WELCOME

CERN Courier – digital edition

Welcome to the digital edition of the 2022 *CERN Courier* In Focus report on Big Science and Industry.

How can Europe's large-scale research facilities better engage with the industrial R&D community and, in so doing, broaden their collective user base while amplifying downstream socioeconomic impacts? That's the central question informing the exclusive coverage in our latest *CERN Courier* In Focus report, whether that's the ENRIITC consortium's efforts to establish a pan-European network of industry liaison and contact officers (p5) or the pivotal role played by the business development office at research centres like DESY and the ESRF – opening up access pathways so that established technology companies and small and medium-sized enterprises can address R&D problems at all stages of the innovation lifecycle (p17, p31, p33). Elsewhere, the focus shifts to neutron science (p9) and case studies in successful industry engagement at ILL – including transferable lessons for other large-scale facilities – while CERN experts provide a high-level tour of the industry opportunities associated with the laboratory's unique equipment procurement and knowledge transfer programmes (p25). Big science and industry, it seems, is increasingly a win–win.

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IN FOCUS
BIG SCIENCE AND INDUSTRY

2022 cerncourier.com

REIMAGINING SCIENCE IMPACT

DESY focuses on collaboration
Neutron science at your service
CERN: the innovation pipeline
ENRIITC forges connections

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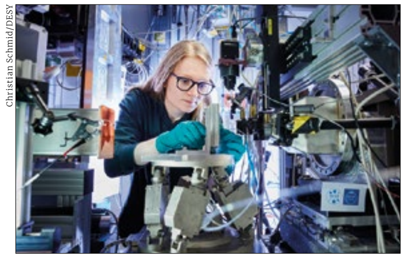
Christian Schmid/DESY



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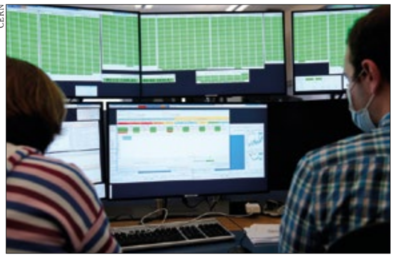
CERN



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From the Editor

How can Europe's large-scale research facilities better engage with the industrial R&D community and, in so doing, broaden their collective user base while amplifying downstream socioeconomic impacts? That's the central question informing the exclusive coverage in our latest *CERN Courier In Focus* report, whether that's the ENRIITC consortium's efforts to establish a pan-European network of industry liaison and contact officers (p5) or the pivotal role played by the business development office at research centres like DESY and the ESRF – opening up access pathways so that established technology companies and small and medium-sized enterprises can address R&D problems at all stages of the innovation lifecycle (p17, p31, p33). Elsewhere, the focus shifts to neutron science (p9) and case studies in successful industry engagement at ILL – including transferable lessons for other large-scale facilities – while CERN experts provide a high-level tour of the industry opportunities associated with the laboratory's unique equipment procurement and knowledge transfer programmes (p25). Big science and industry, it seems, is increasingly a win-win.

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Editor Matthew Chalmers
Consultant editor Joe McEntee
E-mail cern.courier@cern.ch
Advisory board Peter Jenni, Christine Sutton, Claude Amsler, Philippe Bloch, Roger Forty, Mike Lamont, Joachim Kopp

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Head of media Jo Allen
Head of media business development Ed Jost
Content & production Kyla Rushman
Recruitment advertisement sales Chris Thomas
Display advertisement sales Curtis Zimmermann
Advertisement production Katie Graham
Marketing & circulation Alison Gardiner
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ENRIITC: collaboration is key

The ENRIITC consortium is working to establish a permanent pan-European network of industry liaison and contact officers to drive engagement between large-scale research facilities and industry. Project coordinator Anne-Charlotte Joubert reports on progress and next steps.

The European Network for Research Infrastructures and Industry for Collaboration (ENRIITC) has emerged as something of a bridge-builder between large-scale science facilities and key stakeholders in industry since its formation in January 2020. With over 500 network members – including more than 100 industry liaison and contact officers (ILOs/ICOs) from Europe's big-science labs and the university research sector – ENRIITC's goal is to accelerate the societal and economic impact of national and pan-European research programmes, working together to define best practices for industry's relationship (as supplier, user or collaborator) with Europe's large-scale research infrastructures (RIs).

Here Anne-Charlotte Joubert, ENRIITC project coordinator and grants officer at the European Spallation Source (ESS), a neutron science facility currently under construction in Lund, Sweden, tells *CERN Courier* how ENRIITC is helping ILOs and ICOs to join the dots between big science and industry.

ESS

Anne-Charlotte Joubert *"Success is all about longevity: if the ENRIITC network is strong and sustained, the project has succeeded."*

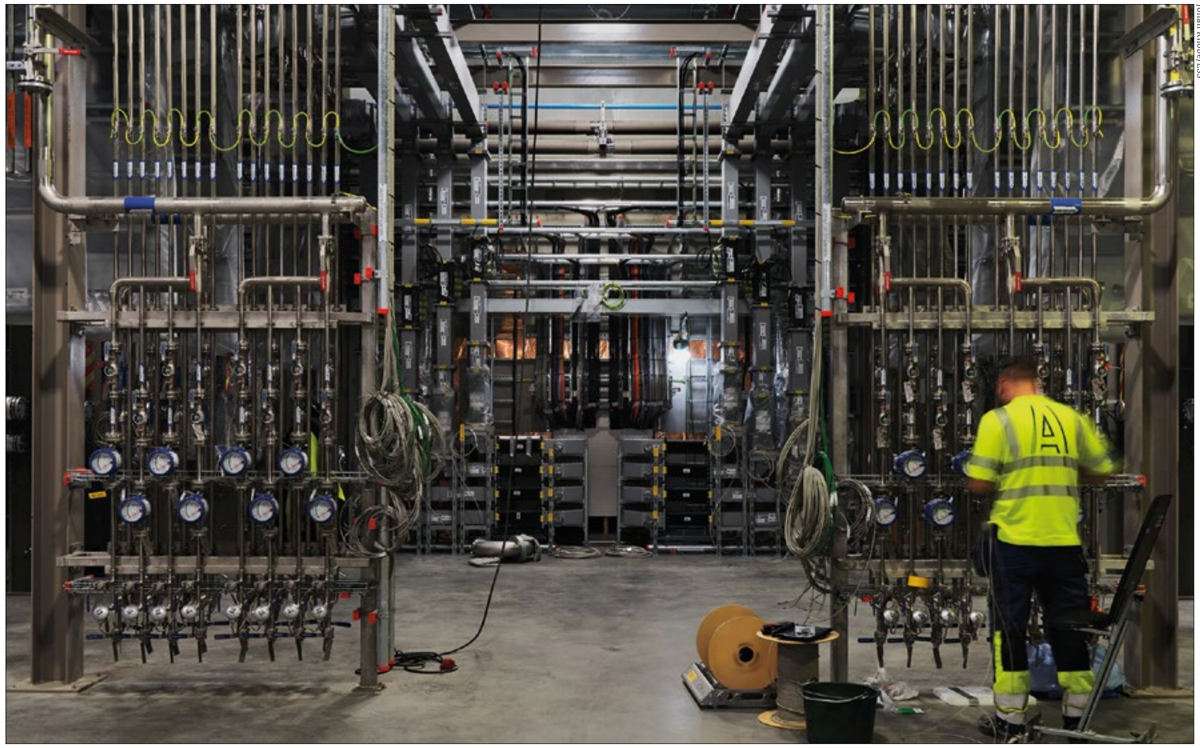
How does ENRIITC connect ILOs, ICOs and industry?
Connection and collaboration underpin the ENRIITC mission to build a permanent pan-European network of ILOs and ICOs supporting cross-border partnerships between industry and RIs. Our first formal community meeting, for example, took place in October 2020 when Europe was in the midst of the COVID-19 pandemic. Although a virtual rather than face-to-face experience, we attracted more than 120 RI and industry representatives from 21 countries for two days of interactive sessions and workshops to address topics relating to the growth and impact of the ENRIITC network.

Building on this initial success, we established #ENRIITCyourCoffee, a virtual meeting series to bring network members together on a weekly basis for group discussion on "issues arising" at the interface between big science and industry (with 38 sessions held to date attracting more than 200 unique participants). Initially launched to sustain the collective conversation among ENRIITC members through the Europe-wide lockdowns, #ENRIITCyourCoffee is now an established and ongoing part of the project mix.

What about support for training and education of ENRIITC members?
Under the snappy banner ENRIITC your Knowledge (you see what we're doing here), the ENRIITC consortium organised a programme of eight training webinars (concluding in May this year) to encourage knowledge transfer, skills development and best practice around the ILO/ICO core competencies needed for successful industry engagement. The series attracted 140 new individual members into the network. In a different direction – with the aim of raising industry awareness about business and R&D opportunities at Europe's RIs – the project consortium organised five brokerage events for existing and prospective RI industrial users and equipment suppliers (as well as funding five other brokerage events).

What lessons has ENRIITC learned about the relationship between Europe's large-scale research facilities and industry?
ENRIITC members have conducted two surveys to map the level and scope of engagement between industry and RIs, looking specifically at "Industry as an RI supplier" and "Industry as an RI user". The surveys focused, among other things, on the nature of the RI access routes used by industry; business sector and enterprise size; the effectiveness of current ILO and ICO performance indicators; as well as drivers of (and barriers to) closer collaboration between RIs and industry.

