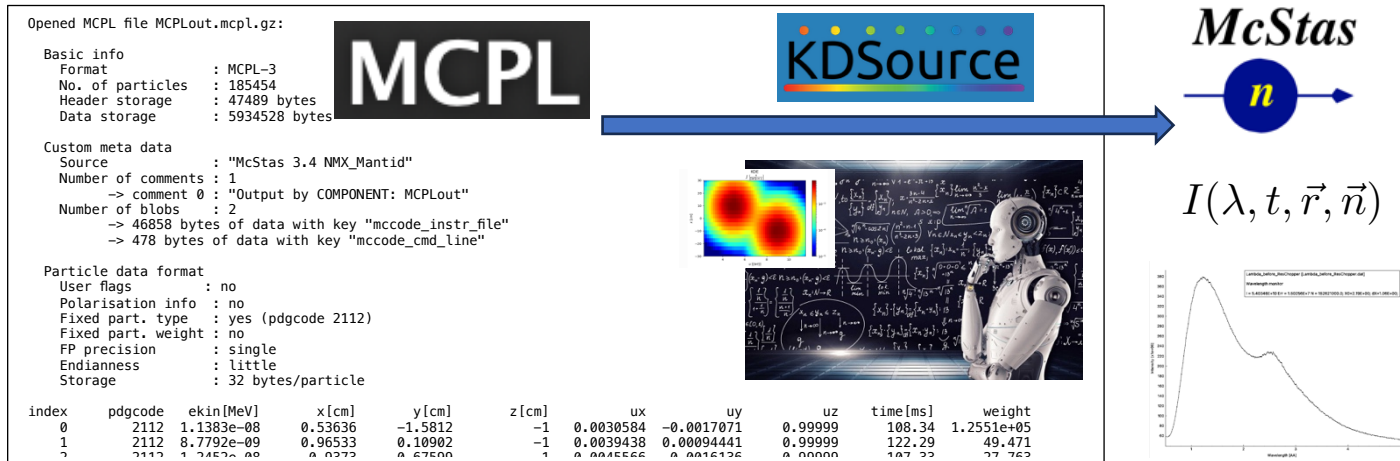# Student project at European Spallation Source Data Management and Software Centre

Use MCPL and KDSource utils and ML / AI to generate "analytical" McStas source models from particle clouds

Supervisor	?	Math / code difficulty	★★★★★
Co supervisor	Peter Willendrup, peter.willendrup@ess.eu	Physics difficulty	★★★★☆

DESCRIPTION

Neutron scattering is an investigative technique that examines matter at the atomic scale, particularly the distances between atoms in crystals. This process involves placing a sample in a neutron beam. By analysing the scattering patterns of these neutrons, researchers can infer the sample's properties. Instruments used in these experiments are highly specialized for various types of samples and scattering methods.

The European Spallation Source, nearing completion in Lund, Sweden, houses 15 such instruments. These instruments have all leveraged Monte-Carlo ray-tracing for their design, a method that predicts performance in terms of neutron intensity on the sample and the resolution of detected signals. McStas is a popular software tool for this purpose and mainly developed in Denmark,

The most sophisticated simulations schemes require us to "find a needle in a haystack" - i.e. very long and demanding simulations where only a small distillate contains the final, wanted information. In other words we need some effective variance reduction. Based on arbitrary particle "clouds" with parameter correlations you will assist us in developing AI/ML tooling to extract and synthesise "analytical expressions" for the particle distributions. These analytical models then serve as heuristical variance- reduction input for further simulations. This project aims to synthesize "analytical" McStas source descriptions from sparse particle data originating from e.g. MCNP, facilitated via the MCPL particle list format and KDSource.

REQUIREMENTS:

Experience with the Python and C programming languages

Knowledge of statistics and information theoretical concepts

Interest and experience in ML/AI techniques

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