Physics | Lancaster University

Systemic Creative

Wearable Neurovascular Assessment and Diagnosis Device

Information for Investors

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Executive Summary

The Biomedical Physics Group at Lancaster University and Systemic Creative are partnering to produce a groundbreaking prototype wearable device to provide early diagnosis of dementia, Huntington's and other neurodegenerative diseases, along with neurophysical diagnosis of autism spectrum disorder and other neurocognitive conditions. It has the potential to radicalise global health diagnostic protocols and dramatically shrink the health inequalities gap.

Based on a functional methodology uniquely developed at Lancaster University by Prof Aneta Stefanovska and her research group, the device will be the first with high-accuracy non-invasive diagnostic capability usable by a non-specialist operator. It will replace MRI for these functions at less than 4% of the asset life cycle cost and will bring significant additional savings for clinical operators. The wearable cap format will be particularly beneficial to those with ASD and ADHD, for whom it may also provide anxiety-reducing biofeedback, and improve autonomy and dignity for those who struggle with MRI and CT scanning.

The production device will fit into the huge, continually growing medical device market with a heterogeneity of value streams and market segment applicability, matched by global sales potential. It presents a high-yielding investment opportunity with potentially double- or triple-digit multiples in ROI, and contains a number of additional income pathways from the R&D process to offset risk. Perhaps most importantly, it represents an opportunity to make great returns whilst also helping millions of people to have better lives and reducing suffering and inequality worldwide.

The investment is suitable for (but not limited to) EIS or SEIS investors, facilitating significant tax benefits, and provides additional advantages of enhanced CSR, publicity and affiliation with cutting edge biophysics research with a globally renowned research group and university.

The theoretical basis upon which the prototype will work is proven and backed by decades of research and several million pounds of funding. The group has global collaborators including Sony Corporation, University Medical Centre Ljubljana, and MyMind, and are considered world leaders in the understanding of the non-linear dynamics of living systems as networks of self-sustained non-autonomous oscillators. The combination of this state-of-the-art biophysical theory with recently developed wearable sensor hardware will produce a device with proprietary diagnostic algorithms and multiple patent potential.

In short, we want to radically improve the diagnosis and monitoring of neurodegenerative disease and neurocognitive disorders globally, and we're seeking visionary investors to help us do it. If you're one of them, or think you might be, and for all initial enquiries, please contact:

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andrew.smalley@systemic-creative.co.uk
07775 523 088

Business Case and Opportunity

The Problems

Diagnosis of dementia typically comprises a multi-step process involving cognitive testing, clinical assessment, an MRI or CT brain scan and sometimes blood and urine tests and/or an ECG.

MRI and CT scanning uses expensive, bulky equipment which requires costly maintenance by a team of specialist engineers. This size, cost and complexity means that it cannot be made readily available outside of hospital or specialist facilities. Additionally, the resulting scans require significant interpretation by highly qualified medical professionals.

These factors can lead to long wait times, stress and anxiety for a group of patients whose symptoms already include anxiety and depression. Further frustration is experienced by GPs and clinical staff who make referrals for their patients knowing the distress that the wait will cause. This can exacerbate health inequality between those who rely on NHS services and those who can afford private clinical support.

Furthermore, a study by the Alzheimer's Society [1] shows that 1 in 4 people wait for 2 years before getting help for dementia symptoms. Whilst dementia is a degenerative disease, symptoms and progression can be mitigated with early diagnosis and treatment, so unnecessary wait times can be tragic for sufferers and their families.

MRI and CT scanners are uncomfortable places which require the ability to stay very still for long periods of time in a confined space. This is disproportionately difficult for certain groups of people. For example, an Autistic person with high sensory sensitivity, a person with severe ADHD or OCD, or a person with learning difficulties. Indeed, someone with memory problems associated with dementia and other health conditions can simply forget they need to remain still. Therefore, this requirement further exacerbates the health inequality often faced by already vulnerable members of society.

Finally, these scanners also use elements which can be dangerous. CT scanning uses x-rays, a known form of ionizing radiation, whilst MRI uses powerful electromagnets which can be dangerous for those with medical implants such as pacemakers.

In summary, using MRI and CT scanning for dementia and other diagnoses:

- Is expensive, using bulky equipment requiring regular specialist maintenance,
- Requires interpretation by highly qualified specialist medical practitioners,
- Is unavailable outside of hospitals or specialist clinics,
- Require long wait times which cause distress and delays in treatment with tragic consequences,
- Is uncomfortable, difficult or impossible to use for some already vulnerable patients,
- Has inherent risk,
- Exacerbates health inequalities for multiple groups of people.

The Solution

What if dementia and other neurodegenerative diseases could be effectively diagnosed and monitored with a single, low-cost, low-power, portable device which caused minimum discomfort and was usable by a trained nurse or GP?

This is what we are building – for a production cost equivalent to the *monthly electricity bill* for a high field MRI scanner. Our prototype device will take the form of existing wearable data acquisition 'hats' which are used for combined functional near-infrared spectroscopy (fNIRS) and electroencephalography (EEG) – see Figure 1 below. It will combine a specifically developed version of this measurement technology, including proprietary algorithms, with existing ECG and respiration monitors to acquire and process diagnostic data and present this in an easy to interpret user interface. See How It Works below for more information.

The benefits of our device are the solutions to the problems above:

- Low cost (tiny fraction of MRI), easily portable and requires minimal maintenance.
- The diagnostic information can be interpreted by a trained person with basic medical training. In-depth analysis can be provided for doctors and consultants;
- Can be used and operated in any medical facility, including GP practices, walk-in centres and care homes with a clinical team. It can also be used in remote clinics in developing countries and situations such as war zones and refugee camps;
- It's simplicity and availability will dramatically reduce wait times. A GP could prescribe and undertake the diagnosis in a single appointment;
- Offers a significant improvement in usability and safety for all people. It does not require the user to be in a confined space or to stay perfectly still, and has no inherent risks associated with the technology;
- It can make early diagnosis available for everyone, irrespective of means or pre-existing medical conditions, in any part of the world – particularly those that cannot afford MRI and CT technology – and improve autonomy and dignity for many vulnerable people. It can thereby have a huge impact in the reduction of health inequality in society.