This granular mapping exercise laid the foundations for a set of complementary strategies, subsequently articulated by ENRIITC, to enhance collaboration between RIs and industry. The headline goal here: to promote – and scale – the role of RIs



Johan Knobe/ESS

Shared understanding
The ENRIITC consortium is helping ILOs and ICOs in Europe's big-science labs to build bridges with applied researchers and engineers in industry. Above: the klystron gallery at the ESS neutron science facility in Lund, Sweden.

in supporting applied R&D, technology innovation and long-term growth opportunities for Europe's technology companies. Equally important is the emphasis on coordinated operational implementation, with separate strategies to guide ILO/ICO training on industry outreach (including brokerage events) and policy recommendations to follow on optimisation of ILO/ICO performance.

The current iteration of the ENRIITC project wraps up in December. What are the priorities until then?
Although a lot has been achieved, there is much work still to do. Our immediate priority is the second ENRIITC community networking meeting, which takes place in October at the Big Science Business Forum (BSBF) in Granada, Spain, when we will bring together ILO/ICO members for a series of intensive knowledge-sharing, networking and training activities. Longer term, a policy paper is in the works to ensure the sustainability of the network, covering: strategic goals and propositions for the project's continuation; the need to secure funding for a follow-on ENRIITC 2.0 initiative; a transition plan for 2023/24 to build support for our partners and associates; and a business case for the registration of ENRIITC as an independent legal structure. From there we hope to agree a memorandum of understanding between RIs and the ILO/ICO community.

Tell us about ENRIITC 2.0
Right now, the ENRIITC consortium is looking for sources of funding to support an ENRIITC 2.0 initiative, the plan being to consolidate a pan-European ILO/ICO network and secure the successes of the initial project phase. The business model for this follow-up activity is still under discussion, though it is already clear there will be a transition period between the current publicly funded network (within the EU's Horizon 2020 programme) to a set-up that is necessarily self-sustaining in the long term – likely some sort of mixed membership model that is part open access and part membership/fee-based service offering. Operationally, one of the fundamental objectives of ENRIITC 2.0 will be to establish what we're calling the Innovation and Industry Services Central Support Hub. The idea is for an online platform to deliver training, connectivity and professional development for ILOs and ICOs, while also streamlining industry engagement with a common pathway to handle the flow of requests from companies to RIs.

Define success for ENRIITC
Success is all about longevity: if the ENRIITC network is strong and sustained, the project has succeeded. What does that look like? I guess one tangible measure of success over the next decade will be the launch, and widescale adoption, of the ENRIITC Innovation and Industry Services Central Support Hub – a unifying vehicle to scale and diversify the innovation ecosystem connecting RIs with industry. ●

● *ENRIITC is running a specialist workshop, "Infrastructures and industry engagement – enabling European innovation", on 19 October at the International Conference on Research Infrastructures (ICRI 2022) in Brno, Czech Republic. The event is organised in collaboration with CzechInvest, the Investment and Business Development Agency of the Czech Republic.*

THE AUTHOR
Joe McEntee *is a consultant editor based in South Gloucestershire, UK.*

NEUTRON SCIENCE: SIMPLIFYING ACCESS FOR INDUSTRY USERS

The Industry Liaison Unit at the Institut Laue-Langevin is prioritising engagement with Europe's technology companies and positioning the neutron science laboratory as a natural extension of the R&D and innovation pipeline. Caroline Boudou and Mark Johnson chart progress to date and the transferable lessons for other large-scale facilities.

Steph Monfront/ILL

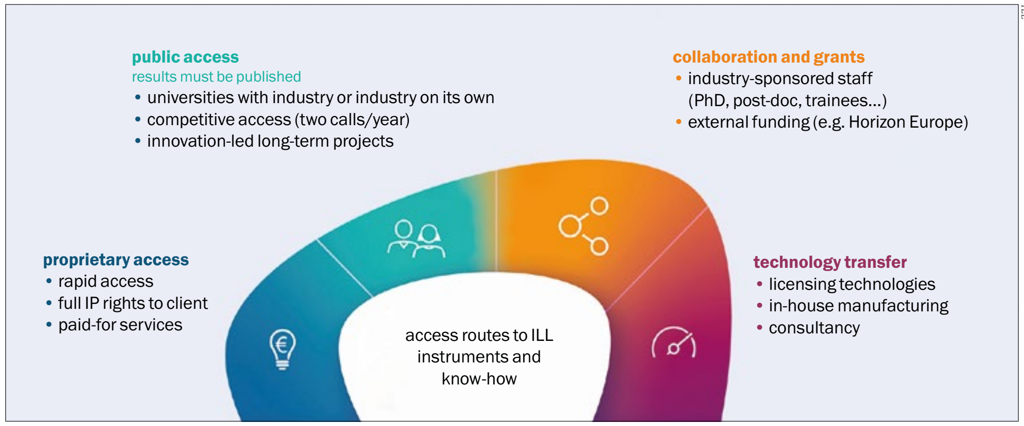
Neutrons for industry *The ILL in Grenoble, France, hosts a suite of scientific instruments that enable academic and industry researchers to probe materials properties across multiple timescales (fs to µs) and length scales ranging from sub-nm to cm and beyond.*

The Institut Laue-Langevin (ILL) is an international research centre at the leading edge of neutron science and technology. As a service institute, the ILL makes its expertise available to about 1400 researchers every year across a suite of 40 state-of-the-art instruments. Taken together, those instruments provide the engine-room for a portfolio of unique analytical techniques that enables process, materials and device characterisation far beyond what's possible in a traditional academic or industry laboratory – as well as spanning a diversity of disciplines from the physical sciences and engineering to pharmaceutical R&D, food science and cultural heritage.

Yet while neutrons are unique and ubiquitous, they are neither widely available nor routinely accessible for applications in front-line research. Intense, tunable neutron beams can only be produced at nuclear reactors (like the ILL) or with high-power proton accelerators (so-called spallation sources). By default, there are no

THE AUTHORS

Caroline Boudou *is an industry contact officer at ILL;* **Mark Johnson** *is head of partnerships and communication service at ILL.*



It's all about access *Industry users are able to access ILL's suite of 40 state-of-the-art neutron instruments via several routes, each one with its own merits.*

laboratory-based neutron sources for initial training of early-career scientists and preliminary experiments – in contrast to the established development pathway afforded scientists transitioning from laboratory X-ray techniques to the large-scale synchrotron X-ray facilities.

By extension, scientists seeking to access neutrons as a research tool can only do by securing beam time at large-scale facilities. That's not always straightforward. Large-scale neutron facilities have their own dedicated proposal and contract mechanisms for accessing beam time, adding to perceptions of "impenetrability" for new and occasional users – especially those working in industry. All of which begs a leading question: how can ILL – indeed Europe's large-scale research facilities generally – build on their successes to date in engaging the industrial R&D community and, in so doing, broaden their collective user base while simultaneously amplifying their societal and economic impact?

Scaling industry engagement

The Industry Liaison Unit (ILU) at ILL, nominally with two full-time staff, leads the laboratory's industry outreach activities – typically through dedicated local, national and international industry events, all of which are supported by an active online and social media presence. By preparing contracts and agreements as required, the ILU also acts as the interface between the industry partners and ILL instrument scientists who will perform the experiments.

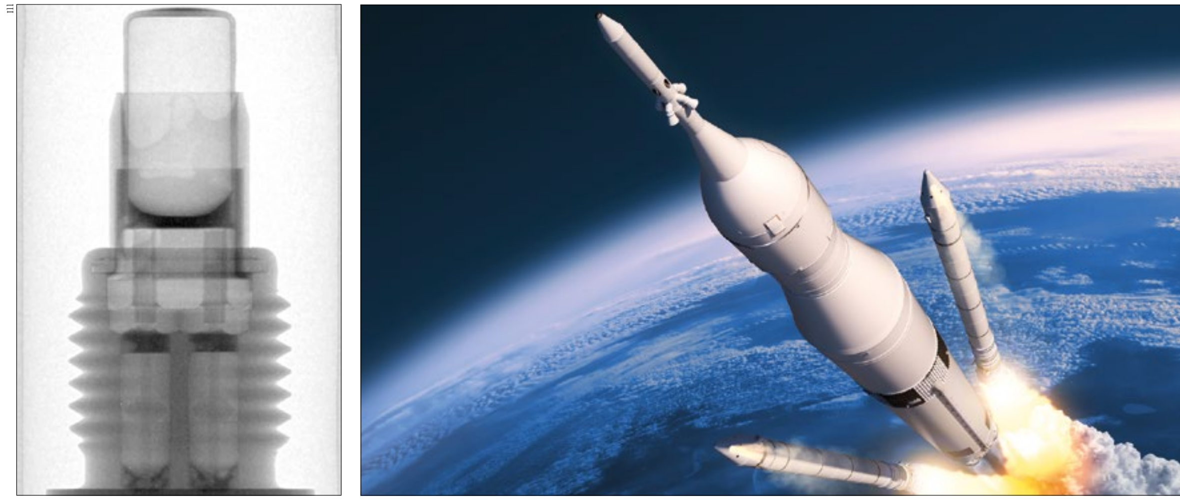
Working with industry can proceed along several routes, each with its own merits. For context, 80% of beam time at ILL is awarded through a competitive peer-review process, with two calls for proposals each year. For this so-called public access model, including precompetitive research at low technology readiness level (TRL), the ILL data policy requires open data and publishable results, with industry partners in many cases collaborating with academic research groups (and, in turn, tapping the latter's high level of expertise in neutron science). Such "indirect" use of the ILL facilities is the most common access model for industry – though conversely the most difficult for the ILU to capture since the industry partners are not always "visible" members of the research collaboration.

