Professional Development

Buckley Systems is dedicated to providing a world class manufacturing facility and invests heavily in fostering talent.

We have implemented an industry leading apprenticeship scheme where up to 20 apprentices who meet our stringent requirements are mentored in all aspects of high precision magnet manufacture.

Department team leaders also undertake training in developing strong, innovative teams to ensure Buckley Systems remains at the forefront of the industry.

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Upcoming 2016 Conferences and Events

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

- **June 11-15 SNMMI 2016: San Diego**

  Society of Nuclear Medicine and Molecular Imaging Annual Meeting

- **June 23-24 Cycleur 2016 and Bern Cyclotron Symposium: Bern**

  European Cyclotron Network Workshop plus Bern Cyclotron Symposium

- **July 12-14 SEMICON West: San Francisco**

  Semiconductor Industry Conference

- **August 29-September 01 WTTC16: Sante Fe**

  International Workshop on Targetry and Target Chemistry

- **September 11-16 CYC 2016: Zurich**

  International conference on Cyclotrons and their applications

- **September 12-16 NIBS'16: St Anne's College, Oxford, UK**

  Negative Ion Beams and Sources

- **October 9-15 NA-PAC: Chicago**

  North American Particle Accelerator Conference

- **October 30-November 04 CAARI: Fort Worth**

  Conference on Applications and Research in Industry

- **November 7-11 IMRP 2016: Vancouver**

  International Meeting on Radiation Processing

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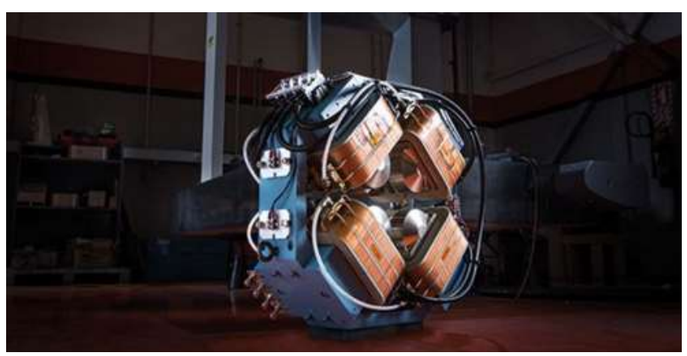

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BUCKLEY SYSTEMS
Ingenious at work

Buckley Systems News

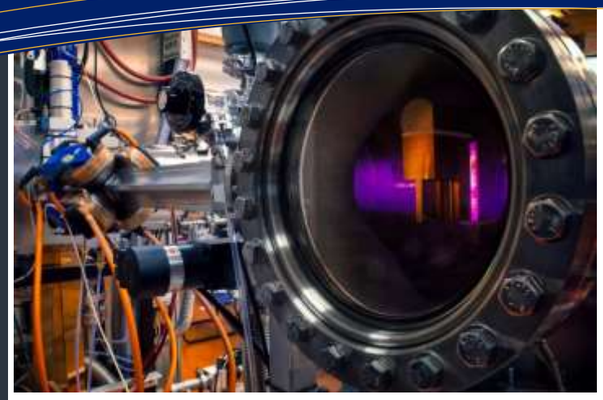
Buckley Systems buys stake in D-Pace

Buckley Systems, world leader in the production of electro-magnets for the ion-implantation and medical industries, has purchased a 50% stake in Canadian based ion technology company D-Pace.

Already manufacturing many D-Pace designed and licensed components, the closer involvement of Buckley Systems has already brought many benefits to both companies.

The ISTF project is a perfect demonstration of the advantages of combining a world-class electromagnet and related component manufacturing business with an industry specialist that is focused on developing new products for a rapidly expanding market.

D-Pace



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Ion source test facility stage two is launched

There was great excitement in March 2016 when the installation team from D-Pace achieved a visible ion beam from stage two of the Buckley Systems / D-Pace ISTF joint venture.

While not normally able to be seen, the ion source beam was made visible by the introduction of nitrogen into the vacuum chamber. Rather than looking at complex numbers on screens, the purple glow given off by the beam gave the non-scientists a small glimpse into what was actually happening inside the equipment.

Stage one of the ion source development had been in operation since November 2015 and has already proved itself as a valuable testbed. Stage two, consisting of a D-Pace Mini-PET 30 beamline and an analyzer magnet has greatly expanded the capability of the facility allowing both D-Pace and Buckley Systems to test and develop the capacities of related products in-house.