According to The Dementia Service [2], 1 in 6 people in the UK over the age of 65 are sufferers of dementia, and a predicted 1 in 3 people born in the UK this year will develop dementia at some point in their life. The impacts and benefits listed here can therefore affect every single person in the UK – both the sufferers and the friends and family who care for them. Of course, this situation is replicated in every country in the world.

Figure 1. Wearable measurement caps from Brain Products [3] with fNIRS and EEG sensors.

The Opportunity

A global problem, with a global solution provides a global opportunity. The medical device market is huge – according to Fortune Business Insights [5], its global value was USD 518 billion in 2023, projected to grow with a CAGR of 6.3% to USD 887 bn in 2032. Innovative devices capable of providing improved resolution to the problems of an ever-increasing and aging global population are one of the key drivers of this enhancing market share.

The prevalence of dementia means that the total spend on dementia diagnosis and care is similarly huge. In a recent report commissioned by the Alzheimer's Society from Carnall Farrar [9], the cost of dementia in the UK is forecast to be £42 billion in 2024, rising to £90 billion by 2040. Much of this comprises health and social care costs, with only a small fraction spent on diagnosis. Our device can be positioned as a low-cost way to reduce this enormous societal burden, whilst increasing market share for diagnosis and returns for investors.

On achieving our phase 1 goal of a prototype, there are a number of potential routes to market. At current manufacturing prices, even with a 500% markup, our device would retail for less than a one-year maintenance contract for a comparably capable MRI scanner, would have just 3.4% of the asset life cycle cost, and bring many additional savings for hospital and clinical customers. This provides an extremely strong purchase incentive with large margin potential. Coupled with the size of the global market, ubiquity of need for the device and huge demand for the solutions it brings, this a compelling and potentially very high yielding opportunity – large multiples of the amount invested is a realistic expectation. See our Financial Outlook for more detailed information.

In the UK alone, there are 515 hospitals, 6,925 GP services, and approximately 5,010 clinically equipped care homes (from NHS England, 2023 [4]). In many of these situations, the purchase of one or more of our devices will represent a large overall cost saving, making the decision to purchase an easy one. Aside from the dramatically lower cost relative to MRI and CT, early diagnosis means easier treatment with less intensive care required in the earlier stages of the condition. Reduction of waiting lists is impactful for hospitals and GPs, not only in terms of targets, but in the reduction of costs of agency workers and sickness from overworked medical staff. Additionally, expensive MRI and CT scanners can be freed up for use in other circumstances.

A private clinic or care facility which can advertise their ability to undertake diagnosis has a competitive advantage, thus incentivising purchase in the private sector, and opening up a new market segment for whom the cost of MRI or CT technology would be prohibitively expensive.

Such sales potential can be replicated across Europe and the developed world, but an arguably bigger market exists in developing countries. In the hundreds of thousands of medical facilities for whom owning and operating MRI or CT equipment is an impossibility, our device could provide a diagnostic lifeline. In the continent of Africa, there are over 101k hospitals and medical facilities which could benefit from, and afford to buy, our device.

In addition to the primary goal of production of the prototype device, IP will be generated in the production pathway, including datasets, algorithms and device components. The directors will provide investors with maximum security from these additional opportunities for ROI in the form of additional licensing or patenting wherever possible. For more information, see Additional Routes to ROI below.

Finally, investing in research and development which has a profoundly beneficial effect on society is a wonderful way to enhance your corporate social responsibility. We will help you to publicise your contribution and collaboration for maximum reciprocal effect, including press releases, publications (both popular and academic), social media and events. Furthermore, yours or your company's name will be forever associated with both the contributions and results, and will be listed in academic journals which publish the research.

We seek investors who share our vision, and in return, we present an opportunity not only to make a large and sustained return on investment, but to do so whilst positively impacting the lives of billions of people across the world, particularly those who are most in need.

Additional Applications and Opportunities

Whilst Alzheimer's Disease diagnosis and monitoring is the most rapidly achievable application of the device, other applications exist which bring their own significant potential returns.

Autism Spectrum Disorder

The group have a current patent application for the algorithmic detection of the neurophysiological correlates of ASD, using the same non-linear dynamics methods as employed in this device. The group have been able to successfully detect ASD in a patient-control group with a 100% accuracy rate in a small sample size. The heterogeneity of ASD necessitates that further work is undertaken with larger and more diverse groups to establish thorough diagnostic protocols and accuracy rates. However recent research in the group conducted since the patent application began, and which demonstrates a significant reduction in alpha and theta functional connectivity in children with ASD, further suggests that high accuracy diagnostic capability is realistic. Moreover, the same device proposed in this document will contain all of the functionality required.

This opens up another large market without any additional product or manufacturing costs.

Huntington's Disease

Whilst Huntington's disease is diagnosed using genetic testing, the efficacy of symptom-reducing, and potential life-prolonging treatments is very difficult to evaluate. Subject to further research based on wider datasets, we believe that our device will be able to provide clear insight into the rate of degeneration in the brain based on known parameters of the oscillatory dynamics of the neurovascular unit.

Repeated measurement of the brain of a Huntington's sufferer using MRI, CT, or PET scans to determine treatment efficacy is unrealistic or impossible for all of the reasons mentioned above in reference to dementia diagnosis. Since the measurements required use the same sensory equipment and underlying biophysics, our device solves these issues in the same way – it is portable, low-cost, low-power and usable by a trained nurse. This could dramatically improve the treatment protocols for Huntington's disease by providing new and more detailed insights into the associated degeneration, thus improving the quality of life for sufferers and their families.

This provides a further market segment and additional value streams with the developers of pharmaceuticals and treatment protocols.

Vascular Dementia, Lewy Body Dementia and Parkinson's Disease

Since these diseases are similarly neurodegenerative in nature, sharing common factors with the above, we expect that our device will be similarly effective in their diagnosis and monitoring. We will undertake research to determine the patterns of oscillatory dynamics which differentiate these conditions from other diseases and from healthy people. From the collection and analysis of this data, we expect to produce successful diagnostic capability for these conditions.

Scientific Involvement

Finally, this is also an opportunity to be involved at the forefront of scientific development in the burgeoning field of biophysics. Shareholders will receive scientific updates on the advances we make and will have the opportunity to meet with researchers, visit the laboratory, and learn about new horizons as they develop. We find science, and its power to affect human lives for the good, tremendously exciting, and we want to share it with you.

