



BRAGG CENTRE FOR  
MATERIALS RESEARCH  
**ANNUAL REPORT**

2021/2022



UNIVERSITY OF LEEDS

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**Vision:**



*“The Bragg Centre nurtures a vibrant and innovative materials research community to deliver the greatest impact across disciplinary boundaries.”*



**EDI Statement:**



*The Bragg Centre is an inclusive, diverse and creative materials research community which attracts and develops students and staff of all identities, characteristics and backgrounds, valuing everyone’s contribution and supporting them to thrive.*

*The Bragg Centre is committed to continuous, ongoing action to improve everyone’s well-being and productivity.”*



# Our Capabilities

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## **New ways of using energy: power efficiency, scavenging and biohybrid capture**

- Engineering interfaces between electronic, magnetic, and photonic materials to deliver ultralow power electronics.
- Exploiting tribology, piezoelectric materials and thermal sources to develop energy scavenging systems for wearable textiles, robotics and self-powered devices.
- Creating biohybrid approaches to solar energy capture using bacteria, mitochondria and self-assembled systems – a “bionic leaf”.

## **New approaches to personalised healthcare: model systems, diagnostics and interventions**

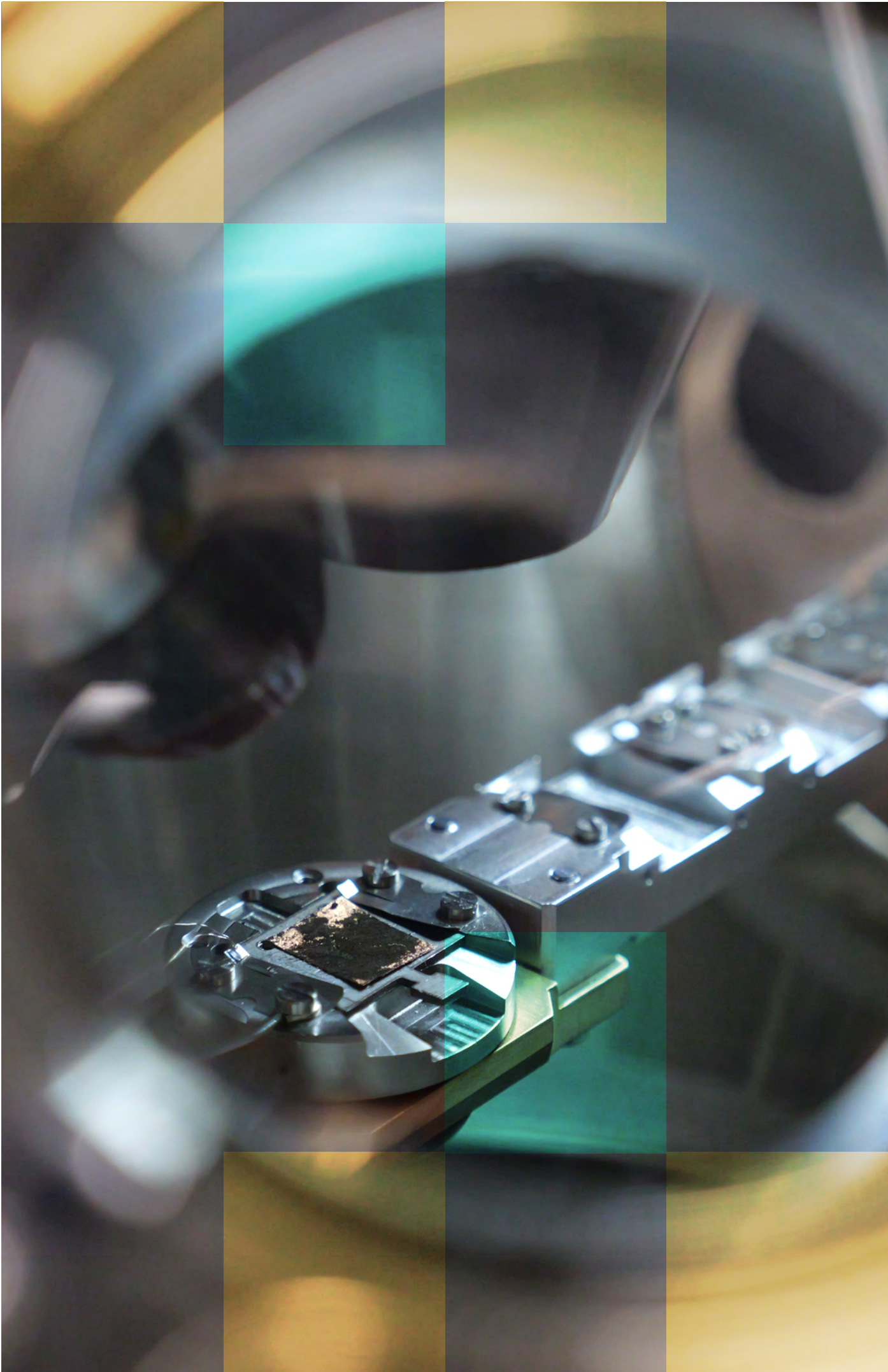
- Accelerating drug development, understanding disease, and reducing in vivo trials through developing model membrane and organ-on-chip systems.
- Developing new tools and approaches for precision diagnostics and treatment, including biosensors, smart materials, and cell enrichment.
- Designing new materials for delivery of bioactives, human tissue replacement and surgical lubrication.

## **New ways of computing: architectures, algorithms and storage**

- Alternative computing methods (e.g. neuromorphic and quantum) providing energy efficient and secure architectures.
- Innovative computer algorithms for interpreting big data sets.
- Biological based approaches (e.g. DNA) for low energy archival data storage.

## **New approaches to materials design: prediction, mitigation and sustainability**

- Multiscale characterisation, in *operando* analysis and simulation informing in silico prediction of materials properties from atoms and crystals to products and manufacturing.
- Developing resilient engineering mitigation strategies against wear, corrosion and failure based on predictive interface performance.
- Sustainable approaches to material synthesis from research to production, inspired by and using natural materials, and reducing waste.



# Director's Summary

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**Prof. Edmund Linfield,**  
Director of the Bragg Centre

## From strength to strength

I can't think of a better way to describe the Bragg Centre's progress over the last year. A transformation has happened since October 2021, when we were debating whether or not to hold the first Bragg

Exchange in person. We did! Since then, the Centre has significantly expanded its activity, with its membership growing by a third, to more than 300 active members, including 118 postgraduate researchers.

A great excitement this year was the formal opening of the Sir William Henry Bragg building by Sir Adrian Smith, President of the Royal Society. This included a special programme of commissioned music, literature, and exhibitions, and was accompanied by an inspirational lecture by the Chair of our External Advisory Board, Dame Julia Higgins. We also released a children's book in partnership with the Cultural Institute, featuring the Bragg Centre and bringing materials science to a primary school audience.

The Bragg Centre has continued to focus on a 'people first' approach, where the development of knowledge, skills and opportunities is at the heart of everything we do, working in close partnership with the **Henry Royce Institute** to develop the future UK materials landscape. Over the year we have recruited a third cohort to our PhD programme and held our summer PhD Colloquium with a panel of industrial experts invited for the first time to provide perspectives on non-academic career opportunities. We also supported a further eight undergraduate internships, with a showcase of their work in September, and it was a pleasure to see some of our previous internees returning to Leeds as PhD researchers.

Capitalising on our relocation to the Sir William Henry Bragg building, and the relaxation of pandemic restrictions, we have been able to showcase our world-leading facilities and capabilities. This has translated into the development of five new industrial partnerships, and the strengthening of existing relationships, including support for new iCASE studentships. And we have seen a 35% increase in external access to our research facilities through the Royce SME and HEI access schemes. We participated in the KTN's Materials Research Exchange in London, and have led a regional materials Science and Innovation Audit, working with the West Yorkshire Combined Authority.

A continued focus is the working across interdisciplinary boundaries to widen participation in materials science and engineering. We have introduced a wide-ranging events programme, 'Lunch@Bragg', and re-developed our annual symposium, now the Bragg Exchange, into an external facing and publicly livestreamed research conference. We also worked through the **Henry Royce Institute** to engage >2000 members of the public at New Scientist Live. Our DNA Origami outreach project (with Royce and the Institute of Research in Schools) has now supported 400 'A' level students nationally, and was recognised by a national award. It has also been a delight to see participants being inspired towards science and engineering careers, and securing University places.

2022 has been a remarkable year for the Bragg Centre – my thanks and congratulations to all who have contributed to its success.



# Our Progress in Perspective

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## Perspective from the External Advisory Board



**Prof. Dame Julia Higgins**  
DBE FRS FEng,

**Chair of the Bragg Centre  
External Advisory Board**

My first visit to Leeds to discuss chairing the External Advisory Board (EAB) of the newly formed Bragg Centre was in June 2018, and the first meeting of the EAB itself was held in Leeds in January 2019. The

EAB visited Leeds again in July 2019 and held its first annual review of the Centre in Leeds in January 2020. Little did we realise how precious these three face-to-face meetings were to become in retrospect! The EAB was unable to meet in person again until June 2022. The Centre team performed miracles of online meeting organisation throughout the pandemic years of '20 and '21 until finally the EAB was able to join the celebrations surrounding the opening of the Sir William Henry Bragg Building in person this last June.

As I stand down as Chair I have been recalling and noting with pleasure the progress the Centre has achieved through those years. This year has been particularly significant, marking the successful move into the new building. In our visit in June we were able to see for ourselves the high quality of the new laboratory space and how access to this is raising the experience of the research workers from PhD students upwards. The communal space in the building is creating a real “buzz”. It provides many opportunities for formal and informal interactions of the members of the Centre as the EAB has been advocating consistently for over the last 4 years or so.

Over those years the EAB has been providing advice to the Bragg Centre and to the University Management on many aspects. It has been gratifying to note the attention which has been paid to this advice, for example in terms of defining a mission and vision for the Bragg Centre and developing a long term financial and academic strategy. Hopefully, designated space will soon be found within the Bragg Building for the Bragg support team and for meetings of the Centre's Management Committee particularly, for example, with industrial partners.

Of course, nothing should stand still and I shall watch keenly from the sidelines how the Centre continues to grow its successes in coming years, and how it will develop the advisory capacity currently centered in the EAB.

## Comment from the Deputy Vice-Chancellor



**Prof. Nick Plant,**

**Deputy Vice-Chancellor:  
Research and Innovation**

The University of Leeds harnesses expertise in research and education to transform lives and shape a better future for our communities, our region and the world, by working across disciplines to push the boundaries of

knowledge. The opening of the Sir William Henry Bragg building, a state-of-the-art integrated teaching and research facility, will help the University achieve this strategic aim of making a positive difference in the world through scientific discovery and collaboration. These world-leading experimental and analytical facilities will help scientists and engineers across the globe to understand and build materials from the atomic to the macro-scale and will provide a shared interdisciplinary environment to address some of the most significant global challenges.

The Bragg Centre has seen growth in strategic partnerships with industry which has contributed to a heightened global reputation, establishing the Bragg Centre as an international hub of research excellence in materials science. The Centre's membership has seen further growth across many disciplines and its emergent interdisciplinary researcher community and team is recognised as one which is committed to developing a positive and inclusive research culture. The launch of a comprehensive events programme, successful internships, impactful UG, PhD and outreach programmes have further contributed to the Bragg Centre's success over the last year, and these programmes have shown tangible benefits that have enabled our students to thrive throughout their learner journey and graduate as research leaders equipped to make a difference in the world.

