HORIZON EUROPE

Research and Innovation Action (RIA)

Quantum-Enhanced Magnetometry for Early Neurological Diagnosis

QSENSE-MED

Field	Value
Call Identifier	HORIZON-CL4-2026-DIGITAL-EMERGING-01
Type of Action	RIA
Duration	42 months
TRL Range	TRL 3 to TRL 6
Total Budget	EUR 4,000,000
EU Contribution	EUR 4,000,000

Abstract

QSENSE-MED will develop chip-scale diamond nitrogen-vacancy (NV) quantum magnetometer arrays operating at room temperature with femtotesla-level sensitivity, and integrate them into a portable magnetoencephalography (pMEG) platform for early neurological diagnosis. The current gold standard, SQUID-based MEG, requires liquid-helium cryogenics and EUR 2 million or more in capital infrastructure, limiting access to fewer than 50 specialist centres worldwide. QSENSE-MED eliminates this barrier by combining NV ensemble spin physics, on-chip silicon nitride photonic integration, and adaptive signal processing to deliver a 64-channel pMEG system at approximately one-tenth the cost of SQUID-MEG - a step change beyond the current state of the art. The project advances from TRL 3 to TRL 6 over 42 months through a rigorously milestone-gated work plan encompassing sensor optimisation, photonic chip fabrication, prototype assembly, and a first-in-human clinical validation study in epilepsy patients at Charité Berlin. The consortium - Quantum Sensing Institute (FR, coordinator), TU Delft (NL), Charité Berlin (DE), and NanoFab SME (BE) - uniquely combines quantum physics, photonic engineering, clinical neuroscience, and medical-grade manufacturing expertise. All clinical data will be managed in compliance with FAIR principles and released as open-access datasets; key software outputs will be released under open-source licences. QSENSE-MED will establish European leadership in solid-state quantum medical devices, enable earlier epilepsy and stroke diagnosis for millions of patients across Europe, and create a commercially scalable product platform addressing a serviceable market exceeding EUR 1.2 billion within a decade of commercialisation.

Keywords: quantum magnetometry, nitrogen-vacancy centres, diamond sensors, magnetoencephalography, portable brain imaging, epilepsy diagnosis, photonic integration, quantum sensing, neurological disorders, femtotesla sensitivity

SECTION 1 - EXCELLENCE

1.1 Objectives and Ambition

Neurological disorders - including epilepsy, ischaemic stroke, and traumatic brain injury - represent the leading cause of disability-adjusted life years in Europe, generating an estimated annual societal cost exceeding EUR 800 billion. The current gold standard for functional neuroimaging, superconducting quantum interference device (SQUID)-based magnetoencephalography (MEG), requires liquid-helium cryogenics, dedicated magnetically shielded rooms, and capital expenditure above EUR 2 million per installation. This combination of cost, infrastructure demand, and operational complexity confines high-resolution brain magnetometry to fewer than 50 specialised centres worldwide, rendering early and point-of-care neurological assessment inaccessible to the vast majority of patients. QSENSE-MED addresses this critical gap by developing chip-scale diamond nitrogen-vacancy (NV) centre quantum magnetometer arrays capable of femtotesla-level sensitivity at room temperature, and integrating them into a portable, cryogen-free magnetoencephalography (pMEG) platform validated in a clinical setting.

The project pursues five specific, measurable, achievable, relevant, and time-bound objectives: (O1) Demonstrate ensemble NV-centre magnetometers with magnetic field sensitivity below 10 fT/Hz^0.5 at room temperature in a single-channel configuration by month 18; (O2) Fabricate and characterise chip-scale NV sensor arrays incorporating on-chip photonic integration - waveguides, beam-splitters, and photodetectors - achieving a minimum of 64 sensor channels on a single diamond substrate by month 30; (O3) Assemble and validate a portable pMEG helmet prototype operating within a lightweight two-layer mu-metal shielded enclosure (unit cost below EUR 50,000), and demonstrate neural field recordings equivalent in spatial resolution to 50-channel SQUID-MEG by month 36; (O4) Complete a first-in-human clinical validation study at Charité Berlin involving a minimum of 30 subjects (15 epilepsy patients and 15 healthy controls), demonstrating clinically relevant sensitivity for interictal epileptiform discharge detection by month 42; (O5) Deliver a scalable manufacturing route for NV sensor chips with NanoFab SME, achieving a per-channel fabrication yield above 85% and a cost per channel below EUR 500, establishing TRL 6 by project end.

