**Mockup expected key figure**  
DSAI Student Project – Quantum Photonics Group (J. Eschner & Team)

**Key figure:** Schematic diagram of an intelligent acousto-optic modulation system. The figure shows the setup used to control and optimize the laser beam’s frequency and intensity using real-time feedback from a photodetector. The system uses an AI-driven controller to regulate the RF input to the AOM based on photodetector readings.

**Objective of this figure:**

The objective of this figure is to illustrate how machine learning techniques can be integrated into a laser optics experiment to create an adaptive, self-correcting system. Specifically, it shows the main components of the setup—laser, AOM, arbitrary waveform generator (AWG), beam splitter (BS), and photodetector (PD)—and how they interact. The AI-based controller adjusts the RF input signal to the AOM in real time, based on optical feedback from the PD, in order to maintain or optimize laser beam properties like frequency or intensity.

**Unit of observation:**

Laser beam after passing through the AOM, measured via optical intensity and frequency shift.

**Unit of measurement:**

Photodetector voltage (proportional to light intensity); RF signal frequency; AOM diffraction efficiency.

**Time window of observation (if applicable):**

Continuous real-time monitoring during experiment runtime (typical range: seconds to minutes per trial).

**Overall description of this figure:**

The figure is a block diagram showing the flow of the experimental system. A laser beam is directed into an acousto-optic modulator (AOM), which is driven by a radio frequency (RF) signal from an arbitrary waveform generator (AWG). A beam splitter (BS) redirects a portion of the modulated beam to a photodetector (PD), which captures changes in intensity. The PD sends these readings to an AI-based control unit, which analyzes the data and adjusts the AWG output accordingly. This closed-loop system allows the AOM to operate intelligently, dynamically optimizing beam parameters through machine learning algorithms.

**Y-Axis (if applicable):**

Not applicable for the schematic diagram; may be applicable in subsequent performance plots showing photodetector voltage or modulation stability.

**X-Axis (if applicable):**

Not applicable for the schematic diagram.

**Legend (if applicable):**

Labeled components include Laser, AOM, AWG, BS, PD, and the AI-based feedback controller. Arrows indicate the direction of signal flow (optical and electrical).

**Data processing required (if applicable):**

1. Set up the laser–AOM–PD experimental chain.
2. Calibrate the AWG to provide initial RF signals.
3. Collect PD voltage readings for different modulation scenarios.
4. Train AI model (e.g., reinforcement learning or regression) on PD response data.
5. Deploy trained model in feedback loop to dynamically adjust RF signal.
6. Monitor and log modulation stability, beam drift, or intensity control.
7. Visualize performance improvements over time or compared to a non-intelligent baseline.