There have been many achievements by the vibrant and innovative materials research community in the last year, and I am looking forward to seeing what the Bragg Centre can bring to 2023.





# Our Governance

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## Research Theme Leads



**Prof. Rik Drummond-Brydson**  
Analytical Science



**Prof. Christoph Wälti**  
Bionanotechnology



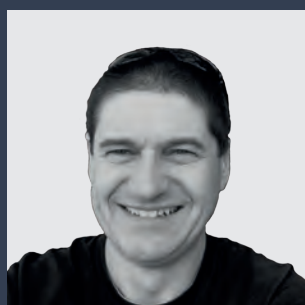
**Prof. Christopher Marrows**  
Electronic & Photonic  
Materials



**Prof. Ardian Morina**  
Functional Surfaces



**Prof. Fiona Meldrum**  
Multiscale Materials



**Prof. Brent Murray**  
Soft Matter  
(Stepped down Dec 2021)



**Prof. Edmund Linfield**  
Centre Director

## Bragg Centre Team



**Dr Andrew Lee**  
Centre Manager



**Ms Lucy Leonard**  
Research & Innovation  
Development Officer



**Daniel Paterson**  
Research & Innovation  
Development Officer  
(Joined January 2022)



**Mrs Helen Walters**  
Research & Events  
Administrator  
(Returned from maternity  
leave April 2022)

## Ex Officio Members

- **Dr Oliver Harlen**, Pro Dean for Research & Innovation
- **Prof. Giles Davies**, Pro Dean for Research & Innovation
- **Dr Ceri Williams**, Director of Research & Innovation Development

## Management Committee Members by Application

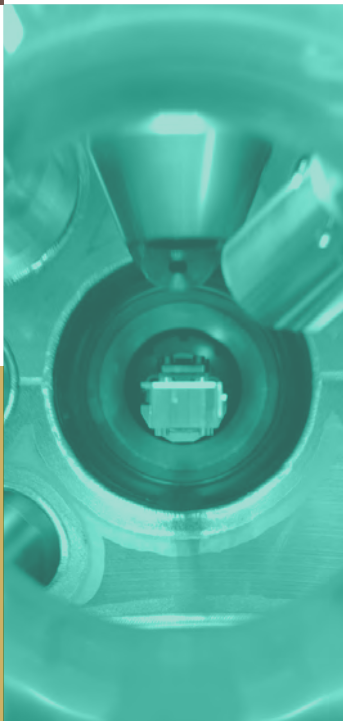
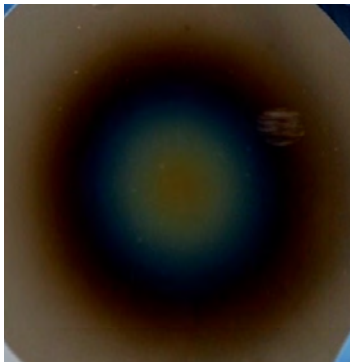
To ensure that the management committee continues to represent a balanced view of the community, members are appointed by application to sit for a two-year term. This year the Centre has also recruited a student representative to the committee to be the voice of our growing post-graduate research community.

### Term: October 2020 – September 2022

- Dr Maisoon Al-Jawad, School of Dentistry
- Dr Sean Collins, School of Chemical & Process Engineering
- Dr Adam Sweetman, School of Physics & Astronomy

### Term: October 2021 – September 2023

- Dr Almut Beige, School of Physics & Astronomy
- Prof. Robert Kay, School of Mechanical Engineering
- Prof. Anwasha Sarkar, School of Food Science & Nutrition
- Dr Philippa Shepley, School of Physics & Astronomy
- Ms Rachel Bocking, School of Chemistry (Student representative),



## External Advisory Board

Our external advisory board helps to shape the strategic direction of the Bragg Centre. Drawn from academia and industry, they continue to support the growth of the Centre and its international reputation for materials research.

- **Chair:** Prof. Dame Julia Higgins DBE FRS FREng, Imperial College London
- Prof. Jeremy Baumberg FRS, University of Cambridge
- Prof. Peter Dowding, Infineum UK
- Dr Mark Hampden-Smith, Saint-Gobain Innovative Materials
- Dr Sheetal Handa, BP International Centre for Advanced Materials
- Dr Rob Hardeman MBE, Independent Technology Consultant
- Prof. Mary Ryan FREng, Imperial College London
- Prof. Adrian Sutton FRS, Imperial College London (Stepped down June 2022)
- Dr Alan Turnbull OBE FRS FREng, National Physical Laboratory (Stepped down January 2022)
- Prof. Jim De Yoreo, Pacific Northwest National Laboratory

# Innovate

## Industrial Engagement

**This year, with the relaxation of COVID-19 restrictions the Bragg Centre has finally been able to open its doors to industrial partners and showcase our stunning new facilities in the Sir William Henry Bragg building.**

Whilst hosting an increasing number of tours, the Centre has ensured that it maximises any potential opportunities by engaging visitors directly with the community on site. In February, QinetiQ visited the Centre with delegates enjoying a packed schedule of facility tours, academic meetings, and delivering a talk to the wider community as part of the Centre's Lunch@Bragg seminar series. The talk provided key insights into QinetiQ as a company and presented wide ranging opportunities, including collaborations and career pathways which engaged both the academic and student communities.

This exemplifies the Bragg Centre's approach to industrial engagement, which aims to develop long term strategic partnerships with multiple points of interaction, including collaborative projects, experimental services and joined up career pipelines.

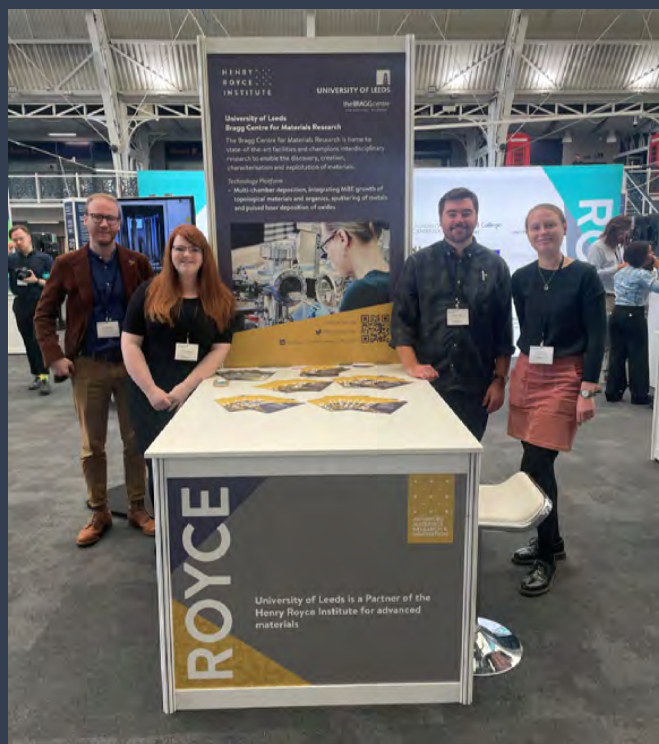
As a result, during the visit QinetiQ agreed to fund an iCASE studentship to begin in October 2022 and expressed further interest in supporting future PhD studentships and Undergraduate Internships through the Bragg Centre. More significantly, the Centre is enabling a stronger relationship by permanently hosting a member of QinetiQ staff on site in Leeds. By bringing industry into its community as equal partners, the Centre aims to increase the breadth, depth and longevity of its research collaborations.

Elsewhere, the Bragg Centre has committed to enhance the commercialisation pathway at Leeds for materials science research. This year the Centre has worked hard to establish itself as a liaison between academics and the commercialisation team within the Research and Innovation Service (RIS). This will enable the Centre team to expertly identify and develop opportunities more quickly from within the community. Several projects are beginning to be delivered through this new route, in particular a collaboration with SureScreen Diagnostics.

Looking outward, the Bragg Centre joined the Henry Royce Institute at Innovate UK's Materials Research Exchange conference this year. With over 160 speakers, 73 exhibitors and 1400 registered delegates, this was a fantastic opportunity for the Bragg Centre to connect its research opportunities and experimental capabilities to a national audience. The Centre delegation engaged with a range of industry representatives, international academics and investors during the event and have subsequently been busy following up many leads in the months since.

## Industrial Engagement Highlights

- **Established 5** new research partnerships with businesses such as; QinetiQ, SureScreen Diagnostics, and Nippon Sheet Glass.
- **Strengthening connections** with 3 partners, including; Futamura, Merck Group, and Invibio Ltd.
- **Attended 2 industry** facing conferences, the Advanced Materials Show and the Materials Research Exchange.
- **Supported delivery** of a regional Materials Science and Innovation Audit.



## Industrial Scale Innovation

### A pure bridge between industry and academia

Research is typically done at a small scale, which often leaves a significant gap between proof-of-principle and realisation at an industrial scale.

In this regard, the Bragg Centre's Physical Vapor Deposition (PVD) facility breaks the mould. Working in close partnership with the manufacturer Hauzer, the PVD system has undergone significant upgrades in recent years to create a facility that has the unique capability to perform fundamental research with the capacity of an industrial scale chamber.

When describing the facility, Dr Liuquan Yang said;

***"We use the machine to do research on small components, but it also has the capacity to scale up the processes for transfer to industry"***

Planning for the new upgrades started in 2018, with Hauzer's engineers gradually upgrading the entire system *in situ* over the proceeding years to minimise down time in the facility. This presented significant engineering challenges, which had to be overcome, in order to retain the existing technology whilst adding the capabilities to address new materials.

Now in full operation, the system can deposit insulating coatings, such as aluminium oxide, for the first time thanks to the addition of an AT-Mode unit. Whilst an RF bias was added to enable the creation of denser insulating coatings for which the existing pulsed DC bias was redundant.

The upgrades further included essential plasma diagnostic tools such as optical emissions spectrometer and Langmuir probes. These research tools, not typically seen on industrial systems, enable researchers at the Bragg Centre to explore the foundations of the plasma physics process as it is *in situ* in the large chamber.

***"This makes it a pure bridge between industry and academia, being able to understand the plasma physics on an industrial scale"***

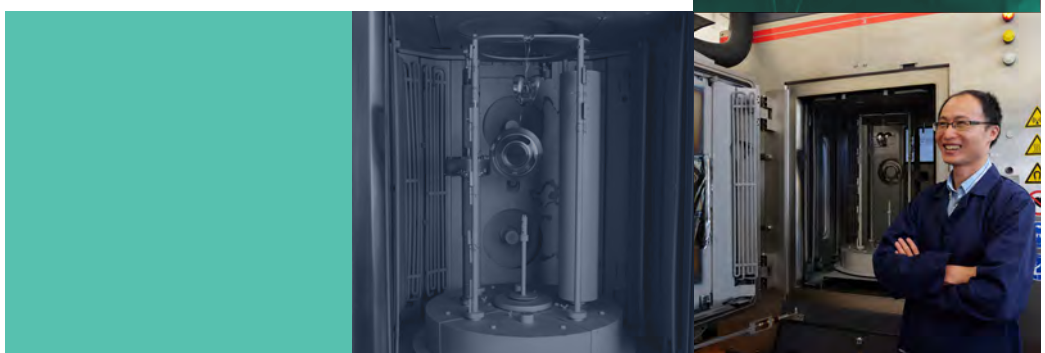
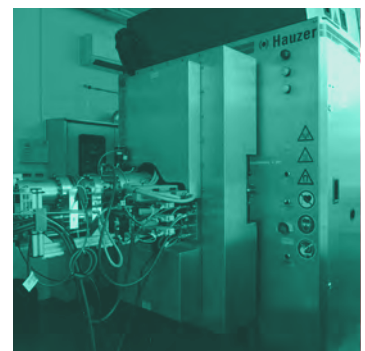
However, by far the standout element of the system is the integration of a nanoparticle source (NPS), provided by the manufacturer HVM Plasma. This one-of-a-kind integration enables the incorporation of nanoparticles directly into a coating rather than introducing them through spraying or painting in subsequent layers.

