Wire crimping

The wide variety of our work means we must terminate electrical cable from as small as 30 AWG (0.049 mm²) to high-amperage power cables. To ensure the quality and reliability of our terminations we have recently invested in new, high-precision, calibrated crimping tools. All termination and QA staff have also completed practical training courses in their correct use. Crimping tools are serialised and calibrated on a routine basis. An in-house testing machine is also under development to help check the quality of terminations.

Refurbishing old magnets

Some of the magnets we have made have been in service for over 25 years. If a magnet ever needs repair, we carefully strip it down and inspect all components. By re-using parts, we can keep the cost of repair below the price of a new item. Note: We do require all magnets shipped to us to be certified free from contamination.

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Upcoming 2019/20 Conferences and Events

Buckley Systems and/or D-Pace will have a presence at all these events. Please contact us if you would like to arrange a specific meeting with us while we are there.

- **September 1-6 NAPAC 2019: Lansing, Michigan, USA**
  North America particle accelerator conference
- **September 1-6 ICIS2019: Lanzhou, China**
  18th International Conference on Ion Sources
- **September 8-12 IBIC 2019: Malmö, Sweden**
  International beam industry conference
- **September 22-27 CYC19: Cape Town, South Africa**
  22nd international conference on cyclotrons and their applications
- **September 22-27 MT26: Vancouver, Canada**
  Magnet technology conference
- **October 13-18 IBA2019: Antibes, France**
  24th International Conference on Ion Beam Analysis

2020

- **August 31st - September 4th NIBS2020: Auckland, New Zealand**
  7th International Symposium on Negative Ions, Beams and Sources.
  Includes tour of Buckley Systems' manufacturing facility

Negative ion beam accelerators & applications
By Dr Morgan Dehnel, Chief Science & Innovation Officer

Negative ion beams are utilized with several different accelerator technologies. For example, negative ion beams are used at CERN for charge-exchange injection into a synchrotron, at TRIUMF for charge exchange extraction from a cyclotron, at WERC for energy-doubling via a Tandem Accelerator, and at ITER for the precursor beam in the Neutral Beam Injector. Also, negative ion beams are utilized in a variety of fields. The examples given already verify that negative ion beams are important for discovery science. However, negative ion beams are important for medical applications as well. Charge exchange extraction from ~2000 commercial cyclotrons is important for producing SPECT and PET radio-tracers for medical diagnostic imaging, as well as for producing certain radio-immunotherapy drugs for cancer. Some accelerators used for BNCT utilize negative ions, and, thus, medical therapy applications, in this case for cancer, are also an application area for negative ion beams. Companies such as HVE, NEC, and IonPlus use negative ion beams for their Carbon Dating accelerators which is the Tandem technique combined with negative ions to ensure that N14 does not contaminate their C14 dating measurements. The Tandem acceleration technique is also used in certain implanters used in semiconductor manufacture. These are but a few of the accelerators and applications that utilize negative ion beams today. Please join us at the University of Auckland August 31 through September 4th, 2020 at the Negative Ions, Beams and Sources conference to learn more about this fascinating field.

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Ingenious at work

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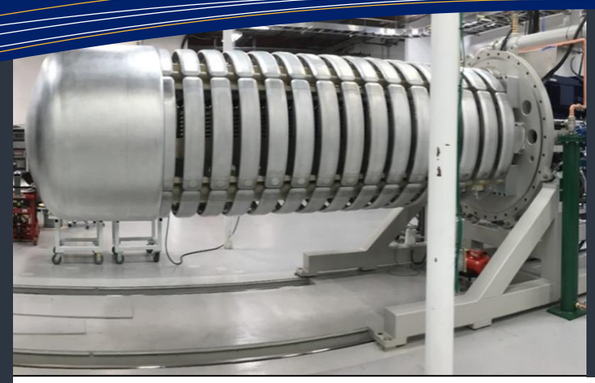


This issue

Making a stand

As start-to-finish manufacturers, we not only make magnets, beam tubes and vacuum boxes but can manufacture all the associated support structures. To ensure components stay correctly aligned, we design and fabricate sturdy frames with precision machined mounting bosses and adjustment features. Mountings for power supplies, cable, hoses, cranes, lifting points and accessories can be modelled by our design department to make the installation fit within a restricted footprint yet allow access for easy servicing. By keeping manufacture in-house, we make sure that the highest quality is maintained all the way through to the finished paintwork.

Taking a stand

It is a company policy that Buckley Systems does not produce equipment for weapon manufacture or military use.

While we cannot completely control the end-use of our products, we may seek assurances from new customers that our devices will not be directly involved in weapon manufacture.

