

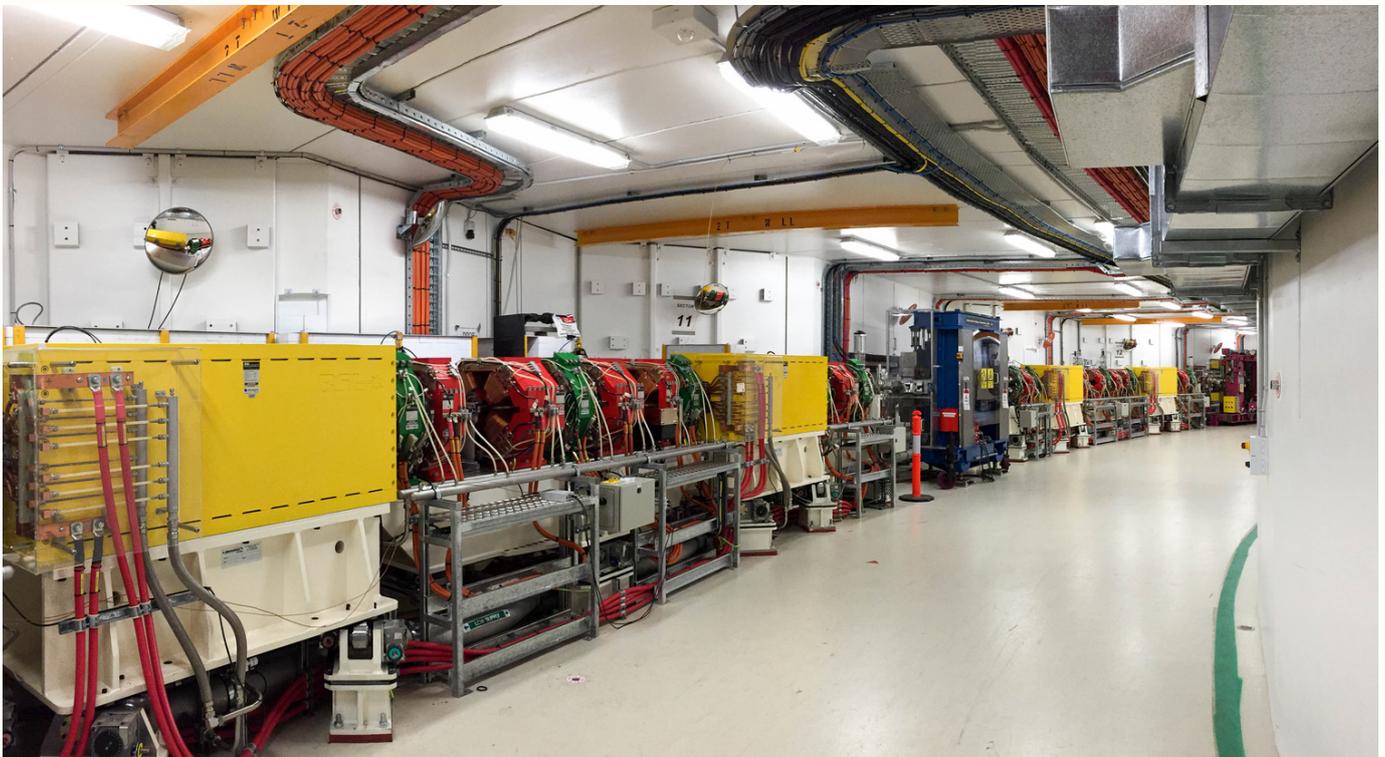
# TECHNICAL BULLETIN

The latest news and updates from Buckley Systems



**BUCKLEY  
SYSTEMS**

Ingenious at work



(Image: Internal storage ring at the Australian Synchrotron)

*Buckley Systems entered the synchrotron research sector in 2004 with the Australian Synchrotron and has subsequently supplied electromagnets, ion sources, and vacuum chambers to multiple synchrotron projects around the world. With **20 years** of excellence in the sector we have worked on numerous projects with outstanding results.*