Company Overview

The founders of the company, Systemic Research Ltd, comprise the lead members of the Non-linear and Biomedical Physics Group at Lancaster University, and Andrew Smalley of Systemic Creative. The company is formed as a sister company to Systemic Creative, which is providing funding, administrative, branding and marketing support.

Whilst Systemic Creative holds a share in the company, it is not a controlling share, and Systemic Research is an independent limited company wholly owned by its shareholders.

Initial shares have been issued and are distributed among the founders, with a small number held by contributors to the research such as PhD students and postdoctoral researchers. Further shares will be issued and sold to investors to facilitate the first funding round.

Company Name: Systemic Research Ltd
Company Number: 15907959
Company Type: Private, limited by shares.

The Non-Linear and Biomedical Physics Group

The Nonlinear and Biomedical Physics group at Lancaster University stands at the interface between physics, biology, medicine and mathematics. These fields are united by an effort to understand the dynamics of living systems and the application of this knowledge to improve health. This area of academic research has its origins in the latter part of the 20th century with the development of theories including synergetics and network synchronization, as well as chaos and stochastic dynamics. These theories provided a first step towards an understanding of the time-dependent and apparently random behaviour of living systems. Various tools resulting from these theories have since found wide adoption, such as fractal scaling in heart rate variability as a way to determine cardiac health and the modelling of the brain as a dynamical network as a way to understand neurological health.

Prior to the research undertaken by the Lancaster group there was always a missing piece to the puzzle: Living systems exist in a state that is time-dependent and far from equilibrium, but are also characterised by stable rhythms that are not random or chaotic. This drove the researchers in Lancaster to develop and use a whole array of data-driven techniques including wavelet-based methods, dynamical Bayesian inference, nonlinear mode decomposition, and synchronization analysis methods, in order to investigate these system dynamics. This work led to a new class of systems that exhibit time-dependent but stable dynamics, which they named Chronotaxic Systems. With this knowledge and set of tools, the Lancaster group have been able to probe living systems in a way that matches their natural characteristics, rather than forcing these systems to conform to the false assumptions used in previous theories and their corresponding methods.

The new techniques have been applied to many real-world problems, which include:

- Distinguishing between the awake and sleep states during surgery to inform administration of safe quantities of anaesthetic.
- Developing a quantitative assessment of autism spectrum disorder based on brain wave measurements in children.
- Diagnosing skin cancer based on measurements of microvascular blood flow.

- Developing a method to diagnose dementia and other neurological disorders based on the interaction between blood flow and electrical activity in the brain.

It is also worth noting that while the group has focused on applications within biology and medicine, the theory and methods have been developed from fundamental physical principles. This means that they are broadly applicable to almost any problem where data are measured over time. Applications have therefore been found in climate science, space science, low-temperature physics, mechanical engineering, seismology, finance and beyond.

Systemic Creative

Systemic Creative is an organisational dynamics consultancy and training company, founded by Andrew Smalley, which supports businesses and organisations to realise their potential through maximising operational capability and dynamism. Using a foundational principle of modelling companies as structurally coupled, non-linear, living systems and by using the theoretical goal of organisational consciousness, clients are supported to assess and rebuild systems, operations and culture within an organisation in order to maximise effectiveness, harmony, stability and growth.

The Systemic Creative Organisational Development Programme has been described as radicalising the way companies work, an experiential reprogramming, and "innovative, challenging and inspiring". Testimonials from a diverse range of clients, including University of Birmingham, Hallmark Cards, Age UK and the Association for Real Change, can be found here: Testimonials | systemic-creative

Systemic Creative also provides strategic management consultancy and assessment, including the development of strategic and operational plans, systemic analysis and management, and leadership and listenership coaching. All of these are delivered using a unique, innovative approach, underpinned by the living systems modality, involving 3D 'molecular' organisational modelling, board games and group activities.

The Founders

Andrew Smalley – Managing Director

In addition to his work through Systemic Creative, Andrew has 20 years' experience in operational and strategic management in local, regional and national organisations at a senior and directorial level. He has worked as a non-executive director and governor for more than 10 years and has been instrumental in the success of three start-up companies. Additionally, Andrew has worked as executive producer and/or director on several large scale public and community events, including two music festivals and three fashion shows, all of which were sell-out successes.

Early in his management career, Andrew built a reputation for turning businesses from loss to profit, followed by continually increasing profit year on year. He replicated this several times, winning numerous national awards, before compiling his knowledge and methodology into his brand and company, Systemic Creative. In this role, Andrew has worked as a consultant, educator, and business coach for the last 8 years, with clients including Bradford Metropolitan District Council, Champion Education Trust, Cruinniú hÉireannaigh Learpholl and VoiceAbility. He has also given talks and lectures at Liverpool Hope University, Mensa, The Women's Institute and many local groups.

In addition to his business experience, Andrew has physics qualifications including a first class BSc and an MRes (distinction) in quantum electronics, is a member of the Institute of Physics and will be completing doctoral studies in this project.

Andrew brings his commercial and strategic experience to the group to ensure that the research and development undertaken is guided toward a marketable product. Andrew will also undertake the administrative and financial running of the company, ensuring that patent applications and IP protections are pursued, market and competitor analysis is undertaken, and the drivers for commercial success are put in place as the development proceeds.

Reviews and testimonials about Andrew's work with companies through Systemic Creative can be found here: Reviews and Testimonials

Prof Aneta Stefanovksa – Scientific Director

Aneta is professor of Biomedical Physics at Lancaster University. For more than three decades, Aneta has devoted her life to the understanding of the dynamics of open systems, including the physical principles underlying living systems. She coined the term "Chronotaxic Systems" and for many years has led the field in the understanding of living systems as interacting, self-sustained non-autonomous oscillators. With collaborators, she has introduced a mathematical theory of Chronotaxic Systems and methods for studying their dynamical properties using measured data. The resultant algorithms encompass wavelet phase coherence, couplings using wavelet bispectra and dynamical Bayesian inference, ridge-extraction of instantaneous frequencies, detection of high-harmonics of oscillations with time-varying frequencies, and couplings in networks.

Aneta has worked on the applications of these methods to living systems ranging from oscillations of energy metabolism in cells to cardiovascular and brain oscillations and circadian rhythms. Applications include ageing, anaesthesia, autistic spectrum disorder, dementia, diabetes, coma, cardiomyopathy, cardiac failure, hypertension, hypoxia, melanoma, and malaria. Aneta is a globally renowned academic with collaborators in several countries, more than 250 academic publications, and several successful commercial collaborations including with Sony Corporation and MyMind.

