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The University of Manchester
Dalton Nuclear Institute

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DALTON CUMBRIAN FACILITY
NEWSLETTER

Spring 2024

WELCOME

Dear friends, colleagues and collaborators,

Once again, a time of welcoming – new team members and new equipment as we take forward our vision of progressively automating measurements at DCF. Aidan Milston and Volkan Yasacki have both joined us and are already making great impact. Volkan is leading our synthesis of copper nanoparticles, an important component of our DESNZ grant 'Optimised Production of Theragnostic Isotopes of Copper and Scandium (OPTICS)'. Here the goal is to develop a fully automated platform for radiopharmaceutical production. This modular platform will become available to users who will be able to develop their own prototype radiopharmaceuticals, including in nanoparticle form.

Aidan is also part of the OPTICS team and is developing automated components to go inside a new hot cell currently being commissioned. The automation should allow us to go from transmutation via separation/purification to synthesis, all without a human in the room. Aidan is also further developing our automated sample handling offering in other directions. He is primarily focussing on systems to support special nuclear materials research in two projects, 'Small Modular Radiation Experimental Systems (SMoRES)' and 'Radiation Directed at Gaseous and Solid Targets (RaDaGaST)'. Both projects are funded by the NDA, for which we are extremely grateful.

We are also extremely grateful to the Henry Royce Institute for funding new spectrometers which will offer new user capabilities and will also be ideal for linking to our ever-developing automated sample handling capabilities. See page 2 for more details.

If you want to be in the conversation with us providing higher-throughput automated solutions focussed on your research, then there is no better place to start than the DCF User Engagement Day – 21st of May, tickets can be booked here. We are very much looking forward to meeting with you, sharing the emerging capabilities in greater detail and see how we can better support great radiation science in general.

Fred Currell
Director of DCF

Hayley Austin
Editor

EQUIPMENT DEVELOPMENT

Two new UV-Vis-NearIR spectrophotometers installed & commissioned at DCF

A new, top of the range, Agilent Cary 5000 UV-Vis-NearIR Spectrophotometer has been installed and commissioned in the DCF analytical laboratory.

Absorption and transmission measurements can be performed on both liquid and solid samples with a wavelength range from 175-3300 nm, with a wide photometric range, up to 8.0 Absorbance units, and with variable slit widths, down to 0.01 nm.

Additionally, an internal diffuse reflectance accessory (DRA 2500) can be used to measure reflectance of both solids and powders up to 2500 nm. Reflectance measurements are made by mounting the sample on the wall of an integrating sphere, where the 100% reflectance reference is pressed PTFE powder, and no sample is used for the 0% reflectance reference. The reflected beam from the sample is diffused throughout sphere and measured by the detector, while the reference beam enters the sphere directly and is dispersed. Diffuse reflectance is measured with the sample flat against the sphere and both diffuse and specular reflectance can be measured with the sample angled (3° 20').