Nanoparticles have a lot of promise within coating applications, including antimicrobial and medical treatments, as well as catalysts. They are also enabling the development of advanced sensing technology embedded within smart tribological and tool coatings.

Integrating the NPS was a significant undertaking, enabling not only the generation, but also the size selection and distribution control of the nanoparticles within the chamber. The Bragg Centre is proud to support this kind of one-off cutting-edge integration, which pave the way for new innovations and applications.

The relationship between the Bragg Centre and Hauzer continues to go from strength to strength, with three established industrially sponsored PhD students. When asked about their interactions with the Bragg Centre, Hauzer said;

***"It's important to us to not just sponsor and give money, but also help shape the project so it's relevant to both academia and industry"***



## Translating Research into Impact: AquaLub



### Dr. Olivia Pabois

Postdoctoral Research Fellow,  
School of Food Science and  
Nutrition

Dry mouth is an age-related condition that affects 1 in 10 adults in the UK, significantly impacting the quality of life and leading to malnutrition. This lack of salivary lubrication is

linked to increased risk of dental conditions including dental caries, periodontal diseases, and oral ulceration, which collectively cost the NHS an estimated £7.3Bn annually.

At present, there are numerous commercially available salivary replacers, but none offers long-lasting relief due to their poor lubrication properties, thus forcing sufferers to use mouth spray repeatedly all day long to be able to speak and eat. This sub-optimal performance is due to the use of hydrophilic polymers - for example, xanthan gum - which act as gelling agents to form a viscous fluid film to moisten and lubricate the mouth. However, these formulations do not adsorb efficiently onto the tongue and palate, offering only short-lived relief.

To combat this, Dr Olivia Pabois has helped to develop e.g. AquaLub as an effective human saliva substitute which offers up to 95% more effective lubrication and 50% longer relief than current formulations. This exciting work bridges the Bragg Centre's soft matter and functional surfaces research themes through the creation of a new biomaterial which uniquely combines a microgel and hydrogel together in a patented formulation. AquaLub provides outstanding lubrication between biological surfaces due to the high-water content encapsulated within the biopolymeric hydrogel. Whilst the inclusion of a proteinaceous microgel significantly increases the biocompatibility and adhesion to biological surfaces following ingestion, providing long lasting hydration.

The development of this technology spans chemistry, physics, engineering, dentistry and food sciences, exemplifying the Bragg Centre's interdisciplinary ethos. Through this work, Oliva further strengthened international partnerships undertaking a three month placement at the Weizmann Institute of Science (Rehovot, Israel) with the support of the Royal Society International Exchanges Scheme. Whilst much of the small-angle neutron and X-ray scattering experiments conducted during her research were enabled by the Bragg Centre's partnership with the ISIS Neutron and Muon source at Didcot.

Olivia's journey towards real world application has been supported by the Bragg Centre's partners at NEXUS, alongside external consultants, and industry to translate the technology into a commercial product. To date, this work has successfully demonstrated regulatory compliance and up-scale feasibility, alongside identifying further potential personal, surgical and health care lubricant applications.

Olivia graduated from King's College London with a PhD in Chemistry, prior to joining the Bragg Centre as part of Prof. Anwesa Sarkar's research group. Her exceptional postdoctoral work developing AquaLub into a commercial product, continues to be recognised with a multitude of successful funding awards including a Michael Beverley Innovation Fellowship. When reflecting on her involvement with the Bragg Centre, Olivia explained that;

***"Belonging to Bragg's community is rewarding from a professional networking perspective as it gives me an outstanding opportunity to get access to and interact with a broad range of scientists, both early career scientist peers and more senior academics/industrialists. [Bragg] gives me a great opportunity to draw upon an extensive industrial network and engage with potential stakeholders for commercial exploitation, partnership development, and potential creation of university spin-out from this platform technology"***

## Taking Technology Through TRL Levels: the Ceramic Hybrid Additive Manufacturing Platform (CHAMP)



**Prof. Robert Kay**  
*Professor in Advanced Manufacturing,*  
 School of Mechanical Engineering

Ceramics are used across a wide range of industries due to their superior materials properties, in particular their resistance to extremely high heat and abrasion, excellent electrical characteristics, and chemical inertness. These properties make ceramics the perfect material for applications in electronics, sensors, transducers, orthopaedic implants, and chemical processing, to name but a few.

Despite the demand, the full potential of ceramic materials remains unrealised with many applications limited by the ability to manufacture the ceramic components. In particular, the ability to 3D print ceramic materials is extremely challenging and it is currently not possible to produce parts by 3D printing with the same material properties as conventional manufacturing techniques. However, it is becoming clear that there are unique advantages that would be unlocked by the ability to additively manufacture these materials, enabling the production of bespoke orthopaedic implants, high performance electronics systems or complex components for use in molten salt nuclear reactors, as prime examples. As such, the printing of ceramic materials remains the holy grail of the additive manufacturing field.

Not one to shy away from a challenge, Prof. Robert Kay is developing a hybrid additive manufacturing technique within the Bragg Centre which overcomes some of the previous challenges in this area. This approach promises to allow for the seamless integration of 3D ceramic printing processes directly into industrial production lines.

The term hybrid additive manufacturing refers to a system that integrates additive, subtractive and assistive processes within a single digitally controlled manufacturing platform. Robert began developing this technology in 2012 during his time at Loughborough University through the Innovative Electronics Manufacturing Innovation Centre, IeMRC which included seven industrial partners; Renishaw, Morgan Advanced Materials, Mactaggart Scott, Baker Hughes, Torishima, Zettlek, and Eltek Semiconductors. Taking the platform from concept to technology readiness level (TRL) 2 throughout this period.

Since joining Leeds in 2016, Robert has successfully progressed the technology through TRL 3 – 5, supported by the EPSRC Hybrid Manufacturing Platform Grant [EP/P027687/1] and then an impact accelerator award in partnership with new industrial partners and the Manufacturing Technology Centre (MTC) catapult. Despite several other unsuccessful grants to support development on the project, the technology secured significant industrial attention which has led to £300K of

direct industry funding in 2021. In addition to direct capital investment, the company – who cannot be named at the time of writing – has further supported two DTP+CASE studentships and a two year PDRA to translate the technology into an industrial manufacturing platform through TRL 5 – 7.

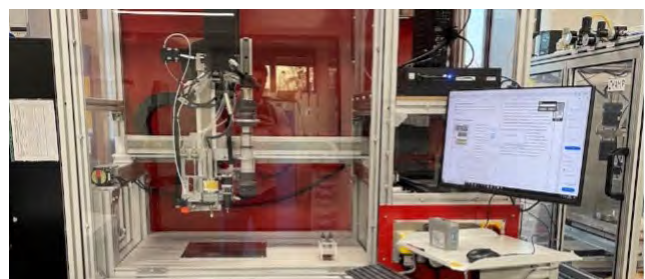
This remains an intensely active research area for Robert, with machines now on site with the partner company as the technology progresses towards TRL 9. At this stage the focus is now on seamless integration of the platform into existing ceramic manufacturing lines. Meanwhile the original research and development lab equipment remains in the Bragg Centre, where it is currently being used as a test bed to formulate new materials. This is allowing Robert to develop novel applications which benefit from the platform's unique ability to manufacturing materials and product complexities beyond that of current 3D printing techniques.



Throughout his career, Robert has developed several disruptive manufacturing techniques and exploited these ideas to benefit industry, society, and scientific research. In 2003, Robert founded his first venture, MicroStencil Limited, which commercialised his early research and established a manufacturing partnership licence in Asia. It is this combined background in fundamental scientific research and enterprise which subsequently enabled Robert to draw on blue-sky funding routes to successfully develop speculative manufacturing concepts and to work with a range of industrial partners, translating academic research into the engineering sector.

Robert believes that the Bragg Centre is the perfect place to build on the UK's legacy as a world leader in advanced ceramics, with its multidisciplinary research approach to solving industrial problems.

***"The Centre provides a key interface between manufacturing and materials science, enabling access to the critical mass of knowledge and analytical facilities to underpin the development of future ceramic materials"***



## Game Changing Philanthropy

The Wolfson Imaging Facility was established within the Sir William Henry Bragg building as a joint venture between the Bragg and Astbury Centres at the University of Leeds. Its aim is to develop a world-leading set of microscopy and analytical instrumentation for the real-time studies of biological processes.

This vision is being delivered through the award of £750,000 from the Wolfson Foundation in 2020 to secure state-of-the-art equipment, whilst the University has invested in new purpose-built laboratory space within the basement of the Sir William Henry Bragg building. Now entering an operational phase, following installation of the primary equipment, the Wolfson Imaging Facility is poised to become a national hub of excellence in biological imaging.

However, to realise the full potential of outstanding infrastructure, it is also necessary to significantly invest in the expertise and skill sets necessary to deliver world leading research from the cutting-edge equipment.

Within the Wolfson Imaging Facility, this is being made possible by a generous donation from Dr Chris Pointon and Liz Pointon, both University of Leeds graduates, which will underpin staffing for the new facility. Throughout his career, Chris has been a strong supporter of the need for interdisciplinary research, and, as a result, he was keen to support the development of this cross-faculty initiative at Leeds.

***"Throughout my career I have believed there is great value in interdisciplinary collaboration and breaking down boundaries between 'specialisms'. As a Leeds graduate and longstanding supporter of the University, I'm excited by the potential the facility has to produce ground-breaking outcomes by combining various scientific disciplines with medical research"***

Chris is a respected mining executive with deep public company board and operational management experience. Having graduated with a degree in Earth Science & Chemistry from the University of Leeds in 1970, Chris went on to achieve a PhD in Geology at Aston University in 1979. With over 40 years-experience in the resources business, his career has spanned multiple continents and companies, including Rio Tinto, Royal Dutch Shell and Gencor. Chris became President of Stainless Steel Materials at Billiton (subsequently BHP Billiton) where he built its nickel business into the world's third largest producer with sales in excess of \$5bn. Following his retirement from BHP Billiton in 2007, Chris has held a number of non-executive board positions and consulted to the mining industry.

Liz has had a wide-ranging career working in education, the arts world and local independent radio, whilst her voluntary work with children's groups, libraries, the Pony Club and School Governance underpins her interests in supporting young people's development.

This year Chris visited the Bragg Centre and met with researchers in the Wolfson Imaging Facility to connect with impacts of their generous donation. Chris commented that;

***"I was really delighted to see the development of a truly cross-disciplinary research facility which has the real opportunity to allow us to obtain an understanding of biological processes that underpin a breadth of medical conditions and treatments. I am delighted that my gift has really made a difference and to be able to visit and talk with such an enthusiastic and very impressive set of researchers. I really believe that the work that is being pursued provides the opportunity to make a difference to global society"***

The Bragg Centre believes that the route to world leading research and innovation is through investment in people, training, and community. Something that is exemplified by the development of the Wolfson Imaging Facility.





