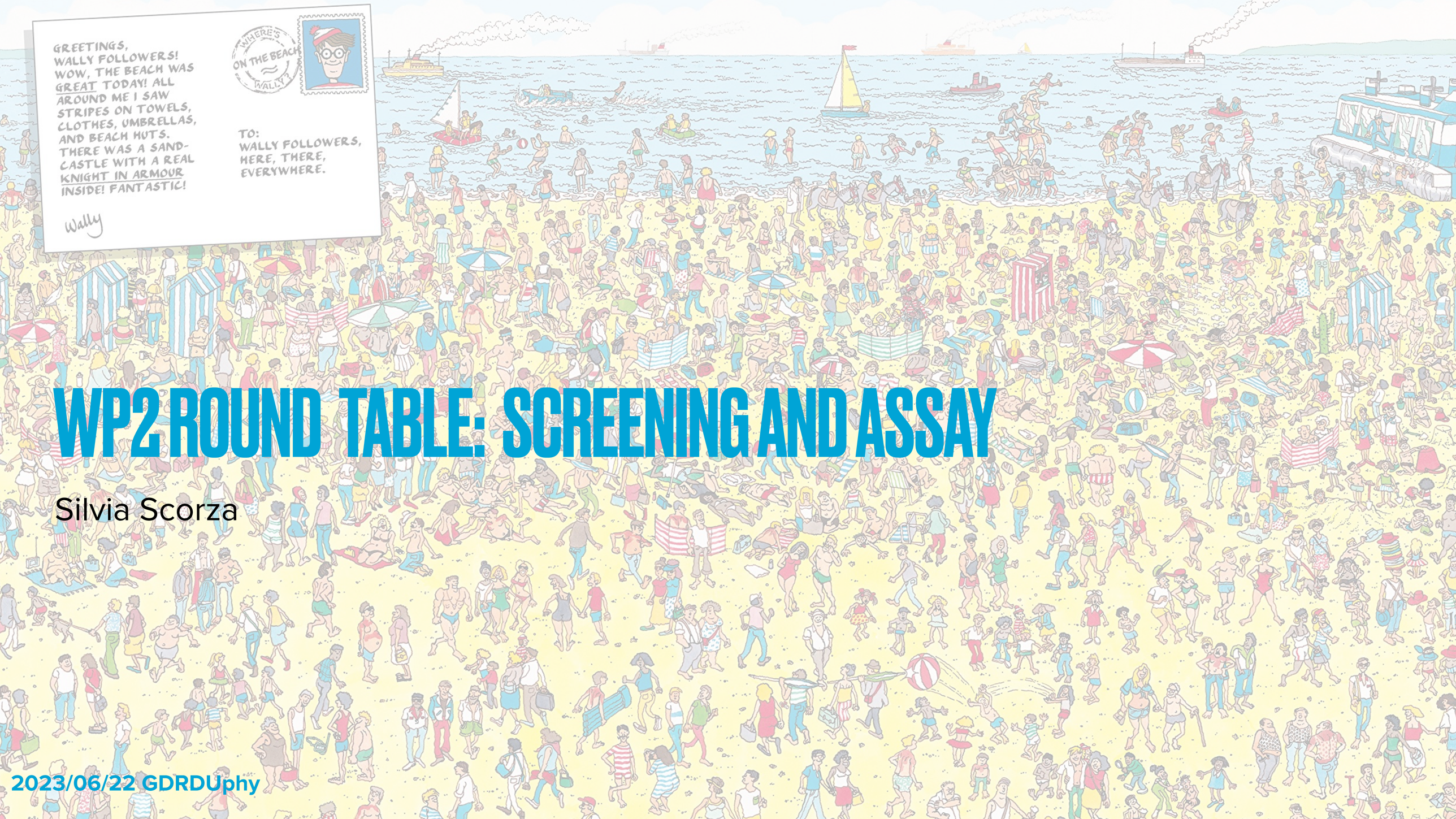


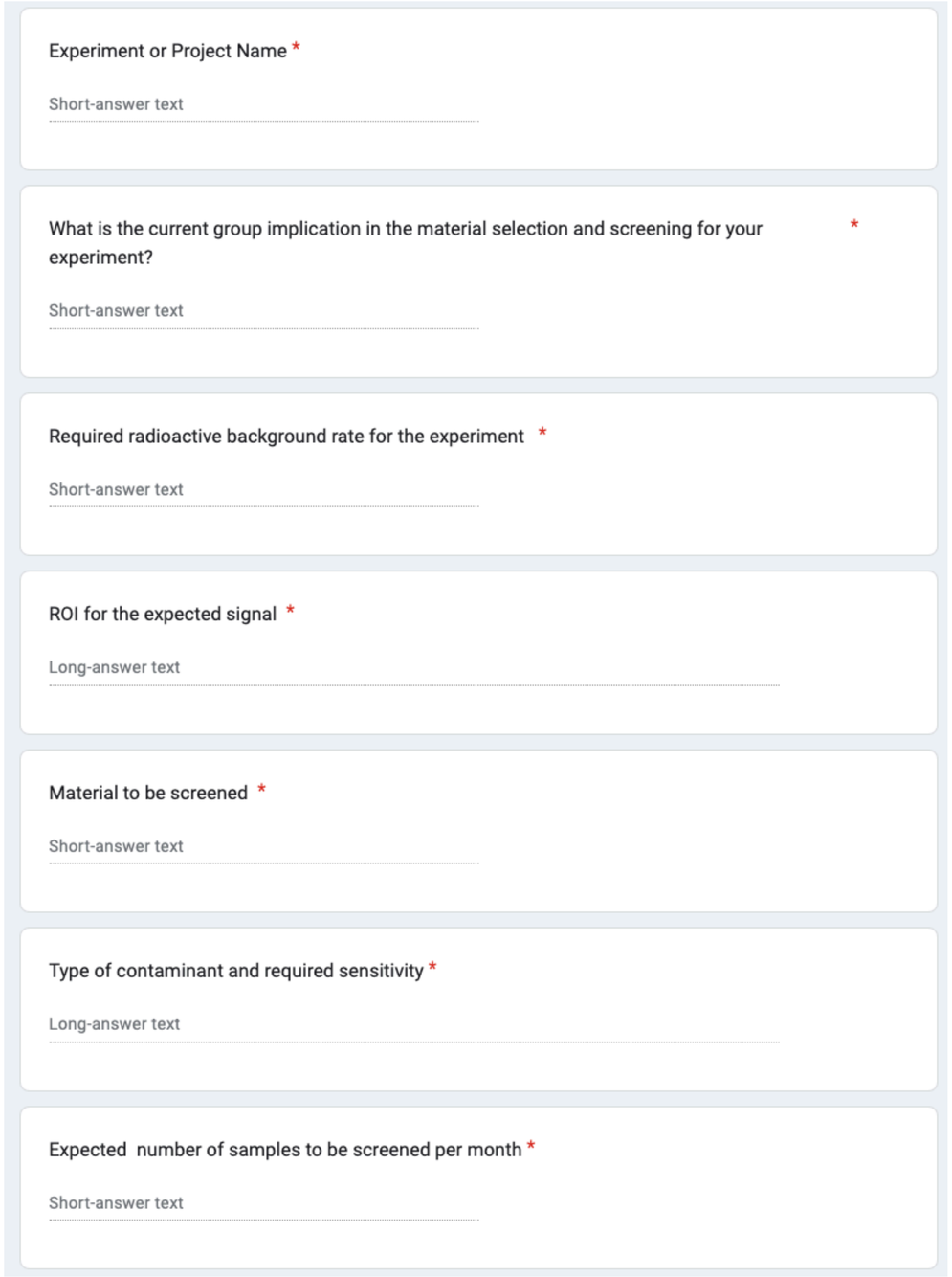
WP2 ROUND TABLE: SCREENING AND ASSAY

Silvia Scorza

2023/06/22 GDRDUphy

WP2 SCREENING SURVEY

- The survey is meant to gather information from the community to better focus and coordinate work related to WP2 screening/assay
- Your input is important, please fill it in by the summer
- If you are running one/more screening detector(s) please let us know so we can compile a compendium of available screening methods, the community could easily access to



WHAT BACKGROUND?

