

# TECHNICAL BULLETIN

The latest news and updates from Buckley Systems



**BUCKLEY  
SYSTEMS**

Ingenious at work



*Buckley Systems founder Bill Buckley and the company's manufacturing specialist, Peter Schuetze, circa 2000*

*Buckley Systems Limited is the world's leading supplier of precision electromagnets used in the manufacture of more than 90 percent of the world's silicon chips. It is also part of an emerging market for new, non-invasive cancer treatments, notably proton therapy. "It is my dream and dearest wish to design equipment that can cure cancer," Mr Buckley says.- **Engineering News NZ July 2014**. Bill Buckley has since also invested in Neutron Therapeutics which designs and sells Boron Neutron Capture Therapy machines that are used in cancer therapy.*

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## CHIEF PEOPLE OFFICER



Dion Orbell

## IPAC'23

Buckley Systems and D-Pace attended IPAC'23 (International Particle Accelerator Conference) in Venice, Italy from May 7th through 11th 2023, where our two companies had adjoining exhibition booths.

The conference was a return to the size and interest of pre-Covid meetings with an estimated attendance of 1300 scientists and engineers, and close to 100 exhibition booths representing businesses from around the world.

Technical discussions were held during the week at the Venice Convention Center, and guests were accommodated at the famous beachfront Hotel Excelsior Venice Lido.

Of particular note was a session outlining the significant number of upcoming large particle accelerator projects scheduled to be built worldwide in the next five years in China, Europe and North America.

Dion Orbell has been Chief People Officer at Buckley Systems since joining the company seven years ago. Born in New Zealand, he emigrated with his family to British Columbia, Canada when aged ten. He returned to New Zealand in his twenties to complete his Bachelor of Business Studies at Massey University. After graduating, Dion became involved in human resource roles including at bathroom-ware manufacturer Kohler, where he led initiatives in China, Australia, Thailand and the USA. This work culminated in winning the Directors' Award for Change Management.

At Buckley Systems, Dion has helped develop a robust organisational structure and negotiated the challenge of growing staff numbers that have rapidly risen from 265 in 2017 to over 550 today. A key factor in the success has been the dedication to growing both skills and leadership within the workforce.

Married with a teenage daughter, Dion in his spare time helps behind the scenes with the running of Surf Lifesaving and swimming events throughout New Zealand and enjoys skiing and mountain biking on his trips back to visit family in Canada.



## NEW INTEGREGX E-1850V/12

Buckley Systems has recently added another Mazak Integrex e-1850/V12 multitasking machining centre to our machining workshop. This large five-axis machine is capable of milling, turning, boring, drilling, and tapping operations on five faces with just a single setup, and will be primarily used for producing magnet yokes and poles to minimise repositioning errors caused by multiple setups.

The machine is an upgraded version of our existing Integrex e1850 but with a 7 kPa high-pressure coolant pump and faster servo motors. This has resulted in a 30% decrease in machining time and a longer cutter life. It is also fitted with the latest Mazatrol Smooth controller which adds many user-friendly features not available on earlier controllers. One key advantage is the ability to check its own work using an on-board, ruby-tipped probe. This eliminates the manual measurement and recording of in-process measurements. The data can also be exported to the Quality Control department for comparison between the machine and final inspection CMM measurements, to confirm the machine is running within tolerance.



## MAZAK-NZ MACHINE TOOLS

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).

Contact NZMT on 0800 85 87 84 to learn more about the range of Mazak products available in New Zealand or visit [www.nzmachinetools.co.nz](http://www.nzmachinetools.co.nz).

## KNOW-HUB LAUNCHES AT BUCKLEY SYSTEMS

At Buckley Systems we are always looking for ways to upskill our current staff and to on-board new staff quickly. Making high-precision electromagnets is a niche industry, so many new employees are unfamiliar with many of the specialised manufacturing and testing processes involved.

### How to Braze (Part 1) Brazing Safety



My name is Olivia.

