

I-STEM Software Request - Guide Approval Form

User Details

- **Name of Researcher:** Muhammed Nahiyen Archa Valappil
- **User Type:** Bachelor's
- **Institution Name** : National Institute of Technology Calicut
- **Institutional Contact No:** 04952286104
- **Research Topic:** Trapped Ions for Quantum Cryptography

Software Request Details

- **Software Name:** COMSOL Multiphysics
- **Justification for Software Request:**

My research focuses on the comprehensive 3D modeling, simulation, and design of next-generation quantum devices that integrate trapped ions (using Paul traps), optical fibers, and lasers for qubit manipulation. Achieving the research goals requires a unified simulation environment that can accurately represent the electromagnetic, optical, and quantum-mechanical phenomena involved in such integrated systems.

How COMSOL Multiphysics Supports These Objectives:

1. **Integrated Multiphysics Modeling:**
Quantum devices such as trapped ion systems require precise simulation of the Paul trap's RF and DC fields, optical pathways for laser delivery (including optical fibers), and their interplay with quantum bits (qubits). COMSOL's modular architecture, particularly with the AC/DC, Particle Tracing, Wave Optics, Ray Optics, and RF modules, enables seamless coupling of these diverse physical phenomena within a single 3D environment, something not afforded by separate or purely open-source tools.
2. **Design Optimization and Realistic Device Prototyping:**
The ability to create detailed 3D models, incorporating electrode geometries, photonic components, and laser paths, supports accurate prototyping and virtual validation of quantum device architectures prior to fabrication. This reduces costly trial-and-error in the lab and accelerates development.
3. **Simulation of Real-World Effects:**
Modules such as Heat Transfer and Structural Mechanics further enable the study of thermal and mechanical effects, which are critical for maintaining qubit coherence and overall device reliability. Understanding these coupled effects is essential for robust quantum information processing and hardware development.
4. **Academic Impact and Community Standards:**
COMSOL Multiphysics is the standard simulation platform used worldwide for quantum device R&D, its workflows and results are widely published and recognized in the scientific community, ensuring reproducibility and peer acceptance of simulated results.
5. **Enhanced Learning and Student Training:**
Access to COMSOL not only supports my research objectives but also provides valuable experience with industry standard simulation tools, benefiting both my professional development and training of peers/students involved in collaborative quantum technology projects.

COMSOL Multiphysics, with the requested modules, is essential for my research on integrated quantum devices because it uniquely enables realistic, coupled, and high-fidelity simulations across the electrical, optical, and quantum domains, directly supporting objectives in device analysis, optimization, and development.

Guide/Supervisor Approval

I, Dr. Nikhil Kumar C S,

- Confirm that the above-mentioned researcher is affiliated with our institution
- Have reviewed the software request and its relevance to the researcher's academic work
- Approve the software request for research purposes

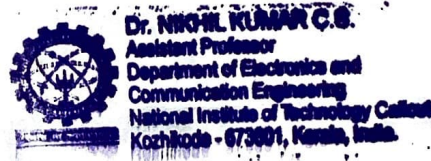
Approval Confirmation

- I approve the software request
- The software aligns with the researcher's research objectives
- The request meets the institutional research guidelines

Guide/Supervisor Signature: *Dr. NIKHIL KUMAR CS* *Nikhil*

Date: *11/08/2025*

Official Stamp/Seal:



Important Notes

1. This form must be signed and scanned
2. The scanned copy must be uploaded with the software request
3. Electronic signatures are acceptable if from an official institutional email