WP2: Activity Summary Report

Maryvonne De Jesus

GDR-DUPHY General Meeting #5 October 9-11, 2024, IP2I Lyon

WP2 conveners: José Busto, Silvia Scorza, MDJ

Invited conveners: Frédéric Perrot, Luca Terray

Kick-Off meeting May 31st - June 2nd 2021

Deep Underground Physics

WP2: Low radioactivity techniques

Jose Busto CPPM
Maryvonne de Jesus IP2I

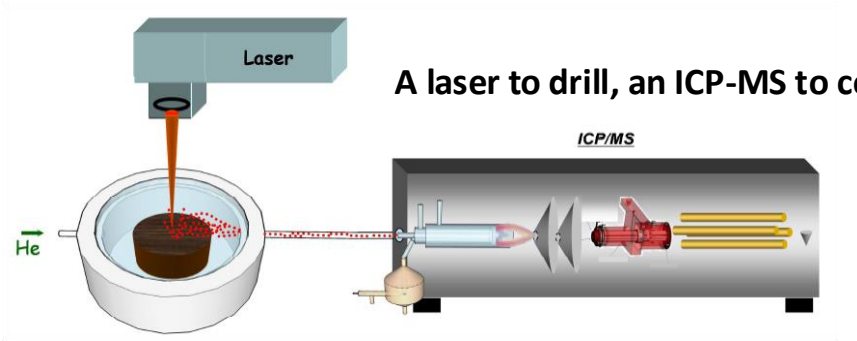
➢ Objectives of WP2 :

- Status of existing techniques to study and mitigate backgrounds : alpha, beta and gamma spectroscopy, ICPMS, NAA, Rn trapping …
- Availability of these techniques for the community in France and abroad : underground lab , Accelerators for activation, ICPMS companies or labs, …
- Make the information available to the community -> dedicated web site https://gdrduphy.in2p3.fr/
- Radiopurity Data base : participate to reactivate the radiopurity database https://www.radiopurity.org (hosted by SNOLAB, S.Scorza)
- Organize regular round tables on specific topics: radiopurity database, joint discussions with other WP (ex simulations, detectors,…), Radiopurity Data Base, discuss new techniques, …
- Youth training : training school dedicated to Low Radioactivity Techniques …

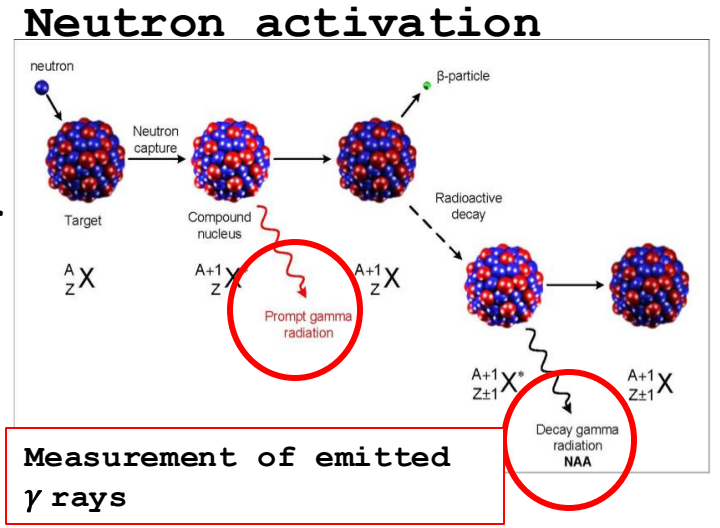
Topics covered during this first 4-year term within WP2

Topics discussed during general meetings and round tables with invited speakers from different fields other than underground physics

- **Neutron Activation Analysis : NAA**
- **Laser-Ablation Inductively-Coupled Plasma Mass Spectrometry (LA – ICPMS)**
- **Radon**
- **HPGe spectrometer @ Underground labs**



