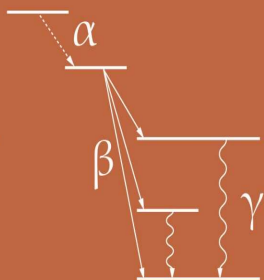


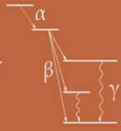
Low
Radioactivity
Techniques



The LRT Workshop Series

A look back in history

Richard Ford
SNOLAB Director of Operations
23-Sept-2026
The Guildhall – York, UK



LRT2004

LRT2004.snolab.ca

Conference organizing committee

Mark Chen (co-chair) (Queen's University)
Richard Ford (co-chair) (SNOLAB)
Doug Hallman (co-chair) (Laurentian University)
Fraser Duncan (SNOLAB)
Jacques Farine (Laurentian University)
Arthur McDonald (Queen's University)
Tony Noble (Queen's University)
David Sinclair (Carleton University)
Clarence Virtue (Laurentian University)

International science advisory committee

B. Cleveland (Sudbury Neutrino Observatory)
J. Collar (University of Chicago)
P. Cushman (University of Minnesota)
V. Gavrin (Moscow University)
G. Heusser (Max Planck Institute, Heidelberg)
T. Kishimoto (Osaka University)
A. McDonald (Queen's University)
S. Schoenert (Max Planck Institute, Heidelberg)
D. Sinclair (Carleton University)
N. Spooner (University of Sheffield)
T. Shutt (Princeton University)
A. Suzuki (Tohoku University)
Y. Suzuki (ICRR, Tokyo)

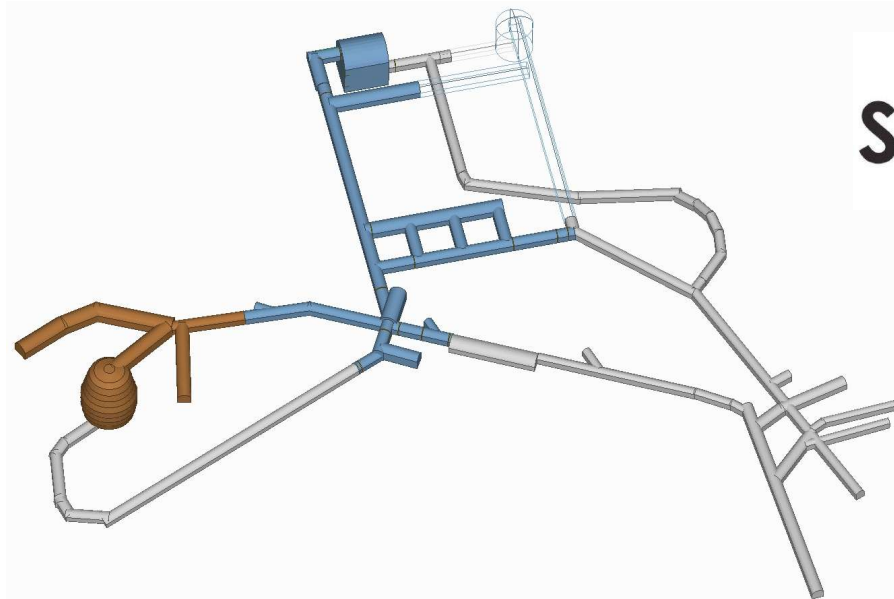
The LRT (Low Background Techniques) workshop was proposed by Art McDonald and David Sinclair as the Sudbury Neutrino Observatory (SNO) was being decommissioned, and excavation had just started for the expansion to create SNOLAB.



December 12th-14th,
Laurentian University

LRT 2004 Website

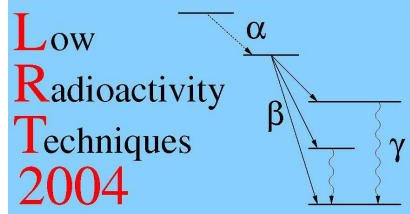
[General](#)
[Motivation and Topics](#)
[Registration](#)
[Program and slides](#)
[Final workshop agenda](#)
[Participants](#)
[Workshop proceedings](#)
[Committees](#)
[Accommodations & Travel](#)
[Contact](#)
[Regional & Tourist](#)





LRT2004

LRT2004 was held at
Laurentian University,
Sudbury,
12 – 14 December 2004.



The next generation of proposed experiments will demand ultra-low detector backgrounds. This will require novel techniques in the development, construction, operation and analysis of these experiments. Such issues include the low background radioactivity assay and purification of detector components and materials, and the development of high purity noble gases.