The ambition of QSENSE-MED is scientifically transformative. While recent literature has demonstrated NV-based DC magnetometry approaching 1 pT/Hz^0.5 in laboratory conditions (TRL 2–3), no prior work has achieved the combination of femtotesla AC sensitivity, photonic integration, multi-channel chip-scale array format, and clinical validation required for practical brain imaging. QSENSE-MED will advance the state of the art across all four dimensions simultaneously - a step change beyond the current frontier - targeting a technology readiness progression from TRL 3 to TRL 6, and establishing Europe as the global leader in solid-state quantum brain sensing.

1.2 Relation to the Work Programme

QSENSE-MED directly addresses the objectives of HORIZON-CL4-2026-DIGITAL-EMERGING-01, which calls for breakthrough quantum sensing technologies with clear application pathways in health and industrial sectors, and for advancing European competitiveness in emerging deep-tech domains. The call specifically targets quantum technologies at intermediate TRL that are ready for scale-up demonstration and encourages the integration of quantum hardware with photonics - both of which are central to QSENSE-MED's technical approach.

The project aligns with Cluster 4 priorities by combining quantum physics, advanced manufacturing, and photonic integration into a coherent innovation pathway. It supports the EU Quantum Flagship strategic research agenda, particularly the Quantum Sensing roadmap objective of demonstrating quantum-enhanced sensing in real-world application contexts by 2027. The health application - portable brain magnetometry for epilepsy and stroke - connects directly to the goals of the

European Health Data Space and Europe's Beating Cancer Plan to reduce diagnostic delay and improve neurological disease outcomes. QSENSE-MED further contributes to the European Strategic Technology Platform objectives on medical devices and digital health by offering a disruptive, accessible alternative to incumbent SQUID-MEG infrastructure.

The consortium composition - combining a French quantum research and technology organisation, a leading Dutch quantum hardware group, a German university hospital, and a Belgian deep-tech SME - reflects the cross-border, multi-actor model required by the call and maximises the probability of a credible, proximate exploitation pathway within the project timeline.

1.3 Concept and Methodology

The conceptual foundation of QSENSE-MED rests on the unique magnetic sensing properties of the nitrogen-vacancy (NV) defect centre in diamond. The NV centre is a spin-1 system whose ground-state magnetic sublevels are split by the Zeeman effect in the presence of an external magnetic field. Optically detected magnetic resonance (ODMR) enables readout of this spin state via red fluorescence under green laser excitation, yielding a magnetic field sensor that operates at room temperature with no cryogenic overhead. For brain magnetometry, the relevant signal bandwidth is 1–1000 Hz with field amplitudes in the femtotesla range (10–100 fT); achieving this sensitivity with NV ensembles requires the simultaneous optimisation of spin coherence time (T2*), microwave driving efficiency, and optical collection efficiency.

QSENSE-MED's methodology is structured around three interconnected technical pillars. Pillar 1 - Diamond Material and NV Engineering, led by Quantum Sensing Institute - will create high-density NV ensembles in ultra-pure CVD diamond substrates using controlled nitrogen implantation and annealing protocols. The project will systematically explore the trade-off between NV density (targeting 1–10 ppm) and spin dephasing, employing dynamical decoupling pulse sequences (XY-8, CPMG) to extend T2* beyond 100 µs. This constitutes a direct advance beyond the state of the art, where published ensemble NV sensors have achieved T2* values limited to 10–30 µs under comparable doping conditions. Pillar 2 - Chip-Scale Photonic Integration, led by TU Delft - will replace bulk optics with on-chip photonic circuits fabricated in silicon nitride (SiN), delivering green excitation light to the NV layer via evanescent coupling and collecting red fluorescence via integrated waveguides and on-chip single-photon avalanche diode (SPAD) arrays. This monolithic integration approach is a world-first for NV magnetometry and is the key technological enabler for multi-channel, chip-scale, low-cost sensor arrays. Pillar 3 - System Integration and Clinical Translation, led jointly by Charité Berlin and NanoFab - will tile individual sensor chips into a 64-channel helmet geometry. Signal processing will employ a beamforming algorithm adapted from conventional MEG, combined with adaptive noise cancellation exploiting dedicated reference sensors for ambient field rejection. Clinical protocols for epilepsy and stroke assessment will be co-designed with Charité's neurology and epileptology departments from the outset, ensuring that technical specifications remain grounded in genuine clinical utility.