Aneta will lead and supervise all academic work undertaken on the project along with facilitating data acquisition, compilation and analysis from clinical collaborators and component and sensor acquisition from device manufacturers.

Find out more about Aneta and her work here: Aneta Stefanovska - Lancaster University

Dr Philip Clemson – Technical Director

Phil Clemson is a physicist with expertise in the analysis of biomedical data. Together with Aneta and colleagues at Lancaster University, he contributed to the development of the Chronotaxic Systems model of biological oscillations and devised a technique to detect these systems from measured data. He also has extensive experience in the development of Markov chain Monte Carlo methods used in machine learning, working on applications such as enhanced detection of underwater objects using sonar and accurate calculation of R numbers in epidemiological modelling.

In addition to academic research, Phil has held two positions in industry where he developed novel medical devices. This included a device for the non-invasive measurement of blood pressure using electrical and optical sensors, which resulted in the successful publication of a patent. He also developed an algorithm to screen patients for atrial fibrillation and worked in a team to develop wearable technology for the measurement of cardiorespiratory health.

Phil will be the technical and algorithm development lead in the project, utilising his expertise in mathematics and coding, both directly and in the supervision and support of others.

A summary of Phil's publications can be found here: Philip T Clemson - Google Scholar

Prof Peter V E McClintock – Scientific Director

Peter is Research Professor of Physics (emeritus) at Lancaster University. He completed doctoral studies at Oxford University (DPhil), and came to Lancaster in 1968. He was a SERC/EPSRC Senior Fellow and is Editor-in-Chief of the journal 'Fluctuation and Noise Letters'. Peter has published 7 books and more than 500 papers and is a key member of two research groups at Lancaster - Non-Linear and Biomedical Physics, and Ultra Low Temperature Physics. Peter's expertise in the latter, specifically in the use and production of helium-4, allowed him to found and run Lancaster Helium Ltd, a global supplier of isotopically purified helium-4 to academic and commercial customers. He is currently the company CEO.

His diverse research experience includes low temperature physics, superfluidity, quantum turbulence, nonlinear dynamics, and the applications of nonlinear dynamics to biomedical problems. In addition to working closely with Aneta on advancing the physics of biological non-autonomous oscillators, his recent biomedical work has included phase coherence in spontaneous oscillations in the neurovascular unit and selective conduction in biological ion channels.

In addition to contributing to the development of the physics and technical aspects of the device, Peter will provide guidance, support and advice to the team in both an academic capacity and in respect of the commercialisation of physics projects. Peter will also assist in the academic supervision of doctoral researchers and the support of postdoctoral researchers.

Find out more about Peter and his work here: Peter McClintock - Lancaster University

How it Works

The device will have three main operational steps – measurement, signal processing and the user interface, as per Figure 2 below. There will be a mains power connection from the signal acquisition component (which will power all sensors), and a USB connection from this device to a computer. It will be compatible with all up to date office or clinic computers with sufficient processing power and RAM, and will come with the necessary proprietary software to undertake processing and provide the UI.

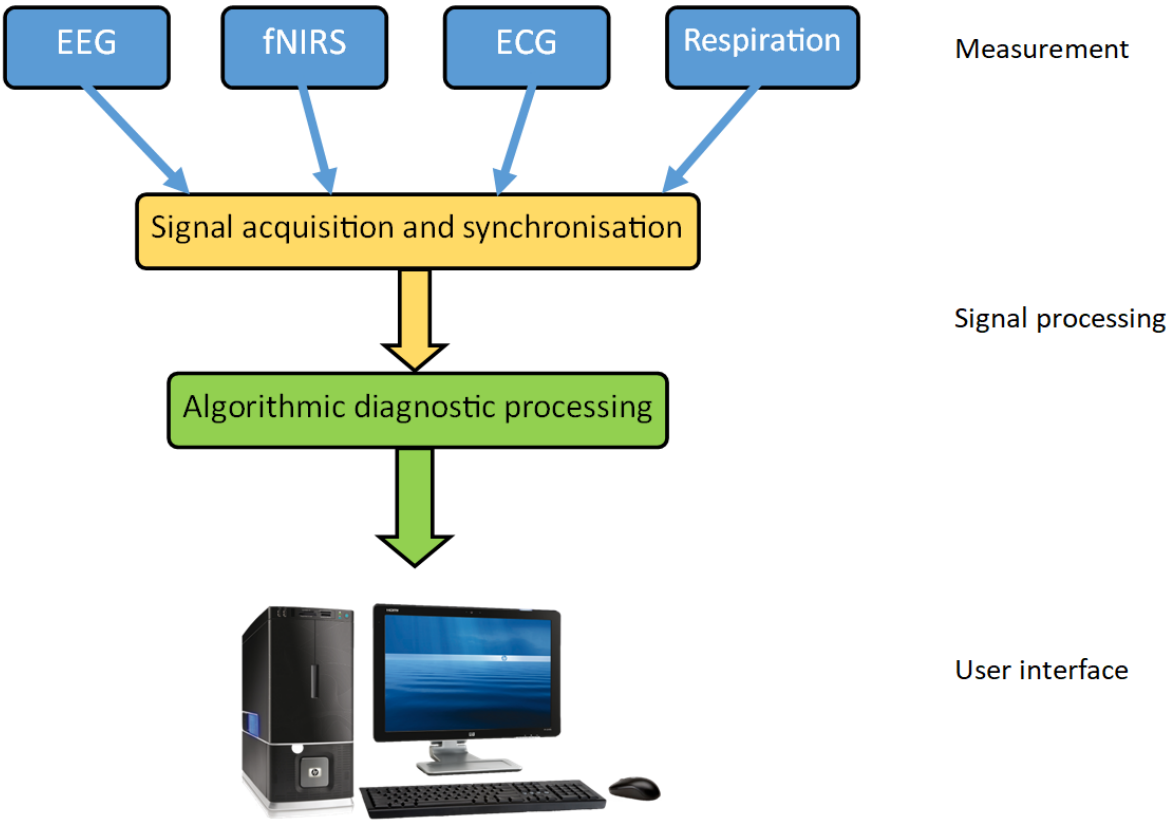

Figure 2. Device operational schematic.