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## BILL DODGE'S RETIREMENT

Bill Dodge, Buckley Systems' VP of Global Sales, officially retired at the end of 2023. Bill has been an invaluable member of the Buckley Systems management team since 2001, when his own company, Boston Transformers, was purchased by Buckley Systems. His decades of knowledge and contacts within the semiconductor industry opened doors, helping secure many of the long-term business relationships we enjoy with our customers today. During his tenure Bill worked tirelessly at promoting the company, attending numerous industry conferences around the globe, cementing Buckley Systems as a global leader in the high-precision electromagnet industry. Always focused on customer service, he ran Buckley Systems International, based in Rowley, Massachusetts, providing a service workshop and warehousing facility for our North American customers.

In 2017 he assumed the position of CEO for Buckley Systems Ltd. Running both the New Zealand and USA based operations involved working long hours to span the eighteen-hour time difference between the two countries. When the Covid-19 pandemic meant travel between the two countries was no longer possible, Bill stepped back from the CEO role to focus again on sales and the US based operations, expanding capabilities, and providing extra service and support for the parent company. Long after most other people would have retired and sat back to reflect on their achievements, Bill continued to follow his drive towards the ongoing success of Buckley Systems. Although Bill has retired and thus will step back from day-to-day operations, he will remain as a consultant and oversee the smooth handover of his role to his successor, Tony Misa.

During his farewell ceremony at Buckley Systems' end-of-year celebrations last December Bill was presented with a carved, ceremonial pounamu (greenstone) mere (Māori weapon pronounced me're) in appreciation of his hard work and dedication to the company over the past 22 years. The whole of Buckley Systems would like to wish Bill a long and happy, well-earned retirement.



Bill Dodge (L) Bill Buckley (R)

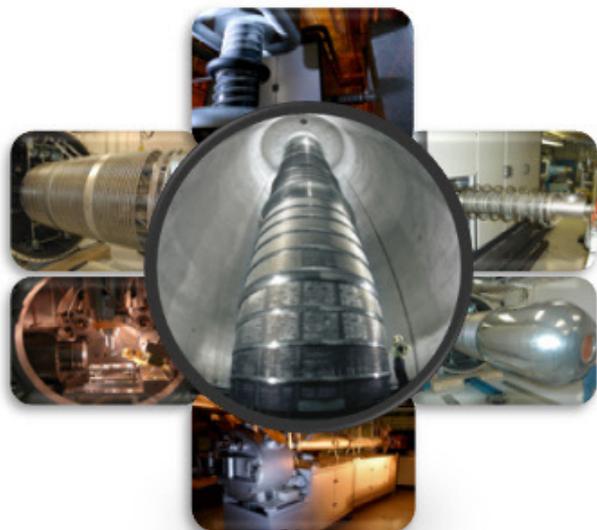
## CONFERENCES 2024



Buckley Systems and D-Pace will be exhibiting at The 15th International Particle Accelerator Conference (IPAC) being held in Nashville, Tennessee, USA from 19 to 24 May 2024.

At IPAC '24, the pre-eminent global conference in the field of particle acceleration, international experts will present leading research and development in accelerator technologies. Visit our company booth to learn about our capabilities.

Buckley Systems will be attending SEMICON West in San Francisco, USA from 9 to 11 July 2024. SEMICON supports the semiconductor ecosystem by aligning the global electronic supply chain.



Buckley Systems and D-Pace will be attending the 27th International Conference on the Application of Accelerators in Research and Industry (CAARI) and the 55th Symposium of Northeastern Accelerator Personnel (SNEAP) in Fort Worth, Texas, USA from 21 to 26 July 2024.

The conference focuses on bringing together researchers who work in the field of particle acceleration used in research and industrial applications globally.

## NEW CNC MACHINE

Investing in new machinery continues to be an important part of Buckley Systems and we recently installed a new FJW 100/160 CNC machining centre.