A laser to drill, an ICP-MS to count…



Measurement of emitted γ rays

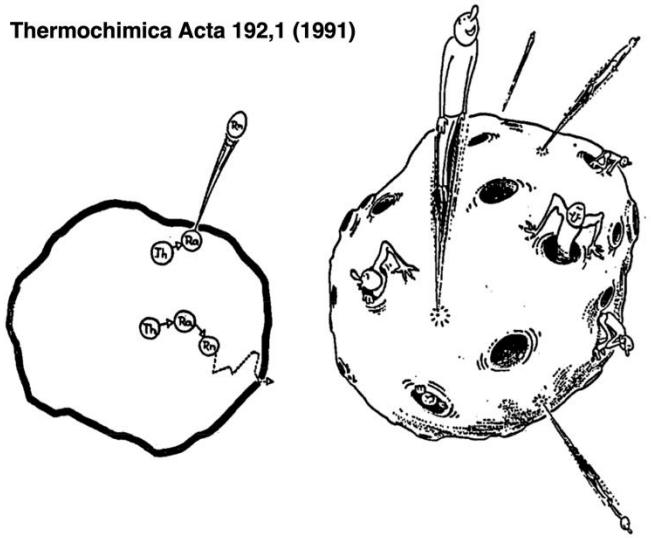
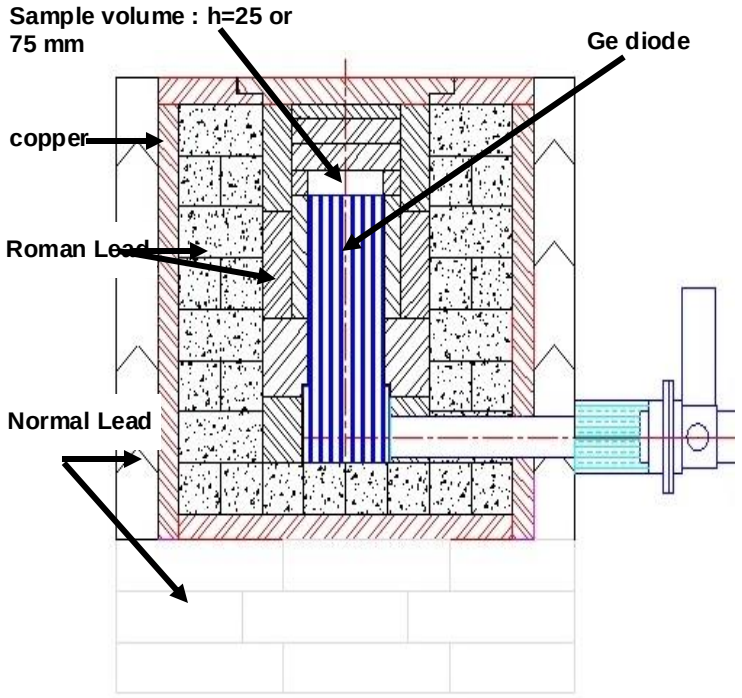


Fig. 2. Scheme of the release of radon from the sample by recoil and diffusion mechanisms.

