Dalton Cumbrian Facility

The University of Manchester’s Dalton Cumbrian Facility (DCF) houses a range of irradiation equipment as well as supporting analytical equipment.

Situated on the West Cumbrian coast, DCF is available to researchers from both academia and industry. Dedicated staff are on hand to provide expert advice and facilitate work by visitors. In addition, they can design and run experiments as required so that you get the results you need when you need them.

Irradiation capability comprises our 5MV tandem ion accelerator and a self-contained $^{60}\text{Co}$ gamma irradiator, and our extensive range of analytical equipment includes wet chemistry as well as materials science. Examples from this range of equipment are listed over the next pages of the flyer. However, since our capability is always expanding, check online for the most up-to-date details.

www.dalton.manchester.ac.uk/dcf

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5MV tandem ion accelerator

• Model: 15SDH-4 Pelletron
• Sources: high current TORVIS for hydrogen and helium ion beams; SNICS, with a current capability for C, O, V, Cr, Fe, Ni, Cu, Zr and W ions
• Maximum energies are: 10MeV for H\(^+\) at 100µamps and 15MeV for He\(^{2+}\) at 15µamps); up to 10MeV for protons
• Strong electromagnets focus the ion beam to a circular area of 0.28cm\(^2\)
• Six beam lines split between two target rooms allow one experiment to be set up while another is running, thus reducing wait time
• One target room for radiation chemistry studies at relatively low beam currents of typically 100 nanoamps or less
• A second target room is used for radiation damage experiments at much higher currents, up to the maximum of 100 microamps for protons, incorporating raster equipment.

An additional 2.5MV single-ended accelerator was installed at DCF in 2016, creating the world’s highest energy dual beam accelerator system.
Self-contained $^{60}$Co gamma irradiator

Source rods are located at the back of the chamber, resulting in a planar irradiation field. This results in a variety of dose rates. Attenuation can be added to reduce the dose rate further. Various turntables can be used to ensure even irradiation of samples.

The Foss Therapy Services Model 812 has the following:

- 9 litre irradiation chamber (20 x 25 x 27cm) – this limits the size of the sample being irradiated (see photo)
- Releases gamma rays of 1.17 and 1.33MeV
- Two sample ports with 19mm internal diameter complete with scatter shielding for in-line analysis

Agilent 7890B gas chromatograph (GC)

This GC has been specifically built to filter nitric acid out of the sample. Nitric acid is a key component of many nuclear waste streams and can be very damaging to certain detectors, as well as the steel components in the GC. This purpose-built piece of equipment allows for robust sampling of waste simulants and allows highly accurate data to be collected.

- Temperature range: 4°C – 450°C, with a resolution of 0.1°C
- Maximum ramp rate: 120°C/min
- Cool down rate: 450°C to 50°C in 4 minutes with an ambient temperature of 22°C
- Pressure control: 0 to 150 psi, accurate to 0.001 psi
- Detectors: TCD, ECD and FID
- Available carrier gases: Nitrogen, Helium
- Column: 2m long packed 2mm internal diameter
- Inlet: Capillary S/SL with EPC to 100 psi

Bruker Vertex 70 FT-IR with RAMII spectroscope

Our FT-IR spectrometer uses data acquisition based on two channel deltasigma ADCs with a 24-bit dynamic range. These run in parallel and are integrated into the detector preamplifier electronics. This advanced DigiTect technology prevents external signal disturbance and guarantees the highest signal-to-noise ratio. Fourier transform of the signal allows a spectrum of wavelengths to be measured simultaneously. This model can determine IR and Raman spectra of both solid and liquid samples.

Detectors:

- MIR: DTGS (10,000 – 370cm$^{-1}$, room temp), MCT (10,000 – 600cm$^{-1}$, LN cooled)
- Raman: Ge diode (11,750 – 5,800cm$^{-1}$, LN cooled). Suitable for stokes shift Raman (3600 – 50cm$^{-1}$). Source is a 500mW Nd:YAG laser, diode pumped. Excitation is at 1064nm with a line width of <0.5cm$^{-1}$
- Diamond ATR
- Pike VeeMax Accessory for specular reflectance
- Harrick DRIFT Accessory for diffuse reflectance

Analytik Jena
Multi N/C 2100 S total carbon analyser

Determining organic species allows us to assess the environmental impact of irradiating a material.

- Detector: focus radiation NDIR for TOC analysis
- Temperature range: Catalyst promoted high temperature combustion of up to 950°C
- Simultaneous determination of TOC and TNb with a single injection using the same catalyst
- Sample feed by direct injection
- VITA flow management system
- Easy Cal, auto-protection and SCS
**FEI Quanta 250 FEG ESEM**

Capable of analysing the atomic surface of a sample, our ESEM has a resolution of 2.0nm (SEM) and 0.8nm (STEM). At the same time, an EDX detector allows elemental analysis while an EBSD detector means we can determine crystal orientation.

- Emitter: Schottky Type field emission gun (FEG)
- Vacuum modes: High vacuum, Low vacuum (<1.3 mbar), ESEM (<40 mbar)
- High Voltage: 0.2 – 30kV
- Temperature control range: -25°C to +55°C, expandable to 1000°C for in-situ heat treatment
- Large stage: 50 x 50mm
- Wet STEM analysis for a wide range of applications
- Detector systems: ETD (SE); LFD (SE low-Vac); Gatan 3view + BSE; WDS

**Micrometrics TriStar II 3020 gas adsorption analyser**

This sophisticated piece of equipment allows determination of porosity and surface area.

- Analytical gases: N₂, CO₂, CH₄, C₆H₁₀ plus other light hydrocarbons and non-corrosive gases
- Range: 0 to 950mmHg
- Minimum measurable specific surface area: 0.01m²/g nitrogen, 0.001m²/g krypton
- Minimum measurable total surface area: 0.1m²/g nitrogen, 0.01m²/g krypton
- Minimum measureable pore volume: 4x10⁻⁶cm³/g
- Capability: single and multipoint BET, Langmuir SA and isotherms, t-plots, BJH adsorption, DFT pore size and surface energy
- BET surface area can be measured in under 20 minutes
- Degassing temperature range: 100 to 400°C

**Also available**

- Surface Analysis (Characterisation Laboratory)
  - Optical Microscopy (Olympus GX71 inverted microscope, Zeiss Stemi 2000-C stereo microscope, Zeiss Axio lab A1)
  - Microhardness Testing (Stuers Durascan automatic, Stuers Duramin 2 manual)
  - Raman (Bruker Senterra Raman Microscope for both FT and dispersive Raman - laser wavelength of 532, 633, 782 and 1064nm)
- Analytical Chemistry (Analytical Laboratory)
  - Chromatography (Thermo Scientific DIONEX ICS2100, Agilent Tech 1260 HPLC, SRI 8610C multigas analyser)
  - Fluorometry (Agilent Tech Cary Eclipse)
  - UV-Vis / nIR spectrometry (Agilent Tech Cary 5000)
- A purpose-built electron radiolysis chamber
- Centrifuge (Grant Bio LMC-3000UK)

There will be further additions to come. For the most up-to-date information on our equipment see our website.
Dalton Cumbrian Facility

For more information on any of our equipment, how to use the facility or what we can do for you contact our Commercial Manager, Anne Knott.

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