

VALIDATION OF SIMULATED X-RAY SPECTROSCOPY

Context

Scanning electron microscopy is a versatile surface analysis technique, used in for instance fundamental quantum matter research, material identification, and for studying biological processes such as virus replication.

A secondary signal is the X-rays emitted by atoms that were ionized by the electron beam; since the energy of these X-rays is directly related to the atomic structure of the constituents in the sample, this is called energy-dispersive X-ray spectroscopy (EDX). With modern photodetector improvements, the EDX signal has become increasingly important in recent years.

The precise physical understanding of the X-ray generation and the resulting EDX signal has remained lacking despite 50 years of research. New hope in improving this situation comes from major computational and simulation advances combined with novel EDX detector technology. At Sioux Technologies, we complement traditional physics modelling with optimization and machine learning algorithms, leading to improved data analysis.

Internship overview

- Master Student
- Internship
- Physics / Electrical Engineering / Math, with some SW affinity
- Location: Eindhoven

Technologies

- Monte-Carlo simulation
- Scanning Electron Microscopy (SEM)
- Energy Dispersive X-ray spectroscopy (EDX)
- Particle Physics
- C++ / Python



Assignment

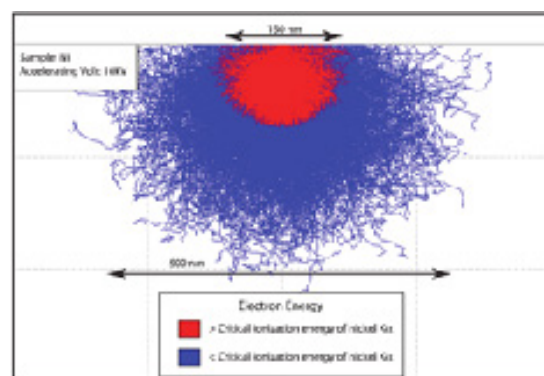
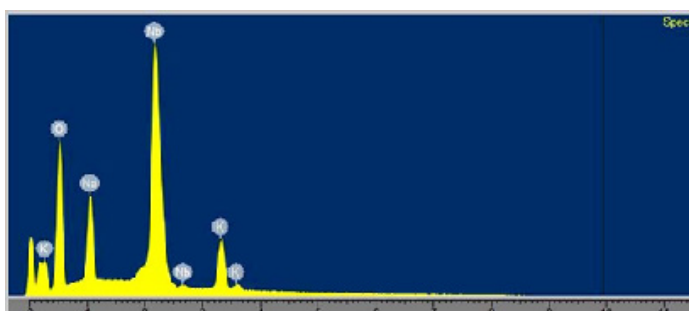
An electron microscope is a multi-modal imaging machine. Besides direct detection of scattered electrons, X-rays emitted after ionization by the electron beam contain a lot of information. A long-standing problem in electron microscopy is the accurate analysis of the X-ray data.

For this assignment, we want to validate a simulation against experimental data from a scanning electron microscope (SEM) with an energy-dispersive X-ray (EDX) detector.

CERN has developed Geant4, a Monte-Carlo simulation package for the relevant particle physics. We want to use this package to model electron microscopy measurements. This model is to be validated against EDX measurements from an in-house SEM. With these validations we want to understand where the limitations in the simulation are.

Activities

- Set up a Monte-Carlo simulation with a typical geometry of an electron microscope.
- Design and perform experiments on an in-house SEM to validate the simulation.
- Carry out a first-order error breakdown analysis considering the imperfections of various models of particle interactions.



Why choose Sioux?

- Working on innovative technology
- Challenging, dynamic and varied work
- A comfortable and personal work environment
- Plenty of opportunities for personal development
- Great career opportunities
- Contributing to a safe, healthy and sustainable society

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Would you like to know more about this student assignment?

Contact:

Thijs Withaar

Aron Beekman

+31 (0)40 751 61 16

werving_mathware@sioux.eu