Beam Me Up, Scotty

Diamond Light Source | Case Study

The Client

Diamond Light Source situated in Oxford, UK has over 60 laboratories and to meet the wide range of user applications, 20 ELGA PURELAB® Option-Q water purification systems were required to meet the demanding specific water quality standards.

What two factors do macromolecular crystallography microfocus spectroscopy, non-crystalline diffraction, high resolution powder diffraction and surface interface structural analysis have in common? Each has dedicated Diamond beamlines, and each needs ultra pure water.

The Client's Needs

Diamond Light Source, the synchrotron complex on the Harwell Science and Innovation Campus, produces x-ray, infrared and ultra-violet beams of exceptional brightness. These highly focused beams of light are enabling scientists and engineers to probe deep into the basic structure of matter and materials, answering fundamental questions about everything from the building blocks of life to the origin of our planet. When Diamond opened in 2007, seven cutting edge experimental stations, called 'beamlines' were operational. Four more are now operational, with an additional 11 in various stages of construction and optimisation, bringing the total of operational beamlines to 22 by 2012.

The facility will ultimately host up to 40 cutting edge research stations each designed primarily to support a particular research community or technique. The portfolio of beamlines at Diamond has been chosen, in consultation with the scientific community, to support the life, physical and environmental sciences.
The beamlines are 'spurs' from the synchrotron's storage ring and each consists of three 'hutches' (figure 2). Synchrotron light generated in the storage ring is monitoring and as much of the 215W/mm2 heat load as possible is removed from the light beam and it then enters an optic hutch, which contains optical devices such as mirrors and diffraction gratings to filter and focus the beam.
The second or experimental hutch houses the experimental equipment. Researchers place their sample on a rotating arm, surrounded by detectors, to register the data given by the sample when the beam of light is targeted on it.

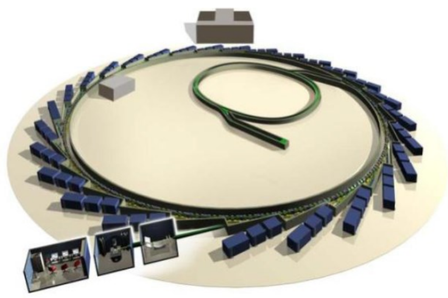

Figure 2. Model of the machine at Diamond Light Source

The final hutch or control cabin is where the scientific team monitors the experiment. Through powerful computers, they can control the alignments, sample position and gather the data obtained by the detectors.

Synchrotron light is advancing research and development in a range of scientific fields, including protein crystallography and cell biology in the biomedical sector; microbiology, disease mechanisms and high resolution imaging for medical research; toxicology, atmospheric research, clean combustion and cleaner industrial production technologies for environmental sciences and plants genomics, soil studies and plant imaging for agriculture.

Parameter	Value	Units
Resistivity	18.2	MΩ-cm
TOC	<10	µg/1C
Bacteria	<1	CFU/ml
Particle Filtration	0.2	µm

Table 1. Purified water specifications

In the engineering field it contributes to rapid analysis of drill core samples, comprehensive characterisation of ores for ease of mineral processing; advanced materials including nanostructures, intelligent polymers, ceramics, light metals and alloys, electronic and magnetic materials; imaging of industrial processes in real time, high resolution imaging of cracks and defects in structures, the operation of catalysts in large chemical engineering processes; and forensic analysis of extremely small and dilutes samples.

Users at Diamond will have access to a range of facilities to support their experiments. When it's complete there will be over 50 laboratories around the ring, occupying over 2400m2 and providing both general facilities for all users, and specialised laboratories for individual beamlines. Each laboratory needs ultra pure water for a variety of uses like standard solution and sample preparation, media production and analytical procedures. The modular approach to construction and expansion at Diamond lends itself to a modular approach to water purification.

Mains water (via laboratory breaktanks) is supplied to all the laboratories and ultra pure water is generated locally wherever it is needed, directly from the main supply. Diamond has so far installed 20 of ELGA's PURELAB Option-Q 15 laboratory water purifiers to meet this duty, each capable of producing up to 15 liters/hour of ultra pure water. With such a wide range of user applications, each demanding specific water quality standards, Diamond set a quality specification (Table 1) that would satisfy them all.
Meeting this specification from mains water means that the PURELAB Option-Q has to cram a lot of technology into a small, bench-top cabinet, as the process flow (Figure 3) shows.

An integral pump boosts the main water pressure and delivers it to a pre-treatment cartridge that combines particle filtration and granular activated carbon to remover residual chlorine, heavy metals and organic contaminants. It then passes through a reverse osmosis membrane. The latest generation of membranes provide up to 98% rejection of dissolved ionic impurities and over 99% removal of organics, particles and bacteria. The resulting water, typically better than distilled water, is then passed to the 'polishing' section. This consists of a storage reservoir from which water is continuously re-circulated through an 185nm UV lamp and ion exchange cartridges to produce ultrapure water at 18.2 MΩ.. Finally, a 0.2 µm point of use filter ensures virtually sterile water at the dispensing tap.

Cartridge changing on the PURELAB Option-Q is made easy by large front access doors and sanitisation is a simple and fully validated procedure. A microprocessor-controlled management system provides continuous monitoring of water purity, cartridge change early warning and data collection capabilities via an RS232 interface in full compliance with GLP guidelines.

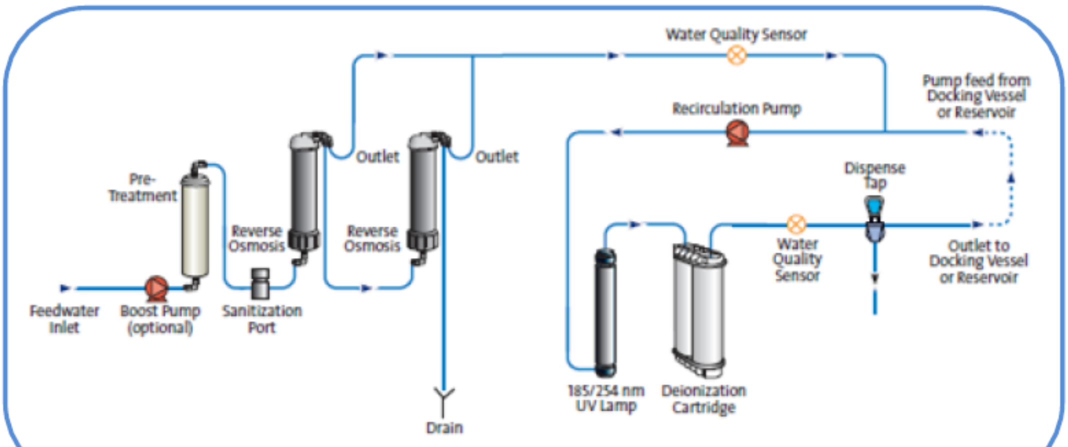

Figure 3. Process Flow for PURELAB Option-Q