## Developing Future Leaders



**Dr. Richard Mandle**  
*University Academic Fellow*  
 School of Physics &  
 Astronomy and School of  
 Chemistry

Virtually everyone experiences nematic liquid crystals within their daily lives through their use in display technology. This

industry was worth \$157Bn in 2021 and exploits the ability of an electric field to alter the optical properties of the liquid crystal medium. To date, the nematic liquid crystal phases used commercially are described as non-polar, which refers to their lack of organisation on a bulk scale.

However, in 2017, work by Dr Richard Mandle demonstrated the existence of a new class of these materials which displayed long range order, or a polar ferroelectric nematic phase. In this phase the electric polarity of the individual molecules is organised such that they display a whole host of properties that are absent from conventional nematic liquid crystals or indeed most other phases of matter.

The combination of fluidity and polar order opens the door to many applications, for example sensors or energy harvesting. However, the current materials generally require elevated temperatures and have very limited scope for tuning properties towards a given application or experiment.

Richard's work is opening up an entirely new, field as ferroelectric nematics are uncharted territory. This puts the Bragg Centre at the forefront of a hugely active area of research, with decades of basic science to explore thanks to properties which cannot be realised in any other system or phase of matter.

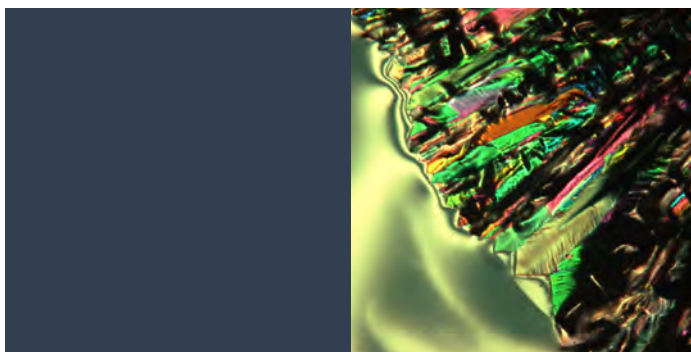
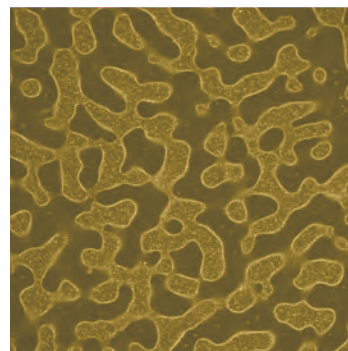
In 2022 Richard was awarded a prestigious Future Leader Fellowship (FLF) to develop these new materials within the Bragg Centre. His aspiration is to develop a materials platform that enables the physical properties to be tuned to meet the requirements of a given application or experiment. To do this he is employing artificial intelligence (AI) to generate and score candidate molecular structures, the best of which will then be synthesised using automated methods. With his UKRI FLF award, Richard has been able to expand the soft matter research laboratory space within Bragg to now include state-of-the-art systems for automated chemical synthesis systems to support his ambitions.

When discussing the Bragg Centre, Richard highlighted that Soft Matter is a real strength of the Centre, with some of the best equipped laboratories in the world for this research. Whilst Richard also indicated that the Bragg Centre's inherent cross-school structure will significantly support his work in the years to come;

***"Interdisciplinarity is another strength of Bragg, with my research sitting at the interface between Chemistry and Physics"***

Prior to joining the Bragg Centre, Richard completed his PhD in Chemistry at the University of York, before moving to the School of Physics at the University of Leeds for a PDRA position with Prof. Helen Gleeson in 2020. This was followed by the award of a UKRI Future Leaders Fellowship in 2022, which enabled him to set up his own research group. When describing his career path, Richard commented that;

***"My background to date had a huge influence on my career path; of course making molecules and studying material properties, but also combining these endeavours with modelling, data analysis and AI has given my research an unusual direction in the field"***



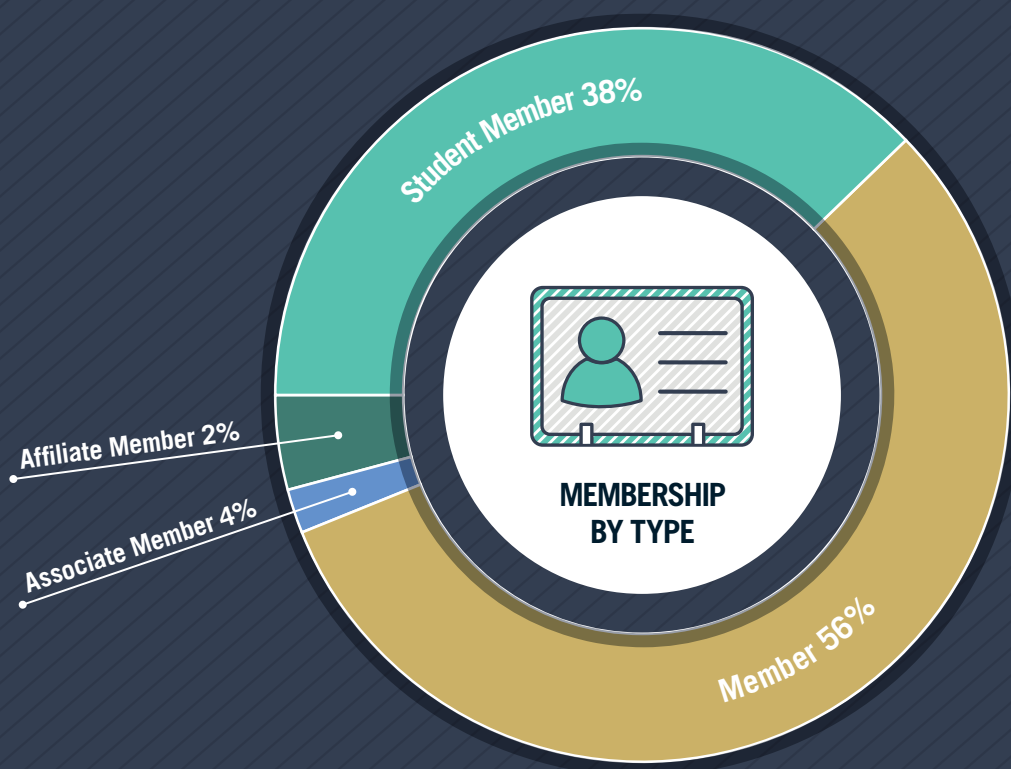
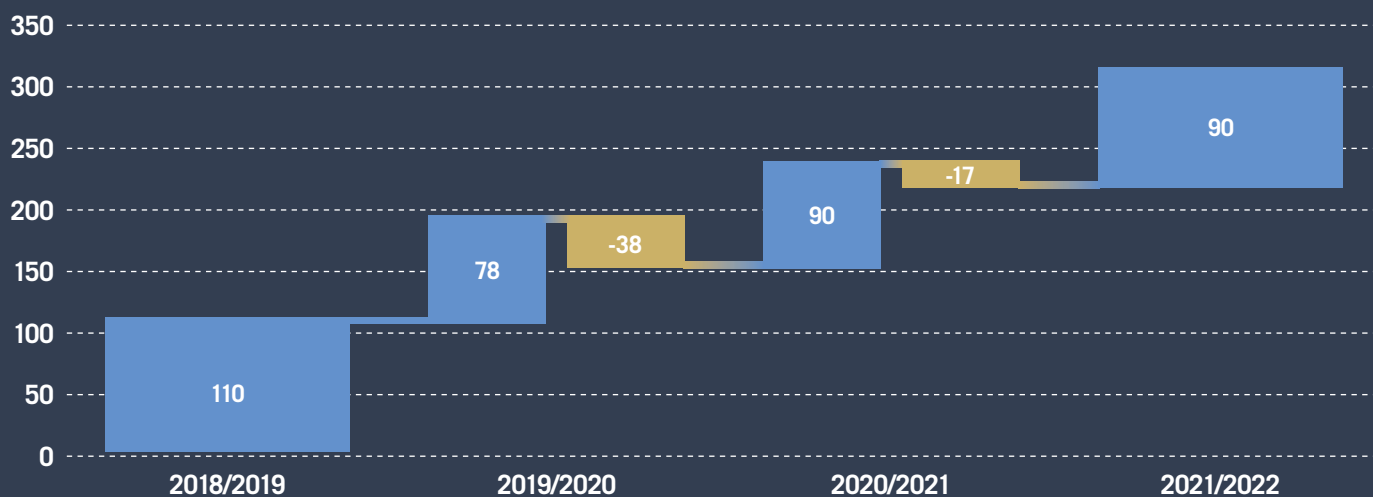
# Collaborate

## Membership

This year the Bragg Centre's membership has continued to swell alongside its growing national reputation as a hub of excellence in materials research. Within the reporting period the community grew by a third to a total of **313 active members** despite a

small turnover in memberships. This was significantly driven by a **30% increase in student membership**, alongside a growing representation of technical staff within the Centre.