The device will record two types of signals from the brain: neuronal activity via the electroencephalogram (EEG) and oxygenation via functional near infra-red spectroscopy (fNIRS). Numerous probes will be included, so that the neurovascular dynamics can be evaluated in different locations. In addition, cardiorespiratory function will be captured via the electrocardiogram (ECG) and a respiration belt.

EEG and fNIRS probes will be placed on a cap, which can then be placed on the head of participants. EEG probes are electrodes, while fNIRS relies on both a transmitter and detector of near-infrared light. Currently, ECG electrodes are placed on each shoulder and the lower left rib of the participants, while the respiration belt is placed around their chest. Our prototype device will include fully 'wearable' versions of these.

Currently, we use a suite of signal conditioning systems, with the data post-analysed in MATLAB. Our prototype will combine these functions into a bespoke combined device for signal conditioning and synchronisation, to operate in a 'black box' format, along with a set of proprietary algorithms for diagnosis. These algorithms will evaluate the strength and coordination of the cardiorespiratory and neurovascular oscillations, based on the state-of-the-art time-frequency analysis methods developed at Lancaster University.

From previous research, oscillations at different frequencies can be linked to specific physiological processes spanning from 0.005 to 2 Hz. In addition, biological oscillations are time-varying. These properties mean that the traditionally used Fourier transform is not optimal, due to the linear frequency resolution and no time resolution. Instead, our algorithms will be based on the wavelet transform. This transforms the signals to the time-frequency domain, and has logarithmic frequency resolution which allows us to resolve the low frequency oscillations.

An oscillation has both amplitude and phase. The phase of the oscillations can be calculated from the wavelet transform, and it is then possible to calculate the wavelet phase coherence. The level of phase coherence will give an indication of how well the different systems collaborate, and specifically how well the neurovascular unit is maintaining the cooperation between the brain and the blood.

Using a neurovascular oscillatory coherence ‘fingerprint’ corresponding to different disease or disorder types, we have been able to accurately diagnose Alzheimer's Disease, Huntington’s Disease and Autism Spectrum Disorder. Furthermore, it is likely that with further work and a wider dataset (already planned), the progression of Alzheimer’s and Huntington’s can be effectively monitored, and we will also be able to diagnose and monitor Parkinson’s Disease, lewy body dementia and vascular dementia. These latter diagnoses may not be ready before the prototype construction but can likely be added at a later date, since we envisage that the sensors and physical device required will be the same.

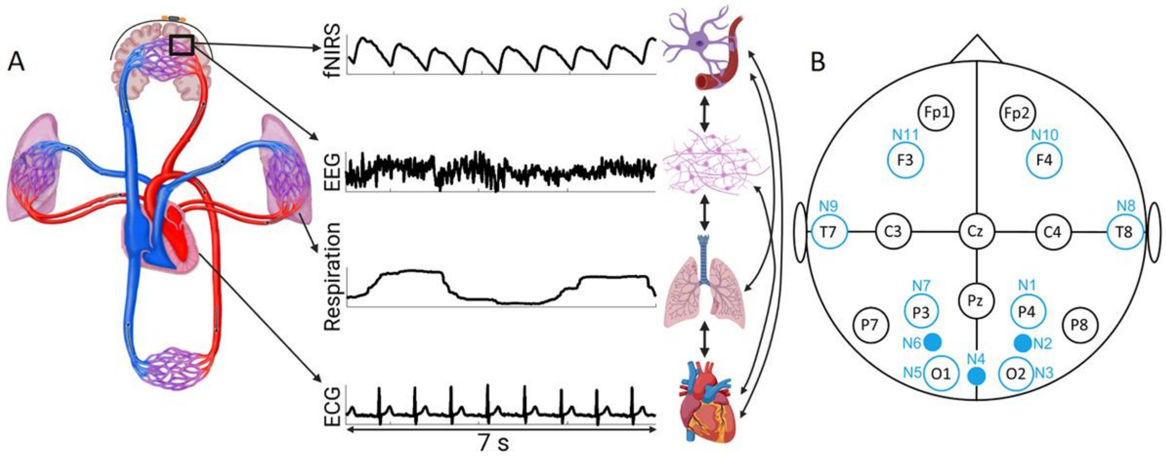

Figure 3. A) The cardiovascular system and brain, illustrated schematically with a zoom to show the neurovascular unit (NVU), and examples of recorded signals: fNIRS to capture brain oxygenation, EEG to capture the electrical activity of the brain, and respiration and ECG to capture systemic effect of the blood circulation. The vertical arrows show the combinations for the phase coherences investigated. B) Sketch illustrating the 16 EEG electrode (black) and 11 fNIRS probe (light blue) placements. Note that 8 EEG and fNIRS probes (indicated with blue open circles) are co-located. Created using BioRender.com. From Bjerkan et al (2023).

For more detailed information on how the measurements and non-linear dynamics methodology have been used to produce some of the foundational research for this project, see Bjerkan et al (2023) [6]. For more information on phase coherence and the underlying biophysics, see Barnes et al (2024) [7].

Can this be copied or replicated with AI?

Since our proposal relies in part on published research, it is reasonable to ask if a competitor group or company could simply replicate our processes and proprietary algorithms using machine learning and artificial intelligence. However, the two approaches differ on a fundamental level. The success of machine learning depends on fitting models of increasing complexity to observed data. As with all statistical model fitting, the more complex the model, the more data is required to determine the parameters and train the algorithm. As such, machine learning is heavily reliant on large datasets and will likely fail whenever it is applied to a data sample outlier that was not within the training dataset. In the context of our device, this could be the presence of movement artefacts in the data.

While having a baseline dataset is still important when applying our new techniques, the approach is almost the inverse of the one taken in machine learning. Instead of improving accuracy by increasing the complexity of the model, these methods work by decomposing the data into simpler component parts. By identifying components of interest and studying their physical rather than statistical features, algorithms based on these methods are very resistant to perturbations or noise in the data. They also bring with them knowledge of the underlying system and provide a complete understanding of what is actually being measured, which is in contrast to advanced AI "black box" algorithms such as deep learning, which do not give any such insight. This highlights how the expertise offered by the Lancaster group is unique in the world and provides a capability to solve diagnostic data-driven problems that goes beyond the state of the art.

Strategy and Operations

Key Objectives and Goals

There are two key objectives for the company in this phase:

- Develop existing research and proven analytical findings and combine them with technology to produce a prototype device,
- Develop commercial aspects of the project, including market analysis and protection of IP to enable a successful value proposition and market positioning of the device.

