QOMPAS: Center for Quantum Computing and Sensing (Proposal summary)

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Vision & Strategic Context

- **Vision:** Establish Norway as a nationally and internationally leading hub for theoretical advances in quantum state preparation, control, and algorithms for quantum computing and sensing. (focus on state engineering across multiple platforms).
- Interdisciplinary emphasis: condensed-matter / many-body theory, quantum chemistry, quantum algorithms, computational science, ML/AI, and quantum sensing.
- Strategic fit: aligns with national priorities for quantum readiness and leverages existing cloud quantum HW and national HPC.
- Collaboration UiO, USN, OsloMet, Kristiania University College and Simula Research Laboratory

Core Research Objectives (ROs)

1. **RO1 — Many-body physics and entanglement:** develop analytical and numerical tools to characterize multipartite entanglement and its use for state preparation and gates.
2. **RO2 — QML and state engineering:** integrate ML to optimize state preparation, classification and control; study when quantum resources improve learning.
3. **RO3 — Quantum sensing:** design and benchmark protocols and states (squeezed/entangled) that improve metrological precision on realistic platforms.
4. **RO4 — Quantum algorithms and control:** use advanced state preparation to build algorithms and error-correction methods that reduce resource overheads.

Implementation: Work Packages and Methods

Main Work Packages (WPs):

- **WP1:** Entanglement in many-body systems (benchmarks, QMC, CI, CC, time-dependent methods).
- **WP2:** Quantum machine learning libraries, benchmarks, hybrid workflows.
- **WP3:** Hybrid quantum-state engineering, QC error mitigation and RL-driven protocol optimization.
- **WP4:** Quantum sensing metrology — sensitivity benchmarks and protocols.
- **WP5:** Quantum algorithms, simulation and error-correction design for NISQ/near-term devices.

Methods & tools: analytic theory, large-scale numerics (QMC, DFT, CI/CC), ML (classical and QML), prototype circuit design and cloud-accessible quantum simulators/HW.

Impact, Management and Resources

Anticipated Impact

- Scientific: new theoretical limits, state engineering protocols, entanglement benchmarks.
- Technological: improved gate fidelities, sensor designs, transferable software and control toolkits.
- Educational / workforce: train PhD/postdocs (target: 7 PhD + 3 postdocs), courses, workshops, open-source code and datasets. National driver in developing PhD and MSc courses and EVU courses in Quantum Technologies

Management and Budget

- Director and WP leads form Executive Committee; external Advisory Board for strategic guidance. Regular milestone reviews and risk mitigation (six-month internal evals).
- Budget (RCN NOK 61M): personnel-dominated (70%), travel/workshops (20%), HPC and ops (10%). Plan to hire 7 PhD and 3 postdocs.

One-slide summary

QOMPAS in one line: A theory-centered, interdisciplinary center that unites many-body physics, quantum control, ML and algorithms to deliver state-preparation protocols, sensor designs and algorithmic advances with strong educational and open-science outputs.