This large capacity machine with a 4000mm x 2000mm table and a machining envelope of 4250 x 3200 x 800mm was purchased as a workhorse machine to cope with the increasing demand for larger magnets and friction stir welded vacuum chambers. It was chosen for its rigidity and high torque 828 N·m, 6000 rpm spindle motor enabling it to handle the forces involved in friction stir welding large aluminium chambers. Twin, interchangeable tables improve efficiency, allowing one table to be unloaded and set up for the next job while the other is being worked on. A 120 station, magazine style tool changer, means a wide variety of specialist tools are instantly available for use, reducing tool setup times between jobs. The large capacity tool magazine also allows the possibility of having multiple identical tools installed, that can be automatically swapped out after a set machining time, allowing unattended overnight machining without compromising on quality.

Fitted with the latest Mazatrol Smooth conversational type controller, it takes productivity another step forward using intuitive programming of operations that previously required extensive experience and user knowledge to manually program.



*Mazak is a market leader in the design and manufacturing of productivity-enhancing machine tool solutions. Mazak produces machine tools such as multi-tasking centres, CNC turning centres, machining centres, and laser processing machines. Bill Buckley, the founder of Buckley Systems Ltd, owns the Mazak distribution rights in New Zealand under NZ Machine Tools Limited (NZMT).*

## LAMINATION GLUING MACHINE

Our lamination department has recently purchased a dedicated machine for applying glue to laminations. The machine can handle almost any bonding system requested by customers. Precision metering and adjustable application roll pressure means that the thickness can be controlled, minimising wastage and cleanup while ensuring complete coverage and bonding. With large yokes requiring in excess of a thousand laminations, even a few microns of extra glue can create issues with overall size, bonding and stacking factor. Similarly, too little glue can result in weak joints and potential failure when the yoke is removed from the bonding jig. Buckley Systems is dedicated to continual improvement in both product quality and efficiency. The new machine along with the deburring machine purchased in 2023 will reduce labour and material costs, cleanup time and will minimise any variation of stacking factor between yokes.



## UPGRADES TO TESTING DEPARTMENT

Our testing department has had a new inverter-controlled heat pump / chiller installed. The new chiller will replace our evaporation-tower type system and give a higher level of precision over cooling water temperature. While our old chiller system struggled with some of the large, one-off project coils, the new machine increases our capability to perform full power tests on multiple coils with ease. Water temperature is controlled to a higher degree of accuracy especially during hot, humid weather.



