MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

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DALTON CUMBRIAN FACILITY
NEWSLETTER

August 2022

WELCOME

Dear friends, colleagues, and collaborators,

Recent months have seen DCF as a veritable hive of activity – we performed what we think is the world's first irradiation of lunar regolith, working with scientists from the Open University and Kent University. The preliminary data gave us just a sneak peek at the potential DCF has to contribute to the development of future lunar bases. Coupled with preliminary measurements by the same team concerning ion-induced chemistry on astrophysical ices, we are breaking new ground as a new astrochemistry community starts to form around DCF. Of course, we have not forgotten our existing user base as we continue to upgrade DCF's accelerator-based capabilities; more details of the ongoing programme of work are on pages 5 and 6.

The hive-of-activity feeling has been further enhanced by us welcoming eight summer students to DCF, with them being involved in a diversity of projects such as developing new radiation chemistry simulation codes, developing a sealed/portable robotic system (biobox) to support irradiation of biological samples, developing automated production of new radiopharmaceuticals and developing 3D-printable radiation sensors. Again, there are more details later in the newsletter on pages 2 and 3.

We find this focused high-intensity activity to be tremendously productive. Discussions with several of our users indicate this is a way many of them like to work at DCF too. In order to facilitate user-communities having periods of focused activity at DCF, we are putting together a new ***community access mode*** whereby a research community, drawn from several universities, can put together an umbrella application to have access to all of DCF's facilities in a coordinated way for up to a month. We anticipate there being 3 – 4 such months per year once our upgrades are complete with the umbrella application being approved 6 – 12 months ahead of the access. Although we are still working up the details of the application process, it is never too soon for a research community to think about making an application and interest parties are encouraged to contact me (Fred).

Fred Currell
Director of DCF

Lian Murdoch
Editor

SUMMER PLACEMENTS

Dalton Cumbrian Facility Paid Summer Research Placements

This year, Dalton Cumbrian Facilty has the pleasure to once again offer university students the opportunity to engage in using our world-leading radiation equipment and purpose-built facilities, to take part in paid Summer Research Placements.

Our successful 2022 candidates have begun their placements in earnest.

Amie McClintock

"I am currently a Physics and Astronomy student at Durham University, about to start the last year of my integrated masters. I am involved in the 'Biobox' project at DCF, where I have been learning the fundamentals of Fusion 360, in order to design and 3D print a holder for the syringe pump, according to specifications. I have also spent my time at DCF building on previous knowledge of Arduino coding and circuits, in order to fully understand how to implement the syringe pumps, which will dispense a sample into the spinning wineglass, where the sample is then irradiated."

Art Purser

"I'm joining DCF for my MChem year as part of the MIRaCLE collaboration to develop in silico investigations of fast cytotoxic reactivity around radiosensitisers in augmented therapy. I'm a mature student and before returning to education I worked in a supporting role in the NHS and have seen first-hand the impact science and technology can have on people's quality of life. I left this job to pursue chemistry. In one way or another I've always been fascinated by the dynamics of complex systems and have become especially interested in the physicochemical dynamics of disease states.
I'm originally from a village in Worcestershire, the inspiration for Tolkien's Shire, and I've lived and worked in New Zealand and Japan, before returning to college near Birmingham (Isengard) and doing my undergrad in Mordor (Manchester), in Medicinal Chemistry."

Eliza Wojcik

"My project at DCF focuses on the novel synthesis methods of zirconium nanoparticles for radiopharmaceutical purposes. Zirconium-89 has an amazing potential of being used as a diagnostic tool in Positron Emission Tomography and this project aims to further understand the nanosynthesis of zirconium compounds that could be potentially safely applied in medical settings. During my master's project, I explored Zr/Y chromatographic separation and mostly conventional nanoparticle synthesis of zirconia, but the DCF placement opportunity allowed me to further my interests in zirconium chemistry. Although medicinal chemistry was always something that interested me, it was the chemistry of transition metals that was my favourite topic during my studies at The University of Manchester Chemistry Department. Thus, I was extremely excited to pursue both a bit further with this research opportunity, this time focusing on the radiolytic zirconia synthesis."

Joe Percival

"I have recently finished my first year at The University of Manchester studying computer science, looking to specialise in the field of AI development and robotics. Currently, I am working on an interface with a built-in programming language and compiler specifically designed for the robotic arm as part of the Biobox project. I hope this will allow Biobox to become more modular and scalable since my interface will simplify future programming of the robot and separate the more technical aspects from the user. I have also modified the head of the robot arm to accommodate the motor and mount for the wine glass model. My next steps are to begin developing software for the radiopharmaceuticals project,
giving me a great opportunity to really refine my technical skills."

