Sellafield Ltd

GAMECHANGERS
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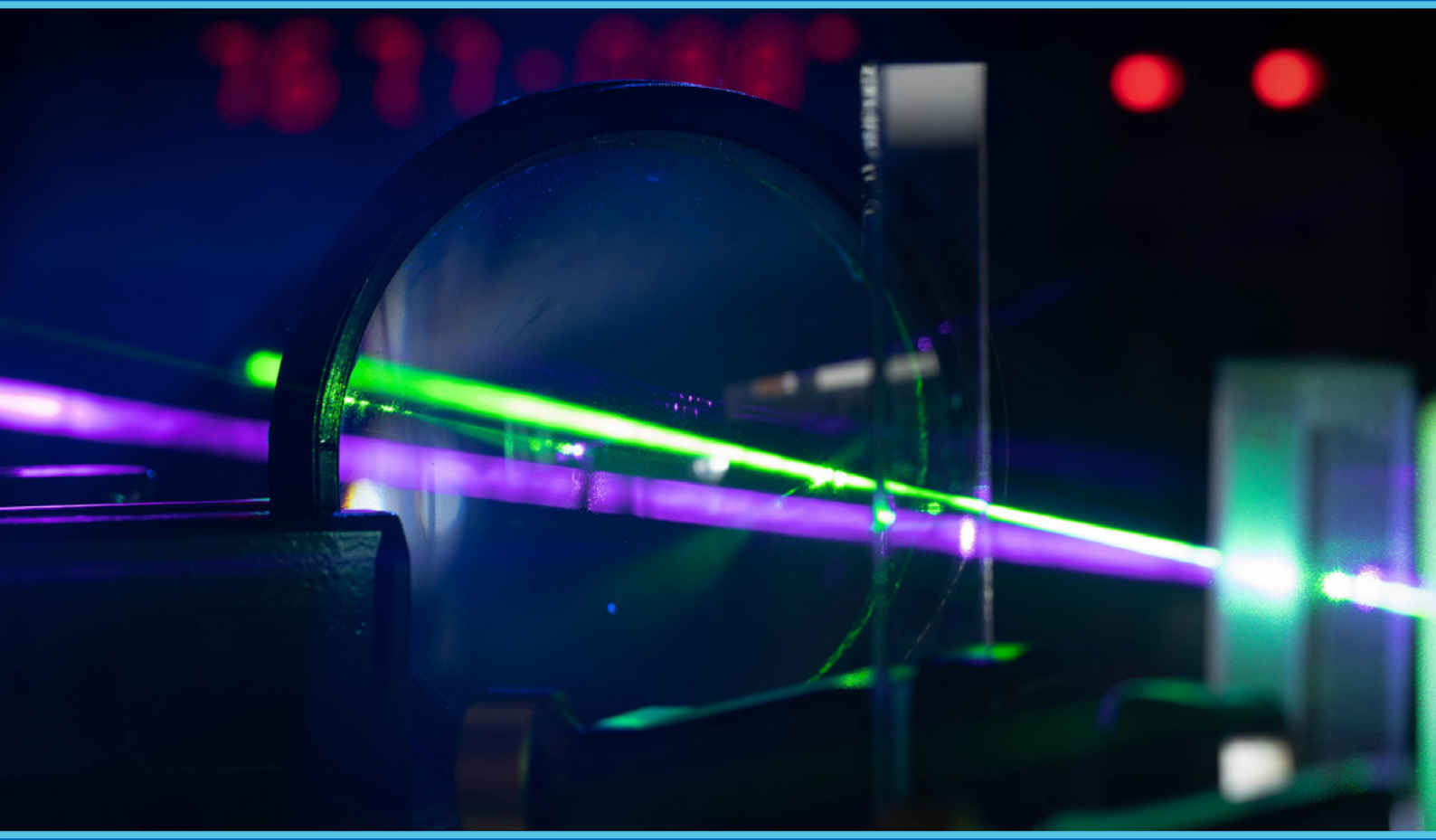

CHALLENGE: Analytical Services: Novel separation and direct measurement technologies for radionuclides and analytes

Sellafield Ltd would like to explore new and novel technologies or techniques to analyse radionuclides and other analytes, to improve upon the current practices used, reducing cost and inefficiencies.

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Introduction

As the UK's largest nuclear site, Sellafield has played a central role in the history of the nuclear industry in the UK. Operations at Sellafield initially involved supporting national defence. This was followed by energy production and spent fuel management through to the present-day challenges of nuclear waste management and the development of safe treatment and storage options. Today, Sellafield Ltd is using its unrivalled nuclear expertise to create a clean and safe environment for a sustainable future. Throughout all operational phases, Sellafield Ltd's Analytical Services teams have provided essential support to safe operations, waste processing, and hazard/risk reduction activities.