Brought in on-budget and ahead of schedule, the facility has shown the advantages of the two companies working as an integrated team since the purchase of a 50% stake of D-Pace by Buckley Systems in 2014.

Having an in-house facility has allowed experimentation into characterizing different ions, calibration of instrumentation and computer simulations to be verified.

In the first month of commissioning, the ISTF proved its worth in allowing D-Pace technicians to replicate a client's problem and mirror them through the procedure to remedy it.

The ISTF and all associated components such as the faraday cup, emittance scanner analyzer and Mini-PET are commercial products in their own right and can be purchased individually through D-Pace. The facility is available for hire and can also be used for pre-purchase certification and verification of products if required.

D-Pace founder and CSIO, Morgan Dehnel, says "The collaboration between D-Pace and Buckley Systems has been incredibly successful for both companies, allowing us to explore new uses for our products and help our existing customers optimize their own systems."

With the commissioning of stage two, the ISTF already has a full program of internal testing and experimentation ahead but with enough flexibility to accommodate inquiries from interested parties.

D-Pace

Purchase of new building almost doubles manufacturing space.

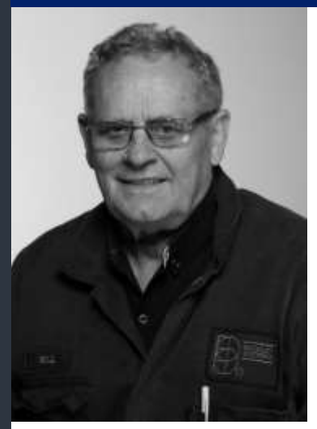
With the purchase of the neighboring building at 8 Bowden Road, Buckley Systems has taken a huge leap forward in manufacturing capability.

With the demand for larger and larger screen implantation machinery, some of the magnet assemblies were exceeding 25 tons and stretching the resources of the existing building. The new facility will consolidate the heavy fabrication and large coil forming operations, improving workflow and reducing bottlenecks.

The new building is directly opposite the machine shop so there is less distance for heavy machined parts to travel. With some parts requiring repeated welding and machining steps, this means significant time savings.

The space in the existing building created by the move will allow smoother workflow and greater throughput of smaller magnets, giving the business the agility to quickly react to market demand.

Buckley's philosophy of keeping quality in-house means that every step of manufacture can be closely monitored – an essential element when micron precision tolerances are required.



Bill Buckley, the man behind Buckley Systems

It takes someone special to keep a business at the leading edge of technology for 35 years.

Bill Buckley takes great pride in doing things himself. Seldom seen in a suit and tie, he is more often to be found in coveralls, sorting out problems around his factory.

An engineer by trade, Bill has always thrived on a challenge. Approached by PhD graduate Hilton Glavish in 1976 to build prototypes for his ion implantation designs, he embarked on a journey that has seen Buckley Systems become the world's leading supplier for particle guiding electromagnets and ultra-high vacuum systems. Being at the very birth of the silicon chip industry and helping solve the many problems involved in bringing theoretical designs to working reality, he gained a deep insight into the physics of particle acceleration.

Never afraid of investing in equipment to achieve his goals, he has bought some of the largest and most sophisticated machining equipment available in order to achieve the precise tolerances required for the industry. Investment continues today with the recent purchase of a DMG Mori DMC 210 machining center.

Not content to lead the world in electromagnets, Bill also used his engineering know-how to take a tilt at the World 500cc motorcycle championship in 1998, putting together a team to design, build and race in this most competitive of sports. Rule changes made before the bike had reached its full potential put paid to the dream but he gained valuable industry exposure from the venture.

With the company landing the electromagnet supply contract for the Australian Synchrotron Light Source, the successful delivery and implementation of the project has seen Buckley Systems subsequently awarded contracts for the Brookhaven Synchrotron and Taiwan Photon Source projects.

The high pole tip accuracy needed for these projects saw Bill developing innovative manufacturing techniques to meet the demanding specifications.

Always on the lookout for fresh challenges Bill also had a shot at high-performance offshore yacht racing as a partner in the 100ft (30 meter) Maxi racing yacht Maximus. The boat with its ground-breaking retractable, canting keel (partly fabricated by Buckley Systems) and rotating carbon-fiber mast (a first for a keel boat), won line honors in the prestigious 2005 Fastnet yacht race.