Jordan Elliot

"I am a PhD student joining DCF from my undergraduate and master's degree in Biochemistry at the University of Portsmouth. My project is focused around investigating the folded structure of ribonucleic acids using ion beams with the hopes of using ion beams to break the RNA structure at specific points and use biochemical analysis to predict the structure of the RNA using those breaks. The understanding of RNA structure and how it informs us about its function has always been a popular topic and techniques surrounding probing RNA structure have exponentially increased as our understanding of RNAs importance has increased, especially in the public health field. My interest in RNA sparked well before my university course and has always fascinated me. Understanding RNA is the underpinning step to allow more focused genetic engineering, drug targeting and epigenetics research and various other fields where RNA is the focus. I've joined DCF to pursue my fascination further and hope my contributions made here at DCF can benefit the scientific community as a whole."

Will Sarsfield

"I'm a computer science undergrad at The University of Manchester, and I've come to DCF to further my programming ability over the summer. I'm working on coding the Biobox's robotic arm that is mounted by a spinning wine glass, and automated to handle irradiated RNA samples within a protective casing. I also plan to work on the inventory tracker system for the radio pharmaceuticals project over summer. I hope that as I work at DCF, my knowledge of nuclear chemistry increases as well as programming, because I believe the nuclear industry will be imperative for developing future technologies."

RAICO

RAICo1 welcomes visitors

RAICo1 had open days in March and April to give invited guests a sneak preview of the latest developments. Copeland MP Trudy Harrison visited the facility and heard from researchers as they demonstrated robotics technologies including ground and aquatic vehicles designed for monitoring and inspection tasks; saw examples of the NNUF Hot Robotics capability; had a tour of the modular robotic system for remote handling of special nuclear materials (DPaCc) and experienced UKAEA's control room for the LongOps programme.

RAICo1 is a new collaborative facility in Whitehaven that has been set up as a partnership between Sellafield Ltd, The University of Manchester, UK Atomic Energy Authority, and National Nuclear Laboratory. RAICo1 will allow researchers from academia to work directly with the nuclear industry to address key nuclear decommissioning challenges.

DCF ACCELERATOR

Following the initial Covid-19 lockdown in 2020, demand for the DCF ion beam accelerators has been noticeably higher than normal as our user community has picked up their research programmes following the global interruption to normal life. Consequently, the DCF team have been running an intensive programme of user operations since then. Whilst we have not been neglecting routine maintenance during this period, the accelerator systems started to exhibit various faults which have led to a drop in performance. As a result, our normal spring shutdown for routine maintenance is being extended this year to allow for a more thorough series of investigations and repairs. In some cases, the necessary repairs have turned out to be more complex than originally expected, requiring the downtime to be extended in order to source additional replacement parts from the US.

One of the major components to be investigated is the MC-SNICS ion source, whose production of heavy ions had been getting increasingly problematic. Having purchased new lens assemblies, caesium diffusers and ioniser prior to starting work (most of the Cs sputtering optics), we subsequently discovered ion beam erosion to other lens apertures further downstream from the ion production area. At time of writing, we are waiting for replacement components before we can refit, outgas and re-commission the source. We are however confident that the extensive rebuild will restore the performance of the ion source to its original level, both in terms of ion current, and in better separation of isotopes for some of the more challenging ion beam experiments.
We are not yet certain of the date at which we can resume ion beam operations, although as maintenance of the 2.5 MV accelerator is now complete we can use that machine and are using it to catch up on some of the outstanding irradiations.