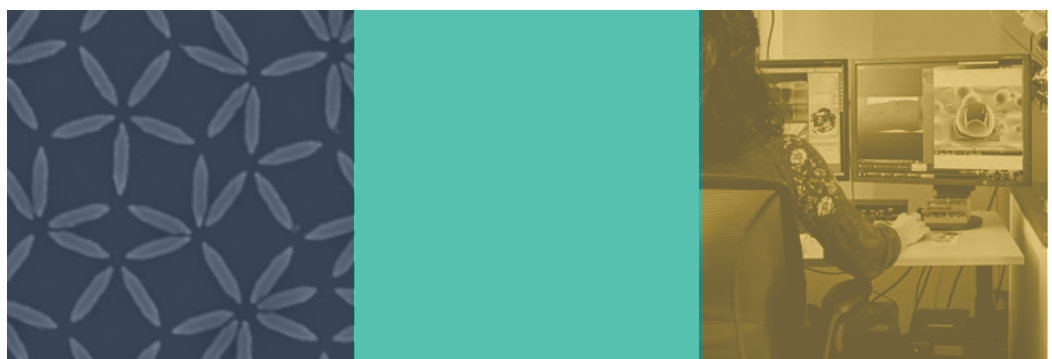
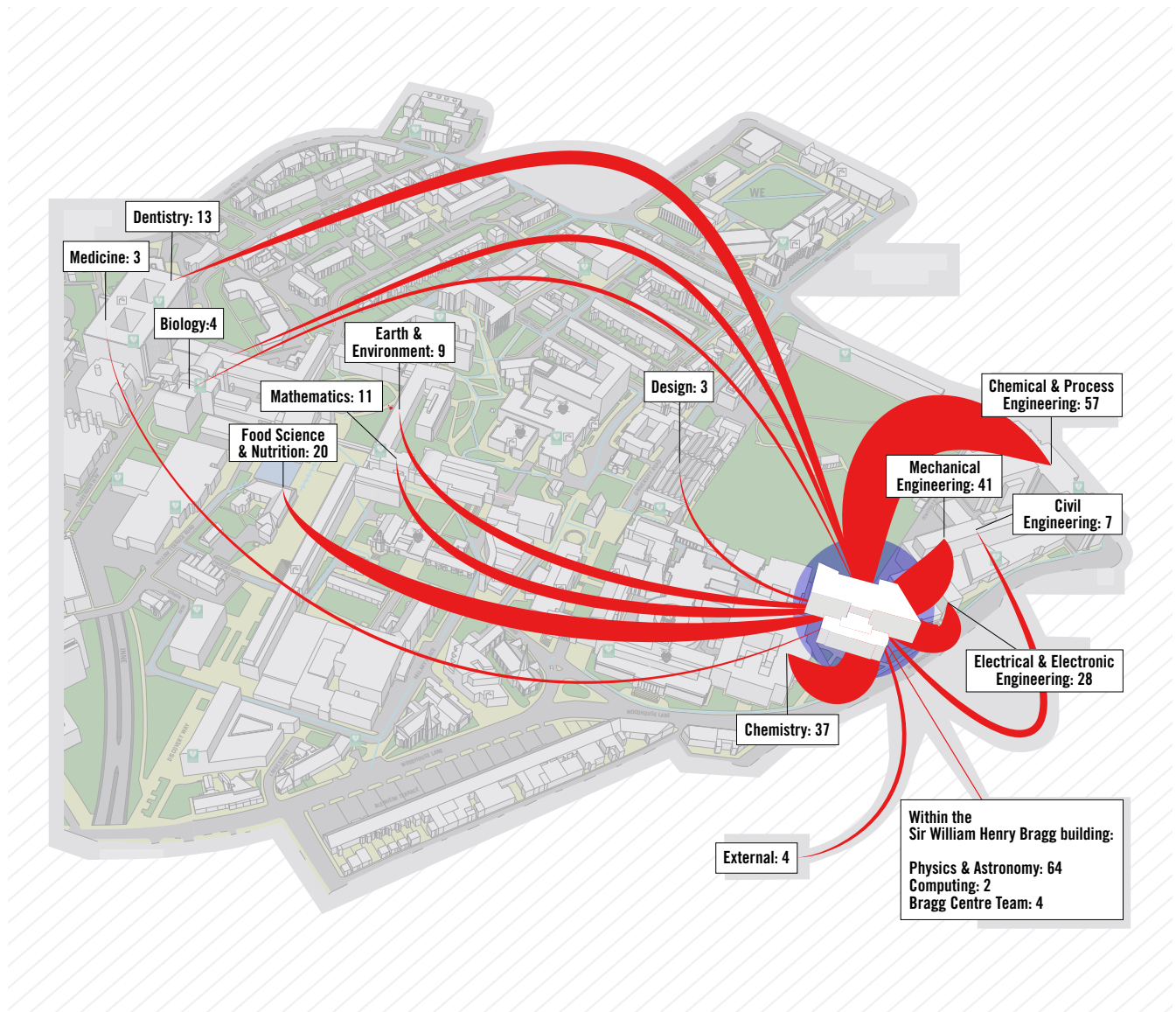
## Membership Growth



## A Focal Point of Activity

With its relocation into the Sir William Henry Bragg building throughout 2021, the Bragg Centre has established a physical focal point of materials research and innovation that draws in members from right across the University of Leeds, and beyond.

Now integrated right at the heart of the Faculty of Engineering and Physical Sciences, the Centre has seen a notable increase in engagement from its core audiences across the schools of Physics & Astronomy, Chemistry, and Faculty of Engineering. Whilst, throughout the year the Centre has begun strengthening key relationships across the University, most notably with the Faculty of Medicine and Health, and the Faculty of Environment, with an uptake in memberships from the Schools' of Medicine, Dentistry, and Earth & Environment.



## Facility Usage

The Bragg Centre's partnership with the **Henry Royce Institute** continues to strengthen, providing a national platform for our state-of-the-art capabilities.

In particular, the Royce Institute continues to enable researchers from across UK-based academic institutions and SMEs to access the capabilities of our experimental facilities through its funded access schemes. This year saw a **35% increase** in access funding, to a total value of **£79,000 across our facilities**.

Demand for our expertise remains high, with the Bragg Centre facilities conducting work for a range of industrial partners throughout the reporting period, from SMEs and multinational companies, and across a range of sectors including petrochemical, electronics and advanced manufacturing.

In addition, the Centre has expanded its relationships with national and European Research Organisations, including the National Physical Laboratory and ISIS Neutron & Muon Source in the UK, as well as the Łukasiewicz Research Network in Europe.

## Grant Portfolio & Highlights

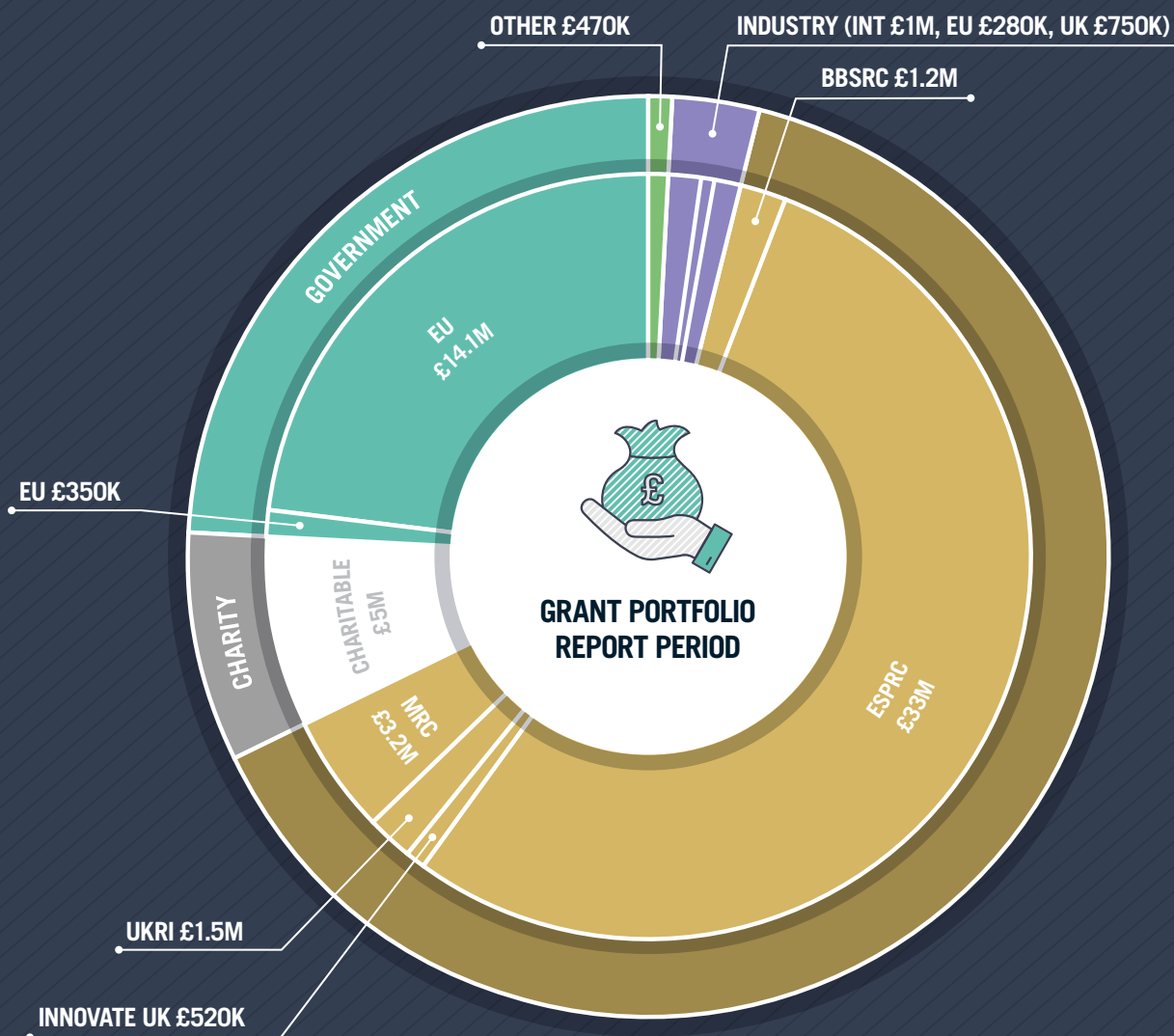
The Centre continues to boast a strong portfolio despite a decrease in the number of active grants, down to 132 during the reporting period September 2021 - September 2022. This is due to the closure of several significant programmes without an influx of new grants coming online within the same period, resulting in a **total open portfolio of £61.7M** across the breadth of the Bragg Centre's remit.

This downturn was to be expected as a knock-on effect from the COVID-19 pandemic, where there was significant disruption to submission and decision timelines of major funding bodies. However, the Centre remains confident in its position with **new awards totalling**

**£20.3M of grant funding secured** throughout the reporting period and due to come online in the next year.

Our current portfolio boasts **£2.05M of direct industry funding** from a diverse range of companies, including BP international Ltd, Merck, Radioactive waste management and Plant Meat Ltd.

Whilst the Centre has experienced an increase in funding from the European Union to £14M, and awards from charitable organisations have doubled to £5M during the last year.



## New Award Highlights

- New direction in high temperature dielectrics: unlocking performance of doped tungsten bronze oxides through mechanistic understanding, *EPSRC*, Steven Milne, £318,238
- Stretching the boundaries: new soft matter systems, *EPSRC*, Helen Gleeson, £2,039,383
- Stopping tooth decay before it begins: Biomimetic Innovative Technologies for dental Enamel Wellbeing (BITE Well), *Diamond Light Source Ltd*, Maisoon Al-Jawad, £206,970
- Bragg Cleanroom Equipment, *EPSRC*, Edmund Linfield, £1,355,703
- Terahertz frequency devices and systems for ultrahigh capacity wireless communications, *EPSRC*, Alexander Davies, £1,390,055
- MESONET: Exploiting in situ protein unfolding to understand and control mesoscopic network formation, *EU*, Lorna Dougan, £ 2,138,063
- BubbLES for TArgeting and TRreatment of biOfilm infectioNs (BETATRON), *EPSRC*, Stephen Evans, £ 397,543
- Customised molten salt (MS) electrochemical test system, *Royal Society*, Frederick Pessu, £24,781
- 2.0 THz local oscillators for radiometric observation of atomic oxygen, *UK Space Agency*, Alexander Valavanis, £94,296
- Laser Processing of Green Bone Scaffolds for Enhanced Biological functionality, *Greenbone Ortho SPA*, Animesh Jha, £55,119

## Guiding Regional Policy: the Materials Science and Innovation Audit

In 2018 an Innovate UK report stated that the global market for materials was soon expected to pass £3 trillion per annum, with the UK materials sector responsible for a substantial segment of that. In that report, Yorkshire, Humber and the wider NP11 region, NP11 is the business-led voice for the North that brings together the 11 Local Enterprise Partnerships, across the North of England were cited as making nationally significant contributions to the UK materials sector in terms of both scale and expertise.

A review of international strategies highlights how materials research and innovation is becoming increasingly important for economic prosperity, supply chain resilience, and security. Whilst the UK has yet to develop a fully comprehensive materials policy it is clear how vital the sector is to UK economic, security and reputational ambitions. While this lack of policy presents some challenges for directing and coordinating materials research and innovation activity, it also presents a clear opportunity for regional stakeholders, such as the Bragg Centre to take a leading role in shaping future materials policy and funding.

In order to gauge how the Bragg Centre can help to support regional materials research and innovation activities the University of Leeds commissioned Perspective Economics in 2021 to undertake an ambitious audit to map the regional materials innovation ecosystem. This Materials Science and Innovation Audit (SIA) is now providing a clearer understanding of the strengths, challenges, and opportunities within the West Yorkshire region.