The key goals for each objective can be broken down as follows:

Research and Development

- Development of a database of assessment data from patients and control groups to account for the full heterogeneity of the target neurophysiological conditions and for use in the development of diagnostic algorithms.
- Assessing and developing the sensors required, including fNIRS and EEG, and also assessing the potential suitability of Laser Doppler Flow (LDF) devices.
- Develop data acquisition and synchronisation algorithm(s) to successfully combine and process sensor data from multiple sources in real time.
- Develop proprietary diagnostic analysis algorithm(s) suitable for use in the device design – local, PC or remote based.
- Develop an output protocol and UI suitable to be understood by a trained medical professional (but non-expert) in non-linear analysis.
- Develop the structure and form of the wearable device, including the optimisation of sensor placement.
- Produce a functional prototype, test and qualify in the clinical environment.

Note that this is not an ordered list, since many of these goals will be worked on concurrently by members of the team.

Commercial Development

- Understand regulatory frameworks and their impacts on the device and distribution.
- Perform an in-depth market analysis and segmentation, including public and private sectors and global distribution.
- Perform a thorough competitor analysis, along with a forecast of potential future competitors using both research-based and commercially focussed outlooks.
- Establish and implement a framework for monitoring and protecting IP arising from the research and development work. This will include proprietary algorithms, patent applications, and publishing restrictions.
- Establish a robust value proposition and market positioning for the device based on the market research undertaken.
- Build a comprehensive suite of options of route to market, licensing and sale of IP for presentation to shareholders with associated financial forecasts and anticipated ROI.

Delivery

The research and development work will be undertaken primarily by two doctoral researchers and one or more senior researchers, supervised by Aneta as Principle Investigator, and Peter. The commercial and business development work will be led by Andrew, supported by Phil and one or more post/undergraduate researchers.

Andrew and Phil have dual roles based on their experience, expertise and involvement in the group. Hence, Phil is Technical Director and a commercial developer, and Andrew is Managing Director and a doctoral researcher.

The remaining doctoral researcher and postgraduate researchers are yet to be appointed.

It is anticipated that the research and development work will take approximately 4 years to complete, and so this is the timescale on which both workflows will operate. Much of the commercial and business development work could be done more quickly but is of course dependent on the R&D to inform its focus. However, work on IP protection will begin immediately and run concurrently in order to ensure maximum value for shareholders is retained.

Technology Readiness Levels

Our objective in the proposed timescale is to move the project from TRL 4 to TRL 7, which is the final stage before commercial system manufacturing. The fundamental, proof-of-concept research is already complete, which gives the current project base at TRL 4. However, some of the goals within levels 5 and 6 are also complete – we have working sensors and acquisition devices, signal processing algorithms and have used these to demonstrate diagnostic capability. Hence, we expect to be able to efficiently move through these levels, with the key elements required for the progression to TRL 8 specified in the R&D list above.

Further investment will be sought to either complete TRL 8 (manufacture the commercial system), or license / sell rights to the device IP. In the latter option, TRL 8 and 9 are undertaken by a third party.

Figure 4. EU Technology Readiness Levels Diagram.

Investment And Financial Outlook

Use of Funds

We are seeking funds to enable the development in the project specified in our Strategy and Operations Section, in order to bring the technology to TRL 7, ready for manufacturing the commercial system. These seed funds will be used in R&D and commercial development over the next four years as follows:

- Materials: including sensors, instruments, cables etc
- Software licenses and purchases
- Development of IP protection, including patent applications
- 1 doctoral researcher
- Partial salaries for the Technical and Managing Directors

Provided to the company free of charge are:

- Andrew's doctoral research (funded by Systemic Creative)
- Postgraduate / undergraduate researchers (provided by the university)

EIS / SEIS

We will initiate and maintain registration for this scheme with HMRC in order to enable incentives for applicable investors. The company is eligible under the technology research and development criteria.

Equity Distribution and Future Funding

Founders' shares have been issued upon Company formation. Further shares will be issued to facilitate this early stage investment, thus diluting the founders' shares. Upon completion of the prototype development phase TRL 7, a second round of investment may be sought, with additional shares issued. Statutory pre-emption rights will apply. Additionally, the university may acquire a small share in return for IP it owns (see below).

The scale of the future round 2 investment will be determined by the strategy of the company at that time. There will be several options on forward progress, requiring significantly different amounts. These may include:

- Continuing to manufacture and sell the device.
- Outsourcing manufacture and/or sales of the device whilst retaining operational control.
- Licensing the IP and commercial rights.
- Selling the IP and commercial rights.

The directors will compile a report and recommendations for all possible options from the commercial development and research undertaken through phase 1. This will be presented for shareholder vote at the appropriate time. All options will provide a return for investors.

Financial Outlook

We believe this investment provides the opportunity for an extremely high return – double- or triple-digit multiples of the amount invested. We apply the following considerations and reasoning:

According to the ONS [8], in the UK alone, healthcare expenditure was around £292 bn in 2023, approximately 11% of GDP. In a recent report [9] commissioned by the Alzheimer's Society from Carnall Farrar, the cost of dementia in the UK is forecast to be £42 bn in 2024, rising to £90 bn by 2040.

According to Fortune Business Insights [5], the global value of the medical devices market was USD 518 bn in 2023, projected to grow with a CAGR of 6.3% to USD 887 bn in 2032. Innovative devices capable of providing improved resolution to the problems of an ever increasing, and ageing, global population are one of the key drivers of this enhancing market share.

The huge amount spent on healthcare is both an indicator of the size of the market, and an indicator of the level of incentives that health authorities and providers have to reduce costs. This means that we have a large market to sell into and a product which satisfies the incentives of the players within it. A perfect storm, so to speak. According to KPMG [10]:

"Governments around the world are desperately trying to reduce the cost of healthcare – especially in the most expensive part of the system: hospitals. They want to pay less for medical devices and see proof of greater value in terms of better patient outcomes."

The starting cost of an MRI scanner capable of complex neuroimaging is £320k ($400k from Medical Imaging Source [11]), running up to around £2M. These machines, running at capacity, consume large amounts of electrical power, at a cost of up to £10k per month, require specialist facilities in which to run and have high maintenance costs of £19k to £94k per annum (DirectMed Imaging [12]).