## ASYMMETRIC QUADRUPOLE/SEXTUPOLE DESIGN

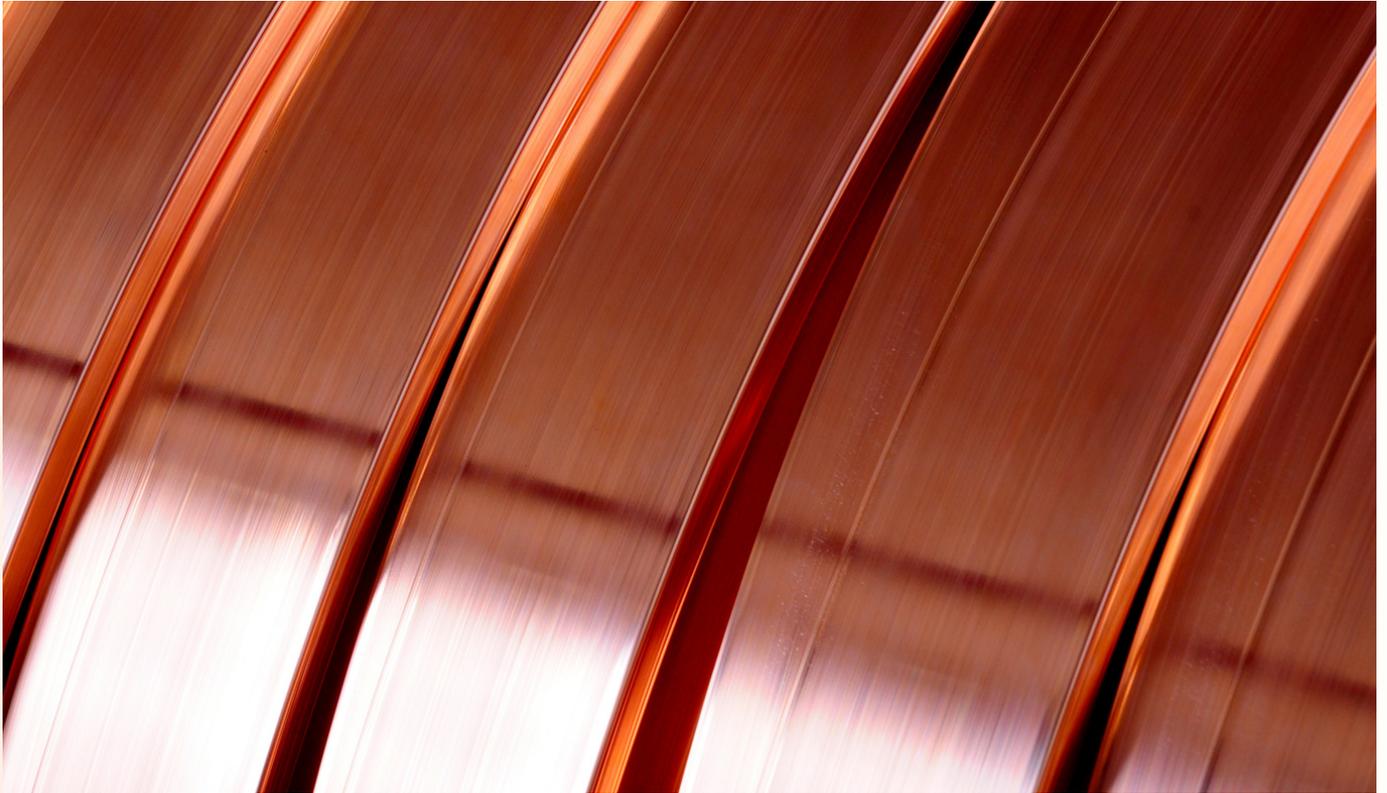
Our physics department has been working on a design of a combined-function quadrupole/sextupole magnet. By designing poles that are iso-potentials of multipole fields, combined with heterogeneous coils, we have been able to provide an asymmetric good-field region with integrated field errors corrected to high-order. Combined-function magnets save space and cost compared to discrete magnets, but traditional designs have trade-offs in field strength and/or quality.

This design provides the benefits of a combined-function magnet but with field quality of close to the best discrete multipole magnets. This is one of many projects undertaken by our experienced physics and engineering design teams who enjoy the challenge of discovering innovative solutions to our customers' requirements. The results of this design, along with work done on similar projects, opens the prospect of applications across a wide combination of multipole magnets. Contact our physics department to discuss whether this innovation may be suitable for your project.



(Image: Vincent Kuo, Physicist at Buckley Systems, working on an Opera Magnetic Simulation)

## SUBSTANTIAL COST SAVINGS ACHIEVED OVER SUPERCONDUCTING MAGNET



After discussions with our physics team, a recent project to supply just the iron yoke for a superconducting magnet, turned into an order to supply an entire magnet using copper coils.

The customer was initially focused on reduced power consumption for their magnet, and assumed superconducting coils would provide them with the best results. Our physics team ascertained that, as space was not a confining factor, a larger copper coil could provide the same magnetic field for similar overall power input as a superconducting coil and at a substantially lower cost.

This project opened a wide-ranging conversation on all the opportunities and constraints around magnet design. As most procurement teams are usually looking for the lowest up-front costs, the common focus is on designing magnets using the smallest amount of expensive copper. This generally results in coils with a high-power density which in turn, requires large power supplies, cabling and cooling systems to power the coils and maintain them within a safe operating temperature.