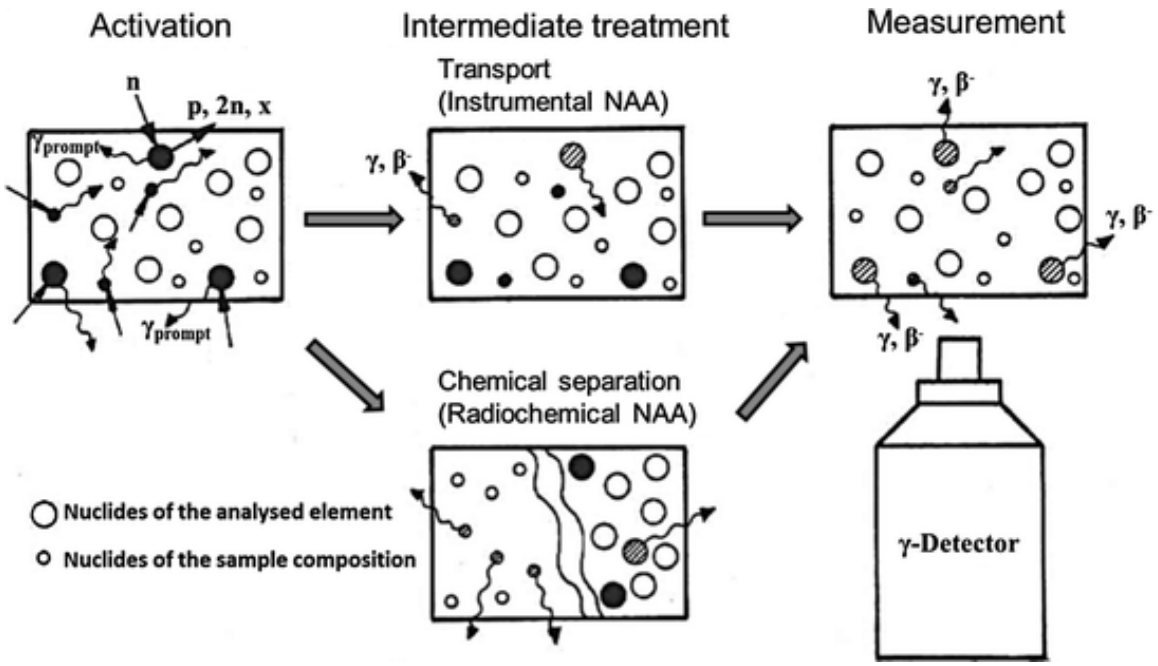


Neutron Activation Analysis NAA:

Epithermal and thermal neutrons:

→10^{11} - 10^{14} neutrons cm^{-2} s^{-1}

- Nuclear research reactors
- HPGe measurement
- Sample preparation

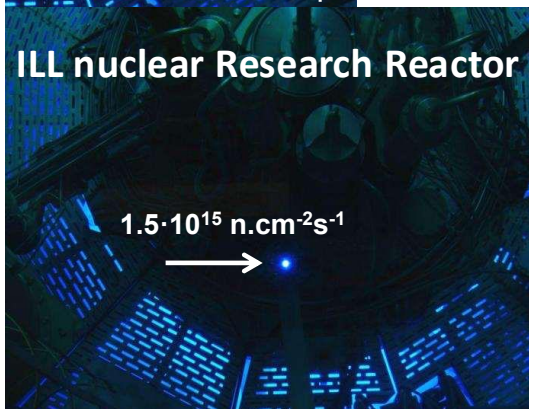


- ➢ OSIRIS (CEA Saclay) stopped in 2015
- ➢ Orphée Reactor (CEA Saclay) closed in 2019
- ➢ ILL neutron source two strong for our application
- ➢ Futur research reactor Jules Horowitz @ Cadarache 2025 ?

Conclusion:

No NAA possible in France in near future

V4: The highest neutron flux in Western Europe



- Monica Sisti (INFN, Milano-Bicocca) (Invited Talk Kick-off meeting may 2021
- Olivier Meplan (LBA @ LPSC Grenoble) Wednesday November 24th 2021
- Ulli Coster (Research nuclear reactor @ ILL) January, Monday 10th 2022
- Ali DASTGHEIBI-FARD – LSM@LPSC Activation de la poudre ^{40}Ca pour la calibration de SEDINE à basse énergie

Laser Ablation – ICPMS
(Invited convener Frédéric Perrot)

The concept of the LA-ICPMS technique is to replace the chemical preparation of a sample by using a laser in ablation mode. It reduces the risk of sample contamination