The current combined cost for a one-off purchase of a wearable fNIRS+EEG device, plus ECG and respiration belt is around £51k. However, quotations from our collaborators and device manufacturers for bulk purchase (>1000 units) indicate a current cost of around £6k. A reasonable estimate of the potential production price of our complete device, which includes these components along with the signal acquisition device, plus synchronisation and diagnostic algorithms, is around £10k.

These numbers mean we can produce a device with enormous competitive advantage, as shown in Table 1 below.

10 Year Costs	Typical High-Field MRI	Systemic Research Device
Acquisition	£750,000.00	£50,000.00
Facilities and installation	£350,000.00	£0.00
Electricity	£660,000.00	£9,000.00
Maintenance	£700,000.00	£25,000.00
Liquid helium	£30,000.00	£0.00
TOTALS	**£2,490,000.00**	**£84,000.00**

Table 1. Example asset life cycle cost (LCC) comparison for a period of 10 years. This shows our device (sold at a 500% markup) at around 3.4% of MRI. This applies an annual maintenance contract cost to our device of £2,500, which itself is a source of revenue and potential profit. Furthermore, this does not include savings on staff time (both in number and qualification level), for which our device presents a significant additional reduction.

This provides a lot of headroom for markup to generate excellent returns, whilst still providing a very large cost saving for medical customers along with significant added value – low power, operable by less qualified staff, ease of repeated use for monitoring degeneration, applications in improving treatments (including new pharmaceuticals) and many more, all of which improve patient outcomes.

In their report, "Medical Devices 2030" [10], KPMG state that, in this market, "value is the new byword for success", and the way forward is to "reinvent, reposition and reconfigure". Our device fits their requirements for fulfilling these criteria perfectly. It integrates intelligence and smart value into the device, offering many potential uses and benefits, both clinically and for patients; it provides technological innovation to benefit the clinical setting and is most beneficial to emerging new markets in high growth developing countries; it offers a reconfiguring of the typical 'install and forget' value chain of existing manufacturers – there is significant repercussive potential across multiple market segments with our company as innovators. For example, our device will provide monitoring of treatment effectiveness of Huntington's which supports patients, their families and pharmaceutical companies developing the treatments, which in turn support the patient and provide us with data to improve and expand the device capability, which again better supports patients and starts the cycle again.

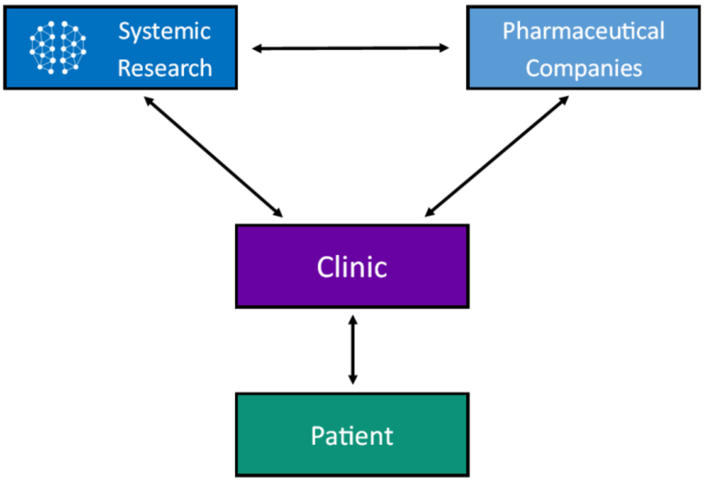

Figure 5. An example of collaboratively enhanced value streams and repercussive revenue potentials.

There are a large number of potential customers across several market segments. In the UK alone, there are 515 hospitals, 6,925 GP services, and approximately 5,010 clinically equipped care homes (from NHS England, 2023 [4]). The huge asset life cycle cost savings in Table 1 present a strong purchase incentive in many of these situations, with additional incentive from the reduction of treatment costs, waiting lists, staff time, facilities management and from freeing up more expensive equipment for other purposes.

A private clinic or care facility which can advertise their ability to undertake diagnosis has a competitive advantage, thus incentivising purchase in the private sector, and opening up a new market segment for whom the cost of MRI or CT technology would be prohibitively expensive.

This sales potential can be replicated across Europe and the developed world, with an even bigger market in developing countries. In the continent of Africa, there are more than 101k hospitals and clinics (Wikipedia, 2024 [13]). In many of these facilities, owning and operating MRI or CT equipment is an impossibility - our device could provide a diagnostic lifeline, providing a high purchase incentive.

Of course, initial sales are just the starting point. We envisage that the device will be constantly updatable with new diagnostic tools, both in software and hardware. As mentioned above, several new potential developments are already on the horizon and the research trajectory and broad applicability of the underlying biophysics indicate that many more will be possible. This will create a symbiotic commercial environment where everyone benefits – our device aids diagnosis and treatment development, we use data from this to improve and expand the device capability, more sufferers are helped, and excellent ROI is generated to reward investors.

Finally, the diversity in applicable value streams provides an attractive overall value proposition with a high level of security. The use cases, customers and collaborators across these value streams and market segments touch many people with an enormous number of beneficiaries, generating significant social collateral and brand momentum in addition to robust sales potential. Alzheimer's, ASD and Huntington's are examples of this diversity, with proposed future developments providing still greater heterogeneity of potential markets.

During the commercial development and prior to presenting the suite of options to shareholders at TRL 7, full profit and loss forecasts for each strategic direction will be drawn up to facilitate comparison of the ROI potentials.

Funding to Date and Investment Security

The project has so far received significant direct grant funding and large contributions in valuable data and hardware from collaborators. The recent work of researchers on the project, and data collection at Lancaster, was funded by a £600k grant from the Engineering and Physical Sciences Research Council, part of UK Research and Innovation (UKRI). Key collaborator University Medical Centre Ljubljana, Slovenia have provided contributions valuing >£200k, and more than £1M of data have been provided by collaborators globally. Hardware, including sensors, have been provided by collaborators Sony Corporation and MyMind, and the project itself is part of decades of funded work by Aneta Stefanovska and her research groups, which are globally renowned as world leaders in the field - see Figure 6 below.

We seek investors for this project in order to commercialise the work and produce a prototype which can be taken into production. The foregoing is to provide reassurance that this rests on a well-funded operation with a long history. We need private and commercial investors at this point because public grant funding is for public domain research rather than commercialisation.

