Nuclear Metrology Group Overview

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Nuclear Academics Meeting
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THE MEASURE OF ALL THINGS

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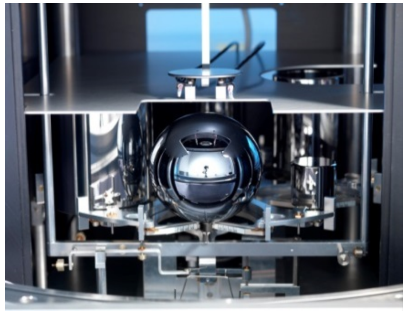

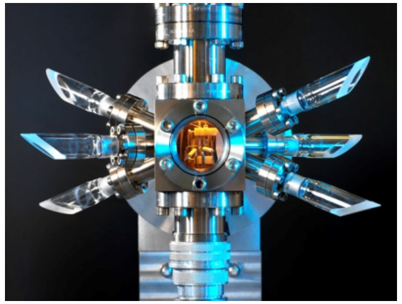

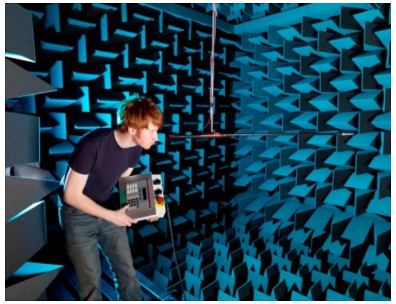

- The UK's National Measurement Institute, engaging with government, academia and industry
- Founded in 1900, Radioactivity measurement since 1913
- Responsible for establishing, maintaining and disseminating national standards and measurement science
- ~800 employees
- ~150 students with Post Graduate Institute
- Purpose built laboratory campus in Teddington, UK
- Operated and owned by the Dept for Business, Energy and Industrial Strategy

Why do we need measurement?

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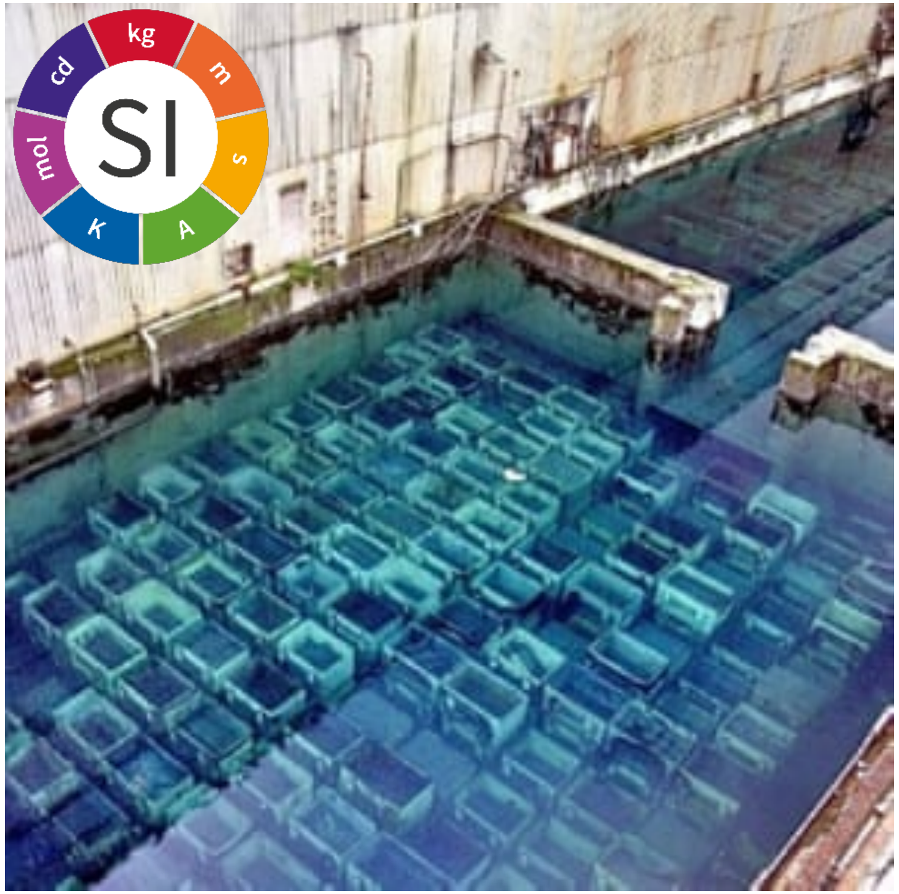
Quantitative comparison of an unknown quantity with a standard quantity