By increasing the mass of copper used in the coil, power is reduced. This results in lower power supply requirements, less cooling water, and reduced need for environmental control. With the rising price of energy and a drive for greener and more power-efficient infrastructure, the physics team demonstrated what can be achieved with magnets designed around efficiency, reliability, and project lifetime cost rather than the lowest initial cost of a magnet.

Of course, superconducting coils have applications for which they are ideally suited, and making copper coils larger is not always practical or feasible. However, our physics and design team are happy to discuss magnet design options that can achieve the optimum balance around the performance, maintenance, environmental impact and financial criteria our customers seek.

## NEUTRON GENERATOR RECEIVES FINAL ACCEPTANCE FOR USE

An accelerator-based neutron generator supplied by Neutron Therapeutics has received final acceptance for use at the University of Birmingham's High Flux Accelerator-Driven Neutron Facility. Its intended use is to enable research into the effects of neutrons in a variety of applications, including nuclear energy, nuclear science and boron neutron capture therapy (BNCT). Buckley Systems' founder, Bill Buckley, is a major shareholder in Neutron Therapeutics and Buckley Systems manufactured many of the components used in the device. Key parts supplied to the project included the high frequency alternators, steering and focusing magnets, beam dump, support structures and vacuum components.

The neutron generator supplied to the University of Birmingham is based on the Neutron Therapeutics' NuBeam, BNCT treatment device which is working towards trials at Helsinki University Hospital in Finland and Tokoshukai Kamakura Hospital in Japan.

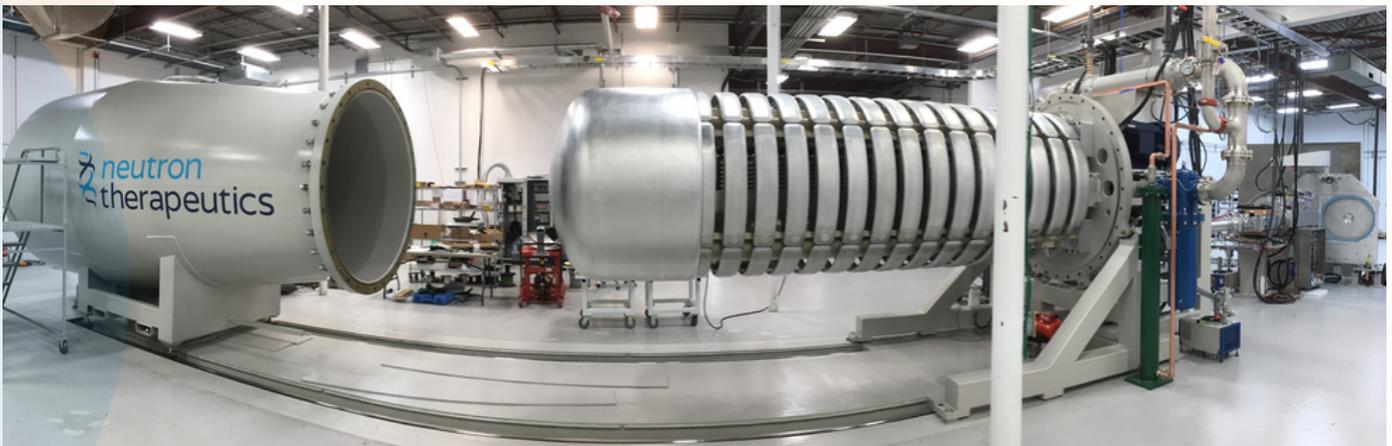
Capabilities of the accelerator include:

Nominal proton current of 30 mA

Nominal proton energy of 2.6 MeV

Typical neutron yield of  $3 \times 10^{13}$  primary neutrons per second

Contact Neutron Therapeutics for all BNCT inquiries or D-Pace for any applications for the ion source, accelerator or any non-BNCT use.

