IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Status of work to implement ICP-MS for analysis of excreta and to update the technical basis for internal dosimetry

P. Kenny[1], R. Alonso Vazquez[1], A. Capote-Cuellar[1], M. Hajek[1], S. Kinase[1,2] & D. Tucker[1]

[1] *Division of Radiation, Transport and Waste Safety, International Atomic Energy Agency, Vienna International Centre, PO Box 100, 1400 Vienna, Austria*

[2] *Nuclear Science Research Institute, Japan Atomic Energy Agency, Tōkai, Ibaraki 319-1195, Japan*

IAEA Webinar: Tips and Tricks for the Practice of Internal Dosimetry in Occupational Radiation Protection
2020 October 8

Radiation Safety Technical Services Laboratory

- External and internal individual monitoring for all operations under IAEA control or supervision around the globe
  - 3000 monitored individuals, 45000 assessments per year
  - Bound to IAEA Radiation Safety and Nuclear Security Regulations implementing requirements of International Basic Safety Standards

Services to events in 110 countries

Internal Dosimetry

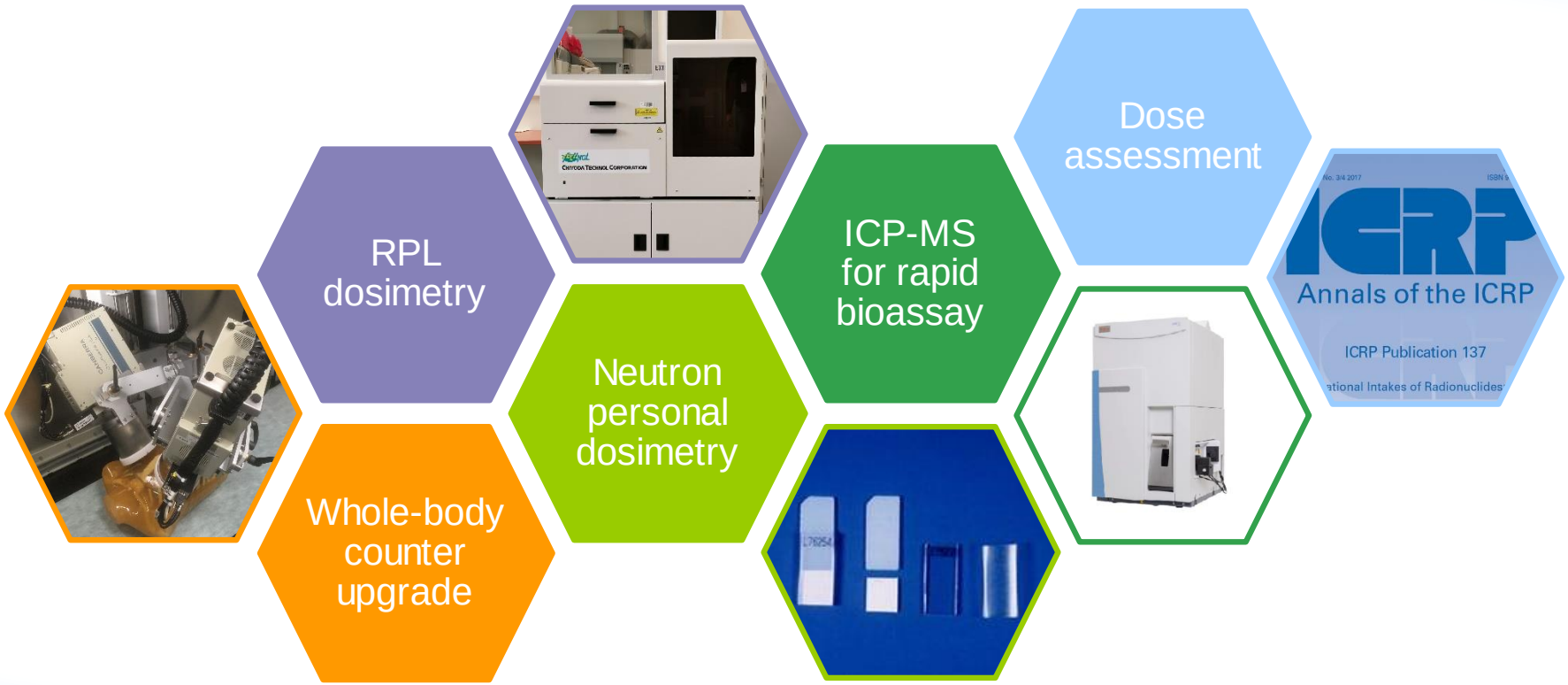
- Largest cohort of occupationally exposed workers monitored at regular intervals is from Safeguards
  - Nuclear safeguards inspectors
  - Staff in Nuclear Materials Laboratory