The West Yorkshire region has a long and well-established history in materials research and innovation, including the Bragg Centre's namesake and Nobel Prize winner Sir William Henry Bragg. Across the NP11 region, the Materials SIA study identified over 40 publicly funded academic research and innovation assets. In West Yorkshire alone, these included nationally significant resources such as the National Physical Laboratory, Future Metrology Hub, and the Polymer IRC.

In addition, more than 250 research and innovation active businesses across the NP11 were identified, almost a third of these are in the West Yorkshire region, including innovative companies such as; Solenis, Wayland Additive, Optalysis and Ionix.

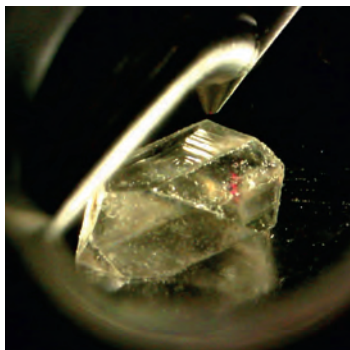
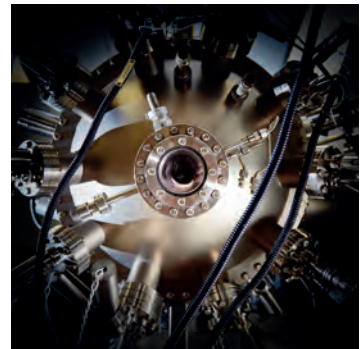
In particular, the Materials SIA demonstrates that expertise in technical textiles, healthcare, advanced manufacturing, computing, electronics and photonics are strengths of the West Yorkshire region. Whilst the activity across these areas spans a range of developmental stages, from discovery and characterisation to application and optimisation.

As part of the audit process, Perspective Economics undertook consultations with many of the businesses identified to understand the challenges that they face. This revealed a general lack of awareness around how to engage with the University, as well as the sort of support and facilities that Universities can offer.

Despite this challenge many of the industry representatives consulted for the audit expressed a strong appreciation and future appetite for the expert knowledge and facilities available at academic institutions. The analysis demonstrates that if the lack of awareness can be addressed, then a greater number of effective research collaborations could be quickly formed.

In addition, the audit further revealed that there exists a considerable demand for access to materials related skills. Businesses identified the crucial contribution that Universities could make to the materials innovation skills pool. Many of the businesses consulted highlighted that access to both undergraduate and postgraduate research projects was of significant interest to them and as such there is a considerable opportunity to increase the number of students engaged in project work with industrial partners through the Bragg Centre.

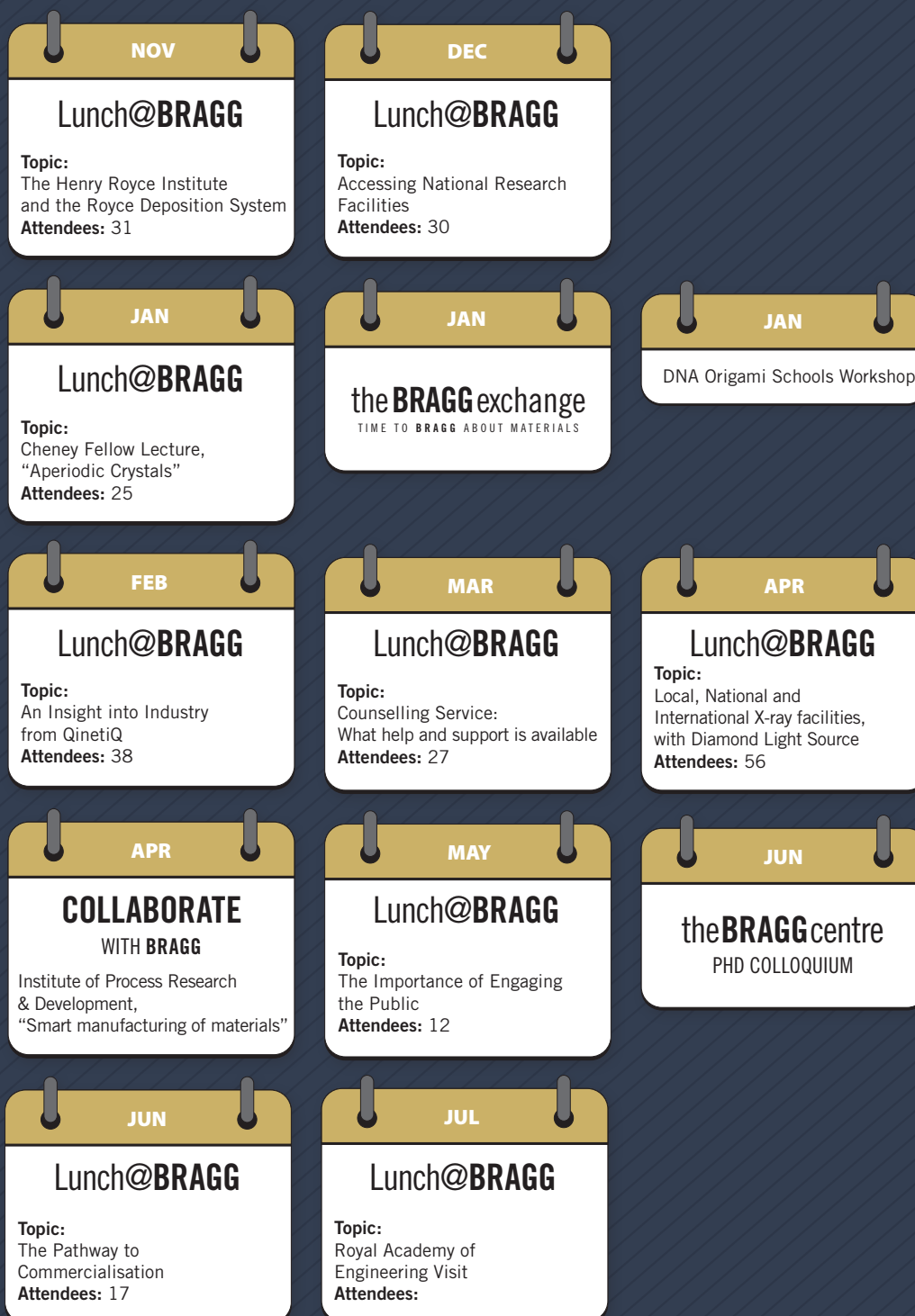
These early insights are encouraging and with the final Materials SIA report due to be published in early 2023, the Bragg Centre is poised to develop wider regional discussions to help advance materials research and innovation activity in a strategic and informed manner across the North. The Bragg Centre is already working with the **Henry Royce Institute** to input into the UK's Advanced Materials Policy and currently strengthening its local partnership with the West Yorkshire Innovation Network to drive growth and development in the region.



## Bringing the Community Together

This year the Bragg Centre launched a new comprehensive events programme which aims to provide something for every member of our broad community.

This includes a new monthly seminar series, **Lunch@Bragg**, which fills the niche between research specific topics and presents practical information to the wider community alongside lunch and networking. Whilst an ad hoc forum, **Collaborate with Bragg**, was launched to allow those who are looking to work with our community to pitch ideas, spark discussions and ignite collaborations. The programme is anchored by the Bragg Centre's key annual events, **the Bragg Exchange** in winter and **the Bragg Centre PhD Colloquium** in summer.





# the BRAGG exchange

## TIME TO BRAGG ABOUT MATERIALS

Traditionally the Bragg Centre has brought its community together for an annual research symposium. This internally focussed event was designed to draw together the disparate members of the materials research community to share ideas and showcase research across the full breadth of the Centre's broad portfolio.

This year, to celebrate the opening of the new Sir William Henry Bragg building and the growing national reputation of the Centre, the internal symposium was re-imagined into an externally facing conference.

The new event draws together outstanding expertise from the Bragg community and external institutions to present the latest research alongside one and other. With dedicated sessions for each of the Centre's thematic areas and a livestream to a public audience, the event is designed to be a platform for the "exchange" of ideas between external and internal audiences, and across research themes and disciplinary boundaries.

With the delivery of the "Bragg Exchange" the Centre was proud to push forwards and deliver the very first large-scale in-person conference held at the University of Leeds since the pandemic began. This has continued the Centre's reputation for pushing the boundaries, adapting to changing restrictions and upholding an unwavering commitment to focus on the wellbeing of its community when other institutions ceased all activities.

The inaugural Bragg Exchange was hosted in the awe-inspiring Great Hall on the University of Leeds campus,

with a poster session and drinks reception held within the stunning atrium of the Sir William Henry Bragg building. The event was well received by the Bragg community with 110 members attending in person, alongside 5 external speakers, and 25 contributed posters.

The Bragg Centre is proud to champion widening participation in materials science, with the public livestream viewed by over 200 people from around the world. In the future, the Bragg Exchange will return as the centrepiece to the Bragg Centre's annual events programme with aspirations to grow the event into a mainstay of the national materials science conference circuit by opening the event up to external audiences.



# Educate

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The Bragg Centre remains committed to developing the skills pipeline in materials research and engineering. In pursuit of that goal, this year the Centre has expanded its internship programme and welcomed a further cohort into its PhD Studentship programme.

## Undergraduate Summer Internship Scheme

Throughout the summer of 2022, the Bragg Centre expanded its support for undergraduate internships with a further eight students supported through a combination of Bragg Centre, Royce and EPSRC funding. The scheme offers materials science-related research projects to students about to enter their final year of study. Each student undertook an 8-week research placement which culminated in a poster showcase attended by their fellow interns, supervisors and academic staff.

This year the Centre sought to increase the benefits offered by the scheme by providing supervision opportunities to early career researchers. As a result,  $\frac{3}{4}$  of the projects on offer were led by researchers undertaking a supervisory role for the first time.

The projects included:

- Structure formation in PEG membranes induced by hexosome liquid crystalline particles - **School of Food Science & Nutrition**
- Characterising the mucoadhesion of an innovative, patented aqueous lubricant - **School of Food Science & Nutrition**
- The Diffusion of Small Molecules through Fractal Gel Networks: The Good Kind Of Drug Delivery - **School of Physics & Astronomy**
- 3D printing bio-materials of the future! - **School of Physics & Astronomy**
- On water N-alkylation reactions in flow, investigating surface interactions - **School of Chemistry**
- Investigating the mechanical properties of rust surfaces and iron-rust interfaces at the nanoscale in order to decode the lost secret of rust-resistant iron from ancient India - **School of Physics & Astronomy**
- In-situ XRD studies to characterise early age hydration interaction of calcined clay-cement blends - **School of Civil Engineering**
- Investigation of Chiral Antiferromagnetic Multilayer Thin Films using a Magneto-optical Kerr Effect Magnetometer - **School of Physics & Astronomy**

## Internship Poster Showcase

The 2022 internship scheme culminated with a Poster Showcase and celebration event in the Sir William Henry Bragg Building on the 15 September, hosted by the Bragg Centre. The event championed the incredible work that student interns had completed over the summer and gave staff and students from across the University a chance to see posters representing the broad range of fascinating projects.