At the other end of the spectrum, and often for projects with a high TRL, industry is able to request proprietary beam time for business-critical research using a paid-for access model. In return, any resulting experimental data remains private, the work can be covered by a non-disclosure agreement, any resulting intellectual property (IP) stays with the client, and experiments are scheduled on an appropriate timescale (usually as soon as possible). Often this sort of work may take the form of a consultancy, in which case the results (rather than just experimental data) are delivered by ILL scientists with the support of the ILU.

In between these limiting cases, precompetitive research collaborations are an ideal way to build long-term industry engagement with ILL. Backed by European and/or national research funding, these initiatives typically run for several years and are often governed by memoranda of understanding. As such, the collaborative model allows an industry partner to gain experience and confidence at ILL while confirming the feasibility (or not) of its R&D goals – all of which can potentially lead on to requests for proprietary beam time. Partners often include established European technology companies – the likes of Rolls-Royce, EDF and STMicroelectronics, for example – or research and technical organisations (RTOs) – among them the French Alternative Energies and Atomic Energy Commission (CEA) and Germany's Fraunhofer institutes.

Operationally, the main experimental techniques used by industry at ILL are neutron imaging (specifically, radiography and tomography – the former used to reveal the internal structure of manufactured components, while the latter generates 3D images of a sample by measuring neutron absorbance); small-angle neutron scattering or SANS (elastic neutron scattering to investigate the structure of samples at the mesoscopic scale between 1–100 nm); powder diffraction (a form of elastic scattering that reveals atomic and magnetic structures); and strain scanning (which provides insights into strain and stress fields deep within an engineering component). Worth adding as well that neutron imaging takes full advantage of the very intense, continuous neutron beams at ILL and offers potential for significant growth in industry engagement, assuming that capacity can be created to match demand.

The ILU acts as the interface between the industry partners and ILL instrument scientists who will perform the experiments



Feel the heat *French aerospace company Dassault Aviation makes regular use of the ILL's neutron imaging capabilities, with the focus on radiographic analysis of high-reliability pyrotechnic equipment (left) destined for applications in rocket launchers (illustrated right).*

Where we are now

It's fair to say that ILL's engagement with industry, while on an upward trajectory, remains a work in progress. The latest estimate of "indirect" use of beam time at ILL is that 15% of experiments (about 100 per year) are industry-relevant and likely to involve an industry partner. By monitoring who actually comes to ILL to carry out experiments, the ILU has identified 106 companies using the facility over the last decade. What's more, proprietary beam time in 2021 involved 26 measurement periods by 14 unique industry customers with an aggregate income to ILL of €0.51 million.

In large part, though, it is pan-European and national research collaborations (precompetitive, low TRL) that continue to stimulate industry interaction with ILL. A case in point is the Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy (NMI3), in which dedicated workshops were held with diverse industry partners, with the follow-on project, Science and Innovation with Neutrons in Europe 2020 (SINE2020), including an industry consultancy work package with a budget of €1.5 million. The primary focus of the work package was to provide free feasibility studies for companies seeking to evaluate neutron techniques versus their R&D requirements. In all, SINE2020 carried out 37 studies, 14 of which were conducted by ILL.

Two current European projects, BrightnESS-2 and EASI-STRESS, have a common focus on neutron measurements of residual stress – a critical factor, for example, in the mechanical stability of 3D-printed (additive-manufactured) components. The EASI-STRESS project aims to strengthen industrial access and uptake of non-destructive synchrotron X-ray and neutron-diffraction-based characterisation tools. The goal: to enable a better understanding of the formation and progression of residual stresses by direct incorporation of measured data into modelling tools. In parallel, part of the BrightnESS-2 remit is to support ongoing work at ILL about the standardisation of measurements across neutron facilities and instruments, delivering a quality approach that has been formalised as a Neutron Quality Label trademark.

In this respect, it helps that ILL is colocated on the European Photon and Neutron Campus in Grenoble – a geographical convenience that allows close coordination with the adjacent European Synchrotron Radiation Facility (ESRF) when engaging with existing and prospective industry users. The two laboratories are core partners in the EASI-STRESS initiative as well as BIG-MAP, another pan-European project that brings together academic and industry partners on low-TRL battery research as part of the EU's Battery2030+ roadmap.

ILL and ESRF are also collaborating within the national IRT Nanoelec project, which enables ILL to showcase its unique analytical capabilities to address key R&D questions in the microelectronics industry. In this context, ILL has created a dedicated irradiation station that allows users to evaluate the sensitivity – and reliability – of electronic components subjected to low-energy (thermal) neutrons.

Industry success stories

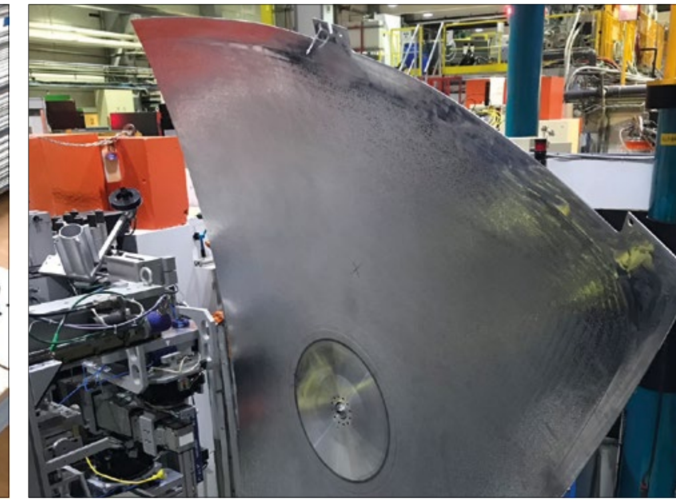
Successful case studies for industry engagement can be found along several operational coordinates at ILL. In terms of the proprietary access model – with paid-for beam time plus full IP rights and confidentiality allocated to the customer – projects will typically focus on targeted lines of enquiry relating to a company's manufacturing, R&D or failure-analysis requirements.

As part of its quality control, for example, French aerospace company Dassault Aviation makes regular use of the

ILL

Flying high *A custom ILL detector is currently being used by Airbus Avionics on commercial aircraft to measure the flow of thermal neutrons at different altitudes. The design, development and implementation of advanced neutron detectors is a core activity at ILL.*

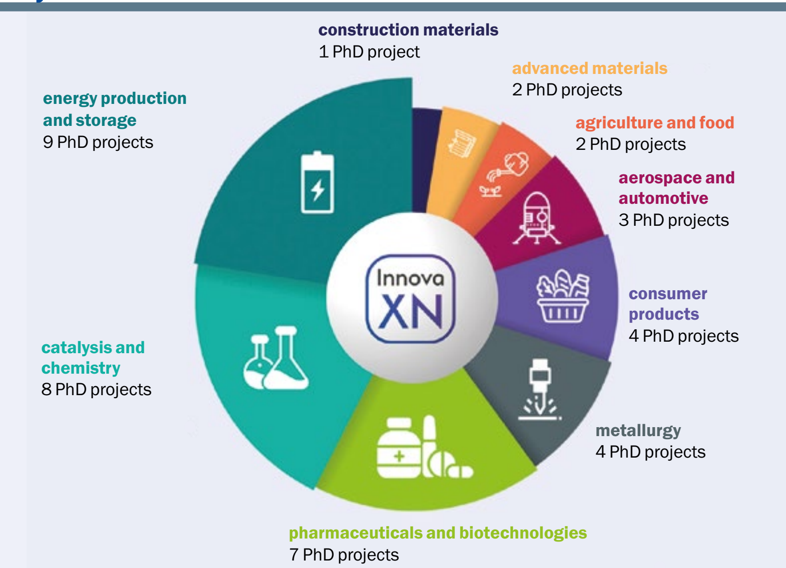
ILL/MT Aerospace



Mission-critical *Part of a space-launcher fuel tank section positioned on SALSA, the strain scanning instrument at ILL, for the non-destructive determination of strain and stress maps in the welded area. Such investigations provide primary data to optimise MT Aerospace's numerical models while also benchmarking versus destructive lab-based analysis techniques.*

InnovaXN: reinforcing industry connections

ILL/ESRF



The InnovaXN PhD programme represents a ground-breaking approach to working with industry – a joint initiative between the ESRF and ILL in which 40 research projects are split between the two large-scale facilities (although most projects require the use of both synchrotron and neutron analytical probes). Launched in 2019, the programme is co-funded by the ESRF (25%) and ILL (25%), with the remainder covered by a Marie Skłodowska-Curie Actions grant agreement within the European Union's Horizon 2020 programme.

All InnovaXN projects have an academic and an industry partner (as well as the ESRF and/or ILL), with each PhD student spending at least three months at the industry partner during the course of their research. In this way, the programme attracts industry R&D teams and activities to ESRF and ILL to explore the use of their unique, cutting-edge synchrotron and neutron capabilities for precompetitive research.

Equally important is the fact that InnovaXN students are exposed to the industry research environment, offering an additional career path post-PhD (either with the industry PhD partner or with another company). This represents the best form of industry awareness for ESRF and ILL, effectively seeding trained scientists in an industry setting. On the other hand, if students end up pursuing an academic career pathway, they will know how to collaborate with industry and how to exploit large-scale facilities when necessary. A win-win.

So far, there have been two intakes of InnovaXN students (in 2020 and 2021). In-progress projects involve 35 unique industry partners (some partners are involved in more than one project), with a quarter of these being SMEs or technology R&D centres. The top three industry sectors covered are energy production and storage; catalysis and chemistry; and pharmaceuticals and biotechnologies – a ranking that reflects the broad reach of neutron and synchrotron techniques for industrial applications.