The project adopts an iterative, milestone-gated development methodology. Each 12-month cycle culminates in a go/no-go decision point at which sensitivity and yield metrics are assessed against pre-defined quantitative thresholds. This approach, combined with risk mitigation reserves built into the work plan, ensures robustness against the inherent uncertainty of deep-tech development. Open Science principles are embedded throughout: all datasets from the clinical validation study will be deposited in a FAIR-compliant repository, and key software outputs - including the signal processing and sensor modelling tools - will be released under open-source licences (Apache 2.0). Gender and sex considerations are integrated into all experimental and clinical design decisions, including stratified recruitment in the clinical study and reporting of sex-disaggregated analysis where relevant.

1.4 Interdisciplinary Considerations

QSENSE-MED is intrinsically and constitutively interdisciplinary, requiring sustained integration across quantum physics, photonic engineering, materials science, neuroscience, and clinical medicine. This interdisciplinarity is not incidental to the project design but is its enabling condition: the core hypothesis - that chip-scale quantum sensors can replace cryogenic infrastructure in brain imaging - can only be tested and validated through the simultaneous, integrated expertise of physicists, engineers, clinicians, and manufacturers working as a unified team rather than as sequential contributors.

To govern this integration, the consortium establishes a cross-cutting Scientific Integration Board (SIB), co-chaired by Quantum Sensing Institute and Charité Berlin, which convenes monthly and is responsible for ensuring that technical specifications at each pillar level remain aligned with clinical requirements and manufacturing constraints. Disciplinary translation - converting neuroscientific signal requirements into quantum sensor engineering targets, and manufacturing yield data into clinical feasibility projections - is an explicit function of the SIB.

Gender and diversity considerations are systematically integrated at two levels. In clinical trial design, stratified recruitment ensures balanced sex and age representation across both the epilepsy patient and healthy control cohorts, and all primary analyses will be reported with sex-disaggregated data. In consortium team composition, a target of at least 40% female researchers across all partner institutions is set, supported by transparent monitoring through the annual progress review process.

Perspectives from the social sciences and humanities inform the ethical framework governing first-in-human testing and the patient engagement protocol co-developed with Charité's patient advisory panel. This engagement ensures that the technology's design and deployment pathway is sensitive to patient experience, informed consent quality, and equitable access considerations - factors that are increasingly recognised as determinants of clinical adoption for novel diagnostic technologies.

SECTION 2 - IMPACT

2.1 Pathways Towards Impact

QSENSE-MED's primary pathway to impact runs from scientific breakthrough through technology demonstration to market-ready prototype and, ultimately, to widespread clinical adoption. At project completion (TRL 6), the pMEG prototype validated in a clinical pilot study will constitute the most advanced room-temperature portable brain magnetometry system globally. This positions the consortium for immediate follow-on funding - via EIC Transition or EIC Accelerator - to carry the technology to TRL 8–9 and CE marking under the EU Medical Device Regulation. NanoFab SME is the designated exploitation lead and enters the project with an existing ISO 13485-certified cleanroom infrastructure, providing a credible and proximate route to commercial manufacturing without requiring further capital investment at the prototype stage.

The societal impact pathway targets the estimated 50 million people living with epilepsy in Europe, of whom approximately 30% remain undiagnosed or misdiagnosed for more than five years, in large part due to lack of access to MEG. Portable, low-cost pMEG deployed at district hospitals and outpatient neurology clinics would substantially collapse this diagnostic delay, enabling earlier pharmacological or surgical intervention and improving long-term outcomes. For ischaemic stroke, pMEG offers a rapid, non-invasive modality to assess functional cortical reorganisation within the acute phase, directly informing and personalising rehabilitation planning. The European Brain Council estimates that improved early neurological diagnosis could reduce the total economic burden of neurological disease in the EU by 15–20% over a decade - a return that exceeds the total investment in QSENSE-MED by three orders of magnitude.

At the level of European industrial competitiveness, QSENSE-MED creates a new product category - solid-state quantum medical devices - in which European actors currently hold a first-mover advantage. The global MEG market is valued at approximately USD 600 million and is projected to grow at 8% CAGR over the next decade. By offering a system at approximately one-tenth the cost of conventional SQUID-MEG, the consortium estimates a serviceable addressable market of EUR 1.2 billion within ten years of commercialisation, encompassing both new clinical installations and scheduled replacement of ageing SQUID-MEG systems. This represents a strategically significant export opportunity and directly supports the EU's strategic autonomy objectives across quantum technology value chains.