- Home
- Soaautu faa-Samoa
- 'Ulu'i tohi faka-Tongá
- Filipino Subtitles

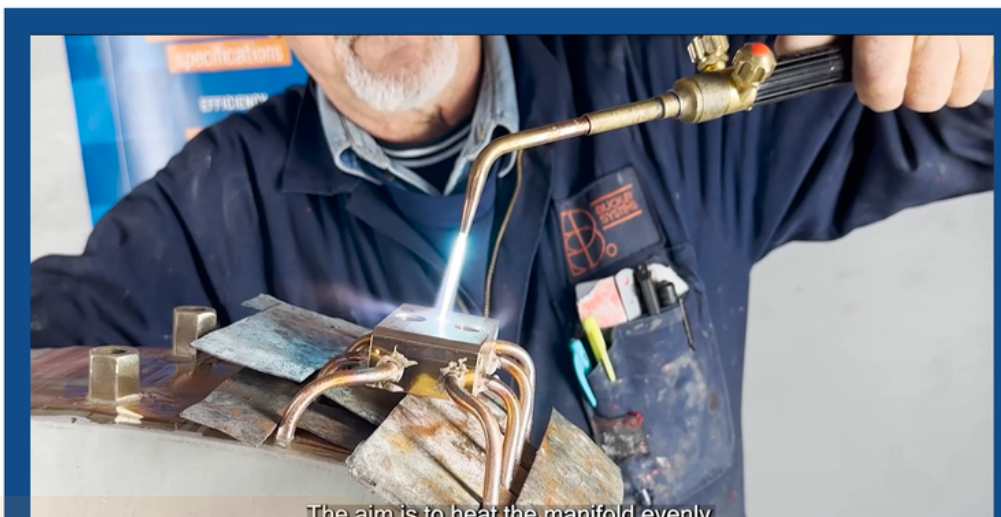
In this video you will learn how to conduct a resistance test. Once completed please be sure to test your knowledge.

- (Part 2) Brazing Equipment
- (Part 3) Setting Up

To help get staff up to speed we have developed a series of short training videos on safety, using software, reading drawings and how to perform various common procedures used in coil and magnet manufacture. The videos are created using an AI-generated narrator, accompanied by in-house footage, still images and animated captions. Key videos are also subtitled in different languages to make our diverse workforce feel welcome. The videos can be viewed on large screen, kiosk-type displays placed around the factory. Accompanying the videos are hardcopy flip-book instructions containing the key points and images from each of the videos. The flip books can be taken to the work area to serve as a reminder of the key points. To test knowledge, quizzes on each video can be accessed via a QR code.

Called the Know Hub, it is being trialed in the coil workshop with the intention to roll it out to the other manufacturing departments as our library of videos increases.

### How to Braze (Part 4) Brazing Practical



The aim is to heat the manifold evenly.

- Home
- Soaautu faa-Samoa
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In this video you will learn how to conduct a resistance test. Once completed please be sure to test your knowledge.