Hitting the target on medical radioisotopes

Radioisotope production is a core function of nuclear research reactors. At the ILL, which delivers one of the highest neutron fluxes available within the neutron science community, the focus is on producing low-yield, neutron-rich radioisotopes – and especially nonconventional medical radioisotopes with applications in highly targeted radionuclide cancer therapy. Examples include 177-lutetium, which has been used in the treatment of over 1000 patients to date, and 161-terbium, currently in the preclinical trial phase.

In 2021, ILL income from radioisotope production was close to €1 million, and plans are taking shape to increase production over the medium term. The ILL's work in this area feeds into PRISMAP, an EU-funded initiative to develop an extensive infrastructure for nonconventional medical radioisotope production.

ILL's neutron imaging capability, with the focus on radiographic analysis of high-reliability pyrotechnic equipment for rocket launchers such as Ariane. Materials and process innovation also underpin a series of ILL measurements carried out by OHB and MT Aerospace (a group of companies specialising in space transportation, satellites and aircraft equipment), mainly to investigate residual stress on friction stir welds (when two facing metal workpieces are joined together by the heat generated from friction). The non-destructive determination of strain and stress maps provides primary data to optimise the company's numerical models while also benchmarking versus destructive lab-based analysis techniques.

Notwithstanding the proprietary pathway, collaborative projects represent the most popular route for direct interaction between ILL and industrial researchers and RTOs. For example, a joint R&D initiative on metal additive manufacturing (MAM) kicked off in 2018 with the Fraunhofer-Institut für Werkstoff- und Strahltechnik (IWS) in Dresden. Using *in-situ* laser printing at SALSA, the stress-scanning instrument at ILL, the partners are delivering new knowledge of lasing parameters to ensure robust industrial production of MAM pieces. The initial 24-month project, involving teams from ILL and the Fraunhofer IWS, will be followed by further measurements in 2023 (part of a European Space Agency project that will also include additional X-ray imaging measurements at the ESRF).

Another example of collaboration involves Airbus Avionics, which is running a project to mitigate the risks associated with high- and low-energy (thermal) neutrons for avionics programmes. The ILL's instruments were first used by Airbus to predict thermal neutron risks for state-of-the art semiconductor technologies – with direct measurements being the only way to estimate the real thermal neutron flux inside an aircraft. In 2021, the ILL therefore provided thermal neutron detectors for on-board use in commercial flights, whilst also sharing its technical expertise in this area. The design, development and implementation of advanced neutron detectors is at the heart of the ILL's activity, as all of its scientific instruments require detectors with unique technical specifications.

Industry use of large-scale research facilities like ILL will remain on an upward trajectory for the foreseeable future

Meanwhile, there are many examples of precompetitive research performed at ILL in partnership with industry, often linked to the "indirect" use of the facility highlighted previously. A timely example is the work involving pharmaceutical company AstraZeneca, in which SANS was used to study lipid nanoparticles containing messenger RNA2 – the delivery mechanism for COVID-19 vaccines produced by Pfizer-BioNTech and Moderna. BioNTech also performed a SANS experiment at ILL in 2020.

Lessons learned, new perspectives

With these and other notable success stories to build on, it's evident that industry use of large-scale research facilities like ILL will remain on an upward trajectory for the foreseeable future. Yet while the laboratory's near-term thrust is on outreach to industry – raising awareness of the unique R&D opportunities herein – there's also a requirement for a dedicated selection path for applied R&D projects, with appropriate criteria to give industry streamlined access. Equally important is the ability for companies to study industry-relevant processes, samples and devices on ILL beam lines ("bringing industry to the neutrons"), while delivering experimental data or analysed research outcomes to the industrial customer per their requirements. Improved tracking (and subsequent promotion) of outcomes is another priority, with impact evaluated not just on a financial basis, but acknowledging other metrics such as savings versus energy and raw materials.

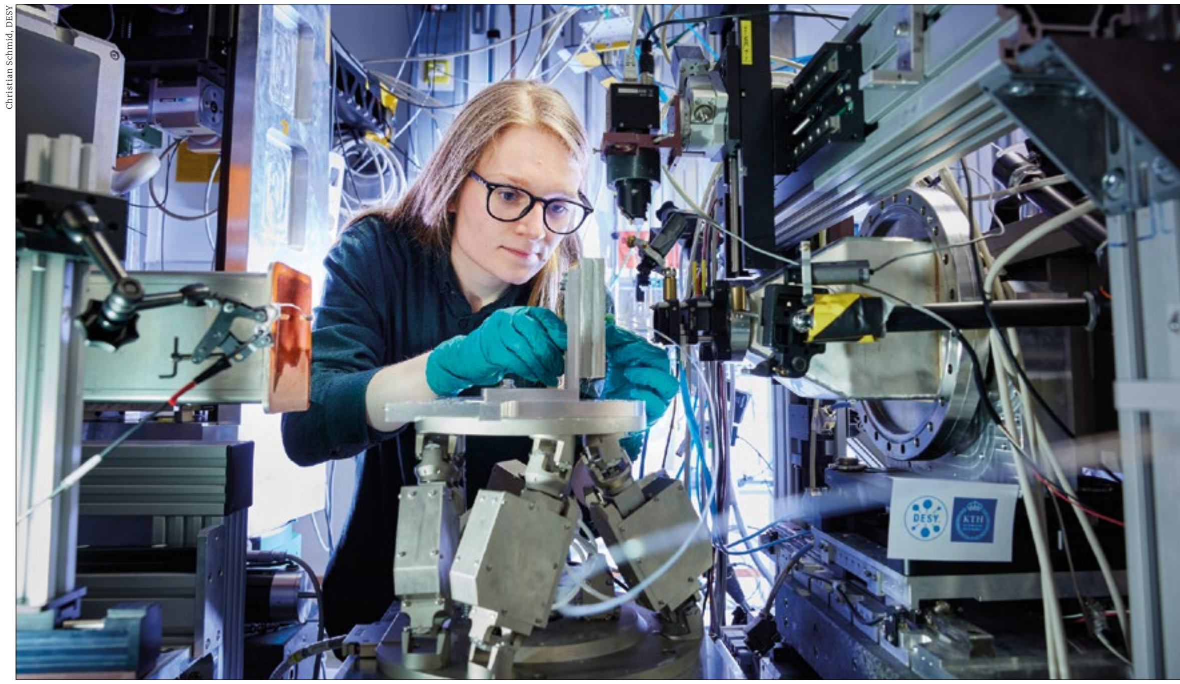
At the same time, so-called mediator companies are a growing – and increasingly vital – part of the mix. Operating at the interface between large-scale facilities and industry, these intermediary providers offer a broad portfolio of consultancy services – everything except the beam time – to enable industry customers to fast-track their R&D projects by easing access to the unique measurement capabilities offered by the big-science community. Examples include ANAXAM, a spin-off from the Paul Scherrer Institute in Switzerland, and Grenoble-based IROC Technologies – both of which are already connecting industry end-users with large-scale neutron facilities like ILL. Other companies – including Novitom in Grenoble and Finden in the UK – are facilitating industry research at synchrotron facilities like the ESRF, though could ultimately evolve to cover neutron techniques see p31.

In the long term, ILL and other laboratories like it must focus on lowering the barriers to engage small and medium-sized enterprises, as well as established technology companies, so that they come to see Europe's large-scale research facilities as a natural extension of their R&D and innovation pipeline. While indirect industry use of ILL will continue to grow, what constitutes success a decade from now would be an increase in the direct use of the facility by industry for precompetitive and proprietary research. Opportunity knocks. ●

Further reading

F Sebastiani *et al.* 2021 *ACS Nano* **15** 4 6709.
C Weulersse *et al.* 2018 *IEEE Trans. Nuclear Science* **65** 1851.

● *The authors would like to acknowledge the role of various colleagues in industry-related work at ILL: Duncan Atkins (ILU); Manon Letiche (IRT Nanoelec); Sandra Cabeza, Thilo Pirling, Ralf Schweins, Lionel Porcar, Alessandro Tengattini, Lukas Helfen (all instrument scientists at ILL); Ed Mitchell, Ennio Capria (both ESRF).*


Christian Schmid, DESY

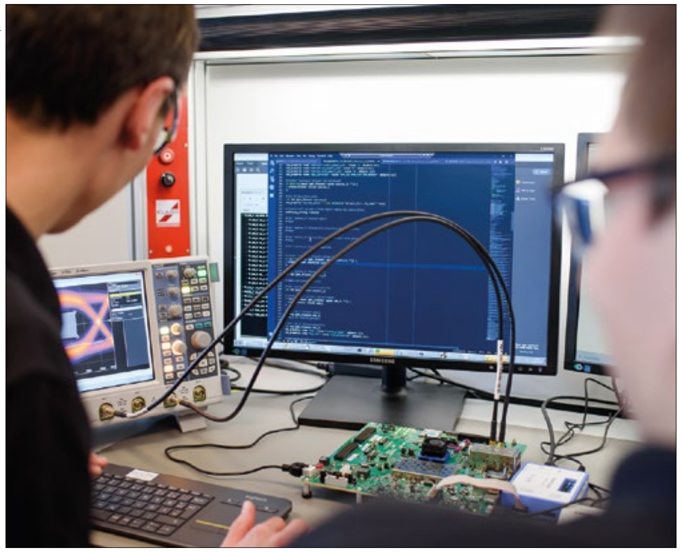
At your service *DESY scientists and engineers ensure industrial users make the most of their beam time at the PETRA III synchrotron source, offering a portfolio of services that includes feasibility studies, sample preparation, execution of measurements, as well as analysis of experimental data.*

DESY's INNOVATION ECOSYSTEM DELIVERS IMPACT FOR INDUSTRY

Collaboration with industry is hard-wired into the operational DNA of the German accelerator centre DESY. Djamschid Safi, head of the laboratory's business development office, explains how big science is helping Europe's technology and manufacturing companies to fast-track the development of innovative products, services and applications.