Mole: Radiation Induced ***Corrosion*** of Uranium Spent Fuel

Candela: Polyoxo Actinide Chemistry

Kelvin: Drying Magnox Waste for Dry Storage

Kilogram: Enhancing information content of geophysical measurements in nuclear site characterisation



Second: In-situ ***Real-time*** Monitoring of Waterborne Low Energy Betas

Metre: ***Long-range*** scanning based detection of Alpha-induced air-fluorescence even under daylight conditions

Ampere: Improved characterisation and modelling of measurement errors in ***electrical resistivity*** tomography surveys

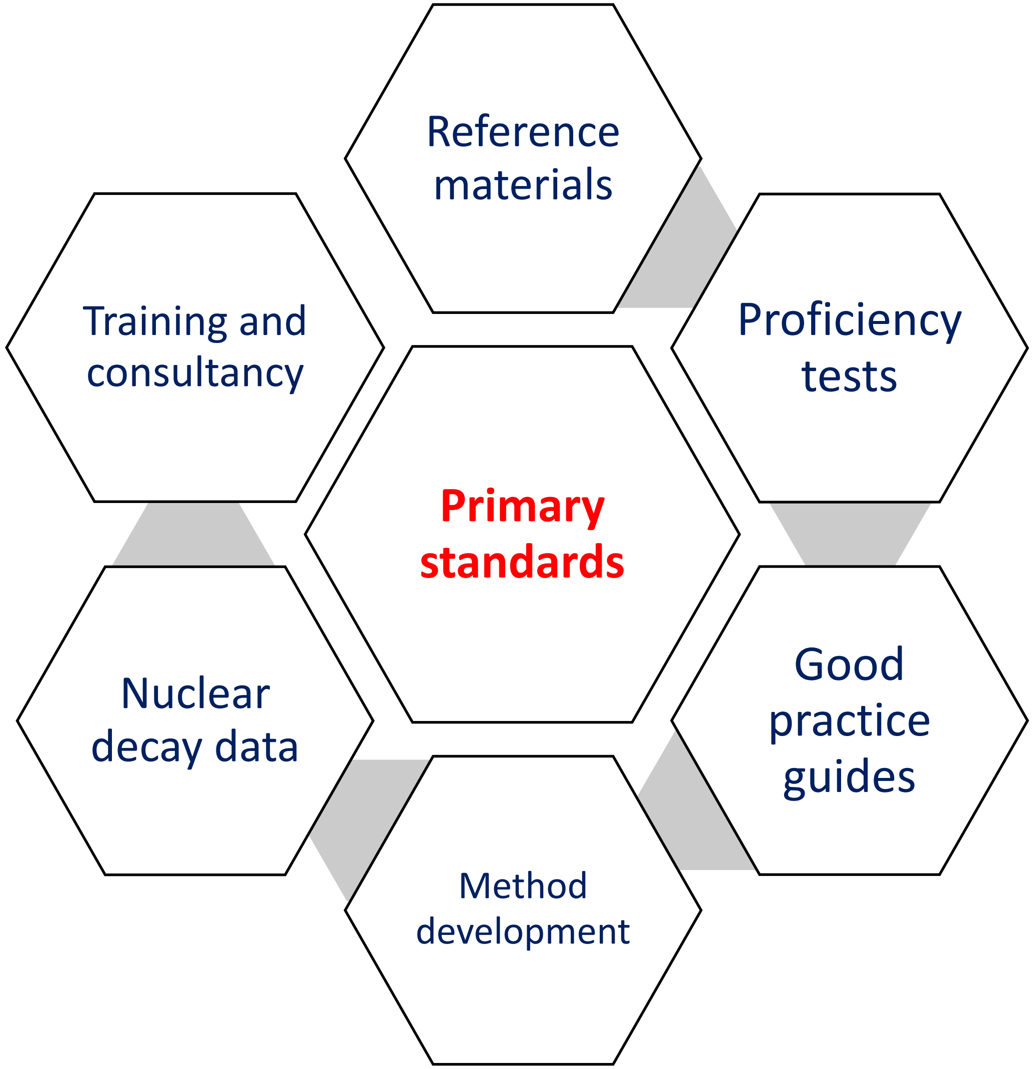
Nuclear Metrology Group

- Responsible for standards of radioactivity and neutrons
- First established for standardisation of radium (provided by Marie Curie)
- **Standards provide a route to demonstrate that measurements are accurate, consistent and independent - to support regulatory compliance**
- Standardisation contributes to finding new applications and measurement systems to provide additional confidence
- Supporting UK industry and academia
- Currently ~30 scientists, 6 PhD students, 4 MSc students, and 2 professorial co-chairs with the University of Surrey

