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Low Voltage Power Supply Quality Control with Machine Learning for ATLAS Tile-Calorimeter

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The Large Hadron Collider (LHC) will undergo its high-luminosity upgrade to increase its luminosity, affecting the ATLAS detector and, consequently, its hadronic Tile-Calorimeter (TileCal). As a part of the ATLAS Phase-II Upgrade project to adapt to the new high-luminosity environment, the TileCal is upgrading its low-voltage power supplies that power its on-detector front-end electronics. Over 1000 Bricks (transformer-coupled buck converters) housed within the Low Voltage Power Supplies (LVPS) are being manufactured in South Africa. Quality control is crucial due to the limited access to the Bricks once installed in the TileCal detector. A Brick failure would result in offline front-end electronics, degrading detector performance. This study proposes enhancing the current quality control procedures, test-bench station and burn-in station, by integrating machine learning techniques and anomaly detection models. Brick quality control data collected post-production ensures that they operate within design limits, increasing population reliability once on-detector. Subsequently, a fully connected neural network is trained using supervised learning on the test-bench station dataset to automate the detection of defective Bricks. This approach improves production checkout procedures with high accuracy, ensuring heightened efficiency and precision in identifying defective Bricks before installation within the TileCal at CERN.

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