Motivation and Topics

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.

This conference is intended to be wide in scope to include all aspects of the development of low background detectors and techniques. Topics include, but are not limited to:

- 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 and cosmic ray backgrounds and neutron fluxes.
- Adaptation of industrial processes and instrumentation.

The entire field of deep underground and rare event physics is becoming a dominant area of global research, with dark matter in a very intriguing phase, the neutrino mass within the range of double beta decay experiments, and precision solar neutrino measurements becoming possible. More than ever, the next generation of rare event detectors needs advanced materials and techniques in low radioactivity.

Meanwhile, around the world countries are investing in new and expanded underground facilities, and new experiments are being funded and constructed.

In Canada, the new SNOLAB international underground laboratory has now completed the expansion and civil outfitting, with an additional 3,700 m^2 of clean room space, and recently celebrated their Grand Opening. The first suite of experiments are in advanced stage of construction (COUPP-60, DEAP-3600, MiniCLEAN, SNO+, SuperCDMS) while several are already in operation (COUPP-4, DEAP-I, HALO, PICASSO-III). The main cryopit cavern is currently unallocated and is ready for the best next-generation large scale detector to be funded.

In the United States, the Homestake Mine in South Dakota is home to the new Sanford Underground Research Facility (SURF) which hosts Majorana and LUX. The Soudan Lab is the target for long baseline neutrinos (MINOS), operates two dark matter experiments, and gamma screeners. Two other underground labs, WIPP (New Mexico) and KURF (Virginia), continue to provide space for experiments, screening and R&D.

In Europe, Gran Sasso Lab (LNGS) is the largest underground facility with unique features in terms of experimental space and access possibilities. The scientific programs of the lab are supported by low background detection facilities, with a large underground HPGe installation, a high sensitivity ICPMS facility, and supporting staff and labs.
After the conclusion of the first generation of successful experiments (such as GALLEX), a second generation of large detectors are operating in different neutrino related searches. Borexino, for solar neutrinos, OPERA, for neutrino beam tau appearance, LVD, for supernova neutrinos, and ICARUS, a liquid argon prototype for next generation neutrino experiments, are currently developing their physics programs. Neutrinoless double beta decay detectors are starting their new phase as well, with the operating GERDA phase I that will scrutinize the ^{76}Ge claimed evidence, and with the upcoming CUORE detector that will search for the decay of ^{130}Te. In Dark Matter search, LNGS is continuing its renowned tradition with the DAMA/LIBRA project, with new cryogenic liquid based detectors, such as XENON and DarkSide, and with the CRESST bolometric detector. In parallel a nuclear astrophysics program is carried on with the LUNA facility.

In the Canfranc lab in Spain, after the realization of two new halls, the installation of several experiments on Dark Matter (Anais, ArDM, Rosebud) and Double Beta Decay (NEXT) is started.

The Modane lab in France (LSM) is expected to be expanded to five times the current volume during the Frejus second tunnel construction, with the EURECA dark matter experiment and the SuperNEMO double-beta decay experiment being prime candidates for running in the new lab.

In Asia the large facility at Kamioka has expanded again with new halls which will accommodate XMASS and CANDLES experiments, and the KamLAND detector is preparing for the double beta decay phase of the experiment. The new Chinese CJPL lab is under construction with a low background facility and the first phase of CDEX to be ready in 2012. Meanwhile Korea is expanding the Yangyang underground lab with a new hall for the TEXONO detector.

Dark Matter direct investigations are carried out in the underground laboratories all over the world and, in particular, since decades in the Gran Sasso Laboratory. Both model independent and model dependent strategies with various target materials are exploited in the field, in a continuous effort for the improvement of related low background techniques. Detectors features, experimental and theoretical uncertainties, and their implications in the interpretation and comparison of results emerge as a fundamental aspect.

Recent experimental proof of neutrino mass and flavour oscillations continues to enrich and expand the field of neutrino astrophysics. The next steps in neutrino research seek to fix the absolute mass scale, measure the mixing parameters and CP-violation, determine if neutrinos are Majorana or Dirac particles, and to measure the flux of lower energy neutrinos from the primary reaction processes in the sun. The field also includes detectors for the detection of geo-neutrinos, reactor neutrinos and from possible beamed neutrino sources.

These facilities, detectors and experiments all require ultra-low detector backgrounds to reach the instrument sensitivities required. This demands 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.

The goal of this workshop series is to bring together experts in this field for presentations and discussion covering broadly the issues of low radioactivity techniques. The intention is to foster and continue the collaboration and resource sharing required for the new generation of detectors to be developed at underground facilities. Common tasks and shared resources may include:

1) Coordinated use of HPGe gamma-ray spectrometers, other gamma-ray and neutron detectors by different groups/collaborations;
2) Databases of material purity;
3) Joint purchasing of radio-pure materials;
4) Monte Carlo simulation tools;
5) Radon emanation measurements;
6) Purification processes etc.

The last (third) LRT workshop was in 2010 at Laurentian University in Sudbury as it was hosted in the first edition in 2004. The second LRT workshop was in in 2006 at Aussois, France hosted by Modane underground laboratory. It is intended that the workshop be held approximately every 2-3 years. The major underground labs around the world are now planning and constructing experiments, and are strongly in need of the LRT principles examined in this workshop series.