The first radium standard held by NPL was prepared by Mesrs. Curie, Meyer and Rutherford

From “Radiation Science at the National Physical Laboratory, 1912-1955”, E. E. Smith

Measurement of radioactivity



Relevance of nuclear metrology

UK					International		
Defence / security	Energy	Environment	Health	Education & academia *	International measurement system	Treaties *	Other
Nuclear propulsion	Existing civil nuclear power	Nuclear decom	Nuclear medicine	University education	BIPM / CIPM / ICRM	IAEA	Fukushima
Forensics	Nuclear new build (i.e. Hinkley)	Oil/gas decom	Quantitative imaging	Staff training (internal & external)	Other NMIs	CTBTO	US Government
Trafficking of illicit materials	Modular / GenIV / Fusion	Environmental monitoring (NORM and anthropogenic)	Theranostics	Contribution to international experiments	International Standards bodies	EURATOM	Private companies
Nuclear weapons test monitoring	Biogas (C-14)	Preparedness (emergency response)	Proton therapy (secondary neutrons)				Public entities
Weapons manufacture	Fracking (NORM)	Radiometric dating	Radiation protection				

* Feeds into other sectors

The NPL Nuclear Metrology Group is active in many of these sectors, with funding from UK Govt., European research grants or commercial contracts as appropriate

Tracer production for method validation/instrument calibration

Measurement challenge

- Development of methods for measurement of difficult-to-measure radionuclides must have suitable tracers to calibrate instruments and validate procedures

Solution

- NPL develop methods to produce tracers via irradiation. These are then chemically separated and measured to produce standards for end-users
- Long-lived decommissioning and activation product ^{93}Zr a recent example

Technique	Activity (Bq/g)
CIEMAT/NIST	1046 ± 24
TDCR	1030 ± 23
DCC	1028 ± 17
Average	**1035 ± 24 (k=1)**

