

Research Industry Report

Slovenia Joins the World's Flagship Neutron Facility, ILL

Professor Mark Johnson, Scientific Director, Institut Laue-Langevin

The coronavirus pandemic has presented unprecedented challenges to the scientific community. Its economic impact has threatened research funding, national lockdowns have obliged scientists to part from their experiments and instruments, and international travel restrictions have prevented the typical buzz of global conferences and collaborations. Yet, in the face of these obstacles, scientists worldwide have mobilised with incredible speed and agility to cooperate across international borders, often remotely, and adapt their research to the new challenges that have emerged from the SARS-CoV-2 virus.

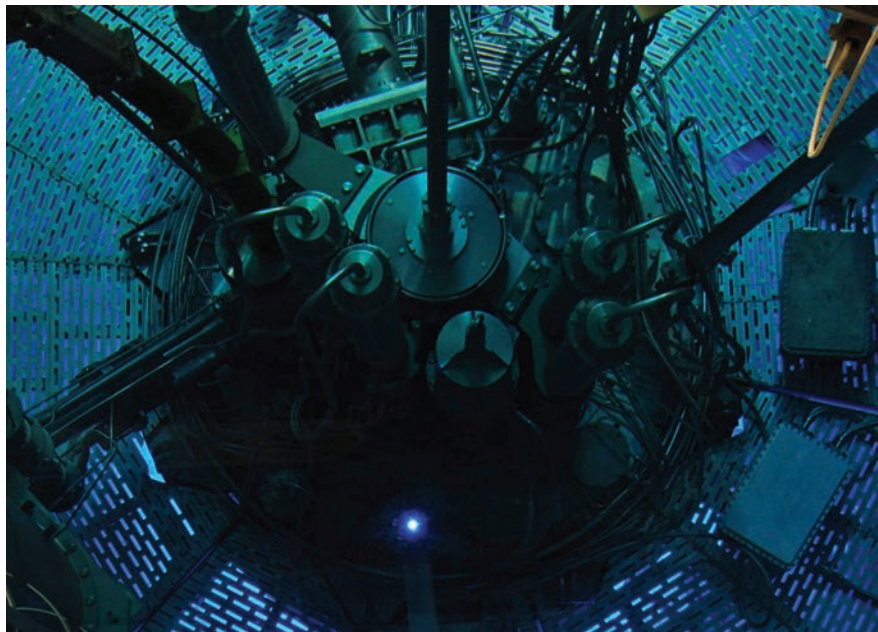
This determination to strengthen collaboration and find new ways to conduct research could also have not come at a better time. The spotlight is on scientists, not just to understand and inform developments for coronavirus, but other global threats we face - including climate change and lack of renewable resources. These challenges will need innovative approaches from scientists across the world.

In this remarkable era for science, one of Europe's most important scientific facilities has just welcomed a new nation to its partnership. As of August 2020, Slovenia has become an official member of the Institut Laue-Langevin (ILL) - the world's most powerful neutron source. This makes Slovenia one of the 14 countries that can use the world-leading facilities at ILL to conduct scientific research, allowing its researchers to participate in the projects that look to answer the world's most pressing scientific questions.



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The international partnership is governed and primarily funded by three founding countries - the UK, France, and Germany - with 11 member countries, including Slovenia, that make financial contributions to enable access to the facility, and send their nations leading scientific projects to benefit from the tools and expertise at the ILL.



Top view of ILL's high flux reactor - bright spot in the centre shows the Cherenkov light of the irradiation position used for medical isotope production

What is the ILL?

Institut Laue-Langevin is an international research centre based in Grenoble, France, home to around 40 world-class neutron science instruments that researchers use to analyse materials, explore microscopic structure, and reveal fundamental behaviours of the universe.

The research is conducted by directing powerful beams of neutrons at a sample, through specialised instruments that are constantly being developed and upgraded to support a huge variety of research areas. Neutrons are an ideal tool to probe materials, as these elementary particles have a low mass and no charge and can therefore penetrate deep into matter. The interactions of the neutron beam with the nuclei of the atoms in the sample can reveal an enormous amount of information, from the atomic structure to the magnetic properties of the material.

Neutrons are capable of illuminating the materials central to almost all scientific fields - from uncovering how molecules travel across cell membranes, to revealing the inner workings of batteries, to informing how drugs are designed. They are also a crucial component of fundamental research into the laws that govern our universe, including nuclear physics and mysteries that have plagued science for decades: including dark matter, and the puzzling lifetime of the neutron itself.

The ILL is host to over 1,400 researchers per year who travel from all over the world to use neutron techniques as part of their research, as well as benefit from the world-leading knowledge of the chemists, physicists, biologists, crystallographers and other specialists at ILL that are available to support users of the facility.