- Potential exposures to U, Pu, Am, Np, Cm and Th
  - Mixture of ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu and ^{241}Am
  - Confirmatory and routine monitoring for possible intakes
  - Special monitoring in case of suspected accidental intake

- EN ISO/IEC 17025:2017 accreditation
  - In-vitro radiobioassay (urine, faeces and saliva; 9000 measurements per year)
  - In-vivo radiobioassay (whole-body counting; 2700 measurements per year)

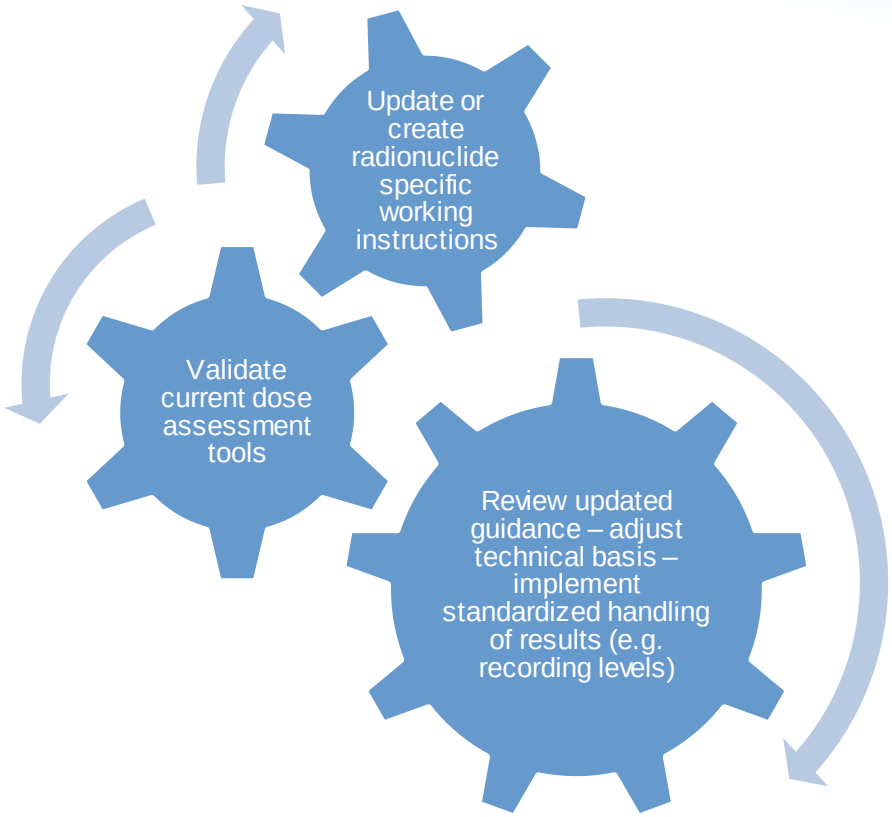
RADSED Major Capital Investment Project

- Enhancing Radiation Safety through Efficient and Modern Dosimetry



Updated Technical Basis for Dose Assessment and Optimized Internal Monitoring

- Review of recent guidance to adjust technical basis and validate current dose assessment tools for internal dosimetry
  - ICRP Occupational Intakes of Radionuclides (OIR) series
  - EURADOS TECHREC (EC Radiation Protection No. 188)
  - ISO 27048:2011
- Development of Dosimetric Data Generator
- Update of work procedures for confirmatory, routine and special monitoring
- Technical recommendations on specification of recording levels for internal monitoring to standardize handling of results