A large number of projects were on display, with Bragg and Royce funded projects displayed alongside those from across the Schools of Chemical and Process Engineering, Civil Engineering, Electronic & Electrical Engineering, Mechanical Engineering and Physics & Astronomy

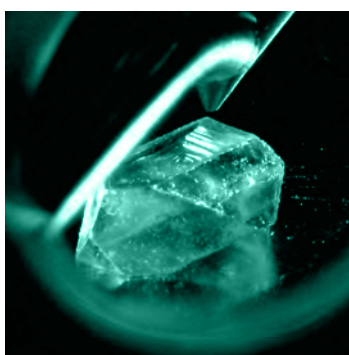
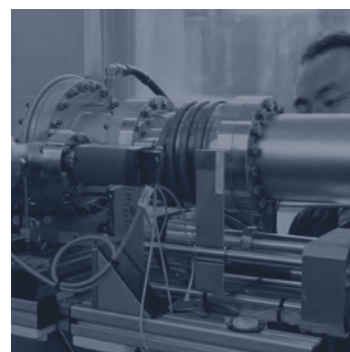
The evening also included a poster competition, with prizes sponsored by the **Henry Royce Institute**. The judging panel consisted of Prof. Ozz Querin (Pro-Dean for Student Education), Dr Andrew Lee (Bragg Centre), Prof. Edmund Linfield (Bragg Centre) and Jade Rogan (Engineering and Physical Sciences) Employability Team.

The quality of posters produced was incredibly high, and the level of detail and enthusiasm communicated by the interns clearly demonstrated the positive experiences had by all. Despite the challenging decision, the panel awarded 1st prize to Benjamin Bellavia, 2nd prize to Chaodao Wang and joint 3rd prize to Guanyi Chen and Minnie Strange.

Commenting on the event, Dr Nicole Hondow, Director of Student Education in the School of Chemical and Process Engineering said;

*"The celebration was a fantastic event not only for everyone to see the range of projects undertaken, but also for networking between the interns, their supervisors, and the wider Leeds community"*

The Bragg Centre is proud to support widening participation in research through the provision of events, training opportunities and funding. These internships are a brilliant way for students to support themselves throughout summer and provide many with their first experience of real research within a world class environment. As a result, many students go on to pursue PhDs and research careers. Not only do these internships increase the skills pipeline, but they provide a test bed for new ideas and collaborations across the Bragg Centre's remit.



## From Intern to PhD Student



### Nathan Fox

*PhD Student,*  
School of Electronic &  
Electrical Engineering

During my Masters degree I developed a keen interest in Condensed Matter physics, in particular Quantum many-body systems, and I wanted to experience what research in this field might be like.

Sadly, due to the COVID-19 pandemic, I missed out on the opportunity to undertake an internship working in my second year and I was eager to apply again at the end of my third year.

I discovered an internship project working with Dr Joshua Freeman and Dr Satoshi Sasaki which was offered through the Bragg Centre and funded by the **Henry Royce Institute**. The project “Topological insulators and the extreme infrared” stood out to me as it spanned the subject areas where I had a particularly keen interest.

I found that working on the project was deeply satisfying and it gave me a real glimpse into what life as a postgraduate researcher was really like. I thoroughly enjoyed working with both my supervisors, who were very supportive and pushed me to produce work that I was proud of.

From the outset, my supervisors encouraged me to pursue the subject and began discussing possible options for future PhD projects which could continue the work I had begun in the internship project.

The internship experience inspired me and confirmed my interest in pursuing further research in the area of topological insulators. As a result, I chose to undertake an MPhys project in “topological insulator molecular interfaces” with Prof. Oscar Cepedes in my final year of study. After which, I subsequently secured an offer for a PhD which followed on from my internship project, again working with Dr Freeman.

The PhD project, “Advanced Topological materials for plasmonics”, encompasses my interests in topological isolators and plasmonics, whilst expanding into device fabrication, computer simulation and spin electronics. I look forward to continuing working on my research as well as meeting new people as part of the Bragg Centre, NAME programme grant and **Royce**.

*I would highly recommend an internship as part of the Bragg Centre. Everyone has been very welcoming and the I am grateful to the Centre for providing me with the opportunity to work alongside experts in my field of interest, grow as a physicist and produce meaningful research.*



## Bragg PhD Studentship Programme

Each year, the Bragg Centre offers up to five EPSRC funded PhD positions as part of its Studentship Programme. All projects supported by this highly competitive scheme are designed to establish novel connections between disparate research areas under the Bragg Centre's remit, putting our students at the bleeding-edge of materials research and engineering.

The programme encourages peer-support and cross-cohort activities, whilst the students benefit from being embedded within a vibrant interdisciplinary community which provides exposure to a much broader range of expertise and capability than a traditional PhD.

This year the Centre has welcomed its third cohort of three students into the programme. Whilst members of the first and second cohorts have continued to excel, winning poster prizes and travel grants, presenting oral presentations at international conferences and summer schools, and undertaking international research secondments. All whilst continuing to engage with the Bragg Centre community and conduct great research.



## 2022 Cohort



### Manoj Rajankunte Mahadeshwara

I completed my bachelor's in mechanical engineering from VTU-Belgaum, India. I was fascinated by material science research since my engineering days which led me to work at a tribology research laboratory in IISC-Bengaluru, India.

Later I got into the prestigious Erasmus Mundus joint master's degree program in surface engineering and tribology, where I got to participate in three different universities across Europe for my courses. In my first year, I attended courses at the University of Leeds, UK, and the University of Ljubljana, Slovenia. Later I undertook my thesis at the University of Coimbra, Portugal. These courses along with my research project during my master's helped me in gaining an interest in tribology and materials research.

My PhD. will investigate the changes in cartilage structure and function in patients with skeletal and metabolic comorbidities using a multidisciplinary approach. The project will give me the opportunity to explore the multidisciplinary in material science, working across tribology, biomaterials, and medicine.

I am very excited to be part of the Bragg Center, and to explore the facilities available and tap into the enormous amount of knowledge in different areas. I hope that my research will help in finding an early treatment for regulating osteoarthritis in Type-2 diabetes patients, with the aim of avoiding total knee replacement.

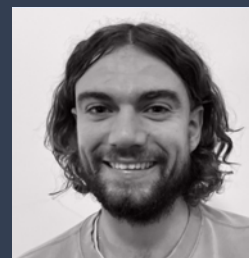


### Mae Jankowski

Having just finished my MPhys here at Leeds I was keen to continue studying and deepen my knowledge in a subject that I am passionate about, while being at the forefront of cutting-edge research.

My masters project studied piezoelectric materials and monitoring the response of stress on magnetostrictive thin films. This research directly leads into the topic of my PhD, by harnessing the modulation of stress employed by a piezoelectric and exploring the phenomenon of magnetic exchange bias at the interface of a heterostructure. The project aims to provide novel data processing component technologies, that will be incorporated into the next generation of secure and low power data storage and communications networks.

The Bragg Centre stood out to me due to its multidisciplinary nature, allowing me to work outside of my school and collaborate with other departments. This provides the opportunity to use expertise and equipment belonging to other schools. In addition, joining the Bragg Centre has allowed me to become part of a wider research group, creating a sense of community and an excellent space for collective work. Finally, the Bragg Centre has excellent links with industrial partners, encouraging the transfer of knowledge from this project with potential companies in industry for future device demonstrator projects.



### Oliver Ayre

In my four years spent at the University of Leeds, I obtained a master's degree in chemistry and completed a year in industry. In my master's year, I investigated surfaces that promote crystal nucleation. Whilst, during my industrial placement I helped to develop new lubricants while working for the energy technology department of Croda, a speciality chemicals manufacturer.

As I'm fanatical about materials science I decided to continue with the University of Leeds, embarking on a PhD investigating a biomimetic additive that universally assembles complex inorganic crystal morphologies. Using the vast array of technologies made available to me by the university and the Bragg Centre, I hope to reveal the mechanism of action of this additive.

The project draws on inorganic and physical chemistry to track the assembly process as it develops in size and complexity from the nano to meso scale, with the aim of ultimately progressing our understanding of functional materials.

## Connecting to Industrial Career Opportunities: The Return of The PhD Colloquium

Following on from the success of the inaugural event in 2021, the Bragg Centre PhD Colloquium returned in June 2022 fully in person. With a student membership that now exceeds 120 post-graduate researchers across the University, the PhD Colloquium is designed to promote collegiality, discovery, and collaboration between students in different schools.

The student led event provides a platform to develop confidence, communication, and awareness of career development opportunities through an agenda of student talks, posters, and networking.



This year, the Colloquium was attended by **65 students**, and was highly praised for the inclusion of a career focussed panel discussion of industry experts. With six guests representing a range of career stages and industries, the students were exposed to opportunities outside of academia which they highly welcomed and indicated was insightful.

Given the warm reception to our Student focussed events, the Bragg Centre has renewed its commitment to supporting the career and personal development of its student community through the Colloquium and along with the development of future careers workshops and training opportunities in the future.



# Inspire

The Bragg Centre continues to reach a broad audience through its academic outputs, social media channels and public engagements, with the goal to widen participation in material science. This year the Centre has expanded its creative partnerships as part of the inspired by Bragg programme, connecting materials research and innovation to more people than ever before through art, literature, and music.

With the Centre's reputation growing rapidly, our community continues to contribute to the academic conversation, publishing **121 journal articles** in the last year.

Throughout the same period the Centre increased its audience across YouTube, LinkedIn and Twitter. The Centre has posted 214 tweets, receiving more than 138,000 impressions and 33,000 unique visits to the Centre's Twitter profile. This has result in an 25% increase in the Centre's followers to 808.

Meanwhile, the Bragg Centre's audience on LinkedIn has increased by 74% to 365 followers from a range of industries including, Biotechnology research, Nanotechnology research, Semiconductor manufacturing, and defence & space manufacturing.

The Bragg Centre also publishes content to its YouTube channel, including a public livestream of the Bragg Exchange which has been viewed by over 400 people from across the globe.



**214 >25%**  
TWEETS

**>130K**  
IMPRESSIONS

**+74%**  
FOLLOWERS

**YouTube**  
**+400**  
VIEWERS



## Supporting Research Culture

This year the Bragg Centre was recognised as part of the University of Leeds' inaugural Research Culture Awards for its ongoing dedication to support the wellbeing and development of its community.



The awards were established to recognise that improving research culture is a complex and challenging process, and to celebrate all those involved in contributing to research success and lasting organisational change.

The Centre team received an award for their perseverance and willingness to innovate in order to provide a collegiate and supportive environment throughout the COVID-19 pandemic.

In particular, the team's ability to adapt to changing restrictions by developing virtual and hybrid events led the way across the University with colleagues looking to the Centre for advice to support their own events. Whilst the Centre's efforts to promote awareness of mental health and wellbeing through its cross-University platform were also commended.

The awards were presented during a campus showcase on Tuesday 19th July 2022 hosted by the Chancellor, Prof. Dame Jane Francis and Prof. Nick Plant, Deputy Vice-Chancellor: Research and Innovation.

Speaking during the ceremony, Dame Jane said:

***"Improving our research culture is a complex and often challenging process that requires the collaboration of all colleagues at the University, so I'm really pleased to be able to celebrate the range of projects and people involved in this initiative"***



## Inspiring the Next Generation of Materials Scientists

**A core mission of the Bragg Centre is to widen participation in materials science by connecting the general public and school students to cutting edge research and innovation. A perfect example of this, is the Centre's nationally acclaimed 'DNA Origami' project.**

The project, which is generously supported with funding from the **Henry Royce Institute**, aims to expand students' horizons beyond the school textbook and introduce them to the creativity and interdisciplinarity of real research.

Now entering its third round with a further 150 participants, the project has reached nearly 400 students nationally since it began, and the real-world impacts of this work are now becoming clear.