Beyond the primary commercial pathway, the open-source release of the pMEG signal processing software suite (KER3) creates an ecosystem of secondary exploitation opportunities for academic and clinical research groups, amplifying the project's scientific impact and accelerating broader adoption of quantum sensing methods in neuroscience.

2.2 Dissemination, Exploitation and Communication

Dissemination strategy: QSENSE-MED will pursue a dual-track dissemination approach targeting both the scientific community and clinical and industrial stakeholders. A minimum of 15 peer-reviewed publications are planned over 42 months, with priority given to high-impact journals in quantum technology (npj Quantum Information, Physical Review Applied) and medical imaging (NeuroImage, Brain). All publications will be made available via immediate open access in compliance with the Horizon Europe mandate, using the Open Research Europe platform where appropriate. A minimum of 20 conference presentations are planned, including contributions to IEEE Quantum Week, the European Conference on Biomagnetism (BIOMAG), and the European Congress of Epileptology - venues chosen to maximise reach to both the quantum hardware and the clinical neuroscience communities.

Exploitation strategy: The consortium's Key Exploitable Results (KERs) are: (KER1) the NV ensemble magnetometer chip design and fabrication process (owned by Quantum Sensing Institute, with a licensing option to NanoFab); (KER2) the on-chip photonic integration architecture (co-owned by Quantum Sensing Institute and TU Delft; patent application to be filed by month 24); (KER3) the pMEG signal processing and source localisation software suite (released open-source under Apache 2.0 with a dual-licensing option for commercial derivative works); and (KER4) the clinical validation dataset and study protocol (owned by Charité Berlin and deposited in a FAIR-compliant open-access repository). An Intellectual Property Management Agreement (IPMA) will be signed at project month 3, prior to the commencement of any joint development activity, to ensure clear foreground/background IP delineation from the outset. NanoFab will pursue a commercial manufacturing licence for the NV sensor chip, targeting first commercial product release within 24 months of project completion.

Communication plan: Public-facing communication will be managed by a dedicated communication officer hosted at Quantum Sensing Institute. Activities include: a project website live by month 3; bi-annual press releases timed to coincide with major milestones; a LinkedIn presence targeting medical device and quantum technology industry stakeholders; and annual public engagement events at science festivals in France, Germany, and Belgium. A three-minute explainer video for patient and general-public audiences will be produced by month 18. A policy brief addressed to EU health and quantum technology directorates will be delivered by month 36, drawing on the clinical validation evidence base to make a concrete case for investment in quantum-enabled diagnostic infrastructure.

2.3 Summary of Impact Indicators

Indicator	Target	Measurement
NV magnetometer sensitivity (single channel)	Below 10 fT/Hz^0.5 at room temperature by M18	Allan deviation measurement in magnetically shielded environment; independent verification by TU Delft
Number of integrated photonic channels on single chip	Minimum 64 channels by M30	Optical characterisation and ODMR mapping of fabricated chip arrays
pMEG clinical sensitivity for epileptiform discharge detection	Non-inferior to 50-channel SQUID-MEG in 30-subject pilot study by M42	Blinded expert scoring; ROC analysis; Cohen's kappa inter-rater agreement
Sensor chip fabrication yield	Above 85% per-channel yield at NanoFab by M40	Automated optical and electrical wafer-level testing
Peer-reviewed publications	Minimum 15 publications in indexed journals by M42	Web of Science / Scopus citation tracking
Patent applications filed	Minimum 2 patent applications by M36	EPO filing records
Follow-on funding secured	At least one EIC Transition or national follow-on application submitted by M42	Submission confirmation from funding body

SECTION 3 - IMPLEMENTATION

3.1 Work Plan and Work Packages

WP	Title	Lead	PM	Duration
WP1	Diamond NV Sensor Development and Optimisation	Quantum Sensing Institute	42	M1-M30
WP2	Chip-Scale Photonic Integration	TU Delft	52	M6-M36
WP3	pMEG System Integration and Prototype Assembly	Quantum Sensing Institute	38	M18-M38
WP4	Clinical Validation	Charité Berlin	30	M30-M42
WP5	Exploitation, Dissemination, and Communication	NanoFab SME	18	M1-M42
WP6	Project Management	Quantum Sensing Institute	16	M1-M42