Collaboration, applied research services and innovation networks: these are the reference points of an evolving business development strategy that's building bridges between DESY's large-scale research infrastructure and end-users across European industry. The goal: to open up the laboratory's mission in basic science to support technology innovation and, by extension, deliver at-scale economic and societal impact.

As a German national laboratory rooted in physics, and one of the world's leading accelerator research centres, DESY's scientific endeavours are organised along four main coordinates: particle physics, photon science, astroparticle physics and the accelerator physics division. Those parallel lines of enquiry, pursued jointly with an established



Anne Gaertner, DESY

Setting the standard *DESY's MicroTCA Technology Lab supports industry partners and customers with hardware, firmware and software development, as well as product testing and technical consultancy. The dedicated laboratory space is open to prospective end-users interested in applying the MicroTCA.4 electronics standard for novel applications in research and industry.*

network of regional and international partners, make DESY a magnet for more than 3000 guest scientists from over 40 countries every year.

In the same way, the laboratory is a coveted research partner for industry and business, its leading-edge experimental facilities offering a unique addition to the R&D pipeline of Europe's small and medium-sized enterprises as well as established technology companies.

Technology transfer pathways

Industry collaboration with DESY is nothing if not diverse, spanning applied R&D and innovation initiatives across topics such as compact next-generation accelerator technologies, advanced laser systems for quality control in semiconductor-chip production, and the 3D printing of custom resins to create parts for use in ultrahigh-vacuum environments. While such cooperative efforts often involve established companies from many different industries, partners from academic science play an equally significant role – and typically with start-up or technology transfer ambitions as part of the mix.

This is the case for an envisaged spin-off project in which scientists from the University of Hamburg and DESY are working together on a portable liquid biopsy device for medical diagnostics applications (for example, in cancer screening and treatment evaluation). Reciprocity is the key to success here: the university researchers bring their background in nanoanalytics to the project, while DESY physicists contribute deep domain knowledge and expertise on the development of advanced detector technologies for particle physics experiments. As a result, a prototype test station for high-sensitivity *in-situ* analysis is now in the works, with the interaction of the nanochannels and the detector in the test device representing a significant R&D challenge in terms of precision mechanics (while the DESY team also provides expertise in pattern recognition to accelerate the readout of test results).

DESY photon scientists and engineers ensure that industrial users are in a position to maximise the return on their PETRA III beam time

Elsewhere, DESY's MicroTCA Technology Lab (TechLab) represents a prominent case study of direct industry collaboration, fostering the uptake of the MicroTCA.4 open electronics standard for applications in research and industry. Originally developed for the telecommunications market, the standard was subsequently adapted by DESY and its network of industrial partners – among them NAT (Germany), Struck (Germany) and CAENels (Italy) – for deployment within particle accelerator control systems (enabling precision measurements of many analogue signals with simultaneous high-performance digital processing in a single controller).

As such, MicroTCA.4 provides a core enabling technology in the control systems of the European X-ray Free Electron Laser (European XFEL), which runs over a 3.4 km span from DESY's Hamburg location to the main European XFEL campus in the town of Schenefeld. Another bespoke application of the standard is to be found in the ground-based control centre of the Laser Interferometer Space Antenna (LISA), a space-based gravitational wave detector jointly developed by NASA and the European Space Agency.

Underpinning this technology transfer success is a parallel emphasis on knowledge transfer and education. This is the reason why TechLab, which sits as part of the business development office at DESY, offers a programme of annual workshops and seminars for current and prospective users of MicroTCA.4. The long-term vision, moreover, is to develop a commercially self-sustaining TechLab spin-off based on the development and dissemination of MicroTCA into new applications and markets.

Industry services to fast-track innovation

One of the principal drivers of industrial engagement with DESY is the laboratory's PETRA III synchrotron light source (comprising a 2.3 km-circumference storage ring and 25 experimental beamlines). This high-brilliance X-ray facility is exploited by academic and industrial scientists to shed light on the structure and behaviour of matter at the atomic and molecular level across a range of disciplines – from clean-energy technologies to drug development and healthcare, from structural biology and nanotech to food and agricultural sciences.

Operationally, DESY photon scientists and engineers ensure that industrial users are in a position to maximise the return on their PETRA III beam time, offering a portfolio of services that includes feasibility studies, sample preparation, execution of measurements, as well as downstream analysis of experimental data. Industry customers can request proprietary access to PETRA III via the business development office (under a non-disclosure agreement if necessary), while clients do not even need to come to DESY themselves, with options for a mail-in sample service or even remote access studies in certain circumstances. Publication is not required under this

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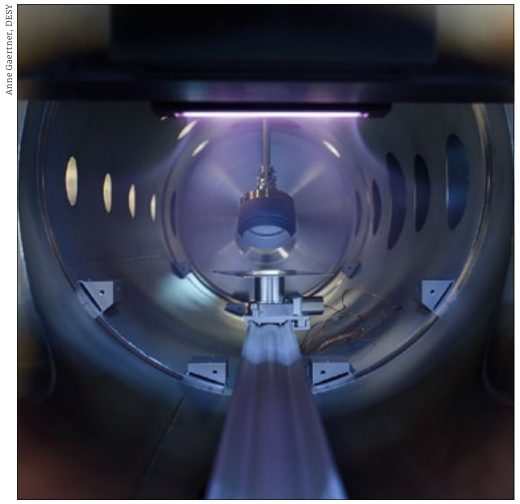
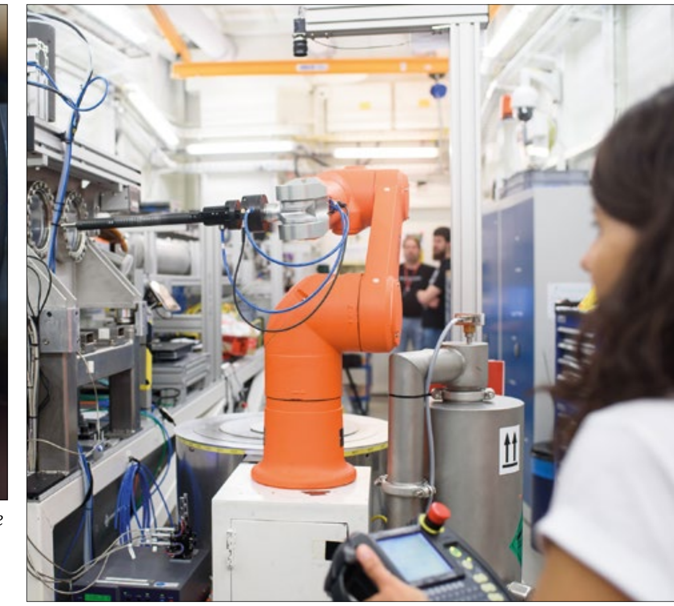
IN FOCUS BUSINESS DEVELOPMENT



Anne Gaertner, DESY

Quality assurance *Thin-film deposition is part of the service offering to industry users at DESY, opening up unique coating tasks that are not otherwise commercially accessible. The laboratory's magnetron-sputtering deposition systems (shown above) enable functional thin-film development as well as complex multilayer coatings on small and medium-sized planar and 3D objects.*



Anne Gaertner/DESY

Take your pick *Industry scientists do not even need to go to DESY to access PETRA III beam time, with options for a mail-in sample service or even remote studies in certain circumstances.*

access model, though discounted fees are available to industry users willing to publish a "success story" or scientific paper in partnership with DESY.

Alongside the proprietary route, companies are able to access PETRA III beam time through academic partners. This pathway is free of charge and based on research proposals with strong scientific or socioeconomic impact (established via a competitive review process), with a requirement that results are subsequently published in the formal scientific literature. Notwithstanding the possibilities offered by DESY itself, the laboratory's on-campus partners – namely the Helmholtz Centre Hereon and the European Molecular Biology Laboratory (EMBL) – use PETRA III to deliver a suite of dedicated services that help industry customers address diverse problems in the applied R&D pipeline.

The German biotech company BioNTech is a case in point. Best known for its successful mRNA vaccine against SARS-Cov-2 infections, BioNTech conducted a programme of X-ray scattering experiments at EMBL's PETRA III beamline P12. The results of these investigations are now helping the company's scientists to better package mRNA within nanoparticles for experimental vaccines and drugs. Along an altogether different R&D track, PETRA III has helped industry users gain novel insights into the inner life of conventional AAA batteries – studies that could ultimately lead to products with significantly extended lifetimes. Using non-invasive X-ray diffraction computer tomography, applied under time-resolved conditions, the studies revealed aspects of the battery ageing process by examining phase transformations in the electrodes and electrolyte during charging and discharge.

Building an innovation ecosystem

While access to DESY's front-line experimental facilities represents a game-changer for many industry customers, the realisation of new commercial products and technologies does not happen in a vacuum. Innovators, for their part, need specialist resources and expert networks to bring their ideas to life – whether that's in the form of direct investment, strategic consultancy, business and entrepreneurship education, or access to state-of-the-art laboratories and workshops for prototyping, testing, metrology and early-stage product qualification.

