The use of Machine Learning to improve Quality Control in electronics for CERN.

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The Calorimeter Upgrade of the ATLAS detector

The ATLAS detector at the LHC is undergoing upgrades for the HL-LHC. This upgrade is necessary to handle the higher radiation levels expected during HL-LHC operations. For example, by implementing a robust architecture and advanced front-end electronics, the Tile Calorimeter, will be able to withstand the radiation and effectively handle high digitization rates and large data volumes

Low Voltage Power Supply (LVPS)

The Tile Calorimeter LVPS powers the front-end electronics and provides control and feedback. In the Phase-II upgrade, each super-drawer is powered by a single LVPS module, resulting in 256 LVPS boxes. Each box consists of eight bricks for voltage conversion, grouped into four sets for redundancy.

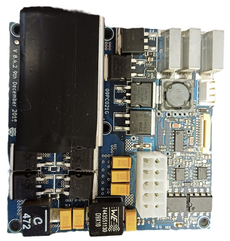

Figure 1. LVPS Top View

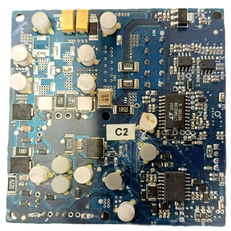

Figure 2. LVPS Bottom view

Test Station

LVPS Bricks undergo tests at the first test station to assess reliability and performance. These tests include 11 binary metrics, recorded as PASS/FAIL. Results are obtained using the program "UTA LVPS RUN WAVESURFER 3024," allowing manual testing and control.

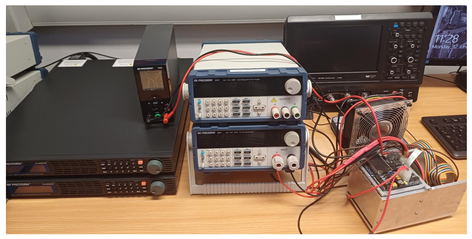

Figure 3. Test Station

We are using **Deep Learning** to improve the **Quality** of **Electronics** for CERN.

Results

We employed four out of the eleven tests for machine learning due to limited data from the test station. These tests include data from the ATLAS Data Control System (DCS) and involve testing the output load, output voltage, temperature 1, and temperature 2 of the LVPS Bricks.

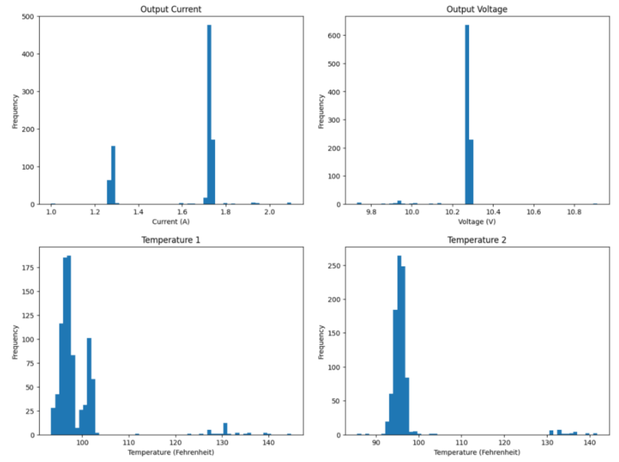

Figure 4. Results of Test Station

Cross-validation was used to avoid data loss during training. Random selection of training set data ensures applicability. The data was divided into 80% for training, 10% for model validation, and 10% for testing, with labels as PASS: 1 and FAIL: 0. Two DNN models were used and the best one is displayed below.

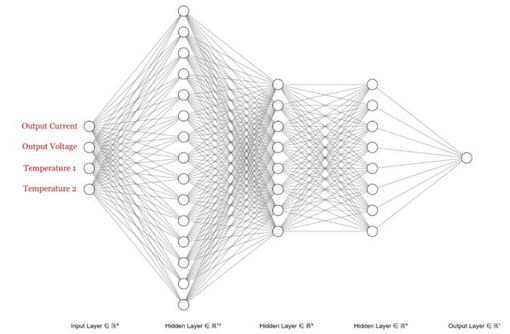

Figure 5. DNN Structure

DNN Performance

Excellent predictions however, enhancements can be made by using all 32 parameters as input for the DNN model. A well-designed program is essential for data acquisition and processing considering the constraints of the test station.

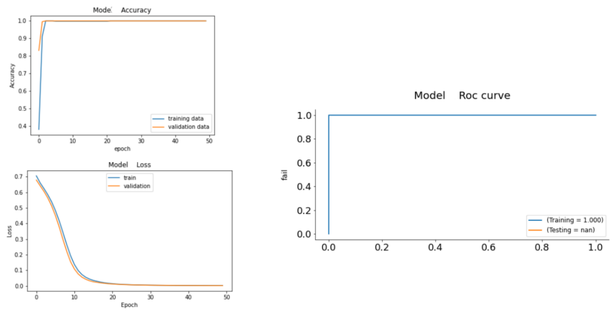

Figure 6. DNN Performance