WP1: Diamond NV Sensor Development and Optimisation

Lead: Quantum Sensing Institute | Person-months: 42 | Duration: M1 - M30

WP1 covers the full development cycle of high-sensitivity NV ensemble magnetometers, from CVD diamond substrate selection and nitrogen implantation through to ODMR characterisation and sensitivity benchmarking. The WP systematically optimises NV density, spin coherence time (T2*), and microwave excitation parameters to achieve the target single-channel sensitivity of below 10 fT/Hz^0.5 at room temperature - a direct and quantified advance beyond the current state of the art of approximately 1 pT/Hz^0.5 reported in the literature for ensemble NV sensors at comparable TRL. TU Delft contributes expertise in spin physics and advanced dynamical decoupling pulse sequence design throughout the WP. All characterisation data will be recorded in open electronic laboratory notebooks and released in a FAIR-compliant repository at WP conclusion, in line with the project's Open Science commitments.

T1.1: Diamond substrate selection and NV implantation - Procure and characterise ultra-pure CVD diamond substrates from a minimum of three suppliers; implement controlled nitrogen ion implantation at varying doses and anneal profiles to create NV ensembles at target densities of 1–10 ppm. Substrate and implantation parameters will be systematically varied using a design-of-experiments approach to identify the optimal trade-off between NV density and spin dephasing rate.

T1.2: ODMR sensitivity characterisation - Construct a reference ODMR measurement bench compliant with traceable calibration standards; systematically measure T2*, spin contrast, and magnetic sensitivity as a function of NV density and microwave parameters. The primary milestone target - single-channel sensitivity below 10 fT/Hz^0.5 - will be verified by independent measurement at TU Delft by month 18 to ensure objectivity of the go/no-go assessment.

T1.3: Dynamical decoupling and signal bandwidth optimisation - Implement and benchmark XY-8 and CPMG pulse sequences to extend T2* beyond 100 µs and optimise magnetic sensitivity within the 1–1000 Hz neurologically relevant bandwidth. The relative performance of each pulse sequence will be characterised under realistic ambient noise conditions representative of the target clinical environment.

WP2: Chip-Scale Photonic Integration

Lead: TU Delft | Person-months: 52 | Duration: M6 - M36

WP2 develops the on-chip photonic architecture that enables chip-scale, multi-channel NV magnetometry without bulk optics - the central hardware innovation of QSENSE-MED and a world-first for NV-based sensing. Silicon nitride (SiN) waveguides deliver excitation light to the NV layer via evanescent coupling and collect fluorescence; on-chip SPAD arrays provide integrated photodetection. The WP progresses through a staged fabrication programme - from single-waveguide proof of concept, through 16-channel prototype, to the full 64-channel integrated photonic-NV chip - with each stage subject to a formal yield and sensitivity review. NanoFab contributes ISO 13485-certified cleanroom fabrication capacity throughout, ensuring that process

development is conducted under conditions compatible with eventual medical-grade manufacturing.
T2.1: SiN waveguide design and fabrication - Design and fabricate SiN waveguide circuits for evanescent-field excitation of the NV centre layer; optimise coupling efficiency and minimise optical propagation loss in collaboration with NanoFab. Two alternative waveguide geometries - evanescent coupling and butt-coupling - will be prototyped in parallel from month 6 to mitigate the risk of insufficient coupling efficiency in either configuration.
T2.2: On-chip SPAD array integration - Integrate SPAD photodetector arrays and beam-routing elements monolithically on-chip; characterise the noise floor, dark count rate, and photon-collection efficiency per channel. Results will feed directly into the sensitivity model maintained in WP1 to enable end-to-end system SNR prediction.
T2.3: 64-channel chip assembly and validation - Assemble the full 64-channel photonic-NV chip using the optimised processes from T2.1 and T2.2; perform ODMR sensitivity mapping across all channels; validate sensitivity uniformity and confirm per-channel yield above 85% using automated wafer-level testing at NanoFab. This task constitutes the primary gate for WP3 system integration.

