to conversion points

- Window:
  - Scattering increases
  - Coherent and incoherent scattering
- Choice of blade materials:
  - Vacuum: 1
  - Titanium: 1.30
  - Aluminium 1.26