Evaluations conducted by the Centre's partner, the Institute for Research in Schools, indicate that:

- $\frac{3}{4}$  of students said that they knew more about materials science after completing the project
- $\frac{3}{4}$  of students said that they wanted to find out more about materials science
- 9 out of 10 students were interested in finding out more about DNA nanotechnology

Students were found to be very enthusiastic about their experience of the project, commenting that it gave them a chance to work differently, to see how science works in the real world and that they learned that science is an interactive, collaborative and creative process. While it required repetition and persistence to overcome setbacks, students found the process well worth it for the skills they gained and the satisfaction of getting their end result.

The evaluation indicates that the experience has been eye-opening for students, who were excited to be working at the cutting edge of

materials science and could see the many important applications in the real world. It gave them experience of working in science and showed them that there are many opportunities in scientific research, leaving them with the belief that they could make a contribution to this progress.

In addition, many of the teachers involved commented on how they enjoyed the challenge of learning about advances in materials science and DNA nanotechnology. It put them back in touch with science research and reminded them of the camaraderie of working together on a project, helping them to develop a different relationship with students as they all worked together to learn something new. Teachers remarked that they were able to use what they had learned in their teaching, and some stressed how working on the project enhanced their enjoyment of their teaching role. Teachers also worked across curriculum, drawing on, and learning from, the expertise of their colleagues.

Follow up reveals that this inspiration has translated into tangible impacts for the students, with many referencing the project in their university applications and indicating that the soft skills gained including presenting, referencing and team working have benefited them significantly. Whilst, more notably the project has influenced students' degree and University choices in multiple instances.

## Seeing the Impact



### Hamdaan Sheikh

*First year Undergraduate  
Chemical Engineering  
Student, University of  
Leeds*

I participated in the first round of the DNA Origami Project whilst in year 13 at St. John Fisher Catholic

Voluntary Academy in Dewsbury. We first learned about how DNA Origami worked and the CAD processes to design it, we then were able to synthesise our own 'smiley-faces' out of DNA Origami which were then imaged with Atomic Force Microscopy. I was able to undertake research by investigating different variables in the DNA Origami to understand how the material's structure was affected. This was then presented at the Bragg Centre, and I was able to discuss my findings and scope of the project with various researchers at the University of Leeds.

The way this influenced me as a student was the actual ability to fabricate my own thoughts and logic, and then presenting those ideas. This is something that rarely happens in our GCSEs/A-Levels. It felt like I'd finally been inputting into my studies and working on something new, and that it had a meaning. After that 'rush', I wanted to chase that feeling and so I decided to change my degree choice from Medicine to Chemical Engineering. I like the mix of novel research in the field and the breadth of topics covered with real world applications.

I benefitted a lot from the chance to present, something I was not well versed in, and I enjoyed talking to the academics. It also has been a great talking point for me in University applications, as I was able to lead a team in school for the project and that further improved my leadership skills. But most importantly I think it was the ability to express my thoughts with others and truly discuss it at a high level that inspired me.

## Awarding Outstanding Partnerships

**The Bragg Centre's work on DNA Origami was recognised in September 2022, with receipt of the "Special Award for Outstanding Partner" at the Institute for Research in Schools (IRIS) awards ceremony.**

The event, which was hosted at the Francis Crick Institute, was attended by an array of VIPs from across the STEM community in the UK and celebrated the outstanding achievements of talented students and teachers who innovate in the classroom every day.

Awards were handed out by IRIS director Dr Jo Foster as well as scientist, writer and broadcaster Dr Adam Rutherford and scientist and author Dr Maggie Aderin-Pocock MBE.

In addition to the Centre's own award, the DNA origami project was at the core of no less than three out of seven awards, demonstrating how innovating the project has been. The winners included students from Tipton School, who used their expertise learned through the DNA Origami project to design a nanoscale Tesla valve made from DNA. DNA Origami pilot school, Liverpool Life Sciences UTC was recognised for its research culture and programmes

which allow students to experience what it is like to be a research scientist. Whilst, inspirational teacher David Fairclough, was recognised for his active promotion of research alongside the curriculum in school, including piloting the DNA Origami project throughout COVID restrictions.



## STEM for Britain Award



### Adele Parry

4th Year PhD Student  
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Realising the full impact of outstanding research and innovation requires equally outstanding communication. It can be very challenging to explain scientific work to non-specialist audiences, which

often reveals the inaccessible specialist language that scientists use to explain key concepts.

In recognition of this, the UK Parliamentary & Scientific Committee holds an annual "STEM for BRITAIN" poster competition at the House of Commons to challenge early career scientists from across the UK to communicate their research with diverse audiences. These key skills are becoming ever more important in the age of misinformation.

This prestigious poster competition, which has been running since 1997, is split into subject areas including Physics, Maths, Chemistry, Biology and Engineering, with contributions initially judged by scientists. There are Gold, Silver and Bronze medals awarded within each group. Subsequently, the gold medallist from each category are invited to present their work to MPs, where the overall Westminster medal is awarded for successful communication.

This year, Bragg Centre researcher Adele Parry won the gold medal in physics and then the overall Westminster medal for her poster entitled; 'A better lateral flow test? The design of novel liquid crystal droplet biosensors'.

Now in the 4th Year of her PhD, Adele's research focusses on the use of liquid crystal droplets for biosensing applications. Liquid crystals are commonly associated with display technologies, such as LCD TVs, however they are now

demonstrating promise as a new class of biosensors capable of detecting viral and bacterial infections. Adele's work uses chiral nematic liquid crystal droplets which are coated in phospholipids to mimic living cells. When a bacteria or virus interacts with these droplets, they destroy the phospholipid layer which causes the liquid crystal to change alignment and the resulting optical response can be detected as a visible colour change.

The relevance of Adele's research in light of the COVID pandemic enabled her to communicate the clear potential and impacts of her technology, and demonstrate to MPs the importance of different scientific areas intersecting when attempting to solve new problems.

***"Although I'm based in the Physics department, my PhD is about far more than just Physics, it has elements of biology and chemistry woven throughout"***

Since winning Adele has continued to highlight how important it is to make research accessible and engaging for all. Initiatives like STEM for BRITAIN really drive home how difficult science communication can be and Adele hopes that by winning such a unique competition it can give other Bragg Centre members the confidence to talk about their own scientific research more widely.

***"Many researchers I have spoken to over the last few months have told me of their intentions to enter the 2023 competition which is extremely heartening to hear, and I wish them the absolute best of luck!"***

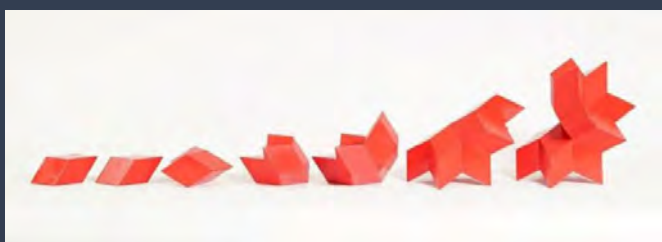


## Inspired by Bragg Cultural programme

There can be no doubt that the Braggs were talented individuals. Not only did Sir William Henry and Sir William Lawrence share the 1915 Nobel Prize for their brilliant scientific discoveries, but both were also gifted artists in their own right. So it is fitting that to celebrate the opening of the Bragg Centre's new home, the Sir William Henry Bragg building, that an innovative programme which drew together a series of both scientific and cultural events was created.

The programme, "Inspired by Bragg" was designed to showcase some of the interdisciplinary work taking place at the Bragg Centre to a wider, non-scientific audience, adding to the Bragg's scientific and artistic legacy.

Kicking off with Leeds Light Night, where an animation made by Dutch artist Melvin Moti celebrating the Braggs' work was projected onto the side of the Bragg Building, as part of the annual Leeds city-wide event.



This was followed by an exhibition Shaping the course of modern science: William Henry Bragg and his legacy at the University of Leeds, which ran for over five months and featured some outstanding objects from the University's Special Collections, including some artworks from William Henry Bragg himself.

The Braggs' work inspired a three-part concert series curated by percussionist Delia Stevens, and connecting with Bragg Centre research areas. The performances were:

- Aurora Percussion Duo: Metal
- ConunDrums: Algorhythms
- Kabantu: Multiscale Modelling



Whilst a children's book was commissioned, making some of the highly innovative materials research at the Bragg Centre accessible to primary age children. Over 1,000 copies of That's Amazing, Mum! were distributed through food banks, charities, and participating schools across Leeds. A digital edition is available to rent via Leeds Libraries.

Embodying the connections between science and culture, a public lecture, A Thing of Beauty: Where Science and Art Combine demonstrated how eminent scientist Professor Ron Lifschitz's understanding of crystals inspired sculptor Dominic Hopkinson.

Finally, a specially commissioned poem celebrating the Braggs' work was read by the poet and a newly arranged fanfare was performed at the official opening of the Bragg Building. Crystal Avenues was written by poet Zaffar Kunial, while the fanfare evoked the mathematical puzzle that faced Bragg and his son Lawrence as they investigated the atomic structure of crystals using X-ray beams.

Scan the QR code for more details, including links to some of the performances and events.



## Bragg Creative Labs PGR Edition

**The Bragg Centre has shared a fruitful partnership with the Cultural Institute since 2019, when an edition of Leeds Creative Labs first paired Materials scientists and engineers with professionals from the cultural and creative industries. Since then, the partnership has returned for an edition of the creative labs each year, with 2022 being no exception.**

This year, as part of the Inspired by Bragg programme, this iteration of the labs focussing entirely on Postgraduate Research Students. The projects lasted for several weeks, culminating in an open share event held in the Sir William Henry Bragg building on the 9th June 2022.

The pairings included; Alex Gresty, a Soft Matter PGR student working in the Bragg Centre, who worked alongside Catherine Howard, a PGR student from the School of Design. Alex's research explores how the microscopic properties of cellulose films, including orientation, crystallinity or composition, can be tuned to improve their macroscopic properties such as strength, elongation to failure or water and oxygen barrier capability. Whilst, Catherine's work addresses a perceived deficiency in therapeutic provision and intervention for students in secondary school through arts and crafts. Together the pairing created a playful installation of fractured coloured disks derived from Alex's cellulose films that had undergone impact testing.

Jean-Yves Desaulles is a theoretical physics PhD student working on quantum many-body systems, such as electrons in a solid, and in particular on how they retain information which may have applications in quantum computing. Jean-Yves was paired up with, Sarah Dawson, PGR student from the School of English who's work focusses on failure as a generative methodology in the creative arts. Together the

pairing attempted to replicate and propagate human-like error in computationally simulated environments as an approach to generate creativity.

Finally, Merin Joseph is an applied mathematics postgraduate researcher working on the tessellation properties of polymers. Alongside Merin, was an artist and researcher, Alice Chandler, who's art explores themes relating to value, impact and sustainability in artist networks. Together this pair engaged in a wide range of activities, including visits to Alice's art studio where the pair practiced metal working.

This iteration of the Bragg creative labs was underpinned by an EPSRC Public Engagement Champion Grant (EP/T028718/1) awarded to Prof. Lorna Dougan, and was a notable success. 80% of the participants strongly agreeing that the project provided them with new creative ideas, insights, or direction in their own research. Whilst, the Cultural Institute has continued to work with one to feature their project outcome, 'Extreme Pressure', in this years' Leeds Light Night.



## Get in touch

To find out more about the Bragg Centre for Materials Research, please contact us:

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