Forging a partnership

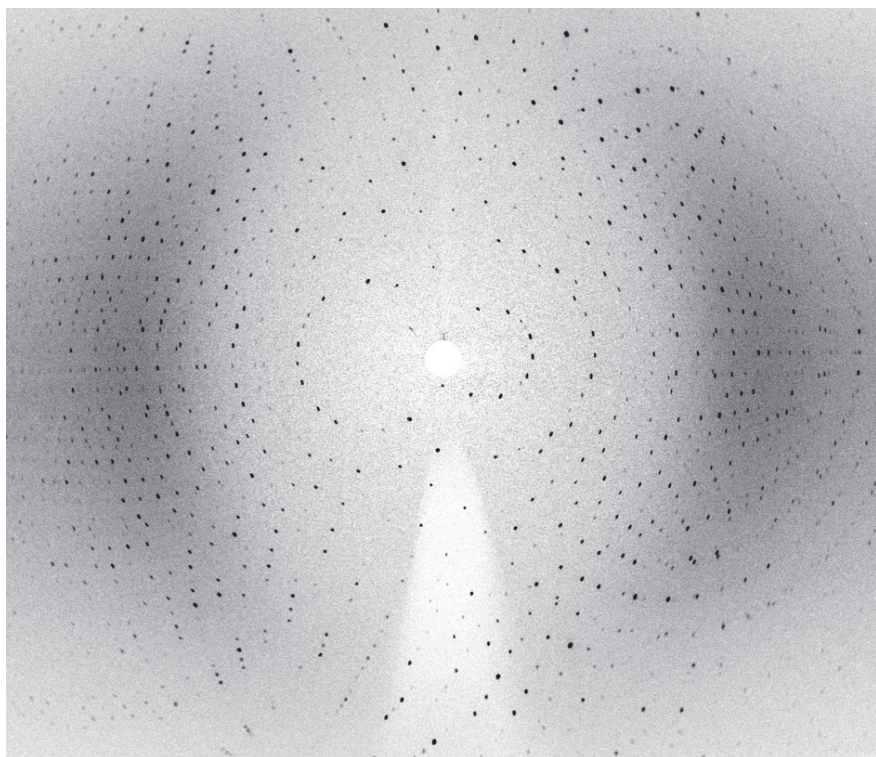
ILL and Slovenia have explored the possibility of scientific membership for over a decade. The discussions on joining the facility began as talks between a number of research groups about how Slovenia's researchers would benefit from access to neutron beams and grew to eventually become negotiations at the ministry level.

Yet, the finalisation of the agreement was delayed by several years, due to the impact of the 2008 financial crisis which hit many smaller European countries such as Slovenia very hard. This had a predictable impact on budgets for funding scientific research, and it has taken a number of years to get the negotiations and necessary R&D funding back on track. The official signing of the agreement between Slovenia and ILL came at a time of another significant economic challenge, during the global pandemic, but its progression is a testament to the dedication of scientists and policymakers at both ends.

ILL's mission is to provide the international scientific community with the brightest neutrons beams possible and conduct research of the highest scientific excellence. Ideally, this would involve countries from across the European Research Area and the doors would be open to scientists based on their research merit alone. However, large research infrastructures including ILL are extremely expensive to build, operate, and upgrade. The cost of operating the ILL as well as carrying out essential maintenance and upgrades makes up more than 50% of the annual €90 million budget. The agreements with the associate countries and scientific member countries involve vital financial contributions to keep the ILL's doors open, and it has become necessary that the facility operates like a business to remain financially viable - the beam time must be paid for.

A winning alliance

Slovenia's scientists in academia and industry will now have access to some of the world's most powerful tools for scientific discovery. Slovenia is a small country, but punches above its weight in terms of its research credentials. Its scientific landscape is built on several strong academic institutions, with researchers ranking among the most prolific in Europe.



A neutron Laue diffraction pattern from a crystal of HIV-1 protease in complex with a clinical inhibitor collected using the LADI instrument at ILL. Credit: Matthew Blakeley, ILL; Andrey Kovalevsky, Oak Ridge National Laboratory, USA

