# Murshed SK

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## Education

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| Sept. 2025 – Sept. 2026 | Quantum Information for Physics (M2) at **Sorbonne Université**<br>**Courseworks:** Advanced Quantum Algorithms, Quantum Cryptography, Quantum Information Theory, Photonic Quantum Computing, Quantum Optics, Atomic Physics for Quantum Information, Project with industry and Labs, Quantum Programming (Qiskit), Research Internship |
| Sept. 2024 - July 2025 | Paris Physics Master (M1) at **Université Paris Cité and Sorbonne Université** |
| August 2020 - May 2023 | Bachelor of Science in Physics (Honours) at **Aligarh Muslim University** |

## Work and Research Experience

**Autonomous Stabilization of Gottesman–Kitaev–Preskill Qubits** *(M2 Internship)*
**Organization:** Institut Quantique, Université de Sherbrooke, Canada Mar. - Sep. 2026
**Supervisor:** Benjamin Brock (Assistant Professor)

- Developed open quantum system Python/QuTiP simulation frameworks for finite-energy GKP codes; modeled autonomous Small-Big-Small (sBs) stabilization via Kraus operator channels ($K_{gg}, K_{ge}$) and benchmarked code fidelities using Wigner distributions and parity diagnostics.
- Assisted in dilution refrigerator operations down to 10 mK; performed continuous-wave (CW) microwave spectroscopy on a 3-qubit transmon processor to extract dispersive frequency shifts.
- Programmed real-time FPGA control logic on Quantum Machines OPX+ (via QUA) and QICK RFSoC platforms to execute low-latency feedback routines and Rabi oscillation characterization.

**A Routing Protocol for Continuous-Variable Quantum Position Verification** *(M1 Internship)*
**Organization:** Laboratoire d'Informatique de Grenoble, UGA, France May - Jul. 2025
**Supervisor:** Andreas Bluhm (Research scientist at CNRS, France)

- Designed a continuous-variable routing protocol to conditionally route quantum states and verification data in CV-QPV architectures using Gaussian-modulated coherent states (GMCS).
- Derived analytical information-theoretic security bounds against multi-party intercept-and-resend and replacement attacks, establishing noise and transmission loss thresholds for secure verification.

**Comparing QEC Codes on different types of circuits** *(with UCLA Students)* Oct. 2026 – Present

- Benchmarking the rotated surface code (MWPM) against the $[[144, 12, 12]]$ bivariate bicycle code (BPOSD) across memory, Clifford-dominated, and non-Clifford circuits assuming all-to-all QCCD connectivity.
- Simulating fault-tolerant circuits and magic state preparation pipelines in Stim, utilizing Sinter for high-throughput Monte Carlo syndrome sampling and logical performance analysis.

**QEC with Squeezed Cat States** *(IKAA Summer School, Indian Inst. of Sci. Edu. & Res.)* Aug. 2025

- Investigated squeezed Schrödinger cat states for continuous-variable quantum error correction, analyzing code resilience against simultaneous particle loss and dephasing channels in bosonic systems.
- Evaluated code performance against the Knill–Laflamme conditions and calculated overall quantum channel fidelities under open-system noise models.

**Error Mitigation via Zero-Noise Extrapolation (ZNE)** Jun. - Aug. 2024

- Developed a scalable quantum circuit simulation framework, expanding from a 4-qubit baseline to modular architectures supporting variable qubit counts and multi-step Trotter evolution.
- Implemented polynomial and exponential Zero-Noise Extrapolation (ZNE) models under simulated Pauli Lindblad noise channels to mitigate processor errors.

## Laboratory & Instrumentation Experience

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| **Cryogenics & RF Control** | Dilution refrigerator operation down to 10 mK, Keysight PSG RF signal generators, PyHegel measurement automation, continuous-wave (CW) transmon spectroscopy, and dispersive shift of readout resonator. |
| **FPGA Hardware Logic** | Low-latency feedback loop programming and active reset execution on Quantum Machines OPX+ (QUA language) and AMD Xilinx UltraScale+ RFSoC (QICK architecture). |
| **Quantum Optics Bench** | Free-space optical alignment, single-photon detectors, coincidence counting, Bell inequality tests (EPR paradox realization), and BB84 polarization encoding. |
| **Laser Design & Velocimetry** | Constructed and aligned a 1064 nm diode-pumped Nd:YAG laser system; implemented Doppler velocimetry via Michelson interferometry with RF spectrum analyzer detection. |

## Achievements and Honours

**SMARTS-UP Scholarship** funded by Université Paris Cité 2024

**Womanium Global Quantum Scholarship** 2023, 2024, 2025

**University Topper in National Graduate Physics Exam** conducted by IAPT 2023

## Selected Summer Schools & Hackathons

**AlgoLab Summer School: Towards FTQC** – Institut Quantique, Université de Sherbrooke June 2026

**IQM Quantum (Summer) School** – IQM Academy 2025, 2026

**MIT Quantum Hackathon (iQuHACK)** – Massachusetts Institute of Technology Feb. 2025, 2026

**IKAA Quantum Error Correction Summer School** – Indian Inst. of Sci. Edu. & Res. Aug. 2025

**Qiskit Global Summer School** – IBM July 2023, 2024, 2025, 2026

## Technical & Computational Skills

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| **Quantum Frameworks:** | QuTiP, Stim, Sinter, Qiskit, Pennylane, Cirq, Pytket, QUA (Quantum Machines API). |
| **Software & Programming:** | Python (NumPy, SciPy, OOP), C/C++, MATLAB, Julia, Linux / Unix, Git, Bash, LaTeX. |
| **Multiphysics Simulation** | COMSOL Multiphysics (RF electromagnetic eigenmode, microwave resonance, and cavity simulations) |
| **Instrumentation & Control:** | LabVIEW, COMSOL Multiphysics, PyHegel, FPGA logic (QICK RFSoC, OPX+), and SMD soldering. |
| **Languages:** | English (Fluent), Bengali (Native), Hindi (Fluent), French (Basic / A1). |

## Academic References


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