WP3: pMEG System Integration and Prototype Assembly

Lead: Quantum Sensing Institute | Person-months: 38 | Duration: M18 - M38

WP3 integrates individual NV sensor chips into a wearable 64-channel pMEG helmet geometry, combined with a lightweight two-layer mu-metal shielded enclosure targeted at a total unit cost below EUR 50,000. The WP develops the complete signal processing pipeline - encompassing beamforming, independent component analysis, and adaptive noise cancellation - and benchmarks system performance against the reference SQUID-MEG scanner at Charité Berlin using both phantom measurements and healthy volunteer recordings. The signal processing software will be released as open-source (Apache 2.0) by month 36, in line with the project's Open Science commitments. WP3 interfaces closely with WP2 (sensor chip supply) and WP4 (clinical readiness requirements), with Charité Berlin contributing clinical signal quality specifications from the outset.
T3.1: Helmet geometry design and mechanical integration - Design an ergonomic 64-channel sensor helmet suitable for clinical use; integrate sensor chips with microwave delivery, optical fibre bundles, and electrical readout cabling; validate mechanical stability, subject comfort, and electromagnetic compatibility in a pre-clinical test environment.
T3.2: Signal processing pipeline development - Develop, validate, and document beamforming, independent component analysis, and adaptive noise-cancellation algorithms tailored to NV sensor noise characteristics and the target signal bandwidth. The full software suite will be packaged and released under an open-source licence (Apache 2.0) with dual-licensing provisions for commercial derivative applications.
T3.3: System benchmarking against SQUID-MEG - Conduct paired phantom and healthy volunteer MEG measurements using the pMEG prototype and the Charité SQUID-MEG reference system simultaneously; quantify and compare spatial resolution, sensitivity, signal-to-noise ratio, and artefact levels. Results from this benchmarking will constitute the primary technical evidence base for the TRL 6 claim and will inform any final design adjustments prior to the clinical study in WP4.

WP4: Clinical Validation

Lead: Charité Berlin | Person-months: 30 | Duration: M30 - M42

WP4 conducts the first-in-human clinical validation of the pMEG prototype in a 30-subject pilot study at Charité - Universitätsmedizin Berlin, encompassing 15 epilepsy patients and 15 healthy controls. The study is conducted under prospective Ethics Committee approval and in full compliance with ICH GCP guidelines and the EU Clinical Trials Regulation. Recruitment is stratified by sex and age to ensure representative coverage and to enable sex-disaggregated analysis in line with Horizon Europe gender integration requirements. The WP generates the primary clinical evidence dataset underpinning the TRL 6 claim and provides the evidentiary foundation for subsequent regulatory and commercial development steps.
T4.1: Ethics approval and clinical protocol design - Submit the full study protocol for Ethics Committee approval; finalise patient recruitment strategy, inclusion and exclusion criteria, and the measurement protocol in co-design with Charité's epileptology team and patient advisory panel. The protocol will include sex-stratified recruitment targets and a pre-registered analysis plan deposited in a public registry prior to first patient enrolment.
T4.2: Patient recruitment and data acquisition - Recruit and measure 30 subjects (15 epilepsy patients, 15 healthy controls) according to the approved protocol; acquire simultaneous pMEG and reference SQUID-MEG recordings for each participant to enable blinded comparative analysis. A pre-identified backup recruitment site, confirmed under a letter of support, will be activated if enrolment lags more than 20% behind schedule at month 34.
T4.3: Clinical data analysis and validation report - Perform ROC analysis, blinded expert scoring, and statistical comparison of pMEG versus SQUID-MEG for interictal epileptiform discharge detection; report Cohen's kappa inter-

rater agreement and all pre-registered endpoints. The clinical validation dataset will be deposited in a FAIR-compliant open-access repository, and the final validation report will be made publicly available as a project deliverable.

WP5: Exploitation, Dissemination, and Communication

Lead: NanoFab SME | Person-months: 18 | Duration: M1 - M42

WP5 manages all exploitation, intellectual property, dissemination, and public communication activities across the full project lifetime. NanoFab leads exploitation planning and commercial pathway definition, drawing on its established position as a medical-grade sensor manufacturer. Scientific dissemination is coordinated by Quantum Sensing Institute, which hosts the dedicated communication officer. Patient and public communication is coordinated by Charité Berlin, leveraging its patient advisory panel and established health communication infrastructure. WP5 interfaces with all technical WPs to ensure that exploitable results are identified early, IP protection measures are timely, and scientific outputs are disseminated in alignment with project milestones.

T5.1: IP management and exploitation planning - Establish the Intellectual Property Management Agreement (IPMA) by month 3, prior to any joint development activity; conduct quarterly KER reviews to track the maturation of exploitable results; prepare patent applications for the NV chip design (target: month 24) and the photonic integration architecture (target: month 30) in coordination with Quantum Sensing Institute and TU Delft.

