Karlsruher Institut für Technologie

Karlsruhe Institute for Technology (KIT)
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Master Thesis

EFFICIENT MEASUREMENTS AT PARTICLE ACCELERATORS USING BAYESIAN EXPERIMENTAL DESIGN

Institute for Beam Physics and Technology (IBPT)

IBPT operates the 110m long electron storage ring KARA and the short-pulse linear accelerator FLUTE on Campus North. The construction and constant improvement of these large-scale research facilities offer a variety of exciting theses for physicists and engineers. Are you interested in particle accelerators, but you do not find a topic that you like at the moment? Just get in touch with us! Due to the many possibilities, we do not advertise every job.

Tasks and main topics

- Read and review current magnet alignment methods
- Implement BAX or develop other methods for magnet alignment
- Test the algorithms in simulation
- Test the algorithms during dedicated beam time at FLUTE

Requirements

- Interest in particle accelerator physics
- Previous knowledge in machine learning methods is advantageous, but not required
- Programming experience in Python
- A good level of written and spoken English

Motivation and Project Description

At particle accelerators, we often face *multi-point query* measurements, where a physical quantity can only be measured indirectly by scanning or varying other parameters, which can often be very time-consuming. Some examples are the beam-based alignment of the magnets or emittance measurements using quadrupole scans. This thesis will tackle the solenoid magnet alignment task at FLUTE. A transverse misalignment will lead to a deflection of the beam passing through the solenoid. This affects the electron injection into the linac or other experiments, where precise beam positioning is required. Previously, an iterative method was developed to observe the beam traces on the diagnostic screen by scanning the solenoid strengths, deriving the misalignment values from the beam trace, and correcting them. Recently, the Bayesian Algorithm Execution (BAX)[a] has been proposed as an efficient method to solve such multi-point query problems[b]. During this thesis you will implement and further develop state-of-the-art algorithms, such as BAX, to solve the magnet alignment task at FLUTE. The developed method will be tested in simulation and in the real accelerator.

[a] https://github.com/willieneis/bayesian-algorithm-execution
[b] https://arxiv.org/abs/2209.04587

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