- (Part 1) Brazing Safety

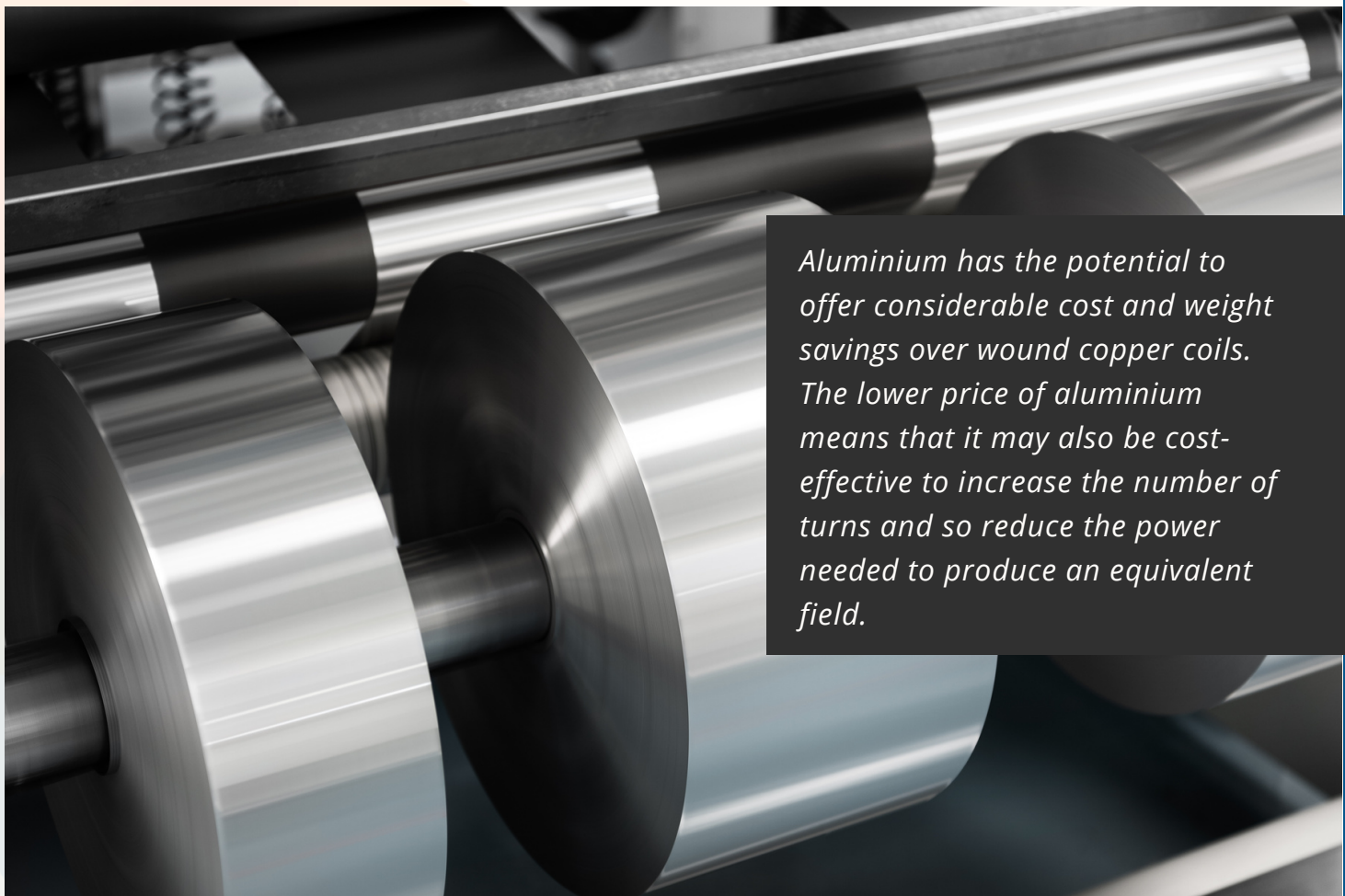
## ALUMINIUM COILS

Our Physics and Design teams are investigating the potential of using aluminium conductor for strip wound coils. Aluminium has the potential to offer considerable cost and weight savings over wound copper coils. The lower price of aluminium means that it may also be cost-effective to increase the number of turns and so reduce the power needed to produce an equivalent field. This means smaller, lower-cost power supplies can be specified. Lower power consumption along with reduced waste heat, results in lower long-term operating costs for our customers.

By using the anodised coating on the surface of the aluminium as an insulator, coils can be wound without the need for additional interturn insulation. This saves time, material, and space. Anodising is almost unaffected by temperature, so coils can potentially run continuously up to 500 °C without degradation. Anodised cooling plates can be placed directly against the coil, offering superior heat transfer. Termination can be made directly to the aluminium strip or by cold welding copper tails using either pressure or ultrasonic welding.