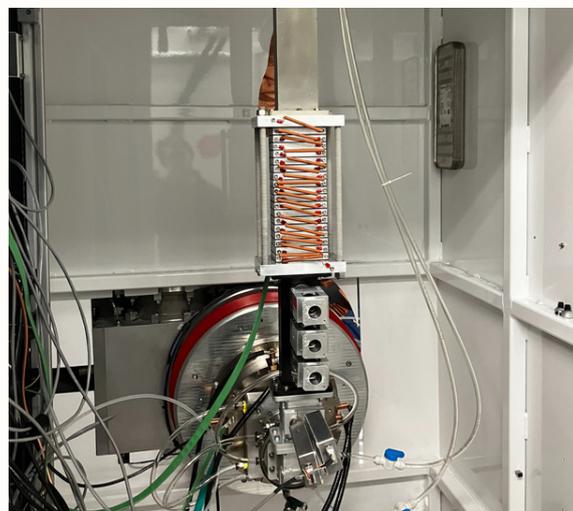
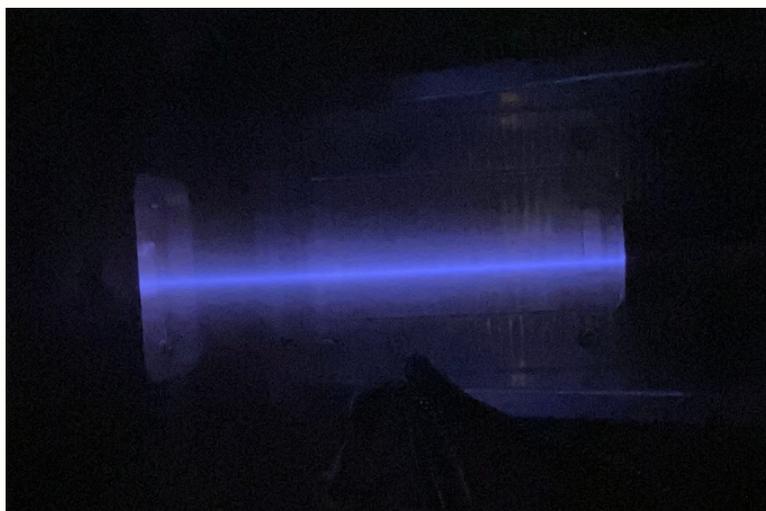
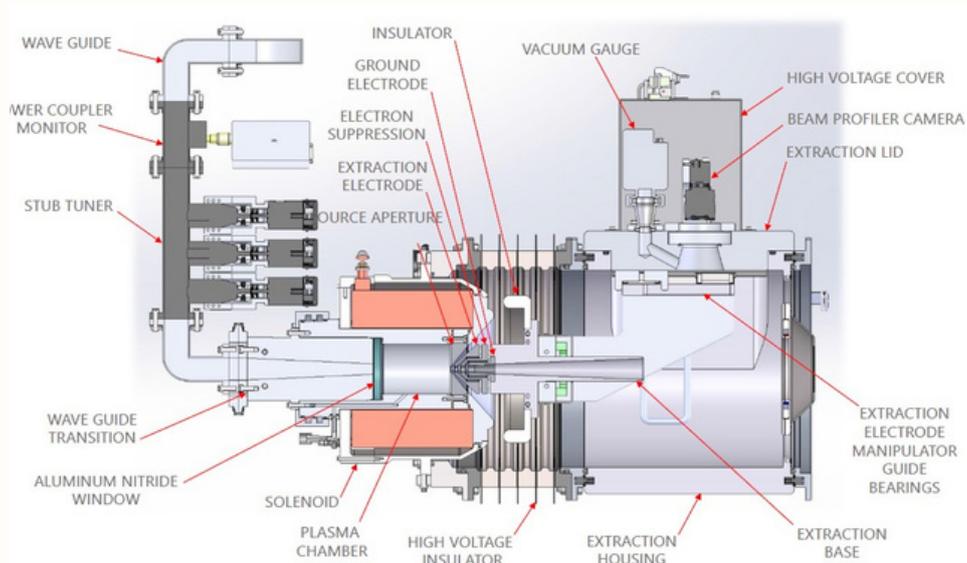