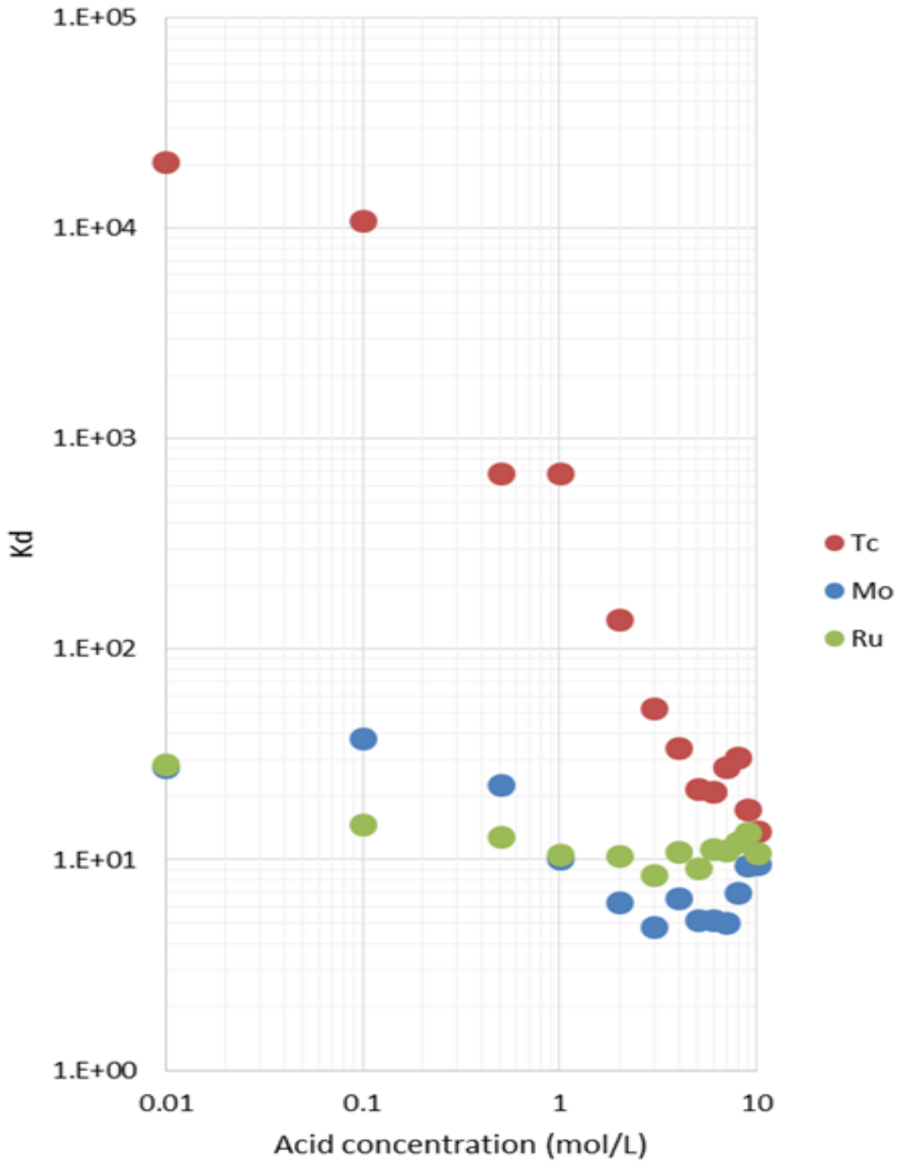
Radionuclide separation

Measurement challenge

- Accurate measurement of radionuclides is prevented by stable or radioactive elements present in the sample
- Example: separation of Tc from Ru and Mo for decommissioning and nuclear medicine applications

Solution

- NPL characterise novel separation materials developed for various radionuclides e.g. TK201
- Development of materials based on functionalised nanomaterials and graphene oxide



Rapid measurement

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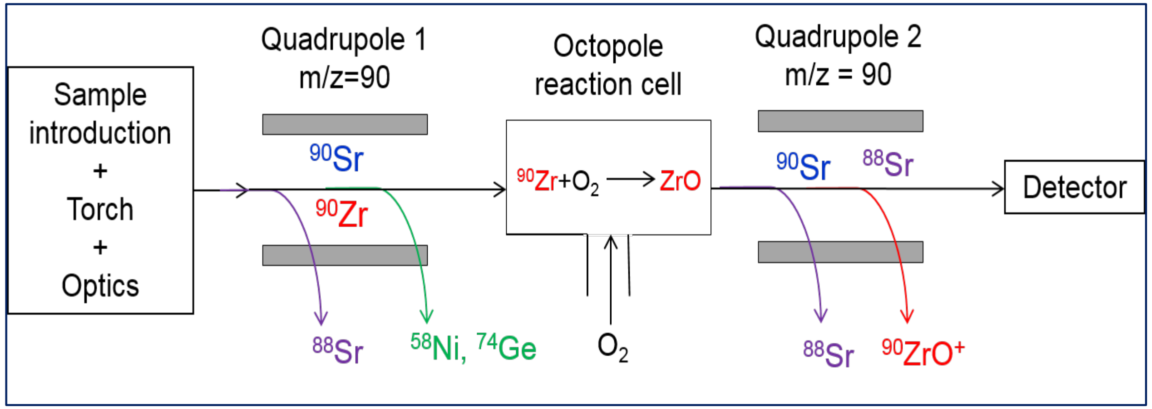
Measurement challenge

- Can measurement of radioactivity by mass rather than decay energy offer a higher throughput for decommissioning samples
- Simultaneous measurement of stable elements and radionuclides in aqueous decommissioning wastes

Solution

- Radionuclide measurement using ICP-MS/MS
- Online separation offers a rapid alternative to offline separation
- Higher number of samples can be processed
- Samples measured as received without any treatment



Nuclide	Instrument LOD (optimised method) (Bq g^{-1}, pg g^{-1})	Method LOD (optimised method) (Bq g^{-1}, pg g^{-1})	Target LOD (Bq g^{-1})
^{63}Ni	0.5 (0.3)	25.6 (12.1)	100
^{90}Sr	1.0 (0.2)	90.0 (17.6)	1
^{93}Zr	1.3×10^{-5} (0.1)	1.7×10^{-4} (2.2)	10
^{99}Tc	3.0×10^{-4} (0.5)	3.1×10^{-4} (0.6)	1
^{129}I	8.1×10^{-5} (5.2)	8.6×10^{-5} (5.1)	0.01
^{237}Np	1.0×10^{-5} (0.4)	1.1×10^{-3} (42.3)	1
^{239}Pu	1.6×10^{-4} (0.07)	1.6×10^{-3} (0.7)	0.1

Thank you for listening

Department for
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& Industrial Strategy

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