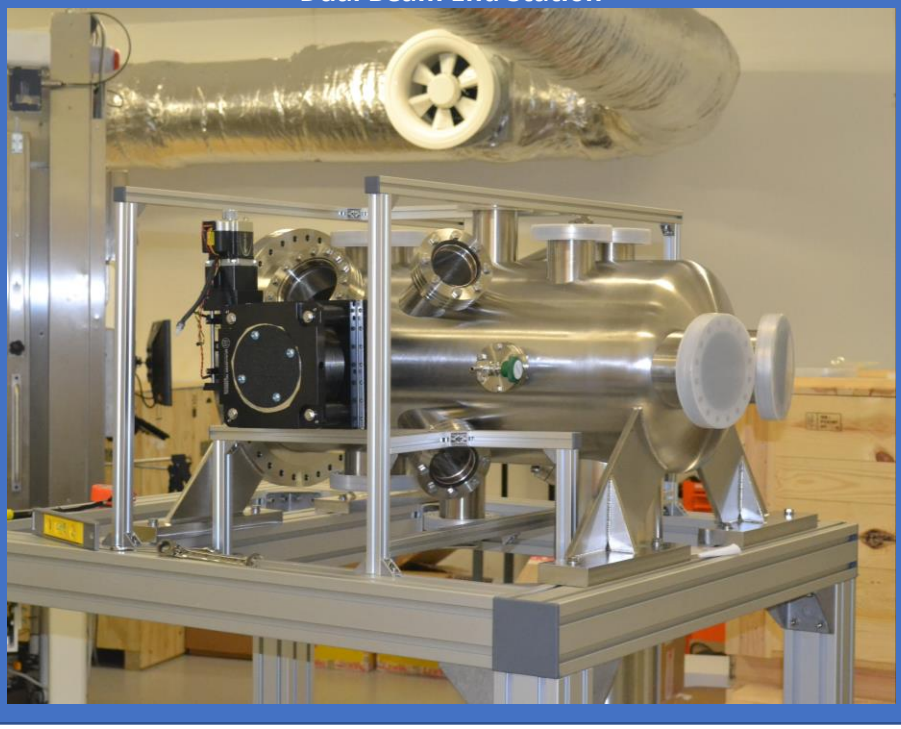
Beamtime however will be extremely limited this year with a longer shutdown scheduled for the second half of 2022. This is to retrofit additional radiation shielding to our Accelerator Hall to enable high current, high energy ion acceleration through the 5 MV tandem. This project involves major building work to replace the internal walls in the accelerator hall with lead panelling. We currently do not have a confirmed start date for this but expect work to commence in the summer. Whilst we will not be able to operate the accelerators during this work, we will however be constructively using the downtime to develop new capabilities on the accelerator system, these include:

- Recommissioning the hot cell on Line 1 with a new sample stage. This will take samples mounted on standard sample flags and will have electron beam heating capable of 1000°C. The hot cell is designed to offer a remote handling capability to manage the higher activation of samples, irradiated with high current (up to 100 μA), high energy protons (up to 10 MeV) from the 5 MV tandem. An additional complementary addition in the Far Target Room is the purchase of a radiological containment glovebox. Whilst the glovebox is primarily intended for use with alpha & beta emitters, its close proximity to the irradiation hot cell does open the prospect that in the future DCF could offer ion beam irradiation of active components.
- Additional beam diagnostics on Line 2. This beamline is ‘open ended,’ allowing for users own experimental chambers to be fitted. A beam position monitor and Faraday cup will be installed close to the end of the installed beam pipe, providing better beam setup into the user’s sample in their sample environment

- Dual beam irradiation end station on lines L5 of the 5 MV tandem, and Line A of the 2.5 MV accelerator. This long-awaited development is finally beginning to take place, see photograph. The large end flange on this vessel will have a smaller port which can take either our standard ion beam damage end-station or other custom stages, either user developed or in-house developed, making this a versatile end-station.
- Dual beam analysis end-station on lines L6 of the 5 MV tandem and Line B of the 2.5MV accelerator. This will incorporate both SIMS (Secondary Ion Mass Spectroscopy) and an imaging HR-EELS (High energy Reflection Electron Energy Loss Spectroscopy) capability. The sample stage for this will take a larger version of the sample flag in the new hot-cell stage, as well as an ability to cool to LN_2 temperatures or heat to 1000°C. This clearly will be a complex end-station and so whilst we expect to have it assembled on the floor of the Near Target Room by the end of this year, anticipate that full commissioning may not be completed until sometime in 2023. We will welcome hearing from users interested in the capabilities offered by this end-station and who would be willing to work with us during commissioning to help develop the full scientific potential.
- Third gas source in the Torvis ion source offering scope for Deuterium or He^3 ion irradiation.

We do have a limited window of ion beam operations between the current maintenance period and the Accelerator Hall building programme, most of which is already committed to fulfilling previously scheduled irradiations. We hope to have a little scope in which to accommodate a few, short, urgent irradiations. If you have an urgent requirement, maybe due to impending grant or studentship end, or for other conversations about the new ion beam capabilities, please get in touch by emailing dcf.experiments@manchester.ac.uk

Dual Beam End Station



DCF STAKEHOLDER MEETINGS

The DCF Stakeholder meetings, originally planned to take place in Manchester on Tuesday 26 and Wednesday 27 July 2022, have unavoidably been postponed.

We will inform every one of the new dates once they have been re-scheduled. It is likely that they will have a focus on potential community access mode bids, once we have expressions of interest in making these.