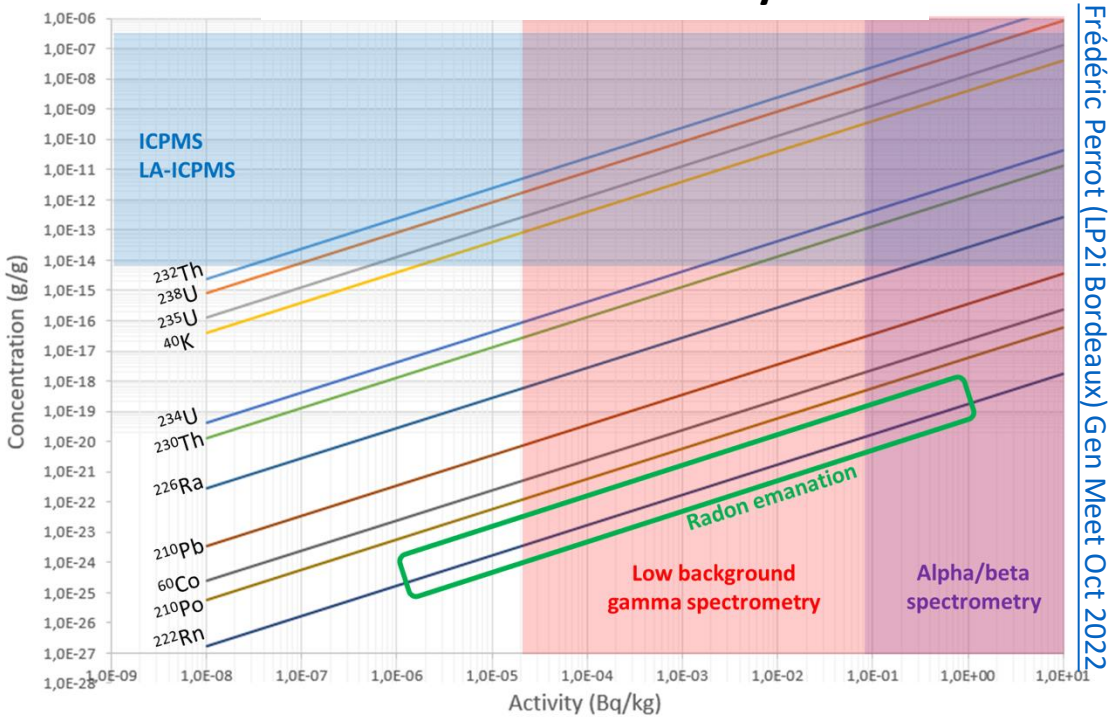
- Inductively-Coupled Plasma Mass Spectrometry (ICP-MS)
- Femtosecond lasers developed @ the IPREM laboratory
  (IPREM: Institut des Sciences Analytiques et de Physico-Chimie pour l'Environnement et les Matériaux)

Since 2019 IPREM + LP2i -> measuring surface and bulk contaminations of materials @ the sub-ppt level.

Conclusion:

Request human ressources (postdoctoral position) to develop LA-ICPMS quantitative protocols for several materials with experts at IPREM

Concentration vs Activity



Frédéric Perrot (LP2i Bordeaux) Gen Meet Oct 2022

- ✓ Mass spectrometry: well-suited for long-lived isotopes to reach concentration $<10^{-12}$ g/g
- ✓ Gamma spectroscopy: well-suited for short-lived isotopes to reach activity >10 µBq/kg

- Frédéric Perrot (LP2i Bordeaux) kick-off meeting May 2021
- Christophe Pécheyran (IPREM, Université de Pau et des Pays de l'Adour) Gen Meet Nov 2021
- Frédéric Perrot (LP2i Bordeaux) Gen Meet Oct 2022

Radon (Invited convener Luca Terray)

- an important background source in astroparticle physics experiments the ($0\nu\beta\beta$, DM, ...)
- a probe in Earth science and Environment (atmospheric sciences, hydrogeology, volcanology, seismology, karstology, planetology, oceanography, etc...)
- a source of health risk (lung cancer,...)
- ...

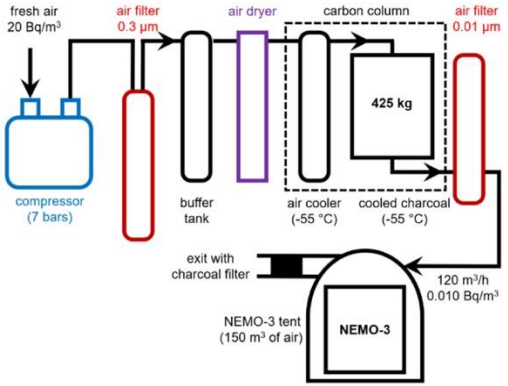
Conclusion:

- **Strong support of GDRDUPhy for a Radon platform @IN2P3**
- **Organisation of a workshop in May 2025 in Marseille on the radon topic within different communities**