- Survey of existing and planned low background facilities and resources.
- Low background detectors, shielding techniques and radiopurity requirements.
- New scintillators (optical properties, loading, and purification).
- Radon emanation and diffusion studies.
- Radon assay techniques.
- Radon free air, very low background noble gases (free of Rn, Ar and Kr).
- Radium assay techniques.
- Wash-off, leaching, surface contamination, screening and cleanliness studies.
- Water and scintillator purification studies.
- Low-level gamma-ray spectrometry.
- Neutron activation analysis techniques.
- ICPMS, atomic absorption and x-ray fluorescence spectroscopy.
- Studies of cosmogenic activation of materials.
- Software, simulations, electronics, vetoes and in-situ assay techniques.
- Simulation of background radiation, cosmic rays, and neutron fluxes.
- Adaptation of industrial processes and instrumentation.

Low level counting from meteorites to neutrinos:

*spectroscopy with multi coincidence NaI systems, Ge detectors
proportional counters and rare gas mass spectrometry*

Gerd Heusser

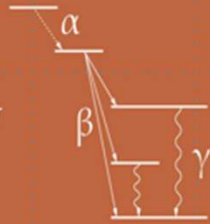
Max-Planck-Institut für Kernphysik, Heidelberg, Germany
(gerd.heusser@mpi-hd.mpg.de)

Outline:

Experience in low level counting
collected over almost 40 years
or the chronology of a nerd

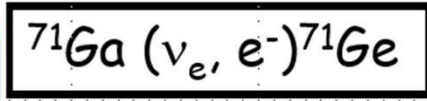
Thanks to the colleagues of the collaborations:
HEIDELBERG MOSCOW, GALLEX/GNO, BOREXINO, GERDA

Low
Radioactivity
Techniques

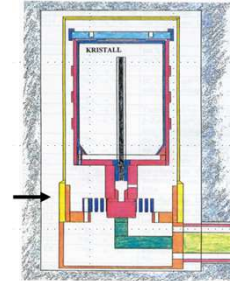


Gerd Heusser
MPI Heidelberg

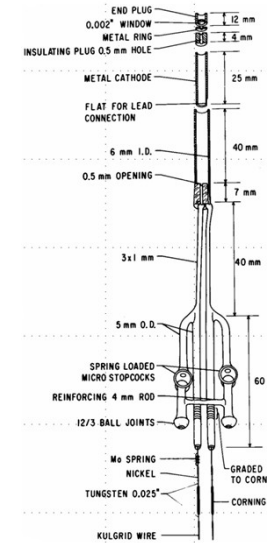
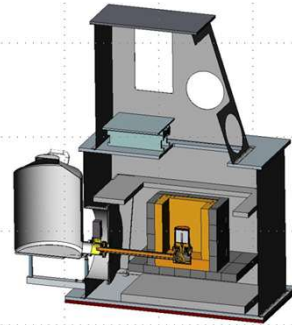
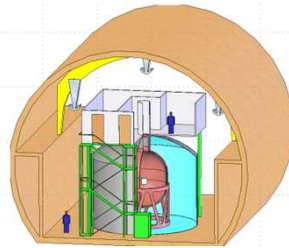
Keynote talk at LRT2004 to celebrate Gerd's retirement from MPI and his 40 years of experience in low background counting.



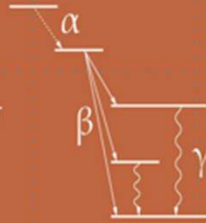
$$T_{1/2} = 11.4 \text{ d}$$



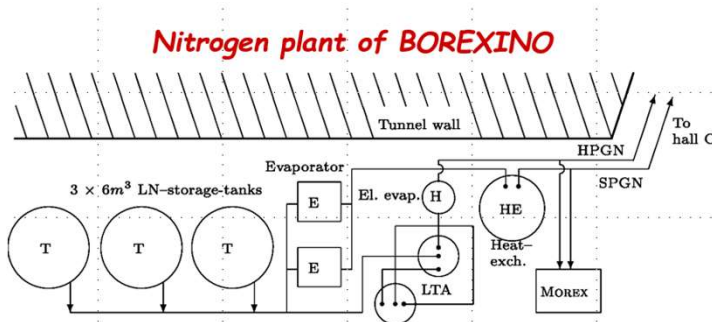
- Counting meteorites with Ge spectrometry
- Miniature proportional counters (Rn, Ar, Kr, GeH₄)
- Radon emanation, permeability, concentration, counting
- Heidelberg-Moscow ($^{76}\text{Ge}-0\nu\beta\beta$)
- Naked Ge crystals in N₂/Ar -> GERDA
- GeMPI at LNGS



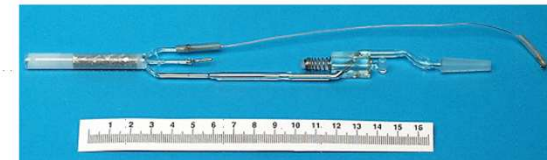
Low Radioactivity Techniques



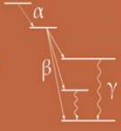
- Borexino (MOREX, HP-N2, LAK-N2)