DESY is single-minded in its support for this wider "innovation ecosystem", with a range of complementary initiatives to encourage knowledge exchange and collaboration among early-career scientists, entrepreneurs and senior managers and engineers in established technology companies. The DESY Start-up Office, for example, offers new technology businesses access to a range of services, including management consultancy, business plan development and networking opportunities with potential suppliers and customers. There's also the Start-up Labs Bahrenfeld, an innovation centre and technology incubator on the DESY Hamburg campus that provides laboratory and office space to young technology companies. The incubator's current portfolio of 16 start-ups reflects DESY's pre-eminence in lasers, detectors and enabling photonic technologies, with seven of the companies also targeting applications in the life sciences.

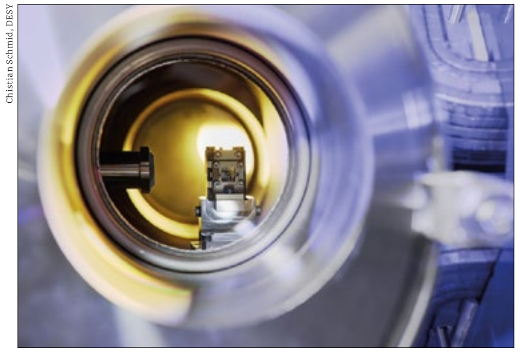
A more focused initiative is the CAROTS 2.0 Startup School, which provides scientists with the core competencies for running their own scientific service companies (intermediary providers of analytical research services to help industry make greater use of large-scale science facilities like DESY). Longer term, the DESY Innovation Factory is set to open in 2025, creating an ambitious vehicle for the commercial development of novel ideas in advanced materials and the life sciences, while fostering cooperation between the research community and technology companies in various growth phases. There will be two locations, one on the DESY campus and one in the nearby innovation and technology park Vorhornweg.

Basic science, applied opportunities

If the network effects of DESY's innovation ecosystem are a key enabler of technology transfer and industry engagement, so too is the relentless evolution of the laboratory's accelerator R&D programme. Consider the rapid advances in compact plasma-based accelerators, offering field strengths in the GV/m regime and the prospect of a paradigm shift to a new generation of user-friendly particle accelerators – even potentially "bringing the accelerator to the problem" for specific applications. With a dedicated team working on the miniaturisation of particle accelerators, DESY is intent on maturing plasma technologies for its core areas of expertise in particle physics and photon science while simultaneously targeting medical and industrial use-cases from the outset.

Meanwhile, plans are taking shape for PETRA IV and conversion of the PETRA storage ring into an ultralow-emittance synchrotron source. By generating beams of hard X-rays with unprecedented coherence properties that can be focused down to the nm regime, PETRA IV will provide scientists and engineers with the ultimate 3D process microscope for all manner of industry-relevant problems – whether that's addressing individual organelles in living cells, following metabolic pathways with elemental and molecular specificity, or observing correlations in functional materials over mm length scales and under working conditions.

Fundamental science never stops at DESY. Neither, it seems, do the downstream opportunities for industrial collaboration and technology innovation. ●


Christian Schmid, DESY

Think small, win big *DESY is developing a new generation of compact plasma-based particle accelerators. Right: a laser plasma subsystem under vacuum.*

THE AUTHOR

Djamschid Safi *is head of the DESY business development office, which is responsible for all of the laboratory's innovation and new business services.*

CERN's PARTNERSHIPS UNDERPIN A JOINED-UP INNOVATION PIPELINE

Procuring the future *The scientific discovery potential of the LHC is intrinsically linked to sustained technology innovations from industry suppliers, in the process disseminating CERN's domain knowledge and expertise to applications and industries outside high-energy physics.*

From equipment procurement to knowledge-transfer initiatives, Giovanni Anelli, Anders Unnervik and Marzena Lapka provide a high-level tour of CERN's unique research and innovation ecosystem.

CERN sits at the epicentre of a diverse innovation ecosystem. Developing and implementing the enabling technologies for the laboratory's particle accelerators, detectors and computing systems is only possible thanks to the sustained support of a global network of specialist industrial and institutional partners. Those applied R&D and product development collaborations come in many forms: from the upstream procurement of equipment and services across multiple industry supply chains to the structured transfer of CERN domain knowledge to create downstream growth opportunities for new and established technology companies. Emphasising the role of big science in delivering broad societal and economic impacts, the following snapshots showcase a technology innovation programme that is, quite simply, one on its own.

Procurement: a world of opportunity

CERN is budgeted to spend CHF 2.5 billion (Euro 2.6 billion) on procurement of equipment and services for the period 2022–26 and is always looking to engage new industry suppliers. Contracts are awarded following price enquiries or invitations to tender. The former relate to contracts with an anticipated value below CHF 200,000 and are issued to a limited number of selected firms. Invitations to tender, meanwhile, are required for contracts with a value above CHF 200,000 and issued to firms qualified and selected based

THE AUTHORS

Giovanni Anelli *is head of CERN's Knowledge Transfer (KT) Group;* **Anders Unnervik** *is head of CERN Procurement and Industrial Services;* **Marzena Lapka** *is a communication and marketing officer in CERN's KT Group.*

on a preceding open market survey. Prospective industry suppliers should visit https://procurement.web.cern.ch/ to register for CERN's procurement database.

Procurement: amplifying the upsides

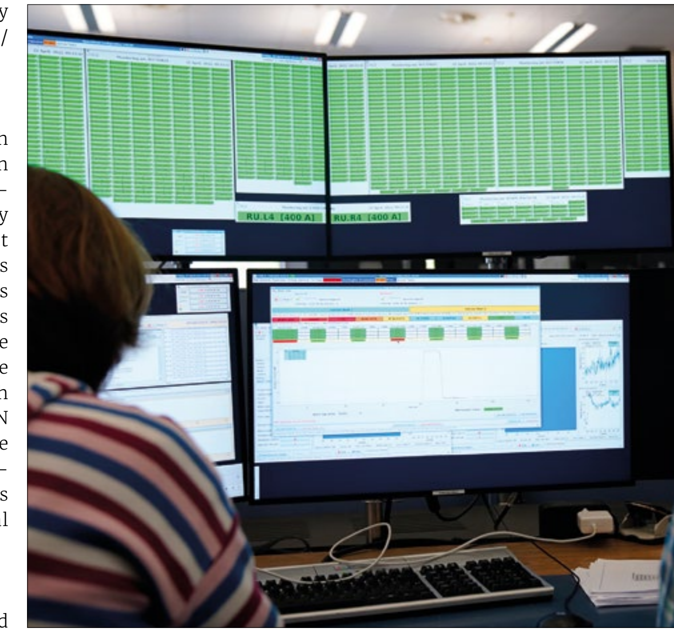
For industry suppliers, the benefits of doing business with CERN go well beyond direct financial returns on a given contract. Like all big science projects, CERN provides fertile ground for technology innovation. As such, industry partners are also investing in future visibility and impact within their given commercial setting. CERN, after all, is well known for its technological excellence, which means preferred suppliers must, as standard, push the boundaries of what's possible, creating a virtuous circle of positive impacts versus firms' product innovation, sustainable practices, profitability and competitiveness. A 2018 research study, for example, investigated whether becoming a CERN supplier was linked to enhanced innovation performance within partner companies, and it showed a statistically significant correlation between CERN procurement contracts and corporate R&D, knowledge creation and commercial outcomes (see "Further reading").

Following the procurement roadmap

The LHC is undergoing a major upgrade to sustain and extend its discovery potential. Scheduled to enter operation in 2029, the High-Luminosity LHC (HL-LHC) project is a complex undertaking that requires at-scale industry engagement for all manner of technology innovations, whether that's cutting-edge superconducting magnets or compact, ultraprecise superconducting RF cavities for beam rotation. What's more, the machine's enhanced luminosity (i.e. increased rate of collisions) will make new demands on the supporting vacuum, cryogenics and machine protection systems, while advanced concepts for collimation and diagnostics, beam modelling and beam-crossing schemes will also be required to maximise physics outputs. Industry is front-and-centre and has a pivotal role to play in delivering the core technologies needed to achieve the HL-LHC's scientific goals. Down the line, even bigger opportunities will come into play as the HL-LHC draws to a close (in 2040 or thereabouts). Designs are now in the works for the proposed Future Circular Collider (FCC), an advanced research infrastructure that would push the energy and intensity frontiers of particle accelerators into uncharted territory, reaching collision energies of 100 TeV (versus the LHC's current 13.6 TeV) in the search for new physics.

The engine-room of knowledge transfer

Although fundamental physics might not seem the most obvious discipline in which to find emerging technologies with marketable applications, CERN's unique research environment – reliant as it is on diverse types of radiation, extremely low temperatures, ultrahigh magnetic fields and high-voltage power systems – represents a rich source of innovation spanning particle accelerators, detectors and scientific computing. Industry partnerships underpin CERN's core research endeavour through the procurement of specialist services and co-development of cutting-edge components, subsystems and instrumentation – a process known as upstream innovation. Conversely, companies looking to solve innovation challenges are able to tap CERN's capabilities to support technology development and growth opportunities within their own R&D pipeline – a process known as downstream innovation. In this way, companies and research institutes collaborate with CERN scientists and engineers to deliver breakthrough technologies ranging from cancer therapy to environmental monitoring, radiation-hardened electronics to banking and finance.