*Neutron Therapeutics is a medical equipment manufacturing company founded in November 2015. Bill Buckley is a major shareholder in Neutron Therapeutics and co-founder. The company focusses on Boron Neutron Capture Therapy (BNCT) which is used in the field of cancer therapy. BNCT technology is a type of radiation therapy that enables targeting of cancer at the cellular level. Neutron Therapeutics is a global company with offices in the US and Finland. Visit their website for more information: [neutrontherapeutics.com](http://neutrontherapeutics.com).*



## D-PACE ECR ION SOURCE FOR LOS ALAMOS

D-Pace, an associate company of Buckley Systems, is supplying a Neutron Therapeutics' licensed ECR ion source to Los Alamos National Laboratory for the extraction of Krypton ions. The beam extracted out of the ion source will be used to perform an inverse kinematics neutron capture reaction, which will be the first time that such an experiment has been done. Extensive research and development of the source has been undertaken by D-Pace's ion source team to optimise it for the ions required. Using Neutron Therapeutics' ECR ion source test stand and building an in-house test stand at D-Pace's research centre has allowed significant development that will pay off with fine tuning the final design, optimising output and reducing commissioning time at Los Alamos. Buckley Systems has also provided many of the precision machined parts for the project and has designed the mass spectrometer needed to isolate the Kr-84 ions needed for the neutron capture. Coming together and cooperating on the project has been beneficial for Neutron Therapeutics for their source, Buckley Systems in enhancing their place as manufacturers of ion source beam components, Los Alamos in receiving the benefit of extensive product development before installation and D-Pace in adding another proven ion source to their product line and test facility. Dr Morgan Dehnel, founder and CSIO of D-Pace, is delighted with the project and the knowledge gained by D-Pace's ion source team that will have benefits for future uses of the source.



## NEW RESEARCH STUDENTS AT D-PACE

D-Pace has just received funding approval for a new PhD student at the University of Victoria, and a summer student from the University of Saskatchewan. Funding is from Mitacs, a Canadian nonprofit organisation dedicated to funding innovation, science, and research. The students will be part of D-Pace's computational group. Dr Morgan Dehnel is excited to have more resources in this department. "At D-Pace we realise that to solve ion source problems in the most comprehensive and efficient way possible, we will ultimately combine the forces of our experimental staff, and our plasma modelling people. With such a combination we will have a good bit of muscle to stay ahead of the competition in terms of solving ion source problems with new or improved products."

## SPREADING THE WORD ABOUT D-PACE

Dr Morgan Dehnel is always keen to share his knowledge and experience of D-Pace with the wider world. In December 2023, he co-hosted a successful ion source workshop together with Dr. Olive Kester, Head of the TRIUMF Accelerator Division in Vancouver. While there he presented a separate well-attended public talk in the TRIUMF Auditorium for management, staff, and students highlighting all the technologies D-Pace has licensed, and which have since been developed and commercialised. He also spoke on the R&D efforts which have morphed single use TRIUMF licensed technologies into different products that now serve many industries and applications instead of just one or two. Examples of this include technology developed for a specific original TRIUMF use, now through D-Pace R&D, serving diverse industries such as discovery science, medical imaging, medical therapy, ion implantation, fusion, and contraband detection. The list is ever growing as the technology is validated for new applications. Since the talk, D-Pace has also been approached for a system to be utilized to facilitate satellite propulsion in deep space.



*Dehnel-Particle Accelerator Components and Engineering, Inc. (D-Pace) was founded by Dr. Morgan Dehnel in 1995 as a supplier of specialised components and technical support for beamline systems, beam diagnostic devices, and ion sources for research, industrial, and commercial accelerator systems around the world. Buckley Systems Limited, a major supplier of components to D-Pace, purchased a 50% stake in the company in 2014.*

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