^{222}Rn (^{226}Ra) assay with proportional counting



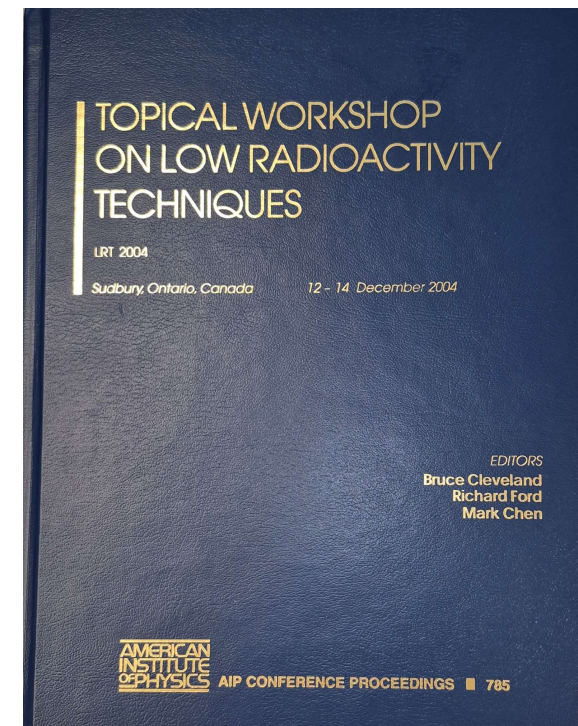
Ray Davis Jr.
type
miniature
counter



LRT2004 Highlights

- Overviews of low background facilities
(Miramonti, Nakahata, Cushman, Hime)
- Low background techniques
(Heusser, Litherland (AMS), Pillalamarri (NNA))
- Materials screening
(Inoue, Bauer, Gaitskell, Shutt)
- Detectors and components
(Danevich, Kim, Loaiza, Kishimoto, Irastorza)
- Radon reduced air and noble gases
(Simgen, Takeuchi, Orzel, Zuzel, Koga)
- Clean fabrication techniques
(Pocar, Hallman, Aalseth, Pirro, Leung)
- Purification systems
(Kishimoto, Farine, Yeh)
- Calculation/simulations of backgrounds
(Formaggio, Mitsui, Kudryavtsev, Moriyama, Pocar)

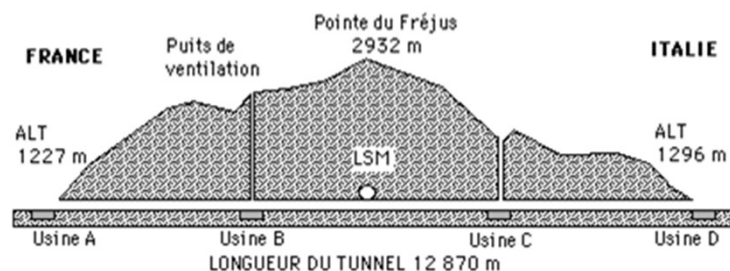
- ❑ Round table discussion about resource sharing
- ❑ Preliminary SAC and decision for LRT2006

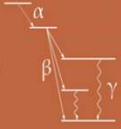




LRT2006

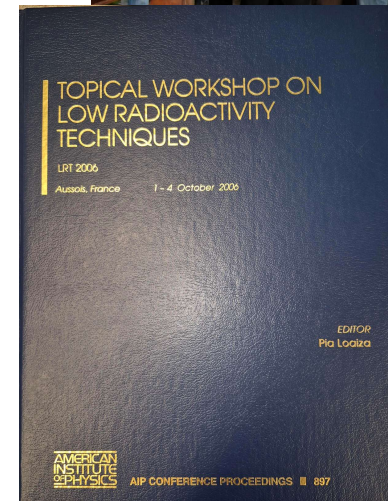
LRT2006 was held 1-6 October 2006 at the beautiful mountain ski resort Centre Paul Langevin in Aussois, France. The workshop was organized by Pia Loaiza and colleagues at nearby Laboratoire Souterrain de Modane (LSM) in the Frejus road tunnel. The workshop included hiking in the mountains and a visit to LSM, which was planning an expansion of the underground lab.

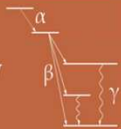




LRT2006 Highlights

- NEMO results and SuperNEMO
- Electroforming at Canfranc
- Ultrapure gases – H. Simgen and G. Zuzel
- ^{222}Rn daughters on Cu – M. Wojeik, G. Zuzel
- Rn assay – H. Simgen
- XIA, Betacage, ...
- ICP-MS for U, Th in materials – E. Hoppe
- Vac-swing Rn reduced air plant – R. Schnee
- Low background gamma spectroscopy for determining origin of marine salts and prunes (and vintage wine, paintings, ...)
- Updates NEXT-100, DEAP3600, XMASS, GERDA, ...