Cosmic rays & cosmogenic activation of detector/ shielding materials

Underground EF copper
Underground liquid noble gas purification
Underground Ge crystal growing/detector fab

Natural radioactivity (^{238}U, ^{232}Th, ^{40}K):
γ, e^-, n, α, β

Material screening and assay program
Advanced cleaning techniques

Select LowRad materials

Ultimately:
neutrino-nucleus scattering (solar, atmospheric and supernovae neutrinos)

UNDERGROUND ADVANTAGES

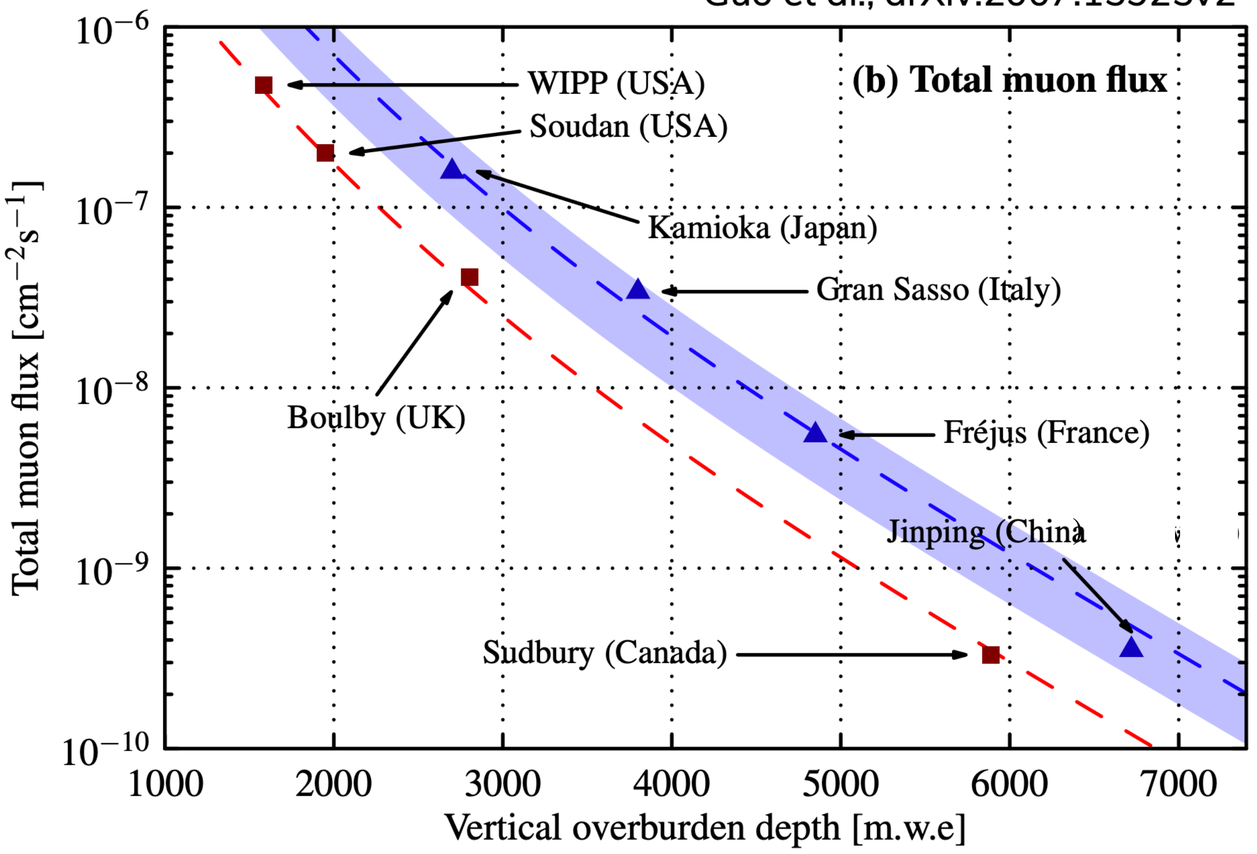
Rock overburden reduces muon flux