- Hardy Simgen (Max Planck Institute Heidelberg) Rn Bkd in astroparticle physics experiments Gen Meeting Aussois June 2023
- Guillaume Bertrand (CEA Saclay) Metal Organic Framework for radioactive gas detection. RT Nov 14th 2023
- Luca Terray (LP Clermont) The radon in Earth and Environment Sciences in France Gen Meet Nov 2021
- Jose Busto (CPPM Marseille) Radon capture on Microporous Materials Gen Meet Nov 2021

[Characterization and long-term performance of the Radon Trapping Facility operating at the Modane Underground Laboratory R Hodák et al]

(a)



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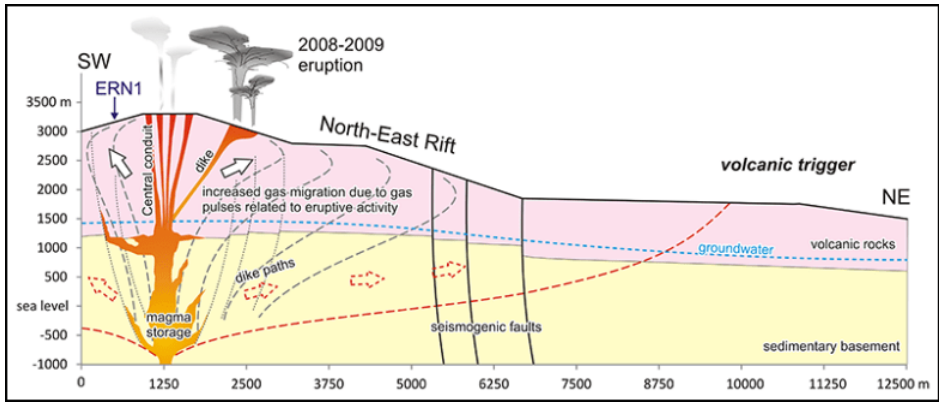


[Radon Tells Unexpected Tales of Mount Etna's Unrest , by S. Falsaperla, M. Neri, G. Di Grazia, H. Langer and S. Spampinato 22 March 2018]

Gamma spectroscopy: HPGe spectrometers

- HPGe detectors improved technology for high-resolution gamma-ray *spectroscopy*
- Sample préparation easy to handle
- Non destructuve
- Sensitivities down to ~10 μBq/kg U,Th
- …