LRT2010 - Topical Workshop in Low Radioactivity Techniques

August 28th-29th, 2010
SNOLAB, Sudbury, Canada

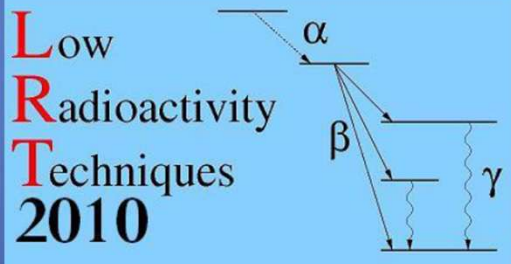
This workshop examines topics in low radioactivity materials and techniques, which is probably the most fundamental part of rare event physics detectors, such as for solar neutrinos, dark matter, double-beta decay, and long half-life phenomena.

Conference organizing committee

Richard Ford (committee chair)
Pat Brouse
Fraser Duncan
Doug Hallman
Chris Jellings
Samantha Kuula
Christine Kraus
Ian Lawson
Nigel Smith (SNOLAB director)

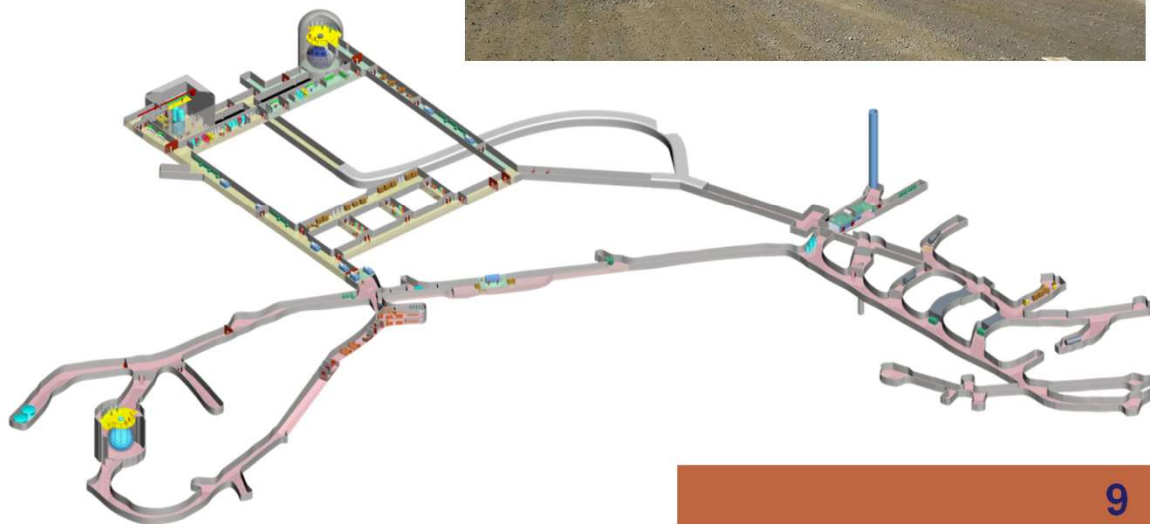
International science advisory committee

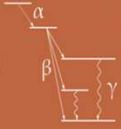
Mark Chen (Queen's U.)
Pisca Cushman (U. Minnesota)
Steve Elliot (Los Alamos)
Jacques Famine (Laurentian U.)
Aldo Ianni (INFN Gran Sasso)
Vitaly Kudryavtsev (U. Sheffield)
Pia Loatza (LSM CNRS/CEA)
Art McDonald (Queen's U.)
Lino Miramonti (U. Milano)
Masayuki Nakahata (ICRR U. Tokyo)
Tony Noble (Queen's U.)
Andreas Piepke (U. Alabama)
Hardy Simon (MPIK Heidelberg)
David Sinclair (Carleton U.)



The workshop will be held at SNOLAB, Canada's deep underground astroparticle physics laboratory, at the Vale Inco Creighton mine near Sudbury, Ontario. It is a two day workshop held over the weekend August 28-29, 2010. There will be underground laboratory tours arranged for both the Friday and the Monday, so if possible participants should plan to include at least one of August 27th or 29th in their travel plans