Buckley Systems to help manufacture BNCT machine bound for Japanese Hospital

Following very promising early tests on Neutron Therapeutics' first BNCT machine installed at Helsinki University Hospital (HUH), an order has been received for another unit to be installed in Tokoshukai Kamakura General Hospital, Japan in 2020. Buckley Systems will be closely involved in the development for production and manufacture of this potentially life-saving device.

Boron Neutron Capture Therapy (BNCT) is a cancer treatment that directly targets tumour cells with little or no damage to surrounding tissue. The treatment has been previously proven using neutrons from nuclear reactors. Being able to generate a viable dose of neutrons from a compact, reliable and comparatively cheap accelerator, is a breakthrough with potential to bring this treatment into general oncology. Buckley Systems manufactures most of the physical components for the BNCT machine including the alternators, beam steering magnets, the target petals, the large pressure vessel, plus pipework and flanges.

To bring the machine to reality, many engineering obstacles needed to be overcome. The challenges included winding and encapsulating alternator stators, accurately drilling deep, small diameter, holes into solid copper, mirror polishing titanium discs and fabricating a 2700 mm Ø x 5400 mm vessel capable of withstanding both vacuum and pressure. Engineers from both Neutron Therapeutics and Buckley Systems collaborated to find robust solutions within strict milestone deadlines. Extensive performance and reliability tests of the proton accelerator were performed at both Buckley Systems and at Neutron Therapeutics' headquarters before the first machine was installed in a 17 metre by 25 metre, radiation shielded bunker at HUH for neutron production.

On start-up, the 30mA @ 2.6MeV proton beam successfully produced a neutron flux of 1.3×10^9 neutrons/cm²/sec. which exceeds the recommended minimum IAEA level for BNCT treatment. Following this major milestone, there are hundreds of validation tests to be performed on the systems and sub-systems to have the machine fully commissioned and in use for clinical trials by the middle of 2020.

Neutron Therapeutics and Buckley Systems engineers will be working closely together to drive efficiency, repeatability and reliability. The depth of Buckley Systems' manufacturing experience is key to ensuring that this complex, high-powered device will be built to the highest standards.

The compact, reliable and power efficient nuBeam accelerator contains several patents and has many other potential uses for both research and industry. It is being marketed globally by Buckley Systems' partner D-Pace for non-medical applications. Available as either a 30+ mA at 2.6MeV proton source or a neutron source, it can be customised to each specific application.

New mill-turn CNC lathe

Our recently installed Mazak i400-ST CNC lathe is a new generation “mill-turn” machining centre that allows complex turned parts to be finish machined in just one setup. The machine consists of a main lathe spindle with a 300mm (12”) chuck and a 250mm (10”) chuck sub-spindle plus a fully articulating machining head. The machine can swap a part between chucks, allowing all faces to be accessed by either the traditional tool turret or any of the 36 tools available for the machining head. Both spindles have full rotational control to within 0.0001°, so that forward and reverse rotation of the chuck can be interpolated with the machining tools. This means that complex, off-centre shapes can be machined with ease.

The machine is already making parts that previously required several setups to achieve the same result, improving repeatability and productivity. While not related to our core business, a recently completed project has been a crankshaft for a four-cylinder race motor that was fully machined from solid in just one setup.

Arron Sands

Chief Operating Officer

Day to day management of Buckley Systems’ manufacturing operations.

Arron Sands has been with Buckley Systems since 2016 but his relationship with the company goes back much further. Arron’s father completed his apprenticeship alongside Bill Buckley before founding his own company, United Engineering. Arron was brought up around engineering and started in the family business at the age of 14, completing an apprenticeship as a fitter-welder before taking over the company and running it for eighteen years. United Engineering had a close relationship with Buckley Systems, helping with general engineering work, installing cranes and constructing factory space as Buckley Systems expanded.

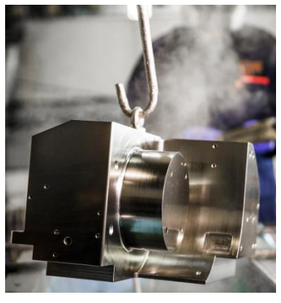
In 2016, Arron was persuaded to come and work for Buckley Systems, starting as an estimator to gain a good understanding of the business before being appointed Chief Operating Officer in 2017. His practical knowledge of fabricating heavy, rolled steel plate proved invaluable when the company was called on to build the large pressure/vacuum vessel for the first BNCT proton accelerator for Neutron Therapeutics.

Today, Arron oversees factory operations and the general day-to-day running of the business.