The heart of it all *CERN's research environment represents a rich source of innovation opportunities spanning particle accelerators, detectors and scientific computing.*

Intellectual property: getting creative

A curated portfolio of intellectual property (IP) policies provides the framework for transferring CERN's applied R&D and technology know-how to industry and institutional partners. Democratisation is the driver here, whatever the use-case. Many of the organisation's projects, for example, are available via CERN's Open Hardware Repository under the CERN Open Hardware Licence, offering a large user community the chance to transform prototype products and services into tangible commercial opportunities. CERN also encourages the creation of new spin-offs – companies based, partially or wholly, on CERN technologies – and supports such ventures with a dedicated IP policy. Custom licensing opportunities are available for more established start-up businesses seeking to apply CERN technologies within an existing product development programme.

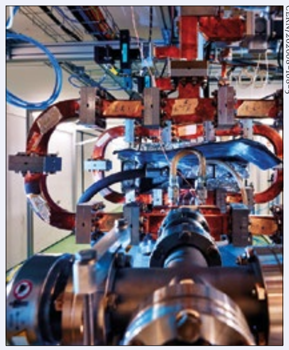
Innovation partnerships: a call to action

The Knowledge Transfer team at CERN is exploring a range of innovation partnerships across applied disciplines as diverse as energy and environment, healthcare, quantum science, machine learning and AI, and aerospace engineering. The unifying theme: to translate CERN domain knowledge and enabling technologies into broader societal

Knowledge transfer at CERN: unique technologies, unprecedented performance

The applied R&D and technology advances that underpin CERN's scientific mission are a rich source of product innovation for companies working across multiple industry sectors. Industry collaborations with CERN scientists and engineers – including the projects below – are overseen by the laboratory's Knowledge Transfer Group.

Next-generation radiotherapy



Out of the lab, into the clinic *Clinical researchers are using CERN's Compact Linear Collider (CLIC) prototype to evaluate VHEE FLASH radiotherapy.*

An R&D collaboration involving scientists from CERN and Lausanne University Hospital (CHUV) seeks to fast-track the development of a next-generation radiotherapy modality that will exploit very-high-energy electron (VHEE) beams to treat cancer patients. A dedicated VHEE facility, based at CHUV, will exploit the so-called FLASH effect to deliver high-dose VHEE radiation over short time periods (less than 200 ms) to destroy deep-seated tumours while minimising collateral damage to adjacent healthy tissue and organs at risk. The pioneering treatment system is based on the high-gradient accelerator technology developed for the proposed CLIC electron–positron collider at CERN. Teams from CHUV and its research partners have been performing preclinical studies related to VHEE and FLASH at the CERN Linear Electron Accelerator for Research (CLEAR), one of the few facilities available for characterising VHEE beams.

The future of transportation

CERN has unique capabilities in real-time data processing. When beams of particles collide at the centre of a particle detector, new particles fly out in all directions. Different detector systems, arranged in layers around the collision point, use a range of techniques to identify the resulting particles, generating an enormous flow of data. Similar challenges apply to the development of autonomous vehicles, with the need for rapid interpretation of a multitude of real-time data streams generated under normal driving conditions. Zenseact, owned primarily by Volvo Cars, worked with CERN scientists to optimise machine learning algorithms, originally developed to support LHC data acquisition and analysis, for collision-avoidance scenarios in next-generation autonomous vehicles.

Zenseact

Hit the road *Zenseact, part of Volvo Cars, is exploring how CERN's machine-learning algorithms can optimise the decision-making of self-driving vehicles.*

Sustainability and energy-efficiency

Another high-profile innovation partner for CERN is ABB Motion, a technology leader in digitally enabled motor and drive solutions to support a low-carbon future for industry, infrastructure and transportation. The partnership has been launched to optimise the laboratory's cooling and ventilation infrastructure, with the aim of reducing energy consumption across the campus. Specifically, CERN's cooling and ventilation system will be equipped with smart sensors, which convert traditional motors, pumps, mounted bearings and gearing into smart, wirelessly connected devices. These devices will collect data that will be used to develop "digital twins" of selected cooling and ventilation units, allowing for the creation of energy-saving scenarios. Longer term, the plan is to disseminate the project learning publicly, so that industry and large-scale research facilities can apply best practice on energy-efficiency.

CERN/Guillaume Jeanneret

Stay cool *An innovation partnership with industry aims to reduce the energy footprint of CERN's cooling and ventilation infrastructure. Above: cooling equipment used for the ATLAS experiment and the Super Proton Synchrotron (SPS) accelerator.*

and economic impacts. Companies should visit CERN's Knowledge Transfer website (https://kt.cern/) to learn more about partnership opportunities, including R&D collaborations; technology licensing; services and consultancy; and starting up a new business based on CERN technology.

IdeaSquare: networking young innovators

IdeaSquare is CERN's platform for early-stage collaborations between students, scientists, other CERN personnel and relevant organisations working across multiple disciplines. The initiative operates at what it calls the "fuzzy front end" of the R&D and innovation process and seeks to "trigger transformations in the way we think about societal challenges and...identify solutions that will have a real impact on people's lives". In this way, IdeaSquare ties science innovation at CERN to the UN's Sustainable Development Goals, engaging young innovators in the CERN Entrepreneurship Student Programme (CESP), for example, or Challenge-Based Innovation (CBI). Other activities include selected EU R&D projects; prototyping and innovation workshops; as well as international educational programmes. Prospective partners should visit https://ideasquare.cern and https://kt.cern/cesp for more information about the latest opportunities. ●

Further reading

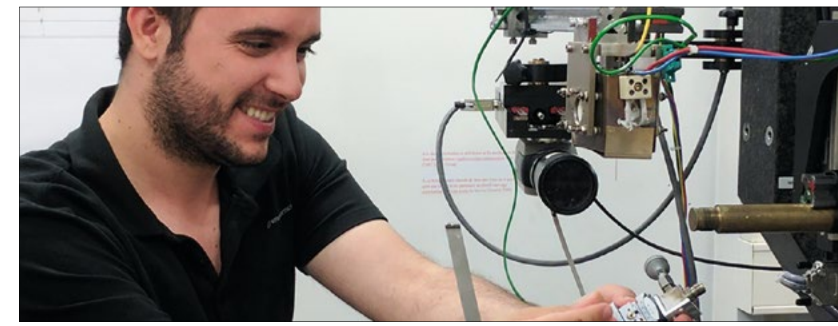
P Castelnovo *et al.* 2018 The economic impact of technological procurement for large-scale research infrastructures: evidence from the Large Hadron Collider at CERN *Research Policy* **47** 1853.

OPINION
SERVICES

Prioritising the industry customer

Mediator companies are the ultimate connectors between the big-science community and industry end-users. Joe McEntee checks out the business model for specialist science services.

Mediator companies (also known as science-service companies) have emerged as one of the main engines of connection and collaboration between Europe's large-scale research facilities and industry. A case in point is Finden, a UK-based outfit that helps applied scientists and engineers in a range of industry sectors – energy, industrial chemistry, catalysis and automotive, among others – to access leading-edge materials characterisation services at Europe's synchrotron research laboratories. Finden managing director Simon Jacques talked to *CERN Courier* about the company's science-as-a-service business model and plans to diversify beyond conventional X-ray analysis techniques and synchrotron science.


Finden

Express turnaround *Speed is key to the successful delivery of high-end materials characterisation services.*

How is Finden helping the big-science community to grow its industry user base?

As a regular user of large-scale synchrotron facilities within Europe, we enable our industry customers to fast-track R&D projects through unique measurement capabilities tailored to their needs. Put simply, Finden helps industry clients to solve complex materials problems that they're unable to solve on their own. It's a winning formula: many of our customers come back to us on a serial basis, tapping the collective expertise of the Finden team and the streamlined access we provide to Europe's synchrotron light sources.

What do you mean by streamlined access?

There are often significant logistics overheads when it comes to finding and securing beam time at a synchrotron facility – a barrier to direct industry engagement with big science. At Finden, we have the know-how, as well as an extensive network of contacts within the synchrotron community, to take care of all the associated "legwork" for our clients, matching the right beamline and scientific instruments to the industrial problem at hand. That translates into express workflows and turnaround – the key to successful delivery of high-end materials characterisation services for industrial problem-solving.

Operationally, how do new industry clients engage with Finden?

For the most part, our client base comprises established companies rather than small and medium-sized enterprises. First contact can happen in a variety of ways: an exploratory conversation with a Finden scientist at a conference, for example, or sometimes a synchrotron facility may point an industry enquiry in our direction. Once the dialogue is under way, we'll meet with the client to understand their materials problem at a granular level – often under a non-disclosure agreement to ensure commercial confidentiality. My task as managing director is to make sure we've got all the right people in the room from Finden to establish the appropriate characterisation methods versus the client's problem and specified timeline – as well as an accurate financial quotation for the plan of work.


Finden

Simon Jacques
"We help industry clients to solve complex materials problems that they're unable to solve on their own."

THE AUTHOR
Joe McEntee *is a consultant editor based in South Gloucestershire, UK.*

Do all of the industry problems you tackle require synchrotron beam time?

Not all of them. We have access to a suite of powerful materials analysis techniques here on the Harwell campus (in Oxfordshire) and those lab-based tools often represent a cheaper and more efficient option for our industry clients. When we do engage with the large-scale facilities – for example, the nearby Diamond Light Source or the European Synchrotron Radiation Facility (ESRF) in Grenoble – we make all the necessary arrangements and carry out the work on behalf of the client. Sometimes our scientists will conduct materials studies at the synchrotron beamline – "eyes on the sample" so to speak – though even when working remotely the team will be conducting on-the-fly data analysis and liaising throughout with scientists and technicians *in situ*.

What does the business model look like for the provision of these big-science services?