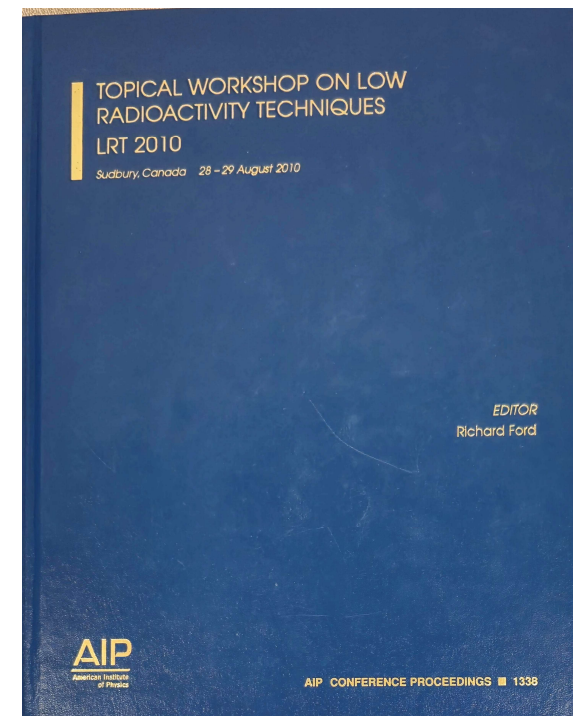
<http://www.snolab.ca/lrt2010/>





LRT2010 Highlights

- DUSEL design proposal – Murdock Gilchriese
- FAARM concept design – Prisca Cushman
- Low background labs at SNOLAB and Sanford lab
- XIA – Jodi Cooley
- Betacage – Zeesh Ahmed
- Radon reduction in UHP-Cu – E. Hoppe
- CUORE crystals – I. Dafinei
- Reduced Rn air plant and cleanroom – A. Hallin
- Liquid scintillator purifications – Yoshida, Hans, Keefer, Ford
- LRT and community coordination round table discussion



Low
Radioactivity
Techniques
2013



UNIVERSITÀ
DEGLI STUDI
DI MILANO



IV Workshop in LOW RADIOACTIVITY TECHNIQUES

Laboratori Nazionali del Gran Sasso
Assergi (AQ), Italy • April, 10th-12th 2013

This workshop examines topics in low radioactivity materials and techniques, such as solar neutrinos, dark matter, double beta decay and long half-life phenomena. This conference is intended to be wide in scope to include all aspects of the development of low background detectors and techniques.

INTERNATIONAL SCIENCE ADVISORY COMMITTEE

Ugo Miramonti
Milano University
(Coordinatore Chair)
Mark Clark
Queen's University
Priscilla Cushman
Minnesota University
Matthias Lamberstein
INFN-NGS
Steve Elliott
LANL
Jacques Farine
Laurentian University
Richard Ford
SNOLAB

Aldo Ianni
INFN-NGS
Vitaly Kudiyatov
Sheffield University
Pia Leszka
LSM ONS/CSA
Giovanna Moroni
Milano University
Art McDonald
Queen's University
Masaruhi Nakahata
ICRR Tokyo
Tony Noble
Queen's University

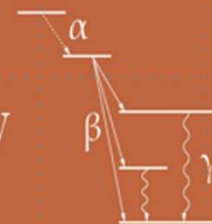
CONFERENCE ORGANIZING COMMITTEE

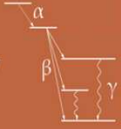
Luciano Pandola
INFN-NGS
(Coordinatore Chair)
Carlo Bacchi
INFN-NGS
Riccardo Geronzi
INFN-NGS
Aldo Ianni
INFN-NGS
Matthias Lamberstein
INFN-NGS
Ugo Miramonti
Milano University
Fausto Chiarida
INFN-NGS
(Workshop Secretary)

CONTACT
Low Radioactivity Techniques • LRT2013
INFN - Laboratori Nazionali del Gran Sasso
Research Division
S.S. 17 bis, km 18+910
67100 Assergi (L'Aquila), Italy
Tel: +39 0862 437 437
Fax: +39 0862 437 570
E-mail: lrt2013@lngs.infn.it
Site: <http://lrt2013.lngs.infn.it>