Technology topics

Electroless nickel plating

Nickel plating is commonly used to provide corrosion protection and abrasion resistance to steel components. At Buckley Systems we use a catalytic electroless plating process. Electroless nickel plating has advantages over traditional electroplating for precision electromagnets, including increased hardness, better corrosion resistance and a more even surface deposition. To obtain the best results, we have installed our own plating baths with rigorous preparation and monitoring procedures to ensure full adhesion and specified plating thickness are obtained. For our electromagnet components we use a high phosphorous nickel plate (P>10%) which is non-magnetic and offers superior corrosion resistance over lower phosphorous content coatings.



Zirconium oxide conversion coating

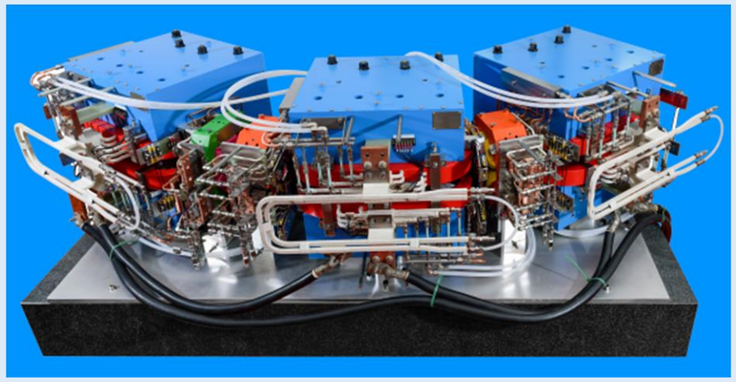
Buckley Systems has been undertaking research into high-performance aluminium conversion coatings. We now offer a zirconium-based coating system that maintains excellent corrosion resistance along with high electrical conductivity. It is environmentally sound and phosphate, chrome, zinc and cobalt-free.

Group3 Technology

Group3 Technology designs and manufactures robust control systems and scientific instruments for accurately measuring magnetic fields over a broad range of conditions. Based not far from Buckley Systems’ manufacturing headquarters, Group3 equipment is extensively used by us for product verification. Their products can also be easily integrated into any system we design or manufacture.

Group3

www.group3technology.com



News

Ring segment testing

A recent project for SLAC National Accelerator Laboratory involved making a prototype set of magnets for a positron damping ring. Consisting of three dipoles, two quadrupoles and one sextupole, the magnets needed to have multi-function capability to allow them to fit within a small design footprint. Buckley Systems’ physics and engineering design teams were heavily involved in the design process and produced the manufacturing drawings. To ensure the close proximity of the magnets to each other did not affect field quality, the magnets were assembled into an arc and the magnetic fields mapped using different combinations of magnets operating at the same time. To obtain the required measurement precision, the magnets were positioned on a ground granite bench and aligned using a portable CMM. High precision linear motors were used to insert the hall probe from different locations to construct a comprehensive field map of the system. These prototype magnets will eventually form the basis of a full ring within the FACET-II project.

IPAC’19 presentation

Dr Chris Philpott, Buckley Systems’ CTO was invited to present at IPAC’19 in Melbourne. He spoke on the lessons learned from working on light source projects and the importance of matching the theoretical expectations with both the physical properties of materials and the logistics of the manufacturing process.

ISTF news

Research undertaken by PhD students on the Buckley Systems, D-Pace Ion Source Test Facility (ISTF) resulted in two white papers being presented at IPAC’19. *Improvements in RF Multicusp Negative Ion Source* by Anand George* and *Development of a Penning Ion Source Test Stand for Production of Alpha Particles* by Nicolas Savard* were displayed at the poster session. The ISTF has been in service for over four years and has been instrumental in the commercial development of more than a dozen new products. It is available for hire for product verification and research projects. (*et al)

Continuing education

To ensure the products that we make are of the highest quality, staff undergo regular training sessions. Recent in-house developed training has included crimping of wire terminals and an overview of our quality processes.

D-Pace designed penning magnet to be used in researching high-current alpha particles for potential use in medical cyclotrons.

400-ton lamination stamping press

A recent addition to our workshop is a 400-ton mechanical press. Sitting almost two metres into the ground with the top over 4.5 metres above, this large, yet versatile machine will primarily be used for stamping lamination steel. The high power and wide platen mean that it will be possible to cut several laminations in a single stroke making it ideal for high-volume production. A decoiler, straightener and feeder will be installed to help automate the process.

The machine is also being used to form the domed ends of aluminium resonator cans. The power and rigidity of the new press has resulted in a higher quality pressing and eliminated stress cracking. The press will complement our two laser cutting machines, allowing us to undertake high-volume production or one-off projects without compromising production of our regular work. Bringing lamination stamping in-house allows us to be in complete control of the manufacturing process for all types of laminated magnets.

New website

Launched in July, our new, mobile friendly website gives visitors quick access to news, upcoming events and our contact details. Also included are links to published white papers and archive copies of this Technical Bulletin.