T5.2: Scientific dissemination and open science - Coordinate the publication strategy targeting a minimum of 15 open-access peer-reviewed publications and 20 conference presentations; manage deposition of datasets and software in FAIR-compliant repositories; maintain the project website and social media channels with regular milestone-linked updates throughout the project.

T5.3: Stakeholder engagement and policy communication - Organise two multi-stakeholder workshops (month 18 and month 36) bringing together clinical, industrial, and policy audiences to gather feedback and build the adoption ecosystem; produce a policy brief targeted at EU health and quantum technology directorates by month 36; deliver a three-minute explainer video for patient and general-public audiences by month 18.

WP6: Project Management

Lead: Quantum Sensing Institute | Person-months: 16 | Duration: M1 - M42

WP6 ensures efficient project governance, financial oversight, and proactive risk management across the full 42-month project lifetime. It establishes and operates the Scientific Integration Board (SIB), the General Assembly, and the Executive Board; manages all reporting obligations to the European Commission; and coordinates quality assurance, data management, and ethics compliance across all WPs. The SIB, co-chaired by Quantum Sensing Institute and Charité Berlin, meets monthly and serves as the primary mechanism for maintaining alignment between technical development, clinical requirements, and manufacturing constraints - the central interdisciplinary integration challenge of QSENSE-MED.

T6.1: Governance and coordination - Establish and operate consortium governance structures, including the SIB, General Assembly, and Executive Board; organise quarterly progress meetings, annual internal reviews, and the project kick-off meeting; maintain a living risk register and escalate issues to the Executive Board as required.

T6.2: Financial management and reporting - Oversee financial reporting, budget monitoring against the approved cost categories, and preparation of all periodic and final reports to the European Commission in full compliance with the grant agreement obligations and Horizon Europe audit requirements.

3.2 Consortium Composition

Organisation	Country	Type	Role	Description
Quantum Sensing Institute	France	Research and Technology Organisation (RTO)	Coordinator	Project coordinator; leads WP1 (NV sensor development) and WP3 (system integration); responsible for overall scientific direction and IP strategy.
TU Delft	Netherlands	University	Partner	Leads WP2 (photonic integration); provides world-class expertise in quantum

				photonics and NV spin physics; co-inventor on photonic integration patent.
Charité - Universitätsmedizin Berlin	Germany	University Hospital / Clinical Research Organisation	Partner	Leads WP4 (clinical validation); provides clinical infrastructure, SQUID-MEG reference system, Ethics Committee access, and patient cohorts for epilepsy validation.
NanoFab SME	Belgium	SME	Partner	Leads WP5 (exploitation); contributes ISO 13485 cleanroom fabrication capacity to WP2; develops manufacturing scale-up route; primary commercial exploitation partner.

The QSENSE-MED consortium uniquely combines the four competences that are each necessary and jointly sufficient for the project's success: (1) quantum sensing physics and NV centre engineering, provided by Quantum Sensing Institute; (2) integrated photonics design and chip-scale fabrication, provided by TU Delft; (3) clinical neurology, MEG infrastructure, and human subjects research, provided by Charité Berlin; and (4) medical-grade manufacturing and commercial scale-up, provided by NanoFab SME. No single partner possesses all four competences, and the absence of any one partner would render the project technically or clinically infeasible. Their combination is therefore the direct and non-substitutable source of the consortium's competitive advantage.

The geographical spread across France, the Netherlands, Germany, and Belgium reflects genuine scientific and operational complementarity rather than administrative convenience. Each partner brings capabilities developed through independent national and European research programmes, ensuring that the collaboration creates genuine added value beyond what any national consortium could achieve. This spread also ensures that exploitation routes are embedded in multiple national quantum and medtech ecosystems, substantially broadening the commercial and societal reach of the project's outputs and supporting the Horizon Europe objective of strengthening the European Research Area.