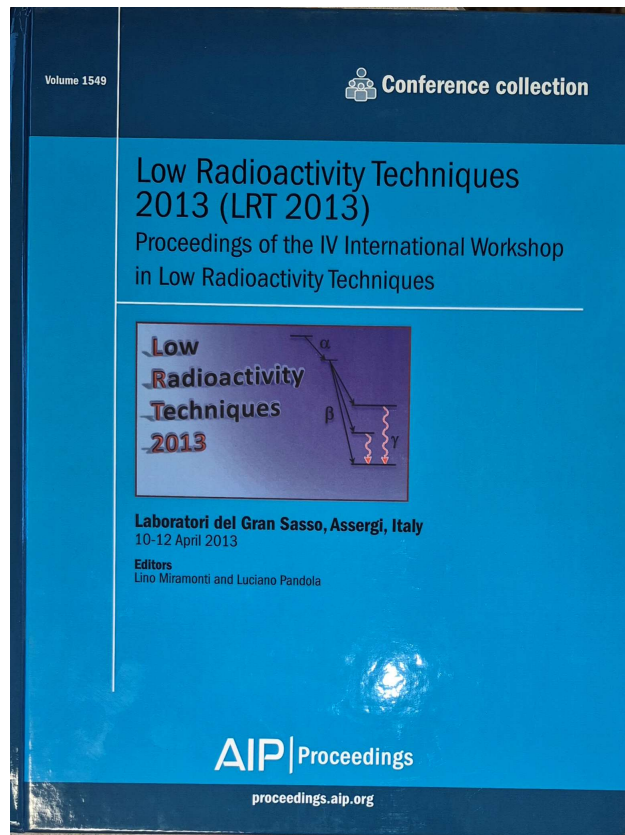
LRT2013

Low
Radioactivity
Techniques





LRT2013 Highlights



AARM and FAARM update – Prisca Cushman

Rollout of radioactivity.org – James Loach, Jodi Cooley

SNOLAB LBL – Ian Lawson

LBNL Low background lab -

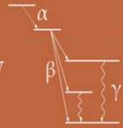
GIOVE – New shallow HPGe ~100 – G. Heusser

Overview of Cosmogenic Activation – S. Cebrian

Ultra pure Ti – Nisi, Suvorov, M. di Vacre

Low background crystal growth

Many updates: COUPP, Edelweiss, SuperNEMO, ANAIS, DEAP3600



LRT2015

Low
Radioactivity
Techniques
2015

WORKSHOP V

The LRT workshop examines topics in low radioactivity materials and techniques, a fundamental aspect of rare event searches, including dark matter, solar neutrinos, double-beta decay, and long half-life phenomena.

This is the fifth workshop in the LRT series focusing on all aspects of the development of low background detectors and techniques.



- Facilities overviews
- Trace assays in metals – Eric Hoppe and Isaac Arnquist
- Betacage (surface) – Richard Schnee
- BiPo-3 – Sarazin
- AARM / radiopurity.org – Prisca Cushman, Jodi Cooley
- Review of Rn progeny – Frank Calaprice
- LZ backgrounds – V. Kudryavtsev
- Purification systems – several talks on water and scintillator
- Background models
- Results GERDA, CANDLES, ...

March 18-20, 2015
University of Washington Campus | Seattle, WA USA

CO-HOSTED BY
Pacific Northwest National Laboratory
and University of Washington

Local Organizing Committee

John Orrell (PNNL), Conference Chair
Jason Detwiler (UW), Science Organizing Chair
Allen Seifert (PNNL), Local Organizing Chair
Hamish Robertson (UW)
Bob Shupe (UW)
Nikolai Tolich (UW)
Blake Wright (PNNL)

International Science Organizing Committee

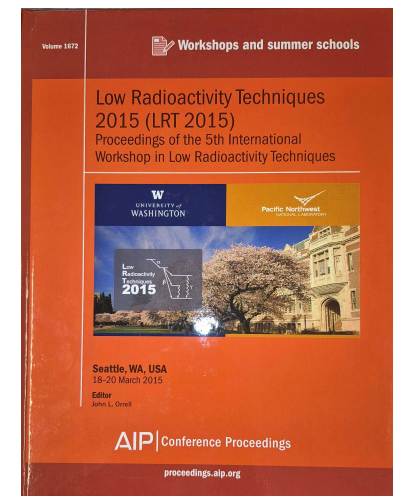
Frank Avignone (USC)
Mark Chen (Queen's U)
Prisca Cushman (UMN)
Richard Ford (SNOLAB)
Xiangdong Ji (SJTU, UMD, CJPL)
Eric Hoppe (PNNL)
Vitaly Kudryavtsev (U Sheffield)
Matthias Laubenstein (LNGS)
Kevin Lesko (UCB, LBNL, SURF)
Pia Loaiza (LSM)
Art McDonald (Queen's U, SNOLAB)
Lino Miramonti (Milan U, INFN)
Shigetaka Moriyama (Tokyo U, IPMU, Kamioka)
Luciano Pandola (INFN, LNGS and LNS)
Alan Poon (LBNL)
Henry Wong (Academia Sinica)

Abstract Submission and Registration Opens
November 1, 2014

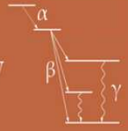
Abstract Submission Closes
January 16, 2015

Registration Closes
March 3, 2015

lrt2015.npl.washington.edu LRT2015@pnnl.gov







LRT2017 Highlights

Trip to Yangyang (Y2L) underground lab.