Clean room necessary for experiments and detectors assembly and handling

Dirt is high in radioactivity

Growing community of users

Guo et al., arXiv:2007.15925v2

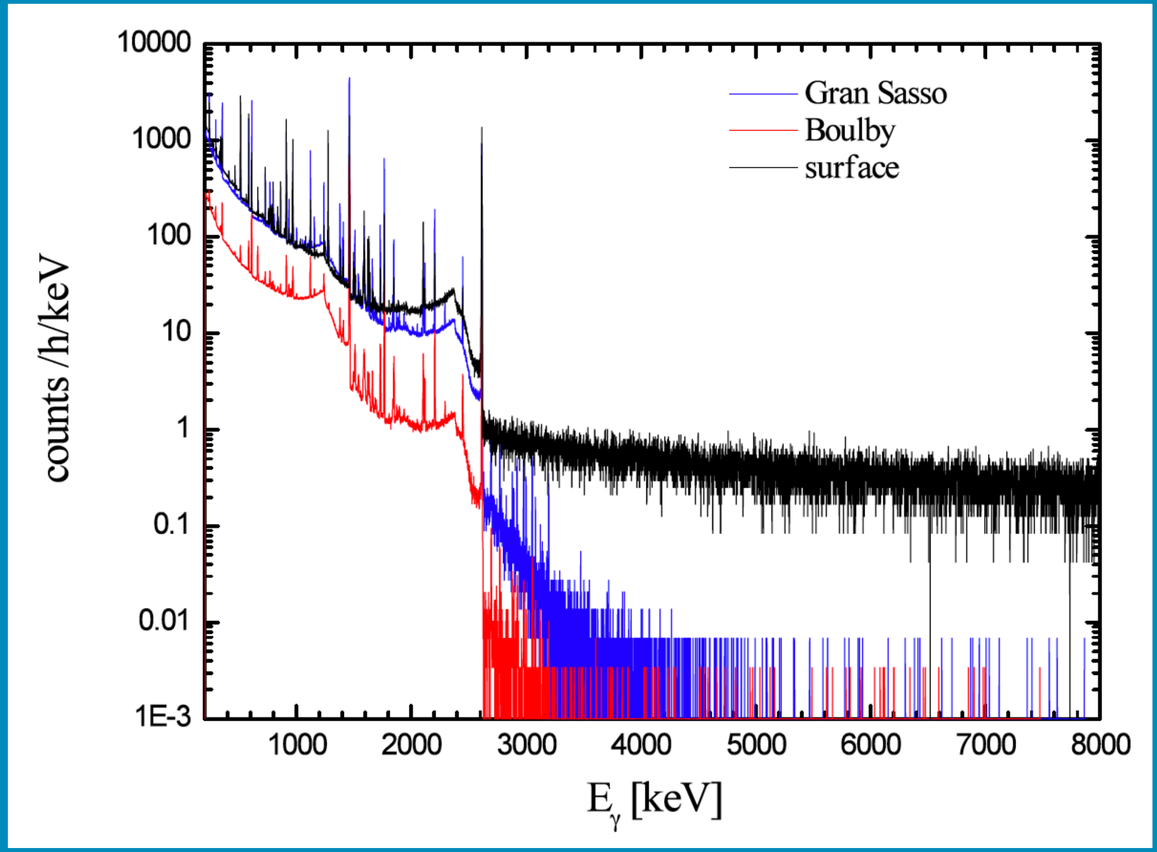


BACKGROUNDS FROM THE ENVIRONMENT DOMINATE UNDERGROUND

Reduction in γ-ray background at **higher energies** from c.r. and neutron reduction

Below 3.5MeV dependent on local geology
and rock material

➜ environmental background measurement capabilities at ULs is essential to perform systematic surveys of the background radiation