It might seem counter-intuitive, but we don't charge a premium for synchrotron beam time. That's all billed at-cost to mitigate the chance of the customer going direct to the synchrotron. Our differentiation – and where we make our money – lies in the collective expertise of the Finden team in synchrotron science, instrumentation and techniques – not least our capabilities across experimental design, data analysis and interpretation. By extension, one of the growth opportunities we're now pursuing is the application of machine-learning and deep-learning technologies to high-throughput data analysis. It's early days, but we're already securing industry contracts that tap this capability exclusively, including projects that do not require any experimental data collection on our part.

How is Finden structured right now?
Finden is really two parallel and complementary businesses under one roof. The mediator company, which provides specialist materials science capabilities to industry, rents laboratory space and equipment across the Harwell Innovation Campus on an as-needed basis, while developing a pipeline of higher-level characterisation projects that require access to Europe's synchrotron light sources. Alongside the science-service business, we run our own dedicated research laboratory that we lease from the Science and Technology Facilities Council, a UK government funding agency. This lab is largely ring-fenced for in-house R&D and innovation initiatives under the broad themes of catalysis and machine learning – essentially longer-term bets with a view to building sustainable royalty and licensing revenues from the associated intellectual property portfolio.

What do the growth opportunities look like for Finden?
Diversification is very much part of Finden's development roadmap. Right now, the heart of our business is materials characterisation using diffraction, spectroscopy and imaging techniques spanning conventional X-ray and synchrotron science. Conceptually, it's a logical progression to apply those transferable capabilities to other modalities used in fundamental and applied materials research. In summary: expect to see Finden scientists tackling industry's R&D problems at large-scale neutron and laser facilities in the not-too-distant future. ●

MiXN's network effects

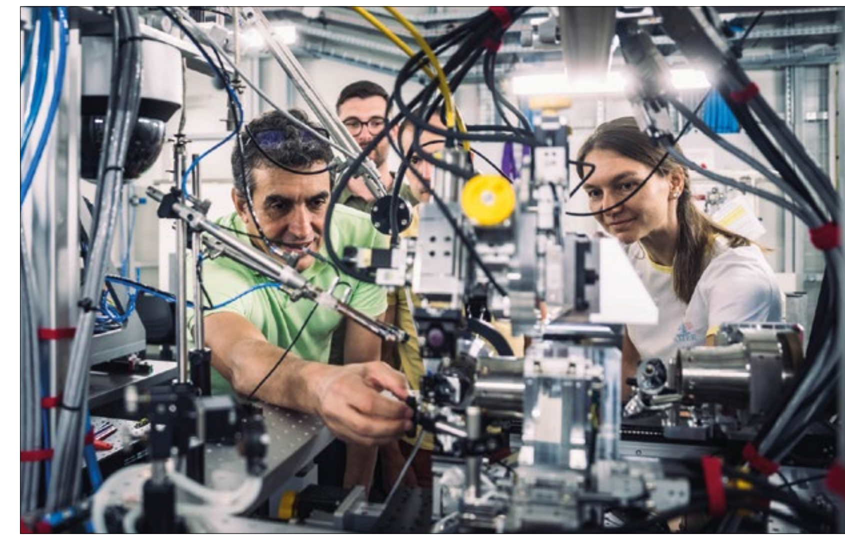
Based at the Harwell Innovation Campus in Oxfordshire, UK, Finden is part of a specialist pan-European network of analytical service providers called MiXN (Mediators connecting Industry to X-rays and Neutrons). As such, Finden and its MiXN peers help industry customers tackle complex problems in applied R&D and product development through facilitated access to Europe's synchrotron and neutron research laboratories. Currently the MiXN membership comprises 12 science-service companies.

OPINION
FACILITIES

Building bridges with industry

The European Synchrotron Radiation Facility provides a unique environment for industry users to translate their materials R&D into high-impact technologies. Joe McEntee reports.

The European Synchrotron Radiation Facility (ESRF) in Grenoble, France, is among an elite class of fourth-generation advanced light sources – an X-ray "super-microscope" that enables researchers to illuminate the structure and behaviour of matter at the atomic and molecular level. As such, the ESRF's synchrotron beamlines offer leading-edge materials characterisation capabilities for applied scientists and engineers to address research challenges at all stage of the innovation life cycle – from product development and manufacturing through operational studies related to ageing, wear-and-tear, restoration and recycling. Here *CERN Courier* talks to Ed Mitchell, head of business development at the ESRF, about the laboratory's evolving relationship with the industrial R&D community.



ESRF/Stef Candé

Shine on *The number of academic and industrial researchers accessing the ESRF's X-ray beamlines has grown significantly over the past decade to approximately 9000 scientific visits per year.*

What does your role involve as head of business development?
I lead a core team of seven staff looking after the ESRF's engagement with industry – though not the procurement of equipment and services. It's a broad-scope remit, covering industry as a user of the facility as well as technology transfer projects and R&D collaborations with industry partners as they arise. The business development activity increasingly dovetails with the outreach efforts of leading research technology organisations – the Fraunhofer institutes in Germany, for example, and the French Alternative Energies and Atomic Energy Commission (CEA) in France – which have extensive networks and amplify ESRF's engagement with industry at the regional and national level.

The business development office is also responsible for identifying – and securing – strategic European Union (EU) grant opportunities. A case in point is InnovaXN, a joint PhD programme with the Institut Laue-Langevin (ILL), a neutron science facility here in Grenoble, and a ground-breaking approach to working with industry partners (see p9). STREAMLINE is another of our important EU-funded projects (under Horizon 2020) and supports the recent ESRF-EBS (Extremely Brilliant Source) upgrade with new-look operation, access and automation procedures on several beamlines.

ESRF

Ed Mitchell *"Our task is to listen to industry users and design the services they need for what they want to do – not what we think they might want."*

How does your team engage new industry users and partners for the ESRF?
Initiating and developing new industry contacts is a big part of what we do, though the challenge is always to talk to companies on their own terms, so that they understand the extent of the opportunities available at ESRF. A related issue is getting to the right people, especially in multinational companies with extensive R&D programmes. Sometimes we get lucky. At BASF, for example, we work closely with a senior applied research manager, someone who knows ESRF well having

had links with us for many years. He's an amazing contact, though the exception rather than the rule when it comes to industry engagement.

What about the ESRF's outreach efforts with small and medium-sized enterprises (SMEs)?
There is EU funding available to help SMEs work with the ESRF and other advanced light sources in Europe. While this is relatively modest support, it is critical as a way of de-risking that first access for cash-strapped SMEs when they approach the big-science community. We need more of this support to scale our engagement with SMEs. Operationally, the so-called mediator companies are also incredibly important for bridging the gap to SMEs – as well as larger companies – helping them to plan, execute and deliver high-end materials characterisation services for their industrial problem-solving. It's worth adding that the mediator companies offer value-added analysis of experimental results for research studies where we do not have the niche expertise – for example, petrochemical catalysis or the testing of consumer products (see p31).

So the mediator companies are one of the key elements of the ESRF's engagement with industry?
Correct. I get a little frustrated when people imply that the mediators are simply making money off the back of the large-scale facilities. Mediator companies are another wholly valid element of the big-science ecosystem and should be celebrated as such. They add niche value, generate jobs and amplify the marketing and business development efforts of ESRF (and facilities like it) with prospective industry users. Their role is wholly positive. Entrepreneurs have seen a space, been innovative, and they're making a living along the way. It's a win-win.

How is the industry user base at ESRF evolving?
A substantial majority of our commercial users used to be from the pharmaceutical sector, using structural biology for drug discovery. The pharma researchers are still there, but over the last decade the industry community has become more diverse, covering more industry sectors and using a broader portfolio of synchrotron techniques. What's more, a lot of industry users are not – and don't aspire to be – experts in synchrotron science. Instead, they just want access to the facility for what we might consider routine measurements rather than cutting-edge research.

Those routine measurements – billed internally as "access to excellence everyday" – are only possible thanks to the specific qualities of a light source like the ESRF, with our science and technology experts working with industry to make such services more accessible and more automated. On the horizon, we can also see interest in some level of standard operating procedure for various industry use-cases, so that quality can be assured – though this will need to be considered within the context of facilities whose main mission is academic research.

What steps can you take to remain aligned with industry's changing requirements?
Our task is to go out and listen to industry researchers and design the services they need for what they want to do – not what we think they might want. A case study in this regard is our collaboration with BASF in which ESRF and BASF scientists are co-developing a high-throughput mail-in service to support X-ray powder diffraction studies of hundreds of samples per shipment from the client's R&D lab. This is essentially chemistry genomics, with the synchrotron beamlines providing automated and high-resolution studies of materials destined for applications in next-generation batteries, catalysts and the like. We hope to see more co-designed services being built with other companies very soon.

What about tracking the impact of industry research conducted at ESRF?
This is always tricky. More often than not, the downstream impact of confidential industry R&D conducted at ESRF remains hidden even from our view. After all, companies are unlikely to reveal how much money they saved on their manufacturing process, for example, or whether a new product was an indirect or direct result of X-ray studies at our beamlines.

In some ways, the laboratory needs perhaps just one killer quantifiable result every 10 years – think multibillion euro outcomes for industry – and the ESRF could be thought of as having justified its existence. Of course, this ignores the longer-term impact of the fundamental science conducted by academics – far and away the main user community at the ESRF. The bottom line: industry clients come back, they pay for access, so one has to assume that there is significant business impact for them. ●

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Brilliant science *The recent Extremely Brilliant Source (EBS) upgrade makes the ESRF the world's brightest synchrotron source and a centre of excellence for fundamental and applied research.*

THE AUTHOR
Joe McEntee *is a consultant editor based in South Gloucestershire, UK.*