Yangyang(Y2L) Underground Laboratory

(Upper Dam)

Korea Hydro & Nuclear Power Co.
Yangyang Pumped Storage Power Plant

1000m

(Power Plant)

700m

(Lower Dam)

KIMS (Dark Matter Search)
AMoRE (Double Beta Decay Experiment)

양양양수발전소

Minimum depth : 700 m / Access to the lab by car (~2km)

Volume 1921

Workshops and summer schools

Low Radioactivity Techniques
2017 (LRT 2017)
Proceedings of the 6th International
Workshop on Low Radioactivity Techniques

2017
Low
Radioactivity
Techniques

Center for
Underground Physics

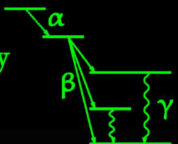
EWHA WOMANS UNIVERSITY

Seoul, Korea
23-27 May 2017
Editor
Douglas S. Leonard

AIP | Conference Proceedings

proceedings.aip.org

Low
Radioactivity
Techniques



19-23 MAY, 2019



Palacio de Congresos, Jaca (SPAIN)

Hosted by: Laboratorio Subterráneo de Canfranc

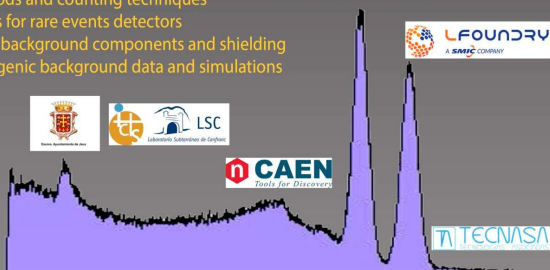
- Topics:

- Underground laboratories
- Low background methods and counting techniques
- Purification of materials for rare events detectors
- Radio-purity assay, low background components and shielding
- Radiogenic and cosmogenic background data and simulations

More info:

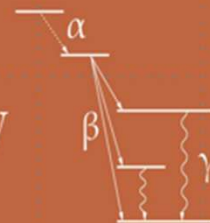


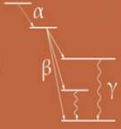
<https://indico.cern.ch/event/716552/>



LRT2019

Low
Radioactivity
Techniques

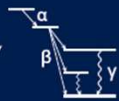




LRT2019



LOW RADIOACTIVITY TECHNIQUES



2022 WORKSHOP VIII

Abstract Submission Closes
March 31, 2022

Registration Closes
April 30, 2022

June 13-17, 2022

SOUTH DAKOTA MINES CAMPUS, RAPID CITY, SD
Co-hosted by South Dakota Mines and Sanford Underground Research Facility

The LRT workshops examine topics in low-radioactivity materials and techniques that are fundamental for quantum information science and rare-event searches, including dark matter, solar neutrinos, double-beta decay, long half-life phenomena and nuclear astrophysics.

Plus, tours of Sanford Underground Research Facility, Mount Rushmore, and the Badlands

LOCAL ORGANIZING COMMITTEE

Richard Schnee (*South Dakota Mines*), Local Organizing Committee Chair
Jaret Heise (*SURF*), Science Advisory Committee Chair
Cabot-Ann Christofferson (*South Dakota Mines*)
Markus Horn (*SURF*)

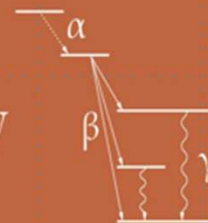
Brianna Mount (*BHSU*)
Juergen Reichenbacher (*South Dakota Mines*)
Doug Tiedt (*SURF*)
Jingbo Wang (*South Dakota Mines*)

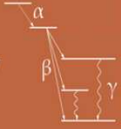


LEARN MORE AT
indico.sanfordlab.org/e/LRT2022



Low Radioactivity Techniques





LRT2022 Highlights

- Overviews of global facilities
- Additive manufacturing – D. Orlandi
- Radioactivity and Quantum science – J. Formaggio, J. Hall, XinRan Li, G. D'Imperio
- Purification and growth of crystals – cosine-200, Amore
- Stawell Underground Lab (SUPL) – Lindsey Bignell
- New updates and features radioactivity.org – S. Scorza
- Many experiments low background updates
- Background models and simulation updates



LOW RADIOACTIVITY TECHNIQUES



2024 WORKSHOP IX

lrt2024.fais.uj.edu.pl

Abstract Submission Closes
August 18, 2024

Registration Closes
September 16, 2024

The LRT workshops examine topics in low-radioactivity materials and techniques that are fundamental for quantum information science and rare-event searches, including dark matter, solar neutrinos, double-beta decay, long half-life phenomena and nuclear astrophysics.

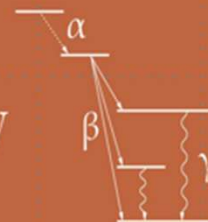
LOCAL ORGANIZING COMMITTEE

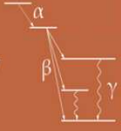
G. Zuzel (chair)
N. Frodyma
D. Gil
M. Harańczyk
A. Jany
K. Jędrzejczak
M. Misiaszek
T. Mróz
Z. Nliackar
D. Rozpędzik
K. Szczepaniec