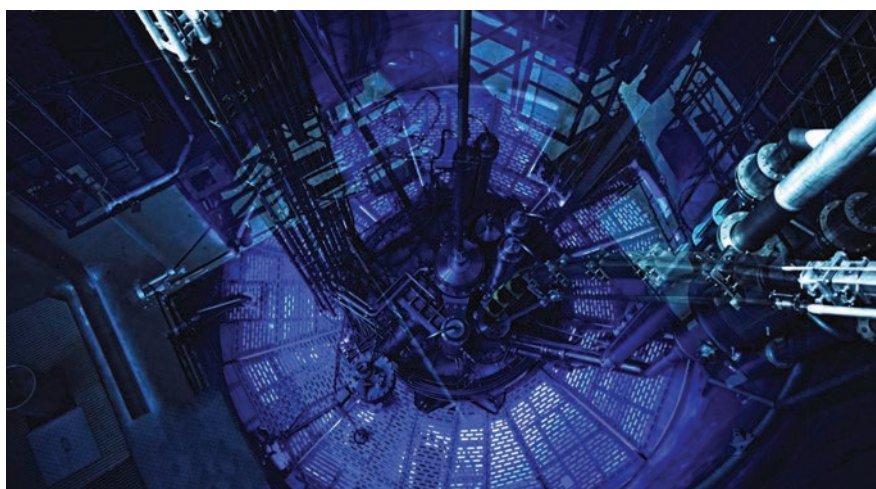
It also has an above-average number of PhD students, and the rate of higher education qualifications and the number of new doctoral graduates exceed the EU average. This active scientific community will now be able to submit innovative research projects to ILL, in fields ranging from nuclear physics, to pharmaceutical research, to cutting edge materials, integrating the advanced analysis capabilities at ILL with their plans for experiments.

The partnership will also open the doors to Slovenia advancing its scientific capabilities further. Historically, Slovenia's use of large-scale scientific infrastructure such as the ILL has been limited. Becoming a scientific member of ILL has unlocked new opportunities for scientists, including early-career researchers, and has enabled them to access more European research programmes, develop new sources of funding and qualify for grants, and take part in collaborations tackling global scientific challenges.

For example, currently experiments are being undertaken at the ILL that look into components of the SARS-CoV-2 virus. This will include neutron crystallography experiments that characterise the spike proteins responsible for penetrating human cells - neutron diffraction is an excellent complementary technique to X-ray scattering, providing key details of the hydrogen atoms within molecules that dictate so much of the behaviour of biological compounds.

Neutrons are particularly good for studying the life sciences as they are non-destructive and can be used in experiments at room-temperature close to physiological conditions. Other pioneering projects include the study of complexes between HIV-1 protease - the enzyme responsible for maturation of virus particles into infectious HIV virions - and drug molecules, to reduce drug resistance, and identify the binding characteristics of cancer-related proteins.

As well as establishing new routes for Slovenia to get involved with vital research, such as finding treatments to stop the coronavirus, ILL will also benefit significantly from Slovenia's active and diverse scientific community. The partnership with ILL is being facilitated in Slovenia by the National Institute of Chemistry (NIC), based in Ljubljana. This institution carries out and funds scientific research, both basic and applied, in fields including organic and physical chemistry, materials science, life sciences, biotechnology and engineering - many of which are core areas of focus for experiments at ILL. The NIC is therefore a perfect partner for enabling the most talented and promising researchers from Slovenia gain access to ILL and provide their expertise on the exciting collaborations underway.



Reactor Credit: B. Lehn, ILL



SuperSun - a new high-density source for ultracold neutrons Credit: Laurent Thion ILL

Paving the way for other nations

ILL is dedicated to opening the doors for smaller countries such as Slovenia to join this international partnership, and forging ties that will lead to better science across Europe, future-proofing the region against impending challenges such as climate change or future pandemics. While these challenges provide their own economic trials, it is crucial that nations manage to maintain scientific funding and participation in international collaborations that seek to prepare us to tackle these threats.

Driving discussions about how more scientific communities can use ILL's facilities will lay the foundations for advancing the country's level of science and innovation. Through FILL2030, a Horizon-funded programme at ILL, the institution has allocated over half a million Euros to ensuring that researchers from these countries can make their initial steps into the facility, by covering the costs of visiting researchers and the beam time for their experiments. This has recently included Romania, Portugal, and Norway, and both enrich the scientific possibilities for their research, as well as building testimonies for the value of a long-term partnership. As with many scientific collaborations, including Slovenia's membership, large-scale, international cooperation often originates from the experiences and conversations of a small number of researchers.

Scientific and economic challenges, such as the current pandemic, often lead to new and innovative approaches to conducting research, whether that means new ways to carry out experiments remotely or triggering joint efforts between previously distinct fields of research. Further, these events often increase awareness among the public and policymakers for the importance of maintaining scientific funding and infrastructure to help prepare the research community to tackle these challenges.

Flexibility and patience, however, are essential when proposing and progressing these conversations. As in the case of Slovenia, an extremely promising and mutually beneficial relationship, the process is often gradual and must secure the commitment of many parties. Yet, once over the line, the opportunity for ground-breaking science to emerge from the new partnership is enormous and will mark a new era for scientific capabilities in Slovenia, making European science stronger overall.



ILL - Exterior of ILL: Credit: Cedrine Tresca

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