MINIMIZE BACKGROUND

Pacific Northwest NATIONAL LABORATORY

radiopurity.org

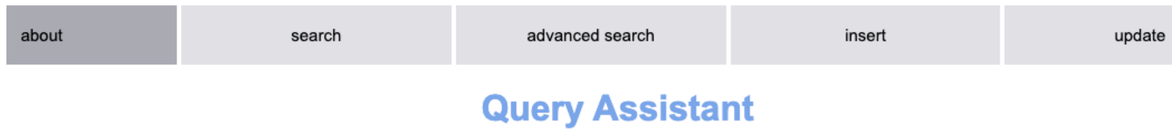
SNOLAB

Passive/Active shielding

Reduce backgrounds from natural (^{238}U, ^{232}Th, ^{40}K) radioactivity

Material screening and assay and cleaning techniques

Select LowRad materials



MATERIAL SELECTION: A CRITICAL CHALLENGING TASK

Radiopurity requirement: μBq/kg range or lower

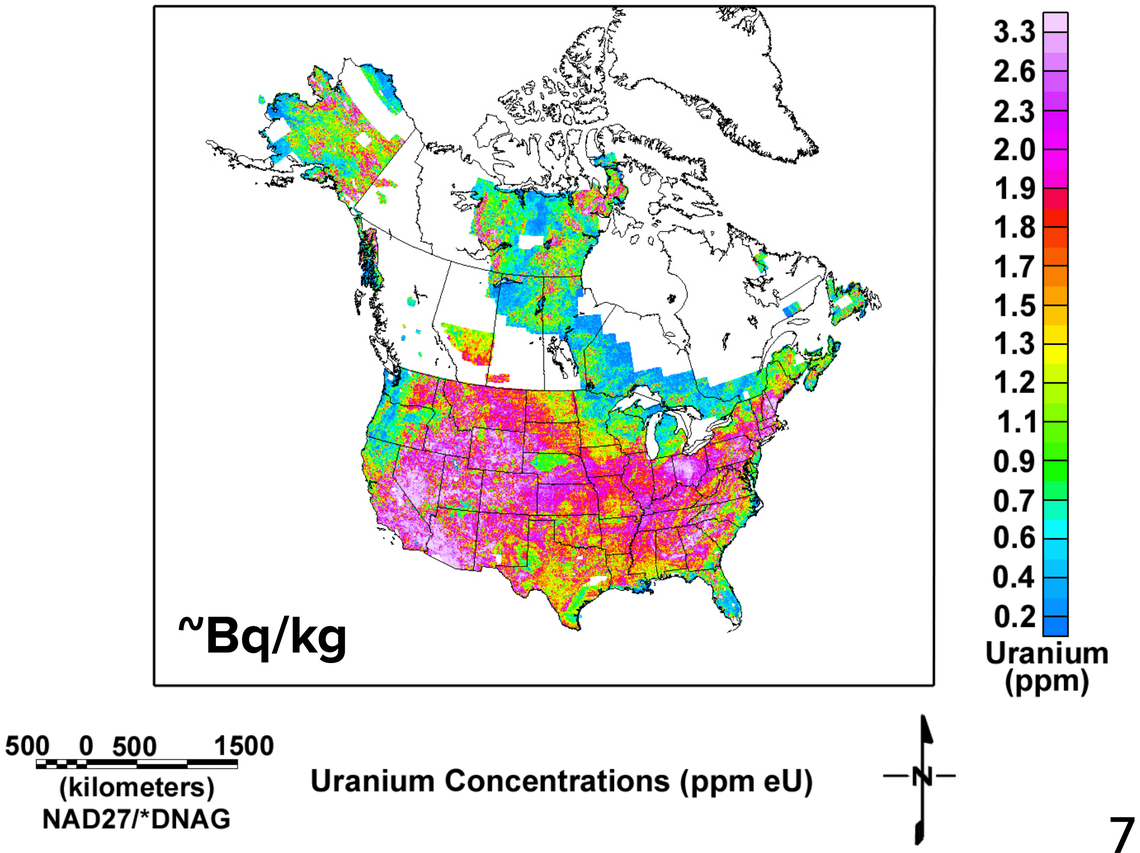
Extensive assay campaigns

Selection of the most-radiopure materials

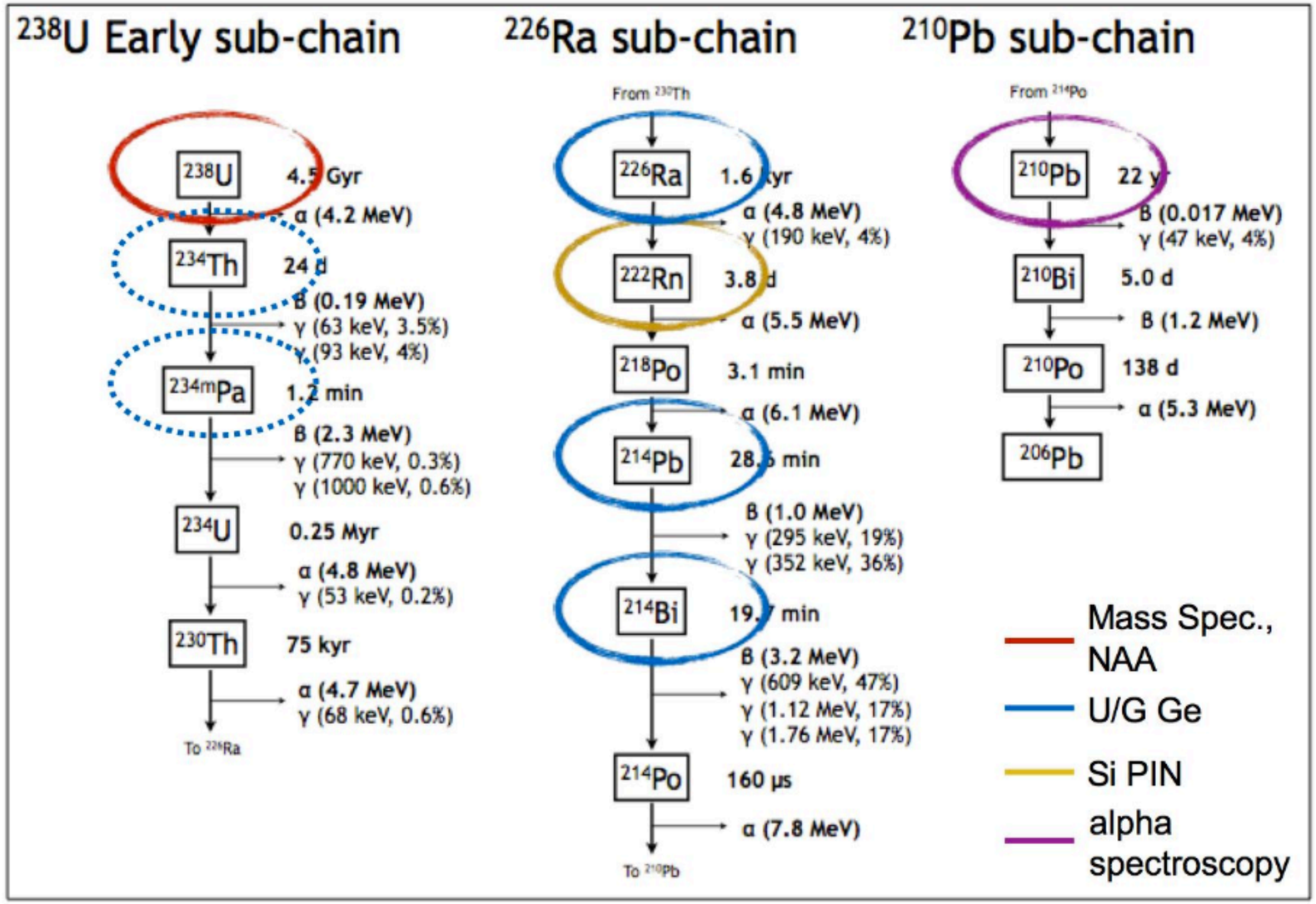
Ultrasensitive analytical techniques

Ultraclean analytical procedures and material handling

https://pubs.usgs.gov/of/2005/1413/maps.htm



WHAT SCREENING IS NEEDED?



WHAT SCREENING IS NEEDED?

- Experiment's ROI
- BG leves to control (ER/NR) [before discrimination]

Technique	Isotopes	Typical Sensitivity Limits	Sample Mass	Destructive/ Non-desctructive	Assay Duration	Notes
HPGe	^{238}U, ^{235}U, ^{232}Th chains, ^{40}K, ^{60}Co, ^{137}Cs (any γ emitter)	50 ppt U, 100 ppt Th	kg	Non-destructive	Up to 2 weeks	Very versatile, not as sensitive as other techniques, large samples
ICP-MS	^{238}U, ^{235}U and ^{232}Th (top of chain)	10^{-12} g/g	mg to g	Destructive	Days	Requires sample digestion, preparation critical
Rn Emanation	^{222}Rn, ^{220}Rn	0.1 mBq	kg	Non-destructive	Days to weeks	Large samples, limited by size of emanation

WHAT SPECIALTY CLEANING ?