October 1–4, 2024
Jagiellonian University, Kraków, Poland



Low Radioactivity Techniques

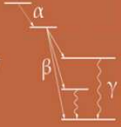




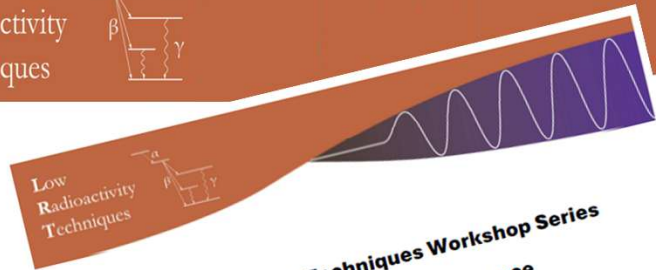
LRT2024 Highlights

- Keynote talk by Frank Avignone – History and methods in HP crystals
- Low background for Quantum devices – Laura Cardani, Ben Loer
- JUNO scintillator purification plants – Cecilia Landini
- Update on radiopurity.org and background explorer model tools – B. Loer
- Radon adsorbents – IRENE project – J. Busto
- Cu electroforming – Canfranc (S. Sanchez), Birmingham/PNNL alloys (Spathara)
- Gd-PMMA studies for neutron tagging in acrylic cryostats – Yi Wang
- Background studies/models – Kudryavtsev, Santorelli





LRT ToR



Low Radioactivity Techniques Workshop Series Committees Terms of Reference

Revision: 00

Date: 2024-10-08

The Low Radioactivity Techniques (LRT) workshop series examines topics in low-radioactivity materials and techniques that are fundamental for quantum information science and devices, and rare-event searches, including dark matter, solar and geoneutrinos, double-beta decay, supernovae, long half-life phenomena, and nuclear astrophysics. The expertise and knowledge base for low and ultra-low radioactivity materials and practices is generally key for the science programs at the global underground laboratories. Thus, the LRT workshop series is closely aligned with the scientific research community working and collaborating at underground laboratories around the globe, and the workshops serve also to bring this community together.

The workshops typically feature updates from the underground laboratories as well as the latest information regarding all aspects of low background detectors, techniques and assay programs, in addition to recent developments in the production of pure materials (eg. electroformed copper), high-purity crystals growth, advanced machining and 3D printing using ultra-pure materials, quantum devices, and quantum computing.

The goal of this workshop series is to bring together experts in this field for presentations and discussion broadly covering topics related to low radioactivity techniques. The intention is to foster and continue the collaboration and resource sharing required for new generations of detectors to be developed at underground facilities. The workshop is intended to be held every two years, from the spring through late autumn, and at various global venues that represent the community.

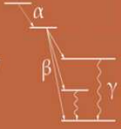
The LRT workshop series is created and maintained within the functions of the following committees: the Steering Committee (SC) provides the long-term stewardship of the workshop series and selects the venues, the Local Organising Committee (LOC) organises and executes each workshop event, and the Science Advisory Committee (SAC) advises on the science and talk agendas for each workshop event and produces the proceedings.

www.lowradioactivity.org

Page 1 of 14

The LRT workshop series is maintained on the principle that the venue host organizes all aspects of the workshop. The baton passes from one host to the next, on a cycle of every two years.

A Steering Committee sustains the workshop series by running a process to seek and select the next venue host. The steering committee provides stewardship and advise to ensure the format and organization of each workshop is consistent and meets the needs of the community.



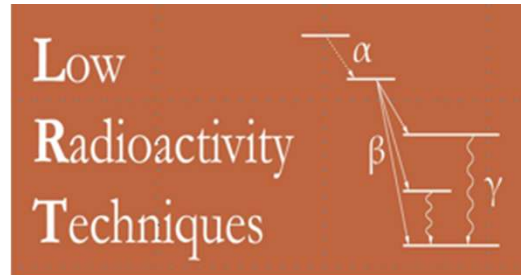
LRT Committees

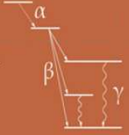
The LRT workshop series is functionally organized through the following committees:

- 1) The local organizing committee (LOC) – has ultimate responsibility for the workshop
 - Formed and chaired by each venue host
 - Venue, budget, caterings, hotels, transport, brand and website, tours, volunteers, ...
 - Works with the SAC on agenda logistics
- 2) The science advisory committee (SAC)
 - Formed and chaired by each venue host (now Paul Scovell)
 - Includes all SC, and adds new local members, and members at large
 - Fixes dates, and organizes the workshop agenda, solicits speakers, ...
 - Helps the LOC publish the proceedings
- 3) The steering committee (SC)
 - Chaired by nominated and elected member (now Pia Loaiza)
 - SAC chair from each venue host joins the SC, provides continued experience
 - Selects next host, stewardship, serves on the SAC, helps with proceedings, ...

The Next LRT Workshop

- The SC will send out a solicitation memo later this year
- Proposals to host the next LRT will be reviewed by the SC
- Consider hosting LRT!! Many benefits!





End – Questions?