Whilst the main opportunity presented here provides a strong investment opportunity, we will also provide investors with maximum security from additional opportunities in the journey to overall success. These will include the following:

Additional Routes to ROI

Shareholders will have ownership of, and access to:

- All marketable IP generated in the R&D pathway.
- Licensable databases and datasets of biophysical medical data.
- Patents produced for subsystems or related systems of the main product.
- High quality commercial and legal research on medical device markets, regulatory frameworks and health systems globally.

Additional Benefits for Investors

- Significant reduction in tax liability if investing through (S)EIS.
- Association with cutting edge biophysical research with a globally renowned group and university.
- Publicity through press releases, publications, media and social media from Lancaster University and Systemic Creative.
- Enhanced CSR through investment in R&D with large scale societal benefits.
- Access to Systemic Creative's Organisational Development Suite of Courses at discounted rates or FOC for high value investors.

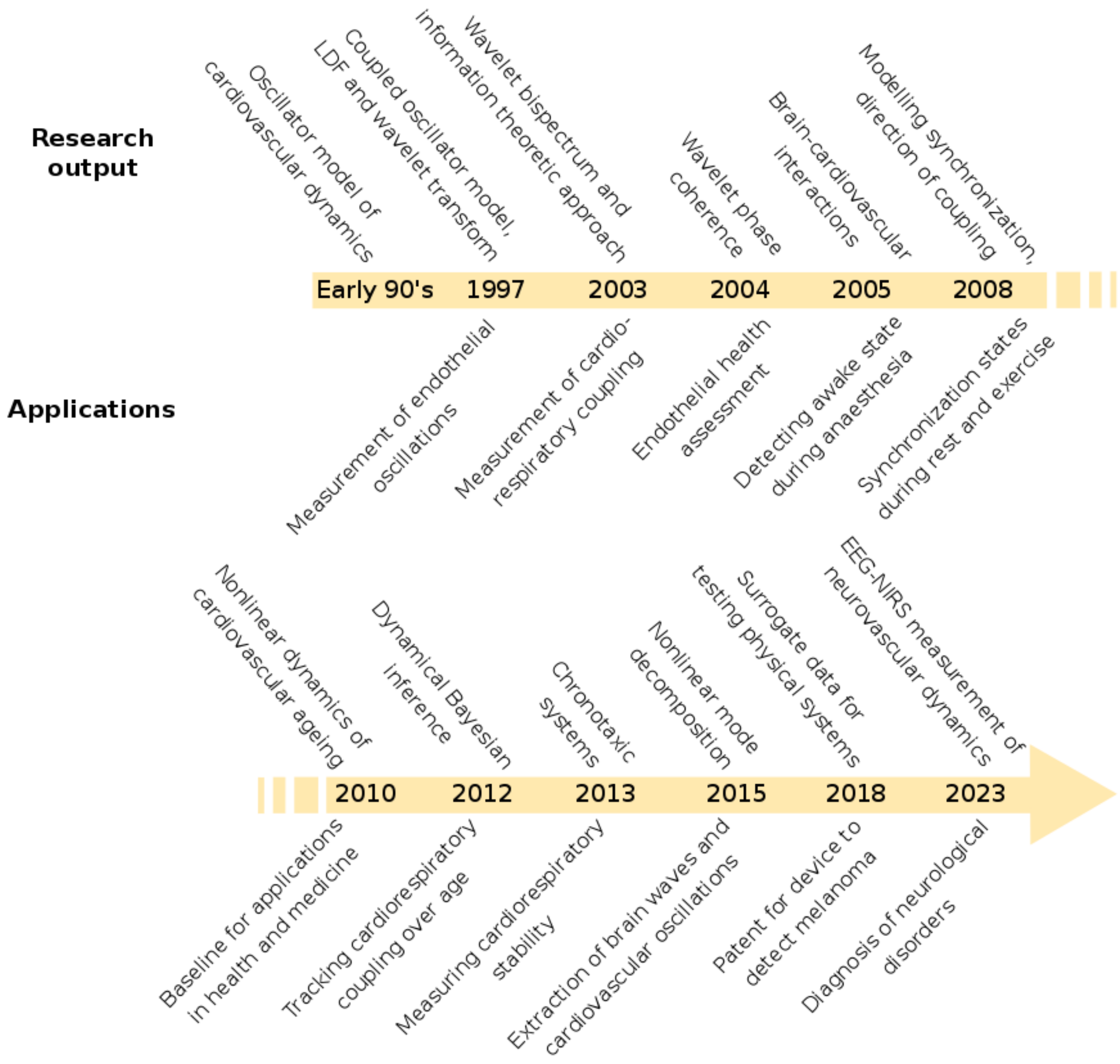

Figure 6. The history and breadth of work undertaken by the Nonlinear and Biomedical Physics Group. The investment opportunity presented here rests on 30 years of successful, funded and published work, several patents and several careful clinical studies. This bedrock of knowledge and technical ability, coupled with the latest research results, is unparalleled in the field.

Intellectual Property and University Involvement

By contractual agreement, the company will own all intellectual property (IP) generated by the doctoral research. For the primary goal of dementia diagnosis, the fundamental research has been published and hence is not subject to IP considerations. Proprietary algorithms and patents developed from the starting point of previously published work will similarly be owned by the company, along with all commercial rights associated with them.

It is likely to be necessary to include elements in which Lancaster University has partial or total ownership of associated IP. Direct contributions (not including academic supervision) by Aneta and Peter fall into this category under the terms of their professorships at the university. Development of the work on ASD diagnosis will also include such elements.

In these cases, a commercialisation agreement(s) with the university will be drawn up. This may include an equity share, royalties, milestone payments or other factors to be negotiated depending upon requirements. This can be seen as a benefit to the company rather than a dilution of potential revenue, since the university will add significant value in terms of support and cost reduction of patent applications, expertise and connections in supporting IP licensing or sale, connection and facilitation of collaborators who can add value, and support and facilitation of acquiring large venture capital investments required to bring products to market.

The university is motivated and incentivised to support commercialisation of research originating on its premises and conducted by its academic staff and students. Lancaster University has an excellent reputation for doing so, and will not unreasonably refuse IP usage. It will, on the contrary, be encouraged, with favourable terms applied.

Investment Contact

We thank you for your interest in investing in our company and hope you see the incredible potential as we do. For all enquiries, please contact:

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