3.3 Milestones

ID	Title	WP	Due	Verification
MS1	NV sensitivity below 50 fT/Hz^0.5 demonstrated (single channel)	WP1	M12	ODMR sensitivity measurement protocol; verified by independent measurement at TU Delft
MS2	Sub-10 fT/Hz^0.5 sensitivity confirmed and go/no-go for photonic integration	WP1	M18	Allan deviation report; project Scientific Integration Board approval
MS3	16-channel photonic-NV chip fabricated and characterised	WP2	M24	Channel-by-channel ODMR map; yield and sensitivity uniformity report

MS4	64-channel photonic-NV chip validated; go/no-go for helmet integration	WP2	M30	Full-chip characterisation report; yield above 85% confirmed by NanoFab
MS5	pMEG prototype assembled and benchmarked against SQUID-MEG (phantom)	WP3	M36	Comparative phantom measurement report; spatial resolution and sensitivity metrics
MS6	Ethics approval obtained and first patient enrolled	WP4	M32	Ethics Committee approval letter; first patient consent form
MS7	Clinical validation study completed (30 subjects)	WP4	M42	Clinical validation report; statistical analysis; blinded expert scoring results

3.4 Deliverables

ID	Title	WP	Due	Type	Dissemination
D1.1	NV Ensemble Characterisation and Optimisation Report	WP1	M18	Report	Public
D1.2	Diamond NV Sensor Module (functional prototype, single channel)	WP1	M18	Prototype	Restricted
D2.1	SiN Photonic Circuit Design Files and Fabrication Protocol	WP2	M24	Technical Report / Design Package	Restricted
D2.2	64-Channel Integrated Photonic-NV Chip	WP2	M30	Prototype	Restricted
D3.1	pMEG Signal Processing Software Suite (open-source release v1.0)	WP3	M36	Software	Public
D3.2	pMEG Helmet Prototype and System Integration Report	WP3	M38	Prototype / Report	Restricted
D4.1	Clinical Study Protocol and Ethics Approval Documentation	WP4	M32	Report	Restricted
D4.2	Clinical Validation Dataset (FAIR-compliant, open access)	WP4	M42	Dataset	Public
D4.3	Clinical Validation Final Report	WP4	M42	Report	Public
D5.1	Data Management	WP5	M6	Plan	Public

	Plan (DMP) v1.0				
D5.2	Exploitation and IP Management Plan	WP5	M6	Plan	Restricted
D5.3	Policy Brief: Quantum Sensing for Neurological Diagnosis	WP5	M36	Report	Public

3.5 Resources and Budget Summary

Cost Category	Amount (EUR)
Personnel Costs	2800000
Subcontracting	120000
Travel & Subsistence	140000
Equipment	480000
Other Direct Costs	160000
Indirect Costs (25%)	300000
TOTAL	4000000

3.6 Risk Management

ID	Risk	Likelihood	Impact	Mitigation
R1	NV ensemble sensitivity target of sub-10 fT/Hz^0.5 not achieved within planned timeframe due to unexpected spin dephasing from surface contamination or material inhomogeneity.	Medium	High	Parallel exploration of three diamond substrate suppliers and two implantation protocols from M1; 6-month schedule buffer built into WP1; fallback sensitivity target of 50 fT/Hz^0.5 sufficient for a clinically useful device in an initial product iteration.
R2	Photonic integration coupling efficiency insufficient, leading to inadequate photon collection and degraded per-channel SNR in the 64-channel chip.	Medium	High	TU Delft will prototype two alternative waveguide geometries (evanescent coupling and butt-coupling) in parallel from M6; iterative fabrication cycles with NanoFab ensure design corrections can be implemented within a 3-month turnaround.
R3	Clinical recruitment at Charité Berlin falls below the target of 15 epilepsy patients within the planned window (M30-M40) due to inclusion/exclusion criteria stringency or patient withdrawal.	Medium	Medium	Recruitment protocol co-designed with Charité epileptology and patient advocacy representatives from M6; a pre-identified backup recruitment site (university hospital partner under letter of

				support) can be activated if enrolment lags by more than 20% at M34.
R4	NanoFab chip manufacturing yield remains below 85% target due to process variability in NV implantation and photonic layer co-fabrication.	Low	High	Dedicated process development task (T2.3) includes design-of-experiments approach to identify and control yield-limiting steps; NanoFab's ISO 13485-certified quality management system provides structured corrective action protocols.
R5	Intellectual property conflicts arise between consortium partners regarding co-invented photonic-NV integration architecture.	Low	Medium	IPMA signed at M3 prior to any joint development activity; clear foreground/background IP delineation agreed at kick-off meeting; mediation clause included in consortium agreement.
R6	Ambient magnetic noise in clinical environment exceeds rejection capability of the lightweight shielding enclosure, preventing clinically meaningful recordings.	Medium	High	Active noise cancellation using reference sensor array is a core design feature of WP3; system benchmarked in Charité's existing partially-shielded MEG room before deployment in standard clinical environment; shielding design reviewed by independent magnetics engineer at M24.