Analytical Services operate in a 70-year-old facility using many analytical protocols, some of which were developed 30 to 40 years ago. The facility houses 90 separate laboratories analysing approximately 100,000 samples annually. These samples range from effluents to plutonium products, and complex wastes. The analysis involves the use of a range of specialised equipment, and is undertaken on benches, in fume hoods, glove boxes, or in active cells. Most of the current protocols are designed for homogenous samples of known matrix. However, future samples may be heterogeneous and of uncertain matrix.

Operations in these laboratories are currently being phased out and much of the future work will be performed in the National Nuclear Laboratory Central Lab (NNLCL), a facility that is being substantially re-fitted to meet this demand. The move to the NNLCL creates a great opportunity for new and innovative technologies and techniques to be introduced into the analytical work to improve the efficiency, safety and quality of the analysis.

It is vital Analytical Services assess and understand the development of new technologies to ensure the benefits are achieved.

One of the challenges Analytical Services at Sellafield encounter is the cost and inefficiency of processes and techniques currently used to analyse radionuclides and other analytes. Sellafield Ltd would like to explore new and novel technologies or techniques to improve upon its current practices.

Current Practice

Treatment and safe storage of highly radioactive material is a priority for the Sellafield site. Analytical Services at Sellafield employ a variety of chemical and radiochemical separation techniques to enable analysis of radionuclides and other analytes. Techniques include solvent extraction, co-precipitation and ion exchange resins.

Very often these separations are costly, time-consuming processes and produce radioactive liquid waste. Sample dissolution is used to facilitate the use of traditional analytical techniques. Therefore, Analytical Services are keen to improve efficiency in this area through the use of new and novel technologies.

Ion exchange and chromatographic resins are increasingly effective separation tools, and improvements in Inductively Coupled Plasma Mass Spectrometry (ICP-MS) design and technology have enhanced the effectiveness of separation and measurement. However, Analytical Services are keen to hear about new techniques for chemical or radiochemical separation. These could be improvements to existing separations, integration of existing separation and measurement techniques, or brand-new technologies.

Challenge Aims

Sellafield Ltd is exploring new and novel technologies to analyse radionuclides and other analytes to improve current operations. Analytical Services recognise that non-destructive techniques usually require minimal modification for nuclear operations and could deliver quicker and cheaper analysis. The specific areas of interest include:

- **Direct measurement technologies of liquids, solids and powders** – where separation of species is not required and the need for chemical separation is negated. These technologies could be deployed on plants or in the laboratory inside cells or glove boxes.
- Simple, efficient and clean **separation technology** – to separate species of interest from interference from other species (possibly with integrated measurement technology).
- Microfluidic techniques and laser techniques that bring the additional advantage of low waste volume generation.

Benefits to Sellafield

New technologies that can analyse radionuclides and other analyte samples through direct measurements or using clean and simple separation techniques will lead to improved efficiency, a reduction in the time of analysis and a reduction in costs. Any solution that reduces radioactive waste delivers significant savings. A solution may also have other potential application areas across the site.

Constraints

- All sample analysis will be performed in glove boxes. Working within a glove box environment impacts dexterity, making some tasks difficult. Some techniques and technologies have to be adapted for glove box use.
- Glove boxes have limited space, with all equipment going into a box through a 200 mm diameter port. Approximate glove box internal dimensions are: 910 mm (h) x 1700 mm (w) x 890 mm (d).
- Cell working involves the use of remote handling techniques, which severely impacts dexterity, making some tasks challenging or impossible. Some techniques and technologies have to be adapted for in-cell use.
- All items imported into a cell (rather than a glove box) are done so via a container analogous to a 17 L paint tin. All items must be able to fit inside a 17 L paint tin.
- Separation techniques must not produce organic solvent waste.

Functional Requirements

- The technology should be suitable for use in cells or glove boxes noting the size constraints described above.
- Separations should be simple, efficient and clean (i.e. avoid waste generation). The potential to integrate with measurement technology is desirable, e.g. High precision measurement of actinide nuclides.
- Solutions should limit the amount of radioactive waste generated.
- Solutions could involve the use of photonics for organic chemical analysis. Techniques such as RAMAN, LIBS, XRF and fluorescence analysis are of interest for operation within containment (which could be in glove box, or within an active cell).

Several radiometric and instrumental analytical techniques are employed currently and could benefit from inclusion; for example, full radiometric analysis identification of exotic species, e.g. beta emitters.

Find Out More

Game Changers are hosting a workshop for this challenge where delegates will have the opportunity to meet challenge owners. Details are available on the Game Changers website www.gamechangers.technology.

If you have new ideas or innovations which can be applied to address this challenge, we invite you to join us. If you'd like more information about the funding available through the Game Changers programme, please visit Our Funding Process (gamechangers.technology)

The deadline for applications for this challenge is 12 noon on Tuesday 24th October 2023.

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