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Novel Application of Density Estimation Techniques in Muon Ionization Cooling Experiment

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Abstract content

The international Muon Ionization Cooling Experiment (MICE) is a high energy physics experiment located at Rutherford Appleton Laboratory in U.K. The aim of MICE is to demonstrate muon beam cooling for the first time. The process of reducing beam phase-space volume is known as beam cooling and this process is necessary for a beam of muons because of the large phase-space volume that they occupy upon production. Cooled muon beams are essential for future muon-based facilities such as neutrino factory or muon collider. Several beam cooling techniques exist, but the ionization cooling is the only technique fast enough to be used for muons within their short lifetime. In MICE, common figures of merit for beam cooling are the beam emittance and phase-space volume reductions, and phase-space density increase. Given the precision with which MICE aims to demonstrate beam cooling, it is necessary to take any beam effects which may lead to inaccurate cooling measurements into account. Non-linear effects in beam optics are examples of such effects and they can result in beam heating. The Density Estimation (DE) techniques are analysis tools which are insensitive to these non-linear effects and these techniques are used to measure the muon beam phase-space density and volume. This talk will give an overview of the recent MICE results and the novel application of the density estimation techniques, in specific Kernel Density Estimation (KDE) in MICE.

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