**Key Figure - DSAI Student Project – “Intelligent AOM” Leo Forster & Jonas Henker**

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**Key figure:** Illustration of the machine learning integration process into an acousto-optic modulation (AOM) experiment. The figure shows how real-time photodetector data is used to train and deploy a machine learning model that dynamically controls the RF signal driving the AOM, creating an intelligent, feedback-based control loop.

**#Insertafuckinpicture**

**Objective of this figure:** The objective of this figure is to demonstrate how a hardware-based optical system can be augmented with machine learning techniques to form an intelligent control loop. Specifically, it highlights the dynamic feedback process where real-time data from the experimental setup is used to iteratively train a machine learning model, which then autonomously adjusts system parameters—such as the RF driving signal—to optimize the behaviour of the AOM. This enables improved precision and adaptability in quantum optics experiments.

**Unit of observation:** Frequency spectrum f’ of AOM for given input frequency f and a non-linear interference v, as well as the differences f - f’ & f’ - f

**Unit of measurement:** Mhz

**Time window of observation:** Continuous real-time monitoring during experiment runtime

**Overall description of this figure:** The figure presents the intelligent control process in stages. It begins with raw photodetector signals captured during AOM operation. These signals are fed into a data preprocessing pipeline, which structures and filters the data. The cleaned data is used to train a machine learning model (e.g., a regression model or reinforcement learning agent). Once trained, the model operates in a closed-loop system, continuously receiving photodetector input and adjusting the RF signal to the AOM through an arbitrary waveform generator (AWG). Over time, the system becomes increasingly precise in stabilizing or tuning the laser output, demonstrating a successful AI–hardware integration in a quantum optics context**.**

**Y-Axis:** Intensity (-1 to 1)

**X-Axis:** Mhz (50-150)

**Legend: #ineedthefuckinpictureforit #pythoninterpreterficktmeinarsch**

**Data processing required: #adddetails(idontknowshit)**

1. Operate the AOM system with varying RF signals and record photodetector outputs.
2. Preprocess and structure collected data (e.g., filtering noise, aligning timestamps).
3. Split data into training and test sets.
4. Train a machine learning model to predict optimal RF input based on PD feedback.
5. Evaluate model performance using validation data.
6. Integrate the trained model into a real-time feedback control loop.
7. Continuously monitor system performance and retrain if necessary for long-term adaptation.