Exploring new cures for cancer is another passion of Bill's. Buckley Systems has now made over 1,000 magnets for radiotherapy machines and also magnets for proton and carbon therapies which are regarded as less invasive treatments. Bill is currently working on machines for boron neutron capture therapy (BNCT), an experimental treatment that until recently, has required access to a nuclear reactor to provide the spectrum of neutrons required. Bill is working on developing a powerful enough accelerator to create neutrons without the associated risks of a reactor.

… create neutrons without the associated risks of a nuclear reactor.

Bill is also helping research into climate change by co-funding the Glavish-Buckley Chair and Buckley-Glavish Senior Lectureship in climate physics at the University of Auckland. To help young people into engineering careers, Buckley Systems is also establishing one of the largest apprentice training schemes seen in New Zealand.

At 73 years old, Bill's passion for discovering, inventing and helping others still burns brightly and he is certainly not looking to hang up his coveralls just yet.

Technology news

Paper presented at IPAC 2016.

The new Ion Source Test Facility (ISTF) designed by D-Pace Inc. and installed at Buckley Systems Ltd in Auckland, New Zealand has already been used to perform experiments that form the basis for two scientific papers presented at the IPAC 2016 conference. The following is a summary of A PID Control Algorithm for Filament Powered Volume-Cusp Ion Sources, presented by S. Melanson:

The plasma inside the TRIUMF licensed, D-Pace designed, ion source is generated by passing a current through a tantalum filament assembly. Since the generation of plasma with a filament is highly non-linear, a proportional-integral-derivative (PID) control algorithm was implemented to precisely control the filament current in response to measured changes in the discharge current. Once filament power supply current passes the threshold of Townsend discharge, the filament current needs to be reduced to keep the arc current and ion beam constant. The PID control algorithm first calculated the current error using: $E(\mathrm{t}_i) = I_{\mathrm{arc}}(\mathrm{t}_i) - I_{\mathrm{arcset}}$ where I_{arc} is the arc current, t_i is the present iteration and I_{arcset} is the arc current setpoint entered by the operator. The new current in the filament power supply is calculated by: $I_{\mathrm{fil}}(\mathrm{t}_i) = I_{\mathrm{fil}}(\mathrm{t}_{i-1}) + u(\mathrm{t}_i)$ where $u(\mathrm{t}) = K_P E(\mathrm{t}) + K_I \int_{\mathrm{t}_0}^{t} E(\mathrm{t}')\mathrm{dt}' + K_D \frac{dE}{dt}$. The parameters K_P, K_I and K_D are the proportional, integral and derivative terms respectively. These parameters are tuned for the specific system. For our filament- powered H− ion source, the filament current (I_{fil}) is controlled by the algorithm while the arc current (I_{arc}) is the read-back parameter.

To evaluate the algorithm on the ISTF, the arc current was set at 24.6 A, the arc voltage was fixed at 130 V and the H^2 gas flow set at 15 sccm. Over 60 minutes of operation, we obtained a root mean square error in the arc current of 0.058 A and 0.025 mA for a beam current of 10.16mA on the Faraday cup. The maximum peak-to-peak variation was ±0.76% for the arc current and ±0.45% for the beam current.

The complete paper including actual test results is available on request from D-Pace Inc. or Buckley Systems Ltd.

Mini PET beamline

Designed to be retrofitted to existing cyclotrons with minimal modification and no support structures, the Mini-PET beamline is an economical way to add new life to older machines.

Mini-PET system allows the radioisotope target to be moved away from the proton cyclotron, facilitating the use of local shielding to reduce prompt gammas and neutrons. More importantly this attenuates residual target radiation, minimising ionizing radiation exposure to research and maintenance staff. In addition, dynamic focusing and steering provide increased control of the proton beam, greatly improving radioisotope production rates. The Mini-PET is available through D-Pace at www.d-pace.com.

Machining multipole magnets

Multipole electromagnets perform focusing and higher order corrections in a myriad of particle accelerator applications. Synchrotron light sources are amongst the most demanding of these applications and as the technology has developed, ever tighter multipole magnetic and mechanical specifications have been required. In order to meet this challenge the way in which multipole magnets are manufactured has also evolved. When contracted to build 90 storage ring multipole magnets in the Brookhaven National Laboratory's NSLS II synchrotron light source project Buckley Systems found that traditional machining techniques were unable to achieve the 15 µm tolerances required. By laser cutting the laminations then using high precision wire-cut machines to shape the poles, fiducials and mounting features, the required tolerances were easily achieved. Refining the process further, Buckley Systems has been able to produce a quad coil prototype with sub 10 µm tolerances on both profile and symmetry.