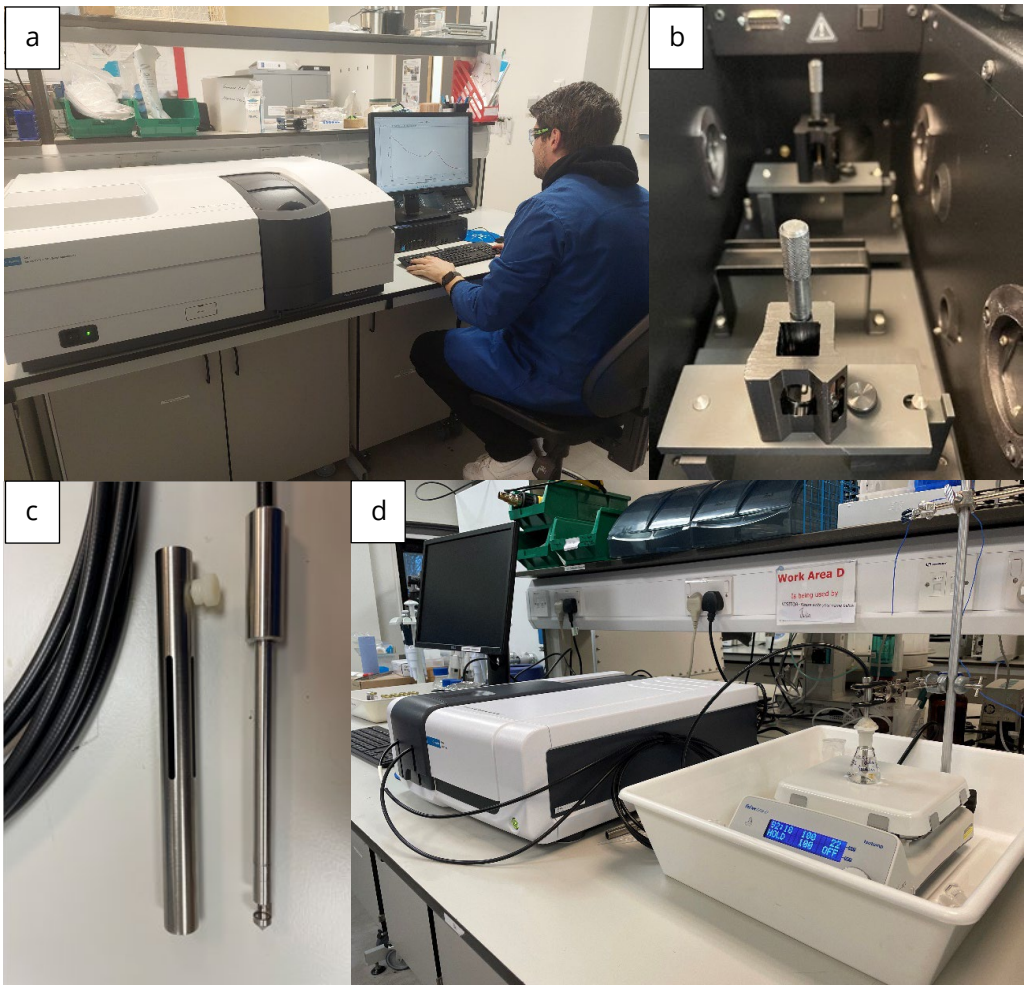


Figure 1 a) Cary 5000 in use by Will; b) Cary 5000 sample compartment with cuvette holders; c) Cary 60 liquid sample fibre optic probe; d) Cary 60 in use with the fibre optic probe in a stirred conical flask.

The second UV-Vis spectrophotometer is the smaller, portable, Agilent Cary 60. This instrument can be moved on a trolley to any of the DCF radiation sources for inline experiments.

The instrument features a flash lamp meaning it is room-light immune so, needs no warm-up time, it is good for light-sensitive samples and measurements can be made with the sample compartment open. It has a focused beam, good for small samples (<4 µl) and fast data collection scan rates (up to 24,000 nm/min - scans 190 to 1100 nm in <3 s).

A stainless steel fibre optic probe and coupler is available for remote sampling of liquid samples.

More details of both pieces of equipment can be found at:
https://www.agilent.com/en/product/molecular-spectroscopy/uv-vis-uv-vis-nir-spectroscopy/uv-vis-uv-vis-nir-systems

This equipment was funded by The Henry Royce Institute, to whom we express our gratitude.
Initial enquires to dcf.experiments@manchester.ac.uk or Ruth ruth.edge@manchester.ac.uk please.

OUR PEOPLE

Dalton Cumbrian Facility welcomes some new starters into its family

Aidan Milston
Technical Specialist

Tell us about your career journey so far
I am just beginning my academic career starting with an integrated masters degree in physics at the university of Kent where I spent a year at Indiana university in the US. I started working in the field of nuclear materials with my PhD project at the MIAMI group at the university of Huddersfield. Where the department was focused on ion irradiation of materials with in situ transmission electron microscopy. Shortly after this I moved here to DCF.

What brought you to DCF?
I'd heard of the department through contacts at The University of Manchester and meeting the team at conferences. The ion accelerators and beamlines were one of the main factors in attracting me to the department and are similar to systems I've used in the past.

What are your research interests?
My PhD project was focussed on the formation and dynamics of gas bubbles in metals under irradiation and I would be interested in continuing in this area however, I am open to working on new projects with the diverse set of interests explored here at DCF in any field not necessarily just in nuclear materials or subjects I've worked on before.

What do you enjoy doing when you aren't at work?
In my spare time I try and keep up with current tech news and enjoy listening to music.

Volkan Yasacki
PhD Student

Tell us about your journey in education so far.
I graduated with a bachelor's degree in chemistry from Ege University, Faculty of Science, Izmir, Turkey, in 2013. After a two-year break, I pursued a master's degree in Nuclear Applications at the same university's Institute of Nuclear Sciences, starting in 2015. I focussed on iron oxide particles conjugated with FDG. In 2018, I commenced my PhD studies at the same institute, working on the synthesis of cubic iron oxide nanoparticles and a molecule named DPAPA, investigating its effects on prostate cancer. Throughout my PhD, I was supported by a scholarship for 4 years under the Council of Higher Education of the Republic of Turkey. Moreover, I participated in a bilateral cooperation project between my institute and the Institute of Nuclear Chemistry and Technology in Warsaw, Poland, focusing on the labeling of cubic iron oxide nanoparticles and PSMA-617 with $^{44/46/47}$Sc radionuclides for prostate cancer theranostics. I completed my doctorate in April 2022 with three separate scholarships. I also worked as a production specialist at a FDG production facility in Istanbul for one year, adhering to GMP and GLP standards. Winning one of Turkey's most prestigious scholarships in 2019, I am currently at The University of Manchester, working on the production of ^{64}Cu and the synthesis of active Cu nanoparticles for cancer diagnosis and treatment at the Dalton Cumbrian Facility. This journey is far from over; I am committed to contributing to humanity.

