Management Plan: Determination of Absolute Neutrino Mass Using Quantum Technologies

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1 QTNM Consortium Management Plan

Members of the QTNM (Quantum Technologies for Neutrino Mass) Consortium bring a wealth of experience in managing complex interdisciplinary projects in areas of particle physics, astrophysics, cold matter and electronics. The main executive body of the QTNM project will be the Institutional Board (IB) with one representative from each of the participating institutions plus the Lead PI.

The work will be arranged around 5 work packages described in the Case for Support. The day-to-day execution and coordination of the project will be under the responsibility of the Executive Board (EB) comprised of the Lead PI, Work Package managers and Integration and Operation manager. The list of the project responsibilities is as follows.

Lead PI – Ruben Saakyan. The Lead PI will spend half of their time on the project/consortium management and coordination between individual work packages. The Lead PI is also responsible for liaising with external organisations (such as tritium facilities, other neutrino mass experiments, e.g. KATRIN, Project-8) and with an internal Oversight Committee (see below), as well as with the funding body (UKRI).

WP1: Simulations and Analysis – David Waters

WP2: Atomic Beam Source and Trap – Stephen Hogan

WP3: 3D Magnetic Field Mapping in the Trap – Stephen Hogan

WP4: Cyclotron Radiation Detection – Ling Hao

WP5: Geonium Atom Detector – Jose Verdu-Galiana

Integration and Operation Manager (IOM) – Ryan Nichol. The role of IOM is to ensure a close coordination between WP2 and WP4/5 and to oversee data taking with D-atom ionisation electrons (eV-scale) and ^{83m}Kr source (keV-scale).

To ensure efficient coordination, workflow monitoring and project planning weekly meetings of the EB will be held using videoconferencing facilities with experts on subsystems invited as needed. Updates from each work package will be given and plans for future work agreed. Written reports from from each WP will be submitted on quarterly basis to the IB. The project progress will be monitored against individual tasks and milestones shown in the Gantt chart attached with critical paths and mitigation actions identified. The project will have major review points against critical milestones:

1. Baseline software framework readiness (Month 12)
2. Operational readiness of D-source, Zeeman decelerator, trap and baseline receiver (Month 18).
3. Operational readiness of D-trapping and electron sources (Month 24).
4. Downselection of SLUG/JTWPA and performance of geonium chip (Month 28).
5. Integration readiness of CRESDA (Month 30)
6. CRESDA performance (Month 35)

In order to provide an independent scientific and technical advice to the QTNM Consortium an Oversight Committee (OC) will be set up. The OC will include representatives from the Culham Centre for Fusion Energy, international experts in neutrino mass physics (e.g. from Project-8 and KATRIN collaborations) and will have an independent Chair. The OC will meet quarterly and will receive WP written reports mentioned above. The terms of reference for the OC will be defined and agreed with the STFC office but the focus is expected to be on the assessment of the project status against the review points listed above.

2 Work Package Milestones

The milestone numbering scheme is the same as in the Gantt chart to help their identification.

WP1. Simulations and Analysis

Milestone	Description	Date
M1.1	A preliminary version of the particle-trajectory beamline simulation is complete and is used to optimise the design of a new Zeeman decelerator.	Month 6
M1.2	A preliminary cyclotron radiation emission and detection model is complete.	Month 24
M1.3	Beamline simulation is validated using initial deuterium data taken with the new Zeeman deceleration line.	Month 24
M1.4	An initial trap simulation is complete.	Month 30
M1.5	A full CRES simulation and analysis chain exists, and a preliminary sensitivity projection is complete.	Month 36

WP2. Atomic Beam Source and Trap

M2.1	D atom beam construction	Month 9
M2.2	Multistage Zeeman decelerator construction	Month 15
M2.3	Characterisation and optimisation of Zeeman decelerator operation	Month 18
M2.4	Magnetic trap construction.	Month 16
M2.5	Trapping cold D atoms in superconducting magnetic trap.	Month 24
M2.6	Test CRES detection in magnetic trap by photoelectron production in D atom ionisation, and ^{83m}Kr decay	Month 26
M2.7	Optimisation of trap loading scheme and demonstration of trapping high density samples of D atoms.	Month 36

WP3. 3D B-field mapping in the trap

M3.1	D atom spectroscopy and circular state preparation	Month 12
M3.2	Microwave spectroscopy of circular-to-circular state transitions	Month 18
M3.3	Controlling the motion of D-atoms in circular Rydberg states with static inhomogeneous magnetic fields	Month 24
M3.4	1D magnetic field mapping	Month 30
M3.5	3D magnetic field mapping	Month 36

WP4. Cyclotron Radiation Detection

M4.1	Baseline receiver delivery	Month 18
M4.2	SLUG and JTWPA delivery and downselection	Month 28
M4.3	Amplifier integrated with trap	Month 30
M4.4	CRES detection results	Month 36

WP5. Geonium Atom Detector

M5.1	Fabrication of optimised chip and planar magnetic field source for CRES.	Month 12
M5.2	Integration with trap.	Month 16
M5.3	Detection of MW signals at UCL.	Month 22
M5.4	First detection of β particles.	Month 34