- **Surface contamination will add radioactive background to the background budget**

- **Some speacialty cleaning might be required:**
  - Ultrasonic bath
  - Etching + passivation for copper, metals
  - Electroplating
  - Leaching for plastic/glass materials

- **What recipes are already in use, what labs are available to the community?**

DUST PARTICULATE:

A SIGNIFICANT CONTRIBUTION TO MATERIAL SURFACE CONTAMINATION

High purity materials
    Concerning (even in cleanrooms!)

Ongoing efforts to **estimate** backgrounds from dust, mainly from
    Fallout **models**
    Assumed dust composition

Dust in cleanrooms = local soil ← **Not necessarily!**
    Generated by handled materials and ongoing activities

DIRECT METHOD FOR QUANTITATIVE ANALYSIS

PACIFIC NORTHWEST NATIONAL LABORATORY, SNOLAB

Nuclear Inst. and Methods in Physics Research, A 994 (2021) 165051

Contents lists available at ScienceDirect

Nuclear Inst. and Methods in Physics Research, A

journal homepage: www.elsevier.com/locate/nima

Direct method for the quantitative analysis of surface contamination on ultra-low background materials from exposure to dust

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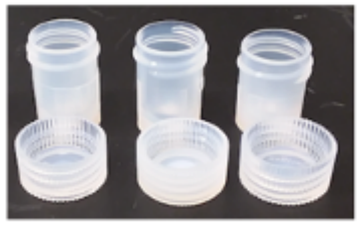
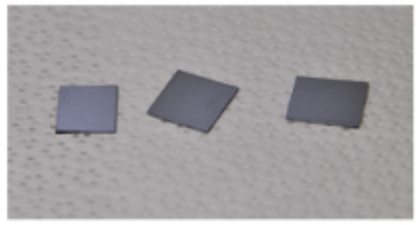
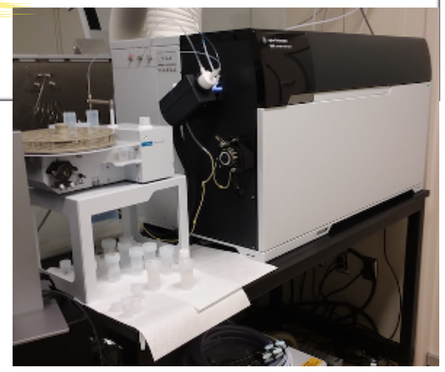
[c] Laurentian University, Department of Physics, Sudbury, ON P3E 2C6, Canada







Exposure of dust collection media

Dissolution of deposited contamination

Analysis via ICP-MS at PNNL (long-lived radionuclides and stable elements)
Triple quadrupole Inductively Coupled Plasma Mass Spectrometer

COMMUNITY MATERIAL ASSAY DATABASE

Good record keeping is essential
Sharing results is invaluable

Let's collaborate adding new data and cross calibrating HPGe detectors!

http://radiopurity.org

Community tool used by several experiments
Originally from the AARM collaboration
Nuclear Instruments and Methods in Physics Research A 839 (2016) 6–11

Open source code: https://github.com/pnnl/Radiopurity-database-assistant

UPDATED RADIOPURITY.ORG FRAMEWORK

PACIFIC NORTHWEST NATIONAL LABORATORY, SNOLAB

Material Assay Data Format (MADF)

Standardized, but flexible, json format

Database Assistant **New!**

Open source format for storing, displaying and manipulating MADFs

Public instance maintained by SNOLAB

https://www.radiopurity.org/ **Upgraded!**

Can share results easily with community when ready

MongoDB Database and python-based toolkit

Up-to-date standardized codebase

Improved structure, ability to modify

'old versions' collection in database to track changes to entries (linked by document ID)

This replaces a deprecated CouchDB database (Persephone)


That's all Folks!