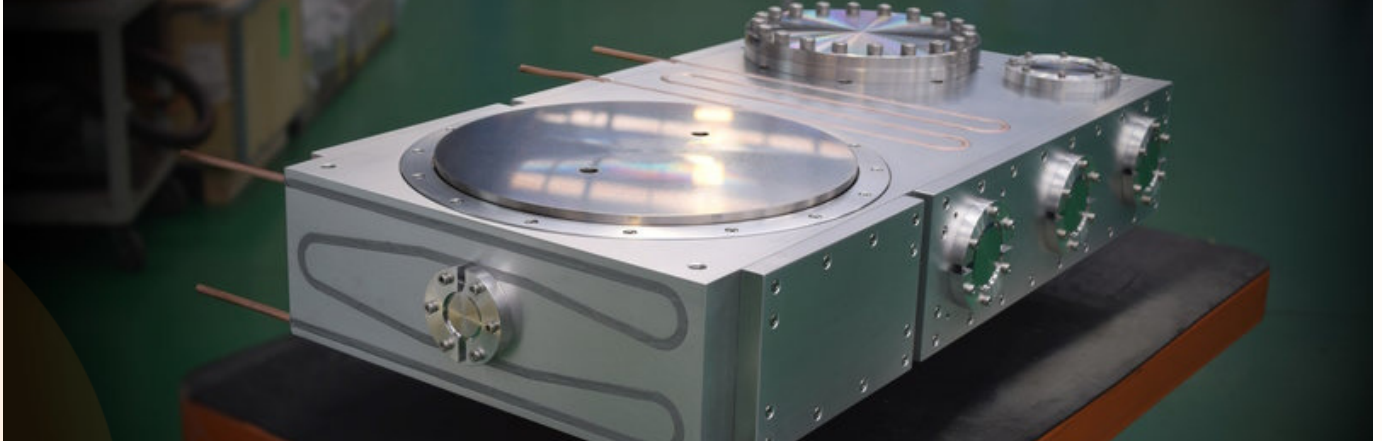
The challenges of aluminium coils include increased size due to the cross-sectional area required to obtain the equivalent resistance of copper. Joining together pancake stacks is not as easy to perform and termination can require specialised techniques to create a good electrical connection. Strip aluminium coils are most suitable as a replacement for strip copper coils, but there is also potential for it to be an alternative for some enamelled wire and hollow core conductor applications.

Talk to our Physics Team to discuss the potential of aluminium coils for your project.



*Aluminium has the potential to offer considerable cost and weight savings over wound copper coils. The lower price of aluminium means that it may also be cost-effective to increase the number of turns and so reduce the power needed to produce an equivalent field.*

## ALUMINIUM VACUUM BOXES



Buckley Systems has decades of experience in manufacturing vacuum boxes from high-grade aluminium. While stainless steel has been the traditional material for vacuum components, more customers are discovering that aluminium can often provide a superior solution for many applications. Some of the advantages of aluminium include:

- Ease of machining and the ability to manufacture complex shapes from solid billets can offer savings over fabricated stainless steel
- With no magnetic properties, aluminium will not modify magnetic fields
- Low gas permeability makes it suitable for high-vacuum applications
- Very low outgassing
- Mounting features for in-vacuum components can be machined rather than welded in place
- Lighter than stainless steel means that tubes can span longer distances without support structures
- Machining from solid aluminium vastly reduces the possibility of virtual leaks
- Chambers too big to be fabricated from solid can be fabricated using conventional or friction-stir welding techniques
- Suitable for high ionising radiation environments as aluminium has no long half-life radioisotopes
- Relatively simple high-vacuum cleaning process compared to stainless steel

While aluminium favours the use of elastomer O-ring seals, metal knife-edge seals can also be fitted if an especially high vacuum is required. Our team is happy to discuss your next project to see if an aluminium vacuum chamber can offer any advantages.

## ADVANTAGES OF POLE-IN-VACUUM DESIGN

Traditionally beamline magnets had an independent vacuum chamber placed between the poles. This still works well in many situations, but in some instances, it is advantageous to incorporate the vacuum chamber into the magnet. Large vacuum chambers can be subject to deflection under vacuum. Making chamber walls thicker to eliminate deflection can increase the pole gap on external poles and require more power to create the desired field. Inserting the pole inside the vacuum box means the vacuum box can be made more robust.

Complex pole tip profiles can also be employed without having to create a complex-shaped vacuum chamber to match. With the pole tips being part of the vacuum box instead of the yoke, accurate machining is required to eliminate any air gap or excessive crush between the main yoke and the vacuum box. Fortunately, our on-site, modern machine shop and experienced tradespeople are highly experienced in achieving the fine tolerances required. With careful design and preparation, single O-ring seals can handle vacuums down to  $e-7$  mbar, making them suitable for most industrial and medical applications. Lower vacuums are potentially possible with double O-ring seals. Our Physics and Engineering departments have experience in designing pole-in-vacuum magnets and can perform magnetic and stress analysis to determine the best design for your application.