Thermo Scientific™ iCAP TQ ICP-MS

ICP-MS purchased

- Reduce turn-around time
- Improve detection limits

Triple quadrupole ICP-MS

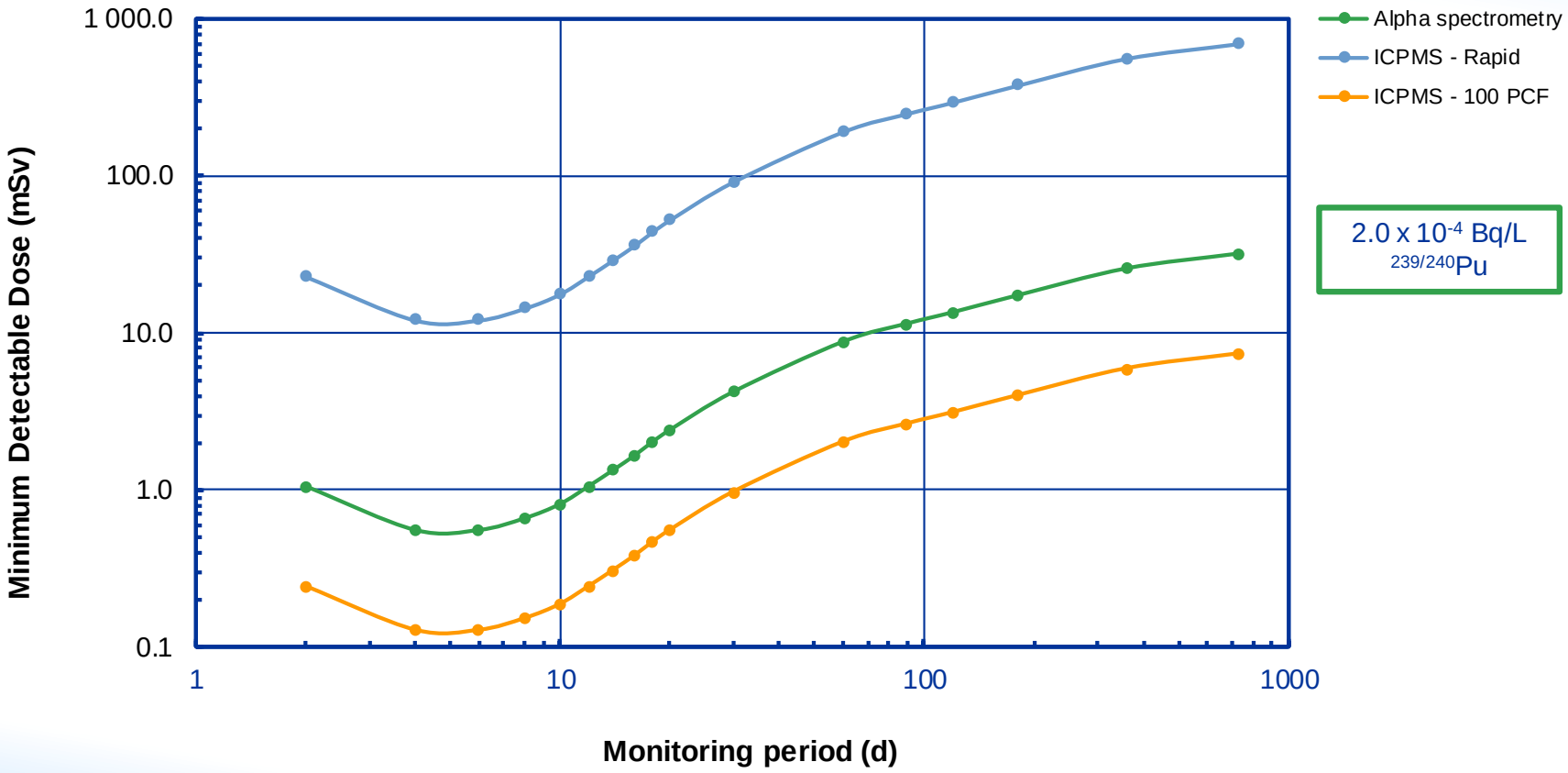
- Q1: 4 MHz, 2−240 u
- Q2: CRC (H_2/He/O_2/NH_3 and 13 other gases)
- Q3: 2 MHz, 2−290 u
- SQ mode not using CRC
- TQ on mass mode
- TQ on mass shift mode

SC-2 DX autosampler (ESI)

We are very grateful for financial support provided by the USA!

Why ICP-MS? Consider Time and Minimum Detectable Dose

Minimum Detectable Dose (MDD) for typical Nuclear Materials Laboratory source term.
Most restrictive in urine, assuming that intake occurred at mid-point of monitoring period.



Anticipated Next Actions

- Buy standard solutions
  - ^{241}Am
  - ^{239}Pu, ^{240}Pu, ^{241}Pu
  - Others?

  Note: Laboratory has ^{242}Pu, ^{232}U, ^{243}Am, ^{244}Cm, ^{237}Np and ^{229}Th

- Sample introduction system
  - Identify suitable sample introduction system (e.g. APEX Q/Ω)

- Collision/reaction Cell
  - Currently only He
  - Configure for CO_2 and NH_3

- Testing with $^{239/242}Pu$ standard solutions
  - Determine DLs with and without ^{238}U

- Add and configure sample introduction system

- Test and optimise collision/reaction cell for CO_2 and NH_3 using Pu and U standard solutions
  - Optimise flow rate for most effective reaction

- Test for Pu in urine with routine method(s)
  - All nuclides
  - Separated elements

- Develop and test rapid method

We are very grateful for implementation support being provided by Health Canada

What does it take?

ICP-MS + Nebulizer and equipment + Standards	~€250K
Method development and optimization, method validation, procedure writing, training	~ 1.5 person year (expert resources)
Data management software changes, increased scope of accreditation, ongoing intercomparison participation	
Other things that we have forgotten?	We'll let you know

IAEA
International Atomic Energy Agency
Atoms for Peace and Development