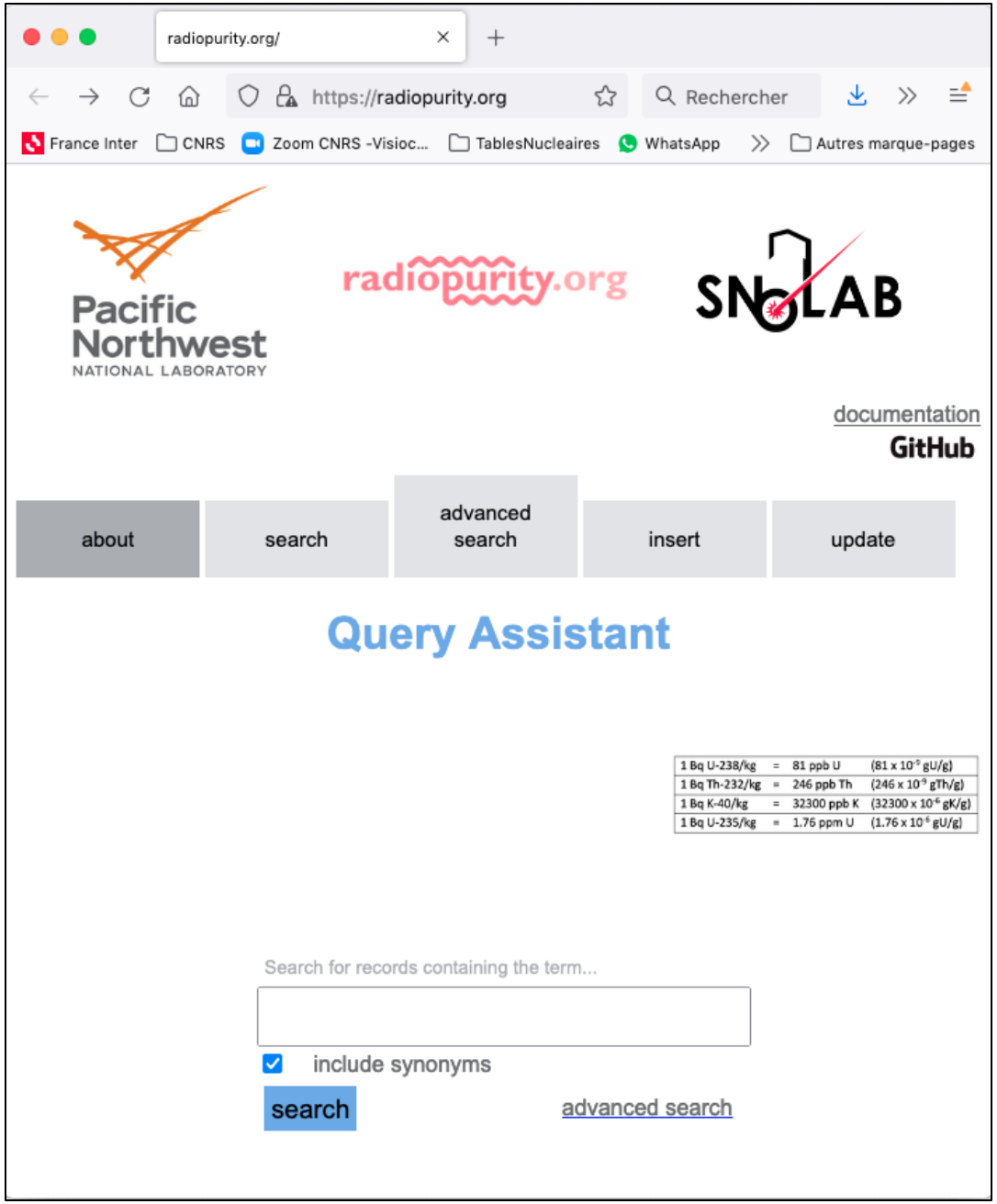
Conclusions:

Strengthen exchanges between underground laboratories and set up protocols for intercalibration of geranium detectors

- Pia Loaiza Screening activities with HPGe Kick-off meeting may 2021
- Anne De Vismes Ott (IRSN/LMRE) HPGe for environment Gen Meet Nov 2021
- Silvia Scorza (SNOLAB) - March 17th 2022 Seminar: Material screening and assay program for underground science @ SNOLAB
- WP2 Community Survey for Screening - RT @ 2023 General Meeting
- Matias Laubenstein HPGe @ INFN-LNGS (Gran Sasso) Italy, RT Sept 20th 2024
- Carlos Pena Garay HPGe @ LSC (Canfranc Spain) RT Sept 20th 2024

Radiopurity database @ SNOLAB

- The *radiopurity.org* database hosted@SNOLAB has *been* upgraded and is operational
- A WP2 seminar will be organized
- Contact person S.Scorza (LPSC)



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+ Silvia Scorza (DR, January 2023)

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General remarks:

Although the topics of low radioactivity and radioactive mitigation are crucial for the success of rare event search experiments, very few collaborators engage in these activities as they are perceived as too technical.

- Very low attendance to the round tables (~<13 attendees included invited speakers and conveners !)
- Very few new faces
- The average age of the public is high

Recommendations:

- **Nominate a low radioactivity correspondent for every experiment**
- **Raise awareness among young people about the problem of low radioactivity within each collaboration**

Within the collaborations, it is the responsibility of senior members to do educational work and encourage young people to attend and participate in WP2 round tables.

WP2 future activities next 4 years:

- Engaging the community (see survey « WP2 Survey for Screening Round Table »)
- Continue the round table activities: radon, underground labs, HPGe spectrometers,…
- Start round tables on new topics: material providers, cleanning procedure,…
- Organize workshops or schools devoted to specific low-background topics
- **Suggestions from the community ??**

Thank You