What brought you to DCF?
The DCF is a facility designed with the infrastructure suitable for multidisciplinary studies and equipped with a skilled staff, which has the potential to become one of the future centres for medical isotope production and application and may even lead in this field. I hope I can contribute to the DCF in my area of work and create potential for future studies.

What are your research interests?
My field of work focuses on radiochemistry and the production of next-generation radiopharmaceuticals. It involves designing targeted drug delivery systems integrated with nanotechnology to offer new approaches to cancer diagnosis and treatment.

What do you enjoy doing when you aren't at work and tell us about your family.
I am a nature and outdoor sports enthusiast. Although I haven't been able to devote much time to it lately due to family life and scientific commitments, I am a semi-professional paragliding pilot. I have participated in competitions and trained many students. Alongside these, I really enjoy activities like nature walks and hiking. I look forward to the weather improving so I can explore the magnificent nature of the Lakes Region in terms of all activities, together with my wife and little daughter.

PROJECT SPOTLIGHT

Compound Trials Program – Elastomer Compound Exposure to Varying Levels of Irradiation

Bethany Evans – Northern Engineering (Sheffield) Limited (NES)

Compound Trials Program – The Challenges

NES Provide sealing systems in demanding environments such as Aerospace and Defence, Semiconductor and Nuclear, with our nuclear clients having perhaps the most exacting requirements.

One knowledge gap was the mechanical performance of our seal compounds after exposure to varying levels of ionising radiation. This is particularly important on RAM transport flask and nuclear blast door applications. Our challenge was therefore to fill this gap by applying controlled radiation dose rates under tightly controlled environmental conditions, a Compound Trials Program (CTP) to determine the impact on seal integrity.

After initially investigating the use of industrial irradiation facilities we approached the team at Dalton Cumbrian Facility (DCF), and following our initial meeting settled on the DCF as a key building block for the program using the Foss Cobolt-60 Irradiator. The other key participant was Croft Associates, a leading designer and manufacturer of RAM transport flasks.

The Solution, program plan and execution

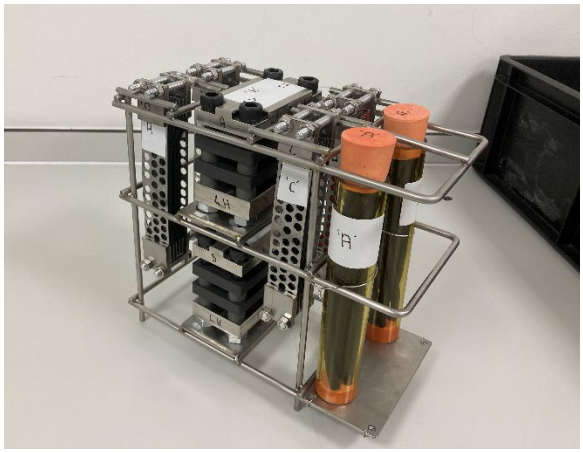
Four elastomer compounds were selected for the compound trials program:

Program Phase	Key Stages and Aims
Test coupon preparation	Test coupons were prepared in accordance with ASTM code requirements from a single lot or consignment of compound. Standard ASTM geometries and test coupon formats were utilised. Where O-Ring cord sections were used, these replicated the cross-section requirement for the appropriate dumb bell cross sections.
Test coupon aging	Several test coupons were artificially aged to represent in service conditions equivalent to ten years of typical service. In accordance with ASTM standards coupons were artificially aged, as informed by the Arrhenius equation. Some test coupons remained “un-aged” to enable comparative aged and un- aged testing to be performed.
Test coupon physical testing	Testing to determine the physical properties of the compound test coupons was executed prior to and following irradiation.
Test coupon Irradiation	Test coupons were fixed within specialist test rigs and fixtures and mounted within the custom chamber test rack. Test coupons were then subject to varying levels of irradiation to simulate in service conditions. The target total gamma irradiation dose was **17.5 KGy** to **600 KGy** dependant on coupon type. The test involved dose rates of **0.95 KGy** to **8.26 KGy** per hr. at intervals of 16 hrs with intermediate visual examination at these intervals.
Test Coupon characterisation	Characterisation of specific test coupons, O-Ring cord sections, both pre and post irradiation helped determine chemical changes within the test coupons.

The Benefits

Significant data sets were obtained from the CTP program, enabling service life estimations for specific radiation exposure levels to be developed. These learnings will be used to inform the elastomer compound formulations to enhance sealing systems under exposure to radiation.

Core Team – Ruth Edge (DCF), Beth Evans (NES & photographer) and Nick Fuller (NES)



Coupon samples loaded into dedicated test rack

Test Rack prior to loading

UPCOMING EVENTS

Dalton Cumbrian Facility User Engagement Day
Tuesday 21 May 2024
The Henry Royce Institute, Royce Hub Building, Oxford Road, Manchester, M13 9PL

Join us at our User Engagement Day in Manchester to learn about new and emerging capabilities for DCF, hear from current and past users and have the opportunity to give feedback on what works well, what requires improvement and what you would like to see at DCF in the future. Click here for booking information. **Places are limited and bookings will close on Tuesday 14 May.**