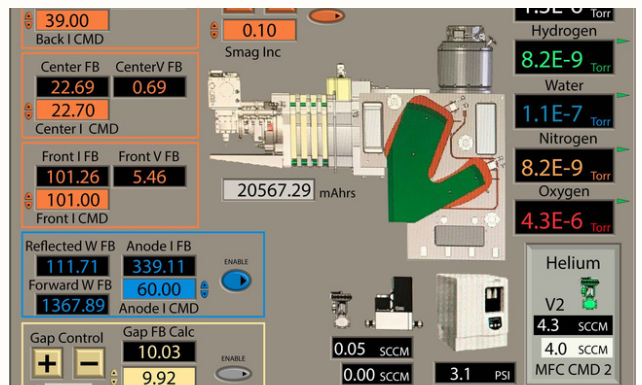
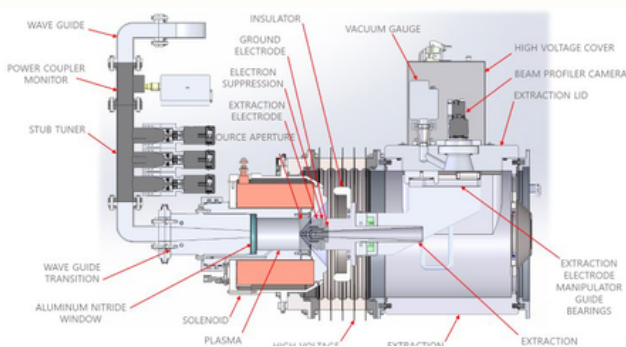
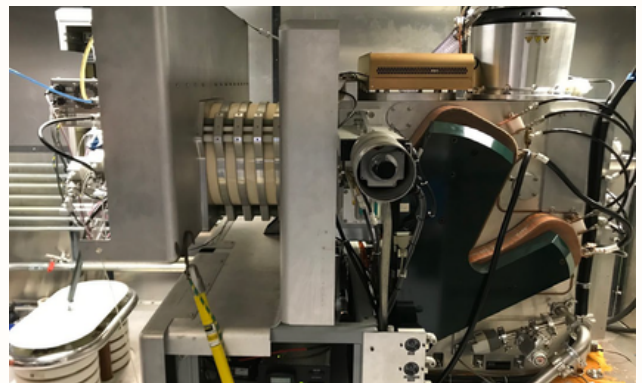
## D-PACE

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.

### D-PACE ADDS ECR ION SOURCE TEST STAND

D-Pace is currently developing an ECR ion source test stand based on a well-proven design licensed from Neutron Therapeutics (NT). Already successfully implemented in the NT nuBeam BNCT device, the source has also been validated for the production of H<sup>+</sup>, H<sub>2</sub><sup>+</sup>, He<sup>+</sup>, and He<sup>++</sup> using the NT test stand. Positive assessments have been made for the production of D<sup>+</sup> but it has not currently been tested due to the neutron radiation produced. D-Pace has received its first order for the NT-licensed ECR Ion Source Technology Product from a US National Lab.

The D-Pace test stand is under construction and will allow D-Pace staff to focus on optimising beam current for the established ions and for validating higher charge states and new ions. The ECR source has a wide range of possible applications with interest already shown for medical radioisotope production. Senior scientist Stephane Melanson PhD is overseeing the project with the assistance of other D-Pace staff.



### D-PACE STAFF PRESENT PAPERS AT ICIS 2023

Staff from D-Pace presented five papers at the 20th International Conference on Ion Sources held in Victoria, British Columbia between the 17th and 22nd of September, 2023.

- Philip Jackle, Positive to Negative Helium Ion Production Ratios When Using Nano-Foils as a Charge Exchange Medium
- Dr. Anand George, Investigation of Plasma Chamber Erosion in an RF Ion Source
- Dr. Stephane Melanson, The Extraction of Both Positive and Negative Ions from a Modified Volume Cusp H<sup>-</sup> Ion Source
- Andrew Paul, Production of Negative Ion Beams through Charge Transfer between Negative Hydrogen Ion Beams and Non-metallic Gases
- Dr. Nicolas Savard, Implicit PIC Development for Bounded Plasmas

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