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Machine learning for the anomaly detection and characterization of the 24 GeV/c proton beam at CERN IRRAD Facility

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The accurate assessment of beam quality is the most important aspect in the irradiation facilities operation such as IRRAD at CERN. The Beam Profile Monitor (BPM) sensor system developed for the high-intensity proton beam at IRRAD features minimal particle interaction, improved radiation hardness and higher sensitivity and sampling rate than previous systems. It provides a wealth of high-quality BPM data not available earlier, enabling the development of data processing more advanced than before. To take advantage already today of this upgraded BPM system's features, we propose innovative Machine Learning (ML) techniques to adapt and improve upon existing DAQ technology.
This paper details the application study of (1) autoencoder architectures to perform the automatic pattern recognition and anomaly detection of proton beam profiles, and (2) deep learning techniques to predict relevant beam parameters. We applied this approach to a new dataset (made publicly available) of BPM data taken during the recent runs of IRRAD; our preliminary results demonstrate good performance in comparison to existing methods. This work is a first step towards the "intelligent" irradiation facilities.

Footnotes

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Author: SZUMEGA, Jaroslaw (European Organization for Nuclear Research)

Co-authors: BOUGUEROUA, Lamine (Engineering School of Information and Digital Technologies); GKOTSE, Blerina (École Nationale Supérieure des Mines de Paris); JOUVELOT, Pierre (MINES ParisTech); RAVOTTI, Federico (European Organization for Nuclear Research)

Presenter: SZUMEGA, Jaroslaw (European Organization for Nuclear Research)

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